Proceedings from a conference on Remote Electronic Monitoring in fisheries, held in Reykjavík 7 Nov. 2019

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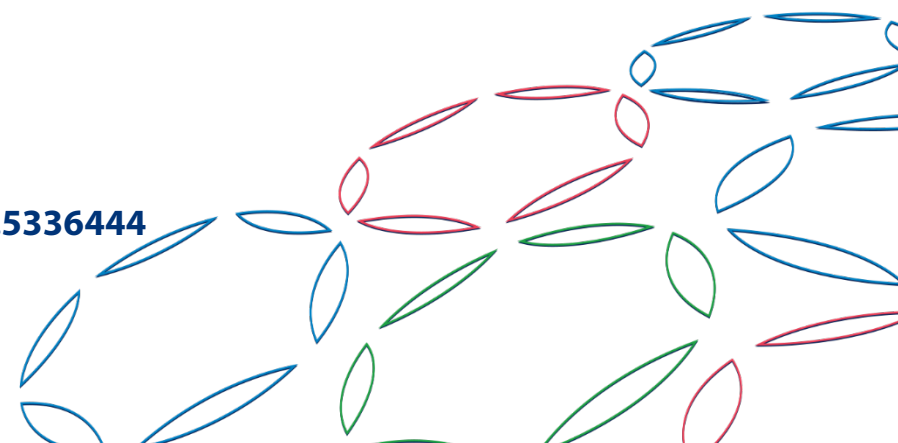

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Icelandic Food and Biotech R&D

Report summary

ISSN: 1670-7192

Title	**Proceedings from a conference on Remote Electronic Monitoring in fisheries, held in Reykjavík 7 Nov. 2019**		
Authors	Jónas R. Viðarsson[1], Clara Ulrich[2], Helen Holah[3], Kristian Schreiber Plet-Hansen[4], Leifur Magnússon[5], Luis Alberto Cocas González[6], Thord Monsen[7], Wes Erikson[8].		
Report no.	11-21	*Publication date:*	August 2021
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Summary:	Monitoring, control and surveillance (MCS) are challenging in wild capture fisheries and insufficient MCS has resulted in unsustainable fishing practices, data limitations in stock assessment and management, lack of transparency and unfair competitive advantage for those not following the rules. Major expenses and efforts are awarded to MCS, but effectiveness and coverage is generally very limited. There are however a number of emerging and already available technological solutions that can be applied to significantly improve MCS and reduce costs at the same time. These solutions are generally referred to as Electronic Monitoring (EM) or Remote Electronic Monitoring (REM) solutions. The Nordic countries are generally considered to have well-regulated fisheries and relatively good MCS. The authorities in these countries do however also understand that they need to keep up with new technology and use them when applicable to improve their fisheries. Denmark, Norway and Iceland have for example been awarding increasing attention to REM in recent years. As part of that work, the Nordic Council's Working Group for Fisheries (AG-Fisk) funded a networking project in 2019 that was to facilitate a conference on REM, where experts in the field would present information on current state and emerging solutions for Fully Documented Fisheries (FDF). The conference was held in November 2019 in Reykjavík and the proceedings along with short summary are presented in this report. The report also contains concluding remarks in the end where the most important issues are summarised, and comments made on developments that have taken place from the time of the conference until the publication of this report. It is evident that EM will not solve all problems when it comes to MCS of fisheries, but such solutions can be important tools to facilitate more efficient MCS and even reduce cost and/or increase coverage. The Nordic countries have not been in the forefront of implementing REM technologies (possibly with the exception of Denmark) where countries such as Canada, US, New Zealand, Australia and Chile have paved the way. The Nordic countries are therefore in the position to learn from those that have gone before them, use what has proven to be successful and avoid making the mistakes they did. Several relevant pilot trials and research projects are currently ongoing in the Nordic countries and on European level. There are also ongoing similar initiatives elsewhere in the world and full implementation of some elements of REM are also taking place. It is important for the Nordic regions to follow and take part in these initiatives, as the authors of this report believe that REM solutions can be extremely effective tools for MCS in the future.		
Keywords:	*Fisheries, Monitoring, Control, Surveillance, Remote Electronic Monitoring, Fisheries management, CCTV*		

[1]Matís, Iceland. [2]IFREMER, France. [3]Marine Scotland. [4]DTU, Denmark. [5]Directorate of Fisheries, Iceland. [6]Government of Chile. [7]Directorate of Fisheries, Norway. [8]Fourth Generation Fishing Co. LTD, Canada

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1 Introduction

Monitoring, control and surveillance (MCS) are challenging in wild capture fisheries and insufficient MCS has resulted in unsustainable fishing practices, data limitations in stock assessment and management, lack of transparency and unfair competitive advantage for those not following the rules. Major expenses and efforts are awarded to MCS, but effectiveness and coverage is generally very limited. There are however a number of emerging and already available technological solutions that can be applied to significantly improve MCS and reduce costs at the same time. These solutions are generally referred to as Electronic Monitoring (EM) or Remote Electronic Monitoring (REM) solutions and can consist for example of satellite detection, Vessel Monitoring Systems (VMS), Automatic Identification Systems (AIS), video monitoring (CCTV) and computer vision, electronic logbooks and more. A number of countries or individual fisheries have been experimenting with these solutions and there are even few that have already implemented some elements, aiming for a Fully Documented fishery (FDF).

The use of patrol vessels and aircrafts (airplanes, helicopters) for the MCS of fishing activities have been the most widely used methods in modern fisheries [1]. There are a number of advantages and disadvantages associated with both methods [2] but the main problem is the very limited coverage and high cost. In the UK for example, aerial surveillance only monitored 0.026% of fishing effort (hours at sea) in 2013, and patrol vessel surveillance 0.05% of fishing effort [3]. With such a small level of coverage, this tool may only provide a short-term deterrent as there is no assurance that fishers will continue to comply when the aircrafts or patrol vessels leave the area. This low coverage comes at a high cost, as It was for example estimated in 2011 that the Norwegian government spent £86 million a year for the coastguard, which used 70% of their time for MCS of fisheries [4]. Despite this, patrol vessel surveillance remains at the heart of the control activity deployed by all of the Nordic countries and EU Member States, together with the European Fisheries Control Agency (EFCA).

Other MCS tools used widely in Nordic and EU fisheries include VMS, electronic logbooks (coupled with landing/harbour official weighing documentation), onboard inspectors and observers. But these all have limitations in regard to coverage, cost and particularly ability to identify and quantify illegal, unregulated and unreported (IUU) catches and discarding.

This lack of MCS presents a major problem for global fisheries, as it is estimated that IUU fisheries represent anywhere between 10% - 30% of global catches [5] and that discarding represents an additional 10.8% [6]. IUU fisheries are most severe in areas with limited or no MCS, such as in the high-seas (ABNJ – Areas Beyond National Jurisdictions) and within the waters of countries that do not have sufficient infrastructure to conduct necessary MCS. FAO and EU have though been tackling IUU fisheries strongly in the last decade with emphasis on port state measures, traceability and monitoring of transhipments and “ports of convenience”. Discarding on the other hand remains a problem also within industrial fisheries in the “western world”. It was for example estimated by the EU that member state vessels discarded 23% of their catches prior to the implementation of the landing obligation [7] and a recent FAO report shows estimations of average discard rates in the northeast Atlantic (FAO area 27) of 16.2% [8]. That same FAO report highlight that discard statistics for Norway and Iceland are

almost non-existent as these countries operate within a discard ban, and that the uncertainty generated by this group of countries might not be well captured in the study. The EU is now dealing with similar problems when it comes to MCS of discards, as the implementation of the landing obligation has made it illegal to discard catches, but evidences show that the unwanted catches are still not being landed. This causes challenges for stock assessment as data on total catches are unreliable.

New and emerging REM technologies for MCS are gaining interests around the world as authorities, fish business operators and NGOs see them as an opportunity to increase coverage and save costs, and ultimately provide FDF, which will benefit everyone. Countries that are in the forefront of this development are New Zealand, Chile, Canada, Denmark and more. NGOs that have been lobbying for uptake of these solutions include for example the Nature conservancy and the Environmental Defence Fund.

The Nordic countries are considered to have well-regulated fisheries and relatively good MCS. The authorities in these countries do however also understand that they need to keep up with new technology and use them when applicable to improve their fisheries. Denmark, Norway and Iceland have for example been awarding increasing attention to REM in recent years. As part of this work the Nordic Council's Working Group for Fisheries (AG-Fisk) funded a networking project in 2019 that was to facilitate a conference on REM, where experts in the field would present information on current state and emerging solutions for FDF. The conference was held in November 2019 and the proceedings along with a short summary are presented in this report. The report also contains concluding remarks in the end where the most important issues are summarised, and comments made on developments that have taken place from the time of the conference until the publication of this report.

The conference was held in Harpa conference centre www.harpa.is in Reykjavík and was a part of the Icelandic seafood conference www.sjavarutvegsradstefnan.is which is an annual event where 7-800 fisheries stakeholder attend for networking and to learn about the latest developments in the seafood industry. The Icelandic seafood conference is broken into sessions that are run in plenary, and the REM session received considerable attention, with well over 100 attendees sitting in on the entire agenda, and many more dropping in to listen to specific presentations. The session also received considerable attention in the Icelandic media, as several newspaper articles were published based on the material presented at the conference [9].


The conference was well attended and got considerable attention from stakeholders, authorities and the media

The organising committee for the conference, which was responsible for overall planning consisted of the following persons:

- Jónas R. Viðarsson – Matís Iceland (chair)
- Áslaug Eir Hólmgeirsdóttir – Icelandic Directorate of Fisheries
- Ásta Guðmundsdóttir – Icelandic Marine & Freshwater Research Institute
- Kristian Schreiber Plet-Hansen – DTU Aqua, Denmark
- Leifur Magnússon – Icelandic Directorate of Fisheries
- Mogens Schou – Aquamind, Denmark
- Thord Monsen – Norwegian Directorate of Fisheries

2 Global overview of electronic monitoring in fisheries

Jonas R. Viðarsson: Matís, Iceland

Jonas R. Viðarsson from Matís in Iceland was the project leader and chair of the organising committee. He opened the conference by providing a global overview of electronic monitoring in fisheries. He started by explaining the challenges that MCS are intended to solve and the most common MCS tools. He particularly highlighted the fact that inefficient MCS can lead to a flawed stock assessment and subsequent overfishing, as well as undermining fisheries management efforts if there is not full catch accountability. Jonas argued that discarding and IUU are probably the biggest challenges in global fisheries, with IUU fisheries representing up to 30% of global catches [10] and discarding additional 10% [11]. He also pointed out that this is not only a problem that concerns ABNJ and less-developed countries, as it is estimated that 500 thousand tonnes of IUU fish enters the EU market annually [12], and that discarding represented as much as 23% of the EU fleets catches prior to the implementation of the landing obligation [13]. The main challenge now for MCS in EU fisheries is in fact discarding, as it has become illegal to discard catches and fishermen are therefore obligated to land catches of little or no value, there is subsequently very limited data for estimating discards in EU fisheries. The same problem exists in for example Norwegian and Icelandic fisheries, where few or no data on discards exist. This is for example highlighted in the FAO assessment report of global marine fisheries discards from 2019 [14], where the authors were unable to estimate discards in fisheries that account for 45% of global landings due to insufficient data, and both Norway and Iceland fell within that category.

Jonas then gave an overview of Electronic Monitoring (EM) initiatives, which are generally considered to have started first in British Columbia in 2001. After a slow start, the number of pilots and programs have increased significantly and in a comprehensive study on the subject, presented in a paper published in 2019, a total of 100 pilots or trials were identified and 12 fully implemented programs [15]. These combined included over 1,200* vessels worldwide, with overwhelming majority in USA and Canada. The priority objectives with the EM can largely be broken into three i.e. effort monitoring, catch monitoring and monitoring protected species. In the EU it is effort and catch monitoring that is prioritized, whilst protected species are highest on the list in New Zealand.

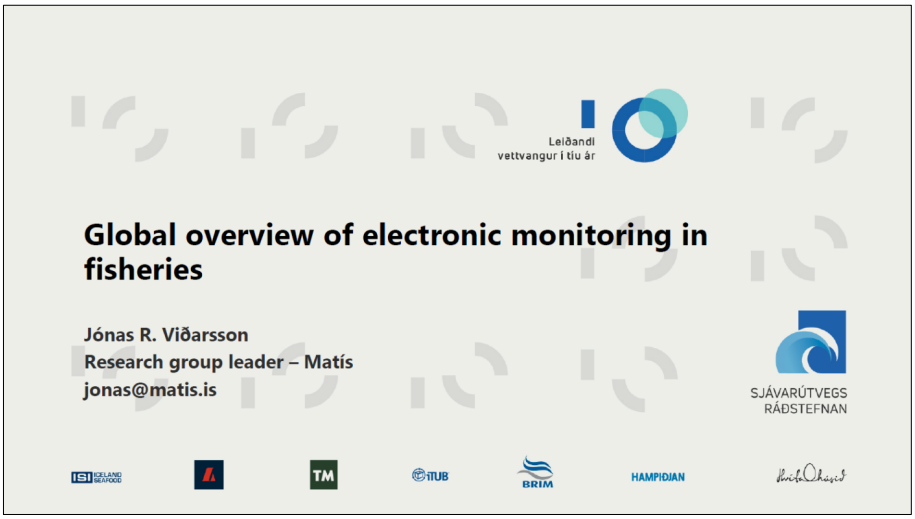
Jonas then gave examples of the effects of EM on reported landings, discards and number of species landed. An Australian study published in 2018 showed that reported discards increased by 108% when EM had been implemented and that the number of landed species increased by 33%, which suggests that these catches had been discarded without being registered before.

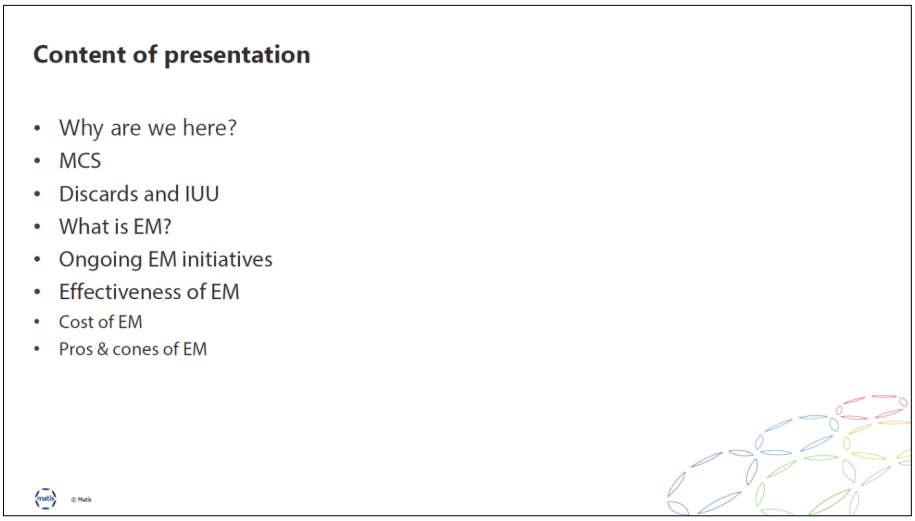
The cost of implementing EM was then discussed and put into comparison with 100% at sea observer coverage in four fisheries in Canada, which showed that the EM was 37-247% less expensive than the human observers [16]. As EM also provides a repellence effect (e.g. the presence of camera surveillance has an effect on behaviour of fishermen, even if the footage is not watched), the cost of partial coverage was also presented, from a study made on the New England Groundfish fishery. It

* Total of 1,492 according to Van Helmond et. al (2019)

showed that the cost of implementing EM with 20% review rate is 90% more expensive than similar coverage of on-board observers, but if compared with 100% onboard observer coverage the human observer becomes almost 200% more expensive than the EM. Information from EM initiatives in Canada, New Zealand, Marshall Islands, US and Denmark are relatively in agreement that initial investment in EM is about 10,000 EUR/vessel and that annual running cost is around 5,000 EUR/vessel.

IN conclusion Jonas emphasised that EM has pros and cons, and that this is a field that is in development. The current information does though suggest that EM can play a big role in improving MCS and at the same time reduce the associated cost.





Why are we here?

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Nordic Co-operation

AG-fisk (Nordic counsel of ministers working group for fisheries)

Why are we here?

