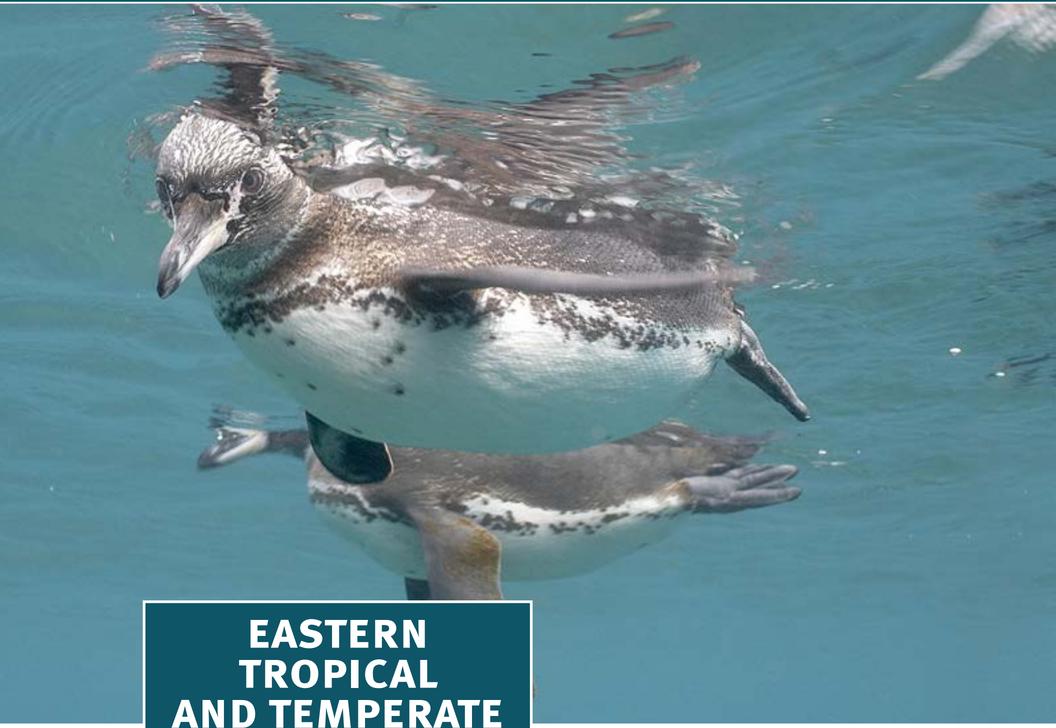
5

Ecologically or Biologically Significant Marine Areas (EBSAs)

Special places in the world's oceans



EASTERN TROPICAL AND TEMPERATE PACIFIC OCEAN

Areas described as meeting the EBSA criteria at the CBD Eastern Tropical and Temperate Pacific Regional Workshop, in Galapagos, Ecuador, 28 to 31 August 2012

UN environment programme

Convention on Biological Diversity

Japan Biodiversity Fund

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FOREWORD

Since 2011, the Secretariat of the Convention on Biological Diversity has embarked on an incredible journey around the world. Working in close collaboration with governments, United Nations agencies, international and regional organizations, and scientists, we have been on a quest to find and describe the "special places" of the ocean and seas—places that are crucial to the healthy functioning of the global marine ecosystem. Known as "ecologically or biologically significant marine areas", or EBSAs, they are defined by a set of seven criteria that were adopted at the ninth meeting of the Conference of the Parties to the Convention, in 2008.

Over the years, our collective work on EBSAs has helped to identify the areas that are most in need of enhanced management and further research. It has significantly advanced our understanding of these "special places" in the ocean and has provided a sound basis for actions by governments and competent authorities on where to focus their efforts to better conserve and sustainably use marine and coastal biodiversity.

In addition to describing these special places, 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 coalescing various sources of information as well as identifying knowledge gaps, yielding important insights about the state of our knowledge of marine ecosystems and biodiversity.

The fruits of our efforts thus far can be seen on the EBSA website (www.cbd.int/ebsa). Yet, EBSAs are more than just shapes on a map; they are reflections of living, breathing ecosystems, the loss and degradation of which would 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.

While the name of this region (Eastern Tropical and Temperate Pacific) is not at the tip of anyone's tongue, it is home to one of the most famous marine reserves in the world, the Galápagos Marine Reserve, which has been characterized as a living laboratory, due to the astounding level of endemism of its marine species. But it doesn't stop there. The region harbours the easternmost atoll in the Pacific Ocean, which provides habitat for the most important, diverse and healthy coral grounds in the Tropical Eastern Pacific. It is home to deep-sea hydrothermal vents that are unusually close to the coast, an area of seasonal aggregation for adult great white sharks and an area of high primary productivity that provides year-round habitat for the endangered blue whale. This area comprises the equatorial divergence, a major oceanographic feature of the Pacific Ocean, as well as highly productive upwelling systems, seamounts and guyots. It is a dynamic and turbulent region, with migratory species crossing the vast Pacific, and powerful ocean gyres and currents.

This booklet, which was produced with the kind support of the European Union, aims to paint portraits of the EBSAs described in the Eastern Tropical and Temperate Pacific region, giving tangible character to the vast amounts of scientific data made available for describing these precious ecosystems. It aims, in short texts and evocative photographs, 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 Eastern Tropical and Temperate Pacific region and their important roles in a healthy functioning planet.

Elizabeth Maruma Mrema
Acting Executive Secretary, Convention on Biological Diversity

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 and humpback whales that migrate from the Antarctic to the equator and back.

The distribution of life in the ocean, however, 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.

Much of this unique and special biodiversity is facing major threats, however, 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 order to protect and preserve marine biodiversity effectively, however, we need to know where to focus and prioritize conservation and management. We must have a good understanding of the many different types 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.

Scalloped hammerhead sharks. Photo courtesy of Simon Pierce / Galapagos Conservation Trust

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.

This booklet belongs to a series of booklets intended to capture the essence of oceanic areas that are the most ecologically or biologically significant around the world, distilling hundreds of pages of data compiled by experts into an easily accessible and informative format.

This volume, the fifth in the series, provides summaries of the areas described during the Eastern Tropical and Temperate Pacific Regional Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas, which took place in Galapagos, Ecuador, from 27 to 31 August 2012. The workshop was organized in collaboration with the Secretariat of the Permanent Commission for the South Pacific (CPPS) and hosted by the Government of Ecuador, 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. The workshop was co-chaired by Ms. Elva Escobar (Mexico) and Mr. Patricio Bernal (Global Ocean Biodiversity Initiative) and attended by experts from Chile, Colombia, Costa Rica, Ecuador, El Salvador, France, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, National Oceanic and Atmospheric Administration (NOAA)/USA, Permanent Commission for the South Pacific (CPPS) Secretariat, South Pacific Regional Fisheries Management Organization, Corredor Marino del Pacifíco Este Tropical, Global Ocean Biodiversity Initiative (GOBI), IUCN-WCPA, BirdLife International, Galapagos National Park, Instituto de Fomento Pesquero/CPPS, Pontificia Universidad Católica de Valparaíso/CPPS, Universidad Católica del Norte de Chile/CPPS, Conservation International-Ecuador and World Wildlife Fund. The full report of this workshop is available at: **www.cbd.int/doc/meetings/mar/ebsa-ettp-01/official/ebsa-ettp-01-04-en.pdf**.

To find out more about this and other work on EBSAs under the Convention on Biological Diversity, see **www.cbd.int/ebsa**.

Galapagos penguin. Photo courtesy of Bill Hale / Galapagos Conservation Trust

EASTERN TROPICAL AND TEMPERATE PACIFIC OCEAN

Few places on Earth elicit a sense of awe and wonder as does the mighty Pacific Ocean. Along its eastern extent alone, dreamy Californian sunsets, pelican convoys cruising in formation, rolling barrel waves, circling hordes of hammerhead sharks, salt-snorting marine iguanas, the legendary Galapagos Islands, belly-flopping mobula rays, frigid currents surging silently from the abyss, the swaying canopies of towering kelp forests, imposing glacier-backed fjords, breaching whales defying gravity, fearsome storms that whip up fickle cavalries of frothy white horses, and the lure of undiscovered natural wonders lurking beneath the vastness of the horizon are enough to captivate even the most contemptuous of imaginations. To single out any element of this magnificent creation as being particularly ecologically or biologically significant is a task that requires considerable restraint and discernment.

