Reef effects of structures in the North Sea: Islands or connections? (RECON)

Joop Coolen, presented by: Han Lindeboom

31 October, 2017. INSITE Science Day, London

WAGENINGEN UNIVERSITY & RESEARCH

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North Sea history: lost oyster reefs

1883: ~27.000 km² oyster reefs

= 32% of Dutch sea bottom covered

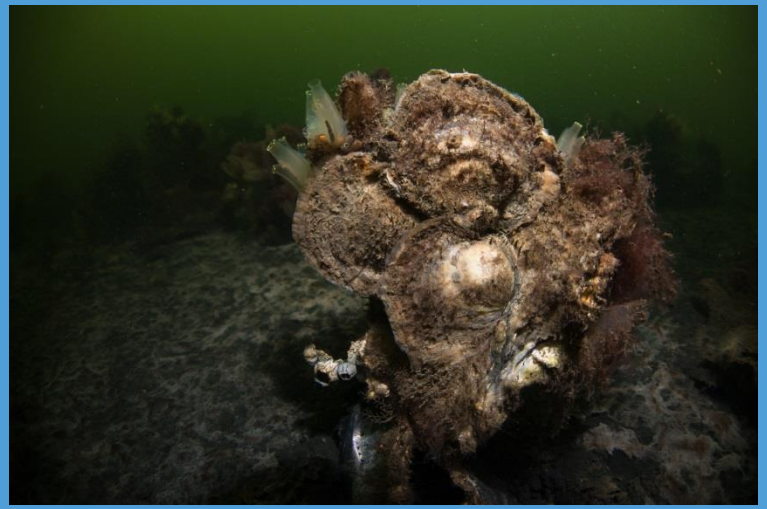
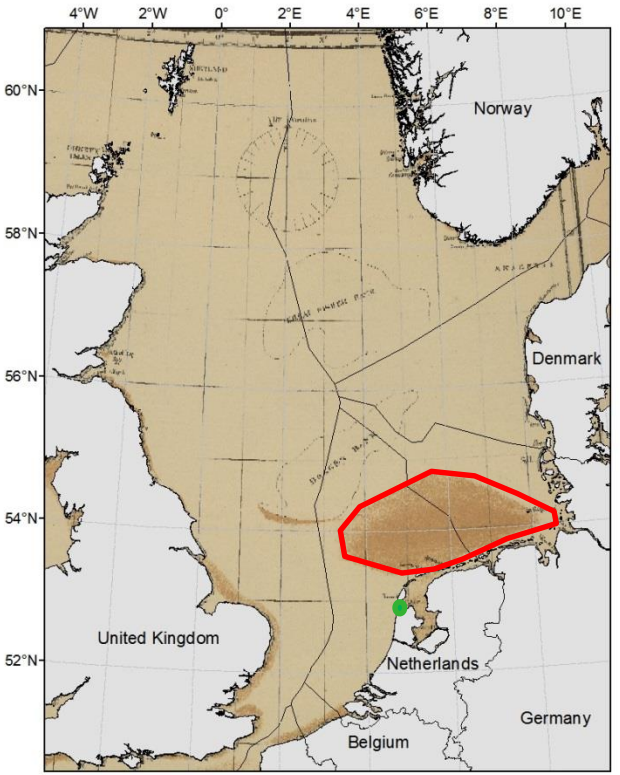


Photo credits: Yoeri van Es

Olsen 1883



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North Sea history: lost oyster reefs

Today: oyster reefs extinct offshore

< 800 km^2 rock/gravel beds in NL

= 1.5% of Dutch sea bottom covered

The rest (98.5%) = sand bottom

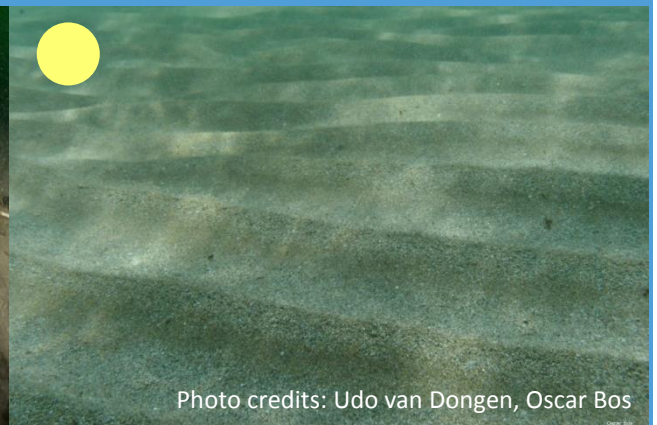
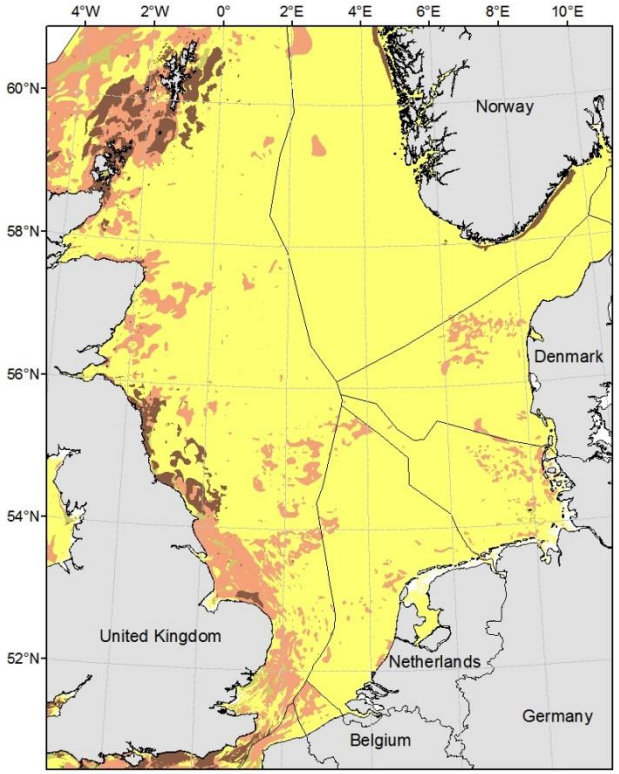
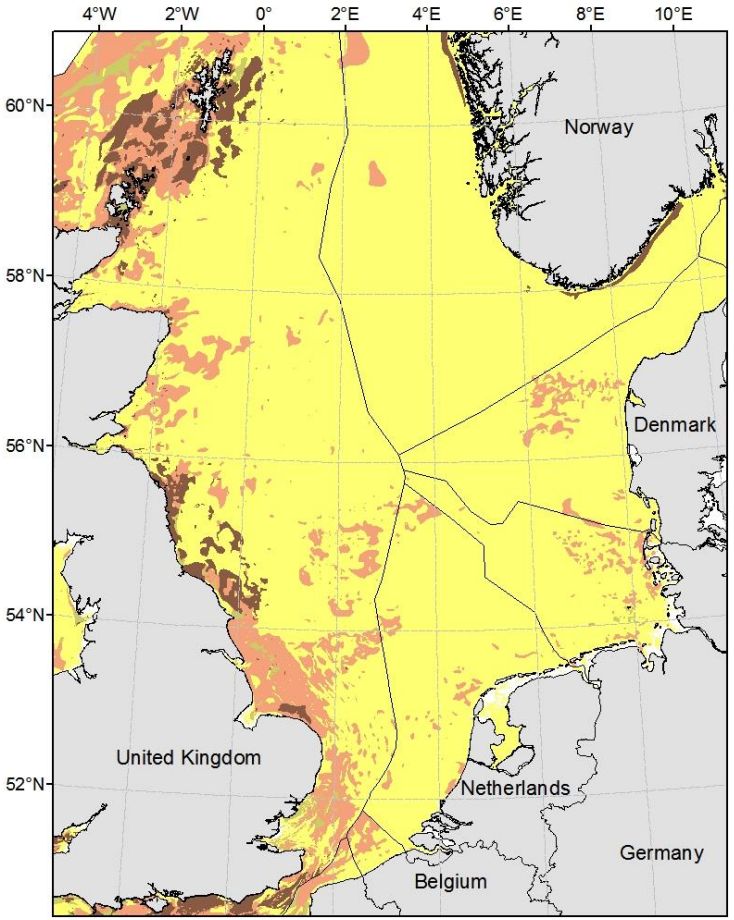


