LIFE Environment project

Integral Networking of **F**ishing Sector **A**ctors to Organize a **R**esponsible, **O**ptimal and **S**ustainable Exploitation of Marine Resources

(FAROS)

LAYMAN'S REPORT

FAROS

What does fishing discards mean?

When fishing, and particularly when using rather unselective fishing gear, a whole range of very different marine organisms are caught when they are trapped in the nets or in other fishing tackle such as on long-line fishing hooks or in bottom gillnets. Part of these trapped species, the majority of which are dead or injured, is thrown back into the sea which constitutes what is known as **fishing discards**.

These discards are mainly made up of fish, crustaceans, molluscs, but also include the organisms that live on the sea bed and even occasionally cetaceans, turtles and birds. The onboard discard volume and type are subject to the influence of many factors: by fisheries legislation, the fishing technique use, the fishing zone and period, along with market factors. The can likewise vary according to each boat and the requirements of the crew itself.

Discards are now one of the main problems associated to fishing, both from a socio-economic and environmental perspective. When the discard practice is added to the other major problems facing fishing, such as overfishing of the species and the unreported illegal fishing, this unnecessary waste of high-value resources cannot go unnoticed and calls for the search for solutions, involving all the stakeholders in the fishing sector, from fisheries associations to European, national and regional authorities, without forgetting industrial processors and researchers.

To what is this onboard squandering of biomass that we call discard due? The two main causes or circumstances underlying this waste of resources are **economic grounds** and aspects linked to **current legislation**.

- In the first case, many species stand out as they do not have a traditional and/or known commercial use in the zone. They therefore have no interest for the fleets or their value is very low and therefore part of the catch or its less valuable part is discarded.
- As regards the legislation, aspects such as the EU quotas for the different species sometimes force fishermen to throw back to sea, for example, some species that they are not authorised to catch, or the quota overages of the target species in question as they are not authorised to offload them. The commercial species with legal minimum landing sizes are also subject to a high discard rate.

The fleets decide which part of the non-target species they discard onboard. The commercial interest of each species, the sizes and/or the proportion of species retained/discarded may vary in accordance with fisheries regulations, market prices (which often fluctuate even according to the catches of other boats), weather conditions, presence/occasional absence of the main target species, space available

onboard, the refrigeration or preservation techniques, the preservation state of the fish, etc. Thus, as we have seen, the decisions regarding the discard can be grouped into two main categories:

- **Economic grounds:**

  - There is no or hardly any market for some species and/or sizes.
  - Need to maximise the amount of species with greater market/commercial value.
  - Preference for the larger specimens of a species *(high grading)*.

- **Legislative grounds:**

  - Quota underage or overage for a specific species in the fishery, very important in the mixed cases.
  - Existence of minimum legal sizes (MLS - given that species under the minimum legal size cannot be landed).
  - Existence of protected and, therefore, non commercial species.

In recent years, this problem, which affects world and European fish stocks, has been denounced by many NGOs, and by different public research institutions. As regards the need for and proposal of solutions to solve the discard problem, two complementary and main approaches can be considered. On the one hand, **defining measures aimed at reducing discards**, such as improving the selectiveness of fishing techniques, thus avoiding the catching of unwanted species by zones or seasons. On the other hand, **defining and implementing technologies that enable increased use of the discards**. The research endeavours are therefore aimed at defining solutions to prepare value-added products and composites for food and nutrition (gelatines, chitosan, oils, etc.) using unwanted by-catches.

Definition of discards and recovery performed by the FAROS project available at: http://www.educabarrie.org/palabrario

The FAROS Project

The aforementioned situation is the context for the FAROS (LIFE08/ENV/E/000119), co-funded by the **European Union LIFE programme** *(Duration from January 2010 to April 2013; Total budget: €2,182,906 % EU co-funding: 48.71%).*

This programme is the European Union's funding instrument for the environment. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental policy and legislation by co-financing pilot or demonstration projects with European added value. **The "Environment Policy and Governance" section co-finances initiatives that contribute to the implementation of European environmental policy and the development of innovative policy ideas, technologies, methods and instruments.**

FAROS is led by Instituto de Investigaciones Marinas – CSIC, de Vigo and the partners are Centro Tecnológico del Mar – Fundación CETMAR, the Instituto Español de Oceanografía, Autoridad Portuaria de Vigo (APV), the Centro de Supercomputación de Galicia (CESGA) and the Instituto Português do Mar e da Atmosfera, IP (IPMA) from Portugal.

