# Final Fisheries Industry Roadmap

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FISH-X

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| **Abstract** | In line with the EU Green Deal objectives, the Farm-to-Fork Strategy, the EU Common Fisheries Policy, and the EU 2030 Digital Compass, the Fish-X Project – co-financed by the Horizon Europe Programme – has been established to provide key contributions to transparency and compliance in EU fisheries management with regards to its digital transformation.<br><br>This Roadmap for EU Fisheries Digitalisation consolidates the key findings of the Fish-X consortium from research and various types of expert and stakeholder consultations. After the presentation of the policy and regulatory context, EU fishery industry and practices, as well as challenges for small-scale fisheries, this paper provides an insight into the project's vision on the digital transformation of EU fisheries management. This vision is then translated into a roadmap with suggestions for priority action areas and items for the different stakeholder groups, followed by an outlook on the expected results.<br><br>The project is carried out by nine European organisations, called consortium partners, including TransMarTech Schleswig-Holstein (TMT, Germany), EU Tech Chamber (EUTECH, Germany), Collecte Localisation Satellites (CLS, France), north.io (Germany), Sciaena (Portugal), OURZ (Germany), Low Impact Fishers of Europe (LIFE, Belgium), Irish Islands Marine Resource Organisation (IIMRO, Ireland), and WWF EPO (Belgium) with the affiliates WWF Portugal, WWF Adria, and WWF MMI. |

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# Acronyms and Abbreviations

| Abbreviation | Meaning |
|---|---|
| AI | Artificial Intelligence |
| AIS | Automatic Identification System |
| Art. | Article |
| CATCH | Certification and Catch Documentation Scheme |
| CFP | Common Fisheries Policy |
| CMO | Common Market Organisation |
| CSF | Community Supported Fisheries |
| EC | European Commission |
| EEZ | European Exclusive Economic Zone |
| EMFAF | European Maritime, Fisheries, and Aquaculture Fund |
| ERS | Electronic Reporting System |
| EU | European Union |
| EUMOFA | European Market Observatory for Fisheries and Aquaculture Products |
| EUR | Euro(s) |
| FAIR | Findability, Accessibility, Interoperability, and Reusability |
| FAO | Food and Agriculture Organisation of the United Nations |
| FCR | Fisheries Control Regulation |
| FTE | Full-Time Equivalent |
| GDPR | General Data Protection Regulation |
| HR | Human Resources |
| IT | Information Technology |
| ITQ | Individual Transferable Quota |
| IUU | Illegal, Unreported and Unregulated |
| kg | Kilogram(s) |
| kW | Kilowatt |
| LSF | Large-Scale Fisheries |
| M | Meters |
| MS | Member States |
| MSFD | Maritime Strategy Framework Directive |
| MSPD | Maritime Spatial Planning Directive |

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| | |
|---|---|
| No. | Number |
| PECH Committee | Committee on Fisheries of the European Parliament |
| PO(s) | Producer Organisation(s) |
| REA | (European) Research Executive Agency |
| REM | Remote Electronic Monitoring |
| SDG | Sustainable Development Goals |
| SFPA | Sustainable Fisheries Partnership Agreement |
| SME(s) | Small and Medium-sized Enterprise(s) |
| SSF | Small-Scale Fisheries |
| UK | United Kingdom |
| UN | United Nations |
| VMS | Vessel Monitoring System |
| vs. | versus |
| WP | Work Package |

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# Foreword by Fish-X

Small-scale fishers represent about 76% of active EU fishing vessels, while providing over 53% of seagoing jobs and contributing approximately 7% of total catches by volume and 29% by value from European vessels.[1] If implemented properly, these fishers will benefit from the suggested actions mentioned later in this document.

Not only does small-scale fishing (SSF) account for the majority of European fishing vessels, it also plays a much more important role because of the vital contribution it makes to creating jobs, keeping fishing ports active and, more broadly, is an integral part of coastal communities. Small-scale fishing generally utilises low impact fishing techniques and has the potential to be part of the solution to Europe's changing and troubled seas if given appropriate support and policy space. The digitalisation of the sector could provide some vital tools to SSF in this regard.

The global picture of SSF suggests that, despite the name, by no means does it have a "small" role. On the contrary, SSF are much more important than previously thought and appear to have an outsized impact on human health and nutrition, poverty alleviation, jobs, and the structure of seafood markets.[2]

The Fish-X Roadmap aligns with the EU's maritime agenda by considering existing initiatives and roadmaps focused on sustainable fisheries, digital transformation, and environmentally friendly SSF management. This approach helps to avoid duplication and to foster collaboration among all stakeholders, ultimately identifying gaps and opportunities to enhance the fisheries sector's digital transition for better, cohesive outcomes.

This Fish-X Roadmap has been developed through a robust methodology that started with a preliminary version in 2022, built on desk research and Fish-X consortium expertise. This initial version was refined through a series of consultations with experts from different sectors and

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[1] *Prellezo, R., Sabatella, E. C., Virtanen, J., Tardy Martorell, M., & Guillen, J. (2024). The 2024 Annual Economic Report on the EU Fishing Fleet (STECF-24-03 & STECF-24-07). European Commission, Joint Research Centre, Scientific, Technical and Economic Committee for Fisheries (STECF). Retrieved from https://publications.jrc.ec.europa.eu/repository/bitstream/JRC139642/JRC139642_01.pdf*

[2] Jentoft, S., Chuenpagdee, R., Barragán-Paladines, M. J., & Franz, N. (Eds.). (2017). *The Small-Scale Fisheries Guidelines: Global Implementation*. Springer. https://doi.org/10.1007/978-3-319-55074-9

disciplines. Over a period of three years, these consultations were conducted through a combination of online and physical event formats as well as more than 40 surveys and in-depth interviews with key stakeholders from the public and private sector, science and civil society.

The process also included comprehensive data analysis and the integration of best practices from existing digitalisation efforts. Additionally, feedback from pilot projects and case studies was incorporated to ensure the roadmap reflects the latest advancements and real-world applications in digital transformation for fisheries. Special attention has also been given on what could make the sector more attractive to the younger generation, which will be vital for the successful digital transition of the sector.

We invite all actors from EU fisheries to join this very important and common journey towards the empowerment of small-scale fisheries.

## Acknowledgements

The Fish-X team expresses sincere gratitude to all representatives of the stakeholder groups for their assistance in gathering the material that formed the basis of this roadmap. Your invaluable contributions have helped shape the key recommendations and conclusions that will ensure the successful implementation and development of the project.

## Executive Summary

The Fish-X Roadmap outlines the strategic direction for the EU fisheries sector's digital transformation, aiming to enhance sustainability and efficiency. It provides a guide for maritime agencies and fisheries to adopt emerging digital tools and practices. The roadmap emphasizes the involvement of EU fisheries stakeholders in the digital transition by 2030, focusing on small-scale and recreational fisheries.

The roadmap addresses critical needs in digitalizing fisheries, offers an actionable plan for evaluating innovative solutions, and provides insights into the current state of digitalisation in EU fisheries. It also introduces novel IT tools and methodologies, emphasising practical

applicability and scalability for the sector. Through stakeholder consultations and validation, the roadmap ensures that proposed solutions meet the sector's needs and align with EU policy goals for modernisation.

By following this roadmap, stakeholders can support the sector's digital transition, fostering sustainability and growth through modern technological solutions.

