Chapter 15
Ecuador Case Study

Transboundary Marine Conservation and Fisheries Management in Ecuador and Northern Peru

Gabriela Navarrete-Forero, Alonso Del-Solar-Escardó, Eliana Alfaro-Cordova, Leonardo Rodríguez-Escalante, Solange Andrade-Vera, and Demian A. Willette

Abstract Marine fisheries are an important source of food security, livelihood, and employment for coastal communities around the world. However, their sustainability is undermined in contexts of weak institutions at multiple levels of governance, illegal fishing, and poor seafood traceability. Ecuador and Peru share historical, ecological, social, and economic features in terms of marine affairs, conservation, and fisheries development, and therefore face similar challenges to sustainability. The goal of this synthesis is to provide an overview of the aspects in common and to highlight the relevance of bi-national cooperation in scientific research in times of transformation of seafood systems into more sustainable ones. We show that there are important fishery resources in common, and potentially many more that are

G. Navarrete-Forero (✉)
Centro del Agua y Desarrollo Sustentable, Escuela Superior Politécnica del Litoral. Campus Gustavo Galindo, Guayaquil, Ecuador

Resource Management Group, Leibniz Centre for Tropical Marine Research, Bremen, Germany
e-mail: gnavarr@espol.edu.ec

A. Del-Solar-Escardó
Resource Management Group, Leibniz Centre for Tropical Marine Research, Bremen, Germany

E. Alfaro-Cordova
ProDelphinus, Lima, Peru

Carrera de Biología Marina, Universidad Científica del Sur, Lima, Peru

L. Rodríguez-Escalante
Laboratorio de Ensayo de Patología Acuícola. Subsecretaría de Calidad e Inocuidad, Ministerio de Producción Comercio Exterior, Inversiones y Pesca, Guayaquil, Ecuador

S. Andrade-Vera
Charles Darwin Research Station, Charles Darwin Foundation, Puerto Ayora, Galapagos, Ecuador

D. A. Willette
Biology Department, Loyola Marymount University, Los Angeles, CA, USA

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poorly known and monitored. At the national-government level, Ecuador and Peru cooperate through international organizations to manage some shared stocks like tropical tunas, dolphinfish and Chilean jack mackerel. At the community level, members of artisanal fishing associations have participated in bi-national workshops around dolphinfish management. We propose that bi-national academic and scientific research networks can also contribute to this process and suggest some lines of research in which the cooperation could develop.

Keywords Marine fisheries · Regional management · Sustainability · Ecuador · Peru · Transboundary stocks

1 Introduction

Global marine fisheries have grown over the past century, reaching a peak of 90–130 million metric tons per year in the mid-1990s, before the steady decline in recent decades (FAO 2016b; Pauly and Zeller 2016). The availability of diesel-powered vessels and sonar technology after World War II facilitated the development of distant-water fishing fleets by the United States, Japan, China, the Soviet Union/Russia, Taiwan, South Korea, Spain, and France. As their name implies, distant-water fleets fish away from their country's waters in international seas and in the maritime zones of foreign nations, including those of Ecuador and Peru. However, perceiving the threat of exhaustion of local fisheries resources by distant-water fleets, in 1952 the governments of Chile, Peru and Ecuador signed the "Santiago Declaration on the Maritime Zone," claiming exclusive sovereignty and jurisdiction over seas extending 200 nautical miles (nm) from each country's respective coast (Chile Ecuador and Peru 1976). This declaration, however, was not ratified internationally and was largely ineffective in stemming the problem. Following the combined pressure from Asian and African nations, along with others in Latin America (Thorpe and Bennett 2001), the international community agreed on the designation of 200 nm Exclusive Economic Zones (EEZ) of coastal nations in the United Nations Convention on the Law of the Sea in 1974 (UNCLOS; UN 2019). Under UNCLOS, distant-water fleets may harvest unexploited fish in foreign EEZs if they pay a negotiated fee for access. Bolstered by the newly-established zones, and pressured to harvest domestic stocks to exclude foreign fleets, Ecuador, Peru, and other Latin American nations rapidly developed their own fishing fleets and joined the global fishing nations (Thorpe and Bennett 2001).

The race to capture fish led to governmental fuel subsidies and over-capitalization of the fishing industry and unsustainable harvest of local stocks. Consequently, multiple regional stocks have since been designated "fully exploited," "overexploited," or "depleted," including South Pacific hake *Merluccius gayi*, mackerels *Trachurus picturatus*, *Trachurus murphyi* and *Scomber japonicus,* and South American pilchard *Sardinops sagax* (FAO 2016a, b). Other relevant regional pelagic fisheries include those of sharks and tunas, and more recently the rise of the dolphinfish *Coryphaena hippurus* and giant squid *Dosidicus gigas* fisheries (Argüelles et al. 2008; Del Solar et al. 2017).

The decline of stocks due to unsustainable fishing is further compounded by the forecasted deleterious effects of climate change (Defeo et al. 2013; Dueri et al. 2014) and by the global challenge of Illegal, Unreported, and Unregulated (IUU) fishing. IUU fishing relates to unsustainable harvest practices and is linked to organized crime. Its products infiltrate fish and fishmeal distribution channels, particularly in developing countries with low levels of governance (Agnew et al. 2009). The mislabelling of seafood products contributes to cover this malpractice from consumers (Cawthorn et al. 2018; Grillo et al. 2018). As a response, some of the main fish importers in the European Union and United States are improving their standards of seafood traceability (Willette and Cheng 2018).

In this context, the UN Agreement on Port State Measures to combat IUU fishing (FAO 2009) defines the route for national governments to develop more efficient control systems and improve their legislation and the procedures used to detect IUU fishing. This approach targets industrial vessels that land their catch in major ports but does not include small-scale fisheries. Thus, different approaches are needed to improve seafood traceability across fisheries sectors. For Ecuador and Peru, both industrial and artisanal fishing are important contributors to the national economy and food security. In the following sections, we will present arguments in favor of strengthening cooperation between these countries in order to meet the challenges of IUU fishing, market competitiveness and local food security.

2 Historical Development of Fisheries Management and Coastal Conservation in Ecuador and Peru

Ecuador possesses a continental EEZ and an insular EEZ surrounding the Galapagos Archipelago, with marine conservation and fisheries management efforts having historically focused on the Galapagos region. In contrast, Peru has a single, continuous EEZ with no islands located far from the coastline (Fig. 15.1). Both countries

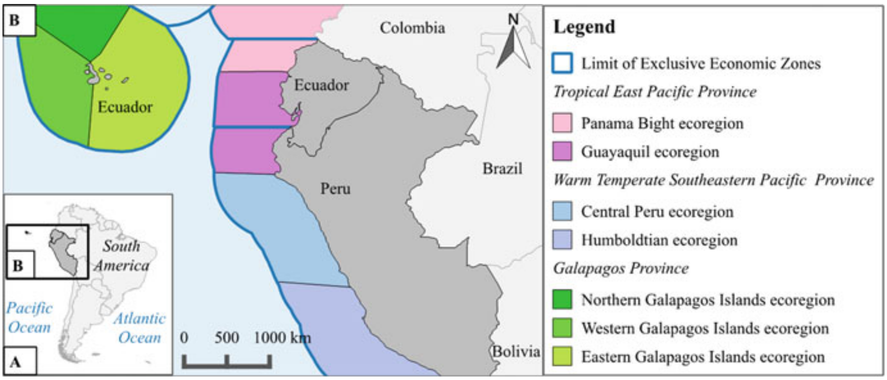

Fig. 15.1 Biogeographic and political subdivisions off the Ecuadorian Peruvian coast (Spalding Mark et al. 2007).

exploit their marine resources in open access regimes, and largely depend on extractive, export-oriented economies.

The first initiative to protect marine biodiversity in Ecuador occurred in 1934 when the Galapagos Archipelago was declared a “conservation area” (Varea 2004). The oldest institutions conducting research for the conservation of the Galapagos Islands are the Galapagos National Park Directorate (GNPD), created by the Ecuadorian government, and the Charles Darwin Foundation, both founded in 1959 (see Box 15.1). Meanwhile, marine conservation in Peru started in 1958, with measures to maintain guano exploitation (i.e., bird excrement from coastal capes, exported as fertilizer). The state prohibited fishing nearby the capes because the activity—in combination with El Niño events, (see Cushman 2003)—was reducing the birds’ source of food, anchoveta *Engraulis ringens*. Currently, the National Reserve of Guano Islands, Islets and Capes System allows ecosystem-based management and resource use around these highly productive areas.

The 1950s saw the rise of industrial fisheries in Ecuador and Peru. In Ecuador, the shrimp trawl fishery began in this decade and eventually entered in conflict with coastal communities for the use of ancestral fishing grounds and high rates of bycatch. In 2012, the shrimp-trawl fishery was officially closed (MAE 2012). In Peru, the industrial fishing of anchoveta started in 1952 (Mendo and Claudia 2016). For a long time, this was the most important economic activity associated to the sea. Anchoveta stocks collapsed in the early 1970s but measures were taken and the fishery is today one of the largest single-species and best-managed fisheries in the world (Chavez et al. 2008; Tarazona and Arntz 2001).

During the 1970s, mangrove deforestation for shrimp farming prevailed in Ecuador and Northern Peru. The process started in Ecuador early in the decade and affected the traditional fishing communities depending on crustaceans, molluscs, and fish (Terán et al. 2007). The mangrove forest ecological reserve Manglares Churute was created in Ecuador in 1979 to counter this process. During the 1990s, the Ecuadorian government adopted the strategy of managing mangrove forests through concessions assigned to legally constituted fishing associations. Similarly, the Peruvian State initiated a series of experiments in shrimp aquaculture in 1970, and by 1978 it allowed the private sector to take part. For Peru, shrimp aquaculture was an alternative to the recently collapsed anchoveta fishery, but it was also motivated by a shift toward a liberal economy. Shrimp production in Peru has increased ever since, despite disastrous El Niño events in 1982–1983 and 1997–1998, which destroyed ponds, channels, and facilities (Mialhe et al. 2013). In 1988 the Sanctuary “Los Manglares de Tumbes” was created as an important natural reserve to protect the mangrove forests of northern Peru in response to the growth of unregulated shrimp farming in the area (INRENA 2002). However, its management is still challenging due to contamination, deforestation, aquaculture, agriculture and urban expansion, added to information gaps that deter decision-making (Flores et al. 2013). Ecuador is currently the second largest exporter of frozen shrimp after India, while Peru occupies the 13th place (Workman 2019).

During the 1980s the artisanal fishing fleet of Ecuador experienced a significant development of its capacity to reach fishing areas outside the continental platform. In

1989, the National Fisheries Institute (INP) of Ecuador started monitoring the main artisanal fishing ports along the coast, collecting information about landings, fishing effort and biological data about the main target species (Peralta 2009).

