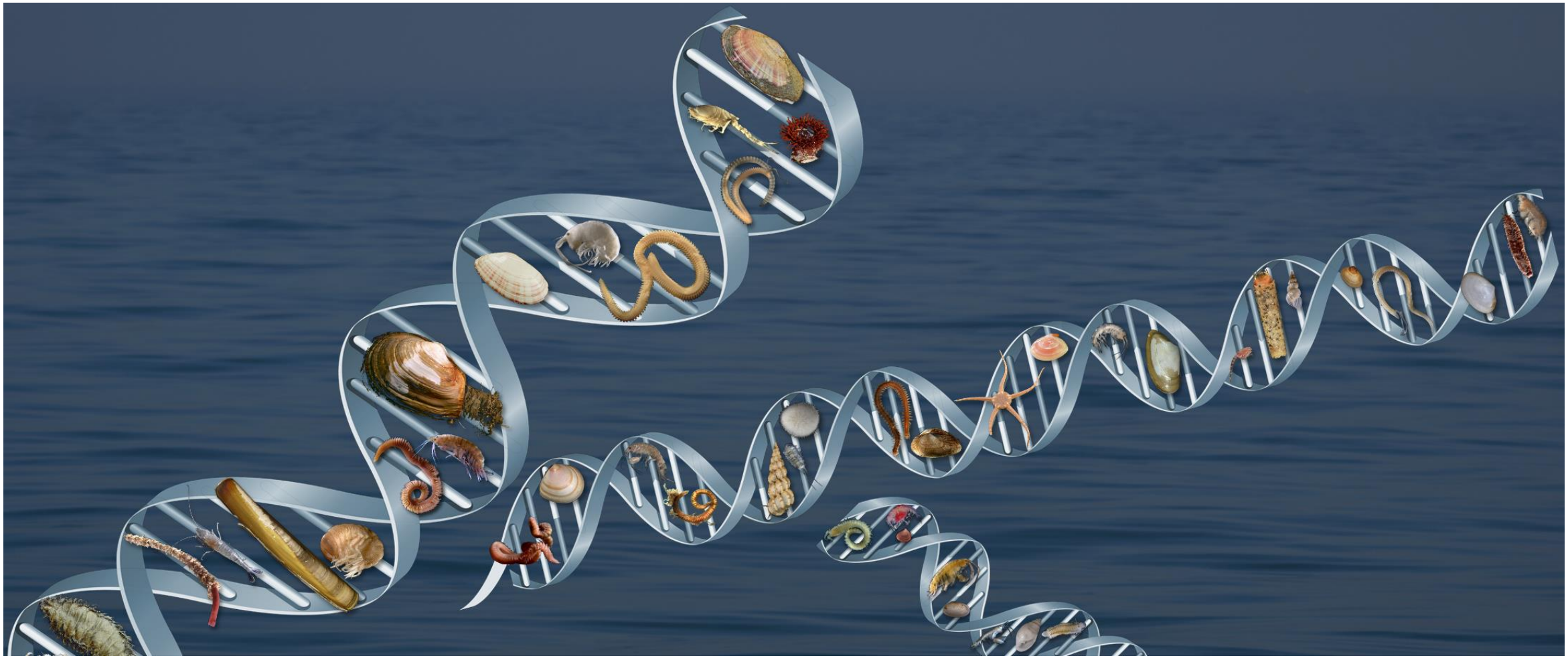
Genetic tools for Ecosystem health Assessment in the North Sea region



GEANS final webinar – 27 June 2023

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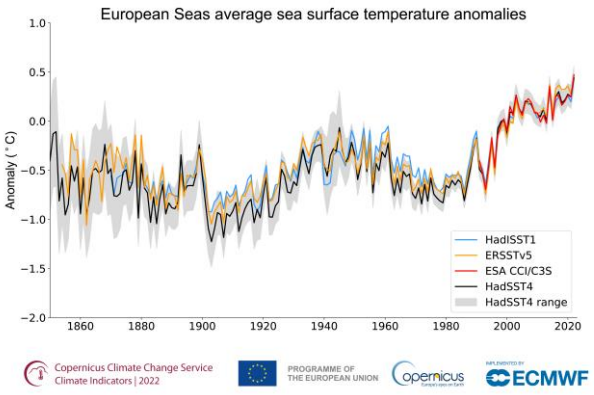
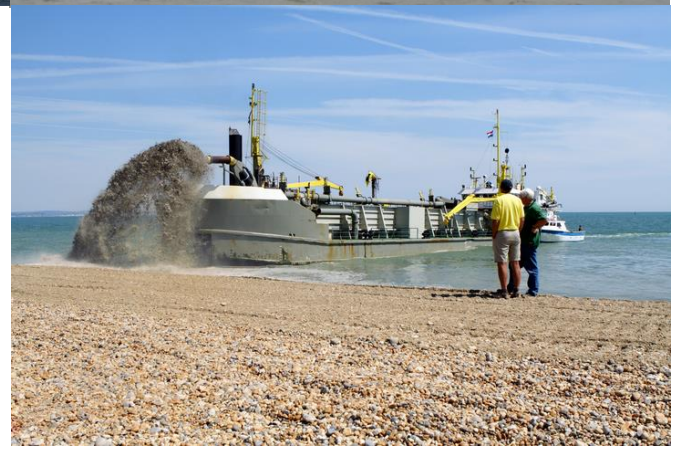
Why GEANS?





