Report of the piston-line trolling survey in 2007/2008

ピストンライン曳縄調査 2007/2008 の結果報告

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Summary

In January 2008, the trolling research survey that provides the recruitment index of age one southern bluefin tuna with low cost was carried out in similar manner as in 2006 and 2007. In the survey, a chartered Australian vessel goes and back on the same straight line (piston-line) off Bremer Bay in the southern coast of Western Australia using trolling for five days. The adjacent area of the piston-line and the area between Esperance and Albany were also surveyed. A total of 218 SBT individuals were caught during the whole survey in 13 days and 193 (89%) of them were tagged with CCSBT conventional tags and released. The total amount of SBT mortality due to the survey was 18 individuals and 48.7 kg. The trolling index, the number of SBT age one school per 100 km searched, was higher in the 2005-2007 year classes than the 1995-1998 year classes by taking into account of both the trolling survey and the trolling catch data in the acoustic survey.

要約

2008 年 1 月に、ミナミマグロ 1 歳魚の加入指数を低コストで提供する曳縄調査を、2006 年、2007 年と同様に実施した。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 5 往復した。ピストンラインの周辺海域及び Esperance-Albany 間の海域も調査した。13 日間の調査航海全体を通じて漁獲したミナミマグロは 218 個体で、その内 193 個体(89%)には CCSBT 標識を装着して放流した。調査のために死亡したミナミマグロは 18 個体、合計重量 48.7kg であった。探索 100km 当りの群れ数である曳縄指数を音響調査による曳縄データも含めて考慮すると、2005-2007 年級が 1995-1998 年級レベルより高いレベルであった。

1. Introduction

Since the agreement of the Extended Committee of CCSBT in 2006, the largest catch of southern bluefin tuna (SBT) has been attained by the Australian purse seine fishery (Anon. 2006). The Australian purse seine fishery catches SBT of age 2-4, mainly age 3, for farming, which is the earliest age fished in the SBT life stage compared to other

nations' fisheries. Any fisheries can not provide reliable information of recruitment level of SBT younger than age 2 at present. Because the catch of the Australian purse seine is concentrated on young fish, the importance of research activities for monitoring the recruitment level of SBT in their early life stage becomes higher than previous years.

Several research activities have been attempted for the recruitment monitoring of SBT. Since 1989, Japan has been conducted series of recruitment monitoring surveys within a research framework with Australian scientists. Japan conducted a trolling and pole-and-line catch monitoring survey from 1989 to 1993, and then conducted an acoustic monitoring survey using sonar and echo sounder from 1995 to 2006 for age one SBT distributed off the southern coast of Western Australia (Itoh 2006). These researches had been providing the recruitment indices of age one SBT for years. Australia conducted the scientific aerial survey in the Great Australian Bight in South Australia since 1993 and also provided the recruitment indices (Eveson et al. 2006). However, because the Australian indices is for SBT age 3 which is the same age of the Australian purse seine catch, it gives little time to consideration to regulate the fishery based on the results of the research survey. Catch information of SBT age one off the southern coast of Western Australia had been provided by the CCSBT tagging 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 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. In 2006 and 2007, we carried out a feasibility survey that a chartered Australian vessel go-and-back on a single straight line and find SBT schools by catching with trolling (Itoh and Kurota 2006, Itoh and Sakai 2007). In January 2008, we carried out similar trolling monitoring survey and the results of the survey are presented in this paper.

2. Material and method

Field Research

An Australian vessel, St Gerard M with 18 m in total length, was chartered (Fig.1). The vessel was also used in the last two year surveys. The vessel departed Esperance on 20 January 2008, and stayed off Bremer Bay from 21 to 23 January for research. The vessel went further west and surveyed the area between Bremer Bay and Albany from 24 to 29 January. The vessel surveyed off Bremer Bay again from 30 to 31 January. The vessel left off Bremer Bay and arrived at Esperance on 1 February, and then the research

survey was finished. Three researchers including the authors, and two Australian crew members were on board.

The research area was off the south coast of Western Australia between Esperance to Albany including off Bremer Bay (Fig. 2). Within the research area, continental shelf of 70 m in depth extended largely and then dropped sharply to deeper than 500 m in depth at shelf edge in 2 km distance toward offshore. The piston-line laid between two points; one is 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 the range from continental shelf to offshore through the shelf edge. The piston-line was in almost same location used in previous years. In addition to the piston-line, adjacent areas, west or south (offshore) of the piston-line, were also surveyed so that evaluate whether the piston-line is a representative area in regard to SBT distribution (Fig. 3).

