CPUE TRENDS OF THE INDONESIA'S TUNA LONGLINE FISHERY: LESSONS LEARNED FROM A TRIAL OBSERVER PROGRAM

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ABSTRACT

In an effort to address a shortage of reliable CPUE information, and as a preliminary step to a broader observer program, Indonesia established a Trial Observer Program (TOP) for the industrial tuna long line fishery based at Benoa Fishing Port, Bali, in mid 2005. The objectives of this paper are i) to describe spatial and temporal catch and effort trends from the Indonesian Indian Ocean industrial tuna long line fishery based at Benoa Fishing Port, and ii) to provide an understanding of the fishing strategies used by different companies and of the environmental conditions that may influence catch trends. The observed effort covered areas both north and south of 20°S, with a concentration within 10°-20°S; 105°-120°E which overlaps with the only known spawning grounds of southern bluefin tuna (SBT). This data set showed that SBT comprised the lowest catch proportion, relative to the other three tuna species caught, bigeye tuna (BET), yellowfin tuna (YFT) and albacore (ALB). BET and ALB had been suggested as the main target species for the fishery, but this varied by region. The TOP data set suggests that different tuna fishing companies targeted different species and used different fishing practices, including differences in bait used, areas fished, start time of setting, and the number of hooks between floats (HBF). It is a priority to improve the spatial and temporal coverage of the observer program before the data can be considered to be representative of the fleet, particularly given the high degree of variability in fishing practices between companies.

KEYWORDS: Trial Observer Program, longline, Indian Ocean

INTRODUCTION

Indonesia became a member of the Indian Ocean Tuna Commission (IOTC), Commission for the Conservation of Southern Bluefin Tuna (CCSBT) and Western and Central Pacific Fisheries Commission (WCPFC) on 9 July 2007, 8 April 2008 and 29 November 2013 respectively. As a consequence, Indonesia has responsibility to meet all the requirements of these RFMOs (Regional Fisheries Management Organisations). The requirements include reporting of catch and effort data for vessels operating in the area of competence of RFMOs. For IOTC and CCSBT, this regulation is specified in IOTC resolution 10/02 (Mandatory Statistical Requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)) and in Article 5 (2) of the CCSBT Convention, respectively.

Since 1976, the Fisheries Statistics of Indonesia (referred as "National Statistics") have been collected and have provided information on numbers of fishers, number of fishing trips per year and number of vessels by gear. In addition, the production data for large pelagic species were reported as aggregated category "tuna" (tuna were recorded only by weight and total number of tuna rather than species specific data). The species-specific catch began to be recorded in 2006. However, the effort information in terms of number of hooks remains unavailable, such that catch rates, and hence proxy abundance indices, are unable to be calculated. Since 1992, Indonesia and Australia have collaborated on collection of data, in a program of port-based monitoring, for landings of the tuna longline fleet in Benoa, Bali ("Benoa Port-based Catch Monitoring Program data") (Davis & Andamari, 2003). This program has provided quality data on the amount of species-specific catches landed by the Indonesian longline fleet and information on tuna longline fleet activity. However, these data sets contain no spatial information and little useful CPUE data, as number of trips (for the National Statistics) and number of landings (number of vessels) (for the Benoa Port-based Catch Monitoring Program) are the only available effort proxies. These data sets are not able to provide the type of effort 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 behaviour of the fishing fleet.

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In an effort to address the shortage of reliable CPUE information, and as a preliminary step to a broader observer program, Indonesia established a Trial Observer Program (TOP) for the industrial tuna longline fishery based at Benoa Fishing Port, in mid 2005. This program was a collaboration between Indonesia's Ministry of Marine Affairs and Fisheries (MMAF) through the Research Center for Capture Fisheries[1] (RCCF), and CSIRO Marine and Atmospheric Research (Australia), and was funded through the Australian Centre for International Agricultural Research (ACIAR) Project FIS/2002/074: *Capacity development to monitor, analyse and report on Indonesian tuna fisheries*.

Catch-per-unit-effort (CPUE) data from commercial fisheries may be used to obtain proxy abundance indices (Hilborn & Walters, 1991, Polacheck, 1991, Bach *et al*., 2000, Goodyear, 2003, Maunder & Punt, 2004), as fishery-independent abundance estimates are generally unable to be obtained for tuna fisheries (He *et al*., 1997). Although aerial surveys and genetic technologies are two fishery independent methods showing "promise" or something to that affect. Both these things are being used for the SBT fishery. The TOP data set is currently the most detailed and most reliable available from the fishery, providing catch and effort data that could ultimately allow a better understanding of the fishery, and form the basis for informing a stock assessment via standardised CPUE proxy abundance indices.

This paper provides an exploratory analysis of the Trial Observer Program data for the four main tuna species caught by the fishery: bigeye tuna, *Thunnus obesus* (BET), yellowfin tuna, *T. albacares* (YFT), albacore, *T. alalunga* (ALB) and southern bluefin tuna, *T. maccoyii* (SBT), but also for the dominant bycatch species caught. Specifically, the objectives of this paper were i) to describe spatial and temporal catch and effort trends from the Indonesian Indian Ocean industrial tuna longline fishery based at Benoa Fishing Port, and ii) to provide an understanding of the fishing strategies used by different companies and of the environmental conditions that may influence the catch trends.

