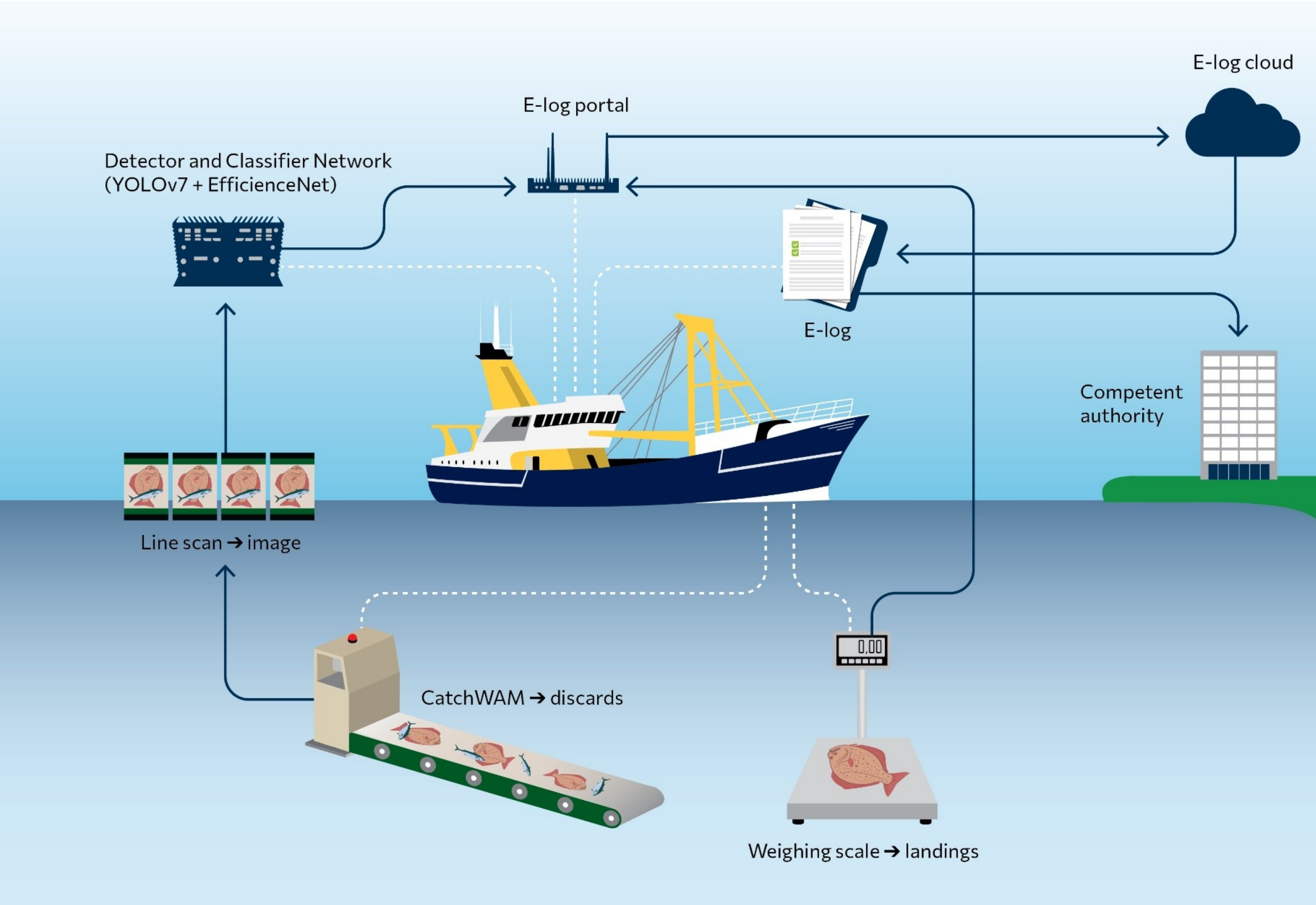

Towards Fully Documented Fisheries (FDF)

Creating an automated video and AI-based discards recording sytem

Authors: Allard van Mens, Edwin van Helmond, Floor Quirijns, Alba Pulskens

Wageningen Marine Research

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Contents

Glossary & Abbreviations

Abbreviation	Explanation
AI	Artificial Intelligence: Technology enabling automated fish species recognition, measurement, and data processing
BT	Beam Trawl: demersal fishing gear type using a rigid beam to hold open the trawl mouth
CatchWAM	Catch Wageningen Automated Monitoring: system using cameras and AI to automatically identify, count, and (potentially in the future) measure discarded fish
DG MARE	Directorate-General for Maritime Affairs and Fisheries: European Commission department responsible for EU fisheries policy
EC	European Commission: executive branch of the EU, also initiator of fisheries legislation
EFCA	European Fisheries Control Agency: EU body coordinating fisheries control and inspection across Member States
EFICE	Commercial provider of electronic logbook (e-log) systems used in Dutch fisheries
E-log	Electronic logbook system fishers are required to fill their catches in
EM	Electronic Monitoring: system using cameras and sensors to monitor fishing activities at sea
EU	European Union
FDF	Fully Documented Fisheries: A future fishery system where all catches (including discards) are recorded with high spatial and temporal resolution
FDF 1.0 / FDF 2.0	Fully Documented Fishery research project with successive phases developing CatchWAM prototypes and validation (1.0 and 2.0)
GDPR	General Data Protection Regulation
ICES	International Council for the Exploration of the Sea
LO	Landing Obligation: EU policy requiring all regulated species caught to be landed and counted against quota (Regulation (EU) No 1380/2013, Article 15)
LVVN	Dutch Ministry of Agriculture, Fisheries, Food Security and Nature
REM	Remote Electronic Monitoring: term used for camera-based fisheries control systems under the new Control Regulation 2023/2842.
SSC	Scottish Seine / Purse Seine: fleet segment targeting demersal and pelagic fish species using encircling nets
TAC	Total Allowable Catch: maximum quantity of a species that can be caught in a period under EU law
VMS	Vessel Monitoring System: satellite-based tracking of vessel position, speed, and course for control purposes
WMR	Wageningen Marine Research: Dutch research institute developing CatchWAM and leading FDF projects
WUR	Wageningen University & Research: Dutch academic and research institution

Samenvatting

Dit rapport beschrijft een stappenplan (roadmap) voor de ontwikkeling en invoering van een automatisch registratiesysteem voor discards op basis van kunstmatige intelligentie (AI): CatchWAM (*Catch Wageningen Automated Monitoring*). Het systeem wordt ontwikkeld voor de Nederlandse demersale visserij.

Het doel is om op een betrouwbare, automatische en juridisch goed onderbouwde manier vast te leggen wat er aan ongewenste vis (discards) overboord gaat. Dit moet bijdragen aan beter visserijbeheer, duidelijkere quotaverantwoording en betere wetenschappelijke gegevens.

Achtergrond

Binnen het Gemeenschappelijk Visserijbeleid (GVB) geldt de aanlandplicht. Dit betekent dat alle onder quota vallende soorten moeten worden aangeland, ook ondermaatse vis, tenzij er een vrijstelling is. Vissers moeten ongewenste vangst registreren in hun elektronische logboek. In de praktijk blijkt dit lastig. Er zijn operationele beperkingen aan boord, en handmatig ingevoerde discardgegevens zijn niet altijd betrouwbaar.

Camerasystemen (Electronic Monitoring, EM) zijn eerder getest om betere controle en betere data te krijgen. Maar het handmatig terugkijken van video’s kost veel tijd en geld en is moeilijk op grote schaal toe te passen. Daarom wordt nu gewerkt aan een systeem dat met behulp van AI automatisch vis herkent en telt.

Wat is CatchWAM?

CatchWAM is een camerasysteem dat boven de sorteerlijn wordt geplaatst. Het systeem:

- Maakt hoge resolutiebeelden met een speciale line-scan camera in een beschermde behuizing met eigen verlichting;
- Zet deze beelden automatisch om in één duidelijke foto;
- Gebruikt AI om vissen te herkennen, de soort te bepalen en ze te tellen.

In de toekomst kan het systeem mogelijk ook automatisch de lengte en het gewicht van vissen schatten.

Een belangrijk voordeel is dat de analyse direct aan boord gebeurt. Er hoeven dus geen grote hoeveelheden video’s meer handmatig bekeken of opgeslagen te worden. Het systeem is ontwikkeld om te werken onder praktijkomstandigheden: natte (zeewater)omgeving, wisselend licht, gemengde vangsten en vissen die over elkaar heen liggen. De huidige doelstelling is om voor vijf belangrijke quota-soorten - schol, wijting, makreel, horsmakreel en haring - minimaal 80% registratienauwkeurigheid te behalen in de boomkor-, ottertrawl- en flyshootvisserij.

Onderzoeksvoortgang (FDF-projecten)

De ontwikkeling van CatchWAM is gebaseerd op twee onderzoeksprojecten (FDF-projecten):

FDF 1.0 (2018–2023) - Hieruit bleek dat gewone camerasystemen vaak discards onderschatten. Dat komt vooral doordat vissen op de band over elkaar heen liggen. Ook bleek dat het handmatig terugkijken van videobeelden veel tijd kost. Conclusie: een beter camerasysteem in combinatie met AI is nodig.

FDF 2.0 (2024–2027) - In dit project worden prototypes getest op commerciële schepen. De systemen draaien langere tijd mee aan boord. De discardregistratie worden automatisch gekoppeld aan het elektronische logboek per trek.

Technologisch ontwikkelingen

Voor verdere technologische ontwikkeling zijn acht belangrijke stappen benoemd:

1. Vastleggen wie eigenaar wordt van het algoritme en hoe licenties geregeld worden.
2. Zorgen dat het systeem werkt met verschillende e-logboektypen.
3. De registratienauwkeurigheid verder verbeteren.
4. Meer soorten toevoegen (zowel veel voorkomende als zeldzame soorten).
5. Lengtemetingen mogelijk maken.
6. Gewichtsinschattingen ontwikkelen (belangrijk voor quota).
7. Het systeem blijven controleren en verbeteren (met menselijke controle waar nodig).
8. Het systeem aanpassen voor andere visserijen.

Voor grootschalige invoering is het belangrijk dat commerciële bedrijven de hardware gaan produceren, installeren en onderhouden. Daarvoor is een duidelijk en stabiel beleidskader nodig.

Beleidsmatige voorwaarden

Om CatchWAM officieel te kunnen gebruiken, moet het systeem juridisch goed ingebed worden. Belangrijke punten zijn:

- AI-gegevens moeten wettelijk erkend worden voor rapportage en quotabeheer.
- Er moeten duidelijke eisen komen voor nauwkeurigheid en controle.
- Dataformaten moeten in de EU geharmoniseerd worden.
- Er moeten duidelijke afspraken komen over data-eigendom, toegang en bewaartermijnen (AVG).
- Er moeten regels zijn voor hoe fouten of geschillen worden afgehandeld.

Nieuwe Europese regelgeving kan invloed hebben op de invoering van dit systeem.

Wat vinden vissers belangrijk?

Uit gesprekken met vissers blijkt dat acceptatie niet vanzelfsprekend is. Belangrijke aandachtspunten zijn:

- Gebrek aan vertrouwen tussen sector en beleid.
- Angst dat gegevens tegen vissers gebruikt worden (bijvoorbeeld voor strengere controle).
- Zorgen over aansprakelijkheid bij technische storingen of AI-fouten.
- Privacy en wie toegang krijgt tot de gegevens.
- De noodzaak van duidelijke voordelen, kostendekking en werkbare oplossingen aan boord.

Tegelijkertijd zien vissers ook mogelijke voordelen. Denk aan:

- Beter inzicht in actuele visbestanden;
- Snellere aanpassing van quota op basis van de actuele situatie op zee;
- Mogelijk eerlijkere gebiedssluitingen, op basis van de actuele situatie op zee.

Op dit moment doen vissers vooral mee vanwege vrijstellingen van de aanlandplicht voor schol, niet omdat zij het systeem zelf als direct voordeel zien.

Drie fasen richting invoering

De roadmap stelt voor de Nederlandse demersale visserij een gefaseerde aanpak voor:

- **Fase 1 – Onderzoek en testen:** De technologische ontwikkeling afronden en zorgen dat het minimaal 80% nauwkeurig werkt bij het registreren van soorten.
- **Fase 2 – Betrokkenheid en commercialisering:** Meer schepen aansluiten; meer soorten toevoegen; commerciële partijen betrekken voor de ontwikkeling, het installeren en het onderhouden van de hardware; en duidelijke beleidskaders vastleggen.
- **Fase 3 – Volledige invoering:** Uitrol binnen de hele vloot (behalve garnalenvisserij), inclusief lengte- en gewichtsmetingen. Daarna moet duidelijk zijn of deelname vrijwillig of verplicht wordt.

Toepasbaarheid buiten de Nederlandse demersale visserij

Hoewel de ontwikkeling gestart is in de boomkorvisserij op tong, kan het systeem mogelijk ook gebruikt worden in ottertrawl-, flyshoot-, garnalen-, pelagische en kleinschalige visserijen. Elke visserij vraagt wel om aanpassingen in hardware en software, omdat vangstsamenstelling en werkwijze verschillen.

Tot slot

CatchWAM kan een belangrijke stap zijn richting volledig gedocumenteerde visserij. De techniek ontwikkelt zich snel. Maar succesvolle invoering hangt niet alleen af van technologie. Net zo belangrijk zijn:

- Duidelijke en stabiele regelgeving;
- Goede afspraken over data;
- Eerlijke en transparante controle;
- Vertrouwen tussen overheid, wetenschap en sector.

