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Report
**Technology
for sustainable
fisheries**

Photo: IÑAKI OYARZABAL



03 Introduction



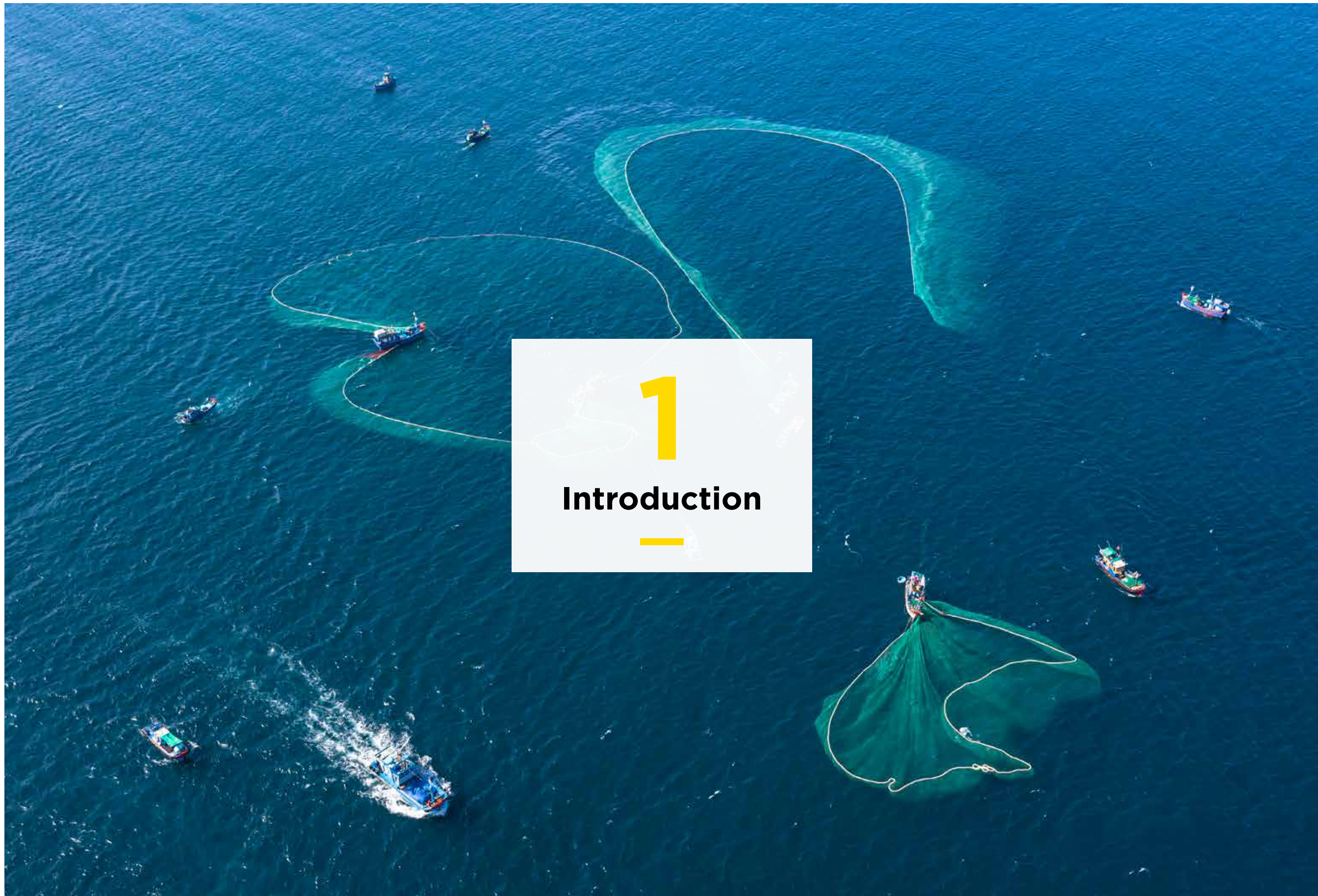
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Introduction



ARTIFICIAL INTELLIGENCE is the ability of a machine to exhibit the same capabilities as humans, such as reasoning, learning, creativity and planning.

AI enables technological systems to perceive their environment, interact with it, solve problems and act for a specific purpose. The machine receives data (already prepared or collected by its own sensors, e.g. a camera), processes it and reacts to it.

AI systems are able to adapt their behaviour to a certain extent, analyse the effects of previous actions and work autonomously.

According to the latest data from the European Commission (2022), the European fishing fleet comprised more than 50,000 active vessels, providing direct employment to nearly 120,000 people. Total fish landings reached around 3.5 million tonnes, with a total market value of €6.6 billion.

However, the fishing industry is highly dependent on external factors beyond its control. The impact of climate change, fuel price volatility and instability, changing consumer trends and consumption patterns, and evolving regulations and policies governing fishing activities all have a significant impact on the future of the sector.

To ensure its long-term viability, the fishing sector must become more resilient to these challenges, with sustainability as its guiding principle.

Fishing businesses must remain profitable while adapting to today's paradigm, which requires greater protection of marine biodiversity and ecosystems. This

includes reducing reliance on fossil fuels to drastically cut pollutant emissions and carbon footprints, promoting digitalisation as a key tool to make the sector more attractive and improving working conditions to secure future crews.

In the Sustainable Fishing Technologies team, we address these challenges by leveraging our expertise, research and close collaboration with the industry. By integrating science and technology, we have achieved major milestones with significant impact.

Here are some of them.

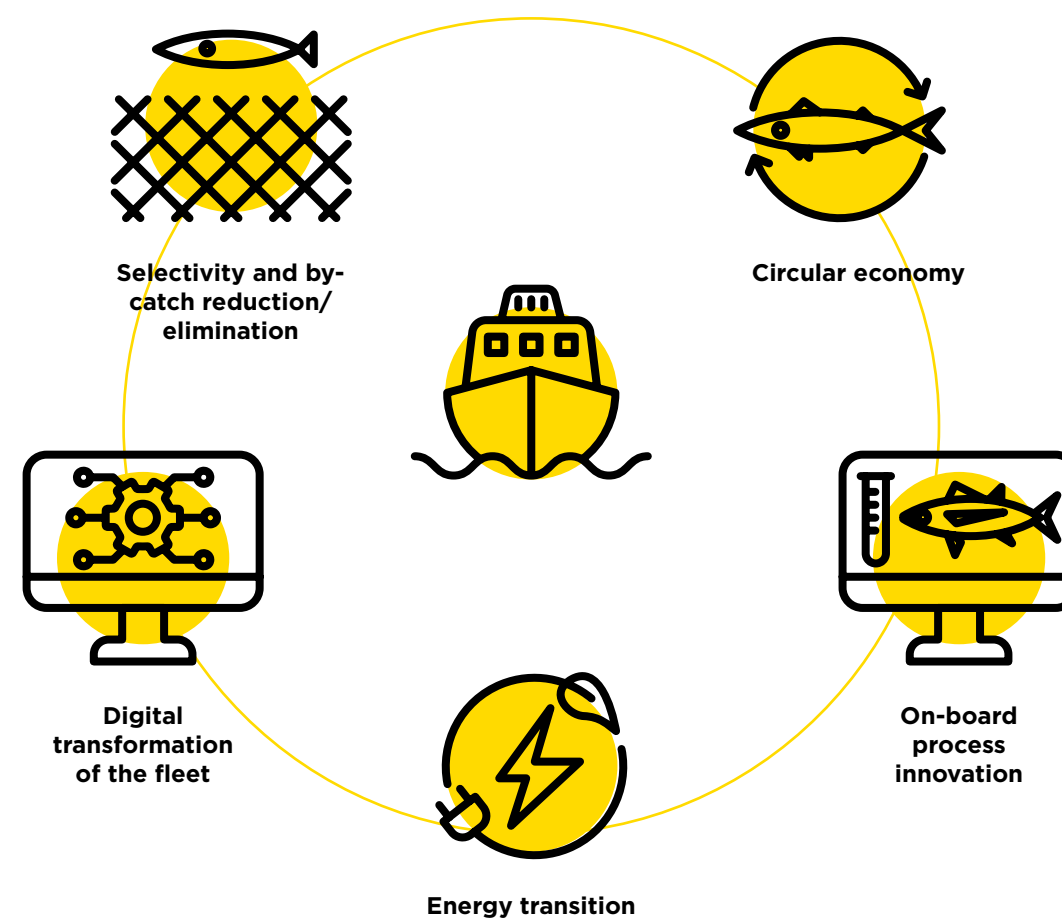
Gorka Gabiña,
Sustainable Fishing Technologies Coordinator at AZTI

