Chapter 36B. South Atlantic Ocean

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1. Introduction

In this chapter we refer to the area of the Atlantic Ocean south of the Equator and north of the Polar Front (Antarctic Convergence). The main topographical feature in the South Atlantic is the Mid-Atlantic Ridge which runs between Africa and South America from approximately 58° South to Iceland in the north. A rift valley is associated with the Ridge. The Ridge is of volcanic origin and the development of transverse ridges creates a number of basins: the Argentine, Brazil, Guinea, Angola and Cape Basins.

The Atlantic coast of South America is influenced by three major rivers, Orinoco, Amazon and La Plata, that discharge large amounts of freshwater and sediment into the Atlantic Ocean. The Amazon discharges about one-fifth of the world's total freshwater runoff into the Atlantic (Curtin, 1986) and it is transported offshore up to 500 km seaward (Lentz, 1995). The heavy sediment discharge ($2.9 \cdot 10^8$ tons year)$^{-1}$) is not deposited over the outer shelf, but is carried by the North Brazil Current to Guyana's shelf, where it forms extensive mud deposits (Gratiot et al., 2008). The continental shelf is wider along its West Coast, both in the north at the Amazon (≈300 km) and in southern Argentina, where it reaches up to 600 kilometres (Miloslavich et al., 2011). The shelf is narrower along the East Coast of the Atlantic and also along the east coast of Brazil, where riverine muds give way to calcareous deposits and the shelf in some areas reaches a minimum of 8 km width (Miloslavich et al., 2011).

The continental slope is cut by deep canyons connecting shelf and deep waters. High benthic richness was reported at the head of the submarine canyons, and about half of the species are shared with the shelf-break community (Bertolino et al., 2007; Schejter et al., 2014b). The ~7500 km of the Brazil coasts comprise a combination of freshwater, estuarine and marine ecosystems, with diverse but poorly known habitats in its northern part and with sandy beaches, mangrove forests, rocky shores, lagoons and coral reefs to the south (Miloslavich et al., 2011). Uruguay's coasts are dominated by sandy beaches; a narrow rocky portion has high biodiversity (Calliari et al., 2003). The coasts of Argentina are mostly sandy beaches, with some rocky formations located mainly at Mar del Plata, Peninsula Valdes and Tierra del Fuego; pebble beaches are common in Patagonia. The coasts of South Africa are part sandy beaches, rocks and rocks mixed with sand on the upper shore and a wave-cut rocky platform (Bally et al., 1984).

South Atlantic waters are characterized by the counterclockwise central subtropical gyre of surface and intermediate waters running close to South America and South Africa, with more complex currents developing on the coasts of both continents (Campos et al., 1995; McDonagh and King, 2005). The gyre is approximately 4,500 km in diameter and lies between the equator and 40° S (Piontkovski et al., 2003). The eastern (African) branch transfers warm water to the northern hemisphere and the western (South American) branch carries cold water from the north, both as part of the global circulation known as the Atlantic Meridional Overturning Circulation. The gyre is closed to the south by the subantarctic branch of the Antarctic Circumpolar Current (West Wind Drift). The gyre constitutes a biogeographic province with distinct physical and biological properties relative to adjacent regions (Longhurst, 1998).

The currents, closely linked to the topography, result in a series of surface fronts with varying depth expressions associated with the different ridges which effectively limit exchange of water among the different basins. The Benguela Current runs northward off the African continent carrying cold water towards the equator, with a coastal branch close to the continent (Griffiths et al., 2010). Its counterpart near South America is the Brazil current, which meets the northward current derived from the Antarctic Circumpolar Current (West Wind Drift) running close to the Patagonian shelf (see chapter 36H, Figures 1 to 3).

The offshore waters in the South Atlantic Gyre occupy more than half of the South Atlantic Ocean; the Gyre is characterized by low concentrations of nutrients, and low phytoplankton and zooplankton abundances. Along the South American continental shelf, circulation patterns are modified by topography, upwelling and continental runoff (Gonzalez-Silvera et al., 2004). The South Subtropical Convergence is the intersection point of low-macronutrient subtropical gyre waters and high-macronutrient Antarctic Circumpolar Current waters and therefore represents one of the most dynamic nutrient environments in the oceans (Ito et al., 2005).

On the African shelf, as in the South American coasts, the Agulhas retroversion, and the Benguela and the Angola Currents are responsible for upwelling processes and enhanced primary production (Lutjeharms and Ballegooyen, 1988). The different water masses resulting from these processes offer an ample variety of habitats for pelagic biodiversity. The Congo and, on the western side, the Amazon and the Plata plumes can also seasonally contribute to the enhancement of plankton, thus becoming one of the most productive marine areas of the Atlantic Ocean, which is essentially due to the presence of a great variety of frontal productive systems (Acha et al., 2004; da Cunha and Buitenhuis, 2013).

On the western coasts and shelves, the plumes of the Amazon and of the De la Plata Rivers extend up to 1000 km into the ocean, modifying coastal waters. The De la Plata River plume impinges on coastal and shelf waters of Argentina, Uruguay and Brazil (Muelbert et al., 2008). Lateral mixing results in a water mass typical of the De la Plata plume waters (Piola et al., 2008) with high nutrient concentrations and primary productivity. The Amazon plume influence is felt on the northwest coast of Brazil and modifies the vertical structure of the Equatorial West Ocean (Hu et al., 2004).

Modelling and observed trends predict that the low-productivity subtropical gyre will expand as a result of climate warming. Such an increase will affect not only the plankton communities, but also fisheries on both sides of the South Atlantic Ocean. Since 1998, the gyre has been expanding at average rates between 0.8 per cent/yr and 4.3 per cent/yr. The rate of expansion is greater during the winter (Polovina et al., 2008; Henson et al., 2010).

2. Plankton and Nekton

Water-mass properties and movements are the main factors behind plankton distribution in the South Atlantic. The quantitative distribution of pelagic life in the South Atlantic parallels those found in the other oceans: a large area of poor central waters bound to the north and south by richer equatorial and subpolar bands, respectively, with the biologically richest sectors found in the coastal regions, especially along Africa (Boltovskoy et al., 1999). These conditions are exacerbated at the inshore component of the Benguela Current, which exhibits strong a wind-driven upwelling with a periodicity of 5 to 10 days; more intense in summer (Shannon and Nelson, 1996). Much of the organic matter associated with this high productivity sinks onto the relatively wide continental shelf, where decay results in the reduction of dissolved oxygen in bottom waters. Periodically, these low-oxygen conditions extend close inshore, sometimes reaching the shoreline itself and resulting in mass mortalities of fish, rock lobster, and other invertebrates (Griffiths et al., 2010).

In general, knowledge of the plankton taxonomy and ecology is relatively scarce in the South Atlantic, in particular the oligotrophic waters of the South Atlantic gyre are very little known; little sampling has been conducted there (Piontkovski et al., 2003). Table 1 presents a summary of the relevant parameters for different regions of the South Atlantic Ocean.

Table 1. Major structural-functional characteristics of the South Atlantic (0–100 m layer). Data presentation adapted from Greze (1984) and Boltovskoy et al. (1999) in Piontkovski et al., 2003.

