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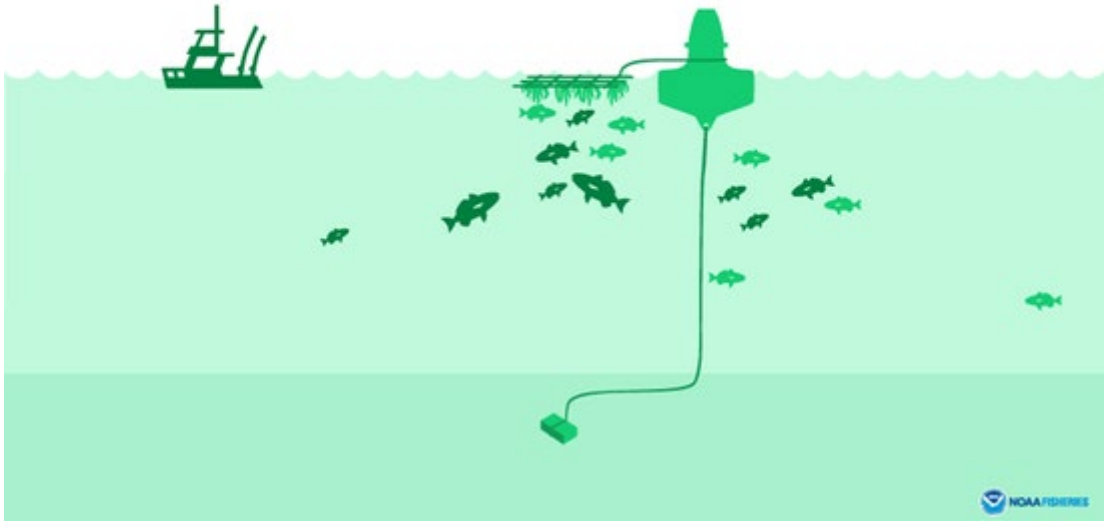
RELATIONSHIP BETWEEN FISH AGGREGATING DEVICES (FADS) AND MARINE DEBRIS IN THE MEDITERRANEAN SEA

(Prepared by the Secretariat)

Summary:

This document contains the report on *Relationship between Fish Aggregating Devices (FADs) and Marine Debris in the Mediterranean Sea* that was developed in accordance with Decision 14.36 (a) and (b).

Relationship between Fish Aggregating Devices (FADs) and Marine Debris in the Mediterranean Sea



Prepared by David Shiffman, Ph.D.

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COVER IMAGE: A simplified diagram of an anchored FAD from NOAA Fisheries.

EXECUTIVE SUMMARY

Fish aggregating devices (FADs) are a commonly used commercial fishing gear that, depending on how they are constructed and used, can cause environmental harms to marine life and marine and coastal habitats. Many of these harms can be mitigated or significantly reduced with appropriate regulations on their construction, operation and post-use recovery, described in detail throughout this report.

FADs with netting or mesh ('entangling FADs') entangle marine life of conservation concern, including sharks, sea turtles, marine mammals and seabirds, as well as non-target species of fish. FADs are often lost (sometimes due to storms or gear breakage) or abandoned by fishers, which results in 'ghost gear' that continues to entangle marine life for years. When abandoned, lost or otherwise discarded, FADs can sink or drift into shallow water. They can smother, crush or entangle sensitive marine and coastal habitats, including coral reefs, causing habitat destruction and loss, with wide-ranging ecological impacts. Many FADs are made of plastic, and when lost or abandoned, they contribute to issues relating to marine plastic pollution (including entanglement or choking hazards) and microplastic pollution (including ingestion of toxic substances).

This report reviews the relationship between FADs and marine debris using the Mediterranean region as a case study – though these problems are global and the proposed solutions are widely applicable. In this region, an estimated 60,000 FADs are deployed each year, and overwhelmingly not recovered. The report focuses on existing regulations in the Mediterranean, with consideration of both sustainable fisheries management and reducing plastic pollution and marine debris. It also reviews similar regulations and best practice recommendations in other regions that could be adapted to the Mediterranean context (or anywhere else in the world).

Numerous management and control measures can mitigate the potential environmental harms associated with the construction and usage of FADs. Summarizing regulations, research and best practices from around the world, this report makes a number of recommendations to reduce the potential environmental impacts of FADs. These include:

- Regulating the design and materials used in the construction of FADs, with recommendations to require non-entangling designs and biodegradable materials. This includes design elements to reduce the risk of gear breakage and loss, such as stronger anchors;
- Controlling the total number of FADs that can be deployed per fishing vessel or fleetwide, and where FADs can and cannot be deployed;
- Requiring markings so that any lost gear can be traced to its original owner if recovered;
- Requiring regular and thorough reporting of data to relevant authorities; and
- Encouraging recovery efforts for lost FADs.

Acronyms used in this report

Acronym	Definition
ALDFG	Abandoned, Lost, or Otherwise Discarded Fishing Gear. This catch-all term refers to fishing equipment that was once used by commercial fisheries, but is now marine debris. It is sometimes also known as “ghost gear” because it continues to capture fish (or bycatch species, including species of conservation concern). ALDFG also potentially can cause navigation hazards to vessels.
CBD	Convention on Biological Diversity, an international environment treaty.
CMS	Convention on the Conservation of Migratory Species of Wild Animals. This intergovernmental organization is run under the auspices of the United Nations Environment Programme and focusing on migratory species conservation.
CPC	Contracting Parties and Cooperating Non-Contracting Parties to RFMOs
EBSAs	Ecologically or Biologically Significant Marine Areas
FADs	Fish aggregating devices/fisheries aggregating devices. This commonly used commercial fisheries gear attracts and aggregates fish that can later be caught by fishing vessels. There are many different designs of FADs, which have different environmental impacts.
FAO	The United Nations Food and Agriculture Organization is a United Nations agency focused on food and food systems. FAO fisheries collects and shares global fisheries statics, and created the Code of Conduct for Responsible Fisheries, a voluntary set of standards.
GFCM	General Fisheries Commission for the Mediterranean, a RFMO focusing on sustainable fisheries in the Mediterranean and Black Seas.
IATTC	Inter-American Tropical Tuna Commission, an RFMO focused on sustainable tuna fisheries management in the Eastern Pacific.
IGO	Inter-governmental organization. An IGO is a group of nations working together, often established through a legal charter (e.g., Interpol, the World Trade Organization).
IMO	International Maritime Organization. The IMO is a UN agency that has responsibility for pollution from shipping vessels.
IOTC	Indian Ocean Tuna Commission, an RFMO focusing on sustainable tuna fisheries management in the Indian Ocean.
ISSF	International Seafood Sustainability Foundation. The ISSF is a coalition of fisheries scientists, environmental advocates, and representatives from the fishing industry. Their goal is improving sustainability of tuna fisheries using the best available science and best practices.
MSC	Marine Stewardship Council. The MSC is a sustainable seafood ecolabel. They also maintain the MSC Fisheries Standard, a set of sustainability best practices that fisheries are evaluated against to determine their sustainability.
NOAA / NOAA Fisheries	National Oceanographic and Atmospheric Administration. This United States Government agency manages fisheries in the United States, among other roles.
RFMOs	Regional Fisheries Management Organizations. These treaty-established fisheries management organizations focus on the sustainable exploitation of stocks of fish that are shared between countries.

Acronym	Definition
UNCLOS	United Nations Convention on the Law of the Sea. UNCLOS is an international treaty that governs a variety of activities taking place in the marine environment, including sustainable resource management.
UNEP	United Nations Environment Programme. The United Nations' leading global authority on the environment, driving transformational change on the triple planetary crisis: the crisis of climate change, the crisis of nature, land and biodiversity loss, and the crisis of pollution and waste.

