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Preliminary analysis of length frequency for FAD associated catch in the archipelagic waters of Papua New Guinea from port sampling data.

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Abstract

Catches of skipjack and yellowfin in the archipelagic waters of PNG have steadily increased since 1997. The maintenance of relatively high levels of effort by most major fleets in archipelagic waters of the Bismarck Sea coincides with the installation and maintenance of AFADs in this area. The current port sampling program has detected a significant difference in the mean lengths of skipjack and yellowfin caught in the archipelagic waters of PNG compared to the PNG EEZ. A short aging program is advocated to verify an increase in length-at-age.

Background

The Papua New Guinea (PNG) Exclusive Economic Zone (EEZ) is an extremely productive tuna fishing area in the Western and Central Pacific Ocean (WCPO). Total tuna catches in PNG's EEZ have averaged about 250,000 tonnes per year over the past decade peaking at approximately 466,000 tonnes in 2007 (Kumoru, 2008). The purse seine fishery in PNG is strongly dependent on sets on floating objects, in particular floating logs, drifting fish aggregation devices (DFAD) and anchored FADs (AFAD) ((Nicol, et al., 2009). Although a locally based longline fleet operates in the southern part of the EEZ, most of the catches are taken by foreign licensed and locally based purse seiners (Kumoru, 2008). Catches of skipjack and yellowfin in the archipelagic waters of PNG have steadily increased since 1997. The maintenance of relatively high levels of effort by most major fleets in archipelagic waters of the Bismarck Sea coincides with the installation and maintenance of AFADs in this area (Nicol, et al., 2009).

Since 2008, the National Fisheries Authority (NFA) of PNG has been collecting landings data through a port sampling program located at the four major landing and transshipment ports in PNG. The four major landing and transshipment ports are; Lae, Madang, Wewak and Rabaul.

This paper presents an initial look at the port sampling data and to assess if there is any significant difference in the sizes of tuna caught in the archipelagic waters as opposed to the entire EEZ of PNG.

Methods

Sampling

An estimated 20% by weight of all tuna catches that was taken to the ports of Lae, Madang, Wewak and Rabaul by fishing vessels to either land or transship were sampled. A well in a vessel was divided into three layers (Top, Middle and Bottom) in which a number of nets were selected from each layer and were sampled. The number of nets per layer was selected or determined based on the total weight of catch in the well to ensure that 20% of the catch, in the particular storage well was sampled. This was done for all storage wells on a vessel that were unloaded. All fish in the net were identified to species level and fork length (cm) measurements were taken for all the fish in the net. A total of 20 vessels were sampled and samples were taken from wells that we could easily identify that the fish contained in that well were caught by the same set type and were caught at the same location (archipelagic waters, PNG EEZ...etc).

Data Entry and Analysis

The data was entered into a Microsoft Access database specifically set up for the port sampling program. Data on date of sampling, vessel name, position of storage well, net number, well layer, and fork length (cm) were some of the fields collected. This preliminary analysis focused on the data for skipjack (SKJ) and yellowfin (YFT) and bigeye (BET) data only, by-catch data was not included. Length frequencies were converted to percentages and mean lengths compared for set type and set location by species. One way single factor ANOVA was run on the length data for individual species by set type (anchored fad, drifting fad and unassociated sets) and by set location (archipelagic waters, PNG EEZ, and the high seas pockets).

Results

A total of 2, 404, 184 records were collected for 2009 and the first half of 2010. Of this a subset of data, 127, 308 records, containing complete data on set type and set location was used for this preliminary analysis. The bigeye data set was deemed too small to make any real inferences regarding the population in the Bismarck and was thus left out of the data analysis.

Length Frequency Distribution

Figures 1-6 show the length frequency distributions of skipjack and yellowfin, sampled during the port sampling program, caught by purse seine gear and landed or transshipped in the ports of Lae, Madang, Wewak and Rabaul for which we had complete data on set type and set location. Nicol et al. (2009) demonstrated that skipjack and yellowfin caught on associated sets displayed smaller median sizes than those caught on unassociated sets.