=> Sustainable use and management of the North Sea = grand challenge

=> Fast and accurate monitoring is needed => DNA?

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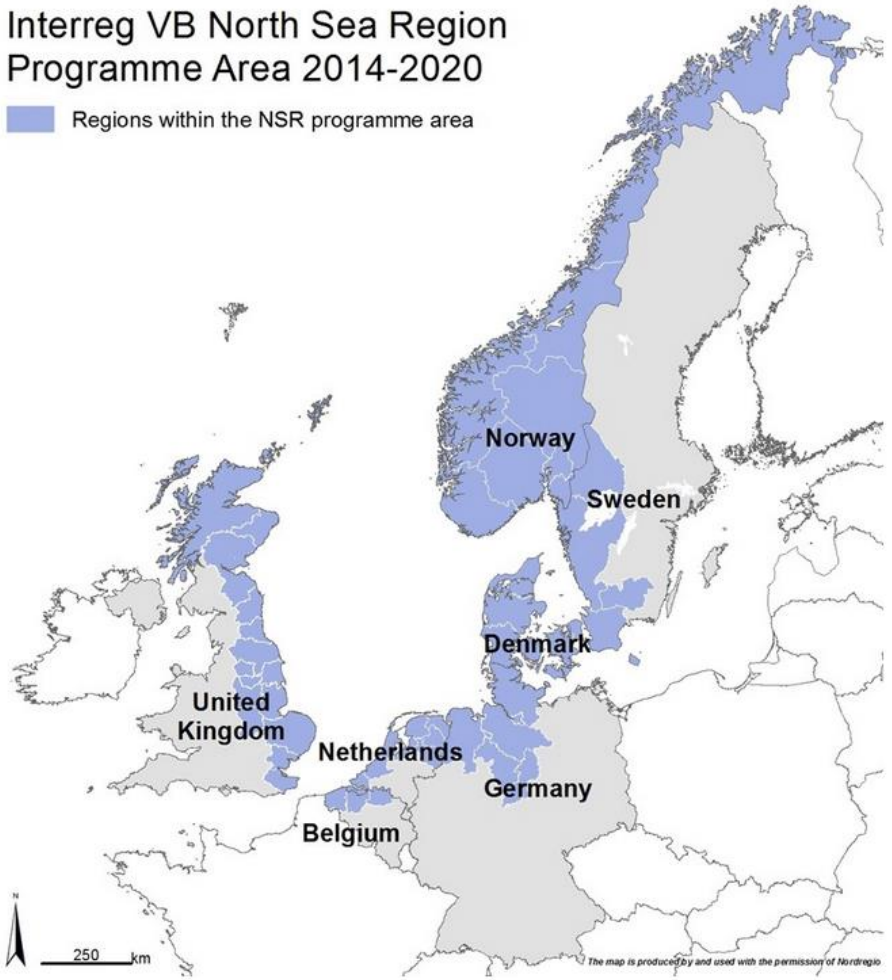
Focus area of GEANS?

North Sea



Target organisms of GEANS?

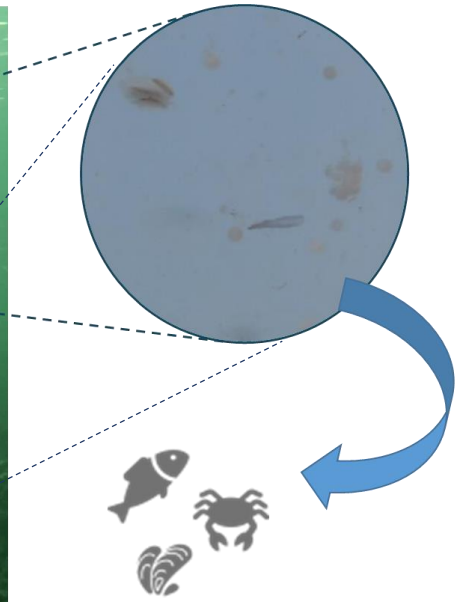
Macrobenthos = invertebrate taxa (body size > 1 mm) living in or near the seafloor

©Hans Hillewaert

What is “DNA-based”?

