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Indonesian Fishery School data on Southern Bluefin Tuna: summary and preliminary analyses

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Indonesian Fishery School data on Southern Bluefin Tuna: summary and preliminary analyses

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Abstract

Trainees from Indonesian Fisheries Schools have accumulated an enormous amount of information on daily fishing operations of the Benoa-based longline fleet, including catch and effort data from 1995 to the present. Although the program was not designed for the collection of operational fisheries data, but simply to fulfill a training requirement for the students, the data are nonetheless potentially valuable as it provides the only detailed information on the operations of the fleet which fishes on the spawning grounds. Information from the student's logsheets were entered into a database. The data entered spans the years 2000 to present and includes catch data on almost 59,000 longline sets from just over 2000 different fishing trips.

This paper presents summary information on effort and southern bluefin tuna catch from this dataset in an attempt to characterise the operation of the fleet. It is, however, important to remember that the coverage by students is not even through the year or over the fleet. The size of the dataset, the nature of the data collection process and the fact that SBT is primarily taken as a bycatch makes this a difficult dataset to analyse, however, and results presented here are still preliminary.

Introduction

Biological sampling and catch monitoring programs set up in Indonesia in the 1990s have provided crucial data for the understanding of SBT spawning dynamics, the quantification of the catch and the characterisation of the size and age composition of the catch. There has, however, been a lack of information on catch rates of SBT from the longline fleet fishing on the spawning ground during the spawning season. Such information is important for understanding the impact of fishing and the status of the spawning component of the stock.

Across the Indonesian archipelago there are over 20 Fisheries Schools that provide training to students wishing to become fishers, skippers, and fishing masters. As part of their final year of training and as a prerequisite for graduation, students must successfully complete a full fishing trip at sea aboard a longline vessel. The average length of the trips is 30 – 40 days. This fisheries student 'observer' program was an initiative of WASKI ("Unit Pengawas Kapal Ikan" = Unit for control and surveillance of fisheries vessels), a government office in the Port of Benoa that is under the Directorate General of Marine Resources and Fisheries Control. The potential to use these data to try to address the lack of information on catch

[1] CSIRO Division of Marine and Atmospheric Research, Hobart
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rates and to gain a better understanding of the fishery on the spawning grounds was recognised, and with the excellent cooperation and assistance from WASKI a collaborative project was set up (see below for detail).

Since the program began in 1995, WASKI has managed the placement of students on longline fishing vessels and also the archiving of the data collected by them. The students are provided with data sheets on which they record daily catch of the main tuna species, as well as information such as, setting position, gear details and number of hooks used. The Manager of WASKI at Benoa, Mr Nengah Nesa, has emphasised that the Fisheries School Program was not designed for, nor ever intended to provide operational fisheries data, but simply to fulfill a training requirement for the students. However, through the program, an enormous amount of information has been accumulated on daily fishing operations of the Benoa-based longline fleet with specific fishing locations, and catch and effort data from 1995 to the present (unfortunately WASKI staff have not been able to locate the data sheets from years pre-2000 and these are now considered lost or destroyed). As each trip involves a different student recording catch and gear details, and with only limited observer training skills provided to the students before they journey to sea, there is wide variation in quality and quantity of data recorded (reflecting each individual's ability and motivation at sea, and the latter undoubtedly influenced by the student's susceptibility to seasickness). Those records that provided the basic information needed to determine CPUE for the key tuna species by location were entered on a database prior to analysis. The data entered spans the years 2000 to present and includes catch data on almost 59,000 longline sets from just over 2000 different fishing trips.

Building on earlier collaboration between RIMF[7] and WASKI, to examine the utility of the fisheries school data, in 2004 CSIRO began collaboration with both these organisations, and with RCCF[8] and DGCF[9], on projects to: 1. develop a database to accommodate the data, 2. train Indonesian scientists in data entry and database access, and 3. analyse the data, particularly in terms of catch rates, species composition and bycatch. This paper presents only very preliminary summaries and the further analyses will be conducted jointly by CSIRO and RCCF/RIMF.

The dataset

The database currently contains trip and set records for Indonesian longline vessels spanning the years 2000 (October) to 2005 (June). The 2037 trips listed contain data pertaining to 58,702 observed sets. The trip data also contain information on vessel details (e.g. gross tonnage) and hull type, though these fields are not always filled in. All records are for vessels operating out of Benoa.

The database currently has significantly higher number of sets recorded for third and fourth quarters, reflecting an aim to prioritise the entry of data pertaining to SBT, and possibly also relating to seasonal variation in fishing effort (to be confirmed) and the timing of the observer component of the student programs. There were 'quiet months' when not as many students were going to sea because of school holidays, i.e. January and February. From recent

[7] Research Institute of Marine Fisheries, Jakarta
[8] Research Centre for Capture Fisheries, Jakarta
[9] Directorate General of Capture Fisheries, Jakarta

discussions with WASKI, we understand that the number of students is now so high that all months are being used for going to sea. Set details include location (latitude & longitude), time of setting and time of hauling. Gear details include float line length, branch line length, number of baskets and hooks per basket. The catch, in numbers, of the main tuna and billfish species are recorded for each set.

It is important to bear in mind that the nature of these data are such that they do not necessarily represent a random sample of vessels in the fishery. There are likely to be many factors that could bias the allocation of students to vessels (e.g. preference for shorter trips or nearshore trips, company preferences and willingness, lack of space to take students on some or many vessels). We therefore strongly caution against extrapolating from these data to the whole fleet. For the same reason, we use the term ‘observed fishery’ to refer to that part of the fleet which is reflected in this dataset, noting however that they are actual commercial longline vessels.

Approach to analysis

This Fishery School data is a relatively complex dataset which has been collected in a manner that differs, in a number of ways, from most fishery logbook or observer programs. We therefore consider that the progression of the data analyses towards development of standardised catch rates should be undertaken carefully and in three phases:

1. Exploration and documentation of data characteristics/reliability
2. Preliminary analyses and summarisation
3. Catch rate standardisations

The first stage has being ongoing over the past 12 months and has served to inform and guide the preliminary analyses and summarisation undertaken in stage 2, which is the subject of this paper. The more complex analyses associated with catch rate standardisations are currently underway and will be reported on in the near future. We note that the most up-to-date version of the dataset (including data for the first 6 months of 2005 which only became available a few weeks ago). There are still possible data errors that need to be re-checked and resolved before more detailed analyses can be undertaken.

