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Taiwanese Tuna and Tuna-like Fisheries in the North Pacific Ocean¹

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Introduction

Taiwanese tuna fisheries are comprised of two major fisheries, longline, and purse seine fisheries, and other small scale fisheries, such as harpoon, set net, gill net in the North Pacific Ocean (North of equator). Longline and purse seine fisheries occupy around 99% of the total tuna catch of Taiwanese fisheries. For longline fishery, it consists of large-scale tuna longline fleet (LTLL, previous named DWLL, ≥ 100 GRT) and small-scale tuna longline fleet (STLL, previous named OSLL, < 100 GRT). The total catch of tunas and billfish (including swordfish, striped marlin, blue marlin, black marlin, and sailfish) for longline fishery (including the catch of LTLL and STLL) in the North Pacific Ocean was 31,983 mt (metric ton) in 2009. The active vessels of LTLL operating in the Pacific Ocean in 2009 were 75 and STLL were 1,220. For purse seine fishery, the total catch was 192,075 mt caught by 33 vessels in the Pacific Ocean in 2009. This paper described the recent trend of Taiwanese tuna fishery in the North Pacific Ocean, and purse seine fishery in the Pacific Ocean.

1. Fisheries Monitoring

1.1. Tuna Longline fishery

1.1.1 Large-scale tuna longline fleet

Large-scale tuna longline (LTLL) vessels refer to those vessels larger than or equal to 100 gross register ton (GRT). Those vessels mostly operate in the high sea areas or in the EEZs of coastal countries under fisheries cooperation agreements. Table 1 shows the number of Taiwanese vessels actually engaged in fishing in the Pacific Ocean from 2005 to 2009. For the purpose of sustainable use of fishery resources, Taiwan imposed a fleet size reduction program on its large-scale tuna longline vessels from 2005 to 2007. Through this program, 32 large-scale tuna longline vessels were reduced in the Pacific Ocean during 2005 - 2007. Thereafter, due to high fuel price and low fish price, the number of active LTLL vessels continuously declined. In 2008, the active vessels were 84, and in 2009, it further reduced to 75.

Table 2 shows catch and effort of Taiwanese LTLL vessels operated in North Pacific Ocean during 1997-2009. Before mid 90s, the catch and effort of albacore in the North Pacific was very low. Thereafter, because of constraint of accessing agreements in the South Pacific, the fishing effort in the North Pacific shows increased trend from 1997 to 2004. Since 2005, due to reasons as the above mentioned, the fishing efforts reduced year by year. The active vessels targeting albacore in the North Pacific Ocean decreased from 32 in 2006, 24 in 2007, 18 in 2008, to 14 in 2009.

From 1997 to 2000, albacore is the main catch of Taiwanese tuna longliner in the North Pacific Ocean, occupied more than 70% of total catch, but since 2001, the catch of bigeye tuna, yellowfin and swordfish increased significantly. The albacore catch in 2007 and 2008 was estimated as 2,465 mt and 2,490 mt respectively. The catch in 2009 was preliminarily estimated as 1,866 mt. For LTLL fleet, pacific bluefin tuna is just incidentally caught, and the amount has been very minor. Before 2000, the catch of swordfish in the North Pacific was low and less than 100 mt. Thereafter, the catch increased substantially to more than 1,000 mt from 2001 to 2003 for the increase of fishing efforts on bigeye tuna, but declined to less than 500 mt from 2005 to 2009 due to reducing efforts.

The length frequency of albacore, swordfish caught by LTLL in the North Pacific are shown in Figure 1, Figure 2. For LTLL fleet, the catch at length data is from logbook. Fishermen are requested to measure the length of the first 30 fish caught each day. The amount of length measurement for albacore from 2007 to 2009 was 42,951, 37,130 and 15,112, and the coverage rate for length measurement was 7.5%, 9.4%, and 2.8%, separately. The predominate range for albacore caught by LTLL from 2007-2009 were 70-90cm, 78-94cm and 78-98cm in fork length. The length measurement for swordfish is measured from low jaw fork length and the amount of length measurement from 2007-2009 was 2,318, 2,569 and 1,833 and the coverage rate for length measurement was 9.4%, 12%, and 7% separately. The dominant range for swordfish caught by LTLL from 2007-2009 was 135-180cm, 125-175cm and 125-185cm.

The distribution of fishing efforts of Taiwanese LTLL vessels operating in the Pacific Ocean during 2007-2009 is shown in Figure 3. These vessels fish for northern albacore seasonally from September to March of the following year, and shift to the South Pacific for southern albacore from April to August. In 2009, the distribution of fishing effort for Taiwanese LTLL operated in the North Pacific Ocean concentrate on the west of 165° W compared with 2007 and 2008.