Photo credits: Udo van Dongen, Oscar Bos



North Sea artificial objects

Mainly sand bottom



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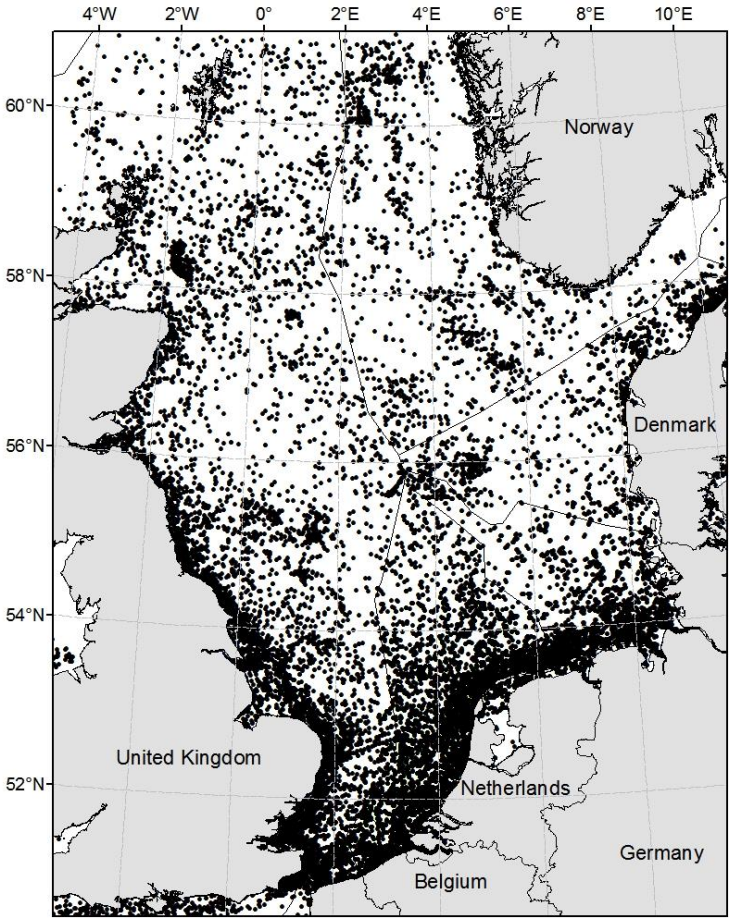
North Sea artificial objects

Mainly sand bottom

Add objects:

Wrecks (~25.000)



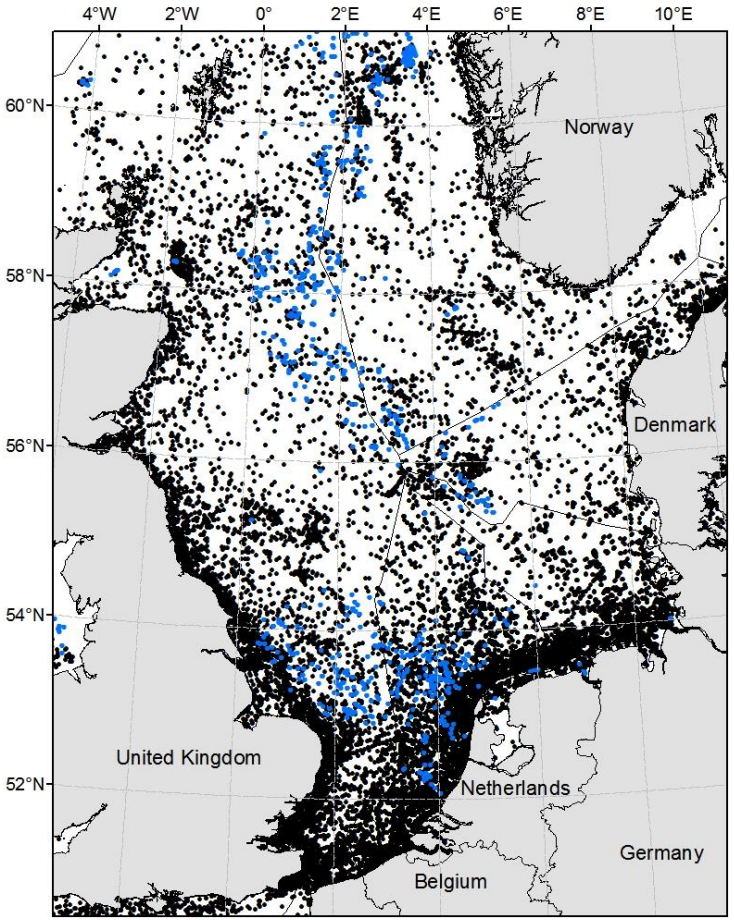
North Sea artificial objects

Mainly sand bottom

Add objects:

Wrecks (~25.000)

O&G installations (~ 1,300)



