Changes in recruitment of Pacific bluefin tuna (*Thunnus orientalis*) from 1980 to 2012

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The original version of this document used a CPUE time series with error (ISC/14/PBFWG-1/07 appendix). Consequently, the recruitment values used in this document were slightly different from the stock assessment report (URL XXX), which shows the corrected results.

Abstract

Changes in recruitment of Pacific bluefin tuna (PBT) were mainly examined from 1980 to 2012. The shifts in recruitment were detected in 1994 and 2009 by a sequential regime shift detection method and the following three periods were defined; 1980-1993, 1994-2008, and 2009-2012. The recruitment of PBT was significantly lower in 1980-1993 and 2009-2012 than in 1994-2008. Catch per unit effort (CPUE) for troll fisheries in Nagasaki was also significantly lower in 1980-1993 than in 1994-2008. Significant positive relationships were found between the recruitment and CPUE in Nagasaki (R^2=0.581), Kochi (R^2=0.206) and Wakayama (R^2=0.288), and the recruitment forecasts using these relationships were thought to be promising. Significant but weak negative relationships were found between the recruitment and Pacific Decadal Oscillation (PDO) in fall (R^2=0.202) and winter (R^2=0.193).

Introduction

The current biomass level of Pacific bluefin tuna (PBF) in 2010 is near historically low levels and experiencing high exploitation rates above all biological reference points (BRPs) commonly used by fisheries managers. Based on projection results, extending the fishing levels in 2007-2009 is unlikely to improve stock status. So strengthening the monitoring of recruitment is highly recommended to comprehend the trend of recruitments in a timely manner. Also further reduction of fishing mortality is expected to reduce the risk of spawning stock biomass (SSB) falling below its historically lowest level (PBFWG 2013).

The Northern Committee Ninth Regular Session (NC9) of the Western and Central Pacific Fisheries Commission (WCPFC) requested the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) to provide information regarding the range of historical variation in recruitment, such as in terms of standardized Catch per unit effort (CPUE) for particular fisheries, or other appropriate measures. Specifically, information for the low recruitment period during the 1980s, and for the last 10 years, is requested (WCPFC 2013).

The objectives of this paper are (1) to describe the monitoring research of the recruitment of PBT, (2) to examine the changes in recruitment of PBT and standardized CPUEs for troll fisheries, and (3) to consider the possible factors affecting to the recruitment.

Data and Methods

Fishing grounds of troll fisheries in Nagasaki, Kochi and Wakayama Prefectures are shown in Fig.1. The characteristics of fisheries, quality of catch-and-effort data and abundance indices, that is, standardized CPUE of young PBT are reported by Ichinokawa et al. (2012). Recruitment and standardized CPUE data from 1980 to 2012 were updated and used in this paper, expect for Wakayama Prefecture. Updated recruitment data set from 1952 to 2012 was provided by Fukuda et al. (2014) and used to examine the long term changes in recruitment.

The Pacific Decadal Oscillation (PDO) index values are obtained from the following site:http://www.data.kishou.go.jp/kaiyou/shindan/b_1/pdo/pdo.html.
The season was defined as follows: spring: March-May, summer: June-August, fall: September-November, winter: December-February.

A sequential regime shift detection method is described by Rodionov and Overland (2005). The program to detect shifts in the mean level of fluctuations was obtained from the following site: http://www.beringclimate.noaa.gov/regimes/index.html. The following parameters were used in this method; significant level was 0.2-0.4 for the recruitment, 0.2 for Nagasaki CPUE, 0.4 for Kochi CPUE, and 0.1 for PDO. Cut-off length was 10 and Huber's weight parameter was 1.

Results

Description of Monitoring Research, Catch and Abundance

Abundance indices and catch for PBT are described in time series in Table 1. A cohort of PBT born in April-Aug. in year t is monitored and caught by different fisheries in different time and space. Timely juvenile monitoring based on real-time monitoring system provides the juvenile index in Oct.-Dec. in year t just before the purse seine fisheries for juvenile to start in Oct. in year t in Japanese and Korean waters. Ordinary juvenile monitoring based on sales slips takes about a half year to provide the juvenile index in Dec. in year t+1 after the troll fisheries ceased in June in year t, because troll fisheries are really small-scale fishery conducted in remote locations such as islands.

Recruitment and standardized CPUEs

The recruitment and standardized CPUE are variable from year to year (Table 2). Coefficient variations from 1980 to 2012 were 0.57 in the recruitment, 0.35 in Nagasaki CPUE, 0.93 in Kochi CPUE, and 0.96 in Wakayama CPUE. Ranges of the values were 3755.96-38710.10 in the recruitment, 0.47-1.97 in Nagasaki CPUE, 0.10-3.69 in Kochi CPUE and 0.13-4.37 in Wakayama CPUE (Table 3).

The first shift was detected in 1994 in the recruitment, Nagasaki CPUE and Kochi CPUE. The second shift was detected in 2009 in the recruitment, in 2012 in Nagasaki CPUE, and in 2010 in Kochi CPUE. In Wakayama CPUE, a shift was not detected due to a short data set (Fig. 2-5). The shifts in recruitment in 1994 and 2009 were also confirmed based on the long term data set from 1952 to 2012, although significant level was 0.4 (Fig. 6).

Based on the shits detected in the recruitment, three periods were defined as follows; 1980-1993, 1994-2008, and 2009-2012. Statistical values for the recruitment and CPUE were summarized by each period in Table 3. The differences in the recruitment and CPUE between two periods were examined. The recruitment was significantly lower in 1980-1993 and 2009-2012 than in 1994-2008. Nagasaki CPUE was also significantly lower in 1980-1993 than in 1994-2008 (Table 4). The differences in the recruitment were examined between 1952-2012 and three periods, and between 1980-2012 and three periods. The average of recruitment in 1980-1993 was significantly lower than that in 1952-2012. The average of recruitment in 1994-2008 was significantly higher than that in 1980-2012 (Table 5).

Significant positive relationships were found between the recruitment and CPUE in Nagasaki (R^2=0.581), Kochi (R^2=0.206) and Wakayama (R^2=0.288). By each period, significant positive relationships were found between the recruitment and standardized CPUE in 1980-1993 and 1994-2008 in Nagasaki, in 1994-2008 in Kochi, but not in 2009-2012 in Nagasaki and Kochi (Fig.7).

Environmental Factors

PDO index values in spring were positive before the first sift in 1999, and no distinct trend was observed after 2000 (Fig. 8). There was no statistically significant relationship between PDO in spring and recruitment (Fig. 9). PDO index values in summer were positive before the first sift in 2008, and negative values continued after 2009 (Fig. 10). There was no statistically significant relationship between PDO in summer and recruitment (Fig. 11). PDO index values in fall were positive before the first sift in 1998, and negative values continued after 1998 (Fig. 12). There was a statistically significant negative relationship between PDO in fall and recruitment (Fig. 13). PDO index values in winter were positive in 1980s. No distinct trend in PDO index values was observed after 1990s, as the values repeatedly varied from positive to negative with periods of several years. Then negative values mostly continued after 2011. The first shift was detected in 1989, and the second shift was found in 2011 (Fig.14). There was a statistically significant negative relationship between PDO in winter and recruitment (Fig. 15).

Discussions and Conclusions

Variation in Recruitment

Two shifts in 1994 and 2009 were detected in recruitment from 1980 to 2012 by a sequential regime shift detection method using significant level 0.2. These two shifts were also confirmed based on the long term data from 1952 to 2012 using significant level 0.4. Due to the large variation in recruitment, it is difficult to detect the same shifts using the same significant level, if we use the different data sets. However, the average of recruitment in 1980-1993 was significantly lower than that in 1952-2012 (p=0.0275), even if not significantly lower than that in 1980-2012 (p=0.0795). Also, the average of recruitment in 1994-2008 was significantly higher than that in 1980-2012 (p=0.0425), even if not significantly higher than that in 1952-2012 (p=0.0792). Thus the recruitments in 1980-1993 and 1994-2008 are not always significantly lower and higher than the long term averages, but they might be good candidates for the lower and higher recruitment for future projection scenario.

