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SUMMARY

Korean distant water fisheries for tuna and tuna-like species have two types of fishing gears, purse seine and longline, operating in the Pacific Ocean. The number of longline vessels was 99 in 2020, which has remained less than 100 since 2015. The number of purse seine vessels in 2020 was 26, which was the same of the recent years. The total catch of tuna and tuna-like species caught by those two fisheries in the North Pacific Ocean was 60,475 ton in 2020. The total catch of the longline fishery in 2020 was 13,971 ton, which was 14% lower than 2019. That of the purse seine fishery was 46,504 ton, which was decreased by 33% compared to 2019. The main target species of the longline fishery were bigeye tuna and yellowfin tuna which accounted for 65.5% and 22.7% of the total catch in 2020, respectively. For the purse seine fishery, skipjack tuna (76.8%) was dominant, followed by yellowfin tuna (21.4%) and bigeye tuna (1.8%). Pacific bluefin tuna has been caught by coastal and offshore fisheries in the Korean waters, and mostly caught by offshore large purse seine fishery operating around the Jeju island. The catch by the offshore large purse seine fishery in 2020 was 567 ton which accounted for 94% of the total catch. In 2020, the catch of large PBF (30kg or larger than 30kg) accounted for 68% of the total catch, which is the highest record.

1. Introduction

Korean distant water fisheries for tuna and tuna-like species consist of longline fishery and purse seine fishery in the Pacific Ocean. Korean distant water tuna longline fishery (herein ‘longline fishery’) commenced its first fishing in the Indian Ocean in 1957, and has explored to the Pacific Ocean since 1958 and the Atlantic Ocean since 1967. The number of active vessels was the highest of 220 in 1991, but it has shown the decreasing trend thereafter.

Korean distant water tuna purse seine fishery (herein ‘purse seine fishery’) was initiated by accessing into the Eastern Pacific Ocean (EPO) with 3 vessels in 1971, and helicopter-aided mass operations were introduced in 1979 for the first time. The number of active vessels was the highest of 39 in 1990 and sharply decreased to 27-28 during the early 1990s and then maintained around 25-28 in the recent decade.

All Korean distant water fisheries are managed by the Distant Water Fisheries Development Act, which came into effect on 4 February 2008. From 1 September 2015, electronic reporting (ER) system started its operation, and catch information of all fishing vessels belonging to Korean distant water fisheries have been reported in real time from vessels through this system. All catch and effort data reported through ER system are monitored and managed by the National Institute of Fisheries Science (NIFS).

Pacific bluefin tuna has been caught by domestic fleets in the Korean waters, mostly by offshore large purse seine fishery (herein 'offshore purse seine fishery') which targets pelagic species such as mackerels by operating in the Korean waters. For monitoring and managing of fisheries associated with PBF, the Ministerial Directive on conservation and management for PBF stock put established on 26 May 2011, since then it has been amended several times, and its latest was put into force in 2020. Under this Ministerial Directive, the annual catch limit of PBF has been set by fishery and province, and the catch reporting system has improved as well.

This document provides the fishery information on catch and effort of the Korean distant water fisheries for tuna and tuna like species and PBF catch information of the Korean domestic fisheries.

2. Fisheries

2.1 Distant water fisheries

2.1.1 Fleet structure

The number of active vessels by fishery and size operated in the Pacific Ocean is presented in Table 1 and Fig. 1. The number of purse seine vessels, once peaked at 39 in 1990, reduced to 28 in 1996 and since then has been maintained around 25-28. In 2020, it was 26, which is same as last 3 years, of which 6 vessels were 501-1,000 GRT class, 15 vessels were 1,001-1,500 GRT class and 5 vessels were over 1,500 GRT class. The number of longline vessels reduced from 220 in 1991 to 108 in 2008, and then slightly increased up to 126. After 2013, however, it decreased to 96 vessels and maintained this level during the last 4 years, and it has increased to 99 in 2020. Most of longline vessels belong to 201-500 GRT class except one vessel of 51-200 GRT.

2.1.2 Fishing pattern

The distributions of catch and effort for the recent 5 years by purse seine and longline fisheries in the Pacific Ocean are presented in Figs. 2 and 3, respectively.

In general, purse seine fishery has operated in the tropical area of the western and central Pacific Ocean (WCPO) between 140°E-170°W throughout the year, and its fishing area extended to the east subject to oceanographic conditions from time to time. Fishing efforts of purse seine fleets in 2020 were relatively concentrated on east of 165°E, and the fishing area was shrunk longitudinally compared to the previous years (Fig. 2).

Longline fishery has mainly operated in the tropical area of 160°E-120°W. In 2016-2017, fishing efforts of longline fleets were higher in the area of 170°E-175°W and further extended to the near area of EPO. In 2018 and 2019, however, fishing efforts were more concentrated on the central tropical area of 170°E-160°W of 10°N-10°S compared to the previous years. In 2020, they were highly focused on the central tropical area, which was same of 2018-2019 (Fig. 3).

2.1.3 Annual catch and effort

Annual catches and efforts by Korean distant water tuna fisheries in the North Pacific Ocean are shown in Tables 2-3, and Figs. 4-5. Most catches by longline and purse seine fisheries came from south of 20°N (Figs. 2 and 3).

