EXAMINATION OF DATA AVAILABLE FOR DEVELOPING A BENCHMARK ASSESSMENT AND OPERATING MODELS FOR NORTH ATLANTIC ALBACORE

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SUMMARY

In 2020, the albacore working group recommended that a new benchmark assessment be developed for the North Atlantic albacore stock using Stock Synthesis. This benchmark configuration will also be used to build a new set of Operating Models for the North Atlantic albacore MSE. For this, we examine the information provided by ICCAT Secretariat for different fisheries. The data available includes catch, size frequency, catch-per-unit of effort and, tagging data. This examination aims to contribute to the specifications of the Stock Synthesis configuration, including the definition of fisheries, spatio-temporal stratification, and identification of key sources of information.

RÉSUMÉ

En 2020, le Groupe d'espèces sur le germon a recommandé qu'une nouvelle évaluation de référence soit développée pour le stock de germon de l'Atlantique Nord en utilisant Stock Synthesis. Cette configuration de référence sera également utilisée pour élaborer une nouvelle série de modèles opérationnels pour la MSE du germon de l'Atlantique Nord. Pour ce faire, nous examinons les informations fournies par le Secrétariat de l'ICCAT pour différentes pêcheries. Les données disponibles comprennent la capture, la fréquence de taille, la capture par unité d'effort et les données de marquage. Cet examen vise à contribuer aux spécifications de la configuration de Stock Synthesis, y compris la définition des pêcheries, la stratification spatio-temporelle et l'identification des principales sources d'information.

RESUMEN

En 2020, el Grupo de trabajo sobre el atún blanco recomendó que se desarrollara una nueva evaluación de niveles de referencia para el stock de atún blanco del Atlántico norte utilizando stock synthesis. Esta configuración de niveles de referencia se utilizará también para construir un nuevo conjunto de modelos operativos para la MSE del atún blanco del Atlántico norte. Para ello, se ha examinado la información proporcionada por la Secretaría de ICCAT para diferentes pesquerías. Los datos disponibles incluyen las capturas, la frecuencia de tallas, las capturas por unidad de esfuerzo y los datos de marcado. Este examen pretende contribuir a las especificaciones de la configuración de stock synthesis, lo que incluye la definición de las pesquerías, la estratificación espacio-temporal y la identificación de las principales fuentes de información.

KEYWORDS

North Atlantic albacore, Stock assessment, Management Strategy Evaluation, catch statistics, size composition, catch at size, tagging, catch distribution, CPUE

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1. Introduction

Fishery stock assessment models are demographic analyses designed to determine the effects of fishing on fish populations and to evaluate the potential consequences of alternative harvest policies (Methot Jr and Wetzel, 2013). One of the most widely used stock assessment model is Stock Synthesis (Methot Jr and Wetzel, 2013), a fully integrated age-structured model that uses catch, size, age, effort, tagging and abundance indices to estimate the historical trends of the stock abundance, fishery dynamics and reference points.

In 2013, a benchmark assessment was developed for North Atlantic albacore (ICCAT, 2013). This model and the uncertainty explored during the assessment were the base upon which the grid of Operating Models for the Management Strategy Evaluation (MSE) of this stock was developed (Merino *et al.*, 2017). In 2020, the albacore working group recommended to start developing a new benchmark assessment using Stock Synthesis (ICCAT, 2020). This benchmark configuration would also be used to develop a new, updated, set of Operating Models for MSE (Merino *et al.*, 2020). One of the first tasks of this work is to examine the updated data (catch, effort, size, age and tagging) provided by the Secretariat and to assess their ability to inform on stock and fishery dynamics.

The ICCAT Secretariat manages the information from national fisheries and specific monitoring programs and, makes this information available for the scientists responsible of stock assessments in the form of stock-specific datasets. In this document we examine the updated data of North Atlantic albacore provided by the Secretariat in 2021 to provide a basis for the albacore working group to discuss options for potential Stock Synthesis configuration. This includes the identification of potential suitable definitions of fisheries, yearly or quarterly time steps, options for a spatially disaggregated model and key sources of information.

2. Material and methods

The data available for the North Atlantic albacore benchmark stock assessment and to develop a new set of Operating Models for the MSE consist of catch, length composition data, catch per unit of effort (CPUE) indices and tag release-recapture data. In particular, the data made available in 2021 include nominal catch (*Task 1, 't1nc-ALB_20201218.xlsx'*), observed size frequencies (*Task 2 sz, 't2sz_ALB1950-19_v1.csv'*) and estimated catch at size (*Task 2 cs, 't2cs_ALB1950-19_v1.csv'*), catch data raised to total landings (*Task 2 cdis, 'cdis5018_ALB.csv'*) and conventional tagging data (*Tag, '_tagALB_v1.xlsx'*). In 2021 the Secretariat did not provide catch and effort data (*Task 2 catch/effort*) by the time this analysis was made, but we have analysed the standardized CPUE indices available for the 2020 stock assessment.

The data contained in the files made available by the Secretariat have been compiled, filtered, disaggregated etc using R-scripts which will be available for the Atlantic albacore working group in the repository of the 2021 Intersessional Meeting of the Albacore Species Group (21-30th June).

3. Results

Task 1 (Nominal catch data)

The file '*t1nc-ALB_20201218.xlsx*' contains nominal catch data per species, stock, year, Contracting Party (CP), flag, fleet, area, gear and type of catch (among other information). Nominal catch data can be used to monitor the catch trends per major gear. **Figure 1** shows the catch per gear in the period 1950-2019. The total catch of North Atlantic albacore increased between the mid-1950s until 1964 when the maximum catch of the time series was recorded. Since then, catch has steadily decreased to a lowest in 2009 and then steadily increased again until 2019. In the initial years of the series North Atlantic albacore was only caught using trolls, followed by bait boat fisheries. Since the 1960s to 1980s the stock was exploited by troll, baitboat and longline fleets with a decreasing trend in the proportion of trolling catch and comparable proportions of baitboat and longline. In the early 1980s the proportion of longline catch increased significantly until the second part of the decade when it dropped sharply. At the end of the 1980s trawl and purse seine fleets started to capture albacore but purse seine reduced its contribution to a minimum since the early 2000s. In recent years, the proportion of batiboat and trawling fleets has increased, longline and trolling catch has remained relatively stable.

In the 2010s decade, 96% of the catch of North Atlantic albacore has been taken by 14 fleets (**Figure 2**). Spanish baitboat and trolling vessels operating in the Cantabrian Sea represent 44% of the total catch of albacore. Midwater trawl fleets from France and Ireland (EU) represent 26.2% of the total catch and deep freezing longline fleets from China, Chinese Taipei and Japan sum up to (10%) of the total catch. Bait boats from the

Canary Islands (Spain), Madeira and Azores (Portugal) amount 11% of the total catch. With regards to the regional distribution of recent catch (**Figure 3**), 67.4% from the catch is captured in the Northeast Atlantic (by Cantabrian (Spain), French and Irish fleets), 16.7% from the North Atlantic (mostly by longliners from Chinese Taipei and Japan), Central-East Atlantic (bait boats from the Canaries, Madeira and Azores) sum-up 10.4% of the catch and 4.7% of is captured in the Northwest Atlantic. Also, 0,6% of the catch is taken in the Western tropical area.

The historical trends of catch can be disaggregated by gear and fleet code. **Figure 4** shows the main fleets operating with each of the major gears responsible for North Atlantic albacore catch. This figure shows that 76 fleets have captured albacore since the beginning of the time series but again, only 14 are currently responsible for 96% of the catch (in colors). **Figures 5, 6, 7**, 8 and **9** allow for a closer look of the fleets targeting albacore with each major gear. These figures show how French trolling fleet disappeared (or transformed) into mid-water trawl fleets in the 1990s decade, followed by the development of Irish trawling activity, the large proportion of longline catch from Japan (1960s) and Chinese Taipei (1970s) and the rise and fall of other surface gears.

Task 2-sz (size samples) and Task 2-cs (estimated catch at size)

Sampled size and estimated catch at size files include numbers of samples of each length class by year, fleet, flag-name, gear and geographical location (only size samples) in 5ºx5º resolution. We aggregated both data sources by fleet-gear groups. For visualization purposes we selected the 15 fleet-gear combinations that represent 96% of the catch of albacore in the 2010s decade with a relatively wide coverage of gears and timeframes (**Figure 10**). Note that since 2011, size samples are not available for the Cantabrian baitboat and troll fisheries, which represent 44% of the catch in the last decade (despite being annotated as available in the data catalogue). Also note that Japanese and Chinese Taipei longline data was split in three periods each for the 2013 benchmark assessment, with the aim of reflecting the transition from targeting albacore to bigeye and yellowfin (Japanese fleet) and the transition between traditional longlines to deep-freezing longline boats (Chinese Taipei).

Sampled size data can be used to inform on the size distribution of fish for each fleet ang gear throughout the history of the fishery (**Figure 11**) or in specific periods (e.g., 2010s decade, **Figure 12**). These figures show that in the 2010s-decade longline fleets of Japan, Chinese Taipei and Venezuela catch large specimens of albacore (mean ~100 cm) while smaller individuals are captured using troll and baitboat in the Cantabrian Sea (~63 cm). The bait boats of the Azores, Madeira and Canary Islands fish individuals of >75 cm on average. The trawl fleets of Ireland and France capture individuals of ~75 cm on average. The US commercial fleet of longlines show very small sample sizes (<25 cm) in the 2010s decade in the sampled size data, but it seems implausible to fish such a small sized fish with longlines (this should be checked with the Secretariat). The US rod-and-reel fleet captures fish of ~85 cm on average. The temporal evolution of the sampled size is first appreciated with the differences on the size distribution across the entire time series (**Figure 11**) and the last decade (**Figure 12**). The largest differences are found in the US commercial longline, which displays a very clearly separated by-modal distribution across the time series. A closer look to the temporal trend of the size distribution of each fleet-gear category (**Figure 13**) and mean sizes (**Figure 14**) shows that the size distribution was bimodal between 2000 and 2005 (with average and medians between the two modes) and then shifted to the smaller mode only, which explains the size distribution of the 2010s decade being distributed around an average of less than 25cm.

Task 2-cs contains species-based estimations of the size composition of the catches, extrapolated by the ICCAT CPCs and reported to ICCAT. *Task 2-cs* includes catch at size (CAS) for each fleet and gear. These data do not contain the same fleet-gear categories as *Task 2-sz* or *Task 1* data (**Figure 15**). CAS is not available for the EU.PRT-PT-MADEIRA with gear code "BB", the Venezuelan longline (VEN-LL) and Spanish swordfish longline (EU.ESP-ES-SWO-LL) categories. The size distributions of the catch at size (**Figures 16, 17** and **18**) display similar patterns (as expected) to the sampled size information except for the US longline fleet. In the CAS mean sizes of fish across the time series and the mean size is ~100 cm on average for this fleet, comparable to other longline fleets (**Figure 19**). The difference with the sampled sized data for this fleet should be clarified.

Task 2-cdis (catch raised to total landings)

Catch distribution data provides information on the catch per season (trimester), year, flag, fleet and gear per 5ºx5º geographical coordinates and is available for the fifteen fleet-gear categories responsible of 96% of the catch of the 2010s decade except for the US recreational rod-and-reel fishery (**Figure 20**). Catch distribution data can be used to identify inter-seasonal differences on the activity of fisheries and to examine changes on the geographical distribution of catch. This analysis can contribute to the definition of the temporal and spatial stratification of the stock assessment model.

Figure 21 shows the quarterly distribution of catch in the 2010s decade per fleet-gear category. All fisheries display intersessional differences but the most evident are the seasonality of the Cantabrian Sea bait boat and troll fisheries and, Irish trawl, which mostly occur during the summer months (Q3). The French trawl fishery is also seasonal with higher activity in the summer months. The bait boat fisheries of Azores, Madeira and the Canaries are distributed in the spring and summer months with lower catch in the first and fourth quarters of the year. With regards to longline fleets, Japanese longlines catch albacore in the first and fourth quarters, Chinese Taipei captures equally in the first three quarters and, at lower levels in the fourth. The West Atlantic longline fisheries show disparity of patterns with Venezuelan being relatively stable across the year, the US concentrated on the first, third and fourth quarters.

Figures 22 and **23** shows the geographical distribution of North Atlantic albacore catch per decade since the begging of the fishery. **Figure 22** shows a fishery that very localized in the Northeast Atlantic in the early years and distributed to the rest of the Atlantic thereafter. For the longline fleets (**Figure 23**, added for clarity), Japanese fleets started operating in the southwest area and moved northwards together with the activity of China. Chinese Taipei fleets. In the recent years, Belize and Venezuela have increased catch in the southern area.