Environmental Factors

PDOs in four seasons were examined how they affect the recruitment of PBT. The spawning season of PBT is from April and August, so we expect that PDOs in spring and summer might affect the recruitment. However, significant negative relationships were found not in spring and summer, but in fall and winter. CPUE values in Nagasaki and Kochi were collected from troll fisheries from July in year t to June in year t+1, and indicated a similar variation with recruitment, so the PDOs in fall and winter might actually affect the recruitment. A future work is to investigate how the PDO affects the juvenile PBT in fall and winter. Also we need to find other factors affecting recruitment in spring and summer.

The negative values in PDO mean that the sea surface temperature in the central North Pacific is higher than the average and vice versa (Japan Meteorological Agency. 2014). Figs. 13 and 15 showed that negative values in PDO related to higher recruitment. Kawasaki (2013) examined the regime shifts of energy flow between trophic levels in the warm-water pelagic fish assemblages in the Northwest Pacific. He showed the higher proportion of large pelagic fish including tunas corresponding to warm regime in POD and vice versa. These suggest that negative PDO is good for PBT production. Recent PDOs in fall and winter seem to shift to negative values, but the recruitment seems to shift to lower values. It is necessary to monitor recruitment to confirm whether or not the recent recruitment shifts to the lower level.

Conclusions

The recruitment was shifted in the following three periods; 1980-1993, 1994-2008, and 2009-2012. The recruitments in 1980-1993 and 1994-2008 were lower and higher than the long term averages and might be good candidates for future projection scenario.

References

Ichinokawa M, Oshima K, Takeuchi Y (2012) Abundance indices of young Pacific bluefin tuna, derived from catch-and-effort data of troll fisheries in various regions of Japan. ISC/12-1/PBFWG/11

Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. Northern Committee. Regular Session (9th : 2013 : Fukuoka, Japan). Ninth regular session, Fukuoka, Japan, 2-5 September 2013 : summary report. Kolonia, Pohnpei : Western and Central Pacific Fisheries Commission, 2013. 56 p. ; 30 cm. ISBN 978-982-9103-30-7

Pacific Bluefin Tuna Working Group (PBFWG). 2013. Report of Pacific bluefin tuna Working Report, 14-15 July 2013, Busan, Korea. Available at:

Kawasaki, T. 2013. Regime Shift -Fish and Climate Change–, Tohoku University Press, Sendai, Japan, 162pp.

Japan Meteorological Agency. 2014. The Pacific Decadal Oscillation (PDO) index values.http://www.data.kishou.go.jp/kaiyou/shindan/b_1/pdo/pdo.html (2014-01-12)

Rodionov, S and Overland J E (2005) Application of a sequential regime shift detection method to the Bering Sea ecosystem. ICES Journal of Marine Science, 62: 328-332.

Fukuda H, Oshima K, Takeuchi Y (2014) A review of the model setting for the update of stock assessment for Pacific bluefin tuna. ISC/14/PBFWG-1/

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Table 1. Abundance indices and catch for Pacific bluefin tuna (PBF) in time series. A cohort of PBT born in April-August in year t is monitored and fished in the following time and regions.

Indices or Catch (available date)	Descriptions
Timely Juvenile Abundance Index (October in year t for Pacific Ocean hatched cohort) (December in year t for Sea of Japan hatched cohort)	Timely juvenile monitoring Troll fisheries for farming during Jul.-Sep. for Nagasaki and Kochi, and during Sep.-Dec. for Shimane in year t Based on real-time monitoring system.
Conventional Juvenile Abundance Index (December in year t+1)	Ordinary juvenile monitoring Troll fisheries in Nagasaki, Kochi and Wakayama from July in year t to June in year t+1. Based on Sales slips.
Juvenile Catch (October in year t+1 for age 1)	Catch data Japanese and Korean purse seines from October in year t to July in year t+1. Mexican purse seine from June to August in year t+2.
Recruitment (June in year t+2 or later)	Output of stock assessment
Adults Catch (October in year t+3 for ages < 6)	Catch data Japanese tuna purse seine from June to August in years of t+3. Japanese and Taiwanese longlines from April to June in year ≥ t+6.
Spawning Stock Abundance Index (December in year t+6 for Japanese longline)	Japanese and Taiwanese longlines from April to June in year ≥ t+6. Based on logbook data for Japanese longline and auction records and information relevant to fishing effort obtained from the security checking station of the harbor.
Spawning Stock Biomass (June in year t+5 or later)	Output of stock assessment

Table 2. Recruitment (1000 fish) estimated by the base-case model and standardized CPUE from 1980 to 2012.

Year	Recruitment	Nagasaki CPUE	Kochi CPUE	Wakayama CPUE
1980	6785.94	0.66	3.69	
1981	18639.40	1.14	0.81	
1982	8345.09	0.58	0.25	
1983	11732.10	0.89	0.20	
1984	8681.99	0.89	1.13	
1985	11287.70	0.83	0.76	
1986	12172.10	0.95	0.29	
1987	8175.23	0.68	0.16	
1988	8087.73	0.77	0.60	
1989	6360.58	0.62	0.31	
1990	29491.80	1.23	0.65	
1991	3755.96	1.32	0.57	
1992	5939.52	0.57	0.31	
1993	4779.89	0.47	0.51	
1994	38710.10	1.97	3.16	1.40
1995	11835.90	1.07	1.09	0.78
1996	18579.60	1.60	0.91	1.26
1997	9328.52	0.90	0.50	0.71
1998	16041.70	0.82	1.48	0.55
1999	21809.40	1.49	0.33	0.18
2000	16562.60	1.15	0.31	0.53
2001	18573.50	1.16	2.17	0.94
2002	14179.30	0.73	0.86	0.62
2003	10306.00	0.65	0.41	0.30
2004	27675.20	1.29	3.41	4.37
2005	13583.60	1.36	0.92	1.08
2006	10707.40	0.71	1.07	1.04
2007	24660.40	1.38	1.33	1.51
2008	18018.40	1.44	0.71	1.20
2009	7188.68	1.11	0.10	0.13
2010	14704.20	1.09	1.58	0.40
2011	9753.30	0.94	2.05	
2012	7120.89	0.52	0.39	

Table 3. Statistical values for recruitment (1000 fish) from the base-case model and standardized CPUE in each period, 1980-2012 and 1952-2012.

Year	Recruitment	Nagasaki CPUE	Kochi CPUE	Wakayama CPUE
1980-1993				
Mean	10302.50	0.83	0.73	
SD	6681.94	0.26	0.89	
CV	0.65	0.31	1.22	
Max	29491.80	1.32	3.69	
Min	3755.96	0.47	0.16	
1994-2008				
Mean	18038.11	1.18	1.24	1.10
SD	7780.96	0.38	0.96	0.99
CV	0.43	0.32	0.77	0.90
Max	38710.10	1.97	3.41	4.37
Min	9328.52	0.65	0.31	0.18
2009-2012				
Mean	9691.77	0.91	1.03	
SD	3559.17	0.28	0.93	
CV	0.37	0.30	0.91	
Max	14704.20	1.11	2.05	
Min	7120.89	0.52	0.10	
1980-2012				
Mean	13744.66	1.00	1.00	
SD	7854.39	0.35	0.93	
CV	0.57	0.35	0.93	
Max	38710.10	1.97	3.69	
Min	3755.96	0.47	0.10	
1952-2012				
Mean	14782.13			
SD	7963.97			
CV	0.54			
Max	39288.10			
Min	2696.64			

Table 4. Probability densities of t and F values for recruitment and standardized CPUE between two periods.

Recruitment	1980-1993	1994-2008	2009-2012
1980-1993		0.0040**	0.4323
1994-2008	0.5892		0.0278*
2009-2012	0.3275	0.2234	
Nagasaki CPUE	**1980-1993**	**1994-2008**	**2009-2012**
1980-1993		0.0035**	0.2874
1994-2008	0.1882		0.1027
2009-2012	0.7441	0.6717	
Kochi CPUE	**1980-1993**	**1994-2008**	**2009-2012**
1980-1993		0.0751	0.2834
1994-2008	0.7996		0.3488
2009-2012	0.7783	0.8948	

Table 5. Probability densities of t and F values for recruitment between three periods in 1980-1993, 1994-2008, 2009-2012 and long term periods in 1952-2012 and 1980-2012.

