iSEAS

MARTEC18

International conference on advances in marine technologies

applied to discard mitigation and management

2 · 4 May 2018 | VIGO · Galicia (SPAIN)

INSTITUTO DE INVESTIGACIONES MARINAS

CSIC
Consejo Superior de Investigaciones Científicas


MARTEC18

WELCOME

International conference on advances in marine technologies

applied to discard mitigation and management

Dear Colleagues,

Welcome to the International **Conference on Advances in Marine Technologies Applied to Discard Mitigation and Management (MARTEC'18) 2018**, which is held in Vigo, Spain, from 2nd to 4th May 2018.

The **MARTEC'18** Conference focuses on innovative solutions to meet the requirements of the recent fishing policies, ensuring the sustainability of marine resources and the long term viability of the fishing sector. It is organized under the framework of the LIFE iSEAS Project, funded by the DG Environment of the EC (www.lifeiseas.eu).

On behalf of the Organizing Committee of **MARTEC'18**, I would like to cordially thank you for attending the conference and actively participate in its technical sessions.

Vigo, the biggest city in the northwest of Spain with one of the most important fresh fish ports worldwide, is hosting the MARTEC Conference. The Institute of Marine Research (IIM) of the CSIC will be the institution in charge of the congress organization, in collaboration with the Technological Center of Sea (CETMAR) and with the support of all partners of LIFE iSEAS (IEO, CESGA, USC, JOSMAR, OPROMAR).

We hope you will also enjoy your participation in our Conference.

Professor Ricardo I. Pérez-Martín
President of the MARTEC'18 Scientific & Organizing Committee
Coordinator of the LIFE iSEAS Project


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introduction

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Discarding is the practice of returning unwanted, usually deceased, catches to the sea due to economic or legislative reasons. Discards constitute a purposeless waste of valuable marine resources which plays an important role in the depletion of marine populations.

Practically all fishing gears catch a certain amount of unwanted or non-targeted species and specimens, representing approximately 20 Mt/year worldwide, 5.2 Mt/year of which are generated in the EU.

Discards are the result of a conflict of three complex systems: economy, environment and policy (social). There is a need to upgrade and integrate knowledge about the three systems to clearly understand the areas of intersection and conflict and bridge possible solutions. Knowledge should progressively facilitate solutions, but the complexity of the problem is high and there will always remain barriers such as the natural human resistance to change.

There are two main common approaches to address the discard problem:

i) Reducing by-catch.
ii) Increasing by-catch utilization.

As these two harvesting strategies may be complementary, an appropriate balance between by-catch reduction and utilization is desirable for any fishery, being the first option the most desirable in terms of environmental impacts and pursued sustainability of marine resources.

The new regulatory framework forces the fishing industry to adapt the fisheries management and practices to the new rules. The objective is to improve fishing behavior through research in selectivity, monitoring as well as other solutions to minimize and manage unavoidable discards.

By 2019 all species subject to TACs regulation and those below the minimum sizes will no longer be permissible for discard. As a result, the entire catch must be kept regardless of age, size or species and quantified on board, landed, counted against the quotas and managed in land as residue and/or byproduct/resource. In contributing to the implementation of these new European regulations for a sustainable exploitation of fisheries, simultaneous actions covering both socio-economic and technological aspects are needed in both above mentioned approaches to deal with the discards problem.

The **MARTEC18** Conference event will be focused in the R+D+i oriented to global societal needs, looking for innovative solutions to meet the requirements to comply with this new legal framework while ensuring the sustainability of marine resources and the long term viability of the fishing sector as well. Therefore, the meeting is open to commercial interests, government agencies and academic expertise. Selected papers will be published on a Special issue of Marine Policy (Elsevier).

The **MARTEC18** program will be covered and elaborated through the following five session topics:

1. Advances on-board: Innovative gears and identification/quantification of the total catch.

2. Data management and processing: Definition of an efficient modelling of fishing activity and new policies for resources assessment.

3. Solutions in land: Innovative management solutions for the landing obligation compliance.

4. Environmental and socio-economic implications of recent fishing policies: Determining the lowest-impact BATs (Best Available Techniques) to complain with them.

5. The future of the fishing sector: Threats and opportunities beyond 2019. Round table with experts.

Vigo, the biggest city in the northwest of Spain with one of the most important fresh fish ports worldwide, is hosting the MARTEC Conference. See more info about our beautiful city in: **www.turismodevigo.org**

The Institute of Marine Research (IIM) of the CSIC will be the institution in charge of the congress organization, in collaboration with the Technological Center of Sea (CETMAR) and with the support of all LIFE iSEAS partners (IEO, CESGA, USC, JOSMAR, OPROMAR).

The venue will be the Sede Afundación · Vigo (Policarpo Sanz, 24-26).
See **www.afundacion.org/es/centros/centro/centro_social_afundacion_vigo** for further info about the venue.

MARTEC18

programme

International conference on advances in marine technologies

applied to discard mitigation and management

MAY

Wednesday, 2nd

08:30 • Registration

09:30 • Welcome session

09:45 • Opening session

KEYNOTE SPEAKER:
Mr. Rashid Sumaila (University of British Columbia, Canada)
"The role of climate change, fisheries subsidies and large scale high seas protection on the conservation and fair sharing of the global ocean"

10:30 • THEMATIC SESSION TOPIC 1: ***Advances onboard***

CHAIRMAN:
Mr. Juan Santos (Thuenen Institute, Germany)
"Bycatch reduction at sea: Expanding the toolbox in the view of the EU Landing Obligation"

INVITED SPEAKER:
Mr. Greg Hamman (Marine Instruments, Spain)
"Discard Monitoring and Evaluation with Electronic Monitoring Technologies"

11:00 • Coffee break

11:30 • THEMATIC SESSION TOPIC 1: ***Technical talks***
(10' talk + 2' questions)

Ms. Dorothee Koop (IFEREMER, France)
"A promising selective device for multi-species trawl fisheries: the T90 cylinder"

Ms. Lucy Southworth (University of Bangor, United Kingdom)
"Trialling disruptive technology using a square mesh panel incorporating artificial light to reduce bycatch in the Isle of Man queen scallop trawl fishery"

Ms. Sonia Méhault (IFREMER, France)
"Escapement patterns of red mullet and horse mackerel facing three different trawl selective devices"

Ms. Catalina Román (IFOP, Chile)
"Rigid separation grid device in demersal trawls fisheries: Have implications in discard reduction?"

Mr. Barry O'Neil (DTU, Denmark)
"Using illuminated grids to separate fish in the codend extension"

Mr. Amos Barkai (OLSPS, South Africa)
"OLRAC Electronic Logbook and Image-Recognition Solutions: A fully integrated Electronic Monitoring and Reporting (EMR) solution"

Mr. Sebastian Uhlman (ILVO, Belgium)
"Digital image analysis of flatfish injuries"

Mr. Carlos Vilas (IIM-CSIC, Spain)
"An innovative technology for on board automatic identification and quantification of the catch"

Ms. Cristina Barragán (University of Cádiz, Spain)
"Physiological recovery after bottom trawling as a method to manage discards: the case study of Nephrops norvegicus and Squilla mantis"

Mr. Ignacio Ruiz-Jarabo de la Rocha (University of Cádiz, Spain)
Evaluation of survival capacity and physiological recovery after longline capture of the blackspot seabream (Pagellus bogaraveo)

Mr. Fernando Martín (University of Vigo, Spain)
"Use of computer vision on board to monitor discards"

14:00 • Lunch

15:00 • THEMATIC SESSION TOPIC 2: ***Data Management and Processing***

CHAIRMAN:
Mr. Petri Suuronen (Luke, Natural Resources Institute - Finland)
"Solutions for data acquisition, management and processing of fisheries discards, with potential contribution for fisheries management"

INVITED SPEAKER:
Ms. Cristina Morgado (European Fisheries Control Agency, Spain)
"Discards estimates as a tool to evaluate compliance"

INVITED SPEAKER:
Mr. Xosé Tubío (S.G. Control and Inspection - MAPAMA, Spain)
"Electronic tools in place in Spain for catch reporting and quota management"

16:00 • THEMATIC SESSION TOPIC 2: ***Technical talks***
(10' talk + 2' questions)
Ms. Amparo Pérez (FAO, Italy)
"Discards in European demersal fisheries"

Mr. Amos Barkai (OLSPS, South Africa)
"The development and use of a "real-time" data management system with a map-based interface to better inform the management of Shetland islands' inshore fisheries: A case study"

Ms. Maitane Grande (AZTI, Spain)
"Taking another step forward: system of verification of the Code of Good Practices ***in the Spanish tropical tuna purse seiner fleet operating in the Atlantic, Indian and Pacific oceans"***

Mr. José María Bellido (IEO-Murcia, Spain)
"Predicting possible fishing strategy outcomes due to the EU landing obligation"

Mr. Petri Suuronen (Luke, Natural Resources Institute · Finland)
"Monitoring and management of fisheries discards"

Mr. Francisco Landeira (CESGA, Spain)
"Spatial Data Infraestructure technologies applied in LIFE iSEAS project to improve efficient fishing"

17:30 · 18:30 • Coffee break and Poster Session

19.30 • Bus to the MARTEC18 Welcome Reception. Departure point at MARTEC'18 Venue. (C/ Policarpo Sanz, 24-26)

20:00 • Welcome Reception hosted by Concello de Vigo · **Pazo de Quiñones de León**

MAY
Thursday, 3rd

06:30 · 08:30 • Visit to the Fish Auction of the Port of Vigo

09:45 • Opening session

KEYNOTE SPEAKER:
Mr. Tom Catchpole (CEFAS, United Kingdom)
"Advances in Marine Technologies Applied to Discard Mitigation and Management"

10:30 • THEMATIC SESSION TOPIC 3: ***Solutions in land***

CHAIRMAN:
Ms. Begoña Pérez-Villarreal (EIT Food CLC South, Spain)
& Mr. Jean Pascal Bergé (former IDMer Director, France)
"Small decentralized processing unit or large scale processing plant?"

