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Report of the piston-line trolling monitoring survey for the age-1 southern bluefin tuna recruitment index in 2017/2018

ミナミマグロ 1 歳魚の加入指標のためのピストンライン曳縄モニタリング調査 2017/2018 の結果報告

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要約

ミナミマグロ *Thunnus maccoyii* 1 歳魚の加入指数を求める曳縄調査を、2018 年 1 月から 2 月に、2006 年以降と一貫した方法で実施した。この調査では、豪州船を用船し、西オーストラリア州南岸の Bremer Bay 沖に設定した単一ライン（ピストンライン）上を、曳縄をしながら 1 日に一往復、合計 9 ラインを調査した。ピストンラインの周辺海域及び Esperance – Bremer Bay 間の海域のミナミマグロ分布状況も調査した。航海を通じて漁獲したミナミマグロは 257 個体で、その内 66 個体にはアーカイバルタグを装着して放流した。

Summary

In January and February 2018, the trolling research survey that provides the data for recruitment index of age-1 southern bluefin tuna *Thunnus maccoyii* (SBT) was carried out in a similar manner since 2006. In the survey, a chartered Australian vessel went and back on the same straight line (piston-line) off Bremer Bay on the southern coast of Western Australia using trolling for a total of 9 lines. The adjacent area of the piston-line and the area between Bremer Bay and Esperance were also surveyed. During the cruise, a total of 257 SBT individuals were caught. Among them, 66 fish were implemented archival tags and released.

1. Introduction

Recruitment level is crucial information on stock management of fish, including southern bluefin tuna (*Thunnus maccoyii*, SBT). Several research activities have been attempted for the recruitment monitoring of SBT. Since 1989, Japan has conducted a series of recruitment monitoring survey within a cooperative research framework with Australian scientists. Japan carried out a trolling and pole-and-line catch monitoring survey from 1989 to 1993, and then carried out an acoustic monitoring survey using sonar and echo sounder from 1995 to 2006, for age-1 SBT distributed off the southern coast of Western Australia (Itoh 2006). The recruitment index derived from the acoustic monitoring survey predicted the low recruitment levels of the 1999-2001 year classes of SBT which was confirmed several years later by the model-based assessment so that it was likely to be a reliable index. However, the survey was ceased after the final survey in 2006 due to the budget restriction. Alternatively, we have carried out a trolling survey since 2006. Australia had carried out a scientific aerial survey in the Great Australian Bight in South Australia since 1993 and provided the recruitment indices, as the aerial survey index, to CCSBT (Eveson et al. 2006). The aerial survey was discontinued after 2017 because of budgetary reason and logistical problems. Since 2016, pilot Gene Tagging (GT) project has been started instead of the aerial survey. GT estimates the absolute amount of resources of age-2 SBT for next Management Procedure (MP).

The trolling survey is a reasonable way to know the recruitment status of age-1 SBT. The recruitment index of age-1 SBT from this survey have provided to CCSBT as fisheries indicators and robustness test for MP. This survey finds SBT schools by trolling off southwestern Australia. Additionally, we set the single straight transect line in the survey area and are investigating intensively each year on this line (Itoh and Kurota 2006). This survey is a long-term survey covering 12 years from 2006 to 2018 (Itoh and Kurota 2006, Itoh and Sakai 2007, 2008, 2009a, 2010, Itoh et al. 2011, 2012a, 2013, Itoh and Tokuda 2014, Itoh and Tsuda 2016, Tsuda and Itoh 2017). The longtime series data can be expected to detect not only the interannual fluctuation of recruitment of age-1 SBT but also a medium-term trend of it. Additionally, the recruitment index from this survey become available immediately in the same year of the survey carried out, i. e. the time-lag from the survey to data become available is 0 year. On the other hand, the GT data has not yet to be a time series. The estimated absolute age-2 SBT abundance from GT has the time-lags of 2 years from sampling to the data become available. Therefore, to find recruitment failure, if it occurred, as quick as possible and understand the recruitment trend roughly, it is necessary to continue the trolling survey for the age-1 SBT.

In January and February 2018, we carried out the 12th trolling monitoring survey. This paper describes the general results of the survey. Trolling index calculated from this

survey data is described in another paper (CCSBT-ESC/18/09/27).