The signing of the Convention on Biological Diversity (CBD) in Rio 1992 had a positive effect on conservation efforts in Ecuador, although not immediately. In 2000, stakeholders from the coastal region engaged with the Ministry of Environment, exerting pressure for the declaration of a series of coastal marine protected areas. However, a study of biodiversity conservation gaps and priorities in continental Ecuador concluded that the existing protected areas failed to cover and represent the different ecosystem types, particularly, the marine ecosystems (Terán et al. 2007). A portfolio of potential conservation areas resulting from the study was included in the National Strategy for Biodiversity 2015–2030 to guide the development and expansion of the National System of Protected Areas (MAE 2016).

In Peru, the creation of the Peruvian Ministry of Environment in 2008 constituted a turning point from fisheries-oriented coastal zone management, toward ecosystem-based management. The current policy for integrated coastal zone management (Ministerio del Ambiente 2016) was assessed by Barragan and Lazo in 2018. The authors explain that the State has recently included coastal zone management in the political agenda, but only as a bottom-up process. They consider that this is an incomplete approach, lacking a clear description of the role of the State in supporting coastal communities in policy implementation, and in facilitating the advance of regions and districts. Therefore, Peru is considered to be in a transition toward a more integrated model but still with a long way to go. For instance, it has been suggested that the marine nature of the Guano Islands and Capes system should be complemented with a protected terrestrial coast strip that would act as a coastal ecological corridor, but this is not yet included in official plans (Barragán and Lazo 2018).

In summary, Ecuador and Peru have had similar, parallel processes of natural resource exploitation in marine and coastal ecosystems. Both have significant environmental sustainability challenges and therefore national policies are now turning toward ecosystem-based management.

Box 15.1 Fisheries Management in Galapagos, Ecuador

The importance of Galapagos for global marine biodiversity has been widely recognized: UNESCO World Heritage Site (1978), Biosphere Reserve and Whale Sanctuary (1985), and Shark Sanctuary (2016). However, multiple drivers of environmental degradation are still acting, including biological invasions and extinctions, overfishing, massive tourism, and contamination (see Wolff and Gardener 2012).

The Galapagos Marine Reserve (GMR) is a multi-use oceanic protected area of ~138,000 km^2 from a 40 nm buffer measured from the baseline around of the archipelago and its inland waters. Industrial fishing was prohibited in

(continued)

Box 15.1 (continued)
1998 by the Special Law for Galapagos, and its special regulation for fishing activity. However, industrial fishing has been displaced outside the boundaries of the GMR. The local artisanal fishery is the only permitted and managed by GNPD and takes place in 99% of the GMR (Moity et al. 2018). Measures to reduce the fishing effort and pressure on coastal and demersal fish include the use of anchored fish aggregation devices (FADs). These are being evaluated as sustainable alternatives for the fishing sector. Evidence shows that the GMR had a positive effect on industrial fisheries targeting yellowfin and skipjack tuna during the first decade of operation (Wolff et al. 2012), whereas the sustainability of industrial fisheries operating outside the GMR is threatened by the overuse of FADs (Bucaram et al. 2017).

Despite management efforts and the existence of a muti-stakeholder management board ("Junta de manejo participativo"), the threat of illegal fishing is still real for Galapagos. In 2017, a Chinese-flag fishing vessel was caught inside the GMR containing 300 tons of protected species, including hammerhead sharks (EFE 2017). More recently, the Ecuadorian Navy caught four fishing vessels manned by Peruvian crews inside the Galapagos EEZ, once again, targeting protected shark species (El Comercio 2019). The illegal entry of industrial vessels is evident, especially long-liners (Carr et al. 2013; Jacquet et al. 2008). Long-line fishing is not a sustainable option for Galapagos, where marine-based tourism is related to megafauna sighting (Cerutti-Pereyra et al. 2019; Moity and Izurieta 2017). In addition, marine-based tourism represents the biggest economic revenue (58%) (Lynham et al. 2015) in the GMR. Other illegal activities such as fishing inside no-take zones, targeting species in closed seasons and using banned fishing gear are daily local challenges.

Although small-scale fishing practices and management are different between Ecuador mainland and the Galapagos Archipelago, governance problems persist in both sub-regions due to incongruent jurisdictional and legal frameworks, and a lack of attention to the social and cultural dimensions of fisheries governance (Barragán Paladines 2015).

3 A Continuous Environment Across Political Borders

Marine ecology around the political border between Ecuador and Peru is highly dynamic due to the proximity of three biogeochemical provinces: the Central American Coastal Province, which extends from Baja California to the Gulf of Guayaquil, in Ecuador; the Humboldt Current Coastal Province which covers the coastal waters off Chile and Peru from 40–45 to 5°S; and the Pacific Equatorial Divergence Province, dominated by the South Equatorial Current west of the Galapagos Archipelago (Longhurst 1998). The exact latitudinal extent of these provinces is subject to variations associated with the El Niño Southern Oscillation

(ENSO). Additionally, this political border is located inside the Tropical East Pacific—Guayaquil biogeographic ecoregion (Spalding Mark et al. 2007), dominated by the Gulf of Guayaquil, the largest estuary in the Pacific coast of South America (Fig. 15.1).

The predominant feature throughout this region is the presence of the Humboldt Current (HC)—the most productive eastern boundary current system in terms of fish production (Mendo and Claudia 2016; Miloslavich et al. 2011). The northern coast of Peru is particularly productive in this sense. For example, the Region of Piura represents only 10% of the Peruvian coastline but hosts ~30% of all fishers and ~35% of all artisanal boats and small-scale vessels (Guevara-Carrasco and Bertrand 2017). In the HC system, upwelling of cold water sustains a highly productive plankton community, which in turn supports a high biomass of small pelagic fish (mainly anchovies and sardines) and top predators feeding on them. However, during ENSO's warm phases, the upwelling current brings warm, nutrient-poor but oxygen-enriched water from offshore and from equatorial latitudes (Taylor et al. 2008). This generates a disruption of the food chain that cascades all the way from the phytoplankton through herbivores and leads to the drastic reduction of pelagic fish stocks (Longhurst 1998).

The environmental oscillation between ENSO's warm and cold phases also causes changes in the composition of the marine communities for a given latitude (IOC 1989). For instance, warm phases have been associated with a decrease in catches of *Engraulis ringens, Merluccius gayi peruanus, Aulacomya ater*, and increases of *Trachurus picturatus murphyi, Octopus* spp., and *Penaeus* spp.; additionally, the fisheries have shown a trend from mono- to multi-specific catches (Badjeck 2008) during these times. In the case of the highly valued scallop *Argopecten purpuratus*, warmer waters have increased catches almost 50-fold in the Ica Region, central Peru, which lies under typical upwelling conditions (~14°S). On the other hand, scallop stocks collapse around 4°S, due to increased rainfall that leads to decreased salinity and higher discharge of particulate matter (Mendo et al. 2008; Taylor et al. 2008; Wolff 1987). Similarly, Ecuadorian waters are also heavily affected by ENSO and the HC's upwelling system, as documented in studies of periodic modifications of ocean biogeochemistry (Borbor-Cordova et al. 2019; Wolff 2010).

4 Fishing Target Species Common to Ecuador and Peru

This section presents the biodiversity of fishery resources that have been documented both in Ecuador and Peru. It is supported by a list of species (see Appendix) compiled using public information in English and Spanish. Species were included in this list based on their latitudinal distribution across the political border and after confirmation of their presence in both countries from the literature. Taxonomic synonymy was checked using online databases (Maddison et al. 2007) and conservation status was retrieved from IUCN (2019). The compiled list consists

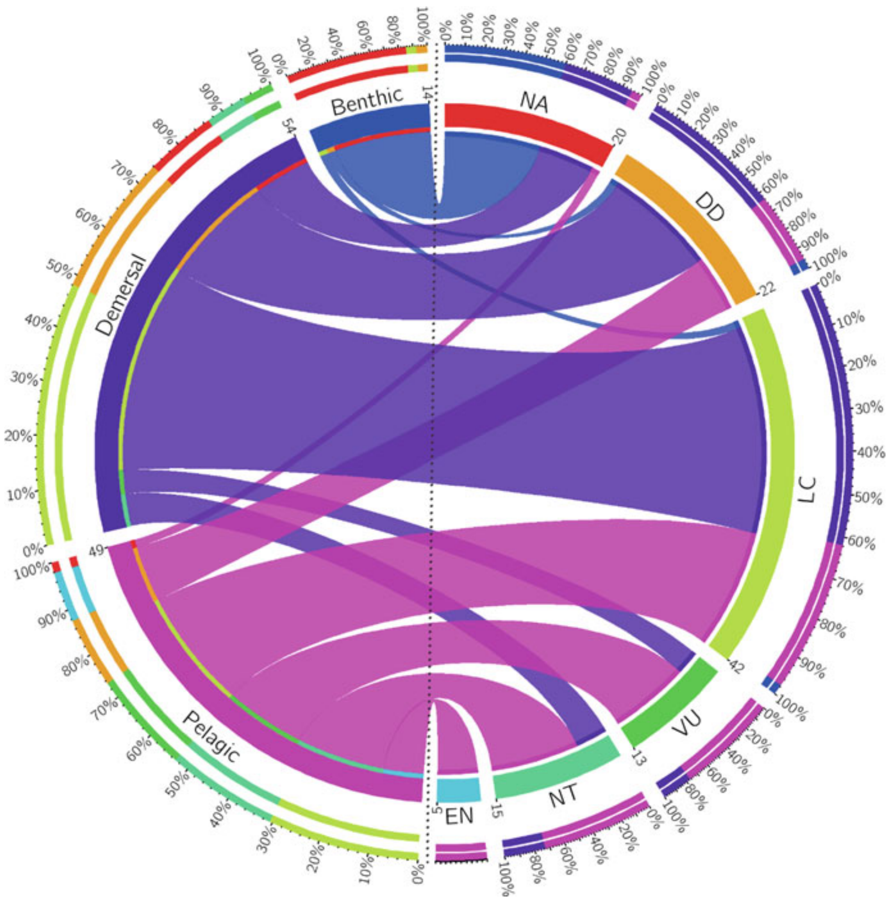

Fig. 15.2 Two-variable circular diagram built with information from 117 fishing-target species reported both in Ecuador and Peru. The first variable is ecological distribution (benthic, demersal, pelagic)—represented on the left hemisphere. The right hemisphere contains the second variable: threat categories from least to most (NA not assessed, DD data deficient, LC least concern, VU vulnerable, NT near threatened, EN endangered IUCN 2019). Bands connecting both sides represent the proportion of species in each combination. Number of species in each category is written next to the category's name. Percentages of species in each subcategory are colored on peripheral scales (e.g., demersal and LC: 62%). Diagram generated with Circos Table Viewer (Krzywinski et al. 2009)

of 117 species, including fishes (95 spp.), crustaceans (16 spp.), and molluscs (6 spp.).

