Theme 5: Ecosystem and Fisheries Observations in the Tropical Atlantic

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1. Background

Observations of Ecosystem and Fisheries Observing Systems in the Tropical Atlantic are mostly carried out on national scales along the continental shelf and international scales in the high sea. There are exceptions where regional programmes support observation and monitoring efforts along the shelf. Overall, the ability to carry out coordinated observations is still limited as is the capacity to access and analyse data from other sources like remote sensing. This chapter gives an overview on major initiatives and programs and highlights capacity development needs.

2. Relevance of fisheries and ecosystems

Most fisheries are happening in the coastal and shelf areas and are thus often in the Exclusive Economic Zones (EEZs) of countries and as such are under the jurisdiction of only one country. Exceptions are transboundary stocks, which migrate between the EEZs of several countries (e.g., *Sardinella spp.* in North West Africa, a shared stock between Morocco, Mauritania, Senegal, Gambia and Guinea-Bissau) or are straddling stocks, which migrate between EEZs and the high seas, and highly migratory fish stocks. The most prominent example of the latter are tuna stocks. Management and thus monitoring are commonly done through regional agreements or Regional Fisheries Management Organizations (RFMOs) and increasingly using co-management tools (Deme and Brehmer 2022). The main RFMO is the FAO Fishery Committee for the Eastern Central Atlantic (CECAF) aimed at promoting the sustainable utilization of the living marine resources within its area of competence by the proper management and development of the fisheries and fishing operations. In the case of tuna species in the Atlantic, this role is played by the International Commission for the Conservation of Atlantic Tuna "ICCAT" (Bekiashev and Serebriakov 1981). We will present this as an extra paragraph in the following work. Coastal ecosystems can be categorized in Large Marine Ecosystems (Hempel and Sherman 2003), which are marine areas with similar ecosystem characteristics. In the tropical Atlantic, two East boundary upwelling systems occur and are highly productive (Auger et al. 2016; Hutchings et al. 2009). Neighbouring countries of some of tropical Atlantic LMEs have developed programs and conventions to regulate the use and extraction of living resources. Many LME programs include extensive scientific projects and together with many national efforts these can include observations and monitoring programs. However, most of these efforts are done through individual programs and only few are maintained as consistent time series. One prominent example for LME programs success is the Benguela Current Commission.

In recent years, the importance of monitoring and observation of commercial and non-commercial species has increased, as the realization of the impact of climate variability has been extended with a steady trend of change, which forces changes in productivity and changes in distribution alike (Sarré et al. 2018; Franco et al. 2020). To understand current systems, particularly also the effect of human activities including fishing and climate change for the future of ecosystems, an increasing number of ecosystem models have been developed, which are also in need of data for parameterization, calibration and validation. In addition, these models also use input data from coupled climate-ocean models (Keenlyside et al. 2021). It has been recognized that observations of a few essential ecosystem and ocean variables of pressures and state of the ocean are required for an ecosystem-based analysis (UNESCO 2012), and that observations systems should be organized around "essential ocean variables (EOVs)," rather than by specific observing system, platform, program, or region. Implementation of EOVs can be made according to their readiness levels, allowing timely implementation of components that are already

mature, while encouraging innovation and formal efforts to improve readiness and build capacity (FOO 2012; Miloslavich et al. 2018). Thus, there is a clear need for more integration with respect to data collection and analyses. However, there are some challenges with respect to a coordinated Trans-Atlantic observing system, namely, the need to:

- link national and regional coastal observations with open ocean observations;
- link different observation systems and programs with currently different goals;
- integrate observation systems with very different timescales between collection of raw data and availability of processed data;
- collections of a set of pre-defined essential variables that would enable ecosystem and fisheries management.
- strengthen national logistical means for ocean observations

Even if capacity building is no longer needed in numerous developing countries but but rather, capacity strengthening and making use of the expertise in national and regional institutes (Brehmer et al. 2018), we need to encourage North-South and South-South collaborations.