MATERIALS AND METHODS

Data were collected by 6 observers in the Trial Observer Program (TOP) for Indonesia's tuna longline fishery in the Indian Ocean, focused on the longline fishery operating from Benoa Fishing Port, between August 2005 and December 2007. The number of landings observed per year comprised less than 2% of the total Benoa landings (number of landings at Benoa Fishing Port was presented in Prisantoso *et al*. (2008).

Thirty-eight trips, including 793 longline sets, were surveyed during the study period. Only vessels from a single company (PT. PSB) were covered in 2005, whilst in 2006 and 2007, observer coverage embraced 3 companies each year (companies A, C and D, and companies B, C and D, respectively) and privately owned boats ("others") (Tables 1). 66% of the total recorded trips or 41% of the total recorded sets were from Company C, which is PT PSB (Table 1).

Across the observed trips, the trip duration ranged from less than a month (19 days) to more than three months (108 days), with an average trip length of 35 days (Table 2). The number of sets per trip recorded by the observers ranged between 7 and 58 sets per trip with an average of 21 sets per trip (Table 2). Observed vessels varied in size, ranging between 37 and 140 GT (Table 1). The number of hooks per set varied between 400 and 1921 hooks, with 1.434 hooks being the average (Table 2). The number of hooks between floats (HBF) varied from 4 – 21 hooks (13 hooks on average). Suzuki *et al*. (1977) and Marcille et al. (1984) defined deep longlining as equating to at least 10 HBF, and surface longlining as equating to 4-6 HBF. Thus, the observers covered vessels setting both surface and deep longlines. The number of floats per set ranged between 20 and 420 floats (Table 2). There were six bait species commonly used (Table 2), with Lemuru (*sardinella spp.*) the main bait type, followed by Milkfish (*Chanos chanos*), scad mackerel (*Decapterus* spp.), gizzard shad (*Anodontostoma chacunda*), frigate Tuna (*Auxis thazard*) and squid (*Loligo* spp.).

Observed fishing locations were between 0° and 35°S and between 80° and 135°E (Figure 1). Based on the spatial separations in catch by species (Figure 2c), three broader spatial zones were used in further analyses: the Banda Sea, Eastern Indian Ocean I (north of 20°S) and Eastern Indian Ocean II (south of 20°S). The "Indian Ocean I" region overlaps with the only known SBT spawning ground, in the waters between Indonesia and Australia in the northeast Indian Ocean, south-east of Java (Indonesia) (Collette & Nauen, 1983, Nishikawa *et al*., 1985, Safina, 2001).

Table 1. Number of trips, sets and vessel sizes of the observed vessels by company

Companies	No. of trips*) 2005	2006	2007	No. of vessels sampled between 2005 and 2007 per company	No. of sets	Mean vessel size (GT) (range in parentheses where applicable)
A		7		7	268	119 (94-140)
B			1	1	22	59
C	9	7	9	11	328	75 (61-102)
D		1	1	1	63	37
Others**)		2	1	3	112	91 (73 – 106)

Note: Actual company names are not provided, but note that Company C is PT PSB
* Number of trips by year was defined based on the departure date.
** "Others" refers to vessels with private owners.

Table 2. Summary of trips covered by the observers between 2005 and 2007

	Mean	Range
Length of trip (days)	35	19 – 108
Number of sets/trip	21	7 – 58
Number of hooks/set	1434	400 – 1921
Number of hooks between floats	13	4 – 21
Number of floats/set	128	20 – 420
Common Bait Used :		
Lemuru, *Sardinella* spp.(LMR)		
Milkfish, *Chanos chanos* (MIL)		
Scad mackerel, *Decapterus* spp.(RUS)		
Gizzard shad, *Anodontostoma chacunda* (CHG)		
Frigate Tuna, *Auxis thazard* (FRI)		
Squid, *Loligo* spp. (CMI)		

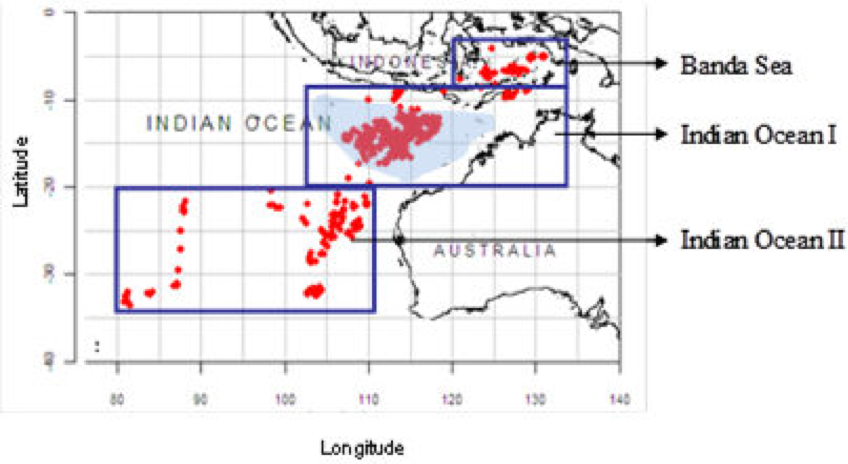

Figure 1. (modification of Figure 2a) Three zones (Banda Sea, Indian Ocean I and Indian Ocean II) used in analyses of this paper. Note that the shaded blue area illustrates the location of the SBT spawning grounds.