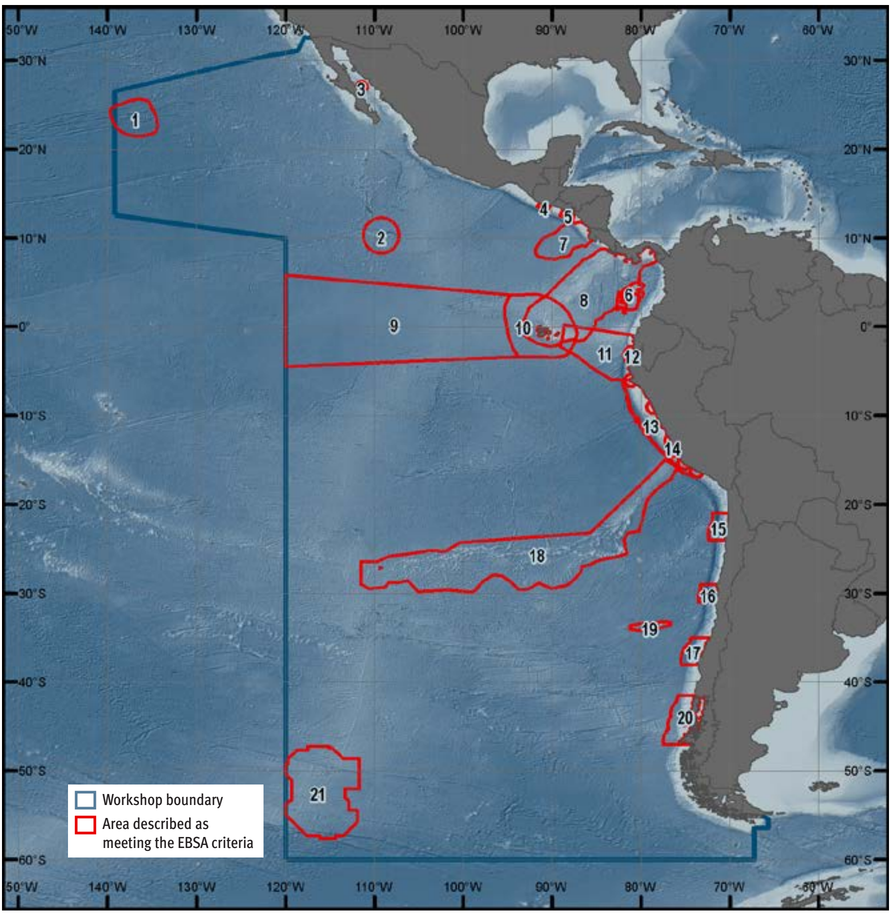
Flightless cormorant. Photo courtesy of Gordon Chambers / Galapagos Conservation Trust

There are, of course, easy pickings. The Galapagos Islands are renowned the world over as the cradle of our contemporary understanding of how species evolve and diversify. The Humboldt Current is responsible for fuelling the biological productivity that sustains fisheries that catch more fish by area than anywhere else in the world. And who could ignore the influence across the globe of the climatic and oceanographic phenomenon known as El Niño?

In addition to obvious areas like the Galapagos Islands or those under the influence of the Humboldt Current, surprising evidence for other areas came from satellite tracking data records that show where tagged oceanic wanderers congregate. Seemingly nondescript and featureless places in the middle of the ocean regularly attract certain species of sharks or birds, leaving scientists baffled and curious to understand their motives. Other notable areas included chains of active and extinct submarine volcanoes whose existence could never be guessed from the air, but which qualify as veritable oceanic oases of riotous biodiversity.

Since the El Niño phenomenon exerts such a direct influence on this region and its EBSAs, as well as its rippling effects being felt worldwide, a brief description of its causes is included here. El Niño is a climate pattern that occurs every few years around Christmas time, which is why it was named in Spanish as The [Christ] Child. When it occurs, the water in the Pacific Ocean near the equator gets hotter than usual and affects the atmosphere and weather around the world. Most of the time under normal conditions,

MAP OF WORKSHOP BOUNDARY AND AREAS MEETING EBSA CRITERIA IN THE EASTERN TROPICAL AND TEMPERATE PACIFIC OCEAN



Marine Geospatial Ecology Lab, Duke University the warmest water at the ocean surface is in the far western Pacific Ocean, pushed there by the prevailing trade winds. During El Niño events, trade winds area weakened and the warm surface water remains spread more evenly across the equatorial Pacific Ocean, affecting the jet stream high up in the atmosphere and altering weather patterns worldwide. Changes in the usual pattern of ocean temperature and weather affect ocean productivity, with knock-on effects on species on land and at sea.

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1

NORTHEAST PACIFIC WHITE SHARK OFFSHORE AGGREGATION AREA (SANTUARIO VENTILAS HIDROTERMALES DE LA CUENCA DE GUAYMAS)

Halfway between Hawaii and California is an area of ocean dubbed the "White Shark Café". Contrary to expectation, this is not a hip hangout for wave-weary surfers, but a seasonal all-you-can-eat buffet for great white sharks and other top predators. Surfers beware!

Frivolities aside, the White Shark Café—or the Northeast Pacific white shark offshore aggregation area—is a unique feature of the open ocean recognized for its ability to attract adult North Pacific great white sharks (*Carcharodon carcharias*) from coastal wintering areas in central California, Guadalupe Island in Mexico and Hawaii. The reason for their persistent and predictable gathering at this spot in the otherwise featureless ocean has remained a mystery until recently.

Great white shark, Guadalupe Island. Photo courtesy of George T. Probst

The precise location and boundary of this area is defined by the behaviour of the sharks themselves. Over the years, satellite tracking devices tagged onto sharks near the coast have yielded countless tracks of shark movements throughout their range. Every year from December onwards, these tracks converge in an area about 500 km in diameter and covering approximately 210,000 km^2, centred around latitude 23.4°N and longitude 132.7°W. The boundary of this area is defined by a contour encompassing 50 per cent of the home range of tracked sharks during the months of occupation. Average water depth here is 4,920 m. The sharks occupy the top 100 to 200 m of the ocean and regularly dive to depths of 400 m.

When in the offshore aggregation area, great white sharks exhibit daily vertical migrations, diving deep during daylight hours and rising to shallower waters during the night. This suggests that the sharks are feeding on prey that track the “deep scattering layer”—a dense blanket-cloud of small filter-feeding organisms, including fish, squid and jellyfish, themselves rising in unison at night to feed on plankton under the safe cover of darkness. It remains unclear why this area of the ocean is so rich in biomass. It is thought that a shallower-than-normal low-oxygen layer may be responsible for compressing the habitat for all pelagic organisms against the ocean surface, including the deep scattering layer, therefore making prey more easily accessible. The surface waters of the area are typical of central ocean gyres: low in nutrients and primary productivity, with slight seasonal variability.

Great white sharks have been listed for international protection under the Convention on International Trade in Endangered Species (CITES) and the International Union for Conservation of Nature (IUCN). Observed mating displays by male great white sharks suggest that the area may be important for reproduction as well as for feeding, meaning that any degradation of the area or deterrent to their gathering could compromise the continued viability of the shark’s population in the Northeast Pacific. The area is commercially fished for tuna, sailfish and swordfish, with unknown direct or indirect impacts on the sharks. Also of great concern is the potential for an alteration of the ecosystem caused by climate change, which could diffuse the unique combination of conditions that makes the area so attractive to sharks and other predators in the first place. The area is crossed regularly by ships travelling between North America, Hawaii and Asia, increasing the risk of marine pollution.

Aside from the knowledge acquired by tracking great white sharks to this remote and featureless patch of ocean, very little else is known of the area. There is anecdotal evidence of giant squid and squid-eating sperm whales (*Physeter macrocephalus*) occurring in the area, as well as migrating leatherback turtles passing through. Further dedicated surveys are necessary to inform a comprehensive assessment of its biodiversity.

2

Aerial view of Clipperton Island. Photo courtesy of Phillip Colla / Oceanlight.com

CLIPPERTON ATOLL
(ATOLÓN CLIPPERTON)

Clipperton atoll—or *Île de la Passion* (Passion Island) for the romantically inclined—is an uninhabited ring of rock and sand enclosing a freshwater lagoon more than 1,000 km off the coast of Central America. It is the only atoll in the tropical eastern Pacific Ocean, and it harbours species from both the eastern and western tropical Pacific Ocean; for this reason, it is unique in the area. It also serves as a beacon and resting spot for species making the long migration across the vast, largely empty ocean.

True to its French name, the atoll is one of the most significant breeding spots for several species of seabirds and for the white tip shark. It is primarily because of its importance for seabirds that it is considered ecologically and biologically significant.

Just 3 to 4 km wide, the Clipperton atoll has a land surface area of 2 km^2, and a combined land and lagoon surface area of 6 km^2. It is fringed by steep-sided coral reefs and forms part of a chain of seamounts running east to west along the Clipperton Fracture Zone. Despite the atoll's diminutive size, the EBSA around it extends 200 km in every direction, defined by the foraging range of the masked booby (*Sula dactylatra*), a species with up to 110,000 individuals present on the island. In addition, the island hosts 10–20,000 breeding individuals of brown booby (*Sula leucogaster*), as well as smaller numbers of great frigatebird (*Fregata minor*), red-footed booby (*Sula sula*), wedge-tailed shearwater (*Puffinus pacificus*) and four species of terns. In all, 11 seabird species are known to breed on the island, and 24 species of visiting birds have been observed. On this evidence alone, the site qualifies as an Important Bird and Biodiversity Area, a designation provided by BirdLife International.

Masked and red-footed boobies feed on large species of shoaling fish, especially flying fish, but will also take squid. Their foraging habits have been associated with marauding groups of dolphins and tunas, whose own feeding behaviour forces their prey towards the surface, where it is easily picked off by the birds. Such observations indicate that the waters surrounding Clipperton atoll are relatively productive and able to support a complex and dynamic food-web. Accordingly, a commercial tuna fishery, mainly targeting yellowfin tuna, is intense in the area and is thought to be detrimental to the foraging and breeding success of the boobies.

Life below water around the atoll has been well documented and includes a high proportion of species that are "endemic" (occurring nowhere else in the world). There are 21 coral species, 277 mollusc species, 95 crustacean species (six of which are endemic), 28 echinoderm species and 163 fish

Top: Great frigate bird. Photo courtesy of Fernando Félix
Bottom: Clipperton angelfish, endemic to Clipperton Island. Photo courtesy of Chris Grossman, diver.net

species (eight of which are endemic). There are also six species of sharks, including white tip, whale and tiger sharks, as well as manta rays, sea turtles and sea snakes. The endemic Clipperton angelfish (*Holacanthus limbaughi*) is highly prized in the reef fish aquarium trade and is currently listed as Near Threatened on the IUCN Red List of Threatened Species. Six other recorded fish species also appear on the IUCN Red List.

