**Western and
Central Pacific
Fisheries
Commission**

**SCIENTIFIC COMMITTEE
NINTH REGULAR SESSION**

**Pohnpei, Federated States of Micronesia
6-14 August 2013**

**The fishing characteristics of Korean tuna purse seine fishery in the Western and Central
Pacific Ocean**

WCPFC-SC9-2012/SA-IP-12

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Abstract

Korean tuna purse seine fishery in the Western and Central Pacific Ocean (WCPO) commenced in 1980, its catch increased thereafter and had a level of over 2 hundred thousand mt in 1991, and then it showed a fluctuation with about 2 hundred thousand. In this study, the fishing characteristics of Korean tuna purse seine fishery in the Western and Central Pacific Ocean were investigated using the logbook data compiled from captain onboard and the statistical data from 1980 to 2012. We analyzed catch trend, species composition and operating rate by set type used in Korean tuna purse seine fishery in the WCPO during 1998-2012. The set type recorded in logbook was categorized as 'Unassociated school', 'Log-associated school' and 'FAD-associated school'. The fishing distribution of catch and effort combined by 5-year and 5°×5° block from 1980 to 2012. And the fishing distribution by set type in recent five years was analyzed as well. From a result, Korean tuna purse seine fishery has operated depending on mainly 'Unassociated school in the WCPO, and showed that the portion of FAD operating had somewhat of increasing in recent years. As this is a fundamental research on Korean tuna purse seine fishery operated in the WCPO, it is expected to be used as a basic data for establishing management plans of FADs for Korean tuna purse seine fishery.

Introduction

The Western and Central Pacific Ocean (WCPO) is one of the main fishing grounds of tropical tuna, and the total catch in the WCPO occupied over 55% of the global tuna catch.

And the total catch caught by purse seine fishery accounted for about 75% of the total tuna catch in WCPO.

However, it has been reported that since Fish Aggregating Devices (FAD) was introduced in the mid-1990s, the catch of yellowfin and bigeye has been increasing, and there are many juvenile included. Therefore, it is stressed that establishing management plans of FADs need to conserve those stock resources.

In this study, we analyzed the historical catch and effort trend and fishing characteristics of Korean tuna purse seine fishery. The fishing characteristics by set type were investigated using data classified into 'Unassociated school', 'Log-associated school' and 'FAD-associated school'. We also analyzed the fishing distribution of catch and effort and that of effort by set type. These results are expected to be used as a basic data for establishing management plans of FADs for Korean tuna purse seine fishery operated in the WCPO.

Data and methods

The data of annual total catches, catch and effort by operating position and set type used in this study comes from statistical data for Korean distant-water fisheries and logbook data compiled from captain onboard.

The historical trend of Korean tuna purse seine fishery in the WCPO was investigated using the statistical data from 1980 to 2012 and the fishing characteristics by set type were analyzed using logbook data from 1998 to 2012. The fishing distribution of catch and effort was investigated using raised data combined by five-year and 5°×5° block, and that of effort by set type using data combined by 5°×5° block for recent 5 years.

Results and Discussion

1. Historical trend of Korean tuna purse seine fishery

Korean tuna purse seine fishery commenced in 1980, the total catch had a sharp increasing after the mid-1980s, and recorded at 227,000 mt in 1991. Since then it had declined and fluctuated to 150,000 ~ 200,000 mt until the mid-2000s, and then it had shown an increasing trend and the catch in 2009 was 283,278 mt, the highest on record. In recent years except for 2011, it is showing a level of 250,000 mt (Fig. 1).

Since Korean tuna purse seine fishery commenced with 2 vessels in 1980, the number of active vessels had sharply increased and recorded at 39 vessels in 1990 which was the highest level. After then it declined gradually, and showed a stable trend within 26-29 vessels in the 2000s. The 28 vessels in 2012 operated in the WCPO. (Fig. 1)

As for the annual catch trend by species, the catch of skipjack which is a main species of purse seine fishery showed a similar trend with the annual total catch of Korean tuna purse seine fishery in the WCPO. The catch in 2009 recorded at 257,481 mt which was the highest level, and it is showing a level of 200,000 mt in recent years except for 2011 (Fig. 1). The catch of yellowfin had increased since the mid-1980s as well, and the recent five years showed the level of 46,500 mt in average. The catch of bigeye was below 1,000 mt which accounted for just below 1% of the total purse seine catch, but those of 2010 and 2011 recorded at over 2,000 mt (Fig. 1).