North Sea artificial objects

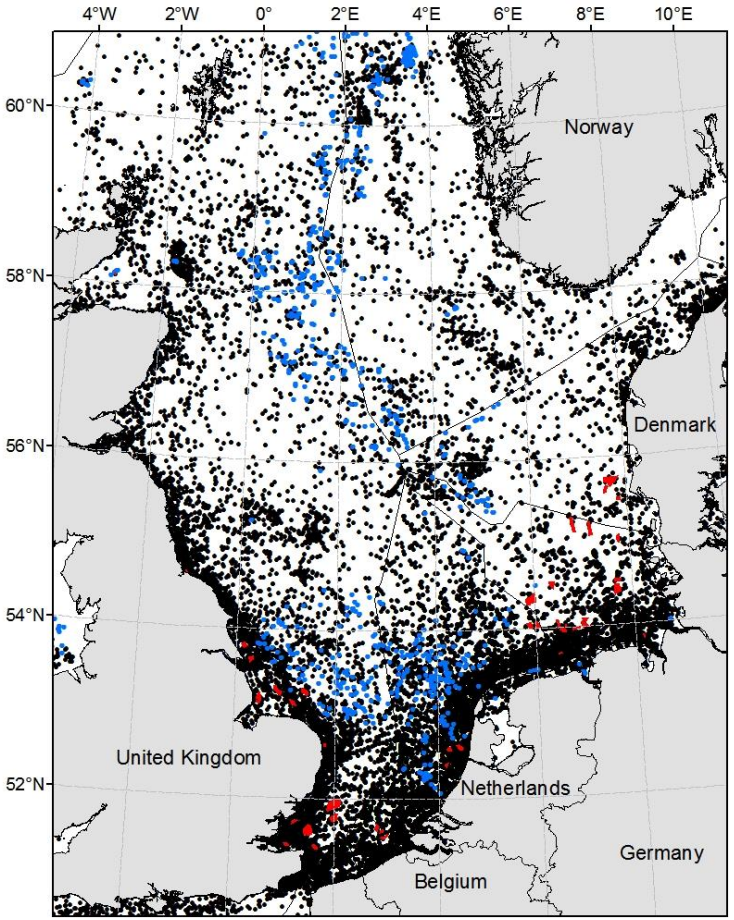
Mainly sand bottom

Add objects:

Wrecks (~25.000)

O&G installations (~ 1,300)

Wind turbines (> 2,500)



North Sea artificial objects

Mainly sand bottom

Add objects:

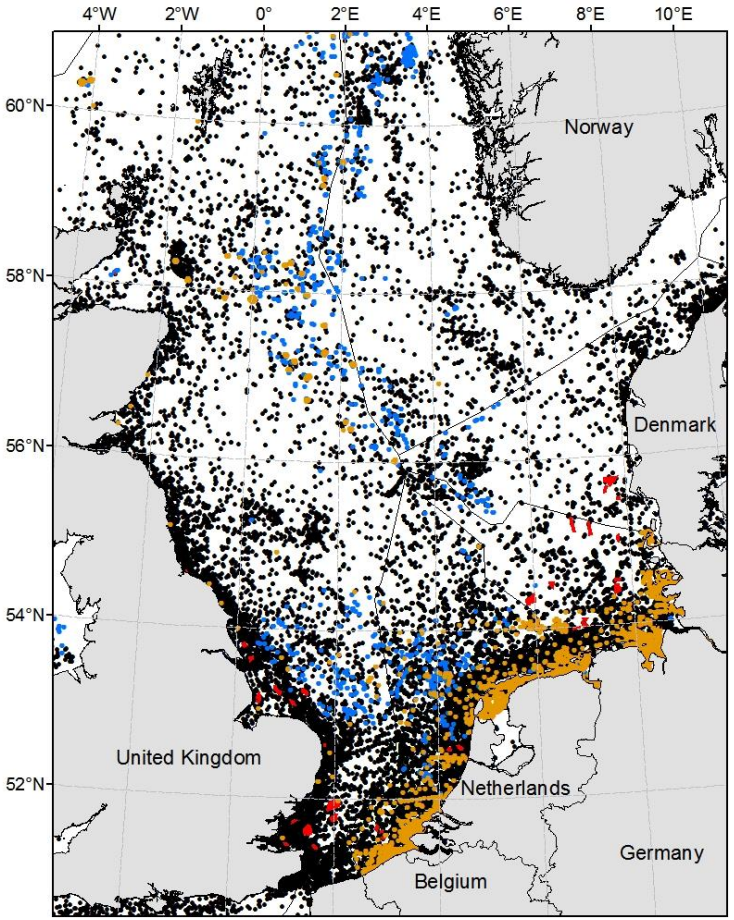
Wrecks (~25.000)

O&G installations (~ 1,300)

Wind turbines (> 2,500)

Buoys (many thousands)

Et cetera



Artificial structures facilitate reef species

Photo credits : Udo van Dongen

RECON Research questions

- What is the effect of artificial objects on the distribution of reef species in the North Sea?

1. Which benthic species live on offshore structures?
2. Can we identify the drivers for their presence?
3. Can we predict which species grow at locations?
4. Are these locations interconnected or isolated?

RECON topics

1. Analyse ROV data from platforms
2. Modelling species patterns on offshore installations using samples
3. Identifying new and rarely observed species for the Dutch North Sea
4. Develop hard substrate benthic metabarcoding techniques
5. Assess interconnectivity using *Mytilus edulis* genetics
6. Assess interconnectivity using *Jassa herdmani* genetics

RECON project team

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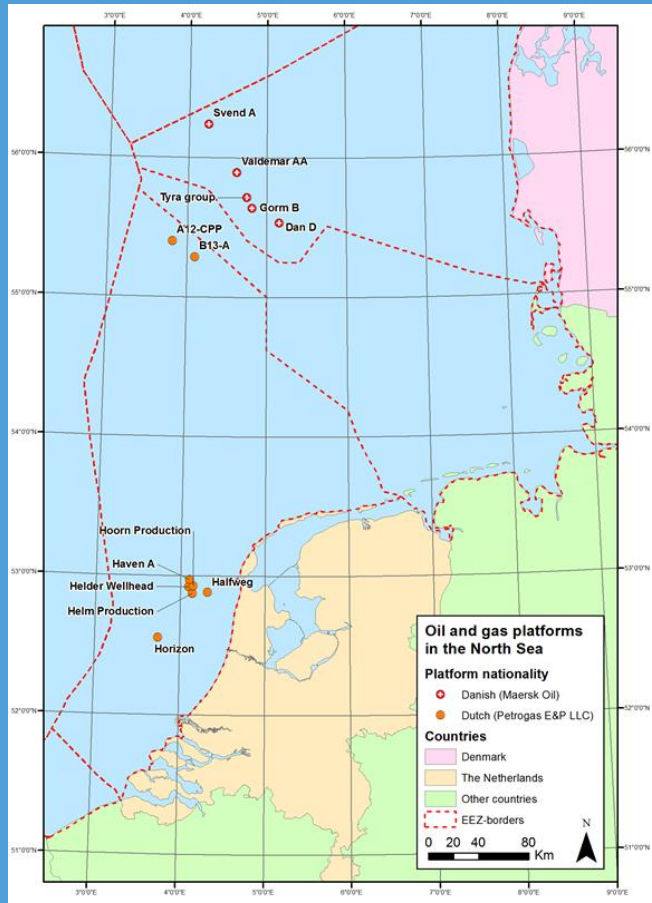
Robbert Jak
And many interns