Parameters	Benguela Current	South Equatorial Current	Brazil Current	West Wind Drift	Central Gyre
Extension of current (km)	4000	4000	4800	6400	
Current velocity (cm s^{-1})	50–150	40–70	150	50–65	
Primary production (mgC m^{-2} d^{-1})					
(1) Koblentz-Mishke (1977)	250–>500	150–250	<100–150	100–250	<100
(2) Greze (1984)	1000–5000	175–480	117–547	285–515	95–201
(3) Longhurst et al. (1995)	880	360–430	830	330–370	210

Chl a (surface) (mg m–3)	3.0 ± 1.5	0.15 ± 0.05	0.30 ± 0.10	0.22 ± 0.10	0.09 ± 0.04
C:Chl a (0–100 m) (mg mg–1)	35	70	45	91	85
Phytoplankton total biomass (mgC $m^{-3)}$	105	15	14	18	13
>5-µm phytoplankton (mgC $m^{-3)}$)	103	3	2.9	1.2	1
Species of >5-µm phytoplankton	110	264	155	70	233
Phytoplankton diversity (a)	13	49	46	27	56
Zooplankton biomass (mgC $m^{-3)}$)	3.5	3.4	1.6	1.1	1.3
Copepod species (number)	176	215	280	161	300
Copepod diversity H' (bit $ind^{-1)}$	3.1	3.9	4.4	2.5	4.5

Primary production values in the central gyre range around >0.1-0.2 g C m-2 d^{-1}, with phytoplankton concentrations below 103 cells $l^{-1.}$ In the vicinity of the equator, biological richness is enhanced by equatorial divergence and by seaward advection of nutrient- and biomass-rich Benguela upwelling waters (Boltovskoy et al., 1999). A 30-fold difference in mean surface chlorophyll and a 100-fold difference in phytoplankton biomass were found between the centre of the gyre and the Benguela Current waters (Piontkovski et al. 2003). The high productivity region extends to the north along the African coast. In the Southwestern Atlantic, primary production and chlorophyll-a measurements show a number of areas of enhanced phytoplankton output. Diatoms play an important role in this biomass build-up (Olguin et al. 2006).

Diversity increases in oligotrophic waters; the abundance in the Antarctic Circumpolar Current decreases from West to East, whereas the diversity index increases. In the Benguela Current, the number of species is similar to that in the Antarctic Circumpolar Current, but the diversity index is lower; the taxonomic composition of the South Equatorial Current and the central gyre are similar (Greze, 1984). South of the Subtropical Convergence, the primary limiting nutrient is Fe, whereas to the north the phytoplankton standing crop seems to be limited by macronutrients (Browning et al., 2014).

In general, the taxonomic study of plankton species in the South Atlantic is poor to average, approximately 2500 zooplankton species have been identified in the South Atlantic and it is expected to find 300 more (Boltovskoy et al., 2003). Copepods, in terms of numbers and biomass, are the main component of zooplankton; within this group the largest proportion is made up of the smaller copepods (less than 0.3 mm). Euphausiids and amphipods are important components, especially in neritic zones (Thompson et al., 2013).

Squid are important components of the South Atlantic marine ecosystem, for ecological and socioeconomic reasons. They show high predation rates and contribute substantially to the flux of energy and nutrients to higher trophic levels (Rosas-Luis et al., 2013). The Argentine shortfin squid (*Illex argentinus*) is a common species on the western shelf; mainly feeding on amphipods and euphausiids (Ivanovic, 2010), it sustains an important fishery by trawlers and jigging vessels, and *Doryteuthis gahi* is also targeted by the commercial fishery with substantial annual catches (Arkhipkin et al. 2013). On the African coast, the chokka squid (*Loligo vulgaris reynaudii*) is closely linked to the Agulhas ecosystem; its catches and biomass are highly variable (Roberts, 2005) and, in the south Brazil ecosystem, *Loligo plei* is an important link between pelagic and demersal energy pathways (Gasalla et al. 2010), supporting small-scale fisheries around São Sebastião Island (Postuma and Gasalla, 2010). Other squid species, such as *D. gahi, Onykia ingens and Histioteuthis atlantica*, are important components of the ecosystem on the outer Patagonian shelf.

3. Benthos

In general, the development of the benthic communities is mainly linked to the availability of food (primary producers and nutrients), closely related with the development of the seasonal and permanent frontal systems, as well as upwelling processes. Benthic habitats are variable in the South Atlantic, with unique and highly diverse ecosystems (Miloslavich et al., 2011), such as kelp forests (Rozzi et al., 2012) and huge rhodolith beds (Amado-Filho et al., 2012). The services derived from benthic habitats (e.g., Copertino, 2011) support several human activities, such as fisheries (Salas et al., 2011) and tourism. Distribution patterns of the different taxa, benthic communities and assemblages mainly obey oceanographic conditions; the majority of them are distributed according to biogeographical regions (Kröncke et al., 2013), although patterns are not always clear because of the fragmented and unequal sampling effort along the total extent of the South Atlantic.

To date, benthos studies have been based on basic sampling methodologies, were usually limited to descriptive results, and population and ecological features were mostly studied in communities dominated by commercial species (mussels, scallops, oysters). There is still a lack of knowledge in coastal and mid-shelf waters, whereas benthic communities beyond the shelf-break are only poorly known.

The available information on the fauna inhabiting the deep basins is scarce: ophiuroids and surface deposit feeders are dominant in the Cape Basin, sponges, sipunculids and fish in the Angola Basin, asteroids, crustaceans and fish in the Eastern Guinea Basin, and sipunculids in the Western Guinea Basin. The content of chlorophyll in sediments is consistent with primary production and flux rate of organic matter in the three basins of the south-east Atlantic. The structure and function of the three basin communities correlate with the amount of seafood reaching the seafloor (Wei et al., 2010).

Along the South American coast, many research programmes have been developed that focus on individual, but mainly coastal, communities and species. Several adopted an integrated approach to the study of benthos in deep waters, such as the REVIZEE Programme (Programme for the Evaluation of the Sustainability Potential of Living Resources in the Exclusive Economic Zone), which so far is the most concerted effort to increase knowledge (see Lana et al., 1996, for a baseline of the REVIZEE) on the benthic diversity on the continental shelf and slope, recording more than 1000 taxa in 322 samples. More recently, the Pampa Azul initiative focused on the interdisciplinary study of the marine environment in the South Atlantic (www.mincyt.gob.ar/accion/pampa-azul-9926). As part of the environmental requirements of the licensing policies, the offshore oil industry produced an important amount of data on benthos that are not yet available for scientific research purposes.

In coastal areas the benthos is better known; several research groups work along the South Atlantic, although with distinct hotspots of effort. Most of the information regarding benthic biodiversity, richness and distribution patterns must be obtained from publications devoted to a single taxonomic group or from local ecological studies.

