

## Sharing knowledge and building collaboration to guide research and development on fish aggregating devices in the Pacific

### Background

In the late 1970s, fish aggregating devices (FADs) were introduced in the Pacific Islands region to support industrial tuna fishing. Initially, FADs were anchored (a-FADs) (Fig. 1) to the seabed in archipelagic waters away from inshore reefs and islands, and the aggregated tuna were harvested mostly by pole-and-line fishers. While oceanic purse-seine operators had long realised that setting on drifting logs or even whales or whale sharks could produce good tuna catches, the use of purpose-built FADs was not practical in deep oceanic waters. With the development of radio buoys in the 1980s, and satellite global positioning system tracking technology through the late 1990s and early 2000s (Fig. 2), this situation changed. FADs could be set free to drift throughout oceanic waters, aggregating tuna species (skipjack, yellowfin and bigeye) as they drifted, and then be easily relocated by fishing vessels. The use of these drifting FADs (d-FADs) has now become widespread by industrial tuna purse-seine fleets. The addition of affordable echosounder technology to these buoys beginning in the mid-2000s further increased the attractiveness of d-FADs because skippers could make informed decisions on which d-FAD was likely to produce suitable catches, given travel distances and other operational considerations. These technological developments in d-FAD

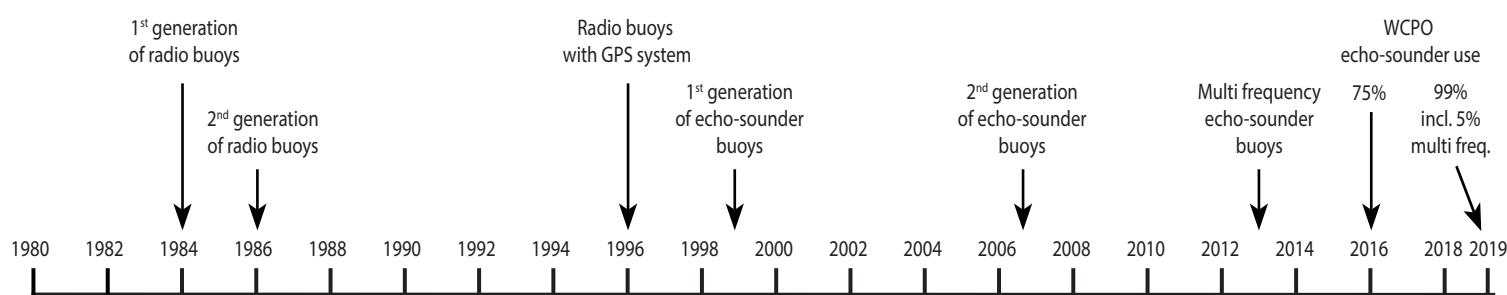
buoys have transformed the way oceanic tuna purse-seine fleets operate in the Pacific and elsewhere.

The operational and economic benefits of these new buoy technologies are plainly demonstrated by their uptake, with recent data indicating that 99% of d-FADs in the western and central Pacific Ocean now have satellite echosounder buoys (Escalle et al. 2020a) (Fig. 2). There are concerns, however, regarding how this technology is being used and managed. Dedicated research and development work is required to address these concerns. For example, there is a need to improve data collection and monitoring systems for d-FADs, mitigate ecological and marine pollution impacts, and better understand the implications of large-scale d-FAD use for tuna behaviour and the interpretation of catch and effort data used in stock assessments (Leroy et al. 2012; Escalle et al. 2020a; Vidal et al. 2020). Finally, d-FADs have no doubt increased the effectiveness of purse-seine tuna fishing, such that a day of purse seine fishing now likely returns, on average, greater catches for the same stock abundance than it would have, say, 10–20 years ago. While this improved effectiveness is desirable for the economics of the fishery, quantifying how much this “effort creep” has influenced catch rates is important as it may have implications for effective application of effort-based management approaches, such as the successful vessel day scheme.<sup>1</sup>

<sup>1</sup> <https://www.pnatuna.com/vds>



Figure 1. L: Anchored FAD used by pole-and-line tuna vessels. (image: © Lindsay Chapaman, SPC, 1982) R: Drifting FAD, equipped with a radio buoy with a GPS system to locate it, used by tuna purse seiners. (image: © Jeff Dubosc, SPC, 2015)



Modified from Lopez et al. 2014

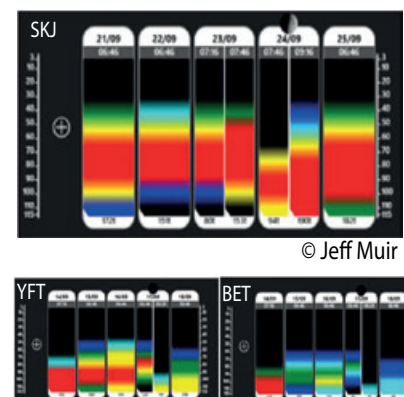
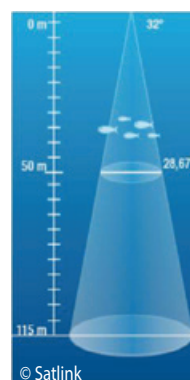


Figure 2. Drifting FAD use development timeline (modified from Lopez et al. 2014).

