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Effects of net depth on the reduction of juvenile bigeye tuna (*Thunnus obesus*) catch

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I.C. Tanangonan¹, R.V. Ramiscal², M.B. Demo-os¹, and A.C. Dickson²

¹ Marine Fisheries Development and Vessel Operations Center

² Capture Fisheries Division, Bureau of Fisheries and Aquatic Resource (BFAR), PCA Bldg., Elliptical Road, Quezon City, Philippine

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Isidro C. Tanangonan¹, Rafael V. Ramiscal², Marlo B. Demo-os¹, and Alma C. Dickson²

ABSTRACT

Analysis on the catch of bigeye tuna (*Thunnus obesus*) from purse seine and ring nets of various net depths was conducted to assess the effect by reducing net depth as a compatible measure implemented in the Philippines to reduce the catch of bigeye tuna in its archipelagic waters and the Exclusive Economic Zone (EEZ). The study was based from the Fisheries Observer reports gathered from ring net and purse seine fishing vessels operating in internal waters and EEZ as well as from group seine operations in the high seas pocket 1. Nets were classed by depth to determine and compare variations on the catch of bigeye, catch rates and relative proportion, species composition, and fishing grounds. Results indicated that the catch of bigeye is correlated with the depth of net, with a significantly higher catch of bigeye in deeper nets. The result of the study is consistent with other studies elsewhere, and in consonance with the implementation of Fisheries Administrative Order 236 limiting the depth to 115 fathoms for ring net and purse seine operating in Philippine internal waters and the EEZ as a compatible measure to reduce the catch of bigeye.

¹*Marine Fisheries Development and Vessel Operations Center*

²*Capture Fisheries Division*

*Bureau of Fisheries and Aquatic Resource
(BFAR) PCA Bldg., Elliptical Road, Quezon
City, Philippines*

1. INTRODUCTION

Tuna fishing significantly contributes to the country's fish production contributing about a quarter of the total marine fish production annually. There are eleven tuna species reportedly caught in the country that include Skipjack (*Katsuwonus pelamis*), Yellowfin tuna (*Thunnus albacares*), Bigeye tuna (*Thunnus obesus*), Albacore (*Thunnus alalunga*), Longtail tuna (*Thunnus tonggol*), Striped bonito (*Sarda sarda*), Pacific bluefin (*Thunnus orientalis*), Frigate tuna (*Auxis thazard*), Bullet tuna (*Auxis rochei*) and Eastern little tuna/kawa-kawa (*Euthynnus affinis*). The Philippine total tuna production was 669,645 MT comprised of frigate/bullet, yellowfin/ bigeye, skipjack, and kawa-kawa. The bulk of the contribution came from commercial fisheries with 41.0% while municipal fisheries contributed 7.8% or a total of 10.6% contribution to the total fisheries production of the country (BFAR 2019). The bulk of oceanic tuna caught in purse seine and ring net vessels operating in internal waters and Exclusive Economic Zone (EEZ) of the Philippines was composed of 49.6% Skipjack, 18.2% Yellowfin and 1.9% Bigeye tuna (Ramiscal et al. 2014).

The sustainability of Bigeye tuna in the Western and Central Pacific Ocean (WCPO) is under threat with assessments indicating spawning stock biomass below the limit reference point with the level of catch unlikely to be sustainable (Davies et al. 2011). The Western Central Pacific Commission (WCPFC) has introduced measures to rebuild the stock of Big-eye, among which is the FADs closure, which prohibits purse seining with FADs in the high seas and EEZ (WCPFC 2008). Schaefer and Fuller (2002) and Matsumoto et al. (2006) determined the influence of gear characteristics to catch composition and depth layering of different species around FADs. The Philippines has implemented Fisheries Administrative Order No. 236 (FAO 236) that requires all purse and ring net fishing vessels operating in internal waters and the EEZ to reduce the net depth to 115 fathoms or less as a compatible measure to reduce the catch of Bigeye tuna. The monitoring of this measure had been annually reported to the Science Committee (SC) of WCPFC. This study cover 10-year Fisheries Observer data from 2010 to 2019 to further validate catch of Bigeye tuna with various net depths and to evaluate current measure. This also updates and complement the previous study results of Dela Cruz et al. (2019) covering 7-year period from 2010 to 2016. Further, this study aims to validate Bigeye tuna reduction in High Seas Pocket 1 where net depth is not restricted.

