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PAYAO FISHING AND ITS IMPACTS TO TUNA STOCKS: A PRELIMINARY ANALYSIS

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Introduction

The main issue that is leveled against the use of FADs is on the sustainability of fisheries resources, particularly tuna. There are concerns that FADs contribute to the depletion of tuna populations because of higher catches of juvenile tuna, particularly bigeye and yellowfin, by purse seine methods in FAD-associated sets compared to other types of set (Anon. 2005), and that regulating the use of FADs would reduce the mitigate their impacts (Hampton et al. 2005). Although this observation is probably true for drifting FADs, limited studies have been conducted yet to confirm whether it is also true for anchored FADs (Lawson and Williams 2005), locally called payaos in the Philippines. It is therefore necessary to investigate the possible impacts of payaos on tuna stocks because the growing pressure to reduce the level of fishing effort using FADs may be expanded to include payaos and could have a severe impact on the Philippine tuna industry, which relies heavily on these structures to capture tuna and other non-tuna associated species.

This study aims to assess payao fishing in the Philippines and its impacts to tuna stocks. The preliminary analysis presented here will attempt to fill in some gaps that are deemed essential to the management of tuna stocks in the West and Central Pacific Ocean (WCPO).

Methods

Much of this study is based from the landed catch and effort monitoring (LCEM) data that were gathered through the National Stock Assessment Program (NSAP) of the Bureau of Fisheries and Aquatic Resources (BFAR). Specifically, it focuses on LCEM data gathered and compiled in 2005 from Markets 1 and 3 within the General Santos Fishing Port Complex. Market 1 serves as the landing site for tuna handline vessels while Market 3 is the designated unloading area for ring netters and purse seiners. The vessels that dock in the fishing port complex generally operate with the use of payaos in Indonesian waters or Moro Gulf. Emphasis is given to the analysis of length data because they appear to be the most reliable among all the data sets gathered through NSAP for assessing the impacts of payao fishing in the Philippines. The assessment was limited to the data gathered in 2005 because it was only during this year when attempts were made by NSAP enumerators to classify catches according to the type of set. Initially, the aggregated data from vessels using these three fishing gears are presented to characterize their catch of skipjack, yellowfin and bigeye tuna, together with albacore tuna in the case of handlines. Average lengths and the variation of size with respect to season for each species are presented and compared. Using the recorded length frequency from the LCEM data sets, preliminary attempts are also made to compare the catch based on the type of set

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for purse seines and ring nets. However, the results presented in this paper are limited because of the limited number of samples from non-payao sets.

Results

The total number of data sets from the 2005 LCEM data of NSAP that were used in this preliminary analysis vary depending on the type of gear. A total of 73 records were used for purse seine; corresponding data records used for ring net and handlines were 23 and 606, respectively.

Size distributions

Figures 1-3 show the aggregated length frequency distribution plots of skipjack, yellowfin, bigeye and albacore tuna that were captured using the three fishing gears in 2005. There were no records of albacore tuna in the catch of purse seines and ring nets and skipjack in the catch of handlines.

For purse seines, majority of the fish measured for all three species measured less than 30 cm. The size range of captured skipjack and yellowfin is similar, ranging from 14 to 66 cm while the corresponding size range for bigeye is from 18 to 59 cm. The median length of skipjack is 26 cm while the corresponding median lengths of yellowfin and bigeye tuna are the same at 25 cm.

Relative to the catch from purse seines, the range of captured the tuna species captured with ring nets is similar. The sizes of skipjack varied from 15 to 57 cm, while those of yellowfin and bigeye ranged from 17-64 cm and 18-36 cm, respectively. Most of the measured seem to be smaller with an apparent shift in the median to lower values compared to those captured purse seines. The median length of skipjack tuna is 24 cm while those of yellowfin and bigeye are 25 cm and 21 cm, respectively.

For handlines, most of the catch measured higher than 60 cm. The largest yellowfin was measured at 235 cm. Bigeye tuna ranged from 61 to 178 cm. The range of albacore tuna was narrower, from 58 to 148 cm. The median lengths of yellowfin and bigeye tuna are 113 cm and 140 cm, respectively. The gear also captured albacore tuna and the median length of measured fish is 106 cm.