Abundance indices

The catch per unit of effort (CPUE) information is generally provided in the *Task 2-ce* data files. Also, CPCs produce standardized CPUE indices to inform stock assessment models about the abundance trends of the stock. The range of the indices available for the most recent stock assessment of North Atlantic albacore (2020) are shown in **Figure 24**. It is noted that currently only indices for bait boat and longline fleets are available. With regards to the regional distribution, indices are from the Northeast Atlantic (Cantabrian Sea bait boat), North (Japanese and Chinese Taipei longline) and western Atlantic (Venezuelan and US longline). In terms of temporal range, the longest index starts in 1981, hence spans for 38 years. Note that nominal catch data (*Task 1*) is available since 1950.

The trajectory of the standardized indices available for the 2020 stock assessment are shown in **Figure 25**. In order to reflect stock abundance trends, it would be desirable that all indices provide similar information, and this can be assessed using correlation plots (**Figure 26**). The indices used in the 2020 stock assessment show a strong correlation between the US and Chinese Taipei longline and a moderate correlation between these and the Japanese longline. The Cantabrian Sea index shows a weak correlation with the Chinese Taipei longline index, almost no correlation with the Japanese and US longline indices and a negative correlation with the Venezuelan longline index.

Tagging data

Tagging data can provide information on growth, migrations, mortality and exploitation rate (Fu, 2020, Hillary *et al.*, 2008, Eveson, 2011, Fonteneau, 2014). For the North Atlantic albacore, the available samples include information on tag-released fish since 1960 and recoveries from 1968 (**Figure 27**). In total, 41,232 North Atlantic albacore fish have been tagged, with two periods (1988-1991 and 2003-2006) with particular effort on tagging experiments (**Figure 28**). In total, 1,394 tagged fish have been reported with a relatively large fraction of recovery in the early period (1968-1974) with much lower rates thereafter. In total, the recovery rate is 3.38% (**Figure 29**), which can be considered relatively low. For example, the Indian Ocean Regional Tuna Tagging Programme achieved a percentage of tag returns of 15% for tropical tuna species (Fu, 2020). Tagging data was not used in the North Atlantic albacore stock assessment configuration on which the scientific advice was based upon in 2013. However, one run with tagging data was included for sensitivity purposes. Also, the sensitivity configuration was included as a factor of uncertainty in the Operating Models developed for the MSE (Merino *et al*., 2017).

Tagged albacore fish have been released mostly from the Northeast Atlantic area with few releases in the North, Northwest and western areas of the Atlantic (**Figure 30**). The recoveries also have been made in the Northeast (**Figure 31**). From the 1,394 recoveries, only 11 correspond to fish that have crossed the Atlantic (**Figure 32**). From these, only one was released in the western area and recovered in the East (tropical area). From the 10 individuals that have crossed the Atlantic from East to West, all were tagged and released in the NE and recovered in the Northwest (3), Southwest (4) and West-central Atlantic (3). From these, only three individuals correspond to the 13,788 fish tag-released during the 1988-1991 tagging programme (**Figure 33**).

4. Discussion

This document examines the updated data (catch, effort, size, age and tagging) provided by ICCAT's Secretariat for the different fleets and gears that catch North Atlantic albacore. With this document, we aim to assess data's ability to inform on stock and fishery dynamics with the view of producing a new benchmark assessment with the integrated age-structured model Stock Synthesis (Methot Jr and Wetzel, 2013) and, developing a new grid of Operating Models for the MSE of this stock.

To develop a new benchmark assessment, the albacore working group will have to make decisions on the model configuration, which includes the data to be used as input, the definition of fisheries and the spatio-temporal structure of the model (among others). The databases currently available include nominal catch (*Task I*), size of the catch (*Task 2-sz and Task 2-cs*), geographical and seasonal distribution of catch (*Task 2-cdis*), effort data (from the CPUE series presented to the 2020 stock assessment) and tagging data.

"Fisheries" in integrated models aim to represent relatively homogenous fishing units, with similar selectivity and catchability that remain relatively stable over time, or at least during the temporal definition of the fisheries. For the 2013 benchmark stock assessment, twelve fisheries were defined based on the type of fishing gear, fishing strategy and in some cases their area of activity (Table 6 of the 2013 Data Preparatory meeting report). Fishery definitions are based upon a major gear and includes the main fleets and associated (gears/fleets), which are merged to obtain combined nominal catch and size frequencies for each fishery.

The historical catch trends show that the exploitation of North Atlantic albacore has been dominated by 14 fleets that can be aggregated into five or six major gears. Also, that a large part of the catch is taken in the Northeast area of the Atlantic. The size-structure pattern of the different fleet-gear categories can also be used to identify homogeneous fishing units. However, the exploration of size-data raises specific questions that may need to be clarified by the Secretariat and the albacore working group:

- There seem to be inconsistencies between the sampled size (*Task 2-sz*) and catch at size data (*Task 2-cs*). Comparing *sz* and *cs* it is seen that some fleets have more years with size samples than with CAS (e.g., Japan, Chinese Taipei and Venezuelan longline fleets). On the contrary, Spanish baitboat and trolling fleets, which represent 35% of the total catch in the last years, have more yeas of CAS than years with size samples. The group will need to consider how to make the best use of the two databases for these important fisheries.
- Also, relatively little information is available about the size distribution for the midwater trawl fleets of Ireland and France. The Irish midwater trawl seems to show a similar pattern to the Spanish troll fishery and the French midwater trawl seems to select smaller fish (age 1) than the others.
- The ridge plots built with sampled size data (**Figure 13**) show that for the longline fleet of Japan there are a number of small fish around 1995, 2004 and 2009, but not in the recent years. It would be necessary to clarify if there has been any change in the fishing operations that may have caused a change in selectivity across the recent time series.
- Also, the Japanese longline fleet shows a mode at very small size classes in the sampled size.
- The longline fleets of Japan and Chinese Taipei were split in three periods for the 2013 stock assessments which represented three different species targets for Japan (target, transition and by-catch) and three modalities of longline for Chinese Taipei (traditional longline, transition towards deep longline and stable deep longline). The group may want to discuss if this distinction would be adequate for the 2021 benchmark assessment too, for instance in the light of the new data for the 2010s.
- With regards to the US longline size data, there is an apparent contradiction between the sampled size and CAS data. Sampled size data shows (**Figures 13** and **14**) a dramatic reduction of the size of fish to ~25 cm. It would be necessary to clarify the origin of these values and if such small fish is really part of the longline catch. Also, in the CAS (**Figure 18**) there seems to be a large portion of catch above 125 cm during the 2004-2007 period only. The albacore group may discuss if this has been due to a change in the selection of the fishery or due to a change in the population.
- In 2013 there were extensive discussion on the adequacy of using size data from Chinese Taipei or not (ICCAT, 2013). The albacore working group may discuss this again and investigate why the inclusion of this data was part of one sensitivity run (*Alt1*) for the 2013 benchmark assessment.
- Ridge plots suggest that there could be some cohort signals in the CAS data. For example, the Cantabrian Sea bait boat fleet shows a strong cohort entering the fishery in 2003 and increased size until 2008. The same pattern is seen between 2011 and 2014.
- The group may consider the option for random walk methods for the shape of selectivity of some fleets (e.g., Cantabrian bait boat).

The catch distribution (temporal and geographical distribution of catch per fleet/gear category) information can also help deciding on the spatio-temporal structure of the stock assessment. **Figure 21** shows that the most important albacore fisheries are highly seasonal. For example, Cantabrian Sea baitboat, troll, and Irish/French midwater trawl are essentially summer fisheries. Others distribute their production in two quarters and very few seem to be stable throughout the year. *Task-cdis* information makes it possible to design a model configuration that describes seasonal dynamics of fisheries and fish stocks.

With regards to the spatial configuration, North Atlantic albacore is mostly exploited in the Northeast, but important fisheries have operated in other areas too. A spatially disaggregated model would require information on fish movement such as tagging information. However, the current tagging data show a very minor fraction of fish moving from the East to the West Atlantic and even less on the reverse. In 2013 the albacore working group included one scenario for sensitivity that contained tagging information but there was no spatial disaggregation of the model. In this regard, the albacore working group will need to re-evaluate if the tagging data shows sufficient evidence for a spatial model. There are other specific points that the albacore group may want to discuss:

- The information on releases in the first years is strange and show an almost 100% recovery rate. This may indicate that the information on tag releases was not fully documented.
- Also, it is surprising that the fish tagged in the middle of the Atlantic were not recovered. The group would need to clarify if the information of release location were correctly documented.
- There have been substantial tag-releases (deployments), but mostly linked to opportunistic sport fishery activities and from scientific surveys. The group may suggest using the scientific surveys conducting during 1988-1999, as done in the 2013 stock assessment.

The abundance indices shown in this document were built using catch and effort information. All indices represent different areas of the Atlantic but similar size patterns (longlines) except for the Cantabrian Sea bait boat. The group may want to explore additional indices for some of the most important fleets targeting albacore. For example, midwater trawl fisheries are becoming increasingly important, and the assessment would benefit from increasing the information from these fisheries too.

Acknowledgements

We are thankful to the ICCAT Secretariat staff for their help with data filtering and analysis and to Dr. Fabio Fiorelatto, from the IOTC Secretariat, for the help with the code for some of the figures presented in this document.

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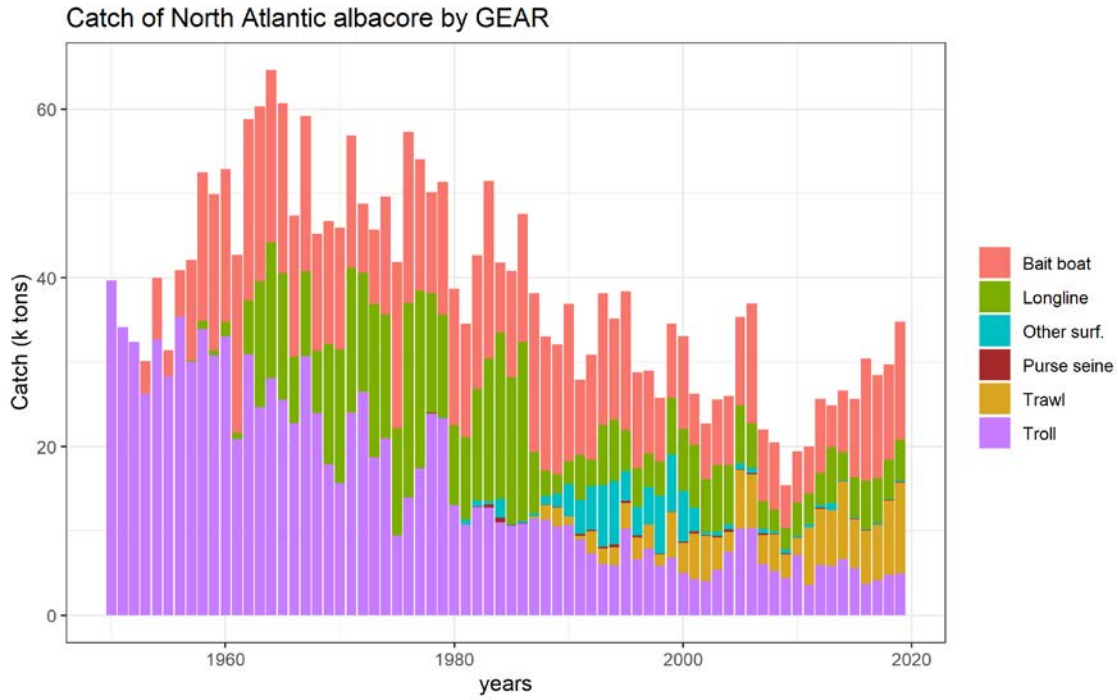

Figure 1. North Atlantic albacore historical catch per major gear (Task 1).

