Interaction Between Surface and Longline Fisheries for Yellowfin

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The issue of interaction between surface and longline fisheries for yellowfin is one of the key questions being targeted by WPYRG. The concern is essentially that large catches of yellowfin by purse seiners may have a detrimental impact on catch rates by longliners. It is clear that a yellowfin population dynamics model that integrates all the factors that could affect such interaction – movement, natural mortality, fishing mortality, size selectivity and the spatial distribution of effort for both gears – is required. This is one of the motivating factors for the proposed development of the integrated yellowfin assessment model.

One factor that has a substantial bearing on the potential for interaction between surface and longline gears concerns the availability of the yellowfin population to these gears. It has long been suspected that longline fisheries may exploit only a fraction of the total yellowfin stock of a size vulnerable to longlining (typically fish >100 cm FL). This suspicion has been fueled mainly by the fact that estimates of maximum sustainable yields based on production models fitted to longline catch and effort data have subsequently been greatly exceeded as purse seine fisheries have developed and the catches of both small and large yellowfin increased. That this has not resulted in the stock collapses that would have been predicted by the production models has led scientists to suspect that yellowfin may only be partially available to longline gear, ie., that some significant part of the stock never becomes exposed to longline fishing. The tagging data generated by the RTTP provides a means of testing this hypothesis.

Using Japanese longline and purse seine length frequency data that was made available for the study, other such data held at SPC and the RTTP tagging data, an analysis was carried out to test the null hypothesis that the relative probabilities of capture of large (>100 cm FL), tagged yellowfin by purse seine and longline gear are determined only by the relative catches by these gears. The null hypothesis would be true if yellowfin were equally

available to both gears; if the null hypothesis was rejected, unequal availability is one alternative hypothesis that might be posed.

We chose a reference area for the study (10_N-10_S, 130_E-170_W) that encompassed much of the purse seine fishery and a substantial amount of the longline fishery. From this area, 181 returns of tagged yellowfin >100 cm FL were received between 1991 and 1993. Only 4 of these were from longliners. We stratified these returns by 10 cm length classes and years, then estimated the catch in number of yellowfin for the same strata using Japanese and OFP data holdings. For this preliminary analysis, only the 1991 Japanese longline length frequency data were available. We therefore assumed that the 1992 and 1993 length compositions of the Japanese longline catch were the same as that in 1991.

The expected numbers of returns for each stratum by purse seine and longline gears under the null hypothesis were calculated by apportioning the total number of returns in each stratum according to the estimated catch number by each gear. The observed and expected numbers of returns are shown in Table 1. Overall, approximately 160 purse seine returns and 21 longline returns would be expected under the null hypothesis.

Typically, c^2 tests (with 1 degree of freedom) would be used to test the null hypothesis. Unfortunately, the power of the test is low when one or more of the expected frequencies is small. Generally, such tests are recommended only where all expected frequencies are at least 5. Therefore, the test was applied to various aggregations of year and length class categories so that the expected number of both purse seine and longline recoveries was _5. For all but 2 of the 9 such tests, the probability of correctly accepting the null hypothesis was <0.05.

The null hypothesis can also be assessed by calculating the cummulative binomial probabilities of obtaining the observed number of longline recoveries or fewer in each stratum, assuming the null hypothesis is correct. Some of the probabilities were high (even where no longline returns were observed) because of low numbers of returns overall (5 out of 13 >0.5), but several (with higher numbers of returns) were low (5 out of 13 <0.1), suggesting that, overall, the null hypothesis is highly unlikely.

Table 1. Observed (O) and expected (E) returns of large, tagged yellowfin in the reference area during 1991-1993, by length class and gear type (PS:purse seine, LL:longline)

Length class (cm)	1991 PS		1991 LL		1992 PS		1992 LL		1993 PS		1993 LL		1991-1993 PS		1991-1993 LL	
	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E
100-109	43	40.4	0	2.6	35	34.7	2	2.2	13	10.2	0	2.8	91	85.4	2	7.6
110-119	13	11.2	0	1.8	22	18.5	0	3.5	9	9.1	1	0.9	44	38.8	1	6.2
120-129	2	1.7	0	0.3	18	13.9	0	4.1	7	7.7	1	0.3	27	23.3	1	4.7
130-139	3	2.4	0	0.6	7	4.8	0	2.2	2	1.8	0	0.2	12	9.1	0	2.9
140-149	0	0.0	0	0.0	0	0	0	0	3	2.9	0	0.1	3	2.9	0	0.1
100	61	55.7	0	5.3	82	72.0	2	12.0	34	31.8	2	4.2	177	159.5	4	21.5

A reduced probability of tagged yellowfin recovery from longliners could result from:

- Tagged yellowfin recaptured by longliners are less likely to be reported than tagged yellowfin recaptured by purse seiners. Given that longline recoveries are highly likely to be detected at the time of capture or as fish are being processed on board the vessel, the probability of a tag being found in the first place is probably higher for longliners than for purse seiners. However, the long duration of typical longline voyages could result in tags being misplaced or forgotten. Also, there may still be tags recaptured during 1991-93 that have not yet been returned because the vessel has not yet returned to port. At this stage, we cannot discount the possibility that the shortfall in tag returns by longliners was due to non-reporting of tags.

- Recaptures of tags are not independent events, but are highly clumped with respect to their probability of capture by the two gears. This might occur if numbers of tagged yellowfin tended to remain in the same school over lengthy periods and therefore were exposed to fishing gear in groups rather than as individuals, thus reducing the effective sample size. There is some evidence of this in the overall RTTP tagging data – there are 25 instances of 2 or more tagged yellowfin being recaptured in the same purse seine set 100 days or more after being released from the same school. If such cohesive behaviour is common, the observation of very few longline returns could occur by chance with a higher probability than indicated by the statistical tests, which assume independence.

- Large yellowfin tend to belong to one of two groups, one available principally to surface gear such as purse seine and the other available principally to subsurface gear such as longline. In this case, few longline returns would result if most of the

tag release effort was directed towards the surface group. While there is no direct evidence that this is the case, some characteristics of the tag return data suggest that different groups of tagged yellowfin may have had different availability ot longline gear. Two of the four longline recoveries were released from the same school, while the other two were released in the same location two days apart. Several similar instances have been noted for the SSAP yellowfin releases, where only 12 longline recoveries were recorded. A consistent feature of most longline recoveries of tagged yellowfin from both the SSAP and RTTP is that they were of larger than normal size at release (>60 cm FL). By contrast, the returns of large yellowfin by purse seiners were generally of the smaller, typical size when released (50-60 cm FL). At this stage, it is not clear why size at release might be correlated with the probability of capture by longline.

While no definitive results have been obtained from this study, we have established that there has been a significant shortfall in returns of large tagged yellowfin by longline, and identified several hypotheses that might explain this observation. During 1994-95, collaboration with the I-ATTC and possibly ORSTOM is planned to see if tagging data sets in the eastern Pacific and Atlantic Oceans exhibit similar features. Depending on the results and on the availability of funding, a research project aimed at testing some of the proposed hypotheses might be planned. One possibility would be a tagging experiment on yellowfin captured by longline, using conventional and/or archival tags.