ISSF Technical Report 2017-03

ISSF SKIPPERS' WORKSHOPS ROUND 6

Photo: J. Murua

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Abstract

ISSF Skippers' Workshops round 6 in 2016 continued to expand fisher-scientist collaborations by visiting 14 locations in 7 countries. New workshop locations included Shangai in China, Quy Nhon in Vietnam, Posorja in Ecuador, Madeira in Portugal, or Kendari, Banda Aceh and Benoa in Indonesia. A record number of 559 participants was reached, with 343 being skippers. This was partly thanks to the establishment of a "train-the-trainer" program in Indonesia with native fisheries scientists conducting workshops to reach small-vessel tuna purse seiner captains at the multiple ports across the archipelago.

The workshops reported advances in the use of non-entangling FADs, which are now the principal FAD design in the Indian, Atlantic and Eastern Pacific Oceans. The concept of biodegradable NEFADs has received positive feedback by many captains. The adoption of best release practices is also gradually increasing with EU fleets using them regularly, as well as other fleets in the Eastern Pacific and Atlantic. Some Western and Central Pacific fleets were visited and learned for the first time about best release practices, and will hopefully show a gradual adoption. Other activities to release sharks in the net (e.g. shark escape panels, shark backdown) received poorer acceptance due to fear of manipulating sharks or because of operational constraints. Meanwhile, technology for discrimination with multi-frequency echo-sounder buoys shows promise and captains discussed alternative management options which could reduce bigeye tuna catches. Finally, utilization of bycatch bony fish species is quite high in most regions.

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ISSF is a global coalition of scientists, the tuna industry and World Wildlife Fund (WWF) — the world's leading conservation organization — promoting science-based initiatives for the long-term conservation and sustainable use of tuna stocks, reducing bycatch and promoting ecosystem health. ISSF receives financial support from foundations and industry sources.

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Executive Summary

During 2016, the sixth round of ISSF Skippers' Workshops visited 14 locations in 7 countries covering 12 purse seine fleets with the participation of 343 skippers and other 216 stakeholders (**Table 1**). This document summarizes the results and acceptance levels of participants to various bycatch mitigation activities and advance in the adoption of best fishing practices by various fleets distributed across 4 tropical tuna RFMOs.

The adoption of several bycatch mitigation activities, such as entanglement-minimizing FAD designs, continued to grow in three out of four oceans (**Table 7**). In the Western and Central Pacific fleets using anchored FADs such as Indonesia or Philippines do not use netting. Scientists also learned how the Vietnamese tuna fleet does not use drifting or anchored FADs. On the other hand, Western and Central Pacific fleets utilizing drifting FADs (dFADs) still have high entanglement risk designs, according to the categories of the ISSF Guideline for non-entangling FADs. Chinese captains were introduced for the first time to non-entangling FADs (NEFADs) and showed a medium level of acceptance. Meanwhile, biodegradable FADs, which reduce environmental pollution caused by stranding FADs were generally well accepted across fleets and some companies are starting to test prototypes in the Atlantic, Indian Ocean and Eastern Pacific. A specific biodegradable workshop by ISSF with scientists and skippers examined best materials and designs options currently available for each ocean.

Best bycatch release methods from deck are widely accepted and some fleets are now routinely applying them in daily fishing (**Table 6**). Use of stretcher beds, cargo nets or other equipment to release large bycatch like manta rays or sharks is spreading. In contrast, low acceptance levels for activities related to shark release from the net like fishing in the net, shark escape windows or the shark backdown are documented. Fishers thought that these methods would be difficult to implement in their ocean or with their current nets, or could entail risk to crew.

Use of FADs with echo-sounder buoys continues to increase in all oceans, with many companies now using 100% instrumented buoys. Development of echo-sounder selective technology to avoid FADs with higher bigeye tuna (*Thunnus obesus*) proportions, accompanied by control measures (e.g. vessel TACs), are viewed by many captains as a promising option.

Some small-vessel fleets like Indonesia or Vietnam lack high-tech fishing equipment and a different approach to bycatch mitigation is required. In 2016, a new train-the-trainer program was set in Indonesia to enable tuna fisheries scientists from the Indonesian Centre of Fisheries Research and Development (CFRD) to conduct more workshops to reach more fishers from the numerous wooden small purse seine vessels distributed across this archipelago facing both the Indian and Western Pacific Ocean. Some of the principal tuna ports including Jakarta in the island of Java, Benoa in Bali, Kendari and Bitung in Sulawesi, and Sibolga and Banda Aceh in Sumatra were visited in 2016. In this region, only non-entangling anchored FADs (aFADs) are used and utilization of bycatch fish species is very high.

Key Findings:

1. **Workshops reached a record number of participants in a year with more than 340 skippers, at 14 locations in 7 countries. The workshops continued to expand to more fleets including China, Vietnam and Portugal.**
2. **Adoption of best practices for non-entangling FADs and release of bycatch from deck continues to advance in most oceans.**
3. **A specific program with local fisheries scientists was set up to reach the numerous small tuna vessels in Indonesia**

Research Questions

- **What is the added value of participatory approach between tuna scientists and fishers from diverse fleets and oceans to find bycatch mitigation solutions?**

- **Can all bycatch reduction activities function equally between and within oceans?**

- **Are there any promising activities to mitigate shark bycatch in FADs?**

- **What is the current state of adoption of NE FADs by fleets across oceans?**

- **Which are the latest advances in the application of best release methods from deck for bycatch species like turtles, manta rays or sharks?**

- **What solutions do fishers see as more feasible for avoiding undesirable sizes of bigeye tuna?**

- **Do small-vessel tuna purse seiner fleets, with different fishing practices and technological capabilities, require custom-made bycatch mitigation approaches?**

Introduction

The ISSF Skippers' Workshops started in November 2009 in Sukarrieta (Spain), where an international panel of tuna scientists and fishing technologists met with **captains from tropical tuna purse seine fleets** to discuss ways in which to **reduce bycatch**. Since then more than 60 workshops have been facilitated in 17 countries and covered over 25 flags. Tuna fleets from Asia, Africa, Europe, North and South America have regularly attended these meetings since. At the workshops scientists inform fishers and other key stakeholders (e.g. ship-owners, fleet managers, fisheries managers) about the latest advances in bycatch reduction, principally focusing on FAD fisheries, and present possible mitigation activities that **ISSF Bycatch Mitigation Steering Committee (BMSC) scientists** would like to test at sea during the **ISSF research cruises**. Scientists seek the opinions from experienced fishers on these mitigation activities, trying to identify improvements in their experimental design, their applicability in each ocean, or to collect feedback on new ideas to test. Many of the advances in bycatch mitigation like NE FAD designs or equipment for bycatch release from deck have originated from the cooperation between scientists and fishers (Poisson et al., 2012; Murua et al., 2014). There is added value to this participatory approach as it enables fishers to become part of the solution. This empowerment leads to higher voluntary rates of best fishing practice adoption by many fleets and to a faster advance in the development of practical and efficient bycatch solutions. In addition, the global character of the workshops has provided a broader-view of the different operational and gear characteristics between fleets, oceanographic parameters affecting each region, and tuna behaviour variations between oceans. For example, many workshops are conducted at key tuna ports and scientists can observe first hand types of FADs and other fishing gear (e.g. nets, buoys, sounders, etc.) in each fleet. Most workshops cover industrial sized purse seiner fleets, sometimes referred to as "super-seiners", but other fleets with smaller-scaled vessels are also targeted.

