ISSF Technical Report 2020-01

ISSF SKIPPERS WORKSHOPS ROUND 9

 Photo: David Itano

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Abstract

Round 9 of the ISSF Skippers Workshops in 2019 maintained the collaboration links between tuna purse seine fishers and scientists through a series of 12 participatory bycatch-reduction meetings in 9 countries. Key fleets in the Indian and Atlantic Oceans (e.g. Spanish, French, Ghanaian), Eastern Pacific Ocean (e.g. Ecuadorian, Mexican) and Western Pacific Ocean (e.g. Filipino, Marshallese, Indonesian) were covered. Zadar, hometown to Croatian skippers operating in the Pacific Ocean, was also added to the extensive list of locations covered by the workshops. A new attendance record was reached in Manta (Ecuador) with 173 participants in a single workshop.

The workshops highlighted the consolidation of non-entangling FADs as the principal form of man-made floating objects in all oceans. Experiences of fishers using biodegradable FADs (e.g. Indian Ocean BIOFAD project) were collected and upcoming trials were discussed in person with the fishers who will soon participate in them (e.g. biodegradable FADs with the Ghanaian fleet, Ecuadorian fleet, Micronesian fleet). Best release practices from deck continue to receive good acceptance and part of the vessels are implementing them (e.g. stretcher beds, cargo nets). New tools such as manta sorting grids and shark velcros are being tested too at sea. Updated fishing strategies in each fleet and ocean were discussed, especially in relation to how they affect present management conservation measures like FAD limits and closures. The role of echo-sounder buoy information influencing vessel movements is widespread, and selective species discrimination with this tool would be important, especially now that bigeye and yellowfin quotas are in place in several regions. Finding ways to release bycatch, especially vulnerable species like sharks, before sacking up is still a priority. While catching and releasing sharks in the net with fishing lines has been proposed and tested with relative success, more research for better mitigation measures may be required.

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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. Helping global tuna fisheries meet sustainability criteria to achieve the Marine Stewardship Council certification standard — without conditions — is ISSF's ultimate objective. ISSF receives financial support from foundations and industry sources.

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Executive Summary

During 2019, the ninth round of ISSF Skippers' Workshops visited 10 locations in 9 countries, conducting 12 workshops in total, with the participation of 531 fishers and stakeholders (**Table 1**). This document summarizes the results and acceptance levels of participants to various bycatch mitigation activities and describes the advance in the adoption of best fishing practices by different tropical tuna purse seiner fleets around the globe.

The change to non-entangling FADs (NEFADs) was already well established in most oceans, except in the Western and Central Pacific Ocean. This situation is rapidly changing as CMM 2018-01 requires NEFAD implementation in this region by January 2020. Most of today's FADs employed by fleets worldwide to minimize entanglement risk are still constructed with small mesh or tied-up netting material. The next move should be to eliminate all netting material in FADs, as will happen in 2020 in the Indian Ocean, thanks to Resolution 18/08.

Many skippers think that biodegradable FADs are the way forward to reduce FAD marine pollution and is more practical than FAD retrieval options. During 2019 many large-scale trials with biodegradable FADs have been conducted (e.g. BIOFAD in the Indian Ocean) or about to start (e.g. Ghanaian fleet trials in the Atlantic, Ecuadorian fleet trials in the Eastern Pacific, or Micronesian fleet trials in the Western and Central Pacific). In addition to the Skippers Workshops a series of specific ISSF biodegradable FAD workshops (e.g. Papua New Guinea, Philippines, Micronesia, Marshall Islands, Croatia) have provided a platform for scientists and fishers to plan experiments at sea. Initial biodegradable FAD trials have shown acceptable working life for some materials such as cotton ropes with wax coating (e.g. 4-5 months), but improvements in natural material FAD floatation and materials with greater duration at sea are viewed as necessary. Development of new simpler FAD designs, using a minimum amount of material to minimize marine debris, is also being explored by scientists with the help of fishers.

Key Findings:

1. **Fishers and key stakeholders continued to engage with scientists in round 9 of the Skippers Workshops through 12 workshops in 9 countries, with a total of 472 participants obtaining PVR certification.**
2. **Advances in the use of NEFADs, trials with biodegradable FADs and new tools for bycatch release took place during 2019.**
3. **Collaboration with small-scale tuna purse seine fleets in Asia were maintained through measure-specific targeted workshops.**

Up to now best release practices recommendations involved manual handling of small sharks and a limited range of tools for larger sharks (e.g. bed stretcher) and mantas (e.g. cargo net). While these solutions are easy and cheap to implement, maybe better options can be found. Scientists are working with skippers on a range of release tools such as the "shark velcros" and manta sorting grids with promising results in terms of faster release times, improved crew safety and better survival chances of released individuals. Also, fishers using hoppers supported this tool to facilitate bycatch release from deck.

Potential tuna species discrimination with acoustic tools was highly accepted by fishers, who would benefit especially now that many vessels have yellowfin and bigeye quotas. Meanwhile, activities to release bycatch before sacking up, such as fishing and releasing the sharks from the net, received poor acceptance, as thought to be impractical by fishers.

Cooperation with small-vessel tuna purse seiners utilizing anchored FADs, such as those in Indonesia and Philippines, continued this year. The cumulative catches of the vast number of these small vessels often exceed those of industrial fleets and require their own mitigation solutions.

Research Questions

- **Which are the best ways to obtain fishers' knowledge on marine ecosystems and fishing strategies?**
- **How can we identify bycatch solutions that are best suited to each ocean?**
- **How can vulnerable bycatch species be managed better?**
- **Which are the best designs and materials for biodegradable non-entangling FADs?**
- **What tools can be developed to facilitate speedy release of bycatch on deck?**
- **In which ways can the catch of undesirable sized tuna be reduced?**
- **Which impact mitigation options are best suited to large-scale and which to small-scale vessels?**

Introduction

The **ISSF Bycatch Project** reached in 2019 its 10th anniversary, and so did the ISSF Skippers Workshops, which are a key component of this program. To recapitulate on the past achievements on this project in the last decade and the future challenges ISSF celebrated a special **workshop in Rome** in the FAO headquarters, where key fishery stakeholders participated, including skippers from each oceanic region. From November 2009 to this date, skippers and fisheries scientists have been engaging through workshops in fruitful knowledge exchanges to improve the sustainability standards in tropical tuna purse seine fisheries across the world. Over 100 workshops have taken place in 5 continents, covering vessels from more than 25 flag states. The workshops serve several purposes. One is for scientists to gain feedback and new ideas from fishers on ways to improve selectivity in fishing operations which can be later tested in **ISSF research cruises**. A second objective is for scientists to pass on information on **best available fishing practices** including biodegradable NEFADs or best bycatch release methods. Many good practices are often gathered from skippers in different oceans and transmitted on to other fishers elsewhere so they can add them into their daily routines. The in-person workshops also help skippers obtain their certification for the **Proactive Vessel Register (PVR)**, which along with an array of other meaningful efforts (e.g. 100% observer coverage, use of NEFADs, RFMO fishing registration, non-IUU fishing, full tuna retention, shark anti-fining policy, etc.) demonstrates that their vessels are committed to sustainable fishing.

