



# Foodscapes: Integrating BRUV monitoring with bomb calorimetry to improve understanding of value of offshore wind farms

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University of Exeter & SMRU Consulting



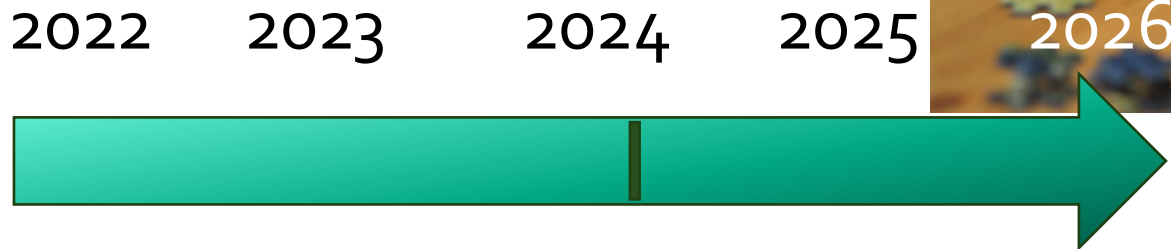
# Background

- PrePARED aims to improve evidence base:
  - how offshore wind structures alter species distribution and behaviour
  - advance links between prey + predators
  - improving impact assessments and potential for marine net gain.



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# Team effort

- Presenting on behalf of many collaborators in PrePARED
- Especially
  - Exeter: Matthew Witt, Sam Gierhart
  - St Andrews (SMRU): Philippa Wright, Gordon Hastie



Dr Matthew Witt  
*(PI & Task Lead)*



Dr Tony Bicknell  
*(co-I & Task Lead)*



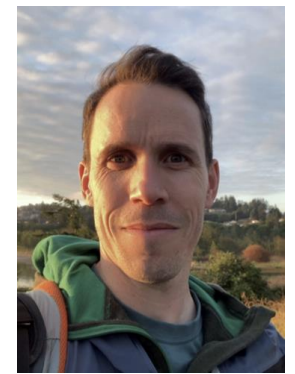
Sam Gierhart  
*(Research Assistant)*



Dr Gordon Hastie  
*Task Lead*



Philippa Wright  
*(PhD Student)*



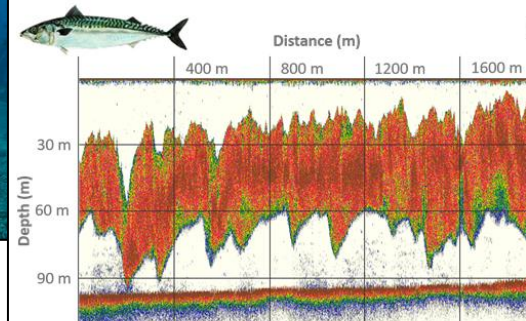
Dr Cormac Booth  
*Task Lead*

# Effects of introduced subsea structures on marine fish

- Long history of research
- Many types of structures
  - Shipwrecks
  - Oil and gas platforms
  - Pipelines
  - Artificial reefs
  - FADS (fishing)
  - Renewable energy
- Various sampling methods
- Species, time, structure location specific effects
- Aggregation and/or production
- Effect on predators?

International Council for the Exploration of the Sea  
C.M.1977/B:41  
Gear and Behaviour Committee  
Ref. Fisheries Improvement Committee

1977



## Correspondences

### Marine mammals trace anthropogenic structures at sea

Deborah J.F. Russell<sup>1,2,\*</sup>,  
Sophie M.J.M. Brasseur<sup>3</sup>,  
Dave Thompson<sup>1</sup>,  
Gordon D. Hastie<sup>1</sup>, Vincent M. Janik<sup>1</sup>,  
Geert Aarts<sup>3,4</sup>, Brett T. McClintock<sup>5</sup>,  
Jason Matthiopoulos<sup>6</sup>,  
Simon E.W. Moss<sup>1</sup>,  
and Bernie McConnell<sup>1</sup>

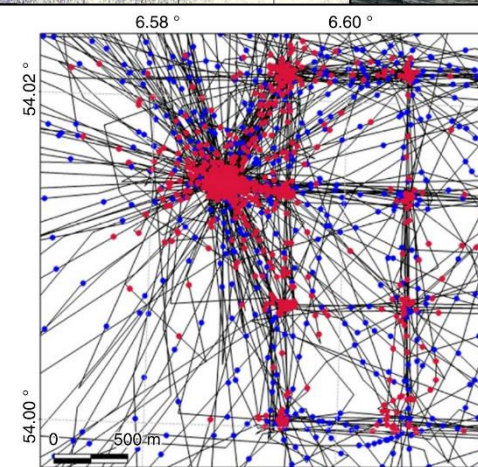


Figure 1. The tracks of a harbour seal around Alpha Ventus wind farm.

frontiers | Frontiers in Marine Science

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Check for updates

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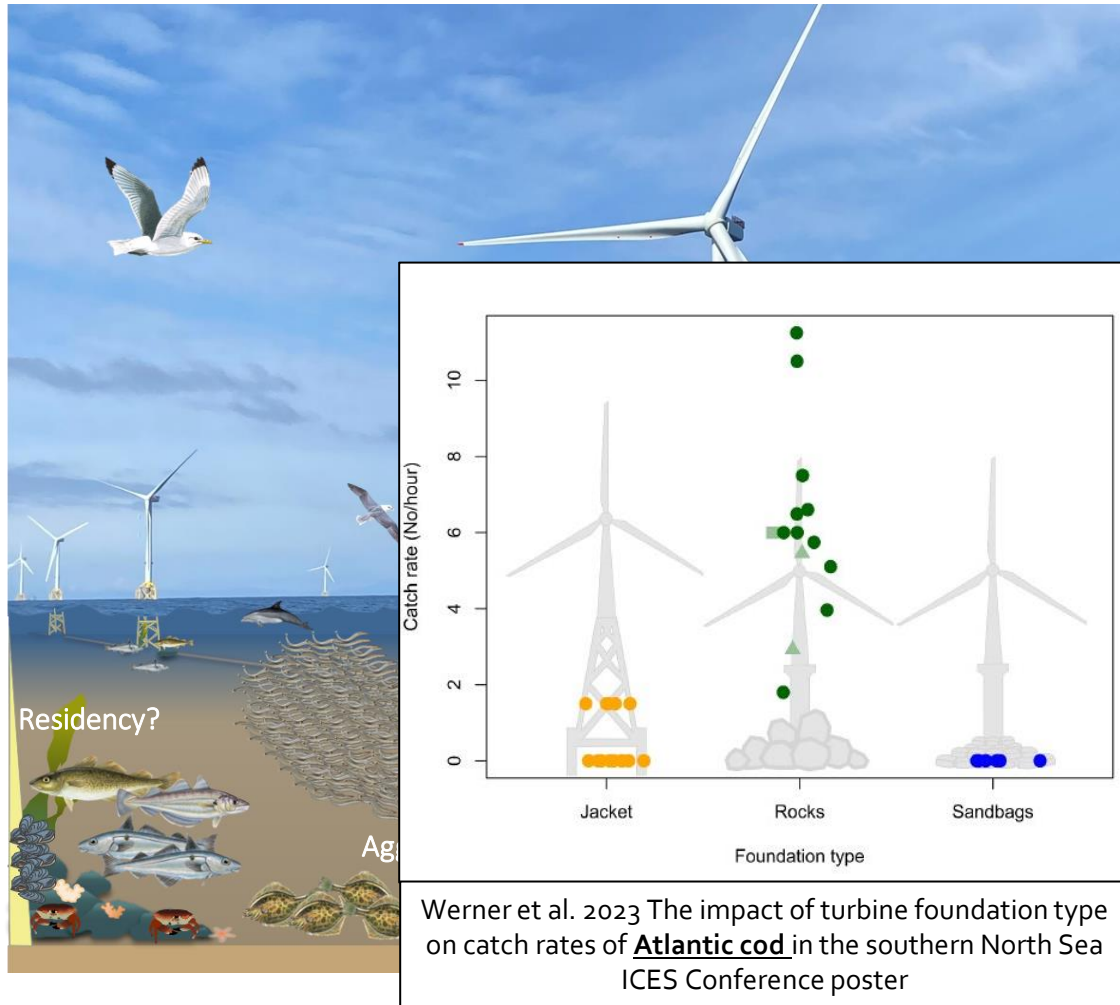
### Reef effect of offshore structures on the occurrence and foraging activity of harbour porpoises

Oihane Fernandez-Betelu\*, Isla M. Graham  
and Paul M. Thompson

Lighthouse Field Station, School of Biological Sciences, University of Aberdeen,  
Cromarty, United Kingdom



# Do offshore wind farm sites effect benthic fish distribution?

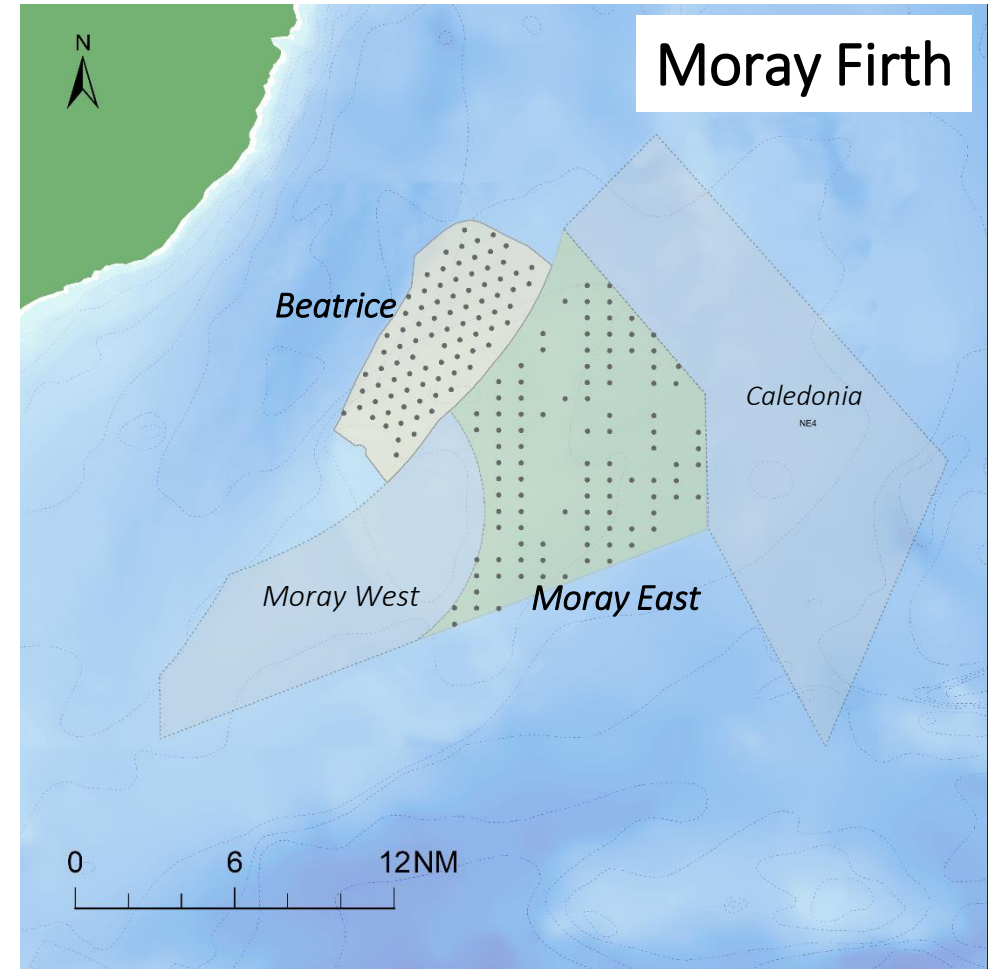
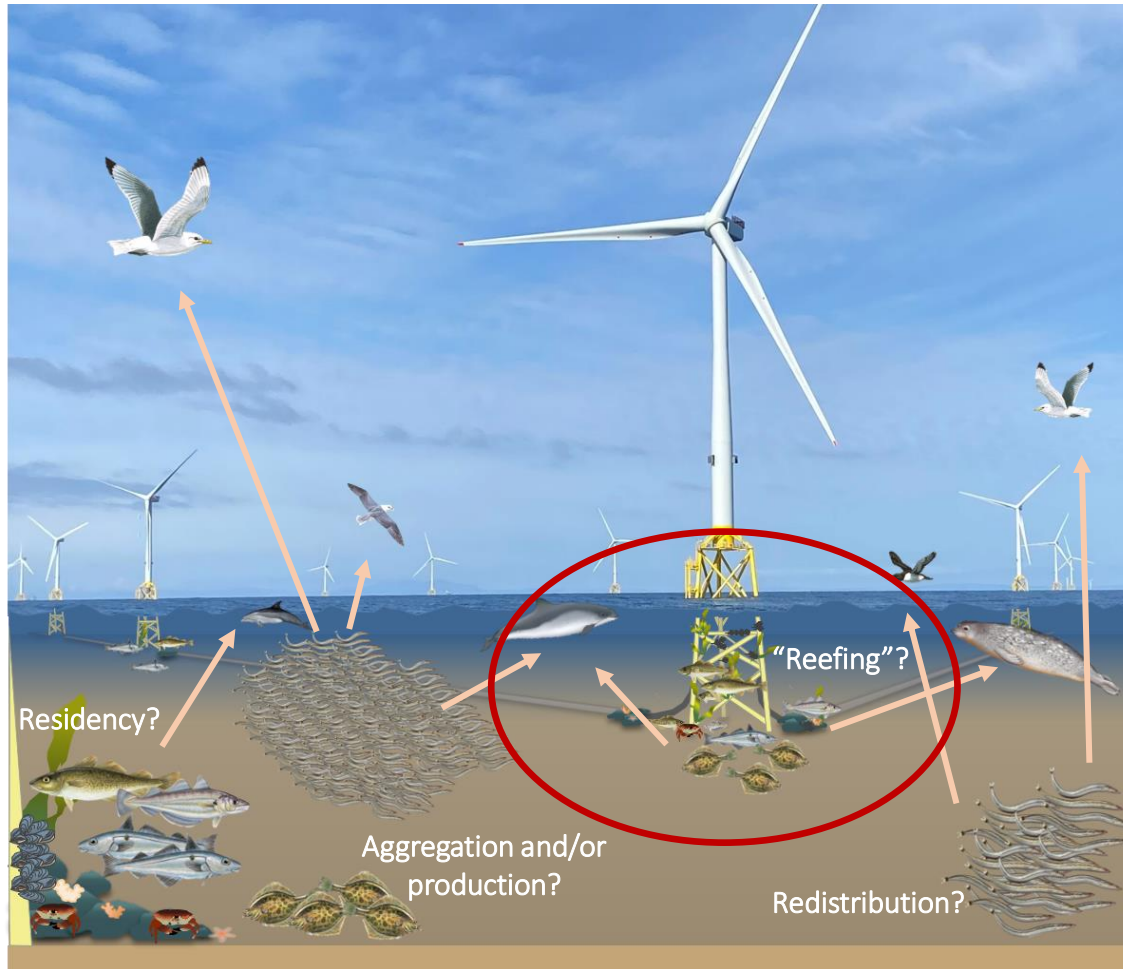