3. Fisheries

The importance of fisheries in the Tropical Atlantic can most easily be demonstrated by the total catch and the dependence on the sector in the region. Almost ten million tons of seafood (from 87.2 million global marine capture) were harvested in the Central and South Atlantic (FAO major areas 31, 34, 41 and 47) in 2016 (FAO 2018). In addition, the fishing sector has a high importance in the tropical Atlantic coastal countries. The total amount of fishers in Africa, Latin America and the Caribbean is eight Million, although not all of them are operating in the Atlantic. But not only these countries fish here, many foreign fleets (e.g., Korean, Chinese, Turkish, Russian, European) also target the resources. The fishing activities cumulated over a period of 10 months was shown by Global Fishing Watch, which is a good example for a global remote sensing observation system for fishing activities (Fig. 1). However, it only shows vessels with an Automatic Identification System (AIS), which only vessels above 300 BRT need to install and run (IMO, SN/Circ.227) (Mullié 2019). Thus, smaller fishing vessels, especially those close to the coast, cannot be detected. Moreover, the system can be easily switched off by the crew, even if it appears efficient on e.g., the European fleet operating in the tropical area. More efficient system to monitor fishing activities is the use of Vessel Monitoring System (VMS) even if we can report contrasted operationalization in developing countries. The use of embarked fishing observers remains the more reliable monitoring system to report location and catch.

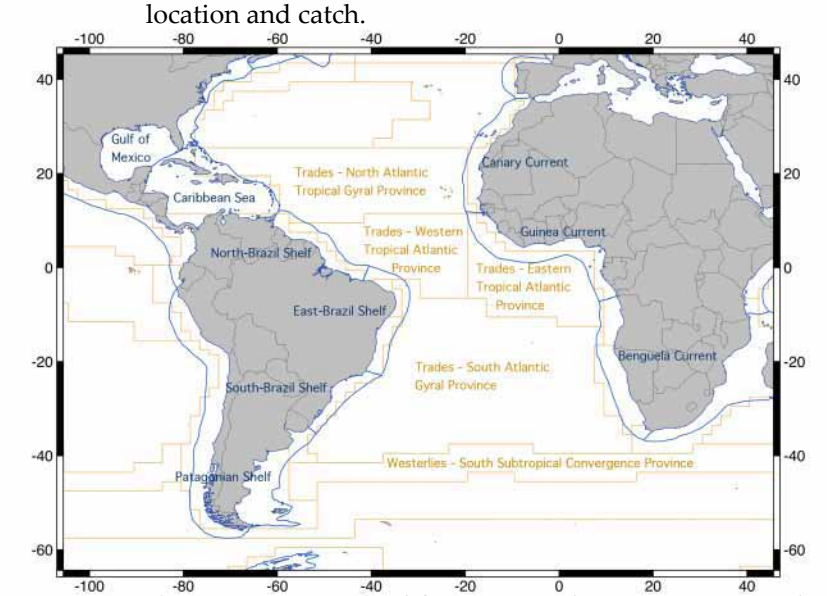

Figure 1. *Fishing activities cumulated from 31 December 2016 to 15 November 2017, taken online from Global Fishing Watch (https://globalfishingwatch.org/; accessed the 07/06/2022).*

4. Ecosystems

4.1. Relevant ecosystems in the tropical Atlantic

Depending on the definition of tropical Atlantic, the area contains roughly 7 – 9 LMEs (Hempel and Sherman 2003) and 4 – 5 Longhurst provinces in the open Ocean (Longhurst 1998) (Fig. 2). Most of the LMEs are shared between different countries, with some of them having developed programs and conventions to coordinate scientific efforts, harmonization of national legislations and to regulate some shared activities, e.g., fisheries. Most living resources are extracted in coastal and shelf areas and thus these ecosystems are supporting the livelihoods for millions of people directly by providing income, employment and food through artisanal and industrial fishing. In addition, coastal ecosystems also support income generating activities including tourism, industry, diving, game fishing, recreational activities among others. In all tropical areas as everywhere, the marine ecosystem management is a trade-off between conservation and exploitation (Brehmer et al. 2011), usually in disfavour of the conservation targets. However, both goals must be simultaneously considered for management purposes, taking into account that an ecosystem in bad health or not sustainably exploited by the fishers, is less productive.