1.1.2 Small-scale tuna longline fleet

The small-scale tuna longline (STLL) vessels generally refer to those vessels smaller than 100 GRT (mostly 50-70 GRT). Table 3 shows catch of STLL vessels operated in the North Pacific by species from 1997 to 2009. The main catch of STLL vessels is yellowfin tuna rather than albacore. The catch of albacore fluctuated between 450 and 930 mt within recent ten years. A preliminary estimated catch of albacore in 2009 was 512mt. The catch of swordfish stayed stable from 1,200 mt to 1,700 mt from 1997 to 2002, but since 2003, it increased remarkably and then remained stable from about 3,400 mt to 4,000 mt from 2003 to 2008. The catch of swordfish in 2009 was preliminarily estimated as 3,177 mt. As for pacific bluefin tuna, in 2007, the catch was 1,401 mt, but in 2008 it declined to 979 mt. The preliminary estimated catch in 2009 was 877 mt.

The length frequency of albacore, swordfish, and pacific bluefin tuna caught by STLL vessels in the North Pacific are shown in Figure 1, Figure 2, and Figure 4. For STLL fleet, the size

measurements for albacore, swordfish and pacific bluefin tuna were sampled from domestic fishing ports. The amount of size measurements for albacore from 2007-2009 were 425, 369 and 724, and the coverage rate for length measurement was 2.3%, 1.8%, 3.5%, separately. The dominant size for albacore caught by STLL from 2007-2009 was 88-106cm, 90-106cm and 84-100cm. Since the low jaw of swordfish was generally cut on board, eye-fork length was then measured instead. The amount of length measurement for swordfish from 2007-2009 was 1,023, 661 and 1,497, and the coverage rate for length measurement was 1.2%, 1.0%, and 2.6%, separately. The dominant range for swordfish caught by STLL from 2007-2009 was 94-140cm, 105-160cm and 105-145cm, separately. The coverage rate for length measurement of pacific bluefin tuna from 2007-2009 was 22.9%, 31.9%, and 70.1%, separately. The dominant size for pacific bluefin tuna caught by STLL from 2007-2009 was 200-240cm, 200-245cm and 205-245cm.

The distribution of fishing efforts for STLL vessels based at domestic ports from 2007 to 2009 is shown in Figure 5. The fishing area mainly distributed between north of equator and south of 40° N and between eastern of 100° E and western of 165° W.

1.2. Distant water purse seine fishery

Tuna purse seine fishery was introduced into Taiwan in 1982. At the outset second-hand Japanese group purse seiners were imported and Japanese fishing masters were employed. Through years of research, the first single boat purse seiner was launched in October 1984, as the cornerstone for rapid development of this fishery in the following 10 years. In 1992 the number of purse seiners reached to the highest level of 45 boats. Due to the adjustment of business strategy of some companies, the number of fishing vessels was then reduced to 42. The fleet further reduced to 34 vessels in 2003, after 8 vessels were exported.

Fishing operations of the fleet moved along the equator under a seasonal pattern, mainly concentrating in the exclusive economic zones of Papua New Guinea, Federated States of Micronesia, Kiribati, Nauru, Marshall Islands and Solomon Islands, as well as the neighboring high seas. In the years where El Niño phenomena occur the fish tends to move eastwards and the fishing activities will follow the pattern of this movement. In contrary, in years of La Niña, fish schools tend to concentrate more in the western part of the Pacific, and likewise do the fishing activities.

In 2009, the number of active distant water purse seine vessels was 33. The fleet distribution was within the areas 5° N-10° S, and between 141° E-165° W of the western and central Pacific Ocean (Figure 6). The total catch by purse seine fishery in 2009 was 192,075 mt (Table 4), which was 5.8% lower than the catch of 203,973 mt in 2008.

1.3 Other fisheries

Some other small scale fisheries, such as harpoon, set net and gill net may also catch tunas and tuna-like species in the Taiwanese coastal and offshore waters. The total catch of tunas and tuna-like species of these fisheries was estimated about 1,523 mt consisted of harpoon of 437

mt, set net of 630 mt and gill net of 456 mt in 2009. Among them, the catch of tunas and billfish is about 1,123 mt and skipjack is about 400 mt.

2. DATA COLLECTION

2.1 Tuna longline fishery

2.1.1 Large-scale tuna longline fleet

Two types of fisheries statistical data are routinely collected for LTLL fleet: the commercial data (for estimation of total catches), and the logbook data (for stock assessment purposes). Several sources of commercial information were available including traders, Taiwan Tuna Association, certified weight reports provided by the Organization for the Promotion of Responsible Tuna Fisheries (OPRT) and so on. After cross-checking and compilation, the commercial information was used to estimate total catches of the Category I data.

The logbook data includes each set of catch in number and weight by species, effort deployment, fishing location, as well as the length measurement of the first 30 fishes caught each day. Categories II and III data were all compiled based on this data set.

2.1.2 Small-scale tuna longline fleet

Two categories of STLL are defined: one is that station and unload their catches at domestic fishing ports (domestic-based STLL), and the other is that station and unload catches at foreign ports (foreign-based STLL). For domestic-based STLL, the landing records from local fishing markets provide the best information for estimating the ISC Category I data. For foreign-based STLL, there was not much information to estimate total catches, preliminary estimations were basically made from fishing vessels activities and import statistics of Japanese markets.

