Leiðandi
vettvangur í tíu ár

Remote Electronic Monitoring (REM) of Scottish fisheries:

A strategic approach to development of an evidence base

SJÁVARÚTVEGS
RÁÐSTEFNAN

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Early years

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

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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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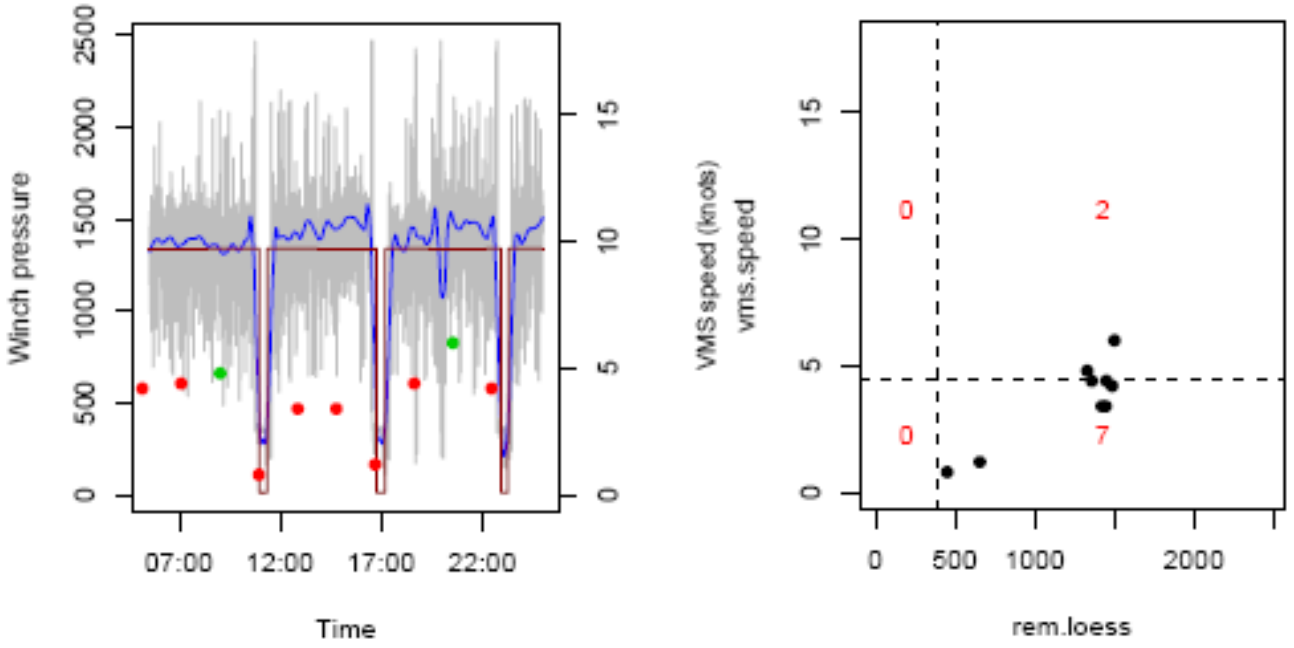
Early years: Early conclusions

- 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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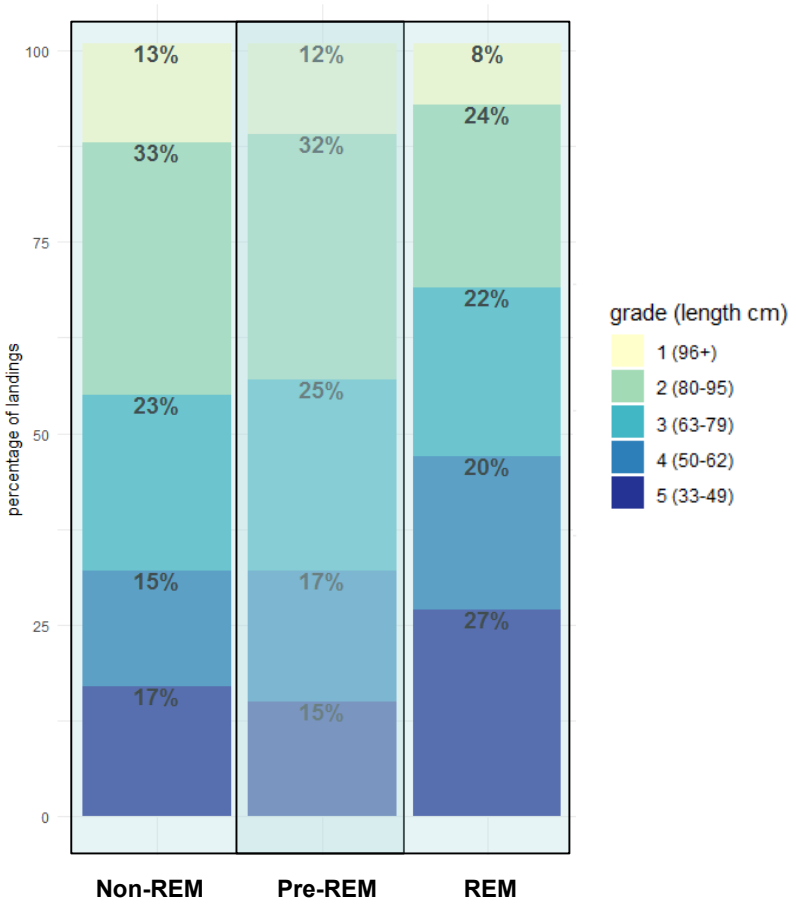
FDF rise & fall: Evidence of change?

