SCIENTIFIC COMMITTEE

TWENTIETH REGULAR SESSION

Manila, Philippines

14 – 21 August 2024

Update and Workplan on FAD Research

WCPFC-SC20-2024/EB-IP-02

1st July 2024

Lauriane Escalle[1], Jennyfer Mourot[1] and Paul Hamer[1]

[1] Oceanic Fisheries Programme of the Pacific Community

Executive Summary

Drifting Fish Aggregating Devices (dFADs) are used in large numbers in the Western and Central Pacific Ocean (WCPO), and their potential impacts are of growing concern to managers, industry, NGOs and other stakeholders. Considering these concerns, while acknowledging the importance of dFADs to the tropical tuna fishery, the WCPFC are working towards improving the reporting, management and environmental sustainability of dFAD use in the Western and Central Pacific Ocean. This paper summarises the progress of the different dFAD-oriented research projects led by SPC and a workplan for future activities in order to support monitoring of current CMMs and the development of potential future CMMs to reduce the environmental impacts of dFAD use. This summary is provided in view of WCPFC priorities highlighted in the FAD Management Options IWG 2024–2026 work plan that includes: Satellite Buoy Data Transmission Requirements; FAD Recovery Programs/Strategies; FAD logbook; Biodegradable FADs; dFAD Deployment.

The dFAD related research led by SPC includes:

- analyses of satellite buoy data: trajectory and echosounder data
- scoping of feasibility of dFAD recovery programs and assessing the impact of FAD loss and abandonment, including:
    - regional stranded FAD data collection programme and support for recovery of stranded FADs;
    - re-using satellite and echosounder buoys to support local projects;
    - identification of hotspot of dFAD stranding events, loss and abandonment;
    - analysis of feasibility and cost-effectiveness of dFAD recovery options in the WCPO;
    - a legal study on the international and regional frameworks around dFADs;
    - monitoring of dFADs drifting outside the fishing grounds
- analyses of FAD data collected using FAD logbook and comparisons with observer data
- non-entangling and biodegradable dFADs, including:
    - trials of non-entangling and biodegradable dFADs, including industry partnership and training in biodegradable and non-entangling dFAD design aspects and construction;
    - monitoring dFAD designs and materials used in dFAD's construction;
    - assessment of impacts of dFADs on Species of Special Interest and marine ecosystems
- assessments of dFAD use per vessel, including deployments and active numbers of dFADs

We invite WCPFC-SC20 to:

- Note the current broad range of dFAD research implemented or planned by SPC, that has direct value and linkage to the FAD Management Options Intersessional Working Group (IWG) work plan for 2024–2026 and the Scientific Committee.
- Provide feedback on the current and future focus of dFAD research and on priorities for the Scientific Committee and WCPFC.
- Acknowledge the funding contributions to this research from certain WCPFC members and external organisations (i.e., EU, US, ISSF), and the industry involvement as formal partners in some of this work.

1. Introduction

Drifting Fish Aggregating Devices (dFADs) are an essential part of the purse seine fishery in the Western and Central Pacific Ocean (WCPO) and worldwide (Pons et al., 2023; Williams and Ruaia, 2023). In the WCPO, it has been estimated that 30,000 to 40,000 buoys attached to dFADs are deployed annually (Escalle et al., 2021b). In view of the impacts of this extensive use of dFADs (Pons et al., 2023), the Western and Central Pacific Fisheries Commission (WCPFC) has adopted several Conservation and Management Measures (CMM), mostly encapsulated in CMM-2023-01 ('*The Tropical Tuna Measure*'), including annual FAD closures, during which all dFAD-related activities (e.g., fishing, deployment, servicing) are prohibited; a limit of 350 dFADs per vessel monitored at any one time with activated instrumented buoys (activation on-board only); banning the use of netting in dFAD construction; promoting the use of biodegradable material in the construction of dFADs; and promoting dFAD recovery. In order to support monitoring of current CMMs and the development of potential future CMMs to reduce the environmental impacts of dFAD use, several research projects linked to dFADs are currently ongoing or have been developed and lead by the Pacific Community (SPC), the WCPFC Scientific Services Provider (SSP).