Its main objective is to define an efficient discard management network of the different stakeholders involved in the fishing industry, by optimising the existing synergies between them. This is aimed at:

1. Reducing the unwanted by-catch based on optimum knowledge of the time-space behaviour of the catches (mapping by means of GIS), avoiding fishing mortality of species with no current value and enabling the catches demanded by industry more easily.

2. Developing a comprehensive characterisation of discards in the selected fisheries (based on automated classification, analysis and data collection tools) as potential raw material for different recovery processes on shore.

3. Creating a network to use by-catches for the efficient and integral management of the catch, based on information flows between fleets and shore stakeholders, and to highlight its benefits.

Discard characterisation

a) Identification and quantification

As the first step of the project, a current snapshot was established of the composition of the catch of the fleets considered as part of the project (trawlers from Spain and Portugal operating in the Grand Sole and coastal fishery grounds of Spain and Portugal), by identifying those métiers where the levels of unwanted catches must be reduced (Figure 1). The métier concept refers to the group of fishing operations aimed at a species (or a set of them), using a similar fishing technique, during the same period of the year and/or within the same area and which is characterised by a similar exploitation pattern.

Some of the results obtained from this analysis are summarised in Table 1:

Métier	Target species	Discard volume (t/year)	Discard level (%)
OTB11	*Demersal species*	10,300	53.6
OTB12	*Horse mackerel*	2,000	9.1
OTB13	*Atlantic mackerel* (Seasonal fishery – first quarter of the year)	260	7.3
OTB51	Megrim, monkfish and cod fishery (Boats based in Vigo and Marín)	60,000	74.4
OTB52	Hake, monkfish and Norway lobster (Boats based in A Coruña and Celeiro)	11,000	54.6
PTB11	*Blue whiting and hake* (pair trawling)	4,100	14.2
OTB_DEF_02	*Demersal species*	2,800	-
OTB_DEF_03	*Blue Jack Mackerel and Horse Mackerel* (Seasonal fishing – first quarter of the year)	2,400	-
OTB_CRU_01	*Deepwater shrimp and hake*	1,800	-
OTB_DEF_01	*Horse mackerel*	1,100	-

Table 1. Discard quantities in the analysed *métiers* (Source: FAROS Project)

It should also be pointed out that the species mainly discarded by metier are as follows:

OTB11: Henslow's swimming crab *(Polybius henslowii)*, lesser spotted dogfish *(Scyliorhinus canicula)*, blue whiting *(Micromesistius poutassou)*, horse mackerel *(Trachurus trachurus)*, blackmouth catshark *(Galeus melastomus)*, Atlantic mackerel *(Scomber scombrus)* and hake *(Merluccius merluccius)*. The discards of these species account for **58.2 %** of the total discarded weight in this métier.

OTB12: Blue whiting, Atlantic mackerel, bogue *(Boops boops)* and Henslow's swimming crab. They account for **60.8 %** of the discarded weight.

OTB13: Atlantic mackerel, blue whiting, Henslow's swimming crab. The four account for **82%** of the total discarded weight.

OTB51: Horse mackerel, sea anemone *(Actinauge richardi)*, boar fish *(Capros aper)*, haddock *(Melanogrammus aeglefinus)*, lesser spotted dogfish, blue whiting, megrim *(Lepidorhombus spp.)* and Atlantic mackerel. They account for **59.3 %** of the total discarded weight.

OTB52: Blue whiting, greater argentine *(Argentina silus)*, forkbeard *(Phycis blennoides)*, Mediterranean Geryon *(Geryon longipes)*, Blackbelly rosefish *(Helicolenus dactylopterus)* and softhead grenadier *(Malacocephalus laevis)*. These species account for **45.5 %** of the total discarded weight.

PTB11: Blue whiting and hake, which account for **89.5 %** of the total discarded weight.

OTB_DEF_02: Atlantic chub mackerel *(Scomber colias)*, hake and blue jack mackerel *(Trachurus picturatus)*, representing **57.9 %** of the total discarded weight.

