

Agenda Item 5.2

Implementation of the Triennium Work Plan
(2010-2012) – Other Issues
Review of New Information on Pollution and
its Effects

Document 5-04

**Ecological Effects of Ghost Net
Retrieval in the Baltic Sea
Pilot project: collecting ghost nets**

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REPORT
DECEMBER
2011

BalticSea2020

ECOLOGICAL EFFECTS OF GHOST NET RETRIEVAL IN THE BALTIC SEA.
PILOT PROJECT: COLLECTING GHOST NETS.
FINAL REPORT





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WWF Poland**

**ECOLOGICAL EFFECTS OF GHOST NET RETRIEVAL IN THE BALTIC SEA.
PILOT PROJECT: COLLECTING GHOST NETS.
FINAL REPORT**

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BalticSea2020

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1. Ghost nets: the invisible problem of the Baltic Sea

The impact of ghost nets on marine ecosystems is part of a wider problem of marine pollution, consisting of fishing gears or their elements that keep their fishing effort and are also a threat to navigation, as well as any other marine debris that remains at the sea bottom or on the coast. Solid wastes that remain in the sea constitute a lethal threat to the marine fauna. Living organisms may swallow parts of nets and thus introduce them irreversibly to the digestive system. Human activities, as well as some natural phenomena constitute the source of the above mentioned marine debris. The main causes of gear losses in the sea are:

- accidental loss of fishing gears, most often due to snagging (or “hooking”) of the nets trawled by a fishing vessel on objects lying at the sea bottom. In the case of set nets, gear loss is caused mainly by bad weather conditions, navigation errors and non-compliance with fishery rules, as well as due to frequent thefts and acts of vandalism;
- voluntary discarding of fishing gears, mainly in the event of illegal, unreported and unregulated fishing;
- discarding of useless, broken fragments of fishing gears as well as other wastes that result from repair work in the fishing grounds or anywhere else during the trip of a fishing vessel.

On a global scale, entangling nets and gill nets as well as traps are considered to be the most common type of gears that contribute to marine litter¹. However, in the Baltic, aside stationary gillnets

(bottom gillnets and herring gillnets) also contribute to this problem.

In comparison to the gillnets and trawls, pots and traps constitute a marginal problem in the Baltic. The Baltic Sea is also characterised by dynamic development of recreational fishing, which has an increasing impact on this type of marine litter.

The main aspects of the ghost net phenomenon as well as legal provisions related to marine debris composed of fishing gears are described below on the basis of existing literature as well as observations made during the project’s realisation.

An example how lost fishing nets that remain in the sea can be dangerous for navigation is the sinking of a Korean passenger ferry which resulted from the loss of manoeuvre abilities due to entangling of the propeller by derelict fishing gears.

¹ Macfadyen, G. et al. 2009: Abandoned, lost or otherwise discarded fishing gear. UNEP Regional Seas Refootnoteorts and Studies, No. 185; FAO Fisheries and Aquaculture Technical Paper, No. 523, Rome UNEP/FAO.

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1.1. Assessing the amount of lost nets that remain in the Baltic and other seas. Accumulation of lost nets on ship wrecks.

The specific character of the marine environment resulting from physical and chemical barriers hampers any direct observations with human eyes. Therefore, all assessments that refer to the amount of fishing nets and their fragments should be treated with precaution. Direct observation as well as indirect calculations based on the fishing effort divided into fishing techniques, as well as on comparisons of materials and fishing gears purchased by fishermen with the amount of used gears deposited on land for recycling and also interviews with fishermen can only be used to get an imprecise estimate. Systematic research, including collection of statistical data in relation to Polish Baltic fisheries has never been done. The trip of the research vessel of the National Marine Research Institute in Gdynia permitted to collect some fragments of fishing gears² and had served as an experiment. The research was not continued thereafter³. Observations of fishing gears and their fragments remaining on ship wrecks, as well as the retrieval actions conducted on ship wrecks by divers constitute the basic, however not complete, source of information. The retrieval actions carried out in the framework of this project covered two types of activities, described in chapter 2: searching the bottom with the use of a device used for trawling the bottom and retrieval of nets from ship wrecks by a specialised group of divers. Notwithstanding the so-far largest intensity of retrieval

actions carried out in the Baltic in the framework of the project, both the area covered by these actions as well as the number of ship wrecks from which the nets were removed do not constitute an adequate database to make a reliable assessment using the results of the project. Therefore, it is necessary to use information enclosed in literature on ghost net phenomenon in other seas as well as one publication pertaining uniquely to the Baltic⁴. According to the classification of the sources of marine litter presented in UNEP-FAO report, lost or abandoned fishing gears are classified in the group dominated by marine litter from merchant (not fishing) shipping which account for 88% of the total input of marine litter. The report does not quote any information on the overall proportion of marine litter that is made up of lost or abandoned fishing gears on a global scale. It has however been noted that the proportion is higher in areas remote from urban development. For various regions the report presents the following proportions of abandoned and lost nets in the total amount of marine litter:

- Brazil 46% (found in subtidal benthic environment);

² Blady W., Moderhak W., 2004: Próby poszukiwania zagubionych sieci stawnych na r.v. „Baltica” w 2004 r. *Wiadomości Rybackie*, 7-8 (139): 7-8.

³ Moderhak, W. 2011 – personal information.

⁴ Tschernij V, Larsson, P.-O., 2003: Ghost fishing by lost cod gill nets in the Baltic Sea. *Fisheries Research*, 64 (2-3): 151-162.

- Japan 12% (collected on beaches, the percentage refers to the number of gears by piece);
- Mediterranean – beach research programme in 5 countries – rare cases;
- United States – 6.1% (collected on beaches in 1988, the percentage refers to the number of gears by piece);
- United States – 16.7% (collected on beaches in 2007);
- United Kingdom – 11.2% (collected on beaches in 2006).

The above data illustrates the easy-to-observe nature of lost net phenomenon. Various research studies have been developed in order to assess the real scale of the phenomenon of abandoned, lost or otherwise discarded fishing gear (ALDFG) in several countries and regions. One of the earliest research aimed at assessing the magnitude of ALDFG was conducted in the seventies of the 20th century due to the high value of crab and lobster fisheries. This research referred to trap nets. A few years later, lost gill nets were investigated in Canada. More recent studies to investigate the magnitude of abandoned fishing gears were conducted in the EU (FANTARED 1, FANTARED 2 and DeepNet). These big projects focused on

gillnets. Some projects were also carried out in the Pacific in relation to pelagic longline fisheries. These studies are, however, based on limited data and they do not permit to precisely assess the magnitude of the problem on a global or regional scale. However, the possible magnitude of the ghost net problem should be noted. It could be assumed with high probability that the amount of marine litter has not decreased since 1997, for which the US Academy of Sciences estimated the total input of marine litter into the oceans at 5.6 million tonnes, and therefore considering that 10% is comprised of fishing nets, we get nearly 560 thousand tonnes of fishing gears and their fragments per year, originating from fishing vessels and aquaculture.

Since the amount of marine litter has not decreased since 1997, it could be assumed with high probability that each year 560 thousand tonnes of fishing gears and other marine litter are thrown overboard or lost in the sea from fishing vessels and aquaculture.



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In the Baltic the assessment of lost gill nets was carried out under FANTARED 2 project with relation to the Swedish gillnetter fleet operating in open sea conditions, both in coastal areas and in distant fishing grounds. It was found that the number of lost gillnets increased in the open sea, further from the coast. The regular gear loss only occurred in fisheries targeting demersal species, such as turbot and cod. In 1998, the total number of gillnets lost by the Swedish fleet was about 2750 – 3000, equal to approximately 156 – 165 km in length. Percentage wise this number constituted 0.1 % of lost nets per year. Fishing gear conflicts with the trawl fleet were identified by gillnetters as the main reason for gear loss, and therefore the areas with higher risk of gear loss could be identified. Longer nets and their fragments were retrieved by bottom trawling in these areas. Small remnants were found randomly over a larger, less defined area. It should be noted that fishermen estimate the rate of recovery of lost nets at 10%. In the case of the Swedish fleet, the net loss would therefore amount to approximately 2475 – 2700 nets in 1998. In order to estimate the number of lost nets for the entire Baltic (excluding Russia), one should make the following assumptions:

- Swedish gillnet fleet was not subject to any considerable reductions in 1998 – 2004 (before the reform of the Common Fisheries Policy in 2002, which had not been implemented in practice in the first years of its existence); the year 2004 is considered to be the basis due to the accession of Poland, Lithuania, Latvia and Estonia to the European Union;

- the rate of recovery of lost nets is similar in all Member States in the Baltic region and amounts to 10 %;
- the number of lost gillnets is proportional to the fishing effort.