The outline of the WCPO dFAD research presented in this paper has been developed to reflect the FAD Management Options Intersessional Working Group (IWG) work plan for 2024–2026 and provides feedback to the WCPFC Scientific Committee (SC) on the research led by the WCPFC-SSP on priority topics identified by SC19 and WCPFC20.

The tasks of the FAD Management Options IWG for 2024–2026 include:

- Satellite Buoy Data Transmission Requirements
- FAD Recovery Programs/Strategies
- FAD logbook
- Biodegradable FADs
- DFAD Deployment

The current document provides a summary on the progress of the different research projects led by SPC and a workplan for future activities, in view of WCPFC priorities highlighted in the FAD Management Options IWG work plan.

2. dFAD research in the WCPO

2.1 Analyses of satellite buoy data

- **Trajectory data**

Analyses of dFAD trajectory data have been performed and presented to WCPFC-SC on a regular basis since 2017 (e.g., Escalle et al., 2017, 2023) using the PNA FAD tracking data (data from 2016 until now). This has allowed investigation of dFAD deployment patterns, dFAD density and inter-FAD distances, dFAD stranding events, dFAD loss and abandonment, use of echosounder, and estimates of active dFADs and dFAD deployments per vessels.

Recently, dFAD trajectory data are also submitted directly to WCPFC-SSP, following the adoption by the International Seafood Sustainability Foundation (ISSF) Proactive Vessel Register Conservation Measures. This measure states that proactive vessels should report dFAD position data to the relevant

Regional Fisheries Management Organization (RFMO) science bodies with a maximum time lag of 90 days, from 1 January 2023 (Management measure 3.7 Transactions with Vessels or Companies with Vessel-Based FAD Management Policies). Data have been received since January 2023 and analyses of a small subset of the data has been performed (Escalle et al., 2023a). Similar investigations to those using the PNA FAD tracking data can be performed but now with a larger dataset.

- **Echosounder data**

SPC has also started receiving echosounder data on a voluntary basis, following the ISSF Proactive Vessel Register Management measure 3.7. Since January 2024, in addition to position data, echosounder data should also be submitted to SPC with a maximum time lag of 90 days.

A preliminary study analysed a subset of echosounder data, comprising over 4.7 million acoustic transmissions from buoys (Satlink, Zunibal and Kato) deployed on dFADs in the WCPO in 2016–2018 (Escalle et al., 2021b) and indicated that acoustic biomass estimates from regional dFADs could assist in the development of an independent biomass index for skipjack tuna in the WCPO. A tuna biomass index has been derived from echosounder buoys in the Eastern Pacific Ocean, and used in the IATTC benchmark stock assessments of skipjack tuna and explored for bigeye and yellowfin tuna assessments in 2024 (Uranga et al., 2024). Long-term, including historical data, availability of echosounder data from buoys attached to dFADs in the WCPO could also potentially be used as independent biomass indices in stock assessments. We suggest this could be discussed in relation to the 'Tuna Assessment Research Plan' which notes the need for focused project work to improve tropical tuna abundance indices for stock assessment.

Table 1. Research topics and projects based on analyses of satellite buoy data.

Topic	Objective	Latest report	Next submission of results to SC
Analyses of trajectory data	Identification of: - deployment patterns, - dFAD density, - inter-FAD distances, - stranding events, - dFAD loss and abandonment - use of echosounder, - estimates of active dFADs and dFAD deployments per vessels and at the scale of the WCPO.	SC 19 (Escalle et al., 2023a)	SC 21
Analyses of echosounder data	- independent tuna biomass indices that could be included in stock assessments	SC 17 (Escalle et al., 2021b)	Consider as part of a tuna abundance indices project under the Tuna Assessment Research Plan