Recruitment	1952-2012	1980-2012	1980-1993	1994-2008	2009-2012
1952-2012		0.2731	0.0275*	0.0792	0.1057
1980-2012	0.9542		0.0795	0.0425**	0.1598
1980-1993	0.4961	0.5455		0.0040**	0.4323
1994-2008	0.9826	0.9852	0.5892		0.0278*
2009-2012	0.2077	0.2161	0.3275	0.2234	

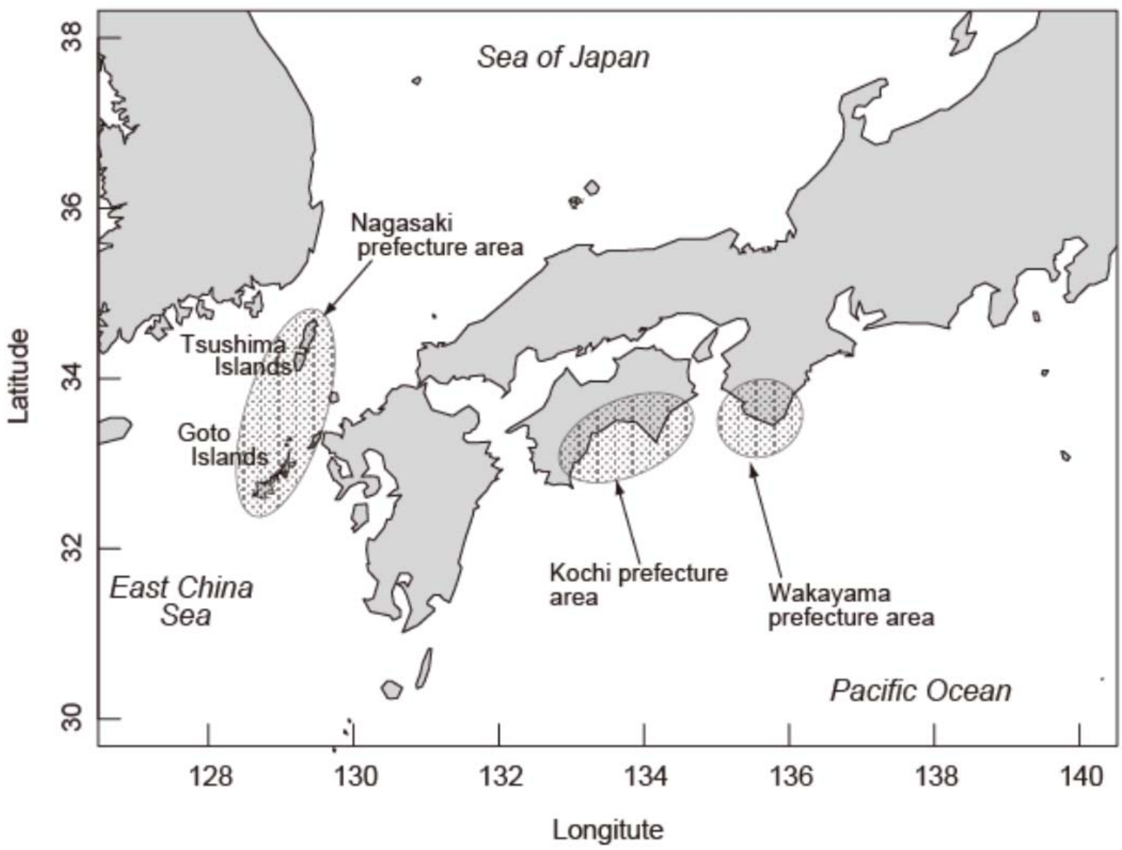

Fig. 1. Location of fishing grounds of troll fisheries conducted in Nagasaki, Kochi and Wakayama Prefectures in Japan. (From Ichinokawa et al. 2012)

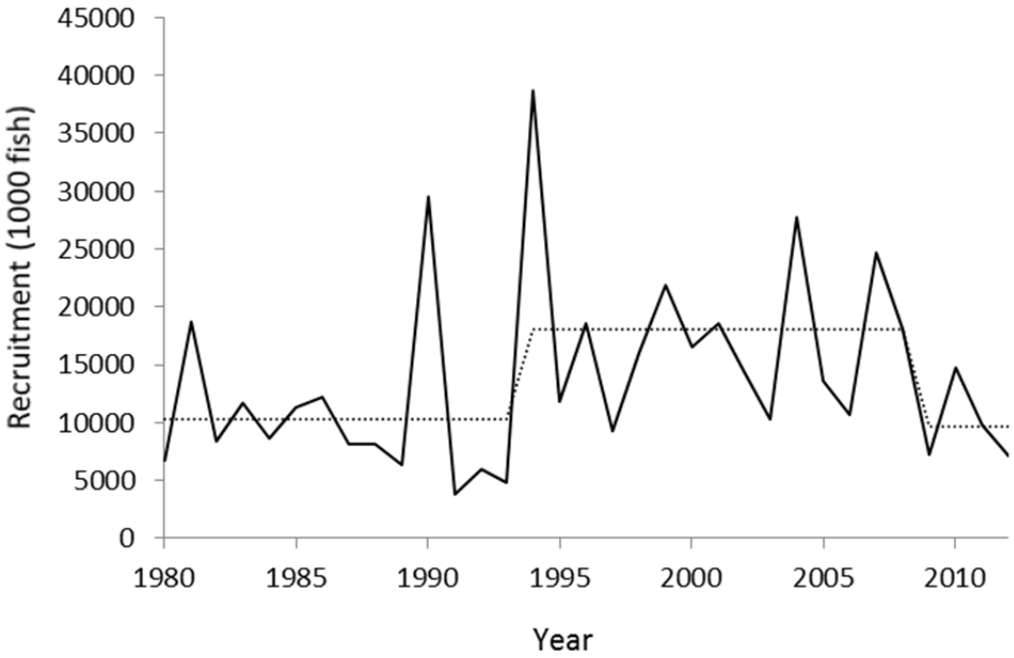

Fig. 2. Recruitment (1000 fish) estimated by the base-case model from 1980 to 2012. Dotted line indicates the means and shifts detected by a sequential regime shift detection method. The first shift was detected in 1994, and the second shift was found in 2009 using significant level=0.2.

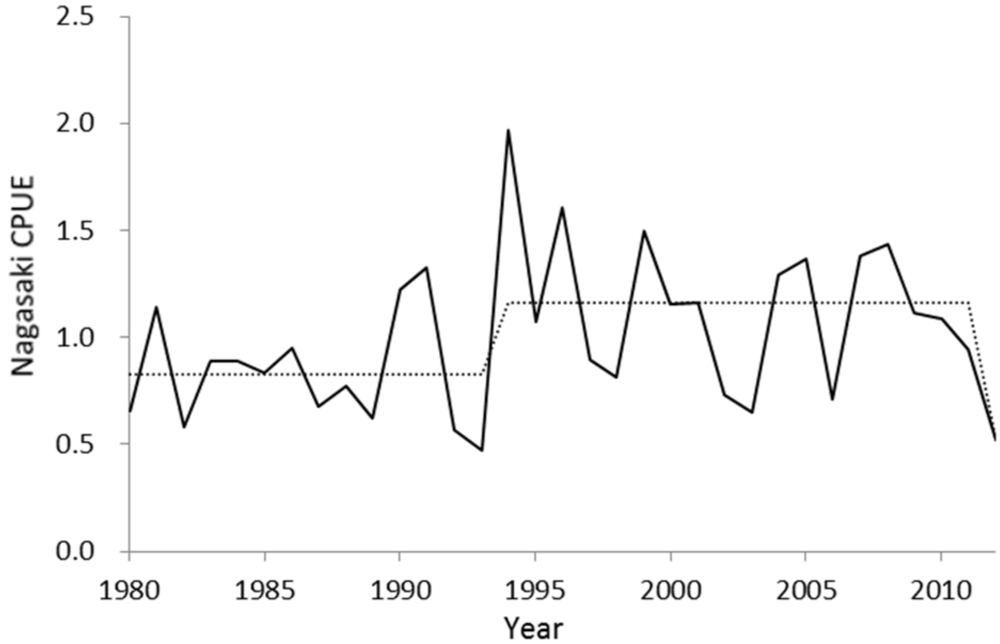

Fig. 3. Abundance indices based on troll fisheries in Nagasaki Prefecture in Japan from 1980 to 2012. Dotted line indicates the means and shifts detected by a sequential regime shift detection method. The first shift was detected in 1994, and the second shift was found in 2012 using significant level=0.2.