The fishing effort (no. of hooks) of longline fishery was 30,428 thousand hooks in 2020, which was increased by 5% and 10% compared to 2019 and the average of the recent 5 years (27,681 thousand hooks) (Table 2). As for the fishing effort (no. of sets) of purse seine fishery, it was 1,145 sets in total in 2020, which was 24% and 30% lower than those of in 2019 and the average of 5 recent years, respectively (Table 3).

The total catch of longline fishery in the North Pacific Ocean was 13,971 ton in 2020, which was decreased by 6% compared to those of 2019, whereas it was increased by 4% compared to the average of recent 5 years. Whereas the catches of most species were decreased compared to 2019, bigeye tuna catch was slightly increased (Table 2 and Fig. 4). The total catch of purse seine fishery in 2020 was 46,504 ton, which was sharply decreased by 33% compared to 2019 and 24% lower than the average of the recent 5 years (60,838 ton). In particular, skipjack tuna

catch was drastically dropped by 39% and 27% compared to those of 2019 and the average of the recent 5 years (48,754 ton) (Table 3 and Fig 5).

As for the catch proportions by species of longline fishery in 2020, bigeye tuna, yellowfin tuna, blue marlin and swordfish accounted for 65.5%, 22.7%, 6.0% and 2.8% in total, respectively (Fig. 4). For purse seine fishery, skipjack, yellowfin and bigeye tunas accounted for 76.8%, 21.4 % and 1.8% in total, respectively (Fig. 5).

2.2 PBF catch by coastal fisheries

2.2.1 Fleet structure

Pacific Bluefin tuna (PBF) is mainly caught by offshore purse seine fishery which targets mackerels in the Korean waters. Due to the strategy of government to control the fishing capacity of this fishery for conservation and management of major commercial pelagic species, the number of vessels belonging to the offshore purse seine fishery was decreased from 32 in 2002 to 24 in 2012, after then, it had maintained this level. In 2020, 18 vessels operated and caught PBF, which is 5 vessels less than 2019. PBF has also been caught by set net, troll and trawl fisheries operated in the Korean waters (Table 4).

2.2.2 Fishing pattern

In 2020, most PBF were caught by offshore purse seine fishery around the eastern and southern part of Jeju island from March to April, which is similar fishing pattern to the previous years. And the catch by set net fishery which were located along the coast of north of 36°N in the East Sea has been largely increased from 2019 (Fig. 6).

2.2.3 Annual catch and effort

The annual PBF catch by fishery are presented in Table 4 and Fig. 7. The total catch of PBF was the highest with 2,601 ton in 2003, and it has shown a decreasing trend with annual fluctuations thereafter. In 2020, the PBF catch by offshore purse seine fishery was 567 ton, which accounted for 94% in total. The PBF catch by set net fishery was 35 ton in 2020, which accounted for 6% in total, and trawl fishery caught about 3 ton similar as in 2019.

Fig. 8 shows PBF catch by size (large and small) from 2002 to 2020 and its catch proportion by fishery and size in 2020. Since 2008, large PBF (30kg or larger) has been caught in the Korean waters, and the catch in 2016 was caught about 469 ton which accounted for over 46% in total. In 2020, the proportion of large PBF was about 68%, which is the highest record, and large PBF were mostly caught by offshore purse seine fishery which were operated around southern part of Jeju island during March and April. And a little amount of large fish was caught by trawl and set net fisheries as well (Fig. 8).

The mean fork length of PBF caught by offshore purse seine fishery was 101.2 cm in 2020, which is quite larger than 89.0 cm of 2019 (Fig. 9)

3. Data collecting system

3.1 Distant water fisheries

The National Institute of Fisheries Science (NIFS) is responsible for data collection and management of Korean distant water fisheries. In accordance with data reporting and submission requirement by the RFMOs, necessary improvements have been continuously made in data coverage, accuracy and verification through cross-checking among relevant organizations and agencies. Since 1st September 2015, the Act on Distant Water Fisheries Development has obliged fishers of distant water fisheries to report fishing information to the NIFS in real time through the electronic reporting (ER) system. This system continuously be reviewed and updated to include data reporting and collection requirements recently adopted by tuna RFMOs.

3.2 Observer program

The scientific observer program of Korean distant water fisheries started in 2002. The basic requirement for observers is college graduate with major in nature science or fisheries high school graduate with at least 1-year experience on board and certificate of qualification to deck officer. Candidates for observer, who have passed the paper review (including medical check) and oral interview, have to take three-weeks training program. Observer training program includes basic safety training for seafaring, operations of navigation devices, biological information training on target and non-target species and data collecting/reporting method for fishing activities. During the training program, they have two kinds of test. One is for a technical term of fisheries and biology, and the other is for species identification. The person who scored 70% out of 100 points in the two tests and attended 100% of the course timetable can be qualified for a scientific observer and deployed on board. Korea has a total of 61 scientific observers at present. In 2020, there were several difficulties in dispatching observers on board due to the COVID-19 pandemic.