Mean length

Figure 4 shows the mean lengths of the three species captured with these fishing gears. For purse seine, the overall mean length of skipjack is significantly higher than yellowfin however, there is no difference between skipjack and bigeye or between yellowfin and bigeye (Kruskal Wallis, $p<0.001$), which appears to be partly due the small sample size. Meanwhile, the length of fish captured by ring nets varies depending on species ($p<0.001$). The mean length of skipjack tuna and yellowfin tuna are 25.7 cm and 26.1 cm, respectively, which are not different, but are significantly higher than that of bigeye tuna (22.5 cm). For handlines, the mean lengths of yellowfin, bigeye and albacore tuna are different from each other ($p<0.001$). Bigeye has the largest mean length (126.3 cm) followed by yellowfin (116.2 cm) and then albacore (105.2 cm).

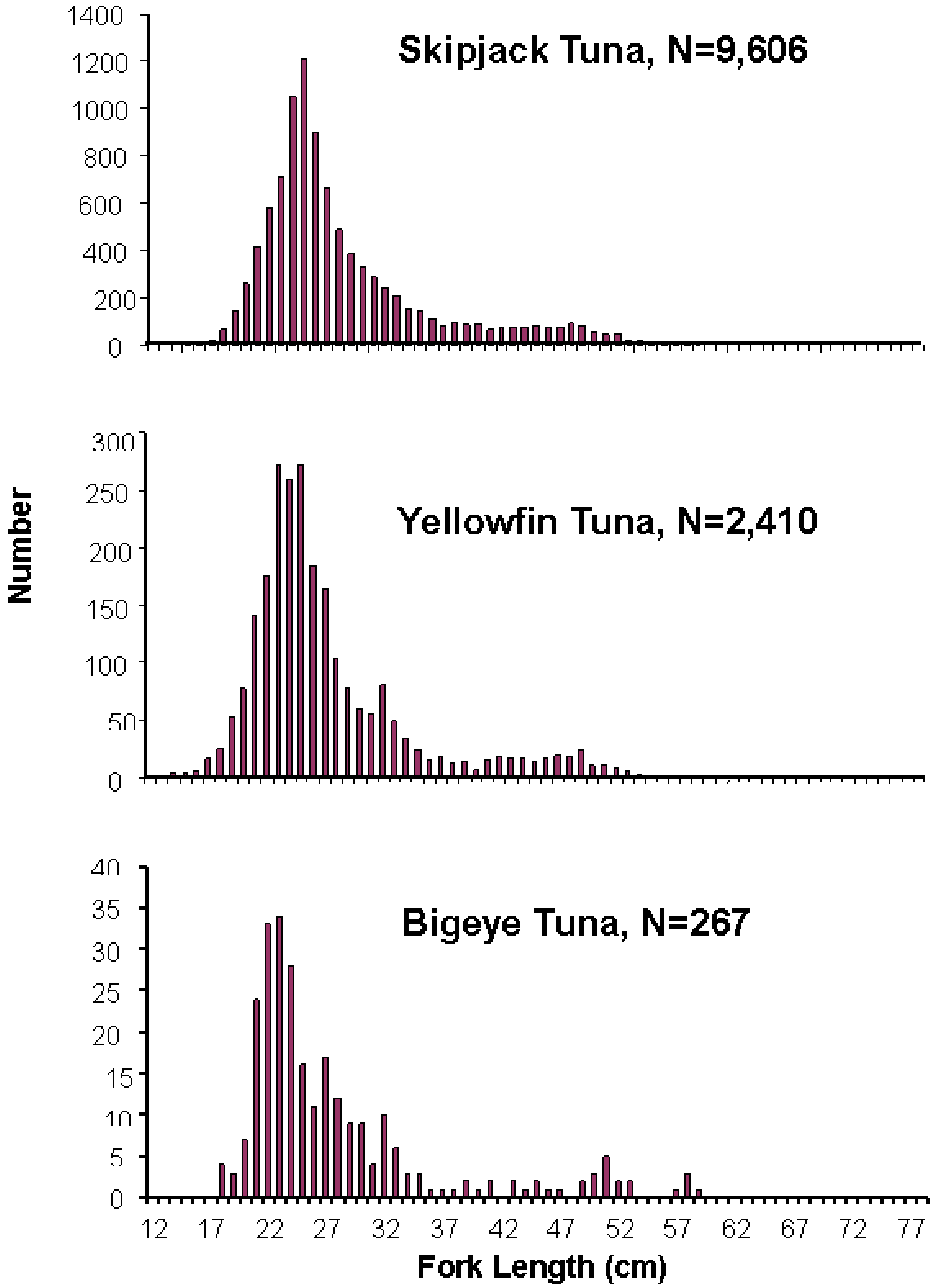

Figure 1. Size distribution of tuna captured by purse seine in Moro Gulf and Indonesian waters in 2005.

