

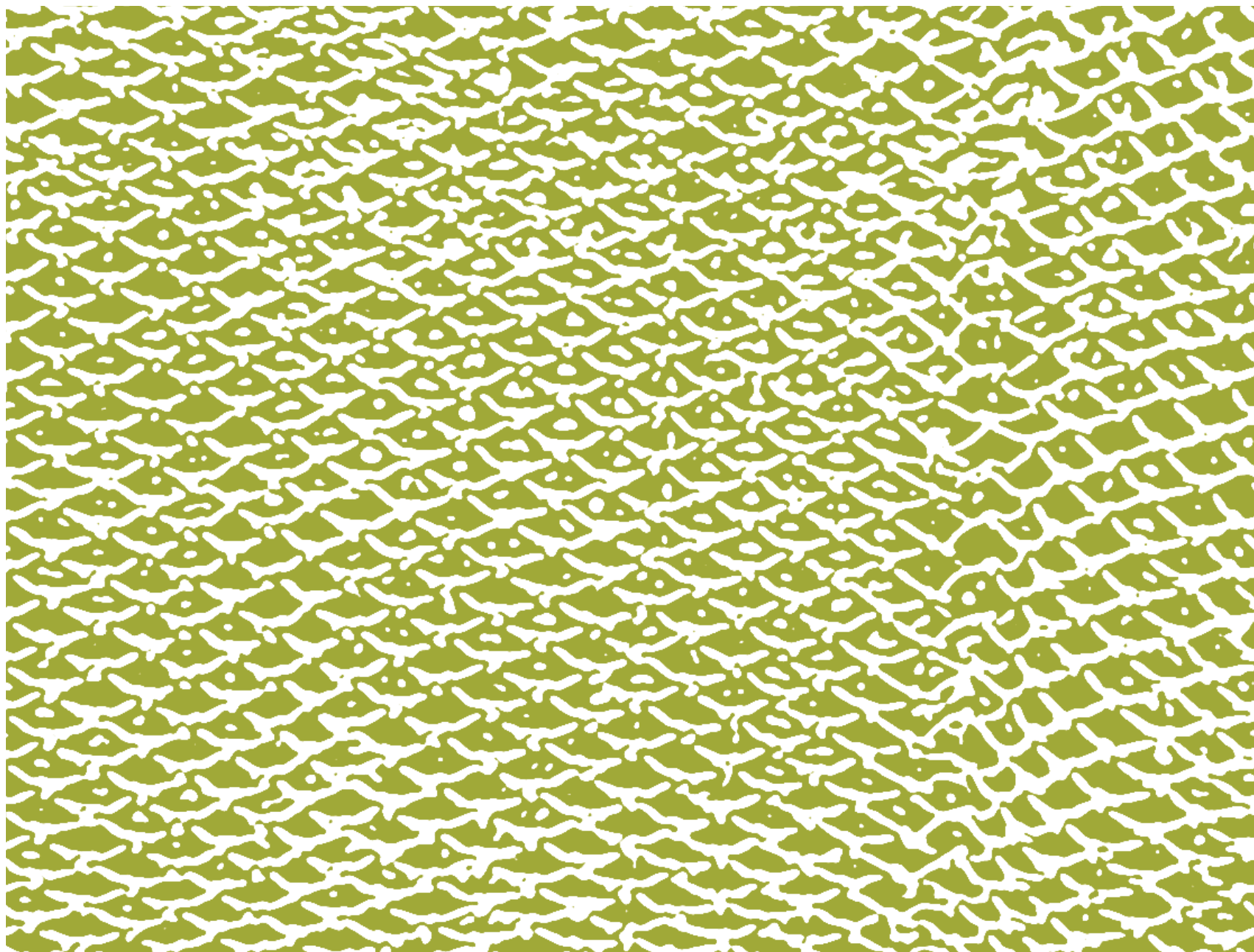
**3R
FISH**

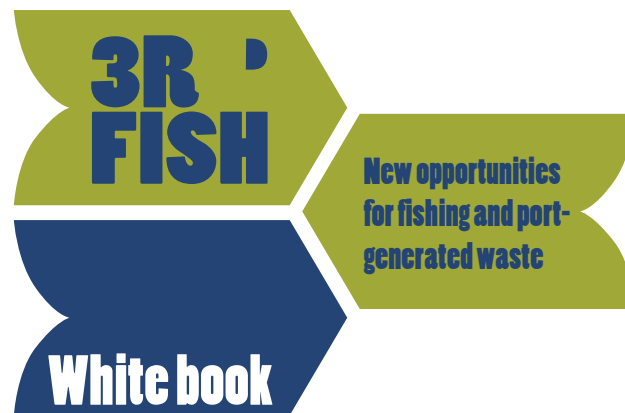
**New opportunities
for fishing and port-
generated waste**

White book



www.3rfish.org





www.3rfish.org

3R FISH is a project by:



With the contribution of the LIFE financial instrument of the European Community



With the collaboration of **FUNDITEC**
Designed by **divu***Ciencia
Printed on **november 2011**

Foreword

Dear reader:

By means of this White Book we want to present the work developed during these recent years by the consortium involved in the 3R-Fish Project - Integral Management Model of recovery and recycling of the proper solid wastes from the fishing and port activities and to raise awareness on our experience amongst those parties that might be interested in furthering this initiative or to engage in new activities encouraged by our experience.

One of our society's main challenge is to develop its activities in a more sustainable and environmentally-friendly way. This objective requires an appropriate management of the waste generated in the performance of economic activities. Thanks to our role and experience, we have tried to identify the way in which two of the most important sectors of social-economic activities in Galicia and Portugal, namely fishing and marine activities, can perform their activities in a more respectful way for the marine environment, minimizing their impact.

An inadequate management of the waste generated in these activities can have a rather negative impact for the marine environment, endangering the fauna and damaging marine ecosystems. The 3R-Fish intends to implement a new system of waste management, limiting their impact upon the environment and, at the same time, promoting economic activity through an efficient use of these new resources.

The 3R-Fish Project objectives are integrated within multiple European policies and strategic priorities such as the (Strategy for the Marine Environment, Action plan for an integrated maritime policy, Directive on Waste), that constitute the pathway for a more accountable and sustainable development of human activities.

Projects similar to the one hereby presented, aimed at managing and limiting the negative impact of waste, must encourage the implementation of environ-

