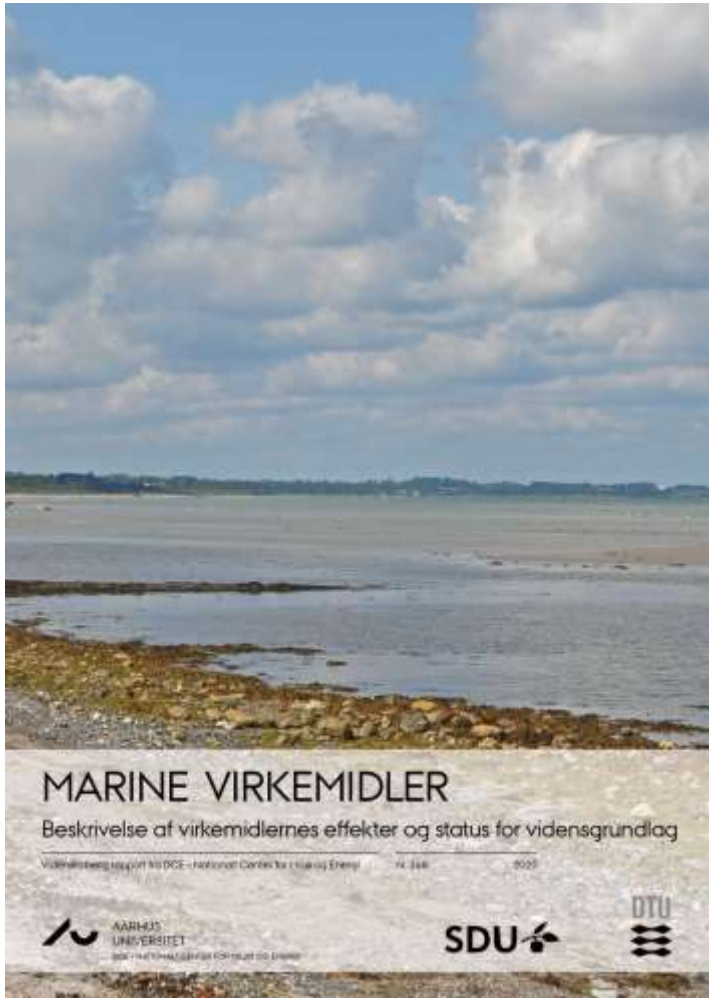
Miljøaftryk af muslingeopdræt

Maren Lyngsgaard

Vandmiljøkonferencen 25. oktober 2024

Det marine virkemiddelkatalog –vurdering af muslingeopdræt fra konkrete målinger



- Øget sedimentation af organisk materiale under opdrætsanlæggene kan medføre en lokal forøget næringsstoffrigivelse (Carlsson et al. 2009, Holmer et al. 2015).
- Muslingeopdræt forbedrer sigtdybde og reducerer koncentrationen af klorofyl med helt op til 60-70% i opdrætsanlægget, afhængig af muslingernes filtrationskapacitet og strømforhold og temperatur (Nielsen et al. 2016, Petersen et al, 2019, Timmermann et al. 2019, Maar et al 2020).
- Målinger af sigtedybden i muslingeanlæg viser en forbedring på 0,8-1,1, og helt op til 2,3 m (Maar et al 2020).
- muslingeopdrættet kan virke som et flydende biogent rev og dermed øge biodiversiteten i området. Muslingernes filtration kan ændre sammensætningen af fytoplankton (Taylor et al. 2024) og tiltrække prædatorer.

Tidligere studier - modelstudie

Hvad sker der hvis vi øger produktionen fra 14 til 52 muslingefarme?

- En øget høst per farm fra 72 – 2000 tons per farm
- Ingen ændring i koncentrationen af opløst kvælstof og en lille stigning i koncentrationen af P
- ændring i koncentrationen af ilt i bundvandet i sommerperioden stiger med op til 0,2 mg O_2 l^{-1}
- koncentrationen af mikroplankton (Chl a) falder med 1-2 mg m^{-3}
- vandets klarhed (Secci-depth) stiger med 20-30 cm
- biomassen af bundlevende muslinger falder med op til 0,1 kg vådvægt m^{-2}

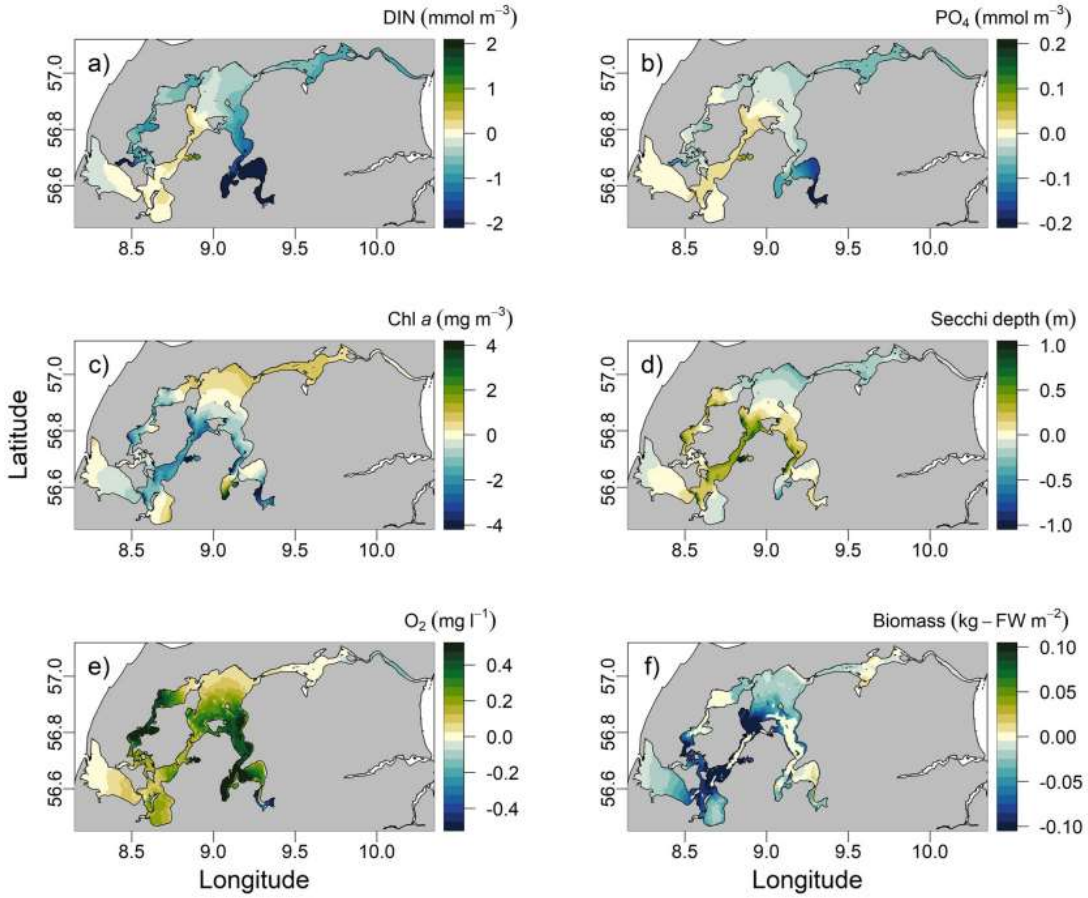


Figure 7. Spatial changes in scenario MF4 year 2017 relative to MF1. (a) Winter DIN, (b) winter PO_4, (c) summer Chl *a*, (d) summer Secchi depth, (e) summer bottom oxygen, and (f) benthic bivalve biomass.