Als aan deze voorwaarden wordt voldaan, kan CatchWAM bijdragen aan betere gegevens, minder administratieve lasten en een visserijbeleid dat beter aansluit bij de actuele situatie op zee.

Summary

This report presents a roadmap for the development and implementation of an AI-based automated discard recording system – CatchWAM (*Catch Wageningen Automated Monitoring*) - for Dutch demersal fisheries. The roadmap integrates technological, regulatory, and social dimensions required to transition from pilot-scale research to full operational deployment across fleet segments. Its ultimate objective is to enable reliable, automated, and legally robust documentation of discards at sea, contributing to improved fisheries management, quota accountability, and scientific data quality.

Background and rationale

Under the EU Common Fisheries Policy, the Landing Obligation (LO) requires fishers to land all quota-regulated species, including undersized fish, unless exemptions apply. While fishers must record unwanted catch in electronic logbooks, evaluations have shown persistent challenges in implementation, including operational constraints and limited reliability of manually recorded discard data.

Electronic Monitoring (EM) systems have been explored to improve compliance and data accuracy, but manual video review is labour-intensive, costly, and difficult to scale. These limitations have motivated the development of AI-based image analysis systems capable of automating discard detection and recording.

The CatchWAM system

CatchWAM is being developed by Wageningen University and Research (WUR) as a dedicated onboard camera and AI-based processing system to identify, classify, and count discarded fish on sorting belts. The system combines:

- A high-resolution line-scan camera in a protective housing with controlled illumination;
- Onboard image stitching and processing;
- AI networks trained for object detection, species classification, and registration.

Future extensions may include automated length and weight estimation.

CatchWAM performs automated onboard analysis, eliminating the need for manual video review, large-scale video transfer, and extensive storage infrastructure. The system is designed to operate under challenging real-world conditions, including occlusion, variable lighting, mixed catches, and debris. The current objective is to achieve at least 80 percent species identification accuracy for five key quota-regulated species - plaice, whiting, mackerel, horse mackerel, and herring - across beam trawl, otter trawl, and flyshoot fisheries.

Research progress (FDF Projects)

Two sequential Fully Documented Fisheries (FDF) projects underpin the technological foundation of CatchWAM.

FDF 1.0 (2018-2023): demonstrated limitations of conventional EM, including systematic underestimation of discards due to occlusion on sorting belts and the high resource demand of manual

video review. It concluded that a more advanced camera system combined with AI would improve efficiency and data quality.

FDF 2.0 (2024-2027): focuses on establishing scientific and technical foundations for operational AI-based discard registration. Prototype systems are being installed and tested onboard commercial vessels, with demonstrated capability to function over extended periods under operational conditions. Integration with e-logbook systems enables automated upload of discard data per haul.

Technological development pathway

The roadmap defines eight key development actions for the software component:

1. Algorithm ownership and licensing to enable controlled, scalable deployment.
2. Interoperability across e-logbook platforms.
3. Accuracy enhancement, supported by expanded annotated datasets and human-in-the-loop validation.
4. Expansion of species coverage, including common and rare species.
5. Length estimation functionality for biological assessments.
6. Weight estimation, relevant for quota accounting.
7. Continuous performance monitoring and retraining.
8. Extension to other fleets, accounting for fishery-specific operational differences.

Hardware commercialization is considered essential for long-term scalability. Commercial maritime engineering firms should take responsibility for industrial production, installation, servicing, and lifecycle maintenance, supported by predictable regulatory and financial frameworks.

Policy and regulatory preconditions

Successful implementation requires early and structured alignment with EU fisheries control frameworks. Key enabling conditions include:

- Legal recognition of AI-generated data for reporting, quota management, and enforcement;
- Certification and validation standards for system accuracy and data integrity;
- Harmonised EU data formats and interoperability standards;
- Clear rules on data ownership, access rights, retention periods, and GDPR compliance;
- Defined dispute-resolution mechanisms and operator rights.

Upcoming regulatory developments, including potential revisions to the Common Fisheries Policy and mandatory REM/CCTV obligations, may significantly influence the pace and structure of CatchWAM deployment.

Social preconditions and stakeholder acceptance

Interviews with fishers indicate that social acceptance will be decisive. Key themes include:

- Trust deficits between fishers and policymakers;
- Concerns about misuse of data for stricter control or sanctions;
- Fear of being held responsible for AI errors or technical malfunctions;
- Privacy and data-access concerns, especially regarding third-party access;
- Demand for clear incentives, cost coverage, and operational flexibility.

Fishers also recognize potential benefits, including improved real-time stock insights, more adaptive quota management, and evidence-based spatial measures. However, participation is currently primarily motivated by exemptions from the Landing Obligation rather than intrinsic support for monitoring systems.

Three-stage implementation roadmap

The roadmap proposes a phased approach:

- **Stage 1 – Research and Prototyping:** Finalize proof of concept, hardware specifications, validation protocols, and minimum performance benchmarks (≥80% accuracy).
- **Stage 2 – Engagement and Commercialization:** Establish licensing structures, involve commercial hardware providers, expand species coverage, and increase fleet participation. Clarify policy objectives and adoption frameworks.
- **Stage 3 – Scaling and Consolidation:** Deploy a fully operational system fleet-wide (excluding shrimp fisheries), integrate length and weight estimation, formalize regulatory recognition, and determine mandatory versus voluntary participation models.

Applicability beyond Dutch demersal fisheries

While initial development focuses on beam trawl fisheries targeting sole, the system has potential applicability to otter trawl, flyshoot, shrimp, pelagic, and small-scale fleets. Each fishery presents distinct operational constraints - such as catch volume, sorting mechanisms, and spatial limitations - requiring tailored algorithm development and hardware configuration.

Strategic outlook

The CatchWAM roadmap positions AI-based discard registration as a transformative step toward fully documented fisheries. Technological feasibility is advancing rapidly; however, large-scale implementation depends equally on:

- Regulatory clarity and harmonisation at EU level;
- Predictable commercialization pathways;
- Robust governance of AI-generated data;
- Transparent validation standards;
- Trust-building measures with industry stakeholders.

If these enabling conditions are met, CatchWAM could significantly enhance data coverage, reduce manual administrative burdens, and support more adaptive, evidence-based fisheries management across EU waters.

1 Introduction

1.1 Discards and why are they recorded

The catch in a fishery consists of two components: the marketable catch and the unwanted catch. The marketable component can be sold for human consumption. The unwanted catch consists of fish that are too small, i.e. below regulated minimum size, and species that have no commercial value. This unwanted part of the catch historically was, and in many cases still is, discarded back to sea. Hence the name “discards”.

Typically, nets are hauled on board and emptied in so-called 'hoppers' or fish-holding tanks on deck of larger vessels in demersal fisheries. From these tanks, the entire catch is transported over a set of conveyor belts where the crew sorts out marketable catches. Subsequently, the unwanted part of the catch – the discards – is thrown back to sea through a 'discard chute'. The composition and quantity of this part of the catch is difficult to record, because usually it does not stay onboard long and it is not sorted.

In January 2015, as part of the Common Fisheries Policy, the EU started with the implementation of the Landing Obligation (LO)[1] which is fully in force since 1 January 2019. The LO states that all catches of regulated commercial species should be landed and counted against quotas, including undersized fish. The rationale behind the LO is that setting quotas on total catches – and therefore managing the total removal from fish stocks – creates an incentive for fishers to maximize the value of their individual quota while avoiding catches of undersized fish, thereby reducing waste of natural resources. Since the full implementation of the LO, EU fishers are not allowed to discard unwanted species or sizes, unless they have an exemption. This means that fishers should remove unwanted quoted species from the catch, store them onboard and bring them back to shore.

Recording of both the marketable and the unwanted catch for quota regulated species is relevant for the registration of quota use. Therefore, fishers are required to record these parts of the catch in their e-logbooks.

1.2 How are discards currently recorded and how can recording be automated?

Unless exemptions are in place, all EU fishers are obliged to land unwanted and undersized quoted species. Fishers manually record the total estimated weight per species of the unwanted catch in their logbooks. Five years into full implementation, the Directorate-General for Maritime Affairs and Fisheries (DG MARE) of the EC commissioned an in-depth study to support its ongoing policy evaluation of the LO [2]. A general conclusion was that the implementation of the LO is challenging, as many fishers consider it unworkable in practice due to limited space on board, increased handling time, and operational constraints. One of the findings of the study was that even though discards are now manually recorded in logbooks, there remain issues with the reliability of those discards data.

[1] Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, Article 15. https://eur-lex.europa.eu/eli/reg/2013/1380

[2] Davie, S., Wakeford, R.C., Whitley, C., van den Berg, P., Rimpler, A., Burke, A., Verschuur, X., Oudmaijer, S., Kraan, M., Chai, S.M., Pearce, J., Peat, W., Stacy, R., Ligas, A., Sartor, P., Pulskens, A., Vallina T., Aranda, M., and Basterretxea, M. Study supporting the evaluation of the landing obligation – Common Fisheries Policy, Publications Office of the European Union, 2025, doi:10.2926/5282226

The evaluation also refers to good practices to address the challenges of the LO. One of the potential solutions is the automation of onboard discard recording. Therefore, technologies are being developed in several member states, e.g. Denmark, Spain, Belgium, and the Netherlands. One of the frequently explored systems is *Electronic Monitoring* (EM), which uses remotely operated video systems onboard fishing vessels, often combined with various sensors, to observe catch processing onboard. In a typical setup, cameras are mounted above the sorting belt or sorting table to record the catch handling process. After video data are retrieved, when a vessel is back in the harbour, the videos are used to verify if fishers have correctly reported the quantities and species composition of both marketable fish and those below regulated minimum size in their logbooks.

EM systems in their current form are not without limitations [3]. Very large amounts of video footage are collected during each fishing trip. The footage is reviewed manually, which is a labour-intensive and time-consuming task, requiring many skilled observers and therefore costly and limiting the extend of data that can be monitored. The implementation of automatic processing of the image data using Artificial Intelligence (AI) provides a solution to overcome the heavy workload of manual video review.

1.3 Introducing an AI-based catch recording system: CatchWAM

Wageningen Univesity and Research (WUR) is currently developing a system to improve image quality and the reviewing process of footage, named CatchWAM. The CatchWAM system uses a high-resolution camera close to the conveyor belt in a protecting box including illumination, combined with AI for the processing of the camera images (**Figure 1**). A protecting box avoids dirt on the camera, prevents blocked camera view by crew processing the catch, and LED (light-emitting diode) lights inside improves illumination. It furthermore does not infringe on the privacy of the crew members as only a part of the conveyor belt and the bycatch is in view. The high-resolution camera provides the quality and details needed to accurately identify discards on species level (**Figure 2**). The space needed for the system on the sorting belt is minimized (~25 cm wide), to avoid taking up too much space from the sorting belt where the crew processes the catch. To minimize the footprint of the camera box, the system makes use of a so-called line-scan camera setup. This camera generates images of a few pixels wide, and through 'stacking' the raw images, a resulting two-dimensional image is generated. Repetition or overlap between lines is avoided by taking the speed of the sorting belt into account.

[3] van Helmond, A. T., Mortensen, L. O., Plet-Hansen, K. S., Ulrich, C., Needle, C. L., Oesterwind, D., ... & Poos, J. J. (2020). Electronic monitoring in fisheries: lessons from global experiences and future opportunities. *Fish and Fisheries*, *21*(1), 162-189.

Figure 1. CatchWAM system. Concept (left) and two prototypes on board (right). Two systems are used because this vessel operated two conveyor belts to sort their catch.

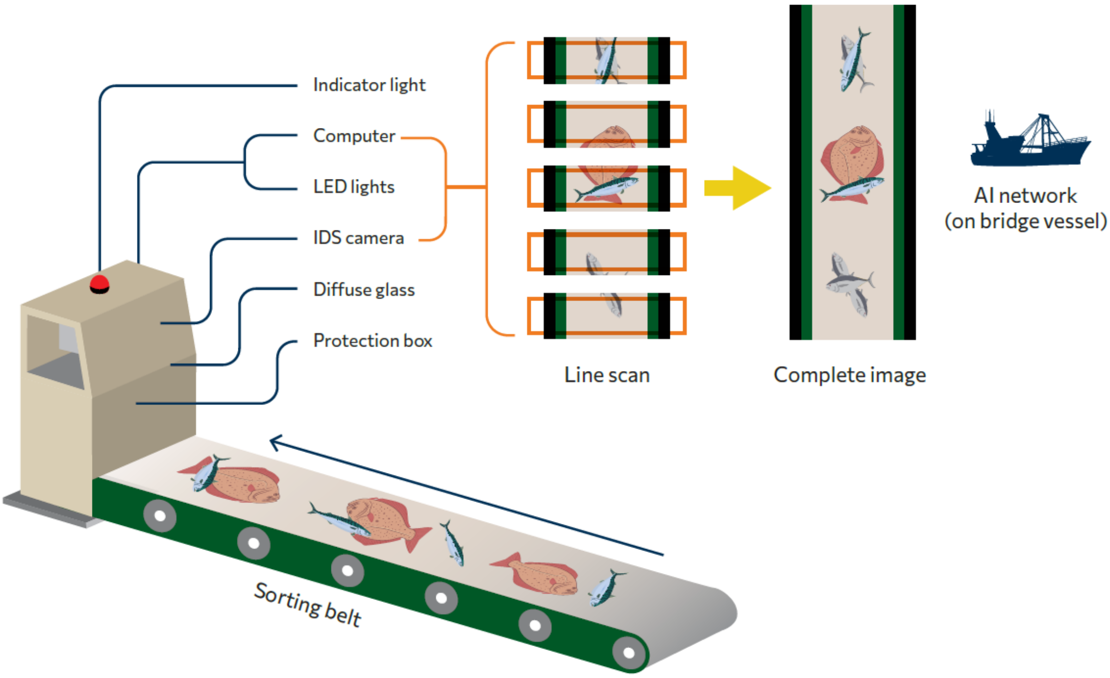


Figure 2. CatchWAM set-up above a sorting belt. A line-scanner records a narrow area, e.g. a line, over the width of the conveyor belt. A small computer in the top of the CatchWAM box stiches all lines together into a larger high-resolution image, which is sent to the AI network on the computer on the bridge of the vessel for further processing.

