A Publication from the International Cable Protection Committee (ICPC)

Submarine Cable Protection and the Environment

A Bi-Annual Update from ICPC's Marine Environmental Advisor, Dr Mike Clare

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SUBMARINE CABLE PROTECTION AND THE ENVIRONMENT

A Bi-Annual Update from ICPC's Marine Environmental Advisor

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EDITOR'S CORNER

[The International Cable Protection Committee (ICPC)](#) has a long-standing commitment to not only understanding the marine environment in which the submarine cable industry operates, but also to promote forward-thinking scientific research and updates for the ICPC Membership. The marine environment is an ever-evolving place with an increasing number of stakeholders including marine infrastructure developers, fisheries, seabed mining, shipping, regulatory bodies and policy makers, as well as ICPC Members—submarine cable owners, operators, manufacturers, service providers and international governments. While the ICPC has the designated expertise of a Marine Environmental Advisor (MEA)—Dr Mike Clare—for the benefit of our organisation and its Members, we also recognise the benefit these continuing efforts can bring to the submarine community and wider public. As a result, this is the first open-access **"Submarine Cable Protection and the Environment"** publication offered to the public (i.e., for Media outlet reference, non-Members and those interested in the same goal—safeguarding submarine cables). This newsletter will be produced bi-annually and complements ICPC's monthly **"Environmental Update"** which is written and provided exclusively to Member-only organisations.

The ICPC's MEA has produced timely and relevant articles in this publication that not only ponder the relevance of the environment in our daily lives, but also the sustainability and resiliency of the submarine telecom and power cable industries and their submarine infrastructure. It is our pleasure to have Mike supporting our organisation and providing a voice of sound and peer-reviewed research that benefits our understanding of the marine environment and our submarine cable community.

Please enjoy the content and consider these topics as only scratching the surface of very pertinent, timely, and important issues the ICPC is putting effort towards in our ever-changing world.

Sincerely,
Ryan Wopschall
ICPC General Manager

INTRODUCTION

Whenever you use your laptop to send an email, check social media on your smartphone, join a video call with your relatives, or make an internet banking transaction, do you think about how that information is transported around the world? In a new age of lockdowns, remote working and virtual conferences, our reliance on global digital communications has dramatically grown—yet most people incorrectly assume that satellites are responsible for sending that data. In reality, more than 99% of all international digital data and communications is transferred via a network of more than 400 cables that span a distance of >1.8 million kilometres across the world's oceans[1].

This global network of fibre-optic cables, that are typically no wider than a garden hose[2], keeps the internet running, providing access to electronic commerce, online teaching and medical resources, and keeps us in contact with friends, family and colleagues far and wide. Given our reliance on this global network, it is critical that it remains as resilient as possible. But global telecommunications are not the only infrastructure delivering resilient services through submarine cables.

INTRODUCTION

The increasing demand on resilient, diverse, and sustainable power generation and transmission has led to the increasing growth of submarine power cable installations across the world for both transmission and renewable energy applications such as wind and hydrokinetic energy generation[3]. As global climate has and will likely continue to warm, increased demand for sustainable energy sources will continue to drive the dependence on submarine power cables which need to be protected and maintained to support a resilient power grid.

The International Cable Protection Committee (ICPC) was established for this very purpose—providing leadership and guidance on issues related to submarine cable protection, security, and reliability for both sumbmarine telecoms and power cables. Comprised of over 170 members from over 60 nations including cable operators, owners, manufacturers, industry service providers, as well as governments, ICPC Members represent approx.-imately a great majority of submarine cables around the world.

In this first public ICPC news-letter, we put a spotlight on some recent topical issues, including:

- What roles do submarine cables play in a post-COVID world and how can they contribute to a lower carbon future?
- Understanding the threat posed to the global telecommunications network by powerful underwater avalanches and other natural hazards in the deep sea.
- What is the long-term environmental effect of cables on the seafloor?

CLIMATE CHANGE AND THE ROLE OF SUBMARINE CABLES IN A POST-COVID WORLD (pages 7-9)

The submarine cable industry recognises ongoing and future climate change and looks to anticipate emerging threats in a changing ocean:

- New networks need to be resilient to future as well as present day conditions.
- Submarine cables have a critical part to play in a reduced carbon future.