Maar et al. 2023

MILJØAFTRYK AF MUSLINGEOPDRÆT

Undersøgelser fra 2023

MILJØPARAMETRE UNDERSØGT:

- **Bundforhold dokumenteret med film**
- **Biodiversitet (epifauna & infauna)**
- **Havbundens indhold af organisk materiale samt N og P**
- Modelleret sedimentspredning
- **Muslingebiomasse**
- **Bundens iltforbrug**
- Bundens denitrifikationsrate

RESULTATER:

- Mere biodiversitet under anlæg end på reference
- Mere N og P under anlæg end på reference
- Tendens til højere iltforbrug under anlæg

[Ny rapport om muslingeopdræt | WSP]

Den Europæiske Union
Den Europæiske Hav- og Fiskerifond

HAV & FISK

wittrup

SDU

wsp

Blue research

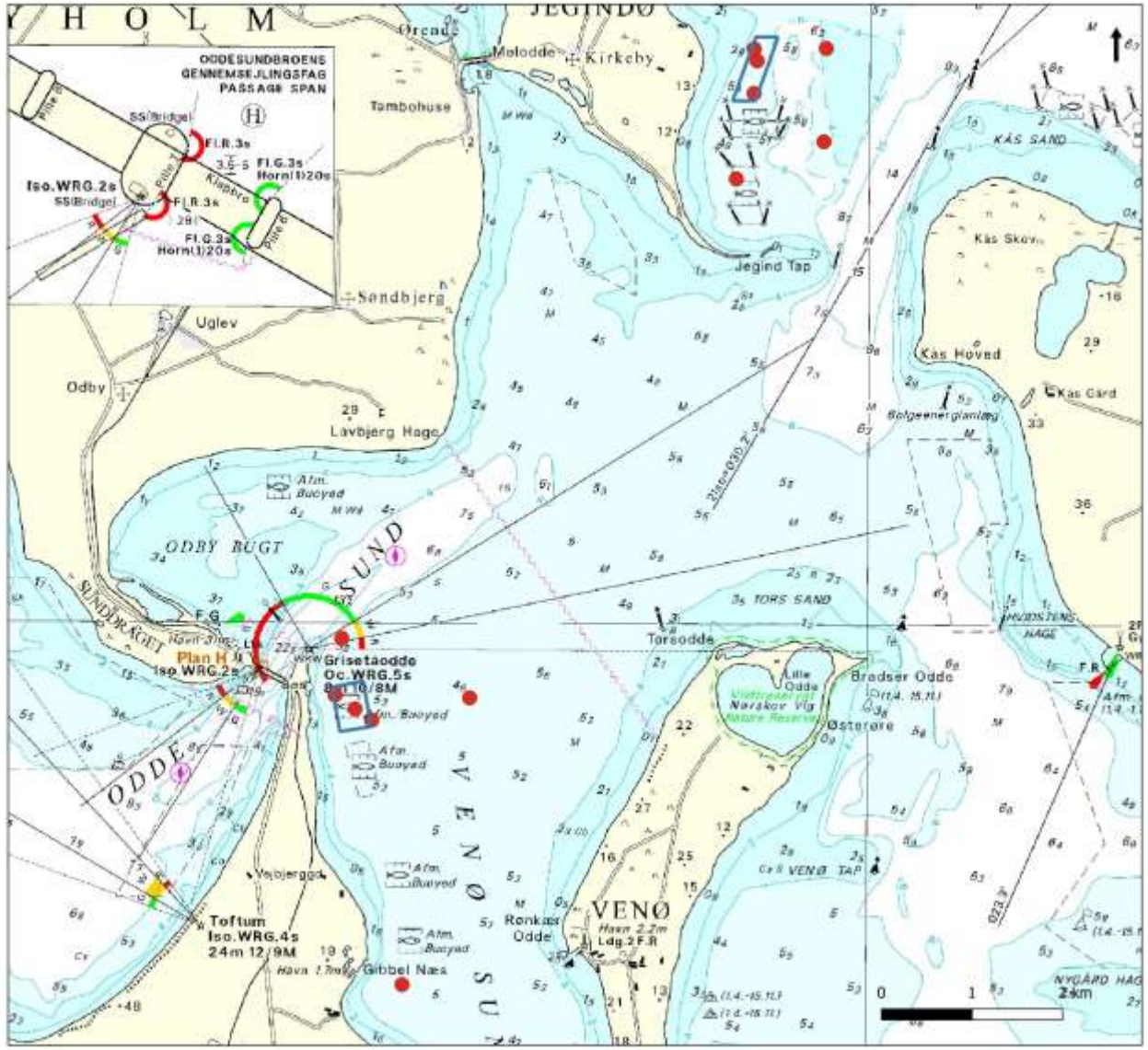
KØBENHAVNS UNIVERSITET

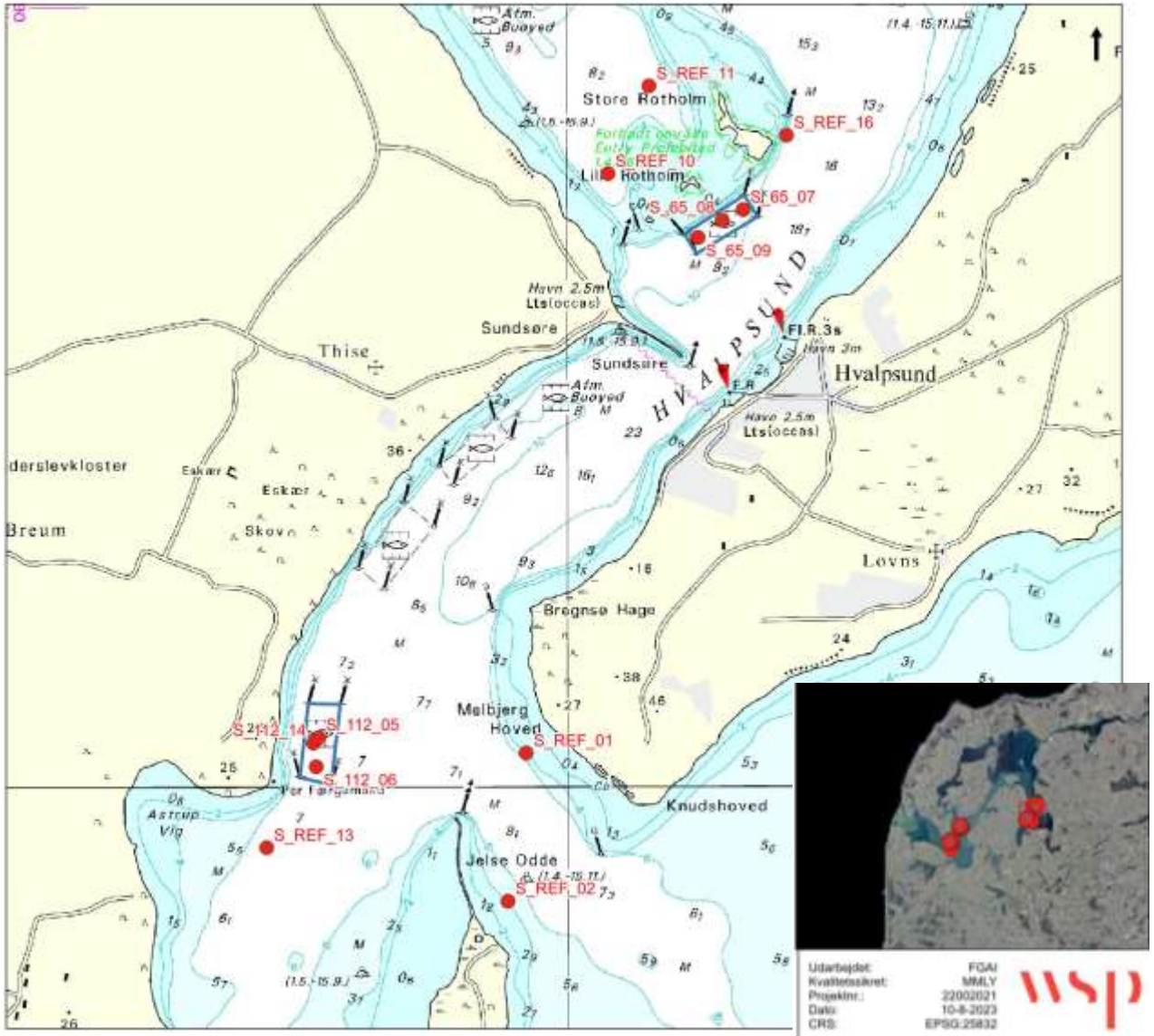
Fishlab.dk
Environmental Investigations

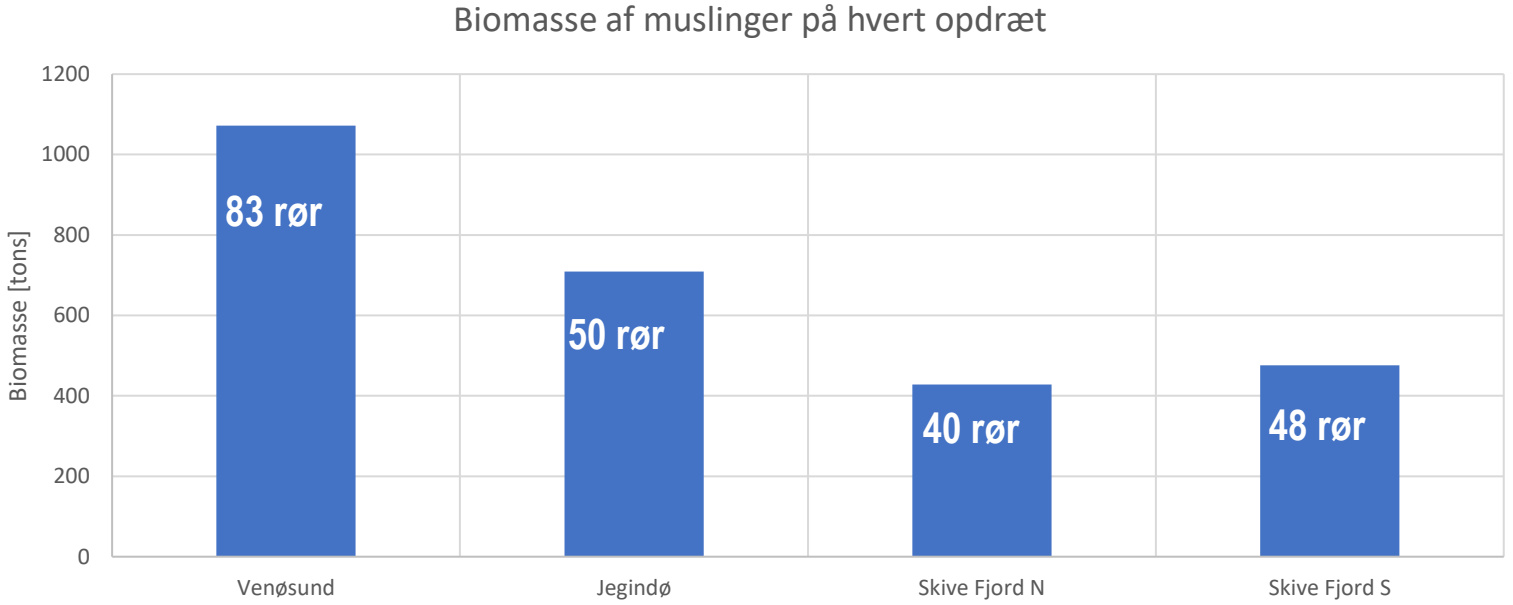
Undersøgelsesområder: 4 muslingeanlæg i Limfjorden

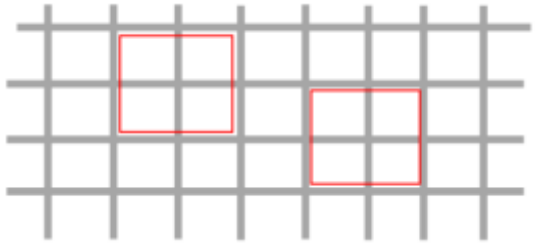
Skive Fjord Nord Skive Fjord Syd Jegindø Venøsund