For skipjack caught on AFAD associated sets the archipelagic waters of PNG the range of fish caught ranged from 29-80cm, skipjack caught on AFAD associated sets in the PNG EEZ the range of fish caught ranged from 23-80cm, skipjack caught on DFAD associated sets in the PNG EEZ ranged from 32-80cm, skipjack caught on DFAD associated sets in the high seas ranged from 29-80cm, skipjack caught on unassociated sets in the archipelagic waters of PNG ranged from 31-80cm, skipjack caught on unassociated sets in the PNG EEZ ranged from 30-80cm and skipjack caught on unassociated sets in the high seas ranged from 29-67cm.

For yellowfin caught on AFAD associated sets in the archipelagic waters of PNG ranged from 21-152cm, yellowfin caught on AFAD associated sets in the PNG EEZ ranged from 19-146cm, yellowfin caught on DFAD associated sets in the PNG EEZ ranged from 33-122cm, yellowfin caught on DFAD associated sets in the high seas ranged from 36-103cm, yellowfin caught on unassociated sets in PNG EEZ is 30-122cm, skipjack caught on unassociated sets in the high seas ranged from 42-128cm and skipjack caught on unassociated sets in the archipelagic waters of PNG ranged from 40-140cm.

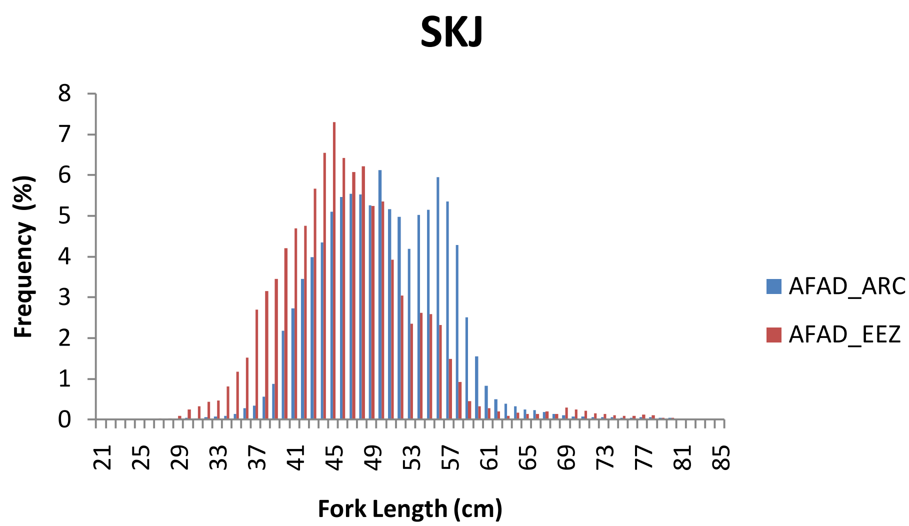

Figure 1. LF distribution of SKJ caught on AFAD sets.

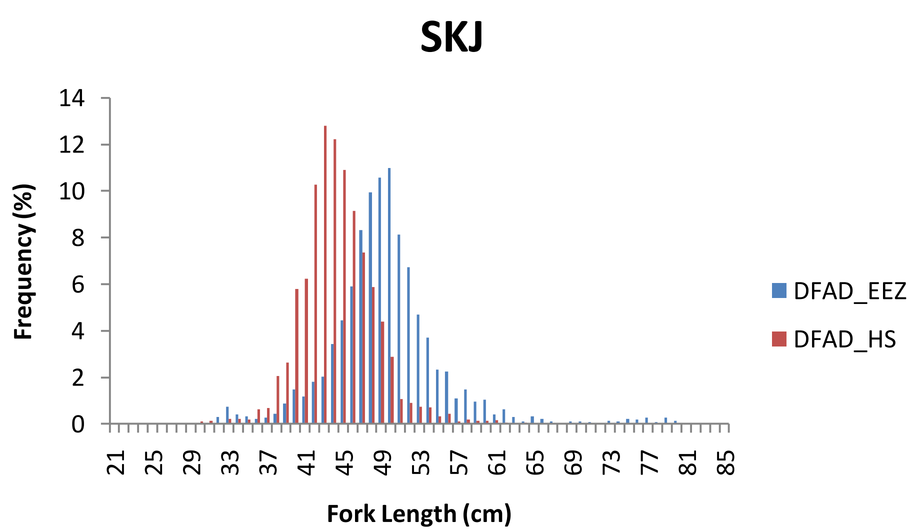

Figure 2. LF distribution of SKJ caught on DFAD sets.

