



## Protecting the Salas y Gomez and Nazca Ridges: A review of policy pathways for creating conservation measures in the international waters of the Southeast Pacific

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### ABSTRACT

Seamount ecosystems host ecologically important species, including many that are found nowhere else on Earth. The Salas y Gomez and Nazca Ridges, two adjacent seamount chains in the Southeast Pacific, are biodiversity hotspots marked by the highest levels of marine endemism on Earth. Historically isolated from many human activities, this region has produced a unique biodiversity and provides an excellent opportunity for protecting a global biodiversity hotspot before it is degraded. However, no legal protection mechanism currently exists for comprehensively protecting areas beyond national jurisdiction (ABNJ) of the Salas y Gomez and Nazca Ridges. After years of negotiations at the United Nations for a legally binding instrument to address conservation in ABNJ, the Biodiversity Beyond National Jurisdiction (BBNJ) Agreement was finally agreed in March 2023. While this Agreement may provide one avenue for protecting the high seas, the Agreement has yet to be adopted and ratification may take several years. As it stands, conservation efforts in ABNJ will rest on sectoral bodies primarily set to manage large-scale industries like fishing, shipping, and mining, but that do have the ability to enact conservation measures other than restricting these industrial activities. Our study provides an overview of the major international organizations managing activities in the ABNJ of the Salas y Gomez and Nazca Ridges, identifies current conservation measures, and maps out potential policy pathways for creating conservation measures in this unique region. Our synthesis focused on identifying conservation procedures within the documents of international organizations and applying their rules and procedures to implement conservation measures. We identify three potential pathways. A regional and national pathway that relies on cooperation among international organizations spearheaded by the South Pacific Regional Fisheries Management Organization (SPRFMO), and an international pathway through the BBNJ Agreement.

### 1. Introduction

Over 60% of the ocean lies in areas beyond national jurisdiction (ABNJ) [110], yet only 1.2% lie within marine protected areas (MPAs), ocean spaces where human activities are limited or prohibited [62,63,70]. Thus, the waters and seabed in ABNJ represent one of the Earth's

last resource management and conservation frontiers [5]. ABNJ contain 90% of the available habitat for life in our ocean [52,87] and comprise most of the Earth's interconnected oceans, hosting complex ecosystems that play vital roles in sustaining life and providing goods and services [48]. Biological diversity found within ABNJ is mostly unprotected, with mounting pressure from human activities ([48]; Yadav and Gjerde et al.

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[110]). Oceanic seamounts and coral ecosystems, found throughout ABNJ, are considered among the most fragile environments to anthropogenic activities and climate change [8,38,65,82,106]. These habitats harbor unique ecosystems, species, and ecological processes that exist nowhere else on Earth [106]. An integrated approach for the conservation of ABNJ is urgently needed to protect these important marine ecosystems from anthropogenic impacts ([32,48,65,82]; Wagner et al. [105]).

The Salas y Gomez and Nazca Ridges are recognized as an Ecologically and Biologically Significant Area (EBSA) by the United Nations Convention on Biological Diversity (CBD [13]; Wagner et al., [105]; Wagner et al. [107]; and references therein). This region is also recognized as an important area by the Global Ocean Biodiversity Initiative and the Census of Marine Life on Seamounts, highlighting its ecological value and need for protection ([13]; Wagner et al. [105]; [90]). These two adjacent seamount chains in the Southeast Pacific have the highest known level of marine endemism on Earth ([13,38,40,41,46,65,104]; Wagner et al. [105]). Similarly, recent studies provide evidence that this region has numerous vulnerable marine ecosystems (VMEs) and endemic taxa of high natural significance and conservation value [38, 43,46,108]. The United Nations General Assembly (UNGA) has passed resolutions 61/105 & 59/25 for the identification and protection of VMEs from the effects of bottom fisheries [97], and calls on States and Regional Fishery Management Organizations (RFMOs) to protect VMEs, including through the closure of areas to fishing [2,3,36,46]. The Food and Agriculture Organization (FAO) of the United Nations is the body responsible for setting the guidelines for the identification and conservation of VMEs, but does not hold the power to designate VMEs. The protection of VMEs centers on the presence of “distinct, diverse benthic assemblages that are limited and fragmented in their spatial extent, and dominated by rare, endangered or endemic component species that are physically fragile and vulnerable to damage by human activities” ([2], p. 2). Furthermore, UNGA resolution 64/72 specifically calls on RFMOs to implement appropriate protocols to protect VMEs from significant adverse impacts and implement FAO guidelines for the management of deep sea fisheries in the high seas [89]. Despite international recognition towards the need for protecting the ABNJ of the Salas y Gomez and Nazca Ridges, and its diverse benthic assemblages and endemic species, this global biodiversity hotspot remains unprotected.

Ecosystems in international waters such as the Salas y Gomez and Nazca Ridges have been difficult to protect. Historically, most marine conservation measures have been developed near coastal areas within national jurisdiction [57,68,74], which does not have the governance complexities of working within ABNJ [48]. There continues to be a lack of awareness that globally important ecosystems exist in the remote high seas [29,31,48,106]. ABNJ are characterized by a fragmented and polycentric management structure, which lacks cooperation and harmonization among global and regional actors ([5,11]; De Santo et al. [26]; [51,79,110]). To date, only two regional sea Conventions have implemented MPAs in ABNJ [87]. Two MPAs have been established in the Southern Ocean by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), and several others in the Northeast Atlantic through a collective arrangement between the Oslo Paris (OSPAR) Commission and the North-East Atlantic Fisheries Commission (NEAFC) [24,26,87].

Unlike CCAMLR or the collective Arrangement between the OSPAR Commission and NEAFC, the Southeast Pacific lacks a regional seas Convention or Agreement. This is the case in most ABNJ, where the mandate to conserve biodiversity is divided and rests with various sectoral bodies that were primarily set up to manage large-scale industries like fishing, shipping, and mining. Historically, there has been little coordination between RFMOs and other sectoral bodies operating in ABNJ [110], despite the overlapping issues affecting their mandates, particularly in terms of impacts to biodiversity. RFMOs have been criticized for failing to achieve their conservation objectives, with few attempts to coordinate activities, mitigate conflicts, and address

cumulative impacts, such as overfishing, bycatch, climate change adaptation, and managing shared fish stocks sustainably [5,51,56,77, 79]. Their narrow remit coupled with governance gaps and limited coordination emphasize the current challenges of managing marine ecosystems in ABNJ [73].

