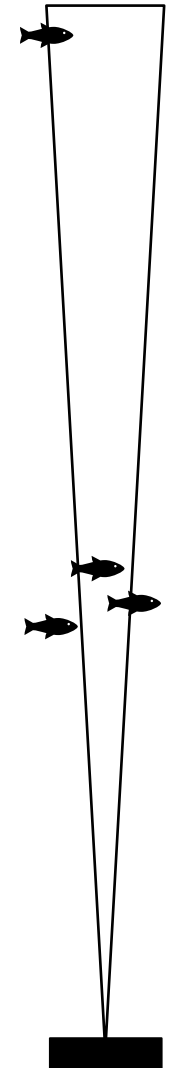
Continuous acoustic measurements:
the behaviour and occurrence of small pelagic fish in the inlet of the Wadden Sea revealed

SPF symposium, Lisbon, 9th of November 2022

Margot Maathuis, Bram Couperus, Jan Jaap Poos, Ingrid Tulp & Serdar Sakinan



Waddentools Swimway

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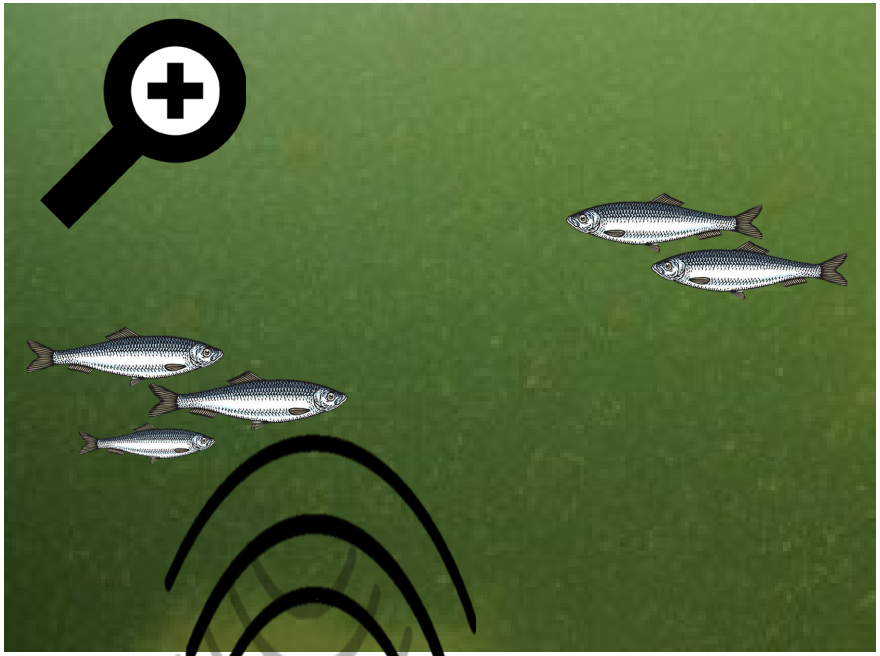
North Sea



Echosounder:
- Long term
- High resolution

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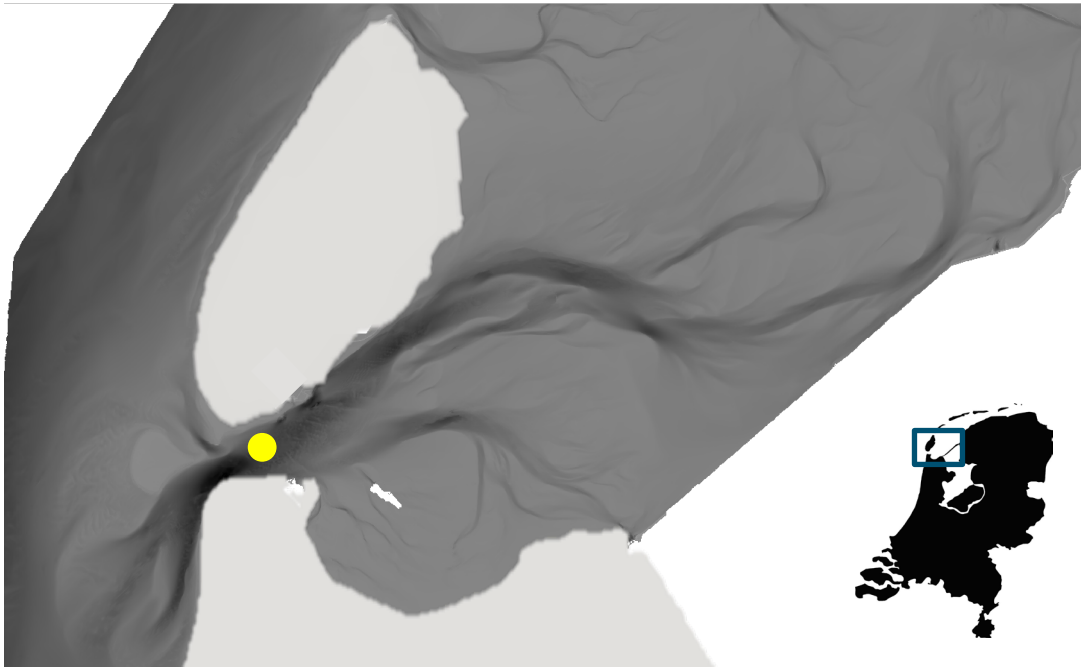
Research questions

- 1) How does fish **density** vary over the season and which environmental factors explain the variance?