Ringe vandudskiftning God vandudskiftning







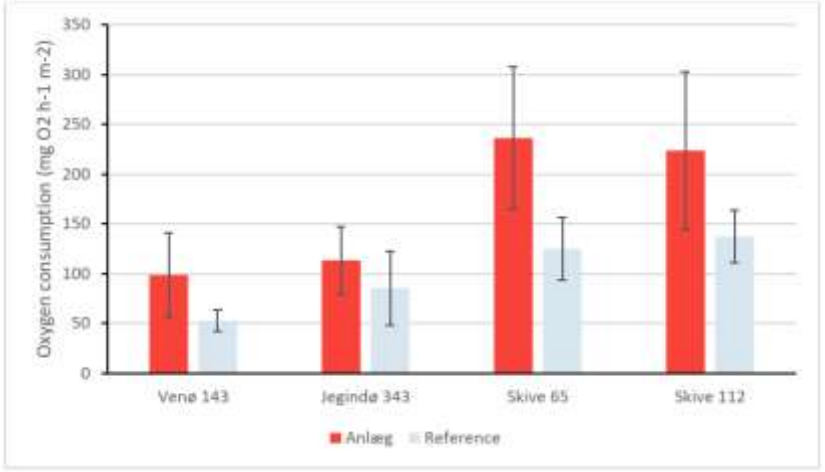


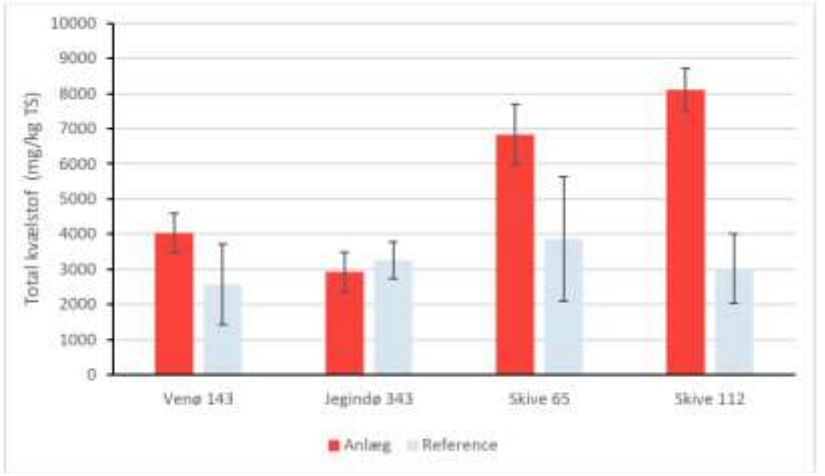
Kryds per meter X 120m X 3m dybde

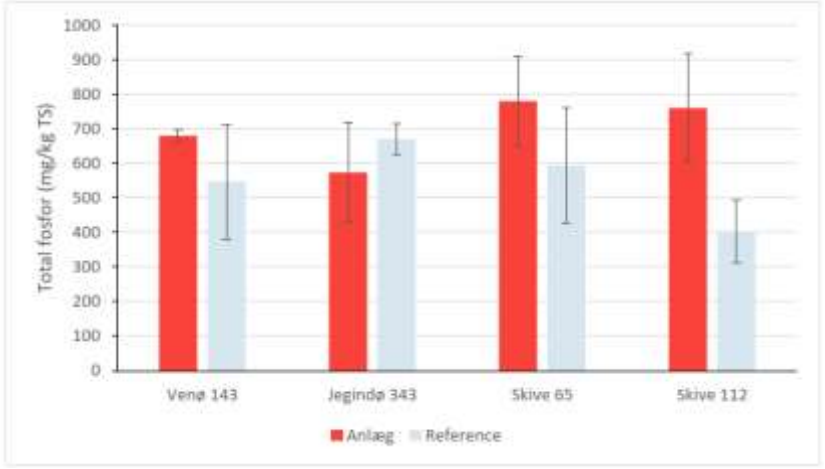
ILTFORBRUG

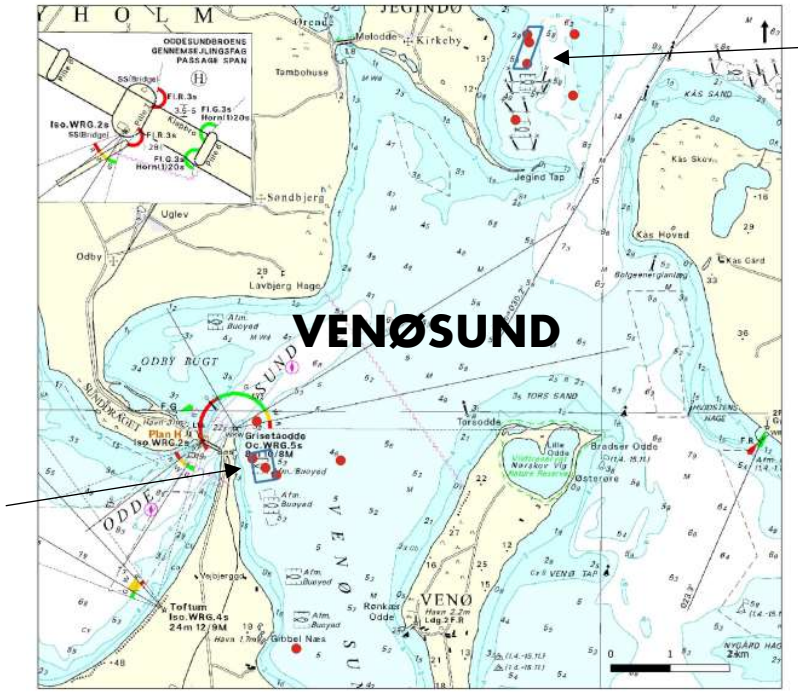
KVÆLSTOF

FOSFOR



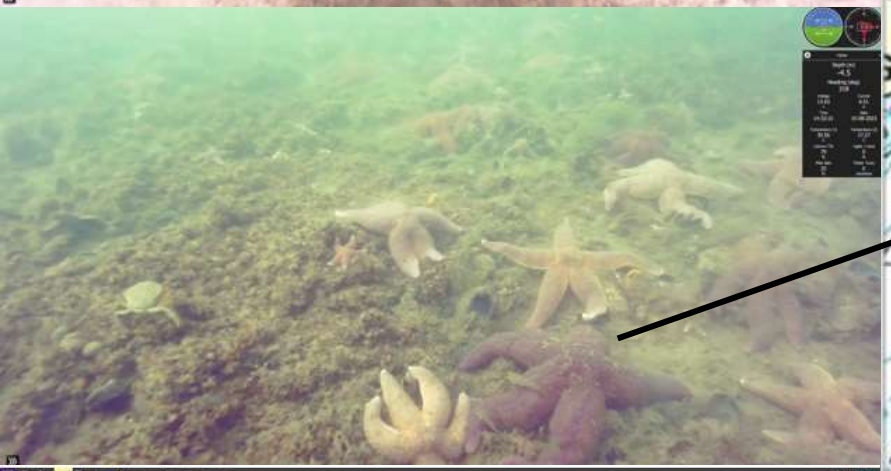