RESULTS AND DISCUSSION

RESULTS

1. Catch and Effort

Fishing areas of the observed longliners included the Eastern Indian Ocean between latitudes 7° and 34°S and longitude 80° and 132°E, but also the Banda Sea (Figure 2a). The furthest distance of these sets from Benoa Fishing Port was on the latitude 34°S. The longline sets were concentrated within the area between 10°-20°S and 105°-120°S (more than 50% of the total number of recorded sets occurred in this area). Approximately 74% of recorded sets occurred in the Indian Ocean I region, whilst around 18% of the total sets occurred in the Indian Ocean II region. Less than 10% of observed sets were those deployed in the Banda Sea.

The spatial distribution of observed effort and tuna catch composition is presented by 5-degree blocks (5° latitude x 5° longitude) (Figure 2b-c). Set positions and more than 50% of the total number of hooks recorded were concentrated between 110° and 120°E and 10° and 15°S (Figure 2a-b). South of 20°S (the temperate area of the Indian Ocean) and in the Banda Sea, the effort recorded in any 5-degree block never exceeded 100,000 hooks.

The overall catch distribution of the four tuna species was separated latitudinally (Figure 2c). Large proportions of YFT and BET occurred within the tropical area of the Indian Ocean, north of 20°S, and also in the Banda Sea, while SBT was predominantly caught within temperate areas of the Indian Ocean south of 20°S. By contrast, ALB was caught in both tropical and temperate areas of the Indian Ocean. According to Hsu (1993), spawning ALB stay between 10° and 30°S in the Indian Ocean. As such, 74% of the recorded ALB could be assumed to be caught from ALB spawning ground, as they were caught between 10° and 30°S (Figure 2c), but evidence is not available to show whether or not these fish were in spawning condition. The highest tuna catch occurred in the area where the highest effort occurred, i.e. between longitude 110° and 120°E and between latitude 10° and 15°S (Figure 2b-c).

The total number of observed hooks varied between months, being higher between May and October 2006 and reaching a maximum in May 2006 (~15% of total recorded effort) (Figure 3a). Effort was usually concentrated in the Indian Ocean I region, except in January and November 2006, and in May and October 2007 (Figure 3a).

Between August 2005 and December 2007, trends in the total fish, total tuna, BET, YFT and ALB caught by month (Figure 3b) mostly reflected the monthly effort pattern (Figure 3a). However, the SBT catch was higher during its 2006/2007 spawning season (between September 2006 and April 2007) (Figure 3b). The large drop in observed catch for most catch categories (total catch, tuna, BET, YFT and ALB) in August 2006 (Figure 3b) was due to the low number of hooks recorded, with only two sets observed in that month (Figure 3a).

However, in some cases the magnitude of catch was inversely correlated with effort where an increase in number of hooks was accompanied by a decrease in the number of fish caught and vice versa. For example, although the magnitude of reported effort in January 2006 was lower than that in October 2005 (Figure 3a), the number of reported YFT caught in January 2006 was 70 compared to only 20 fish in October 2005, and occurred when the fishing effort moved from Indian Ocean I (October 2005) to the Banda Sea (January 2006) (Figure 3b). However, it is unclear whether this was directly attributable to the shift in fishing area because no additional data are available from the Indian Ocean I region for January 2006 nor from the Banda Sea in October 2005 (Figure 3a). It seems likely that the increase in the YFT catch between October 2005 and January 2006 was predominantly influenced by the change in fishing grounds. Similar patterns were found when the fishing ground moved from Indian Ocean I in November 2006 to Indian Ocean II in March 2007: the amount of tuna catch, and numbers of BET and YFT caught increased by 3.5, 13 and 2.5 times, respectively. Nevertheless, other factors may also be important, such as spawning behaviour, fishing tactics (other than moving to a different fishing ground) and environmental conditions.

An example of an increase in catch with decreased effort occurred in May and June 2006 (where observed fishing occurred mostly in the northern part of the Eastern Indian Ocean area), where the number of ALB caught rose by up to 20% even though the number of hooks deployed decreased by around 43%. Furthermore, the number of BET and ALB caught increased between September and October 2006 by about 19% and 10% respectively, and SBT observed catch between September and November 2006 increased about threefold, whilst the fishing effort fell by about 28% and more than 60% (of that in September 2006), respectively. This inverse correlation between catch and effort also occurred in November 2006 and March 2007 for the observed tuna catch, BET, and YFT catches.