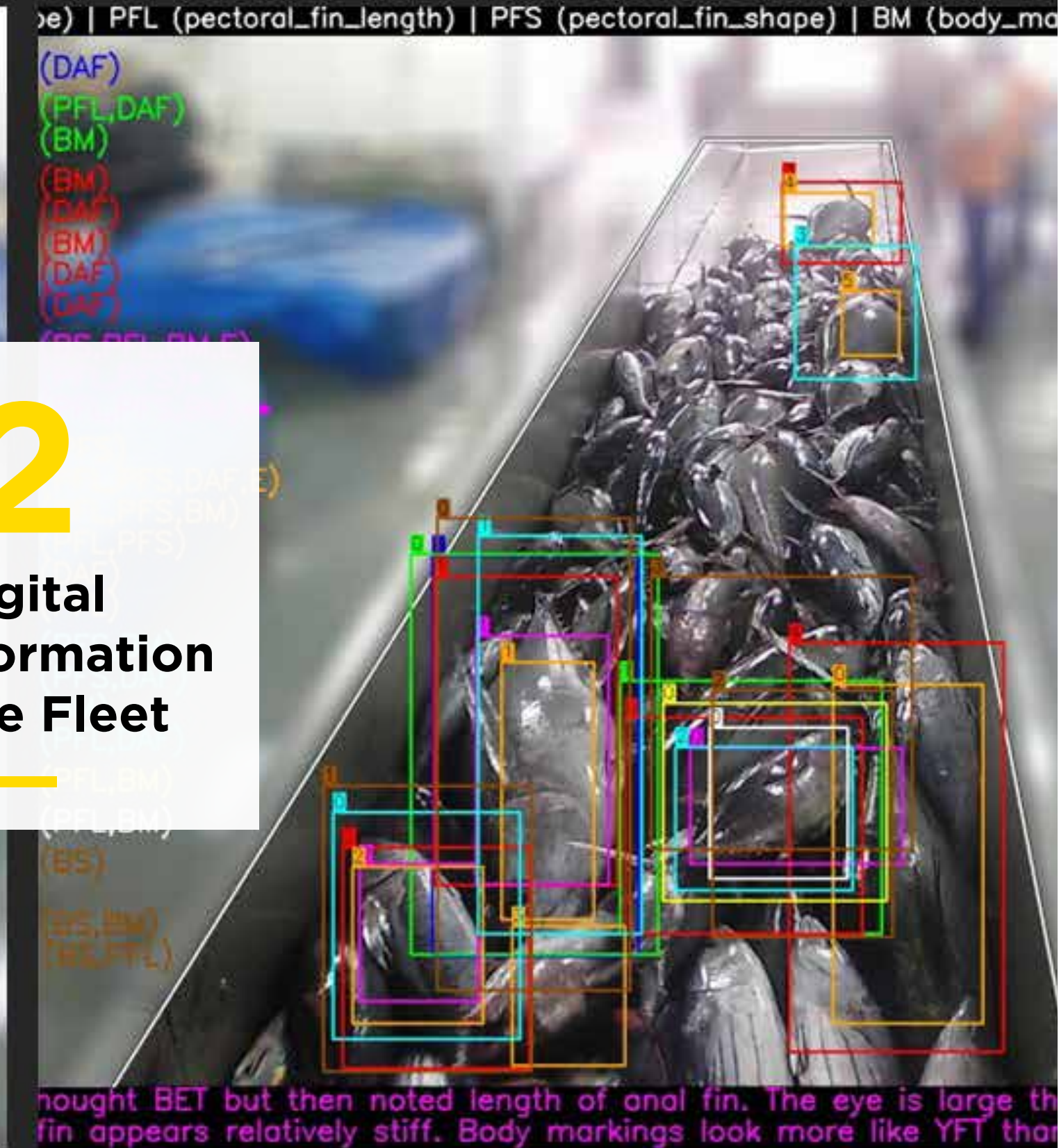


An ALGORITHM is a set of ordered and finite instructions that are followed to solve a problem or perform a specific task.

These instructions must be well defined, precise and executable in a reasonable amount of time.

In computer science, algorithms are the basis of computer programs and systems because they allow data processing, decision making and task automation. They can be simple, such as adding two numbers, or complex, such as those used in artificial intelligence and cryptography.





2

Digital Transformation of the Fleet

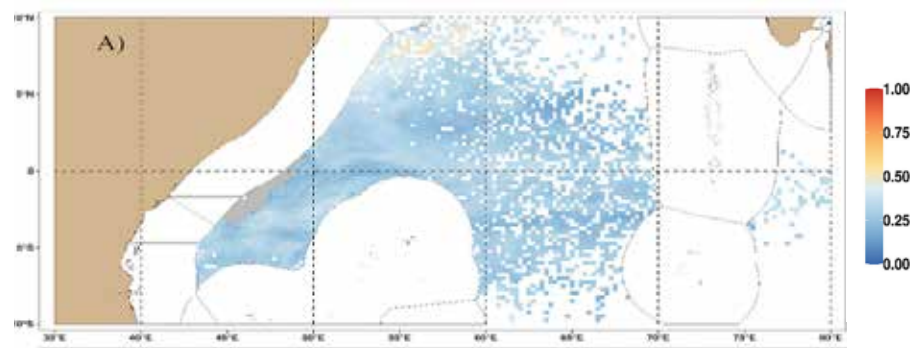
2. Digital Transformation of the Fleet

2.1 Efficiency and fishing operations

The development of **artificial intelligence** has been a turning point in fishing technologies, allowing the automatic processing of large amounts of data.

An example of such developments is **algorithms for identifying areas of maximum fishing probability**. Thanks to artificial intelligence models trained on historical data sets, catch models are created with environmental data for future use in predictive mode.

Predictive algorithms have been developed for several species of interest to the Bay of Biscay pelagic fleet.



High biomass probability model



WHAT DO WE ACHIEVE?

- Fuel savings.
- Reducing CO2 emissions.



WHAT NEEDS TO BE IMPROVED?

- Data collection and processing systems.
- Resistance to the implementation of new technologies.

SUSTUNTECH



The project combined state-of-the-art research with industry expertise and technical know-how **to develop innovative monitoring and decision-making systems to improve the sustainability of tropical tuna fisheries, as well as to avoid by-catch.**

Some results achieved:

- Route optimisation and fuel savings of 20% or more. This is crucial as fuel accounts for almost 50% of the operating costs of tuna vessels when fishing cooperatively by sharing data between vessels from the same company.
- Using Earth observation data and machine learning algorithms, algorithms have been developed to predict tropical tuna catches and avoid bycatch.
- Providing quality data to improve Copernicus services



Copernicus is the **European Union's Earth Observation Programme**, providing environmental information services based on satellite Earth observation and in-situ (non-space) data. Huge amounts of global data from satellites and ground-based, airborne and in-situ measurement systems are used to provide information that helps service providers, public administrations and other international organisations to improve the quality of life of European citizens.

The information services provided are freely and openly accessible to their users.

2. Digital Transformation of the Fleet

2.2 Control and traceability

Artificial intelligence (AI), through innovative computer vision applications, has become a fundamental tool for the modernisation and sustainability of the fisheries sector. Thanks to its ability to **automatically identify, classify and count catches on board**, it enables more efficient management of marine resources, ensuring responsible and long-term exploitation of fish stocks.

This technology not only improves the accuracy of catch recording, but also streamlines administrative and commercial processes, facilitating traceability and optimising the management of fisheries from catch to marketing. Automating the counting and classification of species reduces human error, **improves compliance and promotes more sustainable and efficient fishing.**



WHAT DO WE ACHIEVE?

- Streamline on-board species identification and categorisation processes.
- Improve compliance with fisheries policies by obtaining reliable and high quality data.

