An update on the use of the Indonesian Fishery High School dataset to obtain a standardised CPUE series for SBT on the spawning grounds.

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Abstract

Trainees from Indonesian Fisheries High Schools have accumulated an enormous amount of information on daily fishing operations of the Benoa-based longline fleet, including catch and effort data. In 2004, a project was set up to enter fisheries data from the Fisheries High School (FHS) 'Observer' program. The database now contains data from student's logsheets spanning the years 2000 to the present. At time of writing (July 2007), a total of 80,528 long line sets had been entered into the database, with 6,257 sets entered during 2006/2007. A total of 1,453 SBT were entered as catch in the database during this period.

In 2005, data summaries and very preliminary results from investigations were presented in a a working paper to the CCSBT (Basson et.al 2005, CCSBT-ESC/0509/17). Further investigations of the data have raised some concerns about the quality of the data collected by the FHS students, particularly with respect to some of the fishing location information and some of the species identifications. WASKI had made it very clear from the beginning that these data should be treated 'with caution' in any scientific analyses as their FHS program was not originally designed to provide robust observer data. However, we still consider a thorough analysis of the FHS data to be worthwhile as it is likely there will be some useful CPUE information that can be extracted from the dataset.

Improvements to the level of training provided to the FHS students before they depart have are being made in the hope that the FHS program can become a more reliable and valuable source of observer-generated data for the longline fleet.

This paper presents an update on the Fisheries High School data collection, investigations to date, and implications for the development of a CPUE series based on these data.

Introduction

Biological sampling and catch monitoring programs, that were first established at Benoa fishing port in Bali in the early 1990's, 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 and more recently the catch rates of SBT caught south of the spawning ground (see Proctor et al. 2006 for discussion of the 'southern zone' fishing activity). The port-based monitoring provides good data on the amount of SBT landed by the Indonesian longline fleet but is not able to provide the type of CPUE information that is required for a full understanding of the impacts of fishing, the factors that influence trends in the catch over time, and the reasons behind changes in 'behaviours' of the fishing fleet. An understanding of all these is, in turn, required for conducting scientific stock assessments for all key species within the fishery.

In efforts to address this shortage of CPUE information, Indonesia and Australia have collaborated to establish a direct source of CPUE data through a trial observer program (see Sadiyah et al. 2007, CCSBT-ESC/0709/Info XX), and, in addition, have been collating and analysing data from an existing 'observer program'. Across the Indonesian archipelago there are over 20 Fisheries High Schools (FHS) 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, the 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 FHS 'observer' program was an initiative of WASKI ("Unit Pengawas Kapal Ikan" = Office 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 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).

Preliminary investigations of the FHS data were done by Don Bromhead (Bureau of Rural Sciences, Australia) in collaboration with CSIRO Pelagic Fisheries and Ecosystems Group (PFE). The results of some of those investigations were reported to the 2005 CCSBT Scientific Meeting (Basson et al. 2005). The data filtering (clean up) of the data during those preliminary analyses was only relatively coarse. Subsequent to that early report, further investigations of the data have been done by CSIRO PFE staff and by Lilis Sadiyah, stock assessment trainee from RCCF who is currently based at CSIRO in Hobart and University of Tasmania as part of an RCCF/ACIAR/CSIRO project. In this paper we discuss some of these further exploratory analyses and the implications for standardised CPUE.

Methodology and Results

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 unrecoverable. As each trip involves a different student recording catch and gear details, and with only limited training on observer 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).

During the past three years, copies of the FHS logsheets (year 2000 – present) have been provided by WASKI to the project, and with the support of funding provided by Department of Agriculture, Fisheries and Forestry (Australia), the basic information needed to determine CPUE for the key tuna species by location have been entered on a database by staff at Research Institute for Mariculture, Gondol, in north Bali.

The number of Fisheries High Schools that provided students for on-board training increased from 13 in 2000 to 19 schools in 2005 (Table 1). The number of students involved increased from 465 students in 2000 to 706 students in 2002, but decreased in the following years to 444 students in 2005. The primary reason for this decline is that the number of active vessels at Benoa largely determines the number of opportunities available to WASKI for placement of the students. Vessel activity was greatly reduced in the third quarter of 2005, following the

dramatic fuel price rise (> 100% increase following a lowering of Indonesian Government subsidies), which resulted in vessels of many fishing companies becoming less active. The number of students going to sea for the year subsequently decreased during 2005 to 444, a reduction of ~ 13% relative to 2004.

Table 1. Number of Fisheries High Schools and the number of students who participated in the training trips to sea, during the period 2000 – 2005.

Year	Number of Schools	Number of Students
2000	13	465
2001	15	701
2002	16	706
2003	18	549
2004	18	508
2005	19	444

Source: WASKI

At time of writing, a total of 80,528 long line sets had been entered into the database (Table 2 and Table 3), with 6,257 sets having been entered during the past year (July06-June07), and the sets themselves having been done by vessels during the period April 2005 to June 2007. Data from these sets included a total of 5263 SBT, bringing the total of SBT in the database to 27,466 (Table 4).