Introduction

Fisheries aggregating devices (FADs, also called “fish aggregating devices”) are a commonly used type of commercial fisheries gear in fisheries around the world (Pew Environment Group 2015). They can cause environmental harms to marine life and marine and coastal habitats, depending on how they are constructed and used. Many of these harms can be mitigated or significantly reduced with appropriate regulations on their construction, operation, and post-use recovery. A recent study estimated that about 60,000 FADs are deployed each year in the Mediterranean Sea (Sinopoli 2025).

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) adopted several decisions at its 14th Meeting of the Conference of the Parties (COP14) that related to the use of
fish aggregating devices (FADs).[1]

This report was written in response to Decision 14.36, which requested the Scientific Council to evaluate the relationship between FADs and marine debris and establish principles for best practice to avoid their loss, entanglement with marine wildlife, and beaching in corals, mangroves and other aquatic and coastal habitats, and that seek to reduce their contribution to plastic pollution. It further asked to consider a case study area looking at FADs as a source of marine debris, for example in the Mediterranean Sea, to look at compliance with existing regulations, recommend environmental management and control measures to avoid gear loss and explore ways of improving the environmentally sound retrieval of lost FADs.

Recommendations to Parties are made in this report to reduce the potential environmental impacts of FADs. They are based on regulations, research, and best practices from around the world.

Overview of FADs and their use

FADs, which range widely in their size, complexity, and the materials used to construct them, rely on the natural behavior of fish species to congregate near any object floating in the ocean. FADs are most commonly associated with industrial-scale tuna fisheries, and in the Mediterranean are often used to also catch dolphinfish *Coryphaena hippurus* (Sinopoli 2025). By aggregating target fish species into a smaller and more easily identifiable area, FADs help make tuna fishing more efficient and profitable, which lowers the cost of tuna and other seafood products to consumers. The International Seafood Sustainability Foundation (ISSF RFMO Best Practices Snapshot 2025) estimates that FADs are used for about 40% of tuna catch globally.

FADS come in several different designs, which, accordingly, have a wide variety of associated impacts. Entangling FADs have attached netting or mesh, and physically catch marine life themselves. Non-entangling FADs do not have netting or mesh, and attract marine life which is later caught by a large purse seine net (ISSF 2019). The ISSF distinguishes between non-entangling FADs, lower entanglement risk FADs and high entanglement risk FADs (Figure 1).

Anchored FADs are designed to be attached to the seafloor, often but not exclusively in shallow coastal waters, while drifting FADs are designed to float freely and can move vast

[1] https://www.cms.int/en/document/decisions-conference-parties-cms-effect-after-its-14th-meeting

distances. Some drifting FADs have telemetry trackers attached to them so they can be easily located and recovered (Sinopoli 2025).

Most FADs deployed in the Mediterranean are anchored FADs (Sinopoli 2025). In fact, most of the anchored FADs deployed worldwide are deployed in the Mediterranean region. However, many anchored FADs are lost (becoming drifting FADs) or abandoned when it becomes too costly or complex to retrieve them. Anchors and attachment lines vary in construction and quality, with some as simple as bricks or heavy garbage (Sinopoli 2025). Stronger anchors that are better attached to gear can reduce the chance of gear breakage.

Some FADs are made of metal and/or plastic (including plastic waste such as beverage containers, and other trash such as car tires), while others are made of non-toxic organic (e.g., wood, plant fiber, plant-based, or bio-based) or other biodegradable materials.

Though many FADs are deployed by fisheries with essentially no regulations (Blue Marine Foundation 2022), regulations exist in different regions for FADs construction and operation (ISSF RFMO Best Practices Snapshot). The Blue Marine Foundation, the International Seafood Sustainability Foundation, and the Marine Stewardship Council generally recommend the use of non-entangling FADs made out of biodegradable non-toxic materials, combined with appropriate markings that give authorities the ability to track them and trace their owner/operator.

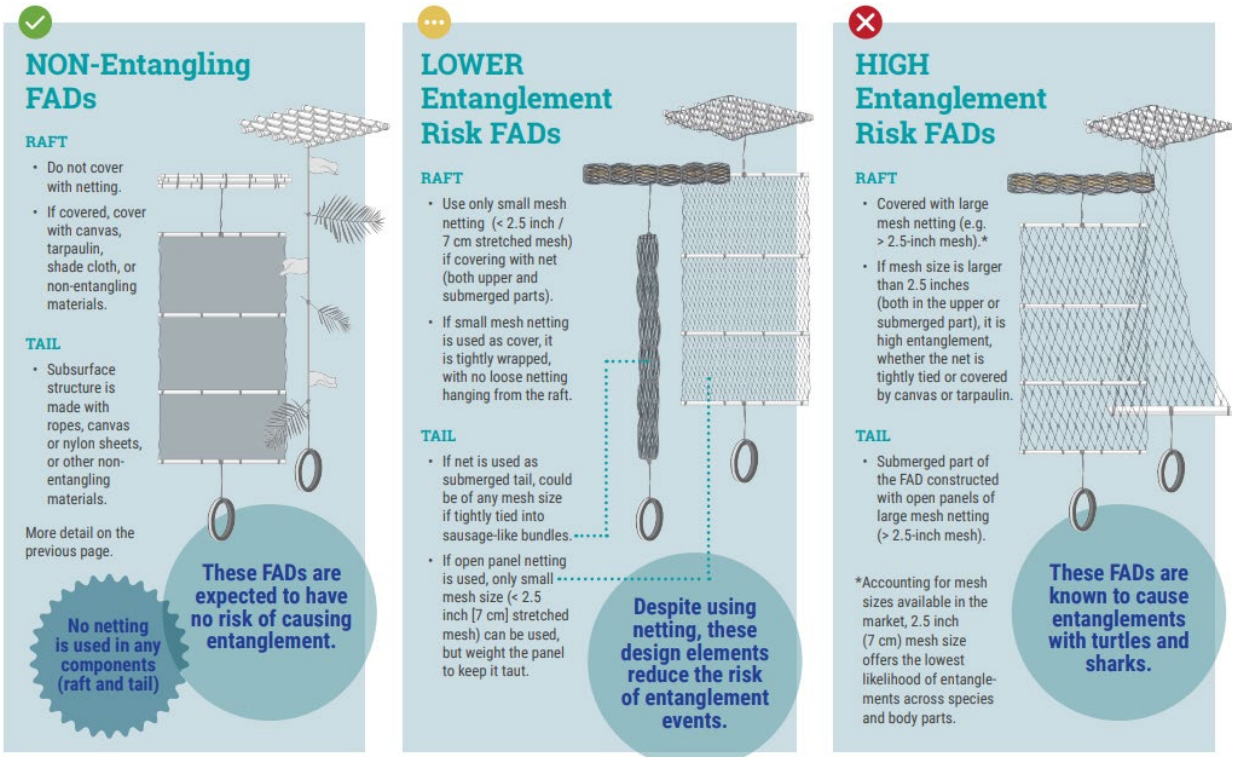

Figure 1: Image from the International Seafood Sustainability Foundation report on non-entangling and biodegradable FADs. This graphic is available in multiple languages from ISSF. Source: International Seafood Sustainability Foundation.

Lost or abandoned FADs: Ghost gear, marine debris, entanglement, and plastic pollution

Though most commonly used to attract and catch tuna (and in the Mediterranean Sea, dolphinfish *Coryphaena hippurus*), entangling FADs also attract and catch many other species of marine life as well, including non-target species of fish, sea turtles, seabirds, marine mammals, and sharks and rays, including CMS-listed species. Greenpeace estimates that FADs result in catching between 2.8 and 6.7 times as many non-target species as target species, including many species of conservation concern (Greenpeace 2019).

