

# Haunted sea

An overview of problems and initiatives in relation to lost fishing gear

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## About the report

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**Additional information:** KIMO's aim with this report is to explore the magnitude of the issue of ghost nets, as well as existing initiatives to solve the problem. It is based on academic articles, reports and interviews with relevant actors.

**Front page photo:** Anna Axelsson

## KIMO Sweden is part of KIMO International

KIMO stands for Kommunenes Internationale Miljøorganisation (Local Authorities International Environmental Organization). The organization was founded in Denmark in 1990 with the aim to protect the marine environment. We want to reduce the environmental problems caused by pollution, waste, climate change and microplastics in the sea and on our beaches.

KIMO works to influence legislators and decision-makers to improve the conditions for the marine environment in the North Sea and the Baltic Sea. With more than 80 member municipalities in eight countries, we represent more than five million citizens in Europe.

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## Preface

This year we would like to extend our warmest thanks to Anna Axelsson, who wrote this report on ghost gear with the support of our KIMO scholarship. The purpose of announcing a scholarship to a student is to get help with compiling a report on an important environmental issue linked to the marine environment and to see what measures and solutions there may be to the problem. The scholarship report 2020 was about microplastics from textiles. Both reports can be downloaded at [www.kimointernational.org](http://www.kimointernational.org).

As fisheries have intensified during the 20<sup>th</sup> and 21<sup>st</sup> centuries, the amount of fishing gear in the oceans has increased and 27 percent of the marine litter in EU waters is estimated to be fishing-related. One of KIMO's priority areas is to reduce the amount of marine litter. Please read this report and learn more about the concept of 'ghost nets', lost fishing gear. It can be concluded that further efforts are needed to collect lost fishing equipment and to think about the circularity of materials. Collaboration is important for success. Everyone who handles fishing gear also needs to prevent the equipment from ending up as ghost gear in the sea. At KIMO, we encourage collaboration and sharing of experiences between our member municipalities.

KIMO Sweden's hope is that the report will arouse interest and invite conversations about lost fishing gear and the circular economy.

**Emmyly Bönfors**

Chair KIMO Sweden

# Executive Summary

Marine litter is a growing problem globally. As fisheries have intensified during the 20<sup>th</sup> and 21<sup>st</sup> centuries, the amount of fishing gear in the oceans has increased and 27 percent of the marine litter in EU waters is estimated to be fishing-related. At the same time, the equipment's materials have changed from being biodegradable to mainly consisting of synthetic materials. Ghost nets refer to fishing nets that, with or without intention, remain in the oceans and lead to negative consequences for the surrounding ecosystem. Cages, fyke nets, fishing lines, ropes and other types of fishing equipment also contribute to the problem. The purpose of this report is to provide an overview of the problem of ghost gear, with a focus on the North Sea and the Baltic Sea. The report also intends to examine the possibilities, challenges and future prospects for circular and sustainable solutions to the problem, as well as providing examples of pioneers in the field. This is done with the help of literature studies and interviews with relevant actors in the field.

The results show that the problems in Sweden differ depending on the sea area. In the Baltic Sea and the Sound, nets are the biggest problem, while lobster creels and cages are most common off the west coast. Regardless of the type of equipment, it causes extensive ecological consequences in the form of ghost fishing, the spread of microplastics and heavy metals, degraded habitats, the spread of invasive species and the harmful effects on marine mammals and birds. Because the equipment can be transported a long way, the consequences can be seen far from the place where it was lost. Besides fisheries, more sectors may be affected, such as tourism.

There are several actors at international, national and local level who work in various ways with actions regarding lost fishing equipment. Recurring themes for these initiatives are that they are characterized by a circular approach and collaboration between different actors and sectors. Circular solutions mean that the entire life cycle of fishing gear is taken into account: from the choice of material and design, to how the gear is handled after use. It generates a holistic perspective that is necessary in the matter of ghost gear, due to its complexity. Collaboration is realized, for example, through ongoing projects where municipalities take the help of professional fishermen and professional divers to collect lost equipment. Circularity and collaboration are also factors that have a great potential to benefit local actors.

In 2019, the EU issued a directive on single-use plastics, where fishing gear containing plastic is highlighted as a significant problem. The directive encourages member states to create increased financial incentives for fishermen to return their discarded gear. Producer responsibility is also advocated, which means that it is the manufacturers of fishing equipment who must finance environmentally friendly waste management as well as efforts to increase consumers' awareness of the issue. The legislative changes that Sweden needs to make to live up to the single-use plastics directive will, according to the proposal, enter into force in November 2021. As regards fishing gear specifically, it may take longer before the effect is visible, but the directive gives great hope that the issue is now taken seriously. Existing initiatives addressed in this report also offer good collaboration opportunities for

manufacturing companies that want to submit their contribution to the requirements of the directive. The next step in the work against ghost nets is legislation preventing the loss of fishing equipment and reducing its ghost fishing effect.

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# I. Introduction

## I.1 Marine litter

Marine litter is material manufactured or processed by man that with or without intention ends up on the seabed, in the water column or on beaches (Swedish Agency for Marine and Water Management/SwAM, 2015). The objects can be both small and large (micro and macro debris) and consist of a variety of materials, with plastic being by far the most common (Ibid.). It is estimated that 80-85 percent of the waste on Europe's beaches consists of plastic (Clean Nordic Oceans/CNO, 2020).

The Swedish west coast is particularly exposed to marine debris, due to the accumulation of sea currents from both the North Sea and the Baltic Sea (County Administrative Board, Västra Götaland, 2014). Surveys between the years 2001 and 2011 showed that the number of litter objects on reference beaches in Bohuslän [Sweden's western province from Gothenburg to the border with Norway] was 1,190 per 100 meters of beach, which can be compared with the average of 712 per 100 meters of beach within the entire OSPAR area (SwAM, 2012). The amount that is washed up every hour on the Bohus coast is estimated to correspond to five bathtubs (Keep Sweden Clean, 2021). The litter is mostly transported long distances from both sea and land-based sources (SwAM, 2015). As for land-based sources, they largely consist of tourism, recreation and shortcomings in the management of waste, wastewater and stormwater, while litter at sea is mainly caused by commercial shipping, recreational craft and fishing activities (Ibid.)