Counting with the collaboration of fishers from all important tuna fishing fleets across the globe year after year is a tremendous achievement. This kind of mass-scale cooperation, with over 4,000 participations accumulated in the workshops, is unprecedented and has helped shape in a positive way many of the fishing practices across tuna purse seine fleets. For example, while in the early 2010s NEFADs did not even exist, currently they are the norm in all fishing regions, even before RMFOs required them through conservation measures. While scientists initially encouraged industry to use NEFADs, it was the fishers with their technical expertise who came up with the different designs to make them fully functional in the different fishing regions. Thanks to continuous exchanges with fishers the workshops also allow scientists to learn in real-time about rapid changes taking place in each region. Tuna purse seine fisheries are very dynamic and drastic fluctuations such as types and quantities of FADs or adoption of fishing aids like echo-sounder buoys or drones/helicopters, etc. can happen within a very short time period. Observer data can take from months to years to be analysed and even then, not all meaningful information is recorded. Meanwhile, talks with fishers can quickly alert scientists of alterations in fishing strategies and technology which may affect fishing effort, tuna stocks and their environment, so that scientists and managers can act upon these situations in a timely fashion. Providing fishers with a forum to be heard and take part in solution-solving initiatives is a game changer. In the past fishers have been far removed from scientific evaluations and management decisions, feeling alienated from the whole conservation measure process. Empowering fishers through the development of sustainable fishing practices, makes them more prone to voluntarily adopt and implement these measures, as they see themselves as part-taking owners of the solutions.

The following sections provide information on the ISSF Skippers Workshops completed during round 9 in 2019.

2019 SKIPPERS WORKSHOPS FLEET COVERAGE

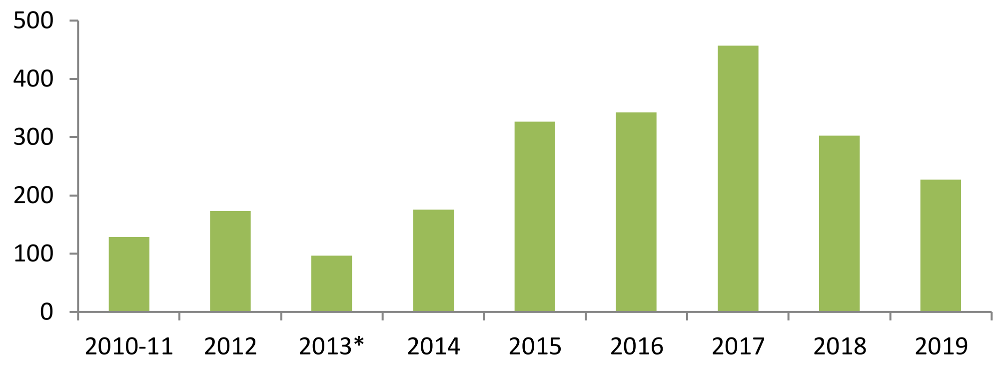
In 2019, a total of 9 countries were visited, with 12 workshops conducted at 10 locations (**Table 1**). By continent, there were 3 workshops in South America, 3 in Asia, 4 in Europe, 1 in Oceania and 1 in Africa. In two of the locations, Manta and Sukarrieta, there were two workshops in the same year. This was because a collaboration with the Poseidon Project (https://oceanconservancy.org/sustainable-fisheries/poseidon/) arose providing the opportunity to organize extra workshops targeting these key fleets.

The total number of participants in 2019 was 531, and of those 227 were skippers (i.e. fishing masters or captains) and 189 crew (i.e. chief engineers, chief officers, deck bosses, deck crew) (**Table 1**, **Fig.1 and 2**). While having skippers in the workshops is essential as they are in-charge of the vessel and the principal decision-makers, it is also important for crew to be present as they are the "hands" onboard, which must execute many of the best practices such as releasing sharks in the right way or constructing the FADs correctly.

Timing of the workshops at the optimal time of the year, for example when most fishers are on land during a FAD closure, is essential to reach a critical mass of participants. This can be clearly seen in the number of attendants in the first workshop organized in Manta (Ecuador) in April 2019, with 64 participants, when there was no closure, and a later workshop in August, during IATTC's 1st closure period, which reached 173 attendees. The latter meeting set a new record for number of participants in a single Skippers Workshop. Most workshops in 2019 covered large-scale industrial vessel fleets, but small-scale and semi industrial vessels were also targeted, primarily through the meetings in Jakarta (Java) and Sibolga (Sumatra) in Indonesia, and part of the companies attending the workshop in General Santos in Philippines.

Table 1 – Skippers Workshop locations and participation by work group category in 2019.

WS	LOCATION	DATE	SKIPPERS	CREW	SHIP-OWNERS	FLEET MANAGERS	FLEET REP.	GOV. OFFICIALS	SCIENTISTS	TOTAL
9.1	TEMA (GHANA)	26/02/2019	22	28	4	6	9	0	1	70
9.2	MANTA (ECUADOR)	09/04/2019	18	23	1	5	11	2	4	64
9.3	JAKARTA (INDONESIA)	03/05/2019	7	16	0	3	0	4	0	30
9.4	SIBOLGA (INDONESIA)	06/05/2019	14	4	0	2	0	9	2	31
9.5	MAZATLAN (MEXICO)	10/06/2019	11	5	0	1	2	0	1	20
9.6	GENERAL SANTOS (PHILIPPINES)	27/06/2019	8	3	2	4	10	4	1	32
9.7	MAJURO (MARSHALL ISLANDS)	01/07/2019	5	0	0	2	0	0	1	8
9.8	MANTA (ECUADOR)	30/08/2019	70	96	0	1	6	0	0	173
9.9	SUKARRIETA (SPAIN)	26/09/2019	18	2	0	0	0	0	1	21
9.10	ZADAR (CROATIA)	05/09/2019	8	0	0	0	0	0	1	9
9.11	CONCARNEAU (FRANCE)	07/10/2019	9	1	0	2	3	0	4	19
9.12	SUKARRIETA (SPAIN)	07-11/10/2019	37	11	0	1	3	0	2	54
TOTAL			227	189	7	27	44	19	18	531



**2013 – only 5 workshops were conducted.*

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

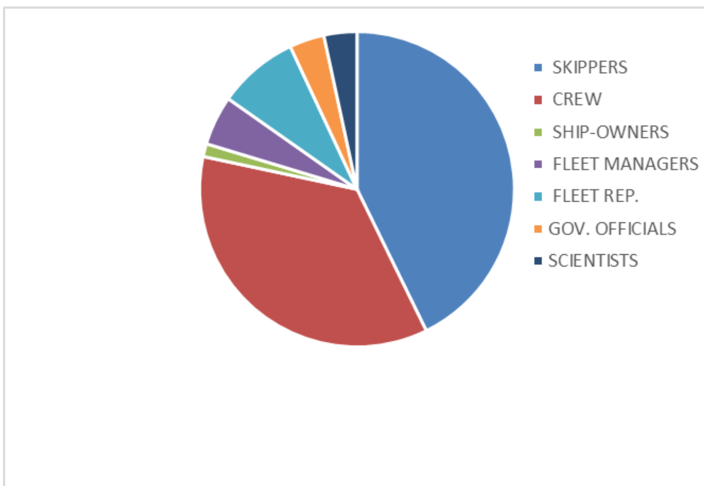


Figure 2. Participation by work group category in 2019 Skippers Workshops.

The overall number of attendances since the commence of the Skippers Workshops is of 4221, with 2226 by skippers and 950 by crew (**Fig. 3**). Highest fisher attendance has been typically in locations like Sukarrieta (Spain) or Manta (Ecuador), where workshops have been conducted on an annual basis. The small-scale vessel workshops in Indonesia have also yielded important numbers of participants, due to ISSF efforts to reach out to the fishers scattered across the multiple ports of this archipelago (e.g. Jakarta, Sibolga, Benoa, Kendari, Bitung, Prigi, Pekalongan, etc.) since 2012 (**Table 2**, **Fig. 4**).

