

Kystvandråd for den centrale del af Limfjorden delområde 157 og 158
Teknikermøde, onsdag 22. november 2023, DTU Aqua og DHI
v/ Tobias K Andersen, Ph.d., postdoc, DTU Aqua

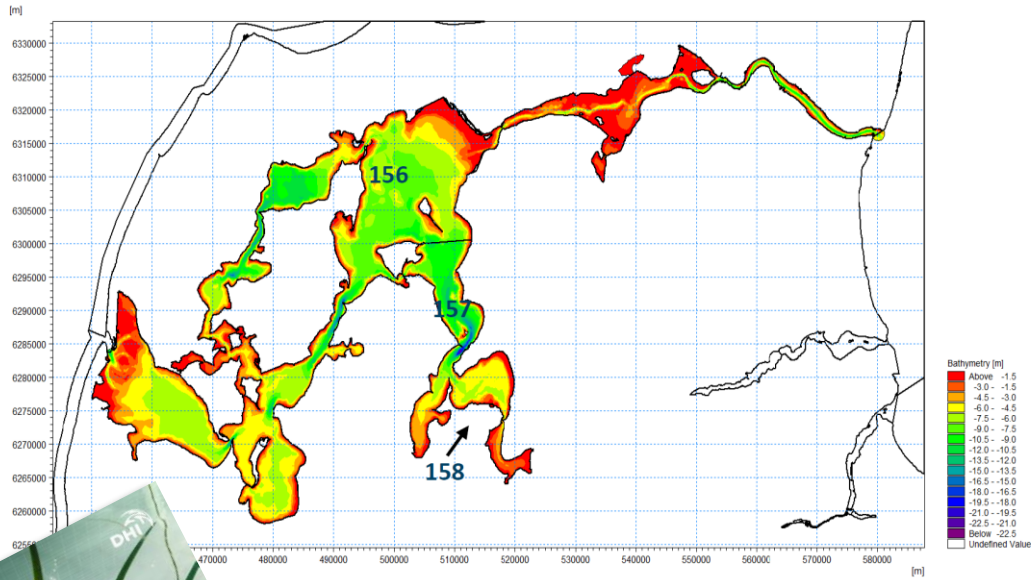
Status for muslingescenarier

Disposition

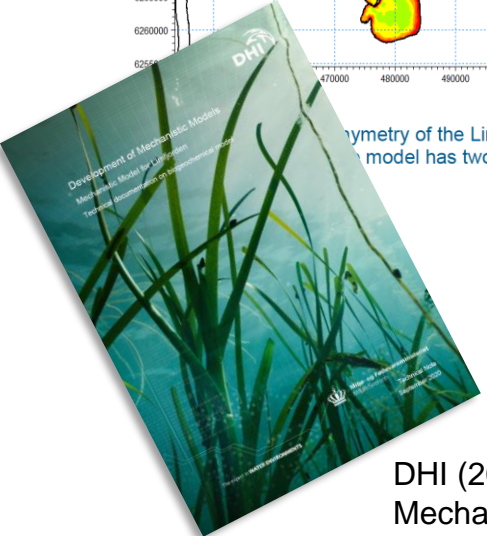
1. Kort beskrivelse af modelkompleks
2. Scenariebeskrivelse og foreløbige resultater
3. Sammenligning af resultater med andre studier
4. Andre opmærksomheds-punkter



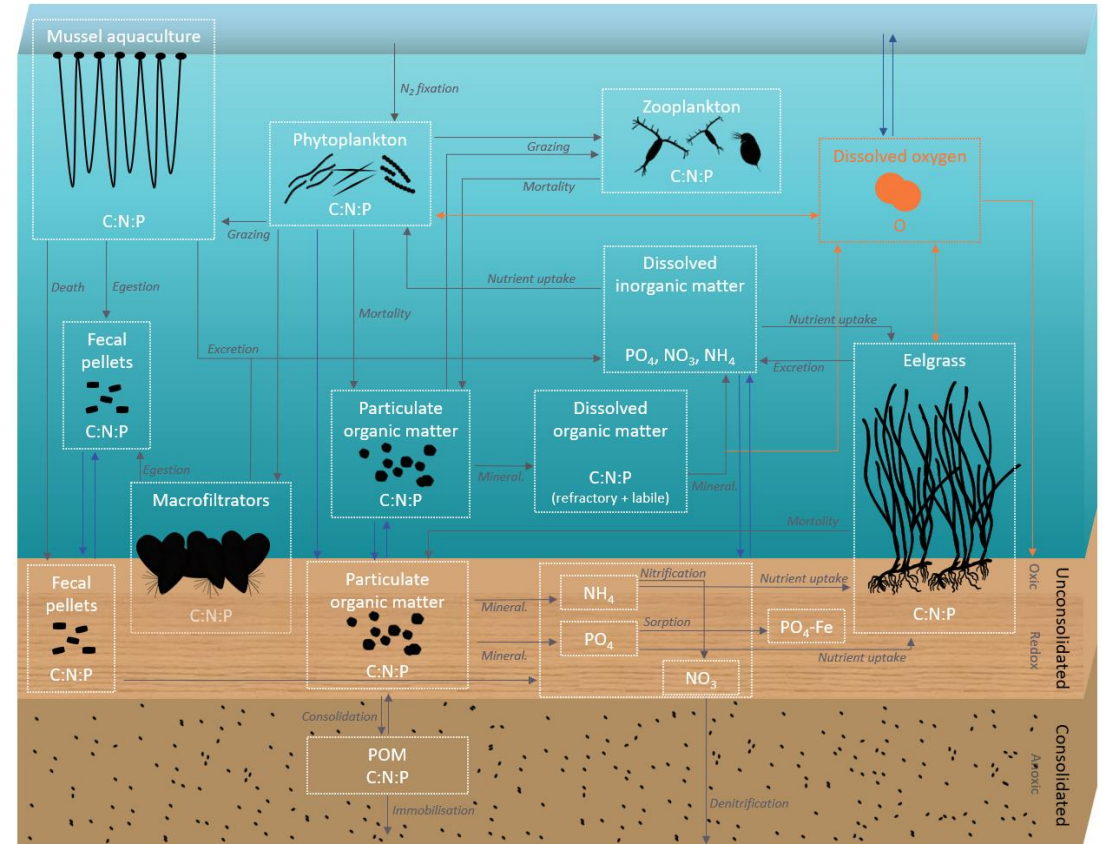
Modelkompleks



Asymmetry of the Limfjorden model and indication of water bodies. Water depths refer to the bathymetric map. The model has two open boundaries. Map projection is ETRS-1989-UTM-32.