Species inventory ROV

- 17 platforms
- NL Petrogas
- DK Maersk Oil
- ROV inspection video legs & risers



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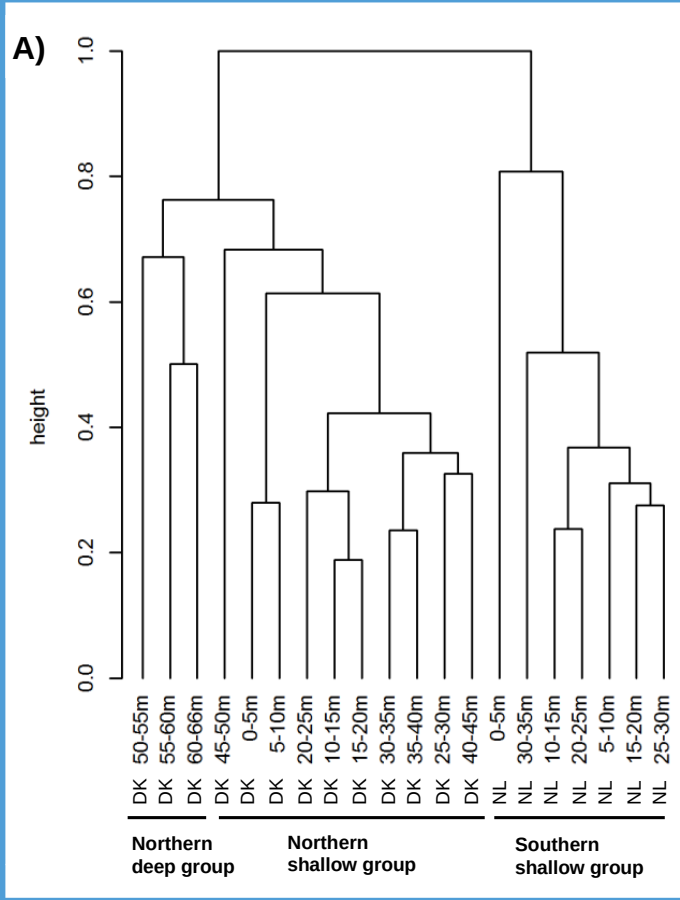
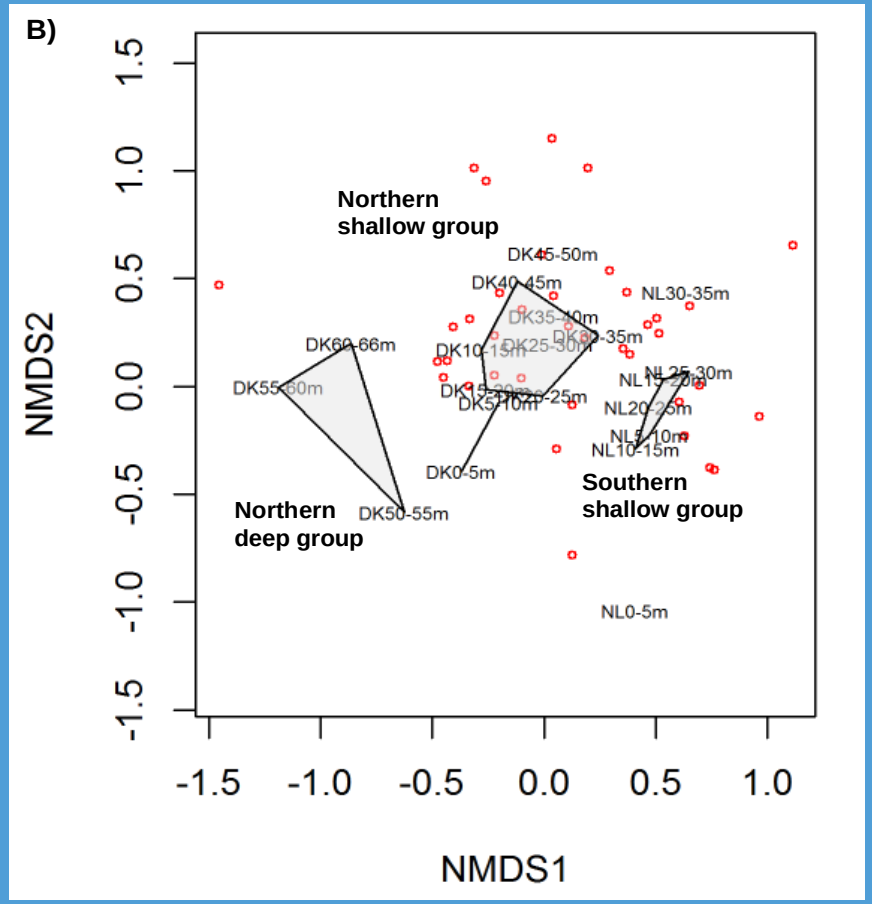
Results species inventory ROV





Blue mussel
Mytilus edulis

Dead men's finger
Alcyonium digitatum

Plumose anemone
Metridium dianthus

Common starfish
Asterias rubens

Fig sponge
Suberitus ficus

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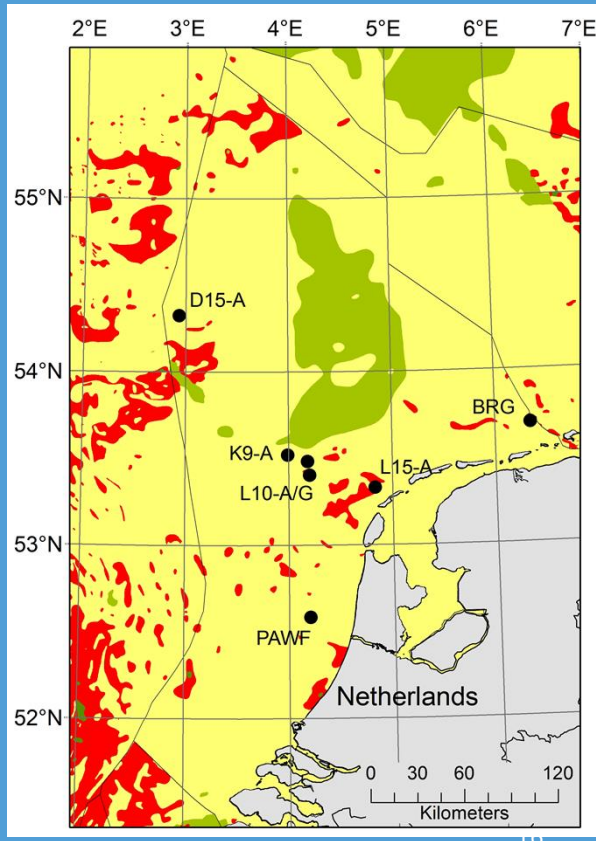
Reef species on oil & gas platforms ENGIE