The following sections provide information on the ISSF Skippers' Workshops that took place in the latest completed round of workshops during 2016.

2016 Skippers' workshops fleet coverage

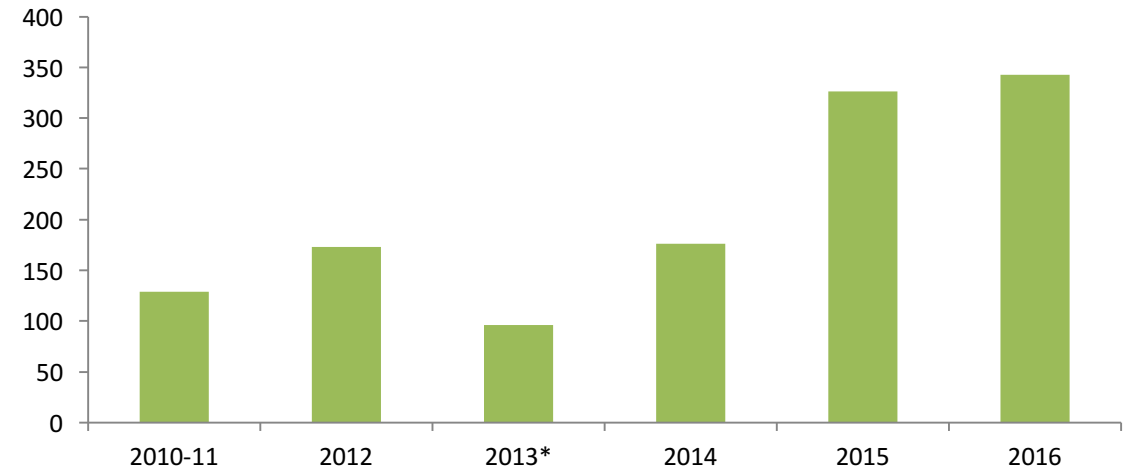
In 2016, a total of 7 countries were visited and workshops conducted at 14 locations (**Table 1**). By continent, there were 2 workshops in South America, 8 in Asia, 3 in Europe and 1 in Africa. The skew towards the larger number of workshops in Asia was due to the workshops conducted in Jakarta, Bitung, Kendari, Benoa, Sibolga and Banda Aceh with the train-the-trainer program set up this year in Indonesia.

The total number of participants in 2016 was 559, and of those 343 were skippers (i.e. fishing masters or captains). This was a new record in number of attending skippers in a year, surpassing the previous record reached in 2015 (**Figure 1**). Also, for the first time since the start of the workshops the number of certified skippers belonging to small-sized purse seiners (i.e. < 100 GT vessels) has been higher than that for skippers from "super-seiner" vessels. Small-vessel skippers amounted to 55% of all skippers certified. All fishers participating receive a certificate in skipper education valid for the ProActive Vessel Register (PVR).

Table 1 – Skippers' Workshop locations and participation by work group category in 2016.

WS	LOCATION	DATE	SKIPPERS	CREW	SHIP-OWNERS	FLEET MANAGER	FLEET REP.	OFFICIALS	SCIENTISTS	TOTAL
6.1	SHANGHAI (CHINA)	06/04/2016	10	0	0	6	5	0	6	27
6.2	TEMA (GHANA)	04/05/2016	8	6	2	5	20	4	2	47
6.3	VIGO (SPAIN)	20/07/2016	51	23	0	1	0	0	0	75
6.4	MANTA (ECUADOR)	03/08/2016	33	17	0	2	3	0	1	56
6.5	POSORJA (ECUADOR)	05/08/2016	8	5	0	1	0	0	0	14
6.6	JAKARTA (INDONESIA)	05/09/2016	27	0	0	1	3	0	0	31
6.7	BINTUNG (INDONESIA)	07/09/2016	27	1	1	0	0	1	10	40
6.8	KENDARI (INDONESIA)	09/09/2016	32	0	1	3	1	3	10	50
6.9	BENOA (INDONESIA)	10/09/2016	21	0	0	0	6	0	0	27
6.10	SIBOLGA (INDONESIA)	14/09/2016	15	0	0	7	1	2	0	25
6.11	BANDA ACEH (INDONESIA)	16/09/2016	23	0	0	0	8	0	0	31
6.12	QUY NHON (VIETNAM)	17/09/2016	42	0	0	0	13	0	3	58
6.13	SUKARRIETA (SPAIN)	24-28/10/2016	42	5	1	0	3	0	1	52
6.14	MADEIRA (PORTUGAL)	01/11/2016	4	19	0	0	2	0	1	26
TOTAL			343	76	5	26	65	10	34	559

The second largest group of participants at the workshops was crew members (e.g. chief officers, deck bosses, deck crew; 13%) (**Figure 2**). It is important to have crew know about best practices as they are often the ones constructing the FADs onboard or releasing bycatch species from the deck. Especially in the Eastern Atlantic and Western Indian Ocean, it is often difficult to get these crew members to attend workshops as many come from remote areas of Africa.



**2013 – only 5 workshops were conducted.*

Figure 1. Historical number of skippers participating in the ISSF Skippers' Workshops.

