UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Higher Polytechnic School of Gandia

Characterization of main tuna and tuna-like species and major fishing fleets in the Tropical Atlantic Ecoregion of the International Commission for the Conservation of Atlantic Tunas.

Master's Thesis

Master's Degree in Assessment and Environmental Monitoring of Marine and Coastal Ecosystems

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Abstract:

The implementation of the Ecosystem Approach to Fisheries Management (EAFM) requires the identification of a spatial framework within which different ecosystems can be characterized, monitored, and reported on. Since 2019, the International Commission for the Conservation of Atlantic Tunas (ICCAT) has been developing a process to advance the identification of a spatial framework of ecologically meaningful regions (ecoregions) within its convention area. Currently, eight candidate ecoregions have been identified, but their validation is still required to ensure that these tools can serve as spatial framework to support the planning and prioritization of scientific activities, stimulate ecosystem research, and facilitate the development of integrated ecosystem-based advice products to inform fisheries management decisions at the regional level. To validate these tools, in this thesis I contributed to the development of a pilot Ecosystem Fishery Overview (EFOs) for one specific ecoregion, the Tropical Atlantic Ecoregion (TAE) by answering two main questions: i) Who is fishing in the TAE? and ii) What species are being caught in the TAE?

This was achieved through an analysis of indicators to identify the core fisheries and fleets operating in the TAE and to characterize the main spatio-temporal patterns of their catches from the 1950s to 2021 A total of 61 core fleets of four major gear groups (purse seiners, longliners, gillnets and bait boats) were identified reporting catches in the TAE. The main fleets based on the dominance of substantial number spatial prevalence in the TAE were largely industrial purse seine (PS_BLZ, PS_EU and PS_PAN) and longline fleets (LL_CHN and LL_JPN, LL_KOR) but a significant number of more coastal artisanal fleets of gillnets, bait boats and longliners also operate in the TAE. In terms of total catches, the European Purse Seine fleet emerged as the primary fleet in the TAE. Historically the fleets operating in the TAE have mostly targeted the three tropical tuna species. Currently, Skipjack tuna contributes 53% of the total catch in the region followed by Yellowfin Tuna (24.7%) and Bigeye Tuna (11.78%). The catch of small tunas has also been increasing over time, currently contributing to 5.94% of total catch. The study provides the first preliminary EFO for an ICCAT ecoregion supporting the feasibility of creating regional ecosystem advice products to complement the existing advice for single species. However, our findings underscore the need for enhanced fisheries statistical reporting with improved spatial resolutions at the fleet level and an increased representation of species interacting with ICCAT fisheries. This is crucial to strengthen the use of these products as a foundation for informing the implementation of the EAFM in ICCAT.

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Introduction

1.1 Background

The Ecosystem Approach for Fisheries Management (EAFM) aims for sustainable fisheries that support both the ecological integrity and well-being of human communities reliant on those resources (Garcia, et al., 2003). It has emerged to address shortcomings of traditional fisheries management which traditionally has treated fisheries as isolated entities within marine ecosystems. The EAFM seeks to implement an integrated strategy for managing fisheries considering not just the management of target species but also the broader ecosystem, including bycatch and ecosystem impacts as well as species interactions, their habitats, and environmental considerations (Garcia & Cochrane, 2005). Globally its implementation has been slow, yet it varies significantly from one region to another. EAFM implementation has progressed at the national levels in countries such as the United States, Australia, and South Africa (Hilborn et al., 2020). Furthermore, at the international level, some Regional Fisheries Management Organizations (RFMOs) are also making efforts towards its implementation (Juan-Jorda et al., 2018; Koen-Alonso et al., 2019).

The implementation of EAFM has been slow, in part, because it requires specific initiatives and tools to facilitate its operationalization. Over the last two decades, there has been a surge in tools supporting EAFM implementation globally, including (i) the development of ecoregions to facilitate ecosystem planning, (ii) the development of ecosystem risk assessments for prioritization of work, (iii) the development of ecosystem modeling tool for quantifying the cumulative impacts of fishing and climate on fishery resources, (iv) the development of indicator-based ecosystem report cards for monitoring the ecological state of marine ecosystems upon fisheries depend on, and (v) the development of ecosystem-based management strategy evaluations for quantifying trade-offs among multiple objectives (Gilman et al., 2022; Link, 2010; Todorović et al., 2019). These tools aim to provide integrated and ecosystem-based advice for informing fisheries management and are being developed and utilized at the national level and international level by RFMOs worldwide (Link, 2010).

One EAFM tool currently under development in tuna RFMOs is the establishment of spatially defined ecoregions within their convention areas. The ecoregions partition the marine environment into ecologically meaningful regions that exhibit relative homogeneity in terms of main oceanographic patterns, fish communities and major fleets targeting them. In particular, the International Commission for the Conservation of Atlantic Tunas (ICCAT) has made efforts developing ecologically meaningful ecoregions as a foundational spatial framework to support the operationalization of EAFM in the context of tuna and billfish fisheries in the Atlantic Ocean (Juan-Jorda et al., 2022; Nieblas et al., 2022). ICCAT is one of the 5 global tuna RFMOs and it is in charge of managing tuna and tuna-like species and oceanic sharks in the Atlantic Ocean and adjacent Seas. This organization conducts scientific research, assesses the status of tuna and tuna-like species and oceanic sharks, and establishes conservation and management measures to prevent overfishing and promote the long-term conservation of these species and associated ecosystems.

At the first ICCAT Ecoregion Workshop in 2022, eight candidate ecoregions were proposed within the ICCAT convention area (Figure 1, Table 1). The delineation of ecoregions within ICCAT was guided by specific criteria involving the main oceanographic and biogeographic patterns in the Atlantic Ocean, the macroecology of the major tuna and billfish species managed in ICCAT, and the spatial dynamics of the major ICCAT tuna and billfish fisheries (Juan-Jorda et al., 2022). The eight candidate ICCAT ecoregions now require validation and refinement before their practical application in resource planning and management (Juan-Jorda et al., 2022). The ongoing development and validation of ecoregions within ICCAT represents a significant step towards operationalizing EAFM in ICCAT (Juan-Jorda et al., 2022). The proposed ecoregions hold potential as a crucial tool for supporting ecosystem-based research, planning, and generating advice products for informing fisheries management decisions in the context of tuna and billfish fisheries. This aligns well with the global trend towards more integrated and ecosystem-based approaches to support fisheries management.

One approach for validating and verifying ecoregion maps contends that the ultimate test of the utility of ecoregions as tools for resource planning, research, assessment, and provision of advice may be the extent to which they meet the end user needs. Therefore, it consists of developing pilot advice products (i.e., Ecosystem Fishery Overviews) to test if they meet the end-user needs. Validation is needed to guarantee that the ecosystem research products developed using them as spatial frameworks are effective in providing ecosystem-based advice to inform fisheries management.

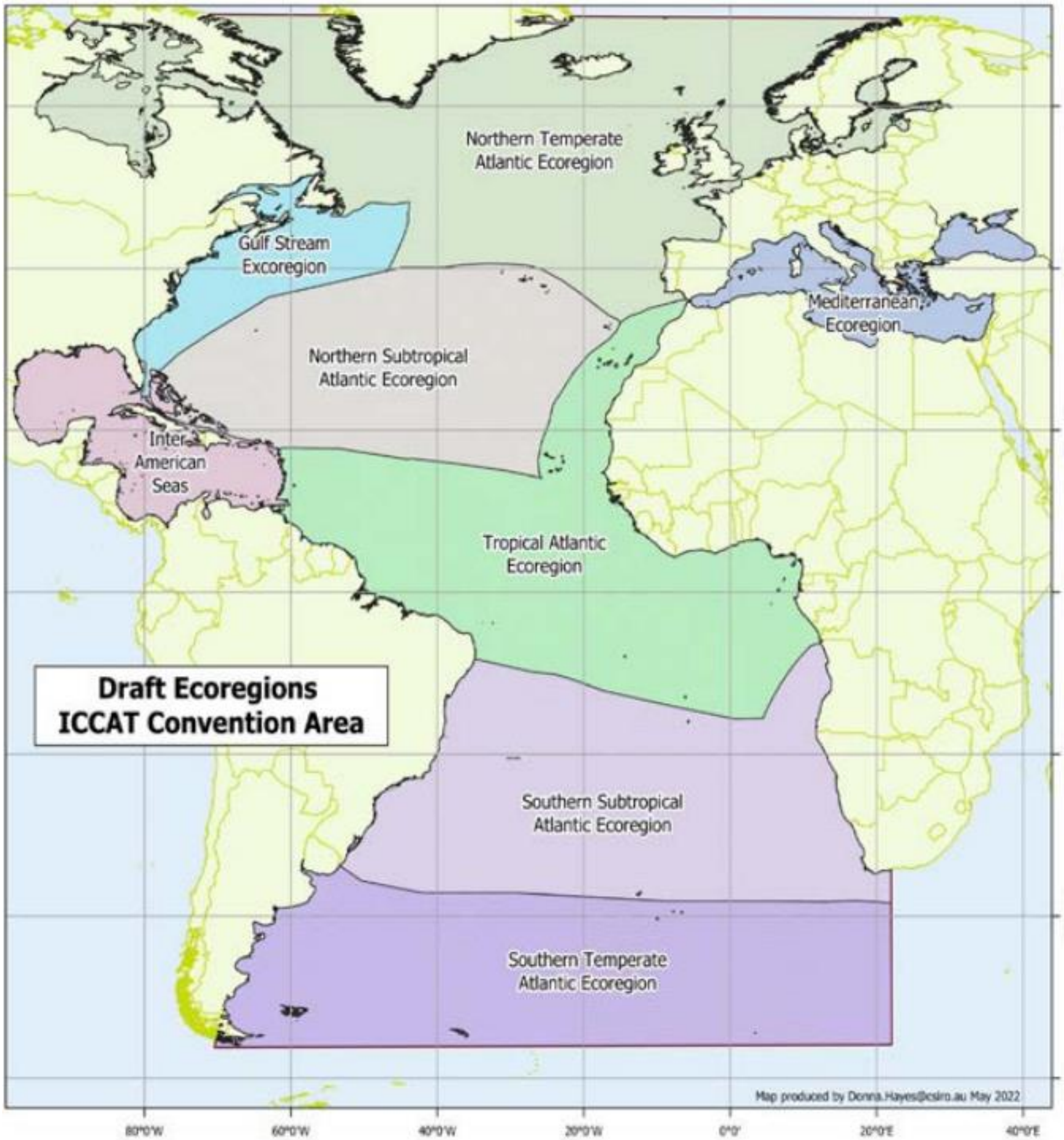


Figure 1. Candidate ICCAT Ecoregion delimitation

International organizations such as the International Council for the Exploration of the Sea (ICES) and the Northwest Atlantic Fisheries Organization (NAFO) have experience developing various ecosystem-based advice products at the ecoregion level (Koen-

Alonso et al., 2019; ICES, 2023). These products, including Fishery Overviews, Ecosystem Overviews, State of the Ocean Reports, and State of the Ecosystem Reports, have been designed to offer comprehensive narratives for specific ecoregions. They cover both general ecosystem aspects and concentrate on the central species and fisheries managed within an ecoregion, highlighting their impacts on the ecosystem. The primary goal of these ecosystem-based advice products is to provide decision-makers with fisheries and ecosystem context, enabling informed decisions on fisheries management that consider regional bycatch, ecosystem, and climate considerations. Essentially, these products aim to complement the existing single-species fisheries advice tailored for the managed species within an ecoregion. Ultimately these products aim to facilitate users in understanding the broader implications of decisions tailored for single stocks within an ecosystem context.

In the context of ICCAT, the ICCAT Subcommittee on Ecosystems requested in 2022 the development of a pilot ecosystem-based advice product, named an Ecosystem and Fisheries Overview (EFO), using a selection of case study ecoregions to show their applicability and intended use to the ICCAT Commission. The initiation of a pilot project for an EFO holds multiple aims: first, to test the applicability and potential uses of an ecoregion framework as "units of analysis" for developing regional advice products such as the EFO; second, to identify the strengths, weaknesses, opportunities, and threats (SWOT analysis) of these regional products. This endeavor serves as an exploration of the viability and utility of ecoregions as a spatial framework for developing advice products tailored for providing regional ecosystem-based advice.

