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EFFICIENCY OF ELECTRONIC MONITORING ON FAD RELATED ACTIVITIES BY SUPPLY VESSELS IN THE INDIAN OCEAN

Photo: David Itano

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Topic Categories: FADs, Electronic Monitoring, Supply/Tender vessels, Tuna fisheries, Sustainability

Abstract

Electronic Monitoring (EM) has been shown as an effective monitoring tool for fisheries management. This study tests the potential use of EM to monitor Fish Aggregating Devices (FADs) used by supply vessels in a tropical tuna purse seine fishing fleet. The study was conducted on 5 supply vessels operating in the Indian Ocean equipped with EM systems during eight trips accounting for 371 days at sea. The resulting footage was analysed by observers on land. FAD-related activities recorded by the EM were compared to those recorded in the vessels' logbooks. The results show a high level of coincidence between both methods. The observed capability of EM in detecting and describing FAD components and activities suggests that it can become a key method for collecting FAD data onboard supply vessels in support of fisheries management.

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I. Introduction

Fish are known to aggregate around floating objects and fishers have been utilizing natural floating objects to maximize their catch for a long time (Castro et al., 2002; Assan et al., 2015). For the last three decades, purse seine fishers targeting tropical tuna have benefited of this natural occurrence and now make and deploy their own artificial floating objects, known as Fish Aggregating Devices (FADs) (Fonteneau et al., 2000; Dagorn et al., 2012). It has been estimated that the number of FADs deployed annually by the industrial tropical tuna purse seine fishery is around 100,000 (Baske et al., 2012; Scott & Lopez, 2014; Assan et al., 2015; Gershman, et al., 2015). More than 40% of the annual global tuna catch is caught using FADs (Restrepo et al., 2017). FADs are known to increase fishing efficiency and sets on FADs are also known to have a higher bycatch rate than free-swimming school fishing (Hall & Roman, 2013; Restrepo et al. 2017). Just as any other fishing method, FADs need to be well monitored and managed (IOTC, 2015; ISSF, 2016).

However, it is not until recent years that tuna Regional Fisheries Management Organizations (RFMOs) have started to require that their member countries provide more complete information on FADs, either through observer programs and/or from vessel logbooks. Advanced technologies, such as Electronic Monitoring (EM) are increasingly playing a role in monitoring tuna fisheries.

Some tropical tuna purse seine fleets use supply vessels. These are small vessels of less than 40 m length overall (Sarralde et al., 2007; Assan et al., 2015) and their main objective is to assist purse seiners in the management of the stock of FADs at sea. Thus, supply vessels (also called auxiliary or tender vessels) deploy and retrieve FADs and visit them, reporting the amount of fish found at FADs to the fishing vessels they work with. Supply vessels also take ownership of other vessels´ FADs found at sea by replacing the tracking buoy attached to the FADs. Therefore, monitoring supply vessels where they are used is essential to understand the strategy and quantify the degree of use of FADs by these purse seine fleets. Until now, reports of supply vessel activity were obtained by observers on-board with very limited coverage (Arrizabalaga et al., 2001; Pallares et al., 2002), complemented with data from their own logbooks (Sarralde et al., 2007; Ramos et al., 2010; Assan et al., 2015). Logbooks are a fishery-dependent data source, which makes them prone to problems such as incompleteness, or inaccuracy (Cotter & Pilling, 2007). For this reason, observer programs are deemed to be a more appropriate and well-accepted way of collecting information (Uhlmann et al., 2014).

Recently, it has been acknowledged that human observers and EM, are complementary when it comes to monitoring tropical tuna purse seine fisheries (Restrepo et al., 2014; Ruiz et al., 2016). EM installation on fishing vessels has been evolving very quickly in the last five years and its effectiveness, as an alternative or complement to human observers, has been studied in several fisheries with different fishing gears (Ames et al., 2005; McElderry et al., 2007; Stanley et al., 2011; Kindt-Larsen et al., 2011; Hosken et al., 2014; Van Helmond et al., 2015). As far as tropical tuna purse seine fishery is concerned, several pilot studies have been conducted in purse seiners to test its effectiveness (Chavance et al., 2013; Ruiz et al., 2014; Monteagudo et al., 2014; Ruiz et al., 2016). However, the efficiency of EM has never been tested before on supply vessels.

The present study was carried out in order to evaluate the potential of EM to effectively monitor FAD related operations in supply vessels.

II. Materials and Methods

1. Data collection

The study was carried out with the data obtained from EM and logbooks recorded from June 9th to November 6th, 2015 on supply vessels operating in the Indian Ocean and owned by Albacora, a Spanish fishing company. The data covered 8 trips from 5 different vessels accounting a total of 371 days at sea.

LOGBOOK DATA

Both EM and the vessels' crew followed the data recording procedures described in AZTI (2014). These included the logbook fields required by the flag state and the IOTC, but also additional ones needed to fulfil the obligations of a "Code of Good Practices" that were agreed to by all Spanish vessel owners (Goñi et al., 2015). Accordingly, the identified events recorded include the date, time, geographical position, FAD activity and a detailed description of the nature and composition of the FAD involved in the event (see Table 1).

Table 1. Explanation and abbreviations (in brackets) of Fish Aggregating Device (FAD) related activities and materials recorded as variables. Raft is the floating structure and tail is the submerged structure hanging underneath.