2.2 FAD recovery programs and impact of FAD loss and abandonment

- **Regional stranded FAD data collection programme and support for recovery of stranded FADs**

Stranded FAD data collection programmes are in place in Pacific Island Countries and Territories (PICTs) to collect data on lost or abandoned FADs (industrial drifting and anchored FADs) reaching

coastal waters and/or becoming stranded, as well as the potential impacts of these events on coastal environments (Mourot et al., 2023). Data are then collated into a regional database at SPC. A total of 3,148 stranding events have been reported in the regional database across 18 PICTs between 2006—2023 (Table 2 and Figure 1), with dedicated programs now in place in 11 PICTs (Australia; Cook Islands; Federated States of Micronesia; Galapagos; Hawai'i; Marshall Islands; New Caledonia; French Polynesia; Palmyra; Tuvalu; and Wallis and Futuna). These numbers vary greatly between country programmes depending on the longevity of the program, the location of each country and the resources and effort available for stranded FAD monitoring.

Table 2. Summary of data collected through stranded FAD data collection programs in the Pacific Ocean and number of events recorded since the beginning of each programme.

PICT	Start of the program	Events recorded
French Polynesia	2019	1,492
Australia	2004	332
Cook Islands	2020	310
Wallis and Futuna	2020	193
Federated States Micronesia	2021	183
Kingdom of Tonga	2023	150
Republic of the Marshall Islands	2021	103
Hawai'i	2014	96
New Caledonia	2022	90
Palmyra Atoll	2009	86
Tuvalu	2022	59
Vanuatu	Opportunistically	20
North Pacific Ocean	2023	9
Wake Atoll (US)	Opportunistically	8
Pitcairn Islands	Opportunistically	7
American Samoa	Opportunistically	5
Fiji	Opportunistically	1
Alaska	Opportunistically	1
Northern Marian Islands	Opportunistically	1
PNG	Opportunistically/under discussion	1
Samoa	Opportunistically/under discussion	1
Solomon Islands	Under discussion	0
Total		3148

