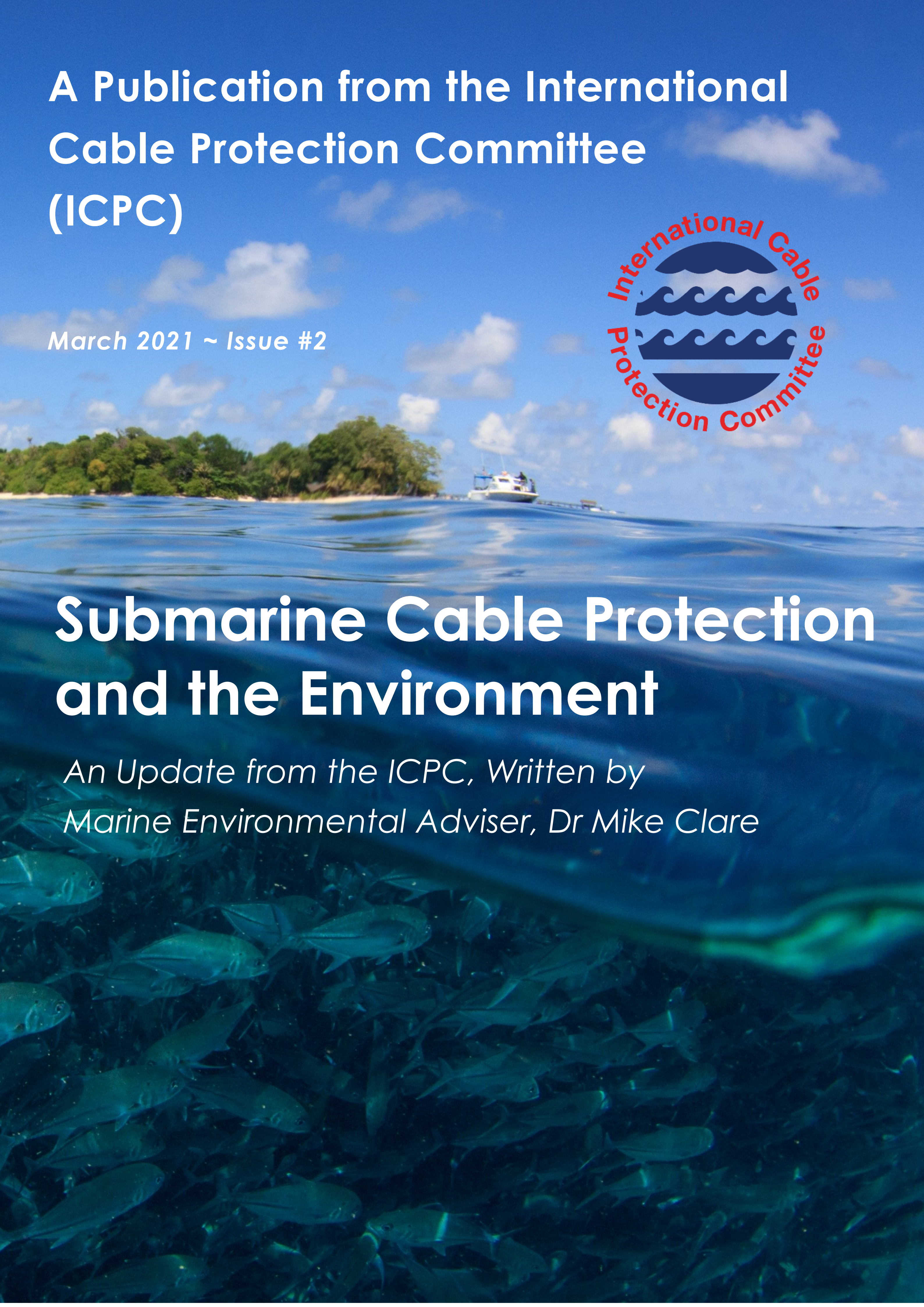

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Submarine Cable Protection and the Environment

An Update from the ICPC, Written by Marine Environmental Adviser, Dr Mike Clare

SUBMARINE CABLE PROTECTION AND THE ENVIRONMENT

An Update from the ICPC, Written by the Marine Environmental Adviser (MEA)

PUBLISHER

The International Cable Protection Committee (ICPC)

AUTHOR

Dr Mike Clare

ICPC Marine Environmental Adviser

Also, Principal Researcher – Ocean BioGeoScience at the National Oceanography Centre, UK

EDITOR

Mr Ryan Wopschall

ICPC General Manager

DESIGN & LAYOUT

Ms. Christine Schinella

ICPC Secretariat

CONTACT

PO Box 150 Lymington SO 41 6WA UK

Website: www.iscpc.org

Secretariat: secretariat@iscpc.org

LinkedIn

EDITOR'S CORNER

The submarine cable industry has changed substantially in the last ten years to support increasing worldwide demands for data transfer and communications. Cable ownership has shifted, new routes have been and are being developed, and fibre count for even the longest trans-oceanic systems is increasing. This coupled with an increase in capacity per fibre pair has enabled the data-driven growth across our global network.

Despite the expansion of this critical network, the nature of events that can damage submarine cables around the world has not changed dramatically over the last decade, or even the previous decade. Inadvertent human related activity still poses the largest risk of damage to submarine cables, with bottom contact fishing being the predominant contributor. But what is changing is the nature of fishing activity itself, as well as the uses of the world's oceans and the seafloor.

