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Progress report of Project 110: Non-entangling and biodegradable FAD trial in the Western and Central Pacific Ocean

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Executive Summary

WCPFC Project 110 (the project) is conducting trials of non-entangling and biodegradable drifting Fish Aggregation Devices (dFADs) in the Western and Central Pacific Ocean (WCPO), with the objective to provide essential information to the WCPFC and tuna fishing industry on the designs, types of materials, performance, implementation challenges and cost-effectiveness of non-entangling and biodegradable dFADs in the WCPO context. The project will support industry to uptake more ecologically sustainable dFAD designs and provide the WCPFC with information to support consideration of Conservation and Management Measures (CCM)s related to non-entangling and biodegradable dFADs. While Project 110 was initially planned to start in March 2021, the design phase of the non-entangling and biodegradable dFADs and the trials at-sea could not start as planned due to the COVID-19 pandemic and the associated restrictions put in place by various coastal states on access to ports and materials. The project, however, made substantial progress in 2022 and the first half of 2023, when the first trial non-entangling and biodegradable dFADs were deployed. We have also been collaborating closely with the International Seafood Sustainability Foundation (ISSF) on non-entangling and biodegradable dFAD trials in the Pacific, involving both this project and their US Bycatch Reduction Engineering Program (BREP) project, so that data, skills and resources can be leveraged across all the bioFADs work in the Pacific. The BREP project is in collaboration with the US purse seine fleet.

Five stakeholders representing more than 15 fishing companies (Caroline Fisheries Company ("CFC"); FCF Co., Ltd ("FCF"); the American Tunaboat Association ("ATA"), including Cape Fisheries; and Silla) were identified and engaged as project partners. Initial planning and training workshops have been held in three construction locations: Pohnpei (Federated States of Micronesia), Manta (Ecuador) and Pago Pago (American Samoa). The initial phase of the project allowed the identification of an appropriate non-entangling and biodegradable design to be tested, and it was decided to use the "jelly-FAD" developed by ISSF and the Insitute de Ciències del Mar in Barcelona (Spain). A total of 214 jelly-FADs are planned to be constructed and deployed by the industry partners as part of Project 110 and 216 as part of the ISSF-led BREP project. As of July 2023, 180 jelly-FADs have been constructed and 72 deployed as part of Project 110 led by SPC, and 216 have been constructed and 52 deployed as part of the ISSF BREP project. The costs associated with materials and construction of the jelly-FADs, as part of this trial, were 500–550 USD / FAD, but 350–362 USD / FAD if only the materials and their shipment are considered. Preliminary results of the project included evaluation of the catches from 11 sets on the jelly-FADs deployed so far for the project, with an average of 26.8 t taken on sets on these FADs.

We invite WCPFC-SC19 to:

- Note the delays in the activities planned due to the COVID-19 pandemic and the 2-year no-cost project extension requested to the donors and the WCPFC (i.e., final report at SC21 in 2025).
- Note the updated timing of activities and the proposal for a supporting project to trial additional non-entangling and biodegradable dFADs and investigate alternative construction locations and locally sourced materials.
- Note that 180 jelly-FADs have been constructed and 72 now deployed as part of Project 110 led by SPC, and that 216 have been constructed and 52 deployed, as part of a related project led by ISSF.
- Note that the costs associated with materials and construction of the jelly-FADs, as part of this

trial, are 500–550 USD/FAD (includes labour), but 350–362 USD/FAD for materials and their shipment only.

- Note that eleven fishing sets have been performed on jelly-FADs in this trial so far, representing 12% of the jelly-FADs deployed, with an average catch of 26.8 t per set.
- Note that results from analyses of all non-entangling and biodegradable FADs from this project are expected to be available by SC21.

Contents

1. Introduction

Recent estimates indicate that the number of drifting Fish Aggregating Device (dFAD) buoy deployments in the Western and Central Pacific Ocean (WCPO) have varied between 23,000 and 40,000 per year over the last decade (Escalle et al. , 2020, 2021a). Traditional dFAD designs can lead to entanglement and unnecessary mortality of Species of Special Interest (SSIs; i.e., sharks, turtles). Of increasing concern is the rate of subsequent abandonment and stranding of deployed dFADs, recently estimated at 44.8% and 11.3%, of tracked dFADs, respectively (Escalle et al., 2023a). The resulting marine pollution, ghost fishing and environmental impacts are of concern to the coastal states of the region, NGOs and fishery stakeholders and are increasingly impacting on the social license of the purse seine tuna industry in the WCPO. To mitigate these undesirable impacts of dFAD use, there is a growing need to transition to dFADs that are constructed from materials that are both biodegradable and mitigate the entanglement of SSIs. For the fishing industry to make this transition, research and development in collaboration with fishing industry is required to design and test dFADs made of non-entangling biodegradable materials and to demonstrate their functionality, cost and practicality relative to traditional designs.

In recognition of the need to reduce the environmental and ecological impacts of dFADs in the WCPO, CMM 2021-01 (Conservation and Management Measure for bigeye, yellowfin and skipjack tuna in the western and central Pacific Ocean), requires that the design and construction of any dFAD to be deployed in, or drifts into, the WCPFC Convention Area, by 1 January 2024, shall comply with the following specifications:

- all dFADs in the WCPFC Convention Area should comply with low-entanglement design specifications (as described in CMM 2018-01) from January 2020, and;
- all dFADs in the WCPFC Convention Area should comply with non-entangling materials and design specifications (the use of mesh net shall be prohibited for any part of a dFAD) from January 2024 and;
- the use of biodegradable materials to construct dFADs is encouraged.

A recent review of observer data (2010–2023) shows limited use of non-entangling and/or biodegradable dFAD designs in the WCPO (Escalle et al., 2023c) thus far. However, there are data limitations with the 2020 to 2023 data, due to the low observer coverage linked to the COVID-19 pandemic. It is therefore not yet possible to identify the recent response to the requirements of CMM 2018-01 and CMM 2021-01. Importantly, greater support to national fisheries agencies and information is needed to guide construction and encourage the use of 'effective' non-entangling and biodegradable dFADs, which will be essential to drive wider industry uptake. This will require that industry is consulted and involved at every stage of this process.

While trials of non-entangling and biodegradable dFADs have been implemented worldwide for several decades (see review in Escalle et al., 2022), they are relatively recent in the WCPO (Gala Moreno et al., 2020). Additional work and collaborative actions are required if non-entangling and biodegradable dFADs are to become the 'norm' in the WCPO. The current paper provides an update on activities of WCPFC Project 110: non-entangling and biodegradable FAD trial in the WCPO; as well as of another similar parallel project led by the International Seafood Sustainability Foundation (ISSF) and in collaboration with The Pacific Community (SPC), (e.g., National Oceanic and Atmospheric Administration's Bycatch Reduction Engineering Program (BREP) project).

2. Methodology

2.1 WCPFC project 110

Project 110 (the project) aims to conduct trials of non-entangling and biodegradable dFADs in the WCPO to contribute to the data required to deliver robust information to industry on the designs, types of materials, performance and cost-effectiveness of non-entangling and biodegradable dFADs in the WCPO. It has the following objectives:

1. Explore design and cost-feasibility of non-entangling and biodegradable dFADs. Informed by previous trials in the WCPO and other oceans, Project 110 will foster industry and national fishery agency input and utilize readily available (locally or shipped) suitable construction materials and labor where possible.
2. Undertake at-sea experiments to compare the performance/functionality of non-entangling and biodegradable dFADs to conventional dFADs.
3. Provide robust scientific advice to industry and national fisheries managers on the performance of non-entangling and biodegradable dFAD designs.
4. Increase regional support, capacity building and partnerships on non-entangling and biodegradable dFAD research with various stakeholders in the WCPO.

The project is led and coordinated by WCPFC Science Services Provider, SPC, with the support of the ISSF, and donor funds from the EU (majority), US and the ISSF. The work is in collaboration with fishing industry, government and national fisheries agencies. The project aims to construct and deploy a minimum of 200 'experimental' non-entangling and biodegradable dFADs that will be compared with 200 'conventional' (currently used) dFADs. The initial project duration was 3 years from mid-2021 to mid-2024 (Table 1), with activities divided into 4 stages (see Appendix 1 for details of each stage):

- **Stage 1:** Information and planning workshop: identify dFAD construction locations and initiate capacity building in design and construction.
- **Stage 2:** Construction of non-entangling and biodegradable dFADs
- **Stage 3:** Conduct at sea trials and broader industry communications program
- **Stage 4:** Data analysis, reporting, final workshop and industry adoption of plan of action

Table 1. Updated timing of activities. D = delayed; C = completed; P= planned.

	2021												2022												2023												2024												2025						
Stage	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
1	D	D	D	D	D	D	D	D	D	C	C	C	C	C	C	C	C	C	C	C																																		
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3																			D	D	D	D	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C						
4					C										C				D	D	D	D	D	C	C	C	C	C	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P

2.2 NOAA project

The project "Towards the Use of Biodegradable Fish Aggregating Devices (FADs) in the Pacific Ocean", under the framework of a National Oceanic and Atmospheric Administration Fisheries (NOAA)'s funded BREP project is being led by ISSF, in collaboration with SPC. It also aims at constructing and trialling non-entangling and biodegradable FADs, but more widely across the Pacific Ocean (including IATTC area) in collaboration with the US fleet (the American Tunaboat Association "ATA", including Cape fisheries). The project has similar objectives and methods to project 110 and the data from both projects can be directly compared.