Data referring to the fishing effort of gill netters fishing for cod comes from the report of the Working Group Fishing Effort Regime in the Baltic⁵. It is illustrated synthetically by the table below:

| Year | Fishing effort Sweden | Fishing effort European Union | UE/Sweden |
|------|-----------------------|-------------------------------|-----------|
| 2004 | 2 127 686 | 8 516 584 | 4.00 |
| 2009 | 1 364 228 | 4 528 668 | 3.32 |

Table 1. Fishing effort of the Swedish fleet fishing with cod gillnets (with technical parameters that permit to keep caught cod on board) in relation to the fishing effort of the entire Baltic fleet fishing with cod nets [kW x days].

The table shows that in 2004 the fishing effort of the entire Baltic fleet of the EU member states was approx. 4 times higher than the fishing effort of the Swedish fleet, and in 2009, approx. 3.3 higher. In order to estimate the number of lost nets in 2009

⁵ Bailey, N. et al. 2010: Scientific, Technical and Economic Committee for Fisheries. Report of the SGMOS-10-05 Working Group Fishing Effort Regime in the Baltic. Luxembourg: Publications Office of the European Union.



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by the entire EU fleet in the Baltic the fishing effort of the entire UE fleet of 2009 should be compared to the fishing effort of the Swedish fleet of 2004.

$$4 \times 2475 = 9900$$

and in 2009:

$$2,13 \times 2475 = 5170 \text{ (rounded up).}$$

The above values should be treated as the lower limits due to the fact that the fishing effort of vessels below 8 meters has not been included.

The share of Baltic cod catch taken by these vessels was estimated at 3.1% in 2009. This fleet segment uses gillnets. There is no data available at the EU level on the fishing effort used to take this percentage of the catch.

From 2004 to 2009, changes in the fishing effort of the EU fleet (vessels above 8 m) were characterised by a increasing tendency with the peak in 2005 (due to the accession of 10 member states in 2004), followed by a gradual decrease. It could be assumed that in 2005 – 2008 the number of cod nets lost by the EU vessels amounted from 5500 to 10000 annually.

” It could be assumed that in 2005 – 2008 the number of lost cod gillnets amounted from 5500 to 10000 annually.

The UNEP-FAO report underlines the almost complete lack of data on lost trawls. This is explained by the fact that more and more effective methods of recovery, economic incentives (high cost of fishing gears as well as modern navigational technology. The already mentioned specific character of the Baltic requires an attempt to assess also this category of the fishing gear. In analysing this case, two kind of “hooks”, where trawls or their fragments cumulate should be taken into account (usually the netting alone or with ropes), as well as a elements of trawls (trawl cables, trawl doors): ship wrecks or other objects lying at the sea bottom such rocks, machines and hydrotechnical constructions, among others the “pipeline” already mentioned in one of the preliminary reports⁶. Risk factors in relation to a ship wreck depend on several factors, of which the most important are:

- location of the wreck (e.g. if it is found in the 3 mile zone from the coast, there is no real danger, because in the light of the Polish legislation⁷ it is forbidden to fish with trawls in this zone, similar bans have been adopted in the majority of Baltic countries) – most of all in relation to the configuration and character

⁶ Malik, R., Wójtowicz, W. 2011: Actions at sea. Report on the retrieval of lost nets from the Baltic. *Report from the consultation seminar WWF Poland.*

⁷ Regulation of the Ministry of Agriculture and Rural Development 2008

of the sea bottom (the more unfavourable conditions for trawling due to rocky and hilly sea bottom, less chance for trawling and in consequence lower threat);

- degree of its physical degradation;
- coverage with bottom residues and minerals brought by currents;
- type of the sea bottom (hard or muddy seabed).

Notwithstanding the fact that not all wrecks have been localised and identified, the output data for calculating the number of lost trawls is characterised by diverse values. It results from differences in estimating the number of wrecks in the Polish Economic Zone of the Baltic, which ranges from one thousand to three thousand shipwrecks⁸. Spatial distribution of these wrecks is not homogenous, not due to navigational reasons (shipping routes) but due to difficulties in localising the wrecks. The chances to localise a wreck and estimate its exact position are much higher in shallow waters close to the coast. Lack of detailed descriptions of many wrecks in relation to the already mentioned risk factors additionally affects the accuracy of calculations. Available photographic documentation proves that wrecks are usually covered with small or big amounts of netting pieces, wire cables and fibre ropes. In the framework of project activities it was discovered that the two explored ship wrecks were covered with both set nets and trawls. Considering with precaution that the trawl fragments could constitute

50% of the debris, the weight of fishing nets calculated per one wreck amounts to approx. 450 kg. Depending on the next assumption, that is the share of wrecks which constitute a risk for trawls in the entire group of wrecks, the calculations will differ considerably. It could however be assumed with precaution that one-third of all wrecks pose similar risks as wrecks from which lost nets had been recovered. We get the following results after re-calculating:

- for 1000 wrecks in the Polish Economic Zone:

$$(1000:3) \times 450 \text{ kg} = \text{approx. } 150 \text{ t}$$

- for 3000 wrecks the result is approx. **450 ton**.

Estimated amount of nets
deployed on ship wrecks
localised in the Polish Economic Zone
ranges from 150 to 450 ton.

⁸ Hac, B. 2011: Wrecks in internal waters, territorial sea and in the Polish Exclusive Economic Zone. *Report from the consultation seminar WWF Poland*.



The amount of nets deployed in the entire Baltic will be proportionately higher, however, it seems that an attempt to interpolate proportionately the above results to the proportion the Polish EEZ covers in the entire Baltic Sea area is impossible due to different concentration of shipwrecks and clearly uneven distribution of the fishing effort of bottom trawl fishery, illustrated in Figure 1:

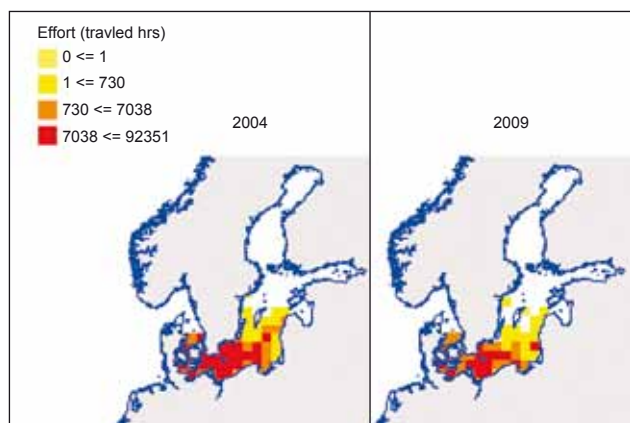


Fig. 1. Spatial distribution of the EU fishing effort in the Baltic (only bottom trawls allowed for use in cod fishery, except for Sweden and Poland).

Elements of angling equipment used in sport and recreational fishing, in particular the so-called pilkers are a specific category of fishing gears found during net recovery actions carried out on wrecks. They get lost when hooked in nets snagged on wrecks. This is understandable, taking into account the fact that skippers of fishing vessels carrying tourists often choose the area above wrecks as fishing grounds, because of high concentration of cod. Partial information on the number of pilkers that could remain in the wrecks⁹ show that this type of fishery should be taken into account when planning next projects aimed at combating the problem of lost or abandoned fishing gears in the Baltic Sea. It could even be assumed that recreational fishery could increase the fishing capacity of nets deployed on ship wrecks by lifting and stretching them. This problem has also been identified by observations carried out in the framework of the project as well as during net retrieval carried out in the area adjacent to the Baltic, Skagerrak¹⁰.

⁹ Malik, R. 2011 – personal information.

¹⁰ Anon. 2007: Obtaining sustainable fisheries in the Skagerrak. Retrieval of lost fishing gear to reduce “Ghost fishing”. www.forumskagerrak.com



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1.2. Estimated fishing capacity of ghost nets and their impact on fish populations in the Baltic.

The way a fishing gear degrades over time if left at sea from the moment control is lost over its functioning until the total loss of any fishing capacity is the key issue when it comes to estimating its catching efficiency. The state of the gear and the point of loss are equally important. Lost but still fully operational fishing gears, and in the case of set nets properly anchored, will have high catching efficiency than gears intentionally discarded. There is a potential for the fishing capacity to recover when due to decomposition nets lose the burden of fish captured in the initial phase of the fishing process in the amount that had caused the gear to sink to the bottom. Once control over a fishing gear has been lost, the selectivity and efficiency of the gear for catching the original target species may be altered. This change in specificity may result from:

- alterations in mesh characteristics if the entire net becomes distorted;
- changes in gear detectability due to marine growth, which is itself function of depth and productivity;
- translocation of the gear to different environment than the one it was supposed to be used in;
- accumulation of other organisms that may act as bait for other species (of different market value).

