SCIENTIFIC COMMITTEE
FIFTH REGULAR SESSION

10-21 August 2009
Port Vila, Vanuatu

Effects of set type on catch of small-sized tuna by the Korean tuna purse seine fishery in the WCPO

WCPFC-SC5-2009/FT-WP-02

Doo-Hae An[1], You-Jung Kwon[1], Doo-Nam Kim[1], Dae-Yeon Moon[1] and Seon-Jae Hwang[1]

[1] National Fisheries Research and Development Institute (NFRDI), Busan, Korea

Effects of set type on catch of small-sized tuna by the Korean tuna purse seine fishery in the WCPO

Doo-Hae An, You-Jung Kwon, Doo-Nam Kim, Dae-Yeon Moon and Seon-Jae Hwang
National Fisheries Research and Development Institute (NFRDI)
Busan, Korea

Abstract

To investigate the effect of set type on the catch of small-sized tuna, onboard observers monitored fishing operation of two Korean tuna purse seiners in the WCPO. 28 experimental FADs with hanging net of various lengths were deployed for comparison of the effect of underwater structure on the catch of bigeye and yellowfin tuna during June to October in 2008. Of 208 observed sets, 180 sets were from unassociated schools of tuna and 28 sets from FAD-associated schools, accounting for 13.5% of the total sets. The FAD sets caused catch of small-sized bigeye and yellowfin tuna with fork length smaller than 60cm. There was no significant differences in catch (number) of bigeye (P=0.20) and yellowfin (P=0.10) tuna between associated and unassociated sets, but fork length of both tunas by associated and unassociated (P < 0.001) was significant. The difference of fork length of yellowfin tuna by each depth of FAD was not significant, but bigeye tuna was shown significant difference. Spatial variable, which was longitude, was the paramount factor about small-sized yellowfin tuna, and bigeye tuna was temporal variable, month. The depth of FAD was second factor for yellowfin tuna. Bigeye tuna was not significant to the depth of FAD.

Introduction

Since it is known that purse seine fishery targeting tunas associated with floating objects such as natural logs and fish aggregating devices (FAD) are responsible for the significant catch of small-sized tunas, WCPFC has endeavored to make necessary measures and urged CCMs to conduct research on how to mitigate catch of small tuna on FADs. To implement CMM 2006-01, Korea, as one of the major fishing nations in WCPO area, started this year to investigate the effects of set types of its purse seine fishery on the catch of small-sized bigeye and yellowfin tuna.

Methods

To investigate the effect of set types of purse seine fishery on the catch of small-sized bigeye and yellowfin tuna, NFRDI dispatched two observers onboard Korean purse seiners operating in WCPO (Fig. 1). The experimental survey was conducted 28 sets from FAD-associated school of 208 observed sets by the Korean tuna purse seine fishery during June-October in 2008. While the observers monitored usual fishing practices of respective vessel, 50 sets of experimental FADs with hanging net of different fork length of 40m, 60m and 90m were deployed for comparison of the effect of underwater structure on the catch of bigeye and yellowfin tuna.

The onboard observers recorded catch, effort, set type either natural log or FAD or unassociated, bycatch species, size of tuna, oceanographic condition, depth of purse seine net using TDR. As for the specification of floating objects, they recorded material, structure, depth of underwater structure of FAD, anchored or drifting. Deployed FADs were identified by its own number.
There are an experimental FAD with hanging net and rope strands and identification of FAD (Fig. 2).

The difference of fork length by the each depth of FAD on yellowfin, bigeye and skipjack tuna was statistically analyzed by T-test. The effect of the depth of FADs on catch of yellowfin and bigeye tuna were statistically analyzed using GLM in R (vers. 2.5). Catch (weight) of yellowfin and bigeye tuna was response variable and explanatory variables were latitude, longitude, month and depth of FAD. GLMs were fit in forward and backward selection and reductions in the Akaike Information Criterion (AIC) were used to determine the order of entry for the predictors.