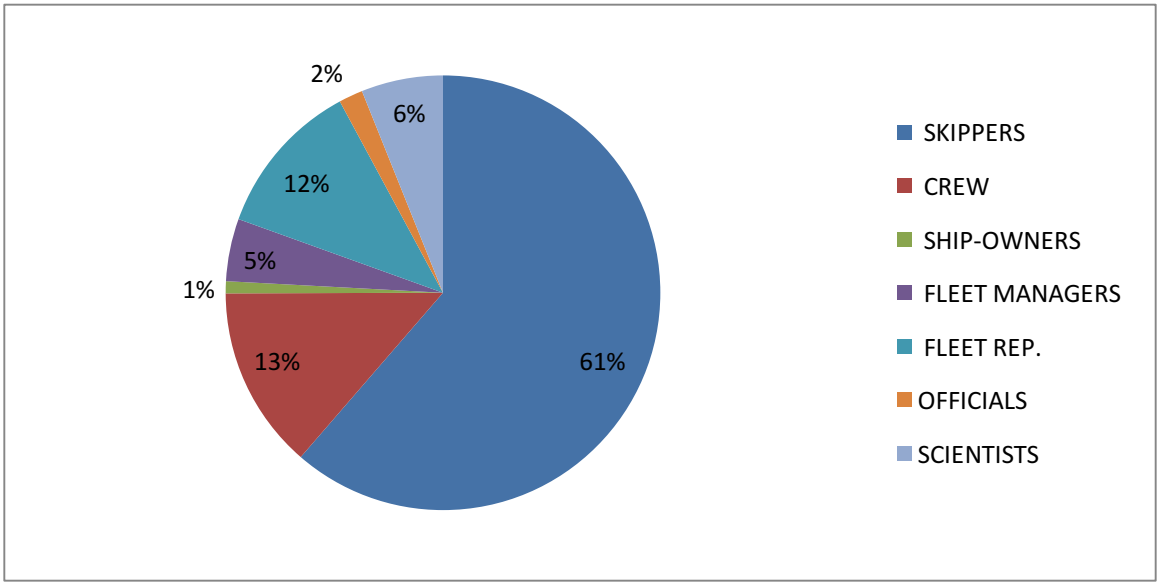


Figure 2. Participation by work group category in 2016 Skippers Workshops.

Looking at the overall attendant numbers since the start of the Skippers' Workshops there have been 2262 participations, of which 1246 were skippers and 312 crew (**Table 2**). Highest fisher attendance has been typically in locations like Sukarrieta (Spain) or Manta (Ecuador), where workshops have been conducted on an annual basis. Also, these large fleets are easier to access than others as many captains originate from and live in the same location and most are available for meetings at defined times of the year (e.g. during the two-month FAD closure in the Eastern Pacific).

Table 2 – Skippers' Workshop locations and participation by work group category since 2009.

WS	LOCATION	DATE	SKIPPERS	CREW	SHIP-OWNERS	FLEET MANAGERS	FLEET REP.	OFFICIALS	SCIENTISTS	TOTAL
1.0	SUKARRIETA (SPAIN)	27/11/2009	15	1	1	1	6	1	0	25
1.1	MANTA (ECUADOR)	18/09/2010	56	18	1	0	1	0	0	76
1.2	PANAMA CITY (PANAMA)	22/09/2010	6	6	1	0	0	3	6	22
1.3	ACCRA (GHANA)	10/11/2010	2	0	0	2	21	6	1	32
1.4	SUKARRIETA (SPAIN)	13-17/12/2010	32	0	0	0	6	0	5	43
1.5/1.6	MAHE (SEYCHELLES) / PORT LOUIS (MAURITIUS)	1-19/02/2011	11	5	0	0	1	0	0	17
1.7	PAGO PAGO (AMERICAN SAMOA)	05/03/2011	2	0	2	1	4	3	2	14
1.8	MAJURO (MARSHALL ISLANDS)	22/06/2011	2	1	0	0	1	1	0	5
1.9	POHNPEI (MICRONESIA)	24/06/2011	3	1	0	0	4	0	0	8
2.1	ACCRA (GHANA)	14/03/2012	2	0	0	2	18	6	0	28
2.2	MAHE (SEYCHELLES)	21-18/05/12	5	2	0	0	1	0	0	8
2.3	PAGO PAGO (AMERICAN SAMOA)	11/06/2012	3	2	0	0	3	0	2	10
2.4	GENERAL SANTOS (PHILIPPINES)	08/09/2012	26	4	0	1	3	0	21	55
2.5	BINTUNG (INDONESIA)	11/09/2012	20	0	0	0	0	25	3	48
2.6	JAKARTA (INDONESIA)	13/09/2012	13	1	0	0	0	10	3	27
2.7	MANTA (ECUADOR)	26-27/09/2012	17	4	4	0	1	0	1	27
2.8	SUKARRIETA (SPAIN)	09/10;27/11-5/12/2012	87	3	2	2	9	0	6	109
3.1	ACCRA (GHANA)	08/05/2013	13	0	2	1	18	7	0	41
3.2	LIMA (PERU)	05/08/2013	0	0	2	2	16	2	15	37
3.3	MANTA (ECUADOR)	08/08/2013	37	5	0	3	4	1	0	50
3.4	PANAMA CITY (PANAMA)	12/08/2013	2	0	2	1	7	0	7	19
3.5	SUKARRIETA (SPAIN)	07/11-10/12/2013	44	6	2	2	5	0	0	59
4.1	BUSAN (KOREA)	14/02/2014	8	9	0	1	10	3	12	43
4.2	KAOHSIUNG (TAIWAN)	18/02/2014	1	0	0	6	12	0	0	19
4.3	CANGAS (SPAIN)	28-29/05/2014	20	10	0	0	0	0	0	30
4.4	ACCRA (GHANA)	15/07/2014	7	6	10	9	11	4	1	48
4.5	MANTA (ECUADOR)	12/08/2014	35	1	0	0	1	0	3	40
4.6	JAKARTA (INDONESIA)	19/08/2014	21	2	0	0	1	1	3	28
4.7	GENERAL SANTOS (PHILIPPINES)	05/09/2014	24	6	0	0	2	0	2	34
4.8.	SUKARRIETA (SPAIN)	18/09-14/10/2014	52	5	0	1	3	1	1	63
4.9.	PAGO PAGO (AMERICAN SAMOA)	15-20/10/2014	8	1	0	0	4	0	1	14
5.1.	MANZANILLO (MEXICO)	12/01/2015	34	20	1	1	2	4	0	62
5.2	MAZATLAN (MEXICO)	14/01/2015	65	46	0	1	1	4	1	118
5.3	SAN DIEGO (USA)	12/02/2015	5	0	0	1	3	0	0	9
5.4	TEMA (GHANA)	08/05/2015	10	5	2	9	18	0	1	45
5.5.	JAKARTA (INDONESIA)	19/06/2015	8	14	1	0	5	0	4	32
5.6	BINTUNG (INDONESIA)	22/06/2015	21	13	0	0	1	1	2	38
5.7	SIBOLGA (INDONESIA)	25/06/2015	22	15	0	0	0	1	1	39
5.8	LIMA (PERU)	11/08/2015	10	5	1	1	16	3	6	42
5.9	MANTA (ECUADOR)	14/08/2015	83	8	3	8	6	0	0	108
5.10	BUSAN (KOREA)	15/09/2015	8	0	0	1	8	2	25	44
5.11	CONCARNEAU (FRANCE)	13/10/2015	14	6	0	2	2	0	2	26
5.12	SUKARRIETA (SPAIN)	8,26-30/10/2015	49	5	4	1	2	0	0	61
6.1	SHANGHAI (CHINA)	06/04/2016	10	0	0	6	5	0	6	27
6.2	TEMA (GHANA)	04/05/2016	8	6	2	5	20	4	2	47
6.3	VIGO (SPAIN)	20/07/2016	51	23	0	1	0	0	0	75
6.4	MANTA (ECUADOR)	03/08/2016	33	17	0	2	3	0	1	56
6.5	POSORJA (ECUADOR)	05/08/2016	8	5	0	1	0	0	0	14
6.6	JAKARTA (INDONESIA)	05/09/2016	27	0	0	1	3	0	0	31
6.7	BINTUNG (INDONESIA)	07/09/2016	27	1	1	0	0	1	10	40
6.8	KENDARI (INDONESIA)	09/09/2016	32	0	1	3	1	3	10	50
6.9	BENOA (INDONESIA)	10/09/2016	21	0	0	0	6	0	0	27
6.10	SIBOLGA (INDONESIA)	14/09/2016	15	0	0	7	1	2	0	25
6.11	BANDA ACEH (INDONESIA)	16/09/2016	23	0	0	0	8	0	0	31
6.12	QUY NHON (VIETNAM)	17/09/2016	42	0	0	0	13	0	3	58
6.13	SUKARRIETA (SPAIN)	24-28/10/2016	42	5	1	0	3	0	1	52
6.14.	MADEIRA (PORTUGAL)	01/11/2016	4	19	0	0	2	0	1	26
TOTAL			1246	312	46	86	302	99	171	2262