When lost or abandoned (i.e., “Ghost Gear,”) they continue to entangle and kill long after they are no longer being used as fishing gear. This is also known as ALDFG (Abandoned, Lost, or otherwise Discarded Fishing Gear). Greenpeace estimates that over 640,000 tons of ghost gear end up in the ocean each year (notably that figure is from all fishing gear, not just from FADs, and in many cases, it is difficult or impossible to identify the exact source of ALDFG, Greenpeace 2019).

Lost or abandoned FADs are a major contributor to global marine debris (Simmonds & Nunny 2024). Though the use of properly maintained stronger construction materials and thoughtful restrictions on where they can be deployed can reduce this chance, anchored FADs can break free, often during bad weather. Some drifting FADs drift so far that the fishing vessels that deployed them cannot recover them (or are not willing to spend the time and fuel to do so). Sinopoli (2020) notes that over one million FADs have been abandoned in the Mediterranean region, with many constructed out of materials including harmful marine debris such as plastic bottles and sheets, and lines and cables made out of plastics.

Schatz (2024) points out that natural floating objects are an important part of pelagic ecosystem ecology, but the increased use of FADs can disrupt or modify these natural processes. The paper further claims that more than 85% of all floating objects in the Indian ocean are FADs, and over 90% of them end up lost or abandoned.

Over time, lost or abandoned FADs break down into smaller pieces and become marine debris, which can cause choking or entanglement hazards for marine life, as well as becoming plastic (and even eventually microplastic) pollution. Some FADs also contain electronics used to track or locate them If drifting or lost, electronic which contain materials that can cause environmental harms if abandoned (Greenpeace 2019).

When these FADs sink or drift into shallow water, they can damage sensitive habitats including reefs, sponges, and seagrass meadows, while continuing to entangle marine life (Figure 2, Greenpeace 2019).

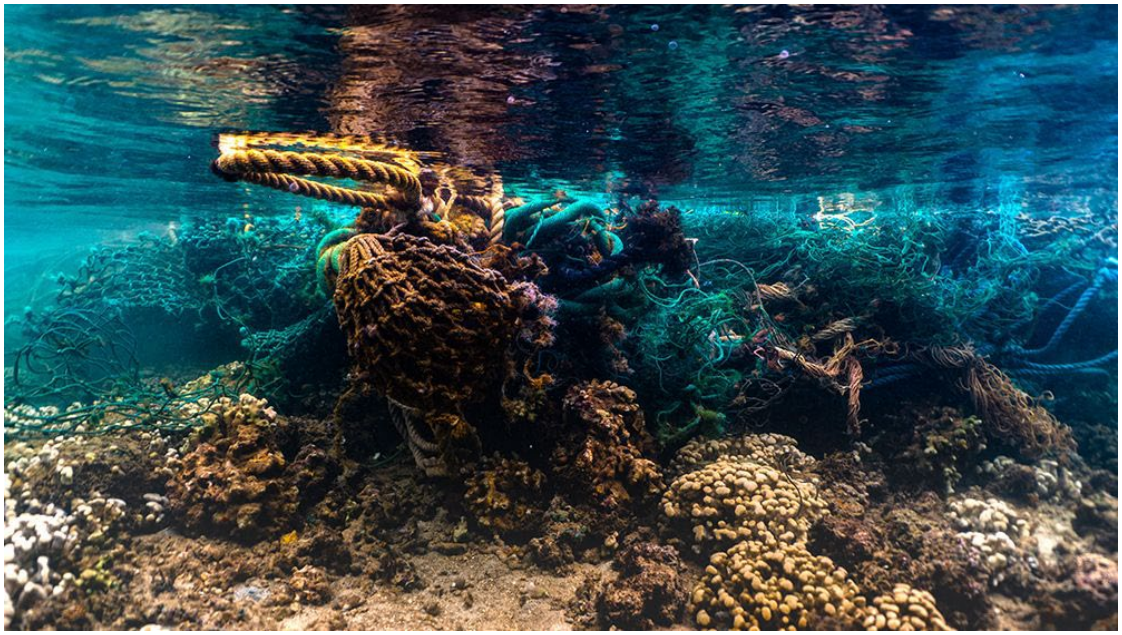

Figure 2: Image of "Ghost Gear" fishing nets (not FADs) harming a coral reef in Hawaii, photo by Rachel Sandquist, Hawaii Pacific University marine debris research team.

Species and Ecosystems of Particular Conservation Concern Impacted by FADs

Numerous species and ecosystems can be impacted by FADs, either by entanglement during regular intended use, or by lost or abandoned “ghost gear” (Table 1.)

Globally, hundreds of thousands of silky sharks (*C. falciformis*) are entangled in FADs each year (Filmalter et al. 2013). Murua et al. (2019) suggests that estimates of shark deaths from FADs entanglement are an underestimate because dead sharks often fall out of the FADs and are not observed. Zudaire (2020) notes that sea turtles can get entangled not only in the submerged netting but also if they attempt to crawl on top of the FADs, and while most marine mammals are at limited risk for entanglement, some marine mammals have behaviors which pose particular conservation challenges (e.g., feeding on fish entangled in netting and then becoming entangled themselves, NOAA Fisheries).

Table 1: Representative examples of species or ecosystems of conservation concern affected by FADs or ALDFG.

Species or ecosystem	**Impact**	**Reference**
Black coral, IUCN “Endangered”	81.1% of the observed waste was FAD ropes, and nearly half (47.57%) was observed smothering or entangling benthic fauna including black coral.	Consoli et al. 2020
Silky shark, IUCN “Vulnerable”	480,000-960,000 silky sharks are entangled in drifting FADs in the Indian ocean each year	Filmalter et al. 2013.
Oceanic whitetip shark, IUCN “Critically Endangered”	Entangled obligate ram ventilating sharks suffocate	Murua et al. 2019
Loggerhead sea turtles, IUCN “Vulnerable”	19.4% of rescued or dead turtles in the Mediterranean were entangled in fishing gear, much of FAD origin	Blasi et al. 2016
Marine Mammals	Anchored FADs are of particular concern with respect to marine mammal entanglement, because the anchor line, not just the gear itself, poses an entanglement risk.	NOAA Fisheries
Porpoises	7 dead porpoises were found entangled in drifting FADs, which was 1/3 of examined drifting FADs.	Chanrachkji & Loog-On 2003