- Species, time, structure type and/or location specific effects

**North Sea studies** (Belgium, Denmark, Netherlands and Germany):

- **Flatfish (*Pleuronectiformes*)**
  - **Sole** show no affinity to turbines or sites
  - **Plaice** showed some residency during feeding season
- **Gadoid fish (*Gadiformes*)**
  - **Cod** show attraction & seasonal residency
  - Local **cod** populations enhanced with more food
  - Increase in **pouting** close to turbines
  - No effect on **whiting**

# Do Moray Firth offshore wind farm sites effect benthic fish distribution?



## Beatrice (BOWL)

84 turbines

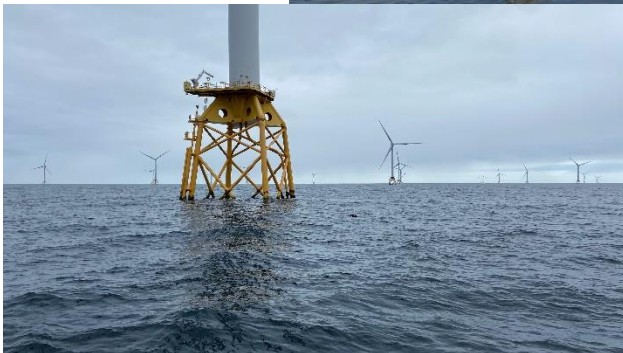
4 legged jacket  
turbines

Jackets installed by  
mid 2018



Consistent  
spacing

<12nm



## Moray East (MEOW)

100 turbines

3 legged jacket  
turbines

Jackets installed  
by end of 2020



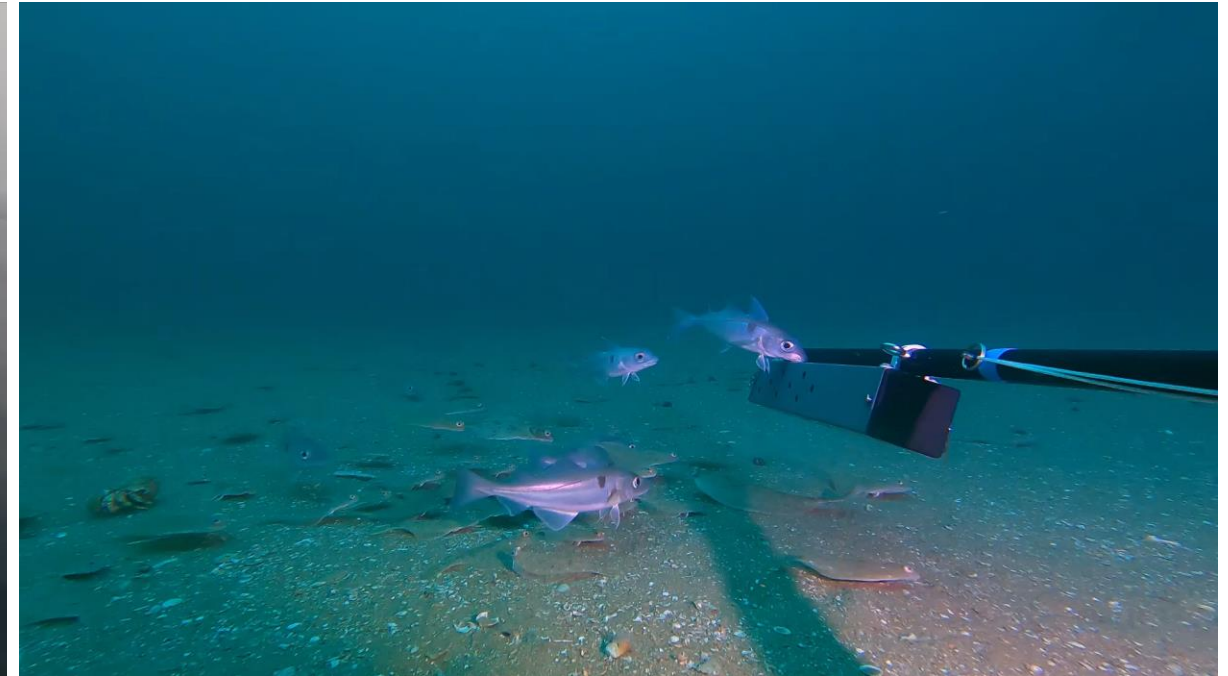
Different spacing  
with gaps

>12nm





## Camera surveys for fine-scale benthic fish distribution



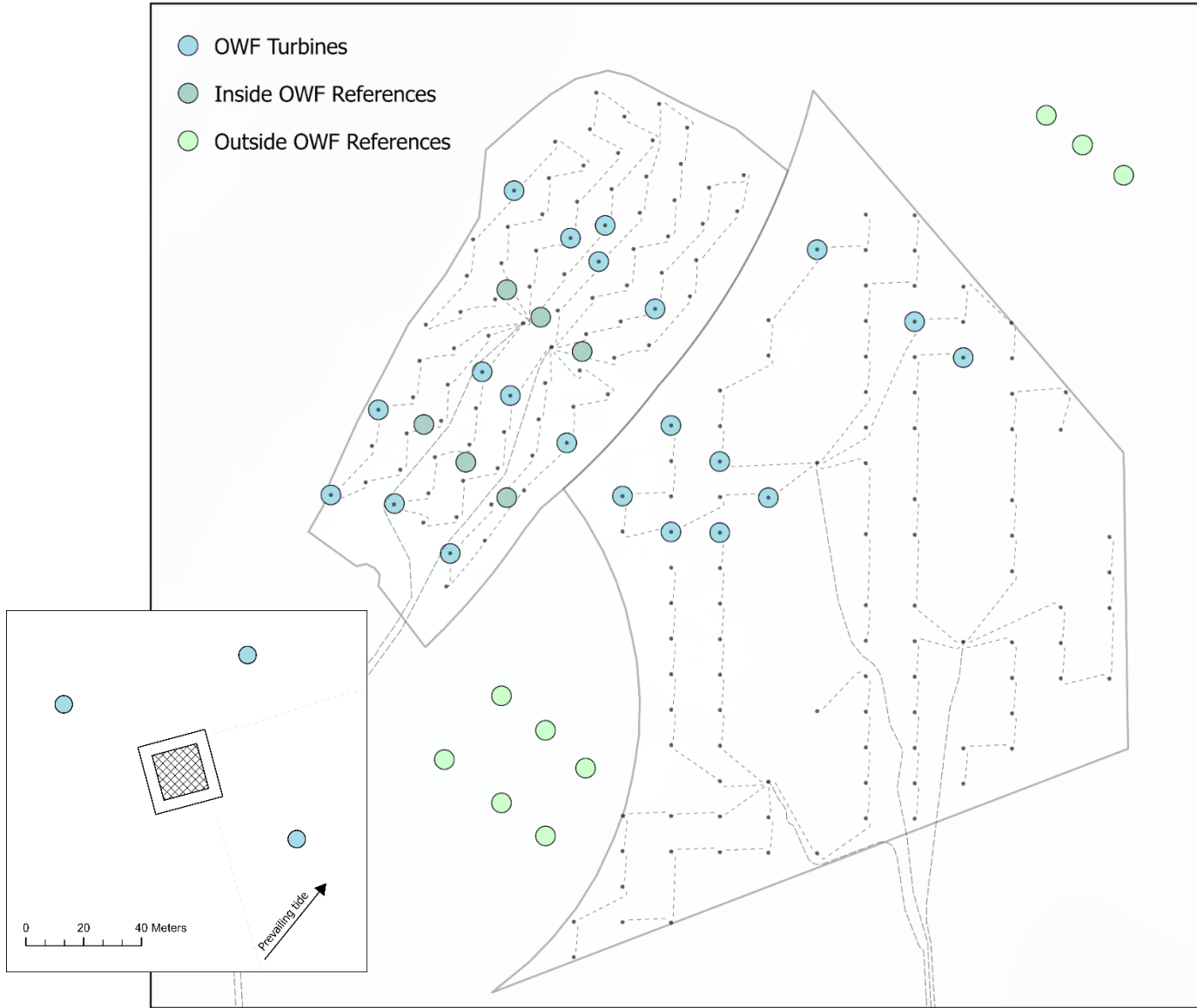
- Stereo baited remote underwater video systems
- Deployed close to turbine jackets and in reference locations
- Attraction to structures? Wind farm age/structure effects?



- **Relative** abundance (MaxN) (conservative estimate)
  - Individual length measurements
- **Relative** diversity & community composition



# Moray Firth August 2022 Survey



Total deployments = 108

Three replicates at each location:

- Turbine sites = 21 (x3)  
(Turbine deployment ~30m of structure)
- Inside OWF References = 6 (x3)  
○ 500m from turbines
- Outside OWF References = 9 (x3)  
○ >2km from turbines

~81 hours of video footage collected

First 30mins of footage analysed

- Designed to be a self contained study
- Not assessing annual variation (very aware)
- Snapshot in time (summer 2022)
- Daytime sampling

# Species observed

## 13 fish species recorded

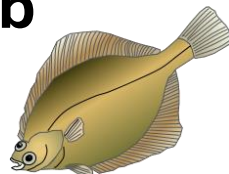
By far the most abundant:

### Flatfish = Common dab

*Limanda limanda*

(with flounder spp.)