In 2016, some of the workshops which often attract more fishers (e.g. > 50 participants in Spain or Ecuador) were broken down into smaller group meetings, for example one workshop per fishing company, or captains were invited in one-to-one interviews with scientists after the main workshop. The aim of this strategy was to maximize feedback collection from fishers, as sometimes in very large groups participants can be more reserved and speak less.

Indonesian train-the-trainer program

In 2016, a new program referred to as “Train-the-Trainer” was set up in Indonesia with the collaboration of national scientists from the Centre for Fisheries Research and Development (CFRD) in Jakarta. A group of 8 Indonesian tuna fisheries scientists was trained in relevant bycatch mitigation information and how to conduct ISSF Skipper Workshops. The purpose of the program is to have an “in house” team that can cover multiple opportunistic or planned workshops in Indonesia. Given the vast number of ports and small scale purse seine vessels in this country it requires extra workshop coverage if a relevant number of fishers are to be certified. Low access by many fishers to online training materials (e.g. Skipper Guidebooks or videos) means that in-person training is required. In September 2016, the first round of workshops covered 6 ports in the islands of Java, Bali, Sulawesi and Sumatra. The lead scientists for the team, Mr. Anung Widodo, conducted the six workshops in Bahasa Indonesian and translated best practice posters were distributed to fishers. Further workshops are planned for 2017.

Figure 3. (a) Training in FAD bycatch mitigation of Indonesian CFRD fisheries scientists in Jakarta; (b) Skippers' Workshop in Bitung (Sulawesi) 2016 conducted by CFRD scientists.

The coverage of small-vessel tuna purse seiner fleets has also been further expanded by the incorporation of workshops in Vietnam. The first ever workshop with this fleet took place in October 2016 with the collaboration of the national tuna fisheries association, VINATUNA, and ISSF canneries like Foodtech. The meeting at the port of Quy Nhon was very successful and further workshops in other ports of Vietnam are being planned.

Bycatch mitigation activity acceptance levels

The acceptance levels recorded followed the tendency of previous rounds, with highest level of acceptance for use of non-entangling (NE) FADs and bycatch release practices from deck (**Table 3**). Note that these acceptance levels are based on the comments from skippers present at the time of the workshops and do not necessarily represent the views of a whole fleet.

It should also be pointed out that many of the mitigation activities initially thought for the large-scale vessels (e.g. > 500 GT) are not applicable to the smaller-sized tuna vessels like those of Indonesia or Vietnam. These small boats are very different to the modern super-seiners and lack many of the technological advances (e.g. echo-sounder buoys, high-tech sounders and radars) or even large enough nets to install shark escape windows. The small-vessel fleets require specific bycatch mitigation practices adapted to their fishery and vessel characteristics.

Table 3 – Acceptance level of activities proposed in 2016 workshops by fleets. H-High, M-Medium, L-Low, NA-No Answer.

GROUP	MEASURES	CHINA	GHANA	ECUADOR	INDONESIA	VIETNAM	SPAIN	PORTUGAL
SHARKS	NET WINDOWS	L	L	M-L	NA	NA	L	L
	BACKDOWN	L	L	M-L	NA	NA	L	M-L
	FISHING IN THE NET	NA	NA	M	NA	NA	M-L	H-M
	RELEASE PRACTICES	M-L	M-L	H	M	M	H	H-M
	NON-ENTANGLING FADS	M	M	H-M	H	H	H	H
	BIODEGRADABLE FADS	M	M	H-M	H-M	H-M	H-M	H-M
	DOUBLE FADS	L	L	L	NA	NA	L	NA
TURTLES	RELEASE PRACTICES	M-L	M-L	H	H	H	H	H
	NON-ENTANGLING FADS	M	M	H-M	H	H	H	H
SMALL TUNA	ECHO-SOUNDER BUOYS	M	H-M	H-M	NA	NA	H-M	H
	PRE-ESTIMATE ACOUSTICS	L	L	L	L	L	M-L	M-L
	SMALL SETS	L	L	L	L	L	L	L
	REDUCE NUMBER OF FADS	H-M	H-M	M	NA	NA	H-M	H-M
	SHORT APPENDAGE FADS	H-M	H-M	M	NA	NA	H-M	M-L
BONY FISH	UTILIZATION	L	H	H	H	H	H-M	H-M

Shark release from the net

In general escape windows in the net and back down for sharks have received poor acceptance ratings among fishers (**Table 4**). Fear of tuna escaping or entangling in the net are the biggest criticisms by captains. In addition, skippers think that some of these methods will not be possible to use in many sets due to conditions often encountered at sea such as strong currents, shallow thermocline, poor visibility, or lack of a V-shape for the shark escape window and high probability of smaller sized skipjack getting meshed in the net for the back down.

The idea of fishing sharks in the net from the speedboat with hooks has received mixed reviews, but out of the shark release options from the net presented is the one with the highest acceptance. Improvements to the current method tested at the Mar de Sergio cruise in the Atlantic Ocean include catching several sharks before releasing outside the net.

Table 4 – Evolution in the acceptance level of fishers for the use of shark escape panels by different tuna fleets in ISSF Skippers' Workshops between 2011 and 2016.

