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National Report of Japan[1]

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National report of Japan

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Summary

Japanese tuna fisheries consist of the three major fisheries, i.e., longline, purse seine, pole-and-line, and other miscellaneous fisheries like troll, drift-net, set-net fisheries. These fisheries occupy around 90 % of the total tuna catch of Japanese fisheries in recent years. This paper described the recent trend of the Japanese tuna fisheries in the north Pacific Ocean and updated the statistics given in the previous National Report for ISC10 (Koji Uosaki et. al., 2010). The total landing of tunas (excluding skipjack) caught by Japanese fisheries in the north Pacific Ocean in 2009 was 115,482 metric ton (t) and that in 2010 was 70,060 t which was 61% of the 2009 catch. The total landing of swordfish and billfishes was 10,323 t in 2009 and 8,132 t in 2010 which was 78% of the 2009 catch. The landing of skipjack tuna was 172,961 t in 2009 and 177,549 t in 2010 which was 103% of the 2009 catch. In addition to fisheries description, a brief description was given on Japanese research activities on tuna and tuna-like species in the Pacific Ocean in 2010 and 2011. Moreover, management and conservation measures for PBF and the effect of the earthquake and Tsunami were also described.

1. Trends in fleet size

Table 1A and 1B show the number of Japanese tuna vessels actually engaged in fishing by type of fishery and by vessel size class during 1980-2006 (Anonymous 1982-2008) and 2006-2010. The number of active vessels 2006-2010 was estimated based on logbook data. Therefore some vessels who actuary operated but did not submit logbook were not included. The coastal longline vessels less than 20 Gross Register Tonnage (GRT), and the research and training vessels of longline and pole-and-line are not included in Table 1B.

The total number of longline vessels shows continuous declining trend since the early 1990s. The number of longline vessels of the largest size class (larger than 200 GRT) was near constant in

the period between the late 1960s and the mid-1990s. In accordance with the agreement of the FAO's international action plan on fishing capacity, Japan decreased its large longline boats by 20% in 1998. The number of longline boats continued to decline thereafter. Recent declining trend for larger than 100 GRT are remarkable and the number of vessels of 100-200 GRT and over 200 GRT in 2009 was 33 and 82 which is 63% and 72% of that in 2006, respectively. This large reduction were mainly derived from high price of fuel especially since 2007 and the fleet reduction program implemented by the Government of Japan in March 2009 according with management measures agreed in the various tuna RFMOs. While the number of vessels for 20-49 GRT and 50-100 GRT showed a sharp decline since the late 1980s, the number of vessels of smallest size class (less than 20 GRT) fluctuated at around 700.

The total number of purse seine vessel was 52 in 2006, and it was nearly 80% of that in the 1980s. The number of the smaller size (smaller than 200 GRT) purse seine vessels has decreased since the late 1980s. The larger vessels which operate mainly in the tropical waters were 35 and have been stabilized since 1995. In contrast to longline and pole-and-line fishery, the number of purse seine vessels was relatively stable in the recent 5 years.

Regarding the pole-and-line fishery, the number of vessels larger than 20 GRT declined to 121 in 2006 from 140 in 2005, which was almost one third of the average in the 1980s. The trend in the number of vessels smaller than 20 GRT also showed the general decreasing trend since the 1980s, and the number of vessels in 2006 was only 8% of the average of the 1980s.The number of pole-and-line vessels, 50-200 GRT, decreased from 83 in 2006 to 63 in 2010. The number of pole-and-line vessels for over 200 GRT also decreased from 30 in 2006 to 28 in 2010.

2.Catch and effort trends of the major fisheries

The logbook systems have been in place for offshore and distant water longline, pole-and-line, and purse seine fisheries. From 1994, the logbook system was introduced to the coastal longline vessels (10-20 GRT) fishing both within and outside the Japanese EEZ and these vessels were included in the offshore category since 2002. Historical Category II data was compiled from those logbook data and submitted to the ISC Statistics Working Group in July 2010.

There are small scale fisheries in the coastal waters of Japan such as troll and set net which are not covered by the current logbook system. Catches by these fisheries are covered by the landing statistics collected by the Statistics Department, Minister's Secretariat, the Ministry of Agriculture, Forestry and Fisheries (Anonymous 1982-2008).

Catch and effort data used in this paper are mostly based on the logbook data compiled by the National Research Institute of Far Seas Fisheries, Fisheries Research Agency (NRIFSF). The data source of catch and effort for the coastal longline fishery are mainly derived from Statistics Department, Minister's Secretariat Ministry of Agriculture, Forestry and Fishery (Anonymous 1982-2010).

The total landing of tunas (excluding skipjack) caught by Japanese fisheries in the north Pacific Ocean in 2009 was 115,482 metric ton (t) and that in 2010 was 70,060 t which was 61% of the 2009 catch. The total landing of swordfish and billfishes was 10,323 t in 2009 and 8,132 t in

2010 which was 78% of the 2009 catch. The landing of skipjack tuna was 172,961 t in 2009 and 177,549 t in 2010 which was 103% of the 2009 catch.

2.1 Longline

Longline fisheries are classified by the type of license issued by the Government, i.e., coastal (smaller than 20 GRT and can fish only in Japanese EEZ), small offshore (10-20 GRT), offshore (10-120 GRT), and distant water (larger than 120 GRT).

The fishing effort of the distant water and offshore longline vessels remained stable at around 200 million hooks in the North Pacific in the 1980s, and then it decreased continuously to 100 million hooks in the early 2000s, and it has further decreased in the most recent years (Fig. 1). The amount of effort was 46 million hooks in 2008 and 2009, which is about half of that in 2004. Annual distribution of fishing effort for longline vessels larger than 20 GRT in 2008, 2009 and 2010 are shown in Fig. 2. In those years, the fishing grounds were located in east-west direction off Japan to Hawaii, equatorial area between 15 ˚S and 15 ˚N, off Australia and off Peru.

Total catch of distant and offshore longline vessels in the north Pacific has been decreased since the highest catch of 138,000 MT in 1980 into lowest catch 19,077 (20,146) MT in 2010 (2009), which was about 14% of that in 1980 (Fig. 1). Bigeye has been the dominant species for the north Pacific. The bigeye catch, which was stable in the 1980s and about 50,000 MT in late 1980s, showed a declining trend in the 1990s and decreased to less than 20,000 MT in 2005. Bigeye catch in 2009 and 2010 were 8.7 and 7.5 MT respectively (Table 2-A). Yellowfin catch was 30,000-50,000 MT until early 1980s. It has gradually decreased into about 10,000 MT in 2001 and into less than 6,000 MT in 2006. Yellowfin catch in 2010 (2009) was 2,457 (2,349) MT (Table 2-A). Pacific bluefin catch have been fluctuate since 1980s ranging from 313 MT to 8 MT (Table 2-A). Albacore catch which have fluctuated around 10,000 MT until 2001 decreased to about 4,000 MT to 5,000 MT and kept stable at a low level during the period 2003-2008. The catch in 2009 and 2010 were 3,820 and 3,751 MT (Table 2-A), which was the lowest since 1980. The catch of billfishes in 2010 (2009) were 4136 (4281) MT, 162 (150) MT and 960 (737) MT for swordfish, striped marlin and blue marlin, respectively (Table 2-A).