1.2 Objective

The main goal of this thesis is to support the development of a pilot product that can help assess the effectiveness of ecoregions as a tool for developing ecosystem advice products to support the management of ICCAT fisheries and associated ecosystems. To do so, in this thesis I will contribute to the development of an Ecosystem Fishery Overviews (EFOs) for one specific ecoregion, the Tropical Atlantic Ecoregion (TAE). An EFO may incorporate multiple sections tackling different subjects (Figure 2.) The incorporation of subjects will ultimately depend on the interest of the end-users (the ICCAT Scientific Committee and Commission) and the capacity of experts to periodically update them, among other criteria. For this thesis, I will be focusing mainly on addressing two research questions: i) Who is fishing in the TAE? and ii) What species are being caught in the TAE? Which will contribute to two main sections of the EFO for the TAE.

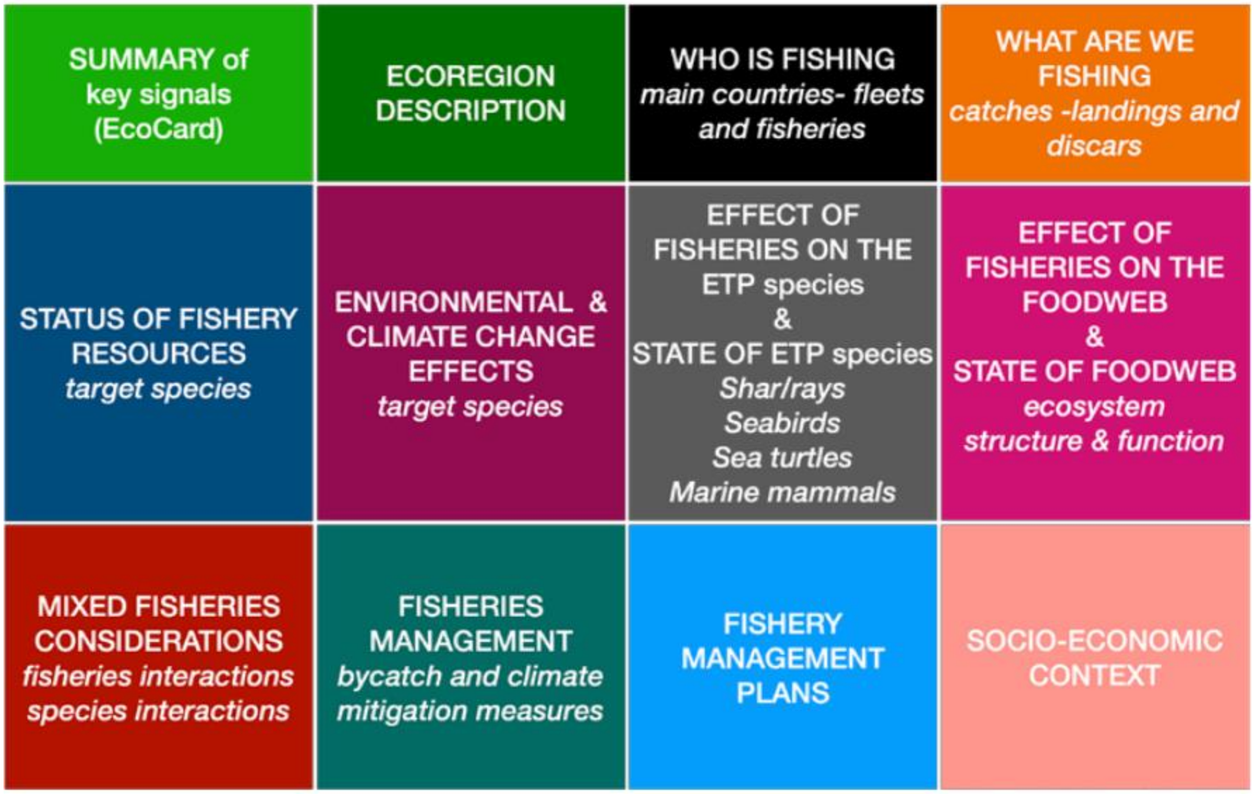


Figure 2. Potential sections to be incorporated in an Ecosystem-Fishery Overview (EFO).

Specifically, this thesis has two main objectives:

Objective 1- Who is fishing? I identified, mapped and described the most important fisheries and fleets operating within the TAE including the gears used and their spatial-temporal patterns of activity using ICCAT publicly available fishery statistics datasets. This provides an overview of the core fisheries and fleets operating in the ecoregion and whether their fishing grounds are contained within a single or over multiple ecoregions.

Objective 2 – What species are being caught? Based on the core fisheries and fleets identified under Objective 1, I described the main spatial-temporal patterns of catches by species, gears and fleets in the TAE ecoregion using ICCAT publicly available fishery statistics datasets. This provides a historical overview of what species are caught in the TAE ecoregion and their catches over time from the 1950s until 2021.

Table 1. Proposed ICCAT Ecoregions and their acronyms. See ecoregion map in Figure 1.

Ecoregion Name	Acronym
Northern Temperate Atlantic Ecoregion	NTAE
Northern Subtropical Atlantic Ecoregion	NSAE
Gulf Stream Ecoregion	GSE
Inter Americas Sea Ecoregion	IASE
Mediterranean Ecoregion	ME
Tropical Atlantic Ecoregion	TAE
Southern Subtropical Atlantic Ecoregion	SSAE
Southern Temperate Ecoregion	STAE

Table 2. Major ICCAT gear groups operating in the TAE

Main Gears	Acronym
Baitboat	BB
Longline	LL
Gillnet	GN
Purse Seine	PS
Haul Seine	HL
Harpoon	HP
Rod and Reel	RR
Trolling Lines	TR
Trawl	TW

*Table 3. Major tuna and tuna-like species and oceanic sharks managed by ICCAT. *These are the nine major species reported in the TASK2 CATDIS dataset.*

Common Name	Acronym	Scientific Name	Climate
***Bluefin Tuna**	**BFT**	*Thunnus thynnus*	Temperate
***Albacore Tuna**	**ALB**	*Thunnus alalunga*	Temperate
***Swordfish**	**SWO**	*Xiphias gladius*	Subtropical
***Blue Marlin**	**BUM**	*Makaira nigricans*	Subtropical
***White Marlin**	**WHM**	*Tetrapturus albidus*	Subtropical
***Sailfish**	**SAI**	*Istiophorus albicans*	Tropical
***Bigeye Tuna**	**BET**	*Thunnus obesus*	Tropical
***Yellowfin Tuna**	**YFT**	*Thunnus albacares*	Tropical

***Skipjack Tuna**	**SKJ**	*Katsuwonus pelamis*	Tropical
Blue Shark	**BSH**	*Prionace glauca*	Subtropical
Porbeagle Shark	**POR**	*Lamna nasus*	Boreal
Shortfin Mako shark	**SMA**	*Isurus oxyrinchus*	Subtropical
Small Tunas	Smaller species that are exploited by coastal and artisanal fisheries. Amongst these are Blackfin Tuna, Bullet Tuna, Atlantic Bonito, Plain Bonito, Atlantic Spanish Mackerel, Dolphinfish, Frigate Tuna, etc.		
Other Tunas	Marlins and sailfishes like Kawakawa, Black Marlin, Striped Marlin, Oilfish, True Tunas etc.		
Other Sharks	Shark species like Longfin Mako, Silky Sharks, Smooth Hammerhead, Sandbar Shark, Pelagic Sharks, etc.		
Other Species	Smaller species like Orange Filefish, Barracudas, Needlefishes, Flyingfishes, Vadigo, etc.		

2. Methodology

2.1 Area of study

The Tropical Atlantic Ecoregion boundaries combine three Pelagic Provinces of the World: including the Equatorial Atlantic province, the Guinea Current province and the Canary Current province (Spalding et al., 2012). Its oceanography is characterized by numerous zones of coastal upwelling along the northwestern African coast, that have heightened biological productivity and abundant fishing grounds. The equatorial region also undergoes seasonal equatorial upwelling from July to September. This phenomenon results in environmental conditions that differ significantly from the neighboring gyres (Spalding et al., 2012). The pelagic ecosystem boasts a diverse taxonomy, prominently featuring a community dominated by large pelagic fishes such as the tropical tunas (Skipjack tuna *Katsuwonus pelamis,* Yellowfin Tuna *Thunnus albacares*, and Bigeye Tuna *Thunnus obesus)* and billfishes (Swordfish *Xiphias gladius,* White Marlin *Tetrapturus albidus,* and Blue Marlin *Makaira nigricans)*. The primary ICCAT fisheries capturing these species involve purse seiners, followed by deep and shallow setting longliners, among other gears (Table 2).

The main anthropogenic pressures having an impact on the ecological state of the tropical Atlantic Ecoregion consists of fishing and climate change (Juan-Jorda et al. (2020)

2.2 Data Sources

For the data analysis in this study, I retrieved two statistical databases from the ICCAT website[1]. The first dataset, referred to as Task 1, comprises the nominal annual catches (including both landings and dead discards). Task 1 dataset is categorized by Flag, Fleet, Species, Region, Gear group, and Stock. The second dataset set is Task 2 CATDIS data, which contains geo-referenced live weight data, covering both landings and dead discards for the nine major tuna and tuna-like species under ICCAT's purview (Albacore, Bigeye Tuna, Bluefin Tuna, Blue Marlin, Sailfish, Skipjack, Swordfish, White Marlin, and Yellowfin Tuna). The Task 2 CATDIS dataset includes the life weight data by time and area strata in 5x5-degree squares. Similar to Task 1, CATDIS data also includes

[1] https://www.iccat.int/en/accesingdb.HTML

information on Flag, Fleet, Gear group, Stock, and School type for describing the purse seine operations. While Task 1 includes the landings and discards of a broader range of species (see Table 3), it lacks spatial information of the catches (longitude and latitude). In contrast, Task 2 CATDIS contains the geo-referenced catches of only nine tuna and tuna-like species segmented by fleet and major gear, which accurately represents the equivalent Task 1 overall annual catches distributions.

I performed the data analysis using the R statistical software (R version 4.3.1, R Core Team 2023) and relied on several essential R packages, including ggplot2 (Wickham 2016), sp (Bivand et al. 2013; Keitt et al. 2010), rgdal (Bivand et al. 2013), dplyr and tidyr (Wickham et al. 2023), and plyr (Wickham 2011).

2.3 Identification of Operating Core Fleets in the TAE

I identified the core fleets operating within the TAE, following a series of steps: First, I applied a filter to isolate fleets reporting catches within the TAE based on their specificity and fidelity to the ecoregion. Second, for those fleets reporting catches within TAE I calculated a range of additional indicators to facilitate the accurate identification of the core fleets within the ecoregion. For the fleet analysis, I used data from 2010 to 2021 to get a more representative and current picture of the core fleets in TAE. Furthermore, I used as a unit of analysis a variable that combines the gear type (Table 2) with the fleet code as categorized in the ICCAT datasets. I defined a fleet as a group of vessels with the same gear type and fleet Code. According to the CATDIS dataset and our definition of fleet, there were potentially 119 fleets reporting catches for the nine major ICCAT species between 2010-2021 (Annex 1). After combining multiple fleet codes reported by the same flag state and excluding fleet codes with errors or not relevant to the TAE ecoregion, 61 fleets were identified reporting catches in the TAE region (Annex 2).

First, for those 61 fleets reporting catches within TAE (Annex 1), I performed a Specificity-Fidelity indicator analysis to identify the core fisheries and fleets in TAE based on their dominance and prevalence of their fishing grounds within the ecoregion (Dufrene and Legendre 1997; Reygondeau et al. 2012) (Annex 2). The overall indicator is based on the multiplication of these two metrics, the “specificity” of fishery or fleet to the TAE and their “fidelity” to the TAE.

Specificity ($A_{i,j}$) of a fleet (i) for an ecoregion is calculated as the ratio of the mean catch of the fleet in an ecoregion ($N_{i,j}$)) to the total catch of the fleet across all the ecoregions (N_i).

Fidelity ($B_{i,j}$) of a fleet (i) for an ecoregion is calculated as the ratio of the number of geographical cells in one ecoregion where the fleet is present ($S_{i,j}$) to the total number of geographical cells present in the ecoregion (Sj) This indicator shows the extent of the spatial prevalence of a species (stock) within an ecoregion.