To process the camera images, Artificial Intelligence (AI) networks and software applications are trained and applied for:

- Identification of individual fishes (object detection);
- Classification of species; and
- Counting of individual fish per species (registration).

In the future, potentially two additional uses can be developed:

- Measuring lengths and
- Estimating weights.

By automating the recording of discards, CatchWAM enables full catch documentation while eliminating the need for manual sorting, storage, landing, and processing of unwanted or unmarketable fish. It also eliminates the labour-intensive manual review of videos, of which, often only a small part of the available total footage is reviewed. Also, video data transfer and storage is expensive. Alternatively, the CatchWAM system provides direct and complete video analysis on board and automated recording of discards in e-log systems, providing direct feedback to fishers and eliminates the need for data transfer and storing large amounts of video data. In addition, it reduces the administrative burden and errors caused by manual entry in logbooks by fishers

Currently, the CatchWAM system is still in an experimental phase. It is envisaged that, once it is fully developed, the system will function as a compact, robust camera installed at the end of the conveyor belt, coupled with an onboard AI model running locally on a dedicated computer.

The objective of the Dutch Ministry for Agriculture, Fisheries, Food Security and Nature (LVVN) is that eventually the CatchWAM-system should be able to record five quota regulated species in discards of Dutch beam trawl (BT), otter trawl (OT) and flyshoot (Scottish seine, SSC) vessels operating in the North Sea, including a Danish bottom trawler (section 2). The species for which the system is primarily being developed are some of the main commercial species in these fisheries for the Netherlands: plaice, whiting, mackerel, horse mackerel, and herring. The current objective is to reach an identification accuracy of at least 80% for these species.

A future objective, beyond 2026, is to expand the technology, data collection and research to other species and fisheries, building upon the results and prototypes developed in the ongoing research projects.

1.4 A roadmap towards CatchWAM implementation

The Ministry of LVVN has asked WMR to develop a roadmap outlining the steps that are needed to get to the ultimate goal of recording all discards across a wide range of fisheries, using the CatchWAM system, addressing the main technological, practical, and legal challenges. This report presents this roadmap.

Section 2 outlines the current available knowledge and experiences in relation to automated catch recording systems. It also describes the technological challenges for the near future to implement such systems in commercial fisheries.

Section 3 outlines the steps needed to transition from pilot studies to a wide-scale implementation. While the technological development of the automated catch recording system is essential, also several conditions are required for the system to be functioning on a larger scale. Section 4 describes policy and legislation conditions; section 5 describes conditions required for international acceptance of the system.

The last section of the roadmap proposes a stepwise implementation process towards an operational system across the EU fishing fleet with a case study for beam trawl fisheries specifically (section 6). The timeline in **Figure 3** shows three different stages in the development of the AI-based discards recording in the Dutch demersal fisheries. Since 2018, the focus is on research, prototype development, and trials onboard of commercial vessels (stage 1). From 2027 onwards, it is expected to have an increased focus on involvement of hardware companies (stage 2). Once the system is fully developed, a roll-out to a larger part of the Dutch demersal fisheries is envisaged (stage 3). Throughout the report, the staged approach will be further elaborated with required technological developments (section 3) and policy context (section 5).

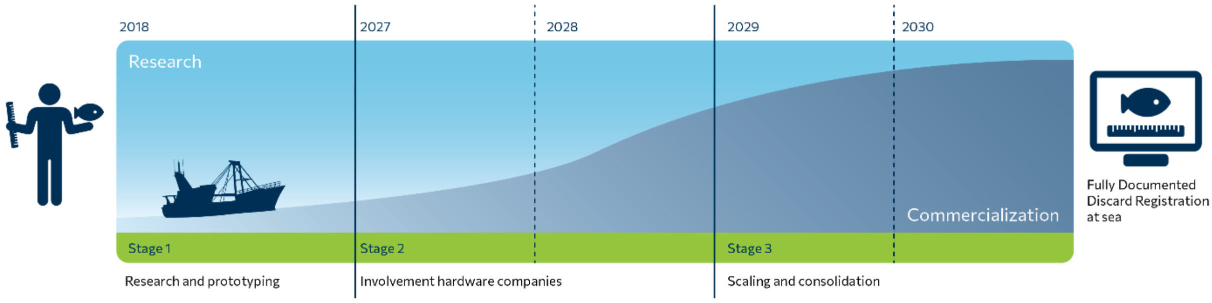


Figure 3. *Basic timeline with staged approach towards a fully documented discard registration at sea for the Dutch demersal fisheries.*

1.5 Methodology

The roadmap was developed by WMR using insights gathered through literature reviews, semi-structured interviews and various workshops with key stakeholders from scientific research institutions. Stakeholders that have been involved include:

- scientists and engineers from The Netherlands, Denmark, United Kingdom, France, Germany, Belgium, Spain, United States and Canada
- fisheries management agencies (Directorate-General for Maritime Affairs and Fisheries (DG MARE), LVVN),
- policy authorities (through a brainstorm session attended by Dutch representatives from LVVN, the Permanent Representation of the Kingdom of the Netherlands to the European Union in Brussels, *Rijksdienst Voor Ondernemend Nederland* (RVO), European Fisheries Control Agency (EFCA), *Nederlandse Voedsel en Waren Autoriteit* (NVWA), and
- industry representatives (Netherlands and Denmark).

This provided essential information on operational challenges, regulatory frameworks, market dynamics, and implementation concerns.

Insights on fishers' perspectives were also gathered. Fishers were asked to reflect how automatic catch registration with EM-like systems (differing slightly from the CatchWAM concept) could be implemented and its associated concerns, conditions, advantages and disadvantages.

These fishers' perspectives are based on a small number of contributions: semi-structured interviews with five fishers for the European Optifish project[4] (mainly beam trawl) and an additional focus-group discussion with four additional participants from the flyshoot (SSC) fisheries[5]. This is a small sample size and did not lead to achieving qualitative representativeness[6] which would be required to draw firm conclusions on fishers' perceptions about automatic catch registration systems and are indicative only; they offer an initial insight in potential perceptions and attitudes towards AI-based catch recording systems.

All data were pseudonymized so that information cannot be traced back to respondents, as agreed prior to the interviews. Key themes were systematically identified through the coding of interview transcripts and the development of so-called Vensim diagrammes. This qualitative analysis allows the distillation of

[4] Optifish: https://optifish.eu/
[5] The participating fishers gave their permission to use the results in the FDF-project (see section 2.1), in which the present report was one of the deliverables.
[6] Dinklo, I. (2006). Fabels en feiten over kwalitatieve onderzoeksresultaten: hardnekkige misverstanden over generaliseren van kwalitatieve onderzoeksuitkomsten. KWALON, 32: 35–43.

central insights and provides a structures representation of fishers' perspectives. These themes were furthermore directly aligned with the objectives of the roadmap.

The stakeholder process involved iterative consultations, ensuring that the roadmap is informed by scientific research, industry practices, and policy frameworks, and is designed to address current challenges while preparing for future opportunities.

2 Automated catch recording systems

This chapter describes what the current available knowledge and experiences are in relation to automated catch recording systems and what the technological challenges are for the near future to implement such systems in commercial fisheries.

2.1 CatchWAM research Projects

Between 2018 and 2026, WMR and its partners, supported at different stages through funding of the Dutch Ministry of LVVN, the European Maritime and Fisheries Fund and the European Maritime Fisheries and Aquaculture Fund programmes, took on the challenge of developing a system to record discards through electronic monitoring. Over this period, from the first concepts to the present technologies, important lessons were learned, and substantial technological progress was made. This chapter provides an overview of the main findings and developments from the two so-called 'FDF' projects (Fully Documented Fisheries), culminating in the creation of an AI-based tool for automated recording of discards on the sorting belt: the 'CatchWAM'.

2.1.1 Outcomes of the first FDF research project (FDF 1.0, 2018-2023)

Within this study a review of the possibilities of the implementation of standard EM, e.g. manual review of video data, on the beam trawl fishery was undertaken (van Helmond, 2023[7]). At the same time an investigation on the possibilities to automate the process of video review (with AI) in the Dutch demersal fisheries was investigated. The main findings were:

- The project trials of FDF 1.0 confirmed the expectation that not all plaice can be recorded with EM in a discarded beam trawl catch (**Figure 4**). An outcome similar to a previous study on using EM in beam trawl fishery[8]. Not all discarded plaice are visible for the video reviewer. The main reason for this is occlusion, e.g. overlapping fish on the sorting belt, which results in an under estimation of discarded plaice. A comparison between the number of discarded plaice counted by observers on board and an estimate based on a manual review of EM video data showed that EM resulted in an underestimation of discarded plaice counts for more than 20% on a beam trawl vessel.

- When vessels are equipped with EM systems all catches can be video recorded, resulting in a 100% monitoring coverage. However, the time needed to conduct a manual review of EM video data varied between vessels and hauls, depending mainly on the size of the catch, but in any case, EM video review can be considered as a time-consuming task. Videos have to be replayed frequently in slow motion and/or paused to be able to identify species. Methods to speed up this process through subsampling, e.g. using a selection of video segments which are extrapolated to the complete estimated for a haul, can be considered as an option but creates additional uncertainty and bias in discard estimates.

- When implementing EM on a large part of the fleet, significant practical and logistical challenges should be considered. Installing and maintaining EM systems on board differs from vessel to vessel, but is often resource and time demanding. When fishing time is taken in consideration, maintenance and repairs are frequently planned outside office hours (weekend), since vessels are at sea during the week. Adequate IT infrastructure is needed to store and transfer video

[7] van Helmond, A.T.M. (2023). Fully Documented Fisheries. Final report. Wageningen Marine research, report C076/23.

[8] van Helmond, A.T.M., Chen, C., & Poos, J.J. (2017). Using electronic monitoring to record catches of sole (Solea solea) in a bottom trawl fishery. *ICES Journal of Marine Science*, *74*(5), 1421-1427.

data to land-based servers. For example, during the project we experienced that standard 4G network is not sufficient to transfer all video data of one fishing trip to the server when the vessels are in the harbour over the weekend.

- Deep neural networks can successfully detect and count fish species of discarded fish under challenging conditions, e.g. cluttered and occluded catch on conveyer belts on board vessels (**Figure 5**). However, the use of a dedicated camera box system, with additional lighting, high definition industrial camera and protection box help to control external variables to get the image quality needed for sufficient AI performance.

General conclusion from FDF 1.0: A more technological advanced camera system, in combination with computer vision technology (AI), would enable a more efficient and improved documentation of discarded catches.

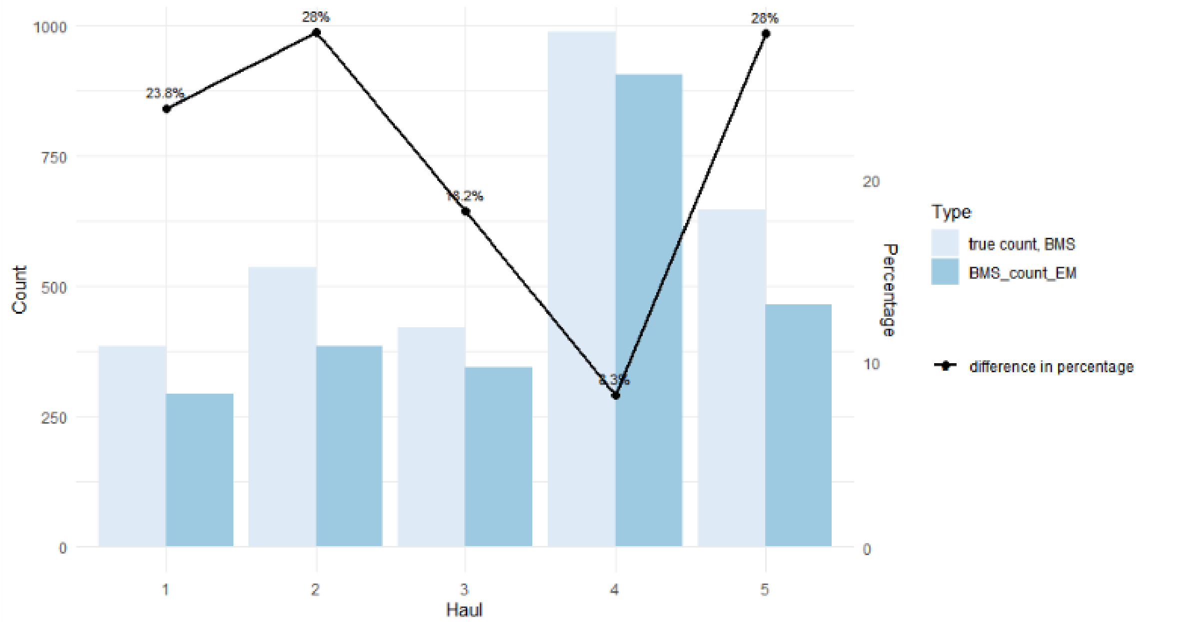


Figure 4. *Number of discarded plaice (BMS = Below Minimum Size), based on onboard observations (light blue) and on manual review of Electronic Monitoring (EM) video data (dark blue) of Dutch beam trawl vessels. The line shows the difference between the two counts, expressed as a percentage.*