It is known that SBT age 1 distributed not only off Bremer Bay but also widely in the coastal area of Western Australia from off Fremantle to off Esperance. Detail survey on the whole area in a short period with small cost is unrealistic. This year, we focused on off Albany to evaluate whether off Bremer Bay is a representative area in regard to age 1 SBT distribution. Survey that start on continental shelf, through shelf edge and returned at offshore, were carried out off Albany for three days.

The vessel operated trolling at speed of 7-8 knots. Eight trolling lines at maximum were trolled.

The index derived from the survey is based on the number of SBT schools, not the number of SBT individuals caught. Therefore, when catch was succeeded and reach 10 individuals presumably from single school, trolling was suspended and the vessel went forward around 1.0 mile without trolling the lines so that left from the school, in order to minimize mortality by the survey.

Individuals caught of any species were measured length. SBT were tagged and released with two CCSBT conventional tags, following the CCSBT tagging procedure. SBT with severe damage around its mouth or bleeding from gill were weighed and taken biological samples (stomach contents, otoliths and muscle tissue).

At 78 locations, vertical profile of temperature and salinity (conductivity) were measured down to just above sea bottom or 200 m in depth using a CTD (Alec Electronics, compact CTD). Temperatures of sea surface were recorded successively throughout the survey (Alec Electronics, MkT). GPS positions data were recorded every 10 seconds.

Calculation of Trolling Index

Five types of trolling indices were calculated as follows.

(1) The number of schools of age one SBT per 100 km search distance. A catch of age one SBT that apart from 2 km in distance from last catch of age one SBT is defined as the different school. TRI_2km.

(2) The number of schools of age one SBT per 100 km search distance. A catch of age one SBT that apart from 20 minutes in time from last catch of age one SBT is defined as the different school. TRI_20min.

(3) The number of schools of age one SBT per 100 km search distance. A catch of age one SBT that apart from 30 minutes in time from last catch of age one SBT is defined as the different school. TRI_30min.

(4) The number of times of catch of age one SBT per 100 km search distance. All the catches even it was likely to be from the same school were counted. TRI_times.

(5) The number of age one SBT individuals per 100 km search distance. TRI_ind.

Trolling indices were calculated from data sampled 1000 times by bootstrap methods, and the results were shown by box plots or median, 5% and 95% points. The indices were calculated for three data series and compared over 13 years between 1996 and 2007; 1) piston-line trolling survey from 2006 to 2008, 2) trolling catch on the piston-line in the acoustic (sonar) survey from 2005 to 2006, and 3) trolling catch other than the piston-line in the acoustic (sonar) survey from 1996 to 2006 (Itoh, 2007).

3. Result

Usually, the vessel engaged in the research survey from 6:00 to 18:00 and anchored in calm bay at night. While there are a few days in rough sea, we could carry out the survey in the successive 13 days. The piston-line was surveyed off Bremer Bay in three days in the first half and in two days in the second half, in total of five days for 10 lines (Fig. 3).

During the whole period, total of 282 fish individuals were hooked, including 218 SBT, 7 skipjack *Katsuwonus pelamis*, 18 bonito *Sarda orientaris*, 19 blue mackerel *Scomber australasicus* and 2 barracouta *Thyrsites atun*. Among the 218 SBT, 193 SBT (89% of SBT catch) were tagged with CCSBT tags. 20 SBT were also implemented archival tags (Lotek, 2310) and another 38 SBT were also implemented acoustic tags (Vemco, V16). Eighteen SBT with severe damage were killed and remaining were escaped near the vessel. Total weight of SBT sampled was 48.7 kg.

Trajectory of the research survey and locations of SBT caught are shown in Figure 3. Off Bremer Bay, SBT were caught not only on the piston-line but also in the adjacent areas on the continental shelf. Few SBT were caught offshore area from self edge.

No SBT were caught on the way to Albany, while several were caught on the way back to Bremer Bay five days later. Many SBT including larger fish as age 2 were caught off Albany.

