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Characteristics of tuna fisheries associated with anchored FADs in the Indonesian Fisheries Management Areas 572 and 573 in the Indian Ocean.

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Abstract

With the primary aim of addressing information gaps on the scale and operations of Indonesia's FAD based tuna fisheries, to aid improved fisheries management, an Indonesia - Australia research collaboration conducted a study during Nov 2013 – Dec 2015 at four key fishing ports in eastern Indonesia and western Indonesia. The full outputs from this study, involving an enumeration program with skipper interviews, biological sampling and direct observations are to be published as final report and subsequent papers. Presented here are preliminary results from research at two locations in West Sumatera, Muara Padang and Bungus Fishing Port, and Pelabuhanratu Fishing Port in West Java. Tuna FADs in western Indonesian waters are anchored and are of 2 main float types: steel pontoon (*ponton*), and polystyrene block (*gabus*). Subsurface attractors are biodegradable materials and most commonly palm branches (nypa and coconut), and do not include netting materials. Tuna fisheries based in Padang region include the fishing gears hand line / troll-line (HL/TL) and purse seine (PS), and fishing areas include the Indian Ocean waters of Indonesian Fishing Management Area (FMA) 572. Tuna fisheries based in Pelabuhanratu include the gear hand-line/troll-line (HL/TL), and fishing areas in the Indian Ocean waters of FMA 573. Estimating the total number of FADs in these FMAs is difficult because of the current lack of effective systems of FAD registration and monitoring, and also because of the desire of fishing companies and boat skippers to keep FAD position information confidential. Estimates range from several hundred to several thousand FADs. The success rate of HL/TL based at Muara Padang shows a much lower level of success rate compared to that of HL/TL based at Pelabuhanratu. This may be result of there being more FADs in the Padang region at higher FAD density compared to Pelabuhanratu (see Figure 4), and/or result of competition with PS boats which operate on similar fishing grounds. The number of fishing days in trips of HL/TL boats in Padang (133 trips surveyed) ranged between 12 - 16 days with an average of 10 actual fishing days per trip. The average catch rates (per trip) in 2013, 2014, and 2015 were 1500 kg, 914 kg and 1027 kg respectively. At time of survey, most PS boats (catcher boats) conducted transhipment of catch to carrier boats at sea. The 5 carrier boats surveyed at Bungus during 2013 and 2014 unloaded catches between 1,530 and 43,500kg respectively. Results of enumeration of 1091 trips of HL/TL vessels from Pelabuhanratu showed the number of sea days in trips ranged from 5 – 8 days with an average of 6 actual fishing days. The average catch rates (per trip) in 2013, 2014, and 2015 were 487kg, 517kg, and 680kg respectively. The species of tuna making up the highest percentage by volume in the catch of HL/TL vessels in Padang was skipjack tuna (SKJ), *Katsuwonus pelamis*, at 34.7% over the study period. Yellowfin tuna (YFT), *Thunnus albacares*, and bigeye tuna (BET), *Thunnus obesus*, were 24.7% and 13.1% by volume respectively. Catch composition of landings by PS carrier vessels at Bungus included SKJ at 29.9 %, YFT at 19.5 %, BET at 4.9 %, and tongkol (*Euthynnus affinis, Auxis rochei, A. thazard*) at 27.3%. For HL/TL vessels at Pelabuhanratu, over the 26 months of survey, YFT made up the largest proportion of the catch at 49.2%, with SKJ and BET at 32.9% and 6.2% by volume respectively. The data of YFT include both large and small fish, so obviously, the YFT proportions (volumes) are larger than if we were looking at just the small fish catch. A large proportion of the SKJ, YFT and BET landed from the FAD-based fisheries at both Padang and Pelabuhanratu were juvenile fish, below reported Lengths at Maturity (L_m) for those species.

Introduction

Utilization of floating objects (logs, seaweed, etc.) as known attractors of fish has been a feature of artisanal, coastal fishing in the waters of the Western and Central Pacific Ocean (WCPO) for hundreds of years (Kakuma 2000, Morales-Nin et al. 2000). The 1970s marked the beginnings of fishers deploying floating Fish Aggregating Devices (FADs) in deep-water in eastern Indonesia waters to attract and catch tunas. Anchored FADs in waters as deep as 2000 – 2500 m have since become a dominant practice for tuna fishing in Indonesia's archipelagic waters, including those in western Indonesia. With the aim of increasing the efficiency of catch by purse seine vessels in Prigi Bay, East Java (FMA 573), Indonesia's Research Institute for Marine Fisheries (RIMF) conducted a trial with deployment of anchored FADs in 1986. In 1992, with similar purpose, RIMF deployed 2 anchored FADs in Binuangen Cape waters (FMA 573), in waters of depth 500-600 m, for the hand line and troll-line fisheries, 2 FADs in Cempi Bay, Nusa Tengara Barat (FMA 573) for purse seine fisheries, and 2 FADs for hand line and troll-line fisheries in Semangka Bay, Lampung (FMA 572) and Pesisir Selatan waters, West Sumatera respectively. RIMF did not monitor the results of the FAD trial but did obtain information that some fishers subsequentlydeveloped FADs. Since early 2000s, the use of FADs has developed rapidly in FMAs 572 and 573, including in waters near Pacitan, East Java (FMA 573) (Nuraini *et al.,* 2014). Anchored FADs in deep-water have become an integral component of tuna fishing in Indonesian waters.