Peer-reviewed science shows that the global climate has been and will highly likely continue warming at an unprecedented rate due to human-induced greenhouse gas emissions[4]. The effects of climate change are felt most acutely in the oceans, as the ocean takes up >90% of all the Earth's excess heat[5]. With this change comes a range of emerging threats to critical infrastructure such as submarine cables and the terrestrial landing site infrastructure that supports them. **What threats should we expect and how is the global network designed to stay resilient?** In this article we first tackle these points and then look at how the recent spate of lockdowns across

the world has provided a unique chance to stop and observe the effects of reduced human activity. What can we learn from the lockdown and what role do cables play in a reduced carbon future?

WHAT DOES FUTURE CLIMATE CHANGE MEAN FOR THE GLOBAL NETWORK OF CABLES?

Ongoing and future climate change is likely to affect the nature, frequency, intensity, and regional character of a range of hazards that may pose a threat to submarine cables[6]. For instance, rising sea levels and the increased incidence of storm surges in the Atlantic and elsewhere may threaten coastal facilities (where cables connect to shore) that are close to sea level[7,8]. Increased storminess under continued or more intense El Niño-La Niña events and other climatic cycles means that regions in the Pacific will become more exposed to onshore flooding, higher river discharge and underwater landslides that can break cables or threaten their terrestrial infrastructure[9-14].

Climate change is also forecast to have many negative implications for marine life, which may not intuitively seem to pose a threat to submarine cables. However, changes in ocean temperature are triggering a migration of commercially-important fishing stocks, while changes in surface ocean conditions and formerly ice-covered areas may shift shipping routes[15-20]. As accidental anchor drops and snagged fishing gear

account for most of the breaks (>90%) on the global network, it is therefore crucial to understand how the current and future cable locations will correspond to future seabed use and vessel locations, and in particular—the impact of deeper fishing which may mean cables need to be buried to a deeper water depth for their protection[2].

Future cable routes and cable landings need to take into account present day as well as predicted future conditions when designing new infrastructure to ensure that they are as resilient as possible. This can include a range of analysis such as onshore and coastal flooding including 100-year flood events, fishing trends over the lifetime of a cable with increased depth of burial or burial limit to mitigate any changed fishing behaviour, coastal or onshore areas susceptible to sea level rise, as well as ensuring a diversity of routes[21-29]. In fact, diversity is key to mitigating against present and future hazards. By ensuring submarine network or transmission infrastructure is redundant and diverse, there stands a better chance to deliver services in the event of damage. This may push submarine cables into new regions, landing in new areas, or simply building out additional cables in areas where they already exist to ensure redundancy and resiliency.

LEARNING FROM LOCKDOWN TO ENABLE A LOWER CARBON FUTURE

At the start of the pandemic, factories closed, air traffic was grounded, road and rail commutes stopped, while strict lockdowns kept people in their homes. Several new studies show that these changes resulted in widespread improvements in air quality, including dramatic decreases in greenhouse gas emissions such as Carbon Dioxide[31-34]. It is estimated that widespread lockdowns triggered a bigger drop in such emissions than any previous war or economic downturn[31]. Unfortunately, this drop is likely to be short-lived, and even the temporarily reduced emissions will be the highest of those over the past decade. Global warming can only stabilise once annual emissions reach net-zero, so a bigger change in pre-COVID living and working practices is needed[1,31].

Lessons learned from the lockdown will inform how businesses operate in future—leading to an increase in virtual, online meetings compared to those requiring long haul flights, and increased home-working—all of which will help in lowering greenhouse gas emissions. The ICPC estimates that internet traffic increased between 25% and 50% between November 2019 and the early stages of lockdown in April 2020, and this will likely continue as we adapt to the "new-normal"[35]. Zoom Video Communications revenue for the quarter ending July 31, 2020 saw a 355% increase compared to the previous year[36]. This is just one indication of the increased video conferencing occurring as a result of widespread remote work, remote education, and remote personal video communication.

FOOD FOR THOUGHT

Submarine telecommunications cables are an enabler for changing our behaviour away from hydrocarbons and climate impacting sources. Additionally, submarine power cables that transmit energy harnessed from offshore renewable sources are another aspect of important solutions being developed to reduce this dependency and create a more resilient and sustainable energy sector through the use of submarine cables.