195 SBT (92 %) caught were estimated as age one (49-63 cm FL) from its length (Fig. 4). Six SBT of age two (71-79 cm FL) were caught off Albany. Ten SBT of small size age one (32-36 cm FL) were caught off Bremer Bay near shelf edge. Mean length of age one SBT (49-63 cm FL) between off Bremer Bay and off Albany was not significantly different (ANOVA, $F=1.372$, $p>0.05$).

On the piston line, the total number of age 1 SBT school was 19 and 22 if the successive SBT catches more than 30 minutes and 2 km are defined from different schools, respectively. The total distance searched on the piston line was 348km. The mean trolling indices are calculated as 5.4 school/100 km (30 minutes definition) or 6.3 school/100 km (2 km definition).

Figure 5 shows the five different trolling indices produced by the 1000 times bootstrap. The indices relative to its median at 10 lines are shown in Figure 6. Along the number of lines increased, median values become stable at five lines and the ranges between 5% and 95% points were decreased largely to three lines and then decreased gradually.

Figure 7 shows the trolling indices (TRI_2km) off Bremer Bay and off Albany. While the two values are not the same (6.26 off Bremer Bay and 4.74 off Albany in median), the difference is not quite large.

Figure 8 shows two trolling indices of the piston line from the trolling survey between 2006 and 2008 and that from the acoustic (sonar) survey between 2005 and 2007. Because there were no sequential detail location records (GPS time series data) in the acoustic survey, TRI_30min was used. In 2006 when both surveys carried out on the same piston line, the median of the trolling indices of the acoustic survey was slightly higher but half of the ranges on the indices between 5 and 95% were corresponded. The trolling indices are in increasing trends from 2005 and 2008.

Figure 8 also shows another TRI_30m from the acoustic survey in whole the rectangle research area, which lay between off Esperance and middle of the Bremer Bay and Albany, except the piston line between 1996 and 2006. The indices on the piston line in the acoustic survey are high 1.2-1.5 times as much as that in the whole area. Considering these, the indices are similar in 2005 and higher after 2006 compare to the

1996-1999 level.

4. Discussion

The results obtained so far from the piston-line trolling survey and trolling data in the acoustic survey show that the recruitment level of the 1999-2001 year classes are low, those of the 2002 and 2004 year classes are same level of the 1995-1998 year classes, and those of the 2005-2007 year classes are high. Among these year classes, it was supported that the 1999-2001 year classes are low level with various fishery data and scientific researches (Anon., 2006). Aerial survey index and fishery data from longline in Japan and New Zealand suggests that the 2002 and 2004 year classes are in relatively high level. Therefore, the trolling index is a reliable index of SBT recruitment. Information of the year classes after 2005 has not been obtained from other sources.

The trolling survey is a robust research against wind, wave and swell. There was no days that suspended the research during the cruise due to rough sea condition in three years. We did not find a tendency that SBT were less caught in rough sea condition. In addition, species identification and size of SBT are actual data, without uncertainty, in the trolling survey. These are advantages of the trolling survey compared to the acoustic survey and the aerial survey.

SBT of age 3 and more are distributed so widely in the area between off New Zealand and off Cape that a part of the whole stock is the subject of the aerial survey in the Great Australian Bight and Japanese longliners. In contrast, it is believed that SBT age 1 is distributed in the coastal area of Western Australia. A hypothesis that not the whole of the SBT age 1 stock is distributed there can be made, but there is no information supporting this hypothesis so far. A recruitment index derived from SBT age 1 in Western Australia has a potential that represents whole the stock at an age.

In Western Australia, SBT age 1 is distributed not only off Bremer Bay but also in a wide area between off Fremantle and Esperance. The acoustic tagging survey showed that few of SBT released off Fremantle came off Bremer Bay (Hobday, et al. 2007). This suggest that the previous hypothesis, we assumed for the acoustic survey, that SBT age 0-1 migrate from the spawning ground to south and then to east along the Western Australia coast continuously, which justify a survey in an area repeatedly produce a representative index of whole the recruitment stock, was wrong. We need to know how does SBT off Bremer Bay represents whole the SBT age 1.