As for the proportion of catch by species, skipjack accounted for over 77% in average. It recorded at 61% which as the lowest level in 1993 and 91%, the highest level in 2009. Yellowfin recorded at 39% which was the highest level in 1993 and 11%, the lowest level in 1996. It is showing a stable with about 19% in average during recent three years. Bigeye accounted for only 0.4% which was very low proportion of the purse seine catch, but it used to record at 12% in 1981 (Fig. 2).

Nominal CPUE of Korean tuna purse seine fishery had sharply increased since commencing fishing, it recorded at the highest level in 1989, and then it decreased to 19 in 1993. After then it had has somewhat of increasing about 25 in average with fluctuations from the mid-1990s to the early 2000s, and it had increased up to 30 in the mid-2000s and then decreased again in 2011. In 2012, it recorded at 28, which showed somewhat of increasing than that of 2011 (Fig. 3).

2. Fishing characteristics by set type of Korean tuna purse seine fishery

In this study, set type of purse seine fishery was categorized as 'Unassociated school', 'Log-associated school' and 'FAD-associated school' to investigate the fishing characteristics of Korean tuna purse seine fishery. Set on 'unassociated school' of tuna had predominated using 1998-2003 which accounted for 68~83% of range and 76% in average during that period. But it recorded at 43% in 2004, the lowest level which is even lower than proportion of 'Log-

associated school'. In 2005, set on 'Unassociated school' increased again which was about 80% of set proportion. But it had accounted for about 60% since 2006 as set on FAD started to increase. Recently, it showed an increasing pattern in 2010 and 2012, which accounted for over 70%. Set on 'Log-associated school' recorded a high level of 46% in 2004, but it has had lower level of proportion and accounted for only below 5% in recent years. Even though set on 'FAD-associated school' was introduced in the mid-1990s, its proportion was not high which was about 7% in average at that period. But since 2006, it started to increase and recorded at 36% in 2009. And it showed 20% and 42% in 2010 and 2011, respectively. In 2010, it showed somewhat of decreasing accounting for 26% (Fig. 4).

As for the species composition by set types, in the 'Unassociated school', it showed a stable pattern without any significant change that skipjack accounts for 75.3% with yellowfin accounting for 24.5% and bigeye accounting for only 0.2% in average. In the 'Log-associated school', skipjack accounted for over 80%, which is higher level compared to that of the 'Unassociated school', and accounted for over 95% since the mid-2000s in particular. And bigeye also recorded at 0.6% in average which is slightly higher than that of 'Unassociated school'. In the 'FAD-associated school', the proportion of skipjack and bigeye were 91.2% and 0.63%, respectively, which are higher level than those in the 'Unassociated school'. And the proportion of both species showed an increasing pattern in this set type since the mid-2000s. But in case of yellowfin only showed a different trend that 'Unassociated school' had higher proportion compared to other set types (Fig. 5).

As for the proportion of set types by species, skipjack had shown the higher level of 70% in the set on 'Unassociated school' until the mid-2000s. But as the proportion of set on 'FAD-associated school' had somewhat of increasing, the catch by FAD operating is likely to increase in recent years. For yellowfin tuna, the proportion of set on 'Unassociated-school' was 86% in average which is higher level than other species. And it is shown that even the proportion of set on 'FAD-associated school' increases, the catch by this set type decreases. For bigeye tuna, it was shown that the proportion of this species sharply increased as set on 'FAD-associated school' increased after the mid-2000s (Fig. 6).

As indicated above, 'Unassociated school' is a main set type of Korean purse seine fishery operated in the WCPO, but the proportion of 'FAD-associated school' has increased since the mid-2000s. Even though the set on 'FAD-associated school' increased, the proportion of

yellowfin was very high level in the 'Unassociated school' unlike other species. The catch proportion of skipjack has been increased since the mid-2000s with increasing set on 'FAD-associated school'. Bigeye had the highest level of catch proportion in the 'FAD-associated school' compared to other species.