# 1. Introduction

Digitalisation offers a transformative opportunity for the European fishing industry to provide traceable, healthy, affordable, and sustainable seafood. It empowers small-scale fishers to adopt informed, sustainable practices and enhancing their visibility and skills. It also supports the achievement of UN Sustainable Development Goals (SDGs), particularly SDG 14 on "Life Below Water," by addressing overfishing, illegal practices, and marine ecosystem degradation.

Europe's fisheries sector faces significant and multifaceted challenges, including illegal, unreported, and unregulated (IUU) fishing, overfishing, and biodiversity loss. In addition, the sector is increasingly impacted by climate change and other anthropogenic pressures such as marine pollution, habitat degradation, eutrophication, and the spread of invasive species. These interconnected threats not only compromise the ecological integrity of marine ecosystems but also undermine the long-term sustainability and economic resilience of the fisheries sector across Europe. While some fish stocks are overexploited, the misalignment between fishing capacity and available resources remains a concern. In parallel, the privatisation of fisheries resources, particularly through track record requirements and Individual Transferable Quotas (ITQs), is a growing issue, especially in regions like the North Sea and Baltic Sea. Although ITQs aim to reduce overcapacity and enhance economic efficiency, they disproportionally disadvantage small-scale fisheries (SSF). The concentration of quotas in the hands of larger commercial enterprises has made it more difficult for small-scale fishers to access resources and maintain their livelihoods, undermining their ability to participate in sustainable fishing practices. Issues like these also impact broader SDGs like decent work (SDG 8), reduced inequalities (SDG 10), and climate action (SDG 13). To strengthen monitoring and enforcement, the EU has adopted the revised Regulation (EU)

2023/2842 of 22 November 2023, concerning Fisheries Control, introducing modern digital tools for SSF, such as electronic logbooks for catch reporting and vessel monitoring systems to improve traceability, monitoring, and enforcement.

The Fish-X project, co-funded by the Horizon Europe Programme, showcases how digital technologies can be integrated into the EU small-scale fisheries sector and provide a path towards more sustainability, efficiency, and transparency. Focusing on SDG target 14.b 'Provide access for small-scale artisanal fishers to marine resources and markets', Fish-X seeks to empower small-scale fishers by introducing innovative digital solutions that play a central role in this transformation:

- **Fish-X Data Space:** A platform facilitating secure data collection, sharing, and analysis among fisheries stakeholders, enabling better compliance and decision-making and empowering SSF as owners and providers of data.
- **Insight Platform:** A monitoring tool providing actionable insights into fisheries operations to increase visibility of the SSF fleet segment, promote sustainable practices and enhance transparency in the seafood supply chain.
- **Traceability Platform:** A system to trace seafood from catch to consumer, ensuring transparency, traceability and accountability while complying with EU regulations.

The Fish-X Roadmap for EU Fisheries Digitalisation 2030 addresses three major challenges:

- **Challenge 1:** Achieving harmonised digital infrastructure across all EU countries to enable unified tools for catch reporting, data sharing, and analysis, ensuring interoperability and a complete picture of the sector.
- **Challenge 2:** Encouraging fishery stakeholders to actively participate in data-sharing by offering incentives, addressing privacy concerns, fostering fair competition (especially against non-EU competitors), and educating fishers about data ownership and security.
- **Challenge 3:** Expanding digital cooperation by ensuring the platform is reliable, accessible, and usable for all stakeholders through interoperable, user-friendly, and affordable tools.

By addressing these challenges and leveraging its innovative platforms, Fish-X aims to help foster a sustainable future for the EU fisheries sector. This transformation will drive investment, improve traceability, and support the development of efficient, digital solutions that benefit all stakeholders.

# 2. The EU Fishing Industry

As one of the pillars of coastal communities and economies, EU fisheries play a vital role in providing a healthy supply of food to local, national, and international markets, contributing significantly to food sovereignty, cultural identity, employment, income generation and making seafood a vital component of the EU's internal and external trade.

## 2.1. The EU Fishing Fleet

When analysing its structure and economic performances in the Annual Economic Reports issued by the Scientific Technical and Economic Committee for Fisheries (STECF), the EU Fishing Fleet is categorized into 3 macro-segments: the Small-Scale Coastal Fleet (SSCF), Large-Scale Fleet (LSF) and Distant-Water Fleet (DWF). These macro-segments gather several fleet segments formed by a combination of a particular fishing technique (fishing gear) and a vessel length category as defined in the EU Data Collection Framework[3]. Performance results are also available per length classes within each segment.

Table 1 presents their characteristics and figures issued in the 2024 report for year 2022[4].

*Table 1: EU fishing vessel macro-segments and their characteristics (STECF, report of 2024, data of 2022)*

| | Small-Scale Coastal Fleet (SSCF) | Large-Scale Fleet (LSF) | Distant-Water Fleet (DWF) |
|---|---|---|---|
| Characteristics | all marine and inland fishing vessels under 12 | all vessels above 12 metres and all vessels using towed gears | fishing vessels over 24 meters flying the flag of an EU Member |

[3] Fleet Segment DCF / EU-MAP : https://dcf.ec.europa.eu/data-calls/definitions-and-terminology/f/fleet-segment-dcf-eu-map_en

[4] Scientific, Technical and Economic Committee for Fisheries (STECF) - The 2024 Annual Economic Report on the EU Fishing Fleet (STECF 24-03 and 24-07), PRELLEZO, R., SABATELLA, E.C., VIRTANEN, J., TARDY MARTORELL, M. and GUILLEN, J. editor(s), Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/5037826, JRC139642

| | Small-Scale Coastal Fleet (SSCF) | Large-Scale Fleet (LSF) | Distant-Water Fleet (DWF) |
|---|---|---|---|
| | metres using non-towed gears[5] | operating predominately in EU waters | State and fishing predominantly in non-EU waters (NAFO, ICCAT, IOTC, CECAF and NEAFC) |
| Gears used | 'Drift and/or fixed netters', 'pots and/or traps', 'hooks', 'passive gears only', 'other passive gears', 'polyvalent passive gears only', 'active and passive gears' | 'dredgers', 'demersal trawlers and/or demersal seiners', 'other active gears', 'polyvalent active gears only', 'purse seiners', 'beam trawlers', 'pelagic trawlers' | Not specified |
| Number of active vessels<br><br>(total active vessels: 52830 or 74% of total fleet in 2022) | 40 083<br><br>(76% of the active fleet) | 12 503<br><br>(23.7% of the active fleet)<br><br>4 223 under 12 meters | 244<br><br>(<0.5% of the active fleet) |
| Number of fishers<br><br>(total: 119 702 fishers, or 75 816 FTEs) | 59 694<br><br>(50% of the total engaged crew) | 53 516<br>(45% of the total engaged crew) | 6 500<br><br>(5% of the total engaged crew) |

[5] As defined in the Regulation (EU) 2021/1139 of the European Parliament and of the Council of 7 July 2021 establishing the European Maritime, Fisheries and Aquaculture Fund and amending Regulation (EU) 2017/1004. Fishing carried out by 'fishers on foot, including shellfish gatherers' are excluded from this analysis.

| | Small-Scale Coastal Fleet (SSCF) | Large-Scale Fleet (LSF) | Distant-Water Fleet (DWF) |
|---|---|---|---|
| Landings ratio/Landing in tons of all EU landings (total=3.49 million tonnes) | 7%<br>(229 000 tons) | 72%<br>(2.5 million tons) | 21%<br>(760 000 tons) |
| Landings ratio/Landing in value of all EU landings (total EUR 6.6 billion) | 15%<br>(1,0 billion) | 65%<br>(4.3 billion) | 19.5% |

**Fleet Capacity and trends**

- **Small vs. Large:**
  - Small-scale fisheries dominate numerically, representing 76% of the fleet and providing 53% of jobs, yet account for only 7% of catch volume (weight landed) and 19% of its landed value.1 kg of fish from SSF is sold 2,5 times the price of 1 kg of fish from LSF. In contrast, large-scale and distant-water fleets drive most of the sector's economic output and landings.
- **North vs. South:**
  - The southern EU member states, bordering Southern Western Waters[6] and the Mediterranean Sea, show the highest concentration of SSF (e.g., Greece, Italy, Portugal, Croatia, Spain, France).