There is however a general opinion, that overall ghost fishing catches are low in comparison to fishing activities controlled by fishermen. However, one should take into account that this may vary according to gear type and operating conditions of ghost nets¹¹.

The catching efficiency of gillnets depends on their vertical profile, relation of the mesh size to the size and shape of targeted fish, mesh stiffness and transparency as well as type of gear material (single strings or rope, smoothness). According to present opinions, mesh size is important for selectivity but less important in terms of effectiveness than other characteristics. Other factors important for the overall catching efficiency of gillnets are sea depth and sea bottom type. Exposure of the gear to environmental phenomena such as currents, waves and fouling are the key determinants of the catching efficiency of ghost nets.

Differences between different seas and habitats may be significant. Research carried out in the Baltic revealed the characteristics of the catching efficiency of cod gillnets:

- gillnets “lost” experimentally preserved their catching ability;
- gradual decrease of the catching efficiency to approximately 20% of initial catch rates after three months, mainly due to net degradation caused by storms and currents as well as captured fish (cod, flounder);
- from this point nets continued to capture fish notwithstanding substantial increase of their visibility due to fouling, but their efficiency continued to fall, slowing down gradually, to stabilise at about 5-6% after 27 months;
- it is possible that this catching efficiency will continue over several years;
- experimental nets captured cod of particularly unfavourable size structure and underwater observations showed that decomposing fish could attract various organisms that can in turn become an attractive prey for juvenile cod.

Experiments have proved that the catching efficiency of lost gillnets amounts to approximately 20% of initial catch rates after three months to 6% after 27 months and is characterised by unfavourable size structure of captured fish.

¹¹ Tschernij V, Larsson, P.-O., 2003: Ghost fishing by lost cod gill nets in the Baltic Sea. *Fisheries Research*, 64 (2-3): 151-162.

It is assumed that lost trawl gears retain the catching efficiency for a shorter time than gillnets. These assumptions originate from the fact that the material, that is the multifilament twine with a larger diameter than gillnet monofilament is more visible and better sensed by the fish. As mentioned earlier, the specific Baltic phenomenon such as suspension of trawl elements on shipwrecks calls for further underwater observations in order to identify the scale of the hidden catching efficiency of net twine in trawl gears.

1.3. Main reasons for the occurrence of ghost nets in the sea.

The causes of abandoned or lost fishing gears in the Baltic Sea only partially correspond to the description of this problem in literature. It results from the specific character of fishing grounds in the Baltic which are dominated by shelves, from a much lower number of commercial species than in oceans, as well as from the fact that there are no species captured in cages. The panel of experts who participated in the consultation seminar to prepare the actions at sea in the framework of the project principle listed the main reasons for the occurrence of lost nets in the Baltic in the following way:

- In the past, imprecise navigation caused by the lack of precise navigation devices;
- In the past, collisions of gears with other objects, called “hooks” by fishermen, during hauling were caused by the lack of precise navigation devices;
- Loss of gears caused by weather conditions;
- Damages of set nets with trawls used by other vessels;
- Damages of identifying marks of fishing gears by cargo ships;
- Polluting the sea with new “hooks” by throwing cars, containers and other litter from cargo ships into the sea;
- Lack of accessible possibilities to dispose and utilise of removed ghost nets as well as high costs of recycling¹².

¹² Anon. 2011: Pilot Project – Report on the retrieval of lost nets from the Baltic. Consultation seminar 20 April 2011. Unpublished document WWF Poland.



1.4. Review of legal provisions in force at national and EU level referring to abandoned, lost or otherwise discarded fishing gears, their retrieval and recycling.

The catalogue of legal provisions that regulate marine fisheries with regard to preventing damage and loss of fishing gears and cover deterrent measures for voluntary abandonment of gears contains several EU normative acts, as well as Polish legal acts, including those referring to the territorial sea and also the Exclusive Economic Zone, in its context not covered by the EU legislation. The legal provisions are enforced by the Minister responsible for fisheries, and in relation to internal waters by Regional Sea Fishery Inspectorates. Moreover, the directors of Maritime Offices issue enactments that regulate the activities carried out in marine ports, also including conflict mitigation between fisheries and shipping as well as environmental protection in relation to waste disposal.

” The FAO Code of Conduct for Responsible Fisheries considers the negative impact of ghost to be similar to the negative impact of harmful fishing practices such as lack of selectivity, undesirable by-catch or habitat destruction.

The legal measures of the European Union pertaining to the problem of ghost nets belong to technical measures aimed at resource protection. Technical measures referring to control and enforcement are included in the Council Regulation¹³ which in the existing form has not been fully implemented, since several provisions and requirements shall enter into force in 2012-2013, and the Executive Directive¹⁴ had been published in April 2011 with a date of entry into force being 1 July 2011 or even 1 January 2012. Already the preamble of Council Regulation 1224/2009 which is the basis for implementation of the legal provisions, includes the following statement: “(25) Special provisions should be foreseen that only allowed gears are used and that lost gear is retrieved.”

¹³ COUNCIL REGULATION (EC) No 1224/2009 of 20 November 2009 establishing a Community control system for ensuring compliance with the rules of the common fisheries policy, amending Regulations (EC) No 847/96, (EC) No 2371/2002, (EC) No 811/2004, (EC) No 768/2005, (EC) No 2115/2005, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007, (EC) No 676/2007, (EC) No 1098/2007, (EC) No 1300/2008, (EC) No 1342/2008 and repealing Regulations (EEC) No 2847/93, (EC) No 1627/94 and (EC) No 1966/2006

¹⁴ COMMISSION IMPLEMENTING REGULATION (EU) No 404/2011 of 8 April 2011 laying down detailed rules for the implementation of Council Regulation (EC) No 1224/2009 establishing a Community control system for ensuring compliance with the rules of the Common Fisheries Policy



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The Regulation contains several requirements aimed at preventing the ghost net phenomenon:

- Obligation to respect conditions and restrictions relating to the marking and identification of fishing gears (Article 8);
- A Community fishing vessel shall have the equipment onboard to retrieve lost gear; the master of a Community fishing vessel that has lost gear or part of it shall attempt to retrieve it as soon as possible. If the lost gear cannot be retrieved the master shall inform the competent authority of its flag Member State (Article 48);
- If the gear is retrieved by competent authorities and not reported as lost, Article 48 foresees the possibility to recover the costs of gear retrieval from the master of the fishing vessel.



” *Special provisions should be foreseen that only allowed gears are used and that lost gear is retrieved. Council Regulation 1224/2009.*

It should be underlined that the implementing rules of provisions referred to in Article 8 of Council Regulation 1224/2009 are defined under Articles 6 and 7 of Regulation 404/2011, whereas the provisions referred to in Article 48 of Regulation 1224/2009 which do not have implementing rules have formally entered into force.

Council Regulation 2187/2005¹⁵ defines technical measures aimed at conservation of fishery resources in the Baltic. It is a continuation of legislation on fishery rules established by the International Baltic Sea Fishery Commission which ceased to exist in the end of 2005. With regard to restrictions aimed at preventing the ghost net phenomenon, the Regulation contains provisions restricting the use of gillnets with regard to their dimensions and number which could exceed the operational capacity onboard (the literature contains examples of vessels carrying an exceeding amount of nets onboard using the empty storage space, and after the storage space had been filled with the catch, part of these gears were discarded. It refers to catches of economically valuable fish which can compensate the value of “disposable” fishing gears). In accordance with Article 8 the use of more than 9 km of nets for vessels with an overall length up to 12 m and for vessels of more than 12 m – 21 km is allowed. The immersion time of these nets shall not exceed 48 hours.

In order to prevent the destruction of passive gears by trawling, a total ban on trawling has been introduced in the Gulf of Riga (ICES sub-division 28.1) in waters of less than 20 m in depth. (Article 22) The Fisheries Act of 19 February 2004¹⁶ setting the detailed conditions for carrying out fisheries activities in the territorial waters and the Polish Exclusive Economic Zone was enforced by the Minister responsible for fisheries. The Act includes measures aimed at protecting marine living resources from ghost nets. Provisions referring to lost nets are set in Article 36 (prohibition to use fishing gears that

belong to some else) and Article 37 (prohibition to set or use fishing gears in a way that can cause destruction of other fishing gears). The Regulation currently in force¹⁷, issued on the basis of Article 31 of the Act contains several provisions that directly or indirectly pertain to the need to prevent situations in which control over fishing gears could be lost or in which they could be destroyed and in consequence lost. These measures include limitation of the number of combined gillnets, manc and gillnets set at the same time (paragraph 9 and 10), as well as obligations and prohibitions referring to fishing activities (paragraph 17 – 19). The key provision, that is the prohibition to leave elements of fishing gears or elements of their marking on fishery grounds after the end of fishing operations, addresses directly to the problem of ghost nets (paragraph 20). Legal provisions that address marking of fishing gears in order to prevent navigational failures (paragraph 21 – 22) or to identify them (paragraph 23). Analogical provisions were enforced by regional fisheries inspectors for Polish internal waters (Article 32 point 3 of the Act). Information presented in chapter 2.2. and 2.3. is complementary to this review of legal provisions.