3. Updates on activities of the projects

3.1 Review of project timing – adaptation to COVID-19

WCPFC project 110 was initially planned to start in 2021, with the non-entangling and biodegradable dFAD trials starting in October 2021, following the annual FAD closure period. Several fishing companies were contacted in 2021 and 2022 with all indicating interest in joining the project. However, none of the companies were able to start the project in 2021, including the workshops with fishers to consider design and construction requirement for the non-entangling and biodegradable dFAD and the at-sea trials phase, due to COVID-19 restrictions. Finally, in 2022, discussions continued with greater intent with five stakeholders representing more than 15 fishing companies (Caroline Fisheries Companies ("CFC", Federated States of Micronesia); FCF Co., Ltd ("FCF", Chinese Taipei); ATA (US), including Cape Fisheries; and Silla (Korea)), with agreements achieved to partner on the project from mid-2022.

Regular meetings with ISSF collaborators and fishing company partners have been occurring since 2022, and online discussions have included a workshop with skippers and fisheries managers to discuss the project and provide better understanding of their perspectives and the logistical requirements and needs of industry. Due to the COVID-19 pandemic, and the uncertainty linked to travel in the region, the plan for initial workshops and defining construction locations had to be adapted. Virtual workshops were used instead, as well as a workshop in Croatia, in the hometown of most skippers from CFC. Finally, Pohnpei was considered as an ideal location to base the construction of a large part of the non-entangling and biodegradable dFADs, due to the local presence of one SPC staff who could coordinate construction, and several companies interested to join were regularly transhipping in Pohnpei. Given the impossibility to run in-person workshops to discuss and define non-entangling and biodegradable prototypes, it was decided to trial only one design, the "jelly-FAD" developed by ISSF (Moreno et al., 2020; Moreno et al., 2022), that has shown very promising results in previous trials.

Because the project was not able to start as planned in 2021, both in terms of work conducted and expenditure, a no-cost extension was requested to allow the project to complete the required activities under the original funded workplan. A further project proposal has also been submitted to the EU for funding, and to SC19 for review, in order to enhance and expand the work from Project 110 (SPC-OFP and WCPFC Secretariat, 2023). This project has been developed to capitalize on the momentum and expertise in the current project; to ensure there is scope to deploy a larger number of non-entangling and biodegradable dFADs to increase the robustness of the results; and to provide opportunity to conduct additional work on industry engagement, training, and logistical aspects to support transition to use of non-entangling and biodegradable dFADs in the WCPO.

In parallel, the ISSF BREP project was planned to start in 2020, but due to the COVID-19 pandemic, most activities started only in 2021 and the project will now run until the end of 2023. The project will also test the jelly-FADs in collaboration with the US fleet (ATA), with construction occurring in Manta and Pago Pago, the main ports for the US fleet fishing in the Eastern Pacific Ocean (EPO) and WCPO respectively. Results from both projects can be combined to increase the sampled size of non-entangling and biodegradable FADs tested.

3.2 Stage 1. Information and planning workshops

In terms of activities already performed, a literature review has been undertaken on the designs and materials of non-entangling and biodegradable dFADs that have already been used globally as well as summarising previous initiatives in terms of their efficiencies, effectiveness, cost and the lessons learned (Escalle et al., 2022; Lopez et al., 2016; Moreno et al., 2020; Moreno et al., 2023; Zudaire, 2017).

Following the review already performed (Escalle et al., 2022), and discussion with project collaborators at ISSF and fishing companies, it was decided to adopt and only trial the jelly-FAD (Moreno et al., 2023a) (Figure 1). The review, as well as first experiments with the jelly-FAD, highlighted that cotton rope (20mm for the main rope) and cotton canvas were strong enough to last several months to a year at-sea (Moreno et al., 2019).

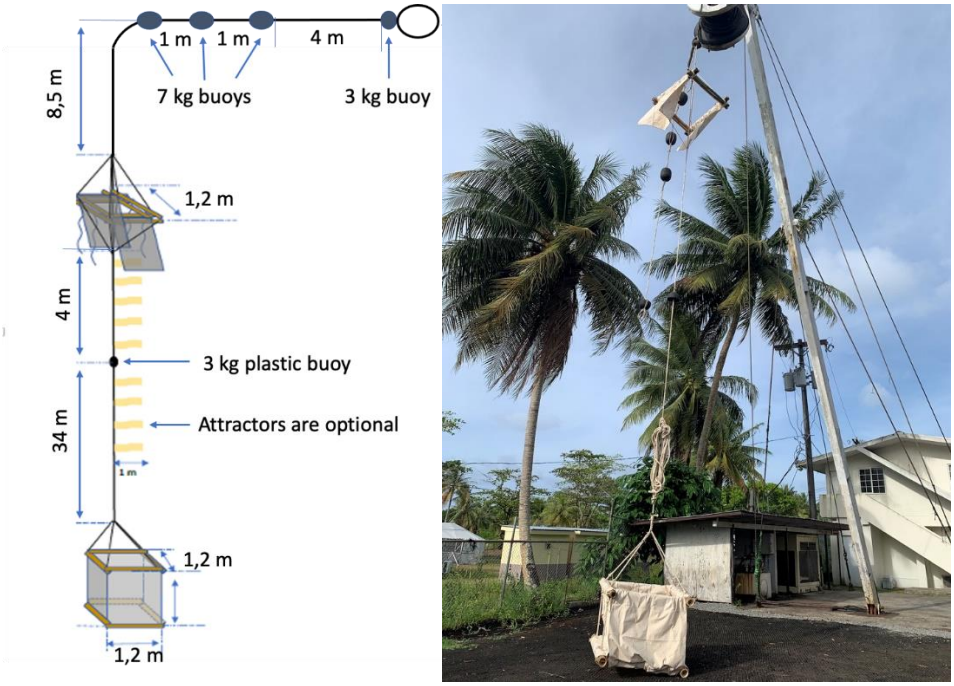

Figure 1. Design and picture of the jelly-FAD developed by ISSF and the Insitute de Ciències del Mar in Barcelona (Spain) (Moreno et al., 2023a). Example photo is the first jelly-FAD constructed under Project 110 in Pohnpei.

Partners involved in the non-entangling and biodegradable dFAD trials are operating in i) the Western part of the WCPO, mostly based or transshipping in Pohnpei (CFC, FCF and Silla), or ii) the Central and Eastern WCPO and the EPO (ATA) and based out of Pago Pago and Manta (Table 2). The initial construction locations were therefore decided to be: Pohnpei, Pago Pago and Manta.

Table 2. Partner fishing companies in the non-entangling and biodegradable dFAD trials in the WCPO, construction location and number of non-entangling and biodegradable dFADs (BioFADs) to be tested.

Partners	No. of vessels	Project	Construction location	No. of BioFADs	
				WCPFC 110	BREP
Caroline Fisheries Corporation	6	WCPFC 110	Pohnpei	50	
FCF Co. ltd	8	WCPFC 110	Pohnpei	50	
American Tunaboat Association					
- Cape Fisheries	6	WCPFC 110 & BREP	Manta	30	108
- Others	10	WCPFC 110 & BREP	Manta and Pago Pago	50	108
Silla	2	WCPFC 110	Pohnpei	34	
TOTAL	32			214	216

Several training workshops for skippers, crew, fisheries managers and representatives, and on-the-ground staff from companies in port (net yard, fishing company staff or dedicated fishing gear companies) have been conducted. These workshops aimed at presenting the project, its objectives and the jelly-FAD design. A practical part of the workshop involved training in how to build the jelly-FADs step by step. When skippers or fleet managers were present, the at-sea part of the trial was also discussed, in terms of deployment method, ideal areas/time periods depending on each fishing company's fishing grounds and strategies.

In Manta, the company *Pronaval* was trained by ISSF senior scientist Gala Moreno and Joaquín Salvador from Institute de Ciencies del Mar in July 2022. In addition, a virtual workshop with fishing companies' managers and skippers from the ATA, was held remotely in January and February 2022.

In June 2022, a workshop was held in Zadar, Croatia, with 4 skippers from CFC, and SPC and ISSF project managers (Lauriane Escalle and Gala Moreno). The skippers had already deployed and used non-entangling and biodegradable FADs, using an earlier design of the jelly-FAD. Discussions therefore involved reviewing performance and challenges of their first trial and the improvements made to the jelly-FAD design and materials. In Pohnpei, a training workshop was organized in December 2022 (Figure 2), led by Gala Moreno as well, with two SPC staff (James Wichman, FAD focal officer, and William Sokimi, SPC gear technology Fisheries Development Officer) who supported and learned the construction processes. In addition to ISSF and SPC staff, twenty people attended the workshop, including fishing company managers from CFC, FCF and Silla; WCPFC staff; officers from FSM oceanic and coastal fisheries departments; and 10 CFC staff that were trained and will now be constructing the non-entangling and biodegradable jelly-FADs in Pohnpei.

Finally, in May 2023, a training workshop was organized in Pago Pago. Gala Moreno trained *Purse Seine American Samoa* company's staff on the construction of the jelly-FAD, in their factory in American Samoa. This company that supplies nets and provisions to purse seiners will now also supply jelly-FADs to the U.S. companies entering Pago-Pago port. In May, eight purse seine vessels from the U.S. were also visited by Gala Moreno, in Pago-Pago port to be trained on the Jelly-FAD construction and deployment.