Bulk DNA

Environmental DNA



Is DNA-based monitoring reliable, accurate, fast and cheap?

the heart of GEANS: stakeholder driven pilots

Soft sediment

NIS - harbors

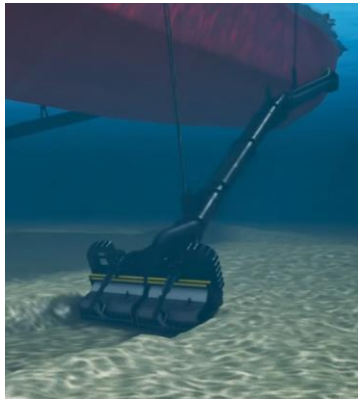
Hard substrate

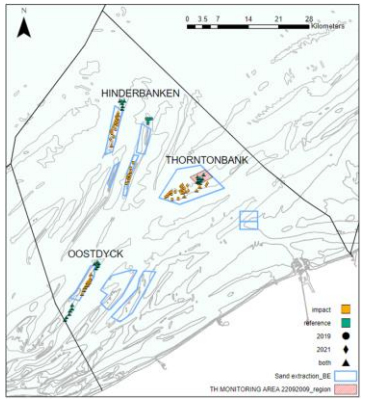
eDNA seawater

Soft sediment pilot

Bulk DNA

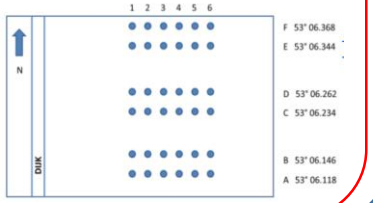
Environmental impact assessment





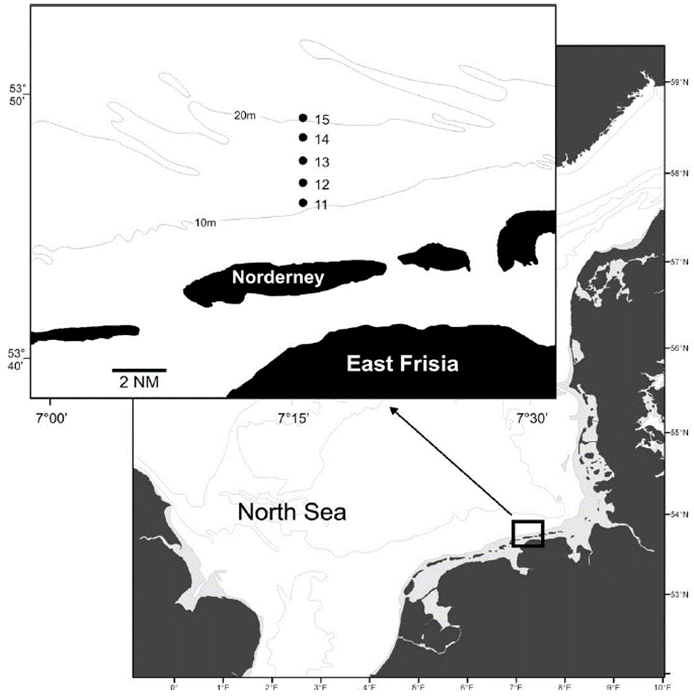
Sampling location and dates

T0	20-3-2016		
T1	21-3-2016	T9	4-7-2016
T2	31-3-2016	T10	31-8-2016
T3	5-4-2016	T11	14-11-2016
T4	11-4-2016	T12	13-3-2017
T5	20-4-2016	T13	9-5-2017
T6	9-5-2016	T14	23-5-2017
T7	23-5-2016	T15	6-6-2017
T8	6-6-2016	T16	26-6-2017



Bulk DNA

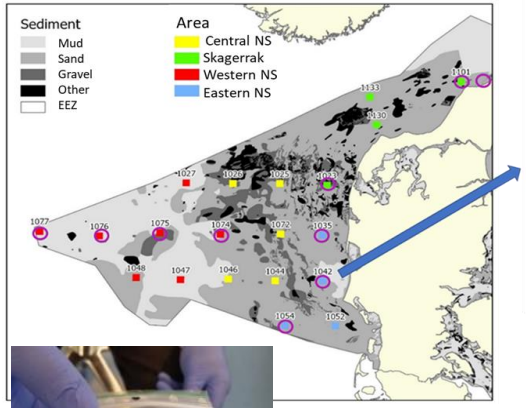
Long term monitoring station (45 years)

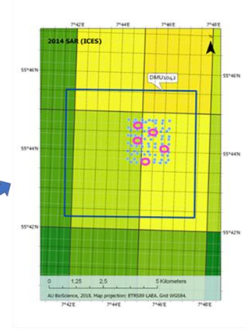


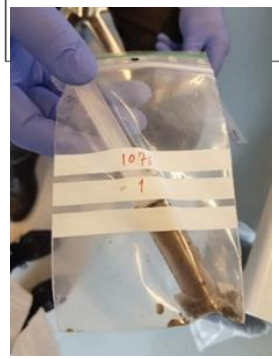
Three seasons

Environmental DNA

MSFD monitoring







Two depth zones (44m)