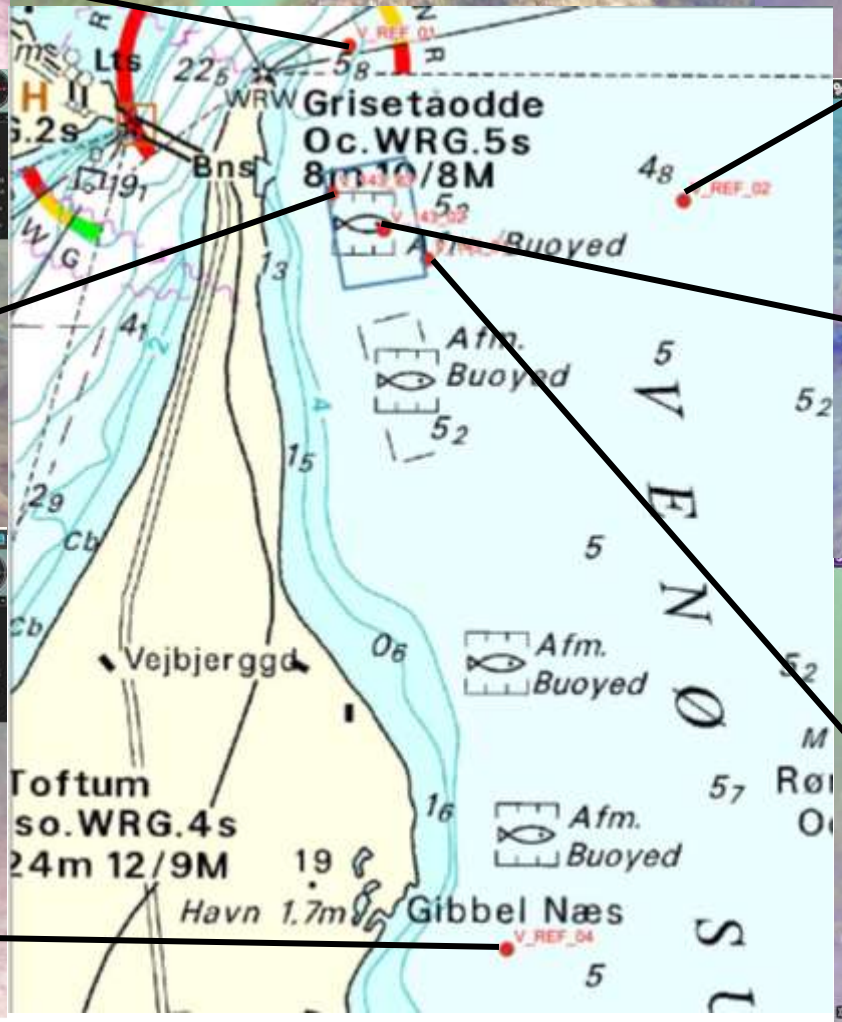





VENØSUND


NET




Grisetaodde
Oc.WRG.5s
Buoyed
Afm.
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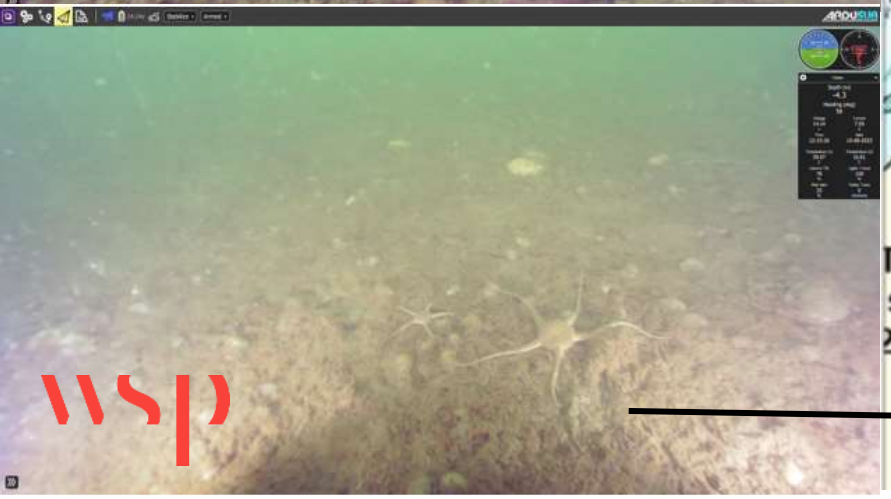
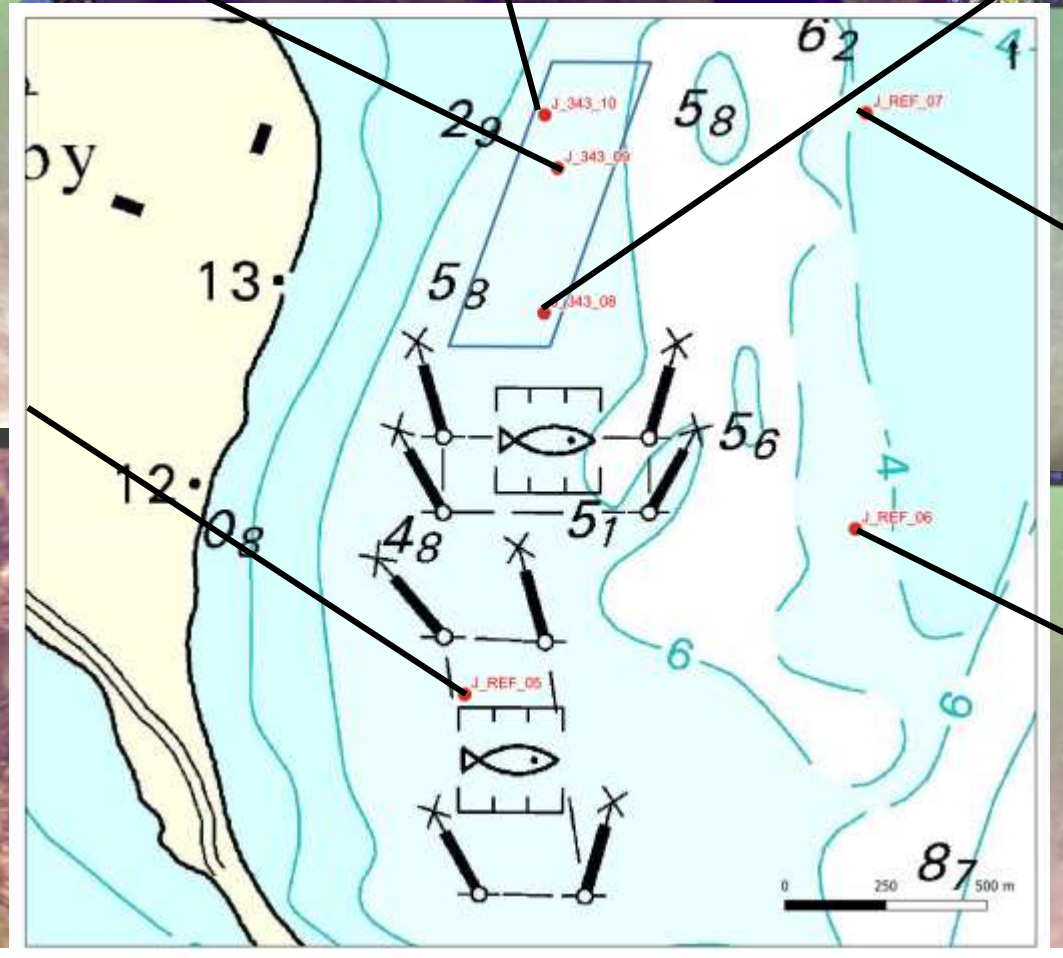
Afm.
Buoyed
Afm.
Buoyed
Vejbjerggd
Toftum
so.WRG.4s
24m 12/9M
Havn 1.7m
Gibbel Næs
V_REF_04
VENØ SUND