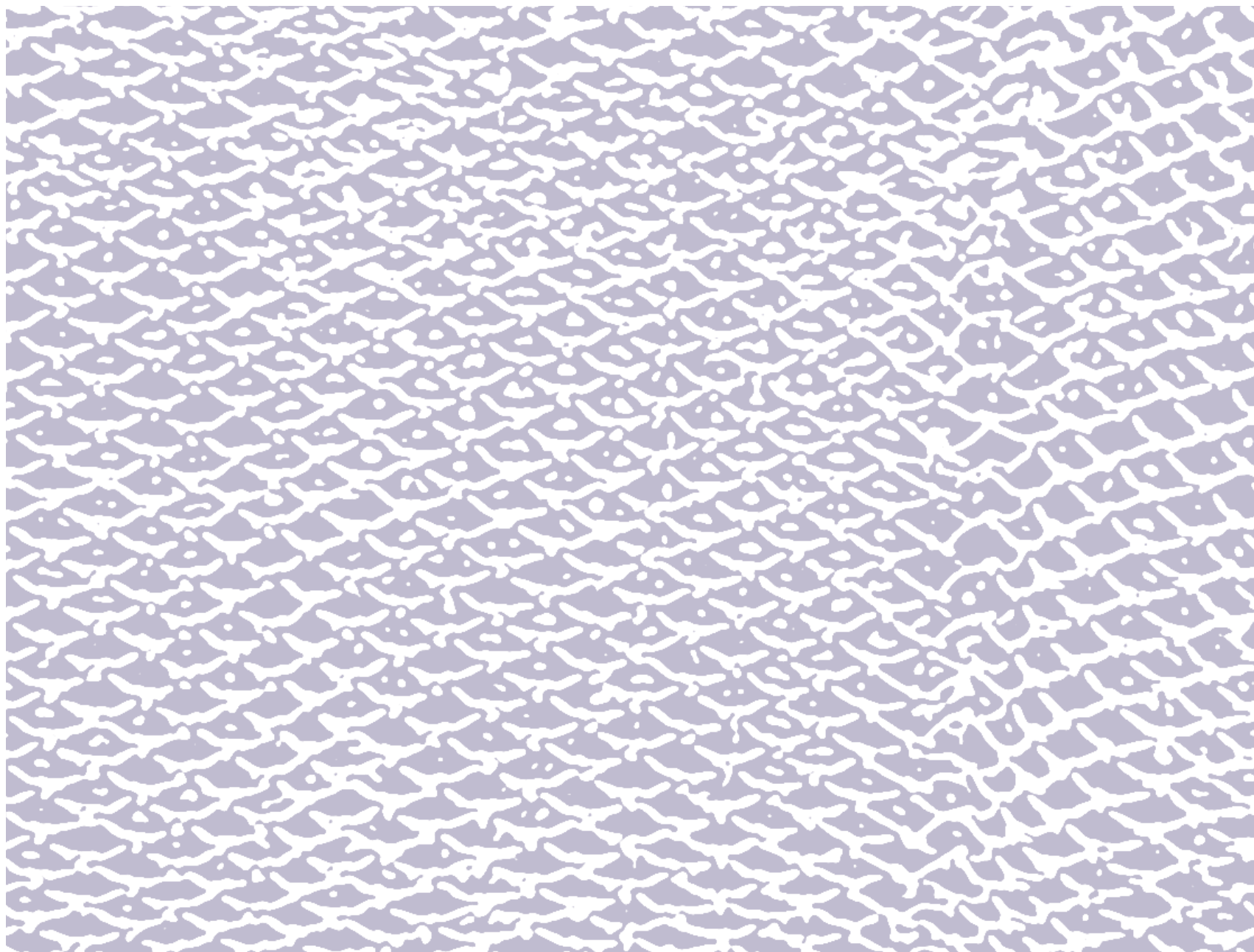
mental-friendly practices in fishing ports facilities, protecting fishing communities, marine ecosystems and fauna and, therefore, allowing for a more sustainable activity that will result in significant improvements for Galician and Portuguese ports, which will be easily transferable to other fishing ports within the European Union.

I hope the present report will allow you to discover new ways to contribute to the improvement of our society and that our experience can be furthered by relevant parties such as yours.

Thank you very much for your kind interest,

Paloma Rueda Crespo

Managing Director of the Centro Tecnológico del Mar – Fundación CETMAR.



1. Introduction: the 3R-FISH project and its general context	8
1.1 Introduction	8
1.2 3R-FISH Project	8
2. Regulatory framework:	10
2.1 International Regulations and Recommendations	10
2.2 European Union Regulations and Recommendations	12
2.3 Fishing gear (nets and related apparel) and Expanded Polystyrene Boxes properties and their life cycle..	13
2.4 Concepts and Definitions: waste/gear and EPS Composition	14
2.5 Waste typologies	16
3. Waste generation.	17
3.1 Waste Disposal.	18
3.2 Waste management.	19
3.3 Waste treatment and recycling processes.	20
3.4 Organisational and logistic requirements	26
4. Product valorisation and market opportunities	27
4.1 Transforming waste into market-aimed products.	27
4.2 Identified commercial applications for Recycled Fishing Nets and EPS materials	28
5. Evaluating fishing gear and Expanded Polystyrene Boxes recycling priorities and strategies	29
5.1 Market access recommendations	29
5.2 Inter-sector strategic collaborations	30
5.3 Eco-design.	31
5.4 Awareness raising initiatives	33
5.5 Market development Support Policies	33
5.6 Summary of Findings and Recommendations.	34

1. Introduction: the 3R-Fish project and its general context

1.1 Introduction

The last decades have witnessed an important growth of fishing activity and significant innovations in the materials and gear used in the development of this activity. This growing usage has posed a significant problem for the industry as to what to do with these materials at the end of their lifetime, considering their diverse nature and characteristics. Whereas some of these materials can be reused for alternative purposes, their vast majority are simply discarded, abandoned and, in the best of the cases, deposited into landfills to be subsequently incinerated.

When analysing the accumulation of these materials, questions arise such as what do fishermen, port authorities and fishing industry representatives need to do with all these materials when they reach the end of their life cycle? However, in order to provide a reliable answer, different aspects need to be considered, ranging, among many others, from the

costs associated to the process, the physical space where these materials will be deposited or the agents in charge of the operational process.

Although most attention, within the industry, is focused on the economic loss resulting from the accumulation of discarded materials (gear loss, cleaning activities, deposit facilities provision and adaptation, technical damage, gear entanglement, etc), the worse consequences of fishing waste mismanagement can be seen in its environmental impact: marine pollution, ghost fishing, landfill deposits overuse, incineration polluting emissions, etc.

1.2 3R-FISH Project

In this context the **3R-FISH** project (Integral Management Model of recovery and recycling of the proper solid wastes from the fishing and port activities) was launched within the framework of the European programme LIFE+¹ (Component 2: Environment Policy and Governance, 2007) and has been implemented over the period 2009-2011.

The **3R-FISH** project's consortium, led by CETMAR (Centro Tecnológico del Mar- Technological Center of the Sea), is formed by the same coordinator, LEITAT, Portos de Galicia, Port Authority of Marin and Ria de Pontevedra, the University of A Coruña and Plastimar-Industries of plastic materials. Similarly, the project also involves recycling companies from Galicia, Portugal and Catalonia.

The main objective of the **3R-FISH** project is to improve the quality of marine waters and seabed through the correct

*Free man, you will always cherish the sea!
The sea is your mirror; you contemplate your soul
In the infinite unrolling of its billows;
Your mind is an abyss that is no less bitter.*

Charles Baudelaire

use of devices and equipment used in the fishing sector, together with the proper management and recycling of the solid waste generated in these activities. The objective of the 3R-Fish project responds to a key component of the European Union's strategy on fisheries and ports' sustainable development (as represented in the Common Fisheries Policy, the Integrated Maritime Policy, the Integrated Coastal Zone Management and the Thematic Strategy on the Prevention and Recycling of Waste). Three major types of solid waste generated in fishing and port activities have been dealt with during the project; namely, fishing nets, packaging polystyrene and lighting devices.

The project has also evaluated the potential implementation of a management plan for port & fisheries waste in Galician and Portuguese port facilities (potentially applicable also in other European ports).



1- LIFE is the EU's financial instrument supporting environmental and nature conservation projects throughout the EU, as well as in some candidate, acceding and neighbouring countries. Since 1992, LIFE has co-financed some 3115 projects, contributing approximately €2 billion to the protection of the environment.

2. Regulatory framework

The implication of waste mismanagement in the fisheries sector constitutes an issue of increasing concern among relevant institutions and government departments, and it has generated an important regulatory corpus within International, European and National legislation.

2.1 International Regulations and Recommendations

The United Nations International Maritime Organisation (IMO) has played a crucial role in the definition of a stable regulatory corpus for marine environment protection and the IMO's Conventions have set the basis for mostly all national and regional legislation.

The first agreement reached by the IMO in terms of maritime environmental prevention and control was published under the heading **International Maritime Organisation (IMO) Convention for the Prevention of the Pollution from Ships (commonly referred to as MARPOL 73/78)** and prohibited the abandonment and dumping of fishing gear (Annex V, Regulation 3) and also highlighted the impact of fishing gear accidental loss (Annex V, Regulation 6).

