

## Report of the piston-line trolling survey in 2008/2009

### ピストンライン曳縄調査 2008/2009 の結果報告

Tomoyuki ITOH and Osamu SAKAI

伊藤智幸・境磨

National Research Institute of Far Seas Fisheries 遠洋水産研究所

#### Summary

In January 2009, 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 previous three years. 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 six days. The adjacent area of the piston-line and the area between Esperance and Albany were also surveyed. Another research cruises for SBT distribution in Western Australia was also conducted for 10 days. In the two cruises, a total of 312 SBT individuals were caught and 273 of them were tagged with CCSBT conventional tags and released. The total amount of SBT mortality due to the surveys was 21 individuals and 49.9 kg. The trolling index, the number of SBT age one school per 100 km searched, was higher in the 2005-2008 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

2009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、過去3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6日間、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。2008年12月には西オーストラリア州沿岸の分布を調べる別の航海を10日間実施した。2調査航海を通じて漁獲したミナミマグロは312個体で、その内273個体には 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21個体、合計重量49.9kg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、2005-2008年級が1995-1998年級レベルより高いレベルであった。

## 1. Introduction

Since 2006, Australia has the largest national allocation of TAC of southern bluefin tuna (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 becomes much more important than in previous years for stock management of the species.

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 cooperative 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 to CCSBT for years. Australia conducted the scientific aerial survey in the Great Australian Bight in South Australia since 1993 and also provided the recruitment indices, as aerial survey index, to CCSBT (Eveson et al. 2006). However, because the aerial survey index is for SBT age three 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. Since 2006, we have carried out a monitoring 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, 2008). In January 2009, we carried out similar trolling monitoring survey and the results of the survey are presented in this paper.

In this paper, we also report a research cruise for SBT distribution held in December 2008 from southern WA to western WA. Detail examination of SBT distribution in WA including these researches are shown in CCSBT-ESC/0909/35 (Itoh and Sakai 2009).

## 2. Material and method

### **2008/2009 first survey cruise for general SBT distribution in Western Australia**

An Australian vessel, *Quadrant*, was chartered (Fig. 1). *Quadrant* engaged in CCSBT tagging and the acoustic tagging of SBT in the recruitment survey. The vessel departed Albany on December 3, 2008 and went west, passed south-west corner of Australian continent (Cape Naturaliste) and changed its course toward north, and then arrived Fremantle on December 12 (Fig. 2). Two researchers (authors), and three Australian crew members were on board. The survey course was determined to cover the area between coast and shelf edge.

The vessel operated trolling at speed of 7 knots. Seven trolling lines at maximum were trolled. The specification of the trolling gears were almost same as those used in the piston-line survey last year. When SBT were caught with trolling, pole-and-line was also carried out.

Individuals caught of any species were measured its length. SBT were tagged and released with two CCSBT conventional tags, following the CCSBT tagging procedure. Some of SBT were also implemented archival tags (Lotek , LTD2310). SBT with severe damage around its mouth or bleeding from gill were weighed and taken biological samples (stomach contents, otoliths and muscle tissue).

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 ten seconds.

### **2008/2009 second survey cruise for trolling index on the piston line**

An Australian vessel, *St Gerard M* with 18 m in total length, was chartered (Fig.1). The vessel was also used in the surveys for last three years. The vessel departed Esperance on 17 January 2009, which was three days earlier than the survey in 2008. The vessel surveyed off Bremer Bay from 18 to 21 January, and then went further west and surveyed an area between Bremer Bay and Albany from 22 to 26 January. The vessel came back and surveyed off Bremer Bay again from 27 to 28 January. The vessel left off Bremer Bay and arrived at Esperance on 29 January, 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 and 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 within 2 km distance toward offshore. The piston-line laid between the two points same as last year; 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 addition to the piston-line, adjacent areas, west or south (offshore) of the piston-line as well as the area west to off Albany, were also surveyed so that examine whether the piston-line is a representative area in regard to SBT distribution (Fig. 2).

The vessel operated trolling at speed of 7-8 knots. Eight trolling lines at maximum were trolled. The specification of the trolling gears were almost same as those used in the last year survey.