ACTIVITY	Deployed at sea (DAS)	FAD deployed at sea during that trip
	Checked (CHK)	Checking of FADs found at sea (state, surrounding fauna…)
	Collected (COL)	FAD removed from the sea
	Transferred (TFD)	Replacing buoy
MATERIALS	Raft structure	(1) Bamboo (2) Metallic or PVC (3) Others (nets, floats, buoys, derived from plants)
	Cover material	(1) Covering net (2) Non-meshed material (3) No covering material
	Tail type	(1) Rolled up net (2) Open net (3) Ropes (4) No tail

ELECTRONIC MONITORING SYSTEM

All supply vessels involved in this study had installed a *SeaTube Lite* equipment that consisted of two HD cameras connected to a separate VMS satellite tracking device which provides GPS position, course, speed of the boat, date and time. All this information together with the camera number and vessel ID were simultaneously recorded in an encrypted metadata file and embedded into the video. While the vessels were at sea, cameras were recording 24/7 at 1280 x 720 resolution at 24FPS (Frames Per Second), portioning the footage into 10-minute long files and storing it in 4TB hard disk drives. The hard disk drives are tamper proof, only recognized by encrypted codes, guaranteeing that unauthorized persons cannot alter the resulting recordings. A backup system was also equipped on board where a total recording time of up to 6 months can be stored containing the copy of the videos to be used in the analysis. In addition, the health status of each EM system was checked remotely on a daily basis to ensure it was operational and that the cameras were clean and recording correctly. It also contained an open alarms system that warned of any malfunction immediately.

FOOTAGE ANALYSIS

The analysis of the EM data was undertaken using a tailor-made reviewing software, *Satlink View Manager 3.1.* (SVM) developed by Satlink. Digital Observer Services (DOS) land-based observers (trained Biologists, with both at-sea and EM experience) examined the footage by fishing trip (the whole time the vessel is at sea). In order to avoid erroneous interpretation of unproven events by the observer on land, the analysis was carried out in a conservative way: only events with visual evidence (images) available were taken into account. For example, a *Check* activity is sometimes done from far afield to avoid disturbance when fish are spotted. In this case, the FAD might not be caught on camera footage, and therefore this type of uncertain events was not considered in our analysis as an activity.

2. Comparative study

In order to compare and analyze data, observed FAD events by both methods, logbooks and office-based observer, were matched taking into account time and position overlap of the events encountered by both sources. This way, the total amount of FAD operations was calculated. The proportion of activities recorded by each method and the percentage of coinciding recorded operations by both methods were calculated. The Sørensen-Dice index (Sørensen, 1948) was applied to examine the similarity between both methods, utilizing the following formula:

$$S_S = 2a / (2a + b + c)$$

Where,
S_S= Sørensen-Dice index
a = number of recorded operations common to both methods,
b = number of recorded operations unique to the EM, and
c = number of recorded operations unique to the logbooks.

For the analysis on the type of activity recorded by each method, the number of operations obtained were plotted and the Sørensen-Dice index was also calculated for each vessel. Regarding the analysis of FAD components, only ‘Deployed at Sea’ and ‘Collected activities’ were considered because only in these activities FAD components can be observed in detail on the deck. Likewise, only ‘Raft Structure’, ‘Cover Material’ and ‘Tail Type’ descriptions were considered both in the logbooks and EM reports. Percentages of coincidence between both methods were calculated.

III. Results

1. Number of FAD related operations

A total of 2,388 different FAD operations were identified taking into account the ones recorded only by the logbook (n=201), only the land-based observer (n=265), and operations observed by both methods (n=1922). The logbooks recorded an average of 88.90% of the total occurring FAD operations while the EM was able to identify 91.58% of them (Table 2, for further detail see the Annex).

Table 2. *Number of Fish Aggregating Devices (FAD)-related operations recorded by the vessel's logbook and Electronic Monitoring (EM) indicated per vessel and in total. The percentages (%) from total operations for each method are also specified.*

VESSEL	TOTAL	LOGBOOK	EM	% LOGBOOK	% EM
1	693	625	640	90.19	92.35
2	250	234	218	93.60	87.20
3	668	594	636	88.92	95.21
4	388	338	327	87.11	84.28
5	389	332	366	85.35	94.09
All	2388	2123	2187	88.90	91.58

Overall, EM recorded a higher number of operations, 2.68% more than the logbooks. The EM did not register 201 activities and 265 were not registered in the logbook. However, the Sørensen-Dice index revealed high similarity (S_s = 0.89) between the methods (Figure 1), having coincided on 80.48% of the recorded operations.

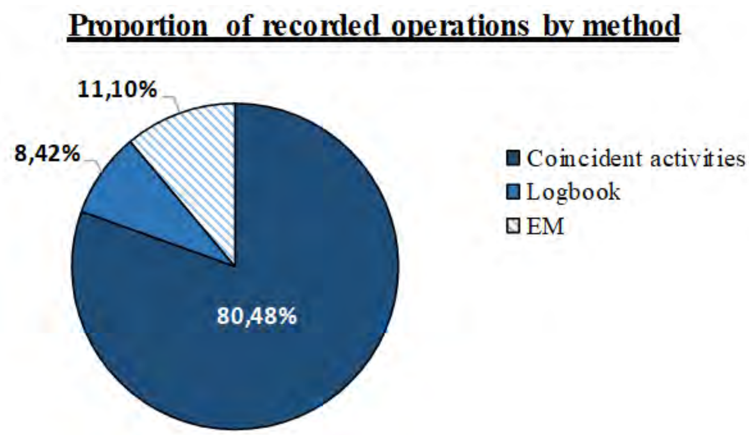

Figure 1. Proportion of recorded Fish Aggregating Devices (FAD) operations by method; vessel's logbooks or Electronic Monitoring (EM). The total Sørensen similarity coefficient (S_s) is indicated in the inbox. If $S_s > 0.75$ reflects high similarity; $0.75 > S_s > 0.5$ moderate similarity; $S_s < 0.5$ low similarity

Table 3. Operations recorded by each vessel and the Sørensen similarity coefficient (Ss) between the methods.

