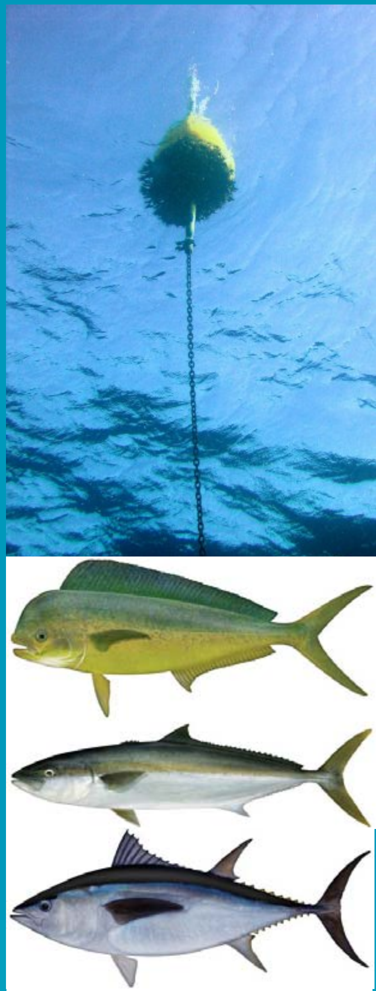

Photos courtesy of NSW Fisheries

Victorian Fish Aggregation Devices

Feasibility Assessment and Concept Design

Recreational Fishing Grants Program Research Report

State Government Victoria

Your fishing licence fees at work

DEPARTMENT OF PRIMARY INDUSTRIES | fisheries

Victorian Fish Aggregation Devices Feasibility Assessment and Concept Design

Project number: RFGP/11/12/13

March 2013

Recreational Fishing Grants Program Research Report

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Executive Summary

Fish Aggregation Devices (FADs) are man-made objects that attract ocean going pelagic fish such as tuna and dolphinfish. They usually consist of buoys or floats tethered to the ocean floor. FADs have the potential to hold fish in specific locations and increase the potential for anglers to successfully target them.

Through experience gained from FAD deployments in national and international waters, scientific studies, and angler input, this project aimed to ascertain the feasibility of establishing a FAD network in waters offshore from Victoria. The feasibility study represents the first stage in the development of a new and exciting fishery for Victoria that will be highly valued by fishers from across the state.

The suggested FAD to deploy in waters offshore from Victoria is a simple design consisting of a float, mooring line and anchor. This design enables ease of deployment / retrieval, and has been demonstrated to aggregate pelagic species.

Pelagic species that show aggregative potential in Victoria include:

- Dolphinfish (*Coryphaena hippurus)*
- Yellowtail kingfish (*Seriola lalandi)*
- Southern bluefin tuna (*Thunnus maccoyii*)
- Striped tuna (*Katsuwonus pelamis*)
- Albacore (*Thunnus alalunga*).

Based on population, infrastructure, ease of access and species availability, three locations were found to have greatest potential: Portland, Cape Woolamai, and Mallacoota. A line of five FADs from inshore to offshore locations which are deployed during January and retrieved during May provides greatest coverage and access to aggregating pelagic species.

As FADs are proposed to be deployed in waters up to and extending beyond 3 nautical miles, their presence must meet requirements under both State and Federal legislation. Consulting with Port Authorities, Australian Hydrographic Service and Seafood Industry Victoria will be required prior to deployment. Suggested FAD locations may change due to legislative obligations and requirements.

Recreational anglers should be engaged through various media to promote the improved fishing opportunities offered by FADs and how best to use them safely. Charter fishers could provide the most cost effective monitoring for determining FAD success should a logbook system of recording species, catch and effort be introduced.

It is recommended that an initial trial is conducted at Portland for at least a two year period before FADs for other regions are considered. The cost of the Portland trial in the first year is about $85,000 and about $58,000 for subsequent years. Catch and effort data acquired from a volunteer charter logbook program will be used to ascertain FAD success and whether to extend the FADs trial to include other locations.

This project was co-funded by the Victorian Government using Recreational Fishing Licence fees and the $16M Victorian Government Recreational Fishing Initiative.

Introduction

FADs are man-made objects that attract ocean going pelagic fish such as tuna, kingfish and dolphinfish. They usually consist of buoys or floats tethered to the ocean floor. Fish tend to move around FADs, rather than remaining stationary below the buoys. FADs have the potential to hold fish in specific locations and increase the potential for anglers to successfully target them.

This project represents the first stage in the development of a new and exciting fishery for Victoria that will be highly valued by fishers from across the state. The project provides increased fishing opportunities for offshore anglers in Victoria by introducing FADs at key Victorian fishing grounds.

This report details a feasibility assessment and design brief for FAD installations located in State and Commonwealth waters off Victoria's coast

Methods

This project will build on learnings from FAD deployments in national and international waters; and seeks angler input on preferred locations to assess the feasibility of establishing a FAD network in waters offshore from Victoria. The most appropriate FAD array and monitoring program for Victoria was devised through:

- Participation at the Second international symposium on: tuna fisheries and fish aggregation devices; where international best practice for FAD design and deployment was discussed
- Acquiring knowledge from NSW Fisheries on suitable design, deployment, permit and approval requirements, and costs of FADs for Australian waters
- A workshop with key stakeholders involved in FAD design, maintenance, monitoring, and codes of conduct.

The assessment will consider:

- Potential gamefish species
- Environmental variability
- Preferred FAD design
- Legislative requirements
- Construction, deployment and retrieval
- Monitoring
- Project costs for partial to full implementation
- Recommendation

Results

Full documentation of results are detailed in Appendix 1.

Potential species in Victoria

The success of a FAD depends largely on the abundance and seasonality of pelagic fish that naturally occur in the surrounding waters. Species may be found some 10 to hundreds of metres from the structure.

The following pelagic species show aggregative potential based on previous studies, their association with FADs in other areas, and their spatial / temporal presence in waters offshore from Victoria.

- Dolphinfish (*Coryphaena hippurus)*
- Yellowtail kingfish (*Seriola lalandi)*
- Southern bluefin tuna (*Thunnus maccoyii*)
- Striped tuna (*Katsuwonus pelamis*)
- Albacore (*Thunnus alalunga*).

Type, location and cost

The suggested FAD to deploy in waters offshore from Victoria is a simple design consisting of a float, mooring line and anchor. This design enables ease of deployment / retrieval, and has been demonstrated to aggregate pelagic species (Figure 1). A Global Positioning System (GPS) mounted within the buoy is used to monitor its position online.

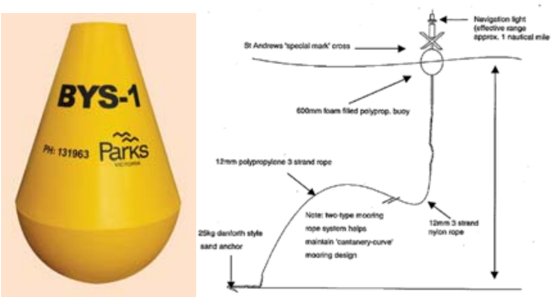

Figure 1. Recommended FAD design for Victoria.

Portland, Cape Woolamai and Mallacoota were three locations considered during a workshop as appropriate for FAD deployment based on species distribution and availability to recreational fishers. Five FADs from inshore to offshore locations were thought to provide anglers with greatest access to the pelagic species most often targeted. Based on environmental conditions, fishing conditions and the need to minimise any likelihood of whale entanglement during migrations, January – May was considered an appropriate period for FADs to be in place.