Under this framework the management of the Salas y Gomez and Nazca Ridges is fragmented. Fishery resources are managed by the South Pacific Regional Fisheries Management Organization (SPRFMO) and the Inter-American Tropical Tuna Commission (IATTC). SPRFMO whose conservation remit encompasses “fish within the Convention Area, including: molluscs; crustaceans; and other living marine resources” ([92], p. 2) makes legally binding decisions on deep sea fisheries in the region [72]. Whereas IATTC has a conservation remit for the “conservation and management of tuna and tuna-like species, associated species and their ecosystems” [54]. Unlike SPRFMO, IATTC has no competence in the field of conservation and management of deep sea fisheries [72]. Additionally, the International Maritime Organization (IMO) manages shipping, and the International Seabed Authority (ISA) manages seabed mining for the ABNJ of the Southeast Pacific. For the RFMOs, the United Nations Fish Stock Agreement (UNFSA), provides a set of obligations and conservation frameworks that obliges States and RFMOs to “assess the impacts of fishing, other human activities and environmental factors on target stocks and species belonging to the same ecosystem” ([98], Part II Article 5d, p. 4) and assess impacts on “non-target and associated or dependent species and their environment” ([98], Part II Article 6–3d, p. 4) [73]. While the UNFSA calls for the conservation of species and ecosystems in ABNJ, a lack of comprehensive coordination between RFMOs complicates the implementation of conservation measures across the high seas [5,48,64].

To overcome these challenges, in 2015 the UNGA agreed to develop a legally-binding instrument under the United Nations Convention on the Law of the Sea (UNCLOS) on the conservation and sustainable use of marine biological diversity in ABNJ, also known as the Biodiversity Beyond National Jurisdiction (BBNJ) Agreement [96,99]. The BBNJ Agreement sets the basic framework via a Conference of Parties for regulating human resource use throughout the high seas, as well as providing an additional pathway to implement the obligation to protect rare and fragile ecosystems (see UNCLOS articles 192 and 194(5), 1982) [100]. In accordance with UNGA resolution 72/249, the negotiations addressed “the conservation and sustainable use of marine biological diversity in ABNJ in particular, together and as a whole, marine genetic resources, including questions on the sharing of benefits, measures such as area-based management tools (ABMTs), including marine protected areas, environmental impact assessments and capacity-building and the transfer of marine technology” ([7], p. 1). The BBNJ Agreement provides a potential opportunity to enhance cooperation and coordination of management bodies under one legal framework, without undermining existing legal instruments and frameworks such as RFMOs [23, 78,101,104]. The fifth and final meeting resumed in February 2023 and a new agreement for the high seas was reached. Once adopted and opened for signature, the BBNJ Agreement still needs to be ratified by UN member States, which could take several years. Once it is entered into force it could provide a streamlined process for high seas conservation.

The BBNJ Agreement may provide one avenue for the protection of ecosystems in ABNJ in the future. However, given uncertainties about when the Agreement will enter into force, and time to establish the BBNJ organization, identifying currently available conservation measures in ABNJ is warranted [39]. In this paper, we define best available conservation measures as rulings that (1) are legally binding on the contracting parties of the decision making center and (2) meet the mandates outlined by their Convention. Best available conservation measures can operate within the remit of the decision making body such as mining closures (e.g., through the ISA), fishing gear restrictions (e.g., through an RFMO), or marine spatial planning through multisectoral engagement (e.g., two RFMOs or an RFMO and the ISA). While MPAs have been

identified as one of the most important tools to conserve biodiversity, manage fisheries, and mitigate threats to marine systems [11,14,62,63,85,109], they are not the only tool for ocean conservation, and their effectiveness rests on being well-designed and managed [16,33]. Other tools, such as fishing closures and spatial management measures, have been successful with respect to their specific design objectives [5,28,37]. Without the BBNJ Agreement being in force, protection of the Salas y Gomez and Nazca Ridges - as well as the vast majority of international waters - rests on several bodies taking action.

The purpose of this study is to review information on the significance of protecting a critically important area in ABNJ—the Salas y Gomez and Nazca Ridges—and to discuss policy pathways to achieve this. This study builds on a previous review of the importance, opportunities, and challenges for protecting this unique region [105], by presenting a more detailed account on the legal pathways to achieve best available conservation measures of this region. Our synthesis focused on identifying conservation procedures within the documents of international organizations and applying their rules and procedures to implement conservation measures. Specifically, we identify the existing management bodies in this region and outline potential conservation measures that could be enacted through them. Finally, we outline pathways for increasing protection, focusing on fishing, shipping, and mining, that might be enacted through national, regional or international mechanisms.

## 2. Study area

The Salas y Gomez and Nazca Ridges consist of about 110 seamounts of volcanic origin that stretch across 2900 km in the Southeast Pacific (reviewed in Wagner et al. [105]). The average depth of these ridges is 2100 m, with most of the ridge ranging in depth between 2000 - 2500 m, but with some portions reaching into the photic zone [43,44]. Located 105 km off the coast of Peru, the Nazca Ridge stretches 1100 km westward towards the eastern edge of the Salas y Gomez Ridge, which then stretches another 1600 km westward towards Rapa Nui (also known as Easter Island) (Fig. 1). The majority of these two ridges lie in international waters (~73%) and account for 41% of seamounts found in the Southeast Pacific [43]. Despite its geographic proximity to Peru and Chile, the Salas y Gomez and Nazca Ridges are isolated from the South American continent by the Humboldt Current and the Atacama Trench ([85,86]; Von Dassow & Collado-Fabbri, 2014). As a result of its isolation and historically low levels of anthropogenic impacts, this region contains a unique biodiversity that is marked by the highest level of marine endemism on Earth (Friedlander et al., 2016; [71,76,75,81,83]; Wagner et al. [105]). Regional endemism estimates for fish and invertebrates range from 40% to 46.3% [13,71,83,95]. The dominance of endemic species is unlike any place on Earth [40].

To date, this region has remained free from mining and largely unimpacted by international shipping commerce (Wagner et al. [105]), with industrial fishing levels remaining moderate since Soviet Union trawling for Mackerel and Pilchard in the 1970–80s [80]. Soviet Union fisheries utilized several fishing methods including longlines, baited fish traps, and otter trawls [75]. On average, historical fishing effort on these ridges has declined over time, with the last bottom trawl fishery having closed in the 1980s, and with no bottom fisheries developed since 1992 [90]. However, damage caused by bottom trawlers continues to be seen through ROV surveys [44]. Commercial fishing continues to occur in the pelagic realms of this ecosystem, especially outside Peruvian national waters of the Nazca Ridge [49]. Fishing in this area targets Skipjack Tuna (*Katsuwonus pelamis*), Bigeye Tuna (*Thunnus obesus*), Yellowfin Tuna (*Thunnus albacares*), and other pelagic species (Wagner et al. [105]). International commercial fisheries also target anchovies, squid, Jack mackerel (*Trachurus murphyi*) and Bonito (*Sarda chiliensis*) [49]. Furthermore, squid jiggers have become considerably more active in this region from 2012 to 2020 [44]. The vast majority of the fishing effort in this area is accounted for by vessels flagged to China (72.7% of all

vessels), and to a lesser degree Spain (16.5%), and Japan (3.4%) (Wagner et al. [105]). Future fishing activities are actively being proposed [88].