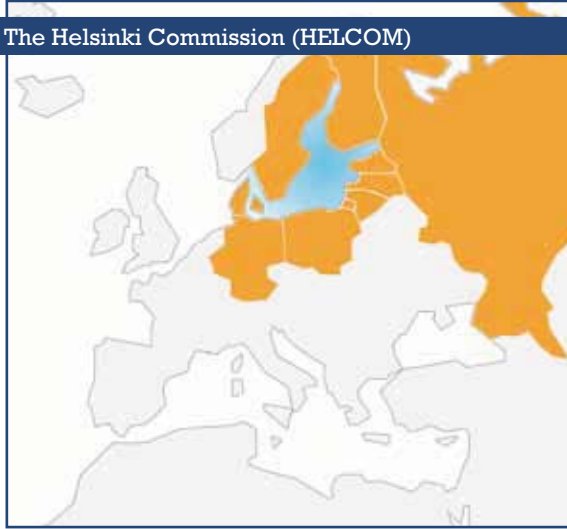
The MARPOL Convention was followed by an important number of ensuing resolutions:

- United Nations General Assembly Resolutions A/RES/60/30 and the A/RES/63/111 on Oceans and the Land of the Sea signed on the 29th November 2005 and 5th December 2008 respectively
- United Nations General Assembly Resolution A/RES/60/31, encouraging close cooperation between states, intergovernmental organisations, UN representative bodies.

International regulations are coupled with an extensive number of regional regulatory corpuses that cover directly and indirectly the field of activity of this report:

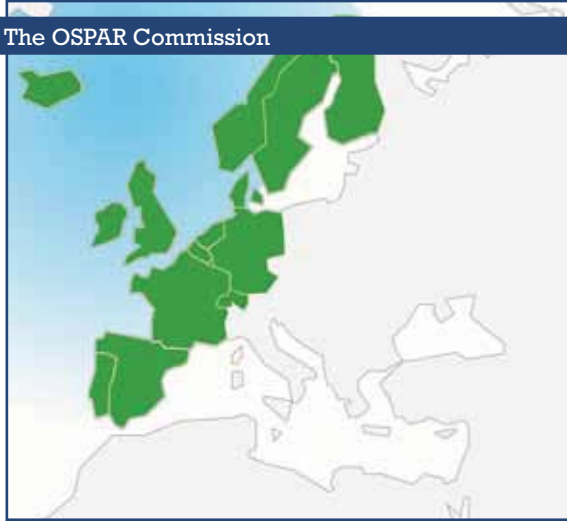
- The Helsinki Commission (HELCOM)
- The Bonn Agreement on North Sea Maritime Pollution – Prevention and Remedy
- The OSPAR Commission
- The Barcelona Convention for the Protection Of The Mediterranean Sea Against Pollution

The Helsinki Commission (HELCOM)



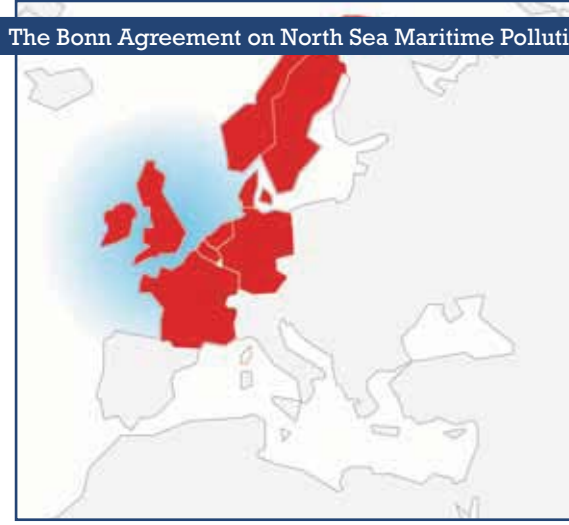
Denmark, Estonia, Finland, Germany, Latvia,
Lithuania, Poland, Russia, Sweden

The OSPAR Commission



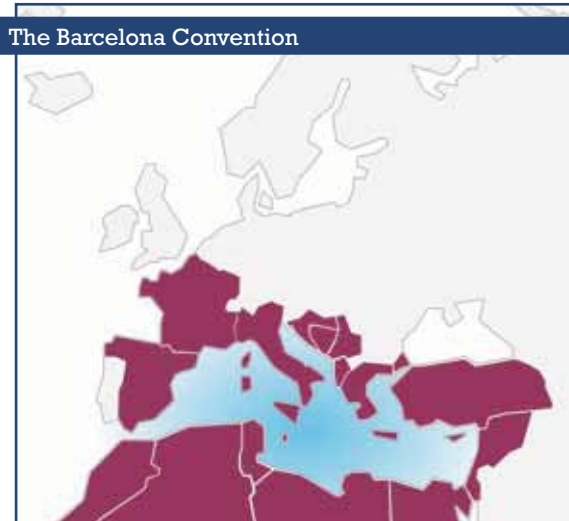
Iceland, Ireland, UK, Norway, Sweden, Finland,
Denmark, Luxembourg, Belgium, Netherlands
Germany, Switzerland, France, Spain, Portugal,

The Bonn Agreement on North Sea Maritime Pollution



Belgium, Denmark, EU, France, Germany, Ireland,
Netherlands, Norway, Sweden, UK

The Barcelona Convention



Spain, France, Monaco, Italy, Malta, Croatia, Albania, Greece,
Cyprus, Turkey, Syria, Lebanon, Israel, Palestinian
Territories, Egypt, Libya, Tunisia, Algeria, Morocco

2.2 European Union Regulations and Recommendations

The European Union (EU) has integrated the obligation to comply with Environmental protection requirements into all its policies within Article 6 of the Community Treaty, after the issue had already been contained within the Article 174 of the Community Treaty (ex Article 130).

The Waste Framework Directive 2008/98/EC constitutes the legislative framework for the handling of waste in the European Union and has set the basis to minimise the negative effects of waste generation and management on human health and the environment.

The integration of environmental protection plans from fishing-related activities has been gaining importance within the European Union's environmental priorities. The European Parliament passed on 23rd October 2000 the "Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy" (most commonly known as the **EU Water Framework Directive**) establishing an integrated approach to the protection, improvement and sustainable use of rivers, lakes, estuaries, coastal waters and groundwater throughout the EU territory.

Other EU Directives were passed aimed at preventing negative effects on the en-

vironment from the land filling of waste and environment protection such as the EU Directive on the landfill of waste (Directive 1999/31/EC) or the EU Directive on the conservation of natural habitats and of wild fauna and flora (DIRECTIVE 92/43/EEC).

Following these publications, the environmental impact of fishing activities became the focus of the EU's legislation under the Article 1 of the new Common Fisheries Policy Regulation² (2371/2002).

Subsequently, in 2002, with the publication of the **Directive on Port Reception Facilities for Ship-generated waste and cargo Residues (EC2000/59)** the European Union addressed again the issue of illegal dumping of waste, and established a regulatory mechanism that indirectly addressed the issue of ghost fishing.

In 2004, the European Commission published a new communication under the heading Promoting more Environmentally-friendly Fishing Methods (CEC, 2004), identifying "ghost fishing" prevention and control as part of the new drive to tackle unwanted catches. A year later, in March 2005, the EC adopted a Commission Regulation 356/2005 laying down detailed rules for the making and identification of fishing gear as well as for the identification of fishing gear with durable labels.

Another European instrument directly addressing the issue of marine litter was the **Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008** establishing a framework for community action in the field of environmental policy, also known as the Marine Strategy Framework Directive³. This strategy aims to enable the sustainable use of marine goods and services and to ensure the marine environment is safeguarded for the use of future generations.

Later on, on the 1st September 2010, the European Commission made public a decision on Criteria and methodological standards on good environmental status of marine waters C (2010) 5956 (2010/477/EU) that outlined the key criteria necessary to achieve good environmental status by 2020 under the Council directive 2008/56/EC establishing a framework for community action in the field of marine environmental policy. This long term strategy, framed under the objectives of the EU Agenda 2020, needs to be seen as an important step in the implementation of environment-friendly initiatives at the European level.