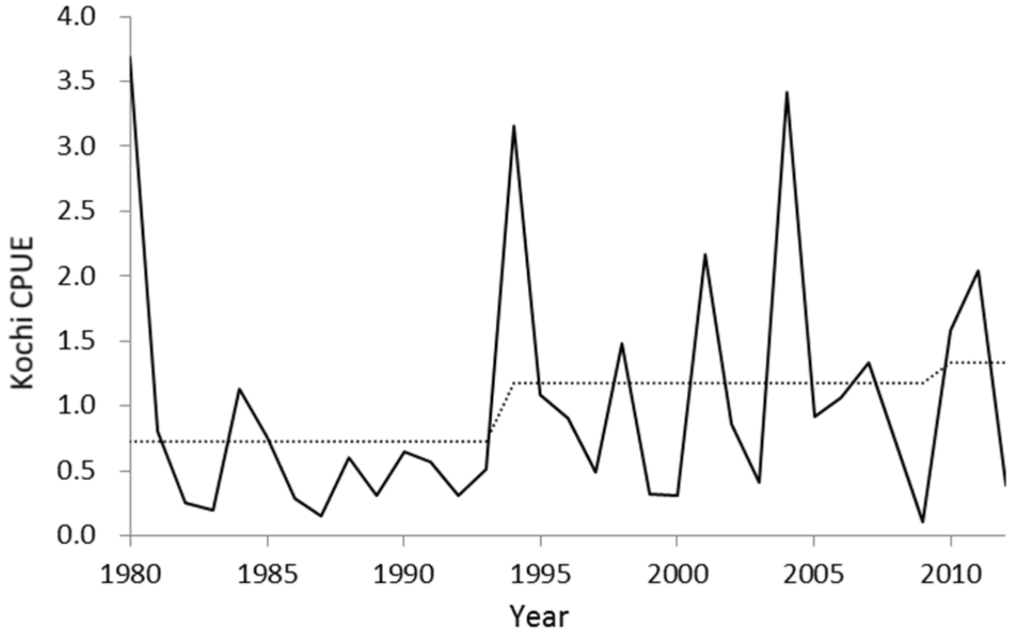

Fig. 4. Abundance indices based on troll fisheries in Kochi Prefecture in Japan from 1980 to 2012. Dotted line indicates the means and shifts detected by a sequential regime shift detection method. The first shift was detected in 1994, and the second shift was found in 2010 using significant level=0.4.

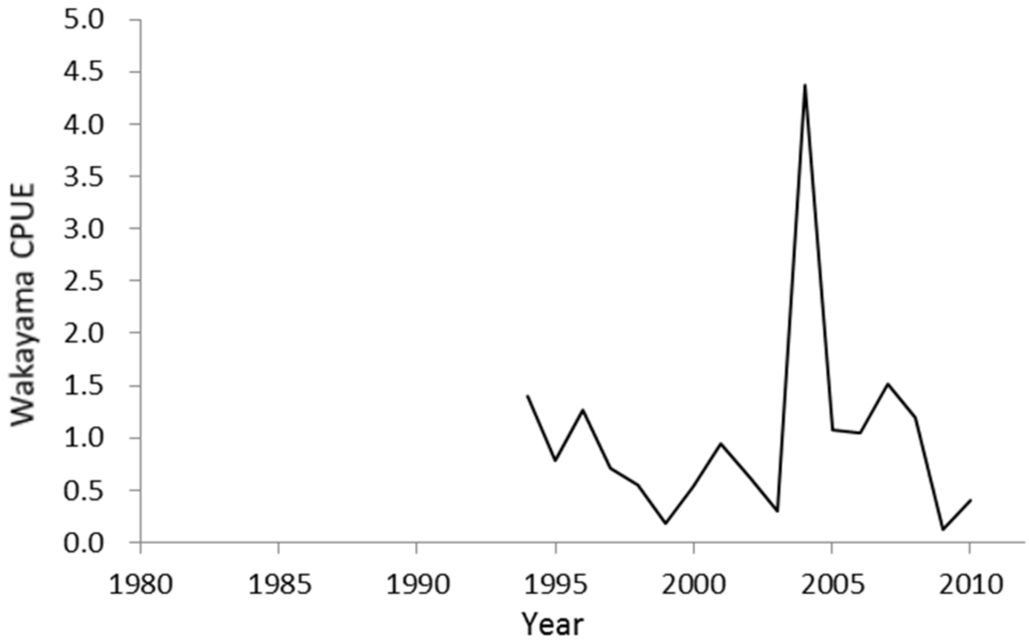

Fig. 5. Abundance indices based on troll fisheries in Wakayama Prefecture in Japan from 1994 to 2010.

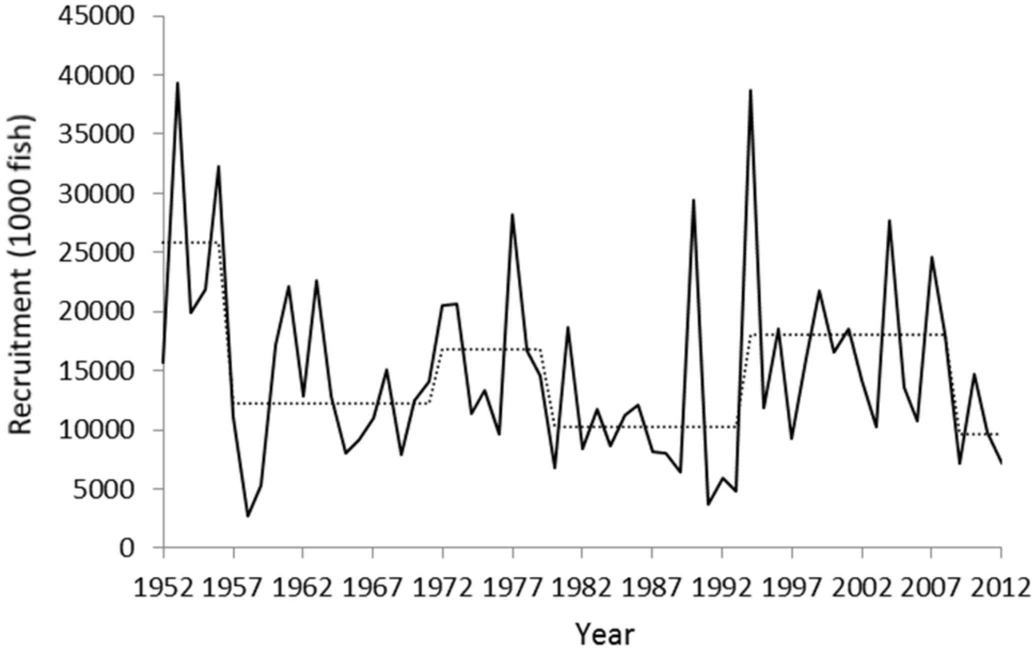

Fig. 6. Recruitment (1000 fish) estimated by the base-case model from 1952 to 2012. Dotted line indicates the means and shifts detected by a sequential regime shift detection method. The shifts were detected in 1957, 1972, 1980, 1994 and 2009 using significant level=0.4.