- 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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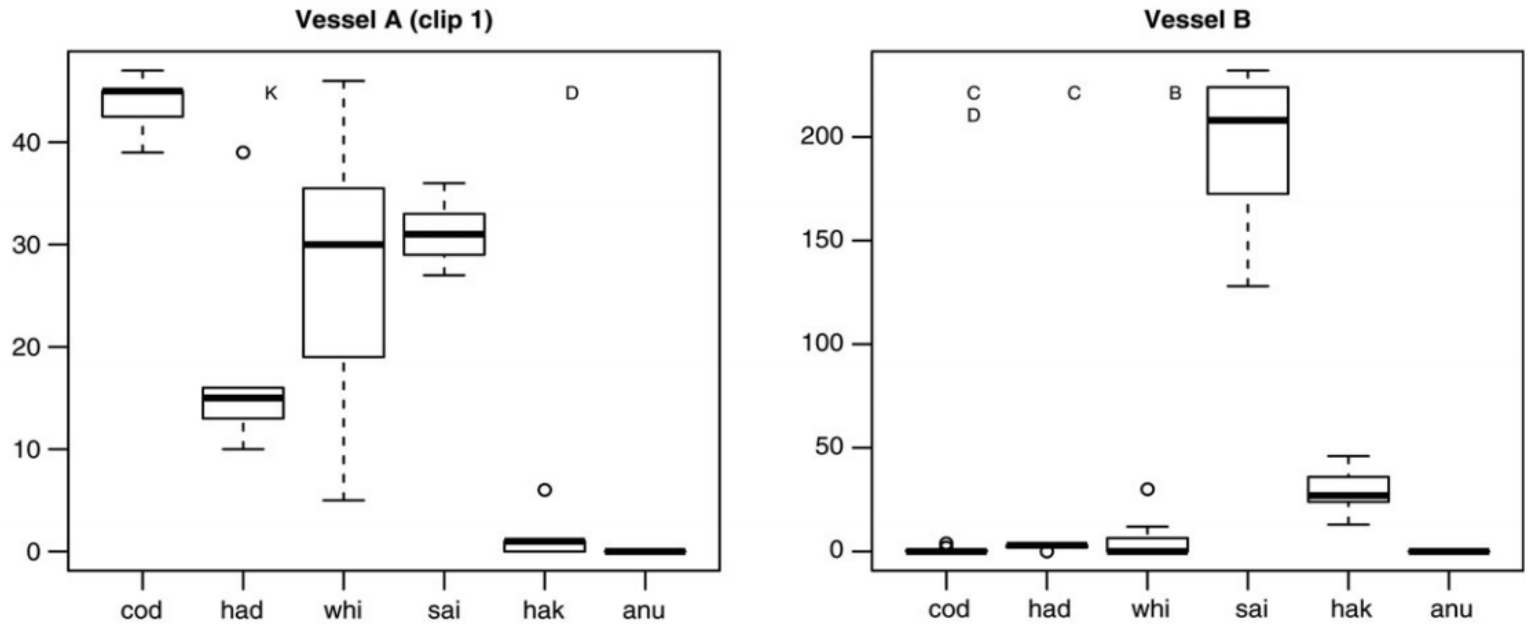
FDF rise & fall: Method development

