LIFE Project Number

LIFE13 ENV/E/000131

FINAL Report
Covering the project activities from 01/07/2014 to 30/06/2018

Reporting Date

30/09/2018

LIFE+ PROJECT NAME or Acronym

LIFE iSEAS

Data Project

Project location	Spain
Project start date:	01/07/2014
Project end date:	30/06/2018
Total budget	3,866,342 €
EC contribution:	1,919,325 €
(%) of eligible costs	49.79 %

Data Beneficiary

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1. LIST OF CONTENTS

The present report is structured in the following sections, briefly described below:

A list of documents related to the project attached to the present report.

List of abbreviations

- **iSEAS:** Knowledge-Based **I**nnovative **S**olutions to **E**nhance **A**dding-Value Mechanisms towards Healthy and **S**ustainable EU Fisheries.

- **LIFE+:** Current phase of the programme LIFE (EU's funding instrument for the environment).

The LIFE iSEAS Consortium is composed by the following institutions:

- **IIM - CSIC (Coordinating Beneficiary):** Instituto de Investigaciones Marinas - Agencia Estatal Consejo Superior de Investigaciones Científicas.
- **CESGA**: Fundación Centro de Supercomputación de Galicia.
- **CETMAR:** Centro Tecnológico del Mar - Fundación CETMAR.
- **IEO:** Instituto Español de Oceanografía.
- **JOSMAR:** Talleres JOSMAR, S.L.
- **OPROMAR:** Organización de Productores de Pesca Fresca del Puerto y Ría de Marín.
- **USC:** Universidad de Santiago de Compostela.

Other abbreviations:

- **GIS:** Geographic Information Systems.
- **SDI:** Spatial Database Infrastructure.
- **CFP:** Common Fisheries Policy.
- **SGP:** Secretaría General de Pesca.
- **OGC:** Open Geospatial Consortium.
- **WPS:** Web Processing Service.
- **WMS:** Web Map Service.
- **FAROS:** Integral Networking of Fishing Sector Actors to Organize a Responsible, Optimal and Sustainable Exploitation of Marine Resources.
- **iDPV**: Integral Discards Processing and Valorization Point.
- **UVIGO:** Universidad de Vigo.
- **LO:** Landing Obligation.
- **MAPAMA:** *Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente*

2. PROJECT SUMMARY

2.1. Project objectives

The main objective of LIFE iSEAS was to demonstrate that a sustainable scenario (in terms of biological and socioeconomic indicators) of the European Fisheries is possible through the enhancement of the real application on the fishing sector of existent knowledge and innovative solutions on discards reduction and management. According to this objective, the aims of this project were:

1. To test the implementation and performance of the iObserver on board oceanographic vessels.
2. To optimize the fishing activity through the definition of a reliable tool based on mathematical models that analyze the spatio-temporal conditions of considered fishing areas. This tool will help:
    a. To take real time decisions over fishing activity, defining more appropriate areas/periods/species in terms of lower discard levels, and to develop effective short-time policies over marine resources/fishing areas that guarantee the stocks populations while maximizing the yield of the fishing activity.
    b. To perform more selective fishing, fuel-saving and on-board caught processing times.
3. To define a real fully operative in-land demonstration facility for discards valorization processes and trade named iDPV (Integral Discards Processing and Valorization Point).
4. To demonstrate the environmental and socio-economic impacts/benefits that the implementation of proposed innovative solutions and the new management model will have in the fishing sector.

Regarding the implementation of innovative tools to fully document the catch on board, it must be mentioned that some key objectives of the Common Fisheries Policy (CFP) are very close connected with the goals of LIFE iSEAS project. The Commission proposes that by 2019, vessels must keep on board and land both target and those non target species subject to quota regulations and/or below the minimum size (that cannot be used for direct human consumption). This is the so called *Landing Obligation*, defined in the Article 15 of the CFP of the EU (*Regulation (EU) No 1380/2013 of the European Parliament and the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC*). Moreover, the Commission also wants to enforce real time monitoring and control obligations towards attaining a full compliance of this new regulation together with the achievement of a fully documented fishing activity. In this way, LIFE iSEAS objective aimed to contribute to the minimization of the adverse ecological, environmental and socio-economic impacts that this new legal framework could have over the fishing sector and their activities (on board as well as on shore) by helping fleets to comply with the this Landing Obligation, in agreement with the CFP reform (that aims to promote a future responsible and sustainable management of fisheries).

2.2. Actions developed and key deliverables/outputs achieved

ACTION A1: Drivers and incentives for discarding: socio-economic implications and quantification of discards in target fisheries.

This action allowed LIFE iSEAS partnership to gain a deep knowledge on the initial snapshot of considered *métiers* catches particularities, including the key socio-economical assessment of the activity of selected trawling fleets (operating in ICES Areas IXa and VIIIc) at the beginning of the project (Month 1 until Month 12). The main outputs achieved are summarized next:

1. The IIM-CSIC, in collaboration with OPROMAR, carried out 20 preliminary trips on board of 9 commercial boats from OPROMAR fleet, two of them targeting pelagic fish whereas the others are directed to demersal species. The objective of such trips was to ***characterize and quantify the discarded biomass in the target fisheries together with the motivation for its waste***. Depending on such reason, the retained discards have to be processed in the iDVP1 or iDVP3 (Action B4). The main conclusions can be checked in Deliverable A1.4.
   Moreover, based on the results of these pilot tests, **22 species** were selected for automatic identification by the iObserver (Action B1) and valorization (Action B4).
2. USC performed a total of 13 highly detailed interviews (of around 80 min) ***to obtain the information regarding discards perception by the fishing sector*** (results compiled in Deliverable A1.3). Ship-owners and captains were very collaborative and homogeneity has been observed in their responses. There was a negative perception of the discards, but they perceived that the fishing sector viewpoint has not been taken into account in the drafting of the new Landing Obligation. This fact results on a high degree of distrust and ignorance in how to comply with it. In addition, a complete study about the costs associated to the implementation of the new common fisheries policy and its landing obligation was also carried out (in connection with Action B4).
3. ***Bottlenecks and potential solutions related to the landing obligation have been analyzed in addition to strategies for innovative valorization*** (conclusions can be consulted in the Deliverables A1.1 & A1.2). Based on the analyzed studies and reports, the general conclusion in European fisheries seems to be that Member States are not yet ready to receive and manage these unwanted catches and they have a hard way to go before having sufficient infrastructures and logistics in place to deal with it. It is here where LIFE iSEAS tried to overcome this drawback by giving a solution through the iDVP.

ACTION B1: Definition and testing of an iObserver.

The aim of this action was to install on-board oceanographic vessels and commercial trawlers operating in selected areas ***a set of technologies able to perform the work of an observer on-board a vessel***. This is the main output of this Action.

The iObserver is located over the conveyor belt in the fishing park. It consists (*hardware*) of an industrial camera and an industrial PC equipped with computer vision software. Hardware is protected by a steel waterproof case able to operate in harsh environments. The lighting system consists of a pair of LED strip lights. It includes a

system of sensors for automatic capture of the images. The whole system weights around 18 kg.

Regarding *software,* the fishermen interaction with the iObserver is through a GUI. Fishermen only have to start (finish) the image capturing process at the beginning (end) of the haul. The rest of the process is automatic. Moreover, a simple GUI for other functionalities (training/addition of new species, calibration, etc.) has been also developed. The developed recognition algorithms (*software*) are based on skin descriptors (color/texture) as well as shape.

The iObserver has been used/tested on board during:

- **Ten (10) oceanographic surveys** where carried out in the regions ICES-Spain; ICES-West Ireland; and NAFO on board two oceanographic vessels (Vizconde de Eza and Miguel Oliver) were performed between March 2016 and October 2017 with a total number of 270 days at sea in which the iObserver was used in 780 hauls, taking over 170,000 pictures. The aim was the *iObserver calibration and to capture a wide set of image in order to develop and optimize the identification algorithms.*
- **Nine (9) surveys on board two commercial vessels**, with a total number of 36 days at sea, were carried out so far on board two commercial vessels from ORPOMAR (Ría de Marín y Portosanto) in ICES-Spain regions VIIIc and IXa from May 2017 until the end of the project. The iObserver was used in 162 hauls taking around 35,000 pictures. *The aim was to quantify iObserver reliability (error level) in real conditions.*

In addition, an intense work in land with an iObserver unit available at IIM-CSIC and CETMAR facilities has been carried out to improve the identification algorithms previously their implementation and test in the units installed on board.

As a result, and for the 22 selected discarded species, the identification precision by iObserver is up to a **95%** (with optimal light conditions and no overlapped specimen) with **less than a 3% of error** in the length estimation, that it is a basic measurement to calculate the species weight.

Results of iObserver identification and quantification are transmitted to land by using the RedBox (in connection with Action B2) and shown in the Marine SDI towards the optimization of the fishing activity through the definition of a reliable tool based on mathematical models that analyze the spatio-temporal conditions of considered fishing areas (Action B3).

This technology has a great potential to be used/transferred in other fisheries/EU countries as presented in Deliverable B1.2 (see **Annex 1)**

ACTION B2: Development of a fish discards FSI.

The objective of this Action was to develop a fishing Spatial Data Infrastructure (SDI) in compliance with the INSPIRE Directive 2007/2 and to improve and develop a discards data management geoportal. The main outputs are:

1. CESGA, in collaboration with IEO, has worked in the ***definition of the initial data model for the Marine SDI*** that has been obtained based on the results of FAROS

Project (Deliverable B2.1). Data model was subsequently refined during project execution until its final version.

2. The same structure of information was used for ***RedBox updating and improvement***, the system for the whole catch data registering, processing, storing and sending from a vessel to the central system.
3. ***Definition of a marine SDI:*** It gives access to geoservices specifically developed to allow the consultation of discards fishery information (from pilot tests in Actions B1 and B4 + historical data) taking into account its particularities. This info is managed and exposed to the final users based on a set of level of access to this platform, available at http://iseas.cesga.es/. Therefore, ship-owners will have access to all their own catch info and to all the prediction models based on the aggregation of all catch info supplied by the iObservers while the general public will have access to the hotspots models together with the valorization info.
4. ***Definition of protocols for data management and integration with the modelling results*** (1. Advanced FSI; 2. Fuel efficiency and; 3. Hotspots models) generated in the framework of Action B3.
5. ***WCS, WFS and WPS services definition and integration in the SDI.*** Among these standard Open Geospatial Consortium (OGC) services, WCS service was identified as a key part to promote networking activities with other LIFE/European projects (Action E2). The main difference with the SDI is that these data can be easily exported and added to other users/webs/companies/etc. under demand.

Regarding implementation on board, RedBox was tested in connection with the iObserver system. From initial tests, the protocols for on board connection of iObserver with RedBox and other vessel's equipment (GPS, probe, etc.) in order to georeferenced the obtained catch/discard data were implemented, achieving very positive results.

RedBox is now available for downloading under request via mail to the project coordinator.

ACTION B3: Optimization of fishing activity monitoring towards the sustainability of resources.

The aim was to define and to develop reliable mathematical models that analyze the spatiotemporal conditions of considered fishing areas, being a powerful tool for policy assessment and optimal marine resource management. We can highlight the following items as main outputs of this action:

1. ***Model for FSI Discard:*** We have developed a statistical tool in order to identify areas and/or periods with high probability of by-catch/discard species. For this purpose, we developed a specific tool by means of a statistical algorithm integrated into a geo-portal which aims to help fishers to select in real-time the best fishing grounds with lower discard rates while reducing fuel consumption by penalizing the scoring of distant fishing grounds. Inputs include two components: i) the fishing activity information (catch and discard information by species and haul) and; ii) environmental variables on the prediction area. The main outputs of the system are, a *Fishing Suitability Index (FSI)* for each location in the area of interest shown to the user as spatial maps (i.e. probability of a location to keep catches of a species above a minimum limit and discards below a given admissible discard rate based on

its environmental characteristics and previous fishing activity information) together with algorithm performance statistics.

2. ***Fuel Efficiency model:*** The main aim was to develop a real-time "fuel-saving" model to increase the efficiency and reduce carbon footprint of the fleet. For this purpose, we developed a statistical algorithm integrated into a geo-portal which aims to help fishers to select in real-time the most profitable fishing grounds, from an economic and ecological point of view, penalizing fuel consumption of distant fishing grounds. Inputs include three components: i) the fishing activity information (catch and discard information by species and haul); ii) the environmental variables on the prediction area and; iii) the economic costs of the fishing activity. The main outputs of the system are two: i) a map of predicted revenues by area; ii) and a map of predicted profits by area, together with algorithm performance statistics.
3. ***Hotspot areas model:*** We have developed reliable mathematical models to identify key conservation areas that could be avoided by fisheries, reducing unwanted catch and overfishing. These models allows describing species geographical trends, to identify spatial ontogenetic shifts of commercially exploited species and provide essential tool to support the marine spatial planning framework such as predictive maps. These easy-to-use interpretation tools, combined with information on the distribution of fishing activity, could be a suitable approach to implementing an effective ecosystem-based marine spatial planning that embraces the Ecosystem Approach and Landing Obligation requirements. All the generated spatial maps were integrated in the developed marine SDI portal that could be consulted by users with additional information about the datasets and methods implemented.

ACTION B4: Definition of a fully operative on-board and in-land pilot facility for discards valorization and management.

The objective of this Action was double:
1) To adapt ships to bring separately: a) Individuals of target species for landing at the auction as usual; ii) Species affected by quota regulation that could be used in the production of products for human consumption in the room prepared for this purpose (iDVP1) and; iii) Specimens not satisfying minimum legal size (MLS) that will be processed in another area (iDVP3) to obtain non-food products.
2) To propose and construct a reliable design for a pilot facility named iDVP (Integral Discards Processing and Valorization Point) to be installed in the Marín Port Authority to process the aforementioned discards. This pilot facility will allow proper valorization of discards into added-value commercial products together with a set of tools and protocols to facilitate the management and further trade of discards/obtained final products.

In this aims, the more important outputs of this action are:

1. ***Definition of protocols and requirements to properly and separately store each biomass/catch fraction:*** Observers onboard quantified and characterized the total catch. Unwanted catch of species regulated by MLS or quota the catch was collected separately in compartments other than the retained commercial catch. A special permit was obtained from the ministry to carry out the trials. The objective was to test handling and collection of forced fish to be landing in this mixed bottom trawl fishery.
   Observer used two types of cages onboard:

- Fish boxes of about 10 kg, tagged to distinguish of fish retained catch.
- Containers of 370 l hard-wearing polyethylene.

The boxes are easy to handle and the fishermen are highly trained, with a fast and safe work. The containers were purchased on property for use in performed trials within the project. It has a great capacity and they are isothermal. These large boxes can be handled on board, although they reach weights of more than 100 kg, so they are not handy. All the unwanted fish were kept mixed onboard to avoid time by the crew. A research team on shore makes the identification and separation of fish to quantify by species.

The ships have not made any significant structural changes since the landing obligation is beginning and they have been considering bringing the unwanted fish into fish boxes or normal containers. These containers can be adapted on board to the available space and moved by hand or crane. It allows to have space and to adapt the containers depending on the amount of discards that it is necessary to take to port.

2. ***The design, construction, startup and operation of the iDVP (Integral Discards Valorization Point)***: It applies a bio-refinery concept to make the best possible/optimal use to the important quantity of marine biomass due to the compliance with the Landing Obligation that has to be managed or processed to avoid its waste. It is divided in three different rooms: i) Chilled room storage; ii) Food elaboration area (iDVP1) and; iii) Non-food products area (iDVP3). *Production lines implemented in the iDVP1* are based in the use of the fish muscle (from over quota species and from nowadays noncommercial/low commercial value species) for food purposes, including a line of restructured products and a line for fish protein hydrolysates (FPHs) and bioactive peptides. In the other hand, *the iDVP3 includes production lines* to process specimen under legal size and byproducts from the iDVP1/other fish processors to obtain valuable bio-compounds such as collagen/gelatin, FPHs, chondroitin sulfate or chitin/chitosan, among others, from iDVP1 fish wastes and undersized specimen.

ACTION C1: Monitoring of impacts of the project.

The monitoring protocol had been defined during first months of project execution, with the support and supervision of the external monitoring team.

Based on this document, the checking of defined indicators was carried out by the Monitoring Committee and results of this follow-up work were briefly indicated in previous reports (Progress, Midterm and Progress reports).

ACTION C2: Environmental and socio-economic impact assessment of proposed solutions.

In this Action, the LIFE iSEAS partners defined environmental and socio-economic evaluation methodologies of the proposed technological solutions for discards reduction and management:

a) Environmental impacts:

- ***On-board:*** Ecological Footprint (EF) and Carbon Footprint (CF) were applied to quantify the reduction of the environmental impacts of vessels fish extractive activity.

- ***In-land:*** Material and Energy Flow Analysis (MEFA) were applied to optimal manage the discarded biomass resource to be employed in the different valorization processes implemented in the iDVP (Action B4) together with Environmental Risk Assessment (ERA) to measure the probability of valorized products to pose adverse effects to the human health.
- ***Whole sector:*** Sustainability of the whole activity was evaluated by Life Cycle Assessment (LCA).

b) Socio-economic impacts:

New interviews (developed in 2017) with the fishing sector were developed. Comparing them with initial situation (Action A1), the general opinion about the landing obligation continued to be very similar to the one defined at the beginning of the LIFE iSEAS project. Indeed, two negative aspects can be remarked:

- The sector has even more doubts now.
- The sector has not the same positive opinion regarding alternative uses for the discards.

Time required to manage the discards on board (in the new scenario of landing obligation) was analyzed by IIM and USC. Results on board commercial vessels from ORPOMAR showed the high impact of the LO, taking into account additional times on board, the potential necessity of additional personnel and the current benefits of the fishing companies. These results could be used to justify the necessity of the exemptions of some species for this fleet.

ACTION D1: Diffusion, demonstration and dissemination

Taking into account LIFE iSEAS diffusion tasks presented in the proposal, the following activities/materials for dissemination results of the project to a local, regional, national, European and even international audience were carried out:

- Communication and dissemination plan.
- Corporative image of the project (logo, templates, etc.).
- Webpage (private and public part) and Twitter and Linkedin channels of LIFE iSEAS (daily updated during the project period).
- LIFE iSEAS mail for fishing sector stakeholders and administrations questions regarding project objectives, results, events, etc.
- Edition and distribution of leaflets, folders and Layman report.
- Info panel boards and posters for congresses.
- LIFE iSEAS videos and documentary production to show the general audience the aim and main results of the project. A LIFE iSEAS youtube channel.
- Advertising material of the project (pen, moleskine and USB memory).
- Technologies manuals for users' training. (iObserver and SDI/geoportal).
- Articles production (scientific and technical) and media contact (high impact in media regarding with LIFE iSEAS seminars, technologies testing on board and in land, etc.).

In addition, dissemination/diffusion of LIFE iSEAS results was carried out through the organization of 7 LIFE iSEAS seminars/workshops (focused on project presentation, the discard issue, technologies) and the ***International Conference on Advances in Marine Technologies Applied to discard Mitigation and Management*** (MARTEC18), held in

Vigo (2-4 May 2018), where more than 50 scientists from more than a dozen of countries in Europe, America and Africa together with people linked to the maritime-fishing and business sectors and members of regional, state and European administrations discussed about R+D+i oriented to global societal needs, looking for innovative solutions to meet the requirements to comply with the new legal framework of the fishing sector related to the Landing Obligation of nowadays discarded species while ensuring the sustainability of marine resources and the long term viability of the fishing activity as well.

Finally, also indicate the participation of LIFE iSEAS partners in other dissemination activities (seminars organized for the fishing sector, scientific congress, events for student's dissemination, fishing sector fairs, etc.) and networking activities.

ACTION D2: After-LIFE Communication plan.

The AFTER-LIFE Communication Plan was defined during the last 3 months of the projects (Months 46 to 48), with the objective to continue the dissemination and communication of the results of LIFE iSEAS Project during the next 5 years after the end of the project.

In order to reinforce the dissemination of the objectives, the activities and the results of the project, it is planned a wide diffusion of the Layman's report, which will edited in paper and as an interactive PDF in two languages (200 copies in Spanish and 200 in English).

ACTION E1: Management, coordination and information to the European Commission.

IIM-CSIC, as coordinating beneficiary, had been executed a continual follow-up of all tasks under progress in tight collaboration with the *Project Steering* and *Monitoring Committees*. It has contacted partners/companies involved by telephone, email, website private area, etc. in order to determine the proper acquisition and fulfillment of objectives through a proper technical and administrative implementation of the project. In addition, technical meetings were held when it was necessary in connection with actions under progress. Between partners, the coordination and management activities were done by periodic meetings around every 6 months.

A fluid and proper communication both with the Monitoring Team and the European Commission was carried out along the project implementation.

ACTION E2: Networking with other similar LIFE+ projects.

This action aimed at identifying previous and present projects on the issues of sustainability and efficient management of the agro-food sector in order to share experiences with other related projects and networks and to find synergies. This pooling and exchange of information and experiences on each particular project were highly beneficial to all parties.

LIFE iSEAS partners have organized and/or attended to several events with significant repercussion in the framework of project's goals:

- Organization of a workshop to boost the exchange of experiences of networked projects. It was a technical meeting organized by CETMAR with the selected projects on the discards issue: DISCARDLESS, MINOUW, DESMAN and VADEAR (Santander – June 2016).
- Organization a collaborating event among several projects and the EFCA (Vigo - February 2017).
- Participation of IIM in the DISCARDLESS meeting in Rome (March 2017).
- Participation of IEO in one training activity developed by the project MINOUW (Zaragoza – February 2017 & April 2018).
- Participation of LIFE iSEAS Project coordinator (Ricardo I. Pérez Martín) and staff from IEO and USC as members of the Spanish Discards Committee of the MAPA, the forum where main decisions on the CFP/LO implementations at a national level are taken.
- Organization of the ***International Conference on Advances in Marine Technologies Applied to discard Mitigation and Management (MARTEC18)*** (Vigo – May 2018).

ACTION E3: Audit.

LIFE iSEAS audit was performed in connection with the Midterm report and the Final report (Final audit). Auditors support and considerations were taking into account from June 2016 until June 2018.

3. INTRODUCTION

3.1. Background, problem and objectives

a) Description of the technical / methodological solution

The hypothesis to be verified by LIFE iSEAS project is to demonstrate that a sustainable scenario (in terms of biological and socioeconomic indicators) of the European Fisheries is possible through the enhancement of the real application on the fishing sector of existent knowledge and innovative solutions on discards reduction and management. In particular, the innovative technologies and/or methodologies cited are the following:

- ✓ **The iObserver**: a system able to perform the work of a human observer (identifying and quantifying discarded biomass and target catch as well) on-board but without interfering in the normal activity of fishermen.
- ✓ **A fish discards SDI,** that integrates a data and metadata model together with a complete range of OGC services (WMS, WFS, WCS, WPS) for acquired discards information, satisfying INSPIRE Directive.
- ✓ **A powerful modelling tool** to analyze the spatio-temporal conditions of considered fishing areas in terms of discards/stock status towards discards reduction by avoiding those areas identified with higher discard levels (based on the info/data provided by the SDI).
- ✓ **A real pilot service located** on Marín Port facilities to valorise, manage and the new biomass due to compliance with the Landing Obligation (previously discarded): **the iDPV** (Integral Discards Processing and Valorization Point).

b) Expected results and environmental benefits

The results of LIFE iSEAS Project contributed:

- To the reduction of the environmental impact and the minimization of the socio-economic costs related to the compliance of the LO by proposing integrated valorization alternatives which will add economic value to this raw material while reducing the costs associated to on board and in land handling and management of the whole catch (target species plus biomass due to the LO).
- To reduce pressure on marine resources by reducing discards in all possible cases by using the SDI and models. The aim is to attain an optimal management of fisheries by defining more effective policies based on real fishing data.
- To a better understanding of fisheries based on technologies/methodologies application in fleets. It is expected a lower fishing pressure over stocks that will not only lead to a much lower discarding of undersized fish (juveniles) but also will reduce the incidental by-catch of non-target marine organisms. All these factors, thus, have a positive impact on biodiversity and the structure of marine ecosystems.

3.2. Expected longer term results

The project will contribute to the implementation of the Landing Obligation (LO-gradually elimination of discards in European fisheries), to the principles for data

collection defined in the newly reformed Common Fisheries Policy (CFP) and to the consecution of better scientific advice taking into account complete data from fisheries (data of total capture, including discards, should be included).

4. ADMINISTRATIVE PART

4.1. Description of the management system

a) Schematic presentation of working method (project phases, activities and tasks, planning)

In order to achieve the final objective of LIFE iSEAS, the project structure is composed of a number of tasks oriented to:

1. A complete assessment of the actual situation of discards issues on ships selected as project collaborators, focusing on the socio-economic implications and impacts that the performance of policies aiming the drastic reduction of discards (like the new CFP) will have on the fishing sector.
2. The definition and implementation of methodologies/technologies towards the fully identification, quantification and management of the new biomass (previously discarded) generated by the compliance with the Landing Obligation (reduction and valorization/make the best possible use) in real-time, taking into account environmental and socio-economic indicators at different levels. (Actions B1-B4, 2014-2018).
3. The assessment of the environmental and socio-economic impacts of proposed solutions over all fishing sector agents as well as over the whole region (Galicia) (Action C2, 2016-2018).

b) Presentation of the beneficiary, partners and project organization

The *Project Steering Committee (PSC)* is constituted by at least one responsible of each participant leading the different actions namely IIM-CSIC (Actions A1, B4, C1, E1, E2), CETMAR (Action D1), IEO (Actions B1, B3), USC (Action C2) and CESGA (Action B2) plus OPROMAR and JOSMAR and chaired by the Coordination Committee or Scientific Coordinator (IIM-CSIC). The PSC is the main responsible of doing a continual follow-up all tasks under progress. It has contacted partners/companies involved by telephone, email, technical meetings, etc. in order to determine the proper acquisition and fulfilment of objectives through a proper technical and administrative implementation of the project.

IIM-CSIC, as leader of the PSC, has promoted the contact between partner/companies. The private part of the website has been used as a useful tool for project coordination. The PSC met regularly since the beginning of the project.

The *Monitoring Committee (MC)* composed by one expert per partner, met together regularly (mainly through videoconference and during the Coordination Meetings) since the beginning of the project with the aim of reviewing the indicators established for a proper monitoring during the project. The result of this monitoring to measure and to report the effectiveness of the actions from June 2017 is attached on the Monitoring Protocol (see **Annex 2**).

The following figure (Figure 1) shows the project management structure, defining the responsibilities of each working groups identified:

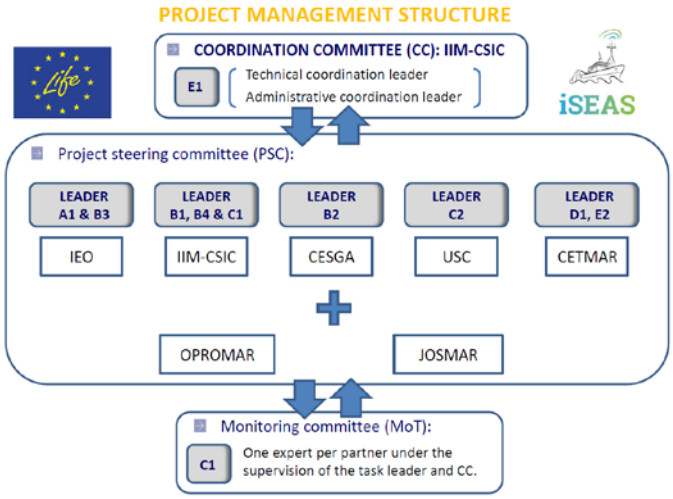


Figure 1. LIFE iSEAS Management Structure

To keep records of these management actions, minutes have been made by IIM-CSIC for all meetings held between project beneficiaries and with the external assistants or collaborating companies **(some minutes are attached as example in Annex 3)**. In the case of seminars and other dissemination events, they were organized by CETMAR in collaboration with each involved partner. For technologies implementation and pilot tests carried out on board, contacts were executed by IEO, CESGA, IIM and OPROMAR in a complementary and organized manner. Regarding the construction, installation, start-up, testing and tuning of the iDVP plants in the Port of Marín facilities, a tight and fluid work has been carried out among JOSMAR, OPROMAR and IIM-CSIC.

The consortium is composed by the following institutions and companies:

- **IIM-CSIC (Coordinating Beneficiary):** Instituto de Investigaciones Marinas-Agencia Estatal Consejo Superior de Investigaciones Científicas.
  Groups participating from CSIC:
  - **IIM-IP:** Grupo de Ingeniería de Procesos.
  - **IIM-BA:** Grupo de Bioquímica de Alimentos.
  - **IIM-REVAL:** Grupo de Reciclado y Valorización de Residuos.
- **CESGA (Associated Beneficiary 2)**: Fundación Centro de Supercomputación de Galicia.
- **CETMAR (Associated Beneficiary 3):** Centro Tecnológico del Mar - Fundación CETMAR.
- **IEO (Associated Beneficiary 4):** Instituto Español de Oceanografía (Centros Oceanográficos de Vigo, Murcia, Santander y Baleares).
- **JOSMAR (Associated Beneficiary 5):** Talleres Josmar, S.L.
- **OPROMAR (Associated Beneficiary 6):** Organización de Productores de Pesca Fresca del Puerto y Ría de Marín.
- **USC (Associated Beneficiary 7): Universidad de Santiago de Compostela** (Grupos de BioIngeniería Ambiental y Economía Pesquera).

During the project, different companies and institutions showed their interest in collaborating in the development and in using the results of LIFE iSEAS Project. These new collaborators are listed below:

- 3B's Research Group (Biomaterials, Biodegradables and Biomimetics) - University of Minho
- ANFACO-CECOPESCA.
- Valora Marine Ingredients (Grupo JEALSA).
- Conresa (Grupo JEALSA).
- AZTI-Tecnalia.
- Cabomar.
- Málaga Port Authority.
- MAPA – Ministerio de Agricultura, Pesca y Alimentación (Spanish Government).

c) Partnership agreements

The Partnership Agreement of LIFE iSEAS was signed on November, 11th 2014, by the coordinating beneficiary (IIM-CSIC) and the associated beneficiaries (CESGA, CETMAR, IEO, JOSMAR, OPROMAR and USC), and attached to the Inception Report as Annex 1.

4.2. Evaluation of the management system

a) The process

All the programmed coordination meetings (every 6 months plus the final meeting) were held between the partners in order to discuss, assess and implement decisions which have ensured the proper technical progress of the project. In addition, the work developed by the PSC and MC was essential to quickly and efficiently solve any eventual problem merged during the development of the LIFE iSEAS tasks. Regarding the management of administrative activities of the project, including the elaboration of the required technical and financial reports (Inception Report, Mid-term, Progress and Final Reports), these were carried out in time and without significant problems.

In case of LIFE iSEAS audit, in addition to the Final audit (Month 48), an Interim/Mid-term one was performed in connection with the Midterm report (Interim audit).

b) The project management

No important management issues were found during the LIFE iSEAS Project life. All partners and external companies collaborating in the project (as subcontractors) have shown a very positive attitude regarding LIFE iSEAS tasks and, as a consequence, its results were fully achieved.

c) Technical and commercial application

Regarding developed technologies, especially in case of REDBOX, a manual for future real implementation on board commercial vessels has been produced in order to define and control limiting factors that could risk their implementation and on board

performance. However, the current reluctant vision of part of fishing sector regarding innovative solutions on board could be the most important limitation nowadays.

d) Comparison against the project-objectives

LIFE iSEAS proposal objectives have been totally completed during the project execution.

e) Effectiveness of dissemination activities

A very interesting discussion was performed during LIFE iSEAS workshops, demonstration sessions and especially in case of the final conference MARTEC. It was oriented to global societal needs, looking for innovative solutions to meet the requirements to comply with the new legal framework of the fishing sector related to the Landing Obligation of nowadays discarded species while ensuring the sustainability of marine resources and the long term viability of the fishing activity as well.

f) The future

The current reluctant vision of part of fishing sector about retaining previously discarded species subject to TAC and quotas (due to the high extra work required to store and manage on board/in land a fraction of biomass with no commercial value) and on-board electronic monitoring tools could be overcome with the economic support of the European Maritime and Fisheries Fund to implement the LIFE iSEAS innovative solutions as key point of the CFP (Landing Obligation compliance and monitoring and control of fishing activity).

5. TECHNICAL PART

5.1. Task by task- description

A. PREPARATORY ACTIONS

Action A1: Drivers and incentives for discarding: socio-economic implications and quantification of discards in target fisheries

Activities/subtasks description:

Task A1.1: *Nine* commercial boats from OPROMAR fleet have participated, two of them targeting pelagic fish whereas the others are directed to demersal species. The objective of such trips was to characterize and quantify the discarded biomass in the target fisheries together with the motivation for its waste.

In the framework of **Task A1.2**, *20 preliminary trips* in commercial vessels have been performed and a deep analysis of the current status has been carried out by IIM-CSIC). A detailed summary of the study can be found in **Deliverable A1.4**, presented with the First Progress Report.

Discard quantities and reasons by species were analyzed. Depending on such reason, the discard will be processed in the iDVP1 or iDVP3. The following conclusions can be highlighted:

- The reason *"no size"* is the most common for the discard fraction generated in the selected fleet.
- Atlantic mackerel *(Scomber scombrus)* and horse mackerel (*Trachurus trachurus)* are now discarded in large quantities due to *"no quota"*.
- For these species, among others like blue whiting (*Micromesistius poutassou),* hake (*Merluccius merluccius)* and megrims (*Lepidorhombus* spp.), the reason catalogued as *"damaged"* is also significant.
- Not large quantities of boarfish (*Capros aper)* have been found during tests.
- The main reason of discard for some species, like small-spotted catshark (*Scyliorhinus canicula),* is the *lack of commercial uses* in the markets.
- The total amount of discarded biomass is very important, up to 70 t for the selected species on the developed fishing trips.

Regarding **Tasks A1.3** and **A1.4**, USC performed a total of *13 highly detailed interviews (of around 80 min*) to obtain the information regarding discards perception by the fishing sector. The final analysis of the data has been compiled and presented in **Deliverable A1.3**. Ship-owners and captains were very collaborative and homogeneity has been observed in their responses. There is a negative perception about discards, including that the fishing sector viewpoint has not been taken into account in the drafting of the new landing obligation. This fact results on a high degree of distrust and ignorance in how to comply with it.

A complete study about the costs associated to the implementation of the new Common Fisheries Policy and its landing obligation was also carried out (in connection with Action B4). An input-output methodology was applied in order to predict potential economic consequences of a cost variation for the analysed fleet in Marín. When comparing costs to gross operating surplus, it can be observed that the fleet has already some profitability problems: the fleet is vulnerable so any modification in the cost structure will have inevitable economic effects.
The important impact of the fleet in the local economy has been also established by taking into account the data from activity costs by ship.

Task A1.5 is directly related with Action B4. Bottlenecks and potential solutions related to the Landing Obligation have been analyzed in addition to strategies for innovative valorization (conclusions can be consulted in the **Deliverables A1.1 & A1.2**). In **Deliverable A1.2**, SWOT analyses have been performed by best practice to reduce discards.

Based on the analyzed studies and reports, the general conclusion in European fisheries seems to be that Member States are not yet ready to receive and manage these unwanted catches and they have a hard way to go before having sufficient infrastructures and logistics in place to deal with it. It is here where LIFE iSEAS tries to overcome this drawback by giving a solution through the iDVP and proper on-board and in-and management and storage solutions. More projects/initiatives/technologies should be developed and solutions must be implemented in different ways and always with stakeholders' implication.

Based on Action A1 results, ***22 species*** were selected for automatic identification by the iObserver (Action B1) and valorization purposes (B4). **Task A1.6 and A1.7** have been executed by taking into account the selected species and results can be consulted in **Deliverable A1.4.**

<u>Outputs: Comparative with planned outputs</u>

The final outputs of this Action are not exactly as described in LIFE iSEAS proposal since during project they were improved since **20 pilot trips** were carried out instead of proposed 10 to collect more info about discards composition, volumes and motivation and finally, **22 species** were selected to be identified by the iObserver (Action B1) instead of proposed 5-7. Finally, it must be mentioned that only **13 interviews** were sufficient to collect the required information for the development of the tasks (15-20 proposed).

As a conclusion, complete planned outputs were achieved and all related Deliverables in the framework of this Action have been produced on due time (D1.1 to D1.4).
In connection with A1.1, A1.2 and A1.3 (review of the state of art and current situation at a local, national and European level) and with A1.4 (data obtained on board selected fisheries), the associated milestone to this Action has been achieved:

- **Milestone A1.1:** "*Existing valorization solutions to reduce actual discards on selected fisheries and other European fleets*".

Indicators used to test the performance:

Indicators defined in LIFE iSEAS proposal were used to test Action A1 development:

- *Number of pilot test* to characterize discards and the motivation for this practice. As mentioned, a more detailed description about volumes, composition and main reasons to discard was achieved due to the higher number of pilot test that have been carried out (Real : 20/ Proposed: 10). This fact also shows the availability and predisposition of analyzed fleets (Galician coastal bottom trawlers) on collaborating with the LIFE iSEAS partnership.
- *Number of involved vessels and ship-owners* has been higher than expected (9 vessels participating in the pilot tests and 13 ship-owners participating in the interviews), showing the great interest and implication of the fishing sector on the LIFE iSEAS project.
- *Number of selected species* (with higher discards volume) to be identified by the iObserver. Once again, the results of the Actions where excellent and higher than in the proposal since up to 22 species (5-7 proposed) where selected to be implemented for identification with the iObserver (B2).

Moreover, all produced materials (Deliverables) have been distributed among fleets/ship-owners in order to get their feedback and to make decisions based on the reality and necessities of the selected fleet.
Finally, other indicator defined in relation with this first Action was the monitoring of its interaction with the other consecutive actions (B1, B2, B4 and C2). This indicator was used during the whole project duration.

Issues found:

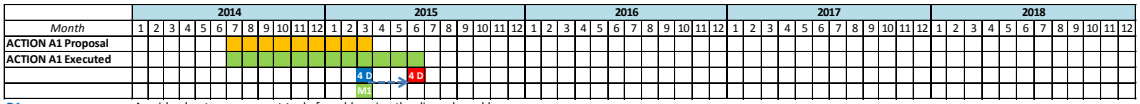
Issues were found to coordinate the interviews with the ship-owners, because their availability is very limited due to the workload. The OPROMAR's collaboration was critical in order to complete the task.

No other relevant problems were founded.

Task duration: Comparative with the established time schedule

Action A1 was finished in June 2015 (Month 12) to consider a whole natural year of pilot tests.

Proposal: 9 months (*from Month 1 to Month 9*).
Real: 12 months (from *Month 1 to Month 12*), taking into account the extension of the deadline of this Action requested in the Inception report and approved by the EC.



D1	A guide about management tools for addressing the discards problem
D2	A report of best practices in discards reduction projects
D3	A report on incentives for discarding, discarding behaviour and fishermen perception of the issue
D4	A report presenting the selected discarded species and potential valorization uses by species
M1	Existing valorisation solutions to reduce actual discards on selected fisheries and other EU fleets

Summary description of associated reports:

Produced deliverables in the framework of this Action include the following:

- **Deliverable A1.1**: *"A guide about management tools for addressing the discards problem"*. Including an analysis of some specific related research and demonstration projects/initiatives, management experiences in other countries and recent European reports/evaluations focusing in the landing obligation framework.
  Submitted with the First Progress Report (Month 18).
- **Deliverable A1.2**: *"A report of best practices in discards reduction problems"*. A review of some of the best discards mitigation measures proposed by different authors and documents. Thirteen mitigation measures were reviewed, comprising the numerous biological, technical and operational factors, as well as social and economic drivers that any discard mitigation involves. Some of the main findings are that mitigation measures become more successful in achieving their goal when used in combination, rather than isolation. Finally we consider the best discards mitigation measure occurs at the sea and it is not to catch unwanted catch.
  Submitted with the First Progress Report (Month 18).
- **Deliverable A1.3***: "A report on incentives for discarding, discarding behavior and fishermen perception of the issue"*. The main objective of this report is to analyze, from a socioeconomic point of view the phenomenon of discarding, including the perception of fishermen about the problem, their perception of the legitimacy of the landing obligation and the analysis of the economic effects associated to its enforcement.
  Submitted with the First Progress Report (Month 18).
- **Deliverable A1.4***: "A report presenting the selected discarded species, possible substitutive and potential valorization uses by species"*. A summary of the main results and conclusions obtained during 20 pilot trips is presented. The main outcome of this report is the selection of the species chosen for valorization studies indicating the final targeted product.
  Submitted with the First Progress Report (Month 18).

B. TECHNICAL ACTIONS

Action B1: Definition and testing of an iObserver

Activities/subtasks description:

Regarding **Task B1.1,** it started on month 1 (July, 2014) and since then, IEO, IIM-CSIC and OPROMAR have been working, together with the main developer (Universidade de Vigo), in the construction, testing and improvement of the iObserver. A detailed description of this device was presented in **Deliverable B1.1**.

LIFE iSEAS partners evaluated, during the first six months of the project, the main advantages and limitations of the BEOS system developed in the framework of the FAROS project to establish the main hardware and software requirements that the iObserver has to include. This allowed us to identify the following weaknesses: (i) the difficulties to implement changes in the software since it was built as closed software and (ii) the number of species that could be identified, seven, is not enough according to the discards data obtained during the pilot tests carried out in the framework of Preparatory Action A1.

A public tendering for the development and installation of 4 iObservers was prepared and awarded to Universidade de Vigo.

The first prototype of the iObserver included the lighting system in the protection case. This was tested in the R/V Miguel Oliver during PELACUS survey. From the experience acquired during the first trial onboard, several improvements regarding holding structure were carried out. Specifically, camera and control PC were placed inside the box (including touch screen) as a manner to facilitate its use/control in the fishing park rather than have it in a separated area. The carcass with the lights is complementary to avoid the excessive influence in the final dimensions.