Investigated 2012 - 2016:

Patterns in biodiversity on structure

Similarity to natural reefs (EU protected habitats)



Patterns biodiversity

Total: 138 species on platforms

Shallow: Blue mussels

Intermediate: Hydroids & Gammarids

Deep: Anemones & soft corals

Shallow parts most ‘unnatural’

High diversity at intermediate depths

Deep parts most like natural reefs

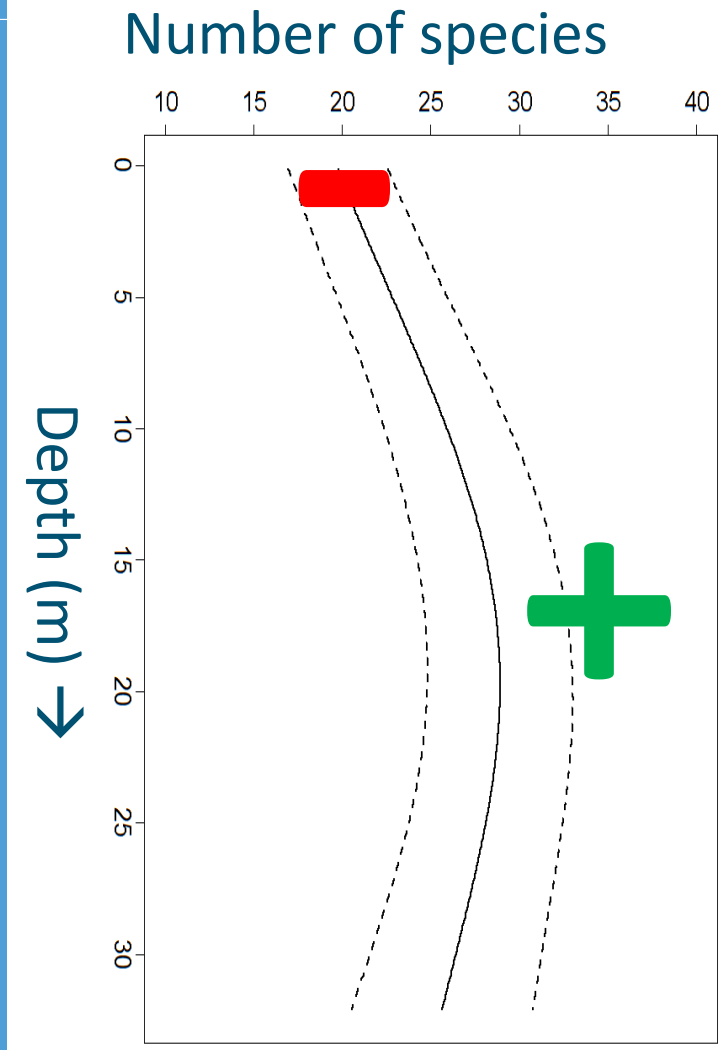


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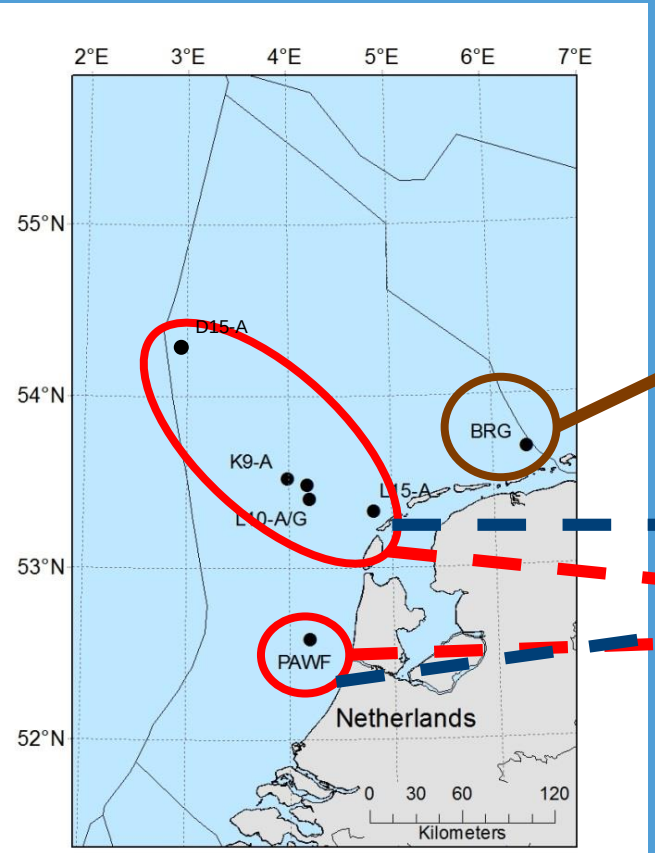
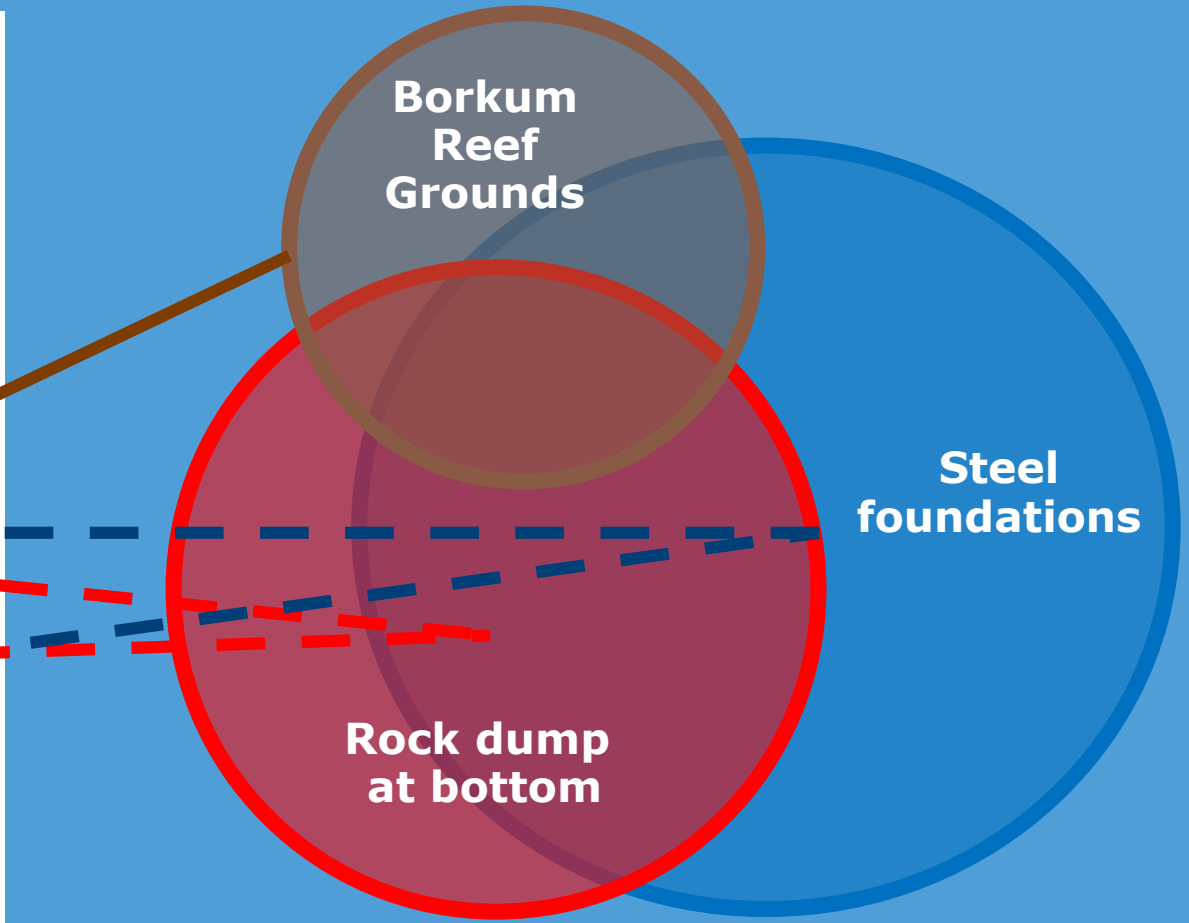
Photo credits: Inductiveload, Bernard Picton, Hans Hillewaert, André-Philippe D. Picard, Bengt Littorin