INVITED SPEAKER:
Mr. David Cabanelas (Valora Marine Ingredients S.L., Spain)
"Use of discards for valorization fishmeal and pet food"

11:15 • Coffee break

11:45 • THEMATIC SESSION TOPIC 3: ***Solutions in land (Cont')***

INVITED SPEAKER:
Mr. Javier Borderías (ICTAN-CSIC, Spain)
"By-catch valorization in Galician waters"

INVITED SPEAKER:
Mr. Mike van't Land (ILVO, Belgium)
"Potential valorisation of by-products from the Belgian fisheries: fish silage as protein source in animal feed"

INVITED SPEAKER:
Mr. Ricardo I. Pérez (IIM-CSIC, Spain)
"A Smart pilot plant to valorize biomass associated to the new landing obligation: The LIFE iSEAS initiative"

12:50 • THEMATIC SESSION TOPIC 3: ***Technical talks***
(10' talk + 2' questions)

Mr. Bruno Iñarra (AZTI, Spain)
"Simplified methodology for the selection of an option for unavoidable unwanted catches valorization"

Mr. Xosé Antón Vázquez (IIM-CSIC, Spain)
"Marine peptones production from biomass due to the Landing Obligation"

Mr. Raul Pérez (University of Granada, Spain)
"Production and fractionation of tuna by-products protein hydrolysates by ultra and nanofiltration"

Mr. Luis Taboada (IIM-CSIC, Spain)
"Production of fish protein hydrolysates (FPHs) from three fish species discarded: from lab to pilot plant"

Ms. Mónica Carrera (IIM-CSIC, Spain):
"Potential bioactive peptides from the sarcoplasmic fish proteome"

14:00 • Lunch

15:00 • THEMATIC SESSION TOPIC 4:
Environmental and socio-economic implications of the Landing Obligation

CHAIRMAN:
Mr. Francesc Maynou (ICM-CSIC, Spain)
"Environmental and socio-economic implications associated to the implementation of the Landing Obligation"

INVITED SPEAKER:
Mr. Sveinn Agnarsson (University of Iceland - Iceland)
"Using multi-criteria analysis to assess socio-economic impacts of change in management: The case of the Icelandic cod"

15:30 • THEMATIC SESSION TOPIC 4: ***Technical talks***
(10' talk + 2' questions)

Mr. Gonzalo Rodríguez (University of Santiago de Compostela, Spain)
"Value of time spent in additional tasks imposed by the landing obligation"

Ms. Julia Calderwood (Marine Institute, Ireland)
"Simulations showing how the use of discard hotspot maps could help reduce the economic impact of the landing obligation for Irish vessels"

Mr. José María Bellido (IEO-Murcia, Spain):
"Coastal areas and small pelagic discards: a spatial planning approach"

Ms. Marian Torres (University of Algarve, Portugal)
"Ecological impacts of adopting the discard ban policy in the deep-water crustacean trawl fishery off southern Portugal"

Ms. Xela García (University of Santiago de Compostela, Spain)
"Ecological footprint implications of discards reduction in selected fisheries"

Mr. Gonzalo Rodríguez (University of Santiago de Compostela, Spain)
"Input-output analysis of the economic impact of the landing obligation enforcement"

Mr. Francisco J. Ferreiro (University of Santiago de Compostela, Spain)
"Economic result of the valuation of discards through the iDVP of the Port of Marín"

17:30 · 18:00 • Coffee break and Poster Session

20:00 • Bus to the Gala Dinner. Departure point at MARTEC'18 Venue.
(C/ Policarpo Sanz, 24-26)

20:30 • Gala Dinner. **Pazo Los Escudos Hotel y Spa**

MAY
Friday, 4th

THEMATIC SESSION TOPIC 5: ***The future of the fishing sector***

09:15 • Opening session

KEYNOTE SPEAKER:
Mr. Ernesto Penas (DG Mare)
"Implementing the landing obligation under the Common Fisheries Policy"

10:00 • Round table with experts from different stakeholders

MODERATOR:
Mr. Ernesto Penas (DG Mare)

PARTICPANTS (One introductory talk per participant):

- **Mr. Nikos Zampoukas** (DG Research)
- **Mr. Santiago Urquijo** (DG Environment)
- **Mr. Pingguo He** (FAO, Rome)
- **Mr. Juan Carlos Martín Fragueiro** (OPROMAR, Spain)
- **Mr. Rafael Centenera Ulecia** (Secretary General for Maritime Fisheries, Spain)

11:00 • Coffee break

11:30 • Round table with experts from different stakeholders (Cont')

12:15 • General discussion with the audience

13:30 • Closing Ceremony of MARTEC'18

16:30 · 20:30 • Visit to Islas Cíes, part of the **"Islas Atlánticas National Park"**
Limited seats available

MARTEC18

MAY
Wednesday, 2nd

topic 01

"advances onboard"

A promising selective device for multi-species trawl fisheries: the T90 cylinder

AUTHORS: Dorothée Kopp[1], Fabien Morandeau[1], Camille Vogel[2], Maud Mouchet[3], Sonia Méhault[1]

[1] IFREMER, Unité de Sciences et Technologies halieutiques, Laboratoire de Technologie et Biologie Halieutique, 8 rue François Toullec, F-56100 Lorient, France
[2] IFREMER, Department of Biological Resources and Environment/ Fisheries Science for the English Channel and North Sea/Fisheries Resources Laboratory, Avenue du Général de Gaulle, F-14520 Port-en-Bessin-Huppain, France
[3] UMR 7204 MNHN-UPMC-CNRS Centre d'Ecologie et des Sciences de la Conservation CP135, 43 rue Buffon, 75005 Paris, France

In the Bay of Biscay, the selective properties of bottom trawls are mainly studied from a single species point of view. Current research mostly focused on *Nephrops* or hake and identified several technical measures that could be used to avoid undersize individuals in the catch (e.g. square mesh panel for hake or 80mm codend for *Nephrops*). However, for bottom trawl mixed fisheries targeting fish, it remains challenging to find a selective device that allows limiting catches of small individuals of several species without commercial losses. The present study focuses on an innovative technical solution to reduce catches of undersized individuals in a bottom trawl multi-species fishery from the Bay of Biscay. More precisely, we present new results on a cylinder composed of 100mm T90 meshes mounted in the extension piece for 6 species of commercial interest. The selectivity study *was implemented using* a fine-mesh size cover designed to collect escaping fish from the trawl extension section. The device is efficient at letting escape small individuals of *Solea solea*, *Trachurus trachurus* and *Spondyliosoma cantharus*. No commercial losses of Sepia officinalis were recorded. Patterns for *Dicentrarchus labrax* and *Mullus surmuletus* require further investigation due to limited size ranges in the data.

Reducing discard of undersized fish in the Celtic Sea, a study combining size selectivity assessment and catch comparison analysis

AUTHORS: Paul Gatti[1], Sonia Méhault[1], Fabien Morandeau[1], Marie Morfin[1], Marianne Robert[1]

[1] Ifremer, LTBH (Laboratory of Fisheries Technology and Biology). Station de Lorient, 8 Rue François Toullec, 56100 Lorient

This study dealt with the implementation of a square mesh cylinder (SMC), with a 100 mm mesh size, in addition to the mandatory square mesh panel (SMP) and its ability to improve the size selectivity of important target species for fleets fishing in the Celtic Sea, i.e. whiting and haddock. Analyses were based on the results of the project CELSELEC, which was supported by a partnership between the producer organisation "Pêcheurs de Bretagne" and Ifremer. Comparisons were based on twin trawl experiments conducted from commercial fishing vessels. The methodology proposed combined both selectivity and catch comparison approaches. First, the size selectivity of the whole gear was assessed for whiting, haddock and megrim. The combination of position of the SMC and of an additional dispersive device resulted in 4 different configurations. The catches at length of the test gear were compared to the catches (at length) of the control gear equipped with a 20 mm mesh size. Second, landings and discards weights and rates were compared between experimental devices and the standard gear currently used by the industry. Catch comparison analyses were carried out for a panel of species of economic importance, as well as for unwanted by-catch species. This combined approach delivered knowledge of both scientists and fishermen interests. First, assessing the reduction of discards balanced with the probability of commercial size escapement are of major concern for the industry. Second, catch comparison models and selectivity parameters of new gears are essential inputs to test management scenario under the EU landing obligation of undersized fish.

Escapement patterns of red mullet and horse mackerel facing three different trawl selective devices

AUTHORS: Sonia Méhault[1], Marie Morfin[1], Jean Pierre Cuillandre[2], Pascal Larnaud[1], Fabien Morandeau[1], Dorothée Kopp[1], Thomas Rimaud[2]

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[2] AGLIA, 6 rue Alphonse Rio, 56100 Lorient, France

The landing obligation implemented under the Common Fisheries Policy promoted the development of fishing gear selective devices. In the Bay of Biscay, a collaborative project between scientists and fishermen tested various innovative trawl devices among which a 90mm square mesh panel placed on the tapered section, an extension piece made of a 100mm T90 mesh cylinder, and a 70mm T90 mesh codend. Each selective device was tested separately using the twin trawl method for catch comparison on board of commercial vessels. The data analysis focused on red mullet (*Mullus surmuletus*) which is of high commercial value and horse mackerel (*Trachurus trachurus*) which represent a large component of the discard fraction. We tested the underlying hypothesis that the functional traits of the species determine the position and the selective device they will escape through. It resulted that red mullet escaped mainly through the T90 codend, whereas horse mackerel escaped through any of the three devices tested. The behavior and the ecology of both species are discussed with respect to the proportion retained by the experimental gears. Such results have direct application in mixed fisheries where fishermen have now to make selective devices their own according to the specificities and species composition of their fisheries.

Physiological recovery after bottom trawling as a method to manage discards: the case study of Nephrops norvegicus and Squilla mantis

AUTHORS: C. Barragán-Méndez[1], I. Sobrino[2], Y. Vila[2], C. Farias[2], J.M. Mancera[1] and I. Ruiz-Jarabo1[3]

[1] Departament of Biology, Faculty of Marine and Environmental Sciences, Universidad de Cádiz, Campus de Excelencia Internacional del Mar (CEI-MAR), Av. República Saharaui s/n, E-11510 Puerto Real, Cádiz, Spain.
[2] Instituto Español de Oceanografía (IEO), Centro Oceanográfico de Cádiz, Puerto Pesquero, Muelle de Levante, s/n, PO Box 2609, E-11006 Cádiz, Spain.
[3] Instituto de Ciencias Marinas y Limnológicas, Facultad de Ciencias, Universidad Austral de Chile, casilla 567, Valdivia, Chile.

European Union Common Fisheries Policy (CFP) propose a progressive discards elimination. To achieve this target all captured species with Total Allowed Captured (or TAC) will be landed by 2019. However, an exception to this law includes that those species which survival is scientifically proven, can be released to the sea. The main goal of the present study is to evaluate survival and recovery capacity of two crustacean species commercially relevant in the South of Europe after bottom trawling. Spain manages *Nephrops norvegicus* (Norway lobster) under the TAC scheme within the CFP. On the other hand, unless *Squilla mantis* is not managed under TAC, it has high commercial value in the South Western Atlantic waters of Europe. Moreover, survival and recovery were evaluated in Spring and Autumn. To achieve these targets, we conducted two experiences aboard a bottom trawling vessel in the Gulf of Cadiz (SW Spain). To evaluate the recovery processes, captured animals were maintained in individual tanks in a flow-throw system. Haemolymph and muscle samples were taken just after capture and sorting procedures (0 h), and 1, 3, 6 and 24 h later. The analysis of collected tissues included stress biomarkers related to energy management and the immune system. Results showed that both species were completely recovered 24 hours after trawling. The survival rates showed differences according to the season. In conclusion, this study offers a new methodology to evaluate not only survival but recovery capacity of *N. norvegicus* and S. mantis after bottom trawling. Fisheries stakeholders handling may be thus enriched in the management of discards reduction.