The trolling survey this year also surveyed off Albany, and found that SBT age 1 distributed in similar level to off Bremer Bay. Whole the area between Fremantle and Esperance has been surveyed several times in the acoustic surveys and acoustic tagging

surveys and no extreme difference of SBT distribution within the area was found. There are no data or information that reject the hypothesis that SBT age 1 in January off Bremer Bay represents whole the SBT age1 stock so far, though we still need to determine the detail of the dynamics of migration of SBT age 0-1 from the spawning ground to the south of Western Australia, as well as the dynamics of residence/movement of SBT age 1 in the coastal water of Western Australia.

The objective of trolling survey has been to obtain a rough recruitment index with low cost. Index on the piston-line which become stable around 5-7 lines in the three years suggests that four days or more is sufficient for the piston-line survey. Indices between on the piston-line and on adjacent areas were not different very much (Itoh, 2007). Indices between off Bremer Bay and off Albany were not different very much this year. Unfortunately, these differences are not small. We should recognize that the trolling index, which based only on the number of school and ignore the biomass of the SBT school, is a rough recruitment index. Even if the number of days for survey or the number of vessels were increased, the resolution of the index is not likely to be increased largely. In order to obtain such a rough recruitment index, the research design has already established.

The recruitment monitoring is needed to be continued further at least in similar scale in the consistent procedure. In addition, to determine the robustness of the index obtained, more data of the dynamics of distribution of SBT age 0-1 in Western Australia should be collected.

Acknowledgement

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Fig. 1 St Gerard M, used for the research

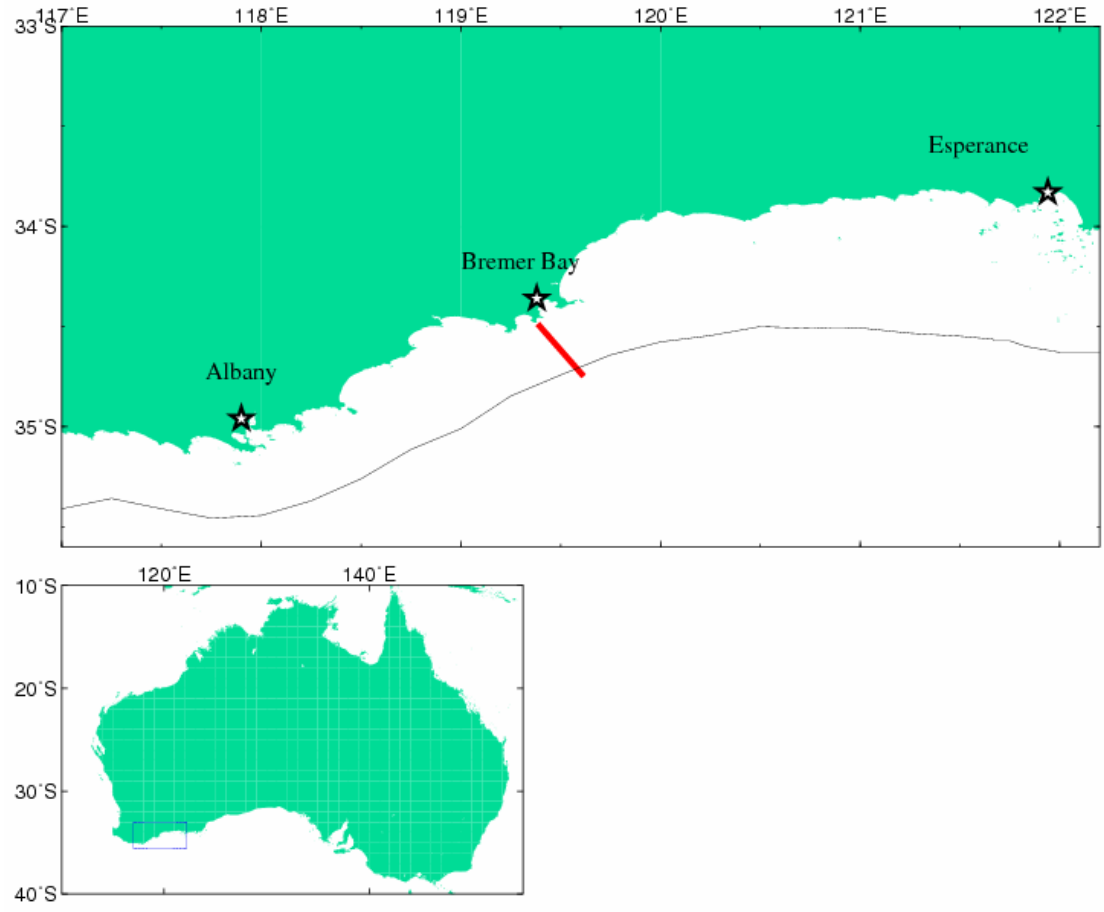
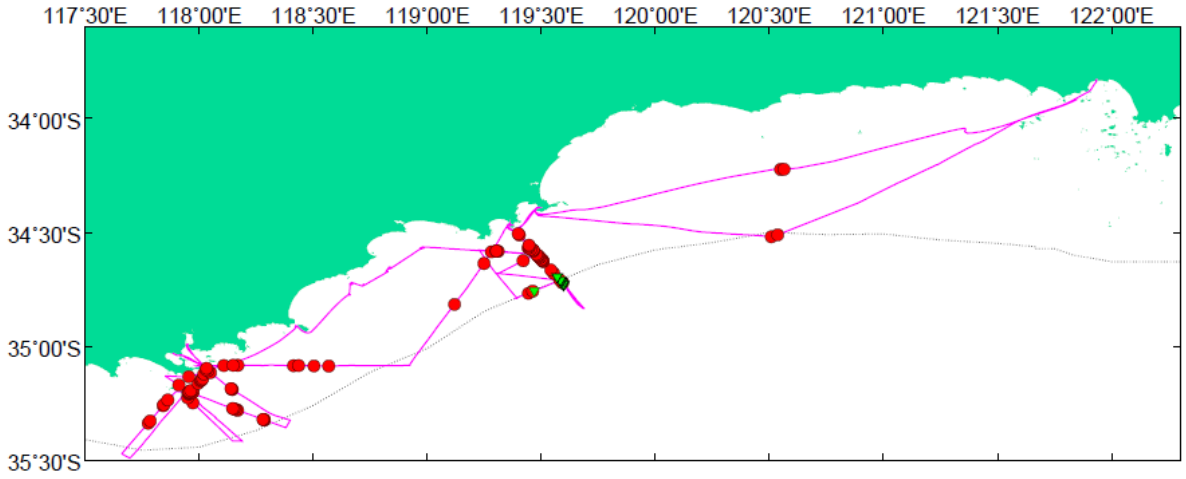