Materials for the communication and engagement strategy were developed, and included:

- A flyer explaining the project and what is the jelly-FAD. The flyer can be used as a one-page sheet to communicate around the project. Two additional pages were also developed, so that a two-page version can be distributed to skippers; and one page 'flyer' version to observers (Appendix 2). Flyers have also been translated in Chinese.
- A data collection form for skippers (Appendix 3). The form has also been translated in Chinese.
- A data collection form for observers (Appendix 4).
- A video related to the training workshop help in Pohnpei (https://www.youtube.com/watch?v=Y3bPaT2tZsM).
- A training video (to be released soon), as well as a step-by-step guide on how to build the jelly-FAD (Appendix 5).
- A Fisheries newsletter article (Escalle et al., 2023b) and a story on SPC website and ISSF enews (https://www.spc.int/updates/blog/interactive-story/2023/04/jelly-fad-trial-in-the-pacific-a-step-towards-sustainable).

- Design of t-shirt for the project to provide to workers and industry members involved in the project (Appendix 6).

Figure 2. Photos from the jelly-FAD training workshop in Pohnpei (Federated States of Micronesia).

2.4 Stage 2: Construction of non-entangling and biodegradable dFADs

Materials for the construction of the non-entangling and biodegradable jelly-FADs are detailed in Table 3. The buoys, bamboos and clay were sourced/purchased locally in each construction location. The cotton ropes were ordered from two companies: *Itsaskorda* in Spain, which has been used in the past to build jelly-FADs and proven to last long-enough; and *Sea Master* from Chinese Taipei, tested for the first time to build jelly-FADs during this project. Canvas was ordered from *Soluciones Anmarsaq* from Ecuador; and *Sea Master* from Chinese Taipei. Canvas needed to be sewn to form pockets to slide bamboos into, this was done directly by the company *Soluciones Anmarsaq* for jelly-FADs built in Manta, and by a local company for the jelly-FADs built in Pohnpei and Pago Pago. Satellite echo-sounder buoys to be deployed on the experimental non-entangling and biodegradable dFADs were Satlink SLX+ buoys and were ordered from Spain. In is noted that procurement and shipment was delayed from the original plan, due to i) the time needed to identify suppliers; ii) delays with SPC procurement processes; iii) the difficulty in shipment to some remote location in the Pacific, particularly during the COVID-19 pandemic; and iv) raw materials shortage and shipment delays due to the COVID-19 pandemic.

Table 3. List of materials and quantity needed to build a jelly-FAD.

Materials	Per FAD
Plastic buoy or purse seine cork of 7kg (EF70) – painted dark blue or black	3
Plastic buoy of 3kg or half 7kg purse seine cork (EF70) – painted dark blue or black	2
Large bamboos (about 90–100mm diameter) of 1.2 m length	4
Small bamboos (about 30–40mm diameter) of 1.2 m length	12
Bamboo nails or pins	8
Piece of cotton canvas (110cm x 110cm) with one pocket on top and one in the bottom	4
Piece of cotton canvas (110cm x 130cm) with only one pocket on top	2
Cotton rope of 20mm diameter	65 m
Cotton rope of 10–12mm diameter	22m
Bricks of clay 4kg	2
Attractors (optional): Cotton ropes with loops or offcuts of cotton canvas	8m

Construction of the experimental jelly-FADs started after each of the training workshops (see section 2.3). In Manta, *Pronaval* constructed 100 jelly-FADs in 2022 and 142 in 2023. In Pohnpei, CFC staff, supervised by the SPC FAD focal officer, constructed 100 jelly-FADs in 2023, with 34 still to be built (Figure 3). Finally, in Pago Pago, *Purse Seine Samoa* constructed 52 jelly-FADs in 2023. The cost of

materials, shipment, staff time and net yard used, per location are detailed in Table 4. The cost associated with materials and construction of the non-entangling and biodegradable "jelly-FADs", as part of this trial, is 500–550 USD / FAD, but 350–362 USD / FAD if only the materials and their shipment are included. It should be noted that prices for this project correspond to the materials and construction of a limited number of jelly-FADs and prices will likely decrease when quantity constructed increases.

Table 4. Cost of materials needed to construct the non-entangling and biodegradable FADs and cost associated with their construction in port. Cost indicated corresponds to the materials and construction of a limited number of jelly-FADs and will likely decrease when quantity constructed increases.

	Cost for 100 jelly-FADs (US$)		
Type of materials	**Pohnpei**	**Manta**	**Pago Pago[2]**
Imported materials			
Ropes + shipment	16,896	17,140	
Canvas + shipment	9,975	9,500	
Sewing Canvas 100 FADs[1]	6,000	0	
Total	32,871	26,640	
Local materials			
Dirt + delivery	210	80	
Bamboo	2,250	880	
Corks	700	7,400	
Paint	136	36	
Total	3,296	8,396	
Net yard use and staff			
Net Yard use or/and coordination fee	8,300	10,000	
Staff time	10,280	5000	
Container rental (storage)	300	0	
Total	18,880	15,000	
Total (100 FADs)	55,047	50036	
Cost per FAD (US$)	550	500	
Cost per FAD, materials only (US$)	362	350	

[1] For the jelly-FADs built in Manta, the company supplying the canvas already created the pockets needed to put the bamboos.

[2] Jelly-FADs are still under construction, prices are not available yet.

Details of the construction, including tools and materials needed can be found in the step-by-step construction manual and video (Appendix 5 and link to video available soon). In all the jelly-FAD construction locations, the raw materials (bamboos, cotton ropes and canvas) and/or the jelly-FADs were stored for a duration that extended to several months sometimes. Jelly-FADs were picked up by the partner fishing vessels when they were transiting or transhipping in port. It is therefore crucial that these materials and jelly-FADs are stored in the best possible conditions without excess humidity, and away from insects that can eat the materials.

Figure 3. Photos of the construction of the jelly-FADs in Pohnpei.

Some challenges and lessons learned in construction and storage of jelly-FADs, can therefore be highlighted:

- The type of bamboo used is important, with mature bamboos found to be preferential, as young bamboo can crack or more readily get infested by bugs, as they age during the storage period. While similar diameter of bamboo is preferable to homogenize the construction of the jelly-FADs, the skin of the bamboo should not be removed for size reduction as it greatly weakens the bamboo.
- Ropes and canvas should be stored in a dry area. Rope measuring was conducted in an open area to ensure quality control, and marker pens or electrical tape were useful for marking the cut and splice points. Additional ropes and canvas should be ordered to account for potential loss during construction and can be used to secure some components of the jelly-FADs and/or act as attractors.
- Construction sometimes needed to be made in stages (i.e., one component of the jelly-FAD at a time), due to the delay in materials shipment from overseas. Suspending the FAD during the construction period ensured that correct rope lengths was achieved.
- Bamboo locking pins are used to construct the cube of the jelly-FAD and should have a tapered butt end to create a better locking mechanism. Indeed, pins sometimes came out of the bamboos, as the latter expanded during storage periods. Ropes can therefore sometimes be used, in addition to the pins, to secure the attachments of the bamboo in the frame.
- Tool breakages and damages are to be expected, and planning should include several tools per type (including spares), to allow several people to work at the same time.

- Initially, aggregators were either placed on the main rope and/or attached to the submerged raft. However, splicing aggregators onto the main line added rope twists and entanglement issues and may weaken the main ropes. If possible, aggregators should only be placed on the submerged raft.
- Identifying a good storage location can be difficult in tropical areas. Some of the issues faced involved i) heat and humidity, which was overcome by adding humidifiers to the ceiling and monitoring the jelly-FADs regularly; ii) bugs nesting and feeding on the bamboos, which was overcame by using mature bamboos and spraying insect killer on the bamboo and around the FAD (pre-soaking in salt water before storage might be another solution to test); iii) damages to jelly-FADs when piled up, which was overcome by avoiding stacking up too many jelly-FADs (maximum of 7) to avoid any weight damage. In general, if storing jelly-FADs for a long period of time, regular check and maintenance are required.

In all construction locations, the first phase of construction included a learning curve in best-practices, and the challenges mentioned above led to jelly-FADs being re-worked two to three times, due to rope entanglements, pins unlocking or bamboo damage.

2.5 Stage 3: Conduct at sea trials and broader industry communications program

Once constructed, the non-entangling and biodegradable jelly-FADs were picked up by each vessel (sometimes only one vessel from a fishing company picked up and deployed all the company's jelly-FADs) at each construction location (Figure 4). Communication and awareness activities occurred at the time of jelly-FAD delivery. The project and process to deploy the jelly-FADs, then monitor and use them in real fishing conditions was explained to the captain again, along with the delivery of a flyer of the project and a t-shirt (Appendix 6). Captains should record deployment and any other activity on the jelly-FAD and conventional dFADs from the project (Appendix 3). At time of placement, the observer on-board the vessel was also approached either directly (in Pohnpei), or via email through observer programmes, and provided with a flyer, forms to collect data on non-entangling and biodegradable FADs from the project, and a t-shirt (Appendices 2 to 5).

Figure 4. Delivery of the jelly-FADs to vessels.

Deployments, and hence the start of the at-sea trials, started in September 2022 for the BREP project and March 2023 for WCPFC Project 110 (Table 5 and Figures 5 and 6). As of July 2023, one quarter to one third of the non-entangling and biodegradable jelly-FADs from both projects have been deployed,

with 72 from WCPFC project 110 and 52 from the BREP project (Table 5 and Figure 6). Eleven fishing sets on the jelly-FADs have been performed, and two additional visits without any set; and four fishing sets on paired conventional dFADs. Around 10% of the jelly-FADs deployed have been visited and 6% of the paired conventional dFADs. The average catch from 11 sets performed on jelly-FADs was 26.8 t (2–55 t) and 32.5 t (20–45 t) on 4 conventional FADs (Table 6). Note that these results are still preliminary and another study testing jelly-FADs in the EPO found an average of 44.1 t (2–125 t) from 50 sets on jelly-FADs (Moreno et al., 2023b).