VESSEL	Operations in common	Unique to Logbook	Unique to EM	S_S
1	572	53	68	0.90
2	202	32	16	0.89
3	562	32	74	0.91
4	277	61	50	0.83
5	309	23	57	0.88

2. FAD related activities

Regarding the number and type of activity recorded by each method, both of them showed similar number of DAS events, the EM reported more CHK and COL while the logbooks reported more TFD (Figure 2). From all the operations, 1922 were common to both methods, and 1722 were matches in description of activity.

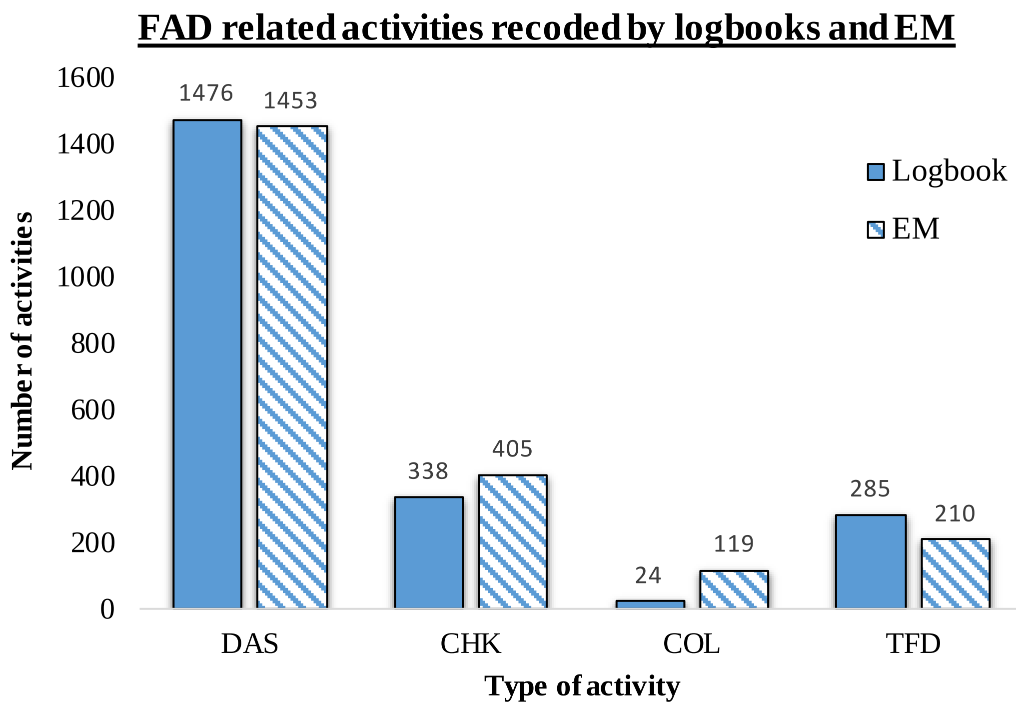

Figure 2. Number of Fish Aggregating Devices (FAD) related activities reported by the vessel's logbook (filled) and Electronic Monitoring (stripped) per type of activity: Deployed at Sea (DAS), Checked (CHK), Collected (COL), and Transferred (TFD)

The EM reported 98.6% of the DAS activities reported by the logbooks, while on the other hand, the logbooks only reported 10.1% of the COL activities reported by the EM (see Figure 3). Logbook and EM matched on 91,85% of the DAS reported activities with a slight disparity (0,39%). CHK and TFD were compared as a unique activity, resulting in a 61,85% of coincidence between both methods and 2,81% of disparity. COL activities show the highest disparity out of all (19,33%) almost doubling the percentage of coincidence (10,08%) and with EM being the only method with unique reports consisting in 70,59% of the total.