***Option 1:* Trial: Portland**

Total cost for the first year	$84,577.14
Total cost for subsequent years	$57,484.62

***Option 2:* Partial implementation: Portland and Cape Woolamai**

Total cost for the first year	$135,846.67
Total cost for subsequent years	$93,219.23

***Option 3*: Full implementation: Portland, Cape Woolamai and Mallacoota**

Total cost for the first year	$187,116.21
Total cost for subsequent years	$128,953.85

Legislative requirements

As FADs are proposed to be deployed in waters up to and extending beyond 3 nautical miles, their presence must meet requirements under Federal and State Law and includes:

- Application for *Sea Installation Act* 1987 Exemption Certificate
- Approval through *Environmental Protection and Biodiversity Conservation Act* 1999
- Determine whether *Native Title* applies to FAD location
- Seek consent through Department of Sustainability and Environment for use of public land under the *Costal Management Act*
- Seek a Licence under the *Land Act*. An application will need to be submitted to DSE
- Consult with the Department of Planning and Community Development in determining if an Environmental Effects Statement is required.

Consultation

Prior to deployment consultation is required with:

- Port Authorities
- Australian Hydrographic Service (Notice to Mariners)
- Commercial fishing industry (Seafood Industry Victoria)

Education and Monitoring

A volunteer charter monitoring program should be used to determine the effectiveness of FADs in Victoria. To advertise the availability of FADs and the opportunities they provide for offshore fishing to recreational fishers, communication through websites, newsletters, email and presentations should be conducted.

Discussion

This study presents comprehensive design requirements and implementation strategies for a FAD program intended to benefit recreational anglers fishing off Victoria.

During this project stakeholders have given much consideration and engaged in discussions on the potential for FADs to attract species, their location and duration. Ascertaining whether FADs will provide a significant increase in catch for recreational fishers remains largely unknown. The success of a Victorian FADs program can only be evaluated by trialling FADs at a location (e.g. Portland) likely to be inhabited by have pelagic gamefish species such as dolphin fish, tuna and kingfish. Despite the stakeholders believe that the benefits to anglers through increases in catch rate will be significant. Up to 25 FADs are deployed for recreational fishers along the majority of the NSW coast. The NSW FADs program is successful with high levels of angler satisfaction achieved through active angler engagement and communication. Fisheries Victoria should be proactive in promoting FADs and educating fishers about the opportunities they provide.

Portland provides the greatest opportunity for FADs to be successful. Monitoring FAD usage and catch statistics can only be cost effective by implementing voluntary logbooks to charter fishers and validating their catch estimates using onboard observers. The charter sector provided much information on FAD locations and is willing to participate in a logbook program.

Although recreational representatives and anglers assisted in providing potential locations, not all fishers will be satisfied with their position. However, a line of FADs positioned from inshore to offshore locations provides the best opportunity for migratory species to come in contact with FADs. If FADs are shown not to be effective at one location, the option of retrieval and redeployment in alternative locations can be explored.

FADs do not need to be restricted to a single moored structure. For example, artificial reefs are successful in attracting benthic species such as snapper. Incorporating FADs with artificial reefs may serve as an additional attractant and serve the fisher as a reef identification beacon.

Recommendation

This project represents the first stage in the development of a new and exciting fishery for Victoria that will be highly valued by fishers from across the state.

The project has built on learnings from local, national and international FADs programs to provide the greatest possible chance for a successful FADs program.

It is recommended that an initial trial is conducted at Portland for at least a two year period. Data acquired from a charter logbook program will be used to evaluate the is success of this trial and whether to include other locations (such as Cape Woolamai or / and Mallacoota) in to the program.

Acknowledgements

This project was co-funded by the Victorian Government using Recreational Fishing Licence fees and the Victorian Recreational Fishing Initiative.

Mr Travis Dowling and Dr James Andrews provided review and comments on this report.

Project was developed by Dr. Daniel Spooner and Dr. Leanne Gunthorpe.

Greatest assistance regarding FAD construction, deployment and approval requirements was provided by Dr. Heath Folpp, NSW Fisheries, Coffs Harbor, NSW.

During the FAD workshop in November 2012, valuable discussion was provided by Christopher Collins, Travis Dowling, Clint Engel, Geoff Fisher, Franz Grasser, Matt Koopman, Bill Lussier, Brian Mottram, Chris Padovani and Richard Rogala. Taylor Hunt document meetings and assisted in MS PowerPoint presentations.

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Appendix 1.

The use of FADs worldwide with reference to Australia

Natural and artificial floating structures have long been known to attract oceanic pelagic fish species. Some 333 species belonging to 96 families of fish are reported to be associated with structures such as logs, seaweed rafts, rubbish, and buoys worldwide (Castro et al. 2001, Cillaurren 1994, Edwards and Perkins 1998, Kingsford 1992). The abundance and range of species inhabiting the region of floating structures comparatively exceeds that found in open water systems (Kingsford 1992) and is used advantageously by fishers to increase catch success. Structures manufactured and deployed in regions to specifically concentrate fishes are known as Fish Aggregation Devices (FADs); and are extensively used for recreational and commercial purposes (Dempster 2005, Fonteneau et al. 2000, Holland et al. 2000, Morales-Nin et al. 2000).

Commercial deployment of FADs in the Philippines in 1960–70 to attract yellowfin tuna (*Thunnus albacares*) instigated the beginning in the development of FADs programmes throughout the world. The global use of FADs is widespread with over 1,000,000 t of tuna and 100,000 t of bycatch caught annually in the Atlantic, Indian and Pacific Oceans (Fonteneau et al. 2000). Today, FADs account for around 70% of tuna caught globally (Hallier and Gaertner 2008); with highest use found in the eastern Pacific Ocean where 9,813 FADs were deployed in 2008 and many more deployed through private commercial operations (WCPFC 2009).

With the development of FADs followed a vast number of scientific papers, technical reports and international conferences devoted to FAD programmes. FADs are used to catch a variety of species that include dolphinfish (*Coryphaena hippurus* and *Coryphaena equiselis*), yellowtail kingfish (*Seriola lalandi)* and several tuna species (Castro et al. 1999, Dempster 2004, Folpp and Lowry 2006, Jaquemet et al. 2011, Taquet et al. 2007).

In Australia, FADs programmes successfully operate off the coast of New South Wales and Western Australia. In NSW, the FADs programme is managed through the Fisheries Enhancement program under the Recreational Fisheries Programs. In 2012, 25 FADs were strategically positioned along the coast and used by recreational fishers to target mainly dolphinfish. Similarly, FADs are deployed off the coast of Western Australia between Cervantes and Jurien Bay, and off Stradbroke Island, Queensland.

A trial of FADs in Victoria was conducted in 2008 with a FAD positioned 4 km SE (depth 30m) of Barwon Heads and 3.8 km SSW (depth 35 m) of Port Fairy (Koopman and Hotchin 2008). At Barwon Heads divers observed a single blue shark, silver trevally and baitfish. As the Port Fairy FAD came adrift on two occasions, no survey data were collected or catches reported.