Fig. 2 Map of area researched

On the upper panel, a straight line is the piston-line and a narrow line is 200m isobath. A square in the lower panel is the area of the upper panel.



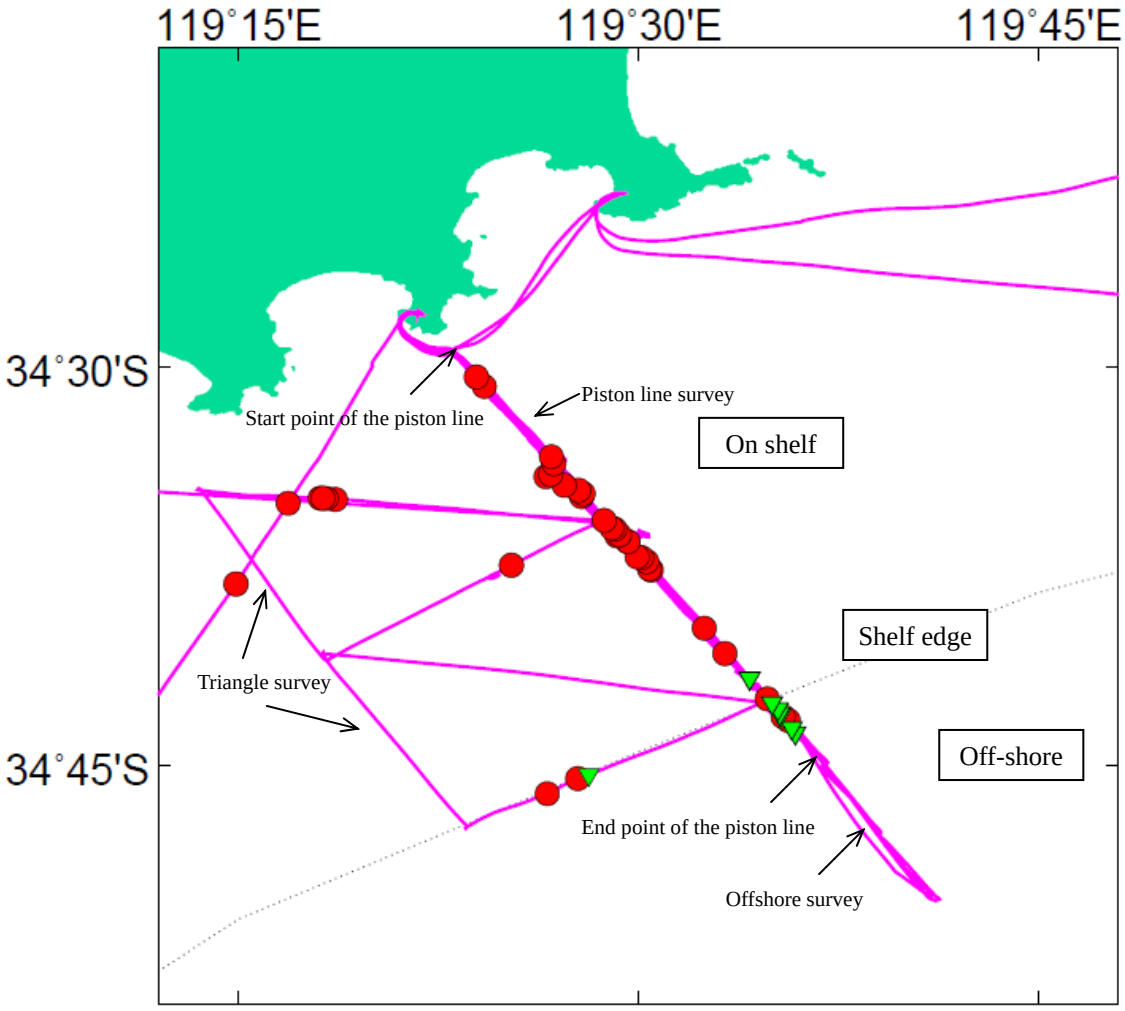


Fig. 3 Trajectory of the trolling survey in 2008

Circles and triangles denote locations where southern bluefin tuna > 40 cmFL and SBT < 40 cmFL were caught, respectively. Dotted line is 200m isobath.

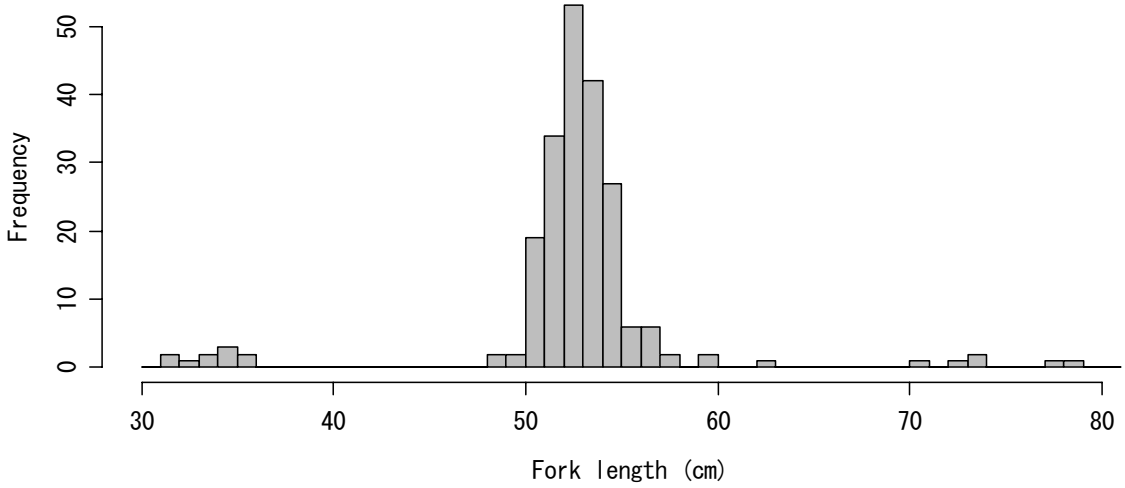


Fig. 4 Fork length frequency distribution of southern bluefin tuna caught in the trolling survey in 2008.

