Transitioning to Bio-FADs: Ongoing Trials with Jelly-FADs by fleets in the western and eastern Pacific Ocean

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Summary

This document summarizes the experiences with jelly-FADs, a new concept of non-entangling and biodegradable FAD, in the eastern and western Pacific as of April 2024. The fleets currently testing the jelly-FAD are from the American Tunaboat Association (ATA, USA), FCF CO. Ltd (Chinese Taipei), Silla (Korea), Caroline Fisheries Corporation (CFC, Federated States of Micronesia), Fishing Industry Association (FIA, Papua New Guinea), Koo's (Marshall Islands), China and KAIMAKI (Japan). The results presented in this document are still preliminary as these tests are ongoing. The total number of jelly-FADs to be tested in the Pacific Ocean is 665, up to April 2025 the fleet deployed 296 and visited or conducted fishing sets in 20.

Resumen

Este documento resume la experiencia acumulada hasta la fecha (abril de 2024) con los jelly-FADs, un nuevo tipo de dispositivo de concentración de peces (DCP) no enmallante y biodegradable, que está siendo probado en las regiones del Pacífico oriental y occidental. Las flotas que actualmente participan en estas pruebas incluyen la American Tunaboat Association (ATA, Estados Unidos), FCF Co. Ltd (Taipei Chino), Silla (Corea), Caroline Fisheries Corporation (CFC, Estados Federados de Micronesia), Fishing Industry Association (FIA, Papúa Nueva Guinea), Koo's (Islas Marshall), China y KAIMAKI (Japón). Los resultados presentados en este documento son preliminares, ya que los ensayos aún están en curso. Está previsto desplegar un total de 665 jelly-FADs en el océano Pacífico. Hasta abril de 2025, se han desplegado 296 y se han visitado o utilizado en operaciones de pesca 20 de ellos.

1. Introduction

In recognition of the need to reduce the impacts of drifting FADs (dFADs) structure in the ecosystem, both the Western and Central Pacific Fisheries Commission (WCPFC) and the Inter-American Tropical Tuna Commission (IATTC) have adopted conservation measures to move towards the use of dFAD structures that reduce ecosystems impacts, i.e. non-entangling and biodegradable FADs (bio-FADs). The IATTC resolution Resolution C-23-04 adopted a stepwise transition to bio-FADs, transitioning from Category V (current dFADs made of plastic) from 2026 on, to Category II (made of biodegradable* materials, apart from buoys used for flotation and made of plastic) in 2030, year in which the potential implementation of 100% biodegradable dFADs including flotation components, will be reviewed. The same conservation measure prohibits the use of any netting or mesh material from 2026 in the IATTC convention area. In the WCPFC, CMM 2023-01 (Conservation and Management Measure for bigeye, yellowfin and skipjack tuna in the western and central Pacific Ocean), prohibited the use of mesh net for any part of the dFAD to be deployed in, or drift into the WCPFC convention area since January 1, 2024. It also encourages the use of biodegradable materials to construct dFADs, with a transition to 100% biodegradable dFADs that should be adopted before 2026.

While trials of non-entangling and bio-FADs have been implemented worldwide for several decades (Moreno et al., 2020; Escalle et al., 2022; Zudaire et al., 2023), they are relatively recent in the WCPO (Moreno et al., 2020). Additional work and collaborative actions are required if non-entangling and bio-FADs, are to become the “norm” in the Pacific Ocean. The current paper provides an update on the tests of jelly-FADs, including the newly developed cylinder jelly-FAD in the Pacific Ocean. In particular the paper presents results from WCPFC Project 110 and 110a: non-entangling and biodegradable dFAD trial in the WCPO as well as a project led by the International Seafood Sustainability Foundation (ISSF) in collaboration with the U.S. fleet and The Pacific Community (SPC), funded by the National Oceanic and Atmospheric Administration´s Bycatch Reduction Engineering Program (BREP) project.

2. Objectives

1. Explore design and cost-feasibility of non-entangling and bio-FADs.
2. Train dFAD manufacturers on the construction of bio-FADs.
3. Undertake at-sea experiments to compare the performance/functionality of non-entangling and biodegradable dFADs to conventional dFADs. Deploying them together in pairs.
4. Provide robust scientific advice to industry and national fisheries managers on the performance of non-entangling and biodegradable dFAD designs.
5. Dissemination of the bio-FADs, construction and use through workshops with fishers

In this document we will only show results of Objective 3 (see Escalle et al., 2023 for details regarding other objectives).

3. Material and methods

The trials at sea in fishing conditions with jelly-FADs consisted of deploying a jelly-FAD in close proximity to a conventional FAD, enabling a comparative assessment of their respective performance under the same environmental conditions and levels of tuna presence. In addition to the jelly-FAD model previously tested, which features a 3D cubic structure (Figure 1), a new cylindrical jelly-FAD design

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* *Biodegradable* means non-synthetic materials and/or bio- based alternatives that are consistent with international standards for materials that are biodegradable in marine environments. The components resulting from the degradation of these materials should not be damaging to the marine and coastal ecosystems or include heavy metals or plastics in their composition.

will be trailed for the first time (Figure 2). This cylindrical structure is significantly lighter, easier to handle, and further reduces the potential impact when stranded.Material and methods are detailed further in the following documents presented to WCPFC (Escalle et al., 2024).