The dimensions of the final device are 40x23x26 cm and weights around 18 kg (Figure 2) which made it more affordable for on board installation. iObserver consists of an industrial (computer vision) camera and a processing unit (industrial PC) equipped with our self-developed computer vision software. The hardware includes a main box and a lighting system (Figure 2). Both units are waterproof and have been designed to operate in a harsh environment.

The main system box is a steel waterproof box that contains the key elements of the system: processing unit (industrial PC), industrial camera, touchscreen and an auxiliary system to avoid water condensation (based on a peltier cell). Varifocal lenses were chosen to deal with the wide variety of fishing parks.

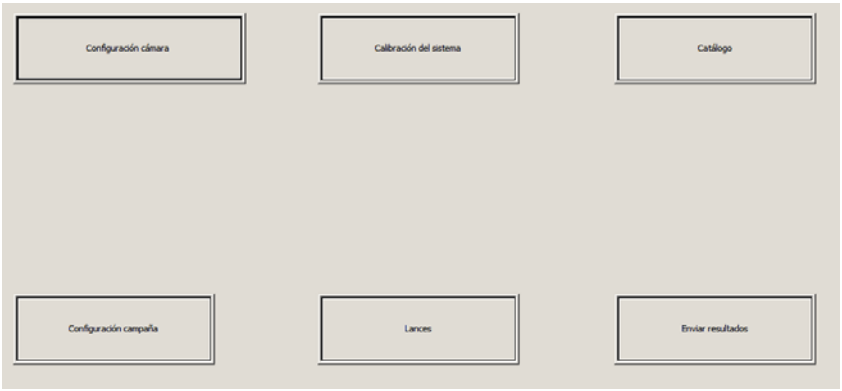
Figure 2. Main box and external lighting as they were mounted in the R/V Vizconde de Eza.

An auxiliary system of magnets and sensors is connected to synchronize the signal for capturing images with the belt movements. Captures can be alternatively launched at constant time intervals. Lighting is designed to provide a constant soft light rectangle on the belt. For such issue, a pair of LED strip lights at both sides of the belt was used. Height and angle of these lights can be modified to minimize shadows and light variations. Lights are embedded in steel waterproof boxes and are electrically fed from a power source inside the main box.

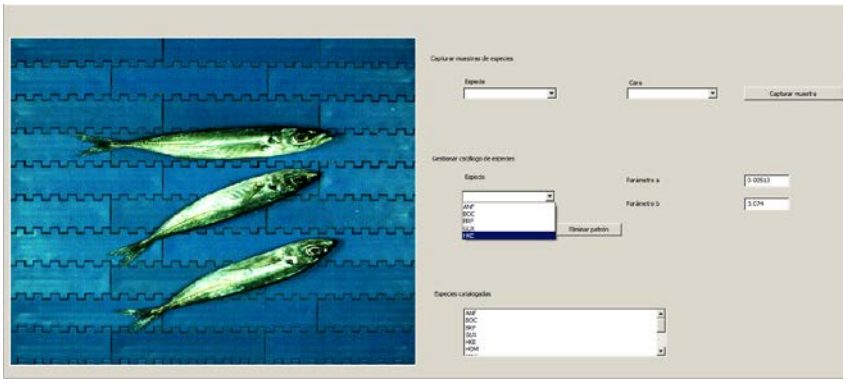
Regarding the software, it offers the possibility of performing in an intuitive way different actions through a graphical user interface (GUI). The GUI and the touchscreen allowed the possibility of using the iObserver without implying extra workload. The different functionalities are (Figure 3):

- "*Configuración de la cámara*". This allows: to modify the camera parameters (Gain, velocity, etc.) to take into account the lightning conditions and to define the region of interest.
- *"Calibración del Sistema"*. This is to calibrate color and distances and to compute the background characteristics for further elimination.
- *"Catálogo"*. This functionality allows for the inclusion of new species (Fig. 3a & 3b). The procedure is simple. A sample for a given species is located in the conveyor belt. The species of the sample and its position (dorsal, lateral, ventral) are indicated and then a picture is taken. When several samples in different positions were used, the main characteristics of the species are saved by pressing "Generar patrón".
- *"Configuración campaña"*. This allows to select the species to consider during the trip. If the user knows that a given species is not going to be present in the hauls, it can be removed from the list in order to facilitate the identification task.
- *"Lances"*. This is for recognition purposes (Fig. 3c). The user presses the button "Empezar lance" and the software starts the procedure of taking and identifying images. When the haul is finished, the user must press "Finalizar lance". When the identification software finishes, a report with the results is generated.
- *"Enviar resultados"*. This button will send the results to the RedBox where they will be combined with vessel instrumentation data for further delivery to an inland center.

(a)



(b)



(c)

Figure 3. (a) Access in the GUI to the different functionalities of the iObserver. (b) Training functionality. (c) Identification functionality.

Along the duration of the project 18 species (12 from ICES regions VIIIc and IXa, green part of the table, and 6 from NAFO regions, blue part of the table) has been trained (Table 1).

FAO Code	Scientific name	Common name	N. Indiv.
ANF	*Lophius spp*	Angler fish	20
BRF	*Helicolenus dactylopterus*	Blackbelly rosefish	17
BOC	*Capros aper*	Board fish	23

GUX	*Trigla spp*	Gurnard	72
HKE	*Merluccius merluccius*	Hake	39
HOM	*Trachurus spp*	Horse mackerel	22
MAC	*Scomber scombrus*	Atlantic mackerel	24
MEG	*Lepidorhombus spp*	Megrim	38
RJC	*Raja clavata*	Cuckoo ray	11
RJN	*Leucoraja naevus*	Thornback ray	5
SYC	*Scyliorhinus canicula*	Small-spotted catshark	32
WHB	*Micromesistius poutassou*	Blue whiting	21
GHL	*Reinhardtius hippoglossoides*	Greenland halibut	10
PLA	*Hippoglossoides platessoide*	American plaice	20
RED	*Sebastes spp*	Redfish	11
RHG	*Macrourus berglax*	Roughhead grenadier	13
RJR	*Raja radiata*	Starry ray	2
WIT	*Glyptocephalus cynoglossus*	Witch flounder	10

Table 1. Species already trained within the iObserver and number of individuals used in the training.

Task B2.1 mainly consisted on the testing and validation of the iObserver. Tests were performed in-land, on board oceanographic vessels and on board commercial vessels.

In-land tests were mainly focused on species identification performance when conditions (lighting system, belt velocity, fish samples) are optimal. Training of the iObserver was also performed in-land. These tests were performed between 01/01/2017 and 30/06/2018.

Figure 4 and Table 2 sketch the identification results when individual are separated. As shown in the figure, the software is able to correctly eliminate the background detect each of the individuals and compute its length.

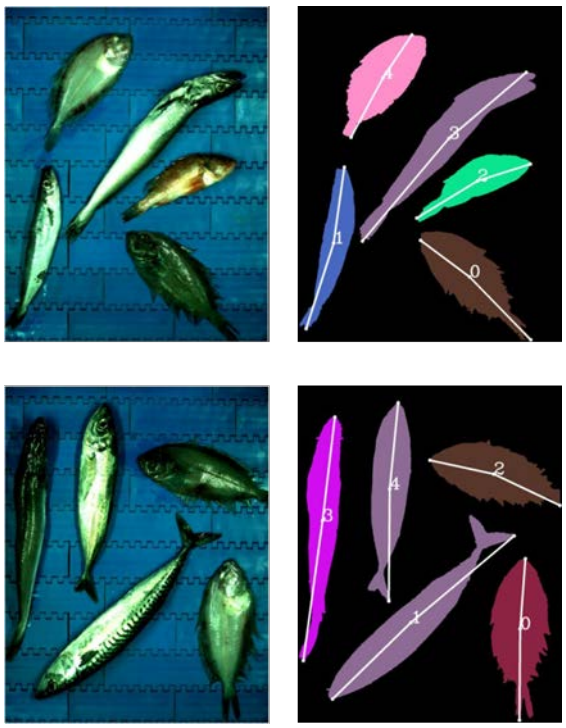


Figure 4. Background elimination, species classification and length estimation when individuals are separated

Table 2 shows the performance of the identification. For the tested pictures, only 25 out of 27 individuals were correctly identified. This results into an accuracy larger than 90%. Mean error in size estimation is below 3%.

Measured		Identified		Comparison	
Species	Length [cm]	Species	Length [cm]	Right?	Err. Length [%]
GUX	21,5	GUX	21,0	T	2,3
MAC	23,0	MAC	22,4	T	2,6
HKE	26,0	HKE	24,8	T	4,6
BOC	7,0	BOC	6,9	T	1,4
SYC	28,0	SYC	26,4	T	5,7
BRF	10,5	BRF	10,4	T	1,0
MEG	17,5	MEG	17,0	T	2,9
ANF	21,0	ANF	20,4	T	2,9
MAC	24,5	MAC	24,2	T	1,2
HOM	19,0	HOM	18,3	T	3,7
MEG	18,0	MEG	17,4	T	3,3
MAC	24,0	MAC	23,4	T	2,5
ANF	21,0	ANF	20,0	T	4,8
MEG	21,0	MEG	21,2	T	-1,0
SYC	44,0	SYC	41,4	T	5,9
HKE	22,0	HKE	21,6	T	1,8
RJC	46,0	RJC	42,2	T	8,3
ANF	28,0	RJN	27,2	F	2,9
MEG	26,0	MEG	25,4	T	2,3
BRF	14,0	BRF	14,0	T	0,0
GUX	20,0	GUX	18,8	T	6,0
GUX	14,0	BRF	13,9	F	0,7
MEG	22,0	MEG	21,9	T	0,5
MEG	21,0	MEG	17,5	T	16,7
HKE	35,0	HKE	34,7	T	0,9
BRF	18,0	BRF	18,6	T	-3,3
WHB	24,0	WHB	24,5	T	-2,1

Table 2. Comparison between the identification results provided by the iObserver and the classification made by a human observer. First two columns refer to the human observer data. Column 4 and 5 show the iObserver results. The last two column indicate whether the identification was right (T) or wrong (F) and the error (%) in size estimation.

When individuals are overlapped (Figure 5) identification accuracy decreases. On the one hand, it considers different overlapped individuals as the same one and, on the other hand, the same individual is separated in several parts. These issues are expected to be improved during the After LIFE+ of the project.

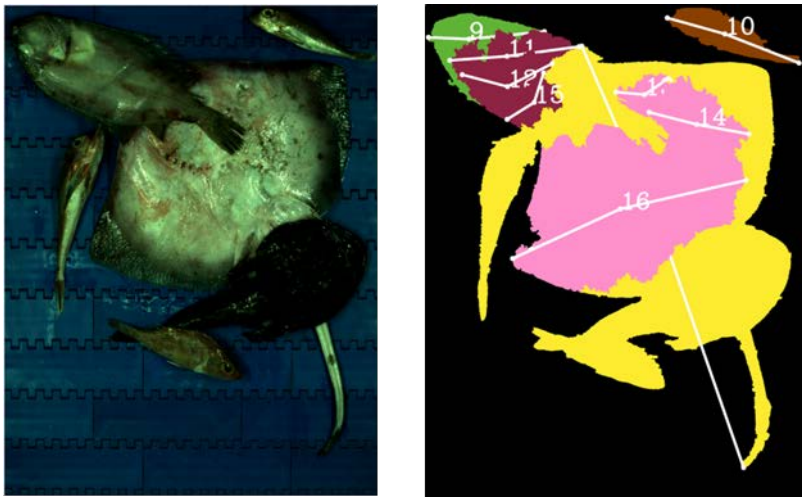


Figure 5. Background elimination, species classification and length estimation when individuals are overlapped.

Regarding oceanographic campaigns, the research surveys covered a total of **270 days at sea**: 90 in Spanish coastal waters (45 days every year 2016 and 2017); 60 international European waters (30 days every year 2016 and 2017); 120 in international Northwest Atlantic waters, NAFO waters (60 days every year 2016 and 2017). More details about these campaigns are given next.

R/V Miguel Oliver (ICES-Spain)

- 12 March-16 April 2016: PELACUS Research survey
- 17 September-23 October 2016: Western IBTS 4th quarter Demersales Research survey
- 30 August-10 September 2017: DESCARSEL Research survey
- 3 October-23 October 2017: Western IBTS 4th quarter Demersales Research survey

R/V Vizconde de Eza (NAFO)

- 22 June-23 July 2016: 3M Flemish Cap Groundfish Survey.
- 27 July-24 August 2016: 3L Fletan negro Groundfish Survey.
- 15 Mayo – 13 Junio 2017: 3NO Platuxa Groundfish Survey.
- 19 Julio – 15 Agosto 2017: 3L Fletan negro Groundfish Survey.

R/V Vizconde de Eza (ICES-West Ireland)

- 10 September-11 October 2016: Western IBTS 4th quarter Porcupine Research survey.
- 24 Agosto – 23 Septiembre 2017: Western IBTS 4th quarter Porcupine Research survey.

During the last 10 months of the project, the iObserver has been tested on three commercial vessels from the OPROMAR fleet (Portosanto, Ría de Marín and Nuevo San Cibrán). Eight surveys (with a total number of 36 days at sea) were carried out so far in ICES-Spain region. In these surveys the **iObserver was used in 128 hauls taking around 29,000 pictures.**

The development of the identification and quantification software will continue by analyzing the photos obtained on board during iObserver tests in the oceanographic campaigns (R/V Miguel Oliver and R/V Vizconde de Eza) and on commercial vessels (Portosanto, Ría de Marín and Nuevo San Cibrán).

Finally, and regarding **Task B3.1,** a complete cost evaluation of implementing the iObserver and RedBox on board commercial vessels has been carried out. It is concluded that the associated costs for shipowners are not high (not higher than 6,000 €) but it will be mainly depend on the own infrastructure of the vessel, including the distribution of the fishing park and the state and/or availability of communication/power installations on board. LIFE iSEAS partners concluded that the installation of these technologies has to be made on a case-by-case way to minimize these costs and that it is possible in the near future to get financial aid or subsides from regional, national or European administrations to install these devices in the framework of fully documented fisheries and LO compliance policies.

All the details of the results of this task are summarized in **Deliverable B1.2**, attached to this Final Report as **Annex 1.**

Outputs: Comparative with planned outputs

- All proposed devices (four - 4 iObservers) were fully developed and tested on board oceanographic and commercial vessels (2 still operating on commercial vessels).
- Data acquired of total catches during testing pilot trips was summarized in Deliverable B2.1 and it is also available in the private part of the marine SDI, including the reason for discarding. This data will feed models developed in B3.
- The definition and implementation on board of the protocol to properly implement the iObserver technology (Milestone B1.1) was properly achieved on due time.
- Finally, a complete report on the total costs associated with proposed technologies has been developed based on the results/experiences/feedback obtained during pilot trips on board oceanographic/commercial vessels testing the iObserver **(Deliverable B1.2 – Annex 1)**

Indicators used to test the performance

The indicators used to test the performance of the action are the ones established in the project proposal, mainly days of test at sea previously described together with the accuracy of the identification (as reflected in Table 2). More information can be found in **Annex 2** (*Monitoring Update*).

Issues found

- The administrative delay (6 months) on solving the Public Tendering of the iObserver affected the scheduled program for testing the iObserver system during 2015. Because on the intensive work on this Action, the delay was reduced to two months so oceanographic campaigns opportunities and days at sea were re-defined.
- Because of the wide variability in the fishing parks of the different boats, the installation of technologies on board, even in oceanographic vessels, must be

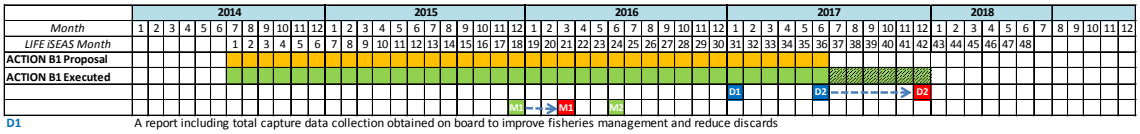
studied in a specific way for each ship. In order to minimize the problems caused by this, the final standard prototype was designed to be as flexible/portable as possible.

- The identification results when samples are overlapped are not accurate. This issue is expected to be approached in the After LIFE. In fact, some sources of funding to improve these results have already been identified and a proposal for a project has already been submitted. Improvement of lighting conditions and tests of new cameras will be also considered.
- Background elimination properly works when the color of the conveyor belt is different from fish color. Issues were found when using white conveyor belts. Blue conveyor belts are recommended.

Task duration: comparative with the established time schedule

Proposal: 36 months (from *Month 1 to Month 36*).
Real: 42 months (from *Month 1 to Month 42*).

The task has been extended six months in order to correct for the delay caused by the Public tendering issue and to continue with the tests of the iObserver on board commercial vessels.



D1 A report including total capture data collection obtained on board to improve fisheries management and reduce discards
D2 A report of proposed technologies costs, including potential solutions for its implementation and funding in EU fisheries
M1 Implementation of technologies on board
M2 Validation of protocols for technologies on board implementation and acquisition
6 months extension to complete testing and validation - Request included in te Midterm Report (June16) to the EC

Summary description of the associated reports

- **Deliverable B1.1:** "*A report including total capture data collection obtained on board to improve fisheries management and reduce discards*". This deliverable explains in detail the work carried out in Action B1 (Definition and testing of iObserver/RedBox) within the period November 2015-January 2017. The document is divided in three main blocks. In the first one, a detailed description of the iObserver (both from the hardware and software points of view) is presented. Then, the work carried out to implement and test the developed technology on board scientific surveys and at inshore lab is described. Main results of these tests are also provided. Final section includes conclusions, and proceeds to discuss possible improvements and directions of future work.
  Submitted with the Second Progress Report (Month 36).

- **Deliverable B1.2:** "*A report of the proposed technologies costs, including potential solutions for its implementation and funding in European fisheries*".
  Submitted with this Final Report – **Annex 1** (Month 48).

Others reports/papers:

1) One chapter in the book: "*The European discard policy-reducing unwanted catches in complex multi-species and multi-jurisdictional fisheries*". Editors: Sven Sebastian Uhlmann, Clara Ulrich and Steve Kennelly. Edited by Springer. Attached to this Final Report in **Annex 8**.

Action B2: Development of a fish discards SDI

Activities/subtasks description:

Task B2.1: Since July 2014 (Month 1) CESGA has worked on completely defining the objectives, functional and non-functional requirements and use cases required by the LIFE iSEAS project for the development of Action B2 (Development of a fish discards SDI). These developments are explained in detail in **Deliverable B2.1.**

A ***Marine Spatial Data Infrastructure (SDI)*** has been implemented, complying with the INSPIRE 2007/2 Directive, which allows access to geoservices specifically related to fishing discards. This infrastructure has the standard services of the OGC Web Map, Web Feature, Web Coverage, Web Processing and Catalog, and is based on a data model and its corresponding database that has been developed with the other project partners. An update on the developments made during last project year is summarized in **Deliverable 2.4** attached to this Final Report as **Annex 4**.

CESGA, in collaboration with IEO, worked in the definition of the initial data model for the Marine SDI that has been obtained based on the results of FAROS Project. The first draft of the data model was presented during the Coordination Meeting held in Vigo on November, 27th 2014 (Month 5).

Data model was subsequently refined during project execution until its final version. The same information structure was used for RedBox (Task B2.2). This database is stored in a PostgreSQL database server system, version 9.2.17 with the PostGIS spatial data extension, version 2.1.8-1. The data model has been refined from the initial model included in the requirements specification document.

In collaboration with the IEO, the concept of *metier* and its relationship with fishing grounds, fishing areas, target species and gears is included in the data model. This is used to categorize catches and to feed the fishing suitability models of action B3. The operator selects the *metier* for each haul and from this and the GPS position the system automatically determines fishing area, fishing grounds, target species and used gear.

There are four access levels with their corresponding permissions to serve the information, both in the Geoportal and in the SDI services:

a) *Administrator (0):* It has full access. It is a user who is responsible for maintenance of the system.
b) *Privileged access (1):* It has access to read all data, services, reports and generated maps. It will be used by the research partners of the project.
c) *Data Introducer (2):* In addition to access to basic data, has permission to enter fishing data and access its own. It is composed of the operators on-board of the iObserver and owners.
d) *Limited access (3):* Access to basic data (ports, valuations, maps ...) and the results of the models. General public.

In case of **Task B2.2**, RedBox (from FAROS project), map viewer and WMS services were adapted by CESGA in collaboration with IEO and IIM-CSIC to the LIFE iSEAS project.

The main objective of the ***RedBox application*** is to record and manage the fishing data generated by a ship during the trip, based on the data entered by the operator and those generated by the artificial vision species recognition system iObserver and contextualize the catch information relating it to the *Trip* and the *Haul*.

The application connects to different ship navigation instruments and collects position, heading, speed and depth information at regular intervals. It also provides a simple user interface that allows the operator to view and modify the information before being sent via satellite to the iSEAS project server at CESGA. Figure 6 presents an overview of the RedBox system within the general scheme of the iSEAS project.

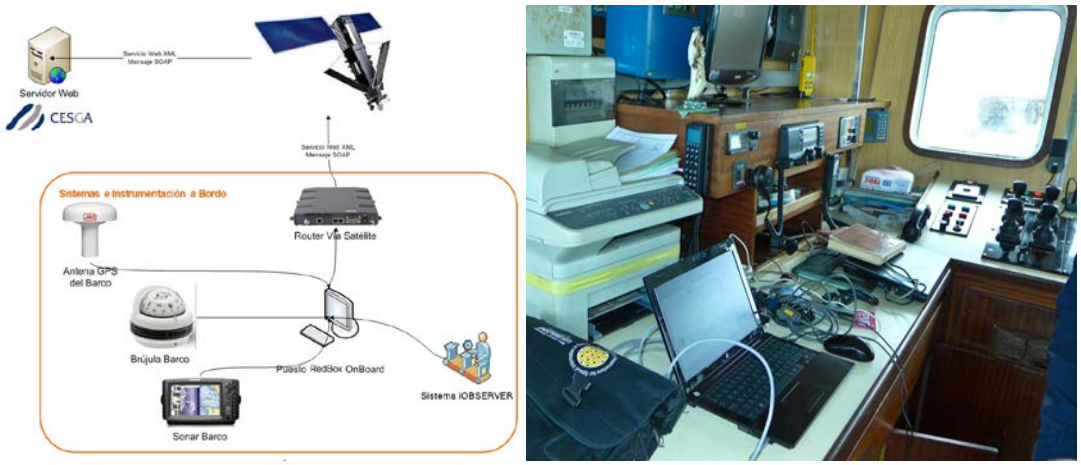


Figure 6. RedBox scheme Installation of the iObserver on-board Portosanto vessel

The RedBox software will be installed on a PC, typically located on the ship's bridge (Figure XX). The software has been designed so that the technical requirements of the computer on which it is installed remain low. A connection, typically by serial cable, allows the acquisition of data in NMEA format generated by on-board instruments. The application is configurable to be able to adapt to the existing connection type and to work with different instrumentation.

The data coming from the iObserver system is received through a network connection. If the ship has satellite equipment for data transmission, it can also be connected to the RedBox. If there is no satellite router available, a cellular network router with WiFi connection can be used to carry out transmissions in coverage areas near the coast.

In a typical trip, the software will be operational as long as the trip lasts or, at least, during the time the ship is in the fishing zone. This is so that the software can collect the GPS position data at any time and then automatically locate the hauls when the operator records them (Figure 7). It must be mentioned that, RedBox is based on the .NET Framework 4.0 work environment and the Entity Framework 6 data access API to enable the use of geographic data.

The application is available in English and Spanish and its functionality is detailed in two manuals in both languages These materials, together with an installer of RedBox to facilitate its installation on board, are available to download (under request) at the LIFE iSEAS web (www.lifeiseas.eu) and are also attached to this Final Report as **Annex 18)**.

RedBox main functionalities can be found in **Deliverable 2.5 & 2.6** attached to this Final Report as **Annex 5.**

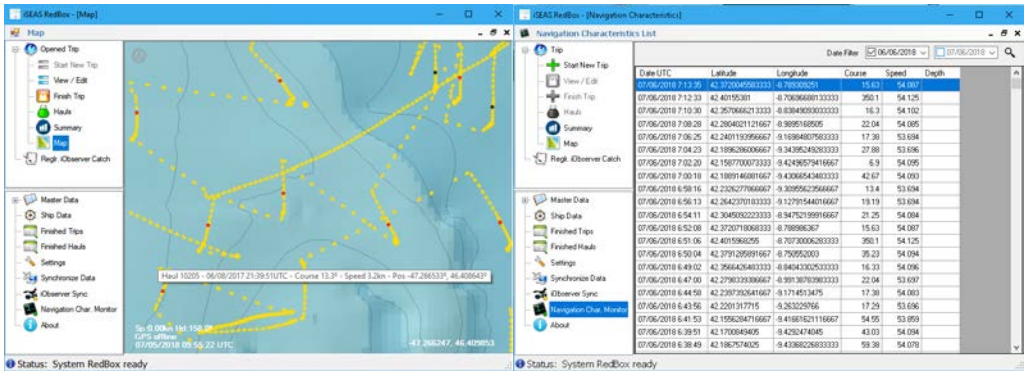


Figure 7. Example of the RedBox geo-referencing process of fishing hauls

Regarding its implementation on board, several testing campaigns have been completed with the RedBox software on board both oceanographic and commercial vessels. The tests allowed debugging the operation of the software and, in collaboration with the observers in charge of its operation, improvements were detected and agreed upon in its use in a real work environment, especially in regard to the interaction between the software and the operator that is in charge of its management, automate the processes of data capture to the maximum and speed up its management. Observers from the IEO were in charge of operating the RedBox software in the oceanographic campaigns and from the IIM in the commercial trips. **Table 3** summarizes the RedBox tests.

Ship	Trip	Hauls	Catch lines (manual)	Catch lines iObserver	Specims. iObserver	Total weight (kg)	Navigat. lines	GPS (%)	Depth Probe (%)
Miguel Oliver	*Pelacus 2016*	15	19	-	-	12540	5419	99	99
Vizconde de	Flemish Cap 16	182	400	-	-	15179	7963	29	67
Vizconde de	Fletán Negro 16	105	286	-	-	7333	3611	39	33
Vizconde de	Porcupine'16	85	702	-	-	42260	7328	86	25
Miguel Oliver	Demersales'16	130	94	-	-	39096	9819	100	100
Portosanto	13/6/17-19/6/17	28	159	0	0	19800	0	0	0
Portosanto	17/7/17-25/7/17	31	0	270	25408	893196	1802	79	0
Vizconde de	*Platuxa'17*	109	22	2	1202	78	3175	39	39
Vizconde de	*Fletán Negro'17*	103	0	157	54693	333444	2616	46	3
Vizconde de	*Porcupine'17*	88	0	208	369181	151868	1413	17	0
Miguel Oliver	*Descarsel'17*	1	1	0	0	230000	393	12	12
Miguel Oliver	*Demersales'17*	67	0	363	40854	21133	3996	70	0
Portosanto	30/1/18-6/2/18	27	0	19	6511	27030	1999	99	-
Portosanto	*6/3/18-9/3/18*	13	-	-	-	-	739	99	-
Ría de Marín	21/2/18-22/2/18	4	0	15	3146	3861	117	45	-
Ría de Marín	25/2/18-27/2/18	4	0	15	2466	2982	196	65	-
Ría de Marín	13/3/18-14/3/18	6	0	42	20889	7054	388	100	-
Ría de Marín	22/3/18-23/3/18	4	0	-	-	-	280	100	-
Ría de Marín	1/4/18-2/4-18	4	0	-	-	-	308	100	-
Ría de Marín	15/4/18-16/4/18	4	0	-	-	-	293	100	-
Ría de Marín	6/5/18-7/5/18	4	0	22	22356	8318	301	99	-
Ría de Marín	10/6/18-11/6/18	4	0	-	-	-	299	99	-

Table 3. RedBox performed onboard tests

The software was able to operate 24 hours a day during all the trips except the campaign ***"Descarsel 2017"*** in which there were some problems of inadvertent closures due to application errors that prevented data capture. This problem was solved in the following updated versions. The iObserver data capture tests were positive in terms of processing the data received by the RedBox, although there were problems in receiving the data, not being able to receive the information in some trips (see Table XX). Regarding navigation instruments, GPS data was received in general terms although there were temporary losses in reception. The processing of GPS signals was refined and improved to minimize losses, although often these losses had an external cause: in the case of oceanographic vessels due to problems with the origin of the signal and, in the case of commercial ones, to problems easily solvable as disconnected or defective cables. The depth probe data was generally poor or non-existent. Regarding the transmission of data to the central server, there were some occasional connection losses due to maintenance tasks of the server or due to lack of coverage, especially in the trips in remote areas such as the Vizconde de Eza campaigns in NAFO areas, but the transmission of all the data for all the trips was achieved.

In conclusion, the test trips were very useful for the achievement of the objective of obtaining a fully operational and efficient RedBox application.

The Geoportal is built with the map viewer as the main component. The viewer presents a reference background map with bathymetry, several toolbars for navigation and control of the available information layers such as ports and reference areas. It is available in English and Spanish (Figure 8).

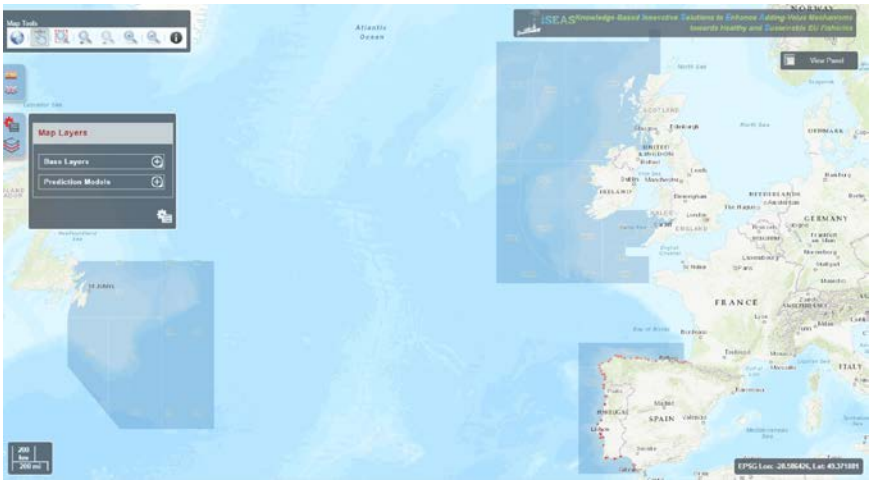


Figure 8. LIFE iSEAS Geoportal

This *Web Map Service (WMS)* is an international standard that defines a "map" as a representation of geographic information as a digital image file. WMS -produced maps are generally rendered in an image format and they can be invoked by any corporate platform or software trained for displaying this type of services, such as desktop GIS.

The Geoportal has two versions: i) *a public, free access* one with generic information and layers with the results of some static models and; ii) *a private one* that, in addition to the information offered in the public, allows access to the fishing data, filtered according to the user access permissions, and dynamic prediction models. An access

portal to the viewer allows the user to choose between the public or private part (Figure 9), which requires the identification of the user and, depending on his role, filters the information to which he can access. The portal is accessible from the address http://iseas.cesga.es

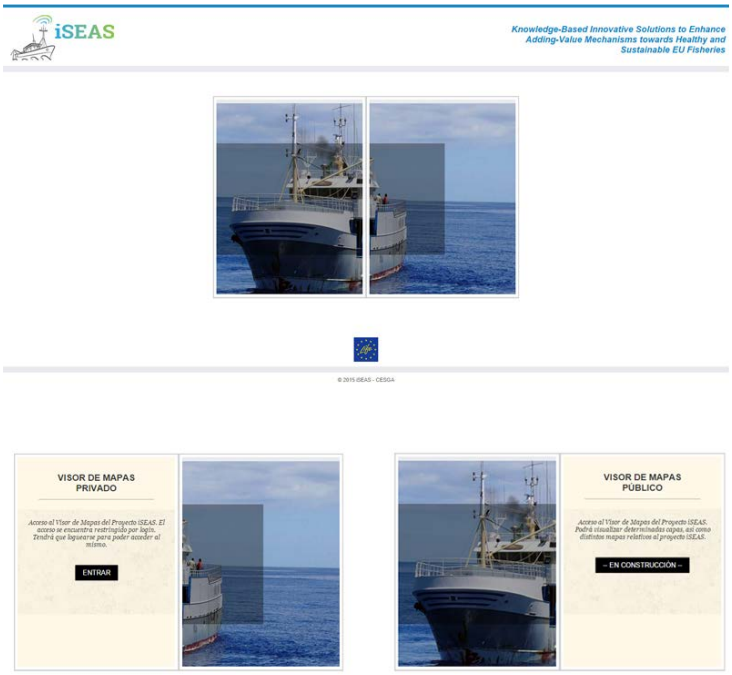


Figure 9. LIFE iSEAS Viewer Access portal

The web link to be used by any desktop GIS software to access the public level of the iSEAS WMS is: http://iseas.cesga.es/ows

The *Web Feature Service (WFS)* service allows access to a web service of phenomena and remote access and editing of geographical data. It is done at the geographic object level, that being able to access its information. This standard allows remote access to the attributes of a specific geographic object. Within the LIFE ISEAS project, WFS services have been implemented to securely query the vector data of hauls with user and password control, in the same way that we can do it with WMS services. The link to which we can access the WFS services is:
http://iseas.cesga.es:8080/geoserver/ISEAS/wfs

The *Web Service Coverage Service (WCS)* allows the obtaining of geospatial data in the form of coverage or raster, which has access to the thematic attribute of the pixels that do not have to be RGB colors as in the case of the WMS standard, but any value thematic. In the case of the LIFE iSEAS project, a WCS service has been implemented that will allow access to the results of the models developed in Action B3.

The OGC® *Web Processing Service* (WPS) standard describes how to access geospatial processes from a Web interface. The processes cover any algorithm, calculation or model that operate on georeferenced raster or vector data.
The WPS processes are divided into three categories: vector, raster and geometry; making reference to the type of geospatial content used as input to the process.

As proof we have proposed the cutout of the model that we have served as WCS that indicates the suitability of the fishing zones, with polygons of known coordinates in WKT format.

Finally, the developed *catalog service (CSW)* allows the publication and search of the description (metadata) of data and web services, through a standard interoperable communication protocol that transmits the requests between client and server. Through this service it is possible to access and consult all available geographic resources.

See more info and technical details of these LIFE iSEAS services on **Deliverable 2.5 & 2.6** attached to this Final Report as **Annex 5.**

Regarding **Task B2.3,** One of the main capabilities of this geoportal (all of them fully described in **Deliverable 2.5 & 2.6** attached to this Final Report as **Annex 5**), and in connection of Action B3, is the definition and development of a powerful modelling tool to analyze the spatio-temporal conditions of considered fishing areas in terms of discards/stock status, available in the "Model" section of the private part of the Geoportal (Figure XX). This can be used both in land as well as on board (if internet connection is available in the vessel). However, LIFE iSEAS partners think that the best way to exploit its capabilities is to plan in-land and in advance the next fishing trips in order to avoid undesirable fishing areas or that the ship-owner uses the Geoportal in real-time to give concrete orders to the skipper about high discarding zones.

There are three types of models available, all developed by the IEO: i) *Fishing Suitability Index Model (FSI); ii) Fuel Efficiency Model* and; *iii) the vulnerable species hotspots models*. The first two are generated dynamically with the catch data existing in the project database. Those of vulnerable species are static and have been pre-calculated with the IEO data. Complete and detailed explaination of these models can be found later on this report in the framework of Action B3.

In the ***FSI model***, input parameter such as the *metier, one or several target species* and a *time interval* (the shorter, the more relevant the modeling by temporary closeness, but less will be the number of samples available to feed the model) must be introduced. The results are presented in a layer in the viewer as a dotted grid with a color code that represents the value of the FSI index for each point (red represents undesired fishing areas and green good ones, with low discards levels of selected species) and in a second layer with the average result of the FSI index for the fishing areas delimited by the IEO from Vessel Monitoring System (VMS) data (Figure 10). This tool allows the skippers and ship-owners to plan the fishing activity in advance based on complete real fishing data obtained from the different iObservers installed, selecting the most suitable fishing areas (those where the levels of discards are lower), minimizing the impacts of generating and managing these unwanted catch that must be retained on-board to comply with the landing obligation. This prediction maps complement the inherent knowledge of fishermen, acquired during years of experience at sea.

Regarding the ***Fuel Efficiency Model***, there are a series of parameters to filter the fishing data that feed it as in the FSI model to execute the model: *metier, time interval in days until the current date* and optional filtering by day or night sets. Additionally there are some parameters to configure the characteristics of the ship and its activity.

The result obtained shows an estimate of the benefit per haul for each fishing zone while minimizing environmental impacts associated to fuel consumption and generated discards (Figure 11).

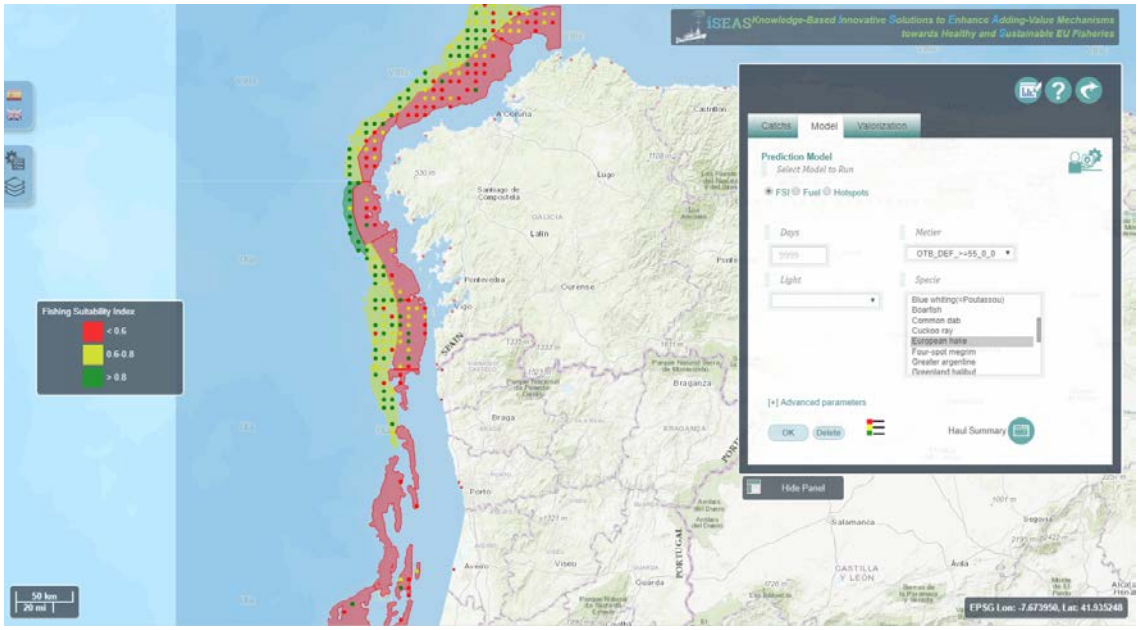


Figure 10. FSI map result for European hake on ICES Area IXa

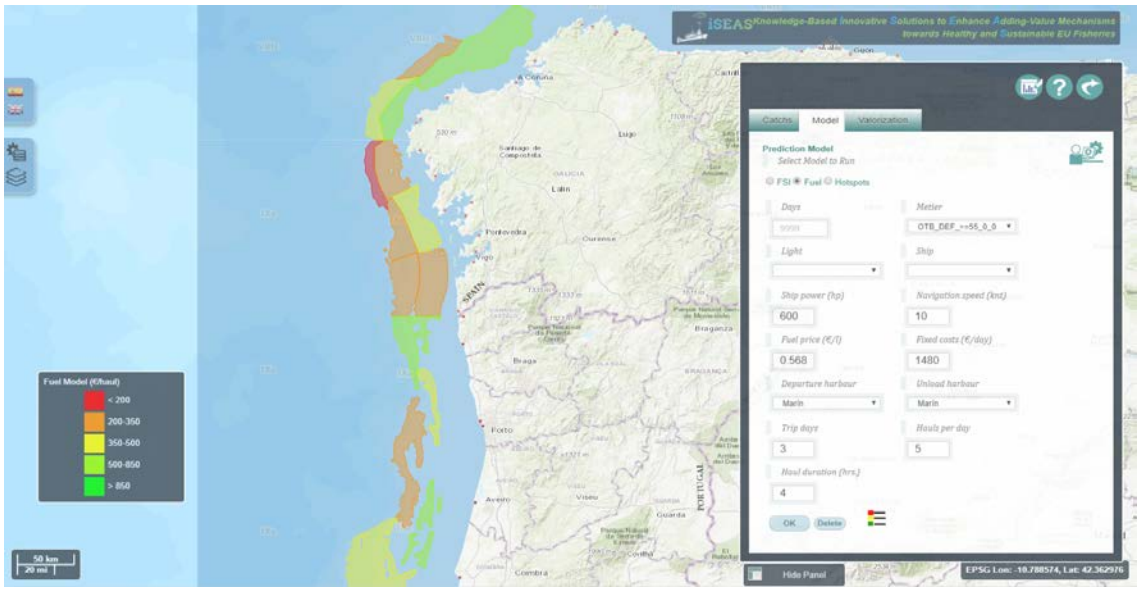


Figure 11. Fuel efficiency map result for European hake on ICES Area IXa

Finally, the ***vulnerable species concentration (hotspots) models*** are accessible from both the public part of the Viewer and the private part. These models identify the areas where a higher concentration of certain protected species (such as the *Pennatulaceous* and the thorny skate) or recruits of commercial species such as European hake (Figure 12) and Norway lobster are expected from data collected in scientific campaigns of the IEO. One species was chosen per reference area of the project. These models are static; they are pre-calculated for specific years, allowing fleets and skippers to avoid those areas where juveniles are more abundant. As a consequence, the discards due to "no

size" reason will highly decrease, minimizing the unwanted catches while ensuring the good health of the future stocks of these resources. In Figure XX, it can be shown that recruitment areas for European hake are mainly located in the northern coast of Galicia (red zones). Therefore, these are the fishing areas that fishermen have to avoid as much as possible during their daily activity.

