NOT IN THE NET:

INNOVATION TO SAFEGUARD SENSITIVE SPECIES WITHIN UK SEAFOOD SUPPLY CHAINS

APRIL 2025

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Front cover: North Atlantic right whale (*Eubalaena glacialis*) off Grand Manan Island, Bay of Fundy, New Brunswick, Canada.
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Scalloped hammerhead sharks and Galápagos green turtles, Galapagos, Ecuador © Antonio Busiello / WWF-US

CONTENTS

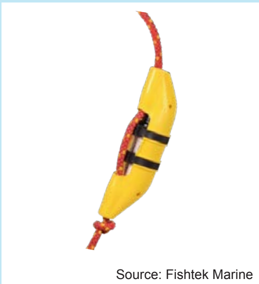
EXECUTIVE SUMMARY

We are facing a triple challenge: producing enough food for a growing population while limiting global temperature rise to 1.5°C, and halting and reversing biodiversity loss. Protecting the rich marine ecosystems that our food system relies upon is essential in addressing these challenges.

Globally, seafood is a vital source of nutrition for 3.2 billion people and provides livelihoods for 800 million people[1]. However, fisheries pose significant threats to marine biodiversity. Every year, millions of endangered, threatened and protected (ETP) species – such as cetaceans, seabirds and turtles – are unintentionally caught as bycatch. While the UK's national regulations have provided an initial framework for action and the seafood industry has made efforts to reduce bycatch, greater adoption of mitigation measures, removal of implementation barriers, and stronger regulatory enforcement are critical if we are to protect our oceans.

This report outlines where ETP bycatch is a major risk within UK seafood supply chains, and assesses the effectiveness, costs, benefits and challenges of various bycatch mitigation methods, highlighting some promising innovations (these are summarised in Table 1). The case studies included demonstrate the importance of partnerships among fishers, governments, scientists and non-governmental organisations (NGOs), emphasising the feasibility of gear modifications that require minimal changes to current practice. Drawing on ongoing research, innovation and stakeholder insights, the report provides targeted recommendations for scaling up these innovative measures to further reduce ETP bycatch (see Table 5).

CASE STUDIES: NINE INNOVATIONS TO MITIGATE ETP BYCATCH



Source: Fishtek Marine

1. PINGERS AND PASSIVE ACOUSTIC REFLECTORS

Source: Fishtek Marine

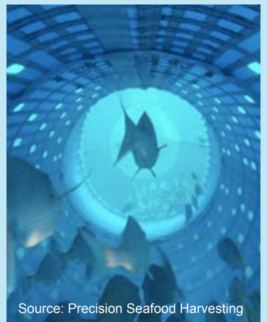
2. NET LIGHTS

Source: Hookpod Ltd (Photo credit: Dimas Gianuca)

3. HOOKPOD

Source: Fishtek Marine

4. SHARKGUARD

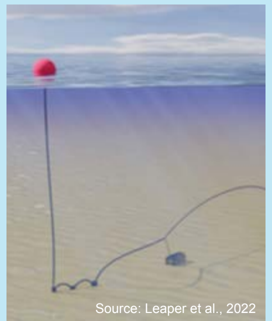


Source: Precision Seafood Harvesting

5. FLOMO

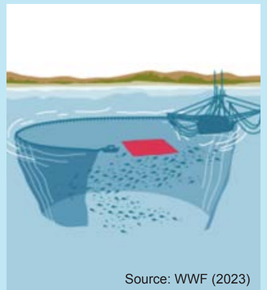
Source: Nick McCaffrey

6. SMARTRAWL



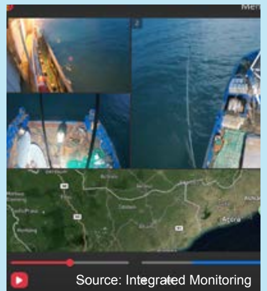
Source: Leaper et al., 2022

7. ROPELESS BUOYS



Source: WWF (2023)

8. INNOVATIONS IN FAD TECHNOLOGY



Source: Integrated Monitoring

9. REAL-TIME AI MONITORING

1. FAO The State of World Fisheries and Aquaculture 2024.

GLOBALLY, SEAFOOD IS A VITAL SOURCE OF NUTRITION FOR

3.2 BILLION PEOPLE

AND PROVIDES LIVELIHOODS FOR

800 MILLION PEOPLE

As well as implementing ETP bycatch mitigation measures, verifying their use and effectiveness is crucial to ensure they are having an impact, and to provide assurances to the supply chain. In addition to onboard observers, remote electronic monitoring (REM) with cameras on vessels plays a key role. Alongside the case studies on gear modification, a further Case Study highlights the combined role of REM and artificial intelligence (AI) in implementation, monitoring and verification of mitigation measures, and in creating strategies to overcome barriers.

Eliminating bycatch of ETP species in the UK seafood supply chain offers substantial benefits for nature, governments, fishers and the broader seafood industry. Notably, using more selective fishing methods that avoid ETP bycatch ensures fishing gear works more effectively, resulting in fewer incidents of unnecessary gear loss or damage.

To support responsible seafood practices and reduce ETP species bycatch in the UK's seafood supply chain, a multifaceted approach is needed across four strategic areas:

- Strengthen policies to eliminate ETP bycatch in the UK's seafood production and supply chains.
- Incentivise trials and adoption of innovative ETP bycatch mitigation methods on fishing vessels.
- Improve data collection on ETP bycatch and the verification of use of mitigation measures.
- Enhance research on and understanding of ETP interactions to further improve mitigation measures.

WWF recommends that regulatory bodies should mandate ETP mitigation measures, remove barriers for innovation, enhance trade standards, and bolster existing strategies such as the UK Marine Wildlife Bycatch Mitigation Initiative. Retailers and suppliers should integrate these measures into sourcing policies and advocate for stronger trade and fisheries policies. We encourage the catching sector to engage in regulatory updates, trial innovative mitigation measures, and collaborate in data collection and REM implementation. Meanwhile, other stakeholders, including certification schemes, should foster independent verification and data digitisation; and the finance sector should incentivise sustainable practices through preferential lending and public transparency. Enhanced research into ETP interactions and gear behaviour is essential to refine and scale mitigation strategies effectively.

Achieving this goal requires close collaboration among government, retailers, suppliers, catching sector, academics, financiers and NGOs. Together, they can drive policy reforms, secure investments, and support at-sea testing and scaling to implement effective measures and overcome existing challenges when it comes to eliminating the impact of fisheries on ETP species at risk from bycatch.

Fishermen use gillnets to fish for shrimp from traditional small boats © Chris Johnson

Table 1. Case studies on innovative mitigation measures to safeguard sensitive species (see section 7 for further details)

Key. Estimated cost per vessel: Low: <£1,000 (very light blue), **Low-Mid**: £1,000-£5,000 (light blue), **Mid**: £5,000-£10,000 (blue), **Mid-High**: £10,000-£25,000 (dark blue), **High**: £25,000-£50,000 (very dark blue).

GEAR TYPE	TARGET CATCH	ETP SPECIES	INNOVATIONS	ESTIMATED COST PER VESSELS	BENEFITS	BARRIERS	OPPORTUNITIES FOR FISHERIES IN UK SUPPLY CHAINS
GILLNETS	Whitefish	Small cetaceans	**Pingers** (Case Study 1)	Low-Mid	• Effective in averting accidental interactions	• Regulatory issues • Battery maintenance	Gillnet fisheries: • Norwegian gillnet fishery • Icelandic cod and haddock • UK southwest fisheries
			Passive acoustic reflectors (Case Study 1)	Low	• Low cost • Little change to fishing practice	• Effectiveness not yet evaluated	
	Tuna	Turtles	**Net lights in driftnets** (Case Study 2)	Small-scale: Low Large-scale: Mid-High	• Effective in clear water • Solar light development	• Needs testing in-situ for each fishery	Gillnet fisheries: • Tuna drift nets • Blue swimming crab • Longfin squid
LONGLINE	Tuna	Seabirds	**Hookpod** (Case Study 3)	Mid-High	• Effectively reduces seabird bycatch	• Needs further RFMO approval	Longline tuna and swordfish fisheries: • Atlantic, Indian and Pacific Oceans
		Elasmobranchs	**SharkGuard** (Case Study 4)	Mid-High	• Effectively deters sharks • Reduces bait loss	• Further testing to check effect on target catch	
TRAWL	Whitefish, nephrops	Elasmobranchs, cetaceans	**FloMo** (Case Study 5)	Mid-High	• High-quality catch • Bycatch survivability	• Regulatory issues • Adaptation for each fishery	Trawl fisheries: • Whitefish and nephrops trawl in Northeast Atlantic Ocean
			Smartrawl (Case Study 6)	High	• Potential to eliminate ETP bycatch	• Still in development	
POTS	Nephrops	Large cetaceans, elasmobranchs	**Negatively buoyant groundline** (Case Study 7)	Small-scale: Mid Large-scale: Mid-High	• Little change to fishing practice	• Does not address pot line risks	• UK crab, lobster and Nephrops pot fisheries
	Lobster, crab		**Smart buoys** (Case Study 7)	Mid-High	• Allows quicker response • Ensures no ghost gear	• Does not entirely remove entanglement risks	• US and Canadian lobster and snow crab fisheries
			Ropeless pots (Case Study 7)	High	• Eliminates pot line risks	• High cost • Change in fishing practice	
PURSE SEINE	Tuna	Elasmobranchs, cetaceans, turtles	**Biodegradable FADs** (Case Study 8)	Low-Mid	• Reduces entanglement risks	• Requires regulatory drivers e.g. RFMO requirement	• Purse seine tuna and swordfish fisheries: Atlantic, Indian and Pacific Oceans
ALL GEARS	All fish and shellfish species	All ETP species	**Real-time AI monitoring** (Case Study 9)	Mid	• Verifies mitigation use in real time	• Cost of Wi-Fi • Lack of standard for web-based systems	• All offshore UK seafood supplies

INTRODUCTION

Seafood is vital for providing animal protein and other essential nutrients to 3.2 billion people, and it supports the livelihood of 800 million people around the world.[1, 2]

However, fisheries are the largest global contributors to marine biodiversity loss, with 37.7% of stocks monitored in 2021 were fished at biologically unsustainable levels.[1,3] A critical issue is the unintentional catch of millions of non-target fish and other marine animals every year, including endangered, threatened and protected (ETP) species. Bycatch of ETP species undermines global efforts to safeguard marine biodiversity and ensure the sustainability of seafood production. Globally, it has been estimated that 1.1 million elasmobranchs (sharks, skates and rays), 720,000 seabirds, 345,000 pinnipeds (seals and sea lions), 300,000 cetaceans (whales, dolphins and porpoises) and 250,000 marine turtles are caught as bycatch each year.[4] These figures highlight the urgent need for innovative solutions and stronger management to address this pressing threat to marine biodiversity. The UK's demand for seafood spans a diverse range of species sourced globally, impacting at least 253 endangered, ETP species, including seals, sharks, rays, porpoises, dolphins, whales, and seabird (Table 1). These species are vital for the health and functioning of our ocean, and their decline due to unsustainable fishing practices poses a serious threat to coastal livelihoods and marine ecosystems.

WHAT ARE ENDANGERED, THREATENED AND PROTECTED SPECIES (ETP)?

ETP species are those safeguarded by national laws and international agreements like CITES and CMS. In the UK (and European Union), protections come from directives on habitats and wild birds, implemented through the Conservation of Habitats and Species Regulations. The term also includes species classified as 'vulnerable,' 'endangered,' or 'critically endangered' on the IUCN Red List.

Pod of dolphin with seagulls and pelicans © 2022 Greg Fiore / WWF-US

Urgent action to reduce ETP bycatch is needed from a range of actors in the seafood system, including policymakers, retailers, suppliers, the catching sector, and others. Beyond environmental drivers, this issue is also shaped by policy obligations, market demands, and economic factors.

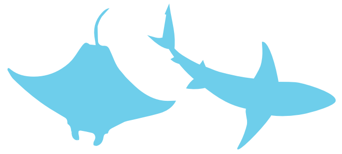
The UK government has an obligation to fulfil its commitments to tackle the ETP bycatch problem. Internationally, the UK government has committed to agreements and policies such as the Convention on Biological Diversity (CBD), CITES and the UN Sustainable Development Goals (particularly Target 14), which emphasise an ecosystem-based approach to fisheries management. These frameworks call for proactive measures to minimise bycatch and promote responsible fishing practices. Nationally, there are policy frameworks aimed at mitigating the impact of fisheries on ETP species. In the UK, key policies and strategies such as the Environment Improvement Plan (2023), Environment Act (2021) and UK Fisheries Act (2020) establish clear objectives for reducing bycatch and protecting marine biodiversity.

Notably, the UK Fisheries Act (2020) sets a primary objective to minimise (and eliminate, where possible) bycatch, further supported by initiatives like the UK Marine Wildlife Bycatch Mitigation Initiative (2022) and the Clean Catch UK programme.[5] The landing obligation requirement also commits UK fisheries to reduce discards. However, to translate these commitments into tangible outcomes requires sustained actions, with a focus on effective implementation, monitoring and enforcement to ensure meaningful progress. Remote electronic monitoring (REM) offers a strong opportunity to improve fisheries management and lead the way in the adoption of progressive technology that delivers sustainability, accountability and confidence in the supply chain.