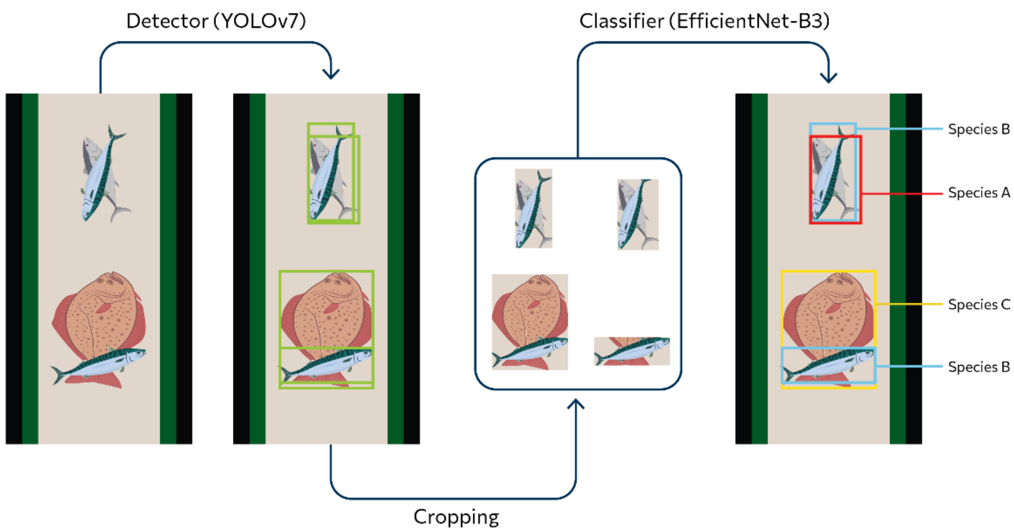


Figure 5. *From images to species identification.*

2.1.2 (Preliminary) Results of the second and ongoing FDF Project (FDF 2.0, 2024-2027)

The second FDF project, FDF2.0, is designed to establish scientific and technical foundations for automated catch registration at sea. It focuses on developing an AI- or computer vision-based monitoring system known as the CatchWAM. The first CatchWAM prototypes were developed during FDF 1.0 (**Figure 6**). By the end of the FDF 2.0 project, under the assumption that a sufficient amount of high quality data to train the AI network is collected, , the system will be capable of identifying and quantifying discarded (undersized) fish species, with a high level of accuracy – particularly plaice, whiting, mackerel, horse mackerel, and herring - across three fleet segments: beam trawl, flyshoot, and otter trawl.

Figure 6. *CatchWAM prototype onboard a fishing vessel.*

At the conclusion of the project by the end of 2027, prototype CatchWAM systems will be operational and installed on multiple vessels. The project intends to demonstrate that, with appropriate camera placement (at the end of the conveyor belt for beam trawl, flyshoot and otter trawl), robust algorithm training (enough training data available, e.g. covering variance between catch composition and vessels), and advanced AI-based image recognition, the system can achieve at least 80% accuracy for detection of discarded target species. A key distinguishing feature of CatchWAM is its ability to operate reliably under real-world conditions, including dealing with the impact of seawater on the system, high variability in weather conditions, catch composition, lighting conditions, and occlusion of catch on conveyor belts. The CatchWAM system has been successfully tested for extended periods (several months) on board multiple commercial fishing vessels (**Figure 7**).

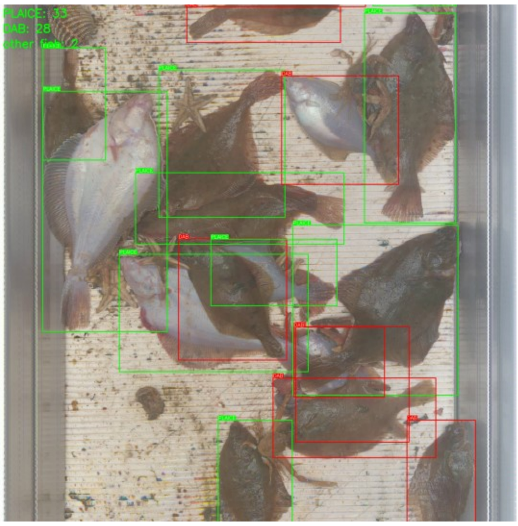


Figure 7. *Realtime CatchWAM image including output of AI network: object detection (bounding box) and species identification (colour, red and green in this example).*

FDF 2.0 also integrated CatchWAM outputs into e-log systems, enabling the automatic upload of estimated discard weights per species for each haul into designated logbook formats (**Figure 8**).

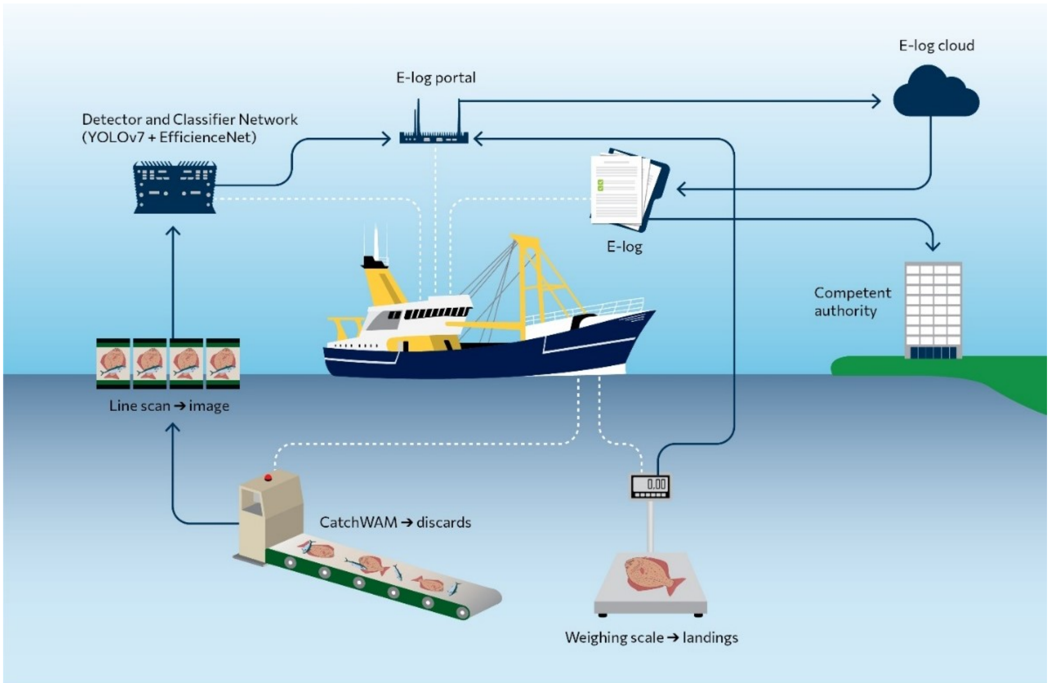


Figure 8. *Recommended FDF workflow: data routing and feedback systems*

2.1.3 Comparable research in other countries

Several research projects with the aim to automate catch registration with AI are conducted in other countries. Expertise and experiences are shared in EU founded projects, e.g. EveryFish, and workgroups of International Council for the Exploration of the Sea (ICES), e.g. Working Group on Technology Integration for Fishery-Dependent Data (WGTIFD). However, the expertise and quality standards developed in this project with the automated registration of discarded catch in the challenging situations of occluded mixed catch as found in the Dutch demersal trawl fisheries are not yet met on other projects.

3 Research, development and capacity building

The CatchWAM system consists of a hardware component (the camera and its physical installation on board) and a software component (the algorithm recording fish), both components are currently being developed by WUR. Details on the future development and rollout of the system are provided in this chapter.

3.1 Software development

By the end of 2028, the CatchWAM algorithm is expected to reliably detect and count five key species for beam trawlers, otter trawlers and flyshooters (Scottish seiners) with an accuracy of at least 80%[9]. From then onwards, eight actions are proposed to maintain and further develop the software component of the system:

1. Decide on algorithm ownership (licensing)
2. Ensure interoperability
3. Increase accuracy
4. Expand species coverage
5. Further develop to estimate individual fish lengths
6. Further develop to estimate weights
7. Continuous feedback on system performance
8. Expand to other fleets

The order of the actions may not necessarily follow the same order as listed above. Some of these actions can take place simultaneously, while others cannot be started before other actions are finished.

3.1.1 Action 1: Decide on algorithm ownership

To support broader implementation of CatchWAM within Dutch fisheries, uptake by commercial maritime engineering companies would be beneficial. To facilitate this the AI networks will be made available by the developer (WUR) through a licensing system. This approach enables the developer to retain control over the algorithm, ensure regular updates and maintenance, and safeguard regulatory alignment, while allowing wider practical use under transparent and fair conditions.

Adopting a licensing pathway requires long-term commitments, including continuous algorithm updates, validation, technical support, and performance monitoring to ensure the system remains robust and trustworthy across fleets, fisheries, and jurisdictions. The organization holding the licence would need to assess the required investment and, together with the relevant governmental organizations (e.g. LVVN, NWVA, DG MARE), prioritise further development steps (e.g. adding more species, develop measurement functions). The licensing organization will also need to maintain close coordination with commercial hardware providers to ensure proper integration.

3.1.2 Action 2: Ensure interoperability

In context of the CatchWAM implementation, interoperability means that the operational workflow of the AI-based recording system, including data capture, processing, and reporting via e-log systems, is compatible across different e-logbook platforms. In other words, the CatchWAM should be able to

[9] F1 score and Blant-Altman agreement score

connect to different type of e-logbook systems, or other forms of data presentation of the CatchWAM output, e.g. registration of discards by species.

At present, the AI-registration outputs (such as species-level discard records) are integrated into the specific EFICE e-log system, which is used on most Dutch vessels. However, it is important is to make the output data compatible with other e-logbook platforms, in order to ensure interoperability across fleets and EU Member States. This will allow seamless data exchange and harmonized reporting for scientific, management and for possible future discard registration frameworks, as e-log systems can be accessed by authorities, managers and scientists.

Software pipeline updates are recommended as soon as it becomes clear if automated discard registration at sea will be continued. This will ensure that different e-logbook systems remain compatible and help create a level playing field. Achieving this will require close cooperation between e-log software providers, the fishing industry, and the algorithm licence holder.

3.1.3 Action 3: Increase accuracy

Currently, the research objective is to configure the algorithm to achieve at least 80% accuracy for detection and species identification of the most common discarded species in the Dutch demersal fisheries. This should be considered a minimum: depending on how the catch is presented (e.g. less mud and benthic debris), and on the species involved (some species are more distinctive than others), accuracy is expected to be higher than 80%.

A key component influencing the performance of the system is the amount of available training data and the variability in the training data. The dataset should contain enough examples covering all observable variations and characteristics, maturity stages, environmental components (mud, debris, trash). The more training data and the more variable the training data, the better the accuracy of the system. Due to variability between vessels, fishing grounds, and seasons, it is likely that there will occasionally be novel situations that the AI system cannot handle yet, due to lack of data. In order to improve this, the human-in-the-loop concept is developed, For the efficiency of this application, the AI system will need to indicate the uncertainty of its predictions. If that uncertainty is too low, a human expert will be placed in the loop to correct the uncertain predictions, which a) ensures that the documented catch is more reliable, and b) that new training data of the difficult situations is gathers, that will lead to a better trained AI system.

The required level of accuracy also depends on the intended use of the results.. However, if the system is intended to support scientific assessments, quota management, or wider policy decisions, different accuracy thresholds may apply. In this context, even more limited systems (i.e. less accurate) could still be sufficient if they improve data collection compared with existing approaches that have extremely low sampling coverage, such as at-sea observer programmes. A lower-accuracy AI-based method for scientific assessments in support of management advice may therefore be acceptable if it enables many more observations across a fishing fleet[10].

In general, improving the level of accuracy will demand additional annotated data (training data) and further training or tailoring of the model to specific vessels, areas, fleets, or fisheries. At some point, model performance may stagnate or even deteriorate, for example due to overfitting or the inclusion of poor-quality datasets. The target level of accuracy is therefore ultimately a balance between what is technically feasible and what is required by policy.

In addition, innovations aimed at improving the accuracy of AI-based detections are continuously being developed. Promising research directions—such as foundation models, improved data subset selection, and synthetic data generation—will be evaluated throughout the various implementation stages and incorporated into the CatchWAM system where relevant to ensure continuous improvement.

[10] Malde, K., Handegard, N. O., Eikvil, L., & Salberg, A. B. (2020). Machine intelligence and the data-driven future of marine science. *ICES Journal of Marine Science*, *77*(4), 1274-1285.

3.1.4 Action 4: Expand species coverage

For the identification of more species than the five species currently under consideration, the algorithm must be trained and validated on a dataset that includes an extended list of species. The approach for algorithm training will depend on whether the additional species are common (e.g. plaice, dab, whiting) or uncommon (e.g. greater weever, smalltooth sand tiger) in catches.

Common species
For common species, species with a regular appearance in daily catches, an extended data collection campaign is needed to capture the full range of variation, i.e. a good in representation, in species appearance and fishing scenes in the data sets used for training algorithms. The collected data must then be annotated, after which the algorithm can be trained to detect and count these species. In case the CatchWAM system is set up correctly, image quality will be sufficient (see sections above). The amount of data required to reach the desired detection performance depends on factors such as species appearance and morphology; these factors can introduce substantial variability, which can differ between fisheries and regions (i.e. member states). When seasonal variation should be captured data acquisition will take at least a year.