Apart from fishing, the other major threats to this ecosystem include: marine pollution, shipping, climate change, and the potential for seabed mining ([44]; Wagner et al. [105]). Due to its proximity to the center of the South Pacific Gyre, where floating litter and debris concentrate, hundreds of species of marine vertebrates including sharks, turtles, birds, and mammals are at risk of entanglement and plastic ingestion [42,44]. Commercial shipping is relatively low (except for the northern section of the Nazca Ridge which intersects with a major international shipping route), but this region has been identified as a potential trans-shipment route for distant water fleets ([44]; Wagner et al. [105]). This could potentially threaten thousands of species via collision, light pollution, noise pollution, and biological invasions [44,73]. The nutrient poor waters of the Nazca Ridge make this region extremely susceptible to climate change and anthropogenic disturbances. Under predicted climate change scenarios, the seafloor will experience an increase in temperature, pH, and dissolved oxygen, making it inhabitable to many endemic species and ultimately threatening the biodiversity and biogeochemistry of the region [17,27,44]. Lastly, there are known cobalt-rich crusts throughout the ridges, which could attract mining interest [44]. While there are currently no mining contracts in this region, and no mining contracts have yet been leased, the potential for future mining remains uncertain. Protecting the Salas y Gomez and Nazca Ridges from current and potential threats will lead to major global benefits including ecosystem connectivity, climate change regulation and food security [44]. Likewise, threat mitigation is only one of many reasons to conserve a region or set up a protected area - many areas are protected based on their immense ecological value (regardless of threat).

## 3. Management bodies

Fishing and shipping are the primary current activities, with mining as an emerging activity, within the ABNJ of the Southeast Pacific. All are governed by a suite of organizations. Each of these organizations has a distinct decision-making body which is represented by Member States. Without the BBNJ Agreement adopted and ratified, the application of best available conservation measures in the ABNJ of the Salas y Gomez and Nazca Ridges rests on these organizations (see Table 1).

Cooperation among these organizations is vital for the effective conservation of the Salas y Gomez and Nazca Ridges ([5]; De Santo et al. [26]), but has proven difficult due to lack of effective coordination and policy integration across agreements ([79], Velázquez Gomar [103]). SPRFMO is the major management body for benthic, demersal, and pelagic fisheries (e.g., Jack Mackerel (*Trachurus murphyi*), squids and deep-sea fishes) in the high seas of the South Pacific. On the other hand, IATTC covers tuna and other highly mobile species. Overlapping membership of these two RFMOs, (sharing eight members: China, Colombia, Ecuador, Panama, Peru, South Korea, U.S.A., and Vanuatu) has the potential to enhance political will, promote ownership over coordination, and increase policy coherence [79]. For example, for IATTC, UNCLOS includes tuna species in the category of “highly migratory species” which are governed under Article 64 of UNCLOS which establishes the duty to cooperate with appropriate international organizations to ensure conservation beyond the Exclusive Economic Zones (EEZs) of Nation States [94]. Therefore, if the IATTC is tasked with ensuring the conservation and sustainable management of tuna species, cooperation with other international organizations will be essential for achieving its Convention’s goals.

Enhancing cooperation among existing structures through cross-sectoral work among international organizations with mandates to regulate all human activities is crucial for the conservation of ABNJ ([79]; Velázquez Gomar [103]). As such, an ecosystem approach is required, in which all users of the ocean operating within the Salas y Gomez and Nazca Ridges (Fig. 1) collaborate to strengthen the

**Table 1**

List of primary international organizations involved in the management of the primary activities (i.e., fishing, shipping, and mining) within the ABNJ jurisdiction of the Salas y Gomez and Nazca Ridges.

Organization	Abbreviation	Area of Interest	Description
South Pacific Regional Fisheries Management Organization	SPRFMO	South Pacific high seas	RFMO of 15 Member States responsible for conservation and sustainable use of fisheries resources (manages all benthic, demersal, and pelagic species, except for tuna and tuna-like species) in the South Pacific Ocean
Inter American Tropical Tuna Commission	IATTC	Eastern Pacific Ocean (high seas and areas under national jurisdiction)	RFMO of 16 Member States responsible for the long-term conservation and sustainable management of tuna and tuna-like species in the Eastern Pacific Ocean.
International Seabed Authority	ISA	Global seabed in the high seas	Autonomous international organization established under the 1982 United Nations Convention on the Law of the Sea responsible for overseeing all mineral-resources-related activities with a mandate to ensure the effective protection of the marine environment from harmful effects that may arise from deep-seabed related activities.
International Maritime Organization	IMO	Global oceans	United Nations specialized agency with responsibility for the safety and security of international shipping and the prevention of marine and atmospheric pollution by ships.
Permanent Commission on the South Pacific	CPPS	Primarily national waters of Chile, Colombia, Ecuador, and Peru, but also adjacent regions of the high seas	Maritime organization that coordinates regional maritime policies in order to adopt concerted positions of its Member States (Chile, Peru, Ecuador and Colombia) in international negotiations, development of the Law of the Sea, International Environmental Law and other multilateral initiatives, including MPAs.

effectiveness of area-based management tools in ABNJ to prevent adverse impacts on biodiversity as a whole [6,23,34,48].

#### 4. Results and discussion

Below, we first outline existing conservation policies; we then introduce ongoing conservation proposals; and finally we outline potential policy pathways for the Salas y Gomez and Nazca Ridges. Our policy analysis, based on the policies and Conventions in place, resulted in three distinct pathways to implement conservation measures in the ABNJ of the Salas y Gomez and Nazca Ridges. The first two pathways involve (1) regional and (2) national approaches that rely on cooperation among international organizations spearheaded by SPRFMO. The third pathway involves an international approach, which based on our analysis, seems to be the most comprehensive. We finish with additional conservation pathways (outside the scope of the major international organizations operating in this region).