Figure 1. Results from a beach clean in Svanesund, Orusts kommun (photo: Anna Axelsson)

## 1.2 Fishing gear and ghost nets

It is estimated that 27 per cent of marine litter in the EU consists of objects related to fishing (Keep Sweden Clean, n.d.). The amount of lost fishing equipment in the oceans has increased during the 1900s and 2000s in line with the intensification of fishing activities worldwide (Macfadyen, Huntington & Cappell, 2009). This has mainly happened as a result of a constantly growing demand for seafood (Dąbrowska, Łopata & Osial, 2021). Over the years, fishing equipment has shifted from natural and degradable into being dominated by synthetic materials (ibid.). These are more difficult for nature to break down and pose a problem if the life cycle is not closed, that is, if they are not taken care of when they are no longer in use (CNO, 2020).

The fishing gear most referred to in this report are nets, fyke nets, cages and creels. Nets are utilized to catch fish by entanglement (Kunskapskokboken, 2014). The meshes of the nets are designed so that only the fish's head gets stuck, and the design varies depending on which fish is targeted. Fyke nets are cone-shaped structures of nets that are kept stretched by a series of bows. They are used for most fish, but especially for eel and cod. Cages can be designed in different ways and used for catching and storing both fish and shellfish (ibid.). Creels are cage-like constructions for catching lobster, crab and crayfish (iFiske, n.d.). They are the only gear permitted for lobster fishing (SwAM, 2021a). It is permitted to catch different species depending on the place and time of the year, as the County Administrative Board states in its mapping tool 'Swedish Fishing Rules'.

Ghost nets refer to fishing nets that, with or without intention, remain in the oceans with a number of negative impacts on surrounding ecosystems. Cages, fyke nets, fishing lines and other fishing equipment also contribute to the problem (SwAM, 2021a). In this report, however, we use the terms ghost nets or lost fishing gear to describe the problem. The equipment can emit microplastics and metals, as well as continue to passively fish in sensitive and former untouched areas, such as on deep seabeds and far from the coast. The phenomenon is called ghost fishing and is a global problem from both an ecological and socio-economic point of view, since both the marine environment and sectors such as fishing and tourism are affected (Macfadyen et al., 2009).

## 1.3 Aim and questions

The purpose of this report is to provide an overview of the problems concerning ghost nets and other lost fishing equipment, focusing on the North Sea and the Baltic Sea. The report also intends to explore the possibilities and challenges of creating circular and sustainable solutions to manage the problem, and it describes some forerunners in the area. A third aspect includes the future prospects for initiatives and measures to solve the problem with ghost nets. The main questions are:

- What is the magnitude of the issue of lost fishing gear/ghost nets and what are the main consequences?

- What circular and sustainable solutions are available to address the problem?
- What are the future prospects for initiatives that want to address the problem?

The questions are answered through literature studies as well as interviews and conversations with persons who work in one way or another to solve the problem of ghost nets.

## 2 Results

### 2.1 Description of the problem of lost fishing gear/ghost nets

When describing the problem of ghost nets, it is difficult to pinpoint individual responsible actors. There are fewer and fewer knowledge gaps, and we know that some of the underlying causes are the lack of legislation and of infrastructure for collection and recycling (CNO, 2020). The physical loss of fishing gear can also be explained by different factors. Among the most common causes is that the actual construction at the surface (float) that should keep the equipment upright sinks due to collision, currents, misjudgements of depth or that they have been abandoned and overgrown. Another common problem is that the floats lose their grip of the equipment below the surface, due to weak ropes or knots, too much load or boat traffic (Ibid.). Weather conditions and inadequate waste management on board are also contributing factors (OSPAR, 2020). Below is a further description of the issue of ghost nets, with focus on scope and consequences in the sea areas off Sweden's coastline.

#### 2.1.1 Magnitude

Figures on the exact presence of ghost nets and other equipment are difficult to ascertain, but across Europe, over 33,000 nets are estimated to be lost annually (Blue Circular Economy, 2020). Around the Swedish coast, the problem is greatest in the southern Baltic Sea, the Sound and along the west coast (SwAM, 2020). However, the problems differ in these areas, with respect to what type of equipment is lost. In the Baltic Sea and in the Sound, it is mainly nets, while lobster creels are the big problem on the west coast (Sixten Söderberg, personal communication, August 10, 2021; Per-Olof Samuelsson, personal communication 27 August, 2021). Within the framework of the project 'Collecting ghost nets in the Baltic Sea' a total of 22,000 kg of lost fishing nets was picked up in 2012 in the Baltic Sea and it is estimated that 5,500 - 10,000 nets are lost there annually (BalticSea, 2020). Along the Swedish west coast accepted figures have long been that 3,000 - 5,000 lobster creels are lost annually (CNO, n.d.). Per-Olof Samuelsson (personal communication, 6 September 2021) who is the project manager for the 'Ghost fishing project' (see chapter 2.2.2.4) explains, however, that the figures in recent years have decreased to 1,000 – 2,000. This is due to new restrictions on the permitted number of lobster pots for recreational as well as professional fishermen.

The extent to which abandoned fishing equipment causes damage in the sea depends on various factors. The type of equipment is crucial, as the fishing efficiency for gear such as Danish seines and trawls generally decrease once they are released from the vessel (Gilman et al., 2021). Passive gear such as cages and nets are also at greater risk of getting lost (CNO, 2020). This is because they generate catches without the fisherman being present and controlling the process. In general, they are also cheaper than active gear, which can affect the degree of caution (Ibid.). Local environmental factors also affect the extent of the damage (Gilman et al., 2021). The risk for ghost fishing is higher in places with high amounts of marine animals. Furthermore, the ghost fishing effect is influenced by the local seabed environment: whether it is open and flat or consist of substrates and three-dimensional structures, as tools can get stuck in these (Ibid.).

## 2.1.2 Ecological impact

One of the main problems with lost fishing gear is the passive fishing that can continue without anyone taking care of the catch (Macfadyen et al., 2009). When the equipment is no longer controlled by the fisherman, it can catch and potentially kill fish and shellfish in an uncontrolled manner. This can affect populations and poses a particular risk to species that are already close to extinction (National Oceanic and Atmospheric Administration/NOAA, 2015). When fish and shellfish get stuck in the gear they also act as bait, which makes the ghost fishing effect cumulative and may continue for many years (Calderon, 2016). In the 'West Coast Projects', run by Sotenäs, Tanum and Lysekil municipalities, dragging is done by professional fishermen and diving by professional divers. Project manager Per-Olof Samuelsson (personal communication, 6 September 2021) believes that the most common species in the lost equipment is large crabs. Also live and dead cod, common dab and lobsters occur frequently. Within the framework of the project '8+fjords' an examination was performed in 2015 - 2016 of lost fishing gear in the fjords inside the islands of Tjörn and Orust. During a total 85 hours of dragging 42 pieces of gear were found. Of these, 31 had continued to ghost fish since they were abandoned. The oldest one had ghost fished for as long as five years, which was calculated by studying mussels and other organisms attached to the gear. A majority of the tools were cages, but there were also nets and fyke nets. Among the living organisms that were found, the hermit crab and shore crab were by far the most common species. Also king crab and toad crab were common (Ibid.).