Evaluation of survival capacity and physiological recovery after longline capture of the blackspot seabream (*Pagellus bogaraveo*)

AUTHORS: I. Ruiz-Jarabo[1, 2], C. Barragán-Méndez[1], M. Fernández-Castro[1], I. Jerez-Cepa[1], M. Pérez[3], E. Pérez[3], J. Canoura[4], J. Gil[5], J.M. Mancera[1] and I. Sobrino[5]

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[4] TRAGSATEC, C/Julián Camarillo, 6B, E-28037 Madrid, Spain.
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European commitment to ban fisheries discards establishes the landing of all captured fish by the year 2019. In NE Atlantic, this must be fulfilled for those species with Total Allowed Catch (and quotas) not meeting the minimum conservation reference size. However, if survival and recovery are guaranteed after the capture, discards could be released into the wild. Studies on this topic are gaining momentum and should include all species, geographic areas and fishing gears. The aim of this study was to evaluate survival rates and physiological recovery of the blackspot seabream (*Pagellus bogaraveo*) captured in the Strait of Gibraltar with a longline gear, locally called "voracera". Several experimental approaches were established: onboard and ground experiments. Blackspot seabream were captured with a fishing boat and maintained 5 hours in onboard water tanks. Survival rates after this time were above 90%. In order to evaluate the physiological recovery of survivors we also conducted another onboard experiment: blood samples were collected just after capture for the analysis of stress biomarkers. Then, fish were also maintained in other onboard water tanks and sampled 5 hours later. To validate the physiological recovery of these captured animals a third experiment was performed in ground facilities. Our results show that blackspot seabream were acutely stressed immediately after its capture, but the survivors were able to successfully recover. Notwithstanding the high survival rates of captured blackspot seabream, we can conclude that released fish below the minimum conservation reference (33 cm Total Length) are physiologically capable of surviving in the sea. With this study we pave the way to further studies on other fisheries in Europe and contribute with a robust methodology for their management. In summary, we hereby offer a holistic approach to evaluate not only survival rates of captured fish but also recovery capacities of released discards.

OLRAC RTI: a novel and operational approach to holistic fisheries management

AUTHORS: Amos Barkai [1], Sarah B. M. Kraak [2, 3], Dave G. Reid[3]

[1] OLSPS, Silvermine House, Steenberg Office Park, Tokai, Cape Town, South Africa
[2] School of Biological, Earth & Environmental Sciences, University College Cork, Ireland
[3] Marine Institute, Rinville, Oranmore, Co. Galway, Ireland

In the face of political and environmental uncertainty, management methods need to be able to change, respond to, and adapt with, the resource whose exploitation they are intended to manage, the people who are being managed, and the framework in which they operate. The Real-Time Incentives (RTI) fisheries management approach integrates mixed-fisheries targets and ecosystem objectives into a single 'currency'. In this approach, fishers would be allocated fishing-impact credits, called RTIs, to spend according to spatiotemporally varying tariffs, replacing the conventional landings quota.

The RTI system requires the use of real-time technology to monitor vessels' whereabouts and rate of RTI usage. OLSPS has developed such an electronic logbook, the Olrac Dynamic Data Logger (OlracDDL) which is linked to an onshore data management system, the Olrac Dynamic Data Manager (OlracDDM). The solution allows users to avoid high bycatch areas and thereby preventing the premature closure of their fishing season, and demonstrate a novel way to manage fishing effort that is user centric by design.

In light of Ecosystem Based Approach to Fisheries Management, and in particular in the context of the European Union landings obligation, the integrated RTI fisheries management approach could offer a practical solution that addresses some of the problems inherent in a multi-objective fishery system.

OLRAC electronic logbook and image-recognition solutions: A fully integrated electronic monitoring and reporting (EMR) solution

AUTHORS: Amos Barkai[1]

[1] OLSPS, Silvermine House, Steenberg Office Park, Tokai, Cape Town, South Africa

European commitment to ban fisheries discards establishes the landing of all captured fish by the year 2019. In NE Atlantic, this must be fulfilled for those species with Total Allowed Catch (and quotas) not meeting the minimum conservation reference size. However, if survival and recovery are guaranteed after the capture, discards could be released into the wild. Studies on this topic are gaining momentum and should include all species, geographic areas and fishing gears. The aim of this study was to evaluate survival rates and physiological recovery of the blackspot seabream (*Pagellus bogaraveo*) captured in the Strait of Gibraltar with a longline gear, locally called "voracera". Several experimental approaches were established: onboard and ground experiments. Blackspot seabream were captured with a fishing boat and maintained 5 hours in onboard water tanks. Survival rates after this time were above 90%. In order to evaluate the physiological recovery of survivors we also conducted another onboard experiment: blood samples were collected just after capture for the analysis of stress biomarkers. Then, fish were also maintained in other onboard water tanks and sampled 5 hours later. To validate the physiological recovery of these captured animals a third experiment was performed in ground facilities. Our results show that blackspot seabream were acutely stressed immediately after its capture, but the survivors were able to successfully recover. Notwithstanding the high survival rates of captured blackspot seabream, we can conclude that released fish below the minimum conservation reference (33 cm Total Length) are physiologically capable of surviving in the sea. With this study we pave the way to further studies on other fisheries in Europe and contribute with a robust methodology for their management. In summary, we hereby offer a holistic approach to evaluate not only survival rates of captured fish but also recovery capacities of released discards.

A novel, spatially based, real-time software solution for the avoidance of "chock" bycatch species

AUTHORS: Amos Barkai[1], Ronald Smolowitz[2] and Heidi Henninger[3]

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[2] Ronald Smolowitz, Coonamessett Farm Foundation, (www.coonamessettfarmfoundation.org)
[3] Heidi Henninger, OLSPS North America East (www.olsps.com)

In order to collect higher quality fishery-dependant data, the Northeast US limited access scallop fleet needed to develop a real-time electronic bycatch monitoring and reporting system. The objective of this system is to have the fishermen report their bycatch and scallop catch in real-time electronically to a central database.

These data will then be anonymized and made available to the entire fleet in order to alert the fishermen to areas of high bycatch CPUE areas. This would allow fishers to make informed decisions regarding where to fish in order to avoid or reduce the yellowtail flounder bycatch, and possibly a premature closing of the access area.

OLSPS (formerly Olrac SPS), a South African company, was contracted in 2011 by the Coonamessett Farm Foundation (CFF) on behalf the Northeast US scallop fleet to develop such a software tool. The Olrac Electronic Logbook (eLog) tool was delivered to CFF by the end of 2012. After more changes and fine tuning a full system was delivered in 2014. The Olrac eLog system included two components: a) Onboard, GIS-based, vessel unit (Olrac Dynamic Data Logger): used to record data and send reports to the shore; b) Web based, Shore unit database (Olrac Dynamic Data Manager): used to aggregate and analyse reports sent from the vessel units and transmit aggregated by-catch ratio density maps back to the fleet. This allow vessels to view the bycatch ratio density map on their Olrac GIS system and avoid areas of high bycatch ratio. The system is now fully operational and is used onboard 15 vessels (soon to be 50 vessels) as a pilot project.

Using illuminated grids to separate fish in the codend extension

AUTHORS: F G O'Neill[1], K Summerbell[2] and Luisa Barros[3]

[1] Technical University of Denmark, National Institute of Aquatic Resources, Willemoesvej 2, 9850 Hirtshals, Denmark.
[2] Marine Scotland Science, PO Box 101, 375 Victoria Road, Aberdeen AB11 9DB, UK
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We present the results of experimental trials to investigate the effect that an illuminated grid may have on the behavioural reaction of fish in the extension section of a demersal trawl. The grid had a fibre optic cable attached to it that could be illuminated by an LED.

During one set of trials the grid was mounted at a 60 degree angle near the start of the extension. Fish that went through the top half of the grid were retained in an upper codend and those that went through the bottom half were retained in a lower one. Four different lighting configurations were investigated: (i) all of the grid illuminated; (ii) top-half of grid illuminated; (iii) bottom-half of grid illuminated; and (iv) no illumination. Half of each days tows took place during daylight hours and half during the night.

During the second set of trials the grid was mounted horizontally in the panel that vertically separated the extension section. A guiding panel was fitted ahead of the separator panel. When the guiding panel was attached to the top sheet, fish were directed into the lower half of the extension from where they could either swim up through the grid and to the upper codend or swim past the grid to the lower codend. Similarly, when the guiding panel was attached to the bottom sheet, fish were directed to the upper half of the extension from where they could swim down though the grid and onto the lower codend or past the grid to the upper codend. Four different configurations were tested during these trials: (i) illuminated grid in top sheet; (ii) non-illuminated grid in top sheet; (iii) illuminated grid in bottom sheet; and (iv) non-illuminated grid in bottom sheet. These tows all took place during daylight hours.

Rigid separation grid device in demersal trawls fisheries: have implications in discard reduction?

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The common hake (*Merluccius gayi*) bottom-trawl fishery in Chilean waters is an emblematic multi-species demersal fishery, where the target specie and the giant squid (*Dosidicus gigas*) often constitute the main by-catch problem. This issue has been monitored since 2013 when a modification in the Chilean Fisheries Law was introduced in order to modified regulations on this subject, sanctions for those engaged in this practice and carry out a research program in main demersal fisheries of Chile, especially bottom trawl fisheries. At date, discard and bycatch estimations suggest a decline from 5000 tons to 1000 tons of total discard, reducing the proportion of common hake and giant squid from 2015. This reduction seems to be coincident with the introduction of a rigid separation grid in bottom trawl gears in 2015 where some of the ships starts to use this device. In this work, we evaluate if the device constitutes an important factor of discard variation over time. In this sense, the use of this rigid separation grid was evaluated comparing hauls with and without device and a general linear model was applied considering discard by haul as a response variable and temporal, spatial and operational factors including grid, as predictive variables.

Use of Computer Vision on Board to Monitor Discards

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I. OVERVIEW

This communication is about an experience of designing a computer vision system to be used on board of fishing vessels to monitor discards. System is implemented as a closed box that contains both camera (and an appropriate lens) and an industrial computer. This box should be appropriately fixed on the conveyor belt of the fish processing room. External lighting system is also needed. The idea is that system should be able to photograph all the catch that comes from the nets and also to use computer vision algorithms to identify fish species from a pre-defined catalogue. We will describe hardware design and also software and algorithms.

II. HARDWARE DESIGN

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).

We have tested different cameras, final election is JAI GO-5000C (big image sensor: 1" and C-mount for optics, resolution above 5 Mpixels). As belt width (and also the height of installation) can be very variable from one ship to another, varifocal lenses are more practical here.

Industrial PC is a fan-less model with solid state disk. Prototypes can also be equipped with an external disk to save captured images (to be used later in refining computer vision software).

A magnetic (hall effect) sensor is used to generate a synchronization signal for capturing images at constant belt advances.

Lighting should to provide a constant soft light rectangle on the belt. For that issue, we use a pair of LED strip lights at both sides of the belt. Height and angle of these lights can be modified to minimize shadows and light variations. Experience has demonstrated that better results would be achieved with a closed lighting camera with indirect lighting. Nevertheless, such a system can be very difficult to be installed in a real vessel.