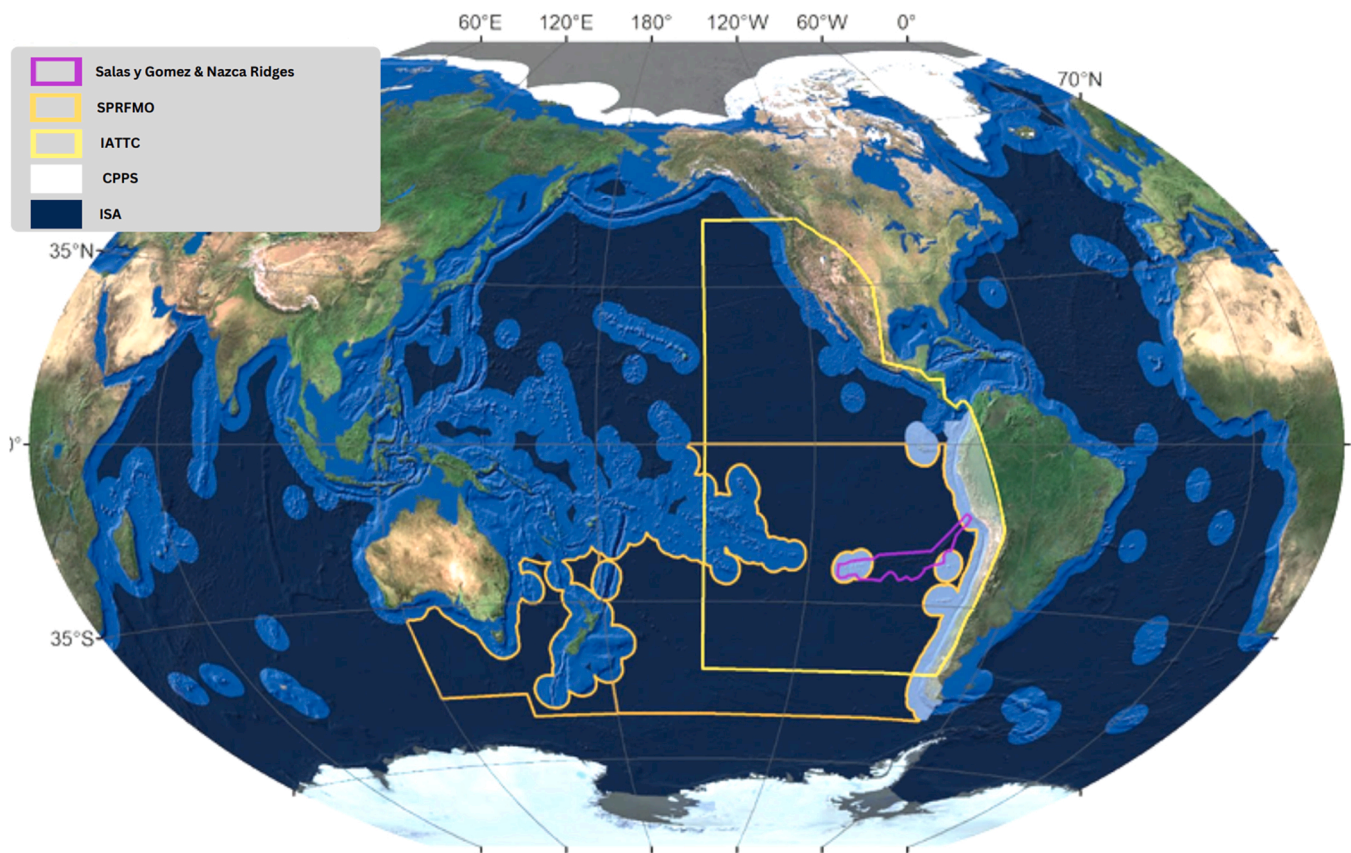
##### 4.1. Existing conservation measures

The Salas y Gomez and Nazca Ridges were recognized as an EBSA in 2014 [13,95]. While EBSAs are recognized as marine areas that are in need of protection or enhanced management, the EBSA status does not in itself provide protection or management. The responsibility of protecting the region encompassed by the EBSA falls to the States and management bodies which govern the area.

Peru and Chile, in accordance with the EBSA designation, have created protected areas within their EEZs of this region. In June 2021, Peru designated the Nazca Ridge National Reserve, which encompasses 62,392 km<sup>2</sup>, which amounts to the entirety of the seafloor portion of the EBSA that lies in Peru's EEZ (Wagner et al. [105]). However, the Peruvian government allows for industrial fishing over two seamounts within the reserve, and the concept of "reserve" under Peruvian legislation does not imply a non-take area. Similarly, in the past decade, Chile has designated three large-scale protected areas that encompass the entirety of the EBSA within their EEZ: the Motu Motiro Hiva Marine Park (a fully no-take MPA that protects 150,000 km<sup>2</sup> around Salas y Gomez Island), the Rapa Nui Coastal and Marine Multiple-Use MPA (a multi-use area that bans industrial fishing and deep-sea mining for 579,368 km<sup>2</sup> around Rapa Nui Island), and the Nazca Desventuradas Marine Park (a fully no-take MPA that protects 300,035 km<sup>2</sup> around San Ambrosio and San Felix Islands) ([32,38]; Wagner et al. [105]). While Peru's Nazca Ridge National Reserve and Chile's offshore island ecosystems are under protection [38], the remaining areas (~73%) that exist within ABNJ lack legal protections (Fig. 2).

##### 4.2. Current conservation proposals

In an attempt to protect the ABNJ of Salas y Gomez and Nazca Ridges, a group of experts from academic and non-governmental organizations grouped in the Coral Reefs of the High Seas Coalition (www.coralreefshighseas.org) presented a proposal for a fishing closure in the SPRFMO area in 2020 that encompassed the EBSA area of the high seas [107]. Building on this proposal, in 2021, Chile subsequently put forward a paper at the 9th meeting of SPRFMO's Scientific Committee on the importance of protecting the high seas of this region [90]. More recently, at the 10th meeting of SPRFMO's Scientific Committee in 2022, the Chilean delegation, together with the Coral Reefs of the High Seas Coalition submitted a revised paper again calling for a fishing closure across the EBSA [44]. The authors recommended: (1) the ABNJ classified as an EBSA should be closed to fishing activities and regulated by SPRFMO; (2) SPRFMO should collaborate with other international organizations to ensure best available conservation measures, including with IATTC and CPPS; (3) SPRFMO should not accept any proposals for exploratory fishing in the EBSA area; and (4) research and capacity development activities should be expanded to support further scientific



**Fig. 1.** International management organizations operating within the boundaries of the Salas y Gomez and Nazca Ridges (highlighted in purple), which extend from Peruvian national waters to Chilean waters around Rapa Nui Island. The South Pacific Regional Fisheries Management Organization (SPRFMO) is highlighted in orange and its management extends from Southern Australia to South America's Pacific coast. The Inter-American Tropical Tuna Commission (IATTC) is highlighted in yellow and extends throughout the eastern Pacific Ocean, from Canada, in the north, to Chile, in the South. The Permanent Commission for the South Pacific (CPPS) is highlighted in white, and its management extends throughout the EEZs of Colombia, Ecuador, Peru and Chile. The International Seabed Authority (ISA) is the darker blue background that extends across all the ABNJ in the world's oceans. The International Maritime Organization (IMO) is not included in the figure because it applies to the whole ocean. See Wagner et al. (2021b) for source details on map layers.

understanding [44]. Chile recommended the SPRFMO Commission to “carefully consider the scientific value of the information provided in this report, and to explore management and conservation options, including area-based measures” ([90], 3).