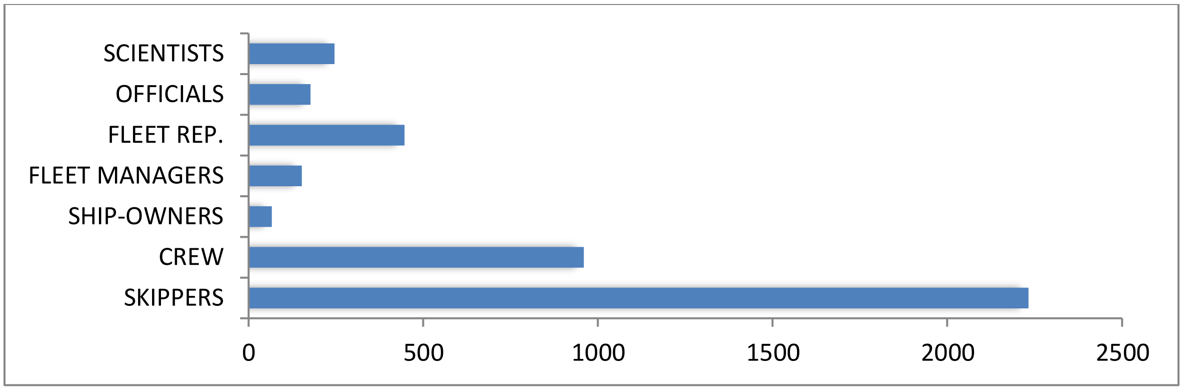


Figure 3. Participation by work group category in Skippers Workshops since 2009.

Figure 4. Round 9 ISSF Skipper Workshops (a) in Ecuador with a record number of 173 participants, (b) in Indonesia with small-scale vessel fishers, and (c) in Ghana with the purse seiner and pole and line skippers and crew.

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

WS	LOCATION	DATE	SKIPPERS	CREW	SHIP-OWNERS	FLEET MANAGERS	FLEET REP.	GOV. 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
7.1	MANTA (ECUADOR)	10-11/01/2017	95	16	0	1	3	0	2	117
7.2	TEMA (GHANA)	21/02/2017	22	20	1	5	6	1	1	56
7.3	SAN DIEGO (USA)	27/03/2017	7	1	2	4	3	1	1	19
7.4	MAJURO (MARSHALL ISLANDS)	03/04/2017	5	4	0	0	2	0	0	11
7.5	POHNPEI (MICRONESIA)	06/04/2017	8	6	1	0	2	0	2	19
7.6	KENDARI (INDONESIA)	03/04/2017	23	9	0	0	0	4	0	36
7.7	PAOTERE-MAKASSAR (INDONESIA)	05/04/2017	20	8	0	0	0	3	0	31
7.8	TUMUMPA-MANADO (INDONESIA)	07/04/2017	35	6	0	0	0	1	0	42
7.9	AMBON (INDONESIA)	11/04/2017	22	1	0	0	0	4	0	27
7.10	ZHOUSHAN (CHINA)	01/08/2017	8	1	0	4	8	0	3	24
7.11	VIGO (SPAIN)	10/08/2017	24	68	0	0	0	0	0	92
7.12	SIBOLGA (INDONESIA)	04/09/2017	16	19	0	3	0	0	0	38
7.13	LAMPULO (INDONESIA)	07/09/2017	23	4	1	1	0	2	0	31
7.14	JAKARTA (INDONESIA)	19/09/2017	33	3	0	0	0	0	0	36
7.15	LIMA (PERU)	29/'9/2017	14	8	0	1	8	3	4	38
7.16	MANTA (ECUADOR)	04/10/2017	29	41	0	0	0	1	1	72
7.17	CONCARNEAU (FRANCE)	09/10/2017	27	7	0	1	1	0	2	38
7.18	SUKARRIETA (SPAIN)	16-20/10/2017	46	16	0	3	1	0	1	67
8.1	TEMA (GHANA)	26-27/02/2018	22	30	4	4	10	5	2	77
8.2	MAJURO (MARSHALL ISLANDS)	12/04/2018	15	6	0	1	4	1	0	27
8.3	POHNPEI (MICRONESIA)	17/04/2018	7	4	1	0	0	0	0	12
8.4	BINTUNG (INDONESIA)	07/05/2018	32	7	0	0	1	9	2	51
8.5	PRIGI (INDONESIA)	09/05/2018	19	1	0	0	3	8	0	31
8.6	PEKALONGAN (INDONESIA)	11/05/2018	18	21	0	0	0	4	2	45
8.7	DAKAR (SENEGAL)	11/06/2018	4	3	0	3	3	3	2	18
8.8	VIGO (SPAIN)	16/07/2018	29	60	0	0	0	0	0	89
8.9	MANTA (ECUADOR)	14/08/2018	65	58	1	3	6	0	2	135
8.10	PANAMA CITY (PANAMA)	16/08/2018	6	0	0	0	2	3	1	12
8.11	SAN DIEGO (USA)	20/08/2018	9	0	3	0	3	0	0	15
8.12	YAIZU (JAPAN)	29/08/2018	1	0	0	0	17	0	11	29
8.13	LIMA (PERU)	01/10/2018	17	5	0	1	9	7	15	54
8.14	CONCARNEAU (FRANCE)	15/10/2018	17	2	0	3	2	0	0	24
8.15	SUKARRIETA (SPAIN)	15-21/11/2018	41	23	0	2	7	0	2	75
9.1	TEMA (GHANA)	26/02/2019	22	28	4	6	9	0	1	70
9.2	MANTA (ECUADOR)	09/04/2019	18	23	1	5	11	2	4	64
9.3	JAKARTA (INDONESIA)	03/05/2019	7	16	0	3	0	4	0	30
9.4	SIBOLGA (INDONESIA)	06/05/2019	14	4	0	2	0	9	2	31
9.5	MAZATLAN (MEXICO)	10/06/2019	11	5	0	1	2	0	1	20
9.6	GENERAL SANTOS (PHILIPPINES)	27/06/2019	8	3	2	4	10	4	1	32
9.7	MAJURO (MARSHALL ISLANDS)	01/07/2019	5	0	0	2	0	0	1	8
9.8	MANTA (ECUADOR)	30/08/2019	70	96	0	1	6	0	0	173
9.9	SUKARRIETA (SPAIN)	26/09/2019	18	2	0	0	0	0	1	21
9.10	ZADAR (CROATIA)	05/09/2019	8	0	0	0	0	0	1	9
9.11	CONCARNEAU (FRANCE)	07/10/2019	9	1	0	2	3	0	4	19
9.12	SUKARRIETA (SPAIN)	07-10/10/2019; 11/12/2019	37	11	0	1	3	0	2	54
TOTAL			2232	959	67	153	447	178	245	4281

BYCATCH MITIGATION ACTIVITY ACCEPTANCE LEVELS AND ADVANCES

The acceptance levels recorded in round 9 are described below, in general the highest levels of acceptance were for the use of FADs that minimize entanglement 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.

Not all impact mitigation activities are applicable in every ocean and fleet. This is especially true for some of the drifting FAD and bycatch mitigation activities designed for large purse seiners which require higher tech equipment (e.g. buoys with echo-sounders) or large-sized nets or deck space (e.g. escape windows, use of hoppers, etc.), which cannot be applied in smaller-scale vessels. A different set of mitigation options are proposed for artisanal and semi-industrial tuna fishing vessels.

Table 3 – Acceptance level of activities proposed in 2019 workshops by fleets. H-High, M-Medium, L-Low, NA-No Answer. *WCPO – combination of skippers from fleets operating in the Western and Central Pacific Ocean.

