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ISSF SKIPPERS WORKSHOPS: UNDERSTANDING FADS FROM A FISHER'S PERSPECTIVE

Jefferson Murua[1], Gala Moreno[2], Victor Restrepo[2]

SUMMARY

The International Seafood Sustainability Foundation (ISSF) has been facilitating meetings between fisheries scientists and purse seiner captains for the last 5 years with the aim of developing and adopting best bycatch reducing measures in tuna FAD fisheries. Over 600 skippers from Asian, European, African, Oceanian and American fleets in all t-RMFOs have participated, providing valuable feedback on relevant FAD issues. The workshops help understand how fishers use FADs and what factors they consider essential for them to work. Gradually, fishers in key fleets are voluntarily utilizing recommended lower entanglement risk FADs and sharing their designs with scientists. In addition, fishers have been completing questionnaires on bycatch mitigation and CPUE. This data is key to interpret how fleets operate, providing a source of "real-time" information on the adoption of new technologies (e.g., echo-sounder buoys) and fishing strategies (e.g., sharing of FADs within companies). This cooperative approach with fishers taking part in the process of developing better fishing practices is resulting in faster adoption of best available FAD practices and making them an active part of FAD fisheries sustainability solutions.

RÉSUMÉ

International Seafood Sustainability Foundation (ISSF) a facilité la tenue de réunions entre des scientifiques halieutiques et des capitaines de senneurs au cours des cinq dernières années dans le but d'élaborer et d'adopter les meilleures mesures visant à réduire les prises accessoires de la pêche thonière sous DCP. Plus de 600 capitaines de flottilles d'Asie, d'Europe, d'Afrique, d'Océanie et d'Amérique de toutes les ORGP thonières ont participé, en fournissant des informations précieuses sur des questions pertinentes liées aux DCP. Les ateliers aident à comprendre comment les pêcheurs utilisent les DCP et les facteurs qu'ils estiment essentiels pour travailler. Peu à peu, les pêcheurs de flottilles clés utilisent volontairement les DCP recommandés présentant un risque plus faible d'emmêlement et partagent leur conception avec les scientifiques. En outre, les pêcheurs ont rempli des questionnaires sur l'atténuation des prises accessoires et la CPUE. Ces données sont essentielles pour interpréter la façon dont les flottilles opèrent, en fournissant une source d'information « en temps réel » sur l'adoption de nouvelles technologies (p.ex. bouées pourvues d'échosondeur) et les stratégies de pêche (p.ex., partage des DCP entre les entreprises). Cette approche coopérative avec les pêcheurs qui participent au processus d'élaboration de meilleures pratiques de pêche se traduit par l'adoption plus rapide des meilleures pratiques disponibles relatives aux DCP et les fait participer activement au développement durable de la pêche sous DCP.

RESUMEN

Durante los últimos cinco años, la International Seafood Sustainability Foundation (ISSF) ha coordinado reuniones entre científicos pesqueros y patrones de cerqueros con el objetivo de desarrollar y adoptar las mejores medidas para la reducción de capturas fortuitas en las pesquerías de túnidos con DCP. En dichas reuniones han participado más de 600 patrones de flotas de Asia, Europa, África, Oceanía y América de todas las OROP de túnidos, proporcionando información valiosa sobre temas pertinentes relacionados con los DCP. Estas reuniones han contribuido a que se conozca mejor el modo en que los pescadores utilizan los DCP y los factores que consideran esenciales para trabajar. Gradualmente, los pescadores de las flotas clave están utilizando cada vez más y de forma voluntaria los DCP con menor riesgo de enmallamiento recomendados, y están compartiendo sus diseños con los científicos. Además, los pescadores han completado cuestionarios sobre mitigación de la captura fortuita y CPUE.

[1] AZTI-Tecnalia, Txatxarramendi Ugartea z/g, Sukarrieta – Bizkaia (Spain), Tel.: +34 946574000 - Email: jmurua@azti.es.
[2] ISSF, 805 15th Street NW, Washington, DC, 20005, USA.

