The Salas y Gómez and Nazca ridges: a global diversity hotspot in need of protection

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Abstract

The Salas y Gómez and Nazca ridges are two adjacent seamount chains of volcanic origin located in the southeastern Pacific, which collectively stretch across over 2,900 km of seafloor. Ecosystems in this region are isolated from the South American Continent by the Atacama Trench and the Humboldt Current System. This isolation has produced a unique biodiversity that is marked by one of the highest levels of marine endemism known on Earth. For many taxonomic groups, nearly half of the species are endemic to the region and found nowhere else on the planet. These areas also provide important habitats for blue whales, leatherback turtles, corals, and a multitude of other ecologically important species, including 93 species that are threatened or endangered. Recent explorations in this region have documented the deepest light-dependent marine ecosystems on Earth, as well as numerous species that are new to science, highlighting that it represents an enormous opportunity for future scientific explorations and conservation. Waters surrounding the Salas y Gómez and Nazca ridges mostly fall within areas beyond national jurisdiction (ABNJ), with smaller portions located in the national waters of Chile and Peru. Chile has already protected all the seamounts that fall within its jurisdiction, and Peru is evaluating a proposal to protect most of the seamounts that fall within its national waters. However, ABNJ seamounts, which represent the majority of seamounts of the Salas y Gómez and Nazca ridges, and over 40% of all seamounts found in the southeastern Pacific, are still unprotected and under threat from a variety of stressors, including climate change, plastic pollution, and potential deep-sea mining in the future. Fishing operations targeting species managed by the South Pacific Regional Fishery Management Organization (SPRFMO) have been minimal to nonexistent in this region in recent years. Consequently, there is a unique opportunity to protect the extraordinary cultural and natural resources of this region, without significantly impacting the fishing industry. This report provides a summary of the relevant science that has been conducted in the region as a foundation to propose a fishing closure to species managed by SPRFMO. Specifically, the proposed fishing closure would encompass an area of 1,097,846 km^2 that is located in international waters of the Salas y Gómez and Nazca Ridges Ecologically or Biologically Significant Marine Area (EBSA). The proposed regulations would have little to no impact on fishing operations, however, they would provide enormous advances in safeguarding the unique biodiversity of this region, as well as showcase the global leadership of SPRFMO and its member countries.

Introduction

Stretching across over 2,900 km of seafloor off the west coast of South America (Figure 1) lies one of the most unique collections of marine biodiversity known on Earth (Rehder 1980; Newman & Foster 1983; Parin 1991; Parin et al. 1997; Poupin 2003; Moyano 2005; Gálvez-Larach 2009; Friedlander et al. 2013; Fernández et al. 2014; Friedlander et al. 2016; Mecho et al. 2019; Sellanes et al. 2019). The Salas y Gómez and Nazca ridges are two adjacent seamount chains of volcanic origin that lie in the southeastern Pacific Ocean (Mammerickx et al. 1975; Gálvez-Larach 2009; Gálvez 2012a; Yáñez et al. 2012; Rodrigo et al. 2014; CBD 2017; Easton et al. 2019). The more adjacent ridge to the South American Continent, the Nazca Ridge, stretches across roughly 1,100 km of seafloor between the subduction zone off the Peruvian coast and the eastern edge of the Salas y Gómez Ridge (Figure 1). The Nazca Ridge is located mostly in areas beyond national jurisdiction (ABNJ), with a smaller northeastern section that is located in the national waters of Peru. The Salas y Gómez Ridge stretches across approximately 1,600 km between the Nazca Ridge and Rapa Nui, also known as Easter Island (Figure 1). The central portion of the Salas y Gómez Ridge is located in ABNJ, whereas both ends of this ridge fall within the Chilean exclusive economic zone (EEZ) around the islands of Rapa Nui and San Felix, respectively. Collectively, the Salas y Gómez and Nazca ridges contain over 110 seamounts, which represent approximately 41% of seamounts found in the southeastern Pacific Ocean (Gálvez-Larach 2009; Gálvez 2012a; Yáñez et al. 2012). The shallow waters of the Salas y Gómez and Nazca ridges span across three different but unique ecoregions, including the Easter Island, Juan Fernández and Desventuradas, and Humboldtian Ecoregions (Spalding et al. 2007). The deep waters of this region include two bathyal biogeographic provinces (Southeast Pacific Ridges and Nazca Plate), and one abyssal province (Chile, Peru and Guatemala Basin) (Watling et al. 2013).

Geology

The southeastern Pacific Ocean is a geologically active region, with multiple geological hotspots (Sandwell et al. 2005; Rodrigo & Lara 2014; Harpp et al. 2014; García et al. 2020) and active hydrothermal vents (Baker et al. 2002; Menini & Van Dover 2019). Seamounts located on the Salas y Gómez and Nazca ridges are all thought to have been produced by a common hotspot that is located close to the present location of Salas y Gómez Island (Mayes et al. 1990; Kruse et al. 1997; Steinberger 2002; Duncan et al. 2003; Ray et al. 2012; Rodrigo et al. 2014; Harpp et al. 2014). Moving eastward along the Salas y Gómez and Nazca ridges, the seamounts become progressively older, from 2 million years on the western portion of the chain, to over 27 million years towards the northeastern end (Duncan et al. 2003; Ray et al. 2012; Rodrigo et al. 2014). These seamounts provide a detailed record of the geological formation of this region that tracks the movement of the Nazca Plate as it moves northeastward before it gets subducted under the South American Continent (Von Huene et al. 1997). In general, the summits of these seamounts become progressively deeper from west to east, and range between just a few meters below the surface on the western portion of the chain, to over 3,000 m towards the northwestern end (Rappaport et al. 1997). Many of these seamounts are drowned coral atolls with nearly intact atoll structures, including drowned fringing and barrier reefs (Parin et al. 1997).

Biology and oceanography

Despite its geographic proximity to South America, the marine biodiversity of the Salas y Gómez and Nazca ridges are isolated from the South American Continent by the Atacama Trench and the Humboldt