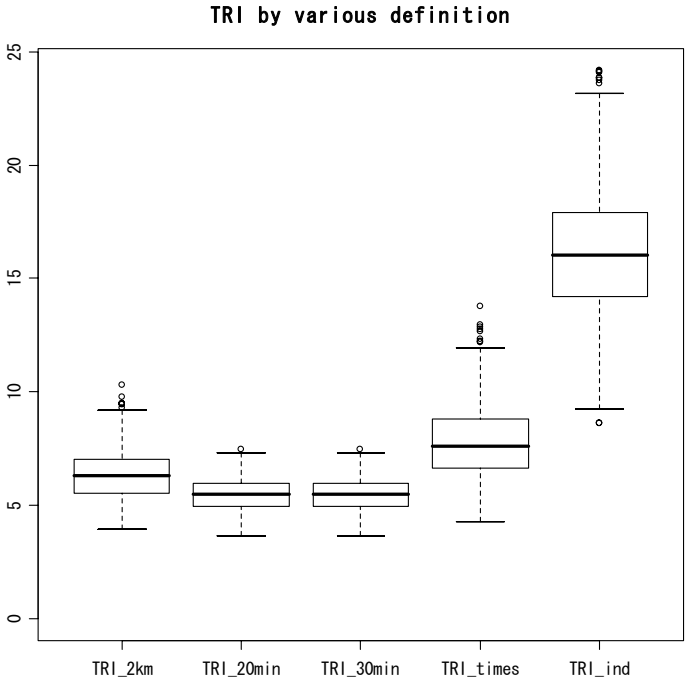


Fig. 5 Trolling indices in absolute value by various definition in 2008. Data were sampled 1000 times by bootstrap methods.

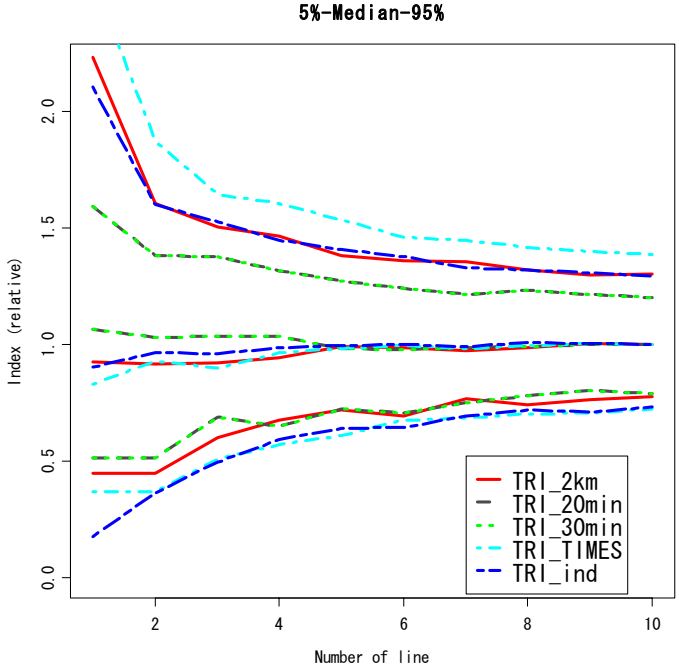


Fig. 6 Bootstrap simulation for the five types of trolling indices and for the number of line surveyed in 2008. Relative values of median, and 5% and 95% points to the median at 10 lines of each trolling indices are shown.