Esta información constituye un elemento clave para interpretar cómo operan las flotas, proporcionando una fuente de información "en tiempo real" sobre la adopción de nuevas tecnologías (por ejemplo, boyas con ecosonda) y estrategias de pesca (por ejemplo, DCP compartidos entre varias empresas). Este enfoque de cooperación con los pescadores mediante el cual éstos participan en el desarrollo de mejores prácticas de pesca está generando una adopción más rápida de las mejores prácticas con DCP disponibles y, además, implica a los pescadores de forma activa en las soluciones encaminadas a incrementar la sostenibilidad de pesquerías con DCP.

KEYWORDS

By catch, gear selectivity, fishing gear, purse seining, tuna fisheries

1. Background

The International Seafood Sustainability Foundation (ISSF) is a global partnership bringing together scientists, industry and environmental NGOs to promote sustainable tuna fishing utilizing science-based initiatives. One of ISSF's strategic aims is to reduce by-catch in tuna fisheries, including that associated with FAD fishing. For this reason ISSF has organized since 2010 workshops with skippers (ISSF Skippers Workshops) and other key stakeholders from the principal tuna purse seine fleets of the world. Over 30 workshops in 17 countries have been conducted. During these workshops scientists present their studies and ideas to reduce bycatch (e.g., non-entangling FADs, escape panels in the net, acoustic selectivity) and skippers are encouraged to adopt the best practices proven to work and provide useful feedback to improve mitigation measures being tested (Murua *et al*. 2014). The principal tropical tuna purse seine fleets in the ICCAT region such as EU (Spain and France) and Ghana have repeatedly taken part in the Skippers Workshops (**Table 1**).

Skippers are great FAD experts as an important part of their livelihoods depends on correctly constructing, deploying, maintaining and fishing on networks of these floating objects. Many have been fishing with FADs on a daily basis for decades, gathering key knowledge on tuna aggregation patterns at FADs, often aided by powerful technological tools (e.g., echo-sounder buoys, sonars, sounders, etc.). This practical knowledge, often referred to as Fishing Ecological Knowledge (FEK), offers great potential to improve our understanding of tuna behavior and FAD related issues.

2. Transition to non-entangling FADs

Fishers worldwide have been discussing with scientists at the workshops the kind of FADs they use and why they construct them in specific ways. This helped identify different FAD types (e.g., "Korean style" FADs, "Spanish style" FADs) which had characteristic elements. Also to detect tendencies in FAD construction, such as the increase in depth of the submerged appendage in part of the Spanish fleet, use of bait under the FAD in South American fleets or the change from metallic rafts to foam ones encased with plastic or corduroy net in anchored Asian payaos.

In addition, since 2009 fishers started learning about concepts like non-entangling FADs and biodegradable FADs (used to be called eco-FADs) when scientists presented them prototypes tested in small numbers (e.g., Franco *et al*. 2009). Gradually many companies of the fleets visited by the Skippers Workshops (e.g., Spain, France, Ecuador, Ghana, etc.) have being increasing voluntarily the use of FADs that reduce entanglement. The ISSF Bycatch Committee presented a series of guidelines for non-entangling FADs, but left the specific design of these FADs open for captains to build them as they thought appropriate. This has resulted in a variety of new alternative FADs in different fleets and oceans. The workshops provide an important direct source of information exchange, with skippers often providing photos/sketches and describing in detail their anti-entangling FAD efforts. For example, unlike in the Pacific and Indian Oceans, in the Atlantic Ocean Spanish skippers construct very deep FADs, with over 85 % of all FADs reaching more than 40 m depth (**Table 2**). This is also true for other Atlantic Ocean fleets like that of Ghana. Fishers say they need deeper reaching FADs in the Atlantic to "anchor" them and prevent the strong westward surface drift taking FADs out the African fishing grounds and towards the American continent. Reportedly simple non-entangling FADs designs with ropes or nets tied in bundles do not work well in the Atlantic (ISSF 2013), and FADs require some kind of deep hanging underwater "sail" structure either made out of small mesh netting or canvas to slow down the drift.