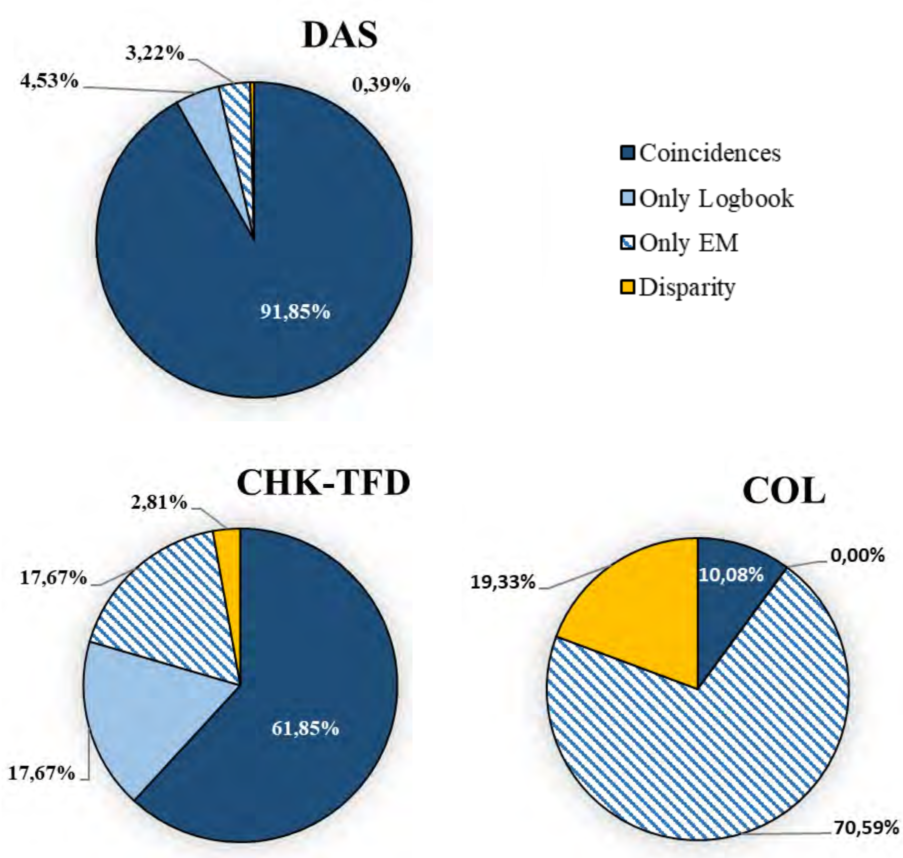

Figure 3. Percentages of described operations by method, Logbook or Electronic Monitoring (EM), for each type of activity: deployed at sea (DAS), checked (CHK), collected (COL), and transferred (TFD). Each graph summarizes the coincidences, uniqueness and disparity in methods when describing the same activity

3. FAD components description

The percentage of coincidence between both recording methods when describing FADs, was up to 86.84%, being over 62% in all categories. Matches in the raft structure resulted in a high percentage of coincidence (86.84%) as 996 out of the 1147 coincided (Table 3 and Annex for further detail). Descriptions of cover material matched 817 out of 1063 reports resulting on a 76.86% of coincidence. Finally, the coincidences in tail type descriptions were the lowest out of all of the categories, 663 matched out of 1053 reported (62.97%).

Table 3. Number of common FAD descriptions, specified for each component and material by both recording methods the vessel's logbook and Electronic Monitoring (EM). Matches and the percentage (%) of coincidence are also specified.

Component	Material	Common descriptions	Logbook	EM	Matches	% Coincidence
RAFT STRUCTURE	1.Bamboo	1147	369	383	336	86.84
	2.Metal/PVC		760	697	654	
	3.Other		18	67	6	
COVER MATERIAL	1.Net	1063	10	214	0	76.86
	2.No mesh		1050	824	814	
	3.No cover		3	25	3	
TAIL TYPE	1.Rolled net	1053	564	407	305	62.97
	2.Open net		363	568	332	
	3.Ropes		123	73	23	
	4.No tail		3	5	3	

IV. Discussion

Monitoring of FAD use comes along with difficulties that depend on the type of vessel and characteristics of the data to be recorded. This paper tested EM capability to monitor FAD related operations, comparing the results to the ones recorded by the crew on the vessel logbooks.

Regarding the identification of total FAD operations, the EM described a higher number of operations than the logbook. This can be due to the fact that supply vessel crew's main objective is helping purse seiners to fish rather than taking note of what they do and therefore, some FADs that were recorded by the EM were not registered in the logbooks. Nevertheless, the Sørensen-Dice index revealed high similarity (S_s = 0.89) between the methods as far as detection of events is concerned. Moreover, there is 80,48% of coincidence about operations recorded by both methods. These results demonstrate the high performance of the EM as a FAD monitoring system.

In terms of each activity individually, both methods reported a similar number of DAS (FADs deployed), with the logbook reporting only 1.6% more that the EM. This slight greater number of DAS reported by the logbook might be due to the infrequent difficulty of the EM to spot FAD activities in the dark with no artificial illumination on deck, giving the crew a greater chance of reporting the activity versus the EM. In these unusual situations, performance could be improved by installing a third camera to cover more closely some areas depending on each vessel's deck distribution. Nevertheless, the reporting coincidence between methods in this category was of 91,85%.

EM reported more CHK (checking a FAD) and less TFD (replacing a buoy) than the logbooks, which can be due to different factors. Firstly, when the EM records an approximation to an object, but the transferring of the buoy happens out of sight, it is reported as a CHK by EM observer while it appears as TFD in the logbook. Secondly, during a visit to a FAD that is found opportunistically and is not part of the supply vessel's stock, it may not have been correctly registered in the logbooks, even though the observer manual (AZTI, 2014) indicates that any change of a FAD components should be recorded as a second operation (with new *Component* and *Activity* descriptions). However, the EM observer would consider this activity as fishing effort and report it. Therefore, these changes were not correctly reflected in the logbooks, leading to a higher difference between CHK and TFD operations between methods. To compare the type of activity coincidence and disparity recorded by each method, CHK and TFD where pulled together as a unique category since the only difference between both is related to buoy handling, ownership, and related issues, and such information is not always recorded accurately by either method. Considering both activities as one, the percentage of coincidence was 61,85%.