Results and Discussion

During June-October 2008, a total of 208 sets were monitored, of which 180 sets were made on free-swimming schools of tuna and 28 sets were on tuna associated with FAD made of nets and ropes. There were no sets on natural logs. Among 180 unassociated sets, 72 sets were considered to be failed due to low catch of less than 1mt, while FAD sets were failed only one set. Catch of unassociated sets consisted of 2,525mt of skipjack accounting for about 47.7%, followed by yellowfin of 2,758mt (52.1%) and small quantity of bigeye tuna. Catch of yellowfin tuna was bigger than skipjack tuna. Catch composition of FAD sets was; 81.9% of skipjack, 16.1% of yellowfin and 1.7% of bigeye tuna (Table 1). There was no significant difference in the catch (weight) of bigeye tuna (P=0.10) and yellowfin tuna (P=0.2) between associated and unassociated sets.

FADs deployed by Korean purse seiners consist of two parts, a bundle of buoys at top and underwater structure made of nets and rope strands. The FADs observed during the period were designed and manufactured by fishing companies and were attached with net of various length, ranged 40-100m and the FADs with 41-80m nets were dominant comprising 79% (Table 2). Catch of tuna by the depth of FAD was presented in Table 2. Due to small sample size, it was hard for us to interpret the results statistically but it appeared that higher CPUE (mt/set) was resulted from both the shallower FADs, 40m or less, and deeper FADs, deeper than 80m. Bigeye catch was observed in all sets but the quantity was very minor, with only less than 1.0% of the total catch.

There was a little difference on bycatch species composition by each the depth of FAD (Table 3). Number of bycatch species in the range of 61-80 was 20, which was the biggest, and the other three depth of FADs were 12 or 13 bycatch species.

Fork length of yellowfin tuna caught from FAD sets ranged from 24cm to 134cm and 40-44cm classes was dominant and mean fork length was 50.1cm, while fork length from unassociated sets ranged 40-162cm with a mode at 136-138cm and mean fork length was 130.1cm (Fig. 3). Fork length of bigeye tuna caught from FAD sets ranged from 28cm to 168cm and 40-42cm classes was dominant and mean fork length was 44.3cm, while fork length from unassociated sets ranged 42-154cm with a mode at 80-82cm and mean fork length was 75.3cm (Fig. 4). Unlike bigeye tuna, yellowfin tuna of medium to large size were also caught from FAD sets. Bigeye and yellowfin tuna caught from unassociated sets were bigger than those from FAD sets. However, more samples for bigeye tuna caught from unassociated set are needed for accurate analysis, statistically. Fork length of skipjack tuna caught from FAD sets ranged from 28cm to 76cm and 62-64cm classes was dominant and mean fork length was 49.0cm, while fork length from unassociated sets ranged 40-80cm with a mode at 80-82cm and mean fork length was 63.0cm (Fig. 5). Fork length between both sets on three tunas, which were yellowfin, bigeye and skipjack tunas, was shown statistically significant difference (all of them; $P < 0.001$).

There was similar to mean fork length of yellowfin, bigeye and skipjack tuna by each depth of FAD, respectively (Figs. 6, 7. and 8). The difference of fork length by each depth of FAD on yellowfin tuna was not significant, but bigeye tuna was significant about all comparison between the depth of FADs. Most differences on skipjack tuna were significant.

Spatial variable, which was longitude, was the paramount factor about small-sized yellowfin tuna, and bigeye tuna was temporal variable, month. The depth of FAD was second factor for yellowfin tuna. Bigeye tuna was not significant to the depth of FAD.

Korean purse seiners usually search for free swimming schools of tuna for higher catch rate and so compared with other major distant-water fishing nations lower proportion of log-associated sets remained until recent years. However, the proportion of log and FAD sets increased from 5% in 2001 to 27% in 2006. According to fishermen (personnel communication), they recently began to deploy more FADs due to difficulty in spotting free swimming schools in the WCPO.