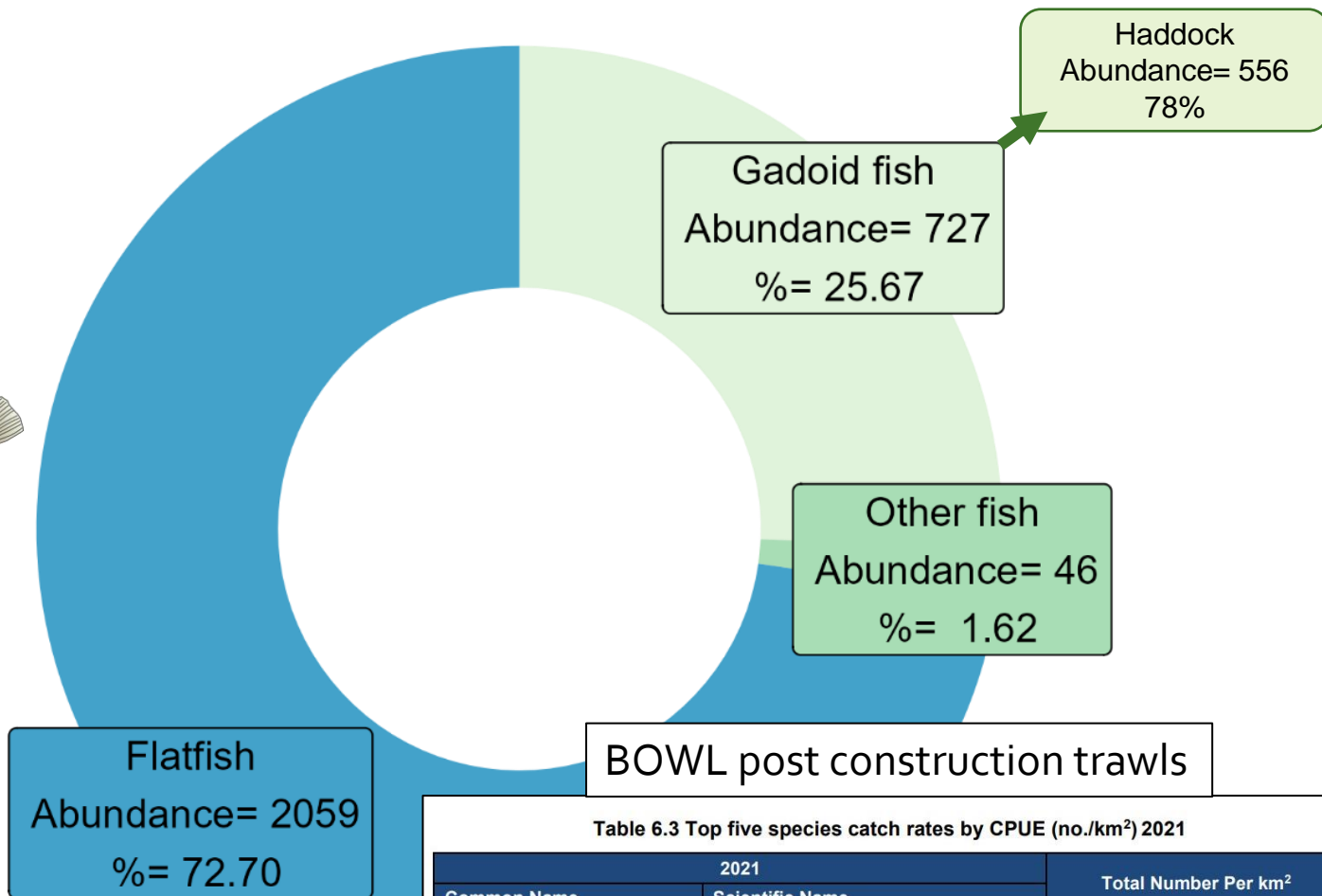
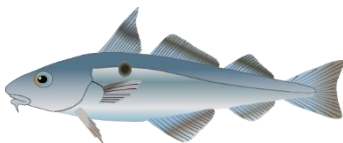
Difficult to distinguish on horizontal video



&

### Haddock

*Melanogrammus aeglefinus*



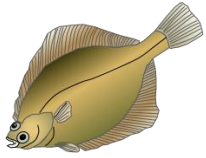
BOWL post construction trawls

Table 6.3 Top five species catch rates by CPUE (no./km<sup>2</sup>) 2021

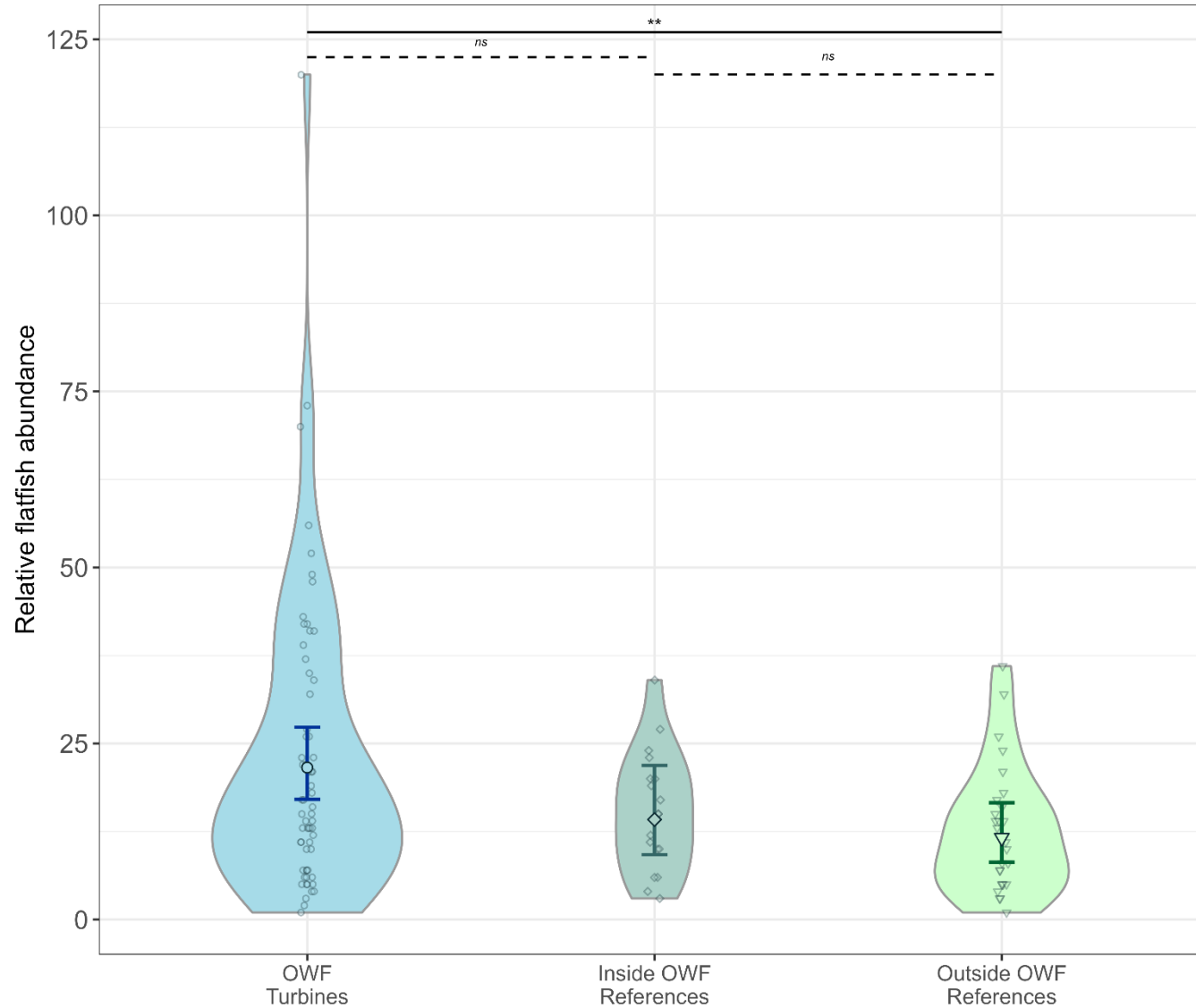
2021		Total Number Per km <sup>2</sup>
Common Name	Scientific Name	
Haddock	<i>Melanogrammus aeglefinus</i>	72,340
Whiting	<i>Merlangius merlangus</i>	11,821
Squid	<i>Loligo sp.</i>	1,084
Dab	<i>Limanda limanda</i>	860
Norway pout	<i>Trisopterus esmarki</i>	488



# Flatfish abundance

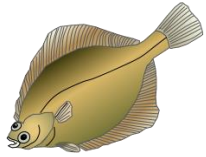


- Increase in abundance at turbines compared to outside OWF references

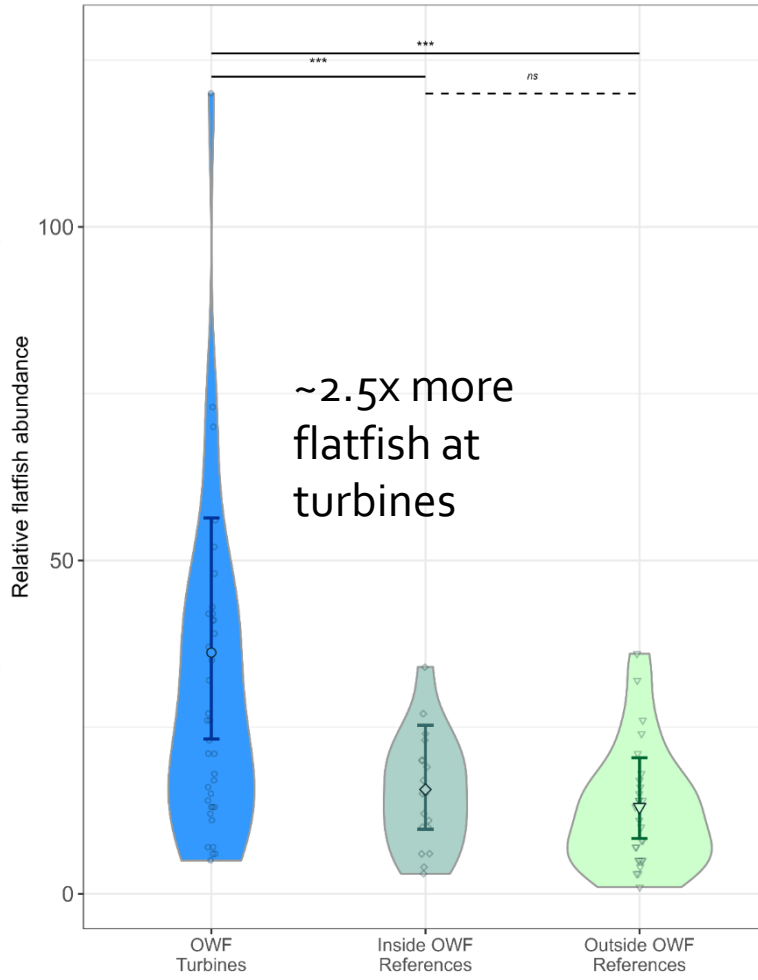


Environmental variables tested as fixed effects: current speed, current direction and depth | Random effects: habitat and location

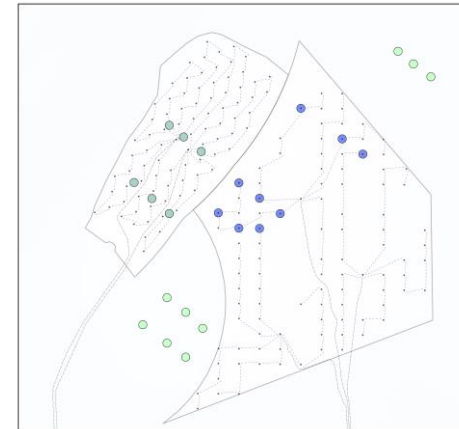
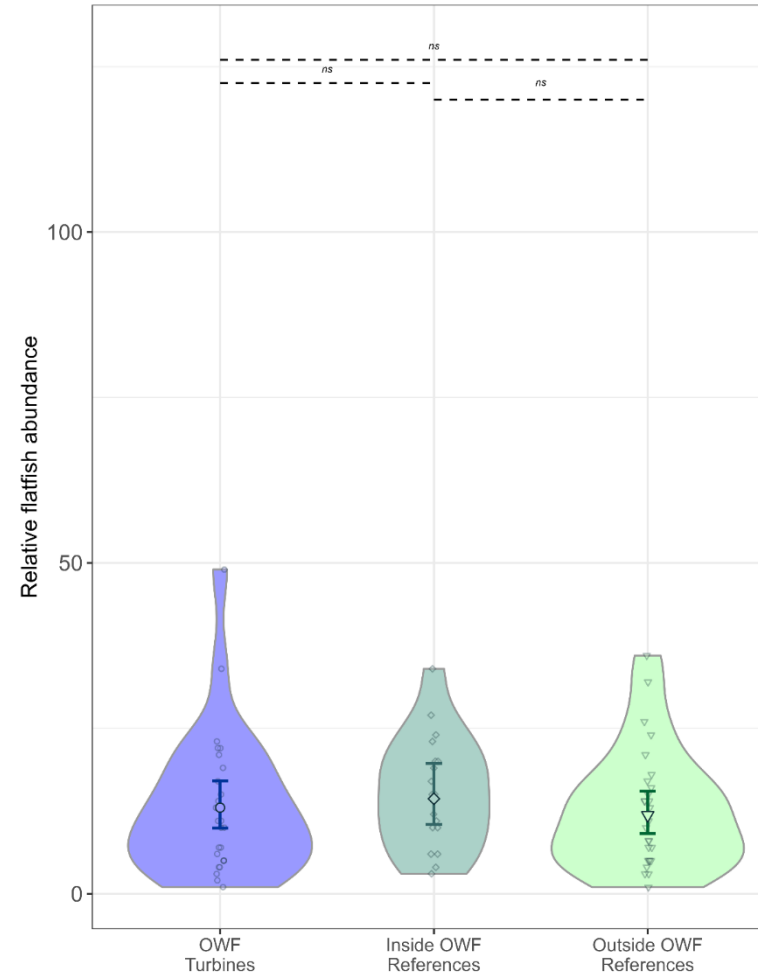
# Flatfish abundance (BOWL | MEOW)