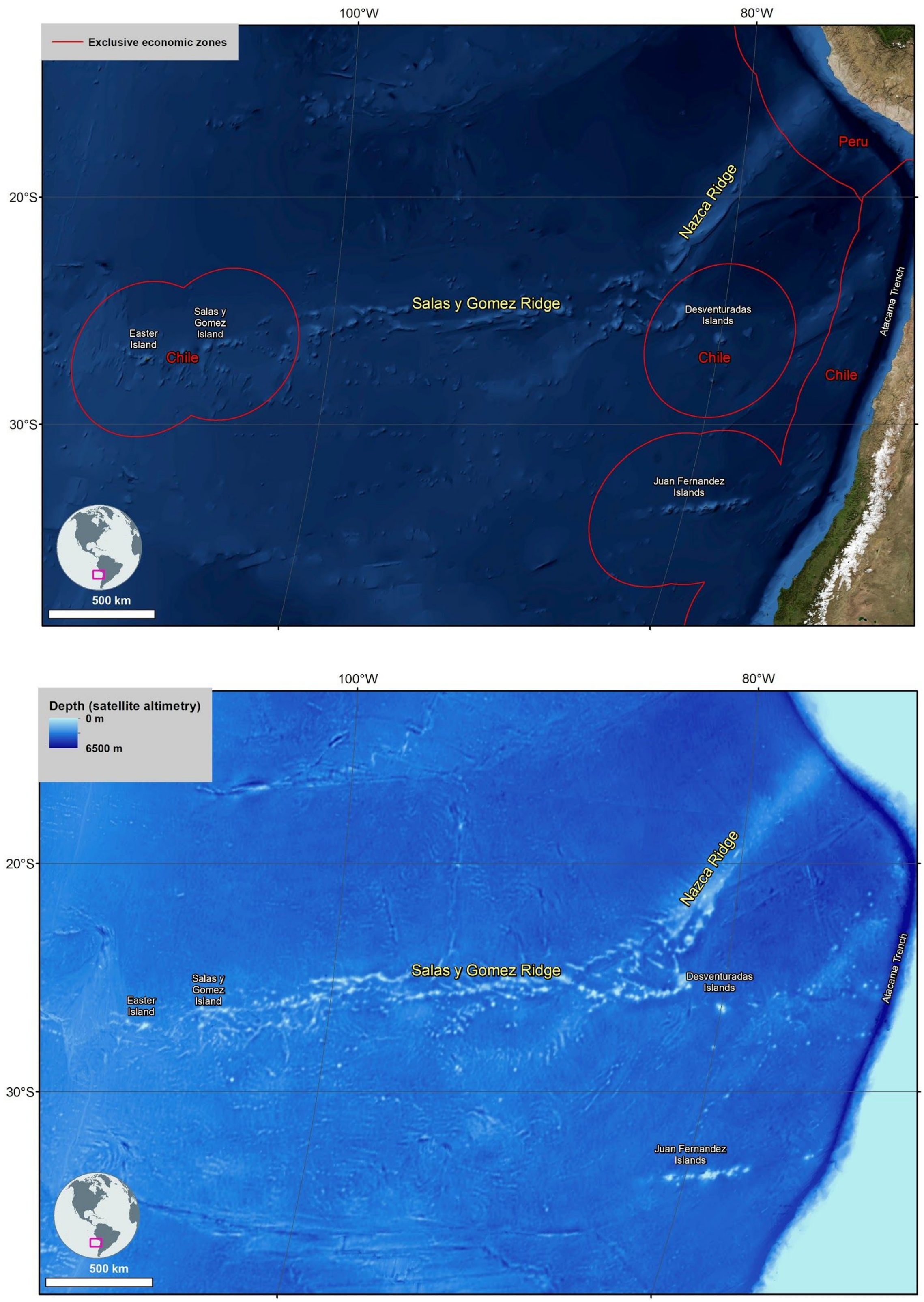

Figure 1. *Map showing the location of the Salas y Gómez and Nazca ridges, the national waters of Chile and Peru (top), as well as seafloor bathymetry in the region (bottom).*

Current System (Figure 1; Von Dassow & Collado-Fabbri 2014). In fact, the marine fauna of this region has higher biogeographical affinities to the Western Indo-Pacific than to the Eastern Pacific (Rehder 1980; Newman & Foster 1983; Parin 1991; Parin et al. 1997; Pequeño & Lamilla 1995; Pequeño & Lamilla 2000; Poupin 2003; Burridge et al. 2006; Gálvez-Larach 2009; Dyer & Westneat 2010; Friedlander et al. 2013; Friedlander et al. 2016; Mecho et al. 2019; Sellanes et al. 2019). The isolation of the Salas y Gómez and Nazca ridges has produced a unique biodiversity that is marked by one of the highest levels of marine endemism on Earth. For many taxonomic groups, close to half of the species are endemic to the region and found nowhere else on our planet (Rehder 1980; Newman & Foster 1983; Parin 1991; Parin et al. 1997; Poupin 2003; Moyano 2005; Gálvez-Larach 2009; Friedlander et al. 2013; Fernández et al. 2014; Friedlander et al. 2016; Mecho et al. 2019; Sellanes et al. 2019).

In addition to hosting a high abundance and diversity of unique organisms, seamounts on the Salas y Gómez and Nazca ridges provide important habitat and migration corridors for blue whales, leatherback turtles, swordfish, sharks, Jack mackerel, deep-water corals, shallow-water corals, and a myriad of other ecologically important species (Arcos et al. 2001; Gálvez-Larach 2009; Gálvez 2012a; Yáñez et al. 2012; Hucke-Gaete et al. 2014; CBD 2017). In particular, the Salas y Gómez and Nazca ridges are home to 93 species that are considered endangered, near threatened or vulnerable to extinction, including eight species of marine mammals, 16 species of corals, 20 species of bony fishes, 23 species of birds, and 25 species of sharks and rays (IUCN 2020). Due to its high productivity, the region also provides important habitat for a high diversity and density of seabirds (CBD 2017; Serratosa et al. 2020).

The Salas y Gómez Ridge and the southern portion of the Nazca Ridge are located near the center of the South Pacific Gyre, an area characterized by particularly high biodiversity for picoplankton, siphonophores and other gelatinous pelagic invertebrates, as well as very nutrient-poor waters (Von Dassow & Collado-Fabbri 2014; González et al. 2019). Water clarity in the central portion of this region, particularly around the Salas y Gómez Ridge, is exceptionally high. This clarity allows sunlight to reach deeper depths than in other ocean areas. Recent scientific explorations of seamounts on the Salas y Gómez and Nazca ridges indicate that photosynthetic marine communities in this region occur below 300 m depth, deeper than in any other place on Earth (Easton et al. 2019).

Limited deep-sea explorations that surveyed different seamounts across the Salas y Gómez Ridge found that the fauna on every seamount has a unique community composition, with nearly no species shared between opposite ends of the ridge (Comité Oceanográfico Nacional de Chile 2017). These results indicate that each seamount of this region is unique, and it is therefore not enough to protect only some of them. Furthermore, these deep-sea explorations have documented numerous species that are new to science (Parin & Shcherbachev 1982; Anderson & Johnson 1984; Parin & Kotlyar 1989; Parin & Sazonov 1990; Parin 1992; Garth 1992; McCosker & Parin 1995; Galil & Spiridonov 1998; Anderson & Springer 2005; Anderson 2008; Motomura et al. 2012; Schwarzhans 2014; Easton et al. 2019; Sellanes et al. 2019). For instance, limited remotely operated vehicle (ROV) surveys at 160-280 m depths recorded six new species of fishes (Easton et al. 2017), as well as two new genera of echinoderms (Mecho et al. 2019). This high rate of new species discoveries indicates that the marine fauna of this region still contains a large number of undiscovered species, which represent an enormous opportunity for future scientific exploration and conservation (Reiswig & Araya 2014; Fernández et al. 2014; Easton et al.

2017). As an example, living individuals of the gastropod *Architectonica karsteni* were recently found on seamounts of the Nazca Ridge (Asorey et al. 2020). This ancient gastropod was previously only known from this region from Miocene paleontologic records in Chilean waters.

The deep waters of the Salas y Gómez and Nazca ridges intersects a region that has some of the most oxygen poor waters in the world (Ulloa & Pantoja 2009; Fuenzalida et al. 2009; Espinoza-Morribedon et al. 2019). While there is very limited information of the deep-water fauna in this oxygen minimum zone, studies in other parts of the world have shown that such deoxygenated waters host a unique assemblage of species (Rogers 2000). Much like the Humboldt Current System (see above), the oxygen minimum zone near the Salas y Gómez and Nazca ridges may act as an additional biogeographical barrier to dispersal, thereby leading to an increase of deep-water speciation in this region (Rogers 2000).

International conservation distinctions

As a result of its unique biodiversity, as well as its ecological and cultural significance, the Salas y Gómez and Nazca ridges have been highlighted by numerous international bodies and organizations. In 2014, the Salas y Gómez and Nazca ridges were recognized as an ecologically or biologically significant marine area (EBSA) at the 12th Meeting of the Conference of the Parties (CBD 2014), following a regional workshop to facilitate the description of EBSAs in the Eastern Tropical and Temperate Pacific (Figure 2; CBD 2013). Prior to the workshop, Parties, Governments and other organizations provided detailed scientific justifications to describe potential EBSAs (CBD 2012). Two separate scientific proposals were submitted for the Salas y Gómez and Nazca ridges that summarize the ecological significance of this region (Gálvez 2012a; Yáñez et al. 2012). As defined by the Conference of the Parties to the Convention of Biological Diversity, EBSAs are significant marine areas that are in need of protection or enhanced management and are evaluated based on seven criteria, including uniqueness, special importance for life history stages of species, importance for threatened or endangered species, vulnerability, biological productivity, biological diversity, and naturalness (CBD 2008). The Salas y Gómez and Nazca ridges were determined to be of high importance on all but two of the EBSA criteria (productivity and rarity), thereby underscoring the exceptional importance of protecting this region (CBD 2014).