Our modern lives rely upon these critical seafloor assets more than ever. Though the global network of submarine cables is designed to be resilient through ensuring a redundancy and diversity of cable routes and landings, it is important to be aware of future changes in human activities that can interact with submarine cables. It is the goal of the **International Cable Protection Committee (ICPC)** to keep the world connected by working to protect submarine cables in coordination with other seabed users. As a result, the ICPC is growing and evolving, with the formation of new working groups to address today's concerns, and the development of new recommendations to provide guidance to the industry. Our goal is to ensure the global network stays resilient.

It is our pleasure to share with you this second issue of *Submarine Cable Protection and the Environment*.

Sincerely,
Ryan Wopschall
ICPC General Manager

INTRODUCTION

More than 1.8 million kilometres of telecommunications cables cross the global ocean, carrying telephone calls, data, documents, and video calls, enabling the internet, access to cloud storage, and underpinning financial trading worldwide. Most of these cables lie in deep water, where they sit directly on the seafloor without any armouring. These polyethylene lined cables are similar in size to a garden hose (17-21 mm diameter). They largely remain untouched during their lifespan, which is usually about 25 years or longer[1].

Every year around 100 to 200 cases of damage are reported on the submarine cables that comprise the global submarine telecommunications cable network. Repairs can be expensive and logistically-challenging—particularly if the fault lies below thousands of metres of water. However, repairs in the deep water of the High Seas are quite rare; averaging fewer than four instances per year worldwide.

INTRODUCTION

Damage caused by underwater landslides or earthquakes tend to make more exciting headlines[2], but natural hazards account for less than 10% of all documented faults **(see Figure 1 on page 7).** A global database of more than five thousand cable faults, analysed by the ICPC since 1959, reveals that most cable faults occur in shallow water (less than 100 m) and are instead related to more mundane causes: accidental human interactions. Human activities account for more cable faults than any other category, with fishing accounting for nearly half of all the reported faults in the database **(Figure 1).** This is perhaps unsurprising, and given the on-going expansion of human activity in the ocean, which is mostly focused on the continental shelf, activities such as maritime transport, hydrocarbon exploration, dredging, hydrocarbon exploration, marine research and fishing are likely to increase[3].

Fishing intensity continues to grow for food security and is shifting to new locations and deeper waters due to depletion of stocks by overfishing and because of the impacts of ocean warming on fish habitats[4]. Understanding future trends in fishing activity, and mitigating against any adverse impacts, is therefore of key importance to the submarine cable industry. In this second issue of *Submarine Cable Protection and the Environment*, we focus on the interactions between submarine cables and fishing, highlighting the following topical issues:

- Changing trends in fishing and interactions with submarine cables.
- How improved cable design has already removed the threat posed by sharks to submarine cables.
- The identification of an emerging and growing hazards for submarine cables: fishing using Fish Aggregating Devices (FADs).

WARMING OCEANS AND CHANGING FISHING PRACTICES (pages 6-10)

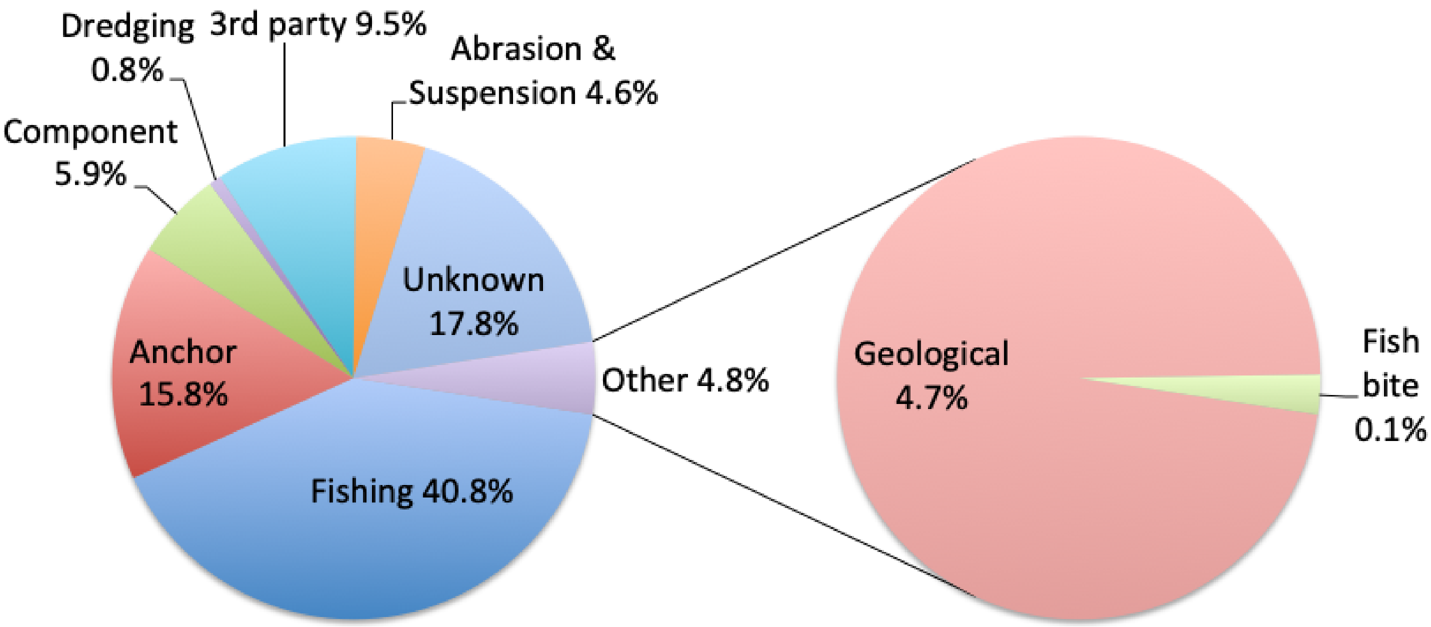
Bottom contact fishing occurs on most of the world's continental shelves and extends on the adjacent continental slopes to water depths of 1,500 m or more[5]. Despite the thousands of fishing vessels that operate worldwide, and hundreds of cables present in these depths, it is remarkable that interactions are relatively infrequent[1]. Many cables operate for years or decades without faults, and most fishing vessels never interact with cables. This is not the result of sheer luck, however. The submarine cable industry, and the ICPC, have been proactively engaging fisheries for decades, promoting the awareness of submarine cables, ensuring both seabed user groups can exist side-by-side in cooperation and harmony. That being said, the fishing-related cable faults (50-100 per year) can have major impacts as they can disrupt communications; particularly affecting countries that rely on a