Preliminary analyses, further discussed below, suggested that the observed fishery has expanded/moved fishing operations further south over the time period (2000-2005). It is therefore important to take ‘area’ into account when analysing or summarising the data. Of particular interest is the southern bluefin tuna (SBT) spawning ground. Three areas were considered:

Area 1 – spawning ground, 10S-20S, 100E – 130E
Area 2 – South of area 1, 20E-40E, 80E – 110E
Northern Area - North East of area 1, 0S-10S, 100E – 135E

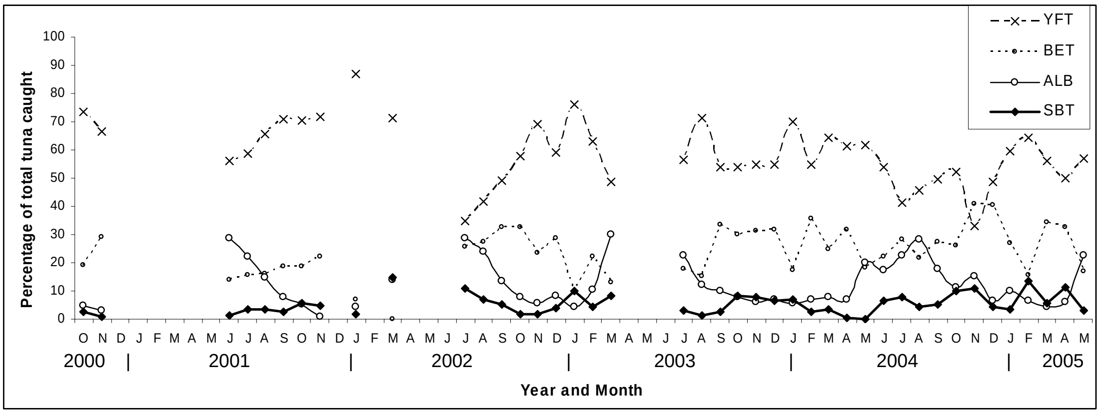
Areas 1 and 2 are essentially the same as those used for SBT longline fishery definitions. The third area was primarily chosen to include fishing to the North of Area 1. It is worth noting that much of the fishing effort in the northern area occurs in the north-east, between 120E-135E, but there is some effort west of this region and these have been included in the larger area for analyses.

Exploration and Data Summaries

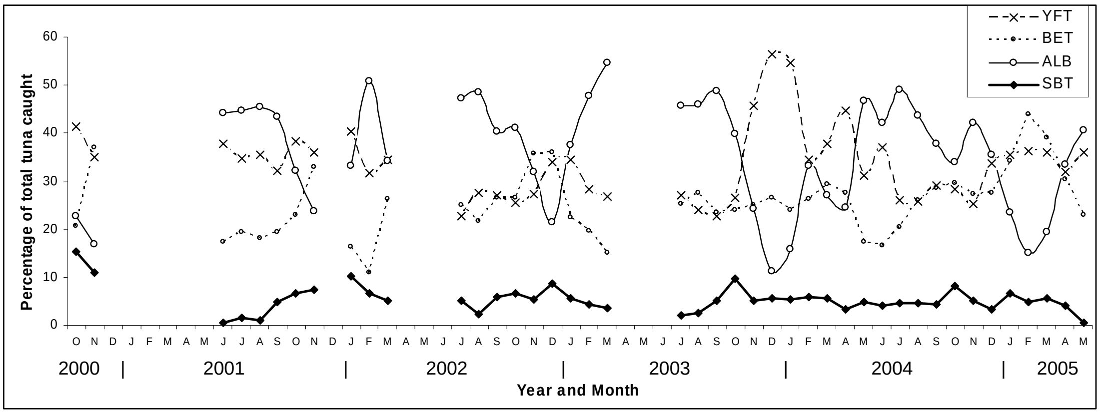
Species Identification

The percent yellowfin, bigeye, SBT and albacore per month and area was summarised to explore whether there were any obvious indications of a serious problem with species identification by the students. Figure 1 shows some differences in the three areas. For SBT in area 1, the general pattern is quite similar to that seen in the monitoring data from Benoa (DGCF et al. in prep.[10]) and the relative percentage is also within the same range (0-10%). There may be some particular months (e.g. non-spawning months in the middle of the year) when the percentage SBT is possibly slightly higher than expected in some years (~5% when a figure closer to 0% is expected), but on the whole there does not seem to be a major problem.

NORTHERN AREA (0-10S, 100E-135E)



AREA 1 (10S-20S, 100E-130E)



AREA 2 (20S-40S)

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[10] **DGCF-RCCF-IOTC/OFCF-CSIRO/ACIAR/DAFF (in prep) Preliminary Results of the Multilateral Catch Monitoring Programme on fresh-tuna longliners operating from ports in Indonesia. IOTC-2005-WPTT-06**

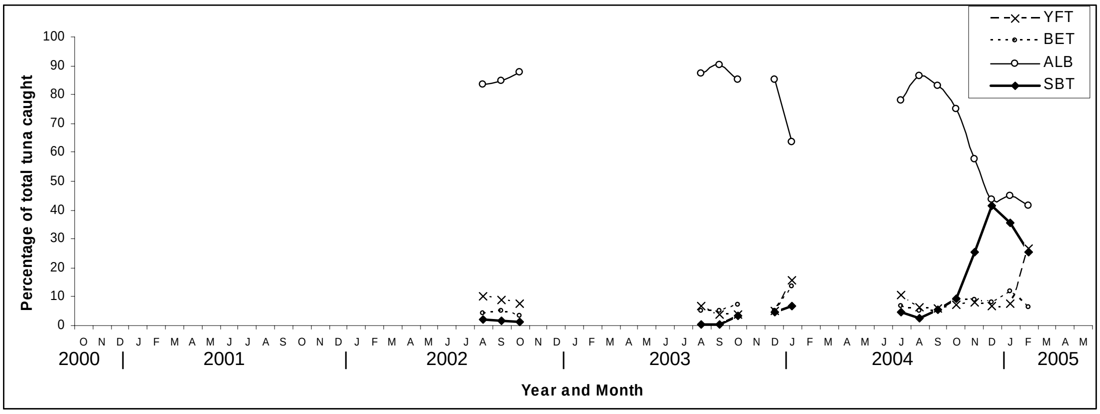

Figure 1: Percentage SBT in the catch (in numbers) for the three areas by month and year starting in October 2000 and ending May 2005, for months with >100 000 hooks set.