POWERFUL AVALANCHES IN THE DEEP SEA
(pages 10-16)

- Infrequent but powerful sediment avalanches can damage seafloor cables across large expanses of the deep ocean.
- Cable breaks provided the first knowledge of these deep sea hazards.
- Advances in technology provide new insights into designing and maintaining resilient cable routes and global connectivity.

Following a large earthquake (M_w 7.2) offshore Newfoundland in 1929, twelve trans-Atlantic cables were severed, halting communications between North America and the U.K.[37]. According to Maritime Logistics, it took every available cable ship in the Atlantic nearly a year to fix or replace all of the damaged cables[63]. The reason for the breaks was not discovered until detailed seafloor surveys were performed in 1950s[38-39]. As well as triggering a tsunami, the earthquake caused a large area of seafloor to collapse, displacing 130 km^3 of sand and mud[40]—an equivalent volume to burying the whole of New York in >100 m of sand and mud. As it moved down the continental slope, the landslide

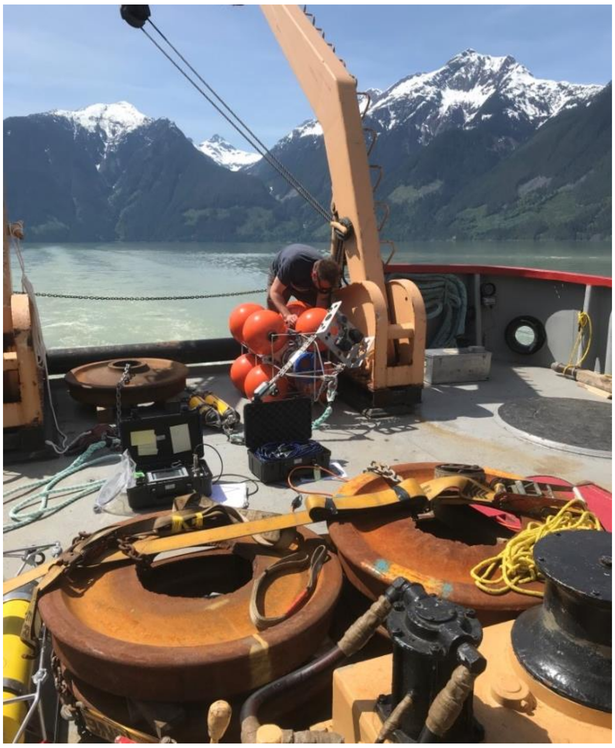
mixed with the surrounding seawater to become a powerful avalanche, travelling at high speed (up to 20 m/s) over hundreds of kilometres into the deep sea[39]. Since 1929, several other instances of cable breaks have been associated with natural hazards, such as typhoons, river floods and tsunamis[10,11,13,41]. Unlike human-related breaks, where typically only one cable is damaged, these large events have the potential to break multiple cables in one event, such as the 22 cable breaks following the Pingtung earthquake offshore Taiwan in 2006[41]. The ICPC therefore keenly stays up to date with and supports research into these hazards, to ensure that lessons are learned to ensure the global network remains as resilient as possible.

POWERFUL AVALANCHES OF SEDIMENT IN THE DEEP SEA

The cable breaks in 1929 provided the first insights into the existence of these submarine avalanches of sediment, now known as turbidity currents (click here for a video of relatively slow turbidity current[43]). Subsequent studies and instances of cable damage have shown that turbidity currents occur in many places around the world: typically within submerged canyons (such as the Monterey Canyon, offshore California, USA) that act like the rivers of the deep sea and can be much larger[44]. A remarkable video of the Monterey Canyon offshore California can be seen here[45]. These flows are the primary means by which sediment is transported to the deep sea and it is increasingly apparent that they play an important role in transporting carbon and nutrients that sustain important deep sea ecosystems[46].