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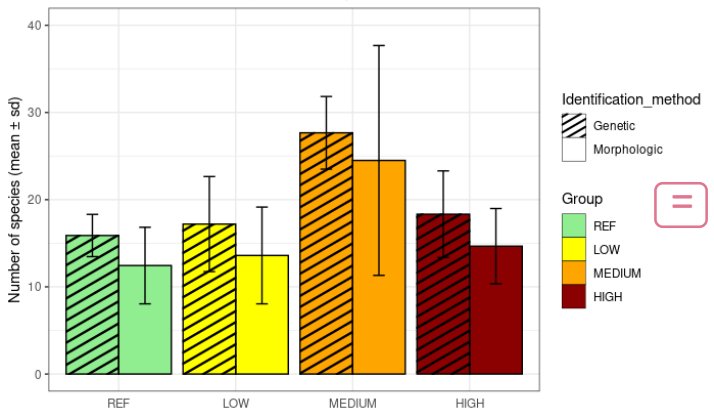
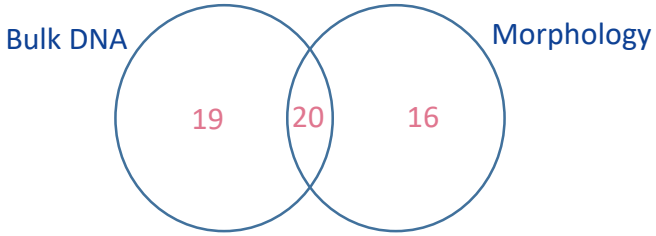
Soft sediment pilot

Bulk DNA

Environmental impact assessment

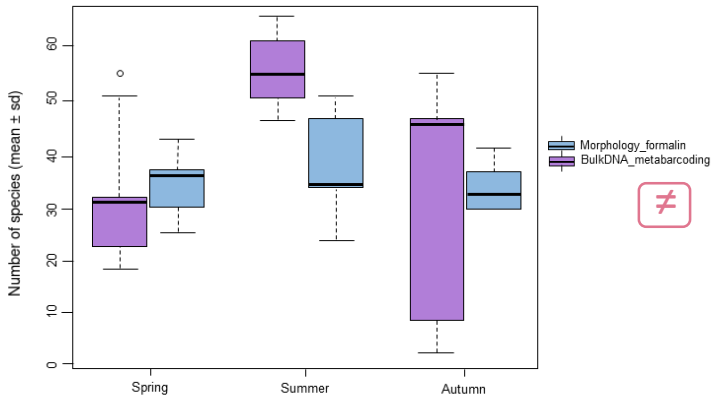


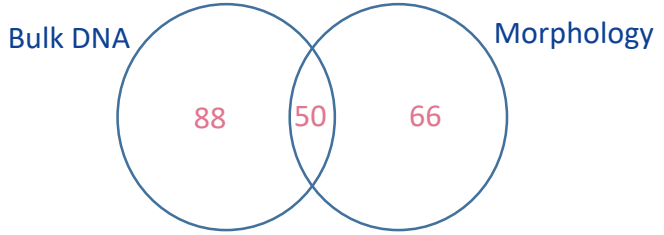


- Main characteristic species for each impact zone were similar for both methods
- Bulk DNA: 46 % faster, 26 % cheaper

Bulk DNA

Long term monitoring station (45 years)

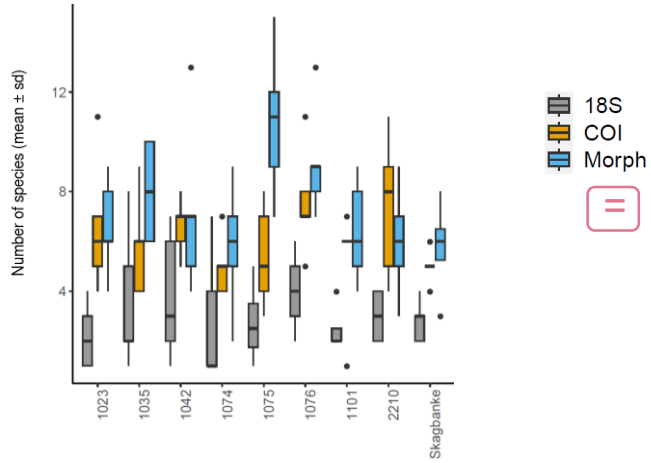


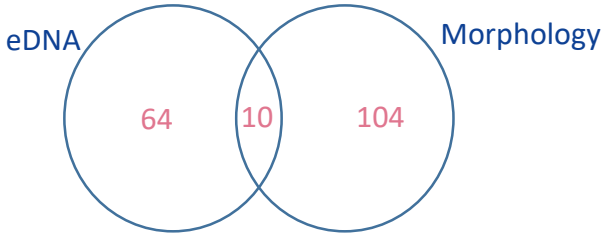


- Characteristic species for each season different between both methods
- Bulk DNA: 66 % faster, 27 % cheaper