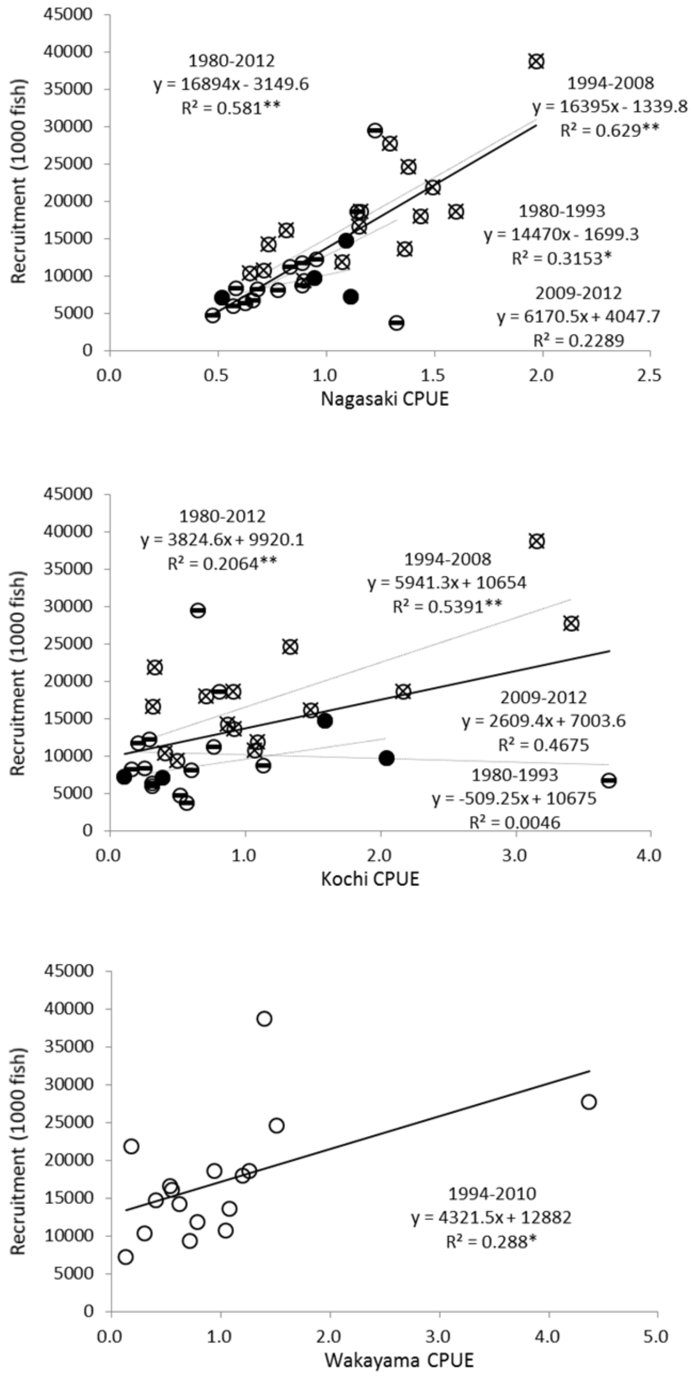

Fig. 7. Relationship between abundance indices of troll fisheries conducted in Nagasaki, Kochi and Wakayama Prefectures and recruitment estimated by the base-case model for Pacific bluefin tuna. ⊖:1980-1993, ⊠ :1994-2008, ●:2009-2012.

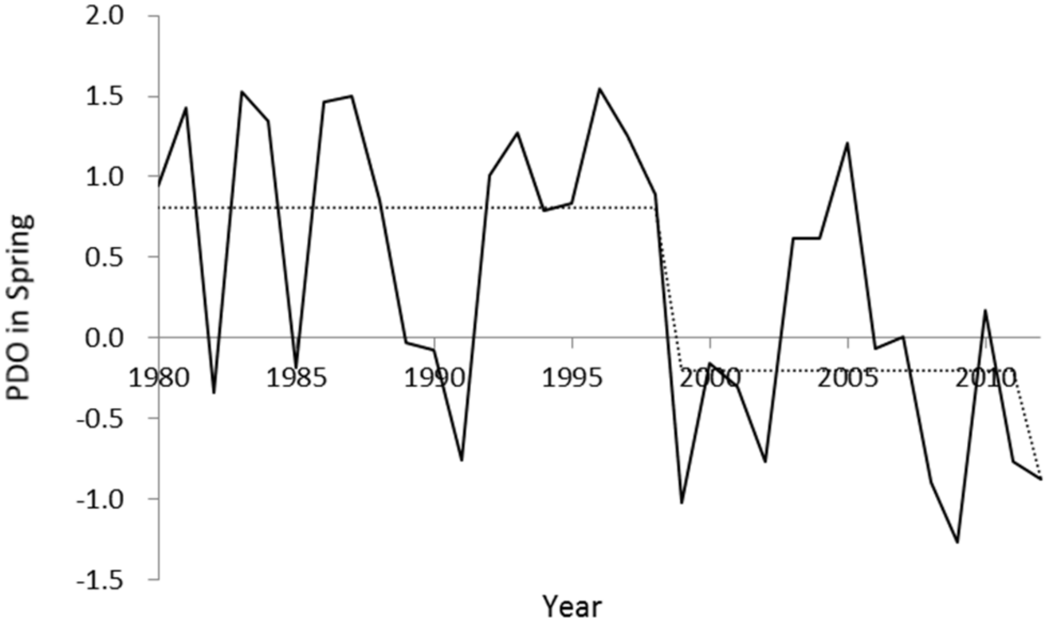

Fig. 8. Pacific Decadal Oscillation (PDO) in spring (March-May) from 1980 to 2012. Dotted line indicates the means and shifts detected by a sequential regime shift detection method. The first shift was detected in 1999, and the second shift was found in 2012.

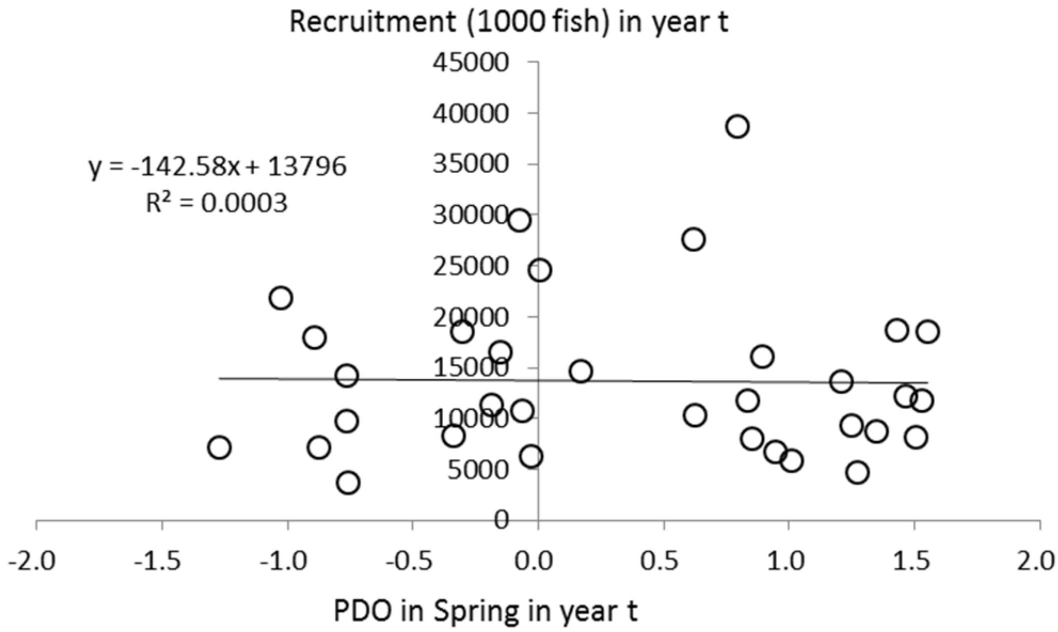

Fig.9. Pacific Decadal Oscillation (PDO) in spring (March-May) in year t and recruitment in year t of Pacific bluefin tuna from 1980 to 2012.

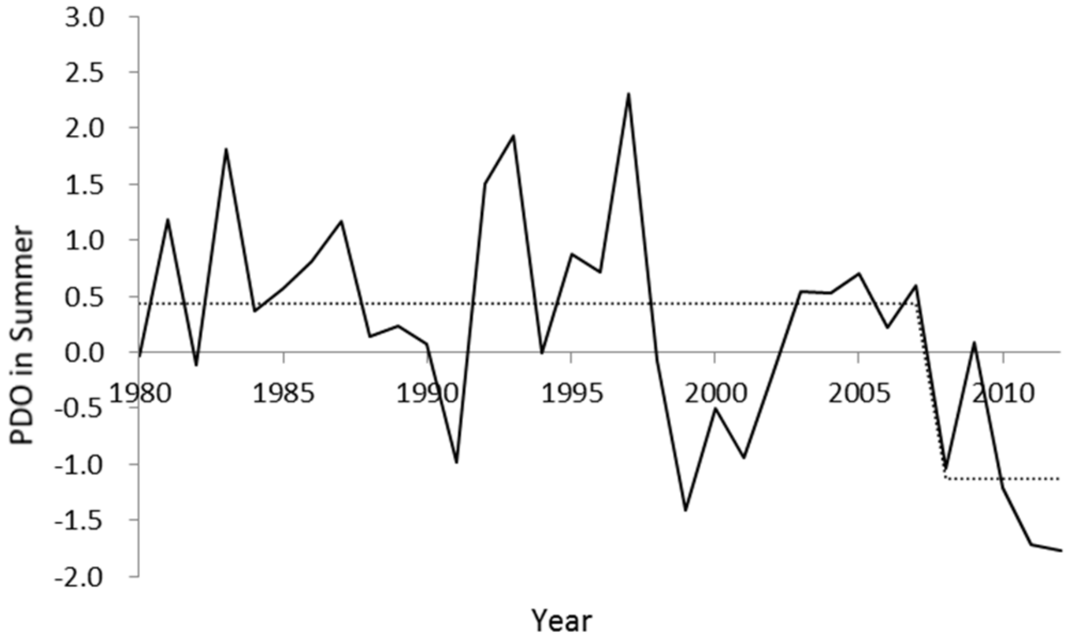

Fig. 10. Pacific Decadal Oscillation (PDO) in summer (June-August) from 1980 to 2012. Dotted line indicates the means and shifts detected by a sequential regime shift detection method. The first shift was found in 2008.