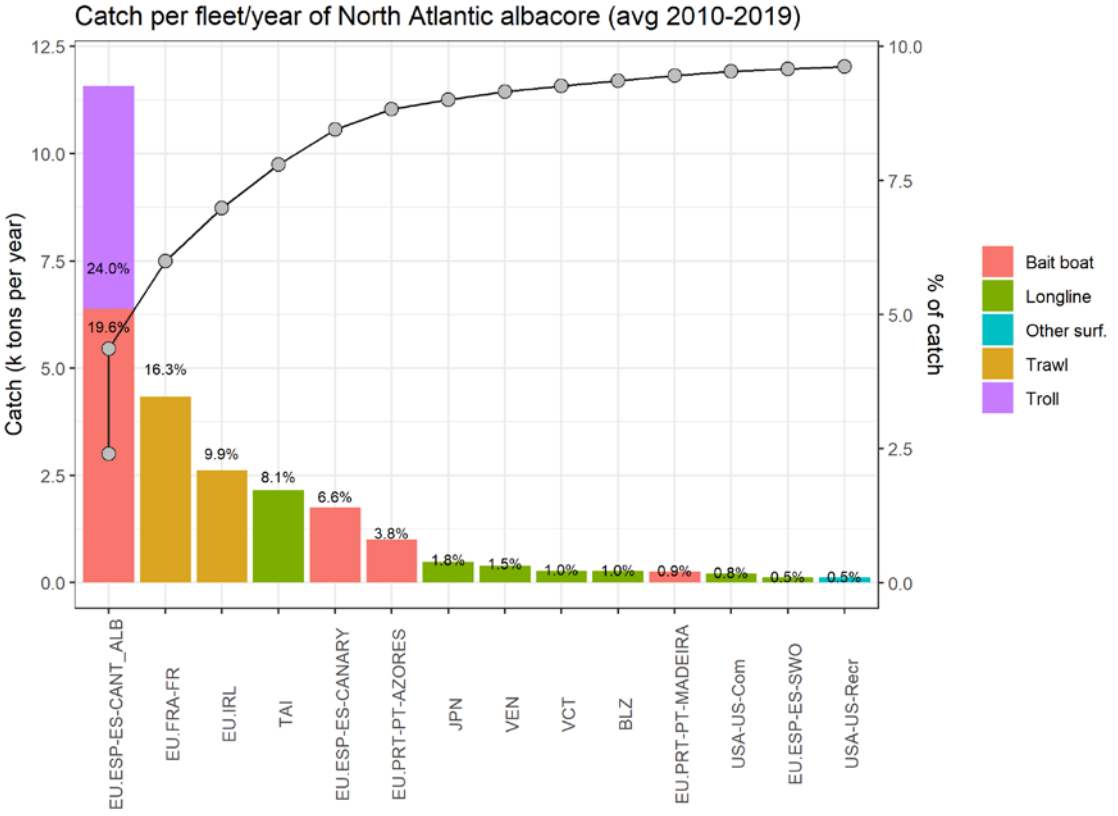

Figure 2. Main fleets and gears that represent 96% of the total catch from the 2010-2019 period, according to catch (Task 1).

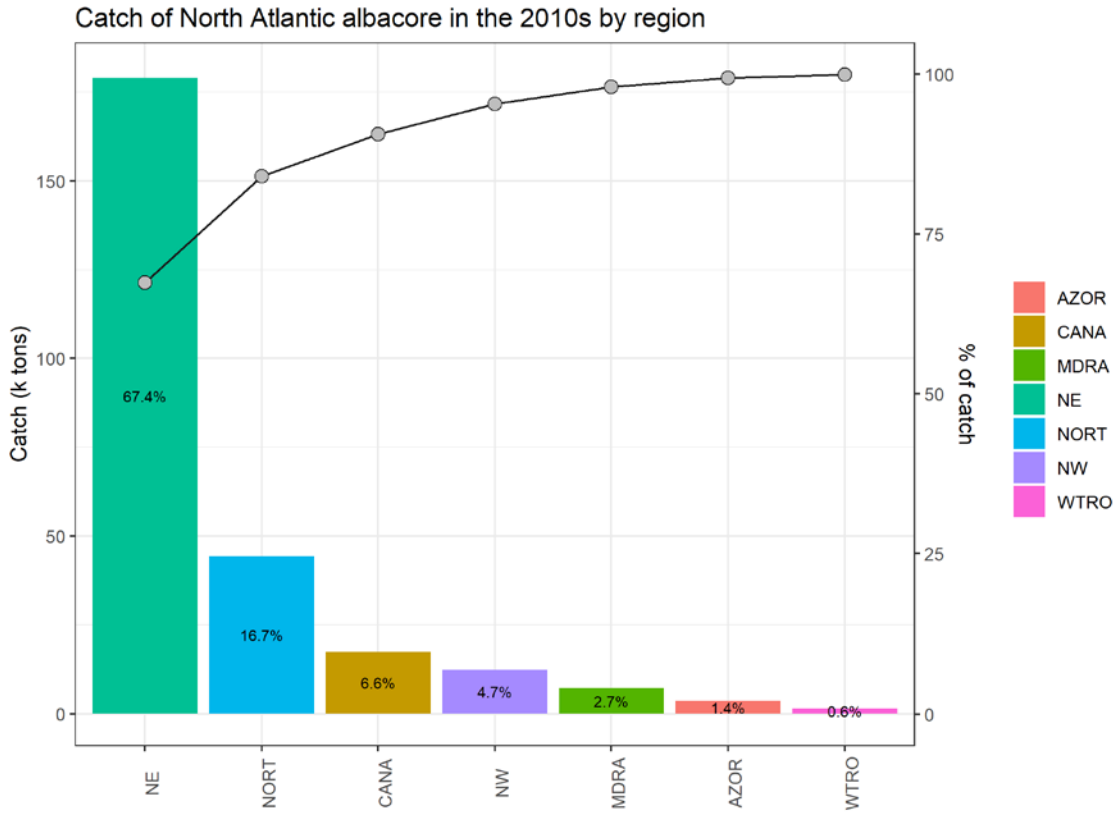

Figure 3. Catch of North Atlantic albacore per Atlantic area in the period 2010-2019 (Task 1).

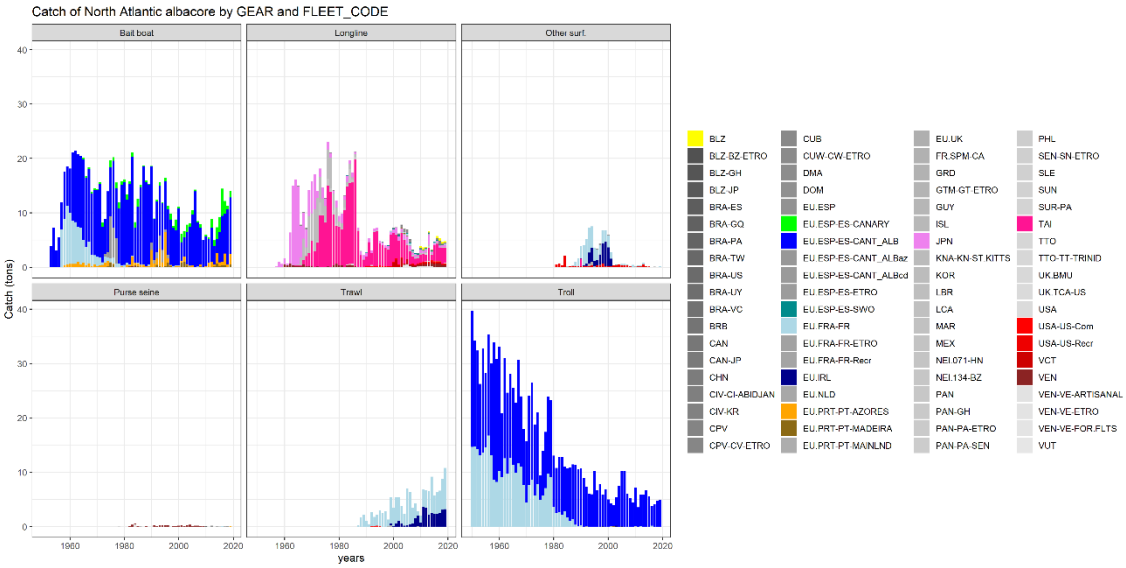

Figure 4. Historical catch of North Atlantic albacore disaggregated by fleet and gear (Task 1).

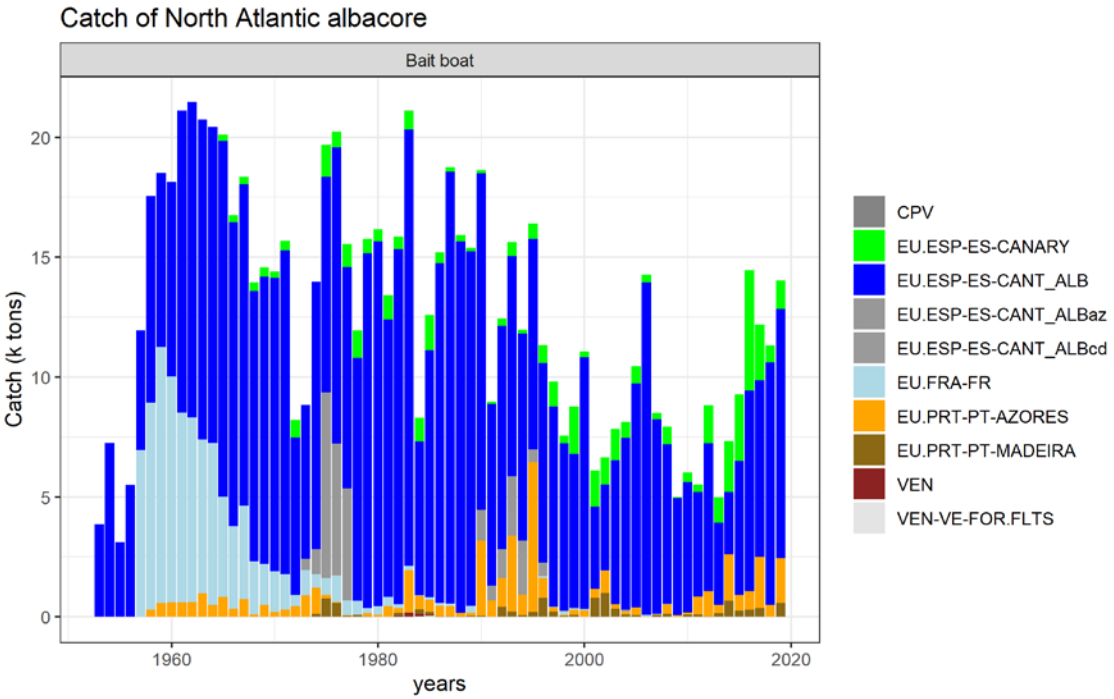

Figure 5. Historical catch of bait boat fleets (Task 1).

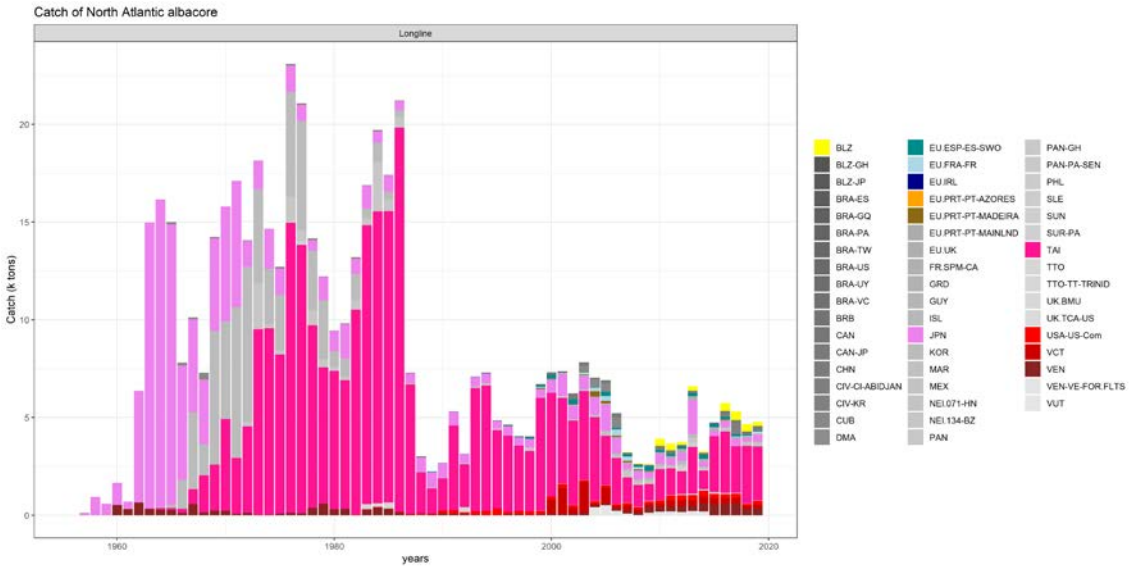

Figure 6. Historical catch of longline fleets (Task 1).