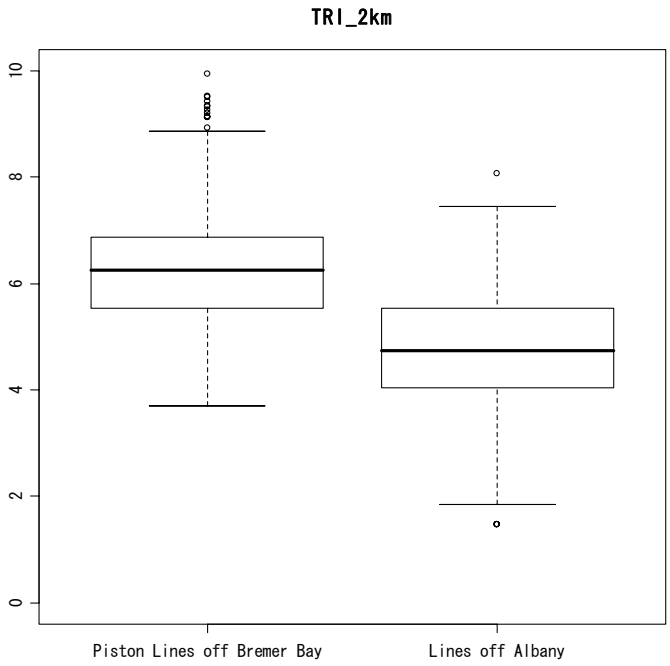


Fig. 7 Trolling index (TRI_2km) off Bremer Bay on the 10 piston lines and off Albany on the six lines between continental shelf and offshore in 2008. Data were sampled 1000 times by bootstrap methods.

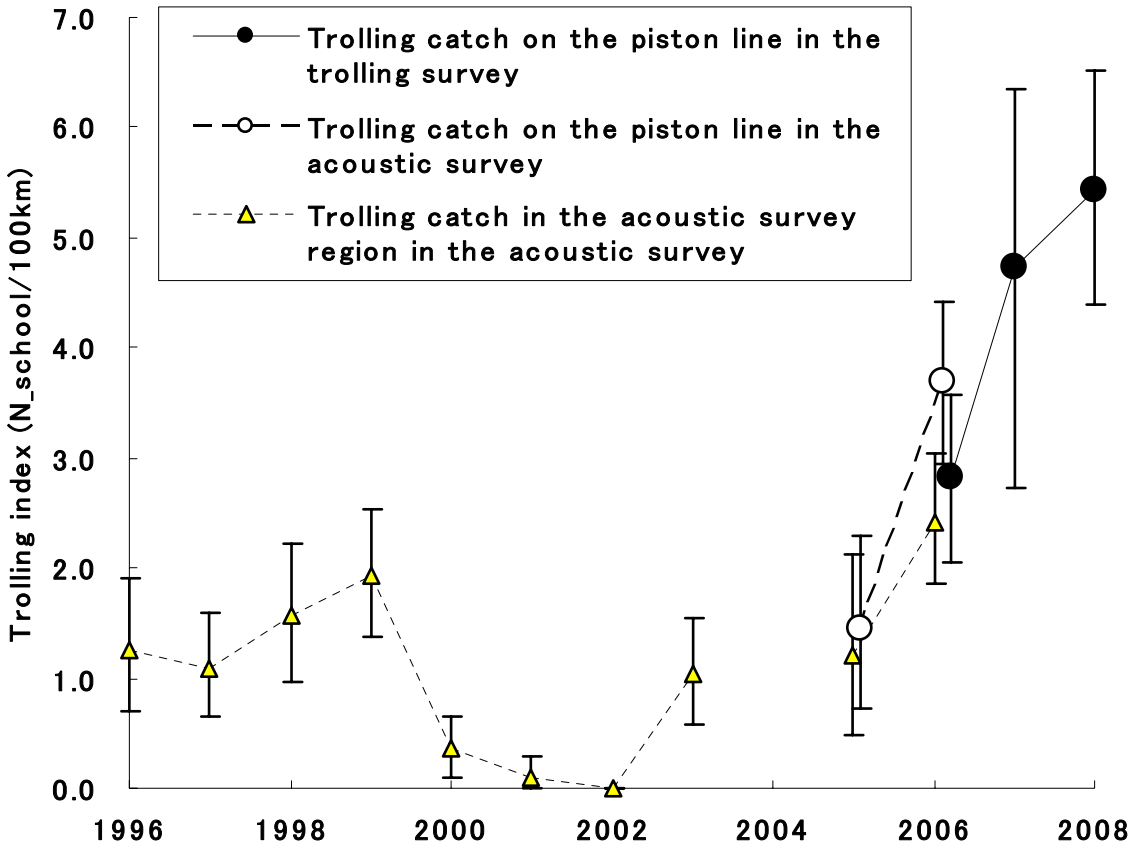


Fig. 8 Trolling indices (TRI_30min) from the trolling survey on the piston line (2006-2008), from the acoustic survey on the piston line (2005-2006) and from the acoustic survey in whole the rectangle research area except the piston line (1996-2006). Marks and bars denote median and 5% and 95% points from 1000 times bootstrap samplings, respectively.