Although there are areas with no information on benthic habitats and diversity, there are places where studies are concentrated. One example is the Aracá Bay, Southeastern Brazil, where 733 benthic species were historically recorded (Amaral et al., 2010) and where, in a recent and continued study, more than 1,000 species have already been recorded in this area. In the SW Atlantic Ocean, 134 echinoderm species have been identified from the five classes (Brogger et al., 2013; Souto et al., 2014), about 360 benthic molluscs (bivalves+gastropods) (Zelaya, 2014 and pers. comm.), of which 27 are of present or potential commercial interest (Roux et al., 2010), 102 crustacean decapod species, with five of commercial interest (Boschi, 2010), at least 212 amphipod species (López Gappa et al., 2006), at least 218 sponge species (López Gappa and Landoni, 2005; Schejter et al., 2006; Bertolino et al., 2007; Goodwin et al., 2011), 246 bryozoan species (López Gappa, 2000), 88 hydrozoan species (Souto et al., 2010) and at least other 27 cnidarian species, including corals (Zamponi, 2008), at least 70 polychaete species (Bremec et al., 2010) and 79 ascidians, including the records of exotic species (Tatián et al., 2013). Many other minor groups (e.g., brachyopods, nemertina, sipunculida, echiurida, other molluscs, etc.) contribute to the total richness of the benthic realm.

Studies on the deep benthic macro- and mega-fauna in the South Atlantic have concentrated on the South American and African continental margins; the deep central areas have remained one of the least studied areas of the world ocean (Perez et al., 2012). Much of the diversity data in the southern Mid-Atlantic Ridge, for example, still derive from large-scale expeditions conducted in the late nineteenth century, such as the *HMS Challenger* expedition, which recorded over 80 species of echinoderms, polychaetes and bryozoans (Murray, 1895), and surveys conducted by the former USSR in the second half of the twentieth century, which focused mostly on seamounts and trenches (e.g., Malyutina, 2004). Fishing surveys conducted on seamounts of the Walvis Ridge provided further descriptions of crustacean (McPherson, 1984) and scleractinian coral faunas (Zibrowius and Gili, 1990), including several new species and the extension of geographic distribution ranges of species from the North Atlantic and Southern Oceans.

More recently, efforts to increase knowledge on deep benthic fauna in the South Atlantic have derived from global initiatives such as the Census of Marine Life (e.g., German et al., 2011; Perez et al., 2012) on the Mid-Atlantic Ridge and Walvis Ridge.

Vent sites 3° – 7° south of the Equator were found to contain the mussel *Bathymodiolus puteoserpentis*, the vesicomyd clam *Abyssogena southwardae*, and the alvinocarid shrimp *Rimicaris exoculata,* also common in North Atlantic vent sites. These records imply that the Equatorial Fracture Zone may not be a significant barrier to dispersal of North and South Mid-Atlantic ridge fauna (German et al., 2011). Nearly 190 benthic species records were obtained in non-chemosynthetic environments of the Mid-Atlantic Ridge and Walvis Ridge, with particularly increased diversity found on the Romanche Fracture Zone (Perez et al., 2012). Among these records new species of Hemichordates, amphipods and caridean shrimp were recently described (Cardoso and Fransen, 2012; Holland et al., 2013; Serejo, 2014). Findings such as the ones described will tend to escalate as the deep areas of the South Atlantic are more and better sampled in the future.

National efforts to increase the knowledge on marine biodiversity are taking place in recent years. The Long-Term Ecological Studies Programme(PELD, in Portuguese), funded by the Brazilian National Science Foundation (CNPq), and the SISBIOTA Programme(National Biodiversity System), funded by national and state science-funding agencies, are examples of structured initiatives to produce relevant information on benthic habitats. Several groups are producing temporal series of benthic data to enable the understanding of the impacts of local and global changes. The Brazilian Network for Monitoring Benthic Coastal Habitats (ReBentos; rebentos.org) is a strategy to aggregate and support this kind of study, linking the scientific efforts to public policies related to marine conservation, such as the National System of Marine Protected Areas, the National Plans for Adaptation to Climate Changes, and the National Action Plans for Coral Reefs and Mangroves. Several research institutions operate along the coastline. A number of regions meeting the criteria set for Ecologically or Biologically Significant Marine Areas (EBSAs) of ecological and socioeconomic importance have been identified in the South Western Atlantic (Falabella et al., 2013); they contain mussel beds, reproductive areas for mammals and birds (Península de Valdés), high primary productivity (shelf-break frontal system), oceanic biodiversity, including corals and sponges (Namuncurá – Burdwood Marine Protected Area), king crab, mussel beds and corals (Beagle and Isla de los Estados). Along the southern South American Atlantic coast, the rocky intertidal community is dominated by the bivalves *Brachidontes rodriguezi* (north to 38ºS, warm temperate waters), *Perumytilus purpuratus* (=*Brachidontes purpuratus*, ca. 42-44ºS, cold temperate waters) or *Mytilus chilensis* (south to 47ºS, cold waters) forming dense beds (Olivier et al., 1966; Penchaszadeh, 1973; Zaixso and Pastor, 1977; Zaixso et al., 1978; Sánchez and Zaixso, 1995; Adami et al., 2004; Bazterrica et al., 2007; Hidalgo et al., 2007; Kelaher et al., 2007; Liuzzi and López Gappa 2008).

On the eastern coast, the UNEP-CBD Regional Workshop (Anon., 2013) recognized the biological and ecological importance at the regional level of the Subtropical Convergence Zone, the Walvis Ridge and the Mid-Atlantic Ridge, and at the subregional level the Guinea-Canary Currents convergence, the migratory corridor along the Guinea Current, the seamounts facing the Congo Basin, the Congo Basin and adjacent canyons' marine area, the Guinea-Benguela Currents convergence zone, and the equatorial production zone. This latter zone stretches along both sides of the Equator to the convergence of the Guinea-Canary Currents; the area was described for its high productivity. It is also a breeding ground and migration area for tuna and related species, as well as of marine mammals. Overall 45 areas of interest were identified as requiring further research in the fields of oceanography, geomorphology, ecology and taxonomy.

The benthic communities are subject to different natural and anthropogenic disturbances, depending on the area. Overfishing, trawling, chemical contamination in harbours and coastal areas, changes in the habitats due to the introduction of alien species, oil prospective and extractive activities are the main activities influencing benthic communities. Succession and stability in rocky intertidal communities are subject to artisanal shellfish gathering, which in some areas occurs so intensely that it may cause the local disappearance of these communities.

Global analyses of environmental impacts reveal that the South Atlantic is experiencing diffuse but increasing impacts that affect mainly the coastal areas (Halpern et al., 2008). Although the Central South Atlantic is characterized as subjected to a “low impact,” most of the region (about 70 per cent) exhibits indicators of higher impacts. “High” and “Very High” affected areas are spread along the coastal zones and concentrated close to the most urbanized and/or populated centres, such as Southeastern Brazil and the Gulf of Guinea. This scenario was also evident based on the Ocean Health Index (Halpern et al., 2012), which indicates the sustainable use of marine and coastal ecosystem services, with the Southeastern Atlantic and Gulf of Guinea presenting the worst performances. Several drivers are responsible for this scenario, which is in essence a consequence of public policy implementation gaps associated with evident indices of poverty. One element that directly influences the benthic habitats is the nutrient and sewage input in coastal areas. Diaz and Rosemberg (2008) reported the occurrence of several dead zones (areas with no oxygen to support life), along the Southwestern Atlantic Coast and the Gulf of Guinea.

Additionally, climate change and global warming are also acting in the South Atlantic Ocean. However, concerted efforts to understand the effects of global environmental changes on the South Atlantic lag behind other regions worldwide, leaving society ill-prepared to cope with future changes (Turra et al., 2013). In fact, the paucity of time-series data in the southern hemisphere is especially acute in developing countries (Rosenzweig et al., 2008).