During Action B2 implementation, a seminar entitled "*Herramientas innovadoras para la gestión y reducción de Descartes pesqueros"* was carried out in the CESGA headquarters in Santiago de Compostela on 08th February 2018 to present these innovative tools developed in the framework of Action B2 (in connection with Actions B1 and B3) to manage and reduce fishing discards. A practical demonstration of these innovative technologies was carried out among assistants, mainly fishermen and adminitrations. More details of this event can be found later on this report (***Section 5.4. Dissemination issues***).

Finally, it must be highlighted that after the end of the project, the perspectives for continuing this action will need the collaboration of the fishing ships (OPROMAR) and oceanographic vessels (IEO) to feed the defined SDI with new data to update it and to feed the prediction models developed in the framework of Action B3. The SDI will be available for using by these collaborated ships and even others (at regional, national and/or European level). Moreover, one aim of the After-LIFE+ plan related to this Action is to increase the use of the prediction maps among the fishing sector in order to complement with complete, aggregated, real fishing activity data from different vessels their own knowledge in order to make its daily activity more environmental friendly and sustainable. Nowadays, the level of use of these maps by involved fleets is not as intense as desired by the LIFE iSEAS partners.

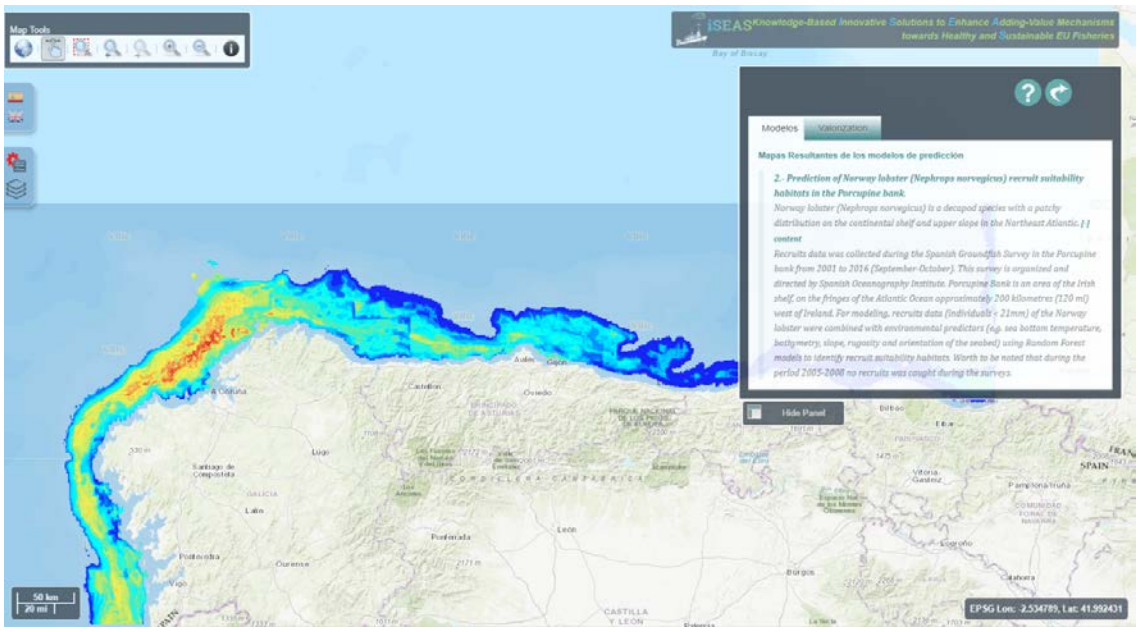


Figure 12. HotSpots model result for European hake recruits

<u>Outputs: Comparative with planned outputs</u>:

Action B2 progressed as expected. CESGA and IEO, together with IIM-CSIC working on this Action, produced all related Deliverables B2.1 to B2.6) together with Milestones B2.1 to B2.5 achieved. Due to the slight delay in action B3, the WPS service was postponed to 31/12/2016 to have a fully operative, powerful tool.

All expected results described in the LIFE iSEAS proposal have been attained/produced, including a fully operative marine SDI (with a complete set of web services to exchange info and data with other environments and GIS tools), a geoportal and an integrated powerful modeling tool for fishing activity effective and real-time management.

Indicators used to test the performance:

Indicators defined in LIFE iSEAS proposal were used to assess the proper development of Action B2, in addition to Milestones B2.1 to B2.5.

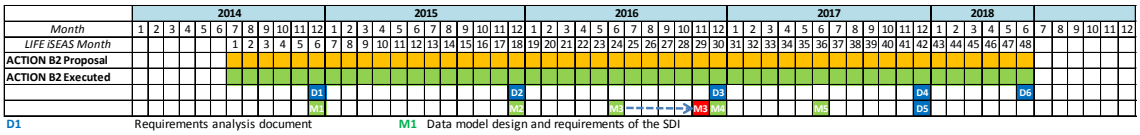
Issues found:

No relevant issues were found so far.

Task duration: Comparative with the established time schedule.

Regarding the expected chronogram of the action, it can be concluded that no delays have been experienced, except for task in connection with Action B3,that did not prevent from fully achieving all the Action results on due time.

Proposal: 48 months (*from Month 1 to Month 9*).
Real: 48 months (from *Month 1 to Month 12*),



D1	Requirements analysis document	M1	Data model design and requirements of the SDI
D2	Annual SDI development report	M2	Map viewer and WMS service
D3	Annual SDI development report	M3	WPS service
D4	Requirements validation document	M4	WCS and WFS service
D5	Annual SDI development report	M5	CS-W (metadata catalog)
D6	Final SDI development report		

Summary description of associated reports:

Produced deliverables in the framework of this Action include the following:

- **Deliverable B2.1:** "*Requirement analysis document*"
  Submitted with the Inception Report (Month 9).
- **Deliverable B2.2:** "*Annual SDI development report*". Including the compilation of technical tasks carried out during 2015, specially related to the SDI design and development works.
  Submitted with the First Progress Report (Month 18).

- **Deliverable B2.3:** "*Annual SDI development report*". Including the compilation of technical tasks carried out during 2016, specially related to the SDI design and development works.
  Submitted with the Second Progress Report (Month 36).
- **Deliverable B2.4:** "*Annual SDI development report*". Including the compilation of technical tasks carried out during 2017, specially related to the SDI design and development works.
  Submitted with the Final Report – **Annex 4** (Month 48).
- **Deliverable B2.5 & B2.6:** "*Requirements validation document" & "Final SDI Development Report"* has been fused in a unique document where all the developments carried out in the framework of Action B2 and all the tests and improvement made on them along the project implementation are explained with high detail.
  Submitted with the Final Report – **Annex 5** (Month 48).

Action B3: Optimization of the fishing activity monitoring towards the sustainability of resources

Activities/subtasks description:

One of main objective of the iSEAS LIFE+ Project, under the action B3, was to develop reliable mathematical models to identify the best fishing areas, considering those best fishing areas as the ones with lower probability of discarding. Hence, the most suitable areas for fishing, in addition to providing a profitable catch, should avoid areas where a large amount of unwanted catch is concentrated, either because they are vulnerable species, they have a sensitive sizes or because the species have no commercial value. In all these cases, these models provide essential tool to support the marine spatial planning framework such as predictive maps. These easy-to-use interpretation tools, combined with information on the distribution of fishing activity, could be a suitable approach to implementing an effective ecosystem-based marine spatial planning that embraces the Ecosystem Approach and Landing Obligation requirements.

According to the tasks carried out in this action, three types of maps have been generated, all of them based on data from the commercial fleet or oceanographic campaigns and including environmental and geographical variables:

Task 3.1. Maps of more suitable fishing areas through the **Fishing Suitability Index** (FSI hereafter), based on data from the analyzed commercial fleet.

In order to obtain the FSI maps, fishing records, which are used as inputs in the Random Forest models, are transformed into a single response binary variable and correlated to explicative environment variables to assess which habitat characteristics are related with high discards. Once this relation is established, it is used to predict high discard areas in space and time based on the estimated species-environment relationship. As results a FSI prediction map is shown, which values range from 0 to 1 indicating the probability of a location to be suitable for fishing activity. In particular, outputs are shown as a "user friendly" probability map, easy to understand by using a "traffic light" rule to show best fishing areas: among those locations identified as suitable fishing areas, those in green will be better than red ones (Figure 13).

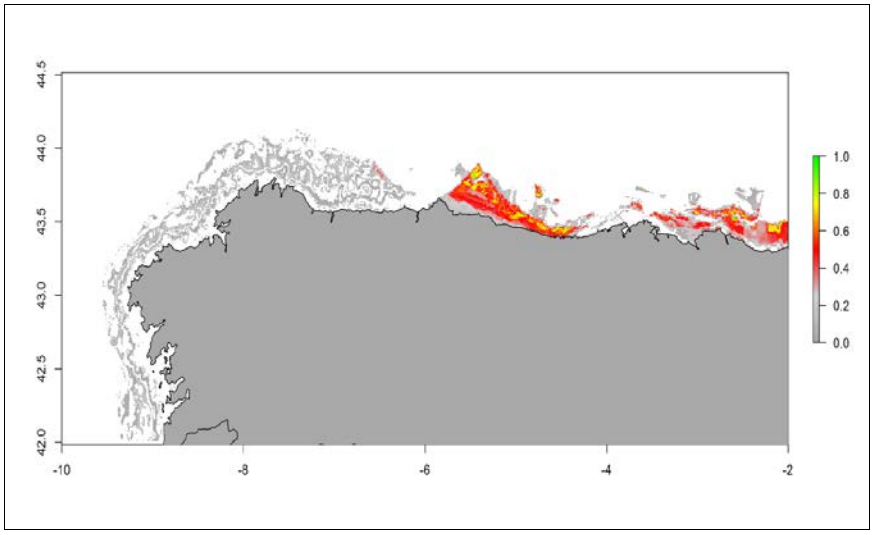


Figure 13. Example FSI map for the hake (*Merluccius merluccius*).

Task 3.2. Maps of sensitive species based on data from oceanographic campaigns: **HotSpots areas**.

In order to obtain maps of interest for all the areas covered by the LIFE iSEAS project, different case studies were selected. The criteria of selection of the cases studies were: i) vulnerability of the species or of the key life cycle; ii) data representativeness in terms of spatial and temporal coverage, and; iii) availability of fishery-independent datasets. Within this context, four different cases studies were selected: a) European hake (*Merluccius merluccius*) recruits in the Cantabrian Sea (ICES VIIIc and IXa); b) Norway lobster (*Nerphrops norvegicus*) in the Porcupine (ICES VIb and VIIc); c) Thorny skate (*Amblyraja radiate*) in the southern Grand Banks area (NAFO 3LNO); and 4) sea pen corals (*Anthoptilum grandiflorum*) in the Flemish Cap area (NAFO 3M). For all these cases fishery independent data derived from oceanographic surveys were related with environmental variables using Bayesian models in order to obtain accurate maps of sensible areas that can be avoided by fishers to preserve marine resources (Figure 14). A complete description of this model can be found in Deliverable 3.2, attached to this Final Report as **Annex 6.**

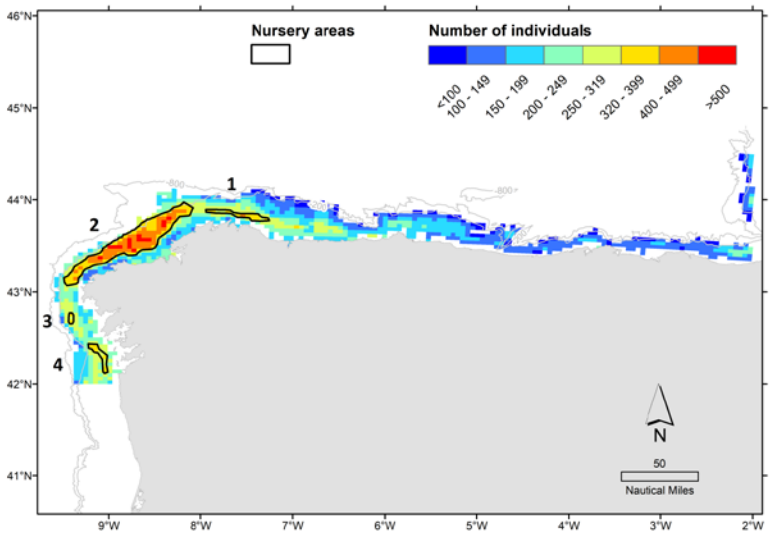


Figure 14. Example of the Bayesian model outputs for European hake (*Merluccius merluccius*) recruits showing average mean abundance estimates (1997-2016) and the four persistent nursery areas identified.

Task 3.3. Maps of cost and benefit strategies, based on commercial and economic data. They are aimed at improving fishing efficiency, including energy and fuel savings: **Fuel Efficiency model**.

In order to obtain fuel efficiency maps *Random Forest* models were used to combine economic and fishery data to identify the more profitable areas for the coastal trawling fleet based in the port of Marín (Spain) which operates in regions ICES VIIIc and IXa. It is a spatial bio-economic model to simulate outcomes from different scenarios, based on the following components: i*) a productivity prediction model of retained catch by fishing ground* (using catch & environmental variables); ii) *the economic component of the fishing activity* (expected revenues and expected costs by ground – Figure 15)

The main outputs of the system are two: i) a map of predicted revenues by area; ii) and a map of predicted profits by area, together with algorithm performance statistics (Figure

16). In addition, model were used to simulate policy makers' scenarios to assess the social-economic trade-offs of the landing obligation implementation in the area.

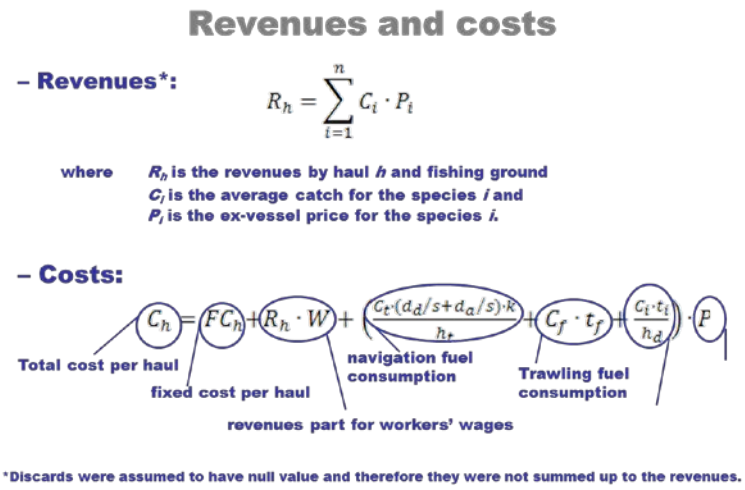


Figure 15. Revenues and costs considered in the development of the Fuel Efficiency Model

A complete description of this model can be found in Deliverable 3.2, attached to this Final Report as **Annex 7.**

All the generated maps were integrated in the LIFE iSEAS SDI/geo-portal and are accessible to users, as explained in Action B2. In particular, maps of the FSI and of the fishing efficiency are a dynamic tool that can be generated directly by users through the LIFE iSEAS geo-portal interface, selecting a priori the species, some specific fishery parameters and the temporal window of the model (Figure 17). In this way spatial prediction maps are produced in real time and can be used as a decision-making tool by fishers. On the contrary, maps of key conservation areas are statics and can be consulted, through the LIFE iSEAS geo-portal, jointly with a description of the dataset implemented and the statistical models used both in English and Spanish.

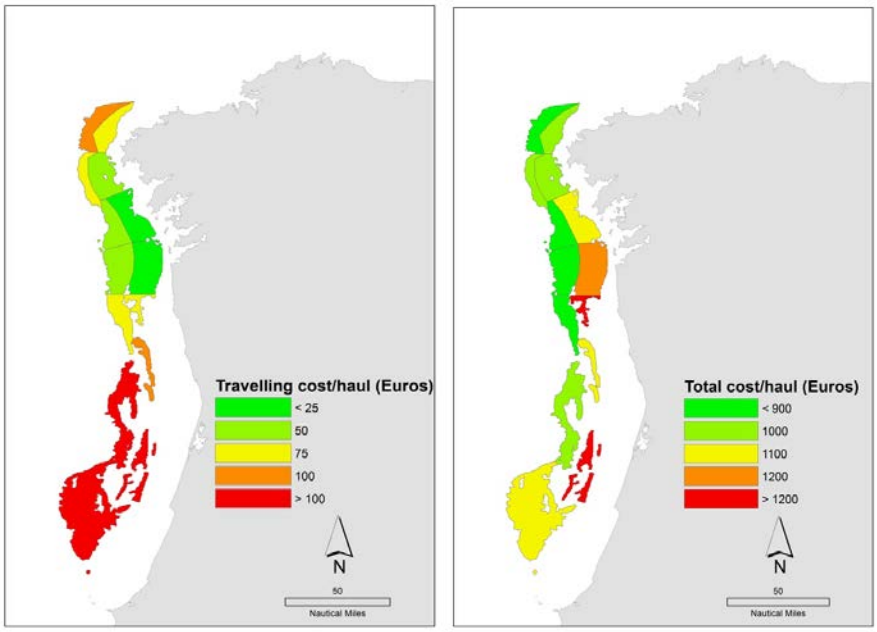
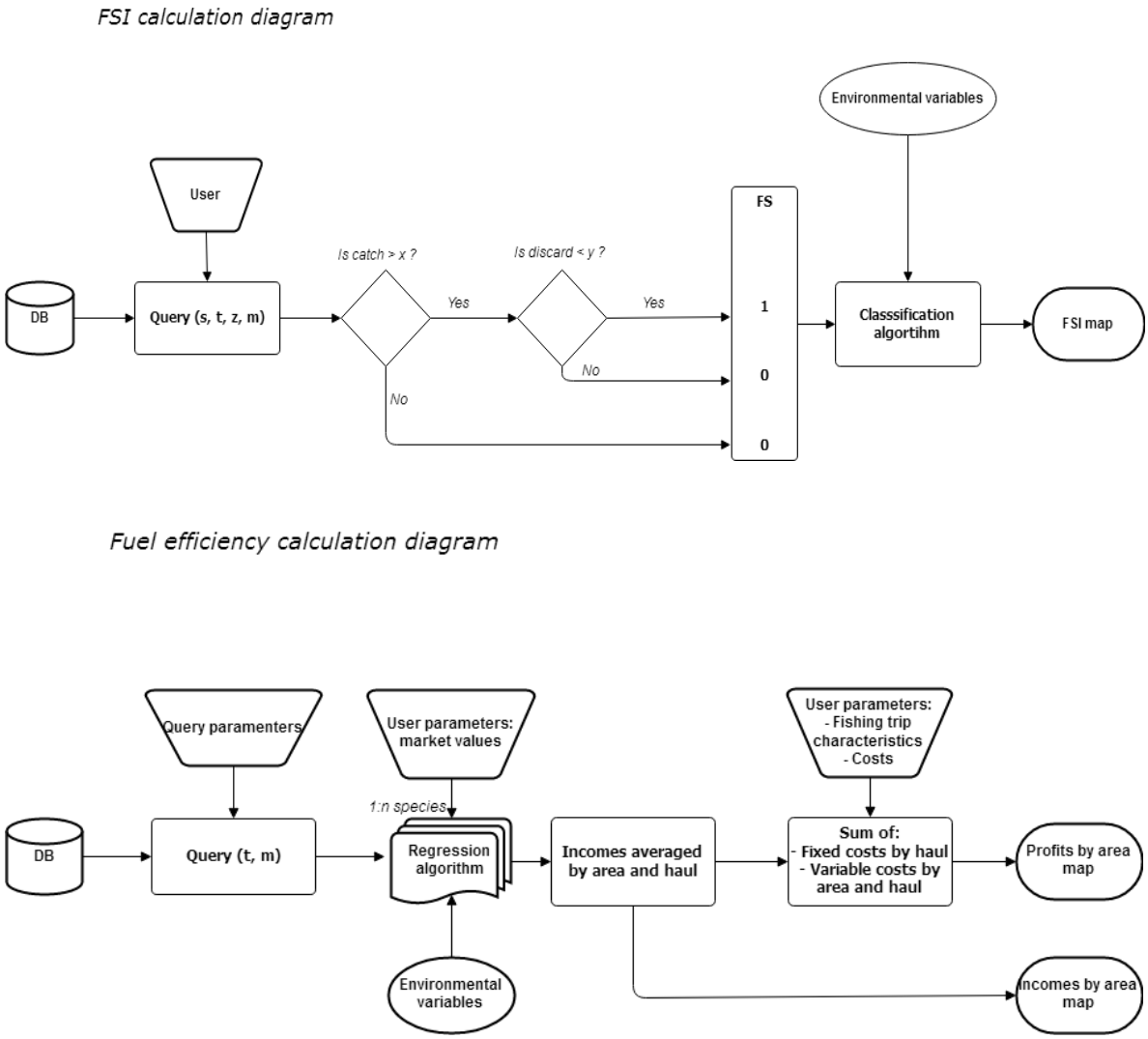


Figure 16. Example of fuel efficiency maps: navigation costs per set (left) and total costs per haul (right).



Abbreviations: s (species); t (time period), z (zone ICES); m (métier); x (catch threshold- default= 0); y (discard ratio threshold - default = 20%)

Query parameters Fuel Efficiency model: boat and type of haul (day/night), **Market values:** expected €/kg per species; **Fishing trip characteristics:** Ports of departure and arrival, number of days, number of hauls per day**; Costs:** Engine power, navigation speed, gasoil price, fixed costs per day (All predefined)

Figure 17. FSI (Up) and Fuel Efficiency (Down) calculation diagrams in the maps tool of the marine SDI of LIFE iSEAS

Regarding **Task 3.4**. developed models have been validated by using real catch data acquired during the 50 pilot trips carried out in the framework of Action B4, showing the predictions of these maps a high accordance/fit to real data (less than a 15% of error). Therefore, it can be concluded that this tool could be of great help to the fleets in order to plan in advance a more efficient and green (with less environmental impact) daily fishing activity.

After the end of the project, the perspectives for continuing this action will need the collaboration of the fishing ships (OPROMAR) and oceanographic vessels (IEO). The

models will be available for using by these collaborating/interested ships and even others (working in the same areas where data are available), being part of the After-LIFE+ actions trying to generalize the use of these map tools among the fleets in order to complete their own knowledge (based on years of experience at sea) and to help them to perform a more sustainable fishing activity.

Outputs: Comparative with planned outputs

All results presented in the LIFE iSEAS proposal for this Action B3 have been fully achieved, including the three mathematical models and the on-line prediction maps tool available in the LIFE iSEAS geo-portal to be used by the fleets.

Indicators used to test the performance:

The indicators used to test the performance of the action are the ones established in the project proposal, mainly those related to the development of the models and their prediction accuracy/capabilities when compared with real fishing data. As previously mentioned, the established level of error between these two values is **less than 15%,** being a good value by taking into account the high spatio-temporal variability of fishing resources, that results in high levels of uncertainty.

More information can be found in **Annex 4 (***Monitoring Update***)**.

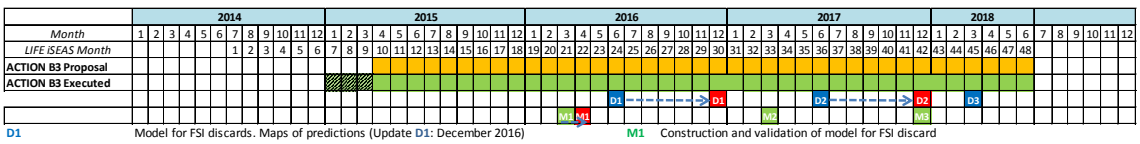
Issues found:

IEO had administrative problems with the personnel contracts which caused a delay in the task. The final incorporation date was in March 2016 (Month 21). The hired personnel to work in Action B3 have previous experience in spatial modelling approaches (from FAROS projects and others). Therefore, and based in the selected applicants' experience/cv, valuable results were produced immediately from that date, allowing to develop the tasks as expected in the proposal, with no remarkable delays.

Task duration: Comparative with the established time schedule

Regarding the expected chronogram of the action, it can be concluded that no significate delays have been experienced, being necessary the re-schedule of the final versions of Deliverables D3.1 and D3.2 due to the late date of hiring carried out by IEO (March 2016) of postgraduates to be involved on the development of these models. But the final products/results fully complies or even overcome the proposed ones (as for the case of the features of the Fuel Efficiency Model).

Proposal: 39 months (from *Month 10 to Month 48*).
Real: 42 months (from *Month 7 to Month 48*).



D1	Model for FSI discards. Maps of predictions (Update D1: December 2016)	M1	Construction and validation of model for FSI discard
D2	Model for Fuel Efficiency. Maps of predictions (Update D2: December 2017)	M2	Construction and validation of model for Fuel Efficiency
D3	Model for HotSpots areas. Maps of predictions	M3	Construction and validation of model for Hotspot areas

Summary/Description of associated reports:

- **Deliverable B3.1** "*Model for FSI Discard. Maps of predictions*" (June 2016, Month 24): A first version was achieved in due time (Month 24). An updated version of D3.1 was produced in December 2016 with complete model results. *Summary:* It is presented a statistical tool in order to identify areas and/or periods with high probability of by-catch/discard species. For this purpose, we developed a specific tool by means of a statistical algorithm integrated into a geo-portal which aims to help fishers to select in real-time the best fishing grounds with lower discard rates while reducing fuel consumption by penalizing the scoring of distant fishing grounds.
  Submitted with the Mid-Term Report (Month 24).

- **Deliverable B3.2** "*Model for Fuel Efficiency. Maps of predictions*" (June 2017, Month 36): A first version was achieved in due time. An updated version of D3.2 was produced in December 2017 with complete model results. *Summary:* It is presented a real-time "fuel-saving" model to increase the efficiency and reduce carbon footprint of the fleet. For this purpose, a statistical algorithm integrated into a geo-portal was developed which aimed to help fishers to select in real-time the most profitable fishing grounds, from an economic and ecological point of view, penalizing fuel consumption of distant fishing grounds.
  Submitted with Second Progress Report (Month 36) & Final Update submitted with the Final Report – **Annex 6** (Month 48).

- **Deliverable B3.3** "*Model for HotSpots Areas. Maps of predictions*" (March 2018, Month 45). The production of this Deliverable was achieved in due time.
  Summary: A reliable mathematical models to identify key conservation areas that could be avoided by fisheries, reducing unwanted catch and overfishing is presented. These models allows describing species geographical trends, to identify spatial ontogenetic shifts of commercially exploited species and provide essential tool to support the marine spatial planning framework such as predictive maps. These easy-to-use interpretation tools, combined with information on the distribution of fishing activity, could be a suitable approach to implementing an effective ecosystem-based marine spatial planning that embraces the Ecosystem Approach and Landing Obligation requirements.
  Submitted with the Final Report – **Annex 7** (Month 48).

Others reports/papers:

1. Pennino, M.G., Vilela, R., Bellido, J.M. (2017) Discard management: A spatial multi-criteria approach. *Marine Policy*, 77:144-151.
   DOI: 10.1016/j.marpol.2016.12.022

2. Pennino, M.G., Vilela, R., Bellido, J.M. (2018) Balancing resource protection and fishing activity: the case of the European hake in the northern Iberian Peninsula. *Fisheries Oceanography.* Accepted.

3. Pennino, M.G., Rufener. M.C., Thomé-Souza M.J.F., Carvalho, A.R., Lopes, P.F.M, Sumaila, R. (2018) Searching for a compromise between biological and economic demands to protect vulnerable habitats. *Scientific Reports*, 8:7791.
DOI: 10.1038/s41598-018-26130-z – ***Open Access*.**
Available at https://www.nature.com/articles/s41598-018-26130-z

Latest documents (produced since the last progress report on Month 36) are attached to this Final Report as **Annex 8.**

Action B4: Development of a decision marking support system for assessing different reuse/valorization scenarios under risk assessment and environmental impact criteria

Activities/subtasks description:

Based on results obtained on Action A1 in terms of available amounts of the different raw material (discarded biomass), species for iDVP1 and iDVP3 were defined.

As explained in Action B1, three commercial ships (*Portosanto*, *Ría de Marín* and *Novo San Cibrán*) were the most active collaborators in connection with the objectives of discards valorization tasks (for bringing the biomass to land and to carry out required on board modifications for such purpose). This task was carried out with the support of OPROMAR.

In the framework of **Task B4.1**, a first step was the analysis of legislation to determine the requirements for storing the new raw material on board. Moreover, the more convenient storing of each biomass fraction was studied in order to define the most suitable on-board management solutions. Boxes/containers storing the different fractions (target species, small sizes, species with rapid degradation on board, etc.) and with several sizes were selected and tested during the different pilot tests carried out in the framework of Action B4. Among these, LIFE iSEAS partners want to highlight those carried out simulating a scenario of fully compliance with the Landing obligation (like it we were in January 2019) as an exercise to make a realistic essay among fleets of the new reality they will face in the near future, identifying the main problems and giving them solutions.

The first pilot test (Figure 18) was carried out at the beginning of May 2018. A total of 2,320 kg of biomass related or due to the proper compliance with the Common Fisheries Policy was retained on board and landed. After this, a full sampling of this high volume of biomass was carried out by personnel of IIM-CSIC, IEO and an external observer specifically hired to perform this simulation (for a total of 6 persons), taking more than 8 hours to identify, classify and quantify all the species present in this new fraction. Pilot tests performed help LIFE iSEAS partners to makes a real idea of the high additional costs for fleets (in terms of extra personnel times/costs) that the compliance with the LO could have related to a proper in land management of new biomass that must be landed and counted against the species quotas.

Figure 18. First Landing Obligation Compliance pilot test (May 8th, 2018)

A second pilot test (Figure 19) was carried out on May, 14th, with a much lower biomass due to the LO compliance: 240 kg. Therefore, this implied an important decrease in the sampling time of this new fraction (up to 1 hour).

Figure 19. Second Landing Obligation Compliance pilot test (May 14th, 2018)

After these two preliminary experiences, personnel from IIM-CSIC and IEO trained the crews of involved vessels (Ría de Marín and Novo San Cibrán) in order to carry out themselves similar tests in order to show them how its daily activity will be modified when the LO comes into force in January 2019. Moreover, new containers of 100 kg (Figure 21) of capacity where tested to compare their management on board/in land capacities when compared with the usually used boxes of 25-40 kg, properly identified and labeled (Figure 20) to not be confused with the fish fraction to be sold in the fish auctions. The reason for this selection is that legislation evolved along LIFE iSEAS implementation, allowing that the biomass due to LO can be kept mixed on board (Figure 21 – Right), except those specimen under legal size, that must be preserved separately since, once landed, they must be used for non-human consumption purposes. The main figures of these 4 pilot tests carried out by the own fleets (with the help of personnel from IIM-CSIC and IEO for sampling in land – Figure 22) are reflected in Table 4. It can be shown that the volumes of biomass are quiet uniform in composition of species, reasons of discarding and volumes, while the times to a complete sampling of this new fraction were, in all cases, lower than 45 minutes. This fact makes possible a quite quick in land management in order to direct the different fractions of this new biomass to the proper final valorization route (iDVP1 or iDVP3).

Figure 20. Labeling of fish boxes to identify on-board the biomass fraction to the LO during pilot tests.

Figure 21. New high-capacity boxes selected to storage on-board the biomass fraction to the LO during pilot tests. On the right, it can be seen how these boxes adapt to the common holds of a trawler.

Figure 22. Landing Obligation Compliance pilot tests carried out by the own fleets during June, 2018

LO compliance pilot trip #3: Discards sampling 12/06/18		
Species	**Total (kg)**	*Reason for discarding*
Blue whiting	229.24	Damaged specimen
Megrim	78.9	No size
Horse mackerel	1.06	No commercial
Total discarded (kg)	**309.2**	
Start time:	9:10	
End time:	9:30	

LO compliance pilot trip #4: Discards sampling 13/06/18		
Species	**Total (kg)**	*Reason for discarding*
Blue whiting	74.44	Damaged specimen
Megrim	31.64	No size
Total discarded (kg)	**106.08**	
Start time:	8:18	
End time:	8:24	

LO compliance pilot trip #5: Discards sampling 19/06/18		
Species	**Total (kg)**	*Reason for discarding*
Blue whiting	64.32	Damaged specimen
Megrim	114.62	No size
Horse mackerel/pouting/scorpionfish	1.1	
Hake	19.26	No size
Atlantic mackerel	10.36	No quota
Boarfish	44.2	No quota
Total discarded (kg)	**253.86**	
Start time:	7:55	
End time:	8:40	

LO compliance pilot trip #6: Discards sampling 20/06/18		
Species	**Total (kg)**	*Reason for discarding*
Blue whiting	19.6	Damaged specimen
Megrim	68.56	No size
Others	0.46	
Hake	13.72	No size
Atlantic mackerel	21.42	No quota
Twait shad	0.86	No market
Boarfish	19.08	No quota
Total discarded (kg)	**143.7**	
Start time:	8:05	
End time:	8:40	

Table 4. Results of the LO compliance pilot tests carried out by fleets (with the advice and help of LIFE iSEAS partners)

The characterization of discards was completed as planned by the IIM-CSIC (**Task B4.2**). Preliminary experiences (**up to 40**) aiming to verify the potential of identified species were performed at laboratory scale. Complementary determinations were also executed at IIM-CSIC in the framework of other projects focused in discards (complementary activities outside LIFE). In addition, the characterization of the potential products to be obtained was carried out with the collaboration with the 3B's Research Group (Biomaterials, Biodegradables and Biomimetics) at the University of Minho. A critical objective of the defined processes was to obtain products with high quality and real economic interest in the markets.

The establishment of flow charts/diagrams of processing lines to valorize discarded biomass into viable products was completed (**Task B4.3**). Complete information can be consulted in produced **Deliverable B4.1.**

In **Task B4.4**, the designs of the iDVP to a pre-industrial pilot level were presented by JOSMAR in the IIM facilities (February 2016, Month 20). From IIM, several changes were demanded regarding residues management, air/odor extractors, etc. Modifications were introduced during next weeks after the meeting by JOSMAR while IIM executed the verification of the processes effectiveness taking into account the defined flow charts (**Task B4.3**). The new designs with all the required modifications were validated by IIM in March 2016 (Month 21).

It aimed at the establishment of so called iDVP (*Integral Discards Valorization Point*) that applies a bio-refinery concept to this important quantity of marine biomass related to the compliance with the LO that has to be managed or processed, in the near future, in an efficient manner to avoid its waste. It is divided in three different rooms: *i) Chilled room storage; ii) Food elaboration area (iDVP1) and; iii) Non-food products area (iDVP3).*

Production lines implemented in the iDVP1 are based in the use of the muscle for food purposes, including a *line of restructured products*. The iDVP3 includes production lines to obtain valuable bio-compounds (Figure 23) such *fish protein hydrolysates, bioactive peptides, collagen/gelatin, peptones, chondroitin sulfate* or *chitin/chitosan*, among others, from iDVP1 fish wastes and undersized specimen.

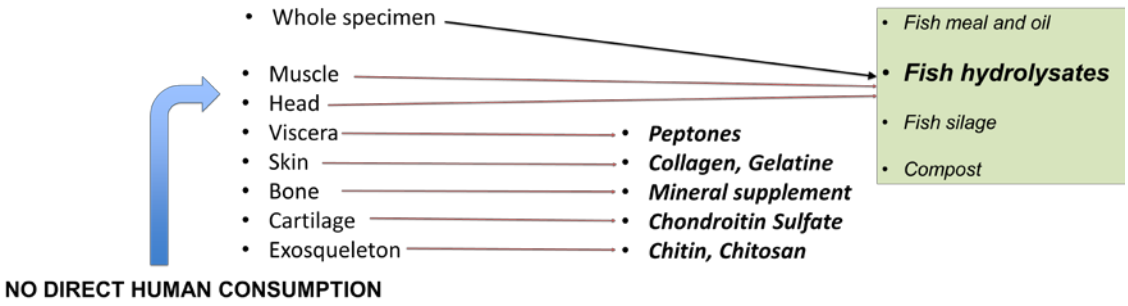


Figure 23. Valorizing processes integrated in the iDVP3 (raw materials and final products obtained)

JOSMAR started the construction of the final designs – **Task B4.5**. An intense work and careful analysis of the available spaces at Port of Marin to optimally install both iDVP1 and iDVP3 was performed by IIM-CSIC and OPROMAR.

In case of iDVP3, the construction and installation of final machinery (**task B4.5**) had to wait for the decision on the final location of the iDVP in the Port of Marin. In the meantime, tests and simulations were developed in the facilities of JOSMAR during November & December 2016 in order to validate the correct operation of all the equipment and processes previously to the transport of the plant to Marin.

To get the permissions, several contacts were established with the Marin Port Authority, veterinary inspectors of the auction, animal health service at a regional level (Galicia government, *Consellería Medio Rural*) and the health service (*Consellería de Sanidade*). Finally, the authorization from the regional government was received in October 2016 (Month 28). The main requirements to install the plant in the room of the Marin Auction intended/defined in the proposal to ”accommodate” the iDVP3 were to clearly separate and identify the areas for processing the new portion (the room had to be divided into 2 separate areas – Figure 24) and to control/manage the residues of the pilot plant. In case of pilot plant in Vigo (at the IIM facilities), a specific permission was obtained to carry out research activities with Category 3 materials. It includes the capability to transport this kind of material from the different LIFE iSEAS facilities.

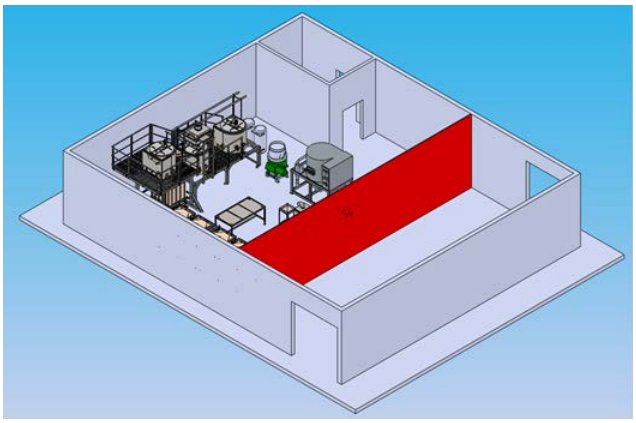


Figure 24. Final distribution of the proposed room to install the iDVP3 at Marin Fish Auction to satisfy the requirements of the Marin Port Authority

In addition, the valorization of discards in areas usually reserved to fish for direct human consumption was an additional critical factor analyzed in detail by the Marín fish market personnel. The health responsible of Marin Auction validated the location of the pilot plant provided the final spaces are isolated and the fraud is avoided.

After intense work by IIM-CSIC and OPROMAR, permissions to land the discards during the pilot tests were obtained from MAPAMA (national authorities - *Subdirección General de Caladero Nacional, Aguas Comunitarias y Acuicultura*) in February 2017 (Month 32), being necessary to inform the authorities of the full calendar of pilot tests of LIFE iSEAS by sending them an email previously to each test indicating dates of departure and return of collaborating vessels and the departure and return ports.

Panel boards to be placed in the Port were developed in order to give information to its users and visitants about the developments carried regarding biomass valorization in the framework of Action B4 of LIFE iSEAS. More information can be found in Action D1.

The iDVP1 was operative since July 2016 (Month 24 – Figure 25). It is formed by a separating and grinding device (Figure 26) that removes the muscle of different degutted species from the skin and heads. These by-products are used as raw material for different purposes in the iDVP3 while the muscle is washed and compacted in a press, where liquid effluent rich in proteins and lipids can be also incorporated to the iDVP3 valorization lines. The washed fish muscle is then placed in a tray, where a natural preserving agent (tocopherol) and a cryoprotector (sorbitol) are added previously to the freezing process in order to stabilize it by avoiding the oxidation of lipids (that gives negative color and odor properties to the final fish mince) while maintaining an adequate level of humidity, respectively.

Figure 25. The iDVP1 installed in the Port of Marín

Taking into account the results of Action A1 (Deliverable A1.4), fish muscle (mince) from species like *Atlantic mackerel, horse mackerel, hake, scorpionfish, pout, gurnards, grenadiers and blue whiting* was used to elaborate restructured food products. Table 5 summarized the **17 complete pilot processing tests** (from keep on board and unload previously discarded biomass until obtaining of fish mince frozen blocks and final products such as burgers and fingers).