Figure 5. Deployments of jelly-FADs at sea in the WCPO. Photos from FCF and CFC.

Table 5. Summary of deployments and activities performed on the non-entangling and biodegradable jelly-FADs and conventional FADs from the project.

	WCPFC project 110		Project BREP	
	Jelly-FADs	Conventional	Jelly-FADs	Conventional
Deployments	72	29	52	34
Deployment period	02/03/2023 – 13/07/2023		04/09/2022 – 07/07/2023	
Sets	4	0	7	4
Visit (without set)	2	0	0	0
Buoy deactivation	6	3	3	4
Stranding events	3	0	0	0

Table 6. Summary information on catches from sets made on the non-entangling and biodegradable jelly-FADs and conventional FADs from the project.

FAD type	Number of sets	Total tuna catches (mt)		
		Min	Mean	Max
Jelly-FAD	11	2	26.8	55
Conventional	4	20	32.5	45

In parallel to the at-sea trials, additional activities related to communication and engagement were performed, in particular towards the Regional Observer Programs, national fisheries departments, regional management bodies and fishing companies. A presentation was made at the Regional Observer Coordinator Workshop in Brisbane in March; as well as one at the Observer Biological Sampling Workshop in Noumea in April 2023; and finally, a presentation to the Parties to the Nauru Agreement Annual Meeting in March 2023.

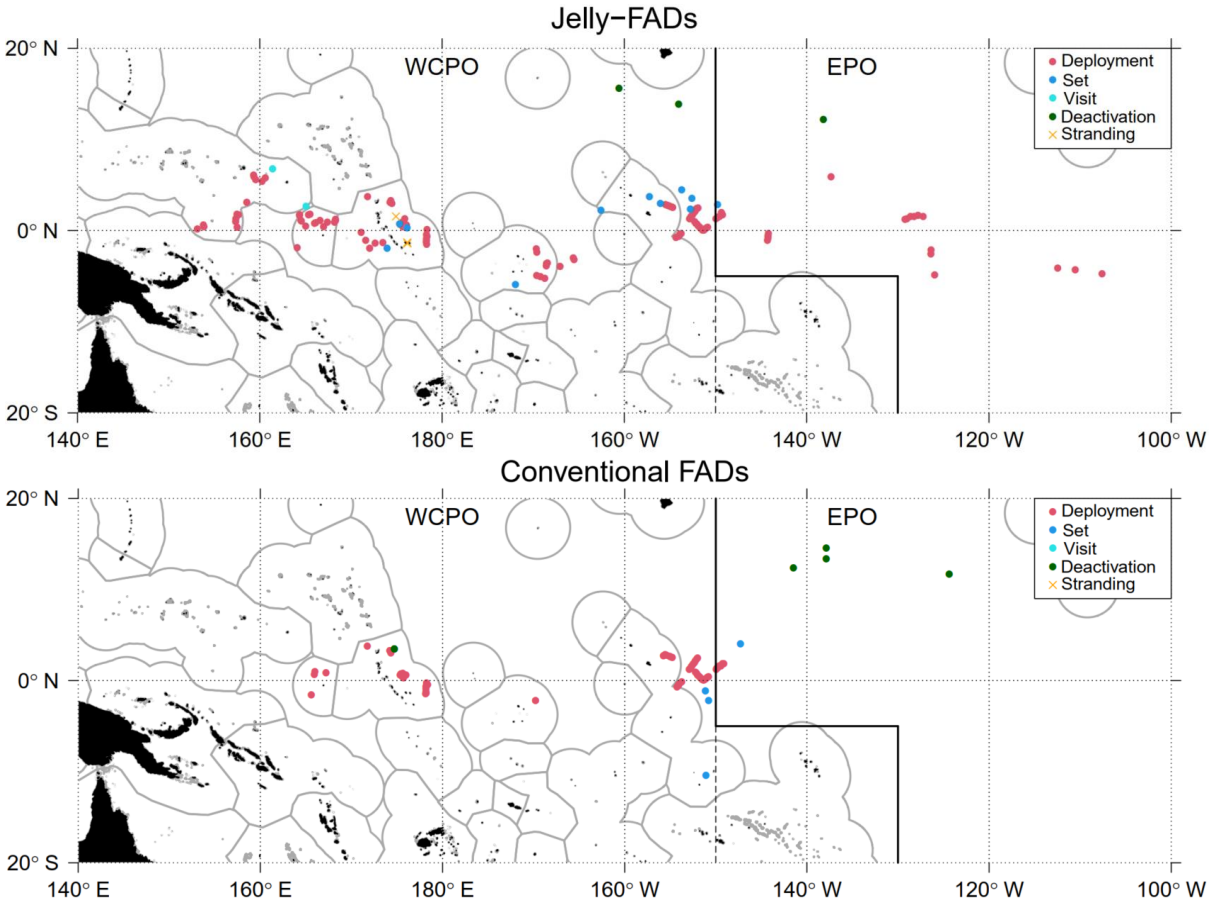

Figure 6. Map of deployment and other activities performed on the jelly-FADs (top) and conventional FADs (bottom) of the project.

2.6 Stage 4: Data analysis and reporting

Stage 4 of the project is only starting. First data from trajectories and echosounder data of jelly-FADs and conventional dFADs were received by SPC in July 2023. In parallel, data from forms filled out by captains and observer will provide information on the condition of the jelly-FADs, to be obtained after uncertain length of time at-sea. The final results from project 110 and BREP project are expected to be presented to SC21, and a progress report again at SC20.

4. Conclusion and next steps

After delays in the initial year of WCPFC Project 110 due to the COVID-19 pandemic, substantial progress has been made since the last update at SC18. The project is running in parallel with another non-entangling and biodegradable FAD trial, led by ISSF with the US fleet, and we continue to collaborate closely on both projects.

Five stakeholders representing more than 15 fishing companies are engaged as project partners. Initial planning and training workshops have been held in three construction locations: Pohnpei (Federated States of Micronesia), Manta (Ecuador) and Pago Pago (American Samoa). The initial phase of the project allowed the identification of a preferred design for the non-entangling and biodegradable dFADs to be tested, which is the jelly-FAD developed by ISSF and the Insitute de Ciències del Mar in Barcelona (Spain) (Moreno et al., 2023). A total of 214 and 216 Non-Entangling and Biodegradable dFADs are planned to be constructed, as part of Project 110 and BREP project, respectively. To date,

180 jelly-FADs have been constructed and 72 deployed as part of Project 110 led by SPC, and 216 have been constructed and 52 deployed, as part of the ISSF led BREP project. The costs associated with materials and construction of the jelly-FADs, as part of this trial, were 500–550 USD / FAD, but 350–362 USD / FAD if only of materials and their shipment are considered (i.e., no labour or shipyard costs). Preliminary results of the project included evaluation of the catch taken on the 11 jelly-FAD sets, with an average of 26.8 t per set.

The next steps include the construction and deployment of the remaining jelly-FADs, as well as the detailed data analysis and reporting.

The communication and engagement strategy will also continue, with presentation of the project progress at the 8th Pacific Tuna Forum, in September in PNG and at the 1st Pacific Islands Conference on Ocean Science and Ocean Management (PICOSOM) in September in Fiji. Finally, to build on the work started as part of Project 110, we recommend that increasing the sample size of non-entangling and biodegradable dFADs trialled, engaging more fishing companies in the trials, running training in the construction of jelly-FADs in alternative locations, and identifying locally sourced materials will all be important. To support this, a project proposal has been submitted to the EU and for review by SC19 to support this additional work (SPC-OFP and WCPFC Secretariat, 2023). Results from project 110, and any follow up work will be critical to supporting industry adoption of non-entangling and biodegradable dFADs and the WCPFC to consider Conservation and Management Measures related to the use of dFADs in the WCPO.

We invite WCPFC-SC19 to:

- Note the delays in the activities planned due to the COVID-19 pandemic and the 2-year no-cost project extension requested to the donors and the WCPFC (i.e., final report at SC21 in 2025).
- Note the updated timing of activities, including those planned over the first year of the project, and the proposal for a supporting project to trial additional Non-Entangling and Biodegradable dFADs and investigate alternative construction locations and locally sourced materials.
- Note that 180 jelly-FADs have been constructed and 57 now deployed as part of Project 110 led by SPC, and that 216 have been constructed and 52 deployed, as part of a related project led by ISSF.
- Note that the costs associated with materials and construction of the jelly-FADs, as part of this trial, are 500–550 USD/FAD (includes labour), but 350–362 USD/FAD for materials and their shipment only.
- Note that eleven fishing sets have been performed on jelly-FADs in this trial so far, representing 12% of the jelly-FADs deployed, with an average catch of 24.4 t per set.
- Note that results from analyses of all non-entangling and biodegradable FADs from this project are expected to be available by SC21.