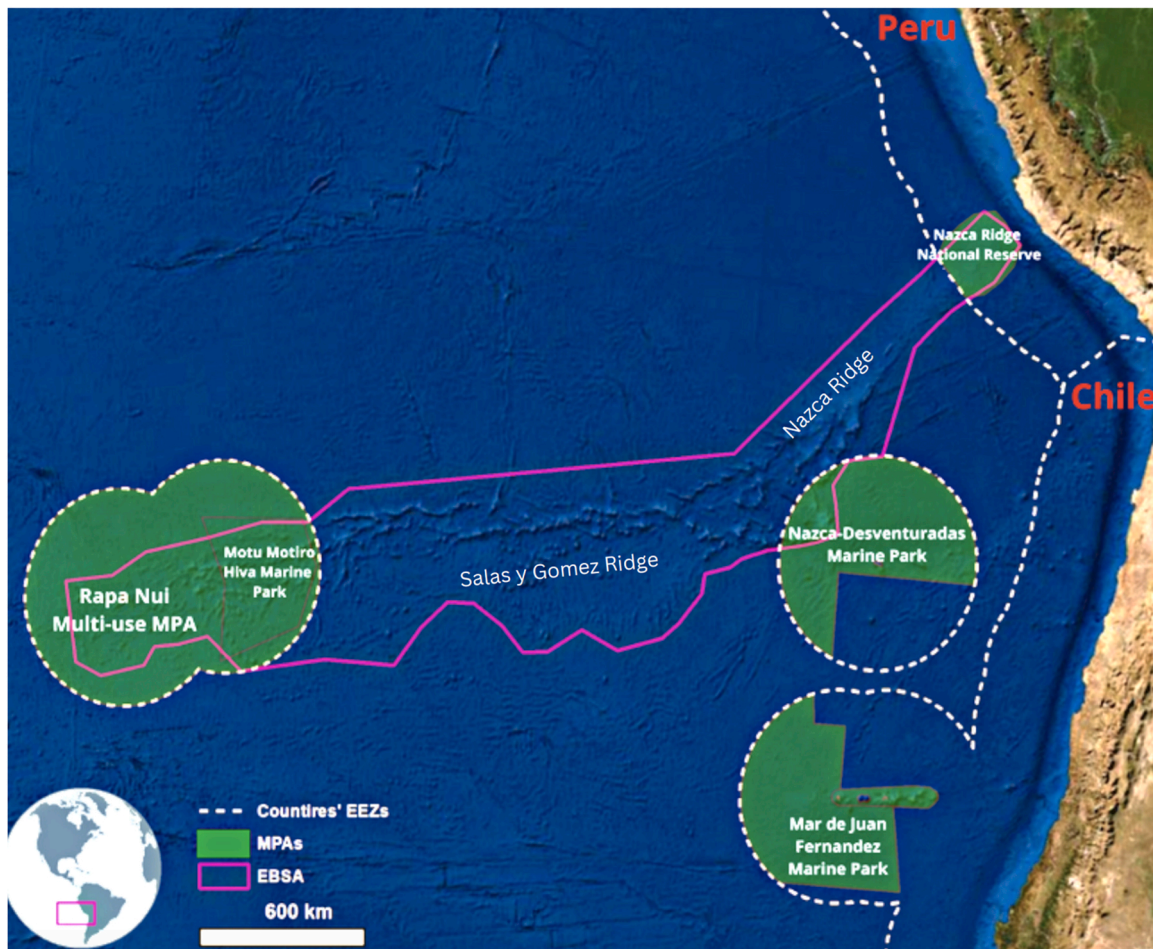
In response to the proposal, the Scientific Committee noted that a fishing closure across the EBSA would affect an exploratory lobster trap fishery run by the Cook Islands, which is managed under SPRFMO arrangements [88]. The Scientific Committee further suggested that Chile's proposal did not demonstrate that a lobster trap fishery would cause irreparable harm to the Salas y Gomez and Nazca Ridges. However, other research in this region has documented that lobster trapping has destroyed long-lived (hundreds of years old) corals (e.g., black corals, classified as VME indicator species by SPRFMO [91] and the FAO [44]). Ultimately, the Scientific Committee suggested the need for additional research to explore the location and threats to VMEs before revisiting Chile's fishing closure proposal [44,88].

#### 4.3. Potential conservation pathways

Developing policy pathways for best available conservation measures requires an understanding of the governance framework in ABNJ of the Southeast Pacific. There are multiple stakeholders across varying geographic scales that have purview over the management of activities in the Salas y Gomez and Nazca Ridges (Fig. 3). The United Nations sits at the top as the leading international body for global governance [58] and forms the foundation for all international bodies below it (Fig. 3). There are other international bodies such as the IMO, CBD, FAO, ISA, as

well as existing Conventions and Agreements like UNCLOS (which established the current legal framework for all marine and maritime activities) and UNFSA (a multilateral treaty under the UN that focuses on enhancing cooperative management of highly migratory and straddling stock fishery resources). International bodies in this region are responsible for managing large-scale industries like mining and shipping, but they are also responsible for designating conservation classifications such as EBSAs (designated under CBD), VMEs (for which the FAO lists the guidelines for identification and conservation of VMEs, but legal protection rests on States and RFMOs under UNGA resolution 61/105 and 59/25), particularly sensitive sea areas (PSSAs) (designated under the IMO), and areas of particular environmental interest (APEIs) (designated under the ISA) (Fig. 3). Furthermore, the existing Conventions and Agreements have led to the establishment of RFMOs such as SPRFMO (in 2012). IATTC, however, was established in 1949, well before the 1995 UNFSA conference that directed UNCLOS signatories to establish RFMOs as a means to achieve the fishery and conservation objectives outlined in the UNCLOS text [111]. These RFMOs are then represented by Member States, such as Peru and Chile.

Note: this diagram does not show all connections or partnerships between international bodies and Member States (e.g., Peru and Chile are members of the ISA, IMO, CBD, and FAO). Instead, this figure shows the processes that led to the establishment of international and regional bodies that have the capacity to designate or implement conservation classifications in the Salas y Gomez and Nazca Ridges.