¹⁵ Council Regulation (EC) No 2187/2005 of 21 December 2005 for the conservation of fishery resources through technical measures in the Baltic Sea, the Belts and the Sound, amending Regulation (EC) No 1434/98 and repealing Regulation (EC) No 88/98.

¹⁶ The Fisheries Act of 19 February 2004. *Journal of Laws* 62, item 574, with later amendments.

¹⁷ Regulation of the Minister of Agriculture and Rural Development of 4 March 2008 on minimum landing sizes and closed seasons for marine organisms and detailed conditions for conducting marine fisheries. *Journal of Laws* No. 43 item 260, with later amendments.

2. Description of methodology, results and recommendations from actions aimed at retrieving ghost nets from the Baltic

2.1. Trawling the sea bottom in search for ghost nets – gear retrieval actions at sea.

In 2009 – 2011, in Poland, a rotational management system in cod fishery was introduced based on catch permits being issued to one third of cod vessels every year. By limiting the number of vessels fishing cod to one-third of the Polish cod fleet the system intended to make the available fishing quota economically profitable. The remaining vessels received compensations from the European Fisheries Fund for suspending their fishing activities for one year. The implementation of such system by the Polish administration permitted to lease a fishing vessel which had no cod permit in 2011 for the purpose of ghost net retrieval actions planned in the framework of the project. The agreement with the owner of the vessel KOŁ-111 specified 24 days of retrieval actions:

15 days at sea to remove ghost nets from the sea bottom and 9 days for the retrieval of ghost nets from two ship wrecks, during which the vessel was to serve as divers' base (see chapter 2.2.). All actions were carried out in the period July – September 2011.

The cutter KOŁ – 111, used in the framework of the project, is 17 meters long. It is used for fishing with active gears such as a bottom trawl or pelagic trawl. The vessel is also equipped with bottom nets with different mesh sizes. Both the owner and the master of the cutter have excellent knowledge of the fishing grounds and this fact determined the choice of the vessel. In addition, in the framework of the agreement, the cutter has been equipped with an opening on the right side as well as a gang-plank for divers. The vessel is also equipped with a pontoon with an external engine to be used for divers during retrieval actions carried out on shipwrecks. After consulting the experts, the vessel was judged to be well suited for retrieval actions mainly due to its length which permits a longer stay at sea and at the same to have adequate tonnage for easy manoeuvres in operating the device to search and retrieve ghost nets.





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A large vessel cannot be stopped quickly enough to avoid breaking hooked nets.

In the Framework of the Project, retrieval actions were conducted during 15 days in order to search the sea bed for lost and abandoned fishing gears. Actions were carried out in G3 and G4 rectangles according to the fishing maps. The outer limits of these rectangles have the following co-ordinates: 54,30''00N, 15,20''00E; 54,30''00N 15,40''00E; 54,15''00N 15,20''00E; 54,15''00N 15,40''00E.

The area selected for retrieval actions is located in waters managed by the Maritime Office in Słupsk, in the close vicinity of Kołobrzeg.

G-3 rectangle covers an area of 100 miles¹⁸ and is characterised by 40% coverage of the sea bottom with rocks, where passive gears are being usually set. Trawling grounds constitute 30% of this area whereas the remaining 30% is not accessible to fishing activities. G-4 rectangle covers an area of 100 miles², 30% of the sea bottom is covered with rocks and 70% is used for trawling.

According to the legislation in force, prior to retrieval actions, Regional Fisheries Inspectorate had been informed about the planned actions.

A description of the vessels and the description of the area to be covered during retrieval actions

had been submitted. At the same time, the Maritime Office responsible for the management of the area in which retrieval actions were planned had been asked to issue a permit to carry out a disposal and recycling of fishing nets recovered from the sea that had no marking. In accordance with the legal regulations in force, before each action at sea, the master of the cutter informed the Port Authority in Kołobrzeg as well as the border guards on the exact time and region of the planned actions.

Activities aimed at removing ghost nets from the sea bottom were carried out on the basis of fishing navigation maps, with "hooks" located by fishermen. Such places were trawled with the fishing gear described below in order to retrieve nets snagged on "hooks". In addition, trawling grounds as well as rocky area where the probability to find lost or abandoned fishing gears was high.

The searched area was not covered by a fishery closure and therefore in many cases trawling of the sea bottom in places with the highest probability of finding lost gears was not possible due to fishing

¹⁸ Blady W., Moderhak W., 2004: Próby poszukiwania zagubionych sieci stawnych na r.v. „Baltica” w 2004 r. Wiadomości Rybackie, 7-8 (139): 7-8.

nets being set in these places. In the future, closer co-operation with fisheries inspectors as well as fishermen and producers' organizations will be required in order to agree on the most suitable period and timetable, with possible fishery closures being introduced in areas covered by retrieval actions.

In the initial phase two devices were used to search the sea bottom for lost or abandoned fishing gears, namely:

1. A device ("searcher") mounted on a soft rope with hooks, permitting to stop the vessel immediately when nets are hooked and therefore permitting to avoid any break of the rope;
2. A device mounted on a steel rope with hooks – used for trawling the bottom for ghost nets.

The effectiveness of both devices was verified. On the basis of trials, it was decided to modify both devices. Both the devices mounted on a soft rope and the device mounted on a steel rope did not show adequate efficiency in fishing for lost fishing nets. The device mounted on a steel rope was too light and did not reach the bottom. It could not hook nets lying at the sea bottom. The surface covered by the device mounted on a soft rope was too small and required several turns and trawling through already searched area.

Modification of fishing gears used for searching ghost nets consisted of joining two devices together. The "searcher" added some weight to the gear and enabled better contact of hooks with sea bottom. In addition, several additional longer hooks were mounted onto the gear, thus increasing its effectiveness.

In the framework of trial trawling, its optimal speed was evaluated for the most effective use of the gear. As a result of some experiments, it was

decided that the most effective speed to search the bottom with the modified fishing gear is 1 to 1.2 Mm/h. Such trawling speed permits the best contact between the hooks and the bottom and thus increases the probability to retrieve ghost nets from the sea bottom.

4288 kg of fishing nets were retrieved as a result of actions. The majority of retrieved nets were gillnets (passive gears) (3988 kg). Trawls constituted 300 kg of the total weight of retrieved nets.

All retrieved fishing gears were covered to a certain extent with living organisms, mainly balanus. Average coverage with this organisms amounted to 26%. Almost all nets were filled with fish, mainly flatfish and cod. By-catch of a cormorant was also observed. All retrieved gears were moderately degraded.

In 15 days, 4288 kg of of ghost nets
were retrieved
by trawling the sea bottom.

Angling hooks were found in most of retrieved gears. One could presume that nets were lifted up several times by anglers who hooked their baits in them. It can also be concluded on the basis of observations that when lifted a fishing net captured fish which then died of hunger inside the net. The state of flatfish found in retrieved nets proved this fact.

The greatest number of gears were recovered on rocky bottom which is often a feeding ground for fish and where passive gears are set. In addition, due to these natural "hooks", these areas are exempt from trawling. This may contribute to the accumulation of lost nets on the "hooks".

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Conclusions and recommendations from ghost net retrieval actions:

1. Retrieval actions should be carried out with a medium size vessel to permit unconstrained operation of the fishing gear.
2. Marked fishing nets prevented trawling of areas with the highest probability of finding lost nets. In the future, closer co-operation with fisheries inspectors as well as fishermen and producers' organizations will be required in order to agree on the most suitable period and timetable, with possible fishery closures being introduced in areas covered by retrieval actions.
3. Mostly passive gears (gillnets) were found in searched areas. This is due to a delicate construction of nets which may cause their loss during operation. In the past, these nets were often broken due to imprecise navigation systems.
4. Lost gillnets remaining at the bottom are places where angling equipment could potentially be lost. Angling hooks lift lost nets, thus causing involuntary by-catch.
5. Observation proved that trawls were most often found on "hooks". After sinking to the bottom they are covered with living organisms and become hiding places for many fish species. These fishing gears do not float in water probably due to their weight.
6. Fishing gears are most often deployed on rocky bottoms. Due to these natural "hooks", these areas are exempt from trawling. This may contribute to the accumulation of lost nets on the "hooks".

