Report of the piston-line trolling monitoring survey for the age-1 southern bluefin tuna recruitment index in 2016/2017

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
2016/2017 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、2017 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 10 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 259 個体で、その内 83 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 2017, the trolling research survey that provides the data for recruitment index of age-1 southern bluefin tuna *Thunnus maccoyii* (SBT) was carried out in similar manner since 2006.   In the survey, a chartered Australian vessel went and back on the same straight line (piston-line) off Bremer Bay in the southern coast of Western Australia using trolling for a total of 10 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 259 SBT individuals were caught.   Among them, 83 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).　Since 2006, Australia has had the largest national allocation of TAC of SBT in CCSBT (Anon. 2006).　Most of the Australian catch, used for farming, is mainly age three with a range between two and four, which is the earliest age of SBT fished compared to other nations' fisheries.　Given high fishing pressure in their younger life stage, monitoring the recruitment level of SBT in their early life stage becomes much more important than in previous years.

　Several research activities have been attempted for the recruitment monitoring of SBT. Since 1989, Japan has conducted a series of recruitment monitoring surveys 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).　These researches had been providing the recruitment indices of age-1 SBT to CCSBT for years.　Australia 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).　However, because the aerial survey index is for SBT age mixing from two to four which is the same age of the Australian purse seine catch, it gives little time of consideration to regulate the fishery based on the results of the research survey.　Catch information of SBT age-1 off the southern coast of Western Australia had been provided by the CCSBT SRP tagging program since 2001, but the areas surveyed by the cruise were limited and the tagging was suspended in 2007.

　The acoustic index derived from the acoustic monitoring survey predicted the low recruitment levels of the 1999-2001 year classes of SBT which was confirmed 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, a type of survey that can be done with lower cost was sought.　Since 2006, we have carried out a monitoring survey that a chartered Australian fishing vessel go-and-back on a single straight transect line and find SBT schools by catching with trolling (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).　In January and February 2017, we carried out the 11th trolling monitoring survey.　This paper describes general results of the survey. Trolling index calculated from this survey is described in another paper (CCSBT-ESC/1708/23) and the effects of environmental conditions on this survey is described in CCSBT/1708/24.

2.   Materials and methods

An Australian vessel, *Big Dreams* with 17 m in total length, was chartered (Fig. 1). Two researchers and three Australian crew members were on board.

The research area was off the southern coast of Western Australia between off Esperance (122E) and Albany (118E), including off Bremer Bay (Fig. 2).   The area covers about 500 km x 70 km.   In the research area, continental shelf of 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.   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 continental shelf to offshore through shelf edge in distance of 35.9 km.   In addition to the piston-line, adjacent areas, east, west or south (offshore) of the piston-line as well as the areas west to off Albany and east to off Esperance, were also surveyed to examine whether the piston-line is a representative area regarding SBT distribution until previous year.   The survey area in 2017 only extended to west (118°49′E) off the Bremer bay.

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 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 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 measured and released.

Vertical profile of temperature and salinity (conductivity) were measured down to just above sea bottom or 200 m in depth using a CTD (JFE Advantech Co. ltd., CTD RINKO-Profiler).   GPS position data were recorded every one second.

3.   Results

The trolling survey started on 27 January 2017 off Esperance in south Western Australia.   After 3days survey off Esperance, the vessel moved to west and surveyed off Bremer Bay from 31 January to 6 February, then came back to Esperance and surveyed again off Esperance from 9 to 13 February.

Usually, the vessels engaged in the research survey from 5:00 to 17:00 and anchored in

calm bay at night.　While there were several days in rough sea, we could carry out the surveys for 14 days among 18 days.　The piston-line off Bremer Bay was surveyed in 5 days for 10 lines.

During the survey, a total of 320 fish individuals were hooked, including 259 SBT, 2 skipjack *Katsuwonus pelamis*, 16 bonito *Sarda orientaris*, 9 yellowtail kingfish *Seriola lalandi*, 2 australian barracuda *Sphyraena novaehollandiae*, 6 australian salmon *Arripis trutta* and 26 unidentified individuals which escaped far from the vessel.　Among the 259 SBT individuals, 83 SBT were implemented archival tags into their body cavity.　94 SBT were killed for biological sampling.　Total weight of SBT killed was 281.3 kg.

In 2017, most of SBT were caught near the coast and lumps.　A few SBT were caught on the continental shelf but they could not catch on the shelf edge (Fig. 2).

Length frequency of SBT caught is shown in Figure 3.　SBT caught ranged from 34 to 78 cmFL.　SBT caught in 2017 is consistent with that of this area in previous 20 years in terms that fish around 50 cmFL, presumably age-1, was the main component.　A mixed normal distribution was applied to the length frequency so that length groups to be decomposed in the method described in Itoh et al. (2012b). In size distribution of SBT in 2017, age-1.0 and age-1.3 fish could not clearly be distinguished, and accounted for 91.0% of the total fish (Fig. 4).　Age-2 fish at mean length of 68.5 cmFL occupied 7.4 % of them. The small fish at 34 and 35 cmFL was appeared to be age-0.3 born in October 2016.

