Report of the piston-line trolling survey in 2009/2010

ピストンライン曳縄調査 2009/2010 の結果報告

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Summary

In January 2010, the trolling research survey that provides the recruitment index of age one southern bluefin tuna with low cost was carried out in similar manner since 2006. 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 east of Esperance and Albany were also surveyed. In the cruise, a total of 219 SBT individuals were caught and 149 of them were tagged with CCSBT conventional tags and released. The total amount of SBT mortality due to the surveys was 48 individuals and 133.9 kg. The trolling index, the number of SBT age one school per 100 km searched, was higher in the 2005-2009 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

2010 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 年以降と同様に実施した。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 東沖-Albany 間の海域も調査した。航海を通じて漁獲したミナミマグロは 219 個体で、その内 149 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 48 個体、合計重量 133.9kg 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、2005-2009 年級は 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 a 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, 2009). In January 2010, we carried out similar trolling monitoring survey and the results of the survey are presented in this paper.

2. Materials and methods

Cruise of the piston line trolling survey

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 four years. The vessel departed

Esperance on 19 January 2010, which was two days later than the survey in 2009. The vessel surveyed off Bremer Bay from 20 to 21 January, and then went further west and surveyed an area between Bremer Bay and Albany from 22 to 28 January. The vessel came back and surveyed off Bremer Bay again from 28 to 31 January. The vessel left off Bremer Bay and arrived at Esperance on 1 February. It surveyed east of Esperance from 2 to 4 February, and back to Esperance on 5 February in which 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 east of Esperance (123E) and Albany (118E), 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 specifications 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 in good condition were tagged and released with two CCSBT conventional tags, following the CCSBT tagging procedure. Some of SBT were also implemented archival tags (Lotek , LTD2310). Another SBT individuals of which relatively large size were released with pop-up archival tags (miniPAT of Wildfile Computers Inc.). 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 small, highly accurate two-channel recorders

for temperature-depth (JFE ALEC co. ltd., Compact-TD) and conductivity-temperature (JFE ALEC co. ltd., Compact-CT). Temperatures of sea surface were recorded successively throughout the survey using the miniature temperature recorder (JFE ALEC co. ltd., MDS-MkV/T). GPS positions data were recorded every ten seconds.

Underwater video images were taken during trolling conducted out of the piston-line. One or two digital cameras in waterproof cases were towed and placed 20-30 m behind of the vessel and 2-3 m below the sea surface. The camera took image toward below and behind direction. The images taken were observed on monitor of PC and SBT presence was checked.

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 14 years between 1996 and 2010; 1) piston-line trolling survey from 2006 to 2010, 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. Results

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 all days but 3 February in east of Esperance. The piston-line was surveyed off Bremer Bay in two days in the first half and in four days in the second half of the cruise, in total of six days for 11 lines.

In the cruise, a total of 274 fish individuals were hooked, including 219 SBT, 12 bonito *Sarda orientaris*, 8 blue mackerel *Scomber australasicus*, 4 samson fish *Seriola hippos*, 3 yellowtail kingfish *Seriola lalandi*, 2 barracouta *Thyrsites atun*, 1 snook *Sphyraena novaehollandiae* and 26 unidentified individuals which escaped far from the vessel. Among the 219 SBT, 149 SBT were tagged with CCSBT conventional tags. 69 SBT were also implemented archival tags. 8 SBT in large size (>66 cmFL) were released with miniPAT. 48 SBT with severe damage were killed and 14 were escaped near the vessel. Total weight of SBT sampled in the two cruises was 133.9 kg of 48 individuals.

Trajectories of the research survey and locations of SBT caught are shown in Figure 2. Many SBT were caught off Bremer Bay not only on the piston-line but also in adjacent areas. Few SBT were caught offshore area from self edge on the piston-line.