3.3 PBF catch by coastal fisheries

To estimate the Korean historical PBF catch, we used the import products information recorded by Japan for 1982-1999, and the export data to Japan markets provided by Korean Offshore Large Purse Seine Fisheries Cooperatives for 2000-2004. Since 2005, PBF catch

information has been collected through the monthly sale slips reported by Busan Cooperative Fish Market and National Federation of Fisheries Cooperative. All PBF catch information obtained from sale slips are monitored and managed by the NIFS.

4. Research

4.1 PBF close-kin program

The NIFS has collected tissue samples of PBF caught by offshore purse seine fishery for the close-kin program since 2016, and analyzed them to develop candidate Single Nucleotide Polymorphism (SNP) markers since 2018 (Table 5).

Table 1. The number of active vessels by the Korean distant water tuna fisheries operated in the Pacific Ocean, 2008-2020

Year	GRT class by fishery									
	Longline					Purse seine				
	Total	0-50	51-200	201-500	500+	Total	0-500	501-1000	1001-1500	1500+
2008	108	-	-	108	-	28	-	15	12	1
2009	111	-	-	111	-	27	-	13	11	3
2010	122	-	-	122	-	28	-	13	13	3
2011	124	-	-	124	-	28	-	12	11	5
2012	126	-	-	126	-	28	-	12	11	5
2013	125	-	1	124	-	27	-	12	10	5
2014	110	-	1	112	-	28	-	10	13	5
2015	98	-	1	97	-	25	-	7	13	5
2016	96	-	1	95	-	25	-	7	14	4
2017	96	-	1	95	-	26	-	7	15	4
2018	96	-	1	95	-	26	-	6	15	5
2019	96	-	1	95	-	26	-	6	15	5
2020	99	-	1	98	-	26	-	6	15	5

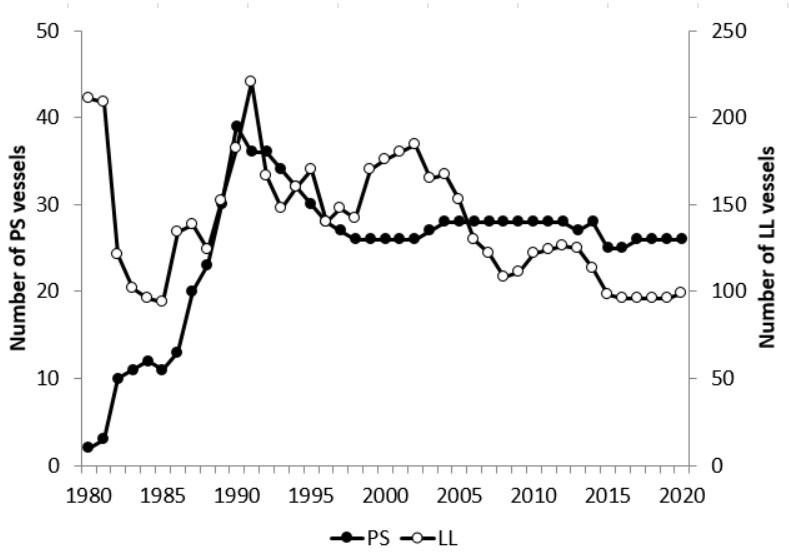

Fig. 1. Historical number of active fishing vessels of the Korean distant water tuna fisheries operated in the Pacific Ocean, 1980-2020.