3. Fishing distribution of Korean tuna purse seine fishery

3.1. Fishing distribution of catch and effort by Korean tuna purse seine fishery

The main fishing ground of Korean tuna purse seine fishery in the early of 1980s was in the area of 0°-5°N, 135°-160°E. In particular, as the number of active vessels increased after the min-1980s, it had shown a trend shifting further southwards, 5°N-5°S. At the beginning of 1990s, area operated by Korean tuna purse seine fishery expanded to 5°N-10°S, 130°-180°E, but main fishing ground was still in the area of 5°N-5°S, 140°-160°E. The distribution extended further to east up to 155°W in 1997, and extended farthest to east up to spread out widest to 140°W in 2002. Since the mid-2000s, the main fishing ground has distributed in the area of 0°-10°S, 150°-170°E shifting further southwards (Fig. 7).

3.2. Fishing distribution of effort by set type of Korean tuna purse seine fishery

Distribution of effort by set type of Korean tuna purse seine fishery during the recent 5 years (2008-2012) is that it was not clear to distinguish main fishing ground in the 'Unassociated school', but it was likely to concentrated on the area of 160°-180°E in the 'FAD-associated school' (Fig. 8).
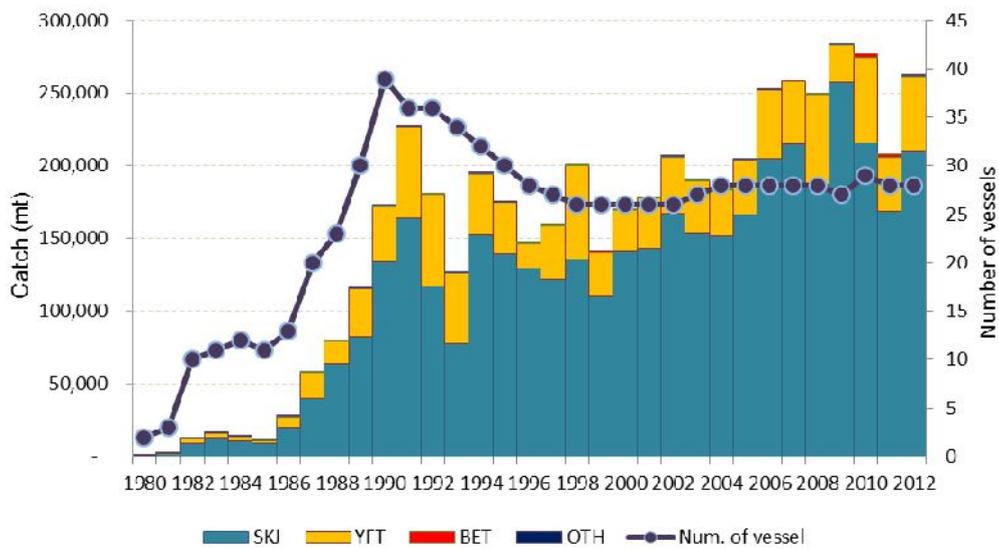
Fig. 1. Historical catch of each species and the number of active vessel in the WCPO operated by Korean tuna purse seine fishery.
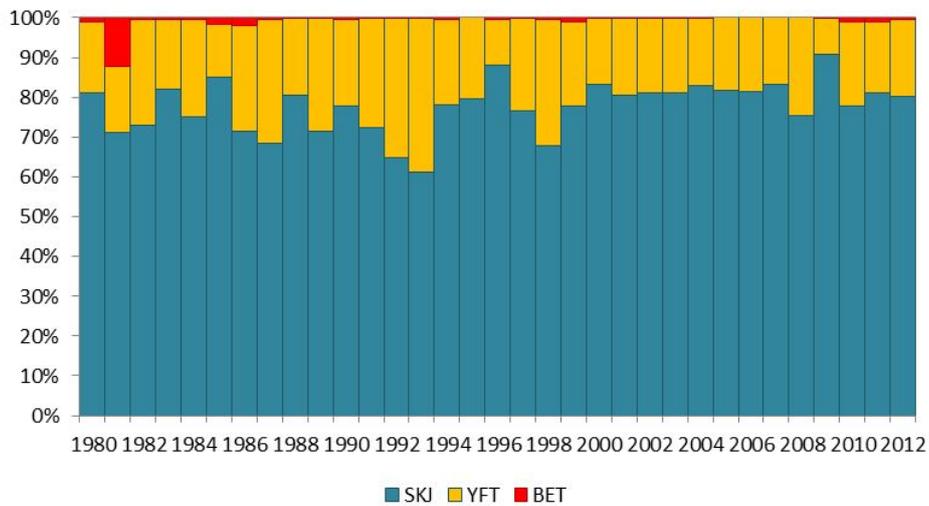