How do FADs work — aggregation and attraction

Physical attributes of floating objects which includes size, structure, colour, presence of epibiont (barnacles, algae) are considered to be factors that govern the attraction of fish (Castro et al. 2001). Although there is no explicit reason why fish aggregate around FADs, Castro (2001) provided a summary of several hypotheses that have been considered to explain aggregative behaviour around floating objects and includes:

- Protection from predators
- Substitute for a seabed
- Availability of food
- Negative phototrophic response of fish to shallows
- Reference point for fish
- Spawning substrates
- Visual stimulus in an optical void
- Cleaning stations
- Meeting point
- Resting areas
- Schooling companion

As well as aggregative behavioural characteristics, species associated with floating objects like FADs may be found some tens to hundreds of metres from the structure. The area of attraction is thought to be dependent on species, size and stage of development (Kingsford 1999).

The likelihood for a FAD to attract species depends largely on the abundance and seasonality of pelagic fish that naturally occur in the surrounding waters. If tunas and other pelagic species are abundant in an area year round, or have a long season of peak abundance, a FAD is likely to increase the number of fish within the area (Watt 1995). Both juvenile and adult pelagic and demersal fish species commonly associated with FADs are spatially and temporally varied (Sinopoli et al. 2012). For this reason FADs are more likely fished at different times of the year depending on the species targeted.

Victoria's Marine environment

Victoria's marine climate is changing (Hobday et al. 2006). Marine waters of south-eastern Australia have been identified as a climate change 'hotspot'. Research indicates the East Australian Current has strengthened by 20 percent over the last 50 years and is predicted to continue to strengthen by another 20 percent by 2100. This is likely to result in more warm water sub-tropical species being observed in Victorian waters in future years via ocean current systems (Figure 2). Southward range expansion is recorded for seaweeds, phytoplankton, zooplankton, demersal and pelagic fish (Hobday et al. 2006, www.redmap.org). Victoria's fisheries are already diverse and geographically extensive and that diversity is likely to increase. Consequently, anglers in Victorian waters are likely to encounter fish species that are new to them such as dolphinfish, yellowfin tuna, stripy tuna and cobia more often

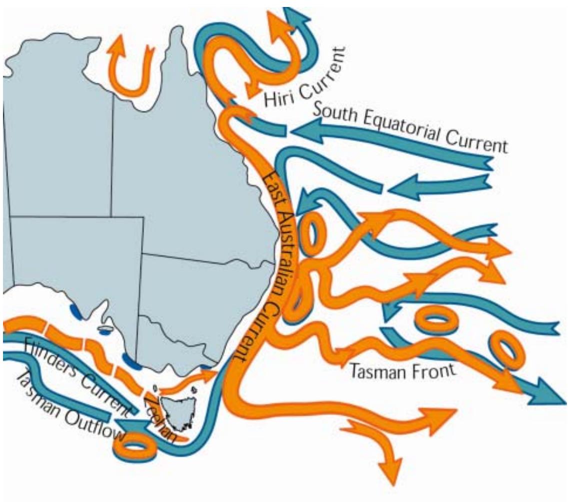


Figure 2. Ocean current systems of south eastern Australia . (source: http://www.oceanclimatechange.org.au)

Potential gamefish species attracted to FADs in Victoria

Dolphinfish

Image: NSW DPI

Dolphinfishes (*Coryphaena hippurus* and *Coryphaena equiselia*) are found in tropical-temperate waters of Australia and New Zealand and commonly caught by commercial and recreational fishermen (Gomon et al. 1994, Kingsford and Defries 1999). Commercial operators caught around 23t and 4t of *Coryphaena spp* on the east and west coast of Australia respectively (Kingsford and Defries 1999). The recreational catch of dolphinfish from NSW was estimated at 11t and 12t for 1994 and 1995 respectively (Steffe et al. 1996); with large numbers likely captured (not quantified) in Queensland, Northern Territory and Western Australia (Kingsford and Defries 1999).

Dolphinfish are associated with FADs (Castro et al. 1999, Dempster 2004, Folpp and Lowry 2006, Kingsford and Defries 1999). Taquet (2007) demonstrated that dolphinfish are found to form small schools up to 365m from a FAD with schools staying within the vicinity of the FAD for several days before moving away and being replaced with another school. Dolphinfish also have the ability to home back to a FAD if displaced by up to 820m (Girard et al. 2007). Off Sydney, dolphinfish appear in greater numbers around FADs during January – May when water temperatures exceed 20°C with greatest abundances occurring when ocean currents were at their strongest (Dempster 2005).

Although commonly caught in NSW, dolphinfish have been a surprise catch by the recreational sector when targeting southern bluefin tuna (*Thunnus maccoyii*) off Portland, Victoria (Green et al. 2012). Fishing reports from Portland from as early as 1997 have documented catches of the species on an annual basis. Off Port Phillip Heads and Apollo Bay, Victoria there have only been relatively few numbers caught (pers comm. Geoff Wilson 2012, Slater Echo fishing report 26/05/2011). During summer 2010/11, dolphinfish were caught near Barwon Heads much to the surprise of keen anglers. Dolphinfish are highly mobile fish and during March and May provided a great offshore fishing opportunity in the coastal waters off Portland. Dolphinfish have also bee sighted as far south as SE Tasmania (redmap.org.au).

Yellowtail Kingfish

Image: NSW DPI

Yellowtail kingfish (*Seriola lalandi)* are a predatory oceanic species up to 70kg in weight and distributed around cool tropical to warm temperate waters in the southern hemisphere and North Pacific (Gomon et al. 1994). They are a valuable commercial, recreational and aquaculture species (Poortenaar et al. 2001) that supports a variety of industries. The recreational catch of yellowtail kingfish is estimated to be between 120t and 340t (Henry and Lyle 2003). In Australia kingfish are highly prized due to their palatability and excellent fighting qualities. Commonly found on inshore reefs they are also found around FADs (Dempster 2004, Folpp and Lowry 2006). Studies of yellowtail kingfish from NSW showed that the attraction to FADs peaks during the summer months where water temperature is greatest (Dempster 2005). Compared with dolphinfish, kingfish have greater residence periods (Dempster 2005).

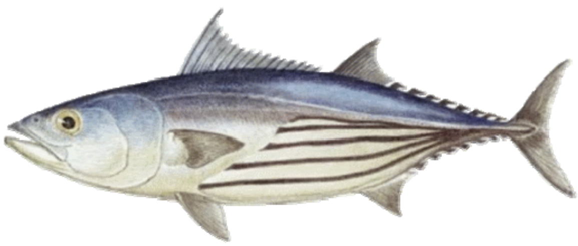
In Victoria, commercial catch records indicate that kingfish are caught using handlines and trolling (pers com Fisheries Victoria - Catch and Effort statistics) at major ports including Portland, Port Fairy, Queenscliff, Inverloch, Wilsons Promontory, Lakes Entrance and Mallacoota. Similar to kingfish, cobia are normally encountered in the warmer waters of Queensland and are expected to be caught by Victorian anglers in late summer and autumn as far south as Port Albert and Corner Inlet in south Gippsland.