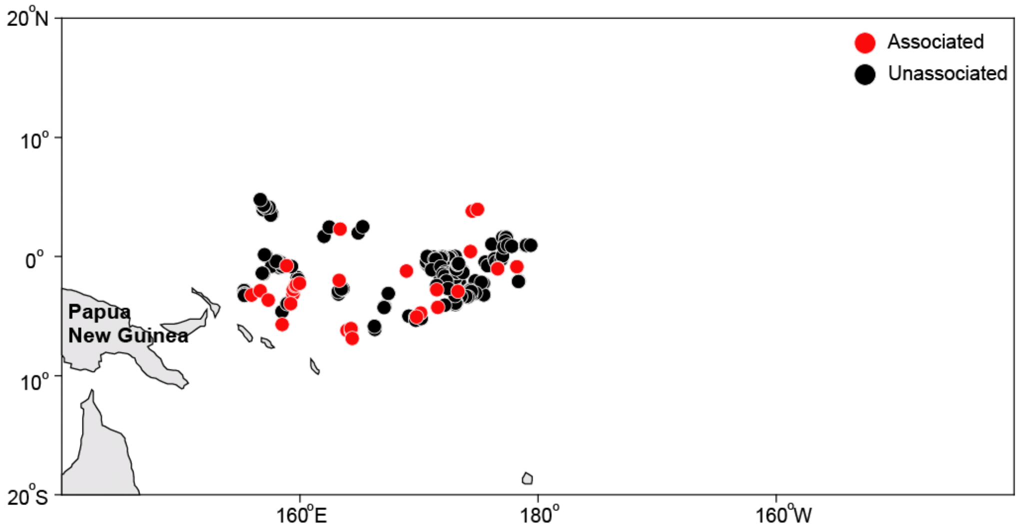

Fig. 1. Survey area, 04° 46' N ~ 06° 12' S, 155° 19' E ~ 179° 50' E.

Fig. 2. An experimental FAD with hanging net and rope strands (left), and identification of FAD (right).

Table 1. Summary of catch during survey period, June-October 2008

Set type	Catch by species (mt) / Ratio (%)			
	Skipjack tuna	Yellowfin tuna	Bigeye tuna	Bycatch
FAD (28)	994.8 (81.9)	195.8 (16.1)	20.7 (1.7)	3.5 (0.3)
Unassociated (180)	2,525.0 (47.7)	2,757.8 (52.1)	7.2 (0.1)	6.0 (0.1)
Total (208)	3,519.8 (54.1)	2,953.5 (45.4)	28.0 (0.4)	9.4 (0.1)

Table 2. Details of catch from FAD sets. Depth indicates the length of underwater structure of FAD

Depth of FAD	No. of set	Catch by species (mt) / CPUE (mt/no. of set)			
		Skipjack tuna	Yellowfin tuna	Bigeye tuna	Bycatch
~ 40	4	235.0 (58.8)	58.3 (14.6)	2.1 (0.5)	0.5 (0.1)
41~60	5	210.0 (42.0)	20.2 (4.0)	0.7 (0.1)	0.6 (0.1)
61~80	13	324.0 (24.9)	110.7 (8.5)	12.7 (1.0)	1.9 (0.1)
80 ~ 100	6	225.8 (37.6)	6.6 (1.1)	5.2 (0.9)	0.4 (0.1)