The index derived from the survey is based on the number of SBT schools, not the number of SBT individuals caught. Therefore, it was planed 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 lines so that left from the school, in order to minimize mortality by the survey. However, such successive catches did not occur this year.

Individuals caught of any species were measured its length. SBT were tagged with CCSBT conventional tags, tagged archival tags, or sampled for biological samples as described in the first cruise. CTD observation, sea surface temperature recording and GPS data recording were carried out as described above.

In the second cruise, we tried to take underwater video images during trolling conducted. It is expected to help understanding of trolling gear movement, catch ability of trolling to SBT that approached to the vessel, structure of SBT school, etc.

### **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 a 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 a 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 a

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.

Confidence intervals of the 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 the following three data series and compared over 13 years between 1996 and 2009; 1) piston-line trolling survey from 2006 to 2009, 2) trolling catch on the piston-line in the acoustic (sonar) survey from 2005 to 2006, and 3) trolling catch in other area of the piston-line in the acoustic (sonar) survey from 1996 to 2006 (Itoh, 2007).

### 3. Result

Usually, the vessels engaged in the research survey from 6:00 to 18:00 and anchored in calm bay at night. While there were a few days in rough sea, we could carry out the surveys in the successive 10 days and 13 days, respectively. The piston-line was surveyed off Bremer Bay in four days in the first half and in two days in the second half of the second cruise, in total of six days for 11 lines.

In the first cruise, total of 162 fish individuals were hooked, including 101 SBT, 2 skipjack *Katsuwonus pelamis*, 25 bonito *Sarda orientaris*, 6 samson fish *Seriola hippos*, 1 dolphinfish *Coryohaena hippurus*, 21 yellowtail kingfish *Seriola lalandi* and 6 unidentified individuals which escaped far from the vessel (Table 1). Among the 101 SBT, 84 SBT were tagged with CCSBT tags. 52 SBT were also implemented archival tags (Fig. 3). 5 SBT were released without tags, 9 SBT with severe damage were killed and 2 were escaped near the vessel.

In the second cruise, total of 242 fish individuals were hooked, including 211 SBT, 2 skipjack *Katsuwonus pelamis*, 20 bonito *Sarda orientaris*, 3 blue mackerel *Scomber australasicus* and 6 unidentified individuals which escaped far from the vessel (Table 1). Among the 211 SBT, 189 SBT were tagged with CCSBT tags. 82 SBT were also implemented archival tags. 12 SBT with severe damage were killed and 10 were escaped near the vessel. Total weight of SBT sampled in the two cruises was 49.9 kg of 21 individuals.

Trajectories of the research survey and locations of SBT caught are shown in Figure 2. In the first cruise, many SBT were caught off Fremantle and off Albany. Small number of SBT were caught between Fremantle and Albany (west of 116.5E and south of 32.5S).

Off Albany, most of SBT were caught around shelf edge and no SBT were caught at lumps or reefs including Mauda Reef where many SBT were caught in January 2008 cruises.

In the second cruise, on the contrary, many SBT were caught at Mauda Reef. Some SBT were caught in areas off Albany and between Albany and Bremer Bay, but no SBT were caught on several lumps between Albany and Bremer Bay where SBT aggregated in some previous years. Many SBT were caught off Bremer Bay not only on the piston-line but also in adjacent areas. No SBT were caught offshore area from shelf edge on the piston-line, while some SBT were caught last year. Some SBT were caught at shelf edge in the middle of Bremer Bay and Esperance within a short period, same as last year.

Length frequencies of SBT caught are shown in Figure 4. In the first cruise, SBT caught ranged from 43 to 62 cmFL, mostly were from 43 to 53 cmFL, presumably age 1. SBT off Fremantle (about 51 cmFL) was larger than that off Albany (about 46 cmFL). In the second cruise, SBT caught ranged from 45 to 69 cmFL. All of SBT caught off Bremer Bay including the piston-line were less than 58 cm so that age of them assigned as age 1.

Underwater video images were taken more than 20 times, 30 – 60 minutes each time. The camera was placed 2-3 m below sea surface. Movements of trolling gears and some SBT individuals attracted lures were observed (Fig. 5).