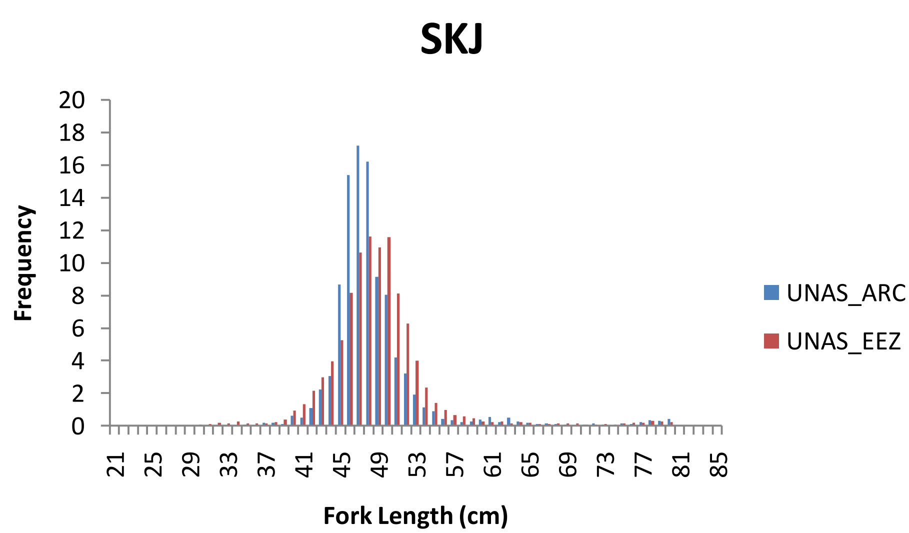

Figure 3. LF distribution of SKJ caught on unassociated sets.

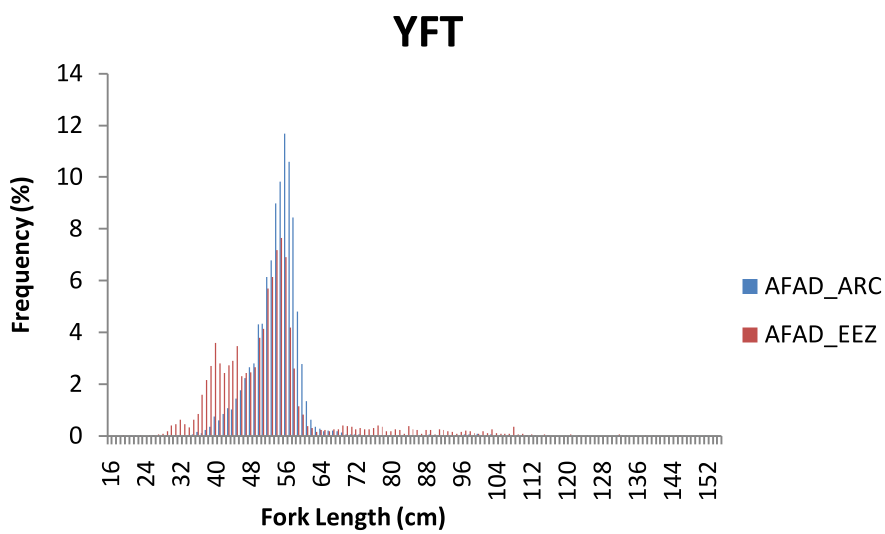

Figure 4. LF distribution of YFT caught on AFAD sets.