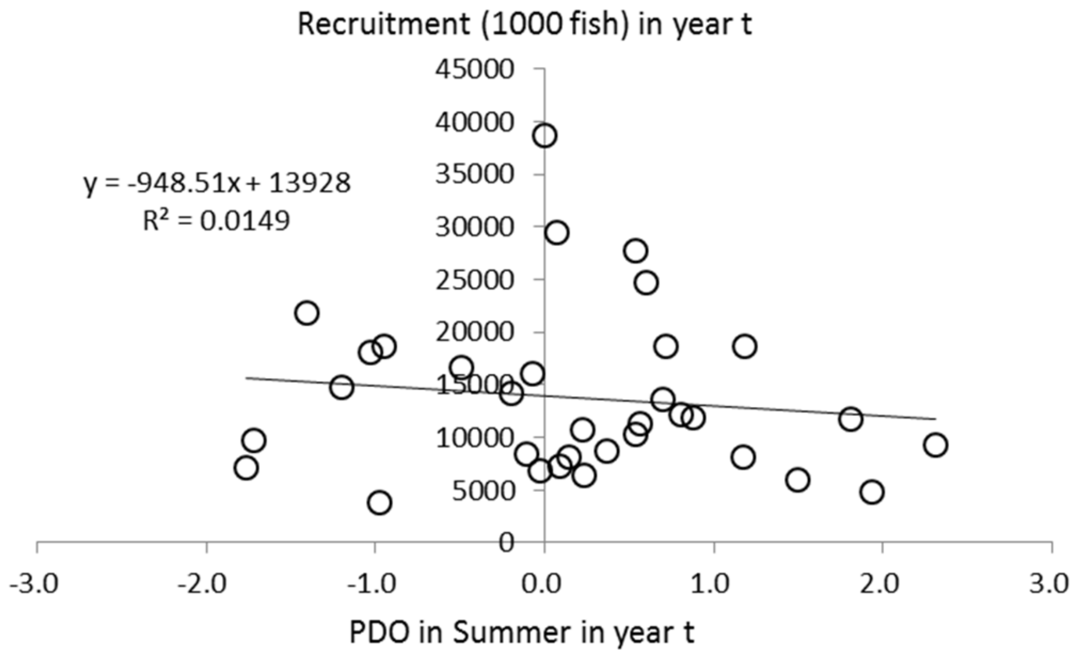

Fig.11. Pacific Decadal Oscillation (PDO) in summer (June-August) in year t and recruitment in year t of Pacific bluefin tuna from 1980 to 2012.

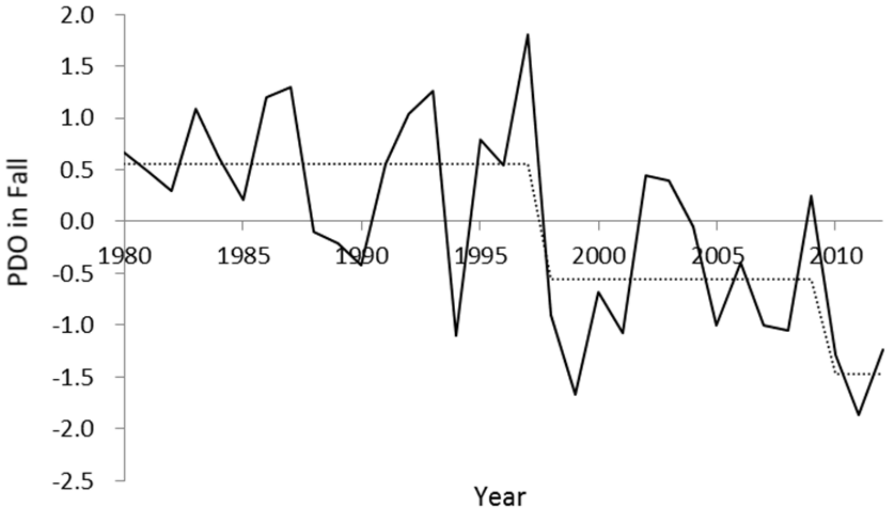

Fig. 12. Pacific Decadal Oscillation (PDO) in fall (September-November) from 1980 to 2012. Dotted line indicates the means and shifts detected by a sequential regime shift detection method. The first shift was detected in 1998, and the second shift was found in 2010

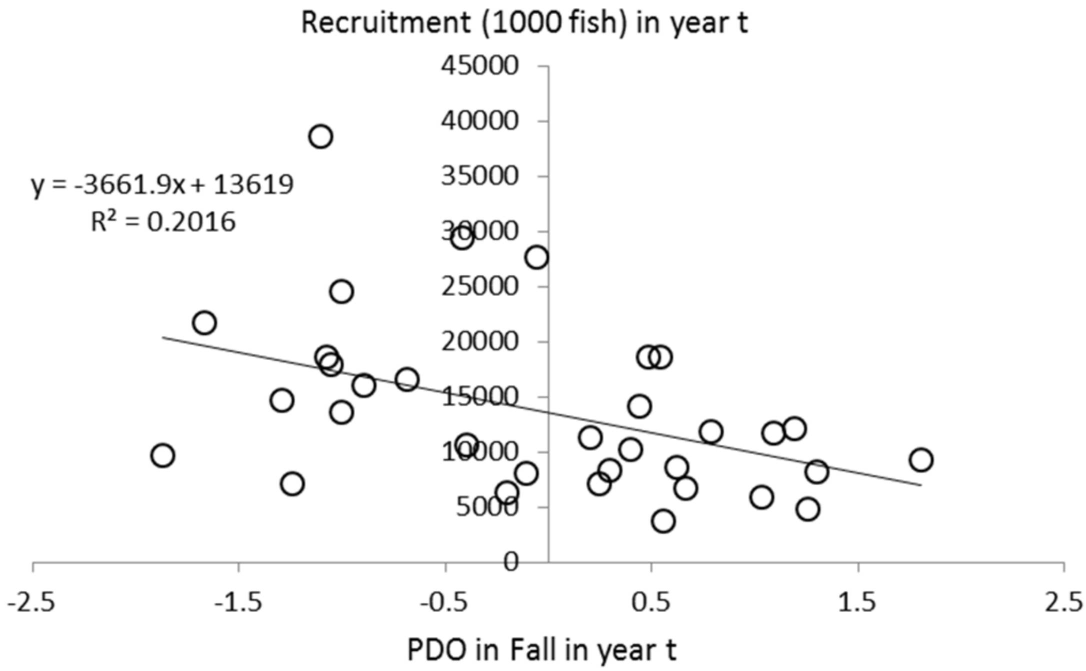

Fig. 13. Pacific Decadal Oscillation (PDO) in fall (September-November) in year t and recruitment in year t of Pacific bluefin tuna from 1980 to 2012.

