CCSBT-OMMP/2507/05
(OMMP Agenda Item 1.3)

日本のミナミマグロ延縄操業パターンの変化の検証：2024 年漁期

Change in operation pattern of Japanese southern bluefin tuna longliners in the 2024 fishing season

伊藤智幸

Tomoyuki ITOH

水産研究・教育機構 水産資源研究所

Fisheries Resources Institute,

Japan Fisheries Research and Education Agency

要約

日本延縄船によるミナミマグロの漁獲データは、CCSBT におけるミナミマグロの資源評価ならびに MP において最も重要なものとして使用される。過去 10 年間と比較し、最近年の操業パターンの変化を検討した。漁獲量、隻数、操業のあった時空間、海区別割合、体長組成、放流投棄、操業の集中度を検討した結果、操業パターンの大きな変化は 2024 年には生じていなかった。2024 年の日本延縄漁業の CPUE は従来と同程度に資源を反映したものとみなすことができるだろう。最近 10 年間の漁獲枠増加は、CPUE の増加に最も強く影響し、操業時空間の拡大及び操業回数の増加はそれより小さい程度で影響した。

Summary

The Japanese longline data have been used as the most important scientific data in stock assessment and Management Procedure of southern bluefin tuna in CCSBT. Compared to the past 10 years, we examined the change of the operation pattern of the longline fishing in the most recent year. No major change was evident in the 2024 operational pattern in terms of the amount of catch, the number of vessels, time and area operated, proportion by area, length frequency, release and discard, and spatial concentration of operations. It can be said that the Japanese longline CPUE in 2024 represents the change of SBT stock abundance consistently as in previous years. The increase in catch quotas over the last decade has had the greatest impact on the increase in CPUE, with the expansion of operating space-time and the increase in the number of operations to a lesser extent.

Introduction

CCSBT におけるミナミマグロ *Thunnus maccoyii* の資源評価は漁業情報に大きく依存している。漁業データは、漁業独立調査よりも比較的容易に低コストで広い時空間からの情報を集めることができる長所がある。しかしそのデザインが系統だってはいないことから、漁業研究者はデータを適切に解釈し、資源指標の変化の理由について資源の変化なのかそれとも漁業の操業パターンの変化に起因するバイアスなのかを区別する必要がある。毎年の注意深い漁業データのモニタリングは CCSBT をはじめとしたまぐろ RFMO での資源評価に不可欠な作業である。

CCSBT におけるそうした操業パターン変化の検証は、ミナミマグロに関連する全ての漁業について毎年実施すべきである。中でも日本延縄船によるミナミマグロの漁獲データは、CCSBT におけるミナミマグロの資源評価において最も重要なものとして使用されてきたこと、ならびに 2011 年に運用を開始した管理方式 MP では TAC を決定するインプットデータであることから、注意深いモニタリングが必要である。よって我々は 2006 年漁期から毎年、検証文書を提出してきた（Itoh 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, Itoh and Yamasaki 2016）。本文書は、2024 年末までのアップデートであり、過去 10 年間との比較で 2024 年の変化を検討する。

The stock assessment of southern bluefin tuna *Thunnus maccoyii* (SBT) in CCSBT highly relies on data from various fisheries. Fishery data have a crucial advantage that a large amount of information from a large scale in time and space can be easily collected without expensive cost compared to fishery independent researches. However, because its design is not systematic, fishery scientists need to interpret the data properly and to distinguish the reason for any changes in stock indices is whether by changes in stock abundance itself or by bias caused by any change of fishing operational pattern. Careful monitoring of fishery every year is an essential task for stock assessment and management of fish in tuna RFMOs, including CCSBT.

Such a careful examination of fishing operational pattern should be carried out annually for all fisheries relevant to SBT. Among them, the catch data of Japanese longliners is the most important because it has been used as the most important data for the stock assessment of SBT for a long period of years and it is a major input dataset of the Management Procedure which implemented CCSBT in 2011. Therefore, we have been evaluating operational pattern of Japanese longline for SBT every year since the 2006 fishing season (Itoh 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, Itoh and Yamasaki 2016). This paper is the update of it up to the end of 2024.

Material and method

三つのデータセットを解析した。一つ目のデータセットは 2001 年から 2024 年までの RTMP データである。Logbook が日本の漁獲についての公式統計ではあるが、Logbook データにはミナミ

マグロを対象としない操業も含まれ、またデータが使用可能となるまでに 2 年程度の遅れがあることから、最近年の RTMP データと同じ条件で比較することができない。なお、RTMP はミナミマグロを対象として出漁する日本延縄船の全てが報告しており、日本が CCSBT 統計海区の 4-9 海区において漁獲するミナミマグロ漁獲尾数全体の過去においては 90%以上（2001-2005 年の平均値は 93%)、近年は 100%が RTMP に含まれていることから、日本延縄船のミナミマグロ操業を十分に反映している(Sakai et al. 2009)。2024 年以前の 10 年間（2014 年-2023 年）を比較対象とした。ある月の緯度 5 度、経度 5 度区画をセルと称し、解析の単位とした。

二つ目のデータセットは、GAM で標準化した CPUE を求めるために作成したデータ（日本タイプ延縄操業別データと称す）で、日本の logbook データを含み（最近年の一部データは RTMP で補完)、NZ ジョイントベンチャーや豪州枠の RTMP 船操業も含む shot-by-shot データから構成される（Itoh and Takahashi 2025)。

三つ目のデータセットは日本延縄船のミナミマグロ漁獲魚についての 1965 年からの歴史的な体長別漁獲尾数および CCSBT で用いられている年齢 - 体長関係から変換した年齢別の漁獲尾数データである。

日本タイプ延縄操業別データを使用してセル数を、全操業ならびに SBT（4 歳以上魚）が漁獲された操業について集計した。また同じデータセットを使用して、5 度区画・月内において操業のあった 1 度区画の数も集計した。これは一種の操業海域の集中を示す情報である。

操業海域の集中の度合いは別途開発したインデックスでも示した（Attachment 1)。この集中指数は Dr. Hillary が計算方法を提供したもので、操業緯経度の平均位置に対する分散を指標化したものである。集中指数は日本タイプ延縄操業別データセットに適用し、4-9 海区、4 月-9 月のデータにおける釣鈎数とミナミマグロ尾数（4 歳以上魚）の両方について求めた。

RTMP データを使用してミナミマグロの全漁獲尾数（取込尾数＋生存放流尾数＋死亡投棄尾数）に対する放流・投棄尾数の割合を集計した。個別漁獲枠の効率的な利用を目的としてはえ縄船では各船の判断によって生存魚の放流及び死亡魚の投棄が行われている。船は生存放流・死亡投棄別に、目測での 3 体重階級別（20kg 未満、20-40kg、40kg 以上）の個体数を RTMP で報告する。これらの放流・投棄個体数は CPUE の計算には含まれていない。もしも年によって放流・投棄個体数の割合ならびに魚のサイズが大きく変動するとしたら、CPUE に影響がある。特にもしも放流が行われなくなった場合、CPUE が資源状態とは無関係に上昇することになる。なお、CPUE は 4 歳以上の魚で求める。CCSBT において 4 歳魚の下限体長は 105.5 ㎝ FL が用いられており、これは漁業者が慣れているエラはら抜き重量では 20.6kg に相当する。よって 20 ㎏未満の体重階級には 4 歳魚は含まれず、20-40kg と 40kg 以上の放流・投棄の合計がほぼ 4 歳以上の魚に相当する（0.6kg 分だけ若干の過大推定にはなる)。

Three datasets were used for analyses in this paper. The first was the RTMP (RealTime Monitoring Program) data between 2001 and 2024. While logbook data are the Japanese official catch-and-effort data, logbook data, which includes longline operations targeting for other tuna species and requires about two years to be available, does not allow comparison with the most recent year to previous years in the same condition. RTMP data fully represents Japanese SBT longline operation because it includes all longline operations targeting SBT. The data includes more than 90% of total SBT catch of Japan in CCSBT statistical area (Area) 4-9 in the past (mean of 2001-2005 is 93%) (Sakai et al. 2009), and 100% of the catch in recent years. Various statistics of the data in 2024 were compared to the previous 10 years, 2014-2023. Five degrees longitude, five degrees latitude in a month is defined as one "cell".

The second ("Japanese-type longline shot-by-shot dataset") was made for the CPUE standardization with GAM which comprised of Japanese logbook data (Some data from recent years has been supplemented with RTMP.), RTMP data from Australia in the 1990s, and New Zealand charter vessel data (Itoh and Takahashi 2025).

The third contains historical catch-at-length data since 1965.   It was converted to catch-at-age by using the age-length relationship used in CCSBT.

The numbers of cells were calculated for the Japanese-type longline shot-by-shot dataset in two cases, all operations and operations with catch of SBT age 4+. In addition, the number of one-degree squares operated within five-degree square, a kind of indicator for operational concentration, was calculated using this dataset.

Concentration of operation was also calculated as another index (Attachment 1). The concentration index was derived from variance to the mean latitude and longitude of operations over the years, and the method was provided by Dr. Hillary in CSIRO. The index was calculated in two cases, all operations and operations with catch of SBT age 4+ by using the Japanese-type longline shot-by-shot dataset in Areas 4 to 9 in April-September.

RTMP data were used to calculate the ratio of the number of released/discarded fish to the total number of SBT caught (number of retained + live released + dead discarded). For the efficient use of individual quotas, longline vessels release live fish and discard dead fish after they landed fish on deck. Vessels report by RTMP the number of fish in three visual body weight classes (<20 kg, 20-40 kg, and >40 kg), separately for live releases and dead discards. These released/discarded numbers are not included in the CPUE calculations. CPUE will be impacted if the proportion of released/discarded numbers and fish sizes fluctuates significantly from year to year. In particular, if the release is stopped, the CPUE will increase regardless of the stock status. Note that the CPUE is calculated for fish aged 4 and over. CCSBT uses 105.5 cmFL as the minimum body length for age-4 fish, which is equivalent to 20.6 kg in gilled and gutted weight that fishermen are accustomed to. Therefore, age-4 fish are not included in the weight class under 20 kg, and the sum of 20-40 kg and >40 kg corresponds to approximately age-4 fish (though a slight overestimation by 0.6 kg).