Surprisingly for such an isolated island, Clipperton atoll is often visited, mostly by crews of fishing boats who land to collect coconuts and lobsters. An annual recreational diving operation has also been established.

Red-footed booby. Photo courtesy of Rémi Bigonneau

3

Guadalupe fur seal. Photo courtesy of Sergio Martínez / PRIMMA

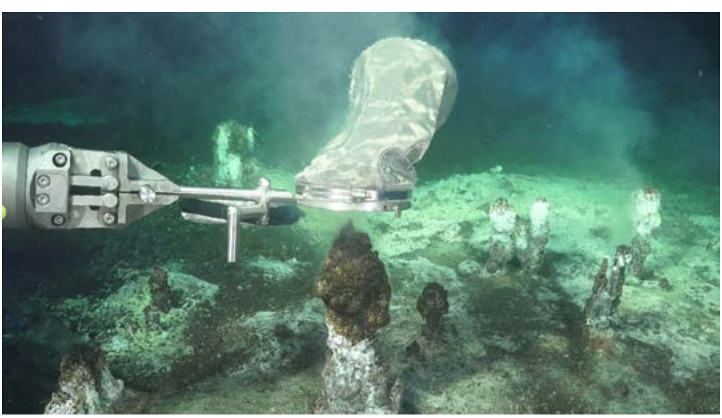
GUAYMAS BASIN HYDROTHERMAL VENTS SANCTUARY (SANTUARIO VENTILAS HIDROTERMALES DE LA CUENCA DE GUAYMAS)

Familiar lifeforms, like plants and animals, derive their energy ultimately from the Sun, either directly by photosynthesis or by eating plants, other animals or their derivatives. Plants use sunlight to convert carbon from the atmosphere and water into biomass, kick-starting the terrestrial food-chain.

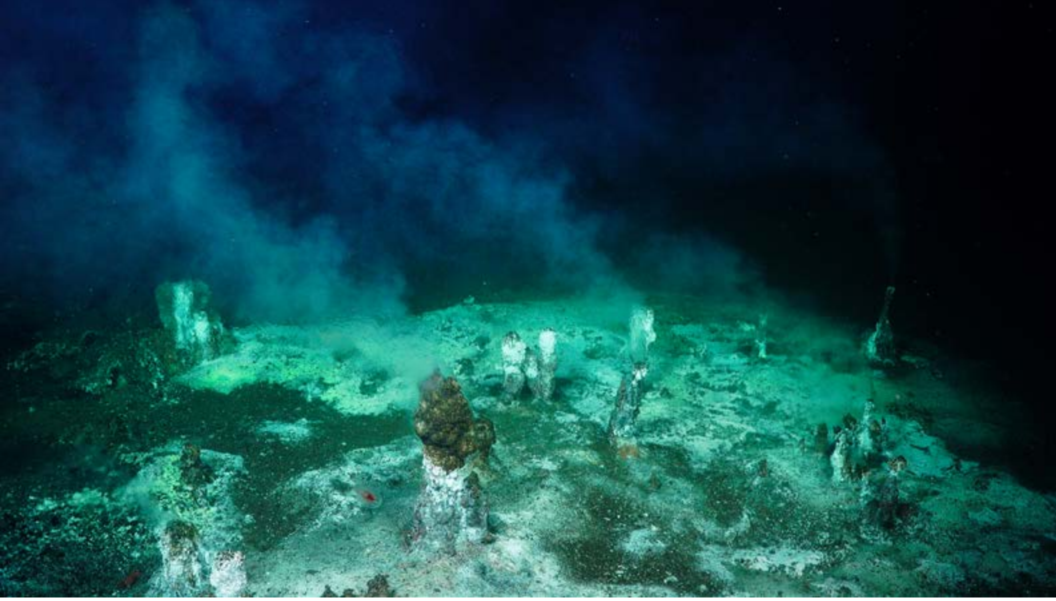
In areas of the deep ocean where no light can reach, some lifeforms harness the energy released from chemical reactions, a process known as "chemosynthesis", and the food-chain begins again. Conditions in the gloom of the Guaymas basin have combined to create a unique chemical cocktail to tantalize the most discerning chemosynthetic gourmet.

Unlike most places where chemosynthetic organisms live—the best-known examples are hydrothermal vents along mid-ocean ridges where precious little reaches the seabed—the hydrothermal vents in the Guaymas basin are awash with organic matter falling from above. The reason for this is that the basin lies at the bottom of the deep, long and narrow Gulf of California, closely surrounded on three sides by land (Mexico). The availability of sunlight and land-derived nutrients at the sea surface means that the water in the shallows is teeming with life. Over thousands of years, the constant sinking of decaying detritus has led to the formation of thick deposits of rich organic sediment. This unctuous pressurised ooze is subjected to scalding jets of mineral-laden water from the Earth's crust, resulting in a cauldron of creation for the most fantastical lifeforms.

To light-loving, air-breathing landlubbers, the microscopic lifeforms that call the Guaymas basin home could not be more different, as they represent a branch of the tree of life that has evolved in the absence of light and oxygen. In this sense, they are truly remarkable, although not necessarily unique; there are plenty more places at the bottom of the ocean around the world where similar lifeforms can thrive. What makes the Guaymas basin so special is the combination of high organic input with high temperature and pressure, which leads to the natural formation of hydrocarbons like heavy oil and natural gas (methane) on the seabed. Consequently, lifeforms have developed to feast on this rich concoction using a variety of unusual chemical processes, and it is this natural ability that has made them interesting to science and industry alike. Heat-tolerant, oil-eating



Sampling from a chimney, Guaymas Basin. Photo courtesy of Schmidt Ocean Institute



Chimneys on the seabed of the Guaymas Basin. Photo courtesy of Schmidt Ocean Institute

or gas-producing bacteria could offer countless opportunities for human engineering, commerce and development. However, it is the lure of naturally occurring and easily accessible hydrocarbons that poses the greatest threat to the future integrity of this ecosystem and its biodiversity.

Apart from scientific research expeditions and limited prospecting activities, there has been little disturbance to this deep and murky world. Above it roam deep-water fish that feed on bizarre, long-lived invertebrates, some of which host chemosynthetic lifeforms within their own bodies (in symbiosis), each partner dependent on the other for survival. Shallower still live species typical of the Gulf of California and the eastern Pacific Ocean, including the Humboldt squid, lanternfish, swordfish, manta ray, hammerhead shark, leatherback turtle, California gray whale and the endemic Guadalupe fur seal. The Gulf of California as a whole supports a productive and overexploited fishery, which has yet to target deep-sea fish stocks.

The boundary of this EBSA description is unusual in the sense that its top edge is 500 m below the sea surface and descends vertically to the sea floor, 2,500 m deep. From above, the EBSA boundary is square, covering an area of around 247 km^2 at approximately latitude 27.0°N and longitude 111.2°W. It is one of two such areas that have been designated as marine protected areas by the government of Mexico, the second located further south on the East Pacific Rise.

4

SIPACATE-CAÑÓN SAN JOSÉ MARINE ECOSYSTEM
(ECOSISTEMA MARINO SIPACATE-CAÑÓN SAN JOSÉ)

On the southern coast of Guatemala, the seabed slopes gently down from the shoreline into the Pacific Ocean for approximately 50 km before plunging to the abyss of the Central American Trench. The steep flanks of this continental shelf margin are breached by the San José canyon, the largest of its kind in the region, bringing the influence of the abyss even closer to shore.

Continental shelf canyons fast-track sediments and coastal nutrients from the shallows to the deep ocean floor; they also create an obstacle for oceanic currents that churn up nutrient-rich deep water layers and raise them towards the surface. Where nutrients meet sunlight in the ocean, life thrives.

This EBSA (area: 10,557 km^2) captures the living richness of the San José canyon and the equally rich shallow tropical coastal habitats along the southern Guatemalan shore. Mangrove-lined coasts provide shelter, food

Top: Central American spinner dolphin, Costa Rica. Photo courtesy of Bryan Long
Bottom: Humpback whale. Photo courtesy of Fernando Félix

and nursery grounds for countless seabirds, fish and sharks, while lagoons and sandy beaches offer resting and nesting sites for migrating marine turtles. Close by, oceanic icons like the humpback whale (*Megaptera novaeangliae)*, whale shark (*Rhincodon typus*), Pacific cownose ray (*Rhinoptera steindachneri*) and sail fish (*Istiophorus platypterus*) gather to feast alongside other less notorious residents, such as 24 species of seabirds, 15 species of sharks, 10 additional species of rays, eight more species of marine mammals—including the endemic Central American spinner dolphin (*Stenella longirostris centroamericana*)—and four species of marine turtles. Many of these species take advantage of the area's bounty to breed and bear their young, like the humpback whale and the scalloped hammerhead shark (*Sphyrna lewini*). Also, many of these species, including the mangrove species, are listed as endangered or vulnerable by IUCN and CITES.

Human pressure on the natural ecosystem is high in the area, as the excesses of land-based activities (pollution from industry, farming, aquaculture and urbanization) ultimately reach the sea. Commercial harvesting of turtle eggs, fishing and incidental catches of megafauna and juveniles, especially of sharks, also take their toll. Ecotourism and lucrative sports fishing, however, are slowly gaining in prominence and providing an alternative to unsustainable practices in the area.