Figure 2. A crab that survived in a lobster pot lost at sea (photo: Anna Axelsson)

In addition to fish and shellfish, marine mammals and birds are also at risk of being affected in various ways by lost fishing equipment. Fishing gear is the type of debris that causes the greatest damage to marine wildlife, through entanglement that eventually leads to the animal suffocating or dying of exhaustion (Wilcox et al., 2016). According to Butterworth, Clegg and Bass (2012), fishing lines or nets are often wrapped around the necks of seals and become difficult to get off, after which they eventually penetrate through the skin. Furthermore, they report that smaller pieces of fishing equipment have been found in the digestive system of

marine mammals and birds. This happens when the animal mistakes the material for food or eats by-products from the fishery, containing, for example, old hooks. The material does not degrade and can contribute to irritation, inflammation and ulceration in the stomach, as well as false feelings of satiety and thus starvation. It can also cause direct damage to the mouth and affect the ability to search for or eat food. It has also been shown that marine birds can find it difficult to fly, dive and nest (Ibid.), and that they use parts of the equipment as material for the nest (CNO, 2020).

The spread and transfer of plastics and other man-made materials are also generating wider ecological consequences. Fishing gear usually consists of synthetic polymers and others types of plastics. The most common are polyamide (also known as nylon), polypropylene (PP plastic) and polyethylene (PE plastic) (OSPAR, 2020). It is also common for the materials to be mixed, containing for example polyvinyl chloride (PVC) and polyester (Ibid.). Plastics such as polymers are resistant materials that are difficult to decompose (Dąbrowska et al., 2021). When they are in water over a long period of time, however, they degrade and emit over time more and more microplastics that can be taken up by surrounding organisms and thus the marine food chain (Macfadyen et al., 2009). The extent of these problems depends on the proportion of plastic in the ghost nets and what kind of plastic it is, because different varieties are differently degradable (Macfadyen et al., 2009; Dąbrowska et al., 2021). The surrounding environment also plays a role, as factors such as heat, UV radiation and mechanical stress from waves affect the degradation and thus the uptake (Ibid.). In addition to plastics and polymers, fishing gear often consists of steel wires, lead sinks, copper coatings and other materials (OSPAR, 2020; Fiskerreturen, 2021), which can contribute to the spread of heavy metals (Macfadyen et al., 2009).

An additional effect of ghost nets is altered and degraded habitats for animals and plants (Macfadyen et al., 2009). Impact occurs when the abandoned fishing equipment, for example, covers, wears down or finds its way into the structure of the habitat. The extent of the impact depends on the type of habitat and how sensitive it is (Ibid.). In general terms, species living on or just below the sediments on the seabed, such as crabs and seagrass, are particularly sensitive, especially to cages. Another example of sensitive habitats is coral reefs (NOAA, 2015), which in Swedish waters is only found in the Koster Sea, where the endangered *lophelia pertusa* coral is home to more than 1300 species (University of Gothenburg, 2021). Due to the unique marine environment in the Koster Sea, fishing regulations such as trawling bans in particularly sensitive areas have been introduced (County Administrative Board, n.d.).

A potentially positive effect of fishing equipment remaining in the oceans is that they can function as artificial reefs. In the previously mentioned study of '8+fjords' a large number of cages were colonized by organisms such as oysters, mussels and eggs from walnut snails, sea urchins and anemones (Calderon, 2016). Marine debris moving through the body of water creates particularly good habitats for sessile species, which live attached to substrates and whose food is particles moving in the body of water (Kiessling, Gutow & Thiel, 2015). However, it also means increased risks of spreading invasive species and microalgae that can cause algal blooms, since the marine debris is transported over long distances by sea currents (Macfadyen et al., 2009). The spread is even more efficient since the materials are durable and move slowly through the ocean (Moore, 2008).

### 2.1.3 Other impact

In addition to their negative effects on marine ecosystems, the remaining ghost nets can also have economic and/or social consequences. For the fisherman, there will be financial consequences both as a result of the loss of equipment and the demise of commercially valuable organisms lost through ghost fishing. Costs include, among other things, replacement of equipment and possibly extra resources (such as time, fuel and better equipment) to catch fish from declining populations (NOAA, 2015). Depending on which species are affected and what commercial value they have, ghost fishing and its impact on fish stocks also means an economic loss for the fish processing industry (Macfadyen et al., 2009).

If fishing equipment ends up on the coast or in coastal areas, tourism, recreation and other human and commercial activities can be affected (Gilman et al., 2021; Macfadyen et al., 2009). This is because the aesthetic and recreational value of a beach decreases when it is littered, which will have effects for both the individual visitor and the tourism sector in general (Beamont et al., 2019). Large amounts of marine debris can also affect the overall image of a destination in a negative way (Moore, 2008). When ghost nets and other debris end up on beaches, coastal municipalities are also affected as financial resources from the municipal budget needs to be spent on beach cleaning (County Administrative Board in Västra Götaland, 2014; HaV, 2015).

There are also safety aspects of ghost gear. If the abandoned equipment occurs in areas with much ship traffic, navigation may be affected (Gilman et al., 2021; Macfadyen et al., 2009). The risks depend on the type of fishing equipment, whether it remains floating and how visible it is after being released from the boat (Ibid.).

## 2.2 Current measures in relation to lost fishing gear/ghost nets

The ghost net phenomenon includes various actors who contribute to and/or suffer from the problem. Solutions therefore need to be characterized by cooperation and communication across sectors (Richardson et al., 2019). The problems are also cross-border with varying geographical and oceanographic conditions (CNO, 2020). This makes the issue more complex and emphasizes the need for measures and agreements both within and between countries (Macfadyen et al., 2009). Below are some examples of actions at international, national and local level, focusing on the North Sea and the Baltic Sea.