Result

1. 漁獲、努力量、サイズ／年齢の概要　Summary of the catch, effort and size/age

図 1 に、CCSBT 統計海区 4-9 海区における、毎年の隻数、使用鈎数、ミナミマグロ漁獲尾数を、過去 10 年間（2014 年から 2023 年まで）の平均値に対する相対値で示す。どの値も 2005 年から 2008 年または 2010 年まで減少し、2010 年から 2013 年までは横ばいで推移した。その後、ミナミマグロ漁獲尾数は増加した。使用鈎数と隻数はほぼ横ばいであり、2022 年に一度低下したが 2023 年と 2024 年にはそれまでよりもわずかに低い水準まで上昇した。

図 2 に、隻数、使用鈎数、ミナミマグロ漁獲尾数の統計海区別組成を示す。漁獲尾数では、7 海区の割合が 2004 年に大きく減少し、2006 年から 2011 年に掛けて再び増加した。それに伴って 4 海区と 8 海区の割合が減少した。2020 年から 2024 年には 8 海区の割合が増加して 9 海区が減少している。

図 3 にミナミマグロの体長組成を示す。2023 年の体長組成は、100cmFL、115cmFL、145cmFL にピークを持つ 3 峰形であった。これに対して 2024 年の体長組成は、110 ㎝ FL と 145 ㎝ FL にピークを持つ 2 峰形であった。過去 10 年間に対して、110cmFL の組成が最も大きくなっている。小型魚の部分は放流による影響も受けている点に留意すべきである（Itoh et al. 2014）。年別の平均年齢（±1 SD）を 1965 年から最近年まで図 4 に示す。歴史的に平均年齢で 6 歳から 8 歳までを利用しており、歴史的な変化は小さい。年別の年齢組成を図 5 に示す。いくつかの豊度の高い年級がおおよそ追跡できる。最近では、1998 年級が 2002 年から 2008 年まで追跡できる。また、2006 年級は 2011 年から 2014 年まで、2010 年級は 2015 年から 2018 年まで、2014 年級は 2018 年から 2022 年まで、2018 年級は 2021 年から 2024 年まで追跡できる。2023 年の 3 歳魚と 2024 年の 4 歳魚の組成が高いことは、2020 年級の豊度が高いことを示唆しているのかもしれない。

図 6 にミナミマグロの全漁獲尾数（取込尾数＋生存放流尾数＋死亡投棄尾数）に対する放流・投棄尾数の割合を示す。6%から 16%まで年による変動が見られた。2021 年から 2023 年には増加していたが、2024 年には 8.2%に低下した。全月・全海区と CPUE に使用される 4-9 月・4-9 海区という二つのデータセット間で実質的な違いは見られなかった。図 7 に 3 体重階級別の割合を示す。小型魚（<20 ㎏）が最も大きな割合を占め、中型魚（20-40 ㎏）がそれに次いだ。2013 年以降に小型魚の割合はわずかに低下傾向で、中型魚と大型魚（>40 ㎏）の割合が増えている。これは漁獲魚全体のサイズの若干の増加に対応している。全月・全海区と CPUE に使用される 4-9 月・4-9 海区という二つのデータセット間で実質的な違いは見られなかった。2024 年に特異的な変化は見られなかった。なお、4 歳+に相当する 20-40 ㎏と>40kg の合計は漁獲尾数（取込尾数+20-40 ㎏放流魚+>40kg 放流魚）の 1.4 から 6.2%、平均 3.8%であり、放流投棄が CPUE を過小にしている程度はわずかであると言える。

Figure 1 shows relative values of the numbers of vessels, hooks used, and SBT caught to the mean values of past 10 years (2014-2023) in the Areas 4 to 9. The values decreased from 2005 to 2008 or 2010 followed by a stable period up to 2013. Since 2013, the number of SBT caught increased significantly. The numbers of hooks used and of vessels were stable, and although they decreased once in 2022, they rose to a slightly lower level in 2023 and 2024 than before.

Figure 2 shows the compositions of numbers of vessels, hooks used, and SBT caught by Area. The proportion of number of SBT in Area 7 dropped in 2004 and increased again from 2006 to 2011. Along with the increase of proportion in Area 7, those in Area 4 and Area 8 were decreased. The proportions in Area 8 increased with a decrease in Area 9 during the period from 2020 to 2024.

Figure 3 shows fork length frequency of SBT by year. In 2023, it has three peaks in 100 cmFL, 115 cmFL and 145 cmFL. In 2024, it has two peaks in 110 cmFL and 145 cmFL, being the largest composition in 110 cmFL over the past 10 years. It should be noted that frequencies in small fish are affected by small fish release and discards (Itoh et al. 2014). Figure 4 shows the mean age (+- 1 SD) from 1965 to the most recent year. The mean age of fish caught ranged between six and eight without historical trend. Figure 5 shows age frequency by year. Several strong cohorts can be seen and possible to follow in several years. In recent years, the 1998 year class can be followed between 2002 and 2008. In addition, several year classes can be followed including the 2006 year class between 2011 and 2014, the 2010 year class between 2015 and 2018, the 2014 year class between 2018 and 2022, and the 2018 year class between 2021 and 2024. The high composition of age 3 fish in 2023 and age 4 fish in 2024 may suggest high abundance of the 2020 year class.

Figure 6 shows the ratio of the number of released/discarded fish to the total number of SBT caught (number of retained + live released + dead discarded). There was a yearly variation from 6% to 16%. It increased from 2021 to 2023, but then dropped to 8.2% in 2024. No substantial differences were found between the two datasets, the all months/all areas and the April-September/4-9 areas used for CPUE. Figure 7 shows the composition for each of the three weight classes. Small fish (<20 kg) accounted for the largest share, followed by medium-sized fish (20-40 kg). There has been a slight downward trend in the proportion of small fish since 2013, and an increase in the proportion of medium and large fish (>40 kg). This corresponds to a slight increase in overall SBT size caught. No substantial differences were found between the two datasets. No specific changes were seen in 2024. In addition, the sum of 20-40kg and >40kg, which corresponds to age 4+, is 1.4 to 6.2% of the number of fish caught (retained + 20-40kg released/discarded fish +>40kg released/discarded fish), an average of 3.8%. It can be said that the extent to which release/discards underestimate CPUE is slight.

2. 操業時空間の変化 Changes of the time and space operated

図 8 に、RTMP 船データセットにおける 4-9 海区内の操業のあったセル（5x5 度・月単位）数の変化を示す。合計セル数は 2006 年の 165 セルから 2018 年の 79 セルまで減少した。2020 年に一時的に 128 セルまで大きく増加したものの、2024 年の 75 セルまで減少した。セルの増減は 9 海区の影響が大きい。

表 1 に、セル数を年、月、海区別に示す。表 2 には、その操業回数を示す。過去 5 年間または 10 年間と比較して 2024 年の操業時期、海域はほぼ同様であった。詳細に見ると、全海区・一年間に対する海区・月別の操業割合が過去 5 年間の組成に対して 3%以上増加したのは、8 海区の 9 月、10 月、11 月であった。逆に 3%以上減少したのは 7 海区の 4 月と 9 海区の 4 月と 5 月であった。各海区の中心時期は 4 海区 6 月、7 海区 5 月、8 海区 9 月、9 海区 5 月であり、過去と同様であった。

図 9 に RTMP 船データセットにおける 1 セル当たりの操業回数を示す。日本の総漁獲枠が半分以下に減少し、漁期撤廃に伴ってセル数が増加したことの結果として、1 セル当たりの操業回数は 2005 年の 114.3 回／セルから 2010 年に 20.7 回／セルにまで減少した。2010 年からわずかな増加が継続し 2018 年に 57.5 回／セルとなった後は減少か横ばいで推移しており、2024 年には 46.1 回／セルであった。7 海区では 1 セル当たりの操業回数が 2010 年から 2018 年まで大きく増加していたが、その後は減少している。

図 10 は日本タイプ延縄操業別データセットを使って求めた 4-9 月、4-9 海区内の操業セル数である。SBT が漁獲されなかった操業も含めた全操業で見ると、操業セル数は 1980 年代から次第に減少し、2002 年、2003 年に低くなった後に 2006 年にかけて増加したが、その後は減少している（図 10a　上図)。2020 年（128 セル）から 2024 年（75 セル）までには 59%に減少した。セルの定義を 5 度区画・月から 1 度区画・月に変更しても傾向は変わらない（図 10a　中図)。5 度区画・月の 1 セル当たりの操業回数（図 10a の白丸）は 1986 年から 2005 年まではほぼ一定であったが、その後は減少し、2007 年以降は横ばいである。データをミナミマグロ 4 歳以上魚が漁獲された操業に限定しても、全操業で見られたものと傾向に違いはなかった（図 10b)。図 11 に 3 年間の年別の努力量分布を示す。努力量が多い 5 度区画は 3 年間で共通しており、周辺的な区画における努力量の有無が年によって異なっていた。9 海区において、2023 年と 2024 年には西側の海域に操業が集中した。

Figure 8 shows the change of the number of cells (five-degree square and month) in Area 4-9 in the RTMP data. The total number of cells decreased from 165 cells in 2006 to 79 cells in 2018. It increased significantly to 128 cells in 2020 but decreased again to 75 cells in 2024. The change in the number of cells is greatly affected by Area 9.