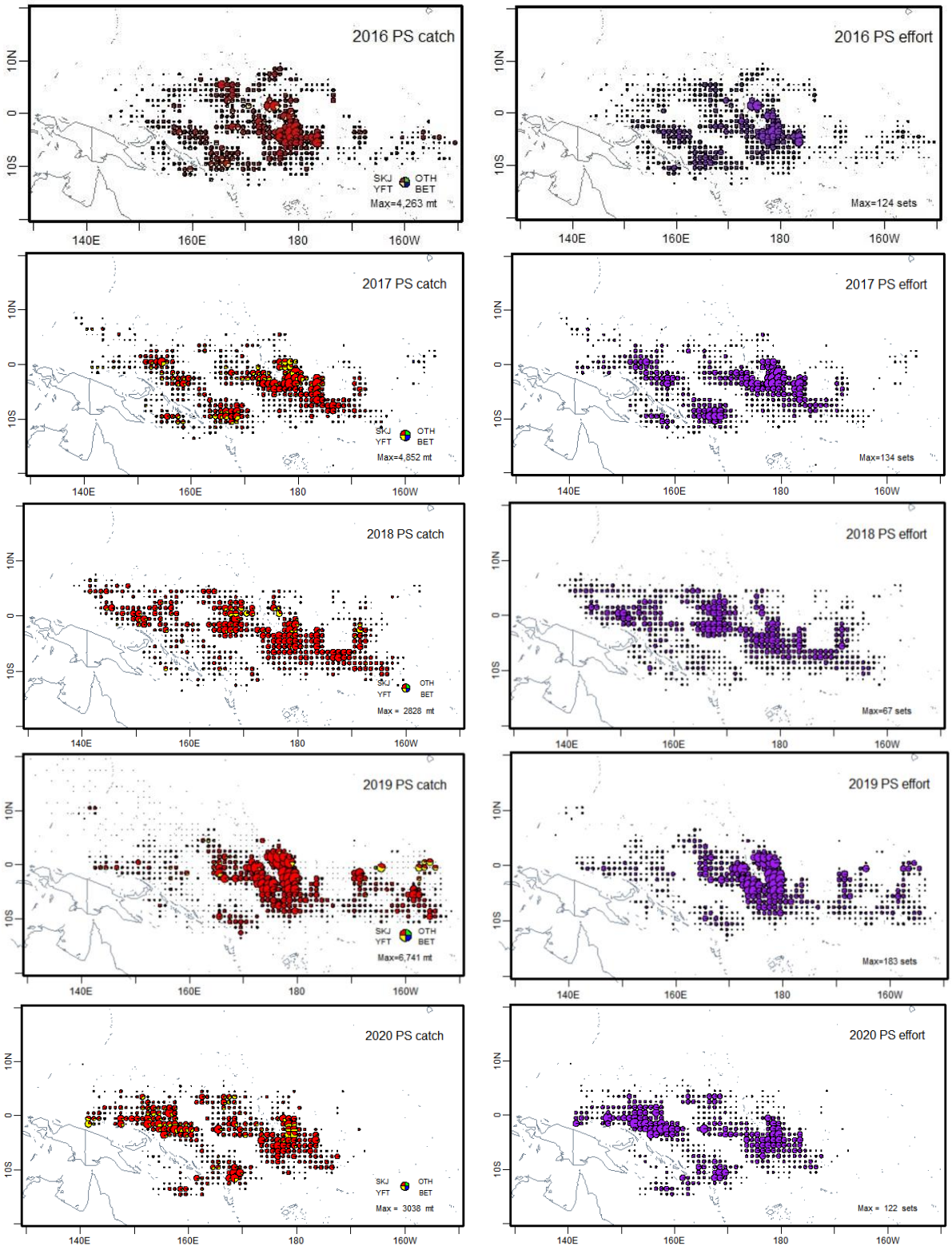
2016 PS catch
SKJ YFT OTH BET
Max=4,263 mt
2016 PS effort
Max=124 sets
2017 PS catch
Max=4,852 mt
2017 PS effort
Max=134 sets
2018 PS catch
Max = 2828 mt
2018 PS effort
Max=67 sets
2019 PS catch
Max=6,741 mt
2019 PS effort
Max=183 sets
2020 PS catch
Max = 3038 mt
2020 PS effort
Max = 122 sets
10N
0
10S
140E
160E
180
160W

Fig. 2. Distributions of catch (left) and effort (right) of the Korean distant water tuna purse seine fishery operated in the Pacific Ocean, 2016-2020.