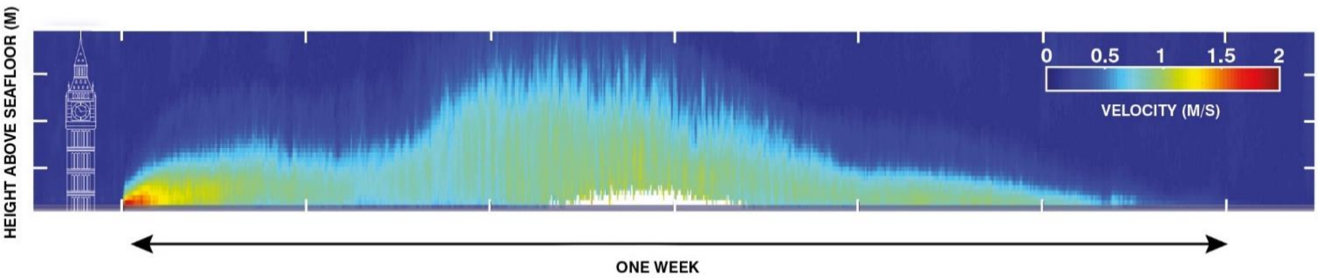
NEW TECHNOLOGY ENABLES THE FIRST DETAILED MEASUREMENTS

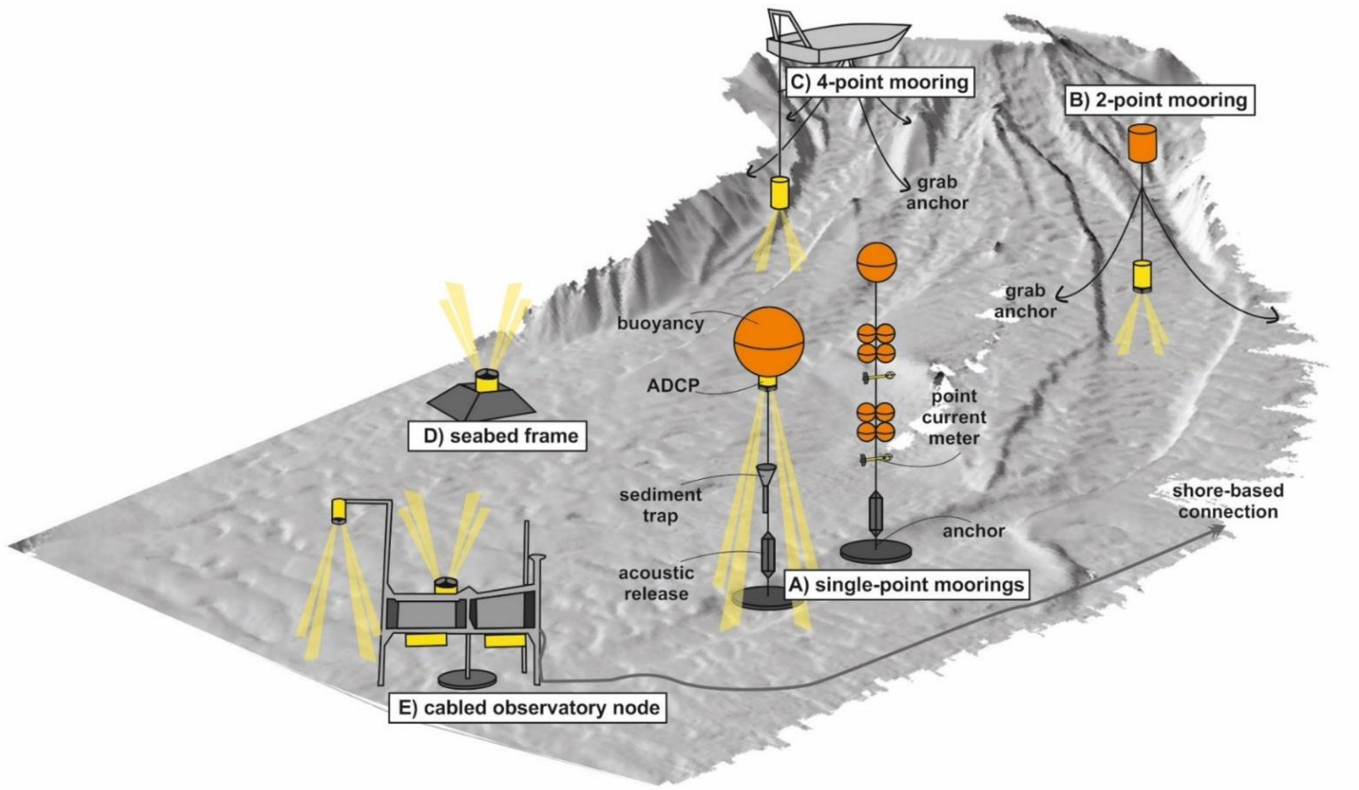
Until recently, scientists have known relatively little about these powerful avalanches, as it has been too challenging to make direct measurements. The locations where turbidity currents occur are often far from shore, in deep water, and any instruments in their path have been destroyed[47]. Despite these challenges, recent advances in technology have enabled the first detailed measurements of turbidity currents in the ocean—providing valuable information on how they are triggered, how they evolve as they travel to the deep sea, and to assess the risk they pose to critical seafloor infrastructure such as telecommunication cables[47-51]. These new tools include acoustic Doppler current profilers that record the speed of flows, acting like an underwater police speed gun and hydrophones that "listen" to ocean noises made by events such as underwater landslides.