Among the 11 piston-line survey data, one was incomplete (line between shelf edge and the most coastal point) and one was tried in slow speed (5kt). Data in these trial surveys were eliminated so that 9 line data were used for calculation of index. On the nine piston lines, the total number of age 1 SBT school was 11 and 13 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 306km. The mean trolling indices are calculated as 3.6 school/100 km (30 minutes school definition) or 4.3 school/100 km (2 km school definition).

Figure 6 shows the five different trolling indices produced by 1000 times bootstrap. The indices relative to its median at 9 lines are shown in Figure 7. Along the number of lines increased, median values become more stable larger than five lines and the confidence interval between 5% and 95% points were decreased largely to four lines and then decreased gradually.

Figure 8 shows two trolling indices of the piston-line from the trolling survey between 2006 and 2009 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 confidence interval between 5 and 95% were corresponded. The

trolling indices have been increased from 2005 to 2008 and dropped in 2009. It should be noted that trolling indices have relatively large range of confidence interval between 5 and 95%.

Figure 8 also shows another TRI\_30min 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 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 2005-2008 year classes are high. It is consistent with that the 1999-2001 year classes are low level in various fishery data and scientific researches (Anon., 2006). For the subsequent year classes, 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, which also consistent with trend of the trolling index. 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 four 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 Taiwanese and Japanese longliners. In contrast, it is believed that SBT age 1 is distributed in the coastal area of Western Australia (Itoh and Sakai 2009). A recruitment index derived from SBT age 1 in Western Australia has a potential that represents whole the stock at an age.

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 four 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 (Itoh and Sakai 2008). 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 (Itoh and Sakai 2009).

### Acknowledgement

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Table 1 Summary of the two cruises of SBT recruitment survey in 2008/2009

	1 <sup>st</sup> cruise	2 <sup>nd</sup> cruise
Vessel name	Quadrant	St Gerard M
Period	Dec. 3 - Dec. 12, 2008 (10days)	Jan. 17 – Jan. 29, 2009 (13 days)
Departure	Albany	Esperance
Arrival	Fremantle	Esperance
Area	south and west of WA (west of Albany)	south of WA (east of Albany)
Piston-line	-	6 days, 11 times
Number of trolling line used	7	8
Pole-and-line	yes	no
SBT hooked	101	211
conventional tags only	32	107
archival tagged	52	82
sampled	9 (18.6 kg)	12 (31.3 kg)
released without tags	5	
escaped near vessel	2	10
Skipjack	2	2
Bonito	25	20
Yellowtail kingfish	21	
others	7	3
escaped	6	6
SBT size		
< 40cmFL	0	0
40 - 59cmFL	98	175
>= 60cmFL	1	26
CTD casts	34	50



Figure 1 Quadrant (upper panel) and St Gerard M (lower panel), used for the research