Uncommon species
For uncommon species, species with less frequent and unregular appearance in the catch, extended data collection campaigns will not necessarily yield sufficient observations, because these species do not frequently appear in video or image data. As an alternative, data augmentation (generating additional samples from existing images) and synthetic data generation (creating realistic artificial data, for example through 3D image modelling) can be used to increase the number of examples. However, these approaches introduce the challenge of a "reality gap": a mismatch between artificial variation applied to existing samples and the full range of conditions encountered at sea.

These techniques are likely to become key components of expanding species coverage, but their effectiveness still needs to be validated.

3.1.5 Action 5: Further develop to estimate lengths

Length data are important for biological studies and stock assessments, as length is often a strong proxy for age and maturity. The functionality of length estimation therefore has high scientific and management value.

The CatchWAM can be used to predict fish length for each detected individual. Then the algorithm architecture must be adapted so that detection and length regression are performed simultaneously. Alternatively, a two-step (ensemble) approach can be used, with a detection stage followed by a separate length-regression stage.

A technical challenge is so-called occlusion: fish may overlap, be partially covered by e.g. debris, or be presented at angles that distort their apparent size. This problem can be more severe in one fishery compared to another, depending on gear, mesh size, and/or fishing ground. Several strategies can address this. One is to train the algorithm on large sets of annotated images that include both species labels and ground-truth length measurements. This can work well when the expected length range is relatively narrow. When the length range is wide, however, it becomes more difficult to estimate the length of an individual based on a partially visible body.

More powerful algorithms trained on broader datasets could also improve performance, but this would require a substantial annotation effort to build a large dataset containing both precise localization and length information.

Lengths can also be estimated directly from the image itself, for example by using the length of the bounding box as a proxy. This is only feasible when fish are fully visible in the image, overlapping fish cause problems for this approach.

Occlusion could be reduced at the source, by introducing mechanical adaptations, e.g. separating fish on the sorting belt, washing out debris, that present fish to the camera in a more controlled and unobstructed way. Advanced imaging technologies, such as X-ray or other specialised systems, are also conceivable, but these come with significant cost and operational constraints.

3.1.6 Action 6: Further develop to estimate weights

Species weight is highly relevant for quota management, which currently is based on landed weight. If weight estimates from images were to be used in this context, this would require appropriate validation and oversight by control authorities. The complexity of this task is high and will require a phased development approach.

Although many species show strong length–weight relationships, estimating weight from images is a different problem from counting or estimating length. It requires a dedicated dataset in which fish of known weight are recorded under controlled conditions and presented consistently to the algorithm. Given how extensive the data requirements already are for counting alone, this represents a substantial additional investment in data collection, and validating such an algorithm will be very time-consuming.

Synthetic data may help reduce the real-world sampling burden by simulating fish shapes and weight distributions. However, a sufficient number of real fish with known weights and lengths would still need to be scanned to provide a robust basis for generating synthetic data. Strengthening and validating species-specific length-weight relationships could also support a hybrid approach, in which length estimates feed into a secondary weight-estimation model. Additional morphological cues, such as body depth or girth, might be incorporated if image quality allows.

The balance between technical feasibility, cost, regulatory robustness and management purposes, as well as on when such a capability could realistically be introduced into operational use should be considered, when starting the developed of such AI networks.

3.1.7 Action 7: Continuous feedback on system performance

A further requirement is continuous feedback on the accuracy of the network’s estimates so that system performance can be monitored over time. This is particularly important when conditions change, for example, when the approach is expanded to other fleets or fishing grounds, or after software or model updates.

Maintaining a “human-in-the-loop" component in data collection and analysis allows the system to adapt to shifts in fishing practices, catch composition, and management requirements, even at larger scales. The network is designed to flag observations for which its uncertainty increases. Having these cases reviewed and annotated by an expert (e.g., a biologist with species-level expertise) provides high-value training data, enabling the network to handle difficult or novel situations more accurately - and with greater confidence - in the future.

Implementing this human-in-the-loop approach within the onboard software pipeline requires an end-to-end workflow: automated transfer of data from vessel to cloud server; a graphical user interface (GUI) for expert review and correction; automated updates of performance statistics; scheduled retraining of the AI models; and deployment of updated networks back to the vessels.

3.1.8 Action 8: Expand to other fleets

The algorithms, initially developed for beam trawl, otter trawl, and flyshoot (Scottish seine) fisheries on vessels over 24 metres, could potentially be extended to other fisheries. However, each fishery brings its own operational and biological constraints—driven by differences in target species, catch composition, vessel characteristics, and onboard handling and sorting practices. These factors determine how much additional algorithm development is needed, what hardware setup is appropriate, and the data collection effort required. The expansion to other fleets is discussed in more detail in Chapter 6.

3.2 Hardware development

As the CatchWAM system moves from research and pilot trials towards operational deployment on the Dutch demersal fleet by the end of 2028, the involvement of commercial maritime engineering companies (e.g. hardware providers) will be essential. Once the technical specification of the CatchWAM hardware and software is finalised and made available under licence at the end of the FDF 2.0 project, and once the policy framework for at-sea recording is in place or at least more clearly defined, the next critical step will be to enable industrial-scale production and maintenance of hardware systems.

Through dedicated policy instruments and strategic guidance (see 4), the commercial value of developing and supplying CatchWAM-like systems should be made clear and predictable. This will require coordinated communication to ensure that hardware providers, initially at a national level, perhaps at a later stage internationally, are aware of the opportunities for hardware production, installation, and servicing under the new monitoring regime.

By 2028, companies should be able to manufacture, supply, and maintain CatchWAM-like systems.

The involvement of commercial partners is needed to establish long-term maintenance and support structures to guarantee system reliability at sea. This includes hardware servicing, maintenance, software updates (based on software provided under the WUR licence), calibration checks, and provision of replacement parts.

Developing this capacity for hardware production will ensure that more fishing vessels (in other fleets) can adopt fully operational, CatchWAM(-like) systems without delay. Collaboration between research institutes, policy makers, commercial maritime engineering and service providers, and fishery industry will therefore be central to the scalable rollout of AI-based catch recording systems.

An essential element that needs to be further developed is the assurance that the acquired images are of high quality. If something is blocking the camera, if the camera lens gets dirty, or if the light fails, for instance, the images will not be usable for further processing of the AI system. This requires:

- the development of software that detects such situations,
- automatic methods to solve the situation, if possible (for instance automatic cleaning of the lens), and
- clear instructions to the crew to solve the situation if it cannot be solved automatically.

3.3 Overview technological developments and timelines

This section presents the technological developments in a timeline for Dutch demersal fisheries (**Figure 9**) and summarises the developments expressed in level of complexity, estimate for the required time needed for the development, and the actions or requirements (**Table 1**).

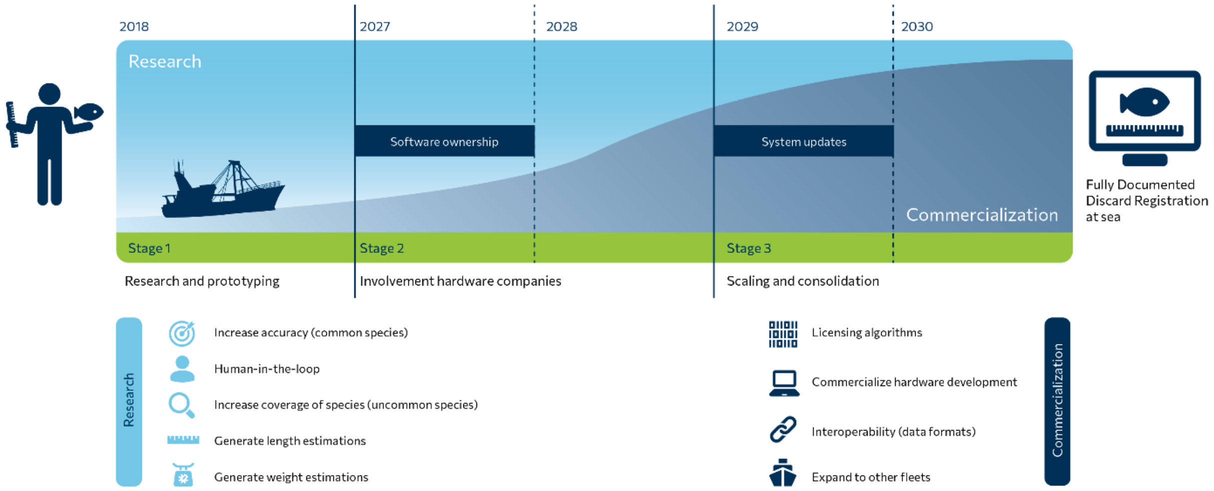


Figure 9. *Technological developments presented in a timeline for Dutch demersal fisheries.*

Table 1. *Overview of technological developments and timelines of an automated discard registration system.*

Action	Purpose / Rationale	Research and development (★ easy - ★★★★ difficult)	Estimated Time	Actions or Requirements
Software ownership (milestone)				
Licensing the algorithm	To make the algorithm accessible to users, software can be licensed by an independent institute, with no commercial goal. This way the algorithms remain relatively accessible, updated and validated.	★★	~1 year	The licensing institute (in this case WUR-WMR) needs to commit to updating and supporting the algorithm for the foreseeable future (depending on future policy decisions). Furthermore, a legal team need to define the licence, and a cost structure needs to be set up.
System updates (milestone)				
Interoperability	To ensure system compatibility across all fisheries using different electronic logbook systems.	★★	Interoperability	To ensure system compatibility across all fisheries using different electronic logbook systems.
AI updates to improve model accuracy and performance (research process)				
Increase accuracy	To reach at least 80% accuracy of species identification. Level of accuracy may vary based on the use of the data (policy, science, management).	★★★★	~5 year	Increasing accuracy is one of the most challenging task in AI development. More annotated data is needed to further increase the accuracy. Also algorithms could be tailored more specific for a métier, area, or vessel to fit the required level. This task also requires the human-in-the-loop system (maintaining a human expert in the data collection and analysis system) and innovations to increase AI accuracy.
Add identification of common species	To include common species relevant for management or quota regulations. *(Time per species)*	★★	~1 year	Requires annotated video data; training is straightforward if such data are available, but annotation of data is time-consuming and needs dedicated experts. On the medium-term the-human-in-the-loop system will take over the dedicated data collection efforts.
Add identification of uncommon species	To include uncommon species of special interest (e.g. endangered,	★★★★	~5 year	Requires the human-in-the-loop-system. Uncommon species will be filtered out, correctly identified by expert and feed back

	threatened, or protected). *(Time per species)*			into the AI training loop. Also, the development of synthetic data to train algorithms could be an alternative approach
Generate length estimates	To assess the length composition of discards by species, which is useful for biological studies and stock assessments (length is a proxy for age).	★★★	~2 years	Occlusion during filming complicates measurement; possibly solutions include mechanical adaptations to present fish to the camera, powerful algorithms with a lot of data, X-ray imaging, or other costly alternatives.
Generate weight estimates	To assess the weight of the discarded part of the catch by species. This would be relevant for quota management, which is weight-based.	★★★★	~2 years	Direct estimation would be a possibility with AI. An alternative could be the use of length-weight relationship to get reliable weight estimates. More
Expand to other fleets (e.g. pelagic, small scale)	To adapt to different circumstances, such as larger volumes of fish and higher processing speed or smaller vessel without sorting belts	★★★	~2-3 years	Collect data of other fleets. Retrain algorithms for new conditions (e.g. for pelagic fisheries, there is a need to manage high fish volumes, with dense stacking). Cooperation with other countries, e.g. data sharing, could be an advantage.
Hardware development (commercialization process)				
Commercialize hardware	To stimulate hardware providers and industry investment in the development, installation, and long-term maintenance of camera systems for discard monitoring	★★★	~2 years	This is a crucial and important step for the long-term success of the use of cameras on board fishing vessels. Policy should be clear on the business case of developing and maintaining these cameras.

4 The required policy, regulatory, and social conditions for successful implementation

Central to the process of implementation of automated recording of discards onboard fishing vessels is the technological development of hardware and software. At the same time, there is a broader context that needs to be taken into account for a successful implementation. This context includes policy and regulatory preconditions; and social preconditions for acceptance. These conditions will influence both the pace and direction of implementation.

4.1 Policy & regulatory preconditions

Successful implementation of an AI-based catch recording system requires a dedicated policy and legal environment. Enabling conditions are summarized in **Table 2** and discussed in more detail in Annex 1, where also recommendations are included.

Several national policy decisions are required to ensure that the system can be used on a fleet level. An approximate time-line for these decisions are listed below:

- Validation and commercialization by 2027: The Dutch government should agree a validation framework that enables licensing and market roll-out (hardware and software). Clear communication of the system’s objectives and limits is needed, alongside a strategy for engaging technology providers, including certification routes for hardware and software.
- Onboarding and regulatory alignment by 2028: An onboarding plan is needed to support early adopters and operational integration at sea. In parallel, the system must be aligned with the EU regulatory framework, so outputs are legally usable for management. Rules on data ownership and access rights must be set, and adopter incentives and implications made explicit.
- Participation model and safeguards by 2030: Member States governments should define participation categories (voluntary, incentivized, mandatory) and obligations for non-participants. Checks, balances, and safeguards should ensure that AI outputs are independent, transparent, and auditable, and that they are used only for their intended purposes.