Table 3. Bycatch species composition of each the depth of FAD

unit: kg

Species	Depth of FADs				
	~ 40	41 ~ 60	61 ~ 80	81 ~ 100	Total
Rainbow runner	96.4	49.5	192.3	96.0	434.2
Common dolphinfish	58.0	135.6	116.2	104.6	414.4
Silky shark	22.2	43.4	262.1	12.3	340.0
Whale shark	-	250.0	-	-	250.0
Wahoo	13.8	56.9	37.7	39.9	148.3
Great baraccuda	32.8	2.5	76.1	4.0	115.4
Indo pacific marlin	-	45.0	50.0	-	95.0
Ocean trigger fish	14.8	29.1	36.8	13.5	94.2
Pelagic thresher shark	-	-	70.0	-	70.0
Flat niddlefish	0.1	-	5.9	12.7	18.7
Bullet tuna	4.3	1.6	3.6	1.6	11.1
Blue mackerel	0.4	3.1	7.1	0.1	10.7
Mackerel scad	-	0.4	6.3	-	6.7
Sawtooth barracuda	-	5.8	-	-	5.8
Silver trevally	2.2	-	1.2	-	3.4
Teira batfish	3.4	-	-	-	3.4
Olive ridley sea turtle	-	-	2.8	-	2.8
Unicorn leatherjacket	-	0.4	1.0	0.5	1.9
Monacanthidae	-	-	0.7	-	0.7
Centrolophidae	-	-	0.6	-	0.6
Carangidae	-	-	0.5	-	0.5
Blue seachub	-	-	0.4	-	0.4
Brownstriped mackerel scad	0.1	-	-	-	0.1
Lesser spotted leatherjacket	-	-	-	0.1	0.1
Pelagic stingray	0.1	-	-	-	0.1
Pomfret	-	-	0.1	-	0.1
Roughear scad	-	-	-	0.1	0.1

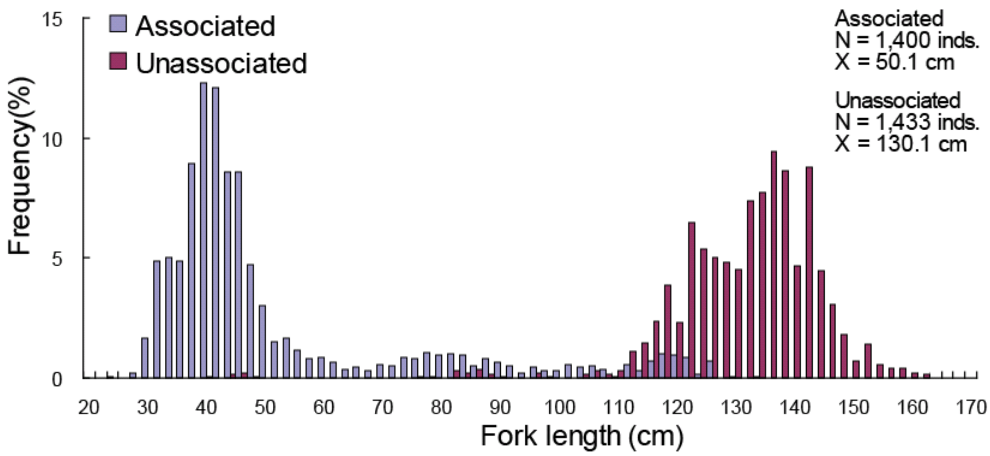

Fig. 3. Fork length frequency of yellowfin tuna caught from associated and unassociated sets.

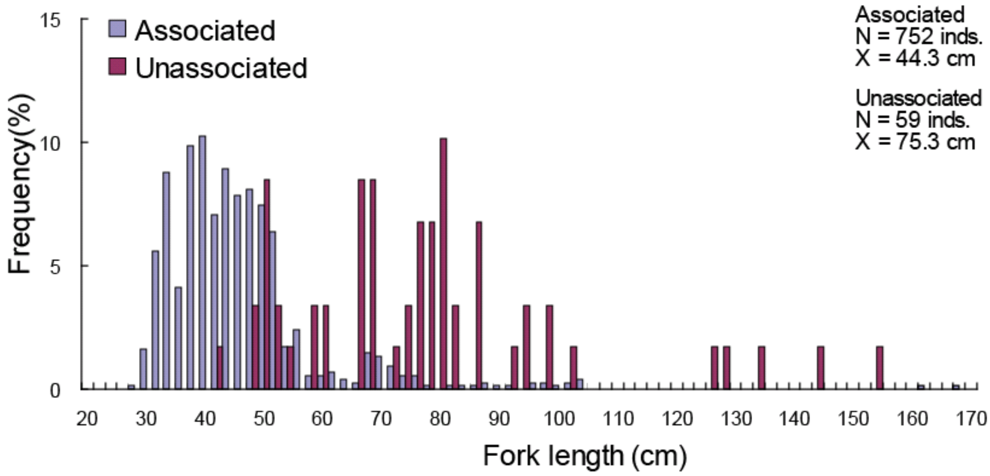

Fig. 4. Fork length frequency of bigeye tuna caught from associated and unassociated sets.