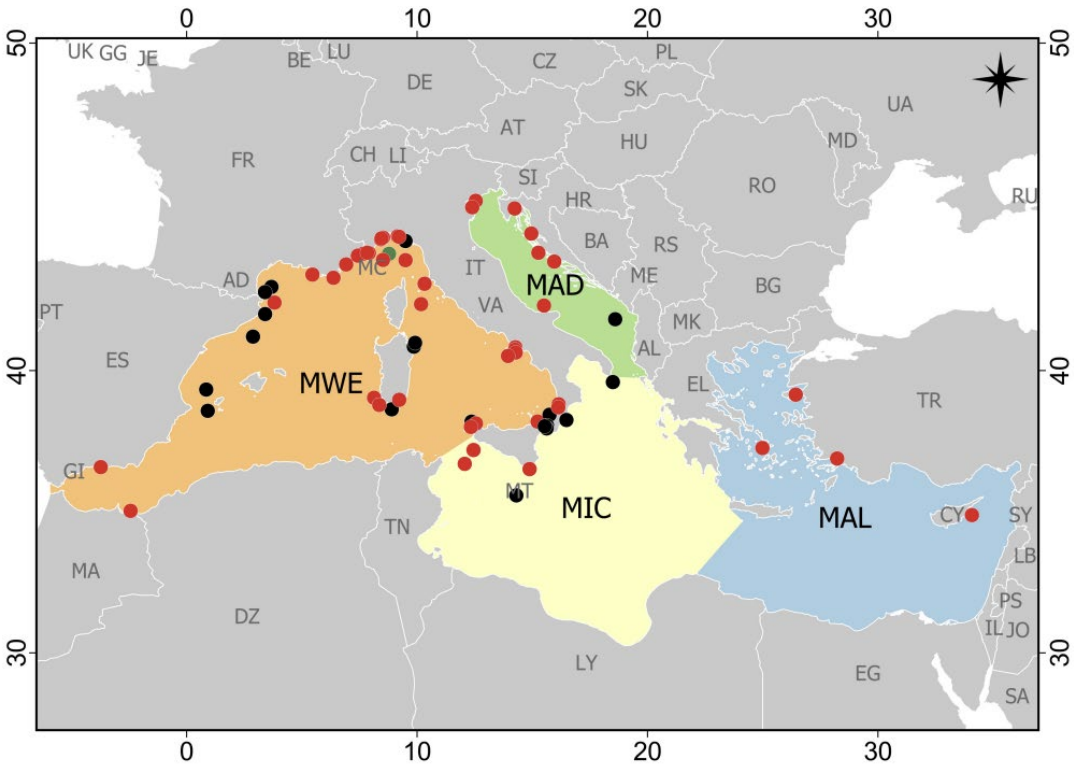

Figure 3: Map from Angiolilo & Fortibuoni 2020 showing the location of studies demonstrating harm from marine litter to shallow (red dots) and deep reefs (black dots) throughout the Mediterranean. They stress that the absence of a marking on this map does not indicate an absence of harm, just that this location has not yet been studied.

Areas identified by the Convention on Biological Diversity (CBD) as Ecologically or Biologically Significant Marine Areas (EBSAs) are heavily impacted by marine litter resulting from ALDFG (Consoli et al. 2018) and include documented impacts to 16 benthic habitat-forming species of conservation concern. Seafloor canyons, recognized as ecologically important and vulnerable habitats, had a great deal of fishing gear marine litter (Cau et al. 2017). Threats and damage to corals resulting from entanglement or crushing were repeatedly observed. Seamounts are particularly impacted with tens of millions of pieces of marine litter, much of it resulting from ALDFG (Greenpeace 2019). Shallow and deep reefs throughout the Mediterranean Sea have been impacted by ALDFG, including from lost or discarded FADs (Angiolilo & Fortibuoni 2020, Figure 3).

FADs in the Mediterranean region

Scale of use and contribution to marine debris

In the Mediterranean Sea, most FADS are anchored (Sinopoli 2025). Historically, FADs in this region were made of palm fronds and cork wood, but in recent years have started to incorporate car tires and a great deal of non-biodegradable plastic, including plastic bottles, sheets, and ropes and cables (Sinopoli 2025). Slightly different designs are used by different nations' fishing fleets, with notable distinctions in materials and designs between Italy, Spain, Malta, and North African fishing fleets (Figure 4, Sinopoli 2025). The studies reviewed for this report focused on fisheries using FADs in these nations, with very few mentions of other nations. It is somewhat unclear if this is because these nations are the only ones with fisheries using FADs of any significant scope, or because other nations do not report their data appropriately to authorities like the GFCM.

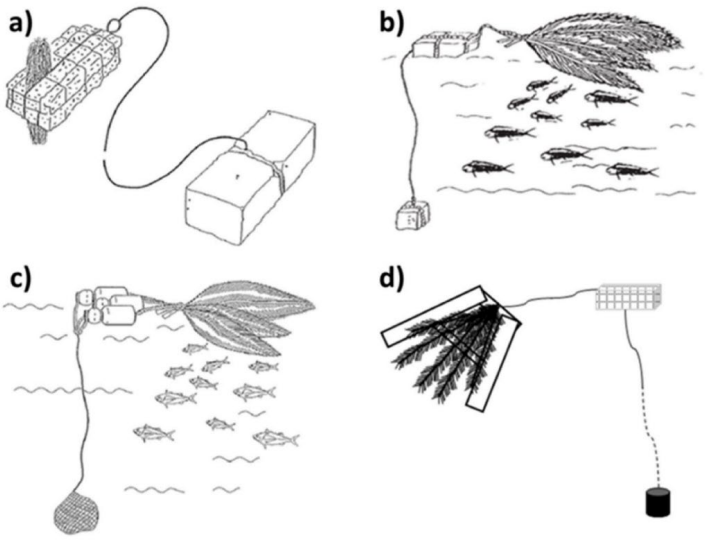

Figure 4. From Sinopoli 2025, showing common designs of FADs deployed in the Mediterranean region, noting that some incorporate plastic floats, the use of heavy pieces of trash as anchors, and some organic/biodegradable components including palm fronds.

Approximately 60,000 FADs are deployed each year in the Mediterranean (Table 2, Sinopoli 2025). General Fisheries Commission of the Mediterranean datasets, while incomplete because not all nations which potentially use FADs in the region submit data on use of FADs appropriately, suggest that there are a few hundred fishing vessels actively using FADs in the region (Sinopoli 2025).

Table 2: Estimates of the scope of FADs usage in the Mediterranean region with remarks on their deployment. This information comes from a search of the General Fisheries Commission of the Mediterranean's database. Modified from Table 2 in Sinopoli 2025, with remarks taken from elsewhere in Sinopoli et al. 2025.

Country	**Number of vessels authorized by GFCM**	**FADs / vessel**	**Total FADs deployed annually**
Spain	34	40	1360
National regulations govern where FADs can and cannot be deployed, how many can be deployed per vessel, and materials of FADs, and require removing FADs after fishing (Orden AAA/1688/2013, a national-scale ministerial decree)			
Italy	261	40	10,440
Regulations limit the total number of FADs per vessel, require biodegradable materials, and in some cases require removing FADs after fishing. Regulations established by local fishers' associations called COGEPAs.			
Malta	119	200	23,800
Regulations govern where and how far apart FADs can be deployed, how many can be deployed per vessel, and that they must be identifiable to an individual vessel via markings. Established by a national-level management plan			
Tunisia	260	66	17,247
Regulations are established by national-level ministerial decree governed by a scientific steering committee, but divide the fishing area into 3 regions. They only government where FADs can be deployed and the number of FADs per boat, and do not include material restrictions or a requirement to remove FADs at the end of the fishing season			
Libya	185	36	6,660
No information found on regulations			
TOTAL			59,507

Sinopoli (2025) notes that most anchored FADs in the Mediterranean are not recovered but are either lost or abandoned, and Sinopoli (2020) estimates that more than a million individual FADs have been abandoned in the Mediterranean Sea over the last few decades. Another study estimates that 76% of all deployed FADs in the Mediterranean Sea are lost (often due to bad weather) or abandoned (Lleonart et al. 1999) - something that could potentially be reduced by restricting where FADs are anchored or requiring stronger anchors or anchor attachment points to be included in their construction.

In the Mediterranean Sea, FAD entanglement is a source of mortality for species of conservation concern including loggerhead sea turtles (Blasi et al. 2016, Figure 5).