Date	SPECIES															
	BLUE WHITING		POUT		SCORPIONFISH		GURNARDS		ATLANTIC MACKEREL		HAKE		GRENADIERS		HORSE MACKEREL	
	kg whole	kg muscle	kg whole	kg muscle	kg whole	kg muscle	kg whole	kg muscle	kg whole	kg muscle	kg whole	kg muscle	kg whole	kg muscle	kg whole	kg muscle
15-16/09/2016	100	72														
13/12/2016													100	34		
26-27/01/2017	45	26	70	36	50	18	55	22								
22/02/2017	70	32														
09/03/2017											80	44				
18-19/04/2017	40	27			55	29	55	23	53	33						
23/05/2017															51	20
02/10/2017			24	12			26	11								
08/11/2017															124	50
10/11/2017	200	55														

Table 5. Pilot tests carried out in the iDVP1

The obtained yields regarding muscle separation by processing entire fish specimen of different species were very good, being near or up the **50% of the total weight of the fish** (Figure 27) for all considered species except the scorpionfish that due to its morphology and high contain in spines and bones makes this operation more inefficient. Therefore, these obtained figures make the proposed valorization process for direct human consumption a proper alternative to manage/valorize: *i) those new fractions of biomass related to compliance of the new legal framework due to over quota and; ii) species not subject to quota nowadays with no or low commercial interest.*

Further details on the fish mince process and on the performed tests in the iDVP1 are summarized in **Deliverable B4.3**, attached to this Report as **Annex 9.**

Figure 26. Developed equipment to separate fish muscle from skin and bones of different species

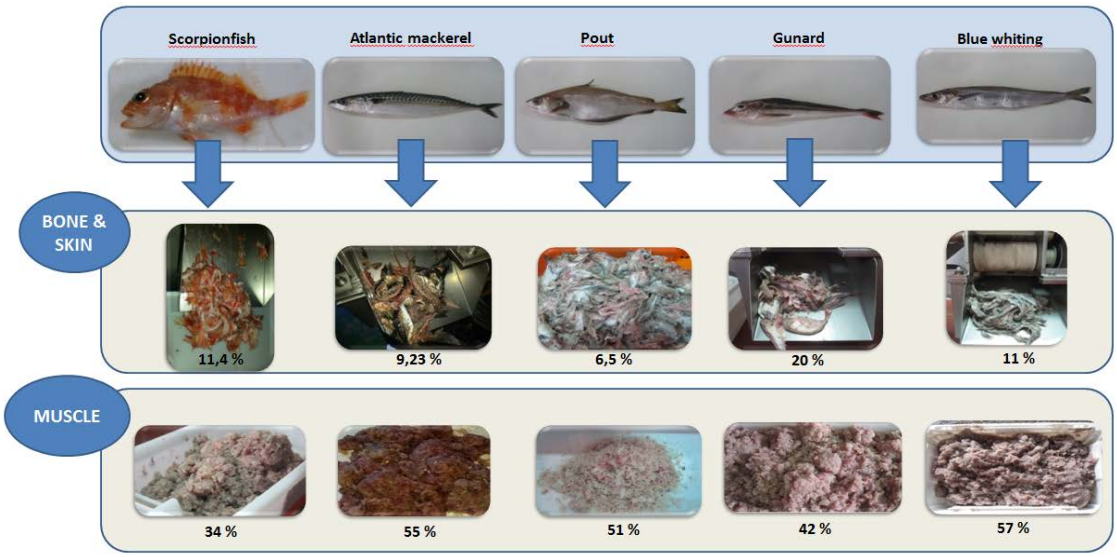


Figure 27. Yields for muscle extraction on the iDVP1 for some used fish species

Moreover, obtained results regarding organoleptic characteristics of these products were very positive among end users and consumers. This excellent feedback of the fish mince based products was obtained during the set of demonstration sessions of the iDVP1 and other related projects like VALDESCAR, where different elaborations and dishes were presented to the participants in the form of burgers, nuggets, waffles, sandwiches, etc (Figure 28). For further details, please, check the *Dissemination Issues* section of this

report. As a consequence, LIFE iSEAS partners consider this kind of elaborated products of highly future interest in the markets.

To verify this, and in the framework of **Task B4.6**, **5 important fish processors** were contacted and involved in the evaluation of the different types of fish mince blocks produced from different species (Table 6). In general, companies have shown interest in a product without the remains of skins, spines or viscera, which is visually white. In addition, they gave importance to the homogeneity in the chopping, and remarked that it is not desirable that different degrees of chopping appear between different blocks or within the same block. Finally, they declared looking for a fish with a mild flavor, hence the preference in many cases for white fish. Regarding product format specifications, the desirable weight and dimensions (7.5 kg and measures 482 x 254 x 62.7 mm) were repeated in many cases, and a mention was also made regarding the type of sample container: waxed cardboard.

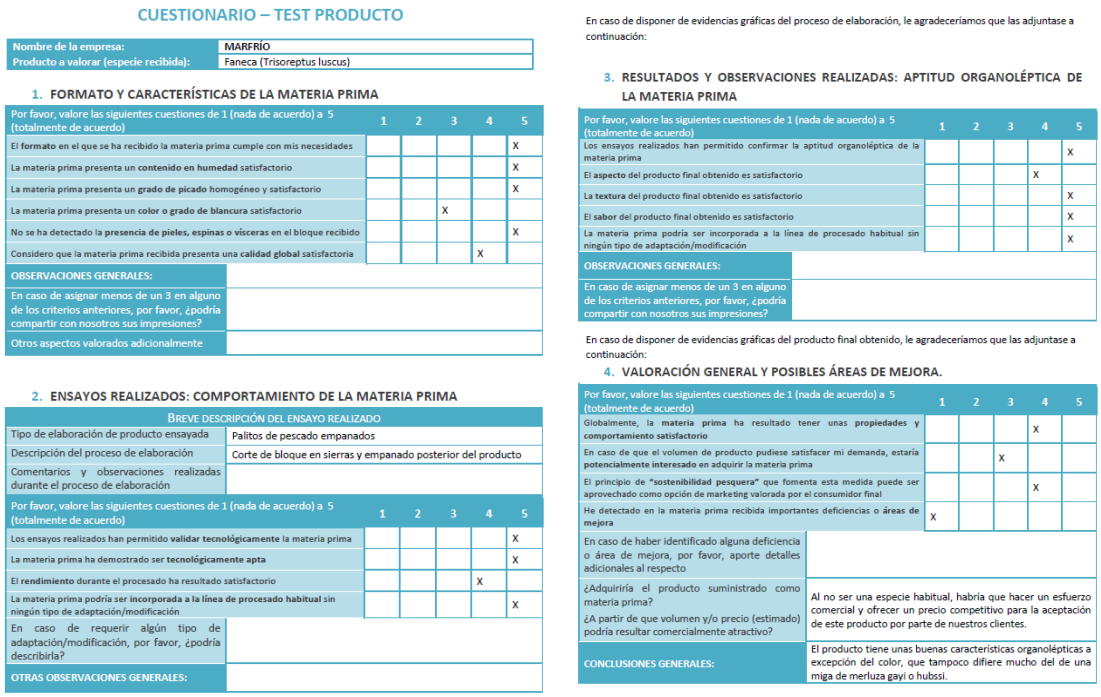
Figure 28. Fish mince (left) block (middle) and final uses of this material on cooking presented during the iDVP1 demonstration session/seminar (right)

To attain these general conclusions, a complete questionnaire regarding 4 main issues has been developed and sent to each company, including concrete aspects on: *i) Format and characteristics of the raw material; ii) Performed essays: raw material behavior; iii) Results and performed observations: organoleptic properties of the raw material and; iv) Overall rating and possible areas for improvement.* The details of this template together with the answer of Marfrío (https://www.marfrio.com/en/) to it can be found in Figure 29. Complete details on the overall perceptions of participating companies about obtained products in the iDVP1 are summarized in **Deliverable B4.3**, attached to this Report as **Annex 9.**

Empresa/Especie	Pouting	Gurnards	Blue whiting	Atlantic mackerek	Scorpionfish
CABOMAR CONGELADOS	Small portions of frozen muscle of the different species				
MARFRÍO	1 Block SL, S, A	--	1 Block L, S, A	--	--
CABEZUELO FOODS	1 Block L, SS, A	--	2 Blocks L, S y SS, A	--	--
CLAVO CONGELADOS	--	1 Block L, S, A	1 Block L, SS, A	--	--
CONGALSA	1 Block SL, SS, A	--	1 Block L, SS, A	--	--

* Abbreviations: L = Washed Mince; SL = Unwashed Mince; S = with Sorbitol; SS = without sorbitol; A = with Antioxidant; SA = without Antioxidant

Table 6. Tests of fish mince blocks produced in the iDVP1 carried out by contacted fish processors



CUESTIONARIO – TEST PRODUCTO

Nombre de la empresa:	MARFRÍO
Producto a valorar (especie recibida):	Faneca (Trisoreptus luscus)

1. FORMATO Y CARACTERÍSTICAS DE LA MATERIA PRIMA

Por favor, valore las siguientes cuestiones de 1 (nada de acuerdo) a 5 (totalmente de acuerdo)	1	2	3	4	5
El **formato** en el que se ha recibido la materia prima cumple con mis necesidades					X
La materia prima presenta un **contenido en humedad** satisfactorio					X
La materia prima presenta un **grado de picado** homogéneo y satisfactorio					X
La materia prima presenta un **color o grado de blancura** satisfactorio			X		
No se ha detectado la **presencia de pieles, espinas o vísceras** en el bloque recibido					X
Considero que la materia prima recibida presenta una **calidad global** satisfactoria				X	

OBSERVACIONES GENERALES:	
En caso de asignar menos de un 3 en alguno de los criterios anteriores, por favor, ¿podría compartir con nosotros sus impresiones?	
Otros aspectos valorados adicionalmente	

2. ENSAYOS REALIZADOS: COMPORTAMIENTO DE LA MATERIA PRIMA

BREVE DESCRIPCIÓN DEL ENSAYO REALIZADO	
Tipo de elaboración de producto ensayada	Palitos de pescado empanados
Descripción del proceso de elaboración	Corte de bloque en sierras y empanado posterior del producto
Comentarios y observaciones realizadas durante el proceso de elaboración	

Por favor, valore las siguientes cuestiones de 1 (nada de acuerdo) a 5 (totalmente de acuerdo)	1	2	3	4	5
Los ensayos realizados han permitido **validar tecnológicamente** la materia prima					X
La materia prima ha demostrado ser **tecnológicamente apta**					X
El **rendimiento** durante el procesado ha resultado satisfactorio				X	
La materia prima podría ser **incorporada a la línea de procesado habitual** sin ningún tipo de adaptación/modificación					X

En caso de requerir algún tipo de adaptación/modificación, por favor, ¿podría describirla?	
OTRAS OBSERVACIONES GENERALES:	

En caso de disponer de evidencias gráficas del proceso de elaboración, le agradeceríamos que las adjuntase a continuación:

3. RESULTADOS Y OBSERVACIONES REALIZADAS: APTITUD ORGANOLÉPTICA DE LA MATERIA PRIMA

Por favor, valore las siguientes cuestiones de 1 (nada de acuerdo) a 5 (totalmente de acuerdo)	1	2	3	4	5
Los ensayos realizados han permitido confirmar la aptitud organoléptica de la materia prima					X
El **aspecto** del producto final obtenido es satisfactorio				X	
La **textura** del producto final obtenido es satisfactorio					X
El **sabor** del producto final obtenido es satisfactorio					X
La materia prima podría ser incorporada a la línea de procesado habitual sin ningún tipo de adaptación/modificación					X

OBSERVACIONES GENERALES:	
En caso de asignar menos de un 3 en alguno de los criterios anteriores, por favor, ¿podría compartir con nosotros sus impresiones?	

En caso de disponer de evidencias gráficas del producto final obtenido, le agradeceríamos que las adjuntase a continuación:

4. VALORACIÓN GENERAL Y POSIBLES ÁREAS DE MEJORA.

Por favor, valore las siguientes cuestiones de 1 (nada de acuerdo) a 5 (totalmente de acuerdo)	1	2	3	4	5
Globalmente, la **materia prima** ha resultado tener unas **propiedades y comportamiento satisfactorio**				X	
En caso de que el volumen de producto pudiese satisfacer mi demanda, estaría **potencialmente interesado** en adquirir la materia prima			X		
El principio de **"sostenibilidad pesquera"** que fomenta esta medida puede ser aprovechado como opción de marketing valorada por el consumidor final				X	
He detectado en la materia prima recibida importantes deficiencias o **áreas de mejora**	X				

En caso de haber identificado alguna deficiencia o área de mejora, por favor, aporte detalles adicionales al respecto	
¿Adquiriría el producto suministrado como materia prima? ¿A partir de que volumen y/o precio (estimado) podría resultar comercialmente atractivo?	Al no ser una especie habitual, habría que hacer un esfuerzo comercial y ofrecer un precio competitivo para la aceptación de este producto por parte de nuestros clientes.
CONCLUSIONES GENERALES:	El producto tiene unas buenas características organolépticas a excepción del color, que tampoco difiere mucho del de una miga de merluza gayi o hubssi.

Figure 29. Questionnaire developed and sent to the selected fish processors in order to get a complete feedback of characteristics and potential commercial uses of the fish mince blocks and restructured products obtained in the iDVP1

The iDVP3 installation in the adapted facilities of the Port of Marín was completed before the end of January 2017. Some additional tasks were developed in the following months: wiring, electric panel installation, screen installation to separate the room into two sections (fresh fish channel and iDVP3 processing lines), etc.

The iDVP3 is constituted by the following equipment/parts (Figure 30):

- Three circular treatment reactors with agitation with internal filter system (750 l).
- Three tanks of 800 liters for storing and water heating.
- Four plastic storage tanks 1,000 L. (NaOH solutions/effluents)
- Plastic storage tank 50 L. (NaOH)
- Plastic storage tank 50 L. (Enzymatic solution).
- Plastic storage tank 50 L. (Acid solution).
- Cutter/grinding device
- Filtering hopper.
- Dryer.
- Spray Dryer.
- Spine Separator JM-301.
- Vertical Centrifugal.
- Filter Press.
- Three odor extractors.

Tests in iDVP3 started in February 2017 (Month 32) with the support of the pilot plant in Vigo (IIM). Several species (blue whiting, mackerel, megrim, boarfish, blue shark, small spotted catshark, tuna and hake, including non-legal landing sizes) were used to produce high-quality protein hydrolysates (FPHs). These FPHs rich in soluble proteins and with high digestibility can be employed as ingredient of aquaculture and pet-food diets, peptones for microbial productions or human consumption, etc. As shown in Table 7, up to **20 complete pilot FPHs production tests** with these different species (whole specimen and whole specimen plus skin and bones from the iDVP1) were performed in the iDVP3.

Figure 30. The iDVP3 installed in the Port of Marín

A complete graphic summary of the steps one of this tests (from charging the undersized fishes until the obtaining of the final products – FPHs and fish oil) is presented in Figure 31.

In addition to these pre-industrial pilot productions, up to **30 preliminary essays** (Table 7) were carried out at lab scale and in the IIM-CSIC pilot plant in order to develop a proper scalability of the designed processes, establishing the most adequate operation conditions to obtain the desired FPHs (in terms of quality and quantity). The objective is

to minimize as much as possible the further tuning procedures to be carried out *in situ* in the iDVP during pilot productions, avoiding operational problems and dead times.

Figure 31. Steps of an enzymatic hydrolysis to produce FPHs in the iDVP3

Obtained FPHs (Figure 32) showed levels of soluble protein of hydrolysates higher than 33 g/L with more than 93% of digestibilities. The maximum degree of hydrolysis of FPHs was always superior to 30% and the liquefactions of the solid fish substrates to the liquid FPHs were higher than 90% (see the complete product profile of different FPHs, including aminoacid composition in Figure 34).

It must be highlighted that, as shown in Table 7, the production of FPHs through enzymatic hydrolysis of the different fish species implies the obtaining of other added value compounds of interest like a fish oil fraction (rich in omega-3 fatty acids) together with solids that can be used to lower blood pressure, triglycerides and cholesterol levels and as mineral supplement for food/feed applications, respectively.

DISCARDS/BY-PRODUCTS	SPECIES	INITIAL SUBSTRATE (kg)	BATCHES	BIOPRODUCTION
Skins	Tuna (*Thunnus albacares*)	50-65	2	Gelatine
Skins	Blue shark (*Prionace glauca*)	48	1	Gelatine
Cartilages	Blue shark (*Prionace glauca*)	28-40	2	Chondroitin sulfate
Whole Body	Catshark (*Scyliorhinus canicula*)	70	1	Chondroitin sulfate and FPH
Whole Body	Megrim (*Lepidorhombus boscii*)	60-100	3	FPH, oil and bones
Whole Body	Blue whiting (*Micromesistius poutassou*)	60-90	3	FPH, oil and bones
Whole Body	Mackerel (*Trachurus murphyi*)	70-100	2	FPH, oil and bones
Whole Body	Boarfish (*Capros aper*)	25	1	FPH, oil and bones
Whole Body	Bigeye crab (*Polybius henslowii*)	60-65	2	Chitin
Whole Body	Atlantic mackerel (*Scomber scombrus*)	90-100	2	FPH, oil and bones
Muscle, heads and skins	Hake (*Merluccius merluccius*)	42-50	2	FPH, oil and bones
Muscle	Blue shark (*Prionace glauca*)	42-45	2	FPH
Heads	Tuna (*Thunnus albacares*)	90-182	4	FPH, oil and bones

Table 7. Pilot tests carried out in the iDVP3

Figure 32. Fish protein hydrolysates (FPHs) obtained in the iDVP3 (left) and the set of valuable compounds that can be produced in the implemented processes (right)

Regarding other processing lines to valorize undersized fish specimen and by-products from iDVP and/or other fish processors, several pilot productions (**up to 8**) where carried out to obtain other bio-compounds of interest in different markets (Table 7):

a) ***Gelatine*** from skins of tuna and blue shark (Figure 33) → *Yield* up to 13%, *density* 168 Blooms and *molecular weights* in the range of 60-220 kDa (similar properties that the ones for bovine commercial gelatines).
b) ***Chondroitin sulfate*** from blue shark and catshark.
c) ***Chitin*** from Bigeye crab.

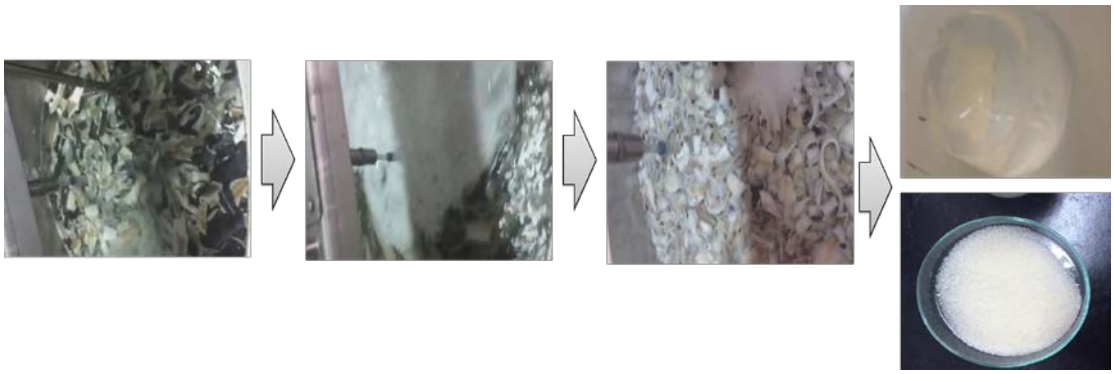


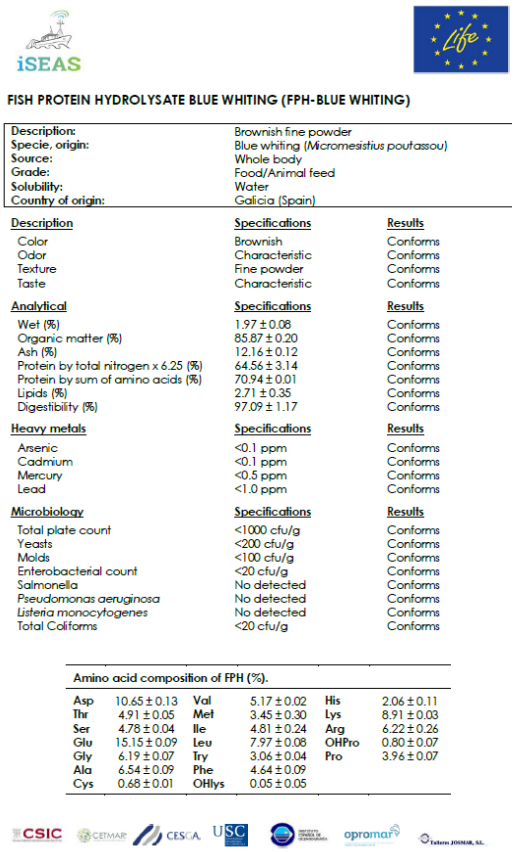
Figure 33. Gelatine obtaining from blue shark skin in the iDVP3

The overall final yields of these three processes are excellent as well as the physic-chemical/quality parameters of the obtained final products.

Complete profiles on the characteristics (as the ones in Figure 34) of all these products obtained in the iDVP3 are attached to this Final Report in **Deliverable B4.3 (Annex 9**).

As for the case of the iDVP1, a seminar and a demonstration session were coupled in the Integral Discards Processing and Valorization Plant (iDVP3) located in the Port of Marín on 1st June 2018. More than 50 representatives, mainly from fleets, ship-owners associations and valorisation companies attended the seminar, showing their great interest on the solutions presented and implemented in the iDVP3 to add value from individuals under legal minimum size (and/or from by-products from the iDVP1), that for legal reasons, must be retained on board, counted against quota, landed and managed/used for non-direct human consumption purposes. For further details, please, check the *Dissemination Issues* section of this report.

Contacts with European companies were stablished by CETMAR in order to check the interest of final users on the products to be obtained in the iDVP3. Very positive answers were obtained from these companies. Samples of several products were sent to contacted companies in order to get information about its potential use in real applications.



iSEAS

FISH PROTEIN HYDROLYSATE BLUE WHITING (FPH-BLUE WHITING)

Description:	Brownish fine powder
Specie, origin:	Blue whiting (*Micromesistius poutassou*)
Source:	Whole body
Grade:	Food/Animal feed
Solubility:	Water
Country of origin:	Galicia (Spain)

Description	Specifications	Results
Color	Brownish	Conforms
Odor	Characteristic	Conforms
Texture	Fine powder	Conforms
Taste	Characteristic	Conforms
Analytical	**Specifications**	**Results**
Wet (%)	1.97 ± 0.08	Conforms
Organic matter (%)	85.87 ± 0.20	Conforms
Ash (%)	12.16 ± 0.12	Conforms
Protein by total nitrogen x 6.25 (%)	64.56 ± 3.14	Conforms
Protein by sum of amino acids (%)	70.94 ± 0.01	Conforms
Lipids (%)	2.71 ± 0.35	Conforms
Digestibility (%)	97.09 ± 1.17	Conforms
Heavy metals	**Specifications**	**Results**
Arsenic	<0.1 ppm	Conforms
Cadmium	<0.1 ppm	Conforms
Mercury	<0.5 ppm	Conforms
Lead	<1.0 ppm	Conforms
Microbiology	**Specifications**	**Results**
Total plate count	<1000 cfu/g	Conforms
Yeasts	<200 cfu/g	Conforms
Molds	<100 cfu/g	Conforms
Enterobacterial count	<20 cfu/g	Conforms
Salmonella	No detected	Conforms
Pseudomonas aeruginosa	No detected	Conforms
Listeria monocytogenes	No detected	Conforms
Total Coliforms	<20 cfu/g	Conforms

Amino acid composition of FPH (%).

Asp	10.65 ± 0.13	**Val**	5.17 ± 0.02	**His**	2.06 ± 0.11
Thr	4.91 ± 0.05	**Met**	3.45 ± 0.30	**Lys**	8.91 ± 0.03
Ser	4.78 ± 0.04	**Ile**	4.81 ± 0.24	**Arg**	6.22 ± 0.26
Glu	15.15 ± 0.09	**Leu**	7.97 ± 0.08	**OHPro**	0.80 ± 0.07
Gly	6.19 ± 0.07	**Try**	3.06 ± 0.04	**Pro**	3.96 ± 0.07
Ala	6.54 ± 0.09	**Phe**	4.64 ± 0.09		
Cys	0.68 ± 0.01	**OHlys**	0.05 ± 0.05		

iSEAS

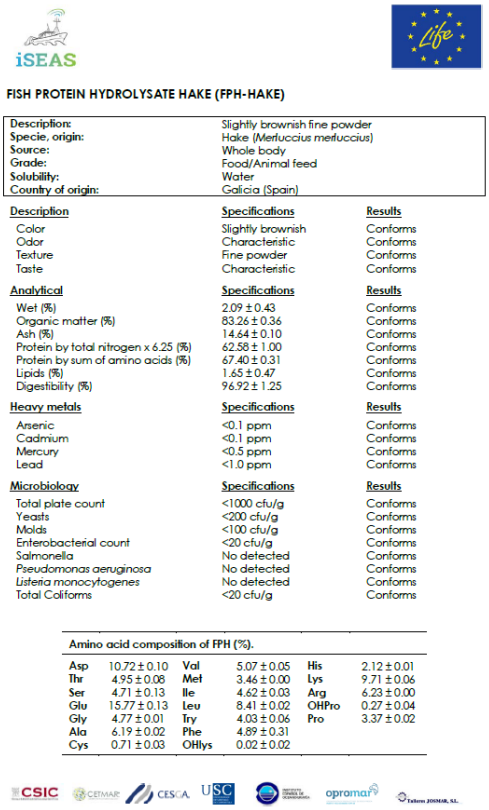
FISH PROTEIN HYDROLYSATE BLUE WHITING (FPH-BLUE WHITING)

Description:	Brownish fine powder
Specie, origin:	Blue whiting (*Micromesistius poutassou*)
Source:	Whole body
Grade:	Food/Animal feed
Solubility:	Water
Country of origin:	Galicia (Spain)

Description	Specifications	Results
Color	Brownish	Conforms
Odor	Characteristic	Conforms
Texture	Fine powder	Conforms
Taste	Characteristic	Conforms
Analytical	**Specifications**	**Results**
Wet (%)	1.97 ± 0.08	Conforms
Organic matter (%)	85.87 ± 0.20	Conforms
Ash (%)	12.16 ± 0.12	Conforms
Protein by total nitrogen x 6.25 (%)	64.56 ± 3.14	Conforms
Protein by sum of amino acids (%)	70.94 ± 0.01	Conforms
Lipids (%)	2.71 ± 0.35	Conforms
Digestibility (%)	97.09 ± 1.17	Conforms
Heavy metals	**Specifications**	**Results**
Arsenic	<0.1 ppm	Conforms
Cadmium	<0.1 ppm	Conforms
Mercury	<0.5 ppm	Conforms
Lead	<1.0 ppm	Conforms
Microbiology	**Specifications**	**Results**
Total plate count	<1000 cfu/g	Conforms
Yeasts	<200 cfu/g	Conforms
Molds	<100 cfu/g	Conforms
Enterobacterial count	<20 cfu/g	Conforms
Salmonella	No detected	Conforms
Pseudomonas aeruginosa	No detected	Conforms
Listeria monocytogenes	No detected	Conforms
Total Coliforms	<20 cfu/g	Conforms

Amino acid composition of FPH (%).

Asp	10.65 ± 0.13	**Val**	5.17 ± 0.02	**His**	2.06 ± 0.11
Thr	4.91 ± 0.05	**Met**	3.45 ± 0.30	**Lys**	8.91 ± 0.03
Ser	4.78 ± 0.04	**Ile**	4.81 ± 0.24	**Arg**	6.22 ± 0.26
Glu	15.15 ± 0.09	**Leu**	7.97 ± 0.08	**OHPro**	0.80 ± 0.07
Gly	6.19 ± 0.07	**Try**	3.06 ± 0.04	**Pro**	3.96 ± 0.07
Ala	6.54 ± 0.09	**Phe**	4.64 ± 0.09		
Cys	0.68 ± 0.01	**OHlys**	0.05 ± 0.05		



FISH PROTEIN HYDROLYSATE HAKE (FPH-HAKE)

Description:	Slightly brownish fine powder
Specie, origin:	Hake (*Merluccius merluccius*)
Source:	Whole body
Grade:	Food/Animal feed
Solubility:	Water
Country of origin:	Galicia (Spain)

Description	Specifications	Results
Color	Slightly brownish	Conforms
Odor	Characteristic	Conforms
Texture	Fine powder	Conforms
Taste	Characteristic	Conforms
Analytical	**Specifications**	**Results**
Wet (%)	2.09 ± 0.43	Conforms
Organic matter (%)	83.26 ± 0.36	Conforms
Ash (%)	14.64 ± 0.10	Conforms
Protein by total nitrogen x 6.25 (%)	62.58 ± 1.00	Conforms
Protein by sum of amino acids (%)	67.40 ± 0.31	Conforms
Lipids (%)	1.65 ± 0.47	Conforms
Digestibility (%)	96.92 ± 1.25	Conforms
Heavy metals	**Specifications**	**Results**
Arsenic	<0.1 ppm	Conforms
Cadmium	<0.1 ppm	Conforms
Mercury	<0.5 ppm	Conforms
Lead	<1.0 ppm	Conforms
Microbiology	**Specifications**	**Results**
Total plate count	<1000 cfu/g	Conforms
Yeasts	<200 cfu/g	Conforms
Molds	<100 cfu/g	Conforms
Enterobacterial count	<20 cfu/g	Conforms
Salmonella	No detected	Conforms
Pseudomonas aeruginosa	No detected	Conforms
Listeria monocytogenes	No detected	Conforms
Total Coliforms	<20 cfu/g	Conforms

Amino acid composition of FPH (%).

Asp	10.72 ± 0.10	Val	5.07 ± 0.05	His	2.12 ± 0.01
Thr	4.95 ± 0.08	Met	3.46 ± 0.00	Lys	9.71 ± 0.06
Ser	4.71 ± 0.13	Ile	4.62 ± 0.03	Arg	6.23 ± 0.00
Glu	15.77 ± 0.13	Leu	8.41 ± 0.02	OHPro	0.27 ± 0.04
Gly	4.77 ± 0.01	Try	4.03 ± 0.06	Pro	3.37 ± 0.02
Ala	6.19 ± 0.02	Phe	4.89 ± 0.31		
Cys	0.71 ± 0.03	OHlys	0.02 ± 0.02		

Figure 34. Main characteristics profile of different fish protein hydrolysates obtained in the iDVP3

Regarding the market tests developed for products of the iDVP3 in the framework of **Task B4.6,** samples of products obtained was sent to interested companies, together with information about each products' characteristics (specifications).

In the framework of LIFE iSEAS 40 (8 in Spain) potential companies/end users were identified, being contacted 18. Finally, we obtained **7 positive answers**: *BIOIBÉRICA*, *COPALIS*, *CRODA*, *GPH Diffusion*, *ROUSSELOT*, *ROXLOR* and *WEISHARDT*. Several products of interest for these companies where sent along 2017 and 2018 in order to get their feedback about them. All these exchanges are summarized in Table 8.

Dry cartilage	Chondroitin Sulfate	Collagen hydrolyzates	Gelatines	FPHs	Date
GPH Diffusion	BIOIBÉRICA		ROUSSELOT		29/05/2017
COPALIS	COPALIS		CRODA		29/05/2017
WEISHARDT	WEISHARDT		WEISHARDT		29/05/2017
CRODA	CRODA				29/05/2017
			WEISHARDT		21/06/2017
			ROUSSELOT		20/10/2017
			ROXLOR		20/10/2017
		WEISHARDT		WEISHARDT	28/06/2018

Table 8. iDVP3 Product samples sent to involved, interested companies

For instance, companies that received gelatin ask LIFE iSEAS partners to reduce color, turbidity and conductivity or, for the case of chondroitin sulfate, the main comment was

to reduce humidity. Gelatins were also applied to some food/dessert cooked by prestigious Galician chefs that were satisfactorily tasted during the Vigo SeaFest carried out in Vigo in 2017 and 2018 (more info in https://www.vigoseafest.com/). They are also being applied in low fat formulations and regeneration of tissues

Finally, regarding the economic assessment of the iDVP several scenarios have been considered:

- ***Scenario 0*** → *Nowadays use:* Biomass landed due to the LO is sold as raw material to produce fish meal and oil (0.05 €/kg).
- ***Scenario 1*** → *Base case:* An annual established production of collagen, gelatines, fish protein hydrolysates (FPHs), dry cartilage and chondroitin sulphate 90% (CS 90) was scheduled on the iDVP while considering a process integration to attain a 75% of recycling on liquid effluents.
- ***Scenario 2*** → *Increased FPHs production:* As Scenario 1 but increasing the production of FPHs (more biomass is processed) while reducing the gelatines one.
- ***Scenario 3*** → *Recycling 90% of water:* As Scenario 1, but with a better process integration by making some readjustments on the iDVP to attain up to a 90% of recycling on liquid effluents.
- ***Scenario 4*** → *Public subsidy:* As Scenario 3, but considering public subsidies for ship-owners associations offered by the Regional and National Governments to implement this kind of added value chains generations in the fishing ports.

To make the economic analysis of the iDVP, LIFE iSEAS partners developed a software tool in Microsoft Excel considering the required investments to implement the pilot plant, general production costs (rent of spaces, supply costs, reagents, effluents management, maintenance costs, etc.) and related personnel costs.
As a result of applying the developed methodology, the most profitable option is **Scenario 4**. But in the case of not considering public subsidies, **Scenarios 2 & 3** are also profitable scenarios, allowing the ship-owners to minimize the impacts associated to keep on board, storage and land/manage in land this important amount of new biomass due to compliance with the LO but without generating an incentive for discarding related to this potential economic activity.

Complete details in this analysis can be found in **Deliverable C2.4** attached to this Final Report as **Annex 11**.

After the end of the project, the perspectives for continuing this action will be related with the iDVP. This pilot plant will be available for both additional researches in valorization tasks as well as for demonstration and dissemination activities. Commercial activity to be carried out in these installations is not considered due to its experimental nature.

Outputs: Comparative with planned outputs

All results presented in the LIFE iSEAS proposal have been fully achieved, mainly a fully operative, efficient iDVP facility in the Port of Marín (including its cost analysis). More than proposed species (7) have been used as raw materials to obtain valuable compounds through the processes implemented the iDVP (up to **14**) **in more than 45 complete production tests** (plus more than **30 pre-pilot preliminary tests** to properly

define the valorization chains). The total number of tests is significantly higher than the one summarized in the LIFE iSEAS proposal (50-60), showing the great effort carried out by the project partnership to achieve the pursued results of this Action.

Indicators used to test the performance:

The indicators used to test the performance of the action are the ones established in the project proposal, including:

- A complete discards characterization to identify/define the most appropriate valorization processes to be used to maximize the use of this new fraction of biomass → this objective was achieved through the **up to 40 lab scale tests** carried out by IIM-CSIC, with the collaboration of 3Bs Laboratory.
- **Three vessels** where permanent involved in the development of Action B4 in terms of: i) allowing to analyze alternatives to properly manage and storage on board the new biomass factions, testing the proposed innovative ways to maintain on board the previously discarded fraction; ii) carrying out simulations of a fully compliance of the Landing Obligation compliance, including in land management and real quantification of extra operational workloads/times ; and iii) supplying biomass to carry out all the pilot tests and pre-industrial productions carried out in the framework of this Action (**up to 58**).
- A fully operative iDVP located in the facilities of the Fish Auction in the port of Marín, including **7 integrated processing lines** to obtain both valorize the different fractions of biomass to be landed related to the LO targeting the obtaining of added-value products for direct human consumption (restructured products obtained in the iDVP1) or intended for non-human consumption (from undersized specimen and by-products from the iDVP1 to obtain FPHs, gelatines, chitin, chondroitin sulfate, oil and bones). The final aim is to give a realistic and viable alternative to fishermen/ship-owners to make the best possible use of this biomass while minimizing the economic impacts associated to the compliance with the new legal framework established by the CFP.
- More than 40 companies where contacted to evaluate the products obtained from the iDVP getting a very positive and valuable feedback about their characteristics and potentialities from **12** of them. This acquired information from end users was also used to improve them by tuning the valorizing processes implemented. More than **25** shipping were carried out including frozen fish mince blocks, gelatin, chondroitin sulfate or collagen hydrolysates among others.
- The economic analysis of the IDPV plant has shown that the production of collagen FPHs, cartilage and CS 90% may be profitable, particularly if 90% of the effluent water is recycled. Regarding the obtained products with higher detected interest/commercial potential, we want to highlight fish mince produced in the iDVP, FPHs from different species and cartilage/CS.

More information can be found in **Annex 4 (***Monitoring Update***)**.

Issues found:

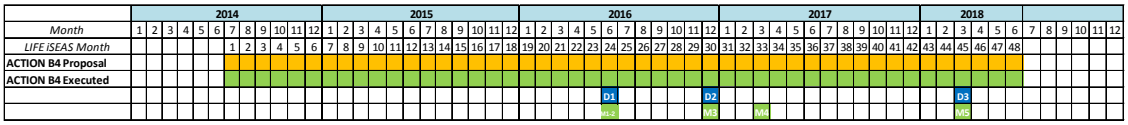
The most relevant issue founded during Action B4 implementation was the decision making procedure about location of the pilot plant and processes to be carried out was longer than expected what caused small delays. A permanent contact was maintained

among OPROMAR, JOSMAR, CETMAR and IIM in order to overcome possible negative consequences/delays. After solving it, no more relevant issue appeared and Action developed and finished as expected, fulfilling all objectives/milestones.

Task duration: Comparative with the established time schedule

Action B4 developed as planned in the LIFE iSEAS proposal.

Proposal: 48 months (from *Month 1 to Month 48*).
Real: 48 months (from *Month 1 to Month 48*).



D1	Integral mass and energy flow models of the iDVP plant
D2	iDVP scale-up based on production volumes, environmental impacts and operation/installation costs
D3	Report on the validation of processing units at pilot scale (pilot landings, products obtaining, market solutions)
M1	Integral mass and energy flow models of the plant
M2	Valorization strategy by discarded species
M3	Dimensionality criteria based on production volumes, environmental impacts and operation/installation costs
M4	Determination of production and markets aspects for obtained products targeting specific segments of the medical, pharmaceutical, food, feed and other sectors
M5	Validation of processing units at pilot scale (pilot landings, products obtaining, market solutions)

Summary description of associated reports:

Action B4 progressed as expected and all proposed Deliverables and milestones where achieved at due time.

- **Deliverable B4.1** "*Integral mass and energy flow models of the iDVP plant*" (June 2016, Month 24) was completed. *Summary:* In this document, the mass and energy balances for various valorisation processes proposed in the LIFE+ iSEAS project are presented.
  Submitted with the Mid-Term Report (Month 24).

- **Deliverable B4.2** "*iDVP scale-up based on production volumes, environmental impacts and operation/installation costs*" (December 2016, Month 30) was completed. *Summary:* In this document, the process of design and start-up of the plant is detailed, taking into account both the expected volumes of discards to be processed and the processes to be implemented, possible environmental impacts and installation costs. It also describes the actions that have been carried out, in parallel, for the obtaining the permits for the installation of the iDVP in the building of the fish auction of the Port of Marin.
  Submitted with the Second Progress Report (Month 36).

- **Deliverable B4.3** "*Validation of processing units at pilot scale (pilot landings, added-value products obtaining, market solutions*". This deliverable is attached to this final Report as **Annex 9** (March 2018, Month 45). *Summary:* In this report, complete information and details of all performed LO compliance pilot tests, pilot productions on the iDVP (including final process and products characteristics) and the market contacts made with different industries are presented.
  Submitted with the Final Report – **Annex 9** (Month 48).

All Milestones B4.1 to **B4.4** reflected in the LIFE iSEAS proposal were achieved in due time.

Other reports/papers:

1. Blanco, M., Fraguas, J., Sotelo, C.G., Pérez-Martín, R.I., Vázquez, J.A. (2015) Production of chondroitin sulphate from head, skeleton and fins of *Scyliorhinus canicula* by-products by combination of enzymatic, chemical precipitation and ultrafiltration methodologies. *Marine Drugs*, 13(6), 3287-3308.
   DOI: 10.3390/md13063287 - ***Open Access***

2. Vázquez, J.A., Pastrana, L., Piñeiro, C., Teixeira, J.A., Pérez-Martín, R.I., Amado, I.R. (2015) Production of hyaluronic acid by *Streptococcus zooepidemicus* on protein substrates obtained from *Scyliorhinus canicula* discards. *Marine Drugs*, 13(10), 6537-6549.
   DOI: 10.3390/md13106537 - ***Open Access***

3. Antelo, L.T., De Hijas-Liste, G.M., Franco-Uría, A., Alonso, A.A., Pérez-Martín, R.I. (2015). Optimisation of processing routes for a marine biorefinery. *Journal of Cleaner Production*, 104, 489-501.
   DOI: 10.1016/j.jclepro.2015.04.105

4. Vázquez, J.A., Blanco, M., Fraguas, J., Pastrana, L., Pérez-Martín, R. (2016) Optimisation of the extraction and purification of chondroitin sulphate from head by-products of *Prionace glauca* by environmental friendly processes. *Food Chemistry*, 198, 28-35.
   DOI: 10.1016/j.foodchem.2015.10.087

5. Vázquez, J.A., Caprioni, R., Nogueira, M., Menduiña, A., Ramos, P., Pérez-Martín, R.I. (2016) Valorisation of effluents obtained from chemical and enzymatic chitin production of *Illex argentinus* pen by-products as nutrient supplements for various bacterial fermentations. *Biochemical Engineering Journal*, 116, pp. 34-44.
   DOI: 10.1016/j.bej.2015.12.012

6. Novoa-Carballal, R., Pérez-Martín, R., Blanco, M., Sotelo, C.G., Fassini, D., Nunes, C., Coimbra, M.A., Silva, T.H., Reis, R.L., Vázquez, J.A. (2017) By-products of *Scyliorhinus canicula*, *Prionace glauca* and *Raja clavata*: A valuable source of predominantly 6S sulfated chondroitin sulfate. *Carbohydrate Polymers*, 157, 31-37.
   DOI: 10.1016/j.carbpol.2016.09.050

7. Valcarcel, J., Novoa-Carballal, R., Pérez-Martín, R.I., Reis, R.L., Vázquez, J.A. (2017) Glycosaminoglycans from marine sources as therapeutic agents. *Biotechnology Advances*, 35(6), 711-725.
   DOI: 10.1016/j.biotechadv.2017.07.008

8. Sousa, S.C., Vázquez, J.A., Pérez-Martín, R.I., Carvalho, A.P., Gomes, A.M. (2017) Valorization of by-products from commercial fish species: Extraction and chemical properties of skin gelatins. *Molecules*, 22(9), 1545.
   DOI: 10.3390/molecules22091545 - ***Open Access***
   Available at http://www.mdpi.com/1420-3049/22/9/1545/htm

9. Vázquez, J.A., Blanco, M., Massa, A.E., Amado, I.R., Pérez-Martín, R.I. (2017) Production of fish protein hydrolysates from *Scyliorhinus canicula* discards with antihypertensive & antioxidant activities by enzymatic hydrolysis & mathematical optimization using response surface methodology. *Marine Drugs*, 15(10), 306. DOI: 10.3390/md15100306 - ***Open Access***

Other three papers are *under review or accepted-in press:*

- "Peptones from Scyliorhinus canicula viscera by-products as nitrogen source for lactic acid bacteria production" – Food Microbiology (Under review).