Since 1997, logbooks of STLL fleet have been collected, and port sampling at domestic fish markets has also been strengthened by collecting size data of major tuna species (mainly bigeye and yellowfin tunas). However, at the beginning, the recovery rate of logbook was about 2% - 5% which was too low to be compiled for Category II data, and insufficient for stock assessment. To improve the recovery rate of logbook, Fisheries Agency have launched a data improving program by dispatching its staffs to collect logbooks, to interview with fishermen so as to obtain fisheries information, and to conduct size sampling program at main domestic fishing ports of Tong-Kang, Suao and Sin-Kang since April 2007. Through the program, the recovery rate of logbook was improved to 23% in 2009.

For the purpose of conservation and management of pacific bluefin tuna resource and well collection of catch data, Fisheries Agency has imposed a Catch Documentation Scheme (CDS) since March 2010. According to the regulation, all vessels fishing for pacific bluefin tuna shall be authorized by Fisheries Agency every year and satellite based vessel monitoring system

(VMS) is required to be installed on board. Once pacific bluefin tuna was caught, fisher shall attach a tag issued by Fisheries Agency to each pacific bluefin tuna, record the number and individual weight of pacific bluefin tuna. The record shall be reported to Fisheries Agency on a daily basis. When the catch of pacific bluefin tuna is landing, Fisheries Agency would dispatch its staffs to fishing ports to measure individual weight and length. In addition, Catch Documentation shall be validated by local authorities before the first sale whether the catch is for domestic consumption or for export. Through the program, the data collection of individual weight and length of pacific bluefin tuna has reached 100% up to now in 2010.

2.2 Distant water purse seine fishery

The logbook recovery rate for distant water purse seine fishery has always been satisfactory, reaching 100% since the development of the fishery.

2.3 Observer program

For the purposes of better understanding the fishing activities of tuna fisheries, including target and non-target fish species and in line with the international requirements for conservation and management of marine resources, Fisheries Agency has launched a pilot observer program since 2001 in the Indian Ocean. Carry out the observer program in Pacific Ocean since 2002. During 2002-2004, 2 observers were dispatched to vessels operating in the Pacific Ocean in each year. The number of observer increased to 21 in 2007 and 2008, 32 trips and 28 trips respectively, for onboard observation on LTLL or DWPS vessels and collection of fishing information and biological data. In 2009, 20 observers were deployed on board.

For North Pacific Ocean, 8 trips were deployed in 2007, but decreased to 2 trips in both 2008 and 2009 for a large number of vessels ceasing operation due to high fuel price. The duty of observer on board is to collect catch and effort data, and biological data, such as otoliths and gonads sampling of albacore.

2.4 VMS monitoring

Vessel monitoring system (VMS) has been installed voluntarily on some longliners prior to 2005. Since 2005, all of Taiwanese large-scale tuna vessels were required to install VMS. In addition to monitoring fishing activities, those data were also used to verify logbook data for improving data quality.

3. RESEARCH

For the purpose of improving stock assessment of species in the North Pacific, government of Taiwan has commissioned scientists to conduct a series of researches as follows :

1. Age and growth study with its applications of albacore resources.
2. Research on the catch at size/age and CPUE standardization of North Pacific albacore.
3. Research on the age and growth and stock assessment of pacific bluefin tuna.
4. Studies on population dynamics and stock assessment for swordfish, sailfish, and blue marlin.
5. Studies on the age/growth, and reproductive biology of black marlin, and striped marlin.
6. Billfish tagging program

Table 1. Number of Taiwanese tuna fishing vessels operated in the Pacific Ocean

Year \ Fishery	Longline Fishery		Purse Seine Fishery
	LTLL	STLL	
2005	133	1,420	34
2006	104	1,490	34
2007	90	1,750	34
2008	84	1,260	34
2009	75	1,223	33

* LTLL: large scale tuna longline vessel, STLL: small scale tuna longline vessel

Table 2. Fishing effort and catch by species for Taiwanese LTLL operated in the North Pacific Ocean

Year	Hooks	ALB	PBF	BET	YFT	SWO	MLS	BUM	BLM	SFA	SKJ	TOTAL
1997	5,254,704	9,119	-	112	41	15	59	20	1	13	72	9,380
1998	9,752,453	8,617	-	156	39	20	90	21	5	34	444	8,982
1999	15,129,625	8,186	-	360	122	70	66	53	8	5	114	8,870
2000	24,950,519	7,898	-	1,450	584	325	153	75	19	49	195	10,553
2001	22,232,830	7,852	-	4,569	1,882	1,039	121	209	4	4	243	15,680
2002	32,474,088	7,055	-	7,257	2,689	1,633	251	138	5	1	16	19,029
2003	20,676,890	6,454	-	2,936	1,105	1,084	241	218	4	7	40	12,049
2004	34,997,887	4,061	-	4,939	1,230	884	261	372	2	11	191	11,760
2005	29,897,156	3,990	-	3,963	1,552	392	199	376	15	63	175	10,550
2006	22,532,898	3,848	1	2,756	1,035	438	204	363	5	11	8	8,661
2007	20,775,642	2,465	-	2,965	657	345	102	275	1	2	3	6,812
2008	17,083,119	2,490	0.16	2,840	484	338	78	255	1	20	129	6,506
*2009	22,653,428	1,866	0	2,302	303	373	37	225	0	8	175	5,114