Figures 1 and 2 show the jelly-FAD structure (Moreno et al. 2023), and its variation the cylinder jelly-FAD. Both are made of bamboo, cotton ropes, cotton canvas and plastic flotation (Figure 3). See [jelly-FAD construction guide] for more information.

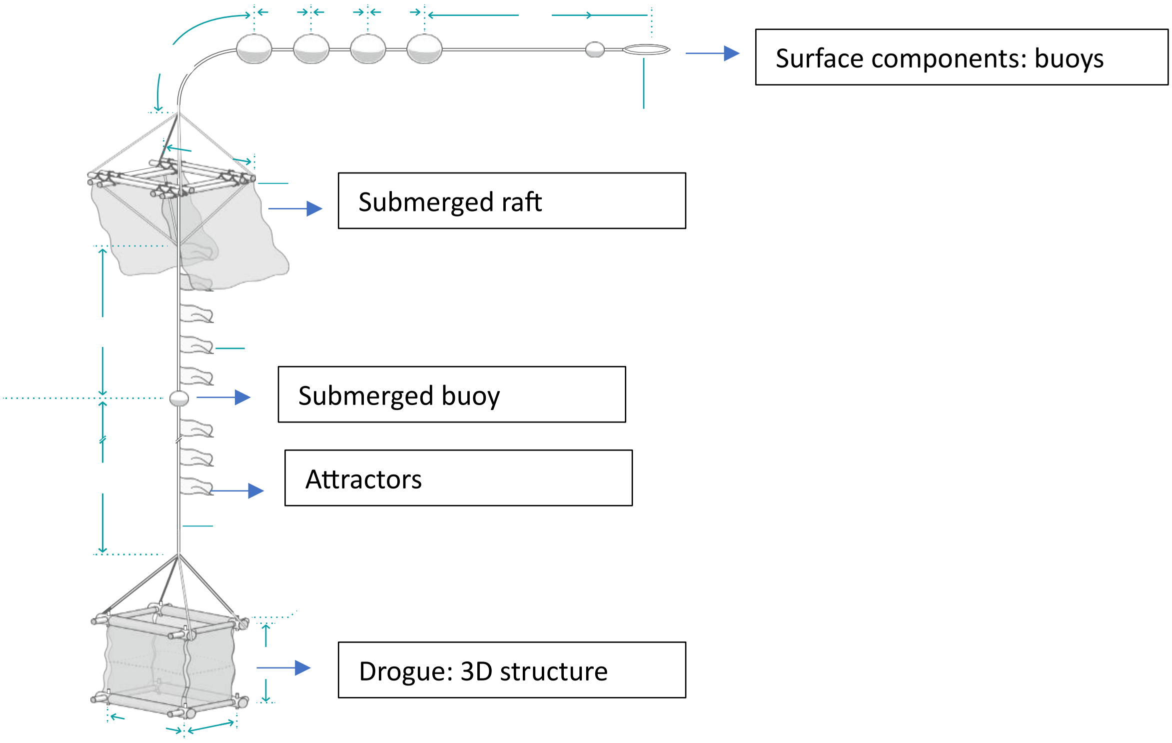

Figure 1. Scheme of the bio-FAD tested, called jelly-FAD.