2.2. Methodology of diving surveys carried out on ship wrecks to retrieve ghost nets.

Provisions of the Act of 17 October 2003 on underwater works (Journal of Laws of 2003, No. 199, item 1936) set out, among others, the methods of carrying out underwater works, defined as "works carried out by persons who stay underwater with divers equipment or in conditions of artificially created high atmospheric pressure, as well as works carried out on land by persons who are in charge of organising underwater works and in charge of operating the equipment needed for underwater works".

The works mentioned in the Act include underwater works aimed at retrieving lost fishing gears deployed at the sea bottom. In view of the above, the co-ordinator of such works needs to have a certificate confirming compliance with safety and hygiene at work management system, issued by a certifying body, in accordance with the legal provisions on certification as well as necessary permissions to carry out underwater works issued by the Director of the Maritime Office, relevant to the location of the works.

Although the procedures related to obtaining the necessary permissions to carry out underwater works result from the national legislation, they differ in different Maritime Offices. In view of the above, in particular when conducting works in the Natura 2000 protected areas, it is necessary to foresee at least a 6 month period for obtaining necessary permissions.

Actions aimed at retrieving ghost nets from two ship wrecks were carried out at sea by two groups of divers from DALBA company which is specialised in underwater works and complies with the above requirements. After locating the wreck, divers from DALBA submitted an application for a permission to carry out underwater works consisting of recovery of unmarked, lost or abandoned nets to the Maritime Office relevant to the location of the wreck.

Retrieval actions carried out on wrecks were carried out from a fishing cutter KOŁ – 111. This cutter, 17 meter in length, after some modifications to guarantee divers' safety, served as the base for divers who took part in the actions. The decision to use the cutter as the base for divers resulted above all from the necessity to have access to a fully available vessel that could be used at any time, in the case of favourable weather conditions. In addition, due to a deeper water draft and deck located near water level, a fishing cutter offered adequate conditions for operating the hydraulic equipment used to cut off the nets.



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Locating wrecks in order to remove ghost nets constituted the first step of the retrieval action. Due to technological requirements, the wrecks could remain in depth not exceeding 20 metres. Retrieval actions on wrecks lying beyond this depth require decompression procedure and use of additional technical measures. This would increase the action costs considerably. Wrecks were located with the use of fishing navigation maps, with “hooks” located by fishermen, including unregistered ship wrecks. After preliminary identification of co-ordinates of shipwrecks on the maps, verification of their location was carried out with the use of underwater search sonar. Next step consisted of gathering information on the amount of nets deployed on the wreck through diving and photography.

It should be underlined that gillnets set in the midst of the fishing season in the vicinity of ship wrecks totally hampered any retrieval actions for security reasons. If similar actions were to be undertaken, it is recommended, in co-operation with fishermen and producers’ organisations, to ask relevant Fisheries Inspectorate for a temporary closure of fishery in a restricted area. Such closure will enable actions on already identified ship wrecks.

As a result of above-mentioned activities, two wrecks were localised, both in the area managed

by the Maritime Office in Słupsk. Ghost net retrieval actions were carried out on both wrecks:

1. Wreck with the following position coordinates: 54.16.100 N 15.30.050. It lies at a depth of 15 meters, is seriously degraded and broken in parts. Retrieval action on 12 – 23 August 2011;
2. Wreck with the following position coordinates 54.17.200N 15.28.950E. It lies at a depth of 17 meters, hulk broken in half, engine room uncovered probably due to an explosion, bow at a height of 9 meters. Retrieval action on 2 – 8 August 2011.

On the basis of collected photographic documentation, the co-ordinator of underwater works prepared a plan of underwater activities to be carried out on both wrecks. It contained the number of divers, type and quantity of equipment needed for the actions as well as timeframes for their execution.

The exact date of the retrieval action depended first of all on weather conditions. For the purpose of divers’ security, underwater works, aimed at retrieving fishing gears deployed at sea may be carried out when the sea state is assessed to be 1-2 and wind blows from the East or South. Such conditions guarantee visibility under water of 4 or more meters. Due to particularly



unstable weather conditions in Poland in 2011, the dates for the retrieval actions were very hard to presume and had to be changed several times. In view of the above, the vessel used as divers' base had to be at coordinator's disposal all the time.

Four divers took part in actions aimed at retrieving ghost nets from shipwrecks. The team was composed of the leader of underwater works and three divers grouped in two teams, composed of two divers each. During underwater actions, two divers were in water and belay was guaranteed by the third one. The following equipment was used for retrieving ghost nets: hydraulic scissors, Broco special devices for cutting steel ropes underwater, different types of knives as well as shears used according to the need. Actions were carried out from a fishing vessel KOŁ-111, 17 meters in length, equipped with a gang-plank for divers on the starboard. During actions the cutter was anchored above the shipwreck.

The methods used for gear retrieval depended each time on the gear type and the way the nets were entangled on the wreck. Gillnets were retrieved as first because they constituted the greatest threat to divers working underwater. Then, other fishing gear types were retrieved, including trawls, that were not a direct threat to divers.

At first, the net was hooked on the trawl winch installed onboard. Once the ropes were tight, the net was cut off and retrieved onboard with the use of the winch. By fixing the nets to the line and then tightening the rope, the diver had easier and safer access to the places where the net was hooked and was able to cut it off. Steel ropes that were parts of the fishing gears, were cut off with hydraulic shears or burnt off depending on the access and thickness. Nets wound tightly between parts of the hull were cut off close to the bottom, to avoid lifting the bottom residues.

Cut-off nets were then retrieved onboard using the trawl lift. After photographic documentation, filling in the net register and cleaning, the nets were weighed

and packed into boxes. The boxes were then transferred to a debris recycling company.

During retrieval actions, in total 1 807 kg of unmarked nets deployed on two shipwrecks were removed, mostly gillnets and trawl nets. Average weight of net fragments amounted to 181 kg. All nets were covered to a certain degree with living organisms. The average coverage amounted to 38%. Both gillnets and trawl nets contained fish, mostly flatfishes and cod. The catching efficiency of nets deployed on wrecks depended mostly on the way they were entangled on the wreck. All fishing gears were degraded to a large degree. The average degree of degradation was 63%.

During retrieval actions, in total 1 807 kg of unmarked nets deployed on two shipwrecks were removed.

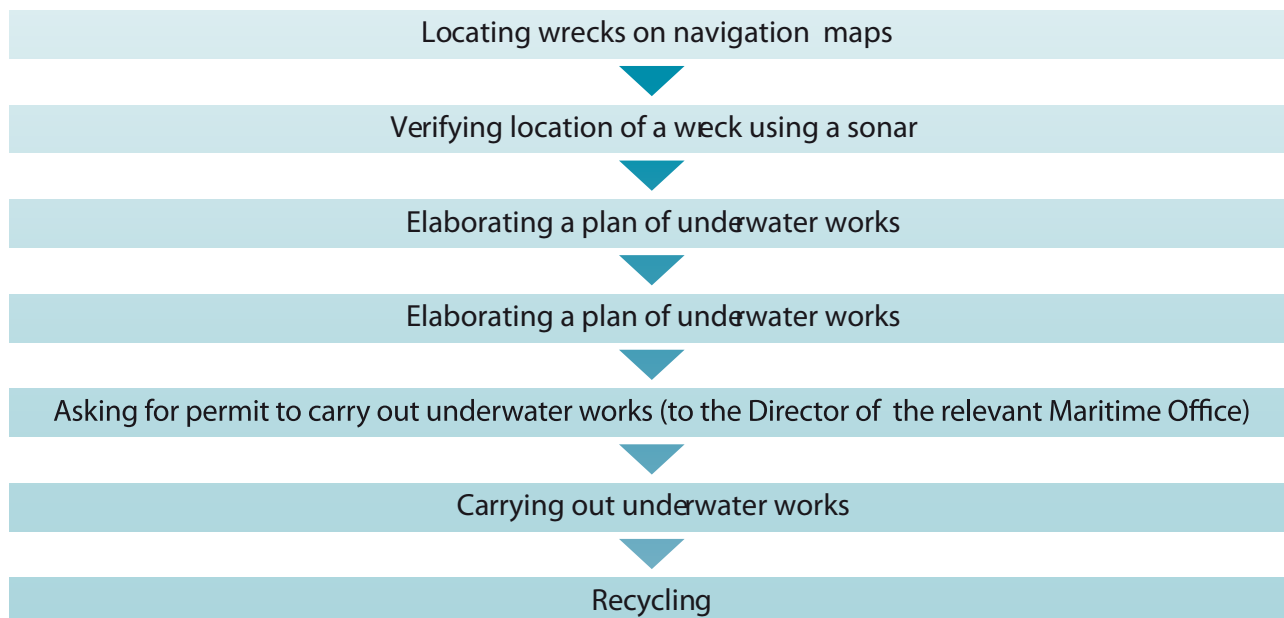


Fig. 2 Scheme of retrieval of lost fishing gears from a ship wreck.