Table 2*. Enabling policy and legislation conditions for the roll-out of an automated catch recording system. More details in Annex 1.*

Enabling conditions (policy & legislation)	What it delivers
Strategy for involving hardware providers Specification of roles, responsibilities and funding models with transparent conditions. Procurement guidelines and certification schemes to guarantee system quality, interoperability, and fair competition among suppliers.	Predictable investment conditions for hardware/service provision and fleet-wide roll-out.
Early alignment of AI-based catch recording with EU regulatory frameworks Appropriate technical integration in the existing e-logbook infrastructure. Harmonised EU standards for data formats and reporting protocols. System flexibility for updates according to evolving EU regulations.	Legal and technical "fit" with existing reporting systems; reduced risk of redesign later.
Legal recognition and status as evidence of AI-generated data. Data integrity, verification and accreditation requirements. Rights of operators and procedural fairness. Consistency of legal status across jurisdictions. Administrative efficiency and practical implementation.	Clear admissibility for reporting, quota management, and enforcement decisions. Verifiable, trustworthy data (audit trails, independent audits, accuracy thresholds). Fairness and clarity when errors occur; protection against unjust outcomes. Coherent enforcement and quota management for shared stocks and multi-state fisheries.
Data governance for storage, ownership, access, and permitted uses Privacy, proportionality, and GDPR safeguards plus streamlined administration	Robust framework for data storage and governance helps to create trust in the system, acceptance and adoption among fishers, authorities, and other stakeholders. An agreement should be established regarding the retention period for raw data. Raw data should not be stored indefinitely but should be available for a defined period of time.

4.1.1 Policy events impacting discards recording

Several policy developments at EU and national level will affect the roll-out of automated discard registration systems across métiers:

1. Start of the discussions of the evaluation of the Common Fisheries Policy (CFP) in 2026): As the CFP sets the regulatory framework for EU fisheries management, the outcomes of the discussions, particularly regarding the continuation or adjustment of the landing obligation and discarding at sea, are expected to influence the development and long-term implementation of automated discard registration at sea.
2. Possibility of registration of discards and catch at haul level from January 2026 onwards (Implementing Regulation (EU) 2025/2196)[11]: This regulation may result in fishers recording data on a higher detailed level, creating an opportunity for the deployment of automated AI-based discard registration systems. These systems can reduce reporting burdens while improving data accuracy and consistency.
3. Mandatory Remote Electronic Monitoring systems, which include Closed-Circuit Television (REM/CCTV), for EU fishing vessels of 18 meters or more that are assessed as having a high risk of

[11] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202502196 – Article 25 and Annex VX

non-compliance with the landing obligation, by 2028 (Regulation 2023/2842)[12]: The recording of discards using AI-based video systems may be affected by the implementation of REM/CCTV monitoring. It will therefore be important to clearly distinguish their objectives, governance arrangements, and data-use, even where technologies or platforms overlap. AI-based discard registration focuses specifically on catch quantification and biological data collection, whereas REM/CCTV focuses primarily on compliance monitoring and (human) behavioral oversight related to the landing obligation. Opportunities for compatibility between both systems should however be highlighted.

4.2 Social preconditions

The introduction of an AI-based catch recording system has far-reaching social implications for fishers and fisheries. The success of its roll-out depends on the social context: acceptance by fishers and fisheries authorities is essential, on an EU-level or even wider.

AI-based catch recording would shift discard estimates from infrequent snapshots, recorded by at-sea observers or fishers themselves, to high-resolution, near-real-time data, potentially reshaping fisheries management. This raises questions on data ownership, data access rights, and secondary use (e.g., enforcement, commercial analysis, public campaigns), and could blur the boundary between management/science and surveillance. Trust and incentives are therefore central: fishers may participate to maintain landing obligation exemptions (e.g., plaice), yet fear the same data could later drive sanctions, quota cuts, closed areas, or withdrawal of such exemptions. Adoption capacity varies across vessels and fisheries, requiring support, dialogue, and co-design, as well as attention to EU-wide "level playing field" effects. Making implementation mandatory on national fleet level, potentially causes differences with fleets from other member states fishing in the same area. Better discard data could improve stock assessments and ICES advice on fishing opportunities, which forms part of the basis of Total Allowable Catches (TAC). Mandatory versus voluntary implementation will strongly shape acceptance and cooperation.

Looking into fishers' perceptions helps to get insight into how fishers view a new AI-based catch recording system (section 4.2.1).

4.2.1 Fishers' perceptions

Interviews with fishers, carried out as part of the European Optifish project (see section 1.5), show that there is an impact on: how fishers work, how they are seen by society, and how policy and practice interact at sea. **Table 3** summarizes the key issues identified through the interviews. More details are provided in Annex 2.

Note that these are results based on a small sample size, providing preliminary perceptions and attitudes towards AI-based catch recording systems. For firmer conclusions on fishers' perceptions about automatic catch registration systems more interviews should be conducted for a qualitative representativeness.

[12] EP and CEC (2023). Regulation (EU) 2023/2842 of the European Parliament and of The Council of 22 November 2023 Amending Council Regulation (EC) No 1224/2009, and Amending Council Regulations (EC) No 1967/2006 and (EC) No 1005/2008 and Regulations (EU) 2016/1139, (EU) 2017/2. L series Official Journal of the European Union, L Series.

Table 3*.* *Social conditions for the roll-out of an automated catch recording system (based on a small sample size of fishers' perceptions). More details in Annex 2.*

Enabling conditions (social)	What are the issues
Trust in AI-catch recording systems	Trust has worsened over years between fishers and policymakers, increasing emotional strain for family businesses facing decommissioning and constant public scrutiny. Camera systems intensify mistrust: fishers fear data will be used against them through stricter quotas, controls, and area closures, misinterpreted without context, and penalize them for technical failures. Privacy and access remain major concerns.
Incentives for participation and willingness to use the system	Fishers participating in the FDF projects voluntarily joined mainly for a landing-obligation exemption and compensation. Unless costs are covered, technology improves, and benefits accrue, fishers see cameras as compliance tools. Fishers say video monitoring could improve area closures, ease mesh rules, and enable targeted enforcement without extra burdens.
Ability to install and use the system	Fishers highlight practical barriers: unreliable internet at sea makes real-time transmission unrealistic, while upgrading connectivity (e.g., Starlink) is costly and storing footage onboard requires time-consuming hard-drive exchanges. They doubt cameras will reduce paperwork, fearing failures will add new obligations as regulations rarely get removed. If mandatory, they favour phased, voluntary roll-out via a central EU body, full cost coverage and operational flexibility are essential.
Data access rights	Data access strongly affects trust and cooperation. Fishers want access limited to themselves and multiple independent research institutes and oppose access by other fishers to protect grounds and strategies. Authorities also need access for management, as quotas often lag reality. Fishers fear broad access (e.g., NGOs) could misinterpret area-specific bycatch without context.
System failure and responsibilities	One fisher reports a year of smooth operation, with rare sensor failures that could be corrected manually. Others fear inevitable system breakdowns would block compliance and disrupt fishing trips, citing stressful permit disputes with authorities. They also worry AI misidentification will be treated as evidence, making fishers liable for machine errors.(This requires a good functioning error log-system, so data is available and can be used in disputes)
Perceived fairness: avoid penalising fishers for uncontrollable catch variability	Fishers refer to experiences with seabass: one winter abundance surged, yet quotas stayed at zero because decisions relied on prior low catches. They lost revenue despite the fish being present. They argue near-real-time camera data could evidence seasonal abundance and support cautious adaptive quotas (e.g., allowing 10–20%), avoiding complete bans.

5 Roadmap to fully documented fisheries

This roadmap proposes a stepwise implementation process for AI-based catch recording in three stages:

- Stage 1 Research and prototyping,
- Stage 2 Engagement and commercialization, and
- Stage 3 Scaling and consolidation.

The ultimate objective is an operational catch recording system across the full fleet of a métier. This requires the system to be at an appropriate technical level. Events external to the technical developments may impact the implementation of the system. Therefore, this roadmap places technical developments in a policy, legislation and social context (**Figure 10**).

The following sections describe the main activities and objectives for the three stages.

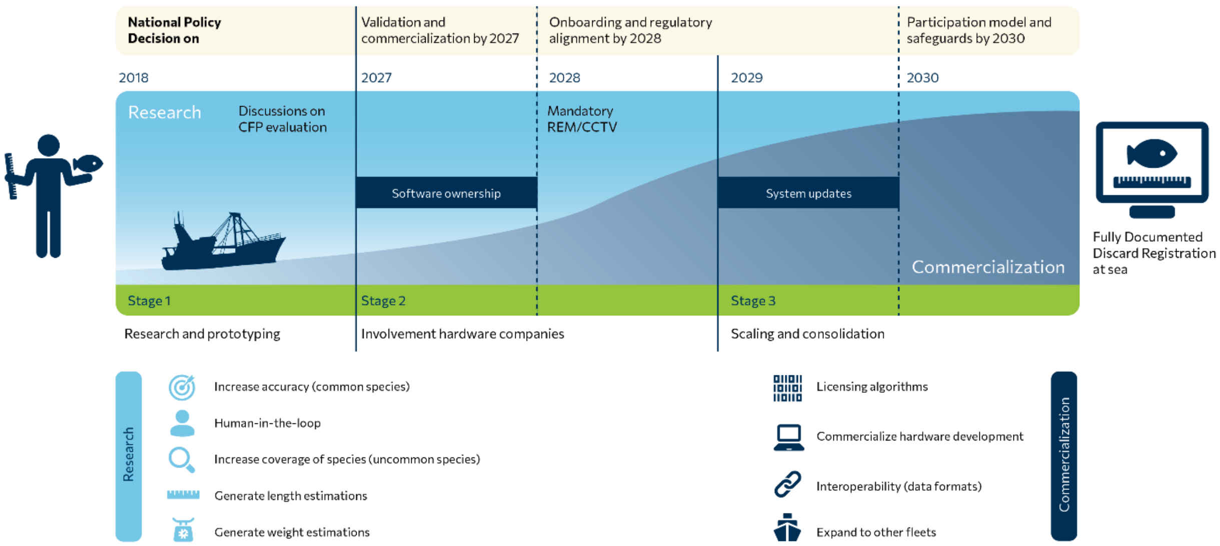


Figure 10. *Roadmap to fully automated discard registration system for Dutch demersal fisheries: timeline of technological developments, in the context of policy and legislation developments.*

5.1 Stage 1 Research and prototyping

Stage 1 focuses on the further development of a proof of concept, construction guidelines for the hardware and performance requirements. In this stage, several commercial fishing vessels should be involved in the development and testing of the system.

The proof of concept consists of a prototype of the AI-based discards recording system. The aim is to demonstrate that, with appropriate camera placement, robust training, and AI-based image recognition, CatchWAM can achieve at least 80% accuracy in detecting the most abundant discarded species. It is designed to perform reliably under real-world conditions, despite variable weather, catch composition, lighting, and occlusion on conveyor belts.

Hardware construction guidelines should be established based on the prototype, covering: camera selection, lighting geometry, housing design, and installation relative to the sorting belt. Performance benchmarks must be stable and repeatable.

Validation protocols and statistical performance requirements of developed and implemented algorithms must be clarified at this stage. The clarification of these metrics should be decided between policy and researchers.

5.2 Stage 2 Engagement and commercialization

Stage 2 focuses on the longer-term use of the hardware and software. It should be decided who owns the developed algorithms and takes care of future updates, including permit schemes for user-licenses. For the hardware, commercial companies should be encouraged to further develop it to a level where it is robust and functional. This requires identifying who will manufacture and supply the equipment to the fleet and what policy environment is needed to establish a viable business model. Financing structures must be defined, alongside incentives to encourage early adopters.

Based on industry and management needs, the range of species that can accurately be identified should be increased. Datasets should be expanded to include additional common and less common species. Species expansion timelines may range from one to two years depending on abundance and detection complexity. The model accuracy should continue to improve, including performance on other, less abundant, species (**Table 1**).

By the end of Stage 2, a larger number of vessels should be equipped and actively operating the system at sea. The industry should have a clear understanding of the system’s management objectives, including its benefits and drawbacks. Governments should also clarify future management plans and requirements to support adoption.

5.3 Stage 3 Scaling and consolidation

Stage 3 aims to deliver a fully operational system across the entire Dutch demersal fishing fleet (with the exception of shrimp fisheries). At this point, proof of use should already be demonstrated in practice and the industry is familiar with the system. Algorithms should be trained to estimate length and weight in addition to species identification, enabling further applications for quota accounting and scientific assessment. Robust protocols for model updating and maintenance must be finalized.

During this phase, governments must have decided whether using the system is mandatory or voluntary, develop checks and balances appropriate to the usage of data, ensure transparency and auditability of AI outputs, and establish the final EU and national legal frameworks supporting system deployment.

6 Potential for use in other fleets

The automated discard recording system is currently being developed for Dutch demersal fisheries by vessels larger than 24 meters. In its intended end state, the system should be operational across five fisheries: beam trawl targeting sole, beam trawl targeting shrimp, otter trawl, and flyshoot (Scottish seining) and pelagic mid-water trawl. The system has the potential to be further developed for other national and EU fisheries.

The development of automated discard recording systems is expected to broadly follow the same staged approach as described in Chapter 5 for all fisheries. However, differences in target species, catch composition, vessel characteristics, and on-board handling and sorting processes introduce fishery-specific challenges. These differences affect the required level of algorithm development, hardware configuration, data collection effort, and overall development timeline. So far, most experience is gathered for the beam trawl fisheries targeting sole. An overview of how other fisheries differ from the beam trawl case is provided in **Table 4**.

Developing the algorithm to other fleet segments is likely to incur relatively high costs, which could be offset through government programmes working in partnership with the research institution and industry representatives holding the licence. Cooperation between these three parties is recommended to develop a CatchWAM system tailored to this fleet segment.