* Species -- pacific bluefin tuna (PBF), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO), striped marlin (MLS), blue marlin (BUM), black marlin (BLM), sailfish (SFA)

* Data of 2009 is still preliminary

Table 3. Catch by species for Taiwanese STLL operated in the North Pacific Ocean

Year	ALB	PBF	BET	YFT	SWO	MLS	BUM	BLM	SFA	SKJ	TOTAL
1997	337	1,814	3,506	9,419	1,358	290	3,625	611	527	59	21,546
1998	193	1,910	3,520	8,955	1,178	205	3,603	469	868	32	20,933
1999	207	3,089	2,578	8,961	1,385	128	3,362	563	402	27	20,702
2000	802	2,780	2,041	7,848	1,531	161	4,056	453	499	31	20,202
2001	747	1,839	1,898	8,166	1,691	129	4,524	428	640	26	20,088
2002	910	1,523	2,150	9,145	1,557	226	4,310	173	504	67	20,565
2003	712	1,863	6,136	15,689	3,687	681	7,467	1110	2079	14	39,438
2004	927	1,714	4,067	12,617	3,364	261	6,300	1506	2081	32	32,869
2005	482	1,368	5,314	12,181	3,572	584	7,254	1144	1333	33	33,265
2006	469	1,148	6,204	13,116	3,944	537	5,366	961	488	24	32,257
2007	451	1,401	5,075	11,885	3,754	199	4,842	259	1059	17	28,942
2008	579	979	6,055	12,567	3,407	192	5,222	249	918	15	30,183
*2009	512	877	3,807	13,122	3,177	225	4,413	298	372	66	26,869

* Species -- pacific bluefin tuna (PBF), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO), striped marlin (MLS), blue marlin (BUM), black marlin (BLM), sailfish (SFA)

* Data of 2009 is still preliminary

Table 4. Fishing effort and catch for Taiwanese DWPS operated in the Pacific Ocean

Year	Effort	Species (metric ton)			
	Fishing days	SKJ	YFT	BET	Total
2005	4,823	165,289	27,572	2,178	195,039
2006	4,493	189,392	19,793	978	210,163
2007	4,873	209,002	21,147	2,386	232,535
2008	4,783	165,007	35,770	3,196	203,973
2009*	4,363	173,725	16,237	2,113	192,075

DWPS: distant water purse seiner

* Species -- skipjack tuna (SKJ), yellowfin tuna (YFT), bigeye tuna (BET)