	FLEET	ACCEPTANCE LEVEL				
		2011-12	2012-13	2013-14	2014-15	2015-16
SHARK ESCAPE PANEL	ECUADOR	MID	MID	LOW	LOW	LOW-MID
	MEXICO	-	-	-	MID	-
	PERU	-	MID	-	LOW	-
	PANAMA	-	MID	-	-	-
	USA	LOW-MID	-	MID-HIGH	LOW-MID	-
	INDONESIA	-	-	NA	NA	NA
	KOREA	-	-	MID	LOW	-
	PHILIPPINES	LOW	-	LOW	-	-
	TAIWAN	-	-	MID	-	-
	FRANCE	LOW	MID	-	LOW	-
	SPAIN	LOW	LOW	LOW-MID	LOW-MID	LOW
	GHANA	LOW	LOW	LOW	LOW-MID	LOW
	PORTUGAL	-	-	-	-	LOW
	VIETNAM	-	-	-	-	NA
	CHINA	-	-	-	-	LOW

Best release practices from deck

In fleets with small scale vessels such as the Indonesian and Vietnamese most of the non-tuna species are utilized and sold in local markets. Manta rays and sharks are manipulated manually when released and acceptance for these activities was high. Best techniques were presented and posters handed out to fishers from these fleets showing how to prevent unnecessary injuries to the animals, such as holding small sharks from the tail and fins, or avoid holding manta rays from the frontal lobes and gills.

For the "super-seiner" fleets high acceptance and application is already taking place in those fleets which have been involved in workshops before, such as Ecuador and Spain. The number of vessels having specific release tools like cargo nets or stretcher beds is gradually increasing. Other newly visited fleets such as China learned for the first time from these better practices and acceptance was lower. This is a pattern commonly observed in first time workshops, as skippers get familiar with some of the options in successive workshops acceptance level tends to increase overtime (**Table 5**).

Table 5 – Evolution in the acceptance level of fishers for the use of best release practices from deck by different tuna fleets in ISSF Skippers' Workshops between 2010 and 2016.

	FLEET	ACCEPTANCE LEVEL					
		2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
BEST RELEASE PRACTICES	ECUADOR	MID	MID	MID-HIGH	HIGH	MID-HIGH	HIGH
	MEXICO	-	-	-	-	HIGH	-
	PERU	-	-	MID-HIGH	-	MID-HIGH	-
	PANAMA	MID-HIGH	-	MID-HIGH	-	-	-
	USA	MID	MID-HIGH	-	MID-HIGH	HIGH	-
	INDONESIA	-	-	-	LOW	LOW-MID	MID
	KOREA	-	-	-	MID-HIGH	MID-HIGH	-
	PHILIPPINES	-	MID	-	MID	-	-
	TAIWAN	-		-	MID-HIGH	-	-
	FRANCE	HIGH	MID	-	-	MID	-
	SPAIN	MID	MID-HIGH	MID-HIGH	HIGH	HIGH	HIGH
	GHANA	LOW-MID	MID	MID	HIGH	HIGH	HIGH
	PORTUGAL	-	-	-	-	-	HIGH
	VIETNAM	-	-	-	-	-	MID
	CHINA	-	-	-	-	-	LOW-MID

Non-entangling FADs

The use of lower risk entanglement FADs (i.e. with small mesh or tied up netting) and NE FADs (i.e. no netting) continues to increase in fleets of the Atlantic, the Indian Ocean and Eastern Pacific. In the Indian Ocean is where more NE DFADs have been reported (e.g. about 30% by the Spanish fleet according to questionnaires), whereas in the Atlantic most DFADs are lower risk entanglement because fishers consider that an open sail, nowadays constructed with small mesh net panels, is required. In the Eastern Pacific, the use of entanglement minimizing FAD tails, mainly in the form of sausages and small mesh Medina panels, is increasing. Meanwhile, Western and Central Pacific Ocean fleets using DFADs still utilize majorly wide mesh (e.g. > 2.5 inch; > 6.35 cm) open panels. Chinese skippers consulted thought that moving to lower risk entanglement FADs should not be a problem, but need encouragement from their companies or the t-RMFOs to do so. Looking at historical NE FAD acceptance levels by fleet (**Table 6**), in many instances acceptance of novel measures is low at the beginning (e.g. Ecuador, Ghana). As fishers become familiarized with these concepts and see that other fleets have not reduced tuna catches using NE FADs, the acceptance and adoption of these measures increases over time.

Table 6 – Evolution in the acceptance level of fishers for the use of FADs that minimize entanglement by different tuna fleets in ISSF Skippers' Workshops between 2010 and 2016. Estimated number of large purse seiners (> 335 m^3 fish holding volume) by fleet and level of use of FADs.

FLEET	OCEAN	LARGE PS	FAD USE	ACCEPTANCE LEVEL					
				2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
ECUADOR	EPO	86	HIGH	LOW	MID	MID-HIGH	MID-HIGH	MID-HIGH	HIGH
MEXICO	EPO	41	LOW	-	-	-	-	HIGH	-
PERU	EPO	8	LOW	-	-	MID	-	MID-HIGH	-
PANAMA	EPO	17	MID	MID	-	MID-HIGH	-	-	-
USA	EPO, WCPO	31	MID	HIGH	HIGH	-	MID-HIGH	MID-HIGH	-
INDONESIA	WCPO	20	HIGH	-	-	-	HIGH	HIGH	HIGH
KOREA	WCPO, IO	32	HIGH	-	-	-	HIGH	MID	-
PHILIPPINES	WCPO	73	HIGH	-	MID-HIGH	-	MID-HIGH	MID-HIGH	-
TAIWAN	WCPO	54	MID	-	-	-	MID-HIGH	-	-
FRANCE	IO, ATL	20	MID	HIGH	HIGH	-	-	HIGH	-
CHINA	WCPO	20	MID	-	-	-	-	-	MID
SPAIN	IO, ATL, EPO	32	HIGH	MID-HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
GHANA	ATL	17	HIGH	LOW	LOW-MID	MID	MID	MID-HIGH	HIGH

More workshops with fleets from the WCPO using DFADs would help promote the idea of moving to NE FADs. Fleets in the WCPO using anchored FADs like Indonesia or Philippines continue to have no netting in the FAD construction and therefore fall automatically under the NE FAD category.

At many of the workshops, questionnaires on bycatch issues are filled in by captains and crew present. An entire section of the questionnaire is devoted to FAD types (e.g. designs, materials) and asks specifically what kind of entanglement category FADs they use (e.g. High Entanglement Risk (HER), Lower Entanglement Risk (LER), or Non-Entangling (NE) FADs). Up to 2016, there were 308 questionnaires collected from fleets including Spain, Ecuador, Peru, Mexico, South Korea, USA, and France. For some fleets like Taiwan or China the information was collected from conversations with captains, fleet managers and ship-owners, rather than through questionnaires. Currently in three out of four oceans, dFADs are predominantly of the entanglement preventing type. According to information provided by skippers almost all HER FADs in the AO and IO have been phased out (**Table 7**). Note that since 2017 all fleets in the AO, including Ghana, have moved away from HER FADs following ICCAT Rec. 16-01.