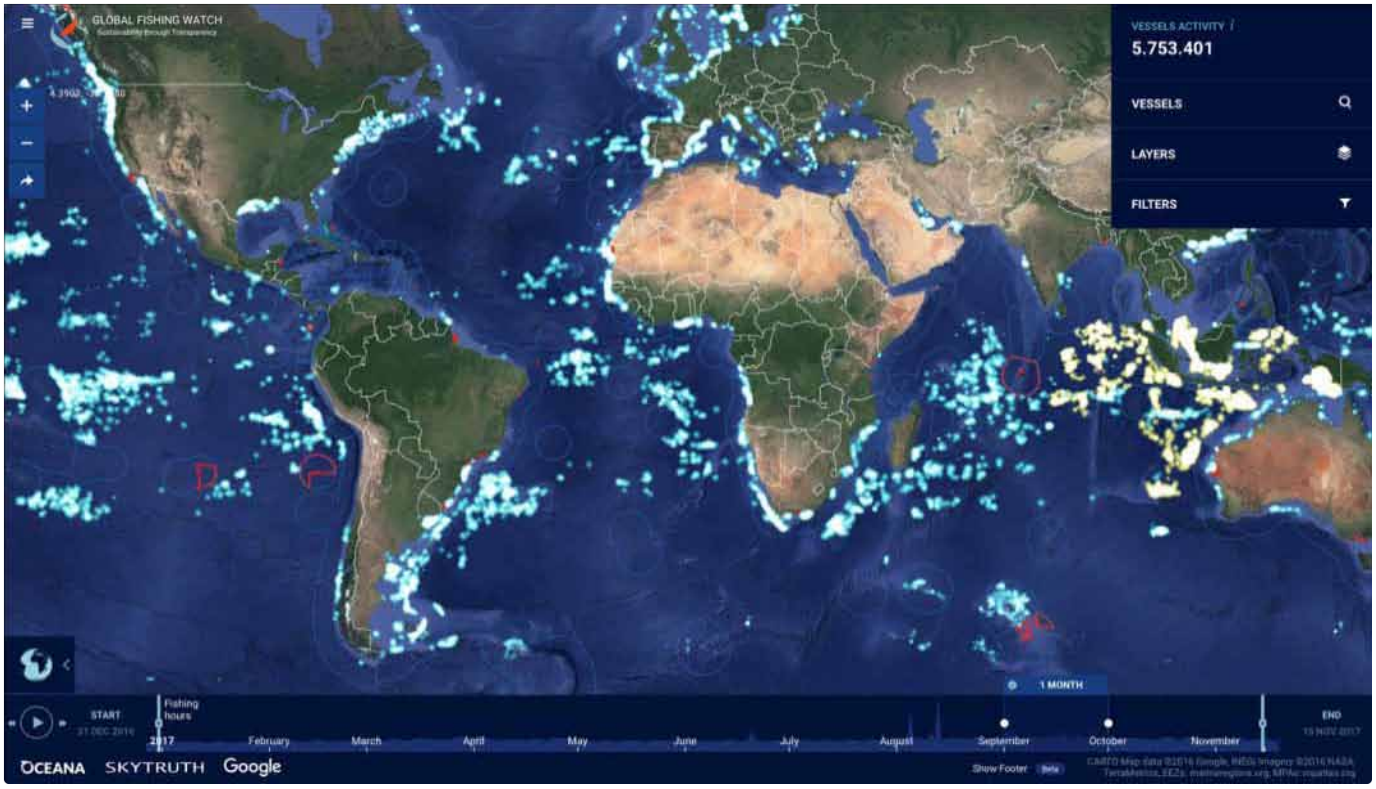

Figure 2. *Map of the Tropical Atlantic Large Marine Ecosystem (LME). Courtesy of J.O. Schmidt.*

4.2. Observations of Fisheries and Ecosystems

Together, fishing and changing environmental conditions (e.g., chemical contamination, hypoxia, toxic algal blooms, ocean warming and acidification) are placing wild fish stocks under unprecedented stress (Nellemann et al. 2008). This problem is being addressed by transitioning from traditional single species management of capture fisheries to an ecosystem-based approach to fisheries management (EBFM) in which fishing is managed in the context of interactions of fish stocks with other organisms (prey, predators, and competitors) and their environment (Garcia and Cochrane 2005). The success of applying an ecosystem-based assessment to inform Ecosystem Based Fisheries Management (EBFM) depends on (1) simultaneously monitoring of multiple pressures and ecosystem states; and (2) rapid detection and timely prediction of changes in ecosystems states and their impacts on carrying capacity. In the southern part of the Canary Current LME the AWA program has supported EAMME (Ecosystem Approach to the management of fisheries and the marine environment in West African waters) for a decade to promote EBFM.

4.2.1. Observations in fisheries

4.2.1.1. Stock taking of species

The most basic observations that happened over the last centuries are related to stock taking of species, i.e., the exploration of their habitats and related species and their description and categorization. Still, in many areas, not all species are scientifically described and thus it is difficult to assess the impact of human activities, including fisheries, on these species. Thus, a continued effort is necessary in almost all tropical Atlantic areas, which remain understudied.