OTB_DEF_03: Atlantic chub mackerel, hake and blue jack mackerel, representing **82.5 %** of the total discarded weight.

OTB_CRU_01: Horse mackerel, hake and blue jack mackerel. They account for **68.4%** of the total discarded weight.

OTB_DEF_01: Blue jack mackerel, Atlantic chub mackerel and bogue. These four species account for **76.6 %** of the total discarded weight.

As can be seen in the table, both the total volumes and the discard rates (catch/discard ratio) are very high in some fishing grounds. The availability of the discard rate and volume per species allows progress to be made in its management by considering the by-catch species as raw materials to supply potential new markets, either for direct human consumption or for different alterative recovery processes.

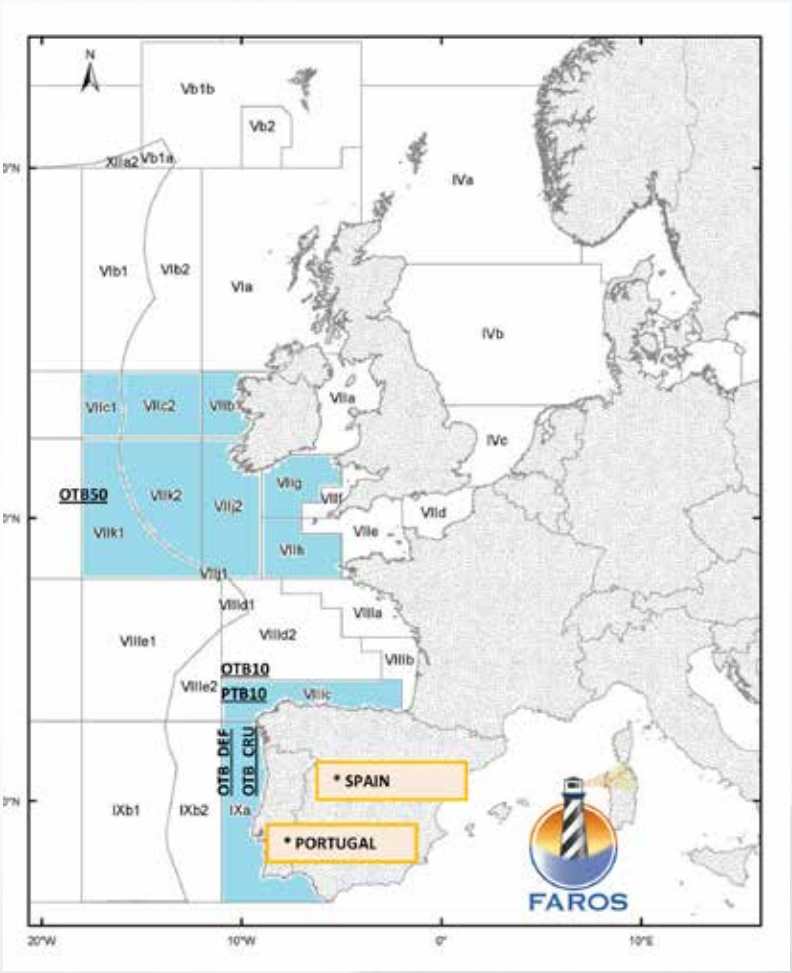


Figure 1. European fisheries on which the project has been focused: Spanish and Portuguese trawlers operating in the Grand Sole and coastal fishery grounds
(Source: FAROS Project)

b) Inorganic and organic pollutants in the discards

The contribution to the sustainable management of this biomass through its optimum recovery will depend on the quality of this new raw material, as well as of the products that may be obtained from it. Scientific studies, apart from fish product surveys on the markets of the different countries and monitoring reports by the Public Administrations and the European Commission, reveal the presence of significant pollutant levels (particularly dioxins, PCBs, organochlorine pesticides and heavy metals) in

the commercial species of different fisheries. Therefore, it is logical to consider the more than possible presence of these pollutants in the discarded non-commercial species even though their levels are usually not determined. In this framework, the pollutant content has been analysed in the most discarded species, including a time-space analysis of heavy metals (mercury, lead and cadmium), PCBs, dioxins and pesticides, along with a statistical analysis of the data obtained. This task is a key step in the correct **definition of recovery strategies** that may overcome the drawbacks arising from certain fish sub-products (such as fish flour, oil, etc.) may concentrate pollutants to non-appropriate levels.