*Table 7. Use of FAD type by fleet according to entanglement characteristics. Source: ISSF Skippers' Workshop fishing master and captain questionnaires. Highest Entanglement Risk (HER); Lower Entanglement Risk (LER); Non-entanglement (NE). Oceanic regions: Eastern Pacific Ocean (EPO), Western and Central Pacific Ocean (WCPO), Indian Ocean (IND) and Atlantic Ocean (ATL). *The Indonesian fleet uses NE Anchored FADs (not drifting FADs); ** Since early 2017 Ghana is using 100% LER and NE FADs.*

FLEET	OCEAN PRESENCE	HERFAD (%)	LERFAD (%)	NEFAD (%)
Ecuador	EPO	39	43	21
Peru	EPO	0	100	0
Mexico	EPO	0	100	0
Spain	EPO, IO, AO	3	61	36
USA	EPO, WCPO	100	0	0
Korea	WCPO	100	0	0
Taiwan	WCPO	100	0	0
China	WCPO	100	0	0
Indonesia*	WCPO, IO	0	0	100
France	IO, AO	0	73	27
Ghana**	AO	60	40	0

"Currently in three out of four oceans, dFADs are predominantly of the entanglement preventing type."

In the EPO the proportion of LER and NE FADs has increased substantially in the last two or three years and currently are more common than HER FADs. For the WCPO the only NE FADs found to date are the AFADS used by fleets like Indonesia or Philippines. As of 2016, no record of LER or NE FADs has been collected from fishers using DFADs in the WCPO. Note that the WCPFC remains the only tuna RFMO with no NE FAD related conservation measures to date.

Biodegradable FADs

In 2016, special emphasis has been given during the workshops to discuss the subject of biodegradable FADs as there is mounting pressure by NGOs to tackle the problem of FAD pollution and other ecosystem impacts. The level of acceptance of biodegradable FADs has been in general high and fishers understand that something must be done about FADs beaching in coral reefs and other sensitive marine ecosystems. Having teams on land to clean up FADs could partially reduce the problem but would not solve it altogether. The use of metallic raft frames and plastic bottle containers for floatation, which could be seen as a negative tendency by NGOs, has been escalating during the last year in the Indian and Atlantic Oceans.

Some promising biodegradable candidate materials and configurations such as cotton ropes and canvases have been tested and are already available commercially. Most fishers across oceans consider that the working life of biodegradable FADs should ideally reach 9 to 12 months. Note that few non-biodegradable material DFADs reach a year at sea and very often a high percentage of DFADs are stolen within the first months after seeding them. In many locations like Ghana, Spain or Ecuador skippers showed good disposition to try biodegradable FADs during their regular fishing trips. In fact, some

companies like Albacora in Ecuador or Inpesca in Spain are trying out some of these biodegradable materials in a small number of FADs (pers. comm.).

In November 2016 ISSF hosted a special workshop on biodegradable FADs in San Sebastián (Spain) with fishers and scientists from the Pacific, Atlantic and Indian Oceans to discuss available options. The principal caveat at present to build a 100% biodegradable FAD is finding a substitute for current raft flotation non-biodegradable materials. For the captains a DFAD's flotation is extremely important as there is a fine balance between maintaining a very slight negative buoyancy to keep the DFAD's raft just below the water surface to prevent detection while at the same time having to prevent buoyancy loss which could eventually sink the DFAD. Nowadays, except for bamboo, there are several flotation materials including fishing net corks, PVC pipes or plastic bottle containers which are not biodegradable. Biodegradable woods, such as balsa, might be options to substitute plastic-build floats. Ways to make these woods more durable in the water, such as with oil or natural resin coatings, should be explored.

Selective echo-sounder buoys

The use of echo-sounder buoys in DFADs continues to rise and most buoys these days belong to this category. AFADs still do not have buoys attached, but the first record of a company in Indonesia trying echo-sounder buoys in their rumpons (i.e. traditional Indonesian AFADs) was observed in Jakarta.

"Fishers would welcome the possibility of knowing if there is bigeye tuna in a FAD."

Despite some advances in biomass estimation reliability, none of the commercially available echo-sounder buoys still cannot provide accurate estimations of biomass at species level (e.g. amount of skipjack, bigeye or yellowfin tuna). Even with the vessel sounder it is difficult to know if there is small bigeye in the aggregation. Fishers would welcome the possibility of knowing if there is bigeye tuna in a FAD, but say that restrictive conservation measures (e.g. bigeye quotas) should be in place as well, otherwise they would continue to fish on the DFAD with the largest biomass, regardless the species composition.

Fishers also seem very interested in echo-sounder buoys that can distinguish small pelagics from tuna, as often unproductive trips to DFADs with large amounts of small pelagics such as mackerel or blue runners could be avoided in all oceans. Thus, this activity has received over all high acceptance across fleets (**Table 8**)

Table 8 – Evolution in the acceptance level of fishers for the use of selective echo-sounder buoys by different tuna fleets in ISSF Skippers' Workshops between 2010 and 2016.

	FLEET	ACCEPTANCE LEVEL					
		2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
ECHO-SOUNDER SELECTIVITY	ECUADOR	MID	MID	MID	HIGH	MID-HIGH	MID-HIGH
	MEXICO	-	-	-	-	MID	-
	PERU	-	-	MID	-	MID	-
	PANAMA	MID	-	MID	-	-	-
	USA	MID-HIGH	MID	-	MID	MID	-
	INDONESIA	-	-	-	NA	NA	NA
	KOREA	-	-	-	MID	HIGH	-
	PHILIPPINES	-	LOW	-	MID	-	-
	TAIWAN	-	-	-	MID	-	-
	FRANCE	MID-HIGH	MID	-	-	-	-
	SPAIN	MID	MID	MID	MID	HIGH	HIGH
	GHANA	LOW	LOW	MID	MID	MID	MID
	PORTUGAL	-	-	-	-	-	HIGH
	VIETNAM	-	-	-	-	-	NA
	CHINA	-	-	-	-	-	MID

Avoidance of small sets

Due to the increasing DFAD theft tendency between vessels, in some cases reaching up to 80% according to some skippers, most fishers prefer to catch whatever is present at the FAD, even if little, when they visit them. Many vessels with limited resources to deploy numerous FADs will use helicopters, high-tech bird radars and supply vessels to try to detect other boats' FADs. In the first rounds of workshops in 2010 fishers used to refer to a minimum size threshold (between 15-20 tonnes) required to go ahead with a set. In the last year, many fishers in regions like the Atlantic or Indian Ocean indicated that even 5 tonnes was enough to make a set, because if they do not fish it other boat will. The tendency in the last two or three years has been therefore towards low acceptance levels for avoidance of small sets (**Table 9**).

Table 9 – Evolution in the acceptance level of fishers for the use of small set avoidance by different tuna fleets in ISSF Skippers' Workshops between 2011 and 2016.