Observed sets in the database

We have already noted that the coverage, in terms of number of trips and sets, is not even through the year. This is relevant in terms of summaries, for example mean values of quantities, since low sample sizes (i.e. small number of sets) would lead to less reliable and more 'noisy' estimates. Figure 2 shows the patterns over months for all sets and areas. It is clear from this that a large proportion of the sets in the current database are from the 3rd and 4th quarters. The figure also reflects the comment by WASKI (see above) that in recent years all months are being used by students for going to sea, whereas previously there were 'quiet months' (e.g. in January and February).

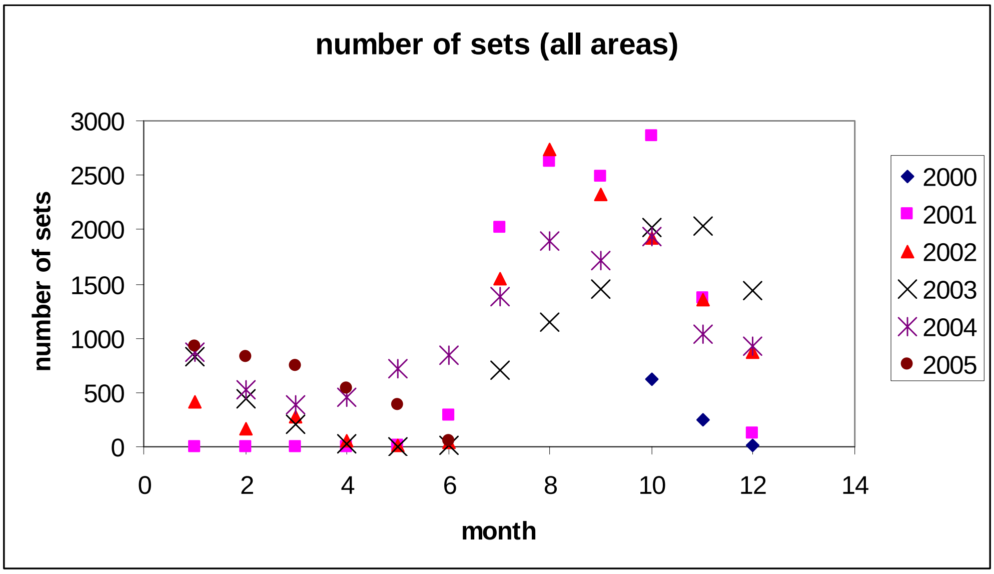

Figure 2: Number of sets in the whole dataset (all areas) by month and year.

Area 1 (Spawning ground)

The amount of observed fishing effort in Area 1 varies by month, with considerably less data collected in the first and second quarters compared to the third and fourth quarters of each year. This variability in monthly sample sizes should be kept in mind when interpreting the following summaries, which focus on data for the SBT spawning months (October to February) . The number of sets in the database for March was too low to justify its inclusion in the data summaries, and March is in any case towards the end of the spawning season.

Figure 3 illustrates the variability in monthly sample sizes for Area 1. Month-year combinations with less than 20 sets were excluded from figures (there were only 2 month-year combinations).

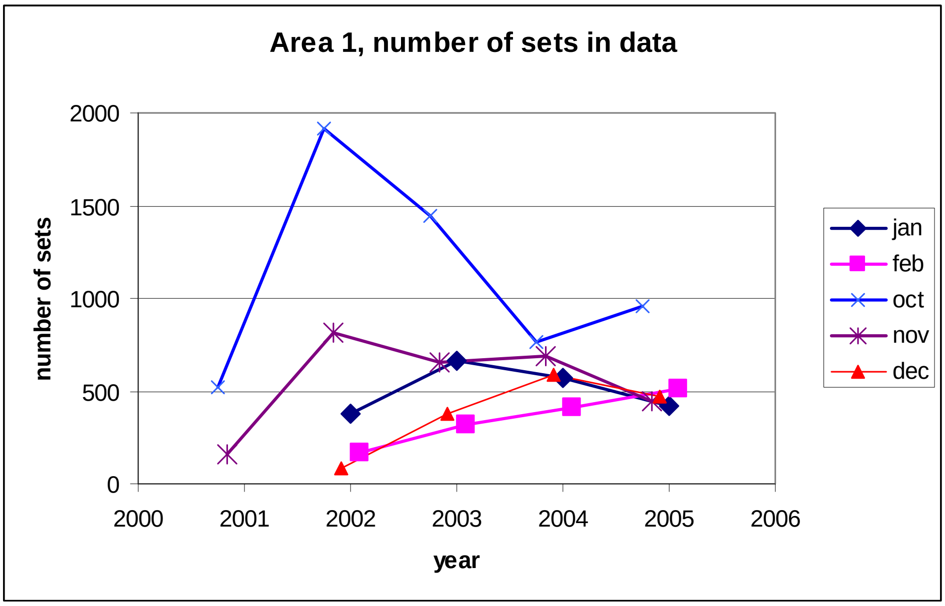

Figure 3: Number of sets in the database for Area 1 by year and for each of the main SBT spawning period (October to February).

Given the many sets with no SBT recorded, it is informative to consider the proportion of sets with 1 or more SBT caught. These are referred to as 'positive SBT'. Figure 4 suggests that the proportion of sets with at least one SBT has declined over the years. This pattern is evident, to a greater or lesser extent, in each of the months,. Note, these values are 'nominal' (i.e. the series has not been standardised).