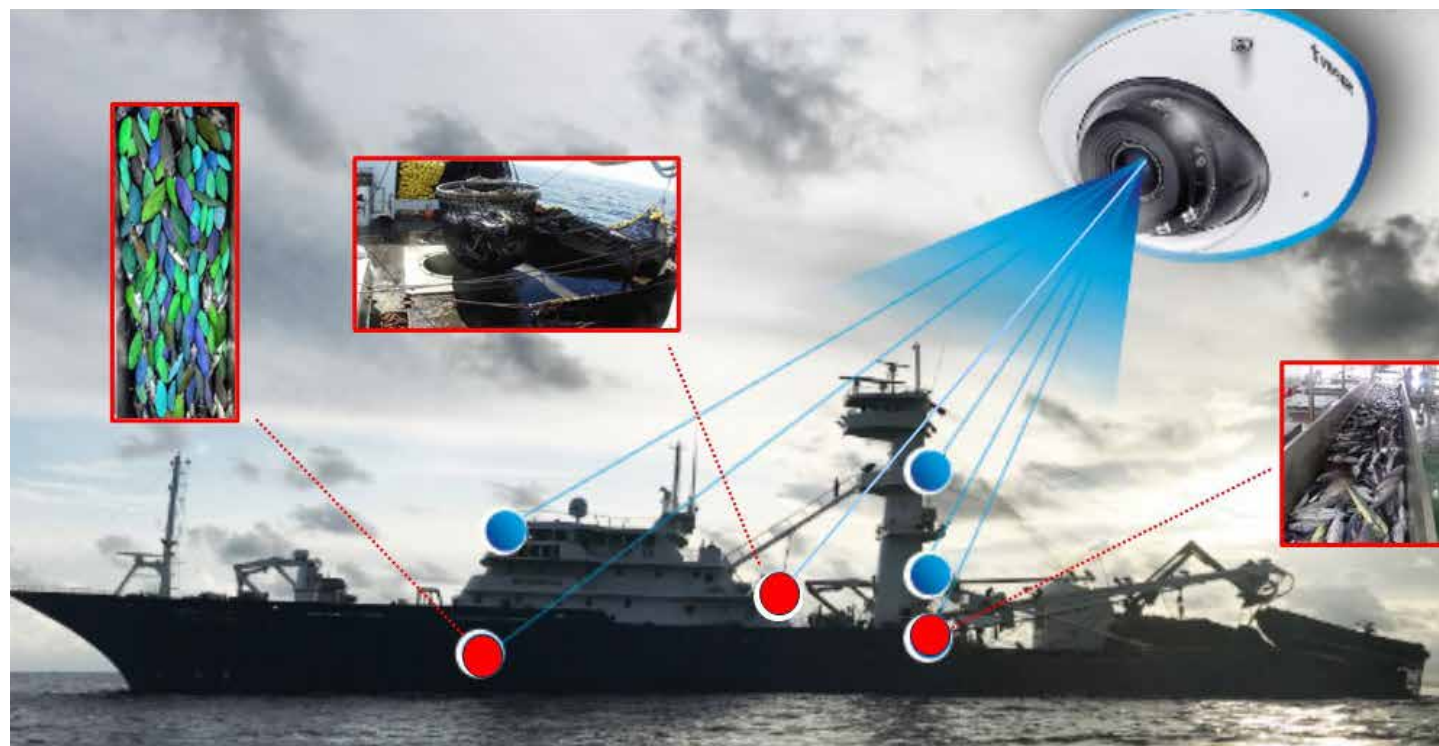


WHAT NEEDS TO BE IMPROVED?

- Field data.
- Knowledge transfer between manufacturers and users.



COMPUTER VISION is a technology based on artificial intelligence (AI) and image processing that **allows machines and computers to 'see' and interpret the environment in a similar way to humans.**



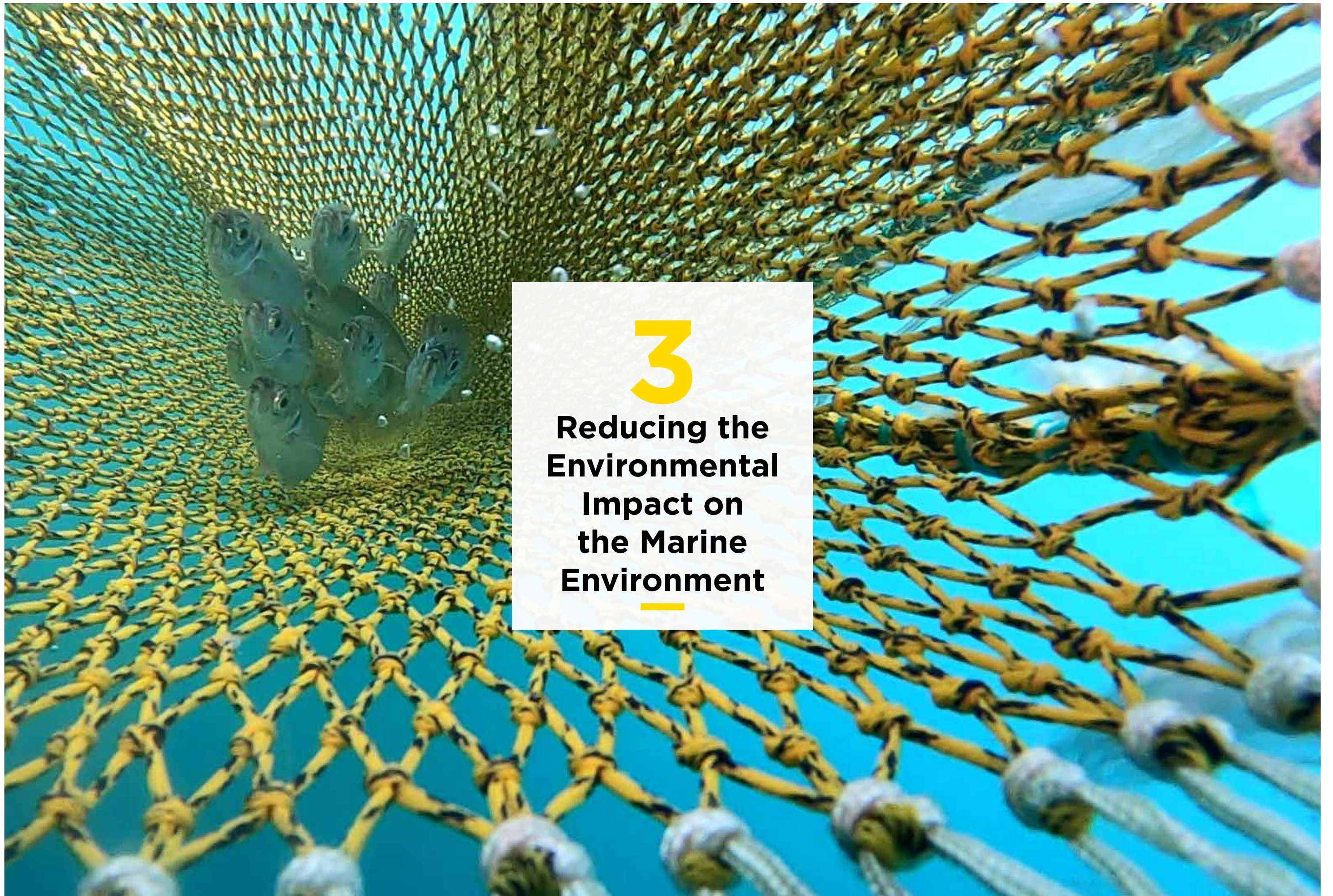
EVERYFISH



EveryFish is working to **develop, test and promote a range of innovative technological solutions for fully automated catch recording and reporting**, with reliable data on catch size, weight and species, for use on board European fishing vessels.

It will also develop innovative management strategies that make use of automatically reported catch data.





3

Reducing the Environmental Impact on the Marine Environment

3. Reducing the Environmental Impact on the Marine Environment

3.1 Marine litter

Plastics and other marine debris have been identified by the European Union and other organisations as **one of the major threats to the oceans, not only because of their environmental impact, but also because of the negative economic impact they can have on coastal regions.**

With an estimated 19 to 23 million tonnes of waste entering the aquatic environment, there is an urgent need for action, especially as this figure is expected to rise to 54 million tonnes by 2030.

Tackling this problem requires a broad approach involving all possible stakeholders. Once again, **cooperation between public, scientific and industrial administrations and with the fishing sector is key to achieving results, as is having the right technologies.**

Operational oceanographic tools, such as **ocean-meteorological models and coastal observation systems, can be used to predict the distribution and origin of microplastics and macroplastics.**

observation systems are also used to monitor floating litter in inland waters to anticipate the arrival of litter on shore, providing important information for taking action at source to prevent litter from entering the sea.