Silvertip shark. Photo courtesy of LCDR Eric Johnson / NOAA

Hawksbill sea turtle. Photo courtesy of Tomas Kotouc

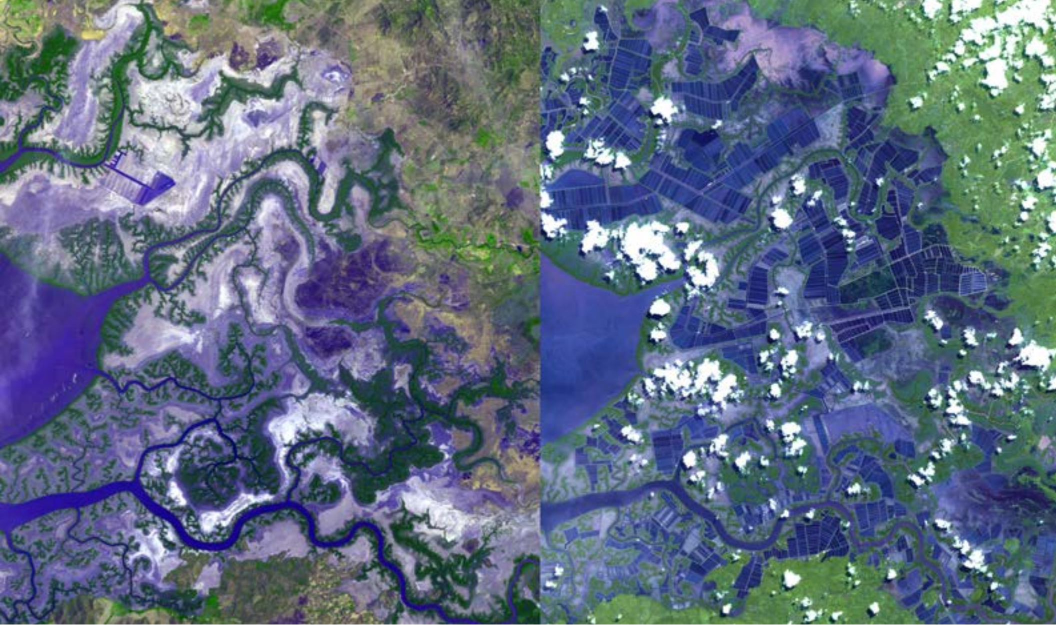
5

GULF OF FONSECA (GOLFO DE FONSECA)

Surrounded by three countries—El Salvador, Honduras and Nicaragua—and speckled with strategically important islands, the Gulf of Fonseca has been the subject of more than its fair share of human disputes over the course of history. Oblivious to this, the resident marine wildlife has enjoyed a bountiful supply of nutrients, shelter and nesting sites over countless generations, and it has flourished.

The Gulf of Fonseca EBSA extends from the shoreline to the edge of the Central American continental shelf in the Pacific Ocean, roughly 80 km offshore, and takes in the large inlet to the isthmus that bears its name. Several rivers flow into the gulf, making its shallow waters turbid with suspended sediment and variable in salinity across its extent. In a rare phenomenon during the dry season, when freshwater input from rivers is reduced, saltier seawater spreads across the surface from the ocean, trapping freshwater below it. This seasonal exposure to saltier water at the surface stunts the growth of fringing mangrove trees, creating unique miniature forests along the coast. On the seabed, this phenomenon has also led to the evolution of unique species of marine invertebrates that occur nowhere else, such as the bristle worms *Eunice salvadorensis* and *Paradiopatra barrazai*.

Pacific seahorse. Photo courtesy of Rémi Bigonneau



Gulf of Fonseca, Honduras. 1986. Left image: 1985, Right image: 2009. On the right, blue rectangles represent shrimp ponds that used to be coastal swamps. Photo courtesy of NASA/GSFC/METI/ERSDAC/JAROS, and U.S./Japan ASTER Science Team

The gulf's productive waters and shoreline play host to several species that are listed as vulnerable or threatened on the IUCN Red List. These include the Pacific seahorse (*Hippocampus ingens*), the hawksbill turtle (*Eretmochelys imbricata*), which feeds in the area, the Galapagos green turtle (*Chelonia mydas agassizi*) and olive ridley sea turtle (*Lepidochelys olivacea*), both of which lay their eggs on the sandy beaches. In addition, colonies of bridled tern (*Onychoprion anaethetus*) and magnificent frigate bird (*Fregata magnificens*) use the mangroves as roosts, while humpback whales frequent the waters offshore during their annual migrations along the coast.

Human activity in the gulf is notable, particularly artisanal fishing. The area's natural wealth has been recognized internationally as it includes several designated Wetlands of International Importance (Ramsar sites), including the wetlands system of the southern region of Honduras (*Sistema de Humedales de la Zona Sur de Honduras*) and further east along the El Salvador coast, away from the gulf, the Jiquilisco Bay Complex (*Complejo Bahía de Jiquilisco*).

6

Smalltooth sand tiger, Malpelo, Colombia.
Photo courtesy of Tomas Kotouc

MALPELO RIDGE
(DORSAL SUBMARINA DE MALPELO)

Circling swarms of sly-eyed hammerhead and silky sharks are perhaps not the most comforting sight for an intrepid visitor to the Malpelo Ridge EBSA, but their presence confirms that the area is a pristine safe-haven for the most sensitive and selective sea monsters. Sharks are not the only heavies prowling this briny beacon of bounty; other top predators also exercise their loitering rights around the veritable "Las Vegas of the Sea".

Scalloped hammerhead shark. Photo courtesy of Simon Pierce / Galapagos Conservation Trust

The Malpelo Ridge is a solitary volcanic submarine ridge that rises 4,000 m from the ocean floor. The irregularly shaped EBSA boundary wraps around the ridge and extends between latitude 1.48–5.00°N and longitude 79.67–82.75°W. The ridge breaks the sea surface once, forming the barren rocky outcrop of Malpelo Island, while other steep-sided peaks remain beneath the waves, attracting and sheltering swirling schools of fish and their predators. On the island, members of the largest breeding colony in the world of Nazca boobies (*Sula granti*) jostle for ledges on which to nest and rear their young. Feeding on fish from far and wide, the localized concentration of their droppings around the island provides a significant contribution of nutrients to the already highly productive local food-web.

Underwater, the ridge attracts and sustains staggering aggregations of forage fish, snapper, grouper, barracuda, bonito, tuna, sharks, eagle and manta rays, whale sharks, dolphins, humpback whales with calves, sperm whales, fur seals, sea lions, sea turtles and many more. There are even two species of endemic sea stars (*Tamaria stria* and *Narcissia gracilis malpeloensis*) among the >1,000 other recorded species. Furthermore, the recent discovery of cold seeps along the ridge can only mean that there are plenty more endemic species awaiting description. Of particular note is the

Tamarisk sea star, Baja California, Sea of Cortez.
Photo courtesy of Paddy Ryan

presence of the smalltooth sand tiger shark (*Odontaspis ferox*), a large, elusive and fearsome deep-water shark known locally as "the monster" (though it is harmless to humans). Together with many of its larger ocean-faring neighbours around Malpelo, it appears on the IUCN Red List of Threatened Species.

Malpelo Island's small size and remoteness render it inhospitable to permanent human occupation, which serves the wildlife well. However, the area's pristine condition and wealth of charismatic species within relative proximity to the mainland does mean that it is often visited by recreational diving operations and research expeditions. Alteration of seasonal circulation patterns of wind and water currents by climate change may affect the persistence of the area's productivity in the future.

Nazca booby with chick, Española Island, Galapagos.
Photo courtesy of Mike's Birds, licensed under CC BY-SA 2.0, Wikimedia Commons

Leatherback turtle. Photo courtesy of Projeto Tamar Image Bank

7

UPWELLING SYSTEM OF PAPAGAYO AND ADJACENT AREAS (SISTEMA DE SURGENCIA DE PAPAGAYO Y ZONAS ADYACENTES)

Oceanic upwellings bring cold, nutrient-rich water up from the deep ocean towards the warm sunlit surface, where millions of microscopic floating algae are poised to use them and multiply, creating a boom of productivity. Where there are algae, there are their grazers—clouds of krill and animal larvae of every kind—and where there are grazers, there are predators—from squid and turtles to sharks and whales.

Off the western coast of Central America, winds and currents conspire to create an upwelling with sufficient regularity and persistence to be considered a distinctive oceanic habitat. As the cold water rises, warmer water above it is displaced sideways, making the warm-water surface layer thinner (around 10–15 m) at the centre of the upwelling than around the edge (30–40 m). This is often visualised in three dimensions as an underwater dome, with cold water bulging below and warm water thinning above. Where both water-masses meet and mix—the thermocline—is where the algal action happens, kick-starting a consumer cascade that attracts hungry ocean rovers from far and wide, including the leatherback turtle (*Dermochelys coriacea*). Some, such as the usually migratory blue whale (*Balaenoptera musculus*), have made it their permanent year-round home.

The top of the thermocline shifts in shape and location throughout the year as a result of changes in the strength and direction of seasonal winds. In February and March, the dome is small and close to the Costa Rican coast. By May, the top of the dome has swelled and moved offshore, expanding its area of influence until November, when it shrinks and weakens, eventually reappearing at the coast the following February. This EBSA captures this seasonal shifting by encompassing not only its average position centred around 9.0°N and 90.0°W in the high seas (about 300 km off the Gulf of Papagayo), but also its transient influence over the waters off the coasts of Costa Rica, Nicaragua, El Salvador, Guatemala and Mexico.