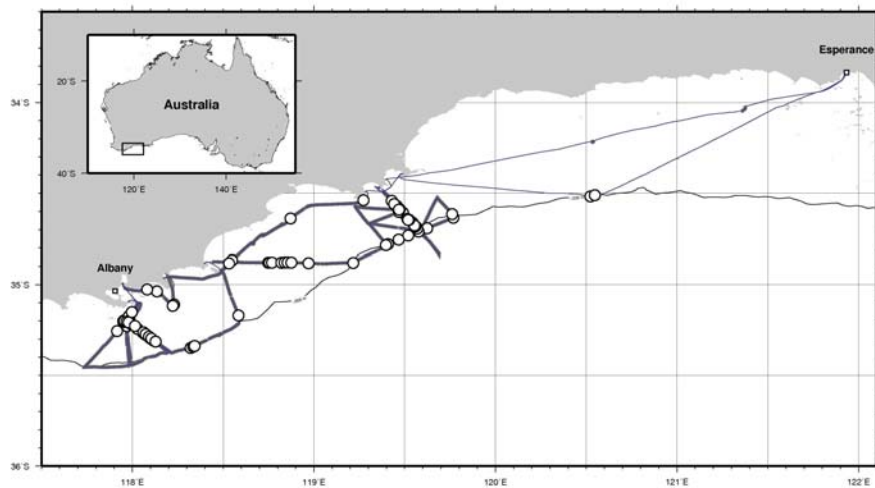
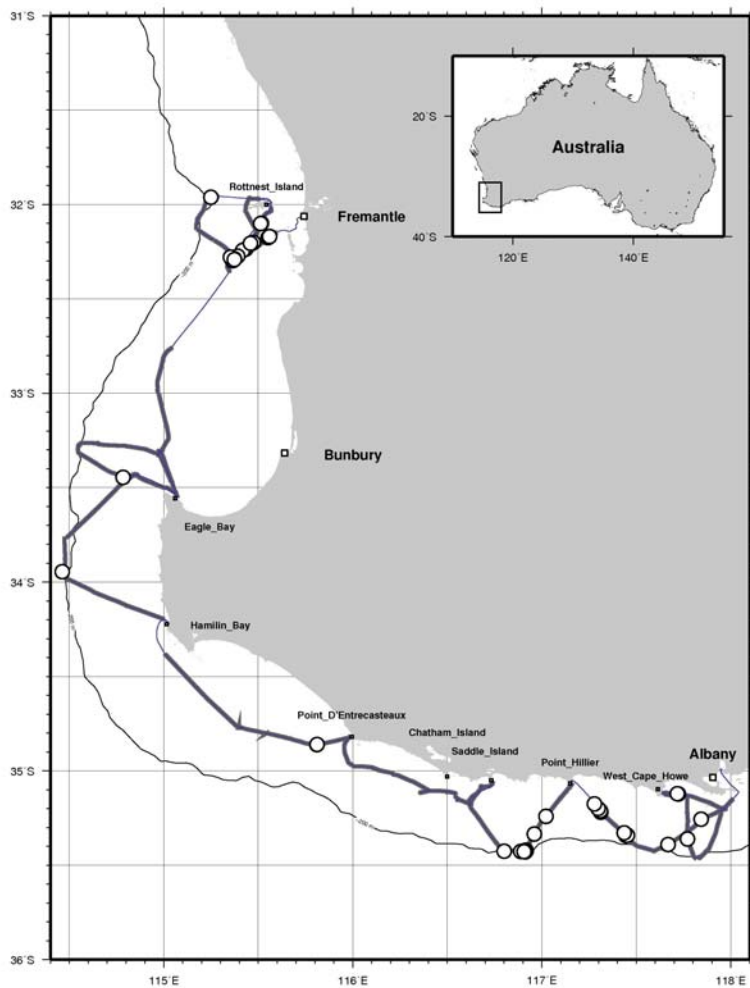


Figure 2 Trajectory of the vessel and location of SBT caught (open circles) in the first cruise in December 2008 (upper panel) and in the second cruise in January 2009 (lower panel).



Figure 3 SBT implemented archival tag in the body cavity with two CCSBT conventional tags on dorsal muscle near second dorsal fin.