	FLEET	ACCEPTANCE LEVEL				
		2011-12	2012-13	2013-14	2014-15	2015-16
AVOIDANCE SMALL SETS	ECUADOR	-	-	LOW-MID	-	LOW
	MEXICO	-	-	-	LOW	-
	PERU	-	-	-	-	-
	PANAMA	-	-	-	-	-
	USA	-	-	MID-HIGH	LOW	-
	INDONESIA	-	-	LOW	LOW	LOW
	KOREA	-	-	LOW	-	-
	PHILIPPINES	-	-	-	-	-
	TAIWAN	-	-	LOW	-	-
	FRANCE	LOW	-	-		-
	SPAIN	-	LOW-MID	LOW	LOW	LOW
	GHANA	LOW	LOW	LOW-MID	LOW	LOW
	PORTUGAL	-	-	-	-	LOW
	VIETNAM	-	-	-	-	LOW
	CHINA	-	-	-	-	LOW

FAD number reduction

Acceptance for a limit or reduction on the number of DFADs has been observed in most workshops. The number of DFADs per vessel has been escalating rapidly in the last two decades. Many fleets have specialized in the intensive use of DFADs, and even fleets that traditionally have not worked with DFADs such as Mexico or Colombia, have now started to do so. In many of the workshops fishers have shown concern over the large amount of DFADs being used, especially in the Indian and Atlantic Ocean where fishing grounds cover a much smaller area than the Pacific, so DFAD density may be greater. In most cases fishers, even those depending largely on DFAD catches, agreed that current limitations of FADs to about 500 units per vessel from ICCAT (500 units) and IOTC (425 units from 1rst January 2017) are beneficial.

Short tail FADs

Many skippers think that short tail FADs in theory would attract less bigeye than longer tailed FADs. The recent tendency in many oceans has been to increase the depth of DFADs, some reaching 80 to 100 m. This is because longer tails slow down drift, have more surface area for fish to detect the DFAD and also may attract deeper dwelling species like bigeye tuna. Some fishers point out that natural objects, like logs, no longer attract tuna given that they have to compete with structurally larger FADs which are more attractive to colonizing fish species and tunas.

Some fishers in the Atlantic and the Eastern Pacific think that shorter tailed DFADs would be detrimental to their catches as in regions of strong superficial currents they would drift too fast for tuna to aggregate. Meanwhile in the Indian Ocean skippers thought that shallower tailed FADs may work in attracting tuna aggregations, and avoiding bigeye, especially in areas of cooler waters where tunas tend to be higher up in the water column. In addition, some fishers thought that specific ocean areas and seasons are more important in finding bigeye in FAD sets than the structure of the FAD itself. Therefore, acceptance levels for this small bigeye mitigation activity have been mixed and ocean-dependent.

Utilization

This option generally receives high acceptance (**Table 10**). In small boat fisheries, like Indonesia and Vietnam, utilization of species is almost 100%, with little or no discards. Only sharks, mantas and turtles are in principle released, everything else reaches the local markets or canneries for human consumption. For the large-scale fleets utilization is high in the Atlantic, sold as "*faux poisson*", and in Eastern Pacific in Ecuador the wahoo, dolphinfish and marlin is processed in factories and commercialized. However, in the Indian Ocean non-tuna finfish species may be discarded due to lack of a large enough local market (e.g. in Seychelles) to buy this catch. In the Western Pacific super-seiner fleets like China may also encounter this problem. Often bycatch fish is consumed onboard or given away to people at local islands.

Table 10 – Evolution in the acceptance level of fishers for bony fish bycatch utilization by different tuna fleets in ISSF Skippers' Workshops between 2010 and 2016.

	FLEET	ACCEPTANCE LEVEL					
		2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
BYCATCH UTILIZATION	ECUADOR	MID-HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
	MEXICO	-	-	-	-	MID	
	PERU	-	-	HIGH	-	HIGH	
	PANAMA	MID-HIGH	-	MID-HIGH	-	-	
	USA	MID-HIGH	MID-HIGH	-	HIGH	LOW-MID	
	INDONESIA	-	-	-	HIGH	HIGH	HIGH
	KOREA	-	-	-	LOW-MID	LOW	
	PHILIPPINES	-	HIGH	-	HIGH	-	
	TAIWAN	-	-	-	HIGH	-	
	FRANCE	HIGH	HIGH	-	-	MID	
	SPAIN	MID	MID	HIGH	MID-HIGH	HIGH	MID-HIGH
	GHANA	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
	CHINA	-	-	-	-	-	LOW
	PORTUGAL	-	-	-	-	-	MID-HIGH
	VIETMAN	-	-	-	-	-	HIGH

Grids and ramps for deck bycatch release

In addition to the simple bamboo built grid to release large manta rays presented by skippers in Sukarrieta in 2015, some fishers in Spain have designed a grid which has a metallic frame with a grid made of chains going across in a crisscross pattern, in a comparable way to the cargo net mesh. For large boats with brails of 9 or 10 tonnes the bamboo grid can brake under so much weight, but the stronger metallic frame and chains can sustain this pressure.

Other Spanish fleet skipper showed scientists how he uses custom-built metallic ramp to release large bycatch such as sharks safely. The ramp is removable, and is used when large bycatch individuals arrive on the deck. The ramp is held up at an angle by a crane and connects directly to the opening door on the deck railing. The bycatch can be emptied from the brail directly and then slide down the ramp to the water, without need to be lifted or handled by crew (**Figure 4**).

Figure 4. Ramp to release large bycatch, such as adult sharks, through the top deck door opening.

Biodegradable FAD materials and designs

In Ecuador, a skipper presented FADs which used balsa wood as floatation. This material is very abundant and relatively cheap in South America and could be a solution for biodegradable FAD flotation. In the case of this skipper, he did use some fiberglass and resin coating to extend the useful life time of the balsa wood. However, natural options like application of organic resins to slow down the decay of the wood and preserve flotation characteristics should be tested. In 2016, an Ecuadorian boat from Guayatuna S.A. tried the idea by making a 100% biodegradable DFAD by making a raft out of bamboo and balsa and a tail with cotton canvas and sisal ropes (**Figure 5**). The latest news received showed that the DFAD was still working after five months at sea.

Figure 5. (a) Bamboo and balsa wood raft and (b) cotton canvas and sisal rope tail of biodegradable DFADS tried by boats of Guayatuna S.A. in the EPO.

Fishing sharks in the net

Several improvements to the method to fish sharks used in the Mar de Sergio opportunistic cruise of the Atlantic were suggested by skippers. For example, several lines should be utilized simultaneously to increase chances of shark capture. When a shark is caught, tie the line to a cleat until a large enough number of sharks (e.g. 3 to 5) is hooked. This would save time wasted if for each shark the speedboat would have to drive outside the net and go back again. In addition, the speedboat could have some custom-made platform or plank on the sides to keep part of the body of the shark resting on it while the speedboat drives out of the net for release. This simple resting structure would prevent dragging the shark underwater to take them out of the net. Other ideas suggested were using de-hookers, like those used in longline fisheries, to take out the hook of the mouth of the animals.