- 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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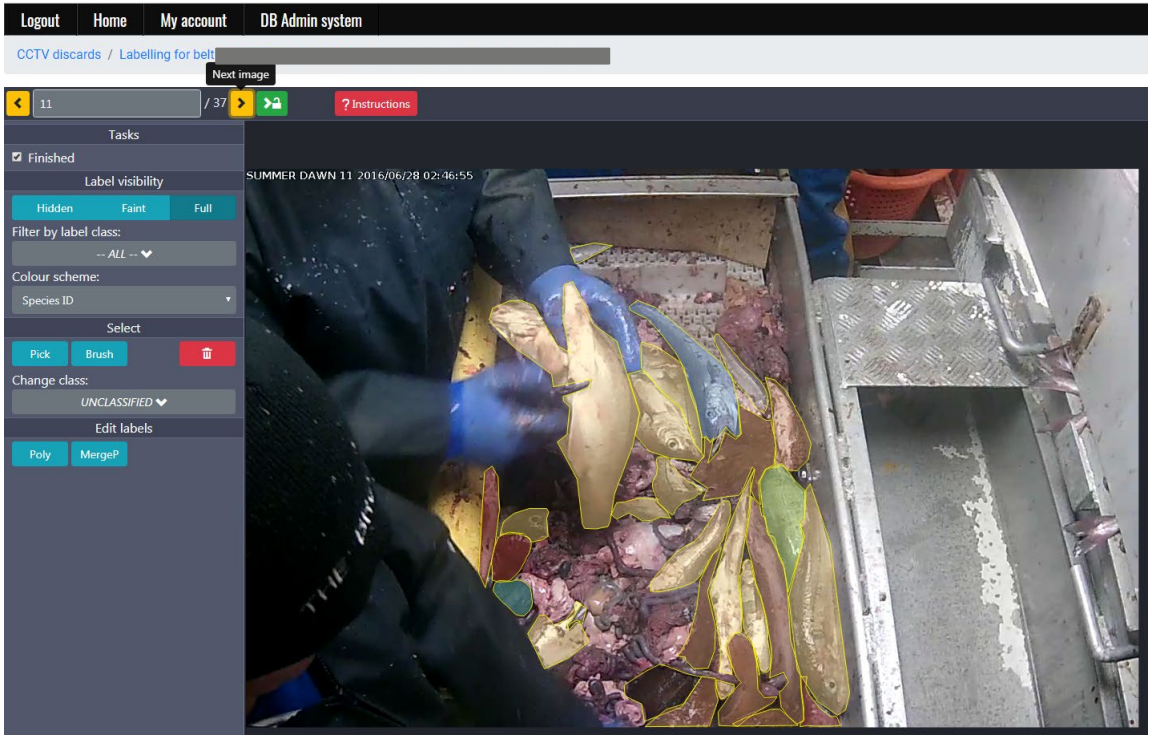
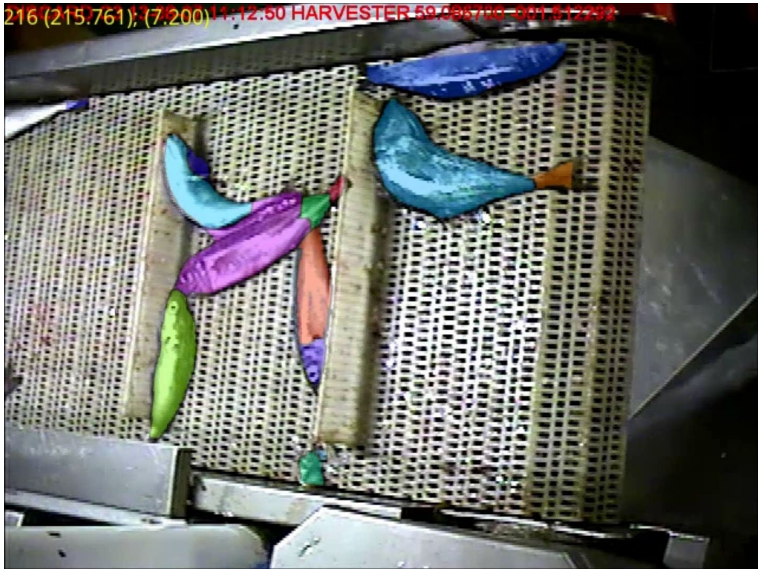
Strat. App: Verifiability & time saving