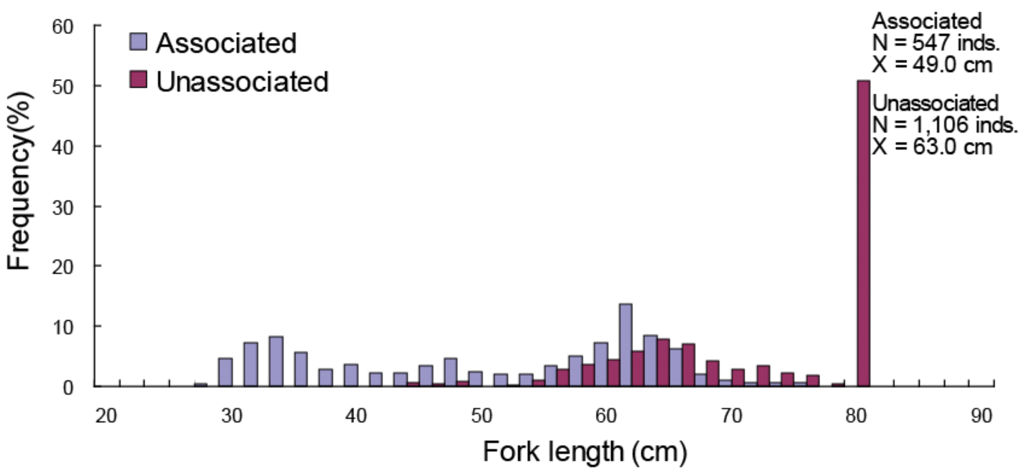

Fig. 5. Fork length frequency of skipjack tuna caught from associated and unassociated sets.