Bottom fishing has represented a variable source of threats to benthic communities in deep areas of the South Atlantic. The development of deep water fishing in slope areas off southern Brazil may have produced significant impacts on benthic organisms as reported by Perez and Wahrlich (2005) and Perez et al. (2013). Further south, off the Patagonian Shelf, benthic communities along the shelf-break front are dominated by scallop beds (Bogazzi et al., 2005) that have been studied and exploited since 1996, when the Patagonian scallop fishery started (Lasta and Bremec, 1998; Bremec and Lasta, 2002). However, interactions of bottom trawling operations and vulnerable benthic communities were found to be generally low (Portela et al., 2012; Schejter et al., 2014a).

A limited number of vessels operate on seamounts of the Walvis Ridge aiming at bottom resources, most notably orange roughy and alfonsino. Although a general paucity of data exists regarding ecosystem impacts of these operations (Bensch et al., 2008; Rogers and Gianni, 2010), catch reports made by different countries throughout the 1980s and 1990s suggest that some seamounts may have been heavily fished by bottom gear, producing an uncertain impact on benthic organisms, including scleractinian corals and sponges (Clark et al., 2007). Countries such as Spain and Namibia have made efforts to describe these communities in different deep fishing areas in the South Atlantic high seas and to identify those considered to be "vulnerable marine ecosystems" (VMEs), whose protection would be a priority in the process of managing deep sea fisheries worldwide (FAO, 2009; Durán Muñoz et al., 2012). In 2006, the Southeast Atlantic Fishery Organization (SEAFO) precautionarily adopted the closure of ten seamount areas for bottom fishing, which were reviewed in 2010 and some reopened (Weaver et al., 2011). Currently, a total of eleven areas are closed in order to protect VMEs (SEAFO Conservation Measure 29/14 Annex 2).

Offshore extraction of oil and gas may cause potential harm to deep benthic communities mostly in association with the production of waste deposits and discharges of chemical pollutants (Davies et al., 2007). Deep areas of Brazilian and West African margins have large reserves, which will be increasingly exploited in the next decade. Nearly 80 per cent of all oil produced annually in Brazil derives from deep oil fields in Campos Basin, off southeastern Brazil, where important efforts to describe benthic diversity and define environmental baselines have been undertaken (Lavrado and Brasil, 2010). It is critical that these efforts expand in the upcoming years, as an even greater offshore oil extraction activity is expected to develop in the large pre-salt reserves recently discovered in the Santos Basin (Abreu, 2013).

Deep mineral deposits have been prospected in the South Atlantic "Area," particularly in association with abyssal plains (polymetallic nodules), the Mid-Atlantic Ridge (seafloor massive sulphides) and seamounts (cobalt-rich crusts) (Hein et al., 2013). In 2013-14 a first plan for exploration of cobalt-rich crusts in a large seamount area named Rio Grande Rise was proposed by Brazil and approved by the International Seabed Authority (ISA, 2014). This contract will aim, in a 15-year programme, to characterize virtually undescribed benthic communities and produce an environmental baseline and monitoring plan for the claimed area. This programme follows ISA regulations for contractors, which include assessing potential disturbances of benthic habitats and organisms caused by crust-removing activities on the seafloor. Although most claims for mineral exploration are currently concentrated in the Pacific Ocean, it may be expected that interest in other areas, such as the South Atlantic, will also develop as knowledge of the South Atlantic increases (Perez et al., 2012).

One promising tool to reconcile benthic conservation and industrial development is offered by the implementation of Marine Protected Areas (MPA) (Marone et al., 2010; Turra et al., 2013). Studies and efforts to increase the number of MPAs are ongoing, such as the survey of priority areas for marine conservation in Brazil (MMA, 2007). In fact, the pressure of particular stakeholders (as shrimp farmers) reduced the protection of mangroves and wetlands along the Brazilian coast (Rovai et al., 2012). In addition, the recent findings of high oil and gas reserves in the Pre-Salt layer off the Southern-Southeastern Brazilian coast, as well as the potential of mining activities, raise awareness about the conservation of the fragile deep-sea benthic habitats.

Due to growing maritime traffic, the record of exotic species is expected to increase. In the Southwest Atlantic, a survey of exotic species in coastal and shelf areas of Uruguay and Argentina revealed that 31 species were introduced and 46 were cryptogenic. Coastal ecosystems between La Plata and Patagonia have been modified. Only exposed sandy beaches appear to be free from the pervasive ecological impact of invasion by exotic species. Poor knowledge of the regional biota makes it difficult to track invasions (Orensanz et al., 2002). Alien species (more than 40 reported for Argentina) severely modified native habitats and may cause loss of biodiversity. The most significant examples are: the Japanese alga *Undaria pinnificata* that highly transformed the benthic structure found in gulfs and bays in Patagonia (Dellatorre et al., 2012), the introduced barnacles that greatly modified hard substrates in harbours and surrounding areas, the polychaete *Ficopomatus enigmaticus* that built reefs in the coastal lagoon Mar Chiquita (Buenos Aires) (Schwindt et al., 2004), the alien oyster *Crassostrea gigas* that transformed and colonized coastal and intertidal areas in Buenos Aires and in Patagonia (Castaños et al., 2009; Giberto et al., 2012), the *Rapana venosa* with an increasing population (Giberto et al., 2006), a voracious gastropod that has already caused huge financial losses in other countries in scallop, mussel and oyster culture and natural populations. In Brazil, a recent report indicated the occurrence of 58 exotic species, with 9 considered invasive (MMA, 2009), one in the phytobenthos, the green alga *Caulerpa scalpelliformis* var. *denticulate*, and six in the zoobenthos: the cnidarian anthozoans *Tubastraea coccinea* and *Tubastraea tagusensis*, the mollusc bivalves *Isognomon bicolor* and *Myoforceps aristatus*, the crustacean decapod *Charybdis hellerii* and the ascidian *Styela plicata*.

Due to continental sources of materials (sediment) and pollutants, including chemicals, nutrients and solid wastes, as well as the strong and widespread impact of human occupation, fishing, mining and oil industry activities, benthic coastal habitats are in danger in the South Atlantic and deserve proper attention from governments and society.

4. Fish

4.1 Status

The area of direct influence of the Amazon and Tocantins rivers is highly heterogeneous in terms of the dynamics of sedimentary deposition and freshwater discharge. This determines the characteristics of its fauna (Coelho, 1980; Camargo and Isaac, 2001) and flora (Prost and Rabelo, 1996), including species richness and distribution patterns (Giarrizo and Krumme, 2008). This area supports high fish biodiversity. Camargo and Isaac (2003) estimated that >300 fish species inhabit this area from 23 orders and 86 families, with a high degree of diversification mainly of the families Sciaenidae and Ariidae, but also of Rajiformes, Pleuronectiformes and Tetradontiformes. Many fish species of these families were also reported in French Guyana, Suriname and Guyana (Lowe Mc-Connell, 1962; Planquette et al., 1996, Le Bail et al., 2000, Keith et al., 2000) and Venezuela (Cervigon, 1996). Souza and Fonseca (2008), who also included information on the shelf and shelf break, identified more than 500 species from 106 families. A river-ocean gradient in the distribution of different species reflects their capacity to tolerate varying levels of salinity. Seasonal changes occur in the composition of the fish community, with predominance of freshwater species during the rainy season and marine species during the dry season (Camargo and Isaac, 2001). The high productivity of the area offers a high potential for fishery activities due to the numerous rivers and estuaries that empty into the Atlantic Ocean, forming a complex aquatic environment with high biological productivity.