Acknowledgments

WCPFC project 110 is funded by the European Union (EU), the United States and the International Seafood Sustainability Foundation. The project “Towards the Use of Biodegradable Fish Aggregating Devices (FADs) in the Pacific Ocean”, is funded by the National Oceanic and Atmospheric Administration Fisheries. We sincerely thank the stakeholders and fishing companies collaborating in

the projects (Caroline Fisheries Companies, FCF Co., Ltd, Cape Fisheries and the rest of the American Tunaboat Association and Silla), as well as their skippers and crew for all their effort and collaboration in this project, in particular Marko and his staff on the ground in Pohnpei for the hard work building and monitoring the jelly-FADs. We thank Iñaki Ostiz from *Pronaval* and Frank Barron from *Purse Seine Samoa*, for support in jelly-FAD construction. We would also like to thank the team at Satlink, in particular Faustino Velasco Gonzalez and Kathryn Gavira O'Neill, for their support in the procurement and monitoring/data extract of the buoys deployed on the project dFADs. Finally, the author would like to sincerely thank Nathalie Lemesle and Paul Judd for their hard work and support in the procurement and administrative monitoring of the project.

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Appendices

Appendix 1. Details of the 4 stages of project 110.

Stage 1: Information and planning workshop: identify dFAD construction locations and initiate capacity building in design and construction.

Initially, project 110 will compile relevant information from previous ISSF and other studies on non-entangling and biodegradable dFADs worldwide (Moreno et al., 2020b) and identify potential industry partners. Following this, in collaboration with ISSF, industry partners, national fisheries agencies, Regional Observer Programme (ROP) representatives and local dFAD construction experts, a planning and information sharing workshop will be held. The workshop will identify plausible dFAD materials and designs to trial and inform the design, data collection protocols and logistics of the at-sea trials. The workshop will also aim to identify locations for land-based construction of non-entangling and biodegradable dFADs for the project, and ongoing support to industry will also be an important part of this initial workshop. Based on the outcomes from the planning workshop a detailed design for the at-sea trials will be developed by the lead SPC scientist in collaboration with ISSF project collaborator and presented back to the initial planning workshop attendees, industry partners, ROP representative for comment and endorsement. Project 110 detailed design will include all aspects of the at-sea trials and clearly outline the data collection protocols and other support required from the relevant stakeholders, in particular industry, national fisheries agencies, and observers. dFAD construction will be ongoing from stage 1 once the prototype dFADs designs are endorsed by industry partners.

Stage 2: Construction of non-entangling and biodegradable dFADs

Based on the outcomes and recommendations of the locations for dFAD construction activities, capacity building activities, design and construction of biodegradable and non-entangling dFADs, it is anticipated that these phases of the project will be integrated as part of the construction of the prototype dFAD design, and eventually rolled out to all dFADs for the project.

Stage 3: Conduct at sea trials and broader industry communications program

The project aims to deploy a minimum of 200 'experimental' non-entangling and biodegradable dFADs that will be compared with 200 'conventional' (currently used) dFADs. We envisage that the performance of the experimental and conventional dFADs will be monitored over eight to ten months. The timing of trials is dependent on COVID-19 restrictions in port(s) where participating fleets dock and ports which will be the primary access way for the construction and distribution of the experimental dFADs. Trials are hoped to begin in the second half of 2022. If logistically feasible, at-sea experimental dFAD trials will follow normal deployment practices, with trials to be coordinated by the lead scientist from the SPC with support from ISSF. Observer involvement and coverage will be important and will be supported by SPC and ISSF in monitoring and data collection. The monitoring program will be developed in collaboration with the observers and industry partners, skippers to ensure it is feasible given their other work commitments. Monitoring of the dFADs will include information on dFAD condition, catch history, acoustic data and drift trajectories (following approaches previously employed in ISSF projects). Comparative analyses of the performance of the two dFAD types will include; aggregative power and drift behaviour; catch rates per species; costs and handling requirements; effective lifespan and condition at different times-at-sea. Analyses of data from echo-sounder buoys deployed on the dFADs will build on knowledge gained through EU funded Project 88 (FAD acoustics). Acoustic buoys will be provided by manufactures used by the participating fleets to ensure data is comparable with their standard dFADs deployed in the region.

The trials will be performed in close partnership with industry (skippers) and the observer programme to ensure marking, deployment, identification and monitoring/data recording of dFADs occurs in a consistent and coordinated way. Two levels of industry participation are anticipated:

- the partner fleets that deploy the dFADs and are actively engaged in the research depending on their fishing activities, and;
- all other fleets that find and/or fish the experimental dFADs. Information from (2) will be important to the success of the research.

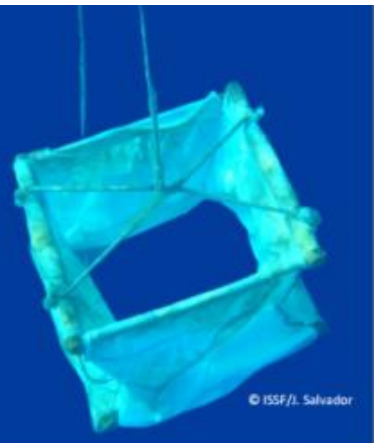
Stage 4: Data analysis, reporting, final workshop and industry adoption of plan of action

Data from the at-sea trials will be summarised (and analysed to the extent possible) as it becomes available and reported back to industry partners at six monthly intervals, including a mid-project review workshop, the WCPFC's dFAD Management Options Intersessional Working Group (FAD-IWG) and papers to the WCPFC Scientific Committee (SC). The final analyses and reporting of results will be delivered to SC20 and a final workshop with industry partners, national fisheries agencies, NGOs and ROP representatives. Assuming positive results of the trial, the final workshop would include a session on 'industry adoption' with an objective of developing an adoption plan of action. SPC is also developing a dFADs communication strategy and will build this project into that broader strategy.

Appendix 2. Communication flyer explaining the project the jelly-FAD.

Non-entangling and biodegradable FAD trial

in the western and central Pacific Ocean (WCPO)
2021 - 2024



What are the objectives of the trial?

- To provide essential information to the tuna fishing industry on the performance, cost-effectiveness, design and materials of non-entangling and biodegradable drifting fish aggregating devices (dFADs) in the WCPO context.
- To support industry increase the uptake of more ecologically sustainable dFAD designs and prepare for a biodegradable dFAD future.
- To test a newly developed design – with physical oceanographers: **the jelly-FAD**

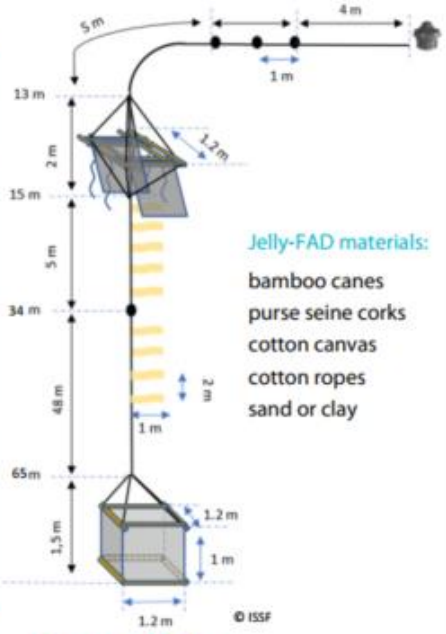
What are the benefits of jelly-FADs?

Environmentally friendly:
- Non-entangling: they do not entangle marine animals and they comply with non-entangling requirements under CMM 2021-01.
- Biodegradable: they degrade slowly, after 9-12 months of operational use.

Neutrally buoyant: ensuring a longer lifespan of its natural materials. The weight (sand or clay) dissolves slowly in seawater and the bamboo canes and cotton get saturated in seawater after 20–25 days. The density then becomes similar to seawater, making the structure drift neutrally in the water column, just like a jellyfish.

Reduce structural stress: minimising the emergence of dFAD structures at the surface which contributes to an increased lifetime through the reduction of structural stress (from wind, waves, and currents).

Reduce the size of dFADs: the 3-D shape of the drogue ensures a slow drift, while reducing the volume of the submerged structure.



Jelly-FAD materials:
bamboo canes
purse seine corks
cotton canvas
cotton ropes
sand or clay

- Lifetime in real fishing conditions >9 months
- Data collection by skippers and observers on the condition and tuna catch
- Comparison with conventional dFADs
- Study of tuna aggregation using Satlink echosounder data
- Scientific analyses
- Provide scientific advice to industry, national fisheries managers and WCPFC

At-sea trials

Ongoing	**400** in the Atlantic Ocean **600** in the eastern Pacific Ocean **216** in the WCPO
This project	**200** in 2023 **More expected** in 2024

Note to skippers

Store on board

- Keep as dry as possible
- Cover the jelly-FADs, to protect from the sun

Do not add

- Flotation, weight or aggregator

Deployment process

- Biodegradable (BIO) and conventional (CONV) dFADs are deployed in pairs (ideally within 1-5 nm of each other)
- Paint codes assigned to the vessel dFADs on Satlink buoys for both dFAD types e.g., BIO100 and CONV100
- If possible, target the deployments to areas and periods with less risk of the dFADs being stolen or lost

In this first phase, the Jelly-FAD should be deployed gently in 3 steps while the vessel is moving slowly:

1. Deploy the cube (the deepest part of the Jelly-FAD)
2. Let the rope run to ensure that the structure is well stretched and deploy the submerged raft
3. Deploy the purse seine corks and Satlink echosounder buoy. Try not to tow the dFAD

- Take photos/videos of the deployments and visits

Jelly-FAD monitoring

- Fill out the Excel form for each Jelly-FAD *and* conventional dFAD (deployment, set, visit) activity.
- At a minimum of every two weeks, send the completed form, to the company contact and: lauriane.escalle@spc.int and gmoreno@iss-foundation.org

Any questions, concerns and suggestions for improvement are also welcome !