2. Materials and methods

An Australian vessel, *The Southern Conquest* with 17 m in total length, was chartered (Fig. 1). The vessel was the difference from the one used in previous years. The boar type and size (both 17 m length) was similar. Two researchers and two Australian crew members were on board.

The research area was off the southern coast of Western Australia between off Esperance (122E) and east of Albany (118E), including off Bremer Bay (Fig. 2). The area covers about 450 km x 60 km. In the research area, continental shelf of about 70 m in depth extended largely from the coast, and then dropped sharply at shelf edge to deeper than 500 m in depth within 2 km distance. In 2018, the survey area only extended to the west (118°82´E) off the Bremer Bay. The piston-line laid between the two points same as previous years; one was at 34°29.2´S - 119°23.1´E and the other was at 34°44.9´S - 119°36.9´E so that the piston-line covered a range from the continental shelf to offshore through shelf edge in distance of 35.9 km.

The vessels engaged in the research survey from 5:00 to 17:00 and anchored in the calm bay at night. The vessel operated trolling at speed of 7-8 knots. Eight trolling lines at maximum were trolled. Each line has one hook with a plastic lure. The specifications of the trolling gears were consistent with those used in the last year survey. Because the trolling index derived from the survey is based on the number of SBT schools, not the total number of SBT individuals caught, we did not try to maximize the number of fish caught.

Individual fish caught of any species were measured by its length. SBT in good condition were tagged with an archival tag (Lotek Inc., LAT2810L) and released without conventional tags. Some other SBT individuals were weighed and taken biological samples (stomach contents, otoliths, and muscle tissue). There were some SBT individuals only its fork length (FL) measured and released.

Oceanographic observation for vertical profile of temperature and salinity (conductivity) was carried out at 25 points using the Conductivity-Temperature-Depth profiler (JFE Advantech Co. ltd., CTD RINKO-Profiler) to just above sea bottom or 200 m in depth. GPS position data were recorded every one second.

3. Results

The trolling survey started on 31 January 2018 off Esperance in south Western

Australia. After 3 days survey off Esperance, the vessel moved to the west and surveyed off Bremer Bay from 4 February to 12 February, then came back to Esperance and surveyed again off Esperance from 14 to 17 February. The piston-line off Bremer Bay was surveyed in 7 days for 9 lines.

During the survey, a total of 285 fish individuals were hooked, including 257 SBT, 3 skipjack *Katsuwonus pelamis*, 1 blue mackerel *Scomber australasicus*, 5 yellowtail kingfish *Seriola lalandi* and 18 unidentified and escaped individuals far from the vessel. Among the 257 SBT individuals, 66 SBT were implemented archival tags into their body cavities. 76 SBT were killed for biological sampling. Total weight of SBT killed was 229.1 kg.

In 2018, there are several points that the distribution of SBT differed from previous years. Off Bremer Bay, few SBT were caught on continental shelf and edge, where the usual area of SBT catch. No age-1 SBT was caught on the piston line off the Bremer Bay, while a few age-2 SBT were caught on the lump near the coast on the piston line. Instead, we encountered a big school of age-1 fish off the shelf edge and many fish were caught from the school. Off Esperance, we could catch a large number of SBT around the lump in West Group Islands. However, in the other area where is off east and south of Esperance, we could not catch any SBT.

Length frequency of SBT caught in the 2018 survey is shown in Figure 3. SBT caught ranged from 36 to 78 cm FL and the mode of frequency was around 50cm FL which is consistent with that of this area in the previous 20 years. Most of that fish was presumably age 1.0 fish born in January-February 2017 (Itoh et al. 2012b) The small fish around 35cm FL was appeared to be age 0.3 born in October 2017.

4. Discussion

Fishery data are basic information to assess the current stock status of SBT in CCSBT. Especially, CPUE of Japanese longline, which covers wide area and season and wide age range that based on detailed information reported from fishermen, is a long time series index more than 40 years for SBT stock status. The aerial survey was also a valuable research. It covered a wide area in a short duration of time in the Great Australian Bight (GAB) by using airplane and data of school biomass is derived as an estimation of a spotter. However, there is no index that directly reflects the status of SBT stock in whole ranges in both age and geographical distribution. Therefore, we need to collect a variety of information as many as possible to decide stock status appropriately. Trolling survey provides an important information of age-1 SBT abundance.