Environmental DNA

MSFD monitoring

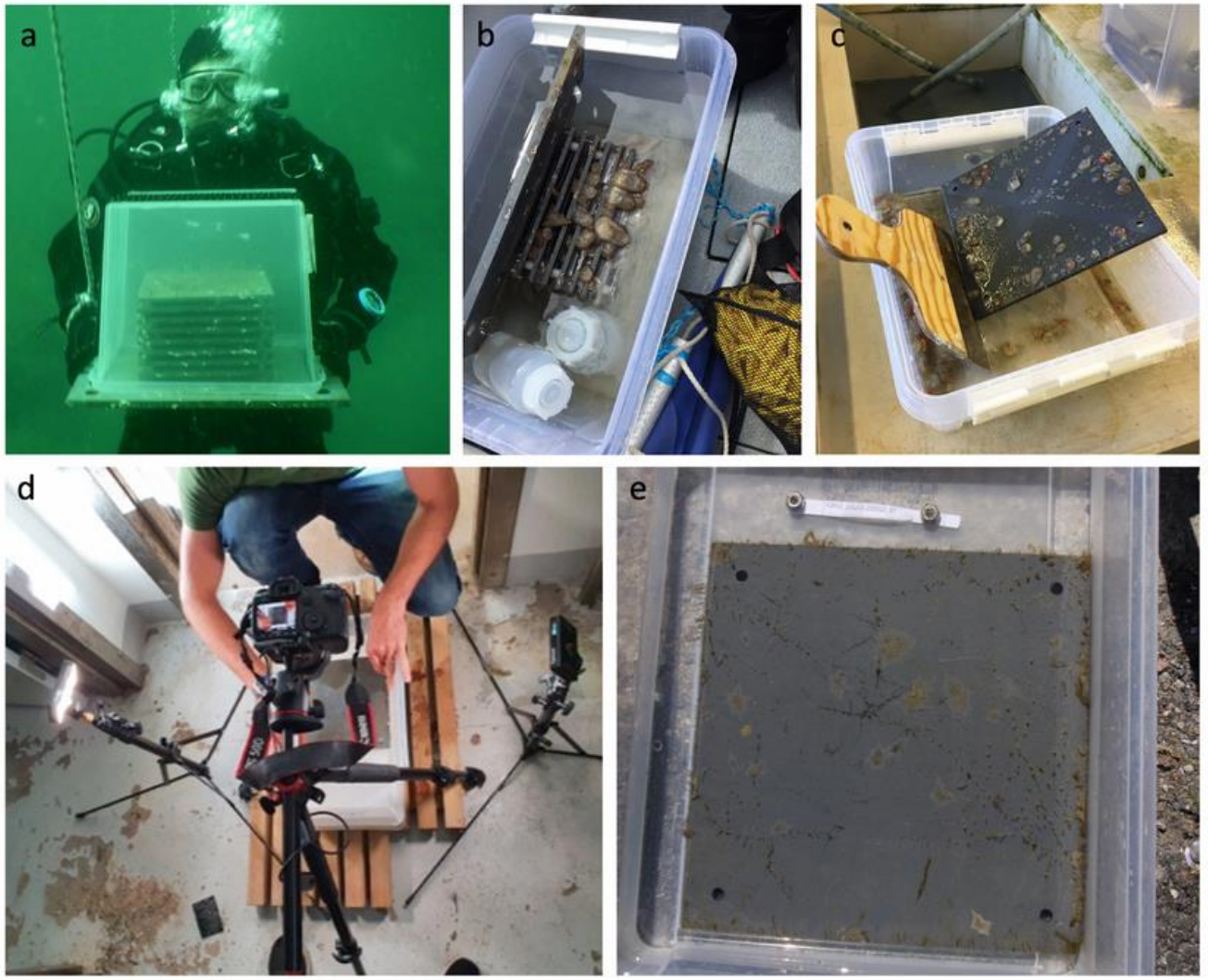




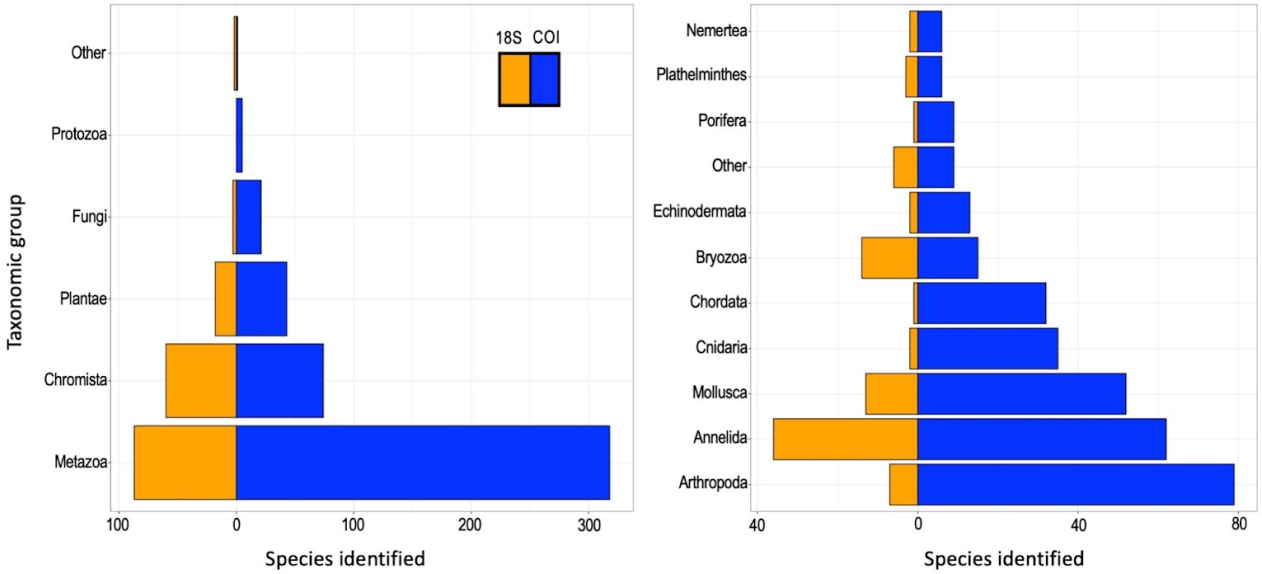
- Characteristic species for each depth different between both methods
- 43 % faster, 9 % cheaper

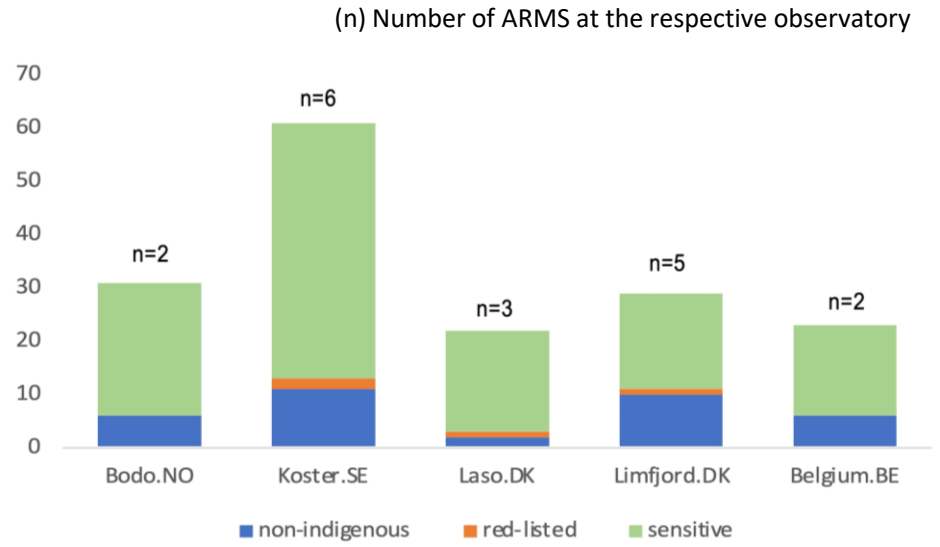
Hard substrate pilot

Autonomous Reef Monitoring Structures (ARMS)



Hard substrate pilot