Heightened public concern, amplified by documentaries highlighting the devastating impacts of bycatch on vulnerable species and ecosystems, has increased consumer demand for sustainably sourced seafood. This growing awareness poses significant reputational risks for retailers, creating pressure to address bycatch challenges across seafood supply chains. Sourcing sustainable seafood is also essential to enable the UK public to adopt sustainable and healthy diets. Voluntary certification schemes such as the Marine Stewardship Council (MSC) play roles in addressing ETP bycatch, with more than 400 certified fisheries and more than 200 fishery improvement projects (FIPs) globally working towards better fishing practices.

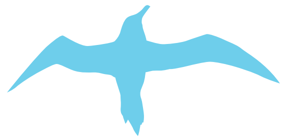
To reduce the environmental impact of seafood in the UK, the WWF Basket highlights the importance of sustainable diets while addressing issues in the seafood sector. If we are to follow the UK LiveWell recommendation of two portions of fish per week, we must do it without harming marine ecosystems. Prioritising sustainable practices, such as reducing bycatch of ETP species, is crucial. However, concerns remain that cumulative impacts on ETP species are not fully addressed even in certified fisheries, and there is now growing advocacy for taking more holistic approaches to seafood sourcing, such as the adoption of a Seafood Jurisdictional Initiative (SJI).

GLOBALLY, IT HAS BEEN ESTIMATED THAT

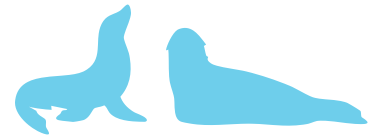


1.1 MILLION ELASMOBRANCHS

(sharks, skates and rays),

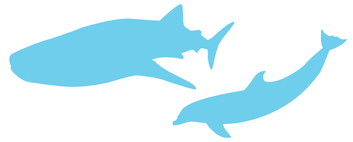


720,000 SEABIRDS,



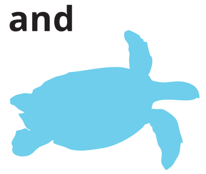
345,000 PINNIPEDS

(seals and sea lions),



300,000 CETACEANS

(whales, dolphins and porpoises) and



250,000 MARINE TURTLES

ARE CAUGHT AS BYCATCH EACH YEAR

SEAFOOD JURISDICTIONAL INITIATIVE (SJI)

SJI focuses on addressing environmental and social challenges through holistic ecosystem-based management, aligning policies and market incentives to create long-term, region-wide improvements in the seafood sector. By leading on sustainable practices, retailers can help to secure the long-term viability of fisheries, and also position themselves as leaders, demonstrating commitment to responsible sourcing, strengthening consumer trust, and enhancing their public profile.

Supermarket seafood isle © Cherris Chi / WWF-UK

For fishers the economic consequences of bycatch are equally compelling. It can lead to gear damage, operational inefficiencies, and restricted market access as buyers and policymakers increasingly require evidence of sustainable fishing practices. The cost of not using bird-deterrents in the Patagonian toothfish fishery, for example, would amount to an estimated US$1.5-2 million over 10 years due to bait loss.[6] Addressing bycatch is not just an environmental imperative: it is also essential for safeguarding market opportunities, maintaining consumer trust, and securing the long-term viability of fisheries.

Trade policies like the EU's IU U Fishing Regulation (transposed into UK law) require catch certificates and improved monitoring for imported seafood, and this has driven countries like the Maldives and Sri Lanka to adopt REM systems to verify compliance and reduce bycatch of ETP species.[7]

Implementing bycatch mitigation technologies to reduce ETP bycatch and verifying compliance with the landing obligation benefits the market (including retailers and suppliers), fishers, governments, consumers, regulators and the ocean.[8]

This report draws on insights from literature reviews and stakeholder interviews, supplemented by case studies, to provide actionable recommendations for effective implementation (see Section 8 for the full methodology). The aim of this report is to provide an overview of ETP bycatch risks and mitigation strategies, supporting the transition towards sustainable seafood sourcing. Its key objectives are:

- Assessing ETP species bycatch risks within UK seafood supply chains (Section 3)
- Reviewing technological innovations for bycatch reduction (Section 4)
- Exploring cost-effective monitoring and verification methods, such as REM (Section 4)
- Identifying barriers to the adoption of bycatch mitigation technologies (Section 5)
- Recommending actions for retailers, suppliers, governments, regulators, the catching sector and financial institutions (Section 6)
- Showcasing innovative solutions and their implementation challenges (Section 7)

By fostering collaboration and driving innovation, we can address bycatch challenges, safeguard marine biodiversity, and secure the future of sustainable seafood.

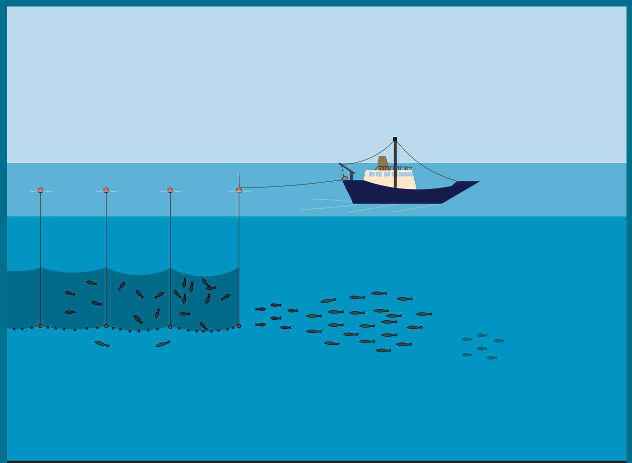
Pollack spills from a trawl net onto the deck of Saga Sea © Getty Images / Natalie Fobes / WWF-US

ETP RISKS IN UK SEAFOOD SUPPLY CHAINS

Seafood is captured through the use of different fishing methods and gear types (Figure 2). The risk of ETP species bycatch varies depending on the gear type employed, therefore mitigation methods must be tailored to each gear type to enhance selectivity and minimise bycatch.

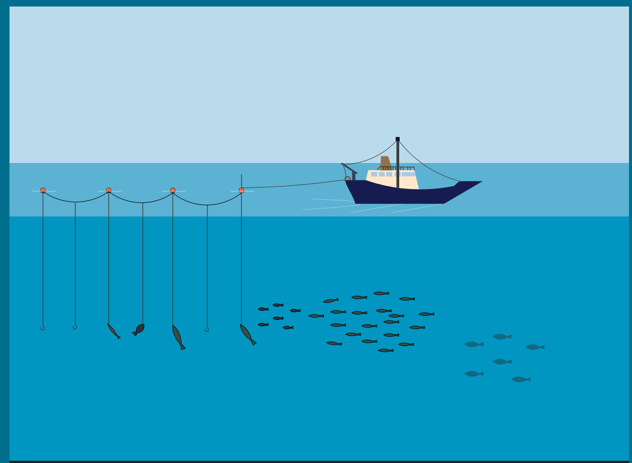
This section summarises impacts of different gear types on a range of ETP species groups including cetaceans, elasmobranchs, marine turtles, seabirds, pinnipeds and groundfish (this is also summarised in Table 1. Due to its scope; this report excludes other ETP species groups such as amphibians, sea snakes and invertebrates.

Figure 1: Key gear types



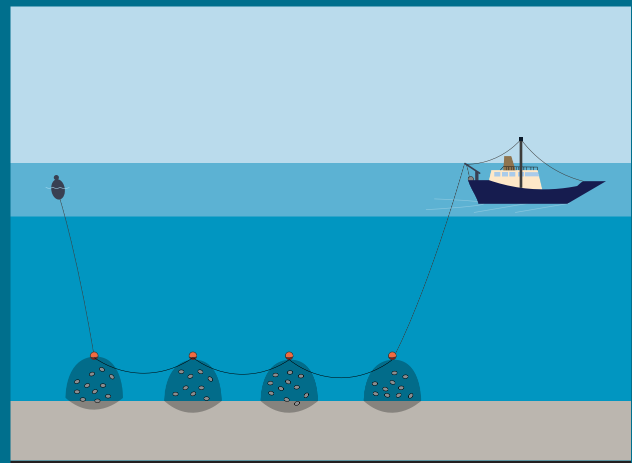
GILLNETS

Gillnets and entangling nets are long rectangular walls of netting that catch fish by gilling, wedging, snagging, entangling or entrapping them in pockets.



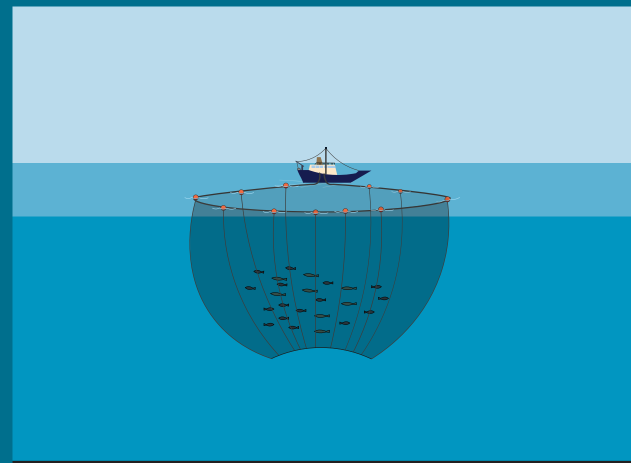
LONGLINE

A longline is a type of hook-and-line gear where hooks with baits are connected to branch lines which are then attached to a long horizontal mainline at certain intervals.



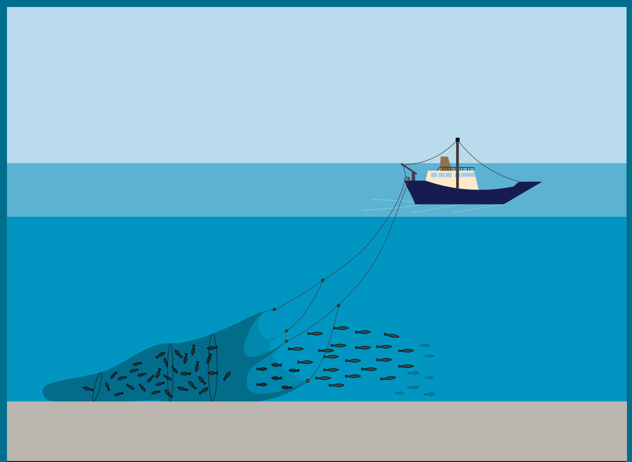
POTS, TRAPS AND CREELS

Traps are stationary structures of many shapes and sizes into which fish are guided, or pushed by the current, or drawn into the gear by bait or other attractants.



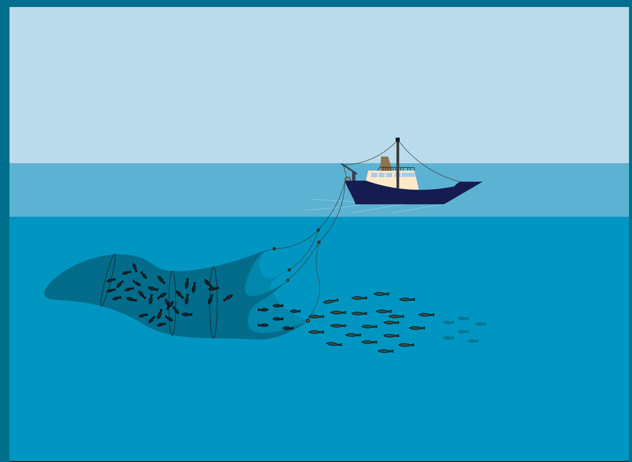
PURSE SEINE

A purse seine is a wall of netting designed to encircle a school of pelagic fish near the surface and use a purse line to close the bottom of the net.



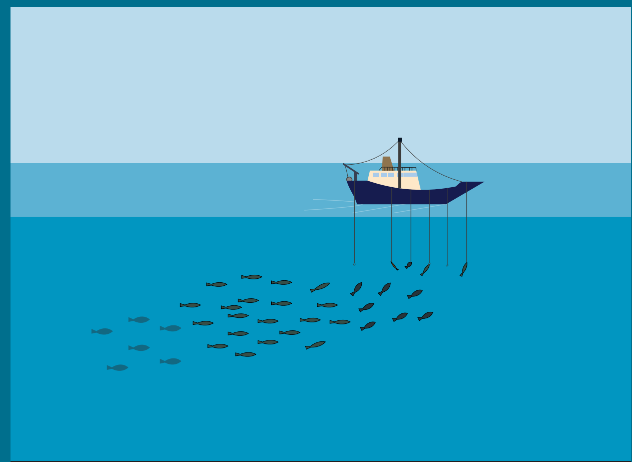
DEMERSAL TRAWL

A bottom trawl is a cone-shaped net towed on the seabed and designed to catch fish living on or near the seabed.



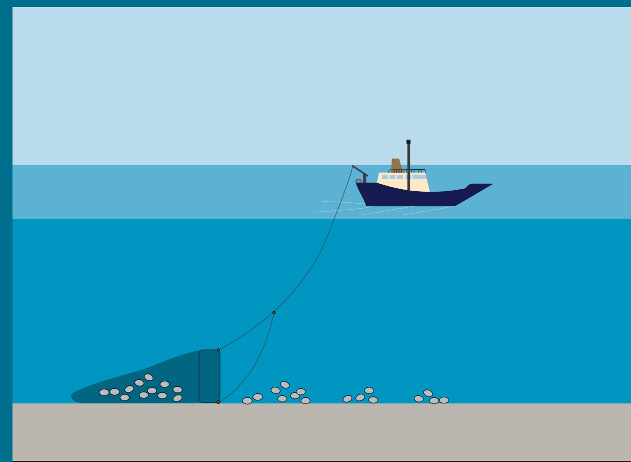
PELAGIC TRAWL

A pelagic trawl is a cone-shaped net towed in midwater by one or two boats to catch pelagic or semi-demersal fish in the water column.