This haven of productivity and biodiversity has not gone unnoticed by its human neighbours, who have developed thriving fishing and tourism industries. Many of the species exploited are listed on the IUCN's Red List of Threatened Species. Efforts are ongoing regionally to facilitate improved management of this area, especially to coordinate the regulation of resources exploited outside of national waters.

Blue whale. Photo courtesy of Rémi Bigonneau

Green sea turtle. Photo courtesy of Rémi Bigonneau

8

EASTERN TROPICAL PACIFIC MARINE CORRIDOR
(CORREDOR MARINO DEL PACÍFICO ORIENTAL TROPICAL)

Few places on earth enjoy such universal recognition for their biological significance as do the Galapagos Islands—the proclaimed "birthplace" of Charles Darwin's renowned theory of evolution by natural selection. Geologically, the Galapagos are part of a larger chain of volcanic archipelagos and seamounts stretching all the way to Central America, providing the potential for species diversification beyond the wildest dreams of any naturalist.

Brown pelican. Photo courtesy of Marek Jackowski / Galapagos Conservation Trust

This collection of geological features encompasses the coastal and offshore islands of Galapagos, Coiba, Las Perlas, Islas del Coco and Malpelo, as well as countless underwater seamounts, ridges, outcrops and trenches. The diversity of seabed topography, coupled with zones of permanent upwelling of nutrient-rich water from the depths of the Gulf of Panama, combine to support infinite variations of conditions in which species can specialize and thrive. Furthermore, larger animals can use underwater features as landmarks, staging posts, feeding areas, aggregation sites, breeding grounds, nurseries and refuges. In warmer El Niño periods, cold-loving species do indeed seek refuge in the cooler upwellings of the Galapagos and Gulf of Panama.

Above water, the islands host clattering colonies of breeding seabirds, including brown pelican (*Pelecanus ocidentalis*), neotropic cormorant (*Phalacrocorax brasilianus*), and Nazca, Peruvian and blue-footed boobies (*Sula granti*, *S. variegata* and *S. nebouxi*). Three species of sea turtles (*Dermochelis coriacea*, *Chleonia mydas*, *Lepidochelis olivacea*) also lay their eggs on the extensive sandy beaches. Like sea turtles, migratory scalloped hammerhead sharks are known to congregate in great numbers around the offshore islands, before the females head to their natal waters inshore to pup. Other migratory giants, like the humpback whale, converge on the area from both northern and southern hemispheres to overwinter, feed, calve and rear their young. The importance of connectivity amongst and between the offshore islands and seamounts with the inshore waters of the Gulf of Panama gives rise to the EBSA's moniker "marine corridor of the tropical eastern Pacific".

Industrial and artisanal fishing fleets frequent the area, targeting mostly large pelagic species like tuna, dolphin fish, swordfish and sharks, many of which are listed on the IUCN Red List of Threatened Species. There are also many areas within the EBSA that are designated for protection under national and international conservation programmes, such as the UNESCO World Heritage Convention.

Sperm whale. Photo courtesy of Martin Prochazka

9

EQUATORIAL HIGH-PRODUCTIVITY ZONE (ZONA ECUATORIAL DE ALTA PRODUCTIVIDAD)

The “equatorial high productivity zone” spans almost the entire width of the Pacific Ocean, hugging the equator from the Marshall Islands in the West to the Galapagos Islands in the East.

This area is the natural continuation of an EBSA described during the western South Pacific EBSA regional workshop.[1] Their separation is merely a logistical compromise, not an ecological distinction. Together, they cover the largest productivity phenomenon on the entire planet.

The Earth's rotation on its axis shapes the circulation pattern of ocean currents and wind cells in the atmosphere. As a consequence, trade winds at the equator blow predominantly from east to west, which in turn push warm sea-surface water westwards. To replace it, cold water is drawn upwards from the ocean depths, bringing the boundary between warm and cool water—the thermocline—closer to the surface in the east than in the west of an ocean basin. Towards the extreme east, the cold upwelling reaches the ocean surface, known as a "cool tongue". At its opposite end in the far west of the Pacific Ocean, the pooled warm surface waters blown there by the wind are known as the "warm pool". Where nutrient-rich cold water from the deep meets warmer sunlit water at the surface, productivity booms. This green girdle of algae around the equator sustains a food-web of global significance, from swarms of fidgety larvae to pods of lunging leviathans.

Despite the immense distance between the ocean surface and the seabed beneath (4,000–5,000 m), organisms deep in the abyss have been shown to benefit from the increased productivity high above. Data from historic whaling efforts attest to the abundance of sperm whales in the area, although present-day numbers are still recovering from those less enlightened times. Of greatest concern now is the potential for climate change and ocean acidification to alter the complex and dynamic ocean-atmosphere interactions, with repercussions for nutrient, heat and carbon cycling on a global scale.

1 Area number 16, https://www.cbd.int/marine/ebsa/booklet-01-wsp-en.pdf

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Galapagos sea lion. Photo courtesy of Nicole Andrews / Galapagos Conservation Trust

GALAPAGOS ARCHIPELAGO AND WESTERN EXTENSION (ARCHIPIÉLAGO DE GALÁPAGOS Y PROLONGACIÓN OCCIDENTAL)

The Galapagos archipelago is arguably the most venerated crucible of biodiversity on the planet. It was made famous by none other than the renowned naturalist Charles Darwin, who used the variations in beak-form of its resident finches to illustrate his theory of evolution by natural selection. Finches are not the only group of animals that display such diversification here; the islands also boast an abundance of marine species that occur nowhere else on the planet, thanks in part to the infinite combinations of environmental conditions that are available for habitation and specialization.

The Galapagos Islands enjoy a unique position in the tropical eastern Pacific, as they are subject to the convergence of winds, currents, upwellings and animal migrations from every direction. The islands lie at the easternmost extent of the equatorial high productivity zone, a phenomenon that spans the entire width of the Pacific Ocean at the equator. Prevailing trade winds that push warm surface water towards the western Pacific Ocean also encourage the upwelling of cooler, nutrient-rich water towards the ocean surface in the east, around the Galapagos Islands, to replace the displaced warm water. This so called "cold tongue" of upwelled water is further influenced by the underwater ridges and seamounts, which force the mixing of water masses into complex, ephemeral yet recurrent eddies. The resulting three-dimensional mosaic of ever-changing productivity hotspots all around the islands attracts migratory animals such as tunas, sharks and whales—and their prey—from both hemispheres, especially at key stages of their life-cycle: breeding, birthing and rearing of young. The blue whale (*Balaenoptera musculus*), Galapagos fur seal (*Arctocephalus galapagoensis*), whale shark (*Rhincodon typus*), giant hammerhead shark (*Sphyrna mokarran*), flightless cormorant (*Phalacrocorax harrisi*), Galapagos penguin (*Spheniscus mendiculus*) and marine iguana (*Amblyrhynchus cristatus*) are just a handful of the countless charismatic species worthy of mention.

Galapagos marine iguana. Photo courtesy of Fernando Félix

Galapagos fur seal pups. Photo courtesy of Jonathan Green / Galapagos Conservation Trust

On the seafloor, geological activity supports chemosynthetic communities around seeps and vents, adding to the biodiversity of the archipelago. Less precarious substrates support coral reefs, and in the shallow coastal waters around the islands, mangroves and wetlands host their own complement of associated species above and below the water. In all, the islands harbour 33 known endemic species, most of which are fish, followed by several invertebrates, birds, mammals and a reptile. There are likely many more that remain undiscovered.

This living evolutionary laboratory has no shortage of protective designations and formal international and national recognitions that encourage its protection. It is a World Heritage Site, a Biosphere Reserve, a Wetland of International Importance (Ramsar site), a Particularly Sensitive Sea Area, and a marine reserve and whale sanctuary, amongst others. Nevertheless, several of the species that reside there, and some of those that regularly visit, are listed on the IUCN Red List of Threatened Species. A large fleet of international fishing vessels prowls the edges of the sanctuaries, targeting fish that venture outside of the protected areas. The cooler waters also offer refuge to species that avoid the oceanic heatwaves experienced during El Niño periods. The potential alteration of this cycle as a result of climate change, as well as an overall increase in global ocean temperature, may make such refuges more significant in the future.

11

Blue-footed booby, Galapagos Islands.
Photo courtesy of Tiffany Dias / Galapagos Conservation Trust

CARNEGIE RIDGE—EQUATORIAL FRONT
(CORDILLERA DE CARNEGIE—FRENTE ECUATORIAL)

A chain of submerged extinct volcanoes forms the 1,000 km long Carnegie Ridge, which spans the Galapagos Islands to the coast of Ecuador on South America's Pacific coast. Each peak along the ridge was formed as the Nazca tectonic plate shifted over millennia above a hotspot deep below the Earth's crust. This same hotspot is what has created the Galapagos Islands.

The equatorial front above the Carnegie Ridge is an oceanic zone of high productivity that results from the convergence of different water masses, namely the sporadic warm El Niño coastal current from the north and the cool Humboldt Current from the south. When both currents are at their strongest, the front where they collide is characterized by a marked gradient in temperature and salinity. The cooler, saltier waters to the south of the front represent the southern limit of the eastern tropical Pacific ecosystem, beyond which warmth-loving species such as mangroves and sea turtles no longer occur.