[6] The Southern Western Waters (SWW) covers the Atlantic zone running from the tip of Brittany in the North to the Strait of Gibraltar in the south and including the outermost regions of Madeira, the Azores and the Canary Islands (ICES areas 8, 9 and 10, and the COPACE divisions 34.1.1., 34.1.2, 34.2.0).

- Northern EU countries bordering North Atlantic Ocean supra region[7] such as Denmark and the Netherlands, are characterised by highly industrialised fishing fleets.

- **Efficiency vs. Scale**:
  - Total number of vessels in the EU fishing fleet have been declining since the 1990s. However, new technology — often called "technological creep" — has made the fleet better at catching fish. Even though there are fewer vessels, improvements in technologies such as engines, fishing gear, fish detection sonars and navigation systems mean that the remaining vessels can catch as much, or even more, than before.
  - Average fuel consumption per landed tonne was 537 litres for SSF and in 2022, and 453 litres for LSF in 2021[8], which could support actions for modernizing SSF engines.
  - LSF often benefit from quota-based consolidation, while SSF face challenges like access to the fishery resource (in terms of fishing rights and availability of fish in coastal waters), aging vessels and limited investment.

## 2.2. The EU Fish Market

As part of the Common market organisation in fishery and aquaculture products, the European Commission has developed the European Market Observatory for Fisheries and Aquaculture Products (EUMOFA), a market intelligence tool managing economic data on fishery and aquaculture products along the supply chain from first sale to consumption, on a weekly, monthly and yearly basis. Figures in the section are sourced from the EUMOFA 2024 annual report[9] for year 2022-2023.

**Market supply and demand**

The EU average seafood consumption per capita in 2022 was 23.51 kg, with a strong preference for wild products compared to farmed ones. The EU is mainly able to maintain a high level of consumption of seafood products by importing them from other regions of the

[7] North Sea and Eastern Arctic, Baltic Sea, North Western Waters, South Western Waters.
[8] STECF 2024, already cited
[9] ‘The EU Fish Market - edition 2024 », European Market Observatory for Fisheries and Aquaculture Products, https://eumofa.eu/documents/20124/145239/EFM2024_EN.pdf

world. The EU is a net importer with a large trade deficit, amounted amounting in 2023 to EUR 22 billion (30.1 billion imports vs 8.1 billion exports).

With such high volumes of imports (over 60%), the need for improved traceability of both unprocessed[10] and processed[11] seafood products are critical.

SSF accounts for 19% of the landings in value, playing an important role in the EU domestic supply of fresh and high-quality seafood products.

**Seafood Supply Chain**

The fishing industry in the EU extends far beyond the direct activities of catching seafood. The EU fishing fleet supplies a vast and complex value chain, including processing, logistics, distribution, and retail industries, which are essential for delivering seafood products to consumers both within and outside the EU.The value chain for SSF typically involves 1) Fishing 2) First Sale where the landed fish[12] is sold or registered at an auction centre or to registered buyers or to producer organisations (PO)[13], or directly to local consumers 3) Processing: several forms of traditional processing are used by producers: filleting, salting, drying, smoking, etc., carried out by individual establishments or by cooperatives of fishers[14]. from SSF are generally distributed through local and regional fresh fish markets and sold close to the landing place within 50 km[15], involving small-scale operators. In contrast, large-scale fisheries operate within a more complex and industrialised value chain.Products from the industrial fleet are generally frozen and used as a raw material, in conjunction with imported raw materi[16].

[10] Unprocessed products are defined as the aggregation of fresh, chilled and frozen finfish, crustaceans, molluscs and cephalopods, packaged and unpackaged. For more details, see the Methodological background.

[11] Processed products are defined as the aggregation of shelf-stable, chilled processed and frozen finfish, crustaceans, molluscs and cephalopods.

[12] First sales may differ from landings since the former do not cover fish that is landed by vessels owned by processing companies or direct sales to processors.
https://eumofa.eu/data

[14] Adding Value to Local Fishery and Aquaculture Products, Guide #3, FARNET, 2011, European Commission, Maritime Affairs and Fisheries

[15] Research for PECH Committee - Small-scale fisheries markets: value chain, promotion and labelling, Study, 2016, DIRECTORATE-GENERAL FOR INTERNAL POLICIES, POLICY DEPARTMENT B: STRUCTURAL AND COHESION POLICIES, Fisheries

[16] Research for PECH Committee - Small-scale fisheries markets: value chain, promotion and labelling, Study, 2016, DIRECTORATE-GENERAL FOR INTERNAL POLICIES, POLICY DEPARTMENT B: STRUCTURAL AND COHESION POLICIES, Fisheries

The study for PECH Committee on Small-Scale fisheries market (2016) highlights that fish brokers and fish processors play an important role in the value chain and estimates that the primary producer (SSF fisher) only receives 10% of the final sales price of his product. It identifies the shortening of the value chain as a must-do to improving the income of the SSF fishers, but also of getting a better product (probably at a better price) to the consumer.However, regulation of first sales varies across EU Member States. as illustrated by the ECA[17] in the Member States visited for the audit: In Spain, all fresh fish must be sold at auction. In Italy, for the first sale, fishery products must be transferred to a registered auction centre, registered buyer or producer organisation but small quantities can be sold directly to the consumer from the fishing vessel. In France, sale by auction or other is possible but to a buyer that must be recorded. Small quantities can be sold directly to the consumer from the fishing vessel.

**Market Trend and Challenges**

Small-Scale Fisheries grappling with rising competition from imports aquaculture, and LSF, posing significant challenges to their market position. In response to these pressures, sustainability efforts are becoming increasingly important. There is a growing focus on short supply chains and eco-labelling as key strategies to support local fishers and enhance the visibility of their products. Furthermore, alternative business models[18] are emerging, leveraging online and digital marketing platforms, innovative labelling systems, and products derived from invasive species. These initiatives, driven by small-scale, low-impact fishers and fishmongers, present the potential to unlock new market opportunities, promote fairer prices for SSF, and reduce the environmental footprint of the sector. These evolving trends highlight the need for strategic adaptation and innovation to ensure the long-term sustainability and competitiveness of small-scale fisheries.

[17] European Court of Auditors | Special report 8/2017: EU fisheries control
[18] Report: Fisheries for a new era - Seas At Risk

# 3. Regulatory Background

The Fish-X project aligns with a range of EU communications, regulations, and directives aimed at promoting sustainability, digitalisation, and marine conservation, specifically within the fisheries, maritime, environment, digital, and energy sectors.