III. COMPUTER VISION SOFTWARE

Software was designed using real images captured in "laboratory" installations but also in oceanographic vessels. Software was designed in two phases yielding two operating versions:

- MATLAB version: designed in the well-known, prototyping tool MATLAB. Appropriate for testing methods.
- C++ version. More appropriate for final use. Uses standard C++ and OpenCV library. It is developed from the MATLAB version and it is the one used in the boxes.

User of the application should follow this work flow:

- Camera configuration (capture parameters), helped by the suitable application section.
- Camera calibration (white balance and conveyor belt colour configuration) also in the application.
- Species catalogue creation: user must present to the system examples of the species of interest so that the catalogue can be created (catalogue can be created at a lab installation and then copied onboard).

Computer vision steps are the following:

- Conveyor belt removing, so that we only retain information about the specimens.
- Specimens segmentation: this is the more difficult part as "general" segmentation of touching objects in an image is a non-solved problem. Experience has showed that most errors can be removed if we can make that specimens will never be touching (using appropriate industrial equipment) so that this stage can be skipped.
- Species recognition: system uses information from colour, texture and (only if specimens do not touch) contour shape to recognize species comparing to information saved in the catalogue.

An Innovative Technology for On Board Automatic Identification and Quantification of the Catch

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In this work we present an electronic device (the iObserver) that can be installed on board fishing vessels to identify the species in the catch, estimate the length of each individual and quantify the biomass without interfering with the activity of fishermen.

The iObserver consists of an industrial (computer vision) camera and a processing unit (industrial PC) equipped with image recognition software developed in collaboration with the University of Vigo. The hardware includes a main box and a lighting system. Both units are waterproof and have been designed to operate in a harsh environment.

Software consists of: (i) an intuitive graphical user interface (GUI) that requires minimal interaction with the user; (ii) computer vision algorithms which, based on color and texture fish properties, are able to perform species identification (including length and weight estimation) from the pictures taken with the camera.

The GUI can be used to: (i) calibrate the system, i.e. adapt it to the lighting conditions as well as velocity and color of the conveyor belt; (ii) train new species; (iii) perform species identification of the catch; and (iv) send the identification results to the RedBox which will process the information and transmit it to land in real time.

The iObserver was also designed to estimate the conveyor belt velocity using the signals received from a sensor system. This velocity is used to adapt the frequency at which pictures are taken so that data from the whole catch is captured without repetition.

The system will allow improving the quality and availability of data so to deepen knowledge on the status of the fisheries resources.

Trialling disruptive technology using a square mesh panel incorporating artificial light to reduce bycatch in the Isle of Man queen Scallop Trawl fishery

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Under the EU *landings obligation*, the Isle of Man queen scallop (*Aequipecten opercularis*) fishery has the potential to choke as the quota for non-target species such as haddock (*Melanogrammus aeglefinus*), cod (*Gadus morhua*) and whiting (*Merlangius merlangus)* is reached before the quota of the target species. This study provides evidence that the catch rate of bycatch species can be reduced while target catch rate is maintained. Commercial trials to develop species-selective trawl gear were conducted using a paired tow design whereby a control net was towed parallel to a treatment net with either: 1) a square mesh panel or; 2) a square mesh panel incorporating six white LED lights, inserted into a traditional all diamond mesh otter trawl. The trial consisted of 70 paired tows, over three fishing grounds. The square mesh panel was most effective in medium depths (29-40m) with high ambient light levels, significantly reducing lesser spotted catshark (*Scyliorhinus canicula*) bycatch by 34% and whiting by 82%. Similar catch rates were observed when fishing with the panel and lights in these depths with reductions of whiting bycatch by 77% and haddock by 55%. The panel plus lights in deep water (45-95m) with low ambient light levels, reduced bycatch of lesser spotted catshark by 48% and flatfish by 26%. Contrary to expectations, in deep water the square mesh panel incurred increases of haddock bycatch by 47%, while reductions of 44% occurred with the addition of lights to the panel. No reductions of cod bycatch were observed in either treatment over all depths, however relatively few cod were caught overall. These results indicate the importance of understanding species-specific responses to bycatch reduction devices and that determining the influence environmental parameters have on species catchability is key to establishing the most appropriate and effective technical modifications to reduce bycatch.

Improving selectivity in the north Spanish trawl fishery: from juvenile protection to the landing obligation

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Over the past ten years several pilot projects onboard commercial vessels have tested selectivity trawl gears, including square meshes and changes on mesh size and geometry. The selectivity projects have been carried out by Instituto Español de Oceanografia (IEO) working together with fisheries companies and associations. Pilot projects set up the theoretical selectivity measures and selectivity trails have been conducted focused on square mesh, mesh netting geometry and mesh size able to balance the roundfish by-catch avoidance.

From landing obligation implementation on European fisheries, a research scientific program is being carried out at Spanish fisheries. Experimental trials are needed to investigate improvements that increase the escape of the unwanted individuals, especially juveniles below the MLS, before making decisions about the commercial use of this type of codends to reduce discards. It is necessary to define the technical characteristics of the fishing gears, to test and to compare the configurations of T90 mesh that are more suitable (mesh size and number of meshes) and study the effectiveness of the T90 codends for hake. Losses of a fraction of the commercial catch must be taken into account and quantified to assess their influence on the economic viability of fishing with these codends.

The scientific evidence shows that increases in selectivity are not easily achievable in the short term, especially for these mixed fisheries. Taking into consideration the provision for de minimis exemptions detailed in Article 15.4(c) and further in 15.5(c) of Regulation (EU) No 1380/2013 we considered that this de minimis exemption can be applied for several species as hake, anglerfish and four spot megrim in Iberian waters fisheries ICES 8c and 9a (metiers OTB_DEF and OTB_MPD).

Good fishing practices to avoid discards: a method to release live mackerel in trawl fisheries

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Otter bottom trawl targeting pelagic and demersal species in Iberian waters is a mixed bottom trawl fishery which takes place throughout the year. Horse mackerel (*Trachurus trachurus*) and mackerel (*Scomber scombrus*) are taken together with other species, mainly hake. This vessels operate in the continental shelf and upper slope of NW Spanish waters and Cantabrian Sea all year around with a one daily-trip scheme. Main reasons for discarding are quota restrictions and the undersized individuals.

During the first quarter of the year, this metier target mackerel because of its high abundance in north Iberian waters. During fishing hauls, it may happen that more fish than desired are caught due to the behaviour of the mackerel, which appears in long schools of fish and can enter the net in large numbers. The vessels that work in this fishery have an adjusted quota, which annually is not sufficient for their activity and can produce discards due to the lack of quota. They have electronic sensors in the codend to know the loaded of the codend, but it fills up in a few minutes despite the retrieval of the trawl net when the school is too large.

With the aim of reducing the discarding of dead fish, a trawler vessel crew uses a technique for the release of live mackerel. With this good fishing practice, they avoid catching too much mackerel and discarding the unwanted catch. In collaboration with this vessel, a trial was carried out to document and study this technique on board a bottom trawler in the north and northwestern Iberian fishing grounds (ICES 8c and 9a), during early 2017. The data collected indicate that a part of the fish released from the codend, escapes alive from the net with signs of vitality, and could have a high survival. It is a case of good fishing practice, which could be used by the fleet to avoid discarding and the negative consequences of the application of the landing obligation

Selectivity of T90 mesh for juvenile fish in the north Spanish trawl fishery

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Vessels from the two metiers: bottom trawlers targeting demersal species (OTB_DEF_>=55). and bottom trawlers targeting pelagic and demersal species (OTB_MDP_>=55) carry out a mixed fishery targeting hake and other species like four spot megrim, monkfish, blue whiting, mackerel and horse mackerel in north and northwestern Iberian waters (ICES 8c, 9a) all around the year. These métiers are reported to have largely and variable hake discards of an annual rate of 37% (up to 89%). Main reasons for discarding hake are the undersized individuals (< 27 cm) and quota restrictions in all trawl fisheries.

Selectivity trials for hake catches were carried out on board a bottom trawler in the north and northwestern Iberian fishing grounds (ICES 8c and 9a), during autumn 2016. The objective of DESCARSEL trials was to assess the selectivity of the commercial trawl using T90 mesh codends.

The results obtained in the experiments are positive and indicate that a fraction of the capture escapes through the tested codends. A high percentage of hake juveniles was captured in the cover, which indicates that the T90 codend is a possible solution to reduce the discard rates of the species and also of other target and secondary species in the fishery. Based in the results of this study regarding turned mesh T90 in OTB metiers, and the differences found between selectivity of T90 and diamond T0 mesh, selectivity of both metiers could be further improved for hake, blue whiting and horse mackerel.

For the metier OTB_DEF, yields and proportions of hake indicate promising results. Yield of landings were much larger in the codend and discarded hake were found in the cover mainly. The proportion of discarded hake in the codend was 15%, which is lower than the observed in previous discard studies.

For metier OTB_MDP, the results indicates differences in yields and proportions of hake between mesh shapes. The diamond T0 mesh showed a larger proportion of juvenile hake retained in the codend. Results indicate a L50 smaller than T90 estimates, and a lowest escape of small hake in diamond mesh.

Survivability of discarded skates in bottom trawlers: implications to the discard ban

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A detailed study of the discards of skates and rays based on sampling by observers on board commercial vessels and in survival experiments has been carried out by IEO. The project has the objective to study the survivability and reduction of fishing discards to complain with the landing obligation rules. The objective was to obtain the composition of species, size and sex of the species caught in fisheries in the Cantabrian-Northwest fishing ground, to analyze the percentage of mixture of species retained on board or discarded and to obtain survival estimates.

During the fishing evaluation campaign "DEMERSALES", T-bar tags were used to mark skates in good conditions that were kept alive in boxes with seawater. After the sampling of sizes, the specimens were separated for marking and the skates were released from the ship with the greatest possible care.

During the "DESCARSEL" selectivity and survival research trials, the individuals who arrived with signs of vitality to the fishing deck were collected and placed in tanks prepared ad hoc for the trials. The specimens were measured and marked individually. The tanks used are containers of 565 liters of polyethylene in an open system 24 hours of seawater circulation without treatment. The monitoring of the mortality of the individuals was carried out, with continuous observations and videos with underwater cameras to monitor survival times and patterns of behavior of the species.

Digital image analysis of flatfish injuries

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Beam-trawled flatfish are often examined visually to assess their quality, health, freshness, vitality, among other descriptors, by scoring for example the type and extent of external injury. But this may be prone to bias given a potentially subjective interpretation of scoring criteria by individual raters. The purpose of this study was to develop a method and device which can eliminate subjectivity by taking standardized, high resolution images to allow for automated calculation of the surface area of visible bleeding injuries relative to the whole fish based on digital image analysis. Injuries of interest are visible multifocal cutaneous petechiae (termed 'point bleeding'), and suffusion or haemorrhaging (termed 'bruising'). To develop a protocol and device for taking digital images of commercially caught flatfish, a reference library was compiled by photographing 66 fish of six species sourced from the R/V Simon Stevin while beam-trawling in the Belgian coastal zone of the Southern North Sea. Out of these, 53 fish were photographed within two days of their capture (kept on ice, fresh), and 13 fish were defrosted. From this reference library, all images that were neither over- nor under-exposed were compiled and scored for the extent (%) of point bleeding and bruising of the head and body region, respectively by three experienced raters. Then, students of the multimedia analysis course at the University of Gent were tasked to develop a protocol which 1) aligned each image; 2) identified fin, body and head regions; and 3) quantified the surface area of bleeding injury of each region by using appropriate thresholding techniques. For validation, results from the algorithmically obtained surface area % were compared to the three rater's averages. By accurately recording the coverage of externally visible bleeding injury, a newly developed, portable device and protocol may find its applications in measuring the effect of different capture techniques on whole fish or fillet quality, and in improving vitality assessments as part of the transition towards a more sustainable fishery and the implementation of the European landing obligation.