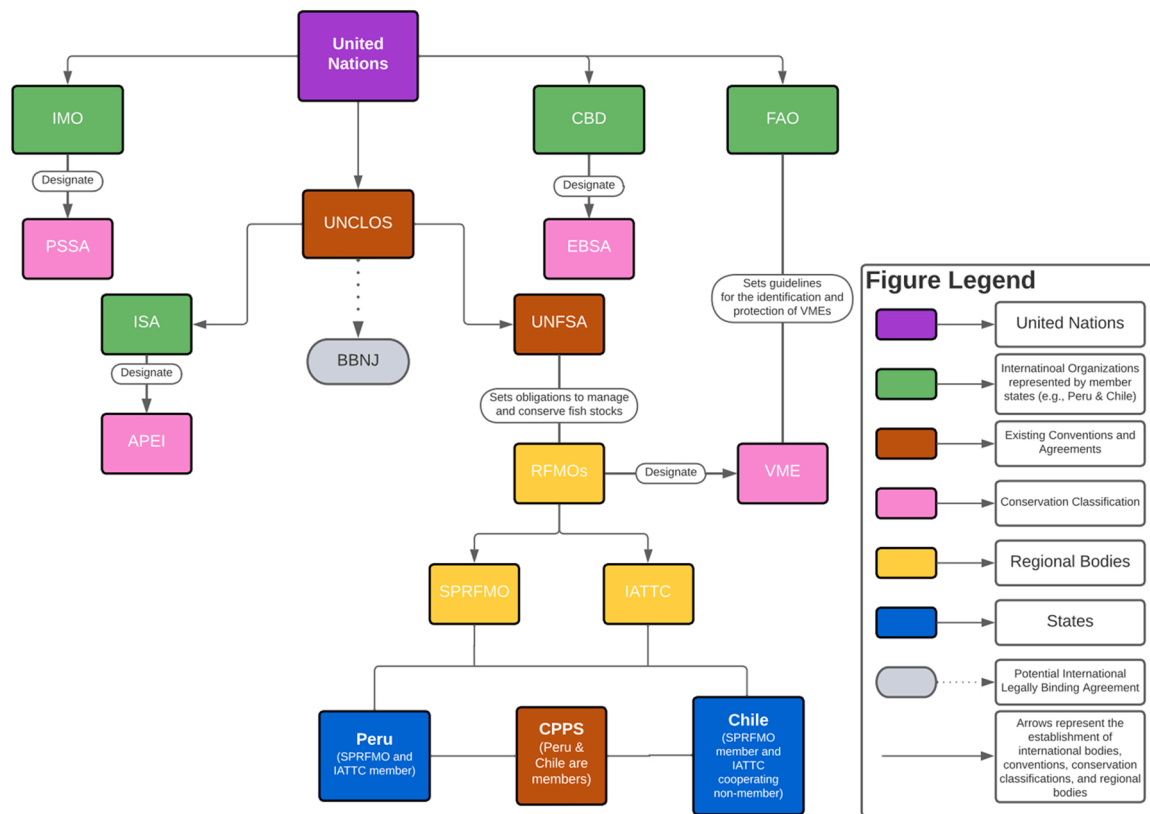
**Fig. 2.** The Salas y Gomez and Nazca Ridges were designated as an Ecologically and Biologically Significant Area (EBSA) (outlined in purple) by the Convention on Biological Diversity (CBD). Established marine protected areas (MPAs) within the jurisdiction of Peru and Chile are highlighted in green. The dotted lines represent the Exclusive Economic Zones (EEZs) of Peru and Chile.

#### 4.3.1. Regional pathway

For the Southeast Pacific specifically, the current institutional framework for protecting biodiversity beyond national jurisdiction rests on regional and sectoral bodies such as SPRFMO, IATTC, and CPPS [15, 31]. We identified SPRFMO as potentially the leading organization for fishery management in this area for three primary reasons: 1) SPRFMO regulates fishing for highly migratory fish species other than tuna, 2) SPRFMO has legally binding conservation management measures (CMMs) calling for the “long term conservation and sustainable use of fishery resources in the Southeast Pacific”, and 3) they oversee all demersal species associated with seamounts in the Salas y Gomez and Nazca Ridges. Both CPPS and IATTC can enact conservation measures, but their conservation purview is limited compared to that of SPRFMO. CPPS, for example, aims to strengthen political, technical and scientific cooperation for the conservation and sustainable use of the ocean and its resources including in the high seas [22,31]. Within its role, CPPS promotes mechanisms for regional coordination among the national jurisdiction of Member States but can extend to adjacent high seas if affected by marine and coastal pollution [31]. IATTC is able to implement conservation measures for the long term conservation and sustainable use of tuna and tuna like species in the high seas of the Southeast Pacific [31]. Both CPPS and IATTC are committed to the conservation and management of ocean ecosystems, and there is clear overlap in their management. One of CPPS main goals is to reduce the effects of pollution in ocean ecosystems, and pollution can negatively affect tuna species, which IATTC has mandate over. However, collaboration between IATTC and CPPS has been minimal. This is also the case for IATTC and

SPRFMO, even though Article XXIV of the Antigua Convention (2003 Convention for strengthening IATTC 1949 Convention between the United States of America and the Republic of Costa Rica) calls on IATTC to “cooperate with subregional, regional and global fishery arrangements to promote the objective of the Antigua Convention”, which is to “support the long term conservation and sustainable use of fish stocks” [1,69]. Coordinated conservation measures among SPRFMO, CPPS, and IATTC would facilitate each management body in reaching their own conservation objectives.

Regional coordination among SPRFMO and IATTC could lead to a concrete pathway for increasing conservation measures for protecting the ecosystems and marine living resources in ABNJ of the Salas y Gomez and Nazca Ridges, and is mandated under UNFSA Part III Article 8. Under Article 20 of the SPRFMO Convention, the Commission is able to implement fishing closures or “the general or specific locations in which fishing may or may not occur” (SPRFMO Article 20, 2015). Similarly, IATTC can apply spatio-temporal fishing closures and restrict purse-seine fishing vessels [44,53]. While neither of these approaches equate to an MPA *sensu stricto*, closing the Salas y Gomez and Nazca Ridges to fishing would add a strong layer of protection for the ecosystem [44]. While SPRFMO and IATTC have never established a joint fishing closure, SPRFMO and IATTC signed a Memorandum of Understanding in 2022 to ensure the objectives of the Antigua Convention and promote cooperation and collaboration in order to advance their respective objectives, particularly with respect to matters of common interest [69]. This is a promising step towards the implementation of collaborative conservation measures in ABNJ of the Salas y



**Fig. 3.** Diagram showcasing the international organizations (purple, green, orange, and yellow) that manage activities in the ABNJ of the Salas y Gomez and Nazca Ridges, and the process that led to their establishment (represented by arrows). The purple box represents the United Nations, with green boxes representing international bodies, orange boxes representing existing Conventions and Agreements at both the international and regional scale, and gray boxes representing potential Agreements currently under negotiations (Biodiversity Beyond National Jurisdiction (BBNJ) Agreement). Yellow boxes represent Regional Fisheries Management Organizations (RFMOs), with blue boxes representing individual Member States to the RFMO (connected by lines). Pink boxes represent different conservation classifications designated by either international or regional bodies.

Gomez and Nazca Ridges.