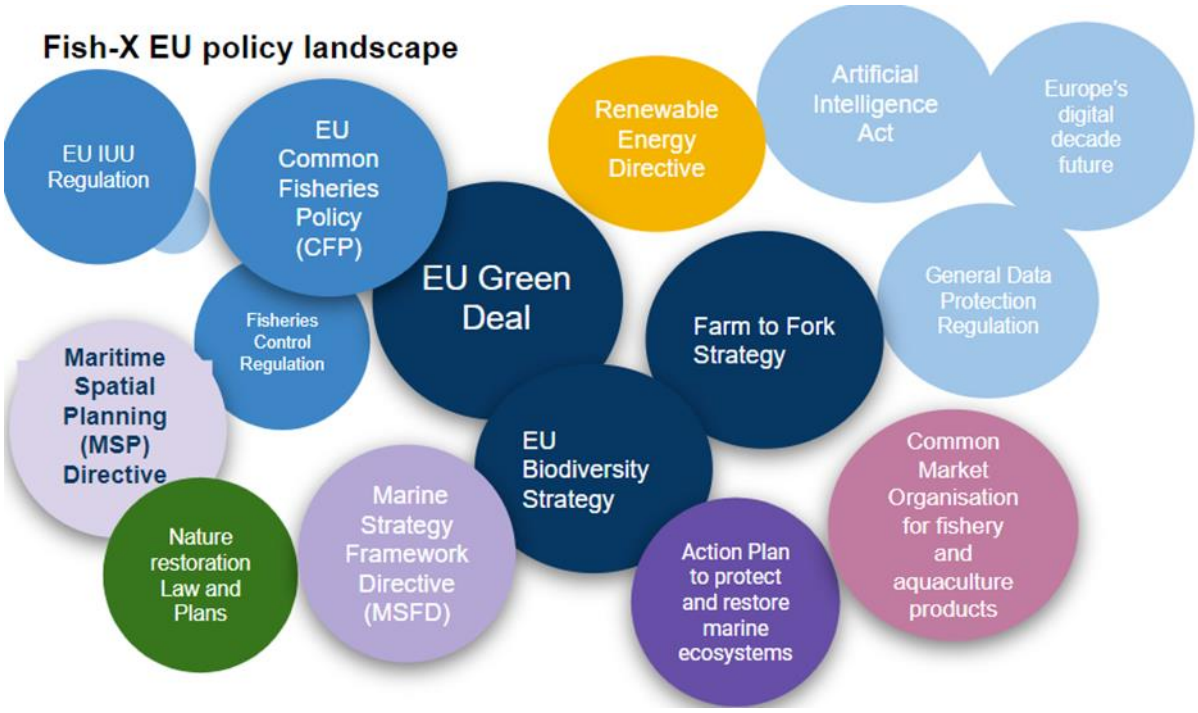


*Figure 1: Fish-X EU Policy Landscape (own elaboration by Fish-X)*

## 3.1. Overarching EU Communications

1. **European Green Deal (2019)** – Sets climate-neutrality goals by 2050, impacting sectors such as food systems, energy, and finance.
2. **Farm to Fork Strategy (2020)** – Promotes sustainable food systems with a focus on environmental impacts and health.
3. **EU Biodiversity Strategy (2020)** – Aims to restore Europe's biodiversity by 2030, focusing on marine ecosystems, including: a) Protecting 30% of marine areas by 2030; b) Restoring marine ecosystems to good environmental status.

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4. **Action Plan for Marine Ecosystem Restoration (2023)** – Targets sustainable fisheries and marine life protection, including bycatch reduction and seabed protection.
5. **2030 Digital Compass (2021)** – Aims for full digitalisation by 2030. Outlines the EU's digitalisation goals, including ensuring 80% of the population has basic digital skills and 75% of businesses using technologies like Cloud and AI.
6. **European Data Strategy (2020)** – Aims to create a single market for data, enhancing competitiveness and data sovereignty**.** Includes sectoral Common European Data Spaces, such as the Green Deal Data Space**,** for better access to environmental and sustainability-related data—while ensuring control remains with data owners.
7. **FAIR Principles -** Guide the development of transparent and interoperable data systems. A FAIR and federated data space ensures data is Findable, Accessible, Interoperable, and Re-usable**,** enabling seamless collaboration across databases and sectors.

## 3.2. Relevant EU Fisheries Regulations

1. **Common Fisheries Policy (CFP)** (Regulation (EU) No 1380/2013): Promotes sustainable resource use through stock recovery plans, landing obligations, and measures to combat IUU fishing. The CFP includes some SSF-specific provisions, such as preferential coastal access and participation in Advisory Councils.
2. **Common Market Organisation (CMO)** (Regulation (EU) No 1379/2013): Regulates market balance and sustainability through Producer Organisations (POs)**,** consumer information, and marketing standards**.** The 2023 Commission report on the implementation of the CMO (COM(2023) 101 final) highlights the underrepresentation of SSF in POs, limiting their access to market benefits and traceability systems: *"it is well recognised that the dedicated small-scale Producer Organisations remains a challenge, that there is a need for a better structuring of small-scale fishers, the lack of appropriate administrative and/or financial support to establish SSF POs or that Member States do not take sufficient account of their specificities laying down criteria for recognition".*
3. **EU Fisheries Control Regulation (2023/2842):** Modernises fisheries control with **mandatory digitalisation** and removes previous SSF exemptions. Key provisions include:

a. **Vessel Monitoring Systems:** All fishing vessels, including those under 12m, must have Vessel Monitoring Systems (VMS), which may not be attached to vessels for vessels under 12 metres (article 9, paragraph 3). SSF have a transition period until 2028, with exemptions for certain passive gear vessels under 9m operating close to shore, valid until 31 December 2029. The commission will develop a VMS application for member states which required it for their vessels below 12 metres.
b. **Electronic submission of fishing logbooks**: All vessels must use Electronic Reporting Systems (ERS) for all catches (no exemption below 50 kg) and submit digital landing declarations. Vessels of less than 12 metres may report only before landing, while large vessels report haul-by-haul. SSF also benefit from a transition period until 2028. The commission will develop an ERS application for member states which required it.
c. **Remote Electronic Monitoring (REM)**: for the purpose of monitoring the landing obligation, vessels above 18 metres in length with a high risk of non-compliance with the landing obligation shall be fitted with onboard cameras with recording capability.
d. **Market control rules:** Traceability must link each lot of fish to a specific fishing trip via digital identifiers. Operators across the value chain must record and transmit data electronically, and Member States must monitor system usage. A limited exemption applies to direct sales under 10 kg/day per consumer for private use — a key sales channel for SSF.
e. **Import control rules:** Imports into the EU must meet the same standards as EU-caught fish. All catch certificate information must be submitted digitally via the EU CATCH system.
f. **Use of the data collected by application of the fisheries control regulation**: as per the article 113, the Member States and the Commission shall ensure that data for which professional or commercial secrecy apply shall be treated accordingly. Using these data for other purposes than control requires the consent of the Member State or the Commission.

## 3.3. Other relevant EU sectoral Regulations

**Maritime Sector and the Blue Economy**

The EU's Sustainable Blue Economy Strategy (2021) supports the European Green Deal by promoting offshore renewable energy, circularity, and green infrastructure. The Maritime Spatial Planning Directive (MSPD) (2014/89/EU) focuses on sustainable maritime growth, ensuring responsible marine resource use and contributing to the 30 by 30 global initiative to protect 30% of the Earth's land and sea areas by 2030.