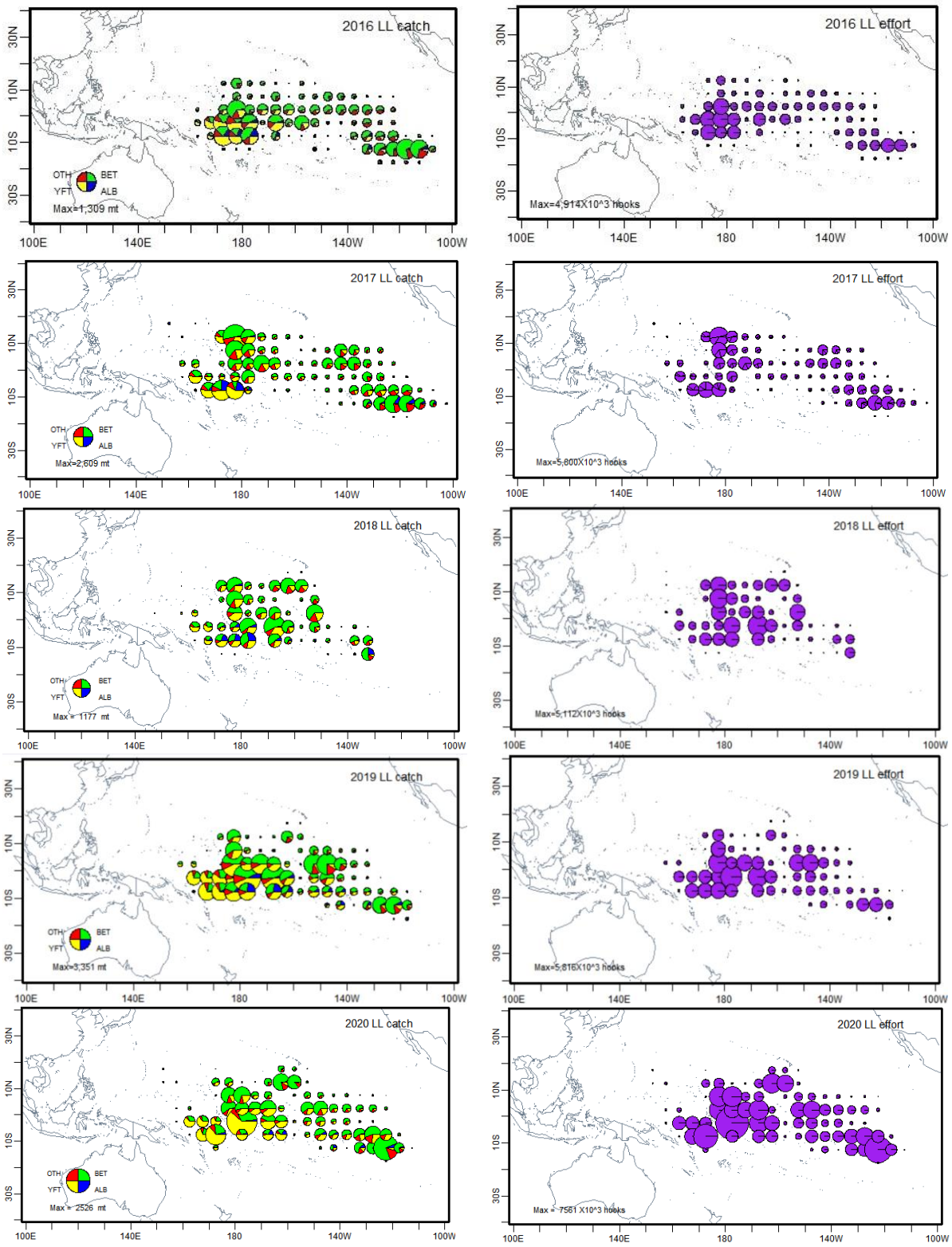

Fig. 3. Distributions of catch (left) and effort (right) of the Korean distant water tuna longline fishery operated in the Pacific Ocean, 2016-2020.

Table 2. Fishing effort (X1,000 hooks) and catch (ton) of the Korean distant water tuna longline fishery in the North Pacific Ocean, 2002-2020

Year	Hooks (X1000)	ALB	YFT	BET	SKJ	BUM	MLS	SWO	BLM	SFA	SKH	OTH	Total
2002	16,478	112	3,137	10,786	0	152	188	439	479	123	185	1,400	17,001
2003	21,431	146	4,741	9,739	6	159	206	381	819	129	95	931	17,352
2004	18,746	78	5,144	12,453	101	227	75	410	919	1	8	404	19,819
2005	14,955	420	2,958	9,257	35	304	136	404	997	0	10	820	15,340
2006	18,259	135	5,096	11,494	0	217	56	465	1,063	0	0	941	19,468
2007	15,441	137	2,175	9,606	0	121	47	453	887	0	1	291	13,718
2008	16,466	400	2,730	11,075	0	220	30	795	748	0	4	741	16,742
2009	13,286	95	2,992	10,979	0	224	23	994	654	0	13	878	16,852
2010	14,729	107	2,011	9,303	0	257	18	663	570	0	69	532	13,531
2011	16,654	78	3,146	9,047	0	684	48	962	159	1	546	941	15,614
2012	15,553	157	2,398	11,385	8	587	34	856	57	1	499	876	16,859
2013	13,780	173	1,988	6,041	22	963	65	1,071	41	2	735	204	11,306
2014	11,646	116	2,102	7,735	50	801	82	829	31	3	610	256	13,208
2015	8,022	38	1,520	6,132	41	531	44	776	82	2	250	115	9,531
2016	26,241	56	1,626	6,871	73	1,116	61	582	30	11	9	158	10,593
2017	36,780	202	3,775	10,303	147	1,453	81	583	17	13	31	262	16,867
2018	38,352	101	3,426	10,286	99	1,373	70	664	35	10	37	230	16,332
2019	29,011	65	4,106	8,758	141	981	48	468	28	8	37	149	14,789
2020	30,428	56	3,169	9,157	102	848	74	392	18	4	10	141	13,971

ALB : Albacore tuna, YFT : Yellowfin tuna, BET : Bigeye tuna, SKJ : Skipjack tuna, BUM : Blue marlin, MLS : Striped marlin, SWO : Swordfish, BLM : Black marlin, SKH : Sharks, OTH : Others.