Fishing closures alone would not be able to protect the whole ecosystem. To achieve full protection, no impact from extractive or destructive activities of both the water column and underlying bottom [50], cross-sectoral work on area-based management as well as cooperation with organizations with global mandates such as the IMO and ISA will be necessary [26,34,43]. For example, exploration and exploitation of seabed minerals in the Southeast Pacific requires approval of the ISA. The ISA can also designate both preservation reference zones (PRZs) and areas of particular environmental interest (APEIs), in which mining is prohibited [26]. Similarly, the IMO can designate PSSAs, which may include environmental protection measures, including areas to be avoided by all ships, or by certain classes of ships [26]. The designation of PRZs, APEIs and PSSAs is particularly important for the Salas y Gomez and Nazca Ridges given the unique and fragile species that are known to exist on its seabed and overlying water column [39,46, 75], and the widespread environmental impacts that would result if large-scale activities were to take place over these sensitive habitats [67]. To ensure that human activities are not harming the Salas y Gomez and Nazca Ridges, coordination between all sectoral bodies with jurisdiction over this entire region will be necessary.

4.3.2. SPRFMO and IATTC

Both SPRFMO and IATTC have the ability to enact conservation measures within their Convention policies. The SPRFMO Convention affirms that its conservation measures are compatible with those of the United Nations and the Member States party to their Convention (see SPRFMO Article 31, and Article 4, 2015). This provides two important pathways for the protection of the Salas y Gomez and Nazca Ridges: 1) a

regional pathway that relies on political compatibility with international organizations with jurisdiction over this region (described below), and 2) a national pathway (discussed on the next section) that relies on extending Peru’s and Chile’s conservation measures to the high seas under the SPRFMO Convention.

Article 31 of the SPRFMO Convention stipulates that the Commission shall cooperate with the FAO and specialized agencies of the United Nations on matters of mutual interest, and that the Commission shall take account of conservation and management measures adopted by international organizations “that have competency in relation to the Convention Area” ([92], p. 31). The Salas y Gomez and Nazca Ridges fit this category as a recognized EBSA by the CBD, making it a matter of “mutual interest” under the SPRFMO Convention [13,95]. Article 31 of the SPRFMO Convention stipulates a regional pathway to establish CMMs in this region based on compatibility between SPRFMO and conservation classifications designated by the CBD (Fig. 3).

While the VME indicator species are widespread across the region [13,38,39,43,46,106] neither SPRFMO or IATTC have classified areas within this region as VMEs. Multiple studies have identified species across the Salas y Gomez and Nazca Ridges that are listed as VME indicators under SPRFMO [13,19,38,39,43,46,106]. Annex 5 of SPRFMO [19] lists stony corals, black corals, anemones and hexacorals as VME indicator species, for which all have been identified in the region [39, 46]. FAO guidelines for high seas deep-sea fisheries [36], specifically outline the process for identification and protection of VMEs [108], but designation of VMEs in the ABNJ of the Salas y Gomez and Nazca Ridges has yet to be implemented.

The objective of SPRFMO CMM 03-2022 includes the prevention of significant adverse impacts on VMEs [19,90]. Significant adverse

impacts are defined by the FAO as “those that compromise the ecosystem integrity (structure and function), i.e., impairs the ability of populations to replace themselves, degrades the long-term natural productivity of the habitat, or causes significant loss of species richness, habitat or community type on more than a temporary basis” ([35], p. 1). UNGA resolution 59/25 mandates RFMOs, such as SPRFMO, to protect VMEs [46]. In response to the 2004 UNGA resolution 59/25 and more recently the 2011 UNGA resolution 66/68 (focused on the management of bottom fisheries in ABNJ), several management bodies across the world have established area closures to protect VMEs [73]. For example, CCAMLR has designated 61 VMEs in the Southern Ocean. While SPRFMO Members have been informed of the presence of VMEs across the Salas y Gomez and Nazca Ridges, have a legal mandate to follow UNGA resolution 61/105 and 59/25 to protect VMEs and the conservation guidelines outlined by the FAO, SPRFMO has yet to designate any VMEs in this region. Furthermore, SPRFMO has not designated any VMEs within its jurisdiction. As written, SPRFMOs CMM 03 would still allow for deep sea trawling in areas potentially designated as VMEs [30]. The 2023 amendment to CMM 03 included a new procedure to identify and register VMEs and ensure the Management Area boundaries are updated to exclude the VME from areas open to fishing (personal communication, Ducan Currie, February 2023). The conservation classification of the Salas y Gomez and Nazca Ridges as an EBSA by the CBD coupled with the mounting scientific evidence to protect VMEs in this region [13,38,39,46] justifies the use of SPRFMO Article 31 combined with Article 20 as a pathway for the protection of this region.

SPRFMO and IATTC have the responsibility to conserve and manage natural resources (UNFSA Part II Articles 5 and 6) as well as the mandate to not only conserve species targeted by fisheries under their jurisdiction ([19] SPRFMO Articles 3(1)(a)(i) and (vii), Resolution C-22-02 IATTC [84]), but the entirety of the Salas y Gomez and Nazca Ridges. Under its collaborative arrangements, and their recent MOU agreement, if SPRFMO implements a fishing closure, it should, in principle, be possible to create an analogous fishing closure for IATTC [34,44]. To strengthen regional conservation, fishing closures that apply to both RFMOs and not just SPRFMO, would protect the entirety of fish species in the ecosystem potentially targeted by fisheries. At the 73rd meeting of IATTC, Member States created a capacity building plan which clearly states that IATTC should support cooperation with relevant fishery management organizations to promote international conservation measures [55] such as the protection of EBSAs and VMEs. A conservation partnership between SPRFMO and IATTC would allow for a stronger protection of the ecosystem as no significant human activities aside from fishing currently take place in this region.

#### 4.3.3. National pathways

As noted above, Peru and Chile have effectively responded to the United Nations designation of the Salas y Gomez and Nazca Ridges as an EBSA by implementing several protected areas within their EEZs [15,38,90]. Peru, Chile or any one other country, however, do not have the authority to designate protected areas outside their national jurisdiction.

Article 4 of the SPRFMO Convention states that “conservation and management measures established for the high seas and those adopted for areas under national jurisdiction shall be compatible in order to ensure conservation and management of straddling fishery resources in their entirety” ([92], p. 5). As noted above, the Chilean Government has taken a leadership role in this by submitting a document to the SPRFMO Scientific Committee advocating for the usage of Article 4 to ensure conservation compatibility with Chile’s protected areas [90]. However, the ABNJ of the Salas y Gomez and Nazca Ridges remain unprotected. Article 4 clearly indicates that if coastal States take the initiatives to protect ecosystems within their jurisdiction, as Peru and Chile both have with the creation of protected areas (Fig. 2), then the Convention has the responsibility to “ensure conservation compatibility beyond their national jurisdiction to match the conservation measures implemented at a

national scale” [90]. Under this Convention provision, Peru and Chile can request an extension to their protected areas under SPRFMO fishery management measures, such as spatial and temporal closures for bottom fisheries [19] in the ABNJ that border the protected areas in their EEZs. Under resolution C-22-05 IATTC can also apply a similar strategy by implementing a purse-seine fishing closure for tuna species [53]. Both regionally and nationally, the SPRFMO Convention alludes to the protection of ecosystems in international waters through Article 31 and Article 4, and coordination with IATTC would allow for a stronger conservation measure.