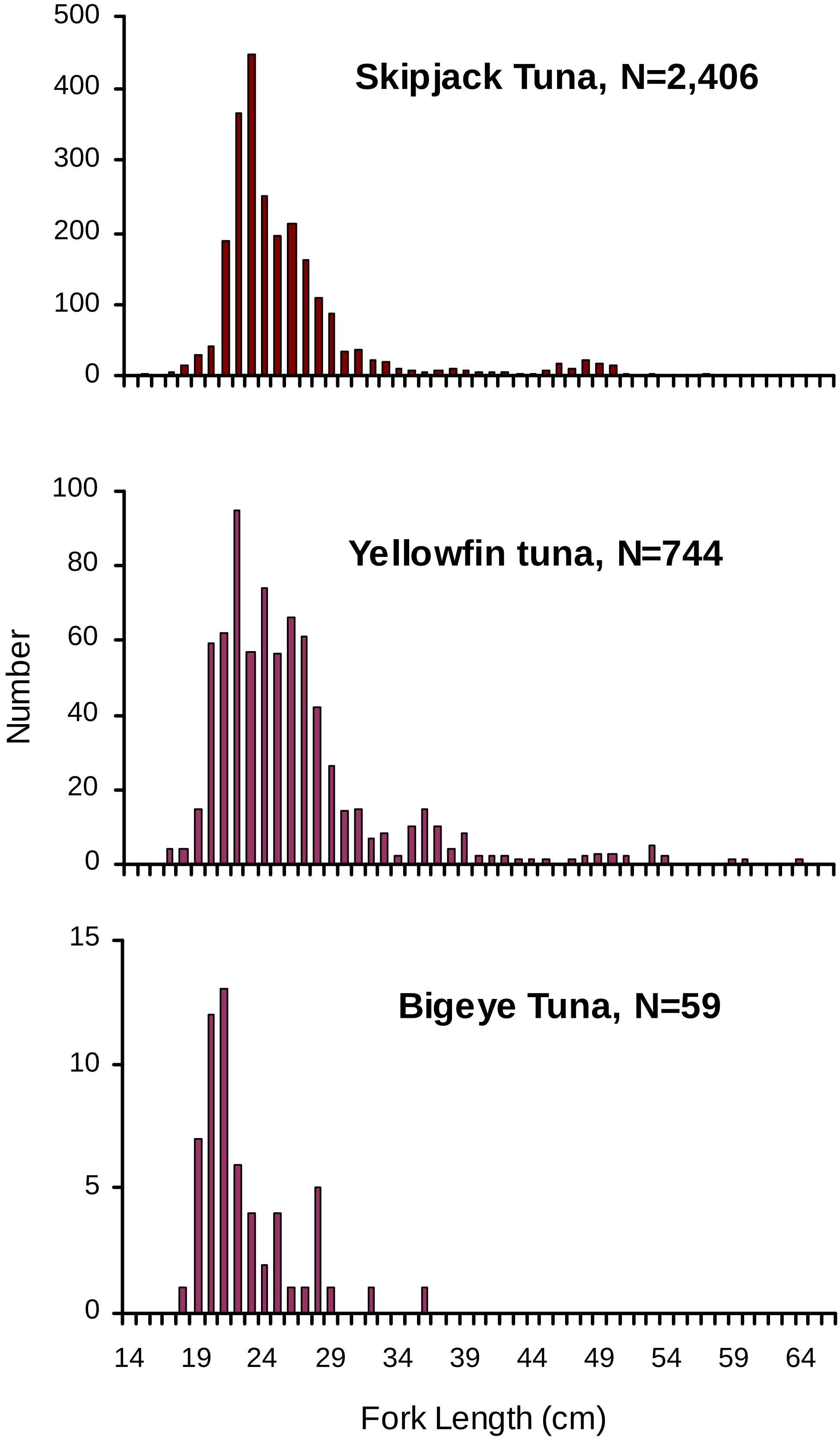

Figure 2. Size distribution of tuna captured by ring nets in Moro Gulf and Indonesian waters in 2005.