Due to the variability associated with the tissues analysed (muscle, ground whole, liver, skin, cartilage, etc.), the results obtains in discards are not always directly comparable with European legislation (focused on the edible parts of commercial species). However, except in the case of cadmium, **the detected pollutant levels were under the legal limits**, as shown in Table 2.

Pollutants analysed in FAROS	Results that exceed legislation (%)
Mercury (Hg)	**0**
Lead (Pb)	**1**
Cadmium (Cd)	**27.5**
Dioxins and PCBs	**0**
Pesticides	**0**

Table 2. Percentage of results that exceed legislation (Source: FAROS Project)

These data indicate that the discarded biomass may be recovered in different applications of interest. The results that were over the legal limits for the cadmium content are usually for sea anemones or for different tissues, such as liver or the ground whole fish. In these cases, analysis prior to their recovery should be performed thus avoiding potential risks.

New tools for discard management

a) GIS models and systems

As has already been indicated, apart from the possibility of the recovery of the unwanted biomass that is inevitably generated during any type of fishery activity, there is another aspect that must be addressed when considering the subject of by-catches and that is **the adoption of measures to minimise their volume.**

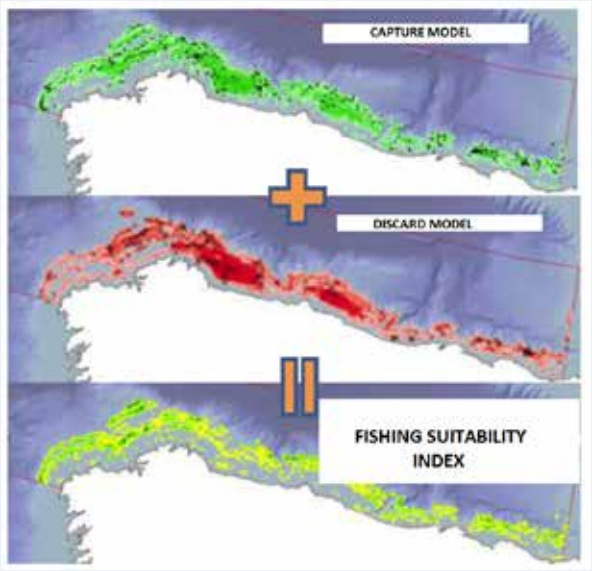


Table 2. Percentage of results that exceed legislation
(Source: FAROS Project)

During recent years, a large part of the research in this area has been aimed at improving the selective nature of the fishing techniques, with good results even though it was sometimes difficult to implement at a real level or scale (due to its technological difficult, its cost, etc.). The FAROS project has sought to supplement this type of approaches aimed at improving the selection of fishing techniques with the **development of tools based on geographical information systems (GIS)** in order to obtain accurate information on the volumes/situation/seasonality of the discard thanks to mathematical models that depend on a set of factors or variables, such as the zone and the period of the year in which the fishing takes place, type of fishery, etc.

Some examples of discard probability models developed as part of the FAROS projects are set out below.