The fishing effort of the small offshore longline vessels (10-20 GRT and make operation at out of Japanese EEZ) has been relatively stable at around 70 million hooks in the North Pacific (Table 2-B) and total tuna and billfish catch fluctuated between 13,000 to 18,000 MT in the recent years. Catch of bigeye and yellowfin are similar level to those of total of distant water and offshore longline, 6082 (8178) and 4462 (3342) MT for bigeye and yellowfin, respectively, in 2010 (2009).

Coastal longline can be characterized by its highest bluefin catch in the Table 2-C. Albacore occupies the largest portion corresponding to about 80-90 % of the total catch, and that in 2008 and 2009 were 13,600 and 18,100 MT, respectively. Although bluefin tuna catch has fluctuated between 1000 and 2000 MT in the latest decade, that in 2009 was low, 1304 MT.

Length frequency distribution for tunas and swordfish caught in the Pacific, which was measured on board or at landing port, is shown in Fig. 3. The length of albacore ranged from 60 to 120 cm in fork length (FL). The length of bigeye and yellowfin had wider ranges approximately from 60

to 200 cm but fish larger than 90 cm formed a dominant part of the catch. The length of the swordfish measured ranged from 50 to 220 cm in eye-fork length.

2.2 Purse seine

There are two types of purse seiners that target tunas in Japan, i.e., single and group purse seine fisheries. The group seiner consists of one purse seiner (100-200 GRT) and one searching vessel and two carrier vessels, and operates in the temperate northwestern Pacific (Fig.5). New type of group seiner launched at March 2005, which consists of one large seiner (300 GRT) than typical size of the purse seiner and one carrier instead of two carriers. The group purse seiner operates in the offshore waters off Japan. The carrier holds fish in chilled water with ice and unloads those catches. On the other hand, the single purse seiner (349-500 GRT) operates mainly in the tropical waters of the central and western Pacific, but seasonally operates in the temperate waters (Fig.5).

The fishing effort of the purse seine in the North Pacific was around 9,000 sets in the late 1980s, and then decreased to about 6,000 sets in 1998 (Fig.4). The fishing effort generally stayed at the level about 4,000-6,000 sets in the last decade. The skipjack catch dominant among species in this fishery, followed by yellowfin. The skipjack catch was about 150,000 MT during the period 2006-2008, and then dropped to 120,000 MT since 2009 (Table 3). Pacific bluefin catch was fluctuated ranging from about 2,500 to 1,000 MT since 1980. In the last 5 years, the Pacific bluefin catch ranged from 3,742 MT in 2010 to 10,221 MT in 2008.

The size of bigeye caught by the purse seine fishery in tropical area ranged from 30 to 90 cm in FL and from 30 to 70 cm (Fig 6). Most of the yellowfin catch was also in the range from 30 to 70cm but there are some fishes larger than 80 cm.

2.3 Pole-and-line

The pole-and-line fishery is composed of three different categories, i.e., coastal (smaller than 20 GRT), offshore (20-120 GRT) and distant water (lager than 120 GRT) vessels in terms of the license of this fishery. It is also categorized into small, middle and large (sized) vessels by vessel size.

The middle-sized vessels generally operate in near shore waters of Japan and their trip is within 10 days. Southern most fishing area for these vessels, in recent years, is near 15˚N, but the important fishing ground is waters north of 25˚N, around Japan and adjacent areas. These vessels primarily fish skipjack and albacore tunas from spring through autumn off Pacific side of Japan, and also harvest relatively small amount of yellowfin and bigeye. They hold fish in cooled water with ice and unload it as fresh fish. The activity of the small pole-and-line vessels is more or less similar to that of the middle vessels but the area of fishing is limited within the Japanese EEZ, and the trip of these vessels is shorter. On the contrary, the large vessels operate more offshore waters and their trips are for two to three months. Usually they primarily target for albacore from summer through autumn season in the waters north of 20˚N, and skipjack tuna in winter and spring in the waters south of 20˚N. These vessels equip a brine freezer, in which fish caught are immediately stored into a tank filled with cooled brine, and then unloads it as frozen fish.

Generally, fishing effort expressed by poles*days for offshore and distant water pole-and-line fisheries rapidly decreased from around 1,100,000 poles*days in the early 1980s to around 320,000 poles*days in 1991, increased to around 430,000 poles*days in 2000, and then decreased to 280,000 poles*days (Fig. 7). Total (species unspecified) catch for those fisheries rapidly decreased from around 280,000 MT to around 170,000 MT during the 1980s, and then gradually decreased from around 130,000 MT to 100,000 MT until the latest year (Fig. 7).

The catch of albacore for offshore and distant water pole-and-line fisheries in the north Pacific has historically fluctuated in the range of 6,000-49,000 MT (Figure.2.3). The albacore catch was 21,666 MT in 2010 (Table 4). The skipjack catch showed decrease trend, from 85,787 MT in 2006 to 71,289 MT in 2010.

Fishing grounds of the pole-and-line fishery are widely spreads ranging from 45˚N and 10˚S, from 120˚E to 170˚W. The fishing grounds were separated by around 25 degree north but more continuous than the purse seine fishing grounds (Fig.5 and 8).

The size of skipjack caught by this fishery is ranged from 40 to 60 cm FL and ranged from 50 to 90 cm for albacore. Several clear modes are obvious (Fig.9).

2.4 Other fisheries

There are miscellaneous small scale fisheries other than the longline, the purse seine and the pole-and-line fisheries, which catch tunas and tuna-like species in the Japanese coastal waters. Among them, the largest catch was made by the troll fishery for which the catch of tunas was 8,775 MT in 2009. The catch of skipjack for this fishery was the largest among species, and was 3,819 MT in 2009.

The large mesh driftnet fishery, that historically expanded its fishing ground covering areas of the temperate North and South Pacific in the 1980s, was suspended in 1991 in the South Pacific and in the high seas of the North Pacific in 1992 due to UN resolution implemented for this fishery. The catch of tunas for the gillnet fisheries including the large mesh driftnet fishery was in Japanese EEZ was 564 MT in 2009.

The size data of Pacific bluefin tuna caught by several fisheries is collected at the main fishing ports in Japan. Total number of the size measurement data was 50,167 and 43,029 MT in 2009 and 2010, respectively.

2.5 Recent trends for Pacific bluefin tuna, albacore and swordfish fisheries

2.5.1. Pacific bluefin tuna

Total catch of Pacific bluefin tuna fell below 10,000 MT in 2010, decreased from 14,491 MT in 2009 to 8,233 MT. The catches by major fisheries such as purse seine, troll, longline and set net declined in 2010. Especially, decreases of more than 1,000 MT recorded in the catches by purse seine and set net. There are two types of purse seine fisheries for Pacific bluefin tuna in Japan. One is called as tuna purse seine, targeting large Pacific bluefin tuna older than 3 years old. The other is called as small pelagic fish purse seine, targeting young Pacific bluefin tuna mainly at ages 0 and 1. The catch of 1,122 MT recorded by the tuna purse seine in 2010 was the second smallest in the recent two decades. The small pelagic purse seine recorded the catch of 2,620

MT, the smallest catch in 2010 over the recent decade. Data sources used to estimate catches for both purse seine fisheries were revised in this year. Annual catches for these fisheries since 2002 were estimated using logbook data, whereas traditional catches were based on landing record obtained at fishing ports.