### BOWL TURBINES



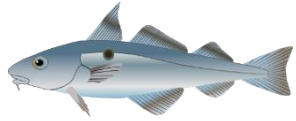
### MEOW TURBINES



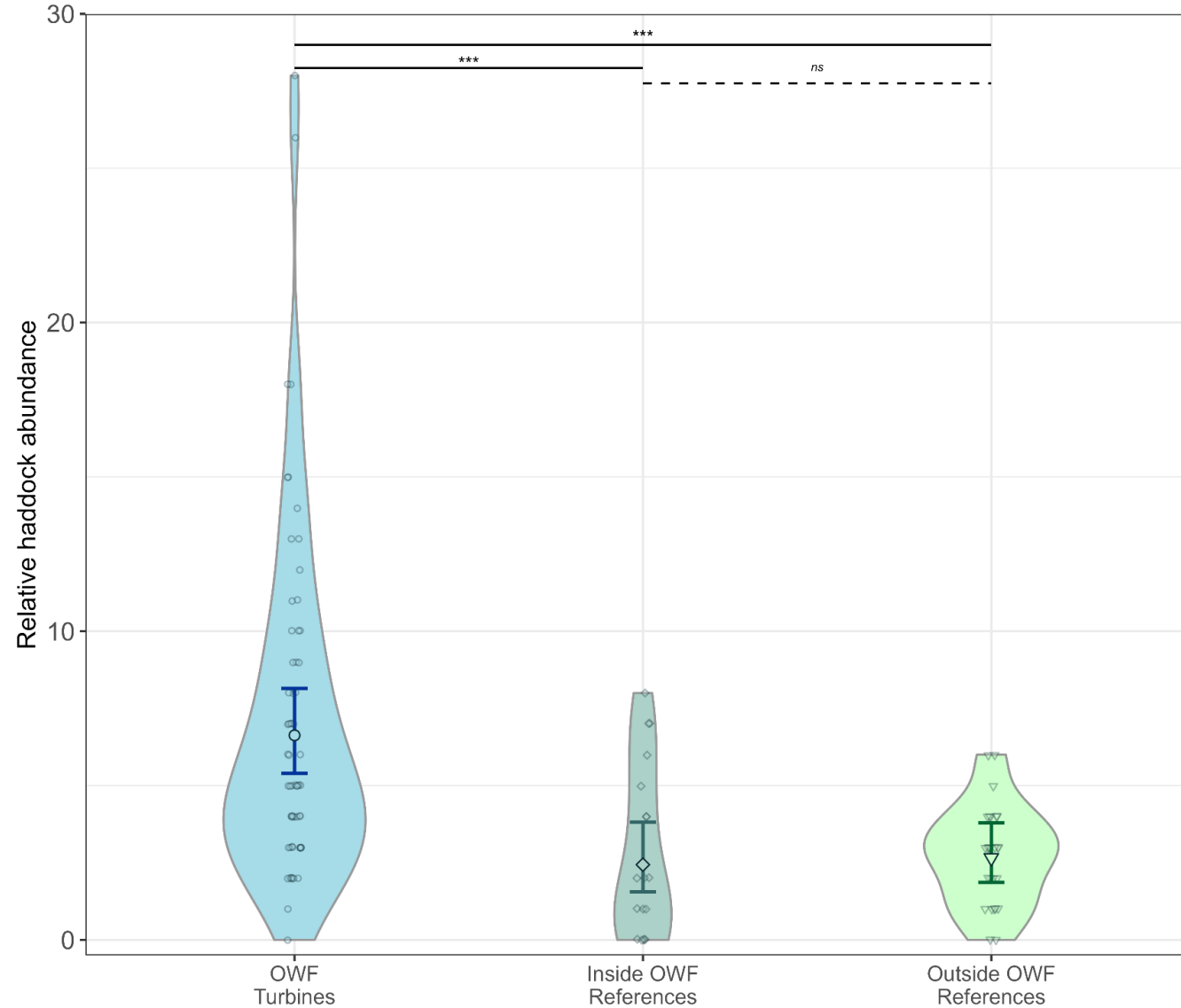
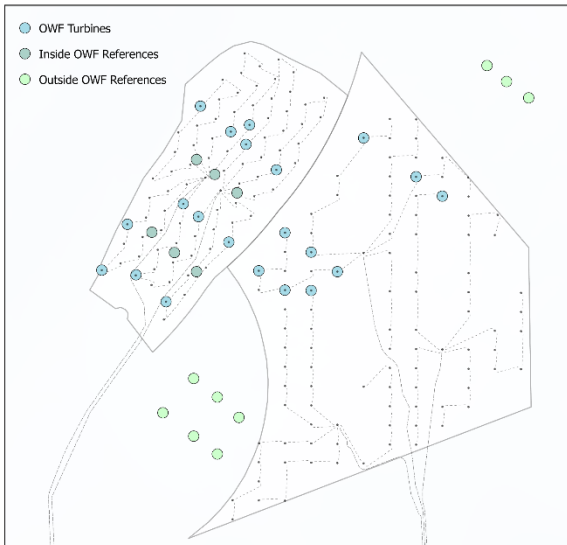
Environmental variables tested as fixed effects: current speed, current direction and depth | Random effects: habitat and location



# Haddock abundance

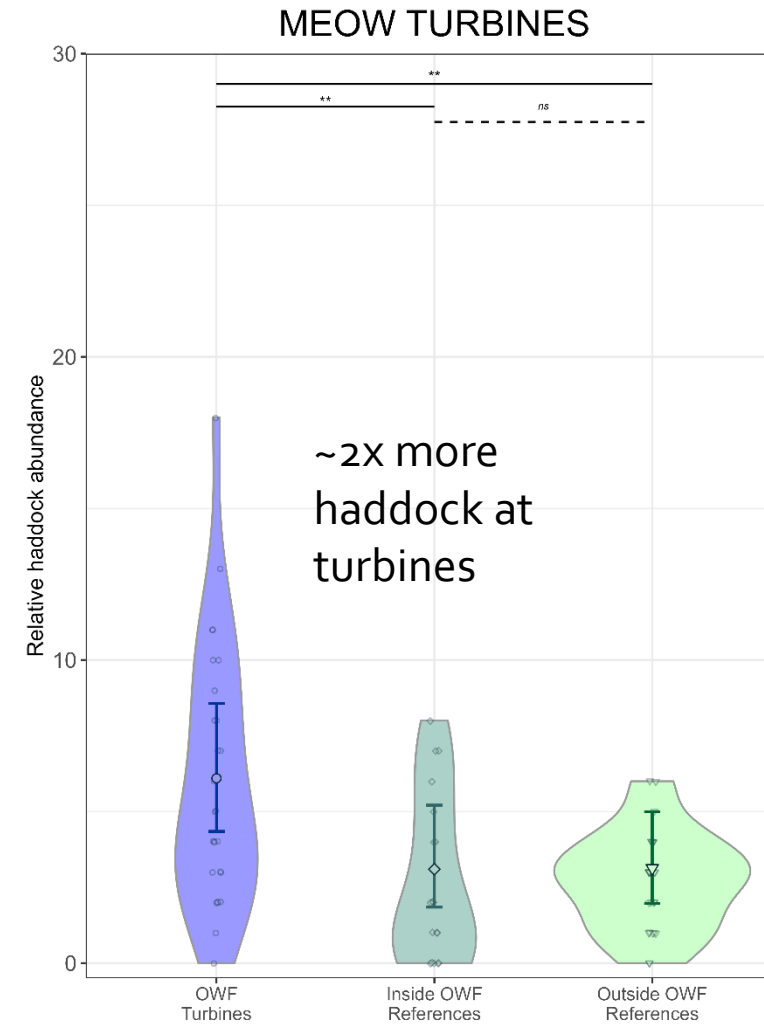
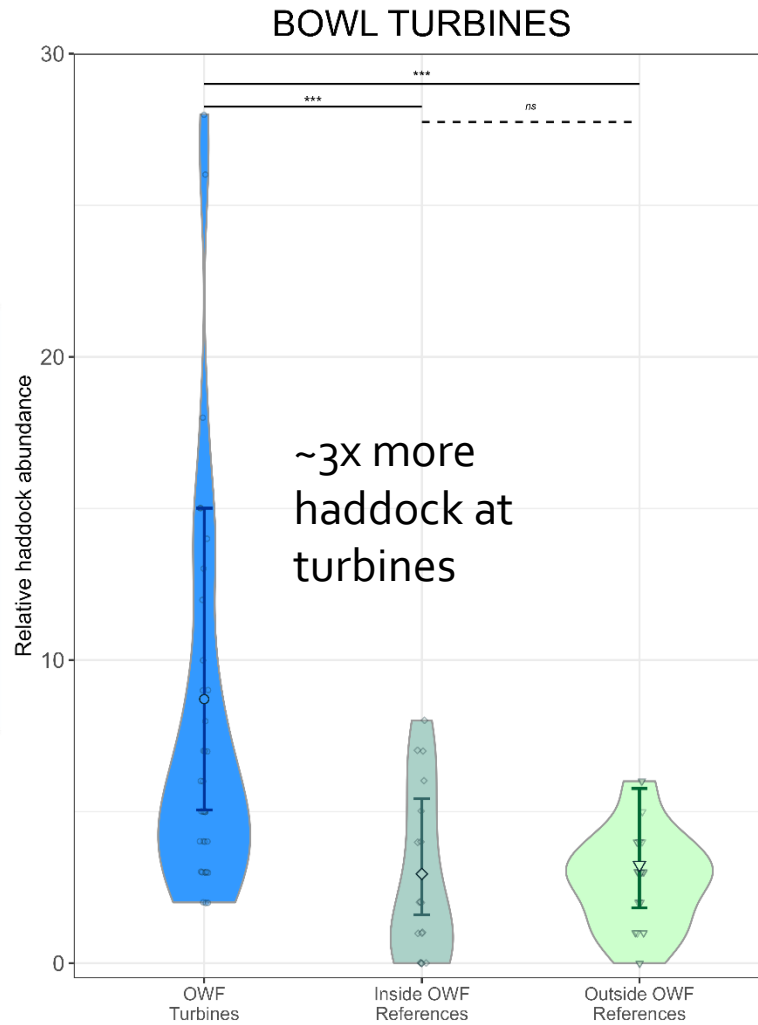
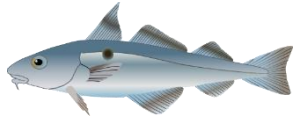


- Increase in abundance at turbines compared to both reference groups



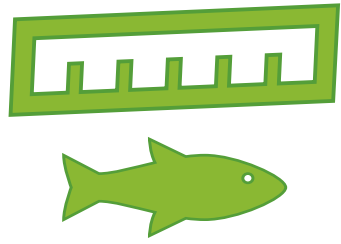
Environmental variables tested as fixed effects: current speed, current direction and depth | Random effects: habitat and location

# Haddock abundance (BOWL | MEOW)



Environmental variables tested as fixed effects: current speed, current direction and depth | Random effects: habitat and location