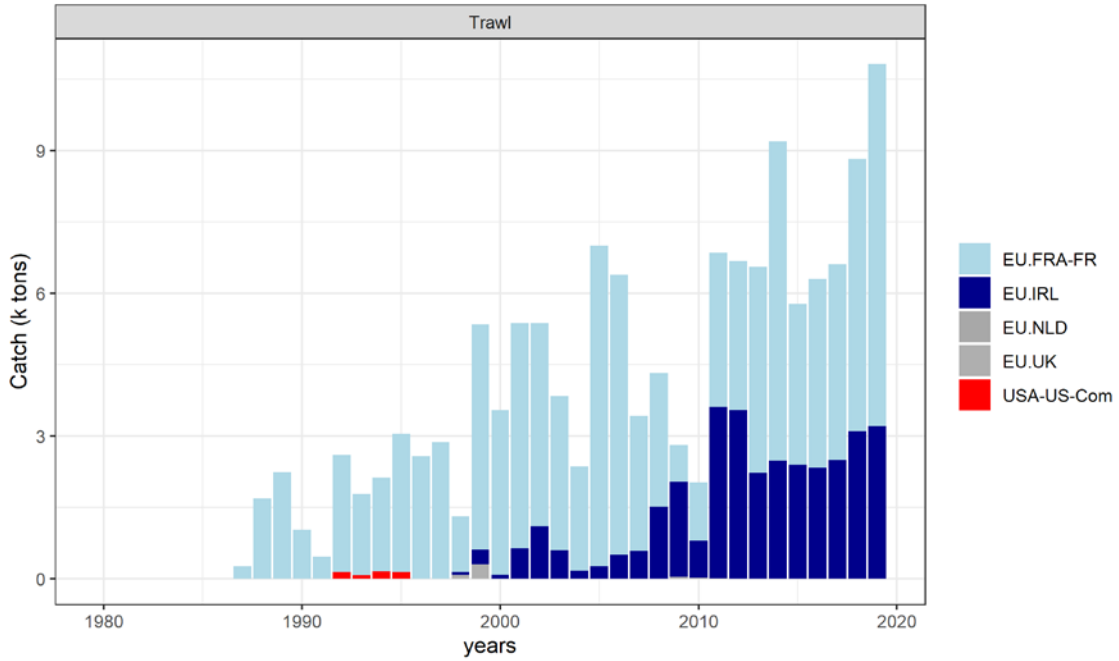

Figure 7. Historical catch of trawl fleets (Task 1).

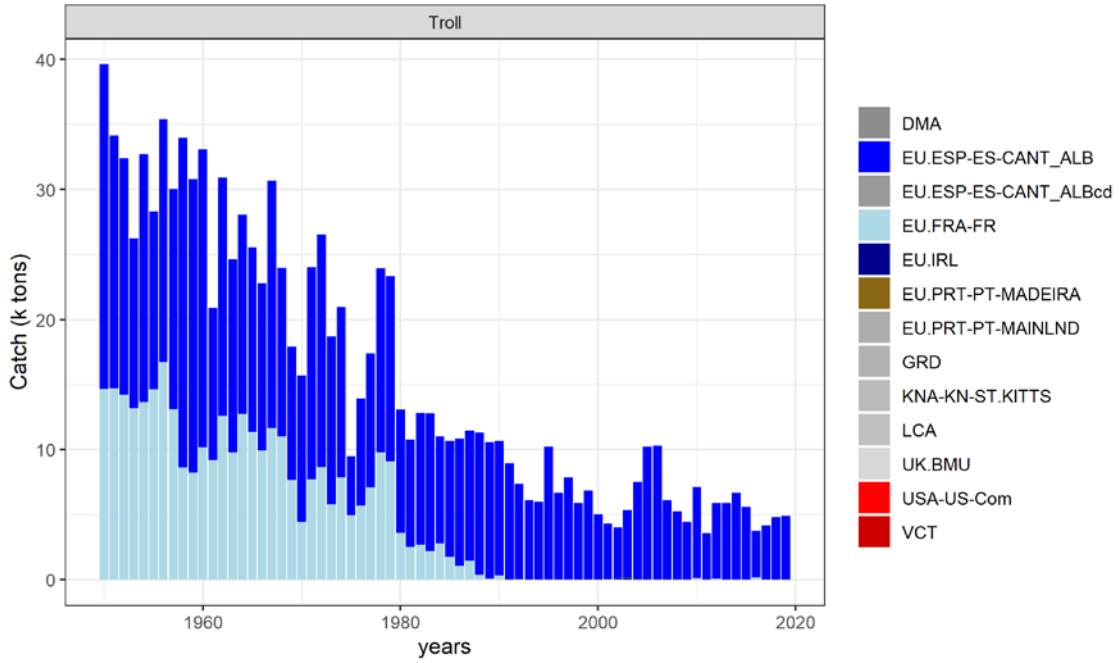

Figure 8. Historical catch of troll fleets (Task 1).

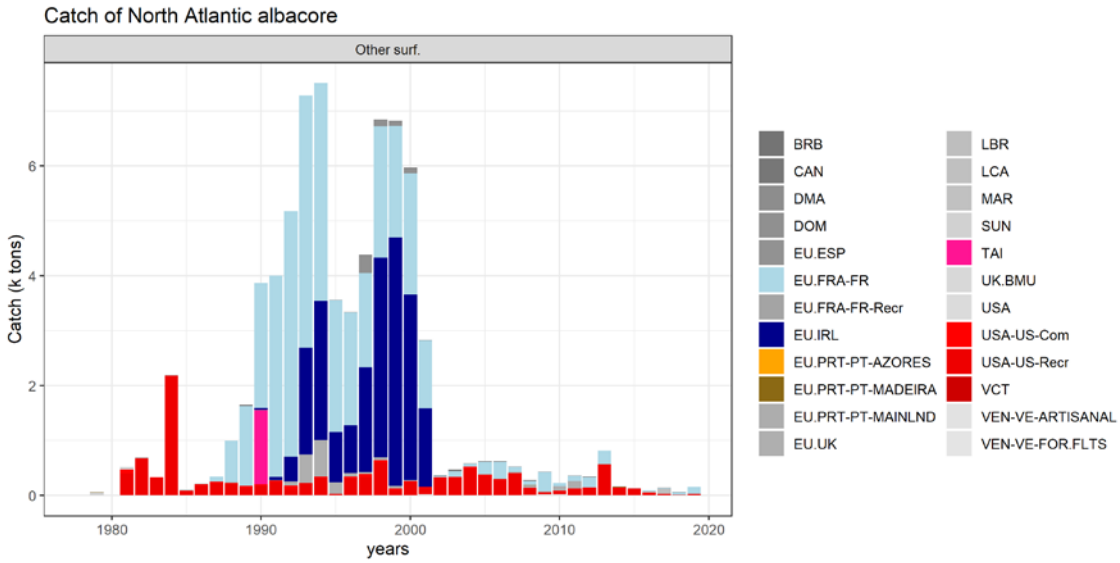

Figure 9. Historical catch of other surface gears' fleets (Task 1).

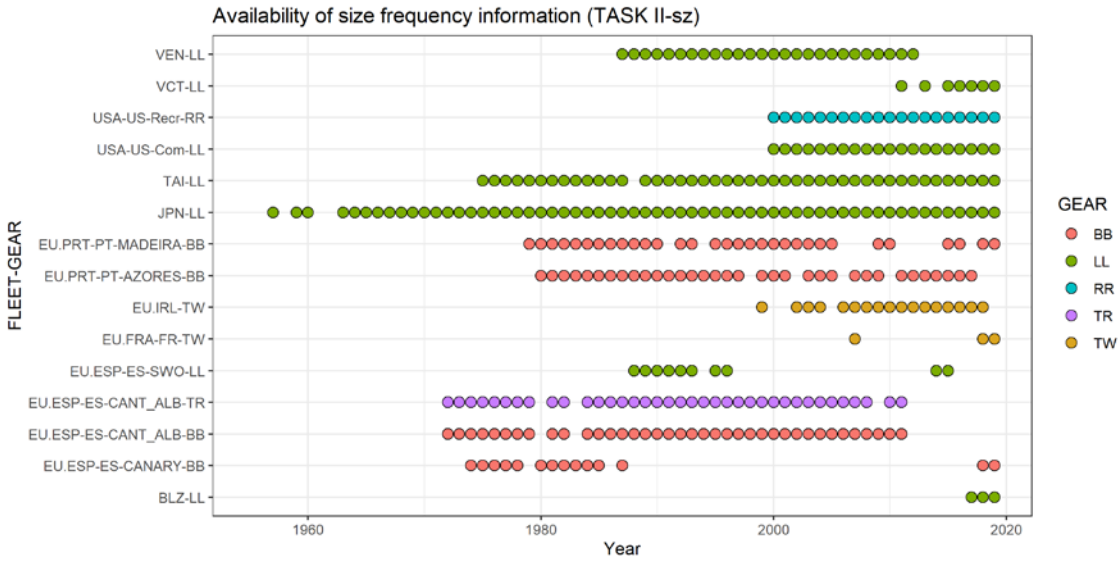

Figure 10. Available data sampled size per fleet/gear category (Task 2-sz).

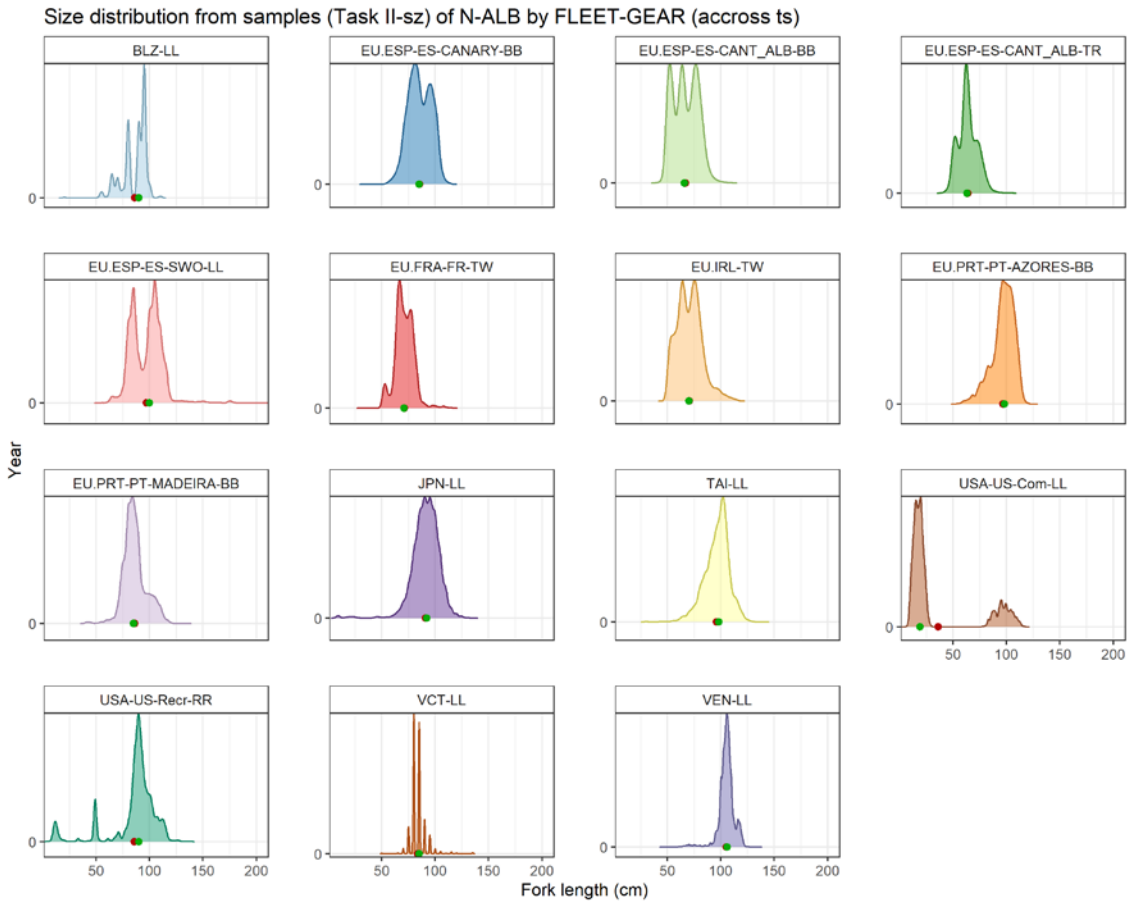

Figure 11. Size distribution of each fleet/gear category averaged across the entire period (Task 2-sz).