2. Nominal CPUE

There was an obvious spatial separation in the nominal CPUEs of the four tuna species of interest (Figure 4). The catch rate of BET was generally higher in the Indian Ocean I region (0.2-0.5 fish per 100 hooks in each 5-degree block) than in the Indian Ocean II region or in the Banda Sea (< 0.2 fish per 100 hooks), except in one 5-degree block between 10°-15°S and 125°-130°E, where the BET CPUE was less than 0.2 fish per 100 hooks. Likewise, the YFT catch rate was greatest in the Indian Ocean I region, with the highest catch rate occurring between 5°-10°S and 110°-115°E (0.5-0.7 fish per100 hooks). On the other hand, ALB and SBT had higher catch rates in the temperate regions. For almost all 5-degree blocks in the Indian Ocean II region, the ALB nominal CPUEs were at least 0.2 to 0.5 fish per 100 hooks. The highest ALB catch rate (>1 fish per 100 hooks) occurred in the area between 30°-35°S and 80°-85°E. The maximum SBT catch rates (0.1-0.2 fish per 100 hooks) occurred within 2 squares between 25°-35°S and 100°-105°E, whilst in other 5-degree blocks SBT catch rates were <0.1 fish per 100 hooks, and even zero for several fished squares.

Of the four tuna species, the temporal CPUE pattern for SBT (Figure 5b) was similar to the temporal catch pattern (Figure 3b), with both series showing peaks during the SBT spawning season (between September 2006 and March 2007; CPUE >0.1 fish/ 100 hooks while CPUE was <0.1 fish per 100 hooks in other months), with maxima in November 2006. SBT had the lowest nominal CPUEs of the four tuna species across the studied period, with the exception of the CPUE in October and November 2006.

Across the studied period, the highest total, tuna, BET and ALB nominal CPUE occurred in 2007 (Figure 5a-b), whilst the maximum nominal CPUE for YFT was recorded in August 2006 (Figure 5b). BET nominal CPUEs were higher than those of the other three tuna species over the studied period, except between August 2006 and May 2007, and in October 2007, where ALB and YFT catch rates were higher, respectively.

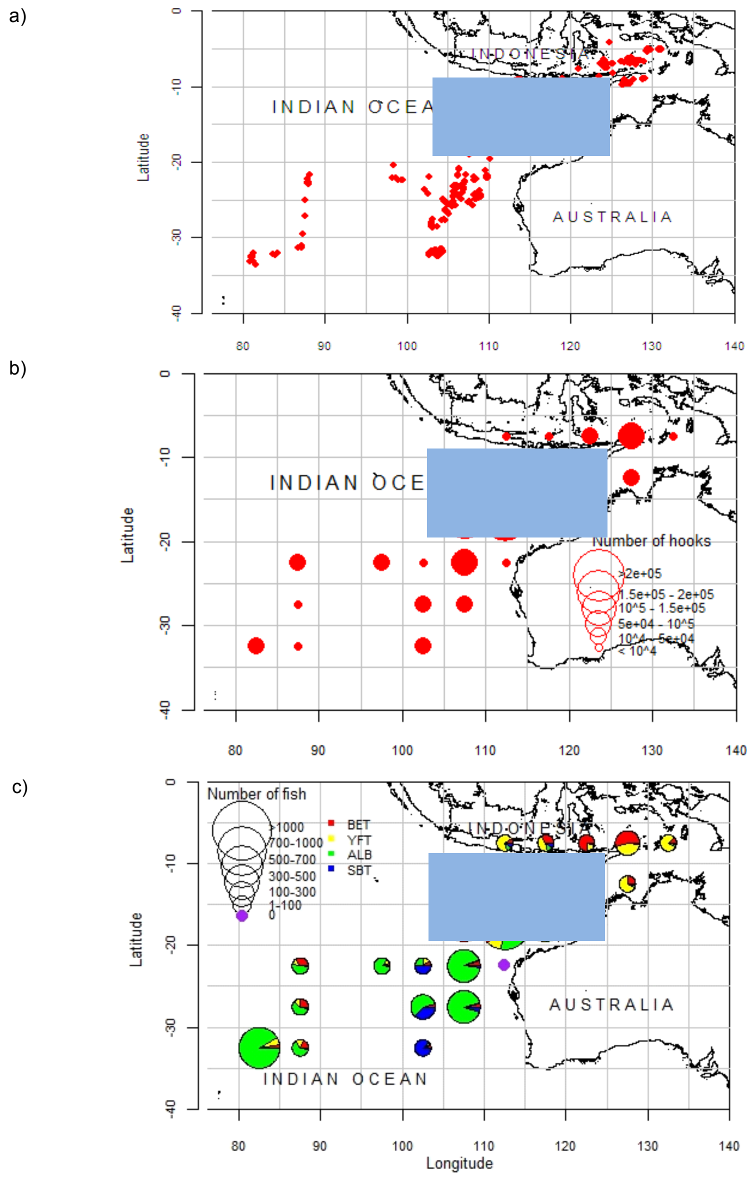

Figure 2. Spatial distribution of observed sets (a), effort (number of hooks) (b) and catch (the four tuna species) recorded (c), aggregated from 2005-2007.