Scientists compile best non-entangling FAD designs observed and show them to other fleets in subsequent workshops. This dissemination of fishers' ideas for non-entanglement through "word of mouth" is picked up more readily by skippers because the examples provided come from FADs used in everyday commercial fishing trips, rather than punctual small-scale scientists' experiments. Despite great improvement in the last 5 years, the majority of the non-entangling FAD designs reported by fishers in the workshops still incorporate some kind of netting. Mostly of small mesh size on the raft or tied in bundles in the subsurface structure, sometimes described as transition FADs. These "lower entanglement-risk" FADs could be improved if no netting was used (see ISSF Guide for Non-entangling FADs; **Appendix 1**). Specific examples of FADs with rafts covered by dark cloth and only ropes hanging below the waterline have been said to be easier to construct, cheaper and still work aggregating tuna by several skippers. In addition, anchored FADs or payaos used in many Western Pacific Ocean regions (e.g., Indonesia, Philippines, Papua New Guinea) are non-entangling as they do not use netting in their construction. Tests with biodegradable materials such as sisal ropes or agricultural tarpaulin have been reported by ship-owners and skippers but with little success at present. Projects funded by ISSF are underway to find and test biodegradable materials better suited for endurance at sea such as coconut fiber and others.

3. Evolution of FAD fishing tools and strategies

Catches of most "super-seiner" tuna fleets of the world depend in great part on FAD fishing. In order to maximize their catches these fleets have historically invested, and continue to do so, in high-tech fishing tools (e.g., radars, sonars, sounders, oceanographic prediction services, etc.). One of the greatest advances in FAD-fishing efficiency in the last decade is the rapid expansion of echo-sounder buoy technology. These instrumented buoys alert the skippers on how much fish is aggregated under each FAD, thus avoiding trips to unproductive areas with empty FADs. In the last five years the workshops have shown how some fleets have moved from 25% or less of FADs with echo-sounder buoys to almost 100% (Lopez *et al*. 2014); meanwhile other fleets do not use yet or are just starting to utilize this technology. For instance for 2013 in the Atlantic, 100% of the Spanish skippers interviewed were using echo-sounder buoys in at least half of their FADs, compared to only 20% of the Ghanaian skippers (**Table 3**). As the Skipper Workshops cover an important range of the tuna fleets, it provides scientists with a good indicator of the level of uptake of these new fishing technologies. This fishing gear information can be useful to interpret changes in fishing catches and CPUEs by fleet and ocean.

Other information that becomes apparent at the workshops is the move towards sharing of FADs between vessels of the same company, either with another specific vessel (e.g., working in pairs) or with all company boats. This tactic confers advantages because several strategically distributed boats cover a greater area than one and thus can move faster to nearby productive FADs, protect better their FADs from theft, seed FADs in different areas, or fish on the FADs of another company's boat that has gone to port for unloading, repairs, or during a closure.

Other tools that traditionally have been used for free school fishing, such as helicopters to spot foaming schools of tuna are now being re-adapted for FAD fishing purposes. For example, in the Eastern Pacific helicopters are frequently used now to find other vessels' floating objects in areas of high FAD densities as it can cover a greater range than radars. Many of these FAD-fishing strategies which can be specific to certain oceans or fleets are better identified and understood through the direct interaction with captains of these fleets at the workshops.

4. Future work

The ISSF Skippers Workshops are an ongoing process collaborating with fishers from fleets around the world towards the development and adoption of best sustainability practices in tuna fisheries. As part of its strategy to achieve healthy fisheries ISSF associated companies have committed to buy tuna from vessels whose skippers have received training (either through the workshops or online) in bycatch mitigation, the process being verified through the Proactive Vessel Register (PVR) audits.

In addition, ISSF scientists continue to test at sea new by-catch reducing measures (e.g., double FADs, selective echo-sounders, net modifications, methods to release live by-catch species from deck, etc.), many ideas of which have been proposed or refined with the help of skippers.

The fact that some of the best FAD by-catch reducing practices in tuna purse seining have not been taken up earlier could be simply due to lack of knowledge on these issues by fishers. For example, new fleets visited by the workshops often have not heard about non-entangling FADs, equipment to release large animals from deck, etc. It is only recently that simple, safe and efficient practical protocols and guidelines in FAD fisheries have been made available to fishers (e.g., Poisson *et al*. 2012). In part thanks to the alternative protocols presented and agreed in consultation with fishers at the workshops, many tuna purse seine fleets have been adopting sustainable FAD practices on a voluntarily basis (e.g. non-entangling FADs, FAD limitations, best on deck release protocols, etc.) when no regulation is in place. The value of this participatory process benefits both scientists and fishers.