Lastly, the biggest difference between methods was in reporting the COL (FAD removed from the water) operations, with a 10,08% coincidence. Land-based observers (EM) noted events with rafts and FADs that did not belong to the vessel, but these were not usually reflected in the logbook. According to these results, the EM showed more efficiency than the logbooks when reporting collected FADs. Those COL operations recorded by EM are irrefutable as no other interpretation can be done from the visual evidence of FADs being kept on-board.

Logbooks and EM matches on FAD components descriptions show a wide range of degree of coincidence. These percentages of coincidence vary from 86.84% when describing *Raft Structure* to 62.97% referred to *Tail Type* descriptions. There are several likely reasons for this variability. First, the more materials involved in the structure, the more the descriptions vary and therefore, the less chances for coincidence. EM reports contained more details on the different FAD materials used than the logbooks did, thus reducing the level of coincidence. In addition, EM had a reduced view of some areas on deck during nigh time activities, due to coverage limitations of camera configuration. Enhancing the system with three cameras could reduce blind spots on board and improve observation accuracy. In this line, it is worth mentioning the capability of the EM system to determine the entangling or non-entangling nature of the FADs. Furthermore, the EM has contradicted the logbooks in FAD structure descriptions and has been able to back the declaration with images.

Recent studies comparing on-board observers and EM had proven that EM can be a reliable source of information of purse seiner fishing activity (Monteagudo *et al.,* 2014). In this study, we show that this conclusion is also applicable on the use of EM to collect FAD information on supply vessels. The very good performance of the generic EM examined in this study can be improved even further if the EM installation is tailored to the characteristics of the vessel and the way in which the crew operates. We recommend that, at a minimum, three cameras be used.

References

Ames, R.T., Williams, G.H., Fitzgerald, S.M. (2005). Using digital video monitoring systems in fisheries: application for monitoring compliance of seabird avoidance devices and seabird mortality in Pacific halibut longline fisheries. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-152, 93 pp.

Arrizabalaga, H, Ariz, J., Mina, X., Delgado de Molina, A., Artetxe, I., Pallares, P., Iriondo, A. (2001). Analysis of the activities of supply vessels in the Indian Ocean from observers data. IOTC Proceedings No. 4: 390–401.

Assan, C., Lucas, J., Augustin, E., Delgado de Molina, A., Maufroy, A., Chassot, E. (2015). Seychelles auxiliary vessels in support of purse seine fishing in the Indian ocean during 2015-2014: Summary of a decade of monitoring, 12 pp. IOTC-2015-WPTT17-41 Rev1.

AZTI (2014). Manual de observación de buenas prácticas a bordo de atuneros cerqueros ANABAC y OPAGAC. Código de Buenas Prácticas ANABAC-OPAGAC (Túnidos Tropicales).

Baske, A., Gibbon, J., Benn, J., Nickson, A. (2012). Estimating the use of drifting Fish Aggregation Devices (FADs) around the globe. The PEW Charitable Trusts Environment Group. Discussion paper, 8 pp.

Castro, J.J., Santiago, J.A., Santana-Ortega, A.T. (2002) A general theory on fish aggregation to floating objects: an alternative to the meeting point hypothesis. Reviews in Fish Biology and Fisheries 11: 255–277.

Chavance, P., Batty, A., Mc Elderry, H., Dubroca, L., Dewals, P., Cauquil, P., Restrepo, V., Dagorn, L. (2013). Comparing observer data with video monitoring on a French purse seiner in the Indian Ocean, 18 pp. IOTC WPEB09/2013/43.

Cotter, A.J.R., Pilling, G.M. (2007). Landing, logbooks and observer surveys: improving the protocols for sampling commercial fisheries. Fish and Fisheries 8: 123–152.

Dagorn, L., Holland, K.N., Restrepo, V., Moreno, G. (2012). Is it good or bad to fish with FADs? What are the real impacts of the use of drifting FADs on pelagic marine ecosystems? Fish and Fisheries 14: 391–415.

Fonteneau, A., Pallares, P., Pianet, R. (2000). A worldwide review of purse seine fisheries on FADs. In: Peche Thoniere et Dispositifs de Concentration de Poissons, Le Gall, J.Y., Cayré, P., Taquet, M. (Editors). Caribe-Martinique Colloquium, Trois-Îlets, 15–19 October 1999, pp. 15–35.

Gershman, D., Nickson, A., O'Toole, M. (2015). Estimating the use of FADS around the world. The PEW Charitable Trusts Environment Group. Discussion paper, 19 pp.

Goñi, N., Ruiz, J., Murua, H., Santiago, J., Krug, I., Sotillo de Olano, B., González de Zarate, A., Moreno, G., Murua, J. (2015). System of verification of the code of good practices on board ANABAC and OPAGAC tuna purse seiners and preliminary results for the Atlantic Ocean. IOTC-2015-WPEB11-INF09.

Hall, M.A., Roman, M. (2013). Bycatch and non-tuna catch in the tropical tuna purse seine fisheries of the world. FAO Fisheries and Aquaculture Technical Paper 568, 249 pp.

Hosken, M., Vilia, H., Agi, J., Williams, P., Honiwala, E., Walton, H., Owens, M., Wickham, C., Zaborovskiy, E., Cheung, B. (2014). Preliminary report on the Solomon Islands longline e-monitoring project, 19 pp. WCPFC-SC10-2014/ST-WP-03.

IOTC (2015). Procedures on a fish aggregating devices (FADs) management plan, including a limitation on the number of FADs, more detailed specifications of catch reporting from FAD sets, and the development of improved FAD designs to reduce the incidence of entanglement of non-target species. IOTC Resolution 15/08. Seychelles, pp. 38-44.