- "Isolation and chemical characterisation of chondroitin sulphate from cartilage by-products of Blackmouth catshark (*Galeus melastomus*)" – Marine Drugs (Under review)

- "An integral and sustainable valorisation strategy of squid pen byproducts" – Journal of Cleaner Production (Accepted)

And one chapter in the book: *"The European discard policy-reducing unwanted catches in complex multi-species and multi-jurisdictional fisheries"*. Editors: Sven Sebastian Uhlmann, Clara Ulrich and Steve Kennelly. Edited by Springer.

Latest documents (produced since the last progress report on Month 36) are attached to this Final Report as **Annex 8.**

Action C1: Monitoring of impacts of the project

Activities/subtasks description:

Regarding **Task C1.1**, the Monitoring Committee (MoC) was constituted and met together in November 2014 (Month 5) to finish the organization of the monitoring indicators and actions of the project, after different phone and email discussions and meetings carried out by the MoC of LIFE iSEAS from the beginning of the project.

Task C1.2. The *Monitoring Protocol* (**Deliverable C1.1**) was developed by the MoC following the experienced attained during previous LIFE projects in which LIFE iSEAS partners were involved in. This is a short document (based on an information table in EXCEL format), in which each task is assigned to a timetable and a monitoring method. It was implemented and updated by the MoC taking into account the progress of the project and the feedback obtained from involved/contacted stakeholders.
The results of this action were presented in the different LIFE iSEAS Coordination Meetings by IIM-CSIC (**Task C1.4**).

The EXCEL document is the tool to check the proper progress of the project. This tool, in which each task is assigned to a timetable and a monitoring method, has been completed with specific indicators by action and tasks taking into account **Task C1.3.** Based on follow-up by task performed, the most recent version (**Milestone C1.4**) is attached as **Annex 4.**

As a result, the annual monitoring to analyze the improvements (environmental, socio-economic) made with respect the initial project scenario was achieved (**Milestone C1.1** to **C1.4**).

Outputs: Comparative with planned outputs

The evaluation of the effectiveness of the proposed actions to achieve the environmental benefits pursued by LIFE iSEAS Project was carried out in relation with Actions A1 to C2 (especially in case of iObserver and marine SDI development, modelling tools, iDVP design, construction and operation, evaluation of environmental and socio-economic impacts of proposed technologies/solutions implementation and dissemination tasks).

Indicators used to test the performance

Milestones achievement (regarding all LIFE iSEAS Actions) was considered the main indicators regarding this action, since it was totally complete in time.

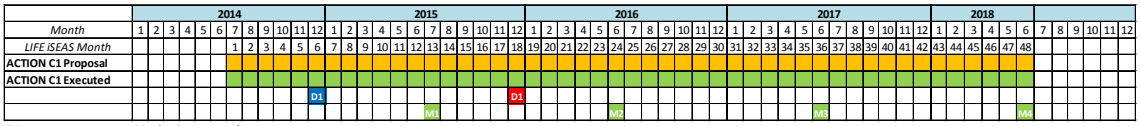
Issues found

None relevant issues were found during the implementation of this action

Task duration: Comparative with the established time schedule

According to the protocol established, monitoring for each task took place throughout the project without delays.

Proposal: 48 months (from *Month 1 to Month 48*).
Real: 48 months (from *Month 1 to Month 48*).



D1	Monitoring protocol
D1	Monitoring protocol (Update)
M1	Annual monitoring summary to analyze the improvements (environmental, socio-economic) made with respect the initial project scenario: Year 1
M2	Annual monitoring summary to analyze the improvements (environmental, socio-economic) made with respect the initial project scenario: Year 2
M3	Annual monitoring summary to analyze the improvements (environmental, socio-economic) made with respect the initial project scenario: Year 3
M4	Annual monitoring summary to analyze the improvements (environmental, socio-economic) made with respect the initial project scenario: Year 4

<u>Summary description of associated reports</u>:

Action C1 progresses as expected.

- **Deliverable C1.1** *"Monitoring protocol"* has been produced (Month 6). An updated version of this document was produced in Month 18.
- **Milestones C1.1** to **C1.4** *"Annual monitoring summary"* have been achieved (Month 12, 24, 36 and 48). See **Annex 4** for the final monitoring report**.**

Action C2: Environmental and socio-economic impact assessment of proposed solutions

Activities/subtasks description:

The evaluation of the sustainability of the fishing activity and the analysis of the environmental impacts associated with the discards valorisation processes were carried out in this action.

In **Task C2.**1, the environmental impacts of vessels fish extractive activity were quantified using the *Ecological Footprint (EF).* This indicator measures the global area required to generate the resources consumed and to absorb the waste generated. Two productive areas were included, the *Fishing Ground Footprint* and the *Forest Land or Carbon Footprint*. The first represents the demand of fisheries on aquatic ecosystems and the second the area of forest land necessary to sequester carbon dioxide emissions.

The contribution of discards to the total EF was analyzed, differentiating the species subjected to quota regulations. Data collected on board of 37 commercial fishing trips developed in the framework of Action B4 was used as inventory data.

As main conclusion of this analysis, it must be highlighted that **11.6 global hectares** are required per ton of fish landed, being the Fishing Ground Footprint eight times higher than the Carbon Footprint. However, these values are highly variable, depending mainly on the quantity and composition of the discards (Figure 35). *Fish discarded represents the 63% of the Fishing Ground Footprint and the 55% of the total EF, while the retained capture only implies 37% and 34%, respectively*. On average, 3.6 global ha are due to discards of species subjected to quota regulations. On the other hand, the forest area needed to absorb the CO2 emissions generated from the combustion of diesel only represents the 11% of the total EF.
Therefore, if the solutions developed in the framework of LIFE iSEAS are used towards a fully implementation of the landing obligation and a reduction of discards by using fully documented fisheries, the marine SDI and the prediction maps, **the reduction of the environmental impacts of the fishing extractive sector will vary in a range between a 31% and a 55%.** This fact implies a more green and sustainable fishing sector while showing the goodness of the proposed innovative solutions developed in the framework of the LIFE iSEAS project.

Regarding **Task C2.2.**, the environmental impacts of the different discards valorisation processes were analyzed using *Life Cycle Assessment (LCA)*, evaluating the contribution of the different steps and identifying areas for improvement. Climate change, terrestrial acidification, freshwater eutrophication, natural land transformation, freshwater and marine ecotoxicity and fossil depletion were the impact categories selected. Data of materials and electricity consumption was collected through direct measurements in the Integral Discards Processing and Valorisation Point (iDVP).

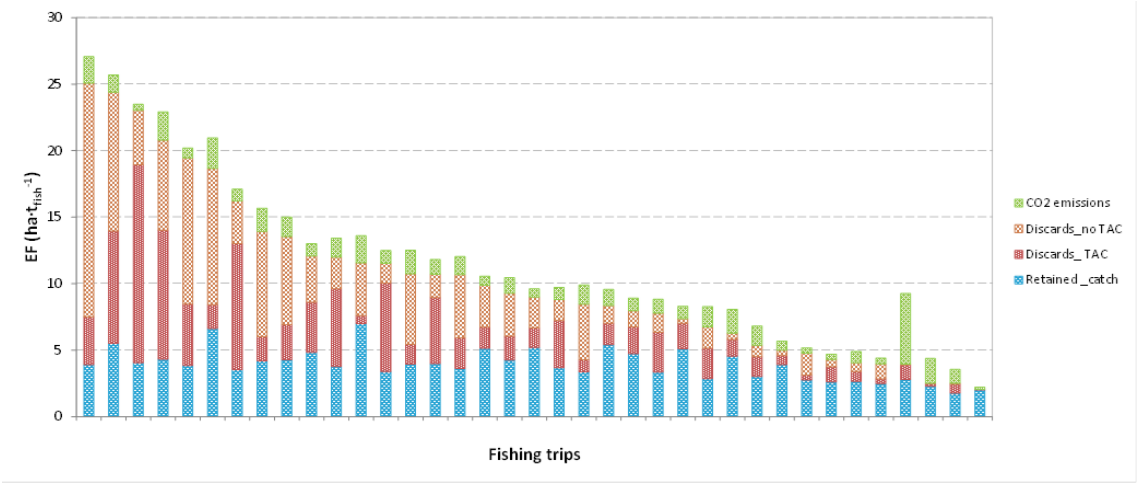


Figure 35. Total Ecological Footprint for each fishing trip and contribution of each productive area.

Electricity consumption is the biggest contributor in the different valorisation processes, with values over 80% in all impact categories, while the consumption of reagents only implies around 5%. The most polluting steps related to electricity consumption are reaction and drying stages, the former due to the heating of the water to reach the operational temperature. Minor impacts can be observed from tap water use and wastewater treatment, although these processes have a high consumption of water. **This call for more efficient processes in terms of water recycling/streams integration** (where possible) together with the implementation of a hot water circuit (based on boiler) that could supply continuously hot water at a maintained temperature, avoiding the heating steps of the used electric thermos.

This kind of integration can be easily done if the processing lines designed and developed in the iDVP are aggregated to fish processing lines already existing and operating in industrial plants. LIFE iSEAS partners are convinced that these valorizing value chains developed in the framework of LIFE iSEAS can complement existing processing plant by using new biomass and side-streams/by-products from the new scenarios of compliance with the landing obligation while provide an excellent business opportunity to these processors. These analysis actions in collaboration with fish processors that showed their interest on the LIFE iSEAS results in Action B4 are considered for future development in the framework of the After-LIFE+ plan.

Regarding **Tasks C2.3 and C2.4**, the work undertaken along LIFE iSEAS project has allowed partners to identify the three main economic impacts of the LO: *i) on board, ii) on shore and; iii) in terms of loss of quota.* All these identified impacts (Figure 36) are summarized in Figure XX. The most relevant or the one with the higher socio-economic impacts will be the ***extra workload*** that will be required in order to manipulate, conserve and stock properly on board all the catches related with the LO.

For the analyzed fleets on LIFE iSEAS (bottom otter trawlers operating in ICEAS areas VIIIc and IXa), it was analyzed the extra time to handle all LO catches that affect this fleet. In 2017, only hake was included in the LO for the vessels in this fleet. In 2019, they must to retain and land all catches of hake, horse mackerel and megrim. These are the two analyzed scenarios. Results are summarized in Table 9. To carry out these

calculations, an *Average Handle Time of a single box of fish* was measured: 4 minutes 48 seconds (4.86 minutes)

	A	B= A/ Boxes Storage Capacity	C=B * 4,86 m	D	E= C/7 Days Trip	F=E/ Nº fishermen
L.O. Scenario	**Kgs L.O.**	**NºBoxes**	**Nº Boxes *Average Time (minutes)**	**Total Extra Time (h)**	**Daily Extra work**	**Assuming 5 fishermen per boat**
2017 (HKE)	478.00	28	136.30	**2h 16 m**	**19 m 30 seg**	4 m
2019 (HKE,LDB,HOM)	8,601.92	476	2,316.37	**38 h 36m**	**5 h 31 m**	1.10 h

Table 9. Evaluation of required extra time to manage on-board all the biomass associated to the LO

As shown in the table, the fully LO compliance scenario (2019) implies an increase in the daily workload per member of crew of more than one hour. To these figures, we must add the ones evaluated during pilot trips in Action B4 related to in land management of the whole catch (unload and further quantification/classification).

This fact will result in a loss of profitability of its activity and of the whole vessel while their safety conditions in the workplace become deteriorate. When giving economic value to the required extra time (Table 10), LIFE iSEAS partners have quantified the catches value of a 7 days trip (26,144.67 €) and 4 hauls per day, 4 hours per haul. Therefore, the *Haul Average Value* is 933.73 €.

L.O. Scenarios	**A**	**B=A/4 h**	**C=B*933.73 €**
	Total Extra Time (h)	**Nº Hauls**	**Total Opportunity Cost**
2017 (HKE)	2h 16 m	0.56	522.89 €
2019 (HKE,LDB,HOM)	38 h 36m	9.65	9,010.57 €

Table 10. Economic evaluation of required extra time to manage on-board all biomass associated to LO

Obtained *opportunity cost* (that represents the benefits an individual, investor or business misses out on when choosing one alternative over another) will reduce the trawler quote causing economic effects on the fleet.

In addition, LIFE iSEAS partners think that these increases in the crew work maybe will be carried out without an increase in their salary since the new fraction of biomass will have low or non-value. Therefore, no extra revenue is expected to the ship-owner who will not reflect these salary increases without a lost in the profit of his ships. To overcome this issue of loss of some extra revenue from LO biomass is where valorization solutions like the developed iDVP will play an important role to generate added value to this new biomass, minimizing the socio-economic impacts of fleets due to LO compliance.

Based on the data and results obtained in these previous tasks, an ***input-output software model*** was developed based on Input-Output tables for the Galician Fishing and Preserved Fish Sectors 2011. The function of production of the trawling fleet was recalculated for 2016 and 2017 based on changes in quotas of the target species and represents the BAU (*Business as Ussual)* scenario. Biological data on captures and unwanted catches come from IEO (Spanish Institute of Oceanography) campaigns and from the data obtained during the LIFE iSEAS pilot trips. In order to address the high variability of discards, the alternative scenarios were calculated taking into account the average quotas, catches and unwanted catches of 2014-2017. These scenarios are assumed to be representative of full implementation of LO if all quota was consumed using those gears:

0. ***Business as Usual (BAU):*** Landings obligation not implemented, i.e. discards allowed.
1. ***Landings obligation – no exemptions (LO):*** Landings obligation implemented. Unwanted species are sold at 0.05 EUR/kg for fish meal/oil production.
2. ***Landings obligation – de minimis***: As Sc-1 but with a 5% *de minimis* exemption implemented.
3. ***Landings obligation – increased costs:*** As Sc-2, but with a reduction in unwanted catches of 50%, either by improving efficiency, non-compliance or by any other reason.

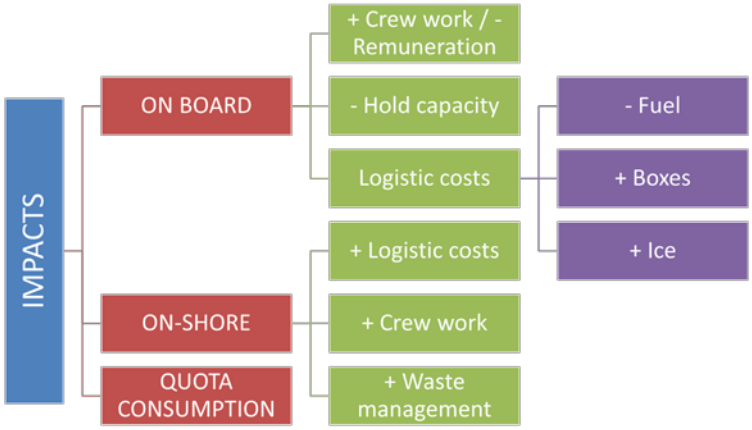


Figure 36. Identified socio-economic impacts in a fully compliance scenario of the LO

Results show (Table 11) that the implementation of the LO may bring a **reduction of the discards and the fishing effort but it may also result in a reduction in the income and revenues of the fishing companies.**

The main drivers of this result are, on the one side, the high rates of catches under MLS (minimum legal size) and, on the other the loss of quota, that's to say the exchange of valuable catches for fish for reduction at a meagre price, being other adverse impacts, as the increase of the working load and consequently of the salaries, limited. It is worth to say that the reduction of the fishing effort will mean less fuel consumption benefiting the profitability (also marginally).

For every euro of unwanted catches it´s sacrificed about 35.8 euros of target species. This amount goes from 85.8 € from megrim to 12 € in the case of blue whiting. These

results have been gotten during a zero-enforcement moment and, hence, we can expect a better performance under the incentives created under full enforcement. Nevertheless even with an increase of 50% of efficiency, the GOS (*Gross Operating Surplus* - similar to profit) of the fleet is **54% of the BAU scenario**.

	BAU	No minimis	5% minimis	Efficiency +50%
Quota (t.)	693,71	693,71	693,71	693,71
Catches (t.)	693,71	313,96	329,66	447,09
Discards (t.)	377,53	0,00	34,57	34,57
Unwanted catches (t.)	0,00	377,53	361,83	244,40
Catches (1000€)	791,54	413,81	434,50	561,11
Unwanted catches (1000€)	0,00	16,74	15,98	10,68
Expected revenue (1000€)	791,54	791,54	791,54	791,54
Revenue (1000€)	791,54	432,68	452,59	573,33
Opportunity cost (1000€)	0,00	358,86	338,95	218,22
Opp. cost per unit of unwanted catches	0,00	50,13	50,13	50,13
GOS (1000€)	72,13	48,97	50,25	58,04

Table 11. Economic impact per vessel of the LO implementation

In the long-term the abundance of the target species will increase as a consequence of the reduction of the fishing effort. Then, quotas may increase in the long term as well as the income. Therefore the problem seems to be how to go from short to long term. The valorization of the unwanted catches is a feasible way to reduce the opportunity cost of the quota loss without creating incentives for discarding. **Therefore, initiatives as the one proposed by LIFE iSEAS (the iDPV) may contribute to both the long term sustainability of the fleets affected by the LO.** This experience should be diffused to other areas as it represents a way to facilitate the adaptation of the fishing companies to the LO.

Outputs: Comparative with planned outputs

Expected results, summarized in the LIFE iSEAS proposal, have been fully achieved, including a complete sustainability assessment of the industrial ecosystem proposed for the fishing activity. This intense and complete work carried out included an environmental and socio-economic evaluation of the own activity and of the proposed alternatives of LIFE iSEAS in terms of possible scenarios and valorization solutions developed.

Indicators used to test the performance:

Milestones achievement (regarding all LIFE iSEAS Actions) was considered the main indicators regarding this action, since it was totally complete in time.

Issues found:

None.

Task duration: Comparative with the established time schedule:

This Action was implemented as scheduled in the proposal, including some preliminary works previous (starting Month 19) to the official start date (Month 24) related to selection of proper methodologies for environmental and socio-economic impact assessment together with first analysis of data obtained from Action A1.

Proposal: 24 months (from *Month 25 to Month 48*).
Real: 30 months (from *Month 19 to Month 48*).

D1	Report of inventory data regarding resources, energy and waste needed for the application of sustainability asessment tools (Update D1: March 2018)
D2	Report of economic benefits of the project at vessel and sectoral level (Update D2: March 2018)
D3	Manual of the main characteristics of the integrated methodology for sustainability assessment of the proposed fishing management network
D4	Report summarising the results of the sustainability impovement after the application of the innovative solutions proposedin iSEAS
M1	Inventories data of resources, energy and waste consumption/generation of the whole fishing activity considered
M2	Development of a modular software tool for the sustainability assessment of fishing activity

Summary description of associated reports:

- **Deliverable C2.1.** *"Report of inventory data regarding resources, energy and waste needed for the application of sustainability assessment tools"* has been produced (Month 33).
  Submitted with the Second Progress Report.

- **Deliverable C2.2.** *"Report of economic benefits of the project at vessel and sectoral level"* has been produced (Month 35).
  Submitted with the Second Progress Report.

- **Deliverable C2.3.** *"Manual of the main characteristics of the integrated methodology for sustainability assessment of the proposed fishing management network"* has been produced (Month 37). This Deliverable is attached to this Final Report as **Annex 10.**

- **Deliverable C2.4**. *"Report summarizing the results of the sustainability improvement after the application of the innovative solutions proposed in iSEAS"* has been produced (Month 44). This Deliverable is attached to this Final Report as **Annex 11.**

Other reports/papers:

1. Antelo, L.T., De Hijas-Liste, G.M., Franco-Uría, A., Alonso, A.A., Pérez-Martín, R.I. (2015). Optimisation of processing routes for a marine biorefinery. *Journal of Cleaner Production*, 104, 489-501.
   DOI: 10.1016/j.jclepro.2015.04.105

2. Lopes, C., Antelo, L.T., Franco-Uría, A., Alonso, A.A., Pérez-Martín, R. (2015). Valorisation of fish by-products against waste management treatments - Comparison of environmental impacts. *Waste Management*, 46, 103-112.
   DOI: 10.1016/j.wasman.2015.08.017

3. Vázquez, J.A., Blanco, M., Fraguas, J., Pastrana, L., Pérez-Martín, R. (2016) Optimisation of the extraction and purification of chondroitin sulphate from head by-products of *Prionace glauca* by environmental friendly processes. *Food Chemistry*, 198, 28-35.
DOI: 10.1016/j.foodchem.2015.10.087

4. Antelo, L.T., Ordóñez-del Pazo, T., Lopes, C., Franco-Uría, A., Pérez-Martín, R.I., Alonso, A.A. (2016). Pollutant levels in discarded fish species by Spanish trawlers operating in the Great Sole Bank and the Atlantic coast of the Iberian Peninsula. *Marine Pollution Bulletin*, 108 (1-2), 303-310.
DOI: 10.1016/j.marpolbul.2016.04.040

5. Lopes, C., Antelo, L.T., Franco-Uría, A., Alonso, A.A., Pérez-Martín, R. (2018). Chitin production from crustacean biomass: Sustainability assessment of chemical and enzymatic processes. *Journal of Cleaner Production*, 172, 4140-4151.
DOI: 10.1016/j.jclepro.2017.01.082

This last article is attached to this Final Report as **Annex 8.**

5.2. Evaluation

a) Methodology applied

A number of tasks and activities were proposed in the LIFE iSEAS framework so to cover the different aspects (and steps) involved in the enhancement of the real application on the fishing sector of existent knowledge and innovative solutions on discards reduction and management, creating new adding-value mechanisms to the fishing activity. These aspects and steps can lie in the following categories:

1. Analysis and characterization of the discards situation on the target fisheries.
2. Development of innovative technologies/systems towards fully documented fisheries with the data transmission to land in real time, including their implementation and validation on a real fishing environment in commercial vessels (iObserver and RedBox). This will improve the quality and availability of data and knowledge about the status of resources.
3. Design and development of a marine SDI, including a powerful modelling tool to analyze the spatio-temporal conditions of considered fishing areas in terms of discards/stock status, being the core to develop quasi real-time, effective policies based on daily-activity data.
4. Definition, construction and operation of a real pilot service located on Marín Port facilities to valorize/manage previously discarded biomass: the *iDPV* (Integral Discards Processing and Valorization Point). It includes possible modifications on the selected fishing vessels have to be carried out in order to guarantee the best conditions of discards for further valoristaion in the iDVP.
5. Dissemination of the results of the project with special emphasis in the demonstration of the developed technologies/tools among the sectors developing their activities around fishing and fish products, administrations and related scientific community.

So far, and as it has been stated during the LIFE iSEAS project implementation, it is possible to assert the following:

Tasks related with category 1 (***Analysis of discards situation***) have been successfully completed as originally devised, including periodic updates of this information until the end of the project due to the **more than 60 pilot trips** on board commercial vessels that have been carried out along the project implementation. These tasks allowed LIFE iSEAS partnership to gain a deep knowledge on the initial snapshot of considered *métiers* catches particularities, including the key socio-economical assessment of the activity of selected trawling fleets (operating in ICES Areas IXa and VIIIc).

As first step, a complete characterization and quantification of the discarded biomass in the target fisheries together with the motivation for its waste was carried out. Depending on such reason, the retained discards have to be processed in the iDVP1 or iDVP3. Moreover, **22 species** were selected for automatic identification by the iObserver and further valorization, clearly improving the proposed figures for this output since 5-7 species to be recognized by the iObserver was considered in the LIFE iSEAS proposal.

As a second step, a complete set of interviews (**up to 13 – 80 minutes each**) with fishing fleets was carried out to obtain the information regarding discards perception by the fishing sector. In addition, a complete study about the costs associated to the implementation of the new CFP and the LO and to identify bottlenecks and potential

solutions related to this new legal framework implementation have been developed to obtain valuable a crucial information to properly develop and implement LIFE iSEAS towards providing a complete set of solutions for the fishing sector that allows to minimize environmental and socio/economic impacts of the discards issue and the LO.

Related reports as Deliverables A1.1, A1.2 and A1.3, 2.2 have been distributed among representatives of the different target actors of the fishing sector to disseminate this new knowledge developed in the LIFE iSEAS framework.

Tasks and activities connected with categories 2 and 3 (***data based technologies development on board and in land***) progressed as planned without facing any substantial obstacle. It must be mentioned that the final features of iObserver, RedBox and the marine SDI are not exactly as described in LIFE iSEAS proposal since during project they were improved and optimized as a result of the several operating tests carried out, increasing their performance and robustness. In addition to LIFE iSEAS partnership work, it must be mentioned that the feedback obtained from fishing fleets, crew and ship-owners involved in the project (as part of OPROMAR) from the very beginning/early stages of development of the project was fundamental to obtain robust and effective solutions towards complete, accurate catch data.
This georeferenced, processed data (available in the marine SDI) feeds the reliable mathematical models we have developed to analyze the spatiotemporal conditions of considered fishing areas, resulting on a powerful tool for policy assessment and optimal marine resource management since it is based on real time fishing activity date (not only in historical data). This result has been explained and provided to the skippers and ship-owners in order to help them as an extra decision-tool to take appropriate decisions towards a more efficient and sustainable fishing activity.

All developed systems are operative (2 fully-operative iObserver + RedBox are still nowadays on-board two commercial vessels – *Ría de Marín* and *Portosanto* – as part of the After-LIFE+ Plan) and ready to generalize their implementation both on board as well as in land.

Finally, it must be mentioned that related Deliverables B1.1, B1.2, B2.1 to B2.6 and B31.1, B3.2 and B3.3 have been distributed among representatives of different fleets in order to mainly get their valuable feedback to improve these technologies and their implementation and use at a real scale and to transfer/replicate them in other EU fisheries/fleets.

Actions under category 4 (***iDVP development***) were implemented as expected, always respecting the schedule of the proposal, achieving the expected results. These contributed to the reduction of the environmental impact and the minimization of the cost related to the management of discards due to the compliance with the LO by proposing alternatives which will add economic value to this new fractions of biomass while at the same time will reduce the costs associated to storage capacity and transportation. Such reduction will be possible through the application of appropriate on board management protocols for discards. To this purpose, more than **50 pilot trips** were carried out, including **6 demonstrations tests of fully compliance with the LO,** where new materials (containers) and working methods both on-board as well in land were applied to quantify the extra time/costs of managing the fraction of biomass

related to the LO compliance and to propose solutions/best available procedures to minimize the associated impacts to this new legal framework.

In relation to Actions in Category 1 and 2, it must be also noted that well-established valorization processes implemented and tested in the iDVP (more than **45 complete pilot productions** of valuable products from previously discarded biomass/species with low commercial value) of previously discards contribute significantly to reduce pressure on marine resources by both efficient management of discards and use of valorized products. The potential market possibilities of the obtained products in the iDVP was analyzed through the protocol to exchange iDVP products samples between LIFE iSEAS and contacted fish processors and end users in order to get their valuable feedback in terms of characteristics and potentialities of these products.

The iDVP is nowadays used to carry out more tests in the framework of the After-LIFE+ Plan, being available to end users and companies in order to obtain *on demand* products requested by them.

Finally, tasks and activities included in category 5 (***Dissemination***) were developed as planned. In this way, a successful dissemination of the results of the project to a regional, national and international scale has been achieved, fulfilling all the expected indicators reflected in the proposal. From the very beginning of the project, a key part of LIFE iSEAS project was the development of effective methods of disseminating and communicating the project's outcomes and achievements between partners, stakeholders and the general public throughout the life of the project. Therefore, we think that this objective has been completely fulfilled through a continuously flow and update of information through the LIFE iSEAS website, the social networks (Twitter and Youtube), technical meetings with different stakeholders, workshops and demonstration sessions, attendance to different national and international conferences in the several categories or Actions above described in the framework of LIFE iSEAS, etc. To clearly understand the intense work carried out in the framework of diffusion activities that have been considered as a priority in LIFE SEAS, see ***Section 5.4.***

Regarding the cost efficiency of the Actions, and as it will be explained in detail in ***Section 6***, all the objectives and technologies aimed during LIFE iSEAS development have been attained (even going beyond, achieving more technical developments than those summarized or described in the LIFE iSEAS proposal) without use all the economic resources reflected in the proposal. This fact indicates that the Actions were fully and properly developed with budget containment, looking always for the best option in terms of technical/economic compromise. This methodology tried to answer to the economic framework of crisis in that LIFE iSEAS was implemented, where losing or wasting money was not allowed.

b) Results achieved

Task	Foreseen in the revised proposal	Achieved	Evaluation
ACTION A1	*Selection of target fleets/fisheries*	**9 trawlers** (Iberian Coastal waters – ICES areas VIIIc and IXa) were selected to carry out	Complete expected results were achieved.

		20 pilot trips.	Very positive and collaborative answer was obtained from many OPROMAR associates to carry out answer LIFE iSEAS questionnaires the pilot tests in the framework of this Action and on B4. Action A1 was a key work for project taking into account that it was the basis for other important tasks (species selection for automatic identification on board, valorization strategies definition in the iDVP, etc.)
	Discards characterization *Selection of discards species for valorization studies*	As a result of full information/data attained during performed pilot trips, **22 species** (5-7 proposed) were selected as most discarded/of interest to be identified (Action B1) and valorized (Action B3) – *Deliverable A1.4*	
	Socio-economic data available for partners	**13 highly detailed interviews** (of around 80 min) to obtain very valuable information regarding discards perception by the fishing sector was developed (and updated during implementation of Action B4) *Deliverable A1.3*	
	Definition of valorization strategies	Based on identified and selected objective species, a set of valorizing value chains/processes (**up to 7 implemented in the iDVP**) where selected based on state-of-the art technologies and previous deep knowledge of LIFE iSEAS partners *Deliverable A1.4*	
	Good Practice Manual to reduce discards	A detailed explanation of a combination of strategies (for discards reduction/properly management on board and valorization in case of unavoidable non-targeted catches) - *Deliverables A1.1/A1.2*	
ACTION B1	*Four (4) iObservers*	All proposed devices were fully developed and tested on board oceanographic and commercial vessels (**2** still operating on-board commercial vessels)	Complete expected results were achieved. iObserver development and implementation on board was a continuous work during LIFE iSEAS implementation in tight collaboration between involved partners (mainly IEO, CSIC, CESGA, OPROMAR) with contracted observers on board oceanographic and commercial vessels together with the feedback from fishermen in order to achieve a fully operational and robust equipment to be used as part of the daily fishing activity.
	Total capture data available	Data acquired of total catches during testing pilot trips was summarized in *Deliverable B2.1* and it is also available in the private part of the marine SDI, including the reason for discarding. This data will feed models developed in B3	
	A protocol for implementation and use on board	Definition and implementation on board of the protocol to properly implement the iObserver technology - *Milestone B1.1* properly achieved on due time	
	Definition of total costs associated with proposed technologies	A complete report on this issue has been developed based on the results/experiences/feedback obtained during pilot trips on board oceanographic/commercial	

		vessels testing the iObserver. *Deliverable B1.2*	
ACTION B2	*Fishery discards data model*	Data model was developed in the early stage of the project and evolved along LIFE iSEAS taking into account previous partners' experience on this field and recommendations/feedback of final users of these technologies on board. It is the core of the **RedBox software**. *Deliverable B2.1 & Milestone B2.1*.	Complete expected results were achieved. RedBox software is now integrated with the iObserver system and available for download in the LIFE iSEAS web (www.lifeiseas.eu) LIFE iSEAS results regarding the creation of a complete marine SDI (including the developed metadata catalog, web services and the new map LIFE iSEAS geoportal) are available for the fishing sector stakeholders and general audience at http://iseas.cesga.es Based on CESGA expertise, several pilot tests of all tools integrated in the marine SDI were carried out in CESGA facilities, getting a valuable feedback from users.
	Fishery discards Metadata Catalog Service *Web GIS Services* *Improved Management Geoportal Web*	Fully catch data obtained by the iObserver and sent by the RedBox during pilot tests was processed and included in this defined catalog. The aim is to provide all this data in the developed marine SDI to provide it to different end users (depending on their defined access rights) by using, for instance, the different developed web services (to connect with different open source GIS tools) and/or through the developed LIFE iSEAS Geoportal (iseas.cesga.es), that includes new features detailed in *Deliverable B2.5 & B2.6 Deliverables B2.2 to B2.6 Milestones B2.2 to B2.5*, all achieved on due time.	
ACTION B3	*A more accurate FSI model*	Based on the previous results obtained in the LIFE FAROS project, a more complete and precise **Fishing Suitability Index (FSI) dynamic model** (that incorporates more environmental variables) was developed to create prediction maps of more suitable fishing areas (in terms of less discards). It is fed on data obtained from the commercial fleets by using the iObserver + RedBox *Deliverable 3.1& Milestone 3.1*	Complete expected results were achieved. Developed models have been validated by using real catch data acquired during the 50 pilot trips carried out in the framework of Action B4, showing the predictions of these maps a high accordance/fit to real data (**less than a 15% of error**). A powerful prediction tool integrating the 3 developed mathematical models is available in the LIFE iSEAS Geo-portal, helping **fleets** to perform a more sustainable fishing activity and being a tool for **administrations** to implement an effective ecosystem-based marine spatial planning that
	A real – time mapping of hotspots areas (juveniles)	Static maps of juvenile concentration areas (**juvenile hotspots**) for different species (**4**) of interest in the framework of LIFE iSEAS were developed based on data from oceanographic campaigns. *Deliverable 3.3 & Milestone 3.3*	
	A Fuel Efficiency Model	Developed **Fuel Efficiency model** models were used to	

		combine economic and fishery data to identify the more profitable areas of operation for the selected trawling fleets. In addition, model was used to simulate policy makers' scenarios to assess the social-economic trade-offs of the landing obligation implementation in the area. *Deliverable 3.2* & *Milestone 3.2*	embraces the Ecosystem Approach and Landing Obligation requirements.
	An integrated maps tool in the marine SDI/LIFE iSEAS Geoportal	All the generated models and maps were integrated in the LIFE iSEAS geo-portal and are accessible to users.	
ACTION B4	*A decision support system aimed to establish optimum design, redesign and operating conditions*	*Deliverables B4.1, B4.2 and Milestone B4.1* were produced in due time to present the integral mass and energy flow models of the iDVP together with the tools for a proper scaling-up, optimization and installation methodology in the Port of Marín	Complete expected results were achieved. Good quality of products obtained in the iDVP was confirmed through the feedback obtained from the exchange of samples with **up to 13 important companies** interested in the obtained compounds. Based on the acquired feedback, optimization procedures have been carried out in the iDVP to tune the integrated processes to satisfy the final product demands made by contacted end users. The iDVP is available for further tests to be developed in the framework of the After-LIFE+ Plan since a high interest among potential end users have been received during the different dissemination7demontrations sessions carried out during LIFE iSEAS.
	A fully operative iDVP (iDVP1 and iDVP3)	Construction and start up/tuning of the iDVP was achieved on due time to perform **up to 58** pre-industrial production tests, obtaining valuable products of high quality. *Deliverable B4.3* and *Milestones B4.4 & B4.5*	
	A detailed cost analysis of the full iDVP environment	This analysis has been carried out, confirming the viability of the proposed pilot plant when used to valorize the biomass associated to the LO (**6 simulations of full compliance scenario was carried out**). It allows to solve both the environmental problem related to the in land biomass management as well as to minimize the socio-economic impacts associated to the on-board management and extra workloads of the crew by generating a way to valorize the LO biomass and by creating employs linked to the iDVP *Deliverable B4.*	
ACTION C1	*Production of a monitoring protocol*	It was defined in Month 6 (*Deliverable C1.1*) and continuously updated during the project implementation	Complete expected results were achieved. New environmental benefits could be defined in connection with After LIFE+ in connection with involved fleets and stakeholders
	Production of deliverables and progress reports	All requested reports (technical and financial) were produced and submitted in due time (Months 9, 18, 24, 36 and 48)	

	Final assessment and evaluation of the project	It was carried out by fulfilling all milestones related to monitoring of the project's implementation *Milestones C1.1 to C1.4*	interested on using the iObserver, RedBox, SDI/Maps and the iDVP).
ACTION C2	*Evaluation of the environmental impacts of fishing activity at sea*	The environmental impacts of vessels fish extractive activity were quantified using the **Ecological Footprint** (EF). **11.6 global hectares** are required per ton of fish landed. If the solutions developed in the framework of LIFE iSEAS are used, **the reduction of the environmental impacts of the fishing extractive sector will vary in a range 31% to 55%.** *Deliverable C2.3*	Complete expected results were achieved. An evaluation in depth of environmental and socio-economic impacts for the whole fishing sector, comparing the initial situation with the scenario defined by the application / implementation of proposed solutions of LIFE iSEAS has been carried out. A continuous update of this assessment has been developed based on the real data obtained both from pilot trips and tests in the iDVP, implementing both on board and in land solutions to mitigate them.
	LCA of the proposed iDVP environment	The environmental impacts of the different discards valorization processes were analyzed using **Life Cycle Assessment** (LCA), evaluating the contribution of the different steps and identifying areas for improvement. **Electricity consumption is the biggest contributor in the different valorization processes, with values over 80% in all impact categories**, while the consumption of reagents only implies around 5%. *Deliverable C2.1*	
	Socio-economic impacts of proposed solutions	The most relevant identified impact is the **extra workload** that will be required in order to manipulate, conserve and stock properly on board all the catches related with the LO. The fully LO compliance scenario (2019) implies an increase in the daily workload per member of crew of **more than one hour**, that supposes an opportunity cost of more than 9,000 € per trip (vessel operating 7 days/trip). It was also stated that implementation of the LO may bring a reduction of the discards and the fishing effort but it may also result in a **reduction in the income and revenues of the fishing companies.** *Deliverable C2.2 & C2.4 & milestone C2.2*	

Table 12. Main LIFE iSEAS results by Action

5.3. Analysis of long-term benefits

a) Environmental benefits

The need to reduce and manage discards in European fisheries was identified by the Commission as an important objective in the framework of the reform of the Common Fisheries Policy (CFP) in 2013. Nowadays it becomes evident to the industry and to the society the need to minimize the adverse ecological and environmental impact of fishery discards (on-board as well as on-shore) as they constitute a purposeless waste of valuable living resources contributing to the depletion of fish populations.

Note that enforcing a 'discard ban' policy like the Landing Obligation of the CFP necessarily requires an evaluation and readjustment of the cost-benefit balance, since bringing previously discarded biomass to land implies an increment on the operational costs of the fleets due to higher volumes of biomass to be handled on board.

The perception we have collected in LIFE iSEAS from fishermen is that compliance with the Landing Obligation CFP will result in an important depletion of employs in the sector and huge negative economic impacts over some fleets. In this framework, LIFE iSEAS partnership has developed an intense work with these stakeholders to clearly explain them that all developed and implemented solutions are going to help them to adapt its activity to the new legal framework defined by the CFP. These tools will allow fleets to reduce discards through alternative fishing strategies using developed marine SDI and prediction mathematical models based on real time fishing data collected from iObserver and RED BOX.

The predictive maps of the identified areas are essential and easy-to-use interpretation tools, generated with the final aim of improving management and conservation of natural resources. Indeed, these areas could be avoided by fishers and consequently unwanted catches could be reduced preserving important species and key-life-cycle. With the use of these prediction tools, a reduction of up to a 90% of the main identified discarded species can be achieved, considering that uncertainty exists in the prediction models and that this drawback could be reduced by continuously feeding the models with real fishing data obtained from several vessels.

Our findings, combined with information on the distribution of fishing activity, could be a suitable approach to implementing an effective ecosystem-based marine spatial planning that embraces the Ecosystem Approach and Landing Obligation requirements. In this respect, the combination of robust statistical models with fishery independent and environmental data might be a key tool due to its flexibility in fitting complex models and its computational efficiency.

The efficient management of the fishery could lead to sustainable economic activities in the long term and therefore favoring employment in coastal regions highly dependent on extractive activities of marine living resources, reducing stress on exploited populations.

Finally, it must be mentioned that these modelling tools have potential benefits in other sectors, integrating socio-economic, biological aspects from a spatial perspective. This

concept can be further developed, especially in the real-time management of marine protected areas and fishing management zones.

In addition, LIFE iSEAS solutions allows to efficiently manage that biomass generated due to the compliance with the Landing Obligation of species with no current commercial value, diminishing the associated cost of retaining the whole catch on board while avoiding its returning to the sea, with the important damages and impacts of this practices over the marine environment.

The processes of valorisation developed in the iDVP, optimized and tested at pilot plant scale within the present proposal have been defined based on stages and procedures of low environmental impact (enzymatic hydrolysis, selective separations by means of membranes, etc.), avoiding the use of organic solvents and reducing as much as possible the needs of reagents, energy costs and water consumption.

As an example, the production of gelatines starting from by-products (e.g., tuna and blue shark skins) has been optimized at the lab scale and corroborated at the pilot plant scale, reducing water, reagents and processing time by more than 50% in comparison to the results previously described in the literature. In the same way, the purification of chondroitin sulfate from cartilaginous by-products and species of chondrites discarded by the fishing fleet has been intensively improved in terms of yields and reduction of productive costs.

The set of valorisation operations defined in the LIFE iSEAS project aim to lead to a more rational and efficient use of fishery resources that involve the recovery and production of bio-compounds of medium-high added value with wide acceptance in different sectors: food, aquaculture, pharmacology and medical, etc. The viability demonstrated by the processes developed, under the concept of Marine Biorefinery, together with the commercial interest in several of the obtained products (fish mince, FPH, glycosaminoglycans) makes our proposal a realistic alternative, even complementary in some case, to the usual production of fishmeal. Our approach based on a set of sustainable, optimal and flexible operations, constitutes a relevant tool for the implementation and promotion of valorising policies applicable to the management and treatment of marine resources and to the environmental improvement of the processes of transformation of the fishing industry.