Since 2004, the Government of Indonesia has issued various FAD related fisheries regulations: PER.30/MEN/2004; PER.08/MEN/2011 and PERMEN No. 26/PERMEN-KP/2014, and the relevant plans: National FAD Management Plan for 2015-2017 (DGCF 2014) and National Tuna Management Plan (MMAF 2015). Effective fisheries regulations for management of FADs requires quality data and information on the Indonesian fisheries including: numbers and locations of FADs, types of FAD ownership, types of fishing gears deployed on the FADs and boat operations, catch rates, and catch compositions for each gear type, by species and size of fish (target tunas and bycatch species). Until now, implementation of FAD regulations has proved difficult, largely due to the lack of such information. To address the information gaps, in 2012 Indonesia's Agency for Marine and Fisheries Research and Development joined with CSIRO Australia in a four year research collaboration that included a FAD fisheries study. This paper provides preliminary results from this study (ongoing to end of 2016), with particular reference to waters of FMAs 572 and 573.

Materials and Methods

The results presented are outputs from an enumeration program at three key tuna landing places in western Indonesia; Muara Padang (in city of Padang) and Bungus Fishing Port (approx. 16

km south of Padang) in West Sumatera, and Pelabuhanratu Fishing Port in West Java. The tuna fishing vessels that are based at Muara Padang are primarily the multi-gear vessels that fish by hand line and troll-line (HL/TL). On occasion the HL/TL vessels also unload catch at Bungus Fishing Port as did purse seine (PS) vessels from Fishing Port of Sibolga (North Sumatera). The fishing areas of the HL/TL and PS include the Indian Ocean waters of Indonesian Fishing Management Area (FMA) 572.

Tuna fishing vessels that unload at Pelabuhanratu Fishing Port (*Pelabuhan Perikanan Nusantara Pelabuharatu*) include HL/TL vessels and tuna longline vessels, but enumeration for the current study focused on only those vessels that use FADs i.e. HL/TL vessels only. The fishing areas for these vessels are the Indian Ocean waters of FMA 573 (Figure 1). Data and information were obtained through daily enumeration (2 enumerators in each port), including interviews with skippers at earliest opportunity after their boats unload catch, and also by direct observations, information sourced from local port authorities, fisheries offices, fishing companies and fishing association representatives. Biological sampling (length measurements of individual fish; tunas and bycatch species) were done on a subsample of the catch at time of catch unloading or at point of auction/sale. Data were first recorded onto hard-copy Landings and Biological Samplings forms and later entered into a project specific database (Oracle/Apex), FAD Fisheries Database.