Length frequencies of SBT caught are shown in Figure 3. SBT caught ranged from 45 to 81 cmFL. All of SBT caught on the piston-line were less than 54 cm so that age of them assigned as age 1.

Underwater video images were taken 32 times, up to 32 minutes long each time (total of 13 hours 43 minutes). In preliminary result, SBT were observed 12 out of 32 (Table 2). In 10 out of the 12, SBT catch were recorded on deck. There were 2 cases that SBT were observed on images but no catch were recorded, on the contrary, there were 5 cases that SBT were not observed on images but caught on deck. Other 15 cases, SBT were not observed and not caught. This coincidence of presence in video image and catch in many cases suggests that SBT schools attracted and came near vessels were usually detected as catch.

On the 11 piston lines, the total number of age 1 SBT school was 10 and 12 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 343km. The mean trolling indices are calculated as 2.9 school/100 km (30 minutes school definition) or 3.5 school/100 km (2 km school definition).

Figure 4 shows the five different trolling indices produced by 1000 times bootstrap. The indices relative to its median at 11 lines are shown in Figure 5. Along the number of lines increased, median values become more stable larger than four lines and the confidence interval between 5% and 95% points were decreased largely to four lines and then decreased gradually.

Figure 6 shows two trolling indices of the piston-line from the trolling survey between 2006 and 2010 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 decreased from 2009 to 2010. It should be noted that trolling indices have relatively large range of confidence interval between 5 and 95%.

Figure 6 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 2005-2009 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 2006 has not been obtained from other sources.

The trolling survey is a robust research against wind, wave and swell. There was few days that suspended the research during the cruise due to rough sea condition in five 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 fraction 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 4-7 lines in five years suggests that four days or more is sufficient for the piston-line survey. Indices between on the piston-line and on adjacent areas, as well as those between off Bremer Bay and off Albany were not different very much (Itoh, 2007, Itoh and Sakai 2008). However, unfortunately, these differences were 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).

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Table 1. Statistics of trolling index.

Survey	Year	N_line	Area	Minimum	5%	Median	95%	Maximum
Acoustic	1996		Not including piston line	0.365	0.711	1.260	1.912	2.955
Acoustic	1997		Not including piston line	0.317	0.644	1.075	1.604	2.361
Acoustic	1998		Not including piston line	0.423	0.958	1.576	2.215	2.949
Acoustic	1999		Not including piston line	0.819	1.373	1.932	2.528	3.127
Acoustic	2000		Not including piston line	0.000	0.092	0.367	0.658	1.068
Acoustic	2001		Not including piston line	0.000	0.000	0.101	0.301	0.716
Acoustic	2002		Not including piston line	0.000	0.000	0.000	0.000	0.000
Acoustic	2003		Not including piston line	0.161	0.570	1.046	1.554	2.270
Acoustic	2005		Not including piston line	0.128	0.483	1.196	2.120	3.390
Acoustic	2006		Not including piston line	1.309	1.859	2.420	3.052	3.738
Acoustic	2005	18	Piston line only	0.142	0.718	1.442	2.284	3.158
Acoustic	2006	18	Piston line only	2.500	2.951	3.682	4.422	5.015
Trolling	2006	12	Piston line only	1.490	2.057	2.817	3.584	4.172
Trolling	2007	14	Piston line only	1.493	3.100	4.723	6.712	8.576
Trolling	2008	10	Piston line only	3.388	4.326	5.426	6.467	7.567
Trolling	2009	9	Piston line only	1.298	2.236	3.578	5.119	6.613
Trolling	2010	11	Piston line only	0.872	1.755	2.918	4.071	4.954

Unit of index was N_school/100 km. School definition was >30 minutes between two catches.

Minimum, 5%, median, 95%, and maximum points were calculated from 1000 times bootstrap samplings.

Table 2. SBT observed in the towing underwater camera images.

	Underwater camera image		
	SBT observed	Not SBT observed	Total
SBT Caught	10	5	15
No SBT catch	2	15	17
Total	12	20	32

Number is the towing underwater image taken.