Table 1 shows the number of cells by year, month and Area. Table 2 shows the number of operations. Fishing season and area in 2024 were similar to those in previous five or 10 years in general. Seeing in detail, it increased (>3% of previous five years composition) in September, October and November of Area 8 in terms of the proportions in the number of operations by Area and month to the total number of operations in Area 4-9 and Month 4-9 in 2024. On the contrary, it decreased in April of Area 7 and April and May of Area 9.

The main fishing periods were the same as previous years like June in Area 4, May in Area 7, September in Area 8, and May in Area 9.

Figure 9 shows the number of operations per cell in the RTMP dataset. Because the allocation of TAC to Japan was reduced to less than half and the number of cells operated was increased with the lift of seasonal area closure, the number of operations per cell has decreased to 20.7 times per cell in 2010 from 114.3 times per cell in 2005. Since then, slight increase has continued, and it reached 57.5 times per cell in 2018, followed by decrease or stable pattern to 46.1 times per cell in 2024. In Area 7, the number of operations per cell increased largely from 2010 to 2018, however, has since decreased.

Figure 10 shows the number of cells operated in Area 4-9 and month 4-9 in the Japanese-type longline shot-by-shot dataset. In all operations including SBT zero catch, the number of cells decreased during the 1980s to 2002 and 2003 followed by slight increase until 2006, then decreasing further (Fig. 10a upper panel). It decreased to 59% from 2020 (128 cells) to 2024 (75 cells). No difference was found in the case that the cell was defined as one degree square and month (Fig. 10a middle panel). The number of operations per cell in five-degree square (line with open circle in Fig. 10a) had been stable between 1986 and 2005, then decreased and has been stable since 2007. No difference was found when the data was limited in operations with catch of SBT 4+ only, instead of all operations (Fig. 10b). Figure 11 shows the distribution of hooks used by year for the recent three years. Main squares with large efforts given were same in three years, while presence/absence was different in squares of small efforts in marginal areas. In Area 9, fishing operations were concentrated in the western waters in 2023 and 2024.

3. 操業の集中度 Concentration of area operated

日本タイプ延縄操業別データによる、ある 5 度区画内で操業のあった 1 度区画の数（全数は 25）は、1986-2006 年の平均値は 6.9 個、2007 年以降はやや低下して横ばいである（図 10a 下図）。データをミナミマグロ 4 歳以上魚が漁獲された操業も同様である（図 10b 下図）。

集中度指数は統計海域別に求めた（図 12）。値が高いことは操業海域の拡散を、また低いことは操業海域の集中を意味する。経年的には 8 海区、9 海区は安定的に推移し、5 海区、7 海区は変動が大きかった。8 海区では 2013 年と 2014 年に、漁獲尾数では集中しているが努力量の分布は拡散していた。同じことが 2022 年にもみられた。7 海区の操業位置を詳細に検討したところ、2003 年まではタスマニア島の東西両方で操業があったが、2004 年以降は東側でしか操業しておらず、全年からもとめた 7 海区の漁場の中心（東西の中央になる）から離れたデータが多いことによって指数が増加（拡散）した。

The number of one-degree squares operated in a five-degree square (total is 25) was 6.9 in the average of 1986-2005. It dropped and was stable since 2007 (Fig. 10a bottom panel).

When the data was limited in operations with SBT 4+ only, it is similar to that of all operations (Fig. 10b bottom panel).

Figure 12 shows the concentration index by Area. Smaller and larger values indicate more and less concentrated operation, respectively. The time series have been stable in Area 8 and Area 9, and fluctuated largely in Area 5 and Area 7. In Area 8 in 2013 and 2014, it was less concentrated in terms of hooks while it was still concentrated in catch. Same thing occurred in 2022. Detailed examination of operated area found that, in Area 7, there were operations both the east and west of Tasmania Island before 2003, but only in the east since 2004 (there were only data far apart from the center of Area 7 which obtained from all the years) and resulted in increase of the index (less concentrate).

4. 船の一貫性 Vessel consistency

表 3 に、2024 年の RTMP 参加船（かつミナミマグロを漁獲した船）が過去とどれほど共通しているかを示す。2024 年の 65 隻中、2001-2005 年に 4 年間または 5 年間、RTMP においてミナミマグロ操業を実施したことがあるのは 17 隻（26%）と比較的大きな割合を占めており、船は一貫したものが多いことが分かる。ただし経験 0 年の船が 36 隻と 55%を占めており、船の更新が一部で進んでいることが分かる。

Table 3 shows the consistency of the vessels that participated in the RTMP in 2024 (and caught any SBT) with those in 2001-2005. Among 65 vessels in 2024, 17 vessels participated RTMP during 2001-2005 for four or five years, and they still consist of a substantial proportion of SBT vessels (26%). However, the number of vessels with 0 years of experience was 36 (55%) in 2024, indicating that some of the vessels are being renewed.

Discussion

漁獲量、隻数、操業のあった時空間、海区別割合、体長組成、放流投棄魚の割合、年齢組成、操業の集中度を検討した結果、操業パターンの大きな変化は 2024 年には生じていなかった。2024 年の日本延縄漁業の CPUE は従来と同程度に資源を反映したものとみなすことができるだろう。

日本の漁獲量は 2013 年の 2,694 トンから 2024 年の 6,505 トン（2013 年の 2.41 倍）へと増加した。これに対して RTMP データにおける 2024 年の 4-9 海区の操業回数は 2013 年に対して 1.04 倍と同水準であり、操業セル数は 0.75 倍（75/100）に減少した。漁獲量の増加に対しては CPUE の増加（2.41 倍）が最も貢献していた。

No major change was evident in the 2024 operational pattern in terms of the amount of catch, the number of vessels, time and area operated, proportion by area, length frequency, release and discard, age composition, and concentration of operations. It can be said that the Japanese longline CPUE in 2024 represents the change of SBT stock abundance consistently as in previous years.

The total catches of Japan were increased from 2,694 tons in 2013 to 6.505 tons in 2024 (2.41 times of 2013). However, the factor in the number of operations in 2024 was similar to 1.04 times of 2013 in RTMP data. The factor in the number of cells operated was also small as 0.75 times (75/100) of 2013. The increase of total catch contributed largely to higher CPUE (2.41 times of 2013).

References

Itoh, T. 2007 Change in operation pattern of Japanese SBT longliners in 2007 resulting the enforce of the individual quota system. CCSBT-ESC/0709/39.

Itoh, T. 2008 Change in operation pattern of Japanese SBT longliners in 2007 resulting from the introduction of the individual quota system in 2006. CCSBT-ESC/0809/37.

Itoh T. 2009 Change in operation pattern of Japanese SBT longliners in 2008 resulting from the introduction of the individual quota system in 2006. CCSBT-ESC/0909/28.

Itoh T. 2010 Change in operation pattern of Japanese SBT longliners in 2009 resulting from the introduction of the individual quota system in 2006. CCSBT-OMMP/1006/09.

Itoh T. 2011 Change in operation pattern of Japanese SBT longliners in 2010 resulting from the introduction of the individual quota system in 2006. CCSBT-ESC/1107/31.

Itoh T. 2012 Change in operation pattern of Japanese SBT longliners in 2011 resulting from the introduction of the individual quota system in 2006. CCSBT-ESC/1208/34.

Itoh T. 2013 Change in operation pattern of Japanese southern bluefin tuna longliners in 2012. CCSBT-OMMP/1307/08.

Itoh T. 2014 Change in operation pattern of Japanese southern bluefin tuna longliners in 2013. CCSBT-ESC/1409/Info03.

Itoh T. 2015 Change in operation pattern of Japanese southern bluefin tuna longliners in the 2014 fishing season. CCSBT-ESC/1509/30.

Itoh T. and I. Yamasaki 2016 Change in operation pattern of Japanese southern bluefin tuna longliners in the 2015 fishing season. CCSBT-ESC/1609/22.

Itoh T. 2017 Change in operation pattern of Japanese southern bluefin tuna longliners in the 2016 fishing season. CCSBT-OMMP/1706/09.

Itoh T. 2018 Change in operation pattern of Japanese southern bluefin tuna longliners in the 2017 fishing season. CCSBT-OMMP/1806/10.

Itoh T. 2019 Change in operation pattern of Japanese southern bluefin tuna longliners in the

2018 fishing season. CCSBT-OMMP/1906/08.

Itoh T. 2020 Change in operation pattern of Japanese southern bluefin tuna longliners in the 2019 fishing season. CCSBT-OMMP/2006/10.

Itoh T. 2021 Change in operation pattern of Japanese southern bluefin tuna longliners in the 2020 fishing season. CCSBT-ESC/2108/28.

Itoh T. 2022 Change in operation pattern of Japanese southern bluefin tuna longliners in the 2021 fishing season. CCSBT-OMMP/2206/06.

Itoh T. 2023 Change in operation pattern of Japanese southern bluefin tuna longliners in the 2022 fishing season. CCSBT-OMMP/2306/04.

Itoh T. 2024 Change in operation pattern of Japanese southern bluefin tuna longliners in the 2024 fishing season. CCSBT-ESC/2409/20.

Itoh, T., K. Suzuki and O. Sakai. 2014 Mortality estimation for southern bluefin tuna released and discarded from Japanese longline fishery. CCSBT-OMMP5/1406/08.

Itoh, T. and N. Takahashi 2024. Update of CPUE abundance index using GAM for southern bluefin tuna in CCSBT (GAM22) up to the 2024 data. CCSBT-OMMP/2507/06.

Sakai, O., T Itoh and T. Sakamoto. 2009. Review of Japanese SBT Fisheries in 2008. CCSBT-ESC/0909/Fisheries-Japan.

Table 1. Number of 5x5 degree square where longline operations conducted by year, month and area in RTMP data.