The Overall Specificity-Fidelity Indicators ($V_{i,j}$) is calculated by multiplying the specificity and fidelity indicators, and further multiplying them by 100, and provides a metric for each fleet based on their dominance and prevalence in the ecoregion.

$$\mathrm{Ai,j} = \frac{\mathrm{Ni,j}}{\mathrm{Ni}}$$

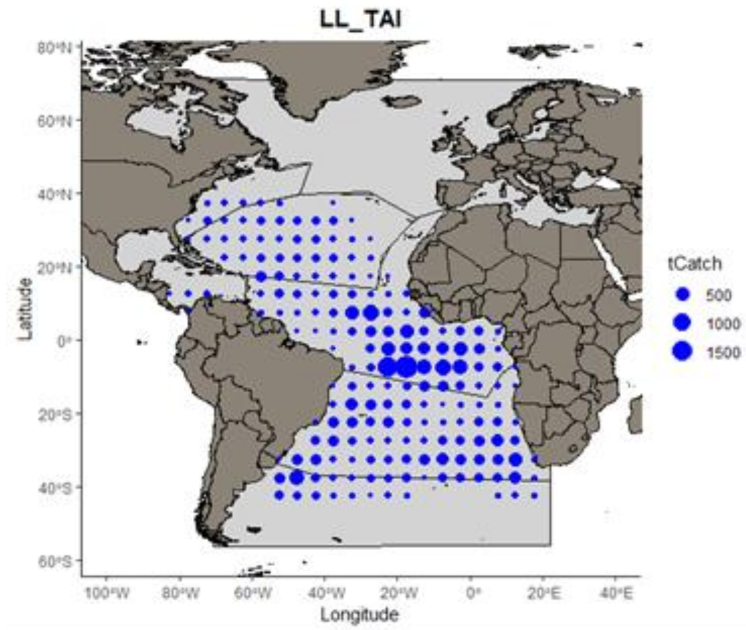
$$\mathrm{Bi,j} = \frac{\mathrm{Si,j}}{\mathrm{Sj}}$$

$$\mathrm{Vi,j} = \mathrm{Ai,j} * \mathrm{Bi,j} * 100$$

Second, for those 61 fleets reporting catches within TAE (Annex 1), I calculated a range of additional indicators to facilitate the accurate identification of the core fleets within the TAE (Annex 2). I calculated; (i) I the number of years each fleet reported catches in the ecoregion between 2010-2021,(ii) the total catch reported by each fleet between 2010-2021 within the TAE and in the entire ICCAT convention area, (iii) the percentage of the total catches of each fleet within the TAE based, (iv) the total number of pixels (each 5x5 degrees) each feet is present with reported catches within the TAE and in the ICCAT convention area between 2020-2021, and (v) the percentage of pixels with catches within the ecoregion relative to the total pixels with catches. Additionally, I analyzed the species composition of the catches of each fleet and identified the species most caught within TAE, outside TAE and within the entire ICCAT convention area for each fleet in order to infer the type of species being targeted by the fleet in each region.

I also generated spatial maps displaying mean catch abundance and species composition for each fleet to supplement the identification of core fleets within the TAE (Annex 3). While Annex 3 contains spatial maps for the initial 119 fleets, here I provide an example of the catch abundance and species composition for the Taiwanese longline fleet (Figure 3). These spatial maps also facilitated the organization of the fleets for the characterization of historical catches in the following section. I also calculated and plotted the total annual catches reported between 2010 and 2021 by each fleet grouped by major gears (Figure 4).

a)



b)

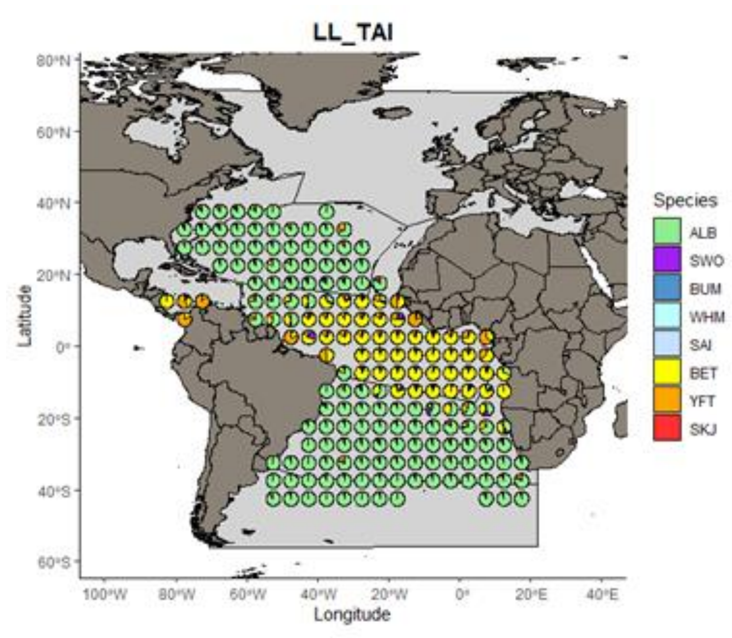
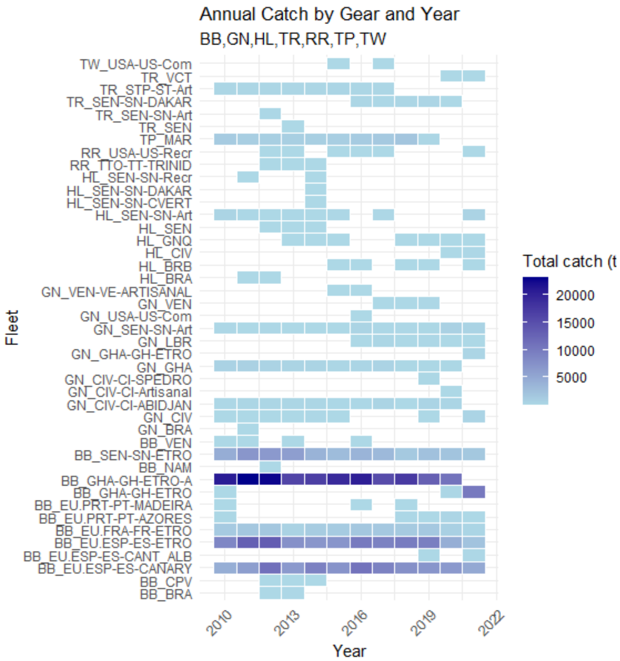
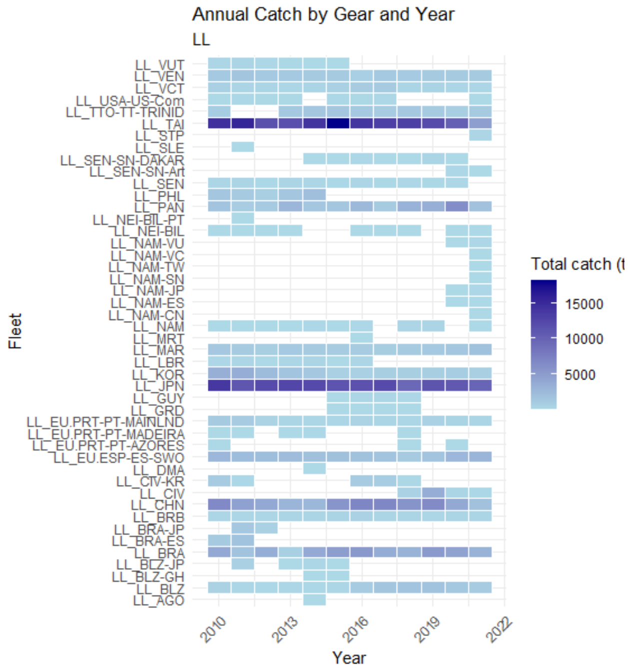


Figure 3. Catches of the Taiwanese longline fleet (LL_TAI) between 2010 and 2021 a) the average catch (in tons) between 2020 and 2021 b) the species composition of the catch

a)


Annual Catch by Gear and Year
BB,GN,HL,TR,RR,TP,TW
TW_USA-US-Com
TR_VCT
TR_STP-ST-Art
TR_SEN-SN-DAKAR
TR_SEN-SN-Art
TR_SEN
TP_MAR
RR_USA-US-Recr
RR_TTO-TT-TRINID
HL_SEN-SN-Recr
HL_SEN-SN-DAKAR
HL_SEN-SN-CVERT
HL_SEN-SN-Art
HL_SEN
HL_GNQ
HL_CIV
HL_BRB
HL_BRA
GN_VEN-VE-ARTISANAL
GN_VEN
GN_USA-US-Com
GN_SEN-SN-Art
GN_LBR
GN_GHA-GH-ETRO
GN_GHA
GN_CIV-CI-SPEDRO
GN_CIV-CI-Artisanal
GN_CIV-CI-ABIDJAN
GN_CIV
GN_BRA
BB_VEN
BB_SEN-SN-ETRO
BB_NAM
BB_GHA-GH-ETRO-A
BB_GHA-GH-ETRO
BB_EU.PRT-PT-MADEIRA
BB_EU.PRT-PT-AZORES
BB_EU.FRA-FR-ETRO
BB_EU.ESP-ES-ETRO
BB_EU.ESP-ES-CANT_ALB
BB_EU.ESP-ES-CANARY
BB_CPV
BB_BRA
Fleet
2010
2013
2016
2019
2022
Year
Total catch (t
20000
15000
10000
5000

b)


Annual Catch by Gear and Year
LL
LL_VUT
LL_VEN
LL_VCT
LL_USA-US-Com
LL_TTO-TT-TRINID
LL_TAI
LL_STP
LL_SLE
LL_SEN-SN-DAKAR
LL_SEN-SN-Art
LL_SEN
LL_PHL
LL_PAN
LL_NEI-BIL-PT
LL_NEI-BIL
LL_NAM-VU
LL_NAM-VC
LL_NAM-TW
LL_NAM-SN
LL_NAM-JP
LL_NAM-ES
LL_NAM-CN
LL_NAM
LL_MRT
LL_MAR
LL_LBR
LL_KOR
LL_JPN
LL_GUY
LL_GRD
LL_EU.PRT-PT-MAINLND
LL_EU.PRT-PT-MADEIRA
LL_EU.PRT-PT-AZORES
LL_EU.ESP-ES-SWO
LL_DMA
LL_CIV-KR
LL_CIV
LL_CHN
LL_BRB
LL_BRA-JP
LL_BRA-ES
LL_BRA
LL_BLZ-JP
LL_BLZ-GH
LL_BLZ
LL_AGO
Fleet
2010
2013
2016
2019
2022
Year
Total catch (t
15000
10000
5000

c)

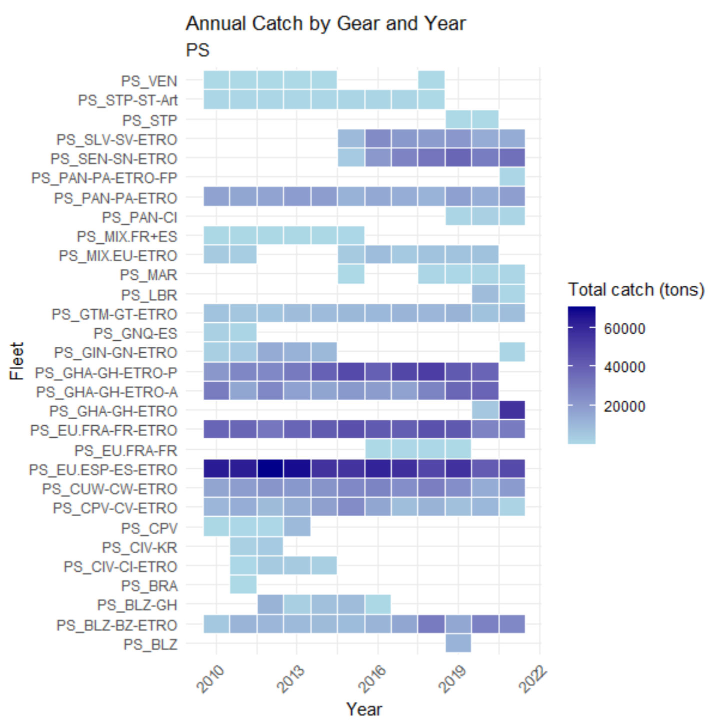

Annual Catch by Gear and Year
PS
PS_VEN
PS_STP-ST-Art
PS_STP
PS_SLV-SV-ETRO
PS_SEN-SN-ETRO
PS_PAN-PA-ETRO-FP
PS_PAN-PA-ETRO
PS_PAN-CI
PS_MIX.FR+ES
PS_MIX.EU-ETRO
PS_MAR
PS_LBR
PS_GTM-GT-ETRO
PS_GNQ-ES
PS_GIN-GN-ETRO
PS_GHA-GH-ETRO-P
PS_GHA-GH-ETRO-A
PS_GHA-GH-ETRO
PS_EU.FRA-FR-ETRO
PS_EU.FRA-FR
PS_EU.ESP-ES-ETRO
PS_CUW-CW-ETRO
PS_CPV-CV-ETRO
PS_CPV
PS_CIV-KR
PS_CIV-CI-ETRO
PS_BRA
PS_BLZ-GH
PS_BLZ-BZ-ETRO
PS_BLZ
Fleet
2010
2013
2016
2019
2022
Year
Total catch (tons)
60000
40000
20000

Figure 4. Total annual reported catch (in tons) of each fleet within the TAE between 2010 and 2021 grouped by major gears. a) BB, GN, HL, TR, RR, TP, TW fleets. b) LL fleets. c) PS fleets. See Table 2 for gear codes.