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Taking another step forward: system of verification of the code of good practices in the Spanish tropical tuna purse seiner fleet operating in the Atlantic, Indian and Pacific Oceans

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About half of the tropical tuna caught worldwide annually is fished by purse seiners mainly using fish aggregating devices (FADs). These devices, although being a very effective fishing tool, are also controversial due to their potential impacts on the ecosystem. In order to improve the sustainability of the fishery, the two Spanish tuna purse seiner associations, ANABAC and OPAGAC, established in 2012 a voluntary agreement for the application of good practices for responsible fishing activities. The aim of this agreement is to use best fishing practices by reducing mortality of incidental catch of sensitive species (sharks, rays, mantas, whale sharks, and sea turtles) and the use of environmentally-friendly FADs. The good practices defined in this agreement comprise: the use of non-entangling FADs, 100% observer coverage, training of fishing crew and overseas observers, best releasing practices for sensitive fauna, verification of the number of active buoys per day, and continuous monitoring by an independent scientific body.

In order to monitor and assess the level of compliance of these good practices, a system of verification has been implemented, and is continuously evaluated, in all the vessels of the ANABAC and OPAGAC fleet (64 purse seiners and 23 supply vessels), including both Spanish and other flags operating globally in 4 tuna RFMOs areas (ICCAT, IOTC, WCPFC and IATTC). The verification is based on specifically designed forms and in-situ data recorded by trained scientific observers, and more recently, also by electronic monitoring systems. Fishing practices are assessed for each vessel every semester and results are used to provide scientific advice and correction mechanisms where necessary. These results also serve as base for the steering committee, created specifically to take decisions and assure the viability of the program. Significant results, the code of conduct as well as the verification mechanisms are presented and discussed in this paper, as an example of responsible and self-regulated fishery.

Integrating fishery management measures: the *Lepidorhombus spp.* case study

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Most fisheries management systems rely on a set of regulatory measures to achieve desired objectives. Controls on catch and effort are usually supplemented with gear restrictions, minimum landing sizes, and in the framework of the new common fisheries policy, limitation of discards and by-catch. However, the increasing use of spatial management measures such as marine protected areas (MPAs) or spatial and temporal area closures presents new challenges for fishery managers. Here we present an integrated spatial framework to identify areas in which undersized commercial species are more abundant. Once these areas are identified, they could be avoided by fishers minimizing the fishing impact over the immature fraction of the stocks. In particular we applied this methodology to two species of megrim, *Lepidorhombus whiffiagonis* and *L. boscii,* in ICES Divisions 8c and 9a, analyzing fishery-independent data provided by bottom-trawl surveys and environmental data through Bayesian spatial models. Results show that species exhibit species-specific spatial pattern, but we identified a particular sensible area that could be used for conservation purposes. We discuss how integrating more technical measures together (e.g. minimum size and spatial closures) could be a more effective approach for fishery management.

Discarding less and fishing better in smaller-scale fisheries

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The spatial management of fisheries has been repeatedly proposed as a discard mitigation measure. A number of studies have assessed the fishing suitability in large-scale fishery. Discards from small-scale fisheries (SSF) are usually ignored when compared with industrial fisheries, not only by policy-makers, but also by scientists. Therefore, SSF social, economic, and ecological impacts are poorly known and especially in the discards context. Such neglect is worrisome due to the role that SSF play in food security and poverty alleviation, especially in coastal and rural communities in developing countries. In this study we present a first attempt to identify shrimp fishing suitability areas in a data-poor small-scale fishery in Brazil. In particular, we first identified areas where discards and catches are more abundant, and then we assessed the most economically relevant sites, where the bulk of fishery profits come from. We overlapped these areas by ranking the level of overlap between these sites in order to assess different levels of conflicts between traditional conservation and economic interests. We discuss as the introduction of some flexibility in the way in which fishery management targets are established could contribute to reaching a middle ground where biological concerns are integrated with economic demands.

Spatio-temporal variability of Nephrops norvegicus on the Porcupine bank (West of Ireland)

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Norway lobster (*Nephrops norvegicus*) is a decapod species with a patchy distribution on the continental shelf and upper slope in the Northeast Atlantic. Among the 30 Nephrops Functional Units considered in this area for assessment and management purposes, the so-called Porcupine bank (FU 16) is fished as by-catch by the Spanish bottom trawler multispecies fleet, being one of the most valuable species. In this study, changes in *Nephrops* abundance in the last decades are analysed regarding a combination of environmental factors and changes in the population structure. We assess the spatio-temporal variability of *Nephrops* by sex and size category (i.e. recruits, juveniles and adults), using Species Distribution Models to link fishery-independent data (Spanish Groundfish Survey in the Porcupine bank) with environmental predictors (e.g. sea bottom temperature, bathymetry, slope, rugosity and orientation of the seabed) from 2001 to 2016. Results show habitat preferences for *Nephrops* in the area, and potential sensitive areas are identified for fishery management and conservation purposes. We discuss how improved knowledge of the spatio-temporal distribution of commercially important species and their relationships with the marine environment could form an integral aspect of a precautionary approach.

Protection of Vulnerable Marine Ecosystems in the Northwest Atlantic deep-sea fisheries (NAFO Regulatory Area): integration of survey data in the fisheries management process

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Deep-sea research in areas beyond national jurisdictions provides valuable insights for management of high-sea fisheries and ecosystems. The integration of scientific data in the management processes of the Regional Fisheries Management Organizations (e.g. The Northwest Atlantic Fisheries Organization, NAFO), is necessary for the sustainable exploitation of deep-sea fisheries resources and the conservation of cold-water corals and deep-sea sponges, both considered by the FAO as examples of indicators of Vulnerable Marine Ecosystems (VMEs). In the Northwest Atlantic (NAFO Regulatory Area), data on VMEs indicator species from annual bottom trawl surveys (e.g. EU groundfish surveys) have been integrated in the "ecosystem advisory cycle" in the framework of the "NAFO management process". Survey data has improved our knowledge on VMEs distribution and definition, and has led to the proposal and implementation of conservation measures to prevent the impacts of deep-sea fishing (areas closed to bottom fishing to protect cold-water corals and deep-sea sponges). These data have particular relevance to delineate and to refine the geographical and bathymetrical boundaries of the protected areas, contributing to the sustainability of the deep-sea bottom trawl fisheries (e.g. mitigation of by-catch of vulnerable benthic invertebrates). This study presents how the data on cold-water corals and deep-sea sponges from the EU groundfish surveys in the Northwest Atlantic, have been collected, processed and integrated in the fisheries management process, contributing to the compliance of impact mitigation and ecosystem conservation international policies (e.g. UNGA Resolution 61/105 on sustainable fisheries), in order to conserve biodiversity and to safeguard the sustainability of marine living resources in the high-seas fisheries.

Identification of Vulnerable Marine Ecosystem indicator species-environment relationships using Species Distribution Models: Sea pens (*Anthoptilum grandiflorum*) in the Flemish Cap and Flemish Pass deep-sea fishing grounds (NW Atlantic)

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Sea pen corals are considered key components of Vulnerable Marine Ecosystems (VMEs). They perform important ecological functions and are potentially vulnerable to adverse impacts from bottom fishing gears, particularly bottom trawl. The understanding of their distribution has demonstrated to be of particular relevance to delineate VME protection areas (areas closed to bottom fishing) in the NW Atlantic, contributing to the sustainability of the deep-sea bottom trawl fisheries (e.g. mitigation of by-catch of vulnerable benthic invertebrates) and to the compliance of conservation policies in areas beyond national jurisdictions (e.g. UNGA Resolutions on sustainable fisheries). Species Distribution Models (SDMs) are widely used to identify species-environment relationships and predict species occurrence and/or density at un-sampled locations. The SDMs implementation allows describing species geographical trends, to identify spatial ontogenetic shifts of commercially exploited species and to assess the effect of climate change on species distribution. Moreover, SDMs could be an essential tool to support the marine spatial planning framework providing essential and easy-to-use interpretation tools, such as predictive distribution maps, with the final aim of improving management and conservation of vulnerable species such as sea pens. SDMs have been previously applied to sea pens in the NW Atlantic, but this study represents a novel approach. We used a 10-yr period (2007-2017) of a bottom trawl survey series to estimate and predict the suitability habitat of *Anthoptilum grandiflorum* as a function of several environmental variables (i.e. bathymetry, sea bottom temperature, sea bottom salinity, slope, rugosity, aspect of the seabed, etc) in the Flemish Cap and Flemish Pass deep-sea fishing grounds (NW Atlantic), using different SDM algorithms. The results show that species exhibit specific habitat preferences and spatial patterns in response to environmental variables. These outcomes could be useful for deep-sea fisheries management purposes in the study area.

Identify vulnerable habitats as fisheries management strategies: the thorny skate (*Amblyraja radiata*) case study in NAFO Divisions 3NO

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Globally, there is increasing concern over elasmobranch species because their biological characteristics make them highly vulnerable to fishing pressure, directly with high catch rates and indirectly through by-catch. Consequently, the abundance of many elasmobranchs is declining and some of them are considered threatened with extinction. At a regional scale this negative trend has also been evidenced in the Southern Grand Banks area (Newfoundland, Canada), affecting vulnerable species as the thorny skate (*Amblyraja radiata, Donovan, 1808*) which occurrence is declined by ~68% in the last decades. Catches of this species are managed by NAFO in this area with Spain, Portugal, USSR, and the Republic of Korea as main participants. In 2005, the NAFO Fisheries Commission established a Total Allowable Catch (TAC) of 13,500 t for thorny skate in the area. This TAC was lowered to 7,000 t for 2013-2016.

In this study Bayesian hierarchical spatial-temporal models were used to map the sensitive habitat of the thorny skate in a period of 14 years (2003-2017), linking five environmental predictors (i.e. bathymetry, sea bottom temperature, seabed aspect, slope and rugosity) and prey distribution information with fishery-independent data. Our findings identify some of the sensitive habitats for this species and the ecological factors that drive its population dynamic in the area. We argue how spatial-temporal effects, and the knowledge about the factors influential species distribution, could potentially be exploited as potential mitigation measures for future fisheries management strategies. However, misidentification of hotspots and uncertain predictions can culminate in inappropriate mitigation practices which can sometimes be irreversible. The proposed Bayesian spatial method overcomes these issues, since it offers a unified approach which allows the incorporation of spatial and temporal terms and variables' uncertainty resulting in a better quantification of the uncertainty and accurate predictions.