wsp

JEGINDØ


J_343_10
J_343_09
J_343_08
J_REF_07
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J_REF_05
29
58
58
56
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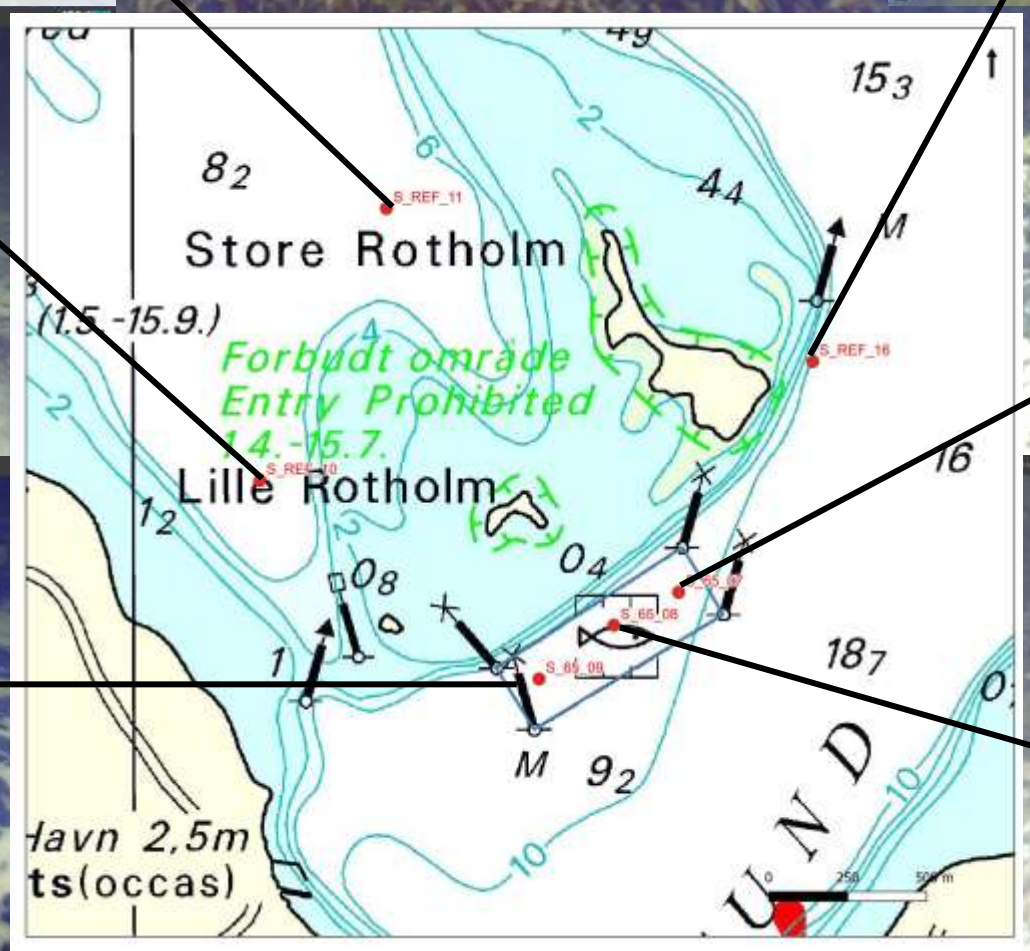
250
500 m