As the industrial tuna fleet switched to d-FADs, interest from coastal communities in the use of a-FADs closer to shore increased (Fig. 3). Interestingly, awareness of the potential of nearshore a-FADs to benefit artisanal, subsistence and small-scale commercial fishers in the western tropical Pacific was apparently sparked by the pole-and-line fishery, which harvests live baitfish from nearshore waters and lagoons. Crew on pole-and-line vessels often came from island communities. They observed how the FADs worked in aggregating tuna and asked the pole-and-line companies to place a-FADs closer to shore for their communities to utilise in return for the harvesting of baitfish from their local waters. Farther east, a-FADs, were also being developed in Hawai'i under the guidance of Japanese practitioners. By the 1980s, a-FADs, also referred to as artisanal FADs, were being deployed in various locations throughout the tropical Pacific region (Desurmont and Chapman 2000).

Early experience with a-FADs in inshore locations suggested that they could provide enhanced fishing opportunities and food supply to island communities, among other perceived benefits. More recently, the use of a-FADs has also been suggested to have potential benefits in alleviating overexploitation of reef fish species, but this has yet to be clearly demonstrated by any studies. While it is thought that a-FADs can enhance opportunities for artisanal and small-scale commercial fishers to access pelagic fish resources (e.g. tunas, mahi mahi, mackerels) (Bell et al. 2015), sustainable long-term a-FAD programmes remain elusive for many Pacific Island countries and territories.

Developing effective and sustainable a-FAD programmes continues to be limited by several information gaps, some that have been recognised for a number of years (Campbell et al. 2016). In particular, despite a-FADs being deployed in some Pacific Island countries, territories or states for over 20 years (e.g. French Polynesia, Hawai'i, Cook Islands, Fiji, Kiribati), there are limited data available on catches, effort, and socioeconomic or ecological benefits of a-FADs (but see Albert et al. 2014; Tilley et al. 2019). It is also recognised that success involves more than just a-FADs attracting fish; communities need to be equipped with vessels, gear and the necessary skills to fish the FADs safely and effectively. Without this information across various locational contexts, it is difficult to support cost-benefit analyses to establish cases for sustained funding and government staff commitments to underpin resilient a-FAD programmes (Campbell et al. 2015; Albert and Sokimi 2016). a-FAD deployments in most Pacific Island countries and territories have thus been *ad hoc* and dependent on intermittent donor or government funding and sporadic staff support from fishery agencies. This appears to have been the case for several decades in many countries (Desurmont and Chapman 2000). Furthermore, there is a lack of information from appropriately designed comparative studies to inform the development of practical guidelines on where, when, how and what types of a-FAD designs will be most effective at aggregating specific species and producing the desired social, economic or ecological benefits, while minimising any negative environmental impacts.





Figure 3. L: Fishing around an artisanal a-FAD in Niue. (image: William Sokimi, SPC) R: Rounding a d-FAD with the purse seine. (image: © SPC)

Finally, the increased use of d-FADs by industrial tuna fleets is now having the consequence that island communities are experiencing increased interactions with d-FADs as they drift into nearshore waters, snag on reefs and mangroves, and wash up on beaches (Escalle et al. 2019, Escalle et al. 2020b).

Currently, most d-FADs are not recovered by industrial fleets once their productive life is over, or they drift out of a company's geographic fishing area, and many others are simply lost (Escalle et al. 2020a). The implications of lost and abandoned d-FADs for island communities and marine pollution, along with other ecological and fishery implications of their large-scale use, are slowly being understood. This has generated increased interest by environmental non-governmental organisations and the general public, which are questioning the legality and management of d-FAD use (Hanich et al. 2019, Gomez et al. 2020) and asking the purse-seine tuna industry how they intend to mitigate, manage and reduce the negative implications of large-scale d-FAD use.

At this point of time in the history of FADs in the tropical Pacific, there is an interesting contrast between the situation with a-FADs and d-FADs. For a-FADs, many countries desire to expand their use to achieve socioeconomic objectives. Development is however constrained by the lack of basic information on return for investment, how a-FAD programmes integrate with broader food security and livelihood strategies, and limited resources. For d-FADs, there are concerns that their use has expanded too much and a recognition of the need for better information to inform sustainable management and mitigation of undesirable impacts. Recent research efforts to design and test non-entangling and biodegradable d-FADs, and improve systems of recording and tracking d-FAD deployments, are seen as positive steps forward.