References

Franco J., Dagorn L., Sancristobal I. and Moreno G. 2009. Design of ecological FADs. Indian Ocean Tuna Commission document, IOTC-2009-WPEB-16, 22 pp.

ISSF (International Seafood Sustainability Foundation). 2013. Report from the skipper's workshop; Round III. Sukarrieta, Spain, December 2013, 58 pp.

Lopez J., Moreno G., Sancristobal I., 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.

Murua J., Moreno G., Hall M., Itano D., Dagorn L., Restrepo V. 2014. ISSF Skipper Workshops: Collaboration between scientists and fishing industry to mitigate bycatch in tuna FAD fisheries. ISSF Technical Report 2014-06, 1-50.

Poisson F., Vernet A. L., Séret B., Dagorn L. 2012. Good practices to reduce the mortality of sharks and rays caught incidentally by the tropical tuna purse seiners. EU FP7 project #210496 MADE, Deliverable 7.2., 30p.

Table 1. List of ISSF Skippers' Workshops by location and participant stakeholder group.

WORKHOP #	LOCATION	DATE	SKIPPERS	CREW	SHIP-OWNERS	FLEET MANAGERS	FLEET REPS.	GOV. MANAGERS	SCIENTISTS
1	SUKARRIETA (SPAIN)	27/11/2009	15	1	1	1	6	1	0
2	MANTA (ECUADOR)	18/09/2010	56	18	1	0	1	0	0
3	PANAMA CITY (PANAMA)	22/09/2010	6	6	1	0	0	3	6
4	ACCRA (GHANA)	10/11/2010	2	0	0	2	21	6	1
5	SUKARRIETA (SPAIN)	13-17/12/2010	32	0	0	0	6	0	5
6	MAHE (SEYCHELLES) / PORT LOUIS (MAURITIUS)	1-19/02/2011	11	5	0	0	1	0	0
7	PAGO PAGO (AMERICAN SAMOA)	05/03/2011	2	0	2	1	4	3	2
8	MAJURO (MARSHALL ISLANDS)	22/06/2011	2	1	0	0	1	1	0
9	POHNPEI (MICRONESIA)	24/06/2011	3	1	0	0	4	0	0
10	ACCRA (GHANA)	14/03/2012	2	0	0	2	18	6	0
11	MAHE (SEYCHELLES)	21-18/05/12	5	2	0	0	1	0	0
12	PAGO PAGO (AMERICAN SAMOA)	11/06/2012	3	2	0	0	3	0	2
13	GENERAL SANTOS (PHILIPPINES)	08/09/2012	26	4	0	1	3	0	21
14	BINTUNG (INDONESIA)	11/09/2012	20	0	0	0	0	25	3
15	JAKARTA (INDONESIA)	13/09/2012	13	1	0	0	0	10	3
16	MANTA (ECUADOR)	26-27/09/2012	17	4	4	0	1	0	1
17	SUKARRIETA (SPAIN)	09/10;27/11-5/12/2012	87	3	2	2	9	0	6
18	ACCRA (GHANA)	08/05/2013	13	0	2	1	18	7	0
19	LIMA (PERU)	05/08/2013	0	0	2	2	16	2	15
20	MANTA (ECUADOR)	08/08/2013	37	5	0	3	4	1	0
21	PANAMA CITY (PANAMA)	12/08/2013	2	0	2	1	7	0	7
22	SUKARRIETA (SPAIN)	07/11-10/12/2013	44	6	2	2	5	0	0
23	BUSAN (KOREA)	14/02/2014	8	9	0	1	10	3	12
24	KAOHSIUNG (TAIWAN)	18/02/2014	1	0	0	6	12	0	0
25	CANGAS (SPAIN)	28-29/05/2014	20	10	0	0	0	0	0
26	ACCRA (GHANA)	15/07/2014	7	6	10	9	11	4	1
27	MANTA (ECUADOR)	12/08/2014	35	1	0	0	1	0	3
28	JAKARTA (INDONESIA)	19/08/2014	21	2	0	0	1	1	3
29	GENERAL SANTOS (PHILIPPINES)	05/09/2014	24	6	0	0	2	0	2
30	SUKARRIETA (SPAIN)	18/09-14/10/2014	52	5	0	1	3	1	1
31	PAGO PAGO (AMERICAN SAMOA)	15-20/10/2014	8	1	0	0	4	0	1
32	MANZANILLO (MEXICO)	12/01/2015	34	20	1	1	2	4	0
33	MAZATLAN (MEXICO)	14/01/2015	65	46	0	1	1	4	1
34	SAN DIEGO (USA)	12/02/2015	5	0	0	1	3	0	0
TOTAL			678	165	30	38	179	82	96

Table 2. Underwater structure depths (m) of Spanish fleet FADs in the Indian, Pacific and Atlantic, and Ghanaian fleet in the Atlantic. Source: ISSF Skippers Workshop questionnaires (2010-2014).