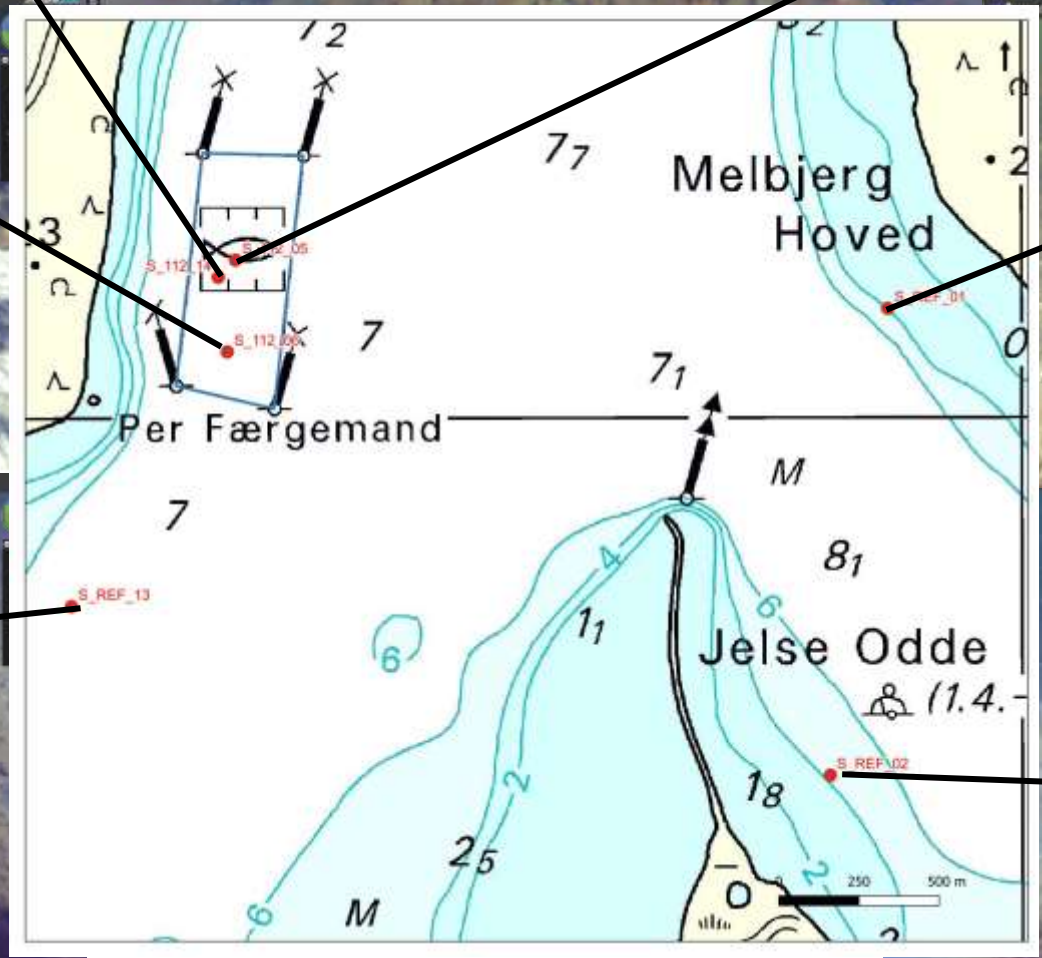
NET

SKIVE FJORD NORD

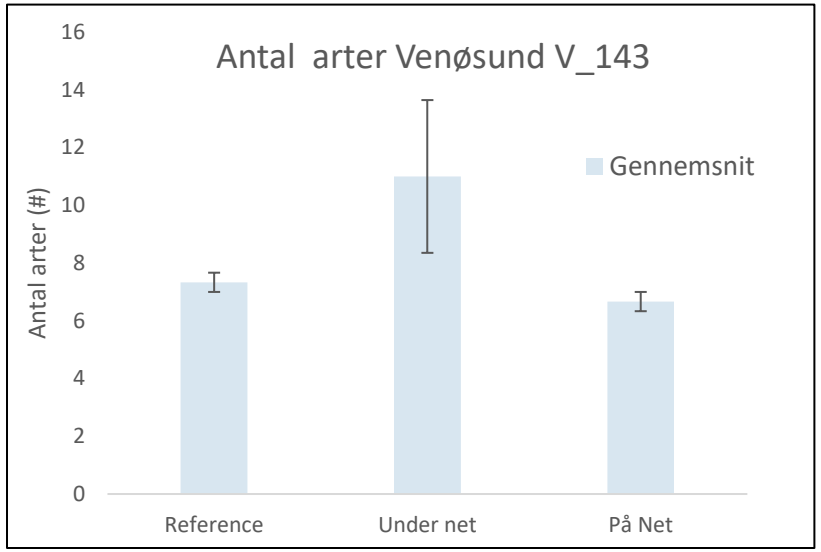


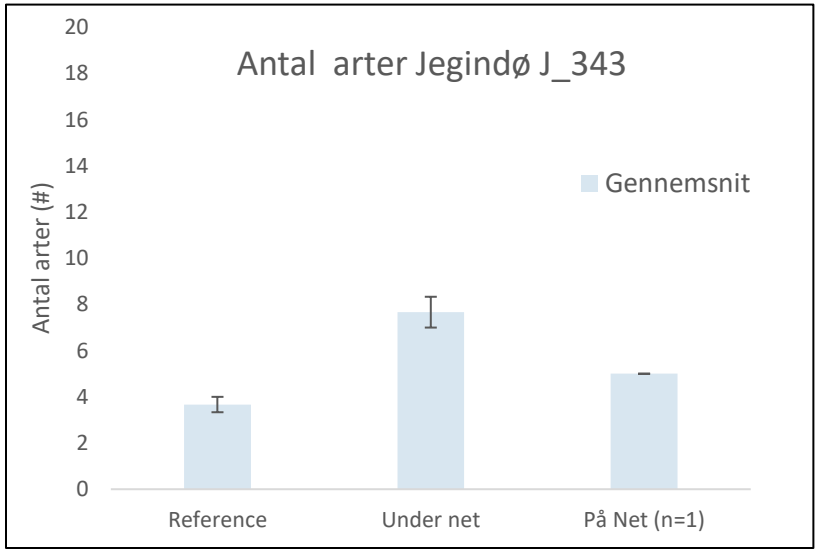
SKIVE FJORD SYD

NET



Antal arter


Antal arter Venøsund V_143
Antal arter (#)
16
14
12
10
8
6
4
2
0
Gennemsnit
Reference
Under net
På Net


Antal arter Jegindø J_343
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16
14
12
10
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6
4
2
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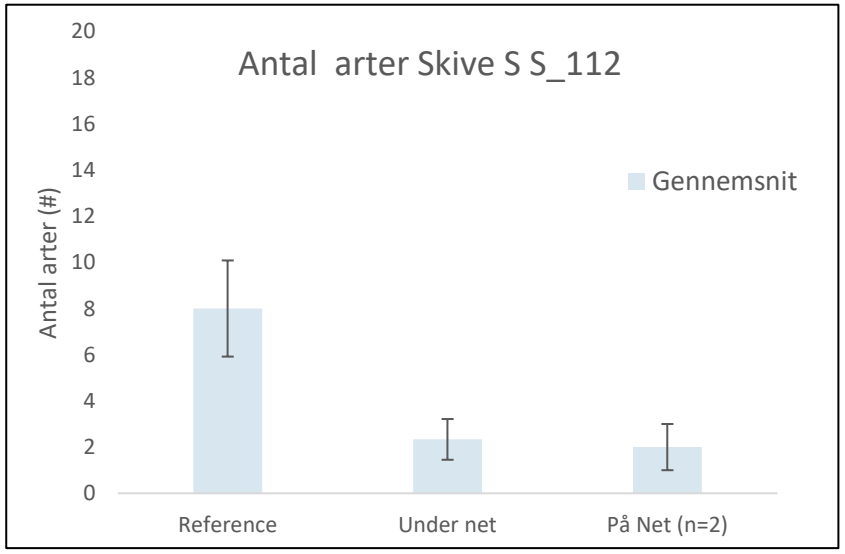
Gennemsnit
Reference
Under net
På Net (n=1)


Antal arter Skive S S_112
Antal arter (#)
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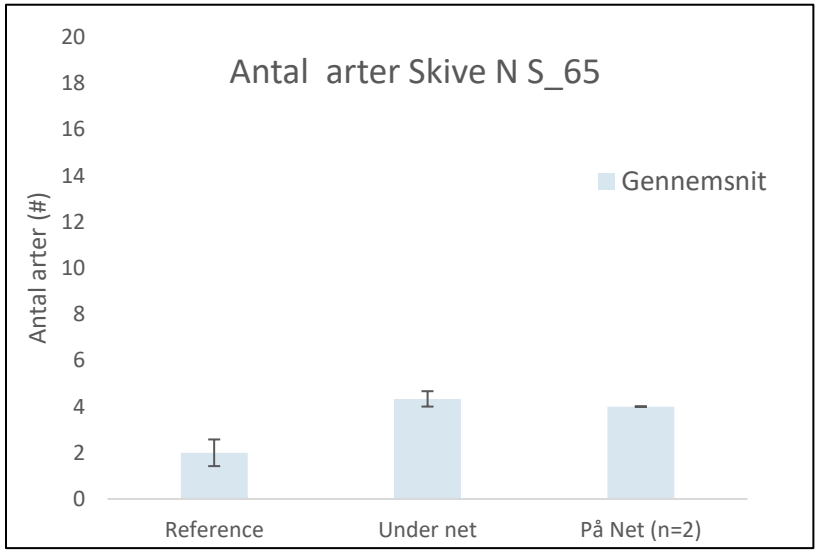
18
16
14
12
10
8
6
4
2
0
Gennemsnit
Reference
Under net
På Net (n=2)


Antal arter Skive N S_65
Antal arter (#)
20
18
16
14
12
10
8
6
4
2
0
Gennemsnit
Reference
Under net
På Net (n=2)