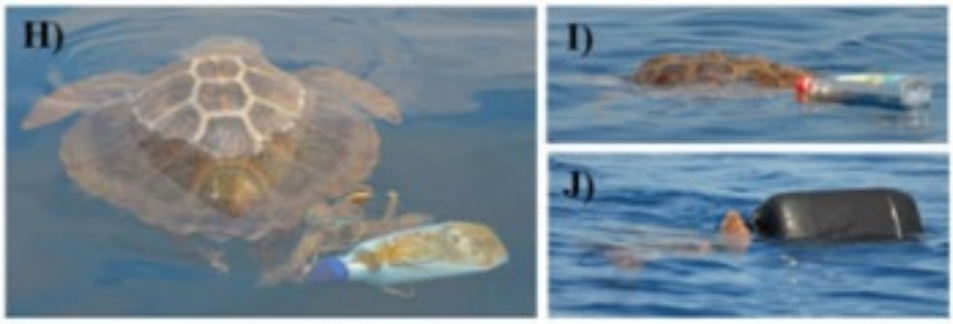

Figure 5: Images from Blasi et al. 2016 showing loggerhead sea turtles entangled in FAD debris (plastic containers used as FADs floats) in the Mediterranean Sea

Studies reviewed in this report document the damage to Mediterranean marine life and sensitive habitats resulting from ALDFG, including FADs (Figure 6). The seafloor of the northern Mediterranean Sea is one of the most polluted on Earth (Pasquini et al. 2016). Damage to a several benthic habitats in these areas, including to threatened black coral habitats, is widespread (Consoli et al. 2018, 2020). More than 96% of the large marine litter identified in sensitive seafloor habitats in the central Mediterranean Sea was traced to FADs, damaging critical habitats like black coral (*Leiopathes glaberrima*, a habitat-forming coral species that's known to be vulnerable to damage from fishing gear, Lauria et al. 2021) and killing protected species of conservation concern directly (Consoli et al. 2020). About 1/3 of pollution on the Adriatic seafloor is discarded or lost fishing gear (Strafella et al. 2015,) along with large percentages of the pollution on the Central Mediterranean seafloor (Cau et al. 2017), along the Italian coastline (Scotti et al. 2021), and along the North African coastline (Loulad et al. 2019). More than ¼ of all observed lost fishing gear on the Central Mediterranean seafloor is entangled in marine animals or on habitat-forming organisms like corals (Consoli et al. 2019). Many also wash up on surrounding beaches and sensitive coastal habitats (Vlachogianni 2019).

Overall, over a million individual small pieces of marine debris resulting from abandoned or lost fishing gear are estimated to be in the Mediterranean Sea at any one time (Lambert et al. 2020). Sinopoli (2025) estimates that between Spain, Italy, Malta, and Tunisia, over half a million kilometers of plastic rope resulting from FADs- enough to wrap around the Earth more than ten times- has become marine litter, along with tens of millions of individual plastic objects that were once used as flotation aids for FADs.

The Mediterranean regulatory landscape for FADs, plastic pollution, and sustainable fisheries

The Mediterranean region has a complex regulatory landscape with a variety of national and international regulations governing plastic pollution, endangered species conservation, and sustainable fisheries management. Many of these regulations apply (or can apply) to the construction and operation of FADs. Some of these regulations are insufficiently enforced, and adopting regulations that have been successfully implemented in other regions could further strengthen the regulatory landscape. Some key points from the literature review are stressed below, which is not intended to be a comprehensive survey of all relevant laws and regulations and treaties.

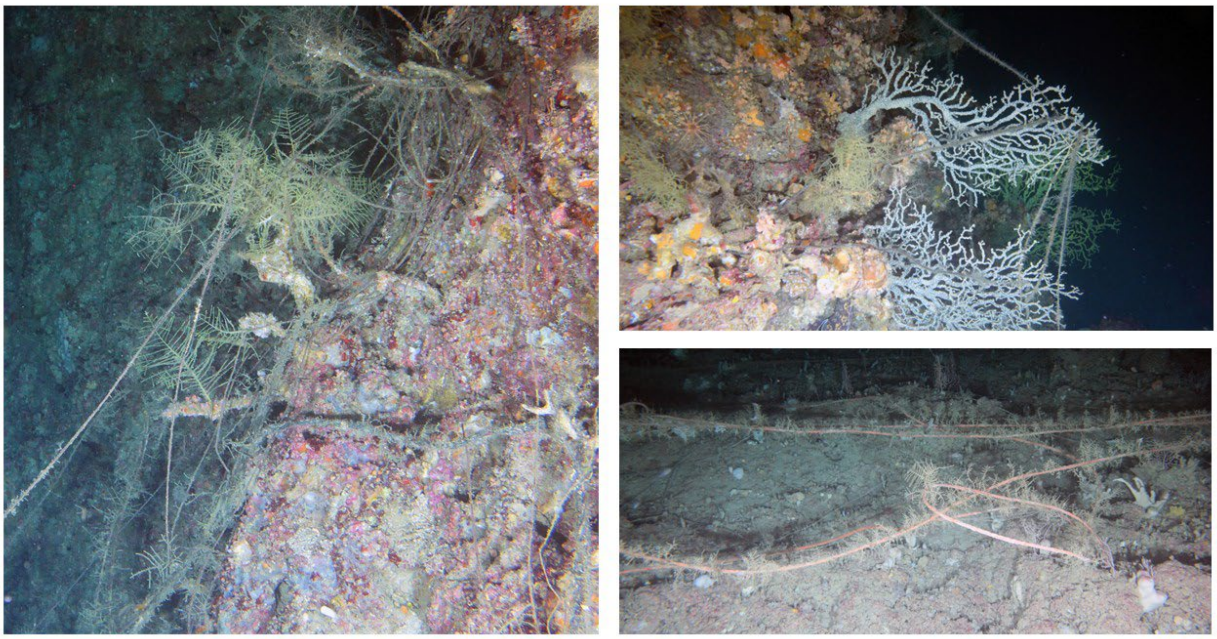

Figure 6: Representative images from Consoli et al. 2018 and Consoli et al. 2020 showing derelict fishing gear impacting benthic habitats in the central Mediterranean. This includes ropes entangling or crushing colonies of black corals; gear crushing gorgonians, and extensive damage

The 2008 European Marine Strategy Framework Directive is described as the leading instrument to protect the marine environment in European waters (Angiolillo and Fortibuoni 2020), including but not limited to the Mediterranean Sea. Descriptor 10 refers to marine litter and the species and ecosystems harmed by it. The European Marine Strategy Framework Directive applies to marine litter resulting from ALDFG in several ways. Consoli et al. (2019) argues that marine liter resulting from ALDFG clearly and unequivocally meets the standard for “causing harm” under the Marine Strategy Framework Directive, and therefore can and should be regulated under the Directive. Galgani et al. (2014) notes that a 2010 decision from the European Commission stressed that monitoring of ALDFG should focus on the composition of ALDFG, the amount of litter ending up on the seafloor especially in sensitive habitats, and on the possibility of microplastic pollution, as well as the quantity and source of the gear.

Until recently, there were few FADs-specific fisheries regulations in the Mediterranean Sea, but there have been three major regulations from the General Fisheries Commission for the Mediterranean (in 2006, 2019, 2021) (Sinopoli 2025). These focus on materials used in construction, marking so that each FADs owner is clear, and requiring recovery of FADs. The 2006 regulation focused on data gathering and did not have any wording focusing on reducing the harmful impacts of FADs, and the 2019 regulation created a registry of authorized FADs users (Sinopoli 2025).

Different nations in the Mediterranean have different regulations for fishing vessels flagged in their nation (Sinopoli 2025). Spanish-flagged vessels are limited to 50 FADs per vessel, while Malta limits the total number of fishing vessels but not the number of FADs each vessel can use. Italian-flagged vessels are obligated to use biodegradable materials when constructing FADs.

Regulations governing the use of FADs globally

As FADs are a globally deployed fishing method, there are different regulations at the national and RFMO scale that apply to their use, and to the reduction of their possible harms (See Table 3 for specific wording of representative regulations).

A general rule of marine debris management, including but not limited to plastic pollution, is that it is exponentially easier, cheaper, and more effective to prevent debris from entering the ocean than to retrieve it from the ocean later (Fonseca et al. 2024). Therefore, to the extent possible, preventing the loss of FADs is strongly recommended as a focus. Pursuing the recovery of ALDFG is important, but preventing gear from being lost, abandoned, or discarded is likely to be more effective and cost-effective.