		Year																				
Area	Month	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
4	2							1			1											
	3					3		2	1	1	3	2	1									
	4	2	2		2	4	2	2	2	3	1	2		2	1	1	1		2			
	5	2	2	2	3	2	5	3	4	4	2	3	2	2	3	2	2	2			1	
	6	5	5	3	5	5	5	6	6	3	4	3	2	4	3	3	3	2	3	2	2	3
	7	6	6	4	6	5	2		2		2	1	3	1				1	3	2	1	1
	8	3	1	1	1	1	3	2	2		2	2	1									
	9					1	1	1	2	1	1											
	10				1	2			1			1										
	11																					
	12																					
5	7	1	1	2	2	2	2	2	1	1	2			1	1					1		
	8			3	3	2	2		2		2		2	2	2					1		
	9				2	2			1				2									
	10					1			1													
	12									2												
6	4				2														1		1	1
	5				2													1	1	1	1	1
	6			1	1													1	1		2	1
	1					2																
	2							2														
7	3							1	2	2	2	2	2	2	2		2		1			
	4	2	2		2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	1	2	1
	5	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	6	2	2	2	2							2		2	2	2	2	1	2	2	2	2
	7			1														1				1
	9			2																		
	10	1			1																	
	11	1			1																	
8	1				1	2	2	6		1								2				
	3					2					1	1	4	3								
	4					2		3	1	1	4	4	6	6	2	3	4	1		2		
	5	3	5	1		3		7	4		5	3	4	3	6	3	4		1	2		
	6	4	5					2	2	3	2	3	2	2								
	7			5	8	6	4	2	1	5	3	2	3	2	1		1	4	4	2	4	1
	8			8	8	6	6	4	5	7	5	3	4	3	2	2	1	5	2	5	6	6
	9	13	5	7	6	5	4	2	3	2	3	2	1	3	1	2	1	4	2	3	5	5
	10	9	7	8	8	8	8	2	6	2			2					4	2	2	3	5
	11	9	8	8	7	7	6	3	4	1	1	2	4				2	2	1	3	3	2
	12	8	4	7	6	4	6	1	1			2	4				1		1	3		2
9	2							1					2					6	1	1	4	
	3					3		7	5	5	2	3	3		2		5	12	8	7	7	4
	4				5	7	8	15	8	13	6	6	8	8	12	17	13	18	15	8	8	7
	5	19	25	21	16	14	8	20	15	13	5	10	16	13	12	16	13	20	16	10	8	15
	6	23	20	18	18	15	10	14	13	12	12	11	15	8	13	13	9	17	12	8	6	10
	7	19	19	21	16	16	12	12	11	9	8	10	11	8	6	8	8	10	6	7	4	5
	8	12	13	15	8	11	9	9	9	6	5	6	4	7	3		5	9	5	5	2	
	9			11	5	5	3	5	6	4	6	3	7	7				1	1			
	10			7	4	6	1	3	2	3	4	1	6	4	3	3						
	11			4	2	2		2		1	2											
	12					1	1	1														

Dotted line shows 2006 when the individual quarter system started.

Table 2. Number of operations by year, month and area in RTMP data

		Year																							
Area	Month	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	%10Y	%5Y	2024%
4	2							4			8												0.0%	0.0%	0.0%
	3					30		33	3	2	31	5	1										0.0%	0.0%	0.0%
	4	23	13		39	45	47	60	30	34	2	38		10	2	2	3		5				0.2%	0.0%	0.0%
	5	447	731	530	55	140	203	139	131	149	38	64	108	44	89	73	54	49			1		1.2%	0.6%	0.0%
	6	1179	1122	457	324	147	46	52	74	8	55	52	37	81	79	190	135	43	135	64	17	83	2.1%	2.2%	2.4%
	7	1110	732	115	75	49	35		72		39	14	46	10				16	31	3	20	13	0.4%	0.4%	0.4%
	8	10	1	3	2	1	3	15	5		34	16	2										0.0%	0.0%	0.0%
	9					12	4	4	35	4	3												0.0%	0.0%	0.0%
	10				2	6			2			1											0.0%	0.0%	0.0%
	11																						0.0%	0.0%	0.0%
	12																						0.0%	0.0%	0.0%
5	7	2	6	11	22	17	8	25	4	1	10			3	8					1			0.0%	0.0%	0.0%
	8			27	34	23	11		65		10		30	14	20					2			0.2%	0.0%	0.0%
	9				17	7			20				6										0.0%	0.0%	0.0%
	10					2			3														0.0%	0.0%	0.0%
	12									10													0.0%	0.0%	0.0%
6	4				13														11		3	5	0.0%	0.1%	0.1%
	5				31													23	138	11	136	94	0.8%	1.7%	2.7%
	6			1	22													4	31		124	5	0.4%	0.9%	0.1%
7	1					2																	0.0%	0.0%	0.0%
	2							7															0.0%	0.0%	0.0%
	3							33	25	102	14	54	30	88	135		55		9				1.0%	0.4%	0.0%
	4	530	603		27	181	189	290	449	547	522	500	613	574	612	593	449	204	108	30	58	30	9.7%	4.8%	0.9%
	5	646	397	180	352	183	64	61	118	48	399	276	243	457	598	628	611	473	408	411	364	396	11.5%	12.8%	11.5%
	6	2	3	66	92							14		35	103	104	56	105	232	96	76	126	2.1%	3.2%	3.6%
	7			46														7				2	0.0%	0.0%	0.1%
	9			6																			0.0%	0.0%	0.0%
	10	6			1																		0.0%	0.0%	0.0%
	11	13			2																		0.0%	0.0%	0.0%
8	1				1	2	4	60		2								4					0.0%	0.0%	0.0%
	3					30					7	6	25	23									0.1%	0.0%	0.0%
	4					5		34	3	16	129	206	138	171	9	55	18	16		23			1.6%	0.3%	0.0%
	5	411	651	12		26		55	26		180	246	214	157	36	36	20		14	27			1.9%	0.3%	0.0%
	6	104	13					88	16	33	17	154	85	33									0.7%	0.0%	0.0%
	7			76	103	177	33	4	15	55	47	17	116	30	11		58	25	23	45	39	57	0.9%	1.1%	1.6%
	8			407	773	921	988	259	197	425	461	600	716	738	570	579	453	720	781	917	897	713	18.0%	21.3%	20.6%
	9	489	551	270	630	482	251	13	214	156	76	58	144	265	144	168	55	292	501	183	710	721	6.5%	9.8%	20.9%
	10	589	687	343	379	131	163	8	68	7			7					45	29	23	233	306	0.9%	1.9%	8.8%
	11	904	821	518	750	362	357	95	125	16	13	32	28				26	12	23	38	108	193	0.7%	1.2%	5.6%
	12	618	488	259	115	177	280	2	39			17	25				23		7	28		54	0.3%	0.3%	1.6%
9	2							1					9					31	3	3	24		0.2%	0.3%	0.0%
	3					23		68	44	66	19	12	10		7		69	167	117	79	134	23	1.5%	3.2%	0.7%
	4				66	111	46	298	155	196	107	113	141	138	389	536	598	530	392	134	154	193	8.1%	10.2%	5.6%
	5	2383	1897	905	160	220	184	473	459	359	241	236	358	573	684	888	610	594	340	216	157	217	12.0%	10.8%	6.3%
	6	2826	2537	1163	575	792	394	443	468	534	504	476	655	640	403	537	330	454	256	219	107	206	10.5%	7.7%	6.0%
	7	2832	2802	1513	683	1032	436	222	270	351	179	349	199	444	145	126	121	178	79	163	33	21	4.7%	3.2%	0.6%
	8	522	1261	1738	755	623	266	115	86	116	31	25	64	37	14		27	76	45	23	15		0.8%	1.0%	0.0%
	9			1033	623	224	34	22	121	38	33	55	80	39				1	10				0.5%	0.1%	0.0%
	10			262	183	105	50	22	26	16	55	1	31	27	13	28							0.3%	0.0%	0.0%
	11			24	5	30		35		7	11												0.0%	0.0%	0.0%
	12					5	1	1															0.0%	0.0%	0.0%
Total		15646	15316	9965	6911	6323	4097	3041	3368	3298		3637	4161	4631	4071	4543	3771	4069	3728	2739	3410	3458	100%	100%	100%

"%10Y" and "%5Y" are the proportion of the Area and month to the sum of 10 years (2014-2023) and 5 years (2019-2023), respectively. "%2024" is the proportion of the Area and month to the sum of 2024 data. Shadow and line enclosing denote %2024 is higher (>3%) and lower (<3%) than %5Y, respectively.

Table 3. Number of vessels that caught SBT in RTMP between 2006 and 2024 by the number of years participated in RTMP in past years (2001-2005) in RTMP data.