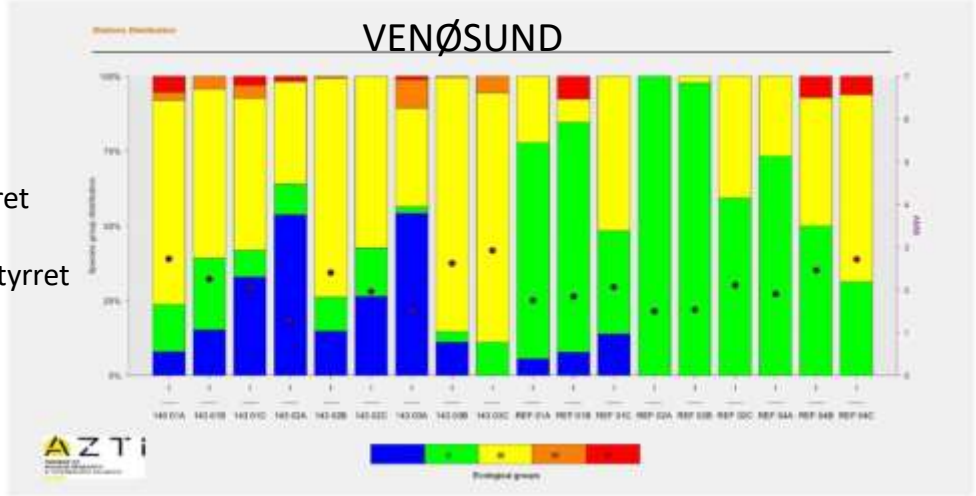
Venøsund

ØKOSYSTEM TILSTAND MÅLT PÅ INFAUNA

LAV AMBI = GOD TILSTAND
HØJ AMBI = RINGE TILSTAND

Skive Fjord

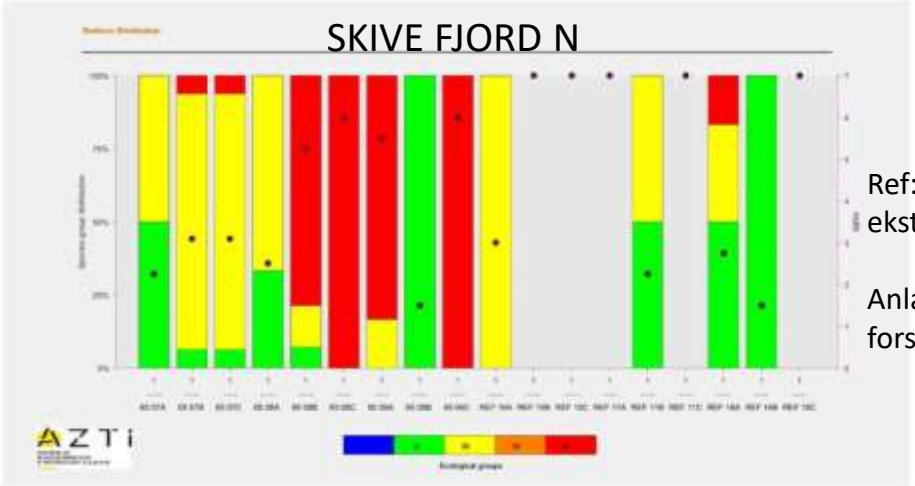
VENØSUND



Ref: Let forstyrret

Anlæg: Let forstyrret

SKIVE FJORD N



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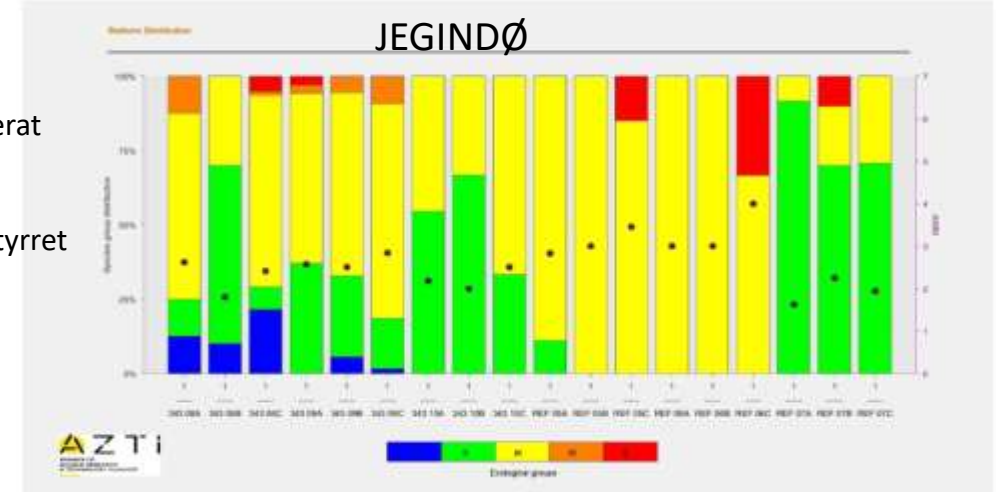
Anlæg: Let - stærk forstyrret

JEGINDØ



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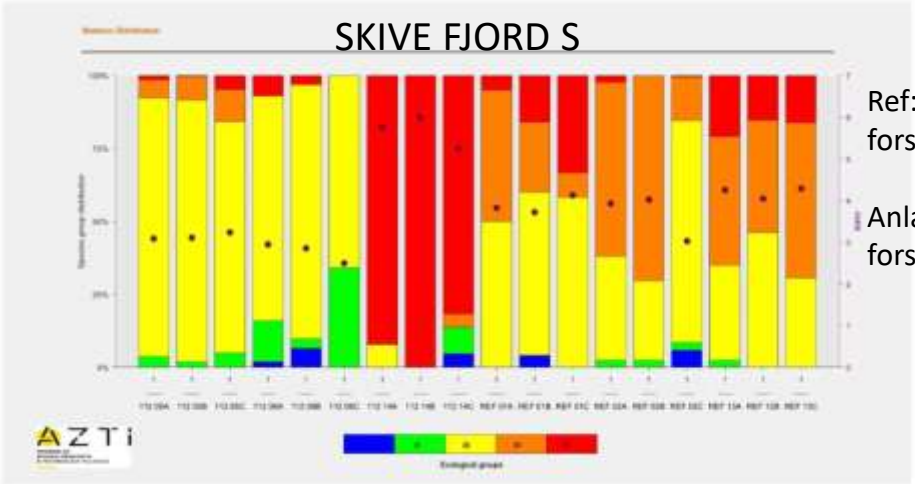
Anlæg: Let forstyrret

SKIVE FJORD S



Ref: Let – Moderat forstyrret

Anlæg: Let – Moderat forstyrret

Muslinger gør vandet mere klart
– en økosystemtjeneste vi har brug for

LIMNOLOGY and OCEANOGRAPHY

ASLO

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Quantifying bivalve phytoplankton depletion in a eutrophic system: an integrated approach

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Abstract

The removal of organic particulate matter, predominantly phytoplankton, in eutrophic coastal seas and estuaries is considered an ecosystem service performed by large bivalve assemblages. Mussel farming has been proposed as a measure to mitigate eutrophication, as filtration directly reduces the concentration of chlorophyll *a* (Chl *a*), a primary ecological indicator. Seston depletion is typically assessed by in situ investigation, which generally lacks spatiotemporal coverage of features relative to greater ecosystem dynamics. To assess the scale and structure of this service, the present study couples multiple measurement approaches, including moored stations, synoptic transect surveys, flow cytometry, a preliminary drone survey technique, and satellite remote sensing within and around a large mussel farm. Significant depletion patterns were observed with all methods, and mixing gradients could be detected hundreds of meters beyond the farm, with repeatable patterns but distinct findings between methods. The intensity of the depletion signal was correlated with mussel biomass loads, ambient conditions, and hydrodynamic regimes, ranging from 5% to 91% relative Chl *a* depletion and Secchi depth increases of up to 2 m. Changes in particle size distributions were impacted in all downstream areas, as well as phytoplankton diversity. Observed depletion gradients with satellite imagery were consistent with other measurements and can be used to complement in situ field measurements. The findings of this study, will inform carrying capacity assessments, farm configuration, and development of impact assessment programs on seston removal for bivalve aquaculture.

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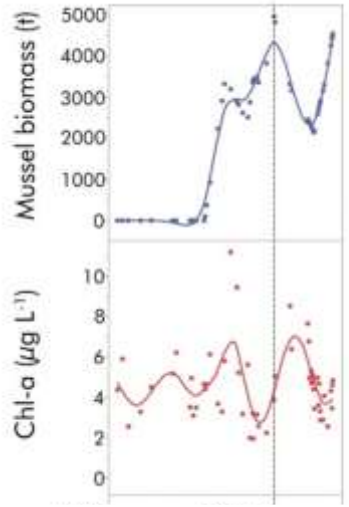
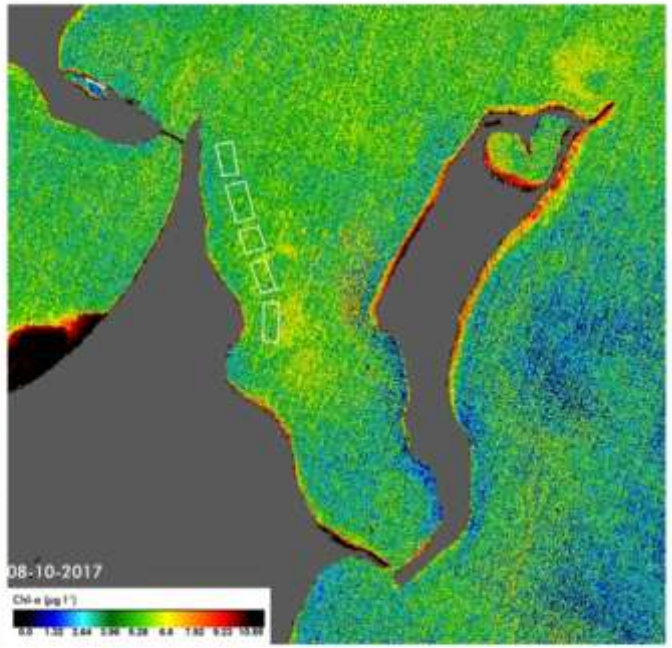
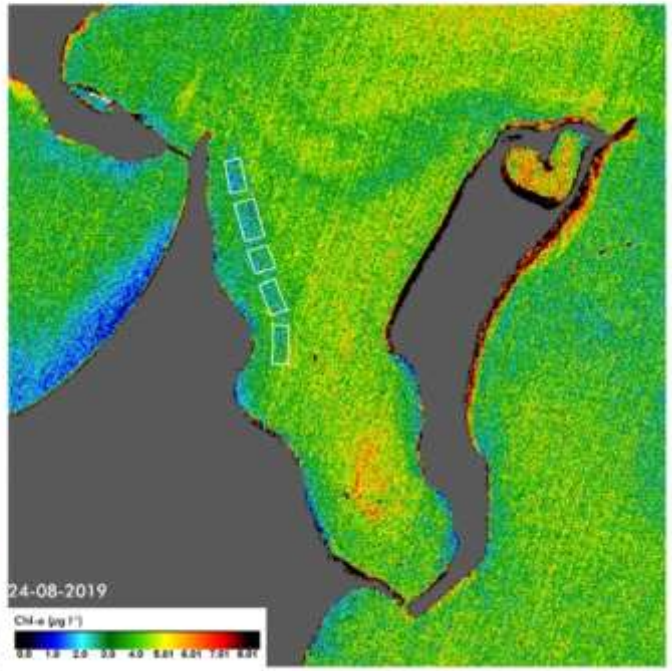
Additional Supporting Information may be found in the online version of this article.