2.5.2. Albacore

Total catch of albacore in 2010 was 45,134 MT, which was about 11,000 MT lower than the 2009 catch and was slightly lower than the average of past 5 years (47,964 MT), though the value in 2009 is provisional. This decrease is mainly based on decrease in the middle size pole-and-line catch. The fishermen of this pole-and-line fleet tended to be favorable to fish skipjack than albacore in May and June, 2011, while they tended to be favorable to fish albacore due to poor abundance of skipjack tuna in the northern region (offshore Japan) in 2009. Although albacore catch by the pole-and-line fluctuated largely, but the catch by longline was relatively stable. The catch by longline in 2010 (22,434 MT) was slightly larger than the catch in 2009 (21,995 MT).

2.5.3. Swordfish

Japanese catch of swordfish in the north Pacific in 2009 was 7,100 MT which is 200 MT of decrease from 2008. This is due to the catch by longliners in the eastern stock which was increased from 5,600 MT in 2008 to 5,800 MT in 2009. The main source of the Japanese swordfish catch is the offshore surface longliners, and this fleet seasonally targets swordfish in the northwest and central Pacific. By the attack of Tsunami in the March, 2011, two boats were lost. The 19 boats had remained, however, 11 boats of them are mooring on June 1st. This is primary due to the loss of fish processing factories by Tsunami attack. Secondary source Japanese swordfish catch is the coastal drift netters. Different from the offshore longliners, many of the coastal drift netters were mooring in the fishing ports at the time of Tsunami attack, and destroyed. The magnitude of their damage are still not clear but believed to be quite serious.

3. Research activities

The Fishery Agency of Japan, in cooperation with the NRIFSF and local prefectural fisheries experimental stations, has run the nationwide port sampling project for collection of catch, effort and size data at the major landing ports since the early 1990s. In addition, there are cooperative works with prefectural fisheries experimental stations and universities. Several cooperative studies are also on going with foreign countries.

3.1. Research cruises

There have been several research cruises in 2010 conducted by the Fisheries Agency of Japan and the NRIFSF relating to tunas and billfishes in the north Pacific.

3.1.1. Pacific bluefin tuna larvae

Two research cruises were conducted in 2010 for ecological study of larval Pacific bluefin tuna (PBF) by R/V Shunyo-Maru. Around Nansei islands, which is a major spawning ground of PBF, a dense patch (>50 individuals) of PBF larvae was found and tracked with using drifter composed of GPS radio buoy and a drogue, and PBF larvae were sampled repeatedly for two days during late June 2010. In the Sea of Japan, which is another spawning ground of PBF, juvenile PBF (4-12cm TL) were collected by surface trawling between Noto peninsula and Sado

Island in August 2010. Totally 245 days of research cruise by 10 research vessels will be conducted around Nansei Island and in the Sea of Japan to clarify spawning ground of PBF. Spatial and temporal distribution of PBF spawning spots would be investigated by simulating particle flow models using the compiled information obtained by the above cruise, such as distribution and daily age of larvae.

3.1.2. Swordfish and blue shark

A longline research cruise has conducted in October 2010 for swordfish and blue shark in the Kuroshio frontal area. The data to investigate the relationship between catch of these two species and environmental factors, as well as the samples of prey species were collected during the survey cruise. The results of the analysis of data and samples obtained by the cruise will be reported to the billfish and shark working groups.

3.1.3. Experiments on tori-line

To explore safe and effective designs of tori-line in the north Pacific in 2010, comparison of three types of tori-line were conducted, by two at-sea experiments. The designs of tori-line which used in this study were; 1) light streamer, 2) hybrid streamer, 3) modified light streamer. Effectiveness of the different colored streamers was also tested. First experiment was conducted using 20 offshore commercial longliners with 567 sets, second experiment was conducted using a chartered longline boat with 24 longline fishing operations.

3.2. Tagging study

The tagging using conventional tag has been conducted by research and training vessels as well as commercial vessels. Some of these activities are opportunistic tagging. In addition to the conventional tagging, tagging studies using the archival and popup tags have been conducted for tuna and tuna-like species.

3.2.1. Tropical tuna

Regarding tropical tuna (mainly bigeye and yellowfin) tagging activity in 2010, 39 bigeye, 675 yellowfin and 65 skipjack were released at area from Kagosima to Okinawa, and 70, 5 and 0 individuals were recaptured for each species. In addition to conventional tagging, 2 bigeye were tagged with electronic tags (archival and pop-up tags) and released. But no recapture of archival tag was reported. Furthermore, 277 bigeye and 40 skipjack were released with conventional tag attached from East off Honshu in which 21 bigeye and 3 bigeye were released with archival tag and popup-archival tag attached, respectively.

3.2.2. Skipjack

Four research/training pole-and-line vessels were involved in the skipjack tagging in 2010. The tagging was conducted in a wide area of Western Pacific ranged from 12˚N to 33˚N, from 128˚E to 149˚E. Total of 1322 skipjack were released in 2010 and 48 skipjack were recovered to date. Most recaptures were recorded in the second or third quarter and within 60 days after release.

In addition, skipjack tagging in the coastal area of southwestern Japan started in 2009. Main objective of this study is to investigate migration to the Pacific coast of Japanese water (mainly western part of Japan) along the Kuroshio Current including migration rate from Nansei Islands area to Pacific coast of Japan. The fish caught by coastal pole-and-line vessels were tagged and

released.Both dummy and real archival tags (Lotek LAT2510 and its dummy) were also deployed on some individuals. In 2010, a total of 3,017 fish (mainly 40-45cm FL) including 44 fish with archival tag and 33 fish with dummy archival tag were released around Amami Island (Nansei Islands, around 28˚N, 130˚E) and off Kochi (around 32˚N, 133˚E) during April-June. So far 91 fish were recaptured mainly around Nansei Islands. Some skipjack were released during tropical tuna tagging mentioned above. In 2010, 65 and 40 fish were released in the Nansei Islands and off central Honshu, respectively.

In order to reveal swimming behavior of skipjack from "subtropical area" to the region of eastern offshore of Japan, which is considered to be direction of migration of skipjack tuna, two cruises for archival tagging were made in January to March, 2011 using pole-and-line type research vessel Miyazaki Maru. Release of total 101 tags of dummy and real archival tags was done in the region of 18-22 ˚N, 132-139 ˚E. Of those, two archival tags were recovered at close point from the released point after one week. The data was retrieved from the tags and is analyzed.