Southern Bluefin Tuna

Image: NSW DPI

Southern bluefin tuna (SBT; *Thunnus maccoyii*) are distributed between latitudes 30–50° S where they are targeted by fleets on the high seas and the exclusive economic zones of Australia, New Zealand, Indonesia and South Africa (Wilson et al. 2010). They are a highly migratory single stock species that spawn in the north-east Indian Ocean and migrates throughout the southern oceans (Caton 1991). Off Victoria, southern bluefin tuna are a highly sought after recreational species targeted mainly off the coast of Portland. A boat-ramp survey conducted in March – July 2011 concluded that there were approximately 19,700 tuna caught in south-western Victoria (Green et al. 2012). Bycatch species such as dolphinfish (n=20) and albacore (n=1885) were also caught during this survey with several more dolphinfish likely to have been caught by fishers not interviewed. There is no evidence that SBT are attracted to or aggregate around FADs; however, other tuna species are commonly taken.

Striped Tuna



Striped tuna (*Katsuwonus pelamis*) are widely distributed in Australia's oceanic waters. The southern limit of striped tuna on the east coast of Australia varies seasonally with fewer sightings in Victoria (Kailola et al. 1993). Stripped tuna are commonly targeted by recreational fishers using trolling or casting small lures from a boat. In recent summers, schools of striped tuna have thrilled anglers from Port Phillip Heads to Lorne where they have been found in relatively shallow water (Weekly times March 2010). Large schools have been reported; however, fishers have found it difficult to capitalise as the schools tended to go deep when approached by vessels. Mallacoota often have schools of striped tuna which move southwards within the Eastern Australian Current (EAC). In the Pacific Ocean striped tuna are found around FADs where they are targeted by purse seine vessels and artisanal fishers (Doray et al. 2007, Jaquemet et al.).

Albacore Tuna

Image: NSW DPI

Albacore tuna (*Thunnus alalunga*) are widely distributed in all tropical, subtropical and temperate ocean (Collette and Nauen 1983). Their distribution extends polewards during summer when water temperatures are highest (Foreman 1980). Albacore are important to the commercial (Wilson et al. 2010) and recreational fishing sectors. Recreational fishers catch albacore using methods identical to catching other species. In 2011, albacore were targeted and caught off the coast of Portland and are commonly caught by fishers when targeting southern blue fin tuna (Green et al. 2012).

Types of FADs

Fish aggregation device design has varied considerably over the years. Simplistic designs such as floating palm fronds or log rafts (Figure 3) to elaborate floating / submerged structures (Figure 4) have all been trialled to attract fish. However, the most common FAD design is a floating buoy that is either tethered to the ocean floor or let drift. Some research suggests there is little difference in attraction ability on FAD design; however, surface FADs were found to attract species such as tuna and dolphinfish compared with subsurface FADs attracting barracuda and mackerel (Friedlander et al. 1994).

Figure 3. A simple FAD design that utilised easily accessible materials like palm fronds (above), logs and rope (below).

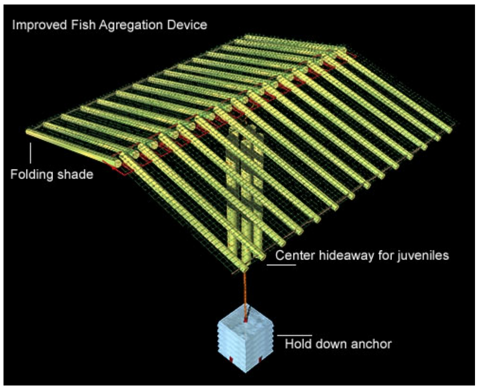


Figure 4. Elaborate floating (top) and subsurface (bottom) FAD designs.

Preferred FAD design and components

Design

The design of appropriate FADs is dependent on factors such as their effectiveness to attract and maintain fish, cost, deployment and retrieval logistics, and durability in varying environment conditions. Simplistic designs are favoured compared with complex structures due to their cost, ease of deployment / retrieval. Simple designs are considered to be just as effective to aggregate pelagic species (*pers. com.*, Folpp). The Department of Primary Industries (NSW) uses a simple buoy that is tethered to the ocean floor (Figure 5).

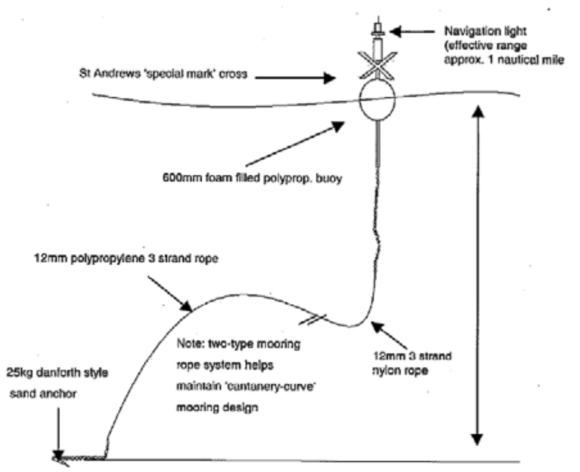


Figure 5. FAD design considered suitable for deployment off Victoria.

Components

There are three components to the FAD: Headgear, Mooring lines and Anchor..

Headgear

Aquafloat 800 Cone (Figure 6), 7m x 12mm drop chain 2x coupling "D" shackles. The FAD should be adequately labelled with FAD number, Safety notes (e.g. No Mooring) and DPI's telephone number.

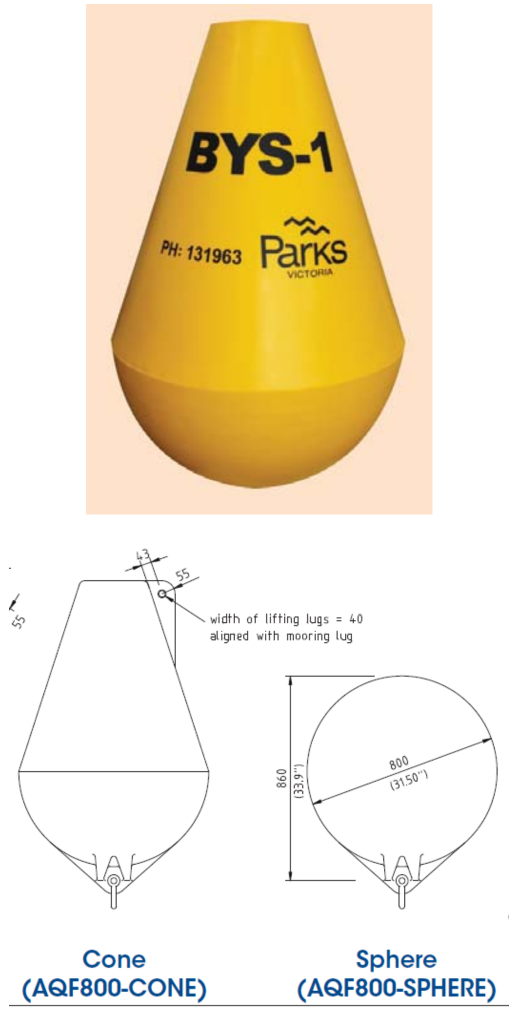


Figure 6. Aqualfloat 800 by Sealite Pty Ltd.

Lighting and signage

For location (and avoidance) during the night, FADs will be fitted with a Sealite SL15 1-2nm LED light (Figure 7).