	Number of years participate in the RTMP during 2001-2005					
	0 year	1 year	2 year	3 year	4 year	5 year
2006	5	7	15	9	20	67
2007	5	10	16	10	22	74
2008	11	8	16	8	22	61
2009	13	4	13	6	15	49
2010	9	4	12	5	14	42
2011	8	6	12	6	12	39
2012	11	6	13	6	14	43
2013	13	4	11	4	14	42
2014	18	3	10	6	13	40
2015	20	3	10	6	11	39
2016	22	3	8	6	11	38
2017	22	3	9	6	11	35
2018	25	3	9	7	10	33
2019	27	3	8	7	9	33
2020	27	3	7	7	7	28
2021	35	3	4	5	7	24
2022	32	2	5	5	7	19
2023	39	2	5	5	7	15
2024	36	2	5	5	5	12

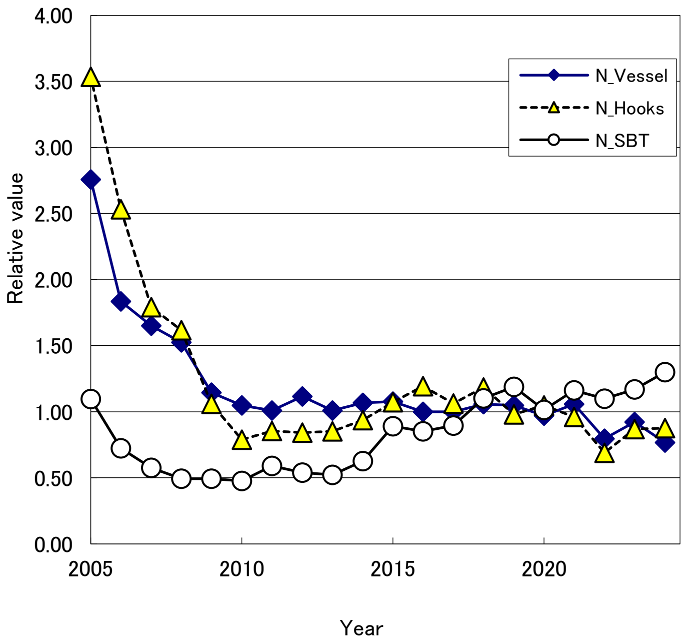

Fig. 1. Number of operation, number of vessels and number of SBT caught in Area 4-9 in 2024 and previous years in RTMP data.

Y axis is the relative value to the average of previous 10 years.

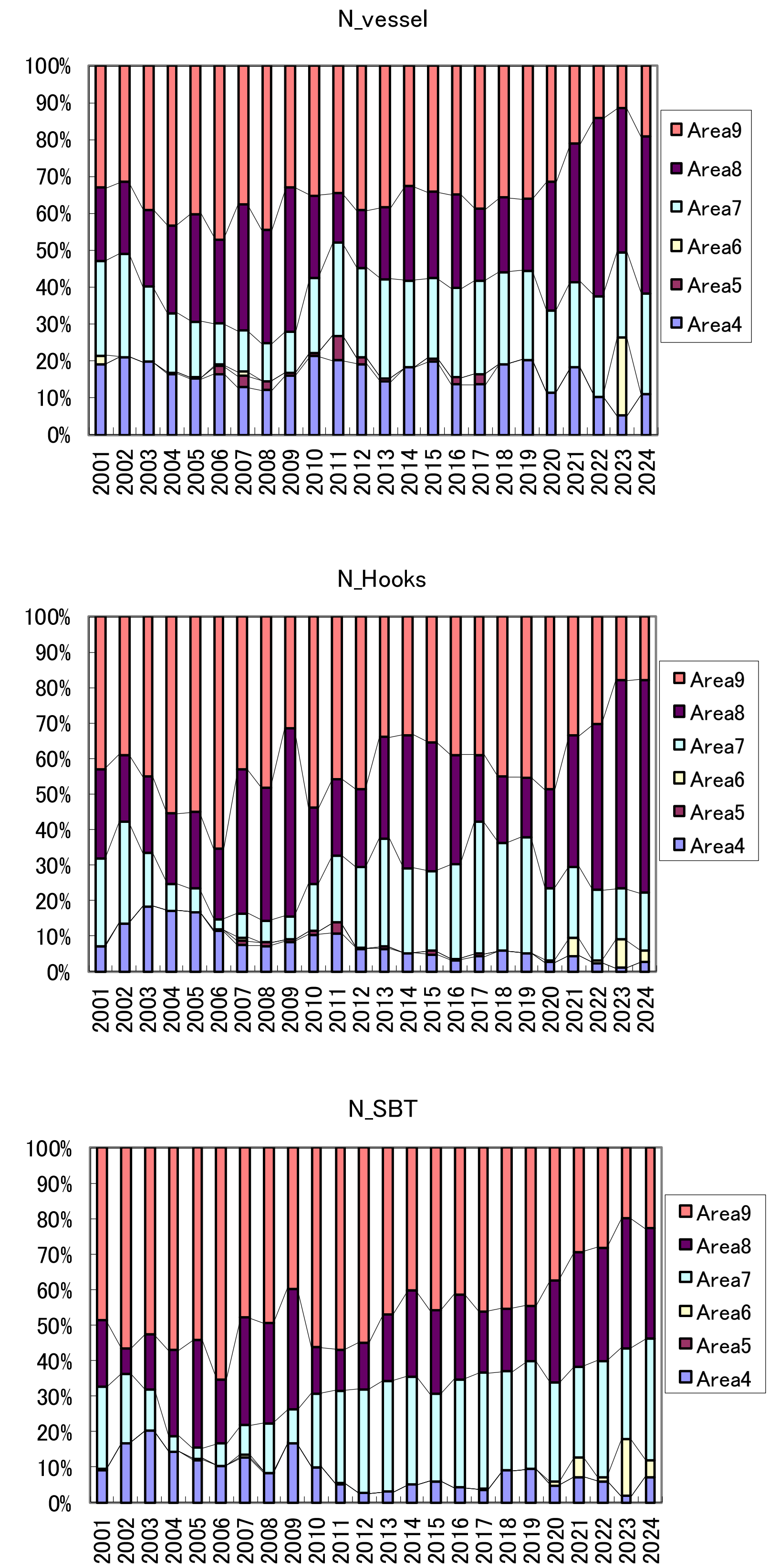

Fig. 2. Proportions of Area in the number of vessels, the number of hooks used and the number of SBT caught in 2024 and previous years in RTMP data.

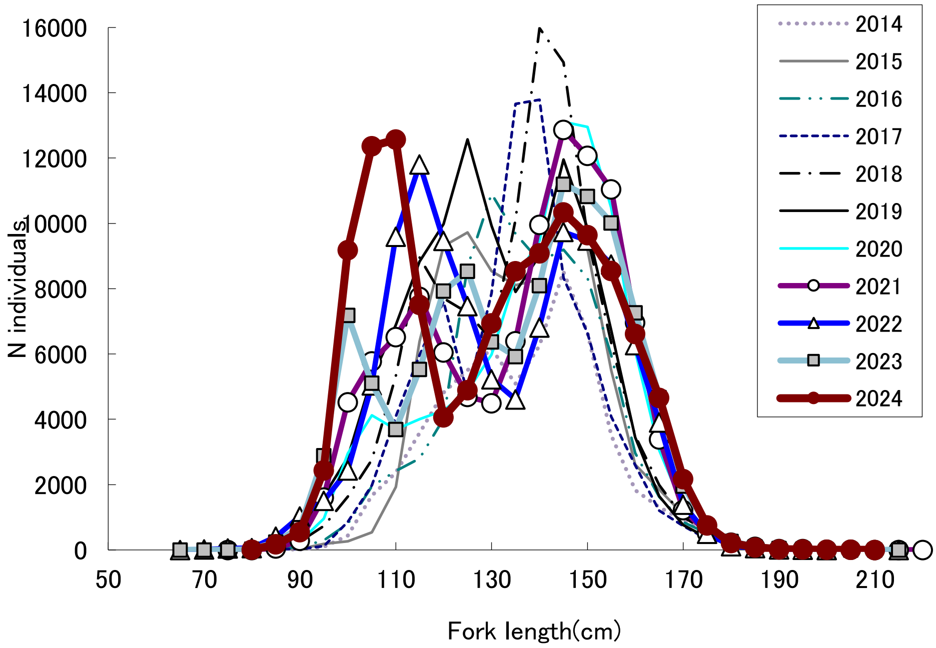

Fig. 3. Length frequency distributions of SBT by year in 2024 and previous 10 years in RTMP data.

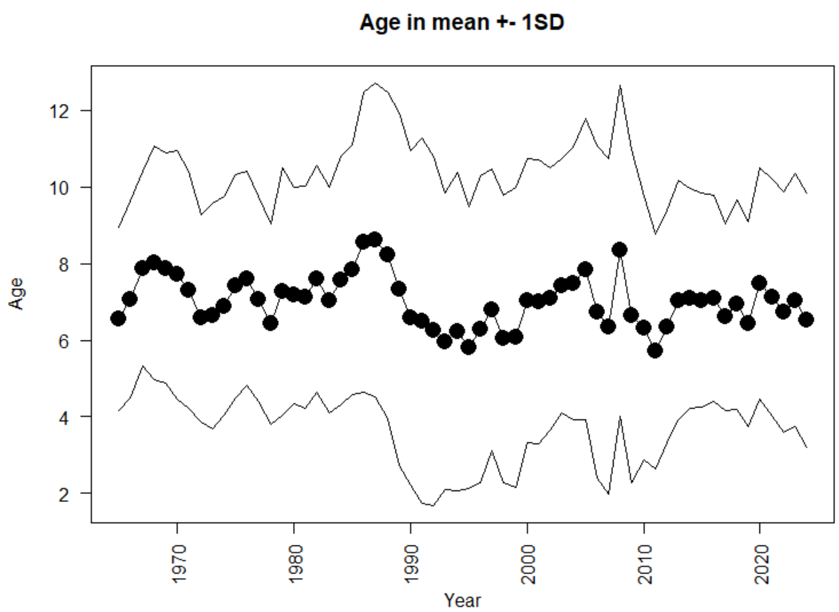

Fig. 4. Mean age SBT by year in the Japanese longline catch.
Range is in +/- one SD.