Species inventory





New and rarely observed species for the Dutch North Sea

Skeleton shrimps

Pseudoprotella phasma

Caprella tuberculata

Caprella equilibra

Polychaete worms

No picture available

Syllis amica

Syllis vitata

Harmothoe aspera

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Metabarcoding of mixed macrofauna samples

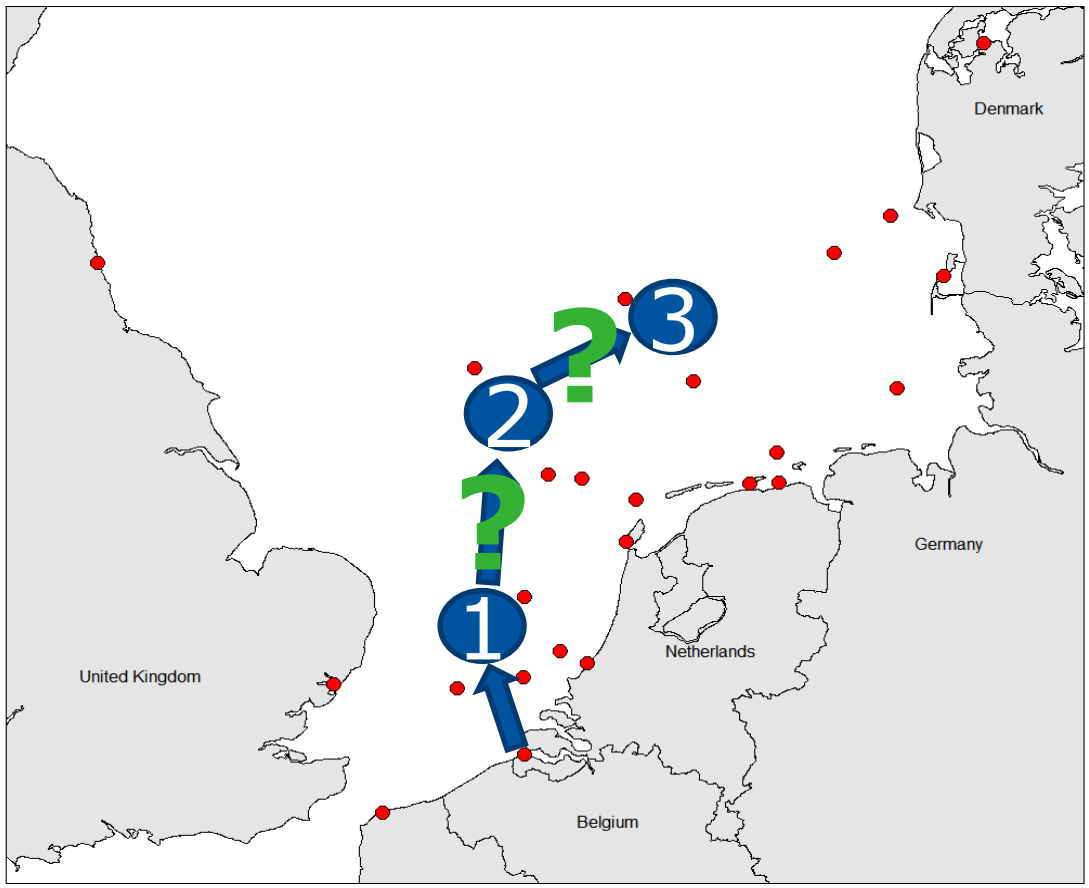
Using samples from shipwrecks & coastal reefs

- Add species to barcode databases
- Develop metabarcoding protocols

- Output:
  - >150 species identified
  - ~300 individuals to be barcoded & published
  - Work in progress

Do mussels use offshore structures to disperse?

