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Analyses of the regional database of stranded drifting Fish Aggregating Devices (dFADs) in the Pacific Ocean: a 2024 update

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EXECUTIVE SUMMARY

Drifting Fish Aggregating Devices (dFADs) are reaching coastal areas where they can become stranded, adding to pollution and/or causing environmental damage. To quantify these events and their impacts, several Pacific Island Countries and Territories (PICTs), in collaboration with the Pacific Community (SPC), and often with support from international Non-Governmental Organisations (NGOs), have implemented voluntary programmes to collect in-situ data. These data collection programmes on stranded and lost dFADs are now fully implemented in sixteen PICTs: American Samoa, Australia, Cook Islands, Federated States of Micronesia, French Polynesia, Guam, Hawaiʻi, Republic of the Marshall Islands, New Caledonia, Palau, Palmyra, Solomon Islands, Tonga, Tuvalu, Samoa and Wallis and Futuna, with data collection spanning 2006–2025.

This document provides an update of SC19-EB-WP-04 (Mourot et al., 2023) presented at the nineteenth Scientific Committee of the Western and Central Pacific Fisheries Commission (WCPFC) in 2023.

A total of 3,591 stranding events could be identified to date; 43.8% of these consisted of a buoy alone, 30.7% of a FAD alone and 21.6% of a FAD with a buoy attached (3.9% were unknowns). FADs and buoys were most commonly found on a beach (37.2%), while others had been previously collected by local communities (32.3%), and some were found drifting in the ocean (6.7%), or caught on coral reefs (4.3%). In some cases, it was possible to record environmental damages caused by dFAD strandings; this was most common for dFADs with submerged appendages and corresponded to coral damage (3.1% of all dFADs but 7.3% of all appendages found) or, very rarely, entanglements with animals (0.7% of all recorded dFADs and 0.8% of appendages found).

The origins of the stranded dFADs and buoys were investigated using markings on the buoys and satellite buoy serial numbers. Markings were compared with the public access vessel registry of the IATTC and WCPFC; while buoy serial numbers were matched with records in the IATTC and WCPFC observer data and the Parties to the Nauru Agreement (PNA) FAD tracking data. Although, the stranding sites in the regional database are all located within the WCPFC area, stranded dFADs were coming from more vessels fishing in the IATTC Convention Area (CA) (47.0%) than those fishing in the WCPFC CA (34.1%), and 19.0% from vessels fishing in both CAs. Large variability in terms of country of origin for stranding events was observed. For example, most stranding events in French Polynesia originated from vessels fishing in the IATTC CA.

It should be noted that the data collection programme presented here provides an incomplete picture of the level and sources of dFAD strandings on Pacific Islands. It is highly dependent on the data collection effort and locations, and we suggest that additional countries and territories consider implementing similar data collection programmes and participating in this regional initiative. Greater coverage of the dFAD stranding data is important to better understand the extent and potential implications of this issue and to help inform dFAD management options in the Pacific Ocean. Consequently, similar efforts and discussions are underway in the Eastern Pacific Ocean to initiate voluntary regional data collection programmes on stranding dFADs to harmonize with the ongoing efforts in the Western and Central Pacific Ocean (WCPO).

We invite WCPFC-SC21 1 to:

- Note the levels of FAD stranding being reported and provided for the regional database;
- Recognise the need for increased support of in-situ stranded FAD data collection and reporting;
- Encourage additional PICTs to participate in this programme;
- Recognise the importance of FAD-buoy trajectory data, including historical data, from both the WCPFC and the IATTC CAs, to better inform development of management and mitigation options;
- Note the need to develop initiatives to reduce FAD loss and abandonment, including through potential offshore FAD retrieval programmes;
- Encourage the development of other initiatives (e.g. FAD watch) by the members, to increase recovery of dFADs reaching coastal areas;
- Promote and support initiatives to process and re-use or recycle FAD materials and buoys in ports and local communities.

1. Introduction

Concerns regarding the number of drifting Fish Aggregating Devices (dFADs) reaching coastal waters and becoming stranded on sensitive habitats have been raised by several Pacific Island Countries and Territories (PICTs), regional entities and international Non-Governmental Organisations (NGOs). These concerns include the potential for dFADs to damage habitats such as coral reefs, entanglement of wildlife such as turtles and sharks, and contribute to coastline debris when stranded (Balderson and Martin, 2015; Escalle et al., 2019).

Such concerns have intensified in recent years due to a general perception of an increasing trend in stranding events, including in PICTs with no purse-seine activities in their EEZs, and by a lack of retrieval plans and solutions to process/recycle the dFAD materials on remote islands. However, the number of studies investigating stranding events in the Pacific remains limited. This is largely due to the absence of data available to adequately quantify the number of dFADs arriving in coastal areas, stranding events, and impacts on ecosystems. Studies based on trajectories from satellite buoys deployed on dFADs operating in the Western and Central Pacific Ocean (WCPO) estimated that 11.3% of dFADs end up stranded (Escalle et al., 2023). However, the number of stranding events and level of ecosystem impacts are very likely under-estimated, given that the current dataset corresponds mostly to data from Parties of the Nauru Agreement (PNA) member EEZs, but also because satellite buoys are commonly deactivated by fishers when they drift outside their main fishing areas (Escalle et al., 2025). To date, estimates of stranding events are also lacking in the Eastern Pacific Ocean (EPO), although efforts to initiate regional data collection programmes are underway.

This document — an update of the report SC19-EB-WP-04 (Mourot et al., 2023)— presents initiatives that have expanded in the WCPO and led by PICTs in collaboration with the Pacific Community (SPC), local organisations, and/or NGOs, to collect data on lost dFADs reaching coastal waters and/or becoming stranded, as well as the impacts of these events on ecosystems. Data collection is carried out in each PICT and stored individually. These individual datasets are then compiled by SPC into a regional database with data from all PICTs, allowing for region scale scientific studies to be performed, as well as the ground-truthing of existing estimates from tracking studies. An expansion of such data collection effort to the EPO, which is currently underway, would facilitate Pacific-wide analyses and an improved understanding of the impact of dFADs on the ecosystem.

2. Regional stranded FAD data collection programme

Data collection programmes have been in place as early as 2004 (Australia), although several PICTs have either recently started or are developing programmes as a collaboration between SPC, national fisheries departments, local organisations and/or NGOs. These programmes collect data on recorded arrival events of dFADs in coastal areas and also address the need to collect in-situ data. Data collection programmes are in place in sixteen PICTs: American Samoa, Australia, Cook Islands, the Federated States of Micronesia, French Polynesia, Guam, Hawai'i, Kingdom of Tonga, New Caledonia, Palmyra, Republic of the Marshall Islands, Republic of Palau, Solomon Islands, Tuvalu, Samoa and Wallis and Futuna.

The main objectives of the programmes are to:

- quantify the number of dFAD stranding events or dFADs drifting nearshore;
- assess the resulting pollution and ecosystem impacts, including on species of special interest (SSIs) and key habitats;
- evaluate materials and designs of dFADs found stranded, in relation to past and current use of dFADs in the Pacific Ocean;
- evaluate how communities and PICTs may repurpose or recycle dFAD materials and satellite buoys locally, when possible;
- consider ways to mitigate the impacts of dFADs and provide scientific-based advice to guide the management of dFADs in the Pacific Ocean.

Table 1. Summary of data collected through stranded dFAD data collection programmes in the Pacific Ocean.

PICT	Start of the programme	Events recorded
French Polynesia	2019	1,539
Australia	2004	393
Cook Islands	2020	310
Wallis and Futuna	2020	268
Kingdom of Tonga	2023	201
Federated States of Micronesia	2021	187
Hawai'i (US)	2014	127
New Caledonia	2022	103
Republic of the Marshall Islands	2021	102
Solomon Islands	2024	93
Palmyra (US)	2009	86
Tuvalu	2022	61
Samoa	2024	28
American Samoa	2024	21
Pitcairn	Opportunistically	21
Vanuatu	Opportunistically	20
Guam	2024	8
Republic of Palau	2024	8
Wake Island (US)	Opportunistically	8
Papua New Guinea	Opportunistically	4
Fiji	Opportunistically	2
New Zealand	Opportunistically	2
Alaska (US)	Opportunistically	1
Northern Mariana Islands (US)	Opportunistically	1
Total		3,591

Since 2020, data collection programmes have been developed by SPC in partnership with local fisheries departments and have started in the American Samoa, Cook Islands, the Federated States of Micronesia, Guam, New Caledonia, Republic of the Marshall Islands, Solomon Islands, Kingdom of Tonga, Tuvalu, Republic of Palau, Samoa and Wallis and Futuna (Table 1). Opportunistic data collection has also been reported to SPC since 2018, including through SPC's existing data collection networks, and includes additional records from Alaska, Fiji; New Zealand, Northern Mariana Islands, Papua New Guinea, Pitcairn Islands, Vanuatu, and Wake Island. These programmes involve local communities reporting their findings to fisheries officers, who enter data on forms and in their country/territory database. Communication, dissemination, and awareness activities are essential because each programme depends on engagement by local communities. The types of awareness activities vary but can include posters, radio and TV broadcasts, and public talks (see appendix in Mourot et al., 2023). For the first few months of the programme in each PICT, reports included dFADs and buoys previously collected by the public. This information is important for creating a baseline inventory and for capturing and identifying new events. Data were also collected through dedicated visits to outer islands by SPC staff, national fisheries departments, and local staff (e.g., fisheries observers or fisheries officers). Island coastlines were then surveyed on a specific day, and data were collected for every dFAD found.

In parallel, other initiatives or opportunistic reports have emerged. This includes data collection at Palmyra Atoll since 2009 (through The Nature Conservancy; TNC); Hawaiʻi since 2014 (through the Center for Marine Debris Research); French Polynesia since 2019 (Marine Resources Authority); Australia since 2004 (Tangaroa Blue Foundation); and, very recently, Galapagos (Galapagos Conservation Trust as well as a private initiative conducted by the Tuna Conservation Group: TUNACONS (Table 1). A description of data collection of stranded dFADs in these independent initiatives are detailed in Appendix 1. Data were added to the regional database and analysed in this document, excluding data from Galapagos as none have been received by SPC.

Data fields collected by the PICTs include date, location, environment, materials, size and fate of the dFAD (e.g., removed, left where it was found, fished), the unique buoy identification alphanumeric code and any other painted marks on the buoy (often vessel names), as well as any observed environmental impacts (e.g., coral reef damage or entanglement of SSI). Data are recorded in standard data forms (Appendix 2), and details of each field in the form can be found in Mourot et al., (2023). Data are then transferred to SPC, where all of the data are compiled into the regional database.

3. Results from analyses of the regional database

a) Summary of stranded events

A total of 3,591 stranding events were identified during 2006–2025 from all PICTs considered. Most of the stranding events consisted of buoys (43.8%), followed by FADs alone (30.7%), and by a FAD with a buoy attached (21.6%) (Table 2). FADs were either dFADs, including biodegradable dFADs (bio-FAD); or anchored FADs (aFADs), such as large metal drums used by some purse seine fleets (i.e. Philippines) in the WCPO (Figure 1 and Figure 2). The remaining events corresponded to a few radio buoys, and oceanographic buoys (Figure 1 and Figure 2), as well as records where the type of floating object was not recorded (6.1%).

Table 2. Number of objects found stranded per type, with percentages of the total in parentheses. The findings of FADs included bio-FAD, dFADs, aFADs and dFAD parts (e.g., float, bamboo, or net found alone); buoys include satellite buoys, radio buoys, and oceanographic buoys.

		FAD (1,904)		
		Absence	Unknown	Presence
Buoys (2,448)	Absence	0	2 (0.1%)	1,103 (30.7%)
	Unknown	4 (0.1%)	10 (0.3%)	24 (0.7%)
	Presence	1,573 (43.8%)	98 (2.7%)	777 (21.6%)

The number of stranding events recorded in the regional database has been increasing with the development of data collection programmes and the growing number of PICTs participating. The first stranding events recorded were in 2006 in Australia with the launch of the Australian Marine Debris Initiative (AMDI) Database in 2004, followed by some records in Palmyra in 2009 (Figure 1). Data collection and awareness activities have been expanding since 2016, resulting in a gradual increase in the number of stranding events reported. As a result, 1,075 stranding events were reported in 2022, 447 in 2023 and 862 in 2024. In many countries, the first stage of the data collection programme included an inventory of all buoys and FADs previously collected by local communities and often accumulating in private properties or ports. Hence, the date is sometimes uncertain (11.6% of all stranding events) or unknown (0.6% of all stranding events). While most floating objects were satellite buoys, dFADs, and dFADs with a satellite buoy attached, they were slightly different depending on the PICT of the stranding events (Figure 2). For instance, in the Federated States of Micronesia and the Marshall Islands, 21.4% and 21.6% respectively, of the stranding events were industrial aFADs (Figure 2); or Australia presented mostly stranding events related to a buoy alone (92.9%).

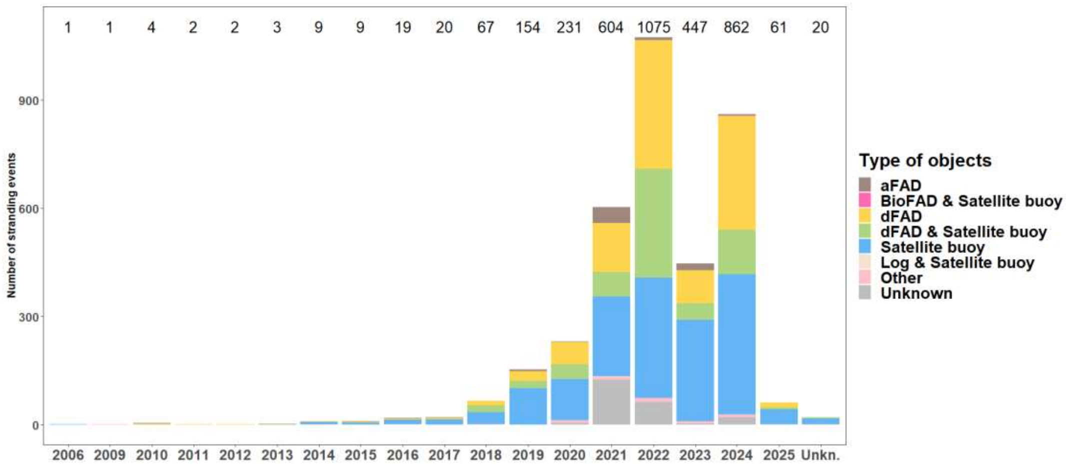


Figure 1. The number of stranding events recorded by year and type of FAD or buoy. The numbers at the top of the figure correspond to the number of stranding events per year.