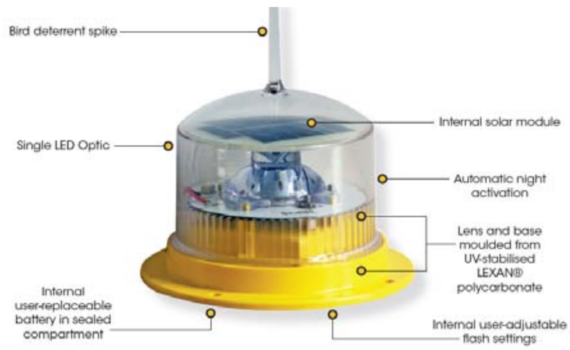


Figure 7. SL 15 1-2nm LED solar light by Sealite Pty. Ltd.

Mooring Ropes

A catenary curve that forms part of the mooring line is used to provide enough 'spring' during high currents or rough waters that enables the headgear to move without dislodging the anchor. A catenary (or "S" shaped) curve between the headgear and anchor is achieved using a combination of sinking (nylon, used in the headgear) and floating (polypropylene, used for anchoring) ropes.

Nylon is one of the strongest, most widely available, synthetic fibre ropes. Nylon is elastic and sinks in seawater. It will stretch up to 17 per cent of its length under a working load equal to 20 per cent of its ultimate breaking strength. Nylon rope can withstand both the routine cyclic loading (stretch and recoil) caused by ocean swells, and the shock loading (strong, sudden jerks) which will affect a FAD mooring during rough seas and stormy weather. Nylon is also durable. It resists surface wear and internal abrasion caused by flexing and stretching. Nylon also withstands ageing and deteriorates only slightly from exposure to sunlight. Nylon does tend to stiffen somewhat with prolonged immersion in seawater (Gates et al. 1996).

Polypropylene has moderate breaking strength, which increases slightly in seawater. It has good elastic properties and can be stretched by about nine per cent of its length and still return to its original length. Polypropylene has excellent shock loading capabilities. Polypropylene is fairly durable. The single most important exception to its durability is that it does deteriorate with exposure to sunlight. Some manufacturers offer treatments which increase polypropylene's resistance to sunlight (Gates et al. 1996).

Mooring ropes: 12mm 3 strand nylon rope (sinking), 12 mm polypropylene 3 strand rope (sinking). Length of rope required is based on the ratio of 3:1 (rope length : depth). The length of the nylon portion should be 33% of the total length (Table 1).

Table 1. Length of nylon and polypropylene rope required for each FAD at varying depths.

Depth (m)	Total rope length (m)	Length of Nylon (m)	Length of polypropylene (m)
50	150	51	99
100	300	102	198
150	450	153	297
200	600	204	396
400	1200	408	792

Anchorage

Fish aggregation devices need to be removed annually (see 'Duration' section below). Danforth anchors are most suitable in providing a suitable securing system yet able to be easily removed (Figure 8).

Anchor: 5m x 12mm bottom chain with 7 links of 24mm 'stud-link' chain (for ballast), Danforth anchor (45 lb.), 2x 12mm, 2x coupling "D" shackles.

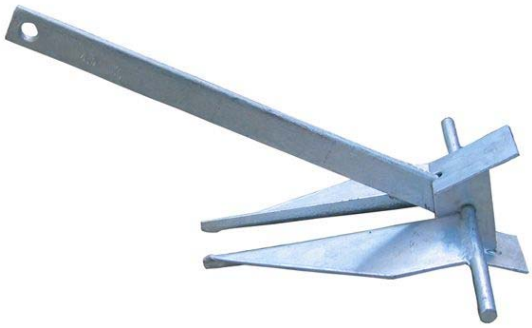


Figure 8. A 'Danforth' style anchor used to secure the position of the FAD.

Online monitoring

Fitting FADs with remote GPS (Global Positioning System) tracking sensors (AT2 Satellite Asset Recovery Unit, Figure 9) coupled with TracerTrak^{TM} enables the FAD to be located using a web-based platform. Each FAD fitted with a unique GPS unit can be customised to provide alerts (email or text) detailing when a unit is outside a fixed radius or 'geofence'. For example, if the FAD moves outside a 400m radius of its original position, an alert will be issued to the FAD coordinator. FAD's previously deployed off Victoria have drifted from their initial deployment location (Koopman and Hotchin 2008) and only later been recovered when visually located. Reasons for FAD loss are difficult to ascertain but generally fall in to three main categories: accidental contact (e.g. shipping), natural events (large seas, strong currents), and deliberate tampering (DPI 2008, Koopman and Hotchin 2008). A GPS tracking system will help locate and retrieve FADs by providing FAD location data up to three times per day. FADs can be easily located, collected and redeployed using GPS technology.

Figure 9. AT2 Satellite Asset Recovery Unit

Legislative requirements

In general terms, state / territory laws apply to coastal waters (up to 3 nautical miles) and Commonwealth laws apply from those waters out to the limit of the Australian fishing zone (200 nautical miles). However, offshore constitutional settlement (OCS) arrangements have been developed in many cases which provide jurisdiction for a particular species, area or fishing method to the Commonwealth or states / Northern Territory irrespective of distance from shore. The Australian Fisheries Management Authority (AFMA) is responsible for the operational management of Commonwealth fisheries (Fisheries Management Act 1991). FADs deployed off the coast of Victoria will be subject to the State legislative requirements (*Fisheries Act* 1995, *Fisheries Regulations* 2009) and Commonwealth requirements. An application and approval process will need to be sought via the relevant authorities.

Commonwealth requirements

Sea Installation Act, 1987

Installation of a FAD requires an Exemption Certificate under the *Sea Installation Act* 1987 from the Department of Sustainability, Environment, Water, Population and Communities.

Section 3 of the Sea Installation Act – Objectives

The objects of the Sea Installation Act are:

(a) to ensure that sea installations installed in adjacent areas are operated with regard to the safety of the people using them and of the people, ships and aircraft near them;

(b) to apply appropriate laws in relation to such sea installations; and

(c) to ensure that such sea installations are operated in a manner that is consistent with the protection of the environment.

Section 4 (1) of the Sea Installation Act – Definitions

The Sea Installation Act 1987 defines ‘fish aggregating devices’ as:

(a) a man-made structure that, when in, or brought into, physical contact with the seabed or when floating, is used solely for the purpose of attracting populations of fish so as to facilitate the taking of those fish; or

(b) any electronic or other equipment designed or intended to be ancillary to, or associated with, such a structure while it is being used, or in order to facilitate the use of the structure, for that purpose; but does not include a net, trap or other equipment for taking, catching or capturing fish.

Application of laws in areas adjacent to States (Section 46- 1) Subject to this Act and the regulations, the laws, whether written or unwritten, in force in a State for the time being (other than laws of the Commonwealth) and any instrument having effect under any of those laws, apply, as provided by, and by force of, this section, in relation to sea installations installed, or being installed, in the adjacent area of the State and so apply as if that area were part of that State and of the Commonwealth.

Environmental Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation* (EPBC) *Act* 1999 is the Australian Government’s central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the *EPBC Act* 1999 as matters of national environmental significance. The *EPBC Act* 1999 is relevant to Commonwealth and State waters (>3nm).

The objectives of the *EPBC Act* 1999 are to:

- provide for the protection of the environment, especially matters of national environmental significance
- conserve Australian biodiversity
- provide a streamlined national environmental assessment and approvals process
- enhance the protection and management of important natural and cultural places
- control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife
- promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources.

Under the *EPBC Act* 1999, an 'action' is a project, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things.