FAD Depth (m)	FADs Spanish fleet			FADs Ghanaian fleet
	Pacific (%)	Indian (%)	Atlantic (%)	Atlantic (%)
0-20	41	36	0	0
21-40	41	41	15	10
41-60	12	13	32	70
61-80	3	5	37	20
> 80	3	5	16	0

Table 3. Percentage of FADs equipped with echo-sounder buoys in the Spanish and Ghanaian fleet in the Atlantic Ocean during 2013. Source: ISSF Skippers Workshop questionnaires (2013).

Proportion of FADs with echo-sounder buoys (%)	Ghanaian fleet boats (%)	Spanish fleet boats (%)
0-25	50	0
25-50	30	0
50-75	20	72
75-100	0	28

Appendix 1

ISSF Guide for Non-Entangling FADS (2015 Revised Version)

Drifting FAD showing netting suspended from the surface float

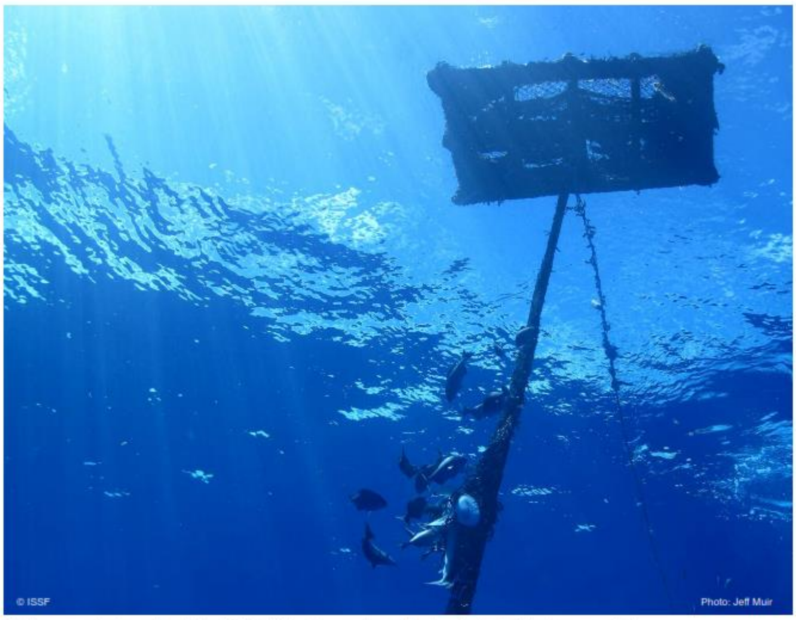
INTRODUCTION

Since ISSF first published its Guide for Non-entangling FADs (fish aggregating devices) in 2012, several tuna fishing fleets have experimented with and adopted the use of the new FAD designs described therein in an effort to reduce shark and/or turtle entanglement. In addition, new research studies on FAD entanglement have been published and tuna regional fisheries management organizations (tRFMOs) have passed recommendations regarding non-entangling FADs. Considering these developments, and based on the findings of a recent workshop organized by ISSF, ISSF is publishing an updated Guide for Non-entangling FADs.

A significant update to ISSF guidance on non-entangling FAD design concerns mesh size in nets and net use in general. Some scientists and fishers previously assumed that using small mesh netting or tying up netting into bundles would potentially eliminate entanglements. Observing these designs in use in fishing operations, however, revealed that while entanglements were less frequent, they were not eliminated. Turtles can easily become entangled in any netting covering the bamboo rafts. Bundles of netting tied up and suspended under a FAD can unravel, and small mesh can tear, creating larger holes in which sharks or turtles have been observed to become entangled. Because our goal is to eliminate the risk of entanglement altogether and any unnecessary mortality, it is clear that previous designs referring to smaller mesh netting are only partial solutions.