small number of cable connections. Submarine cables are critical for global communications as they transmit more than 99% of all digital data traffic worldwide. Satellites currently lack the bandwidth and a direct connection via our world's oceans is still the most effective link for both capacity and latency[1].

▼ **Figure 1:** Percentage of cable faults related to different causes, based on analysis of a global database kept since 1959 (Courtesy of Global Marine). Improvements in modern cable design are thought to have removed the risk of fish bites as discussed on page 19.

THE WIDESPREAD USE OF BOTTOM TRAWLING

Historically, bottom trawling has been the main type of fishing to interact with submarine cables as it occurs on most continental shelves and covers large areas of seafloor[5]. This mode of fishing involves dragging an assembly of lines and netting behind a vessel. Cable faults tend to relate to the impacts of the trawl doors (known as otterboards) that are dragged along the seafloor, and weights that are designed to stir up the top few centimetres of the seafloor sediment to capture fish and shellfish. Otterboards can range



from 100 kg to eight tonnes weight for the largest commercial trawlers and tend to penetrate between 5 to 20 cm into the seafloor sediment, but may locally reach 50 cm or more in very soft sediments[5,6]. Fishers try to avoid deep seafloor penetration as it can lead to damage of fishing gear and slows progress. The environmental damage caused by deep sea trawling is also of growing concern, as it can damage important seafloor ecosystems, and release large quantities of buried carbon that counteracts climate change mitigation measures[7,8,9], a topic recently presented to ICPC Members in an *Environmental Bulletin*.

IMPACTS OF TRAWLING ON SUBMARINE CABLES

Research indicates that when a trawl crosses a telecommunication cable on the seabed, more than 90% of such crossings do not result in any cable damage[1,10]. The armour may provide sufficient protection to avoid damage. Many modern cables are buried more than 60 cm into the sediment in water depths down to 1000 m providing greater protection and reduction in fault rates[1]. Even when cables lie on the seafloor, trawl contact may be light enough for the gear to pass over the cable with no discernable contact. Firmer contact may occur if a heavy otterboard or ground gear scrapes across a cable lying on rocks or other hard seafloor. However, fishing vessels are pushing into deeper water, and burial in water depths of up to 1,500 m can be common in certain areas around the world.

The main instances of fishing-related cable damage include:

- If fishing gear or an anchor hooks or snags on a cable, it may become damaged due to bending, crushing, or stretching.

- A sharp corner of the fishing gear can penetrate cable armour and insulation, or bend or crush the glass fibres within the cable.

- If a grapnel is deployed to recover lost fishing gear. In many areas, normal fishing gear may present almost no risk, but if a grapnel is deployed, the risk becomes extreme.

GREATER THREATS IN GREATER WATER DEPTHS

Cables are more susceptible to damage in deeper water as it becomes more challenging to bury them. Heavily armoured cable is also harder to deploy in very deep water, so cables in deep water tend to carry less or no armour[1]. In contrast, fishing gear in deeper water tends to be heavier, often using large anchors. It is also more common for fishers to drag grapnels to retrieve fishing gear from fixed locations in deep water[1]. All of these aspects increase the risk of cable damage where activities coincide.

OTHER TRENDS AND FUTURE CHANGES IN FISHING

Depletion of fishing stocks, driven by overfishing, has created changes in fishing practices in some regions, stimulating a push into deeper waters[9]. This change has necessarily triggered an increase in the water depths where cables are buried in some locations, such as the north-east Atlantic and the eastern Pacific Ocean, where cables are sometimes buried in water depths up to 2,000 m[13]. As a cable's design life is 25 years, it is important to consider future changes in fishing practices and in which water

Figure 2: Photograph of damage caused to a telecommunications cable by deep-sea trawling (from Carter et al., 2009[1]).

depths they will most likely occur. Recent years have seen a growth in cable faults caused by fishing activities using gear that is fixed in one place—largely in water depths of between 500 m and 1800 m, but sometimes at almost 5,000 m[1]. This type of fishing includes the growing and widespread use of Fish Aggregating Devices that forms the basis of discussion on **page 11** of this issue.