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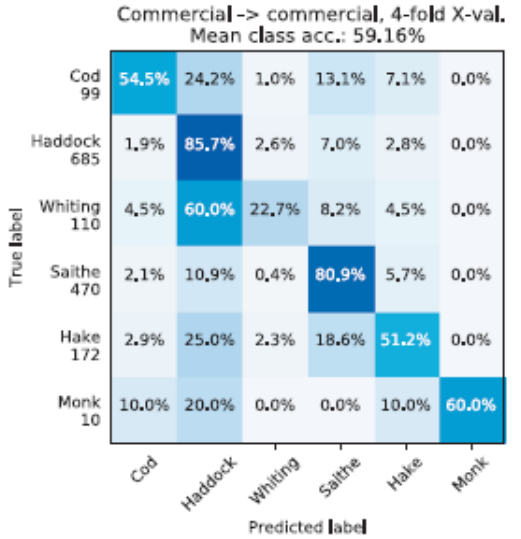
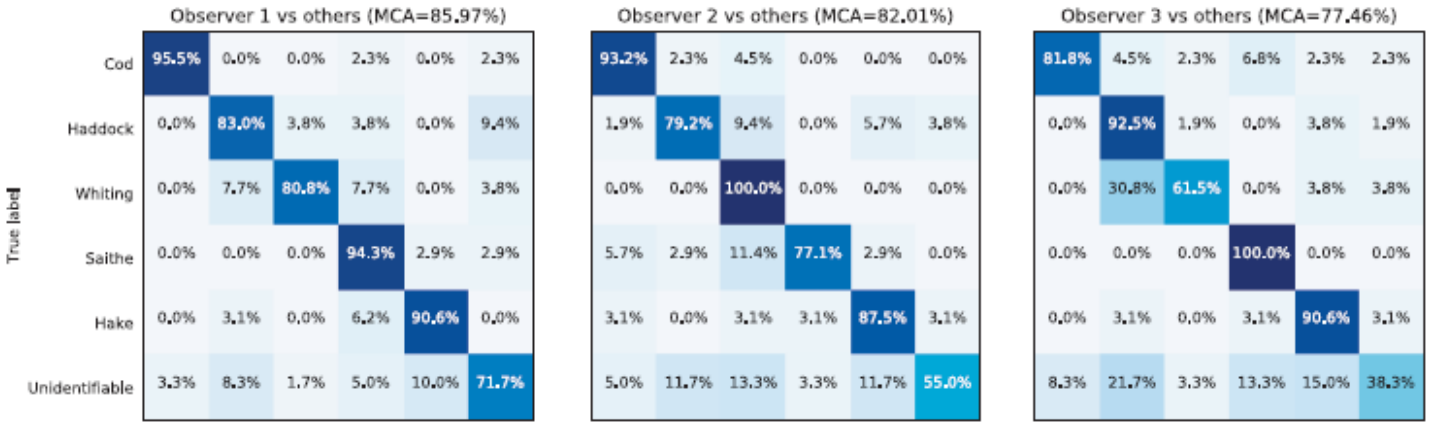
Strat. App: Verifiability



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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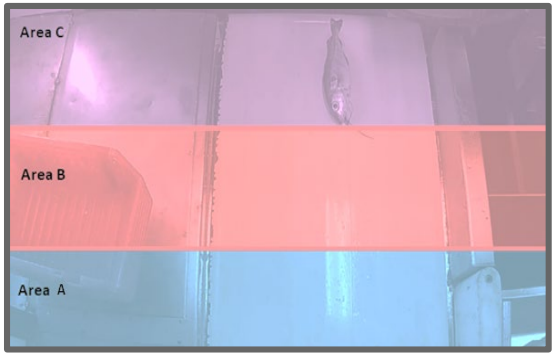
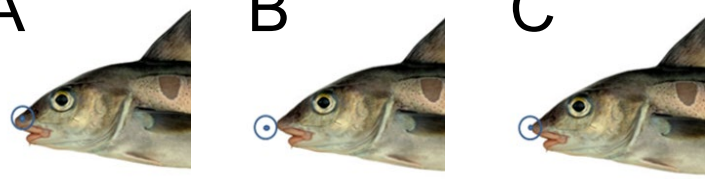
Strat. App: Standardising methods