POLE AND LINE

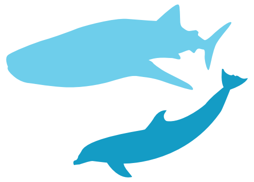
Hooks are attached to a single line to capture tuna or large pelgaic species . Fishers use live bait, enhanced with water spray, to induce an elevated feeding response. Barbless hooks with or without feather lures are fished from the deck of the vessel.



SCALLOP DREDGE

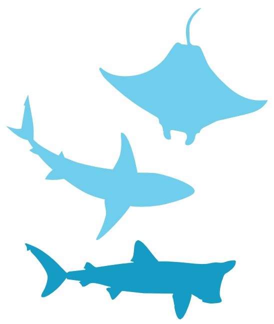
These are gears which are dragged along the bottom to catch shellfish. They consist of a mouth frame to which a holding bag constructed of metal rings or meshes is attached. There are two main type of dredges; heavy dredges towed by boats (boat dredges), and lighter ones operated by hand in shallow waters (hand dredges).

CETACEANS
(whales, dolphins and porpoises)



It is estimated that over 300,000 small whales, dolphins and porpoises die from entanglement in fishing nets each year, making this the single largest cause of mortality for small cetaceans.[4] Gillnets are responsible for the highest levels of cetacean bycatch globally, with notable examples including the entangling of harbour porpoises and common dolphins in whitefish gillnets.[9, 10] Conversely, large whales – such as the North Atlantic right whale off the US and Canada, and humpback and minke whales off Scotland[11] – can become entangled in ropes used with pots and traps targeting crustaceans. Purse seine operations can also have a number of negative impacts on cetaceans, including entanglements related to fishing in association with FADs.[12]

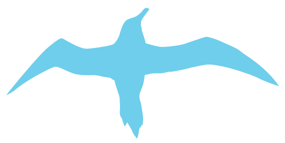
ELASMOBRANCHS
(sharks, skates and rays)



The unintentional capture of elasmobranchs presents a major challenge to their management and conservation, as overfishing, primarily driven by bycatch, threatens 99.6% of species.[13] Caught using various gears like longlines, purse seines, trawls and gillnets, larger species can also become entangled in ropes, caught on hooks, or trapped in nets.[11] While some endangered species are discarded, they may also be valuable catches for their meat and fins.[14] The vulnerability of elasmobranchs is further exacerbated by their slow growth rates and delayed sexual maturatio.[15]

Of particular concern within the UK seafood supply chain is elasmobranch bycatch associated with tuna fishing and entanglement in Fishing Aggregation Devices (FADs). This affects species such as silky shark, oceanic white tip, whale shark and oceanic manta ray. Trawl fisheries for whitefish also present concern, with evidence of impact on a range of species including (but not limited to) the common skate complex, spiny dogfish, porbeagle and Greenland shark.[16,17,18]

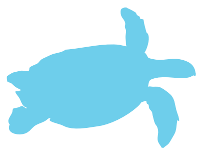
SEABIRDS



Seabirds can become entangled in fishing gear such as gillnets and purse seines, get caught on baited hooks on longlines, or struck by trawl cables on boats fishing for whitefish, salmon, crustaceans, large pelagics and molluscs. It's estimated that at least 160,000 seabirds are caught in longline fisheries and 400,000 in gillnet fisheries annually.[4]

Endangered seabird species such as albatrosses in the high and low latitudes are of particular concern. Seventeen out of the 22 species of albatross are threatened with extinction, and fishing particularly impacts wandering, black-brown and grey-headed albatross.[4] When one of a pair of breeding albatrosses is lost as bycatch, it usually results in the chick starving, and the remaining albatross may take years to find a new mate.[14]

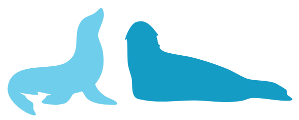
MARINE TURTLES



Marine turtles – including leatherback, green, hawksbill, olive ridley and loggerhead – face significant bycatch risks.[4] In the UK seafood supply chain turtles are often caught in gillnets and on longlines in pelagic fisheries that target tunas, mahi mahi, marlin and swordfish, and in purse seine sardine fisheries in Thailand.[4] Coastal trawl fisheries for demersal fishes and crustaceans like shrimp, prawns and blue swimming crab in Indonesia, Vietnam, India, Sri Lanka and Thailand have historically also led to large decreases in sea turtle nesting populations due to bycatch.[4]

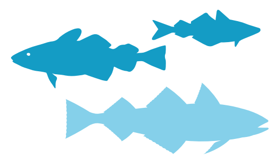
Purse seines present a much smaller threat to sea turtles than longlines, trawls or gillnets. However, sea turtles do get encircled in the nets, especially if they are set around a FAD. In addition, sea turtles can get entangled in FADs that utilise hanging nets and ropes to attract tuna.[19]

PINNIPEDS
(seals, sea lions and walruses)



Seals, sea lions and walruses are susceptible to being caught as bycatch, particularly in gillnets and trawls used for whitefish and crustaceans.[4] Harp, bearded and ringed seals have been recorded as bycatch in the Barents Sea cod, haddock and saithe fishery.[20] Seals are also occasionally bycaught in salmon gillnets in the Pacific.[21,22] The Steller sea lion is also at risk from bottom-towed gear for Pacific cod and pelagic trawls for Alaska pollock.[23]

VULNERABLE GROUNDFISH



Trawling for whitefish in regions such as the North Atlantic and North Pacific poses significant risks to vulnerable groundfish species. The small mesh size commonly used in prawn trawls, particularly in areas like the North Sea and Arctic waters, increases the likelihood of bycatch, notably impacting vulnerable species such as the overfished North Sea cod.[24] Additionally, dredging for marine bivalves in coastal zones, including the North Atlantic and Mediterranean, can result in bycatch of at-risk groundfish, further threatening these species.

Table 2. Key seafood groups imported into the UK and potential bycatch risks for ETP species groups

SEAFOOD GROUP	GEAR TYPE	CETACEANS	ELASMOBRANCHS	SEABIRDS	TURTLES	PINNIPEDS	VULNERABLE GROUNDFISH
Whitefish (Cod, haddock, monkfish, sole, plaice, pollock, saithe)	Demersal trawl		✓			✓	✓
	Gillnet	✓	✓	✓		✓	
	Longline	✓		✓			
	Pelagic trawl			✓			
Salmon (wild)	Gillnet	✓	✓	✓			
	Purse seine	✓	✓	✓			
Crustacean (Crab, lobster, nephrops, prawns)	Demersal trawl	✓	✓		✓		✓
	Gillnet	✓			✓		
	Pots and traps	✓	✓		✓	✓	
Large pelagics (Swordfish, tuna)	Gillnet	✓	✓	✓	✓		
	Longline	✓	✓	✓	✓		
	Purse seine	✓	✓	✓	✓		
Molluscs (Squid, scallops)	Demersal trawl		✓		✓		
	Dredge						✓
	Gillnet				✓		
	Jig			✓			
Small pelagics (Sardines, herring, mackerel)	Gillnet				✓		
	Pelagic trawl	✓					

MEASURES TO MITIGATE ETP BYCATCH AND TO VERIFY CATCH


Sharks in Semporna sea © WWF-Malaysia / Eric Madeja

Bycatch mitigation measures in this report are defined as:

"strategies, practices and technologies implemented during commercial fishing operations that reduce the unintentional capture of non-target species, including cetaceans, elasmobranchs, seabirds, turtles, pinnipeds and vulnerable groundfish."

For mitigation measures to be considered successful, they not only need to reduce bycatch of the unintended species, but also maintain target species catch rate, be economically viable, safe to use and not increase the risk of other ETP bycatch.[25]

This section highlights a range of innovative, gear-specific bycatch mitigation measures that are particularly relevant to seafood groups within the UK seafood supply chain (Table 3). These measures aim to reduce bycatch impacts and support the sustainability of fisheries supplying the UK market.

To provide a more detailed understanding of these advancements, Section 7 offers an in-depth analysis of nine case studies selected to showcase some of the most technologically advanced bycatch solutions. These case studies include:

1. **Acoustic devices for gillnets** – exploring acoustic deterrents to prevent entanglement of non-target species.
2. **Net lights for gillnets** – highlighting how illumination can reduce bycatch by enhancing gear visibility to vulnerable species.
3. **Longline hook-shielding devices** – demonstrating how hook protection can minimise bycatch of seabirds and other non-target species.
4. **Longline SharkGuard sensory devices** – presenting innovative sensory tools to deter sharks from baited hooks.
5. **Trawl FloMo** – focusing on floating panels that guide bycatch species away from trawl nets.
6. **Trawl Smartrawl** – showcasing smart trawl technology that uses sensors and real-time data to reduce bycatch.
7. **Pot line innovations** – highlighting measures to minimise entanglement of marine mammals in pot fishing lines.
8. **Innovations in FAD technology** – FADs designed to minimise bycatch while maintaining efficiency, featuring biodegradable materials and sensory enhancements.
9. **Real-time monitoring and AI on-board detection** – demonstrating how REM systems can be used to verify the effectiveness of bycatch mitigation equipment and increase compliance with fishing policies.

OVERVIEW OF RISKS ASSOCIATED WITH SPECIFIC GEAR TYPES – AND INNOVATIONS IN RESPONSE

Gillnets:

Very high risks posed by gillents owing to indiscriminate bycatch, particularly impacting small cetaceans, marine turtles, seabirds, sharks and non-target fish species. Acoustic pingers have reduced harbour porpoise bycatch by 70-100% in trials.[26] In clear waters, green light-emitting diode (LED) lights have decreased turtle bycatch by 60-80%.[27, 28, 29] However, species-specific trials are necessary, as has been seen with seabird bycatch: green lights reduced it, while white lights increased diving duck bycatch. Case studies 1 and 2 provide more information on pingers and net lights for gillnets, respectively. Other innovations focusing on above-water deterrents – like the Looming Eye Buoy and Scarybird kites – are being trialled, with promising results in Portugal where gull and gannet bycatch has been respectively reduced by 56% and 76%.[30]

Longlines:

Longline fishing poses risks to seabirds, turtles and sharks. To reduce seabird bycatch, line weighting, night setting and tori lines are effective, or standalone hook-shielding devices like Hookpods (Case Study 3). For turtles, circle hooks can reduce bycatch by 55-90%.[31] To deter shark species, recent innovations like electrical deterrents are being explored (Case Study 4).

Cetaceans and pinnipeds are also impacted by longline fishing when they are engaged in depredation and rope entanglement; innovations such as acoustic startle devices (ASDs) can cause seals to swim away. Fine-tuning artificial baits to the specific sensory capacities of target species can also reduce bycatch. Other early-stage technologies such as the Smart Snap, a hook equipped with several sensors to detect and release non-target species in real time, are in the experimental phase.[32]

Demersal trawls:

Demersal trawls affect ETP species like sharks, skates, rays, turtles and marine mammals. Mitigation measures include excluder devices which allow larger animals to escape. For example, seal excluder devices (SEDs) are mandatory in Falkland Islands Patagonian squid fisheries: this has resulted in a 96% reduction in seal mortality.[33] Similarly, turtle excluder devices (TEDs) effectively prevent turtles from entering nets and are now widely used in at least 40 countries.[34, 35] Underwater cameras (e.g. CatchCam) can further ensure nets are operating as they should and monitor the performance of excluder devices.

To mitigate the bycatch of shark, skate and ray species, innovative trawl designs have emerged. Recent developments include a trawl system that uses panelling rather than netting (see Case Study 5). This reduces turbulence in the net and can allow fish to experience the trawl as if there were in a calm environment, similar to an aquarium. This means that if any elasmobranchs are caught, their survival rate when brought aboard may be higher, although this has not yet been measured. Work is also ongoing to develop a 'release-at-depth' mechanism to release the entire catch if a larger mammal or turtle enters the net. Another innovation is AI-controlled gate systems such as the Smartrawl (Case Study 6), which releases bycatch before it enters the cod-end of the net. There is also evidence that artificial light improves the escape rates of vulnerable groundfish from trawl nets.[36]

Pelagic trawls:

Pelagic trawls threaten seabirds and vulnerable groundfish. For seabirds, net-binding (where the net is bound at regular intervals) has been found to help the net to sink quicker and reduce the likelihood of seabird entanglement.[37] This method is mandatory in the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) pelagic trawl icefish fishery, and is highly effective in reducing seabird bycatch to minimal levels.[38] For vulnerable groundfish such as halibut, trials of lights to highlight escape panels are ongoing.[39]

Pots, traps and creels:

Entanglement in buoy ropes and groundlines poses risks to large cetaceans and elasmobranchs. Research off the coast of Scotland has found that 80% of entanglements involving minke whales and basking sharks occur in the groundline.[11] To reduce entanglements, innovations include sinking ropes, which prevents loops from forming on the seabed. Sonar buoys are another advance, remotely transmitting information when a change in environment is detected (e.g. if the gear is being dragged by a whale). Additionally, ropeless pots or 'on-demand' gear enable pots to be brought to the surface without the need for buoy lines. These technologies not only aim to minimise entanglement risks, but also help to reduce ghost fishing. Case Study 7 provides more information on pot line innovations.