4.2.1.2. Assessing the status of stocks

The most basic observational need in relation to management of living resources is the assessment of the fisheries themselves, including fishing capacity (i.e., how many boats of which types and fishing gear), effort (how many days at sea, trips, hooks deployed per day, etc.) and catch (which species and how much of each species). To assess a given stock, additional information on length, weight and age of caught individuals of a given species and how much of each length, weight or age are caught, is needed. This is information that is normally collected through national fisheries institutes and/or respective government fisheries agencies, with representative fish sampling done either directly on board or through landing sites, and market sampling schemes. In some countries fisheries independent data are collected through trawl and hydroacoustics surveys on the fish stock or egg and larvae surveys on the early life stages of a stock.

4.2.1.3. Population dynamics

To get information in relation to population dynamics, regular annual surveys are necessary, which collect information on the development of a cohort in a given stock, estimating migration, growth and mortality

through field studies and performing nested studies on the influence of environmental variables on life history parameters. In addition, stomach content analysis gives insight into the role of species in the ecosystem and the dependence on specific prey species and susceptibility to predators. Many of these studies are normally not carried out regularly and too often done with financial support of projects, which do not allow to constitute efficient time series to monitor population dynamics of exploited fish populations. Assessments of the status of stocks in East Atlantic are performed through CECAF Committee.

5. Current or Recent Coordinated Observations

One example of a survey programme, which started as fisheries survey and turned into an ecosystem survey, is the EAF Nansen Programme. Since 1975, this joint initiative of Norway and the Food and Agriculture Organization (FAO) of the United Nations is performing sea surveys, which were specifically built for the programme, around the African continent. Other surveys programme exist (e.g., Orstom-IRD since 1970's) and regional initiatives involving national research vessels towards coordinated acoustic surveys in Northwest Africa (Sarré et al. 2008).

TheTropical Atlantic was included in the "Census of Marine Life" a 10-year, scientific initiative, involving a global network of researchers in more than 80 nations, engaged to assess and explain the diversity, distribution, and abundance of life in the oceans. The world's first comprehensive Census of Marine Life — past, present, and future — was released in 2010. Census of Marine Life (Costello et al. 2010) has collected biodiversity data in the global ocean, including the Tropical Atlantic. There are numerous other, mostly smaller projects, like the tripartite AWA and European Preface projects. These consortia had promoted the need of projects clustering and synergy in the Tropical Atlantic (Brehmer et al. 2018), nowadays the "All-Atlantic Ocean Research Alliance" involving countries from both sides of the Atlantic Ocean including Tropical Atlantic, appear as a relevant initiative to develop.

Along the Atlantic coast, only one LME programme from FAO became a commission. The Benguela Large Marine Ecosystem Programme (BCLME) (Shannon et al. 2006). The objective was to support Angola, Namibia and South Africa in developing capacity to tackle marine environmental issues in the region, across national boundaries. Similar initiatives were done in the Canary Current (CCLME) and Gulf of Guinea (GCLME) with less success.

In the high sea, off national EEZs, we get different fish communities than the small pelagic dominating the continental shelf (Diogoul et al. 2021). Tunas and the other large pelagic fishes, including swordfish, billfishes, wahoo and oceanic sharks, such as the blue shark and mako sharks, are highly migratory species and, therefore, the management of their fishery needs to be done by RFMO, a task in the Atlantic Ocean and Mediterranean Sea undertaken by the ICCAT.

Lastly, animal tracking networks are spreading around the Atlantic Basin, and will become an important tool to support the understanding of ecosystems and fisheries. The Ocean Tracking Network (OTN) is a GOOS pilot project that combines technologies developed for tagging apex pelagic predators with those developed for smaller animals (Hussey et al. 2015).

6. Conclusions

Not all existing programs and projects have been listed here only the most illustrative, but overall, it becomes clear that no holistic observation program exists for the Tropical Atlantic with respect to biological and specifically fisheries data even less to relate physical, biogeochemical and ecological components of the marine ecosystems. Thus, the general requirements are better use of existing data, extending surveys for commercial and endangered species (giving more attention on key species for food security), and integration of ecosystem and fisheries surveys into a larger observation system, considering the requirements of different user groups, decision makers, society, private sector and the scientific communities. Current gaps include missing or not enough communication between different scientific communities collecting data, missing data exchange protocols and missing common survey protocols.