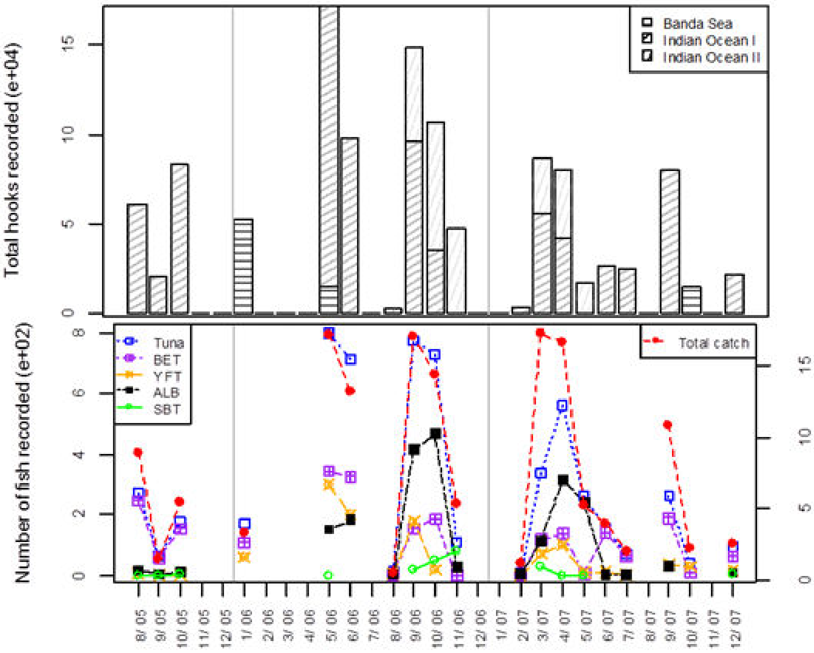

Figure 3. Total hooks recorded by month and region (a), and total catch (number of fish) recorded by month (b).

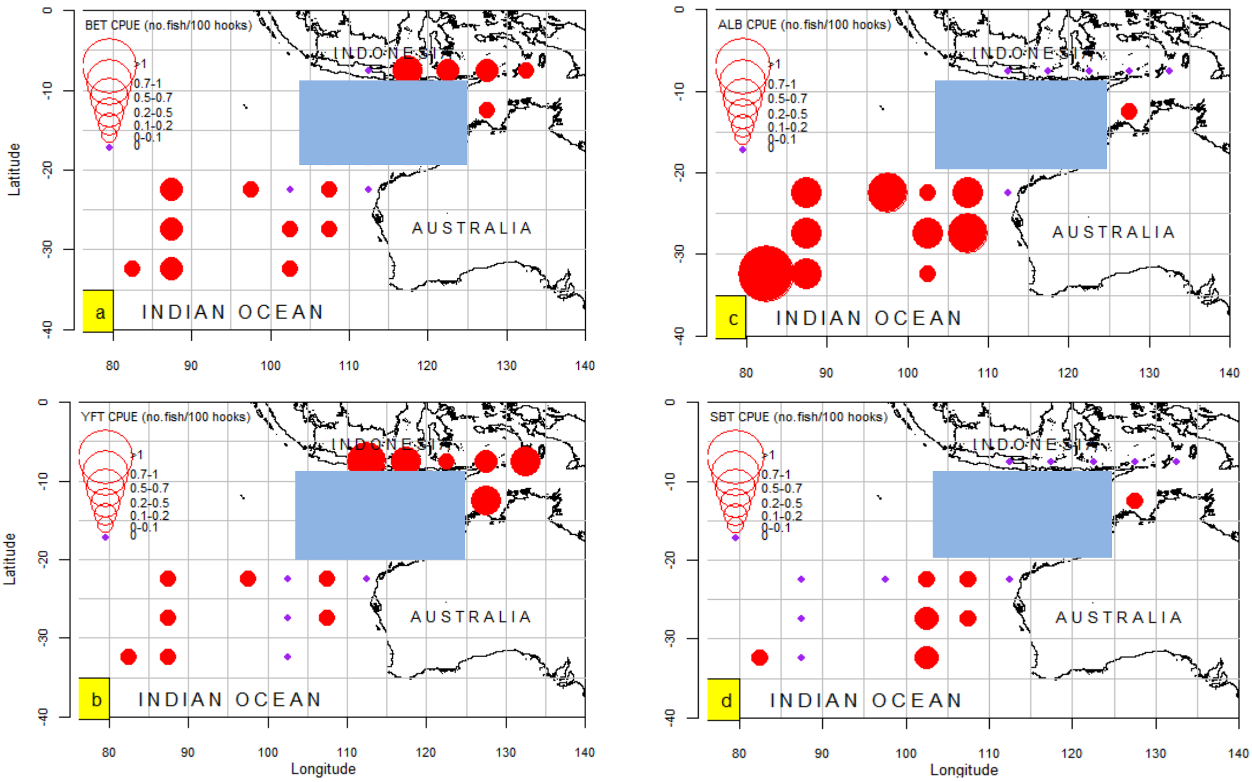

Figure 4. Spatial distribution of nominal CPUEs (fish/100 hooks) for BET (a), YFT (b), ALB (c) and SBT (d), aggregated from 2005-2007.