Figure 1 St Gerard M, used for the research

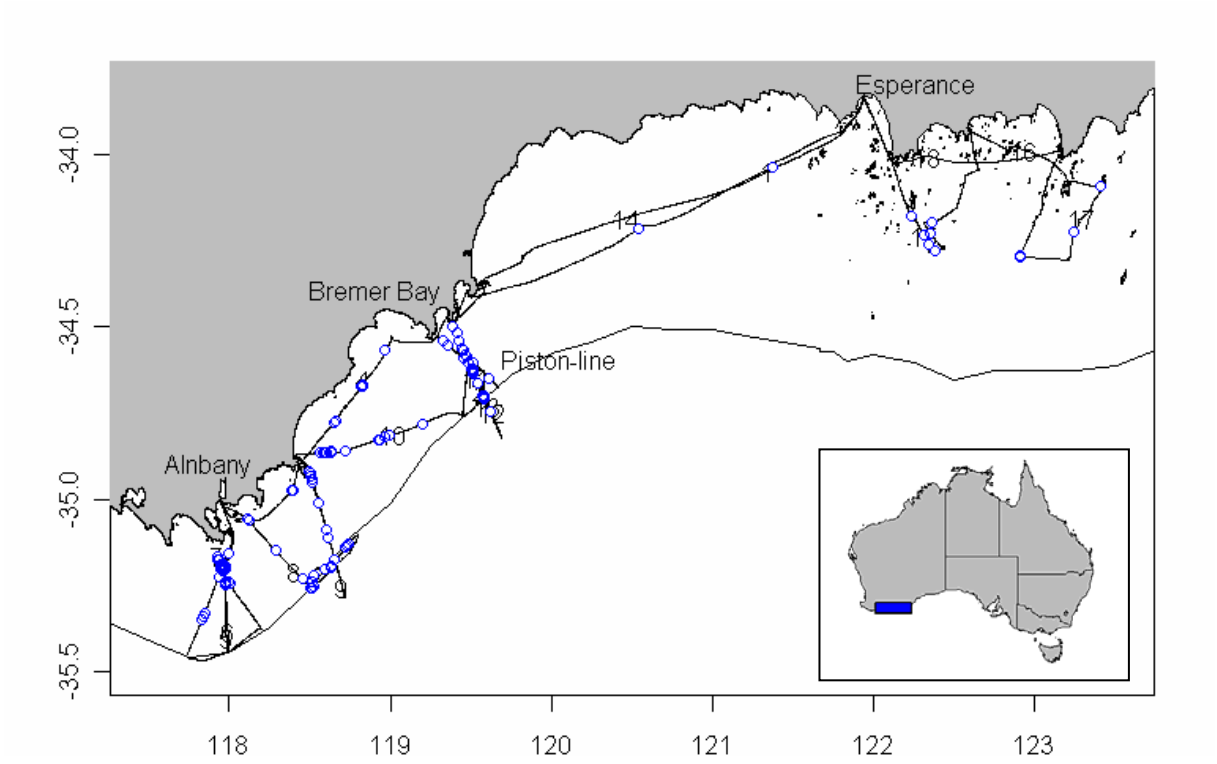

Figure 2 Trajectory of the vessel and location of SBT caught (open circles) in the 2010 trolling survey. The numbers denote *i*th day of the cruise. Note that trolling was not operated in some part (e.g. most of day 1st and 14th).