There is a considerable gap of knowledge in terms of IUCN categories as 35.8% of the list corresponds to species not assessed, or data deficient (Fig. 15.2). The largest gap is among benthic species. Demersal species are mostly under the least concern category, but also include the majority of data deficiency cases. More than half the pelagic species are in threatened categories.

4.1 Threatened Species by Large-Scale Distribution

Coastal Species The coastal zone contains the largest proportion of species in the total list (66.7%). Almost half of coastal species are in the low-concern category, but the population trends are unknown for the majority (78.2%). Two rays (*Rhinobatos leucorhynchus, Myliobatis longirostris)*, and two sharks (*Squatina californica*, *Mustelus mento)* are near threatened, while three other shark species (*Galeorhinus galeus, Mustelus whitneyi, Triakis maculata)* are considered vulnerable.

Oceanic Species Oceanic waters are occupied by 21.4% of the species in the list. Population trends are known for 76.0% and decreasing for 64.0% of oceanic species. Eleven species of rays (genus *Mobula*), sharks (genera *Carcharhinus, Rhincodon, Isurus, Sphyrna, Alopias*) and tuna (*Thunnus orientalis, T. obsesus*), and billfishes (*Makaira mazara, Istiompax indica, Kajikia audax, Xiphias gladius*) are either vulnerable or endangered.

Semi-oceanic Species The semi-oceanic species account for 11.9% of our list, including one ray *(Mobula tarapacana*) and 13 sharks. The near threatened species are *Carcharhinus galapagensis*, *C. limbatus, C. brachyurus, C. leucas* and *Galeocerdo cuvier,* the vulnerable species are *M. tarapacana* and *Carcharhinus falciformis*, and the endangered species are *Sphyrna mokarran* and *S. lewini.* The population trends are unknown for 71.4% of the semi-oceanic species reported.

4.2 Major Fishing Targets and Shared Stocks

Ten species from our list—nine fishes and one squid—were found among the major targets for marine fisheries between 1950 and 2010 (Table 15.1), according to catch reconstructions for Ecuador (Alava et al. 2016; Schiller et al. 2016) and Peru (Mendo and Claudia 2016). In five of these cases, Ecuador and Peru exploited the same stocks. Nowadays, Jumbo flying squid and Pacific sardine are marginal fisheries in Ecuador, while Chilean jack mackerel is developing (Pablo Guerrero, personal communication).

The most important shared stocks are currently those of tropical tunas (*Thunnus obesus*, *T. albacares,* and *Katsuwonus pelamis*), Chilean jack mackerel (*Trachurus murphiyi*), and dolphinfish (*Coryphaena hippurus*; Pablo Guerrero, personal communication). Ecuador and Peru seek to coordinate research and management measures for these stocks through different mechanisms. Tropical tunas and dolphinfish are managed through the Inter-American Tropical Tuna Commission (IATTC), while Chilean Jack mackerel is managed through the South Pacific Regional Fisheries Management Organization (SP-RFMO).

Table 15.1 Major species in catch reconstructions from 1950 to 2010, present in Ecuador and Peru

Species	EEZs where the species was a main target[a]			IUCN category[b]	Shared stocks[c]
	Peru	Continental Ecuador	Galapagos		
1. Jumbo flying squid *Dosidicus gigas*	x		x	DD	x
2. Blue shark *Prionace glauca*			x	NT	
3. Anchoveta *Engraulis ringens*	x			LC	
4. Pacific sardine *Sardinops sagax*	x	x		LC	
5. Peruvian hake *Merluccius gayi* peruanusi	x			DD	x
6. Chilean jack mackerel *Trachurus murphyi*	x			DD	x
7. Pacific thread herring *Opisthonema libertate*		x		LC	
8. Chub mackerel *Scomber japonicas*		x		LC	
9. Skipjack tuna *Katsuwonus pelamis*				LC	x
10. Bigeye tuna *Thunnus obesus*			x	VU	x

[a]Pauly and Zeller (2016)
[b]IUCN (2019): *DD* data deficient, *LC* least concern, *VU* vulnerable, *NT* near threatened
[c]El Telégrafo (2019); Pablo Guerrero, personal communication)

5 Economic and Societal Value of Fishery in Ecuador and Peru

Ecuador and Peru are among the top 25 nations in the world for landed value of fish and fisheries products (FAO 2016b). They are located in the FAO major fishing area 87 (Pacific, SE) where the percentage of overfished stocks is estimated at 41%, and the rate of IUU fishing at 19% (Cawthorn et al. 2018). During 2014, Ecuador contributed with 0.8% of the total global marine captures, while Peru represented 4.4% in total, and 1.5% excluding anchoveta. Peru is around three times larger than Ecuador in area, coastline length and population size, and marine fishing catches in Peru are around one order of magnitude higher to those of Ecuador (Table 15.2). Fishing has been an essential subsistence activity for local coastal populations in this region since pre-Columbian times (see Béarez et al. 2012).

Industrial fisheries are key economic sectors in Ecuador and Peru. Ecuador is the highest tuna producer in the Eastern Pacific Ocean (EPO). The port of Manta takes the largest amount of tuna landed by the industrial purse seine fleet in the EPO (Martínez-Ortiz et al. 2015). Ecuador exports 80% of its industrial fisheries products, mainly to Europe, the United States, China, Japan, Colombia, and Mexico (Ecuador Pesquero 2017). Likewise, Peru has the world's biggest single-species industrial

Table 15.2 Comparative summary of marine fisheries statistics from Ecuador and Peru

Characteristics of marine fisheries	Ecuador	Peru
Coastal geography		
Latitudinal range	01° 24′ N–03° 25′ S[a]	03° 25′ S–18° 21′ S
Coastline length	>1200 km (exc. Galapagos)[b]	3080 km[i]
Oceanic surface	270,670 km^2 [b]	1,100,000 km^2 [i]
Inshore Fishing Area (IFA)	27,202 km^2 [o]	71,057 km^2 [o]
National population	17,317,049 in 2019 [c]	31,237,385 in 2017 [j]
Proportion of the population living in the coast	52% in 2010 [c]	43% in 2007 [k]
Economic value of fisheries		
Marine capture production in 2016 (tones)	715,357 [e]	3,774,887 (total) 919,847 (excluding anchoveta) [e]
Variation from 2015 to 2016 (tones)	72,181 [e]	–1,011,664 (total) –96,784 (excluding anchoveta) [e]
Fleet size *Industrial fisheries*		
Number of designated ports for implementation of FAO Agreement on IUU	2 (Manta, Guayaquil)[f]	7 (Piura, Chimbote, Trujillo, Ica, Moquegua, Arequipa, Lima)[f]
Number of vessels	698[g]	1071[m]
Number of direct jobs	24,000[d]	232,357[k]
Artisanal/small-scale fisheries		
Number of landing sites	243[h]	116[m]
Number of fishing boats (plus >10 000 units not registered in each country)	45,793 in 2013[a]	17,920 in 2015[i]
Number of fishermen	ca. 80,000[h]	ca. 70,000[i]
Fishmeal production		
Number of plants	31[d]	>8000[n]
Number of jobs	950 formal 121 informal[d]	>12,000[k]
Domestic consumption		
Apparent fish consumption per capita 2013–2015	5–10 kg year^{-1} [e]	10–20 kg [e]

[a]Martínez-Ortiz et al. (2015)
[b]Inocar (2012)
[c]INEC (2010)
[d]SCI (2020)
[e]FAO (2018)
[f]SPRFMO (2018)
[g]Ayala Villa (2017)
[h]Alava et al. (2015)
[i]Guevara-Carrasco and Bertrand (2017)
[j]INEI (2019)
[k]Christensen et al. 2014
[l]INEI (2014)
[m]INEI-PRODUCE (2013)
[n]Grillo et al. (2018)
[o]Zeller et al. (2015)

fishery of anchoveta *Engraulis ringens* for the production of fishmeal (Christensen et al. 2014). Industrial purse seine fisheries targeting anchoveta contribute to up to 30% of the GDP generated by the fishery sector in Peru.

Fishmeal production is another activity the two nations have in common. Peru is the largest fishmeal producer in the world (FAO 2014; Grillo et al. 2018) and Ecuador is currently ranked 13th for this commodity (Index Mundi 2019). Fishmeal production is principally related with industrial fishing as most fishmeal comes from small-pelagic species and fish residues from the industrial sector. Yet there are reports of fishmeal-processing facilities lacking official registry and buying prime materials from IUU fishing activities to cover market demands. This way, illegal fishmeal infiltrates processing and trade chains of balanced meal in Peru and Ecuador (Grillo et al. 2018). Furthermore, some of it is then transported from Peru to Ecuador to satisfy shrimp farms' high demand for preparing animal feed. Poor traceability of fishmeal represents a competitive disadvantage for both countries in international markets (Cawthorn et al. 2018; Trujillo 2017).

Artisanal and small-scale fisheries represent the main source of fish for local and national markets in Ecuador and Peru, but have long been overlooked in national policies (Arellano and Swartzman 2010; MAE 2010).

In Peru, fish represents 26% of the animal protein in domestic human consumption (Béné 2006)—among the highest in the world—and small-scale fisheries provide four times more employment than the industrial sector (Alvarez 2003). Additionally, artisanal purse seine, squid boats (and other artisanal subsectors including mariculture) contribute with more than 60% of the fisheries' GDP, and generate more than 75% of the total employment (Christensen et al. 2014). Such statistics are unclear in Ecuador because the artisanal fishing sector has been poorly monitored and managed, particularly in continental waters (Alava et al. 2016; Barragán and Lazo 2018).

Management measures for artisanal fisheries are different in each country. In Ecuador, artisanal fishing has an exclusive zone of up to 8 nm from the coastline, while in Peru this is up to 5 nm. Artisanal fishing often occurs beyond that limit and even outside the EEZ's boundaries, either to target oceanic species (e.g., dolphinfish, tuna, billfish, sharks), or because other target species are becoming more scarce in near shore areas (Guevara-Carrasco and Bertrand 2017; Martínez-Ortiz et al. 2015). The multi-gear, multi-species nature of these fisheries further complicates their monitoring and regulation. Moreover, artisanal fishers tend to rotate efforts among fishing grounds and chase migrating fish (i.e., ontogenetically, seasonally, or on the search for food), resulting in longitudinal and latitudinal displacements. This becomes particularly problematic for communities located close to the bi-national frontier, because fishers become illegal as soon as they cross the invisible political boundary. This has created conflicts between local authorities and communities in both countries, yet fishers have organized bi-national meetings on either side of the border to address this situation.