ISSF (2016). Best Practices Better Solutions, Annual Report 2016. International Seafood Sustainability Foundation, Washington, D.C., USA.

Kindt-Larsen, L., Kirkegaard, E., Dalskov, J. (2011). Fully documented fishery: a tool to support a catch management system. ICES Journal of Marine Science 68: 1606–1610.

McElderry, H., McCullough, D., Schrader, J., Illingworth, J. (2007). Pilot study to test the effectiveness of electronic monitoring in Canterbury fisheries. Department of Conservation, Wellington. DOC Research & Development Series 264, 27 pp.

Monteagudo, J.P., Legorburu, G., Justel-Rubio, A., Restrepo, V. (2014). Preliminary Study about the suitability of an Electronic Monitoring System to record scientific and other information from the tropical tuna purse seine fishery. Collect. Vol. Sci. Pap. ICCAT, 71: 440–459.

Pallares, P., Mina, X., Delgado de Molina, A., Artetxe, I., Ariz, J., Arrizabalaga, H. (2002). Análisis de la actividad de los buques auxiliares en el Océano Atlántico y su efecto sobre el rendimiento de atuneros congeladores. Col. Vol. Sci. Pap. ICCAT, 54: 139–156.

Ramos, M.L., Delgado de Molina, A., Ariz, J. (2010). Analysis of activity data obtained from supply vessels´ logbooks implemented by Spanish fleet and associated in Indian Ocean. IOTC-2010-WPTT-22.

Restrepo, V., Ariz, J., Ruiz, J., Justel-Rubio, A., Chavance, P. (2014). Updated guidance on Electronic Monitoring Systems for tropical purse seine fisheries. ISSF Technical Report 2014-08. International Seafood Sustainability Foundation, Washington, D.C., USA.

Restrepo, V., Dagorn, L., Itano, D., Justel-Rubio, A., Forget, F., Moreno, G. (2017). A summary of bycatch issues and ISSF mitigation initiatives to-date in purse seine fisheries, with emphasis on FADs. ISSF Technical Report 2017-06. International Seafood Sustainability Foundation, Washington, D.C., USA.

Ruiz, J., Batty, A., Chavance, P., McElderry, H., Restrepo, V., Sharples, P., Santos, J., Urtizberea, A. (2014). Electronic monitoring trials on in the tropical tuna purse-seine fishery. ICES Journal of Marine Science 72: 1201–1213.

Ruiz, J., Krug, I., Justel-Rubio, A., Restrepo, V., Hammann, G., Gonzalez, O., Legorburu, G., Pascual Alayon, P.J., Bach, P., Bannerman, P., Galán, T. (2016). Minimum standards for the implementation of Electronic Monitoring Systems for the tropical tuna purse seine fleet. IOTC-2016-WPDCS12-23.

Sarralde, R., Delgado de Molina, A., Ariz. J., Santana, C. (2007). Preliminary data obtained from supply logbooks implemented by the Spanish fleet since 2004. IOTC-2007-WPTT-07.

Scott, G.P., Lopez, J. (2014). The use of FADs in tuna fisheries. European Parliament. Policy Department B: Structural and Cohesion Policies, Fisheries IP/B/PECH/IC/2013-123, 70 pp.

Sørensen, T. (1948). A method of establishing groups of equal amplitude in plant sociology based on similarity of species and its application to analyses of the vegetation on Danish commons. Kongelige Danske Videnskabernes Selskab 5: 1–34.

Stanley, R.D., McElderry, H., Mawani, T., Koolman, J. (2011). The advantages of an audit over a census approach to the review of video imagery in fishery monitoring. ICES Journal of Marine Science 68: 1621–1627.

Uhlmann, S.S., Van Helmond, A.T.M., Stefánsdóttir, E.K., Sigurðardóttir, S., Haralabous, J., Bellido, J.M., Carbonell, A., Catchpole, T., Damalas, D., Fauconnet, L., Feekings, J., García, T., Madsen, N., Mallold, S., Margeirsson, S., Palialexis, A., Readdy, L., Valeiras, J., Vassilopoulou, V., Rochet, M.J. (2014). Discarded fish in European waters: general patterns and contrasts. ICES Journal of Marine Science 71: 1235–1245.

Van Helmond, A.T.M., Chen, C., Poos, J.J. (2014). How effective is electronic monitoring in mixed bottom-trawl fisheries? ICES Journal of Marine Science 72: 1192– 1200.

Annex

Table 1. Number of operations per trip per vessel recorded by Electronic Monitoring (EM) and vessels' logbook.

VESSEL		TOTAL		LOGBOOK		% LOGBOOK	EM		% EM
1	Trip 1	693	211	625	205	90.2	640	201	92.4
	Trip 2		482		420			439	
2	Trip 1	250	250	234	234	93.6	218	218	87.2
	Trip 2		-		-			-	
3	Trip 1	668	464	594	410	88.9	636	445	95.2
	Trip 2		204		184			191	
4	Trip 1	388	294	338	253	87.1	327	248	84.3
	Trip 2		94		85			79	
5	Trip 1	389	389	332	332	85.3	366	366	94.1
	Trip 2		-		-			-	
Total number of operations		**2388**		**2123**		**88.9**	**2187**		**91.6**

Table 2. Number of operations per trip per vessel recorded only by Electronic Monitoring (EM) and by the vessel's logbook individually.