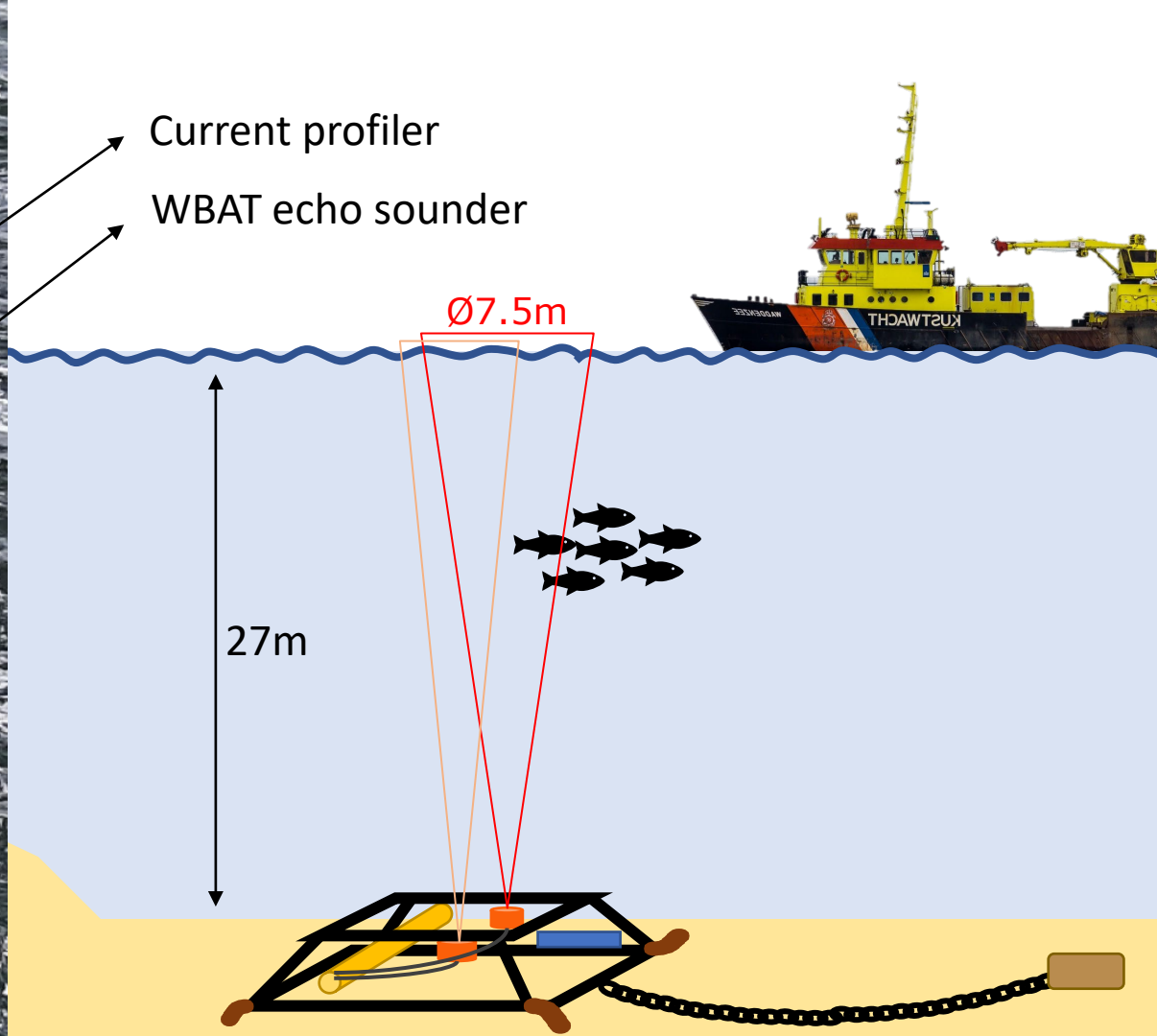
2) How are the **fish distributed** in the water column and how is this related to environmental conditions?

- 3) How does individual **movement behaviour** relate to water currents?

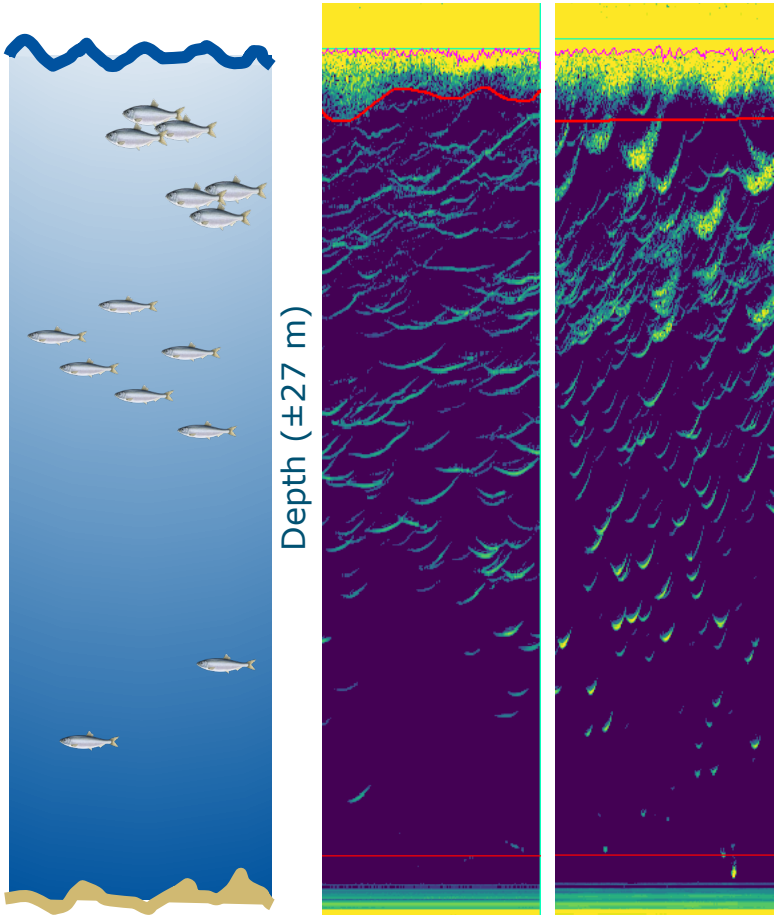
Study area: Marsdiep



- Deep + important inlet
- Strong currents
  - Tidal range 1.4m
  - Tidal asymmetry


Current profiler
WBAT echo sounder
Ø7.5m
27m

Output: Echograms



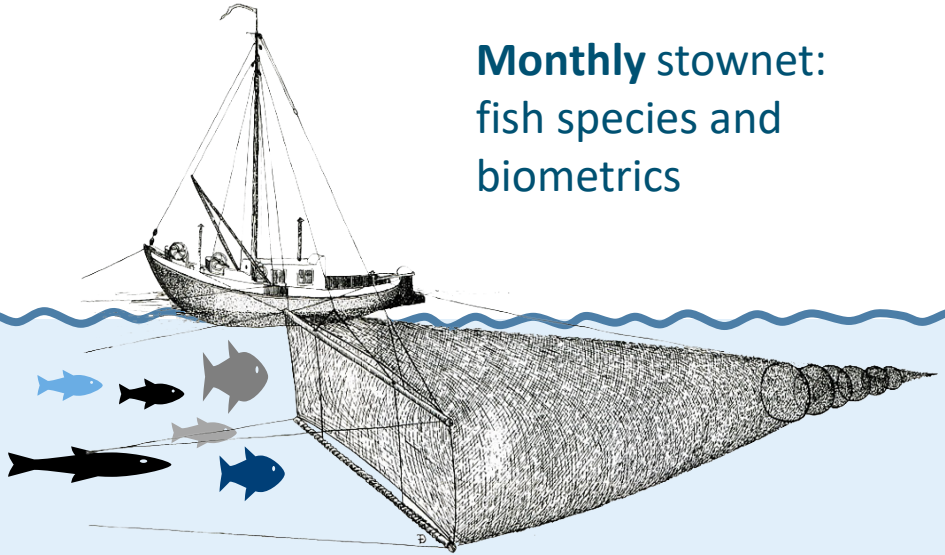
Yellow = backscatter
- Indicator of fish density
  - 'Equivalent' NASC
- Noise excluded