Pollution resulting from vessels in international waters, including fishing vessels, can be regulated by the United Nations International Maritime Organization (IMO) and Annex V of the IMO International Convention for the Prevention of Pollution from Ships restricts discarding fishing gear (Greenpeace 2019). However, Sinopoli (2025) stresses that this does not refer to lost gear, only intentionally abandoned gear, and that the distinction can be difficult to prove. Additionally, the 1995 UN Food and Agriculture Organization's Code of Conduct for Responsible Fisheries requires states to use environmentally responsibly gear and fishing techniques to minimize the loss or abandonment of fishing gear (Greenpeace 2019). The London Convention on the Prevention of Marine Pollution by Dumping and UNCLOS also apply to intentionally abandoned (but not unintentionally lost) FADs (Schatz 2024).

Regulations governing the total number of FADs deployed, both per fishing vessel and fishery-wide, are common. Programs that encourage recovery of lost FADs (and other marine debris including but not limited to other ALDFG) are also common and have been shown to be effective in many cases. A recent study found that surveyed fishers are aware of the environmental harms caused by abandoned fishing gear and are generally willing to help reduce gear loss and participate in lost gear retrieval, but proper economic incentives are needed to help encourage this further (Ngoc et al. 2025). In addition to proper incentives, targeted outreach, including stressing how ALDFG litter is harmful not only to habitats and threatened species but harmful to fisheries themselves, is recommended (Galimany et al. 2019). A large number of abandoned FADs pass within 50 kilometers of a port (not necessarily the port where the fishing vessel that deployed them is docked,) which suggest that targeted programs for recovering FADs could be easily implemented.

Gilman (2015) notes that 1/3 of intergovernmental organizations have no regulations to control ALDFG at all, that half of best practices recommendations from his literature review were not adopted by any IGO anywhere, and that those IGOs that do have regulations in place are only using a handful of the available recommendations.

In addition to restricting the deployment of FADs in important migratory corridors, researchers have identified areas where it is more likely that FADs will become lost, and may eventually beach or sink, based on weather, current patterns, and seafloor topography (Imzilen et al. 2021). This study examined the tracks of tens of thousands of drifting FADs over a decade in both the Atlantic Ocean and Indian Ocean. They noted, for example, that the Northern Equatorial Madagascar Current drives FADs deployed off Southern Africa into the coastlines of Mozambique and Tanzania. Monsoon season impacts the risk of drifting FADs becoming beached in the Maldives, with associated recommendations of temporary or permanent regions of the ocean where the deployment of FADs should be restricted to minimize beaching risk. Similar analyses could be conducted in the Mediterranean region, or any region.

An internationally legally binding instrument focusing on plastic pollution

At the time of this report's writing UN negotiations to create an international treaty focusing on plastic pollution were underway at the Palais des Nations in Geneva, Switzerland, but not yet completed. Just prior to this report's completion, it was announced that the Parties did not reach a consensus. Plastic pollution resulting from ALDFG was discussed in earlier phases of the negotiations (UNEP 2024) and when negotiations resume, this important topic hopefully will be included in thefinal text. It is therefore recommended that the CMS Scientific Council take note of the final text when available, and consider what elements of that treaty are relevant to the issue of FADs in the Mediterranean and elsewhere.

Table 3: Representative wording of key regulations, with hyperlinks to the original source.

Regulation	Selected Wording
Recommendation GFCM/43/2019/1 on a set of management measures for the use of anchored fish aggregating devices in common dolphinfish fisheries in the Mediterranean Sea	"CONSIDERING the impact of the use of fish aggregating devices (FADs) on essential fish and marine habitats and vulnerable marine ecosystems, their possible interactions with other fisheries and the need to establish a minimum set of management measures, in particular for better monitoring and control[…] CPCs shall ensure adequate monitoring of the biological and environmental impacts of FADs used by vessels flying their flag and exploiting common dolphinfish[…]Vessels of CPCs shall be allowed to use FADs for the exploitation of common dolphinfish only if they hold a valid fishing authorization issued by the competent authorities. Each CPC shall maintain a register of these authorizations and communicate the list of authorized vessels to the GFCM[…] In cases where the surface structure of the FAD is covered with material, CPCs shall ensure that it is either not covered or covered only with material that involve minimal risk of entangling nontarget species, especially vulnerable species, or affecting other vessels[…] When designing FADs, biodegradable materials shall be prioritized"
DIRECTIVE (EU) 2019/904 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the reduction of the impact of certain plastic products on the environment (2019/904)	"Single-use plastic products and fishing gear containing plastic are therefore a particularly serious problem in the context of marine litter, pose a severe risk to marine ecosystems, to biodiversity and to human health and damage activities such as tourism, fisheries and shipping[…] The large percentage of plastic stemming from discarded fishing gear, including abandoned and lost fishing gear, in marine litter indicates that the existing legal requirements laid down in Regulation (EC) No 1224/2009, Directive 2000/59/EC and Directive 2008/98/EC do not provide sufficient incentives[…] Member States should monitor and assess, in line with the reporting obligations laid down in this Directive, fishing gear containing plastic[…] Member States shall ensure that each single-use plastic product listed in Part D of the Annex placed on the market bears a conspicuous, clearly legible and indelible marking […] Member States shall, for each calendar year, report to the Commission the following: data on fishing gear containing plastic placed on the market and on waste fishing gear collected in the Member State each year."
FAO Code of Conduct for Responsible Fisheries	"Selective and environmentally safe fishing gear and practices should be further developed and applied, to the extent practicable, in order to maintain biodiversity and to conserve the population structure and aquatic ecosystems and protect fish quality. Where proper selective and environmentally safe fishing gear and practices exist, they should be recognized and accorded a priority in establishing conservation and

	management measures for fisheries. States and users of aquatic ecosystems should minimize waste, catch of non-target species, both fish and non-fish species, and impacts on associated or dependent species[…] States should take appropriate measures to minimize waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non-fish species, and negative impacts on associated or dependent species, in particular endangered species. Where appropriate, such measures may include technical measures related to fish size, mesh size or gear, discards, closed seasons and areas and zones reserved for selected fisheries, particularly artisanal fisheries. Such measures should be applied, where appropriate, to protect juveniles and spawners. States and subregional or regional fisheries management organizations and arrangements should promote, to the extent practicable, the development and use of selective, environmentally safe and cost-effective gear and techniques[…]States should cooperate to develop and apply technologies, materials and operational methods that minimize the loss of fishing gear and the ghost fishing effects of lost or abandoned fishing gear."
London 1996 protocol to the convention on the prevention of marine pollution by dumping of wastes and other matter	"'Dumping' means any deliberate disposal into the sea of wastes or other matter from vessels[…] Contracting Parties shall prohibit the dumping of any wastes or other matter with the exception of those listed in Annex 1." (Note: Applies to abandoned, but not lost, gear)
United Nations Agreement for the implementation of the provisions of UNCLOS relating to the conservation of management of straddling fish stocks and highly migratory fish stocks (UNFSA)	"In order to conserve and manage straddling fish stocks and highly migratory fish stocks, coastal States and States fishing on the high seas shall, in giving effect to their duty to cooperate in accordance with the Convention: […] minimize pollution, waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non-fish species, (hereinafter referred to as non-target species) and impacts on associated or dependent species, in particular endangered species, through measures including, to the extent practicable, the development and use of selective, environmentally safe and cost-effective fishing gear and techniques […] collect and share, in a timely manner, complete and accurate data concerning fishing activities on, inter alia, vessel position, catch of target and non-target species and fishing effort, as set out in Annex I, as well as information from national and international research programmes;[…] promote and conduct scientific research and develop appropriate technologies in support of fishery conservation and management; implement and enforce conservation and management measures through effective monitoring, control and surveillance"
Indian Ocean Tuna Commission Resolution 24/02 on management of drifting FADs in the IOTC area of competence	"'Biodegradable' means non-synthetic materials 1 and/or bio-based alternatives that are consistent with international standards 2 for materials that are biodegradable in marine environments. The components resulting from the degradation of these materials should not be damaging to the marine and coastal ecosystems or include heavy metals or plastics in their composition. CPCs (contracting parties) shall prohibit their flag vessels from deliberately discarding DFADs or associated instrumented buoys