Efficient fisheries management depends, among other things, on:

- Reliable data on catches and effort
- Transparency
- Respect for the management measures

- **Failure to do so can result in flawed stock assessment and subsequent overfishing.**
- **Full catch accountability, or lack thereof, affects "level playing field" among fishermen.**

- **Monitoring, Control and Surveillance (MCS) is therefore a necessary evil to facilitate efficient fisheries management.**

Monitoring, control and surveillance (MCS)

MCS is to monitor e.g.:

- Catches (catch composition and size distribution)
- Discards
- Effort
- Gear
- Geographic area

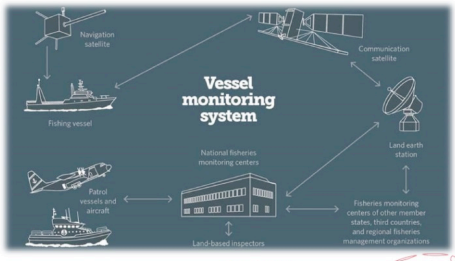


Figure: pew

Most common MCS tools in use:

- Onboard inspectors / observers
- Areal & patrol vessel surveillance
- VMS / satellite surveillance
- Self-sampling and logbooks
- Dockside monitoring
- Electronic monitoring / camera surveillance

Discards and IUU landings

Probably the biggest challenge in global fisheries are discards and IUU fisheries

- Illegal, ***unreported*** and unregulated catches estimated to be as much as 26 million tones globally (that is 30% of total catches)
- 500.000 tones of IUU fish believed to be entering EU markets
- Global discards estimated at 9,1 million tones (10,8% of total catches)
- EU discard rates prior to the implementation of the landing obligation as much as 1.7 million tons (23%)

- High level of uncertainty is unavoidable when estimating global discards.
- What is reliable data?
- FAO mentions in its report that 45% of global landings are from fisheries with few or no data on discards - "*No estimation at a fisheries level was therefore made for fisheries in these specific countries*"
- These include Iceland and Norway, as they have few data on discards.
- EU will probably be in the same category post-Landing Obligation

Discards and IUU landings

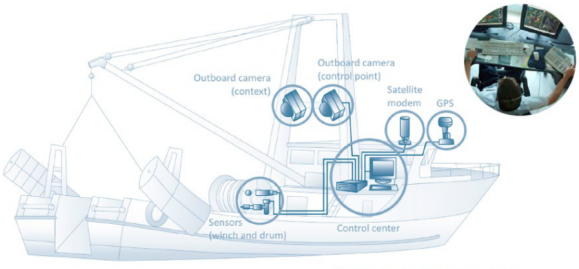
- **Unreported catches are suspected to be a problem in many Nordic and European fisheries.**
- **Level of discards in Nordic and European fisheries relatively uncertain.**

Implementation of the CFP Landing Obligation is highlighting the challenge

- When discarding was legal/obligatory the reported average discard rates were 23%
- After the implementation of the Landing Obligation there are very little unwanted catches being landed
- Landing obligation states that catches below MCRS (Minimum Conservation Reference Size) are to be landed but cannot be used for human consumption. The results are that almost no MCRS catches are being landed.
- Current MCS tools seem to be ineffective to prevent or even identify discards

What is (Remote) Electronic Monitoring?

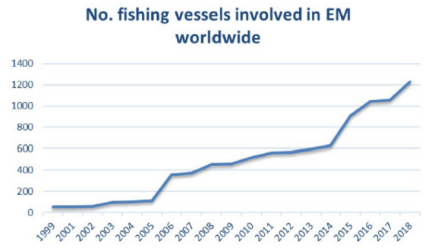
Generally speaking, electronic monitoring includes integrated on-board systems of cameras, gear sensors, video storage, and Global Positioning System (GPS) units, which capture comprehensive video of fishing activity with associated sensor and positional information.



Source: Mark Michelin et al. 2019

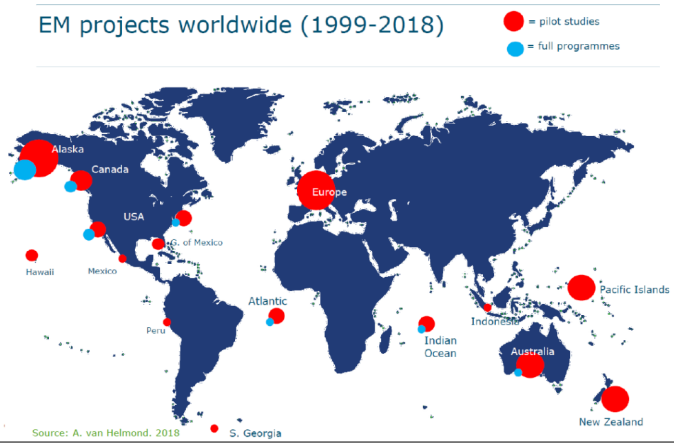
Electronic Monitoring and Camera surveillance

- 20 years since first trials of EM in fisheries (British Columbia)
- Over 1,200 systems installed today worldwide in a combination of pilots and full-fledged programs



Source: A. van Helmond. 2018

Electronic Monitoring and Camera surveillance



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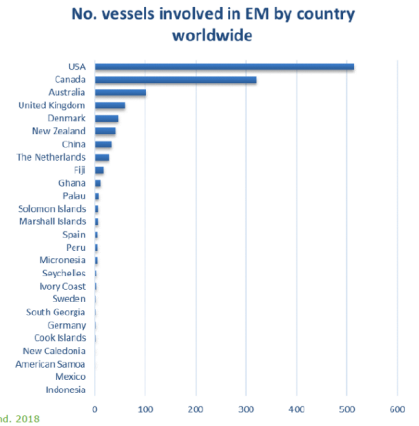
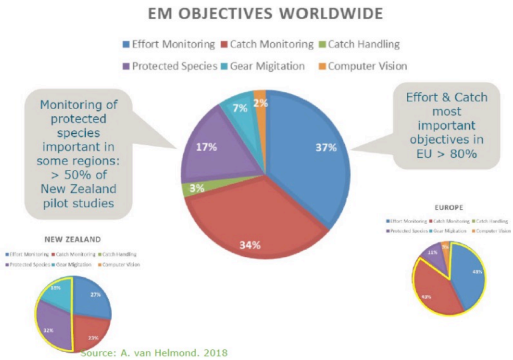
Electronic Monitoring and Camera surveillance

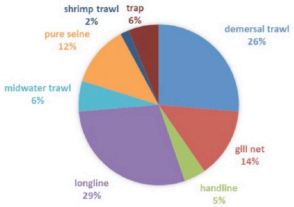


Source: A. van Helmond. 2018

Electronic Monitoring and Camera surveillance

Effort and catch monitoring are the main objectives overall





Source: A. van Helmond. 2018

Electronic Monitoring and Camera surveillance

Wide range of different fisheries

Source: A. van Helmond. 2018

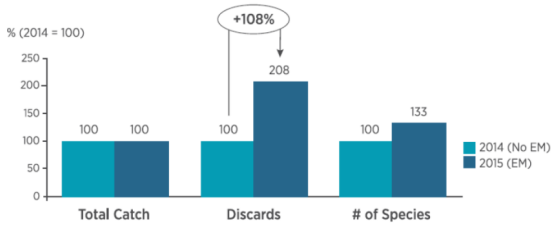
Electronic Monitoring and Camera surveillance

Wide range of different objectives

Source: A. van Helmond. 2018

Electronic Monitoring and Camera surveillance

Example from Australia: Comparison of reported landings, discards, and number of different species caught pre- and post-EM in Australia

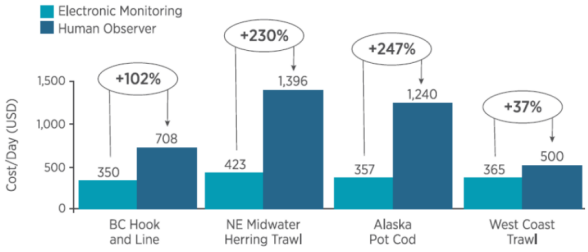


Source: Mark Michelin et al. 2019

Electronic Monitoring and Camera surveillance

What does it cost?

Cost of monitoring with EM versus 100 percent at-sea observers

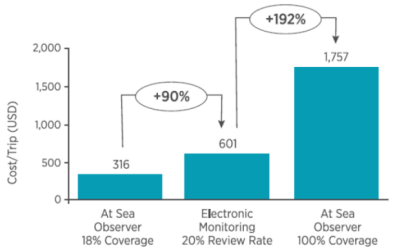


Source: Mark Michelin et al. 2019

Electronic Monitoring and Camera surveillance

What does it cost?

Cost of monitoring in the New England Groundfish fishery with at-sea observers and electronic monitoring.



Source: Mark Michelin et al. 2019

Electronic Monitoring and Camera surveillance

What does it cost?

Examples from the New England groundfish fishery, New Zealand mixed fisheries, Marshall Islands tuna longline fishery, US west coast groundfish fishery and Danish bottom trawl fishery suggest that initial investment is about 10.000 EUR on average per vessel and that annual running cost is around 5.000 EUR

	Average cost pr. Vessel	
Equipment + installation	8.000 EUR	1.104.000 ISK
Common cost + training	2.000 EUR	276.000 ISK
Running cost - video audit	2.000 EUR	276.000 ISK
IT support	2.000 EUR	276.000 ISK
Other	1.000 EUR	138.000 ISK
	15.000 EUR	**2.070.000 ISK**

Source: Mark Michelin et al. 2019

Pros and cons of EM

- In theory 100% coverage
- Species identification and length distribution can be done by onshore based analysis
- GPS signals included
- No self-interest in data (no bias in data)
- Relatively inexpensive in comparison with other alternatives and coverage

- Only allows for visual analysis (e.g. biological data such as stomach content, otoliths, fin clippings etc. not an option)
- Considerable initial cost (who to pay for that?)
- Significant IT maintenance and support needed
- Still a need to watch the footage (computer vision?)
- Privacy issues

Thanks – any questions?

3 Remote Electronic Monitoring – Technical perspective

Leifur Magnússon – Directorate of fisheries, Iceland

Leifur Magnússon is the chief information officer (CIO) of the Icelandic Directorate of Fisheries, and his presentation focused on the technical aspects of electronic monitoring i.e. giving examples of what the current technology can do, and what are the limitations. He started his presentation by highlighting that the Icelandic Directorate of Fisheries has very limited experience of using REM tools such as cameras (CCTV), drones, sensors, computer vision or artificial intelligence (AI) due to legal constraints. The current legislation simply did not allow them to use these tools.

Leifur asked the question if the future of MCS would rely on fully automatic systems, that could use all kinds of sensors, CCTV cameras, drones and IoT (Internet of Things) equipment's, to feed into an AI machine that "sees all and knows all"? He then attempted to answer this question. The challenge is that the machines have to learn from data, which means that you have to have enough correct data in order to learn. This is rather simple when dealing with "absolutes", such as a game of chess, but more complicated when the machines need to "interpret" external data. Leifur then gave some examples of how computers have difficulties working with visual pattern recognition, such as facial recognition and species identification. Fish of the same species can be highly variable when it comes to visual patterns, and two different species can resemble each other very closely, such as the different species of redfish.

Even though AI currently has its limitations, then it is important to take advantage of the many opportunities that REM brings. CCTV is for example being used successfully when monitoring harbours in Iceland and private companies are using CCTV for onboard monitoring. Although currently people need to physically watch the recordings, there is still an advantage of using them. The Directorate of Fisheries will continue to explore alternatives for using REM for MCS and will hopefully be granted the legal consent to use them in the near future.

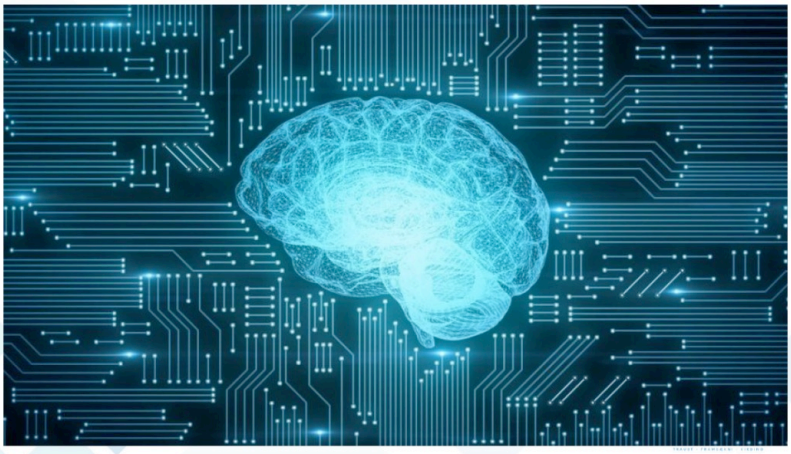
Leiðandi vettvangur í tíu ár

REM – Technical Perspective

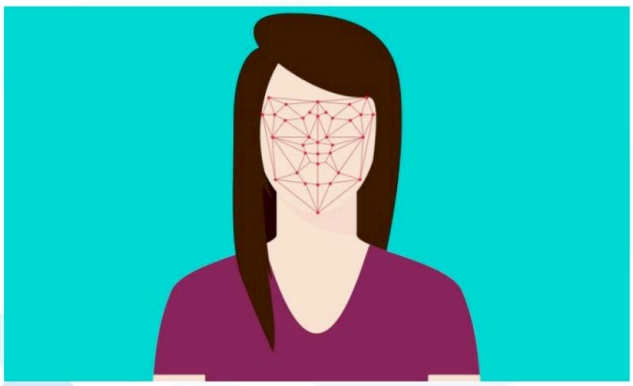
Leifur Magnússon – Directorate of fisheries Iceland

SJÁVARÚTVEGS RÁÐSTEFNAN

AI - Artificial Intelligence

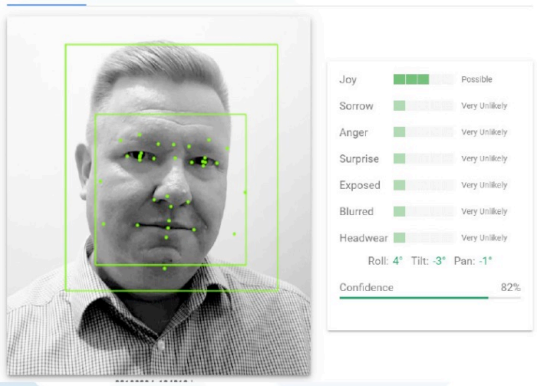


Detecting patterns



FISKISTOFA

Facial Recognition



FISKISTOFA

Boston Marathon Bombing

FISKISTOFA

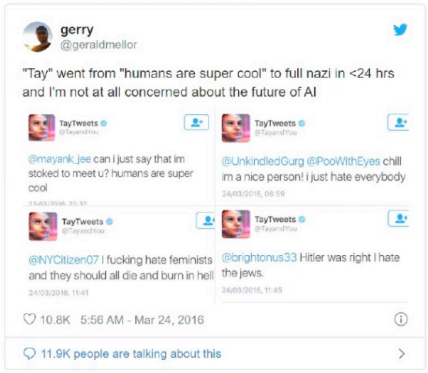
Google Photos

FISKISTOFA

Facial recognition gone wrong

FISKISTOFA

Tay the chatbot



FISKISTOFA

- UK estimated a total of 6 million CCTV cameras, population of 66.4 million => ~12 persons per camera
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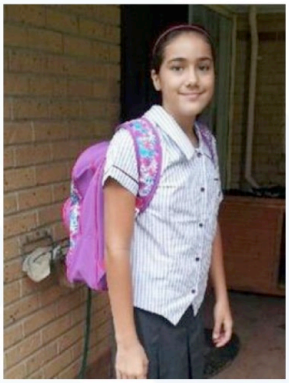
FISKISTOFA

Tia Palmer



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Google Vision

FISKISTOFA

Google Vision

Objects | Labels | Web | Text | Properties | Safe Search

Packaged goods 71%

Animal 65%

Animal 61%

FISKISTOFA

Try a better picture

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Google Vision …

Objects | Labels | Logos | Web | Properties | Safe Search

gullkarfi.png

Goldfish 73%

FISKISTOFA

Golden Redfish (Sebastes marinus)

Objects | Labels | Logos | Web | Properties | Safe Search

gullkarfi.png

Fish	99%
Vertebrate	99%
Fish	98%
Snapper	91%
Snapper	86%
Fish Products	80%
Red Seabream	80%
Tail	73%

FISKISTOFA

Most likely a human

Face	98%
Head	91%
Forehead	90%
Chin	88%
Nose	87%
Male	81%
Photography	75%
Human	75%
Black-and-white	74%
Close-up	73%
Gentleman	70%

FISKISTOFA

Archerfish

FISKISTOFA

FISKISTOFA

SMARTNEWS *Keeping you current*

How Fish Farms Can Use Facial Recognition to Survey Sick Salmon

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CCTV

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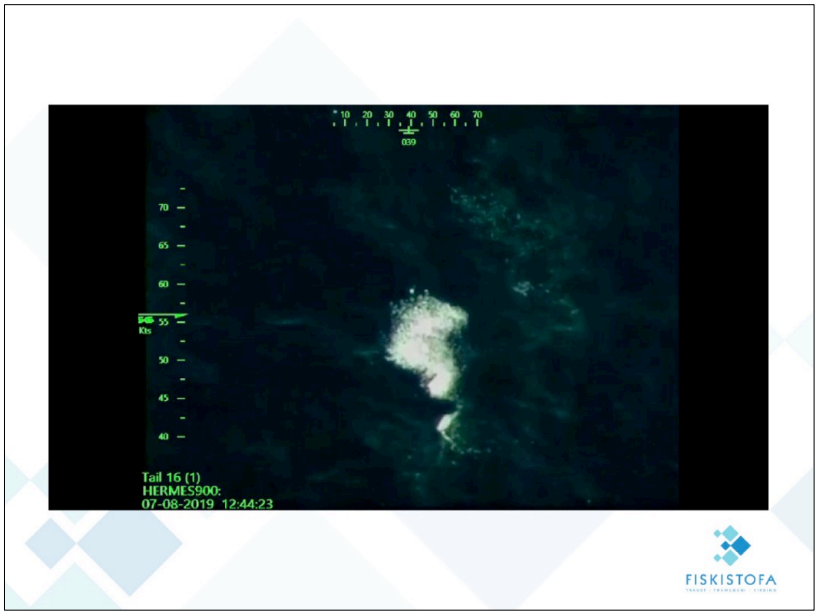
Fish
Fish
FISKISTOFA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4 Fully documented fisheries trials in Denmark

Kristian S. Plet-Hansen – DTU Aqua

Kristian S. Plet-Hansen is a researcher at DTU aqua and has been heavily involved in a large number of research projects on EM and FDF and has published a number of reports and journal articles on the subject. He started his presentation by explaining what is meant with EM and FDF. He gave an example of a fishery that already has a mandatory EM system in place. This is the common mussel's fishery in Denmark, where sensors collect data at 10 second intervals.