2. METHODOLOGY

2.1 Net Depth Inspection/Validation

Net depth and length were determined based on the annual fishing gear inspection conducted by the Fisheries Regulatory and Licensing Division (formerly Fisheries and Regulatory and Quarantine Division FRQD) either at company yard or compound when the vessel is docked in port or at a fishing ground as verified by fisheries observers. The hanging rate was not considered a factor affecting the actual hanging depth of net since General Santos - based tuna fisheries have similar hanging ratio.

2.2 Catch Estimation

Catch estimate was based on the degree of fullness of fish hold and its capacity estimated by the captain of the carrier vessel or the fisheries observers using a standard estimate on brail

capacity, brail full-ness, and number of brails. In the brailing capacity, estimation was based on the following formula:

$$\text{Volume} = \pi r^2 h$$

$$\text{Brail Capacity} = \text{Volume} \times 80\% \text{ where } \pi = 3.1416$$

r = brail radius

Data used in this study were from the reports of Fisheries Observers deployed onboard Philippine flagged vessels in the country's internal waters and the EEZ, as well as from the group seine operations in the high seas pocket 1. Compilations of data were done by the technical staff from Fisheries Observer Program Management Office (FOPMO).

h = brail height with load

The volume of fish catch displaced was approximately 80% of brail volume to account 20% of air and water space. Based on the formula, it was observed that a margin of +/- 2% difference with the actual catch landing in port (Dela Cruz 2010).

2.3 Data Collection

Data used in this study were from the reports of fisheries observers deployed onboard Philippine-flagged vessels in the country's internal waters and the EEZ, as well as from the group seine operations in the high seas pocket 1. Compilations of data were done by the technical staff from Fisheries Observer Program Management Office (FOPMO).

2.4 Catch Sampling and Species Identification

Samples were taken randomly from the catch either by scooping from the brail or the fish hold. Another method was using tub with ropes on both ends and putting it inside the fish hold before pouring off the brail, and in 2014 onwards spill sampling method was introduced. As needed, sub-sampling procedures were conducted.

Samples were sorted according to species, weighed to the nearest 0.1 kg and measured in cm (fork length for tuna and other large pelagic species, and total length for other small pelagic species). Morphological evaluation of the unique external characteristics of Yellowfin and Bigeye tunas was considered to differentiate the two species. Species identification manual was also provided to observers as reference.

2.5 Data and Statistical Analysis

Depths of the net were stratified at 20-fathom intervals. Comparison on average nominal catch (t/set) of Bigeye tuna was done by net depth class/interval across fishing grounds (i.e. internal waters/EEZ and HSP1). Analysis of Variance (ANOVA) and Co-variance (ANCOVA) using Statistical Package for the Social Sciences (SPSS) version 15 was used to compare nominal Bigeye catch by net depth class/interval and by fishing ground. There were nets deeper than 115 fathoms in the past before the implementation of FAO 236. However, data on their operations were not monitored and recorded until the 5% observer coverage (FAD closure). Thus, linear regression analysis on the catch by net depth class/interval was used to estimate the relative reduction of Bigeye across net depth class.

3. RESULTS AND DISCUSSION

3.1 Internal waters and EEZ

Table 1. Distribution of observed sets by net class/interval and fishing grounds.

Net	CEL	PAC	SS	WPS	Total
101-120	1,392	1,205	144	108	2,849
81-100	875	141	60	235	1,311
61-80	47				47
Total	2,314	1,346	204	343	4,207

Observer data covered 4,207 sets between 2010 to 2019 from four (4) fishing grounds that includes the Mindanao/Celebes Sea (CEL), Pacific Seaboard (PAC), Sulu Sea (SS), and West Philippine Sea (WPS). The distribution of observations by net depth class and fishing grounds is presented in Table 1.

3.2 Catch Variation by Net Depth

Analysis on the catch of Bigeye tuna across net depth class/interval indicated a direct correlation of Bigeye catch with the depth of net, with the highest average catch in deeper nets (101-120 fathoms). With this, the Bigeye catch under current net depth regulation of 115 fathoms maximum (100-120 depth class) indicate a decrease by 28.9% when compared to the predicted catch (by linear regression) for next higher net depth class (121-140 fathoms) as shown in Table 2 and Figure 1.