### 2.2.1 International

#### 2.2.1.1 KIMO International

KIMO International is an organization consisting of cooperating municipalities from Belgium, Denmark, the Faroe Islands, Germany, Lithuania, the Netherlands, Norway, Sweden and the United Kingdom (KIMO, n.d.). Through a shared vision, its members strive to protect the sea and marine environments. One of several areas that KIMO works with is marine litter, including the problem with ghost nets. Through the long-running project 'Fishing for Litter', the organization has helped hundreds of fishers in the work of collecting marine debris. In dialogue with fishers, recommendations have also been made for how littering can be avoided in the fisheries sector, within the framework of the 'Net Cuttings' project (Ibid.).

### **2.2.1.2 Clean Nordic Oceans (CNO)**

In 2017, CNO was started in response to the high proportion of marine litter estimated to consist of fishing equipment. Through a network of experts, the main purpose of this collaboration was to generate and disseminate knowledge on the issue. They also mapped how well the Nordic countries are doing regarding knowledge of the issue and current measures to address it. In this way, the network intended to help reduce the amount of lost fishing equipment in the oceans and improve solutions for recycling and reuse (CNO, 2020).

### **2.2.1.3 MARELITT Baltic**

Another international initiative was MARELITT Baltic, which was a collaboration between Sweden, Estonia, Poland and Germany (Tschernij, Press, Migdal, Stolte & Lamp, etc.). The project was funded by the EU and worked with measures on ghost nets in four aspects; mapping, collection, recycling and prevention. Within the framework of the project, a guide was also produced (Baltic Sea Blueprint) for how decision-makers and other actors can work with the issue in these four aspects. The guide contains step-by-step recommendations on what to do at which point in the process, and also on which actors to involve (Ibid.). Within the framework of the project a comprehensive environmental impact assessment was carried out of measures for the collecting of ghost nets in the Baltic Sea (Sahlin & Tjensvoll, 2018).

## **2.2.2 National and local**

### **2.2.2.1 Swedish Agency for Marine and Water Management (SwAM)**

In Sweden, public agencies as well as organizations work with the issue. According to Charlotta Stadig (personal communication, 31 August 2021), an officer at the Swedish Agency for Marine and Water Management, the authority is responsible for coordinating efforts on ghost nets. In addition to financing projects related to ghost nets, locating and collecting lost fishing equipment is included in the agency's action program for a good marine environment (SwAM, 2021).

In accordance with the EU Control Regulation (1224/2009), fishermen are required to report lost gear within 24 hours of the loss. SwAM is responsible for receiving this reporting and for the tool Ghostguard, where it is possible to report coordinates for found ghost nets and completed cleaning efforts. According to Ms Stadig, the authority also works with information initiatives for recreational and professional fishermen and has, for example, produced a checklist to follow when collecting fishing gear. They are also working on the implementation of the EU's new single-use plastics directive, which includes fishing equipment (see Chapter 2.4.2).

### **2.2.2.2 Municipality of Simrishamn**

Several coastal municipalities carry out active work with various initiatives concerning ghost nets. One of the forerunners is the municipality of Simrishamn [in the south of Sweden], which was one of the leading players in the work with MARELITT Baltic. The municipality was also involved in the project 'Fishing For Litter', in collaboration with KIMO Baltic Sea (Camper, 2016). The project involved fishermen bringing litter caught in their fishing gear to the port, where it was weighed and classified and then transported to recycling. The project was funded

by SwAM and in addition to the direct benefit in the form of cleaner seas, it aimed to inform public opinion and showcase possible measures for dealing with marine litter (Ibid.)

### **2.2.2.3 Municipality of Sotenäs**

Another municipality that has taken a lead in the work with lost fishing gear is Sotenäs . Together with SwAM, the municipality is responsible for the implementation of the new single-use plastics directive (see chapter 2.4.2). Below are some more examples of projects where the municipality has been or is involved.

With support from the European Maritime and Fisheries Fund and the County Administrative Board of Västra Götaland, several ghost fishing projects have been conducted since 2017, where lost fishing gear in the sea is located and collected through dragging by professional fishers and diving by professional divers (see chapter 2.2.2.6). The method is based on the local fishermen's good knowledge of the sea areas where they operate and has, according to project manager Per-Olof Samuelsson (personal communication, September 6, 2021) been successful:

‘So far, for example, 600 lobster creels, 100 crayfish cages, 40 nets or pieces of nets with a length of about 3 kilometres and 25 fyke nets have been collected only from the coastal waters of Sotenäs.’

Together with the Fishermen's Association Norden and with support from the Swedish Environmental Protection Agency, the municipality has also implemented a project with the aim of promoting the collection and recycling of fishing gear (Swedish Environmental Protection Agency, 2020). During the project, a total of 37.5 tonnes of equipment were collected, of which 15 percent went to reuse, 66 percent to material recycling and 19 percent to energy recycling. In addition, a proposal for a national system for collecting fishing gear was developed, together with work for increased producer responsibility. The conclusions from the project were, among other things, that policy instruments are needed that create motivation for reuse and recycling, within the framework of increased producer responsibility. To facilitate recycling, the project also advocates labelling (ownership and content) of all gear, as well as a deposit on certain tools (Ibid.). The municipality of Sotenäs is currently collaborating with the Swedish Environmental Protection Agency and SwAM to develop producer responsibility (Emma Ek, personal communication, 23 August 2021).

Fiskereturen (“Fishing return”) is another initiative where the municipality of Sotenäs is involved, in collaboration with Båtskroten, Keep Sweden Clean and the Fishermen’s Association Norden, and with funding from SwAM (Fiskereturen, n.d.). The service offers collection of end-of-life fishing gear at ten locations along the west and east coasts. By agreement, gear can also be collected from lakes Bolmen, Vänern, Vättern and Hjälmaren. A total of 100 tonnes of fishing gear have been collected since Fiskereturen started at the end of 2019. The material is taken care of, separated and recycled, or alternatively reused as, for example, furnishings (Ibid.). Other examples of projects where the municipality has participated or is participating in relation to ghost nets are “Design for circularity of fishing gear” and “System for locating and salvaging fishing gear” (Symbioscentrum, 2021).

## The life cycle of fishing gear

The manufacturing chain for fishing gear is complex and varies between countries (OSPAR, 2020). Different actors are involved in different parts of the process and a study by Andersson et al. (2018) show that a majority of all fishing gear used on the Swedish Bohus coast is procured from foreign manufacturers. Most tools also have a linear life cycle, which means that they are lost or incinerated after being taken out of service (Ibid.). One of the main challenges for creating circular solutions in the EU is infrastructure and logistics (OSPAR, 2020). There are still relatively few facilities for collection and recycling, which means that the materials often need to be transported long distances. In addition to being economically costly, it is also worse from an environmental perspective than if fishing gear is produced locally (Ibid.).