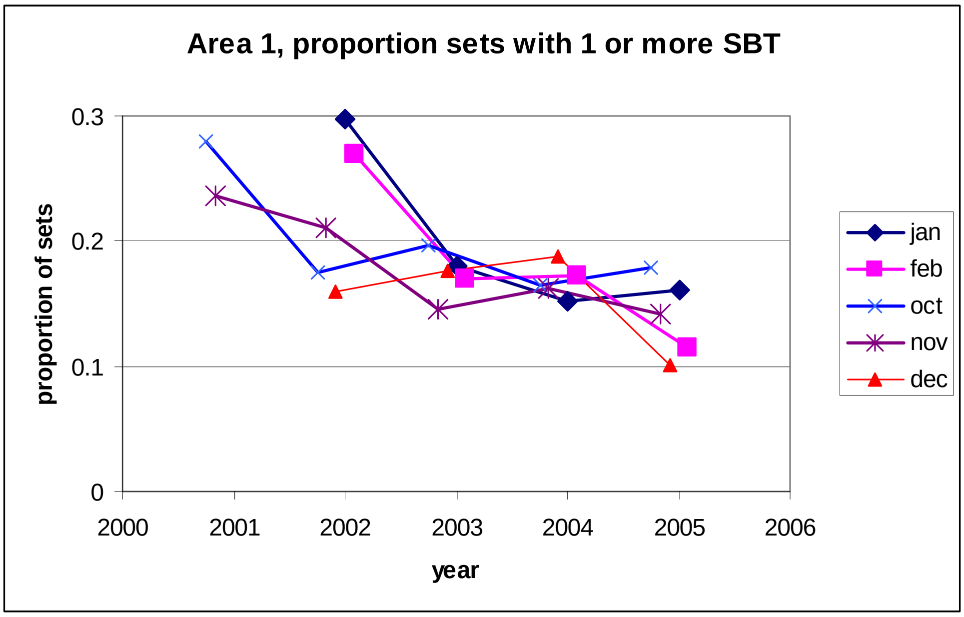

Figure 4: The proportion of sets with 1 or more SBT in the catch by year and for the main spawning months in Area 1.

The overall nominal CPUE, based on all sets (i.e. including sets which caught no SBT), also seems to show a decline over time (Figure 5), though this is strongly influenced by the early points in the series. For example, a linear regression on all points (CPUE vs time) has a significant slope which suggests a drop over the whole period of almost 60%. When the first, highly influential, point (October 2000) is removed, the slope is still significant but suggests a 30% drop[11]. The same conclusions can be drawn directly from the figure. It is also clear that , apart from December, the nominal cpue for the last three spawning seasons is relatiavely flat, and it is mostly the 2001/2 and 2002/3 seasons which drive the negative slope.

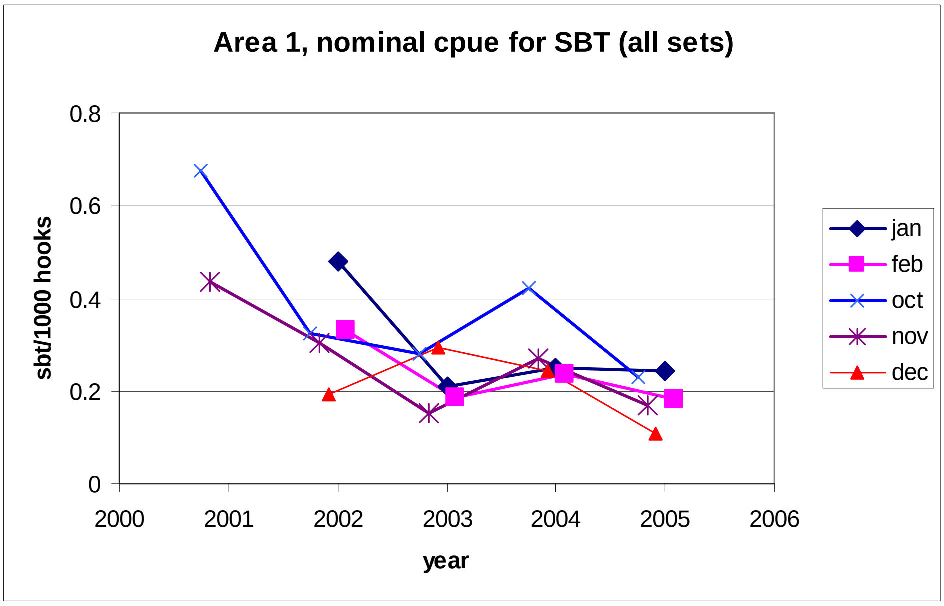

Figure 5: Nominal CPUE (number of SBT per thousand hooks) by month and year in Area 1 for ALL sets (i.e. including those where no SBT was caught).

[11] There is less difference between the slope of a regression with the first point included or excluded when done on log(cpue) against time. With the point included the drop is around 57%, and with the point excluded, the drop is around 50%.

It is worth re-iterating that caution is required when interpreting this information. We have already listed caveats regarding the dataset, and the fact that Figure 5 represents NOMINAL, not standardised, CPUE. However, it should also be remembered that SBT is essentially a bycatch in this mixed-species fishery. It is informative to consider the catch rates and proportions of “positive sets” for the other main species in the catch: yellow, bigeye and albacore (Appendix 1). None of these show strong patterns of decline or increase over time, so there is no obvious alternative explanation for the apparent decline in these quantities for SBT.

It is also informative to consider whether there is likely to have been a substantial change in fishing depth over the period. We used the approach taken by Davis and Farley (2001) where the “bigeye index”, i.e. the proportion of bigeye to the sum of bigeye and yellowfin, is used as a proxy for depth. This approach is used based on the fact the bigeye tuna prefer deeper waters than yellowfin tuna. It should be noted that Davis and Farley (2001) used the index in relation to the size of SBT being caught, not the catch rate. The intended use here is simply as a proxy for depth and to determine whether the proxy shows a trend over time. The intention is NOT to make any inferences about a relationship between the proxy and SBT catch rates . The bigeye index was calculated by month and year (in Area 1 and excluding records where both yellowfin and bigeye were zero), and Figure 6 does not show any strong trends in this index to suggest that there has been a substantial change in depth being fished.