In addition to its distinction as an EBSA, the Salas y Gómez and Nazca ridges have also been recognized as an important area by experts consulted by the Global Ocean Biodiversity Initiative (GOBI) and the Census of Marine Life on Seamounts (CENSEAM) (Dunstan et al. 2011; Gálvez 2012b). Furthermore, these ridges were recognized by Mission Blue as a Hope Spot, which are special places that are scientifically identified as critical to the global health of our ocean (MPAtlas 2020). The islands of Salas y Gómez, San Félix and San Ambrosio are all considered Important Bird Areas (IBA) by BirdLife International, as these islands host important colonies of Christmas Island Shearwater, Masked Booby, White-throated Storm-Petrel, Defilippi's Petrel, and Chatham Petrel (CBD 2017). These islands, as well as Rapa Nui, are considered key biodiversity areas (KBA) by the KBA Partnership Program (KBA 2020). The waters around Salas y Gomez Island and the Desventuradas Islands are both considered critical habitats, as defined by the criteria of the International Finance Corporation's Performance Standard (Martin et al. 2015).

The island of Rapa Nui includes one of the most renowned archaeological sites on Earth, which has been distinguished globally as a World Heritage Site by the United Nations, Educational, Scientific and Cultural Organization (UNESCO 1995). The broader region that contains the Salas y Gómez and Nazca ridges represents the easternmost extent of the Polynesian Triangle, a region with an exceptionally rich and long history of seafaring cultures (Anderson 2008; Ioannidis et al. 2020).

Several studies have recently been conducted to identify priority conservation areas in ABNJ (Clark et al. 2014; Visalli et al. in press; Clark & Reville 2020; Wagner et al. accepted; Sala et al. in review). While these studies used widely different approaches and datasets, all of them identified the Salas y Gomez and Nazca ridges as one of the most important areas to protect in ABNJ globally.

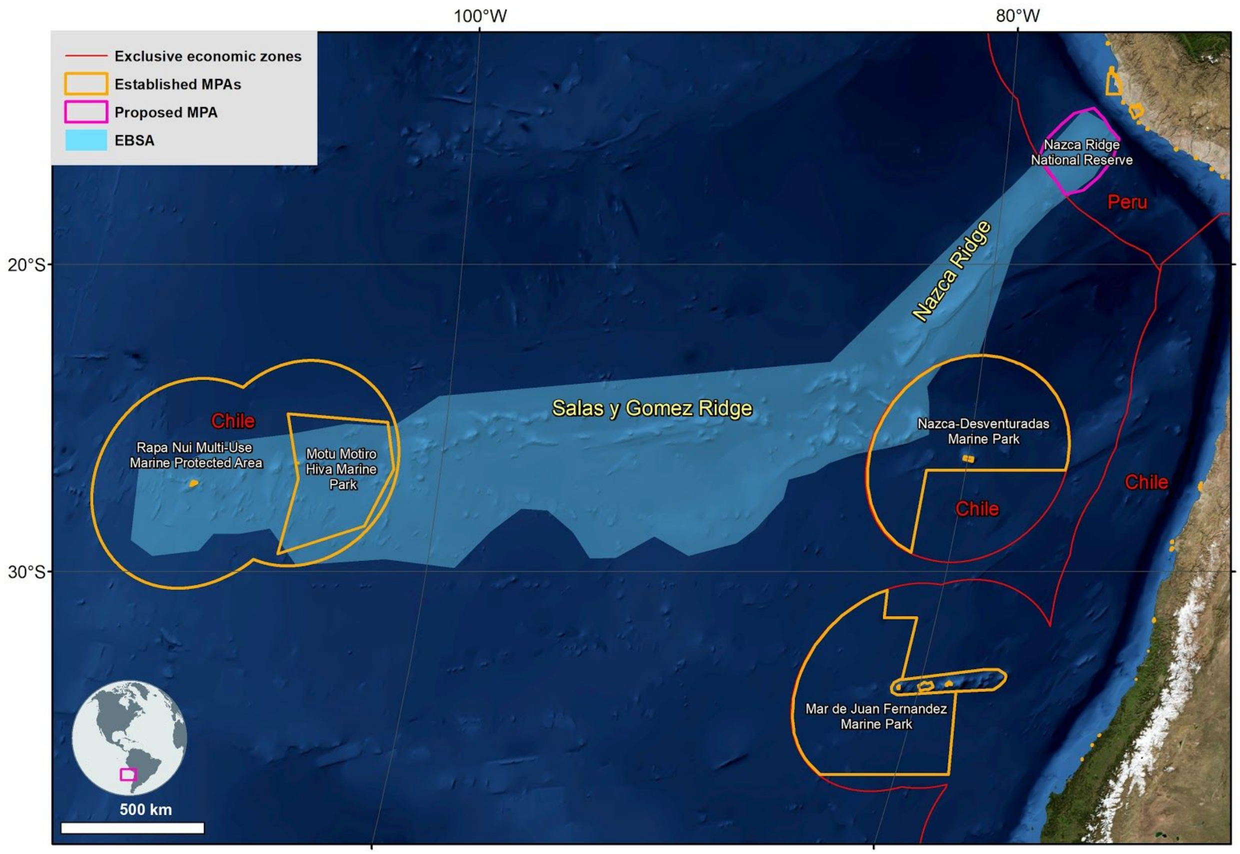

Figure 2. *Map showing the location of the ecologically or biologically significant area (EBSA) around the Salas y Gómez and Nazca ridges, as well as established and proposed marine protected areas (MPAs) in the region. Established MPA data from the WDPA (2020), and proposed MPA data from SERNANP (2020). EBSA data from the Convention of Biological Diversity.*

Existing marine protections

As a result of the exceptional natural and cultural significance of the region, several protected areas have been established in and around the Salas y Gómez and Nazca ridges (Figure 2). Within Chilean waters of the region there are four marine protected areas (MPAs). These include (1) the Mar de Juan Fernández Marine Park, which is a no-take MPA designated in 2018 that protects 262,000 km^2 offshore of the Juan

Fernández Archipelago, in addition to a multi-use area of 24,000 km^2 around the islands, (2) the Nazca-Desventuradas Marine Park, which is a no-take MPA designated in 2015 that protects 300,035 km^2 around the islands of San Félix and San Ambrosio, (3) the Motu Motiro Hiva Marine Park, which is a no-take MPA designated in 2010 that protects 150,000 km^2 around Salas y Gómez Island, and (4) the Rapa Nui Multi-Use Marine Coastal Protected Area designated in 2018, which is currently planned to ban all industrial fishing and deep-sea mining in the 579,368 km^2 around Easter Island, but allow the Rapa Nui people to fish with traditional methods (WDPA 2020). The Rapa Nui Multi-Use Marine Coastal Protected Area is currently the largest MPA in the Americas (Paredes et al. 2019). Furthermore, Rapa Nui National Park and World Heritage Site protects 68 km^2 or 40% of the land of Easter Island, and the Salas & Gómez Nature Sanctuary protects all of the 0.15 km^2 of land on Salas y Gómez Island (WDPA 2020). Since 2014, all seamounts located within the Chilean waters of this region are protected from bottom trawling by the Chilean Vulnerable Marine Ecosystems Law (Martínez et al. 2015).

Within Peruvian waters of this region, there is a proposal to create the Nazca Ridge National Reserve, which would protect 62,392 km^2 around the Nazca Ridge (Figure 2; SERNANP 2020). Specifically, the proposed reserve seeks to prohibit all fishing activities at depths deeper than 600 m, thereby protecting all of the seafloor from fishing activities (SERNANP 2020).

While the recent efforts by Chile and Peru provide important advances to safeguarding the unique biodiversity and cultural resources of this region, all of the seamounts that fall within ABNJ are unprotected and under threat. Importantly, ABNJ represent the largest portion of the Salas y Gómez and Nazca ridges, as well as the most threatened from a myriad of impending stressors (see below).

Fishing activity

Soviet trawling occurred on seamounts of the Nazca and Salas y Gómez ridges for Jack mackerel and redbaits in the 1970s and 1980s (Parin et al. 1997; Arana et al. 2009; Clark 2009). On seamounts around the Juan Fernández Archipelago, a commercial fishery for orange roughy and alfonsino developed in 1998, but was closed in 2006 following decreasing catches. Despite the closure, damage caused by bottom trawling was seen even a decade later during ROV surveys (M. Gorny pers. comm). On the Nazca Ridge, Chilean and Russian vessels have fished for Chilean jagged lobster and golden crab (Parin et al. 1997; Payá et al. 2005; Gálvez-Larach 2009; Vega et al. 2009; Yáñez et al. 2009; Clark 2009; Arana 2014). On the Salas y Gómez Ridge, there has been historic pelagic long-line fishing, which has impacted sharks and other pelagic species (Gálvez 2012b; Friedlander et al. 2013).