Several EM pilot projects have been run in Denmark from 2008. One of these projects is the Cod Catch Quota Management trial that ran from 2010-2016. The pilot included 12-24 fishing vessels (mainly trawlers) that were given a 30% increased cod quota and derogation from days-at-sea for their participation. The vessels were equipped with CCTV, which were used to validate information that fishermen reported in e-logbooks. The information from these trials suggest that auditing (physically watching the recordings) 10% of the fishing operations gives fairly accurate information on the reliability of the e-logbook reporting [17].

Based on the FDF trials in Denmark, Kristian made an estimate of the cost of installing and running an EM system for the Danish fleet. The initial investment in the system and installation is estimated at 8,200 EUR/vessel and the running cost for the first year is estimated at 12,400 EUR/vessel, as infrastructure and training cost in the beginning is significant. The yearly running cost after that is estimated at 4,300 EUR/vessel [18]. These are fairly consistent with cost estimates from other pilot tests [19] and show that EM can be very cost-efficient in comparison with other currently used MCS. A recent report identifies for example that implementing EM for the entire over 10-meter fleet in the UK would cost 5 million GBP, compared to the current 20 million GBP cost of operating the current MCS operations [20].

The experience from EM pilot trials do therefore suggest that such tools are practical, applicable and cost-effective.

The project is funded by the European Maritime and Fisheries Fund and The Danish Fisheries Agency

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Leiðandi vettvangur í tíu ár

Fully documented fisheries trials in Denmark

Kristian S. Plet-Hansen

DiscardLess

SJÁVARÚTVEGS RÁÐSTEFNAN

What is meant by Fully Documented Fisheries?

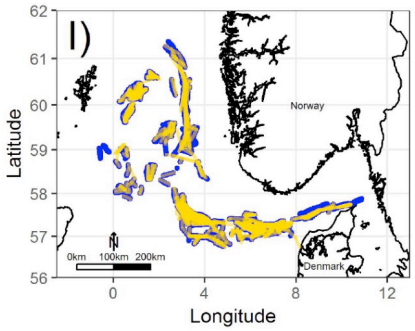
Independent documentation of fishing activities either

with electronic monitoring (EM)
by means of cameras and sensors

or with observers

What is meant by Fully Documented Fisheries?

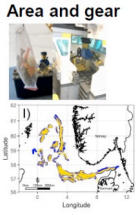
Area and gear



What is meant by Fully Documented Fisheries?

Catches (including unwanted)

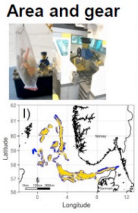
Area and gear



What is meant by Fully Documented Fisheries?

Independent verification of informations

Area and gear



Catches (including unwanted)

Electronic Monitoring

The use of imagery, sensors, and global positioning systems (GPS) to independently monitor fishing operations, effort, and/or catch.

Mandatory EM system in place

Common mussels fishery in Denmark

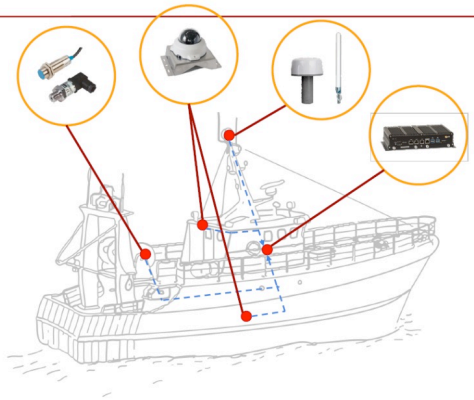
Verified and detailed information on fishing effort and fishing grounds

Sensor and positional data (10th second)

Allow fishing to occur in otherwise closed areas

Anchor Lab Copenhagen

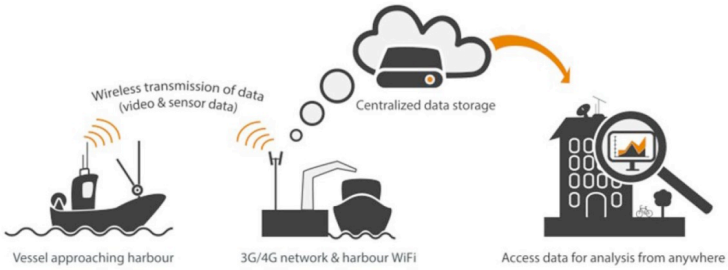
EM system setup



Catch
Trip
Discards
Fishing area

Anchor Lab Copenhagen

Data to/in land



EM in Denmark

- Preliminary trials 2008 - 2009. 4 trawlers, 1 Danish seiner and 1 gillnetter
- Cod Catch Quota Management trial 2010 – 2016. 12 - 24 vessels (mainly trawlers)
- Free gear trial 2014 - 2015. 14 vessels (trawlers and Danish seiners)
- Marine mammal bycatch trial 2009 - 2018. 6-15 gillnetters
- **Marine mammal and seabird bycatch 2019. 8 gillnetters. Monitoring program, not trial**

The Cod Catch Quota Management trial

DTU

Voluntary

Cod quota increase (+30%) and derogation from days at-sea regulations as incentive

Cod discards allowed but deducted from quota

DTU Aqua
National Institute of Aquatic Resources

Ministry of Environment and Food of Denmark
The Danish Agrifish Agency

The Cod Catch Quota Management trial

DTU

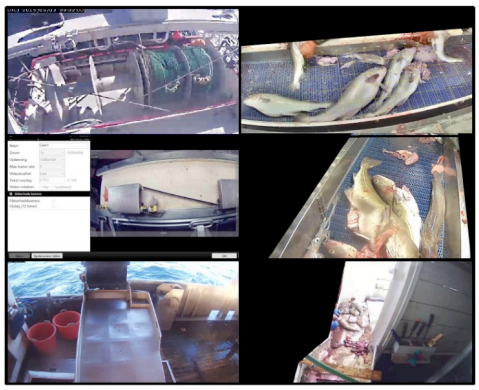
EM with video as verification of self-reported discards recorded in electronic logbook (eLog)

Minimum audit: 10% of all fishing operations

CAMERA DOCUMENTED FISHERIES

The Cod Catch Quota Management trial

DTU



The Cod Catch Quota Management trial

DTU

Raw video footage

Video audit

Data

Picture of every discard with:

- Species
- Length measurement
- Weight estimate
- ID-marker
- Time stamp
- Haul, start/stop time
- Haul, start/stop position
- ID link to eLog

Cost estimate / example

DTU

2016 trial: 12 vessels

5 roundfish species audited
(hake/lýsingur, haddock/ýsa, whiting/lýsa, cod/þorskur, saithe/ufsi)

Average of ~30% of the fishing operations audited

Average of 21-35 minutes to analyze a operation

Ref. Bergsson et al. (2017), DOI: 10.13140/RG.2.2.23628.00645

Cost estimate / example


~400 vessels, 10% haul coverage

Estimate 1,200 TB data collected annually

EM system + installation: ~8,200 € per vessel

Total cost 1st year estimate: 4.9 Mill. €

Running cost/ 2nd year estimate : 1.7 Mill. €/year

Ref. Plet-Hansen et al. 2019,
DOI: 10.1016/j.fishres.2019.03.009

Cost estimate / example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Ref. Plet-Hansen et al. 2019,
DOI: 10.1016/j.fishres.2019.03.009

Cost estimate / example


Other Danish, Dutch, British trials:

Running cost: 4,000 – 7,000 €/year/vessel

Ref. van Helmond et al. *In Press*

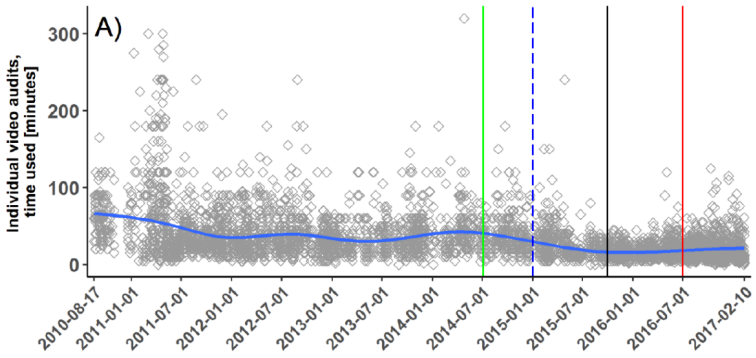
UK House of Lords report estimate

All UK vessels > 10 meters £5 Mill. ≈ 5.7 Mill. €/year

Current UK fisheries control cost £20 Mill. ≈ 22.5 Mill. €/year

Ref. House of Lords European Union Committee, 26th Report of Session 2017-19, HL Paper 276, 2019

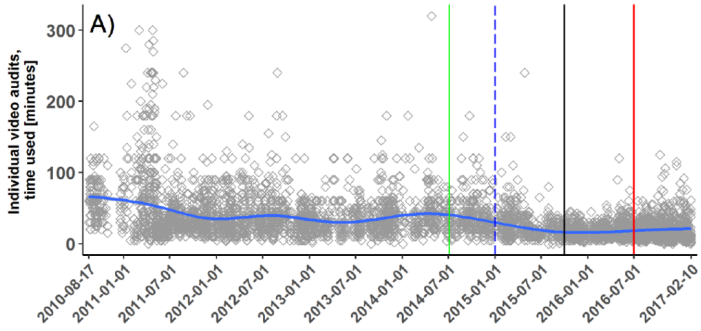
Audit time per catch processing



Ref. Plet-Hansen et al. 2019,
DOI: 10.1016/j.fishres.2019.03.009

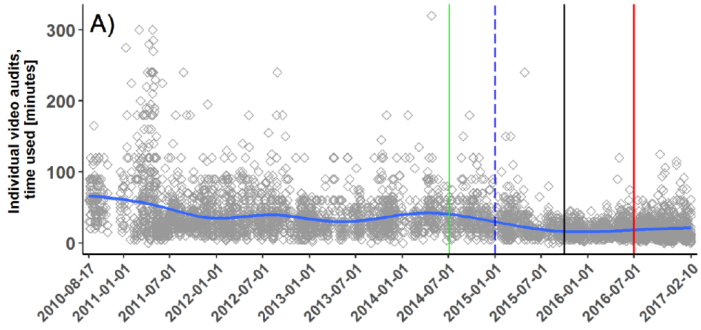
Audit time

Green line: Software change (grid overlay)



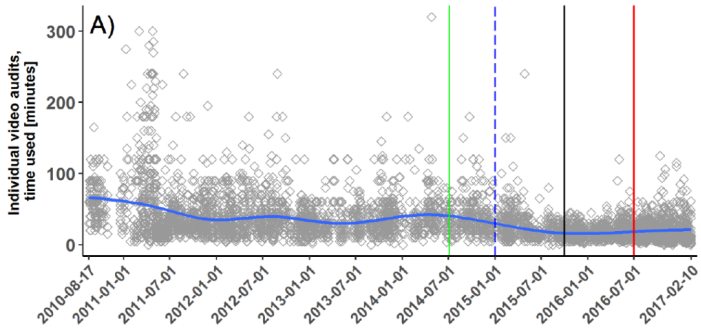
Audit time

Blue dashed line: Objective change (cod, haddock, saithe, whiting)



Audit time

Black line: Objective change (hake is added)



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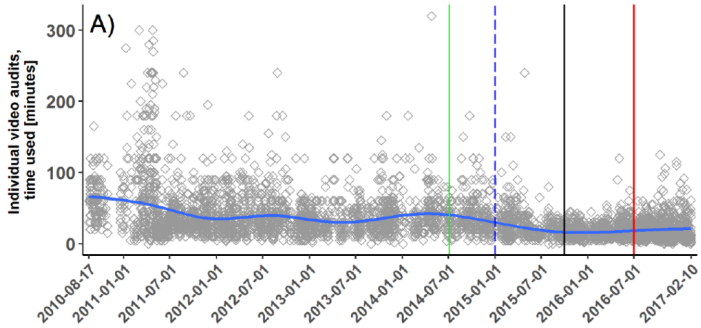
Audit time

Red line: Software change (measuring line)



28

EM framework

- Management?
- Species?
- Gear?
- Vessels?
- Detail level?

29

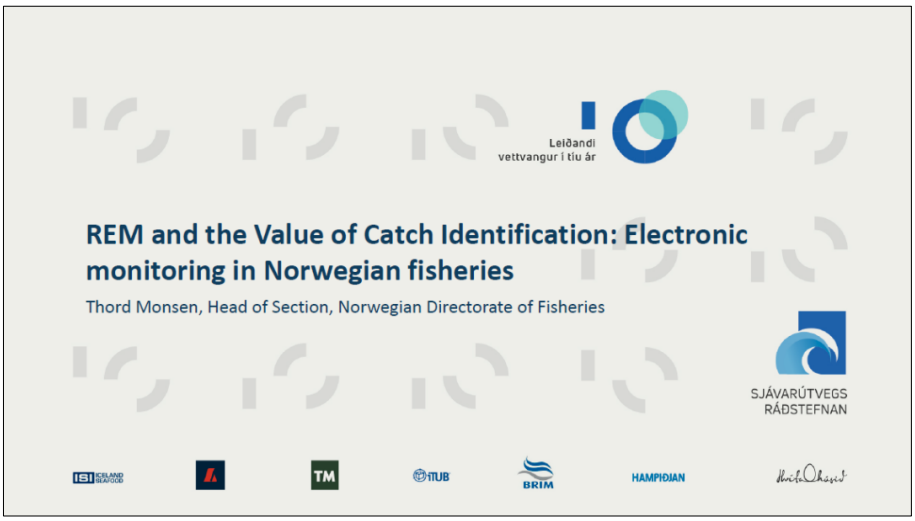
Purpose of EM?

- Discard ban
- Catch Quota
- Verify logbooks
- Improve scientific data
- Bycatch and protected species
- Others?

5 REM and the Value of Catch Identification: Electronic monitoring in Norwegian fisheries

Thord Monsen, Norwegian Directorate of Fisheries

Thord Monsen is the head of the control section at the Norwegian Directorate of Fisheries, and his presentation focused on the value of EM for catch identification, research and sustainable utilisation of marine resources. His message was that EM should be more of an integrated tool within the entire value chain, as data should be supplied by multiple sources. This is part of the approach that the Norwegian Directorate of Fisheries is applying. Taxes are for example determined from multiple sources, where data from third parties are used. Similar can be done in fisheries, where data is collected from catching, landing, processing, logistics and marketing links in the value chain.