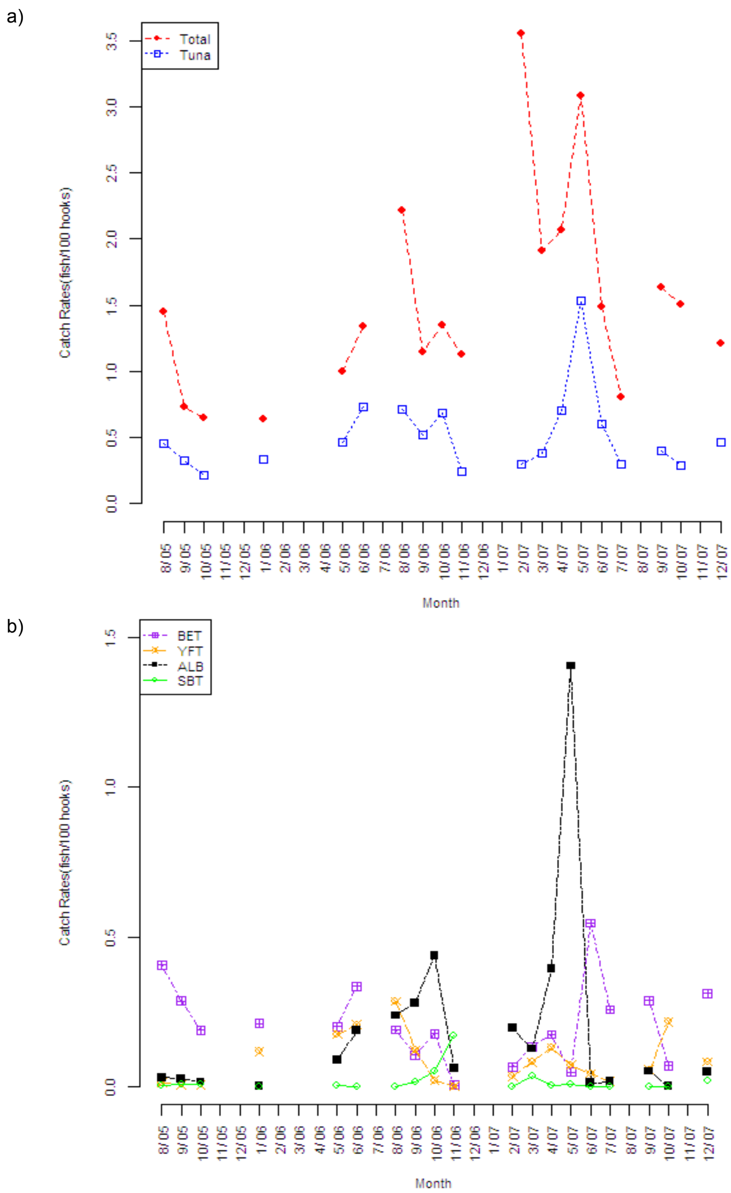

Figure 5. Annual CPUE (fish/100 hooks) for a) total and tuna and b) BET, YFT, ALB and SBT.

3. Targeting Practices by Companies

Fishing practices, and specifically HBF, number of floats per set, length of mainline, start time of setting and bait type, of the observed vessels varied between companies (Table 3). Companies B and C only used deep longlines (18 HBF on average), whilst other companies either used surface longlines only (Company D) or both surface and deep longlines (Company A and Others). Although Company C had the highest average recorded HBF (i.e the deepest sets), their vessels used the lowest average number of floats per set (Table 3). This implies that the average total number of hooks per set by this Company was not the highest within the observed companies (as Company A has the highest average total hooks per set) (Table 3). Companies B, C and D set their longlines mostly in the morning, whereas Company A and Others had start times for setting that covered almost the whole day. Company C only used *Sardinella spp.* as bait, whereas other companies used more than one bait type. Vessels from Companies B, C and D only fished north of 20°S, whereas vessels from Company A and Others fished south of 20°S.

Dominant species caught varied between the observed companies, as shown by the observed catch and nominal CPUE for the four tuna species (Table 4). The catch rates from observed vessels from Company A and Others were highest for ALB (0.36 and 0.19 fish per 100 hooks, respectively). Catch rates from company B were highest for YFT (0.28 fish per

100 hooks), whereas catch rates from Companies C and D were highest for BET (0.28 and 0.31 fish per 100 hooks, respectively). This suggests that species targeted varied among the companies.