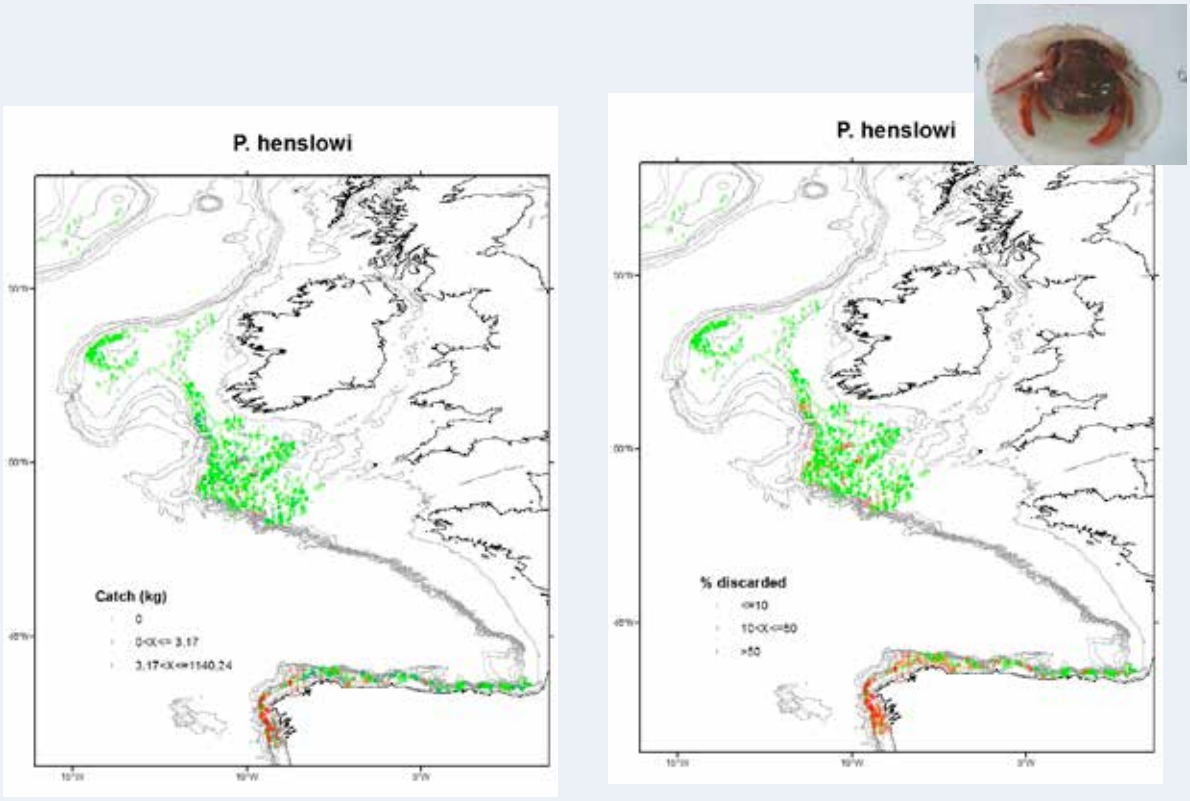


Figure 3. Henslow's swimming crab discard probability model (Source: FAROS Project)

- Henslow's swimming crab *(Polybius henslowii)*: It is mainly caught and discarded along the whole of the Galician coastline (ICES VIIC and north of IXa areas). It may be, depending on the period, the most discarded species in the OTB11 *métier* (9.7% of the total discard).