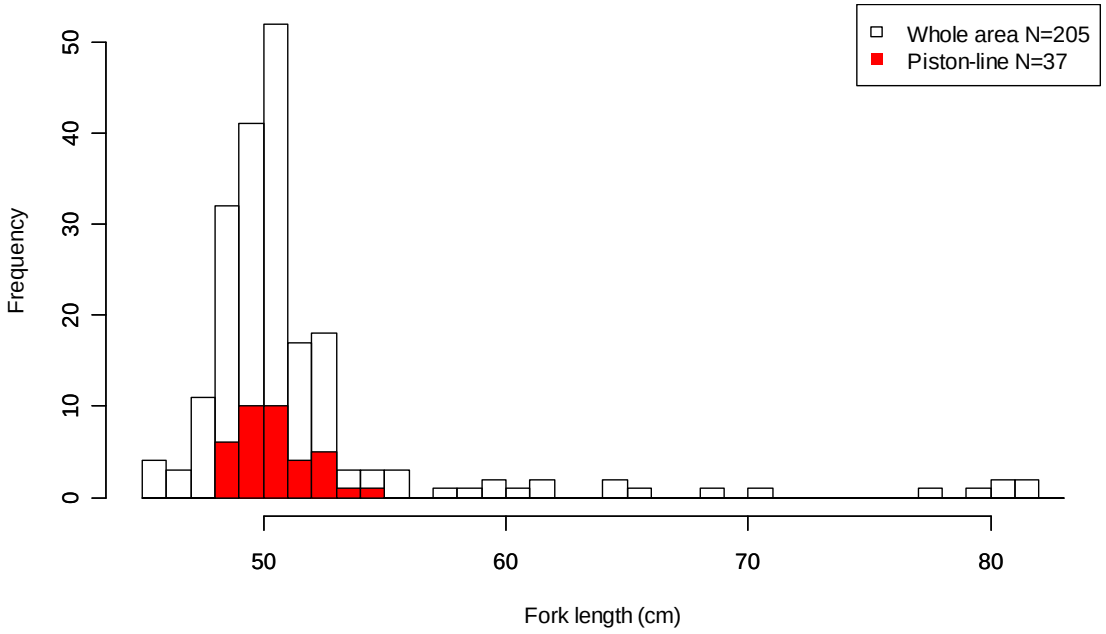

Figure 3 Fork length frequency distributions of southern bluefin tuna caught in the 2010 cruise.

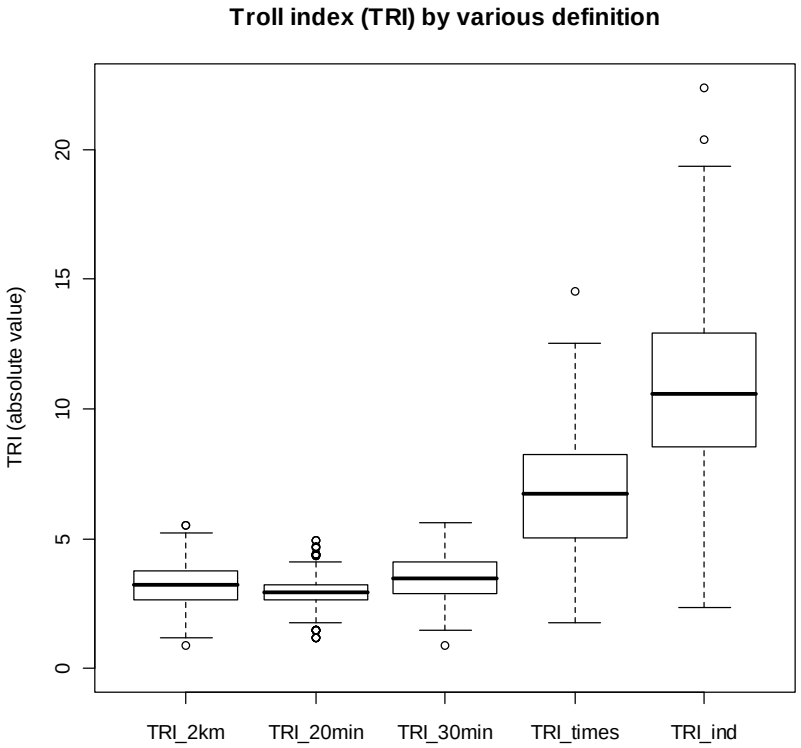

Figure 4 Trolling indices in absolute value by various definition in 2010. Data were sampled 1000 times by bootstrap methods.