Further south along the east Brazil LME, fringing and barrier reefs occur along the coast and over the shelf, harbouring diverse reef fish communities (Maida and Ferreira, 1997; Floeter et al., 2001). Offshore are located a major oceanic plateau, the Ceara Rise, and the Fernando de Noronha Ridge, with a chain of seamounts and the only atoll in the South Atlantic Ocean, Atol das Rocas. The Southwestern Atlantic region (SWA; including Brazilian oceanic islands and Argentina) has an impoverished reef fish fauna in relation to the Northwestern Atlantic and Caribbean, with only over half (471) of the reef species richness and 25 per cent of endemic species distinguishing the 'Brazilian Province' (Rocha, 2003; Floeter et al., 2007).

The Amazon freshwater and sediment outflow is a strong (albeit permeable) barrier to shallow-water reef fish and other organisms, and it is probably responsible for most of the endemism found in Brazilian coastal habitats (Rocha, 2003). Where the continental shelf is narrower and unusually steep, reef formations on the shelf-edge zone and slope down to 500 m depth support important multi-species fisheries, harbour critical habitats for the life cycle of many reef fish species, including spawning aggregation sites (Olavo et al., 2011), serve as a faunal corridor that extends beyond the Amazon mouth area (Collette and Rutzler, 1977), including the hump of Brazil and connect cold habitats in southern Brazil and the Caribbean (Olavo et al., 2011). Snapper dominates the demersal fisheries in the region (Frédou et al., 2006). Further south the shelf widens and the Abrolhos Bank forms a physical barrier to the Brazil Current, hence upwelling and land conditions create even more diversity, especially for the reef fauna.

The South Brazil Shelf Large Marine Ecosystem (LME) extends roughly over the entire continental shelf off southeastern South America. The shelf waters result from the mixing of several water types: coastal, sub-Antarctic, sub-tropical and mixed waters (Bisbal, 1995). The Rio de la Plata represents the greatest freshwater inflow to the region, discharging on average 22,000 m^3/s (with an annual fluctuation of 22 per cent). About 185 species of fish have been identified in South Brazil and around 540 in Argentine and Uruguayan shelf areas (Miloslavich et al., 2011). Two of the most commercially important finfish species exploited from this system are common hake (*Merluccius hubbsi*) and Patagonian hake (*Merluccius australis*) (Bisbal, 1995). Many Sciaenid species are also important as a fishery resource. In this region more than 55 per cent of the stocks are overexploited (MMA, 2006).

At the mouth of the Río de la Plata, the fish fauna comprise 53 marine species (Nión, 1998). The most abundant species undergo migrations related to changes in hydrographic conditions. In the coastal zone fishes from the family Sciaenidae are dominant to a depth of 50 m (Calliari et al., 2003). South of the Rio de la Plata the patagonian shelf is much wider and highly productive with great fish diversity sustaining fisheries on more than 50 species. Common hake (*M. Hubbsi)*, patagonian grenadier (*Macruronus magellanicus),* whitemouth croaker (*Micropogonias furneri)*, sardinella (*Sardinella brasiliensis* and *S. aurita),* southern blue whiting (*Micromesistius australis),* anchovy (*Engraulis anchoita),* prawns (*Pleoticus muelleri)* and several species of skates and rays (http://www.fao.org/fishery/statistics/en).

Along the eastern margin of the South Atlantic, fisheries resources are highly productive, supported by the upwelling resulting from the Guinea and Canary Currents along the coast. Currently fish stocks in the area are already overexploited by the foreign distant-water fleets fishing in the Exclusive Economic Zone of West African countries (Alder and Sumaila 2004; Atta-Mills et al., 2004) under bilateral agreements with the European Union (Alder and Sumaila, 2004).

4.2 Pressures and Trends

Landings of fisheries in Brazil far exceeded sustainable target levels in the main portion of this area, according to the results from fisheries assessments from a multi-year Brazilian research programme called REVIZEE; the majority of stocks were either fully (23 per cent) or over-exploited (33 per cent) and little room remained for expansion into new fisheries (MMA, 2006). The decline of landings of many demersal stocks has been reported in the Southern areas of Brazil [Perez et al., 2003].

Brazilian marine fishes were regionally assessed according to the IUCN Red List criteria. For 151 marine Chondrichthyes species, 39 per cent were categorized as threatened, mainly due to intense and unmanaged fisheries (Peres et al., 2012), and 35 per cent marine teleost species were also assessed as threatened.

Some species in the south west Atlantic have experienced local collapse (e.g., *Cynoscion guatucupa*, a migratory species*)* at Bahía Blanca from the increasing fishing pressure exerted by the industrial fishing fleet operating in open waters (López Cazorla et al., 2014). Information on the status of the exploited species can be found in www.inidep.edu.ar/pesquerias/ppales-pesquerias.

Global climate change affects fish and fisheries. The effects range from increased oxygen consumption rates in fishes, to changes in foraging and migrational patterns in polar seas, to fish-community changes in bleached tropical coral reefs. Projections of future conditions portend further impacts on the distribution and abundance of fishes associated with relatively small temperature changes (Roessig et al., 2004). The information on the effects of climate change and long-term studies to assess those effects in the Southwest Atlantic are scarce or non-existent. Schroeder and Castello (2010) modelled effects of climate change scenarios on Patos Lagoon estuarine-dependent resources, notably pink shrimp, white-mouth croaker and grey mullet. ENSO cycles and climate changes may increase the limnic and decrease the saline influence in the estuary. This scenario may affect the biology and dynamics of estuarine-dependent species and their fisheries, because temperature influences metabolism, which affects the growth of individuals. The natural mortality of larvae may increase due to metabolic stress, although increased growth rates may also reduce the period during which the young are vulnerable to predation. A decrease in the maximum size of the species is also expected, as well as a shift in biomass peaks and the effect of fisheries. West Africa is considered one of the regions most vulnerable to the impact of climate change on fisheries because of the threats to livelihoods and well-being of communities depending on fisheries. The model's estimates indicate a 21 per cent drop in landed value and a 50 per cent loss in fisheries-related jobs (Lam et al., 2012).

5. Marine Mammals

5.1 Status

Marine mammals comprise a diverse group of taxonomically and ecologically distinct aquatic vertebrates that inhabit pelagic to coastal and estuarine waters, from the photic zone to deep ocean canyons (Berta et al., 2006). Most marine mammals are top predators that have spatial and temporal separation of feeding and nursing areas; they must maximize the energy obtained during foraging events and thus are considered good indicators of environmental conditions and health because they depend on the ocean for food and survival (Block et al., 2002; Hooker and Boyd, 2003; Fedak, 2013). Along the coast of South America, several species of marine mammals are found at different (partial or full) stages of their life cycles (Miloslavich et al., 2011 and references herein).