▲ Deployment of a range of sensors on a deep sea mooring to measure turbidity currents offshore British Columbia, Canada. The train wheels in the foreground are needed to provide the anchor weight to stop powerful flows from dragging the instruments and floats (far side) down the canyon. (Photo by Dr Mike Clare).

▼ One of the turbidity currents measured in the deep sea Congo Canyon that reached nearly 100 m thick and lasted for more than seven days. (Copyright National Oceanography Centre).





▲ Illustration of some of the novel sensors and platforms that are now used for measuring natural hazards such as turbidity currents in the deep sea. (Not to scale[47]).

WHAT HAVE WE LEARNED ABOUT THESE SEAFLOOR HAZARDS?

- Events such as that in 1929 offshore Newfoundland are relatively rare; however, major disturbances such as earthquakes, floods or tropical cyclones can and have triggered powerful turbidity currents elsewhere in the world[41,42].
- For instance, the Pingtung earthquake in 2006 and Typhoon Soudelor in 2015 triggered powerful turbidity currents that severed up to 22 cables within a submarine canyon offshore south Taiwan[11,13].
- However, many areas that experience very large earthquakes—such as

Japan—often do not experience many, if any, cable breaks[42]. While the seismicity of the region is high, there is little sediment available on the seafloor to initiate a large turbidity current and the risk is relatively low.

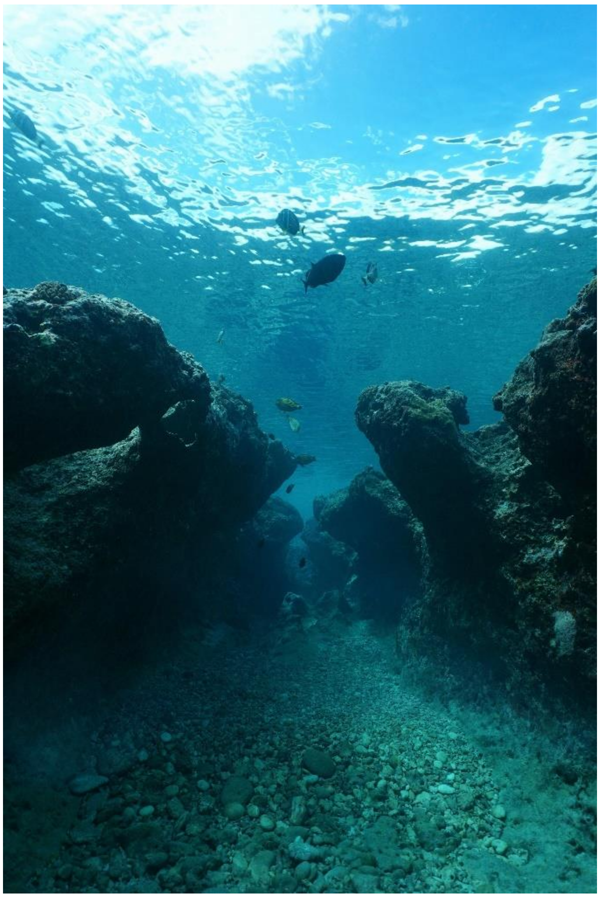
- Turbidity currents are more likely offshore from rivers or other areas where a large amount of sediment is transferred from land to sea. In such areas, sand and mud builds up on the seafloor and becomes progressively less stable, or may settle out from suspended surface plumes of sediment, initiating a turbidity current[10,51].
- Direct measurements in 2 km water depth in the deep-water Congo Canyon, offshore West Africa, show that an individual turbidity current may last for several days and can be up to 100 m thick[46]. Turbidity currents were observed to be flowing down the canyon for more than one third of a three-month monitoring period.
- Some systems, particularly those linked to big rivers, may therefore be nearly continuously active; however, many canyons on the seafloor are far from present-day sediment supply and may not feature any regular turbidity currents. These systems would have been more closely connected to rivers during lowered sea levels during the last glaciation (about 20,000 years ago)[47].
- The number and velocity of turbidity currents tends to decrease further offshore, although some exceptional flows may speed up as they pick up sediment along their path, like a snow avalanche[49]. Turbidity currents have recently been shown to remobilise large areas of seafloor sediment within the upper reaches of