Analysis of Variance (ANOVA) also suggests a significant difference on the average catch of Big-eye by depth of net across all fishing grounds (Table 3), which signifies significantly lower Bigeye catch in shallower nets. Further, environmental factors such as physico-chemical parameters might affect the presence of Bigeye tuna in different fishing grounds. Results are consistent with the study of Lennert-Cody et al. (2008) which also showed that Bigeye tuna are likely caught with net depths extending to 260 meters (142 fathoms), while set locations also influence Bigeye tuna catch.

Similar annual assessments on the catch of big-eye tuna also indicated a reduction of Bigeye catch on shallower nets (Ramiscal et al. 2011) as basis for the implementation of FAO 236.

Table 2. Average Bigeye catch by net depth class, internal waters/EEZ

Net Depth (fathom)	Midpoint	BET catch	%Reduction
121-140	130	0.233*	
101-120	110	0.166 ^b	28.6
81-100	90	0.097 ^a	41.5
61-80	70	0.031	67.8

*predicted by linear regression

Different superscript are significant at $p < 0.05$

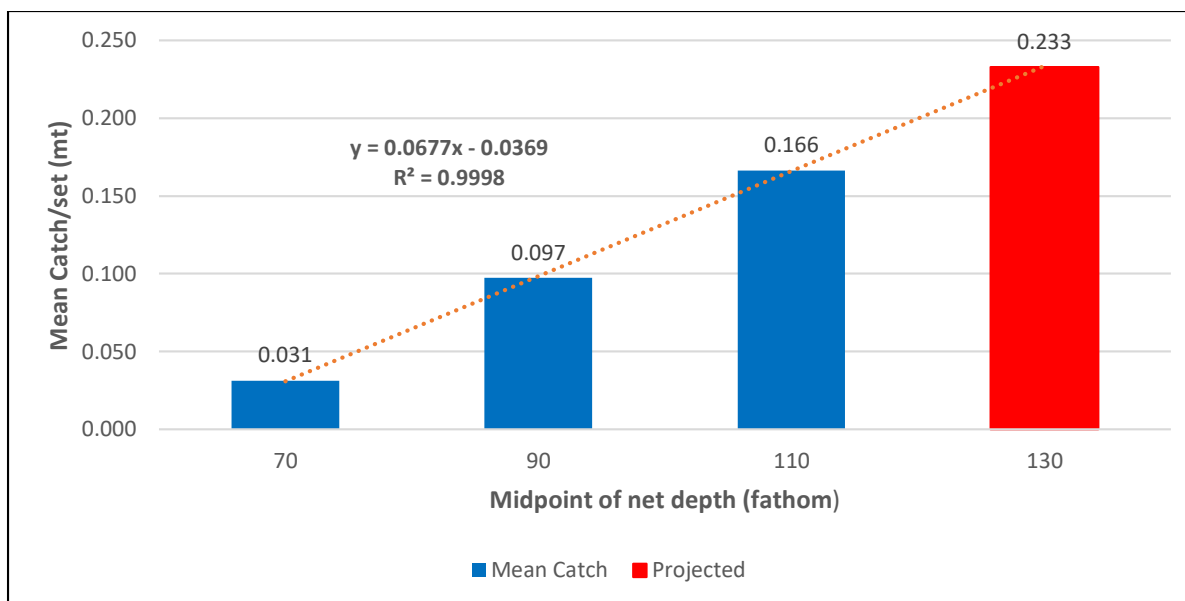


Figure 1. Average Bigeye catch by net depth class (121-140 was predicted by linear regression).

Table 3. Analysis of variance on the average Bigeye catch by net depth class and fishing ground.

Depth (fathom)	Celebes Sea	Sulu Sea	West Phil. Sea	Phil Pacific Seaboard	Across all fishing grounds
61 – 80	0.031 a	-	-	-	0.031 a
81- 100	0.107 b	0.075	0.014	0.184	0.197 b
101 - 120	0.188 c	0.162	0.053	0.152	0.166 c
significance	p < .01 highly sig	p < .05 not sig	p < .01 highly sig	p > .05 not sig	p < .01 highly sig

3.3 High Seas Pocket 1 (HSP1)

In High Seas Pocket 1 where no regulation for net depth is being implemented, variations of Big- eye tuna catch by net depth class was clearly observed. A total of 17,408 sets were conducted by a total of 54 purse seine and ring net vessels operating from 2012 to 2019.

Table 4. Distribution of observed sets in high seas pocket 1 by depth of net.