Worldwide, 129 species of marine mammals are described, of which 60 have also been reported for the South Atlantic Ocean (Perrin et al., 2009). Among resident, frequent and occasional visitors, the South Atlantic Ocean is home to approximately 20 species of the Order Carnivora (Suborder Pinnipeda and Family Mustelidae), and ~45 species of the Order Cetacea. Three Mysticete families (seven species of baleen whales), five Odontocete families (27 species of toothed whales), two Pinniped families (10 species), two Mustelidae species and one Sirenid family (a manatee) were reported for Patagonian and Brazilian coastal waters. Throughout South America, we find marine mammals that are endemic or limited in distribution (La Plata River dolphin, Austral dolphin, Commerson dolphin and manatees), and others with wider distribution that depend on coastal areas of the region for important stages of their life cycles.

Some baleen whales, such as the southern right whale and the humpback whale, breed in waters off Santa Catarina, Brazil (28°S), the north Patagonian gulfs (34°S), or in the Abrolhos Bank (17°S), Northeast Brazil, and on the coast of Southwest Africa. The only representative of the manatees in the SAO, *Trichechus manatus,* occurs discontinuously along coastal waters of Northeast Brazil (Alagoas -9°S to Amapá 0°) where it is under serious threat (Luna et al., 2010). Manatees (*Trichechus* spp.), that are commonly found in mangrove areas in the North and Northeast regions and along the Amazon River Basin, were hunted in the past for their meat and skin and were at risk of extinction, but they are currently protected by the Brazilian Government. Humpback whales (*Megaptera novaengliae)* frequent the southern tip of South America, the Beagle Channel and South Africa. Blue whales (*Balaenoptera musculus)* are only seen sporadically along northern Argentine and South African coasts. Southern right whales, *Eubalaena asutralis,* inhabit the north Patagonian gulfs, one of the most important breeding grounds for the species, and are also regularly seen along the coasts of Uruguay and Brazil. Three coastal dolphins are endemic to the region: Peale's dolphin *Lagenorhynchus australis*, Commerson's dolphin *Cephalorhynchus commersonii* and the La Plata or Franciscana dolphin *Pontoporia blainvillei* (Bastida and Rodriguez, 2010). The orca *Orcinus orca* presents smaller populations with a characteristic predatory behaviour in north Patagonia (Lewis and Campagna, 2008) and Isla de los Estados (Raya Rey, pers. obs.). Given advances in technology, the at-sea movements of several species have been revealed, from the pelagic southern elephant seals (Campagna et al., 1999; Campagna et al., 2006) and the more coastal South American sea lion (Campagna et al., 2001) to the endemic and coastal La Plata River dolphin (Bordino et al., 2008) and breeding and post-breeding humpback whales (Horton et al., 2011).

Resident species also include the South American sea lion *Otaria flavescens,* widely distributed all along the southern coast of South America, including Isla de los Estados and Falkland Islands (Malvinas), South American fur seals *Arctocephalus australis* and southern elephant seals *Mirounga leonina*, with the only land-breeding colony along the coasts of Península Valdés and Punta Ninfa (Chubut, Argentina) believed to be the same stock as the seals breeding at the Falkland Islands (Malvinas) (Lewis and Campagna, 2008). On the African coast between the resident species are found the Cape fur seal *Arctocephalus pusillus pusillus.*

Among the cetaceans that visit and live within the Southwest Atlantic Ocean, five species are considered "vulnerable" or "endangered" worldwide. Among these are the blue whale, the humpback whale, the sperm whale *Physeter macrocephalus*, the La Plata River dolphin *Pontoporia blainvillei* and the manatee *Trichechus manatus.* Most of the Odontoceti species are considered to be data-deficient (Lewis and Campagna, 2008). Two of the three mustelid species, *Lontra provocax* and *L. felina*, that inhabit the southern region, are considered endangered.

5.2 Pressures

Some coastal species are threatened by anthropogenic activities, such as pollution, fishing and fisheries by-catch, tourism activities, coastal development and habitat destruction. Pelagic species are also threatened by increasing traffic of ocean vessels (boats and ships), seismic prospection, fishing, and oil and gas activities.

The indirect effects of fisheries have also been observed in seal populations. For the South American sea lion it has been shown that the level of harvested squid and hake could have a negative impact on seal populations (Koen Alonso and Yodzis, 2005). In the Benguela ecosystem, the interaction of seals (Cape fur seal *Arctocephalus pusillus pusillus)* and fisheries have been also described (Yodzis, 1998).

Artisanal fisheries and entanglement pose a major threat for small cetacean populations, in particular the endangered La Plata dolphin (Praderi et al., 1989; Pérez Macri and Crespo, 1989; Secchi et al., 1997). Although not in big numbers and without a clear impact on the population, some other species caught in fishing nets are the Commerson’s dolphin (Crespo et al., 1994; Crespo et al., 1997; Crespo et al., 2000; Schiavini and Raya Rey, 2001; Dans et al., 2003), dusky dolphin, common dolphin and seals (Dans et al., 1997; Crespo et al., 2000; Dans et al., 2003). Elephant seals are also known to become entangled in squid fishing gear (Campagna et al., 2007), as well as many sea lions dying every year with plastic rings around their necks, although this fact has not been quantified and therefore its effect on the population is not known.

Recently the Southern right whale populations have suffered from kelp gull (*Larus dominicanus*) attacks. This problem started during the 1970s as a consequence of gull population growth due to an increase in food supply of human origin (fisheries and home garbage). Although wounds inflicted by kelp gulls do not pose a real threat for the population, gull attacks impose a change in behaviour by the target whale as it increases its attention to the source of the attacks in 24 per cent of cases, to the detriment of other “natural” forms of behaviour (Rowntree et al., 1998; Rowntree et al., 2001; Bertellotti and Perez Martinez, 2008). On average, 27 southern right whales, mostly pups, die annually in Península Valdés; saw a record of 83 dead whales from unknown causes. Although pathogens are not believed to be a major threat to biodiversity, the growth of human activities and climate change could promote their expansion (Uhart et al., 2008).

5.3 Trends

Recent studies have provided insights into marine biodiversity in South America, specifically regarding the Patagonian Shelf (Uruguay and Argentina) and the Brazilian Continental Shelf (Miloslavich et al., 2011). Even though Miloslavich and colleagues' assessment represented a major breakthrough in our knowledge of marine biodiversity in South America, their focus was on macroalgae, cnidarians, molluscs, crustaceans, echinoderms, and fish. The assessment represented an initiative by the Census of Marine Life (CoML) to promote a thorough background check into the information on marine biodiversity produced and accessed only locally in South America and to make it available worldwide via a marine diversity database (OBIS). The knowledge generated by marine research in South America has been limited, given the poor access to oceanographic vessels, isolation between researchers, and the lack of coordination between scientific programmes (Ogden et al., 2004). The lack of dedicated efforts to examine the trends in biodiversity and species richness for the region has represented a major bottleneck for the development of efficient conservation and management measures. Whereas governmental agencies (e.g., the National Oceanic and Atmospheric Administration (NOAA) and the National Marine Fisheries Service (NMFS) of the United States and the Department of Fisheries and Oceans of Canada (DFO)) in the North Atlantic are focused on performing marine mammal assessments to help establish their status and improve their conservation, south of the Equator most assessments are a result of isolated research initiatives with local or regional scope, given the costs associated with this type of assessment.