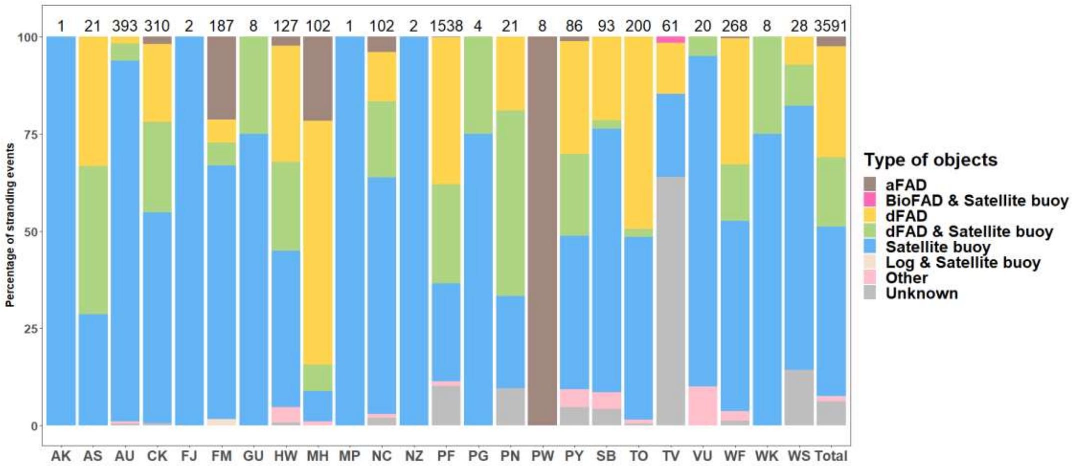


Figure 2. Percentages of stranding events recorded by country and type of materials. Numbers at the top of the figure correspond to the number of stranding events per country. AK = Alaska; AS = American Samoa; AU = Australia; CK = Cook Islands; FJ = Fiji; FM = Federated States of Micronesia; GU = Guam; HW = Hawai'i; MH = Marshall Islands; MP = Northern Mariana Islands; NC = New Caledonia; NZ = New Zealand; PF = French Polynesia; PG = Papua New Guinea; PN = Pitcairn; PW = Palau; PY = Palmyra; SB = Solomon Islands; TO = Tonga; TV = Tuvalu; VU = Vanuatu; WF = Wallis and Futuna; WK = Wake Atoll; WS = Samoa.

Most of the buoys found were one of the three following brands: Satlink (44.3%), Marine Instruments (28.7%), and Zunibal (14.3%), and some were Ryokusei and Kato buoys (Table 3). Note that the brand was unknown for 10.7% of the buoys. Small differences between PICTs were detected (e.g., a higher proportion of Kato buoys was found in the Federated States of Micronesia).

Table 3. Brand of satellite buoys found stranded.

Buoy brand	Number	%
Satlink	977	44.3
Marine Instruments	634	28.7
Zunibal	316	14.3
Kato	32	1.4
Ryokusei	11	0.5
Unknown	237	10.7
Total	2,207	

b) Spatial distribution of stranding events

The spatial distribution of FAD stranding events in the Pacific Ocean shows a large distribution over the PICTs where the data collection programme is implemented (Figure 3 and Figure 4). A higher number of stranding events per 1° cell was detected in French Polynesia, Wallis and Futuna, one location in Solomon Islands and Tonga. However, it should be noted that this could be due to greater data collection efforts in those particular locations rather than a true reflection of relatively higher levels of stranding events. Moreover, few dFADs has been detected far offshore Hawai'i, as the Center of Marine Debris at Hawai'i Pacific University (HPU) launched a financial incentive programme to intercept derelict dFADs at sea through collaboration with longliners (see Appendix 1). Additional years of data and/or accounting for the effort in data collection is needed to better understand the spatial differences detected. In particular, in Solomon Islands, the data collection only started in 2024 in specific locations and data collection in other locations might lead to a similar level of stranding events.

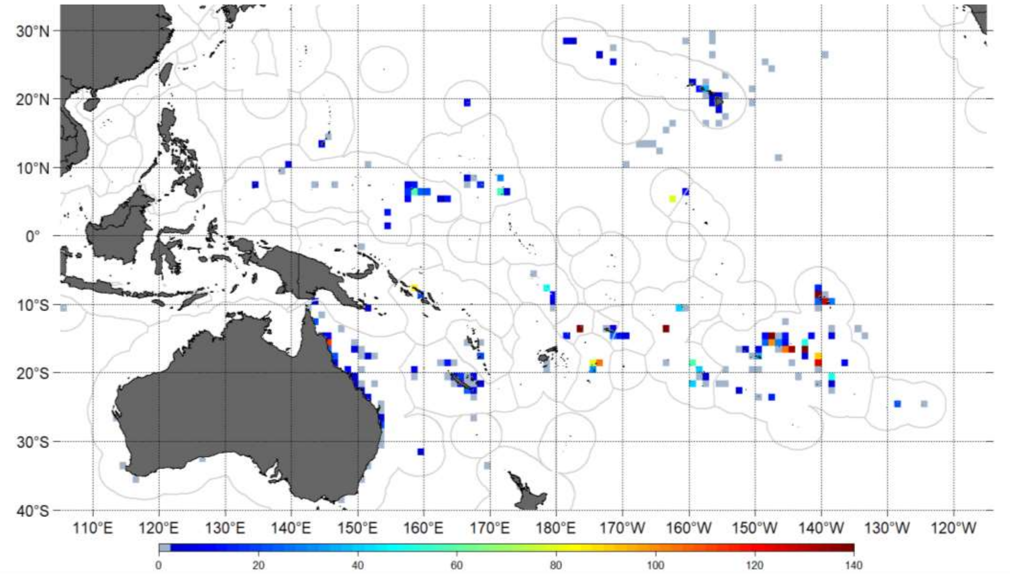


Figure 3. Aggregated map of FADs found in Pacific Island Countries and Territories between 2006–2025. The legend represents the numbers of stranding events per 1° cells.

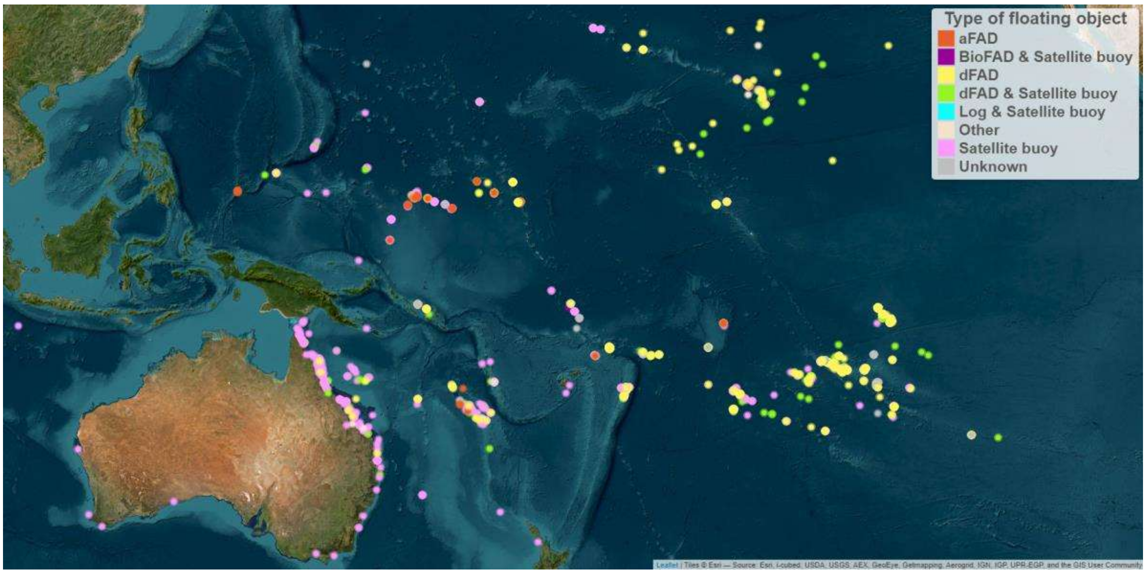


Figure 4. Map of stranding events with known positions (3,527) by type of object found in Pacific Island Countries and Territories and Australia between 2006–2025.

Additional maps provided as supplementary materials in Appendix 3 (Figures S3.1 to S3.10) show locations of stranded FADs and/or buoys (i.e., raft, buoy, both or an unknown object), recorded in some PICTs. For several PICTs, stranding events were greater on one side of the coast, (e.g., the case for some islands in the Tuamotu (French Polynesia, Figure S3.1)). In the case of the Tuamotu Islands, a larger number of stranding events were detected on the east coasts (e.g., Rangiroa, Fakarava, Raraka), but it should be noted that greater data collection efforts occurred in these regions. One interesting case is the atoll of Raroia, with stranding events detected in the lagoon and the coasts inside the lagoon, likely after entering the lagoon on the east side. Some islands, such as Palmyra Atoll have a high density of coral reefs around their coastlines, making them sensitive locations to stranding events.

c) Habitats impacted

FAD stranding events can occur in sensitive environments such as coral reefs and therefore can pose a risk to marine life and habitats. Out of the 3,591 stranding events recorded (FADs or buoys), 37.2% were found on a beach, 6.7% were drifting in the ocean and 4.2% were found on coral reefs (Table 4). Some of the data collected corresponds to objects previously collected by local communities and recorded as found in gardens or private properties, accounting for 32.3% of the data.

Results differ slightly when the type of object is considered separately (i.e., FAD or buoy). Buoys were mostly found in private properties (category "previously collected" in Table 4) (35.2%), followed by beaches (34.7%), then unknown (13.3%) and finally all the other habitats (less than 7.8% each). Buoys were often dismantled to recover electronic materials. In contrast, FADs were mostly found on a beach (41.0%), in private properties (25.4%), on a shore (9.9%) and on coral reefs (6.2%). The aFADs were mostly found on a beach (47.2%), private property (18.0%), on a shore (10.1%) or on a coral reef (7.9%). Results for dFADs varied depending on the presence of submerged appendages (i.e., a tail). dFADs with submerged appendages were more often found on private properties (35.9%), on a beach (27.1%), drifting in the ocean (19.2%) or stranded on coral reefs (10.2%) compared to dFADs without any appendages (12.3%, 56.5%, 2.8%, and 5%, respectively).

Table 4. Numbers and percentages (in parentheses) of stranding events by habitat type and FAD type.

Environment	Total	FADs	Buoys	DFAD with tail**	DFAD without tail**	AFAD
Anchored	1 (0.03%)	1 (0.1%)	1 (0.05%)	NA	NA	1 (1.1%)
Beach	1,331 (37.2%)	720 (41.0%)	765 (34.7%)	167 (27.1%)	364 (56.5%)	42 (47.2%)
Coral reef	154 (4.3%)	109 (6.2%)	57 (2.6%)	63 (10.2%)	32 (5%)	7 (7.9%)
Drifting in the lagoon	45 (1.3%)	35 (2%)	24 (1.1%)	17 (2.8%)	7 (1.1%)	4 (4.5%)
Drifting in the ocean	240 (6.7%)	160 (9.1%)	173 (7.8%)	118 (19.2%)	18 (2.8%)	4 (4.5%)
Mangrove	11 (0.3%)	8 (0.5%)	4 (0.2%)	NA	2 (0.3%)	6 (6.7%)
Previously collected*	1,153 (32.3%)	446 (25.4%)	777 (35.2%)	221 (35.9%)	79 (12.3%)	16 (18.0%)
Shore	249 (7.0%)	174 (9.9%)	100 (4.5%)	21 (3.4%)	127 (19.7%)	9 (10.1%)
Unknown	391 (10.9%)	105 (6%)	306 (13.9%)	9 (1.5%)	15 (2.3%)	NA

*Found on a private property (garden, wharf or landfill). **The term "tail" refers to dFADs' submerged appendages.

The type of environment where FADs and buoys were found differed depending on the PICT considered. Figure 5 shows that a large proportion of objects were previously collected by local communities, who transformed and recycled materials, especially for buoys in the Cook Islands (20.6%) and New Caledonia (14.0%), and for both buoys and FADs in the Solomon Islands (95.7%; 86.4%), Samoa (96%; 80.0%), Tonga (82.2%; 79.6%), the Federated States of Micronesia (53.7%; 22.6%), French Polynesia (52.7%; 25.6%), Marshall Islands (21.1%; 52.7%) and Wallis and Futuna (13.4%; 16.5%). New Caledonia (24.3%), Palmyra Atoll (22.2%), the Federated States of Micronesia (14.5%), Australia (12.5%), Wallis and Futuna (9.45%), and Hawai'i (8.3%) also presented higher rates of FADs stranded on coral reefs.

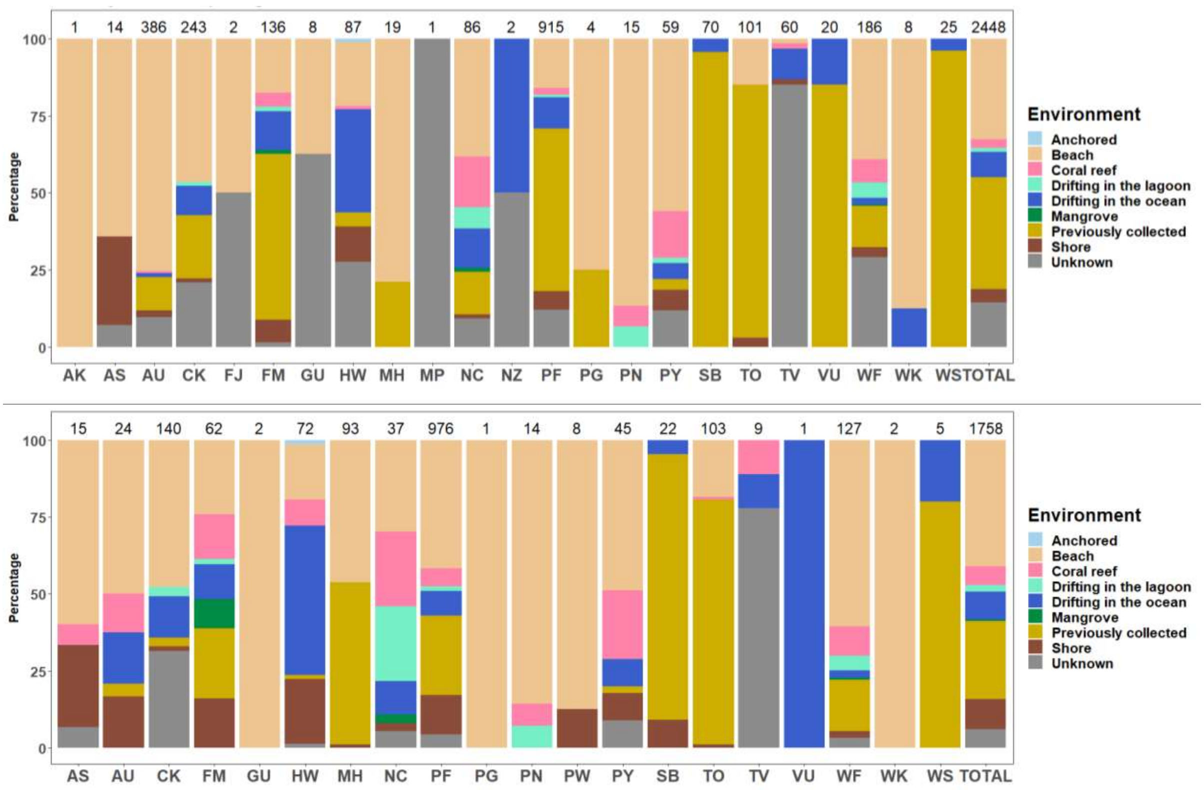


Figure 5. Percentages of stranded buoys (top), and FADs (bottom) by habitat type and country. Numbers at the top of the figure correspond to the number of stranding events for each country. AK = Alaska; AS = American Samoa; AU = Australia; CK = Cook Islands; FJ = Fiji; FM = Federated States of Micronesia; GU = Guam; HW = Hawai'i; MH = Marshall Islands; MP = Northern Mariana Islands; NC = New Caledonia; NZ = New Zealand; PF = French Polynesia; PG = Papua New Guinea; PN = Pitcairn; PW = Palau; PY = Palmyra; SB = Solomon Islands; TO = Tonga; TV = Tuvalu; VU = Vanuatu; WF = Wallis and Futuna; WK = Wake Atoll; WS = Samoa.

d) Type of FADs found stranded

The type and structure of FADs (i.e., dFAD and aFAD) found stranded was investigated. Slightly more FADs were found without submerged appendages (41.2%) compared to FADs with submerged appendages (35.3%). However, information on appendages was not recorded for 23.4% of all FADs (Table 5).