16 samples / 24h
- Wake up every 1.5h
- >90 sec measurements

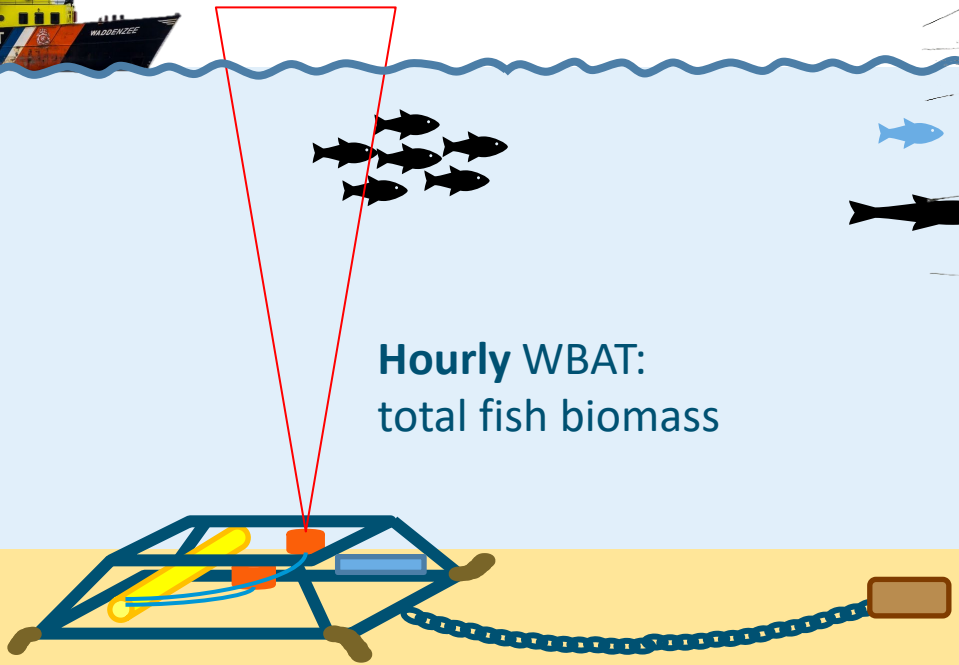
Analysis:
- Total water column
- Single targets

No species identification

Complementary methods

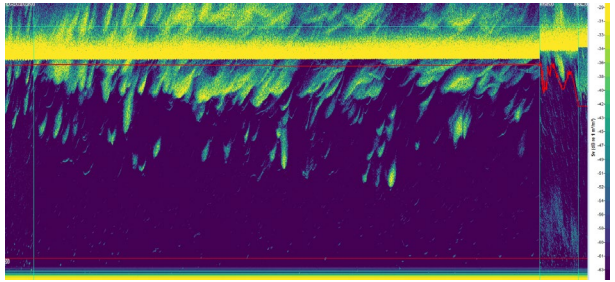


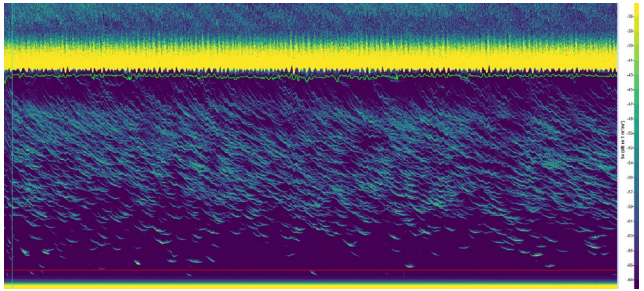
Monthly stownet:
fish species and
biometrics