Standardised method allowing large scale comparisons of hard sub fauna

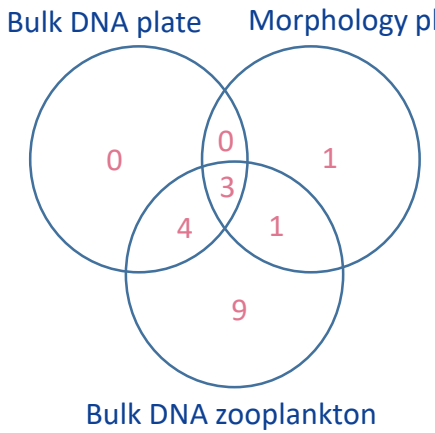
NIS pilot in harbors

© Rune Lagaisse

NIS pilot in harbors

Belgium

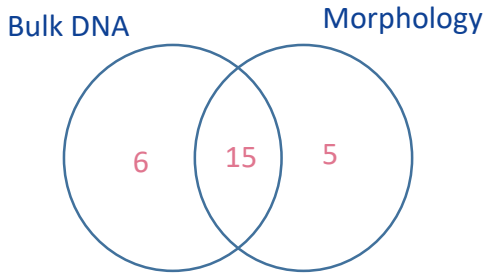
Plate + zooplankton



- DNA-based method detects more NIS
- 93 % faster, 65 % cheaper
- bulk DNA to detect NIS