GROUP	MEASURES	GHANA	ECUADOR	INDONESIA	MEXICO	PHILIPPINES	WCPO*	SPAIN	WCPO (CROATIA)	FRANCE
SHARKS	FISHING IN THE NET	M	L-M	NA	M-H	L-M	L-M	L-M	L-M	M
	DECK RELEASE PRACTICES	H	H	H	H	H	H	H	H	H
	NON-ENTANGLING FADS	H	H	H	H	H	H	H	H	H
	BIODEGRADABLE FADS	H	M-H	H	M-H	H	H	H	H	H
MARINE POLLUTION	FAD RETRIEVAL	H	L-M	H	M-H	H	H	L-M	H	H
SMALL TUNA	ECHO-SOUNDER BUOYS	H	H	NA	H	H	H	H	H	H
	CLOSURES/REDUCE FADS	M-H	M-H	L-M	H	H	M-H	M	M-H	H
	SHORT APPENDAGE FADS	L-M	L	NA	L-M	L	L	L	L	L
BONY FISH	UTILIZATION	H	H	H	L-M	L-M	L-M	H	M	M

Shark release from the net

Release of sharks prior to brailing is preferable as their condition after sacking can be greatly affected. Alternative methods have been tried in the past such as attracting sharks away from the FAD with bait prior to the set or escape windows in the net, but with very limited success. One of the most promising mitigation activities showing almost zero mortality has been fishing of sharks in the net from the speedboat with handlines and then releasing them outside. The trial of this activity in an Atlantic Ocean and an Indian Ocean campaign, yielded positive results in FAD sets with 15-35 % of sharks present in the net being caught and released alive before sacking. Condition after release, monitored utilizing electronic tags, revealed that almost all individuals (> 95%) survived. This contrasts with sharks that end sacked up in the net and brailed to the deck, with an average survival rate of 15-20%. The trials also showed that in free school sets, sharks were less likely to be caught with the handline, and this activity may not be worth pursuing in this kind of sets.

Although experiments for this mitigation action with sharks have shown positive survival results, skippers are relatively skeptical about its applicability in everyday fishing for several reasons. One, is that an extra member of crew is required for fishing sharks from the speedboat, and skippers say they cannot afford losing a member from deck to carry out the fishing. This is especially true in small- to mid-size vessels with fewer crew. Perhaps ship-owners should consider having an extra-crew member dedicated to specific bycatch release tasks, such as releasing sharks from the net or from deck during brailing.

Other objections from skippers are that very often the weather is too rough to fish from the speedboat, or that sharks are often too large and difficult to catch and handle. This might be true in some circumstances, but scientists believe there will also be times of calm weather and with small sharks present at FADs that can allow for the implementation of this activity in a reasonable number of sets.

While most fleets in 2019 continued to show a low-mid acceptance level, two fleets increased from low-mid to mid their acceptance and one rated it as mid-high (**Table 4**). When presented with the option of choosing between fishing area closures to protect sharks (e.g. marine protected areas for shark breeding grounds) or having to conduct this activity to protect shark stocks, fishers prefer the latter.

Table 4 – Evolution in the acceptance level of fishers for fishing sharks in the net by different tuna fleets in ISSF Skippers Workshops between 2015 and 2019.

	FLEET	ACCEPTANCE LEVEL			
		2015-16	2016-17	2017-18	2018-19
FISHING SHARK IN NET	ECUADOR	MID	LOW-MID	LOW-MID	LOW-MID
	MEXICO	-	-	-	MID-HIGH
	PERU	-	LOW-MID	LOW-MID	-
	PANAMA	-	-	MID	-
	USA	-	LOW-MID	-	-
	INDONESIA	NA	NA	NA	NA
	KOREA	-	-	-	-
	PHILIPPINES	-	-	-	LOW-MID
	TAIWAN	-	-	-	-
	WCPO*	-	LOW-MID	LOW-MID	LOW-MID
	FRANCE	-	LOW-MID	LOW-MID	MID
	SPAIN	MID	MID	LOW-MID	LOW-MID
	GHANA	MID	MID	LOW-MID	MID
	PORTUGAL	MID-HIGH	-	-	-
	VIETNAM	NA	NA	NA	NA
	CHINA	LOW-MID	LOW-MID	-	-
	SENEGAL	-	-	LOW-MID	-
	JAPAN	-	-	-	-

Best release practices from deck

Release of bycatch species from deck continues to be highly accepted for revisited fleets in 2019. In the early days of contact with skippers in the 2010s this activity was receiving mid-range acceptance grades, but as repeated workshop interactions have continued the process of fisher "awareness" with this subject has increased (**Table 5**). Nowadays, most tuna PS fleets know about the best available practices (e.g. MADE guide; Poisson et al., 2012) and many try to implement rapid and efficient release of bycatch species such as sharks or turtles. While manual handling is still the most common form of release (even for medium and large individuals), the number of vessels using release tools such as cargo nets or stretcher beds is gradually increasing according to consultations with fishers.

Survival after release for some vulnerable bycatch species, such as turtles or whale sharks, is believed to be almost one hundred percent. However, despite crew's best efforts, rates for sharks or mobulids released after brailing with current methods are low according to ISSF research cruise studies. This research showed that the sharks with best survival chances were those released in the first few brails in the top deck, while those going into the lower deck showed null survival. Preliminary results from a study which arose from a conversation with skippers who used hoppers in their vessels, show very few sharks arrive at the lower deck and most are released from the top deck when using this tool. Hoppers are mostly used in the Pacific, but many fleets do not have them. Even vessels with a hopper onboard do not always use it, as the structure is mobile and can be utilized or not depending on the skipper's preference. Scientists encourage the permanent use of hoppers as a way of improving fast release of bycatch from deck.

In 2019, scientists such as those from AZTI in collaboration with the Spanish fleet, have been designing and testing new tools for faster and safer release of vulnerable bycatch species from deck. If prototypes work well, the objective would be that all vessels carry onboard a set of tools to facilitate and ensure maximum survival of released individuals from deck. For small sharks, a hand-net with a robust handle and large enough frame to hold even medium-sized sharks was constructed. The hand-net has an appendage so that another fisher can assist if required to help lifting the animal. The hand-net would guarantee that small/medium sized sharks are transported from the brail to the water without need for fishers holding the animal, thus minimizing injury to crew and also to the animal (e.g. no holding from gills, tail only or other poor practices). Due to the considerable weight and high-risk of manipulating large sharks, often these are extracted out of the brail using a rope tied around the tail and lifted with the crane towards the water's edge. This practice is undesirable as the rope can cut through the shark's skin causing injuries. A resistant cushioned strap with a velcro has been devised to encircle the shark's tail easily without causing abrasive injuries (**Fig. 5.a**). The strap has holding structures to pass the crane's hook to enable lifting of the animal. As the "shark velcro" wraps around a greater portion of the shark's tail than the rope noose, it helps distribute the pressure of the animal's weight across a slightly larger area when lifted. Once the animal is moved over the deck railing and is on top of the water, the velcro is pulled open with a connecting rope that is pulled manually. Several at sea tests with sharks lifted out of the brail with this equipment appeared to be practical and safe, and released sharks swimming away readily.