Table 4. *Key differences in discard registration system development compared to beam trawl fisheries targeting sole, where main characteristics are a mixed (benthic) species composition, catches including benthos and debris, and moderate volumes.*

Fishery type	Key differences from beam trawl case	Implications for system development
Otter trawls	Cleaner catch (less benthic debris), existing FDF participation	Faster early-stage development, higher initial algorithm accuracy
Flyshooters (Scottish seiners)	Relatively clean catches (less benthic debris), existing FDF participation	Faster implementation and early classification performance
Beam trawl targeting shrimp	Smaller target species, higher juvenile bycatch, automated/mechanical sorting process, relatively high number of vessels in the fleet	Extended algorithm training, longer data collection phase, hardware redesign (smaller and system installation upstream of sorting), space constraints
Pelagic fisheries	Very large catch volumes, homogeneous catches, high processing speeds, automated processing, minimal unwanted catch	Questionable need for discard system; focus may shift to ETP registration rather than discards
Small-scale fisheries (interesting from a more international perspective)	Smaller vessels with less space on deck, no sorting belts, smaller catch volumes, and limited power supply on board.	Hardware redesign, space constraints

7 A living document

To keep the roadmap relevant and actionable, it should be updated regularly to reflect new insights, data, and regulatory changes affecting the AI-based catch recording system. It also needs to be embedded in key decision-making processes so it guides strategy and keeps stakeholders aligned. Because fisheries policy evolves, the roadmap must be able to adapt to new conditions. Its main value is as a shared communication tool: a single reference point for coordinating work, sharing critical updates, and maintaining alignment across regulators, industry, and research.

8 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2015 certified quality management system, certified since February 27, 2001 by DNV. ISO 9001 is an international standard for quality management, focused on the continuous improvement of processes and ensuring customer satisfaction.

Justification

Report: C028/26
Project Number: 4316100316

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

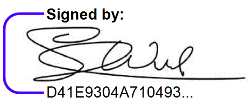
Approved: Dr. Ir. N.A. Steins
Senior scientist

Signature:

Date: 2 April 2026

Approved: C.J. Wiebinga, PhD
Business Manager Projects

Signature:



Date: 2 April 2026

Annex 1 Conditions for the functioning of automated catch recording: policy & legislation

The development and implementation of automated discard recording systems depends on more than just the development of the technology. This Annex deals with the required conditions relevant for policy and legislation for the technical implementation of the discard registration system.

For the involvement of commercial companies (hardware providers) to develop the hardware up to a level where it is suitable for large-scale implementation (see section 3.2 of the main report), a strategy needs to be developed by policy makers. Elements of this strategy are, for example, how to get companies involved, what are the roles and responsibilities, and which funding models are applied. Beside the integration of the AI-based discard recording system in the catch reporting systems that are currently in use, also an integration in the current and future regulation frameworks is needed. The legal status of the data provided by the system needs to be clarified and harmonized on the EU level and, preferably, beyond. Finally, a robust framework for data storage and governance of the collected data needs to be developed. Questions about data ownership and access rights need to be addressed in an early stage.

Strategy for involving hardware providers

Rolling out an AI-based catch registration system requires substantial involvement from commercial companies, both to further develop the technology and to provide hardware, installation, and support services to fishers on a large scale (fleet wide). Research institutes[13] are expected to develop the hardware technology up to a level where it is functional for an experimental/pilot set-up, but not to a level where it is ready for large-scale implementation, while software could remain under licence (see section Algorithm ownership, section 3.1.1). Bringing the hardware system to an advanced level and preparing it for large-scale implementation will require commercial actors and expertise (see also Section 3.2). For companies to engage in this process, government bodies – either the Ministry of LVVN or the European Commission – must outline a clear strategy and define the conditions under which reliable demand, funding mechanisms, or other supporting measures are available.

Roles, responsibilities, and cooperation structures

Clear definitions of the responsibilities of commercial hardware providers are essential. Uncertainty about who is responsible for system development, delivery, and long-term maintenance creates barriers to investment and complicates risk assessments for both companies and fishers. At the same time, insufficient cooperation structures between research institutes, authorities, and commercial parties may slow the transition from prototype to deployable product. Without coordinated development pathways, innovation may stall and hinder commercialization.

Additionally, commercial companies will most likely be involved in handling sensitive fisheries data, requiring safeguards and transparent procedures for data transfer and storage. See also section 4.4.

[13] Also other institutes in the EU work on related topics: DTU-Aqua in Denmark conducts a project on electronic monitoring in the Kattegat; ILVO in Belgium develops AI-driven automation of fish catch (VISIMIII).

Regulatory clarity and cost distribution

Companies and fishers require a predictable regulatory and financial framework. Unclear business models and uncertainties over who pays for development, hardware, or ongoing services can create hesitation. If cost distribution between fishers, national governments, and potential EU subsidies are unresolved, uptake may be blocked altogether. Furthermore, without clear regulation, stakeholders cannot effectively plan or assess the risks associated with adopting AI-based monitoring tools.

Procurement, certification, and market structure

Quality assurance and fair competition depend on well-defined procurement systems and certification schemes. Without such mechanisms, only a small number of suppliers may dominate the market, creating monopoly-like conditions, higher costs, and reduced flexibility for fleets. If fleets adopt proprietary technologies too early, they may become more dependent on a single solution, making it hard and costly to switch later and limiting future adaptability and interoperability of monitoring tools.

Recommendations

- Define a clear strategy for private-sector involvement, specifying roles, responsibilities, and funding models with transparent conditions.
- Create procurement guidelines and certification schemes to guarantee system quality, interoperability, and fair competition among suppliers.
- Develop public-private partnerships to bridge the gap between research prototypes and market-ready solutions, including exploring software licensing through an independent research institute.

Alignment with regulations

There should be an alignment between AI-based catch registration and the EU regulatory framework. The necessary actions should be taken at an early stage to avoid developing a system that later on will need potential costly adaptations. Some flexibility in the new system will be required to allow for adaptation when EU regulations evolve.

Aligning AI-based catch registration with EU regulatory frameworks

For AI-based catch registration systems such as CatchWAM to function effectively, there must be an early alignment between the new system and the EU regulatory framework. This includes technical and legal integration with existing electronic logbook (e-logbook) systems, as well as compliance with the EU control regulation. It may also include modifications to the relevant EU regulations, taking into account such new systems and the data provided by these systems.

Early alignment helps prevent future incompatibilities that could undermine the system’s usefulness for legal reporting, quota control, and scientific monitoring. Engaging the European Commission and Member States during the design phase ensures that evolving regulatory expectations can be incorporated from the start, avoiding costly redesigns later.

Technical integration and interoperability

The interaction between AI-generated catch data and the existing e-logbook infrastructure needs to be defined clearly, including requirements for data formats, transmission protocols, and compatibility with future control frameworks. Without this clarity, fragmentation may arise across Member States or fleets, and fishers could be forced into double reporting – submitting both AI-based data and manual entries – significantly increasing administrative burden.

Early coordination and standardization

Engaging regulators, Member States, and technical experts during the design phase is crucial to anticipate future regulatory requirements and avoid developing systems that later need costly adaptation. At the same time, EU-wide standards for AI-based reporting formats must be established and followed to ensure interoperability of the FDF system across regions. If standardization lags, unequal adoption could emerge, creating competitive disadvantages and inconsistent data quality across fleets.

Regulatory coherence and legal recognition

AI-generated catch registration must be recognized as compliant under EU law, yet there is a risk that systems developed without early regulatory engagement may not meet future requirements set out in the framework of EU regulations or e-logbook specifications. Such a mismatch would undermine the system's legal standing and could delay or prevent its formal acceptance.

Pace of regulatory evolution

Technological developments in AI-based monitoring may advance faster than EU fisheries control frameworks. If EU control regulations evolve too slow, legally recognizing AI-derived data may be delayed, even when the technology is fully functional and ready for operational use.

Recommendations

- Establish structured dialogue between system developers, EU regulators, and Member States to align system design with current and future regulatory needs.
- Map the technical requirements for integration with existing e-logbook systems and anticipated updates under a potential Registration Obligation.
- Promote and follow harmonized EU-level standards for AI-based data formats and reporting protocols.
- Ensure system flexibility so that AI-based tools can be updated as EU regulations evolve.

Clarification of the legal status of AI-generated data

The legal status of AI-generated data in fisheries management, enforcement and control requires clarification. As AI-based monitoring tools become more integrated into fisheries management, unresolved legal questions risk undermining their operational and legal value (e.g. what level of certainty is necessary for AI generated data to be used in legal sense?). Establishing clarity early is essential to ensure that AI-generated observations can be used reliably, fairly, and consistently across jurisdictions.

Legal recognition and status as evidence of AI-based data

A central issue is whether AI-generated or AI-processed data will be granted the same legal status as human-reported information. Clear rules are needed to determine how such data may be used in enforcement decisions, quota allocations, and evaluations of compliance. Without explicit recognition, AI outputs may not be admissible or may carry uncertain evidentiary weight, limiting the usefulness of these systems in practice.

Data integrity, verification, and accreditation

To ensure that AI-generated data are verifiable for data integrity, chain of custody, and audit trails, standards must be established. These standards will help ensure that AI outputs can be trusted and independently validated. Alongside these requirements, formal accreditation processes are needed to confirm that AI systems meet agreed accuracy and reliability thresholds. Without such safeguards, errors or inconsistencies in AI detection could lead to unjust decisions, raising questions about liability and accountability.

Next to the integrity of AI-generated data, the integrity of the entire process of recording of discards is of interest. In the procedure several mechanisms of checks and balances should be included to ensure that regulators, fishers and authorities can place full confidence in the data produced. Moments where checks and balances should be built in the system to make sure that the data coincide with the actual catch composition are:

- before detection: verify that all unwanted/discarded catch passes the CatchWAM system to allow complete registration of the discarded catch.
- during detection: to make sure that the algorithm correctly detects, identifies and records (unwanted/discarded) catch within predefined error margins.
- after detection: to make sure that the produced catch recordings are correctly transmitted to the e-logbook.

To ensure data reliability and transparency, it is crucial to establish verification protocols, cross checks and explore whether the quality of AI-generated data is acceptable.

Rights of operators and procedural fairness

Fishers and operators must have clear rights to challenge AI-generated evidence used in enforcement or quota decisions. If misclassifications or technical errors occur, the legal framework should outline how disputes are addressed and who bears responsibility for mistakes. Without these protections, reliance on AI-generated data may erode trust and raise concerns about fairness in regulatory processes.

Consistency of legal status across jurisdictions

For shared fish stocks and fisheries that are conducted in more than one Member State, consistent recognition of AI-based data across Member States is essential. Ideally, the recognition by the relevant third parties, such as the United Kingdom and Norway, is needed. Fragmented legal treatment would complicate quota management, create uneven enforcement practices, and undermine the efficiency gains intended by AI-based registration systems. Inconsistencies could also increase administrative burdens if authorities require separate or parallel reporting procedures.

Administrative efficiency and practical implementation

Integrating AI-generated evidence into existing administrative processes must be done carefully to avoid increasing burdens on fishers or authorities. If procedures are not streamlined, the introduction of AI could inadvertently add complexity rather than reduce reporting effort.

Recommendations

- Develop a legal framework that clearly defines the admissibility and evidentiary weight of AI-generated data.
- Introduce standardized certification protocols for AI-based catch recording systems, supported by independent audits.
- Assign clear responsibility for errors or disputes arising from AI-generated data.
- Harmonize recognition of AI-generated data across relevant jurisdictions to ensure coherent quota management and enforcement.
- Integrate AI evidence via streamlined, automated workflows that reduce burdens for fishers and authorities.

Framework for data storage

The automated recording of discards at sea requires not only the collection of accurate and reliable data but also the development of a robust framework for data storage and governance. Without such a framework, trust in the system will be undermined, limiting acceptance and adoption among fishers, authorities, and other stakeholders.

In its current form, the system will produce data that follows the same transfer line as marketable catch data through the e-logbook systems. This section discusses some topics related to a framework for data storage.

Data ownership

A fundamental question is who legally owns the data generated by an automatic registration system. Is it the fisher, the national authority, the producer (algorithm owner), or the collective fishery sector? Clear rules on ownership are essential, as they directly influence how data can be used, shared, or repurposed. Lack of clarity risks creating distrust and resistance to adoption.

Access rights

Closely linked to ownership are questions of access. Which actors, fishers, regulators, scientific institutes, or policymakers, are allowed to access raw or processed data? If the data is used the same as current landings data derived from e-logbooks, the same access should be given. Policies must balance transparency with the protection of individual and commercial interests. General Data Protection Regulation (GDPR) should be consulted.

Recommendations

Developing a transparent and phased data governance framework will be critical. Policies must provide clarity on ownership, access, and use, while balancing privacy with accountability. A clear cost-sharing model and harmonised technical standards will be necessary to ensure that data storage becomes a facilitator rather than a barrier in the transition toward fully documented fisheries.

Annex 2 Summary of fishers' perceptions based on interviews

For the FDF project (see chapter 2 of the main report), five semi-structured interviews, and an additional focus group discussion with four more fishers, were used to gather the opinions and experiences of active fishermen regarding automated catch recording. The interviews and focus group discussions were conducted in the European Optifish project[14]; fishers gave their permission to use the results for the present roadmap.

The participants included both fishers with and without onboard experience of electronic and/or automatic catch registration. Fishers using different fishing gear were interviewed.

The interviews provided insights into the experiences and opinions of fishers, resulting in a better understanding of the potential concerns, advantages, disadvantages, risks and conditions for the implementation of these technologies. The findings presented here are based solely on the interview and focus group data. No further interpretation or validation was carried out on the basis of literature, although several of these themes have also been identified in previous studies.