Scallop dredges:

Scallop dredging have impacts on sessile ETP species particularly on complex benthic environments. This report does not focus on habitat impacts and sessile ETP species, but there are two innovations to highlight. The first, popularly known as "disco scallop fishing", involves using a light to attract scallops, which can propel themselves to enter through special slots in the side of the pot. This new fishing method can avoid impacts on habitats and the potential effects these could have on demersal ETP species, as well as creating additional income for pot fishers. The second is the use of underwater cameras (e.g CatchCam) and accelerometer sensors in scallop dredgers to detect and avoid contact with complex habitats. Underwater cameras are being tested in the Irish nephrops and the Alaska pollock fisheries.[40]

Purse seines:

Bycatch of ETP species in purse seine fishing is relatively low except tuna. Adoption of best practices like the backdown procedure, which creates an escape channel for small cetaceans and turtles, and the Medina panel, a small-meshed section at the net's apex, have reduced cetacean mortalities in Eastern Pacific tuna fisheries by over 99%.[41] However, these methods are less effective for elasmobranchs, which remain at the net's bottom. Emerging technologies, such as forward-looking infrared (FLIR) thermal cameras, show promise for detecting whales near the surface, though their effectiveness may be limited by weather conditions. Trials in Chilean small pelagic fisheries demonstrated a 98% reduction in seabird bycatch.[42]

The use of drifting FADs (dFADs) in purse seine tuna fisheries raises significant concerns. These devices attract marine life seeking refuge, creating a 'miniature ecosystem' that often results in a more diverse catch. Shark bycatch is particularly high, estimated to be two to six times greater on dFADs compared to free-swimming tuna shoals.[42]

Modern industrial FADs are highly advanced, featuring satellite-tracked buoys and remote sensing tools capable of acoustic species differentiation, enabling more targeted fishing.[25]

Traditional FADs, constructed with floating structures and hanging ropes or nets, pose entanglement risks, particularly to turtles and elasmobranchs. Sharks, unable to swim backward, often become more entangled through twisting, leading to significant mortality. In the Indian Ocean, silky shark mortality from FAD entanglement is estimated to be five to ten times higher than the known purse seine bycatch, with global mortality ranging between 400,000 and 2 million sharks.[43] The development of non-entangling and biodegradable FADs (such as Jelly-FADs, Case Study 8) offers promising solutions to reduce these risks.

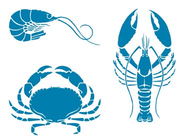
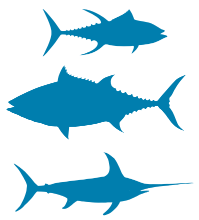
Safe handling and release:

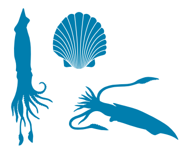
Safe handling and release practices are vital in all fisheries to reduce post-capture mortality of ETP species. Currently available guidelines include dehooking and untangling techniques for seabirds and turtles, alongside shark handling protocols.[44] In purse seine fisheries, quick-release devices like shark velcros, mobulid sorting grids, release ramps, and hoppers enhance animal welfare and crew safety.[45]

In recent years, the development and implementation of bycatch mitigation technologies have been complemented by the creation of information platforms that collate and disseminate knowledge about these innovations. These platforms serve as valuable resources, providing insights into various mitigation measures and the scientific research underpinning their effectiveness. Notable examples include the Bycatch Solutions Hub[46], the Bycatch Management Innovation System[47], and the Clean Catch Bycatch Mitigation Hub.[5] These resources play a crucial role in facilitating knowledge sharing and encouraging the adoption of effective mitigation techniques.

Table 3. Examples of ETP bycatch mitigation measures for key species in UK supply chains

SEAFOOD GROUP	SPECIES	SOURCE COUNTRIES	GEAR TYPE	BYCATCH RISKS	EXAMPLES OF MITIGATION MEASURES (IN PLACE OR POTENTIAL)
Whitefish	Pacific cod (trawl)	US, Russia	Demersal trawl	Vulnerable groundfish	Excluder devices – FloMo (Case Study 5)
					Smartrawl (Case Study 6)
				Elasmobranchs	Excluder devices – FloMo (Case Study 5)
					Smartrawl (Case Study 6)
					Real-time maps
				Pinnipeds	Seal excluder device
	Atlantic cod, haddock, saithe, monkfish (trawl, longline and gillnet); sole and plaice (trawl and gillnet); Alaskan pollock (pelagic trawl	UK, Iceland, Faroes; Norway & Denmark (cod, haddock & saithe); Russia (cod & haddock); Germany (cod); Ireland (monkfish); Netherlands (sole)	Longline	Seabirds	ACAP Guidelines, e.g. line weighting (ACAP, 2024)
					Hook-shielding devices, e.g. Hookpod (Case Study 3)
			Gillnet	Cetaceans	Acoustic pingers (Case Study 1)
				Elasmobranchs	Net lights – most effective in clear water (Case Study 2)
				Seabirds	Net lights Bird scarers, e.g. Scarybird, looming-eyes buoy
			Pelagic trawl	Vulnerable groundfish	Escape panels and LED lights
				Seabirds	Net-binding
Salmon	Pacific salmon: keta and pink salmon	US, Canada	Purse seine	Cetaceans	Thermal camera
					Backdown procedure Medina panel
				Pinnipeds	Quick release ramps on deck
				Seabirds	Modified purse seine
			Gillnet	Cetaceans	Acoustic pingers (Case Study 1)
				Seabirds	ACAP Guidelines, e.g Scarybird; looming-eyes buoy (ACAP, 2024)[48]

Crustaceans 	Crab, lobster and nephrops	Brown crab (UK, Ireland, Norway); snow crab (Norway); lobster (UK, Canada, US, France); nephrops (UK, Ireland)	Pots and traps	Elasmobranchs	Negatively buoyant groundline (Case Study 7)
				Cetaceans	Smart buoys (Case Study 7)
					Ropeless pots (Case Study 7)
				Turtles	Avoid hotspots
	Nephrops	UK, Ireland	Demersal trawl	Elasmobranchs	Excluder devices – FloMo (Case Study 5)
					Smartrawl (Case Study 6)
	Blue swimming crab	Vietnam, Indonesia, India, Sri Lanka, Thailand	Demersal trawl	Elasmobranchs	Excluder devices – Flo-Mo (Case Study 5)
					Smartrawl (Case Study 6)
			Gillnet	Cetaceans	Acoustic pingers (Case Study 1)
				Turtles	Net lights – most effective in clear water (Case Study 2)
				Elasmobranchs	Net lights (Case Study 2)
	Cold water prawn	UK, Iceland, Denmark, Canada, Norway	Demersal trawl	Vulnerable groundfish	Excluder devices – FloMo (Case Study 5)
				Elasmobranchs	
				Cetaceans	
				Turtles	Turtle excluder device
Large pelagics 	Swordfish (longline, gillnet); yellowfin tuna (longline, gillnet, purse seine); skipjack (purse seine, gillnet); albacore (troll, longline)	Swordfish: Sri Lanka, India, Seychelles, Vietnam, Brazil, Spain, Chile, Greece Albacore: Ireland, Spain, France, Malta, Greece, Portugal Skipjack: Seychelles, Mauritius, Ghana, Philippines, Indonesia, Papua New Guinea, Spain, Portugal, Ecuador	Longline	Elasmobranchs	Non-steel leaders
					SharkGuard (Case Study 4)
					Bait change
					Safe handling and release
				Cetaceans	SmartSnap Acoustic pingers (Case Study 1)
				Turtles	Circle hooks (with finfish not squid bait) Safe handling and release
					Avoid hotspots
				Seabirds	ACAP Guidelines, e.g line weighting (ACAP, 2024)
					Hook-shielding devices, e.g. Hookpod (Case Study 3)

		Yellowfin: Seychelles, Mauritius, Ghana, France, Spain, Ecuador, South Korea, China, Sri Lanka, Japan	Gillnets	Elasmobranchs	Net lights (Case Study 2)
				Cetaceans	Acoustic pingers (Case Study 1)
				Turtles	Net lights – most effective in clear water (Case Study 2)
				Seabirds	ACAP Guidelines, e.g Scarybird; looming-eyes buoy (ACAP, 2024)
			Purse seine/Pole and line with FADS	Elasmobranchs	Non-entangling FADS (Case Study 8)
				Cetaceans	Biodegradable FADs (Case Study 8)
					Echosounder and trackable FADs (Case Study 8)
				Turtles	Quick-release ramps on deck
				Seabirds	Modified purse seine
Molluscs 	Longfin squid	UK, India, US, Thailand, Indonesia,	Demersal trawl	Elasmobranchs	Excluder devices – FloMo
				Turtles	Turtle excluder device
			Gillnet	Turtles	Net lights – most effective in clear water (Case Study 2)
	Shortfin squid	China, Taiwan, Spain	Jig	Seabirds	ACAP Guidelines, e.g Scarybird; looming-eyes buoy (ACAP, 2024)[48]
	Scallops	US, Canada	Scallop dredge	Vulnerable groundfish	See above (Whitefish trawl)
				Habitats	Pot lights – disco scallops Underwater cameras – CatchCam

VERIFYING THE EFFECTIVENESS OF MITIGATION MEASURES USING REMOTE ELECTRONIC MONITORING

While it is important to adopt ETP mitigation measures, verifying their implementation is essential to provide robust evidence of their effectiveness within the supply chain. Remote electronic monitoring (REM) is a powerful tool to underpin sustainable fisheries management, overcoming the significant challenges of monitoring ETP bycatch and providing the data needed. Improved REM systems with AI systems such as FishFace and Integrated Monitoring can use cameras combined with sensor data to monitor bycatch and assess mitigation measures, assisted by the advancement of real-time monitoring through at-sea Wi-Fi (Case Study 9).

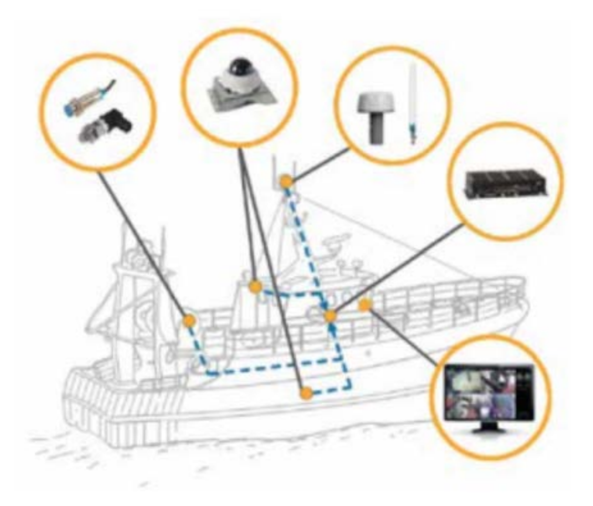
Benefits of REM include cost savings, improving efficiencies for data and science, enabling innovative bycatch management, addressing observer bias, enabling monitoring on small vessels with limited space, improving accuracy and staff welfare.

WWF's What's in the Net report[49] details how REM with camera technology can facilitate the monitoring and mitigation of fisheries bycatch. Although REM is an effective monitoring and verification tool with many benefits, it is essential to address concerns over privacy and commercial confidentiality[49] and to provide the right incentives to encourage its responsible use. It is important that these are designed from the outset to measure specific mitigation measures (e.g. aiming a camera at the stern to detect if tori lines – used to mitigate seabird bycatch – are being used), and video footage must be of sufficient quality to clearly identify which mitigation measures are being employed (e.g. circle hooks, baits of fish rather than squid, Hookpods). Table 4 illustrates how specific mitigation measures can be verified using REM systems.

Apart from fisheries management, market and trade regulations – such as the EU IUU regulation and the US Marine Mammal Protection Act – require evidence of compliance and best practices to ensure access to key markets, and REM can provide assurances of these.

WHAT IS REM WITH CAMERAS ON BOARD?

REM systems on fishing vessels encompass closed circuited television (CCTV) cameras, Global Positioning System (GPS) receivers, gear sensors, communication systems, and control centres to save or transmit footage.



Adopted from WWF What's in the Net report

REM implementation in practice

- REM systems are already in use in several fisheries, such as in New Zealand's fleet to protect Māui and Hector's dolphins and in Australia's eastern tuna and billfish fishery, where they support bycatch survival by monitoring fishing practices, ensuring the safe release of non-target species, and providing valuable data to assess the effectiveness of bycatch mitigation measures.
- Stakeholders in FIPs such as the Pacific Ocean Tuna FIP use REM to ensure sustainable practices are followed.
- Internationally, there is growing momentum for RFMOs to mandate the use of REM. For example, tuna RFMOs including WCPFC (2022), ICCAT (2023), IOTC (2023) and IATTC (2024) have all adopted minimum standards for REM systems. As the rate of REM uptake grows, several pilot projects and working groups have been started to adapt and fit the standards into practice.