# Relative biomass calculation

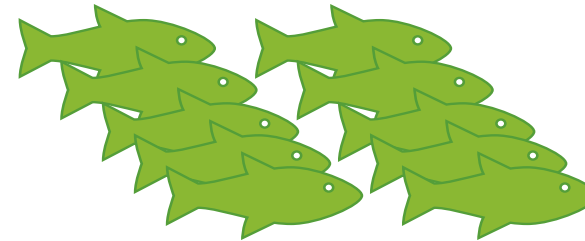


**Length**

$W = a * L^b$   
Species conversion  
factors



**Weight**



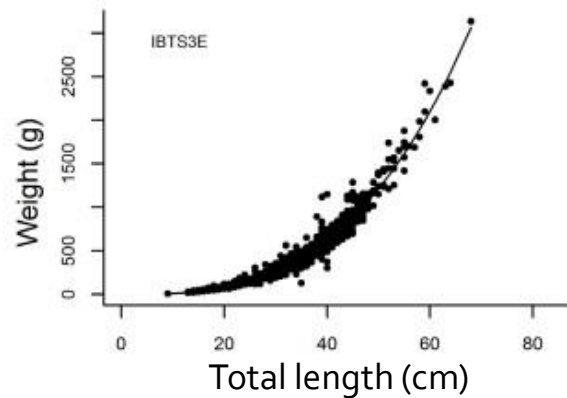
**Abundance**



**BIOMASS  
ESTIMATE**



**BRUV data**

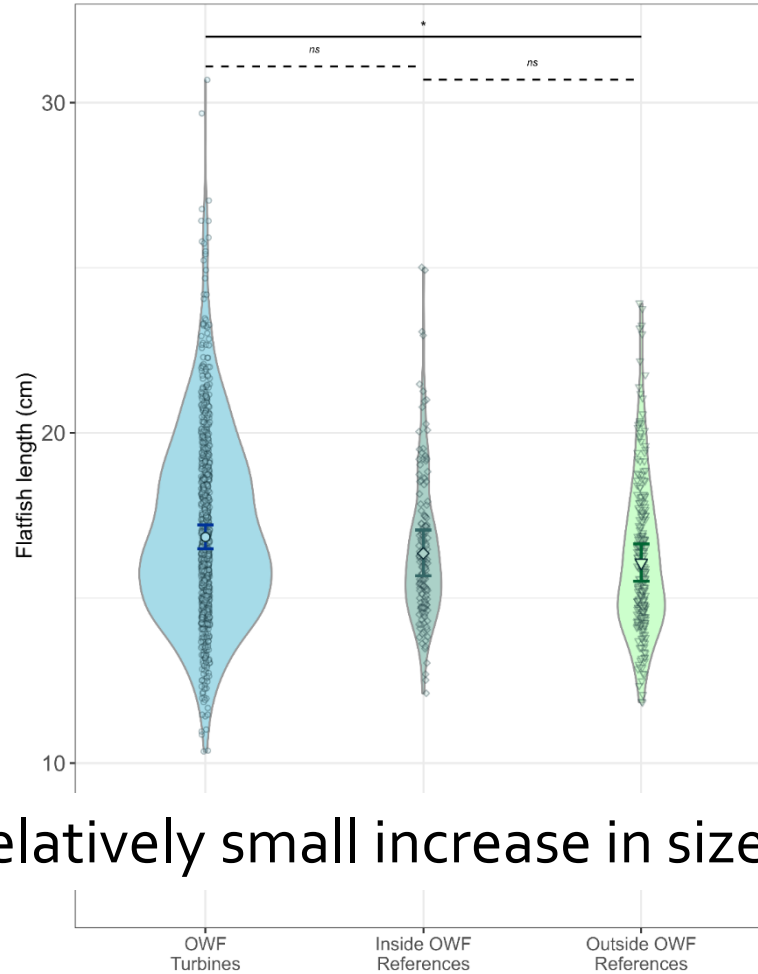


**BRUV data**

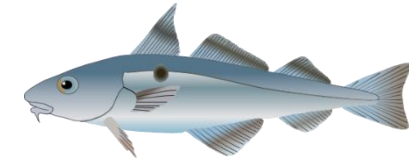
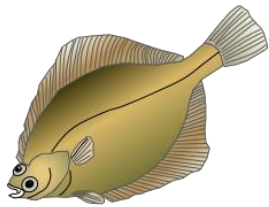
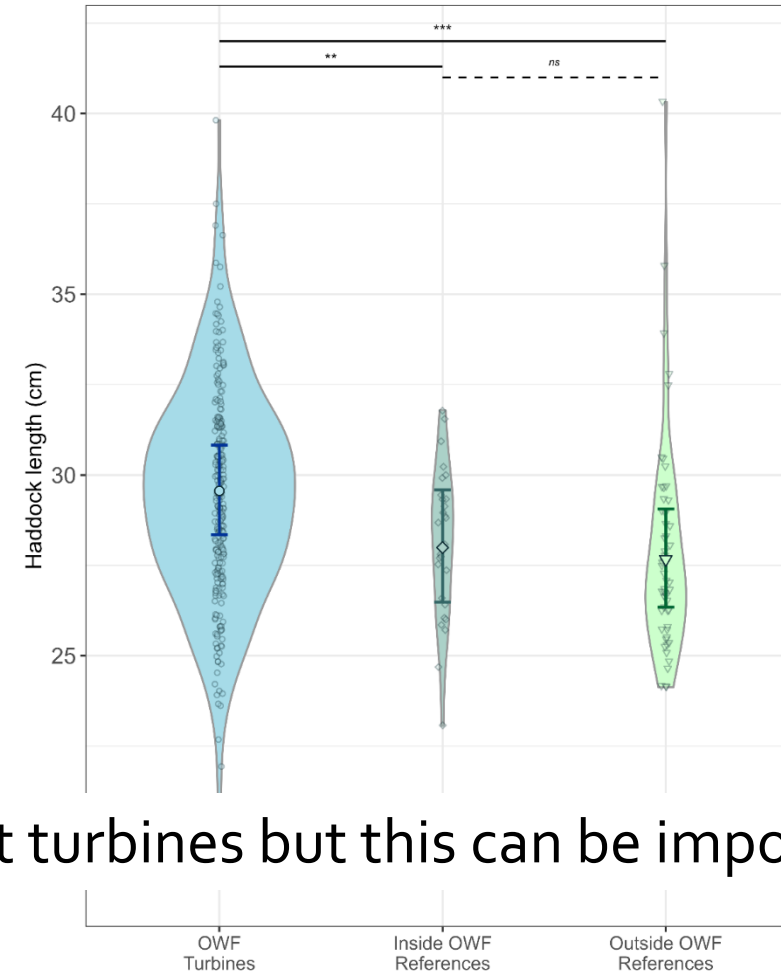


# Lengths

## FLATFISH

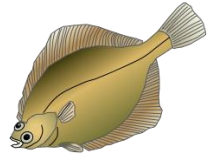


## HADDOCK

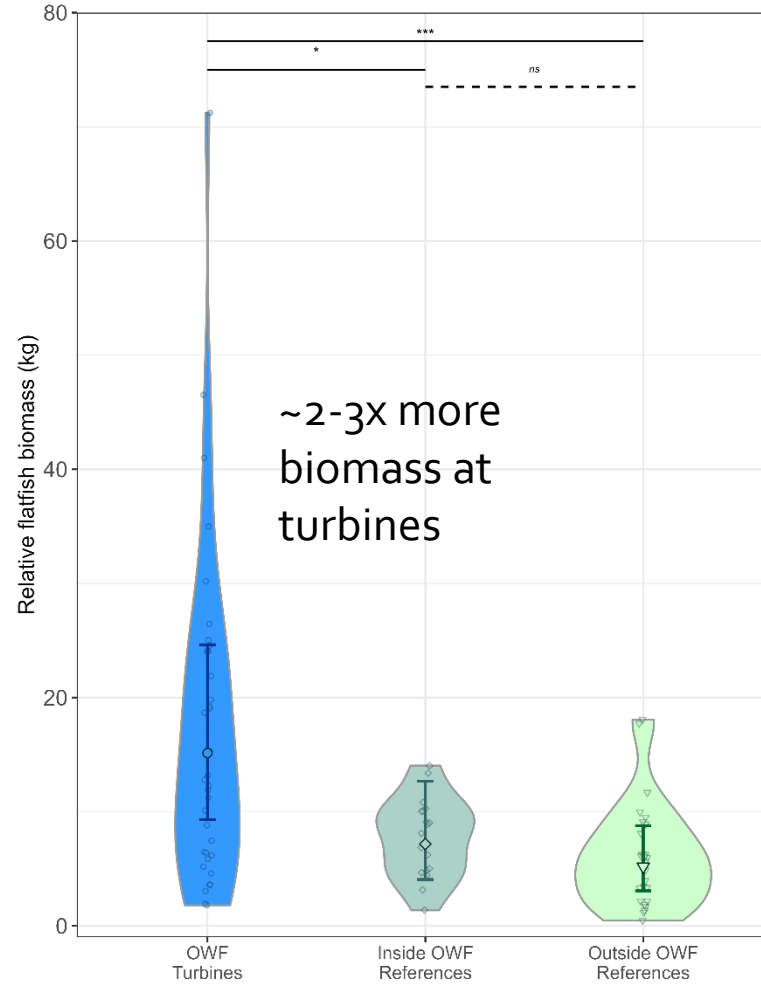


Relatively small increase in size at turbines but this can be important?

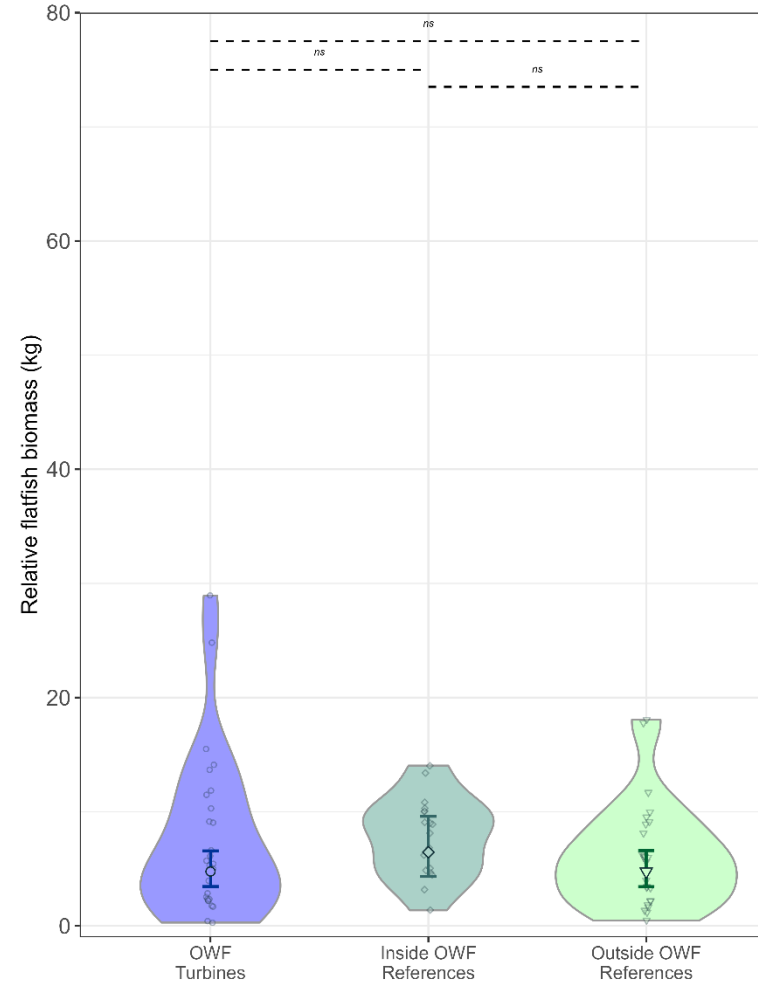
# Flatfish biomass (BOWL | MEOW)