Germany

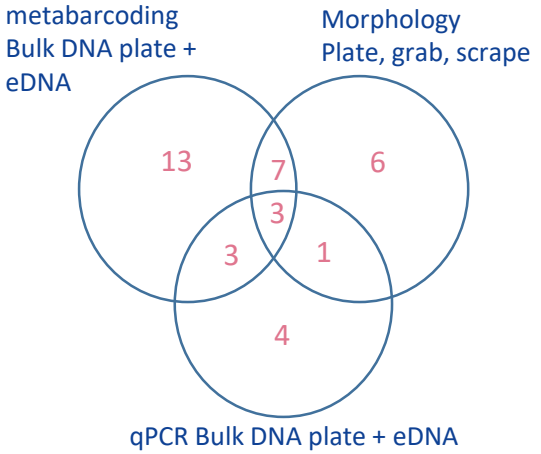
Plate + grab



- DNA- and morphology based methods detect about equal number of NIS
- bulk DNA + morphology to detect NIS

Denmark

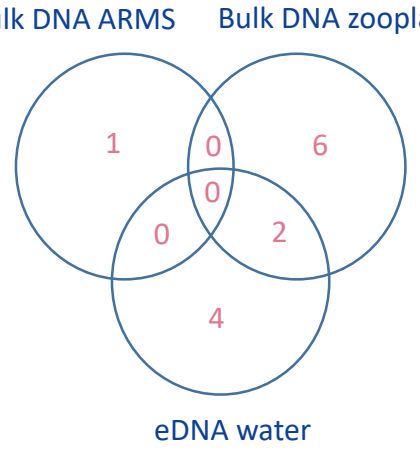
Plate + eDNAwater



- DNA-based metabarcoding detects more NIS
- 20 % faster, 28% more costly
- Bulk DNA + morphology to detect NIS

Sweden

Plate + eDNAwater + zooplankton



- No NIS with morphology
- Bulk DNA plankton + eDNA water to detect NIS

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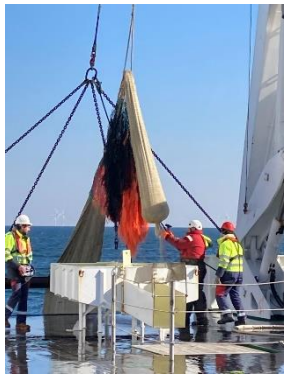
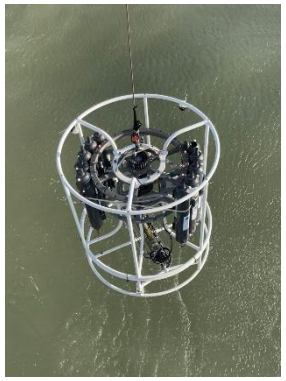
eDNA seawater pilot

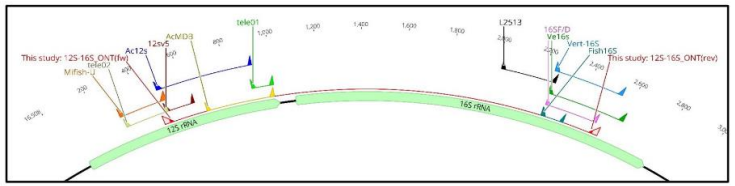
EIA offshore wind farms





Belgium

Reef monitoring



2000 bp long fragment

The Netherlands

NIS monitoring

Belgium + Germany

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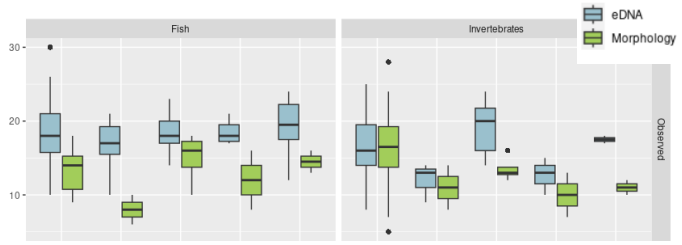
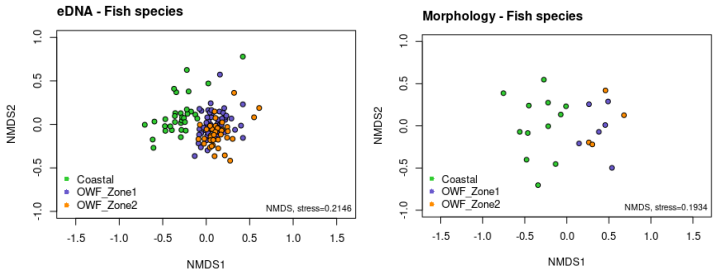
eDNA seawater pilot