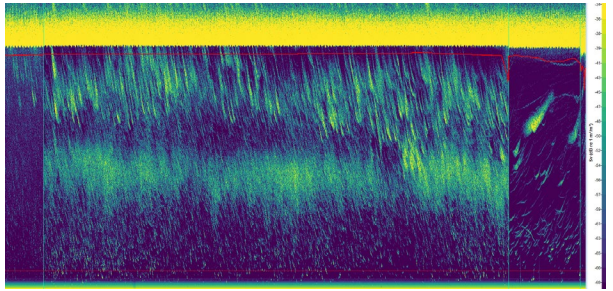


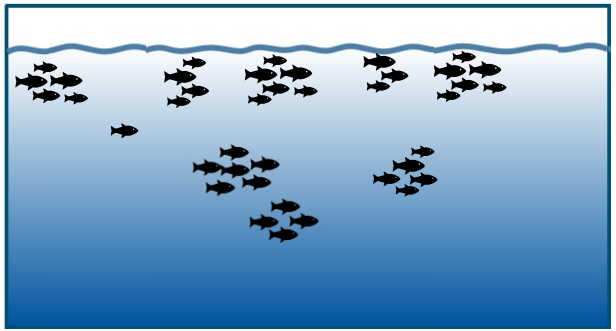
Hourly WBAT:
total fish biomass

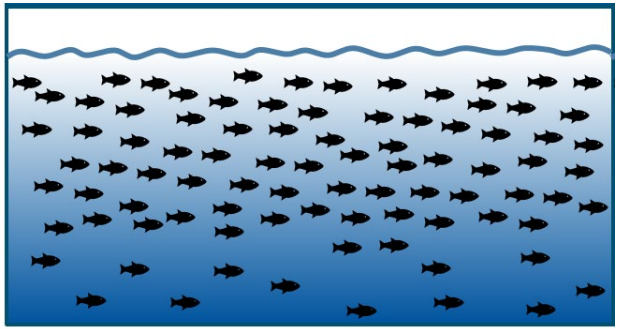
Large variety beneath the surface

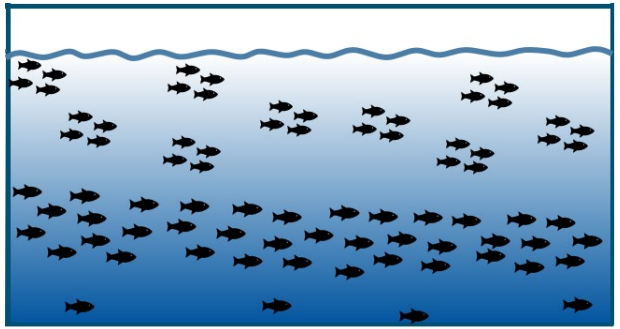












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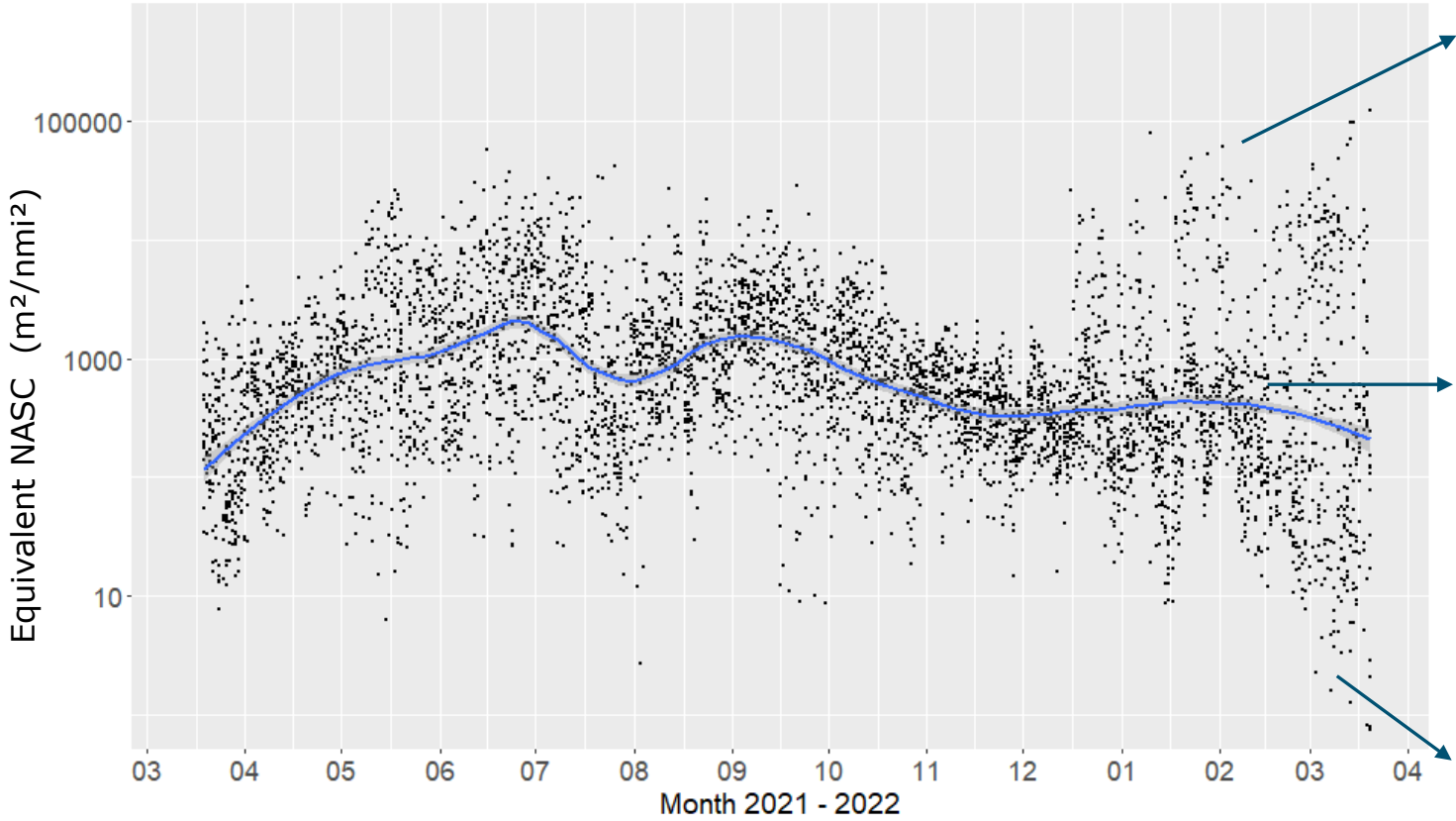
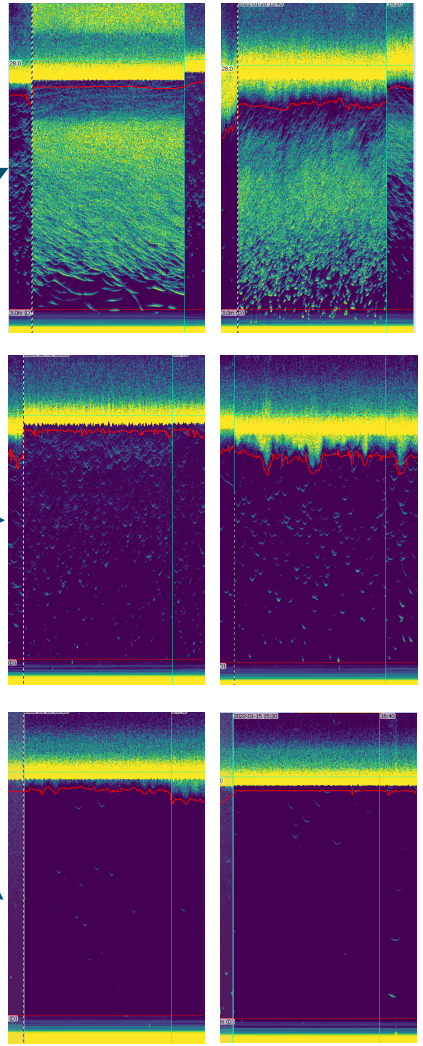
Fish density over time





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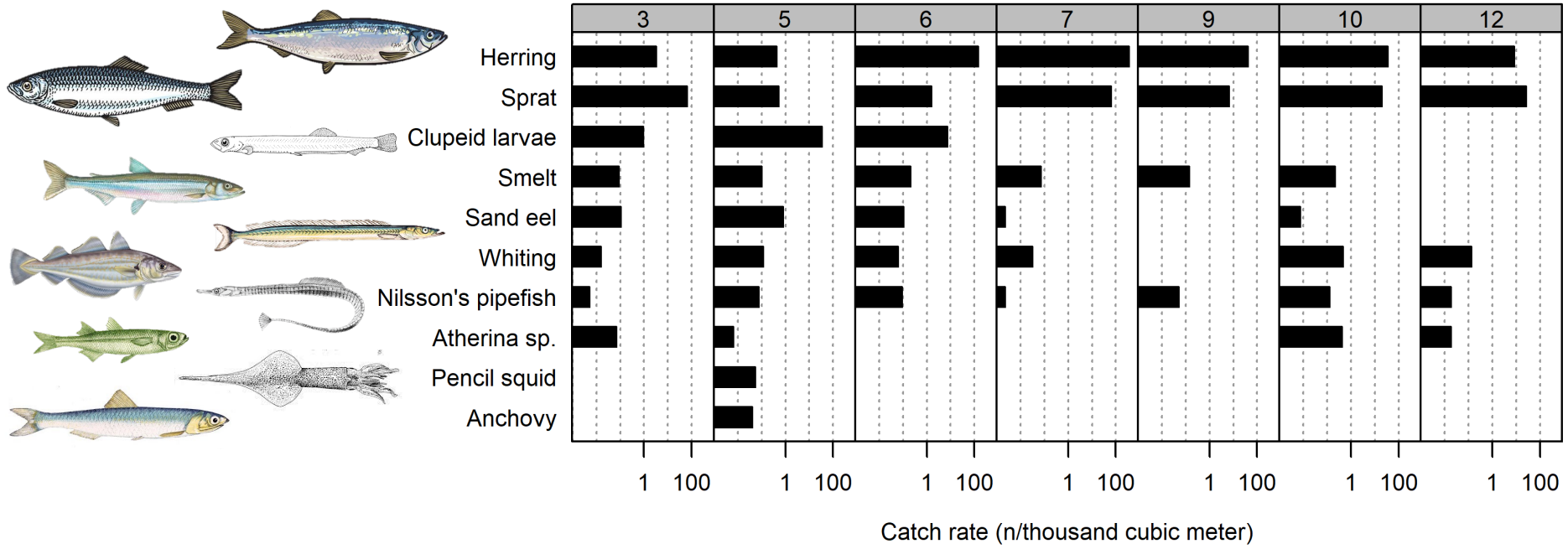
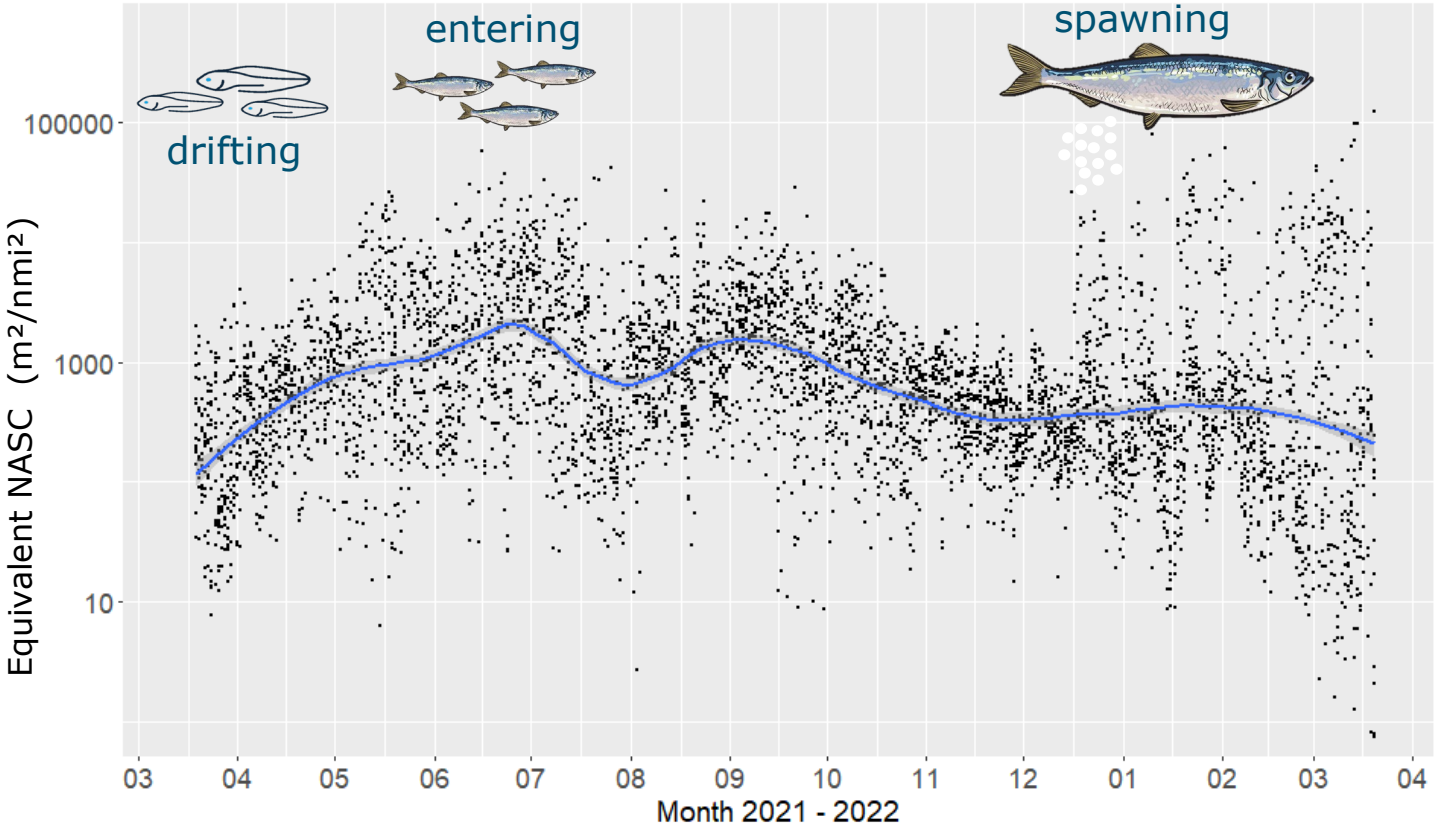
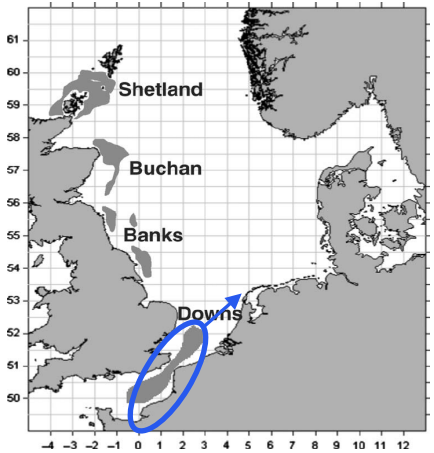
Fish catches Marsdiep - 2021