As a result of some research on marine litter, **fishing activities** were identified as a relevant source. In response, and in close cooperation with the sector, several strategies have been developed. On the one hand, through **circular economy solutions**, discarded fishing gear has been upgraded and given a second life as other products.

On the other hand, work has been done to **innovate fishing gear through the use of biodegradable materials and designs that facilitate their reuse.**



3. Reducing the Environmental Impact on the Marine Environment

3.1 Marine litter

SARETU



Promoted by the Bermeo Tuna World Capital Association, in collaboration with the Basque tuna fishing company Echebaster, the technology centre AZTI and the textile company TERNUA, the project aims to give a **second life to abandoned, lost or discarded fishing nets and gear that accumulate in the oceans**. The project has given rise to a start-up company based in Bermeo.



WHAT DO WE ACHIEVE?

- Reduce the presence of marine litter in the sea.
- Promote new economic activities based on innovation.



WHAT NEEDS TO BE IMPROVED?

- The lack of standards in the manufacture of nets and other fishing gear makes it difficult to reuse or recycle them.
- Infrastructure for large-scale implementation of marine litter collection and management systems.
- Port facilities to facilitate the storage and recycling of fisheries waste. Incentives to implement these measures.



GHOST NETS are fishing nets lost or abandoned while fishing at sea that are at risk of continuing to fish in an uncontrolled manner, negatively affecting marine ecosystems.

LIFELEMA



One of the main outputs of the project was the **floating marine litter prediction and detection tool**, defined as LEMA TOOL. This tool, which could be of great use to administrations, was linked to the application of collection methods in order to identify the best synergies in terms of applicability, cost-effectiveness and analysis and benefits.



3. Reducing the Environmental Impact on the Marine Environment

3.2 Selectivity and by-catch reduction/elimination

By-catch is the **unwanted capture of non-target species** such as juvenile fish, sea turtles, birds or cetaceans.

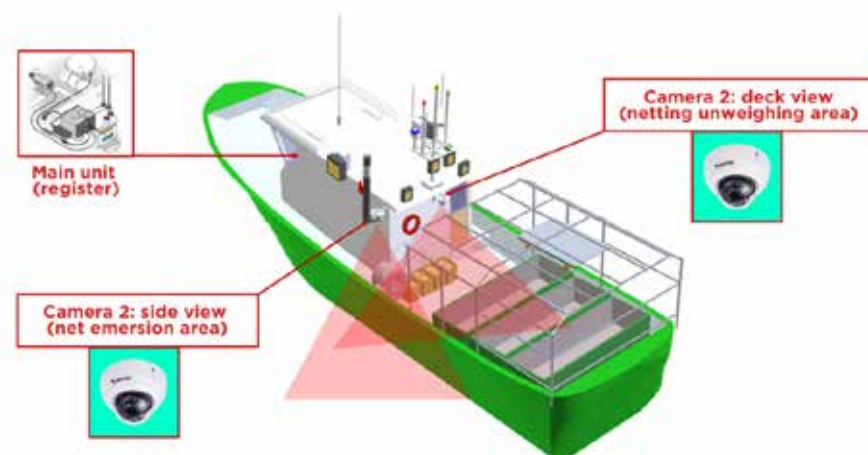
This phenomenon has **significant ecological, economic and regulatory consequences**. Environmentally, it affects biodiversity and can jeopardise the recovery of vulnerable populations. Economically, it generates additional costs for fleets by increasing the time and effort required to sort and discard unwanted species. In addition, increasingly stringent fisheries regulations require the adoption of strategies to reduce this impact, which is a challenge for the industry.

Against this background, the development of innovative technologies, improvements in fishing gear and sustainable management strategies have become key to achieving more responsible and efficient fishing.

3.2.1 Electronic Monitoring Systems (EMS)

Electronic monitoring systems (EMS) are advanced technologies used in fisheries to record, monitor and analyse activities on board vessels in real time or on a delayed basis. These systems **combine tools such as video cameras, sensors, GPS and data analysis** software to provide accurate information on catches, fishing activity and compliance.

These systems provide an **effective and complementary alternative to human observers on board**, reducing operational costs and improving efficiency in the collection of key information for sustainable fisheries management.



WHAT DO WE ACHIEVE?

- **Help authorities to verify compliance with fishing regulations**, such as catch quotas and conservation measures.
- Enable the identification of unintentionally caught species and assess strategies to minimise their impact.
- Facilitate the collection of scientific data to improve the sustainability of marine resources.
- Ensure verifiable records of fishing activity, increasing confidence in the supply chain.

SMARTFISH



The project developed high-tech systems for the EU fisheries sector to optimise resource efficiency, improve automated data collection for fish stock assessment and provide evidence of compliance with fisheries regulations, while reducing the environmental impact of the fishing industry.

These innovations have been deployed both under the sea and on the deck of fishing vessels.

- **TrawlMonitor:** Helping the skipper see what is under the sea. One of its technologies, FlashLidar, uses a 3D camera to accurately calculate the length of free-swimming fish, with an observed length error in the order of 1%.
- **CatchScanner, CatchSnap and CatchMonitor:** Three solutions to automatically record catches, avoiding sorting tables or conveyor belts.

3.

Reducing the Environmental Impact on the Marine Environment

3.2

Selectivity and by-catch reduction/elimination

3.2.2 Cetacean deterrent devices

One of the strategies used to **prevent by-catch is to discourage cetaceans from approaching the boats and getting caught in the nets**. There are visual devices, such as LED lights or reflective markers, that can be attached to fishing nets. Studies have shown that dolphins and porpoises are better able to detect nets when they are illuminated.

Acoustic devices, however, are the most commonly used. These work by emitting high-frequency sounds to warn cetaceans away from fishing nets. The MITICET project, **in collaboration with the fishing industry, is evaluating a variety of pingers with different characteristics to determine the effectiveness of acoustic devices**. They have been shown to be up to 90% effective in reducing the catch of common dolphins in certain fisheries. Effectiveness depends on the specifics of each fishery and the correct use of the devices (routine battery recharging), which is essential to achieve such effectiveness.

3.3.3 Measures on fishing gear

Work has been carried out for many years on the **design and evaluation of prototype nets and alternative fishing practices to conventional nets to minimise unwanted catches**.

It has been shown that changes in the size, shape and material of net meshes, the use of selective devices and/or modifications to fishing gear can significantly reduce by-catch rates.

MENDES2



Among other achievements, this project demonstrated that, in pair trawlers, an 80 mm square mesh panel at the bottom of the codend significantly reduces the catch of hake below the minimum conservation reference size, i.e. by-catch.

CASELEM



Every year since 2017, AZTI carries out a campaign on the oceanographic vessel Emma Bardan (of the SGP), where it conducts **sea trials with innovative technological devices**. The aim is to improve the selectivity of trawls in order **to reduce by-catch**, focusing on species that could become limiting to the commercial fleet's fishing activities.

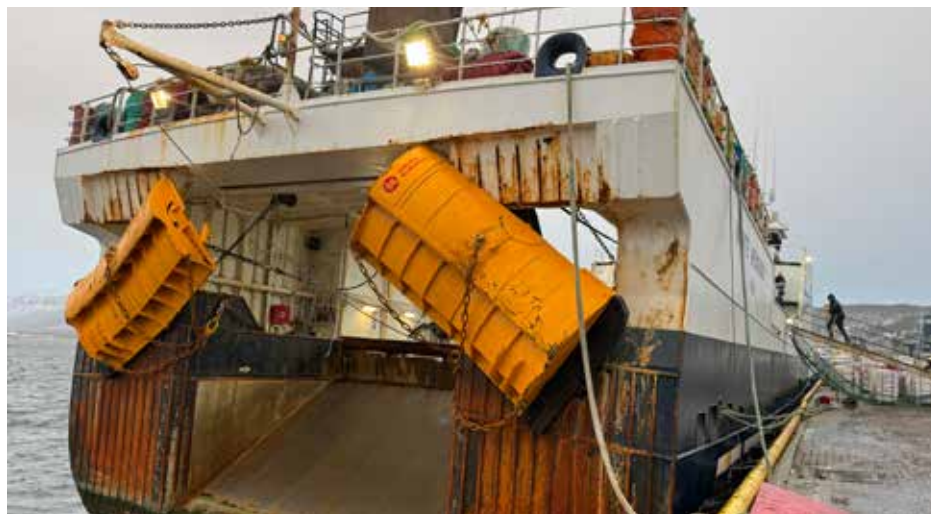
To date, different mesh sizes and shapes, exit windows, LED lights and other mechanisms have been tested to facilitate escape and optimize trawl catch. Year after year, results have been obtained that can be used by the fleet in their commercial fishing.