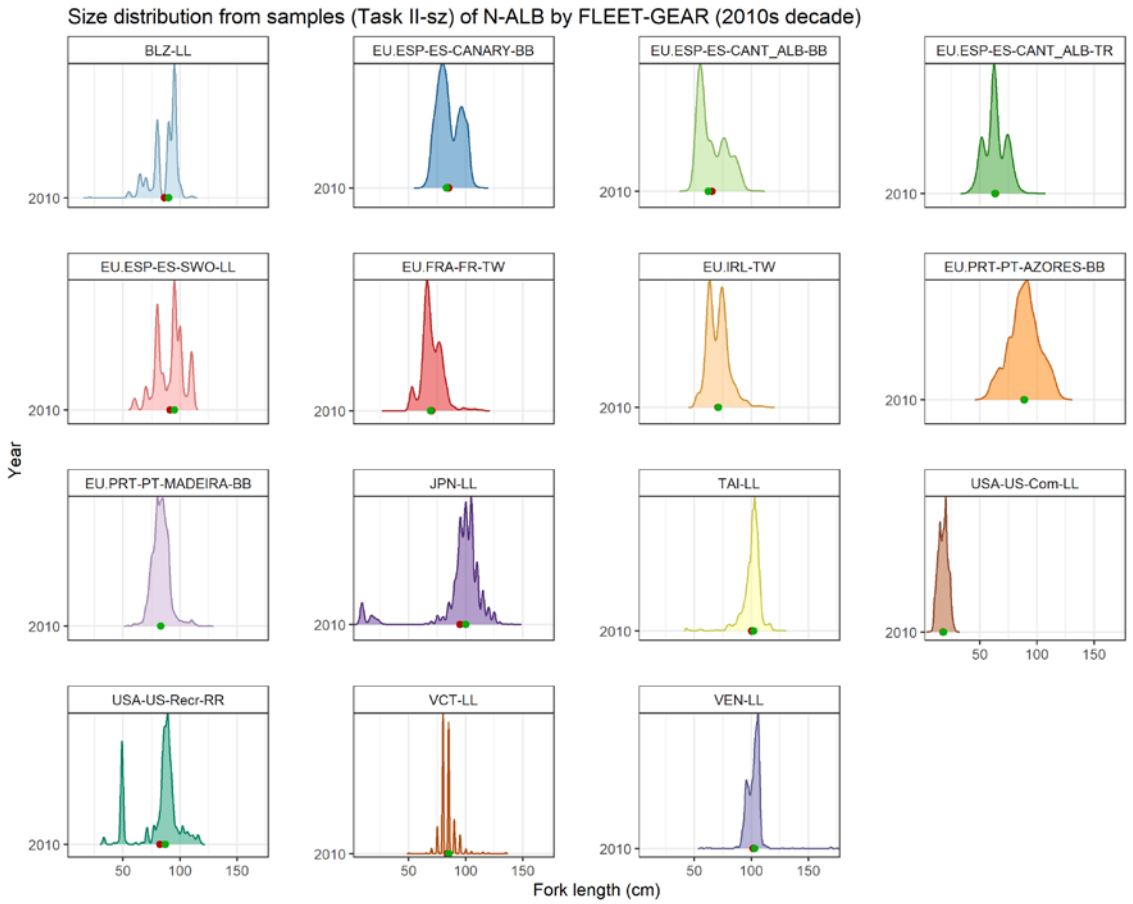

Figure 12. Size distribution of each fleet/gear category averaged across the 2010-2019 period (Task 2-sz).

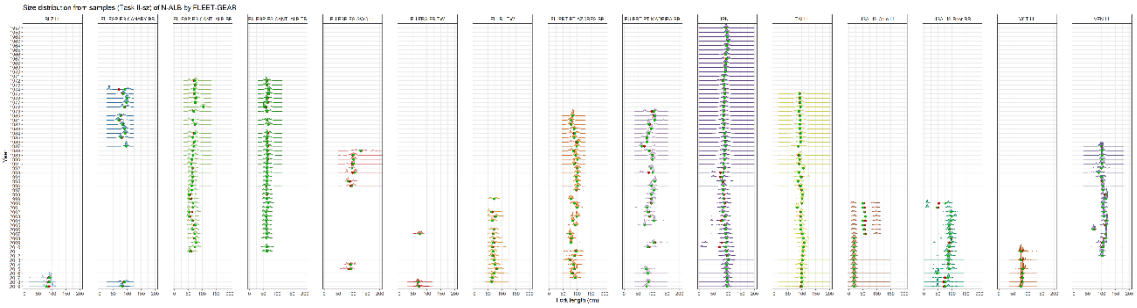

Figure 13. Size distribution of each fleet/gear category per year (Task 2-sz).

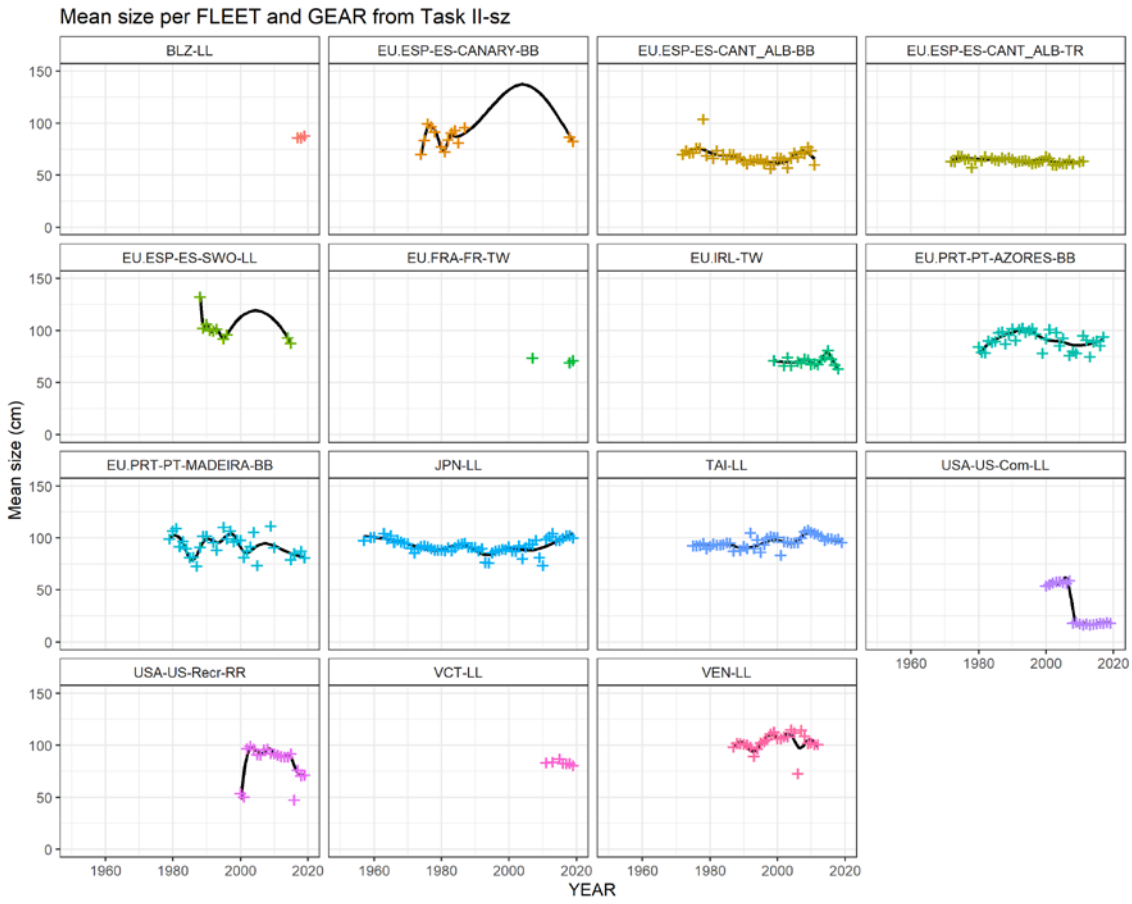

Figure 14. Mean size of fish from sample size data per year and fleet/gear category (Task 2-sz).

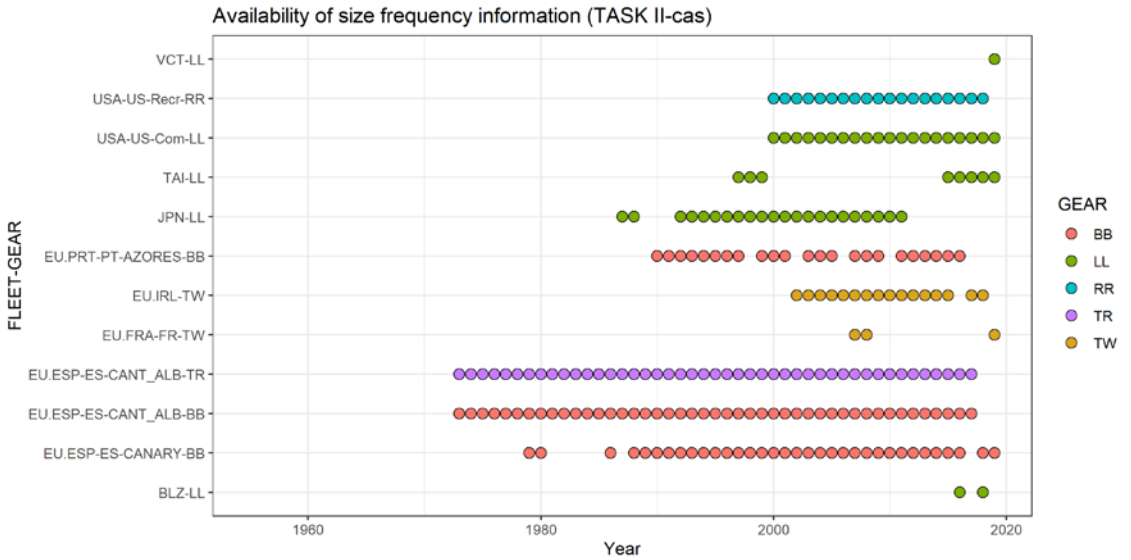

Figure 15. Available catch at size (CAS) per fleet/gear category (Task 2-cs).

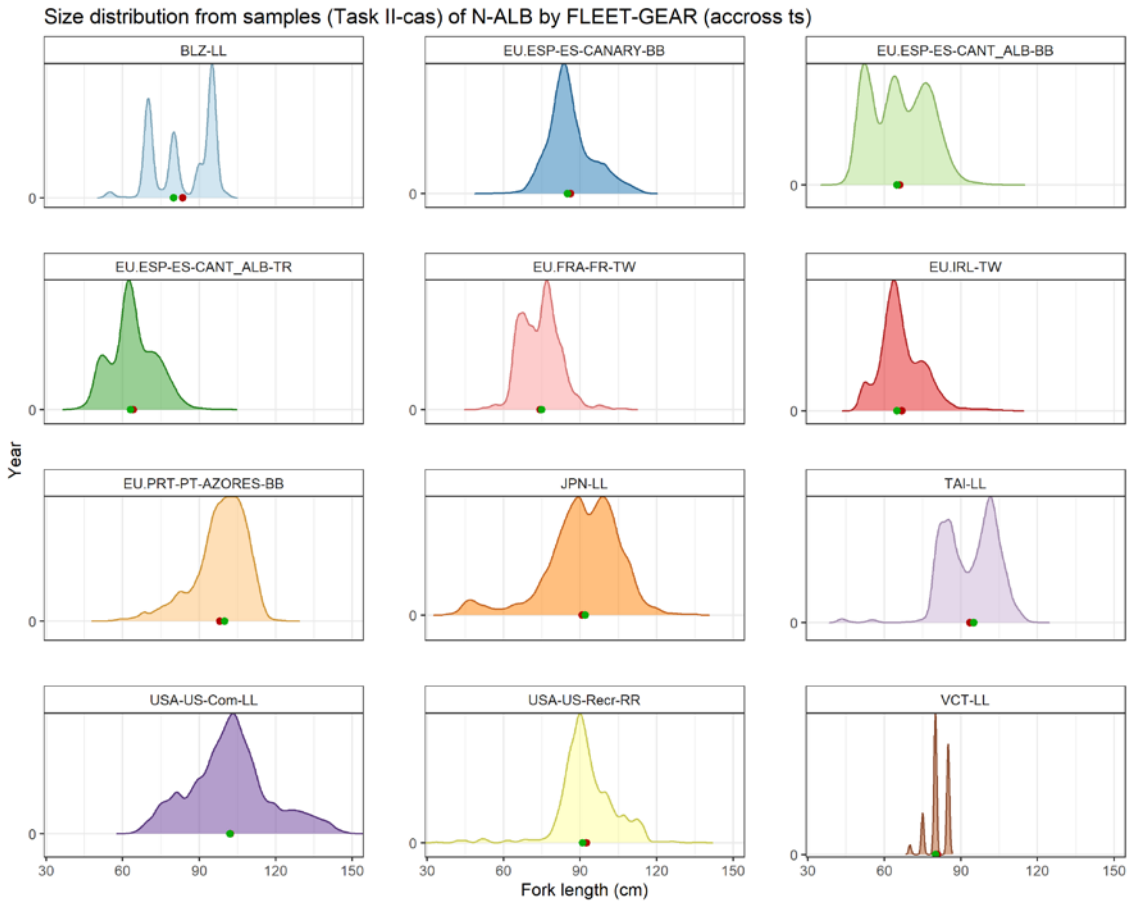

Figure 16. Size distribution of each fleet/gear category averaged across the entire period (Task 2-cs).