Fig. 2. Historical catch proportion by species of Korean tuna purse seine fishery.
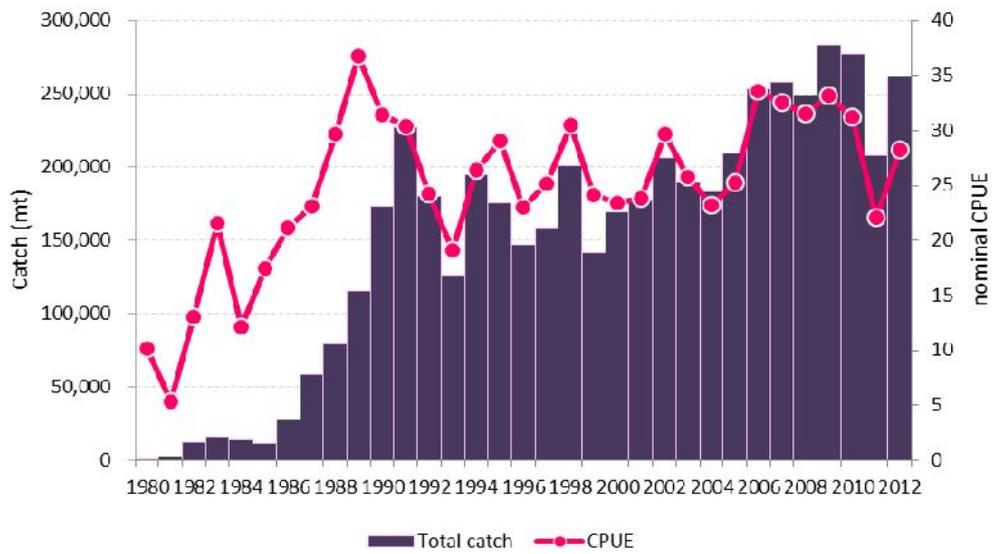
Fig. 3. Historical total catch and nominal CPUE of Korean tuna purse seine fishery.
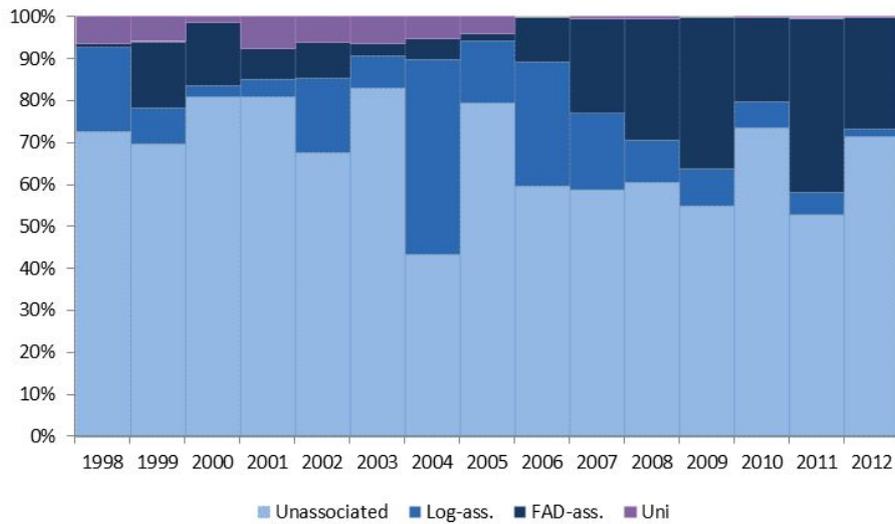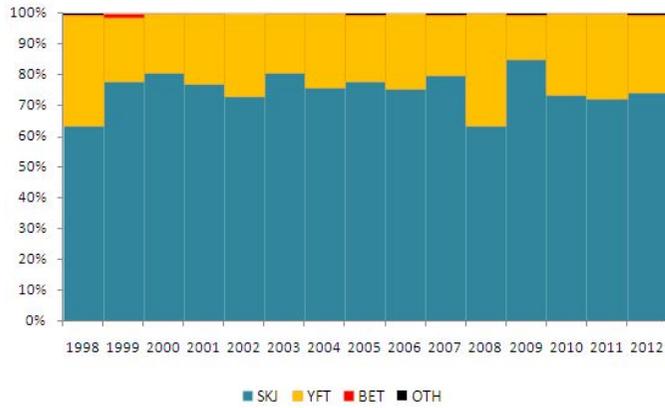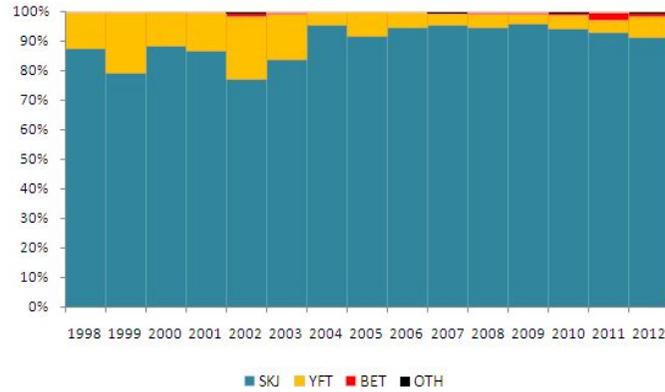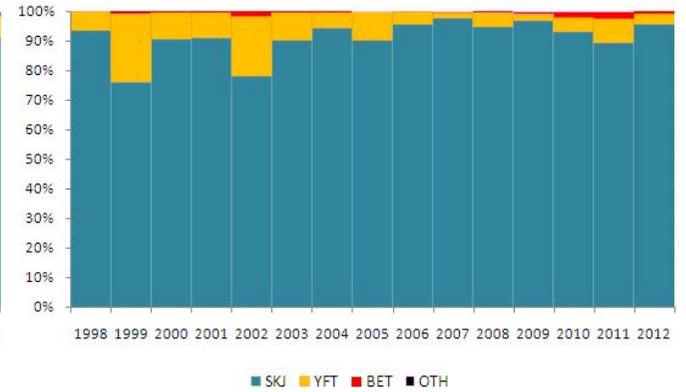