	except in cases of force majeure[…] CPCs shall instruct their flag vessels to take all reasonable precautions to prevent accidental loss of DFADs and instrumented buoys. To reduce the impact on marine biodiversity and the entanglement of sharks, marine turtles or any other species, CPCs shall ensure that their vessels only use DFADs whose design and construction comply with the following specifications as outlined as an example in Annex IV: a) the use of mesh materials shall be prohibited for any part of a DFAD; b) only non-entangling material and designs shall be used"
Inter-American Tropical Tuna Commission Resolution C-24-06	"To prevent drifting loss or stranding, CPCs are encouraged to initiate recovery programs of drifting FADs through cooperative initiatives among fishing vessels operating in the Convention Area or vessels implementing projects for the recovery of such FADs. Without restricting regular fishing operations of purse seine vessels fishing with FADs, such recovery activities shall be limited to the collection of drifting FADs for final disposal and not to perform any type of maintenance or adjustment. Drifting FADs collected under the voluntary recovery program shall be taken on board and brought to port for recycling or disposal. The provisions of this paragraph shall be in effect until 31 December 2028, while the initial results are analyzed."

Best practices for the sustainable use of FADs globally

Academic experts, environmental non-profits, and industry groups have compiled best practice guidelines for the sustainable use of FADs around the world.

Blue Marine Foundation

The Blue Marine Foundation is a UK-based non-profit organization that focuses on ocean conservation and sustainable seafood issues. They wrote a recent report (Blue Marine Foundation 2022) outlining best practices for the use of FADs responsibly. Recommended best-practices include requiring non-entangling designs made out of biodegradable materials, which should be confirmed (and documented) by onboard fisheries observers- observers which should be required in 100% of fisheries using FADs during all deployment and retrieval operations. All FADs should be marked so that they are identifiable to an individual vessel operator, following the FAO guidelines on marking of fishing gear. Also related to transparency, the report calls for all FAD data (including real-time position data when possible, but including the total number of FADs deployed per vessel per season) to be released to relevant fisheries management authorities, and to be made available for scientific analysis. They also suggest a ban on abandoning FADs, and immediate reporting of lost FADs, with repeated issues leading to individual fishing operators having their fishing permits restricted. Finally, they call for a "polluter pays" model to cover costs of FAD retrieval by third parties.

FAO Fisheries

The United Nations Food and Agriculture Organization (FAO) is a United Nations agency focused on food and food systems, including sustainable fisheries management. They collect and analyze data from fisheries around the world, and compile training materials and best practice guides.

Such guides include the Code of Conduct for Responsible Fisheries (FAO 1995). The Code, while voluntary, is based on existing international laws including UNCLOS, and synthesizes

best practices. It is intended to be global in scope but adaptable to local conditions, which means that much of the guidance is general and not overly prescriptive. While the Code does not focus heavily on FADs, it does not that “states should, within the framework of coastal area management plans, establish management systems for artificial reefs and fish aggregation devices.” In other words, it calls for any fishery using FADs to have a management plan, something that far too often is not the case. It also includes a variety of general advice for sustainable fisheries anywhere using any gear type, including preventing overfishing, reducing impacts on non-target species, protecting critical habitats, and taking steps to minimize ALDFG. Many of the other FADs-specific recommendations included in this report provide more detail on how to accomplish these general goals from the Code when fishing using FADs.

Additionally, FAO created the Voluntary Guidelines on the Marking of Fishing Gear (FAO 2019). These best practice guidelines, synthesized from a variety of existing fisheries management agreements, focus on ensuring that any ALDFG can be traced to its original owner. It suggests a globally used system so that no matter which fishing vessel finds ALDFG, the markings can easily be understood, and the owner of the recovered gear can be easily identified. These guidelines recommend that markings traceable to an individual fishing vessel be a condition of permitting the use of FADs, and that any fishing vessel that loses one of their FADs should be required to immediately report it to relevant authorities. Though not directly relevant to markings, the guidelines further encourages the use of a non-entangling design made out of biodegradable materials for any FADs.

The International Seafood Sustainability Foundation

The International Seafood Sustainability Foundation (ISSF) is a collaboration between academic researchers, environmental advocates, and representatives of the seafood industry. They create best practices guidelines and track the adoption of those practices, perform original research, and advocate for improved fisheries practices through RFMOs and national-level fisheries management bodies around the world.

The International Seafood Sustainability Foundation also maintains an annually-updated list of best practices for FAD management, noting which regional fisheries management organizations are following these guidelines (ISSF RFMO Best Practices Snapshot 2025). Their 2025 best practices snapshot notes that “Concerted global effort in every ocean is needed to: collect and report data on fisheries statistics by set type (including FAD sets) through FAD logbooks and observers[….]enhance monitoring of FAD use including the provisions of FAD tracking[….] Adopt science-based FAD management measures such as limits on the overall number of FADs used and/or FAD sets made[….]use only fully non-establishing fads that reduce entanglement and minimize bycatch and ghost fishing[….]mitigate other environmental impacts due to FAD loss by promoting the use of biodegradable FADs and implementing FAD recovery policies[….]and adopt effective bycatch mitigation measures for primary bycatch species.”

Marine Stewardship Council

The Marine Stewardship Council (MSC) is an international science-based environmental non-profit which focuses on promoting sustainable seafood practices around the world by incentivizing sustainable fisheries management (Marine Stewardship Council annual report 2024).

The MSC notes that “every type of gear has some effect on the ocean environment. However, if carefully managed, virtually all gear types can be used responsibly and sustainably” (Marine Stewardship Council Fishing Methods). They also write that “Because of the variations in the impacts that different FADs and fishing techniques can have in different marine environments, the MSC Fisheries Standard does not include specific requirements for FAD use, nor does it

prohibit the use of FADs" (Marine Stewardship Council Fishing Methods- Fish Aggregating Devices).

To earn a MSC certification which signifies that a fishery follows best practices and can be considered sustainable, that fishery must meet certain universal standards of low environmental impact that apply across gear types. Until the past decade, no fisheries which utilize drifting FADs successfully met this standard. The first drifting FAD tuna fishery gained MSC certification in 2018. The Echebaster purse seine tuna fishery (Marine Stewardship Council Echebastar Indian Ocean purse seine skipjack tuna) has made several improvements to their sustainable fishing practices including a relatively small number of FADs deployed at a time, using exclusively non-entangling FADs, and prompt collection of FADs which includes rapid release of non-target species. There have since been 23 MSC-certified fisheries that use FADs (pers. Comm. Adrian Gutteridge, MSC.)

Several subsequent MSC-certified fisheries which use drifting FADs have worked with a program called "FAD Watch," which aims to track and intercept drifting FADs before they can impact sensitive habitats like coral reefs (Herrera et al. 2019). FAD Watch is a collaboration between local governments, the local fishing industry, and local environmental non-profits, and it identifies drifting FADs that pass into particular regions which can then be retrieved.