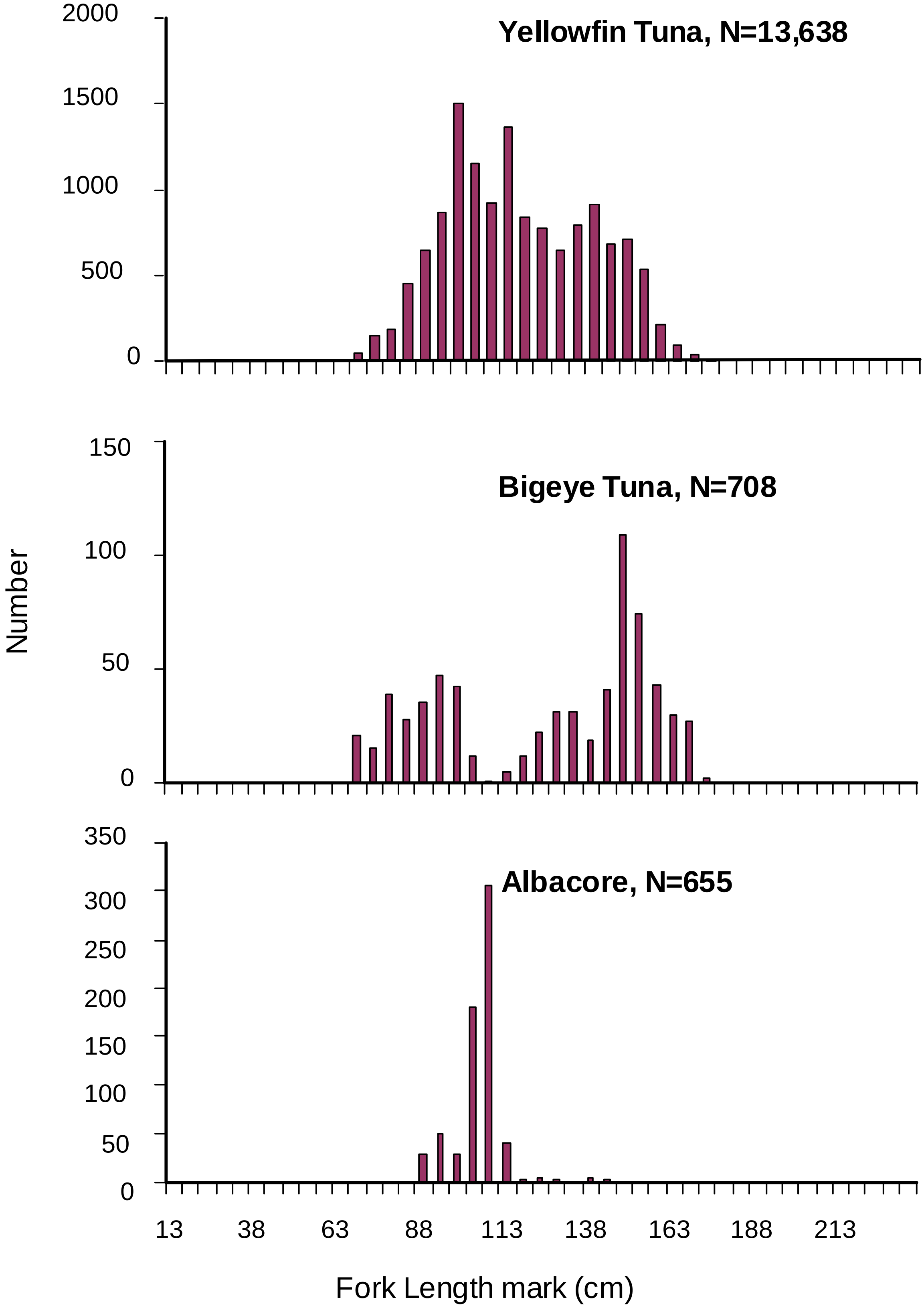

Figure 3. Size distribution of tuna captured by handlines in Moro Gulf and Indonesian waters in 2005.