3.

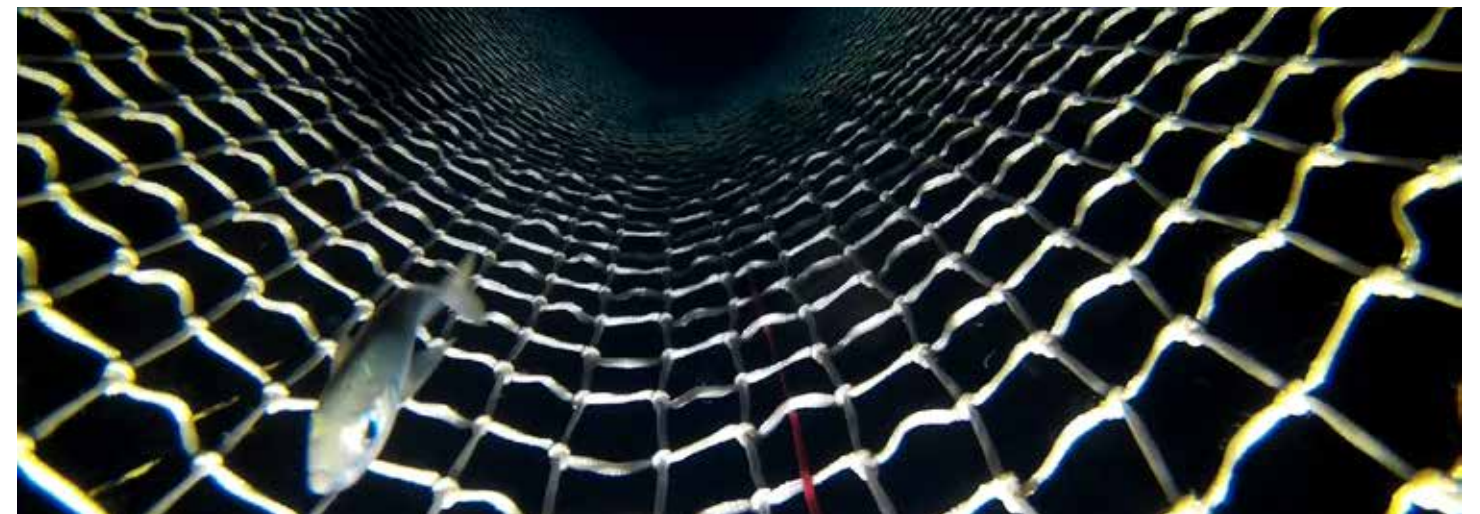
Reducing the Environmental Impact on the Marine Environment

3.2

Selectivity and by-catch reduction/elimination



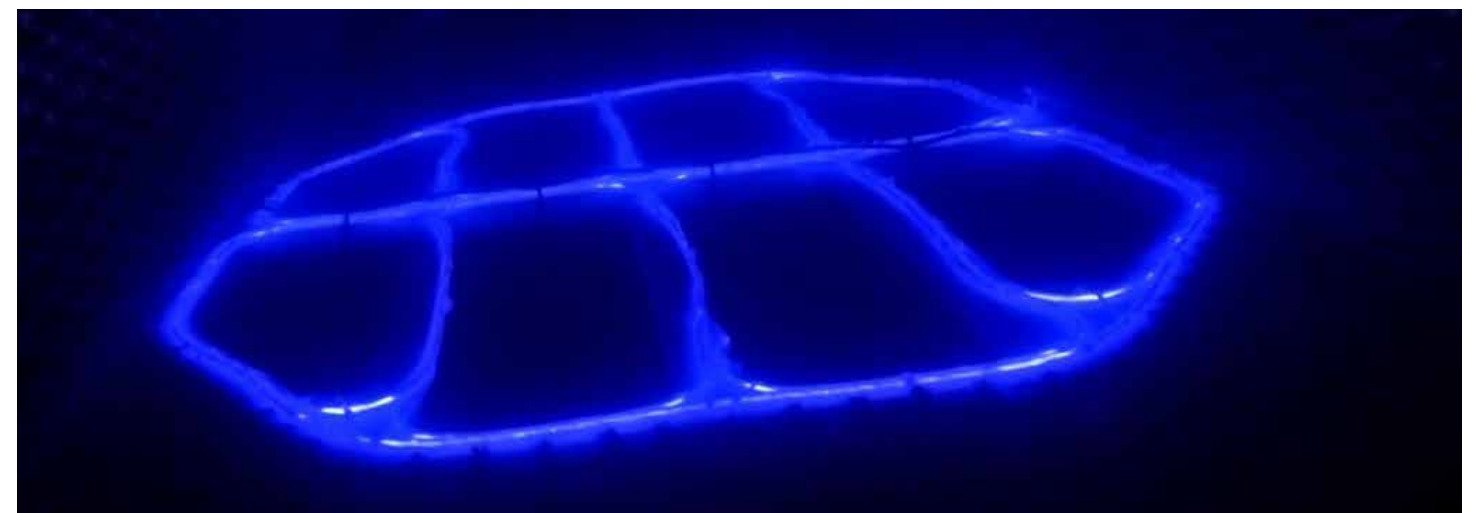
Semipelagic otterboards: As an alternative to the classic bottom doors, they move at a certain height from the bottom, without touching it, so they do not modify the seabed structure and **reduce the impact** on it. In addition, the resistance they offer is lower, thus reducing the vessel's fuel consumption. In terms of maneuverability, they allow more flexibility than the classic bottom trawlers, making it possible to trace curved routes easily.



Innovative designs: Change of the exploitation pattern through modifications in the codend mesh.



Pingers. In research projects, the placement of these acoustic devices is coupled with cameras to confirm that a capture has occurred and to verify their effectiveness.



Innovative designs: LED illuminated escape grid for fish to see an escaping point.

3.

Reducing the Environmental Impact on the Marine Environment

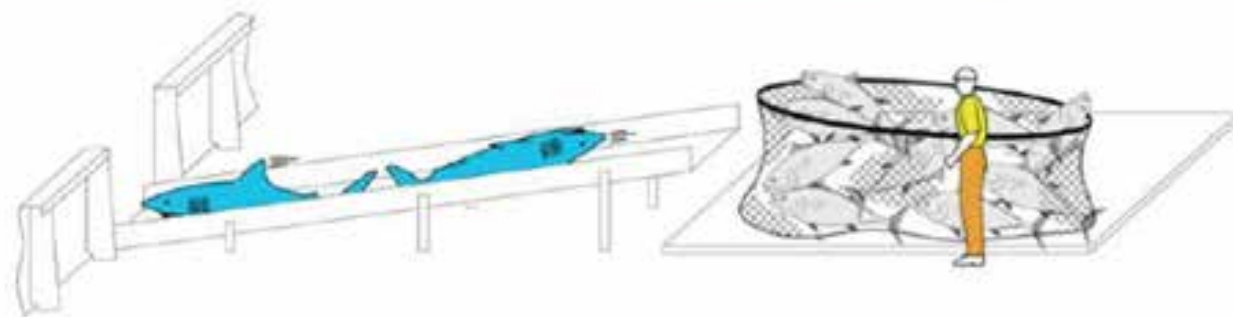
3.2

Selectivity and by-catch reduction/elimination

3.2.4 Release devices and survival of vulnerable species

In the case of tuna purse seiners, the capture of **small sharks and turtles** is relatively common. These species **need to be returned to the sea to continue their life cycle**, and various release systems have been developed to achieve this.

Ramp-mounted **hoppers**, for example, simplify the process of returning unwanted species to the sea, minimizing their stress and improving fishermen's safety. As a result, the percentage of **accidentally caught sharks that can be released directly thanks to the devices developed is 95%**.