Finally, another legislative action related to the protection of the maritime environment and directly linked to the project's scope of action is the **Integrated Coastal Zone Management (ICZM)**, a recom-

mendation adopted by the European Parliament and the Council (and included within EU's Coastal Zone Policy) that defines the main principles for the effective planning and management of coastal areas, based on the proactive interactions of all the agents involved and taking into account both maritime and terrestrial aspects of coastal management.

Each Member State is responsible for the implementation of these International recommendations and the EU's regulatory framework by means of national and regional strategies and legislative instruments.

2.3 Fishing gear (nets and related apparel) and Expanded Polystyrene Boxes properties and their life cycle.

The impact that EPS boxes and fishing nets wastes have in highly-active fishing ports and their rather complex management system has prompted the interest of the 3R – FiSH project partners.



The special treatment of fishing fleets together with their two-folded influence on the marine environment and ports needs to be taken into consideration when designing appropriate strategies at EU level. In this sense, some national legislative frameworks have taken the necessary steps to integrate this idiosyncratic nature in their regulatory provisions.

2- The Common Fisheries Policy – A user's guide. Luxembourg: Office for Official Publications of the European Communities 2009 — 36 pp. — ISBN 978-92-79-09874-1.

3- The Marine Strategy Framework Directive establishes European Marine Regions on the basis of geographical and environmental criteria. Each Member State - cooperating with other Member States and non-EU countries within a marine region - are required to develop strategies for their marine waters.

2.4 Concepts and Definitions: waste/gear and EPS Composition

Fishing nets and related apparel

Increasing amounts of discarded and obsolete fishing nets and related apparel are now stored in port facilities, storage areas or are simply discarded at sea from vessels, with the increasing economic, environmental and logistic impact.

The advances achieved in new material technologies and in the mechanisation of gear handling systems have improved the potential for innovation in the uses and applicability of fishing nets and related apparel during the recent years but has also had a significant environmental impact, with a growing amount of non-degradable amount of lost and discarded gear and apparel.

Recovery and recycling initiatives have gained momentous importance and are becoming more and more popular among the sector representatives. These initiatives and new developments have

resulted in: requirements to port authorities, specific handling and disposal requirements for all the agents using and handling these materials and new classification and segregation constrains.

The material composition of fishing nets is, together with their typology, the most influential issue when designing and implementing a recycling process. Among the most widely used of the fibres are polyamides, such as nylon, and polyethylene (PE). These materials ensure a higher durability of the nets and they can be adapted according to the specific needs of the user or to the fishing method used.

Currently, new usages and materials are being introduced in the materials that compose fishing apparel. Among these innovations it must be highlighted the use of metallic nets and semi-rigid plastics that will seriously hinder the whole proc-

ess (increasing the need to perform accurate segregation and cleaning processes prior to any transformation process)⁴.

Other materials can also be found in fishing nets and related apparel and that must be considered when defining specific recycling strategies. For instance, polypropylene is widely used in the composition of ropes, cables and other related apparel.



When designing retrieval and recycling initiatives it is important to bear in mind that the material composition, the characteristics and the previous usage of the fishing nets and related apparel will influence the potentialities and the requirements of the whole process.

⁴- Although synthetic fibres are more expensive than natural ones they offer additional technical and usability benefits that have turned them into the most widely used in the fishing industry.

The definition of waste collection and recycling strategies will require the direct involvement of both the port authorities and the concessionary firms active in them.

The Expanded Polystyrene - EPS

Expanded polystyrene is mainly used in the fishing industry for the production of fish boxes, food trays and packaging covers, because of its characteristics (insulator, impact protector, low weighted, floatable and hygienic). The fishing industry is an important consumer of EPS packaging the disposal of which creates serious problems and costs for the industry agents.

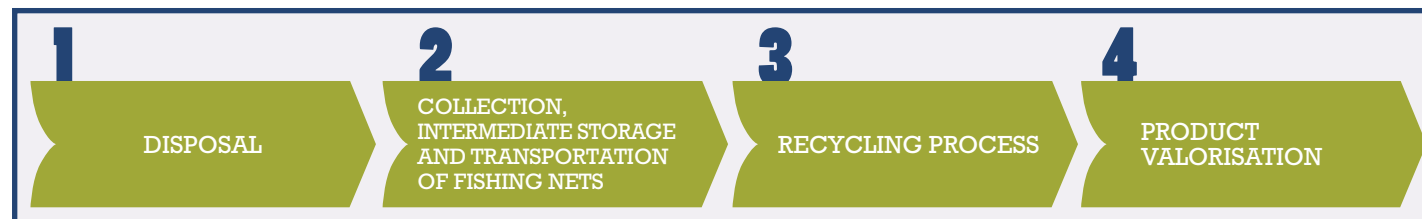
Although EPS boxes can sometimes be stranded and lost in the sea, the major part of EPS waste in the fishing industry is generated in port facilities and throughout the ensuing logistic and commercialisation chains (mainly generated during the handling, commercialisation and transportation of fishing products and goods).

Among EPS Recycling constraints are the following: EPS does not rot or disintegrate easily and when incinerated it generates important amounts of polluting emissions; EPS density does also generate an important transport problem due to its uneven weight-volume characteristics and when disposed in landfills it occupies a significant amount of land; moreover, once put in contact with organic waste, water or blood remains it can be easily contaminated and can create odour problems.

Although EPS has not been traditionally seen as a high-target recycling material, innovative solutions are currently being implemented, with the sector growing fast in terms of capacity and technological innovation.



Key waste management steps for EPS, fishing nets and related apparel



2.5 Waste typologies

Under the Waste Framework Directive⁵ the European Union defines waste as an “object the holder discards, intends to discard or is required to discard”. Following this definition, the EU states that “once a substance or object has become waste, it will remain waste until it has been fully recovered and no longer poses a potential threat to the environment or to human health”.

This directive establishes key concepts on waste generation, recovery and disposal and puts in place the essential requirements for its management (notably the obligation to have permits or to be registered) and the obligation for Member States to draw up waste management plans. Moreover, this waste policy has established a waste management hierarchy.

In general terms, a solid waste can thus be defined as any discarded material that is abandoned by being disposed of, burned or incinerated, recycled or considered “waste-like

By typologies, solid-wastes can be classified in the following categories Non-Hazardous Waste and Hazardous Waste.

According to the EU's Waste Framework Directive, the materials analysed in this report, are classified as Non-Hazardous Waste

⁵- Waste Framework Directive (Directive 2006/12/EC)



3. Waste generation

Fishing waste is produced mainly in port facilities and on-board of vessels and once discarded it is either stored in landfills or dumped at sea.

Although the amount of waste deposited in ports by boats and vessels, recent studies have proved that only an estimated 12% of the waste generated in ports originates in fishing activities, with the remaining 88% generated by land based inputs (handling activities, commercialisation processes, transportation, etc

Like the most part of the solid waste generated in port and fishing activities, EPS and fishing nets are disposed via the normal waste management routes, namely landfill and incineration. Problems related to waste landfilling include: perpetuating the environmental impact, problems in terms of volume and filling capacity, release important amounts of polluting emissions, and problems of high traffic generation.

According to the FAO definition ghost fishing occurs when passive gear such as gillnets, trammel nets, wreck nets, and traps, have been lost or discarded and continue to catch both commercial and

non-commercial species (fishes, crustaceans, birds, marine mammals and turtles) and its entanglement may cause technical problems to fleets.



3.1 Waste Disposal

The issue of waste management is subject to a plethora of legislative requirements dependent on waste types, scale of generation and treatment/disposal methods employed. Local and National Authorities,

EU representative bodies, port authorities, and sector representatives, all have a role to play in the regulation of waste management and the development of alternative options⁶.