6 Antecedents of Bi-national Cooperation Between Ecuador and Peru

As noted in Sect. 1, Ecuador and Peru have a common history of cooperation in marine affairs, despite the territorial conflicts that occurred during the twentieth century. They are partners alongside Colombia and Chile in the Permanent Commission of the Southeast Pacific (CPPS), established in 1952 (Barragán and Lazo 2018). In 1989, scientists from the CPPS countries participated in a workshop to analyze the biological effects of ENSO in the region and identified an "alarming" lack of knowledge exchange among fisheries researchers (IOC 1989). In 2010, the CPPS developed the Regional Action Plan for the conservation of sharks, rays, and chimeras, which allowed these countries to aim for common goals. As it is common with other regional plans, adequate operationalization has been one of the main issues to tackle.

International organizations for fisheries management (e.g. SP-RFMO, IATTC) have allowed a better coordination of actions and policies between Ecuador and Peru. Despite these regional organizations involving several parties, Ecuador and Peru have worked more closely to establish common strategies for the most important shared stocks. The clearest example is that of dolphinfish fisheries management which has been addressed within the IATTC since proposed by Ecuador in 2012. Dolphinfish is highly relevant for Ecuador and Peru because together they produce around 90% of the catches from the Eastern Pacific (Pablo Guerrero, personal communication). Similarly, Ecuador posed another request in the 2019 SP-RFMO meeting, asking Peru to approve an increase in the fishing quota over the Chilean jack mackerel stock. This request was supported by other parties in the organization (El Telégrafo 2019).

In 2014, Ecuador and Peru signed an agreement toward bi-national management of protected areas, followed by meetings, projects, and a common fund (Plan Binacional Peru-Ecuador 2018). Then the National Institute of Fisheries in Ecuador (INP, renamed in 2020 as the Public Institute of Fisheries and Aquaculture Research IPIAP) and the Institute of the Sea of Peru (IMARPE) started working on a joint model of stock assessment for dolphinfish. The same year, hundreds of fishers from both countries gathered for the I Binational Congress for Responsible Artisanal Fisheries, in Lobitos (Piura, Peru). A second congress took place in Huaquillas (El Oro, Ecuador) in 2015. Since then, further initiatives have been working toward a bi-national strategy for responsible fisheries—although this is still unofficial. The growing number of cooperation initiatives between both countries, and the fact that they are coming from "top-down" and from "bottom-up," makes this a particularly important time for developing and formalizing this strategy between the two countries. More bi-national agreements have been recently signed in the same direction (El Universo 2019).

A very relevant and important agreement has to do with the launch in 2017 of a 5-year project led by the UN's Development Fund (UNDP), in collaboration with the NGOs Conservation International (CI) and the Worldwide Fund for Nature (WWF).

The project is part of FAO's Coastal Fisheries Initiative Latin America (CFI-LA), which is funded by the Global Environment Facility (GEF) as "a global effort to preserve marine resources and ensure that coastal fisheries can continue to play their crucial role in society, contributing to food security, as well as economic and social development." It focuses on the following main areas: (1) ecosystem-based, collaborative fisheries management and governance of the following fisheries: mahi-mahi, hake, shrimps, mangrove crabs and cockles, and pole and line tuna; (2) marine spatial planning in the Bay of Sechura in Peru and the Gulf of Guayaquil in Ecuador; and (3) sharing knowledge to develop more holistic processes and integrated approaches to coastal fisheries management. It is worth noting that even when this CFI project includes both countries, each working group is independently managing and developing their tasks toward their particular targets, which might break the whole meaning of bi-national collaboration. At present, the project is yet to produce its final result, so it is not clear if an internal collaboration between countries will arise in the end.

7 Challenges and Needs for Trans-boundary Collaboration Towards Sustainable Fisheries Management

In this chapter, different aspects common to Ecuador and Peru in relation to their coastal and marine resources have been described. Special focus has been given to fishery resources due to their essential role in economic and social development, at the local and national levels. The fishing sectors of both countries demand attention and support from different segments of society in order to enhance their transformation into sustainable systems, capable of adapting to global change and thriving over crisis.

Sustainability is a continuous process that allows the use of a resource without compromising its availability for future generations (Hilborn et al. 2015). In particular, seafood sustainability requires understanding how people affect and respond to ecosystem processes—in other words, understanding fisheries as social-ecological systems that emerge from resource use. The basic elements for sustainable management are: (a) specific objectives and targets for fishing pressure and abundance, (b) monitoring of fishing pressure and abundance, (c) assessments to determine if targets are being met, (d) feedback management systems that adjust regulations in response to the assessments and in particular restrict fishing pressure when it is too high, and (e) enforcement systems to assure compliance with regulations (Hilborn et al. 2015). According to our review, regional organizations (e.g., CIAT) offer a platform for the application of those elements to trans-boundary fisheries management between Ecuador and Peru (Sect. 6)—but equivalent spaces are still needed to address the transformation of small-scale fisheries.

Transformation of fisheries' socio-ecosystems toward sustainability requires action in three equally relevant dimensions: environmental protection, social development, and economic growth (Hilborn et al. 2015). The main challenges faced by Ecuador and Peru in these areas are also those of many developing countries: prevent overfishing, preserve mangrove ecosystems, combat IUU fishing, increase seafood traceability, strengthen fishing associations, visualize women's participation, protect environmental services, among others. In addition, climate change is a transversal component because it is fundamental to know the impact of this global threat on fishing target species, ecosystems and coastal communities. Given the similarities between Ecuador and Peru and the resources they have in common, we argue that some challenges could be better addressed by means of official bi-national cooperation, while others could benefit from academic cooperation and knowledge exchange among stakeholders from both countries. A detailed classification and association of challenges, needs, and prospective collaborators is presented in Fig. 15.3.

Challenges around economic growth in the fishing sector (Fig. 15.3) involve the transformation of value chains into more inclusive and competitive ones. Progress in this aspect can be reached through reduced bycatch rates and increased seafood traceability, which in turn, allow access to markets with strict sustainability standards. Such a goal can be supported by the application of emergent methods and technologies like molecular tools for assessing fishery activity and fish traceability along the value chain. On the other hand, inclusiveness implies recognizing the importance of women and their role within the value chain of marine resources, which can be promoted through bi-national studies and workshops similar to those conducted by fishing associations in recent years (Sect. 6). The situation around illegal fishmeal production and its commercialization (Sect. 5) represents a clear opportunity for both countries to join efforts in solving a common problem.

In terms of social development (Fig. 15.3), there are challenges related with social organization and equal access to basic rights, and challenges related with effective stocks management. Empowering women and fishing associations is necessary to support the rights of local communities and their participation during decision-making processes. Governments can foster such processes by facilitating the exchange of experiences among organizations from the region in the context of bi-national workshops and assist organizations with capacity building in governance. Moreover, bi-national cooperation is essential for the definition of science-based management measures for shared stocks of migratory species, which currently differ from country to country (e.g., dolphinfish ban periods, minimum and maximum catch size, regulations on elasmobranchs and sailfishes). This implies collaboration in fisheries research, agreement on common management measures, and coordination of enforcement procedures.

General challenges in the environmental protection component are related to the prevention of habitat degradation and regulation of resource use. Habitat degradation through direct (e.g., mangrove deforestation) and indirect (e.g., upstream contamination) impacts affects seafood quality and safety. Indeed, water quality assessments are urgent in the border zone as reported concentrations of heavy metals in seafood samples have been above safety levels for human consumption across the Gulf of Guayaquil in Ecuador (Navarrete-Forero et al. 2019). Similar situations potentially

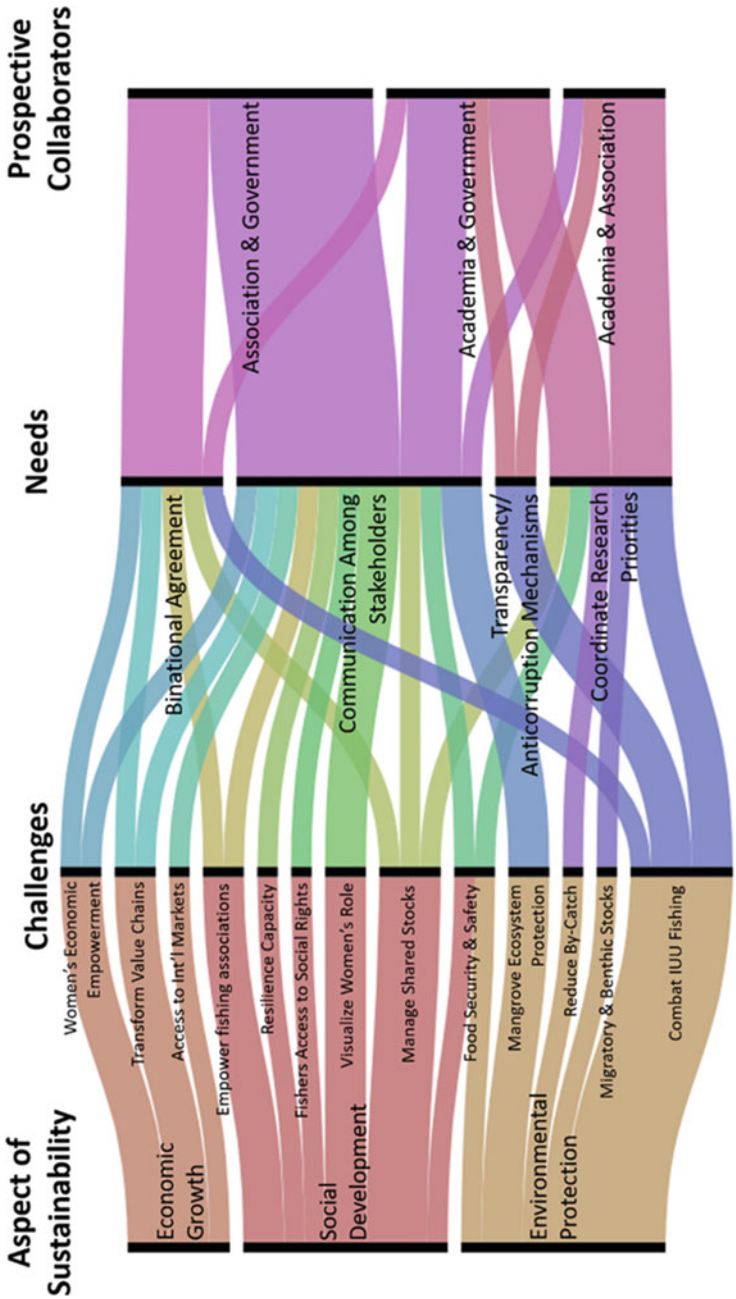

Fig. 15.3 Multi-category alluvial diagram illustrating three primary Aspects of Sustainability and the associated challenges and needs to reach a more sustainable fisheries sector. Prospective collaborators are indicated to meet the challenges and needs for sustainability. Diagram generated in RAWGraphs (Mauri et al. 2017)

occur on the Peruvian side due to widespread gold mining activities in the Andean region. In addition, our analysis of IUCN threat categories (Sect. 4) shows significant knowledge gaps for certain ecological groups, particularly among benthic species that are the basis for livelihoods in mangrove ecosystems. In this context, scientific cooperation is needed in order to assess populations in their natural distribution and not as separate entities based on a political boundary.