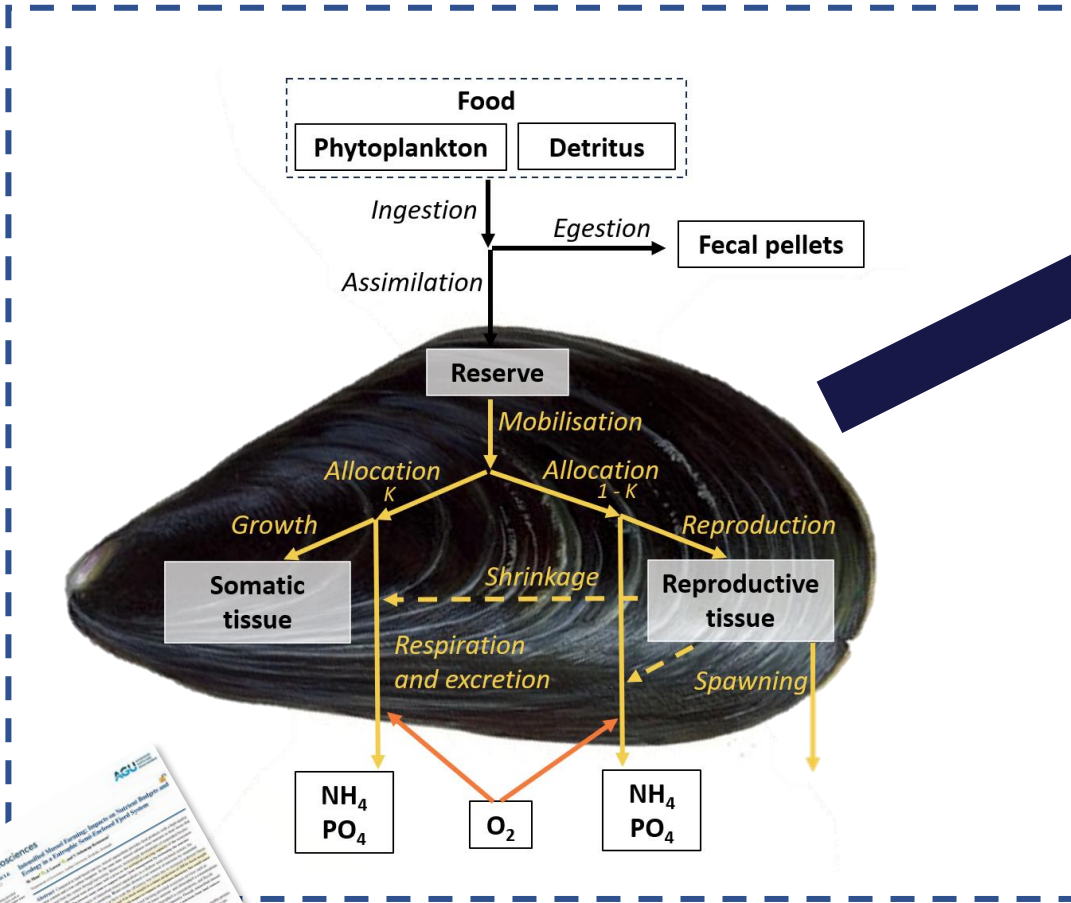


DHI (2020)
Mechanistic Model for Limfjorden

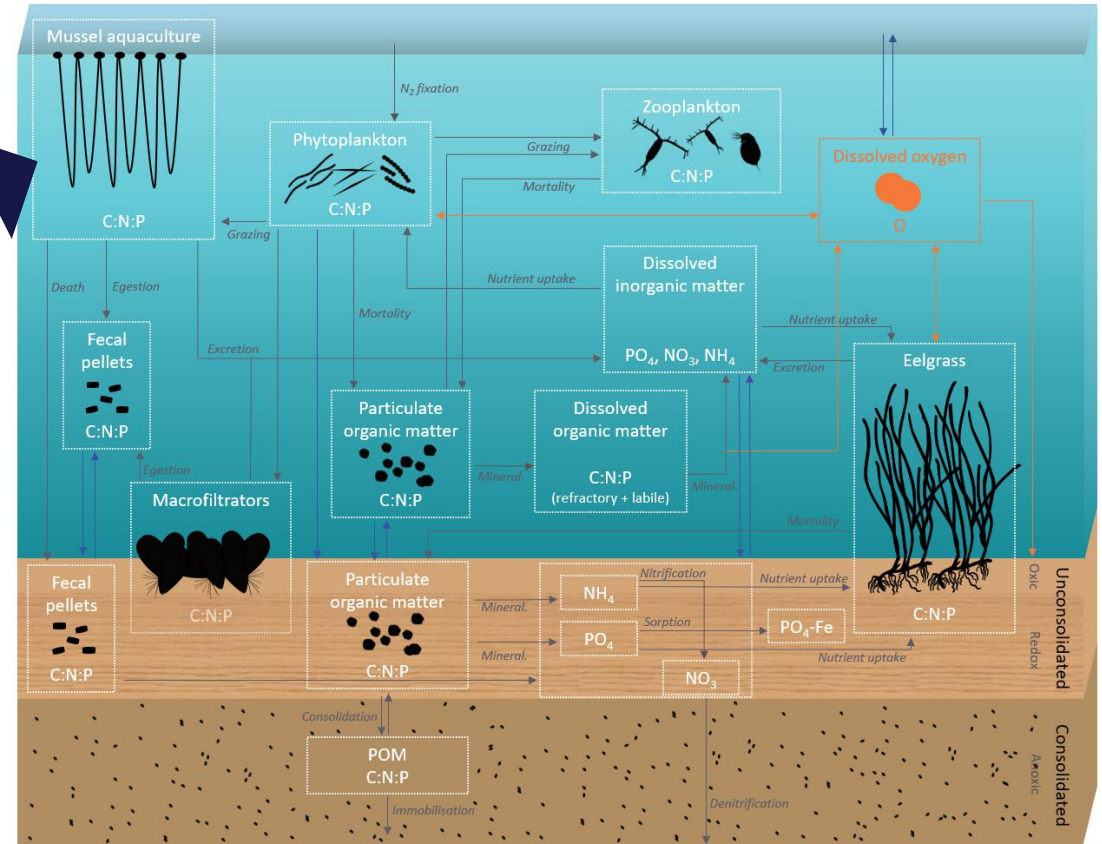


Koblet hydrodynamisk-biogeokemisk model for Limfjorden anvendt i vandplansarbejdet af DHI (simplificeret konceptuel tegning af biogeokemiske processer)

Modelkompleks



Dynamisk Energy Budget model baseret på Maar et al (2023)



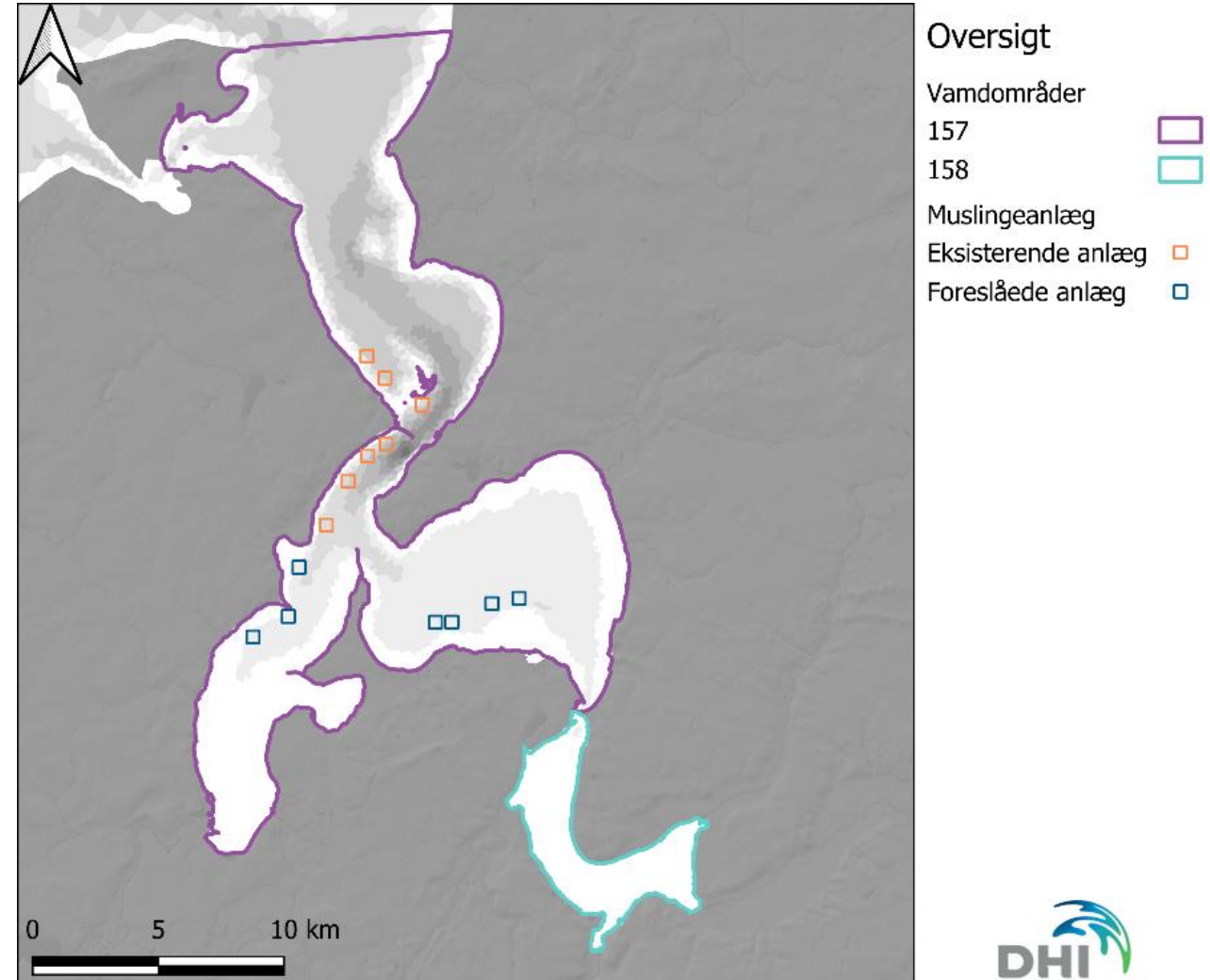
Koblet hydrodynamisk-biogeokemisk model for Limfjorden anvendt i vandplansarbejdet af DHI (simplificeret konceptuel tegning af biogeokemiske processer)