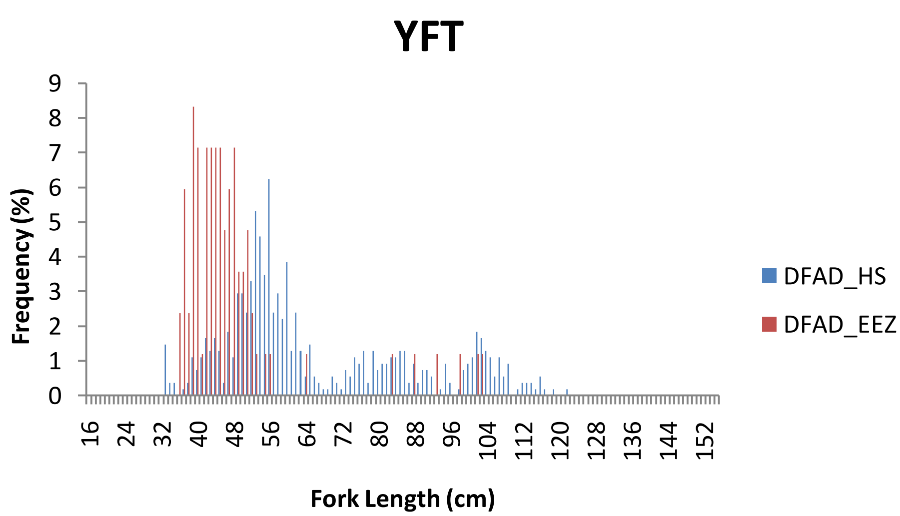

Figure 5. LF distribution of YFT caught on DFAD sets.

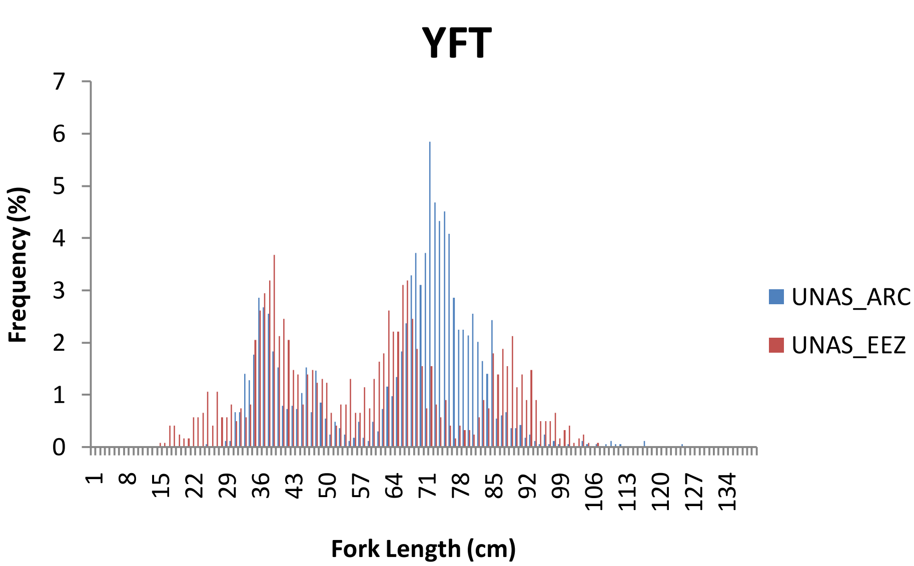

Figure 6. LF distribution of YFT caught on unassociated sets.

Mean Length

The mean length of skipjack caught on AFAD sets in the archipelagic waters of PNG is 53cm, the mean length of skipjack caught on AFAD sets in the PNG EEZ is 46cm, the mean length of skipjack caught on DFAD sets in the PNG EEZ is 49cm, the mean length of skipjack caught on DFAD sets in the high seas is 44cm, the mean length of skipjack caught on unassociated sets in the archipelagic waters of PNG is 48cm, the mean length of skipjack caught on unassociated sets in the PNG EEZ is 51cm and the mean length of skipjack caught on unassociated sets in the high seas is 50cm.The mean length of skipjack is significantly larger for fish caught on AFAD sets in the archipelagic waters of PNG compared to the PNG EEZ (F=3343.51, P=0, α=0.05). The mean length of skipjack is significantly higher for fish caught on DFAD sets in the PNG EEZ compared to the high seas (F=1190.7, P=2e^{-238}, α=0.05).