Table 4. Methods to verify the effectiveness of ETP bycatch mitigation measures using REM

ETP SPECIES	GEAR TYPE	EXAMPLE MITIGATION MEASURES	MEANS OF VERIFICATION USING REM
SEABIRDS	Longline	● Night setting ● Weighted lines ● Tori lines (streamers) ● Hook-shielding device (e.g. Hookpod) (Case Study 3)	● Line sensors and time of day ● Sensors or video footage of tori lines in use ● Video footage of baiting area
		● Brickle curtains	● Video footage of setting/hauling side of vessel
	Gillnets	● Bird scarecrows (e.g. Scarybird)	● Video footage of Scarybird on side of vessel
	Pelagic trawl	● Net binding	● Video of net before deployment
	Purse seine	● Modified purse seine	● Video of headrope
ELASMO-BRANCHS	Trawl	● Strategic deployment of gear ● Use of FloMo panels (Case Study 5)	● Sensors on trawl (e.g. autotrawl) ● Underwater camera footage (e.g. CatchCam)
	Longline	● No shark-finning ● No shark lines ● Use of whole finfish	● Video of catch and discard management ● Video of baiting station
		● SharkGuard (Case Study 4)	● Video footage of baiting area showing use
	Purse seine	● Quick-release ramps	● Video footage of release ramps in use
	Pots and traps	● Negatively buoyant groundline (Case Study 7) ● Smart buoys (Case Study 7) ● Ropeless pots (Case Study 7)	● Gear checks at port; Underwater footage in use ● Geolocation maps; Video of gear in use
CETACEANS	Purse seine	● Backdown procedure and Medina panel ● Quick-release deck ramps	● Video footage of backdown procedure in operation ● Video footage of release ramps in use
		● FAD management (Case Study 8)	● Number of FADs deployed and recovered ● % non-entangling or fully biodegradable
	Longline	● SmartSNAP	● Video footage of baiting area showing use
	Gillnet	● Acoustic pingers (Case Study 1)	● Video footage of pingers in use ● Gear checks at port
	Pots and traps	● Negatively buoyant groundline (Case Study 7) ● Smart buoys (Case Study 7) ● Ropeless pots (Case Study 7)	● Gear checks at port; Underwater footage in use ● Geolocation maps; Video of gear in use
PINNIPEDS	Trawl	● Seal excluder devices (SEDs)	● Underwater footage of SED in use
	Purse seine	● Backdown procedure and Medina panel ● Quick-release deck ramps	● Video footage of backdown procedure in operation ● Video footage of release ramps in use
	Pots and traps	● Negatively buoyant groundline (Case Study 7) ● Smart buoys (Case Study 7) ● Ropeless pots (Case Study 7)	● Gear checks at port; Underwater footage in use ● Geolocation maps; Video of gear in use
TURTLES	Trawl	● Turtle excluder devices (TEDs)	● Underwater footage of TED in use
	Longline	● Circle hooks ● Baits of finfish rather than squid	● Video of baiting station
	Gillnets	● Net lights (Case Study 2)	● Gear checks at port; Video footage of net lights in use
	Purse seine	● FAD management (Case Study 8)	● Number of FADs deployed and recovered ● % non-entangling or fully biodegradable
ALL	All	● Safe handling and release	● Video of handling on deck and point of release (i.e. dead or alive, injured or uninjured)
		● ETP catch composition	● Video to analyse the volumes (and %) of ETP bycatch
		● Improvement or new development of mitigation measures	● Video to record the performance of mitigation measures
		● ETP hotspots or seasons identification	● Video of locations and seasons with high ETP bycatch
		● Offal management	● Video of appropriate offal management

LEVERS FOR CHANGE

While ETP bycatch risks are a major concern for global as well as UK seafood supply chains, the mitigation methods highlighted in this report demonstrate that various established and newer technologies can be used to reduce these risks. These range from low- to high-tech innovations with benefits that include reducing damage to or loss of catches or fishing gear; reducing impacts on vulnerable marine wildlife populations and protecting marine biodiversity; reducing the overall impact of our seafood consumption; and contributing to responsible seafood supplies.

This section highlights the lessons learned from interviews with stakeholders involved in the case studies, including barriers identified and possible options to incentivise the adoption of innovative ETP mitigation measures.

Sea Turtle over coral reef © Will Fallcon / Shutterstock

Implementation of low hanging fruit

Some fisheries already have access to well-established, low-cost mitigation measures that can and should be implemented immediately, reducing the reliance on emergence and testing of new technologies. For example, longline tuna fisheries can adopt practices such as changing from J-hooks to circle hooks and from squid to finfish bait, and improve post-capture handling. These relatively low-cost measures can reduce the bycatch and mortality of marine turtles. In addition, combining multiple mitigation strategies such as change of hook shape and of bait species can enhance their effectiveness and can significantly reduce the overall bycatch impact.

Innovations do not always have to be expensive. Careful scientific monitoring and evaluation can assess what measures offer the greatest impact for the least expense. Conducting thorough cost-benefit analyses is essential to assess the potential effectiveness of each measure in reducing bycatch, maintaining target catch levels and ensuring economic viability, and safety must also be evaluated. Additionally, it is important to consider trade-offs, including risks to other ETP species. [25, 14]

Bottlenose dolphin with calf © Judith van de Griendt / WWF

Collective real-world testing and scaling

Across the case studies in Section 7, interviewees stressed the importance the need to test innovations in real-world commercial fishing operations. This approach helps identify practical and logistical challenges while allowing for necessary adaptations to each specific fishery. Underwater cameras are often used to evaluate how the gear or innovation performs in practice.

It's clear that some of the most successful innovations have involved collaboration between seafood supply chain players, fishers, regulators and scientists, allowing for rapid and adaptive iteration of mitigation measures and carefully designed incentives to drive implementation at scale (e.g. Case Study 5).

BARRIERS TO THE UPTAKE OF MITIGATION MEASURES

Despite the pressing need to address ETP bycatch, and the promising potential of both new and established mitigation measures within UK (and global) seafood supply chains, several significant barriers to uptake persist.

Effective monitoring and data collection

Globally, accurate information on ETP bycatch is severely lacking and in the UK. While human observer coverage for gathering bycatch information is high in some fisheries (e.g. 100% in many industrial tuna purse seine fisheries) it remains very low in others (e.g. less than 2% coverage on longline tuna vessels in the Pacific), with the lowest levels found among demersal trawl and gillnet fisheries. As a result, current estimates of ETP impacts from fisheries are likely to underestimate their true scale.

In the UK, despite vessel licensing requirements which mandate the reporting of marine mammal bycatch to comply with the import provisions of the US Marine Mammal Protection Act (MMPA), the number of reports remains very low. [50]

Improving observer and REM coverage rates will help to fill the knowledge gaps. Additionally, fishery certification and FIPs could play role in tracking ETP bycatch and mitigation efforts, provided that standards and criteria are updated to include specific indicators and compile performance data in centralised, publicly available databases.

Regulatory change

Innovations in fishing methods are often hampered by the slow pace of regulatory change. In many cases, obtaining permission to trial new technologies or amend existing regulations proves challenging. For instance, acoustic pingers (Case Study 1) are not currently approved for use in small-scale fleets in the UK without amending existing regulations. Similarly, EU and UK fisheries technical measures, which primarily focus on mesh sizes and numbers of trawls, require updates to accommodate novel technologies such as the FloMo System (Case Study 5).

In contrast, New Zealand achieved approval for the FloMo System by involving regulators early in the process and enacting enabling legislation that permitted innovative trawl methods. This collaborative and proactive approach is key for facilitating innovation. At the European level, discussions are underway to allow Member States to approve novel fishing gear that adheres to overarching principles.

As an independent coastal state, the UK Government has the opportunity to review its fisheries policies and adopt similar mechanisms to encourage the use of innovative and sustainable fishing methods.

Other regulatory frameworks, including trade policies, can serve as powerful drivers for change. The EU IUU Regulation is a notable example, as it has spurred improved monitoring of fisheries and verification of compliance with regulations in countries like the Maldives and Sri Lanka, with the implementation of REM key for reducing ETP bycatch. Similarly, the MMPA import provisions require foreign fisheries exporting seafood to the US to meet marine mammal protection standards comparable to those of US fisheries, incentivising countries like Chile to monitor marine mammal interactions and bycatch rates to retain market access. It is clear that the UK has lapsed behind the EU and the US in utilizing trade policy to prevent ETP bycatch in entering its seafood supply chains.

The UK should adopt a comparable approach by mandating robust and enforceable fisheries management plans. These plans should encompass a variety of measures beyond traditional gear-based solutions. For example, spatial and temporal closures could reduce interactions with bycatch species, while mandating the use of REM could enhance compliance and accountability. Such policies would align with biodiversity conservation goals, driving reductions in bycatch and promoting the adoption of innovative, sustainable practices. By addressing both the slow pace of regulatory change and the potential of trade policies as a driver, the UK can create a regulatory environment that fosters innovation, supports biodiversity conservation, and ensures sustainable seafood production. Table 5 shows policy recommendations for how to reduce ETP species bycatch.

Access to finance

The costs of innovative measures will often need to be borne by the catching sector – which, given its perceived high risk, may lack access to affordable finance and does not always benefit from any price premium from improved sustainability. However, investing in bycatch mitigation measures can deliver significant long-term advantages. Improved sustainability often leads to better-managed stocks, healthier ecosystems and reduced bycatch rates, all of which enhance target catch quality and quantity. This, in turn, can boost revenue and contribute to the long-term viability of the catching sector.

Alternative finance routes could include blended finance mechanisms supported by government grants; supply chain levies; or multiple financial and in-kind contributions by NGOs, the private sector and government. For example, the operation of the National Oceanic and Atmospheric Administration (NOAA) Fishing Gear Library in the US allows fishers to borrow innovative gear and give critical feedback in return for a daily stipend.[51] Innovations in blue bonds and blue loans in the financial sector could also support these measures by providing loans at preferential rates for monitoring and bycatch mitigation, conditional on the achievement of certain performance indicators.[52]

Improved verification

Within the seafood supply chain, sustainability assurances can help drive change. For example, US retailers have expressed interest in sourcing crab and lobster from fishers trialling ropeless gear (Case Study 7) and other methods to prevent whale entanglements. This relies on an effective means of supply chain traceability back to the vessel, and could be a strong incentive if the rewards filter down to the fishers themselves. As a requirement in retailer sourcing policies, seafood certifications and their evidence requirements support improved monitoring and verification of bycatch rates and mitigation measures. However, the financial burden for improved verification often falls on the catching sector, and this is where more support is needed, as well as a risk-based approach so that higher-risk areas are prioritised.

Peer-peer knowledge sharing'

Providing fishers with their own and aggregated data from REM systems also provides an important incentive, as it allows them to improve catch efficiency, quality and avoid bycatch hotspots, along with the additional costs associated with gear damage or catch sorting due to bycatch.

In the New England groundfish fishery in the US, a web-based platform has been created to track the fishing vessels and review footage of critical events.[53] Primary video-review is undertaken by a third-party company, with the regulator auditing a random selection to ensure the reviews are high enough in quality. This allows fishers to access both video footage of all their fishing trips and aggregated data across the fleet. When this is combined with information on fuel use and bycatch rates, it enables fishers to adjust their gear or practices to improve catch efficiency and avoid bycatch hotspots.

RECOMMENDATIONS AND CONCLUSION

ETP species bycatch is a critical threat to marine biodiversity and long-term fishery sustainability, but there are solutions available to mitigate the risks.

Case studies in this report showcase promising innovations ranging from low-tech solutions to advanced systems, all aimed at reducing bycatch while enhancing catch quality and sustainability. Furthermore, incentives such as regulatory drivers, sustainability certifications and successful experience-sharing can facilitate wider adoption of these solutions.

Table 5 outlines four strategic approaches and the recommended collaborations for stakeholders including governments, retailers and suppliers, catching sector, certification standard holders, finance sector, academics and NGOs to support the elimination of ETP bycatch in UK seafood supply chains. We recognise that some stakeholders are already actively engaged in these efforts, but these needs to be done with greater collaboration to achieve scale.

Innovative solutions like pingers, hookpods and biodegradable FADs show significant promise, but their widespread adoption is essential. Policymakers must implement and enforce stricter regulations, including mandatory mitigation measures and the universal use of REM across all fisheries. Market players must lead by prioritising sustainable sourcing, while the catching sector must rapidly adopt and scale up mitigation technologies.

Urgent collaboration between policymakers, the catching sector, retailers and other stakeholders is necessary to address this pressing issue. Research on the impact of fishing gear on ETP species and the continuous development of mitigation technologies are vital to refining solutions. By fully embracing these strategies and technologies, we can dramatically reduce bycatch, protect fragile marine ecosystems, and ensure a sustainable future for global fisheries.