## BOWL TURBINES

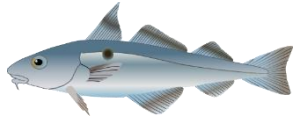


## MEOW TURBINES

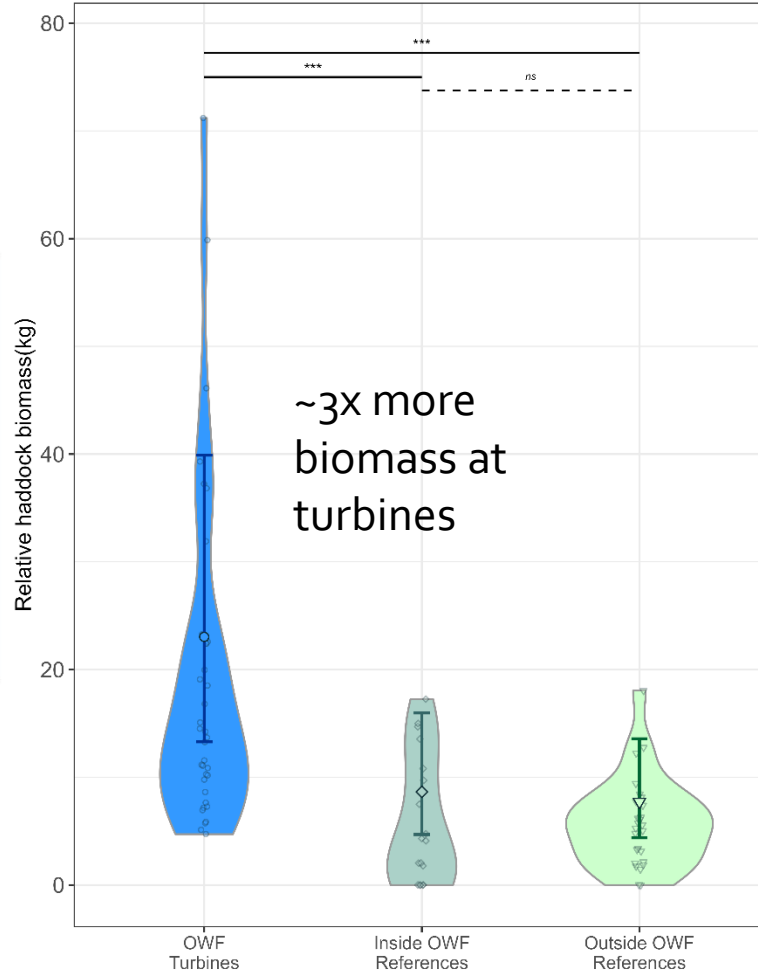


Environmental variables tested as fixed effects: current speed, current direction and depth | Random effects: habitat and location

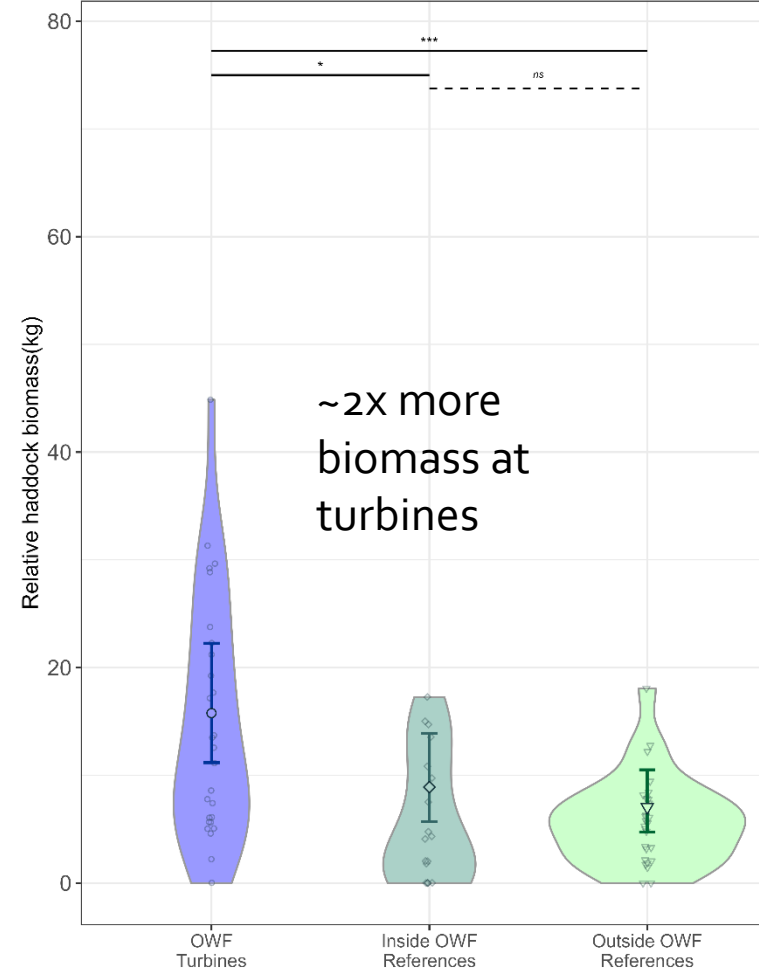
# Haddock biomass (BOWL | MEOW)



## BOWL TURBINES



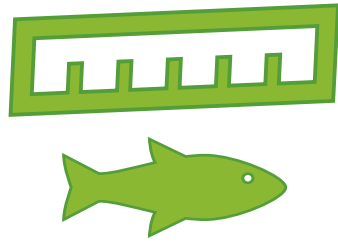
## MEOW TURBINES



Environmental variables tested as fixed effects: current speed, current direction and depth | Random effects: habitat and location



# From biomass to energy

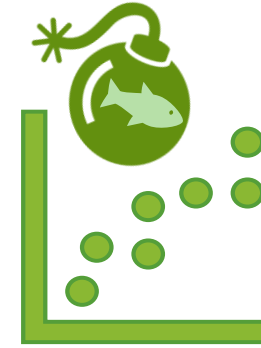


**Length**

$W = a * L^b$   
Species conversion  
factors



**Weight**



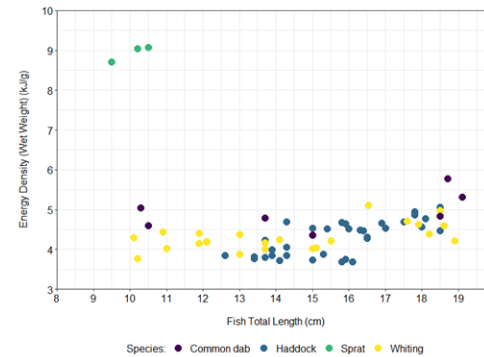
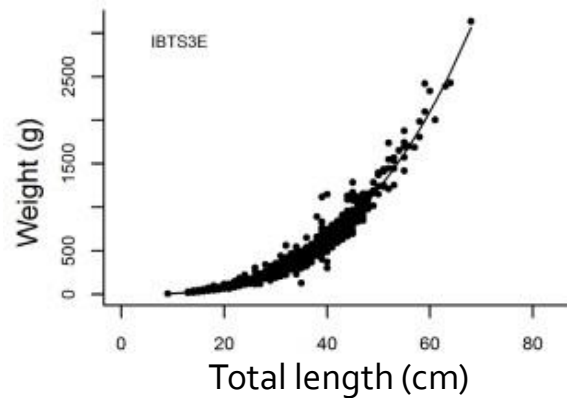
**Energy**