The condition of the FADs when found was also investigated, although this information was mostly not recorded (35.7%). When it was recorded, FADs were mostly fallen apart (28.6%), mainly without submerged appendages (14.2% of all FADs); followed by intact (23.9%), and again mainly without submerged appendages (13.8% of all FADs); and finally classified as beginning to break up (11.7%) (Table 5).

Table 5. Number (N) and percentages of stranded FADs with submerged appendages (left). Percentages of FAD condition and number of FADs in parentheses (right).

Submerged appendages			Condition			
	N	%	Intact	Beginning to break	Mostly fallen apart	Unknown
Present	621	35.3	8.0% (141)	3.0% (53)	7.8% (138)	16.4% (289)
Absent	725	41.2	13.8% (242)	7.6% (133)	14.2% (249)	5.7% (101)
Unknown	412	23.4	2.2% (38)	1.1% (20)	6.6% (116)	13.5% (238)
Total	1,758		23.9% (421)	11.7% (206)	28.6% (503)	35.7% (628)

Materials used in the construction of FADs (i.e., classified as synthetic, natural or a mix of synthetic and natural materials) were also investigated (Table 6). Materials were not recorded for 15.7% of FADs. The remaining FADs (including aFADs) were made with a mix of synthetic and natural materials for rafts and no attachments (i.e., no tails; 26.2%), followed by synthetic rafts with no attachments (10.5%), and mixed rafts with synthetic appendages (10.1%). For all FADs found stranded, none were found with natural submerged appendages. Completely natural FADs without submerged appendages represented only 1.3% of all stranding events.

Table 6. Percentages and numbers (in parentheses) of FADs with the raft and submerged appendages made of synthetic, mixed, or natural materials (including structure, flotation and covering materials).

		Raft			
		Synthetic	Mix	Natural	Unknown
Tail	Synthetic	5.7% (101)	10.1% (178)	0.1% (2)	5.1% (89)
	Mixed	0.5% (9)	1% (17)	0.1% (1)	0.7% (13)
	Natural	0	0	0	0
	None	10.5% (185)	26.2% (460)	1.3% (23)	3.2% (57)
	Unknown	10.6% (187)	7.9% (139)	1.2% (21)	15.7% (276)

Materials were also investigated separately for the raft's main structure, the raft covering, and the submerged appendages. Structure and flotation materials were examined for 1,134 FADs (Figure 6A). Most of the structure and flotation materials detected in stranded FADs were i) bamboo and plastic flotation (42%); ii) bamboo (31.9%); and iii) plastic flotation (18.7%) (Figure 6A).

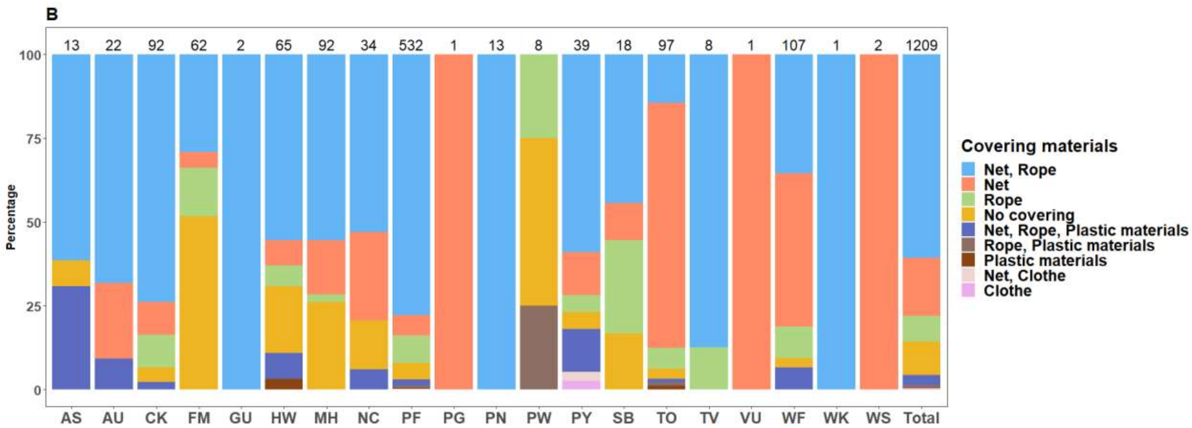


Figure 6. Percentage of flotation and structural materials (A); and covering materials (B) for FADs found stranded and with materials recorded (64.5% and 68.8%, respectively) by country. The numbers at the top of each figure correspond to the number of stranding events with materials recorded by country. "Bamboo", includes bamboo and/or log. "Plastic flotation" materials include float, PVC tube, plastic drum, polystyrene and plastic foam. AS = American Samoa; AU = Australia; CK = Cook Islands; FM = Federated States of Micronesia; GU = Guam; HW = Hawai'i; MH = Marshall Islands; NC = New Caledonia; PF = French Polynesia; PG = Papua New Guinea; PN = Pitcairn; PW = Palau; PY = Palmyra; SB = Solomon Islands; TO = Tonga; TV = Tuvalu; VU = Vanuatu; WF = Wallis and Futuna; WK = Wake Atoll; WS = Samoa.

When considering differences by countries, it can be noted that in the Federated States of Micronesia and the Marshall Islands, many of the stranding events were aFADs, and therefore flotation materials were recorded as metal drums or fiberglass (63.9% and 43.1%, respectively) (Figure 6A). The remaining materials for FADs found in these countries were a mix of bamboo, metal drum, plastic flotation and fiberglass (36.1% to 56.9%). FAD raft coverings were typically made of netting and/or rope (85.8%). A higher percentage of FADs with no covering were also detected in the Federated States of Micronesia and the Marshall Islands, mainly corresponding to aFADs (Figure 6B).

The presence or absence of FAD netting in the raft was not often recorded. When this information was recorded, 22.0% of FADs did not have any netting (mostly aFADs) and 16.7% of FADs had some netting as covering, but details about mesh size were not recorded (Figure 7). When mesh size was recorded, 43.7% of FADs had small mesh netting (<7cm), 22.7% had large mesh netting (≥7cm) and 11.7% had both small and large mesh netting (Figure 7).

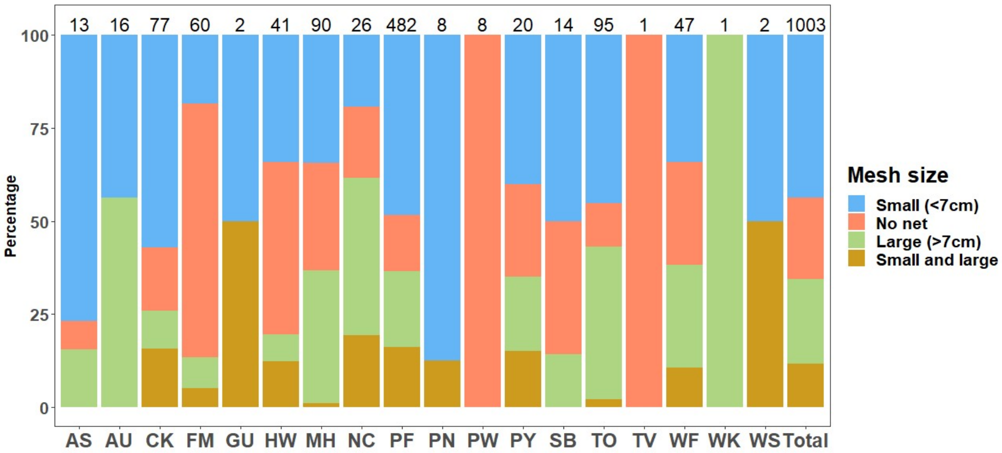


Figure 7. The percentage of visually estimated mesh size used to cover the rafts of FADs (small: <7cm, large: ≥7cm; or a combination of small and large netting), when recorded (42.9% of unknown removed), found stranded by country. The numbers at the top of the figure correspond to the number of stranded events with materials recorded by country. AS = American Samoa; AU = Australia; CK = Cook Island; FM = Federated States of Micronesia; GU = Guam; HW = Hawai'i; MH = Marshall Islands; NC = New Caledonia; PF = French Polynesia; PN = Pitcairn; PW = Palau; PY = Palmyra; SB = Solomon Islands; TO = Tonga; TV = Tuvalu; WF = Wallis and Futuna; WK = Wake Atoll; WS = Samoa.

The most common materials used to construct the submerged appendages attached to FADs were netting and/or rope (76.2%). The remaining (23.8%) were constructed with a combination of bamboo, other plastic materials, net, and weights (Figure 8). In New Caledonia, all the FADs found stranded with submerged appendages were composed of netting, which creates a high risk for coral entanglement. Despite the high numbers of submerged appendage materials recorded as unknown (34.4%), when netting was recorded, the mesh size, as well as the design, were also examined. Small mesh netting (<7 cm) was found in 45.5% of records, compared to 32.7% with large mesh netting (Table 7). Even if a large proportion presented no information on the design used (36.6%), most of the FADs found had an open panel (33.7%) followed closely by submerged appendages rolled up in a bundle (25.4%) (Table 7).

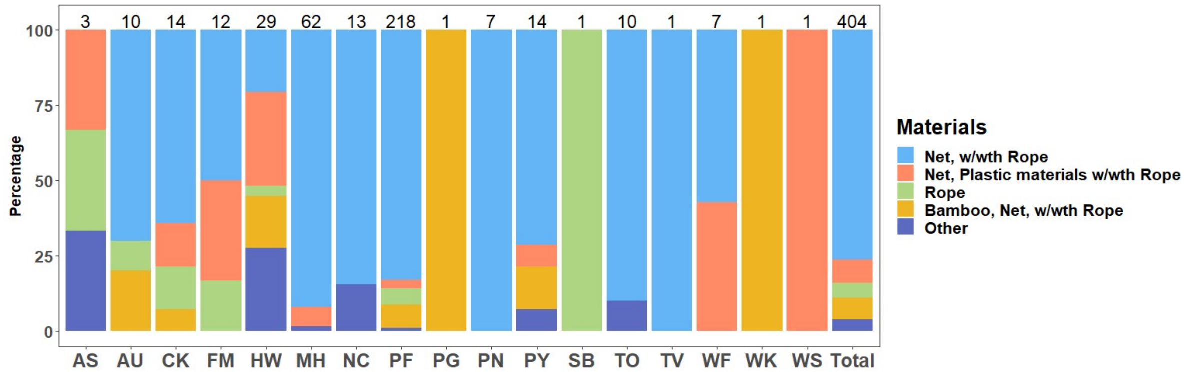


Figure 8. Materials used for the construction of submerged appendages of FADs found stranded, recorded by country. The numbers at the top of the figure correspond to the number of stranded events with materials recorded by country. Plastic materials include plastic sheeting, plastic drums, fishing line, PVC tubes and float. For clarity, the category "Other" is a mix of categories which each represent a low number of stranding events (<4) (combination of bamboo, net, plastic materials, weight, metal and/or fabric). "w/wth"= with or without. AS = American Samoa; AU = Australia; CK = Cook Islands; FM = Federated States of Micronesia; HW = Hawai'i; MH = Marshall Islands; NC = New Caledonia; PF = French Polynesia; PG = Papua New Guinea; PN = Pitcairn; PY = Palmyra; SB = Solomon Islands; TO = Tonga; TV = Tuvalu; WF = Wallis and Futuna; WK = Wake Atoll; WS = Samoa.

Table 7. Design (left) and mesh size (right) of netting used as submerged appendages of stranded FADs.

Design	Numbers	Percentages
Unknown design	111	36.6%
Open panel	102	33.7%
Rolled up in a bundle	77	25.4%
Mixed design	13	4.3%

Mesh net size	Numbers	Percentages
Small (<7 cm)	138	45.5%
Large (≥7cm)	99	32.7%
Unknown size	36	11.9%
Small and large	30	9.9%

In 44.6% of the stranding events, the shape of the FAD rafts was recorded, and different shapes of rafts were detected (Figure 9 and Table 8). Rectangular and square rafts were the most common (22.6% and 11.8%, respectively), followed by cylindrical rafts (4.6%).

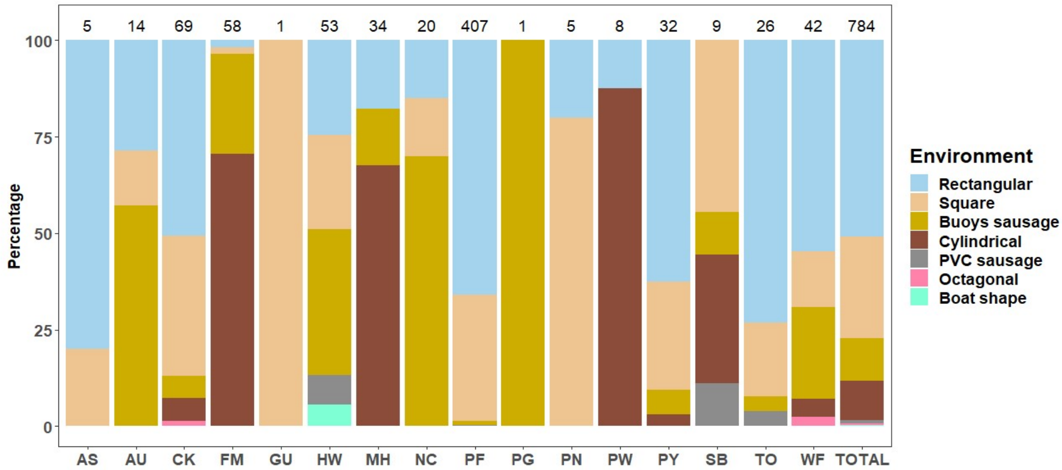


Figure 9. Shape of FADs found stranded by country. Numbers at the top of the figure correspond to the number of stranded events with FAD shape recorded per country. AS = American Samoa; AU = Australia; CK = Cook Islands; FM = Federated States of Micronesia; GU = Guam; HW = Hawai'i; MH = Marshall Islands; NC = New Caledonia; PF = French Polynesia; PG = Papua New Guinea; PN = Pitcairn; PW = Palau; PY = Palmyra; SB = Solomon Islands; TO = Tonga; WF = Wallis and Futuna.

Table 8. Shapes of the FADs found stranded in all the Pacific Islands Countries and Territories.