submarine canyons, such as the Monterey Canyon offshore California. Such flows are capable of moving large and heavy (1 tonne) instruments placed in the path of the flow at speeds of several metres per second[48].

ENSURING THE GLOBAL NETWORK REMAINS RESILIENT TO NATURAL HAZARDS

These new measurements and historical information from past cable breaks provide key guidance for designing new routes that avoid or can withstand the hazard posed. Cable companies therefore consider turbidity currents alongside other natural and human hazards as part of the route planning and design process and take the following steps to minimise the risk:

- Identify potential turbidity current pathways and other potential hazards during route planning studies and by performing detailed surveys to map the seafloor.
- Avoid routing across areas that feature a high sediment supply from onshore to offshore, such as offshore from major rivers.
- Avoid submarine canyons where possible but if it is necessary, route cables across deeper water and wider sections where turbidity currents are likely to slow down.



POWERFUL AVALANCHES IN THE DEEP SEA

(pages 10-16)

Between 65-75% of all telecommunication cable faults occur in water depths shallower than 200m and result from fishing and shipping activities[2]. In comparison, damage caused by natural hazards accounts for less than 10% of faults[2]. However, these relatively low likelihood events do happen and when they do, they can impact numerous submarine cables in one event. As a result, cable owners and operators typically develop mesh networks consisting of multiple cables that provide redundant paths to the same locations in the event of cable damage. However, mesh networks are only one way to provide resilience. Diversity in cable routes and landing sites are also an important aspect to ensuring protection of submarine cables against regionally specific natural hazards.

FOOD FOR THOUGHT

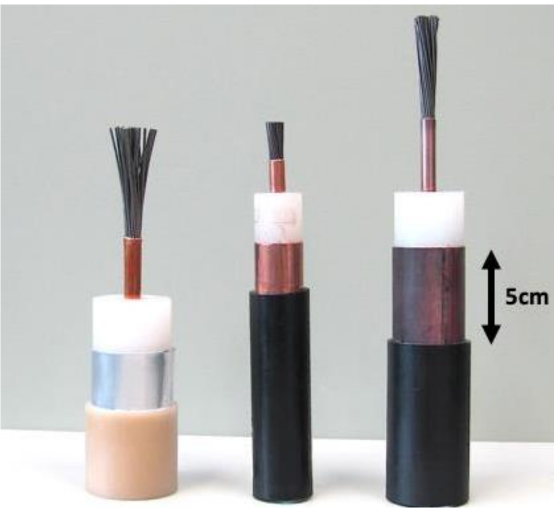
Collaborations between the cable industry and marine scientists have provided important insights into how dynamic the ocean floor can be and continue to stimulate new research into the processes that occur at the deepest parts of our planet. This underscores the importance for cable owners and operators to understand the marine environment in which their infrastructure is routed to adequately plan for and protect these assets from potential damage or otherwise devise ways to build in redundancy or protection in the event of a natural hazard.

CABLES ARE ALMOST PRISTINE AFTER NEARLY HALF A CENTURY IN THE DEEP SEA (pages 17-20)

More than 1.8 million kilometres of submarine telecommunication cables cross the world's oceans, providing essential connections between continents[1,2]. As new fibre-optic technology permits higher capacity networks to keep up with global demand for bandwidth, older legacy systems become redundant or are simply put out-of-service due to the age of the cable system. In many cases, these cables are left on the seafloor, which begs the question regarding their chemical and physical stability in the marine environment. A recent study led by the Universities of Wellington and Southampton[53], investigated several decommissioned cables that had sat on the seafloor for up to 44 years to answer this question.