There has been historical fishing targeting Jack mackerel, squid, tuna and swordfish on the Salas y Gómez and Nazca ridges (Gálvez-Larach 2009; Vega et al. 2009; Morales et al. accepted). However, today most of the fishing in this region targets pelagic species and is primarily focused on ABNJ outside Peruvian national waters of the Nazca Ridge (Figure 3; Global Fishing Watch 2020). Catch data on Jack mackerel, squid and orange roughy in this region are available from the South Pacific Regional Fishery Management Organization (Table 1; SPRFMO 2020a), whereas catch data on tuna and swordfish are available from the Inter-American Tropical Tuna Commission (IATTC 2020). Additional fishing effort data in this region are available from Global Fishing Watch (2020; Figure 3; Table 2).

Table 1. *Recent catch data for species managed by the South Pacific Regional Fishery Management Organization (SPRFMO) in the Salas y Gómez and Nazca Ridges Ecologically or Biologically Significant Marine Area (see Figure 2). Data source SPRFMO (2020a).*

Common name	Species	Years	Effort (hrs)	Comment
Orange roughy	*Hoplostethus atlanticus*	2007-2017	0	Fishery closed since 2006
Squid	*Dosidicus gigas*	2008-2015	20.5	Only effort recorded in 2016 (all other years it was zero)
Jack mackerel	*Trachurus murphyi*	2008-2016	2.17	Only effort recorded in 2011 (all other years it was zero)
Unidentified bony fishes	Osteichthyes	2008-2015	297	Only effort recorded in 2008 (all other years it was zero)

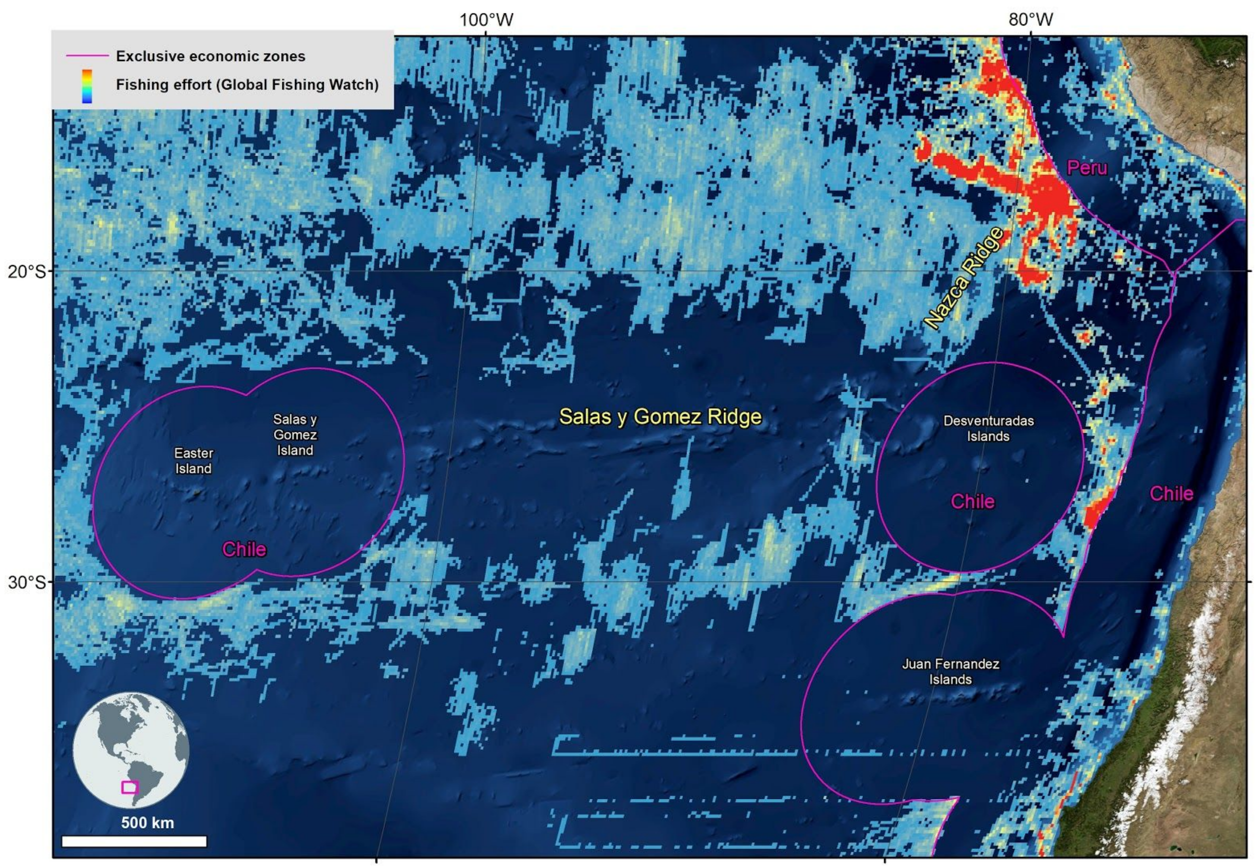

Figure 3. *Map showing annual fishing effort around the Salas y Gómez and Nazca ridges in 2016. Fishing effort data from Global Fishing Watch (2020).*

Table 2. *Total annual fishing effort by vessel class for the Salas y Gómez and Nazca Ridges Ecologically or Biologically Significant Marine Area (see Figure 2). All data reported as hours of fishing effort. Data source Global Fishing Watch (2020).*

Vessel Class	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total	Annual mean
Squid jigger	82,578	120,531	145,632	172,948	192,630	196,833	199,209	194,899	182,322	1,487,582	165,287
Drifting longlines	56,785	72,650	73,405	76,751	76,333	81,127	83,902	84,225	80,089	685,267	76,141
Unknown	39,445	53,249	52,125	62,329	66,677	71,959	97,443	101,704	105,988	650,919	72,324
Non-fishing	4,478	7,591	8,205	9,407	10,190	11,413	10,703	10,732	6,146	78,865	8,763
Pole & line	2,266	2,266	2,266	2,266	5,966	6,914	15,510	16,435	13,411	67,300	7,478
Tuna purse seines	1,518	2,777	3,193	3,954	4,331	5,490	6,323	6,077	5,514	39,177	4,353
Seismic vessel	1,572	1,572	1,572	1,572	1,572	3,876	3,876	3,884	8	19,504	2,167
Specialized reefer	736	736	771	771	1,214	1,176	1,693	1,693	1,174	9,964	1,107
Tug	0	1,500	1,502	1	1	1,502	1,502	1,502	1,502	9,012	1,001
Cargo or tanker	612	612	1,015	869	801	869	1,015	1,194	287	7,274	808
Trawlers	382	446	502	534	565	613	616	626	593	4,877	542
Other purse seines	27	107	107	202	202	375	541	602	594	2,757	306
Passenger	0	0	0	435	443	451	451	451	16	2,247	250
Purse seines	0	0	0	48	48	117	126	126	57	522	58
Patrol vessel	0	0	0	0	0	0	0	167	0	167	19
Set longlines	16	16	16	16	16	16	16	16	16	144	16

As noted above, the orange roughy fishery has been closed in this region since 2006, and therefore there is no current catch data from the Salas y Gómez and Nazca ridges (Table 1; SPRFMO 2020a). According to data reported by SPRFMO, squid fishing is also low in the area that contains the Nazca and Salas y Gómez Ridges EBSA. In 2008-2015, SPRFMO catch data only shows two vessels fishing in the area, for a cumulative time of 20.5 hrs (Table 1). Noteworthy, Global Fishing Watch data shows that squid jiggers were considerably more active in this region in 2012-2020 (Table 2). SPRFMO reported catch data for Jack mackerel and other unidentified bony fishes is also low in this region (Table 1). In 2008-2016, the total cumulative fishing effort was 2.17 hrs for Jack mackerel and 297 hrs for other unidentified bony fishes (SPRFMO 2020a). The total amount of Jack mackerel caught in this region from 2010-2016 was zero (SPRFMO 2020a).