Author Contribution Statement: DT: Conceptualization; Methodology; Validation; Formal analysis; Funding acquisition; Investigation; Data curation; Writing – original draft; Visualization; Project administration. HJ: Methodology; Investigation; Resources; Writing – review and editing. MML: Methodology; Investigation; Resources; Writing – review and editing. MD: Methodology; Validation; Formal analysis; Investigation; Writing – review and editing. MW: Methodology; Writing – review and editing. MM: Resources; Writing – review and editing. CS: Project administration; Investigation; Resources; Funding acquisition; Writing – review and editing.

Nutrient enrichment of coastal seas and estuaries has long burdened coastal marine ecosystems (Bricker et al. 2008), and the effects of eutrophication are expected to exacerbate with global warming (Rabalais et al. 2009). Many key indicators are used to assess the ecological condition of coastal waters, such as light attenuation, primary production, and oxygen concentrations; and multiple assessment frameworks have been developed over the past decades (Friedland et al. 2021). Elevated concentrations of suspended organic matter constitute two primary indicators in many frameworks: chlorophyll *a* (Chl *a*) and Secchi depth (Fleming-Lehtinen et al. 2015). To mitigate the symptoms of eutrophication, leveraging bivalve filtration has long been proposed as a means to rapidly decrease organic matter content and the nutrients contained therein (Officer et al. 1982; Petersen et al. 2019a). Intensified bivalve farming can through filtration of organic matter







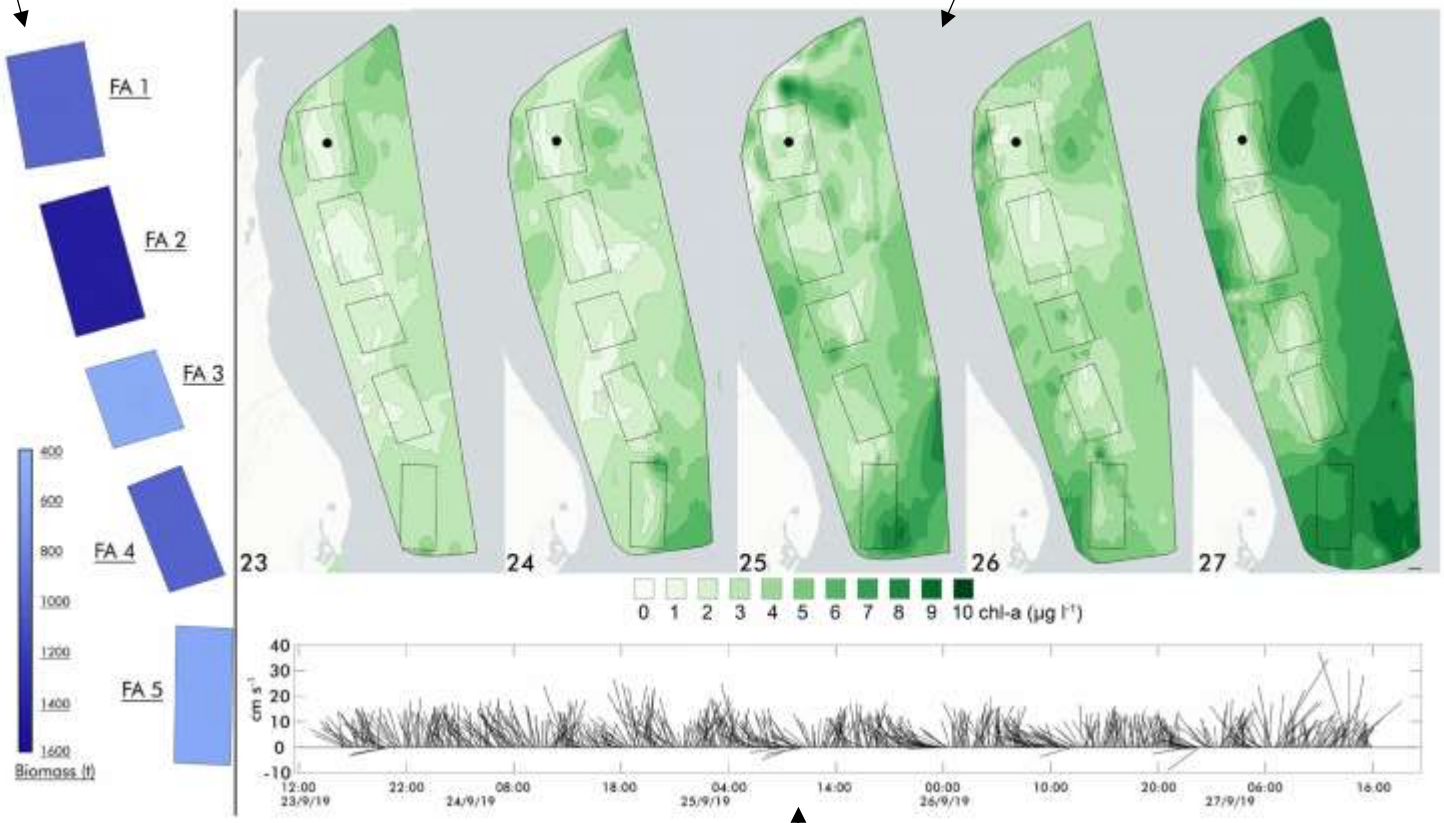
Figur fra Taylor et al. 2024

Klaring af vandet – satellit og in situ fluorescens

- **Fjernelse af fytoplankton** ved kobling af flere metoder; faste stationsmålinger, synoptiske transekter, flow cytometri, droner optagelser, og satellitter ved og omkring Danmarks største muslingefarm i Venøsund
- Alle metoder viste betydelig fjernelse af fytoplankton og klaring af vandsøjle
- Kobling mellem rensnings effektivitet, biomasse af muslinger og vandbevægelse.
- Fjernelse af fytoplankton (relativ) varierede fra 5-91% afhængigt af ovenstående parametre.
- Sigtdybde forøgelse blev fundet op til 2 m
- Ændringer i fytoplankton størrelser og arter som funktion af muslingernes filtrering

Biomasse

Gentaget mønster for muslingernes klaring af vandet



Strømhastighed cm s^{-1}

Figurere fra Taylor et al. 2024


13.14v
Stabilize
Armed
ARDUSUB
342
Values
Depth (m)
-3.6
Heading (deg)
342
Voltage
13.14
v
Current
7.94
A
Time
15:00:53
Date
15-08-2023
Temperature (1)
39.84
C
Temperature (2)
17.14
C
Camera Tilt
75
%
Lights 1 level
100
%
Pilot Gain
25
%
Tether Turns
0
clockwise