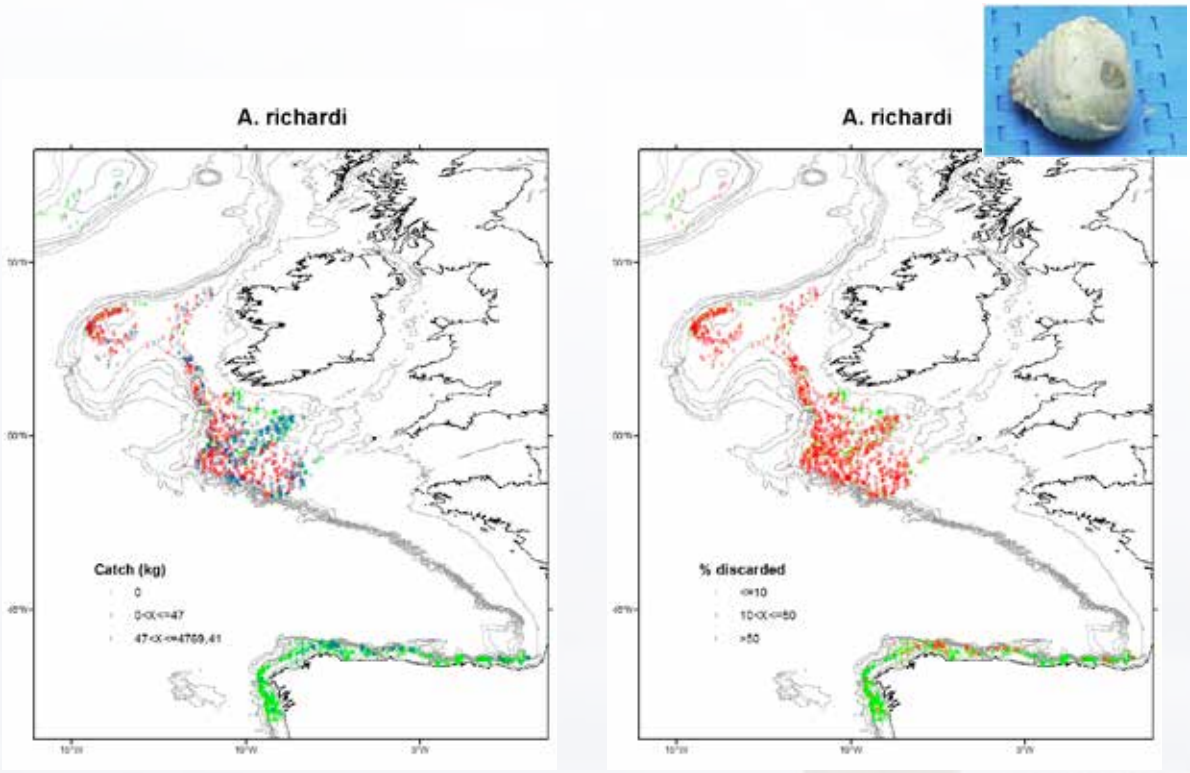


Figure 4. Sea anemone discard probability model (Source: FAROS Project)

- Sea anemone *(Actinauge richardi)*: It is a benthic and sessile organism. It is the second most caught species in the OTB51 métier and is totally discarded in the Gran Sol area.

The final objective of these forecast tools based on geo-referenced models (GIS) is for fishing boats to act as **"online" sensors** that continuously supply the models with real data from their daily activity, and the models will therefore be more accurate and precise. This will enable the fishing to be planned more efficiently both in terms of economic profitability (fishing without discards, without juvenile fish, adult specimens, lower fuel consumption when fishing, etc.) and the environmental sustainability in a specific area, at the same time that a useful tool would be generated in order to facilitate and improve the management of the fisheries based on an eco-systemic approach.

b) New onboard technologies

In order to identify and quantify the most discarded species in the analysed fleets onboard and in real time (data that supplies the GIS models), the FAROS project has developed a series of technologies that can be considered as innovative. The first is a system based on artificial vision called **BEOS** (Biomass Estimator Optical System). This system integrates vision technologies (images captured by a single high-resolution camera placed on the conveyor in the fishing hold), processing optic information and extracting characteristics from the individuals identified in each image by means of a model based in artificial neural network. In the case of the FAROS projects, a neural network has been developed that includes pigmentation, silhouette and morphological characteristics of each individual as a tool to classify and quantify the discards. A schematic diagram of the BEOS can be seen in Figure 5.

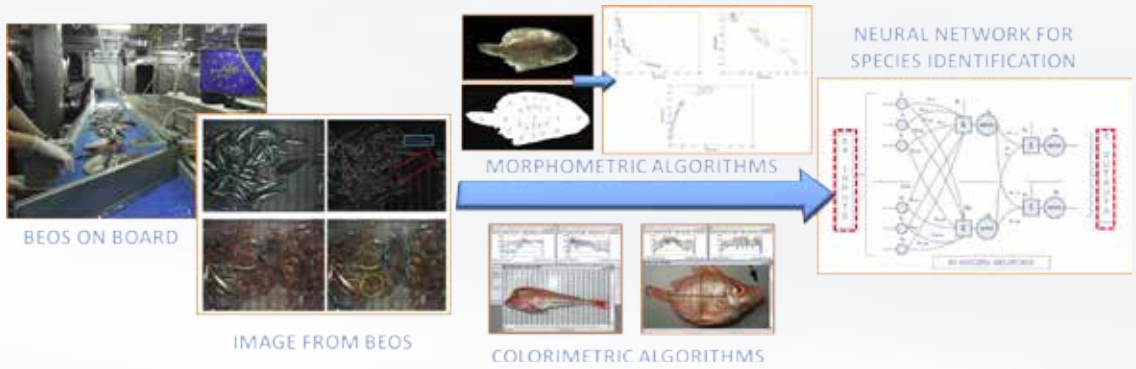


Figure 5. Schematic diagram of the onboard BEOS system (Source: FAROS Project)

The system is therefore capable of identifying up to **seven discarded species** (those identified as being the majority in terms of discarded volume in the target fisheries) with the accuracy levels in the identification of the species and of the weight (in this case according to the size of the individuals) that are indicated in Table 3.