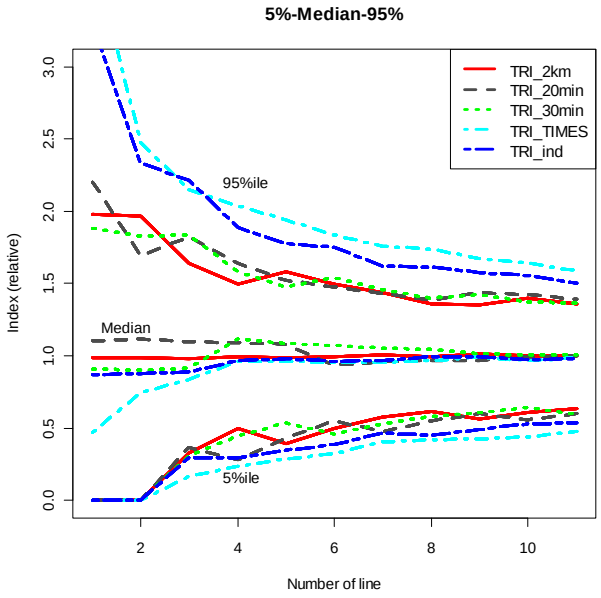

Figure 5 Bootstrap simulation for the five types of trolling indices and for the number of line surveyed in 2010. Relative values of median, and 5 percentile and 95 percentile points to the mean of each trolling indices are shown.

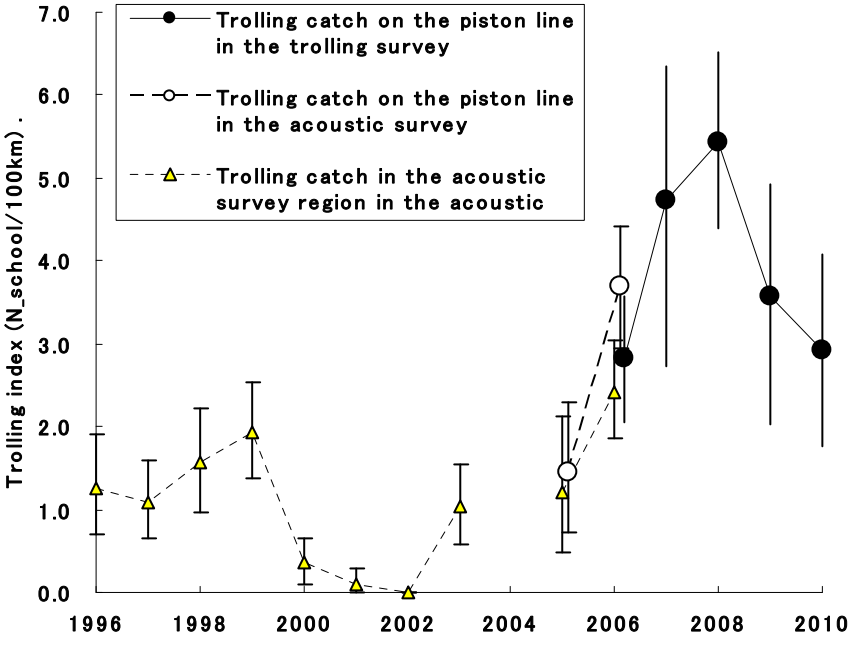

Figure 6 Trolling indices (TRI_30min) from the trolling survey on the piston line (2006-2010), from the acoustic survey on the piston line (2005-2006) and from the acoustic survey in whole the rectangle research area except the piston line (1996-2006). Marks and bars denote median and 5% and 95% points from 1000 times bootstrap samplings, respectively.