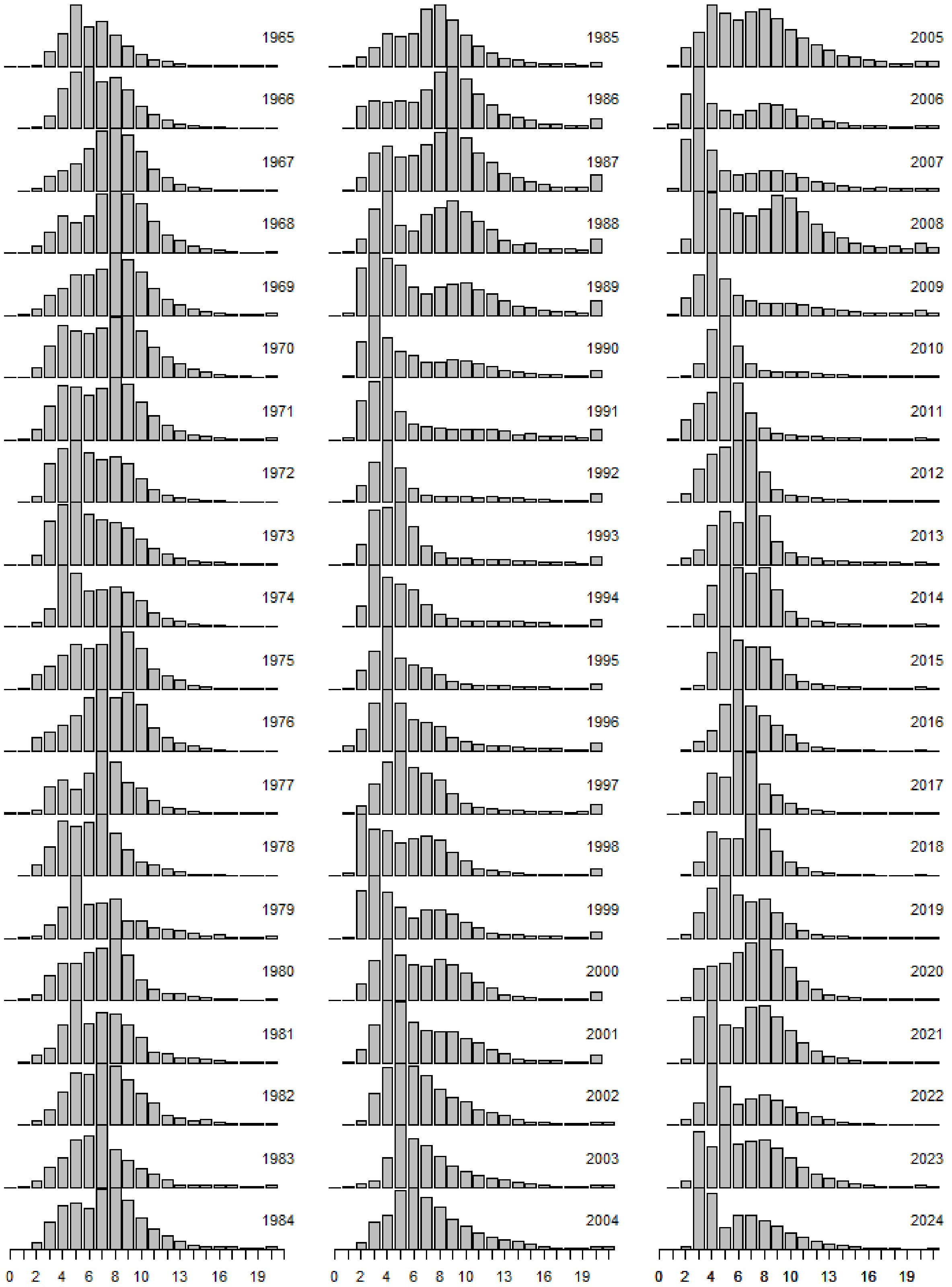

Fig. 5. Age frequency distributions of SBT by year in the Japanese longline catch.

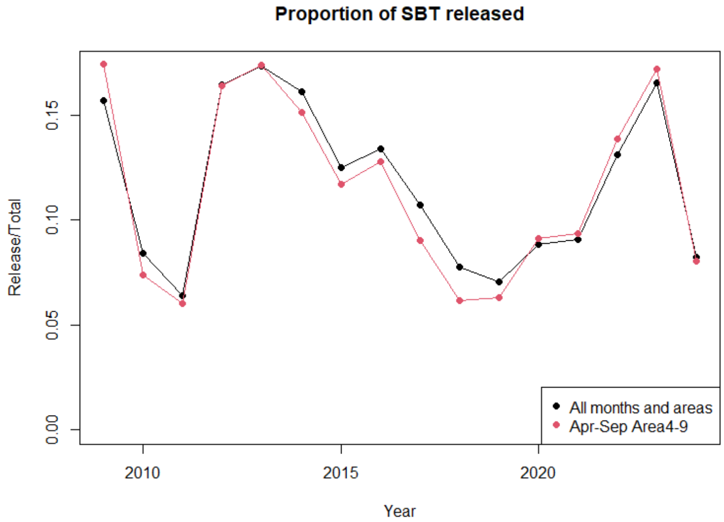

Fig. 6. Proportion of SBT released/discarded in total catch (retained + released + discarded) by year.

RTMP data were used. Two data sets were analyzed; one is in all months and all areas (black) and the other is between April and September and area 4-9 which is used in CPUE (red).

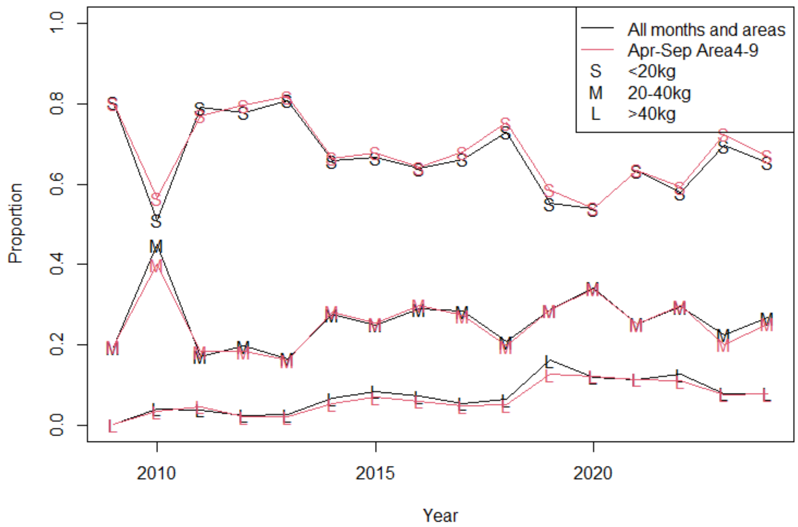

Fig. 7. Proportion of SBT released/discarded in three body weight categories against the total number of released/discarded fish of the year.

RTMP data were used. Two data sets were analyzed; one is in all months and all areas (black) and the other is between April and September and area 4-9 which is used in CPUE (red).

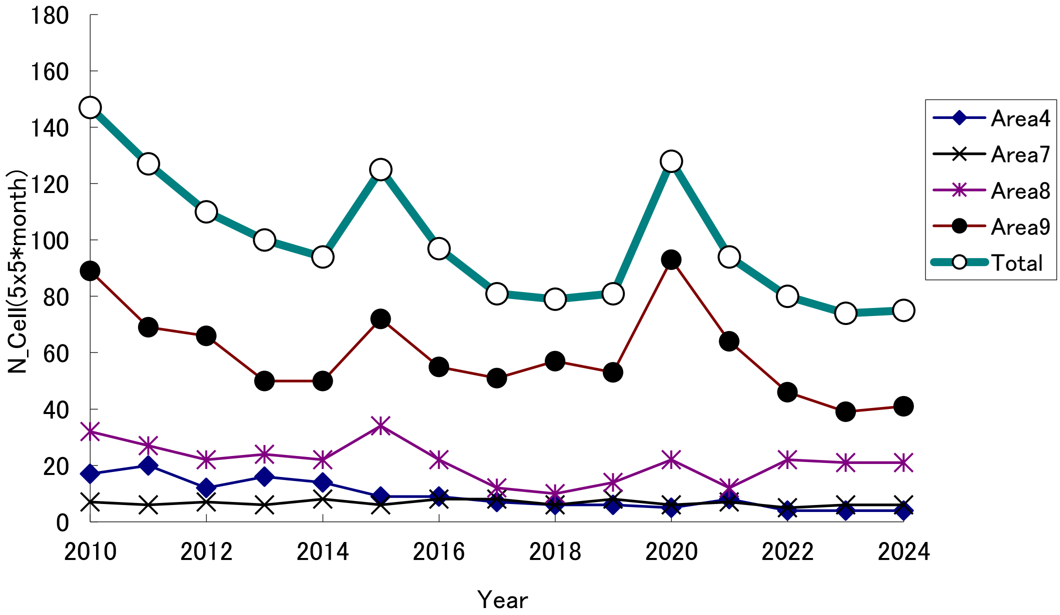

Fig. 8. Changes of the number of cells (5 degrees latitude and longitude and month) operated since 2010 in Area 4-9 in RTMP data.

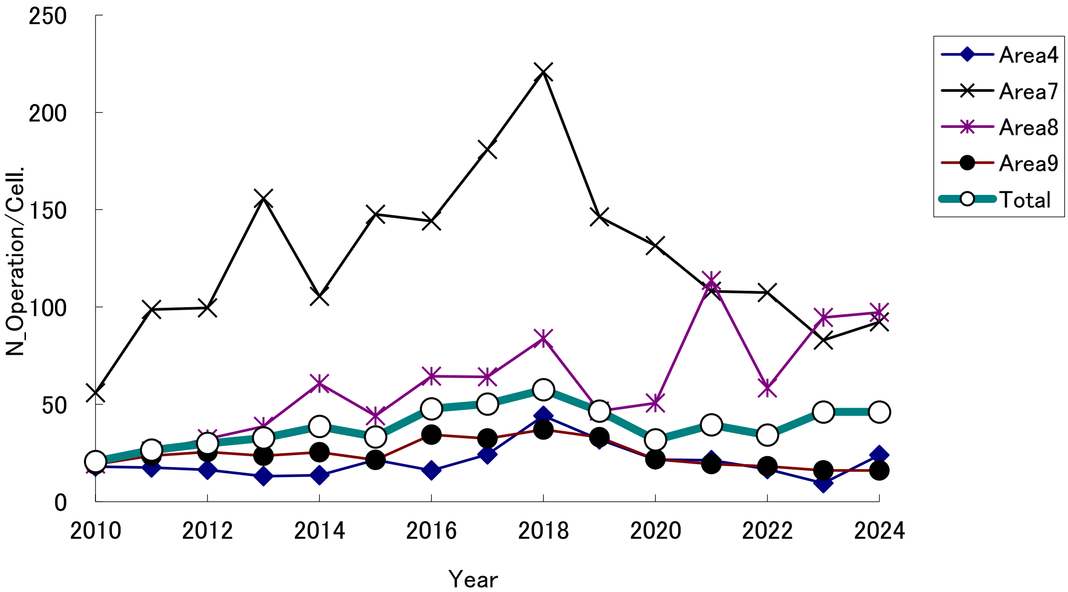

Fig. 9. Changes of the number of longline operations per cell (5 degrees latitude and longitude and month) since 2010 in Area 4-9 in RTMP data.