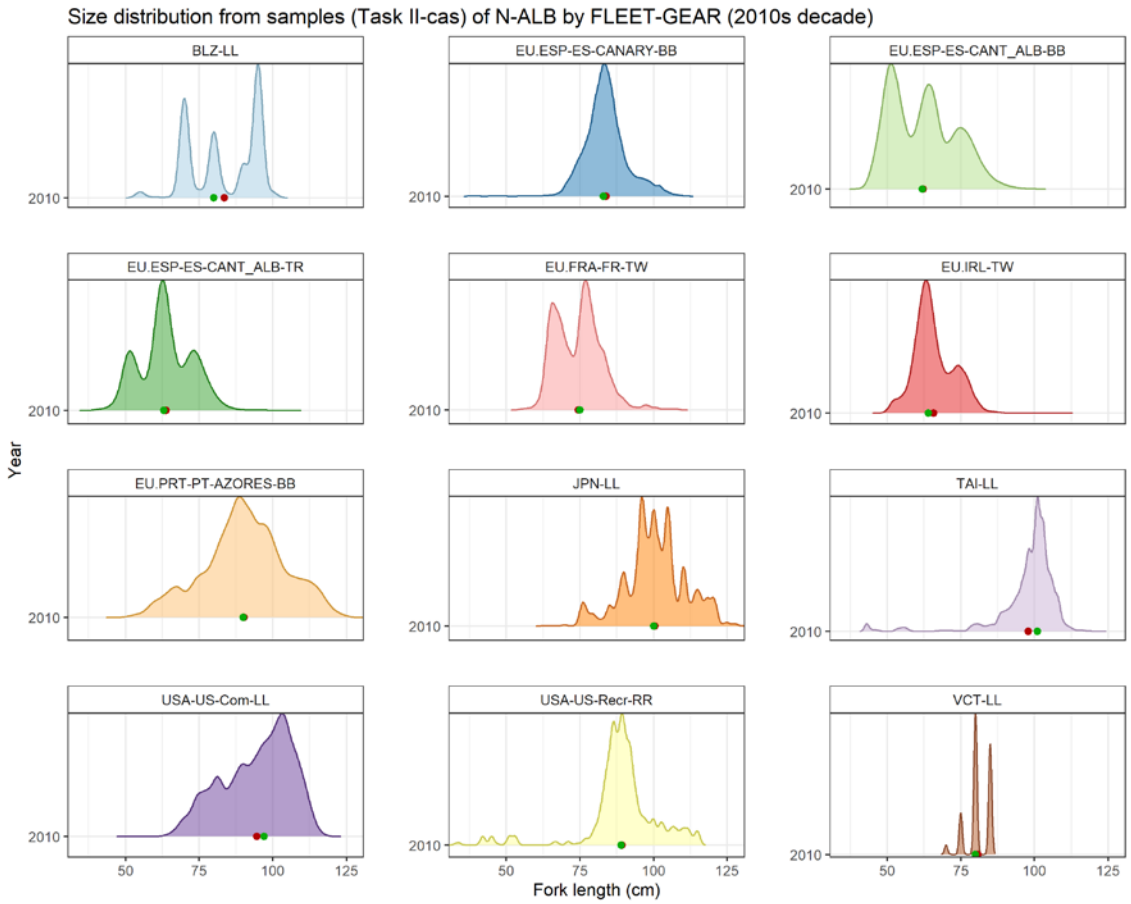

Figure 17. Size distribution of each fleet/gear category averaged across the 2010-2019 period (Task *2*-cs

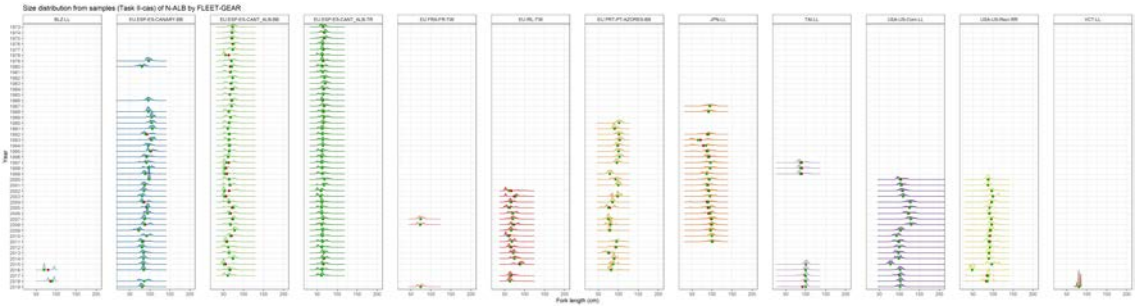

Figure 18. Size distribution of each fleet/gear category per year (Task 2-cs).

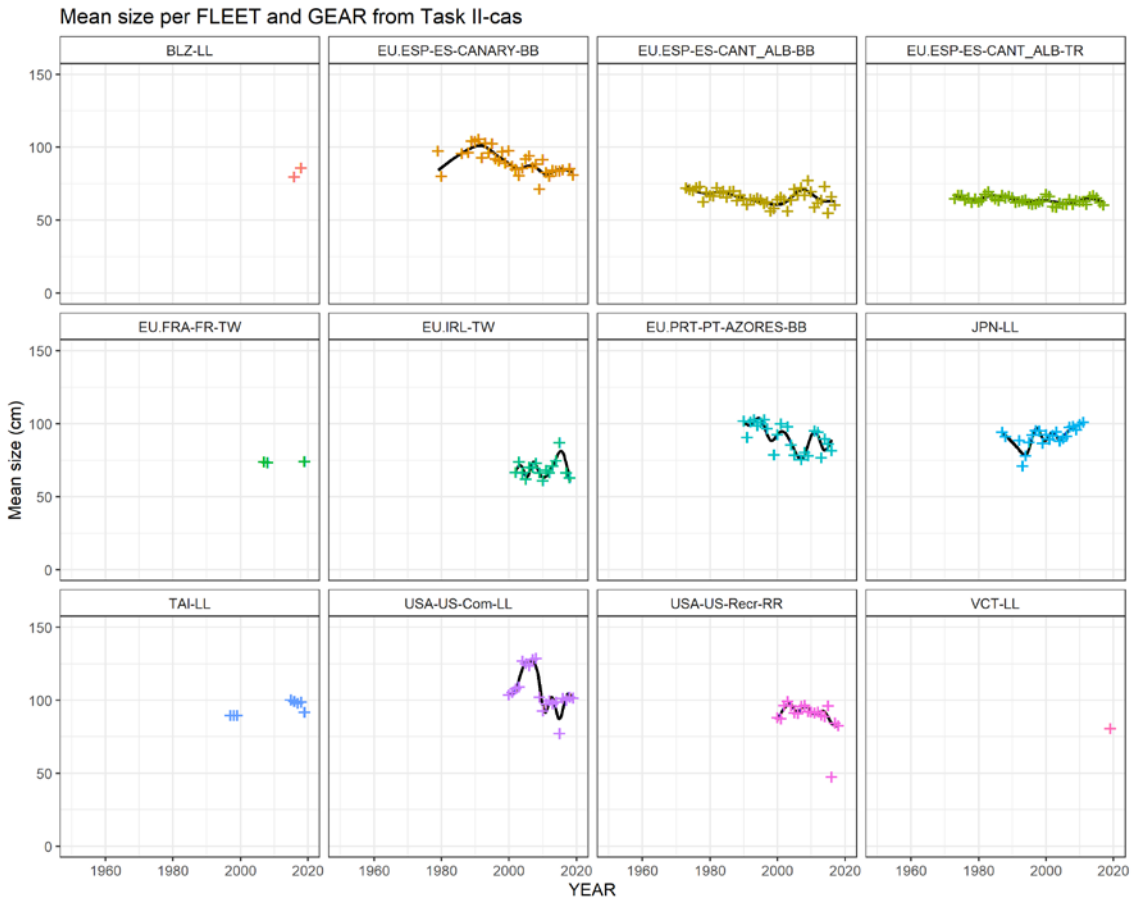

Figure 19. Mean size of fish from CAS data per year and fleet/gear category (Task 2-cs).

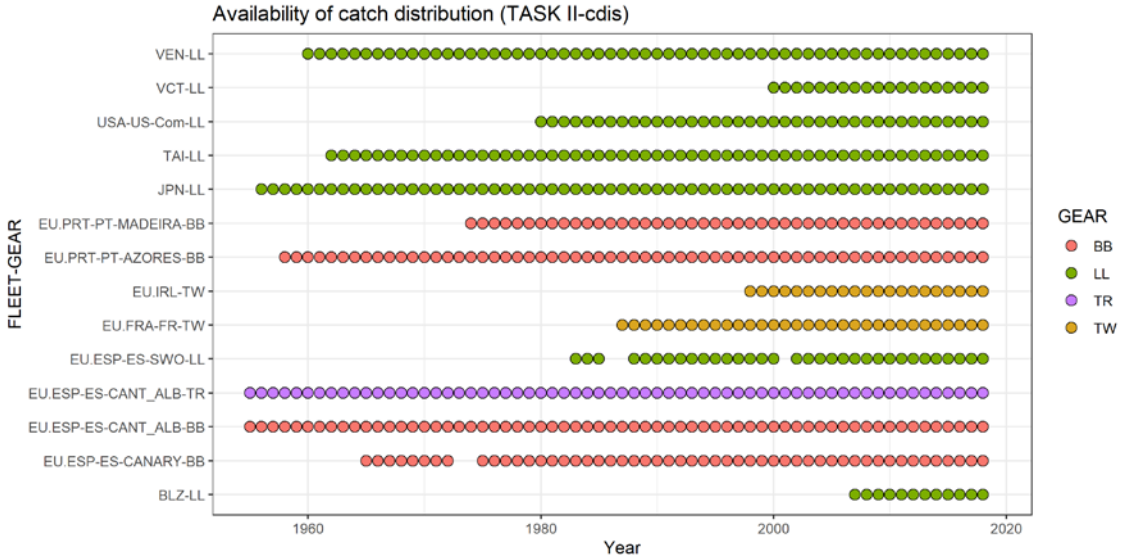

Figure 20. Catch distribution information per fleet/gear category (Task 2-cdis).

Figure 21. Proportion of total catch per season by fleet/gear category in the period 2010-2019 (Task 2-cdis).