Thank you for your cooperation!

Western and Central Pacific Fisheries Commission

Pacific Community / Communauté du Pacifique

ISSF International Seafood Sustainability Foundation

NOAA Fisheries

FCF Co., Ltd.

SILLA

satlink

American Tunaboat Association

Cape Fisheries

Note to observers

I am the observer on-board a participating vessel

- Fill in the designated form

I am the observer on-board another vessel

When observing a jelly-FAD or new type of dFAD:

- Pay careful attention to the materials, design and condition of the dFAD
- Record in GEN-5 form:
  - That you observed a non-entangling and biodegradable dFAD *(comments)*
  - The state (good, needs repair, destroyed, not visible) of each component *(comments)*
  - The *buoy serial number* and any *beacon* or *FAD ID markings*
  - The materials *(main materials and attachment)*
  - Any drawings to help indicate the design and condition of the dFAD *(diagrams)*
- If a fishing set occurred, record the catch and bycatch in PS-3 form

FAD/PAYAO and FLOATING OBJECTS INFORMATION RECORD — **Form GEN-5**

REVISED 2018

OBSERVER NAME:	VESSEL NAME:	OBSERVER TRIP ID NUMBER:	PAGE OF

Date (From PS-2)	Time	Set No.	Object number	Origin of FAD	Deployment date	latitude dd°mm.mmm'	N S	and longitude ddd°mm.mmm'	E W	FAD as found	Beacon/ FAD lifted	FAD as left	Comments / Change details
											Beac/FAD/ NO		

FAD materials Main materials	net/mesh size	Attachments	net/mesh size	Max est. depth	FAD length	FAD width	Buoy serial number	Beacon/FAD ID markings	SSI seen	SSI trapped
	cm		cm	M	M	M			Y/N/U	Y/N/U

Diagrams- *label with 'Object number'*

Take photos/videos of the jelly-FADs, the Satlink buoy attachment, deployments and visits

Feel free to discuss your observations with your observer coordinator or laurianee@spc.int

Thank you for your cooperation!

Western and Central Pacific Fisheries Commission

Pacific Community
Communauté du Pacifique

ISSF INTERNATIONAL SEAFOOD SUSTAINABILITY FOUNDATION

NOAA FISHERIES

FCF Co., Ltd. 豐群水產股份有限公司

SILLA

satlink

American Tunaboat Association

CAPE FISHERIES

Appendix 3. Form to be filled up by vessel captains of the participating vessels.

BIO-FAD DATA FORM

Created July 2022 V2

General Information

Vessel name		Company name		Skipper Name	

Date and time *(GMT)*					Latitude		Longitude	
YY	*MM*	*DD*	*hh*	*mm*	*(dd°mm.mmm')*	*N/S*	*(dd°mm.mmm')*	*E/W*

FAD activity and identification

FAD Activity *(tick)*				FAD ownership *(tick)*	
Deployment	☐	Buoy deactivation date:		This vessel	☐
Visit	☐	Buoy deactivation reason:		Other vessel from company *(specify)*	☐
Retrieval	☐	Buoy replacement	☐	Other vessel *(specify)*	☐
Set	☐	Other *(specify)*	☐	Unknown	☐

Comment on FAD activity and ownership

Type of FAD (tick biodegradable (Bio) or Conventional (Conv) FAD and enter number)

Bio-FAD *(tick)*	☐	Bio-FAD Number *(number asigned to each vessel)*		Conv-FAD *(tick)*	☐	Conv-FAD Number *(same as the paired bio-FAD)*	

(1) Bio-FAD information

(2) Conventional FAD information

Fill up part (1) and (2) in case of joint-deployment

Buoy ID number		Buoy ID number	
New buoy ID number *(if replaced)*		New buoy ID number *(if replaced)*	

Design type *(tick)*		Flotation *(tick)*		Raft type *(tick)*		Submerged structure *(tick)*	
Jelly-FAD	☐	Surface	☐	Bamboo raft	☐	Ropes	☐
Other *(add in comments)*		Submerged	☐	Bamboo bundle	☐	Canvas	☐
FAD depth *(fathom)*		Weight type		Metal	☐	Bamboo	☐
		Weight *(pounds)*		Plastic	☐	Palm leaves	☐

State of FAD *(tick)*	Submerdged raf	Main rope	Cube	Attractors
Good	☐	☐	☐	☐
Needs repair	☐	☐	☐	☐
Destroyed	☐	☐	☐	☐
Not visible	☐	☐	☐	☐
Abstent	☐	☐	☐	☐

Corks	☐	Open net	☐
Other *(specify)*		Net rolled up	☐
Raft cover *(tick)*		Other *(specify)*	
Not covered	☐	Flotation *(tick)*	
Canvas	☐	Surface	☐
Netting	☐	Submerged	☐
Other *(specify)*		Weight type	
FAD depth *(m)*		Weight *(kg)*	

Submered raft repaired component	Other *(specify)*						
Submered raft replaced component	FAD depth *(m)*						
Cube or rope repaired component							
Cube or rope replaced component							

Comments/drawings on FAD information and design

Catch data

Catch	YFT	BET	SKJ	Bycatch	Total
Tonnage					

Comment on catch and set

DETAILS OF THE PROTOCOL AND THE INFORMATION RECORDED

Each **JellyFAD will be deployed close to a conventional FAD (CONFAD)**. The form needs to be filled each time an activity is performed with the biodegradable FAD (JellyFAD) or with the conventional FAD associated to the jellyFAD. An excel file will be created for each **FAD deployed (both jellyFAD and associated conventional FAD)**, the file should be named with the number assigned. Each time an activity is performed with the FAD (i.e. deployment, visit, set, etc) a form within the file should be filled. The first form, Form_1 would be the deployment activity. Then, if other activities occur, new sheets should be filled with those activities: Form_2, Form_3 etc.

Cell colouring	To be filled with text	Tick cell	For comments (optionnal)

General Information			
Vessel, Company and Skipper names	Always print each of these names out in full (e.g. a vessel name "Hai Hsiang No. 959")		
Date and time	Record date/time for each activity, in GMT or UTC, do not use the "Ship's time"		
Latitude/ Longitude	Record position as degrees, minutes and minutes to three decimal places. dd = degrees; mm = minutes; mmm = decimal minutes. Never forget to enter north or south and east or west correctly (for example "05°27.985' S, 152°28.239' W")		
FAD activity and identification			
FAD activity	Tick with an X, the related activaties in the list : Deployment; Visit; Retrieval; Set; Buoy deactivation; Buoy loss; Buoy replacement; Other (specify in comments). Fill in a form for each activity on the Biodegradable (Bio) and Conventional (Conv) FADs of the project. In case of deployment of a Bio AND a conventional FAD simultaniously, only one form should be filled.		
FAD ownership	Record the ownship of the FAD, tick one of the following ownership: This vessel; Other vessel from company (specify in comments); Other vessel (specify in comments); Unknown		
Comment on FAD activity and	Add any additional information or specify details related to FAD activity and ownership		
Type of FAD	Tick if the realed FAD is (1) a Bio-FAD or (2) a conventional FAD. Enter Bio-FAD Number (and Conv. FAD number, as set-up in the project and painted on the buoy		
(1) Bio-FAD information		**(2) Conventional FAD information**	
Buoy ID number	Record the full Buoy ID number (or serial number) of the satellite buoy attached to the FAD		
New buoy ID number	In case of buoy replacement, record the full Buoy ID number (or serial number) of the new satelitte buoy attached to the FAD		
Design type	Tick the type of Bio-FAD: Jelly-FAD; or other (specify in comments)	Raft type	Tick the type of raft used in the conventional FAD (one or several): Bamboo raft, Bamboo bundle, Metal, Plastic, Corks, Other (specify)
State of FAD	For each component of the Bio-FAD: Raft, Submerged structure, and other; specify the current state in the list: good, needs repair, destroyed, not visible or absent.	Submerged structure	Tick the type of submerged structure used in the conventional FAD (one or several): ropes; canvas; bamboo; palm leaves; open net; net rolled up; other (specify in comments)
Raft repaired/ replaced component, Submerged repaired/replaced component	Specify the types of repairs or replacements made to each component of the Bio-FAD	Raft Cover	Tick the type of raft cover used in the conventional FAD (one or several): Not covered; canvas; net; other (specify in comments)
Flotation	Tick the type of flotation used (could be one or both): Surface or Submerged		
FAD depth	Enter FAD depth in fathoms		
Weight type	Specify the type of weight used (rocks, sand, etc.)		
Weight (pounds)	Enter the weigth in pounds		
Comments/drawings on FAD information and design	Record any information that will help assess the type and design of the Bio and conventional FADs used and their states. A drawing of the FAD, the damaged part or the reparation done can be very helpfull		
Catch data			
Catch	For each set made on the Bio or conventional FADs, record catch by species and total (t)		
Comment on catch and set	Add any additional information or specify details related to the catch		

Appendix 4. Form to be filled up by observers onboard participating vessels.