Recommendations

- Waste management strategies need to take into consideration the specific requirements of waste disposal and collection in ports, including the nature of the materials, their durability, the climatic conditions and the related transportation issues.
- It is important to avoid the use of generic containers since they pose important trammels during the recycling process by making it necessary to segregate the materials.
- Ensuring a proper segregation from other materials will ensure that they can be kept in storing facilities maintaining an optimal state to be recycled.
- Protocols for reception should be carefully adapted to 4 different states in which nets and related apparel are collected: clean, quite clean, rather dirty and dirty.

- It would also be important to invest efforts in the sub-segregation of specific materials; for instance, polyethylene and polyamides will need to be dully segregated due to their recycling requirements.
- Segregation should take place either at the reception point in port facilities or at the final treatment plan.
- It is fundamental to generate collaboration initiatives between port reception facilities and treatment plants aimed at defining the responsibilities to be assumed by each of the involved parts.
- Provide clearly indicated disposal areas to encourage fishermen to deposit the nets, lines, trawls, accumulated in their vessels or found at sea.

- Create a standardised system of waste collection based on the typology and nature of the materials received
- Negotiate long term contracts for the disposal of garbage premises with preferred contractors;
- Develop training and informational events addressed to fishermen and ports personnel. Implementing a well defined and standardised collection system will have important consequences for ports personnel since they will need to operate in an area where they have little knowledge and experience and in which these new responsibilities will fall on very few staff

⁶- Plastic waste in the environment: under Framework contract ENV.G.4/FRA/2008/0112 European Commission DG ENV.



3.2 Waste management

After the appropriate collection, waste fishing gear need to be effectively managed, treated and prepared for the recycling process. Many issues will need to be considered during this phase, including the cleaning of the materials, the

intermediate storage and preservation process and the identification of the most appropriate transportation methods. It is also important to define who will be the responsible agent for each one of these phases.

Some of the **measures that might contribute to increase the added value chain of fishing nets and EPS recycling processes** are:

- Establish specific and segregated storage areas for fishing nets and EPS boxes.
- Setting up the minimum standards for segregation and cleaning processes of the waste received for intermediate storage.
- Ensure the climatic and location conditions for the optimal conservation of fishing nets and EPS boxes.
- Perform an environmental impact study for intermediate storage facilities.
- Levy a minimum fee towards the storage of fishing nets, apparel and EPS, in order to indirectly finance the process.
- Reaching commercial agreements to transport collected waste to final processors and treatment plants.
- Ensure that the logistics requirements allow for the fluent cooperation between port facilities and final processors.

3.3 Waste treatment and recycling processes

Fishing Nets

The treatment, recycling and transformation of fishing nets has gathered the attention of the sector during the last decade. More and more initiatives aimed at reusing fishing nets waste are being developed in the sector, with their most successful by-products being the production of plastics based on extrusion processes and their energetic valorisation both in the form of fuel and plasma-induced gasification.

To guarantee that the materials can be successfully recycled it is important to ensure that they are fully separated and segregated from other components (as it has been mentioned in the previous chapter); this process can consist in up to five different stages (always assuming that the initial cleaning processes have been implemented either at the port facilities or at reception) in order to ensure the necessary separation and avoiding that no exogenous or organic materials are merged with fishing nets and EPS boxes.

I. Plastic production through extrusion processes

II. Plastic production through injection moulding process

III. Energetic valorisation: Fuel generation

IV. Energetic valorisation: Plasma Technology-Based Gasification

I) Plastic production through extrusion processes

The aim of this process is to **transform waste fishing nets into pellets** from which to produce different plastics. When performing these recycling processes an issue to be analysed is the characteristics of the received nets; in this sense **four different typologies** can be described:

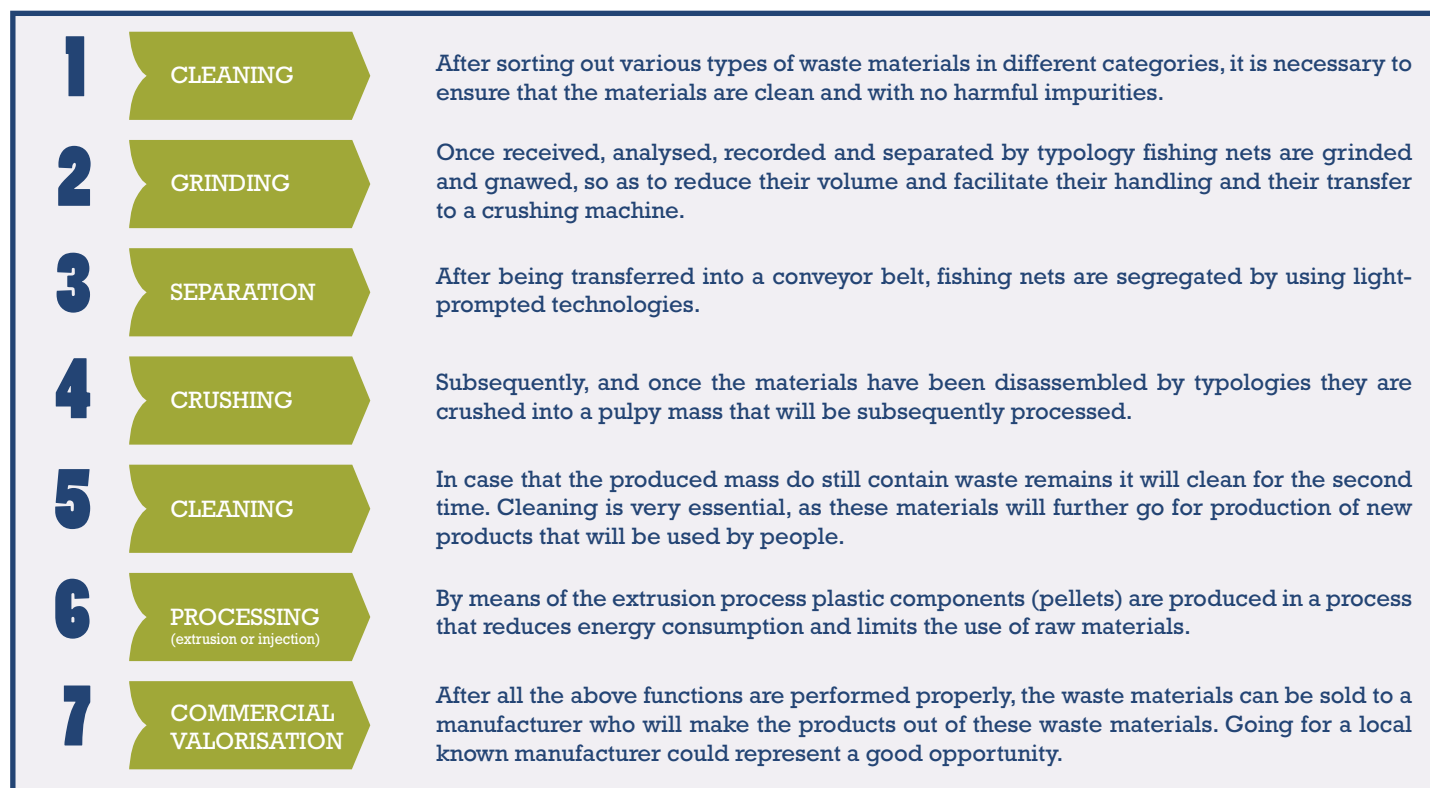
- a) Non-classified clean and homogeneous waste
- b) Classified clean and homogeneous waste
- c) Dirty and homogeneous waste
- d) Dirty and non-homogeneous waste

It is important to remember that not all types of fishing nets can be recycled; only those composed of nylon and polystyrene can be successfully recycled.

In general terms the nature and the characteristics of the fishing nets gathered in port premises can be generally classified into the third category (dirty and homogeneous waste). As it has been suggested in the previous chapter, ensuring that a cleaning process takes place at source, prior to the recycling activities, would facilitate the whole process.