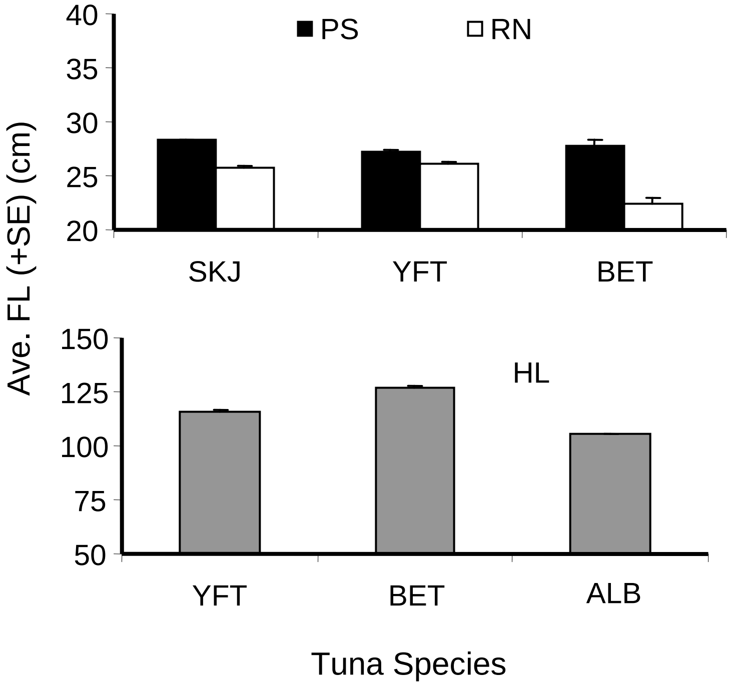

Figure 4. Mean lengths of skipjack (SKJ), yellowfin (YFT) bigeye (BET) and albacore tuna (ALB) landed by Philippine purse seine (PS), ringet and handline (HL) vessels fishing in Moro Gulf and Indonesian waters in 2005.

Seasonal variations

<u>Purse seine</u>

Analysis of results indicates that the mean lengths of skipjack, yellowfin and bigeye tuna vary with respect to season (Kruskal Wallis, $p<0.001$) (Fig. 5A). The mean length of skipjack tuna is significantly different for all quarters. It is highest during the second quarter and lowest during the third quarter. Meanwhile for yellowfin tuna, mean length is highest during the first quarter, which is significantly different relative to the measured lengths for the three other quarters. There is no difference in the mean length of the fish between the second and third fourth quarters, both of which are significantly higher than the recorded length during the third quarter. Finally, the mean length of bigeye tuna is highest during the fourth quarter but this is not significantly different from the recorded length during the first quarter. The mean length during the third quarter is lowest and it is significantly lower than the mean length during the first and fourth quarters. It is important to note that the mean lengths for all three tuna species, which are all lower than 30 cm, is lowest during the third quarter. It is possible to compare the mean lengths on a quarterly basis but there is little value in the information that can be derived by doing so because the data is aggregated for all types of sets.

Ringnet

Using similar procedures, the mean lengths of skipjack and yellowfin tuna exhibits variations with season but not bigeye tuna (Kruskal Wallis, p<0.001) (Fig 5B). For skipjack tuna, the average size during the first quarter (25.7 cm) is significantly different from those of the other quarters. Moreover, the values measured during the fourth (25.7 cm) and second (25.4 cm) quarters are similar and both are significantly higher than the average length during the third (22.3 cm) quarter. For yellowfin tuna, the average length during the first quarter (28.1 cm) is highest however it is not significantly higher than the recorded value during the fourth quarter (26.5 cm); these are significantly higher than the mean length during the third quarter (23.7 cm). Except for bigeye tuna, the size of fish captured by ring nets in this area is smallest during the third quarter.