Shape of the raft	Unknown	Rectangular	Square	Buoy sausage	Cylindrical	PVC Sausage	Boat shape	Octagonal
Percentage	55.4%	22.6%	11.8%	4.9%	4.6%	0.4%	0.2%	0.1%
(Number)	(974)	(398)	(207)	(86)	(81)	(7)	(3)	(2)

e) Environmental impacts

The fate of buoys and FADs found stranded was investigated (Table 9). Most of the buoys (75.5%) were removed from the environment, while a lower number of FADs (28.0%) were removed. It should be noted that in a large portion of the stranding events, the fate was not recorded (18.6% of buoys and 51.8% of FADs).

Table 9. Fate of buoys and FADs found stranded.

	Buoy		FAD	
	Number	%	Number	%
Removed	1,849	75.5	534	28.0
Left	143	5.8	348	18.3
Removed partly	NA	NA	16	0.8
Sunk	NA	NA	8	0.4
Fished and left	NA	NA	6	0.3
Fished and removed	NA	NA	4	0.2
Relocated and left	NA	NA	2	0.1
Unknown	456	18.6	986	51.8

The purpose of the removal of buoys and FADs from the environment was recorded when possible (Table 10). This information was available for 59.8% of the buoys and 80.3% of the FADs. Buoys were mostly removed to be placed in storage (19.6%), in a landfill (10.7%), or left with the finder (8.1%). Communities also reused buoys (9.9%): using them as home furniture, like flowerpots (32.8%), as a light source (14.8%), using the electronic components such as solar panels or batteries (9.3%) or for fishing activities (2.1%). Most of the FADs removed from the environment were reused (48.3%) either transformed into house furniture (86.8%), or for fishing activities or boat furniture (4.7%). Some of the remaining FADs were used for research (9.6%), placed in a landfill (8.5%) or stored at the finder's home (8.8%) or elsewhere (3.8%). It should be noted that fate and purpose of removed buoys and FADs was highly variable between PICTs and not necessarily classified the same way everywhere.

Table 10. Investigation of the purpose and fate of buoys and FADs removed from the environment.

	FADs		Buoys	
Purpose	Number	Percentage	Number	Percentage
Reused	257	48.3	183	9.9
Unknown	105	19.7	744	40.2
Research	51	9.6	46	2.5
Left with the finder	47	8.8	150	8.1
Landfill	45	8.5	197	10.7
Storage	20	3.8	363	19.6
Burned	4	0.8	*NA*	*NA*
Dismantled	3	0.6	11	0.6
Reused/Stored for ReCon	*NA*	*NA*	153	8.3
Relocated	*NA*	*NA*	2	0.1

Environmental damage could sometimes be recorded (36.8% of all FADs found stranded) and corresponded mostly to dFADs with submerged appendages. Damage was associated with coral (3.1% of all dFADs but 7.3% of all FADs with appendages found) or, very rarely, entanglements with animals (0.7% of all dFADs but 0.8% of all FADs with appendages found) (Table 11). Few FADs have been reported as entangled, however it was not precisely determined if it was on corals or on rocks, therefore it is mentioned as "unidentified" (1.7% of all FADs). It should be noted that the environmental damage was recorded at the time of locating a FAD. However, these may be underestimated, as ghost fishing, marine pollution or coral damage can potentially occur throughout the lifetime of FADs (at-sea or on coastal habitats). Marine pollution can also occur through microplastics from FAD parts or heavy metal pollution from electronic components and batteries in satellite buoys, but this would be difficult to quantify under the current data collection methods.

Table 11. Environmental damage caused by stranded FADs recorded in the database.

	Total FADs	dFAD	dFAD with tail	dFAD without tail	aFAD
Entangled animals	12 (0.7%)	11 (0.7%)	5 (0.8%)	3 (0.5%)	1 (1.1%)
Entangled on corals	54 (3.1%)	51 (3.1%)	45 (7.3%)	1 (0.2%)	3 (3.4%)
Entangled on corals and animals	1 (0.1%)	1 (0.1%)	1 (0.2%)	*NA*	*NA*
Entangled (unidentified)	30 (1.7%)	30 (1.8%)	22 (3.6%)	7 (1.1%)	*NA*
No	592 (33.7%)	542 (32.5%)	139 (22.6%)	320 (49.7%)	50 (56.2%)
Unknown	1,069 (60.8%)	1034 (62%)	404 (65.6%)	313 (48.6%)	35 (39.3%)

Environmental damage, particularly related to coral, by the submerged appendages was also investigated. Few records of coral damage and unidentified entanglements were recorded (45 and 22 respectively). Most dFADs with submerged appendages found entangled on corals involved netting with small mesh size (Table 12A). Most dFADs with submerged appendages found entangled on corals also involved a design with open panels (29.2%) (Table 12B). However, the net mesh size, or the design were often not recorded (for coral damage, 24.6% and 26.2%, respectively; for unidentified damage, 7.7% and 6.2%, respectively).

Table 12. Percentage and number (in parentheses) of FADs found with submerged appendages entangled on corals and unidentified, depending on the netting mesh size (A) or the design (B).

(A)	Small (<7cm)	Large (≥7cm)	Small and large	Unknown size
Coral damage	15.4% (10)	10.8% (7)	15.4% (10)	24.6% (16)
Unidentified damage	18.5% (12)	4.6% (3)	3.1% (2)	7.7% (5)

(B)	Open panel	Rolled up into a bundle	Mixed design	Unknown design
Coral damage	29.2% (19)	6.2% (4)	4.6% (3)	26.2% (17)
Unidentified damage	16.9% (11)	9.2% (6)	1.5% (1)	6.2% (4)

f) Origin – Matching with observer and FAD tracking data

Two approaches were used to determine the origin of the FADs and buoys found stranded in the Pacific Ocean. First, the marks painted on the buoys were used to identify the vessel monitoring the buoy. Marks on the satellite buoys were compared to the WCPFC and IATTC online vessel registries to identify the possible vessels, which allowed identification of flag and Convention Area (CA) where the owner vessel has been fishing. The second approach used to determine the origin of the stranded buoys consisted of identifying the unique buoy ID alphanumeric codes from the database and cross-referencing it against three fishery databases: i) the PNA FAD tracking database; ii) the WCPFC observer database; and iii) the IATTC observer database. The last known position in the PNA FAD tracking data and/or the last activity recorded in the observer data from WCPFC and IATTC was identified for each buoy that has a unique ID number that matched a number in the corresponding database. Non-confidential data from the Inter-American Tropical Tuna Commission (IATTC) were shared with SPC through our Memorandums of Understanding (MoUs) to support Pacific-wide collaboration and this analysis.

A painted mark was found on 56.6% of the 2,207 satellite buoys found. 19.0% of the buoys did not have any marks and the presence of any marking was unknown for 24.4% of the buoys. However, markings on the buoy did not always result in the identification of a vessel or a flag. Among all the satellite buoys with painted marks, 32.4% could lead to the identification of the flag of the owner vessel and the CA where it has been fishing. Also a few satellite buoys presented only a letter as a marking (14.3%), making it therefore impossible to identify a vessel, the flag or the CA.

The origin of vessels monitoring the stranded satellite buoys (and attached to a dFAD or not) was highly variable (Figure 10). 29.1% of buoys were from Ecuadorian vessels; 23.2% from United States of America (US) vessels; 11.9% from Korean vessels; 10.9% from Panamanian vessels and the remaining from 17 other flags (Figure 10). Most buoys found stranded were from vessels fishing in the IATTC CA (47.0%), followed by WCPFC CA (34.1%) and both CAs (19.0%) (Figure 11A). With the second method using the unique buoy identification number, among the 2,207 stranded satellite buoys, 37.6% had been found in one of three fishery databases with 48.4% from the IATTC observer database, 35.5% from the PNA FAD tracking database and 16.2% from the WCPFC observer database. However, the last known position indicated that 49.2% of buoys were last recorded in the IATTC CA, 48.3% in the WCPFC CA, and only 2.5% of them in the IATTC/WCPFC overlap area (see Appendix 3, figure S3.11 for the area covered by each CA and the overlap area).

In terms of country of stranding events, 86.4% of the marks on buoys found in French Polynesia were from vessels from the IATTC CA (Ecuador, Panama, US and Colombia) (Figure 10) and 86.9% of the last recorded positions were from the IATTC CA (Figure 11B). The buoys found with marks in the Federated States of Micronesia were almost exclusively from vessels fishing in the WCPFC CA (86.4%), although from a wide range of fleets: Korea, Japan, US, Nauru, Ecuador, Chinese Taipei and Papua New Guinea as examples (Figure 10 and Figure 11A) and the last position were mainly from WCPFC CA (88.1%). In Cook Islands, a large range of vessel flags from the IATTC CA were detected from marked buoys, mostly from US, Ecuadorian and Panamanian vessels (36.1, 22.2%, and 11.1%, respectively) and last positions were mainly recorded from IATTC CA (67.1%). Finally, stranding events in Australia, located in the western part of the Pacific Ocean, consisted mostly of buoys marked from the US (34.6%), Korea (25.0%), Colombia and Ecuador (5.8% each), and the last position were mainly from WCPFC CA (73.1%) and a proportion from IATTC CA (24.9%).

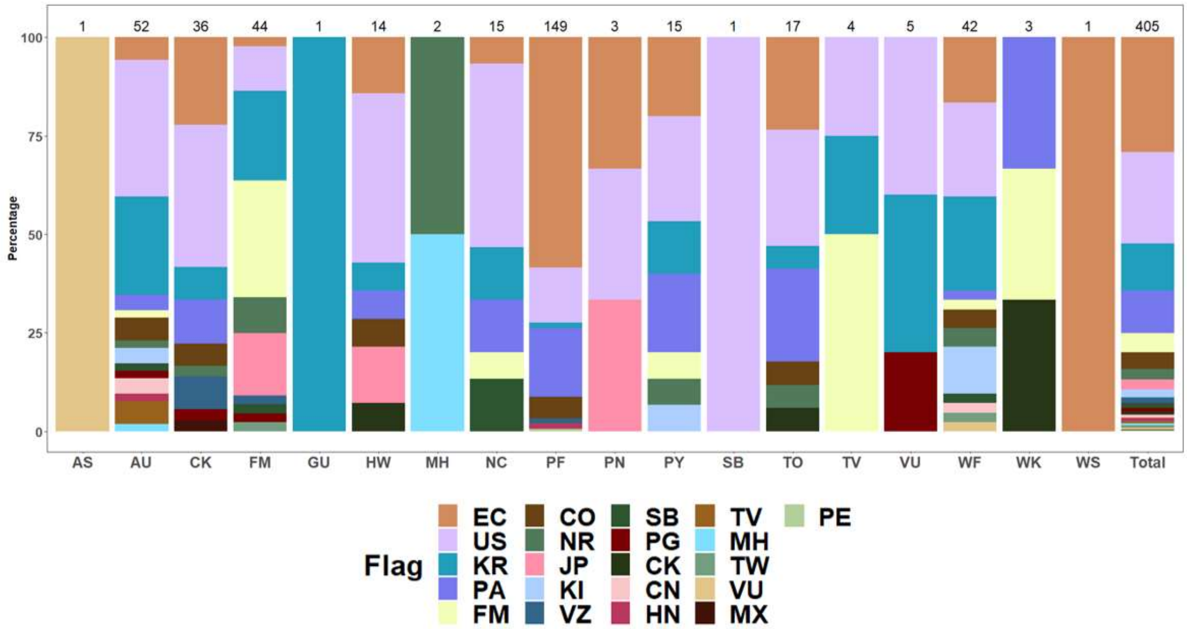


Figure 10. Flag of the owner vessel identified using marks painted on the satellite buoys by stranding location, using publicly available IATTC and WCPFC vessel registers. Numbers at the top of the figure correspond to the number of buoys stranded per country. AS = American Samoa; AU = Australia; CK = Cook Islands; CN = China; CO = Columbia; EC = Ecuador; FM = Federated States of Micronesia; GU = Guam; HN = Honduras; HW = Hawai'i; JP = Japan; KI = Kiribati; KR = Korea; MH = Marshall Islands; MX = Mexico; NC = New Caledonia; NR = Nauru; PA = Panama; PE = Peru; PF = French Polynesia; PG = Papua New Guinea; PN = Pitcairn; PY = Palmyra; SB = Solomon Islands; TO = Tonga; TV = Tuvalu; TW = Chinese Taipei; US = USA; VU = Vanuatu; VZ = Venezuela; WF = Wallis and Futuna; WK = Wake Atoll; WS = Samoa.

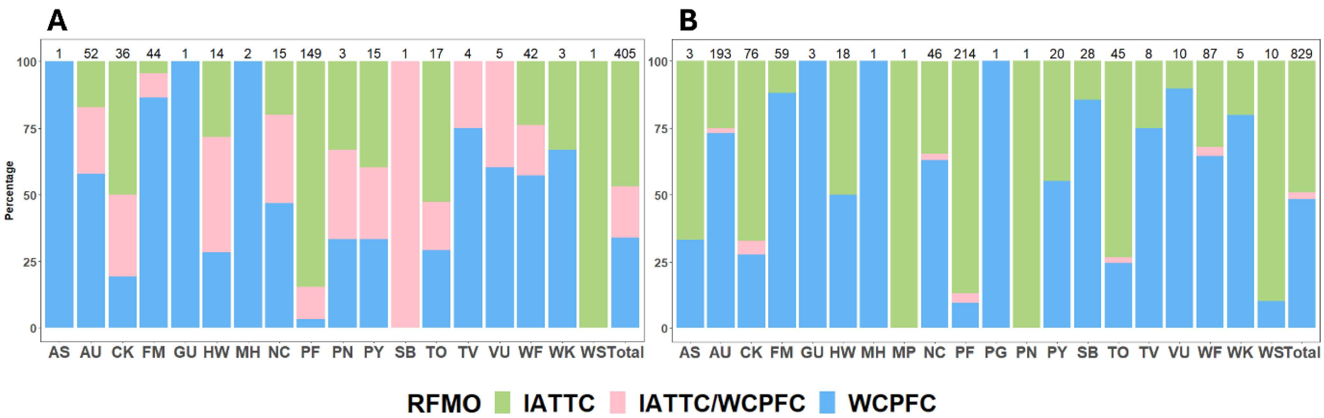


Figure 11. Convention area of owner vessel identified using marks painted on the satellite buoys, using publicly available IATTC and WCPFC vessel registers (A) and convention area of the last known position in the PNA FAD tracking data, the WCPFC and IATTC observer data (noting no confidential information was shared; e.g. vessel ID, flag ID, satellite buoy track) (B) by stranded location. IATTC/WCPFC = vessel fishing in both convention areas (A) or the overlap area between IATTC and WCPFC (B). Numbers at the top of the figure correspond to the number of buoys stranded per country. AS = American Samoa; Australia; CK = Cook Islands; FM = Federated States of Micronesia; HW = Hawai'i; MH = Marshall Islands; MP = Northern Mariana Islands; NC = New Caledonia; PF = French Polynesia; PG = Papua New Guinea; PN = Pitcairn ; PY = Palmyra; SB = Solomon Islands; TO = Tonga; TV = Tuvalu; VU = Vanuatu; WF = Wallis and Futuna; WK = Wake Atoll; WS = Samoa.