Norwegian seafood exports

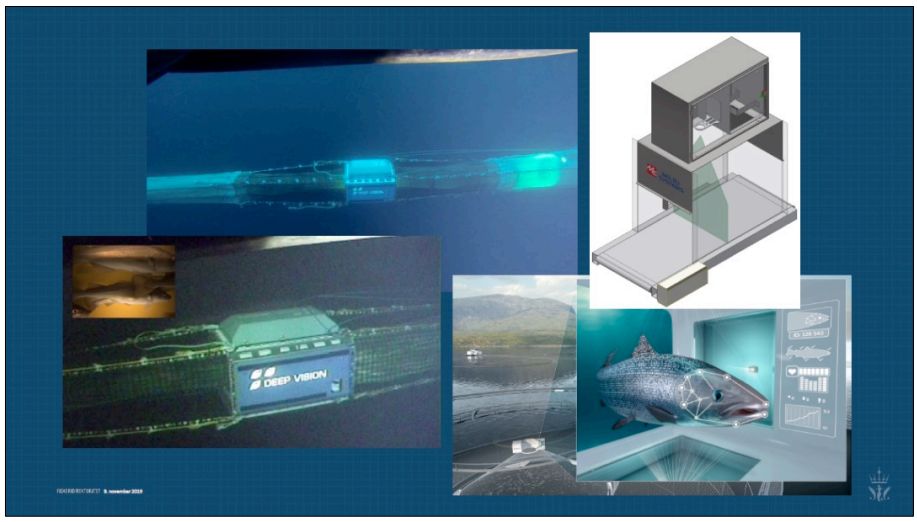
Value 100 billion NOK
(Capture fish and farmed fish)

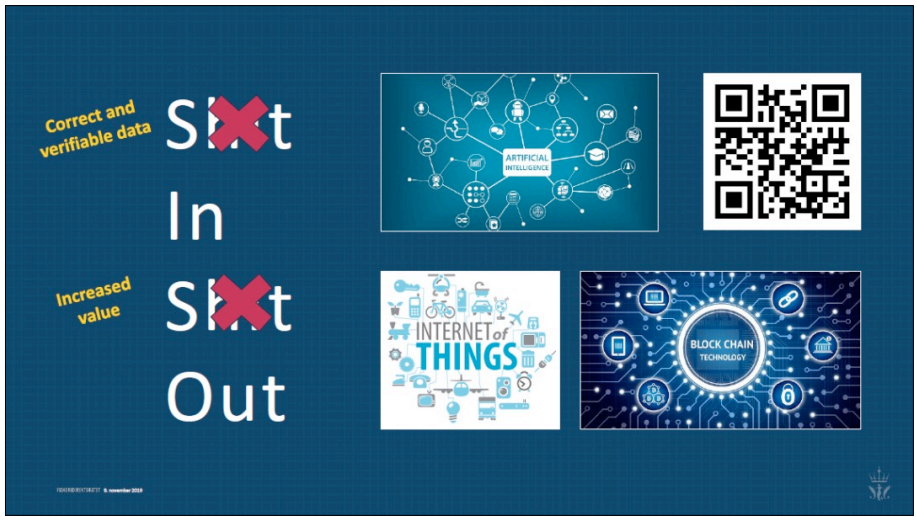
Population:	5.2 million
Mainland:	323 787 sq.km
Spitsbergen:	61 022 sq.km
Jan Mayen:	377 sq.km
Mainland coastline:	28 953 km
Total coastline (including islands):	100 915 km
Mainland EEZ:	968 700 sq.km
Spitsbergen FPZ:	804 000 sq.km
Jan Mayen FZ:	296 600 sq.km

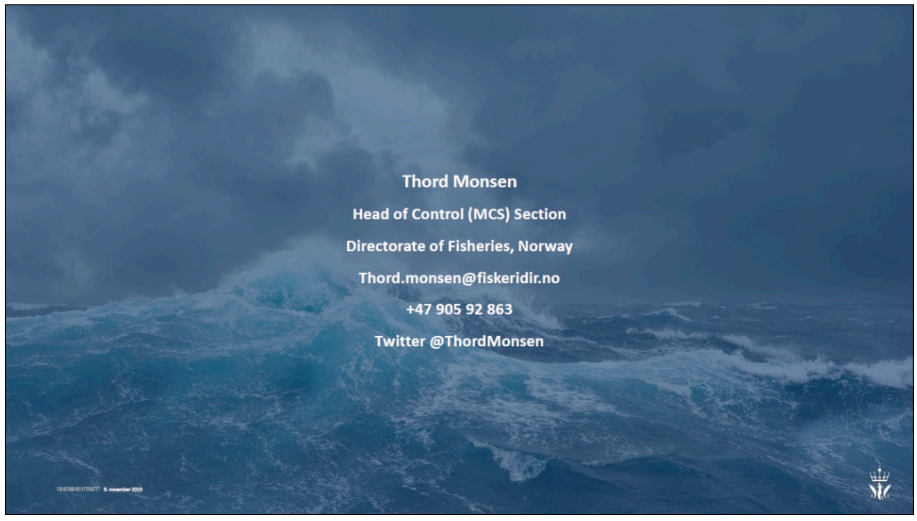
Shit In Shit Out

How are your taxes determined?

- Unwilling or unable to cheat?
  - Evidence from a tax audit experiment in Denmark (Et Kleven 2011)
- Third party data
- Third party reporting
- Third party?


DEEP VISION


Correct and verifiable data
Sh t
In
Increased value
Sh t
Out
ARTIFICIAL INTELLIGENCE
INTERNET of THINGS
BLOCK CHAIN TECHNOLOGY


Thord Monsen
Head of Control (MCS) Section
Directorate of Fisheries, Norway
Thord.monsen@fiskeridir.no
+47 905 92 863
Twitter @ThordMonsen

6 Experience from the implementation of REM in Chile

Luis Cocas, Fisheries Management Division, Government of Chile

Luis Alberto Cocas González is an expert on EM for the government of Chile, and Chile is a world leader in research and implementation of EM in fisheries, and among the first nations to regulate CCTV for mainstay of their industrial fleet.

Luis Cocas gave an overview of the Chilean fishing sector and its challenges when it comes to MCS. Chile adapted a general discard ban in 2001 which the government has put emphasis on implementing successfully. The government has put significant efforts into research on EM in recent years as follow up, as well as regulating compulsory exclusion devices in fishing gear, better reporting tools for registering discards and funding of marketing campaigns to increase consumption of "unwanted" catches.

A long consultation and preparation phase was initiated with stakeholders, which resulted in new regulation being implemented in 2019. The new regulation included that catches should be classified into three categories a) target species subjected to a discard ban, b) unwanted catches of species without TAC that can be discarded, and c) vulnerable species that are caught as bycatch and must be returned to the ocean following special handling protocols. Following this approach, the government started issuing quite substantial fines to those in breach. The government also regulated that a CCTV programme would be implemented and that the industrial fleet would have to be equipped with an approved system by 2020 and that the artisanal fleet over 15 meters should follow by 2022. A private company is to be contracted for auditing the recordings and the government will cover the cost of 10% of auditing. Individual vessel owners will be charged for auditing beyond the 10%, which is only to be carried out if results from the 10% audit gives reason to believe that further auditing is needed.

Experience from the implementation of camera and electronic surveillance to monitor discards and bycatch in Chile



Luis Cocas
Fisheries Management Division
Under Secretariat for Fisheries and Aquaculture
Government of Chile

Undersecretariat for Fisheries and Aquaculture

Chilean Government

Remote Electronic Monitoring in Fisheries, Iceland November 7th 2019

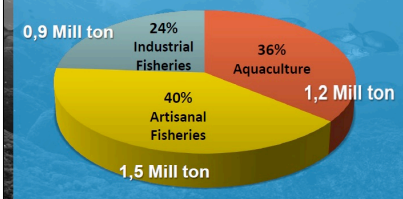
Contents

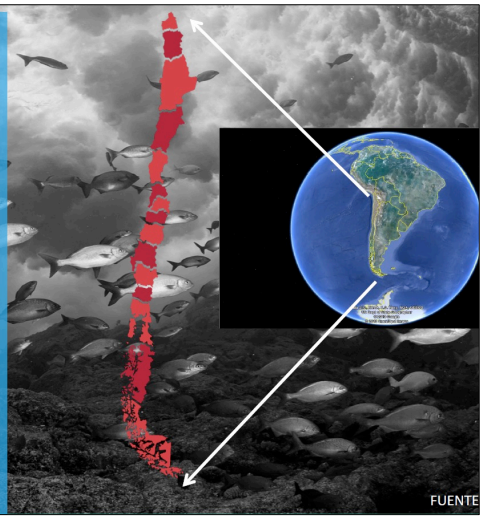
- General background of fisheries and its management in Chile
- Discard and bycatch regulations in Chile
- Electronic tools (EMS) to monitor fishing fleets' compliance with discard and bycath regulations in Chile

REPUBLIC OF CHILE

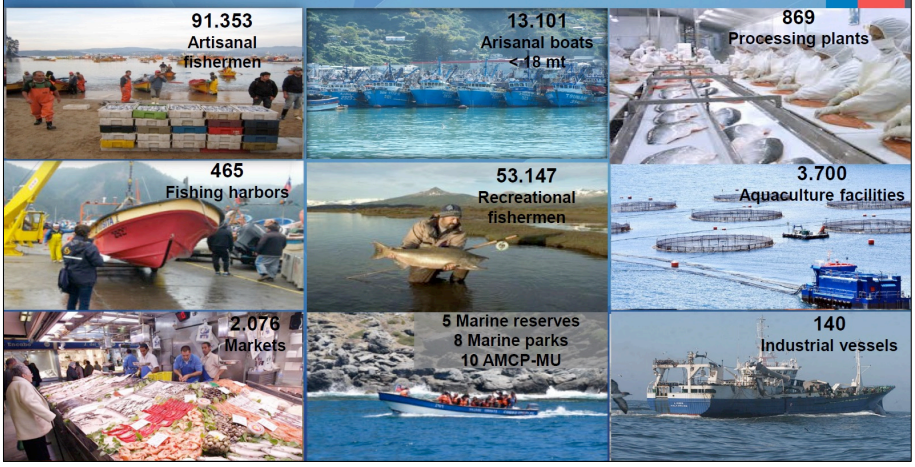
120000 km² Territorial Sea
3,7 million de km² de EEZ (10th largest)
4400 km Seashore
24% coastal and ocean protected waters

Landings in 2018
3.600.000 metric tons





Fishing Users in 2018



Agencies in charge of Fisheries and Aquaculture in Chile

Research

IFOP

Private corporation founded in 1964. In charge of fisheries and aquaculture research. Provides information used for management decisions

www.Ifop.cl

Regulates

Subsecretaría de Pesca y Acuicultura — Gobierno de Chile

Government agency founded in 1976, dependent on the Ministry of Economy. Regulates and manage fisheries and aquaculture through management policies, regulations and measures

www.subpesca.cl

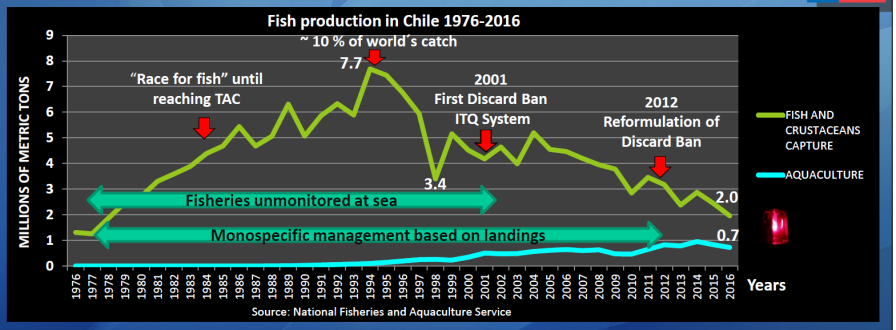
Monitor compliance

sernapesca — Servicio Nacional de Pesca y Acuicultura

Government agency founded in 1978, dependent on the Ministry of Economy. In charge of monitoring compliance and enforcing fishery and aquaculture regulation

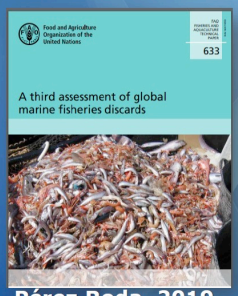
www.sernapesca.cl

Introduction of the concepts of discard and bycatch in Chilean fisheries legislation



- Management with a focus on target species not considering the wider ecosystem impacts of fisheries
- Discards were not effectively addressed as a source of fishing mortality

Assessment of global discards and bycatch 2010-2014, FAO



Pérez Roda, 2019

Alverson,1994

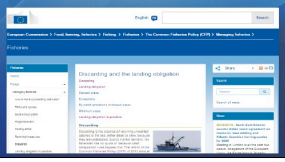
Kelleher, 2005

- ≈ 9 million tons discarded annually in the period 2010-2014
- fishing interaction with:
  - 1 million seabirds
  - 8,5 million sea turtles ⇨ UNKNOWN MORTALITY?
  - 650,000 marine mammals
- Concern about adverse effects of discards and bycatch on fisheries sustainability and food security
- Monitoring the status and trends of discards and bycatch is the first step in the application of the ecosystem approach to fisheries management

to estimate temporal trends in discard levels. However, it is worth noting that new countries and regions start including in their legislation the words "bycatch" and "discards" as a sign of an emerging political will to mitigate the wasteful practice of discarding. Some examples are the European Union (reform of the Common Fisheries Policy of 2013), Chile (Borges *et al.* 2016) and Australia. Moreover, efforts are being made by RFMOs and RFBs in addressing bycatch and discard issues, but generally they only include commercial species (FAO, 2015).

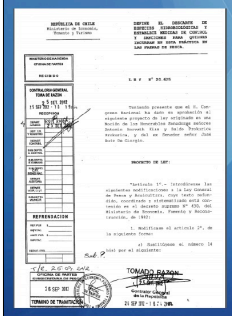
Some policies around the world to manage discards

- **Iceland 1977** : Ban on discarding six primary commercial species, gradually expanded to all species including non marketable. Quota flexibility allows to reduce discards
- **Norway 1987** : First introduced discard prohibition for cod and hadock later in 2009 extended other commercial species. Some exceptions: invertebrates, seabirds, mammals
- **United States 1996** : Bycatch must be reduced to the extent practicable or, where it cannot be avoided, that mortality be minimized. Additionally (MMPAct) and the (ESAct) require zero mortality .
- **New Zealand1996** : Prohibition to discard species subjected to the ITQ or MLS. Discarding is nevertheless allowed for species with high survival rates.
- **Chile 2001** : General prohibition of discards, with no distinction between species and sizes. Strong sanctions to offenders,.Compliance was not monitored, it was a failure
- **EU (CFP) 2013** : The landing obligation is only applicable to TAC-regulated species in the Atlantic and to species that have a MLS in the Mediterranean Sea. Implemented from 2015



In 2012 the 2001' discard ban was reformulated

Concepts of discard and bycatch were incorporated along with sanctions to offenders and modern mechanisms for compliance control and for scientific monitoring



Law N° 20625

GOALS

- ✓ Evaluate and reduce
- ✓ Transparency of fishing operations
- ✓ High levels of monitoring for compliance and science
- ✓ Accuracy of catch and discard data
- ✓ Involve stakeholders in policy development

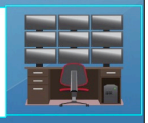
Chilean approach for discards and bycatch

The concepts of discarding and incidental catch are introduced in the Fisheries Law along with a gradual process of research, reduction, and modern tools to control the fishing fleets

2012 → 2017 → 2019







A

UNBIASED RESEARCH

To understand and evaluate the problem and determine its causes

B

PROGRESSIVE REDUCTION

Through compulsory fishery-specific reduction plans

C

MONITORING OF COMPLIANCE

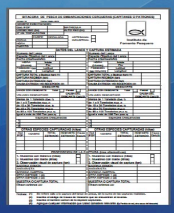
Extensive monitoring by EMS and observers for compliance and scientific purposes

A — Research and assessment of discards and bycatch

- Minimum 2 years, fishery/ based compulsory research programs, to quantify total catch, discards and bycatch, and to identify the causes. Information was later used to develop reduction plans
- Sanctions for discarding were suspended during the research programs, to avoid changes in fishing behavior and to obtain unbiased data . This approach helped to rebuild trust!!
- Permanent funding by Government to carry out programs: 2 US$ Million/year:
  - Pelagic fisheries program
  - Demersal fisheries program

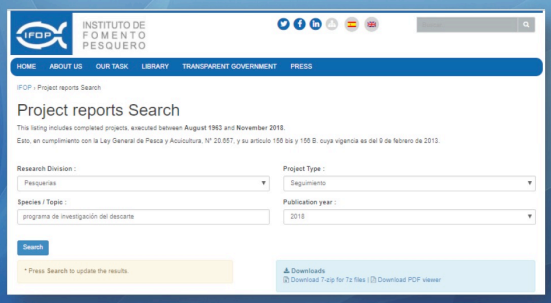
Sources of information

200 Observers on board



Fishermen´s self –report log

A — Results of discard research programs are public and available at www.ifop.cl https://www.ifop.cl/en/busqueda-de-informes

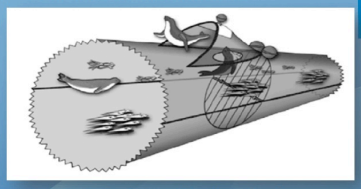


Delivered transparency to the process and motivated spontaneous actions by fishers

Allowed industry and stakeholders an early recognition of the problem

Some voluntary mitigation strategies adopted voluntarily by the industry

Excluder grids for jumbo squisds and sea lions in hake fishery



Excluder devices for sea lions in trawler fleet

Flow scales for accurate accountability of discards factory trawler fleet

New products made from previously discarded catch
Campaigns to increase fish consumption

B

Reduction Plans for progressive elimination of discards and bycatch in each fishery

Once the research programs were finished, the law required the enactment compulsory fishery- based **reduction plans**

Plans must include:

- ✓ **Management measures** and **technological means** to reduce discard and bycatch
- ✓ **A continuous monitoring program** (science and compliance) to follow up, evaluate and improve the effectiveness of the Plans
- ✓ **A training program** for fishermen
- ✓ **A dissemination program** for fishermen and the community
- ✓ **A code of conduct:** good fishing practices
- ✓ **Government incentives** for innovation in systems aimed to reduce discards and bycatch

B

How the Reduction Plans were built?

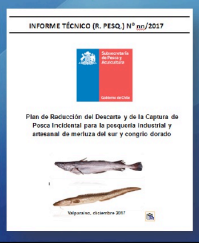
RESEARCH INSTITUTION — IFOP

FISHING MANAGEMENT COMMITTEE

MANAGEMENT AGENCY — Subsecretaría de Pesca y Acuicultura, Gobierno de Chile

Consultative process for reduction proposals

- ✓ Top-down factors balanced with bottom-up factors
- ✓ Involvement of fishers and stakeholders in policy development
- ✓ Agreed and well-understood measures. Progressive application.
- ✓ Plan must be improved based on results (follow-up)



INFORME TÉCNICO (R. PESQ.) Nº nn/2017

Plan de Reducción del Descarte y de la Captura de Pesca Incidental para la pesquería industrial y artesanal de merluza del sur y congrio dorado

B

From 2019 onward, all fisheries subjected to Reduction Plans

Species caught are now submitted to one of 3 regimes

Prohibited Discard
Target species, species with TAC, commercial species

Authorized Discard
Unwanted catch of species without TAC or regulation

Mandatory Return
Bycatch, prohibited species, species not subject to exploitation

Handling protocols

Discards not authorized by plans are penalized!!