Net Depth	2012	2013	2014	2015	2016	2017	2018	2019	Grand Total
>161					143	340	315	402	1,200
141-160	38	94	138	144	244	239	443	455	1,795
121-140	50	361	795	971	1,225	1,116	953	735	6,206
101-120	98	782	1,482	1,302	982	1,001	1,038	1,062	7,747
81-100	25	115	253	18	49				460
Total	211	1,352	2,668	2,435	2,643	2,696	2,749	2,654	17,408

Table 5. Average Bigeye catch by net depth class, HSP1.

Net Depth	n	BET Catch (mt/set)	% Reduction
>161	1,200	1.882c	
141-160	1,795	0.731b	61.1
121-140	6,206	0.399a	45.4
101-120	7,747	0.302a	24.3
81-100	460	0.230a	23.9

Different superscript are significant at $p < 0.05$

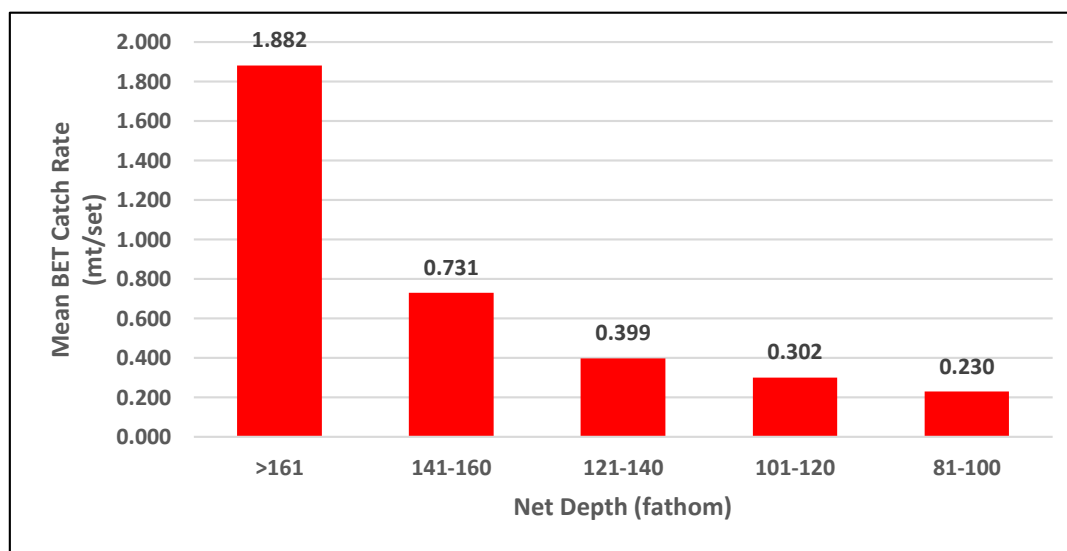


Figure 2. Average Bigeye catch at different net depth class in HSP1

3.4 Catch Variations by Net Depth

Using the same net depth class applied above, data showed a decreasing catch of Bigeye by 61.1% when net depth class is reduced from >161 to 141-160 fathoms. A further reduction to 121-140 fathoms resulted in a decrease of 45.4% and 24.3% for 101-120 fathoms. Analysis of Variance (ANOVA) also showed a significant difference in the average catch of Bigeye in different net depths. Further tests within groups also revealed the significantly higher catch of Bigeye tuna when the net depth is more than 140 fathoms (Table 5, Figure 2).

4. CONCLUSION

Based on the preceding, the reduction and limitation on the depth of net for purse seine and ring nets fishing vessels operating in Philippine internal waters and EEZ is consistent with the objective of reducing the catch of Bigeye and can be considered as a compatible measure with current CMMs to reduce the catch of Bigeye. Adjusting the depth of net has also been suggested elsewhere to reduce the catch of Yellowfin and Bigeye. Similarly, the behavioral study of Matsumoto et al. (2006) on oceanic tunas suggested that it is possible to reduce the catch of Yellowfin and Bigeye tunas to some extent by adjusting the depth of the net.

The study results showed that FAO 236 is an effective compatible conservation and management measure in reducing the catch of Bigeye tuna. Hence, the recommendation to maintain and adopt the said methods. However, the following complementary supports must be given due considerations;

- a.) Strengthen fishery law enforcement. Enhance patrolling and visibility of enforcement units in major fishing grounds to detect/apprehend non-compliant vessels conducting Illegal, Unreported and Unregulated Fishing (IUUF).
- b.) Continue implementation and assessment of the said compatible measure through the Fisheries Observer program and for the National Stock Assessment Program (NSAP) and adapt and adjust the current measures to reduce Bigeye tuna catch as maybe be necessary.
- c. The net depth reduction method can be applied by other interested parties if found appropriate in their respective tuna fishing operations.