* Data of 2009 is still preliminary

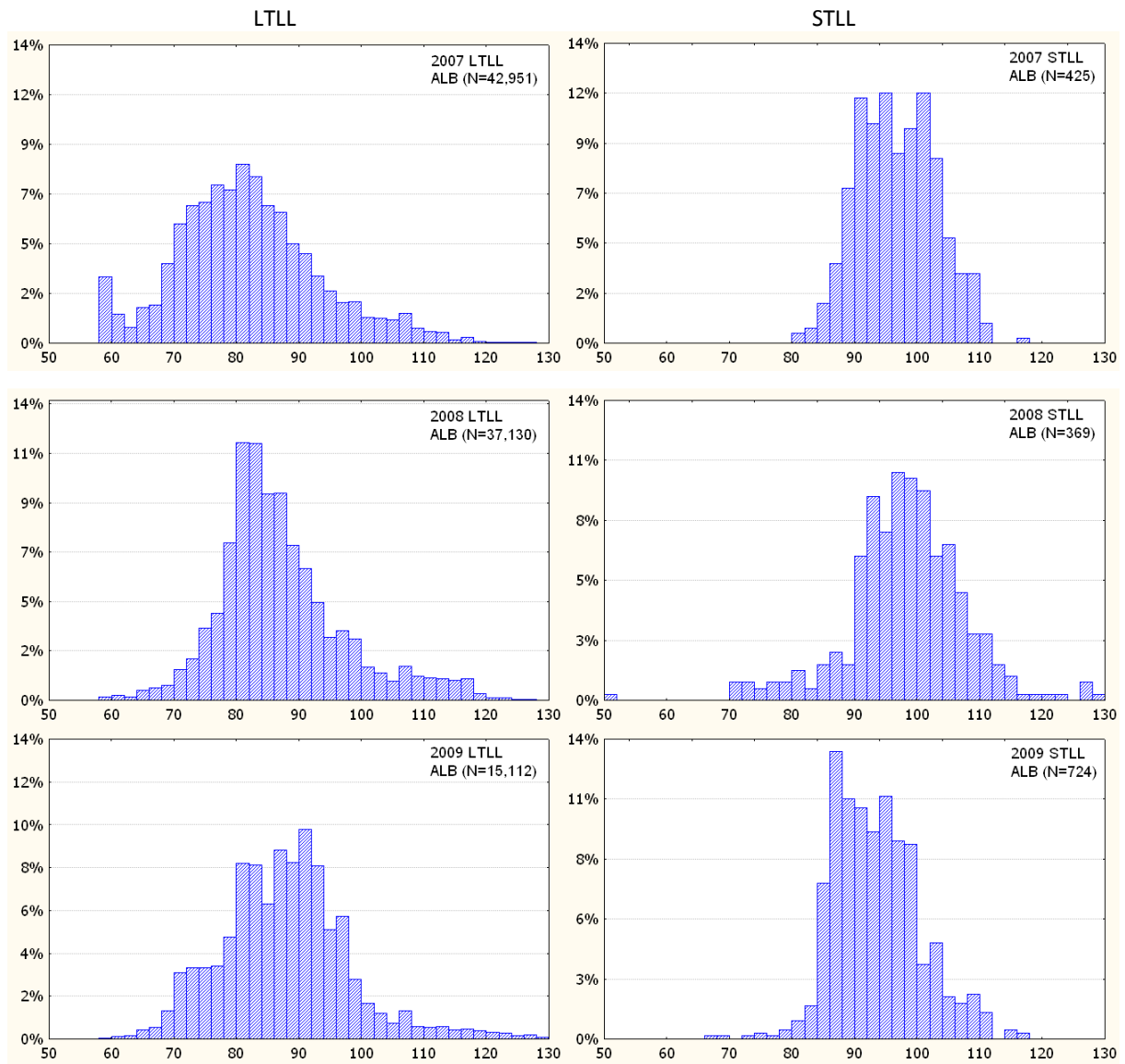


Figure 1. Length frequency distribution of albacore caught by Taiwanese LTLL and STLL vessels in the North Pacific Ocean during 2007-2009.

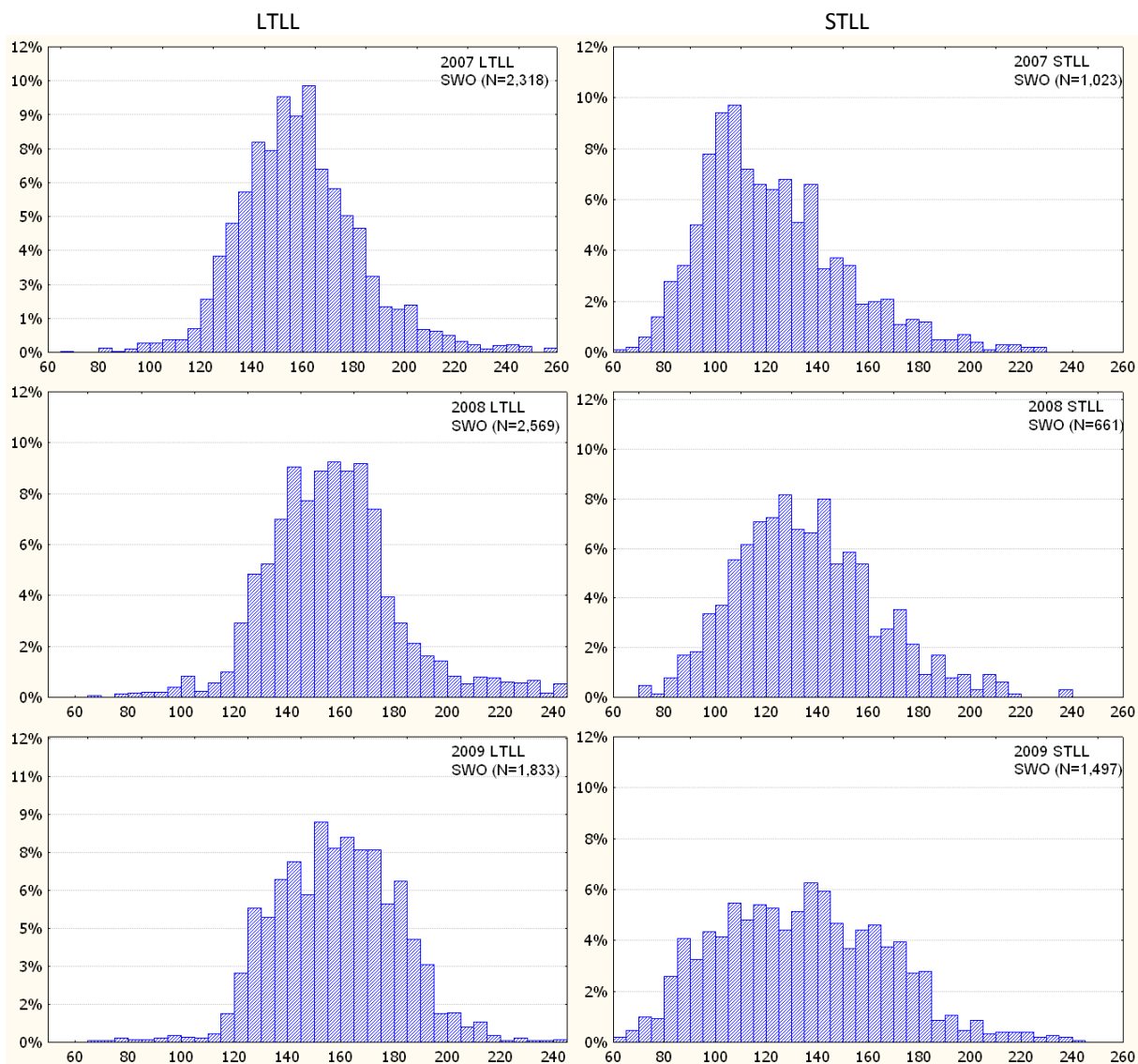


Figure 2. Length frequency distribution of swordfish caught by Taiwanese LTLL and STLL vessels in the North Pacific Ocean during 2007-2009.