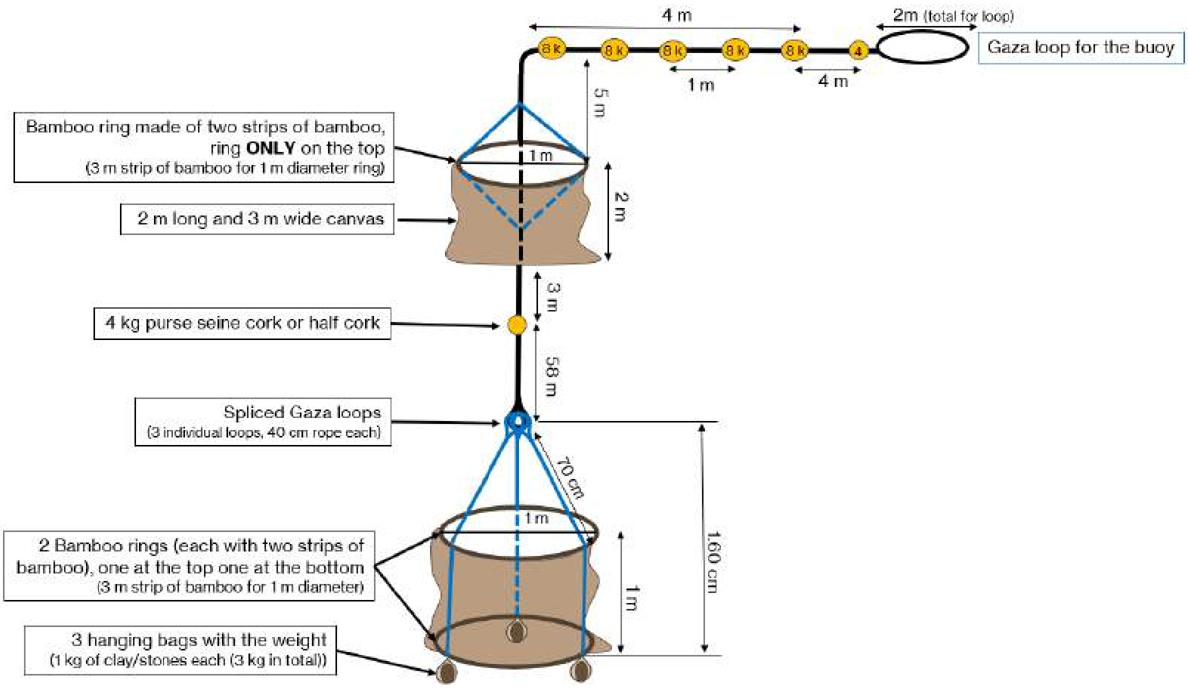

Figure 2. Scheme of the newly developed cylinder jelly-FAD.

4. Preliminary results

4.1 Fleet participation

Table 1 below provides an overview of the partners involved in the trials, including the number of vessels, their flag states, the locations where the jelly-FADs were constructed, and the number of bio-FADs to be tested by each fleet.

Table 1. Partner fishing companies in the non-entangling and biodegradable dFAD trials in the WCPO and EPO; construction location; and number of non-entangling and jelly-FADs to be tested.

Partners	**No. of vessels**	**Flag**	**Construction location**	**No. of BioFADs**	
				WCPFC 110	**BREP**
Caroline Fisheries Corporation (CFC)	6	FM	Pohnpei (FM)	50	
FCF Co. ltd	8	TW	Pohnpei (FM)	50	
Silla	2	KR	Pohnpei (FM)	34	
American Tunaboat Association					
- Cape Fisheries	6	US	Manta (EC)	30	108
- Others	10	US	Manta (EC); Pago Pago (AS)	50	108
Fishing Industry Association (FIA)	12	PG	Lae (PG)	60	
Koo’s	2	MH	Majuro (MH)	10	
Chinese fleet	8	CN	Weihai (CN)	145	
KAIMAKI	2	JP	Pohnpei (FM)	20	
TOTAL	32			449	216

- **CFC Fleet**: Operating 6 vessels under the flag of the Federated States of Micronesia, this fleet tested 50 jelly-FADs, constructed in Pohnpei. The 6 vessels participated in the trial.
- **FCF Co. ltd**: With more than 20 vessels flying the Taiwanese flag, FCF Co, has tested 50 jelly-FADs, all constructed in Pohnpei.
- **US Fleet**: Ten U.S.-based fishing companies — including Cape Fisheries LLC, GS Fisheries, AACH Holding CO LLC, AACH Holding Company No. 2 LLC, Xuk S.A., Tumbaco Fishing Industries S.A., Pacific Princess Partnership LTD, De Silva Sea Encounter Corp, Western Pacific Fisheries, and Tradition Mariner LLC — with 16 vessels will deploy a significant total number of 296 jelly-FADs. The construction locations for these jelly-FADs are Manta and Pago Pago.
- **Silla**: Comprising 6 vessels from Korea, Silla will test 34 jelly-FADs, constructed in Pohnpei.
- **Fishing Industry Association (FIA):** this fleet of 12 vessels from Papua New Guinea (PNG) will deploy 60 jelly-FADs, all constructed in Lae (PNG).
- **Koo’s:** This fishing company, based in the Republic of the Marshall Islands, will be testing 10 jelly-FADs with 2 fishing vessels participating. The jelly-FADs will be constructed in Majuro in May 2025.
- **Chinese fleet:** three fishing companies Zhongyu Global Seafood Corporation, Shanghai Kaichuang Deep Sea Fisheries Co., Ltd and Zhejiang Ocean Family Co., LTD with 18 vessels (8 vessels participating); with the support of Shanghai Ocean University will deploy 145 jelly-FADs. This fleet will exclusively test the newly developed cylinder jelly-FADs (Figure 2), with cotton and ropes made of cellulose (Lycell; 30%) or cotton (70%) (Figure 3). The jelly-FADs are currently being constructed in Weihai (China).

- **Kaimaki:** the Japanese Far Seas Purse Seine Fishing Association will be deploying 20 jelly-FADs that will be constructed in Pohnpei.

In total, the project involves 56 vessels testing 665 jelly-FADs across different countries and fleets. However, the fishing companies participating in the project manage a total of around 90 vessels. The knowledge and insights gained from these trials will be disseminated across all the vessels managed by the participating companies, thus enhancing the overall understanding and implementation of bio-FADs in general and jelly-FADs in particular.

The table below compares the jelly-FADs and conventional dFADs deployed by different fleets, including the US fleet and other international fleets. The data includes the number of FADs deployed, deployment periods, number of sets, visits without sets, buoy deactivations, and stranding events.