Scenariebeskrivelser

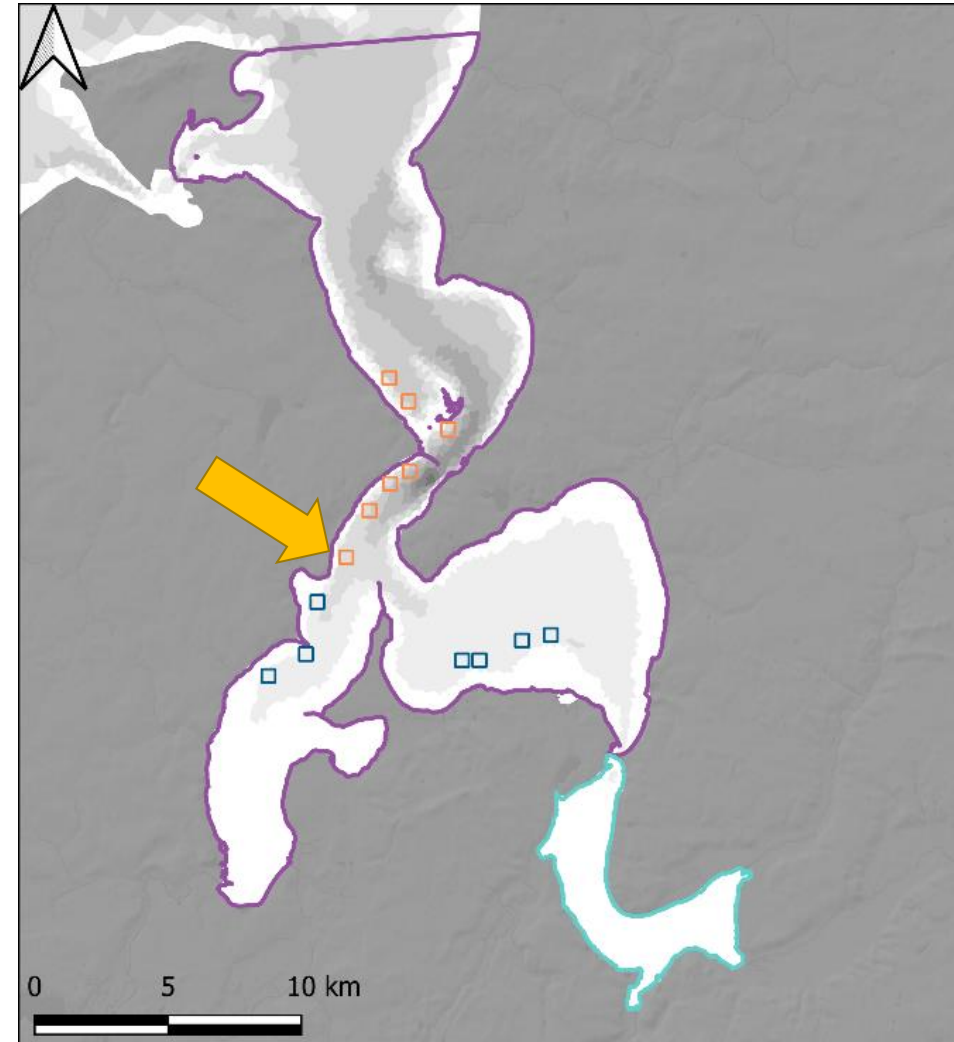
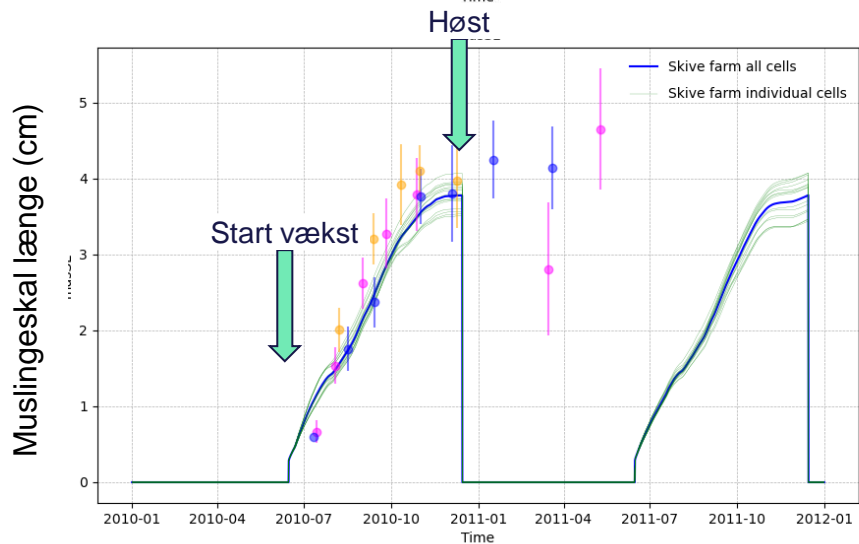
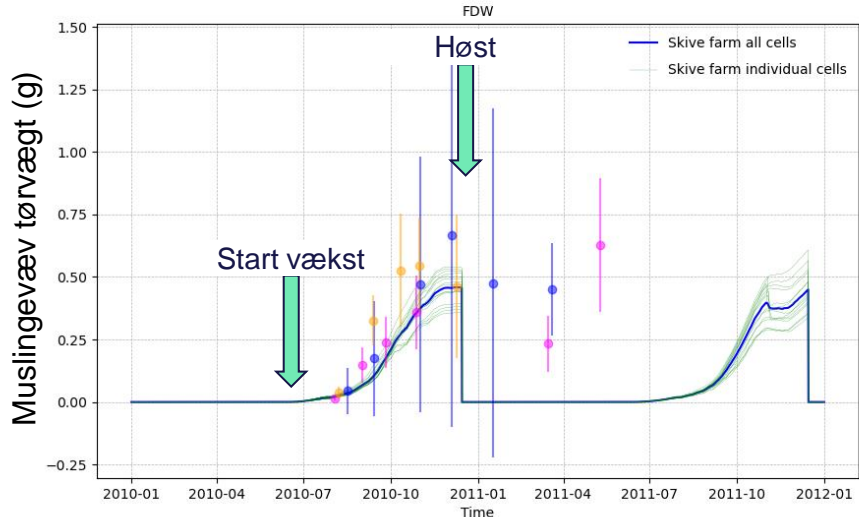
- Baseline
- 7 farme, 45 liner (long-line halv)
- 7 farme, 90 liner (long-line max)
- 14 farme, 45 liner (long-line halv)
- 14 farme, 90 liner (long-line max)
- Konsum (2022)

Muslingevækst fra midt juni til høst i midt december.

Lovns Bredning er Natura2000 beskyttet.



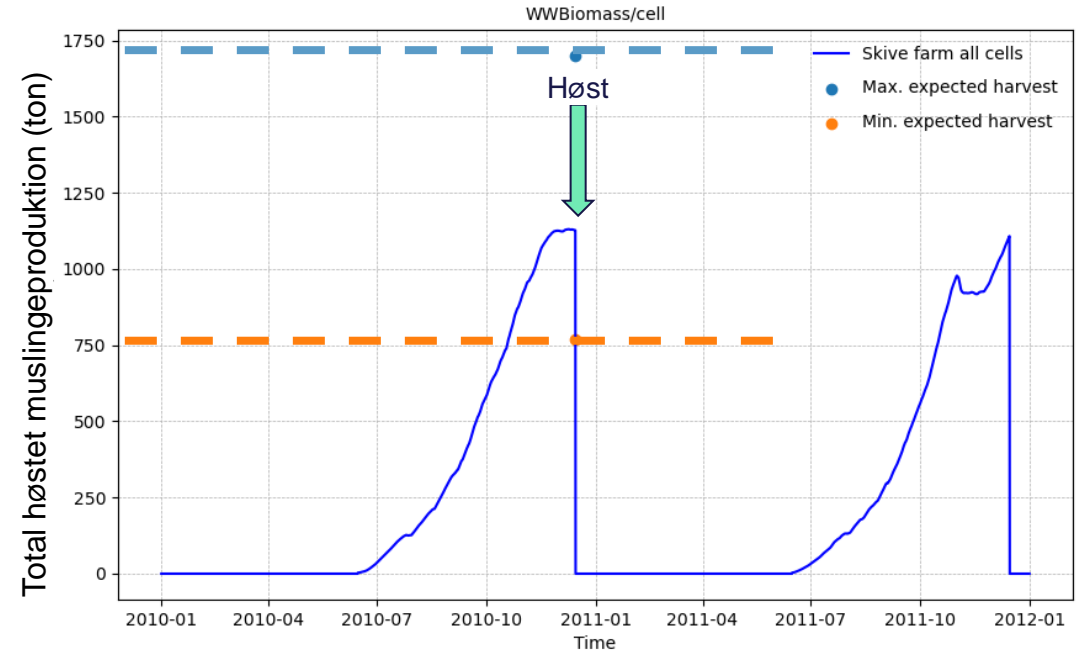
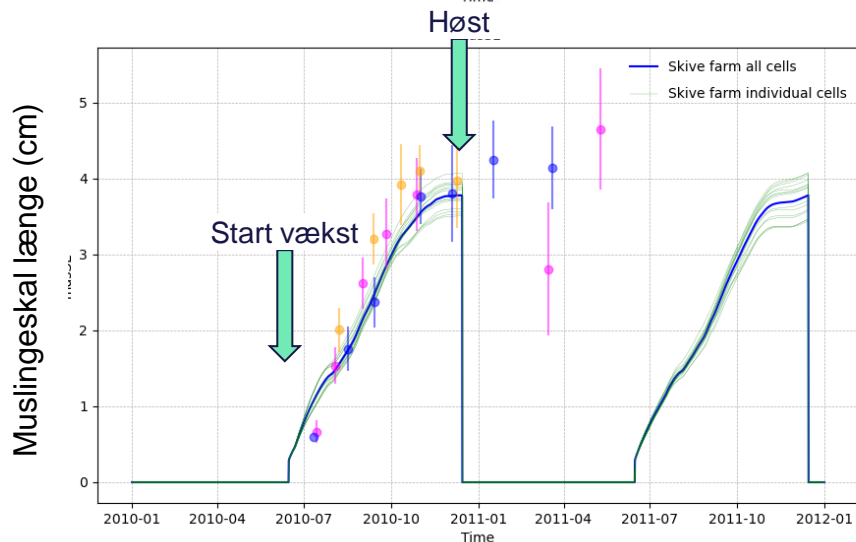
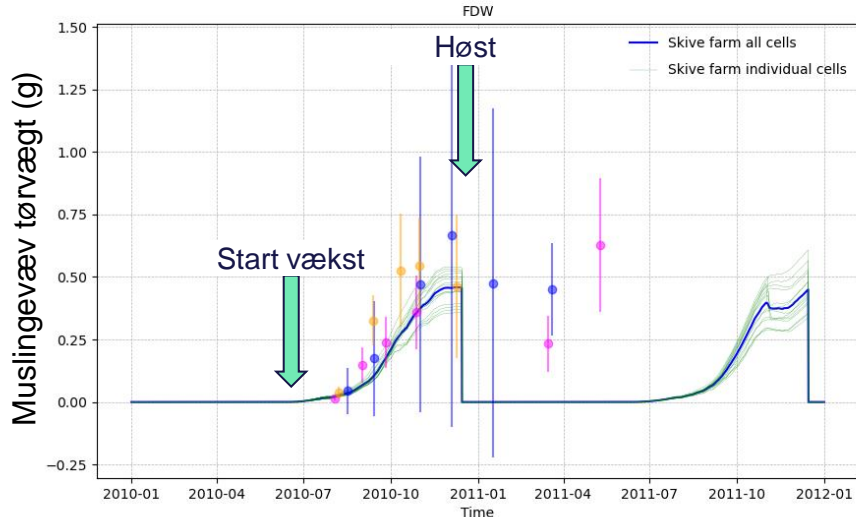
Verifikation af modelleret muslingevækst