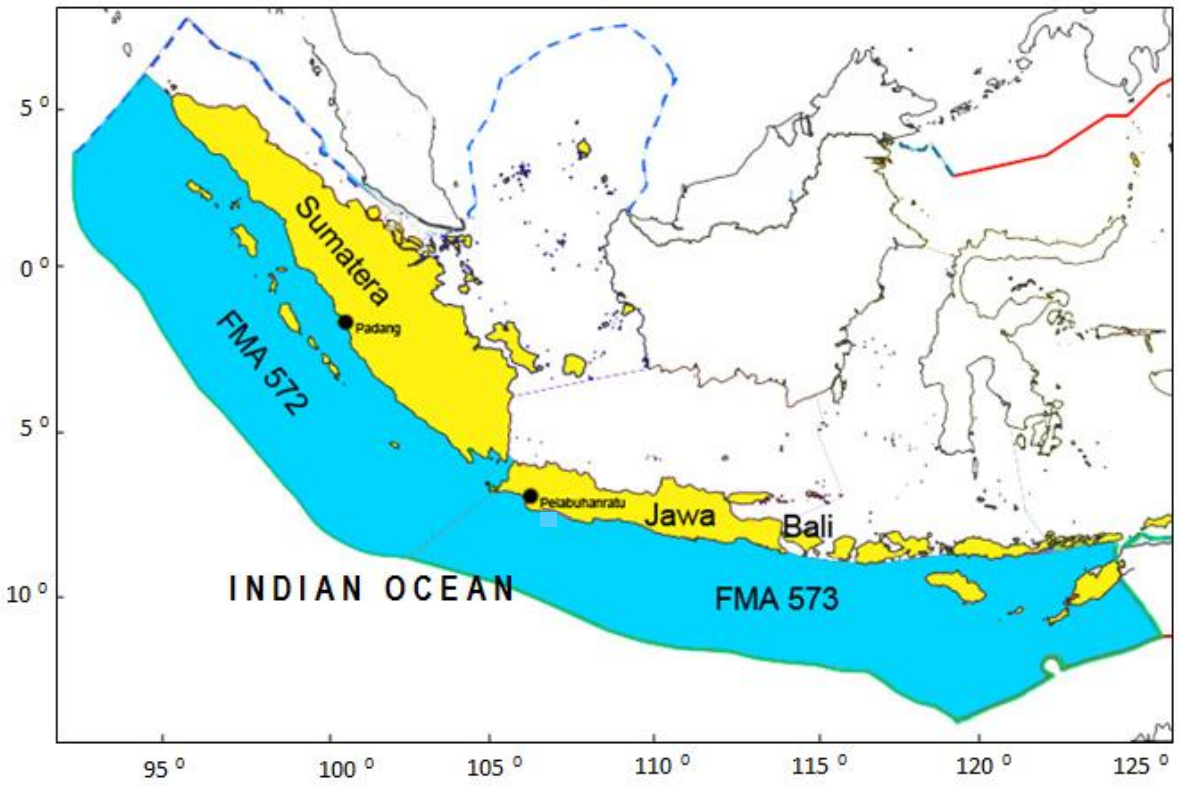


Figure 1. Indonesian Fisheries Management Areas 572 and 573 (modified from Wilayah Pengelolaan Perikanan, KOMNAS KAJISKAN 2010).

Results

1. Technical aspects of Indonesian anchored FADs

Drifting FADs are not used in the Indonesian tuna fisheries, even by purse-seine boats; only anchored FADs are used. Developments in Indonesian FAD construction, including region specific designs, were first detailed by Subani and Barus (1989). Monintja (1993) described ten different types of FAD from Indonesia and more than 20 types of FAD from around the world. In common with anchored tuna FADs employed by fisheries of other countries, the Indonesian FADs have four key components: the surface float (bamboo raft, steel pontoon or polystyrene block), the mainline to seafloor (polypropylene rope), a subsurface attractor (nypa or coconut leaf), and the anchor (Figure 2 and 3). In general, the FAD surface floats are not equipped with navigation aids (no radio signal emitters or radar reflectors), but in some cases have an attached superstructure such as flag to make the FAD more visible.

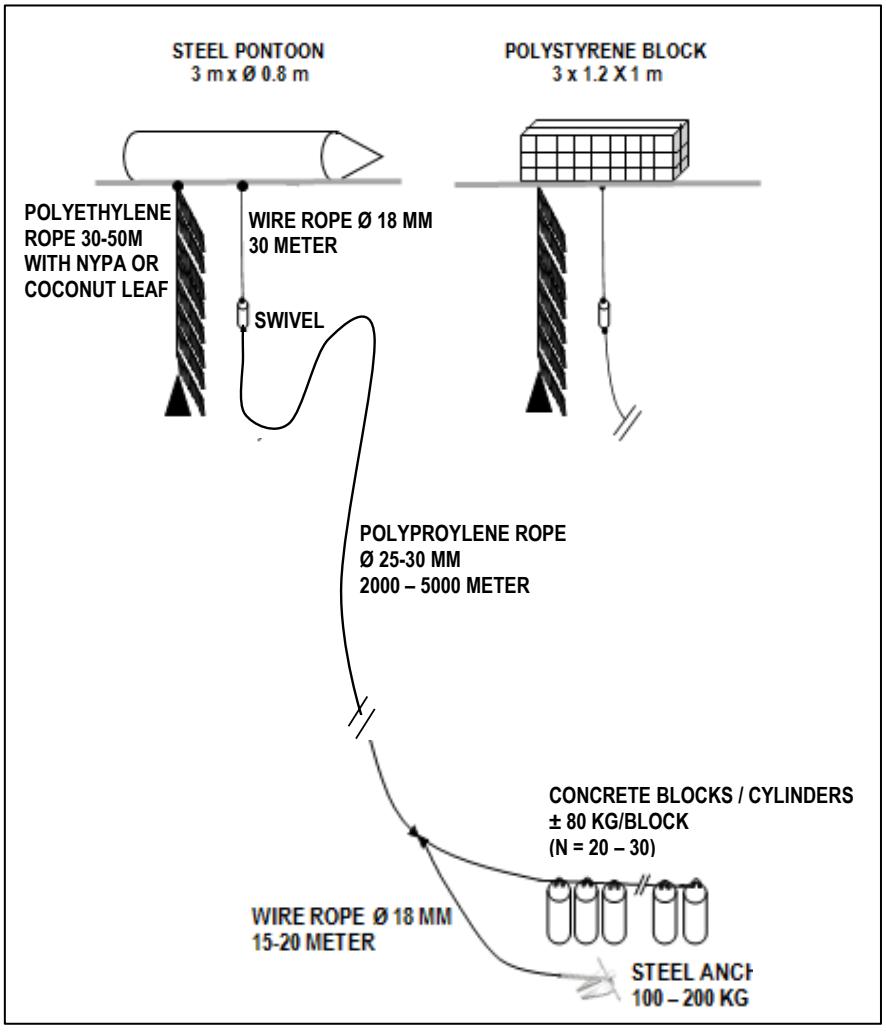
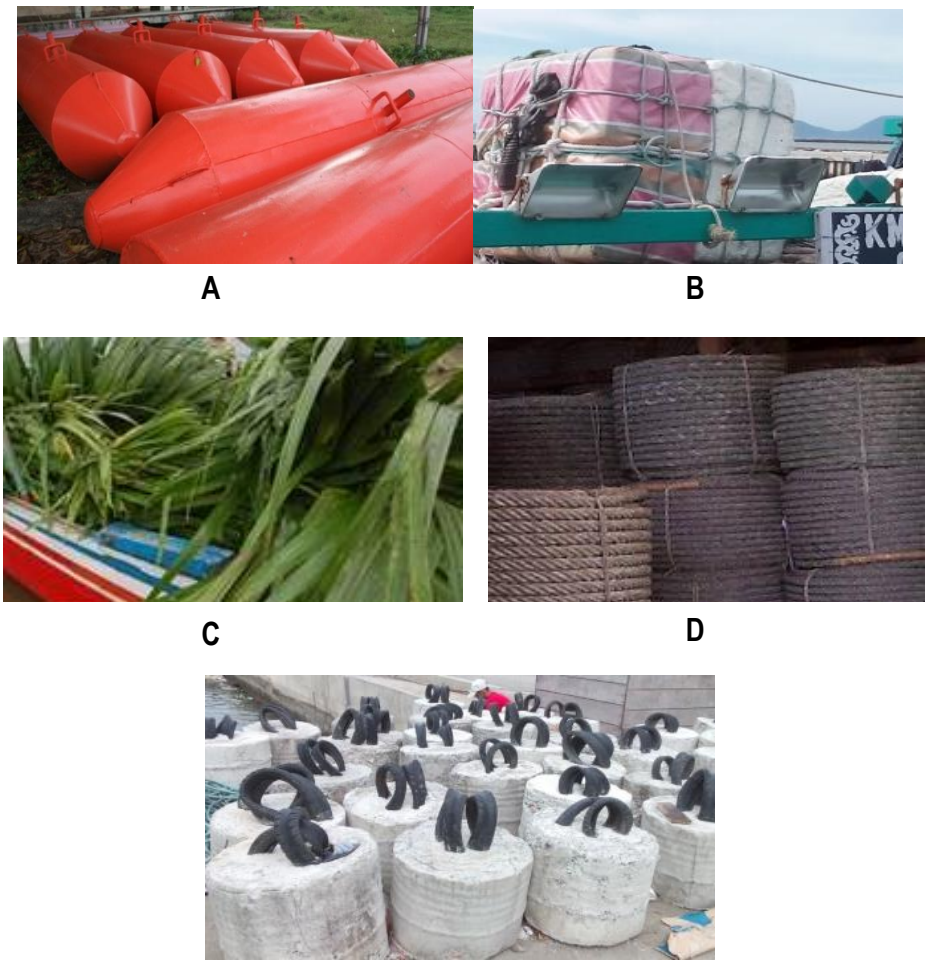