Finally, a complete methodology for environmental and socio-economic impact assessment of the whole discards management cycle has been developed. It is based on environmental indicators such as Ecological Footprint (EF) and Life Cycle Assessment (LCA). In this framework, the different steps on the valorization processes implemented have been analyzed, starting in the extractive fishing activity, the in-land management and finishing with the different scenarios or alternatives nowadays available at real scale to comply with the Landing Obligation. With the proposed approach, it is possible to redesign or optimize proposed solutions to make them more environmental friendly, evaluating and trying to solve those bottlenecks in terms of ecological and socio-economic impacts.

b) Long-term sustainability

The extractive fishing sector (fleets) has to be (from the very beginning and as previously mentioned) a key and active part on developing and implementing innovative measurements and technologies (together with the necessary scientific collaboration, exploiting the existing synergies between them) to avoid unwanted catches towards fully compliance with the Landing Obligation. The CFP enables fishermen to actively participate in designing measures to avoid by-catches and to land all species that are caught. In addition, science-industry alliances are highlighted in the proposal of the CFP as the source of good quality data and knowledge as the core of novel fishing activity management models/methods. LIFE iSEAS has taken advantage of this environment from the conception and proposal stage of the project by implying OPROMAR as a key partner to catalyze the interactions between fishing actors towards the proper definition of strategies and methodologies to solve all together the discards issue.

On the side of how the EC will ensure the fully compliance with the Landing Obligation, the CFP obligates to a full reporting of fishing and processing activities on-board. Therefore, vessels must be properly equipped (electronic logbook, CCTV, other technologies, observers, etc.) to achieve a modern electronic tracking, reporting and analysis technologies towards real-time monitoring, including innovative traceability tools (barcodes, RFIDs, etc.). Closed-circuit television cameras have been tested on board in several countries since a number of pilot studies have been undertaken within Europe over the past years. Most of them are conventional cameras that are fixed to strategic points on a fishing vessel, so some fishermen are sceptical a camera system can be register images along the ship. Nonetheless, results showed that discards were reduced. Captured images would be analyzed when the fishing trip finishes in most of cases. Innovative technologies like the iObserver (together with RedBox) for registering captures, processing and transmit it to land in real-time to the marine SDI (where information is processed and represented in an easy way to be interpreted by fishermen) could ultimately be a much effective and cheaper option. Moreover, a camera system that only is focus on conveyor belt will reduce fishermen distrust. Several companies contacted LIFE iSEAS partners showing their interest in these innovative technologies and data software applications in order to be applied in other fisheries along Europe and America (e.g. in Perú and Chile).

In order to continue improving the iObserver in those weaker points LIFE iSEAS partners detected during its development (like lightning and identification when specimen are overlapped), ***a 2 years action was requested to Fundación Biodiversidad,*** a Public Foundation part of the Spanish Ministry of Agriculture, Food and Environment. Regarding *hardware,* LIFE iSEAS partners want to test different alternatives to synchronize the movement of the conveyor belt in the fishing park with the capture of images through the use of sensors. These alternatives must be adapted to the different conditions of fishing vessels. Moreover, different possibilities will be analyzed to improve the lighting system and thus obtain homogeneous light conditions throughout the acquired photographs. In terms of *software*, one of the biggest difficulties encountered during the development of the iObserver was the separation of specimens when they are overlapped. In this action, LIFE iSEAS partners propose the development and implementation of new techniques that allow a better separation of the

specimens and, therefore, the improvement of the recognition of species. Promising techniques based on *machine learning* and *decomposition into singular values* will be analyzed and compared.

In addition, with the aim of promoting the test/use these technologies in other fisheries to get valuable feedback from different users, all are available under request and the marine SDI and LIFE iSEAS geoportal will be maintained along the After-LIFE+ period for further developments in these potential new areas.

Due to the fact that this project addresses a very important aspect of the Common Fisheries Policy (CPF), and in order to ensure the long-term and general application of the developed technologies in LIFE iSEAS, we think that Administrations themselves maybe have to be responsible of imposing as mandatory solutions/technologies like those developed in LIFE iSEAS on board fishing vessels and in land to make the best possible use of the new fractions of biomass. In this aim, last steps EFCA (European fisheries Control Agency) made were related to the reinforcement of fisheries control and monitoring with electronic technologies.

Moreover, these technologies can be the subject of matter of the different calls for studies and pilot projects for carrying out the CPF of the Directorate-General for Maritime Affairs and Fisheries of the European Commission. Special attention must be paid to the new instrument defined in the framework of the CFP that it is the ***European Maritime and Fisheries Fund (EMFF)***, that will provide support to producers organizations and fishermen to implement the Landing Obligation and handle the landed catches, including storage aid, support for building extra storage facilities on shore and funding valorization and commercialization initiatives of these new fractions of biomass due to a fully compliance scenario. In addition, and to ensure full real time monitoring and reporting of fishing and processing activities through modern electronic tracking, reporting and analysis technologies, the EMFF foresees funding of such innovative technologies.

Finally, the EMFF would also provide financial support to fishermen and producers associations for participating in trials and pilot projects and for collaborating with scientists. In the framework of LIFE iSEAS, given the interest that has arisen in the use of several fishing discards generated due to compliance with the LO for the production of fish mince by OPROMAR, the plausible industrial implementation of the process will obviously generate jobs (both male and female) in the preparation and cleaning steps of the discards and production and conservation of fish mince.

The FPH produced from discards and fish by-products generated in the recovery of fish mince have proven to be protein sources of high nutritional value in the formulation of aquaculture feeds for gilthead seabream and sea bass (Biothesan S.L.). At present, the economic viability of a small production plant for such hydrolysates is being evaluated by an industrial partner. As in the previous case, the achievement of this business adventure would have positive effects on employment and on the socio-economic impact in the locality where such a plant is located.

Both pilot plants, iDVP1 and iDVP3, have been visited by members of several companies (Jealsa Rianxeira S.A., Kitosano, etc.), universities (Santiago, Vigo, etc.) and

technological centres (ANFACO, AZTI) showing in many cases interest in starting collaborations for its use. In fact, with the fish cannery industry Jealsa, we are working on the recovery of DHA-rich fish oils from tuna heads using enzymatic hydrolysis, carrying out experiments at a scale of 100-150 kg of raw material in the iDVP3 pilot plant located in Marín.

Additionally, other companies dedicated to the valorisation of by-products have also shown their interest in carrying out developments and scaling processes in the iDVP3 plant (Aucosa S.A., Hijos de Emilio Ramírez S.A.). This plant is also serving as a base to carry out the tasks we have undertaken in a new H2020 (GAIN) project, which started a few months ago, and which seeks alternatives for the valorisation of aquaculture by-products and side streams and the production of FPH from fishing discards as an ingredient in the formulation of aquaculture feed.

Finally, it must be mentioned that 2 of the developed iObserver are still operating on board *Portosanto* and *Ría de Marín* in order to acquire more valuable data of the full catch. One of the aims of the After-LIFE+ Plan of LIFE iSEAS is to continue, with the help of OPROMAR, the dissemination tasks of the project and establishing collaborations with selected fleets in order to promote the further development and testing at sea of the developed iObservers in commercial vessels towards a final device that could be fully useful for them and commercialized. The same applies for the case of the iDVP. The aim of life iSEAS partners is that this pilot plant will continue in the Fish Auction of Marín facilities to promote its access to interested fish sector stakeholders, producers, industries, researchers and administrations to carry out new productions and tests to valorize the biomass due to the LO compliance scenario as part of future in-land management strategies of these new fractions.

c) Replicability, demonstration, transferability, cooperation

As a direct result of the more than 60 pilot trips carried out along the LIFE iSEAS project, project partners think that standardization on the use/implementation of on board technologies developed during real fishing operation over extended time horizons together with on board discards management and retaining strategies for further reduction and valorization is possible and quite easy to implement at a national and European level. This conclusion results from the fact that the analyzed trawling fisheries maybe are the most complicated case/scenario in terms of number/variety of potential species to be present in a haul that makes much harder the automatic identification and quantification and further handling of the full catch. This fact could affect, for instance, the quality of data processed and presented in the marine SDI due to higher levels of uncertainty and potential errors, deteriorating the prediction capabilities of the mathematical models developed. However, the obtained results for this complicated scenario are very satisfactory, making the potential results to be obtained on more specific fisheries even better.

As stated in the project, the associated costs to implement the ***iObserver and Redbox*** (a free software tool available at the LIFE iSEAS web) on board commercial vessels do not imply an important investment for ship-owners. Since the results of LIFE iSEAS are satisfactory, we suppose that the Administrations themselves have to be responsible of imposing as mandatory on board fishing vessels systems like those developed in LIFE

iSEAS in the near future, using also the marine SDI as a powerful tool (based on a complete and real-time updated fishing data) for policy assessment and for fish stocks management. Moreover, LIFE iSEAS partners think that fishing fleets could get financial aid in the near future from national and European administrations in order to install it (for instance, from the EMFF).

Regarding replicability and transferability of ***GIS tools*** (marine SDI, geoportal and prediction mathematical models), LIFE iSEAS partners have defined them to facilitate their straightforward adaptation and use in other areas/countries along the EU or outside the EU. As explained previously in this Report, all acquired and georeferenced fishing data is available (in different levels depending on the access rights) and can be shared with other GIS environments and potential users in an easy way by using the Web services developed in LIFE iSEAS. In addition, it must be highlighted that both the marine SDI as well as all mathematical models were developed in open-access software and they can be applied to other fisheries and geographical areas in related projects with no costs related to acquiring software licenses, making their transferability more interesting and easy among final end users. The integration of the statistical models with the geoportal allows the continued use of these tools for all the beneficiary and stakeholders that have access to the platform. It worth to be mentioned that part of the models are in real-time and they can be used as a decision-making tool by fishers.

Regarding ***the valorization solutions developed in LIFE iSEAS***, the products obtained in the iDVP1 plant, mainly fish mince, have been very well received by both sectors the fishing industry (OPROMAR) and the marine food processing companies. Different food preparations have been formulated with fish mince from several discards and have been tested in various culinary forums with excellent organoleptic results and diners feedback. In this context, the great interest that this product has aroused in the mentioned sectors makes it foreseeable that in the near future, there may be a business initiative aimed at its production and commercialization.

On the other hand, fish mince from blue whiting has also been supplied to a pet-food company belonging to the Jealsa Rianxeira S.A. group, showing good reception and interest for its incorporation as a raw material in its wet formulations.

Another compound generated in the iDVP3, the chondroitin sulfate purified from cartilages of different species (by-products and discards) and with different physicochemical characteristics (molecular weights and sulfation patterns) is being widely studied in applications related to the regeneration of cartilage in collaboration with several foreign universities under the financing of other projects currently active: IBEROS, CVMar + i and BlueHuman (POCTEP and Atlantic EU-programs). We are also checking various possibilities to make the production of this biopolymer partially purified (nutraceutical quality) or almost completely purified (pharmacological quality) an industrial reality.

In addition, under these mentioned projects both collagen and gelatines obtained from fish skins are showing excellent results in their application in regenerative medicine, functional foods and nanodevices for bioactive delivery in the framework of above mentioned projects.

LIFE iSEAS partners will put their effort to transfer and replicate the results of the project by exploiting both the existing as well as new developed synergies between public/private sector linked to the project initiative and from the local, national and EU institutional impulses. To that purposes, additional demonstrations sessions could be carried out to explain the main advantages of developed solutions technologies when requested by different stakeholder interested in them.

d) Innovation and demonstration value

A key step in order to properly implement effective measures and policies aiming the discards reduction/elimination is to increase fishing data availability and quality (catches, discards, etc.). This data collection problem is identified by the EC as an important issue that needs to be solved. For the particular case of discards, quantifying this wasted biomass on a global scale is not simple either, because of incomplete information for many fisheries and countries. The proposed on-board solutions developed in the framework of LIFE iSEAS (iObserver and RedBox) have demonstrated their applicability and suitability to both attain this objective while overcoming the drawbacks related to the distrust of fishermen about other camera systems (like CCTVs) that fully record all their activity on board vessels and that could disturb them during fishing or that require more maintenance/human interaction.

Regarding the marine SDI and the developed models integration into it are a powerful tool (based on the complete and real-time updated fishing data and innovative fishing prediction maps) for policy assessment and fishing stocks management even on a real time basis or time horizon. The predictive maps of the identified areas are essential and easy-to-use interpretation tools, generated with the final aim of improving management and conservation of natural resources. Indeed, these areas could be avoided by fishers and consequently unwanted catches could be reduced preserving important species and key-life-cycle.

The innovation of these models was that they were developed to provide reliable and accurate statistical results but also to be integrated in a geo-portal that allow: 1) the production of real-time maps using fishery dependent and environmental datasets; 2) to see the outputs as an interpretable maps in an interface created ad hoc for the stakeholder users.

Regarding the iDVP, in general, the unit operations used in the valorization processes (enzymatic hydrolysis, separation by ultrafiltration) are widely known and used in the field of bioprocesses, biotechnology and chemical engineering. However, its application in the field of the valorisation of fishing by-products and discards is relatively scarce. Additionally, our vision involves the use of secondary effluents and wastes generated in the recovery processes in the search for other applications and bio-compounds with the purpose of approaching to the objective of "zero effluents".

Finally, related to the environmental and socio-economic impact assessment methodology developed in LIFE iSEAS, several innovative objectives have been attained related to the quantification of the environmental impacts that discards suppose in the fishing activity and how LIFE iSEAS solutions targeting discards reduction could help to importantly reduce such impacts. Regarding socio-economic impacts, a novel

analysis to identify all potential impacts to the fleets have been developed in order to also quantify the time and money costs of handling on-board and in-land the new fraction of biomass due to the Landing Obligation compliance, showing that a fully compliance scenario could have negative impacts on the future viability of fleets. This is the first time that an exhaustive analysis and quantification of impacts of the LO (based on real fishing data collected during interviews and pilot trips) has been carried out for trawling fleets, giving fishermen/ship-owners accurate results of what will imply the fully compliance of the LO to their daily activity.

Summarizing, the application of innovative knowledge and advanced technologies in the fishing sector must play a key role to attain the inalienable objective of sustainability.

e) Long term indicators of the project success

The level of implementation of developed on-board and in-land solutions has to be the better indicator to measure the success of LIFE iSEAS project in the future. In more detail, the **following long-term indicators** are considered:

a. The number of vessels/fleets that implement iObserver/RedBox as part of its daily activity.
b. The number of vessels/fleets that incorporate/use the developed prediction tools to define their fishing routes in order to minimize discards and to perform a more efficient activity.
c. The number of users of the marine SDI, including the Web services and the LIFE iSEAS geo-portal (fleets, administrations, researchers, etc.).
d. The number of companies, administrations and research centers interested in carrying out pilot tests on the installed iDVP in order to valorize the different fractions of biomass (e.g. associated to the LO compliance or with non-commercial value).
e. The number of companies interested in the compounds/products obtained in the iDVP and in the processes/technologies integration developed in this pilot facility.
f. The number of contacts received by LIFE iSEAS partners from the different fishing sector stakeholders.
g. The number of visitors to the LIFE iSEAS webpage and social network channels.
h. The number of attendees to the AFTER-LIFE+ dissemination activities.

Moreover, it must be mentioned again that the implication of Administrations on the regulation of technologies as those developed in LIFE iSEAS could play a key role to ensure a high level of dissemination and implementation of them in the framework of the CFP.

5.4. Dissemination issues

The objective of this action, conform the project proposal, is the demonstration of the capabilities of the global management discards framework developed, as well as to carry out a complete diffusion of the project to regional, national and international level. Several complementary tools/ methods were established for these purposes (website creation, organization of six workshops, production of technical articles, etc.).

5.4.1 Dissemination: overview per activity

Task D1.1: Development and implementation of a communication strategy

- Activities/subtasks description

The communication strategy was defined by CETMAR at the very beginning of LIFE iSEAS execution. The document identifies the methods of communication and dissemination to be used for the LIFE iSEAS project and it describes the dissemination activities performed and foreseen.
A stakeholder database was created also by CETMAR, and it was updated (in collaborating with all partners) during project execution.

- Outputs: Comparative with planned outputs

It was the basis for the annual elaboration of deliverables in the framework of Action D1 (Deliverable D1.1, Deliverable D1.2 and D1.3). So, an annual comparative between planned communication strategy and executed dissemination tasks was executed and, in all cases, completed objectives were achieved.

- Issues/drawbacks found

None, based on CETMAR experience in these matters.

- List of associated deliverables

As previously cited, the associated deliverables to this task were: Deliverable D1.1- Annual dissemination plan (2014/2015 - with special mention to logo and website creation), Deliverable D1.2- Annual dissemination plan (2015/2016 - remarking the start-up of dissemination events and stakeholders feedback) and Deliverable D1.3- Annual dissemination plan (2016/2017- information regarding the first LIFE iSEAS workshops, networking events, media news, etc.). In case of final project period, Deliverable D1.4 was produced (despite it was not included in the proposal) in order to explain in detail all the demonstration events of the several technologies and solutions developed in the framework of LIFE iSEAS (iObserver, Marine SDI and modelling tools, the iDVP1 & 3 plants, etc.) together with a detailed description of the MARTEC18 Conference, a great knowledge forum to present the main advances on the topics of LIFE iSEAS. This Deliverable D1.4 is attached as **Annex 12.** Moreover, complete information about LIFE iSEAS publications, workshops, mass media links, LIFE iSEAS documentaries, etc. is available in this document (and its annexes).

In connection with the definition of this communication strategy, a project logo and project templates were developed (Figure 37). This logo/templates have been used in all the produced materials, reports and LIFE iSEAS results and actions (for example, deliverables, systems like the iObserver or the iDVP plant, Youtube channel, boxes for discards storing, etc.), as it is exemplified in Figure 38.

Figure 37. Project logo and example of project templates (PowerPoint template)

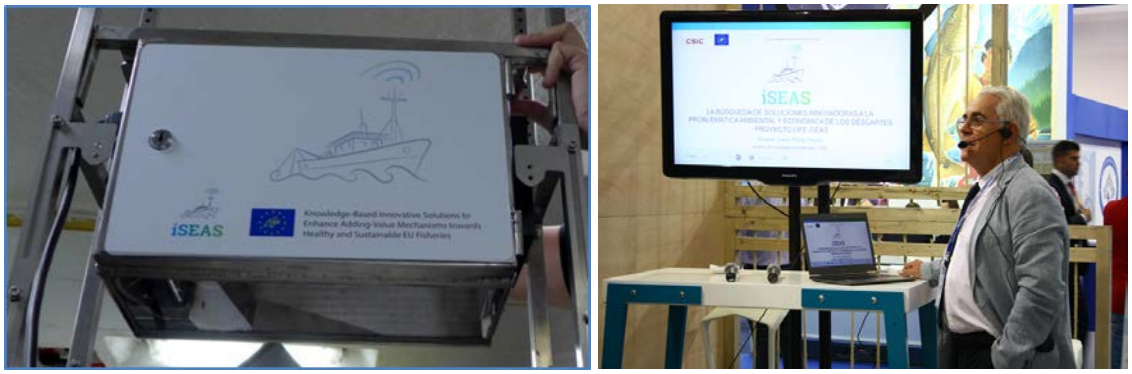


Figure 38. Example of logo and templates utilization (in an iObserver and during MARTEC18 conference)

In addition, the use of the program flag was defined as a requirement for dissemination actions related to LIFE iSEAS (Figure 39).

Figure 39. LIFE flag used in LIFE iSEAS

Task D1.2: Development of a web page for the LIFE iSEAS project and social network accounts

- Activities/subtasks description

WEB:

The project site (available at the address http://lifeiseas.eu/) was and still is being continuously updated with news, events and information related with the LIFE iSEAS Project objectives and discard/fisheries issues.

The project Website (developed in two languages: English and Spanish) will be operational for at least five years after the project ends. It includes different sections:
Intranet: An Intranet of access restricted for internal communication between all partners. This part was mainly used for the project management: General project documentation, budget, deliverables by task, technical and financial reports, calendar, meetings documentation (agenda, minutes), contact points, publicity material, and other information. In November 2016 a new section, which serves as an information repository, was also included. This section allows to LIFE iSEAS partners to share documentation and a common calendar with other related project with which networking actions had been established in the framework of Action E2.
Public part: A public part for large dissemination that includes the project presentation, partners' contact details, a calendar with the more relevant events, public documentation, access to the intranet, etc.
More detailed info about the structure and different parts of the LIFE iSEAS web can be found in the Annexes of Deliverable D1.4.

The target sector was all public; specially, public agencies, associations and organizations linked to the fishing sector and businesses specialized in the recycling of fishing residues. An email publicizing the website was addressed to all the target groups. A stakeholder database was generated during the first months of the project and used to publicize the LIFE iSEAS website. Besides an electronic mailing list was produced to alert all contact of news related to the project (events, conference, new relevant documents, etc.).

SOCIAL NETWORKS:

The project was also on different social networks. The overall project objectives were taking into account in order to choose the target audience, which was identified as general public and specific user (potential collaborators).

Based on these target segments, Twitter, LinkedIn and YouTube were identified like the most appropriate social networks for use as communication tools in the scope of the disseminations actions that LIFE iSEAS carried out. Twitter and LinkedIn groups were created as a discussion forum and meeting point for all the target audience.

All the audio-visual material produced in the framework of LIFE iSEAS project was uploaded to the YouTube channel.

The links to LIFE iSEAS social networks are the following:

https://twitter.com/lifeiseas
https://www.linkedin.com/groups/iSEAS-Project-8191785?home=&gid=8191785
https://www.youtube.com/user/iseaslife

- Outputs: Comparative with planned outputs

WEB:
The project website was periodically improved and updated since mid-November 2014. At the end of the project 5,381 users from 96 countries have visited LIFE iSEAS page, mainly from Spain, UK, Brazil, USA & France.

SOCIAL NETWORKS:
These dissemination tools were constantly updated during the project lifetime.

a) Twitter: At the project closure, a number of 621 users are following @lifeiseas account.
b) YouTube Channel (https://www.youtube.com/user/iseaslife/): 5 videos were elaborated including information about the project main goals and results. In addition, presentations carried out in the project seminar held in Santander in June 2016 were filmed and uploaded in this channel. 1,768 Total views.
c) Linkedin account: iSEAS project group includes 24 members.

More detailed info about statistics of the LIFE iSEAS web and social networks can be found in the Annexes of Deliverable D1.4.

- Issues found

None.

- List of associated deliverables

The Milestone D1.1- Creation of the LIFE iSEAS webpage (Figure 40) was completed. The maintenance will be executed by CETMAR and IIM- CSIC.

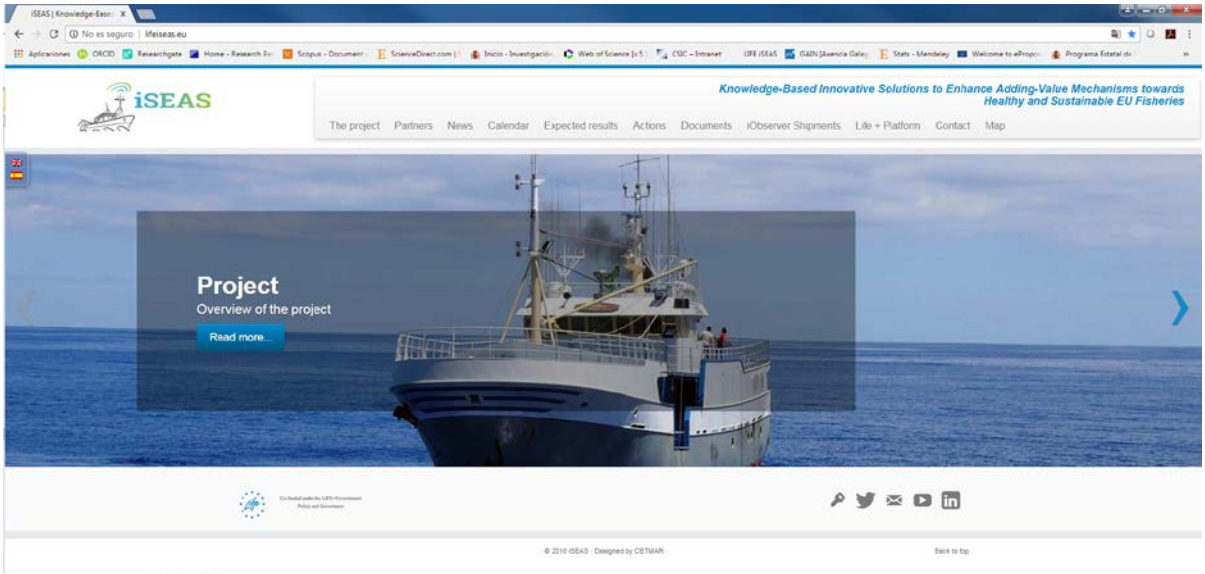


Figure 40. LIFE iSEAS Website

Task D1.3: Organization of events, workshops, seminars and conferences

- Activities/subtasks description

A programme of forums, conferences and seminars hosted by the project itself, were organised to promote the outcomes and achievements of the LIFE iSEAS to specific stakeholders (fishing companies, manufacturers, final users, public administrations, policymakers, etc.) and thus get their feedback.

Ten events were organised during the project lifetime:

SEMINARS:

#1: The first seminar was celebrated on 9th June 2016 in the facilities of The Environmental Hydraulics Institute "IH Cantabria" (Santander – Spain) under the title: "*Afrontando la importancia económica y social de la prohibición de los descartes pesqueros en el marco de una perspectiva integradora"*. The general objective of the seminar was to disseminate knowledge progress achieved through different research and innovation projects at EU level and stimulate debate about the social and economic consequences of the application of the discard ban. Thus, including the implications of the implementation of different technologies to eliminate discards and manage the unwanted catch biomass. This event was part also of Action E2 (Networking) since meetings and knowledge exchange with representatives of other European Projects (H2020 DiscarLess, H2020 Minouw, etc.) was carried out.

More than 60 representatives of different stakeholders of the fishing sector at a national and international level attended this seminar, with a very positive feedback and discussion obtained from them by the LIFE iSEAS partnership in order to improve the technical implementation of the project. Some pictures of the event can be seen in Figure 41.

Finally, a detailed information about this event (and all organized by the LIFE iSEAS team), including the detailed list of participants, can be found in the Annex of Deliverable D1.4 entitled *Deliverable_D1.4_Events_Organization_Annex_V_2018*

Figure 41. Some pictures of the first LIFE iSEAS seminar (Santander, June 2016)

The motivation and the program of this seminar can be checked in Figure 42.

Seminario proyecto iSEAS

iSEAS

AFRONTANDO LA IMPORTANCIA ECONÓMICA Y SOCIAL DE LA PROHIBICIÓN DE LOS DESCARTES PESQUEROS EN EL MARCO DE UNA PERSPECTIVA INTEGRADORA.

Proyecto iSEAS: El objetivo principal del proyecto LIFE iSEAS es demostrar que es factible un escenario sostenible en las pesquerías de la UE, en términos de indicadores biológicos y socioeconómicos. Este objetivo se podrá conseguir mejorando la puesta en práctica de los conocimientos existentes y las soluciones innovadoras para la reducción y gestión de los descartes pesqueros. http://lifeiseas.eu/

Objetivo del Seminario: Difundir el conocimiento adquirido en diferentes proyectos de investigación e innovación a nivel de la UE y fomentar el debate sobre las consecuencias socioeconómicas de la prohibición de los descartes pesqueros. Igualmente, se abordarán los resultados obtenidos a través de diferentes tecnologías para eliminar los descartes y gestionar la biomasa de las capturas no deseadas.

Proyectos implicados: iSEAS, H2020 DiscardLess, H2020 MINOUW, VADEAR y DESMAN.

Fecha: 09.06.16

Lugar de celebración:

Auditorio del Instituto de Hidráulica Ambiental de la Universidad de Cantabria

(IHCantabria)
C/ Isabel Torres nº 15
Parque Científico y Tecnológico de Cantabria, PCTCAN
39011 Santander – Cantabria - España

Inscripción: Asistencia gratuita por riguroso orden de inscripción vía web, indicando nombre e institución a la dirección:

http://www.cetmar.org/seminarios/iSEAS/

PROGRAMA

9.00 Recepción y acreditación de participantes.

9.30 Apertura y bienvenida.

9.45 Charla invitada - Mogens Schou (AquaMind) (videoconferencia). *"Equilibrio entre la implementación de la Política Pesquera Común (PPC) y la creación de valor en las industrias"*.

10.15 OBLIGACIÓN DE DESEMBARQUE DE CAPTURAS EN EL SECTOR PESQUERO. INICIATIVAS DIRIGIDAS A REDUCIR SU IMPACTO.

-Ricardo I. Pérez (IIM-CSIC). Presentación del Proyecto Life iSEAS.
-Erling Larsen (DTU). Presentación del proyecto DiscardLess.
-Francesc Maynou (ICM-CSIC). Presentación del proyecto MINOUW.

11.15 Pausa - Café

11.45 GESTIÓN A BORDO Y EN TIERRA DE LAS CAPTURAS NO DESEADAS. IMPLICACIONES TÉCNICAS Y ECONÓMICAS EN LA CADENA DE VALOR.

-Xabier Aboitiz (AZTI). *"Efecto potencial de la normativa de obligación de desembarque en las condiciones laborales de los barcos pesqueros"*. Proyecto DESMAN.
-Begoña Pérez-Villareal (AZTI). *"¿Podemos optimizar el uso de los descartes?"*. Proyecto DiscardLess.
-Debate.

12:45 PERCEPCIÓN SOCIAL DE LOS DESCARTES PESQUEROS, IMPORTANCIA PARA LA IMAGEN DEL SECTOR PESQUERO. INTERACCIÓN Y PARTICIPACIÓN DE LOS GRUPOS DE INTERÉS.

-Gonzalo Rodríguez (USC). *"Implicaciones económicas de la obligación de desembarque: desincentivar los descartes asegurando la actividad económica de las empresas pesqueras"*. Proyecto iSEAS.
-José María Bellido (IEO – Murcia). *"Valorización de la fracción legalmente comercializable del descarte producido por la pesca de arrastre en el mediterráneo occidental español"*. Proyecto VADEAR.
-Francesc Maynou. *"La percepción del problema de los descartes por parte del sector pesquero en el sur de Europa"*. Proyecto MINOUW.
-Debate.

14:05 CLAUSURA

Las ponencias del seminario contarán con traducción simultánea

Figure 42. LIFE iSEAS Seminar held in Santader in June 2016

All the presentations carried out can be found in the LIFE iSEAS webpage (http://lifeiseas.eu/archivos/?drawer=web*iSEAS_Seminar_Santander_09062016) and in the Youtube Channel (as shown in Figure 43).

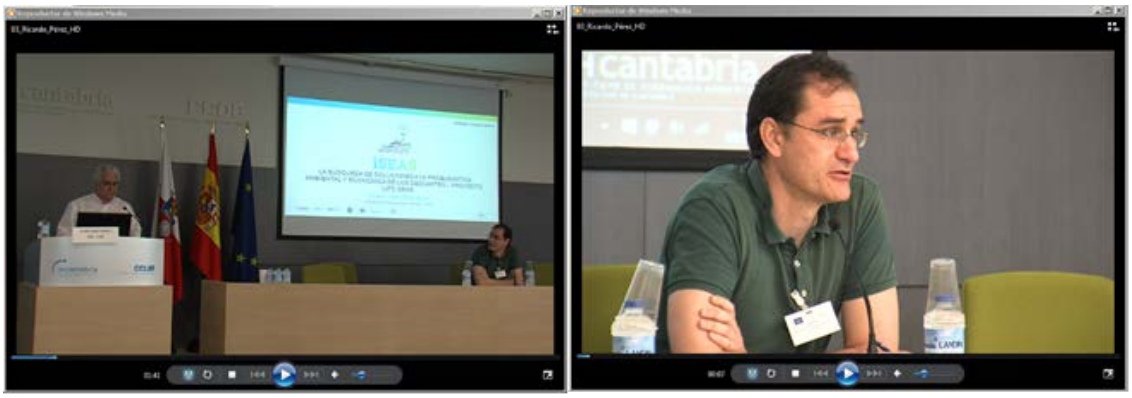


Figure 43. Frames of the videos of the first LIFE iSEAS seminar (Santander, June 2016) available at the Youtube Channel of the project

#2: On 20th June 2017, a second seminar was organized in the facilities of the Port of Marín: *"Jornada y sesión de demostración sobre nuevas vías de valorización de biomasa asociada a la obligación de desembarque: Presentación de la planta piloto para el procesado integral y la valorización de descartes"*. In this port is where the

LIFE iSEAS Integral Discards Processing an Valorization Plant (iDVP) is located. In addition to different presentations that deal with the discards issue and new ways to valorise them, attendees visited the iDVP1 plant pilot facilities (to produce human consumption food products from biomass to be landed due to the Landing Obligation and non-commercial species) and taste different dishes elaborated from this new restructured products elaborated in the iDVP1 (Figure 44).

Figure 44. Different dishes and elaborations based on restructured products obtained in the iDVP1

The motivation and the program of this seminar can be checked in Figure 45.

Proyecto iSEAS

iSEAS

JORNADA Y SESIÓN DE DEMOSTRACIÓN SOBRE NUEVAS VÍAS DE VALORIZACIÓN DE BIOMASA ASOCIADA A LA OBLIGACIÓN DE DESEMBARQUE: PRESENTACIÓN DE LA PLANTA PILOTO PARA EL PROCESADO INTEGRAL Y LA VALORIZACIÓN DE DESCARTES.

Proyecto iSEAS: El objetivo principal del proyecto LIFE iSEAS es demostrar que es factible un escenario sostenible en las pesquerías de la UE, en términos de indicadores biológicos y socioeconómicos. Este objetivo podrá conseguirse mejorando la puesta en práctica de los conocimientos existentes y las soluciones innovadoras para la reducción y gestión de los descartes pesqueros. http://lifeiseas.eu/

Objetivo de la Jornada:

- Presentación de los principales objetivos y resultados esperados del proyecto Life iSEAS en el ámbito de la valorización de descartes;
- Visita a la *Planta Piloto para el Procesado Integral y la Valorización de Descartes*, destinada a la elaboración de productos para el consumo humano a partir de especies que están siendo actualmente descartadas de manera parcial o total

Fecha: 20.06.17

Lugar de celebración:

Edificio de Operaciones Portuarias
Autoridad Portuaria de Marín
Puerto Pesquero de Marín

Organización de Productores de Pesca Fresca del Puerto y Ría de Marín (OPROMAR).
Prto. Pesquero, Edificio Anexo Lonja,
36900 Marín - PONTEVEDRA

Inscripción: Asistencia gratuita por riguroso orden de inscripción vía web, indicando nombre e institución a la dirección:

http://www.cetmar.org/seminarios/iSEAS2017/

PROGRAMA

10.00 Recepción y acreditación de participantes.

10.30 Apertura y bienvenida.

-D. José Benito Suárez Costa, Presidente de La Autoridad Portuaria de Marín y Ría de Pontevedra.

- Dª. Paloma Rueda Crespo, Directora Gerente del Centro Tecnológico del Mar – Fundación CETMAR.

10.45 Nuevas vías de valorización de la biomasa asociada a la obligación de desembarque.

-Juan Carlos Martín Fragueiro (Director Gerente, OPROMAR): Problemática de la gestión asociada a la nueva PPC

-Ricardo Pérez Martín (Profesor de Investigación, IIM-CSIC). Posibilidades de aprovechamiento y valorización de descartes pesqueros: proyecto LIFE iSEAS.

11.45 Desplazamiento a la planta piloto

12:00 Visita a la Planta Piloto de Valorización de Descartes y demostración de los procesos que se realizan en ella.

13.00 Vino español: Degustación de productos elaborados a partir de descartes procesados en la planta piloto.

Figure 45. LIFE iSEAS Seminar to present the iDVP1 held in Marín in June 2017

More than 40 representatives, mainly from fleets, ship-owners associations and valorisation companies attended the seminar, showing their great interest on the solution presented to add value from nowadays discarded or low/non-commercial species to

obtain a very good product to be used directly for cooking or as a base for frozen or refrigerated products like nuggets, burgers or sausages.

Some pictures of the seminar development can be found in Figure 46.

Figure 46. Some pictures of the second LIFE iSEAS seminar (Marín, June 2017)

Once again, all the presentations carried out are available to the general public the LIFE iSEAS webpage:

http://lifeiseas.eu/archivos/?drawer=web*iSEAS_Conference_Port_of_Mar%C3%ADn_20062017

#3: A third seminar entitled "*Herramientas innovadoras para la gestión y reducción de Descartes pesqueros"* was carried out in the CESGA headquarters in Santiago de Compostela on 08th February 2018 to present innovative tools to manage and reduce fishing discards. The LIFE iSEAS Red Box software to obtain full georeferenced catch info and the LIFE iSEAS marine SDI and geoportal as tools to manage discards data and to optimize and properly manage the fishing activities and the marine resources were presented. A practical demonstration of these innovative technologies was carried out.

The motivation and the program of this third seminar can be checked in Figure 47.

35 representatives, mainly from fleets, ship-owners associations and technologic companies attended the seminar, showing their great interest on the solutions presented to obtain fully documented fishing activity and tools to properly manage the fishing activity almost in real time, minimizing discards while trying to maximize their revenues and to ensure the future sustainability of the sector.

Some pictures of the seminar development can be found in Figure 48.

Proyecto iSEAS

iSEAS

HERRAMIENTAS INNOVADORAS PARA LA GESTIÓN Y REDUCCIÓN DE DESCARTES PESQUEROS

Proyecto iSEAS: El objetivo principal del proyecto LIFE iSEAS es demostrar que, en términos de indicadores biológicos y socioeconómicos, es posible un escenario sostenible en las pesquerías de la UE. Este objetivo podrá conseguirse mejorando la implantación de los conocimientos existentes y las soluciones innovadoras para la reducción y gestión de los descartes pesqueros. http://lifeiseas.eu/

Objetivo de la Jornada:

- Presentación de la herramienta RED-BOX para la obtención a bordo de datos espacio-temporales sobre descartes en las áreas pesqueras de interés.
- Presentación del Geoportal de gestión de datos de descartes para la optimización de la actividad pesquera y la gestión de los recursos marinos.

Fecha: 08.02.18

Lugar de celebración:

Centro Tecnolóxico de Supercomputación de Galicia (CESGA)
Avenida de Vigo, s/n -Campus Sur-
15705 Santiago de Compostela
https://goo.gl/maps/wqN6DQ5EueH2

Inscripción: Asistencia gratuita por riguroso orden de inscripción vía web, indicando nombre e institución en el siguiente enlace:

http://www.cetmar.org/seminarios/iSEAS2018/

PROGRAMA

09.45 Recepción y acreditación de participantes.

10.15 Apertura y bienvenida.
- *CESGA*

10.30 Obligación de desembarque de capturas en el sector pesquero. Gestión de capturas no deseadas: Proyecto LIFE iSEAS.
-Ricardo Pérez Martín (IIM-CSIC)

11.00 Presentación de la herramienta Red Box para captura de datos a bordo
-Francisco Landeira Vega; Juan Carlos Ovalle Macías (CESGA)

11.30 Pausa café

12.00 Presentación del Geoportal de gestión de descartes: Infraestructura Espacial de Datos y modelado para reducir/evitar capturas no deseadas
-Francisco Landeira Vega; Juan Carlos Ovalle Macías (CESGA)

12.30 Mesa redonda

13.00 Fin de la jornada

Figure 47. LIFE iSEAS Seminar to present the RedBox and the Marine SDI held in Santiago in February 2018

Figure 48. Some pictures of the third LIFE iSEAS seminar (Santiago, February 2018)

As in the case of previously organized seminars, all the presentations developed during this event are available to the general public the LIFE iSEAS webpage:

http://lifeiseas.eu/archivos/?drawer=web*iSEAS_Conference_CESGA_08022018

#4: The iObserver system was presented in the context of the fourth seminar entitled: "*Tecnologías innovadoras para la gestión de descartes pesqueros a bordo: Sistema iobserver*". It was held in the CETMAR headquarters in Vigo on 05th April 2018. Innovative technologies to deal fishing discards on board was the main theme of this event, which also included a detailed presentation of the electronic observed developed in the framework of Action B1 of LIFE iSEAS (the iObserver), including its performance and main features during a practical demonstration session.

The motivation and the program of this fourth seminar can be checked in Figure 49.

Figure 49. LIFE iSEAS Seminar to present the iObserver held in Vigo in April 2018

This seminar arouses a great interest among different fishing sector stakeholders and administrations, resulting in that he registration to this seminar was closed several days before the deadline due to the high participation demand and the limitations on the space to carry out a proper and interesting demonstration of the iObserver where all participants could follow it (as shown in Figure 50). Finally, 50 participants attended this event.

Some pictures of the seminar development can be found in Figure 50.

Figure 50. Pictures of the iObserver presentation seminar (Vigo, April 2018)

The presentations developed during this event are available to the general public in the LIFE iSEAS webpage:

http://lifeiseas.eu/archivos/?drawer=web*iSEAS_Conference_CETMAR_05042018

#5: Finally, a seminar and a demonstration session were coupled in the Integral Discards Processing and Valorization Plant (iDVP3) located in the Port of Marín on 01st June 2018. It was titled: *"Jornada y sesión de demostración sobre nuevas vías de valorización de biomasa asociada a la obligación de desembarque: Presentación de la planta piloto para el procesado integral y la valorización de descartes no destinados a consumo humano"*. This event consisted of a presentation and a subsequent demonstration about the new ways of biomass valorization associated with the compliance of the Landing Obligation by the fleets (that will suppose the landing and management of important amounts of fish previously discarded). This seminar put the light on the alternatives implemented in the iDVP3 to add value/valorize this new fraction of biomass under legal minimum size that cannot be destined for direct human consumption.