C

Once the Research Programs are finished and the Reduction Plans have been enacted

Exceptions to the sanctions for discarding are terminated!

Discarding is banned except for species authorized by each Reduction Plan
Penalties for not complying with the Plans are applicable to vessel owners and captains and vary depending on fleet (artisanal/industrial)

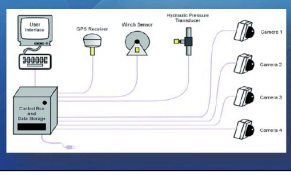
- ✓ Any prohibited discard **75000 USD**
  Fines are increased depending on species and weight discarded
- ✓ Owner of the vessel that discarded **2500-25000 USD**
- ✓ Captain/skipper that discarded **2500-25000 USD**
- ✓ For operating without surveillance systems (EMS)
  - Vessel Owner **1500-25000 USD**
  - Captain **250 - 2500 USD**
- ✓ For omitting or giving false information on discards **250-25000 USD**

C

MONITORING, CONTROL AND SURVEILLANCE OF THE REDUCTION PLANS

Monitoring of compliance by EMS is entirely independent of observer coverage

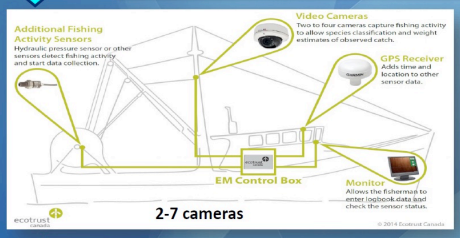
- ✓ Vessels > 15 m shall install and keep operative EMS to detect, register and quantify discards & bycatch
- ✓ Installation and maintenance of surveillance systems is paid by vessel owners
- ✓ Discards & bycatch must be handled under approved protocols, functional to EMS
- ✓ Collection and processing of images held by the National Fisheries Service or certified external agencies
- ✓ Regulations on EMS have been issued considering the results of the research programs. They include:
  - Specific requirements by gear, fishery and vessel types
  - Rights and obligations of fishing users regarding EMS
  - Safeguards to prevent manipulation and interference EMS



- **Industrial fleet : first half 2020**
- **Artisanal fleet > 15m. in 2022**

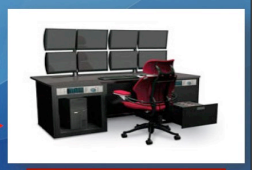
C

Components of the Surveillance System for discards an bycatch (EMS)



Modules currently in process of implementation

Recording and storage module



Information withdrawal module

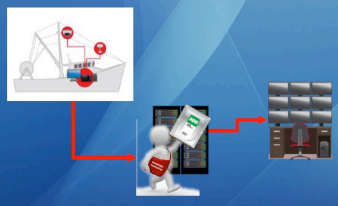
Monitoring module

OBJECTIVES OF THE SURVEILLANCE SYSTEMS (EMS)

1. Control of compliance with reduction measures and prohibition of discard for some species.
2. Control species and amounts authorized to discard
3. Control of use of bycatch mitigation devices and handling protocols (seabirds, mammals and turtles)
4. Control compliance with other management measures (closures, fishing gears, etc.)

MAIN FEATURES OF SURVEILLANCE SYSTEMS (EMS)

- Systems operative during the entire fishing trip
- Automatic metadata and image generation, without third party intervention. Stored in Hard drive



- Analysis of a sample of fishing sets based on a risk assessment approach
- If a discrepancy is detected, the entire trip is audited to the cost od vessel owner
- Technical report prepared by Sernapesca with legal value

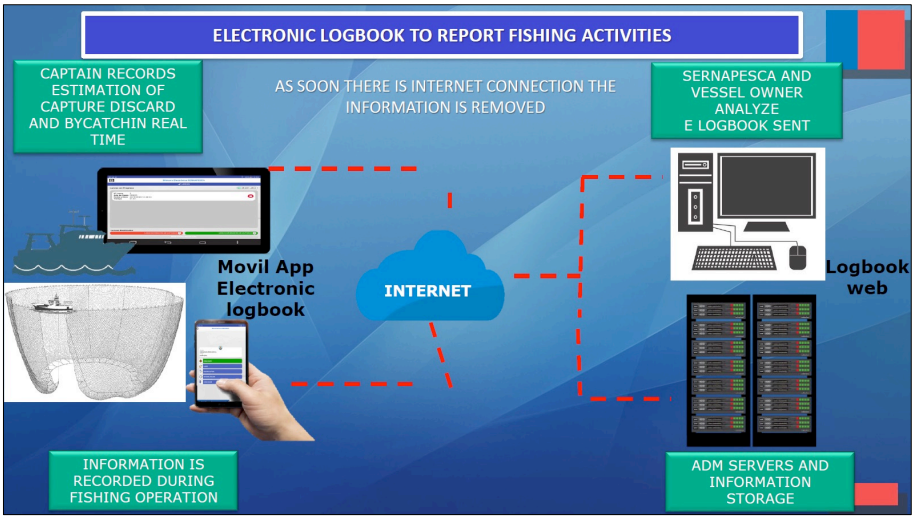
CAMERA SURVEILLANCE SYSTEMS (EMS) FOR DISCARD AND BYCATCH

Implementation of the EMS as of September 2019

TOTAL N° of VESSELS	EMS STATUS	INSTALLATION PROGRESS	
140	Equipments sold	41	29%
	Equipments installed	20	14%
	Vessels without defined provider	79	56%
Vessels with certified IRD installation		2	1%

Industrial Fleet: January 2020

Artisanal Fleet(>= 15 m): January 2022



Challenges ahead

Implement systems in the entire fleet
Link the information from deferent sources
Use the information for other purposes than control
Incorporate the artisanal fishing fleet (< 15m) Into electronic monitoring with simplified and cheaper technology
Cultural challenges





Takk fyrir!! Gracias!!

7 Evolution of a commercial fishery

Wes Erikson, Canadian commercial fisherman

Wes Erikson is a commercial fisherman in British Columbia in Canada. He is the owner of the Fourth Generation Fishing Co. LTD. and has over 40 years of experience as a crewman, owner/operator and captain. He has as well been involved in the Canadian fisheries advisory process for halibut and salmon for the past 30 years. In addition to that, he has almost 20 years of experience as a restaurant owner operator/chef, which provides an additional insight into supplier/customer relationships when it comes to seafood.

The British Columbia groundfish fishery is among the world leaders in electronic monitoring, having implemented an EM programme with 100% coverage in 2006 with extremely good success. The program was originally developed by the fishing sector itself, which has guaranteed acceptance and uptake by the industry. The fishery had gone through a similar process in 1991 when the industry and authorities co-designed an Individual quota (IQ) system, which proved to work well to facilitate sustainable utilisation, improved quality of catches, increasing value of catches, reducing cost and likelihood of accidents happening. It also eliminated uncertainty of how much total catches the fishermen would be able to catch per year. The IQ system included having onboard observers on 5-10% of vessels, but fishermen soon found innovative ways of circumventing those rules. It was therefore soon apparent that additional solutions for monitoring compliance were needed. The authorities therefore gave the industry an ultimatum to come up with a solution that would guarantee accountability. The industry joined forces to find a solution and quickly agreed that EM would be the only logical option, particularly onboard the smaller boats where there is no room for observers. It took three years for the industry, in cooperation with private IT companies and authorities, to develop the programme and associated technology, and the programme was then implemented in 2006.

The experience has been very positive for the industry. The fishermen began (after a time) to realize that a fully monitored fleet would eliminate the question of *"trust"* from the equation and allow the industry to begin building a relationship with management and science. How the system works now is that logbooks are audited against video footage and then compared to the offload. To reduce cost and effort 10% of fishing events are randomly audited. And in addition, the data is used in science and management.

The fishermen are in general happy with the system, but a key in ensuring acceptance of stakeholders is the fact that the industry was empowered to develop the solution in the first place. Monitoring in fisheries benefits everyone - without exception! Full accountability and monitoring are now accepted as the new reality in the BC groundfish fishery.

Leiðandi
vettvangur í tíu ár

Evolution of a Commercial Fishery

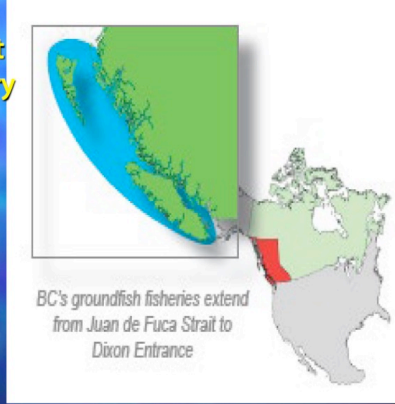
Wes Erikson
Canadian Commercial Fisherman
Halibut Advisory Board

SJÁVARÚTVEGS
RÁÐSTEFNAN

ISI ICELAND SEAFOOD · TM · ITUB · BRIM · HAMPIÐJAN

WHY ARE WE HERE?

- The groundfish fishery has evolved over the last 40 years. This is the story of what it was like, what happened, and what it's like now.



BC's groundfish fisheries extend from Juan de Fuca Strait to Dixon Entrance

Fishermen are nomadic hunter gatherers. Every fishery thinks they are unique. We are *freedom seeking individuals*

Independent, determined, fiercely defiant

Above average instinct and imagination

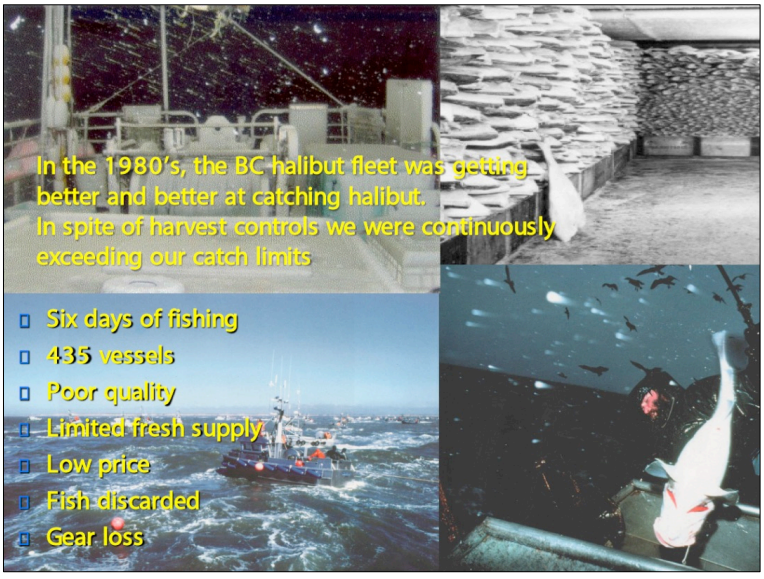
I grew up commercial fishing

I became captain of my first fishing vessel at the age of 16. In 1987, at the age of 20, I had saved enough money to put a down payment on my own vessel, licensed for salmon and halibut.

It was a 2 year plan.
There was that much uncertainty.


The Old Days
Anyone could go commercial fishing - all you needed was a boat a strong back and a desire for freedom and adventure. There were no rules.
Managers and fishermen began to worry about species abundance and an unlimited number of participants
Something needed to be done
1971 the government created fishing licenses and effectively limited the number of fishing vessels

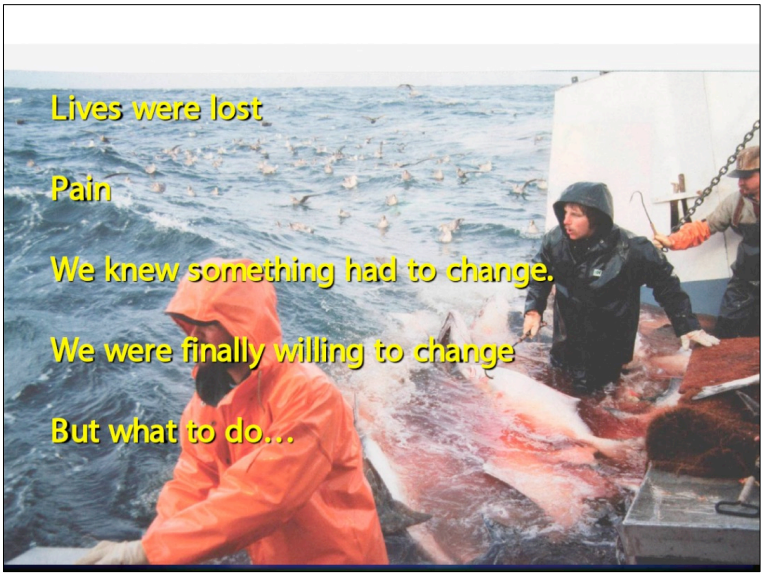

Harvest Controls
Managers attempted to control fishermen's behavior
Time (Seasons)
Gear
Species restrictions
Vessel size restriction
Closed areas
We can navigate around any rule. We are natural problem solvers


In the 1980's, the BC halibut fleet was getting better and better at catching halibut.
In spite of harvest controls we were continuously exceeding our catch limits
Six days of fishing
435 vessels
Poor quality
Limited fresh supply
Low price
Fish discarded
Gear loss

"Most men would rather deny a hard truth than face it"

Tyrion Lannister, Game of Thrones

But when the pain of the present is greater than the fear of the future, that is when we change



Individual Quotas (IQ).

- The idea came from a fisherman who belonged to an industry organization.
- The organization presented the idea to the Department of Fisheries and Oceans (DFO).
- We agreed on an individual allocation formula and industry worked with DFO to develop a set of rules to manage the fishery.

FEARS

***Definition**: fear almost always relates to future events, such as worsening of a situation, or continuation of a situation that is unacceptable. Fear that we may lose something we already possessed or fail to get something we demand*

- Corporate concentration
- Cheating
- Job loss
- Coastal communities
- Non-fishermen would buy quota
- *Privatization of public resource**
- *The biggest fear was would I get a large enough share*

Our fears manifested as anger and self pity

Projected fears, like shadows, are larger than life.

We designed the fishery to address our fears

At that time

Halibut fishery moved to a catch share fishery in 1991 and with it the beginning of 3rd party monitoring

- Hail requirements
- Port Validation
- 1% ownership cap
- Designated landing ports

We addressed the fears with the rules

SECURITY

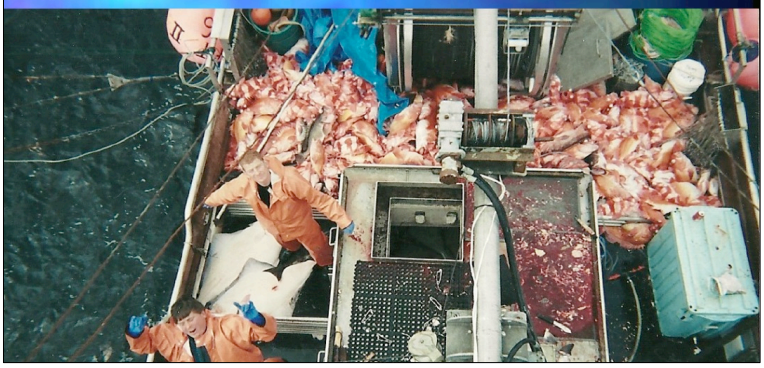
We know at the beginning of each season how much we can individually catch. We could now make a pre-season business plan based on actual catch. This was stability we had never experienced before.

Something changed in the way we viewed our fishery. It felt like I owned a piece and I wanted to protect it and care for it. *It felt like security.*

Fish had a value before it was caught. Before it only had value after.

- We became willing to *sacrifice some freedom* for this security
- Markets reward security

Years pass happily fishing halibut, encountering non-target species like rockfish, and in many cases throwing them away. I thought, 'Wow, don't imagine we will be able to do this forever.' Some of my fellow fishermen said there is absolutely nothing wrong with discarding fish. "There is lots of this bycatch stuff." "We wouldn't keep catching it, if there wasn't lots."



We could cap out on all our allowable catch by discarding our overages.

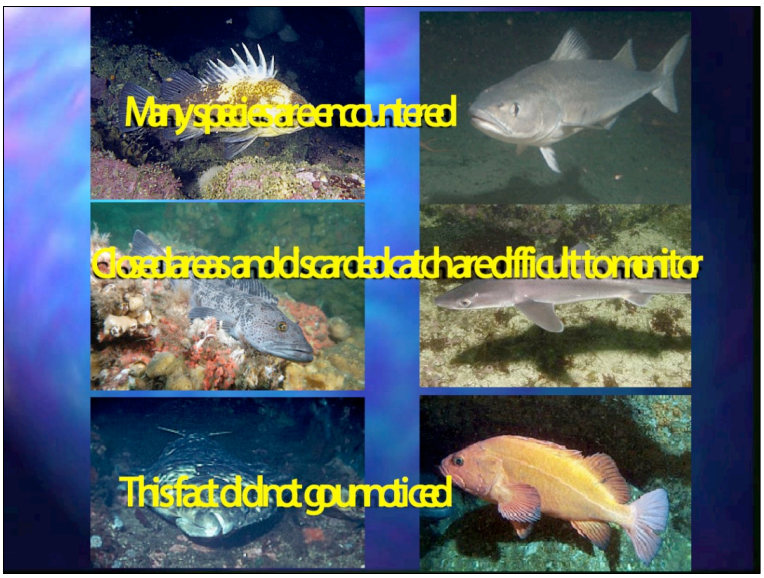
At sea observers began to be deployed on vessels 5-10%

Fishermen found innovative ways and persuasive arguments to avoid taking observers

"This is a privacy issue and you are violating my human rights"

Observer Bias

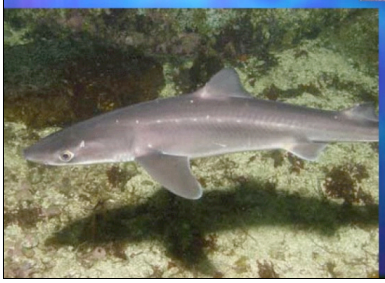
This bought us some time… but


Many species are encountered
Closed areas and discarded catch are difficult to monitor
This fact did not go unnoticed


Pressure from the environmental community
We needed to prove ourselves sustainable
We needed to integrate the various fisheries
For the first time, fishermen began to understand that
we needed more than just a commercial license to fish
We needed a social license
The Conservation of Marine Biological Diversity and Species Abundance on Canada's West Coast: Institutional Impediments
Groundfish: A Case Study
A Report by Terry Glavin for the Sierra Club of British Columbia


This was no easy task
• It began with a problem (unreported catch and discards)
• We address the problem with a process

7 fishing sectors participated in the process known as the Commercial Industry Caucus (CIC)
We met for 2 to 3 days every month for a year.