Another field for scientific collaboration included in the environmental protection component is the fight against IUU fishing. The multiple effects of IUU fishing on the ecosystem, society and economy justify its consideration as a target for bi-national cooperation. This requires basic scientific research about population genetics, but also applied research to develop tools for enforcement procedures and increase transparency in their application.

Perhaps the greatest challenge in this context is to develop governability across scales in the fishery sector, which would allow the effective implementation of sustainable management strategies. Bi-national agreements are valuable for addressing the biggest challenges such as the fight against IUU fishing, which need coordination among multiple institutions and stakeholders. However, no strategy can be effectively applied without local governance and resource users' compliance. Therefore, different sectors of society should join the task and support small-scale fishing associations in their empowerment processes. We consider that while a legal framework for bi-national cooperation at the national government level is necessary (Nikanorova and Egorov 2019), it is also possible to establish cooperation through interdisciplinary research networks between both countries, and even from countries where the fishery products are consumed. This sort of bottom-up pressure can encourage further collaboration at higher levels of governance or at regional platforms, and its influence in the transformation of fisheries socio-ecosystems should not be underestimated.

Acknowledgments We thank participants and co-organizers of the Fulbright-sponsored workshop "Leveraging actionable science to aid policy decisions to combat illegal, unreported and unregulated fishing across the Pacific" held in Guayaquil in July 2017, where this contribution was conceived. In particular, Luis Domínguez Granda (*Centro del Agua y Desarrollo Sustentable CADS-ESPOL*), Giovanna Sotil Caycho and Deivis Cueva (IMARPE), Angie Mera and Julio Bonilla (ESPOL), Jose Luis Pacheco (INP) and Boris Ayala (*Secretaria de Recursos Pesqueros*). DAW thanks M. Joaquin for logistical support during the workshop, as well as U.S. Fulbright Global Scholar Program and LMU's Seaver College of Science and Engineering for their supporting grants. Thanks to Mireya Pozo-Cajas (*Universidad de Guayaquil*) for commenting on the historical development section, and Pablo Guerrero (WWF Ecuador) for providing context information about shared stocks. AdSE thanks the Peruvian association REDES-SP, Wilmer Huamán and Mariano Valverde for information and discussion on bi-national collaboration initiatives.

Appendix

List of fisheries target species distributed across the maritime border between Ecuador and Peru

N	Family	Species	Marine zone	Habitat	Latitudinal range	Threat category[a]	Population trend[a]	Reference
Mollusca								
1	Arcidae	*Anadara tuberculosa*	Coastal	Benthic	32°N–04°S	NA	Unknown	(IMARPE 2009; INP 2010b; Palomares and Pauly 2019)
2	Pteriidae	*Pteria sterna*	Coastal	Benthic	32°N–05°S	NA	Unknown	(INP 2010b; Ordinola et al. 2010; Palomares and Pauly 2019).
3	Ostreidae	*Striostrea prismatica*	Coastal	Benthic	32°N–04°30′S	NA	Unknown	(IMARPE 2009; Palomares and Pauly 2019; Roskov et al. 2019)
4	Ommastrephidae	*Dosidicus gigas*	Oceanic	Pelagic	50°N–30°S	DD	Unknown	(INP 2010b)
5	Octopodinae	*Octopus mimus*	Coastal	Benthic	02°S–33°S	NA	Unknown	(INP 2010b; Palomares and Pauly 2019)
6	Octopodinae	*Octopus oculifer*	Coastal	Benthic	Galapagos	NA	Unknown	(Palomares and Pauly 2019)
Crustacea								
7	Penaeidae	*Farfantepenaeus brevirostris*	Coastal	Demersal	32°N–06°S	NA	Unknown	(IMARPE 2009; INP 2010a)
8	Penaeidae	*Farfantepenaeus californiensis*	Coastal	Demersal	32°N–06°S	NA	Unknown	(IMARPE 2009; INP 2010a)
9	Penaeidae	*Litopenaeus occidentalis*	Coastal	Demersal	32°N–06°S	NA	Unknown	(IMARPE 2009; INP 2010a)
10	Penaeidae	*Litopenaeus stylirostris*	Coastal	Demersal	32°N–06°S	NA	Unknown	(Herrera et al. 2013; IMARPE 2009)
11	Penaeidae	*Litopenaeus vannamei*	Coastal	Demersal	32°N–06°S	NA	Unknown	(Herrera et al. 2013; IMARPE 2009)
12	Palinuridae	*Panulirus gracilis*	Coastal	Benthic	32°N–06°S	DD	Unknown	(Chirichigno 1970; IMARPE 2009; INP 2010a)
13	Penaeidae	*Protrachypene precipua*	Coastal	Benthic	15°N–04°S	NA	Unknown	(INP 2010a; Palomares and Pauly 2019)

14	Penaeidae	*Trachypenaeus byrdi*	Coastal	Demersal	26ºN–06ºS	NA	Unknown	(Herrera et al. 2013; Palomares and Pauly 2019)
15	Penaeidae	*Xiphopenaeus riveti*	Coastal	Benthic	32ºN–18ºS	NA	Unknown	(Herrera et al. 2013; Palomares and Pauly 2019)
16	Calappidae	*Calappa convexa*	Coastal	Benthic	32ºN–18ºS	NA	Unknown	(INP 2010a; Palomares and Pauly 2019)
17	Portunidae	*Callinectes arcuatus*	Coastal	Benthic	34ºN–20ºS	NA	Unknown	(Herrera et al. 2013; Palomares and Pauly 2019)
18	Portunidae	*Callinectes toxotes*	Coastal	Demersal	24ºN–04ºS	NA	Unknown	(Herrera et al. 2013; Palomares and Pauly 2019)
19	Portunidae	*Euphylax robustus*	Coastal	Benthic	32ºN–18ºS	NA	Unknown	(INP 2010a; Palomares and Pauly 2019)
20	Scyllaridae	*Evibacus princeps*	Coastal	Benthic	32ºN–05ºS	LC	Unknown	(INP 2010a; Palomares and Pauly 2019)
21	Menippidae	*Menippes frontalis*	Coastal	Benthic	32ºN–18ºS	NA	Unknown	(INP 2010a; Palomares and Pauly 2019)
22	Ocypodidae	*Ucides occidentalis*	Coastal	Benthic	32ºN–04ºS	NA	Unknown	(Herrera et al. 2013; IMARPE 2009)
Fishes (Chondrichthyes)								
23	Carcharhinidae	*Carcharhinus altimus*	Semi-oceanic	Pelagic	35ºN–07ºS	DD	Unknown	(Froese and Pauly 2019)
24	Carcharhinidae	*Carcharhinus brachyurus*	Semi-oceanic	Pelagic	35ºN–09ºS	NT	Unknown	(Froese and Pauly 2019)
25	Carcharhinidae	*Carcharhinus falciformis*	Semi-oceanic	Pelagic	40ºN–40ºS	VU	Decreasing	(Froese and Pauly 2019; Herrera et al. 2013)
26	Carcharhinidae	*Carcharhinus galapagensis*	Semi-oceanic	Pelagic	35ºN–40ºS	NT	Unknown	(Froese and Pauly 2019)
27	Carcharhinidae	*Carcharhinus leucas*	Semi-oceanic	Pelagic	40ºN–40ºS	NT	Unknown	(Froese and Pauly 2019; Herrera et al. 2013)
28	Carcharhinidae	*Carcharhinus limbatus*	Semi-oceanic	Pelagic	40ºN–40ºS	NT	Unknown	(Froese and Pauly 2019)
29	Carcharhinidae	*Carcharhinus longimanus*	Oceanic	Pelagic	46ºN–43ºS	VU	Decreasing	(Froese and Pauly 2019)

(continued)

N	Family	Species	Marine zone	Habitat	Latitudinal range	Threat category[a]	Population trend[a]	Reference
30	Carcharhinidae	*Carcharhinus porosus*	Semi-oceanic	Pelagic	35ºN–09ºS	DD	Unknown	(Froese and Pauly 2019)
31	Carcharhinidae	*Galeocerdo cuvier*	Semi-oceanic	Pelagic	40ºN–10ºS	NT	Unknown	(Froese and Pauly 2019; Herrera et al. 2013)
32	Carcharhinidae	*Nasolamia velox*	Semi-oceanic	Pelagic	35ºN–04ºS	DD	Unknown	(Froese and Pauly 2019; Herrera et al. 2013)
33	Carcharhinidae	*Prionace glauca*	Oceanic	Pelagic	71ºN–55ºS	NT	Unknown	(Froese and Pauly 2019; Herrera et al. 2013)
34	Carcharhinidae	*Rhizoprionodon longurio*	Semi-oceanic	Pelagic	36ºN–06ºS	DD	Unknown	(Froese and Pauly 2019; Herrera et al. 2013)
35	Rhincodontidae	*Rhincodon typus*	Oceanic	Pelagic	55ºN–48ºS	EN	Decreasing	(Froese and Pauly 2019)
36	Alopiidae	*Alopias pelagicus*	Oceanic	Pelagic	01ºN–13ºS	VU	Decreasing	(Froese and Pauly 2019; Herrera et al. 2013)
37	Alopiidae	*Alopias superciliosus*	Oceanic	Pelagic	35ºN–25ºS	VU	Decreasing	(Froese and Pauly 2019; Herrera et al. 2013)
38	Alopiidae	*Alopias vulpinus*	Oceanic	Pelagic	60ºN–50ºS	VU	Decreasing	(Froese and Pauly 2019; Herrera et al. 2013)
39	Lamnidae	*Isurus oxyrinchus*	Oceanic	Pelagic	61ºN–56ºS	EN	Decreasing	(Froese and Pauly 2019; Herrera et al. 2013)
40	Triakidae	*Galeorhinus galeus*	Coastal	Demersal	70ºN–58ºS	VU	Decreasing	(Froese and Pauly 2019)
41	Triakidae	*Mustelus dorsalis*	Coastal	Demersal	20ºS–04ºS	DD	Unknown	(Froese and Pauly 2019)
42	Triakidae	*Mustelus mento*	Coastal	Demersal	01ºN–55ºS	NT	Decreasing	(Froese and Pauly 2019)
43	Triakidae	*Mustelus whitneyi*	Coastal	Demersal	01ºN–45ºS	VU	Decreasing	(Froese and Pauly 2019)
44	Triakidae	*Triakis maculata*	Coastal	Demersal	01ºN–30ºS	VU	Decreasing	(Froese and Pauly 2019)
45	Sphyrnidae	*Sphyrna lewini*	Semi-oceanic	Pelagic	46ºN–31ºS	EN	Unknown	(Froese and Pauly 2019; Herrera et al. 2013)
46	Sphyrnidae	*Sphyrna mokarran*	Semi-oceanic	Pelagic	45ºN–37ºS	EN	Decreasing	(Froese and Pauly 2019)
47	Sphyrnidae	*Sphyrna tiburo*	Semi-oceanic	Pelagic	25ºN–05ºS	LC	Stable	(Froese and Pauly 2019; Herrera et al. 2013)