FOOD FOR THOUGHT

There are several factors which are pushing fishing into deeper water depths or areas in which fishing has not previously been so common.

- Human-induced climate change is driving the migration of a number of key species towards cooler waters, which in turn will affect the location of fishing grounds[10,11,12].
- Recent modelling of future climate change scenarios indicates that deep-sea fish habitats will likely move between two to nine degrees towards higher latitudes[4].
- Implications of this migration are that cables may require protection in areas and jurisdictions that have historically not been fished before.
- Understanding how climate change will affect fishing activity is therefore of particular interest to the submarine cable industry.

FISH AGGREGATING DEVICES: AN EMERGING THREAT FOR SUBMARINE TELECOMMUNICATION CABLES (pages 11-17)

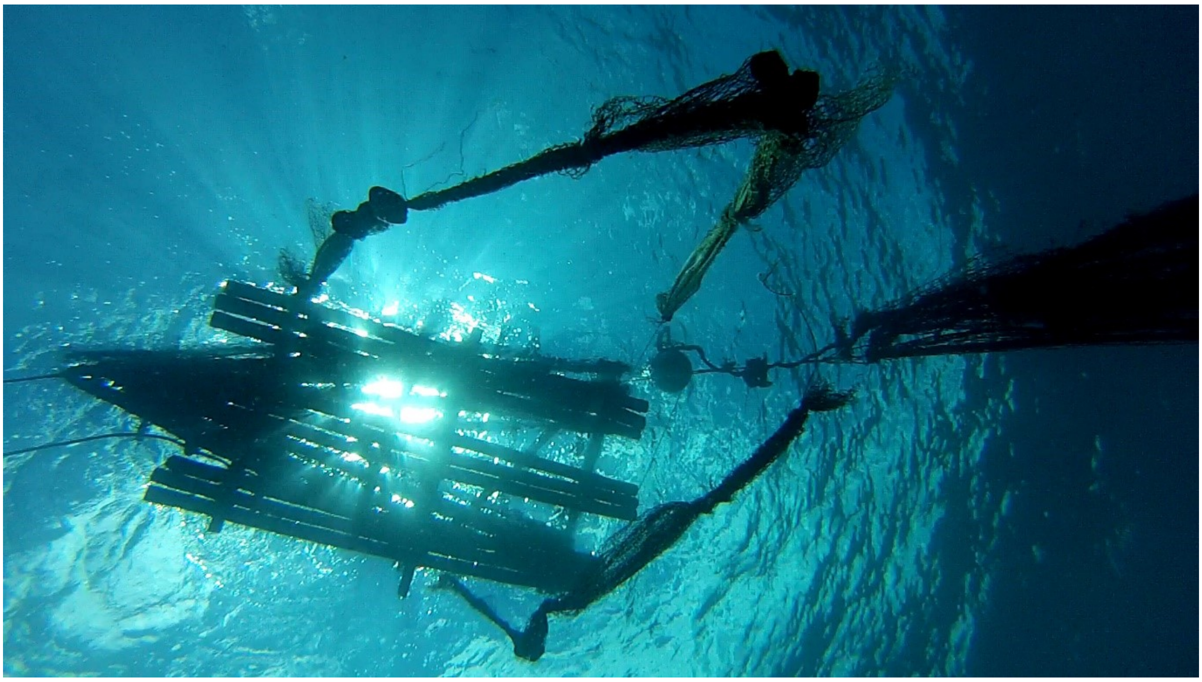
THIS ARTICLE INCLUDES CONTRIBUTIONS FROM THE MEMBERS OF THE ICPC FISH AGGREGATING DEVICE WORKING GROUP (FAD WG)

For centuries, fishers have used floating objects such as logs and other debris to attract fish, as they tend to congregate near them for shelter. These smaller fish then attract larger catches, such as marlin and tuna. Fishing of these catches can be lucrative. The global trade in tropical tuna was reportedly worth about $32 billion in 2019 alone[14]. Purpose-built floating structures (known as Fish Aggregating Devices; FADs) are known to increase the efficiency of fishing for large commercially-valuable fish, and their use has grown dramatically in recent decades. As an example, the introduction of FADs to support tuna fishing in the Philippines in 1975 increased tuna production from 10,000 to 125,000 tonnes per year, growing employment across the country's fishing industry and increasing food security[15]. FAD use is most common in the Indian Ocean and eastern Pacific Ocean, but is increasingly observed in other regions.

- While there are many benefits of fishing using FADs, a number of environmental concerns have been highlighted by various studies[16-21] such as the growing legacy of lost fishing gear that is primarily made of plastic and litters the oceans[22].
- Fishing using FADs is also of increasing concern to the submarine cable industry, as several companies have reported damage to telecommunication cables from FADs.
- This damage is often at far greater water depths (up to 5,000 m) than the fishing-related interactions that the industry has had to deal with historically.

This article covers some of the key points about FADs, including their global distribution, their benefits, and the emerging threats they pose to submarine cables.