High primary productivity in the water, coupled with topographic variability on the seafloor and coastline, is the perfect recipe for the area to host and attract a multiplicity of animals, including whale sharks, hammerhead sharks, leatherback sea turtles, goliath grouper, skipjack and yellowfin tuna, waved albatross, blue-footed boobies, magnificent frigatebird, countless invertebrates and several species of whale. In fact, the Carnegie Ridge—Equatorial Front EBSA is one of just eight marine mammal hotspots around the world, and the only one in tropical waters, hosting blue, Bryde's, sperm and humpback whales in abundance. The latter are known to breed and bear their young in the area. Many of the species are endemic and appear on the IUCN Red List of Threatened Species.

Whilst there is a concerted fishing effort in the area from nearby Ecuador and Peru, as well as concerns over terrestrial sources of pollution, there is no indication that the area is being adversely affected, although dedicated observation efforts have been scarce.

Whale shark. Photo courtesy of Simon J. Pierce / Galapagos Conservation Trust

Bottlenose dolphin. Photo courtesy of Fernando Félix

12

GULF OF GUAYAQUIL
(GOLFO DE GUAYAQUIL)

The Gulf of Guayaquil is the largest estuary on the Pacific coast of South America; its extent is shared by Ecuador to the north and Peru to the south. It also receives the river output from the largest catchment area west of the Andes, delivering each year tonnes of suspended sediment and organic nutrients to the sea, where productivity is enhanced as a consequence.

Mangrove-lined coastlines capture much of the suspended sediment in the water, creating a rich and intricate habitat for marine invertebrates such as the Pacific whiteleg shrimp (*Litopenaeus vannamei*), the Pacific mangrove ghost crab (*Ucides occidentalis*) and mangrove cockles (*Anadara tuberculosa* and *A. similis*). These species sustain a large artisanal fishery and are harvested by the millions every


Left: Waved albatross. Right: Magnificent frigate bird. Photos courtesy of Rémi Bigonneau

year. Submerged mangrove roots also offer shelter and a safe nursery area for numerous fish and shark species, while the branches above are host to around 80 species of marine, coastal and terrestrial birds. National parks and sanctuaries cover much of the mangrove holdings of both coastal nations.

Offshore, schools of filter-feeding sardines and anchovies support populations of common bottlenose dolphins (*Tursiops truncatus*) and humpback whales that flock to the area to breed and bear their young. The small forage fish also provide an important food source for seabirds, such as the endemic waved albatross (*Phoebastria irrorata*), De Filippi's petrel (*Pterodroma defilippiana*), blue-footed booby (*Sula nebouxii*), brown pelican (*Pelecanus occidentalis*) and magnificent frigatebird. Remarkably, the Parkinson's petrel (*Procellaria parkinsoni*), which breeds exclusively in New Zealand, migrates across the Pacific Ocean to feed in the Gulf of Guayaquil during its non-breeding season between May and September.

The impacts on biodiversity from industrial and artisanal fishing, together with shipping traffic and land-based pollution from coastal towns and ports, are of concern in the area. The clearance of mangroves for shrimp farms has also taken its toll on the coastal habitat, although the practice has diminished, and expired farms appear to be reverting to forest. The Gulf of Guayaquil EBSA extends approximately 200 km north to south, and 120 km east to west, from the coastline, over the shallow continental shelf, to the bottom of the continental slope.

13

HUMBOLDT CURRENT UPWELLING SYSTEM IN PERU (SISTEMA DE SURGENCIA DE LA CORRIENTE HUMBOLDT EN PERÚ)

Strong, near-constant winds blowing westwards off the land and over the sea force the circulation of surface water away from the Peruvian coast, only for it to be replaced by cold, nutrient-rich water drawn from the deep ocean. The ecological consequences of this phenomenon are so remarkable that it has been given its own name—the Humboldt Current upwelling system in Peru.

Cold water from the deep ocean contains less dissolved oxygen than the water at the surface. As this cold water rises, the depth at which most animals can live is reduced, as they are unable to attain the oxygen they require. However, because of the high nutrient content of the water, once it reaches the sunlit surface, photosynthetic algae bloom in their billions, producing oxygen and supporting a food-web of global significance. The squeezing of this extraordinary boom of biomass against the top few metres of the sea surface so close to the Peruvian coast has not gone unnoticed.

Top: Chatham albatross. Photo courtesy of Danmantle, licensed under CC BY-SA 3.0, Wikimedia Commons
Bottom: South American sea lion, La Isla de Los Lobos, Argentina. Photo courtesy of Carlos Ponte, licensed under CC BY 3.0, Wikimedia Commons

Peruvian pelican, Paracas National Reserve, Peru. Photo courtesy of Marketa Zackova

Peruvian anchoveta (*Engraulis ringens*), swarming mouth agape to filter everything in their path, thrive in their thousands, supporting the most productive fishery in the world. These and other schooling species, such as sardines and mackerel, also spawn in the coastal shallows, providing a yearly pulse of nutritious supplements to the surrounding wildlife. Humboldt penguins (*Spheniscus humboldti*), marine otters (*Lontra felina*), South American sea lions (*Otaria flavescens*) and South American fur seals (*Arctocephalus australis*) all give chase to the superabundant fish. Resident diving bird species pierce the sea like raining arrows; they include the Guanay cormorant (*Phalacocorax bougainvilli*), the Peruvian booby (*Sula variegata*) and the Peruvian pelican (*Pelecanus thagus*). The pull of the pilchard is so strong, it even attracts migrants from across the Pacific Ocean, such as Parkinson's petrel, the Chatham albatross (*Thalassarche eremita*), Cook's petrel (*Pterodroma cookii*), Salvin's albatross (*Thalassarche salvini*) and the white-chinned petrel (*Procellaria aequinoctialis*), all of which forage in the area between breeding seasons in New Zealand. Migrating marine mammals are not far behind.

Below the explosion of productivity and consumption near the sea surface, there is a dark, low-oxygen zone beyond which most species do not venture. Detritus falling from above is relatively well preserved where it settles, as the specialist cast of low-oxygen-tolerant animals on the sea floor adopts a much slower pace of life. However, their distinctiveness from the multitude of species above them makes the entire area of upwelling a haven for marine biodiversity in its most varied forms.

Industrial and artisanal fishing has profited (and suffered) from this phenomenon for decades; in fact, demand often exceeds supply. Fluctuations in strength of the El Niño phenomenon that disrupts the upwelling of the life-giving, nutrient-laden cold water, can cause fish populations and the industries they sustain to collapse, with significant ecological and economic consequences in the region. Climate change is likely to disrupt the frequency and intensity of such fluctuations, with unpredictable repercussions. This EBSA hugs the Peruvian coastline from 5°S to 18°S and stretches offshore to the 5,000 m depth contour, just beyond the narrow continental shelf.

Humboldt penguin. Photo courtesy of Frank_am_Main, licensed under CC BY-SA 2.0, Flickr

14

PERMANENT UPWELLING CORES AND IMPORTANT SEABIRD AREAS OF THE HUMBOLDT CURRENT IN PERU

(CENTROS DE SURGENCIA PERMANENTES Y AVES MARINAS ASOCIADAS A LA CORRIENTE DE HUMBOLDT EN PERÚ)

This multiple-site EBSA captures core areas of permanent upwelling along the Peruvian coast—even during strong El Niño periods when the Humboldt Current is weakened—which serve as refuge to plankton, fish, seabirds and other species closely dependent on the upwelling.

After any periodic sea-warming event, such as those incurred by El Niño, which weakens the upwelling Humboldt Current, the surface layer of the ocean can be left devoid of photosynthetic plankton through lack of nutrients. Once the widespread upwelling of cold, nutrient-rich water is resumed, remnants of plankton sheltering in cool refuges of localised permanent upwelling can seed the start-up of the productivity boom across the region. The existence and persistence of such discrete cool-water refuges ensure the ecological resilience of high-productivity systems, even after extreme environmental perturbations.

Along the Peruvian coast, certain land formations, like jutting cliffs, stacks and peninsulas, act as obstacles that funnel the wind onto the sea surface, even at times when the trade winds are weak. Combined with the right conditions underwater, such enduring points of wind action sustain the localised upwelling of cold, nutrient-rich water from the deep ocean all year-round. These focal points are a haven for animals that depend on cool productive waters to live and have been recognised collectively as EBSAs. The focal points included in the EBSA description are: Punta Aguja (5.78°S), Chimbote (9.83°S), Callao (12.98°S), Paracas (13.75°S), Punta San Juan (15.37°S) and Punta Atico (16.23°S), each with a circular 75 km buffer zone from its centre.

Inca tern. Photo courtesy of Rémi Bigonneau

The sea around each location teems with planktonic plants and animals that sustain schools of Peruvian anchovieta (*Engraulis ringens*) and other species of forage fish. These in turn are food for countless predatory fish, mammal and seabird species, as well as for humans that harvest them. Notable amongst them are the South American sea lion (*Otaria flavescens*), the South American fur seal (*Arctocephalus australis*), the marine otter (*Lontra felina*) and the Humboldt penguin (*Spheniscus humboldti*). Since the existence of the localised upwellings is contingent on a coastal feature with a strong vertical projection, these are invariably colonised by thousands of seabirds jostling for a ledge on which to nest. The seabirds that breed on these cliffs account for most of their species' global population, and they are strongly dependent on the permanence of the localised upwelling that sustains the whole ecosystem. Some, such as the Inca tern (*Larosterna inca*), are wholly restricted to the Humboldt Current, and are therefore endemic. Several of the resident and migratory species that frequent the localities are listed on the IUCN Red List of Threatened Species, including the Guanay cormorant (*Leucocarbo bougainvilliorum*), the Peruvian diving petrel (*Pelecanoides garnotii*), pink-footed shearwater (*Puffinus creatopus*), and the waved albatross (*Phoebastria irrorata*).