Fish density over time



Herring spawning locations:



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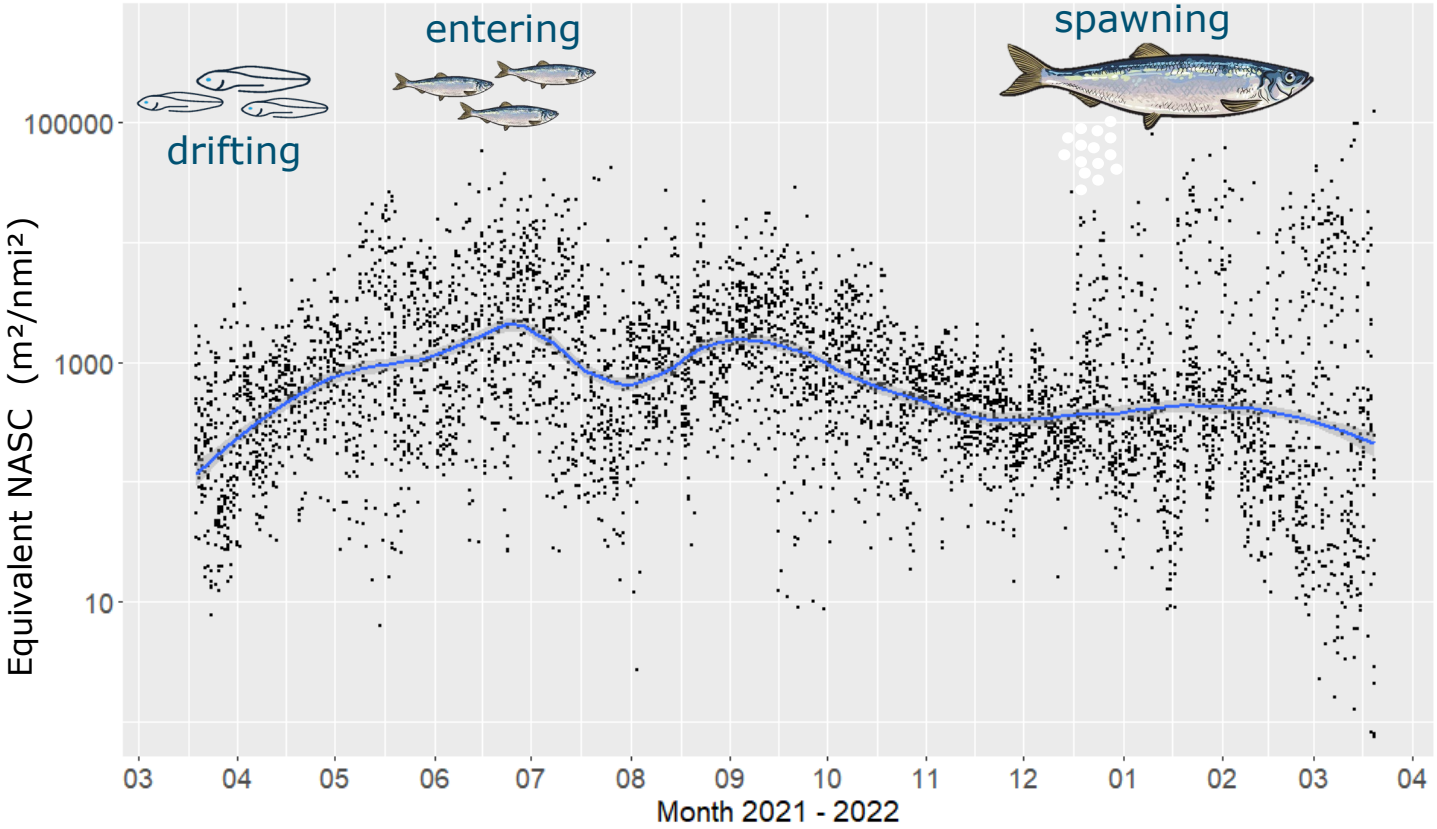
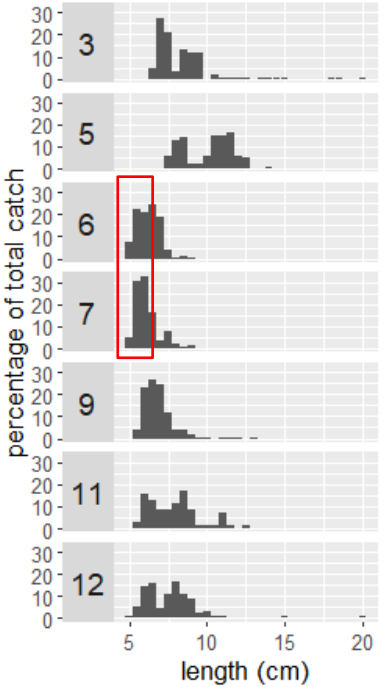
Fish density over time