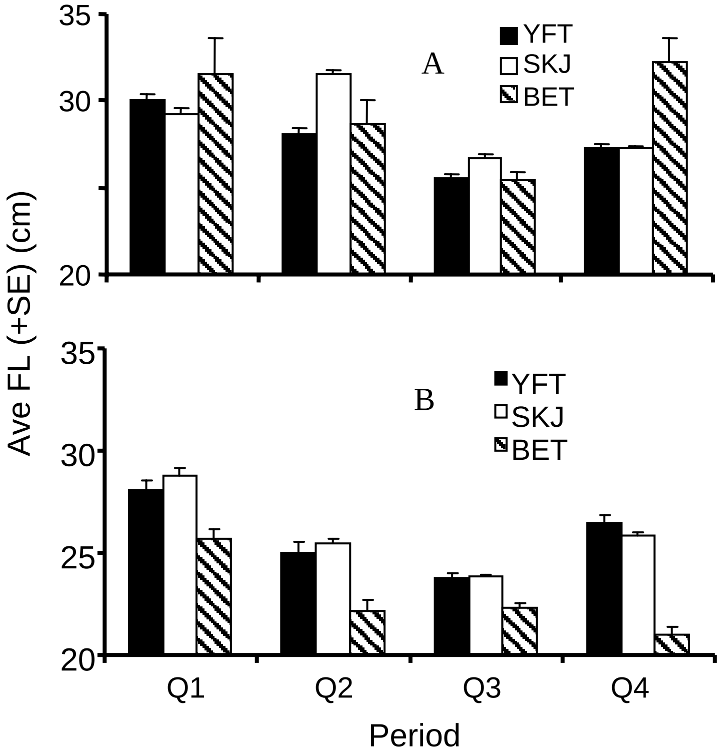

Figure 5. Variation in the mean length of skipjack (SKJ), yellowfin (YFT) and bigeye tuna (BET) captured using purse seines (A) and ringnets (B) and landed in the General Santos Fishing Complex in 2005.

Handlines

The mean size of yellowfin and bigeye tuna captured by hand lines also varies with season (Kruskal Wallis, p<0.001) (Fig. 6). For yellowfin, the average length for all quarters differ with the highest recorded during the fourth quarter (121.5 cm) and lowest during the third quarter (111.2 cm). Meanwhile for bigeye tuna, there is no difference in the mean lengths during the first (139.6 cm) and second (139.3 cm) quarters, which are significantly higher than the mean lengths during the third (98.1 cm) and fourth (118.6 cm) quarters. For albacore tuna, the mean length is significantly lower during the fourth quarter (103.2 cm) relative to first quarter (106.8 cm) (Mann-Whitney test, $p<0.001$).

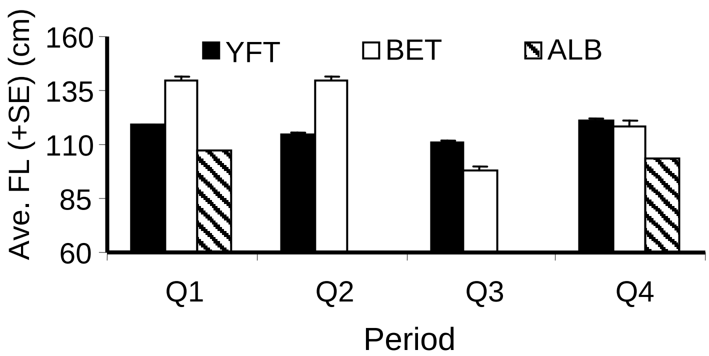

Figure 6. Variation in the mean length of yellowfin (YFT), bigeye tuna (BET) and albacore tuna captured by handlines and landed in the General Santos Fishing Complex in 2005.

Comparison by set type

An initial attempt was made to compare the size of fish captured by various types of set by purse seines. However, only 2 of the landings records were school sets. The dominant species captured were skipjack and mackerel scad. Figure 7 shows an overlay of the size distribution of skipjack for both sets. The size range of captured fish is from 19 to 52 cm in school sets and 14 to 66 cm in payao sets. It is evident that the modes for both sets coincide at 25 cm. Moreover, there seems to be a similar trend in the form of the two size frequency plots. Unfortunately, no further comparisons can be made for this species because the number of school sets is too limited. Moreover, similar comparisons cannot be made for yellowfin and bigeye because few individuals were captured.