Longline and purse seine catch data from IATTC indicate that six fleets (China, Colombia, Ecuador, Peru, Japan and Spain) are responsible for the majority of the catch targeting tuna-like species in the vicinity of the Nazca and Salas y Gómez ridges. In 2013-2017, the Chinese longline fleet caught 438 tons of fish in the area, 88% of which were albacore. Of this volume, approximately 81% was caught in an area north of the Salas y Gómez Ridge. The Chinese fleet obtained a higher catch of albacore and striped marlin within this area when compared to all other global fishing grounds. For all other fishery species, the Chinese fleet obtains higher catches outside the Salas y Gómez and Nazca ridges.

Table 3. *Total annual fishing effort by vessel flag for the Salas y Gómez and Nazca Ridges Ecologically or Biologically Significant Marine Area (see Figure 2) (*Vessel flags of countries that are members of SPRFMO; **Vessel flags of countries that are cooperating Parties. Data source [Global Fishing Watch (2020)](). *

Flag	2,012	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020	Total	Annual mean
China*	123,814	179,954	202,838	242,148	270,247	281,794	313,989	316,255	298,374	2,229,413	247,713
Spain	46,807	56,553	56,177	57,728	55,119	58,156	58,435	59,568	57,149	505,692	56,188
Japan	4,734	9,801	9,801	9,818	12,030	13,370	15,537	14,487	14,487	104,065	11,563
Taiwan	5,053	5,568	7,510	7,289	7,329	7,038	7,046	6,705	5,473	59,011	6,557
Republic of Korea*	5,455	5,373	5,710	5,710	5,710	6,316	6,316	6,316	6,316	53,222	5,914
Unknown	99	905	1,045	1,366	1,463	4,698	8,347	7,113	4,509	29,545	3,283
Peru*	66	1,064	1,145	2,156	2,680	3,666	4,167	4,276	4,276	23,496	2,611
Ecuador*	252	546	1,637	1,637	1,645	2,192	2,647	2,572	2,459	15,587	1,732
Portugal	1,727	1,727	1,727	1,727	1,727	1,727	1,727	1,727	323	14,139	1,571
Colombia**	709	827	827	827	691	827	827	827	691	7,053	784
Panama**	432	432	252	252	252	897	953	1,188	1,188	5,846	650
Belize	37	37	37	37	578	578	578	578	578	3,038	338
Venezuela	306	306	306	319	319	378	357	378	316	2,985	332
Vanuatu*	196	196	204	66	66	66	742	891	310	2,737	304
USA*	100	37	183	160	240	240	323	202	194	1,679	187
Mexico	0	51	121	141	157	281	281	281	211	1,524	169
Cambodia	302	302	302	302	302	0	0	0	0	1,510	168
Fiji	93	93	93	101	101	101	101	101	101	885	98
Namibia	0	48	48	64	96	112	152	168	168	856	95
Germany	68	68	68	68	0	68	68	68	68	544	60
Argentina	48	48	48	48	48	64	72	72	72	520	58
Iraq	0	0	0	0	0	0	0	176	176	352	39
United Kingdom	8	8	8	8	8	8	8	91	91	238	26
Chile*	16	16	16	25	25	25	25	25	17	190	21
French Southern Territories	0	0	0	0	0	0	92	92	0	184	20
Russia*	11	11	11	11	11	11	19	19	19	123	14
New Caledonia	0	16	16	16	16	16	16	16	8	120	13
Bolivia	0	0	0	0	41	0	24	24	24	113	13
Falklan Islands*	16	16	16	8	16	16	8	8	8	112	12
Saint Vincent & Grenadines	0	0	110	0	0	0	0	0	0	110	12
New Zealand*	8	8	8	8	8	16	16	16	16	104	12
Australia*	0	0	0	8	8	8	16	24	24	88	10
Canada	8	8	8	8	8	8	8	8	8	72	8
Iceland	8	8	8	8	8	8	8	8	8	72	8

Flag	2,012	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020	Total	Annual mean
Italy	0	8	8	8	8	8	8	8	8	64	7
Brazil	0	0	0	16	16	24	0	0	0	56	6
Mozambique	0	0	0	8	8	8	8	8	8	48	5
Senegal	0	0	0	8	8	8	8	8	8	48	5
Nicaragua	40	0	0	0	0	0	0	0	0	40	4
Cook Islands*	0	0	0	0	0	0	0	19	19	38	4
Cyprus	0	18	18	0	0	0	0	0	0	36	4
Honduras	0	0	0	0	0	0	0	11	11	22	2

Colombia's purse seine fleet mainly targets skipjack and yellowfin tuna and operates in a substantial portion of the Eastern Tropical Pacific. Within the Salas y Gómez and Nazca ridges, the Colombian fleet concentrates its efforts on the northern portion of the Nazca Ridge. In 2013-2017, catch per unit effort inside the region were between 143-354% higher when compared to the rest of the nearly 28 million square kilometers where the Colombian fleet operates (IATTC 2020).

The Ecuadorian fleet also concentrates its fishing effort in the northern section of the Nazca Ridge and targets bigeye, striped bonito, skipjack, and yellowfin, with skipjack tuna being most important. Catch per unit effort for yellowfin, skipjack, and bonito are higher within the region in comparison to all other fishing grounds where the Ecuadorian fleet operates. The Peruvian purse seine tuna fleet is relatively small and is essentially a coastal fleet operating north of the Nazca Ridge. In 2013-2017, this fleet did not operate in areas directly above seamounts of the Nazca Ridge or the Salas y Gómez Ridge (IATTC 2020).

The Japanese longline fleet operates in a vast area of the Pacific Ocean, but mostly north of the Salas y Gómez Ridge, and also on the Nazca Ridge. In 2013-2017, catch per unit effort for tuna on the Nazca Ridge was almost 26% higher than for all other Pacific fishing grounds.The Spanish longline fleet operates in close proximity of the Salas y Gómez and the Nazca ridges and targets Swordfish exclusively (Vega et al. 2009; IATTC 2020). In 2013-2017, the Spanish fleet caught more than 30% of its total catch within this region, and nearly 5% in areas north of the Nazca or Salas y Gómez Ridges. However, catch per unit effort was higher outside this region. Thus, although the Spanish fleet has caught large percentages of its total catch in this region, it has been much more productive outside of it (IATTC 2020).

Other threats

The majority of the Salas y Gómez Ridges and the southern portion of the Nazca Ridge are located near the center of the South Pacific Gyre, a large-scale oceanographic feature characterized by extremely nutrient-poor waters (Von Dassow & Collado-Fabbri 2014; González et al. 2019). This paucity of nutrients makes this region particularly susceptible to anthropogenic and climatic disturbances (Andrade et al. 2014). For example, model climate change predictions indicate that in the next 20-40 years the seafloor of this region will experience increases in temperature, pH, dissolved oxygen, and export of particulate organic carbon (Cheung & Levin 2018; Levin et al. 2020). These models further indicate that the Salas y Gómez and Nazca ridges will experience substantial negative impacts by 2100, with the Nazca

Ridge being most impacted. Plausible consequences of these changes include biogeographic range shifts, habitat loss, decreased biodiversity, and decreased resilience, among others.

Due to its proximity to the center of the South Pacific Gyre, concentrations of floating litter and marine debris are relatively high in this region, as these pollutants are concentrated and trapped in the circulating waters of this gyre (Ericksen et al. 2014; Boteler et al. 2019; van Gennip 2019; Luna-Jorquera et al. 2019). This litter severely affects many marine vertebrates, particularly sharks, fishes, turtles, birds and mammals, through entanglement and ingestion (Thiel et al. 2018).

There are no known oil or gas reserves on or near the Salas y Gómez or Nazca ridges (Lujala et al. 2007; García et al. 2020). However, seamounts on the Salas y Gómez and Nazca ridges are known to carry cobalt-manganese crusts of considerable cobalt grade, and commercially-valuable manganese nodules are known to exist on both sides of the Nazca Ridge (Figure 4; Hein et al. 2013; Miller et al. 2018; García et al. 2020; Toro et al. 2020). Polymetallic massive sulfides are known from hydrothermal vents located northwest of the Salas y Gómez Ridge (Figure 4; García et al. 2020). While there are currently no contracts to explore or prospect deep-sea minerals in this region (ISA 2020), these resources may attract mining interests in the future.