A third tool, developed for the quick release of large mobulids such as giant manta rays, is also currently under trial in the Atlantic Ocean. When using the cargo net to release mantas there are a few inconveniences because animals must first be removed by hand from the brail, which can be difficult with large individuals (e.g. > 3 m wingspan and 1,500 kg), then dropped on the net laying on the deck floor. Also, when the cargo net is lifted, it can considerably twist backwards the manta ray's wings, which may cause injury. A new manta sorting grid is being trialled which avoids some of these drawbacks. The sorting grid consists of a metallic frame with a series of crisscrossed ropes, with the number of them modifiable (1 to 6 ropes) to adjust grid size. The grid lays on top of the unloading hatch, and when the brail is emptied fish go through the grid, and the manta ray stays on top (**Fig. 5.b**). This way, there is no need to manually handle it. The more rigid structure of the frame and rope grid also prevents excessive bending of the wings. The grid is lifted with a crane and moved to the starboard over the side railing, where the animal drops into the water directly. While the manta is being released with the crane, the brailing process can continue so there is no fish loading time loss involved. Preliminary trials have shown promising results, with mantas being released in about 1 minute (fishers using cargo nets talk about 5-10-minute release times), with most animals swimming away apparently intact. In a rare event during trials, three mantas appeared in a single brail and were lifted and released simultaneously in one go with the grid.

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 2019.

	FLEET	ACCEPTANCE LEVEL								
		2010-11	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**
BEST RELEASE PRACTICES	ECUADOR	MID	MID	MID-HIGH	HIGH	MID-HIGH	HIGH	HIGH	MID-HIGH	HIGH
	MEXICO	-	-	-	-	HIGH	-	-	-	HIGH
	PERU	-	-	MID-HIGH	-	MID-HIGH	-	HIGH	MID-HIGH	-
	PANAMA	MID-HIGH	-	MID-HIGH	-	-	-	-	MID-HIGH	-
	USA	MID	MID-HIGH	-	MID-HIGH	HIGH	-	MID-HIGH	MID-HIGH	-
	INDONESIA	-	-	-	LOW	LOW-MID	MID	MID-HIGH	HIGH	HIGH
	KOREA	-	-	-	MID-HIGH	MID-HIGH	-	-	-	-
	PHILIPPINES	-	MID	-	MID	-	-	-	-	HIGH
	TAIWAN	-		-	MID-HIGH	-	-	-	-	-
	WCPO*	-	-	-	-	-	-	MID-HIGH	MID-HIGH	HIGH
	FRANCE	HIGH	MID	-	-	MID	-	HIGH	HIGH	HIGH
	SPAIN	MID	MID-HIGH	MID-HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
	GHANA	LOW-MID	MID	MID	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
	PORTUGAL	-	-	-	-	-	HIGH	-	-	-
	VIETNAM	-	-	-	-	-	MID	-	-	-
	CHINA	-	-	-	-	-	LOW-MID	MID	-	-
	SENEGAL	-	-	-	-	-	-	-	MID-HIGH	-
	JAPAN	-	-	-	-	-	-	-	MID-HIGH	-

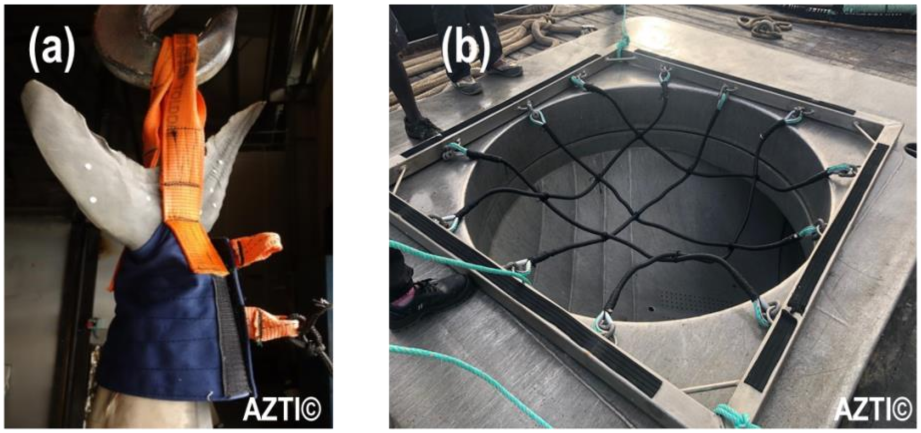


Figure 5. Experimental bycatch tools being tested by AZTI scientists (a) “Shark Velcro” strap to lift and release large sharks, and (b) manta sorting grid to release large mobulids.

Non-entangling FADs

Acceptance levels for NEFADs has been consistently high in the last round of workshops. In most oceans, NEFADs, including under this category those with small mesh or tied netting (regarded as lower entanglement risk FADs, LERFADs, in the ISSF guidelines), have been utilized by most vessels in the Atlantic, Indian and Eastern Pacific Oceans for several years now. However, the Western and Central Pacific Ocean was lagging somewhat behind and it has not been until 2019, when the WCPFC has passed a regulation to adopt them by January 2020, that many vessels in this region are starting to utilize them more regularly. Observer data during FAD inspections in different oceans seem to confirm the generalized absence of sharks and turtles entangled in both LERFADs and NEFADs. The Indian Ocean is the region where the largest proportion of “pure” NEFADs with zero netting are being used and from 2020 onwards netting in FADs will be prohibited by the IOTC. While some companies in the Indian Ocean have made the adjustment to canvases and ropes only, others are using small mesh netting up until the zero netting measure comes into effect soon.

The designs of FADs have also been changing in recent times. While a tendency for FADs with deeper tail appendages has been observed in all oceans over the last years (e.g. see reports from previous rounds), this trend has been reversed in the Indian Ocean. Fishers from the Spanish and French fleets have been constructing cube shaped tails (referred to as “cage FADs”) which are less than 4 m deep. These FADs are preferable in the sense that they produce less marine pollution and have a smaller surface for “potential” accidental entanglement events once the net starts breaking down. Another tendency in this ocean has been the use of “submerged” rafts to make FADs less visible. Again, the lack of a floating raft on the sea surface, prevents turtles from climbing on it to rest, minimizing interactions. In other oceans FAD depths continue to be considerable, ranging between 40 m and 100 m, depending on skipper preferences and typically are made of small mesh netting, tied netting or a combination of both.

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 2019. Estimated number of large purse seiners (> 335 m_3 fish holding volume) by fleet and level of use of FADs.

	FLEET	FAD USE	ACCEPTANCE LEVEL								
			2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
NON-ENTANGLING FADS	ECUADOR	HIGH	LOW	MID	MID-HIGH	MID-HIGH	MID-HIGH	HIGH	HIGH	HIGH	HIGH
	MEXICO	LOW	-	-	-	-	HIGH	-	-	-	HIGH
	PERU	LOW	-	-	MID	-	MID-HIGH	-	HIGH	HIGH	-
	PANAMA	MID	MID	-	MID-HIGH	-	-	-	-	-	-
	USA	MID	MID-HIGH	HIGH	-	MID-HIGH	MID-HIGH	-	LOW-MID	LOW-MID	-
	INDONESIA	HIGH	-	-	-	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
	KOREA	HIGH	-	-	-	HIGH	MID	-	-	-	
	PHILIPPINES	HIGH	-	MID-HIGH	-	MID-HIGH	MID-HIGH	-	-	-	HIGH
	TAIWAN	MID	-	-	-	MID-HIGH	-	-	-	-	-
	WCPO*	MID	MID	MID-HIGH	MID-HIGH	MID-HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
	FRANCE	MID	HIGH	HIGH	-	-	HIGH	-	HIGH	HIGH	HIGH
	SPAIN	HIGH	MID-HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
	GHANA	HIGH	LOW	LOW-MID	MID	MID	MID-HIGH	MID-HIGH	MID-HIGH	MID-HIGH	HIGH
	PORTUGAL	MID	-	-	-	-	-	HIGH	-	-	-
	VIETNAM	NONE	-	-	-	-	-	NA	-	-	-
	CHINA	MID	-	-	-	-	-	MID	LOW-MID	LOW-MID	-
	SENEGAL	LOW	-	-	-	-	-	-	-	HIGH	-
	JAPAN	LOW	-	-	-	-	-	-	-	HIGH	-

Meanwhile, fleets in the Western Pacific like Indonesia and a sector of the Filipino companies, generally small vessels working within the EEZ waters, continue to operate with anchored FADs (aFADs), which have no netting in their construction and therefore fall automatically under the NEFAD category.