▼ A recovered cable being spooled on-board the recovery vessel after having lain on the seafloor in the central Pacific at almost 5 km water depth since 1974. Note the almost pristine condition of the cable. (Image courtesy of Alcatel Submarine Networks [53]).

CABLES ARE ALMOST PRISTINE AFTER NEARLY HALF A CENTURY IN THE DEEP SEA (pages 17-20)



▲ Recovered coaxial cables that lay on the seafloor for between 38-44 years. The well-preserved condition of the components is clear. (Image courtesy of Dr Lionel Carter[53]).

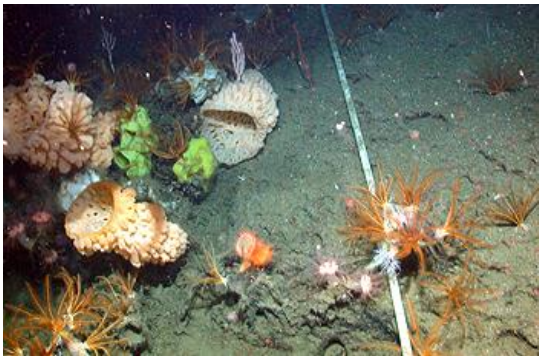
- Telephone era coaxial cables that had lain on the seafloor for up to 44 years were retrieved from more than 4 km water depth in the central Pacific and North Atlantic oceans and the Mediterranean Sea.
- Visual inspection showed that the cables were remarkably well-preserved and physically intact.
- The plastic outer sheath was intact, apart from a few patches of scuffing incurred during recovery operations. No degradation of the inner conductors was apparent, and the stranded steel that provides the strength to the cable was free of corrosion.
- Independent laboratory studies that subjected new and recovered cable sections to a range of simulated environmental conditions confirmed that lightweight cables (the type that is laid in international waters, which accounts for >85% of the ocean and cable length) are chemically inert.
- Laboratory analysis of cables with protective metallic armour (the type installed in shallower water) were found to temporarily release very low concentrations of zinc; this release being most prone on intentionally damaged sections of cables. Zinc

naturally occurs in seawater, largely being introduced from the atmosphere and rivers (17,000-66,000 tonnes per year[55]). The very low concentrations observed (<11 parts per million) recorded in the small, contained experiment would be significantly further diluted within the open ocean, particularly due to the action of currents that sweep across the seafloor.

These findings agree with other independent studies that conclude telecommunication cables exert a nil to minor effect on the seafloor environment[2,57-62]. due to their:

- placement on the seabed surface in waters deeper than 2,000m;
- small physical footprint that is equivalent to a domestic garden hose;
- for depths less than 2000m, cables may be buried beneath the seabed – a process that disturbs the substrate, which still recovers over weeks to years[66];
- construction from materials that are stable over several decades and hence underpin a recycling industry when cables are decommissioned;
- small electromagnetic fields (where cables are powered – that is typically indiscernible from the Earth's magnetic field) that have not yet observed to affect the abundance and diversity of marine organisms.

An example of cable/ environmental research comes from Southern California. Repeat surveys of the Pioneer Seamount and MARS cables show they became naturally buried along much of their lengths within eight years of its installation. Furthermore, there was no statistically significant difference detectable in seafloor fauna near or far from the cables[57,64,65]. This is important because the MARS cable is a hybrid system comprised of fibre-optic cables and a 10 kv power cable with a significant electromagnetic field.



◀ ▲ A variety of life living near the Pioneer Seamount cable. The cable is just over 3 cm in diameter and was often found buried due to the effects of seafloor currents. Fauna include anemones, sea stars, sponges, and corals. (Copyright MBARI[64]).

FOOD FOR THOUGHT

Submarine cable technology has come a long way since such legacy cables were first installed on the seafloor; however, modern fibre optic cables are composed of very similar raw materials as their predecessors with today's cables having ultra-high strength steel wires, copper sheathing, polyurethane insulation, and galvanized wire armouring. While this core construct has not changed much over time, submarine cables have innovated by increasing the fibre count in short- and long-haul cable systems, as well as increasing the speed of data transmission resulting from greatly enhanced terminal equipment, fibre performance and repeater technology.

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 Advisor (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 Advisor 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 14 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: https://www.iscpc.org/publications/.

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