SPECIES	IDENTIFICATION ACCURACY (%)
Megrim	87%
Atlantic mackerel	88%
Boar fish	92%
Horse mackerel	79%
Blue whiting	93%
Sea anemone	95%
Remaining species ("others" category)	83%

Table 3. Species identified automatically using the BEOS system (Source: FAROS Project)

Once the data of every catch is obtained, the relevant information is pre-processed and is sent to shore by means of the device known as the **Red Box**. One of the main tasks of this equipment is the real-time online submission of the data obtained when fishing (satellite connection or 3G/GPRS). The equipment thus records, stores and sends data from each boat to the central system that manages and makes the database generated available to the end users. The confidentiality of the information has been an issue considered since the start of the project, by generating different protection mechanisms throughout the process.

The reduction of the presence of onboard observers, an objective contemplated by the new CFP could be possible thanks to the implementation of the aforementioned onboard tools. In fact, an initial approach to

this future scenario has been shown by the **installation and testing of the technologies developed onboard the Portuguese and Galician trawler fleet** in real fishing conditions, with very positive results being obtained.

c) Management Geoportal Network (MGN)

Finally, and thanks to the joint implementation of the GIS tools and the volume estimation and real time data transmission technologies, the final FAROS objective can be defined, which would be a virtual network capable of including all the stakeholders of the fishing sector (fleets, ports, auction rooms, recovery and transformation industries, end buyers) in order to ensure efficient management of the discards. A virtual environment (called **MGN** – Management Geoportal Network) has been created which connects in real time extractive and recovery/processing industries in order to generate value added (market) for the fishing by-catches. This idea is that the fishing fleets, as the **SUPPLY**, know the market demand (by the recovery/processor industries) for all the species caught during a campaign. On the other hand, the industries on shore (DEMAND) can know in real time the availability of raw material to supply their production lines. This would allow their production to be programmed based on up-to-date information from the management network. Furthermore the MGN (Figure 6) includes landing port information (which can help for the logistic programming of the goods transport, before the boats are unloaded).

The MGN (available, for the general public and for each link in the recovery chain with different levels of access, through the FAROS website: www.farosproject.eu) will be continuously updated with the data collected, processed and transmitted through the BEOS system and the Red Box device.

Finally, and what is more important, it should be noted that these results from the FAROS project may be easily implemented in other European and Spanish fisheries, taking into account the nature of the discard in each and the special onboard characteristics for the deployment of the technology developed.

A set of tools have become available to potential future users that could be managed in the short-medium term by the fishing sector (for example, with the implication of Ship-owners Associations and/or Port Authorities, in collaboration with the ship-owners and skippers) or even by Administration (at regional, national and/or European levels). In any case, we consider as a very important issue that complete data could be always available to research institutions, due to the fact that a better quality in fishing data is required in order to improve the fisheries management.

MGN: Characteristics

- Different user levels (project partners, shipowners, industries, etc.).
- Consulting catches/discard data per species and time period.
- Map visor.
- Catalogue for discard recovery.
- Consulting pollutant levels.
- Discard prediction modelling.
- Reports.

Figure 6. Environment for the real-time discard management: General characteristics, showing pollutants per species and technologies used (Source: FAROS Project)

Some of the fishing and oceanographic vessels involved in the project are shown below. Their involvement has made it possible to achieve the project's objectives.

POSITIVE RESULTS FOR THE ENVIRONMENT AND TRANSFER TO THE FISHING SECTOR

Innovative technology development to reduce the discards in European fisheries (BEOS, RED BOX, MGN):

- **BEOS identifies 6 species discarded by the fleet, along with the "other species" group.**
- **Quantification of the onboard discard volume.**
- **Sending pre-processed data online.**
- **Visualising the available discards (Supply-Demand).**

Determining contaminants in some of the species regularly discarded by the trawler fleet:

- **Between 9-10 discarded species have been analysed monthly to determine their content in heavy metals.**
- **Around 10 discard species have been analysed seasonally (summer 2011 – winter 2012) to establish their organic pollutant contents.**

Onboard testing (fishing and oceanographic vessels) of the developed technologies:

- **3 tests onboard oceanographic vessels (Vizconde de Eza and Miguel Oliver, between 2010 and 2012).**
- **1 test in the Port of Vigo (APV, 2011).**
- **2 tests onboard fishing vessels (Nuevo San Cibrán and Scorpius, in 2012).**

Environment awareness and dissemination: LIFE programme, FAROS project, DISCARDS problem.