Activities that will help in coordinating and further developing capacity includes i) linking and supporting existing coordinated programmes like the EAF Nansen Programme, the LME Programmes and Regional Fisheries Management Organizations like ICCAT; ii) linking and supporting coordinated national survey program, maintaining at least the current survey effort, identifying gaps and supporting the development of extensions where necessary; iii) linking coordinated communities like the Ocean Tracking Network, iv) reaching out to governmental bodies, both national and international like the Ministerial Conference on fisheries cooperation among African States bordering the Atlantic Ocean (ATLAFCO) as well as regional bodies as the Sub Regional Fisheries Commission (SRFC) in the CCLME,

the Fisheries Committee for the West Central Gulf of Guinea (FCWC) in the GCLME, and the Benguela Current Commission (BCC) in the BCLME; and v) develop and carry out a broad consultation on current observing efforts and observing needs.

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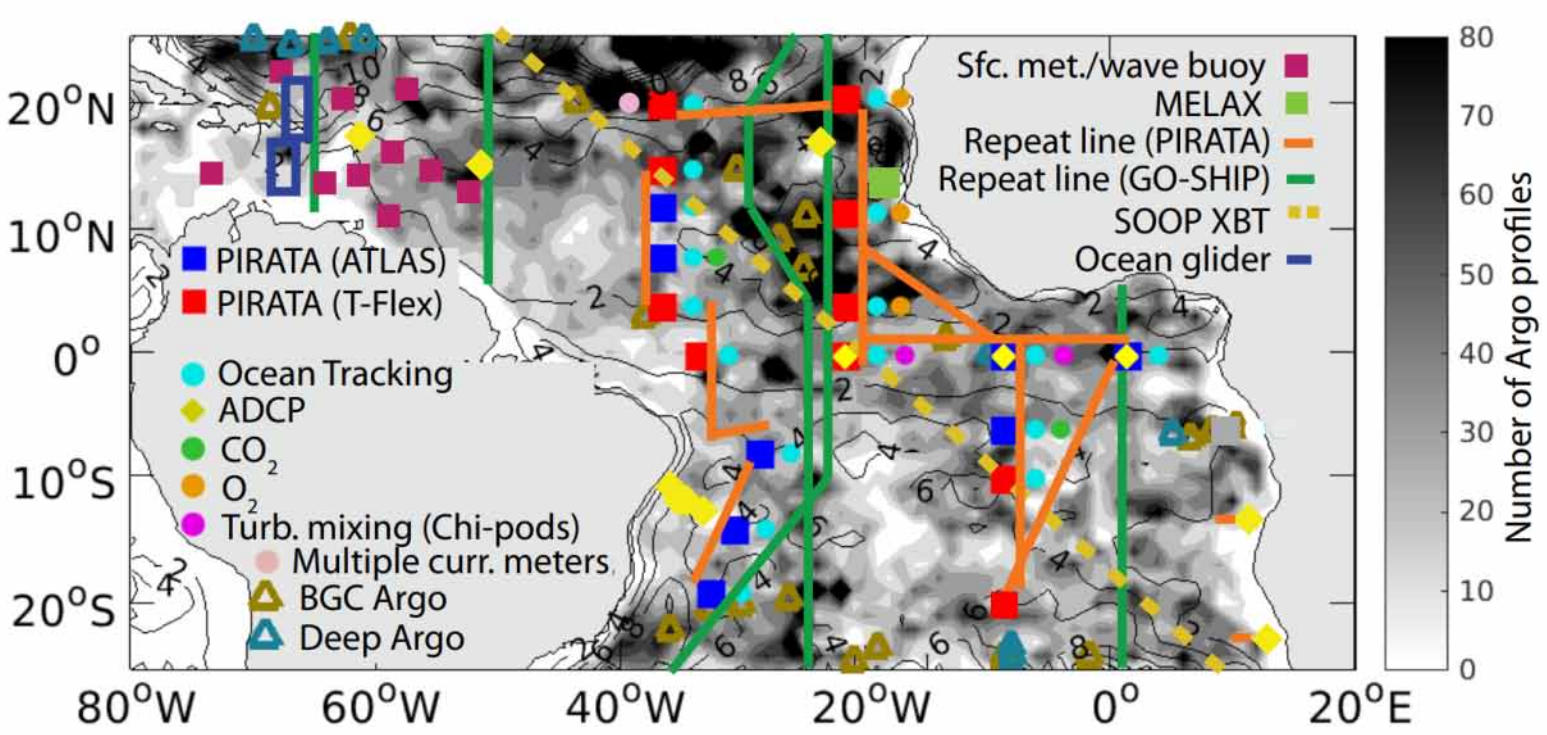

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