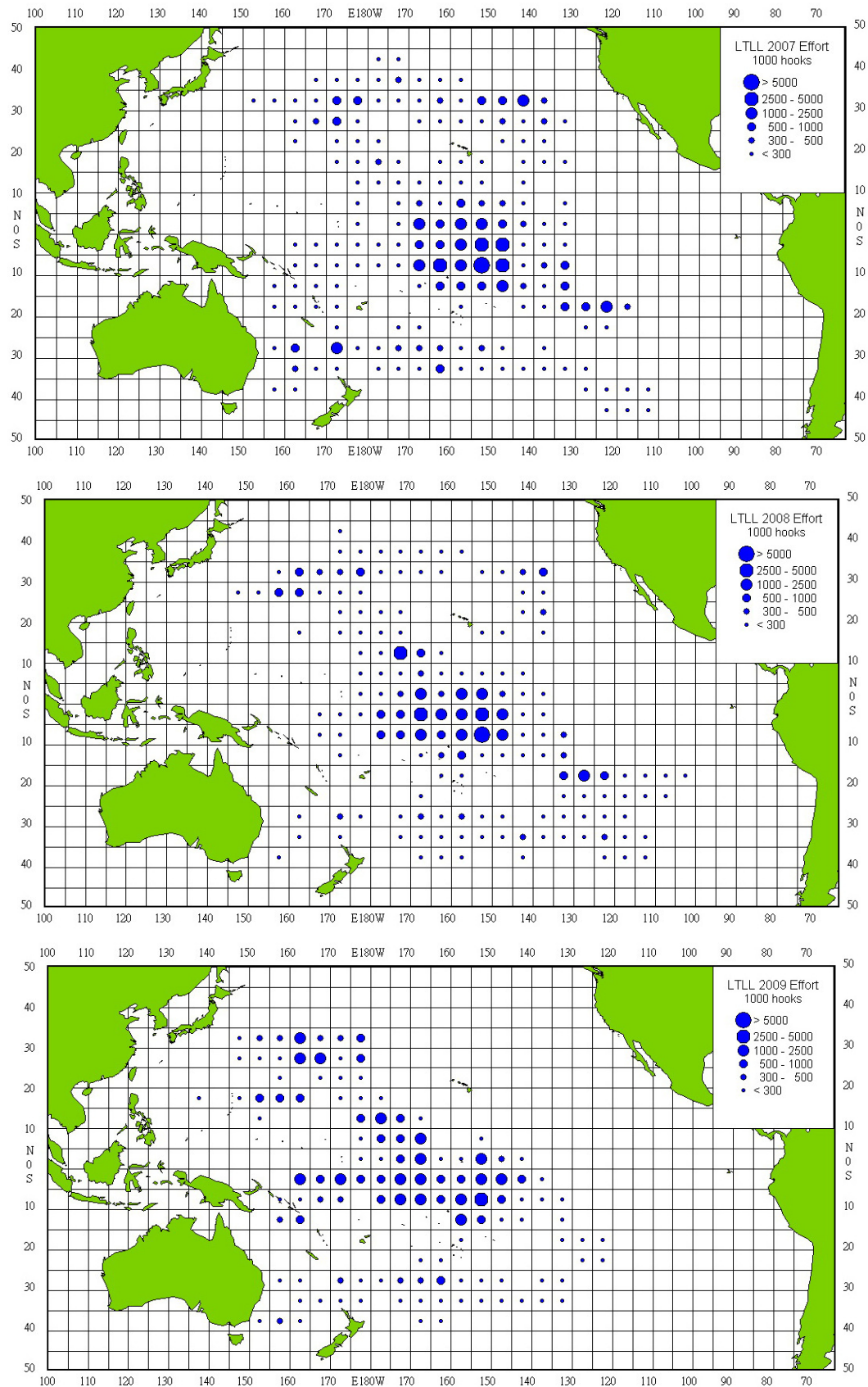


Figure 3. Distribution of fishing effort for Taiwanese LTLL vessels operated in the Pacific Ocean during 2007-2009 (Note: Map of 2008 and 2009 is still preliminary and will be revised shortly.)