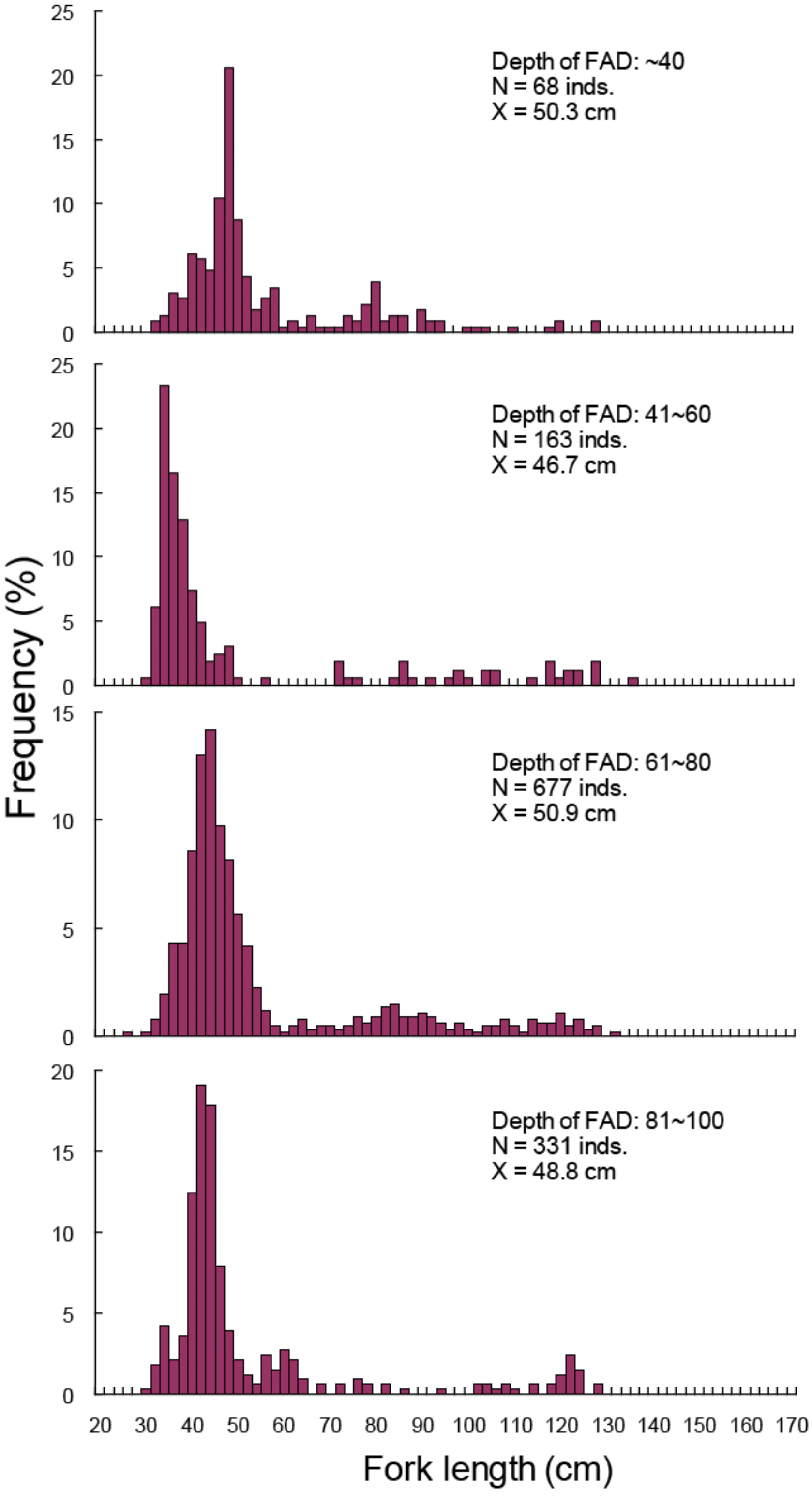

Fig. 6. Fork length frequency of yellowfin tuna caught by each depth of FAD.