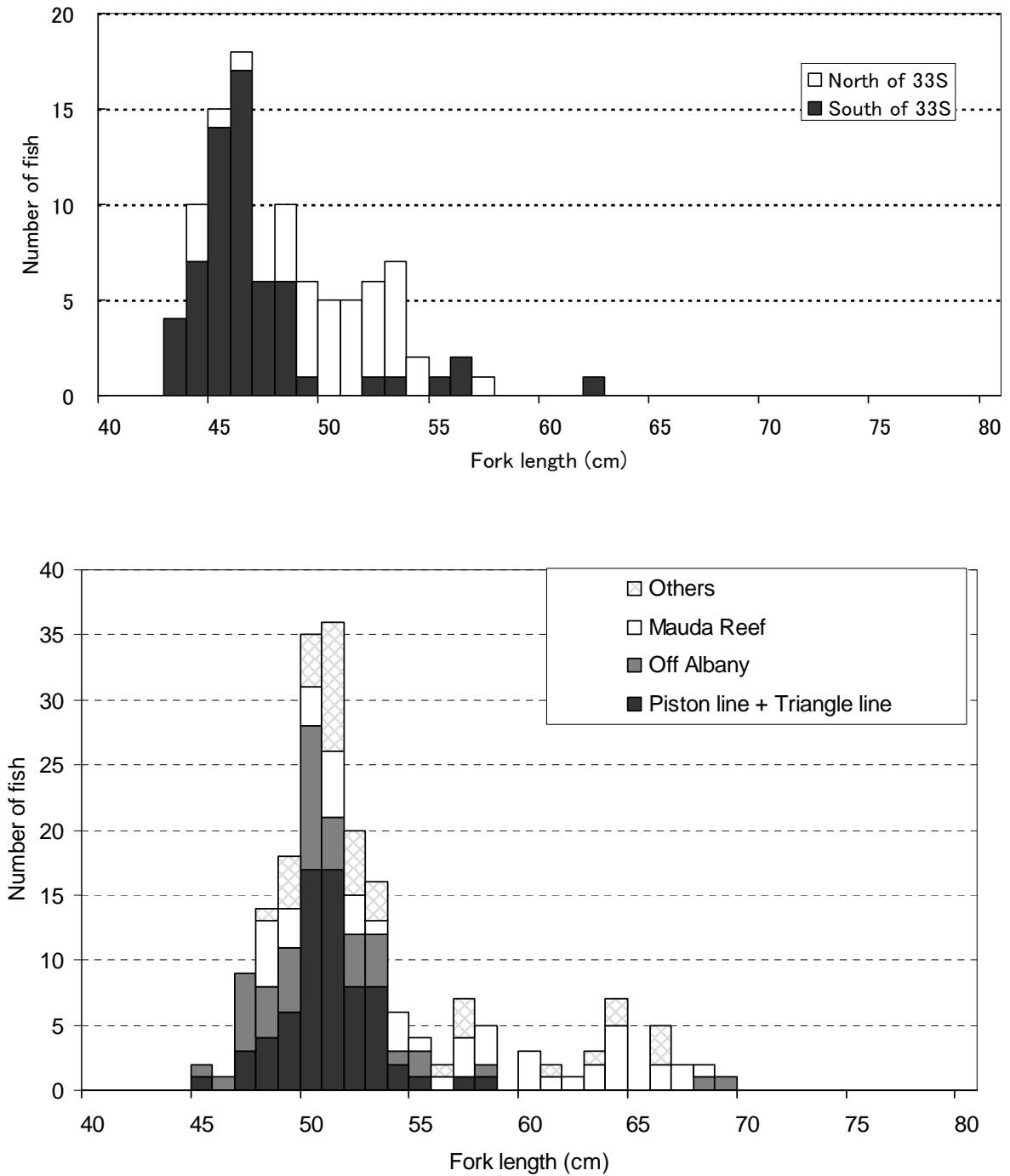


Figure 4 Fork length frequency distributions of southern bluefin tuna caught in the first cruise in December 2008 (above) and in the second cruise in January 2009 (below).