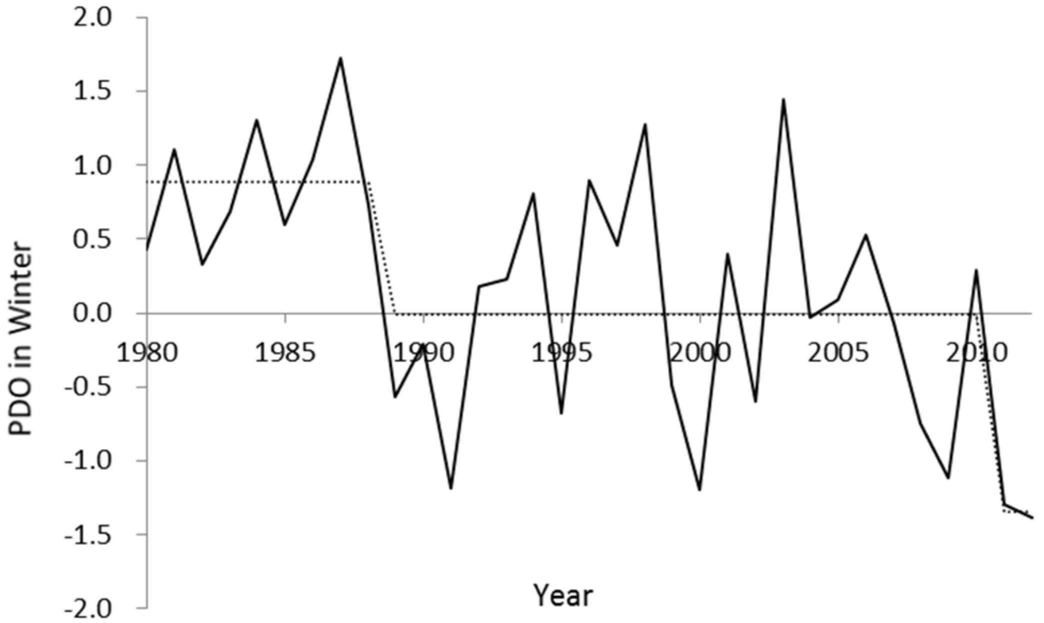

Fig. 14. Pacific Decadal Oscillation (PDO) in winter (December-February) from 1980 to 2012. Dotted line indicates the means and shifts detected by a sequential regime shift detection method. The first shift was detected in 1989, and the second shift was found in 2011.

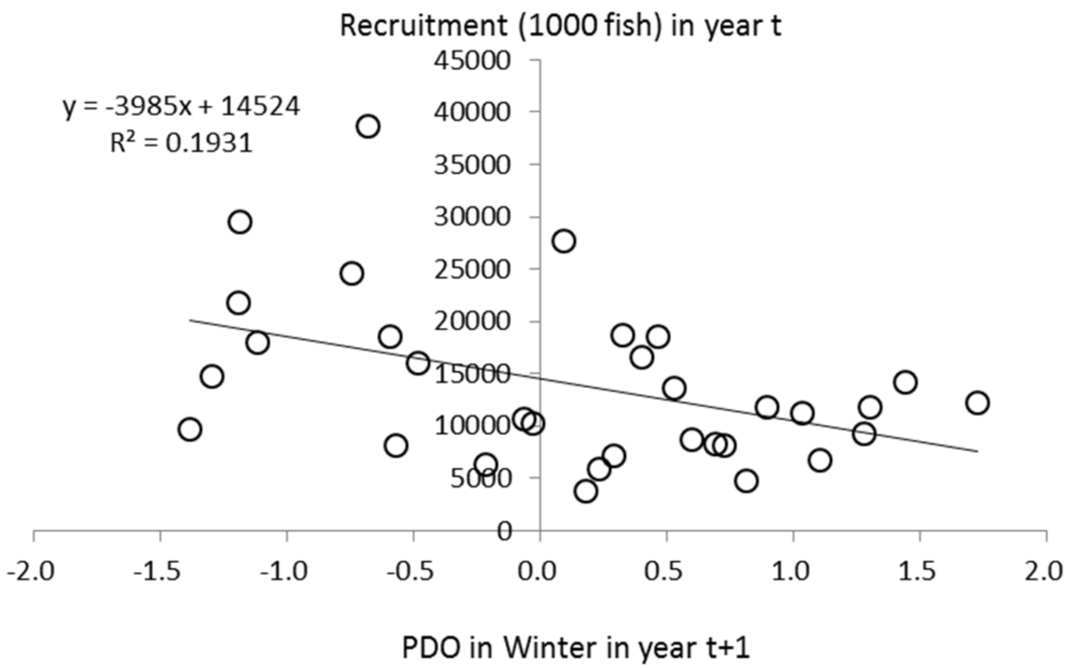

Fig.15. Pacific Decadal Oscillation (PDO) in winter (December-February) in year t+1 and recruitment in year t of Pacific bluefin tuna from 1980 to 2012.

Appendix

Request from NC9 to ISC

Information regarding the range of historical variation in recruitment, such as in terms of standardized CPUEs for particular fisheries, or other appropriate measures, specifically, information for the low recruitment period during the 1980s, and for the last 10 years, is requested.

Draft of response

Changes in recruitment of Pacific bluefin tuna (PBT) were mainly examined from 1980 to 2012. The shifts in recruitment were detected in 1994 and 2009 by a sequential regime shift detection method and the following three periods were defined; 1980-1993, 1994-2008, and 2009-2012 (Fig. 1). The recruitment of PBT was significantly lower in 1980-1993 and 2009-2012 than in 1994-2008 (Table 1). Catch per unit effort (CPUE) for troll fisheries in Nagasaki was also significantly lower in 1980-1993 than in 1994-2008. Significant positive relationships were found between the recruitment and CPUE in Nagasaki (R^2=0.581), Kochi (R^2=0.206) and Wakayama (R^2=0.288), and the recruitment forecasts using these relationships were thought to be promising. Significant but weak negative relationships were found between the recruitment and Pacific Decadal Oscillation (PDO) in fall (R^2=0.202) and winter (R^2=0.193) (Fig. 3).

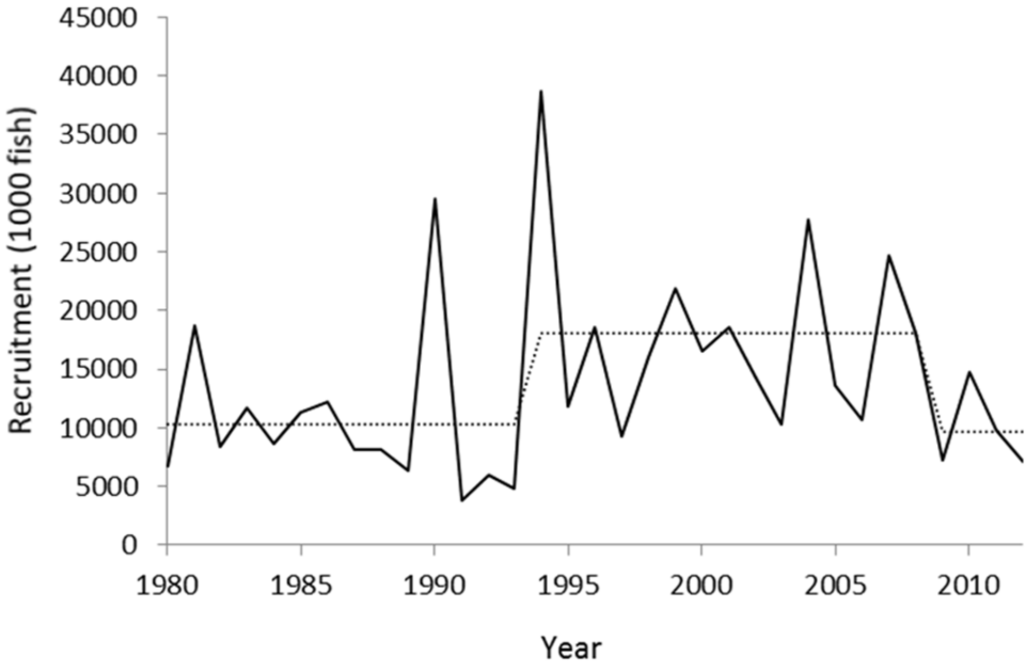

Fig. 1. Recruitment (1000 fish) estimated by the base-case model from 1980 to 2012. Dotted line indicates the means and shifts detected by a sequential regime shift detection method. The first shift was detected in 1994, and the second shift was found in 2009.