3.2.3. Shark

Shark tagging program has been conducted since 1996 to examine migration, population structure and life history parameters of pelagic sharks. In 2010, tags were attached to 1029 blue sharks, 11 bigeye threshers, 37 shortfin makos, 25 salmon sharks and 5 others (total 1107) in the Pacific Ocean. Thirteen tags attached to blue sharks were recovered and the tag recovery data indicated seasonal latitudinal migration of blue shark.

3.2.4. Pacific Bluefin tuna

Natural and fishing mortality of juvenile PBF in the off Kochi prefecture will be investigated using conventional tagging. Juvenile PBF with temperature-depth recorder attached to their second dorsal fin will also be released to determine their vertical habitat utilization. They are expected to provide valuable information on the design of reliable recruitment monitoring survey and the precise estimation of recruitment abundance levels as well as biology of juvenile PBF.

3.3. Recruitment monitoring survey of PBF

3.3.1. Troll survey on age-0 PBF in Tosa bay

NRIFSF targets to develop techniques for timely-monitoring of recruitment strength of age-0 PBF in order to accomplish management of this species. Age-0 PBF migrate to Tosa bay after early July and are caught by troll fishery for farming. Consequently, abundance of age-0 fish in Tosa bay might be able to provide quick estimation on recruitment abundance of age-0 fish. Troll survey, fishery-independent survey, was started in the summer of 2008 as collaborative research of NRIFSF and Kochi Prefectural Fisheries Experimental Station and deployed in the western part of Tosa bay (Fig. 10). This survey aims to gain abundance index of age-0 PBF that migrates to Tosa bay during summer. In this survey, fixed lines are set in research area where depth is shallower than 200 m and two chartered fishing boats track the lines with trolling (Fig. 10). This survey provides number of fish caught or number of fishing per unit distance (e.g. nautical mile), which is expected to be available as the abundance index, and knowledge on distribution pattern of age-0 PBF in coastal area. Development of procedure of this survey and expansion of its scale are required in order to obtain recruitment abundance index through this survey for the next three years.

Furthermore, a monitoring survey of fishing boat of troll fishery targeting age-0 PBF will be started in Tosa bay in this summer. This survey aims 1) to provide information on positions and water temperature of fishing ground and 2) to measure actual fishing effort such as searching distance or time in order to obtain information on the recruitment strength from commercial fishery. In this survey, data loggers, which can collect information on location and sea temperature at a certain interval and include species and number of fish caught during operation, are equipped on 12 fishing boats.

3.4. Studies on PBF's biological parameter

There have been several studies on biological parameters of PBF carried out by the NRIFSF under the support of the Fisheries Agency of Japan.

3.4.1. Reproductive study of PBF

Histological study of ovaries from PBF has been conducted to estimate their spawning interval and the rate of skip spawning. New technique to detect postovulatory follicles (POF) much longer period after the ovulation has been developed. Detecting POF as a trace of spawning would facilitate evaluation of maturation rate of fish by each landing market and fishing ground.

3.4.2. Growth of age-0 PBF

Daily age determination of age-0 PBF using their otolith daily ring increment has been conducted to revise the length growth relationships of PBF especially for their younger age. By using the information of hatch-out date of PBF, their natal origins would be estimated; as PBF spawns during May to June around Nansei Island while during July to August in the Sea of Japan.

3.4.3. Sex specific growth curves of PBF

After the sex combined growth curve was estimated in 2008, NRIFSF started to collect otolith samples accompanying with sex and FL data. From 1996 to 2010, 351 female and 364 male otoliths were collected and analyzed tentatively. Results showed that males were significantly larger than females in the specific older age groups (Fig. 11), implying the existence of sexual difference in growth. NRIFSF are continuing to collect otoliths of large size individuals to derive reliable sex specific growth curves.

3.4.4. Diet of young PBF

Studies on food and feeding habits of young PBF (20-60 cm FL) started from 2008. Specimens were primarily collected for otolith daily growth increment study. Currently, 482 stomach samples collected at two major nursery grounds around Japan (i.e. Tsushima Current region and Kuroshio region) from August 2008 to June 2009 were analyzed (Table 5). Small squid (juvenile Enoploteuthis chunii) and deep sea fish (Maurolicus japonicus) were numerous in the Tsushima Current region, and clupeoid fishes (Etrumeus teres, Sardinops melanostictus and Engraulis japonicus) in the Kuroshio region.

3.4.5.Biological aspects of PBF around Yaeyama region

Size data, gonad and otolith samples of PBF around Ishigaki-jima Island have collected since 2007. At Yaeyama fishing port, almost all landed PBF can be observed, and the size measurement data was obtained with gonad sample. From 2007 to 2010, 513 females and 579

males were recorded (Table 6). Otoliths of 64 individuals were also collected. Occurrence pattern, reproductive conditions and reproductive status at different age classes are under investigation.

4. Management and conservation measures for PBF

The Fisheries Agency of Japan has been taking domestic management actions for Pacific Bluefin tuna (PBF) as below based on the announcement in May 2010 by the Ministry of Agriculture, Forestry and Fisheries (MAFF) on actions toward effective conservation and management for PBF, and the conservation and management measure for PBF adopted by the Western and Central Pacific Fisheries Commission (WCPFC) in December 2010.

- For large and medium scale purse seine fisheries:
  - Set an annual catch limit for juvenile fish at 4500 tons,
  - Set an annual catch limit for adult fish at 2000 tons in the Sea of Japan from June to August (spawning season).

- For small scale coastal fisheries such as troll in the Sea of Japan and off Kyushu:
  - Introduced a vessel registration system from April 2011, with a mandatory catch reporting system from July 2011.

- For aquaculture:
  - Introduced a new licensing category "bluefin tuna aquaculture" under the existing aquaculture licensing system.
  - Introduced a registration system of bluefin tuna aquaculture sites with local governments from January 2011, with a mandatory reporting requirement from aquaculture companies.

5. The effect of the massive earthquake and Tsunami

Following the mega-earthquake on March 11th, 2011, tsunami hit the east coast of Japan, destroying a number of major fishing ports including Kesen-numa, Ishi-nomaki, and Ofunato. Countless fishermen were dead, and their boats, vessels, and fishing gears were also damaged or lost. Most of the set nets in that area, which used to frequently catch PBF from summer to autumn (about 1/4 of annual catch by set net), were completely smashed. In addition, fishery facilities and processing factories were also heavily damaged. This huge damage to the fisheries has been causing a significant negative impact on the tuna fisheries in the North Pacific. It is expected that fishing effort and catch in that area will remain low for years to come.

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Table 1A. Number of Japanese tuna fishing vessels operated in the Pacific Ocean by type of fisheries and vessel size based on Anonymous (1982-2008).