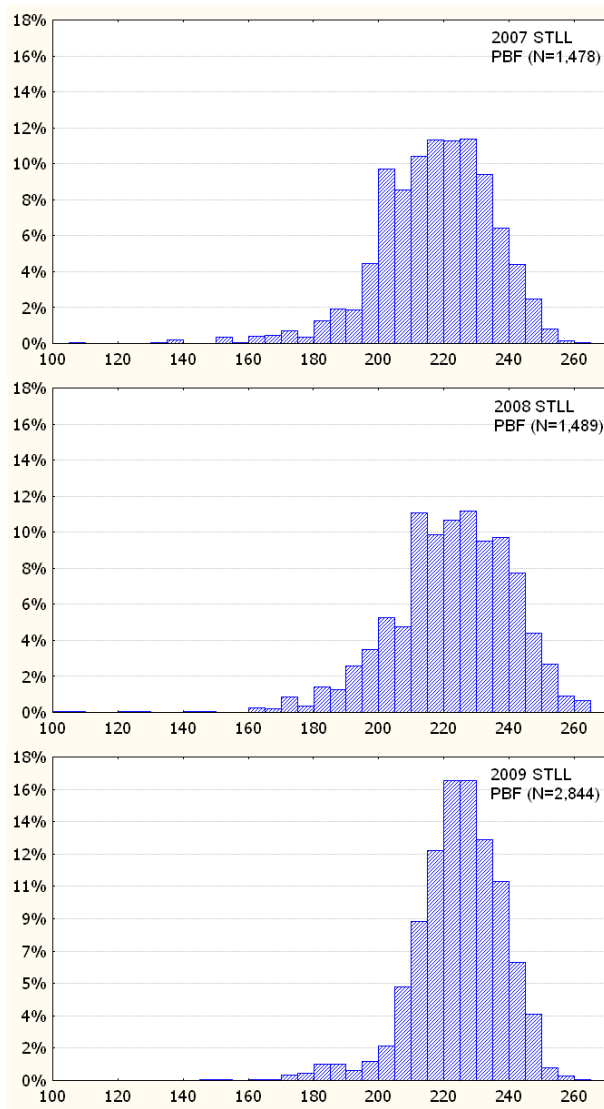


Figure 4. Length frequency distribution of Pacific bluefin tuna caught by Taiwanese STLL vessels in the North Pacific Ocean during 2007-2009.