In the second approach, 829 buoys (37.6% of total) were matched with a fishery database. However, it should be noted that there may be uncertainty regarding buoy identification number. The buoy identification number is composed of the buoy model and numbers, and whether through observer programmes or the stranded FAD data-collection programme, the identifier may be partially recorded (e.g. no access to the buoy, blur top case, absent barcode). In some case only numbers are registered without the model. For instance, in the WCPFC observer database, for 48.8% of the buoys, identifiers were recorded partially (in observer data or in the stranded FAD database).

The time difference between the last known date and the date found stranded was investigated using the second approach. This time difference was then calculated and categorized into three classes: less than one year; between one and two years; and more than two years. Maps indicating the last recorded positions of buoys found stranded, and time between the last known date and the date found stranded have been compiled (Figure 12 and Figure 13).

As previously identified, certain PICTs received satellite buoys mostly from one CA only (Figure 15). For instance, French Polynesia, and Cook Islands have stranded buoys mostly from the IATTC CA and few from the WCPFC CA (Figure 14). It was also found that buoys were mainly drifting and stranded for more than one or two years before being found. Buoys stranded in Australia from WCPFC CA (73.1%), could be linked to geographical proximity, but there were also buoys coming from the IATTC CA (24.9%), within (36.3%) or more than two years (49.2%) after the last recorded activity (Figure 14).

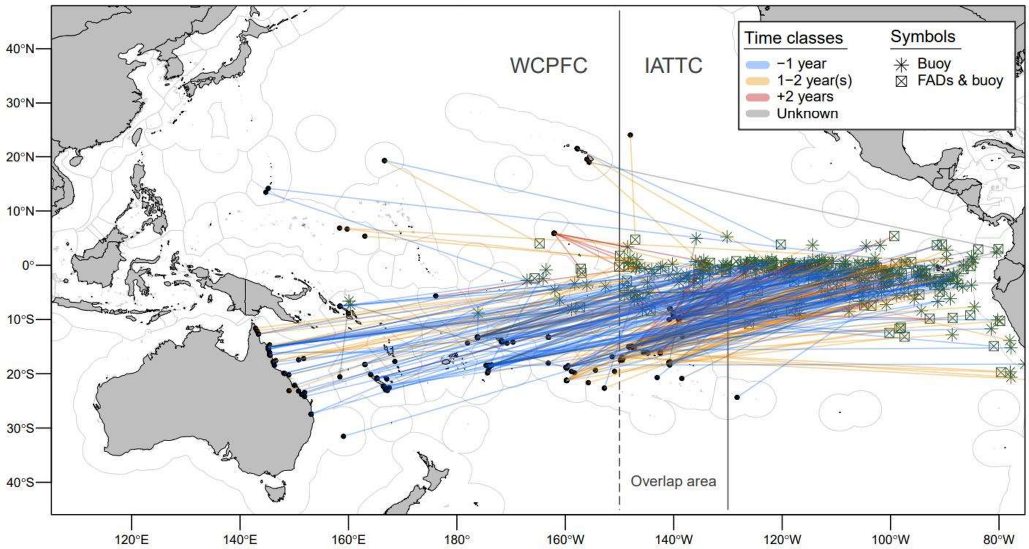


Figure 12. Map with all recorded stranded positions (black dots) and last known positions (green olive symbols) from buoys stranded and found in the IATTC observer data only (noting no confidential information was shared; e.g. vessel ID, flag ID, satellite buoy track). The color of the lines indicates the time between last known position and the date found stranded.

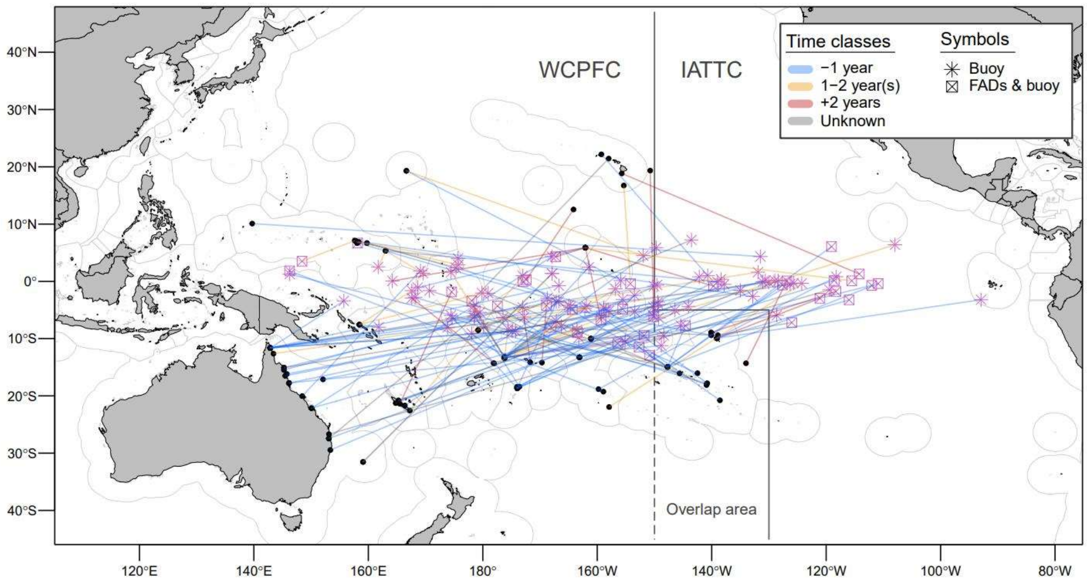
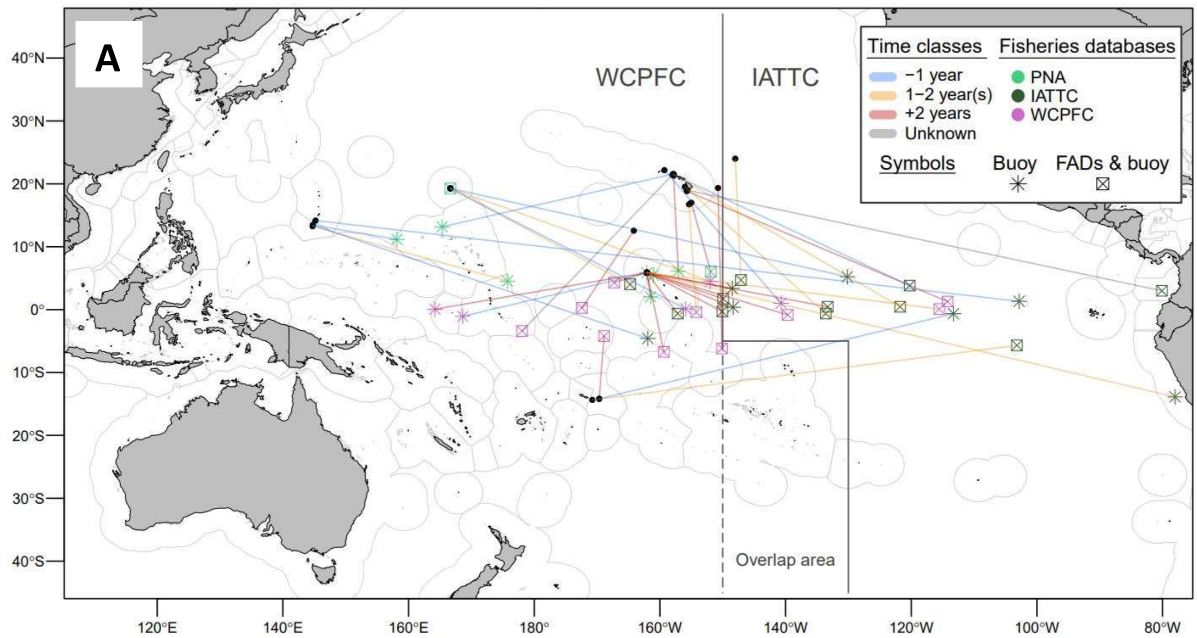
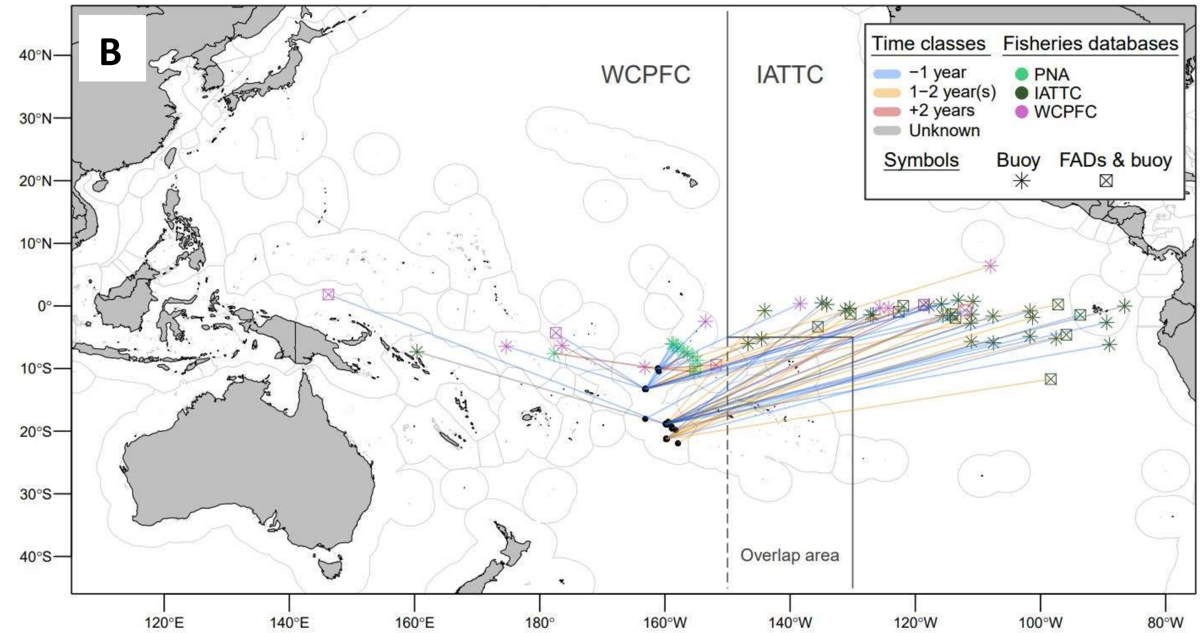


Figure 13. Map with all recorded stranded positions (black dots) and last known positions (pink symbols) from buoys stranded and found in the WCPFC observer data only (noting no confidential information was shared; e.g. vessel ID, flag ID, satellite buoy track). The color of the lines indicates the time between last known position and the date found stranded.

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WCPFC
IATTC
Time classes
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1−2 year(s)
+2 years
Unknown
Fisheries databases
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IATTC
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Symbols
Buoy
FADs & buoy
Overlap area
40°N
30°N
20°N
10°N
0°
10°S
20°S
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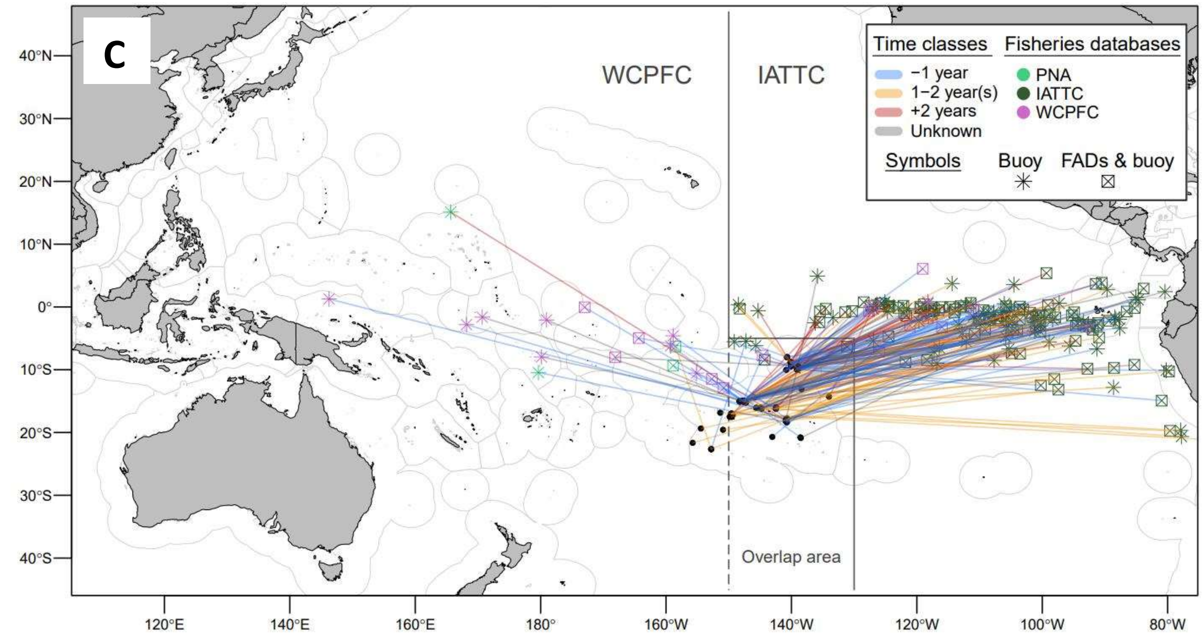
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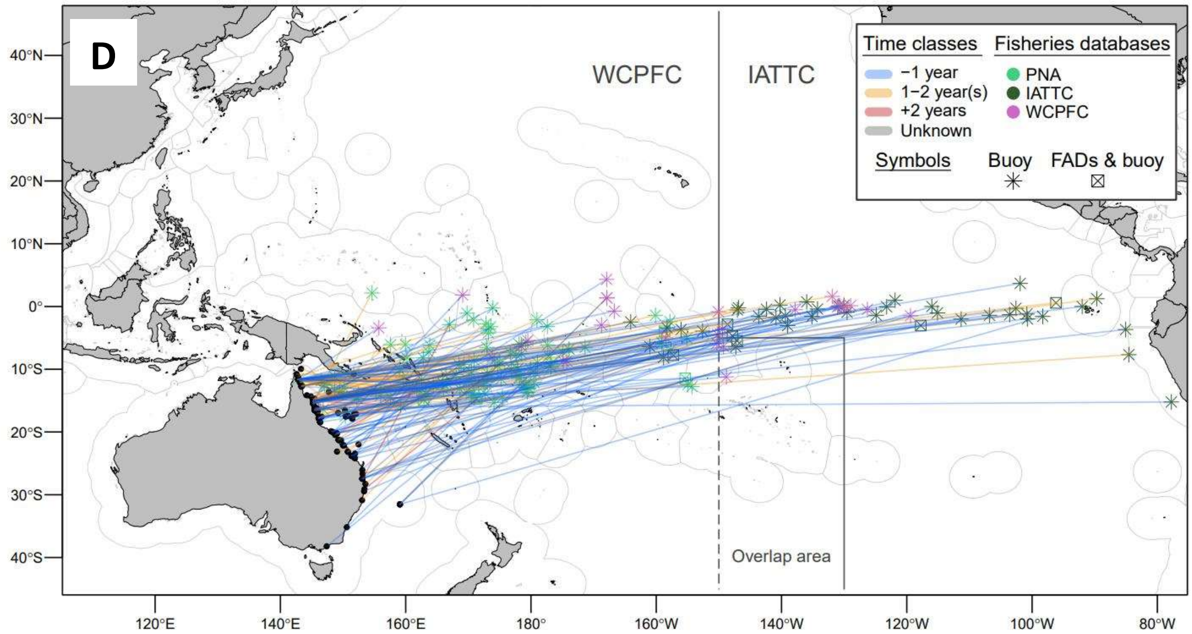

Figure 14. Maps of Hawai'i, Palmyra Atoll, Wake Atoll, Guam, Northern Mariana Islands, American Samoa (A), Cook Islands (B), French Polynesia (C) and Australia (D) with buoy stranded positions (black dots) and the last known position of buoys from three fishery databases: the PNA FAD tracking data (light green symbols); the WCPFC observer data (pink symbols) and the IATTC observer data (green olive symbols; noting no confidential information was shared; e.g. vessel ID, flag ID, satellite buoy track). The color of the lines indicates the time between the last known position and the date found stranded.