Conclusions and recommendations from ghost nets retrieval actions:

1. In view of the legislation in force, actions aimed at retrieving unmarked and lost fishing gears may be carried out only by certified entities which have a special permission to carry out underwater works issued by the by the Director of the Maritime Office, relevant to the location of the works.
2. The procedures related to obtaining the necessary permissions to carry out underwater works differ in different Maritime Offices. In view of the above, in particular when conducting works in the Natura 2000 protected areas, it is necessary to foresee at least a 6 month period for obtaining necessary permissions.
3. A vessel serving as divers' base should be available at any time during the retrieval actions to permit to carry out the works in favourable weather conditions.
4. Shipwrecks lying at a depth of more than 20 meters require additional costs related to the use of special technical equipment to guarantee divers' security.
5. Due to water currents, the number / amount of nets deployed on shipwrecks should be verified prior to actions aimed at recovering lost fishing gears from wrecks.
6. Marked fishing gears set in the vicinity of shipwrecks hamper any retrieval actions. In the future, it is recommended, in co-operation with fishermen and producers' organisations, to ask relevant Fisheries Inspectorate for a temporary closure of fishery in a restricted area. Such closure will enable retrieval actions.
7. Due to unpredictable weather conditions and large amount of nets deployed on shipwrecks, it is recommended to prolong the retrieval actions on each wreck up to a minimum of 8 working days in the case of wrecks located at a depth of less than 20 meters. In the case of wrecks located deeper the time needed for underwater retrieval action should be estimated on the basis surveys carried out on the wreck.
8. Wrecks from which nets had been retrieved should be monitored. Water currents and strong storms could uncover the nets located under the wreck during the actions.

2.3. Recycling of nets.

Since 1950s, modern fishing gears have been made of material obtained through chemical synthesis. Their names derive from the chemical composition of polymers. The main chemical groups of these materials, called synthetic materials, use at present in fishing gears constructions are:

1. Polyamide fibres under various commercial names, such as stilon, nylon, capron, perlon, dederon etc.
2. Polyester fibres such as terylene, dacron, teteron, torlen.
3. Polypropylene fibres such as pylen, ulstron, proplon.
4. Polyethylene fibres such as kuralon, winylon, polyethylene.

The common characteristics of these materials, especially important for their exploitation in fisheries is their resistance to all processes of biological decomposition (bacterial processes) and perseverance of catching efficiency in water for a very long time.

In the past fishing gears were made uniquely from natural fibres, called after plants that were used for their production. Cotton, linen, hemp, sisal, coco fibres dominated. Their common characteristics is vulnerability to bacterial decomposition in water (rotting, decay etc.). Their fragments may still be hooked on underwater objects but due to the time and degradation their catching efficiency is very low.

Pursuant to the Ordinance of the Minister of Environment of 27 September 2001 on the categories of debris (Journal of Laws of 8 October 2001) lost fishing gears deployed at sea and unmarked can be listed under group 2 of debris, that is "debris from agriculture, fruit growing, hydroponics, fisheries, forestry, hunting and food processing" under the code 02 01 04 "Synthetic debris (excluding packaging)".

It should however be underlined that due to long deployment in water lost fishing gears may collect petroleum and mineral substances from shipwrecks. These hazardous substances may also cover fishing gears while retrieved in the port and due to less restrictive storage conditions as compared to nets used for fishing. It should be stated that such contaminating substances occur mainly on trawl nets made of natural fibres. They may also occur on some passive gears with multifilament

construction. Other gears e.g. trammel nets often have a monofilament structure and due to the lack of space between fibres do not absorb such contaminating substances.

Occurrence of contaminating substances on fishing gears deployed at sea have been confirmed by analysis of fishing gears debris conducted by i2 Analytical Ltd for WWF. The analysis confirmed that the values of substances such as mineral oils (C_{10} - C_{40}) described in the Ordinance of the Minister of Economy and Labour of 7 September 2005 on the criteria and procedure for disposal of debris on waste disposal facilities (Journal of Laws No.186, item 1552-1553) have been exceeded. Considering the need to apply precautionary approach, this findings qualify fishing gears retrieved from the sea to the group of wastes that should be disposed in hazardous waste disposal facilities.

This fact called for classifying fishing gears under another waste code than the one mentioned in the Ordinance. After consultations with the waste disposal company, fishing gears retrieved from the sea were qualified as waste under the code 16 03 03 "Inorganic wastes containing hazardous substances". In the future, efforts should be made to establish a new debris code for fishing gears contaminated by mineral compounds.

In Poland, retrieval of lost fishing gears is regulated mainly by three legal acts:

- The Fisheries Act
[Journal of Laws of 14 April 2004]
- The Maritime Code
[Journal of Laws 1998.10.36]
- Act on Monument Protection and Care
[Journal of Laws 2003 No. 162, item 1568].

The Fisheries Act gives the legal basis for retrieval of lost or abandoned fishing gears from the sea by stating that "Fishing gears found in Polish maritime areas with no marking should be considered as abandoned with the aim to renouncing its property." (Journal of Laws 2004 No. 62, item 574, Article 36, paragraph 2).



” Fishing gears found in Polish maritime areas with no marking should be considered as abandoned with the aim to renouncing its property.

The provisions of the Maritime Code as well as the Act on Monument Protection and Care aim at shortening to maximum the period of uncertainty as to the legal status of submerged objects, including fishing gears. Several articles define very short periods after which the objects become state property. Several provisions define very short periods, after which the artefacts become the property of the state. For example, pursuant to Article 252 § 2 of the Polish Maritime Code, if the owner does not commence the removal of artefacts in the period set forth by the Maritime Office or does not finalise this removal one year after the set deadline, the objects shall become the property of the state.

If the owner remains unknown, or does not claim the retrieved property, the person who retrieved the property shall be obliged to return it to the Maritime

Office or relevant military authority. The Maritime Office shall carry out proceedings to identify the owner of the retrieved object pursuant the Regulation of the Minister of Infrastructure of 28 April 2004 on the procedure to identify the owner of objects retrieved from the sea.

In practice, taking into account the above mentioned legal provisions of the Fisheries Act, the Maritime Offices issue permissions for recycling of unmarked fishing gears retrieved from the sea by co-ordinators of such actions.

In the framework of the project, fishing gears retrieved from the sea were transferred to EKOWIT company which disposes of all necessary permissions for recycling of wastes. EKOWIT was responsible for the transfer of dried and cleaned fishing gears to hazardous waste disposal facilities where fishing gears were recycled. It should be mentioned that the dry weight of retrieved fishing gears was half of their weight just after retrieval. This decreased the costs of their recycling substantially.

Conclusions and recommendations

1. It is necessary to establish an additional waste code in the Ordinance of the Minister of Environment of 27 September 2001 on the categories of debris (Journal of Laws of 8 October 2001) in order to classify disposed fishing gears retrieved from the sea due to the fact that the values of substances such as mineral oils could be exceeded.
2. The dry weight of retrieved fishing gears is half of their weight just after retrieval. This decreases the costs of their recycling substantially.
3. The Maritime Code, the Fisheries Act and in the case of shipwrecks the Act on Monument Protection and Care set out the procedure of handling fishing gears retrieved from the sea. The Maritime Office responsible for the management of a given area is responsible for objects found underwater. In the case of fishing gears, under the provisions of the Fisheries Act, the Maritime Offices issue permissions for the recycling of unmarked fishing gears retrieved from the sea.

i2 Analytical

Building 19, BRE, Bucknalls Lane, Watford, WD25 9XX

Criteria for Waste Disposal - results of analysis

Report from research No.: 11-27645
 Project WWF-fishing gears
 Lab sample number 176486
 Date of sample
 Reference number nets

Depth (m)