Effect of distance from camera

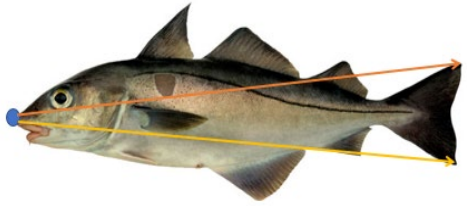


Effect of measurement tool

A B C



Effect of plane measured



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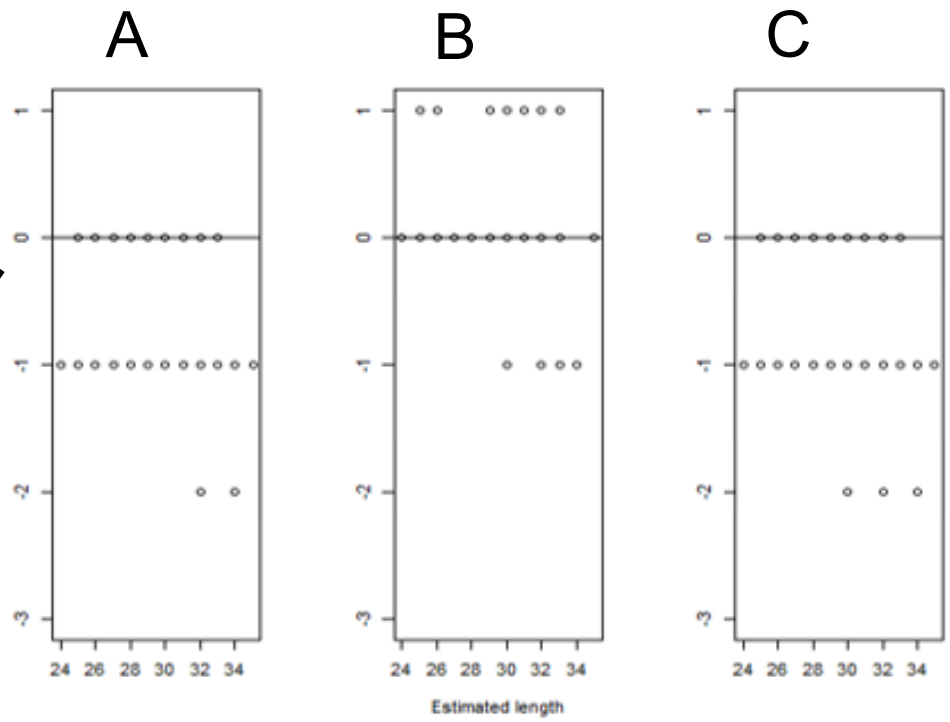

Difference from true measure (cm)	Method A	Method B	Method C
1	0	9	0
0	26	82	23
-1	71	9	72
-2	3	0	5

Strat. App: Costs & precision

Discards accuracy index
for the three scenarios, for haddock and cod

Estimated discards
Known discards

How many vessels with REM do we need to reach the **same accuracy** index given by **current number of observer trips?**

Scenario 1

Number of observer trips

We assume that on-board observers always identify the species correctly

Number of vessels with cameras

Scenario 2

Confusion matrix
Length precision

Scenario 3

Confusion matrix
Length precision

Simulation model

Bio-economic model

How much money can be **saved** if **using REM** instead of on-board observers?

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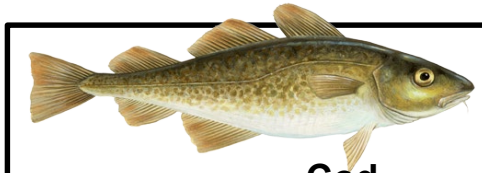
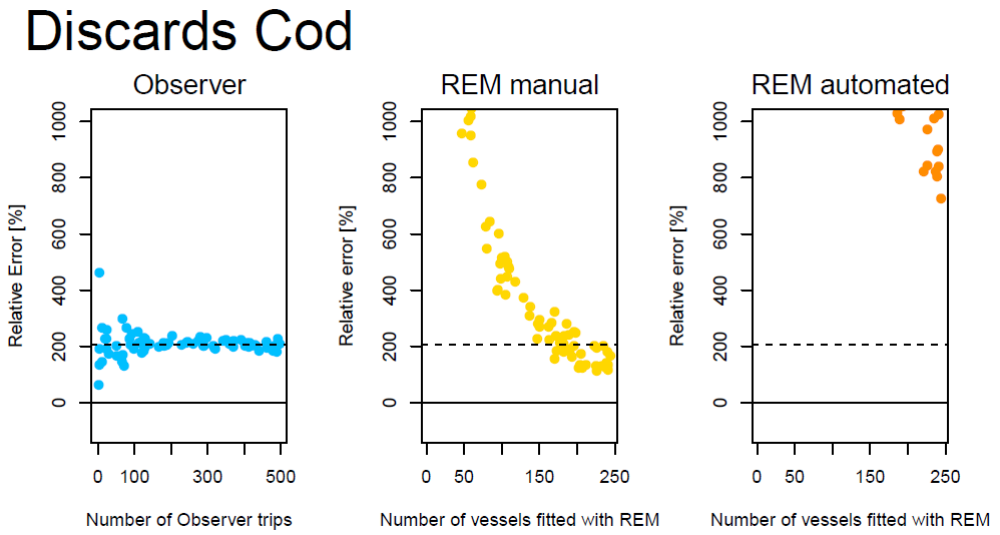
Strat. App: Costs & precision