The exclusive economic zone (EEZ) of the last known position of buoys was investigated to detect potential connectivity and movement patterns (Figure 15). The following focuses on the countries located in the western part of the Pacific Ocean. In the Cook Islands, most stranded FADs were last detected in the high seas in the EPO (I3; 39.5%), the high seas in the central Pacific Ocean (I2; 26.3%), the Kiribati Line Islands (17.1%) and the Galapagos (5.3 %) (Figure 15). In the Federated States of Micronesia, most stranded FADs were last detected in Federated States of Micronesia (53.7%), Kiribati Gilbert Islands (14.8%), Papua New Guinea (9.3%) and the high seas in the central Pacific Ocean (I2; 9.3%).

In French Polynesia, most stranded FADs were last detected in the IATTC CA, in the high seas of the central and eastern part of the Pacific Ocean (I3 and I2, 57.0% and 22.0%, respectively) (Figure 15). In Hawai'i and Palmyra, most stranded dFADs were last detected in the IATTC CA in the high seas of the central part of the Pacific Ocean (I2) (55.6% and 35.0%, respectively). In Wallis and Futuna, most stranded dFADs were last detected in the WCPFC CA, in Tuvalu (20.7%) and the Line Islands (19.5%), as well as the IATTC high-seas areas in the central part of the Pacific Ocean (I2, 19.5%). Some countries such as Pitcairn and Northern Mariana Islands, present 100% of last detections from Galapagos Islands, or I3 zones but a low number of buoys have been found in the different fishery databases for those countries.

Origin areas

Stranding areas	WCPFC CA																					IATTC CA						
	AU	PG	FM	SB	MH	WK	VU	NR	GL	LN	PX	I1	TV	FJ	WF	TK	AS	CK	JV	PY	HW	PF	I2	I3	GP	PU	CO	EC
AU	2.1	7.3	0.5	20.7	0	0	1	0.5	3.6	7.3	3.6	3.6	16.6	2.1	0	1	0.5	1	0.5	0	0	0	17.1	9.3	1	0.5	0	0
PG	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GU	0	0	0	0	33.3	0	0	0	33.3	0	0	33.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WK	0	0	0	0	0	20	0	0	0	20	0	20	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0
MP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0
FM	0	9.3	53.7	0	1.9	0	0	1.9	14.8	3.7	0	1.9	0	0	0	0	0	0	0	0	0	0	9.3	3.7	0	0	0	0
NC	0	0	0	19.6	0	0	0	0	2.2	13	6.5	6.5	10.9	2.2	0	2.2	0	0	0	0	0	0	10.9	19.6	6.5	0	0	0
SB	0	7.1	0	60.7	0	0	0	7.1	3.6	0	0	3.6	3.6	0	0	0	0	0	0	0	0	0	14.3	0	0	0	0	0
VU	0	0	0	40	0	0	0	0	0	0	0	0	30	20	0	0	0	0	0	0	0	0	0	10	0	0	0	0
MH	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TV	0	0	0	0	0	0	0	0	0	0	16.7	0	50	0	0	0	0	0	0	0	0	0	33.3	0	0	0	0	0
TO	0	0	0	0	0	0	0	0	0	11.1	0	4.4	6.7	0	0	0	2.2	0	0	0	0	0	26.7	40	6.7	2.2	0	0
WS	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	40	50	0	0	0	0
WF	0	0	0	0	0	0	0	1.1	2.3	19.5	4.6	5.7	20.7	0	4.6	1.1	1.1	4.6	0	0	0	0	19.5	11.5	3.4	0	0	0
AS	0	0	0	0	0	0	0	0	0	0	33.3	0	0	0	0	0	0	0	0	0	0	0	0	66.7	0	0	0	0
PY	0	0	0	0	0	0	0	5	10	10	0	5	0	0	0	0	0	5	5	10	0	0	35	10	0	5	0	0
HW	0	0	0	0	5.6	0	0	0	5.6	11.1	5.6	0	0	0	0	0	0	0	0	0	5.6	0	55.6	5.6	0	0	5.6	0
CK	0	1.3	1.3	1.3	0	0	0	0	0	17.1	2.6	0	2.6	0	0	0	0	1.3	0	0	0	0	26.3	39.5	5.3	0	0	1.3
PF	0	0.9	0	0	0.5	0	0	0	0.9	2.3	0.5	1.9	0.9	0	0	0	0	0.9	0	0	0	0.5	22	57	9.8	0.9	0.9	0
PN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0

Figure 15. Matrix showing EEZ of origin for FADs found stranded: stranding country (left) and EEZ or origin (top), derived from the stranded position and the last known position in the PNA FAD tracking data, the WCPFC observer data or the IATTC observer data (noting no confidential information was shared; e.g. vessel ID, flag ID, satellite buoy track). Countries are ordered from west to east. AS = American Samoa; AU = Australia; CK = Cook Islands; CO = Colombia; EC = Ecuador; FJ = Fiji; FM = Federated States of Micronesia; GL = Gilbert Islands; GP = Galapagos; GU = Guam; HW = Hawai'i; JV = Jarvis Island; LN = Line Islands; MH = Marshall Islands; MP = Northern Mariana Islands; NC = New Caledonia; NR = Nauru; PF = French Polynesia; PG = Papua New Guinea; PU = Peru; PY = Palmyra ; PX = Phoenix islands; SB = Solomon Islands; TK = Tokelau; TO = Tonga; TV = Tuvalu; VU = Vanuatu; WF = Wallis and Futuna; WK = Wake Atoll; WS = Samoa; I1 = Internal waters between Gilbert, Phoenix and Line Islands (174°–202°); I2 = International waters East of the Line Islands and North of French Polynesia (202°-240°) and I3 = Eastern part of the Pacific Ocean (east of 240°), see Appendix 3, figure S3.11.

The time difference between the date buoys and FADs were found stranded and their last known position was investigated (Figure 16). 17.9% of all buoys were found less than one year after the time of their last known position, 28.8% were within two years, 42.6% of them were found more than two years after the time of their last known position. For 10.8% of them the range of time is unknown.

In most PICTs, the data collection programmes started recently but may have recorded FADs and buoys found years ago by communities. In addition, data on stranding events were collected between 2006 and 2025. Hence, the range of years between the date found stranded and the last known position was highly variable in some PICTs. For example, it reached almost 4,000 days (about 11 years) for some buoys found in French Polynesia. It can also be noted that the time differences varied depending on the database used, for instance, higher time differences were detected for matches with the WCPFC observer's database, which recorded the last activity in the observer data; and smaller time differences for matchings with the PNA FAD tracking data (with available data starting in 2016), which is closer to the real date of last transmission. In the Federated States of Micronesia, more than 75% of the matches with the WCPFC observers' data are under 1,500 days (less than 4 years) between the last record and the stranded position whereas matches with the PNA tracking data were less than 1.5 years. Similar patterns were found for Australia, Cook Islands, New Caledonia, French Polynesia, Palmyra and Wallis and Futuna (Figure 16).

Data from WCPFC and IATTC observer programmes correspond to the last activity on the buoy that was recorded by observers, not the very last position recorded from a satellite buoy. Thus, it can overestimate the time difference between the actual last transmission and the stranding position, while fishers could potentially still have used the buoy and associated FAD, with this information not available to the observer. In addition, a floating object could have been stranded for a long period before being found by local communities. Consequently, the time difference can, again, be overestimated. Another point to note is that the PNA FAD tracking programme started in 2016. No matching could therefore be found with buoys found stranded before 2016. Moreover, the PNA tracking database does not include the full trajectories of buoys, with some buoy trajectories having been "geo-fenced" (Escalle et al., 2023) with the part of trajectories outside PNA country EEZs removed. Complete trajectories from both the WCPFC and the IATTC CAs would therefore be needed to identify more accurately the origin of buoys, and the time buoys were drifting before reaching coastal areas.

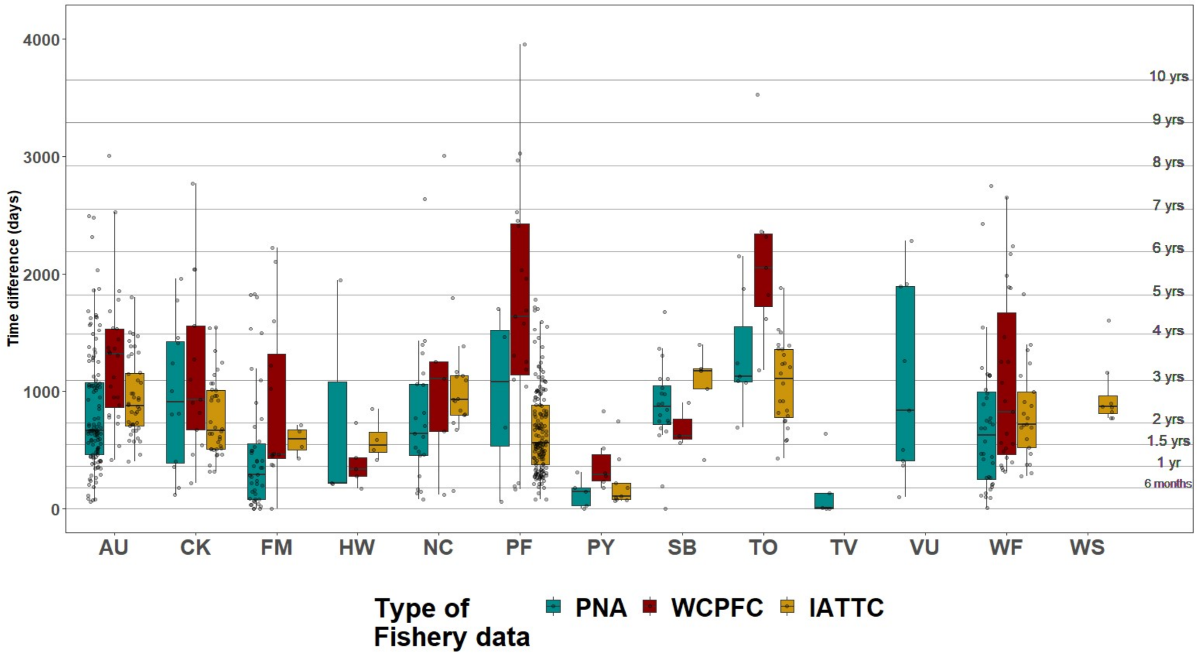

Figure 16. Boxplots of time difference between the date found stranded and the last known position in the fishery databases: the PNA FAD tracking data, the WCPFC observer data and the IATTC observer data (note that no confidential data was shared between organisations; e.g. vessel ID, flag ID, satellite buoy track); by PICT of stranding event. Grey dots indicate an individual stranding event. The lower and upper box boundaries indicate the 25th and 75th percentiles, respectively, the black line indicates the median, and the lower and upper error lines indicate the 10th and 90th percentiles, respectively. AU = Australia; CK = Cook Islands; FM = Federated States of Micronesia; HW = Hawai'i; NC = New Caledonia; PF = French Polynesia; PY = Palmyra; SB = Solomon Islands; TO = Tonga; TV = Tuvalu; VU = Vanuatu; WF = Wallis and Futuna; WS = Samoa.

4. Discussion and next steps

This paper presents the in-country data collection programmes related to dFADs found in coastal waters and on coastlines, as well as the development of a regional database. Data collection is now in place in 16 PICTs: American Samoa, Australia, Cook Islands, Federated States of Micronesia, French Polynesia, Guam, Hawai'i, Republic of the Marshall Islands, New Caledonia, Republic of Palau, Palmyra, Solomon Islands, Kingdom of Tonga, Tuvalu, Samoa, Wallis and Futuna. In the EPO, the voluntary collection of stranded FAD information has also been discussed, with some interested countries, and has started in the Galapagos and potentially other EPO coastal states (see Appendix 1). So far, more than 3,500 stranding events have been recorded, from data collected as far back as 2006. When compiling data from all the different programmes, considerable work in processing, and cleaning the data was necessary to standardise the data collected, while the database also includes links to supplied pictures that were sometimes used to complement the data entered. We also note that the data collection effort is spatially and temporally variable throughout the region, as most programmes are based on voluntary reports from communities, while others used dedicated surveys (e.g., French

Polynesia). In addition, in many places, the first step in the data collection effort included an inventory of all the buoys and FADs that had been stranded on the coastline. Future data collection will allow the identification of the rates of stranding events over a given time. It is important to highlight the growing involvement by more PICTs and the increased use of dedicated surveys, either with the use of drones, or directly in person, which improves temporal and/or spatial scope of stranding events in certain areas.

Data is currently collected at the national level in each PICT on paper and later transferred to their own database through the use of Google Drive spreadsheets, and all of these individual databases feed a regional data collection effort held at SPC. With increasing reporting rates and number of PICTs involved in the programme, the use of an app could be considered. In the future, dFAD stranding officers or coordinators may be needed to account for the large amount of data received.

As mentioned previously, some of the data collection programmes are independent initiatives in specific PICTs (Appendix 1); other independent initiatives may also be occurring throughout the Pacific Ocean. In addition, in oceanic waters, some fishing companies likely sell or collect lost or abandoned dFADs from their own and other fleets and store them in port storage areas to be returned or traded back to company owners.

Relating to initiatives to reuse buoys found stranded throughout the Pacific and elsewhere, several buoy companies have launched their own repurposing programme, such as Satlink “ReCon”, Marine Instruments “Blue Recovery” and Zunibal “Searcle” projects. SPC, on behalf and in partnership with some of its member countries and territories have joined these 3 initiatives. Satellite buoys used in the purse seine fishery have useful functions such as GPS and echosounder which could equip artisanal anchored FADs and benefit local communities if they are found in good condition (e.g., Palau, New Caledonia, Cook Islands) or track marine debris (e.g. Australia, see Appendix 1). While such devices remain expensive for many fisheries departments and organisations in PICTs, the option to give a second life to buoys found stranded presents double benefit of being useful for local communities and decreases the coastal pollution burden as there are often very limited options for local recycling. For buoys found broken, it is important to provide recommendations on how to recycle and/or reuse different components and strengthen collaboration between buoy providers and fisheries departments and local associations working on this subject. As an example, Tangaroa Blue Foundation and Satlink are developing a recycling framework for the Satlink buoys, which involves designing a new tool to open up the buoy, as well as mapping recycling pathways for the components. Project ReCon partners will have access to these resources in the future.