▼ **Figure 3:** A Fish Aggregating Device showing the underside of the floating platform. (Credit: WorldFish; available under a Creative Commons Licence)



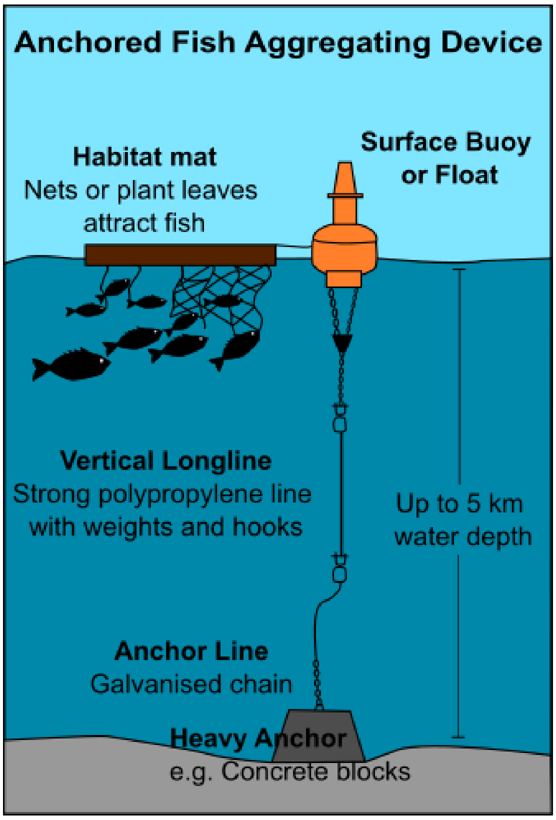
FISH AGGREGATING DEVICES: AN EMERGING THREAT FOR SUBMARINE TELECOMMUNICATION CABLES (pages 11-18)

WHAT ARE FISH AGGREGATING DEVICES?

FADs consist of a surface buoy or float from which fishing gear is deployed and may be crewed by a fisher or left unattended. Some FADs are designed to drift across the ocean, tracked by a GPS transponder. Others are tethered to the seafloor and are known as anchored or moored FADs, which typically include four components:

1. A float made of bamboo, plastic, or other buoyant material. This is the only part of a FAD visible on the sea surface.
2. Sub-surface structures that provide shade and shelter to attract fish. These tend to comprise large leaves, seaweed, or synthetic materials such as plastic sheeting or discarded fishing nets. As these attractors can be attached to the surface float or the mooring line, they are placed at a range of water depths from 20 m to 1500 m.
3. A mooring line that is typically made of polyethylene or polypropylene; however, the upper 40 m or so may be made of wire. Mooring lines are deployed to 5,000 m water depth or more in regions of the world where deep anchored FADs are being used.

▼ **Figure 4:** Schematic showing the main components of an anchored Fish Aggregating Device (not to scale).



4. An anchor to keep the FAD mooring in place, which is typically made of rocks, cast concrete blocks or heavy-duty chain.

ENVIRONMENTAL ISSUES

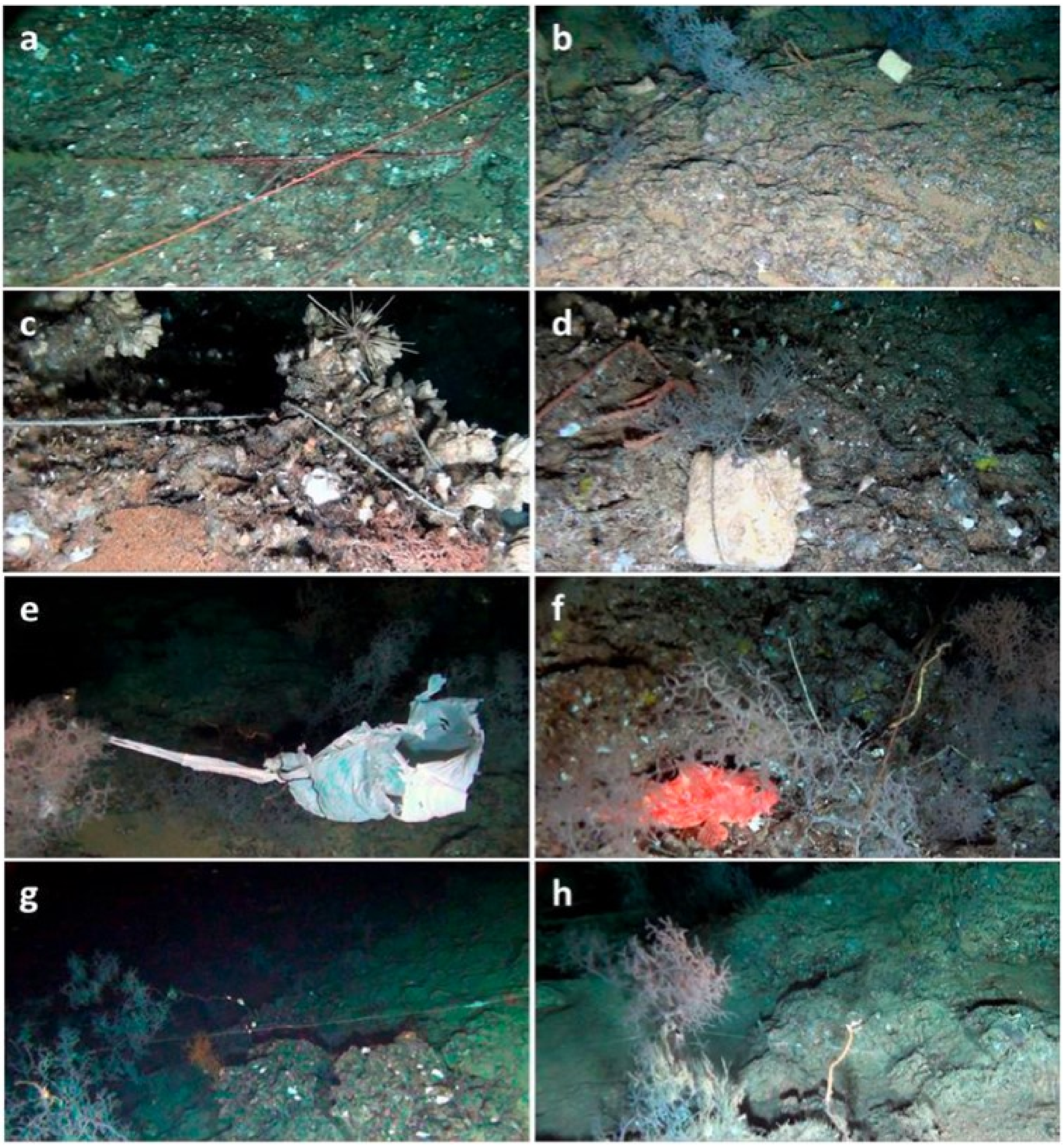
The use of FADs has been widely promoted in many regions, including the western and central Pacific, Indian Ocean, Caribbean Sea, Mediterranean Sea; however, their use is limited in the north Atlantic[17,22,23]. Their use is promoted because:

- FADs remove the need to fish close to dolphin herds or around coral reefs[17].
- The higher catch efficiency leads to greater profitability[16].
- Individual fish species can be more effectively targeted, which reduces pressure on free-swimming schools of fish that include more vulnerable species[19].

The efficiency of FADs in aggregating fish also means that other non-commercially valuable species are attracted and can become caught by accident (known as 'by-catch'). A recent WWF report indicated that FAD fishing was responsible for up to four times more by-catch than fisheries targeting free-swimming schools of fish in the Atlantic, Indian, and eastern Pacific Ocean[16]. In the western Pacific, this figure grows to seven times. While their use is often regulated and managed at a national to regional level, illegal FAD use is commonplace in several regions[19]. Unregulated and overuse of FADs may severely impact sustainable fishing in the future, leading to collapse of local fisheries or pushing activities into deeper water[18].

Once they reach the end of their life (typically a few months, to years at most), the hundreds to thousands of metres of fishing gear and plastic rope associated with FADs become discarded in the ocean. This 'ghost gear' can drift across the oceans or become snagged on the seafloor and will last for prolonged periods of time[24]. In the central Mediterranean, seafloor surveys found that most of the litter observed came from FADs and was wrapped around protected corals[22]. Efforts are underway to mitigate this issue, through the use of biodegradable materials in FAD design, but biodegradable FADs tend to be less durable, and therefore have a shorter lifespan[25].

▼ **Figure 5:** Photographs acquired from surveys showing marine litter on the western Mediterranean seafloor (from Consoli et al., 2020[22]). a) FAD ropes under tension; b) FAD rope anchored to limestone block, entangling corals; c) corals entangled by rope; d) corals growing on a FAD-anchor; e) other litter observed i.e., plastic bag; f-h) live colonies of corals and dead branches entangled by ropes.



FISH AGGREGATING DEVICES: AN EMERGING THREAT FOR SUBMARINE TELECOMMUNICATION CABLES (pages 11-18)

FEW AREAS OF THE OCEANS ARE FREE FROM FISH AGGREGATING DEVICES

The use of FADs has increased globally over recent decades; largely driven by the efficiency of this fishing method, as well as due to public and policy steer[25-28]. Their presence in tropical seas is becoming more ubiquitous and a 2011 review estimated that FADs were used for over 40% of world tropical tuna catches. Approximately 73,000 anchored FADs and between 81,000 and 121,000 drifting FADs are estimated to be deployed annually[29-31].

The number of lost FADs and ghost gear that drifts below of the ocean surface is a vast number. It is perhaps not surprising that reports of interactions between the cables that span the world's oceans and FADs are on the rise.

WHAT THREAT DO FISH AGGREGATING DEVICES POSE TO CABLES?

While floating fishing gear may not seem that dangerous, submarine cable owners have started to identify their impacts. Examples from the last few years in the Indian Ocean and offshore south-east Asia involved snagging of durable plastic fishing lines, and metal link connections, around cables in water depths of between 2,000 and 4,000 m. Cables can be abraded by direct contact with a mooring line, causing damage to the outer cable sheath, and compromising the insulation of the electrical conductor resulting in a short circuit known as a shunt fault[1]. Some faults occurred instantaneously, as the subsurface fishing line became wrapped around the cable, while others developed over several years, which may relate to the long-term effects of abrasion, or due to gear that became entangled as it was transported by storms or seafloor currents. FAD-related damage can occur during installation, when cables are repaired, or at any point during their approximately 25-year lifespan. Some owners have also reported damage from FAD anchors; either from accidental dropping of the concrete weight on the cable itself, or as a result of impact when a moored FAD was dragged over the cable when moved by vigorous ocean currents.

FADs also pose a hazard to other activities that support the submarine cable industry[16]. As FADs are often only marked above the water by a small float, they are difficult to spot at sea, and cannot be spotted at all if they have lost their surface platform. The mooring lines are extremely strong and can also become snagged around ship propellers and expensive towed equipment that is used to survey the seafloor.