48	Sphyrnidae	*Sphyrna zygaena*	Oceanic	Pelagic	59ºN–55ºS	VU	Decreasing	(Froese and Pauly 2019; Herrera et al. 2013)
49	Squatinidae	*Squatina californica*	Coastal	Demersal	50ºN–50ºS	NT	Decreasing	(Froese and Pauly 2019; Herrera et al. 2013)
50	Rhinobatidae	*Rhinobatos glaucostigma*	Coastal	Demersal	28ºN–4ºS	DD	Unknown	(Froese and Pauly 2019)
51	Rhinobatidae	*Rhinobatos leucorhynchus*	Coastal	Demersal	22ºN–4ºS	NT	Unknown	(Froese and Pauly 2019; Herrera et al. 2013)
52	Rhinobatidae	*Rhinobatos planiceps*	Coastal	Demersal	16ºN–20ºS	DD	Unknown	(Froese and Pauly 2019; Herrera et al. 2013)
53	Rhinobatidae	*Zapteryx exasperata*	Coastal	Demersal	35ºN–18ºS	DD	Unknown	(Froese and Pauly 2019)
54	Rajidae	*Raja velezi*	Coastal	Demersal	32ºN–20ºS	DD	Unknown	(Froese and Pauly 2019; Herrera et al. 2013)
55	Urolophidae	*Urotrygon aspidura*	Coastal	Demersal	32ºN–18ºS	DD	Unknown	(Froese and Pauly 2019)
56	Dasyatidae	*Dasyatis brevis*	Coastal	Demersal	42ºN–19ºS	DD	Unknown	(Froese and Pauly 2019)
57	Dasyatidae	*Hypanus longus*	Coastal	Demersal	26ºN–3ºS	DD	Unknown	(Froese and Pauly 2019)
58	Dasyatidae	*Hypanus dipterurus*	Coastal	Demersal	42ºN–25ºS	DD	Unknown	(Froese and Pauly 2019)
59	Mobulidae	*Manta birostris*	Oceanic	Pelagic	32ºN–09ºS	VU	Decreasing	(Froese and Pauly 2019)
60	Mobulidae	*Mobula mobular*	Oceanic	Pelagic	40ºN–30ºS	EN	Decreasing	(Froese and Pauly 2019)
61	Mobulidae	*Mobula munkiana*	Oceanic	Pelagic	30ºN–23ºS	NT	Unknown	(Froese and Pauly 2019)
62	Mobulidae	*Mobula tarapacana*	Semi-oceanic	Pelagic	32ºN–23ºS	VU	Decreasing	(Froese and Pauly 2019)
63	Mobulidae	*Mobula thurstoni*	Oceanic	Pelagic	38ºN–34ºS	NT	Decreasing	(Froese and Pauly 2019)
64	Myliobatidae	*Myliobatis longirostris*	Coastal	Demersal	32ºN–6ºS	NT	Unknown	(Froese and Pauly 2019; Herrera et al. 2013)
65	Myliobatidae	*Myliobatis peruvianus*	Coastal	Demersal	0º–35ºS	DD	Unknown	(Froese and Pauly 2019)

(continued)

N	Family	Species	Marine zone	Habitat	Latitudinal range	Threat category[a]	Population trend[a]	Reference
Fishes (Actinopterygii)								
66	Ophichthidae	*Ophichthus remiger*	Coastal	Demersal	13ºN–30ºS	LC	Unknown	(Froese and Pauly 2019)
67	Engraulidae	*Anchoa nasus*	Coastal	Pelagic	31ºN–14ºS	LC	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
68	Engraulidae	*Cetengraulis mysticetus*	Coastal	Pelagic	32ºN–06ºS	LC	Stable	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
69	Engraulidae	*Engraulis ringens*	Coastal	Pelagic	00º–37ºS	LC	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
70	Clupeidae	*Opisthonema bulleri*	Coastal	Pelagic	25ºN–05ºS	LC	Stable	(Froese and Pauly 2019)
71	Clupeidae	*Opisthonema libertate*	Coastal	Pelagic	32ºN–04ºS	LC	stable	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
72	Merlucciidae	*Merluccius gayi peruanus*	Coastal	Demersal	01ºN–14ºS	DD	Unknown	(Froese and Pauly 2019)
73	Ophidiidae	*Lepophidium negropinna*	Coastal	Demersal	32ºN–07ºS	LC	Unknown	(Froese and Pauly 2019)
74	Mugilidae	*Mugil cephalus*	Coastal	Demersal	62ºN–57ºS	LC	Stable	(Froese and Pauly 2019)
75	Scorpaenidae	*Pontinus sierra*	Coastal	Demersal	25ºN–06ºS	LC	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
76	Triglidae	*Prionotus stephanophrys*	Coastal	Demersal	32ºN–20ºS	LC	Unknown	(Froese and Pauly 2019; IMARPE 2009)
77	Centropomidae	*Centropomus nigrescens*	Coastal	Demersal	33ºN–20ºS	LC	Unknown	(Froese and Pauly 2019),
78	Serranidae	*Acanthistius pictus*	Coastal	Demersal	20ºN–26ºS	LC	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)

79	Serranidae	*Diplectrum conceptione*	Coastal	Demersal	01ºN–37ºS	LC	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
80	Serranidae	*Diplectrum euryplectrum*	Coastal	Demersal	32ºN–06ºS	LC	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
81	Serranidae	*Diplectrum maximum*	Coastal	Demersal	35ºN–06ºS	LC	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
82	Serranidae	*Epinephelus analogus*	Coastal	Demersal	32ºN–10ºS	LC	Stable	(Froese and Pauly 2019)
83	Serranidae	*Epinephelus cifuentesi*	Coastal	Demersal	10ºN–4ºS	LC	Unknown	(Froese and Pauly 2019)
84	Serranidae	*Epinephelus labriformis*	Coastal	Demersal	31ºN–10ºS	LC	Stable	(Froese and Pauly 2019)
85	Serranidae	*Epinephelus quinquefasciatus*	Coastal	Demersal	32ºN–18ºS	DD	decreasing	(Froese and Pauly 2019)
86	Serranidae	*Hemilutjanus macrophthalmos*	Coastal	Demersal	02ºN–54ºS	DD	Unknown	(Froese and Pauly 2019)
87	Serranidae	*Hyporthodus acanthistius*	Coastal	Demersal	33ºN–10ºS	LC	Unknown	(Froese and Pauly 2019)
88	Serranidae	*Hyporthodus niphobles*	Coastal	Demersal	33ºN–9ºS	LC	Unknown	(Froese and Pauly 2019)
89	Serranidae	*Mycteroperca xenarcha*	Coastal	Demersal	32ºN–9ºS	LC	Unknown	(FaPe-UNALM 2018)
90	Serranidae	*Paralabrax humeralis*	Coastal	Demersal	06ºN–30ºS	DD	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
91	Malacanthidae	*Caulolatilus affinis*	Coastal	Demersal	33ºN–18ºS	LC	Stable	(Froese and Pauly 2019; IMARPE 2009)
92	Malacanthidae	*Caulolatilus princeps*	Coastal	Demersal	50ºN–18ºS	LC	Unknown	(Froese and Pauly 2019; IMARPE 2009)
93	Coryphaenidae	*Coryphaena hippurus*	Oceanic	Pelagic	47ºN–38ºS	LC	Stable	(Froese and Pauly 2019)

(continued)

N	Family	Species	Marine zone	Habitat	Latitudinal range	Threat category[a]	Population trend[a]	Reference
94	Carangidae	*Chloroscombrus orqueta*	Coastal	Demersal	33°N–18°S	LC	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
95	Carangidae	*Decapterus macrosoma*	Coastal	Demersal	39°N–34°S	LC	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
96	Carangidae	*Selene peruviana*	Coastal	Demersal	32°N–14°S	LC	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
97	Carangidae	*Trachinotus paitensis*	Coastal	Demersal	32°N–18°S	LC	Unknown	(Froese and Pauly 2019)
98	Carangidae	*Trachurus murphyi*	Oceanic	Pelagic	02°N–52°S	DD	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)
99	Sciaenidae	*Cynoscion analis*	Coastal	Demersal	2.5°N–30°S	LC	Unknown	(IMARPE 2009)
100	Sciaenidae	*Paralonchurus peruanus*	Coastal	Demersal	09°N–20°S	LC	Unknown	(Froese and Pauly 2019; IMARPE 2009)
101	Sphyraenidae	*Sphyraena ensis*	Coastal	Pelagic	31°N–09°20′S	LC	Unknown	(Chirichigno and Cornejo 2001; IMARPE 2009)
102	Scombridae	*Acanthocybium solandri*	Oceanic	Pelagic	46°N–37°S	LC	Stable	(Froese and Pauly 2019)
103	Scombridae	*Auxis rochei*	Coastal	Pelagic	61°N–51°S	LC	Stable	(Froese and Pauly 2019)
104	Scombridae	*Katsuwonus pelamis*	Oceanic	Pelagic	63°N–47°S	LC	Stable	(Froese and Pauly 2019)
105	Scombridae	*Sarda chilensis*	Coastal	Pelagic	40°N–40°S	LC	Decreasing	(Froese and Pauly 2019)
106	Scombridae	*Scomber japonicus*	Coastal	Pelagic	60°N–48°S	LC	Stable	(Froese and Pauly 2019)
107	Scombridae	*Scomberomorus sierra*	Coastal	Pelagic	33°N–27°S	LC	Stable	(Froese and Pauly 2019)
108	Scombridae	*Thunnus alalunga*	Oceanic	Pelagic	59°N–46°S	NT	Decreasing	(Froese and Pauly 2019)