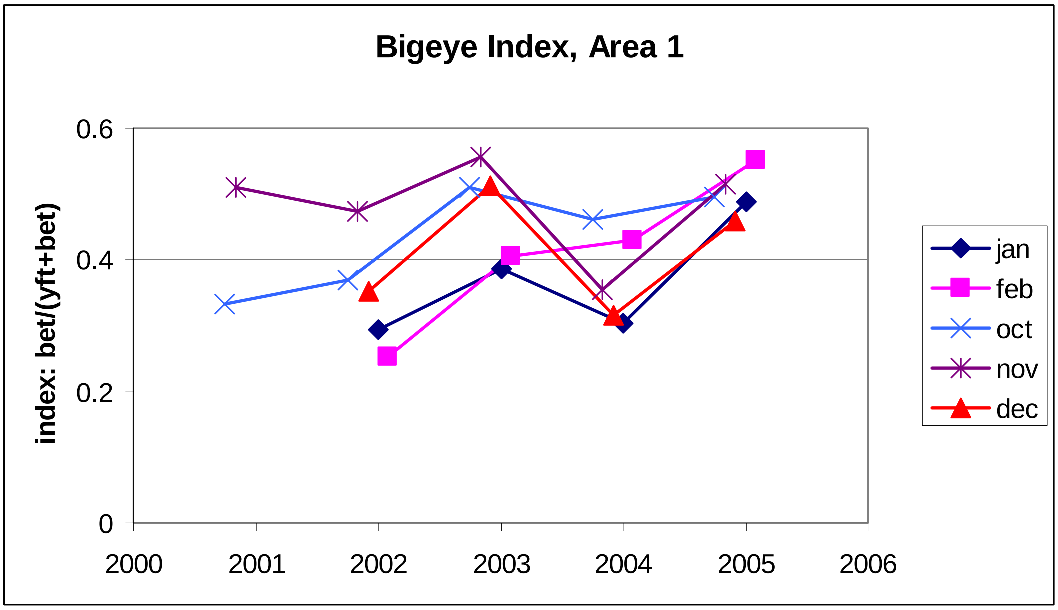

Figure 6: The ratio of bigeye to the sum of bigeye and yellowfin in the catch over the spawning months in Area 1.

<u>Northern Area (North of Area 1)</u>

There are generally fewer sets in the Northern Area than in Area 1, but the pattern by months is similar, as expected (Figure 7). Similar summaries have been done for this area and are plotted on the same scales as those for Area 1. Only the spawning period is considered and months with fewer than 20 sets have been excluded. Catch rates of SBT and proportions of sets with at least one SBT are generally lower in this area where the focus may be more on yellowfin (slightly larger proportions of yellowfin in the catch compared to Area 1). There is no trend in either of these quantities in the Northern Area (Figure 8 and Figure 9).

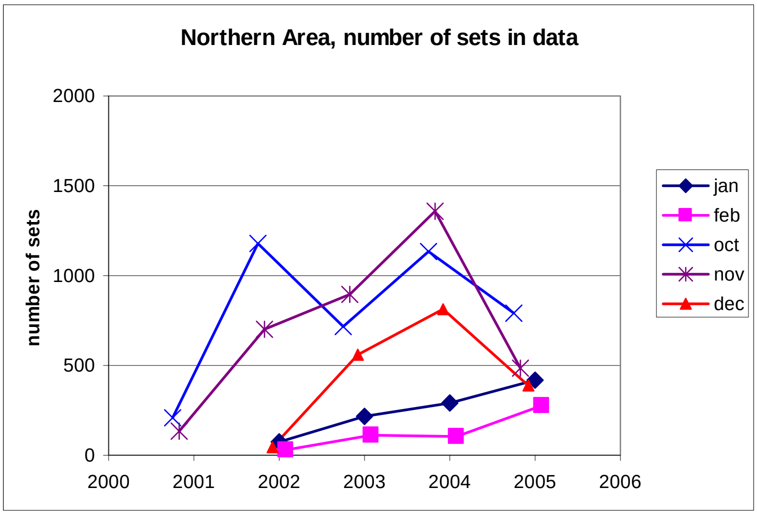

Figure 7: Number of sets in the database for the Northern Area by year and for each of the main SBT spawning period (October to February).

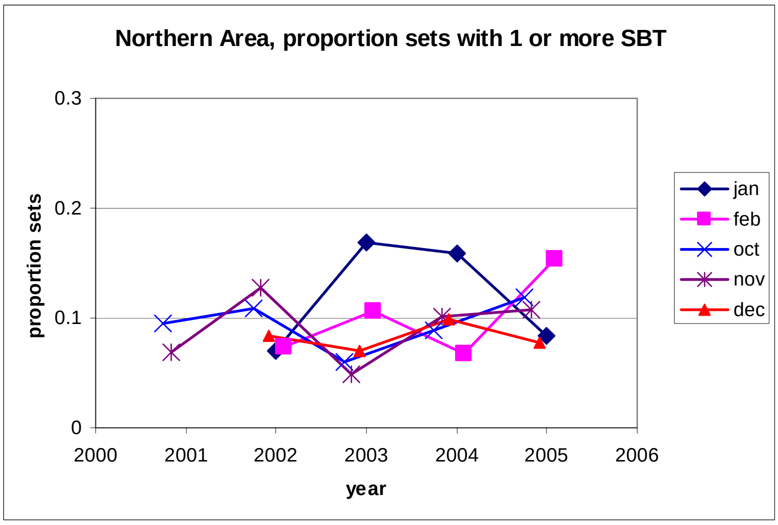

Figure 8: The proportion of sets with 1 or more SBT in the catch by year and for the main spawning months in the Northern Area.