#### 4.3.4. International pathways

There are several international pathways for the implementation of conservation measures in the ABNJ of the Salas y Gomez and Nazca Ridges. However, the most robust pathway relies on the adoption, signature and ratification of the BBNJ Agreement. Once the Agreement enters into force, bringing into existence the BBNJ bodies, this pathway could serve as the most effective and likely path for the protection of the Salas y Gomez and Nazca Ridges. However, this process could take many years, during which harm to the unique ecosystems of the region could occur.

The BBNJ Agreement will be an implementing Agreement for UNCLOS [47], and the current RFMOs operating within the boundaries of the Salas y Gomez and Nazca Ridges which are mandated by the UNFSA Agreement (Fig. 3). A policy pathway for conservation proposals under the BBNJ Agreement could provide the most comprehensive and encompassing conservation measure. The agreed BBNJ text aims to invite participation from all relevant stakeholders, such as regional and sectoral bodies and frameworks, which would include the International Whaling Commission (IWC) and RFMOs such as SPRFMO and IATTC, among others [101]. The text of the BBNJ Agreement aims to enhance cooperation and coordination among regional and sectoral bodies operating within ABNJ [102].

Discussions on how to structure institutional arrangements for BBNJ have been key issues for the Agreement. Global, regional and hybrid approaches have emerged as the major models for institutional arrangements, with the global model enabling the international community to adopt a more effective and comprehensive approach to establishing conservation measures in the high seas involving relevant sectoral bodies [18]. This would work towards an overarching protection of the high seas, and involve the ISA, IMO and the RFMOs in the Southeast Pacific.

#### 4.3.5. Additional conservation pathways

While the regional, national, and international pathways identified in our study provide comprehensive approaches to the conservation of ABNJ of the Salas y Gomez and Nazca Ridges, additional international conservation measures could be enacted by other bodies that regulate human activities across international borders, including those of the high seas [4]. Among others these include the International Whaling Commission (IWC), which regulates whaling, the Inter-American Sea Turtle Convention, which oversees the protection and conservation of sea turtles, the London Convention and Protocol, which regulate the dumping of wastes in the ocean [60,61], and the Convention on Migratory Species, which seeks to conserve migratory species, their habitats and migratory routes [21]. Conservation of the natural and cultural resources located in ABNJ of this region (Delgado et al. [25]; Wagner et al. [105]; and references therein) could also be promoted through the World Heritage Convention. While this convention can be applied to all of Earth’s outstanding natural and cultural places, to date it has not been applied within international waters [59]. Research has shown that the high seas and deep seabed of the Salas y Gómez & Nazca Ridges meets several of the criteria of Outstanding Universal Value for inscription under the World Heritage Convention (Delgado et al. [25]; Wagner et al. [105]; and references therein). Thus, this area could in theory be inscribed under the Convention, which would not only



provide potential financial support, but also encourage States Parties to enhance their protection through educational and information programs.

Similarly, the CPPS could also play an important role in advancing conservation measures in the ABNJ of this region. Article 4 of the CPPS Convention gives it the competence to promote conservation of marine living resources beyond national jurisdiction [31]. Given the large amount of floating pollutants surrounding the Salas y Gómez and Nazca Ridges transported through the South Pacific Gyre [45], CPPS could play an important role in helping to address this issue. Specifically, it could encourage its Member States to implement coordinated measures to increase garbage collection systems in coastal municipalities, eliminate discharges from vessels including through improved port waste reception facilities, and reduce the widespread use of disposable materials that could eventually become marine debris.

## 5. Conclusion and broader implications

Our process for identifying regional and national policy pathways for protecting the Salas y Gomez and Nazca Ridge can be applied to all international waters across the globe. While our study focused on the Southeast Pacific, this same approach can be applied to all oceans that are not governed by a commission such as CCAMLR and OSPAR with competence for MPAs. Identifying stakeholders, their partnerships and collaborations, and more importantly the rules, policies and regulations within their conventions and possible MOUs, is crucial for setting policy pathways for conservation measures in ABNJ.

Even when the BBNJ Agreement enters into force, competent management organizations and their stakeholders in the Southeast Pacific will remain active within their competent areas, and potentially, within the BBNJ Conference of the Parties as well. The Agreement aims for universal participation of stakeholders and shall not undermine existing international frameworks and bodies. Specifically, RFMOs as well as mining, and shipping organizations will continue to manage large-scale industries with direct effects to ocean ecosystems in ABNJ. Regional and national policy pathways demonstrate that intergovernmental organizations are already able to implement conservation measures within their own competence. Measures like fishing or mining closures, or bans on shipping routes, will have immediate benefits for ocean ecosystems. International organizations with competence in ABNJ have the opportunity to safeguard and protect the resources and ecosystems they operate within. Waiting for the bureaucratic process of international treaties can often be time consuming and slow. Applying the precautionary approach, international organizations have the ability to apply their best available conservation measures without the help of BBNJ. Likewise, several RFMOs such as SPRFMO, already mandate a precautionary and ecosystem based approach to fishery management [20]. Protecting the Salas y Gomez and Nazca Ridges could have major benefits for ecosystem connectivity, climate regulation, food security, and ecosystem services for neighboring States like Peru and Chile, but also globally ([8,9,10,12,66,85,93]; Wagner et al. [105, 110]).

These three pathways (regional, national, and international) represent current opportunities for protection of the ABNJ of the Salas y Gomez and Nazca Ridges. The current fragmentation of management in the Southeast Pacific will require international organizations to collaborate with one another to achieve the best available conservation measures. Identifying policy pathways within individual organizations as well as the opportunities for them to collaborate will become even more important as climate change and increased human activity in the high seas threatens these isolated and unique ecosystems.

## CRedit authorship contribution statement

**Vasco Chavez-Molina:** Conceptualization, Formal analysis, Investigation, Supervision, Validation, Writing – original draft, Writing – review & editing. **Daniel Wagner:** Conceptualization, Formal analysis,

Investigation, Supervision, Validation, Writing – original draft, Writing – review & editing. **Emily S. Nocito:** Formal analysis, Investigation, Supervision, Validation, Writing – original draft, Writing – review & editing. **Michelle Benedum:** Investigation, Writing – review & editing. **Emily Golden Beam:** Visualization, Writing – review & editing. **Carlos F. Gaymer:** Formal analysis, Investigation, Validation, Writing – original draft, Writing – review & editing. **Duncan Currie:** Formal analysis, Investigation, Validation, Writing – original draft, Writing – review & editing. **Cassandra M. Brooks:** Conceptualization, Formal analysis, Investigation, Supervision, Validation, Writing – original draft, Writing – review & editing.

## Data Availability

No data was used for the research described in the article.

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