Some sets of Company A and of Others mainly caught SBT south of 20°S. The spatial distribution of the tuna for those sets is given by Figure 6. There were 18 sets (from 2 trips with total sets of 54 and 58 sets each) of this type by Company A and 13 sets (from 1 trip with total number of 53 sets) of this type by Others. This may confirm the suggestion of Davis et al. (2005) and Proctor et al. (2007) that some vessels target SBT south of the SBT spawning grounds (south of 20°S), although the majority of sets from these 3 trips predominantly caught ALB.

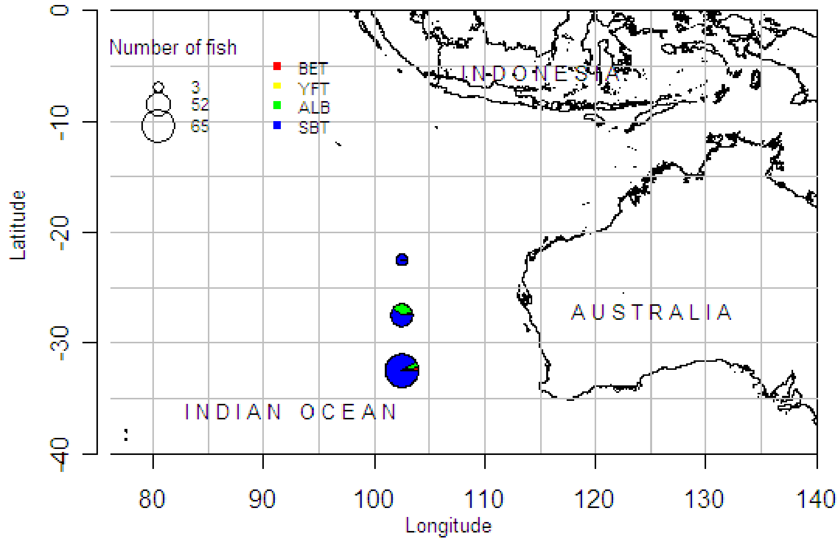

Figure 6. Spatial distribution of tuna catch for the 18 sets by vessels from Company A (from 2 trips of 54 and 58 sets each) and the 13 sets by vessels from Others (from 1 trip with total of 53 sets), respectively.

Table 3. Comparison of fishing practices between companies observed from 2005-2007

Company name	Average HBF per set	Average no. floats per set	Average total hooks per set	Time of start setting	Bait	Fishing area
A	11 (7-15)	136	1522	before 1 am - ~ 10 pm	CHG, MIL, LMR, FRI, RUS, CMI	6°-34°S; 80°-128°E
B	12	82	988	after 6 am - ~ 8 am	LMR, RUS, MIL	4°-10°S; 126°-132°E
C	18 (15-21)	81	1448	before 5 am - ~ 1 pm	LMR	4°-17°S; 107°-129°E
D	4 (4-5)	257	1030	after 5 am - ~11 pm	MIL, CMI, RUS, LMR	8°-14°S; 110°-119°E
Others*	10 (5-13)	181	1495	midnight - ~ 9 pm	MIL, CHG, LMR, FRI, RUS, CMI	11°-33°S; 103°-118°E

* Others refers to private owners.

Table 4. Recorded Catch and CPUE by company, aggregated from 2005-2007

Company name	Catch (no. fish)				CPUE (no. fish per100 hooks)*			
	BET	YFT	ALB	SBT	BET	YFT	ALB	SBT
A	551	443	1507	104	0.14 (0 - 1.8)	0.11 (0 – 1.5)	0.36 (0 – 2.15)	0.02 (0 - 0.38)
B	20	61	2	0	0.09 (0- 0.47)	0.28 (0 – 1.25)	0.01 (0 – 0.21)	0
C	1357	182	120	17	0.28 (0 - 1.72)	0.04 (0 – 1.1)	0.03 (0 – 0.42)	0.004 (0 - 0.31)
D	204	156	45	25	0.31 (0 – 2.46)	0.24 (0 - 1.38)	0.07 (0 – 0.94)	0.04 (0 - 0.66)
Others*)	200	226	337	54	0.13 (0 – 2.5)	0.15 (0 - 0.88)	0.19 (0 – 0.97)	0.03 (0 - 0.30)

* CPUE is presented as the average CPUE per set across all sets and the range of CPUE across all observed sets by the company is given in parentheses.

DISCUSSION

The Observer Program data suggest that ALB and BET were the dominant catch of Indonesia's longline fishery in the Indian Ocean. However, the Benoa Port-based Catch Monitoring Program showed that, overall, the longline fleet caught YFT and BET in a higher volume (by weight) than ALB and SBT (Sadiyah, *et al*., 2011). This indicates that the Observer Program data are not adequately representative of the longline fishery operating out of Benoa Fishing Port. This is because only currently relatively small proportion of the Benoa-based fishing companies were participating in the TOP, and there were only six trained observers. As such, the relative coverage was low, and there were many months of fishing without observations. In addition, the lower ALB catch estimated by the Port-based Catch Monitoring Program (compared to that recorded by the TOP) was due to the port-based program not covering many of the ALB landed as frozen bycatch in some processing plants (Setyadji *et al*., 2012).