Figure 3. Photos from the jelly-FAD construction workshop held in Weihai (China) in March 2025, which included training on the cube jelly-FADs and the newly developed cylinder jelly-FAD. Tests with the Chinese fleets will include jelly-FADs with ropes and canvas made of cotton and Lycell (cellulose), but jute jelly-FADs were also tested during the workshop.

4.2 Activity with experimental FADs

- **Number of deployments**: The US fleet deployed 191 jelly-FADs and 167 conventional FADs, while other fleets (FM TW, KR and PNG only so far) deployed a total of 105 jelly-FADs and 57 conventional FADs.
- **Sets and visits**: The US fleet recorded more sets with conventional FADs (50) compared to jelly-FADs (15). Other fleets recorded 5 sets with jelly-FADs and none with conventional FADs. Additionally, there were visits without sets recorded for jelly-FADs in the FM and US fleets but not in the other ones.

- **Buoy deactivation**: There were more buoy deactivations for jelly-FADs (13 in other fleets and 26 in the US fleet) compared to conventional FADs (4 in other fleets and 24 in the US fleet).
- **Stranding events**: 5 stranding events were detected by the fleets for jelly-FADs in the TW and PNG fleet but none for conventional FADs. Note that this corresponded only to what is detected and communicated by the fleet, more stranding may have occurred and will be further examined in the future using trajectory data.

Table 2. Summary of deployments and activities performed on the non-entangling and biodegradable jelly-FADs and conventional FADs by fleet.

	FM		KR		TW		US	
	Jelly	Conv.	Jelly	Conv.	Jelly	Conv.	Jelly	Conv.
Convention Area	WCPFC		WCPFC		WCPFC		WCPFC & IATTC	
Nb FADs planned	50	50	34	34	50	50	296	296
Deployments	50	27	3	3	42	26	191	167
Deployment period	03/04/23 – 12/04/24		12/04/24		02/03/23 – 11/07/23		04/09/22 – 04/05/24	
Sets	1	0	0	0	4	0	15	50
Visit (without set)	3	0	0	0	0	0	1	0
Buoy deactivation	0	0	1	0	10	4	26	24
Stranding events	0	0	0	0	3	0	0	0

	PNG		MH		CN		JP	
	Jelly	Conv.	Jelly	Conv.	Jelly	Conv.	Jelly	Conv.
Convention Area	WCPFC		WCPFC		WCPFC		WCPFC	
Nb FADs planned	60	60	10	10	145	145	20	20
Deployments	10	1						
Deployment period	28/08/24 – ongoing							
Sets	0	0						
Visit (without set)	0	0						
Buoy deactivation	2	0						
Stranding events	2	0						

Table 2 underscores the challenge of obtaining data on experimental dFADs, both for Jelly-FADs and their conventional counterparts. Out of a total of 296 jelly-FAD deployed, only 20 were visited or fished, representing a mere 10.2%. Similarly, out of 224 paired conventional dFAD deployed, only 50 were visited or fished, accounting for 22.3% of the total deployments. These percentages are consistent with other bio-FAD experiments, where approximately 5-10% of deployed dFADs were visited by the deploying fleets alone. This emphasizes the significance of deploying a large number of dFADs for trials, or alternatively, systematically deploying a percentage of bio-FADs to yield meaningful insights into their performance.

The spatial distribution of jelly-FADs and their conventional counterparts is depicted in Figure 4. In the EPO, both types of dFADs were deployed within the same area. It is a common practice to deploy dFADs around the Ecuador 0º latitude and fish within the region spanning from 10ºS to 10ºN (Lopez et al., 2023). Once dFADs drift beyond these latitudes, typically further north than 10°N or south than 10ºS, they are deactivated. The fleet applied a similar strategy to their regular fishing operations when deploying the experimental dFADs. For the WCPO, we observe deployments along the equator in the central part of the WCPO, as well as along the boundary with the EPO, also known hotspots of dFAD deployments (Escalle et al., 2023).