In brief, **the main phases of any mechanical recycling process** are:

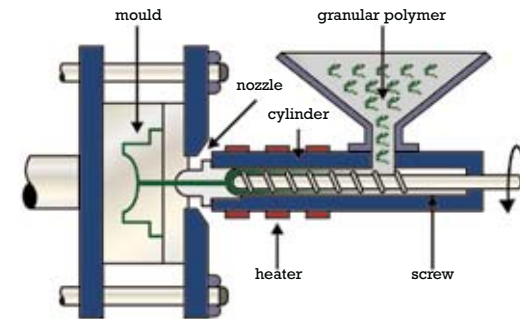


3.3 Waste treatment and recycling processes

Fishing Nets

II) Plastic production through injection moulding process

The aim of this process is to inject the pellets obtained by the extrusion process to obtain a standard ISO samples to characterize the mechanical properties of the recycled fishing nets and in an industrial level, to obtain new products from the recycled fishing nets (such as boxes).



The process consists in five simple phases:



III) Energetic valorisation: Fuel generation

This recycling system is based on the use of a thermal decomposition process, an innovative process that has been already developed by some companies; this system uses a heat-based process that transforms fishing nets into an eco-friendly fuel similar to diesel fuel (this fuel can be used as in the automotive sector and can be used as a basic component of paint).

The fuel produced by means of this system has the following **characteristics**:

- The rate of transformation of fishing nets into fuel is of 80%
- The cetane number is similar to that of Diesel A
- Minimum sulphur index
- It does not require lubricant additives
- Similar characteristics to Diesel A

The **environmental benefits** of using this energy are the following:

- Minimum gas emissions
- Minimum noise and vibrations generated
- Insignificant spilling
- The waste generated in the chamber is inert

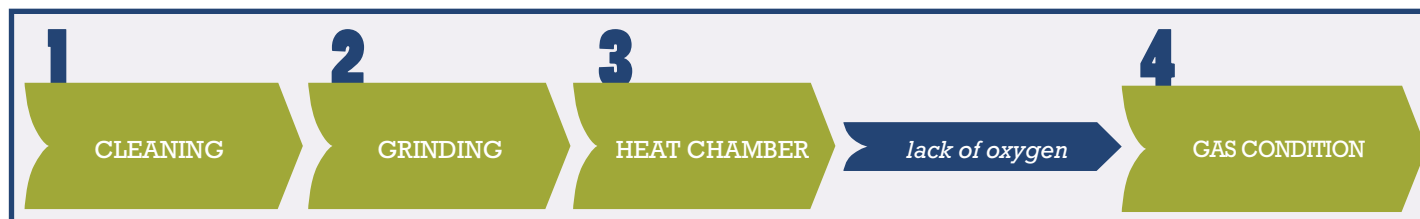
That the nets are in optimal conditions when received is fundamental to ensure the effectiveness of the whole process (the cleaner they are, the most efficient the process will be).

IV) Energetic valorisation: Plasma Technology-Based Gasification

Plasma technology-based gasification system creates an environment of high temperature with an almost complete lack of oxygen in which materials are decomposed into a basic molecular structure.

The waste used in this process is transformed into usable products in a 99% of the cases.

The fuel generation process:



3.3 Waste treatment and recycling processes

Expanded Polystyrene

In general terms, the most important methods and techniques used in EPS recycling processes are:

Processing of waste expanded polystyrene (EPS) floats into polystyrene ingots:

This technique has been analysed as part of the Northwest Pacific Action Plan, developed under the United Nations Regional Seas Programme. The main product recycled following this technique is waste expanded polystyrene. The low quality of the product and the associated costs of reducing the odour have to be seen as the major problems of this type of recycling process.

Processing of waste expanded polystyrene (EPS) products into polystyrene pellets using limonene (monomerisation).

This is a low energy intensive process (since limonene can be dissolved at room temperature); however, the capital costs of the recycling facility are relatively high.

Reuse of EPS through Three Recycling Processes:

- **Material recycling**
To recycle into raw materials to make plastic products.
- **Chemical recycling (material recycling in a broad sense)**
To decompose back to raw chemicals (gas or oil) by heat and pressure and reuse as fuel, etc.
- **Thermal recycling**
To recycling by production of heat energy by combustion and reuse for power generation, etc.



All these processes require that the EPS is compacted first in order to gain savings in the transportation and eliminate the gas contained inside the EPS to correctly transform it.

Compaction processes can be performed by using heating systems (i.e, thermal densification) or non-heat based methods (i.e cold compaction).

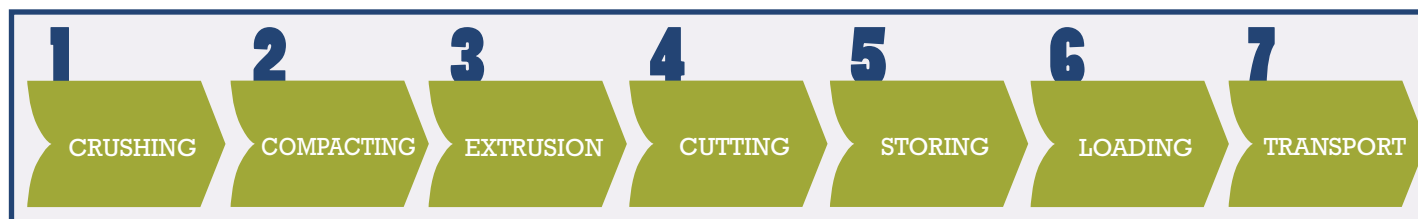
Thermal densification involves breaking up and heating EPS inside a controlled-temperature chamber. The temperature is accurately controlled to allow the EPS to melt without burning. This collapses the expanded foam cells, enabling it then to be recycled into other products.

Higher compaction ratios (up to 95% volume reduction) can be achieved using higher temperatures but the end product has fewer recycling options and is most suited to incineration with energy recovery or disposal to landfill. Thermal densification equipment will also treat and densify other plastic waste products, e.g plastic drinks bottles. However, if there are paper labels included with the fish boxes the thermally-densified product cannot be recycled.

The two resulting by-products of the processes mentioned above are the production of energy and the recycling into other plastic forms.



Example of a cold compaction system



3.4 Organisational and logistic requirements

Some **practices** will ensure the efficient establishment of an accurate strategy:

■ Vessels and boats are already equipped with fishing waste disposal containers that can be easily identified and segregated at port reception. Specific bins should be disposed for the collection of fishing nets and EPS packaging.

■ Port facilities are obliged to dispose of a management plan written in accordance with the guidelines set in the international and national legislation. These management plans that already include procedures for collecting, storing, processing and disposing waste and specific regulations on the use of equipment on board should be updated with specific provision for the management of fishing nets and EPS packaging.

■ Transfer notes should be included providing guidelines on how to transfer and handle waste from vessel and boats to port reception storage facilities. These guidelines must include:

- An accurate description of the types and quantities of fishing nets and EPS being transferred.
- Waste containers labels and indicators according to their contents.

■ The transfer note should be completed by both by the fishing nets and EPS deliverer and recipient.

■ The intermediate storage process must ensure that waste material is clearly identified and segregated.

■ Storage facilities must consider that the collection process is effectively performed and that location requirements are correctly addressed. Ensuring that recycling points are located in port proximities and that they are shared and used in consortium by different authorities might help achieve these goals.

■ Commercial agreements between port authorities and commercial firms must be secured to reduce transportation costs and help improving the commercial viability of the process.

■ Compensation or incentivising measures should be established for recycling companies and plants in order to support them assuming the totality of the transport costs related.

■ Certification and standardisation measures could be discussed to enforce the development of the fishing nets and EPS recycling market.

■ Public authorities must get involved in the process and develop market stimulation measures.

■ Commercial contracts must be established between recycling firms and final market retailers establishing an integrated commercial network.

4. Product valorisation and market opportunities

4.1 Transforming waste into market-aimed products

During the last decade, the recycling industry has steadily grown both in terms of market opportunities and technological capacities. Although the current context of economic stagnation experienced during the last years has halted the development of the sector, an increasing number of products made of “sustainable” and “renewable” recycled materials have been reaching the market.