2.4 Characterization of Historical Catches in TAE.

Based on the core fisheries and fleets identified in Section 2.3 (Annex 2,3), I characterized the historical catches of these fleets since the 1950s until 2021 by species, major taxa groups, major gears and fleets in the TAE using ICCAT publicly available fishery statistics datasets (Task 1 and Task 2 CATDIS). The Task 1 dataset has the advantage of including reported nominal catches for all tunas and tuna-like species for each fleet. However, these catches lack georeferencing, making it impossible to automatically assign them to a specific ecoregion. On the other hand, the Task 2 CATDIS dataset only contains catch data for the 9 major commercial species, yet these are georeferenced (5x5 degrees squares) and can be directly assigned to an ecoregion. Consequently, I had to match each core fleet to its corresponding ICCAT dataset based on the spatial extent of their fishing grounds and catches within and outside the TAE (Annex 3).

For the fleets with the majority of the catches and fishing grounds within the TAE boundaries, I opted for TASK 1 as the preferred database due to its comprehensive coverage of all tuna and tuna-like species, sharks and other teleosts. Conversely, for fleets with fishing grounds and reporting catches across various ICCAT ecoregions, I utilized TASK 2 CATDIS, with a filter ensuring that only catches within the TAE boundaries were considered for the analysis (Annex 2).

Following the identification of the core fleets and the determination of the appropriate dataset for each, I conducted a series of in-depth analyses to gain deeper insights into their fishing activities and historical catches by major taxa and gear groups.

I delved into the historical catches of each core fleet between the 1950s and 2021 with a specific focus on the diversity of species they captured. This analysis provided valuable insights into the evolution of the fleets' fishing activities, revealing trends in species composition, and quantifying the changes in catch volumes.

A similar analysis was also conducted to examine the historical catches by major gear groups. Catch volumes, species composition, and fishing practices associated with different gear types were plotted between 1950s to 2021 within the TAE. This analysis aimed to uncover the preferences and efficiencies of a particular fishing gear and the importance and role of each core fleet operating within the TAE.

The examination of the fleet-specific species captured by major fishing gear groups provided a comprehensive overview of the historical catches of each core fleet within major gear groups. The insights gained from these analyses played a crucial role in characterizing the fishing activities within the TAE, enabling a more informed evaluation of their impact on the region's marine resources and the conservation efforts required to sustain its ecosystem.

3. Results

3.1 Core Fisheries and fleets in TAE Ecoregion.

The main fleets based on the dominance of their catches and spatial prevalence in the TAE were mainly large-scale industrial longline and purse seine fleets (Figure 5). The 10 main fleets (the ones with the highest indicator value > 56) were the Belizean Purse

Seine, the European Purse Seine, Chinese Longline, Panamanian Purse Seine, Panamanian Longline, Korean Longline, Guinean Purse Seine, Ghanan Purse Seine, Belizean Longline, and another European Purse Seine (Table 4).

Table 4. The overall specificity-fidelity indicator for the main fleets with the highest indicator value in the TAE

Fleet	Overall Indicator[2] (Specificity*Fidelity*100)
PS_BLZ	77.34
PS_EU	71.62
LL_CHN	66.60
PS_PAN	62.54
LL_PAN	61.57
LL_KOR	60.47
PS_GHA	58.89
PS_GIN-GN-ETRO	58.80
LL_BLZ	57.5
PS_MIX.EU-ETRO	56.96

[2] This indicator value may differ from the one on Annex 1 as it was done after merging and renaming selected fleets (see Methodology and Annex 2)

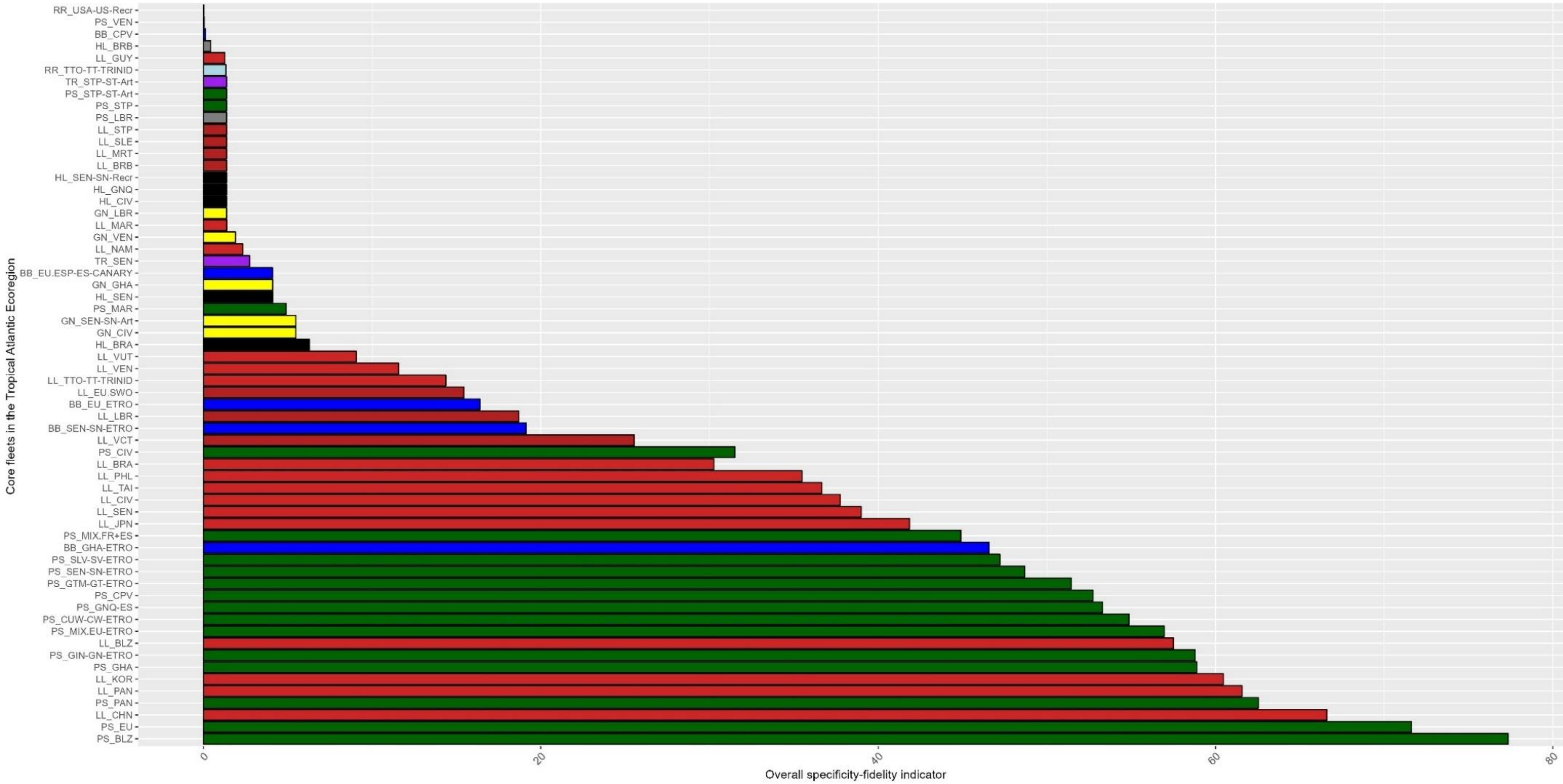


Figure 5. The overall specificity-fidelity indicator values for core fleets in the TAE. Fleet codes including the flag names are listed in Annex 2.

In terms of total caches, the main fleets operating in the TAE were largely large-scale industrial purse seine fleets (Figure 6). The European Purse Seine fleet emerged as the dominant fleet with an unparalleled total catch of approximately 1.37 million tons from 2010 until the last year reported (2021). This catch is mainly comprised of Skipjack and Yellowfin Tuna, complemented by Bigeye Tuna catch and caches of small tuna species. Following closely is the Ghanan Purse Seine fleet, reporting a total catch exceeding 778,000 tons in the same period (2010-2021), primarily consisting of Skipjack, with smaller amounts of Yellowfin Tuna, Bigeye Tuna and Bluefin Tuna. In the third position is the Curaçaoan Purse Seine fleet, reporting a total catch of around 320,000 tons.

In contrast, the remaining fleets report catch volumes below 250,000 tons, primarily capturing Skipjack, Yellowfin Tuna and some Bigeye Tuna. The first bait boat fleet on the list is Ghanan bait boat, capturing around 218,000 tons of mainly Skipjack and some Yellowfin Tuna. Bigeye Tuna is predominantly targeted by the longline fleets such as those from Taiwan, Japan, China, and South Korea in the TAE.

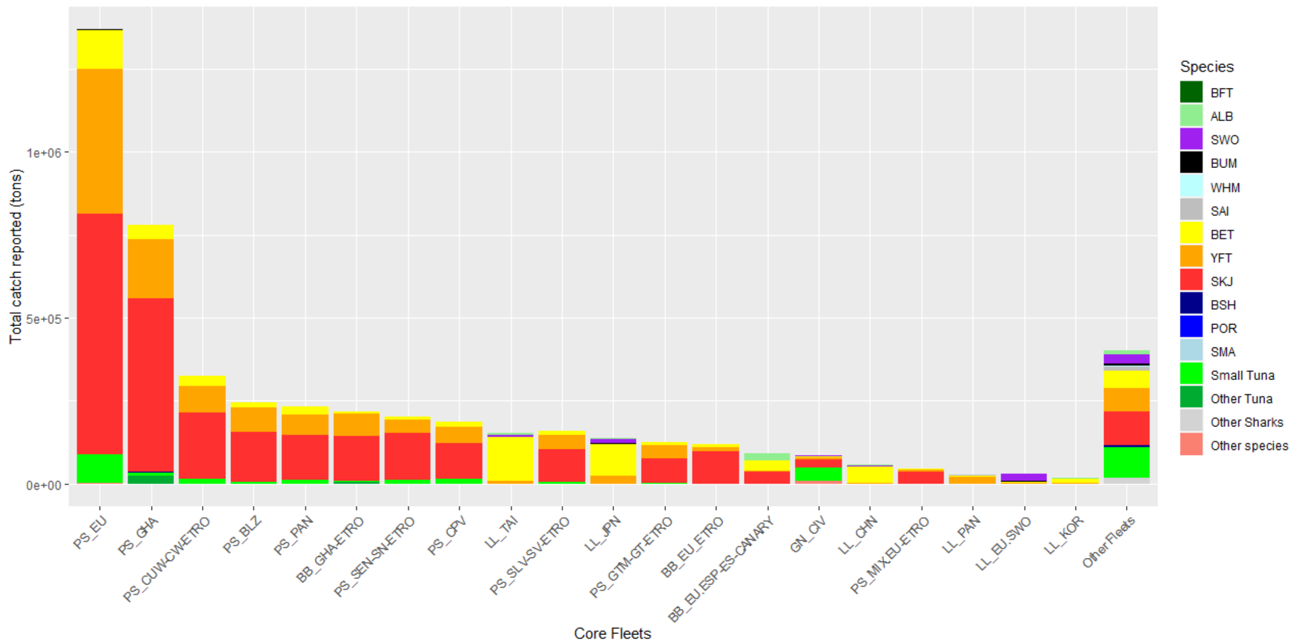


Figure 6. Sum of total catches reported from 2010 to 2021 by fleet. Catches are disaggregated by major ICCAT species or major species groups (see species code in table 3)

The spatial distribution of main fishing grounds of each major gear type differs significantly (Figure 7). The fishing grounds of the purse seiner concentrate largely within the TAE, particularly along the African Coast, emphasizing the significance of this region as a major fishing ground for purse seine fisheries between 2010 to 2021. In addition to purse seiners, the fishing grounds of the bait boat fisheries also concentrate predominantly within the TAE, notably on the north and east side of the TAE. Meanwhile, the fishing grounds of the gillnet fisheries show a concentrated presence within the TAE yet these are more coastal fisheries operating off the South American coast and off the western central African continent in the Gulf of Guinea. In the case of Longline (LL) fisheries, their fishing grounds extend across multiple ecoregions, yet a substantial portion of their catches are registered within the TAE.