The environment assessment process of the Act protects: Matters of national environmental significance including:

- world heritage properties
- national heritage places
- wetlands of international importance
- threatened species and ecological communities migratory species
- Commonwealth marine areas
- the Great Barrier Reef Marine Park, and
- nuclear actions (including uranium mines).

Any action that is likely to have a significant impact on listed threatened species and ecological communities under the *EPBC Act* 1999 must be referred to the Minister and undergo an environmental assessment and approval process.

The *EPBC Act* 1999 is relevant to Commonwealth and State waters (>3nm). Under the EPBC Act you need approval from the Australian Government environment minister for any proposed action—including projects, developments, activities, or alteration of these things—likely to have a significant impact on a matter protected by the *EPBC Act*. NSW Fisheries has assessed impacts of FADs on threatened ecological communities (DPI 2008) under the *EPBC Act* and determined that the installation of FADs was not likely to have significant impact on matters of national environmental significance. For NSW, no application from the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) under the EPBC Act was required. Fisheries Victoria will be required to deciding if a proposed action needs to be referred and to complete the environmental assessment and approval process.

State requirements

They key approvals/considerations the state of Victoria requires for deployment of FADs will be:

- Determine whether Native Title applies in relation to the FAD proposal and their location. Native Title services within Department of Sustainability and Environment (DSE) - Public Land Division
- Seek consent through DSE for the use of crown land under the *Coastal Management Act*. Where consent is provided, an Environment Management Plan (EMP) and risk register will be required to be submitted to the satisfaction of DSE before on ground works commence. The EMP will, among other things, need to consider risks to cetaceans (whales) - and associated cetacean impact mitigation strategies
- Seek a Licence under the Land Act. An application will need to be submitted to DSE.
- no requirement to seek a permit under either the Flora and *Fauna Guarantee Act* or *Wildlife Act* will be required.

It is unlikely that the project would trigger thresholds for an Environment Effects Statement - DPI should undertake due diligence with the Department of Planning and Community Development on this matter.

Environment Effects Act 1978

In Victoria, the Department of Planning and Community Development manages procedures under the *Environment Effects Act* 1978 for assessment of projects with potentially significant environmental effects. An environment assessment of the potential environmental impacts or effects of a proposed development may be required under the *Environment Effects Act* 1978.

The process under this Act is not an approval process itself; rather it enables statutory decision-makers (Ministers, local government and statutory authorities) to make decisions about whether a project with potentially significant environmental effects, should proceed.

If the Minister for Planning decides that an Environment Effects Statement (EES) is required, the project proponent is responsible for preparing the EES and undertaking the necessary investigations. After the EES is completed and released for public comment, the Minister provides an Assessment to the relevant decision-makers. There are also opportunities for community involvement at certain stages of the process.

Fisheries Act 1995

Fisheries Victoria is responsible for managing recreational fishing activities associated with the FADs in accordance with the *Fisheries Act* 1995.

The objectives of the *Fisheries Act* are—

(a) to provide for the management, development and use of Victoria's fisheries, aquaculture industries and associated aquatic biological resources in an efficient, effective and ecologically sustainable manner;

(b) to protect and conserve fisheries resources, habitats and ecosystems including the maintenance of aquatic ecological processes and genetic diversity;

(c) to promote sustainable commercial fishing and viable aquaculture industries and quality recreational fishing opportunities for the benefit of present and future generations;

(d) to facilitate access to fisheries resources for commercial, recreational, traditional and non-consumptive uses;

(e) to promote the commercial fishing industry and to facilitate the rationalisation and restructuring of the industry;

(f) to encourage the participation of resource users and the community in fisheries management.

Fisheries Regulations 2009

Fisheries Victoria is responsible for managing recreational fishing activities associated with FADs in accordance with the Fisheries Regulations 2009.

The objectives of these Regulations are—

(a) to provide for the control and management of fisheries in Victoria on a sustainable basis; and

(b) to provide for any other matters authorised to be prescribed under the Fisheries Act 1995; and

(c) to make consequential amendments to the Fisheries (Fees, Royalties and Levies) Regulations 2008.

Fisheries Victoria

Standard Operating Procedures are written documents or instructions detailing all steps and activities of a process or procedure such as deploying and retrieving FADs. Having an SOP reduces system variation, provides a reference resource for trainees, and is an excellent reference document on how a task is completed.

FAD deployment

Location

Location and duration of FAD deployment are critical factors in achieving an enhanced fishing experience for recreational anglers. FADs deployed in Victoria have the potential to increase the availability of pelagic species to recreational fishers, reduce search time and reduce fuel consumption as well as reducing fishing pressure on inshore and offshore bottom-fish resources.

In November 2012, representatives from Fisheries Victoria, the Recreational Fishing Grants Program, VRFish, gamefishing enthusiasts, spearfishers and anglers met to discuss the feasibility of deploying FADs off the Victorian coast. Potential FAD locations considered were based on:

- Target species and their biological attributes
- Value of species to recreational fishers
- Access for recreational fishers
- Infrastructure
- Population.

Specific deployment area at each location (e.g. Portland) will also be dependent on high traffic shipping lanes and whale migration routes.

Options for FAD deployment off Victoria

Three locations were identified as suitable for FAD deployment (in order of preference): Portland, Cape Woolamai, and Mallacoota. As Portland was considered an area with greatest potential, experienced recreational fishers were identified and contacted to provide further information on locations they would prefer.

The effectiveness of FADs to aggregate pelagic species in Victoria is largely unknown. An experimental trial is proposed for at least two years. FADs would be monitored (logbook survey) to ascertain their effectiveness and levels of angler satisfaction determined.

Portland

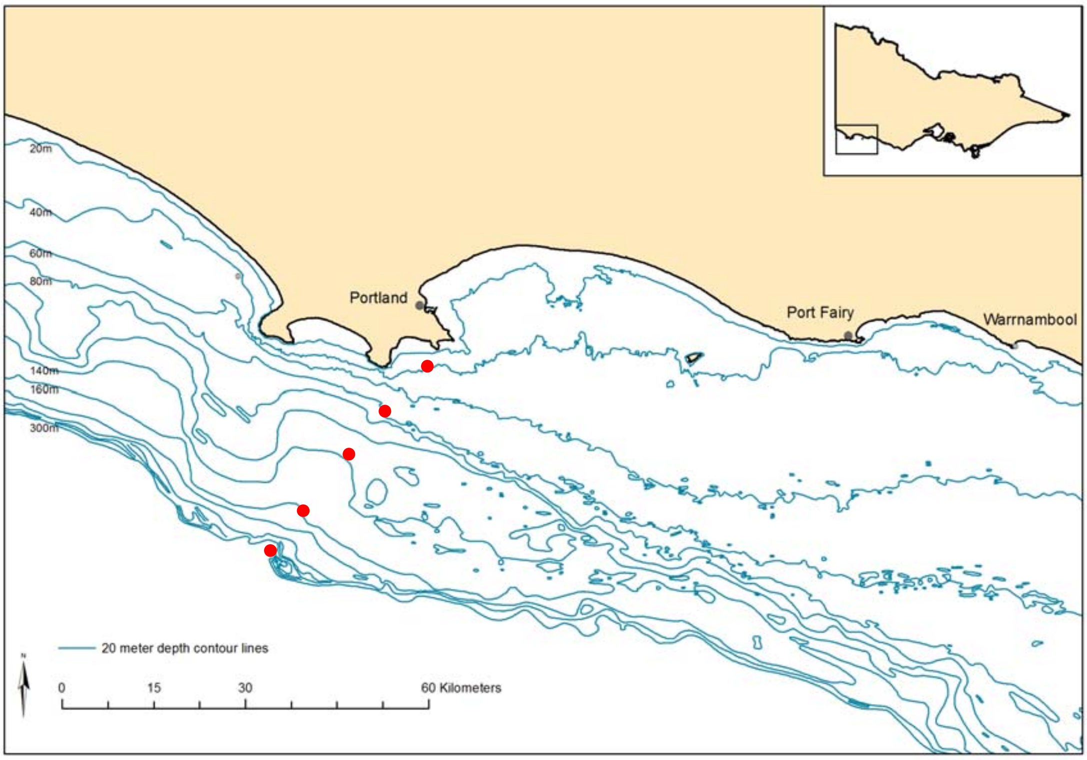


Figure 10. Proposed location of FADs off Portland, Victoria.