	Longline fishery[*1]						Purse seine fishery			Pole-and-line fishery					
Year	1-19 GRT	20-49 GRT	50-99 GRT	100-199 GRT	200- GRT	Total	50-199 GRT[*2]	200- GRT	Total	1-19 GRT[*3]	20-49 GRT	50-99 GRT	100-199 GRT	200- GRT	Total
1980	821	57	715	103	645	2,341	50	16	66	3,232	14	350	10	198	3,804
1981	774	55	706	100	661	2,296	50	23	73	3,064	10	353	6	179	3,612
1982	722	43	634	90	589	2,078	52	33	85	3,011	11	320	6	138	3,486
1983	561	38	589	93	550	1,831	59	36	95	3,021	12	297	9	116	3,455
1984	523	32	538	108	610	1,811	54	33	87	2,904	8	273	10	105	3,300
1985	620	28	512	131	628	1,919	47	35	82	2,754	8	244	9	95	3,110
1986	536	25	435	168	632	1,796	53	38	91	2,455	6	224	9	91	2,785
1987	661	23	348	197	649	1,878	47	34	81	2,404	6	210	9	89	2,718
1988	586	21	289	233	649	1,778	48	39	87	2,613	5	191	11	70	2,890
1989	650	20	248	238	653	1,809	43	37	80	2,254	3	187	12	67	2,523
1990	685	21	227	241	664	1,838	43	35	78	2,228	4	176	9	66	2,483
1991	768	19	199	222	682	1,890	38	35	73	2,277	3	166	10	63	2,519
1992	793	19	164	206	681	1,863	31	38	69	2,093	3	156	11	46	2,309
1993	790	18	138	201	682	1,829	27	36	63	1,927	3	147	10	43	2,130
1994	819	21	110	198	675	1,823	23	33	56	1,830	3	124	10	48	2,015
1995	738	20	92	187	667	1,704	20	31	51	481	3	104	20	46	654
1996	711	17	91	155	640	1,614	21	32	53	512	3	89	29	43	676
1997	698	11	88	145	631	1,573	20	35	55	436	2	76	39	45	598
1998	712	11	80	129	623	1,555	20	35	55	382	2	73	40	46	543
1999	703	6	78	119	567	1,473	22	36	58	416	1	62	54	46	579
2000	732	3	76	111	496	1,418	23	37	60	357	1	56	57	47	518
2001	777	4	76	110	494	1,461	19	36	55	285	1	49	59	47	441
2002	780	4	69	110	484	1,447	18	36	54	251	1	45	58	48	403
2003	764	3	64	99	460	1,390	17	36	53	292	1	44	56	44	437
2004	702	2	55	77	455	1,291	17	36	53	284	1	38	57	43	423
2005	694	2	46	59	432	1,233	17	36	53	247	1	36	58	45	387
2006	709	1	43	54	401	1,208	16	36	52	213	1	27	58	36	335

[*1] Longline vessels larger than 50 GRT include those operated in the area other than the Pacific
[*2] 50-199 GRT class vessels only include those operated in the Pacific side of northern Japan.
[*3] 1–19 GRT class vessels before 1995 include those engaged in trolling

Table 1B. Number of Japanese tuna fishing vessels operated in the North Pacific Ocean by type of fisheries and vessel size based on logbook. Values in 2010 are provisional.

	Longline fishery					Purse seine fishery				Pole-and-line fishery			
Year	10-49 GRT	50-99 GRT	100-199 GRT	200- GRT	Total	50-199 GRT	200-499 GRT	500- GRT	Total	20-49 GRT	50-199 GRT	200- GRT	Total
2006	277	44	52	113	486	27	35	1	62	1	83	30	114
2007	279	42	48	89	458	34	35	1	69	1	77	29	107
2008	275	42	40	90	447	36	35	1	71	1	69	29	99
2009	272	38	33	82	425	35	34	3	69	1	68	28	97
2010	272	29	28	90	419	31	33	3	67	1	63	28	92

Table 2. Catch in weight (MT) by species by longline vessels categories in the North Pacific. The values in table A and B are derived from logbook data and former is raised and latter is un-raised statistics. Values in table C are derived from Anonymous (2005-2009). PBF: Pacific bluefin, ALB: albacore, BET: bigeye, YFT: yellowfin, SWO: swordfish, MLS: striped marlin, BLZ: blue marlin, BLM: black marlins, SAI: sailfish, SPF: shortbill spearfish and SKJ: skipjack. Values in 2010 in tables A and B are provisional. "na" means not available.

A. Distant water (120- GRT) and offshore (10-120 GRT) longlines

Year	#hooks	PBF	ALB	BET	YFT	SWO	MLS	BLZ	BLM	SAI	SPF	Total
2006	79,571	63	4,575	17,777	5,488	6,181	623	1,429	23	16	91	36,266
2007	70,464	83	4,017	13,522	3,040	6,109	306	914	12	7	32	28,042
2008	61,555	19	5,415	10,590	2,798	4,402	390	929	11	8	47	24,609
2009	46,483	8	3,820	8,762	2,349	4,400	166	737	10	6	23	20,281
2010	45,592	4	3,751	7,549	2,457	na	na	960	8	20	30	14,779

B. Small offshore (10-20 GRT) longline

Year	#hooks	PBF*	ALB	BET	YFT	SWO	MLS	BLZ	BLM	SAI	SPF	Total
2006	73,991	-	16,593	11,369	3,661	1,504	538	985	25	18	0	34,693
2007	75,623	-	18,364	10,650	3,629	2,014	860	1,102	17	14	0	36,650
2008	69,209	-	13,677	8,944	3,061	1,778	609	1,142	20	20	0	29,251
2009	71,787	-	18,175	8,178	3,342	1,547	606	1,059	13	25	1	32,946
2010	67,869	-	18,683	6,082	4,462	na	na	1,285	13	29	0	30,554

* Catch of PBF is included in the coastal (-20 GRT) longline

C. Coastal (-20 GRT) longline

Year	PBF	ALB*	BET	YFT	SWO*	MLS*	BLZ+BLM	SKJ	Total
2005	1,818	-	484	1,699	-	-	130	25	4,156
2006	1,058	-	699	1,197	-	-	105	11	3,070
2007	2,004	-	947	1,383	-	-	106	7	4,447
2008	1,476	-	610	1,418	-	-	168	14	3,686
2009	1,304	-	na	na	-	-	na	na	1,304

* Catches of ALB, SWO and MLS are included in the small offshore (10-20 GRT) longline

Table 3. Fishing effort (Number of set) and catch in weight (MT) by species of the Japanese purse seine fisheries (40-GRT) in the north Pacific. SKJ: skipjack, YFT: yellowfin, BET: bigeye, PBF: Pacific bluefin, ALB: albacore. Values in 2010 are provisional.

	Sets	SKJ	YFT	BET	PBF*	ALB*	Total
2006	5,189	151,531	17,585	2,510	8,880	364	186,059
2007	5,450	149,069	11,474	3,164	6,840	5,682	181,678
2008	5,567	146,610	13,366	2,746	10,221	825	179,334
2009	5,364	119,813	16,012	1,560	8,077	2,076	152,901
2010	4,948	106,260	10,875	877	3,742	308	127,009

* ALB and PBF include catch in the Japanese purse seine (5-40 GRT)

Table 4. Fishing effort (Number of poles·days) and catch in weight (MT) by species and of Japanese offshore and distant water pole-and-line fisheries in the north Pacific. SKJ: skipjack, ALB: albacore, YFT: yellowfin, PBF: Pacific bluefin, BET: bigeye. Values in 2010 are provisional.