109	Scombridae	*Thunnus albacares*	Oceanic	Pelagic	59ºN–48ºS	NT	Decreasing	(Froese and Pauly 2019)
110	Scombridae	*Thunnus obesus*	Oceanic	Pelagic	45ºN–43ºS	VU	Decreasing	(Froese and Pauly 2019)
111	Scombridae	*Thunnus orientalis*	Oceanic	Pelagic	52ºN–50ºS	VU	Decreasing	(Froese and Pauly 2019)
112	Paralichthyidae	*Etropus ectenes*	Coastal	Demersal	08ºN–06ºS	LC	Unknown	(Froese and Pauly 2019)
113	Xiphiidae	*Xiphias gladius*	Oceanic	Pelagic	69ºN–50ºS	LC	Decreasing	(Froese and Pauly 2019)
114	Istiophoridae	*Istiompax indica*	Oceanic	Pelagic	44ºN–47ºS	DD	Unknown	(Froese and Pauly 2019)
115	Istiophoridae	*Kajikia audax*	Oceanic	Pelagic	46ºN–50ºS	NT	decreasing	(Froese and Pauly 2019)
116	Istiophoridae	*Makaira mazara*	Oceanic	Pelagic	44ºN–40ºS	NA	Unknown	(Froese and Pauly 2019)
117	Stromateidae	*Peprilus medius*	Coastal	Demersal	32ºN–13ºS	LC	Unknown	(Chirichigno and Cornejo 2001; Froese and Pauly 2019; IMARPE 2009; STRI 2016)

[a]IUCN (2019)

References

Agnew DJ, Pearce J, Pramod G, Peatman T, Watson R, Beddington JR, Pitcher TJ (2009) Estimating the worldwide extent of illegal fishing. PLoS One 4(2). https://doi.org/10.1371/journal.pone.0004570

Alava JJ, Lindop A, Jacquet J (2015) Marine Fisheries Catch Reconstructions for Continental Ecuador: 1950–2010. Fisheries Centre Working Paper #2015-34, p 25

Alava JJ, Alasdair L, Jennifer J (2016) In: Pauly D, Zeller D (eds) Ecuador. In Global atlas of marine fisheries. A critical appraisal of catches and ecosystem impacts. Island Press, Washington, p 241

Alvarez J (2003) Estudio sobre el impacto socioeconomico de la pesca artesanal en los Estados Miembros de la Comisión Permanente del Pacífico Sur. Reporte preparado para la Secretaria General-Dirección de Asuntos Económicos de la CPPS, 27

Arellano CE, Swartzman G (2010) The Peruvian artisanal fishery: Changes in patterns and distribution over time. Fish Res 101(3):133–145. https://doi.org/10.1016/j.fishres.2009.08.007

Argüelles J, Tafur R, Taipe A, Villegas P, Keyl F, Dominguez N, Salazar M (2008) Size increment of jumbo flying squid Dosidicus gigas mature females in Peruvian waters, 1989–2004. Prog Oceanogr 79(2-4):308–312

Ayala Villa B (2017) Pesca Ilegal, No Declara, No Reglamentada - Subsecretaría de Recursos Pesqueros. En El Seminario: Biotecnología Aplicada a La Lucha Contra La Pesca Ilegal, No Declarada y No Reglamentada En Los Países Del Océano Pacífico

Badjeck M-C (2008) Vulnerability of coastal fishing communities to climate variability and change: implications for fisheries livelihoods and management in Peru Universität Bremen

Barragán JM, Lazo Ó (2018) Policy progress on ICZM in Peru. Ocean Coast Manag 157:203–216

Barragán Paladines MJ (2015) Two rules for the same fish: Small-scale fisheries governance in mainland Ecuador and Galapagos Islands. In: Interactive governance for small-scale fisheries. Springer, pp 157–178

Béarez P, Gay P, Lunniss R (2012) Sea fishing at Salango (Manabí province, Ecuador) during the middle formative Machalilla phase. Latin Am Antiq 23(2):195–214

Béné C (2006) Small-scale fisheries: assessing their contribution to rural livelihoods in developing countries, vol 1008. Food and Agriculture Organization of the United Nations Rome, Italy

Borbor-Cordova MJ, Torres G, Mantilla-Saltos G, Casierra-Tomala A, Bermúdez JR, Renteria W, Bayot B (2019) Oceanography of harmful algal blooms on the ecuadorian coast (1997–2017): integrating remote sensing and biological data. Front Mar Sci 13

Bucaram S, Hearn A, Trujillo A, Rentería W, Bustamante R, Morán G, Reck G, García J (2017) Assessing fishing effects inside and outside an MPA: The impact of the Galapagos Marine Reserve on the Industrial pelagic tuna fisheries during the first decade of operation. Mar Policy 87. https://doi.org/10.1016/j.marpol.2017.10.002

Carr LA, Stier AC, Fietz K, Montero I, Gallagher AJ, Bruno JF (2013) Illegal shark fishing in the Galapagos Marine Reserve. Mar Policy 39:317–321. https://doi.org/10.1016/j.marpol.2012.12.005

Cawthorn DM, Baillie C, Mariani S (2018) Generic names and mislabeling conceal high species diversity in global fisheries markets. Conserv Lett 11(5). https://doi.org/10.1111/conl.12573

Cerutti-Pereyra F, Moity N, Dureuil M, Ramírez-González J, Reyes H, Budd K, Jarrín JM, Salinas-de-León P (2019) Artisanal longline fishing the Galapagos Islands–effects on vulnerable megafauna in a UNESCO World Heritage site. Ocean Coast Manag 183:104995

Chavez FP, Bertrand A, Guevara-Carrasco R, Soler P, Csirke J (2008) The northern Humboldt Current System: Brief history, present status and a view towards the future. Prog Oceanogr 79(2–4):95–105. https://doi.org/10.1016/j.pocean.2008.10.012

Chile Ecuador and Peru (1976) Joint declaration concerning fishing problems in the South Pacific. Signed at Santiago on 18 August 1952

Chirichigno N (1970) Lista de Crustáceos del Perú. Boletín IMARPE, Lima

Chirichigno N, Cornejo UR (2001) Catálogo comentado de los peces marinos del Perú. Publicación Especial, Callao
Christensen V, de la Puente S, Sueiro JC, Steenbeek J, Majluf P (2014) Valuing seafood: The Peruvian fisheries sector. Mar Policy 44:302–311. https://doi.org/10.1016/j.marpol.2013.09.022
Cushman GT (2003) The Lords of Guano: science and the management of Peru's marine environment, 1800-1973. The University of Texas at Austin
Defeo O, Castrejón M, Ortega L, Kuhn AM, Gutiérrez NL, Castilla JC (2013) Impacts of climate variability on Latin American small-scale fisheries. Ecol Soc 18(4)
Del Solar EA, Jorge GN, Gozzer R, Correa M (2017) Traceability of the Peruvian Mahi Mahi fishery: assessment and proposal
Dueri S, Bopp L, Maury O (2014) Projecting the impacts of climate change on skipjack tuna abundance and spatial distribution. Glob Chang Biol 20(3):742–753. https://doi.org/10.1111/gcb.12460
Ecuador Pesquero (2017) "Estadísticas." Ecuador Pesquero 83 / Noviembre-Enero. https://issuu.com/cnpecuador/docs/ecuador_pesquero_83_web
EFE (2017) Detienen En Galápagos a Un Barco Chino Con 300 Toneladas de Especies Protegidas. ABC Sociedad. https://www.abc.es/sociedad/abci-detienen-galapagos-barco-chino-300-toneladas-especies-protegidas-201708150209_noticia.html
El Comercio (2019) La Armada Del Ecuador Captura 4 Barcos Pesqueros Extranjeros Dentro de La Zona Económica Exclusiva Insular. El Comercio—Actualidad Ecuador. Retrieved 30 Aug 2019. https://www.elcomercio.com/actualidad/armada-captura-embarcaciones-pesqueras-galapagos.html
El Telégrafo (2019) Ecuador Tiene Apoyo Para Aumentar Pesca Del Jurel. February 14
El Universo (2019) Ecuador y Perú Firman Nueve Acuerdos Nuevos En El XIII Gabinete Binacional. Política, November 7
FAO (2009) Implementation of port state measures. Swan J (ed) Food and Agriculture Organization of the United Nations, Rome
FAO (2014) The state of world fisheries and aquaculture 2014—Opportunities and challenges. Food and Agriculture Organization of the United Nations
FAO (2016a) Report of the FAO workshop on implementing the agreement on port state measures to prevent, deter and eliminate illegal, unreported and unregulated fishing. Montevideo, Uruguay, 29 Sept–3 Oct 2014
FAO (2016b) The state of world fisheries and aquaculture. contributing to food security and nutrition for all
FAO (2018) The State of the World Fisheries and Aquaculture 2018 – Meeting the Sustainable Development Goals. Food and Agriculture Organization of the United Nations, Rome
FaPe-UNALM (2018) Infopes. http://tumi.lamolina.edu.pe/infopes/?page_id=101. Accessed 3 Oct 2019
Flores D, Céspedes Reyes L, Martínez Grimaldo A (2013) Identificación de servicios ecosistémicos en el Santuario Nacional Los Manglares de Tumbes. Informe técnico especial
Froese R, Pauly D (2019) FishBase. In: Froese R, Pauly D (eds) World Wide Web electronic publication. www.fishbase.org, version (12/2019). https://www.fishbase.se/search.php
Grillo J, Gozzer R, Sueiro JC, Riveros JC (2018) Producción ilegal de harina de pescado en Perú a partir de anchoveta extraída por la flota artesanal y de menor escala. Oceana Perú, Lima
Guevara-Carrasco R, Bertrand A (2017) Atlas de La Pesca Artesanal Del Mar Del Perú. IMARPE-IDR. Lima, Perú
Herrera M, Castro R, Coello D, Saa I, Elías E (2013) Puertos, caletas y asentamientos pesqueros artesanales del Ecuador. Boletín Especial del Instituto Nacional de Pesca del Ecuador (Vol. Año 04)
Hilborn R, Fulton EA, Green BS, Hartmann K, Tracey SR, Watson RA (2015) When is a fishery sustainable? Can J Fish Aquat Sci 72(9):1433–1441. https://doi.org/10.1139/cjfas-2015-0062