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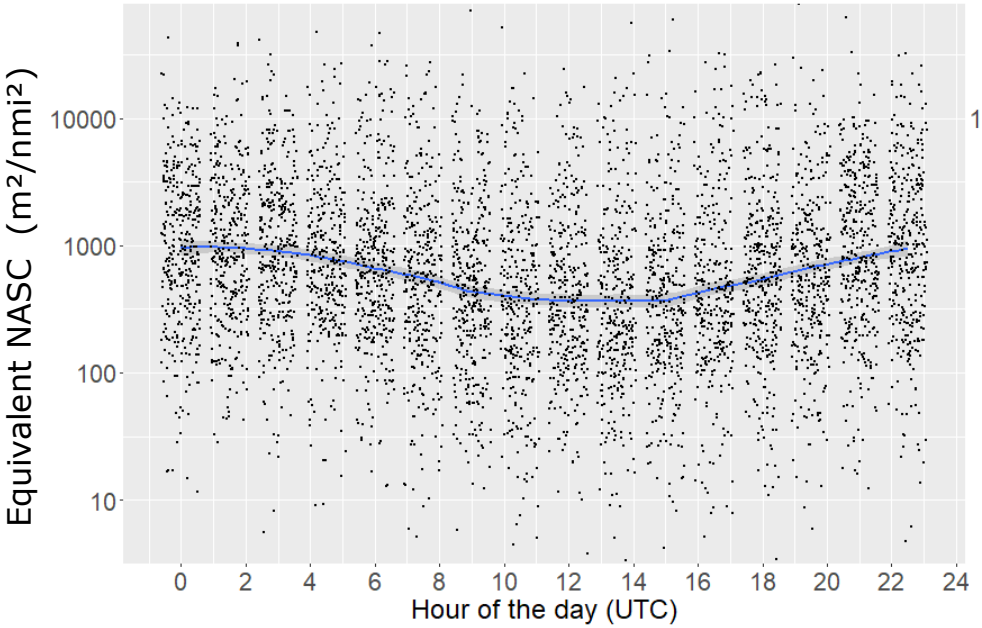
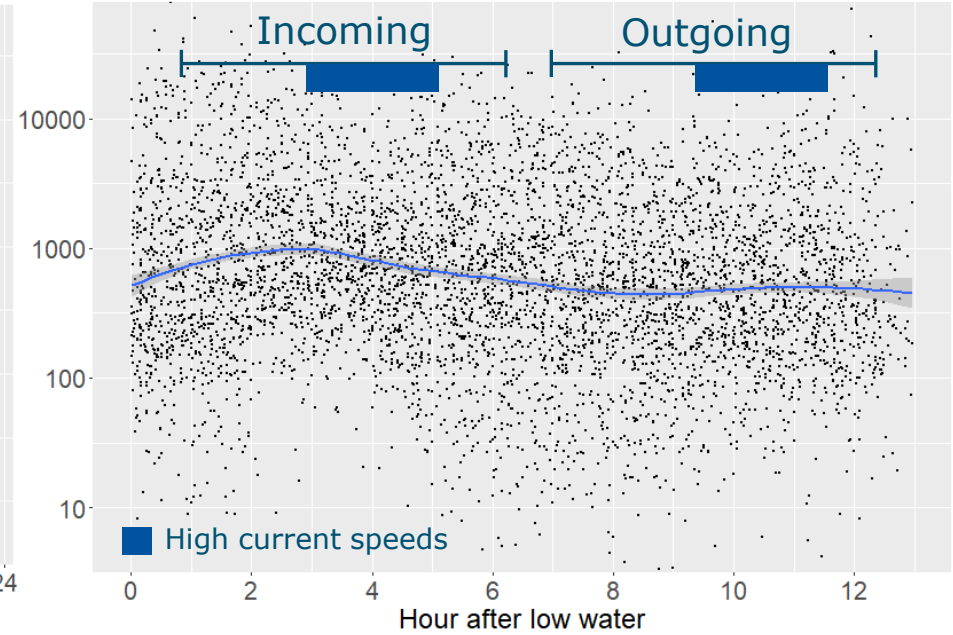
Fish density over 24h & tide





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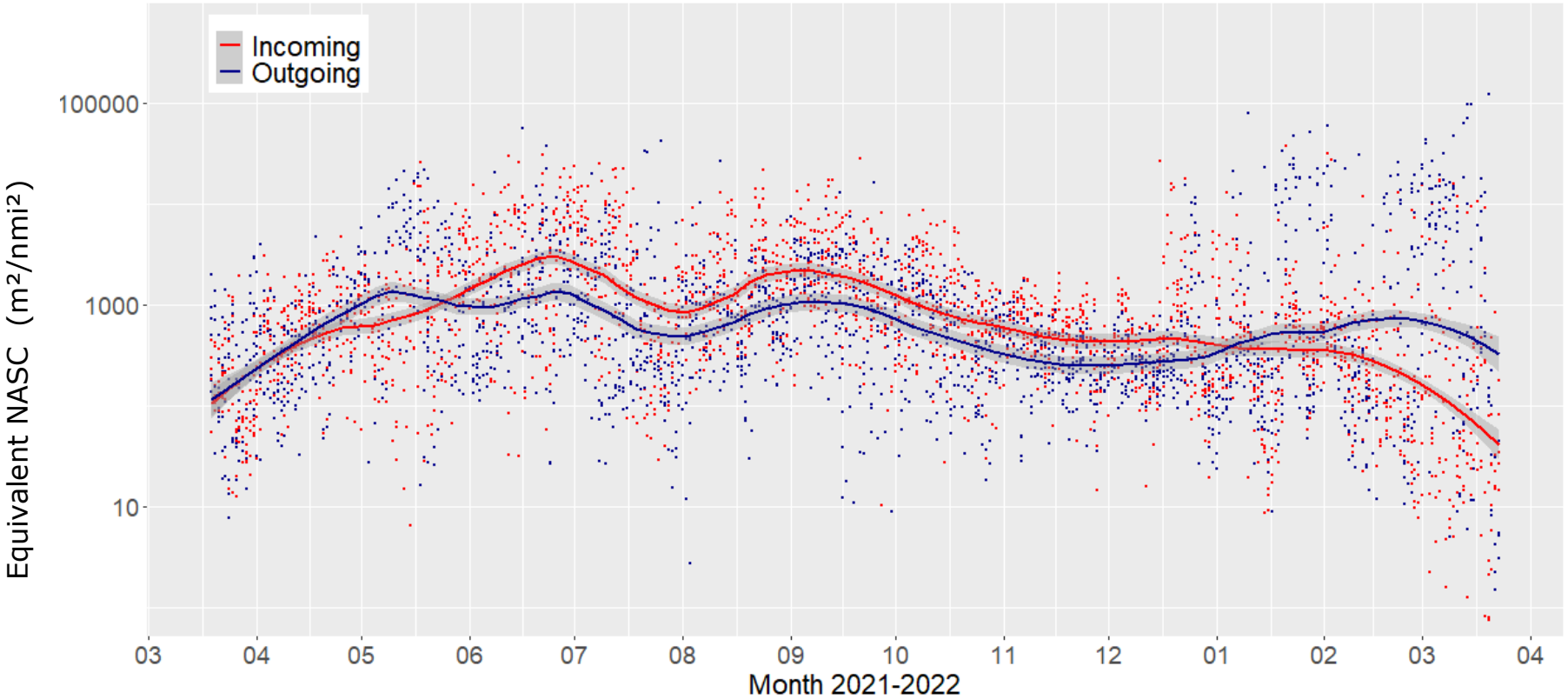
Incoming vs. outgoing tide