Shark and manta ray hotspots

Skippers from different oceans have provided throughout the workshops information on best areas and seasons to have better chances of finding sharks and manta rays (e.g. Gabon and Angola in Africa or Costa Rica and Clipperton Islands in South America). This information can be contrasted with observer data. Note though that observer coverage in some oceans like the Atlantic and Indian Ocean has been low (about 5% of trips) until very recently. Given that many of the research cruises to test shark mitigation activities (e.g. escape window in Atlantic, back down in Eastern Pacific) have encountered problems due to low number of sharks in the net, focusing on conducting research cruises in prime shark areas should be a priority. Additional information from hotspot scientific studies could be contrasted with skippers' knowledge on bycatch hotspots. In addition, skippers can inform of anomalies or changes in distribution of these species on a "real time" basis.

Recommendations

Integration of complimentary knowledge of tuna fishers and scientists in collaborative forums, like the ISSF Skippers Workshops, can improve the development of bycatch reducing technology and fishing operations, and favour the adoption of best sustainable practices for each ocean.

The discussion resulted in three recommendations:

Recommendation 1:

- Encourage the use of NEFADs, especially in the WCPO, and promote at sea trials of biodegradable FADs.

Recommendation 2:

- Continue research work on selective technology, such as improved echo-sounder discrimination, to reduce catches of undesirable tuna species or sizes; and persevere in the search for shark bycatch mitigation options before and during the set. Research on elasmobranch sensory physiology and behaviour around FADs may help find better bycatch mitigation solutions.

Recommendation 3:

- Customize workshops to each fleets' needs. Either by facilitating small group meetings to maximize fishers' feedback; or by supporting programs like train-the-trainer in which local scientists can conduct bycatch reduction workshops adjusted to the requirements of their small-vessel fleets.

Related Reports

Anon. (2009). Mitigation of bycatches in tuna purse seiners. Sukarrieta Meeting, Nov 2009.ISSF Technical Report 2009-03, International Seafood Sustainability Foundation, Washington, D.C., USA

Dagorn, L., Holland, K., Restrepo, V. and 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.

Dagorn, L., Filmalter, J.D., Forget, F., Amandè, M.J., Hall, M.A., Williams, P., Murua, H., Ariz, J., Chavance, P., Bez, N., (2012). Targeting bigger schools can reduce ecosystem impacts of fisheries. Can. J. Fish. Aquat. Sci., 69: 1463-1467.

Filmalter, J. D., Capello, M., Deneubourg, J.-L., Cowley, P. D., and Dagorn, L. (2013). Looking behind the curtain: quantifying massive shark mortality in fish aggregating devices. Frontiers in Ecology and the Environment, 11: 291-296.

Goñi, N., Ruiz, J., Murua, H., Santiago J., Krug, I., Sotillo de Olano, B., González de Zarate, A., Moreno, G., and 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. WCPFC-SC11-2015/EB-IP-11, Pohnpei, Federated States of Micronesia, 5-13 August 2015.

Hall, M., and Roman, M. (2013). Bycatch and non-tuna catch in the tropical tuna purse seine fisheries of the world. FAO Fisheries and Aquaculture Technical Paper No. 568. 249 p. Food and Agriculture Organization of the United Nations, Rome, 249 pp.

Hutchinson, M., Itano, D., Muir, J., Holland, K. (2015). Post-release survival of juvenile silky sharks captured in a tropical tuna purse seine fishery. Mar. Ecol. Prog. Ser. 521: 143-154.

ISSF. 2015. Guide for non-entangling FADs. Knowledge & Tools. Guides & Best Practices. International Seafood Sustainability Foundation. http://iss-foundation.org/knowledge-tools/guides-best-practices/non-entangling-fads/ (last access on 28 April 2017).

Justel-Rubio, A. and V. Restrepo. (2017). Computing a global rate of non-target species catch (bycatch) in tropical tuna purse seine fisheries. ISSF Technical Report 2017-01. International Seafood Sustainability Foundation, Washington, D.C., USA.

Lewis. A. (2014). Exploration of market viability for the full retention of non-tuna species in purse seine fisheries: interim report. ISSF Technical Report 2014-12, International Seafood Sustainability Foundation, Washington, D.C., USA.

Lopez, J., Moreno, G., Sancristobal, I., and Murua, J. (2014). Evolution and current state of the technology of echo-sounder buoys used by Spanish tropical tuna purse seiners in the Atlantic, Indian and Pacific Oceans. Fish. Res. 155, 127–137.

Moreno, G., Dagorn, L., Sancho, G., García, D., and Itano, D. (2007). Using local ecological knowledge (LEK) to provide insight on the tuna purse seine fleets of the Indian Ocean useful to management. Aquat. Living Resour. 20: 367-376.

Moreno, G., Dagorn, L., Capello, M., Lopez, J., Filmalter, J., Forget, F., Sancristobal, I., and Holland, K., (2016). Fish aggregating devices (FADs) as scientific platforms. Fish. Res. 178: 122-129.

Moreno, G., Restrepo, V., Dagorn, L., Hall, M., Murua, J., Sancristobal, I., Grande, M., Le Couls, S., and Santiago, J. (2016). Workshop on the use of biodegradable fish aggregating devices (FADs). ISSF Technical Report 2016-18A, International Seafood Sustainability Foundation, Washington, D.C., USA.

Murua, J., Moreno, G., Hall, M., Itano, D., Dagorn, L., and Restrepo, V., (2014). ISSF Skipper Workshops: Collaboration between scientists and fishing industry to mitigate bycatch in tuna FAD fisheries. ISSF Technical Report 2014-06, International Seafood Sustainability Foundation, Washington, D.C., USA.

Murua, J., Itano, D., Hall, M., Dagorn, L., Moreno, G., and Restrepo, V., (2016). Advances in the use of entanglement-reducing drifting fish aggregating devices (DFADs) in tuna purse seine fleets. ISSF Technical Report 2016-08, International Seafood Sustainability Foundation, Washington, D.C., USA.

Poisson, P., Séret, B., Vernet, A-L, Goujon, M., Dagorn, L. (2014). Collaborative research: Development of a manual on elasmobranch handling and release best practices in tropical tuna purse-seine fisheries. Mar. Pol. 44:312-320.

Restrepo, V., Dagorn, L., Moreno, G., Forget, F., Schaefer, K., Sancristobal, I., Muir, J., and Itano, D., (2016). Compendium of ISSF at-sea bycatch mitigation research activities as of 12/2016. ISSF Technical Report 2016-13A, International Seafood Sustainability Foundation, Washington, D.C., USA.

Restrepo, V., Dagorn, L., and Moreno, G. (2016). Mitigation of silky shark bycatch in tropical tuna purse seine fisheries. ISSF Technical Report 2016-17, International Seafood Sustainability Foundation, Washington, D.C., USA.

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