Index Mundi (2019) Fish meal production by country in 1000 MT—country rankings 2018. Retrieved 28 Mar 2019. https://www.indexmundi.com/agriculture/?commodity=fish-meal
IMARPE (2009) Instituto del Mar del Perú. http://www.imarpe.gob.pe/imarpe/. Accessed 3 Oct 2019
INEC (2010) Población y Demografía. Ecuador. Instituto Nacional de Estadísticas y Censos. http://www.ecuadorencifras.gob.ec/censo-de-poblacion-y-vivienda/. Accessed 21 Feb 2019
INEI (2014) Datos Sobre El Valor Agregado Bruto Por Sectores Económicos y PBI Sectorial. Instituto Nacional de Estadística e Informática. https://www1.inei.gob.pe/. Accessed 6 Mar 2019
INEI (2019) PERU Instituto Nacional de Estadística e Informática INEI. https://www.inei.gob.pe/estadisticas/indice-tematico/population/. Accessed 10 Oct 2019
INEI-PRODUCE (2013) Perú - I Censo Nacional de La Pesca Artesanal Del Ámbito Marítimo 2012. Instituto Nacional de Estadística e Informática. https://webinei.inei.gob.pe/anda_inei/index.php/catalog/223. Accessed 6 Mar 2019
Inocar, Ecuador (2012) CAPÍTULO I: Información General de La República Del Ecuador INOCAR 2012 1.1. Instituto Oceanografico de La Fuerzas Armadas, Capitulo 1:13–24
INP (2010a) Lámina de crustáceos de mayor importancia comercial. Instituto Nacional de Pesca del Ecuador. http://institutopesca.gob.ec/wp-content/uploads/2017/07/Lamina-de-Crustaceos.pdf
INP (2010b) Lámina de moluscos de mayor importancia comercial. Instituto Nacional de Pesca del Ecuador. http://institutopesca.gob.ec/wp-content/uploads/2017/07/Lamina-de-Moluscos.pdf. Accessed 13 July 2020
INRENA (2002) Reserva Nacional de Paracas. Plan Maestro 2003-2007
IOC (1989) Workshop on biological effects of the El Niño phenomenon in coastal ecosystems of the Southeast Pacific Region. Intergovernmental Oceanographic Commission
IUCN (2019) The IUCN red list of threatened species. Version 2019-2. http://www.iucnredlist.org
Jacquet J, Alava JJ, Pramod G, Henderson S, Zeller D (2008) In hot soup: sharks captured in Ecuador's waters. Environ Sci 5(4):269–283
Krzywinski M, Schein J, Birol I, Connors J, Gascoyne R, Horsman D, Jones SJ, Marra MA (2009) Circos: An information aesthetic for comparative genomics. Genome Res 19(9):1639–1645. https://doi.org/10.1101/gr.092759.109
Longhurst A (1998) Ecological geography of the sea. Academic, San Diego. 398 p
Lynham J, Costello C, Gaines S, Sala E (2015) Economic valuation of marine- and shark-based tourisms in the Galápagos Islands. Natl Geogr Pristine Seas 44
Maddison DR, Schulz K-S, Maddison WP (2007) The tree of life web project. Zootaxa 1668(1): 19–40
MAE (2010) Proyecto: Conservación de La Biodiversidad Marina y Costera de Ecuador. Guayaquil, Ecuador
MAE (2012) La Pesquería de Arrastre Camaronero En Ecuador, Guayaquil
MAE (2016) Estrategia Nacional de Biodiversidad 2015–2030. Primera (ed) Ministerio de Ambiente del Ecuador, Quito
Martínez-Ortiz J, Aires-da-Silva AM, Lennert-Cody CE, Maunder MN (2015) The Ecuadorian artisanal fishery for large pelagics: species composition and spatio-temporal dynamics. PLoS One 10(8):e0135136
Mauri M, Elli T, Caviglia G, Uboldi G, Azzi M (2017) RAWGraphs: a visualisation platform to create open outputs. In: Proceedings of the 12th biannual conference on Italian SIGCHI chapter
Mendo J, Claudia W-M (2016) Peru. In: Pauly D, Zeller D (eds) Global atlas of marine fisheries. A critical appraisal of catches and ecosystem impacts. Island Press, Washington, p 366
Mendo J, Wolff M, Carbajal W, Gonzáles I, Badjeck M (2008) Manejo y explotación de los principales bancos naturales de concha de abanico (Argopecten purpuratus) en la costa Peruana. Estado actual del cultivo y manejo de moluscos bivalvos y su proyección futura 101
Mialhe F, Gunnell Y, Mering C (2013) The impacts of shrimp farming on land use, employment and migration in Tumbes, northern Peru. Ocean Coast Manag 73:1–12. https://doi.org/10.1016/j.ocecoaman.2012.12.014

Miloslavich P, Klein E, Diaz JM, Hernandez CE, Bigatti G, Campos L, Artigas F, Castillo J, Penchaszadeh PE, Neill PE, Carranza A, Retana MV, de Astarloa JMD, Lewis M, Yorio P, Piriz ML, Rodriguez D, Yoneshigue-Valentin Y, Gamboa L, Martin A (2011) Marine biodiversity in the Atlantic and Pacific coasts of South America: Knowledge and gaps. PLoS One 6(1). https://doi.org/10.1371/journal.pone.0014631

Ministerio del Ambiente (2016) Lineamientos Para El Manejo Integrado de Las Zonas Marino Costeras. Resolución Ministerial n.o189-2015-MINAM, 28

Moity N, Izurieta J (2017) DiveStat Galapagos: indicadores del turismo de buceo en la Reserva Marina de Galá pagos. Indicadores de Perfil, Satisfacció n, Percepciones y Ciencia Ciudadana. Informe Té cnico (1):45

Moity N, Izurieta JC, Araujo E, Casafont M (2018) DiveStat: A new tool for managing dive tourism. Galapagos report 2017, pp 72–77

Navarrete-Forero G, Morales Baren L, Dominguez-Granda L, Pontón Cevallos J, Marín Jarrín JR (2019) Heavy metals contamination in the Gulf of Guayaquil: even limited data reflects environmental impacts from anthropogenic activity. Revista internacional de contaminación ambiental 35(3):731–755

Nikanorova A, Egorov S (2019) Development of principles and legal rules regulating the use of transboundary water resources by states. Water Resour 46(1):138–142

Ordinola E, Montero P, Alemán S, Argüelles J, Beltrán L, Llanos J (2010) The pearl oyster, Pteria sterna (Gould), in Talara, Peru. April 2007. Informe IMARPE, vol 37. Instituto del Mar del Peru, Callao. http://biblioimarpe.imarpe.gob.pe/handle/123456789/2014

Palomares MLD, Pauly D (2019) SeaLifeBase, version (08/2019). www.sealifebase.org. Accessed 3 Oct 2019

Pauly D, Zeller D (2016) Global atlas of marine fisheries: a critical appraisal of catches and ecosystem impacts. Island Press, Washington, DC

Peralta M (2009) Desembarques de la pesca artesanal de peces pelágicos grandes y tiburones en la costa ecuatoriana durante el 2008

Plan Binacional Peru-Ecuador (2018) Plan Binacional de Desarrollo de La Región Fronteriza Capítulo Perú. https://planbinacional.org.pe/

Roskov Y, Ower G, Orrell T, Nicolson D, Bailly N, Kirk PM et al (2019) Species 2000 & ITIS Catalogue of Life, 2019 Annual Checklist. www.catalogueoflife.org/annual-checklist/2019. Accessed 3 Oct 2019

Schiller L, Alava JJ, Grove J, Reck G, Pauly D (2016) Ecuador (Galápagos). In: Pauly D, Zeller D (eds) Global atlas of marine fisheries. A critical appraisal of catches and ecosystem impacts. Island Press, Washington, DC, p 242

SCI (2020) Plantas Harineras Registradas y Aprobadas. Actualización 17 de Marzo Del 2020. Subsecretaría de Calidad e Inocuidad. Ministerio de Producción Comercio Exterior, Inversiones y Pesca Del Ecuador. Manta, Ecuador

Spalding Mark D, Fox Helen E, Allen Gerald R, Davidson Nick FZA, Finlayson Max HBS, Jorge Miguel A, Lombana A, Lourie Sara A, Martin KD, McManus E, Molnar J, Recchia CA, Robertson J (2007) Marine ecoregions of the world: A bioregionalization of coastal and shelf areas. BioScience 57(7):573–583

SPRFMO (2018) Conservation and management measures. South Pacific Regional Fisheries Management Organisation. https://www.sprfmo.int/measures/. Accessed 31 Jan 2019

STRI (2016) Peces: Pacífico oriental en app store. Smithsonian Tropical Research Institute. https://apps.apple.com/gt/app/peces-pacífico-oriental/id494644648. Accessed 3 Oct 2019

Tarazona J, Arntz W (2001) The Peruvian coastal upwelling system. In: Coastal marine ecosystems of Latin America. Springer, pp 229–244

Taylor MH, Wolff M, Mendo J, Yamashiro C (2008) Changes in trophic flow structure of Independence Bay (Peru) over an ENSO cycle. Prog Oceanogr 79(2–4):336–351

Terán MC, Clark K, Suárez C, Luna S, Yánez FC, Denkinger J, Ruiz D, Jiménez P (2007) Identificación de Vacíos y Prioridades de Conservación de La Biodiversidad de La Plataforma Marina Del Ecuador Continental. In: Prioridades para la conservación de la biodiversidad en el

Ecuador continental. Instituto Nazca de Investigaciones Marinas, EcoCiencia, Ministerio de Ambiente, The Nature Conservancy, Conservación Internacional, Quito, Ecuador, pp 41–62
Thorpe A, Bennett E (2001) Globalisation and the sustainability of world fisheries: a view from Latin America. Mar Resour Econ 16(2):143–164
Trujillo R (2017) 2017, Buen Año Para El Sector. Editorial. Ecuador Pesquero 83, January, 4–5
UN (2019) United Nations Convention on the Law of the Sea. Montego Bay, 10 December 1982. United Nations Audiovisual Library of International Law. http://legal.un.org/avl/ha/uncls/uncls.html. Accessed 30 Sept 2019
Varea A (2004) Iniciativas para conservar la biodiversidad. Universitas (4):7–44
Willette DA, Cheng SH (2018) Delivering on seafood traceability under the new US import monitoring program. Ambio 47(1):25–30
Wolff M (1987) Population dynamics of the Peruvian scallop Argopecten purpuratus during the El Niño phenomenon of 1983. Can J Fish Aquat Sci 44(10):1684–1691
Wolff M (2010) Galapagos does not show recent warming but increased seasonality
Wolff M, Gardener M (2012) The role of science for conservation, vol 34. Routledge, Abingdon, England
Wolff M, Penaherrera-Palma C, Krutwa A (2012) Food web structure of the Galapagos Marine Reserve after a decade of protection: insights from trophic modeling. In: The role of science for conservation. Routledge
Workman D (2019) Big Export Sales for Frozen Shrimps. World's Top Exports. http://www.worldstopexports.com/big-export-sales-for-frozen-shrimps/. Accessed 25 Oct 2019
Zeller D, Pauly D, Kitchingman A, Lai S, Kleisner K, Hoornaert C (2015) Sea around us area parameters