As for the case of the LIFE iSEAS second seminar of the iDVP1, more than 50 representatives, mainly from fleets, ship-owners associations and valorisation companies attended the seminar, showing their great interest on the solutions presented and implemented in the iDVP3 to add value from individuals under legal minimum size (and/or from by-products from the iDVP1), that for legal reasons, must be retained on board, counted against quota, landed and managed/used for non-direct human consumption purposes.

The motivation and the program of this final LIFE iSEAS seminar can be checked in Figure 51.

Proyecto iSEAS

iSEAS

JORNADA Y SESIÓN DE DEMOSTRACIÓN SOBRE NUEVAS VÍAS DE VALORIZACIÓN DE BIOMASA ASOCIADA A LA OBLIGACIÓN DE DESEMBARQUE: PRESENTACIÓN DE LA PLANTA PILOTO PARA EL PROCESADO INTEGRAL Y LA VALORIZACIÓN DE DESCARTES NO DESTINADOS A CONSUMO HUMANO.

Proyecto iSEAS: El objetivo principal del proyecto LIFE iSEAS es demostrar que, en términos de indicadores biológicos y socioeconómicos, es posible un escenario sostenible en las pesquerías de la UE. Este objetivo podrá conseguirse mejorando la implantación de los conocimientos existentes y las soluciones innovadoras para la reducción y gestión de los descartes pesqueros. http://lifeiseas.eu/

Objetivo de la Jornada:

- Presentación de los principales objetivos y resultados esperados del proyecto Life iSEAS en el ámbito de la valorización de descartes;
- Visita a la *Planta Piloto para el Procesado Integral y la Valorización de Descartes*, destinada a la elaboración de compuestos no destinados a consumo humano: hidrolizados de proteínas de pescado, colágeno, cartílago, etc...

Fecha: 01.06.18

Lugar de celebración:

Edificio de Operaciones Portuarias
Autoridad Portuaria de Marín
Puerto Pesquero de Marín

Organización de Productores de Pesca Fresca del Puerto y Ría de Marín (OPROMAR).
Prto. Pesquero, Edificio Anexo Lonja,
36900 Marín – PONTEVEDRA

Inscripción: Aforo limitado. Asistencia gratuita por riguroso orden de inscripción vía web, indicando nombre e institución a la dirección:

http://www.cetmar.org/seminarios/iSEAS Marin/

PROGRAMA

10.00 Recepción y acreditación de participantes.

10.30 Apertura y bienvenida.

-D. José Benito Suárez Costa, Presidente de La Autoridad Portuaria de Marín y Ría de Pontevedra.

-D. Juan Carlos Martín Fragueiro, Director Gerente de OPROMAR.

- Dª. Paloma Rueda Crespo, Directora Gerente del Centro Tecnológico del Mar – Fundación CETMAR.

10.45 Posibilidades de aprovechamiento y valorización de descartes pesqueros. Planta piloto para valorizar la biomasa asociada a la nueva obligación de desembarque: proyecto LIFE iSEAS.

-Ricardo I. Pérez Martín (Profesor de Investigación, IIM-CSIC)

11.00 Producción de compuestos (peptonas, hidrolizados de proteína de pescado, cartílago...) a partir de biomasa descartada.

- Xosé Antón Vázquez Álvarez (Científico Titular, IIM-CSIC)

11.45 Coffee - break

12:15 Visita a la Planta Piloto de Valorización de Descartes y demostración de los procesos que se realizan en ella.

Figure 51. LIFE iSEAS Seminar to present the iDVP3 held in Marín in June 2018

Some pictures of the seminar development can be found in Figure 52.

Figure 52. Pictures of the iDVP3 seminar (Marín, June 2018)

The presentations developed during this event are available to the general public in the LIFE iSEAS webpage:

http://lifeiseas.eu/archivos/?drawer=web*ISEAS_Conference_Port_of_Mar%C3%ADn_01062018

As previously mentioned, more information about the organization, presentations and participants in these t events are included in the Annex *Deliverable_D1.4_Events_Organization_Annex_V_2018* of Deliverable D1.4.

WORKSHOPS:

#1: A workshop *"Initiative for a science-policy dialogue with European Fisheries Control Agency (EFCA) about recent research activities on discards"*, was held on 2nd February 2017 organised in collaboration with the European Fisheries Control Agency (EFCA) and COLUMBUS project (**http://www.columbusproject.eu/**). The aim of this workshop was to present recent progress achieved by different European research projects (LIFE iSEAS, Discardless and MINOUW) and to use this opportunity to know EFCA activities for supporting the implementation of the Landing Obligation as well as to reinforce science-policy dialogue with regard to fishing discards and the CFP compliance. This workshop is also considered as a networking activity in the framework of Action E2.

The agenda of this workshop can be checked in Figure 53.


COLUMBUS - LIFE-ISEAS initiative for a science-policy dialogue with European Fisheries Control Agency (EFCA) about recent research activities on discards.

AGENDA

9.30 Welcome words and revision of meeting objectives and agenda.

9.40 Introductory presentation:

"EFCA activities for supporting the implementation of the Landing Obligation"

10.10 **The problem of fishing discards.**

Presentation and discussion topics
- Motivations and causes
- Discard Practices
- Discard data: state of play and needs

(A maximum of 30' for 3 presentations, 20' for extra inputs, 30' for open discussion)

11.30 Coffee break

12.00 **How to reduce / avoid discards** (I)

Presentation and discussion topics
- Technical measures and selective fishing strategies
- Other technologies for selectivity and for automatic reporting of total catch composition
  - GIS platforms & modelling
  - Molecular tools
  - CCTV and other REM
- Cost-benefit pay-back estimations on technological alternatives

13.00 Lunch break

14.00 **How to reduce / avoid discards** (II)

(A maximum of 40' for 3 presentations, 20' for extra inputs and 60' for discussion)

15.00 **Management, handling and use of the unwanted catch**

Presentation and discussion topics
- Facilities and infrastructures
- On-board retrofitting
- Quality/safety issues

- *(A maximum of 30' for 3 presentations, 20' for extra inputs and 30' for discussion)*
- 16.30 Coffee break
- 17.00 Wrap-up session and way forward
- 17.30 End of the meeting.

Figure 53. LIFE iSEAS Workshop with EFCA and other research projects held in Vigo (February 2017)

At the end, 24 representatives from EFCA, LIFE iSEAS, Minouw and Discarless partners attended this event. Some pictures of this event are presented in Figure 54.

Figure 54. Pictures of the workshop at EFCA headquarters (Vigo, April 2018)

Presentations carried out in the framework of this workshop are available on the Intranet (Private access to the partners) of the LIFE iSEAS website.

#2: A second workshop was carried out by IEO partners in San Pedro del Pinatar (Murcia) from 16th to 20th October 2017 in collaboration with the European research project ATLAS (*A Trans-Atlantic assessment and deep-water ecosystem-based spatial management plan for Europe*). This event was mainly focus on spatio-temporal fisheries modelling. A photo of this workshop and its participants can be shown in Figure 55.

Figure 55. Participants in the modelling workshop LIFE iSEAS - ATLAS (San Pedro del Pinatar, October 2017)

COURSES:

Two courses took place during the project lifetime. Both were focused on the iObserver system and the target audience were the crew of oceanographic and commercial vessels responsible on the functioning/maintaining of the iObserver installed on-board this selected vessels:

#1: *iObserver: Fundamentals, installation and operation*. It was held in the IIM-CSIC on 13th December 2016 and it was organised by IIM-CSIC.

#2: *Course about about the iObserver use: C++, Matlab and physic versions*. It was held in the IIM-CSIC on 13th July 2017 and it was organised by IIM-CSIC and IEO partners.

CONGRESS/LIFE iSEAS FINAL CONFERENCE:

The "*International Conference on Advances in Marine Technologies Applied to Discard Mitigation and Management*" - MARTEC18 (https://www.martec2018.com/) was organised by LIFE iSEAS partners and it was held between 02 and 04 May 2018 in the Sede Afundación Auditorium in Vigo. Its corporative image was defined as shown in Figure 56.

Figure 56. MARTEC18 Logo

This event focused in the R+D+i oriented to global societal needs, looking for innovative solutions to meet the requirements to comply with the new legal framework of the fishing sector related to the Landing Obligation of nowadays discarded species while ensuring the sustainability of marine resources and the long term viability of the fishing activity as well. Therefore, the meeting was opened to commercial interests, government agencies and academic expertise.

The congress was very successful and it was attended by approximately 100 experts, including prestigious invited speakers, who made more than 40 oral presentations and presented more than 30 posters divided in five main topics (*Advances on-board; Data management and processing; Solutions in land; Environmental and socio-economic implications of the Landing Obligation and; The future of the fishing sector*).

Day 3 of the MARTEC18 Conference (May, 4th) was developed as an open discussion forum about the future of the fishing sector under the full compliance scenario of the Landing Obligation. More than 120 attendees (an exclusive registration procedure was opened to give the possibility to the stakeholders to only attend this day without any cost) from the fishing sector (ship-owners associations, fishing brotherhoods, processing and valorizing industries, regional and national administrations, etc.) had a very fruitful debate and exchange of opinions and feedback with the invited representatives from DG Mare, Spanish Fisheries Ministry, FAO, OPROMAR and LIFE iSEAS coordinator (IIM-CSIC).

The complete programme of MARTEC18 together with the Book of Abstracts can be downloaded from the MARTEC18 website: https://www.martec2018.com/

Some pictures of this event can be shown in Figure 57.

Figure 57. Pictures of the MARTEC18 Conference (Vigo, May 2018)

Additionally to the Scientific Programme, the attendees also enjoyed of Vigo of a complete social programme to boost possible networking actions and knowledge sharing that included a Reception that Concello de Vigo (Vigo Town Hall) offered to MARTEC18 participants in Pazo Quiñones de León, a visit to to the Vigo Fish Auction and a Gala Dinner that took place in the Pazo Los Escudos de Vigo (Figure 58).

Figure 58. Pictures of the MARTEC18 Social Events

Finally, it must be mentioned that all the presentations carried out were distributed among all the conference participants and they can be also found as an Annex to this LIFE iSEAS Final Report as **Annex 13**

- Outputs: Comparative with planned outputs

Complete results were achieved and overcame with those presented in the LIFE iSEAS proposal since at least 6 events were proposed and finally LIFE iSEAS partners carried out 10. None issues were found.

- List of associated deliverables

Scheduled Deliverables (D1.1 to D1.3) were produced as proposed, including an extra Deliverable (D1.4) to communicate the EC the dissemination actions' results along the last year of the project together with a complete summary of all the tasks carried out in the Framework of Action D1 along the projects' life.

The Milestone D1.1 8LIFE iSEAS web page) and D1.2 (LIFE iSEAS Final Conference) was achieved on due time.

Task D1.4: Publications in mass media and technical forums

- Activities/subtasks description

MASS MEDIA: From July 2014, 15 scientific papers and 2 book chapters were produced using the developments and results generated by LIFE iSEAS, 7 of them in the last year. 12 papers are already published, 2 are accepted and 3 are still submitted and under review. Some examples are shown in Figure 59.

Figure 59. LIFE iSEAS scientific articles examples

It must be highlighted the effort of LIFE iSEAS partners in publishing many of these articles in ***Open Access***, in order to maximize its diffusion among the scientific community.

Moreover, one of the outcomes of the MARTEC18 Conference is to produce a Special Issue titled: *"Advances in marine technologies applied to discard mitigation and management"*. LIFE iSEAS partners have been contacting with several journals and, finally, the prestigious journal Marine Policy (Impact Factor: 2.495) has accepted to publish that Special Issue. It will be a no open call, as it is restricted to participants to MARTEC18 Conference, including 5 papers from LIFE iSEAS partners to present the main results of the project. This means the process is restricted to 8 weeks for submission of contributions. The call for submission will be opened on September 2nd and finishes October 27th. LIFE iSEAS partners expect that this Special Issue will be published mid-2019, as part of the After-LIFE+ Plan.

Permanent contact with mass media (television, radio and newspapers) was developed during whole project, especially in case of iObserver development and testing on board, LIFE iSEAS seminars and workshops, results presentation and, specially, the high impact that MARTEC18 conference has have at a regional and national level.

Mass media references to LIFE iSEAS includes 82 articles in various newspapers and news websites, 38 from July 2017 until the end of the project, the period with a more intense diffusion of LIFE iSEAS results. In addition, 10 radio and television documentaries and interviews were broadcasted, 8 in the last year of the project.

Some representative examples to this dissemination material are presented in Figure 60 (complete information is available in Deliverable D1.4 – **Annexes:**
Deliverable_D1.4_Documentaries_Annex_V_2018;
Deliverable_D1.4_Interviews_Annex_V_2018;
Deliverable_D1.4_Press-Release_Annex_V_2018):


17/07/2014 - El CSIC elige Marín como base para un estudio europeo sobre descartes de pesca (online) – FARO DE VIGO

FARO DE VIGO

El CSIC elige Marín como base para un estudio europeo sobre descartes de pesca


17/07/2014 – Galicia abandera un proyecto pionero en descartes de pesca (digital copy) – EL CORREO GALLEGO

16 GALICIA

Galicia abandera un proyecto pionero en descartes de pesca

Armadores de Marín crearán dos plantas de procesado para dar valor a las capturas no comerciales, dentro de *Life iSeas*

11/11/2014 - Hacia una pesca sin descartes (digital copy). – **LA VERDAD**

LA VERDAD

NUESTRA TIERRA

La pesca afina la puntería

Hacia una pesca sin descartes

19/05/2016 – Tres buques de Marín serán equipados con un nuevo sistema para monitorizar descartes – **FARO DE VIGO**

http://www.farodevigo.es/mar/2016/05/19/tres-buques-marin-seran-equipados/1463349.html

FARO DE VIGO

MAR · 37

Pesca sostenible

Tres buques de Marín serán equipados con un nuevo sistema para monitorizar descartes

El "iObserver" cuenta con cámaras para identificar y cuantificar estos desechos pesqueros ▶ Forma parte de un proyecto liderado por el CSIC ▶ Los barcos son arrastreros, uno de ellos de aguas lusas

LAS CLAVES DEL PROYECTO

22/05/2016 – El veto a los descartes puede llevar a que si antes faenabas 12 meses, ahora faenes seis - **LA OPINIÓN – A CORUÑA**

http://www.laopinioncoruna.es/mar/2016/05/22/veto-descartes-llevar-faenabas-12/1071995.html

48 | La Opinión | mar

Ricardo Pérez | Investigador del Consejo Superior de Investigaciones Científicas

"El veto a los descartes puede llevar a que si antes faenabas 12 meses, ahora faenes seis"

"Es muy difícil ir contra la obligación de desembarques y modificar el criterio de estabilidad relativa, pero debería ser España y no Galicia la que lidere ese esfuerzo"

21/06/2017 – Opromar se erige como pionera en el aprovechamiento de los descartes. La planta ubicada en el Puerto permitirá comercializar lo que se desecha de las capturas – **DIARIO DE PONTEVEDRA**

DIARIO DE PONTEVEDRA | miércoles, 21 de junio de 2017

Opromar se erige como pionera en el aprovechamiento de los descartes

▶ La planta ubicada en el Puerto permitirá comercializar lo que se desecha de las capturas

Productos

Una planta, tres áreas diferentes

Figure 60. LIFE iSEAS press releases selection

Finally, it must be mentioned that the LIFE iSEAS project was contacted by the Communication Team (within the NEEMO consortium) working on behalf of the European Commission's LIFE Programme to carry out an article (See Figure 61) about the project to be published in the joint publication of the Life Unit and DG Environment's Marine Unit, called *LIFE & the Marine Environment*.

This publication can be downloaded at:

http://ec.europa.eu/environment/life/publications/lifepublications/index.htm

PROJECT FEATURE

Using real-time data to cut fishing discards

A LIFE project in Spain developed ways to map in real time fishing areas with higher levels of discards. Its methods could help make fishing more sustainable, avoid overfishing and reduce waste.

"Discards can be reduced substantially using our tools and fishing activity made more sustainable and profitable."

"Before 2015 fishermen were allowed to discard some species caught accidentally – those below the minimum legal size, without quota, of no commercial interest or in need of conservation," says Luis Taboada Antelo, Technical Coordinator at the Spanish National Research Council's Marine Research Institute (IIM-CSIC) in Vigo. "Generally they were dumped overboard."

A measure in the common fisheries policy is putting a stop to this – the 'landing obligation', being phased in between 2015 and 2019. "It means that all specimens of species subject to TAC [total allowable catch] and quotas must be kept on board and brought to shore, where they're counted against their quotas or, once these are used up, against the quotas for other species," he explains. "It's a big problem for fishing fleets because they have to manage and keep a lot of new biomass on board, and it's a risk for their sustainability and future viability."

Discards can make up a large proportion of fishing hauls, especially in bottom trawling where they can reach as much as 90%. "With LIFE iSEAS, we're trying to obtain data from fishing vessels in real time to determine where there are higher rates of discards or juveniles present," says IIM-CSIC's Ricardo Pérez-Martín, who is coordinating the project. "Then fishing vessels can use the data to avoid those areas."

Precision fishing

The project used LIFE funding to develop a prototype that can identify and quantify all fish caught, turning the information into maps that clearly show which areas are better for fishing and which are less suitable.

The process starts with the iObserver. "It's a small box with a camera and computer inside, fixed above the conveyor belt where fishermen sort the catch on the fishing boat," explains Dr Antelo. The camera photographs the fish as they pass by, while the computer processes the images in real time – identifying the species and estimating the weight – and quantifies the haul.

"We can identify 20 fish species at the moment, with 80–85% accuracy." And fishermen can easily train the iObserver to recognise other species. "This makes it more transferable. We think our technology can be used by any fishing fleet anywhere in Europe and around the world." The team have some ideas for improvements after the project ends, such as "introducing a vibrating device to the conveyor belt or different speeds to help separate the fish, improving the iObserver's accuracy."

The RedBox software developed by LIFE iSEAS processes the iObserver data and information about the vessel's location, speed and the fishing depth. This is sent (via satellite or mobile device) to a geoportal in Galicia where it can be used to create individual maps for the 20 species. The maps are colour-coded to show where discards are low, medium or high, where fish are having problems reproducing, or areas with lots of juveniles present – all useful information for fishing fleets.

"Discards can be reduced substantially using our tools and fishing activity made more sustainable and profitable," reckons Dr Pérez-Martín. "In some cases, we could reduce discards by 50% or more," he says. The information gathered can also be used to help manage fish stocks and populations better, to reach their maximum sustainable yield. "If the data show that lots of juveniles or individual fish smaller than the legal catch size are appearing in a certain area, the authorities could decide to stop people fishing there. If you're catching these, you're risking the sustainability of the stock."

This LIFE project shows that technology can reduce overfishing: "Direct people more precisely where to fish and the fishing itself will be more sustainable," says Dr Antelo. "We think the ideas of LIFE iSEAS could help define a strategy to ensure the sustainability of both the fish themselves and the fishing sector in Galicia – and the results could be transferable to other areas as well."

Making the most of discards

Fish brought to shore in Galicia that aren't sold at auction are generally sent for processing into fish oil and fish meal. "But these producers only pay a few cents per kg," says Dr Pérez-Martín. LIFE iSEAS developed some new ways of using the biomass at a pilot plant in Marín.

Prototypes convert commercial fish species into mince, separating the flesh from the other parts. "This is pressed into large slabs which are frozen and can be used to make restructured food products like fish fingers, burgers and nuggets." He sees a potential market for this mince locally: "There's a broker in Barcelona who buys these blocks from China!"

The leftover parts and fish under the minimum legal size (which can't be used for direct human consumption) are converted into other products, such as collagen, gelatine, mineral supplements, nutraceuticals, peptones and fish hydrolysates. "We sent these products to several companies in Europe that might be interested and we've had a good response about their quality," adds Dr Antelo. The marine research institute is also trying to develop regeneration materials for teeth using hydroxyapatite from fish bones.

Adding value to discards is "a way for ship owners to cut the costs of complying with the landing obligation," says Dr Pérez-Martín. He sees an opportunity for local owners to club together and invest in similar processing equipment, perhaps with support from the regional government. "From our data, the level of discards is high enough to have a plant in each major port where fish are landed in Galicia."

LIFE13 ENV/ES/000131
Title: LIFE iSEAS
Beneficiary: Agencia Estatal Consejo Superior de Investigaciones Científicas
Contact: Ricardo Pérez-Martín
Email: ricardo@iim.csic.es
Website: http://lifeiseas.eu/

Figure 61. LIFE iSEAS article in the LIFE & the Marine Environment publication of the LIFE+ Programme

***TECHNICAL FORUMS*:** In order to accomplish with the LIFE iSEAS dissemination to a regional, national, European and international level, the participation on international conferences and international fairs of products from the sea was scheduled. LIFE iSEAS partners presented project main outcomes in **33 international technical forums (congresses, conferences, workshops, trade fairs, etc.). 27 posters and 32 oral presentations were elaborated and carried out, 26 of them during the last year of the project**. It must be also highlighted the high number of invited participations on relevant events and conferences on the topics of the LIFE iSEAS project, showing the high interest that the technical development and solutions proposed during the project has had both among different stakeholders of the fishing sector as well as among administrations and policy makers. A summary of the events in that LIFE iSEAS partners have participated is presented next:

- The ***44th WEFTA Meeting 2014*** held in Bilbao (Spain) from June, 28th until July, 1st 2014 → ORAL PRESENTATION.
- The ***International Meeting on Marine Research Conference*** 2014 held in Peniche (Portugal) from July, 10th until July, 11st 2014 → POSTER.
- The ***Total Food 2014*** held in Norwich (UK) from November 11th until 13th 2014 → POSTER.
- The ***Sinaval-Eurofishing*** held in Bilbao (Spain) from 21st until 23rd April 2015. A specific networking activity was developed (more information in Action E2) → INVITED ORAL PRESENTATION. (Figure 62).
- The event "*Jornada sobre la aplicación práctica de la política de descartes*" organized by OPROMAR. In this event, held on the Marín Port Authority

facilities on April, 23th 2015, some of the main representatives of regional, national and European administrations regarding fisheries met together with the fishing sector and scientists to discuss the better alternatives in which the new CFP can be applied at a real scale → INVITED ORAL PRESENTATION.

Figure 62. Participation of LIFE iSEAS Coordinator (Mr. Ricardo Pérez Martín) in the Sinaval – Eurofishing event.

- The ***ICEF12 Conference*** held in Quebec (Canada) on June, 14th to 18th 2015 → POSTER. (Figure 63)

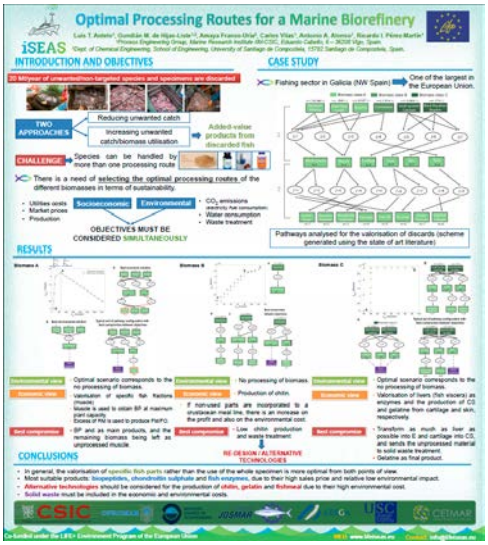


Figure 63. Poster presented in the ICEF 12 Conference (Quebec, Canada)

- The ***CONXEMAR fair*** held in Vigo (Spain) from 5th – 7th October, 2015 → INVITED ORAL PRESENTATION. (Figure 64)

Figure 64. Presentation of LIFE iSEAS Project during CONXEMAS 2015 fair

- Participation in the "***IV Congreso de Calidad de los Productos Pesqueros***" in Madrid (Spain) on July, 09th 2015 → INVITED ORAL PRESENTATION.
- The ***Atlantic geospatial day*** held in Vigo (Spain) on April, 20th 2016 → POSTER (Figure 65)

Figure 65. Presentation of LIFE iSEAS Project main advances on Action B2 during the *Atlantic geospatial day* (2016)

- Participation in the Scientific seminars focusing in the research of the IIM-CSIC, on May, 20th 2016 (Vigo) → INVITED ORAL PRESENTATION. (Figure 66)

Figure 66. Presentation of LIFE iSEAS Project main advances (2016)

- The ***7th World Fisheries Congress*** in Busan (Korea) on May, 23rd to 27th 2016 → ORAL PRESENTATION.
- The ***International Symposium on Oceanography of the Bay of Biscay (ISOBAY XV)*** held in Bilbao (Spain) from 22nd until 24th June 2016 → POSTER
- The ***V Simposio Internacional de Ciencias del Mar*** held in Alicante (Spain) from 20th until 22nd June 2016 → ORAL PRESENTATION.
- The ***Fisheries Economics and Trade 2016 (IIFET 2016)*** held in Aberdeen (Scotland) 11st-15th July 2016 → ORAL PRESENTATION & POSTER.
- The ***XIX Iberian Symposium on Marine Biology Studies (SIEBM)*** held in Porto (Portugal) from 5th until 9th September 2016 → 2 POSTERS. (Figure 67)

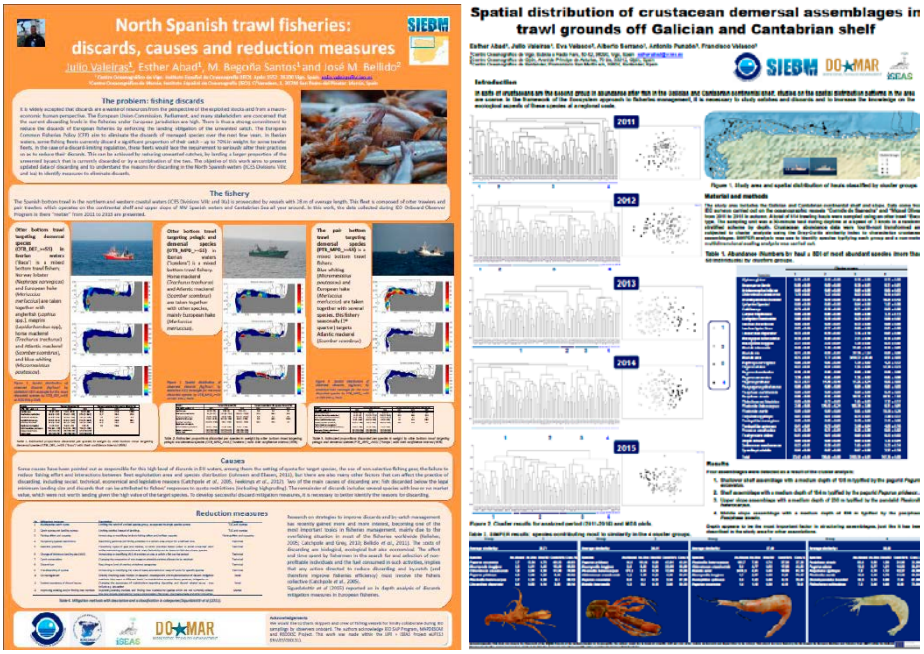


Figure 67. Posters presented in the SIEBM 2016

- The event "***Sustainable Fisheries in the South-Western Indian Ocean: the importance of the Education, Management and Governance"*** held in Quelimame (Mozambique) 8th-9th September 2016 → POSTER
- The ***ICES Annual Science Conference 2016*** held in Riga (Latvia) from 19th until 23th September 2016 → POSTER
- The ***CONXEMAR fair*** held in Vigo (Spain) from 3th – 5th October, 2016 → LIFE iSEAS video presentation and leaflets distributions. (Figure 68)

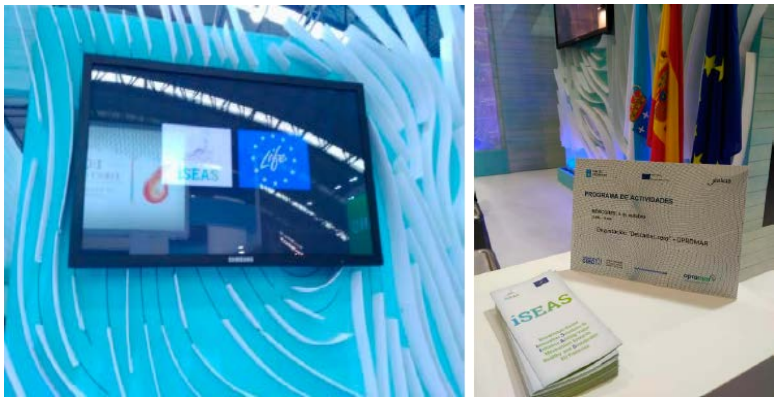


Figure 68. Diffusion material presented and distributed during CONXEMAR 2016

- The event ***"II Jornada sobre la aplicación de la obligación de desembarque – Selectividad de artes y aprovechamiento de descartes"*** held in Vigo (Spain) on December 20th, 2016 → INVITED ORAL PRESENTATION.
- The ***European Association of Fisheries Economics 2017*** held in Dublin (Ireland) from 24th until 27th April 2017 → POSTER.
- The workshop ***Sustainable Fisheries Partnership European Forum 2017*** held in Vigo (Spain) on May 22nd, 2017 → INVITED ORAL PRESENTATION. (Figure 69 - Left)

Figure 69. Presentation of LIFE iSEAS Project main advances during the *Sustainable Fisheries Partnership European Forum 2017* and *EXPOMAR 2017*

- The ***EXPOMAR 2017*** event and fair held in Burela (Spain) from 25th until 28th May 2017 → 2 INVITED ORAL PRESENTATIONS. (Figure 69 - Right)
- The ***INSPIRE Conference 2017*** held in Strasbourg (France) from 6th until 8th September 2017 → ORAL PRESENTATION. Presentations available in video at: http://inspire.ec.europa.eu/conference2017/psessions (Figure 70)

Figure 70. Presentation of LIFE iSEAS Project main advances on Actions B2 & B3 during the *INSPIRE Conference 2017*

- The ***World Seafood Congress 2017*** held in Reykjavik (Iceland) from 6th until 8th September 2017 → ORAL PRESENTATION & POSTER. (Figure 71)

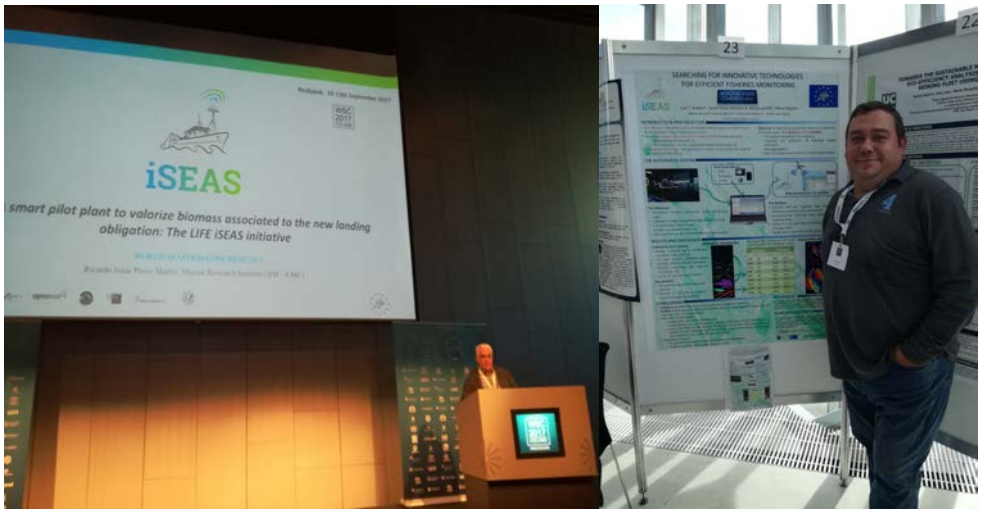


Figure 71. Presentation of LIFE iSEAS Project main advances on Actions B1 & B4 during the *World Seafood Congress 2017*

- The ***ICES Annual Science Conference 2017*** held in Fort Lauderdale (USA) from 18th until 21th September 2017 → ORAL PRESENTATION & POSTER. (Figure 72)

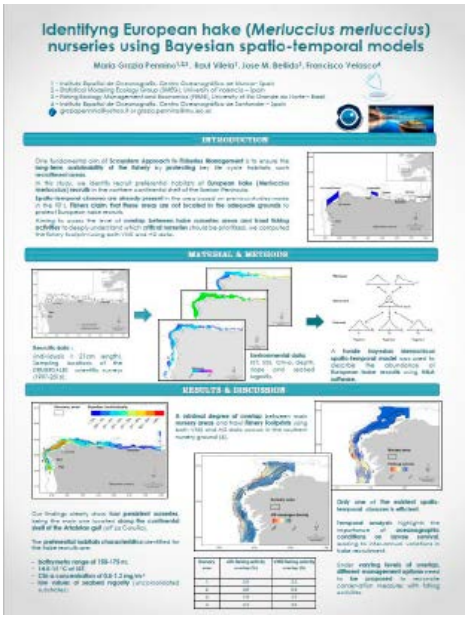


Figure 72. Poster with some of the main results of Action B3 presented during *ICES 2017 Conference*

- The ***VIII Jornadas Ibéricas de Infraestructuras de Dados Espaciais*** held in Lisbon (Portugal) from 15th until 17th November 2017 → ORAL PRESENTATION.
- The event "***III Jornada sobre la aplicación de la obligación de desembarque"*** held in Vigo (Spain) on December 1st, 2017 → INVITED ORAL PRESENTATION.
- The event "***Jornada sobre Descartes, obligación de desembarque y especies con altas posibilidades de aprovechamiento comercial"*** held in Burela (Spain) December 14th 2017 → INVITED ORAL PRESENTATION.
- Participation of LIFE iSEAS Project Coordinator (Mr. Ricardo Pérez-Martín) and Mr. José María Bellido (IEO) as Guest Lecturers in the Advanced Course "***Managing discards in fisheries: Ecological and socioeconomic analysis and methodologies"*** organized by CIHEAM and H2020 Project MINOUW. It was held in Zaragoza (Spain) from 9th until 13th April 2018- This action is also considered as a Networking Action in the framework of Action E2.
- The ***International conference on advances in marine technologies applied to discard mitigation and management (MARTEC18)***, organized by the LIFE iSEAS project, and held in Vigo (Spain) from 2nd until 4th of May 2018 → 9 ORAL PRESENTATION & 12 POSTERS.
- The ***9th International Fisheries Observer and Monitoring Conference (IFOMC 2018***) held in Vigo (Spain) from 11th until 15th of June 2018 → POSTER.
- The ***SeaWeb Seafood Summit 2018*** held in Barcelona (Spain) from 18th until 22nd of June 2018 → INVITED ORAL PRESENTATION.
- The ***7th International Conference on Engineering for Waste and Biomass Valorisation (WasteEng 2018)*** held in Prague (Czech Republic) from 2nd until 5th of July 2018 → ORAL PRESENTATION & POSTER. Regarding this event, it can be seen that the dates of celebration are after the end of the LIFE iSEAS Project. However, we asked during the LIFE+ Monitoring Team and Financial Officer carried out in mid-2017 for a permission from the European Commission to attend this conference due to its relevance to present the last results of the

iDVP tests (Action B4) in the most relevant international scientific forum in the topic of biomass valorization. The EC allowed as to attend this conference, as it can be seen in the received email on 19/06/2018, attached to this report as **Annex 14.**

Also, and as part of the After-LIFE+ Plan, it must be highlighted that LIFE iSEAS coordinators have been invited to participate in the **LIFE FOOD WASTE PLATFORM MEETING**: Effective solutions for prevention and treatment, to be held 8-9 October 2018 in Budapest (Hungary). Participants from 11 countries and from different organizations, including many LIFE and international food-waste projects will participate, being an excellent opportunity for networking towards the continuation, replicability and transferability of the LIFE iSEAS results.

Regarding participation of LIFE iSEAS partners in technical and administration forums, it must be highlighted that the Project coordinator (Ricardo I. Pérez Martín), Mr. Gonzalo Rodríguez from USC and Mr. Julio Valeiras and Mr. José María Bellido from IEO are members of the **Spanish Discards Committee of the MAPAMA since 2017**. This Committee coordinates initiatives that allow a progressive implementation of the prohibition of fishing discards until 2019, year in which all catches of species subject to the TAC (Total Allowable Catch) and quotas in the Atlantic, or minimum sizes in the Mediterranean was made mandatory.

A complete and detailed description of the works presented to all these events, including the titles of the contributions, photos of the events, snapshots of the presentations and posters, etc., can be found in Deliverable D1.4 (**Annex 12**) attached to this Final Report – ANNEX **Deliverable_D1.4_Events_Attendance_Annex_V_2018**

- Outputs: Comparative with planned outputs

Regarding scientific papers, up to **17** have been produced along the project life, ***being 5 more than the number presented in the LIFE iSEAS proposal (12)***. This number will be highly increased during the After-LIFE+ period once the Special Issue of MARTEC18 in Marine Policy has been published in mid-2019.

Participation in conferences, seminars and fairs of interest (international, European, national and regional) to present the project and its main results was executed (***around 10 were planned during project life, but finally they were up to 33***). Moreover, in most of cases, more than one contribution (presentation and/or poster) by conference were presented by LIFE iSEAS partners.

- Issues found

None.

Task D1.5: Off-line promotion actions (Posters/leaflets/catalogues/Videos)

- Activities/subtasks description

Different media/products were used to promote LIFE iSEAS project and were intended to be diffused to the target sectors by mail or be distributed in major events in which the

consortium participated. Also, these materials were distributed in all the events organised in the framework of the project.

Target: Public agencies, associations and organizations linked to the fishing sector, institutions and organizers of congresses, conferences, symposium, etc. The products of dissemination generated during the project were:

Project posters/panel boards that include the main data of the project, useful for a general dissemination in forums and conferences organised by the LIFE iSEAS consortium. Likewise, these posters (7) were displayed in high visibility locations of the main facilities of partners and collaborators of LIFE iSEAS. Two versions of panel boards have been created along the LIFE iSEAS implementation, as it can be shown in Figure 73. It must be mentioned that the second version developed in 2017 was prepared in English and Spanish (the first one from 2015 was only in English).

Figure 73. English LIFE iSEAS Panel Boards (2015 version on the left and 2017 version on the right)

Moreover, specific and permanent panel boards of LIFE iSEAS and the cofinancing of the LIFE+ Programme were installed in the main entrance of the IIM-CSIC (Figure 74), coordinating beneficiary of the project, in order to publicize it among its personnel and visitants.

In addition, several information panels about the project and the iDVP Plant have been located in the Port of Marín in order to give information to its users and visitants about the developments carried regarding biomass valorization in the framework of Action B4 of LIFE iSEAS (Figure 75)

Figure 74. LIFE iSEAS Panel boards located in the main entrance of the IIM-CSIC headquarters in Vigo

Figure 75. LIFE iSEAS Panel boards located outside the Fish Auction of the Port of Marin (left) and in the doors of the rooms where the iDVP has been implemented (right)

Leaflets/brochures that included a brief descriptions of the project have been produced. Copies in Spanish (500) and English (500) were available at the early project stage (Figure 76). Posters and leaflets were elaborated and distributed among the partners on May 2015. These materials were used in the framework of the events organised by LIFE iSEAS project and in those to the project partners attended. A new 14 pages brochure (Figure 77) were designed and printed on January 2017 (Spanish – 1,000 copies; and English – 1,000 copies versions).

Figure 76. LIFE iSEAS leaflets (2015 version)

Figure 77. LIFE iSEAS leaflets (2017 version)

Folders containing partners logos, coordinators address and website and email contact were used (400 units) in all the project promotion events to organize the documentation (agendas, leaflets, etc.) delivered together with other dissemination material (notebooks – 250; pens – 450 and; USB memories - 50in the framework of the different events organised by LIFE iSEAS project (Figure 78).