The South American sea lion is the most abundant marine mammal in the region, with several breeding grounds along the coast from Uruguay to Tierra del Fuego, Staten Island and Falkland Islands (Malvinas) (Reyes et al., 1999; Dans et al., 2004; Schiavini et al., 2004). Most of its populations have been recovering over the last decades from the devastating exploitation suffered between the 17th and 20th centuries (Bastida and Rodriguez, 2010). Nevertheless, whereas colonies in north Patagonia are growing at a 5.4 per cent (Dans et al., 2004) annual rate, the Uruguay populations are decreasing by 4 per cent annually (Páez, 2005). The South American fur seal, with smaller populations, is also recovering, with a 1-2 per cent annual increase rate in the Uruguay populations (Bastida and Rodriguez, 2010). Southern elephant seal populations also increased at an annual rate of 3 per cent from the 1980s to 2000, and have remained stable in numbers since then (Lewis and Campagna, 2002; Lewis and Campagna, 2008).

Data on cetacean population numbers and trends are scarce for the region. Southern right whales show a 7 per cent annual increase rate in Península Valdés (Cooke et al., 2001). Population numbers are known for some of the coastal species (Brownell et al., 1998; Lescrauwaet, 1997; Schiavini et al., 1999; Pedraza, 2008) with no trends available, although given the mortality rate and the narrow distributional range, the La Plata dolphin populations are thought to be decreasing (see threats). No population estimates are known for the Falkland Islands' (Malvinas') resident populations (Otley et al., 2008).

The Brazilian Ministry of Environment has established MPAs and implemented action plans for wildlife, particularly marine mammals (Barreto et al., 2010; Di Beneditto et al., 2010; Luna et al., 2010; Campos et al., 2011). In Uruguay and Argentina, MPAs are increasing, but the implementation of specific action plans for marine mammals has not yet been achieved. In Argentina, marine and coastal resources (Yorio et al., 1998; Sapoznikow et al., 2008), have been under protection in about 59 coastal and marine protected areas, which include marine organisms, such as seabirds and marine mammals, among their main conservation targets (GEF, 2013) . In Uruguay, the process of establishing MPAs is incipient, but a National System of Protected Areas is responsible for this process, and three coastal areas are currently being considered (Santa Lucía, Cabo Polonio, and Cerro Verde), as well as a proposal for a network of MPAs (Defeo et al., 2009). Recently, ecosystem-based fishery management and MPAs are emerging as promising tools to conserve marine environments, in view of declining fisheries indicators in the South Western Atlantic Ocean (Mugetti et al., 2004; Milessi et al., 2005; Defeo et al., 2009). The overall aim is to ensure ecosystem resilience and adaptation to a changing environment while maintaining ecosystem processes and a sustainable use of marine resources. Thus it is important to focus not only on vulnerable species, such as the coastal manatees, sea lions or breeding baleen whales, but also on vulnerable areas, or areas of ecological significance for many species of marine mammals as well as also other groups, such as birds, turtles and fish (Mittermeier et al., 2011).

6. Seabirds

6.1 Status

Tropical waters are relatively poor in seabirds as a result of low productivity. About 130 coastal and marine species are found north of the Río de la Plata. The larger part of these birds comes from the northern hemisphere between September and May and from the southern seas between May and August to reproduce in areas such as Atol das Rocas, which are crucial for the maintenance of their populations (Miloslavich et al. 2011).

South of the Río de la Plata, shelves are high-productivity areas which maintain a great diversity of seabirds. This ecosystem not only harbours many birds that come each summer to breed, but also thousands of seabirds forage within its waters (Yorio et al., 1999; Croxall and Wood, 2002; Favero and Silva, 2005). Pelagic and coastal waters are home to about 50 species that belong to the orders Procellariiformes, Sphenisciformes, and the families Stercorariidae, Sterniidae, Lariidae and Phalacrocoraciidae.

The main breeding sites in the South West for these populations are concentrated in three areas: (a) Península Valdés and adjacent coasts; (b) Tierra del Fuego and adjoining areas; and (c) the Falkland Islands (Malvinas) (Croxall et al., 1984; Strange, 1992; Woods and Woods, 1997; Yorio et al., 1999). Three species (Magellanic penguin *Spheniscus* *magellanicus*, southern rockhopper penguin *Eudyptes chrysocome* and black-browed albatross *Thalassarche melanophris*) have over half their world population in the area (Boersma et al., 2013; Pütz et al., 2013) and two others (gentoo penguin *Pygoscelis papua* and thin-billed prion *Pachyptila belcheri*) probably have more than one-quarter of their world population in the region (Croxall and Wood, 2002).

Seabird diversity and abundance have long been studied by ship surveys (e.g., Cooke and Mills, 1972; Jehl, 1974; Veit, 1995; Orgeira, 2001a; Orgeira, 2001b). With advances in technology (satellite tracks, global positioning system devices and geolocators), the origin, sex, age and status of birds using the area can be established and quantified (Falabella et al., 2009). Therefore, it is known that the area is intensively used by a wide range of species: from pelagic flying birds (e.g., Jouventin and Weimerskirch, 1990; Weimerskirch et al., 1997; Prince et al., 1998; Berrow et al., 2000; González-Solís et al., 2002; Quintana and Dell'Arciprete, 2002; Trathan and Croxall, 2004; Masello et al., 2010) to penguins (Stokes et al., 1998; Stokes and Boersma; 1999; Pütz et al., 2002; Pütz et al., 2007; Wilson et al., 2007; Raya Rey et al., 2007; Sala et al., 2014; Rattcliffe et al., 2014) and coastal birds (Suárez and Yorio, 2005; Suárez et al., 2012). The waters are not only used by resident species but also by seabirds that breed in distant colonies: wandering albatrosses *Diomedea exulans* from the South Georgias Islands extensively use the Patagonian shelf, two fulmarine petrels, cape petrel *Daption capense* and Antarctic fulmar *Fulmarus glacialoides*, which breed on the Antarctic Peninsula and Continent, are very common visitors over the Patagonian shelf (Orgeira, 2001a). Wilson's storm petrel *Oceanites oceanicus*, a trans-equatorial migrant, with a large Antarctic but small Falkland Islands (Malvinas) breeding population is also common in the region (Orgeira, 2001a). Although only present in small numbers, seabirds breeding at Tristan da Cunha and Gough (mainly soft-plumaged petrel *Pterodroma mollis*, Atlantic petrel *P. incerta*, Kerguelen petrel *Lugensa brevirostris* and great shearwater *Puffinus gravis*) visit the southern part of the Patagonian Shelf (Orgeira, 2001a). In addition, substantial numbers of Tristan albatross *Diomedea dabbenena*, Atlantic yellow-nosed albatross *Thalassarche chlororhynchos* and spectacled petrel occur in similar areas of northern Argentina, Uruguay and southern Brazil (Olmos et al., 2000). Finally, northern royal albatross *Diomedea sanfordi,* endemic to New Zealand, is known to forage along the Patagonian Shelf (Nicholls et al., 2005).

Of the seabirds which breed in the region, two species (southern rockhopper penguin and white-chinned petrel *Procellaria aequinoctialis*), qualify under the IUCN criteria for globally threatened status; magellanic penguin, black-browed albatross and gentoo penguin are regarded as Near Threatened. Also seven of the non-resident visitor species qualify for the globally threatened status (BirdLife International, 2014). Seabirds in the region are considered in the International Plans of Action presented by Argentina, Brazil, Chile, South Africa and Uruguay.

