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Notes on YFT/BET Ratio and Size Distributions in the Maldivian Pole-and-line Fishery

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Abstract

The main target species of livebait pole-and-line tuna fishery of the Maldives is surface-schooling skipjack. Small proportion of juvenile yellowfin tuna is also caught with the skipjack. Presence of juvenile bigeye tuna in the yellowfin component was first noticed in 1986. Review of data up to 1990 showed that proportion of bigeye in the *Thunnus* component was higher in the south than in the north. A small-scale tuna tagging experiment during mid-1990s allowed reasonable amount of sampling to provide estimates of bigeye in pole-and-line yellowfin component to be 15% in the south (1° 55'N – 0° 25'S) and 1.3% in the north (7°00'N- 4°50'N). Here we attempt to revise the information on bigeye composition and their size distribution from Maldives' pole-and-line tag release data of the IOTC Regional Tuna Tagging Project. Estimates from releases in the north indicate bigeye composition in *Thunnus* catch was 4% (p = 0.039518) where as in the south it was estimated at 22% (p= 0.2184) Overall composition of the bigeye tuna in the pole-and-line yellowfin component was estimated at 9% (p=0.091376). Size distribution of the bigeye tuna was not significantly different at the cruise level data but sizes of bigeye tuna were found to be slightly larger (43 cm vs. 41 cm) and were significantly different in the overall dataset.

Introduction

The Maldives pole-and-line fishery targets surface swimming tunas. The two main species caught in the fishery are skipjack *(Katsuwonus pelamis*) and juvenile yellowfin tuna (*Thunnus albacares*). A small fraction of juvenile bigeye (*T. obesus*) tuna is also caught among the yellowfin which are not recorded separately in the national statistics. Juvenile bigeye tuna are difficult to identify and is common to misidentify them as yellowfin tuna. As a result records of Maldivian pole-and-line yellowfin catches reported to IOTC requires to be corrected to obtain estimate yellowfin and bigeye in the pole-and-line catch.

Bias may also arise in the yellowfin size data reported from the pole-and-line gear. Although additional emphasis on correctly identifying bigeye among yellowfin has been given in the recent years (MRC 2012), records on size distribution of yellowfin were not available in the past making it difficult to objectively estimate size composition.

Presence of the bigeye tuna in the domestic catches of pole-and-line was first noted by Anderson (1986), followed by Hafiz and Anderson (1988) and Yesaki and Waheed (1991). Following review of the information available up to 1991 Anderson and Hafiz (1991) concluded the presence of bigeye in the yellowfin component was higher in the south than in the north. Based on all the sampling data from earlier work covering 1985 through 1995 Anderson (1986) concluded that composition of bigeye tuna was 15% in the south (1° 55'N – 0° 25'S) and 1.3% in the north (7° 00'N- 4°50'N). From their aggregated sample of *Thunnus* (n= 14,672, size range; 23-147 cm FL) composition of bigeye (n=680) was estimated at 4.6%.

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This proportion has been used by the IOTC to estimate of the composition of bigeye in the yellowfin catch reports of Maldives.

The Indian Ocean Regional Tuna Tagging Programme (RTTP) provided data to revisit the estimates made by Anderson (1986) but also to allow estimating size composition of bigeye along with yellowfin tuna. Most of the tagging was done within close vicinity of anchored fish aggregating devices (aFAD) network and so the data also allowed estimating proportion of bigeye in schools (or catches) close to aFADs and comparing those proportions from schools (or catches) further away from aFADs. The aim of this paper is to present this new information and provide revised estimates of composition and size distribution of bigeye tuna that reflect the current status in the fishery.

Data and Methods

Data used in this work for estimating bigeye composition and size distribution was tag release data in the IOTC-supported tagging cruises of Regional Tuna Tagging Project (RTTP). Tag released occurred during 2004, 2007 and later during 2008-2009. Tags were released from regular pole-and-line vessels by trained MRC officials and later jointly by the MRC and IOTC officials. Initially tagging was done on regular fishing trips on opportunistic basis. During the latter half of 2008 and 2009 all tagging was undertaken from charted pole-and-lined vessels.