Biodegradable FADs

Fishers in most FAD-fishing fleets are nowadays aware of the concept of biodegradable FADs and have seen with their own eyes the effects of marine pollution caused by beaching of lost or abandoned FADs. The acceptance level for this activity is generally high because fishers believe that something must be done about the global rise in marine plastics. Skippers foresee biodegradable FADs as a feasible alternative, especially once the right natural materials and best designs are identified. Industry stakeholders are asking RFMOs and other management bodies for a longer period of at sea experimentation before the adoption of binding biodegradable FAD measures, because an experimental biodegradable FAD performing as well as fishers would require has not yet been identified (e.g. biodegradable FADs able to attract tuna, are cheap, last over a year, have low visibility, and require low maintenance). This year a number first-of-their-kind large-scale experimental trials in most oceans have been conducted or will commence soon (e.g. late 2019/early 2020). These biodegradable FAD experiments with multiple vessels per ocean involved in them, should yield much needed results to advance in the reduction of environmental impacts caused by lost synthetic FAD structures.

The BIOFAD project in the Indian Ocean (sponsored by the EU and ISSF) concluded in 2019 (**Fig. 6.a**). This has been the largest trial of FADs constructed with biodegradable materials to date, with the 3 principal fleets participating (Spanish, French and South Korean) covering over 40 vessels and approximately 800 experimental FADs deployed. Mixed results were obtained with the cotton canvas covering the raft deteriorating very quickly (1-2 months), but better durability for the wax covered cotton ropes of the tail appendage (5-6 months). Tuna catches on the biodegradable FADs were relatively low, but so were the control synthetic FADs they were compared to. Thus, maybe the design used for these experimental FADs was not ideal, or fishers might have deployed the traditional FADs in the best areas and the experimental ones in poorer yielding zones or seasons.

Another biodegradable FAD trial in the Atlantic Ocean is about to start, with the whole tuna purse seiner and pole and line Ghanaian fleet taking part in it, jointly amounting to over 25 vessels. These biodegradable FADs will use similar materials to the Indian Ocean trials (e.g. cotton ropes and canvas) and experimental protocol (e.g. seeded with a paired synthetic control FAD). Meanwhile, in the Eastern Pacific companies participating in fisheries improvement projects (FIPs), like TUNACONS, Tri Marine and OPAGAC vessels, are taking part in a large-scale experiment with over 40 PS vessels testing around 800 FADs (e.g. 20 per vessel) over the course of a year. These biodegradable FADs, which will have 3 design options, will be constructed out of bamboo and balsa wood flotation, and a submerged manila hemp (“abaca” in Spanish) tail (**Fig. 6.b**). IATTC and ISSF scientists will analyse the results of these trials. Preliminary trials by some companies had already occurred in 2018-2019, employing through their own initiative biodegradable FADs, in smaller numbers, to check how they performed. Some fishers from Ecuador, suggested an alternative experimental protocol, whereby a smaller number of biodegradable FADs is deployed, but all are closely monitored by a dedicated vessel following them. This would ensure biodegradable FADs are not lost through appropriation by others, and fish colonization and material degradation processes are examined in more detail.

During 2019 ISSF hosted a series of specialty workshops on biodegradable FADs, targeting primarily fleets from the Western and Central Pacific where work on this subject up to recently had been sparser than in other regions. Only a small number of vessels have recently started experimenting with them at their own expense (**Fig. 6.c**). Biodegradable FAD workshops in Majuro (Republic of the Marshall Islands), Pohnpei (Federated States of Micronesia), Port Moresby (Papua New Guinea) and General Santos (Philippines) were conducted with fishery stakeholders, including skippers. In addition, an extra-workshop was organized in Zadar (Croatia) attended exclusively by fishers from the Caroline Fishing Company (CFC), based in Pohnpei. The first stages of ISSF-funded biodegradable FAD trials for 2020 are being planned with CFC vessels. These experiments include tests with conventional FAD designs (e.g. an open canvas tail forming a "sail" structure reaching 60 m) built with biodegradable materials (e.g. cotton, bamboo, etc.), and also a batch of biodegradable FADs with alternative minimalistic designs that drastically reduce the amount of material required per floating object. The amount of marine pollution caused by FADs is directly related not only to the number of FADs but also the mass of synthetic materials used for each FAD (e.g. kg of plastic per FAD). For example, a single FAD with a large tail structure (e.g. 50-100 m deep net panel) can generate substantially more marine garbage than a shallow tailed FAD of 5-10 m depth panels or one constructed with a simple rope structure. ISSF has been collaborating with an expert in oceanography from CSIC, Joaquin Salvador, who has years of experience constructing very simple drifting floating objects for scientific open-ocean studies. If FADs can be constructed with the minimum amount of materials it will be a win-win situation for the companies as they will be easier and cheaper to build, store and transport FADs, in addition to having a lower environmental impact.

Figure 6. Biodegradable FAD examples (a) with bamboo and cotton from the BIOFAD Project in the Indian Ocean, (b) with bamboo, balsa wood and manila hemp from TUNACONS/OPAGAC/TRIMARINE trials in the Eastern Pacific Ocean, and (c) bamboo, hemp and coconut fiber tried by DONWONG vessels in the Western and Central Pacific.

Table 7 – Evolution in the acceptance level of fishers for the use of biodegradable FADs in ISSF Skippers Workshops between 2015 and 2019.

	FLEET	ACCEPTANCE LEVEL			
		2015-16	2016-17	2017-18	2018-19
BIODEGRADABLE FADS	ECUADOR	MID-HIGH	HIGH	MID-HIGH	MID-HIGH
	MEXICO	-	-	-	MID-HIGH
	PERU	-	HIGH	MID-HIGH	-
	PANAMA	-	-	MID-HIGH	-
	USA	-	MID	MID-HIGH	-
	INDONESIA	HIGH	HIGH	MID-HIGH	HIGH
	KOREA	-	-	-	-
	PHILIPPINES	-	-	-	HIGH
	WCPO*		MID	MID-HIGH	HIGH
	TAIWAN	-	-	-	-
	FRANCE	-	HIGH	HIGH	HIGH
	SPAIN	MID-HIGH	HIGH	HIGH	HIGH
	GHANA	MID	MID-HIGH	HIGH	HIGH
	PORTUGAL	MID-HIGH	-	-	-

	VIETNAM	NA	-	-	-
	CHINA	LOW-MID	LOW-MID	-	-
	SENEGAL	-	-	MID-HIGH	-
	JAPAN	-	-	HIGH	-

FAD retrieval options were discussed with fishers, such as picking up and recycling part of owned FADs, the possibility of having autonomous remotely-driven FADs, or using dedicated vessels to pick up FADs for a fleet in selected hotspots or environments of high conservation interest (e.g. Seychelles Islands, Galapagos Islands, Maldives, etc.). Some skippers, especially those working with lower number of FADs, showed high acceptance levels to ways of recycling certain proportion of their FADs. On the other hand, fleets with higher FAD usage (e.g. Spain, Ecuador), thought that it would be extremely difficult to try to retrieve a large percentage of their FADs across a vast expanse of ocean. The latter saw retrieval options as too time-consuming and costly to be carried out and much preferred the biodegradable FAD route.