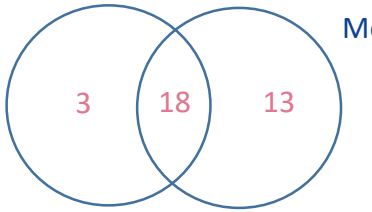
EIA offshore wind farms



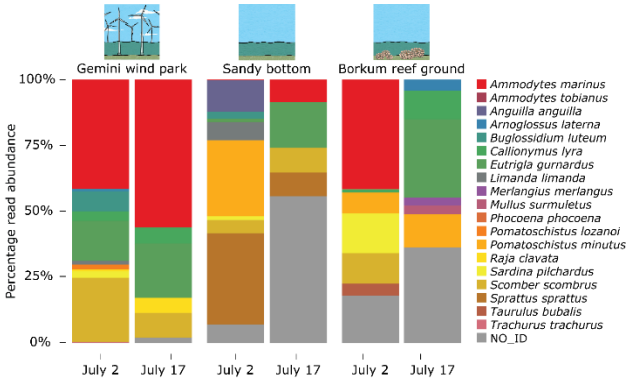


- 83% of fishes and 27% of epibenthic invertebrates from the catches were detected with eDNA
- beam trawl analyses are 42.5% faster and 53% cheaper than eDNA metabarcoding

Reef monitoring



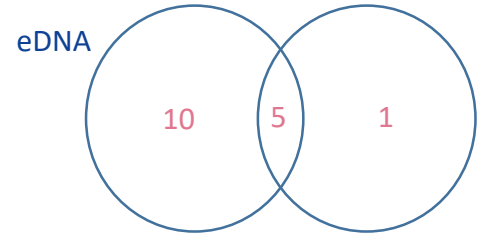
- 58% of fishes detected with long fragment



- Broad diversity of fishes detected
- Reference database incomplete + comparison with short read data needed

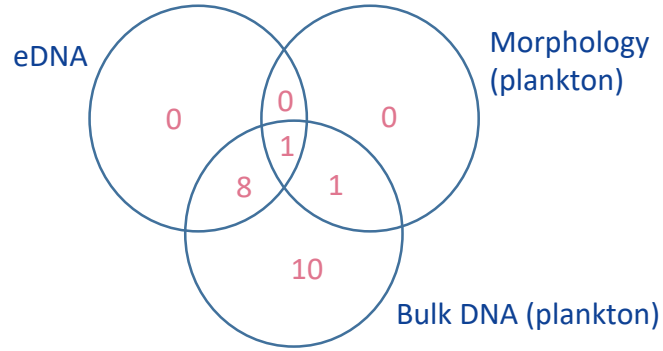
NIS monitoring

Belgium



- twice as many NIS detected with eDNA
- Time of sampling may bias results!

Germany



- Twice as many NIS detected with bulk DNA than with eDNA

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Is DNA-based monitoring reliable, accurate, fast and cheap?

GEANS recommendations

Soft sediment monitoring

- Bulk DNA >> $eDNA_{sediment}$
- Bulk DNA protocol: validated with ringtest
- Curated reference database
- Faster + cheaper

BUT

- Sample preservation is key: switch to ethanol
- No abundance/biomass information
- No life history information
- Species identity
- No good indicators available

Integration of bulk DNA + morphology = highest resolution for a similar cost

NIS monitoring

- Bulk DNA > $eDNA_{water}$ > morphology
- Each method detects unique NIS
- Faster, not always cheaper

BUT

- Reference databases incomplete
- No abundance/biomass information
- Sampling design: temporal + spatial replication

Bulk DNA + eDNA + morphology = highest number of NIS

Bulk DNA plankton + eDNA if resources are limited

eDNA monitoring

- $eDNA_{water}$ = beamtrawl fish
- $eDNA_{water}$ ≠ beamtrawl epibenthic invertebrates
- Non-destructive and non-invasive
- Automatisation and high throughput

BUT

- No abundance/biomass information
- Eggs/adults?
- Not cheaper or faster
- Method development ongoing
- Further harmonisation needed

eDNA for fish monitoring, but further standardisation needed

Hard sub monitoring

ARMS:

- Standardised method for inventory of hard sub species
- DNA-based analyses allows streamlining of sample processing

BUT

- Long deployment time
- No abundance/biomass information
- Similar time/costs as morphology

Bulk DNA of ARMS for cross regional monitoring

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THANK YOU!
QUESTIONS?

CONTACT US

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