Peruvian booby, Valparaiso, Chile. Photo courtesy of S. Rae, licensed under CC BY 2.0, Wikimedia Commons

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Kelp gull, Chiloe Island, Chile. Photo courtesy of Paul Tavares

NORTHERN CHILE HUMBOLDT CURRENT UPWELLING SYSTEM

(SISTEMA DE SURGENCIA DE LA CORRIENTE DE HUMBOLDT EN EL NORTE DE CHILE)

As the Humboldt Current surges northwards towards the equator along the South American seaboard, it encounters physical obstacles and weather patterns that influence its flow and intensity. Close to the coast of northern Chile, conditions conspire to create a zone of intermittent yet persistent upwelling of the current, which has allowed the development of a unique ecosystem synchronised with such pulses of ensuing productivity.

Cold, nutrient-rich water from the deep ocean is drawn to the surface by trade winds that push the surface water layer away from land and out to sea. As this water rises into the sunlight, dissolved nutrients fertilise the growth of plankton, which in turn forms the basis of a formidable food-chain. In northern Chile, between 21°S and 24°S, short bursts of upwelling lasting between four and 15 days take place all year-round; their frequency and duration are greater during the late summer months (January, February) than in the winter months (June, July, August). In winter, however, even when upwelling is less prevalent, nutrients from river runoff make a sizeable contribution to the productivity of the inshore waters.

The persistent pulsating pattern of nutrient enrichment unique to this area has encouraged the development of planktonic species with short but fast life-cycles, able to take advantage of the briefest spells of prosperity. The predictable regularity of such boom and bust patterns of primary productivity also attracts plankton grazers and their predators when food is in short supply elsewhere. These, in turn, sustain substantial local fisheries throughout the year, most notably for anchovy, sardine, jack mackerel and horse mackerel and Humboldt squid (*Dosidicus gigas*).[2] Hungry and highly mobile seabirds, like the Peruvian booby (*Sula variegata*), the kelp gull (*Larus dominicanus*) and the Humboldt penguin (*Spheniscus humboldti*)[3], are quick to react and claim their share.

Although the direct biological effects of recurrent upwelling events are detectable within a discrete cool and narrow "tongue" that stretches westwards for between 45 and 75 km, the Northern Chile Humboldt Current Upwelling System EBSA itself extends seawards for 200 nautical miles. The EBSA boundary thus encompasses the shallow seas above the continental shelf and the steep continental shelf slope all the way down to the abyss at its base, with all the variety in benthic habitats therein. Dense human settlements along the Chilean coast are known to be sources of considerable disturbance to the ecosystem. Climate change could alter the frequency and persistence of upwelling bursts, with unknown ecological consequences.

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Marine otter, Pingüino de Humboldt National Reserve, Chañaral Island, Chile. Photo courtesy of Patricio Fernandez Mackenzie

CENTRAL CHILE HUMBOLDT CURRENT UPWELLING SYSTEM

(SISTEMA DE SURGENCIA DE LA CORRIENTE DE HUMBOLDT EN CHILE CENTRAL)

When Alexander von Humboldt—a celebrated Prussian polymath—explored the uncharted expanses of South America around the turn of the 19th century, little did he know that his legacy would persist centuries later in the names of countless natural features, such as currents, parks and penguins, to list just a few. The central Chile Humboldt Current Upwelling System EBSA is a recent addition to the cannon of his namesakes, ensuring his legacy remains undiminished.

Giant kelp. Photo courtesy of Eduardo Sorensen

In central Chile, between 20°S and 31°S, the eponymous deep-water current that runs northwards along the entire length of South America is drawn to the surface, where it nourishes planktonic blooms all year-round. The upwelling of the current is caused by trade winds, funnelled by land formations, blowing surface water westwards, which is swiftly replaced by cooler, nutrient-rich water drawn from the deep. Where plankton blooms, grazers feed, and predators follow.

The waters off central Chile host the convergence zone between warmer northern sub-tropical waters at the surface and cooler sub-Antarctic waters creeping in from the south at depth. Some organisms traverse the zone regardless, whilst others are bound by their more restricted tolerance of prevalent environmental conditions. The continental shelf at this same latitude is also at its narrowest, bringing the influence of the deep sea close to shore. Together, the permanent upwelling of the Humboldt Current, the convergence of water masses, and the unique underwater topography close to shore make the area a stomping ground for species from diverse and fluid oceanic provinces that rarely overlap.

The shallow, narrow continental shelf provides attachment sites for large seaweed forests, where marine otters can fuss and frolic. In open waters, schools of forage fish, like sardines and anchovies, feast on the constant supply plankton, while themselves being sustenance for local and migrating seabirds, including the Peruvian tern (*Sterna lorata*), the Peruvian diving petrel (*Pelecanoides garnotii*) and the Humboldt penguin. Marine mammals, like the humpback whale, fin whale (*Balaenoptera physalus*), blue whale, and sperm whale, also frequent the area. Many of the species that frequent the area are listed on the IUCN Red List of Threatened Species.

The proximity of large coastal human settlements is a cause for concern locally. However, beyond those settlements there is relatively little influence of human activities on the marine environment.

Chilean jack mackerel. Photo courtesy of Eduardo Sorensen

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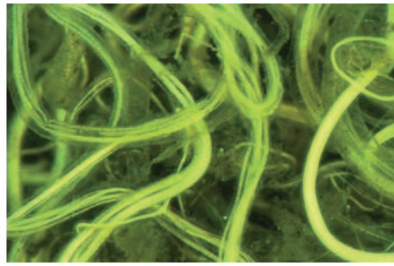
SOUTHERN CHILE HUMBOLDT CURRENT UPWELLING SYSTEM
(SISTEMA DE SURGENCIA DE LA CORRIENTE DE HUMBOLDT EN EL SUR DE CHILE)

The Southern Chile Humboldt Current Upwelling System EBSA is the southernmost member of a family of EBSAs along the coast of South America that captures a unique combination of conditions favourable to bountiful biological productivity. Its southern location, however, gives it a seasonal pattern of variation that makes it markedly different to similar upwelling systems further north.



Rinsed bundles of Thioploca from the Chilean Coast. Photo courtesy of Markus Huettel

Between 35°S and 38°S along the Pacific coastline of South America, the continental shelf is at its widest, extending up to 60 km from the shore into the ocean (30 km wider than in the north). This wide, shallow platform is indented with steep-sided canyons that fast-track sediment to the deep ocean floor beyond. In the spring and summer months (September to February), the upwelling of the Humboldt Current is intense, delivering cool, nutrient-rich and oxygen-poor water to the surface. In winter (June to August), when the upwelling is weak, the flow of fresh water from rainfall and river runoff reduces the overall salinity of the shallow shelf seas. This seasonal seesaw between sources of nutrients and subtle alterations in water chemistry has led to the establishment of novel communities of organisms uniquely adapted to such oscillations.

A low concentration of dissolved oxygen at the seabed during periods of intense upwelling is responsible for the growth of dense mats of a giant filamentous bacterium known as *Thioploca*, which resembles wisps of hair wafting in the waves. Above these, where photosynthesising plankton oxygenate the water, the usual cast of grazers, forage fish (particularly Chilean jack mackerel, *Trachurus murphyi*), their predators and plucky seasonal migrants congregate to feast in times of plenty. Industrial fisheries also make the most of the seasonal productivity boom, although concerns are growing about the impact such activities may be having on the finely tuned ecosystem.

The sporadic El Niño phenomenon, which temporarily suppresses the upwelling of the Humboldt Current, is known to exert significant influence on the energetic dynamics of the ecosystem, occasionally causing catastrophic crashes in productivity that are felt by all who depend on it. Global climate change is predicted to alter the periodicity and intensity of the El Niño perturbation, with unforeseen consequences on such systems.

As with other members of this family of EBSAs that capture the Humboldt Current upwelling systems on the Chilean coast, it captures the full depth-range of habitats from the Chile coast to the chilly abyss.

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Black coral Antipatharia, Los Islotes, Sea of Cortez.
Photo courtesy of Phillip Colla / Oceanlight.com

SALAS Y GÓMEZ AND NAZCA RIDGES (DORSAL DE NAZCA Y DE SALAS Y GÓMEZ)

Two ridges, both alike in origin, in the south-eastern Pacific Ocean, where few human foes have misadventured, are the perfect setting for the toil and strife of countless star-crossed fishy lovers. Fair Verona it is not, but amongst this chain of submarine volcanoes, its denizens thrive in copious profusion, far from the woes endured by their continental cousins.