Selective echo-sounder buoys

Practically all satellite-GPS buoys used today in tuna PS drifting FADs are equipped with echo-sounders. Only anchored FAD fleets have no buoys, as the aFAD is permanent, and fishers have a small number of them which they frequently check. There is an increasing reliance from fishing masters in all drifting FAD-using fleets to plan their trips based on remote echo-sounder buoy biomass information. Several commercial brands are available including Satlink, Nautical, Zunibal, Thalos and Kato. A vessel can use one or several brands, depending on skipper preference, market price or company deals with different manufacturers. Despite advances in biomass estimation reliability, discrimination between tuna species present at a FAD with commercially available echo-sounder buoys is still not possible. Some buoy models have started incorporating two frequencies in their sounders to try estimating species composition in aggregations, but according to fishers still do not provide reliable information.

Fishers during previous workshop rounds have expressed their interest in the development of acoustic equipment which could inform them remotely and continuously about the species composition under their various FADs (**Table 8**). The possibility of knowing how much juvenile YFT/BET is aggregated in each FAD has become even more desirable now that in the Indian and Atlantic Ocean there are individual vessel catch quotas for YFT and BET respectively. The fishing strategy of vessels in these regions has been to avoid any YFT/BET free school sets, to prevent using up their quotas which would result in having to stop fishing completely. Instead they now fish almost exclusively on FADs because these yields more SKJ, but without knowing which FADs have a larger or smaller proportion of juvenile YFT/BET. If fishers had this information at hand, through "acoustic filters" that could infer the types of tuna present, they would certainly target the FADs yielding the least amount of YFT/BET. Fishers would also gain if echo-sounder buoys could clearly distinguish small pelagics from tuna, as often they waste trips to FADs showing large biomasses that end up being aggregations of non-target species such as mackerel or blue runners. ISSF continued in 2019 research to develop acoustic selectivity with experimental work in controlled aquarium environments like Achotines (Panama) (Moreno et al. 2019) and with a three-month trip examining the acoustics in sets onboard a commercial purse seiner in the Atlantic Ocean. Advances in acoustic discrimination gained from these studies will be passed on to fishers and industry in future workshops.

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 2019.

	FLEET	ACCEPTANCE LEVEL								
		2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
ECHO-SOUNDER SELECTIVITY	ECUADOR	MID	MID	MID	HIGH	MID-HIGH	MID-HIGH	HIGH	HIGH	HIGH
	MEXICO	-	-	-	-	MID	-	-	-	-
	PERU	-	-	MID	-	MID	-	HIGH	HIGH	-
	PANAMA	MID	-	MID	-	-	-	-	HIGH	-
	USA	MID-HIGH	MID	-	MID	MID	-	-	HIGH	-
	INDONESIA	-	-	-	NA	NA	NA	NA	NA	NA
	KOREA	-	-	-	MID	HIGH	-	-	-	-
	PHILIPPINES	-	LOW	-	MID	-	-	-	-	-
	TAIWAN	-	-	-	MID	-	-	-	-	-
	WCPO*	-	-	-					MID-HIGH	HIGH
	FRANCE	MID-HIGH	MID	-	-	-	-	-	HIGH	HIGH
	SPAIN	MID	MID	MID	MID	HIGH	HIGH	-	HIGH	HIGH
	GHANA	LOW	LOW	MID	MID	MID	MID		HIGH	HIGH
	PORTUGAL	-	-	-	-	-	HIGH	-	-	-
	VIETNAM	-	-	-	-	-	NA	-	-	-
	CHINA	-	-	-	-	-	MID	MID-HIGH	-	-
	SENEGAL	-	-	-	-	-	-	-	-	HIGH
	JAPAN	-	-	-	-	-	-	-	-	HIGH

Small Sets

The regular consultation of the avoidance of small sets as an alternative to reduce FAD-derived bycatch ceased in 2016 after several rounds showing very low predisposition from fleets to accept this measure. Fishers will always try to set on FADs with the largest biomass of tuna, however, the reality is that very often they will have days when monitored FADs show only small aggregations (e.g. 5-15 t). Fishers prefer to settle for those poorer catches in that situation, than have a non-fishing day. Some skippers argue that the cumulative effect of a large number of small sets, will add up to make ends meet at the end of a trip. In addition, in recent years the increased competition between vessels intercepting FADs from others with the help of various tools (e.g. bird radars, helicopters, supply vessels, drones, etc.), has derived in a trend in which fishers are less likely to let a FAD mature for long periods. Fishers are scared that their FADs will be rapidly stolen, in some oceans over 60% of owned FADs are lost to others. Therefore, fishers often tend to set on FADs relatively quickly after deployment (e.g. days to a few weeks). This practice results in loss of potential extra tonnes that could have accumulated if left to mature longer, but at least ensures some tuna are caught. Statistics in various RFMOs, show that the average catch per FAD set has declined in recent years, despite having supply vessels and echo-sounder buoys to help identify the most productive FADs at any time. While this increase in smaller sets could be the result of other factors (e.g. decline in tuna stocks, smaller aggregations due to schools dividing among a larger number of FADs), it likely also reflects this change in fishing tactics towards faster setting on FADs.

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 and FAD closures

Up until relatively recently the number of FADs per vessel were not restricted, but nowadays all RFMOs have passed measures limiting the number of active buoys (which should be noted is different to the number of FADs a vessel utilizes in a year). In some oceans like the Indian Ocean there are accompanying limitations on the number of buoys that can be purchased per year. The number of active buoys per vessel have been either maintained (e.g. IATTC 450 active buoys for class 6 vessels; the proposal to reduce their number by IATTC scientists was not passed by the Commission Members this year) or reduced. For example, ICCAT recently passed a resolution in the Atlantic to reduce from 500 to 350 by 2020 the number of active FADs per vessel, and to 300 by 2020. Under this scenario, fleets which fishing strategy is more FAD-oriented are less likely to show receptivity for these restrictions. On the other hand, fleets which historically have relied less on FADs, such as the Mexican fleet fishing mostly on dolphin sets, or the French on free schools (but with a recent increase in FAD use) are more supportive of FAD limitations (**Table 10**). Generally speaking, skippers showed their support for a "within reason" FAD reduction to a point where a balance between free school and FAD fishing is reached. Many fishers showed concern about how recent large increases in FADs had modified the behavior of tuna, with fewer free schools available because they now stay under floating objects (i.e. partially supporting the ecological trap hypothesis). It should be noted that active buoy limits (rather than real number of FADs) may have unintended effects, such as a higher rate of abandoned FADs. For example, vessels working with buoy numbers close to the limit, will more readily deactivate (and lose track) of FADs which are drifting towards areas of lower fishing interest. They do this so that they can seed new active FADs, still maintaining their number within the limits, in better fishing zones. Some fleets, or even companies within fleets, use a high-intensity FAD deployment strategy, and when their FADs are stolen (and those buoys are deactivated), will seed more FADs to replace them. On the other extreme, there are companies primarily focusing on a FAD interception strategy, seeding few FADs of their own while trying to find FADs from others. For example, many vessels in the Eastern Pacific (which do not work with dolphin sets) are employing helicopters these days to better locate FADs from others and fish on them.

Table 10 – Evolution in the acceptance level of fishers for reduction of FAD numbers/FAD closures by different tuna fleets in ISSF Skippers Workshops between 2016 and 2019.