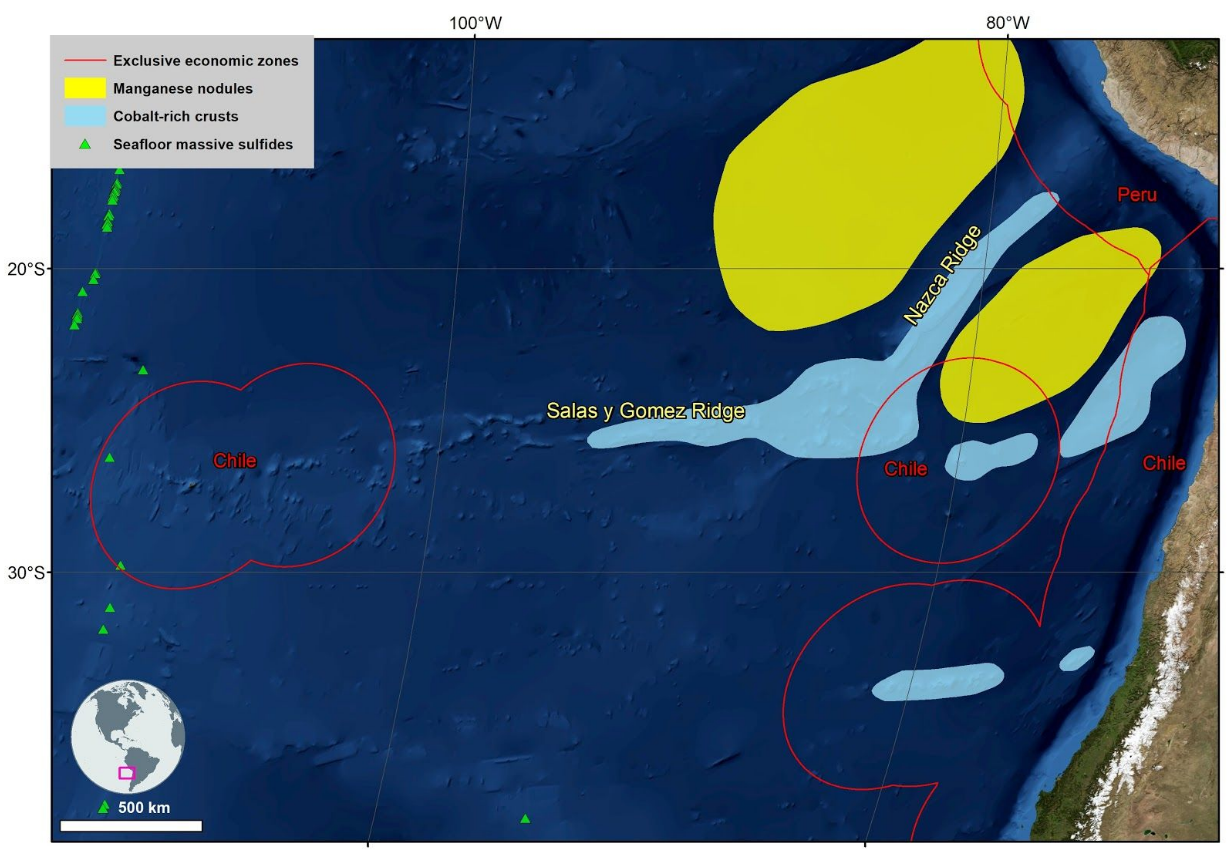

Figure 4. *Map showing the distribution of commercially valuable deep-sea minerals around the Salas y Gómez and Nazca ridges. Deep-sea mineral distribution data from Hein et al. (2013). Note that no oil or gas reserves are known to occur in this region (Lujala et al. 2007).*

Commercial shipping is relatively low throughout the waters of this region, with the exception of the northern section of the Nazca Ridge which intersects a major international shipping route (Figure 5; Halpern et al. 2015). There are also several submarine cables that run across the Nazca Ridge, including in ABNJ of this region (Figure 5; ICPC 2020). However, in comparison to other human activities in the deep sea, submarine cables are considered to have a relatively low impact on the environment. That said, since the Salas y Gómez and Nazca ridges provide habitat for many fragile benthic species like corals (Gálvez-Larach 2009; Gálvez 2012a; Yáñez et al. 2012; CBD 2017; Easton et al. 2019), any future cable laying through this area should be carefully evaluated and planned.

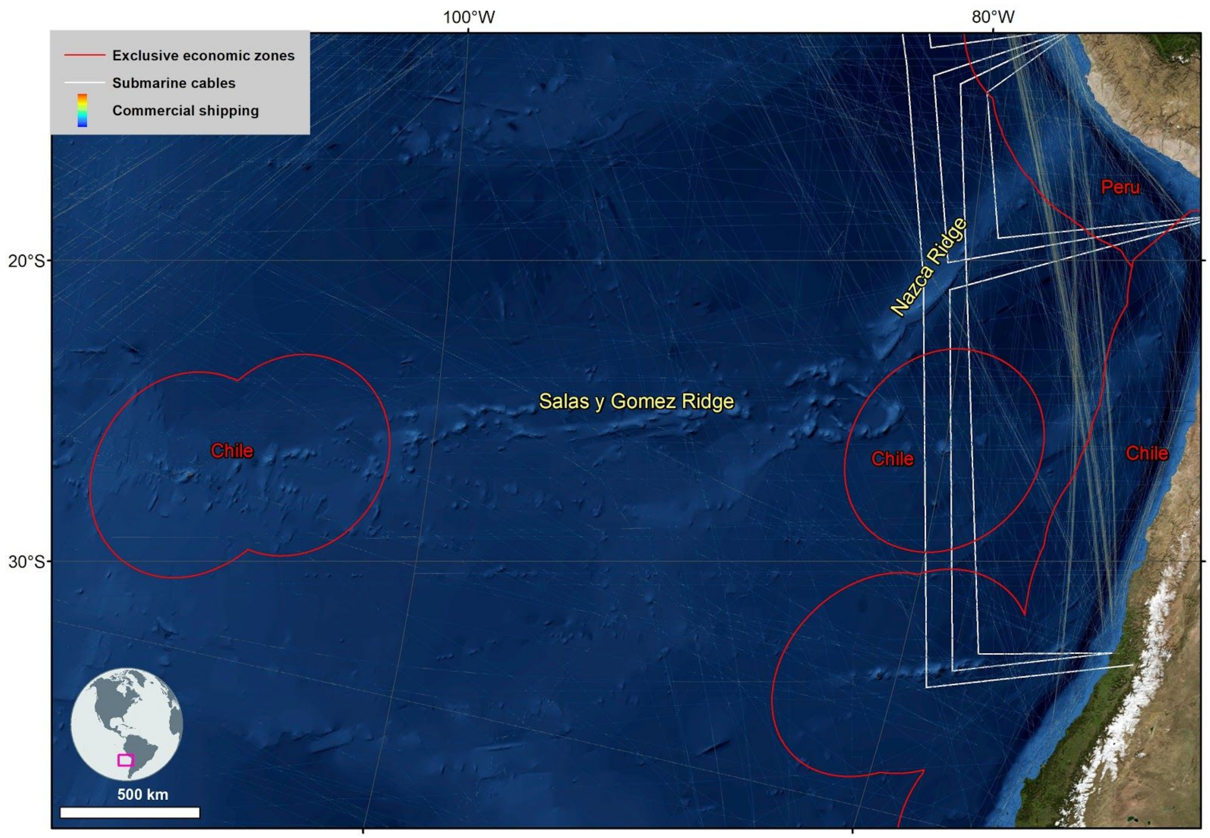

Figure 5. *Map showing the distribution of commercial shipping activity and known submarine cables around the Salas y Gómez and Nazca ridges. Submarine cable data from the ICPC 2020. Commercial shipping activity data from Halpern et al. (2015).*

Competent bodies in ABNJ of the Salas y Gómez or Nazca Ridges

The UN Convention on the Law of the Sea (UNCLOS) lays down rules governing uses of the ocean and its resources; however, it does not specify how States should conserve and sustainably use biodiversity in ABNJ. As a result, a host of regional and sectoral agreements covering sectors like fisheries, shipping, and mining were developed both before and after UNCLOS came into force in 1994. As in other ABNJ, human activities in international waters around the Salas y Gómez and Nazca ridges are regulated by different intergovernmental bodies, including the International Seabed Authority (mining), the International Maritime Organization (shipping), and regional fishery management bodies (fishing), specifically the Inter-American Tropical Tuna Commission (IATTC) for tuna and other highly-migratory fishery species, and the South Pacific Regional Fishery Management Organization (SPRFMO) for non-highly migratory fishery species (Durussel et al. 2017; Boteler et al. 2019). The Permanent Commission for the South Pacific (CPPS) is a strategic regional alliance that aims to consolidate the role of Chile, Peru, Ecuador and Colombia and foster their collaboration in marine policy, resource exploitation, conservation, environmental protection, and research (CPPS 2012a; Durussel et al. 2017). In 2012, CPPS member States signed the Galapagos Commitment, in which they commit to promote coordinated action regarding their interests in living and non-living resources in ABNJ (CPPS 2012b; Durussel et al. 2017; Boteler et al. 2019).