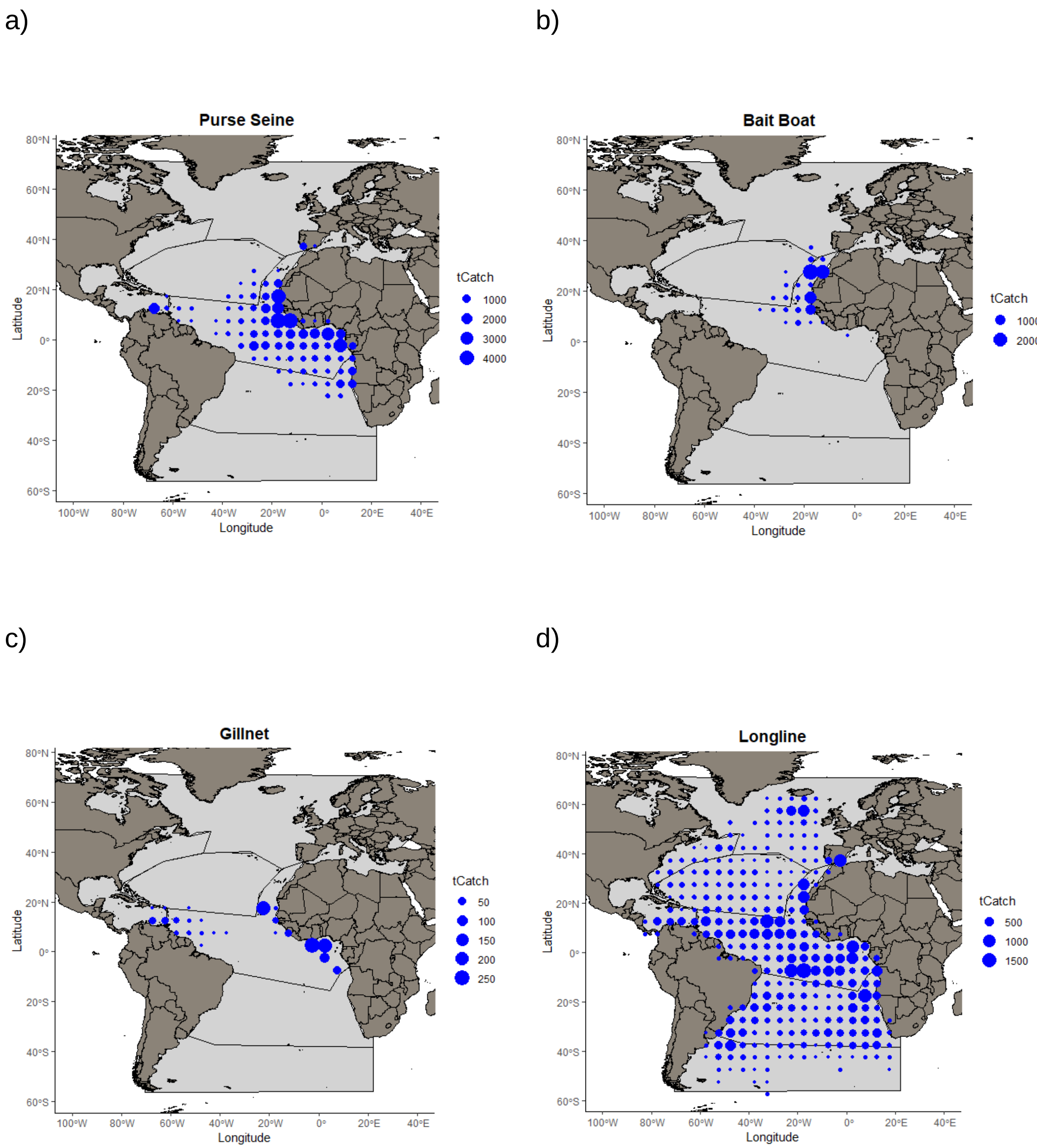


Figure 7. Mean abundance spatial map of gears.

The catch composition also differs significantly among the different gear types (Figure 9). The species composition in the purse seine fisheries located in the TAE consist uniquely of tropical tunas, particularly Skipjack and Yellowfin Tuna, with some minor catches of

Bigeye Tuna. The bait boat fisheries exhibit a species composition primarily dominated by tropical species as well, primarily Skipjack and Yellowfin Tuna, followed by Bigeye Tuna, and some small catches of Albacore, within the TAE. The spatial analysis highlights the TAE as the principal region for the tropical purse seine and bait boat fleets targeting predominantly tropical species.

The species composition in the gillnet catches within the TAE are characterized by a prevalence of Blue Marlin followed by Sailfish, White Marlin and some catches of Swordfish. In contrast, the longline fisheries exhibit a diverse species composition within the TAE boundaries, catching primarily Bigeye Tuna. The catch diversity expands beyond Bigeye Tuna, encompassing yellowfin, Swordfish, Albacore and a smaller percentage of Blue Marlin within TAE. Outside of the TAE boundaries, longline fisheries capture mostly Albacore with some catches of bluefin and Swordfish reported.

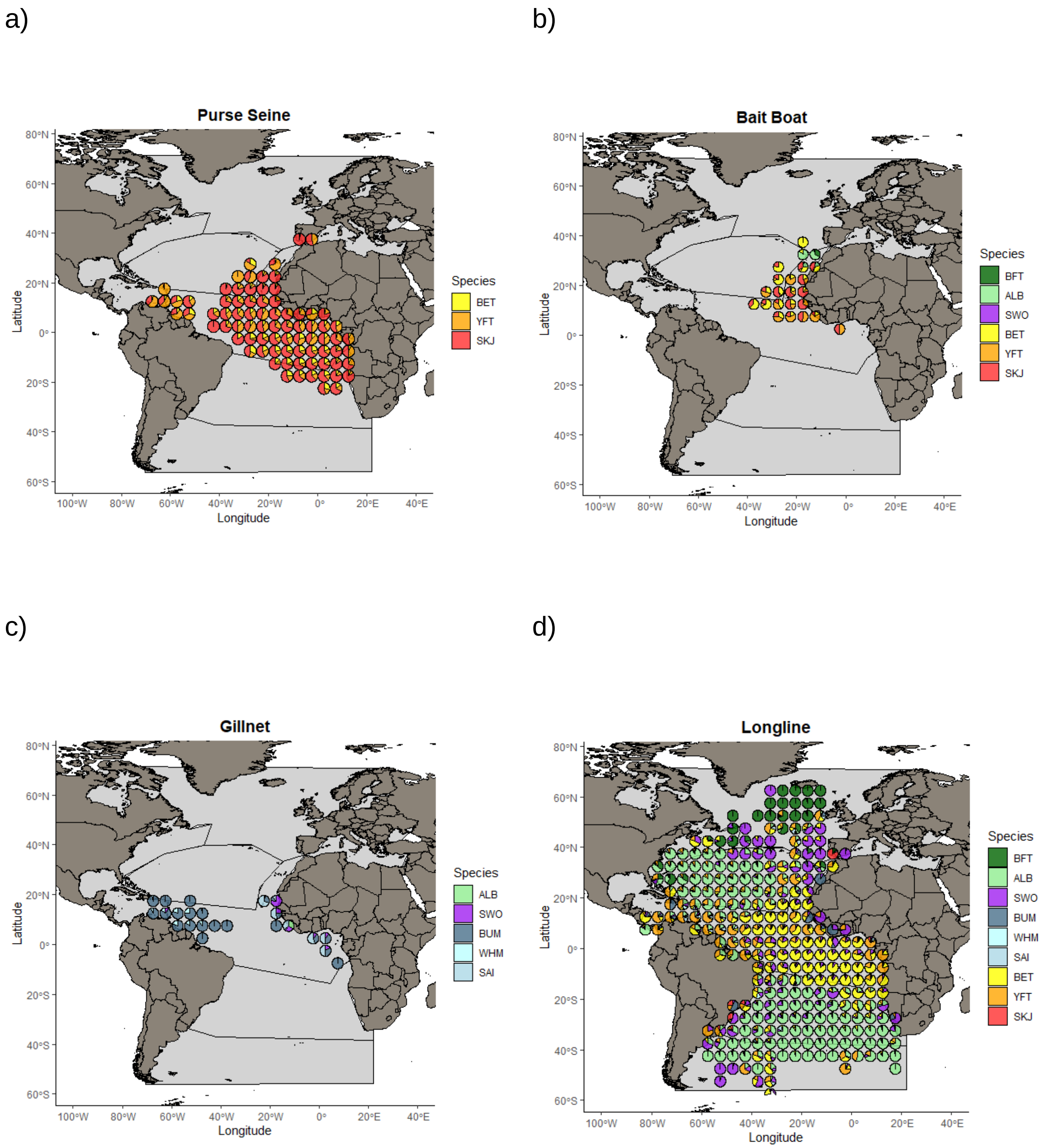


Figure 8. Spatial maps of mean species composition of each gear. a) Purse Seine b) Bait Boat c) Gillnet d) Longline

3.2 Historical Catches in the TAE Ecoregion

Since 1950, the total catches of ICCAT species have increased steadily until the year 2018 (peaking at 481,231 tons) and then decreased a bit reaching 372,928 tons in 2021. Using the last five-year total sum reported, the catch in the TAE corresponds to Skipjack tuna (53.1%), followed by Yellowfin Tuna (24.7%) Bigeye Tuna (11.8%), and small tunas (5.9%) (*Figure 9)*. A historical examination of the results reveals Skipjack tuna is the predominant species consistently captured over time. However, this historical perspective reveals shifts in the dominance of species, with Yellowfin Tuna exhibiting higher catch volumes before 1990. While Yellowfin Tuna has ceded its primary position to Skipjack in recent years, it remains a significant and enduring species within the ecoregion. Bigeye Tuna secures the third position in terms of volume of catches, showing a steady increase in catch volumes until the mid-2000s.

The historical catch trends further indicate that Albacore and Bluefin Tuna were more prevalent before the 1980s. Swordfish also was caught during this period, gaining prominence over time, although not reaching the catch levels observed for Skipjack, Yellowfin and Bigeye Tunas.

Moreover, the depicted historical catches within the TAE highlight a significant growth in the overall amount of fishing activities, expanding nearly tenfold over the years.

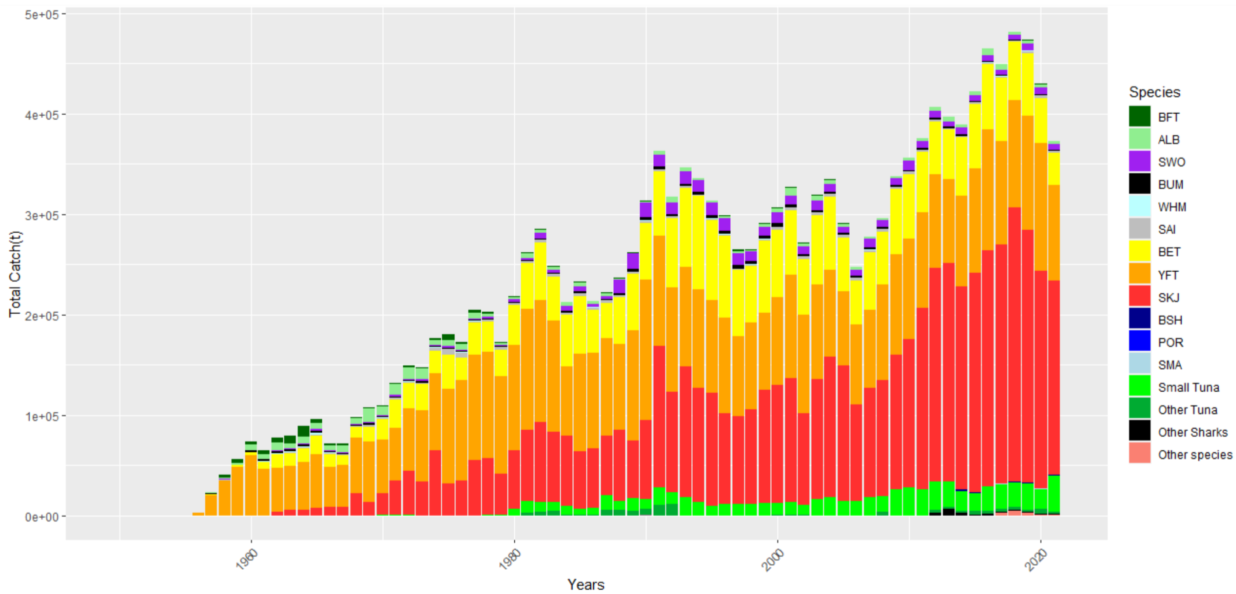


Figure 9. Total catches of ICCAT species between 1950 and 2021 for the 61 core fleets in the TAE. Catches are disaggregated by major ICCAT species or major species groups (see species code in table 3)

Historically catches have been predominantly made by the purse seine fisheries, followed by longline, bait boat, and gillnet fisheries (Figure 10). Using the sum reported in the last five years (2017-2021), 78.01% of the catch is made by purse seine, then bait boat (10.13%), longline (7.18%) and gillnet (3.7%).