Overzicht

- Vamdområder
- 157
- 158
- Muslinge anlæg
- Eksisterende anlæg
- Foreslåede anlæg

Verifikation af modelleret muslingevækst



Marin virkemiddel (Taylor et al., 2019)

Langlinje produktion*	770-1700 t
Net produktion*	2100-2600 t

Nielsen et al., 2016

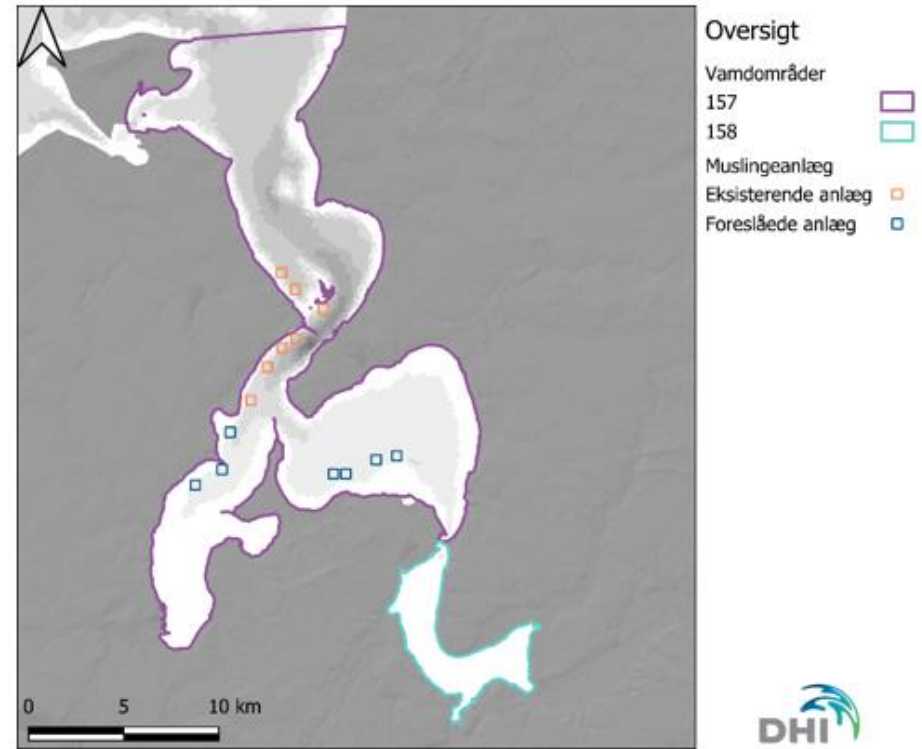
Langlinje produktion*	
28 Oktober	855 ± 315 t
Maj høst	1098 ± 188 t

* Standard anlæg på 18.8 ha

Muslingescenarier

Scenarier

- Baseline
 - Ingen produktion
- 7 farme, 45 liner (long-line half)
 - Årlig produktion: 4374 t
- 7 farme, 90 liner (long-line max)
 - Årlig produktion: 5469 t
- 14 farme, 45 liner (long-line half)
 - Årlig produktion: 8206 t
- 14 farme, 45 liner (long-line max)
 - Årlig produktion: 9895 t
- Konsum
 - Årlig produktion: 3926 t



Marin virkemiddel (Taylor et al., 2019) December høst

Langlinje produktion*	770-1700 t
Net produktion*	2100-2600 t

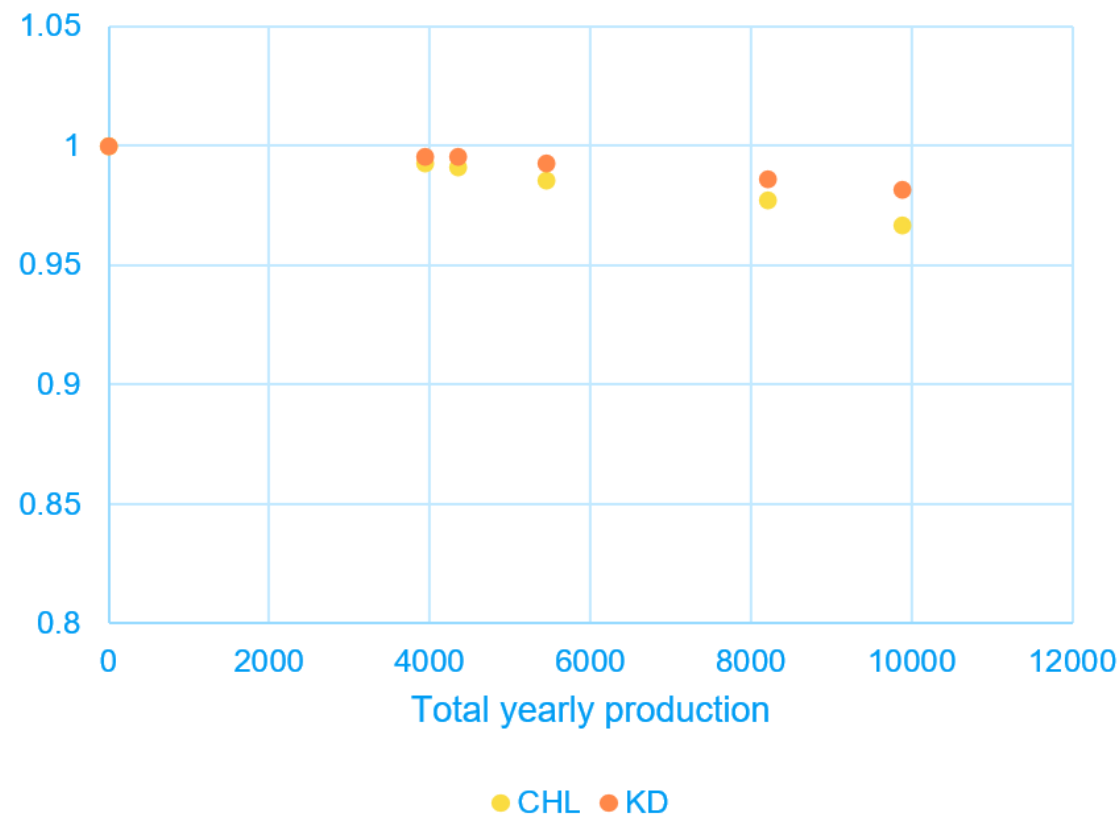
Nielsen et al., 2016

Langlinje produktion*	
28 Oktober	855 ± 315 t
Maj høst	1098 ± 188 t

* Standard anlæg på 18.8 ha

Scenarier - Resultater

	Konsum	7-45	7-90	14-45	14-90
Sommer klorofyl	99.3%	99.0%	98.5%	97.7%	96.6%
Vækst-sæson lys-dæmp-ning	99.5%	99.5%	99.2%	98.6%	98.1%



Relative ændring i sommer klorofyl (CHL) og vækstsæson lysdæmpning (KD).