The following assumptions were made in the analysis of data:

1. Tagging cruises were no different in any way (targeting and use of gear) than normal livebait pole-and-line fishing trips.
2. Presence of tagging teams on fishing vessels did not unduly change the fishing operations in any way or manner.
3. Selection of fish by the tagging team was random without bias and so observed proportions in the release data reflect the composition in the catch.
4. Tagging teams correctly identified all releases and release positions were accurately recorded.

Since tagging exercise does not unduly induce bias in the fishing practice or pattern of operation it was assumed the catches of skipjack and *Thunnus* represent the composition in normal fishing events reported to the Ministry. Figure 1 shows the released data by species and the locations of anchored fish aggregating devices at the time of tagging.

Results and Discussions

A total of 24 cruises were made releasing 5,844 *Thunnus* of which 534 were identified and released as bigeye tuna (Table 1). This makes the proportion of the bigeye tuna 9.1% (p=0.091376) overall. Assuming northern region from Thaa Atoll and north, and south from Laamu atoll and south, composition of bigeye in the north is estimated at 4.0% (p= 0.039518) and in the south is 21.8% (p= 0.2184)[2].

A recommendation from the IOTC to the Maldives is to separate catches from anchored fish fish aggregating devices (aFADs) and from free schools away from the aFADs. The rationale

[2] Test for sample proportions. Used R Function prop.test (x, n, p), where x is the total number of *Thunnus* and n is the no of bigeye in the sample and p is the observe proportion.

for this proposition was the observation of the tendency of juvenile yellowfin, in particular bigeye to occur around drifting FAD fishery by the purse seines (ITOC, 2012). Maldives has a network of aFADs, currently around 50 that area maintained by re-deploying at the same position. The position of the aFADs in existence at the time of tagging was accurately known (Figure 1).

Table 1: Summary of releases of Thunnus and number of bigeye tuna and their proportions.

Cruise	Time period	Region	Main Area of Release	Monsoon Season	Thunnus	no. BET	prop BET
401	May-04	North	SW of Ari Atoll	Interchange	13	0	0.00
402	Aug-04	North	NW of Ha Atoll	South West	72	0	0.00
403	Aug-04	North	NW of Ha Atoll	South West	165	0	0.00
404	Aug-04	North	NW of Ha Atoll	South West	236	0	0.00
405	Aug-04	North	NW and Wof HDh Atoll	South West	259	0	0.00
406	Aug-04	North	NW of Ha Atoll	South West	34		0.00
407	Aug-04	North	NW of HDh Atoll	South West	268	0	0.00
408	Aug-04	North	NW of HDh Atoll [?]	South West	144	0	0.00
409	Aug-04	North	NW of Ha Atoll	South West	5	0	0.00
410	Aug-04	North	NW of Ha. Atoll	South West	16	0	0.00
411	Aug-04	North	NW of Ha Atoll	South West	25	0	0.00
412	Aug-04	North	E of North Malé Atoll	South West	20	0	0.00
701	Aug-07	North	E of North Malé Atoll	South West	21	0	0.00
702	Oct-07	North	W of Sh. Atoll	South West	63	0	0.00
801	Jan-08	North	East of Sh. Atoll	North East	474	40	0.08
802	Feb-08	North	E of North Malé Atoll	North East	87	0	0.00
804	Dec-08	North	East and West of Thiladhunmathi Atoll	North East	1847	19	0.01
901	Jan-09	North	East of North Malé Atoll	North East	16	2	0.13
904	Apr-09	North	East and West of South Double Chain	North East	385	103	0.27
					4150	164	0.04
703	Oct-07	South	West of Huvadhoo Atoll	South West	109	0	0.00
803	Mar-08	South	Centre of Huvadhoo Channel	North East	95	0	0.00
902	Feb-09	South	East and South of Gaafu Alifu Atoll	North East	268	83	0.31
903	Mar-09	South	West & South of Huvadhoo Atolll + SW of Addu	North East	1222	287	0.23
					1694	370	0.22