**Environmental Regulations**

The Nature Restoration Regulation (EU 2024/1991) sets a goal for restoring 20% of EU land and marine areas by 2030, with a long-term vision for broader ecosystem restoration. The Marine Strategy Framework Directive (MSFD) (2008/56/EC) aims for Good Environmental Status (GES) in EU marine environments, supporting sustainable fisheries and ecosystem resilience.

**Energy Transition and the Fisheries Sector**

The Renewable Energy Directive (2009/28/EC) and its 2023 revision aim for higher renewable energy use, with potential impacts on the fisheries sector, especially regarding offshore renewable energy projects and the transition to decarbonisation. Fish-X tools will raise awareness about the carbon footprint of fisheries, encouraging more sustainable fishing practices, in line with EU decarbonisation targets.

## 3.4. Relevant EU Data-related Regulations

**Privacy protection**

The General Data Protection Regulation (GDPR) applicable as of May 25th, 2018, has laid the groundwork that personal data should be handled with specific care for privacy and business confidentiality protection and their processing should comply with the relevant legal provisions.

Fisheries data may be considered as personal if related to the identification of a natural person. In that case, the following principles should apply: lawfulness, fairness and transparency, purpose limitation, data minimisation, accuracy, storage limitation, integrity, confidentiality and accountability.

**Data Space and Fisheries**

The Fish-X Data Space fits into the framework of Common European Data Spaces as a sector-specific initiative, intersecting with both the Green Deal Data Space and the Agriculture Data Space established under the EU Data Strategy.

The Data Governance Act (DGA) (2022) plays a crucial role in the creation and functioning of sectoral dataspaces overseeing the reuse of public or protected data across various sectors. Though not overriding existing sectoral regulations, it introduces governance mechanisms for trusted, secure and voluntary data sharing by regulating new entities known as “data intermediaries” ensuring they operate fairly and transparently while protecting sensitive information. The DGA covers both personal and non-personal data, with the General Data Protection Regulation (GDPR) applying whenever personal data is involved. The inclusion of built-in safeguards, in addition to GDPR, is intended to enhance trust in the sharing and reuse of data.

The Fish-X Data Space would facilitate secure, standardized, and interoperable data sharing among stakeholders in the fisheries sector, including policymakers, scientists, industry actors, NGOs, and enforcement authorities. It could improve how regulatory fisheries control data is accessed, reused, and integrated across fisheries-related stakeholders.

The AI Act (2024/1689) sets binding rules based on a risk-based approach for the development, marketing and use of any “AI system” (a software based on Artificial Intelligence (machine learning models, deep learning systems, expert systems, statistical/logical approaches)). AI systems can be prohibited, High-risk, Limited-risk or minimal-risk. The use of AI in Fisheries has a limited risk: users must be informed that their data will be used by AI systems. AI results should be overseen by human when used for supporting enforcement.

**Current Policy Development**

The Fisheries Control Regulation (FCR), effective from January 2024, and the Nature Restoration Law (June 2024) will bring significant changes to fisheries management. Political shifts following the 2024 European elections may influence national sovereignty in fisheries, potentially impacting Fish-X's pan-European digitalisation objectives.

The European Commission is preparing a future vision for fisheries in 2040 whose biggest challenge is to ensure long-term competitiveness and sustainability for the fisheries sector, as required in the Mission Letter to the incoming Commissioner for Oceans and Fisheries. This vision will be shaped by reflections led throughout 2025 on the European Oceans Pact aiming at ensuring coherence across all policy areas linked to the ocean and on the outcomes of the ongoing evaluation of the Common Fisheries Policy on sustainability and social benefits. 'Fishers of the Future', a foresight study Commissioned by the European Climate, Infrastructure, and Environment Executive Agency (CINEA) and the Directorate-General for Maritime Affairs and Fisheries (DG MARE) explores the changes that the profession, role and identity might face up to 2050 under 4 hypothetical scenarios and across 2 profiles: a small-scale fisher and a large-scale fisher. Supporting technological and digital transition is an emerging key policy topic highlighting the needs for funding and training to ensure equitable access to green technologies and digital skills fostering innovation across fleets.

## 3.5. National Level Initiatives

The EU is progressively integrating digital tools into fisheries management to boost sustainability and regulatory compliance. Several Member States have already initiated national-level transitions to improve data collection, monitoring, and reporting for their SSF communities, though the digital tools were introduced to support specific use cases or research.

- **Atlantic Region**: , The UK already deployed inshore-VMS in England, Wales and will to it in Scotland by end of 2026. They use VMS and automated reporting tools to enhance data accuracy.
- **Mediterranean Region**: Italy, Spain, France, Croatia, Greece, and Cyprus have specific SSF fisheries equipped with VMS or ERS, to improve coastal ecosystem management.

- **Baltic Region**: Germany and Latvia have deployed Automatic Identification Systems (AIS) and Remote Electronic Monitoring (REM) to enhance fish stock management and sustainability. REM is not typically required for SSF due to its cost and operational complexity (in data interpretation) but is installed when a high risk of by-catch exists and when the landing obligation is difficult to comply with.

## 3.6. Modernisation and Sustainability Opportunities

While SSF forms the backbone of the fishing industry in fleet numbers and employment, many vessels lack monitoring tools like vessel monitoring systems (VMS) or electronic reporting systems (ERS), as they were not previously required under EU laws. However, in several MS, SSF are required to complete paper logbooks for catch reporting. Expanding digital adoption is essential to improve traceability and alignment with EU policies such as the Common Fisheries Policy (CFP) and the revised EU Fisheries Control Regulation. The Control regulation requires that all SSF to use VMS and electronic catch reporting from January 10, 2028 (Article 8.2 on Transitional Provisions).

By adopting interoperable digital tools and fostering regional collaboration, the fisheries sector can enhance visibility, sustainability, transparency, and market competitiveness. This digital transformation also presents significant opportunities for small-scale fisheries (SSF). Improved data visibility, for instance, can help demonstrate areas of fishing activity in maritime spatial planning processes, thereby protecting economically vital grounds from closure. Furthermore, digital tools empower SSF actors to engage more directly with EU and national regulatory bodies, co-create fair and inclusive governance frameworks, and actively contribute to the long-term sustainability of European fisheries. Enhancing traceability and documentation also helps SSF operators overcome stigmas related to IUU fishing and ensures they receive fair economic returns for their catch. Altogether, these developments support the EU's broader goals of ensuring environmental, economic, and social sustainability.

To achieve these goals, the Member States and the Commission should be ready to grant access to the data collected for the execution of the fisheries control regulation, assuming all applicable commercial secrecy is protected.

The Fish-X project addresses this gap by developing cost-effective digital tools for SSF, enabling small-scale fishers to comply with the new monitoring and traceability requirements of the Fisheries Control Regulation, protecting their individual rights by data anonymisation and aggregation, and supporting inclusivity in the digital transition. By integrating with existing

EU regulations, Fish-X ensures a smooth transition to digital monitoring, improving transparency and sustainability.

# 4. Fish-X Roadmap – Digital Transformation

The Fish-X Roadmap outlines a joint effort to digitally transform small-scale fisheries by 2030, supporting sustainable management and aligning with the EU's Farm to Fork Strategy. Based on research, expert contributions, and early engagement, the roadmap was refined through a survey of 42 maritime professionals (see section 4.3) —mainly from the Atlantic and North Sea regions—offering valuable insights into sector-specific needs and challenges.