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6. REFERENCES

[BFAR] Bureau of Fisheries and Aquatic Resources. 2010. Rules and Regulations on the Operations of Purse Seine and Ring Net Vessels using Fish Aggregating Devices (FADs) locally known as payaos during the FAD Closure Period as Compatible Measures to WCFPC CMM 2008-01. Fisheries Administrative Order No. 236 (FAO 236) series of 2010. Bureau of Fisheries and Aquatic Resources. Philippines.

[BFAR] Bureau of Fisheries and Aquatic Resources.2020. Philippine Fisheries Profile. 2019. Bureau of Fisheries and Aquatic Resources. Philippines.

Davies N, Hoyle S, Harley S, Langley A, Kleiber P and Hampton J. 2011. Stock Assessment of Bigeye tuna in the Western and Central Pacific Ocean. Scientific Committee Seventh Regular Session. 9-17 August 2011. Pohnpei, Federated States of Micronesia. p. 5. Available from:[https://www.wcpfc.int/system/files/SC7-SA-WP-02%20 \[BET%20Assessment\].pdf](https://www.wcpfc.int/system/files/SC7-SA-WP-02%20[BET%20Assessment].pdf)

Dela Cruz WS, Demoos MB, Ramiscal RV, Tanangonan IC. 2019. Effects of Net Depth Reduction to Bigeye tuna (*Thunnus obesus*) catch. The Philippine Journal of Fisheries (July-September 2019) 26(2):66-71 DOI:10.31398//26.2.2018-0008

Dela Cruz WS. 2010. Observer Trip Report. Philippine Fisheries Observer Programme. Bureau of Fisheries and Aquatic Resources. Philippines. (p. 5-6)

Lennert-Cody CE, Roberts JJ, Stephenson RJ. 2008. Effects of gear characteristics on the presence of Bigeye tuna (*Thunnus obesus*) in the catches of the purse-seine fishery of the eastern Pacific Ocean. – *ICES Journal of Marine Science*, 65:970–978. Available from: <https://academic.oup.com/icesjms/article/65/6/970/603434>.

Matsumoto T, Okamoto H, Toyonaga M. 2006. Behavioral study of small Bigeye, Yellowfin and Skip-jack tunas associated with drifting FADs using Ultrasonic Coded Transmitter in the Central Pacific Ocean. Scientific Committee Second Regular Session. WCPFC-SC2-2006/FTIP-7.7-18 August 2006. Manila, Philippines. Available from: https://www.wcpfc.int/system/files/SC2_FT_IP7.pdf

Ramiscal RV, Dickson AC, Dela Cruz WS, Tanangonan IC, Demo-os MB, Dickson JO. 2014. Analysis of Purse Seine/Ring Net Fishing Operations in Philippine EEZ. Information paper on Scientific Committee Tenth Regular Session held at Majuro, Republic of the Marshall Islands on 6-14 August 2014. Available from: <https://www.wcpfc.int/node/3192>

Ramiscal RV, Dickson AC, Demo-os MB, Dela Cruz WS, Tanangonan IC, Begonia RD, Dickson JO. 2011. Fisheries Observers Preliminary Assessment of Purse Seine/Ring Net Fishing in Philippine Major Fishing Grounds during the FAD Fishing Closure CY 2010. WCPFC-SC7-2011/ST-IP-07. Available from: <https://www.wcpfc.int/file/3417/download?token=lbZMHVMM>

Schaefer KM, Fuller DW. 2002. Movements, behavior, and habitat selection of bigeye tuna (*Thunnus obesus*) in the eastern equatorial Pacific, ascertained through archival tags. *Fishery Bulletin US* 100: 765–788. Available from: <https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/2002/1004/schaefer.pdf>

[WCPFC] Western and Central Pacific Fisheries Commission. [Internet]. CMM-2008-01. Conservation and Management Measure for Big-eye and Yellowfin tuna in the Western and Pacific Ocean. Western and Central Pacific Fisheries Commission. Fifth Regular Session. Busan, Republic of Korea. December 8-12, 2008. [cited 2018 May 29]. Available from: <https://www.wcpfc.int/doc/cmm-2008-01/conservation-and-management-measure-big-eye-and-yellowfin-tuna-western-and-central>