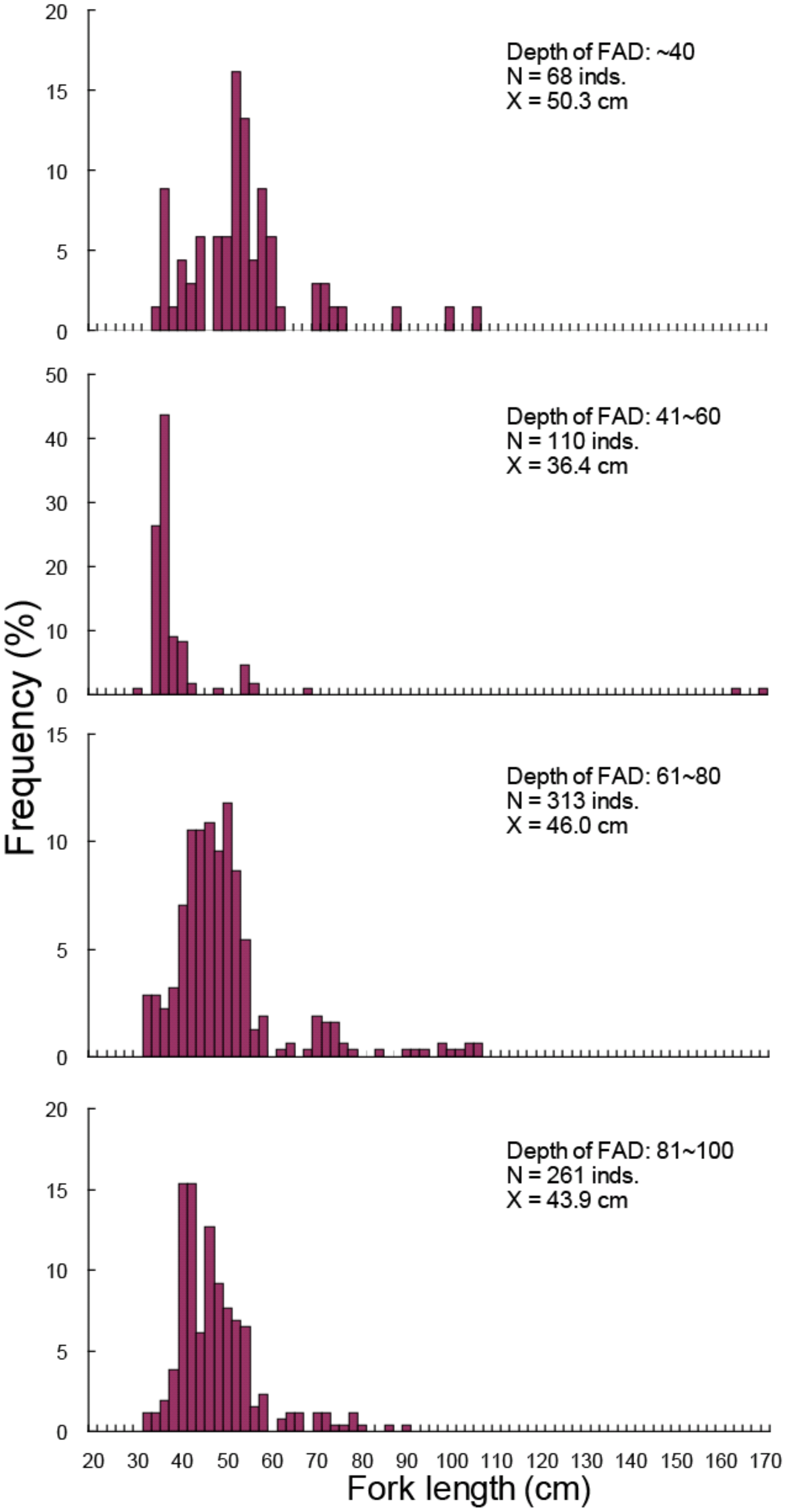

Fig. 7. Fork length frequency of bigeye tuna caught by each depth of FAD.