Best Practice Guidelines for handling and release of bycatch species in tuna purse seiners



Developed with the collaboration of the OPAGAC and ANABAC fleets, this guide updates the best options to maximize the survival of by-catch associated species, always taking into account the safety of the crew as a necessary condition.

[Download the guidelines](#)

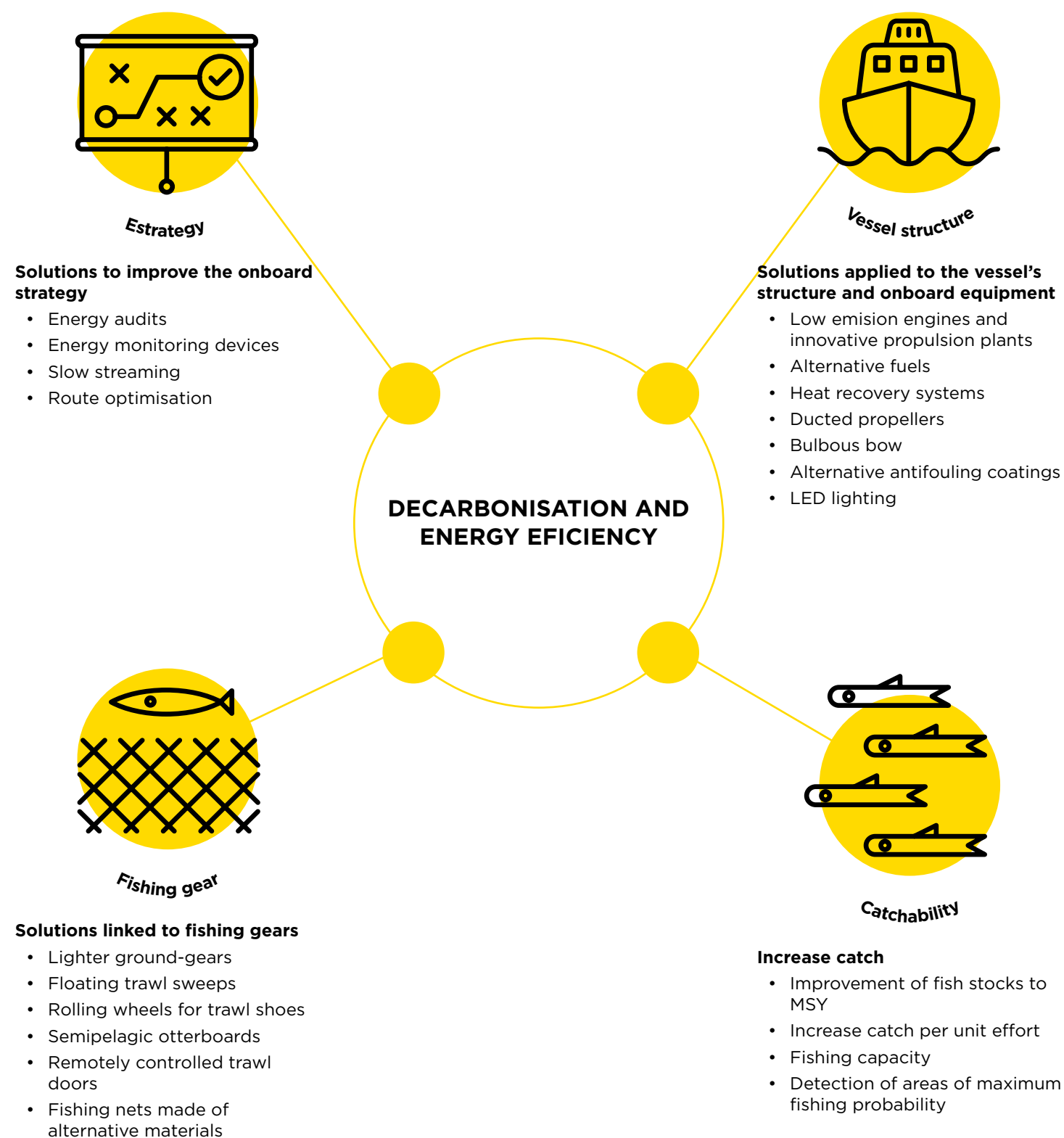
3. Reducing the Environmental Impact on the Marine Environment

3.3 Decarbonisation of the fleet

The fishing sector faces a key challenge in its transition to a more sustainable model: reducing greenhouse gas (GHG) emissions. **The decarbonisation of the fishing fleet is a priority under the European Green Deal (EGD)**, which aims to achieve climate neutrality by 2050 and to reduce emissions by at least 55% by 2030 compared to 1990 levels.

Within this framework, the European Union's Energy Transition Strategy for Fisheries and Aquaculture identifies the need to **implement more efficient technologies, promote the use of alternative fuels and promote the circular economy in the fisheries sector**. In addition, the European Maritime, Fisheries and Aquaculture Fund (EMFF) offers financial support for investments in energy efficiency and carbon footprint reduction under certain scenarios. Decarbonization offers many benefits to the sector:

- Fishing is a fossil fuel intensive activity, which contributes significantly to the emission of carbon dioxide (**CO₂**) and other pollutants. **Reducing these emissions is key to mitigating climate change and protecting marine ecosystems.**
- **Volatility in fuel prices** impacts the profitability of the sector, especially affecting small and medium-sized fleet segments and shipowning companies. **The adoption of more efficient technologies and the use of alternative energy sources can reduce these operating costs.**
- The reduction of emissions and the efficient use of resources not only guarantee the **preservation of fishery resources**, but also **improve the image and competitiveness of fishing companies** in a market that is increasingly demanding sustainability criteria.



3. Reducing the Environmental Impact on the Marine Environment

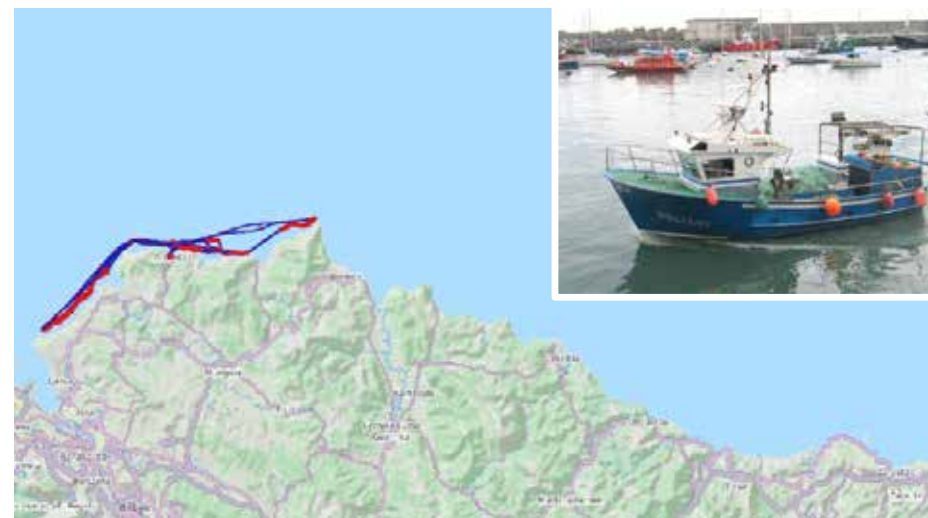
3.3 Decarbonisation of the fleet

3.3.1 No single solution for the whole fleet

The fishing fleet is very diverse:

- The European fishing fleet ranges **from small artisanal vessels to large industrial vessels**, each with **different energy and operational requirements**. The solutions to improve the efficiency of a **deep-sea trawler** are not the same as those for a **small-scale artisanal trawler**.
- Fisheries use **different fishing methods** (trawl, purse seine, longline, gillnet, etc.), which **affect fuel consumption** and the options available to reduce emissions. For example, **some techniques depend on engine power, while others require long voyages to the fishing grounds**, which determines the applicable energy solutions.
- The fleet operates in a **variety of marine environments, from coastal waters to the high seas**, with different requirements for range, resistance to **adverse weather conditions and access to infrastructure for new fuels**. In addition, the introduction of alternative fuels or electric systems is more difficult in regions with limited infrastructure.
- Some solutions, such as **hybrid engines or the use of biofuels, may be viable for large vessels, but are inaccessible to artisanal fleets** due to their high investment and maintenance costs.
- Conversion to cleaner technologies **must take into account the financial capacity of fishermen** and the financing options available.
- **European regulations on engine modernization and available capacity of fishing vessels may limit the ability to implement certain changes in the fleet without affecting fishing capacity.**

Therefore, **decarbonization must be approached with flexible strategies adapted to each segment of the sector**, combining solutions such as fuel optimization, new vessel materials, alternative energy and efficiency improvements.