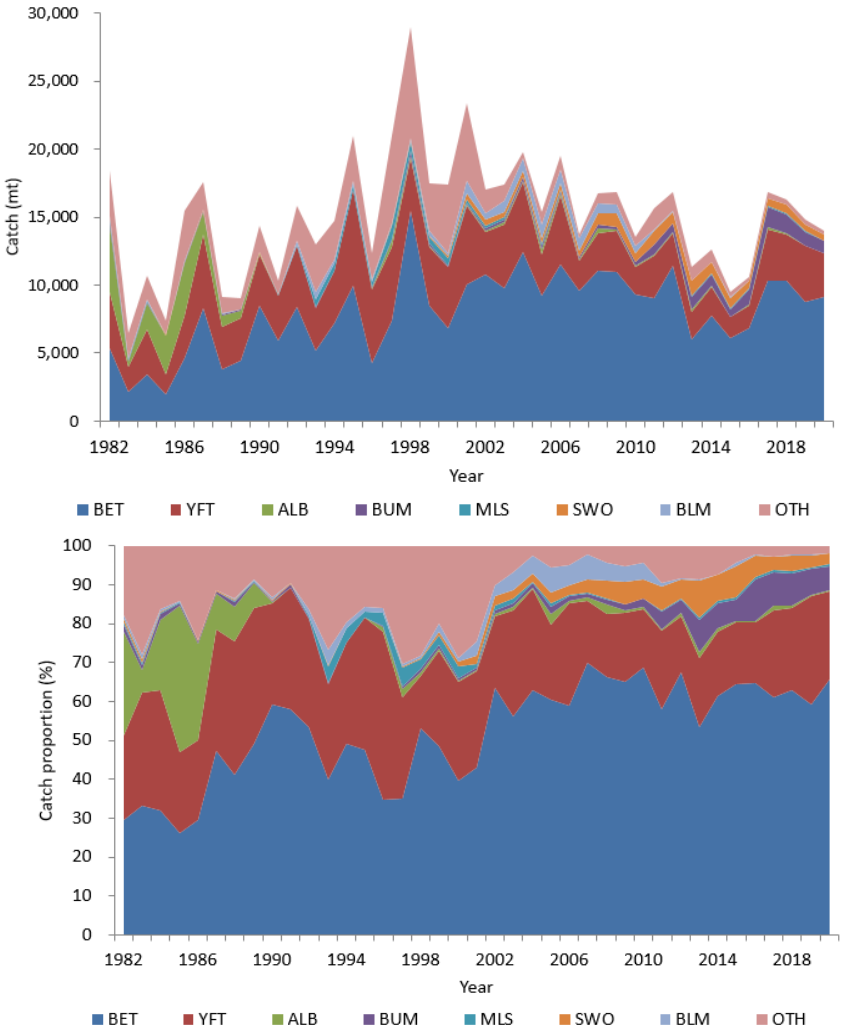

Fig. 4. Historical catches (top) and the catch proportion (bottom) by major species caught by Korean distant water tuna longline fishery in the North Pacific Ocean, 1982-2020.

Table 3. Fishing effort (no. of sets) and catch (ton) of the Korean distant water tuna purse seine fishery in the North Pacific Ocean, 2002-2020

Year	Effort (sets)	Catch (ton)				Total
		SKJ	BET	YFT	OTH	
2002	2,537	64,897	0	16,389	0	81,286
2003	2,876	88,654	319	11,714	0	100,687
2004	1,633	43,797	48	7,426	0	51,271
2005	1,035	49,724	0	11,027	0	60,751
2006	510	67,564	13	15,394	0	82,970
2007	543	18,270	0	3,585	0	21,855
2008	490	9,233	4	7,842	0	17,079
2009	1,237	38,436	15	7,232	0	45,683
2010	727	20,751	374	4,020	0	25,145
2011	770	18,331	216	5,256	0	23,803
2012	2,402	67,448	404	19,467	1	87,320
2013	1,644	40,809	232	4,344	0	45,386
2014	1,732	40,690	265	11,343	0	52,298
2015	1,296	40,195	739	13,859	0	54,793
2016	2,379	62,849	1,025	10,088	31	73,993
2017	863	22,672	858	8,829	2	32,361
2018	2,141	59,479	1,327	12,838	1	73,645
2019	1,507	58,574	398	10,425	1	69,397
2020	1,145	35,698	847	9,959	<1	46,504

SKJ : Skipjack tuna, BET : Bigeye tuna, YFT : Yellowfin tuna, OTH : Others.