The trolling survey is designed to correspond to the temporal and spatial distribution of age-1 SBT, although its survey period and geographic area are limited. A majority of age-1 SBT is thought to be distributed in the coastal area of Western Australia in austral summer (Itoh and Sakai 2009b). Then the age-1 SBT widely migrates to east and west at the end of the summer, although the majority of the SBT move to GAB. SBT of age-2 and older are distributed so widely in the area between off New Zealand and off Cape, and the fish returns to GAB by the following year is not always. Therefore, the recruitment survey targeting age-1 SBT in the southern coast of Western Australia may have a potential to provide abundance index that represents whole the stock at age-1 SBT.

To derive accurate year trend in an index of recruitment level, we need to exclude other factors that fluctuate by year. Carrying out the research in a consistent method for all years is a good way for this. We have not changed the gear specification used, and general research method for 12 years. We changed the research vessel at the 10th and 12th survey, but the type and size of the vessels were consistent all the survey. The research area has been consistent for 12 years where the main research area has been off Bremer Bay and carried out the piston-line survey. Such consistent survey design is expected to facilitate to obtain an index that reflects only for annual SBT recruitment change. Additionally, the trolling survey is a robust research against environmental factors, including wind, wave and swell. There were few days that suspended the research during the cruise due to rough sea condition in 12 years. We did not find a tendency that SBT were less caught in rough weather condition (see CCSBT-ESC/1708/24).

Agreements of trends were observed between the trolling survey indices derived from this survey and several recruitment indices from the CCSBT stock assessment, e.g. recruitment output from OM and Nominal CPUE of age-4 SBT in Japanese longline (Itoh 2014). Up to now, the trolling survey appeared to succeed in providing data for the recruitment index that represents the whole age-1 SBT stock. Then, there is no need to change the current survey design so far.

However, it does not guarantee the survey design to be appropriate in future. There are several points of concerns to be pointed out relating representativeness of the research data against the whole age-1 stock. SBT distribution within the research area may change by year. In this survey, for example, although many SBT were caught on the shelf edge in 2006, 2007 and 2009, few SBT were caught there in recent years (2012-2018) (CCSBT-ESC/18/09/27). To reflect such annual distribution fluctuations on the abundance index, we are intensively conducting the trolling on the piston-line covered from shore to offshore and developing a grid-type trolling index covering all survey area (Itoh 2014, Tsuda and Itoh 2017, Tsuda and Itoh, 2018).

Another concern is the residence time of age-1 SBT in the survey area. Although the survey period from January to early February overlaps the residence time of juvenile SBT in the survey area, the peak of migration through the survey area may be varied. The previous study showed the temporal patterns of residence times of juvenile SBT in the survey area related to these spatial migration pathways in 2004-2007 (Fujioka et al. 2010). The inshore-migrating SBT were left progressively from survey area in the early month of each summer (Dec-Feb) in 2005/06 and the shelf migrating SBT remained on the shelf over a longer period (Dec-Apr) in 2004/05 and 2006/07. The abundance index may be affected by the proportion of the age-1 SBT population migrating in the survey area. The mechanism for the temporal and spatial movement patterns must be considered related to oceanographic conditions. Electronic tagging would be an effective way to know the movement pattern of age-1 SBT on the environmental condition.

The sub-cohort structure is also of concern. All the years, age-1.0 fish were the primary component. In several years, e.g. 2011, 2012, 2013 and 2016, a significant part of age-1.3 SBT was large that corresponding to age-1, such as 42% in 2011, 55% in 2012, 36% in 2013 and 20.8% in 2016. Its effect on the research design or index should be taken into account.

Such uncertainties on the potential existence of age-1 SBT outside of the research area and season may harm the representativeness of the trolling index. However, it would be a little effect if the proportion of the outside fish was negligible or such a proportion was stable over years. If such a proportion changed largely by year probably due to the fluctuation of oceanic conditions, it may give a large impact on the trolling index. Although we should be careful about such potential concerns, there is no actual information to support any of the concerns so far.

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Figure 1 The Southern Conquest, used for the research.