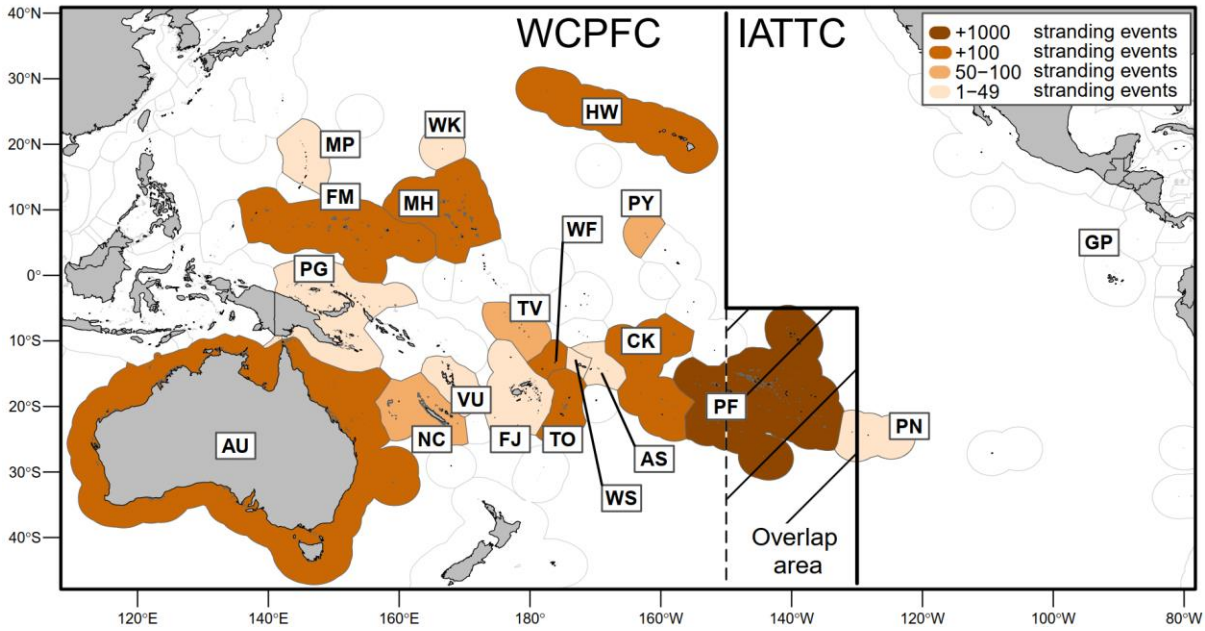

Figure 1. Map of Pacific Island Countries and territories involved in the regional stranded FAD data collection programme, with number of data collected since the start of the programme.

- **<u>Re-using satellite and echosounder buoys to support local projects</u>**

SPC and some member countries have joined initiatives to reduce the material pollution related by the stranding events of FADs and buoys. Since July 2023, SPC is part of the Satlink project ReCon, a global circular economy initiative that works with a network of partners and a large part of the fishing industry with the aim of reusing shore-stranded buoys found by local PICT communities. The objective is to mitigate the potential environmental impact and marine pollution caused by buoys that are stranded on shores, far away from the fishing grounds where they were originally deployed. Noting that some PICTs that receive stranded FADs on their shorelines may receive limited benefit from the purse seine tuna fishery. Buoys found that are in good condition have strong potential to be reused in local projects and benefit Pacific communities. The buoy can be re-used for its GPS function to track marine debris or the position of an anchored community FAD; its flashing light can mark a channel or a fishing spot; and its echosounder can be used to estimate the quantity of fish aggregated under a community anchored FAD. So far, three buoys have been re-used in New Caledonia and have been deployed on artisanal anchored FADs. Additional buoys are currently being tested in New Caledonia, Federated Stated of Micronesia and the Cook Islands.

A similar initiative is currently being developed between SPC and another buoy company, Marine Instruments, through their Blue Recovery project.

- **<u>Hotspots of dFAD stranding events, loss and abandonment</u>**

Patterns of dFAD loss, abandonment and dFAD stranding events are regularly compiled and studied using available dFAD tracking data (e.g., Escalle et al., 2023). With the recent availability of additional and more complete dFAD tracking data, such patterns and quantification of dFAD loss, abandonment and stranding events will be re-assessed by a more thorough identification of hotspots of dFAD loss, abandonment and stranding events (see Figure 2). This will be compared to data available from in-situ stranded FAD data collection. Results will be presented at SC 21 or SC 22.