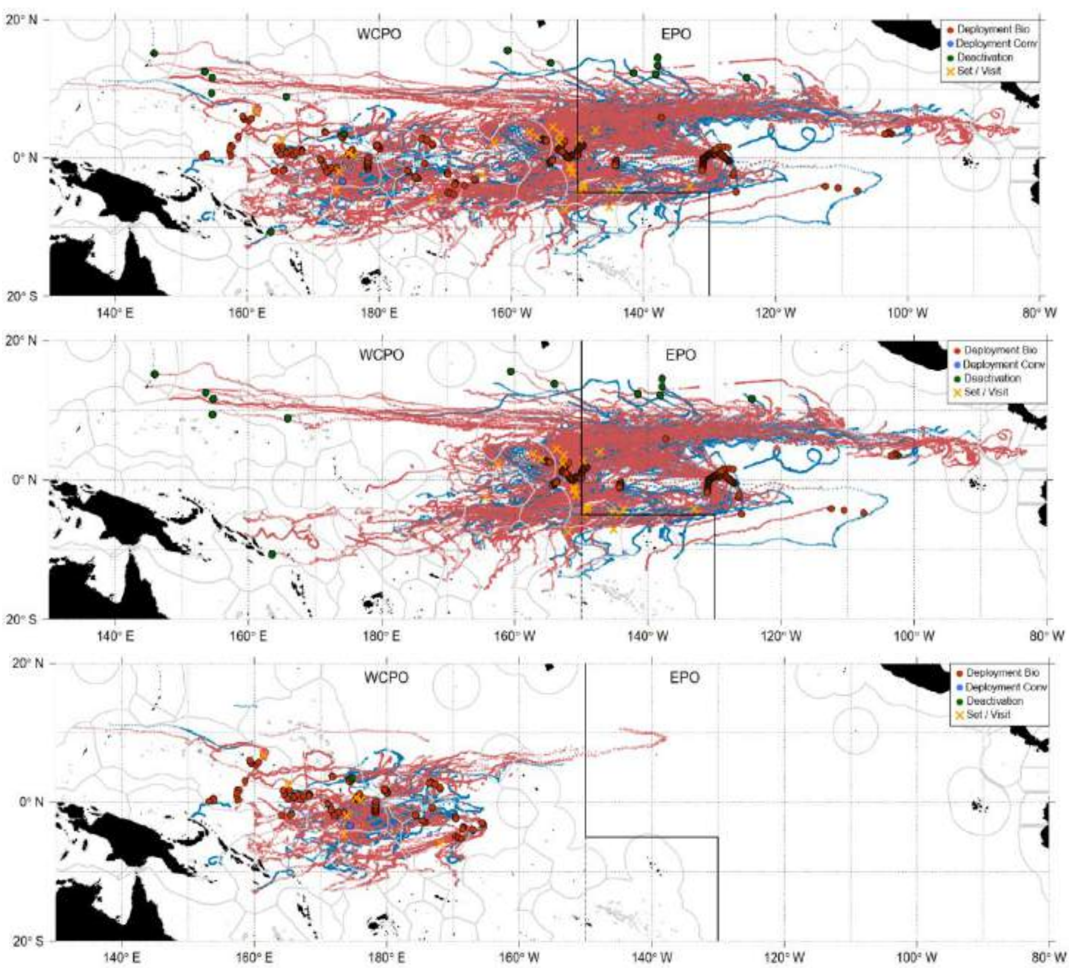

Figure 4. Trajectories, deployments, deactivation, fishing sets and visits of biodegradable (red) and conventional (blue) FADs of the trial. Top: all FADs; middle: US fleet only; bottom: other fleets.

4.3 Preliminary performance results

a. Duration at-sea

The duration at sea is tracked through two primary methods: direct observation by fishers during visits and sets made on the experimental dFADs (both jelly-FADs and their conventional pairs), and indirect monitoring via data provided by the buoy tracking dFADs.

The visits made by fishers involve filling out forms detailing the state of the dFAD, any catches, and other relevant information. This method offers direct insights into the condition and activity of the dFAD while at sea.

On the other hand, the buoy tracking system provides data on biomass and other parameters indirectly related to the duration of the dFAD's deployment. Although the FAD itself is not monitored in real-time, the echosounder data from the buoy serves as an indicator of fish aggregation around the dFAD, thus providing valuable information about its effectiveness. In addition, fishers typically continue to monitor dFADs that are deemed active and productive, while deactivating those that are no longer deemed useful for fishing operations. Thus, active dFADs, or transmissions from the buoy are an indicator of the lifespan.

Table 3. Summary of deployments and data available on FAD monitoring period on the jelly-FADs and conventional FADs by fleet.

	Other fleets		US fleet	
	Jelly-FADs	Conventional	Jelly-FADs	Conventional
Deployments	95	56	191	167
Data available	74	42	129	112
Transmissions (positions or biomass)				
Min	7	5	2	25
Mean	314	274	352	460
Max	1145	1057	2019	2740
Duration (days)				
Min	0	1	1	12
Mean	123	82	160	163
Max	284*	248	457	321

*Note that this corresponds to the maximum duration of data available at time of analyses (from 02/03/2023 to 12/12/2023). Additional data will allow for better identification of duration at sea.

The average number of buoy transmissions before a buoy is no longer monitored varies across fleets, ranging from 274 for conventional dFADs for other fleets in the western Pacific Ocean to a maximum of 460 for the US fleet operating in the western and eastern Pacific Ocean. Notably, dFADs from the US fleets were monitored for a longer duration due to earlier deployments (first deployments in September 2022), compared to the other fleets (first deployments in March 2023). Additional analyses of whole trajectories data, when received in the near future, will allow for further investigation in differences in terms of number of buoy transmissions and monitoring duration between areas or fleets. For instance, dFADs from the eastern Pacific Ocean, where dFADs have a more extended trajectory without encountering islands, may be monitored for a longer period before being deactivated by fishers. Conversely, in the western Pacific, where dFADs may encounter numerous islands along their trajectory, fishers may deactivate them sooner.