FAD number	Latitude	Longitude	Depth (m)
FAD P1	38° 28' 00"	141° 38' 00"	40 (To be confirmed)
FAD P2	38° 31' 00"	141° 34' 00"	100 (To be confirmed)
FAD P3	38° 36' 00"	141° 28' 00"	150 (To be confirmed)
FAD P4	38° 39' 00"	141° 25' 00"	200 (To be confirmed)
FAD P5	38° 42' 00"	141° 22' 00"	500 (To be confirmed)

FADs should be active from January – May which encompass periods of warmer waters. FADs will be removed in May to allow for whale migrations (subject to approvals process). Species likely to be associated with FADs inshore are Kingfish; whereas, southern bluefin tuna and dolphinfish are likely to be on deeper FADs (Green, Brown et al. 2012). The distance from shore to the farthest FAD is approximately 35 km.

Cape Woolamai

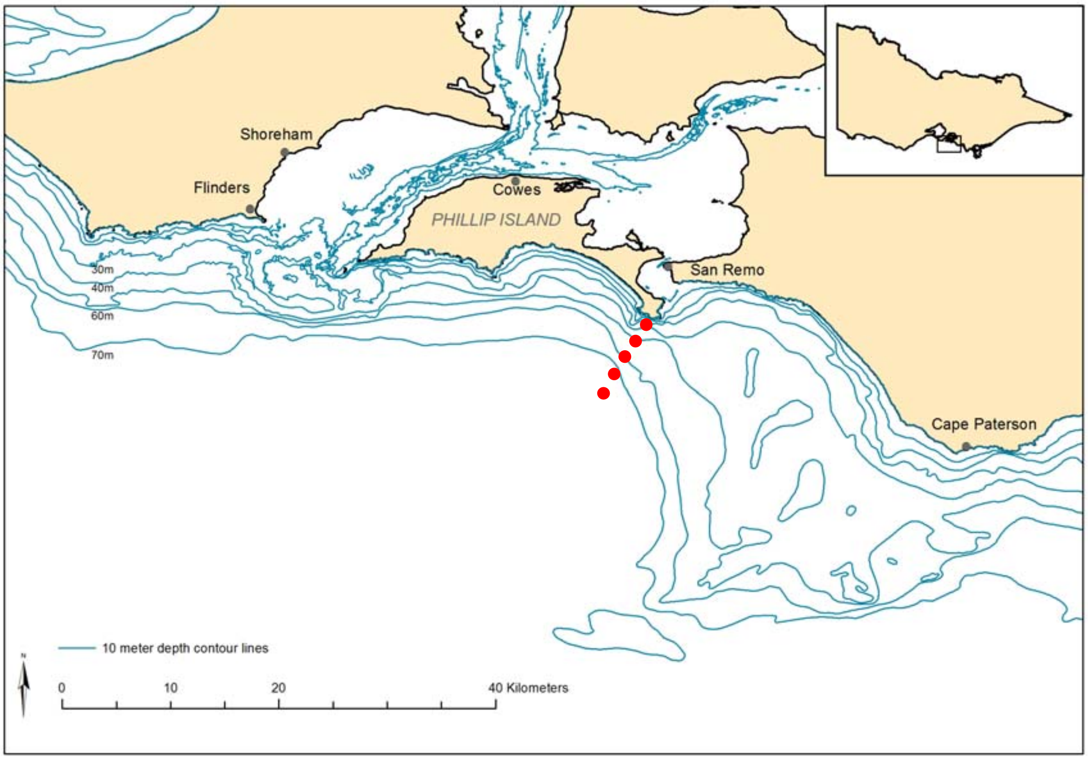


Figure 11. Proposed location of FADs off Cape Woolamai, Victoria.

FAD number	Latitude	Longitude	Depth (m)
FAD W1	38° 34' 00"	145° 20' 00"	40 (To be confirmed)
FAD W2	38° 36' 00"	145° 19' 00"	50 (To be confirmed)
FAD W3	38° 38' 00"	145° 16' 00"	60 (To be confirmed)
FAD W4	38° 40' 00"	145° 14' 00"	70 (To be confirmed)
FAD W5	38° 43' 00"	145° 12' 00"	(To be confirmed)

FADs should be active from January – May. This period encompasses warmer waters which are conducive to kingfish, and tuna. FADs will be removed in May to allow for whale migrations (subject to approvals process). Recreational boat anglers and spearfishing enthusiasts will be key beneficiaries of this FAD. The distance from shore to the farthest FAD is approximately 10km.

Mallacoota

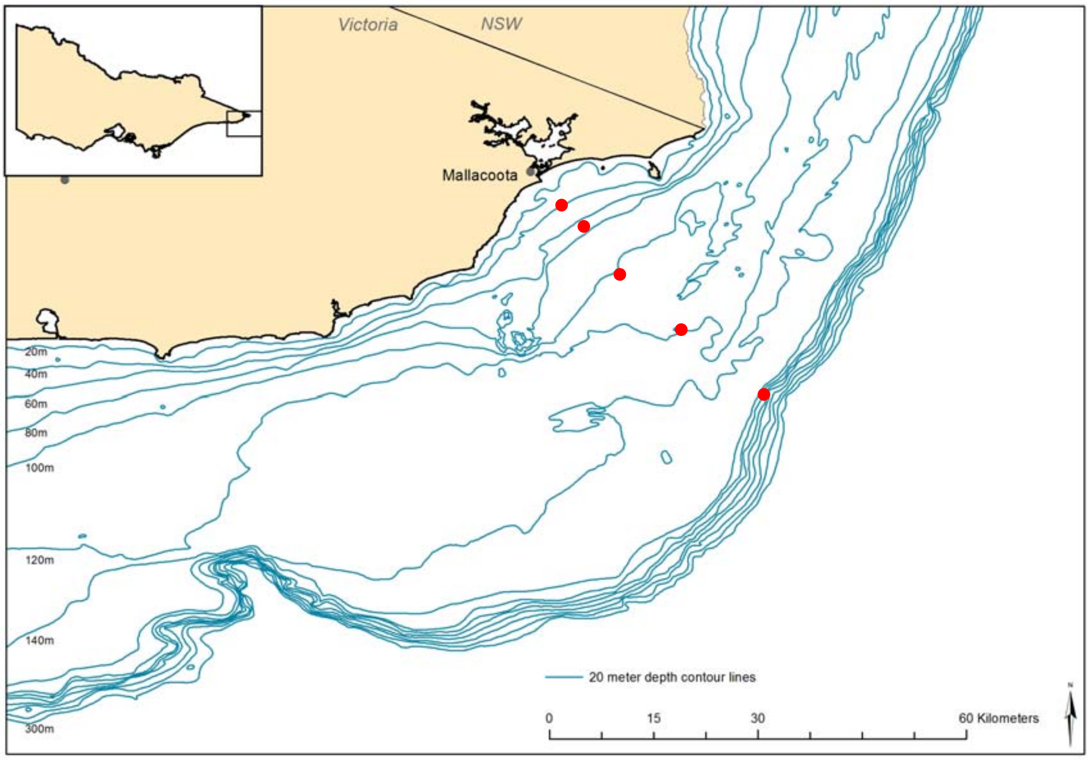


Figure 12. Proposed location of FADs off Mallacoota, Victoria.