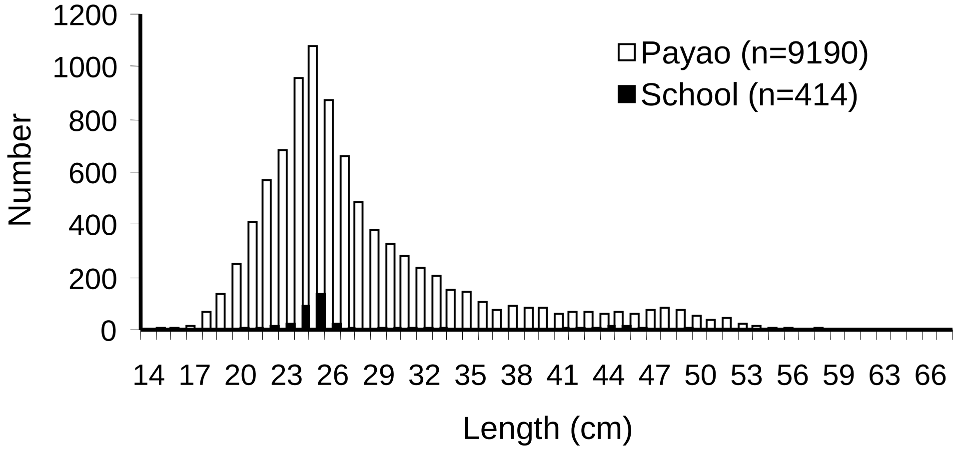

Figure 7. Size distribution of skipjack captured in payao sets (N=2) and school sets (N=71) by purse seiners in Indonesian waters and Moro Gulf in 2005.

Discussions

The preliminary analysis of the LCEM data shown here indicates that the size range of tuna species captured by ring nets and purse seines is wide. In general, skipjack and yellowfin from about 15 cm to 65 cm are captured by both gears although the size range of bigeye caught by ring net is narrower compared to purse seine. Moreover, the calculated median for all three species also seems to suggest that these two gears are capturing small sized fish. However, these findings are just consistent with the results conducted on previously monitored landed catch data from the same area not just in the size range of the captured species but also the apparent median size for all three tuna species (Anon. 1993).

For ring net and purse seine, the mean sizes vary across species but within a very narrow range. Except for bigeye, both gears capture smaller sizes of fish during the third quarter. These results merely reflect that the Philippines is a natural spawning ground for tuna and that spawning seems to be occurring throughout the year. However, the likelihood of growth over fishing has been discounted because the natural mortality rate of tunas during their juvenile stages is high (Anon. 1993). Recent modeling scenarios of the projected impacts of the Philippine domestic fisheries have also shown that while switching purse seine effort from log/FAD sets to unassociated school sets would improve total and adult biomass of bigeye, this has no appreciable effect on yellowfin due to the high natural mortality (Hampton et al. 2005). Regarding this recent finding, it is important to note that there was no distinction between log sets or FAD sets, or information about the proportion of payaos in the FAD sets. Notwithstanding these earlier conclusions, it is probably proper to consider improvements in the economic efficiency of fishing operations by targeting bigger size fish. Unfortunately, this aim may be challenging especially in Philippine waters because there are other target organisms, mostly small pelagic species, which apparently form schools together with the juvenile tuna species.

The handlines capture much bigger sized tuna species, generally over 60 cm. Earlier, the likelihood of recruitment over fishing has been noted based on certain indicators such as the estimated high exploitation rate of skipjack and yellowfin in the Celebes and Philippine Seas, local spawning by much of the exploited tuna and the seemingly limited interaction between local stocks with the rest of the stocks in the western tropical Pacific (Anon. 1993). It appears that the hand lines have similar effects as longlines, which have been noted to have great positive impacts on adult populations of bigeye biomass if restrictions are imposed on catch and effort throughout the WCPO (Hampton et al. 2005). However, it has also been noted that bigeye and yellowfin do not do not seem to be present within Philippine waters at certain stages in their life cycle (Aprieto 1981). Moreover, the occurrence of bigeye in the catch of handliners is much smaller (28%) compared to yellowfin which occurred in almost all records, suggesting that bigeye is less vulnerable to handliners than yellowfin. Clearly, further studies, may be necessary to determine the overall impacts on exploited tuna by Filipino handliners.