Cable owners and their system suppliers and installers have experienced an increasing number of cable faults from FADs over the last few years. This is particularly true where new cables are being deployed along new and diverse cable routes where FAD use is both widespread and also poorly mapped or documented. As a result of this trend, the ICPC established a FAD Working Group towards the end of 2020, where ICPC Members are working collaboratively to define the risk of FADs to cables and their associated activities, determine mitigation measures for these risks, and develop a strategy for outreach and liaison efforts, as well as developing best practice guidance for governments that oversee and monitor FAD deployments.

The submarine cable industry is exploring improvements to cable design to increase resilience to FAD-related impacts; however, the most effective and immediate mitigation measures will most likely relate to highlighting the issues above and through raising awareness.

FOOD FOR THOUGHT

Some of the ongoing measures to reduce the risks posed by FADs to submarine cables include:

- Assessing the likelihood of encountering FADs based on local fishing practices and previous experience in the region. This is best done as part of a desktop study during the planning stage and through liaison with fisheries organisations and representatives.
- Identifying and liaising with FAD owners, such as through national databases.
- Modifying pre-installation surveys for locating FADs.
- Considering different methods for avoiding, removing, or relocating FADs, where necessary, to minimize the likelihood of interactions.
- Increased armouring of the cable, including in deeper water, to mitigate against the abrasion risk during installation.
- Carrying enough spare cable in FAD-prone areas during installation and repair operations if any damage occurs.

IMPROVED CABLE DESIGN ELIMINATES THE THREAT POSED BY SHARKS TO SUBMARINE CABLES (pages 19-22)

So far, we have discussed the impacts of fishing on submarine cables, but what about fish themselves? Can shark attacks cripple the internet? ***Analysis of past cable damage shows that, while biting fish including sharks may have been responsible for a small number of cable faults, these events have declined over time, with no such events occurring in recent decades.***

- **Pre 1957: Shark attacks on telegraphic-era cables in shallow water:**

During the period dominated by submarine telegraphic cables (between 1901 and 1957), at least 28 cables were damaged by fish bites[1,33]. These bites were mostly attributed to sharks, as determined from teeth found embedded in cable sheathings, as well as other fish such as barracuda. Bites tended to penetrate the cable insulation, allowing infiltration of seawater, and causing the internal power conductor to ground. These attacks mainly took place in relatively shallow water, on the continental shelf and continued to the coaxial cable era.

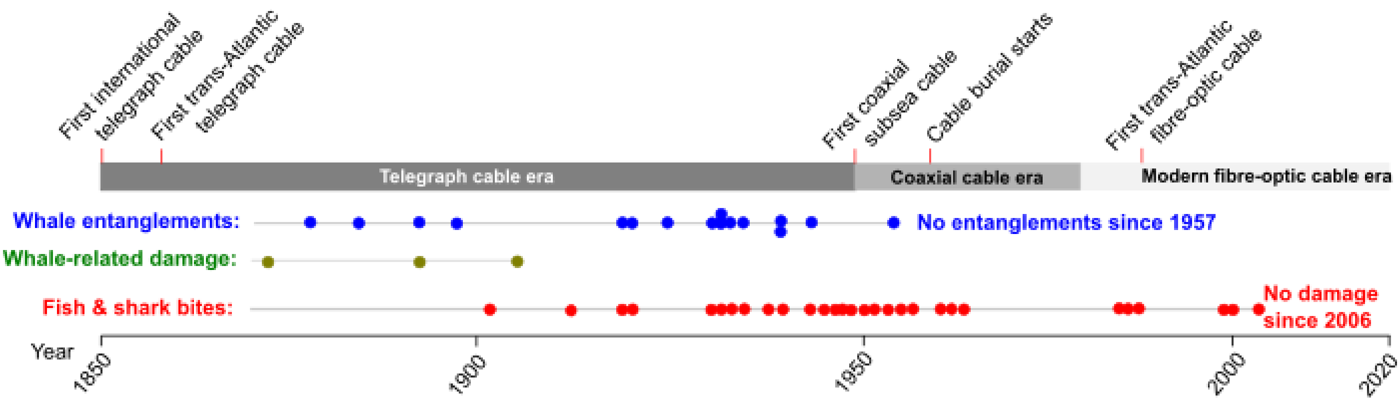
❖ 1959-2006: Deeper water shark attacks on coaxial and fibre-optic cables:

Between 1959 and 2006, 11 cable repairs were recorded as being caused by fish bites[1]. This time window included deployment of coaxial submarine cables, and the advent of modern fibre optic telecommunication cables that began in the 1980s. The first deep-ocean fibre-optic cable failed on four occasions as a result of shark attacks in water depths of up to 1,900 m[34]. At the time this accounted for <0.5% of all cable faults.

❖ Since 2006: Improved design eradicates cable damage from sharks:

As cable routes are often designated as no-fishing zones, they can provide a refuge for various fish, which may attract sharks as has been observed at other seafloor structures such as pipelines[36,37]. Precisely why sharks attacked these cables remains unclear and subsequent studies have not uncovered any clear links. To address the issue, and to protect cables from other external threats such as anchor drops and snagging by fishing gear, cables are now routinely buried in water depths of

▼ **Figure 5:** Interactions of whales and fish (including sharks) with submarine cables based on analysis of records of cable faults. Modern design improvements have led to a cessation of faults caused by sharks and entanglement of whales (Modified from Wood and Carter, 2008[32]).



up to 2000 m, while design improvements have been made to the outer protective cable sheathing to include metal tape.