Interestingly, the monitoring duration for jelly-FADs compared to their conventional counterparts in the eastern Pacific Ocean is quite similar, with averages of 160 and 163 days, respectively. However, in the western Pacific Ocean, the monitoring duration for jelly-FADs was slightly longer than that for conventional dFADs. Figure 5 illustrates that jelly-FADs are monitored for more extended periods compared to conventional FADs across the entire Pacific Ocean. Additionally, the graph depicts how only 50% of both jelly and conventional FADs are monitored after 180 days at sea. The percentage of conventional FADs' monitored, drops below 25% before reaching 200 days at sea, while bio-FADs continue to be monitored for a longer duration.

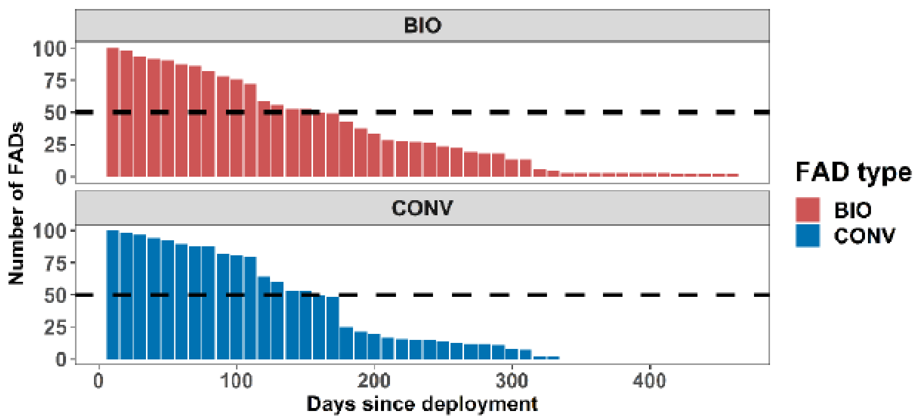

Figure 5. Days drifting (based on satellite and echosounder buoys) of jelly- FADs (top) and conventional FADs of the trial (bottom).

b. Comparison of drift speed

From the fishers' point of view, one of the requirements for a productive dFAD is the slow drift (Moreno et al., 2023). This characteristic helps the dFAD remain in the fishing ground and prevents it from being lost or abandoned due to drifting quickly out of the fishing zone. Therefore, we compared the drift speed of conventional dFADs with that of jelly-FADs, to see if there was any significant change on this feature by the two types of dFADs.

A preliminary analysis was conducted to compare only those conventional dFADs and jelly-FADs that drifted together within the same water masses, presumably experiencing similar physical (oceanographic and meteorological) and biotic (e.g., prey and tuna presence) conditions. It wouldn't make sense to compare dFADs that drifted in different water masses, as differing local conditions would cause them to perform differently.

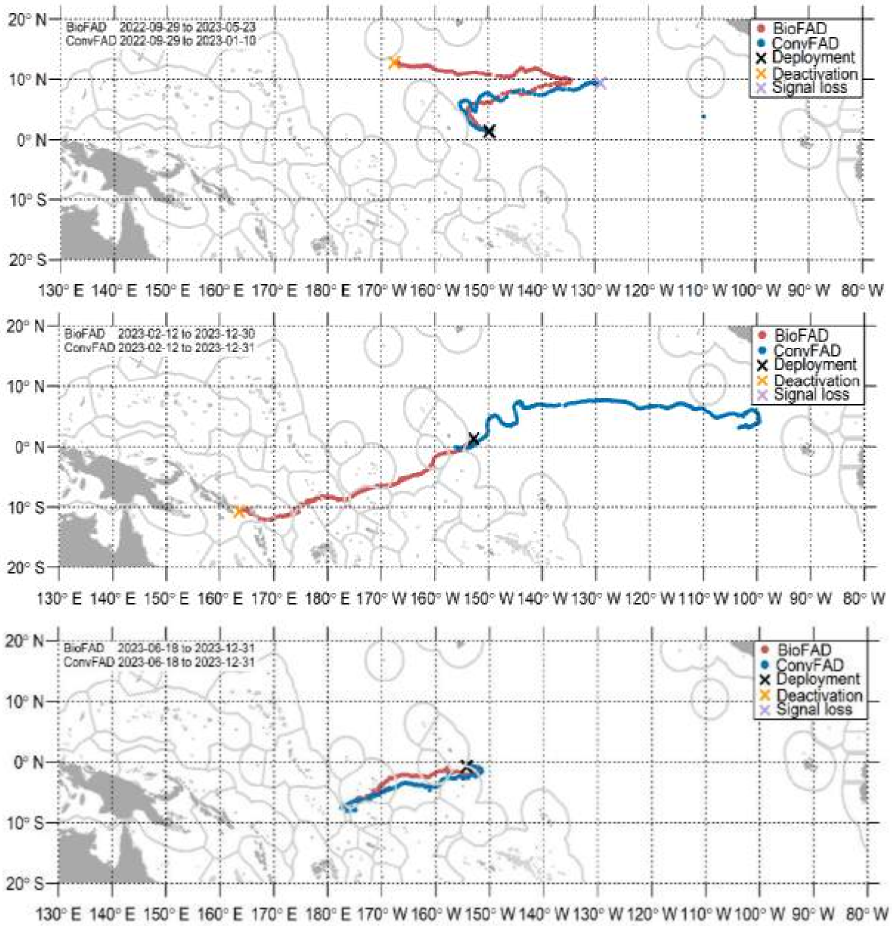

Figure 6. Examples of trajectories of pairs of jelly-FAD and conventional FADs of the trial.