A lobster trap © Alyssa Bistonath / WWF-Canada

Table 5. Recommendations for stakeholders to reduce ETP bycatch in UK seafood supply chains

STRATEGIC APPROACH	POLICYMAKERS (NATIONAL AND REGIONAL)	MARKET PLAYERS (RETAILERS AND SUPPLIERS)	CATCHING SECTOR	OTHER STAKEHOLDERS
STRENGTHEN POLICIES TO ELIMINATE ETP BYCATCH IN THE UK'S SEAFOOD PRODUCTION AND SUPPLY CHAINS	● Set mandatory requirements for ETP mitigation measures in the Fisheries Management Plans in the UK ● Create minimum standards for ETP bycatch mitigation for imported seafood through trade regulations (similar to the US MMPA import provisions) ● Review elements of the UK ETP bycatch reduction strategy (e.g. the UK Marine Wildlife Bycatch Mitigation Initiative) including risks, priorities, means of verification, and incentives for change ● Advocate via regional and international policy arenas (e.g. tuna RFMOs and international conventions) for enhanced ETP mitigation regulations ● Strengthen protection of ETP species	● Set mandatory requirements for use of ETP mitigation measures in sourcing policies ● Include ETP mitigation measures in the Due Diligence process for branded seafood products ● Advocate for ETP mitigation measures in national and international fisheries and trade policies	● Engage in co-development of updates to UK ETP bycatch mitigation policy ● Actively engage in identifying regulatory barriers to the adoption of innovative bycatch mitigation measures	● Certification and sustainability schemes: Strengthen requirements for independent verification of bycatch data and mitigation ● Finance sector: Include ETP bycatch risks and monitoring as key criteria in lending policies (e.g. to seafood companies or fishing vessels). (UNEP 2021)[53] ● Researchers: Research the identification of critical habitats, including mating and nursery areas, to inform spatio-temporal management measures and reduce bycatch rates
INCENTIVISE TRIALS AND ADOPTION OF INNOVATIVE ETP BYCATCH MITIGATION MEASURES ON FISHING VESSELS	● Review and remove current regulatory barriers to trials and uptake of innovations in bycatch mitigation ● Create innovative initiatives similar to the NOAA fishing gear library in the US to reduce costs of trials ● Provide financial support (e.g. via UK Seafood Fund) and other incentives for trials and adoption of mitigation measures	● Invest in testing and scaling up mitigation measures in supply chains or through collaborative initiatives (e.g. Bycatch Solutions Hub) ● Set preferential sourcing from suppliers actively engaged in mitigation trials and implementation ● Advocate for non-entangling, biodegradable dFADs and a comprehensive dFAD registry	● Actively engage in feasibility trials and adoption of ETP mitigation measures ● Immediately adopt bycatch mitigation measures for longline fleets and ban the use of wire traces and/or shark lines, or both	● Finance sector: Set preferential or performance based borrowing conditions for seafood actors who commit to and implement ETP bycatch elimination and REM monitoring ● NGOs: awareness raising and success stories sharing with stakeholders
IMPROVE DATA COLLECTION OF ETP BYCATCH AND VERIFICATION OF USE OF MITIGATION MEASURES	● Speed up the roll-out of REM for UK fisheries, covering all gear types and vessel sizes ● Set clear standards and guidelines on accessing and sharing REM data and ensure all stakeholders can benefit (e.g. fishers having access to their own REM data) ● Invest in AI-review of REM video footage to enhance collection and analysis of ETP bycatch data	● Increase sourcing transparency by reviewing and publishing ETP bycatch risks within seafood supply chains ● Commit to sourcing from fisheries with high rates of independent observer coverage, with 100% observer coverage (human or REM) for high-risk fisheries	● Collaborate in feasibility trials and roll-out of REM in fisheries ● Speed up the adoption of REM with cameras on fishing vessels ● Actively engage in reporting on ETP bycatch and mitigation metrics by seafood source as part of seafood transparency and traceability	● Certification and sustainability schemes: 1) Digitise data on ETP bycatch and mitigation, and share on a public database. 2) Include requirement to provide in person or virtual tour of vessel and fishing practices to sustainability assessors ● REM providers: Ensure REM set-up and video review allows observation of ETP interactions and mitigation
ENHANCE RESEARCH ON AND UNDERSTANDING OF ETP INTERACTIONS TO FURTHER IMPROVE MITIGATION MEASURES	● Provide more research funding to understand behaviour of ETP species and their interactions with fishing gears ● Promote research into the development of metrics to measure ETP bycatch impacts and mitigation ● Request the relevant Committees in RFMO or Convention to review science-based mitigation techniques for ETP bycatch so that they can adopt revisions to reflect up-to-date mitigation practices	● Support research on ETP species and their interactions with fishing gears, as well as the development of metrics to measure impacts and mitigation	● Collaborate with researchers on interactions between ETP species and fishing gears, as well as the development of metrics to measure impacts and mitigation	● Researchers: Collaborate on research into ETP species behaviour and fishing gear interactions, as well as the development of metrics to assess trends in ETP bycatch impacts and mitigation

CASE STUDIES

This section presents a summary of case studies showcasing the latest technological advancements designed to mitigate ETP bycatch. These innovations demonstrate how cutting-edge tools and methods can significantly reduce bycatch while maintaining the economic viability of fisheries.

Fisherman Pulling on Fishing Nets © Getty Images / Natalie Forbes / WWF-US

CASE STUDY 1:

Acoustic devices for gillnets

Acoustic pingers deter small cetaceans like porpoises from gillnets by emitting detectable sounds; they can also be used in trawl fisheries. Despite challenges with regulation, frequency and maintenance, pingers have proven effective in reducing bycatch.[10,26] Passive acoustic reflectors, still in development, could offer a simpler alternative by only requiring changes to fishing floats.

Source: Fishtek Marine

GEAR TYPE

Gillnet, entangling nets, driftnet, demersal and pelagic trawls and purse seines

ETP RISK

Small cetaceans

APPLICABLE FISHERIES

Bottom-set gillnet (cod, bass, haddock, hake, saithe, monkfish, sole plaice), Driftnets (swordfish, tuna),

Trawls (mixed species), Pelagic trawls (bass, mackerel, tuna, herring, anchovy, sardines, blue whiting, sprat, horse mackerel) Purse seines (tuna, anchovy, sardines)

DEVELOPMENT STATUS

Acoustic deterrent devices (pingers): Market-ready; in use

Passive acoustic reflectors (PARs): In development

CURRENT USE

Acoustic deterrent devices (pingers): Mandated in Norway, UK, USA, Denmark, Baltic Sea, EU waters (>12m netters), Bay of Biscay **Passive acoustic reflectors (PARs):** Testing for operational feasibility on vessels in southwest UK

EFFECTIVENESS

Acoustic deterrent devices (pingers): 70-100% reduction in bycatch rates of harbour porpoise in Norwegian gillnet fisheries (Moan & Bjorge, 2023)

Passive acoustic reflectors (PARs): Not yet quantified, but in tests have shown to reflect more 'acoustic energy' than standard floats

APPROXIMATE COST (AS OF AUGUST 2024)

Acoustic deterrent devices (pingers):
- Small-scale: £550-£825 (10-15 pingers)
- Large-scale: £3,000 (up to 60 pingers)
- Durability 5-10 years

Passive acoustic reflectors (PARs):
- Estimated cost is twice that of a typical standard float

BENEFITS

Acoustic deterrent devices (pingers):
- Proven and cost-effective
- No impact on cetacean behaviour
- Less risk of net damage
- No major change to fishing practice

Passive acoustic reflectors (PARs):
- No electronics required
- No change to fishing practice

BARRIERS

Acoustic deterrent devices (pingers):
- Require regulatory changes in some fisheries (e.g. for adoption by under-12m fleets in the UK)
- Require battery maintenance

Passive acoustic reflectors (PARs):
- Not yet proven effective

OPPORTUNITIES

- Support improved uptake in the Norwegian gillnet fishery
- Support trials and uptake in Icelandic cod and haddock gillnet fishery (and other relevant source countries)
- Review and potentially update type of pingers used in UK southwest hake fishery – targeted to small cetaceans

CASE STUDY 2:

Net lights for gillnets

Light emitting diode (LED) lights illuminate the float line (top) of the net and make it more visible to ETP species potentially at risk. Green LED lights are most effective when used in clear water, and have been shown to significantly reduce bycatch of turtles, small cetaceans and some seabird species.[27, 55, 56]

Source: Fishtek Marine

GEAR TYPE

Gillnets, driftnets

ETP RISK

Turtles, small cetaceans, elasmobranchs

APPLICABLE FISHERIES

Gillnet fisheries for large pelagics, blue swimming crab, small pelagics and longfin squid

DEVELOPMENT STATUS

Market-ready; at-sea trials (Solar lights: in development)

CURRENT USE

Mediterranean, Gulf of Mexico

EFFECTIVENESS

Green LED lights: 60-80% reduction in turtle bycatch across a number of studies[27, 28, 29]

Mixed results for cetacean and seabird bycatch, but some promising results: e.g. 71% cetacean and 84% seabird bycatch reduction in Peru[55] and 95% decreases in elasmobranch bycatch[56]

APPROXIMATE COST (AS OF AUGUST 2024)

- Fishtek NetLight: £6.50 each
- Small-scale: Low (less than £1,000/vessel)
- Large-scale: Med-High (£20,000/vessel)

Note: the cost of solar lights has not yet been established

BENEFITS

- Reduced entanglement and net damage
- Proven effectiveness of green lights to deter turtles
- No impact on target catch

BARRIERS

- Costs are high if lights are required every 10-20m interval
- Needs testing in each specific fishery

OPPORTUNITIES

- Most effective in clear water but trials in murky water have also produced substantial bycatch reductions
- Support use of net lights in gillnet fisheries in clear water to reduce turtle bycatch (e.g. tuna driftnets, blue swimming crab, longfin squid fisheries)
- Support trials of lights to deter cetacean and shark bycatch (tuna driftnets)

CASE STUDY 3:

Longline hook-shielding devices

Hook-shielding devices are designed to prevent seabirds from accessing baited hooks on longlines until these are beyond the birds' diving depths. For example, the Hookpod shields the hook until it is below a depth of 10-20m, where the increase in water pressure triggers the pod to open. ACAP advises using a combination of measures (branch line weighting, night setting, and bird-scaring lines), or the use of hook-shielding devices as a stand-alone measure.[57]

Source: Hookpod Ltd (Photo credit: Dimas Gianuca)

GEAR TYPE

Longlines

ETP RISK

Seabirds

APPLICABLE FISHERIES

Longline tuna and swordfish fisheries

DEVELOPMENT STATUS

Market-ready; in commercial use; further at-sea operational feasibility trials

CURRENT USE

- In use in New Zealand
- Received regulatory approval in New Zealand, as well as from the Western Central Pacific Fisheries Commission (WCPFC) and the Indian Ocean Tuna Commission (IOTC)
- Trials are being conducted in South Africa, Brazil, Japan, and regions of the Pacific and Indian Oceans

EFFECTIVENESS

95% reduction in seabird bycatch risk within Hookpod sea trials[38]

APPROXIMATE COST (AS OF AUGUST 2024)

Prices start from £7.95 per unit (~£15,900 for 2,000 hooks)

BENEFITS

- Almost eliminates seabird bycatch
- Stand-alone measure that can be used instead of three measures required by ACAP
- LED version can eliminate need for light-sticks

BARRIERS

- Additional cost

OPPORTUNITIES

- Support additional operational feasibility testing in a range of longline tuna fisheries in the Atlantic, Indian and Pacific Oceans
- Encourage, test, monitor and verify use of Hookpods to reduce seabird bycatch
- Support regulatory approval of Hookpod by the following RFMOs: Inter-American Tropical Tuna Commission (IATTC), International Commission for the Conservation of Atlantic Tunas (ICCAT), Southern Indian Ocean Fisheries Agreement (SIOFA)

CASE STUDY 4:

Longline SharkGuard sensory devices

Pelagic longline fisheries pose significant risks to ETP species, particularly sharks. The SharkGuard device, which emits electrical pulses to deter sharks, offers a potential solution to prevent interactions with fishing gear.

Source: Fishtek Marine

GEAR TYPE

Pelagic longline
Purse seines fishing around FADs
Commercial and recreational rod and line

ETP RISK

Elasmobranchs

APPLICABLE FISHERIES

Pelagic longline tuna and swordfish fisheries

DEVELOPMENT STATUS

Pre-commercialization phase, including at-sea trials

CURRENT USE

Tested in Australia, New Caledonia, US, UK and France

EFFECTIVENESS

91% reduction in blue shark bycatch and 71% reduction in pelagic stingray[58]

APPROXIMATE COST (AS OF AUGUST 2024)

£23,000 (based on 1,600 hooks and 20% maintenance/replacement cost)

ADDITIONAL BENEFIT TO BE ADDED

- Reduced bait loss
- Reduced shark bycatch and associated handling
- Reduced hook-take by unwanted species

BARRIERS

- Clarification needed on effect on target catch
- Limited testing coverage at scale in tuna longline fisheries

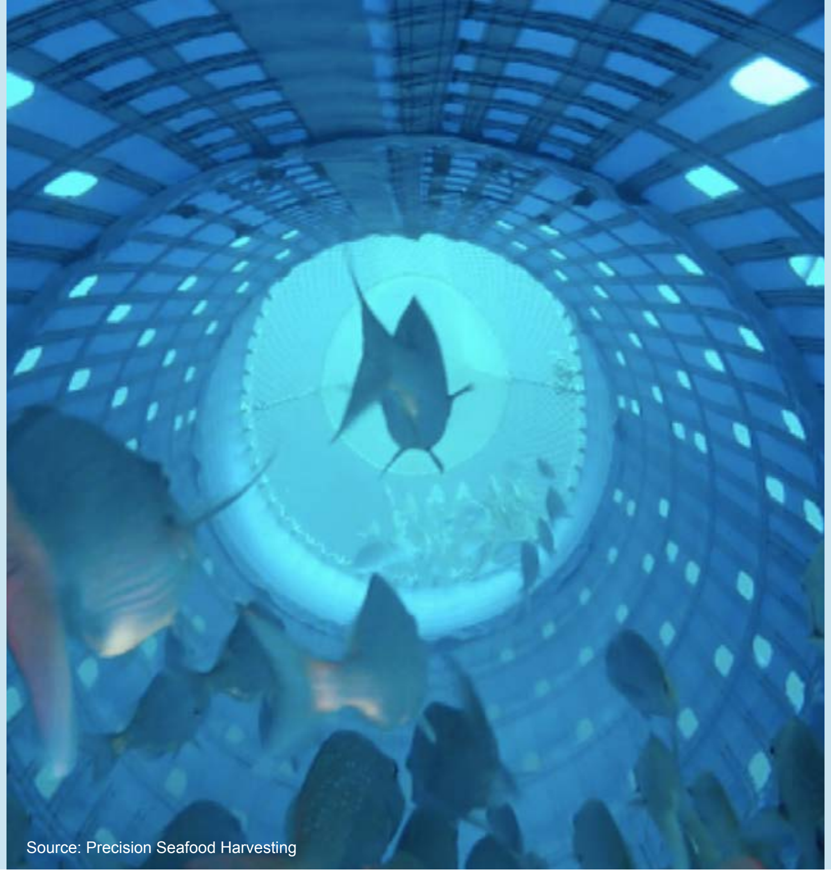
OPPORTUNITIES

- Uptake by longline tuna and swordfish fisheries in the Indian, Pacific and Atlantic Oceans

CASE STUDY 5:

Trawl FloMo

The FloMo system (previously Modular Harvesting System) uses high-strength composite fabric with holes instead of traditional mesh cod-ends and lengtheners in trawl nets. This creates a low-turbulence environment that allows fish to maintain swimming control.[59] The innovative design facilitates the escape of undersized fish at capture depth, improving their survival chances compared to conventional trawls, which often leave fish exhausted and injured. Retaining water in the panels during haul-back further enhances fish quality by preventing crushing.