- *Mytilus edulis*



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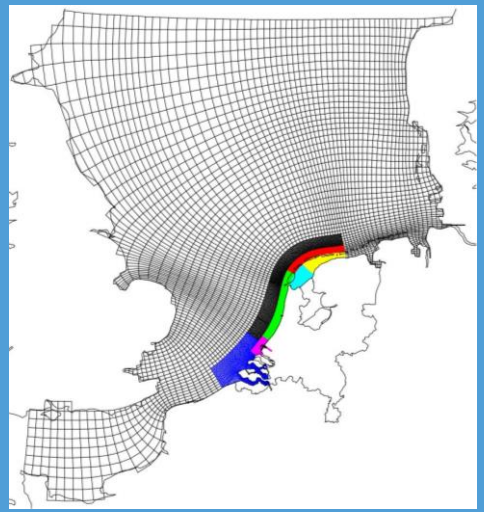
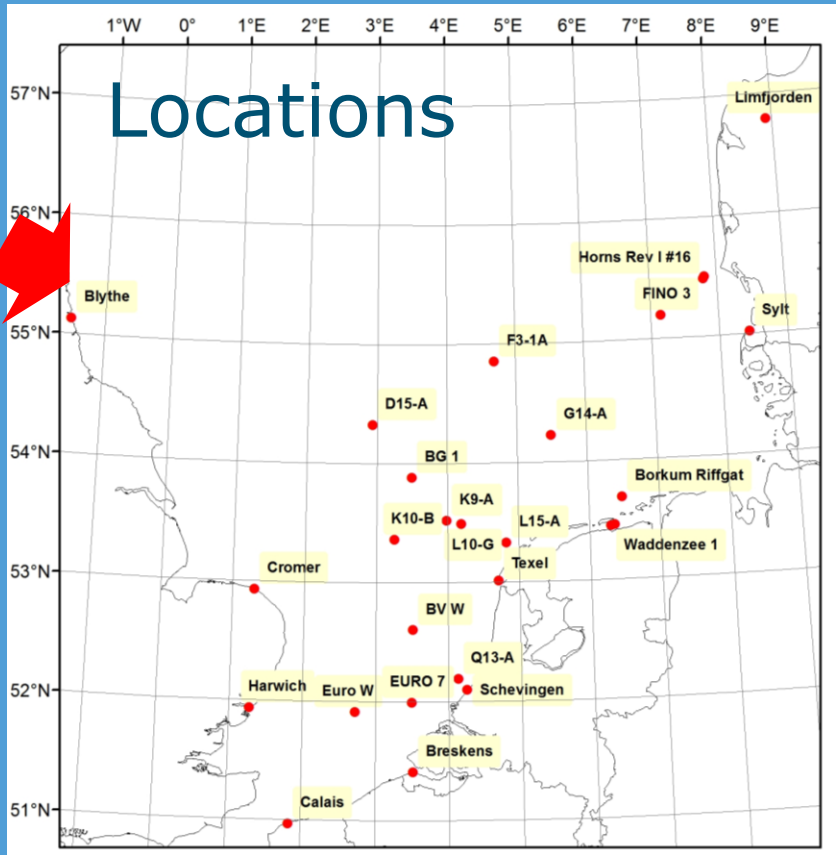
Methods

Modelling

- Delft 3D particle tracking model
- ‘Release’ 10^6 particles per location





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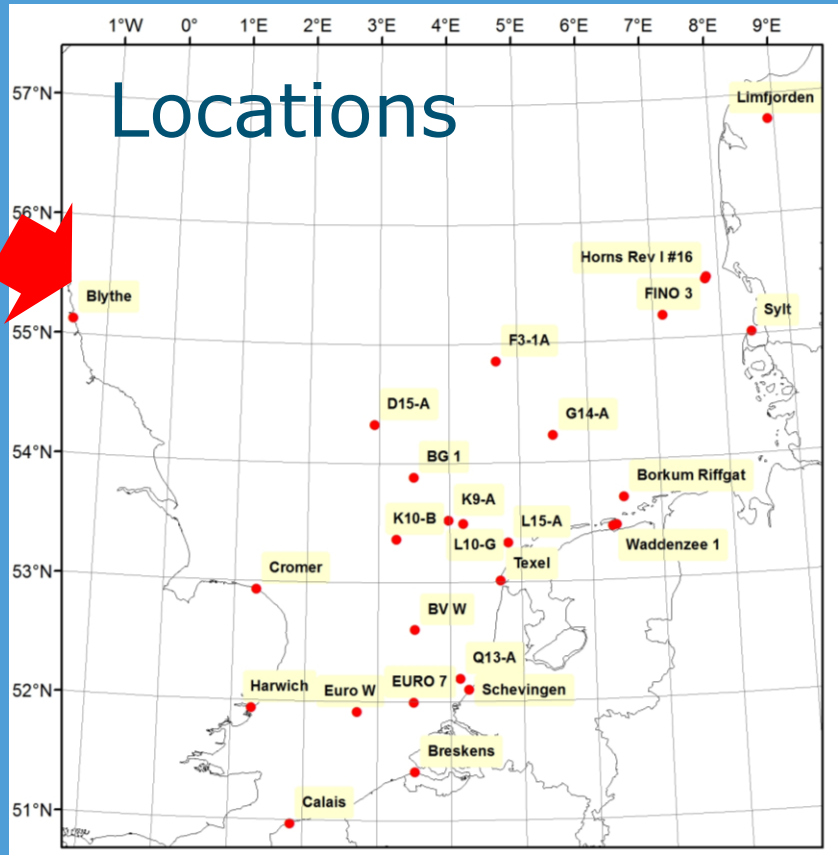
Methods

Modelling

- Delft 3D particle tracking model
- 'Release' 10^6 particles per location

Sampling

- Sampled >48 mussels per location
- Molecular analysis: Microsatellites
- Calculate pairwise distance F_{ST}
- Model migrations with Ima2p



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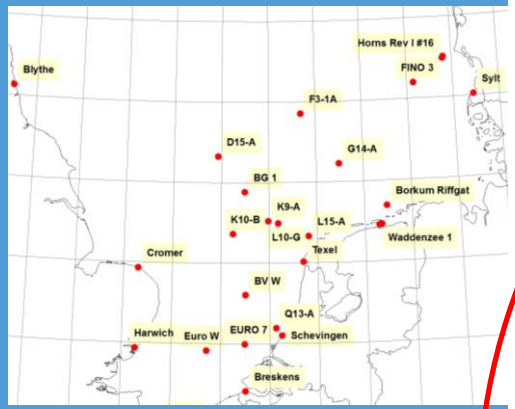
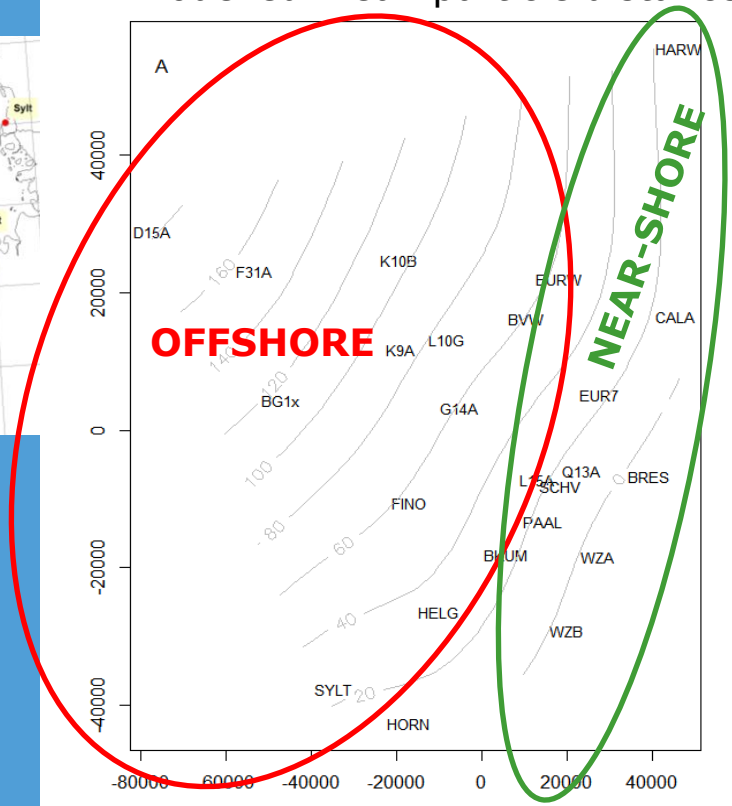
Results: patterns in particle ‘distance’