Figure 2. Common construction of anchored FADs employ by fisher based at Pelabuhanratu and Padang (drawn by Widodo, 2015).

In eastern Indonesia, the most sophisticated type of FAD, made of bamboo raft with a bungalow ("rakit") in which the fishers and/or caretakers of the FAD reside, for weeks or even months, are relatively common. Fresh supplies of food and water, and other necessities for the persons staying at the FAD are brought by fishing boats or carrier boats. The bamboo raft FADs with rakit have not yet extended to western Indonesia, where FADs are commonly of the steel (pontoon) or polystyrene types. The pontoon is a steel cylinder of 2 – 3 m length and approximately 0.8 m diameter, with generally one end conical. Previously, this as the most common type of FAD float in western and southern Indonesia. FADs of polystyrene construction (commonly called "gabus") are large cylinders or blocks of styrene foam, encased in cloth and often bound by rope and used-motorcycle tyres, and strengthened by a wooden frame. This type of FAD has replaced the pontoon as the most common FAD type, due to its lower cost.



A B C D E

Figure 3. Construction materials common to FADs in western Indonesia: (A) steel pontoon, (B) polystyrene block (gabus), (C) subsurface attractor nypa leaf, (D) polypropylene main rope , and (E) concrete anchor blocks (photos : Proctor and Widodo).

2. Total number and positions of FADs

Achieving an estimate of the total number and position of anchored tuna FADs in Indonesia's FMAs 572 – and 573 proved difficult. This was largely the result of the current lack of effective systems of FAD registration and monitoring, and also because of the desire of fishing companies and boat skippers to keep FAD position information confidential. Although current fisheries laws require the registration of FADs and owners of FADs to supply positional and boat use information for each FAD installed to Directorate General of Capture Fisheries in Jakarta. These laws have not yet been effectively implemented and adhered to. In general, National, Provincial, Regency and District offices of Ministry of Marine Affairs and Fisheries (MMAF) were unable to provide information of numbers and locations of FADs. Port Authorities are primarily concerned with monitoring boat traffic into and out of ports, and boat activity in their ports, and do not, in general, maintain records of FAD locations. Some fishing companies, boat owners and skippers interviewed for this study did provide positional information for their FADs, whereas others were reluctant to do so for want of keeping their fishing locations confidential. The information obtained by this study's enumeration program, combined with that from other sources, suggests the total number of FADs in FMAs 572 and 573 is at least in order of many hundreds and may extend to thousands.