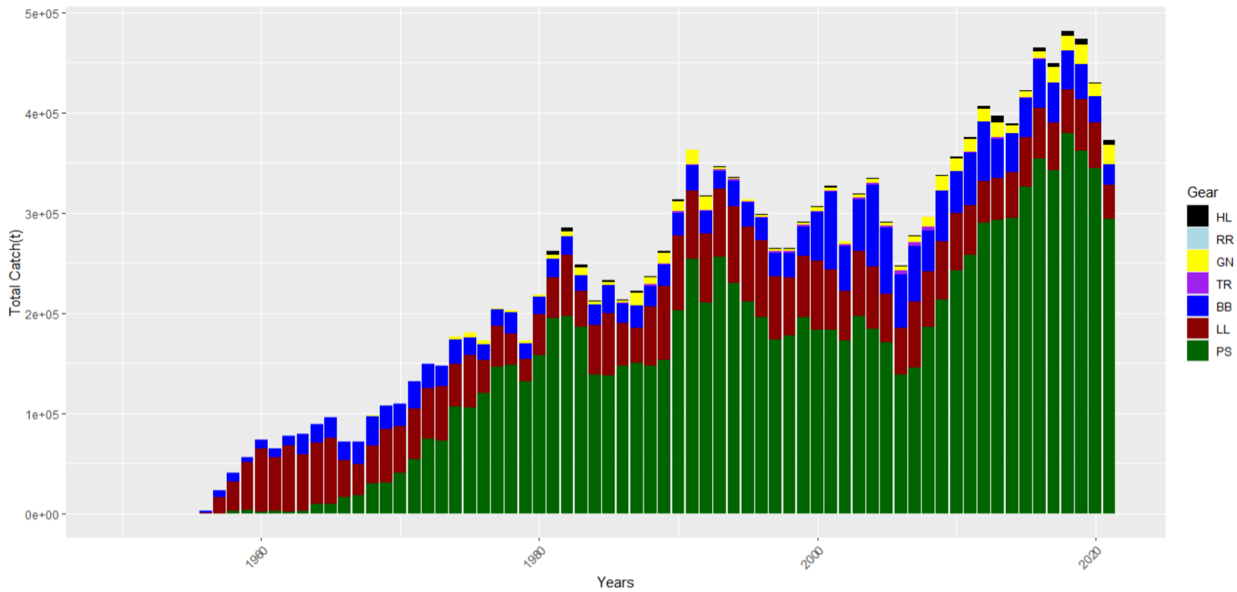


Figure 10. Historical fisheries catches in the TAE. Total catches of ICCAT fisheries between 1950 and 2021 for the 61 core fleets in the TAE. Catches are disaggregated by main fisheries (see species code in table 2)

The temporal trends and species composition in the catches of ICCAT species vary among major fisheries between 1950 and 2021 in the TAE (Figure 11). The catches from purse seine have increased steadily with some fluctuations, peaking in 2018 with

378,818 tons and has since decreased to 293,489 tons in 2021 (Figure 11A). Historically, Skipjack and Yellowfin Tuna have dominated the catches of the purse seine fishery (Figure 11A) with minor contributions from Bigeye Tuna and small tuna. In the last five years, Skipjack accounts for 61.7% of the total purse seine fisheries catches, followed by Yellowfin Tuna with 26.75% and Bigeye Tuna with 6.72%.

Bait boat fisheries (Figure 11B) had a notable peak in 2004 (80,759 tons) followed by a recent decline, coming up to 19,913.5 tons in the year 2021. Historically, bait boat fisheries mainly target Skipjack in the TAE, and in the last years the composition has been reported as 61.2% for Skipjack, 20.19% for Yellowfin Tuna, 12.3% for Bigeye Tuna and 4% Albacore.

The catches reported from gillnet fisheries (Figure 11C), while contributing the least in terms of total catch volume, exhibit an increase in the most recent years. Its peak is registered in 2021 coming up to 19,603 tons. And the recent catches are composed mainly by small tuna (59.4 %), followed by Skipjack (11.4%), Other species (9.7%), Yellowfin Tuna (4.4%), Sailfish (4%), Other sharks (3.65%) and Blue Shark (2.93%).

Longline fisheries (Figure 11D) have had a decline since the peak in the year 1996 (76,991 tons) decreasing by more than half of its catch down to 34,778 tons in 2021. Historically longline fisheries have targeted Bigeye Tuna and Yellowfin Tuna the most and in the most recent years Bigeye Tuna accounted for 55% of the longline fisheries catches in the TAE, followed by Yellowfin Tuna (21.28%), Swordfish (12.8%) and Albacore (5%)

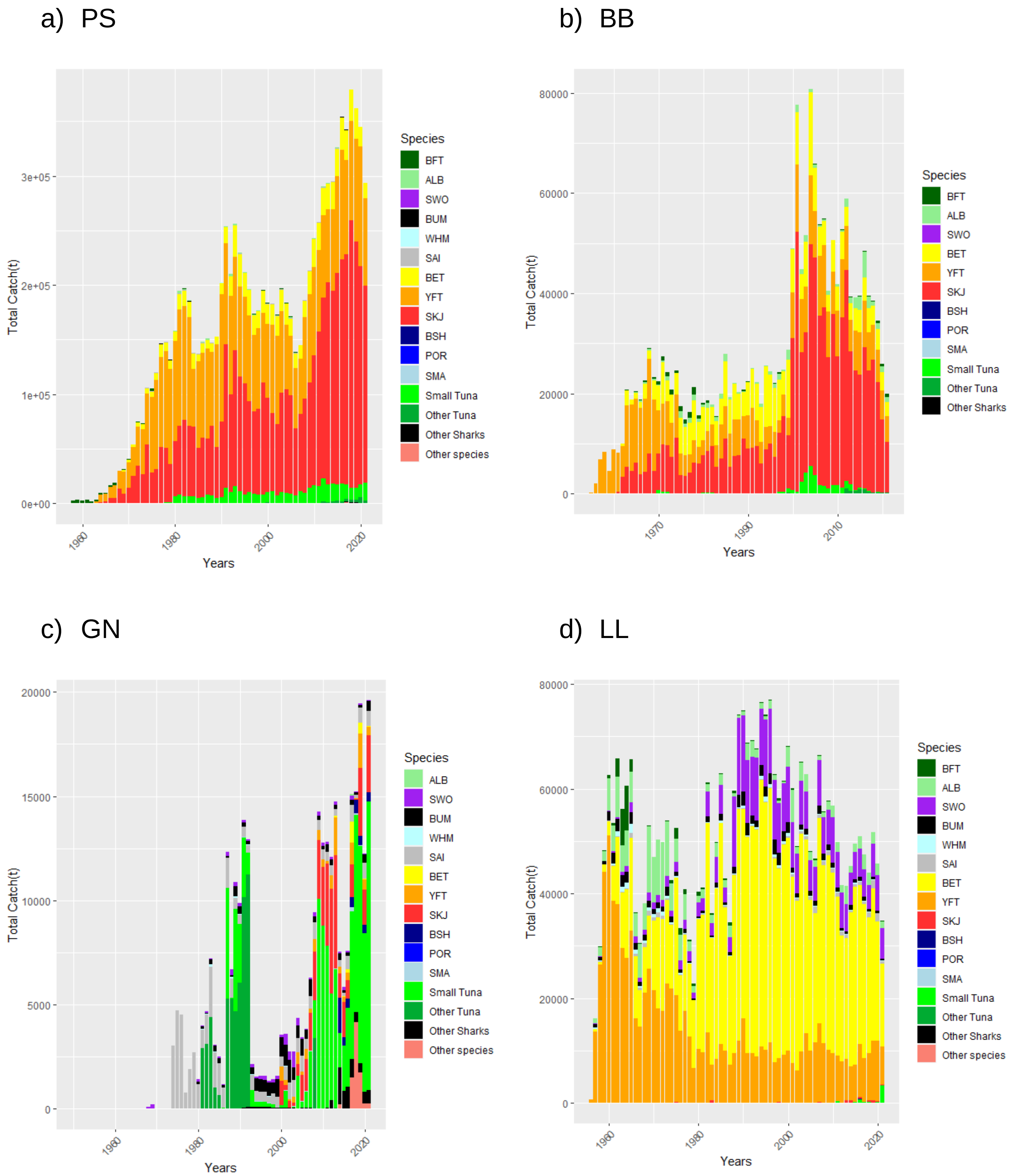


Figure 11. Historical fisheries catches in the TAE from the 61 selected fleets between 1950 and 2021 d. a) Purse Seine b) Bait Boat c) Gillnet d) Longline. Catches are disaggregated by major ICCAT species or major species groups (see species code in table 3)

The fleet composition operating within TAE has also changed historically (Figure 12). The European Purse Seine has maintained a continuous presence in the TAE since the 1960s and has consistently recorded the highest catch volumes among all the fleets, comprising around 40% of the summed total catches in the TAE from 1950 to 2021. Following closely is the Ghanan Purse Seine fleet, which shows a notable increase in catch volumes in recent years, comprising 7.7% of the summed total catches. Additionally, Japanese Longline held a prominent position in the earlier years of the timeline losing dominance in the recent years but comprising 9.15% of all the catches reported in the ecoregion since 1950 until 2021.

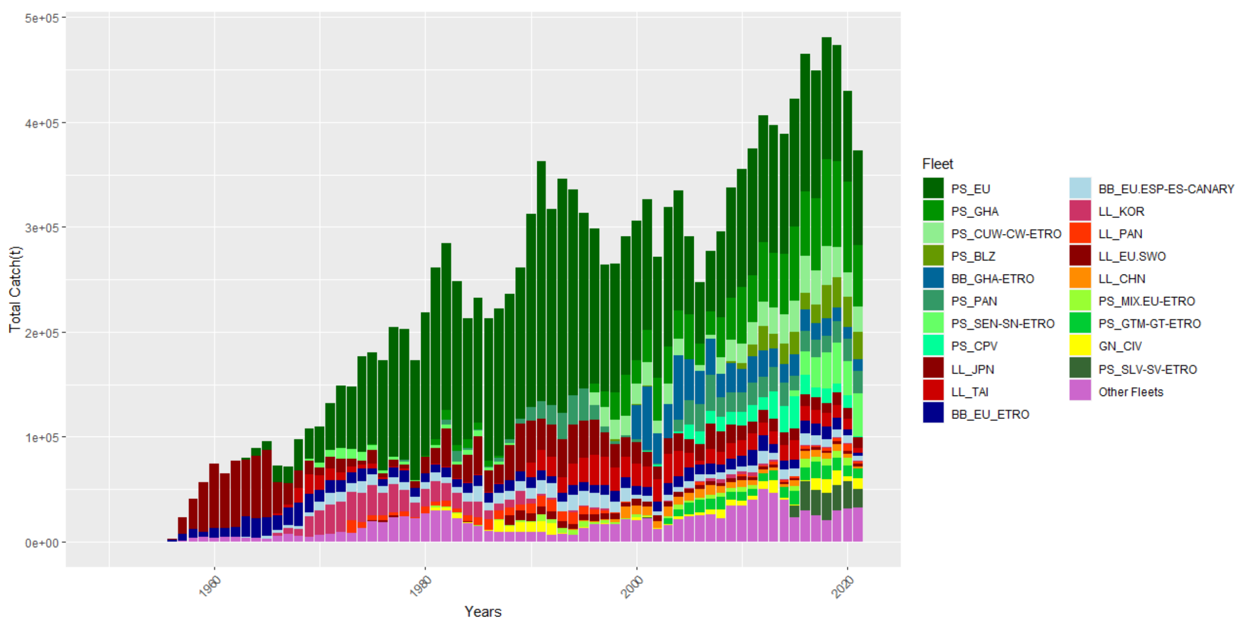


Figure 12. Fleet historical catches in the TAE from the 61 selected fleets between 1950 and 2021 d. a) Purse Seine b) Bait Boat c) Gillnet d) Longline. Catches are disaggregated by major ICCAT species or major species groups (see species code in table 3)

The historical fleet composition operating within TAE within each major gear type can be more easily discerned in Figure 13. Historically the European Purse Seine fleet has been the most dominant purse seine fleet in the region (Figure 13A). In the most recent years, the PS_EU fleet catch composed 30.5% of the total purse seine catches in the region, followed by the Ghanan Purse Seine fleet (22.1%), Senegalese Purse Seine (10.2%), Curacaoan Purse Seine (8.44%) and 28.8% for the rest of the fleets combined. In the case of bait boat fisheries, the prevailing fleet is Ghanan Bait Boat, followed by European Bait Boat and Spanish Bait Boat that register catches for almost all the time period but in smaller amounts. In the most recent years, Ghanan Bait Boat makes up 43.4% of the bait boat total catch, while European Bait Boat and Spanish Bait Boat follow at 26.5% and 23% respectively (Figure 13B). The gillnet fisheries are solely represented by Ivorian Gillnet with a small but constant presence amounting up to 329,097 tons of catch from 1950 to 2021 (Figure 13C) and constituted a 63.4% of the total gillnet fisheries catches reported. The longline fisheries exhibit a more evenly distributed presence with early prominence of Japanese, Taiwanese and Korean fleets and currently the Japanese Longline composes 24.1% of the total long line catches in the region while Taiwanese Longline composes 24.03% followed by Chinese Longline (11.12%) (Figure 13D).