BIO-FAD DATA FORM

Created January 2023 V1

General Information

Vessel name		Latitude	
Company		*(dd°mm.mmm')*	*N/S*
Observer name			

Date and time *(GMT)*					Longitude	
YY	*MM*	*DD*	*hh*	*mm*	*(dd°mm.mmm')*	*E/W*

FAD activity and identification

FAD Activity *(tick)*				FAD ownership *(tick)*			
Deployment	☐	Retrieval	☐	This vessel	☐	Unknwon	☐
Visit	☐	Buoy replacement	☐	Other vessel from company *(specify)*			☐
Set	☐	Other *(specify)*	☐	Other vessel *(specify)*			☐

Comment on FAD activity and ownership

Bio-FAD information

Buoy ID number		Bio-FAD Number	
New buoy ID number *(if replaced)*			

Design type *(tick)*		FAD lifted out of the water ? (Y/N)	
Jelly-FAD	☐	FAD design visible ? (Y/N)	
Other *(add description)*		FAD depth *(m)*	

State of the FAD *(tick)*	Submerdged raft	Main rope	Cube	Attractors	Comments
Good	☐	☐	☐	☐	
Needs repair	☐	☐	☐	☐	
Destroyed	☐	☐	☐	☐	
Not visible	☐	☐	☐	☐	
Abstent	☐	☐	☐	☐	

Submered raft repaired component	
Submered raft replaced component	
Cube or rope repaired component	
Cube or rope replaced component	

Comments/drawings on FAD information and design

Catch data

Catch	YFT	BET	SKJ	Bycatch	Total
Tonnage					

Comment on catch and set

Send form and photos to laurianee@spc.int and inform your debriefer

DETAILS OF THE PROTOCOL AND THE INFORMATION RECORDED

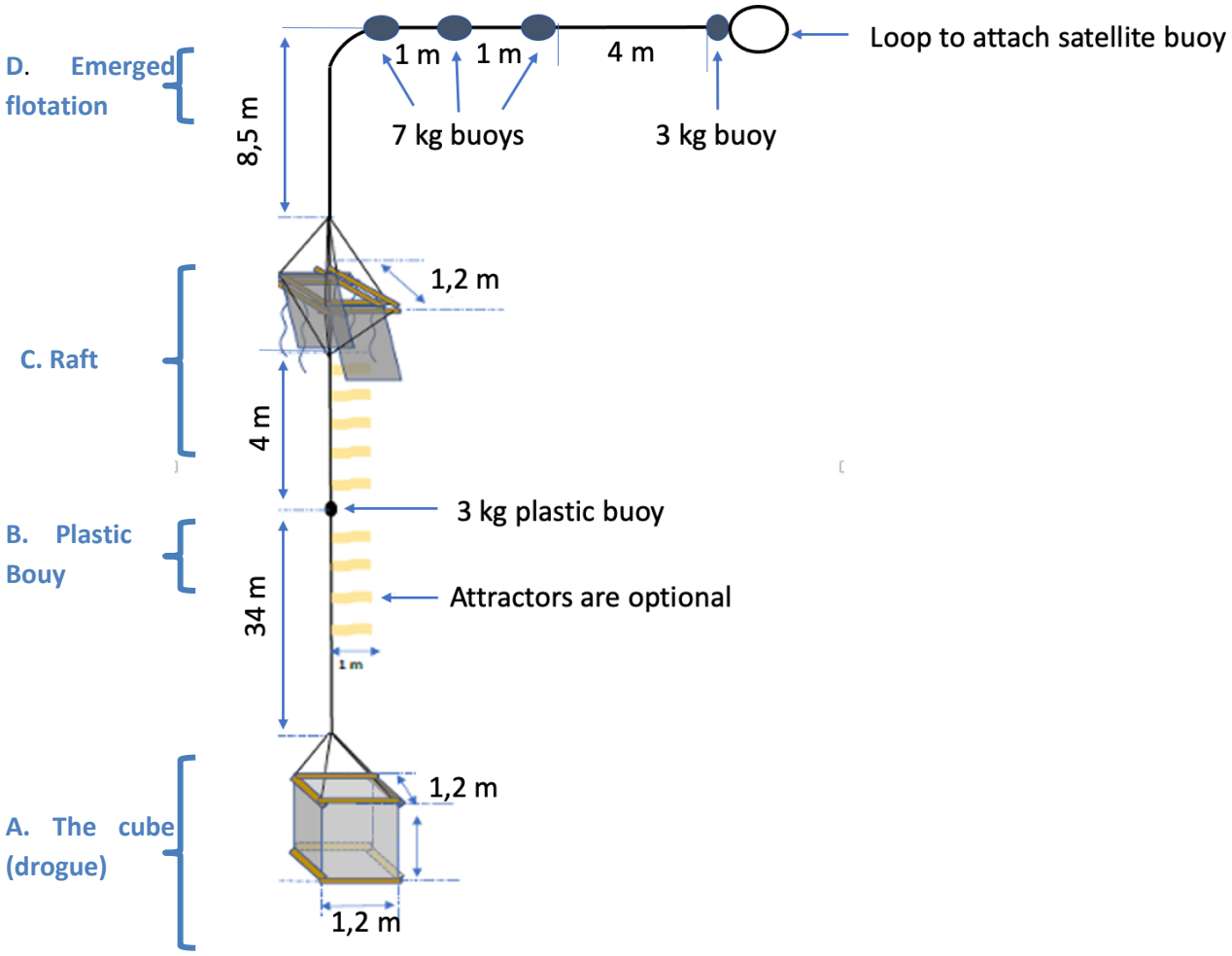
Jelly-FADs are non-entangling and biodegradable FADs tested by WCPFC and SPC. The objective of the project is to provide essential information to the tuna fishing industry on the designs, types of materials, performance and cost-effectiveness of non-entangling and biodegradable drifting Fish Aggregating Device (dFADs) in the WCPO context, and support industry to increase uptake of more ecologically sustainable FAD designs.

Cell colouring	To be filled with text	Tick cell	For comments (optionnal)

General Information	
Vessel and observer names	Always print each of these names out in full (e.g. a vessel name "Hai Hsiang No. 959")
Date and time	Record date/time for each activity, in GMT or UTC, do not use the "Ship's time"
Latitude/ Longitude	Record position as degrees, minutes and minutes to three decimal places. dd = degrees; mm = minutes; mmm = decimal minutes. Never forget to enter north or south and east or west correctly (for example "05°27.985' S, 152°28.239' W")
FAD activity and identification	
FAD activity	Tick with an X, the related activaties in the list : Deployment; Visit; Retrieval; Set; Buoy deactivation; Buoy loss; Buoy replacement; Other (specify in comments).
FAD ownership	Record the ownship of the FAD, tick one of the following ownership: This vessel; Other vessel from company (specify in comments); Other vessel (specify in comments); Unknown
Comment on FAD activity and	Add any additional information or specify details related to FAD activity and ownership
Bio-FAD information	
Buoy ID number	Record the full Buoy ID number (or serial number) of the satellite buoy attached to the FAD
New buoy ID number	In case of buoy replacement, record the full Buoy ID number (or serial number) of the new satelitte buoy attached to the FAD
Design type	Tick the type of Bio-FAD: Jelly-FAD; or other (specify in comments)
FAD lifted out of the water ? (Y/N)	Was the FAD lifted out of the water
FAD design visible ? (Y/N)	Were you able to observe the FAD design and the materials.
FAD depth	Enter FAD depth in fathoms
State of FAD	For each component of the Bio-FAD: Raft, Submerged structure, and other; specify the current state in the list: good, needs repair, destroyed, not visible or absent.
Raft repaired/ replaced component, Submerged repaired/replaced component	Specify the types of repairs or replacements made to each component of the Bio-FAD
Comments/drawings on FAD information and design	Record any information that will help assess the type and design of the Bio FADs used and their states. A drawing of the FAD, the damaged part or the reparation done can be very helpfull
Catch data	
Catch	For each set made on the Bio, record catch by species and total (t)
Comment on catch and set	Add any additional information or specify details related to the catch

Appendix 5. Construction steps for a jelly-FAD of 50 m depth

1- Scheme of the jelly-FAD



2- List of tools needed

- 1x Power drill
- 1x Tape measure or tape rule
- 1x wooden hand saw
- 1x sharp machete knife
- 1x sharp knife for cutting the rope
- 1x Mallet or hammer
- Electrical tape for splicing ends and marking points of splice.
- Spray can for marking crucial points for splice
- Large and small splicing tool
- Assorted drill bits, auger, speed bor with extension
- Wooden hole cutters (90–100mm, 30–40mm)