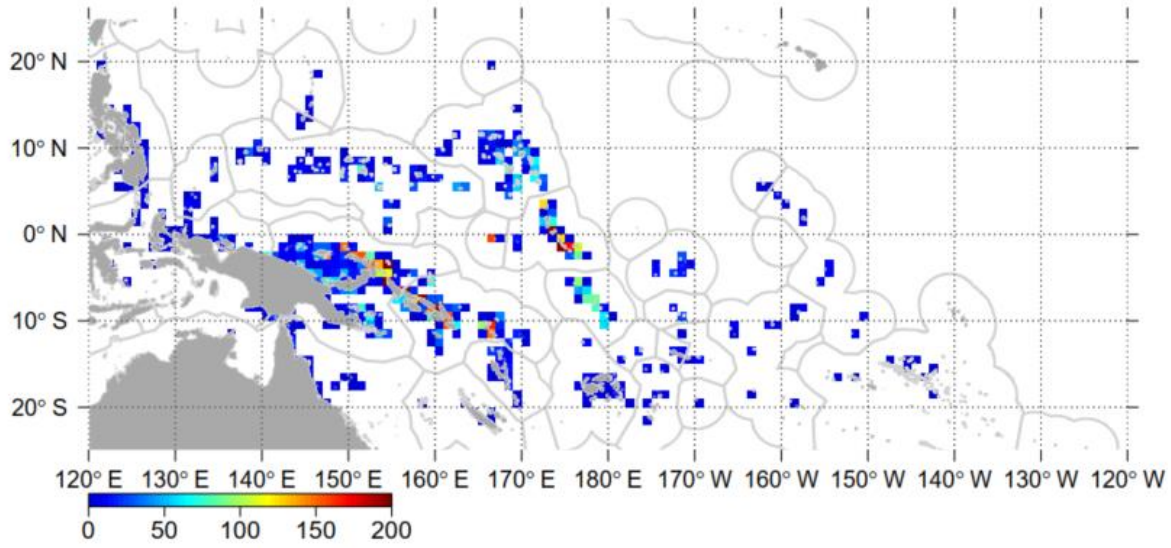

Figure 2. Density maps of stranded FADs identified using the PNA FAD tracking data for the 2016–2023 period.

Simulations can also be used to investigate patterns of dFAD use, loss and stranding events (Escalle et al., 2019, 2024; Scutt Phillips et al., 2019). Recently, we have undertaken a Lagrangian passive drift simulation experiment to examine corridors of loss of operational dFADs throughout the whole equatorial fishing zones, between 10°N and 10°S (Figure 3). Such an approach has also been used to investigate potential reduction in dFADs lost from the fishing ground under different dFAD lifetime scenarios, reflecting the industry's transition to biodegradable dFADs.

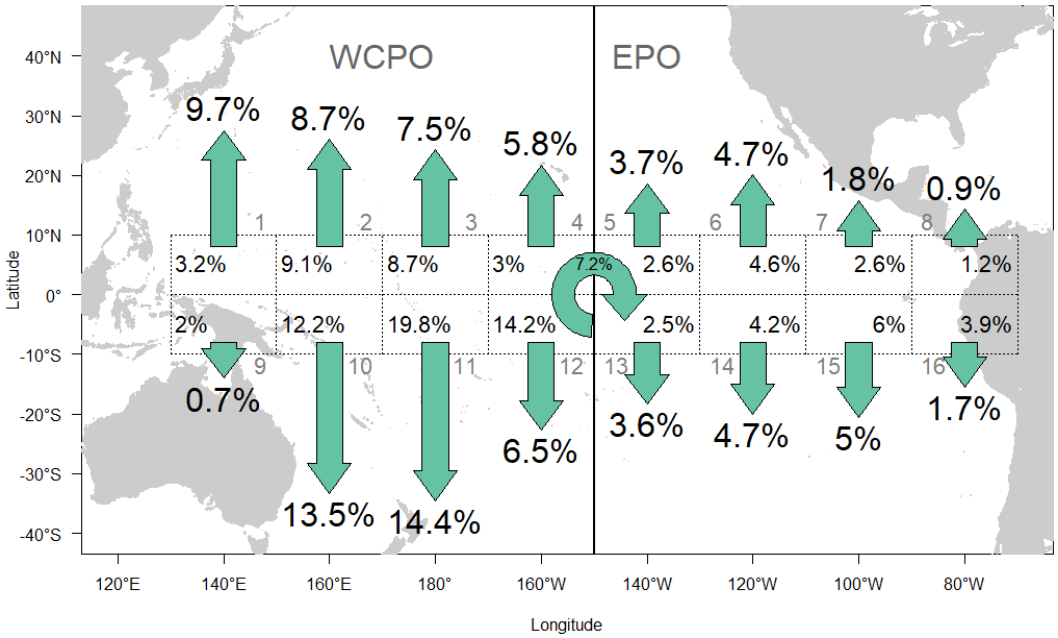

Figure 3. Proportion of all FADs with a maximum physical lifetime of 2 years deployed anywhere in the Pacific Ocean that exit equatorial fishing zone (numbered boxes) via corridors of loss (arrows), and the proportion still present in the equatorial area (circles in the middle of the figure) at the end of their 2-years physical lifetime. Percentage of all Pacific FADs initially deployed in each fishing zone are given inside the equatorial boxes.