Artisanal (<15m)
20-30 t fuel / year

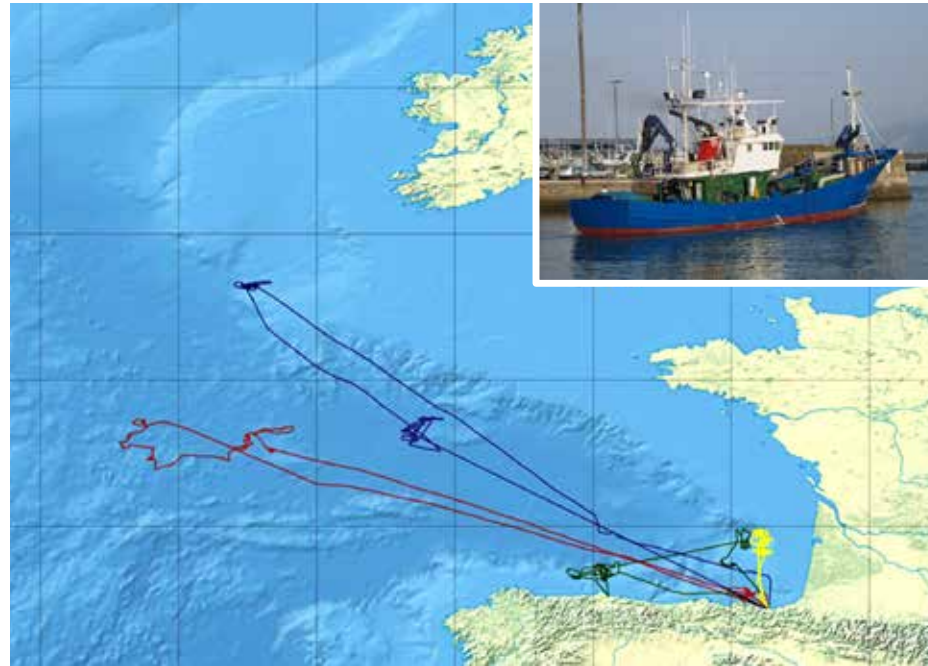


Trolling vessels
(20-25m)
80-125 t fuel / year

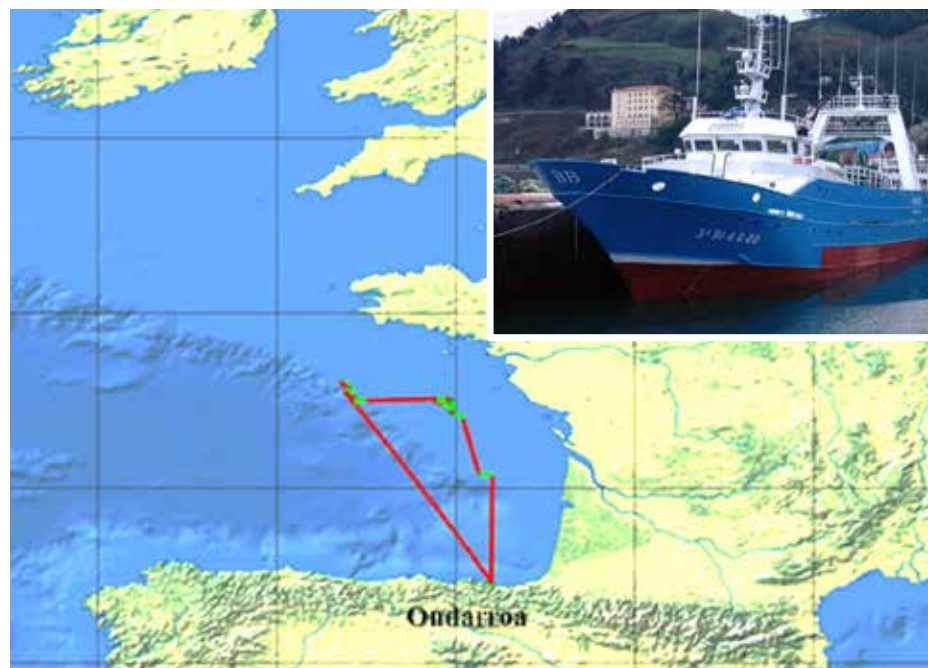
3. Reducing the Environmental Impact on the Marine Environment

3.3 Decarbonisation of the fleet

Purse seiners and Pole & line
(30-35m)
250-300 t fuel / year



Trawler
(35-40m)
1.000 - 1.250 t fuel / year



Tropical tuna purse seiner
(80-100m)
3.000 - 7.000 t fuel / year

3. Reducing the Environmental Impact on the Marine Environment

3.3 Decarbonisation of the fleet

3.3.2 Monitoring

The first step is to understand how vessels operate with their gear throughout the year and what energy they require to complete their fishing operations in order to address a real and effective energy saving and decarbonization solution.

Fleet monitoring is a key element in the decarbonization strategy of the fishing sector, as it allows to accurately assess fuel consumption, optimize operational efficiency and facilitate the transition to more sustainable technologies. Real-time monitoring systems make it possible to identify energy consumption patterns and inefficiencies in vessel operation, enabling the implementation of measures such as route optimization, speed reduction or improved engine management to minimize fuel consumption and CO2 emissions.

This requires knowledge of fuel consumption and operating patterns, proper use of equipment and development of energy audits, and evaluation of different fuel saving strategies through pilot projects, onboard tests and test benches.

Example of monitoring and results for the BAC small-scale fishing fleet:

		Maximum fuel consumption tides			
Buque	Fishing gear	Time [h]	Distance [miles]	Fuel consumption [L]	Energy consumption [kWh]
B#1	Trolling	48	257	476	1869
	Long-line / Hake	13	39	75	293
B#2	Gillnet	13	46	62	246
B#3	Gillnet	13	43	132	520
	Vertical lines	13	54	189	742
B#4	Gillnet	12	32	104	410
B#5	Long-line / Conger	12	37	33	131
	Long-line / Hake	15	44	48	187
	Vertical lines	13	65	67	263
B#6	Gillnet	6	28	81	316



WHAT DO WE ACHIEVE?

- **Identify inefficiencies in energy consumption**, enabling the implementation of strategies such as route optimization, speed reduction, and improved engine management.
- **Evaluate the effectiveness of new technologies** such as hybrid engines, alternative fuels, or improvements in vessel structure.
- **Access grants and funding**, as many financial assistance programs require proof of the actual impact of the improvements implemented.
- **Manage fleet resources more efficiently** to optimize operating costs, better plan catches, and ensure more sustainable use of marine resources.



WHAT NEEDS TO BE IMPROVED?

- Installation of energy monitoring systems, such as fuel consumption sensors and analysis software.
- Access to financing for fleet upgrades.
- Strong long-term profitability.
- Integration into the fishing routine so that it is not an additional burden.
- Improved training: not all crews have access to training to understand and apply the information received.
- Aligning the priorities of both the owner company and the deck and engine officers in the case of large fleets.