SPRFMO regulates fishery resources of non-highly migratory species located in high seas waters of the South Pacific Ocean, including the Salas y Gómez and Nazca ridges. There are 15 current members of SPRFMO (Australia, Chile, China, Cook Islands, Cuba, Ecuador, European Union, Denmark [in respect of the Faroe Islands], Republic of Korea, New Zealand, Perú, Russia, Chinese Taipei, USA, and Vanuatu), as well as four cooperating parties (Colombia, Curaçao, Liberia, and Panama). SPRFMO has implemented fishing effort measures, including total allowable catch, total allowable effort, and allocations by States for some fishery species. Additionally, SPRFMO prohibits the use of large-scale pelagic driftnets and deep-water gillnets, and has by-catch management measures in place for seabirds. SPRFMO maintains a vessel monitoring system, measures on control, inspections in port and at sea, regulates trans-shipment, and implements an on-board observer system. Since 2013, SPRFMO has implemented total allowable catch and total applied effort limitations for Jack mackerel.

Regarding bottom fishing, SPRFMO maintains measures for the identification of vulnerable marine ecosystems, with the opening of all new bottom-fishing areas requiring a research assessment of potential impacts. Specifically, all flagged vessels of SPRFMO member States and cooperating non-contracting Parties are not authorised to engage in bottom-fishing activities in the SPRFMO Convention Area without approval from the SPRFMO Commission (SPRFMO 2020b). Currently, areas that allow for bottom fishing in the SPRFMO Convention Area are all located in the Western Pacific, specifically in the Tasman Sea and the Louisville Ridge (SPRFMO 2020b).

The regulation of bottom fisheries by SPRFMO, and in fact the political impetus to establish SPRFMO in the first place, is a response to a series of United Nations General Assembly resolutions, beginning with Resolution 59/25 adopted in 2004, which commits States individually and through regional fishery management organizations to protect deep-sea biodiversity in ABNJ by managing bottom fisheries in a way that prevents significant adverse impacts on vulnerable marine ecosystems. United Nations General Assembly Resolution 61/105 adopted in 2006 called for the closure of areas where vulnerable marine ecosystems are known or likely to occur, unless bottom fisheries can be managed to prevent significant adverse impacts. These commitments have been reaffirmed and elaborated upon in subsequent resolutions adopted by the United Nations General Assembly. In addition, States have expanded upon these commitments to marine conservation more broadly, such as through the adoption of the 2030 Sustainable Development Goals (SDGs), in particular SDG 14, Target 2, which calls for avoiding significant adverse impacts on marine ecosystems and strengthening their resistance.

The IATTC is responsible for the conservation and management of tuna and other highly-migratory fishery resources in the eastern Pacific Ocean. IATTC has 21 members (Belize, Canada, China, Chinese Taipei, Colombia, Costa Rica, Ecuador, El Salvador, European Union, France, Guatemala, Japan, Kiribati, Republic of Korea, Mexico, Nicaragua, Panama, Peru, USA, Vanuatu, Venezuela) and five cooperating non-members (Bolivia, Chile, Honduras, Indonesia and Liberia). The geographical scope of IATTC covers both the national jurisdiction of its member States and the high seas in the Eastern Pacific, including those of the Salas y Gómez and Nazca ridges. The main fisheries species managed by the IATTC are yellowfin, albacore, skipjack, bigeye, Pacific bluefin tuna, and various species of billfish and sailfish. Conservation measures implemented by the IATTC include restricting purse-seine fishing activity through spatio-temporal closures (72-day annual closure of the entire fishery, as well as 30-day annual closure of an area west of the Galapagos Islands known as El Coralito), limiting the number of fish-aggregating devices each purse seine fishing vessel can have at a given time, and total annual catch limits for bigeye tuna caught by long-line fishing vessels (IATTC 2017).

The International Seabed Authority (ISA) regulates mineral-related activities in the international seabed beyond the limits of national jurisdiction, also known as the “Area” (Miller et al. 2018). It does so by giving out exploration and (in the future) exploitation leases for seabed minerals, as well as by designating areas of particular environmental interest (APEI), which are protected from future mining activities (ISA 2020). There are currently no exploration contracts for deep-sea minerals in the Area of the South Pacific, nor are any areas closed to mining in this region (Miller et al. 2018; ISA 2020). In other places in the Pacific, ISA has previously issued exploration contracts in the Clarion Clipperton Zone and the North West Pacific, and is currently developing regional environmental management plans (REMPs) for the North West Pacific. There are no current discussions for REMPs for the South Pacific in the Area surrounding the Salas y Gómez and Nazca ridges.

The International Maritime Organization (IMO) regulates international shipping activities, including through the designation of particular sensitive sea areas (PSSAs), which may be protected by ship routing measures, such as areas to be avoided by all ships, or by certain classes of ships (Prior et al. 2010; Boteler et al. 2019). There are currently no PSSAs anywhere in international waters, nor are there any PSSAs or shipping route limitations around the Salas y Gómez and Nazca ridges. However, with the exception of the northern section of the Nazca Ridge, this region does not contain any major commercial shipping routes (Figure 5; Halpern et al. 2015). Additionally, through the International Convention for the Prevention of Pollution from Ships (MARPOL), IMO defines certain sea areas as "special areas" in which the adoption of special mandatory methods for the prevention of sea pollution is required. There are no MARPOL special areas in the South Pacific. Within the Chilean waters of this region, the Chilean Navy is currently developing higher standards for ballast water release within the Rapa Nui Multi-Use Marine Coastal Protected Area and the Motu Motiro Hiva Marine Park.

The Permanent Commission of the South Pacific (CPPS) is a strategic regional alliance that aims to foster collaboration in marine policy, conservation, and research amongst its members. CPPS has four member States (Chile, Peru, Ecuador, and Colombia), and the CPPS is also the Executive Secretariat of the Southeast Regional Seas Programme, to which Panama is also a member. CPPS promotes mechanisms for political coordination between these five States on marine pollution, including on the development and management of MPAs. While the jurisdiction of CPPS generally lies in the national jurisdictions of its member States, under Article 1 of the 1981 Lima Convention, the CPPS jurisdiction can extend to adjacent high seas areas that could be affected by marine pollution (CPPS 2012a; Durussel et al. 2017). CPPS has an active working group on marine biological diversity in ABNJ, whose main goal is studying, monitoring and advising about conservation and sustainable use in these areas.

As noted above, a host of regional and global agreements covering different sectors regulate human activities in international waters around the Salas y Gómez and Nazca ridges. To date, there has been a lack of coordination between many of these international bodies. To overcome these challenges, in 2015 the United Nations General Assembly agreed to develop an international legally-binding instrument under UNCLOS on the conservation and sustainable use of marine biological diversity in ABNJ. The negotiations for the treaty are still ongoing, with the fourth and final scheduled session being postponed as a result of the international coronavirus crisis.