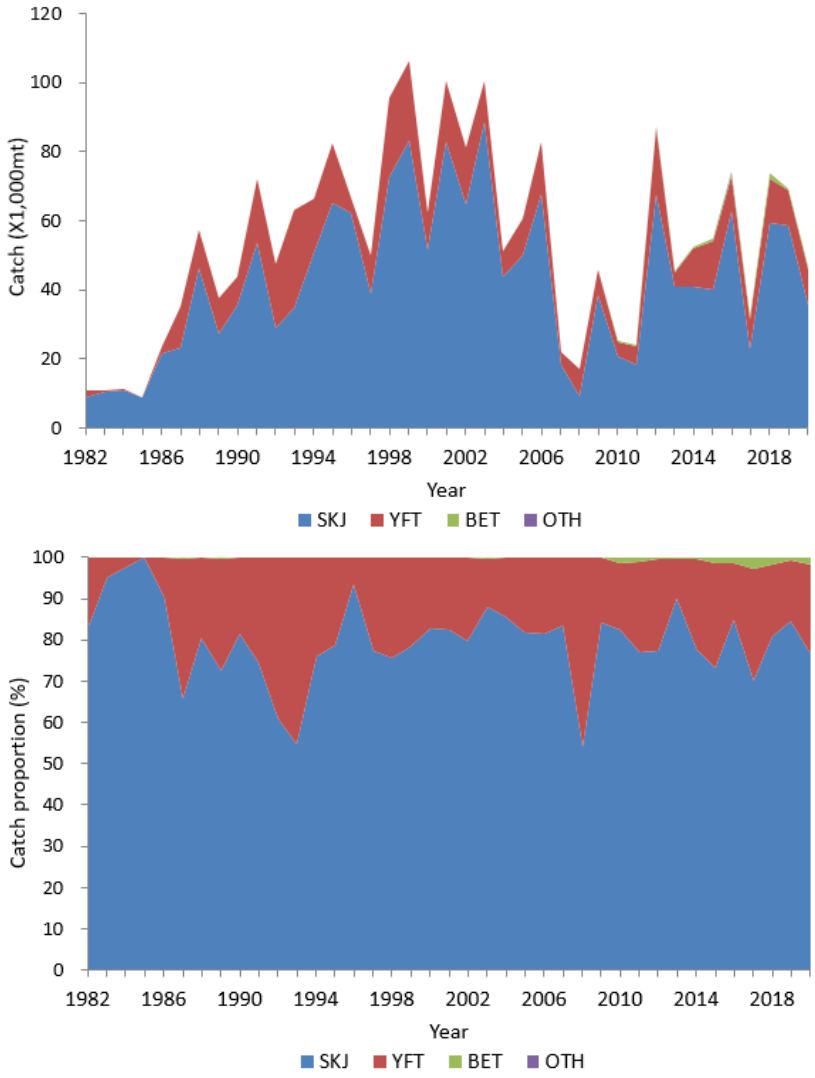

Fig. 5. Historical catches (top) and the catch proportion (bottom) by major species caught by the Korean distant water tuna purse seine fishery in the North Pacific Ocean, 1982-2020.

Table 4. Annual catch of Pacific bluefin tuna by fishery and the number of active vessels of the offshore large purse seine fishery in the Korean waters, 2002-2020

Year	Catch (ton)				
	OLPS (no. of vessels)	Set Net	Troll	Trawl	Total
2002	932 (32)	0	0	1	933
2003	2,601 (29)	0	0	0	2,601
2004	773 (29)	0	0	0	773
2005	1,318 (29)	0	0	9	1,327
2006	1,012 (29)	0	0	3	1,015
2007	1,281 (29)	0	0	4	1,285
2008	1,866 (29)	0	0	10	1,876
2009	936 (27)	0	0	4	940
2010	1,196 (25)	0	0	16	1,212
2011	670 (25)	0	0	14	685
2012	1,421 (24)	0	1	2	1,424
2013	604 (24)	1	0	0	605
2014	1,305 (24)	6	0	0	1,311
2015	676 (24)	1	0	0	677
2016	1,024 (24)	3	0	2	1,029
2017	734 (24)	3	0	6	743
2018	523 (24)	7	0	5	535
2019	542 (23)	36	0	3	581
2020	567(18)	35	0	3	605

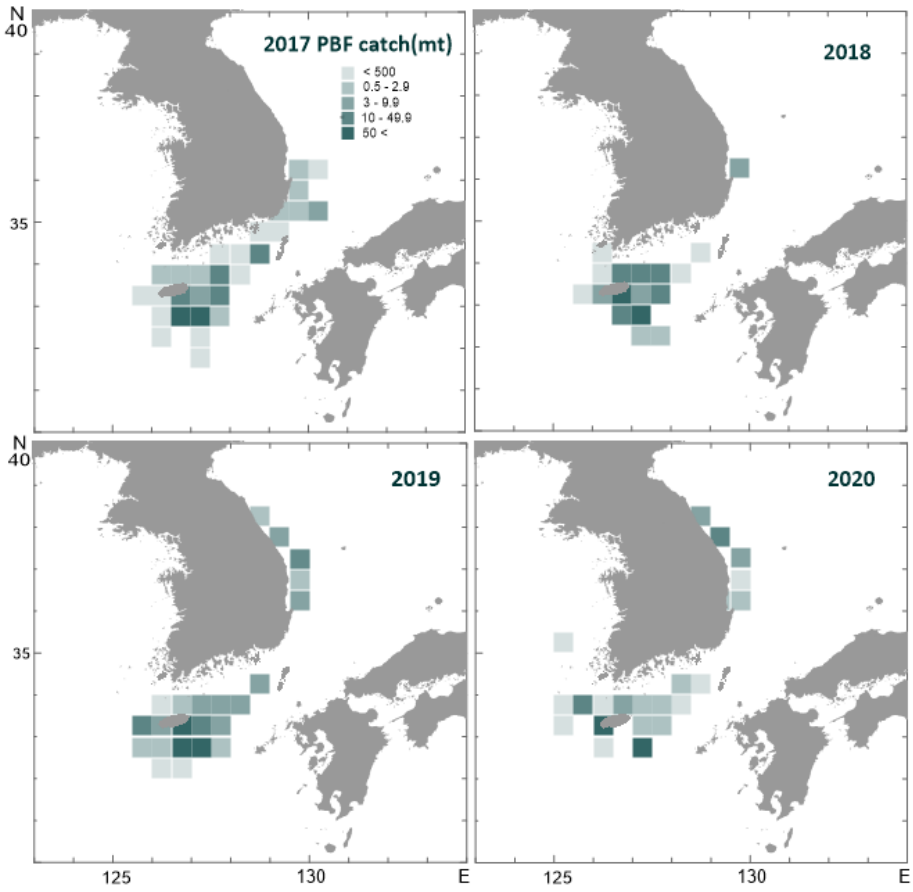

Fig. 6. Catch distribution of Pacific bluefin tuna caught by the Korean coastal and offshore fisheries, 2017-2020.