Klorofyl

Baseline – model

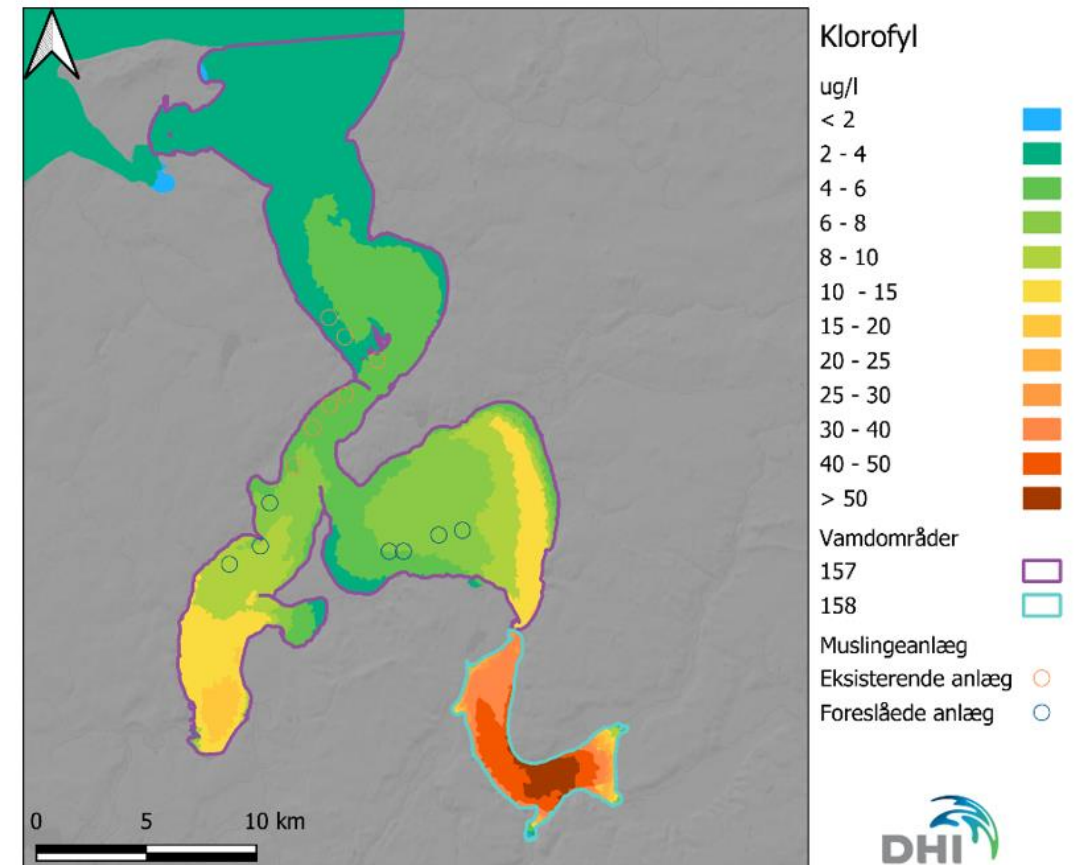
Sommer middel overflade (lag 1-5)

Maj – september 2011-2015 (2010 warm up)

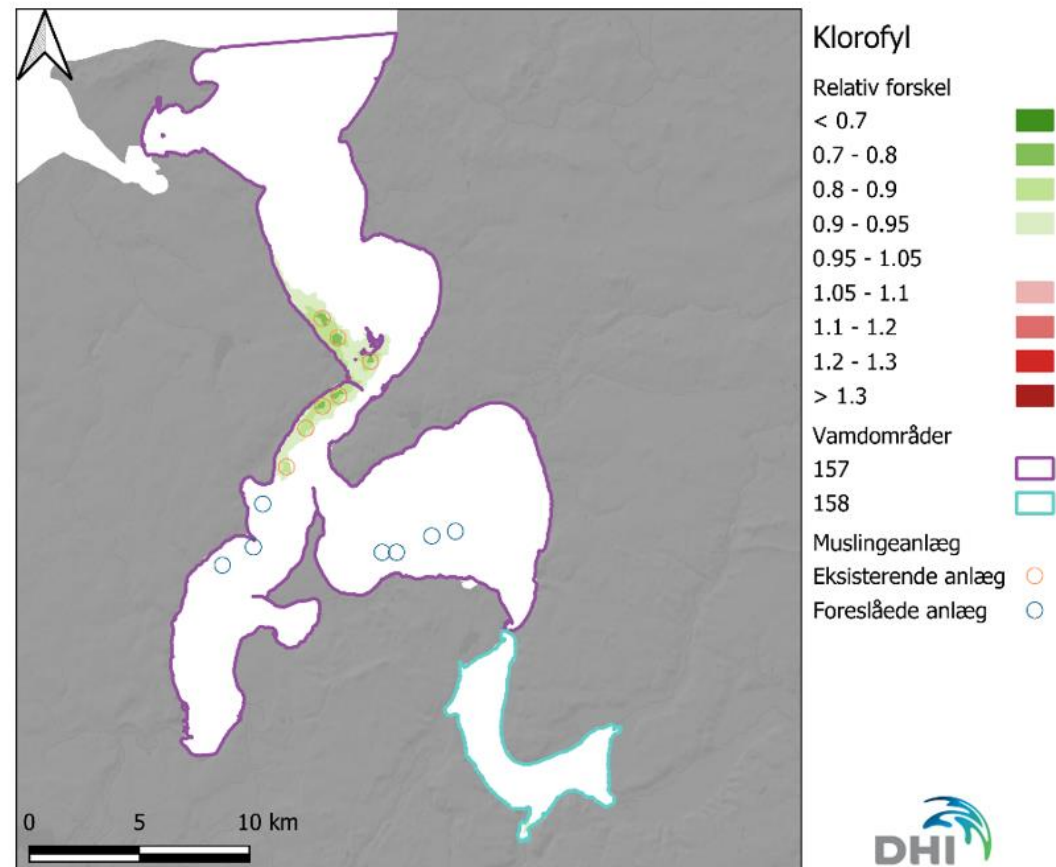
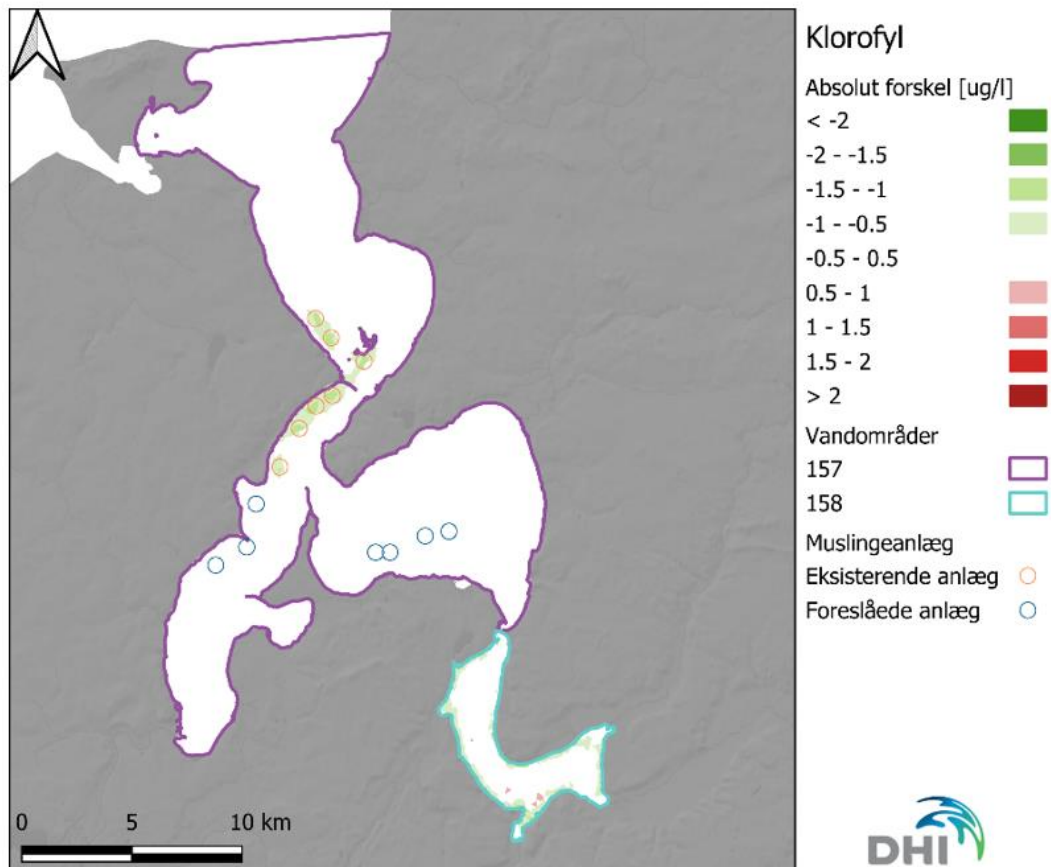
Sammenligninger:

Scenarie / Baseline

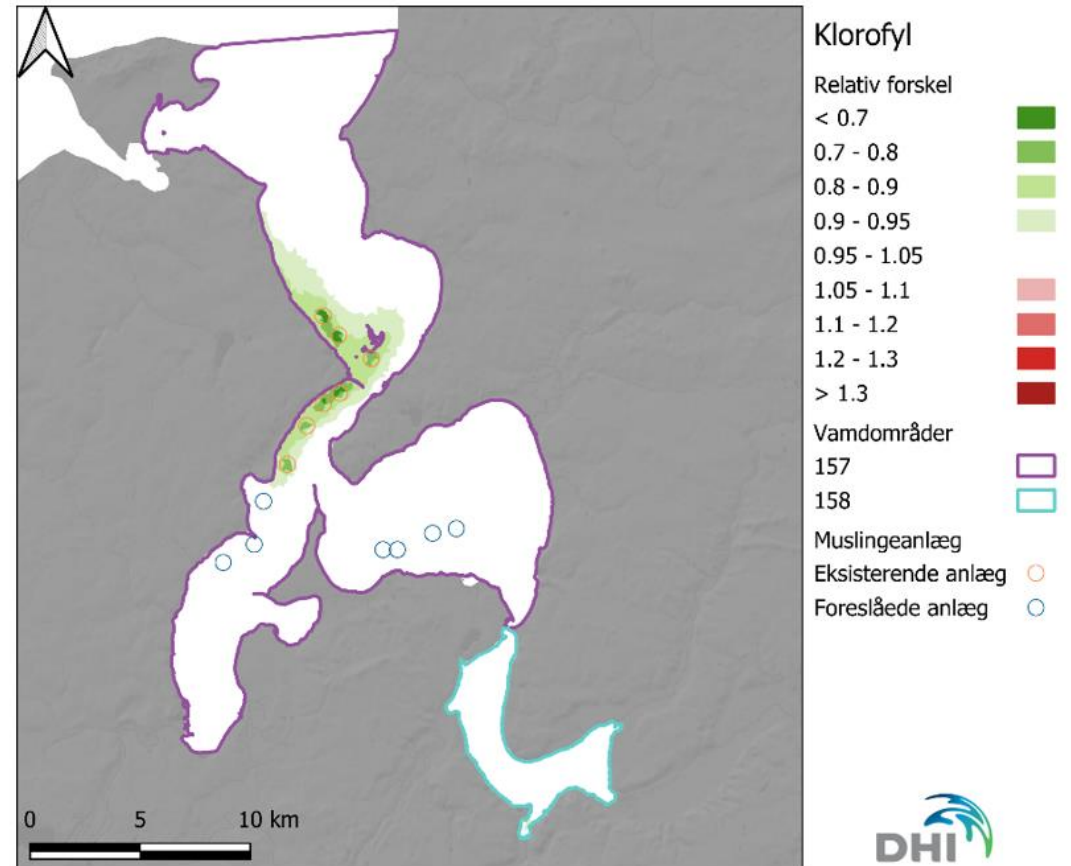
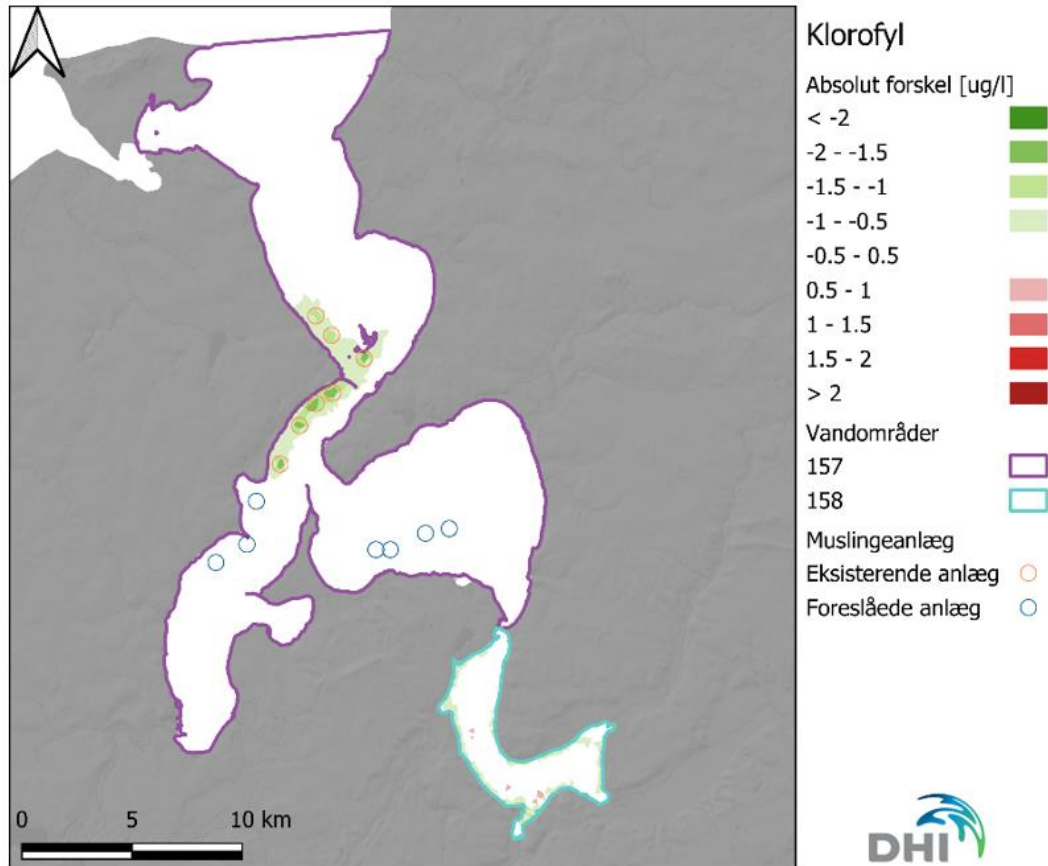
Baseline - scenarie