Table 2. Summary of Indonesian Fisheries School 'observer' data entered each month during the period July 2006 – February 2007, and total number of sets entered to date.

Month	Cumulative total sets entered	Sets entered /month	Months Fishing
Jun'06	68304		
Jul'06	68938	634	Jun 05, Feb 06
Aug'06	69471	533	Sep 05, Apr 05
Sept'06	70518	1047	Aug 05, Apr 06
Oct'06	71262	744	Jun 05, Jan 06
Nov'06	72394	1132	Dec 05, July 06
Dec'06	73656	1262	Jul 05, Aug 06, Oct 05
Jan'07	74796	1140	Feb 06, Nov 06
Feb'07*	76506	1710	Jun 06, Nov 06
March'07	77903	1397	Jun.06;Oct.06
April '07	79565	1662	Feb.06;Jan.07
May'07	79588	23	Des.06;Jan.07
June'07	80455	867	Jul.06;Feb.07
Total	**80455***	**12151**	

*to 13 July 2007

Table 3. Summary of the number of longline sets, covered Fisheries High School observations, by month and year, entered into the database up to 25 July 2007.

Month	2000	2001	2002	2003	2004	2005	2006	2007	Total
1			437	837	902	1040	506	376	**4098**
2			190	472	555	1016	821	135	**3189**
3			311	240	425	1103	957	200	**3236**
4			58	35	489	898	869	261	**2610**
5		14	17		756	882	1173	101	**2943**
6		299	47	20	895	1021	1073	31	**3386**
7		2,125	1,635	1,375	1469	1425	1108		**9137**
8		2,768	2,989	2,440	2012	1642	1358		**13209**
9		2,634	2,532	2,670	1830	1741	961		**12368**
10	719	3,068	2,215	2,457	2066	2074	575		**13174**
11	282	1,506	1,516	2242	1136	1037	438		**8157**
12	16	129	911	1540	1003	709	713		**5021**
Total	**1,017**	**12,543**	**12,858**	**14328**	**13538**	**14588**	**10552**	**1104**	**80528**

Table 4. Summary of the number of tuna caught (by species), as recorded by Fisheries High School Observers, entered into the database up to 25 July 2007.

Year	No. of trips	No. of sets	No. of hooks	**Southern bluefin**	Yellowfin	Bigeye
2000	47	1017	1131857	**489**	3054	1347
2001	605	12543	14249654	**3195**	42828	18414
2002	563	12858	14763211	**3534**	25073	17999
2003	489	14328	17296911	**4157**	30919	19453
2004	355	13538	17282483	**4653**	23980	15793
2005	359	14588	16096409	**6280**	28112	21501
2006	279	10552	12608448	**4750**	17906	15937
2007	40	1104	1255052	**388**	3824	2262
Total	2737	80528	94684025	**27446**	175696	112706

The more recent exploratory investigations of the FHS data have raised some concerns about the quality of the data collected by the FHS students, particularly with respect to some of the fishing location information and some of the species identifications – there are many observations among the data that appear highly questionable. WASKI had made it clear from the beginning that these data should be treated 'with caution' in any scientific analyses as their FHS program was not originally designed to provide robust observer data. The students are provided with some training on how to collect data at sea, but from what we have been told by WASKI staff, it appears many of the students rely heavily on information provided to them by vessel personnel - skippers, fishing masters, and crew. During the very busy periods during fishing operations, such as hauling, it is likely the information provided by the vessel personnel to the students is not always accurate, as the vessel personnel would not be aware of any need for provision of accurate data i.e. their impression may be that any data will suit the training needs of the student.

There are three primary areas of concern with respect to the FHS dataset:

1. Within the dataset there are some highly questionable catch locations. For example, 720 longline sets (~1% of sets entered) were recorded with Lat & Long positions that

correspond to locations on land, not at sea. 371 sets were recorded with Lat & Long positions that correspond to locations in the Java Sea where longline vessels from Benoa are not known to operate. The students do not carry GPS units and rely on vessel positions provided by the vessel's skipper or fishing master, or what they can obtain from the vessel's GPS themselves (but, in general, the students are not permitted to work in the vessel's wheelhouse where the GPS normally resides). It is therefore not unexpected that the positional data is often inaccurate.

2. The dataset includes records of SBT having been caught in areas where there have been no previous confirmed records of SBT ever having occurred. This includes records from the Java Sea (north of Java), Banda Sea (bordered by Sulawesi, Timor Leste, and Arafura Sea), Timor and Arafura Seas. Longline vessels from Benoa do sometimes fish in the Banda Sea but there are no previous confirmed records of SBT having occurred there.

3. The dataset includes records of significant numbers of SBT having been caught on the SBT spawning ground during the non-spawning season – May to August (Table 5). This does not agree with what we know of Indonesia's SBT catch by longline vessels based at Benoa - from both the port-based monitoring program and the trial scientific observer program.

Table 5. Number of SBT catch and number of sets recorded by month within area between longitude 100º and 130ºE and between latitude 5º and 20ºS, aggregated from 2000 to 2006.