However, recycling technology is developing and the market is growing (OSPAR, 2020). The pellets that become the end product in the recycling of plastic from the equipment have broad areas of use in industrial production (Karlsson, 2016). Especially in the clothing fashion industry, the idea of using materials from fishing equipment has had an impact (Liljemalm, 2017). Some examples of ghost net products that have been launched in recent years are spectacle frames from the Karün brand and a rain jacket from Tretorn in collaboration with the retailer Naturkompaniet (Ibid.).

### 2.2.2.4 Sotenäs Marine Recycling Centre

The material collected in projects such as the 'Ghost Fishing Project' and 'Fiskereturen' is disposed of at Sotenäs Marine Recycling Centre, which is the only recycling centre in Sweden that specializes in marine waste. Stephen Andreasson (personal communication, 3 August 2021) works as a technician at the marine recycling centre in Sotenäs and during a tour of the facility, he explained that the business consists of two parts. The first is the reception itself, where collected waste is taken care of and sorted. This includes gear from local fishermen but also larger deliveries from all over Sweden, for example via 'Fiskereturen'. A large part of the materials consists of lead, iron and other metals, which after sorting are sold on to the company Stena Recycling. Most of the sorted plastic, on the other hand, goes on to the other part of the business, which is a test bed where an innovation project is underway in collaboration with research institutes and universities. Companies are invited here to test new ideas and products that the recycled plastic can be used for. Andreasson describes the business as largely based on this type of collaboration and 'symbiosis' between different actors:

*'I think it would be difficult otherwise, because there are so many companies that have good ideas and through collaboration you can get very nice and good products. It is unnecessary to compete, there is money for everyone.'*



Figure 3. Sorting at the marine recycling center in Sotenäs (photo: Anna Axelsson)

Erik Goksøyr (personal communication, 4 August 2021) has worked to develop the marine recycling centre since it started up in its current form in 2018. He says that the foundation for the business was laid by the Fishermen's Association Norden, which until then collected fishing gear and sorted on a quay outside the association's premises in Smögen. Since the marine recycling centre moved to the current premises at Hogenäs industrial area, the business has grown in terms of both employees and collected material and what they can do with the materials. However, the Fishermen's Association Norden is still an important partner.

### 2.2.2.5 Fishermen's Association Norden

The Fishermen's Association Norden has been producing fishing nets on the island of Smögen in Sotenäs municipality since the 1940s, when the majority of the island's population were directly dependent on fishing to support themselves. Since then, a lot has changed and today there are only about 20 fishers left on the island, said Sixten Söderberg (personal communication, 10 August 2021) during a visit to the association's premises. The business has adapted accordingly and at present most of the association's production goes to sports and leisure activities. Mr Söderberg mentioned that the changes have also meant an increased focus on how the association can work to protect the marine environment. Among other things, they develop selective fishing gear, which enables by-catches and species of undesirable size to be diverted out of the net to avoid being caught unnecessarily.



Figure 3. Fishermen's Association Norden's premises in Smögen (photo: Anna Axelsson)

An important part of the association's work is the collection of obsolete fishing gear, which began in 2008 and is still ongoing. This activity has been scaled up to the marine recycling that currently takes place at Hogenäs industrial area. According to

Söderberg, this is because the municipality of Sotenäs saw the potential. He emphasizes the importance of collaboration to find solutions to maritime-related challenges. According to Söderberg, the Fishermen's Association Norden can be described as one of several important hubs for such collaboration - a so-called marine development centre.

### 2.2.2.6 "Ghost fishing project" and the "West Coast model"

"The 'ghost fishing project' is a SwAM-funded initiative in collaboration between the municipalities of Tanum, Sotenäs and Lysekil. Within this project, professional fishermen from each municipality drag for fishing gear, according to project manager Per-Olof Samuelsson (personal communication, 27 August 2021). The "ghost fishing project" has been developed into the so-called "West Coast model". Ropes, weights and drags which have been utilised have been tested in ongoing and completed ghost fishing projects. Samuelsson describes cooperation with the fisheries sector as an effective approach, due to the fishermen's local knowledge of factors such as bottom conditions and currents. They also have access to the equipment required for the work. It is also a way to strengthen cross-sectoral collaboration around the work with lost fishing gear.

The dragging is based on where the local fishermen have identified or suspect an area with lost fishing gear, Samuelsson explains. There is also a constant exchange of experience between the fishermen, which is a requirement from the project manager. Eelgrass beds, mussel beds, contaminated sediments and other sensitive or risky areas can be avoided by this method. The actual dragging is performed with at least two people on board and with the help of dragging tools with hard angled spikes (Figure 5). The results are documented in dragging diaries, registered in Ghostguard and compiled in final reports. The collected gear is rinsed and then transported to the marine recycling centre in Sotenäs. Equipment that is still of good quality is returned to the owner if it is marked. If it is unmarked, it is registered as derelict, in accordance with routines established with the police responsible for derelict finds.



Figure 5. Gear for hauling lost fishing gear (photo: Per-Olof Samuelsson)

Diving after lost fishing equipment follows the requirement that the group consists of at least three people with special certificates. The diving takes place mainly in shallow rock reefs and at steep edges, but also at fixed structures such as stone revetments, navigation marks and the like. These are areas where equipment tends to get stuck and where dragging is difficult to perform. Here, too, the knowledge of local fishermen is used to identify areas with a high incidence of lost fishing equipment. The routines for documentation and registration of the equipment are the same as for fishermen.

#### 2.2.2.7 Divers Against Ghost Nets (DAGN)

A non-profit organization that works with the issue of ghost nets is Divers Against Ghost Nets (DAGN), whose activities are largely to dive and collect lost fishing gear. They are primarily active on Hönö in Gothenburg's northern archipelago, but also in the Gullmaren fjord at Lysekil. In a conversation with the chairman Paul Hultsbo (personal communication, 5 August 2021), he says that the organization in its current form has existed since 2019, but that some of the members have been diving for ghost nets together since 2008. In total, they perform around 1000 dives per year, a large part of which is devoted to practicing cooperation and safety, as it can be risky to dive for ghost nets.