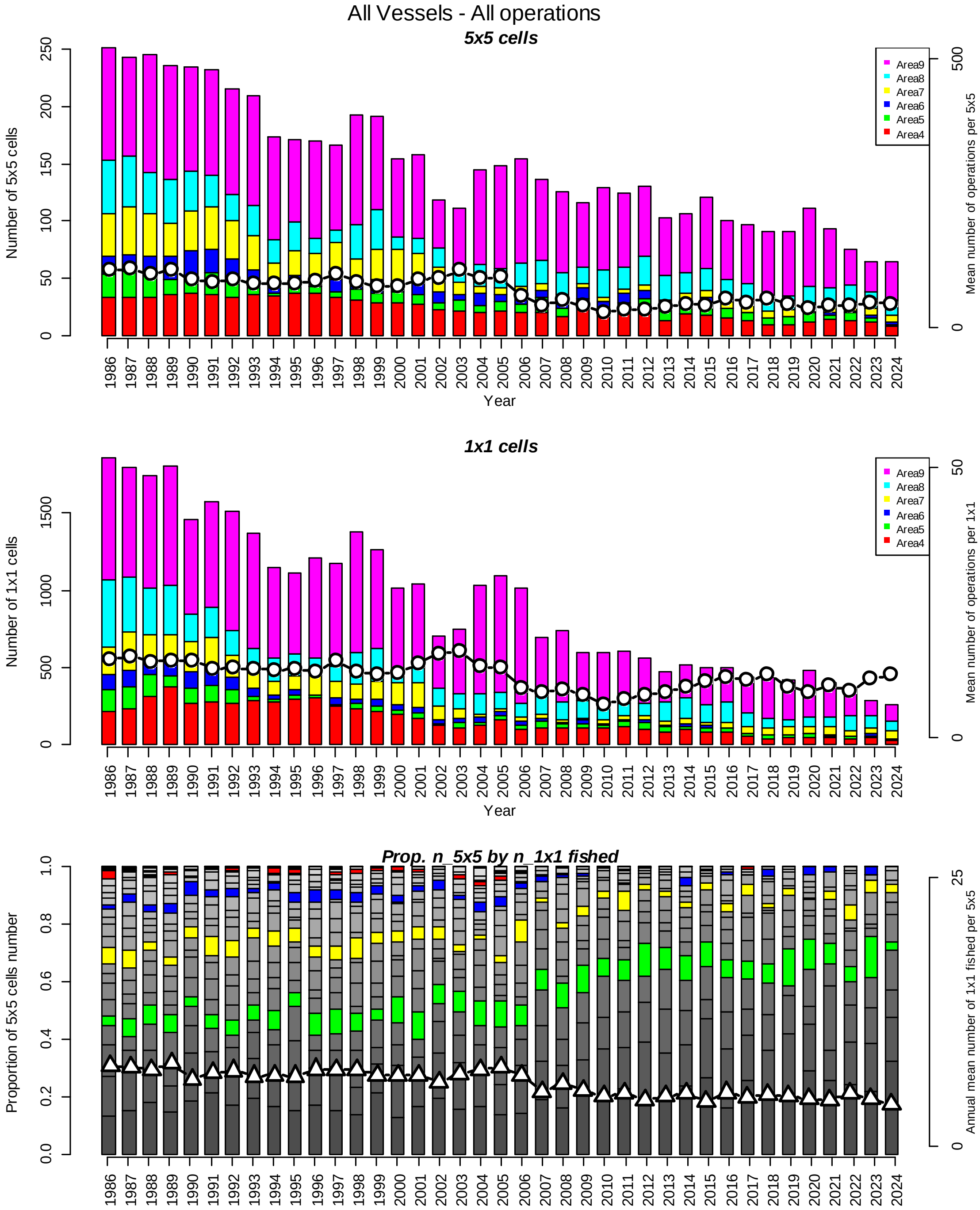

Fig. 10a. Number of cells in the Japanese-type longline dataset for all operations.

(Top panel) Bar represents the number of 5x5 degrees square and month (cell) where fishing operated by CCSBT statistical area and refer to left side y-axis. Line with circle plot represents the mean annual number of operations per cell and refer to right side y-axis. (Middle panel) Bar represents the number of 1x1 degree square and month (cell) where fishing operated by CCSBT statistical area and refer to left side y-axis. Line with circle plot represents the mean annual number of operations per cell and refer to right side y-axis. (Bottom panel) Composition of frequency for the number of 1x1 degree square and month cells operated in a 5x5 degree squares and month cell. Refer to left side y-axis. The grey band is one of 25 cells and that at top is 25 of 25 cells, and every five is colored. Line with triangle represents the mean number of 1x1 month cells operated in a 5x5 month cell and refer to right side y-axis.

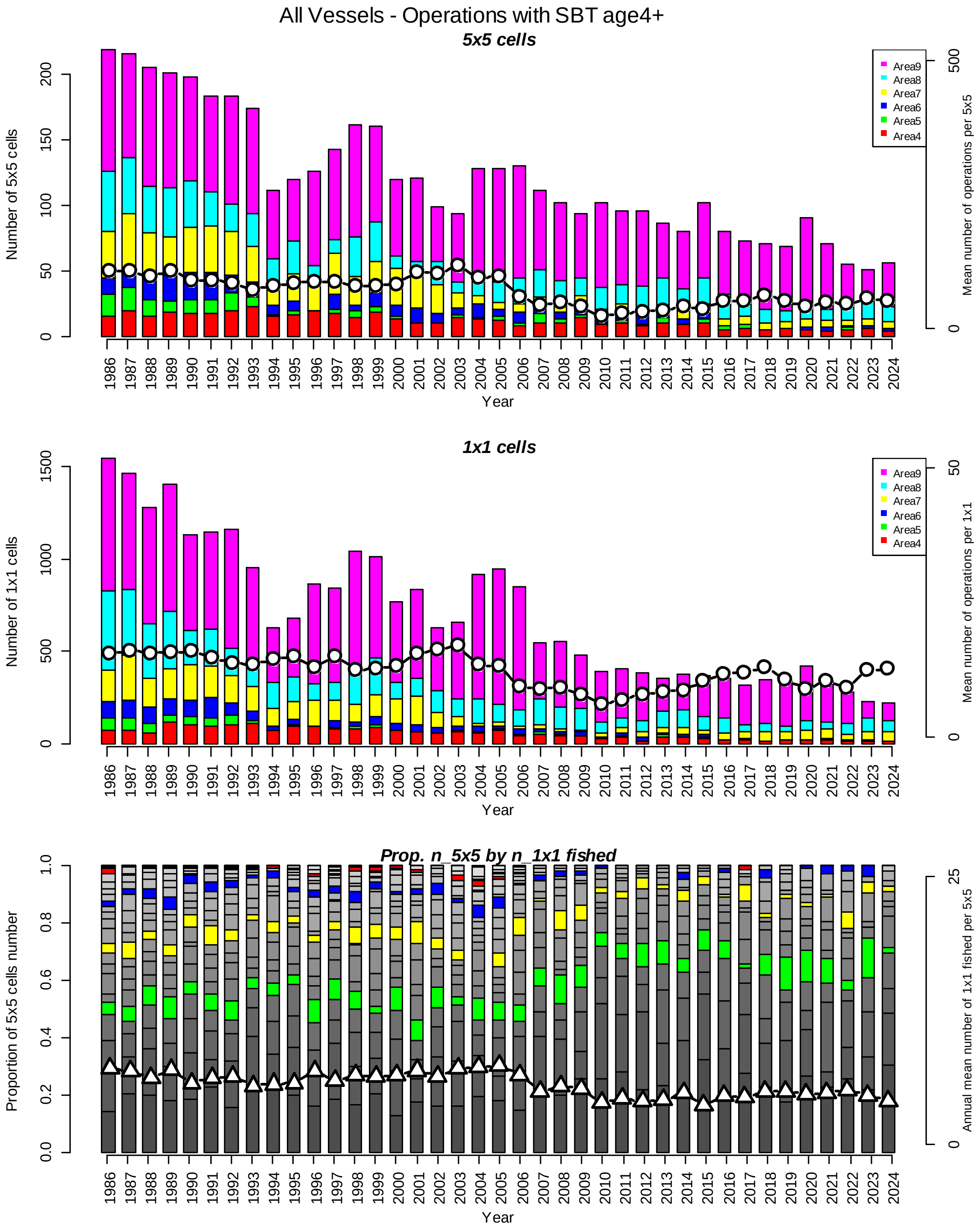

Fig. 10b. Number of cells in the Japanese-type longline dataset for operations of SBT 4+ catch positive. See explanation in Fig. 10a.