Hargiyatno *et al*. (2013) mentioned that fishers based at Pelabuhanratu deployed at least 112 FADs spread from Pelabuhanratu bay waters southward until latitude 8.5 ^{o}S and to the west and east until longitude 104.6 - 107.1 ^{o}E. Figure 4 shows the positional information for FADs in FMAs 572 and 573 based on some of the enumeration done for this study. An assessment of all the positional information obtained through the current study is in progress. Among the current Indonesian fisheries regulations for FADs is the requirement that FADs be a minimum of 10 nm apart. There is strong evidence to suggest that this requirement is not being adhered to, with FADs in many cases being significantly less than 10 nm apart. Achieving effective enforcement of this regulation is undoubtedly one of the biggest challenges faced by Indonesia's management agencies, and requires improved communication to fishing companies, fishing boat owners, and fishers about the proven benefits that are likely to come from a reduction in density of FADs in any given area (Cayré 1991; Marsac and Cayré 1998).

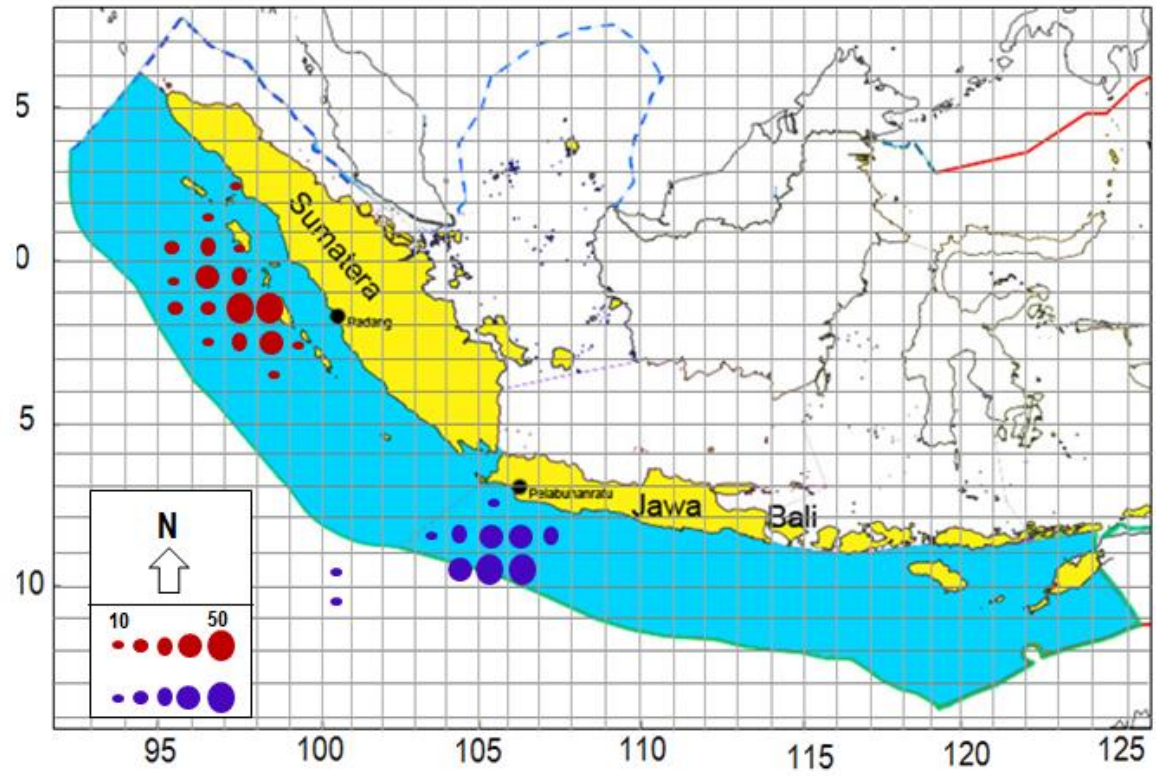


Figure 4. Estimation FAD number and positions in FMAs 572 and 573, from information collected during enumeration in Padang in 2013 and Pelabuhanratu in 2014. FADs in Pelabuhanratu region are used by HL/TR vessels and FADs in Padang region are used by HL/TL and PS vessels.

3. Tuna fisheries associated with FADs

Fishers based at Muara Padang and Pelabuhanratu use multi-gear boats, commonly called '*kapal tonda*', to catch tuna in vicinity of the anchored FADs. The *kapal tonda* normally use hand-line fishing (HL), troll-line fishing (TL) and surface kite fishing switching between gears depending on season, prevailing seas conditions and catch success. The vessels are commonly wooden-hull boats of size 6 – 10 GT. The *kapal tonda* and their fishing methods originated from southern Sulawesi (Bugis fishermen). Fishers based at Padang use TL and purse seine boats to catch tuna around FADs. The purse seine boats are of two types;catcher boat and carrier boat. Both the TL and purse seine boats are commonly of wooden-hull construction. Size of the TL boats ranged 6-10 GT, and the size of purse boats ranged 30 – 150 GT (Figure 5).

A

B

Figure 5. Examples of typical tuna fishing vessels: (A) Kapal tonda at Pelabuhanratu, (B) Kapal tonda photographed at Bungus but common at Muara Padang, and (C) purse seine vessel at Bungus Fishing Port (Photos : Proctor and Widodo (2015).