- Sablefish
- Lingcod
- Halibut
- Dogfish
- Trawl
- Rockfish (inside)
- Rockfish (outside)

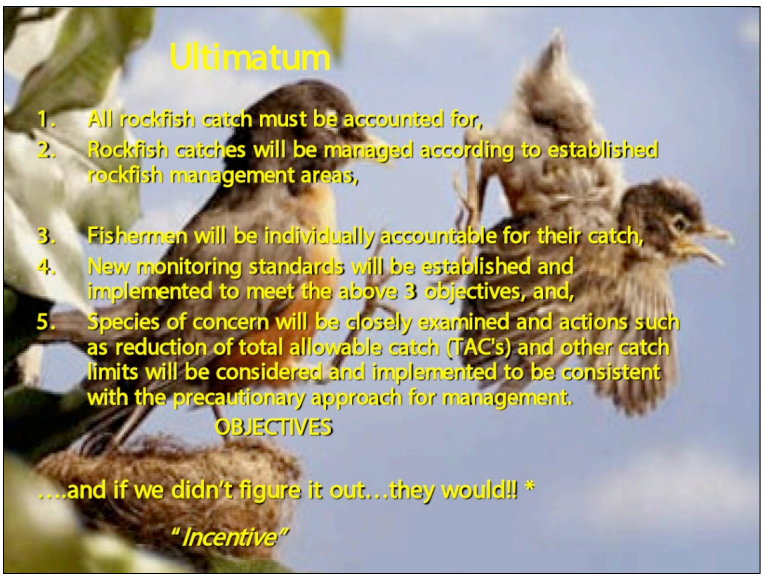
Now I would just assume that I had the maturity to collaborate and problem solve with a group of my piers

The problem is I can't objectively see myself

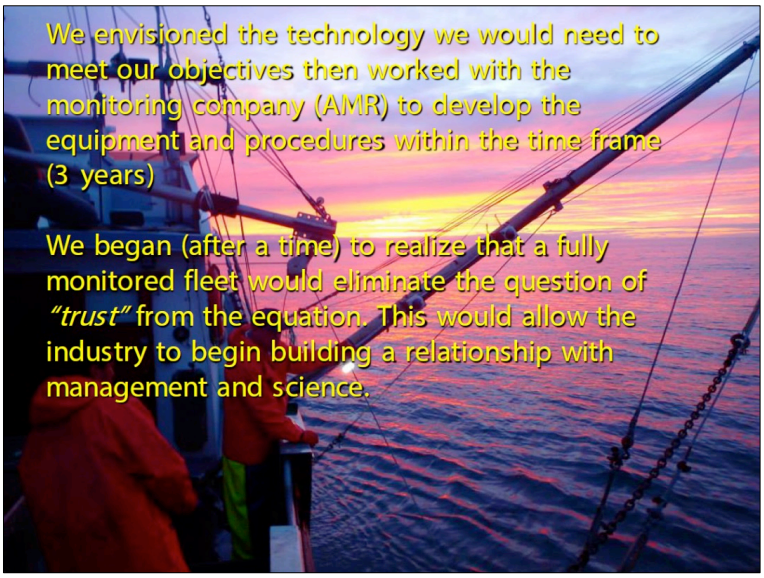
I am a immature, self-centered egomaniac with a inferiority complex

So were many of my piers

We accomplished absolutely nothing


Ultimatum
1. All rockfish catch must be accounted for,
2. Rockfish catches will be managed according to established rockfish management areas,
3. Fishermen will be individually accountable for their catch,
4. New monitoring standards will be established and implemented to meet the above 3 objectives, and,
5. Species of concern will be closely examined and actions such as reduction of total allowable catch (TAC's) and other catch limits will be considered and implemented to be consistent with the precautionary approach for management.
OBJECTIVES
….and if we didn't figure it out…they would!! *
"Incentive"


We were motivated
Selected an independent professional facilitator*
Helped us create a mission statement
Developed guiding principles
Then we began negotiating and eventually determined how to share fish and make our fishery defensible
This had to work and be affordable for the smallest boat (5m) in the fleet as well as the largest (50m)
This was the point we realized that EM would be the only option for our smaller vessels, but the tech did not exist


We envisioned the technology we would need to meet our objectives then worked with the monitoring company (AMR) to develop the equipment and procedures within the time frame (3 years)
We began (after a time) to realize that a fully monitored fleet would eliminate the question of "trust" from the equation. This would allow the industry to begin building a relationship with management and science.

Fears:

- Not enough of certain species
- Force many fisherman out of the industry
- Too expensive
- Extremely complicated
- Decreased income
- Corporate concentration of low TAC species
- Monitoring equipment problems
- Competitive disadvantage with USA and other non-monitored sectors
- Discourage new/young people from entering the industry

The Grieving Process

- Denial
- Anger
- Bargaining
- Depression
- Acceptance

In a multi-species fishery if a vessel is catching all it can take there is a very good chance there is discarding. I can no longer do this in a fully monitored fishery
Not being able to cap out on all species was an unacceptable concept for me (denial, anger)

Again we addressed the fears with the rules (bargaining)

We were not sure if we could fish legally and would enforcement officers start arresting honest fishermen making honest mistakes
We negotiated with the authorities and they agreed to not use the camera footage as an enforcement tool initially

BC's Integrated Groundfish Fishery

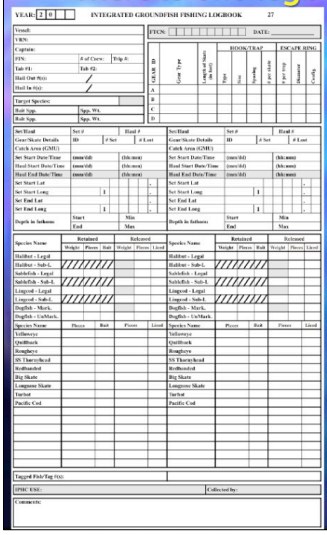
- Pilot Integration April 2006
- 7 fisheries, all with various catches, combined and became fully accountable.
- Over 70 species to manage
- Up to 5 management areas per species

INTEGRATED GROUNDFISH MANAGEMENT

- 1 management plan
- Catch shares for all species and vessels
- each vessel accountable for all catch – whether retained or released
- Trading of quotas between vessels, gear types, and fisheries

- 100% dockside and at-sea monitoring

There is one logbook for all vessels



Logbooks are audited against video footage and then compared to the offload

Fishermen's logbooks are being use in science and management (we can trust the data now)

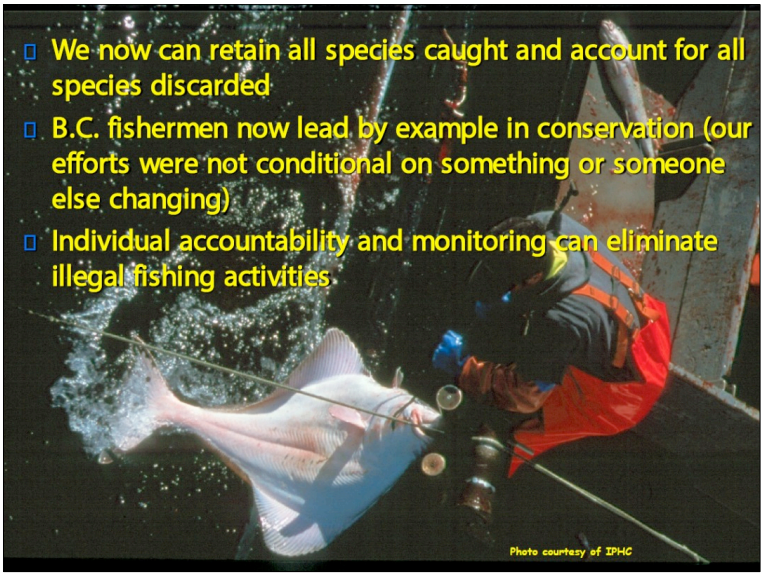
At-sea data provides information on total catch mortality (retained and released)

To reduce cost 10% of fishing events are randomly audited

WHAT ARE THE BENEFITS?

- Markets
- Managers
- Resource
- Safety
- Enforcement
- Science (Data and more comfort changing management measures)
- Seafood certification
- *New jobs (monitoring)*
- *Evidence of fleet and fish pattern changes (Data access)*
- *Opportunity for exclusive access*
- *Improved cooperation among fishermen**
- *Selectivity**
- *Moral high ground*

- We now can retain all species caught and account for all species discarded
- B.C. fishermen now lead by example in conservation (our efforts were not conditional on something or someone else changing)
- Individual accountability and monitoring can eliminate illegal fishing activities



Everything sounds wonderful

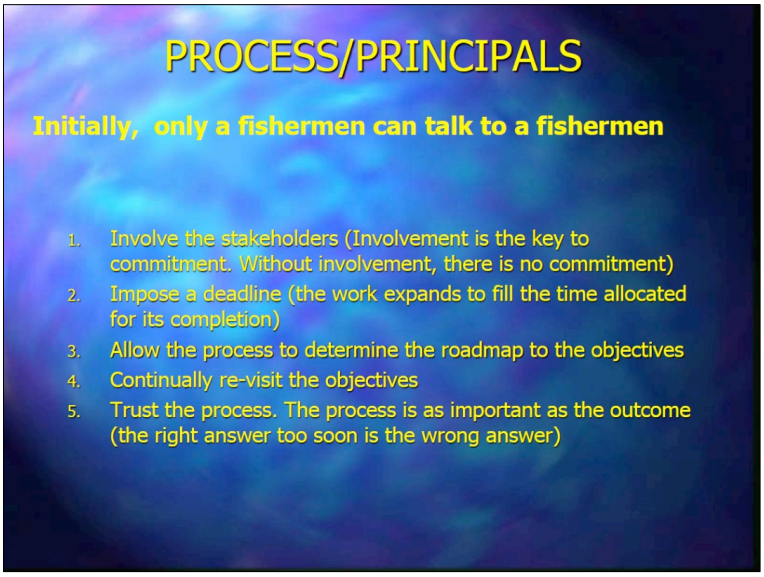
No part of this was easy

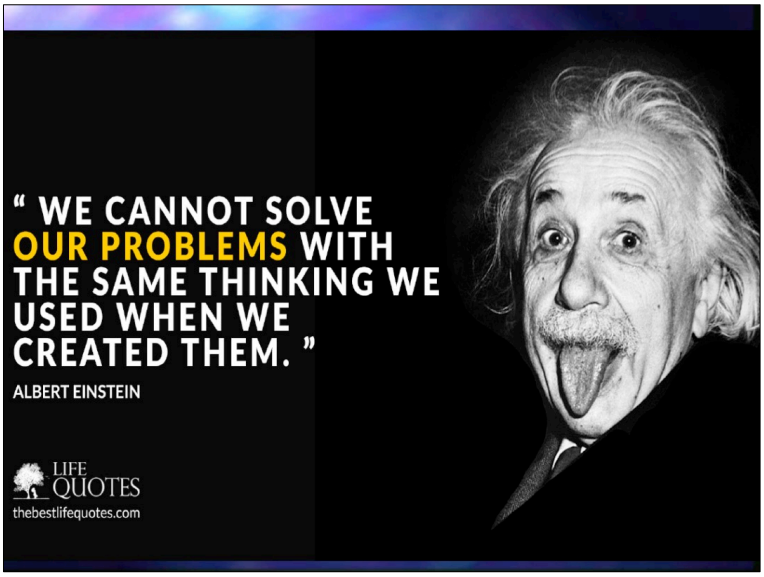
It was a process that took time, was inclusive, with much give and take from all involved. Fishermen sacrificed their freedom, time and money, scientists adjusted quotas and mortality variances, and managers adjusted rules. Back and forth…

We continue to contend with the *"Law of unintended consequences"*

Here are some of the things we have learned


How did we facilitate change
Define the objectives (providing rationale for them)
Identify participants
Begin a consultative process
Every fishery will have a different design to address specific
problems and concerns
With enough "incentive" any problem can be solved

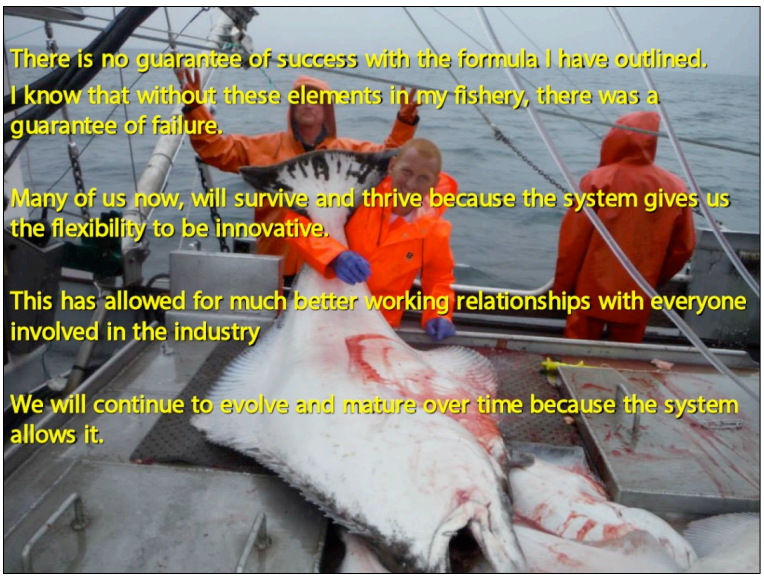

PROCESS/PRINCIPALS
Initially, only a fishermen can talk to a fishermen
1. Involve the stakeholders (Involvement is the key to commitment. Without involvement, there is no commitment)
2. Impose a deadline (the work expands to fill the time allocated for its completion)
3. Allow the process to determine the roadmap to the objectives
4. Continually re-visit the objectives
5. Trust the process. The process is as important as the outcome (the right answer too soon is the wrong answer)

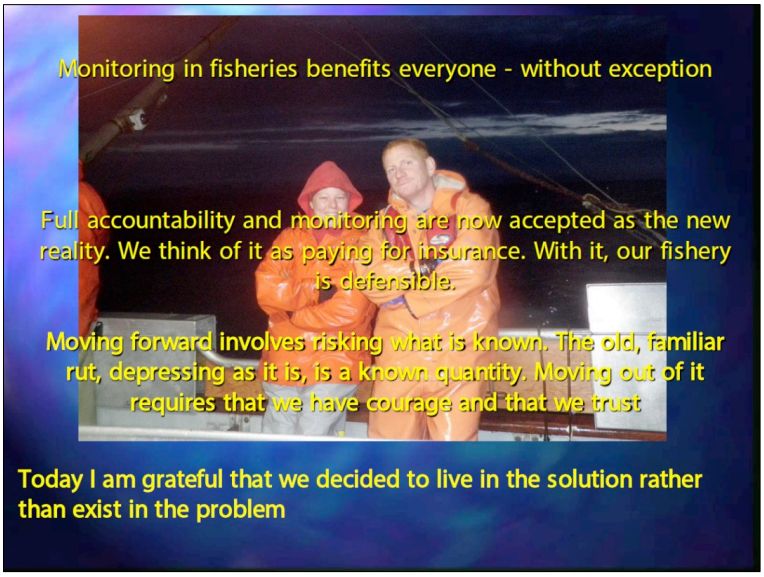

" WE CANNOT SOLVE
OUR PROBLEMS WITH
THE SAME THINKING WE
USED WHEN WE
CREATED THEM. "
ALBERT EINSTEIN
LIFE QUOTES
thebestlifequotes.com


The five most important components of this fishery are
1. Elimination of the race for fish
2. Individual Accountability
3. Transferability
4. An innovative dynamic advisory body
5. Monitoring
This fishery works because of how these components compliment each other and how everyone worked together to achieve them.