The interviews were recorded, and transcribed, followed by data analysis thereafter. The information from the interviews is anonymous and cannot be traced back to individuals or companies.

Theme: Trust in AI-catch recording systems

Trust issues emerge in the majority of interviews, not only connected to AI systems. In general, interviewees stress that the (relationships of) trust have worsened over the years, especially between policy and the industry. Originating from family businesses, fishers emphasize, that it is an emotional challenge when having to sell their businesses in decommissioning rounds for instance. Furthermore, they feel that over the years, every time more and more is asked from them and no matter what actions are undertaken, fishers often feel negativity and high (public) pressure resting upon them. One interviewee stated that their mental well-being is being affected.

Trust concerns are serious concerning camera installations on board. Fishers fear that the data will mainly be used against them, for stricter quota management, increased control, further area closures, etc. There is a deep mistrust in the governments and NGOs, as well as a feeling that the data they provide will be used against them. Other aspects they consider to be risks: they stress that they already report honestly, and fear that data could be misinterpreted later, leaving them to defend themselves against technical errors, consequences if gear is malfunctioning (e.g. no internet or broken/ dirty/ wet camera (can they still go out fishing?). Privacy issues are also a major concern among interviewed fishers, especially regarding the access to data by other fishers and other stakeholders.

Interviewed fishers feel that cameras are installed because authorities do not trust them. They are not convinced that the data could improve stock estimates and assessments, which have not always been accurate. The fishers responded sceptically, saying that even if everything worked, the data would still be used against them, as has happened repeatedly in the past.

Fishers compared the trust in AI system and the usage of its data with the AIS system. Strong concerns were raised about AIS in relation to privacy and data access. They stated that in practice "everyone can see everything" and fishers often know if a colleague fisher had good catches before even arriving in the

[14] Optifish: https://optifish.eu/

harbours. Fishers continuously monitor each other and can infer where someone has been fishing and how successful they were. AIS started as a voluntary safety instrument (in particular for fishing in busy shipping lanes), but has gradually become mandatory. If fishers switch it off now, they receive a fine. According to the fishers, AIS access should be limited to the authorities responsible for safety and enforcement (e.g. coastguard, police) and to the fisher themselves, not to the entire public. Same would need to be applied to CatchWAM data. They stated that the current AIS situation leads to constant surveillance and strategic behaviour between fishers, as repeated back-and-forth fishing movements on AIS often signals that a colleague fisher has good catches in a particular area

Theme: Incentives for participation

Interviews demonstrated that thus far, fishers participating in the FDF project implemented the system due to receiving an exemption from the landing obligation. For some fishers, this was the only advantage and motivation to install the systems. Regarding the workload, an interviewed fishermen said they need to wipe the cameras after each haul because of saltwater, rain, and splashes from the hold. Despite this extra task, the crew does not complain about it. And, every ship participating in the project is compensated.

Fishers suggested that, with camera-based monitoring, several current regulatory instruments could become unnecessary. They argued that RTCs and even the landing obligation could be reconsidered. In their view, mesh size requirements could also be relaxed, because compliance could be verified directly via video. For example, if a maximum of 20% undersized fish is allowed and video data shows that a vessel is above that threshold (e.g. 25–30%), this could be detected and addressed in a targeted way. They stressed that onboard cameras should not create additional disadvantages for fishers, and that regulatory design should allow them to operate their business without excessive legal or administrative burden.

Fishers indicated that participation should ideally include as many fishers as possible, across different fishing métiers. To make the data scientifically useful, representation across different fleet segments is needed. Not every vessel has to participate, but a minimum percentage per segment is required to ensure sufficient data coverage and representativeness. They also argued that participating fishers should receive clear benefits compared to non-participants (e.g. access to additional fishing areas). According to interviewees, experience shows that non-participating fishers are often convinced over time once the benefits become visible. One fisher explains that past experiences, including his father's, showed that any information they shared was always used against them. Even when areas are reopened, new ones are closed.

An interviewed fisherman expressed a sense of exhaustion, asking, "When will it finally stop?" Another interviewee added that this is exactly what fishermen long for: less new rules and demands, so they can simply focus on doing their work again. A third speaker explains that it feels like there is always something new being introduced, one measure after another. The interviewer gives them a chance to vent their frustrations. The fishermen says they keep losing fishing grounds, and at the same time, the pressure on them continues to increase.

Theme: Willingness to use the system

One interviewee only participates because having cameras onboard exempts his vessel from the landing obligation for plaice, which he considers otherwise unworkable. Also other fishers' willingness to install camera's systems on board was influenced highly by receiving an exemption for plaice. Hence, fishers participating in the project do not have to land undersized plaice. This is the reason interviewees were convinced to participate in the project in order to maintain this exceptional position.

Another fisher shared, that the willingness to participate also depends on the target species. If with the camera systems they would observe discards of large amounts of fish, they could decide the go wider with the mesh size. However, fishers targeting sole have to have a narrow mesh size to catch sole, therefore resulting in less flexibility. Their willingness could be lower due to discard data. The fisherman explain that they use 95 mm nets year-round because it is required in English waters, whereas they normally fish with 80 mm nets. Over the summer, they have been using wider nets and noticed they need to process about half as much bycatch. Since they fish with four nets, they cannot swap every time they enter Dutch waters, so they leave them as is and evaluate at the end of the season. Compared to last year, their overall catch has not shown a decrease, sometimes a slight increase due to the nets staying cleaner and fish being less damaged.

Landing undersized fish would require extra crew, space, and costs, making it impossible in practice. Fishers therefore see cameras mainly as a necessary compliance tool, not as something that benefits the business directly. An interviewed fisher stressed that the system provides no advantages in terms of market (access or higher product prices) or sustainability. In his view, cameras simply add to already heavy monitoring and regulatory pressure. Acceptance and willingness of cameras would only be possible under certain conditions: a) Compensation: costs of equipment and maintenance must be covered by the one making it mandatory; b) current hardware & AI need significant improvement (cameras, data transfer, identifying catch composition); c) clear benefits for fishers necessary, such as more quota, access to more fishing grounds, less control, and most importantly: exemption from the LO.

Fishers also referred to whiting and the application of RTC (Real Time Closure) measures. They explained that area closures are often triggered by a single haul being checked for instance for high whiting bycatch. If this is the case, areas are often shortly afterwards closed. Yet, the next haul at the same location may contain no or little volumes of whiting. According to the fishers, onboard camera systems could replace such instantaneous inspections and provide a more accurate basis for decisions. They argued that, depending on the fishing métier, current area closures sometimes cause disproportionate operational and economic constraints, because not all species (e.g. squid or lobster) can be fished everywhere. Furthermore, in other interviews, it was emphasized that fishers are the ‘’eyes at sea’’ being at sea continuously with which they observe species dynamics and abundance shifts. An interviewed fisherman emphasized that he wants to keep fishing, ideally in the areas now closed to them, because he sees little value in the closures. He notes that these areas are rarely monitored, perhaps once a year for a survey which does not reflect the reality of year-round fishing. He sees advantages in that camera monitoring could provide additional data to show actual conditions. If authorities view the situation as problematic, the cameras would make that clear, rather than relying on limited, occasional surveys. Fishers state that science also often lags some years behind whereas they observe real-time species dynamics. Some fishers state that they would like the up-to-date data of fishers to be systematically incorporated and used. Camera’s on board creating real-time data could maybe have an influence on fishers willingness to accept the system on board.

Another fisherman argues that the implementation of on-board camera monitoring systems would provide empirical, real-time data necessary for evidence-based fisheries management. He criticizes current spatial closures as being derived from historical or instant snapshots rather than contemporary ecological observations. According to him, marine ecosystems, such as the North Sea, are dynamic and subject to natural temporal variability, making it inappropriate to base management decisions on presumed historical baselines. The fisherman contends that transparent camera data collection has the ability to lead to fairer and more accurate assessments of fishing activity and ecosystem conditions, thereby improving the legitimacy and effectiveness of management measures.

Fishers indicated that they would like to receive feedback on their own data, structured by species. Such information would allow them to see, for example, how much plaice was caught in a particular haul, and how this compares to the volumes that were actually landed. They noted that discard levels are particularly relevant, because they can signal cohort dynamics: when many small plaice are observed, this may indicate that a stronger cohort is developing, which could translate into higher landings of larger plaice later on. According to them, the added value of camera systems lies precisely in this species-specific measurement of what is discarded. Ideally, they would like to receive that information in the form of a clear species list.

Theme: Ability to install and use the system

Practical issues include poor internet connectivity at sea (making real-time transfer unrealistic), costs of equipment like Starlink, and the extra workload of managing hard drives. Regulations are only added, and not removed.

Interviewed fishers react sceptically to the claim that onboard cameras could reduce administrative burdens by recording everything in real time. A fisher explains that these kinds of promises are always used to persuade fishermen, but in his experience, those burdens never actually disappear. He feels that the incentives offered to justify new monitoring systems are misleading, and that the promised reductions in paperwork or obligations never materialize. Fishers questions what "real-time" monitoring is supposed to mean in practice. One fisherman explains that his vessel's internet connection is unreliable. Because of that, real-time data transmission at sea is simply not feasible. Instead of reducing administrative work, he worries it will actually create new obligations when the system fails to upload data. In the interview, it got clarified that real-time transmission is indeed not yet possible, so all footage is stored onboard for later analysis onshore. The interviewed fisherman then added that this means he also has to physically exchange hard drives: one must be taken back to land while a new one is inserted which is adding to his workload. Transitioning to Starlink is a substantial financial investment.

Another fisher suggests a phased, non-enforced introduction of cameras on board, managed by a central European body, fully responsible for installation and maintenance. Furthermore, he has a strong opinion about what is needed if cameras on board would become mandatory: full financial coverage for equipment, maintenance, and failures should be provided and flexibility needs to be maintained for mixed fisheries vessels.

Theme: Data access rights

Access to the data is a sensitive matter. Depending on who receives access, risks arise relating to trust and to fishers' willingness to cooperate. It is frequently emphasized that access should be restricted to two parties: fishers and research institutes, ideally several different research institutes. Several research institutes for independency reasons. Interviewed fishers generally considered it acceptable for research institutes to have access. In addition, they demanded that they themselves should have access to their own data. At the same time, they stressed repeatedly that they do not want other fishers to access their data, because fishers have their own fishing grounds and fishing strategies.

Furthermore, authorities need access as well for management and quota adjustments. Due to quota reduction and subsequent adjustments in the past, worries continue to persist. At the same time, fisher interviewees noted that quota-setting can lag behind with what is actually happening at sea. As an example, they explained that in recent years turbot abundance visibly increased. However, quotas were reduced, because the historical catch data from a few years earlier had been lower. According to the fishers, auction supply figures currently show that turbot is abundant again, but quota adjustments will still take another one to two years to catch up. Reductions are as a result being made when there is actually plenty of this target species. In their point of view, the system reacts too slowly. They argued that if near-real-time camera data were available, by following a number of fisher vessels all year round, scientific advice could be updated far more frequently and quota decisions could follow the current situation much more accurately. Also another interviewed fisher supports researchers using the data if it contributes to quota estimates or stock assessments.

A major perceived risk is that access becomes too broad, for instance if NGOs would gain access. Within the sector there is a strong sense of mistrust that data would be misinterpreted in such a case. With respect to bycatch, fishers argued that bycatch volumes are highly area-specific, for example the German Bight versus the central North Sea. Fishers fear that, if access is not properly restricted, bycatch data could be misinterpreted without the essential contextual knowledge of spatial catch composition dynamics.

Theme: System failure and responsibilities

A fishermen participating in the project shared to not have had any complaints for a year, indicating that things are working well with the camera's on board. Occasionally, a sensor on the conveyor belt located outside fails to record the exact operating time. In those cases, the camera still captures the fish passing by, and the fishers manually adds the missing time to ensure accurate records.

During another interview, other fishers expressed their worries towards failing systems which results in resistance to mandatory electronic catch registration. In their view, these systems inevitably fail at some point and when they do, fishers can suddenly no longer comply with the rules and risk being unable to go to sea. One fisher shared a recent example: his tracking system broke down just in the beginning of the new year. He had to deal with a lot of administrative burdens and exchange with the NVWA during the weekend. On the one hand, he was told that a permission to sail without a functioning system could be granted by email. However, on the other hand he was refused that permission. This led to repeated emails, escalation, and unnecessary stress. For this fisher, this illustrates a broader concern: mandatory electronic systems make normal business continuity fragile while fishers must keep their family businesses operating. Fishers foresee that regulations will only be added, and not removed.

In another quote, a fisherman expresses his worries about having camera systems on board that are supposed to automatically identify fish. He points out that the computer is still being trained and can make mistakes. He fears that when the camera misinterprets something, he will be held responsible. Weeks later, an inspector may show up to his vessel based on the footage which he barely remembers anymore. This leaves him wondering: *who will be believed, the computer or the fisherman? And how do you tackle an accusation made by a machine that might be false?*

Theme: Perceived fairness - avoid penalising fishers for uncontrollable catch variability

Fishers gave the example of seabass. One winter they encountered exceptionally high sea bass abundance, while the previous year catches had been negligible. However, because quota decisions were based on those earlier low catch levels, a landing ban (zero quota) remained in place. According to the fishers, this meant considerable economic loss of fish that demonstrably existed but could not be landed. In their view, near-real-time camera data could have shown that seabass was actually present for that season. They stressed that this would not imply unlimited landing, but that even a cautious, small, adaptive quota (e.g. 10–20% of catches) would have been far better than a complete zero.

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