The Salas y Gómez and Nazca Ridges EBSA encompasses two sequential strings of seamounts extending over 2,900 km, from the East Pacific Rise to the Peruvian coast (Salas y Gómez from 23.7°S and 29.2°S to 111.5°W and 86.5°W; Nazca from 15.0°S and 26.2°S to 86.5°W and 76.1°W). Each ridge was created over millennia by the passing of the Earth's crust over a hotspot deep in the mantle beneath, the same hotspot that created Easter Island. A deep trench between the eastern end of the Nazca ridge and the Peruvian coastline, combined with strong impassable currents, has limited the exchange of small animals between the ridge and the continental margin. This results in the ridges harbouring seabed communities that resemble more closely those on Polynesian seamounts in the western Pacific Ocean than those on South American shores. What is more, the relative isolation of each of the 110 seamounts that punctuate both ridges has encouraged a high rate of speciation, and consequently, a high number of seamount-specific species that occur nowhere else—41 per cent of fish and 46 per cent of invertebrates are endemic, a higher proportion than at hydrothermal vents. These rocky pinnacles also provide the only extensive hard substrate available for the propagation of long-lived, yet fragile, black corals (Antipatharia) and stony corals (Scleractinia), of which there are at least 19 genera and many more species.

De Filippi's petrel, Juan Fernandez Archipelago, Chile. Photo courtesy of Mike Danzenbaker

Above water, seabirds squabble for nesting sites on the seamounts that break the surface. Breeding colonies of Christmas Island shearwater (*Puffinus nativiatis*), white-throated storm-petrel (*Nesofregetta fuliginosa*), masked booby and the endemic De Filippi's petrel qualify the islands as Important Bird and Biodiversity Areas. Some of the species travel to their nesting sites from as far away as New Zealand. Beneath the waves and clatter, lusty leatherback turtles (*Dermochelys coriacea*), blue whales, bigeye thresher sharks (*Alopias superciliosus*) and swordfish (*Xiphias gladius*) also woo their mates. All of these species are listed on the IUCN Red List of Threatened Species.

Productivity around the ridges is enhanced by localized upwelling gyres, likely caused by complex hydrodynamic interactions between deep-water currents and towering pinnacles. Here, nutrients spiralling up from the deep fertilize the surface waters, fuelling plankton blooms that sustain spinning schools of Chilean jack mackerel. Apart from a short-lived trawler fishery in the 1980s that damaged coral reefs on the tops of the tallest seamounts, the area is considered to be pristine. Ongoing mid-water fisheries for tuna and swordfish do not directly affect the seamounts.

Masked booby. Photo courtesy of Rémi Bigonneau

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Alejandro Selkirk Island, Juan Fernández Ridge.
Photo courtesy Madeleine Pott/Island Conservation
(www.flickr.com/photos/islandconservation/24242547491/in/photostream/)

JUAN FERNÁNDEZ RIDGE SEAMOUNTS
(MONTES SUBMARINOS EN EL CORDÓN DE JUAN FERNÁNDEZ)

The real-life inspiration for the fictional castaway Robinson Crusoe, the ill-fated Scottish privateer Alexander Selkirk, was marooned on one of the three islands that make up the Juan Fernández archipelago, off the Chilean coast. The islands, named by the Spanish sailor Juan Fernández as *Más a Tierra* (More Towards Land), *Más Afuera* (Further Out), and *Santa Clara* (after one of Columbus's caravels), were renamed by the Chilean tourism board as Alexander Selkirk Island, Robinson Crusoe Island and Santa Clara.

The rebranded islands are the emergent expression of the much larger Juan Fernández submarine ridge, an 800 km-long alignment of seamounts running west to east in the south-eastern Pacific Ocean. The ridge is formed as the Nazca tectonic plate creeps above a plume of superheated magma deep in the Earth's mantle. As with other isolated seamounts around the globe, the steep-sided flanks and pinnacles soaring towards the surface provide oases of hard substrate on which corals can attach and around which fish can gather. They also deflect nutrient-rich deep-water currents upwards, fertilizing the sunlit surface waters where plankton can bloom.

Seamount flanks and summits bristle with long-lived corals, feeding on the rich plankton soup that swirls around them. In turn, these fragile coralline structures provide a complexity of crannies for many other species to inhabit in an otherwise featureless seabed. Endemic species abound in their isolation. Such profusion of life attracts wanderers from across the ocean, which use the seamounts as migration beacons, refuelling stop-overs, grooming parlours and speed-dating venues. Slow-growing and long-lived fish, like the orange roughy (*Hoplosthetus atlanticus*) and Hapuku wreckfish (*Polyprion oxygeneios*), congregate around the seamounts to breed, rendering them vulnerable to capture by fishing vessels. Commercial fishing for these and other species has already impacted some of the seamounts, as the trawled nets topple corals and degrade the habitat.

The Juan Fernandez ridge seamounts EBSA is recognized for the distinctiveness of its residents and for the important role the seamounts play in the behaviour and life-cycles of rare and vulnerable species.

Orange roughy. Photo courtesy of National Oceanography Center, UK

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Orca. Photo courtesy of Rémi Bigonneau

WEST WIND DRIFT CONVERGENCE (CONVERGENCIA DE LA DERIVA DEL OESTE)

The rugged and heavily indented coastline of southern Chile bears the brunt of the West Wind Drift as it roars ferociously around Antarctica. Strong tides, stormy downpours and incessant winds whip up the waves and mix water masses that converge there, while eddies, fronts and plumes concentrate plankton into bite-sized bait-balls. The apparent anarchy and chaotic violence of nature in this region make it a worthy contender for the true Wild West of the ocean.

The West Wind Drift Convergence EBSA (located between latitudes 41.5°S and 47.0°S) captures dynamic relationships amongst winds, waves, currents, water depth, substrate, salinity, temperature and nutrients that create an extraordinary degree of habitat diversification, biodiversity and productivity seen nowhere else on Earth. Antarctic, sub-Antarctic and sub-tropical water masses overlap and intermingle at various depths, while river runoff and glacial meltwater deliver whirlpools of freshwater and nutrients to plankton poised for a frenzy of productivity. Braving the elements, marine otters and southern river otters (*Lontra provocax*) frolic in the fjords, munching on urchins among the fronds of giant kelp forests (*Macrocystis pyrifera*). Resident South American fur seals and southern sea lions flourish on abundant fish, as do sooty shearwater (*Ardenna grisea*), which form the largest colony of seabirds in the world on Guafo Island. Just off the coast, blue whales and their calves, southern right whales (*Eubalaena australis*), humpback whales, transient killer whales (*Orcinus orca*), Peale's dolphin (*Lagenorhynchus australis*) and the endemic Chilean dolphin (*Cephalorhynchus eutropia*), all take their fill. Close inshore, cold-water corals usually found at great depth aggregate in the shallow sheltered waters of fjords, hosting their own retinue of diverse and unusual critters.

The hostile yet immensely productive seas here are used by local, small-scale fisheries and salmon farms. In recognition of the area's importance to so many emblematic species, some of which are listed on the IUCN Red List of Threatened Species, the region contains areas under formal protection, management and conservation.

Top: Chilean dolphin, near Puerto Natales, Chile.
Photo courtesy of Jim Wilson / irishwildlife.net
Bottom: Peale's dolphin, Beagle Channel, Tierra del Fuego.
Photo courtesy of Jim Wilson / irishwildlife.net

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GREY PETREL FEEDING AREA IN THE SOUTH EAST PACIFIC RISE

(ÁREA DE ALIMENTACIÓN DEL PETREL GRIS EN EL SUR DEL DORSAL DE LA PACÍFICO ESTE)

Typically, seabirds are portrayed as clumsy and cantankerous as they squawk and squabble in their overcrowded nesting sites. Out on the ocean, however, they are gracious and effective, soaring, diving, dipping and bobbing on the boundless briny blue. Surprisingly, however, during their non-breeding life-phase, some species also congregate in their thousands, year after year, at exactly the same featureless place in the ocean, unable or unwilling to shake off their annoying relatives.

A population of grey petrel (*Procellaria cinerea*) from New Zealand's Antipodes Islands provides a perfect example of these antisocial socialites. Once their chicks have fledged, an estimated 80,000 individuals (80 per cent of the population) descend, quite literally, on

Grey petrel, Antipodes Island. Photo courtesy of David Boyle

the middle of nowhere in the southern Pacific Ocean—close to Point Nemo, the furthest point from land on the planet—to feed on squid. The environmental conditions that compel this species to congregate specifically at this spot at the same time each year (November to February) are not fully understood; the area's remoteness has itself limited the accessibility of oceanographic surveys. However, remotely observed satellite tags on post-breeding birds consistently show the convergence of grey petrel individuals on this area. Other species of tagged birds pass through while migrating, but none use this area to any significant degree.

Given the isolated location of this EBSA—the southernmost of all EBSAs around the world thus far—it seems likely that the site exhibits a high degree of naturalness, hardly perturbed by direct human activities. The grey petrel species itself, however, is prone to getting caught on long-line fishing hooks on its long transoceanic voyages. Because of its longevity and slow reproductive rate, it is vulnerable and slow to recover from any decline in population, which is why it is listed on the IUCN Red List of Threatened Species.


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The full report of this workshop is available at **www.cbd.int/doc/meetings/mar/ebsa-ettp-01/official/ebsa-ettp-01-04-en.pdf**

For further information on the work of the CBD on ecologically or biologically significant marine areas (EBSAs), please see **www.cbd.int/ebsa**

This booklet is available online at: www.cbd.int/marine/ebsa/booklet-05-ettp-en.pdf

Previous pages, top left: Humpback whale. Photo courtesy of Fernando Félix
Bottom left: Galapagos sea lion. Photo courtesy of Rémi Bigonneau
Top right: Lava gull. Photo courtesy of Luis Ortiz Catedral / Galapagos Conservation Trust
Bottom right: Galapagos fur seal pup. Photo courtesy of Ian Dunn / Galapagos Conservation Trust