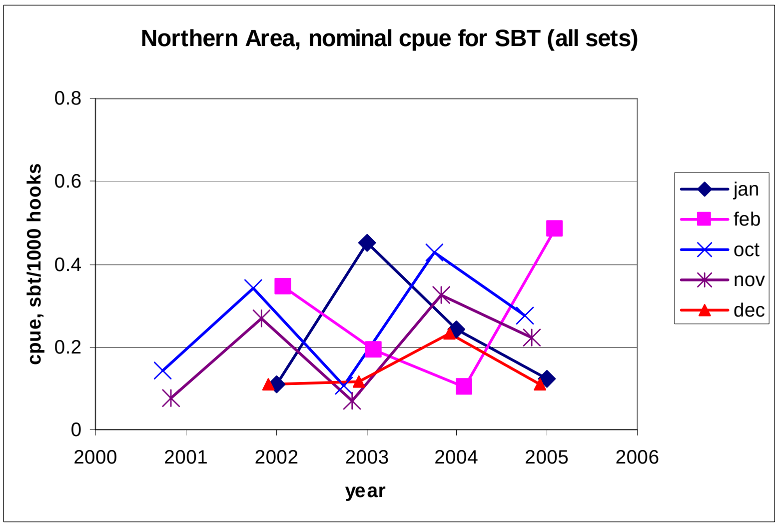

Figure 9: Nominal CPUE (number of SBT per thousand hooks) by month and year in the Northern Area for ALL sets (i.e. including those where no SBT was caught).

Area 2 (South of Area 1)

The main points to note with respect to the observed fishery in Area 2 is the apparent expansion or southward movement over time (

Table 1). Given that the temporal coverage of this area is consistent in the dataset, we do not consider the pattern in Table 1 to be due to (or at least not primarily due to) to changes in seasonality. It is also interesting to note that these sets contain large proportions of albacore, which is consistent with observations from some other fisheries operating in the southern parts of Area 2 (e.g. Taiwanese fleet). The mean latitude (within Area 2) has also increased over the 5 years from about 23°S in 2002/3 to around 26°S in 2004/5.

Table 1: Proportion of observed hooks in the dataset south of 15°S or 20°S over time. The longitude 15°S is still in Area 1; 20°S is the border between areas 1 and 2.

	2001	2002	2003	2004	2005
south of 15 ^{o}	5%	8%	11%	14%	22%
south of 20 ^{o}	0%	1%	5%	8%	17%

Figures in this section are not plotted at the same scales as for Area 1 and the Northern Area. Note that the number of sets (Figure 10) are much less, but that the maximum nominal CPUE and proportion positive SBT sets is much larger in area 2 than in areas 1 and NE.

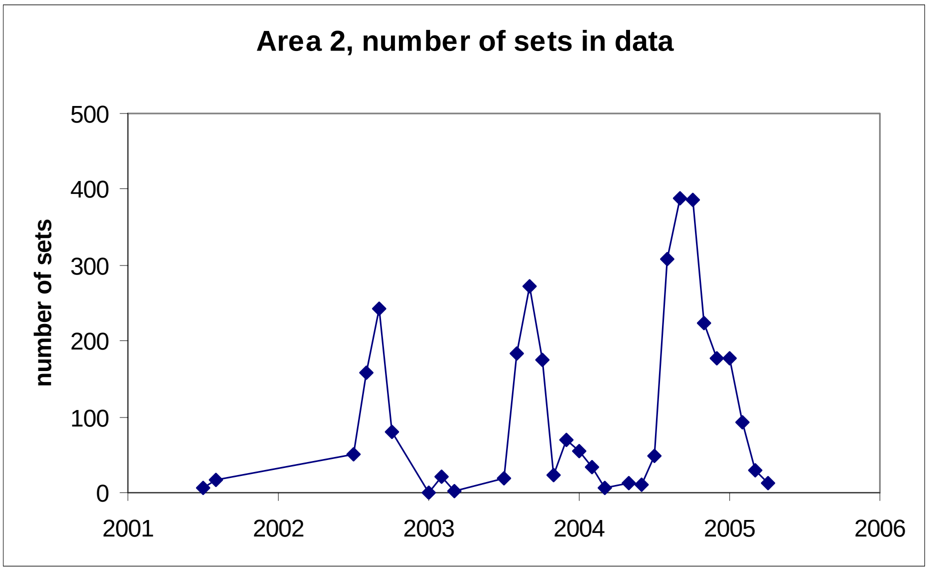

Figure 10: Number of sets in the data in Area 2 by month and year.

The proportion positive SBT sets (Figure 11) and CPUE (Figure 12) peaked in the summer months of 2004/05. The drop towards the end (February and March) is most likely to be a seasonal effect. As noted before, it is difficult to infer what section or proportion of the fleet, these observed vessels in our database represent. Nonetheless, since these vessels are part of the commercial fleet, there is clearly now some fishing by Indonesian longliners occurring in Area 2.

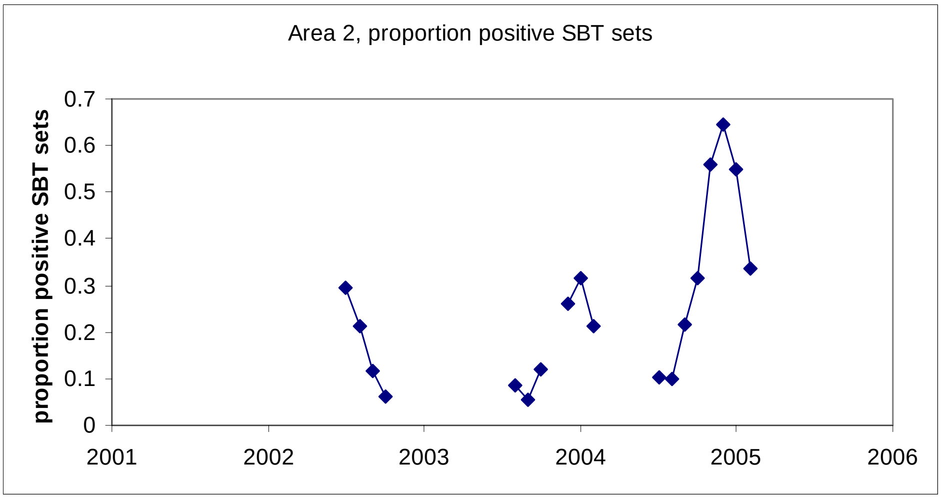

Figure 11: Proportion sets with at least one SBT in area 2 for all months in the database.