Sample analysis

| | | | | Criteria for disposal of waste on waste disposal facilities: | | |
|---|--------|--|--|--|---------------------------------|---------------------|
| | | | | LIMITS | | |
| | | | | Neutral | Other than neutral or hazardous | Hazardous |
| TOC (%) | 36 | | | 3% | 5% | 6% |
| Ignition loss (%) | 95 | | | — | — | 10% |
| BTEX (µg/kg) | <10 | | | 6000 | — | — |
| PCB (mg/kg) | <0.3 | | | 1 | — | — |
| Mineral Oil (C ₁₀ -C ₄₀) (mg/kg) | 780 | | | 500 | — | — |
| WWA (mg/kg) | <1.6 | | | 100 | — | — |
| pH (pH units) | 7.1 | | | — | >6 | — |
| Ability to neutralize acids (mol/kg) | 0.0000 | | | — | Assessed to get pH7 | Assessed to get pH7 |

| Leachate analysis | 2:1 | 8:1 | In total 10:1 | Permitted limit values of washout | | |
|--|---------|---------|---------------|-----------------------------------|-------|--------|
| Component | mg/l | mg/l | mg/kg | | | |
| Arsen (As) | 0.070 | <0.010 | 0.15 | 0.5 | 2 | 25 |
| Barium (Ba) | 0.057 | 0.034 | 0.36 | 20 | 100 | 300 |
| Cadmium (Cd) | <0.0005 | <0.0005 | <0.0020 | 0.04 | 1 | 5 |
| Chromium (Cr) | 0.0019 | 0.0017 | 0.017 | 0.5 | 10 | 70 |
| Copper (Cu) | 0.035 | 0.017 | 0.19 | 2 | 50 | 100 |
| Mercury (Hg) | <0.0015 | <0.0015 | <0.010 | 0.01 | 0.2 | 2 |
| Molibden (Mo) | 0.03 | 0.03 | <0.02 | 0.5 | 10 | 30 |
| Nickel (Ni) | 0.0059 | 0.0028 | 0.032 | 0.4 | 10 | 40 |
| Lead (Pb) | <0.0050 | <0.0050 | <0.0020 | 0.5 | 10 | 50 |
| Stibium (Sb) | <0.0050 | <0.0050 | <0.0020 | 0.06 | 0.7 | 5 |
| Selen (Se) | <0.010 | <0.010 | <0.040 | 0.1 | 0.5 | 7 |
| Zink (Zn) | 0.10 | 0.0168 | 0.26 | 4 | 50 | 200 |
| Chloride (Cl ⁻) | 64 | 13 | 180 | 800 | 4000 | 25000 |
| Fluoride (F ⁻) | <0.050 | <0.050 | 0.47 | 10 | 150 | 500 |
| Sulfate (SO ₄ ²⁻) | 120 | 17 | 270 | 1000 | 20000 | 50000 |
| Total dissolved solids (TDS) | 480 | 120 | 1600 | 4000 | 60000 | 100000 |
| Phenol index | <0.13 | <0.13 | <0.5 | 1 | — | — |
| Dissolved organic carbon (DOC) | 24 | 10 | 120 | 500 | 800 | 1000 |
| Additional information | | | | | | |
| Stone content (%) | <0.1 | | | | | |
| Overall sample weight (kg) | 2.0 | | | | | |
| Moisture content (%) | 0.50 | | | | | |
| Stage I | | | | | | |
| Elution content L2 (l) | 0.35 | | | | | |
| Volume of filtered elution VE1 (l) | 0.18 | | | | | |

Results of analysis are recalculated to get dry weight taking into account moisture content

Table 2. Results of analysis of fishing gears retrieved from the sea.



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3. Assessment of the impact of ghost nets on commercial fish species in the Baltic

Mortality level is one of the key parameters used in assessments and forecasts of the state of wild fish species. It has several components which should be taken into account to guarantee the accuracy of scientific assessments and decisions taken with regard to resource management. One of the components that determine the fishing mortality level is mortality caused by ghost nets. Its negative impact has a twofold nature. On the one hand, loss of fishing gears results in economic losses for fishermen and also causes a reduction in fish populations without any benefit for humans. On the other hand, due to the lack of reporting, the assessment of the amount of ghost nets is impossible and therefore the fishing mortality caused by ghost nets is not taken into account by scientists, thus resulting in decreased assessments of overall fishing mortality. These shortcomings have a direct negative impact on the effectiveness of resource management. Thus the FAO Code of Conduct for Responsible Fisheries¹⁹ considers the negative impact of ghost nets equal to other negative impact of fisheries, such as lack of selectivity, undesired by-catch and habitat destruction.

”Lack of quantified data on the scale of ghost net phenomenon is the reason for omitting the mortality caused by ghost nets in scientific assessments of fishing mortality. This fact has a negative impact on resource management.

As to the methodology, most programmes and publications on the impact of ghost fishing on fish resources uniquely attempt to assess the dynamics

of their catching efficiency as compared to other fishing gears used as reference. The challenge of building up a mathematical model to assess the “fishing” mortality of ghost nets (in quotation marks because it does not bring any benefit for humans) was taken up by Japanese researchers²⁰. As for gillnets, this model requires establishing a mortality coefficient for a single gear in relation to a given species in a given period of time. That is practically impossible for such a large area as the Baltic Sea, also due to the fact that source data is very scarce with reference to this region and cover only the Swedish experiment, already referred to in chapter 1. On the basis of the Swedish data, with a large margin of tolerance, one could make an attempt to calculate the total mortality rate caused by ghost nets (gillnets) in relation to cod. We should, however, bear in mind that it requires several simplifications to be applied:

- The calculations will not include the impact of the changes in the state of Baltic cod stocks between the date of the Swedish experiment and 2009. For this period the number of lost nets, as stated in Chapter 1, was evaluated to be 5170;
- It could a priori be considered that the catching efficiency of a single net observed in the fishing grounds during the experiment did not differ substantially from another gillnet fishing grounds (the experiment was carried out in ICES sub-division 25, on the eastern cod stock);

¹⁹ Anon. 1995: Code of Conduct for Responsible Fisheries. FAO, Rome, 1995

²⁰ Matsuoka, M. et al., 2004: Review of Ghost-Fishing: Scientific Approaches to Evaluation and Solution. Paper presented during APEC Seminar on Derelict Fishing Gear and Related Marine Debris, 13-16 January 2004, Honolulu, Hawaii, USA.

- Lack of knowledge on the actual percentage share of nets lost in 2009 that have preserved their catching ability calls for a variant calculation, using a number of hypothetical values of this share within realistic a range of values and taking into account the evaluation of the state of nets retrieved during the actions described in chapter 2. This state was radically different (much worse) than in the case of experimental nets that had just simulated ghost nets. The authors of the Swedish experiment also draw the attention to this fact and suggest that the results of the catching efficiency of ghost nets may be overestimated.

In order to conduct variant analysis including risk assessment, standard values used in conditions of uncertainty, analogical to the values referred to under Article 57.2 of Council Regulation 404/2011, determining the size of the sample to be inspected, were applied:

- a) very low risk to overestimate the assessment, if we consider that 3% of lost nets continue to fish;
- b) low risk to overestimate the assessment, if we consider that 5% of lost nets continue to fish;
- c) average risk to overestimate the assessment, if we consider that 10% of lost nets continue to fish;

- d) high risk to overestimate the assessment, if we consider that 15% of lost nets continue to fish;
- e) very high risk to overestimate the assessment, if we consider that 20% of lost nets continue to fish.

The risk mentioned above to overestimate the assessment has been justified by the results of actions carried out in the framework of this project as well as observations and photographic documentation of nets recovered during fishing operations conducted with the use of trawls. On the basis of experience gathered by fisheries inspectors it could be stated that retrieved nets are most often rolled pieces of netting, almost completely covered by mussels, with a zero catching efficiency. Table 3 presents the recalculated results of the Swedish experiment in order to estimate average catch per unit effort CPUE (one net/month was used as unit effort) with reference to particular fleets of gillnets, retrieved after 9 different exposure times, first part after 1.2 months, last part after 27.1 months.

| Haul number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|------------------------|-----------------|---------------|-----------------|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|
| Number of nets | 20 | 16 | 12 | 16 | 12 | 12 | 15 | 8 | 12 |
| Time of catch (months) | 1.2 | 3.5 | 4.7 | 6.4 | 12.6 | 16.2 | 19 | 25.3 | 27.1 |
| Fishing effort | 24 | 56 | 56.4 | 102.4 | 151.2 | 194.4 | 285 | 202.4 | 325.2 |
| Catch in kg | 33.8 | 114.1 | 45.1 | 22.6 | 9.8 | 33.7 | 10.3 | 7.6 | 20.7 |
| CPUE | 1.408333 | 2.0375 | 0.799645 | 0.220703 | 0.064815 | 0.173354 | 0.03614 | 0.037549 | 0.063653 |

Table 3. Characteristics of subsequent fishing operations and the average catch per unit effort (CPUE) in experimental catches simulating ghost net fishing

Using the CPUE obtained above, the mortality rate (not corrected with the risk value) of ghost nets capturing cod for the exposure time of 27.2 months was calculated (Table 4). The fishing effort required to make these calculations was calculated using the following formulae: fishing effort = exposure time x average number of lost nets in the Baltic in 2009 (according to calculations presented in chapter 1.1 equalled to 5170 nets). The mortality was calculated using the following formulae: mortality = fishing effort x CPUE.

| | | | | | | | | | |
|---------------------|---------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|---------------|----------------|
| Time (months) | 1.2 | 3.5 | 4.7 | 6.4 | 12.6 | 16.2 | 19 | 25.3 | 27.1 |
| Fishing effort | 6204 | 18095 | 24299 | 33088 | 65142 | 83754 | 98230 | 130801 | 140107 |
| Mortality kg | 8737.3 | 36868.56 | 19430.58 | 7302.625 | 4222.167 | 14519.08 | 3550.067 | 4911.5 | 8918.25 |

Table 4. Cod mortality caused by ghost nets (without the risk factor)

The total estimated catch of all lost fishing gears for the period of 27.1 months (only hypothetically in the period 2009 – 2011, since not all the nets were lost on 1 January 2009) amounted to 108.5 tonnes of cod before correction and as presented in Table 5 after correction.

| % of nets that continued to fish | Estimated catch, kg |
|----------------------------------|---------------------|
| 3 | 6230.688 |
| 5 | 10384.48 |
| 10 | 20768.96 |
| 15 | 31153.44 |
| 20 | 41537.92 |

Table 5. Estimated catch of cod with gillnets lost in 2009 after risk assessment carried out the basis of standard risk value used in uncertainty conditions

At average risk to overestimate the assessment, the catch of cod by lost nets amounts to approximately 20 ton for the period of 27 months, whereas extreme values range from 6.2 to 41.5 tonnes.