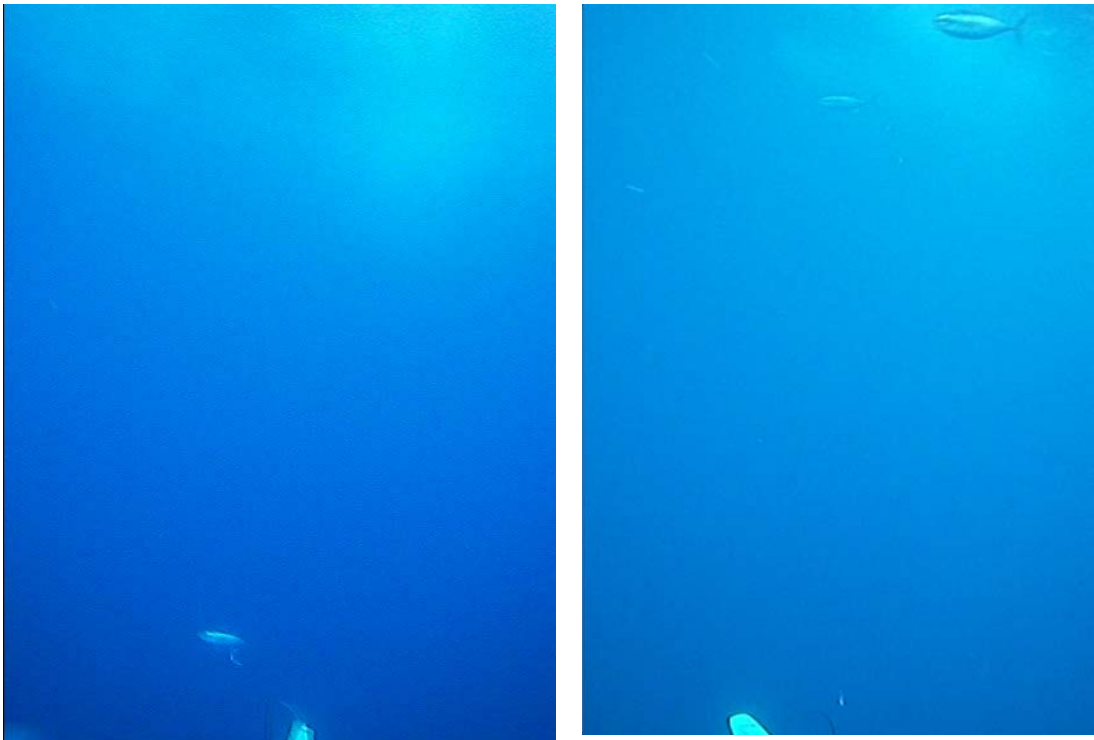


Figure 5 曳航カメラにより撮影された水中映像

左：1月29日6時43分の撮影開始から4分10秒後の映像。映像の上方が水面である。下部中央に見えているのは曳航カメラの潜行板。潜行板に接続されたタコベイトにミナミマグロが接近している。

右：1月27日8時7分の撮影開始から8分15秒後の映像。2個体のミナミマグロが画面を横断していった。

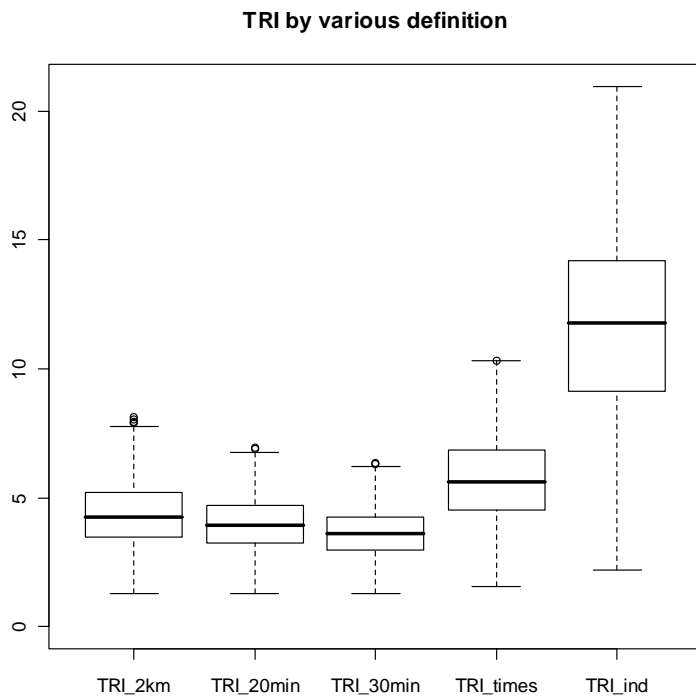


Figure 6 Trolling indices in absolute value by various definition in 2009. Data were sampled 1000 times by bootstrap methods.