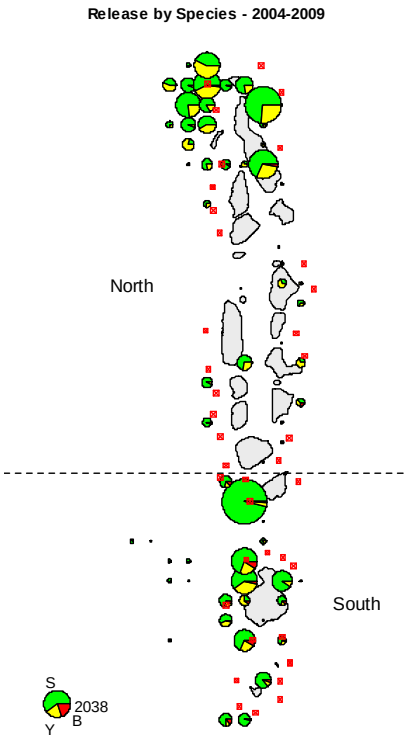

Figure 1: Position of release and aFADs present at the time of release (red squares)

By knowing the release position, releases can be segregated by distance to nearest aFAD of release. Figure 2 shows the density of tags released by distance to closest aFAD. More than 90% of the tags were made within 20 miles distance from aFADs, although few were released as far as 40 miles and beyond from the closet aFAD.

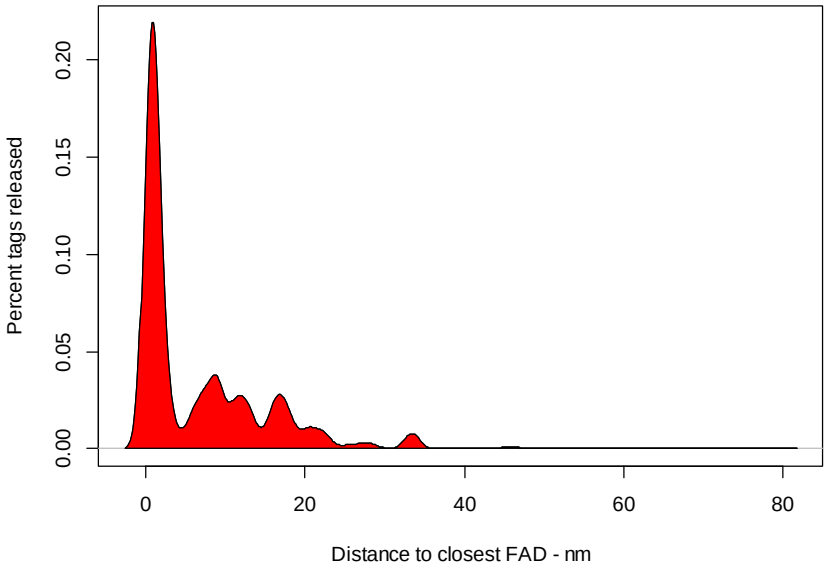

Figure 2: Proportion of the tag releases by distance from anchored FADs

The literature is not clear on cut-off distance from the FADs to determine 'fad schools' and 'fad-free schools' and so an arbitrary cut off distance of 5 miles and 10 miles have been used in filtering the data.

Table 2 gives the number of release by species separated by 5 miles distance or more from aFADs or 10 miles distance or more from aFADs. Proportion of bigeye tuna was 12.4% closer to aFADs at 5 mile cut off. The proportion did not increase much with <10 mile cut-off distance. Tests of observed proportions of bigeye in *Thunnus* catch showed that one cannot reasonably conclude that proportion of bigeye tuna may be greater than the estimated proportions. In other words proportion of bigeye in catches of yellowfin will be no more than 12% closer to aFADs.

Table 2: Proportion of BET in *Thunnus* catch; 10 miles and 5 miles from aFADs. Values of p indicate that one cannot reasonably conclude that proportion of BET is greater than the estimated values from the data.

	< 5miles	> 5 miles	< 10 miles	> 10 miles	Overall
# *Thunnus*	2916	2928	3728	2116	5844
# bigeye	362	172	460	74	534
% bigeye	12.41%	5.87%	12.33%	3.50%	9.13%
p-value	0.5093	0.8046	0.5406	P=1	0.7304

A plot of the proportion the occurrence of bigeye tuna in *Thunnus* catch appears to decline away from the aFADs as suggested in the literature (Figure 3). Assuming equal catchability or gear vulnerability of bigeye and yellowfin tuna this might suggest bigeye tuna may have high affinity around aFADs in the Maldives.