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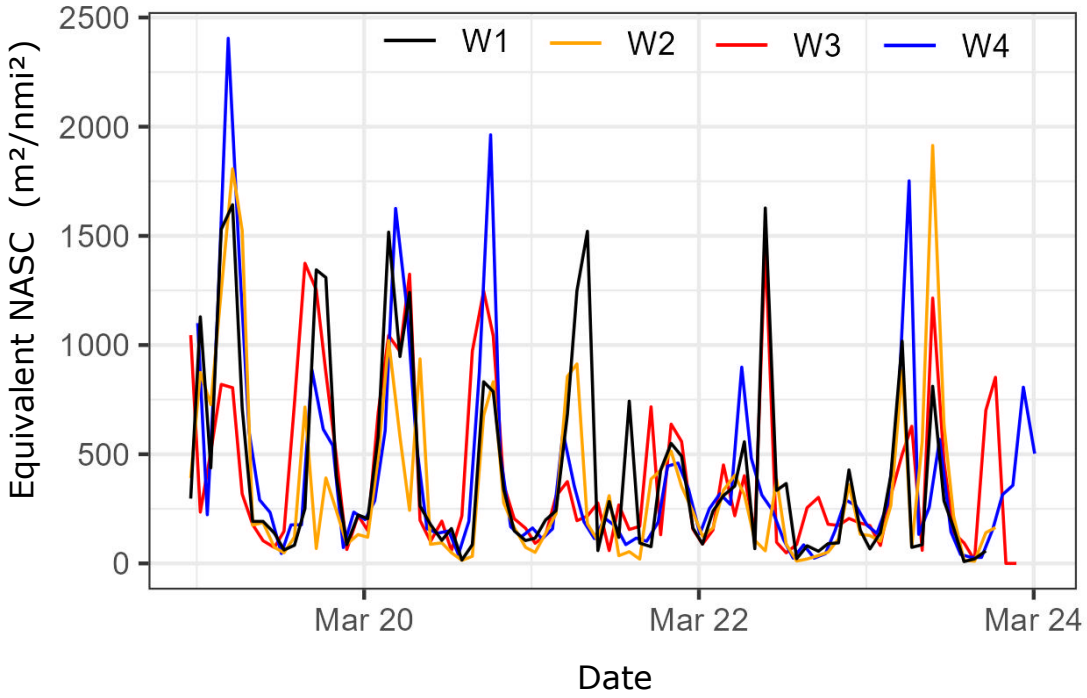
Effect of environmental factors: GAM

- Date ***
- Tide ***
- Hour of day ***
- Water temperature **
- Windspeed ***
- Wind direction *
- Current speed **
- Current direction p=0.06

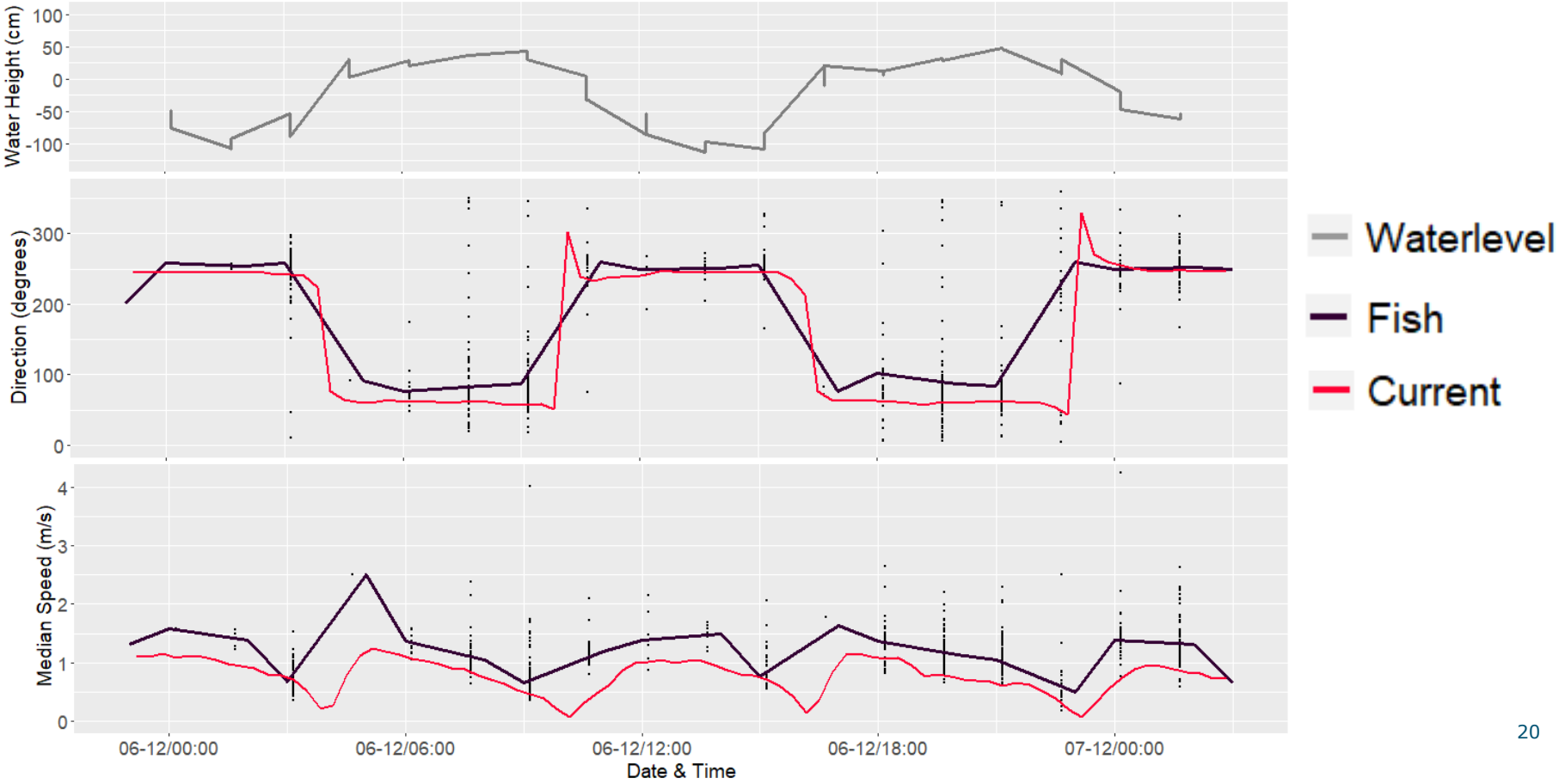
Best GAM model explains 38.7%:
log(NASC) ~ Date * Tide + Hour of day + Temperature + Wind speed + Wind direction + Current speed