Importance of protecting international waters of the Salas y Gómez or Nazca ridges

Many previous studies have documented the extraordinary biological, ecological, oceanographic, geological, and cultural significance of the Salas y Gómez and Nazca ridges. These studies noted not only the remarkable uniqueness of species and habitats of this region, but also their vulnerability to impending impacts. As a result, Chile has already protected most of the habitats of the region that fall within its jurisdiction, and Peru is considering a proposal to protect a large portion of the deep-water habitats that lie within its national waters. However, the majority of the seamounts in this region fall in ABNJ, where they are unprotected and already being impacted by climate change and plastic pollution, with deep-sea mining and overfishing looming in the future. Deep-water surveys of this region have noted that every seamount has a unique faunal composition (Comité Oceanográfico Nacional de Chile 2017), thereby emphasizing that it is not enough to protect only some of them. While the recent efforts by Chile and Peru to establish MPAs in the national waters of this region provide important advances, these efforts could be undermined if surrounding ecosystems in ABNJ cannot be properly conserved.

The nutrient poor waters that surround a big portion of the Salas y Gómez and Nazca ridges makes this region particularly susceptible to climate change impacts, which are predicted to intensify substantially in the next decades. According to United Nations General Resolution 71/123 (article 185), regional fishery management organizations should take into account the potential impacts of climate change in taking measures to manage deep-sea fisheries and protect vulnerable marine ecosystems. The high seas play a critical role as a global carbon sink (Heintze et al. 2015; Li et al. 2019), and protecting international waters of the Salas y Gómez and Nazca ridge would represent an important global contribution towards mitigating impacts of anthropogenic carbon emissions.

Importantly, fishing effort has been relatively low in this region, and thereby there is a unique opportunity to protect the extraordinary cultural and natural resources of this region, without significantly impacting the fishing industry. According to SPRFMO data, recent catch data in the waters around the Salas y Gómez and Nazca ridges has been minimal (SPRFMO 2020a). Thus, protection of this area would have low impacts on fishing activities managed by SPRFMO. Protecting this area would, however, have major global benefits for ecosystem connectivity, climate regulation, food security, and other ecosystem services. Seamounts and other deep-water habitats found on the Salas y Gómez and Nazca ridges represent important reservoirs of global marine biodiversity (Appeltans et al. 2015), and via connectivity with surrounding waters, they also play a critical role of sustaining productivity more broadly (O'Leary & Roberts 2008). Furthermore, protecting this region would be seen as a great accomplishment to the world as a whole, and provide a global example for conserving biodiversity in ABNJ. Specifically, it would establish an example of a high seas protected area being established by neighboring countries that have similar interests in a shared ecosystem, thereby showcasing global leadership. This has already been successfully done in other high seas areas by member countries of the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) and the Convention on the Conservation of Antarctic Marine Life (CCAMLR), which established marine protected areas in ABNJ of the Northeast Atlantic and Southern Ocean, respectively (Durussel et al. 2017). These successful examples highlight that high seas protected areas are possible, but require international cooperation and coordination.

Moreover, all of the other regional fishery management organizations with the legal competence to manage bottom fisheries in ABNJ have established closed areas to protect vulnerable marine ecosystems and biodiversity. Increased protections in this region would therefore also be consistent with the commitments adopted through the United Nations General Assembly resolutions on bottom fisheries, the Sustainable Development Goals and other marine conservation objectives and obligations, including the obligation to protect habitats of special concern and biodiversity in Articles 5-6 of the 1995 United Nations Fish Stocks Agreement.

While the ongoing negotiations by the United Nations provide hope that there may soon be a mechanism to protect marine biodiversity in ABNJ, sectoral organizations like SPRFMO, IATTC, IMO and ISA already have mechanisms to protect the unique biodiversity of the region from harmful practices. For most of the ABNJ there is very little scientific information available, thereby making conservation planning difficult. In contrast, there is a great amount of scientific information available for the Salas y Gómez and Nazca ridges, all of which indicates that this region is of great natural and cultural significance, as well as threatened by a myriad of impending impacts. Commercial activities in this region are still absent or relatively low, so there is a time-sensitive opportunity to conserve its natural and cultural resources before they are lost forever.

Proposed regulations by SPRFMO

We propose to close the waters that are located in ABNJ of the area that was designated as an EBSA to fishing activities regulated by the SPRFMO (Figure 6). This area includes an important collection of seamounts of the southeastern Pacific Ocean and encompasses an area of approximately 1,097,846 km^2 (Figure 6). Fishing activities of species managed by SPRFMO have been minimal to nonexistent in recent years (SPRFMO 2020a). Specifically, the orange roughy fishery has been closed in this region since 2006, and fishing effort for squid and Jack mackerel have been minimal (Table 1; SPRFMO 2020a). Thus, these proposed regulations would cause little to no impact on ongoing fishing operations, however, they would provide enormous advances in safeguarding the unique biodiversity of this region from future threats. Furthermore, they would showcase the global leadership of SPRFMO and its member countries.

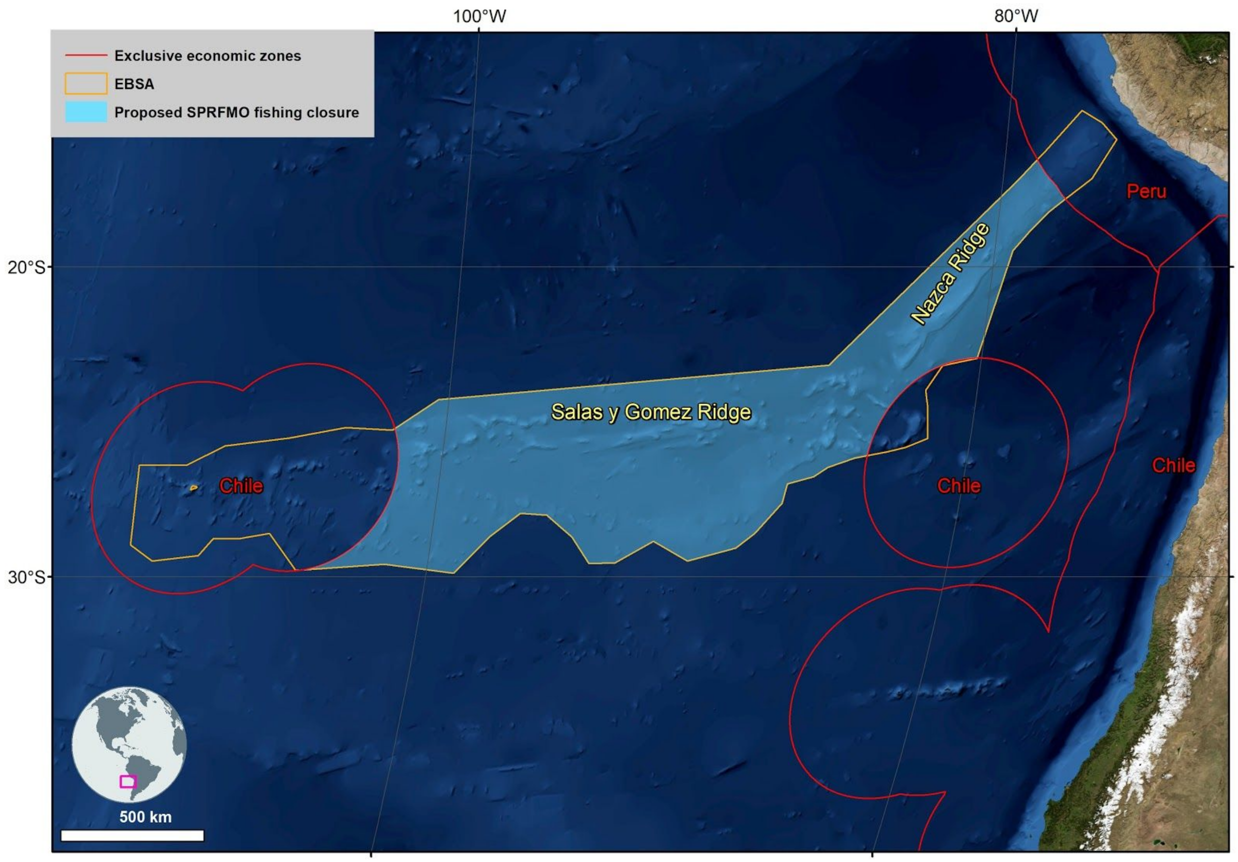

Figure 6. *Map showing the location of the proposed SPRFMO fishing closure. Fishing activities of species managed by SPRFMO have been minimal to nonexistent in recent years (see Table 1).*

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