- **<u>Analysis of feasibility and cost-effectiveness of dFAD recovery options in the WCPO</u>**

SPC is starting a new project that will seek to assess the feasibility and cost-effectiveness of a range of different dFAD recovery options to reduce the environmental and economic damage associated with

lost, stranded and abandoned dFADs. The assessment will include several steps, starting with gathering location specific information regarding feasibility, cost, logistics of different recovery options, as well as assessing industry willingness to partake in the different recovery scenarios. This will rely heavily on different national and regional stakeholders consultations and support.
Recovery options considered could include:

1- Modify purse seiners deployment areas, to avoid areas leading to high loss rates
2- Increase recoveries by purse seiners by promoting inter-company collaboration
3- Dedicated chartered vessel(s) at identified high dFAD loss areas at the edge of the purse seine fishing grounds
4- Longliners or other vessels retrieving dFADs offshore in Economic Exclusive Zones (EEZs) outside the purse seine fishing grounds
5- Local network of partners to recover dFADs close to shore ("*dFAD watch"* type initiative)

Recovery by purse seiners themselves should remain the main mitigation option, as the dFADs owner have the responsibility to recover their own dFADs. Other recovery option should remain secondary when all the effort has been exhausted by the purse seiner to recover their own dFADs or avoid loss and abandonment.

Preliminary results from the study should be available to SC 21.

- **<u>Legal study</u>**

A legal study on the international and regional framework of dFADs, in particular the loss and stranding events is also planned. The objective will be to review the provisions of applicable international law, as well as those of national legislation of certain coastal states worldwide, in order to provide PICTs' decision-makers with reliable and up-to-date information on the topic. The study will include a comparative analysis of legislation from PICTs and from other countries around the world that are relevant to regulation of dFADs (highlighting obligations and associated penalties), including any reference to dFADs drifting in EEZs with or without fishing licences, dFAD recoveries by coastal states, handling of stranding events and environmental damages.

- **<u>Monitoring of dFADs drifting outside the fishing grounds</u>**

SPC is also planning to assess dFADs drifting outside the fishing grounds and normally deactivated by fishing companies. Since January 2024, the PNA fourth Implementing Arrangement prohibits deactivation of dFADs buoys in the WCPFC Convention Area between 20°N and 20°S (except if a FAD buoy has drifted onto a reef or beach and is stationary and may be deactivated after one month). Monitoring of loss and abandonment dFADs will therefore be done outside of this area, for which detailed position data are already available since 2024.

Table 3. Research topics and projects linked to dFAD recovery programs and impact of FAD loss and abandonment.

Topic	Objective	Latest report	Next submission of results to SC
Regional stranded dFAD data collection programme	- quantify the number of dFAD stranding events or dFADs drifting nearshore; - assess marine pollution and environmental impacts	SC 19 (Mourot et al., 2023)	To be determined (TBD)

	- evaluate materials and designs of dFADs found stranded; as well as how communities may repurpose or recycle dFADs and satellite buoys - consider ways to mitigate the impacts of dFADs		
Re-using buoys to support artisanal fishers	- support artisanal fishers - develop a circular economy that reduces waste from industrial fishers		TBD
Hotspots of dFAD stranding events, loss and abandonment	- identify hotspots of dFAD loss, abandonment and stranding events - provide scientific advice to guide the sustainable management of tuna fishery	SC19 (Escalle et al., 2023a)	SC 21 or SC 22
Economic analyses of dFAD recovery options	- assess and compare the feasibility and cost-effectiveness of dFAD recovery options to reduce the environmental and economic damage associated with lost and abandoned dFADs		SC 21
Legal framework	- review the provisions of international law and national legislation of coastal states, associated dFAD drifting in EEZ and/or with the stranding on their coasts		TBD
Monitoring of dFAD drifting outside the fishing grounds	- assess drift, connectivity and potential stranded events of dFAD normally deactivated by fishers outside the fishing grounds		TBD

2.3 FAD logbook

- **<u>Analyses of FAD data collected using FAD logbook and comparison with observer data</u>**

Analyses of dFAD data collected using the FAD logbook newly developed by the PNA and proposed to the WCPFC (PNA and Tokelau, 2024; Pons et al., 2023) will be performed to review materials and designs of FAD use, activities performed on FAD and identification of FADs encountered. A comparison will be made with data collected by observers.