Going forward, only FADs constructed with no netting will be considered “non-entangling” with minimal risk of entanglement. Relatively inexpensive and readily available alternatives –ropes suspending into the water and shade cloth or canvas materials used to cover rafts – are reported to work equally well by fleets that have tested these alternative materials. The use of biodegradable materials in construction of FADs to reduce unnecessary pollution in the sea is also endorsed.

In summary, this document presents updated recommendations on FAD designs and materials to consider using for their construction, so as to minimize unwanted by-catch and pollution of the oceans caused by deployments of FADs worldwide in today’s purse seine tuna fisheries.



Netting suspended beneath a drifting FAD tied into a "sausage" can still entangle sharks if they become untied

WHAT IS A FAD?

Many fish species, including tunas, associate with floating objects in the ocean. There are two main types of floating objects; natural (flotsam) and man-made (jetsam). Man-made floating objects specifically constructed to attract fish (and also natural objects that are found by fishermen and modified) are called FADs. They can be anchored or drifting. Drifting FADs (DFADs) are often equipped with a satellite transmitting buoy to enable their relocation. Anchored FADs (AFADs) (called payaos in some regions) are commonly used by artisanal and sport fisheries but also by industrial pole-and-line and purse seine vessels in some regions such as in the western Pacific Ocean and the Maldives Islands in the Indian Ocean. However, the industrial tuna purse seine fleets around the world primarily use DFADs.

ISSF GUIDE FOR NON-ENTANGLING FADs

SHARK AND TURTLE INTERACTIONS WITH DFADS

Sharks and turtles are among the numerous species of marine life that are often found associated with DFADs. In some instances, turtles become entangled in the netting on the DFAD rafts, and turtles and sharks become entangled in the netting suspended beneath the rafts.

The main shark species that often associate with floating objects are the silky shark (Carcharhinus falciformis) and, to a lesser extent, the oceanic white tip shark (C. longimanus). Sharks can become accidentally entangled in the submerged netting of the DFAD, even when the netting is tied up in bundles ("sausages") if these begin to unravel or untie (Figure 1.a). Small mesh net can reduce chances of shark entanglement, but after long periods of time at sea the net will start to break down and larger holes appear with greater potential to entangle sharks (Figure 1.b.).

Several turtle species can be found around floating objects depending on area, the most common being the olive ridley sea turtle (Lepidochelys olivacea). While turtles can get trapped in the submerged netting, they can also entangle when they climb on the floating structure (Figure 1.c). The turtle's claws can easily become ensnared in the mesh panels covering the raft. Covering the raft with netting and putting cloth or tarpaulin on top is not a solution, because when those fabrics degrade the underlying netting becomes exposed. The proportions of turtles that become entangled with DFADs but escape, and those that become permanently entangled, are currently unknown. In the eastern Pacific, only around 1% of DFADs that are set on by purse seiners have turtles entangled, and many of those are released alive.

Figure1.a
Sharks entangled in large mesh netting beneath a DFAD

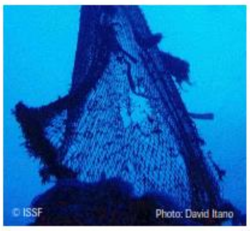


Figure 1.b
Small mesh netting suspended beneath DFADs degrades over time, creating larger holes in the net

Figure 1.c.
Turtle entangled in large mesh netting adjacent to the raft of a DFAD.

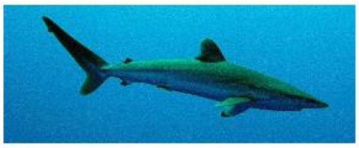
NON-ENTANGLING FAD REGULATIONS

Recently three of the four tRFMOs responsible for the conservation and management of tropical tunas have adopted resolutions that contain regulations and recommendations regarding the use of non-entangling FADs by purse seine fleets.