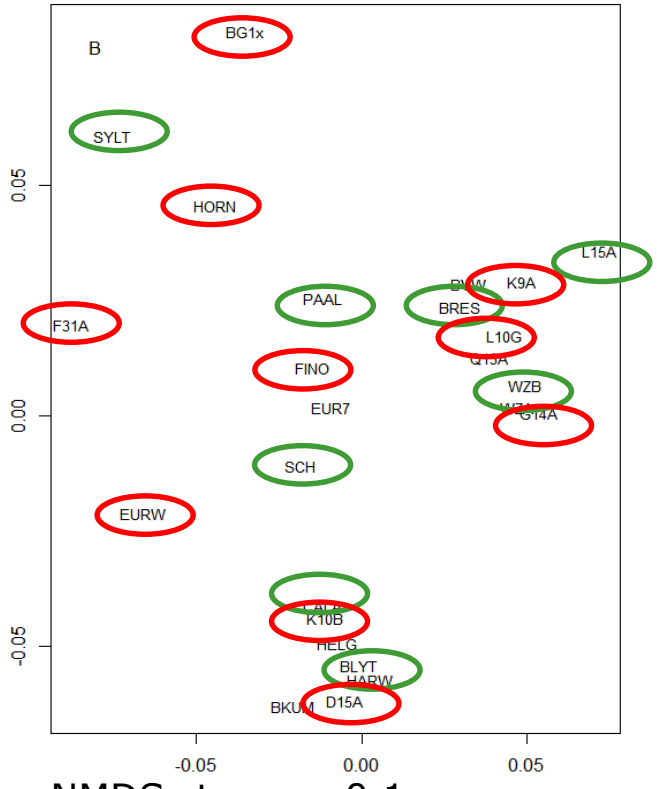


Modelled mean particle distance



NMDS stress = 0.06

F_{ST} genetic distance



NMDS stress = 0.1

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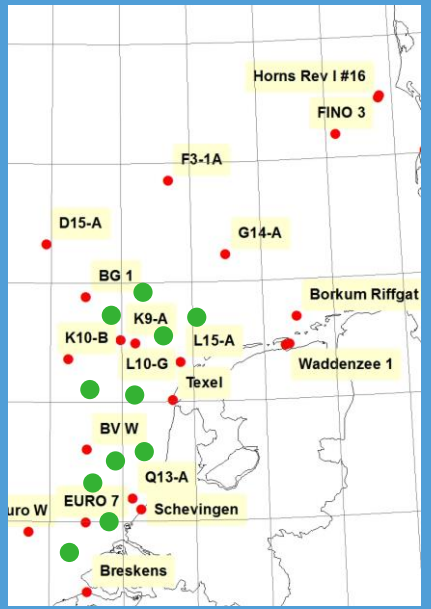
Discussion *M. edulis* connectivity

- Particle tracking 90% zero
  - Locations too far apart?
- Rare events drive colonisation far offshore?

  → UNDINE project
- Next steps
  - Add in-between locations
  - Investigate long term variation in models (Lacroix et al.)



Genetic patterns *Jassa herdmani*

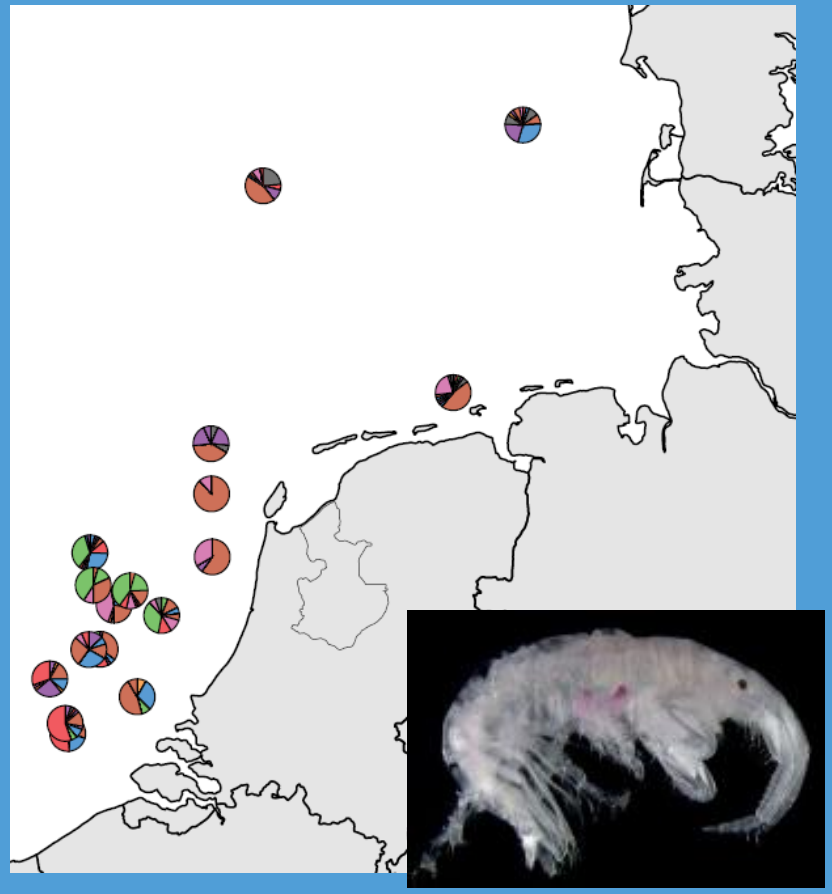
Present in high numbers

→ up to 1.000.000 per m^2

17 successful sample locations

High differentiation = low connectivity

Significant difference among locations



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Conclusions research

- Installations highly biodiverse
- Over 200 hard substrate associated species
- Composition most influenced by location, depth & substrate type
- Deep parts most like natural reefs
- Removal of installations will reduce local biodiversity
- Installations likely connected via water currents

  → Depending on species' life cycles

Recommendations

- Increase spatial distribution of locations to be investigated
- Include concrete structures
- Continue connectivity work by adding in-between locations
- Complete barcoding databases
- Develop methods to sample deeper locations (>50m) using ROV & metabarcoding with high numbers of samples.

Partners & sponsors RECON

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Thank you

With thanks to:

Udo van Dongen; Oscar Bos; Ulf Sjöqvist; Youri van Es

For the use of their photo’s

And many others that took samples for us

This work was supported by:

The INSITE Programme [Foundation Phase, 2016-2017]

The Wageningen UR TripleP@Sea Innovation program

The Dutch Department of Economic Affairs

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Video Sampling

- ENGIE platform: https://youtu.be/edz8CzjybMc