Figure 6 shows the different drift patterns for the various dFADs deployed in pairs. Only those that drifted in the same water mass will be compared.

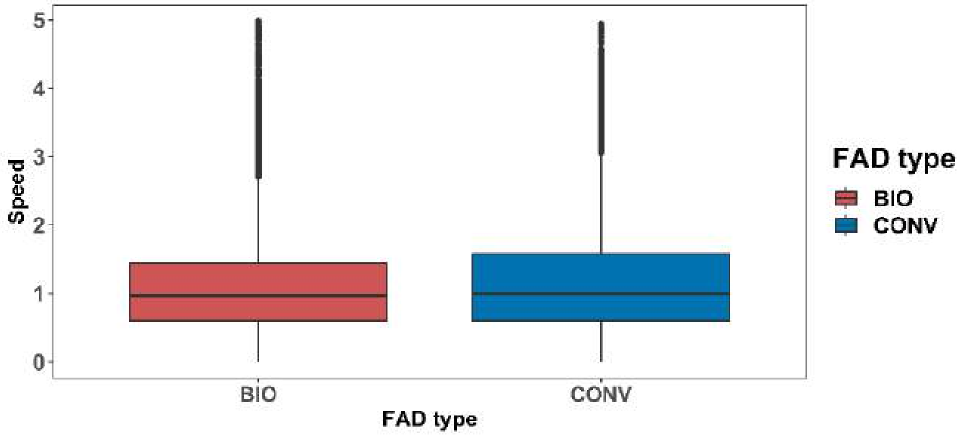

Figure 7. Drift speed at-sea of Jelly-FAD and conventional FADs of the trial for pairs that drifted together under same oceanographic and weather conditions.

Table 4. Summary of speed values (knots) of the jelly-FADs and conventional FADs by fleet.

	Other fleets		US fleet	
	Jelly-FADs	Conventional	Jelly-FADs	Conventional
Min	0.0	0.0	0.0	0.0
Mean	0.9	0.9	1.1	1.2
Max	4.9	4.9	4.9	4.9

From these observations (Figure 7 and Table 4), we can infere that there is no significant difference in the drift speed of the two types of dFADs, i.e., the jelly-FAD and the conventional FAD.

c. Catch

A total of 20 sets were performed on the jelly-FADs, with total catch ranging from 0 to 185 tons (t), and an average of 53.6 t (Table 5). More sets were made on the paired conventional FADs, with 50 sets recorded, and catch ranging from 5 to 260 t and an average of 71.3 t. This is higher than the average catch made on dFADs in the WCPO in 2023 of 46.3 t (0–481 t). Overall the catch made on the jelly-FADs from the trial is higher than the WCPO average but lower than the catch on the paired conventional FADs, however, the very limited number of sets limits the robustness of the conclusion that could be drawn. One potential source of bias in FAD visit patterns is that fishers tend to trust conventional FADs more than experimental ones, leading them to prioritize, monitor, and visit conventional FADs more frequently than bio-FADs

Table 5. Summary information on catches from sets made on the jelly-FADs and conventional FADs from the project and average catch per set for the whole fleet in the WCPO in 2023.

FAD type	Number of sets	Total tuna catches (mt)			
		Min	Mean	Median	Max
Jelly-FAD	20	0	53.6	35.0	185
Conventional	50	5	71.3	52.5	260
2023 WCPO dFADs	11,005	0	46.3	30.0	481

Tables 5 and 6 indicate that the performance of the jelly-FAD, in terms of metric tons per set, is close to the median and mean for the entire fleet in 2023. There is no scientific evidence suggesting that a particular FAD design is more or less capable of aggregating fish (Moreno et al., 2023). Both, fishers and scientists agree that tuna presence in the area and oceanographic conditions are likely the major factors influencing tuna aggregation around a given FAD.

Table 6. Summary information on catches from sets made on the jelly-FADs and conventional FADs from the US fleet only and average catch in 2023 for the US fleet in the WCPO.

FAD type	Number of sets	Total tuna catches (mt)			
		Min	Mean	Median	Max
Jelly-FAD	15	5	68.3	43.0	185
Conventional	50	5	71.3	52.5	260
2023 WCPO US FADs	801	0	49.5	35.0	335

In Figure 8 it is noteworthy that both, jelly-FADs and conventional dFADs can be fished at any time within the first 6 months. This is highly dependent on the strategy of the fleet, in terms of proximity to a given dFAD and also on time needed to the dFAD to aggregate fish, which will probably depend on the presence of tuna in the water masses it crosses. Although the data is insufficient to draw significant conclusions, an interesting observation is that neither type of dFADs was fished after six months.