Fig. 4. The catch proportion by set type of Korean tuna purse seine fishery.
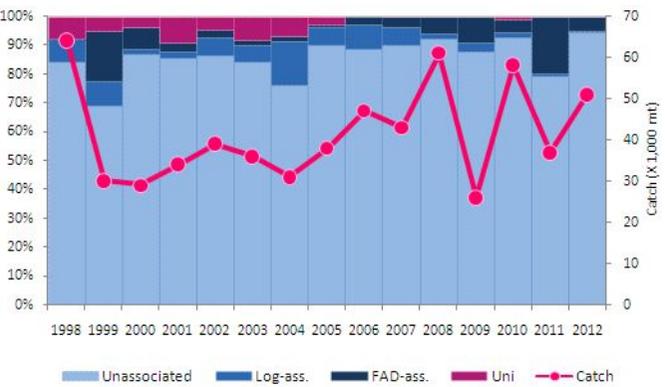
(a) Unassociated School   (b) Log-associated School   (c) FAD-associated School
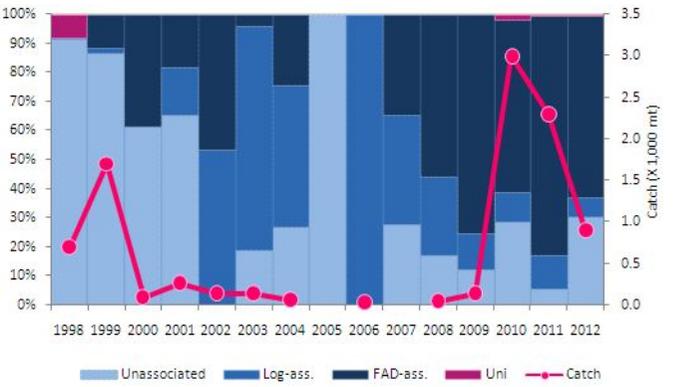
Fig. 5. The catch proportion of species by set type.