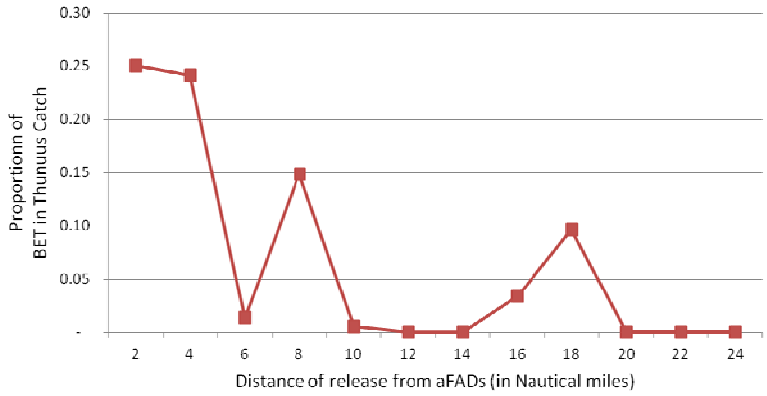

Figure 3: Proportion of BET in *Thunnus* catch with distance from the aFADs

A two sample t-test for comparing two means of yellowfin and bigeye were done for data from cruises 902, 903 and 904 which has reasonable number of bigeye. Results showed it was not possible to differentiate the means size in the sample in the individual cruise data, but when the samples were combined means were significantly different (Table 3).

Table 3: Welch Two Sample t-test for means size of the samples in cruises; (YFT/BET) 902 - 94/48; 903 - 934/287 and cruise 904 - 282/103.

Cruise	p-value	Mean (YFT) /Mean (BET)	Remarks
902	0.62380	51.51 / 52.42	From same population, p > 0.05
903	0.05137	39.14 / 40.48	From same population, p > 0.05
904	0.36350	43.88 / 45.08	From same population, p > 0.05
Combined	0.00018	40.57 / 42.58	From different populations, p < 0.05

Roughly the same results were obtained for samples aggregated at two cut-off distances. It is interesting to note that bigeye tuna were slightly larger in size and this is more pronounced closer to the aFADs (Table 4).

Table 4: Mean size (and standard deviations) of the yellowfin and bigeye tuna from release made <5 miles and > 5miles and <10 miles and > 10 miles.

	< 5miles	> 5 miles	<10 miles	> 10 miles
Yellowfin	40.78[07.31]	42.28[04.72]	40.46[11.27]	43.31[06.36]
Bigeye	45.01[12.67]	42.67[14.35]	44.32[12.29]	43.93[18.39]

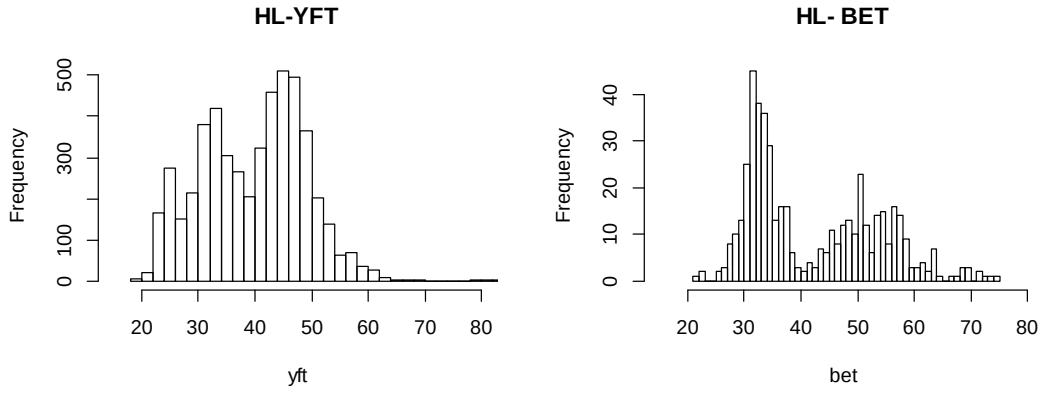

Figure 4: Size distribution of handline caught yellowfin and bigeye tuna during all tagging cruises cf. Table 1 (YFT = 5190, BET = 497).

Additional systematic sampling of bigeye tuna (counting proportion of bigeye in *Thunnus* catch) and size distributions should be done throughout the year to more fully understand the disproportionate observation of the bigeye in close to aFADs.

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