4. Operational aspects of the fisheries using FADs

FAD visit success rate

The FAD visit success rate is defined as the number of successful FAD visits, with respect to fish caught or not caught during the visit, expressed as a % of total number of FADs visited during the fishing trip. This information was obtained as part of post-trip interviews by the enumerators with vessel skippers. The FAD visit success rate, during the 2013 – 2014 survey period of HL/TL vessels based at Muara Padang was 34.5% and for the PS vessels based at Bungus Fishing Port was 48.3%. HL/TL vessels based at Pelabuhanratu Fishing Port was significantly higher at 87.7%. The significantly lower FAD visit success rate of HL/TL vessels based at Muara Padang compared to those based at Pelabuhanratu is interesting, and may possibly be the result of there being more FADs in the Padang region at higher FAD density (see Figure 4), and/or result of there having been competition with PS vessels operating on similar fishing grounds. Widodo, *et al*. (2016) noted that skippers of pole and line (PL) vessels based at Kendari (SE Sulawesi) and Sorong (West Papua) often expressed frustration that FADs were found to "empty of fish" after sets by PS boats. In FMAs 713-717, the PS, PL, and HL/TL fleets have significant overlaps in their fishing areas. Information provided by the PL skippers indicated that it normally takes at least 1 – 2 weeks before fish numbers at the FADs "recover" after a PS set.

Table 1. Summary of trip length (fishing days) and FAD visit success, for HL/TL and PS vessels at Muara Padang, Bungus and Pelabuhanratu, based on information collected by this study during 2013 – 2014.

Location	Gear Type	No. Vessel Trips	Average No. Fishing (Days)	Av. Number of FADs visited	Av. Number of FADs with success	FADs visit Success rate (%)	Average Catch (kg)
Muara Padang	HL/TL	133	12.6	12.9	4.0	34.5	1027
Bungus	PS	5	35.5	8.8	3.3	48.3	3191-4255
Palabuhanratu	HL/TL	976	7.6	1.3	1.0	87.7	566

Catc Rate

Results of enumeration at landing place Muara Padang (Padang), where the majority of HL/TL boats unload catch, showed the average catch rates (based on total catch - all species) of HL/TL vessels per trip in 2013 (Oct – Dec only), 2014, and 2015 (Jan – April only) were 750kg, 914kg, and 1,112 kg per vessel per trip respectively (Table 2). In general, the number of days per trip was 12-16 days, with an average of 10 actual fishing days per trip. Average catch rates by day per HL/TL vessel (based on total catch/number of actual fishing days, for fishing trips with available catch data) in 2013 (1 trips), 2014 (59 trips) and 2015 (73 trips) were 150 kg, 91 kg, and 111 kg per boat/actual fishing day respectively. The main fishing areas for HL/TL vessels based at Muara Padang and Bungus are on the western side of the Mentawai Islands, approximately 70 - 300 nm from Padang (Figure 4).

Only limited data and information were obtained for PS vessels during enumeration (5 PS trips surveyed only). In general, PS vessels based at Bungus Fishing Port operate in a group which consists of a PS catcher vessel, 3 to 4 PS carrier vessels, and 3 to 4 light boats. The pattern of fishing operations of the group is as follows: the PS catcher vessels have fishing trips of more than 6 months; catches are transferred directly to PS carrier vessels because the catcher vessels generally do not have fish-holds of sufficient size to hold the catch; and one setting of the net over 1 day/1 night is normal. The amount of fish that is transported to Bungus Fishing Port by a PS carrier boats is most often the result of 3 to 4 sets by the catcher boat. The enumeration of PS carrier boats in Bungus Fishing Port showed that the 5 carrier boats surveyed during 2013 (3 boats) and 2014 (2 boats) unloaded catches between 1,530 and 43,500 kg (Table 3). If these landings resulted from catches from 3 - 4 sets of the PS net, the estimated average catch per set was 3,191 to 5,722 kg.

Results of enumeration at Pelabuhanratu Fishing Port, showed the average catch rates (based on total catch - all species) of HL/TL vessels in 2013 (Oct – Dec only), 2014, and 2015 and were 487kg, 517kg, and 680 kg kg per vessel per trip respectively (Table 3). In general, the length of trips was 5 - 8 days, with an average of 6 actual fishing days per trip. Average catch rates by day per HL/TL vessel (based on total catch/number of actual fishing days for fishing trips with available catch data) in 2013 (165 trips), 2014 (548 trips), 2015 (263 trips) were 81kg, 86kg, and 113kg per vessel/actual fishing day respectively (Table 4). The main fishing areas for HL/TL vessels based at Pelabuhanratu Fishing Port are in Indonesian EEZ waters, 20 - 200nm from port, but some of the FADs are located in the high seas, about 350 nm from Pelabuhanratu (Figure 4)

Table 2. Catch landings of HL/TL vessels surveyed at Muara Padang (Padang) during October 2013 – April 2015.