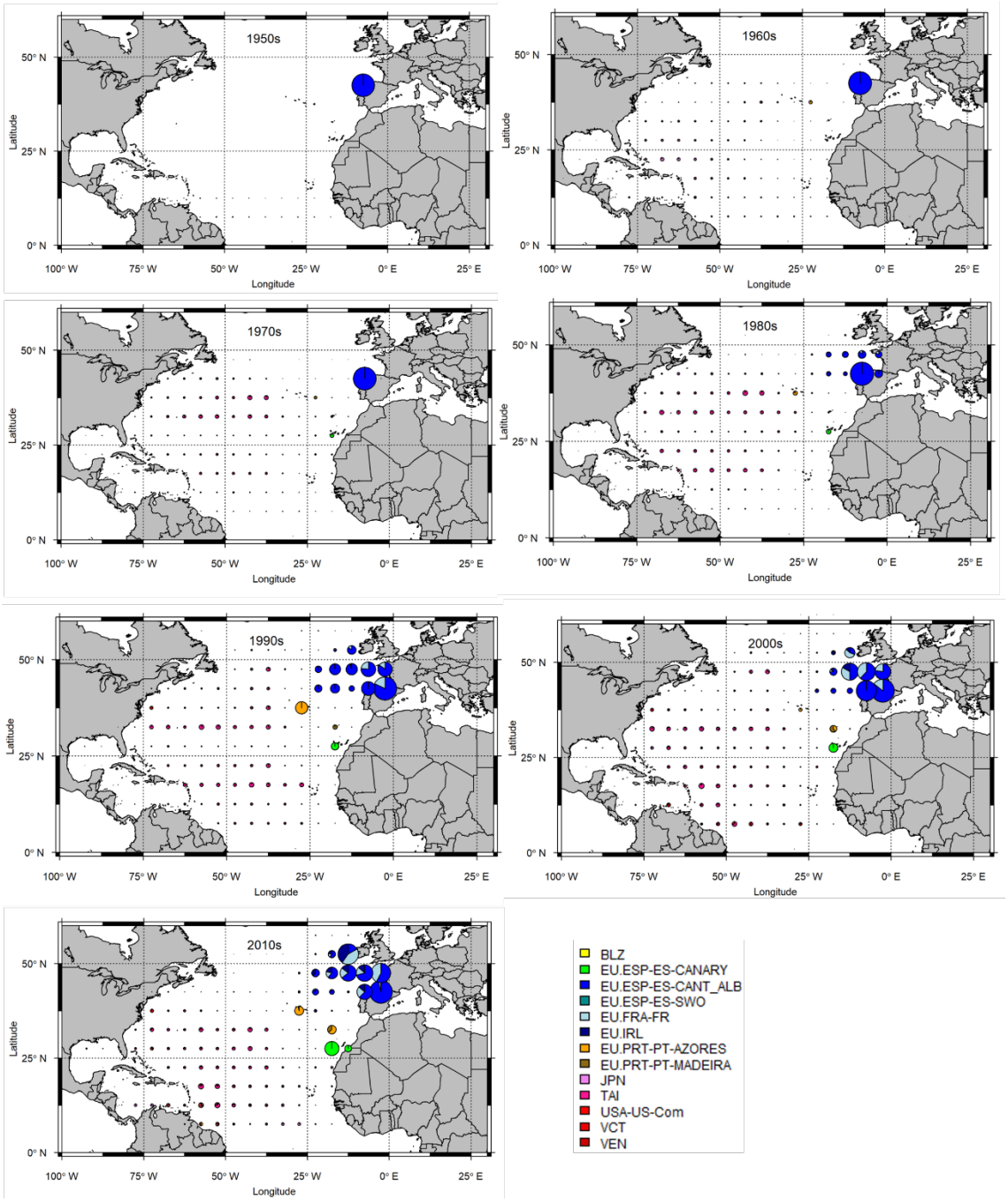

Figure 22. Geographical catch distribution averaged across each decade of the 1950-2019 period by the fleets that represent 96% of the total catch of the 2010-2019 period (Task 2-cdis).

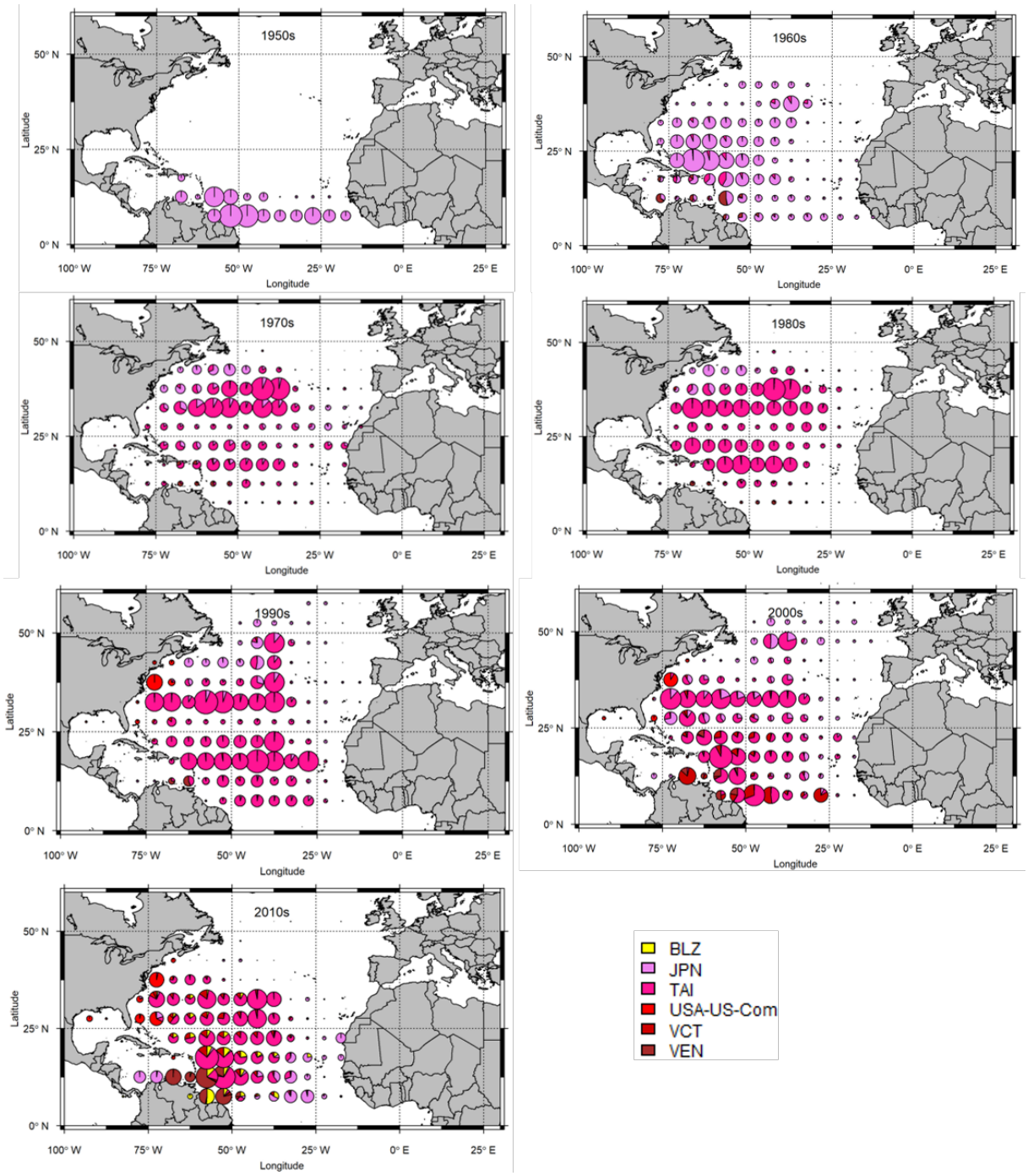

Figure 23. Geographical catch distribution averaged across each decade of the 1950-2019 period for longline fleets (Task 2-cdis).

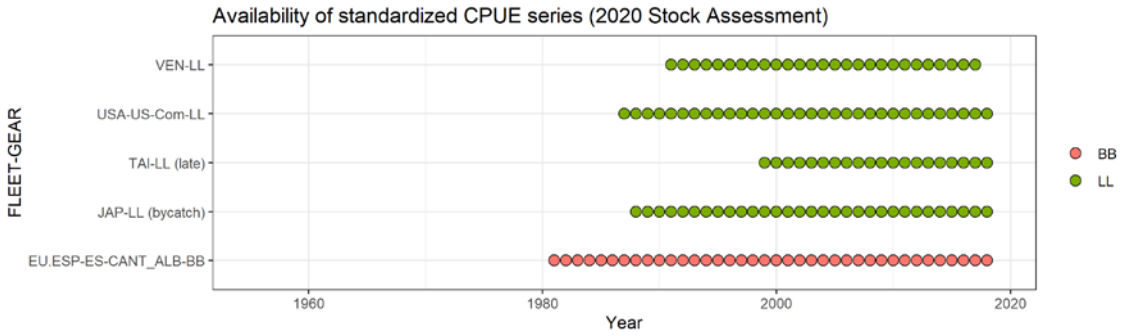

Figure 24. Range of the standardized CPUE indices available for the 2020 stock assessment of North Atlantic albacore per gear type.

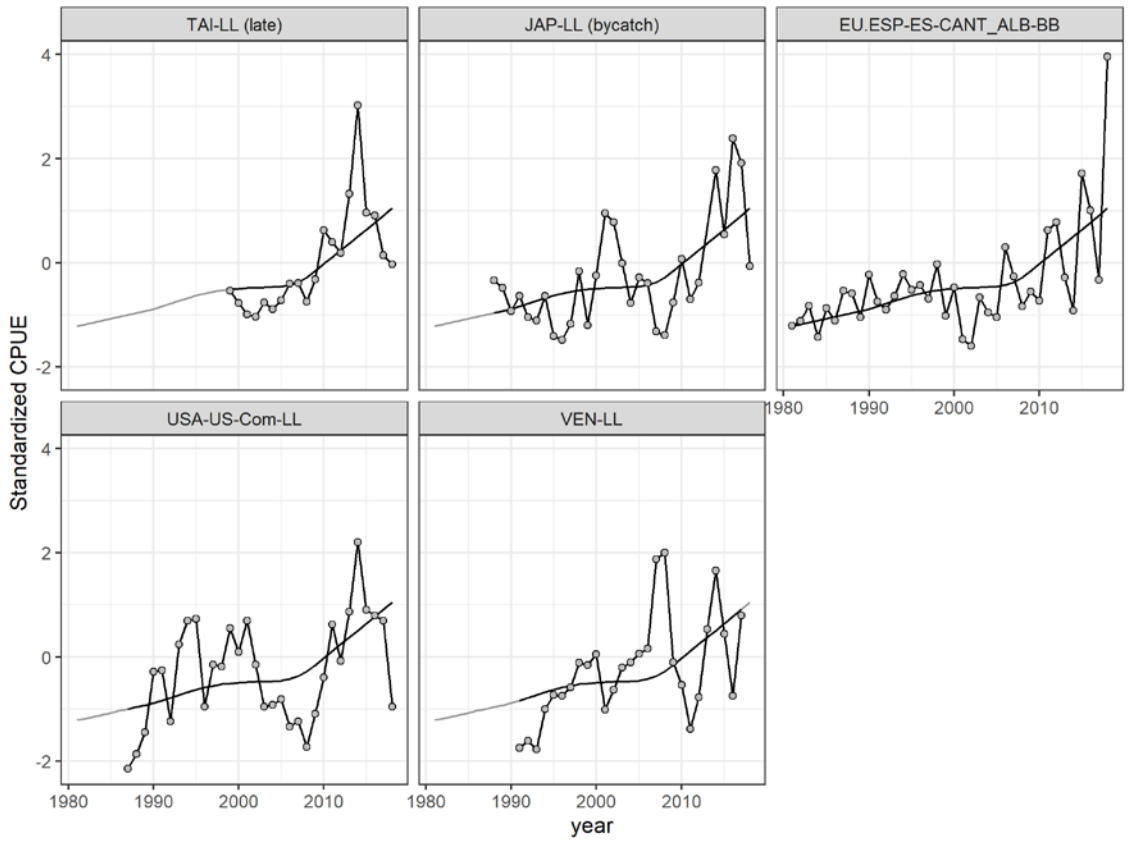

Figure 25. Standardized CPUE indices available for the 2020 stock assessment of North Atlantic albacore.

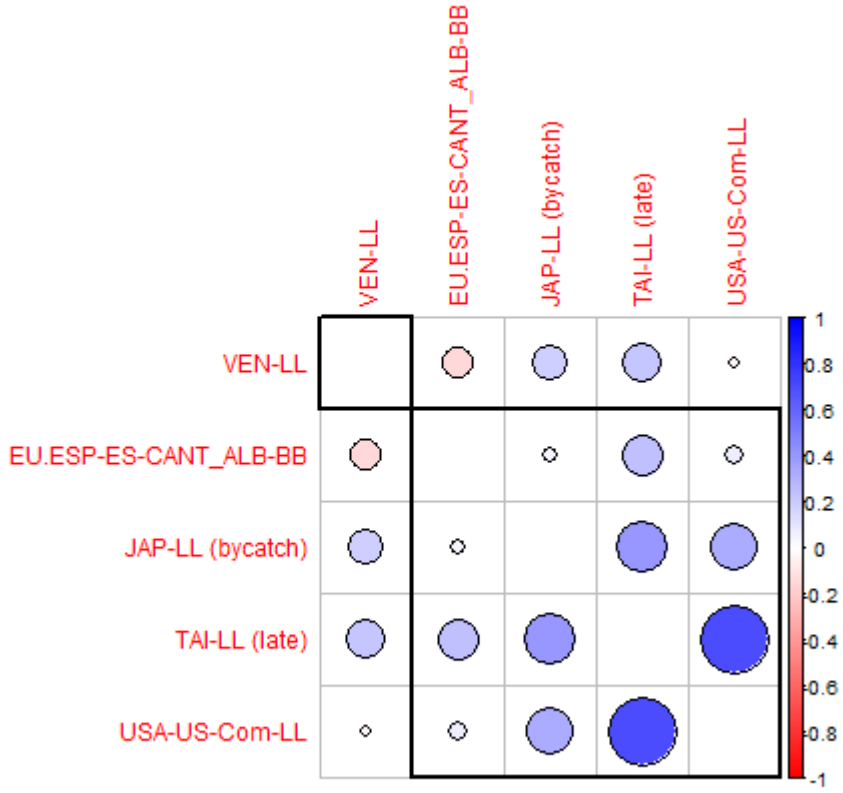

Figure 26. Correlation plot between the standardized CPUE indices available for the 2020 stock assessment of North Atlantic albacore.