	Poles*days	SKJ	ALB*	YFT	PBF*	BET	Total
2006	293,637	85,787	15,400	2,623	108	3,701	107,619
2007	316,059	80,414	37,768	2,293	236	1,790	122,501
2008	294,378	77,737	19,060	2,478	64	1,444	100,783
2009	282,145	53,148	31,172	3,517	50	1,400	89,287
2010	275,325	71,289	21,757	2,649	83	2,086	97,864

* ALB and PBF include catch in the coastal pole-and-line

Table 5. Numbers of stomach samples analyzed for Pacific bluefin tuna (*Thunnus orientalis*) by regions and months

	Tsushima Current region				Kuroshio region			
Month	Nagasaki	Niigata	Shimane	Total	Kochi	Shizuoka	Wakayama	Total
Aug-08					38			38
September			11	11		92		92
October	2	5	60	67	25			25
November	50		30	80	50			50
December	50			50	10	19		29
Feb-09							3	0
May	15			15				
June	25			25				
Total	142	5	101	248	123	111	3	234

Table 6. Numbers of recorded Pacific bluefin tuna (*Thunnus orientalis*) landed at Ishigaki-jima Island from 2007 to 2010

Year	Female	Male	unknown	Total
2007	193	204	3	400
2008	118	156	7	281
2009	116	122	42	280
2010	86	97	6	189
Total	513	579	58	1150

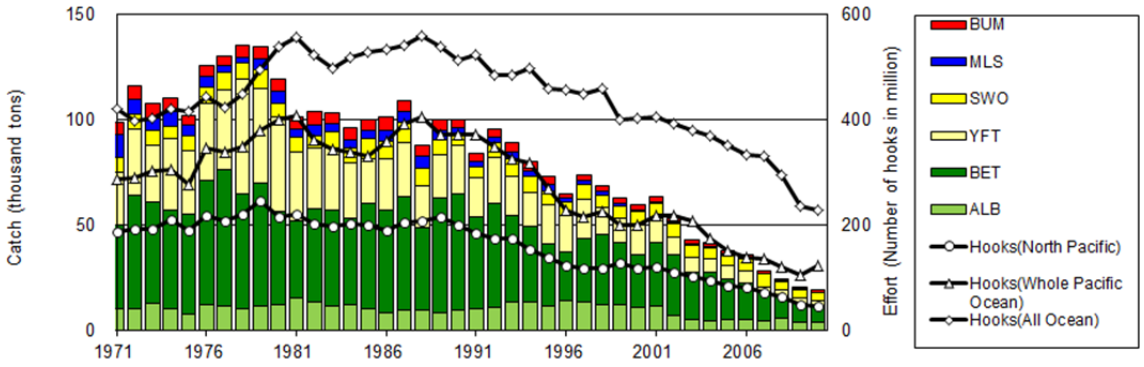

Fig. 1. Historical catches in weight (MT) for major species for the Japanese distant water and offshore longline fishery (not including small offshore) in the North Pacific Ocean and fishing effort (Number of hooks in million) in the North Pacific Ocean comparing to all oceans and whole Pacific Ocean and. ALB: albacore, BET: bigeye, YFT: yellowfin, SWO: sword fish, MLS: striped marlin, BUM: blue marlin.

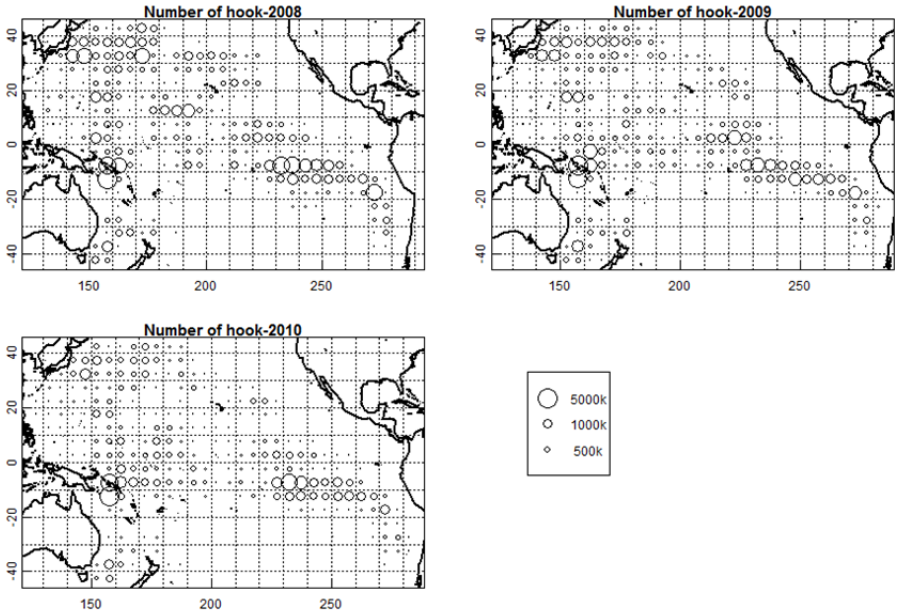

Fig. 2. Distribution of fishing effort (Number of hooks) for the Japanese longline fishery (larger than 20 GRT vessels) in the Pacific, 2008-2010.

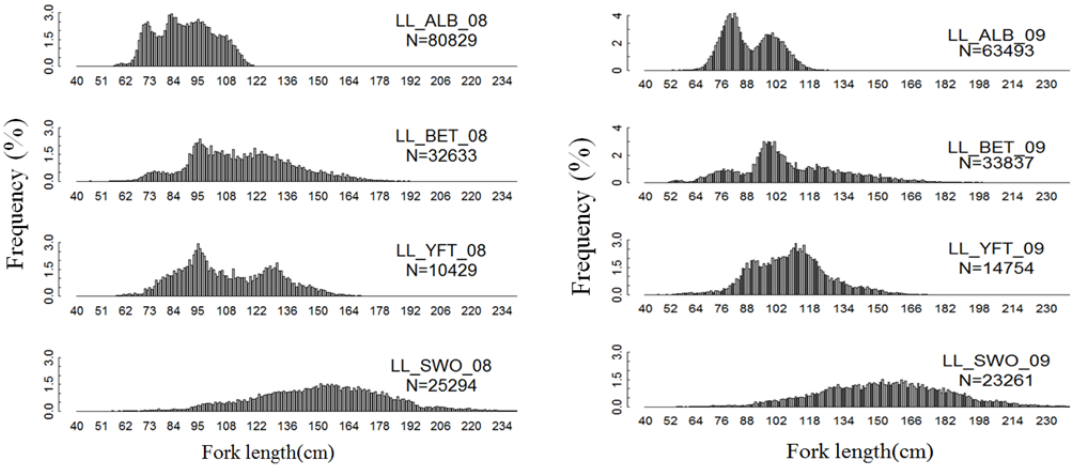

Fig. 3. Annual length frequency distribution (simply summing up all measurements) for longline caught albacore, bigeye, yellowfin, and swordfish in 2008 (left) and 2009 (right). The fork length of the swordfish means eye-fork length. Texts in each graph indicate gear, species, year, and the number of fish measured.