Table 4. Quantifying and transfer of results of the FAROS project (Source: FAROS Project)

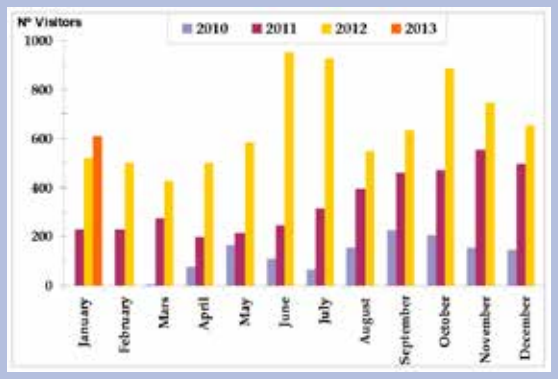
Some Examples of FAROS Dissemination

Project website

http://www.farosproject.eu

Visitors

Total number of visitors (web operative from March 2010): 13.870



Monthly statistics of visits to the project website

Panel

Leaflets

Folders

Others

Youtube Channel

8 videos showing the evolution of FAROS in different phases, together with the final documentary.

http://www.youtube.com/channel/UCLoLc6CW6mPou-1RZUnspWQ

Facebook

Faros Facebook group:

https://www.facebook.com/groups/352213604870

Organization of events (workshops, conferences and seminars).

Dissemination to fishing sector

Project workshops (Spain & Portugal)

CONXEMAR (Vigo – October 2010)

IPMA (Lisbon – November 2011)

CONXEMAR (Vigo – October 2012)

Seminars and Conferences

CETMAR Foundation. Conference in fishing discards (Vigo – June 2012)

Organized in the context of Life program 20th anniversary

Participation in events organized by the fishing sector

FAROS presentation in the Conference "zero discards, organized by PTEPA (Vigo – October 2011)

Scientific Dissemination (Exper-i-Ciencia)

FAROS presentation in the Ramón y Cajal School (Vigo – May 2012)

Attendance to Congress

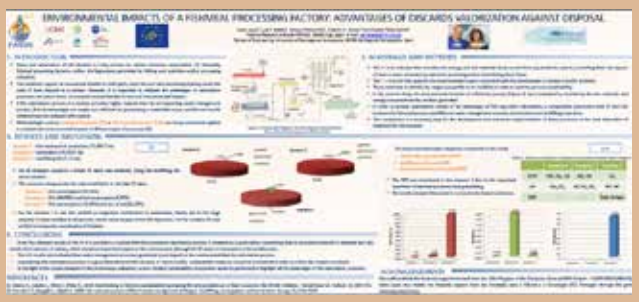
13th Conference on Process Integration, Modelling and optimisation for Energy Saving and Pollution Reduction (Prague – August 2010)

Czech Republic

OCEANS Conference. (Santander – June 2011) Spain

Attendance to Congress

6th SETAC World Congress. (Berlin – May 2011) Germany



4th Trans Atlantic Fisheries Technology Conference (Clearwater Beach, Florida – October 2012) USA

INSPIRE Conference. (Istanbul – June 2006) Turkey

Press release

General media news (newspapers, webs…)

More than seventy press release related with FAROS were published in different regional an national media during the project life cycle.

Scientific press

Several articles carried out in the frame of FAROS project (Fisheries Research journal – 2012).

Interviews

Article about fishing discards published by Industrias Pesqueras journal (March 2011).

Article "No discards, zero wastes" published in the LIFE and resource efficiency journal (May 2011).

PARTNERS

CSIC — Consejo Superior de Investigaciones Científicas

ipma — Instituto Português do Mar e da Atmosfera

CETMAR — Centro Tecnológico del Mar

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA — Instituto Español de Oceanografía

CESGA — Centro de Supercomputación de Galicia

Puerto de Vigo — Autoridad Portuaria de Vigo

INFORMATION / CONTACT

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YouTube **Proxecto FAROS**

FAROS Project

MGN **Management Geoportal Network** http://faros.cesga.es/faros/geo/index.php

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