Effective digitalisation in fisheries depends on strategic alignment across global, EU, and local levels. Fish-X promotes regulatory coherence, data interoperability, and stakeholder collaboration, supporting global frameworks such as UN SDG 14 and the FAO's SSF Guidelines. Within the EU, the project works to harmonise digital tools, reduce technology gaps, and ensure fair access across Member States.

Fish-X connects global sustainability targets with the practical needs and challenges faced by fisheries in different regions. Fish-X involves fishers in the data collection, giving them the information they need to trust the data sharing applications. This approach supports a unified, inclusive, and digital transformation of the fisheries sector, and give fishers a greater visibility.

## 4.1. The Fish-X Approach for Digital Transformation

Fish-X aims to make key fishing data easily accessible by 2030, helping small-scale fisheries become more efficient, sustainable, and resilient. By promoting the use of digital tools, the project improves how data is collected, shared, and applied, making operations smoother, increasing transparency, and supporting compliance. These tools can help reduce costs, improve traceability, and enable smarter decision-making, while strengthening the market position of SSF and building consumer trust. At the same time, Fish-X supports the sustainable use of marine resources by balancing ecological protection with economic viability and better-informed policy.

To manage resources responsibly and stay competitive, SSF need access to digital tools across the value chain—from monitoring catches to engaging in spatial planning and combating illegal fishing. Digitalisation also opens new job opportunities, requiring modern skills and fostering innovation. Fish-X also looked for ways to ensure this shift can be inclusive, practical, and tailored to real-world needs.

The Fish-X approach is guided by principles that promote trust, transparency, and shared responsibility. It builds capacity, ensures legal clarity, and applies ethical standards. By following the FAIR principles—findability, accessibility, interoperability, and reuse—and ensuring full GDPR compliance, Fish-X enables secure, responsible data use across the sector.

Building on the Gaia-X framework, Fish-X establishes a decentralised, federated Data Space that allows safe, flexible data sharing between stakeholders. This creates a strong foundation for a transition to a digitalised fisheries sector.

## 4.2. Fish-X Digital Tools

The Fish-X Toolkit is a key component of the project's strategy to enable digital transformation in small-scale fisheries. It provides practical resources to help fishers comply with EU regulations, improve efficiency, and enhance traceability. Designed to be accessible and user-friendly, the Toolkit supports SSF in adopting digital tools that match their real-world needs and operational context.

Core Digital Tools within the Fish-X Toolkit:

**Fish-X Data Space**

A data space can be defined as a federated and sovereign data sharing and management with an open infrastructure, based on common policies, rules and standards. The Fish-X Data Space will enable the creation of a data ecosystem – a commonplace where fisheries-related data can be offered to those institutions and services that require, or desire information of fish catch or vessel monitoring systems. Building on Gaia-X federation services, data owners can ensure reliable and trustworthy ways of exchanging data, while keeping full control of their data. By offering this digital solution, the establishment of information transfer can not only satisfy regulatory requirements but also provide an added value to fisheries data utilisation and commodity value

**Fish-X Insight Platform**

The Insight Platform is used to visualise and better understand fishing activities, based on fishing vessels' locations, activity reports, and geographic data to analyse the fishing effort. It supports the adaptation of digital systems for small-scale fishing boats and allows to share general information while protecting fishers' privacy. Based on real VMS data sets collected over the project and previous pilot projects, the Insight Platform represents in form of maps and dashboards the activities of SSF vessels: vessel presence, ERS, fishing effort sorted by type of fishing gear using artificial intelligence models developed in the project. All these parameters can be filtered by period (back to 2022), by area or by fishing gear. All data are automatically updated day after day, anonymised and aggregated to protect commercial secrecy.

**Fish-X Traceability Platform**

A solution for tracking seafood from catch to consumer, enabling SSF to prove the origin and sustainability of their products and build market trust.

To ensure that digital tools lead to meaningful change, Fish-X combines technology with skill development and strategic guidance. Training activities focus on closing digital knowledge gaps, offering free, hands-on learning tailored to the needs of SSF. In parallel, the Toolkit provides policy recommendations that support inclusive governance frameworks and responsive regulation.

The primary goal of the Fish-X Toolkit is to make digitalisation simple and accessible for SSF. It provides practical tools and resources to:

- **Ensure compliance with EU regulations**: SSF can use the toolkit to meet regulatory requirements on data collection, traceability, and transparency.
- **Improve digital skills**: The toolkit helps SSF develop essential digital competencies that align with the digital transformation of the fishing industry.
- **Enhance operational efficiency**: By using the Fish-X digital tools, SSF can improve the management of their fishing activities and strengthen sustainability efforts.

## 4.3. Fish-X House – Framework for Action

To simplify and structure the complex process of digital transformation, Fish-X has created the 'Fish-X House'. This framework outlines the different action areas necessary for collective effort across key sectors and stakeholders. It highlights the concrete activities required to ensure that digitalisation within the EU fisheries sector is implemented effectively and efficiently, contributing to the EU's sustainability goals.

The Fish-X Roadmap focuses on four key action areas critical for the digitalisation of EU fisheries:

- **Governance and Policy:** This area focuses on adapting EU and national regulations to enable digital transformation in fisheries. It includes reducing barriers for small-scale fisheries, providing financial support, and aligning policies with sustainability goals. Public institutions lead on legal frameworks, the private sector pushes innovation, research informs decision-making, and civil society promotes sustainable seafood awareness.
- **Data Management & Traceability:** Here, the goal is to standardise fisheries data across the EU, improve traceability, and ensure secure, real-time data sharing. Fish-X applies FAIR principles and ensures GDPR compliance. All sectors contribute: authorities enable secure systems, companies adopt digital tools, researchers generate insights, and civil society strengthens transparency for consumers.
- **Digital Infrastructure & Equipment:** This area ensures SSF have access to the digital tools and infrastructure they need. Key actions include improving connectivity, providing affordable and user-friendly solutions, and supporting the Fish-X platforms: Data Space, Insight Platform, and Traceability Platform. Public and private actors invest in infrastructure, while research and civil society support local implementation.
- **EU Fisheries Capacity Building & Training:** This area develops the digital skills needed across the fisheries sector. Fish-X supports training programmes, digital literacy, and the creation of new job opportunities—especially for youth and women. Public institutions lead education, companies support skills development, research drives innovation, and civil society promotes local knowledge sharing.

Each action area includes specific targets and activities, with recommendations tailored to different stakeholder groups, including the public and private sectors, as well as civil society and scientific communities. Through leadership and active engagement, Fish-X seeks to foster

collaboration and support the achievement of these goals, ensuring a sustainable and digitally empowered future for SSF.

## 4.4. Fish-X Survey

The following section provides a structured summary of the survey that was conducted to assess the current state of the SSF sector, and its digitalisation needs. The survey aimed to gather insights regarding the challenges, opportunities, and future requirements for SSF in Europe, particularly in relation to digitalisation and sustainability. This section is divided into the following categories: Methodology, Demographics, Results, and Recommendations.

**Methodology**

The survey was conducted between February and September 2024, with the goal of collecting in-depth insights from key stakeholders in the SSF sector. A total of 42 experts participated in the survey, representing four key stakeholder groups: the public sector, private sector, research sector, and civil society. Over 200 stakeholders were initially invited to participate, with interviews and personal outreach conducted to ensure a high level of participation. The survey sought to evaluate the challenges and opportunities within the SSF sector in relation to digital transformation, policy effectiveness, data collection and traceability, and regional collaboration.