Cod

Model conditioning settings

- **Large** fish
- Low discarding rate (**1%** of catch)
- **Low identification** percentage
- **Low misidentification** percentage



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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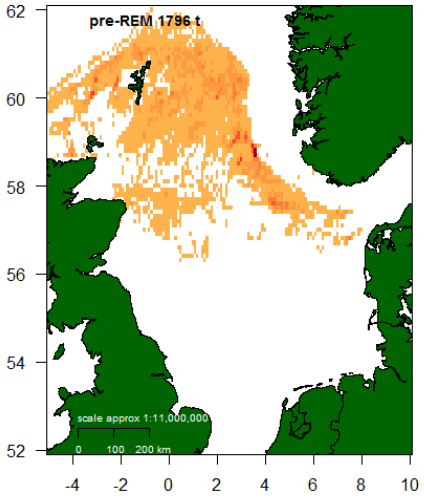
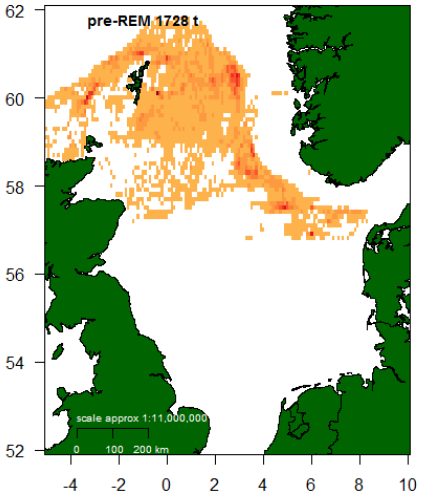
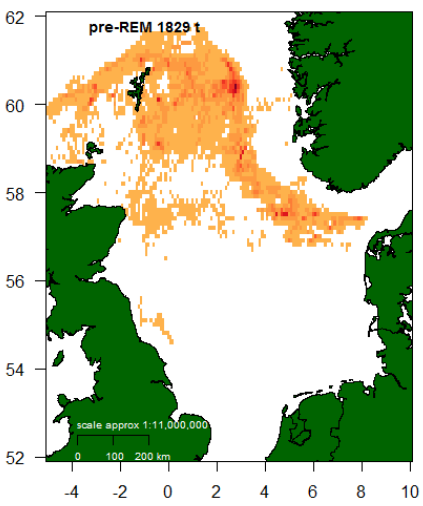
Strat. App: Understanding execution

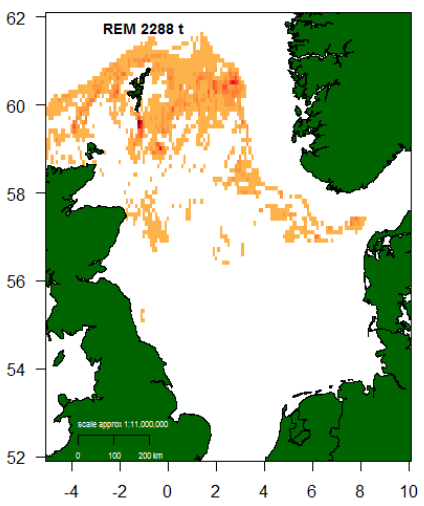






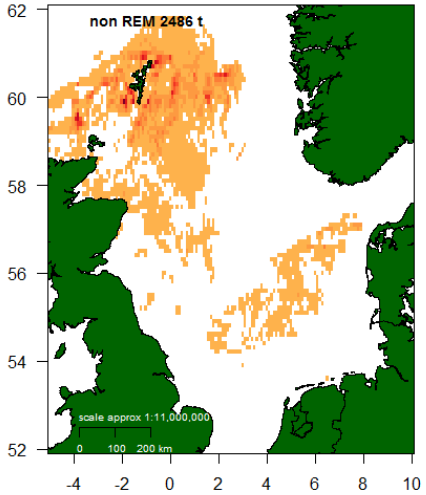
REM introduced

REM



Time

2012



Not participating

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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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