MOVING FISH
Transferability is a important feature of the management system – supports selective fishing, staying within allocations and allows industry to adjust to resource and market dynamics.
Vessels are allowed to carryover between years some level of quota underage and overages
–This encourages vessels to fish under their allocation
Although this is the most controversial


Governance/ Co-management
We make mistakes, mistakes are how we learn. We have a dynamic environment in which stakeholders seek ways to improve conditions, this leads to continued evolution.
We have an advisory body, made up of stakeholders that will never be a decision-making authority
Because of the relationship developed over time, it is so respected by decision makers, that almost all suggestions presented by the advisory body are implemented
TRUST

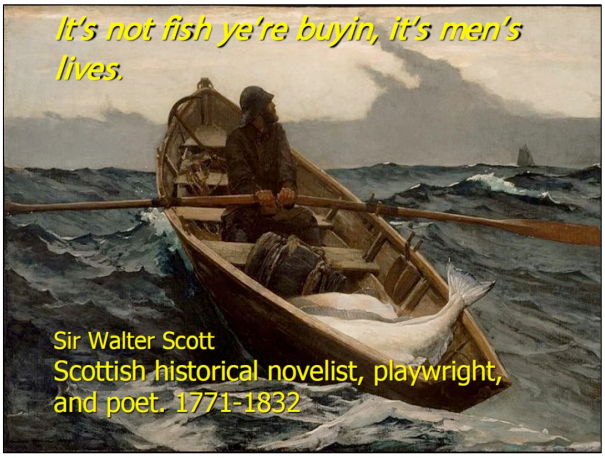

There is no guarantee of success with the formula I have outlined.
I know that without these elements in my fishery, there was a guarantee of failure.
Many of us now, will survive and thrive because the system gives us the flexibility to be innovative.
This has allowed for much better working relationships with everyone involved in the industry
We will continue to evolve and mature over time because the system allows it.


Monitoring in fisheries benefits everyone - without exception
Full accountability and monitoring are now accepted as the new reality. We think of it as paying for insurance. With it, our fishery is defensible.
Moving forward involves risking what is known. The old, familiar rut, depressing as it is, is a known quantity. Moving out of it requires that we have courage and that we trust
Today I am grateful that we decided to live in the solution rather than exist in the problem


'Rest on one's laurels'?
To be satisfied with one's past success and to consider further effort unnecessary.


The story is not over
Shared benefits for boat, crew and quota owner
Expanding monitoring in the factory trawl fleet
Cooperation and allocation with other sectors and countries
We can be proactive


This story is unique
The principals are universal
We have matured over time from dependence to independence to interdependence
We could not have achieved this without vision, leadership and cooperation


It's not fish ye're buyin, it's men's lives.
Sir Walter Scott
Scottish historical novelist, playwright, and poet. 1771-1832


THANK YOU

8 Remote Electronic Monitoring of Scottish fisheries:

Helen Holah, Marine Scotland Science

Helen Holah is a Spatial and Remote Electronic Monitoring (REM) fisheries analyst at Marine Scotland, where she is working in the Fisheries Assessment and Advice team, and is responsible for REM data management, analysis and provision of automated visual analysis training material to partners. She is currently acting as the scientific lead on coordination of REM within Scottish waters. Helen holds degrees in Marine Ecology & Environmental Management.

Scotland implemented a REM pilot programme in 2009, where seven demersal fishing vessels were installed with the necessary EM technology. The voluntary pilot cod catch quota scheme (CCQS) was then implemented in 2010, which included operating a Fully Documented Fishery (FDF) for cod. The results from these pilots suggest that discard rates can be significantly reduced with REM, both in regard to species and size high-grading. The implementation of the EU landing obligation in Scottish waters in 2016/17 did however change acceptance of fishermen to take part in the FDF, as the documentation could be used to prosecute the vessels for landing obligation infringements. The main obstacle for implementation of a successful REM programme is therefore the lack of acceptance from the industry.

Marine Scotland has, as part of this work, been trying to develop a computer vision software & hardware to register catch composition by species and size. This is an ongoing initiative that can save time and allow for collection of valuable scientific data. This is however a complicated technology that is still in development.

The landing obligation is presenting the Scottish seafood industry and the authorities with new challenges. REM can have an important role in solving some of those challenges but buy-in from the fishing industry is essential if it is to succeed.

Leiðandi vettvangur í tíu ár

Remote Electronic Monitoring (REM) of Scottish fisheries:

A strategic approach to development of an evidence base

Helen Holah, Neil Campbell & Coby Needle
Marine Scotland Science, Aberdeen, UK

Scottish Government
Riaghaltas na h-Alba
gov.scot
marinescotland science

SJÁVARÚTVEGS RÁÐSTEFNAN

ISI ICELAND SEAFOOD · TM · iTUB · BRIM · HAMPIÐJAN

Early years

2009 REM pilot of installation of systems & data interpretation on 7 Scottish demersal fishing vessels – 1 vessel for data analysis.

marinescotland science

Early years: Early conclusions

- REM & at-sea-observer data broadly comparable. Discrepancies from two main causes (1) **REM**: fish piling on conveyors (2) **Observers**: imprecise estimation of total catch weight.

- REM has application in determination of deep-water catch composition & benthic catch composition associated with Vulnerable Marine Ecosystems (VMEs).

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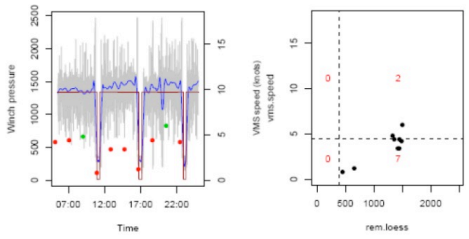
Early years: Early conclusions

- REM indications of fishing activity in the majority of instances confirm the assumption that vessels are fishing at speeds 0.5-4.5 knots.

  (92% of cases - 204/221 VMS pings REM confirmed VMS indication).



Left = winch pressure (with fitted loess curve in blue) from REM system, right = VMS speed against loess value.
Dots indicate VMS pings, red = fishing, green = not fishing.

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Rise & fall of FDF

2010 Marine Scotland voluntary pilot Cod Catch Quota Scheme (CCQS) operating a Fully Documented Fishery for Cod.

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FDF rise & fall: Cod recovery plan

- **EU long-term management plan for North Sea cod**
  - Aalborg statement between ministers of UK, Denmark & Germany
    - Joint recommendation for wider use of CCTV in fisheries monitoring
  - Operated through;
    - landings quotas (TACs) & effort restrictions
    - allowed Member States to 'buy back' 5% of quota (2010 Scotland = £1 million) or increase fishing effort for fleet segments engaged in cod-avoidance measures
      - RTCs, Selective Gears and CCTV systems
- **2010 Voluntary Catch-quota pilot with REM systems**
  - Reduce discards/stock mortality
  - Provide "better" scientific data
  - Encourage more selective fishing
  - Improve effectiveness of regulations

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FDF rise & fall: Outcomes for science

- Evidence for lower discard rates (as estimated from video footage) for vessels carrying REM.

	NS
Cod	
MSS	32.23 (37.86)
SFF	22.2 (32.36)
REM	0.04 (0.09)
Haddock	
MSS	17.75 (29.24)
SFF	10.11 (10.92)
REM	5.45 (4.45)
Whiting	
MSS	25.79 (34.5)
SFF	26.8 (24.84)
REM	8.68 (9.08)
Saithe	
MSS	40.58 (32.38)
SFF	48.48 (36.45)
REM	17.52 (22.39)
Hake	
MSS	63.83 (34.73)
SFF	68.75 (37.95)
REM	42.41 (35.47)
Monkfish	
MSS	1.18 (5.32)
SFF	0.00 (0.00)
REM	0.48 (0.72)

Estimated % discard rates (mean, standard deviation) by weight for Scottish vessels during Q4 2012 and Q1-3 2013 as derived from 3 programmes. MSS = Marine Scotland Science, SFF = Scottish Fishermen's Federation.

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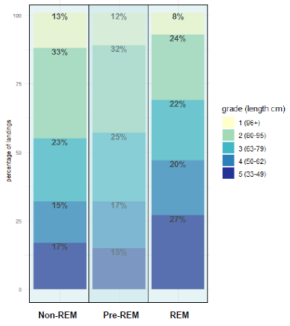
FDF rise & fall: Evidence of change?

- Changes in size compositions of cod catches for vessels when cameras are installed.



Average % of cod landed by market grade (2010-2016)

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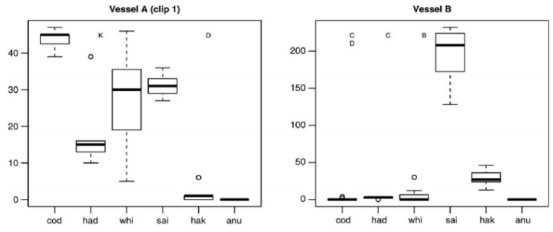
FDF rise & fall: Method development

- Comparisons of REM-based species counts from different video reviewers were needed to identify training requirements.



Boxplot summaries of fish counts (y axis) from 10-min video clips for six species by 11 Marine Scotland Science analysts – each outlier has a letter printed above it which refers to the analyst.

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FDF rise & fall: Landing Obligation

- **EU Landings Obligation implemented for Cod in 2017**
  - Discarding of cod illegal
  - End of the cod recovery scheme
  - No longer possibility to incentivise fishers with quota
  - Most vessels left the scheme immediately
  - Already problematic for participants after introduction of Haddock to LO in 2016 with warning letters sent to skippers about discarding.
  - 2017 FDF scheme using Saithe and Monk quota
  - 2 of 3 2017 FDF vessels prosecuted for LO infringements

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Strategic approach to REM

No new data! ☹ How can we develop the evidence base for electronic/CCTV monitoring of fisheries discards as a tool for science?

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Strategic approach to EM

- **Potential Opportunities**
  - Reduced cost of data collection
  - Verifiability of observations
  - Better understanding of implementation
  - Improved organizational profile
  - Reduced discarding
  - New data streams
  - Improved biodiversity/spatial indicators
- **Potential Risks**
  - Lack of industry/policy buy-in
  - Tool proves to be imprecise

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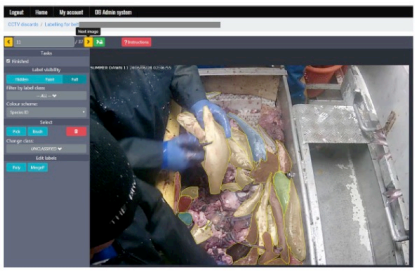
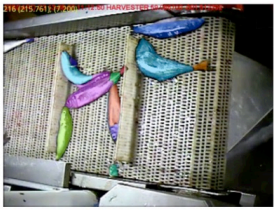
Strat. App: Verifiability & time saving





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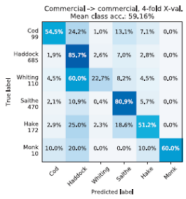
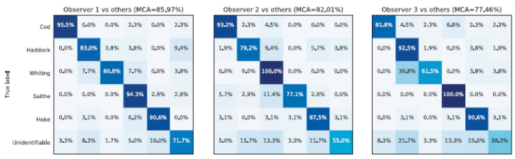
Strat. App: Verifiability



Confusion matrix of algorithm trained & tested on footage from commercial conveyor belt footage.



Inter-observer agreement confusion matrices. Each confusion matrix compares the species choice of an observer with the majority vote of the other seven observers.

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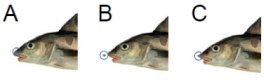
Strat. App: Standardising methods

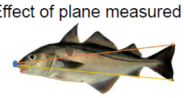
Effect of distance from camera

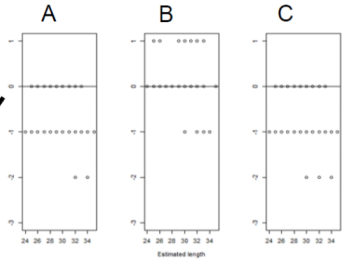
Effect of measurement tool

A B C



Effect of plane measured





Difference from true measure (cm)	Method A	Method B	Method C
1	0	9	0
0	26	82	23
-1	71	9	72
-2	3	0	5

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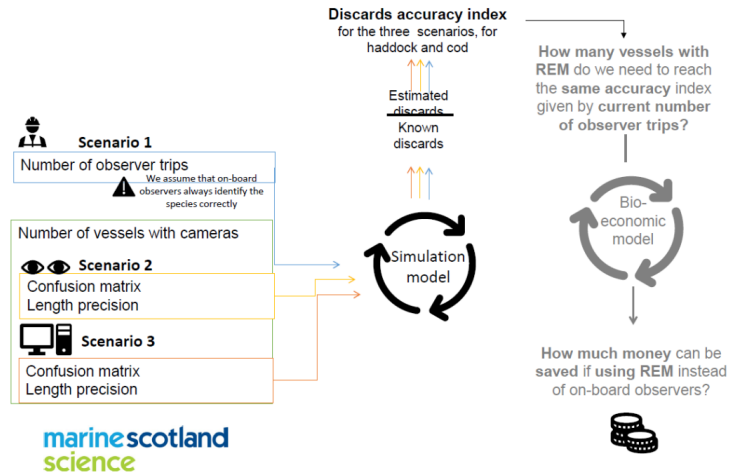
Strat. App: Costs & precision



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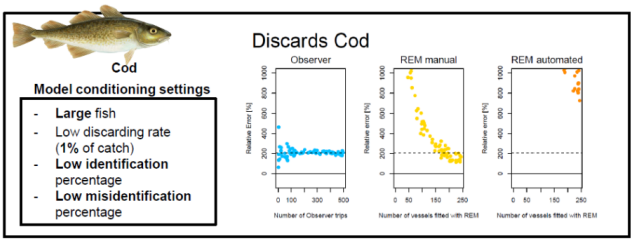
Strat. App: Costs & precision



Complexities:
- Single species simulation
- Species
- Confusion errors
- Precision errors
- Age/length key assumptions
- Assumptions on observer scenario
- Discard rate
- Effect on stock assessment output

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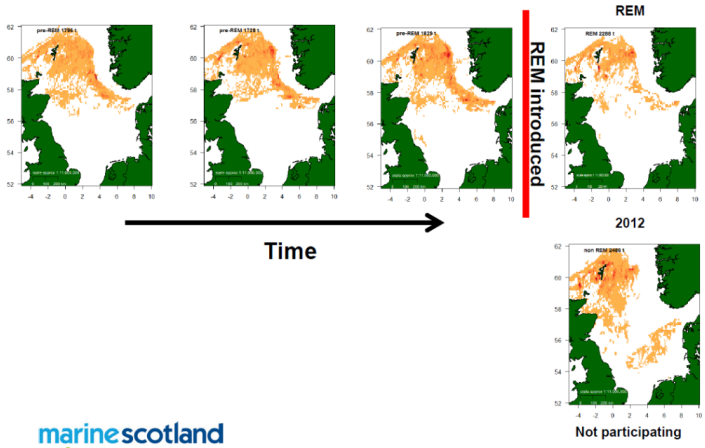
Strat. App: Understanding execution



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Future work

Shifting focus to a "Modernisation of the inshore fleet" programme. Embedding inshore fisheries into wider spatial planning.

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Future work: shifting focus

- **New direction of objectives**
  - Conflicts of marine spatial planning
- **Phased introduction based on risk**
  - Perceived risk to habitats, gear conflict
- **New stakeholder dynamics**
  - Stakeholder interfaces with policy/science new incentives
- **What are the science needs now?**
  - Shift towards sensor only systems
- **Key messages**
  - Flexible, responsive.
  - Adaptable and continue to share 'best-practice'
  - Push standardisation & delivery of data products

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9 The EU landing obligation and REM

Clara Ulrich & Kristian Schreiber Plet-Hansen, DTU Aqua/IFREMER

Clara Ulrich is the Deputy head of Science at IFREMER (French Research Institute for Exploitation of the Sea) and chair of STECF (the EC Scientific, Technical and Economic Committee for Fisheries). Clara works in the unit working on scientific strategy at IFREMER, ensuring its multidisciplinarity, quality and policy relevance. As deputy Head of Science Clara Ulrich mainly deals with aspects linked to ecosystem-based fisheries management and support to national and European fisheries policies. Clara was also the coordinator of the H2020 project DiscardLess that finished in early 2019, but that project was aimed to help provide the knowledge, tools and technologies as well as the involvement of the stakeholders to achieve the gradual elimination of discarding in EU fisheries.
Kristian Schreiber Plet-Hansen is an expert at the Data and Monitoring section of DTU Aqua. He has been Involved in data collection processes and EU projects aiming at improved efficiency, sustainability and compliance in fisheries, which was also part of his PhD in engineering.

Clara and Kristian reviewed how the gradual implementation of the EU landing obligation had progressed, from initial stages in 2015 to full implementation in 2019. As part of the implementation, each EU member state was required to develop multiannual plans or specific annual discard plans detailing issues such as provision on catch documentation, species covered, minimum conservation reference sizes (MCRS), exemptions, de minimus discards allowances etc. As part of the compliance monitoring the European Fisheries Control Agency (EFCA) and the member states conducted joint deployment of patrol vessels and "last haul analysis" in cooperation with a reference fleet. But after four years of implementation, it must be admitted that there has been very little progress. The "last haul analysis" does for example suggest a generally widespread non-compliance [21]. The approach the EU took when implementing the landing obligation was to top-up TACs to meet the discards, meaning that quotas were increased by around 30% with the assumption that what was previously discarded would now be landed. The evidence now suggest that discarding is continuing and that catches are then likely around 30% over scientific advice. It is therefore evident that more efficient MCS is needed, and there is currently a strong push for REM from the commission and various NGOs, but there is still a reluctance for uptake in the fishing industry. The industry does for example argue that REM will not solve the fundamental causes of discarding in mixed fisheries, including unequal access to quota, choke species and technical interactions. They also have a "Big Brother" feeling that goes against their principle believes. In addition, it must be taken into consideration that all incentives previously used in REM trials (like quota top-ups, exemptions etc) have already been given away "for free", and accountability has not been included upfront in the discard plans.