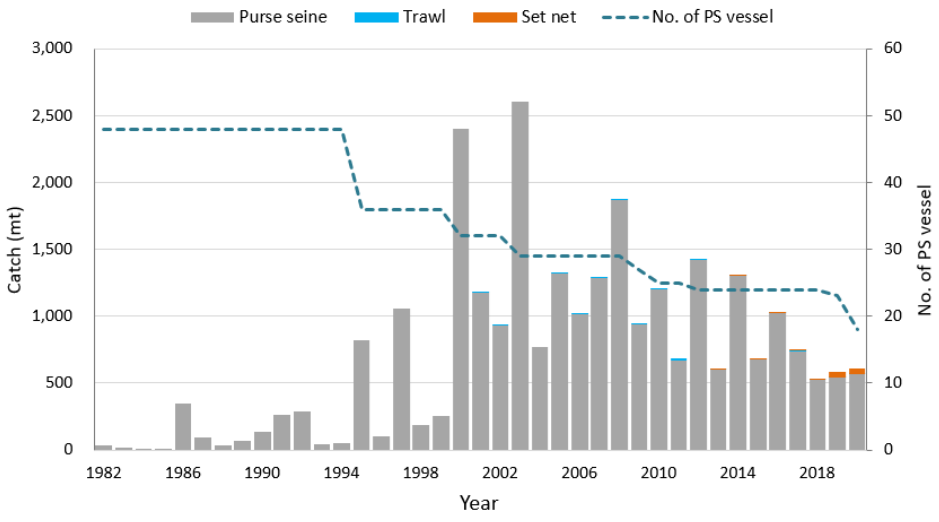

Fig. 7. Historical catch of Pacific bluefin tuna by fishery and the number of active vessels of the offshore large purse seine fishery in the Korean waters, 1982-2020.

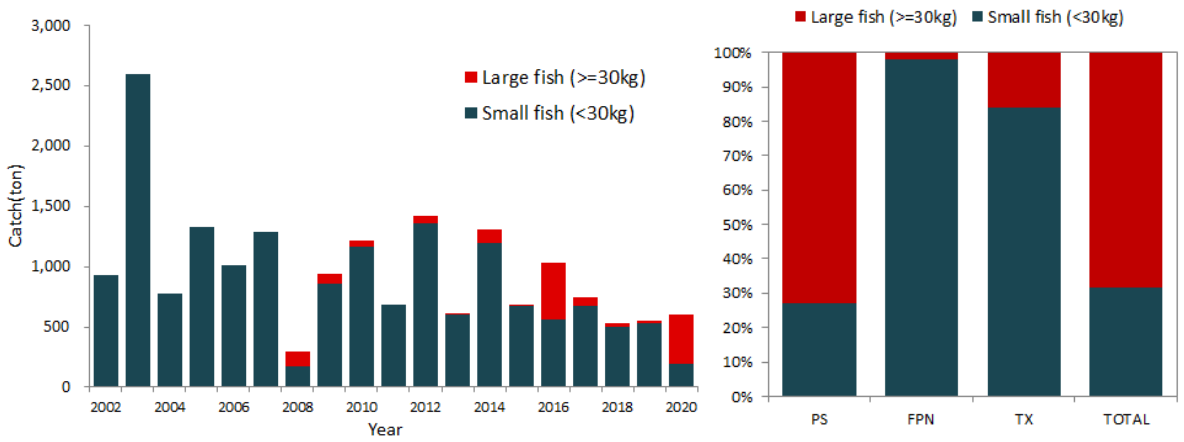

Fig. 8. Catch of Pacific bluefin tuna by size from 2002 to 2020 (left) and the catch proportion by fishery and size in 2020 (right).

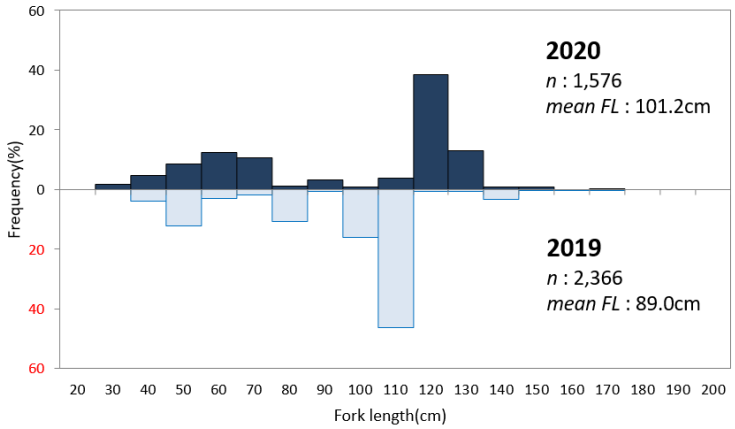

Fig. 9. Length frequency of Pacific bluefin tuna caught by the Korean offshore large purse seine fishery in 2019 and 2020.

Table 5. Summary of the number of samples by year for the Close-kin Mark-recapture

Year	Number of samples
2016	1,045
2017	348
2018	249
2019	313
2020	182