Gear	Year	Month	No. of boats sampled	Total Catch (kg)	Catch / vessel / Trip (kg/vessel/Trip)
HL/TL	2013	10	1	1500	1500
	2013	11	0	0	0
	2013	12	0	0	0
	Total	3	1	1500	Ave. 1500
	2014	1	0	0	0
	2014	2	13	8843	680
	2014	3	16	16585	1037
	2014	4	0	0	0
	2014	5	3	4000	1333
	2014	6	1	1330	1330
	2014	7	0	0	0
	2014	8	0	0	0
	2014	9	1	250	250
	2014	10	1	15	15
	2014	11	22	20600	936
	2014	12	2	2300	1150
	Total	12	59	53923	Ave. 914
	2015	1	22	23950	1089
	2015	2	22	24870	1131
	2015	3	26	29320	1128
	2015	4	3	3000	1000
	Total	4	73	81140	Ave. 1112
	Grand Total	19	133	136563	Ave. 1027

Table 3. Catch landings of PS carrier vessels surveyed at Bungus Fishing Port during during October-December 2013 and January and May 2014.

Gear	Year	Month	No. of boats sampled	Total Catch (kg)	Catch / vessel / Trip (kg/vessel/Trip)
PS	2013	10	1	43500	43500
	2013	11	1	5500	5500
	2013	12	1	2500	2500
	Total	3	3	51500	Ave. 17167
	2014	1	1	24000	24000
	2014	5	1	1530	1530
	Total	2	2	25530	Ave. 12765
	Grand Total	5	5	77030	Ave. 15406

Table 4. Catch landings of HL/TL vessels surveyed at Pelabuhanratu Fishing Port- during October 2013 – December 2015.

Gear	Year	Month	No. of vessels sampled	Total Catch (kg)	Catch / vessel / Trip (kg/vessel/Trip)
HL/TL	2013	10	54	36517	676
	2013	11	78	32321	414
	2013	12	33	11402	346
	Total	3	165	80240	Ave. 486
	2014	1	36	12991	361
	2014	2	37	15213	411
	2014	3	40	21275	532
	2014	4	47	33602	715
	2014	5	49	22980	469
	2014	6	46	21033	457
	2014	7	46	25880	563
	2014	8	39	17236	442
	2014	9	55	38259	696
	2014	10	67	32139	480
	2014	11	41	16348	399
	2014	12	45	26210	582
	Total	12	548	283166	Ave. 517
	2015	1	15	6446	430
	2015	2	14	6651	475
	2015	3	25	15042	602
	2015	4	23	12504	544
	2015	5	29	18088	624
	2015	6	25	12066	483
	2015	7	17	11495	676
	2015	8	29	26729	922
	2015	9	35	35693	1020
	2015	10	26	18645	717
	2015	11	16	10391	649
	2015	12	9	5108	568
	Total	12	263	178858	Ave. 680
	Grand Total	27	976	542264	Ave. 561

5. Biological aspects of the tuna fisheries operating on FADs

Catch Composition

The results from enumeration at Muara Padang showed that, in the landings surveyed, at least 10 species of fish were caught by the HL/TL vessels. The species with highest percentage in the catch overall, over the study period, was skipjack tuna (*Katsuwonus pelamis*) at 37.7% by volume. Yellowfin tuna (YFT) , *Thunnus albacares*, and bigeye tuna (BET), *Thunnus obesus*, were at 24.7% and 13.1% respectively. Black marlin (*Makaira indica*) and various sharks (*Carcharhinus spp*) only made up 0.1% and 0.01% of the catch by volume respectively (Table 5). Catch composition of landings by PS carrier vessels at Bungus included SKJ at 29.9 %, YFT at 19.5 %, BET at 4.9 %, and tongkol (*Euthynnus affinis, Auxis rochei, A. thazard*) at 27.3% (Table 6).

Table 5. Composition of catch by species by volume (kg) from HL/TL vessels surveyed at Muara Padang (West Sumatera) during October 2013 – April 2015.

Fish Species			Number (kg)				%
Local Name	Common Name	Scietific Name	Y. 2013	Y. 2014	Y.2015	Total	
Cakalang	Skipjack Tuna	*Katsuwonus pelamis*	600	17945	28800	47345	37.7
Tuna Madidihang	Yellowfin Tuna	*Thunnus albacares*	800	13115	19800	33715	24.7
Tuna Matabesar	Bigeye Tuna	*Thunnus obesus*	0	8203	9650	17853	13.1
Madidihang/Matabesar*)	Indistinguishable yellowfin or bigeye*)	*T.albacres or T. obesus* *)	0	3490	7400	10890	8.0
Tongkol Lisong	Bullet Tuna	*Auxis rochei*	0	1000	5450	6450	4.7
Tongkol Krai	Frigate Tuna	*A. thazard*	100	3400	0	3500	2.6
Tongkol Komo	Kawa-kawa	*Euthynnus affinis*	0	850	1900	2750	2.0
Lemadang/Mahimahi	Common dolphin fish	*Coryphaena hippurus*	0	4362	5770	10132	7.4
Sunglir	Rainbow runner	*Elagatis bipinnulata*	0	1481	2370	3851	2.8
Setuhuk Hitam	Black Marlin	*Makaira indica*	0	70	0	70	0.1
Cucut	Various Shark	*Carcharhinus spp*	0	7	0	7	0.01
Total			1500	53923	81140	136563	100.0

Note *) juvenile stage

Table 6. Composition of catch by species by volume (kg) from PS vessels surveyed at Bungus Fishing Port during Oct 2013 – May 2014.