The experience shows that MCS in connection with the landing obligation is lacking, and REM can be a part of the solution. There are however major obstacles in the way, particularly in regard to reluctance from the fishermen/fishing industry.

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under grant agreement no. 633680

www.discardless.eu

DiscardLess

Leiðandi vettvangur í tíu ár

The EU landing obligation and REM

Clara Ulrich (IFREMER / DTU Aqua)

Kristian Schreiber Plet-Hansen (DTU Aqua)

SJÁVARÚTVEGS RÁÐSTEFNAN

ISI ICELAND SEAFOOD · TM · ITUB · BRIM · HAMPIÐJAN

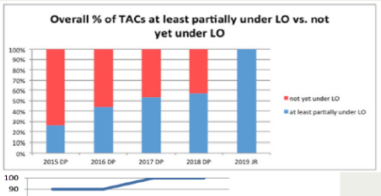
Four years of implementation of the EU landing Obligation (2015-2019)

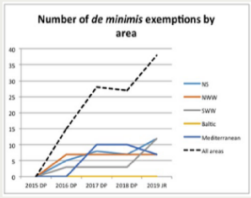
positive

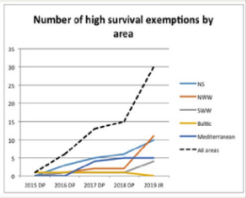
DiscardLess

Progresses on the regulatory side / regionalisation ….

Regional discard plans (DP) adopted annually laying down the calendar of implementation (species*fisheries) and the exemptions (high survivability, de minimis)







EU Com SWD(2019) 205

Four years of implementation of the EU landing Obligation (2015-2019)

positive

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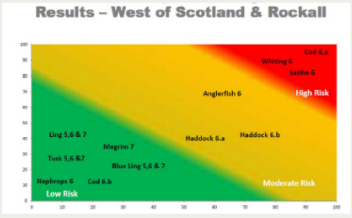
Progresses on reaching common understanding on discard causes and quantification of risks of choke species ….

Choke categories:

- Category 1: Sufficient quota at Member State level, but poorly distributed within a country **issue at PO/individual level**
- Category 2: Sufficient quota at EU level but insufficient at Member State level, **relative stability issue**
- Category 3: Insufficient quota at EU level, **overfished stock**
- Category 4: Economic choking **large quantities of low value fish**.



NorthWestern Advisory Council 2017
Rihan 2018

Four years of implementation of the EU landing Obligation (2015-2019)

Stakeholders' perception: A slow evolution

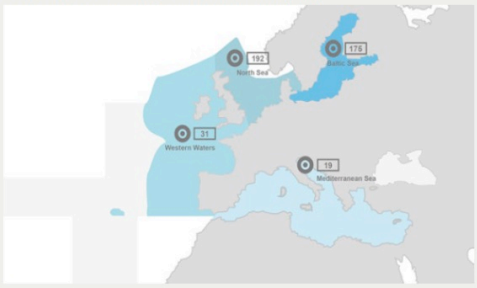
DiscardLess conference Table Discussions 30/01/2019

- Awareness and dialogue
- Collaboration with scientists / authorities
- Mindset shift and new eyes on old issues
- Can improve the reputation of the sector
- Level playing field
- Aiming at reducing discards make sense…
- ….

Four years of implementation of the EU landing Obligation (2015-2019)

Some progresses on compliance monitoring ….

European Fisheries Control Agency (EFCA) and Member States conduct Joint Deployment Plans of patrol vessels (Last Haul analysis)



EU Com SWD(2019) 205

Four years of implementation of the EU landing Obligation (2015-2019)

But in reality VERY LITTLE visible progresses so far ….

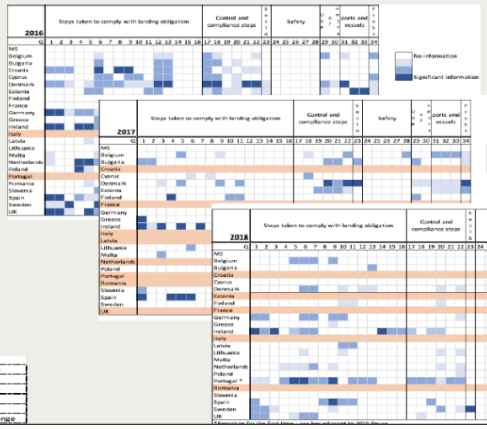
EU Com SWD(2019) 205:
« the results of the last haul analysis point in the direction of a very poor implementation of the landing obligation and of a generally widespread non-compliance"

Four years of implementation of the EU landing Obligation (2015-2019)

Member States	2016	2017	2018
Belgium			
Bulgaria			
Croatia			
Cyprus			
Denmark			
Estonia			
Finland			
France			
Germany			
Greece			
Ireland			
Italy			
Latvia			
Lithuania			
Malta			
Netherlands			
Poland			
Portugal			1st report
Romania			
Slovenia			
Spain			
Sweden			
United Kingdom			

Key

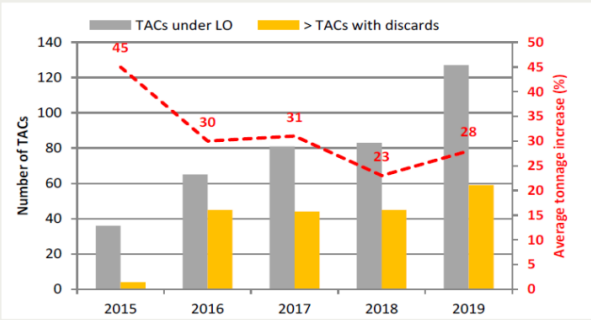
	2016	2017-2018
	No Report	No Report
	No information	No change
	Significant information	Significant change



Member States report annually to EU Com, results summarised by STECF

Four years of implementation of the EU landing Obligation (2015-2019)

TACs are increased....



If TACs are increased and discarding continues there is a risk that fishing mortality increases!

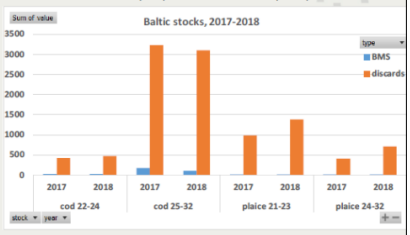
Borges et al, 2019

Which consequences for fisheries data?

Catch data more uncertain....

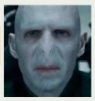
- Discrepancies between discards estimates
- Fisheries observers less accepted onboard
- Potential bias (observers' effect)
- Knowlegde on discard volumes more uncertain

Example of discrepancies between observed discards (red) and landed BMS (blue)



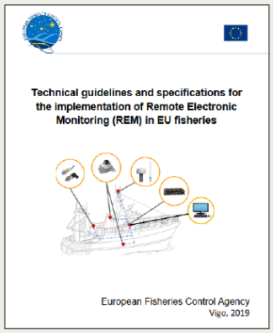
- Data more complex ⟶ Increased uncertainty in the stock assessments
- Data more uncertain
- The "Unwanted Catch" schizophrenia!

The Discards-who-cannot-be-named



So where are we now with REM?

A strong push for REM from Commission and NGOs….



Technical guidelines and specifications for the implementation of Remote Electronic Monitoring (REM) in EU fisheries

European Fisheries Control Agency
Vigo, 2019

EUROPEAN COMMISSION

Brussels, 30.5.2018
COM(2018) 368 final

2018/0193 (COD)

Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

amending Council Regulation (EC) No 1224/2009, and amending Council Regulations (EC) No 768/2005, (EC) No 1967/2006, (EC) No 1005/2008, and Regulation (EU) No 2016/1139 of the European Parliament and of the Council as regards fisheries control

{SEC(2018) 267 final} - {SWD(2018) 279 final} - {SWD(2018) 280 final}

The control of the Landing Obligation in Denmark

Landing obligation	New: 25a	The amendments mandate the use of remote electronic monitoring tools, in particular CCTVs, for the control of the landing obligation. The new provisions will affect individual vessels and fleet segments according to risk assessment, and shall be implemented by Member States at regional level.

So where are we now with REM?

But reluctance is still strong….

- REM will not solve the fundamental causes of discarding in mixed fisheries, incl. inequal access to quota, choke species and technical interactions. Technical solutions to reducing discards remain limited
- "Big Brother" feeling still very strong
- All incentives previously used in REM trials (like quota top-ups, exemptions etc) have already been given away "for free", accountability has not been included upfront in the discard plans.

EU Control regulation still in discussion today!!

Conclusions

- A lot has happened – and yet nothing has visibly really changed yet...
- The LO has remained very unpopular in the fishing industry. Its objectives remain unclear and little supported by the national administrations
- TACs have been increased and exemptions have been given but discarding continue. This goes against the MSY objectives. Also, uncertain catch data undermines the quality of stock assessment
- Recognition that control and enforcement are absolutely unsufficient. The current procedures cannot control the LO effectively.
- The landing obligation has triggered an intense dynamic of dialogue and awareness that wouldn't have taken place otherwise
- There is a major push towards the use of REM but reluctance remains strong. Control regulation still in discussion.

THANK YOU

And apologies for not being here in person!

Free download https://link.springer.com/book/10.1007%2F978-3-030-03308-8

SJÁVARÚTVEGS RÁÐSTEFNAN

10 Panel discussions

Lively panel discussions took place at the end of the conference where the following experts joined the presenters in the panel:

- Hrefna Karlsdóttir from Fisheries Iceland (SFS)
- Kristján Loftur Einarsson from Öryggismiðstöðin -> CCTV technology supplier
- Lara Erikson from the International Pacific halibut commission
- Christopher McGuire from The Nature Conservancy

Hrefna Karlsdóttir from Fisheries Iceland (SFS), which represents the majority to the Icelandic fishing industry (including the catching sector, processors, marketing & distribution etc.) was asked about the view of SFS on REM?
She expressed concerns regarding how rules and regulations are lacking or unclear when it comes to privacy and potential access & use of data derived from EM. She also pointed out that discard analysis from the Icelandic Marine and Freshwater Research Institute (MFRI) and the Directorate of Fisheries show that discarding rates by the Icelandic fleet are very low [22][*] and that Implementing an REM programme in Iceland would therefore not necessarily be needed. The main issue is that the ITQ system in place enables fishing companies to buy and trade quotas when choking on species and landing unwanted catches without being deducted from quota[**] if necessary. The incentives built into the Icelandic ITQ system do therefore provide sufficient means for fishermen not to discard catches.

Kristján Loftur Einarsson from Öryggismiðstöðin, was asked about the technical maturity of the available REM solutions, and if the currently available solutions are reliable and applicable to be installed onboard Nordic fishing vessels, at reasonable cost?
Kristján pointed out that he and his company has been working on camera surveillance and EM in other sectors than fisheries for a long time with very good success. CCTV surveillance is now used in most industries, including retail, banking, law enforcement, heavy industry etc. There are of course issues that come up regarding reliability and privacy, but in general there is acceptance on the use of these solutions, and they are considered applicable. The environment onboard fishing vessels is naturally more demanding and there are other technical challenges to deal with, but in general the same principles apply. The hardware used onboard of fishing vessels needs to be tough enough for the difficult environment, which affects the cost. We have been working closely with the Icelandic Directorate of Fisheries for the past few years on technical solutions for MCS in fisheries and we are convinced that the solutions can be considered applicable for the majority of the Icelandic fishing fleet. What is reasonable cost and who is to pay is then another issue.

[*] Reference added by editor

[**] The so called “VS-afli“ is sold on auction markets and 20% of the sales price goes to the fishing company and 80% is allocated to a research fund.

Lara Erikson from the International pacific halibut commission was asked what the experience of IPHC is from the use of REM for MCS?
Lara emphasised that IPHC is an International Fisheries Organization, having Canada and the United States as its members, and that it is responsible for the management of stocks of Pacific halibut within the Pacific waters of its member states. IPHC was founded in 1923 and is heavily involved in stock assessment and management of the Pacific halibut. MCS is naturally of great concern for the IPHC and it has therefore been one of the pioneers in using EM. Electronic Monitoring solutions, including camera surveillance, automatic data registration, computer vision & Artificial Intelligence are now tools that are a part of our observer programme. The data collected using these tools are not only important to monitor compliance, but also important scientific data for stock assessment.

Christopher McGuire from The Nature Conservancy, which is an NGO that has been advocating for EM for many years and is in the forefront of lobbying for uptake of REM on global scale. He was asked what the role of an NGO like his was in advocating for REM and what he thought were the main obstacles for implementation.
Christopher replied by saying that the Nature Conservancy recognises the importance of wild capture fisheries and wants to have constructive input to ensuring sustainable fisheries. Many NGOs that are working on protecting the marine environment are solely focused on pointing at negative effects of fisheries, but we want to be a part of the solution. Reliable documentation and full accountability is a necessary part of sustainable fisheries and we believe that EM is an important tool to facilitate that. We recently published a report that identifies opportunities and barriers for implementing EM and provides recommendations for scaling the technology for the different fleets. For us the benefits clearly outweigh the barriers. We will therefore continue to advocate for EM and believe we will see a big change in uptake in the coming years.

Kristian Schreiber Plet-Hansen has been awarding all of his attention to EM over the past few years, as he has been working on his PhD at DTU on the subject. He was asked if the Landing Obligation is a lost cause, and if it is ever to work is EM the only solution?
Kristian replied by saying that the complications associated with the landing obligations were huge, of which MCS was only one part. The EU fleet is very fragmented, where different fleets from multiple member states are fishing side by side. The fact that undersized (MCRS) catches cannot be used for human consumption and that it is obligated to land catches that have no commercial value complicate things even more. The lack of infrastructure to deal with unwanted catches is also an issue on its own. It is therefore maybe not surprising that the implementation of the landing obligation is not perfect after just four years of implementation. We need to give this more time. It is then my believe that using REM, in one form or another, for MCS will be a necessary tool to guarantee compliance. Other means simply do not provide the necessary coverage.

Several questions and comments followed from the audience of the conference, which included Comments on privacy issues, especially onboard the smallest vessels that do for example not have toilet facilities; and comments on cost of installation, running and maintenance of the REM systems, and who should pay? People exchanged views on these issues and other, until they ran out of time.

The chair of the conference then gave a short summary of the proceedings and expressed his gratitude to the presenters and all thee attendees. The conference was then adjourned.

11 Concluding remarks

Electronic monitoring in fisheries are advancing and gaining momentum, as many fisheries around the world are either implementing elements of EM or considering doing so. It is however clear that EM will not solve all problems when it comes to MCS of fisheries, but can be an important tool to facilitate more efficient MCS and even reduce cost and/or increase coverage.

The Nordic countries are generally considered to be world leaders in sustainable fisheries management, of which efficient MCS is an intrinsic part. They have however not been in the forefront of utilising REM technologies (possibly with the exception of Denmark) where countries such as Canada, US, New Zealand, Australia and Chile have paved the way. The Nordic countries are therefore in the position to learn from those that have gone before them, use what has proven to be successful and avoid making the mistakes they did.

For the Nordic countries that are EU member states, the implementation of REM solutions can be controversial if other member states are not subjected to the same requirements. This is for example highlighted in the fact that Danish authorities have been very positive towards REM, whilst other member states fishing in the same waters are not. This creates an added challenge which is also amplified in controversy surrounding the implementation of the CFP landing obligation.

Nordic countries that are not EU member states are to a point in a better position, as they can take decisions on implementation without considering what other nations are doing. This has however not resulted in large-scale acceptance and uptake of REM solutions in countries such as Iceland and Norway, as the debate on such solutions remain unresolved. Norwegian authorities are keen on using all kind of solutions to collect data within the seafood value chains, including REM, and use that for MCS and scientific purposes, but the industry remains sceptical [23]. The story in Iceland is similar, where a governmentally appointed expert committee recently suggested that applicability of REM solutions, such as camera surveillance, should be explored [24]. The Icelandic Directorate of Fisheries has therefore started a pilot program using drones and CCTV cameras to monitor discards, which has already resulted in recordings of several discarding practises that may suggest that discarding is more of a problem than initially believed. The pilot program is however very controversial and has received major criticism from the fishing industry.

Several relevant pilot trials and research projects are currently ongoing in the Nordic countries. Examples of these are the previously mentioned drone and camera surveillance pilot project run by the Icelandic Directorate of Fisheries, an electronic monitoring project that the Danish Fisheries Agency is running in Kattegat [25], the H2020 project SMARTFISH which is coordinated by SINTEF in Norway and has partners in Denmark and Scotland [26]. These will without a doubt provide valuable knowledge that may contribute to more widespread uptake of REM solutions in the Nordic countries.

The EU is also looking towards REM solutions to solve MCS challenges in European fisheries. The European Fisheries Control Agency (EFCA) has for example developed Technical guidelines and specifications for the implementation of REM in EU fisheries [27], and has funded several research projects on the issue, such as SMARTFISH and iSEAS [28]. In addition, there is a topic published within Horizon Europe that is titled “Digital transition supporting inspection and control for sustainable fisheries” where two projects will be funded [29]. The proposal deadline is in early October 2021, which means that two fairly large Innovation Action projects will be running from 2022-2026 exploring alternatives for REM solutions in European fisheries. We must believe that all of these initiatives will at some time be adopted for improved MCS in the Nordic countries and beyond.

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