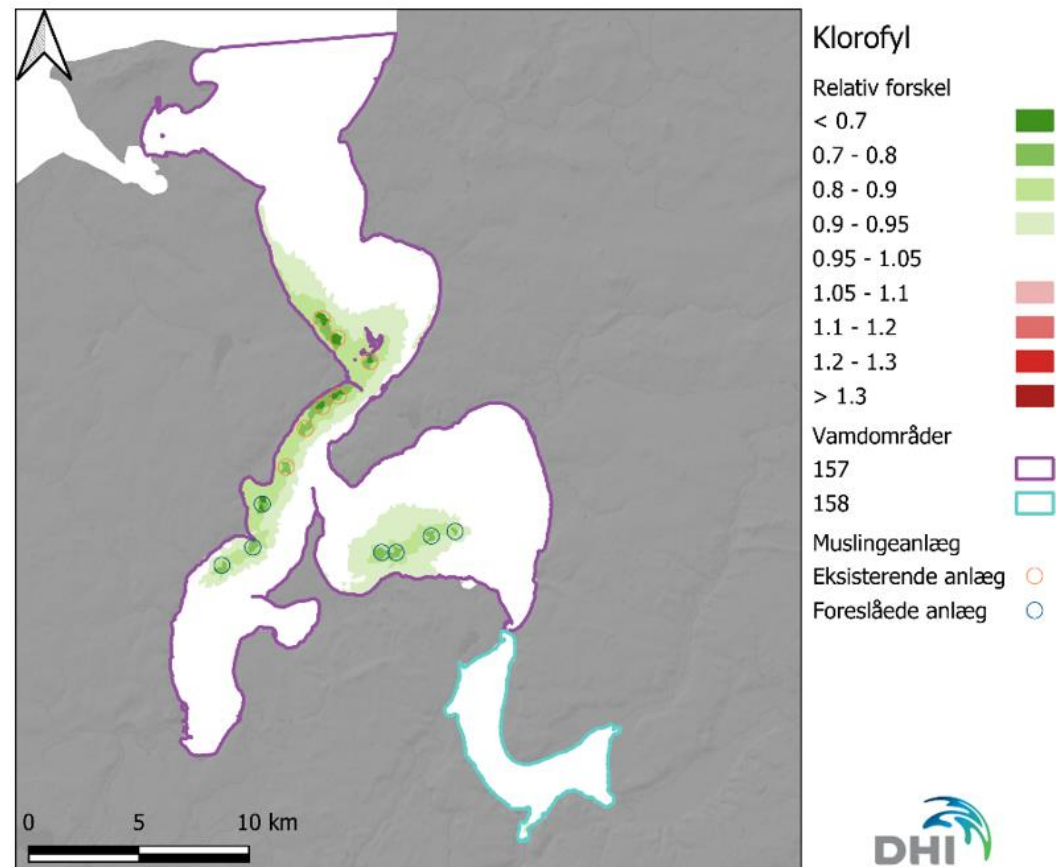
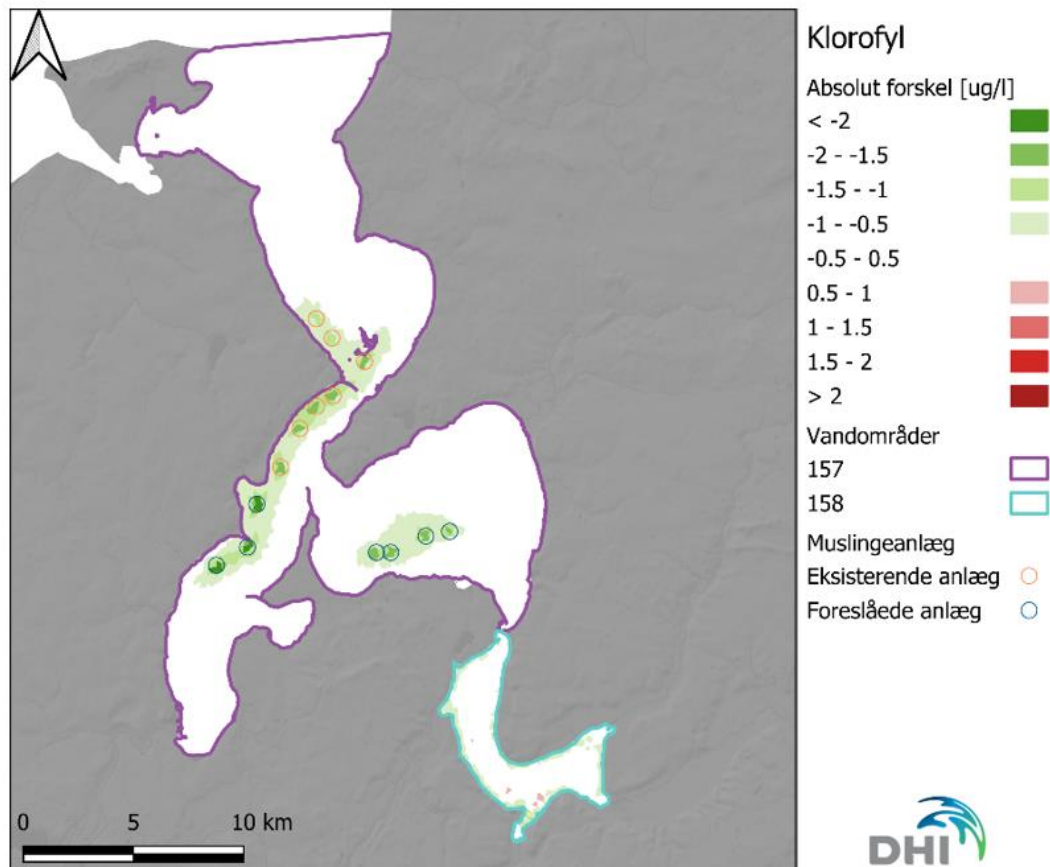
7 farme, 40 liner (konsum)



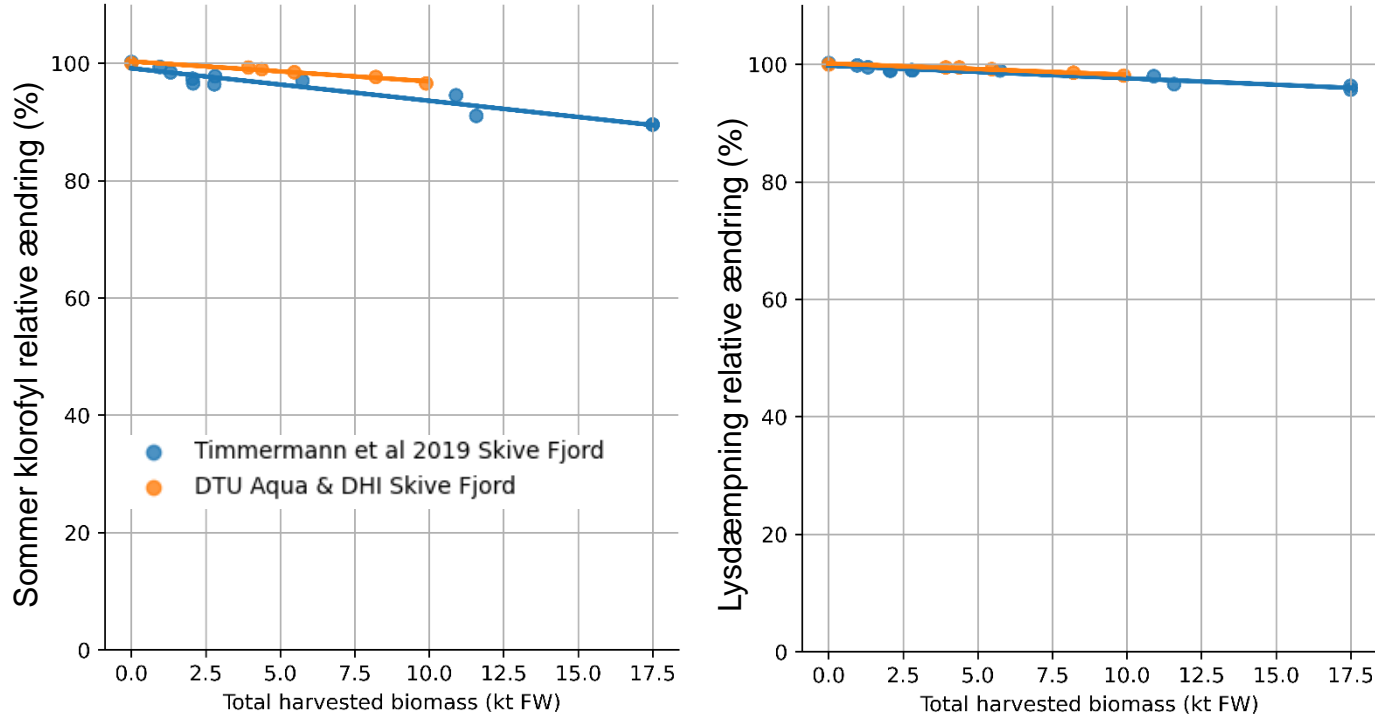
7 farme, 90 liner (long-line max)



14 farme, 90 liner (long-line max)



Sammenligning med andre model studier



Produktionsperiode

Timmermann et al. (2019)