(a) Skipjack tuna   (b) Yellowfin tuna   (c) Bigeye tuna

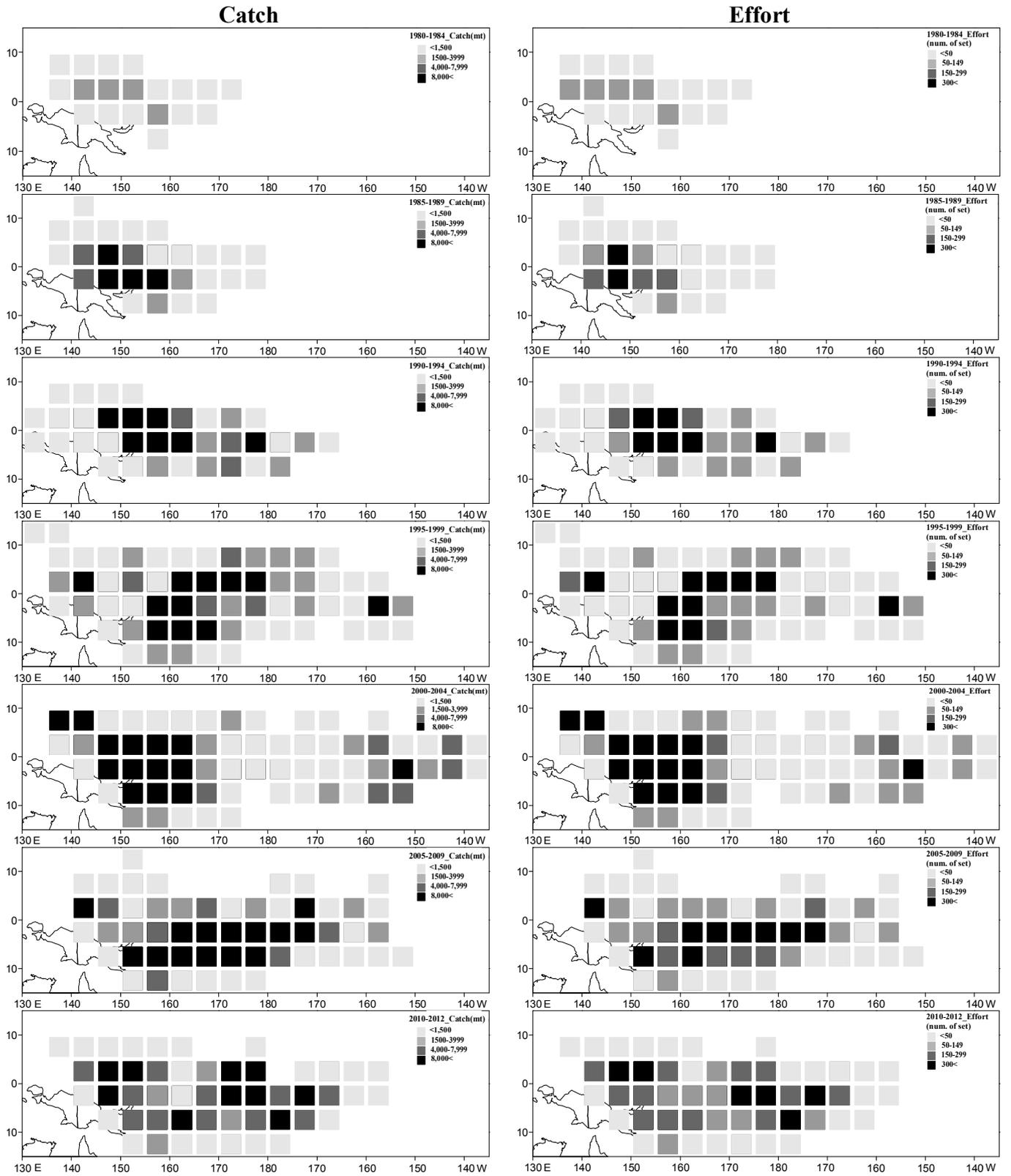Fig. 6. The catch proportion of set type and total catch by species.