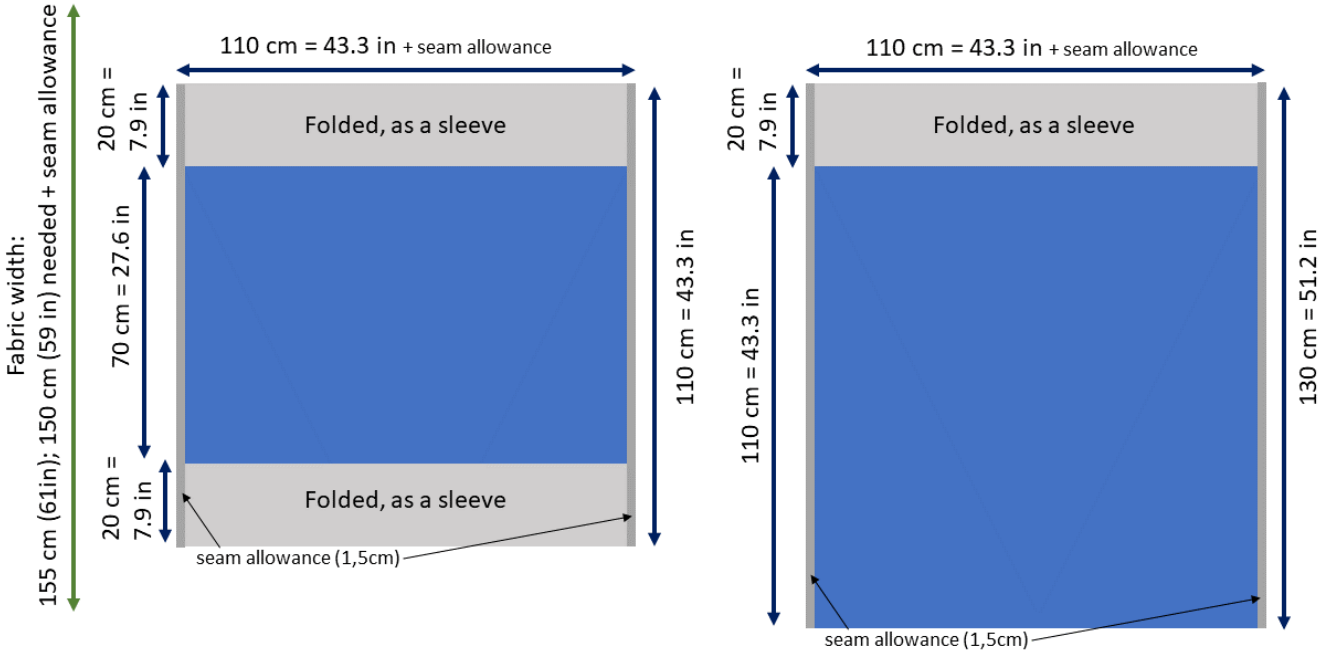
3- List of materials for the whole jelly-FAD

List of materials	Per FAD
Plastic buoy or purse seine cork of 7kg (EF70) – painted dark blue or black OR other sizes of buoy/corks that provide a total of around 20 kg flotation	3
Plastic buoy of 3 kilos or half 7kg purse seine cork (EF70) – painted dark blue or black	2
Large bamboos (about 90-100 mm diameter) of 1.2 m length	4
Small bamboos (about 30-40 mm diameter) of 1.2 m length	12
Bamboo nails or pins/or other wood nails or pins	8
Piece of cotton canvas (110 cm x 110 cm) with one pocket on top and another in the bottom	4
Piece of cotton canvas (110 cm x 130 cm) with only one pocket on top	2
Cotton rope of 20 mm diameter	65 m
Cotton rope of 10-12 mm diameter 11.6m for securing the raft, allow additional 10 m for locking spliced ends, locking bamboo cube in place, and locking the main line corks. Offcut 20mm ropes could also be used if stripped to smaller size.	11.6m + 10m =21.6m
Bricks of clay 4kg	2
Attractors are optional, if used, could be: Organic Ropes, Palm leaves, organic canvas. If rope: 1m x 10 pieces = 10 m spliced onto the raft section only	10 m if rope

4. Preparation of the pieces of cotton canvas

Sew the pieces of cotton canvas, as shown in the drawing below:

- 4 per FAD of 110 cm x 110 cm with one pocket on top and another in the bottom
- 2 per FAD of 110 cm x 130 cm with only one pocket on top



The construction of the jelly-FAD should be made from the deepest part (the cube or drogue A) to the surface component (the emerged flotation D).

A. The CUBE (drogue)

Materials for the cube (drogue)

- 4 large bamboos (about 90-100 mm diameter)
- 4 small bamboos (about 30-40 mm diameter)
- 4 pieces of cotton canvas (110 cm X 110 cm) with one pocket on top and another in the bottom
- 8 Bamboo sticks to use as nails
- Around 65m of cotton rope of 20 mm diameter
- 8 kg of clay to be inserted into two bamboos (4 kg per bamboo)

Steps to construct the cube

1. Cut the bamboos: large (4 pieces) and small (4 pieces) to 120 cm each.
2. Remove the walls inside the large bamboos except the wall in the middle. This will avoid the weight (clay) from sliding from one side to the other, so that the balance is maintained.
   Note, only the large bamboos placed in the bottom of the cube will have clay inside.
3. Drill two 40 mm holes in each of the large bamboos, at 10 cm distance from the ends (two holes per cane). These holes will be used to pass the small 30–40mm canes through.

4. Drill **two 22 mm holes** in each of the large bamboos, at **30 cm distance** from each of the cane ends (two holes per cane). NOTE, these holes must be drilled in a different plane to the previous holes (see picture below). These holes will be used to pass the rope through. Make sure there are no splinters left that could result in rope abrasion.

5. Insert the clay inside the two large bamboo canes that will be located at the bottom part of the cube (4 kg should go in each of the bamboo cane, 2kg in each side of the cane separated by the middle partition wall, 8 kg in total).

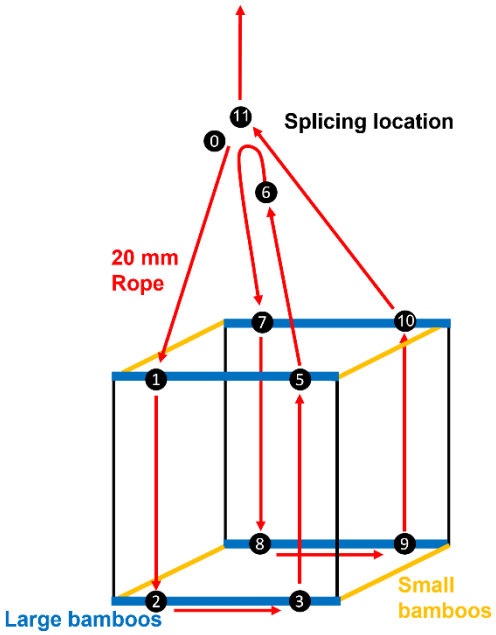
Note that the picture on the left is a split section of where the mud (4kg) should be placed in one large bamboo, for information purposes (the bamboo was cut for the picture to see where the clay should be placed). Ideally, the bamboo should not be cut but filled from one of the ends (pic on the left).

6. Insert the small and large bamboo canes through the canvas pockets and then construct the bottom frame (the weighted bamboo) first, followed by the top-frame of the cube.

7. Lock the joints of the large and small bamboos by drilling 1 cm hole and using a bamboo nail to secure in place (see picture below).

8. Measure a 9.5 m segment from the end of the main rope, marks the splice point for joining the three points to the main rope.

9. Using this 9.5 m of the end of the 20mm main rope (without cutting it), insert it through the holes of the two bamboo frames of the cube. Start starting in the upper part to the lower part and join the three points of the rope back onto the main rope passing through the cube (see diagram and photos). Important note the rope is supporting the weight of the bamboo frame in the bottom, for that, the canvas should be loose and the rope tight supporting the weight.



10. Lock the main rope passing through the top bamboos to avoid the upper bamboo frame from sliding down. Make a knot on both sides (top section) of the bamboo using the smaller rope (10–12mm diameter). Repeat this step for the other side of the cube.

Note: that the rope will be placed after the canvas. These pictures are taken without canvas to allow a better view of the cotton rope configuration to attach the 2 bamboo frames.

B. Add a plastic buoy of 3 kilos at 34 m above the blast joint (splice) of the cube and lock in place.

C. The Raft

Materials for the raft

- 8x small bamboo canes (30–40mm)
- 10–12 mm diameter cotton rope.
- 2 Piece of cotton canvas (110 cm x 130 cm) with only one pocket on top
- Attractors: (optional)
- 1m x 8 pieces of attractors can be spliced onto the raft section.

Steps to construct the submerged raft

1. Using electrical tape or a marker pen, mark the center point of the raft on the main rope (20mm rope) at 4m above the submerged 3kg buoy. Mark 1m sections both above and below this mark for the splice and locking points of the raft to the main rope.
2. Cut the 8 small bamboo canes to 120 cm.
3. Remove all the partition walls inside them.
4. Insert the canvas pieces trough the bamboo.
5. Assemble the bamboos in pairs to create a frame and drill two (2) small 10mm holes at all four (4) corners of the frame and use a bamboo dowel to lock the frame in place temporary. Note these holes need to be in diagonal with the frame for maximum stability.

6. Using the small rope (10–12mm diameter) remove the wooden dowels one corner at a time and pass through the rope from the bottom and lock the bamboos in place by using a lock knot method for both top and bottom half. Allow 1.4m of length for each of the three (3) corners of the raft (both top and bottom). The last corner will need a longer 1.6m length (top and bottom) to secure the splice points together on the main rope (20mm). We mark this corner using a red tape. The desired length from raft to splice point is 1m from all corners of the frame top and bottom. Depending on the size of the bamboos used, allow for extra rope length to achieve this.

7. With the three (3) marks in place begin the splice connections one corner at a time.

D. The emerged flotation

Materials for the emerged flotation

- 3 plastic buoys or purse seine corks of 7 kg.
- 2 plastic buoy or cork of 3 kg.
- Dark or blue paint if yellow purse seine corks are used.

Steps to construct the emerged flotation.

1. Paint the corks/buoys dark or blue. This will camouflage the buoys from other fishers. If plastic buoys, they should be of dark color.
2. At 8.5 m above the raft´s splice place the first 7 kg cork/buoy through the main rope, then the next two corks/buoys at 1m intervals from each other.
3. At 4 m from the last 7 kg cork/buoy attach the 3 kg cork/buoy and lock in place.
4. Finally make a loop in the end of the main rope to eventually use that loop to attach the echo-sounder buoy.

Appendix 6. Design of the project t-shirt