In addition to actively looking for ghost nets, DAGN's activities are also about disseminating information and knowledge about the problems with ghost nets and other marine debris. A

focus is to reach out with media and Hultsbo describes that sound and image are the key to getting a good impact and catching people's attention. The organization also organizes beach cleanings and other events. According to Hultsbo, it is a great advantage if these are adapted for children, as they are easily involved in the issue and take it seriously. Collaboration with other actors is also an important part of the business. For example, they collaborate with SwAM and use the application "Ghostguard" when planning dives. Cooperation with professional fishermen and listening to their information is also important during that planning.

### 2.2.2.8 Ghost Net Hunters (8+fjorðar)

Ghost Net Hunters (Spöknätsjägarna) is a sub-project within '8+fjorðs'. During the project, approximately 300 lobster creels have been collected, says field worker Robin Wolf (personal communication, 12 August 2021) during a ghost net hunt that was arranged on 12 August 2021



in connection with the West Coast Marine Week. He also mentions that they have identified a new method for locating lobster creels, which has shown to be effective. It involves looking at the so-called deep holes, at the edges of which the lobsters move and where most lobster creels are thus placed. These areas are examined with an underwater drone to learn more about the bottom environment. If the area consists of soft clay bottom, dragging can begin.

During the ghost net hunt that was arranged during the West Coast Marine week 2021, about 20 lobster creels were collected in the course of less than an hour near the Tjörn bridge. These were taken ashore to be rinsed and transported to the marine recycling centre in Sotenäs.

Figure 6. Ghost net hunt with 8 + fjorðs during the North Sea Week 2021 (photo: Anna Axelsson)

## 2.3 Other potential measures

It is obvious that a number of actors are affected by ghost nets and that the problem can be tackled in many different ways. Although the challenges look the same, no solutions are universal but rather need to be adapted to each country and/or actor (CNO, 2020). However, it is possible to identify certain suggestions for solutions that recur in the literature on ghost nets and that can be generally applicable and effective. Some examples are provided here.

### 2.3.1 Location and marking

Equipment is often lost due to conflicts between passive fishing and other activities. A trawling fishing boat or other vessel traffic may cut off fishing gear that is fixed at the surface (CNO, 2020). This can be avoided by ensuring that the cage, net or creel is placed outside the fairways. As for cages and creels, it is also important that the ropes are long enough to reach the sea floor so they are not transported away with currents (Keep Sweden Clean, n.d.). According to Per-Olof Samuelsson (personal communication, 27 August 2021), the lines should be at least 10 m longer than the depth at the location and the cage or creel should weigh at least 7 - 8 kg. He also emphasizes the importance of including such requirements in legislation.

Another preventive measure is to make the equipment visible with, for example, flags, lights or reflectors (CNO, 2020). In Norway, this method has been digitized, through online maps with information on the exact location of passive equipment. The maps are available to the public and have, according to CNO (2020), proved effective. Another option is to mark equipment with a name or number that enables the identification of the owner, which can potentially prevent the tendency to abandon fishing equipment at sea (Ibid.).

### 2.3.2 Alternative design

Disassembly and recycling of fishing equipment is facilitated by reducing the number of materials it consists of (OSPAR, 2020). Some equipment is designed to reduce the actual ghost fishing efficiency, using cotton and other degradable materials that dissolve over time and enable escape routes (Gilman et al., 2021). Cages are generally easier to design to avoid ghost fishing, as they can be more easily equipped with escape panels (Hedgärde et al., 2017). According to CNO (2020) and Per Olof Samuelsson (personal communication, 6 September 2021), an effective measure against ghost fishing can be to ban fishing with cages that are not equipped in this way, something that has been done in Norway. However, it is not possible to completely rely on this method, as algae, barnacles, etc can clog the escape routes (NOAA, 2015). Robin Wolf from "8+fjords" (personal communication, 12 August 2021) mentions that lobster fishermen often reinforce their creels with cable ties. This is probably due to fear of lobster thieves, but it also makes it impossible for organisms to escape if the gear is lost and starts ghost-fishing.

Another option is to use biodegradable material for the entire equipment. A study by Kim, Kim, Lim, An and Suuronen (2016) compared such fishing nets with conventional nylon nets, which take decades to fragment. The results showed an equivalent catch of the tested fish (a pikeperch), which indicates that the new nets would be economically sustainable. They also

began to degrade after 24 months and showed lower catches of juvenile fish, which is positive from an ecological point of view. According to OSPAR (2020), however, it is important to apply the precautionary principle when it comes to biodegradable fishing equipment. As it has not yet been tested on a large scale, it is difficult to say anything about the real effects, such as what they degrade into. There is also a risk of reverse effects, because of reduced caution based on false perceptions that biodegradable equipment would do no harm. In the current situation, they should therefore primarily be seen as a solution in cases where preventive measures are not possible (Ibid.)

### **2.3.3 Reporting and locating**

A survey by Andersson et al. (2018) points to shortcomings in the reporting of lost fishing gear which, among other things, seems to be due to misconceptions that the obligation does not apply to all gear. Several fishermen were of the opinion that reporting had no real effect. According to CNO (2020), there is also a fear among many fishermen that the reporting would make them financially responsible for retrieving the material. These aspects emphasize the importance of clear communication between fishermen and the authorities. In Norway, this has been successful, through a reporting system, including clear coordinates, and clarity that the fisherman is not responsible for picking up lost fishing equipment (Ibid.)

There are also preventive measures using remotely controlled underwater vehicles to locate areas where the risk of losing equipment is particularly high. In this way, knowledge is gathered about which areas should be prioritized when cleaning the seabed. Additional innovative technology is also under development, for example sensors attached to the equipment to enable its location. Then it can be collected through dragging or diving (CNO, 2020). One such project is SeaMe, under the leadership of the Fishermen's Association Norden (Symbiosentrum, 2021).

### **2.3.4 Knowledge dissemination and awareness raising**

Surveys regarding the level of knowledge about ghost nets in each Nordic country show that the understanding of the problem is good and that new knowledge is being developed continuously (CNO, 2020). However, this knowledge is not shared between countries, which underlines the importance of dialogue and knowledge transfer across national borders. The level of knowledge for both recreational and commercial fishing also needs to be improved. Although professional fishermen have a high level of expertise in handling fishing gear, there may be little knowledge about the consequences of losing the gear. For recreational fishermen, the problem is rather a lack of knowledge about the handling itself (Ibid.). Increased incentives are also needed for fishermen to hand in worn-out gear (NOAA, 2015). The collaboration aspect is also important for overcoming the problem. There is a need for authorities, organizations and other actors to cooperate on the issue. Above all, the inclusion of fishermen is important in the pursuit of effective solutions (Ibid.).