	FLEET	ACCEPTANCE LEVEL		
		2016-17	2017-18	2018-19
FAD LIMITS/CLOSURES	ECUADOR	MID	HIGH	MID-HIGH
	MEXICO	-	-	HIGH
	PERU	MID-HIGH	MID-HIGH	-
	PANAMA	-	HIGH	-
	USA	MID-HIGH	HIGH	-
	INDONESIA	HIGH	HIGH	MID
	KOREA	-	-	-
	PHILIPPINES	-	-	HIGH
	WCPO*	MID-HIGH	HIGH	MID-HIGH
	TAIWAN	-	-	-
	FRANCE	HIGH	HIGH	HIGH
	SPAIN	LOW	LOW-MID	LOW-MID
	GHANA	MID-HIGH	HIGH	MID-HIGH
	PORTUGAL	-	-	-
	VIETNAM	-	-	-
	CHINA	MID-HIGH	-	-
	SENEGAL	-	LOW-MID	-
	JAPAN	-	HIGH	-

Regarding closures, fishers from the Eastern Pacific insisted that the IATTC closure should be for all vessels in one period, rather than a closure divided into two periods. They thought that by allowing half the fleet to operate during the closure, many of the intended conservation measure effects are lost. Many vessels will continue to exploit their company FADs and those of the vessels that remain stopped at port. Other fishers pointed out that closures across the IATTC and WCPFC should be coordinated, as vessels with licenses in both RMFOs will avoid stop fishing by moving during one closure to the other zone. For example, some vessels mostly working in the Eastern Pacific will go fishing to the Western and Central Pacific during the 2nd IATTC closure period, when the WCPFC FAD closure has already concluded.

Short tail FADs

In recent workshop rounds the idea of a short-tailed FAD to attract less BET tuna has received poor ratings (**Table 11**). While some skippers concede that a deeper tailed FAD might help attract deeper dwelling tunas, especially in regions where the thermocline is further down in the water column (e.g. Western and Central Pacific Ocean); most skippers think that other factors such as the fishing zone, or even the purse seiner's net depth, can have a more profound effect on the amount of BET caught in a set.

Table 11 – Evolution in the acceptance level of fishers for reduction of FAD numbers/FAD closures by different tuna fleets in ISSF Skippers Workshops between 2014 and 2019.

	FLEET	ACCEPTANCE LEVEL				
		2014-15	2015-16	2016-17	2017-18	2018-19
SHORT TAIL FADS	ECUADOR	LOW	MID	LOW	LOW	LOW
	MEXICO	-	-	-	-	LOW-MID
	PERU	-	-	-	MID	-
	PANAMA	-	-	-	LOW	-
	USA	-	-	LOW	LOW	-
	INDONESIA	NA	NA	NA	NA	NA
	KOREA	MID-HIGH	-	-	-	-
	PHILIPPINES	-	-	-	-	LOW
	WCPO*	-		LOW	LOW	LOW
	TAIWAN	-	-	-	-	
	FRANCE	-	-	-	-	-
	SPAIN	MID	MID-HIGH	LOW	LOW	LOW
	GHANA	-	MID-HIGH	MID-HIGH	LOW	LOW-MID
	PORTUGAL	-	LOW-MID	-	-	-
	VIETNAM	-	NA	-	-	-
	CHINA	-	MID-HIGH	LOW-MID	-	-
	SENEGAL	-	-	-	LOW	-
	JAPAN	-	-	-	LOW	-

In addition, the tendency in most oceans up to recently has been towards longer tailed FADs, many reaching from 50 m to 100 m depth. As more FADs are deployed, many fishers consider that having a larger underwater appendage provides a competitive advantage when tuna schools are looking to settle under a FAD. Some fishers said that before the outburst of FADs, tuna would aggregate under any small floating object, from a small branch to random objects such as a shoe, a piece of rope, etc. but nowadays, these events are rarer as fish are more likely to hide or gather under larger floating substrates. However, this theory has been partially debunked by the small sized "cage FADs" (less than 4 m deep; **Fig. 7**) now widely used in the Indian Ocean following successful catches with this design. Fishers do not seem to find differences in the proportion of juvenile YFT/BET caught in short-tailed cage FADs and FADs with deeper appendages.

Figure 7. Short tailed FAD design, commonly known as "cage FAD", widely used currently in the Indian Ocean.

Utilization

This activity is not a bycatch mitigation option *per se*, but for non-vulnerable fish species bycaught in FADs (e.g. small tuna species, triggerfish, mahi-mahi, rainbow runner, etc.) rather than discard it back to sea dead, retention of these species for sale can be an option. Some fleets, especially in the Western Atlantic Ocean, where a large market for these fish species in the African continent exists (referred to as "*faux poisson*"), will store and sell them. This is why countries like Ghana for example show consistently a high acceptance for this activity (**Table 12**). Meanwhile, other zones such as the Seychelles in the Indian Ocean or small islands in the PNA countries, may not have a large enough market to absorb these fish species and thus utilization in these regions is not so prevalent. Some companies are now starting to store these species in a non-brine freezer (e.g. not in the tuna wells) so that the market value of these fish is higher and can be sold at high end restaurants and markets.

Table 12 – Evolution in the acceptance level of fishers for bony fish bycatch utilization by different tuna fleets in ISSF Skippers Workshops between 2010 and 2019.

	FLEET	ACCEPTANCE LEVEL								
		2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
UTILIZATION	ECUADOR	MID-HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
	MEXICO	-	-	-	-	MID	-	-	-	LOW-MID
	PERU	-	-	HIGH	-	HIGH	-	MID	HIGH	-
	PANAMA	MID-HIGH	-	MID-HIGH	-	-	-	-	MID	-
	USA	MID-HIGH	MID-HIGH	-	HIGH	LOW-MID	-	MID-HIGH	MID	-
	INDONESIA	-	-	-	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
	KOREA	-	-	-	LOW	LOW-MID	-	-	-	-
	PHILIPPINES	-	-	HIGH	-	HIGH	-	-	-	LOW-MID
	TAIWAN	-	-	-	-	HIGH	-	-	-	-
	WCPO*	-	-	-	-	-	-	MID-HIGH	MID	LOW-MID
	FRANCE	HIGH	HIGH	-	-	MID	-	MID	MID-HIGH	MID
	SPAIN	MID	MID	HIGH	MID-HIGH	HIGH	MID-HIGH	MID-HIGH	MID-HIGH	HIGH
	GHANA	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
	PORTUGAL	-	-	-	-	-	MID-HIGH	-	-	-
	VIETNAM	-	-	-	-	-	HIGH	-	-	-
	CHINA	-	-	-	-	-	LOW	LOW	-	-
	SENEGAL	-	-	-	-	-	-	-	MID-HIGH	-
	JAPAN	-	-	-	-	-	-	-	MID-HIGH	-

Recommendations

Furthering cooperation between tuna fishers and scientists, through stable exchange platforms such as the ISSF Skippers Workshops and joint research at sea initiatives, can lead to better bycatch mitigation technology and fishing practices, and promote voluntary adoption of sustainable fishing options for each ocean.

The discussion resulted in four recommendations:

Recommendation 1:

- Promote research into best biodegradable FAD materials and test them in large-scale trials in each ocean

Recommendation 2:

- Encourage development of better equipment to maximize survival of released vulnerable bycatch species.

Recommendation 3:

- Support research for before-set solutions to mitigate both undesirable size tuna catches and bycatch of vulnerable species.

Recommendation 4:

- Continue to provide long-lasting in-person platforms to train and learn from tuna fishers, including small-scale artisanal fleets, and extend efforts to other tuna fishing gears such as pole and line, longline, etc.

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