Predicting possible fishing strategy outcomes due to the EU landing obligation

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European landing obligation has not been yet fully implemented. Although it is expected that full enforcement of the landing obligation will have a direct impact on discard reduction through a most responsible and selective fishing, fishers argue that it will be also translated in a decrease of incomes and an increase in the working hours on-board. This study analyses the possible scenarios to which fishers will be subject under the landing obligation. We used a spatial bio-economic model to infer average costs, incomes and gross profits by fishing ground for a coastal trawling fleet based in the North-west of the Iberian Peninsula. Results show how fishing ground selection will remain as key factor affecting gross profits, well above selecting of closer fishing grounds, improving of fuel efficiency, or extend the length of the fishing trip. Increasing number of crew members to overcome the expected excess of worktime on-board would also be a cost-benefit balanced measure, if enough room on-board is available. The study also highlights the penalization that the landing obligation will impose to night hauls, where higher discards and lower profits occur, and a possible advantage for short one day fishing trips.

Discards in European demersal fisheries

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Discards represent significant wastage in the world's fisheries and are considered suboptimal use of fisheries resources. In 2005, FAO estimated that in the 1992-2001 period the yearly average discards in global marine fisheries were 7.3 million tonnes. Trawl fisheries for shrimp and demersal finfish accounted for over 50 percent of total estimated discards. The 2005 estimate of discards is based on data that reflects the situation some 15-25 years ago and is now considered outdated. Therefore, FAO considered it timely to conduct a new study on this vital fisheries and food security issue. In this paper we present an estimate of discards in European demersal fisheries during the period 2010-2014. Discard rates were downloaded from the EU Data Collection Framework (DCF) while landings data were extracted from FAO FishStatJ global landing database. We discuss of the amount and changes in discards in European demersal fisheries during the last decades, and suggest some solutions to reduce these discards. We also discuss the problems encountered in the assessment of fisheries discards.

Monitoring and management of fisheries discards

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Discards are the proportion of the catch that fishers return to the sea after being landed on board, or catch that fishers release from the gear in the water. Recent assessments indicated that discard levels in marine fisheries peaked in the late 1980s and since then have markedly declined. This decline is largely due to wider utilization of species that were previously discarded, implementation of new management measures and adoption of more selective fishing technologies. Nonetheless, with the constantly improving fish capture technologies and expanding fisheries in particular in developing countries, there are still serious global concerns that the combined effect of failing to effectively manage bycatch and reduce discards is threatening the long-term sustainability of fisheries. Reliable information on fisheries discards is an important step towards more effective management and improved utilization of fisheries resources. Accurate information on discards is critical also to improve the quality and reliability of stock assessments and management advice. Discards represent a significant uncertainty in assessments of total fishing mortality and may thereby skew the quality of scientific advice. Solutions for improved data acquisition and processing are an increasingly important global topic, and are used by the fishing sector to avoid discards and inefficient fishing, and by the administration for fisheries management and effective policies development. This paper reviews approaches used to monitor, assess and manage discards.

Spatial Data Infraestructure technologies applied in LIFE iSEAS project to improve Efficient Fishing

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The main objective of LIFE iSEAS project is to demonstrate that a sustainable scenario (in terms of biological and socio-economic indicators) of the EU fisheries is possible through the enhancement of the real application on the fishing sector of existent knowledge and innovative solutions for discards reduction and management.

CESGA have developed the following technological solutions in the framework of the LIFE iSEAS project to help improve more efficient fishing data management:

· A complete data model including species, fishing, valorization and spatial data

· Red Box, a computer application tool for the introduction of fishing data on board, that can be sent in real time to land

· A web Geoportal to manage and view all the captures and discards information, including the results of mathematical data models to predict the presence of unwanted species

· For the management and dissemination of the data resulting from the project, the development of an SDI has been included, which allows the inclusion of this information within the SDI of the Marine Regions and according to the INSPIRE specifications. The set of this action includes the deployment of OGC services (WMS, WFS, WCS, WPS and CSW), as well as a geographic viewer with spatial query capabilities; in which from different user profiles we can give access to information directed to a general public, or to professional actors related to different levels, ownerships or researchers.

Landing obligation: an onboard approach during experimental trials at a mixed bottom trawl in Galicia

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The implementation of the landing obligation in mixed trawl fisheries is a matter of concern to the fishing sector and the authorities. The schedule foreseen for all fleets of the European Union to comply with the unloading of the unwanted captured species has given rise to the need to carry out experiments to look for mitigation measures.

In the LIFE iSEAS project, a trial program on board the trawler fleet of the port of Marin has been carried out, simulating the application of this new rule. The otter bottom trawl targeting demersal species in north Iberian waters is a mixed fishery which takes place throughout the year targeting European hake, anglerfish, megrim, horse mackerel and blue whiting.

The IEO is being in charge of a standardized scientific observer program to analyze and raise the data to obtain discard estimates for stock assessment and complain with European data compilation schemes. During the actions of iSEAS project a dedicated observer program was set up to study the application of the landing obligation in the mixed trawling fleet of Marin fishing port. Observer trials and an automatic observer were used to characterize discards and record unwanted species occurrence and to test the potential use of camera discard recording by the fishermen and scientist to comply with landing obligation regulation. The study also involve trials onboard scientific oceanographic vessels to automates the catch identification.

Landing obligation and choke species in bottom trawl fisheries at South Western Atlantic waters

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The main objective of LIFE iSEAS project is to demonstrate that a sustainable scenario (in terms of biological and socio-economic indicators) of the EU fisheries is possible through the enhancement of the real application on the fishing sector of existent knowledge and innovative solutions for discards reduction and management.

CESGA have developed the following technological solutions in the framework of the LIFE iSEAS project to help improve more efficient fishing data management:

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topic 03

"solutions in land"

Simplified methodology for the selection of an option for unavoidable unwanted catches valorisation

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The Landing Obligation (LO) has enforced an improvement in gear selectivity and fishing strategies but an important amount of Unavoidable Unwanted Catches (UUC) is due to be landed and its management may be foreseen.

New food products and distribution strategies must be designed to avoid the problem related to punctual increases in fish landed, that otherwise may decrease the catches value. Maintaining the catches in the food value chain is the preferred and more profitable option. However, LO states that only UUC above Minimum Conservation Reference Size can be used for direct human consumption. All the other by-catches need to be properly managed and valorised but the profitability of their exploitation must be subjected to the avoidance of incentivizing by-catches. When evaluating a concrete scenario, to be able to select the best and more feasible valorisation option, the study has to deal with all the critical aspects that can have an influence in the technical or economic feasibility.

To facilitate the selection of a valorisation option a simplified methodology is proposed. An extensive review of valorisation options has been performed including information about the obtained product, process and market. Main criteria have been grouped in 3 categories (technical, market and economic aspects) to estimate the main effects and weighted to obtain a score for each valorisation option.

For the prioritisation of valorisation solutions, a methodology based in Multi-Criteria Decision Analysis and Analytic Hierarchy Process is proposed.

The methodology gives a prioritization on valorisation options that may facilitate the evaluation and establishment of UUC management systems.

Potential Bioactive Peptides from the Sarcoplasmic Fish Proteome

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New opportunities for modern food science are emerging using the advances in the Proteomics field.

In this work, we present for the first time new potential Bioactive Peptides for the sarcoplasmic fish proteome. An interactomics map based on a shotgun proteome-wide analysis from 15 different fish species was built up. The final protein compilation was investigated by integrated functional studies and networks analysis. Considerable extent of research was focused on the liberation of Bioactive Peptides, which are inactive or latent in the context of their parent proteins, but can be released in an active form after proteolytic digestion. Thus, bioactive peptides encrypted in the parent sarcoplasmic fish proteome were *in-silico* predicted. The physiology of the enzymatic digestion of proteins in the human gastrointestinal tract was simulated. Sequential hydrolysis with pepsin (stomach) and intestinal enzymes (trypsin, chymotrypsin, elastase, carboxypeptidase A and B and aminopeptidases) were performed *in-silico* using the MS-Digest program. Using PeptideRanker, the complete list of potential bioactive peptides was ranked using the N-to-1 neural network probability. A total of 70 potential Bioactive Peptides (6-18 residues) with a score higher than 0.5 were selected. The majority correspond to peptides encrypted in the collagen and titin proteins. Anti-hypertensive peptides, particularly those that inhibit the action of angiotensin-1-converting enzyme (ACE), are commonly bioactive peptides encrypted in the titin protein. In addition, a total of 16 antimicrobial peptides (AMPs) were predicted. Among them four peptides were encrypted in the titin parent protein.

All these bioactive peptides need to be validated by further bioactivity assays and using synthetic version of the peptides. However, comparing with the classical approaches, the computational methods are fast and low cost alternatives that predict and reduce the number of potential targets to be investigated.

The development and use of a "real-time" data management system with a map-based interface to better inform the management of shetland islands' inshore fisheries: a case study

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Many small scale fisheries are data poor and as a result have limited management. Where data is available it is not always presented in a format that is readily accessible to aid fisheries managers in decision making. In the Shetland Islands, inshore fisheries have benefited from the collection of data for 15 years providing both trends analysis and analytical stock assessments. In order to more effectively facilitate the integration of data and fisheries management the NAFC Marine Centre worked with OLSPS, to customise their Olrac Dynamic Data Manager (OlracDDM) to the specific requirements of this fishery. The OlracDDM for Shetland incorporates fisheries, biological and environmental data with a map based interface which allows fisheries managers' real-time access to spatial data, which can be linked to reference points within harvest control rules. This has resulted in real-time data use in management decision making.

The ability to view any geographically referenced data layers via the map interface has allowed integration of fisheries data with information from the Shetland Marine Spatial Plan, permitting quantifiable consideration of fisheries in the planning process. It has also facilitated the management of fishing activity within marine protected areas, as fishing activity relative to the features of interest can be readily quantified and risks appropriately assessed.

The use of technology to provide a single location for the storage and visualisation of fisheries and related data has been extremely beneficial in facilitating the management of these small scale fisheries.

Production of biomass and microbial metabolites from *Pediococcus acidilactici* on marine peptones obtained from enzymatic hydrolysis of discarded fishing skins.

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From the viewpoint of their industrial interest, lactic acid bacteria (LAB) are an important microbial group due to their role in food fermentation and preservation, either as natural microbiota, or inocula added under controlled conditions. Among them, *Pediococcus acidilactici* is one of the most prominent species due to its probiotic attributes, its ability to produce a very potent and broadspectrum bacteriocin (pediocin SA-1) and its ability to valorize food wastes. It is commonly present in fermented meat, dairy products and vegetables. However, it is a fastidious bacterium that requires complex and expensive culture media for growth in which the sources of organic nitrogen (peptones) are the more costly ingredients. An economic alternative to the commercial peptones can be the use of enzymatic hydrolysates of skins (EHS) from discarded fishing species that under the new European policy will be landed in Galician ports from 2019. In this work, the production kinetics of *P. acidilactici* in culture media formulated with EHS were evaluated and compared with cultures using a commercial medium MRS (Man, Rogosa and Sharpe medium). In all cases the productions of microbial biomass, both as dry weight and viable cells, lactic acid and acetic acid were similar to than those obtained in control one. In this context, we can establish that more than 30% of *P. acidilactici* productions cost were reduced by means of EHS-based media.