## The FAME FADs Workshop

Due to the common interests in FAD research and development, and the extensive FAD-related experience and skillsets within the Fisheries, Aquaculture and Marine Ecosystem (FAME) Division of the Pacific Community, FAD research and development is an obvious area to explore opportunities for collaboration and integrative programming.

On 24 and 25 November 2020, staff from FAME's Oceanic Fisheries Programme (OFP) and Coastal Fisheries Programme (CFP) convened a workshop to share knowledge, talk about their work areas and challenges, and explore collaborative opportunities in the area of FAD research and development. The workshop was also attended by several guest speakers who gave presentations on their FAD-related work, and visions for FAD research and development in their countries and farther abroad.

## Outcomes

Presentations from OFP and CFP staff highlighted their breadth of knowledge about FADs and outlined the current research and development work that FAME is involved in. Staff also highlighted areas where FAME could contribute further to regional progress in FAD issues through greater internal collaboration.

The CFP team are regional experts in the technical aspects of a-FAD design, construction and deployment (see "Lessons learned from deploying 380 fish aggregation devices" p. 23 in this issue). Specifically, their main FAD-related work and interests centre around:

- the design of a-FADs;
- the development of manuals on a-FAD materials, design and deployment;
- providing training in a-FAD design, construction and deployment (Fig. 4);
- supporting countries in developing a-FAD programmes; and
- providing education on sea safety and fishing techniques related to a-FADs.

The OFP team are regional leaders in scientific research and monitoring of industrial d-FADs (Fig. 5), with high-level skills in tuna biology and behaviour, data collection and management, modelling and statistical analysis. Specifically, their main FAD-related work and interests centre around:

- improving data and approaches for monitoring trends in the use, distribution and number of d-FADs in the western and central Pacific Ocean, in partnership with the Parties to the Nauru Agreement, NGOs and several fishing companies;

- understanding the implications of d-FADs for increasing fishing efficiency (referred to as effort creep) and fishery-dependent data used in stock assessment;
- determining the bycatch and ecological implications of d-FADs and options for mitigation, including non-entangling and biodegradable d-FADs;
- understanding the impacts of d-FADs on target tuna species behaviour and fitness;
- examining d-FAD beaching; and
- supporting citizen science monitoring, mitigation, public awareness and communication.

A key outcome of the workshop was to make progress towards combining these practical and analytical skill sets in collaborative research efforts to fill knowledge gaps and guide solutions to regional development barriers and issues around FAD use. Through several breakout groups, the following areas were identified as initial priorities for collaborative projects between OFP and CFP:

#### *Improving the information base and approaches for monitoring and evaluating fishery, social and economic performance of artisanal a-FADs*

- Conduct an initial desktop project to map and analyse available data held by SPC on a-FAD fishing activities and deployments,
- Develop feasible best practice approaches to monitor and evaluate the performance of a-FADs within the Pacific Island context.

#### *Adding value to a-FAD deployments*

- Trialling acoustic buoys on a-FADs to explore the value these may add for a-FAD users, and increasing understanding of fish-FAD interactions and interpretation of acoustic buoy data.
- Contribute to research on the development of biodegradable materials and designs for d-FADs by testing biodegradable materials, in particular flotation materials, on a-FADs.

#### *Communicating SPC's regional science and technical role in the area of FADs*

- Developing an integrated SPC FAD communications strategy and approaches, including defining SPC's mandate and key messages for FAD-related research and development and communication on key issues.

These project ideas will now be further developed and options for funding support explored as necessary.

We would like to thank the presenters and participants who contributed to the workshop, with special acknowledgement of the guest speakers: Mainui Tanetoa (Senior Fisheries Development Officer, Directorate of Marine and Mining



Figure 4. William Sokimi, SPC Fisheries Development Officer (Fishing Technology) assembling an a-FAD. (image: © Boris Colas, SPC)



Figure 5. Lauriane Escalle, SPC Fisheries Scientist (Purse-seine Dynamics), analysing d-FAD data. (image: © Elizabeth Heagney, SPC)



Resources, French Polynesia), Alex Tilley (WorldFish, Asia Pacific), James Wichman (Vice President, Pohnpei Fishing Club, Federated States of Micronesia) and Clay Hedson (Coastal Fisheries Specialist, Office of Fisheries and Aquaculture, Pohnpei State, Federated States of Micronesia), and Johann Bell (Professorial Fellow at the Australian National Centre for Ocean Resources and Security, University of Wollongong, Australia).

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