CNO (2020) points out attitudes and awareness about ghost nets as the most important aspect in order to solve the problem, and according to Dąbrowska et al. (2021) public awareness is not high enough today. They also claim that citizens could be more involved in

research by helping to monitor and map the presence of ghost nets. Similarly, Richardson et al. (2019) argue that data collection is essential to understand the problems surrounding ghost nets and that citizen research could be a solution. In the Nordic countries, measures that include the collection of lost fishing gear are relatively few (CNO, 2020). In addition to identifying where ghost nets occur, citizen science can therefore also include public and collective actions to collect litter in particularly vulnerable areas (Richardson et al., 2019). In addition to the direct benefit, such collecting can be a way to spread knowledge and thus inform opinion about ghost nets (Axelsson, 2021). This is in line with Dąbrowska et al. (2021), who emphasize the importance of educating society about the problem.

## 2.4 Future prospects

### 2.4.1 Circularity

Based on a review of existing definitions, Alhawari, Awan, Bhutta and Ülkü (2021, p. 18) define the concept of "circular economy" as:

*The set of organizational planning processes for creating and delivering products, components, and materials at their highest utility for consumers and society through effective and efficient utilization of ecosystem, economic, and product cycles by closing loops of concerning resource flows.*

In other words, these are processes that intend to produce valuable products for consumers and society by closing problematic resource cycles, where lost fishing gear can be seen as an example. Recycling, reuse and other circular solutions to lost fishing equipment are increasingly considered as necessary components to overcome the problem. According to some researchers (for example, Dąbrowska et al. (2021)), circularity is the main solution and also the actors interviewed for this report express optimism in the matter.

In addition to the economic and ecological value, Andreasson (personal communication, 3 August 2021) from Sotenäs Marine Recycling Centre mentions that there is a historical value in recycling old fishing gear. As an example, he mentioned the boat Tethis that ran aground outside Sotenäs and from which they retrieved nets and other material. This has since been used in a variety of design items, such as bags and clothes. Information about the history of the materials has been attached to the product when sold, which according to Andreasson has added value to the new products. He also believes that recycled materials are often good quality and that more and more people see the value in collaborating for new innovations that close the material circle.

### 2.4.2 Single-use Plastics Directive

In 2019, the EU adopted the Single-Use Plastics Directive (Directive 2019/904), containing measures to handle the negative impact that certain plastic products have on the environment. The directive identifies fishing gear containing plastic as a special problem. This is due to its ecological impact, but also to its impact on activities such as fishing, shipping and tourism. The directive encourages Member States to introduce more economic incentives for fishermen to submit old gear. Increased producer responsibility is also advocated, in accordance with the

principle that the polluter of the environment is to pay for the damage (Polluter Pays Principle). According to the directive, producer responsibility must cover the financing of environmentally friendly waste management of fishing equipment as well as efforts to increase consumers' awareness of the issue (Ibid.).

Prior to implementation, work is now being done on how producer responsibility may look and function practically. The municipality of Sotenäs, together with SwAM and the Swedish Environmental Protection Agency, has the task of developing new working methods and reviewing how collaboration between authorities, producers, businesses and other relevant actors could look. This takes place within the framework of the project SPIRAL (Smart policy development for producer responsibility for plastic fishing gear). The law amendments, provisions and regulations that Sweden needs to make in order to live up to the disposable plastic directive must, according to the proposal, enter into force no later than 31 December 2024 (SwAM, 2021b). A detailed timeline for the process can be read on the Swedish Environmental Protection Agency's website (Swedish Environmental Protection Agency, 2021). According to Charlotta Stadig (personal communication, 31 August 2021), an officer at SwAM, there are high hopes for positive effects from the directive. With regard to fishing gear in particular, she believes, however, that it can take longer before the effect is visible, compared with products that have a shorter life cycle. This is because fishing gear is normally used for a much longer time than, for example, a PET bottle.

## 3 Discussion

### 3.1 Extent and main consequences of ghost gear

The clearest example of ecological effects from lost fishing gear is the ghost fishing that can take place without anyone taking care of the catch. When an animal gets stuck and rots in, for example, a lobster creel, it also acts as bait and the catch becomes cumulative. If the creel is not picked up, this can continue for many years, as today's fishing equipment consists of difficult-to-degrade materials. Ecological impact, however, extends beyond only the fish and shellfish caught by the equipment. Marine mammals are also exposed to the risk of entanglement or that the debris is mistaken for food. Lost fishing gear can also degrade coral reefs and other important habitats by covering, abrading or penetrating its structures. As the equipment often consists of plastic and metal, the proliferation of microplastics and heavy metals is also a worrying effect of the loss.

The literature quoted in this report also shows that fishing equipment lost in the sea has effects on a socio-economic level. Direct costs for the fisherman include compensation for lost fishing gear. It also causes indirect and more long-term costs through the loss of commercially valuable species and additional resources to search for fish from declining populations. Other sectors can also be affected - for example the tourism sector as litter reduces the recreational value of a beach. Municipalities also need to invest in cleaning.

### 3.2 Circular and sustainable solutions to the problem

Humans will never be able to tame weather conditions, sea currents and other factors that play a role in the loss of fishing gear. However, there are measures that can prevent the loss and/or contribute to increased circularity. Once the gear has been lost, there are also methods for collecting it, for example by dragging and diving. This report has shown that in Sweden there are several actors who work with these issues in different ways - on an international as well as a national and local level. It has also addressed direct measures that the fisherman can apply, and indirect measures such as raising awareness to reduce the problem.

Perceptions of which is the most important measure to overcome the problems of ghost nets vary in the literature. There are also various perceptions of which stage in the life cycle of fishing gear is the most important to address. It may be ineffective to point out a measure as the single most important, as it risks pointing out specific actors as the most guilty. The results in this report indicate that a holistic perspective is needed to solve the problem of ghost gear. The entire life cycle of fishing gear must be taken into account - from production with choice of material and design, to how the gear is disposed of when it is discarded. Circular solutions such as recycling and reuse of fishing equipment can add to the direct benefits that come with picking up lost fishing equipment from the sea. This is because circularity is beneficial even from a larger societal perspective, with regard to resource efficiency for a circular and sustainable economy.