VESSEL		TOTAL		ONLY LOGBOOK		% ONLY LOGBOOK	ONLY EM		% ONLY EM
1	Trip 1	693	211	53	10	7.6	68	6	9.8
	Trip 2		482		43			62	
2	Trip 1	250	250	32	32	12.8	16	16	6.4
	Trip 2		-		-			-	
3	Trip 1	668	464	32	19	4.8	74	54	11.1
	Trip 2		204		13			20	
4	Trip 1	388	294	61	46	15.7	50	41	12.9
	Trip 2		94		15			9	
5	Trip 1	389	389	23	23	5.9	57	57	14.7
	Trip 2		-		-			-	
Total number of operations		2388		201		8.4	265		11.1

Table 3. Coincidence or disparity in the reported type of activity (Deployed at Sea, Checked, Transferred, or Collected) by both methods within the common operations.

VESSEL		Common operations		Different reported activity		% Disparity	Coincident reported activity		% Coincidence
1	Trip 1	572	195	99	20	17.3	473	175	82.7
	Trip 2		377		79			298	
2	Trip 1	202	202	10	10	5.0	192	192	95.1
	Trip 2		-		-			-	
3	Trip 1	562	391	17	10	3.0	545	381	97.0
	Trip 2		171		7			164	
4	Trip 1	277	207	45	33	16.2	232	174	83.8
	Trip 2		70		12			58	
5	Trip 1	309	309	29	29	9.4	280	280	90.6
	Trip 2		-		-			-	
Total number of operations		1922		200		10.4	1722		89.6

Activity summary

Table 4. Number of operations recorded by each method (vessel's logbook and electronic monitoring, EM) for every different activity (DAS: Deployed At Sea; CHK: Checked; COL: Collected; TFD: Transferred) and the coincident activities recorded by both methods. Note that vessels 1, 3 and 4 have two fishing trips included in their data.

VESSEL 1

Activity	Logbook	EM	Only Logbook	Only EM	Common Logbook	Common EM	Coincident
DAS	445	429	16	6	429	423	423
CHK	74	161	35	41	39	120	31
COL	18	33	0	18	18	15	7
TFD	88	17	2	3	86	14	12
Total					**572**	**572**	**473**

VESSEL 2

Activity	Logbook	EM	Only Logbook	Only EM	Common Logbook	Common EM	Coincident
DAS	174	158	18	2	156	156	156
CHK	36	36	14	10	22	26	20
COL	3	8	0	3	3	5	3
TFD	21	16	0	1	21	15	13
Total					**202**	**202**	**192**

VESSEL 3

Activity	Logbook	EM	Only Logbook	Only EM	Common Logbook	Common EM	Coincident
DAS	517	532	20	37	497	495	495
CHK	49	33	10	8	39	25	24
COL	1	30	0	27	1	3	1
TFD	27	41	2	2	25	39	25
Total					**562**	**562**	**545**

VESSEL 4

Activity	Logbook	EM	Only Logbook	Only EM	Common Logbook	Common EM	Coincident
DAS	188	179	12	4	176	175	175
CHK	89	60	47	21	42	39	19
COL	1	25	0	18	1	7	1
TFD	60	63	2	7	58	56	37
Total					**277**	**277**	**232**

VESSEL 5

Activity	Logbook	EM	Only Logbook	Only EM	Common Logbook	Common EM	Coincident
DAS	152	155	3	0	149	155	149
CHK	90	115	19	36	71	79	63
COL	1	23	0	18	1	5	0
TFD	89	73	1	3	88	70	68
Total					**309**	**309**	**280**