Fig. 7. Fishing distribution of catch and effort of Korean tuna purse seine fishery.
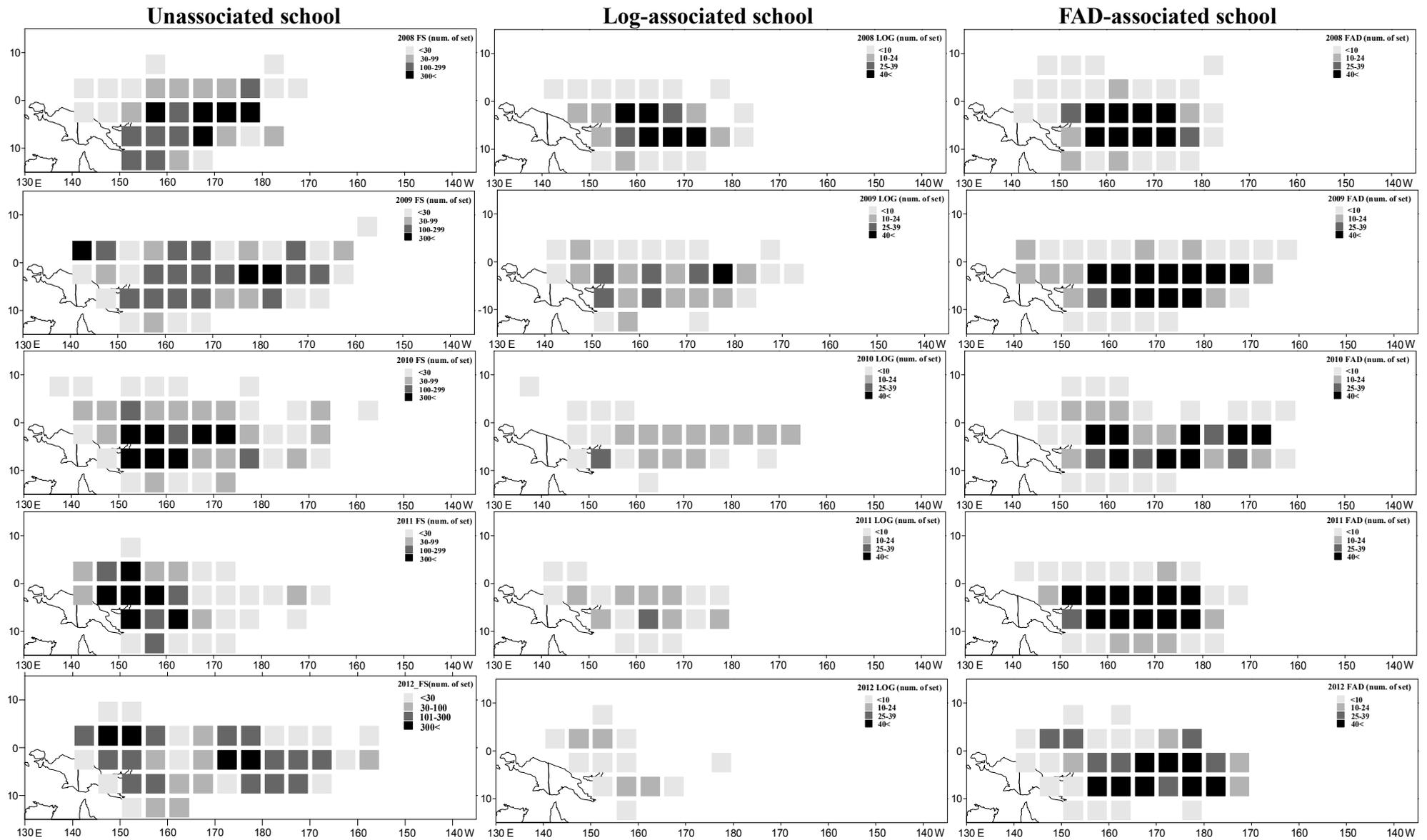
Fig. 8. Fishing distribution of effort by set type of Korean tuna purse seine fishery.