Fishing nets and EPS packaging have not been traditionally seen as key objectives of the recycling industry; the lack of clearly defined strategies and structured proc-

esses must be seen as one of the reasons for the limited attention that these materials have received. Notwithstanding, this very same market under exploitation can be seen as a potential opportunity for its development.

Some **examples** of successful market initiatives are:

- Emergence of companies producing new design products by transforming fishing nets into fabric to manufacture clothing material, homeware products or equipment for public transports.

- The car industry has also benefited from the opportunities posed by the recycling of fishing nets, with important companies, recycling important amounts of nylon fishing nets to manufacture various plastic parts on their motors.
- EPS Fish boxes have a far longer “recycling” tradition than Fishing Nets. There exist in Europe several companies dedicated to the specific tasks of EPS Fish Boxes management and recycling. Some of these companies do perform all the tasks related to the recycling chain, from the collection, cleaning, compaction, recycling and valorisation.

The emergence of the “zero waste” concept is evidence that the recycling industry has the potential to be wholly sustainable.

The impetus and the opportunities of the sector stem both from their expected economic benefits as well as by the increasing demands for green products and environmental concerns.

4.2 Identified commercial applications for Recycled Fishing Nets and EPS materials

Potential uses of recycled fishing nets and EPS boxes are as follows:

IDENTIFIED COMMERCIAL APPLICATIONS FOR RECYCLED FISHING NETS AND EPS MATERIALS	RECYCLED MATERIALS
Plastic Pellets	Fishing Nets / EPS
Energetic valorisation - Fuel	Fishing Nets / EPS
Energetic valorisation - Plasma induced gasification	Fishing Nets / EPS
High Power Diesel at waste-to-electric plant	Fishing Nets / EPS
Artistry elements and materials	Fishing Nets / EPS
Mussel Cultivation Ropes	Fishing Nets
Clothing and bagging equipment	Fishing Nets
Sport Nets	Fishing Nets
Scenic Foot Trails pavements	Fishing Nets
Ski Ramps	Fishing Nets
Art Labs materials	Fishing Nets / EPS
Playground Safety Pavements	Fishing Nets
Chairs	EPS
Engine Plastic Covers	Fishing Nets
Door and Windows Frames	EPS
Hallstands	EPS
CD Sleeves	EPS
Cameras	EPS
Garden Furniture	EPS
Synthetic Wood	EPS
Fencing and Decking materials	EPS
Shop fittings	EPS
Planters	EPS
Picture Frames	EPS
Landfill Lining	EPS
Floating Docks and Bridges	EPS
Beam and Block Insulated Floors	EPS
Precast Concrete	EPS
Nets	Fishing Nets

5. Evaluating fishing gear and Expanded Polystyrene Boxes recycling priorities and strategies

It is important to ensure the active participation of all the agents involved in the process (including decision makers) in the definition and implementation of waste management strategies.

These strategies will need to take into consideration the following **hierarchical issues**:

- Prevent waste mismanagement,
- Promote re-use, recycling and recovery initiatives
- Establish a new sector perspective and raise awareness on recovery

5.1 Market access recommendations

The following is a set of **recommendations that might help fostering the market potentialities for recycled fishing nets and EPS waste**:

- Creating strategic agreements with different retail sectors can improve the market accessibility of the recycled products.
- Working in close collaboration with public agencies and local governments in the identification of potential procurement contracts.
- Integrating fishing waste recycling programmes into the competent environmental strategies to foster the demand for fishing waste recycling initiatives and programmes.
- Regulations should be directed at boosting the demand for recycled fishing waste products.
- Product labelling standards and certificates need to be developed to boost the market development.
- Strategic collaborations with public administration departments, NGO's and consumer groups can contribute to increase consumer awareness on these products.

5.2 Inter-sector strategic collaborations

At an international level, the main objectives of inter-sector initiatives should be:

- Make choices on how to improve waste management mechanisms and channels.

- Encourage citizens, industry and governments to take responsibility for their contribution and find solutions to the waste management process.

- Share openly and freely technical, legal, policy, community-based and economic / market-based solutions that will help improve the development of fishing waste recycling initiatives.

- Facilitate all those initiatives and commercial actions aimed at turning waste into a resource in an environmentally sustainable manner.

- Develop global, regional, national and local targets to enforce the development of recycling initiatives.

- Improve knowledge and understanding among other sectors representatives of the need and benefits of developing recycling initiatives.

- Encourage financial support for fishing waste recycling commercial actions.

- Participate in a global network of stakeholders committed to understanding, preventing, reducing and managing marine debris in an environmentally sustainable manner;



5.3 Eco-design

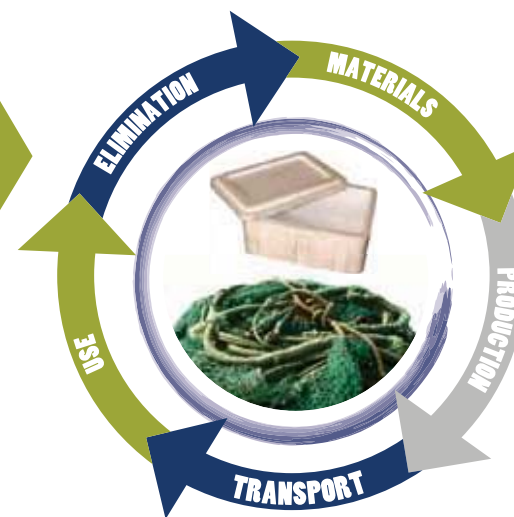
The growing importance of the role of firms in the mitigation of their products' environmental impact is expected to have significant consequences for the development and implementation of recycling initiatives.

The EU published in 2005 the Ecodesign Directive, 2005/32/EC, amended by directive 2009/125/EC that seeks to integrate environmental aspects in the design phase of products with the aim of improving their environmental performance throughout the product's life cycle.

These efforts could be oriented towards:

- Increasing efforts should be invested in avoiding those materials that have a negative environmental impact, at the same time that research and innovation is being invested in the identification and development of more environment-friendly products.
- Promotion and communication efforts should be carried within the sector to raise awareness among companies of the role of eco-design for an enhanced access-to-market.
- Conduct research in the development of materials more easily-recyclable and that allow for a reduction of costs among the agents involved in the process and to consider.
- Guidance should be provided by the agents in charge of the recycling process as to the specific requirements and circumstances that might assist the achievement of these results

Moreover, competitive pressures from the market will benefit those products that provide a visible added value for the industry. In this sense, with the fierce competition faced by the market and the growing concerns for environmental issues, the importance of eco design in the final composition of the products it is expected to gain in importance.



5.4 Awareness raising initiatives

The insufficiency of direct regulatory oversight upon fishing nets and EPS recycling initiatives in the fisheries sector makes it necessary to encourage the agents' involvement by relying on the development of clearly defined informational and awareness raising initiatives.

Public awareness campaigns should be directed at informing all the agents of the fishing industry on the need to support fishing net and EPS recycling initiatives and to foster support for their effective compliance. These campaigns might help to advance social and cultural change both within port authorities, managerial cadres, fishermen, sector-related professionals and representatives of the concessionary firms performing their activities in port facilities.



Among the most important activities foreseen in this regard are:

- Educational activities aimed at fishermen concerning the harmful effects of discarded or lost nets and EPS and the new opportunities offered by recycling initiatives.

- Educational and training programs targeting management cadres, including owners and operators of vessels and shore-based garbage management systems, port authorities as well as government managers describing their responsibilities throughout the whole process.

- Informational activities addressed to non-profit organisations. Non for profit organisations do play an important role in conducting public education projects and the positive benefits of recycling initiatives for the fisheries sector.

- The establishment of Marine Debris Information Offices can also help

fishermen and other agents recognising that improved handling of fishing-related debris is in their own interest.

- Knowledge and expertise transfer initiatives between public and private agents for the definition of new solutions for the process.