The survey used targeted questions aligned with four action areas identified in the preliminary Fish-X Roadmap: Governance and Policy, Data Collection and Traceability, Infrastructure and Equipment, and Fisheries Skills, Behaviours, and Practices. The responses were analysed to provide insights into the state of SSF in Europe and identify actionable recommendations.

**Demographics**

The survey included 42 respondents, comprising 14 women and 28 men. These participants represented a wide range of geographical regions and sectors. Specifically, the public sector was represented by 18 respondents, with the majority from Belgium, and a smaller proportion from Germany, which has relatively fewer SSF vessels. The private sector had 21 respondents, with a strong representation from Germany. The research sector had 11 respondents, mostly from Spain and Portugal, while the civil society sector contributed 13 responses, including participants from Belgium, Denmark, Ireland, Italy, Spain, and the United Kingdom.

These participants were selected to provide a well-rounded view of the SSF sector across Europe, ensuring diverse regional and sectoral perspectives. The responses were divided by region, with strong representation from the Atlantic Sea Basin and North Sea, followed by the Mediterranean and Baltic Sea regions.

**Results**

The survey provided several key findings across the four action areas, with notable regional and sectoral differences.

- **Governance and Policy**: When asked about the future development of SSF until 2030, 73% of public sector respondents expected the sector to grow or maintain its current trend. However, regional differences were evident. Stakeholders in the Atlantic Ocean Basin were more optimistic, with 60% predicting positive growth, while the Baltic Sea region had a more cautious outlook. The survey also revealed that sustainable fishing practices and economic viability were identified as the highest priorities for the sector, while digitalisation was considered an important but secondary factor.
- **Data Collection and Traceability**: A significant 90% of stakeholders agreed on the importance of improving data collection in SSF. Public sector respondents were particularly supportive of encouraging fishers to voluntarily provide data, which they believed would improve data accuracy and support better traceability. There were notable regional differences, with respondents from the Mediterranean and Baltic Seas showing lower engagement in data-sharing practices compared to those from the Atlantic Ocean and North Sea.
- **Infrastructure and Equipment**: The current state of fisheries data exchange was seen as impractical by 40% of respondents, particularly in the Mediterranean Sea, where delays in accessing data were common. Public sector respondents reported that 45% of them experienced delays of 1 to 6 months in accessing new data. The survey also highlighted the need for better digital infrastructure to support data collection and management.
- **Fisheries Skills, Behaviours, and Practices**: The survey revealed that training and digital literacy were crucial for the successful adoption of digital tools within SSF. While the majority of respondents agreed that providing fishers with user-friendly tools and training was necessary, there were regional differences in the support for specific training methods. Respondents from the Mediterranean and Baltic Seas were more supportive of training initiatives than those from the Atlantic Sea Basin.

The survey results led to several recommendations aimed at advancing the digitalisation of SSF and improving the sector's sustainability:

- **Enhance Digital Infrastructure:** There is a clear need to improve digital tools and communications infrastructure, particularly in regions with slower data access, such as the Mediterranean Sea. Investments should focus on creating affordable, user-friendly solutions for fishers.
- **Encourage Voluntary Data Provision:** A significant number of stakeholders recommended promoting voluntary data provision by fishers. This approach was seen as an effective way to improve data accuracy and facilitate better traceability across the sector.
- **Strengthen Policy Frameworks:** To align better with the needs of SSF, EU and national policy frameworks should be adapted to focus on improving economic viability and sustainability. Additionally, better communication and transparency about EU regulations are needed to bridge the gap between public and private sector expectations.
- **Focus on Digital Training:** Digital training programs should be prioritised, particularly in regions with lower digital readiness. These programs should be tailored to the specific needs of SSF to ensure that fishers and stakeholders can successfully engage with new technologies.
- **Promote Regional Cooperation:** Strengthening collaboration between regions, particularly where participation in data sharing is low (e.g., Mediterranean and Baltic Seas), will be crucial for ensuring that the digitalisation of SSF is equitable and effective across Europe.

# 5. Expected Outcomes and Key Recommendations

The Fish-X project set out with a clear and urgent objective: to explore how digitalisation could contribute to the transformation of Europe's small-scale fisheries

(SSF) into a more sustainable, resilient, and transparent sector. However, beyond the scope of the project, it is crucial to focus on what the European Commission (EC) and Member States must do to achieve the objectives outlined in the control regulations.

Based on the results and insights gathered from Fish-X, the following policy recommendations are made, offering a concrete overview and timeline for the necessary steps:

**Immediate Actions (2025–2027):**

- The EC and Member States must prioritize investment in the infrastructure necessary for small-scale fisheries, including expanding broadband access to coastal and island communities. Policy frameworks should also be adapted to ensure that digital tools and systems are integrated into existing fisheries management practices.

**Medium-Term Actions (2027–2029):**

- Policymakers should focus on scaling digital tools that promote transparency and traceability in the fisheries supply chain. The EC must provide financial support mechanisms, including grants and subsidies, to facilitate the adoption of these tools among small-scale fishers. Additionally, Member States must develop and enforce robust training programs to build digital literacy at all levels of the sector.

**Long-Term Actions (2030 and Beyond):**

- By 2030, the EC should establish a unified regulatory framework that supports digitalisation as a central pillar of fisheries management. This includes ensuring that data sovereignty is firmly embedded in all digital systems, with fishers retaining control over their data. Furthermore, regional pilot initiatives must continue to adapt digital solutions to local conditions, with a clear focus on maintaining the participation of fishers in governance decisions.

Through these steps, the European Commission and Member States will create the necessary conditions for achieving the objectives of the control regulations, ensuring that small-scale fisheries are effectively integrated into the digital economy and that their voices remain central in shaping future policy.

## 5.1. Expected Outcomes

The Fish-X project set out with a clear and urgent objective: to explore how digitalisation could contribute to the transformation of Europe's small-scale fisheries (SSF) into a more sustainable, resilient and transparent sector. From the early stages of implementation, it was evident that technology could indeed offer powerful tools to support better fisheries management, improve compliance with regulatory frameworks, and create new market opportunities through traceability and data transparency.

One of the key achievements of the project is the development of the Insight Platform, a digital platform designed to simplify access to fisheries-related data. This platform has been specifically created to meet the needs of fishers, authorities, and supply chain actors who require timely, reliable, and user-friendly access to catch data, effort reporting and compliance support. While this platform will continue to be refined beyond the end of the Fish-X project, its true success will depend on how well it integrates with existing fisheries management practices and how accessible it is. Other digital solutions explored during the project, such as the Data Space and the Traceability Platform, demonstrated real potential to support broader goals of supply chain transparency and regulatory monitoring. However, these initiatives will not be further developed within the current project structure. Their future advancement would rely on independent actions by external stakeholders willing to build upon the foundations laid by Fish-X.

Importantly, the project also generated a body of knowledge and experience that is arguably as valuable as any digital tool. Fish-X highlighted that sustainable digitalisation cannot be achieved through technology alone. Instead, it requires a deep

understanding of the social, economic, and cultural realities of the communities it seeks to serve. It requires respect for traditional knowledge, patience in building digital skills, and careful alignment with the everyday working conditions of fishers

In essence, the real outcome of Fish-X is not a single product or technology but a tested, validated method for how digitalisation can — and must — be approached if it is to genuinely support the future of small-scale fisheries.