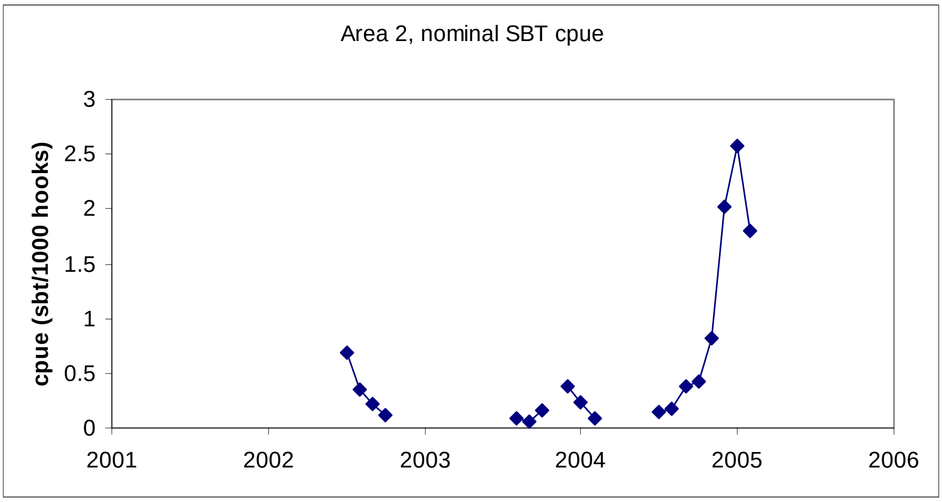

Figure 12: Nominal CPUE (number of SBT/1000 hooks) in Area 2 by month and year (the last month shown is February 2005).

Summary

The Fishery school dataset has already been valuable in showing changes in the observed fishery which, at least to some extent, will reflect changes in the whole fleet. There appears to be an increase in fishing in Area 2, particularly in the south of that area. In Area 1, there appears to have been a drop of possibly as much as 50% between 2000/01 and 2004/05 in the nominal CPUE of observed vessels fishing during the spawning months. In the Northern Area , there is no trend apparent, but catch rates of SBT are generally lower. Also, the maps of larval distribution in Nishikawa et.al. (1985) suggest that this is not a major part of the SBT spawning ground which is more fully contained in Area 1. We again note that the summaries presented here are for nominal CPUE and not standardised for environmental or operational factors. Furthermore, vessels are engaged in a mixed species fishery, and the interpretation of trends in single-species indicators should therefore be made with care.

The intention is to more fully analyse these data with the hope of developing a standardised index of abundance over the coming year. Recently a trial scientific observer program has commenced on longline vessels operating out of Benoa, as part of an Indonesia-Australia collaborative project funded by Australian Centre for International Agricultural Research (ACIAR). This program will hopefully fill many of the information gaps, for example, the level to which SBT are targeted within the different areas and the level of variability in fishing practices between vessels. It is also hoped that the scientific observer program, in collaboration with WASKI, can be used to improve the quality and utility of the data generated by the fisheries school program. A second key component of the ACIAR project is development of Indonesia's capacity for scientific stock assessment. Two trainees with strong mathematical backgrounds have been recruited to RCCF and are currently receiving training in stock assessment skills in both Indonesia and Australia. A primary focus of their work will be analysis and reporting of data from the fisheries school program and that collected within the new observer program.

Acknowledgements

The authors wish to strongly acknowledge WASKI and thank Nengah Nesa and Ketut Mordinatha in particular for providing ongoing access to the fisheries school student data, and for their cooperation in discussing all aspects of the program. A meaningful assessment of these data would not have possible without their valuable contributions. We also thank Budi Iskandar Prisantoso (RCCF) and Scott Cooper (CSIRO) for database management and Rela Febriani Lupitasari and Mujimin for data entry at the Research Institute for Mariculture (Gondol).

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Appendix 1

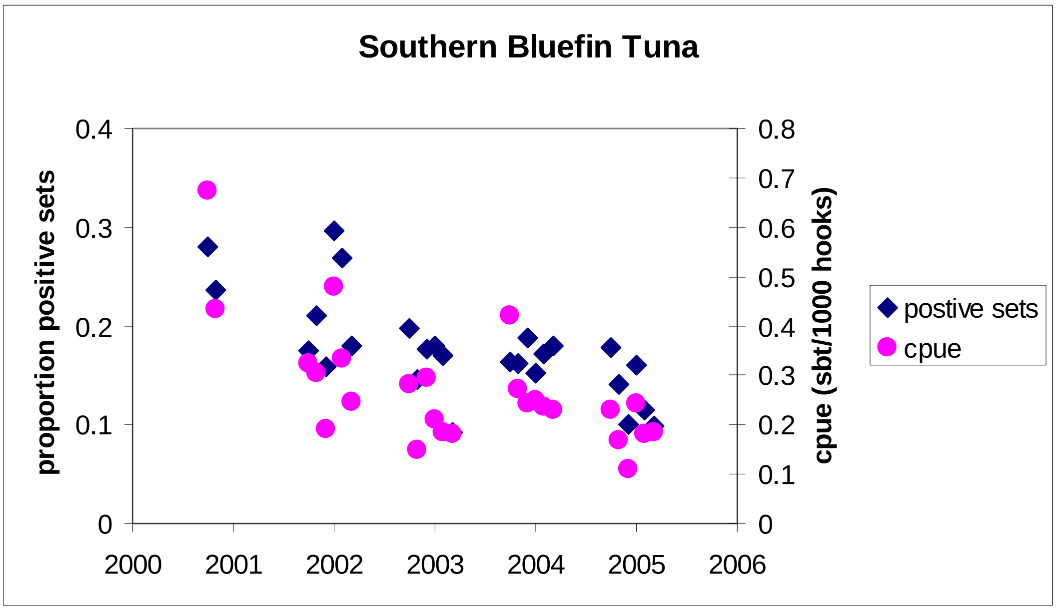

Figure A 1. SBT: Proportion positive sets (i.e. with at least one SBT caught) and nominal catch rates in Area 1 during the spawning season.