Production of fish protein hydrolysates (FPHs) from three fish species discarded: From lab to pilot plant

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The new European fishing rules about fish discards are forcing the search for new ways to process the new biomass that will be compulsory landed in the next years. Species as megrim (*Lepidorhombus whiffiagonis*), blue whiting (*Micromesistius poutassou*) or boarfish (*Capros aper*) are extensively discarded, respectively, by three main reasons: be below its legal size, no more capture quota available and be very little appreciated by the consumer. Thus, they could not be used directly for human consumption when they will be landed. An interesting alternative to their use as substrate for fish meal is the production of fish 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. In the present work, we have studied the kinetics of hydrolysis (using a commercial protease, Alcalase) of the whole bodies of the mentioned species and the chemical characteristics of the hydrolysates obtained at lab scale (5 L-reactor). Then, we have reproduced the productions to pilot scale of 500 liters. Final FPHs 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%.

Scyliorhinus canicula skin: mathematical optimization of collagen extraction using response surface methodology

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The development and promotion of sustainable fishing practices are one of the main objectives of new European fishing policies. Within this context an interesting approach could be trying to maximize the profitability of the fishing activity by means of an integral utilization of all retained captures. Skin of small spotted catshark (*Scyliorhinus canicula*) (a highly dis carded species) represent a 10% of total fish weight. The portion of the capture which is landed is usually sold fresh and skinned, and the skin removed is treated as urban solid waste. In a previous work, we have described the extraction and characterization of collagen from this species and we have shown that the collagen extracted presented interesting antioxidant properties when hydrolyzed, however the extraction yields obtained were low and therefore a study focusing in the optimization of collagen extraction conditions was performed.

Small spotted catshark (*Scyliorhinus canicula*) dorsal skin obtained from fish processing industry was used for the optimization conditions. Two sequential steps of the collagen extraction process were studied by means of response surface methodology (RSM), in particular two different experimental designs were performed. First, for the alkali treatment the influence of temperature (T), NaOH concentration and time (t) (independent variables) on removing non-collagen proteins and subcutaneous tissues were studied. The optimal conditions maximizing the recovery of collagen without impurities in skin residue were 8.3 °C (T), 0.49 N (Na OH concentration) and 11 h (t). These optimal conditions were then used for developing an alkali treatment to obtain the skin residue necessary for the second experimental design. For the acid treatment, the influence of temperature (T), acetic acid concentration and time (t) (independent variables) on the collagen extraction were studied. Two parameters were selected as responses (dependent variables): hydroxyproline and total nitrogen content both in skin residue and filtrated solution.

Antihypertensive potential of tuna viscera protein hydrolysates

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Fish processing industry generates different rest raw materials such as head, skin, trimmings, fins, frames, viscera etc. These by-products are either eliminated as processing wastes, leading to a serious environmental problem, or converted into low marketable products such as fish meal, fertilizer and animal feed. However, because of the high protein content, these inexpensive aquatic wastes could be employed as a source of bioactive peptides. To this regard, enzymatic hydrolysis of proteins can released active fragment of proteins with bioactive characteristics employing mild process conditions (pH and Temperature). Particularly, peptides exhibiting angiotensin converting enzyme (ACE) inhibitory activity are interesting since they could help controlling the blood pressure levels of hypertensive people. Some of these active peptides have shown promising results in vivo studies. ACE inhibitory activity can be influenced by several parameters such as molecular size or hydrophobicity in the C-terminal of the peptide. Therefore, the aim of this work is to produce tuna viscera hydrolysates with ACE inhibitory activity. To that end, fresh viscera protein was hydrolyzed at different degree of hydrolysis (3, 6 and 9%) employing subtilisin. Molecular size distribution and ACE inhibitory activity of each hydrolysate was assessed for comparing with the raw viscera. Hydrolysis with subtilisin improved the ACE-inhibitory capacity of viscera protein producing hydrolysates with an average IC50 value of 450 µg/mL. This value is similar to some of the most potent ACE inhibitory hydrolysates produced from fish proteins.

Production and fractionation of tuna by-product protein hydrolysates by ultra and nanofiltration

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Fish protein hydrolysates (FPH) receive increasing interest due to their potential applications in food, feed and pharmaceutical industry. In this work, tuna heads from the canning industry were hydrolyzed by commercial proteases (Alcalase and Flavourzyme). The goal of the hydrolysis was to obtain a final product enriched in free amino acids. This preparation can be used as ingredient in the formulation of feeding diets for larvae in aquaculture. A high amino acid content increases the digestivility and palatability of the diet. The hydrolysis was carried out in a 200 mL batch reactor. A sequential treatment was proposed employing Alcalase (endoprotease) and then Flavourzyme (exoprotease) until completing 5 h of reaction. An experimental design was proposed varying the conditions of pH (7.5 – 8.5), temperature (45ºC – 55ºC) and the duration of each enzymatic stage (i.e. endoprotease and exoprotease).

For each experimental run, the degree of hydrolysis (DH) and the content of free amino acids (AA) were determined as response variables. DH was determined by the pH-stat method, while the fraction of free amino acids were determined by size-exclusion chromatography and reported as the area percentage below 150 Da. Both responses were fitted to statistical models by Response Surface Methodology. The optimization of DH led to a maximum value of 32.18%, obtained at 45 °C, pH 8.5, and an enzymatic treatment employing 120 min of Alcalase and 180 min of Flavourzyme. As for the content of free amino acids, the maximal content (above 22%) was attained at pH 7.2, 48ºC, 190 min of Alcalalse and 110 min of Flavourzyme.

The optimization of the hydrolysis procedure is a first step towards the design of an ulterior purification step by ultrafiltration and nanofiltration. The purified fractions can be incorporated into feeding diets to ensure a good survival rate and weight gain of the larvae.

Onshore strategies for valorising discarded Southwest Atlantic butterfish (*Stromateus brasiliensis*)

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Southwest Atlantic butterfish (*Stromateus brasiliensis*) is a demersal-pelagic fish which is abundant in some areas of FAO 41, where many trawlers operate targeting different species such as the Argentinian squid (Illex argentines) or hake (*Merluccius hubbssi*). This butterfish species is caught and discarded by these fleet with discard rates of 90 % or higher (IEO 2010-2014).

There is not a consensus about whether Butterfishes of the genus *Stromateus* can be safely consumed by humans since it has been described that problems related with the type of fat, present in these fish, may produce some gastrointestinal mild issues.

A sustainable use of resources as it is established in the European Common Fishery Policy suggest to find alternative uses for discarded fish. Proteins are one of the main components of organisms such as fish and, therefore, one valorisation strategy could be to obtain protein products from the main sources of proteins of discarded fish, such as skin and muscles. In this work, we present a valorization strategy based on the use of skin and muscle of Southwest Atlantic butterfish to obtain collagen and protein hydrolysates which can be then used for several industrial applications, such as cosmetic, pharmaceutical or aquafeed industries.

Southwest Atlantic butterfish (*Stromateus brasiliensis*) were mechanically deboned and muscle and the remaining skins and bones were used for the production of protein hydrolysates and collagen, respectively.

Muscle from this species was hydrolysed with Alcalase and the degree of hydrolysis and the yield achieved were of 26 % and 50 %, respectively. Glutamic acid, Aspartic acid and Alanine were the most abundant amino acids present in the hydrolysates. Collagen from skin and bones was extracted with a yield of 9 % (on dry weight) and characterized by SDS-PAGE and amino acid analysis. Results show that type I collagen was present in the different fractions obtained.

Integral valorization of European hake (*Merluccius merluccius*) discarded for legal reasons

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European hake (*Merluccius merluccius*) is a demersal fish which is the target for some European fisheries, two stocks of this species are recognised in EU waters, the Southern stocks presenting higher concerns regarding its sustainability. In 2005 the European Common Fishery Policy (CFP) (EU2166/2005) has established that measures (Total Allowable Catch system) should be reviewed annually to regulate its capture. The species has also restrictions related with legal size of capture (27 cm). According to the Landing Obligation imposed by the new CFP (EU1380/2013), discarded species regulated by TAC and/or legal size should be landed, however this biomass could not be offer to the market in auctions for direct human consumption, alternative strategies for their valorisation should be implemented.

One of the objectives of the project iSEAS is to demonstrate the potential of value-added processes to manage an important amount of up to now discarded biomass. In this work we demonstrate that European hake (*Merluccius merluccius*) under legal size (<27 cm) can be mechanically deboned onshore, yielding 50 % of white minced muscle and 10% of skin and bones. The mixture of skin and bones, produced during deboning, was used as a raw material for the production of native collagen.

Collagen from skin and bones was extracted with a yield of 19 % (on dry weight) and characterized by SDS-PAGE and amino acid analysis. Results show that type I collagen was present in the different fractions obtained.

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topic 04

"environmental and socio-economic implications of the landing obligation"

Simulations showing how the use of discard hotspot maps could help reduce the economic impact of the Landing Obligation for Irish vessels

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Challenge trials were conducted on two commercial fishing vessels in 2015 to examine the impact of the Landing Obligation (LO) on Irish fishing vessels. The adoption of both technical and tactical measures failed to substantially reduce catches of unwanted choke species. Subsequent economic analysis revealed that fishing vessels operating in a mixed demersal fishery could experience a fall in profits of greater than 50% when the LO is fully implemented. Consequently there is a need to equip industry with the tools and knowledge to avoid catches that could result in quotas being exceeded if they are to remain economically viable under the LO.

Using data collected by on-board observers on commercial fishing vessels we have created maps highlighting areas with an increased likelihood of catching choke species. We then simulated fishing scenarios, using the information provided by these maps. The scenarios were designed to avoid areas with high quantities of choke species whilst also targeting fishing in areas with high CPUE of target species, for which there was adequate quota available. These showed that fishing opportunities under the LO could be increased compared to non-spatially restricted fishing behaviour. Fishing in such 'optimum' areas not only resulted in increased catches of target species prior to chokes being reached but, importantly, also in reduced fishing time, and hence costs. Fishing opportunities under the LO would still likely be restricted compared to those prior to the introduction of this legislation. However, using information from choke species hotspot maps could help make these fishing operations more efficient, reducing the operational costs involved and increasing profitability. By arming the industry with such knowledge and information it is hoped that we can help them optimise fishing opportunities and continue to be profitable whilst operating under the Landing Obligation.

Dealing with the discard ban issue: a multi-step approach

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The discard ban is a "hot point" in fisheries management, both for economic and ecological aspects. The Common Fisheries Policy plan proposed by the European Commission for 2014-2019 presents a controversial goal: to enforce the landing of fishing discards as a measure to promote their reduction. This political decision is expected to shape the future of the fishing exploitation in European Seas with socio-economic implications in the short term. For these reasons, both stakeholders and policy makers are now clamming for more effective tools that can be used to support the decision-making framework. In the present study we implemented a multi-step approach combining Hierarchical Bayesian spatial models (HBSM) with Ecopath with Ecosim (EwE) food web models, exploring different future developments in the North Western Mediterranean Sea in the scope of the landing obligation. In particular, we firstly assessed high density discard areas using HBSM with discard and environmental data, and secondly, we simulated possible spatial closures in the identified areas using the EwE model. We discussed socio-economic implications of the simulated scenarios and proposed a combination of fishery management measures as a more effective global strategy to deal with this important issue.