The observed effort covered areas both north and south of 20°S, with a concentration within 10°-20°S; 105°-120°E which overlaps with the only known SBT spawning grounds. However, SBT comprised the lowest proportion of catch in that area relative to that of BET, YFT and ALB, and even in Indian Ocean I. This can be compared to other longline fisheries operating in the Indian Ocean, such as the Japanese longline fishery. Japanese effort from 1980-1996 was highest in the area bounded by 30°-35°S and 110°-115°E (Dowling and Campbell, 2001). The latter data set showed that the Japanese effort peaked in the first and fourth quarters of the year (Dowling & Campbell, 2001). However, the spatial-temporal effort pattern could not be clearly obtained from the available Indonesian Observer Program data set due to its limited coverage and its relative short history.

Generally, results of this analysis confirms and supports results of studies by Dowling & Campbell (2001) and Wang & Wang (2002) that there was a latitudinal variation of tuna catch distribution in the Indian Ocean. The analyses showed that YFT catch rates were highest in the tropical areas compared to the temperate areas of the Indian Ocean. In addition, the Indonesian Observer Program data set suggested that the highest BET catch rates achieved by the Indonesian vessels occurred north of 20°S, whereas the Japanese vessels caught predominantly BET between latitudes of 31°-40°S (Dowling & Campbell, 2001). This was most likely the result of the respective effort from each fleet being concentrated in these areas, as opposed to this pattern reflecting different BET distributions. The TOP data corroborated that SBT are found widely in the southern temperate regions of the Indian Ocean, shown by the higher observed SBT catch rates in the temperate latitudes relative to the tropical area of the Indian Ocean.

The TOP data also revealed that different companies caught different dominant species by using different targeting practices in terms of HBF, time of start setting, bait type and fishing area. Even within a company, vessels sometimes caught different dominant species by using different targeting practices. This suggests that the fishery is a multispecies and possibly an opportunistic fishery. Although vessels from individual companies have caught predominantly BET, YFT or ALB, a few sets by vessels from Company A and Others have caught more SBT south of 20°S. This confirms the suggestion of Davis *et al*. (2005), that some vessels target SBT south of 20°S. SBT caught on the spawning grounds and measured by observers confirmed that their fork lengths (LCFs) were, on average, more than 142 cm, as was found by the Benoa Port-based Catch Monitoring Program (Farley *et al*., 2008).

The detailed data recorded by the Observer Program data, specifically, the information pertaining to environmental conditions and fishing practices, allows a comprehensive CPUE standardisation to be undertaken. The resulting proxy abundance indices are a key input into stock assessments. In addition, this data set provides exhaustive bycatch information, including that for highly vulnerable species. As such, the continuation of the Observer Program is imperative, but the extent of fleet coverage needs to be significantly increased from the level achieved in 2005 - 2007, as the results of this study indicate that information obtained during the study period was not representative of the Indonesian longline fleet as a whole. In addition, the TOP data are not representative of all the industrial tuna fishing companies based at Benoa Fishing Port. The TOP was voluntary for the Benoa fishing companies and only 5 of the 30 active fishing companies (based on Executive director of ATLI in Kompas, 29 March 2007 (Kompas, 2007)) based at Benoa participated. As such, the observed vessels were not chosen randomly. Considerations for the safety of the Observers also reduced the number of longline vessels that were available for survey. The priority should be to improve the spatial and temporal coverage of the observer program, to achieve data from sea trips spanning a wider range of companies, in order to ensure that a more complete picture of fleet activity is obtained in terms of covering the range of vessel sizes, locations fished, trip durations, targeting strategies, gear configurations and varying levels of expertise.

CONCLUSION

Effort recorded by the Trial Observer Program data set mostly occurred within 10°-20°S; 105°-120°E which overlaps with the SBT spawning ground. The data set showed that SBT were, on average, the lowest proportion of the catch, relative to the other three tuna species. BET and ALB were suggested to be the main target species for the fishery. The TOP data set suggested that different tuna fishing companies targeted different species and used different fishing practices corresponding to the bait used, the fishing area, the start time of setting and the number of hooks between floats (HBF). The TOP data set corroborated the evidence from the Benoa Port-based Catch Monitoring Program that some vessels were targeting SBT south of 20°S (Davis *et al*., 2005, Proctor *et al*., 2007). Given that the current level of observer coverage is inadequate, it is a priority to improve the spatial and temporal coverage of the observer program before the data can be considered to be representative of the fleet, particularly given the apparently high degree of variability in fishing practices between companies.

ACKNOWLEDGEMENTS

The authors wish to thank Indonesia's tuna fishing industry and the Bali Office of WASKI for their cooperation, assistance and support for the trial observer program. Also, we are extremely grateful to the Observer team, without whom this study would not have been possible. Finally, we thank ACIAR and CSIRO for their support to the project, ACIAR project FIS/2002/074.

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