Table 4. Analyses of FAD data collected using FAD logbook and comparison with observer data.

Topic	Objective	Latest report	Next submission of results to SC
Analyses of FAD data collected using FAD logbook and comparison with observer data	- review materials and designs of FADs used in WCPO - assess FAD use and ability to monitor FADs using unique ID numbers		SC 21 or SC 22

	- compare quantity and quality of data collected using FAD logbook to observer data		

2.4 Non-Entangling and Biodegradable FADs

- **Non-Entangling and biodegradable FADs**

SPC is leading WCPFC Project 110, and its follow up project (WCPFC-P19X4 bioFADs), to conduct trials of non-entangling and biodegradable dFADs in the WCPO and is also collaborating closely with the International Seafood Sustainability Foundation (ISSF) on this topic on project 110 and their US NOAA Bycatch Reduction Engineering Program (BREP) project. The objectives of the projects are 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. As part of project 110 and the follow project, industry partners are receiving staff training in biodegradable dFAD design considerations and construction, and materials supply options are necessarily being explored. More details and results of both projects can be found in WCPFC-SC20-EB-WP-03 (Escalle et al., 2024a).

- **Monitoring dFAD designs and materials used in dFAD's construction**

A review of dFAD designs and materials since the adoption of the non-entangling dFAD requirement in January 2024 (CMM 2023-01) will be performed using observer data and the newly developed PNA FAD logbook. Similarly, the use of biodegradable materials, currently encouraged (CMM 2023-01), will also be reviewed. Results will be presented to SC 21 or SC 22.

- **Impacts on SSI and marine ecosystems**

Ongoing work is being conducted by SPC, and other partners, to identify impacts of dFADs on Species of Special Interest (SSI) and on marine ecosystems. A recent project, led by ISSF, reviewed the impact of purse seine fishing, and in particular the use of dFADs, on sea turtles in the Pacific Ocean and provided guidelines to reduce the ecological impacts due to dFAD use, including from lost and abandoned drifting dFADs on sea turtles in the whole Pacific Ocean (Escalle et al., 2024b; Moreno et al., 2023). In addition, dFADs impacts on marine ecosystems, in particular coastal ecosystems, are investigated, but data are often lacking.

Table 5. Research topics and projects linked to non-entangling and biodegradable dFADs.

Topic	Objective	Latest report	Next submission of results to SC
Non-Entangling and biodegradable FADs	- provide essential information to WCPFC and the industry on the designs, types of materials, performance, implementation challenges and cost-effectiveness of non-entangling and biodegradable dFADs - support industry training and uptake of more ecological dFAD designs	Escalle et al. (2023b) Escalle et al., (2024a)	SC 21

Monitoring dFAD designs and materials used in dFAD's construction	- review materials and designs of FADs used in WCPO - compare quantity and quality of data collected using FAD logbook to observer data	Escalle et al. (2023c, 2023d)	SC 21 or SC 22
Impacts on SSI and marine ecosystems	- assess impacts of dFADs, including new non-entangling and biodegradable dFADs on SSI and marine ecosystems	Escalle et al. (2024); Moreno et al. (2023)	

2.5 dFAD deployments

- **Assessment of dFAD use per vessel, including deployment and active number of dFADs**

Monitoring the number of dFADs deployed annually, and their spatio-temporal prevalence is important for assessing their influence on the tuna fisheries and other environmental and ecological risks. Estimates of the number of deployments and active dFADs per vessel and at the scale of the WCPO has been performed previously (Escalle et al., 2021a). These estimates need to be re-evaluated to assess potential changes in dFAD use and provide advice to WCPFC on the effectiveness of the limit on the number of active dFADs that can be monitored at any given time, as set out in paragraph 21 of the CMM 2023-01.