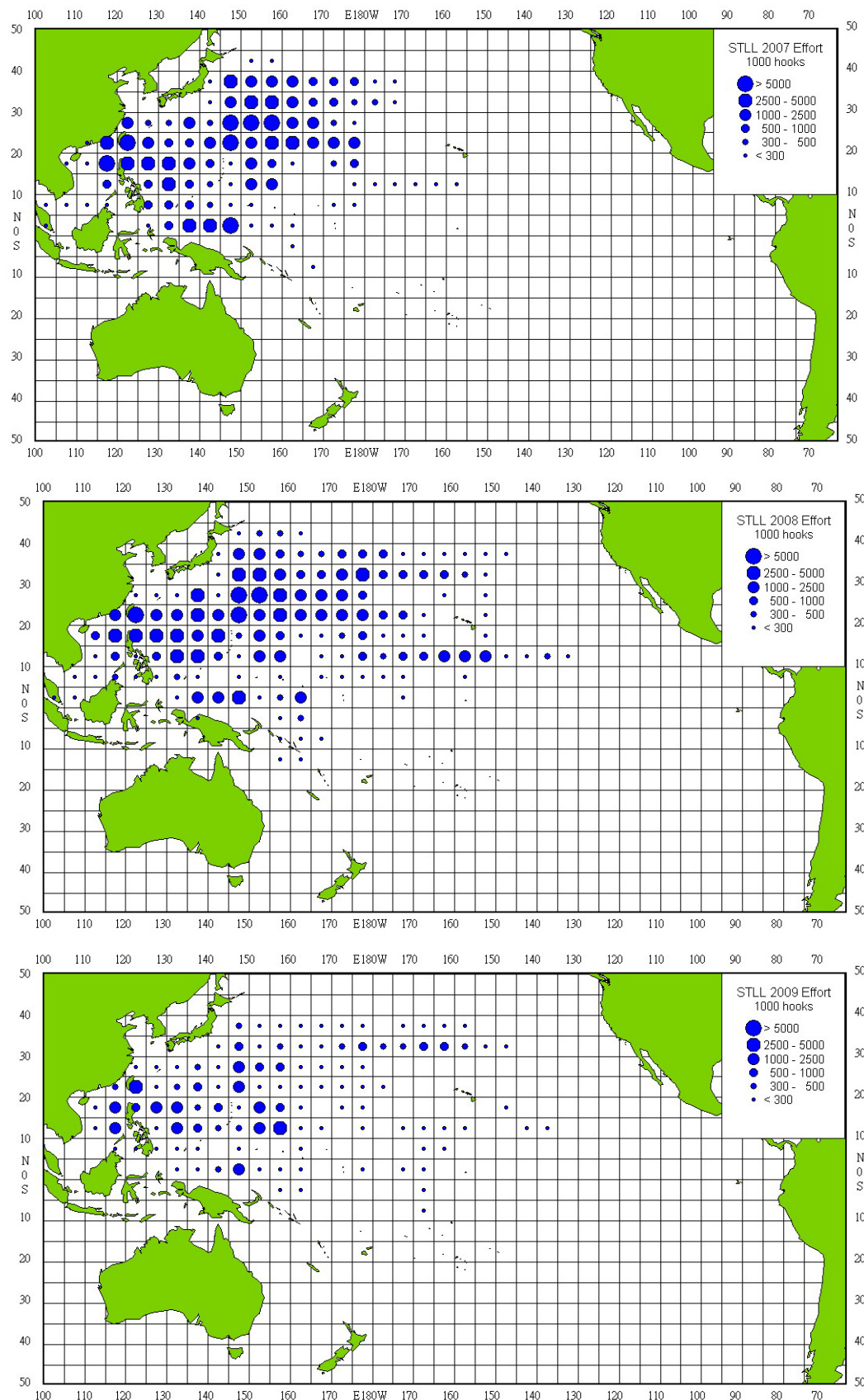


Figure 5. Distribution of fishing effort for Taiwanese STLL vessels based at domestic fishing ports during 2007-2009.
(Note: Map of 2008 and 2009 is still preliminary and will be revised shortly.)

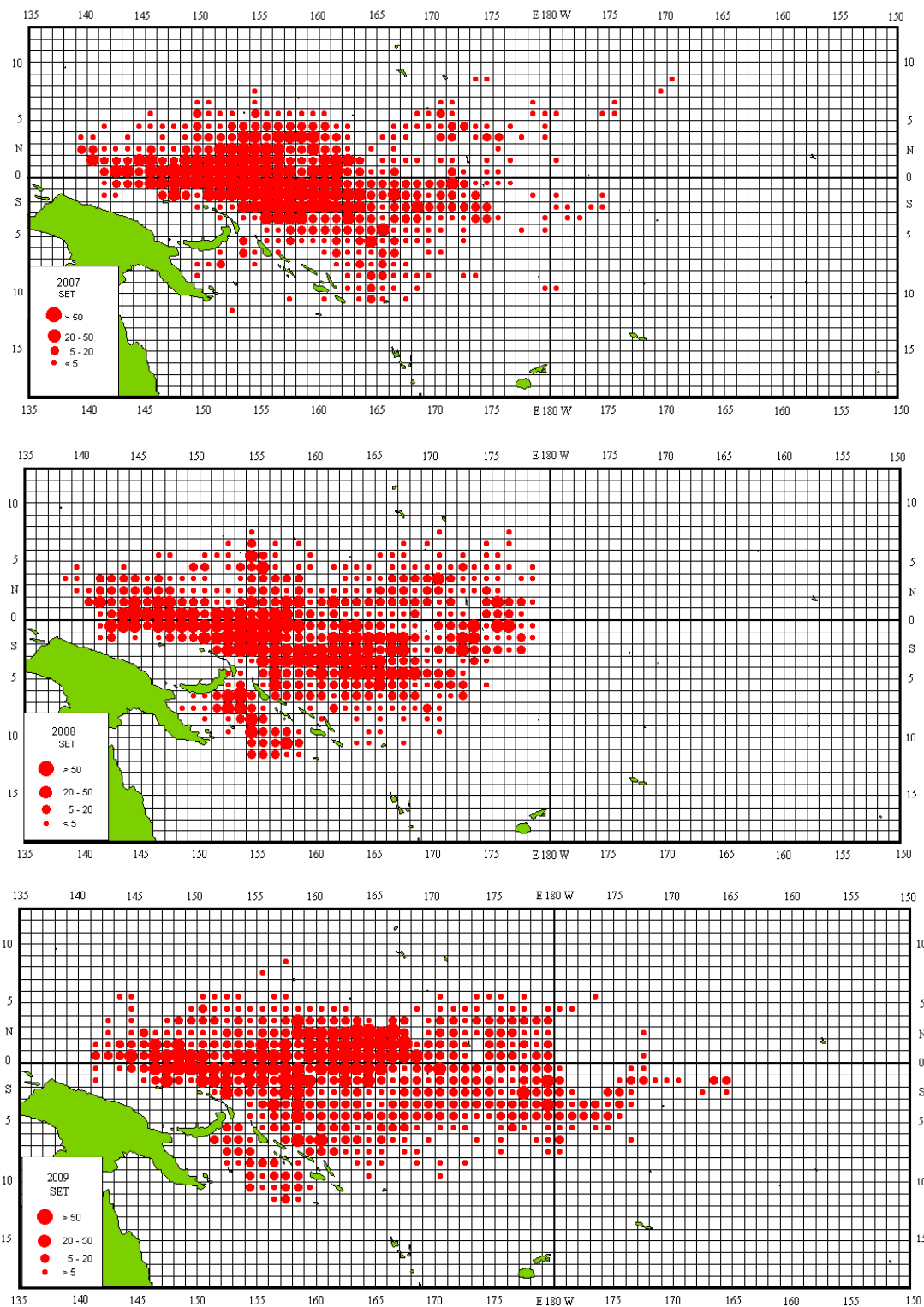


Figure 6. Distribution of fishing effort for Taiwanese distant water purse seine vessels operated in Pacific Ocean during 2007-2009