Fish Species			Number (kg)			%
Local Name	Common Name	Scietific Name	Y. 2013	Y. 2014	Total	
Cakalang	Skipjack Tuna	*Katsuwonus pelamis*	15500	7520	23020	29.9
Tuna Madidihang	Yellowfin Tuna	*Thunnus albacares*	10500	4510	15010	19.5
Tuna Matabesar	Bigeye Tuna	*Thunnus obesus*	1500	2000	3500	4.5
Tongkol Lisong-Krai (mix)	Bullet-Frigate Tuna	*Auxis rochei - A. thazard*	13000	8000	21000	27.3
Layang	Scads	*Decapterus spp.*	11000	3500	14500	18.8
Total			51500	25530	77030	100.0

The results from enumeration in Pelabuhanratu Fishing Port showed that at least 9 species of fish were caught by the HL/TL vessels, with YFT (49.2%) and SKJ (32.9%) making up a large proportion of the catch. Common dolphin fish, *Coryphaena hippurus*, and striped marlin, *Kajikia audax*,

were key bycatch species. The YFT data include both large and small fish, so obviously, the YFT proportions (volumes) are larger than if we were looking at just the small fish catch (Table 7).

Table 7. Composition of catch by species by volume from HL/TL vessels surveyed at Pelabuhanratu Fishing Port during October 2013 – December 2015.

Fish Species			Number (kg)				%
Local Name	Common Name	Scietific Name	Y. 2013	Y. 2014	Y.2015	Ave.	
Tuna Madidihang	Yellowfin Tuna	*Thunnus albacares*	50975	151675	63994	88881	49.2
Cakalang	Skipjack Tuna	*Katsuwonus pelamis*	16824	84451	76877	59384	32.9
Tuna Matabesar	Bigeye Tuna	*Thunnus obesus*	5159	14971	13588	11239	6.2
Tuna Albakora	Albacore Tuna	*Thunnus alalunga*	0	252	0	84	0.0
Tuna Siripbiru Selatan	Southern Bluefin Tuna	*Thunnus maccoyii*	0	0	49	16	0.0
Setuhuk Loreng	Striped Marlin	*Kajikia audax*	5011	24212	20945	16723	9.3
Lemadang/Mahimahi	Common dolphin fish	*Coryphaena hippurus*	1621	6940	3149	3903	2.2
Barakuda	Barracuda	*Sphyraena barracuda*	106	0	0	35	0.0
Sunglir	Rainbow runner	*Elagatis bipinnulata*	24	0	0	8	0.0
Ikan Lainnya	Other Fishes	-	520	655	256	477	0.3
Total			80240	283156	178858	180751	100.0

Fish size

The results of enumeration at Muara Padang, Bungus Fishing Port and Pelabuhanratu Fishing Port showed that the average size of most YFT and BET, caught by HL/TR vessels and PS vessels, were at a size below the reported Lengths of Maturity (Lm); YFT - 103 cm FL (Mardlijah and Patria 2012) and BET - 102 – 105 cm FL (Schaefer et al. 2005). The majority of SKJ landed by HL/TL vessels at Muara Padang were also below their reported Lm of 40 – 42 cm FL (Tandog-Edralin et al. 1990). Although the available measurements on SKJ in the landings of PS at Bungus are limited, those that were taken in 2013 and 2014 showed a mix of size both below and above the reported Lm (Table 8).

Table 8. Length (cm FL) of SKJ, YFT, and BET caught by HL/TL and PS vessels based in Padang and Pelabuhanratu, surveyed during Oct 2013 – Dec 2015. n = number of fish measured.

Location	Gear Type	Species	Year	Min Length (cmFL)	Max Length (cmFL)	Avg Length (cmFL)	n
Muara Padang	HL/TL	SKJ	2013	24	60	37.9	288
			2014	16	58	35.0	887
			2015	26	47	35.9	1023
		YFT	2013	26	52	40.6	250
			2014	16	90	37.2	884
			2015	25	45	36.4	971
		BET	2013	27	52	40.8	258
			2014	22	49	37.2	649
			2015	27	44	35.9	764
Bungus	PS	SKJ	2013	26	50	38.6	32
			2014	70	90	79.2	18
		YFT	2013	27	50	38.5	44
		BET	2013	30	50	39.2	33
	CV	SKJ	2013	30	42	37.1	73
			2014	30	49	41.3	60
		YFT	2013	34	43	39.5	27
			2014	31	48	40.9	40
Pelabuhanratu	HL/TL	SKJ	2013	29	58	42.5	292
			2014	20	88	41.3	1337
			2015	23	63	42.1	1520
		YFT	2013	28	56	39.1	520
			2014	21	72	40.7	1451
			2015	26	66	42.3	1383
		BET	2013	30	53	41.1	226
			2014	26	66	44.6	424
			2015	26	57	43.2	595

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