Source: Precision Seafood Harvesting

GEAR TYPE

Trawl

ETP RISK

Elasmobranchs and vulnerable groundfish

APPLICABLE FISHERIES

Whitefish and nephrops trawls

DEVELOPMENT STATUS

In development; in use in limited fisheries; regulatory approval in New Zealand

CURRENT USE

- Trialled in otter trawl fisheries and deep water semi-pelagic fishery in New Zealand
- Legalised for use in New Zealand
- Trialled in beam trawlers targeting Dover sole in North Sea

EFFECTIVENESS

- Potential for 80% survival of elasmobranchs, but not yet confirmed
- Survivability of undersized plaice was found to increase from 4% to 30% in the FloMo system compared to conventional net

APPROXIMATE COST (AS OF AUGUST 2024)

Currently six to eight times the cost of traditional trawl equipment, but as commercial manufacturing has not yet been established the cost should reduce dramatically as markets develop – the aim is for the technology to be cost-comparable to mesh cod-ends

BENEFITS

- Higher-quality catch (potentially increasing value)
- Higher survival with fish leaving panels at depth
- Potentially higher survival of elasmobranchs post-capture, although further testing is needed to confirm this

BARRIERS

- Regulatory issues, with the technology not yet approved by governments in the UK, EU, Norway or US
- Sheeting needs to be adapted to specific fisheries (dependent on target species and minimum size)
- Higher cost at present while the market develops

OPPORTUNITIES

- Support further trials for other trawl types and fishing areas in the Northeast Atlantic Ocean, and include a research element on the survival rates of released elasmobranch species
- Advocate for the FloMo System to be reviewed and receive regulatory approval in the UK, EU, Norway and US

CASE STUDY 6:

Smartrawl

The Smartrawl system is designed to prevent unwanted fish catch and ETP bycatch in demersal trawls using a patented gate system that releases non-target species before they enter the cod-end of the net.[60] It employs a camera and AI computer capable of identifying up to eight target species and automatically releasing other species. Skippers can specify species and size requirements at the start of each trip through a user interface.

Photo: Nick McCaffrey

GEAR TYPE

Trawl

ETP RISK

Elasmobranchs and vulnerable groundfish

APPLICABLE FISHERIES

Whitefish and nephrops trawl

DEVELOPMENT STATUS

In development (TRL 5/6)

CURRENT USE

Tested near Shetland with nephrops and in Scottish whitefish trawl

EFFECTIVENESS

Not yet quantified, but previous gate trials have shown ray species being released effectively. Escape panels are also large enough to facilitate the release of adult elasmobranchs

APPROXIMATE COST (AS OF AUGUST 2024)

Aiming for costs around £40,000-£50,000 per vessel, but as yet unknown

BENEFITS

- Target catch and size can be specified
- Reduced ETP bycatch via patented gate
- Significantly reduced time handling bycatch
- No choke species (high selectivity)
- Reduced sorting time
- Compliance with quotas and landing obligations
- Fully automated system (Wi-Fi connection not needed); camera/strobes/computer and latch powered by battery

BARRIERS

- Further trials required in a variety of sea conditions
- High initial capital cost
- Potentially needs clear water for the camera system to work effectively

OPPORTUNITIES

- Support further trials with additional trawl fisheries that supply the UK market and in different conditions, particularly different visibility
- When Smartrawl is market-ready, support skippers to take part in the pilot stages, and promote products within the supply chain

CASE STUDY 7:

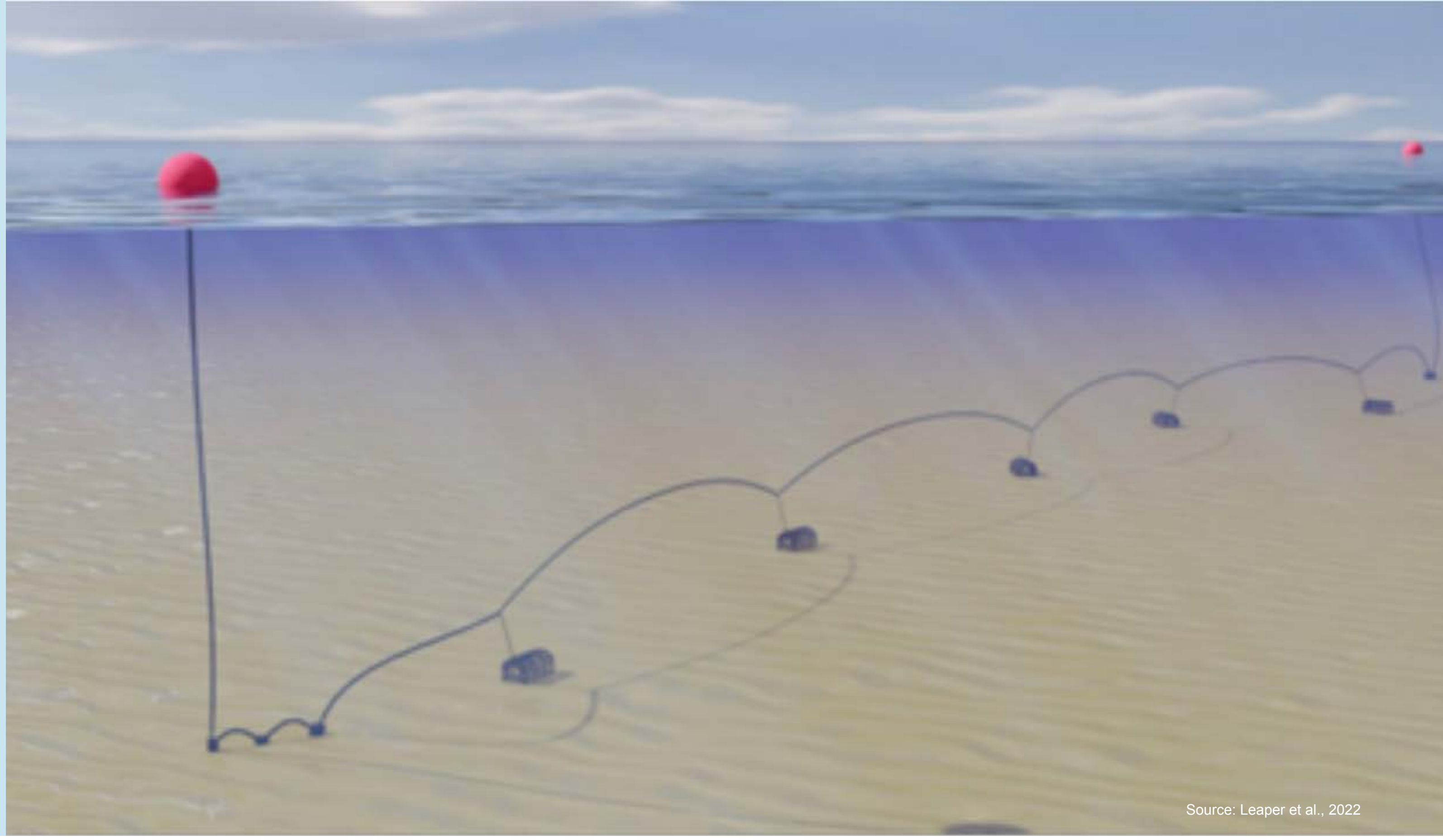
Pot line innovations

This case study addresses mitigating entanglement risks for large cetaceans and sharks in pot and creel fisheries, where low habitat impact is offset by concerns over entanglement in pot lines.

NEGATIVELY BUOYANT ROPE: Using sinking rope prevents loops of rope at the seabed, reducing risks of entanglement in groundlines. Research off the coast of Scotland has found that where entanglements of minke whales and basking sharks have occurred, this has mainly been in the groundlines rather than vertical buoy lines.

SMART BUOYS: 'Intelligent buoys' can send information on change in movement which can indicate an entanglement and allows the buoy to be tracked if a whale drags gear and increase response time. Also helps reduce lost gear and associated ghost fishing.

ROPELESS POTS OR 'ON-DEMAND' GEAR: Mechanisms (for example, using acoustic release devices and a float bag) to bring pots or traps to the surface, thus reducing the need for vertical buoy lines that pose an entanglement risk to whales.



Source: Leaper et al., 2022

GEAR TYPE

Pots and creels

ETP RISK

Large cetaceans and large elasmobranchs

APPLICABLE FISHERIES

Nephrops, lobster, crab fisheries

DEVELOPMENT STATUS

Negatively buoyant groundline:
Market-ready; in use in some fisheries

Smart buoys:
Market-ready; in use as a tracking device in some fisheries

Ropeless pots:
In development; some systems market-ready; at-sea prototype trials ongoing

CURRENT USE

Negatively buoyant groundline:
- Regulatory requirement in some fisheries in US and Australia; testing in Scotland

Smart buoys:
- In use or being trialled in a range of fisheries, e.g. Canada, US

Ropeless pots:
- Early-stage programmes in South Africa
- Testing in the US (e.g. NOAA Gear Library), Canada and the UK

EFFECTIVENESS

Negatively buoyant groundline:
- Most whales and sharks entangled in creel fishing gear in Scotland are caught in floating groundlines, a risk mitigated by negatively buoyant groundlines.[2]

Smart buoys:
- Has not been quantified
- Does not directly reduce entanglements but gives early warnings and reduces ghost gear

Ropeless pots:
- Has not been quantified, but potential to reduce entanglement in vertical buoy lines

APPROXIMATE COST (AS OF AUGUST 2024)

Negatively buoyant groundline:
- Negatively buoyant rope is around double the price of buoyant rope

Smart buoys:
- £17,000-£32,000 (for 20 strings of pots)

Ropeless pots:
- £45,000 for 20 strings of pots (mid-range equipment cost)

BENEFITS

Negatively buoyant groundline:
- No change in fishing practice
- Reduces entanglements and associated gear loss

Smart buoys:
- No change to fishing practice
- Real-time alerts on potential entanglements
- Helps retrieve gear and prevents ghost gear during closed seasons

Ropeless pots:
- Eliminates risk of entanglement within vertical buoy ropes

BARRIERS

Negatively buoyant groundline:
- Additional cost
- Time to re-rope fleets

Smart buoys:
- Does not entirely remove risk of entanglement as buoy rope still present
- Additional cost

Ropeless pots:
- Expensive system
- Takes time to 're-arm' pots
- Current gear-marking legislation requires buoys to mark the location
- Potential gear conflicts
- Reliability of release systems