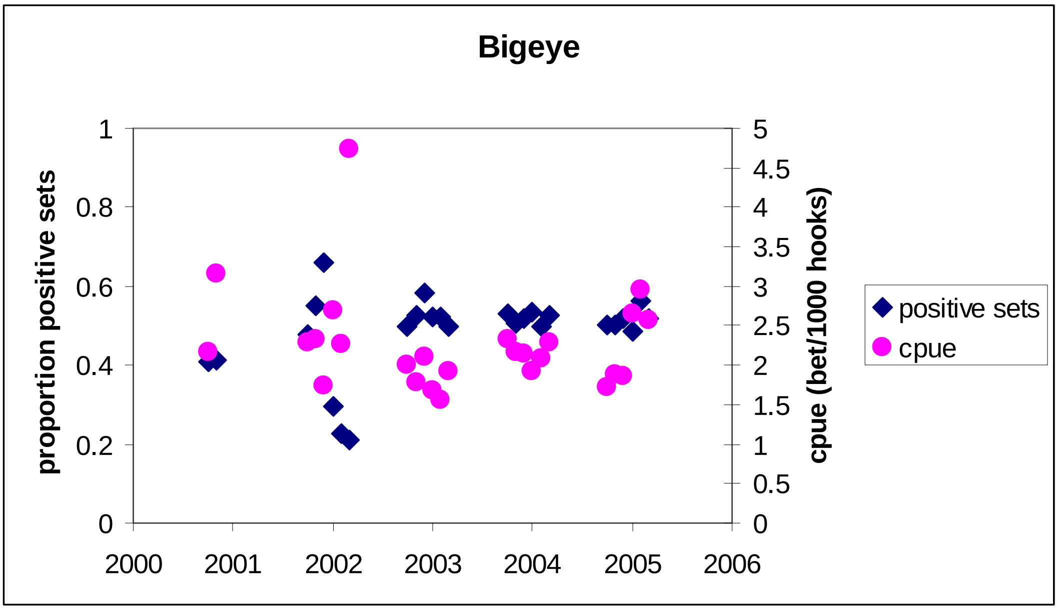

Figure A 2. Bigeye: Proportion positive sets (i.e. with at least one BET caught) and nominal catch rates in Area 1 during the spawning season.

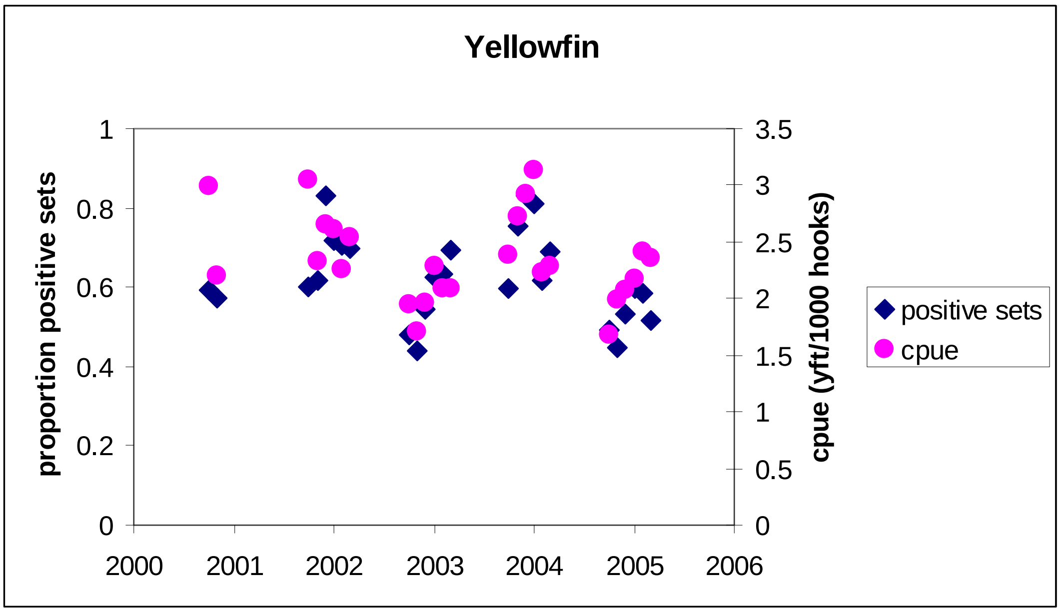

Figure A 3. Yellowfin: Proportion positive sets (i.e. with at least one YFT caught) and nominal catch rates in Area 1 during the spawning season

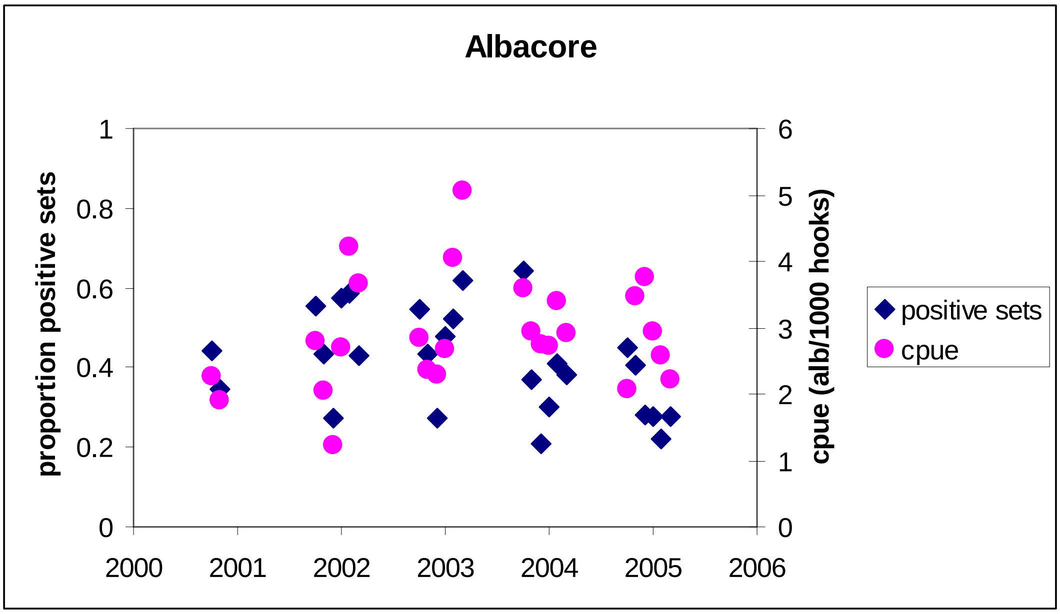

Figure A 4. Albacore: Proportion positive sets (i.e. with at least one ALB caught) and nominal catch rates in Area 1 during the spawning season