In this paper, we presented an updated analysis on the data collected in the stranded FAD regional database (i.e., an update of SC19-EB-WP-04). This highlighted the extent of FAD and buoy stranding events in the WCPO. The type of stranding events, materials of the FADs found stranded, as well as the impacted habitats and the environmental damage detected were studied. Information collected through the data collection programmes and analysed here could also help prioritize and explore potential FAD retrieval programmes in the future, as a measure to mitigate the impacts of lost FADs in the environment. Some PICTs such as French Polynesia, American Samoa or the Federated States of Micronesia express strong interests to launch a FAD watch/retrieval programme based on the FAD watch programme model implemented by TNC in Palmyra based on collaboration with the fishing industry. A similar effort is being piloted in the Galapagos by TUNACONS, and collected 48 FADs since

2022 in collaboration with local fishermen (Moran and al., 2025).

A comparison with existing dFAD-related databases in the Pacific Ocean (e.g., WCPFC and IATTC observer data and PNA dFAD tracking data) was conducted and helped identify the origin (monitoring vessel, the flag and CA) and in many cases, some of the “life history” of the dFADs (area and date of last known position, drift patterns). Note that no confidential information was shared by IATTC to SPC (e.g., vessel ID, flag ID, satellite buoy ID). Some buoys found stranded could not be matched with the fishery data investigated (62.4%). This could be because; i) we did not have access to all the buoy trajectories in the Pacific Ocean (incomplete and modified trajectories from the PNA FAD tracking programme in the WCPO and no confidential trajectory data for the IATTC CA at time of analyses); ii) observers cannot always record the buoy ID accurately from dFADs set on or visited by vessels; and iii) not all dFADs are set on or visited during their lifetime (see Ovando et al. (2025), for a complete assessment of lifespan dynamics in the EPO). In-situ data will always be an underestimate, as not all the stranding events being reported or the identification number could be partially recorded. However, dissemination, communication and involvement of a large portion of the public, including fishermen and other stakeholders, but also the involvement of the fishing industry could help improve data collection and reporting levels and quality.

Additional countries and territories should consider implementing similar data collection programmes and participating in this regional initiative. More reliable and relevant quantification of dFAD strandings or drifting nearshore, development of FAD recovery programmes, as well as assessment of ecosystem impacts will be possible through long-term spatially-relevant data collection programmes, including countries and territories with low or no FAD fishing effort. Although the WCPFC and IATTC are currently moving towards fully non-entangling and biodegradable dFADs, such designs can still have an impact on the environment and sensitive habitats, and there are no biodegradable options for the buoys. This programme will be relevant and timely as these transitions of FAD materials take place and the variety of data being collected will be useful for exploring dFAD management options in the Pacific Ocean.

We invite WCPFC-SC21 to:

- Note the levels of FAD stranding being reported and provided for the regional database;
- Recognise the need for increased support of in-situ stranded FAD data collection and reporting
- Encourage additional PICTs to participate in this programme;
- Recognise the importance of FAD-buoy trajectory data, including historical data, from both the WCPFC and the IATTC CAs, to better inform development of management and mitigation options
- Note the need to develop initiatives to reduce FAD loss and abandonment, including through potential offshore FAD retrieval programmes;
- Encourage the development of other initiatives (e.g. FAD watch) by the members, to increase recovery of dFADs reaching coastal areas;
- Promote and support initiatives to process and re-use or recycle FAD materials and buoys in ports and local communities.

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Appendices

- Appendix 1. Description of stranded FAD data collection in independent programmes
- Appendix 2. Data collection form for fisheries officer
- Appendix 3. Supplementary figures

Appendix 1. Description of stranded FAD data collection in independent programmes

At Palmyra Atoll, TNC and the U.S. Fish and Wildlife Service (USFWS) have collected data on dFAD strandings since 2009. Visual surveys across shallow reefs, lagoon flats, and beaches have been opportunistically linked with other projects; however, now that consistent stranding areas have been established, specific surveys are being scheduled across all 12 months of the year. Designs of the stranded dFADs, the materials used, and the environmental impacts are described. When a satellite buoy is present, and the identification number is visible, it is also recorded. A dFAD Watch-type programme (Zudaire et al., 2018) has also been in place at Palmyra Atoll since June 2021. In this programme, fishing companies alert local partners if a dFAD comes close to Palmyra Atoll's shores, so it can be removed before causing any environmental damage.

In Hawaiʻi, the stranded dFAD collection was first initiated by Sarah-Jeanne Royer as a member of Nikolai Maximenko's group at the University of Hawaiʻi at the International Pacific Research Center. The programme is now being monitored by the Center for Marine Debris Research (CMDR) at Hawaiʻi Pacific University (HPU). The data collection started in 2014 and has expanded to include several collaborators that report the findings to the research group. When the geographical location of the dFADs is known, some buoys are re-directed to the island of Oahʻu and stored in a warehouse to potentially repurpose the buoys to tag and track marine debris like fishing nets. A recent project provides a financial incentive to commercial fishermen that retrieve derelict dFADs at sea, which has resulted in the Hawaiian longline vessels removing several complete dFADs from fishing grounds far offshore of Hawai'i.

French Polynesia has also started a large project to quantify the number of dFADs drifting within its EEZ, including the number of stranded dFADs, and their ecosystem impacts. The programme involves several components: i) data reported by local communities through a form that can be directly downloaded or filled in on the marine resources authority's website (http://www.ressources-marines.gov.pf/dcpech); ii) dedicated surveys in 9 islands of the Tuamotu (Hao, Amanu, Raroia, Rangiroa, Reao, Tikehau, Tureia, Raraka, Fakarava), with visits to local communities, shoreline surveys using a drone, shore cleanings, and FAD recycling operations.

In Australia, Tangaroa Blue Foundation (TBF) coordinates the Australian Marine Debris Initiative® (AMDI), an on-ground network of volunteers, communities, organisations and agencies around the country removing, documenting, and preventing marine debris and plastic pollution. The AMDI Database is the largest marine debris database in the southern hemisphere, with more than 28 million litter items recorded at more than 4,900 clean-up sites since 2004. Marine debris data are collected via community clean-ups or as part of regular site-specific monitoring programmes. In particular, data on dFAD strandings have been recorded in the AMDI Database since 2004 across Australia's coasts, with the majority found along the coast of Queensland. Satellite buoys were recorded frequently prompting Satlink, one of the buoy providers, to partner with TBF to develop Project ReCon: a recover, repair, reuse and recycle programme of satellite buoys. TBF and their partners in the AMDI collect satellite buoys found during clean-up events and Satlink then liaises with the industry to facilitate reassigning ownership of these buoys from the commercial fishing fleet to TBF. Once a buoy is part of the project ReCon, Satlink and TBF check the buoy's condition and find a suitable re-use project, such as scientific research, tagging and recovering ghost nets, etc. Buoys are then stored by community partners from a variety of sectors (i.e., tourism, charter operators, and Aboriginal and Torres Strait Island Rangers), so that they can be deployed on ghost nets that cannot be immediately recovered when located due to their size or the capacity of the vessel that found them. Previously, recordings of dFADs and buoys were limited to stranding events; however, Project ReCon helps improve understanding of dFADs found in the coastal waters of Australia. Historical data that were transferred to the regional database at SPC focused mainly on satellite buoys, however, historical information related to dFADs exist and will be transferred to the SPC database in the future.

In Galapagos, a programme led by Galapagos Conservation Trust and the Galapagos National Park has been in development since 2024, with data that has started to be collected, but not shared with SPC or IATTC yet. The programme will aim to evaluate both opportunistic sightings of dFADs and pilot data where dFADs have been quantified along remote coastlines using drone surveys and during coastal clean-up activities. In addition to these efforts, private initiatives such as a voluntary dFAD recovery programme started in 2022 by the Tuna Conservation Group (TUNACONS) – a consortium of Ecuadorian tuna fishing companies, has recovered dFADs thorough coordination between the TUNACONS –adhered fleet, local coordinators and local fishers (see FAD-09-RD-C).

At the IATTC, discussions on the implementation of a voluntary-based data collection programme on stranded FADs in the EPO have been initiated with their members with multiple CPCs showing interest to participate. IATTC and SPC staff have been collaborating in informal meetings to discuss elements needed to launch a voluntary regional data collection programme in the EPO to harmonize and standardize data collection forms between the two organisations to the extent possible. The elements discussed included the need for developing regional awareness campaigns and communication materials, leveraging local initiatives, securing funding, and coordinating training sessions on data collection and data entry methods. Using a harmonized and dedicated form will facilitate data comparison and exchange between the two organisations, thereby strengthening collaboration and enhancing the regional data collection programme to support Pacific-wide coverage, as recommended by the IATTC FAD-WG and the Commissions.

Appendix 2. Data collection form for fisheries officer

FAD Sighting form v3

Form details Date: __________ Form nb: _____
Completed by: ______________________________

1/2

Type of data
☐ opportunistic ☐ community report
☐ survey* (☐ in-person, ☐ drone)
*Survey name: ____________________

Observer/person who found the FAD/buoy
Name: ______________________________
Phone number: ______________________________
or Email: ______________________________

Entered in the database ☐
Entry number: __________

Sighting information

Date found (yyyy/mm/dd): ______________ **Island:** ______________________________

Location *(Describe where it was found, village/beach name)*: ______________________________

Coordinates *(if possible, in decimal)*: **Latitude:** ______________ **Longitude:** ______________

Environment: ☐Beach ☐Coral reef ☐Drifting in the lagoon ☐Drifting in the ocean ☐Rocky shore ☐Mangrove ☐Private property (found previously*) ☐Wharf (found previously*) ☐Landfill (found previously*) ☐Unknown ☐Other: __________

*If found previously:
- Initial date (yyyy/mm/dd): ______________________________
- Initial location: ______________________________
- Initial environment: ☐Beach ☐Coral reef ☐Drifting in the lagoon ☐Drifting in the ocean ☐Rocky shore ☐Mangrove ☐Unknown ☐Other: __________

Buoy information

Buoy present: ☐ Yes ☐ No

Buoy type: ☐ Satellite (used on dFADs) ☐ Radio (used on longlines) ☐ Oceanographic ☐ GPS ☐ Unknown ☐ Other: __________

Buoy ID Number *(n.b.: on Marine Instruments buoys, "PR0043" is not an ID number)*: ______________________________

Buoy condition: ☐ Modified/reused by communities

☐ Whole buoy
- ☐ Intact
- ☐ Damaged:
  - ☐ Minor cracks on top case
  - ☐ Cracked top case
  - ☐ Cracked bottom case
  - ☐ Cracked plastic circle
  - ☐ Cracked echosounder
  - ☐ Water inside
  - ☐ Other: __________
- ☐ Unknown Damages

or

☐ Buoy part only *(Tick one or several)*
- ☐ Electronics
- ☐ Plastic case (top)
- ☐ Plastic case (bottom)
- ☐ Other: __________
- ☐ Unknown

or

☐ Unknown

Marks on the buoy: ☐ Yes (*specify*): ______________________________ ☐ No ☐ Unreadable ☐ Unknown

Fate of the buoy? ☐Left in the environment ☐Removed from the environment (*tick if "found in a private property"*) ☐Unknown

Only if removed from environment, purpose: ☐ Left with the finder ☐Storage (where?): ______________ ☐Landfill ☐Research ☐Recycled ☐Re-used (*specify*): ______________ ☐Unknown ☐Other: ______________

FAD Information

FAD present: ☐ Yes ☐ No

FAD type: ☐ anchored FAD (aFAD) ☐ drifting FAD (dFAD) ☐ Part of dFAD ☐ Log ☐ Unknown ☐ Other: ______________________________

FAD condition: ☐Intact ☐Beginning to break ☐Mostly fallen apart ☐Unknown

Marks on the FAD: ☐ Yes (*write it down*): ______________________________ ☐ No ☐ Unreadable ☐ Unknown

Shape of the raft: ☐Square ☐Rectangular ☐ Buoys sausage ☐Cylindrical ☐Unknown ☐Other: ______________

FAD Sighting form v3

Form details Date: __________ Form nb: _____
Completed by: ____________________________

2/2

Raft materials *(Tick one or several)*

Raft materials structure and flotation: ☐Bamboo ☐Log ☐PVC ☐Floats ☐Plastic drum ☐ Fiberglass drum ☐Metal drum ☐Steel ☐Polystyrene ☐Unknown ☐Other: ____________________

Raft materials covering: ☐None ☐Ropes ☐Nets ☐Plastic sheeting ☐Canvas ☐Unknown ☐Other: ____________

If net present in the raft, mesh size : ☐ Small (<7cm) ☐ Large(>7cm) ☐ Small & Large ☐Unknown

Estimated size of the raft (m) *(Length x Width)*: __________ x __________ or ☐Unknown

Underwater component/tail *(Tick one or several)*

Submerged tail presence *(i.e., part of the FAD normally under water)*: ☐Yes ☐No ☐Unknown

Submerged tail materials: ☐Unknown ☐Net ☐Rope ☐Canvas ☐Plastic sheeting ☐ Bamboo ☐ Fishing lines ☐Other: ____________________

Design of the tail: ☐ Open net, mesh size: ☐Small (<7cm) ☐Large(>7cm) ☐Other: ____________
☐ Net rolled up in bundle, mesh size: ☐Small (<7cm) ☐Large(>7cm) ☐Other: ____________
☐ Other: ____________________
☐Unknown

Estimated depth of submerged tail (m): ____________________ or ☐Unknown

Fate of the FAD

Fate of the FAD? ☐Left in the environment ☐Sunk ☐Raft removed, tail section left ☐Unknown ☐Removed from the environment (*tick if "found in a private property"*) ☐Other: ____________

Only if removed from environment, purpose: ☐Burned ☐ Left with the finder ☐Landfill ☐ Research ☐ Recycled ☐Re-used (*specify*): ____________ ☐Other: ____________ ☐Unknown

Impact on / interaction with marine life *(Tick one or several)*

Environmental damages caused by the FAD :

Entangled animals: ☐ Yes ☐ No ☐Unknown	Entangled on corals: ☐ Yes ☐ No ☐Unknown
Entangled animals? ☐ Turtle ☐Shark ☐Fish ☐Marine mammal ☐Unknown ☐Other: ________ **Status:** ☐Dead ☐Alive ☐ Unknown **Species** (*if known*): ________ **Number of individuals**: ________	**If FAD is entangled on coral reef, please state the approximate size of the area impacted (m²)**: ________

Fish caught during a set on the FAD: ☐No ☐Yes ☐Unknown	**Fish or other animals aggregated around the FAD :**
If yes, **Species** (*if known*): ________ If yes, **Weight of the catch (in kg)** (*if known*): ________ **Number of individuals**: ________	☐No ☐Yes ☐Unknown If yes, **Species** (*if known*): ________ **Number of individuals**: ________