4.　Discussion

Fishery data are basic information to assess current stock status of SBT in CCSBT. Especially, CPUE of Japanese longline, which covers wide area and season and wide age range and based on detailed information reported from fishermen, is a long time series index more than 40 years for SBT stock status.　Aerial survey is also a valuable research. It covers wide area in a short duration of time in the Great Australian Bight by using airplane and data of school biomass is derived as an estimation of 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 information from as many as possible to decide stock status appropriately.　Trolling survey provide an important information of age-1 SBT abundance.

SBT of age three and more are distributed so widely in the area between off New Zealand and off Cape that any part of the whole stock is the subject of the aerial survey in the Great Australian Bight and longliners in Taiwan and Japan.　SBT of age-1 is thought to be distributed in the coastal area of Western Australia (Itoh and Sakai 2009b).　A

recruitment index derived from SBT age-1 in Western Australia by any measure (not restricting trolling catch) is expected to provide abundance index that represents whole the stock at an age.

There are advantages of the trolling survey compared to the acoustic survey and the aerial survey, which is complementary with other methods. Species identification and size of SBT are definite data which were measured in the trolling survey. The trolling survey is a robust research against wind, wave and swell. There were few days that suspended the research during the cruise due to rough sea condition in 11 years. We did not find a tendency that SBT were less caught in rough sea condition (see CCSBT-ESC/1708/24).

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 consistent method for all years is a good way for this. We have not changed the gear specification used, and general research method for 11 years. We changed the research vessel at the 10th survey, but type and size of the vessels were same to the one previously used. The research area has been consistent for 11 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 index that reflects only for annual SBT recruitment change.

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 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. One concern is that SBT distribution within the research area may change by year. For example, although few SBT were caught on the shelf edge in 2013 and 2014, many SBT were caught on there in 2013 (Itoh et al. 2013). In 2017, any SBT were not catch on the shelf edge at all.

Another concern is that any amount of SBT may be distributed in other areas. A part of SBT age-1 may have already left the survey area at the time of the trolling survey. Some fish may have not yet arrived, or some fish may do not come the trolling survey area. However, we have little information that shows existence of large amounts of age-1 SBT outside of the trolling research area in January and February at present. Even though aerial survey reported "age-1" fish in Great Australian Bight, their definition of less than

8kg to be age-1 (Eveson et al. 2013) was too large for age-1 fish (3 kg in mean). Electronic tagging or examination on the environmental condition would be an effective way to know distribution dynamics of age-1 SBT.

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 SBT was large that corresponding to age-1.3, such as 42% in 2011, 55% in 2012, 36% in 2013, though negligible in other years, e. g. in 2014, 2016 and 2017. Its effect on the research design or index should be taken account.

Such uncertainties on 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 little effect if 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 a possibility, there is no actual information to support the possibility so far.

Acknowledgement

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Table 1 Estimated parameter values of mixed normal distributions which applied for length frequency in 2017 in whole the survey area.

	1st mode	2nd mode	3rd mode	4th mode
Mean length	34.0±0.18cm	49.1±0.11cm	50.5±0.33cm	68.5±0.76cm
Standard Deviation	0.3±0.27cm	1.2±0.15cm	3.4±0.28cm	2.0±0.76cm
Proportion	1.6±4.0%	29.4±6.1%	61.6±6.6%	7.4±2.67%*)

Values following ± is standard error of mean.   *) denotes the standard error was calculated with delta method.
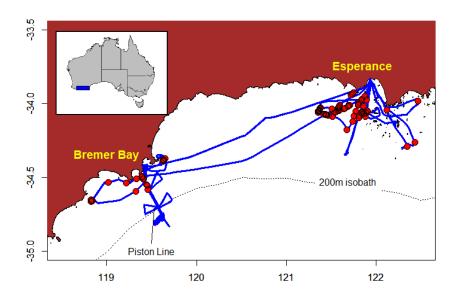

Figure 1 Big Dreams, used for the research.

Figure 2 Trajectory of the vessel and location of SBT caught (circles) in the 2017 trolling survey.
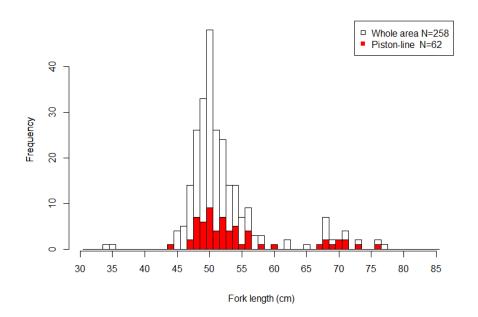
Figure 3   Fork length frequency distributions of southern bluefin tuna caught in the 2017 cruise.   That of fish caught off Bremer Bay (119E-120E) is also show as Piston-line.
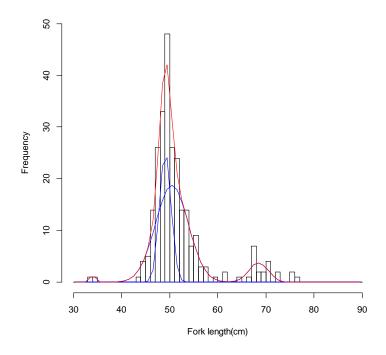

Figure 4   Applied mixed normal distribution to the length frequency distribution of SBT caught in 2017 survey.