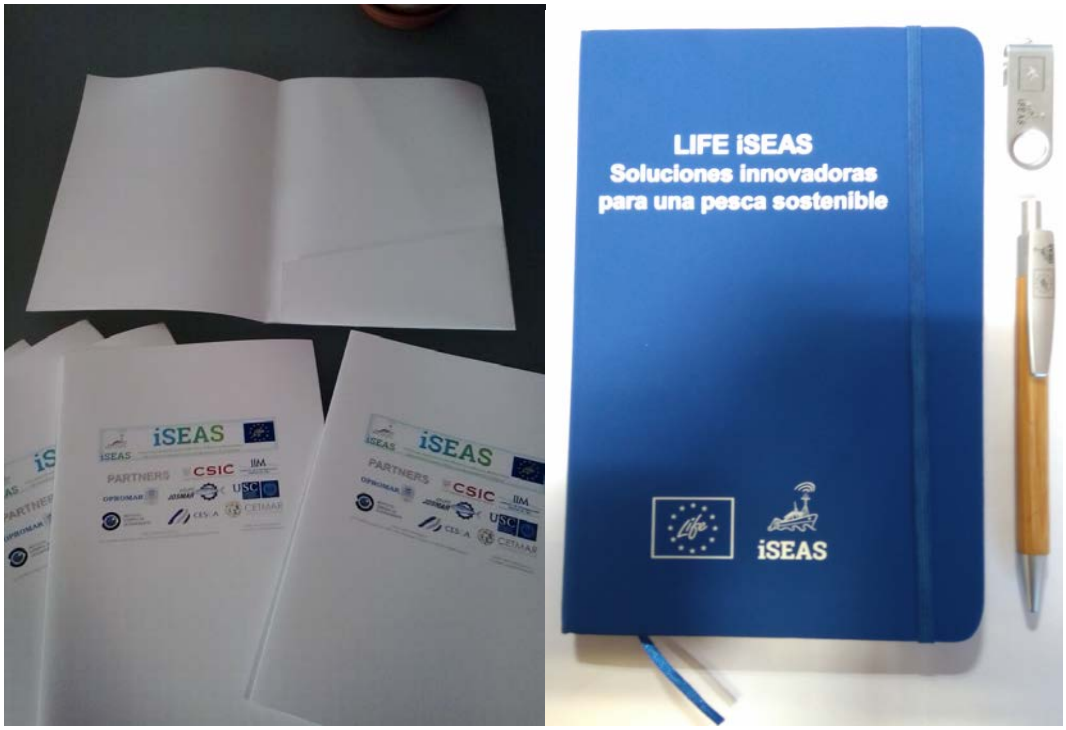


Figure 78. LIFE iSEAS folders and promotional merchandising

Audio-visual material showing the evolution of the project and its main outcomes were generated at different stages of the project. A short video was produced at the early beginning and company including only basic project information. It can be found in the LIFE iSEAS YouTube channel (Figure 79) at:
https://www.youtube.com/watch?v=S3Wz_bqK4a0

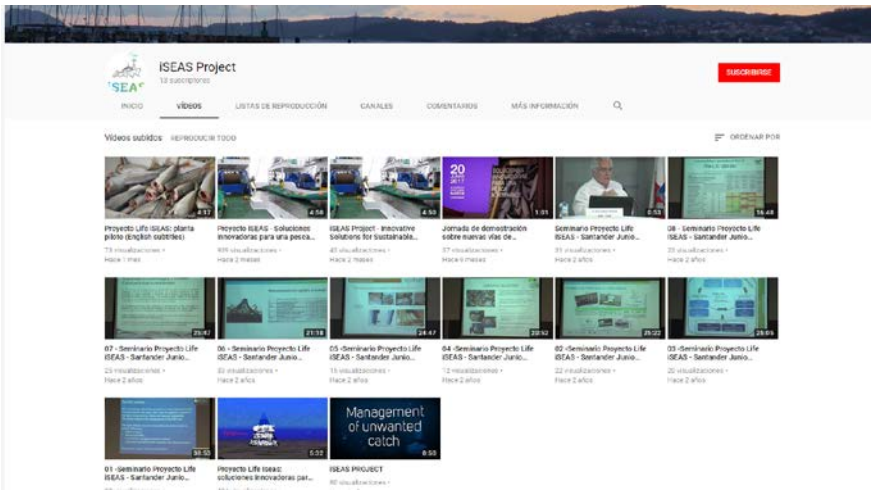


Figure 79. LIFE iSEAS YouTube Channel

In April 2016, a divulgative video ***"Proyecto LIFE iSEAS: soluciones innovadoras para la reducción y gestión de los descartes pesqueros"*** was produced by an audio-visual Company (DIVULGARE). LIFE iSEAS main goals and expected results were summarized in this documentary, which was used in several project presentations. It is available at the LIFE iSEAS YouTube Channel:
https://www.youtube.com/watch?v=OrufHSU7Z5Q

More videos were filmed during the vessel campaings, using the iObserver on board or in the Pilot Plant located in the Port of Marin. All this graphic information was uploaded on the project YouTube Channel, which have nearly 2,000 public views:

Spanish version:
https://www.youtube.com/watch?v=H8UPUCESukI

English version:
https://www.youtube.com/watch?v=pD9wKzQTa00

A new video to present the main LIFE iSEAS results, including interviews, opinions and discussions with different stakeholders that attended the dissemination events organized by the project during 2017 and 2018 was filmed and it is already available at the YouTube channel of LIFE iSEAS.

All these produced videos are also attached to the Final Report as **Annex 23**.

- Outputs: Comparative with planned outputs

Complete expected results were achieved. As complementary material for project and LIFE dissemination, USB memories and pens of LIFE iSEAS project were produced.

- Issues found

None.

5.4.2 Layman's report

The Layman's report (Spanish and English versions) is attached as **Annex 15.** Considerations for its elaboration included in the Final Report document were took into account.

Regarding the content, more than 10 pages (up to 16) were needed in order to summary complete information related to LIFE iSEAS project:

- What is the motivation of the LIFE iSEAS project: the discards and the new scenario of the CFP and the Landing Obligation (LO) compliance.
- The LIFE iSEAS Project: General information regarding FAROS and the LIFE programme.
- The description of the main results of the LIFE iSEAS Project:
    - The iObserver, as a tool to fully document the catches.
    - The RedBox and the marine SDI for data processing, geo-referencing, filtering and proper and useful presentation for the different final users.
    - The developed mathematical models (FSI, fuel efficiency and hotspots) as tools for optimal and real time fishing activity management.
    - The Integral Discards Valorization Point (the iDVP1 and iDVP3) to add value to the different new fractions of biomass landed due to the LO.
    - The proper quantification of the environmental and socio-ecomic impacts of the proposed solutions/obtained results in LIFE iSEAS towards the 2019 scenario of the fully compliance with the LO.
- Positive results for the environment and conclusions.
- Some examples of LIFE iSEAS dissemination in conferences, workshops, fairs, etc.

5.4.3 After-LIFE Communication plan

The AFTER-LIFE Communication Plan aims at continuing the dissemination and communication of the results of LIFE iSEAS Project during the next 5 years after the end of the project, i.e. LIFE iSEAS partners would be willing to continue the work in this line beyond the temporal horizon of the project. The full detailed document (**Deliverable D2.1**) is attached as **Annex 16.**

In addition, it must be pointed out that **both documents** (After-LIFE Communication Plan and Layman Report) **are available for dissemination purposes among the general public in the DOCUMENTS section of the LIFE iSEAS webpage** (http://lifeiseas.eu/archivos/).

6. COMMENTS ON THE FINANCIAL REPORT

6.1. Summary of Costs Incurred

The costs incurred until the end of the project are the following (Table 13):

PROJECT COSTS INCURRED				
	Cost category	*Total cost according to the Commission's decision*	*Costs incurred from the start date to 14/04/2013*	*%*
1.	Personnel	2,753,343 €	2,850,136.41 €	103.52
2.	Travel	176,003 €	114,609.57 €	65.12
3.	External assistance	419,00 €	436,368.86 €	104.14
4.	Durables goods (Equipment)	23,000 €	8,837.43 €	76.85
5.	Consumables	211,511 €	170,722.30 €	80.72
6.	Other costs	31,300 €	49,380.26 €	157.76
7.	Overheads	252,185 €	254,103.84 €	102.46
	SUM TOTAL	**3,866,342 €**	**3,884,158.67 €**	**100.46**

Table 13. Cost statement per category until 30/06/2018

The main issues to be highlighted regarding each expenditure category are described next.

a) Personnel

- In this category, the total amount executed in the framework of LIFE iSEAS was **2,850,136.41 €**, a **3.52%** higher than the figures reflected in the proposal and after the changes in the budget asked and approved by the EC after the First Progress Report. In **Table 14** are summarized the breakdown of personnel costs by partner and by type of personnel (permanent/civil servants and temporary).

PARTNER	EXECUTED PERSONNEL PERMANENT	EXECUTED PERSONNEL TEMPORARY	REVISED PROPOSAL LIFE iSEAS PERMANENT	REVISED PROPOSAL LIFE iSEAS TEMPORARY
IIM	979,352.29 €	475,193.44 €	825,993.66 €	501,580.34 €
CESGA	134,015.21 €	84,513.14 €	130,470.15 €	83,440.00 €
CETMAR	47,298.27 €	0.00 €	38,832.00 €	0.00 €
IEO	324,054.71 €	198,959.55 €	361,827.03 €	245,376.00 €
JOSMAR	175,383.25 €	0.00 €	149,155.00 €	0.00 €
OPROMAR	135,733.95 €	0.00 €	134,493.00 €	0.00 €
USC	171,089.21 €	124,526.39 €	151,981.81 €	124,324.42 €
TOTAL	**1,966,926.89 €**	**883,209.52 €**	**1,792,752.65 €**	**954,720.76 €**

Table 14. Personnel costs executed in the framework of LIFE iSEAS in comparison with the Revised numbers in the proposal after the First Progress Report changes among partners approved by the EC.

The total amount of ***Permanent staff*** is an 9.58% higher than the proposed, while the ***Temporary personnel*** is a 7.49% lower than the estimated budget, mainly due to the initial difficulties that IEO had to hire the 3 postgraduates from the very beginning in the framework of Action B3 and that finally were done in March 2016. This fact also motivates the budgetary movements among Personnel categories of IIM-CSIC and IEO.

Regarding ***Permanent staff***, this increase reflected in the Final Cost Statement is due to:

- *IIM-CSIC:* The change on the personnel category of Luis Taboada Antelo who in the beginning of the project was specifically hired by LIFE iSEAS but in 2016 got a permanent position at the IIM-CSIC. Therefore, this implied an increase on the permanent staff costs since he was the Technical Coordinator of LIFE iSEAS and his associated cost in LIFE iSEAS was important: 30,920.41 € in 2016; 30,944.23 € in 2017 and; 11,603.82 € in 2018 for a total of **73,469.46 €** that supposes the 47.91% of the deviation between executed and proposed permanent staff costs of IIM-CSIC.

  The remaining extra permanent personnel costs are related to the needs of additional experts/technicians of the IIM-CSIC to develop the intense workload regarding the pre-pilot and pilot tests of the iDVP in order to get a fully operative plant capable of obtaining a wide variety of high quality products of interest, as it was demonstrated in Action B4. This is the case of Mrs. Marta Pérez Testa and Mrs. Helena Pazó Malvido whose personnel costs were up to **78,683.17 €** (the 51.31 % of the increase in the IIM-CSIC permanent costs).

  Finally, it must be mentioned that in February 2018, Ms. Tatiana Ordoñez (postgraduate hired in LIFE iSEAS) got a position in the Regional administration and left the project. Due to the fact of the imminent end of the project, coordinators decided to not hire another person and to assume her tasks among the permanent staff of the IIM-CSIC.
- *CETMAR*: The higher Personnel costs (a 21.80%) are mainly associated to the organization of the International Conference MARTEC18, a very important event in the framework of presenting LIFE iSEAS results and of networking with the scientific community on the topics of marine technologies towards ensuring sustainability of marine resources. It was a very successful event that implied and important extra work by CETMAR partners in order to organize all the details of the 3-day event.
- *JOSMAR:* Personnel costs were a 17.58 % higher than those estimated in the proposal, mainly due to the extra work needed to comply with the demands of the Port Authority of Marín. As explained previously in this Report, The main requirements to install the plant in the room of the Marin Auction intended/defined in the proposal to ‘accommodate’ the iDVP3 were to clearly separate and identify the areas for processing the new portion (the room had to be divided into 2 separate areas – Figure 24), opening also a new access to the iDVP3 room. This fact, together with the inherent problems faced during the steps of design, construction and implementation on site of the iDVP and the no availability of temporary staff justify these higher executed costs.
- *USC:* The total figures in this category were a 12.57% higher than reflected in the revised proposal since the socio-economic evaluations of the iDVP was carried out by Mr. Francisco Ferreiro, an economist specialized in industrial processes assessment and scheduling, not considered in the proposal, but of

high relevance to carry out a complete viability assessment of this solution in the framework of LIFE iSEAS, one of the main achievements of the project. His cost was **22,758.07 €** that fully explain the extra costs in this category of *Personnel.*

Regarding ***Temporary staff***, almost all resources were executed despite the referred problems regarding the initial hiring process in the IEO, the transition of Mr. Luis Taboada to a permanent position and the leaving of Ms. Tatiana Ordoñez. These facts allowed IIM-CSIC to hire an own observer to carry out the on board pilot tests in the framework of Actions B1 and B4 (Mr. Xesús Morales) and a postgraduate (Ms. Patricia Ramos) on charge of the in land management of biomass, LO compliance tests and scheduling and reporting of iDVP tests.

- A detailed explanation of the methodology that each beneficiary used for the calculation of the annual gross salaries is presented in **Deliverable E3.2 (Final Audit Report)** and attached to this Final Report as **Annex 18.**

- The detected discrepancies in the cost by person by taking into account the daily rate foreseen in the budget (in €) are summarized in **Table 15:**

Partner	Name of person	Year	The hourly rate of column H converted to a daily rate in €	Daily rate foreseen in the budget in €
CESGA	Mariano Sánchez Martín	2015	146.78	112
	Juan Vilasuso Barreiro	2017	229.11	171
	Juan Carlos Olvalle Macías	2018	176.80	112
JOSMAR	José Carlos Pereira	2015	211.91	175
	José Carlos Pereira	2016	241.31	175
	José Carlos Pereira	2017	230.27	175
OPROMAR	Francisco Teijeira González	2014	161.41	102
	Francisco Teijeira González	2015	159.93	102
	Francisco Teijeira González	2016	169.85	102
	Francisco Teijeira González	2017	288.77	102
	Francisco Teijeira González	2018	213.26	102
	Juan Carlos Martín Fragueiro	2017	453.09	221
	Juan Carlos Martín Fragueiro	2018	366.21	221
	Yolanda Pousada Ferradas	2015	89.45	48
	Yolanda Pousada Ferradas	2016	94.41	48
	Yolanda Pousada Ferradas	2017	98.58	48
	Yolanda Pousada Ferradas	2018	80.47	48
USC	Víctor Hugo Martínez	2015	122.42	100
	Víctor Hugo Martínez	2016	125.96	100

Partner	Name of person	Year	The hourly rate of column H converted to a daily rate in €	Daily rate foreseen in the budget in €
USC	Víctor Hugo Martínez	2017	133.07	100
	María Rosario Babío Arcay	2015	221.54	149
	María Rosario Babío Arcay	2016	215.11	149
	María Rosario Babío Arcay	2017	243.83	149
	María Rosario Babío Arcay	2018	243.00	149
IIM	Luis Taboada Antelo	2014	288.24	172
	Francisco J. Fraguas Cadavid	2016	143.79	116
	Jesús Valcárcel Barros	2017	270.19	172

Table 15. Main differences detected between proposed and real daily rates in the LIFE iSEAS personnel

The reasons for these detected deviations are the following:

Mariano Sánchez Martín: It was a contract for only three months in 2014. The settlement/end of contract cost affect to the total figure.

Juan Carlos Olvalle Macías: He was contracted during 6 months in 2018. Therefore, the settlement/end of contract cost affect to the total figure of the daily cost.

José Carlos Pereira: The difference is due to the category of José C. He is a skilled mechanic worker (not only team mechanic) whose role was finally considered as necessary to the attain project in the framework of Action B4.

Juan Carlos Martín Fragueiro: The daily costs of Juan Carlos Martín Fragueiro in 2017 and 2018 were higher than those in 2014-2016 due to the fact that he was in this last two years exclusively hired by OPROMAR (implying higher annual gross salaries) while the number of productive hours remained quite lower. Therefore, the hourly and daily rates increased significantly. However, the final figures of personnel costs of OPROMAR are almost the same that the ones reflected in the proposal and all the goals pursued in the framework of LIFE iSEAS were attained.

Francisco Teijeira González: The daily costs Francisco Teijeira González are finally different than expected. In any case, the total personnel costs between these two persons are compensated (the cost is lower than expected in the case of Juan Carlos M. and higher in case of Francisco Teijeira) as can be stated in the financial tool of OPROMAR for years 2014-2016 and 2016.

Yolanda Pousada Ferradas: It was an underestimated cost in the project proposal (48€). The correct figures are around 90 €. It must be highlighted that this figures do not suppose a high hourly/daily cost, so a big difference in the total personnel cost of OPROMAR were not detected (due to the salary of this person as well as the hours to be worked in the project).

Víctor Hugo Ballesteros: Finally the cost of hiring in the USC is slightly higher than indicated in the proposal.

María Rosario Babío Arcay: The associated daily cost reflected in the proposal for Assistant Professor was 140 €. Since the considered person to work in LIFE iSEAS in

this category is no longer linked to the Applied Economy Group of the USC, a new Senior Lecturer/Researcher (M. Rosario Babío) has been included to developed technical tasks in the framework of the project, with an associated daily rate of 240 €.

Luis Taboada Antelo: It was a contract for only one month in 2014 (December 2014) that included in the calculation of the daily rate the annual holidays that this person had corresponding to its previous contract out of LIFE iSEAS. As a consequence, lower worked hours resulted in an increased daily rate.

Francisco J. Fraguas Cadavid: The high associated cost is due to a sick leave during the period January to March 2016.

Jesús Valcárcel Barros: He was contracted during 7 months in 2017. Therefore, the settlement/end of contract cost affect to the total figure of the daily cost.

b) External Assistance

- The final level of expenditure in this category (**436,368.86 €)** was slightly higher than the one in the LIFE iSEAS proposal (**419,000 € -** a 4.14 % higher). This difference of **17,368.86 €** was compensated with a transference from the **Travel and Subsistance** category.

- The main deviations in the execution are:
  - *OPROMAR:* Extra costs in this category for this partner are mainly due to the additional Landing Obligation compliance pilot tests on board OPROMAR vessels carried out (**17,206.52 €**) and to the on-board required works to properly install the iObserver, that were higher than expected due, for instance, to the necessity of building specific support for each vessels or to the lack of a proper wiring/communication infrastructure on board.
  - *IIM-CSIC:* This partner, following the established Spanish Legislation on 2015 regarding public tendering (Ley 30/2007 de Contratos del Sector Público), had to prepare a tendering procedure to award the development and installation of 4 iObserver Systems that allow the observation and automatic determination of the total catch in commercial fishing vessels based on artificial vision, discrimination of the percentages of the most common discarded species or predefined groups and the transmission of this information to land in real time. The call was open on March, 30th 2015 (Month 9) and awarded to Universidade de Vigo (UVIGO) on July 2015 (Month 13). The final contact between UVIGO and IIM-CSIC was signed on September 2015 (Month 15).
    It was awarded for a lower price (109,000 € - **90,135 € with non-recoverable VAT**) that the one reflected in the proposal (116,000 €).
    As requested by the EC in its communication of 22 September 2016, all the supporting documentation related to this public tendering procedure is attached to this Final Report as **Annex 20 (2- CSIC iObservers supplier).**
  - *IEO*: This partner asked LIFE iSEAS coordinator during 2017 about the possibility of getting some fund on this category to carry out a divulgation video of LIFE iSEAS in the framework of the oceanographic campaigns developed with the iObserver on board. Due to the high impact that this material could have for the proper and wide diffusion of this important result of LIFE iSEAS, and that the requested amount was low (4,050 €), IIM-CSIC transferred part of its

funds in this category to IEO. Moreover, some translation services were requested and accepted by LIFE iSEAS coordinators.

- Regarding the rest of partners, all of them adjusted well their expenditures to the assigned resources, compensating the no use by some partners (CESGA, CETMAR) with the extra use of others (JOSMAR, USC).

c) Travel and subsistence

- The final level of execution in this category was quite lower (**114,609.57 €**): a 65.12% of the budget presented in the LIFE iSEAS proposal (**176,003 €**). This is mainly due to the fact that the IEO budget in this category (93,533 €) related to pilot trips to test LIFE iSEAS technologies on board oceanographic vessels during different campaigns, was only executed in a 53.90% (50,410.63 €). The reason for this level of expenditure is that the oceanographic campaigns during which the LIFE iSEAS developments were tested were shared with the activities of other research projects. Therefore, in most of them, the costs of the personnel participating in these campaigns and that performed the work in LIFE iSEAS were assumed/assigned/financed by other research actions. As a consequence, the final execution level of our project was lower.

- It must be mentioned that for IEO personnel, the travel expenses were reimbursed to them as part of their salaries. However, these expenses were deducted from their annual gross salaries and declared under the ***Travel and Subsistance*** category.

- Regarding the other LIFE iSEAS partners, only IIM-CSIC incurred in higher costs in this category due to its intense diffusion and networking activity along the project. The other partners make use of other channels to communicate among them and with other institutions (mainly video conference), reducing the final costs without having losing the info and knowledge exchange while fulfilling all diffusion events attendance summarized in the LIFE iSEAS proposal, even at a higher level with less resources consumption.

- In the framework of Action B4, one change in its strategy was incorporated in order to obtain the better results at the iDVP and in terms of highest quality of products obtained from nowadays discarded species. Technologies, best practices and experience from the 3B's Research Group (Biomaterials, Biodegradables and Biomimetics) at the University of Minho will add value to the Action and, therefore, to the project. In this aim, a person temporary hired by IIM-CSIC (Mr. Jesús Valcárcel) was carried out a set of car trips to this University (around 100 km from IIM-CSIC) to use its analysing facilities/technologies and to collaborate on the product developing procedure. The estimated cost per trip was around 80 € and the total number of trips were 32 for a total cost of **2,658.25 €.** This cost was executed by optimizing and readjusting the assigned resources in this category to IIM-CSIC.
- Regarding the costs associated to the WasteEng 2018 Conference (paid after the end of the project), the EC allowed LIFE iSEAS partners to attend this conference, as it can be seen in the received email on 19/06/2018, attached to this report as **Annex 14.** It was held in Prague (Czech Republic) July 2nd - 5th, 2018 (http://www.wasteeng2018.org/), right after the end of LIFE iSEAS in June, 30th

2018. It was a great opportunity and forum to present one of the main results of our project (the iDVP plant) among a specialized audience (both scientific as well as from companies) on biomass, residues and waste valorization towards a sustainable development.

- IEO (Ms. Maria Grazia Pennino) also attended the ICES (*International Council for the Exploration of the Sea*) Conference 2017 to present the main results of Action B3. Annually, this conference provides a formidable platform to boost and steer a scientific advances in the marine environment, as it is one of the major marine international conferences. It is attended not only by numerous eminent scientists but also by managers, decision-makers and the industry, and since ICES is a major marine scientific advisory body to governments and also the European Commission. On 2017, this conference was held in Fort Lauderdale (Florida, USA), i.e., outside the EU. The total cost of this travel was **2,254.84 €**.
  LIFE iSEAS coordinator assumes that made the mistake of not asking for previous permission to the EC to carry out this activity. However, we want to ask now the EC for its elegibility since, as mentioned, this conference is/was one of the best scientific forums to present LIFE iSEAS results together with the fact that the level of expenditure of the IEO in this category is quite low, existing remnant to be used not requiring extra funds.

- Finally, regarding the internal rules for the reimbursement of travel costs of LIFE iSEAS beneficiaries, these are summarized next:
  - *IIM-CSIC, IEO, CETMAR* and *USC* follow the indications and rules stated in the Real Decreto 462/2002 (Royal Decree 462/2002) of the Ministry of the Presidence of the Spanish Government regarding '*Indemnizaciones por razón del servicio'*. In summary, fixed quantities for accommodation and subsistence are paid to the worker per day depending on the destination country of the travel. Regarding transport, a fixed amount of 0.19 €/km is reflected if the worker uses his own car and plane and train tickets have to be Tourist class.
  - *CESGA, OPROMAR* and *JOSMAR* pay the real costs that the worker incurred during the travel based on food tickets, plane and hotel invoices, etc. they provide to the administration services of these partners, always based on containment and value of money for selecting among the different available options for travelling.

  Complete information and supporting documentation for each partner on this topic can be found attached to this Final Report in **Annex 21**

d) Durable goods: Equipment

- In this category, all items reflected in the LIFE iSEAS proposal (an spray dryer, a continuous centrifuge and a compressor) were executed at the estimated costs, for a total of **22,871.03 €** and a total elegible cost of **8,837.43 €** after applying depreciation rules. It is a 77% of the costs reflected in the LIFE iSEAS proposal (11,500 € elegible)

- It must be mentioned that the acquired compressor for the iDVP was a small one to act as emergency solution since the rooms at the Fish Auction of Marín were the iDVP was located had their own compressed air circuits.

- USC purchased a laptop (**1,087.52 €)** to properly record and process the information acquired during performed in-situ interviews with ship-owners/crews in the framework of Action A1. This cost was not explicitly reflected in the LIFE iSEAS proposal but due to the necessity of this equipment to properly fulfill the Action goals, a quantity equal to the eligible value of this equipment (after application of proper depreciation rules of this beneficiary – **929.65 €**) was reallocated from ***Consumables*** to this ***Equipment*** category. Computer equipment is amortized to 4 years in USC. Therefore, the portion of the corresponding depreciation is allocated to this period, taking into account the date of the invoice.

- The depreciation rules applied by the LIFE iSEAS partners that have executed costs in this ***Equipment*** category are the following:

  - *IIM-CSIC:* In the CSIC, the amortization installments are determined by the straight-line method, dividing the carrying amount activated in each year between the years remaining until the end of the useful life of each element to be amortized, being the amortization period being for equipment and scientific instrument class, of 60 months. In the case of equipment for information processes, the amortization period is 36 months.
    A certificate of these rules applied in the CSIC can be found as **Annex 19** attached to this Final Report.
    By applying these rules to the depreciation of the acquired spray dryer and centrifuge, and based on the invoice dates (25/08/2016 –Month 26 and 22709/2016 – Month 27, respectively), the costs to be elegible in LIFE iSEAS will be:

    CENTRIFUGE

    Elegible cost = (22+(7/31))/60*10,588 € = **3,922.11 €**

    Being 22.226 the months of LIFE iSEAS during which the spray dryer was used, 60 the useful life of this type of equipment (in months) and 10,588 € the acquisition price.

    SPRAY DRYER

    Elegible cost = (21+(9/30))/60*10,535.06 € = **3,739.95 €**

    Being 21.3 the months of LIFE iSEAS during which the centrifuge was used, 60 the useful life of this type of equipment (in months) and 10,535.06 € the acquisition price.

  - *JOSMAR:* It followed the same method than CSIC. Therefore, the elegible cost for the compressor will be:

COMPRESSOR

Elegible cost = (22+(10/31))/60*660.45 € = **245.72 €**

Being 22.323 the months of LIFE iSEAS during which the compressor was used, 60 the useful life of this type of equipment (in months) and 660.45 € the acquisition price.

- *USC:* It followed the same method than CSIC but considering a useful life for Laptops and tablets of 48 months, as can be shown in the corresponding document in **Annex 19.**
  By applying these rules to the depreciation of the acquired laptop, and based on the invoice date (31/01/2015 –Month 7), the cost to be elegible in LIFE iSEAS will be:

LAPTOP

Elegible cost = (41+(1/31))/48*1,087.52 € = **929.65 €**

Being 41.032 the months of LIFE iSEAS during which the laptop was used, 48 the useful life of this type of equipment (in months) and 1,087.52 € the acquisition price.

e) Consumables:

- The final level of execution in this category was a little lower (**170,722.30 €**): an 80.72 % of the budget presented in the LIFE iSEAS proposal (**211,511 €**).

- This is mainly due to the fact that the IEO budget in this category (12,362.20 €) was almost unexecuted due to the fact of the administrative obstacles they found. IEO staff needed the approval of controller of the Ministry of Treasury (an economist), not a researcher) for each required costs, taking a long time to get the final ok since he asked several times for extra info to make sure that the cost adjusted to the requirements of the project. However these problems and low level of execution, all planned activities to be carried out by IEO in the framework of LIFE iSEAS were successfully implemented using their own resources and resources shared with other research activities/projects.

- Moreover, OPROMAR not used most of the resources assigned to the ***Consumables*** category (an 84.81 %) since the adaptations on board vessels reflected in the LIFE iSEAS proposal finally were considered in the ***External Assistance***.

- Finally and as previously mentioned, USC reallocated a 49.17% of the assigned funds into this category in the ***Equipment*** category to acquire a laptop.

f) Other costs:

- The final level of expenditure in this category (**49,380.26 €)** was higher than the one in the LIFE iSEAS proposal (**31,300 € -** an 57.76 % higher). This difference of

18,080.26 € was compensated with a transference from the **Personnel** category (specifically, from non-used resources regarding *Temporary staff*).

- In the case of OPROMAR, it has not assigned resources into this category. However, during the implementation and use of the iDVP in the framework of Action B4, the Port Authority of Marín started to charge to this partner a monthly fee regarding the occupation and activity to be carried out in the rooms were the iDVP1 and 3 were installed. These were unexpected costs (for a total of 9,657.31 €), not reflected in the proposal that LIFE iSEAS partners have to face. Following the indications of the LIFE+ Monitoring team on this issue, OPROMAR considered all these monthly costs in the ***Other Cost*** category in order to be considered elegible since no extra funds are required due to the availability of funds in other cost categories among LIFE iSEAS partners, being possible to transfer a 10% or 30,000 € without explicit permission of the EC.

- For IIM-CSIC, the higher level of expenditure in this category is mainly due to the organization of MARTEC18 conference (together with CETMAR that paid the travel and accommodation expenses of invited speakers to this event), mainly related to the payment of the venue (3,820 €), info panels and merchandising (820.00 € + 520.00 €) and the registration of the IIM-CSIC personnel (1,735.51 €). The same reason applies to IEO and USC regarding extra costs related to the participation of their personnel in MARTEC18 (950.40 € and 909.09 €, respectively).

- For IIM-CSIC, in addition, extra costs not reflected in the LIFE iSEAS proposal related to freezing facilities and services by FRIGALSA to properly maintain the biomass collected during pilot trips and to be processed during iDVP were executed in this category (435.70 €).

6.2. Accounting system

- Most of LIFE iSEAS beneficiaries have an **actualized, independent analytic accounting system** to justify the costs incurred during the project, following national regulations. The codes for the internal accounts of the partners are:

  1. IIM: **A06**
  2. CETMAR : **XXXX501026**
  3. USC: **2013-PI022** (PI Gonzalo Rodríguez)
  4. USC: **2014-PI089** (PI Amaya Franco)
  5. OPROMAR: **239**

  IEO uses project SOROLLA from the Spanish IRS as the accounting system. The code for project LIFE iSEAS is **2014/00000054**.

  CESGA uses the code 31/2014 to identify the iSEAS project expenses. The administration department has a spreadsheet with the details of all expenses for each accounting period. Each expense has associated the project code, so they can be filtered per project and per year.

JOSMAR uses a 10 digit code to identify the different cost accounts. For instance, the internal account for personnel costs/salaries has the code **6401000000**. In order to identify LIFE iSEAS expenses the sixth digit in such code is modified. The salaries account for LIFE iSEAS would be **6401010000**. And this change in the code account is also made for all the rest cost categories into the internal account system.

As requested in the communication of the EC after the third Monitoring Team visit to LIFE iSEAS, a printout of the project account of each beneficiary (when available) is attached to this Final report as part of **Annex 20 (10 - Printouts of LIFE iSEAS accounts).**

- All cost documents and invoices have a clear reference to the project (by using a stamp designed for the project and supplied to all partners), relating them with the developed accounting mechanism.

- Regarding the **type of time recording system used**, and as indicated by the EC, the productive time used to calculate the hourly rate is the actual number of worked hours (recorded on the developed LIFE iSEAS timesheets – see Figure 80), comprising hours worked on LIFE iSEAS and all other activities.

- As asked in the letter from the EC regarding the Last monitoring Visit, the person who validates the timesheets in USC and CETMAR are the following:
  - *CETMAR:* The Managing Director, Mrs. Paloma Rueda Crespo
  - *USC:* The Coordinator of LIFE iSEAS at USC, Mr. Gonzalo Rodríguez, signed the timesheets of the USC personnel involved in the project while his timesheets are signed by the Head of the Applied Economy Department of the USC, Mr. Edelmiro López.

Project Reference	LIFE13 ENV/ES/000131
Name of Beneficiary	
Name of staff member	
Is staff member employed Full-time or Part-time?	
Calendar Year	2014
Calendar Month	December

Calendar Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total
In case of absence, indicate one of the reason codes below						WE	WE	PH					WE	WE						WE	WE				PH		WE	WE				
Hours worked on LIFE iSEAS project						WE	WE	PH					WE	WE						WE	WE				PH		WE	WE				0.0
Hours worked on other projects*						WE	WE	PH					WE	WE						WE	WE				PH		WE	WE				0.0
Hours worked on other projects*						WE	WE	PH					WE	WE						WE	WE				PH		WE	WE				0.0
Hours worked on other projects*						WE	WE	PH					WE	WE						WE	WE				PH		WE	WE				0.0
Hours worked on other projects*						WE	WE	PH					WE	WE						WE	WE				PH		WE	WE				0.0
Hours worked on other projects*						WE	WE	PH					WE	WE						WE	WE				PH		WE	WE				0.0
Other activities						WE	WE	PH					WE	WE						WE	WE				PH		WE	WE				0.0
Total hours (including overtime)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0

*indicate project reference

Absences	
Weekend	WE
Sick leave	SL
Public holidays	PH
Annual holidays	AH
Other absence	OA

Summary for this month	
Hours worked on this LIFE iSEAS Project	0.0
Hours worked on other projects*	0.0
Hours worked on other projects*	0.0
Hours worked on other projects*	0.0
Hours worked on other projects*	0.0
Hours worked on other projects*	0.0
Other activities	0.0
Total hours (including overtime)	**0.0**

Date and signature of staff member	Date and signature of Project Manager/ Coordinator/Responsible

Figure 80. Example of LIFE iSEAS timesheet

- Annual VAT certificates for IIM-CSIC are attached to this Final Report as **Annex 20 (1- CSIC VAT certificates)** to allow EC to assess the elegible part of VAT.

- As requested in the EC communication of 27 September 2016, timesheets, salary slips, calculation tables with the social security charges included and relevant contracts of:

  a. CSIC: Francisco Javier Fraguas Cadavid.
  b. CESGA: Francisco Landeira Vega.
  c. CETMAR: Jose Luis Gómez Gesteira.
  d. IEO: Julio Valeiras Mota.
  e. JOSMAR: José Carlos Pereira.
  f. OPROMAR: Francisco Teijeira González.
  g. USC: Gonzalo Rodríguez Rodríguez

  for the years 2015 and 2016 are attached to this final report as part of **Annex 20.**

- It must be also mentioned that all the payments the European Community will make to the Spanish Public Administration with the aim of funding actions in the Spanish State will be canalized through the *Dirección General del Tesoro y Política Financiera*. The 'Dirección General del Tesoro' is a unit and the account proper is the 'Tesoro Público' account, **which dos not generate any interest.** Therefore, all the pre-financing payments made by the EC to LIFE iSEAS did not generated any interest.

- All objectives and technologies/solutions aimed during LIFE iSEAS development have been attained (even going beyond, achieving more technical developments than those summarized or described in the LIFE iSEAS proposal) without use all the economic resources reflected in the proposal. This fact indicates that the Actions were fully and properly developed with budget containment, looking always for the best option in terms of technical/economic compromise. This methodology tried to answer to the economic framework in that LIFE iSEAS was implemented, where executing costs without a strict control was not allowed.

6.3. Partnership arrangements

Partners sent the financial information to the coordinating beneficiary, including timesheets and receipts, every 3 months (6 months in the specific case of USC after attending a query submitted by the International Office of this institution)

The financial reporting was implemented in a monthly basis by each partner. Associated beneficiaries entered the information in the financial tables by their own, but with additional support from coordinating beneficiary in some cases (OPROMAR, JOSMAR, IEO). Once the documentation was received, IIM-CSIC carried out a detailed review and additional information may be requested to the partners. The great experience in European projects justification of most of the member of LIFE iSEAS partnership (USC, CESGA, CETMAR) facilitated this review.

6.4. Auditor's report/declaration

Name and address of the external auditor are:

DF AUDITORS CONSULTORS
Còrserga, 270. 6º
08008 BARCELONA

The final auditor's report is attached to this Final Report as **Deliverable E3.2 (Annex 17)**.

6.5. Summary of cost per action

The cost statement per action is summarized in **Table 16**:

Action no.	Short name of action	1. Personnel	2. Travel and subsistence	3. External assistance	4.b Equipment	6. Consumables	7. Other costs	TOTAL
A1	Discards situation	125,502.21 €	761.69 €	51,243.24 €	464.83 €	99.26 €	104.11 €	178,175.34 €
B1	iObserver	405,925.44 €	33,979.13 €	123,664.32 €		1,480.12 €	470.70 €	565,519.70 €
B2	Marine SDI	358,588.24 €	765.78 €	1,645.47 €		1,996.32 €		362,995.81 €
B3	Models	519,978.41 €	4,199.88 €			17.35 €	250.00 €	528,820.60 €
B4	iDVP	578,446.20 €	15,602.13 €	198,182.72 €	7,907.78 €	166,356.38 €	11,364.16 €	977,759.37 €
C1	Monitoring	151,315.45 €						151,315.45 €
C2	Impact assessment	242,701.25 €	268.60 €		464.83 €	45.03 €	417.00 €	243,896.71 €
D1	Diffusion	122,337.69 €	19,272.24 €	36,898.82 €		738.52 €	31,298.52 €	210,549.79 €
D2	After-LIFE+							
E1	Management	271,236.08 €	37,313.54 €	1,830.33 €			5,475.77 €	315,855.72 €
E2	Networking	60,077.95 €	2,446.59 €			89.32 €		62,613.86 €
E3	Audit	14,027.49 €		18,529.00 €				32,556.49 €
Over		199,509.55 €	8,022.67 €	30,545.82 €	618.62 €	11,950.56 €	3,456.62 €	254,103.84 €
	TOTAL	3,049,645.96 €	122,632.24 €	466,914.68 €	9,456.06 €	182,672.86 €	52,836.88 €	**3,884,158.68 €**

Table 16. Final cost statement per action and cost category of LIFE iSEAS

The total executed costs per action are very similar to those reflected in the LIFE iSEAS proposal, with not very large deviations.

7. ANNEXES

Annex 1 – Deliverable B1.2: A report of proposed technologies costs, including potential solutions for its implementation and funding in European fisheries.

This document is also available in electronic format:

Administrative Annexes\Annex 1 – Deliverable B1.2\Deliverable B1.2.pdf

Annex 2 – Monitoring indicators update.

This document is also available in electronic format:

Administrative Annexes\Annex 2 – Monitoring indicators update\monitoring_Final.xls

Annex 3 – Technical meetings minutes.

This document is also available in electronic format:

Administrative Annexes\Annex 3 – Technical meetings minutes\ Minutes technical meeting 06102017 E1.pdf

Annex 4 – Deliverable B2.4: Annual SDI development report 2018.

This document is also available in electronic format:

Administrative Annexes\Annex 4 – Deliverable B2.4\Deliverable B2.4.pdf

Annex 5 – Deliverable B2.5 & 2.6: Requirements validation document & Final SDI development report.

This document is also available in electronic format:
Administrative Annexes\Annex 5 – Deliverable B2.5 & B2.6\Deliverable B2.5 & B2.6.pdf

Annex 6 – Deliverable B3.2: Model for Fuel Efficiency. Maps of predictions.

This document is also available in electronic format:

Administrative Annexes\Annex 6 – Deliverable B3.2\Deliverable B3.2.pdf

Annex 7 – Deliverable B3.3: Model for hot-spot areas. Maps of predictions.

This document is also available in electronic format:

Administrative Annexes\Annex 7 – Deliverable B3.3\Deliverable B3.3.pdf

Annex 8 – Scientific papers produced since June 2017 until June 2018 (End of project)

These documents are also available in electronic format:

Dissemination Annexes\Annex 8 – Scientific papers

Annex 9 – Deliverable B4.3: Validation of processing units at pilot scale (pilot landings, added-value products obtaining, market solutions)

This document is also available in electronic format:

Administrative Annexes\Annex 9 – Deliverable B4.3\Deliverable B4.3.pdf

Annex 10 – Deliverable C2.3: A manual of the main characteristics of the integrated methodology for sustainability assessment of the proposed fishing management network

This document is also available in electronic format:

Administrative Annexes\Annex 10 – Deliverable C2.3\Deliverable C2.3.pdf

Annex 11 – Deliverable C2.4: A report summarizing the results of the sustainability improvement after the application of the innovative solutions proposed in LIFE iSEAS project

This document is also available in electronic format:

Administrative Annexes\Annex 11 – Deliverable C2.4\Deliverable C2.4.pdf

Annex 12 – Deliverable D1.4: Annual Dissemination Plan (until the end of LIFE iSEAS)

This document is also available in electronic format:

Administrative Annexes\Annex 12 – Deliverable D1.4\Deliverable D1.4.pdf

Annex 13 – MARTEC18 Presentations and Book of Abstracts

These documents are also available in electronic format:

Dissemination Annexes\Annex 13 - MARTEC18 Presentations and Book of Abstracts

Annex 14 – Communication of the EC allowing the participation of LIFE iSEAS partners in the WasteEng18 Conference

This document is also available in electronic format:

Administrative Annexes\Annex 14 - Letter from EC allowing participation in WasteEng18\ RE Request LIFE iSEAS (LIFE13 ENVES000131).msg

Annex 15 – Layman's Report.

These documents are also available in electronic format:

Dissemination Annexes\ Annex 15 – Layman report\LIFE iSEAS Layman Report ESP.pdf
LIFE iSEAS Layman Report ENG.pdf

Annex 16 – After-LIFE Communication Plan.

This document is also available in electronic format:

Administrative Annexes\Annex 16 - Deliverable D2.1 After-LIFE+ Plan\Deliverable D2.1.pdf

Annex 17– Deliverable E3.2: Final Audit Report

This document is also available in electronic format:

Administrative Annexes\ Annex 17 - Deliverable E3.2 Final Audit Report\Deliverable E3.2.pdf

Annex 18 – RedBox software and manuals

These documents are also available in electronic format:

RedBox app and manuals\ Annex 18 – Redbox.rar

Annex 19 – Durable Goods depreciation calculation rules

These documents are also available in electronic format:

Financial Annexes\ Annex 19 - Durable Goods depreciation calculation\ Durable Goods depreciation calculation CSIC.pdf

Financial Annexes\ Annex 19 - Durable Goods depreciation calculation\ Useful life of durable goods for depreciation calculation USC.pdf

Annex 20 – Requested documents by the EC in the answer to the MidTerm Report (22 September 2016)

These documents are also available in electronic format:

Financial Annexes\ Annex 20 - Requested documents in Mid Term Report 22092016

Annex 21 - Travel expenses reimbursement rules for IEO, IIM-CSIC, USC and CETMAR

This document is also available in electronic format:

Financial Annexes\ Annex 21- Annex 21 - Travel expenses reimbursement rules for IEO, IIM-CSIC, USC and CETMAR\ Real Decreto 462_2002.pdf

Annex 22 – Deliverable E2.2: Final Report on the results and main achievement of networking activities

This document is also available in electronic format:

Administrative Annexes\Annex 22 – Deliverable E2.2\Deliverable E2.2.pdf

Annex 23 – LIFE iSEAS videos developed

These files are available in electronic format:

Dissemination Annexes\Annex 23 – LIFE iSEAS videos