Ecological impacts of adopting the discard ban policy in the deep-water crustacean trawl fishery off Southern Portugal

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The obligation of landing the whole catch in European fisheries is the cornerstone of the 2013 Reform of the European Union's Common Fisheries Policy, constituting a framework for promoting a reduction of discards. With the latter objective in mind, the H2020 project 'MINOUW: Science, Technology, and Society Initiative to minimize Unwanted Catches in European Fisheries' was conceived in support to the gradual elimination of discards by finding technological and socio-economic solutions, on a case-by-case analysis, for some of the most important Atlantic and Mediterranean fisheries generating high discard rates. One such case study is the deep-water crustacean trawl fishery off the South and Southwestern coasts of Portugal, targeting the rose shrimp (*Parapenaeus longirostris*), the Norway lobster (*Nephrops norvegicus*) and the red shrimp (*Aristeus antennatus*). Technical options (By-catch Reduction Devices, BRD) aiming at minimizing the by-catch that is subsequently discarded have been tested with positive results, but not legally implemented. It is therefore of the utmost importance to estimate both the commercial and ecological impacts of adopting such implementation. We report herein the first results on how the adoption of different types of BRD in this fishery, at the scope of the 'discard ban', will influence the yields of the target species and simultaneously the foreseeable impacts on the whole ecosystem structure and functioning. To achieve this goal, the Ecopath with Ecosim modelling approach has been used, establishing a baseline situation and proceeding to simulate alternative scenarios including zero discards and the use of selective devices to reduce unwanted catches. Finally, we argued that the ecological effects of such implementation need to be considered along with the socio-economic impacts if sustainable management policies are to be adopted and conservation benefits obtained.

First plan to reduce discards in the Chilean demersal crustacean fishery: a review of the measures implemented

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In Chile, a Discard research program was implemented in crustacean trawl fisheries (shrimp, red squab lobster and yellow squab lobster) four years ago. The results obtained until now, have allowed to identify the discard composition, where important commercial species (common hake), other bone fishes, chondrichthyes and crustaceans without commercial value are commonly founded. Particularly, the elasmobranchs are a vulnerable group and some of them are included in IUCN red list. The main causes of discard are quota limitation and absence of economic value.

To reduce the discard in this fishery, a reduction plan of discard has been implemented since 2017. This plan, is oriented to progressively reduce the discard following FAO recommendation, and based in discard research program. This first plan includes proposal management and conservation measures, technological improves to reduce discard of the target and no target species and by-catch. To evaluate the reduction plan, a monitoring program into the discard research program is in development. However, to achieve a successful application it is necessary to understand discard patterns, generate interaction between fishery stakeholder's and define how the new demands were adapted.

In this work, we present a synthesis of principal results generated during the first year of plan implementation, the gaps to reach adapted measures and the possibility to adopt the proposed measures from another fisheries experience around the world.

Coastal areas and small pelagic discards: a spatial planning approach

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In the Spanish Mediterranean coast, the purse seine fishery mainly harvests small pelagic fish. The most common type of fishery operates during the night and targets mainly anchovy (*Engraulis engrasicolus*) and sardine (*Sardina pilchardus*). Purse seine fisheries are characterised by active search of fish (unlike trawls). Skippers identify fish based on nature of fish echo traces, behaviour of school and season. This makes it a reasonably selective fishery with generally lower discard rates than trawlers, gillnetters and longliners (thus attracting less studies in terms of discards). In this research we will first explore the Spanish Mediterranean purse seine reference fleet with respect to discards, then will try to identify discards driving pattern, and lastly we will simulate and compare the results of 3-4 different fishing closures applied to our study area, trying to maximise the retained fraction as a measure of lowering the ecosystemic impact of the fishery.

Discards are present in 104 out of 171 hauls (60.8%) and the mean discarding ratio conditional to presence of discards is reasonably higher, 20.3%, with a bootstrap confidence interval in between 16.6% and 24.3%. The occurrence model found that the bathymetry is a significant factor that influences the probability of discarding. In particular, at higher depths the discarding probability is lower and vice versa. In the contrary, retained volumes show a moderate positive trend with respect to depth, suggesting that shallow waters have higher probability of discarding and the retained fraction is slightly smaller. Complementary models showed that at lower depths, the heterogeneity of the catch is higher, what could explain the higher probability of discarding non-marketable fish at lower depths.

Ecological Footprint implications of discards reduction in selected fisheries

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Fisheries should be managed in a sustainable way to guarantee the viability of the fishing sector in the future. Thus, to quantify the environmental performance of the fishing sector, different sustainable indicators and tools can be used. In this study, Ecological Footprint (EF) and Data Envelopment Analysis (DEA) methodologies will be applied together to analyse the environmental performance in alternative fishing areas.

EF will provide the quantity of sea area and land necessary to produce the resources consumed and to absorb the wastes generated. The first part, the fishing grounds footprint, is calculated based on the primary production required to sustain the harvested aquatic species, which is highly dependent on the trophic level of the species (Table 1). The sea area is then calculated dividing by the productivity of the area analysed. Moreover, the percentage of the marine ecological footprint related to the discarded biomass will be established.

Table 1. Trophic level and primary production required for different species

ENGLISH NAME	Scientific name	TL	PPR (tC·tfish-1)
BLUE WHITING	Micromesistius poutassou	4.13	49.47
ATLANTIC MACKEREL	Scomber scombrus	3.63	18.67
ATLANTIC HORSE MACKEREL	Trachurus trachurus	3.71	21.82
EUROPEAN HAKE	Merluccius merluccius	4.42	87.04
BOARFISH	Capros aper	3.14	7.19

The second part, the carbon footprint, will mainly depend on the fuel use intensity. It will be estimated taking into account the distance from the departure and landing port to each fishing area, the regular activity of each vessel and the expected number of days of the fishing trip.

Finally, DEA methodology will be used to compare the relative environmental fishing efficiency in the different fishing regions.

The results obtained will allow us to distinguish between the different fishing areas in function of their environmental impacts and also to know the environmental implication of a reduction of fish discards.

Economic result of the valuation of discards through the iDPV of the Port of Marín

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The European Union has progressively introduced between 2015 and 2020 the obligation to disembarkation (O.D.) of all captures subject to TAC or fee, with the aim of minimizing the discards of biomass which does not reach the minimum size, also those which does not have commercial value, those whose quota runs out, etc. But ones the ship reaches the harbor, what can the ship-owner do with the captures they used to discard? This report intends to analyze a possible option of valuing the discards beyond the production of fish flour. Given that the regulation regarding O.D. sets limitations to the commercialization of some captures forbidding their selling in markets destined to human consumption, the objective is to see if viable alternative uses can be proposed through the non-direct consumption, from the socio-economic point of view. Making emphasis on the economic viability of alternative uses, the results of a pilot factory will be shown: the iDPV (Point of Valuation and Integral Processing of Discards) located in Marin's harbor and which, by means of the production and selling of collagens, gelatins, hydrolysate, proteins (feed for aquaculture) and chitin from calamari, covers the costs of production and obtains a possible economic and social benefit.

Value of time spent in additional tasks imposed by de landing obligation

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The Landing Obligation (L.O.) will demand extra workload to manage all the bycatch that formerly were dumped into the sea. The new landing protocol, in some cases, will generate a huge amount of regulated catches that must be handled and landed. In this situation, additional extra work will be required in order to manipulate, conserve and stock properly on board all the catches related with the L.O. Through on board observer data time spent in manipulating a single box was calculated allowing for inferring results to the annual activity of the fleet.

Results show that under full enforcement of the LO and under current technology, strategies, management, etc. the impact may be equivalent to one full time worker.

Input-output analysis of the economic impact of the landing obligation enforcement

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The European Commission (EC) has recognized discards as one of the major challenges facing the Community fishing fleet. The obligation to land all regulated catches has been proposed as a mandatory and essential measure to minimize discarding practices. This paper analyzes the socioeconomic consequences of enforcement of the Landing Obligation (L.O.) on a Galician coastal trawler fleet. A representative number of in-depth interviews were carried out with ship owners and/or skippers of the fleet in question, in order to identify the envisaged operational and logistic problems on board and/or in port arising from the L.O. Furthermore, the current economic performance of the target fishing companies was analyzed using the Input-Output methodology in order to identify their most significant activity costs. Results show that the LO implies monetary costs that are not actually compensated, being reflected in three areas: on board, onshore and in eventual loss of quota. Therefore, an approach of pragmatic flexibility that allows progressive learning and adaptation is recommended.

Fishermen perception on the landing obligation two years after

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During Life-iSeas Project fishermen perception on the LO was gathered through in-deep interviews firstly in 2015 and secondly in 2017. Therefore, 2015 represents a baseline reflecting fishermen perception before the implementation of the new rules, 2017 data allows for the identification of possible changes once fishermen have gained experience and deeper knowledge both on the regulation and it´s consequences.

Results shows, on the one hand, limited changes in perception after the two years, and, on the other hand, a lack of perceived legitimacy among the fishermen. Criticisms emerged about both process and results. Ultimately, a low expectative of compliance stems from the analysis.

As benefits of discard reduction are also recognized by fishermen, opposition to the LO should not be vaguely considered as some kind of uninformed behaviour but rather as a function of incentives. Therefore there is a need for improving the legitimacy of the regulation in order to reduce fishermen reluctancy.

The future of the Gulf of Cadiz multispecies trawl fishery under the 'zero' discards policy

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The European Union Regulation 1380/2013 revising the Common Fisheries Policy (CFP) aims at addressing the by-catch and discarding problem in commercial fisheries by implementing the "Landing Obligation" of the regulated species by 2019. To date, the impacts of the Gulf of Cadiz (GoC) multispecies trawl fleet on the demersal stocks have not been fully evaluated, but it is known that discard rates are high. Along this line, the present study comprises key steps to achieving a more sustainable strategy for managing this fishery. Temporal trends of commercial catch, by-catch and discarding rates generated by the GoC multispecies trawl fishery over the last decade are analyzed here using multivariate statistical techniques. Technical and social measures currently in use for discards reduction in this fishery are also examined. The challenge of this work is to find relevant and efficient management solutions under the discard ban policy. To achieve this goal, we focused on meetings, questionnaires and interviews with stakeholders, fishers and other representatives of the trawling fleet from the main ports in the GoC, underlying the importance of the fishing industry taking part in the decision-making process. We conclude that to improve the current management of this specific fishery and to bring it in line with the requirements of the CFP, economic incentives and the participation of the fishing industry at all stages is of vital importance. Therefore, opportunities and entrepreneur ideas for an efficient use of the discards generated by this fleet are promoted with the aim of contributing to the establishment of alternative management strategies for this fishery.

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