Month	SBT catch (number of fish)	Number of sets
January	1016	3046
February	564	1861
March	489	1833
April	457	1417
May	390	1544
June	616	2064
July	2067	7295
August	1700	10029
September	2389	9300
October	4145	10572
November	1874	6624
December	912	3603

We consider it most likely the inaccuracies detailed in points 2 and 3 above are the direct result of the students misidentifying tuna species as SBT, either because they don't possess sufficient skills for tuna identification themselves and/or because incorrect information on species are provided by vessel personnel at the time of recording.

In an attempt to address the abovementioned concerns and to hopefully improve the utility of data collected by FHS students on future trips, RCCF/RIMF and CSIRO have begun to work more closely with WASKI to improve the level of pre-sail training provided to the students. During the past year, tuna, billfish, and shark identification guides have been provided to the

FHS program and a more complete manual is currently being prepared. We, and WASKI, consider that with these improvements to student training, the FHS program can become a more reliable and valuable source of observer-generated data for the longline fleet and contribute further to the development of fisheries science capacity.

A continuation of entry of the FHS data into the database, as more trips are completed, and a thorough analysis of the FHS dataset are still considered worthwhile. The dataset has the potential for providing a much broader coverage of the Indian Ocean longline fleet than is currently possible by our trial scientific observer program, which at present achieves < 5% coverage of the fleet's activities. A more comprehensive analysis of the FHS dataset will be presented to the 2008 CCSBT Scientific Meeting.

Implications for Standardisation

The original aim was to develop an index of spawning biomass abundance, based on Indonesian longline CPUE on the spawning ground. The dataset, particularly in recent years, show that there are also many observations from non-spawning months and from non-spawning areas. This means that there is a need to take location, and month, into account when extracting a subset of data which may best relate to the spawning period and area. Although one can be confident that the time (month) would be correctly recorded, there are now doubts about the accuracy of locations and/or species identification.

First consider location. We note that some locations are obviously incorrect because they are on land. These records need to be excluded because it is impossible to tell whether fishing occurred on the spawning grounds or not. It does, however, also suggest that other locations (at sea) could be inaccurate. With respect to distinguishing between the spawning ground and off the spawning ground, we have no way of knowing just how inaccurate the locations might be. Based on information from the trial scientific observer program (Sadiyah et al. 2007) and the Indonesian catch monitoring program however, it is known that Indonesian longline vessels have been fishing on the Southern Indian Ocean fishing grounds[2]. We therefore do not consider the locations reported in that area (e.g. South of 20^{o} S) to simply be grossly incorrect. It would, however, be relatively easy to test how sensitive results (i.e. standardised CPUE series) are to different subsets of records in the database, based on different definitions of 'spawning ground', and/or different error structures on the reported locations. On a very coarse spatial scale, the inaccuracies in location may not make a big difference to results.

The notion of incorrect species identification comes primarily from records where SBT are reported in locations where they are not expected. For these records, it is of course also possible that the species identification is correct, but that the location is wrong. It is also not totally impossible that SBT distribution has changed, though catch and landings data collected and reported by provincial and regency fisheries offices do not support this, at least for Banda and Arafura Seas (Proctor and Nugraha, in prep). If the species identification is indeed incorrect, then a more serious doubt is cast on the species identification implicit in the whole dataset.

The first question then is what are the most likely species 'confusions'? It is known that bigeye and SBT can be confused because their general body form and colouration can often

[2] The catch monitoring does not directly record location, but informal verbal information from the fishing companies and processors indicate that this is the case.

appear similar. We consider it less likely that a yellowfin tuna would be confused with a southern bluefin tuna. Under this hypothesis, and an assumption that, in the historic data (i.e. before additional pre-trip training of students to improve species identification) SBT and bigeye may have been confused at times, it would again be possible to conduct sensitivity analyses. Since we are not interested in the absolute level of CPUE, but rather changes in CPUE over time, a standardised CPUE index may turn out not to be very sensitive to some level of mis-identification between SBT and bigeye tuna. On the other hand, if the series is sensitive to this, it may still be possible to 'bound' the likely ranges of change in CPUE over time.

The concerns about the accuracy of location and species identification in the FHS dataset imply that it will be necessary to conduct extensive sensitivity analyses when doing standardisation of the catch and effort data. This means extracting subsets of the data using different assumptions and exploring how/whether the standardised CPUE series is substantially changed. This is in addition to any model uncertainty that one might explore when fitting generalised linear models, or general additive models (GLMs or GAMs). The variance estimates from such models would need to be interpreted with caution, and treated as lower bounds given all the uncertainties about the data.

This is by no means a straightforward task. The intention is to conduct some preliminary investigations along these lines, in the hope that it would indicate whether it would be worth proceeding with a full analysis of the historic data. The improvements in pre-trip training of students should improve the future data from this program, and together with the trial, and any subsequent observer program, should provide important fisheries-related information on SBT from the spawning grounds, as well as any other areas being fished by the Indonesian longline fleet.

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