” Average catch by lost nets in the Baltic, at average risk to overestimate the assessment, amounts to 20.8 tonnes of cod during 27 months.

The above calculations refer only to gillnets. It should be underlined that other lost fishing gears may also cause fishing mortality, however, there is no possibility to assess this mortality with analytical methods at present state of knowledge. In order to solve this problem, representative and planned observation in situ should be carried out on shipwrecks and similar places where ghost nets tend to cumulate. Such information, including information on gillnets deployed on wrecks, will gradually permit to change the risk related to uncertainty with reference to the percentage of gillnets that continue to fish.

4. Conclusions and recommendations

The problem of fishing gears that remain at the sea bottom as a consequence of commercial and recreational fisheries has a diverse negative impact on the environment. Ghost nets cause pollute marine environment by introducing materials and substances characterised by considerable durability, cause damages to the marine flora and fauna, have detrimental effect on resources exploited by fisheries and hamper rational management of these resources, incur unnecessary costs and cause navigational threats.

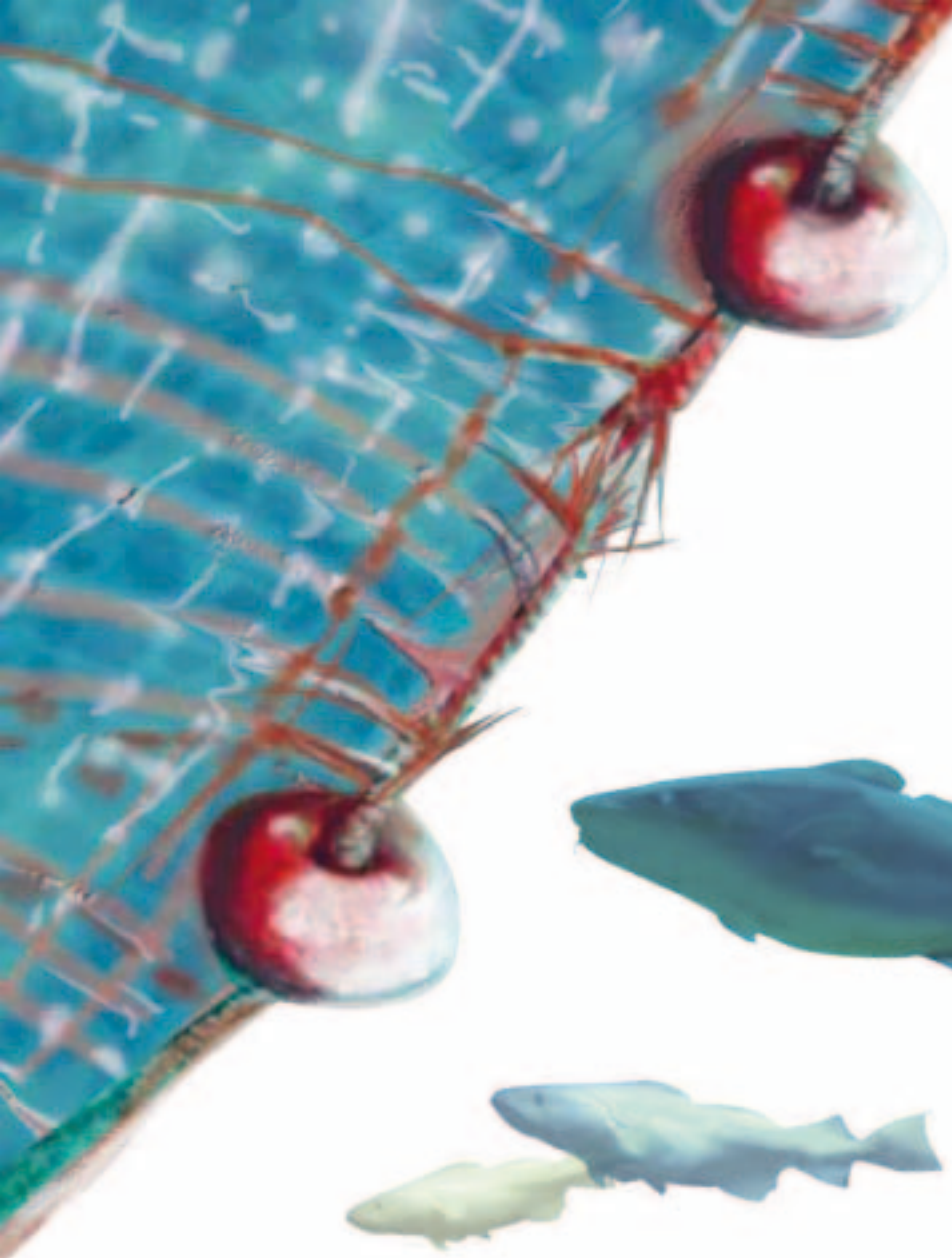
Taking into account the number of nets lost annually in Baltic fishing grounds (gillnets and trawl nets) and estimated in this report, there is no doubt as to the need to carry out further actions aimed at minimizing this problem, possibly on a wider scale.

In the light of pilot actions carried out in the summer of 2011 in the Baltic and on the basis of data from international publications, it could be assumed that the impact of ghost nets on commercial fish species in the Baltic is substantial from the economic and biological point of view. It should be underlined that this impact results not only from the amount of fish captured by ghost nets but also from the fact that these catches are not taken into account in fishing mortality statistics. This fact causes uncertainties in resource assessment. It should also be stressed that ghost nets capture mainly juvenile cod and that their catching efficiency remains for years outside of human control.

In order to prevent gear loss and mitigate the impact of ghost nets, it is recommended to:

- increase enforcement, without any exceptional treatment, of legal provisions referring to the fishing gears and reporting of lost gears;
- introduce marking of fishing gears with coded metal elements or other identification elements issued by fisheries administration, similarly to car plates that prevent theft;
- use most modern electronic devices to carry out effective and safe navigation on fishing vessels and spread information on location of underwater obstacles;
- guarantee the possibility to deposit any marine debris in fishing ports without any additional costs for vessel owners (in accordance with Annex V of MARPOL Convention);
- raise the incentives for retrieval and collection of any objects generated by human activities by disposal facilities onshore through programmes aimed at cleaning the coast, not only on voluntary basis but also with financial incentives;
- enforce compliance with the rules on the number of fishing gears allowed on different sizes of fishing vessels and implement optimal methods for equipping trawl gears used for fishing operations on heavy sea bottom;
- develop technologies aimed at implementing elements of fishing gears made of biodegradable materials;
- inform other sea users on areas where fishing operations are conducted, carry out trainings for fishermen on threats caused by other sea users with regards to fishing gears, educate on responsible behaviour of all sea users;
- implement innovative technologies to conduct effective search for lost fishing gears such as for example passive pingers or use of fibres modified by adding substances which increase acoustic reflectivity in the production process (such as barium sulphate) in order to facilitate location with the use of acoustic echo-sounding;
- develop programmes aimed at ghost net retrieval, including actions at sea with the use of fishing vessels that do not fish due to the excess of fishing capacity in relation to available resources and in co-operation with divers;
- develop disposal and recycling technologies;
- develop programmes aimed at raising awareness and education, directed to future sea users;
- all measures aimed at limiting the impact of ghost nets and other debris on marine environment taken up by administration, scientific institutions, schools and universities, non-governmental organisations and expert consultations should be well co-ordinated and coherent, both at national and international level;
- take into account the specific character of the Baltic Sea in planning and promoting the above-mentioned measures.





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