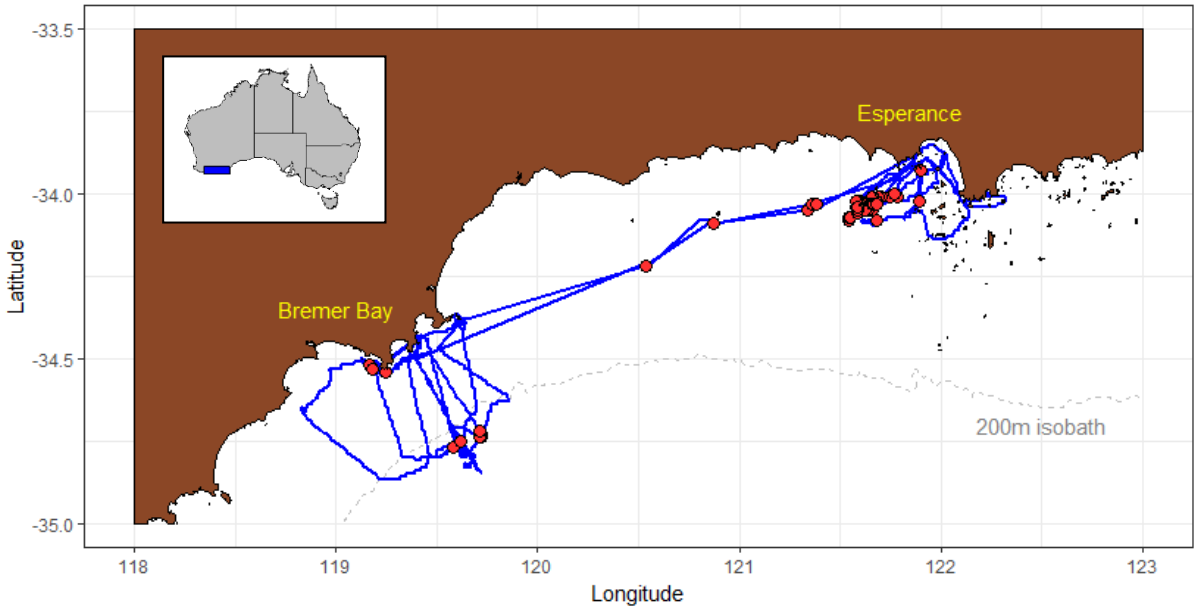

Figure 2 Trajectory of the vessel (blue line) and location of SBT caught (red circles) in the 2018 survey.

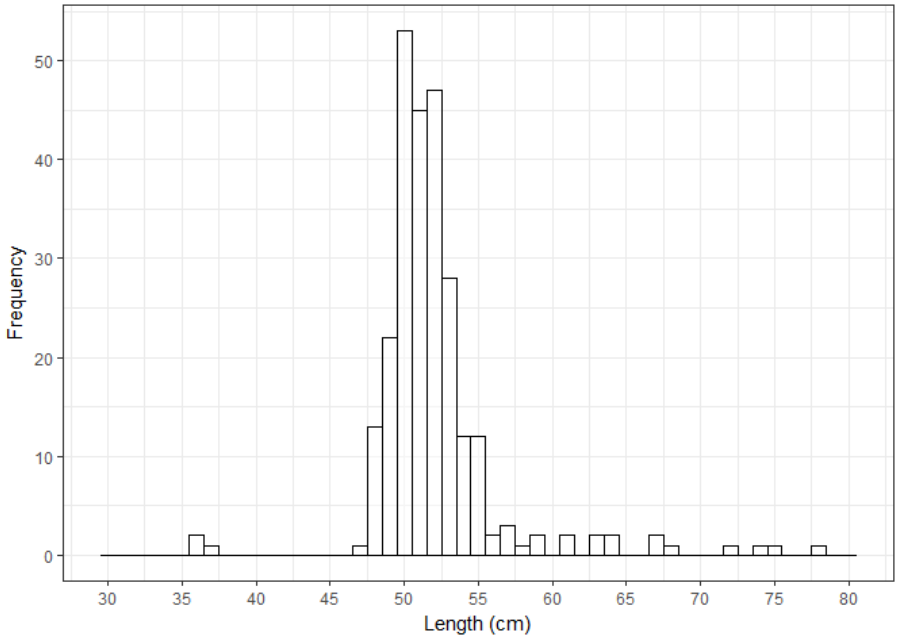

Figure 3 Fork length frequency distribution of southern bluefin tuna caught in the 2018 survey.