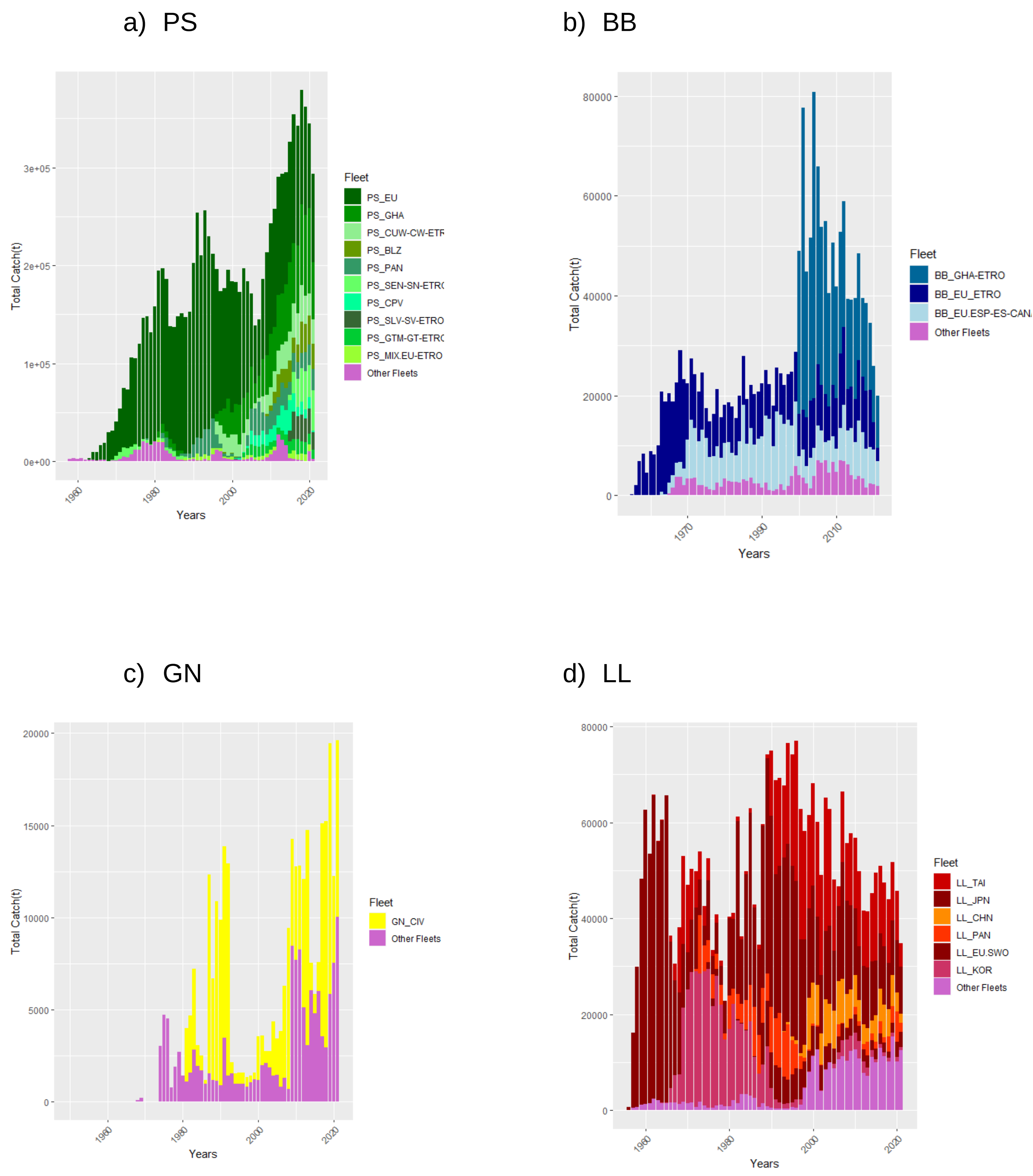


Figure 13. Fleet historical catches catches in the TAE from the 61 selected fleets between 1950 and 2021 divided by gears. a) Purse Seine b) Bait Boat c) Gillnet d) Longline Fleet. Catches are disaggregated by fleets (see flag names for fleet codes in annex 1,2)

4. Discussion

The primary objective of this thesis was to contribute to the development of an EFO for the TAE and assist in the assessment of the effectiveness of the ICCAT ecoregions as tools for developing ecosystem advice products. In this section, I discussed the main challenges faced using the publicly available ICCAT fishery datasets for describing the historical catches and major fleets operating in the TAE. Second, I discussed the spatial and temporal patterns of the major core fleets in the TAE region, comparing the results with previous work describing other ICCAT Ecoregions and recommending potential changes for the boundaries of the TAE. Finally, I elaborated on the contribution of the ecoregions as tools for supporting the implementation of the EAFM in ICCAT, highlighting its limitations and suggesting future directions for research.

4.1 Challenges and difficulties faced using publicly available ICCAT fishery datasets to describe main fleets and catches in the TAE

The characterization of major core fishes and catches for the TAE relies on two public fishery datasets available on the ICCAT website. These datasets compile information collected by member states which is then reported to ICCAT. Historically these datasets had the primary option to support the fishery stock assessment evaluations for major ICCAT tuna and billfish stocks for the provision of fisheries management advice. However, it is important to acknowledge that while these ICCAT fishery statistical datasets are valuable for their intended historical purpose, they are lacking the design and fail to possess the required temporal and spatial resolution needed to support comprehensive regional integrated ecosystem assessments. While the spatial reporting of catches has improved over time in ICCAT, at least for the nine major ICCAT species, the proportion of catches reported with georeferenced locations accounts for only 68 % of the total reported catches (Heidrich et al., 2022).

Some potential data errors were also identified in the catch reporting of specific fleets in the Task2 CATDIS dataset. For instance, the PS_EU-ESP-ETRO fleet, which is part of the European Purse Seine; the most significant fleet on the TAE, has reported catches for tropical tunas and billfishes in TAE and has erroneously reported Blue Marlin catches in all the Atlantic Ocean, a discrepancy acknowledged as a reporting error. Similarly, the fleet HL_GNQ reported the presence of Bluefin Tuna in the TAE, also identified as a reporting error. Similar errors were observed in other fleets, and once identified, these were rectified before analysis.

Some discrepancies have also emerged between the nominal catches in Task 1 and Task 2 CATDIS datasets, which ideally should align. CATDIS is expected to offer an accurate representation of the actual catches of the nine main species, as reported in Task 1, given that CATDIS is an estimation derived from Task 1 data for these nine major tuna species. However, certain species were not reported as catches for specific fleet types in CATDIS, notably Skipjack for gillnet or Bluefin Tuna for harpoon, despite these catches being reported in Task 1 for the same fleets. Such discrepancies have the potential to introduce errors in analyzing the dominance and prevalence of each fleet for the TAE.

In addressing these challenges, it becomes evident that an ideal solution would involve the utilization of a unified dataset. A comprehensive dataset encompassing complete information for all species and their spatial distribution would serve as a powerful tool to mitigate discrepancies, enhance data accuracy, and provide a more reliable foundation for analyses. This underscores the necessity for ongoing efforts to improve the design and resolution of datasets to meet the evolving demands of regional integrated ecosystem assessments within the ICCAT framework.

4.2 Recommendations for delimitation of the Tropical Atlantic Ecoregion

Based on the analysis conducted in this thesis, a key recommendation emerges regarding the delineation of the Tropical Atlantic Ecoregion (TAE). Currently, the southeastern boundary of the ecoregion is situated on the border between the Democratic Republic of Congo and Angola (Figure 14). However, an intricacy arises as considerable amounts of purse seine catches targeting tropical species within the TAE continue to be reported in the Angola shoreline, a region falling under the Southern Subtropical Atlantic Ecoregion (SSAE) (Figure 1). To address this discrepancy and ensure a more accurate representation of the distribution of the fisheries targeting tropical tunas, it is advised to revise the southern boundary of the TAE. The proposed adjustment involves extending the boundary southward to encompass the entire Angola shoreline up to its border with Namibia, as depicted in Figure 15.