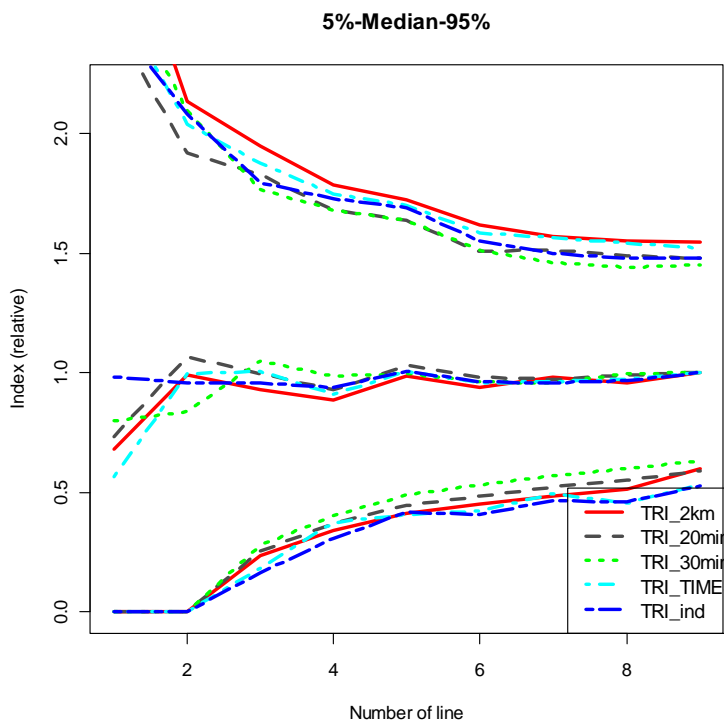




Figure 7 Bootstrap simulation for the five types of trolling indices and for the number of line surveyed in 2009. Relative values of median, and 5% and 95% points to the median at nine lines of each trolling indices are shown.

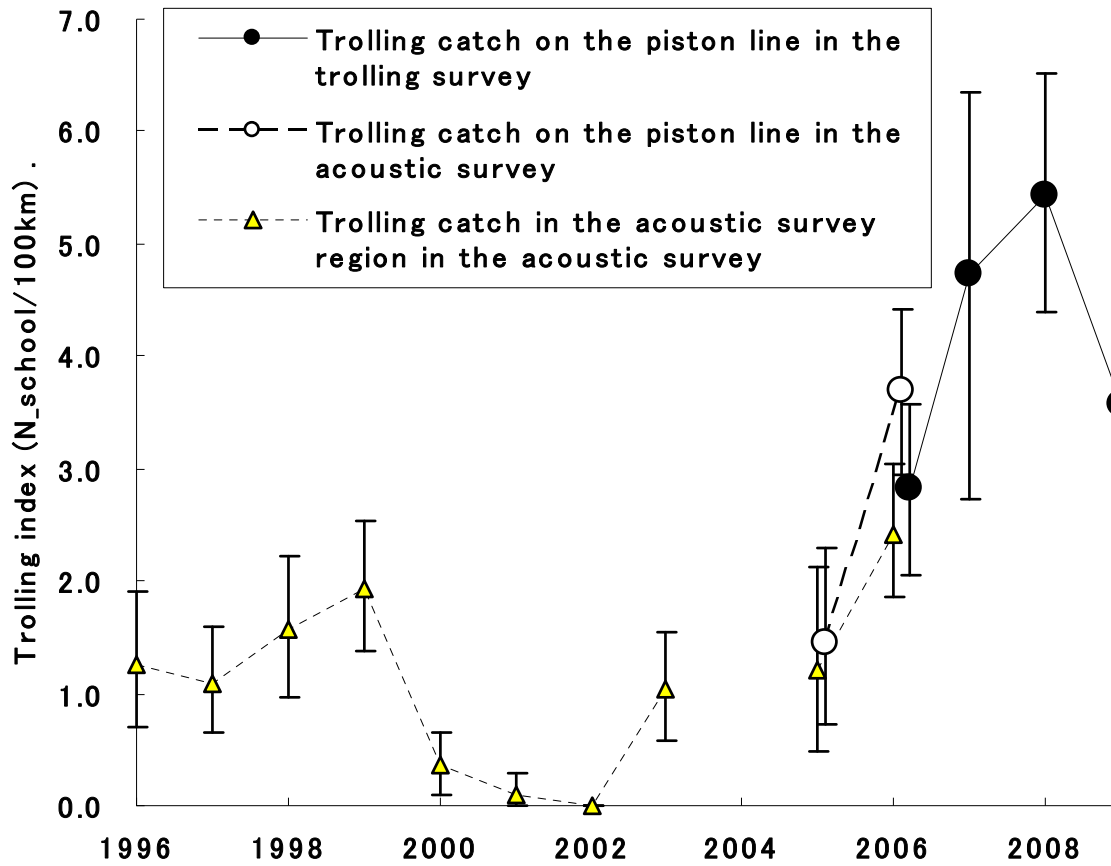


Figure 8 Trolling indices (TRI\_30min) from the trolling survey on the piston line (2006-2009), from the acoustic survey on the piston line (2005-2006) and from the acoustic survey in whole the rectangle research area except the piston line (1996-2006). Marks and bars denote median and 5% and 95% points from 1000 times bootstrap samplings, respectively.