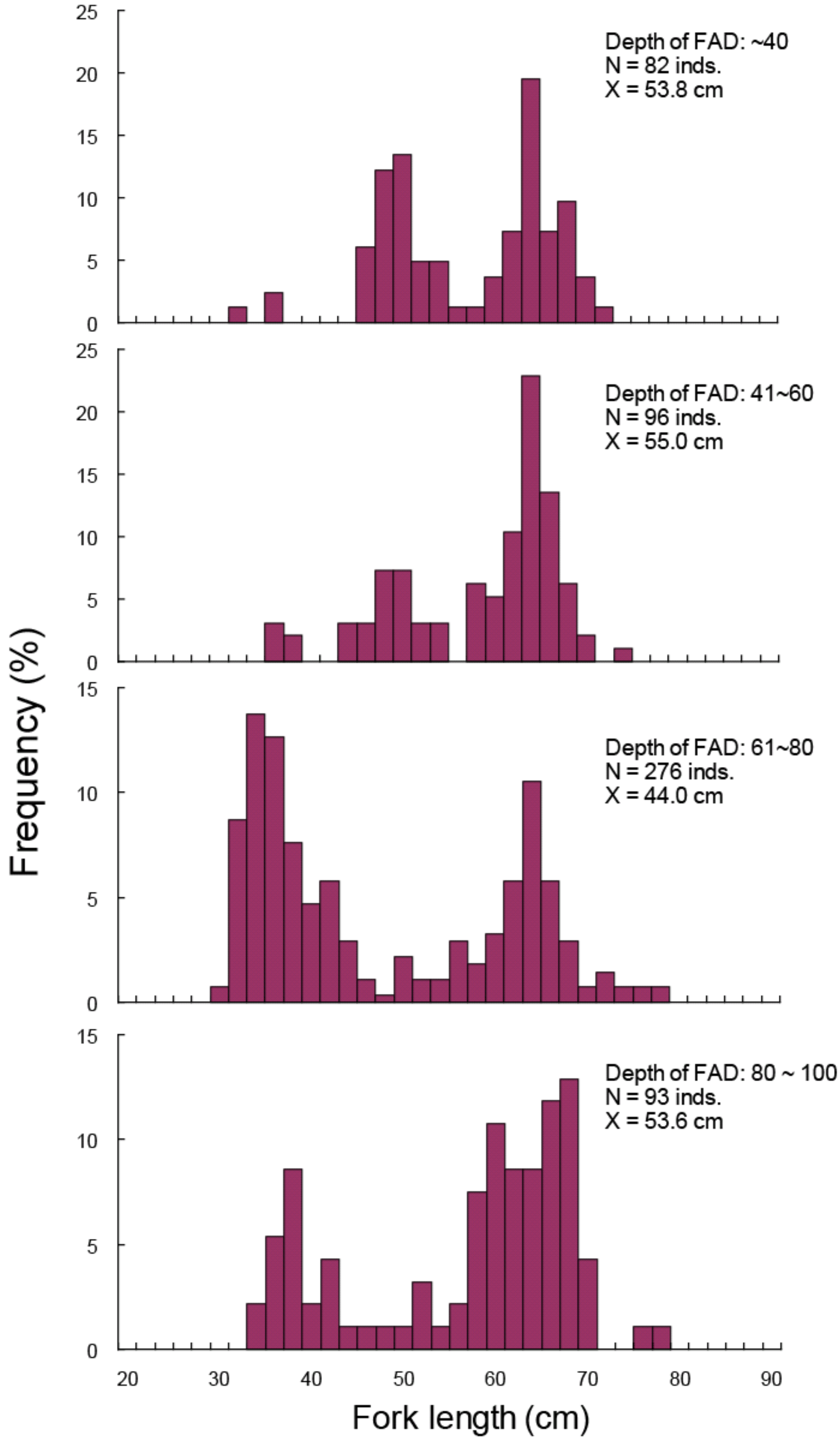

Fig. 8. Fork length frequency of skipjack tuna caught by each depth of FAD.

Table 3. Model comparison of a generalized linear model fit to yellowfin tuna catch as a function of latitude, longitude, month and depth of FAD. Bold indicates the best fitting GLMs

Models	AIC	△Residual deviance	d.f	Pseudo-R^2
Lat	114.5	1.3	26	0.015
poly(Lat, 2)	114.7	2.1	25	0.025
Long	107.2	8.6	26	0.100
poly(Long, 2)	98.4	18.4	25	0.214
Month	106.5	12.3	23	0.144
Depth of FAD	107.0	10.8	24	0.126
poly(Long, 2)+ poly(Lat, 2)	91.1	27.7	23	0.323
poly(Long, 2)+Month	90.8	30.1	21	0.350
poly(Long, 2)+Depth of FAD	91.5	28.3	22	0.330
poly(Long, 2)+Month+ poly(Lat, 2)	86.7	36.1	19	0.420
poly(Long, 2)+Month+Depth of FAD	82.1	41.7	18	0.486
poly(Long, 2)+Month+Depth of FAD+ poly(Lat, 2)	**78.0**	**47.8**	**16**	**0.557**

Table 4. Model comparison of a generalized linear model fit to bigeye tuna catch as a function of latitude, longitude, month and depth of FAD. Bold indicates the best fitting GLMs

Models	AIC	∆Residual deviance	d.f	Pseudo-R^2
Lat	64.5	13.8	26	0.285
poly(Lat, 2)	61.2	18.0	25	0.374
Long	73.8	4.5	26	0.092
poly(Long,2)	72.2	7.0	25	0.145
Month	51.5	29.7	23	0.616
Depth of FAD	76.2	4.0	24	0.084
Month+poly(Lat,2)	47.3	35.9	21	0.744
Month+poly(Long,2)	46.7	36.5	21	0.758
Month+Depth of FAD	54.1	30.1	20	0.624
Month+poly(Long,2)+poly(Lat,2)	**46.3**	**39.0**	**19**	**0.808**
Month+poly(Long,2)+Depth of FAD	49.1	37.1	18	0.770
Month+poly(Long,2)+poly(Lat,2)+Depth of FAD	47.7	40.5	16	0.840