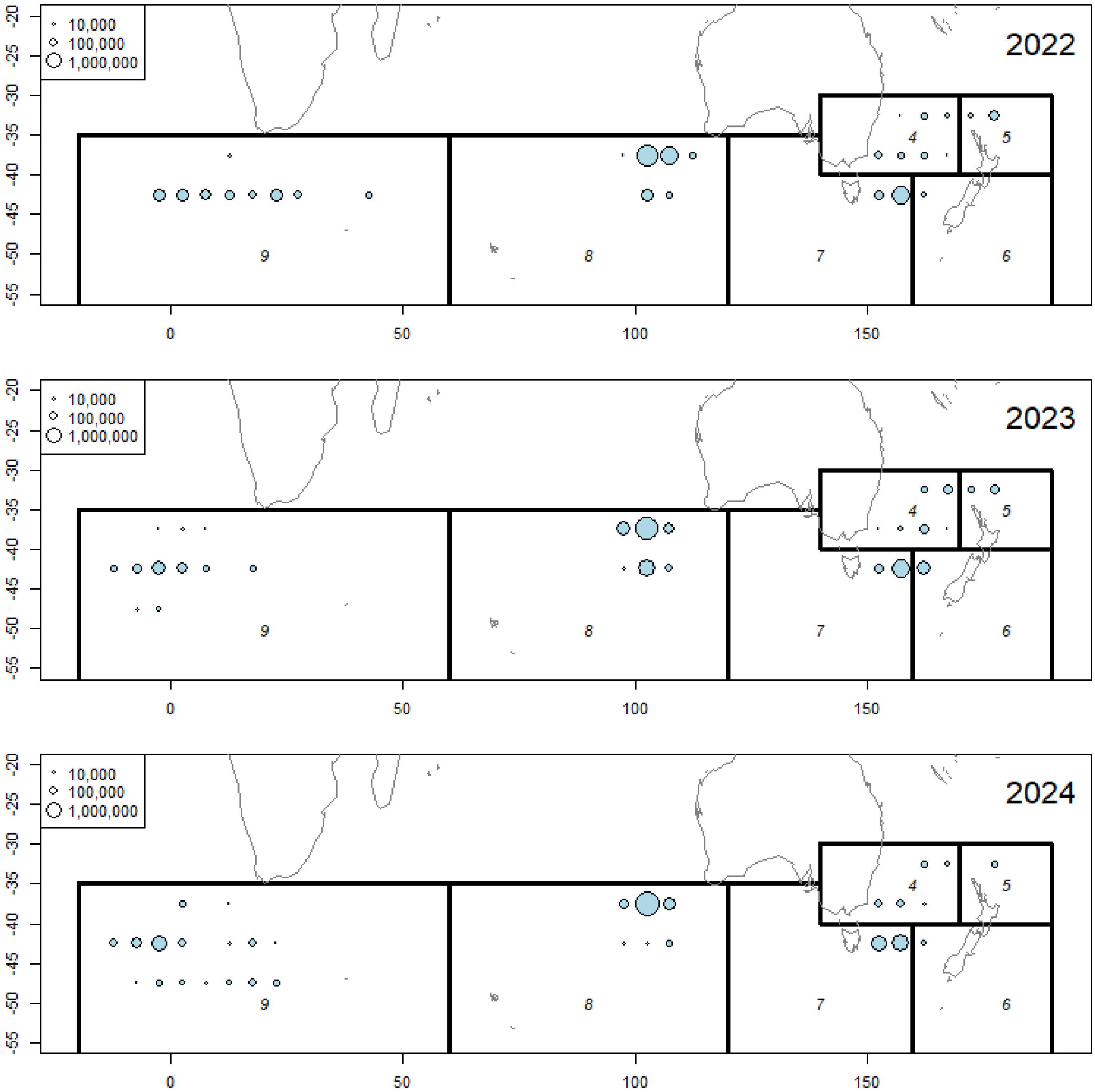

Fig. 11. Effort distribution of Japanese-type longline dataset by year.

Effort is the number of hooks used.

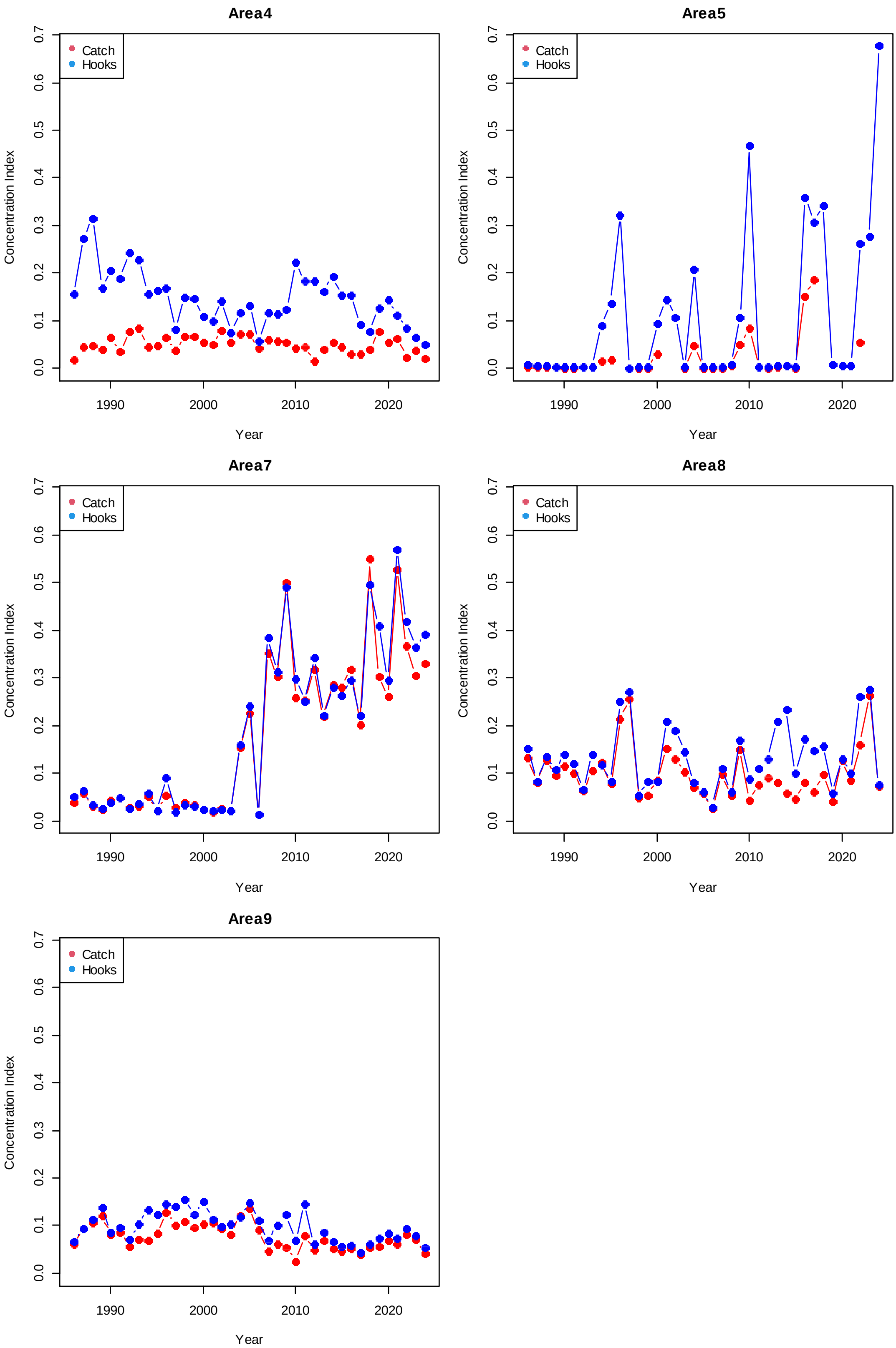

Fig. 12. Concentration index in the Japanese-type longline dataset for catch (age 4+) or hooks to years by CCSBT statistical area

Smaller/larger values relate to more/less aggregated.

SBT exploratory data analysis Idea

In conjunction with usual analyses done for the indicators paper there are some potentially revealing but simple things we can do to be primed for the upcoming assessment of SBT.

CPUE data

This obviously really refers to the $LL1$ CPUE data that will form the basis of the main abundance index in the OM. While that will work with the standardised CPUE there are several things we can look it in the raw data. In terms of a reasonably detailed spatial analysis, by area and 5 × 5 square there are some basic spatial statistics we can look at, henceforth, I_{ijk} denotes the raw CPUE (over a given length/age range) for year i, in region j, in square k. To look at a rough trend in how the average fishing location as changed in each area over time we can simply compute the centre of mass, R_{ij} of the CPUE in a given year i and region j:

$$R_{ij} = \frac{\sum_{k\in j} \rho_k I_{ijk}}{\sum_{k\in j} I_{ijk}} \quad , \tag{1}$$

where ρ_k denotes the physical location of square k in area j (i.e. lat and long) and then the square center of mass of that region in a given year is the square containing R_{ij}. A secondary measure is to see how the density of either effort, catch or CPUE changes over time and in each area. This can be calculated by first estimating the discrete mass density of the given quantity of interest, X_{ijk}, in a given region at a given time:

$$\mu_{ijk} = \frac{X_{ijk}}{\sum_{k\in j} X_{ijk}}, \tag{2}$$

and from this we can estimate the (relative) aggregation, α_{ij}, of the quantity X_{ij} fairly easily:

$$\alpha_{ij} = \frac{E^k(\mu_{ijk})^2}{E^k\left(\mu_{ijk}^2\right)} \tag{3}$$

where $\alpha_{ij} \in \left[N_j^{-2}, 1\right]$ (where N_j is the number of squares in region j) and smaller/larger values of $\alpha_\bullet$ relate to more/less aggregated spatial quantities. Even spread it is equal to 1 and all in one square it is equal to N_j^{-2}.