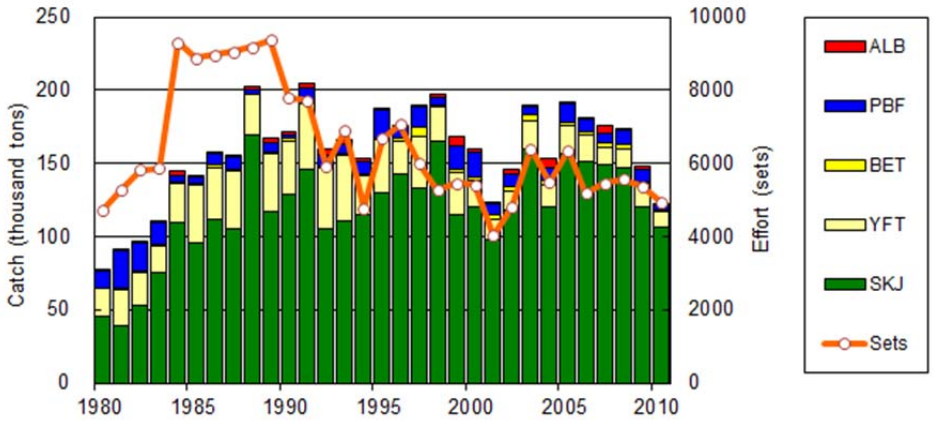

Fig. 4. Historical catches in weight (MT) for major species for the Japanese purse seine fishery and fishing effort (Number of sets) in the Pacific Ocean. SKJ: skipjack, YFT: yellowfin, BET: bigeye, PBF: Pacific bluefin, ALB: albacore. Value in 2010 is provisional.

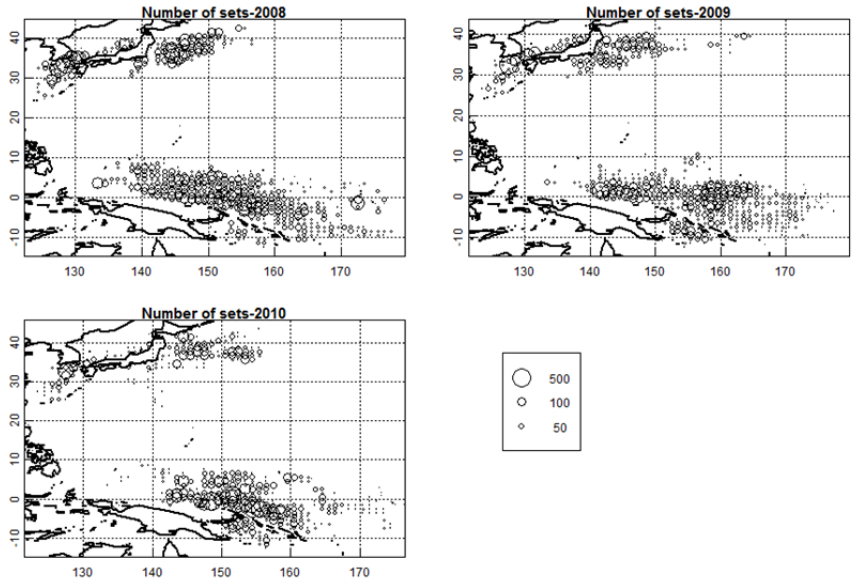

Fig. 5. Distribution of fishing effort (number of sets) for the Japanese purse seine fishery in the Pacific, 2008-2010.

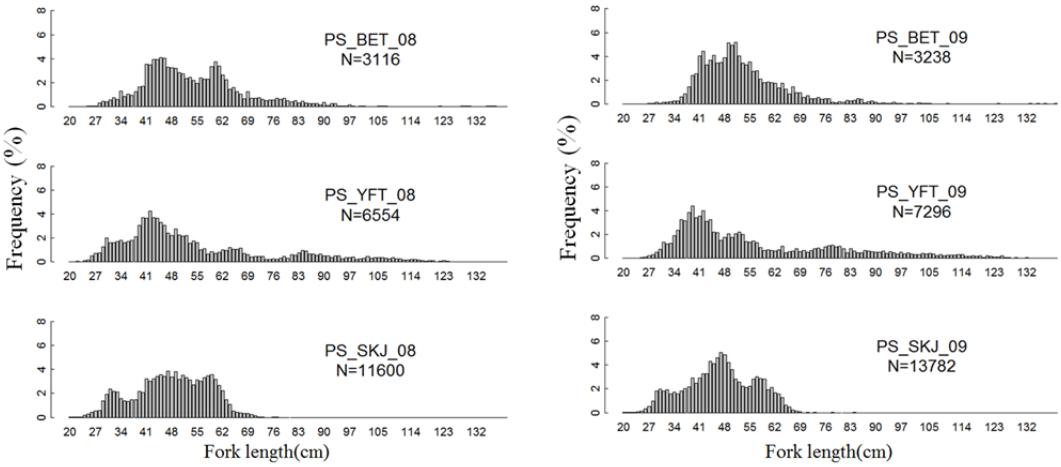

Fig. 6. Annual length frequency distribution for distant water purse seine caught skipjack, bigeye, and yellowfin in 2008 (left) and 2009 (right). Texts in each graph indicate gear, species, year, and estimated number of fish caught by this fishery.

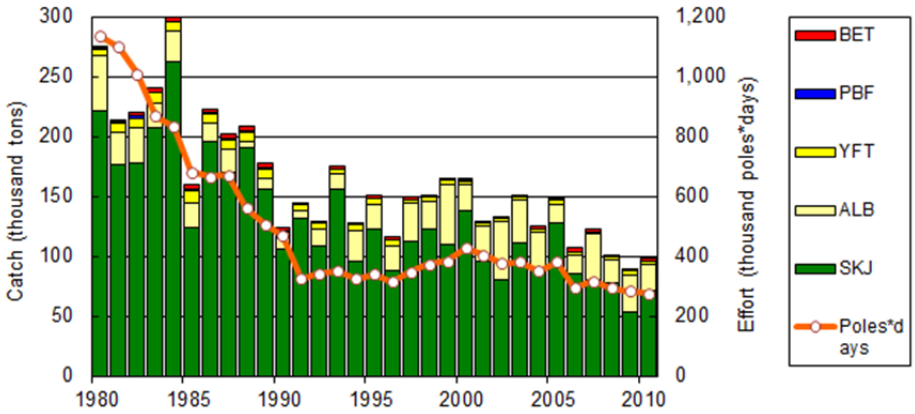

Fig. 7. Historical catch in weight (MT) by species and fishing effort (Number of poles·days) of Japanese offshore and distant water pole-and-line fisheries in the north Pacific. SKJ: skipjack, ALB: albacore, YFT: yellowfin, PBF: Pacific bluefin, BET: bigeye. Value in 2010 is provisional. The catch for PBF includes the catch by coastal pole-and-line (less than 20 GRT vessels) fishery.