3. Reducing the Environmental Impact on the Marine Environment

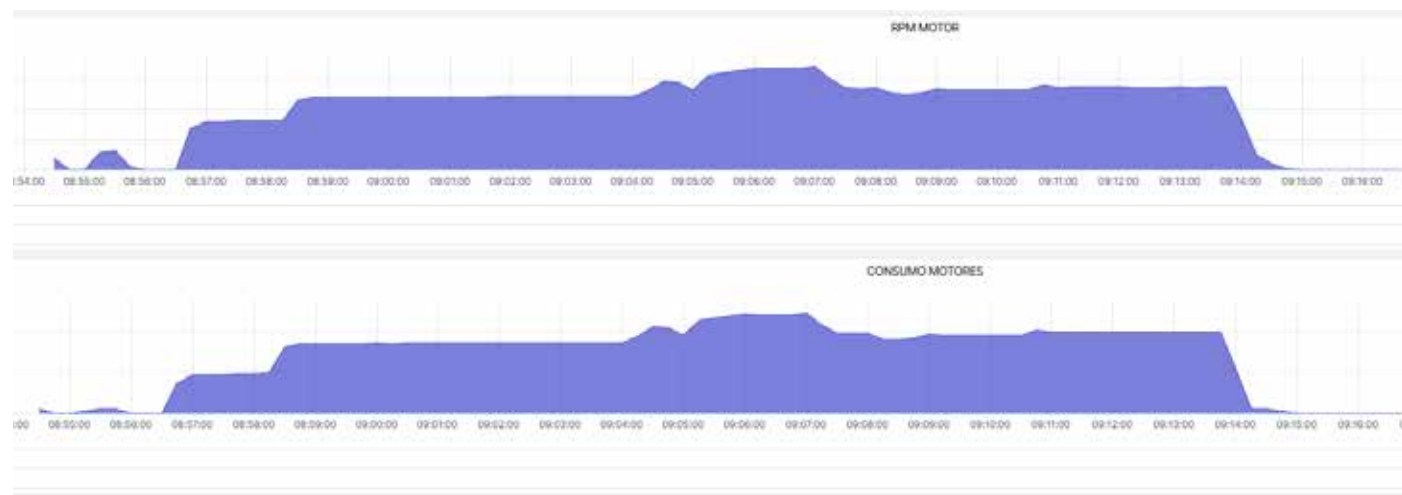
3.3 Decarbonisation of the fleet

SIMUL



Installation of systems to monitor the operation of small-scale artisanal fishing vessels in the ports of the Basque Country, in order to obtain operational and energy consumption patterns. This will provide the necessary data to study possible real and effective alternatives for the decarbonization of this fleet segment, such as hybrid-electric propulsion. The systems used include non-intrusive fuel consumption simulation and calculation units. A fuel consumption visualization tool on the bridge is also key to making the right decisions on board regarding fuel consumption.

[More information about SIMUL.](#)



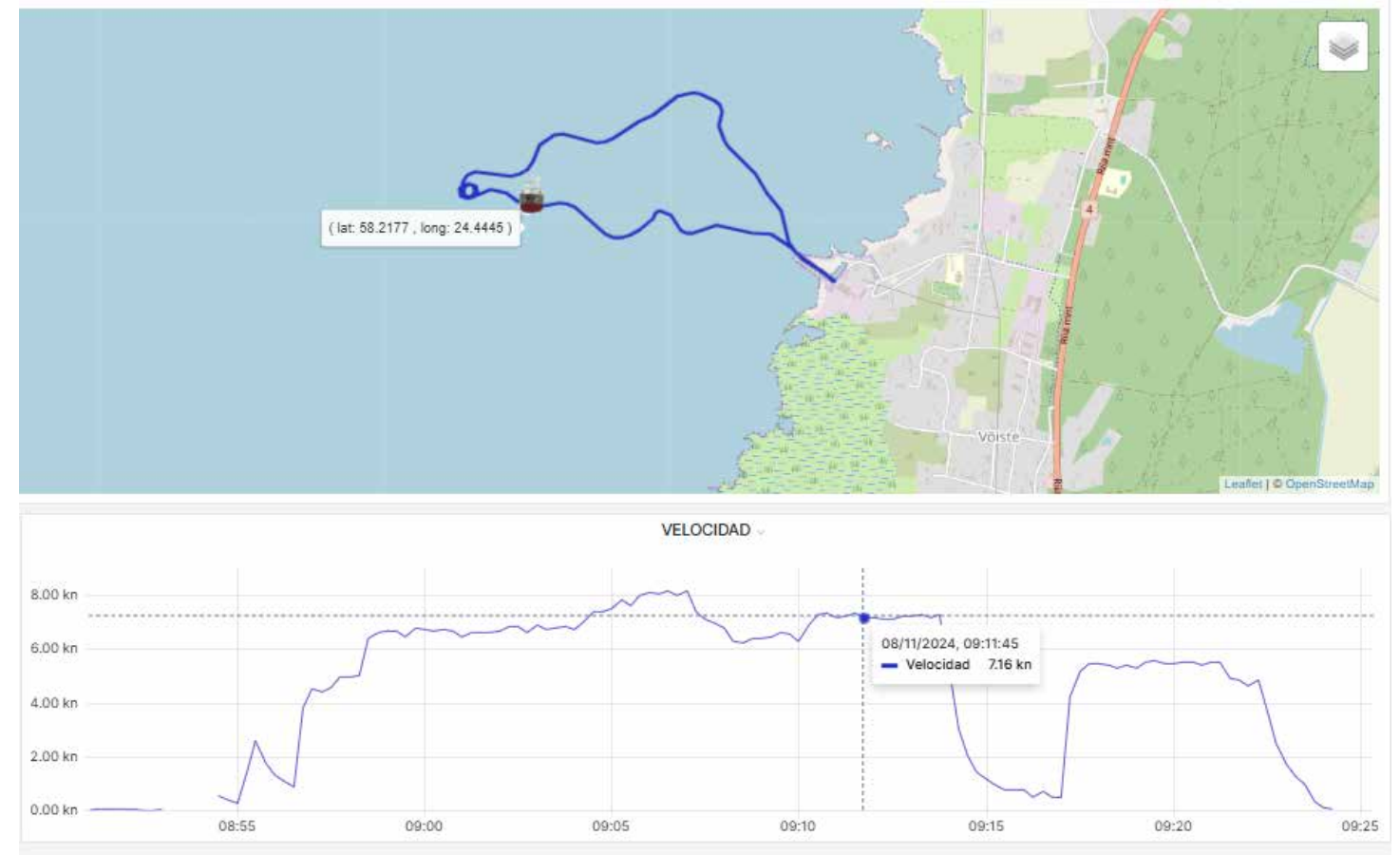
WHAT DO WE ACHIEVE?

- Detailed knowledge of the fishing activity of this segment of the artisanal fleet.
- Obtaining results in numerical values with which it is possible to design and dimension possible decarbonization alternatives.



WHAT NEEDS TO BE IMPROVED?

- Increased number of fishing units monitored to improve knowledge of the real energy needs of different fishing operations.
- Improve the transmission of knowledge and capabilities of the sector in terms of decarbonization.



Results of monitoring of small scale vessels in different EU countries, such as Denmark, Norway or Estonia. In the images, you can see the tracking of a monitored vessel together with its speed history; above you can see the rotational speed and fuel consumption history collected for this same tide, while in the left graph you can see the values displayed in real time on the bridge of the vessel.

3. Reducing the Environmental Impact on the Marine Environment

3.3 Decarbonisation of the fleet

3.3.3 Electrification

Electrification of the fishing fleet is one of the most promising solutions for the decarbonization of the sector, as it **reduces dependence on fossil fuels and improves energy efficiency**. Its implementation brings multiple benefits, but also faces considerable challenges. Switching from a diesel to an electric or hybrid propulsion system is not always feasible, but some examples already exist.

ORTZE



Ortze is the **first electric-hybrid ship conversion** with a consortium of Basque companies, and has been a before and after in terms of decarbonization. This vessel is a pioneering example of the real possibility of the integral renovation of the engine room of a training (fishing) vessel, consisting of the removal of the conventional diesel propulsion system and the installation of the new electric propulsion system with hybrid electric plant developed within the framework of the project. This modification has allowed the vessel to sail near the port with zero emissions and also to navigate in hybrid mode, minimizing emissions even far from the coast.



WHAT DO WE ACHIEVE?

- Reduce greenhouse gas emissions to near zero at port.
- Reduce operating costs such as dependence on fossil fuels.
- Reduce noise and vibrations.



WHAT NEEDS TO BE IMPROVED?

- Port facilities that facilitate connectivity and cargo.
- Economic incentives for fleet modernization.
- Technical training for the sector and auxiliary industry.

KAINDAR



Pilot project in the port of Pasaia, within the OARSOALDEA URDINA initiative, which uses renewable sources such as wind and solar energy, as well as the Cold Ironing concept, which **allows ships to connect to an electrical supply in port to recharge their electric accumulators or supply their energy demand in port while the engines are switched off, thus reducing greenhouse gas emissions**, and other combustion-related pollutants (such as nitrogen oxide and sulfur oxide), as well as minimizing noise (acoustic pollution). This system consists of an intelligent energy manager from shore to ship and vice versa. This Living-Lab is also a smart-grid where it is produced and consumed locally with the option of accumulation in case its instantaneous consumption is not necessary.

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