No conclusions can be drawn yet on the effect of set type on fish size primarily not just because the number of data records available for school sets is few but also because the measured samples of yellowfin and bigeye are also limited. Even for skipjack, the number of samples measured is probably not representative of the population even though the distribution plots for school and payao sets appear to be similar, with their modes coinciding at the same level. For this species, the size range of fish captured in school sets seems narrower however this may have been influenced by seasonal factors because the samples were collected during the first two quarters when the mean sizes for this species are normally high. With more data records that uniformly represent all quarters of the year, it would be informative to make the comparison of all set types, including log sets, to determine and compare their effect on fish size.

Deficiencies in the sampling scheme used by NSAP have been noted previously (Barut and Garvilles 2004, Lewis 2005, Williams and Lawson 2005). It appears that the LCEM data for purse seines and ring nets are also biased, with more representations of smaller fish. These data sets were gathered by trained enumerators using Market 3 in General Santos Fishing Port Complex as their monitoring station. Market 1 at the same port is also a designated station for monitoring the landed catch of handliners. In the case of purse seine and ring net catches, interviews with the personnel involved in gathering the data sets and with members of the fishing industry reveal that the data are usually taken from fresh samples, which probably come from the catch of small vessels operating in nearby Moro Gulf or Indonesian waters, and rarely from frozen catch that are generally landed by super seiners. The operations of these bigger vessels are also generally payao-based with occasional sets on logs and lost payaos but in the high seas. It seems that the preference for fresh samples, which is probably partly due to the difficulty in taking precise measurements of frozen fish, already adds a bias to the data. Another source of bias arises due to the limited number of stations even in General Santos City to measure the overall range of fish sizes landed by purse seines. The catch from most of the larger vessels is most likely underrepresented because these are usually unloaded in private wharves where no enumerators are stationed. Thus, the data sets presented here probably do not reflect the complete picture of payao fishing by Philippine purse seiners.

Considering the apparent biases in the LCEM data gathered by NSAP, it is likely that available data sets used in this study only represent the catch of gears with small mesh size. Unfortunately, the possible influence of mesh size on these data sets could not be assessed in this study because the registration papers submitted to BFAR are currently not available for the vessels where the data sets were derived. Nonetheless, it is important to note that super seiners, especially those operating under bilateral agreements in some island nations in the Pacific under the management jurisdiction of the WCPFC, normally have bigger mesh sizes in compliance with accepted standards while group seiners operating in Moro generally use smaller gears with presumably smaller mesh sizes. More informative results on the effect of mesh size would be gained if the sizes of landed tuna are also measured at the private wharves and compared with the LCEM data of NSAP.

A range of options has been suggested to minimize the catch of FAD-associated juvenile yellowfin and bigeye tuna (Itano 2005). Pending completion of the proposed additional studies, recommendations to regulate the use of payaos by Filipino fishermen should be deferred because these could touch on serious socio-economic issues. Moreover, undue haste in implementing regulatory measures based on preliminary results may only promote illegal, unregulated and unreported (IUU) fishing.

It is important to emphasize that the preliminary results of analysis presented here do not seek to evaluate the effects of payaos *per se* but rather represent ongoing attempts to assess the possible impacts of payao fishing by the Philippine tuna fleet.

Although some initial results can be drawn, it is premature to assess these impacts considering the enormity of the data gaps and the need to undertake additional activities to address them. Areas of concern that need immediate attention include the following:

- Aggregate weight per species from the samples should be recorded in the LCEM data sets to determine the proportion of each species in the catch. This information is particularly crucial for bigeye tuna, which is usually misreported as yellowfin especially during their juvenile stages (Lawson 2005); it may also be useful for assessing the real impacts of payao sets relative to other FAD sets, which were previously taken as one treatment (Hampton et al. 2005).
- Apart from improving the monitoring activities on the landed catch, additional data gathering activities should be pursued, preferably covering all fishing periods, to fill up existing gaps, with due consideration to eliminate sources of bias during sampling.
- The allowable minimum size of skipjack, yellowfin and bigeye to be captured, sold and traded in the Philippines, which is set at 500 gm (Anon. 2004), should be reviewed.
- Aside from using the LCEM data that are regularly gathered through NSAP, additional information should be gathered at the fishing operations level, probably through the use of scientific observers. These initiatives can evaluate more carefully the effect of set type and effect of mesh size on the composition and sizes of fish captured. Similar information may be obtained by conducting controlled field experiments.

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