Comments: ____________________

Number of pictures: _____

Appendix 3. Supplementary figures

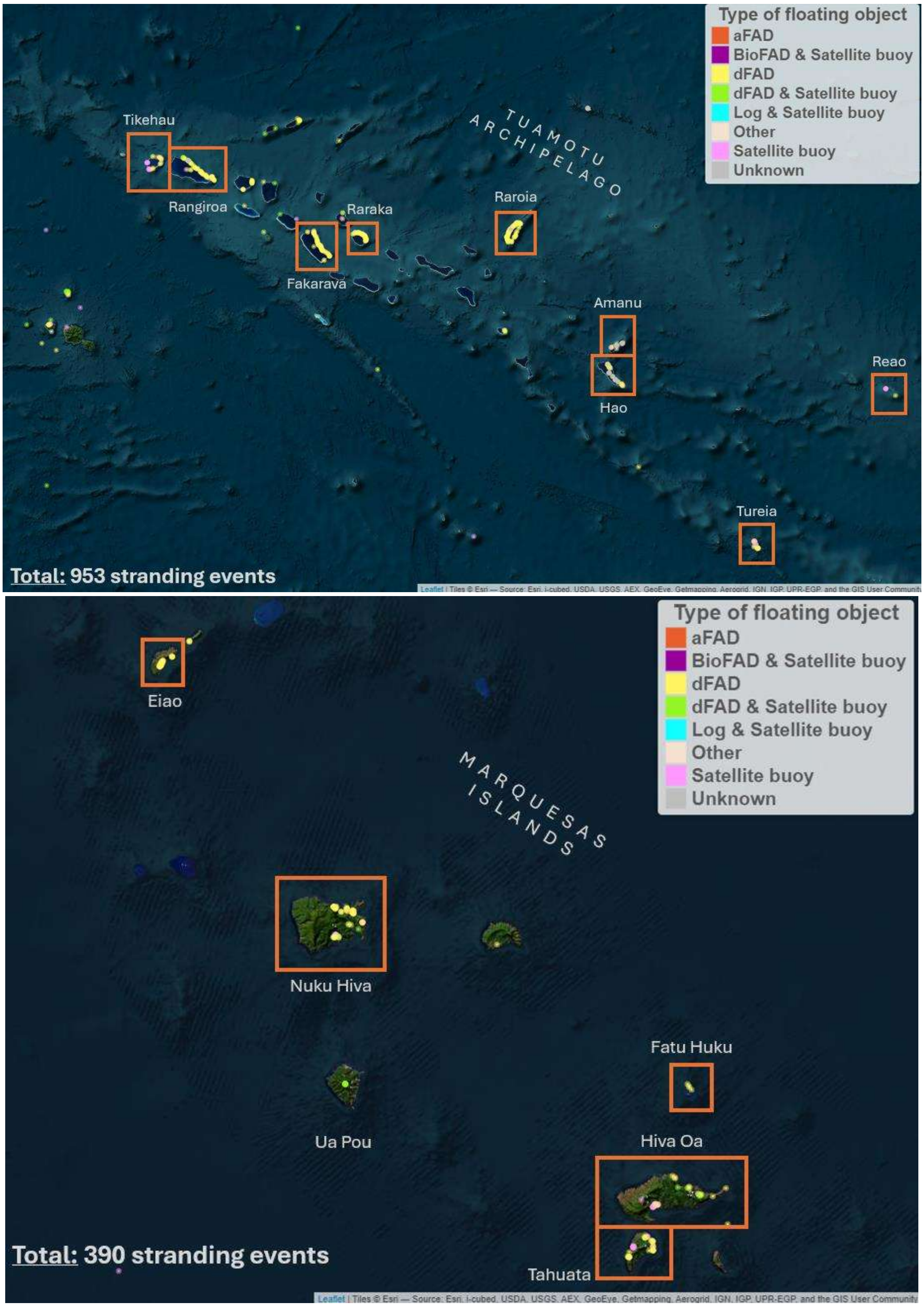

Figure S3.1. Map of stranding events by type of object in some islands of the Tuamotu Archipelago (top) and Marquesas Islands (bottom) (French Polynesia) between 2019–2025. Islands inside orange squares are islands where dedicated surveys using drones occurred.

Figure S3.2. Map of stranding events in Rarotonga (left) and in Aitutaki (right) (Cook Islands) by type of object between 2018–2024.

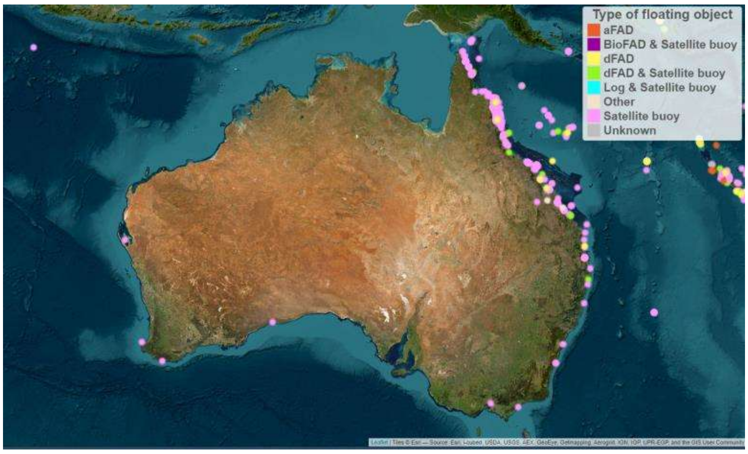

Figure S3.3. Map of stranding events in Australia by type of object between 2006–2025.

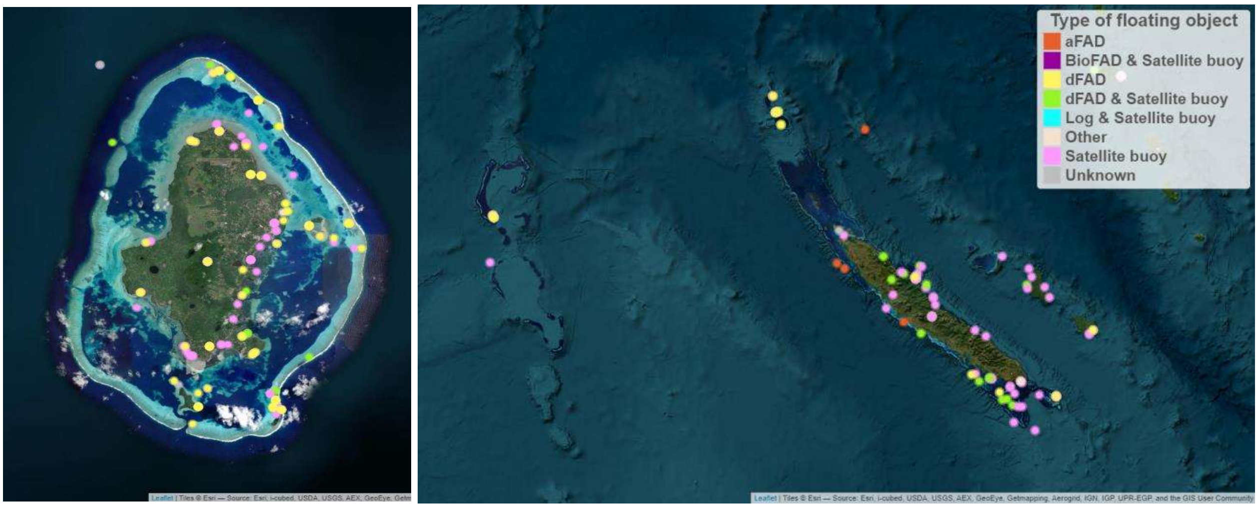

Figure S3.4. Map of stranding events in Wallis (left) between 2013–2025, and in New Caledonia between 2015-2025, by type of object

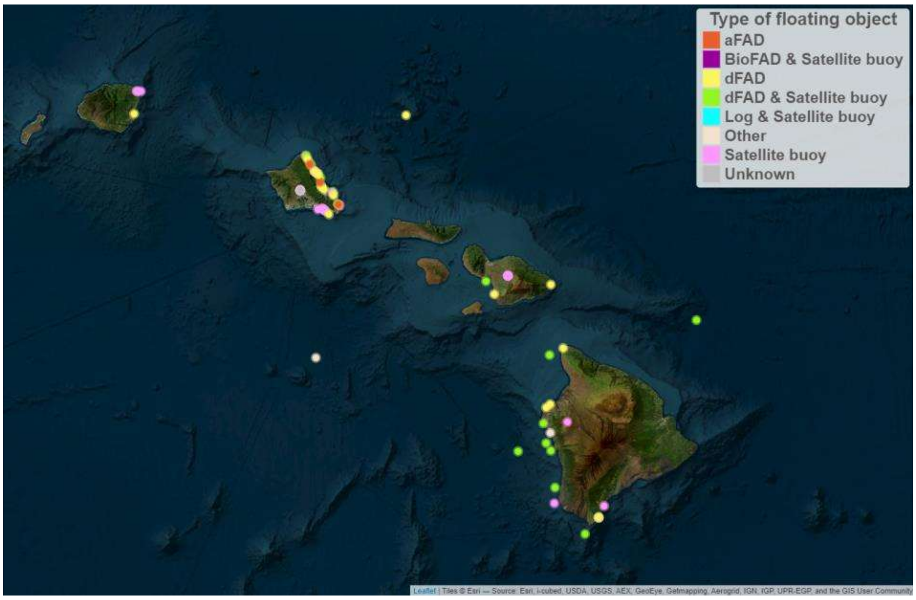

Figure S3.5. Map of stranding events in the Main Hawaiian Islands (Hawai‘i) by type of object between 2014–2025.

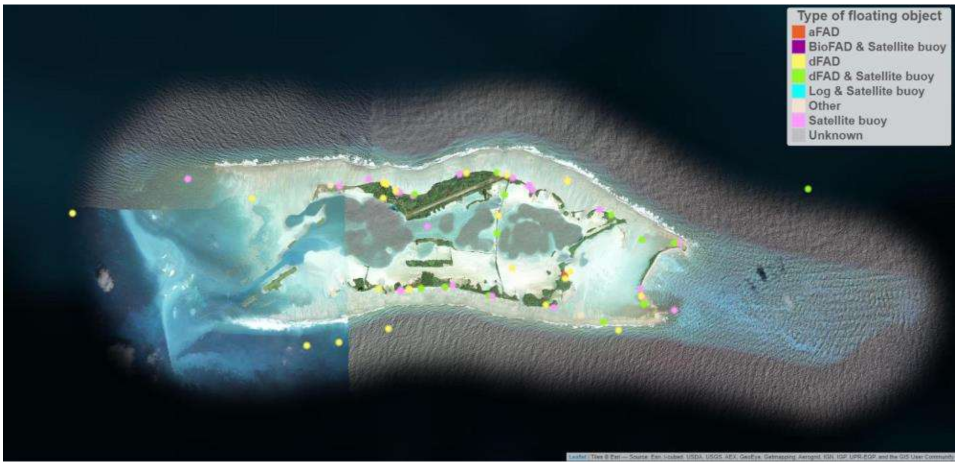

Figure S3.6. Map of stranding events in Palmyra Atoll by type of object between 2009–2024.

Figure S3.7. Map of stranding events in Pohnpei, Ant Atoll and Pakin Atoll (Federated States of Micronesia) by type of object between 2010–2024.

Figure S3.8. Map of stranding events in Mili Atoll (Republic of the Marshall Islands, left) and in Wake Atoll (US, right) by type of object between 2021–2023.

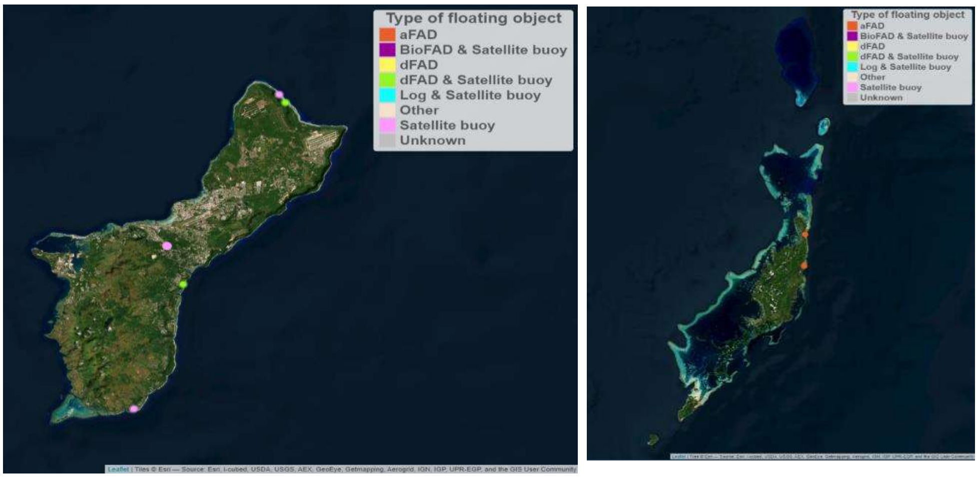

Figure S3.9. Map of stranding events in Guam (left) and Republic of Palau (right) by type of object between 2018–2024.

Figure S3.10. Map of stranding events in Samoa (left) and American Samoa (right) by type of object between 2015–2025.

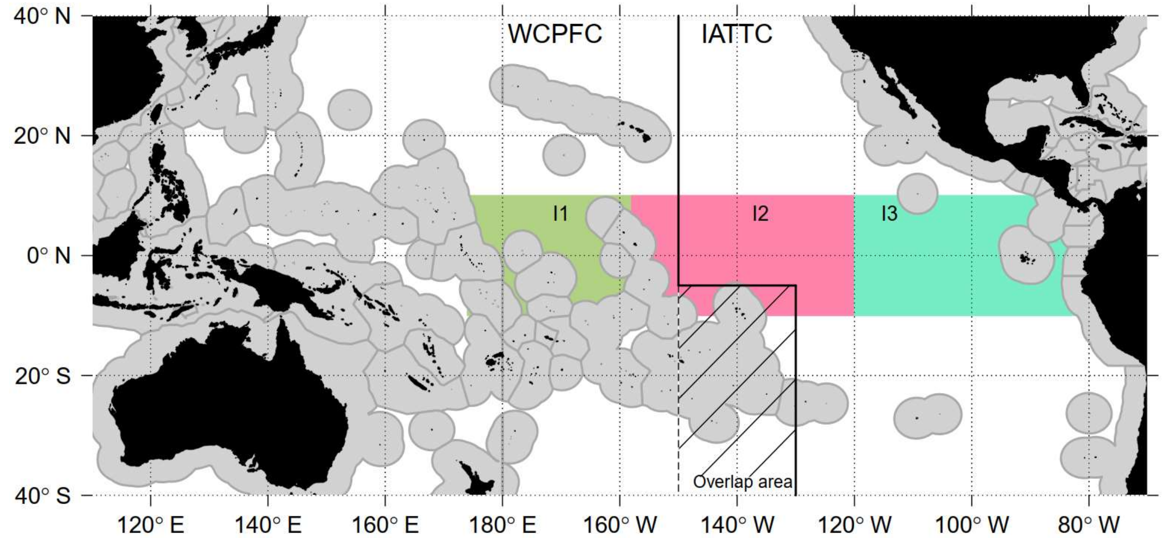

Figure S3.11. Map of the WCPFC and IATTC Convention Areas, including the overlap area. Areas of international waters I1, I2, and I3, as used in Figure 15, are indicated in green, pink and light green.