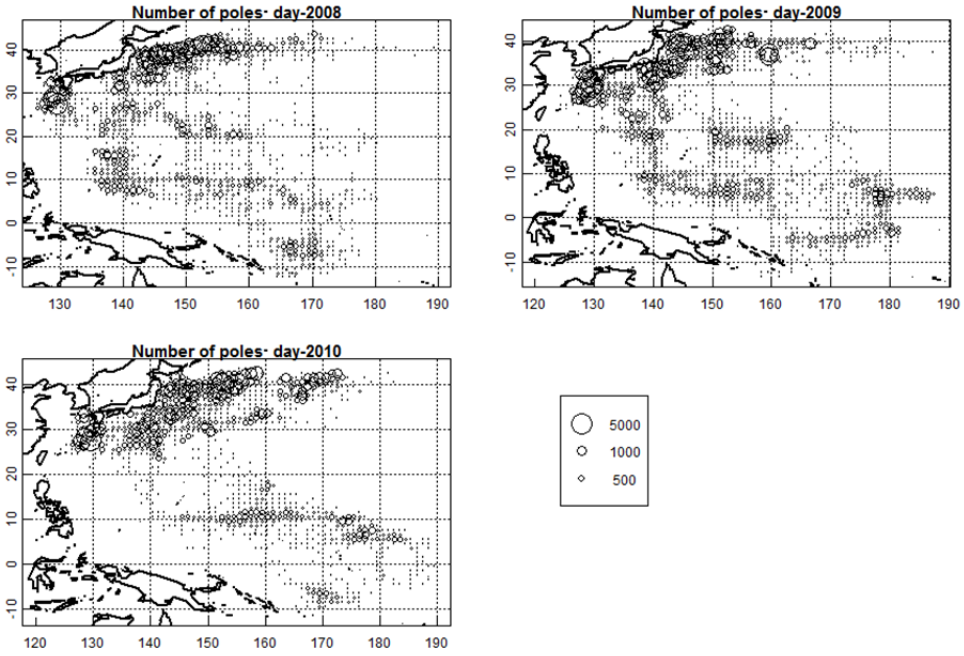

Fig. 8. Distribution of fishing effort (number of poles·days) of the Japanese pole-and-line fishery (larger than 20 GRT vessels) in the Pacific, 2008-2010.

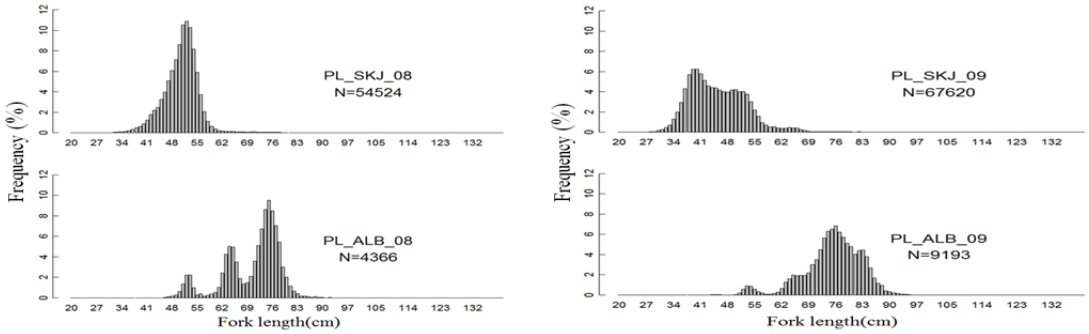

Fig. 9. Annual length frequency distribution (simply summing up all measurements) for offshore and distant water pole-and-line caught skipjack and albacore in 2008 (left) and 2009 (right). Texts in each graph indicate gear, species, year, and the number of fish measured.

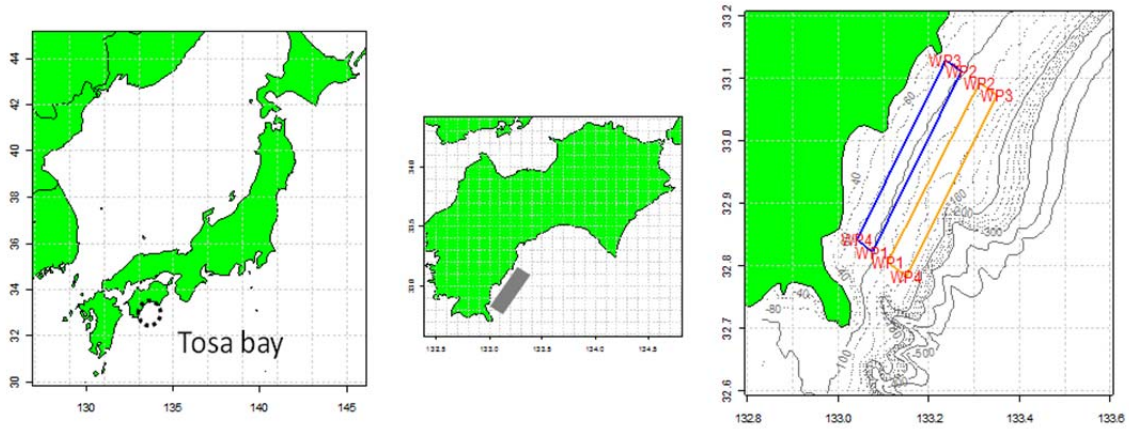

Fig. 10. Location of research area and fixed lines for troll survey in Tosa bay. Area colored in grey indicates the research area.

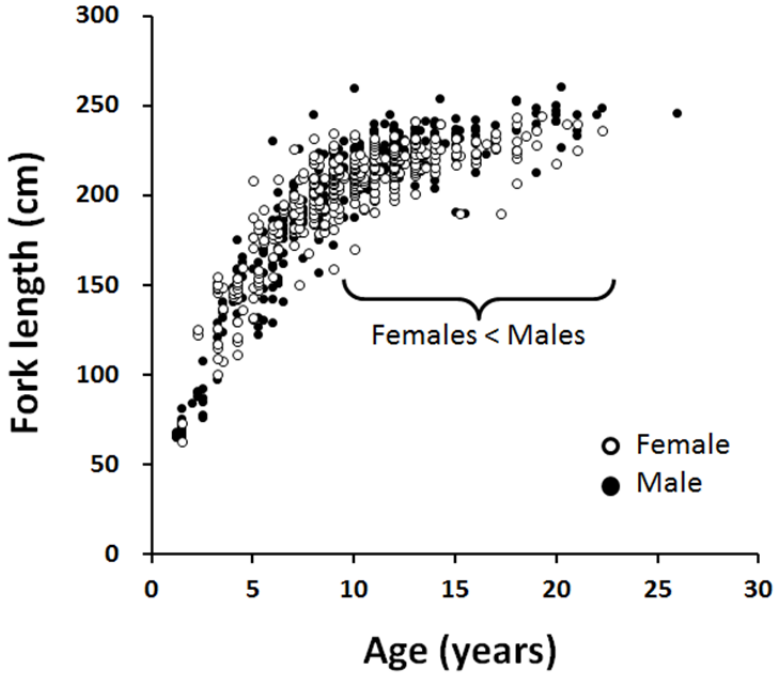

Fig. 11. Relationship between age and fork length of female and male Pacific bluefin tuna (*Thunnus orientalis*).