The mean length of yellowfin caught on AFAD sets in the archipelagic waters of PNG is 54cm, the mean length of yellowfin caught on AFAD sets in the PNG EEZ is 52cm, the mean length of yellowfin caught on DFAD sets in the PNG EEZ is 66cm, the mean length of yellowfin caught on DFAD sets in the high seas is 48cm, the mean length of yellowfin caught on unassociated sets in the archipelagic waters of PNG is 80cm, the mean length of yellowfin caught in unassociated sets in the PNG EEZ is 73cm and the mean length of yellowfin caught on unassociated sets in the high seas is 74cm. The mean length of yellowfin is significantly larger for fish caught on AFAD sets in the archipelagic waters of PNG compared to the PNG EEZ (F=114.2, P=1.3e^{-26}, α=0.0.5). The mean length of yellowfin is significantly larger for fish caught on DFAD sets in the PNG EEZ compared to the high seas (F=58.9, P=6.3e^{-14}, α=0.05).

Discussion

The principal conclusions of the current skipjack stock assessment is, that the skipjack is being exploited at a moderate level relative to its biological potential (Langley & Hampton, 2008). The stock assessment for yellowfin in the western and central Pacific Ocean is that it is fully exploited and any increase in effort is likely to occur in region three (this region includes PNG) and will exacerbate the already high rate of depletion (Langley, Harley, Hoyle, Davies, Hampton, & Kleiber, 2009).The primary concern with FAD associated catches is the depletion of tuna populations due to the catch of a high proportion of juvenile yellowfin and bigeye compared to other set types (Babaran, 2006).

The current port sampling data shows that there is a significant difference in the mean length of skipjack and yellowfin caught on AFAD associated sets in the archipelagic waters of PNG compared to the PNG EEZ. Similarly there is a significant difference in the mean length of skipjack and yellowfin caught on DFAD sets in the PNG EEZ compared to the high seas. This suggests that the skipjack and yellowfin in the archipelagic water of PNG are growing at a faster rate than those occurring in the rest of the PNG EEZ. Fishing tends to change the size and age structure of a population, with mean body size and mean age decreasing as fishing mortality increases (Jennings, Kaiser, & Reynolds, 2007). The selective capture of the larger sizes of younger age groups and the removal of the older age groups from the larger age classes will reduce the average age corresponding to a given length (Criske, Caddy, & Garcia, 1985). The plasticity of the life history parameters of fishes though can be density-dependent (King, 1995) (Walters & Martell, 2004) and may lead to increased growth rates and production (Criske, Caddy, & Garcia, 1985) (Berryman, 1981) (Weatherly, 1972) (Royce, 1972) in a compensatory manner in response to the decrease in population density due to intensive fishing pressure. The biological mechanisms by which density dependence occurs certainly shape the opportunity for compensation to occur. The archipelagic waters in PNG are highly productive (Kumoru, 2008). In addition the waters of the Bismarck Sea are very intensively fished, thus decreasing population density and allowing for a situation where there is resource abundance in terms of forage and optimum habitat.

While the bulk of the data from the port sampling program is still to be incorporated into this preliminary assessment, a short term ageing program is advocated here to produce a length-age key and verify if the skipjack and yellowfin being caught in the archipelagic waters of PNG are indeed growing at a faster rate than the skipjack and yellowfin in the PNG EEZ. A further study on fish condition may assist in determining if the difference in size-class detected in this preliminary analysis is reflective of the state of the fishery or an anomaly due to the small sample sizes in some of the data sets.

Conclusion

The data collected from the port sampling program is indicating a significant difference in the size of skipjack and yellowfin tuna being caught on associated sets in the archipelagic waters of PNG compared to the PNG EEZ. The complete port sampling data set needs to be screened, corrected and verified and the analysis done again to check that the results from this preliminary analysis are correct and that the results are reflective of what is happening in the fishery. A small ageing study is advocated to assess age-at-length and to reassess the other life history parameters associated with growth for skipjack and yellowfin caught in the archipelagic waters of PNG.

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