South African waters are of prime importance for conserving seabirds because the Benguela upwelling system and the Agulhas Bank provide rich foraging opportunities for a wide diversity of seabirds (Petersen et al., 2009). The Benguela Ecosystem harbours 15 seabird species, of which 10 are endemic to South Africa. Species belong to the families

Spheniscidae, Hydrobatidae, Pelecanidae, Sulidae and Haemotopodidae with one species each, three species of the Laridae family and four species in the Phalacrocoracidae and Sternidae families (Kemper et al., 2007). Seabirds from the Benguela Ecosystem are highly threatened; in particular, the African Penguin *Spheniscus demersus* and Cape Cormorant *Phalacrocorax capensis* are now considered endangered following ongoing decreases (Birdlife, 2014).The Southeast Atlantic Ocean also has numerous islands (Ascension, St. Helena, Inaccessible, Tristan and Nightingale) rich in seabird species (Cuthbert 2004; Birdlife, 2014). Most of these islands are home to the endangered northern rockhopper penguin *Eudyptes moseleyi* (Birdlife, 2014), and 15 albatrosses and petrels foraging within these waters qualify under the IUCN criteria for globally threatened status, such as the Tristan albatross which is critically endangered (Abrams, 1983; Abrams, 1985; Ryan and Moloney, 1988; Nel and Taylor, 2002; Wanless et al., 2009; Petersen et al., 2009; Birdlife, 2014).

6.2 Trends

Population trends of resident and non-resident seabirds that forage in the Southwest Atlantic Ocean present different trajectories over the years, with some species showing opposite trends at different locations. Some of the large Procellariiformes species have declined over the past decades (i.e., wandering albatross) and this trend continues (Poncet et al., 2006), but others, such as the southern giant petrel, are recovering at least at some colonies (Reid and Huin, 2005; Quintana et al., 2006; Wolfaardt, 2012). Small petrels' trends are not well known in the area (Otley et al., 2008). Among penguins, southern rockhopper penguins have experienced dramatic declines between 1930 and 2005 (Pütz et al., 2003), although this trend seems to have reverted within the Falkland Islands (Malvinas) (Baylis et al., 2013), whereas the population at Staten Island has reduced its numbers during the last decade (Raya Rey et al., 2014). Gentoo and Magellanic penguins present different trends, depending on the colony. Gentoos in the Falkland Islands (Malvinas) presented a 42 per cent decrease, which was attributed to a paralytic shellfish poisoning in 2002, with a later increase of 95 per cent since 2005 (Pistorius et al., 2010); a recent study showed interannual fluctuations without a clear trend (Baylis et al., 2012), but in the meantime the small population of Tierra del Fuego has increased (Raya Rey et al., 2014). Magellanic penguin population trends are variable: some of the bigger colonies are decreasing, but at the same time new colonies are being established in northern Patagonia (Boersma, 2008; Boersma et al., 2013); the population in the Falkland Islands (Malvinas) does not present a clear trend, whereas populations in Tierra del Fuego are increasing (Raya Rey et al., 2014).

Long-term population trends for coastal birds, such as gulls, cormorants, skuas and terns, are scarce and limited for certain regions. Cormorants present opposite trends depending on the species and site, but in general numbers have been stable with some populations slightly increasing or decreasing (Frere et al., 2005; Raya Rey et al., 2014). Kelp gulls take advantage of human garbage, and their populations are increasing all along the Patagonian coast (Lisnizer et al., 2011; Raya Rey et al., 2014). Terns and skuas are the least studied of the species, with small populations and frequent variations in colony locations with unknown trends (Yorio, 2005; Otley et al., 2008).

Southeast Atlantic seabird population trends contrast between species, but several have experienced severe decreases during the last decades, such as the African penguin, the Cape Gannet *Morus capensis* and Cape cormorant (Kemper et al., 2007). Some gull populations are increasing, which is largely attributable to the provision of additional food sources from human activities (Crawford, 1997) and the cessation of population control measures (mainly the destruction of eggs and chicks) at most breeding localities (Hockey et al., 2005). The decrease in Northern rockhopper penguins is evident from population estimates in the Tristan da Cunha group and Gough Island, which indicate a decline of more than 50 per cent (Cuthbert et al., 2009). The Tristan albatross also decreased severely at 3 per cent per year, and the sooty albatross *Phoebetria fusca*, Atlantic yellow-nosed albatross *Thalassarche chlororhynchos* and southern giant petrels *Macronectes giganteus* remained stable during the last decade (Cuthbert et al., 2014).

6.3 Pressures

Direct and indirect discharge of chemical pollutants, industrial and expanded city pollution, bycatch, entanglement, climate change and alien species pose severe threats for seabird populations both at sea and at their colonies in the Southwest Atlantic Ocean. Oil pollution in Argentine inshore waters is of major concern and kills thousands of Magellanic penguins annually (Gandini et al., 1994; Garcia-Borboroglu et al., 2006; Garcia-Borboroglu et al., 2010). Negative consequences of garbage disposal have also been documented in the region (Copello and Quintana, 2003; Otley and Ingham, 2003).

Bycatch (incidental mortality) of seabirds in fishing gear has been a foremost conservation issue, due to the large number of albatrosses and petrels killed by longline fishing vessels (Croxall, 1998; Neves and Olmos, 1998; Olmos et al., 2000; Prince et al., 1998; Schiavini et al., 1998; Stagi et al., 1998). Seabird mortalities decreased by one order of magnitude towards the end of the decade (2001-2010), not due to lower bycatch rates but rather to a drop in the number of hooks set per year (Favero et al., 2013). Black-browed albatrosses, white-chinned petrels, southern giant petrels and southern royal albatrosses are the most common species interacting with trawlers. The total annual mortality of these birds associated with the trawl fleet under investigation was roughly estimated to be from several hundred to over a thousand albatrosses (Favero et al., 2011). Entanglement of penguins in trawl nets is considerable, and other inshore feeding species are doubtless at risk (although this risk is in some cases minor) in various other net fisheries (Gandini et al., 1999; González-Zevallos et al., 2007; González- Zevallos and Yorio, 2011; Seco Pon et al., 2012; Seco Pon et al., 2013).

Seabirds foraging and breeding in the Southeast Atlantic are subject to many threats, such as: human disturbance of breeding colonies; destruction of breeding habitats by development (du Toit et al., 2003); predation by domestic cats and mice (Wanless et al., 2009); egg and chick predation by Kelp Gulls and Great White Pelicans (Crawford, 1997;

du Toit et al., 2003); competition with commercial fisheries for food (du Toit et al., 2003). Longline fisheries pose a serious threat in particular for the Tristan albatross, and also for albatrosses and petrels in general (Baker et al., 2007). Introduced mice species at Gough Island are known to affect albatrosses and petrels (Cuthbert et al., 2013). Food supplies for northern rockhopper penguin may be affected by squid fisheries, climate change and shifts in marine food webs (Cunningham and Moors 1994; Guinard et al., 1998; Hilton et al., 2006). African penguins have dramatically decreased during the last decade, which is related to prey abundance (Crawford et al., 2011).

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