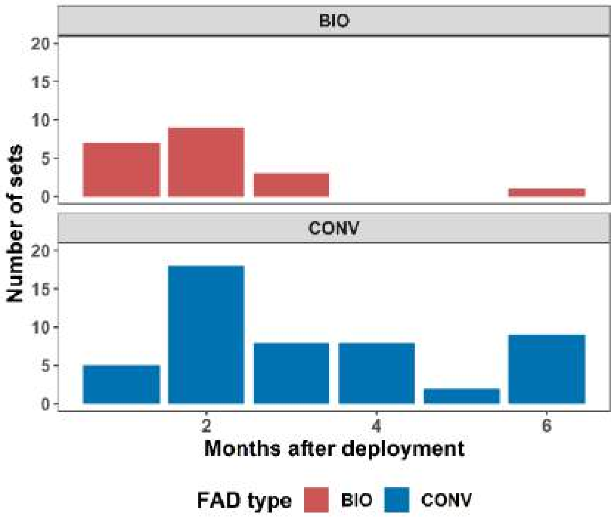

Figure 8. Soaking time for the bio-FAD and conventional FADs fished.

d. Bio-FAD state

For the few in situ observations, Figure 9 shows that the main rope used to sustain the bio-FAD structure, made of recycled cotton, is after 6 months at sea in good condition. The submerged raft and the attractors needed repair after 6 months at sea. For the cube, the single observation after six months showed that the cube was destroyed. More data is needed to draw significant conclusions and account for the diverse casuistic that FADs suffer along their lifetime.

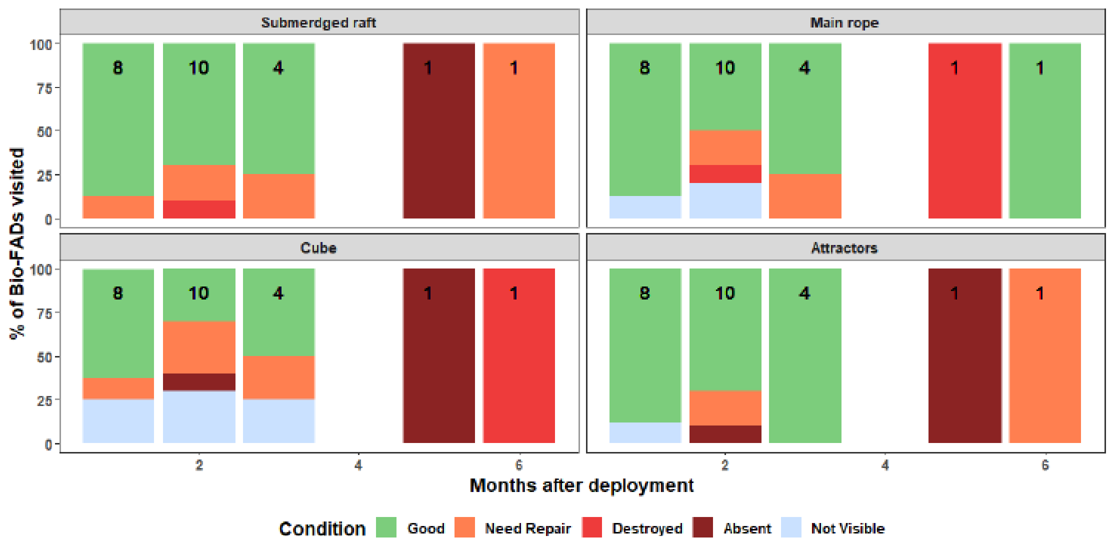

Figure 9. State of the different components of the 12 jelly-FADs with time at sea

5. Conclusion

Main conclusions until now from the monitoring of the jelly-FADs tested by fleets in the Pacific Ocean are the following:

- It is important to deploy a large number of bio-FADs to get meaningful results, or better deploy systematically a given number of FADs made of biodegradable materials.
- The drift speed of the two types of dFADs, conventional and jelly-FAD is similar
- Jelly-FADs were monitored longer than the conventional dFADs, being an indicator of the usefulness of the FADs at sea.
- Conventional FADs showed a higher catch per set compared to jelly-FADs however the median catch per set on the jelly-FADs for this trial were similar to that of the whole fleet in 2023.
- Bio-FAD condition for the monitored period and limited data shows that the FAD is alive and useful at least, until month 6, there were no observations after that time, both, for conventional and jelly-FADs.

6. Recommendations

It is essential to carry out dedicated outreach and dissemination efforts targeting fleets, particularly those that have not yet begun testing bio-FADs. These initiatives should aim to inform fishers and shipowners about ongoing work related to biodegradable FADs, clarify the requirements established by the tRFMOs, and facilitate knowledge transfer from past trials, including both challenges and successes. In addition, such workshops play a critical role in raising awareness among fleets about the environmental and operational implications of transitioning to bio-FADs.

Given the low proportion of deployed FADs that are actually visited, we recommend that fleets begin the systematic deployment of experimental bio-FADs as soon as possible (for instance, deploying 20% of total FADs made of biodegradable materials). This approach will help advance the transition to bio-FADs and support compliance with the requirements of IATTC CM-23-04.

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