- Regular meetings with private sector agents (recycling companies, transport and logistics firms, etc) in order to raise awareness on the potential benefits of recycling initiatives of fishing waste. It is better to conduct these meetings with those companies already involved in waste recycling tasks since they will also serve to ensure the smooth performance of the system.

- Regular information and communication actions on the developments and achievements reached by the sector.

5.5 Market development Support Policies

Institutional involvement is indispensable for the successful development of the fishing waste recycling sector and policy measures need to act as the pillars upon which the sector can grow and expand.



Among the most important measures of policy support identified by the study are:

■ **Setting up an appropriate legal framework:** Endorsing a set of guidelines and recommendations establishing the operational framework for the waste management and recycling process.

■ **Local and regional plans integration:** Fishing nets and EPS litter and recycling initiatives should be incorporated into local, regional and national authorities' sea management plans. The involvement of port authorities is paramount for the effective and informed integration of these strategies.

■ **Fostering inter-sector dialogue:** Public administration will play a key role in fostering the dialogue among the different agents of the sector in order to identify common objectives.

■ **Streamlining the recycling chain:** For the successful development of the recycling system it is important that public bodies work together with the sector representatives towards the definition of a clearly defined recycling chain including a legally binding system of waste management and

waste valorisation. Moreover, public administrations must promote cooperation between different port authorities and sector-related agents.

■ **Implementing indicators:** Implementing indicators to evaluate the logistic requirements to ensure an efficient collaboration between the agents involved in the recycling process (fishermen, port representatives, recycling companies, etc).

■ **Developing market support initiatives for fishing nets and EPS recycled products.**

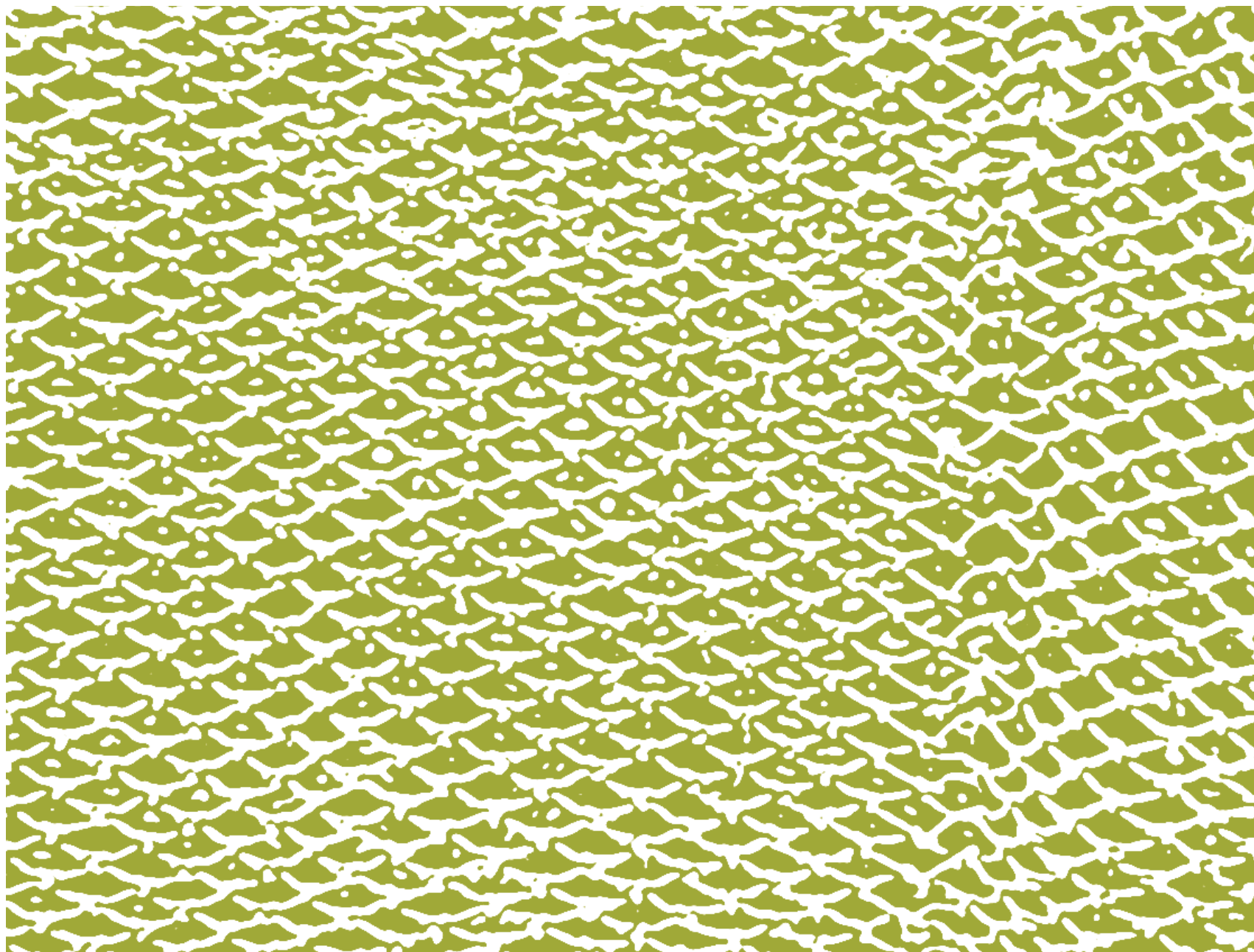
■ **Creating new market consumption paradigms:** Institutional agents can contribute to the sector development by promoting new consumption attitudes.

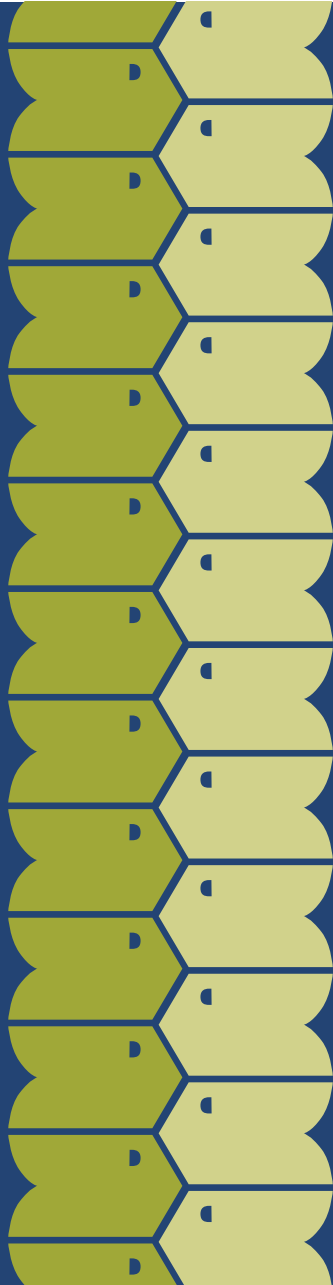
■ **Strengthening public awareness:** Public administration need to play an important role in implementing raising awareness initiatives and public education programmes on the opportunities and benefits generated by fishing waste recycling initiatives.

5.6 Summary of Findings and Recommendations

Recommendations

- Set up an appropriate legal framework
- Involvement of competent authorities in the integration of fishing nets recovery and recycling initiatives within strategic plans
- Implementation of certification and standardisation measures
- Ensure public administration involvement in the streamlining of waste management strategies
- Create public-private partnerships for the development of market support initiatives
- Encourage financial support for fishing waste recycling initiatives
- Create strategic sector agreements with other sectors
- Create new consumption paradigms
- Foster research and innovation activities
- Promote the implementation of eco-design solutions
- Foster inter-sector collaborative actions
- Implement a set of indicators to evaluate the growth of the market
- Implement and foster education and informative activities on the benefits of fishing gear recycling activities
- Strengthen public awareness on the environmental impact of fishing waste and the importance to define corrective measures
- Encourage knowledge and expertise transfer on technical and logistics channels





www.3rfish.org