Table 6. Research topics and projects linked to dFAD use per vessel, including deployment and active number of dFADs .

Topic	Objective	Latest report	Next submission of results to SC
Assessment of dFAD use per vessel, including deployment and active number of dFADs	- assess potential changes in dFAD use - provide advice to WCPFC on the effectiveness of the limit on the number of active dFADs that can be monitored at any given time	Escalle et al. (2021a)	SC 21 or SC 22

5. Conclusion and recommendations

The current paper summarises current and planned dFAD related research led by SPC, including timelines of future SC papers. This summary was developed in view of the WCPFC priorities highlighted in the FAD Management Options IWG 2024–2026 work plan that includes: satellite buoy data transmission requirements; FAD recovery programs/ strategies; FAD logbook; biodegradable FADs; and dFAD deployment. Given the importance of dFADs to the WCPO purse seine fishery and the growing number of research topics, SPC is seeking feedback from SC 20 and WCPFC 21 on the ongoing research projects and future work plan presented in this paper, including any gaps or priority focus areas.

We invite WCPFC-SC20 to:

- Note the current broad range of dFAD research implemented or planned by SPC, that has direct value and linkage to the FAD Management Options Intersessional Working Group (IWG) work plan for 2024–2026 and the Scientific Committee.
- Provide feedback on the current and future focus of dFAD research and on priorities for the

Scientific Committee and WCPFC.

- Acknowledge the funding contributions to this research from certain WCPFC members and external organisations (i.e., EU, US, ISSF), and the industry involvement as formal partners in some of this work.

Acknowledgments

The authors would like to thank the members of the Parties to the Nauru Agreement for providing us access to PNA FAD tracking data, as well as the Pacific Islands Regional Fisheries Observer Programme and observers involved in the collection of observer data. The regional stranded FADs data collection programme has been supported by World Wildlife Fund (WWF); the New Zealand Aid Program, the Fond Pacifique, Trimarine, and the World Bank. The authors are grateful for the assistance provided by the fisheries department and their officers, organisations and staff in the field in each of the PICTs involved, as well as local communities, fishermen, and general public involved in data collection. Project ReCon is led by Satlink and Blue recoveries by Marine Instruments. Acoustic analyses were carried out under WCPFC Project 88 'Acoustic FAD analyses' with funds from the European Union and the WCPFC. The authors would like to thank Cape Fisheries, National Fisheries Developments (NFD) and South Pacific Tuna Corporation fishing companies for giving us access to their data. Joe Scutt Phillips led and run the Langrangian simulations experiment to assess dFAD loss outside the fishing grounds and has been involved in many projects highlighted in this document.

WCPFC project 110, non-entangling and biodegradable FAD trial, is funded by the European Union (EU), the United States and the International Seafood Sustainability Foundation (ISSF). 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. Gala Moreno from ISSF has been working in collaboration with SPC on these projects, and we thank her for her guidance, experience and expertise. 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, Silla and the Fishing Industry Association (FIA) of PNG), as well as their skippers and crew for all their effort and collaboration in the trial. We thank James Wichman and Donald David for their involvement and hard work in the non-entangling and biodegradable FAD trial and other FAD projects in the Federated States of Micronesia.

The project to assess the impacts of FADs on sea turtles in the Pacific is led by the International Seafood Sustainability Foundation (ISSF) and Gala Moreno as lead researcher, in collaboration with SPC, the Inter-American Tropical Tuna Commission (IATTC), the Hawai'i Pacific University (HPU) and NOAA; and with funding under award NA20NMF4540142 from NOAA Fisheries Pacific Islands Regional Office.

Finally, the authors would like to sincerely thank SPC admin staffs in Noumea, Nathalie Lemesle, Hélène Ixeko, Gaelle Godin, Paul Judd and the procurement team for their hard work and support in the procurement and administrative monitoring of the FAD-related projects.

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