DOCUMENT	RFMO	WEB LINK
C-13-04	IATTC	https://www.iattc.org/PDFFiles2/Resolutions/C-13-04-FADs.pdf
13/08	IOTC	http://www.iotc.org/cmm/resolution-1308-procedures-fish-aggregating-devices-fads-management-plan-including-more-detailed
Rec. 14-01	ICCAT	https://www.iccat.int/Documents/Recs/compendiopdf-e/2014-01-e.pdf
NA	WCPFC	NA

In addition, in most tuna purse seine fishing regions, observers working under tRFMOs, now record the types and configuration of FADs used by fishers (e.g. FAD size, construction materials, design, entanglement incidents) in specific log sheets. This information is important for scientists to assess the efficiency of different designs in reducing FAD entanglements. The collection and recycling of old FADs by fishers can also help reduce the environmental impact of this gear.

ISSF GUIDE FOR NON-ENTANGLING FADs



BEST PRACTICE RECOMMENDATIONS

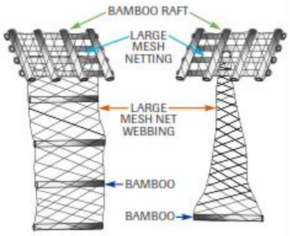
Although the design and development of functional non-entangling FADs should continue by the industry, considering the expertise of fishermen, some suggested guidelines for consideration in the construction of non-entangling FADs are presented below:

- To reduce entanglement of turtles on the rafts of FADs, the surface structure should not be covered with any netting or meshed materials. If a sub-surface or submerged component is used, it should not be made from netting but from non-meshed materials such as ropes, canvas or cloth sheets.
- A recent trend has developed in which fishers are using plastic or metal frames to build FAD rafts. To reduce the amount of synthetic marine debris being introduced into the oceans the use of natural and/or biodegradable materials such as bamboo, palm leaves, coconut fiber, or sisal among others, should be promoted.

More than two years have passed since fishers began experimenting with and using so-called non-entangling DFADs constructed with netting. Only FADs constructed without netting can eliminate the unintentional entanglement of turtles and sharks and be considered non-entangling. Some skippers report good performance in attracting and catching tuna aggregations at DFADs constructed without any netting.

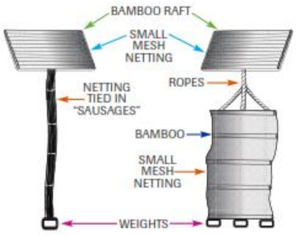
Considering the variety of designs and materials used in construction of FADs worldwide the ISSF Bycatch Steering Committee proposes a ranking of FADs according to the risk of entanglement associated with each design. Starting from highest to lowest risk of entanglement, four categories are described and illustrated examples provided of FAD designs:

HIGHEST ENTANGLEMENT RISK FADs:



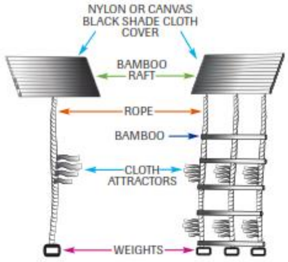
- Constructed with any netting materials, including old purse seine netting, used to cover rafts or suspended beneath in open panels
- These DFADs are known to cause entanglements with turtles and sharks

LOWER ENTANGLEMENT RISK FADs:



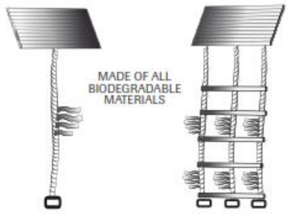
- Only small mesh netting used (e.g. < 2.5 inch (7 cm) stretched mesh)
- Rafts are tightly wrapped with small mesh netting, with no loose netting hanging from it
- The underwater structure is tightly tied into bundles (sausages)
- A single panel can be used instead of bundles, but the panel must be weighted to keep it taut
- The panel should consist of either netting with a stretched mesh of 2.5 inches (7 cm) or less, or a solid sheet (e.g., canvas or nylon)
- Despite using netting, these design elements reduce the risk of entanglement events

NON-ENTANGLING FADS:



- No netting is used in their construction
- The raft is not covered or covered with shade cloth or canvas
- The subsurface structure is made with ropes, canvas or nylon sheets, or other non-entangling materials
- These FADs are expected to have minimum risk of causing entanglement

BIODEGRADABLE NON-ENTANGLING FADS:



- In addition to having minimal risk of entanglement, they are constructed exactly like other non-entangling FADS, but using only natural and/or biodegradable materials, further reducing the environmental impact of DFADs on the oceans

HIGHEST RISK ⟵⟶ **LOWEST RISK**