## 5.2. Learnings from Webinars, Working Groups and Surveys

Throughout the Fish-X engagement process, involving more than a hundred stakeholders across webinars, working groups, surveys and regional case studies, several core lessons emerged that shaped the project's understanding of what digitalisation means in practice for small-scale fisheries.

The first and perhaps most striking lesson concerns trust. Time and again, fishers expressed concerns that digital tools could be used against them — that data collected under the promise of supporting sustainability or compliance could later be used for punitive enforcement, quota reductions, or unfair competition. Building trust, therefore, is not a supplementary task but the starting point of digital transformation. It requires complete transparency about data usage, clear legal protections for data ownership, and a genuine commitment to voluntary participation.

A second major lesson relates to digital literacy. While some fishers, particularly younger individuals, are already adept with smartphones and digital applications, many others are unfamiliar or even wary of new technologies. Older generations in particular view digital tools as complex, intrusive or irrelevant to their daily lives. Successful digitalisation must therefore include strong, continuous investment in practical training that respects these starting points. Training should not be one-off; it must be an ongoing service, integrated into the support structures that already exist for small-scale fisheries.

The third lesson concerns the physical barriers to digital participation. In many coastal and island communities, mobile and broadband infrastructure remains poor or unreliable. Fishers operating in remote areas often cannot access online systems in real time, making standard digital reporting unworkable without offline-capable solutions. Addressing infrastructure gaps must be a policy priority if digitalisation is to reach all parts of the sector, not just the most accessible.

Economic viability formed a fourth consistent theme across all engagements. Fishers are pragmatic: they will adopt new technologies if they see clear, immediate advantages. If digital systems are seen primarily as administrative burdens, uptake will be slow or superficial. Conversely, when digital tools enable better prices through traceability, open new markets, or simplify regulatory compliance, fishers become active proponents of innovation.

Finally, a strong emphasis emerged around the participatory design of systems. Fishers consistently called for digital tools to be developed with their direct involvement, not simply imposed after design decisions have been made. Co-creation is not a luxury or a politically correct exercise; it is essential for ensuring that systems are usable, relevant, and welcomed by those they aim to serve.

Together, these learnings reveal that digitalisation must be viewed as a broad, multifaceted process — not merely a technical upgrade, but a transformation rooted in trust, skills, economic opportunity, and shared governance.

## 5.3. Key Actions for Digital Transformation

Drawing on the depth of insights gathered, the Fish-X project recommends a set of clear, practical actions to guide the next phase of digital transformation in the SSF sector.

First, efforts to develop and deploy digital platforms must continue, but with a sharpened focus on usability, mobile access, and offline functionality. Systems must be lightweight, intuitive, and able to function even under conditions of intermittent

connectivity. Tools must be designed around the workflows of fishers, not around the administrative convenience of authorities. As SSF activities last a few hours, the sampling interval for positions should be adapted to allow accurate analysis.

Second, investment in training must become an ongoing commitment. Digital literacy support should not be delivered in a one-off fashion or confined to the launch phase of a system. Instead, it must be seen as a standing service, as essential as gear maintenance or safety training. Training must be practical, site-specific, and peer-led wherever possible, building digital confidence step by step.

Third, digitalisation must be accompanied by strategic investment in infrastructure. While it is important to design tools that can function offline, real progress will only come when coastal communities enjoy the same quality of mobile and internet access as urban centres. Infrastructure planning must prioritise those regions where small-scale fisheries are economically and culturally central.

Fourth, the principles of data sovereignty must be hard-wired into all digital systems from the outset. Fishers must be able to see, understand, and control what happens to their data. Participation must always be voluntary, and the benefits of participation must be tangible and clearly communicated. The present EU fisheries control regulation makes it possible to use key data sets (such as VMS and ERS) for other uses than control upon express consent by the Member states or the Commission, while protecting the individual privacy. These rights should be exercised.

Fifth, financial support mechanisms are essential to making digitalisation viable for small-scale operators. Without grants for equipment, subsidies for system adoption, and premium markets for traceable products, there is a real risk that only better-resourced or larger operators will fully participate, widening existing inequalities.

Sixth, regional pilot initiatives must continue to be used to adapt solutions to local conditions. A flexible, iterative approach, based on learning from real-world experiences rather than imposing a one-size-fits-all model, is the only way to ensure that digitalisation truly supports SSF communities.

Finally, the governance of digitalisation must be genuinely participatory. Fishers must have a real voice in system design, in regulatory frameworks, and in decisions about data use. Digital transformation cannot be seen as something 'delivered' to fishers; it must be something they own and shape at every stage.

## 5.4. Practical Pathway

The pathway to successful digitalisation is not a single straight road but a series of interconnected steps that must be taken carefully and deliberately.

The first step is to build durable trust by designing systems that place fishers in control of their data. Transparency must be absolute, participation in the regulation must be mandatory, and systems must clearly demonstrate that they serve the interests of fishers first and foremost.

Next, capacity building must be made a structural feature of the fisheries support landscape. Digital skills development should be seen not as an add-on but as an essential investment in the sector's future, with local training hubs, peer mentors, and mobile training resources established across all major fisheries regions.

The third step involves addressing infrastructure deficits head-on. Funding must be mobilised at national and EU level to expand mobile coverage and internet access to all coastal and island communities, ensuring that no fisher is digitally excluded due to where they live and work.

Fourth, economic incentives must be built into digitalisation schemes. Fishers who participate in traceability programmes, adopt mandatory catch reporting, or use sustainable practices should see direct, tangible rewards, whether through better prices, access to support programmes, or benefits for adopting environmentally friendly practices. Additionally, any reduction in regulatory burdens should be carefully considered to ensure that it does not compromise essential protections for sustainability and fishery management.

Fifth, technology must be kept as simple and robust as possible. Systems should not require high-end devices, constant internet access, or extensive technical expertise. They must be practical tools for real-life conditions,conditions; not theoretical models designed from afar.

Sixth, digital systems must be tested and refined through pilot projects before any wide-scale implementation. Pilots should be seen not as demonstrations of success but as opportunities for learning and adaptation.

Finally, governance must be open, participatory, and adaptive. Fishers must be integrated into the governance of digital systems at all levels — from design to implementation to evaluation — ensuring that digitalisation remains aligned with their interests, values and needs.

## 5.5. Final Reflection

Fish-X has shown that digitalisation in fisheries is not simply about installing new technology; it is about rethinking how knowledge, power, and opportunity are shared within the sector. It is about building systems that support those who work the sea, rather than burdening them with new forms of control or exclusion.

The lessons are clear. Digitalisation in fisheries can be effective, but only if it is built slowly, carefully, and in partnership with fishers themselves. Trust must be earned, not assumed. Skills must be built patiently, not demanded instantly. Infrastructure must be developed strategically, not left to market forces. Economic benefits must be real, not promised in theory. And governance must be shared, not imposed.

The path forward is challenging. It requires courage to prioritise the needs of small-scale fishers over administrative convenience. It requires patience to build systems that truly work in the messy, complex realities of fishing life. And it requires vision — a vision of a fisheries sector that is stronger, fairer, and more resilient because it has embraced digital tools in ways that respect and enhance traditional ways of life.

The foundation laid by Fish-X provides a starting point. Now it is up to policymakers, fishers, researchers, and industry to continue the journey — carefully, collaboratively, and with an unwavering respect for the communities that make Europe's fisheries a living, breathing reality.

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