The fact that most fishing gear is purchased from foreign manufacturers benefits neither the environment nor local actors. A circular approach to fishing gear, to which several exemplified projects in the report contribute, is not only resource-efficient but also a way to promote small-scale and local production. Persons interviewed for this report have also described that the story behind the material can create added value for the consumer. This can be done, for example, by attaching an explanation of where the material comes from to a bag or other object made of recycled material.

The holistic perspective is also in line with the idea of collaboration between different actors and sectors to achieve results. Because circularity requires collaboration across different sectors, cooperation is also strengthened, which can lead to the identification of more innovative solutions related to sustainability. Collaboration is also a factor that several of the interviewees in this report pointed out as particularly important. A successful example is that Sotenäs municipality saw the potential in the Fishermen's Association Norden's work to collect obsolete fishing gear, which enabled the upscaling to the marine recycling centre in its current form. Collaboration with companies to find new, innovative products from recycled plastics is an important part of the business and something that everyone benefits from. Another example is the 'Ghost Fishing Project', whose project manager claims that collaboration with local professional fishermen and professional divers was essential to perform safe, effective and successful dragging. In that project, collaboration across municipal boundaries has also been a success factor.

### **3.3 Future prospects regarding initiatives**

A central problem with ghost nets, like many other challenges related to the sea, is that it is easy to turn a blind eye to what is happening below the surface. At present, littering at sea does not have any real consequences for those who produce or lose fishing gear. However, the new single-use plastics directive, which requires legislative amendments to be implemented in EU member states, gives some hope that the problem will be taken seriously. Through concrete measures for producer responsibility including financing of recycling, the directive can be regarded as an important step towards a circular economy. How the implementation goes and what the effects will be remains to be seen. The innovation project that is underway at the marine recycling centre in Sotenäs can be seen as a promising example of how producer responsibility can be realized. There, companies are invited to test new products and thereby create commercial value from recycled materials, which gives producers an opportunity to close their resource cycle.

In parallel with this, further measures are needed to inform, above all, fishermen about the consequences of losing fishing equipment. Commercial fishermen are already obliged, according to the EU Control Regulation (1224/2009), to report lost gear within 24 hours after the loss. Therefore, it is especially important with information efforts aimed at recreational fishers. It is also important that all relevant actors have a voice when measures are to be identified, in order to avoid dissatisfaction and inefficiency. Involvement of the fisheries sector is potentially the most important in this regard, due to the already existing and extensive knowledge of fisheries issues.

Consumers are also an important part of circularity, as there needs to be a demand for what is recycled or reused. Therefore, consumer awareness is also needed, which in turn underlines the importance of knowledge-raising and awareness-raising initiatives. This report has shown that citizen science is a promising method, which could be applied to a greater extent. Within this framework, public and communal collection of fishing gear on beaches can be arranged, which can be occasions where the public learns about the problems of lost fishing gear, informing public opinion at the same time.

Several actors interviewed for the report also expressed optimism regarding future technical solutions for lost fishing equipment. Examples are devices that are attached to the equipment and that are self-triggered when they have been lost for a certain period of time, to enable retrieval. Norway is at the forefront in this area, as well as in terms of digital and publicly available maps with precise location of equipment and reporting systems. There is inspiration to be found here and further studies could investigate how similar methods can be implemented in Sweden. The importance of collaboration can be emphasized here as well - that knowledge and experience are shared across national borders.

Despite circular solutions, information initiatives, new technology and legal requirements for fishing gear, we will never be able to completely avoid losing equipment. Therefore, it is of great importance that the loss of gear is prevented and minimised. This can be done, for example, by requiring sufficiently long ropes, a certain weight of lobster creels and by avoiding fairways and deep cliffs. Ghost fishing in lobster creels should be prevented by requiring the use of soluble cotton thread, which is a cost-effective method and already a legal requirement in Norway. It is also important that dragging and diving initiatives similar to those carried out within the framework of the 'Ghost Fishing Project', '8+fjords' and Divers Against Ghost Nets can continue to be implemented and receive financial resources. It is also in line with the circular perspective by not allowing the life cycle of fishing gear to be interrupted in the sea. If they are collected, it can instead be closed by recycling or reuse.

## 4 Conclusion

Lost fishing equipment has extensive ecological consequences in the form of ghost fishing, spread of microplastics and heavy metals, degraded habitats, spread of invasive species and negative impact on marine mammals and birds. Because the equipment can be transported long distances, the consequences can be seen far from the place where it was lost. More sectors than fisheries may be affected, such as tourism. The exact extent of the problem is difficult to describe, but when it comes to Sweden, nets are the biggest problem in the Baltic Sea and the Sound, while lobster creels and cages are most common off the Bohus coast.

In Sweden, there are several players who work with circular and sustainable solutions for ghost nets and other lost fishing equipment. What is important in order to identify effective efforts is a holistic perspective. This means that the entire life cycle of fishing gear needs to be taken into account, which is in line with the idea of a circular economy for a sustainable society. In parallel with the reuse and recycling of fishing gear, it is also of great importance that projects for the recovery of lost fishing equipment are carried out. In addition to this, the holistic perspective also includes the collaboration between actors and sectors to find common and long-term solutions. All of these aspects are realized through the solutions applied by the actors interviewed for this report.

The new Single-Use Plastics Directive, which covers fishing gear, will increase the responsibility of producers to ensure that their products are disposed of in an environmentally friendly manner after use. Existing initiatives covered in this report offer good collaboration opportunities for manufacturing companies that want to secure their contribution to the requirements of the directive. Although the visible effects of fishing gear in particular may be delayed due to its long life cycle, the new directive gives hope that the issue of circular and sustainable solutions to lost fishing gear will be taken seriously. In addition, there is a need for requirements for fishing equipment that will minimize loss and, in the event of loss, the ghost fishing effect. Making such requirements statutory should be seen as the next step in the work against ghost nets and other lost fishing gear.

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## Personal communication

Charlotta Stadig (31 August, 2021), officer, Swedish Agency for Marine and Water Management.

Erik Goksøyr (4 August, 2021), developer, Sotenäs marine recycling centre.

Paul Hultsbo (5 August, 2021), chair, Divers Against Ghost Nets.

Per-Olof Samuelsson (27 August, 2021), project manager, 'Ghost fishing project'.

Robin Wolf (12 augusti 2021), field worker, '8+fjords'

Sixten Söderberg (10 augusti 2021), chair, Fishermen's Association Norden.

Stephen Andreasson (3 augusti 2021), technician, Sotenäs marine recycling centre.

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