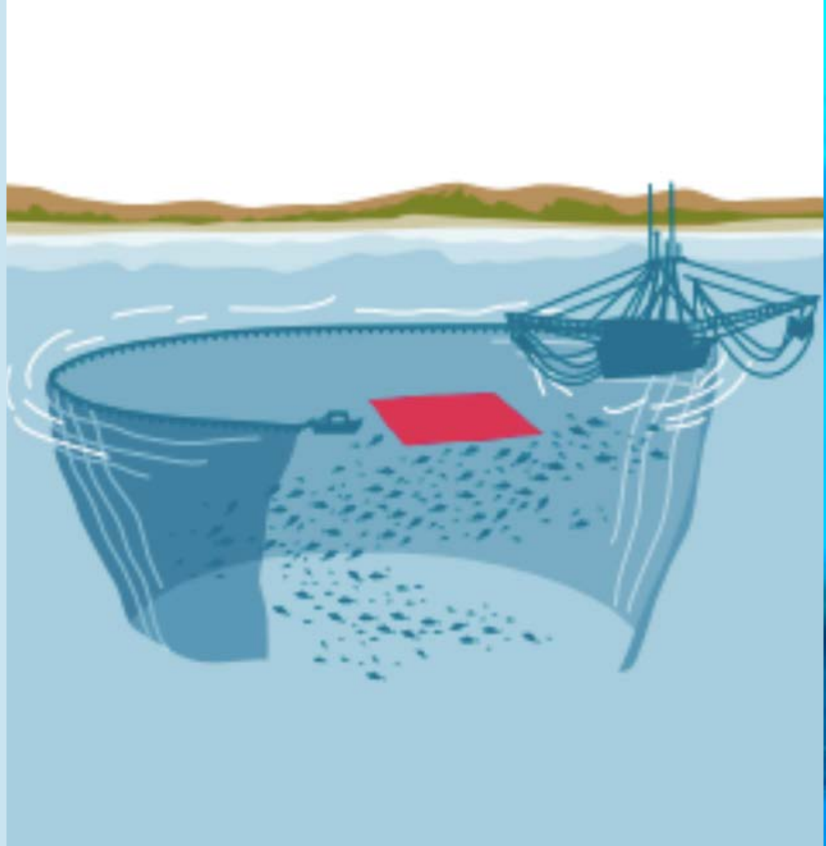
OPPORTUNITIES

- Support transition to negatively buoyant groundline within identified high-risk fisheries in UK
- Support trials of smart buoys within US and Canadian fisheries (potentially also in the UK, Ireland and Norway) to help reduce ghost gear
- Support gear libraries for ropeless and other innovations in the US and Canada, and set one up in the UK

CASE STUDY 8:

Innovations in FAD technology: Biodegradable and Acoustic Discrimination

Drifting fish aggregating devices (dFADs) deployed by tuna purse seine vessels present entanglement risks to a range of species including elasmobranchs and turtles. Jelly-FADs are designed to be non-entangling and biodegradable to reduce this risk and to prevent ghost fishing and habitat impacts.[61,62] Sonar buoys can also be used to detect the biomass under a FAD and distinguish the tropical tuna species that commonly aggregate around FADs (by detecting the sound signatures of different species, a process known as 'acoustic differentiation').[58]



Source: WWF (2023)

GEAR TYPE

Purse seine

ETP RISK

Elasmobranchs, turtles

APPLICABLE FISHERIES

Tuna fisheries

DEVELOPMENT STATUS

Market-ready; in use in some fisheries (jelly-FADs). In use and further development (acoustic differentiation)

CURRENT USE

Jelly-FADs are being tested at sea in the Pacific, Indian and Atlantic Oceans, e.g. by fleets from Ecuador, Spain, Micronesia, Taiwan, the US and Korea operating in the Eastern and Western Pacific Ocean

EFFECTIVENESS

Over 90% reduction in shark entanglements in non-entangling FAD designs such as the jelly-FAD (without netting) (Restrepo et al., 2016)

APPROXIMATE COST (AS OF AUGUST 2024)

- A jelly-FAD costs £200-£400 depending on the depth of the FAD and the materials used
- Acoustic buoys cost £600-£800 and an additional £250 for acoustic discrimination abilities

BENEFITS

Biodegradable jelly-FADs

- Dramatically reduce entanglement risks and ghost fishing
- Fewer habitat impacts from beached FADs

Acoustic differentiation

- Can help fishers to fish only on FADs with a high biomass of target species (and proportionally less bycatch)

BARRIERS

Biodegradable jelly-FADs

- Additional effort to find ropes and canvas made of natural materials

Acoustic differentiation

- Technology and interpretation still in development, but significant advancements with two frequency-discriminating buoys already in use

OPPORTUNITIES

- Continue to test operational feasibility of biodegradable dFADs in tuna purse seine fisheries operating in the Atlantic, Indian and Pacific Oceans
- Further develop the acoustic differentiation capabilities of sonar buoys to distinguish tuna and other species that mix under dFADs

Atlantic bluefin tuna © Wild Wonders of Europe / Zankl / WWF

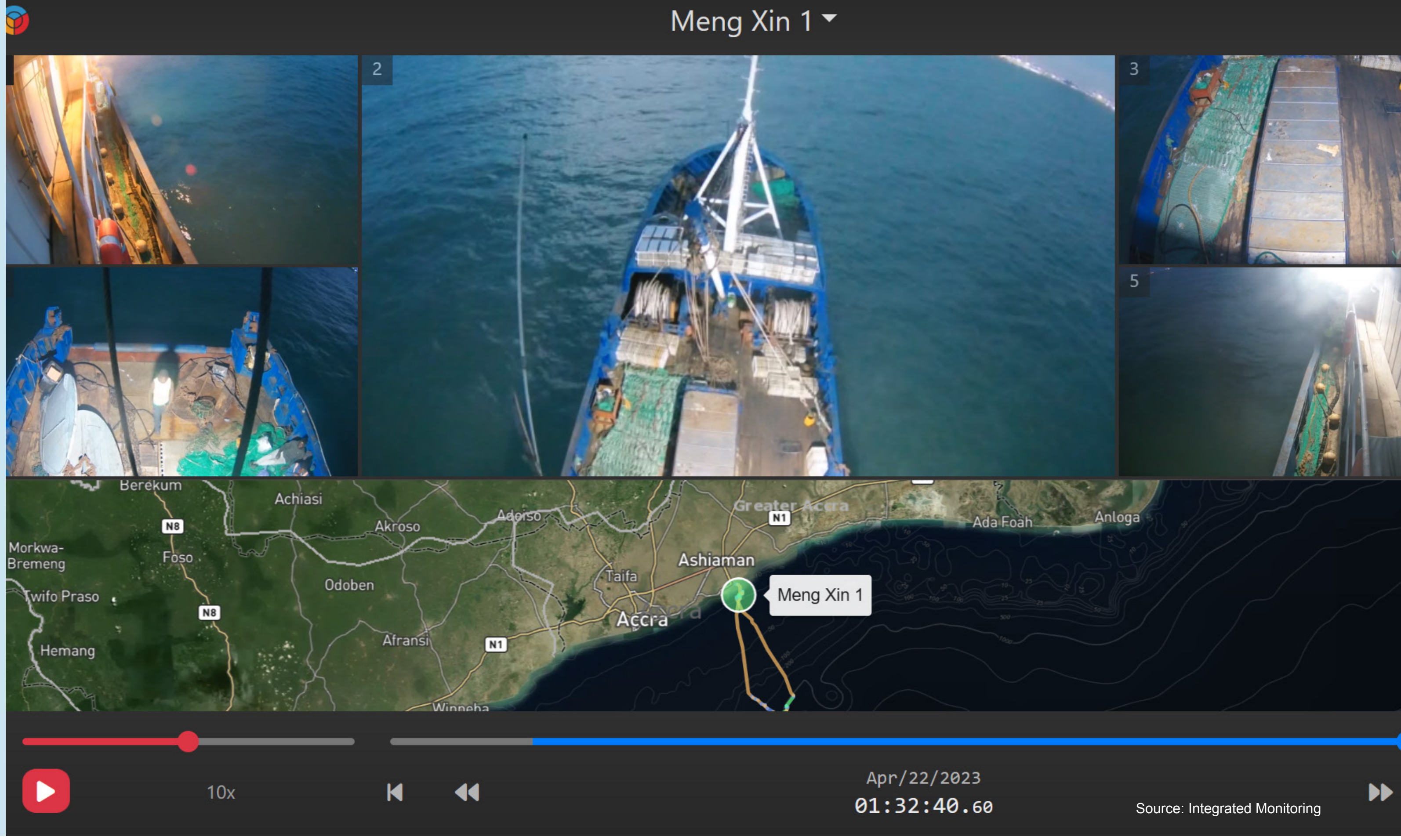
CASE STUDY 9:

Real-time monitoring and AI on-board detection

Real-time transmission of video files from REM systems has historically been impractical due to high costs and limited offshore connectivity. By leveraging more affordable marine Wi-Fi and cloud-based REM systems, these innovations improve fisheries management, regulatory oversight, and sustainability certification. Vessels operating far from 4G networks, such as longline tuna vessels, have had to store footage on hard drives for months until returning to port, delaying data review and preventing timely management decisions. However, with more affordable marine Wi-Fi, real-time video transmission is now feasible.

This technology allows for streaming selected areas in real time, or uploading footage in lower resolution with full resolution uploads possible when vessels are closer to shore.

Advanced AI developments, such as species detection on discard chutes on deck, further enhance REM capabilities, although these systems still require extensive image datasets for improved accuracy. The transition to real-time REM offers significant benefits for responsive fleet management, regulatory oversight and sustainability certification.



Source: Integrated Monitoring

GEAR TYPE

All gears

ETP RISK

Turtles, cetaceans, pinnipeds, elasmobranchs, seabirds

APPLICABLE FISHERIES

High-risk fisheries for ETP bycatch (large-scale)

DEVELOPMENT STATUS

- Real-time monitoring available
- AI recognition: developing all the time

CURRENT USE

Examples of fisheries that have implemented real-time monitoring:

- New Zealand inshore fleet
- Kenyan swordfish, tuna and prawn fisheries
- Selected Ghana trawl fisheries
- Danish pelagic vessels
- Hawaii longline (seabird interactions)
- New England groundfish fisheries (demersal)
- Chilean toothfish fisheries (demersal longline)

EFFECTIVENESS

REM systems in the Australian eastern tuna and billfish fishery have been found to increase reporting on bycatch interactions by 500% for turtles, 800% for seabirds, 1,100% for pinnipeds and 1,000% for dolphins (Timothy et al., 2019)

APPROXIMATE COST (AS OF AUGUST 2024)

- The annual cost of REM systems with real-time capability (assuming a five-year life span) is about £7,500-£12,000 per vessel per year. This covers hardware, maintenance and data transmission[65]
- Video review costs vary depending on the proportion of footage reviewed and indicators measured
- At-sea Wi-Fi access is currently priced at £200 (US$250) per month for 50GB of data (included in the costs above)[66]

BENEFITS

- Fishers given access to data can improve catch efficiencies and avoid bycatch hotspots
- Wi-Fi access supports crew welfare
- AI detection ensures recording only when fishing in operation
- AI species recognition can provide near-real-time information on catch composition
- Video and sensors can be used to verify deployment of bycatch mitigation measures

BARRIERS

- Cost of Wi-Fi is high, and download costs using 4G vary considerably between countries
- Privacy and data ownership concerns
- Fishing data not always available to fishers, reducing incentives
- Camera clarity and lens maintenance are needed for good-quality images
- Lack of harmonised standards for web-based REM systems

OPPORTUNITIES

- Develop indicators for ETP bycatch outcomes and mitigation measures that can be measured through REM systems, and can also be measured in real time and compared over time (e.g. to demonstrate improvements)
- Allow snap-shot audits that incorporate video footage of fishing operations

A group of reef manta rays © Vincent Kneefel / WWF

METHODOLOGY

This report is based on a desktop literature review, stakeholder interviews, a compilation of bycatch mitigation measures for UK seafood suppliers, and a summary of nine in-depth case studies. The methodology involved six steps:

1

Step 1: Literature review
We conducted a comprehensive review of literature on bycatch of ETP species within the UK supply chain and innovations to reduce impacts. This included information from online bycatch mitigation platforms like UK Clean Catch, BMIS and Bycatch Solutions Hub, and materials shared by stakeholders.

2

Step 2: Stakeholder engagement
Engaging 25 institutions – including regulators, the catching sector, retailers, technology providers and NGOs – was crucial to understanding motivations and approaches to bycatch mitigation.

3

Step 3: Compilation of bycatch mitigation measures
We identified common UK seafood types, their source countries, and gear types posing risks to ETP species. Supply sources (by country) identified as medium to high risk were previously identified in the WWF Risky Seafood Business report[4], and we included these in this report. After we identified the key UK seafood sources that pose a medium or high risk to ETP species, we then investigated and compiled potential mitigation measures using available literature and online bycatch mitigation information platforms,[5-47] and information from interviewed stakeholders.

4

Step 4: Selection of case studies
Criteria for selecting case studies included ETP species risk, seafood consumption volumes, and fisher adoption likelihood. Case studies spanned different seafood groups, ETP species, gear types, geographic regions, innovation types, and fishery scales.

5

Step 5: Case study research
We conducted detailed research and interviews for each case, covering innovation trials, costs, barriers to implementation, and potential UK seafood applications.

6

Step 6: Recommendations
Based on the stakeholder interviews and desktop literature review, we formulated recommendations for key stakeholders to support and encourage the uptake of bycatch reduction policies and innovations for the highest-risk UK seafood supply chains.

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ACRONYM LIST

ACAP	Agreement on the Conservation of Albatrosses and Petrels
AI	Artificial Intelligence
CBD	Convention on Biological Diversity
CCTV	Closed Circuited Television
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on Migratory Species
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
dFAD	Drifting Fish Aggregating Device
ETP	Endangered, Threatened and Protected
FAD	Fish Aggregating Device
FIP	Fishery Improvement Project
GDST	Global Dialogue on Seafood Traceability
GPS	Global Positioning System
IUU	Illegal, Unregulated and Unreported
LED	Light-Emitting Diode
MMPA	Marine Mammal Protection Act
MSC	Marine Stewardship Council
NGO	Non-Government Organisation
NOAA	National Oceanic and Atmospheric Administration
PARs	Passive Acoustic Reflectors
REM	Remote Electronic Monitoring
RFMO	Regional Fisheries Management Organisation
SJI	Seafood Jurisdiction Initiative
SED	Seal Exclusion Device
TED	Turtle Excluder Device


Fishermen hauling in the trawl with seagulls
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