No effect of specific location



Tukey Test P values	
W2-W1	0.51
W3-W1	0.9
W4-W1	1
W3-W2	0.16
W4-W2	0.44
W4-W3	0.94

Fish are driven by the water current



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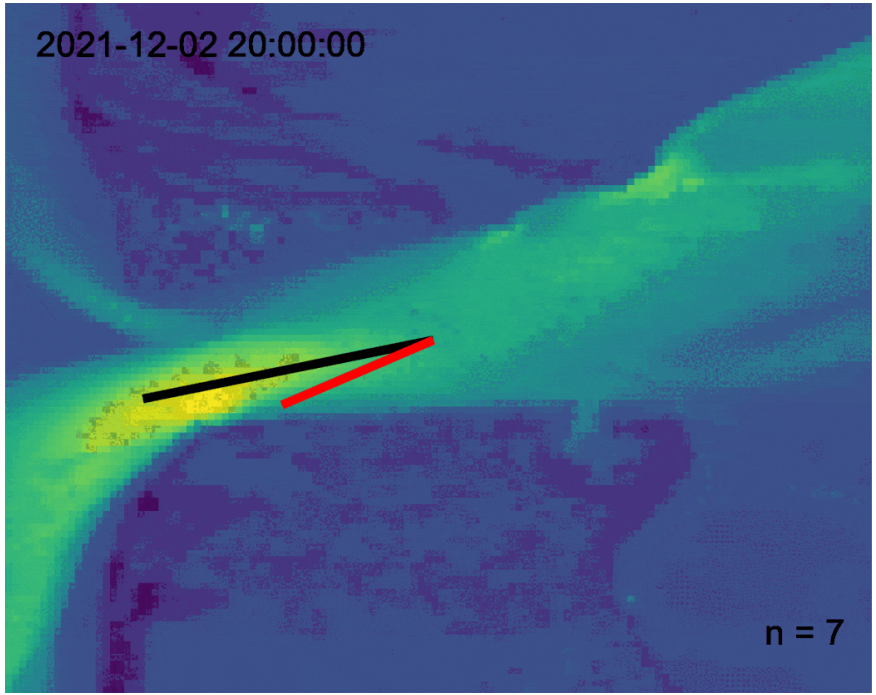
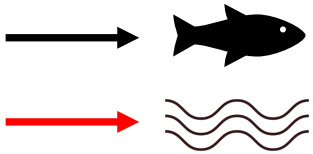




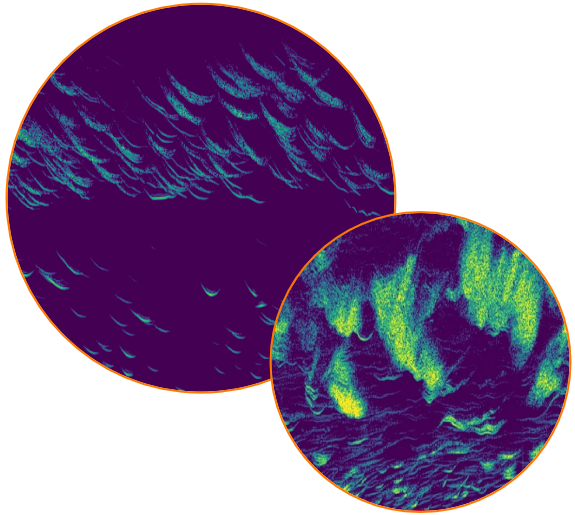
Length arrow = speed

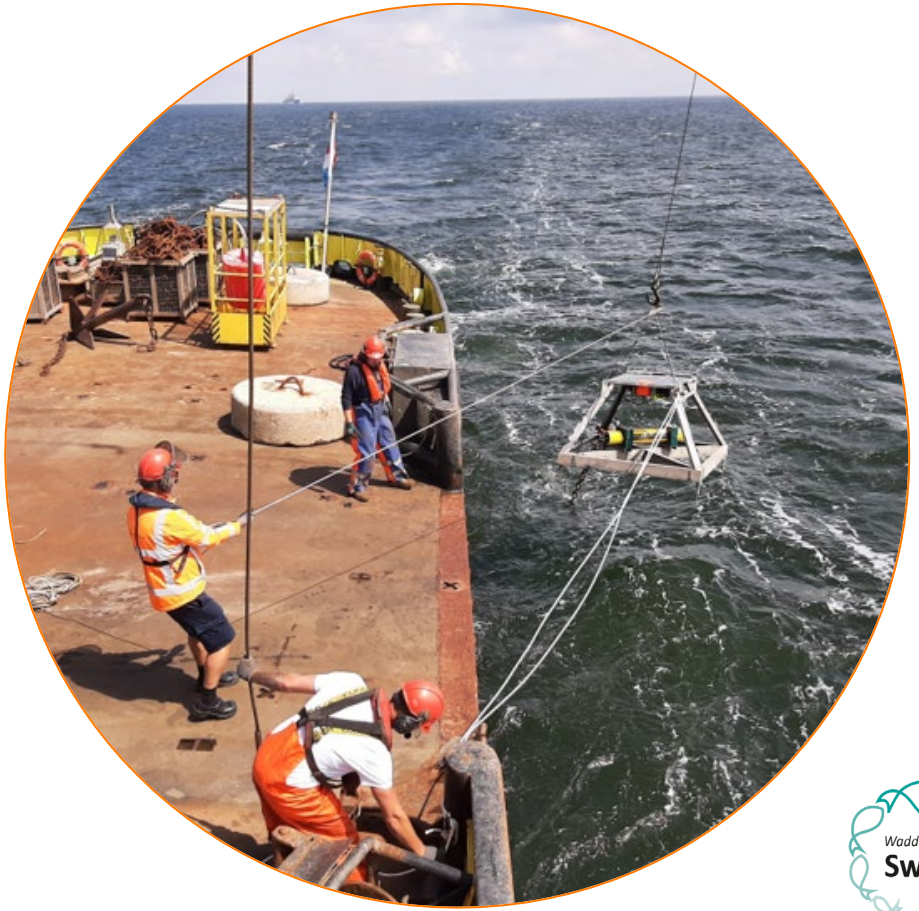
Take home messages

- Successful method: high resolution in time, represents larger area, cost-effective & non-invasive
- Able to observe patterns in density:
    - Seasonal, dial and tidal
- Complex system: many environmental factors effect density
- Fish movement is driven by currents

Thanks to:

- Arjen Ponger (RWS) & the crew of ‘de Terschelling’
- Dirk Burggraaf & Hans Verdaat (WMR)





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