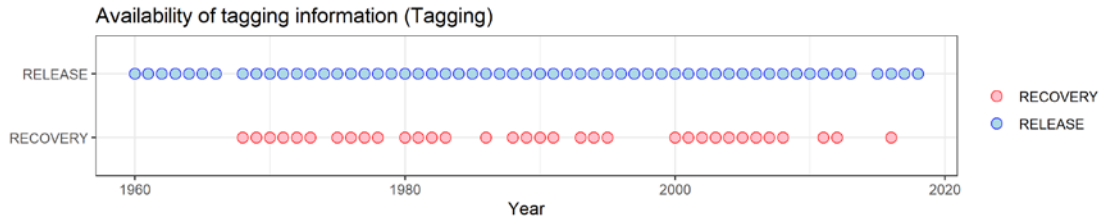

Figure 27. Temporal range of tag-release and recoveries of North Atlantic albacore (Tagging).

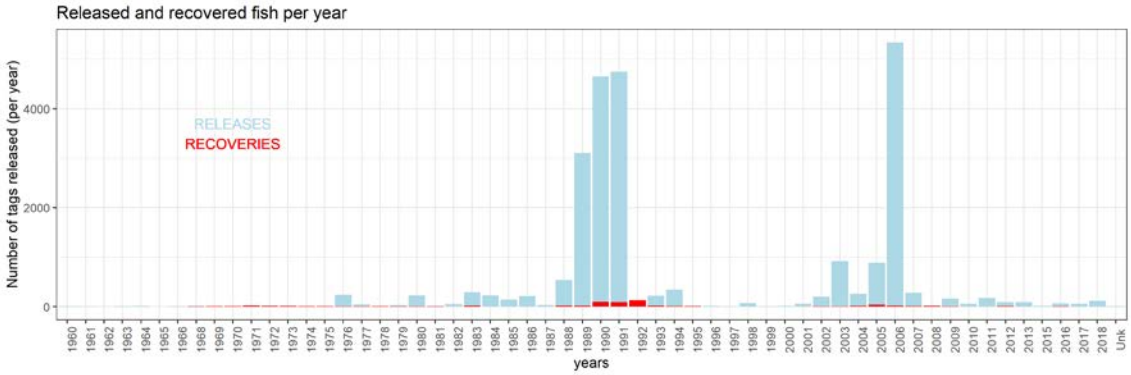

Figure 28. Number of tagged fish released (blue) and recovered (red) per year (Tagging).

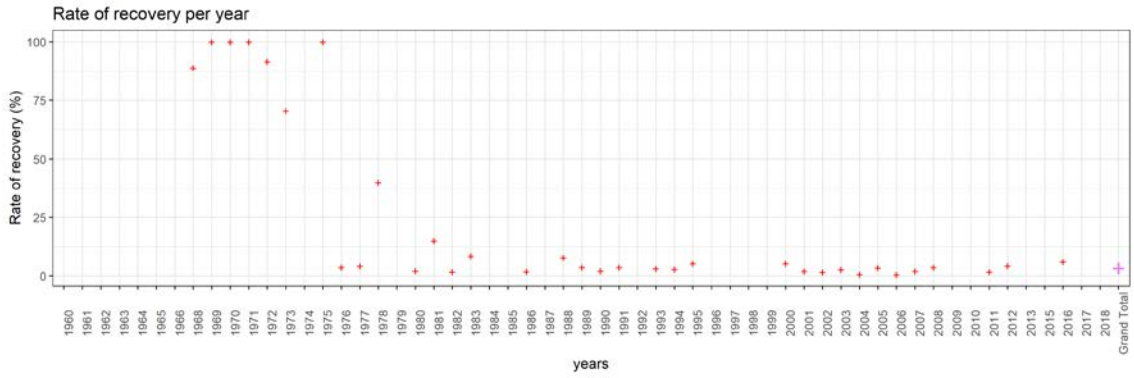

Figure 29. Tag recovery rate per year (Tagging).

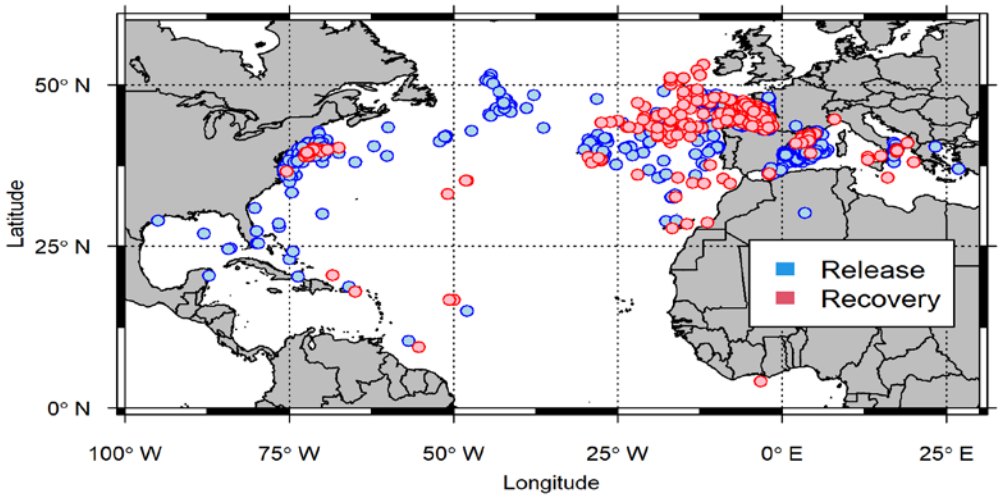

Figure 30. Geographical location of tag-release (blue) and recoveries (red) (Tagging).

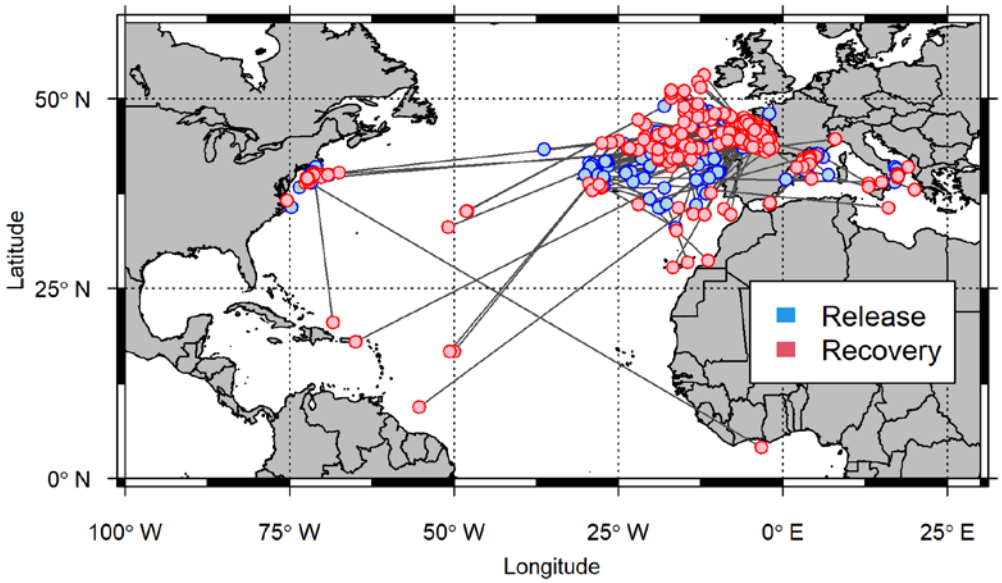

Figure 31. Geographical location of tag-release (blue) and recoveries (red) including tracks (Tagging).

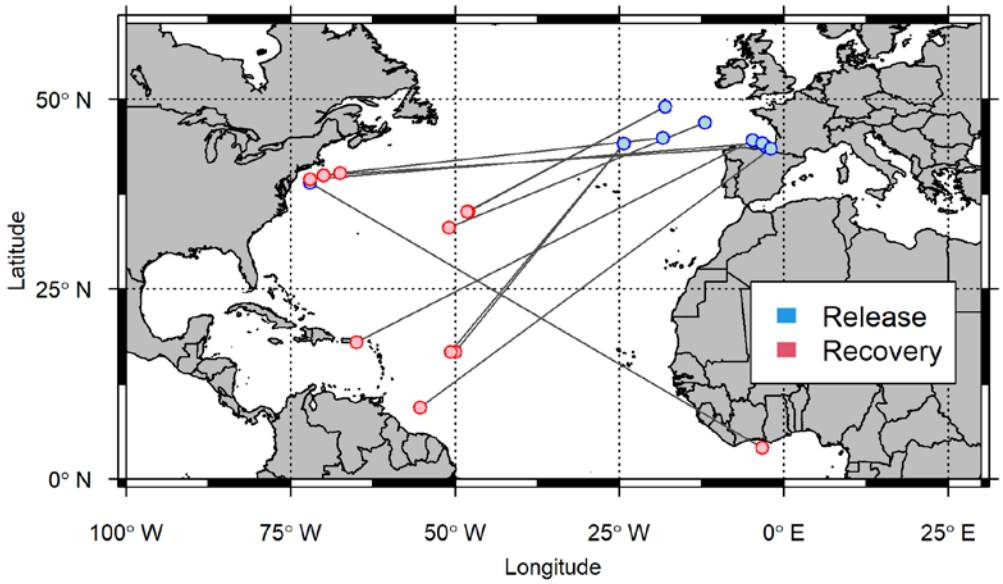

Figure 32. Geographical location of tag-release (blue), recoveries (red) and, tracks of the fish with demonstrated transoceanic migration (Tagging).

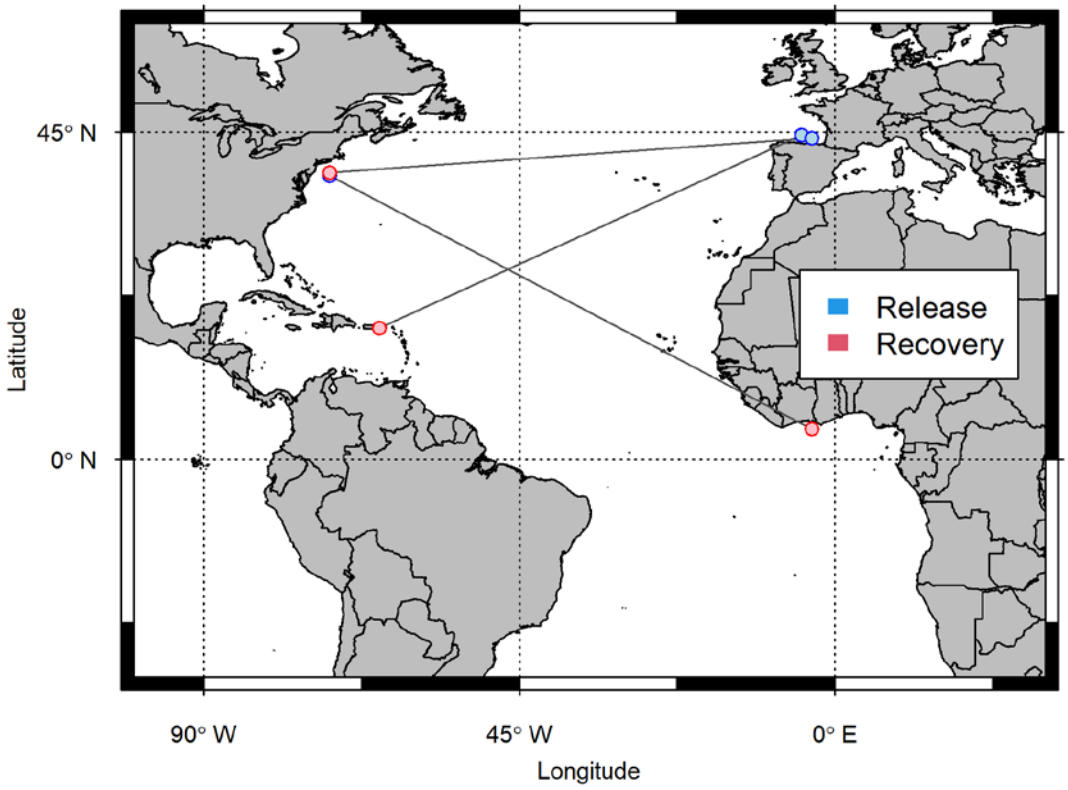

Figure 33. Geographical location of tag-release (blue), recoveries (red) and, tracks of the fish with demonstrated transoceanic migration and released in the tagging programme during 1988-1999 (Tagging).