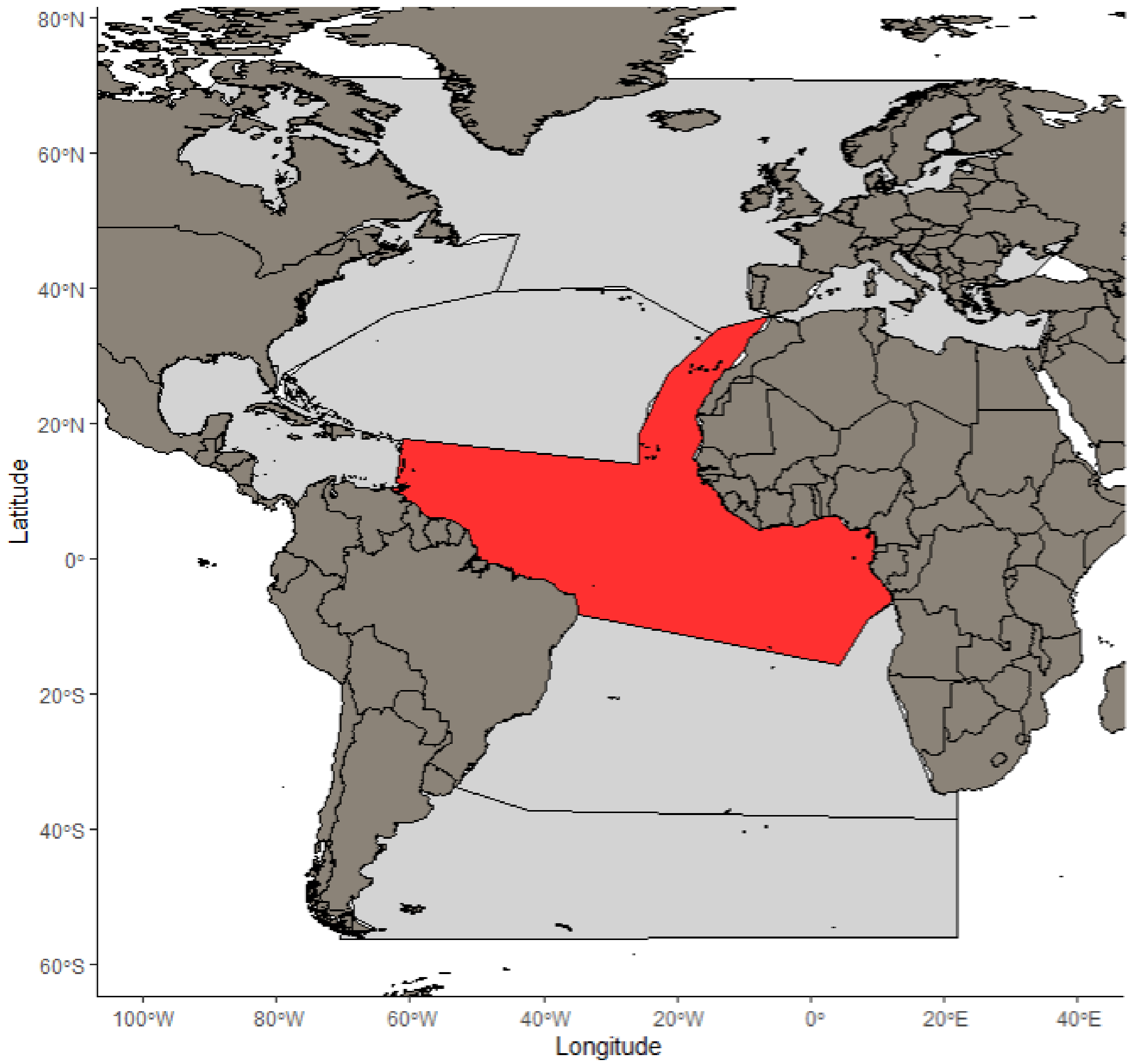


Figure 14. Original Tropical Atlantic Ecoregion boundaries by ICCAT

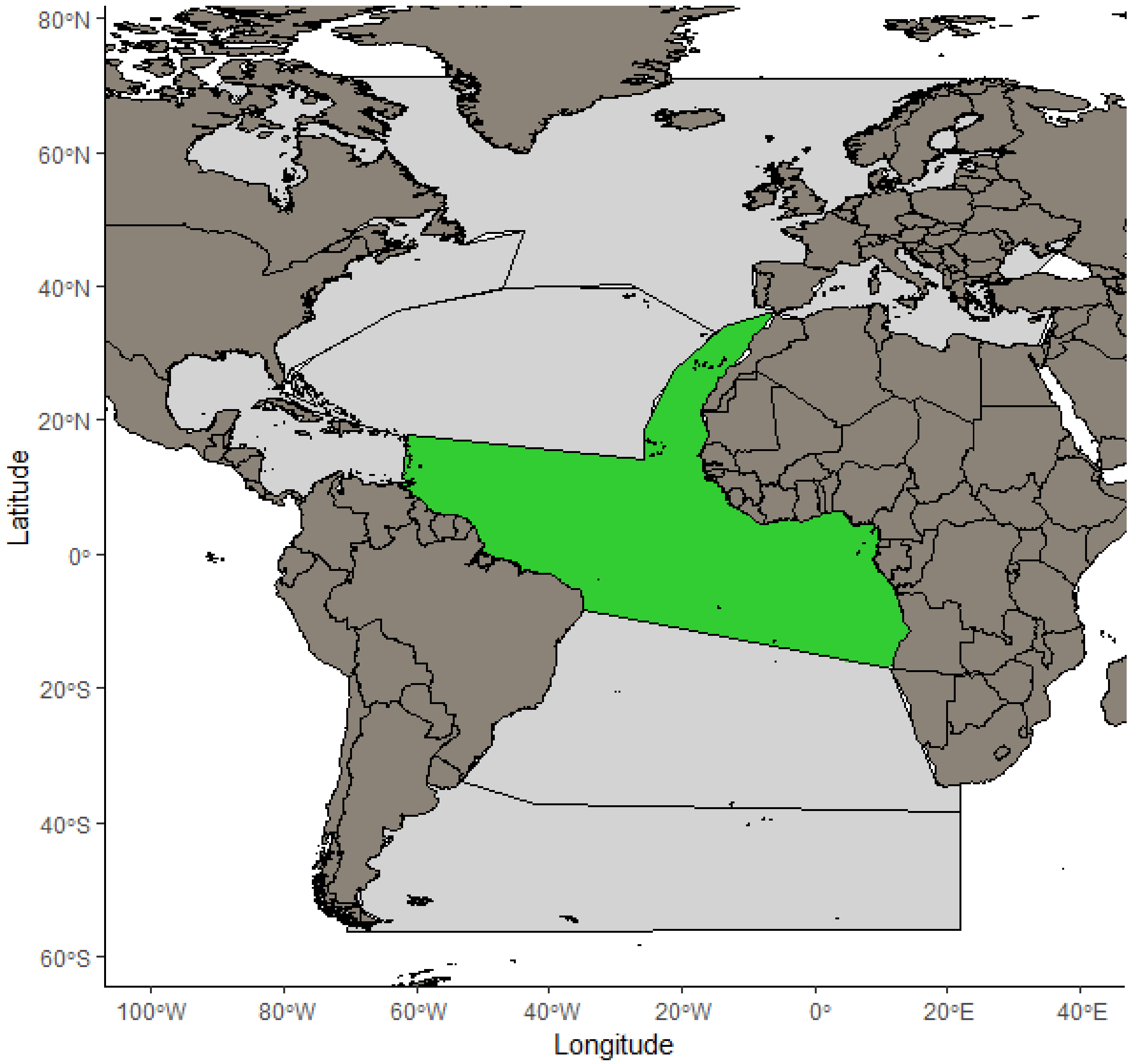


Figure 15. Proposed Tropical Atlantic Ecoregion boundaries.

By lowering the boundary in this manner, not only will the catches of tropical tunas be comprehensively integrated into the TAE, but it will also harmonize the delineation with the broader ecological context. Specifically, aligning the boundary to cover the complete Angola shoreline conforms to the geographical distribution of the previously proposed Pelagic Provinces of the World, as outlined by Spalding et al. (2012). This adjustment is particularly significant in incorporating the dynamics of the Canary and Guinea Currents and ensuring a more holistic representation of the Equatorial Atlantic within the defined TAE boundaries. In essence, this recommendation seeks to refine the delineation of the TAE to better capture the ecological and distributional nuances of the region, offering a more precise foundation for developing integrated ecosystem assessments for this region.

4.3 Ecoregions and Fisheries Overviews as ecosystem-based advice products and their contribution to implement the EAFM in ICCAT.

The primary objective of Ecoregions is to serve as a comprehensive spatial framework that not only directs ecosystem planning but also acts as a catalyst for ecosystem-based research (Juan-Jorda et al., 2022) This framework plays a pivotal role in providing valuable insights for ecosystem-based advice (Link, 2010). The EFO seeks to complement and inform fisheries management decisions within ICCAT and actively support the implementation of EAFM strategies.

This thesis also aims to validate the ecoregions by contributing to the development of an Ecosystem Fisheries Overview for the TAE, ultimately to evaluate if this product meets the end user needs. Towards this aim, next I address the main strengths and weaknesses that these tools may have.

Fisheries Overviews have the potential to excel in their ability to synthesize data from diverse sources, offering a comprehensive perspective on fisheries activities within a region. Their ecosystem-based and integrated approach aligns with modern conservation and fisheries practices and has the potential to support informed decision-making in fisheries management. However, the accuracy of much of the information is highly contingent on what each country or states report as their catches (including landings and discards), leaving room for errors or potential motivations to misrepresent the actual numbers reported in the FEOs. This dependence on data availability and reliability and potential complexities in interpretation may limit their accuracy and accessibility, respectively.

On the other hand, ecoregions can serve as a valuable spatial framework, facilitating an understanding of the ecological impacts of fishing and climate change on the ecosystem and contributing to effective ecosystem-based advice for the core fisheries and fleets in a region (Link, 2010). Additionally, the ecoregions offer adaptability, allowing for adjustments in delineations and accommodating changes in ecological understanding. Additionally, the Fisheries Overviews of Ecoregions could also be used by other organizations to improve ocean conservation and general knowledge of the areas. Nevertheless, incomplete or outdated data may affect the precision of the spatial representations of catches and fleets in the region. Opportunities lie in technological advancements, where emerging technologies can enhance data collection and analysis, and in collaborative research efforts to refine spatial frameworks based on the latest ecological insights. However, political influences, geopolitical challenges, and resource limitations pose threats to the stability and accuracy of these advice products.

Overcoming these challenges will require continuous improvement, technological adaptation, and collaborative efforts to ensure the effectiveness of Fisheries Overviews and Ecoregions in guiding fisheries management decisions within ICCAT.

5. Conclusions

This study characterizes the main fleets and historical catches of tuna and billfish fisheries in the TAE using publicly ICCAT fisheries datasets (Task 1 and Task 2 CATDIS). The study involves a thorough examination of the historical catches, fleet dynamics, and their species compositions, providing insights into the ecological dynamics of this critical marine ecosystem.

The primary findings reveal 61 fleets of four main gear types (purse seiners, longliners, gillnets and bait boats) operate in the TAE.

The spatial mapping of the fleets and their species composition provided additional intricacies within the TAE. Skipjack and Yellowfin Tuna emerged as the predominant species, with notable variations across different fleets and fishing methods. These insights contribute to our understanding of the ecological dynamics influenced by distinct fishing practices.

Additionally, I produced a detailed breakdown of the historical catch composition of each fishery, emphasizing the significant role of specific fleets within the broader categories of purse seine, bait boat, gillnet, and longline. This analysis revealed the primary fleets for each fishery, being the European Purse Seiner, Ghanan Bait Boat, Ivorian Gillnet and Japanese Longline respectively. The identification of fleet dominance within each fishery offers valuable information for informing resource management, development of ecosystem impact assessments and understanding economic considerations of fisheries management decisions.

Moreover, historical analysis of the evolution of catch volumes and species compositions from 1950 to 2021 reveals dynamic shifts in species dominance. Monitoring species catches over time and shifts in species dominance are crucial for effective fisheries management, monitoring the overall health and balance of ecosystems, and anticipating potential economic challenges, allowing for adaptive resource management (Link, 2010)

In conclusion, this study not only enhances our understanding of the Tropical Atlantic Ecoregion's core fisheries and fleets but also provides the first preliminary EFO for an ICCAT ecoregion. It also proves the feasibility of developing regional ecosystem advise products for complementing single-species advise contributing to EAFM implementation in the TAE, as well as highlighting the actions that would better the use of Ecoregions as EAFM tools. The insights gained from this research contribute to the ongoing efforts to balance conservation goals with sustainable fisheries practices in ICCAT. As we navigate the complex challenges of preserving marine resources, the findings presented serve as a valuable resource for policymakers, researchers, and stakeholders involved in the conservation and management of tunas and billfish fisheries in the Tropical Atlantic Ecoregion.

6. Sustainable Development Goals

This thesis is expected to contribute to the achievement of some of the Sustainable Development Goals. The corresponding SDG along with their anticipated impact or relevance levels are shown in Table 5. The following sections provide more detailed explanations for those identified as most crucial.

This thesis aims to provide a comprehensive understanding of the fisheries dynamics in the TAE. The historical spatio-temporal analysis of catch volumes, species compositions, and fleet performances offers valuable insights for sustainable fisheries management. By promoting responsible fishing practices and informed decision-making, the research aids in mitigating overfishing and ensuring the long-term availability of marine resources. This, in turn, contributes to food security and aligns with the goal of achieving **Zero Hunger.**

Additionally, it may contribute to the goal of **Responsible Consumption and Production** by advocating for sustainable fisheries practices. The emphasis on informed decision-making, species compositions, and fleet performances aids in reducing wasteful practices and promoting responsible consumption. This medium-level impact aligns with the broader objective of ensuring sustainable patterns of consumption and production within the fisheries sector.

Reduced Inequalities by highlighting the importance of both industrial and coastal fisheries in the region. Industrial fleets are mostly owned by rich countries and coastal artisanal fisheries are mostly operated by developing countries. So, making coastal fisheries visible and their importance in the larger picture could contribute to reducing inequalities in terms of access to resources.

By providing insights into fleet performances and fishing dynamics, the thesis indirectly supports the Sustainable Development Goal of **Decent Work and Economic Growth** on a lower level. Sustainable fisheries management ensures the longevity of the industry, preserving employment opportunities and fostering economic growth in coastal regions. This can also be argued in the case of the SDG of **No Poverty** since fisheries account for important economic activities.

Additionally, the research has a high-level impact on the Sustainable Development Goal of **Climate Action**. By understanding the ecological dynamics of fisheries and promoting sustainable practices, the study addresses the interconnectedness of climate change and marine ecosystems. Responsible fisheries management contributes to the resilience of marine ecosystems, which, in turn, supports climate action by preserving biodiversity and enhancing ecosystem health.

This work can also contribute to **Peace Justice and Strong Institutions** and **Partnerships for the Goals** as it improves ocean and fisheries governance in international institutions.

And finally, because of its focus on marine ecosystems and fisheries, this work may have a significant impact on the goal of **Life Below Water.** The insights provided contribute to the preservation of marine biodiversity, reduction of overfishing, and the establishment of sustainable fishing practices. By enhancing our understanding of life below water, the research promotes the conservation of marine ecosystems, aligning with the broader objectives of the SDGs.

Table 5. Impact of the research on Sustainable Development Goals

Sustainable Development Goal	**Relevance level**			
	High	Medium	Low	Does not apply
1. No Poverty		X		
2. Zero Hunger		X		
3. Good Health and Wellbeing			X	
4. Quality Education				X
5. Gender Equality				X
6. Clean Water and Sanitation				X
7. Affordable and Clean Energy				X

8. Decent work and Economic Growth			X	
9. Industry Innovation and Infrastructure				X
10. Reduced Inequalities			X	
11. Sustainable Cities and Communities			X	
12. Responsible Consumption and Production		X		
13. Climate Action		X		
14. Life Below Water	X			
15. Life on Land				X
16. Peace Justice and Strong Institutions			X	
17. Partnerships for the Goals		X		

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