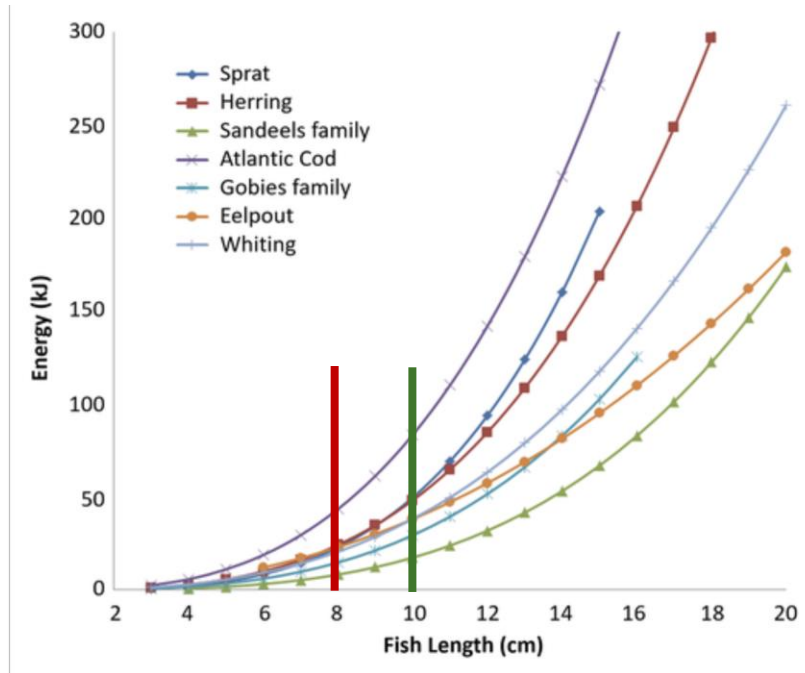
**ESTIMATE  
OF ENERGY  
AVAILABLE  
TO PREDATORS**



**BRUV data**

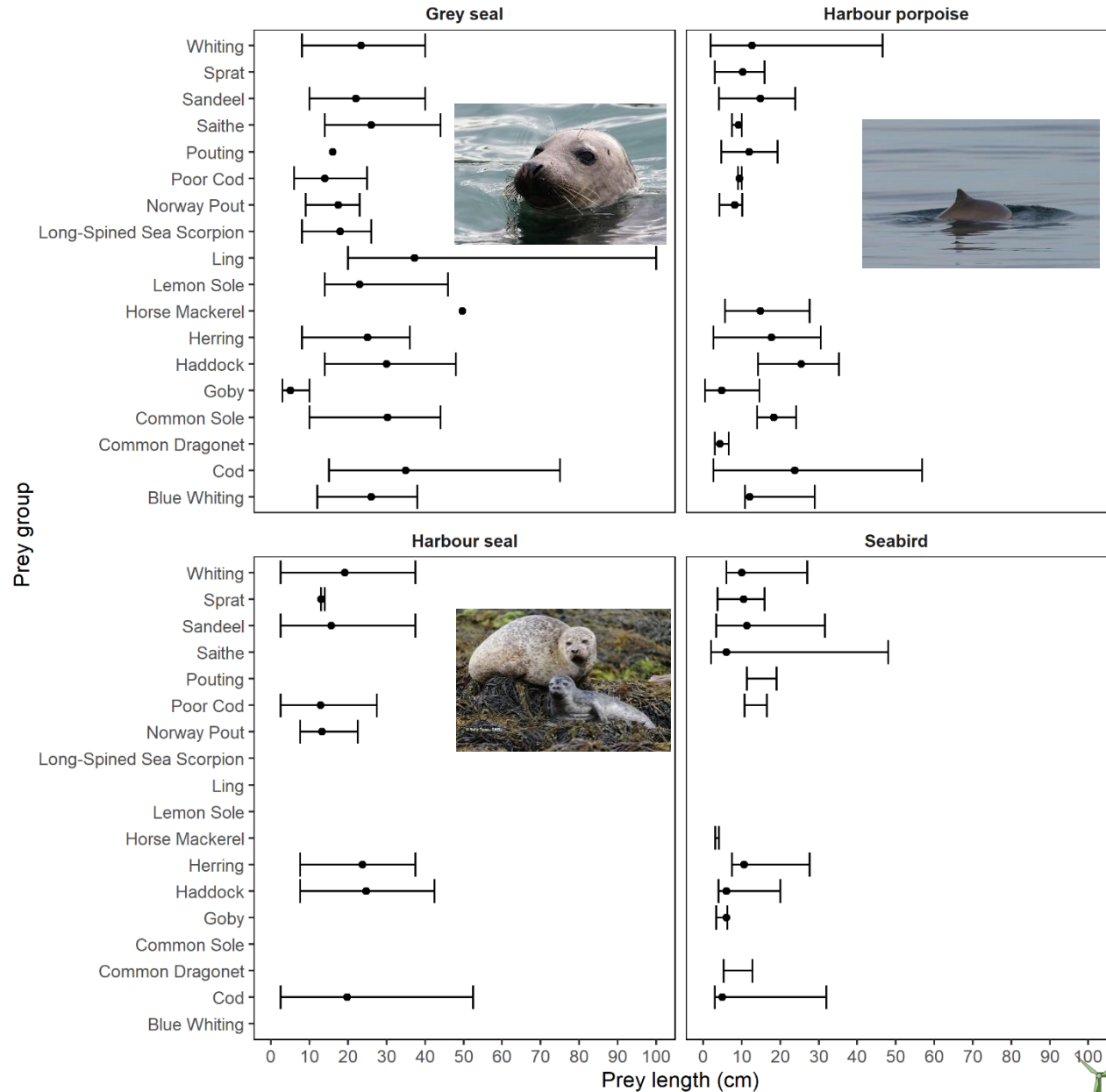


# Prey & prey quality



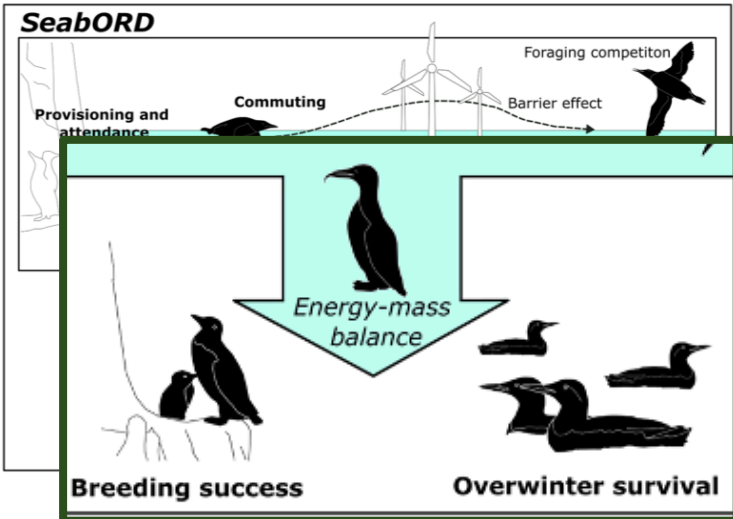
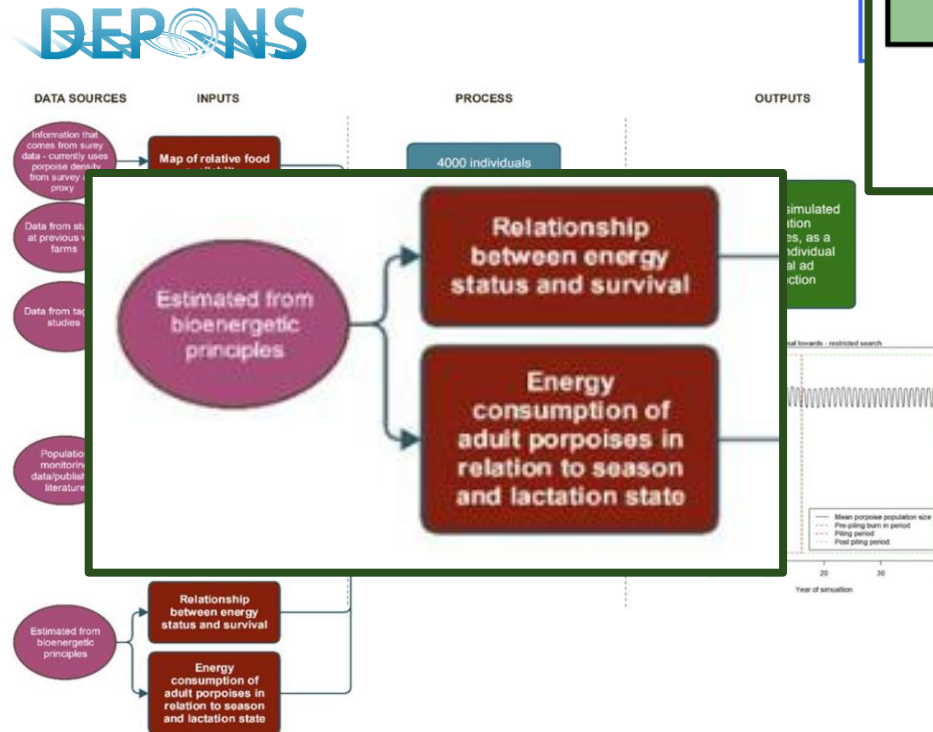
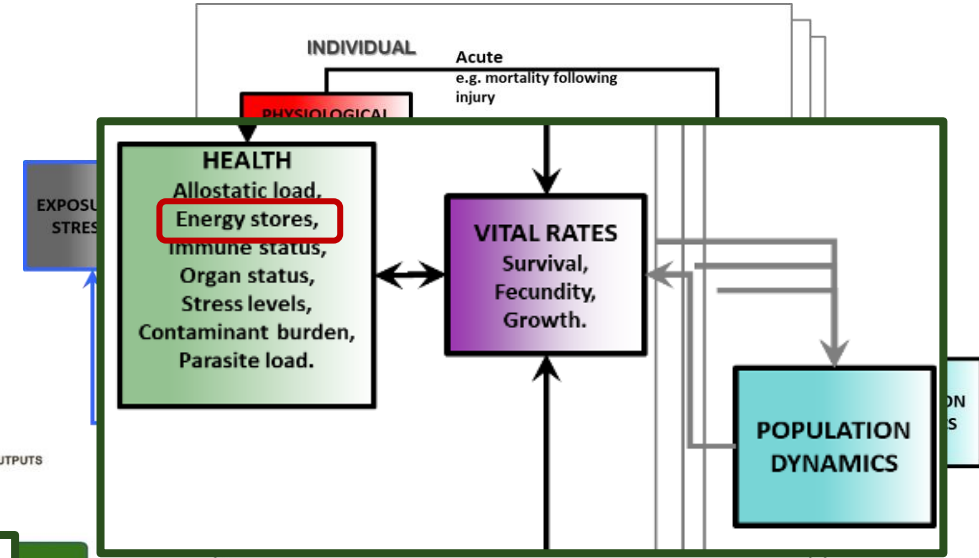
## Size matters!!!

- 10 cm 'average' fish = 37 kJ
- 8 cm 'average' fish = 19 kJ
- = half the energy



# Current Cumulative Impact Assessment tools

- Porpoises (and other MM species)
  - DEPONS
  - Interim PCoD
- Seabirds
  - SeabORD

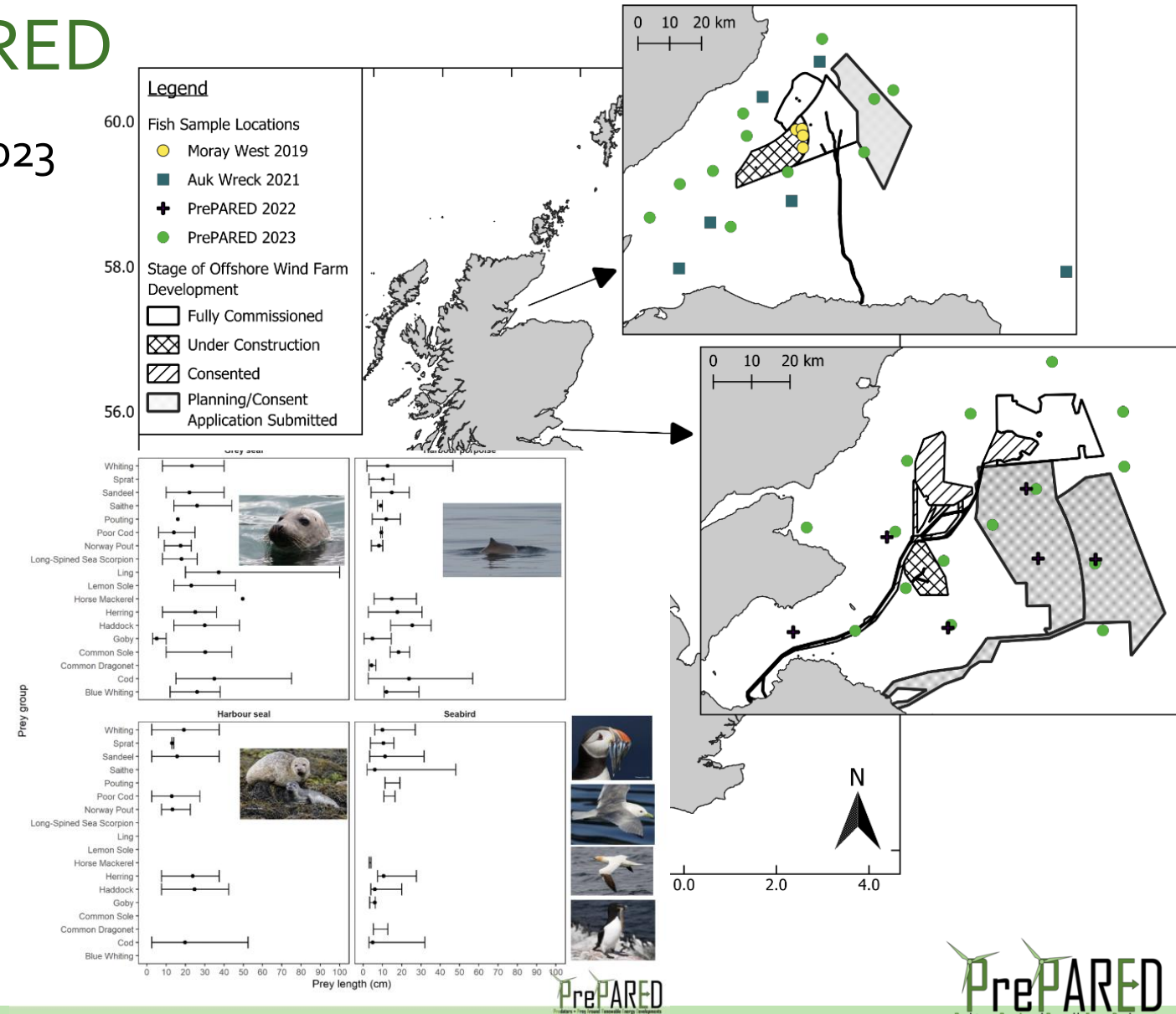




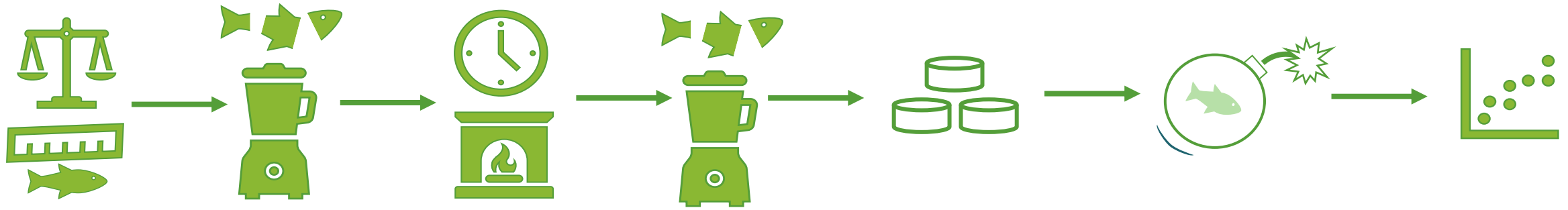
# Fish samples in PrePARED

- Samples from 2019, 2021, 2022, 2023
- More surveys in 2024
  - PrePARED sampling
  - Moray East post-construction surveys

Species	
Bull-rout	Long rough dab
Cod	Mackerel
Common dab	Northern squid
Corbin's sandeel	Norway Pout
European squid	Plaice
Flounder	Poor Cod
Grey gurnard	Scadfish
Haddock	Sprat
Herring	Thickbacked sole
Lemon sole	Viviparous eelpout
	Whiting