Recommendations

A review of peer-reviewed scientific literature, technical reports from regional fisheries management organizations, and best practice guides for commercial fisheries from industry groups and environmental non-profit organizations, was used to develop a clear set of recommendations for reducing the harmful impacts of FADs while still permitting their use in potentially sustainable well-managed fisheries (Table 1).

While this report focuses on the Mediterranean region as a case study, problems from poorly managed FADs are global, and these solutions can be adapted to any region's management systems.

It should be noted that any regulation is only valuable if it is enforced. Regional fisheries management organizations (including the General Fisheries Commission for the Mediterranean), as well as nations whose fishing vessels use FADs, should cooperate and coordinate with each other to increase compliance and effectiveness.

These recommendations include:

When constructing FADs:

Parties are encouraged to:

Require the use of non-entangling FADs (and restrict the use of entangling FADs). A non-entangling design for FADs still aggregates target species of fish just as effectively, with dramatically reduced impacts on non-target species caught as bycatch, including marine mammals, sharks, sea turtles and seabirds, as well as non-target fish species. Non-entangling refers to construction without any netting or mesh material that can pose a risk of entanglement to numerous marine species.

Require the use of biodegradable, organic, non-toxic materials when constructing FADs (or key components of FADs), including in components such as ropes and floats, and restrict the use of materials such as plastic. A life cycle analysis can be used to determine the most suitable material – for instance, a strong non-biodegradable component that can be reused for many years may have less environmental impact than a biodegradable element that can only be used for one season. However, gear components that are most frequently lost, or are most often associated with ecosystem impacts when lost, should be required to be biodegradable. Though some plastics may be considered biodegradable under some definitions, the regulations should stipulate that materials used in the construction of FADs should be non-toxic in the marine environment, and therefore should preclude the use of most biodegradable plastics.

Require stronger (and reusable) anchor systems to reduce the chances of gear loss during normal operations. Some fishing operations prioritize ease (including low cost) of anchor construction, but lower-quality anchor systems are more likely to break resulting in lost gear. Ideally, anchor systems should be designed to be reusable (and recoverable) even if the rest of the anchored FAD is lost. Reusing anchors reduces total material waste associated with FADs.

When deploying FADs / monitoring deployed FADs:

Parties are encouraged to:

Restrict the total number of FADs in use at a time, both per vessel (to reduce the chance of a fishing vessel losing gear inadvertently, a risk which increases when there are more FADs to keep track of) and in total in the whole fishery or region (reducing total impacts ecosystem-wide). Currently some Mediterranean Sea nations have rules along these lines, but others do not. A General Fisheries Commission of the Mediterranean regulation (43/2019/1) requires a register of fishing vessels authorized to deploy FADs in the region, but several nations have yet to comply.

Regulate where FADs can and cannot be deployed, including avoiding:

- shipping lanes
- areas of potential conflict with other fisheries
- key migratory routes or critical habitats
- seafloor habitat where breakage and loss are more likely

While drifting FADs (or lost anchored FADs that become drifting FADs) may drift into these regions, restricting where they can be initially deployed reduces this chance. And reducing deployment in areas where breakage is more likely reduces the chance of breakage and lost gear.

Require identifying markings on FADs so that any recovered FADs can be traced to their owner. Such markings should be standardized and internationally recognizable. The markings should be such that any vessel or management authority can easily determine the source of recovered lost FADs (rather than simply allow fishers/captains to identify gear that came from their own boats). These marks should be placed on multiple key components of each FAD in case the gear breaks and only one component is later recovered.

Require inspection and maintenance of FADs. The ocean is a dynamic and challenging environment, and some gear breakage (and therefore loss) is likely inevitable. However, some gear breakage is due to poor maintenance, and requiring inspection, maintenance and repair prior to deploying FADs (and restricting the deployment of damaged FADs) will reduce gear loss.

Require the use of electronic tracking devices so that FADs can be easily recovered and do not become abandoned ‘ghost gear’. Electronic-signalling devices on FADs can also reduce the chance of them being struck by ships.

End of fishing season / end of FADs’ operating life:

Parties are encouraged to:

Require the removal of FADs at the end of the season. Many fisheries that use FADs have a distinct fishing season. Requirements to remove FADs at the end of the season can reduce the long-term environmental impacts of the gear and reduce the chances of it becoming lost. All FADs should be inspected and repaired during this timeframe, and irreversibly damaged gear should not be redeployed the following season.

If FADs are lost:

Parties are encouraged to:

Require monitoring and reporting of lost gear. A striking number of studies reviewed in this report rely on estimates because reliable data on the scale of the problem is unavailable. Requirements for fishing vessels to document and report lost FADs would both improve scientific understanding of the scale of the issue and, in some cases if reported quickly, could trigger recovery efforts.

Implement FAD recovery policies including financial incentives (e.g., paying fishers directly to recover FADs, including those that are not their own). This could be facilitated by electronic tracking devices. In some regions, a communications network could be used to rapidly inform fishers of any FADs drifting nearby that could be recovered. There could be some form of deposit that fishers get back when gear is delivered at the end of a fishing season, as well as penalties for careless avoidable gear loss or intentional abandonment.

Table 1: Key recommendations and their benefits

TECHNICAL / POLICY SOLUTION	PROPOSED BENEFIT
During the construction of FADs	
Non-entangling design elements	Dramatically reduces the possibility of entangling non-target marine life including species of conservation concern
Biodegradable design elements	Dramatically reduces environmental impacts of 'ghost gear' if FADs are lost or abandoned
Stronger anchor system	Reduces the chance of FADs being lost during moderate storms or normal operations
Life Cycle Analysis of gear to reduce total lifetime impact	Reduces multi-year impact of gear (e.g., a non-biodegradable component that can be reused repeatedly may have less environmental impact than a single-season use biodegradable component)
During the deployment of FADs / monitoring of deployed FADs	
Restrict total number of FADs deployed, per vessel and fleetwide	Reduces the chance of lost gear and total impacts
Restrict where FADs can be deployed	Reduces the chance of breakage leading to lost gear and impacts of gear on sensitive habitats or on migratory species of conservation concern
Require identifying markings	Ensures that each FAD is traceable to an individual fishing vessel
Require inspection and maintenance of gear	Reduces the chance of lost gear
Require electronic tracking devices	Reduces the chance of lost gear / facilitates recovery of lost gear
At the end of fishing season / end of FADs' operating life	
Require removal of FADs after the fishing season	Reduces long-term impact of gear
If FADs are lost	
Require monitoring and reporting lost gear	Facilitates an understanding of the scale of the problem and can trigger recovery efforts
Financial incentives for recovery of lost gear	Reduces long-term impacts of lost gear

Conclusions

FADs are a commonly-used and important commercial fishing gear, and like any other type of fishing gear will have some environmental impacts. The studies reviewed in this report document damage to many species and habitats of conservation concern, including marine mammals, sharks, seabirds, sea turtles, and corals, via entanglement or crushing. However, solutions focusing on the design, operation, and recovery of FADs can dramatically reduce these impacts, and regulations to implement these solutions are recommended.

Regulations focusing on the construction and design of FADs can reduce their chances of becoming lost due to gear breakage, and ensure that the FADs that are lost have a reduced chance of entangling, choking, or crushing marine life and sensitive habitats. Requiring regular inspection and maintenance of gear, and not deploying damaged gear, will further reduce gear breakage and associated loss. Requirements to limit the total number of FADs deployed, the season in which they can be deployed, and locations where they can deployed will further limit gear loss. Requirements to clearly label gear so that its original owner is clearly identifiable are also important, and financial incentives for recovery of lost FADs can help reduce their chance of becoming “ghost gear.”

While this report focuses on the Mediterranean region as a case study, problems resulting from poorly-managed fisheries using FADs are a global problem, and these recommendations can be adapted to any nation or region. Parties are encouraged to incorporate them into local fisheries management plans.

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