FAD number	Latitude	Longitude	Depth (m)
M1	37° 36' 00"	149° 49' 00"	40 (To be confirmed)
M2	37° 37' 00"	149° 50' 00"	80 (To be confirmed)
M3	37° 40' 00"	149° 54' 00"	100 (To be confirmed)
M4	37° 42' 00"	149° 59' 00"	120 (To be confirmed)
M5	37° 45' 00"	150° 05' 00"	300 (To be confirmed)

FADs should be active from January – May. This period encompasses warmer waters bought southwards via the Eastern Australian Current. FADs will be removed in May to allow for whale migrations (subject to approvals process). The distance from shore to the farthest FAD is approximately 45 km.

Commercial fishing consultation

Seafood Industry Victoria (SIV) is the peak body representing the Victorian seafood industry. Members of SIV are involved in the harvesting, processing, wholesaling, retailing and exporting of seafood in Victoria.

Prior to applying for Commonwealth or State permits, SIV will be provided information on proposed locations for FAD deployment. Comments provided by commercial fishers will be used to ascertain whether FADs will impact commercial fishing activities and how best to minimise any disruption.

Shipping Routes, Port Authorities and Notice to Mariners

The potential loss and damage to FADs can be high if deployed in busy shipping lanes. Suggested FAD locations for Portland, Cape Woolamai and Mallacoota need to be forwarded to the respective Port Authorities to ascertain the risk of entanglement. Port authorities control shipping movements within 3 nm. Outside the 3nm state jurisdiction is considered 'open seas' where there is no requirement to maintain a specific route. All attempts will be made to deploy FADs in areas thought to promote recreational fishing activity and outside common shipping routes.

There are no specific shipping routes off Victoria; however, ships generally stay clear of 3 nautical mile distance from shore and track the straightest line to their next port. From the Port of Portland, ships generally head out to at least 3 nm and either turn east (e.g. toward Melbourne), west (e.g. toward Adelaide) or south (e.g. toward Tasmania). From Portland, greatest shipping activity occurs between 3–20 nm in an east-west direction (pers.com, Portland Harbour Master).

The Australian Hydrographic Service will be notified to issue a 'Notice to Mariners' (NtM). Australian NtM are produced fortnightly to inform mariners of amendments of navigational significance to their chart portfolios. A NtM should be declared approximately one month prior to FAD deployment.

Duration

The duration which FADs are deployed at any of the locations will be governed by factors including period of species availably, environmental and meteorological conditions and presence of other species of significance (e.g. whales). Duration in which FADs will be in place will require approval from Commonwealth and State agencies (see above).

Monitoring and associated programs

Monitoring FAD usage and catch rates will be vital in ascertaining their benefit. A charter vessel logbook will provide greatest information at a relatively low cost. An assessment will include: fishing effort, number of species caught, catch per unit effort, spatial and temporal species variability, and angler satisfaction; and will provide a mechanism to evaluate their impact.

Other programs

Fish aggregation devices can also be utilised by other agencies (e.g. Bureau of Meteorology, Integrated Marine Observing System) for various other projects. For example environmental data such as water temperature, salinity, productivity etc. can be remotely collected by installing monitoring systems.

Similarly, acoustic receivers such are the VEMCO VR2W are used globally to monitor acoustically tagged fish. NSW Fisheries is presently using this technology to track dolphinfish; this system could be extended to track various species in Victorian waters.

Education and communication

The success of a FADs program will be largely based on the number of recreational fishers using and catching targeted species. Recreational fishers from NSW are familiar with FADs and how to fish them; however, in Victoria, anglers are likely to be less familiar with fishing techniques and the code of conduct around FADs. Educating and communicating with fishers will be an important part of maximizing the success of this alternative fishing activity.

Code of Conduct

A code of conduct has been develop for fishing FAD by Koopman (2008).

- No Mooring
- Respect other FAD users at all times
- FADs are for the benefit and enjoyment of all recreational sectors
- Courtesy should be given to fishers who are already using the FAD

- FAD users should take turns in fishing the FAD and accommodate new arrivals
- All fishers should keep boats, lines and lures a safe distance from the FAD
- Do not use braided fishing lines near the FADs. This line type causes cutting damage to the mooring line of the device. This will result in the FAD breaking free and the loss of anchoring gear
- Do not tie your boat up to the FAD
- Report any damage to the FAD to Fisheries Victoria
- Comply with bag limits and only take what you need.

Project costing

The cost of

implementing a FADs program in Victoria is dependent on location. FADs positioned in deeper water (e.g. Portland) require more rope, and consequently dearer compared to shallower water FADs (Table 2). Costs for the Year one include capital requirements. Costs for subsequent years were based on tracking, deployment, retrieval, maintenance and salaries only.

Three options for FAD deployment were calculated based on a Trial (Portland only), Partial implementation (Portland and Cape Woolamai), Full implementation (Portland, Cape Woolamai and Mallacoota). Costs were calculated for the first (which comprises capital expenditure) and subsequent years.

Table 2. Costing model developed for deployment and retrieval of FIVE FADs.

Portland

	Year one	**Subsequent Years**
FAD Capital Cost		
5 FADs including all fixtures and construction	$18,727.14	$0.00
Ongoing costs		
Tracking subscription	$900.00	$900.00
Deployment	$7,100.00	$7,100.00
Retrieval	$7,100.00	$7,100.00
Salaries including oncost	$50,750.00	$42,384.62
Total	**$84,577.14**	**$57,484.62**

Cape Woolamai OR Mallacoota

	Year one	**Subsequent Years**
FAD Capital Cost		
5 FADs including all fixtures and construction	$15,534.92	$0.00
Ongoing costs		
Tracking subscription	$900.00	$900.00
Deployment	$7,100.00	$7,100.00
Retrieval	$7,100.00	$7,100.00
Salaries including oncost	$20,634.62	$20,634.62
Total	**$51,269.54**	**$35,734.62**

***Option 1:* Trial: Portland**

Total cost for the first year $84,577.14

Total cost for subsequent years $57,484.62

***Option 2:* Partial implementation: Portland and Cape Woolamai**

Total cost for the first year $135,846.67

Total cost for subsequent years $93,219.23

***Option 3*: Full implementation: Portland, Cape Woolamai and Mallacoota**

Total cost for the first year $187,116.21

Total cost for subsequent years $128,953.85

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