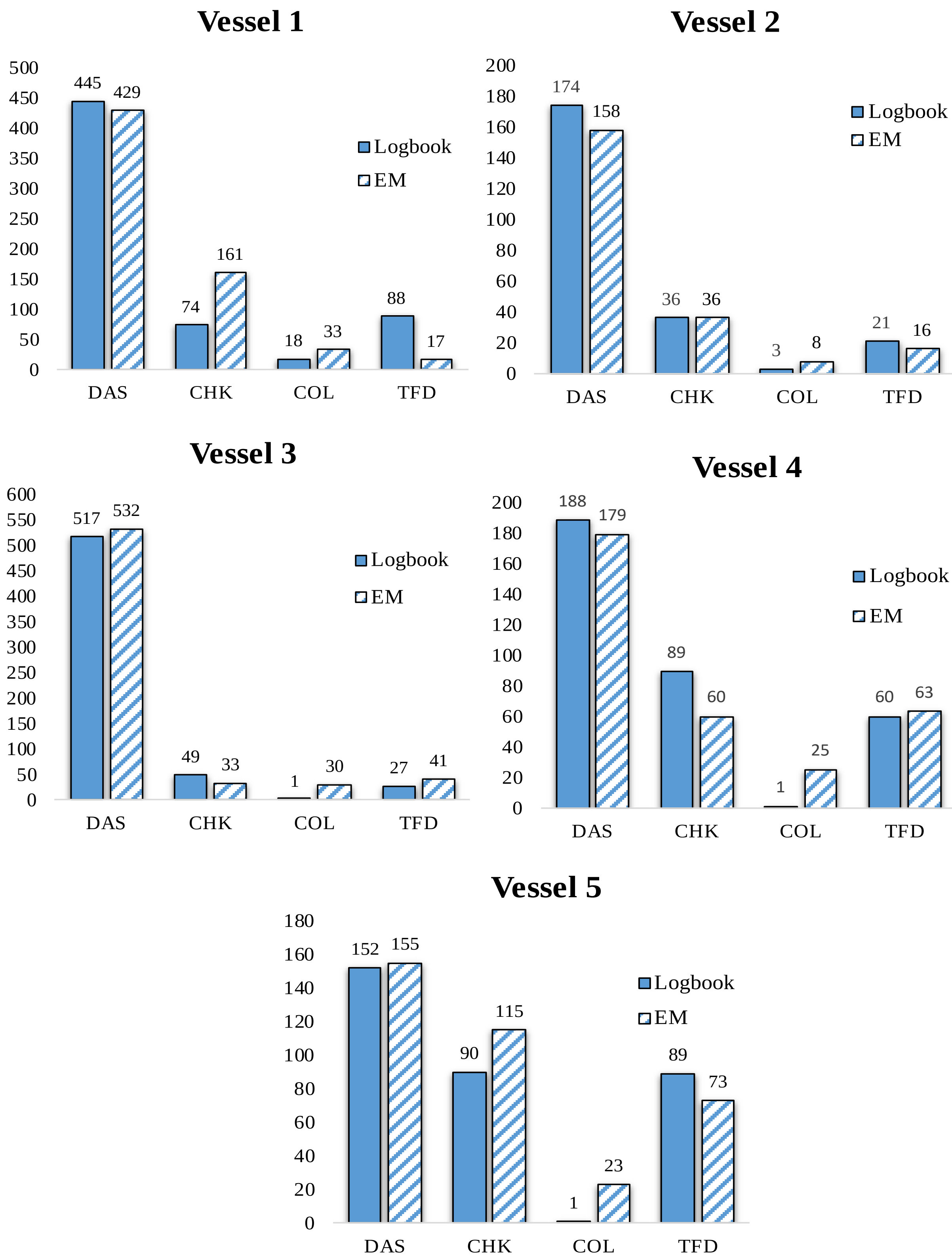

Figure 1. Fish Aggregating Device (FAD) related activities reported by the vessel's logbook and the Electronic Monitoring (EM) per vessel. Note that vessels 1, 3 and 4 have two fishing trips included in their data.

Materials summary

Table 5. The following tables specify the number of matches on FAD components descriptions reported by both method (vessel's logbook and Electronic Monitoring, EM) for the DAS and COL activities (DAS: Deployed At Sea; COL: Collected) and the percentage of coincidence in the description of the materials for these activities. Note that vessels 1, 3 and 4 have two fishing trips included in their data.

VESSEL 1

Component	Material	Common descriptions	Logbook	EM	Matches	% Coincidence
RAFT STRUCTURE	1.Bamboo	352	64	72	59	75
	2.Metal/PVC		273	217	202	
	3.Other		15	63	3	
COVER MATERIAL	1.Net	283	1	28	-	89.05
	2.No mesh		282	253	252	
	3.No cover		-	2	-	
TAIL TYPE	1.Rolled net	334	240	20	19	32.34
	2.Open net		94	280	89	
	3.Ropes		-	33	-	
	4.No tail		-	1	-	

VESSEL 2

Component	Material	Common descriptions	Logbook	EM	Matches	% Coincidence
RAFT STRUCTURE	1.Bamboo	83	51	42	42	92.78
	2.Metal/PVC		29	38	29	
	3.Other		3	3	3	
COVER MATERIAL	1.Net	83	-	-	-	100
	2.No mesh		80	80	80	
	3.No cover		3	3	3	
TAIL TYPE	1.Rolled net	83	16	16	12	84.34
	2.Open net		55	55	49	
	3.Ropes		9	9	6	
	4.No tail		3	3	3	

VESSEL 3

Component	Material	Common descriptions	Logbook	EM	Matches	% Coincidence
RAFT STRUCTURE	1.Bamboo	480	122	146	118	93.13
	2.Metal/PVC		358	333	329	
	3.Other		-	1	-	
COVER MATERIAL	1.Net	473	9	103	-	76.11
	2.No mesh		464	369	360	
	3.No cover		-	1	-	
TAIL TYPE	1.Rolled net	418	137	203	124	74.17
	2.Open net		203	208	186	
	3.Ropes		78	6	-	
	4.No tail		-	1	-	

VESSEL 4

Component	Material	Common descriptions	Logbook	EM	Matches	% Coincidence
RAFT STRUCTURE	1.Bamboo	128	62	53	50	88.29
	2.Metal/PVC		66	75	63	
	3.Other		-	-	-	
COVER MATERIAL	1.Net	124	-	35	-	56.46
	2.No mesh		124	70	70	
	3.No cover		-	19	-	
TAIL TYPE	1.Rolled net	124	96	103	93	87.91
	2.Open net		9	11	7	
	3.Ropes		19	10	9	
	4.No tail		-	-	-	

VESSEL 5

Component	Material	Common descriptions	Logbook	EM	Matches	% Coincidence
RAFT STRUCTURE	1.Bamboo 2.Metal/PVC 3.Other	104	70 34 -	70 34 -	67 31 -	94.23
COVER MATERIAL	1.Net 2.No mesh 3.No cover	100	- 100 -	48 52 -	- 52 -	52
TAIL TYPE	1.Rolled net 2.Open net 3.Ropes 4.No tail	94	75 2 17 -	65 14 15 -	57 1 8 -	70.22

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