# Bomb calorimetry

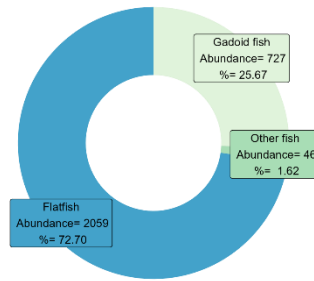


## Since start of PrePARED project:

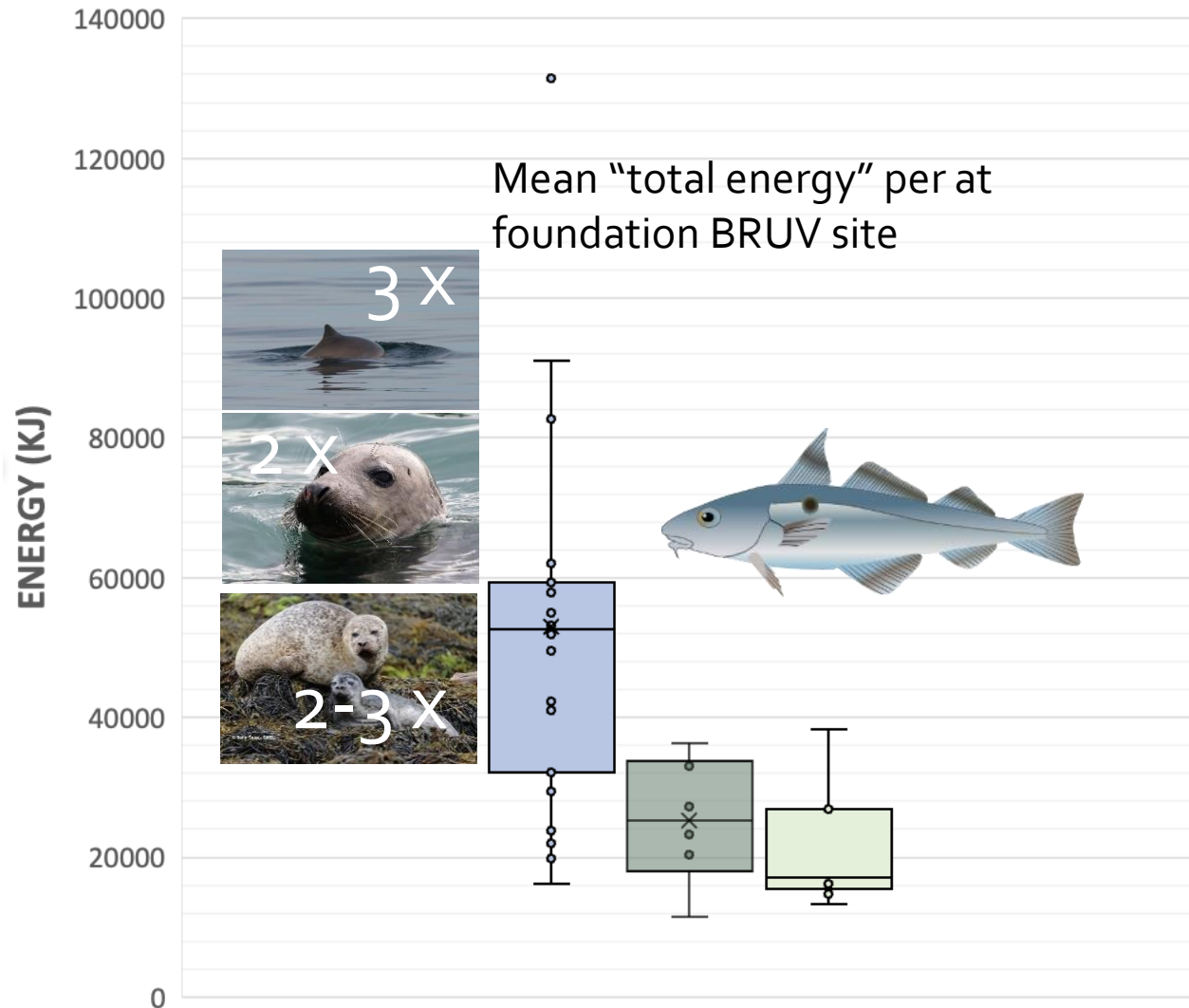
- 500 fish samples processed
- 247 new energy density estimates
- 21 prey species
- Size range across species: 7.0 – 47 cm

# Total energy (BOWL | MEOW)

Flatfish  
+  
Haddock  
+  
Poor cod



Foundations Between Foundation Outside OWF



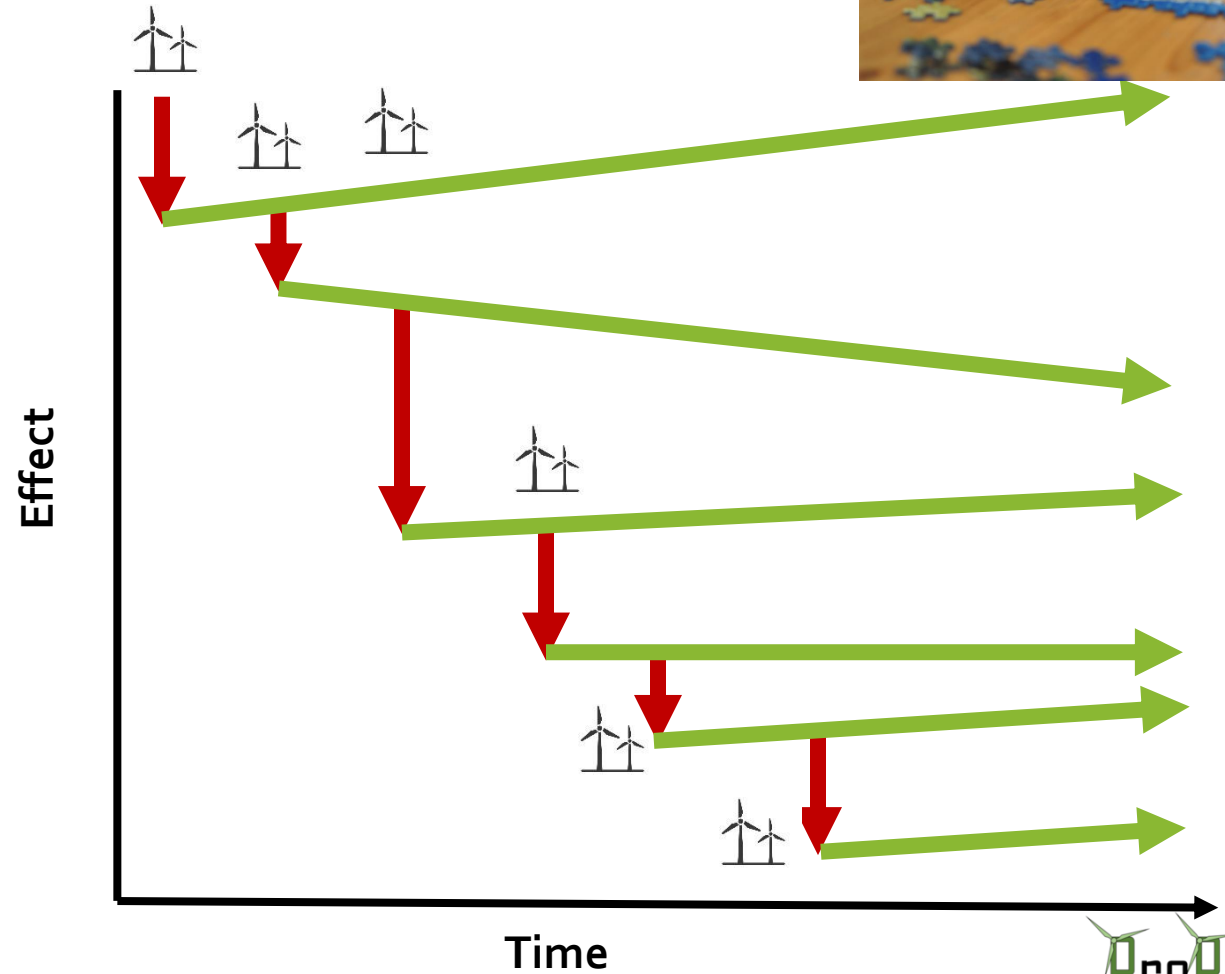
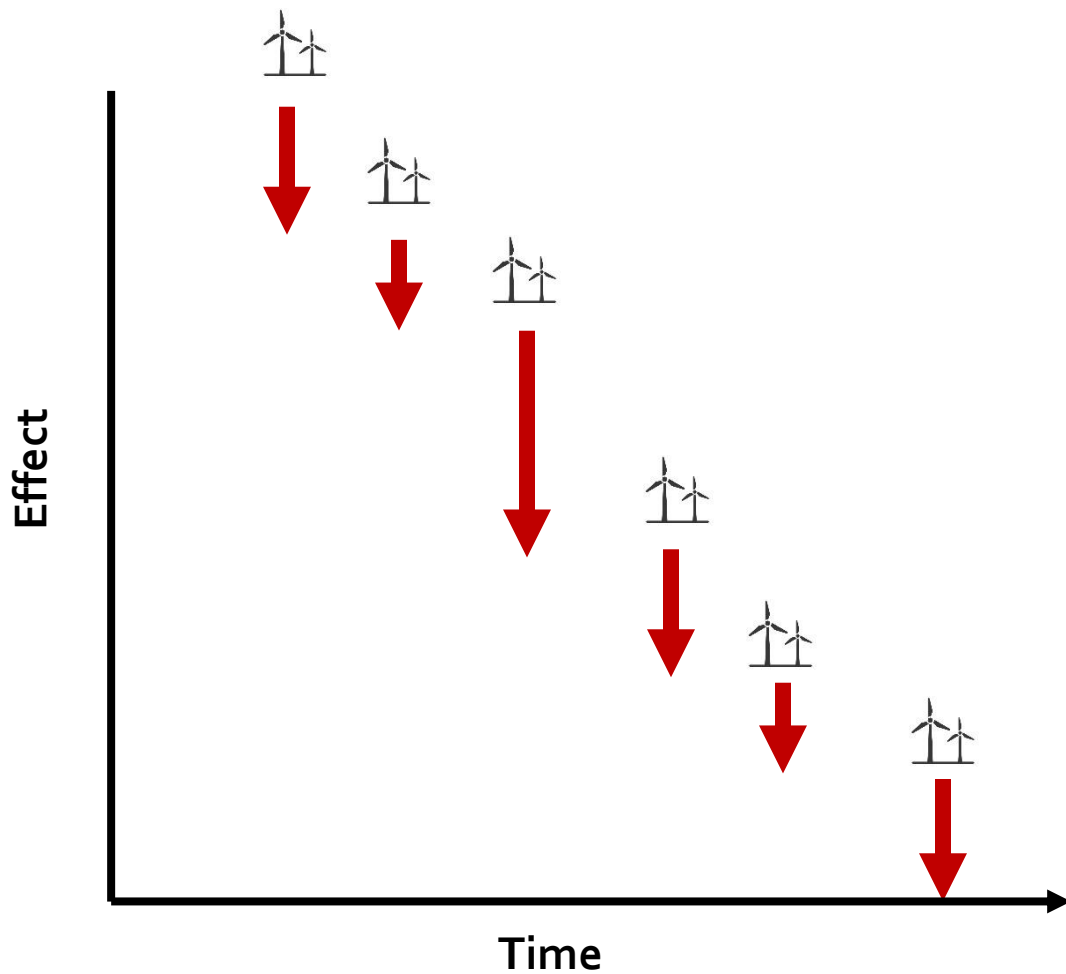
Each BRUV  
monitors  
~0.03 km<sup>2</sup>

vs

BOWL  
~131 km<sup>2</sup>  
84 turbines

MEOW area  
~295 km<sup>2</sup>  
100 turbines

# How PrePARED *could* support CIA





# How PrePARED *could* support MNG



Biodiversity pressure indicators	
Habitats	Species
Reduction in habitat extent Increase in fragmentation Change in primary productivity Change in ecosystem carrying capacity Reduced ecological connectivity Alteration to diversity	Change in individual species populations Change in distribution and range Alteration to important functions Increased extinction risk

Residual Magnitude Categories
No or negligible impact
Minor impacts that are unlikely to lead to long term measurable effects on ecosystem integrity
Moderate impacts that cannot be avoided and could lead to irreversible change, but do not lead to an irrecoverable loss in ecosystem integrity
Major impacts that would lead to an irrecoverable loss of ecosystem integrity



## Summary

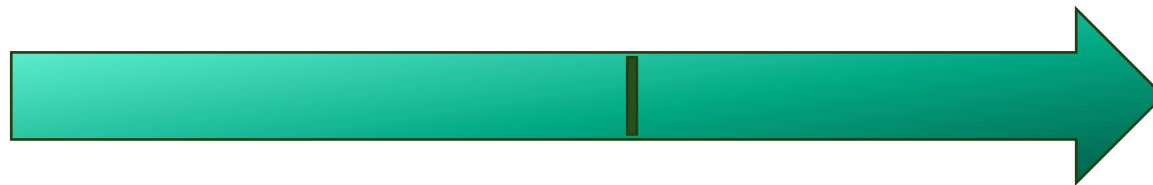
- Summer daytime BRUV survey
  - higher haddock and flatfish abundance and biomass close to turbines in BOWL, compared to references
- The turbine effect is consistent for haddock at MEOW, but effect size is smaller.
- Some evidence of 'Age' or 'Structure' effect
- Able to quantify observations in terms of energy
  - Common currency linking predators and prey
- Demonstrated how these points can support
  - CIA tools
  - Marine Net Gain



# Next steps

- 2024 summer BRUV survey planned in Moray Firth
- Integrate with Firth of Forth BRUV data
- Future efforts (beyond PrePARED plans)
  - Expand spatial and temporal coverage
  - Effect of age and structure type?
    - cf Seagreen + NnG?
  - Understand within/between year variations in species assemblages

2022      2023      2024      2025      2026.....







Thank you!

# PrePARED

Predators + Prey Around Renewable Energy Developments