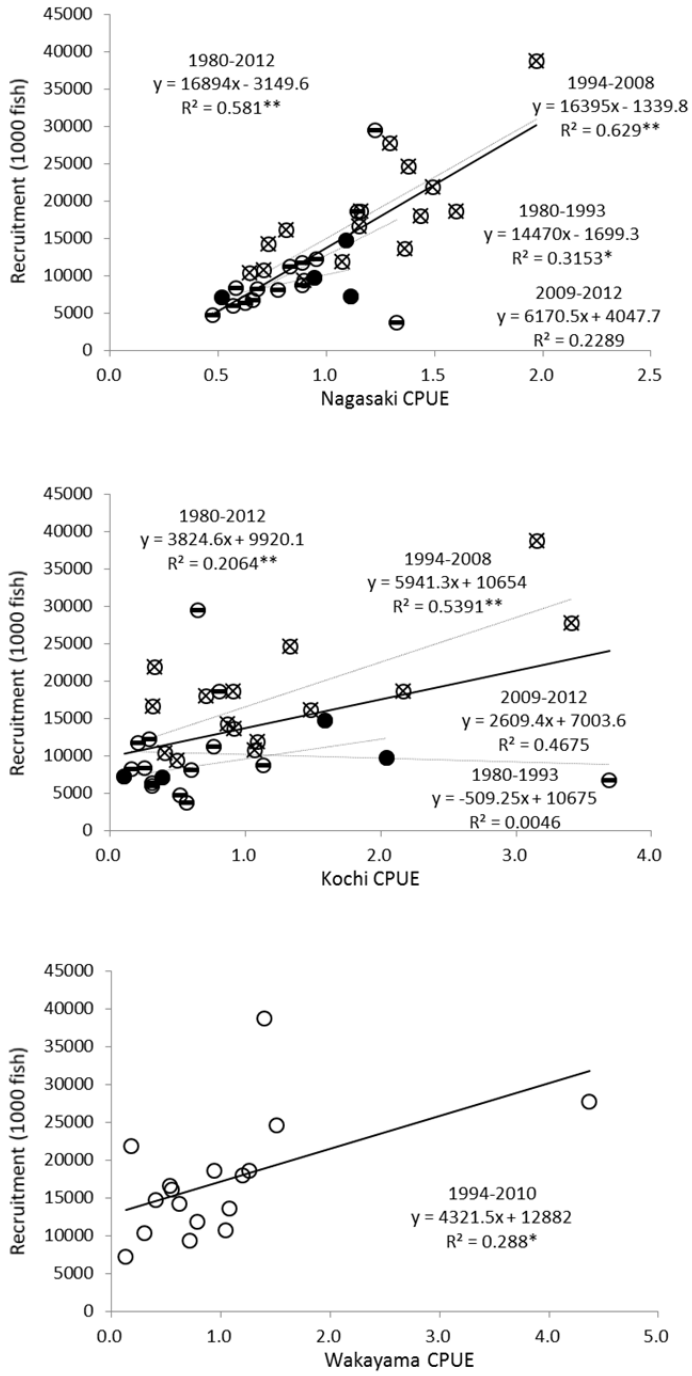

Fig. 2. Relationship between abundance indices of troll fisheries conducted in Nagasaki, Kochi and Wakayama Prefectures and recruitment estimated by the base-case model for Pacific bluefin tuna. ⊖:1980-1993, ⊠:1994-2008, ●:2009-2012.

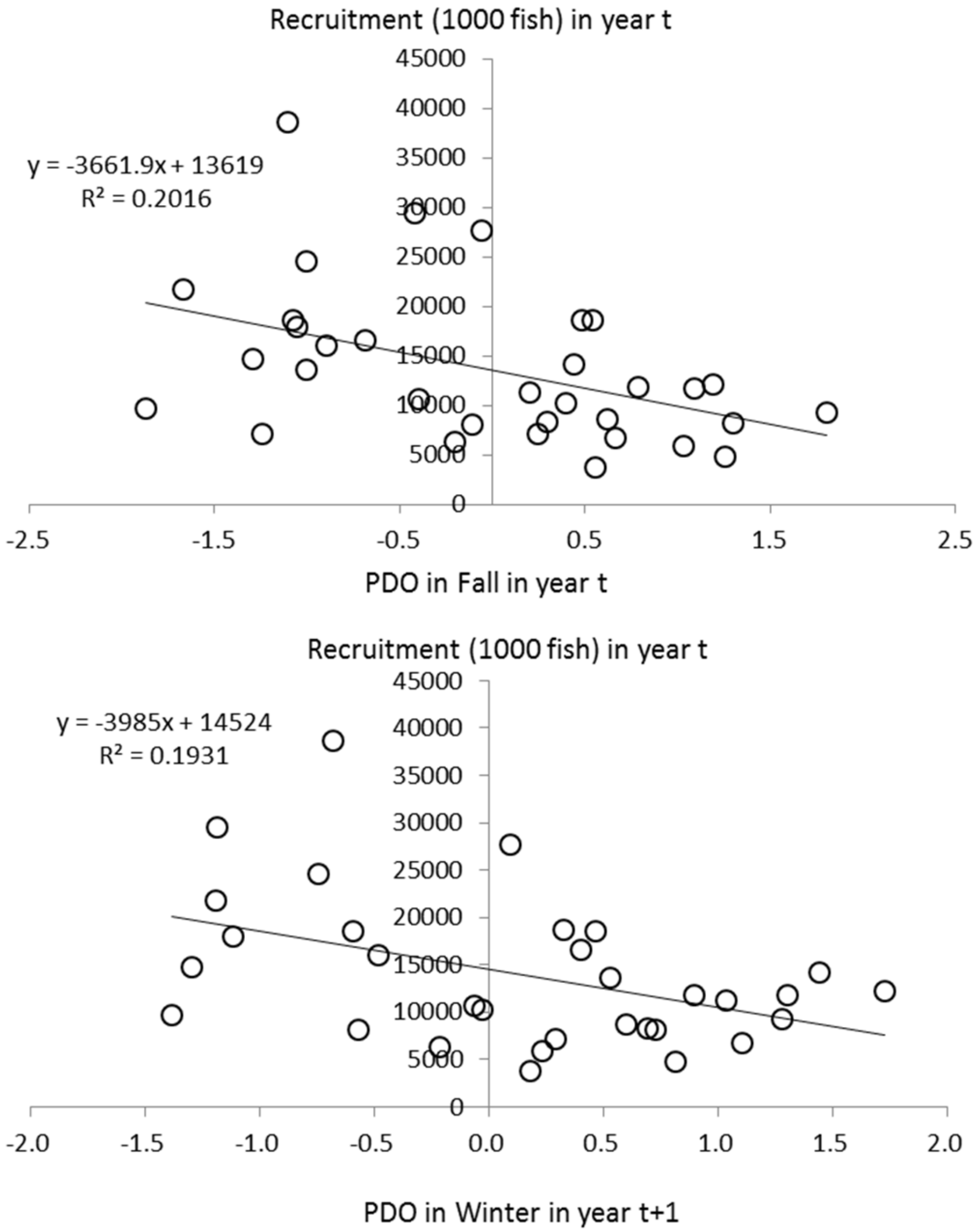

Fig. 3. Relations of Pacific Decadal Oscillation (PDO) in fall (September-November) in year t and in winter (December-February) in year t+1 with recruitment in year t of Pacific bluefin tuna from 1980 to 2012.

Table 1. Statistical values for recruitment (1000 fish) from the base-case model and standardized CPUE in each period, 1980-2012 and 1952-2012.

Year	Recruitment	Nagasaki CPUE	Kochi CPUE	Wakayama CPUE
1980-1993				
Mean	10302.50	0.83	0.73	
SD	6681.94	0.26	0.89	
CV	0.65	0.31	1.22	
Max	29491.80	1.32	3.69	
Min	3755.96	0.47	0.16	
1994-2008				
Mean	18038.11	1.18	1.24	1.10
SD	7780.96	0.38	0.96	0.99
CV	0.43	0.32	0.77	0.90
Max	38710.10	1.97	3.41	4.37
Min	9328.52	0.65	0.31	0.18
2009-2012				
Mean	9691.77	0.91	1.03	
SD	3559.17	0.28	0.93	
CV	0.37	0.30	0.91	
Max	14704.20	1.11	2.05	
Min	7120.89	0.52	0.10	
1980-2012				
Mean	13744.66	1.00	1.00	
SD	7854.39	0.35	0.93	
CV	0.57	0.35	0.93	
Max	38710.10	1.97	3.69	
Min	3755.96	0.47	0.10	
1952-2012				
Mean	14782.13			
SD	7963.97			
CV	0.54			
Max	39288.10			
Min	2696.64			