These improvements in cable protection appear to have eliminated the problem as records since 2006 (analysed here to the end of 2020) provide no evidence of any cable faults linked to sharks or other fish bites **(Figure 6).** It is unlikely that shark bites are missed from this recent analysis, as previous damaging attacks left clear evidence in the form of teeth imprints or teeth embedded in the cable's outer polyethylene sheath.

▼ **Figure 7:** Photograph of a crocodile shark: one of the species of shark known to have previously damaged cables. Reproduced under a Creative Commons license (Source: https://fishesofaustralia.net.au/home/species/3001).

❖ Whale-related faults have also ceased due to improved cable design:

Improvements to cable design also eliminated the number of cable faults caused by whales. Between 1877 and 1955, 16 faults were thought to have been caused by whales that became entangled by submarine telegraph cables[38,39]. Of these, thirteen were linked to Sperm whales as their remains were found within the cables, and most occurred at the edge of the continental shelf and the adjacent continental slope. Recent analysis provides no evidence for any whale entanglements since 1959, however[32]. This absence of entanglements is also related to improvements in modern cable design, laying and maintenance, including: i) reducing the coiling of

cables when laid on the seafloor and after repair; ii) using accurate seafloor surveys to avoid rough seafloor where cables are more prone to become suspended or looped; iii) burial of cables below the seafloor in water depths of up to 2,000 metres, which is the typical diving depth of sperm whales[1,40,41].

As noted in the article on page 11, titled: "Fish Aggregating Devices: An Emerging Threat for Submarine Telecommunication Cables," information was also provided by ICPC's Fish Aggregating Device (FAD) Working Group. The FAD Working Group is one of nine Working Groups where ICPC Members are involved. If your organisation is interested in becoming a Member (or is currently a Member) of the ICPC, you have the opportunity to participate in the following groups: *Affiliations, Biodiversity Beyond National jurisdiction (BBNJ), Business Planning, Cable Security (currently at full capacity), Charting, Media & Public Relations, Mining, and the Recommendations Steering Group. Any enquiries, please send an e-mail to:* secretariat@iscpc.org.

FOOD FOR THOUGHT

Of all the documented cable faults worldwide, fish bite-related faults account for a tiny proportion of damaging events (0.1% of the total), which pales in comparison to other fault types (e.g. fishing, anchor drops and geological hazards). Lessons learned from past attacks prompted improvements to cable design that has removed the threat posed by shark and other fish attacks.

Sharing the seabed in harmony with others

The International Cable Protection Committee (ICPC) was formed in 1958 and its primary goal is to promote the safeguarding of international submarine cables against human made and natural hazards. The organisation provides a forum for the exchange of technical, legal and environmental information about submarine cables and, with more than **170 MEMBERS** from over **60 NATIONS,** including cable operators, owners, manufacturers, industry service providers, and governments, it is the world's premier submarine cable organisation. The ICPC comprises of an 18 Member Executive Committee (EC)-led organisation voted in by its Full Members. In addition to the Marine Environmental Adviser (MEA), General Manager (GM) and Secretariat team, the ICPC also has an appointed International Cable Law Adviser (ICLA) as well as a United Nations Observer Representative (UNOR).

Prime Activities of the ICPC:

- Promote awareness of submarine cables as critical infrastructure to governments and other users of the seabed.
- Establish internationally agreed recommendations for cable installation, protection, and maintenance.
- Monitor the evolution of international treaties and national legislation and help to ensure that submarine cable interests are fully protected.
- Liaison with UN Bodies.

Recommendations:

- Taking into account the marine environment, the ICPC authors Recommendations which provides guidance to all seabed users ensuring best practices are in place.
- Educating the undersea community as well as defining the minimum recommendations for cable route planning, installation, operation, maintenance and protection as well as survey operations.
- Facilitating access to new cable technologies.

Advancing Regulatory Guidance:

- Promoting United Nations Convention for the Law of the Sea (UNCLOS) compliance.
- Championing uniform and practical local legislation and permitting
- Protecting cable systems and ships.
- Aiding education of government regulators and diplomats.

Working with Science:

- Supporting independent research into cables.
- Publishing reviews for governments and policy makers.
- Working with environmental organisations.
- Effective public education via various media.

To learn how to become of Member organisation of the ICPC, please click on join here.

EDITORIAL STAFF

Author: Dr Mike Clare

Mike is the Marine Environmental Adviser for the International Cable Protection Committee (ICPC) and is a Principal Researcher at the National Oceanography Centre, UK, where he works as part of the Ocean BioGeoscience Research Group. His research focuses on better understanding the dynamic seafloor, the implications of past and future climate change, impacts of human activities, and quantifying risks to critical infrastructure. Prior to his research role at NOC, he worked for ten years as a geohazard consultant to a range of offshore industries.

Editor: Ryan Wopschall

Ryan is the General Manager for the ICPC. He has spent the last 15 years in the telecommunications industry with a focus on international undersea and terrestrial backhaul telecommunications.

Design & Layout: Christine Schinella

As part of her Secretariat role, Christine coordinates marketing activities for ICPC. With a background in graphic design and publishing, Christine has been working in the telecommunications industry since 2000.

FURTHER READING & REFERENCES

Further information on submarine cables and the marine environment can be found in the references and text within the peer-reviewed UNEP-WCMC report via: **["Submarine Cables and the Oceans: Connecting the World"]** as well as other resources via: https://iscpc.org/publications

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