Aqua+DHI

Juni til Maj

Juni til December

Timmermann et al. (2019)
Model domæne

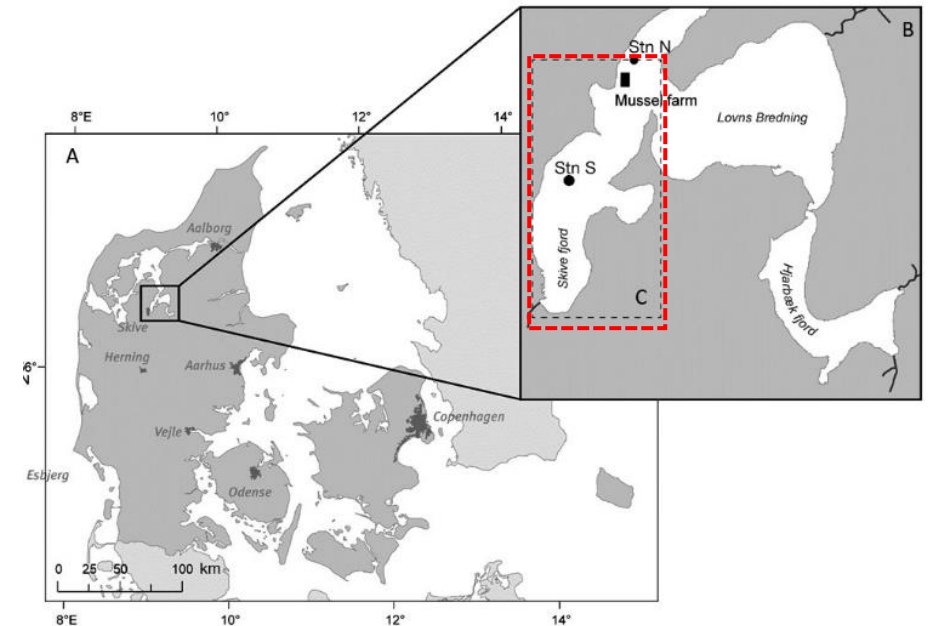
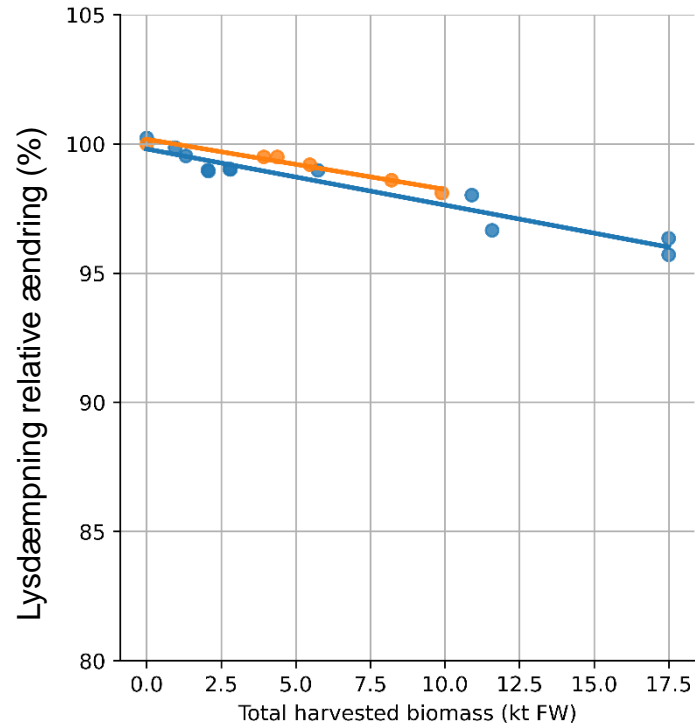
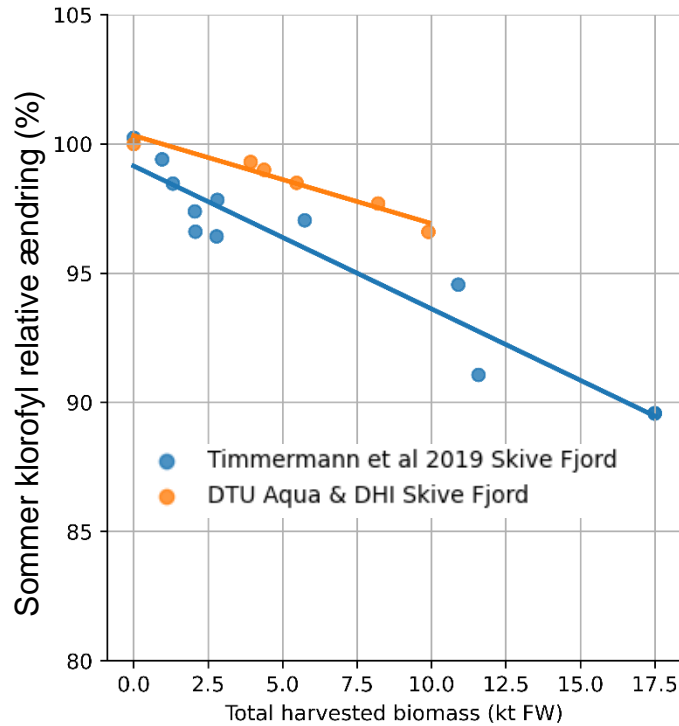


Fig. 1. (A) Location of the Skive Fjord complex, Denmark, with (B) a close-up of the model domain covering Skive Fjord, Lovns Bredning and Hjarbæk Fjord. The mitigation mussel culture unit optimized for nutrient removal is located in the northern part of Skive Fjord (■). The monitoring station providing data for boundary conditions, Stn N (●), is located north of the farm, whereas the monitoring station used for model validation, Stn S (●), is located south of the mussel farm. In the present study, basin scale is defined as (C) Skive Fjord, whereas local scale is related to a single mussel farm

Sammenligning med andre model studier



Timmermann et al. (2019)
Model domæne

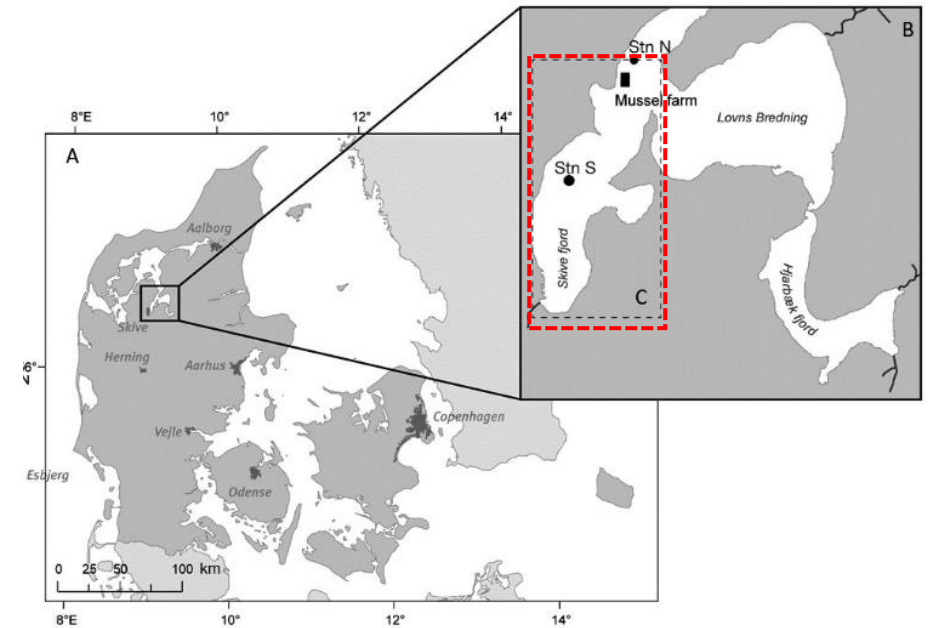


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Produktionsforskelle

Timmermann et al. (2019)
Aqua+DHI

Juni til Maj 1-10 anlæg
Juni til December 7-14 anlæg

Sammenligning med andre model studier

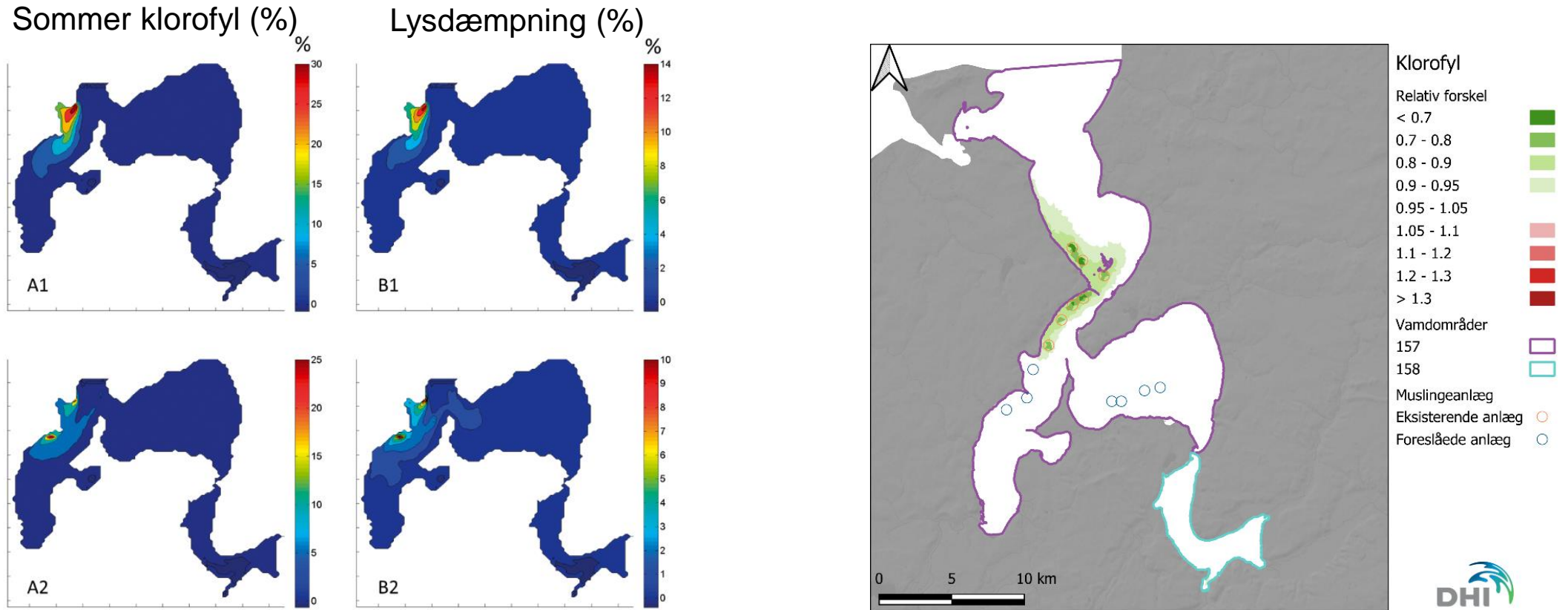
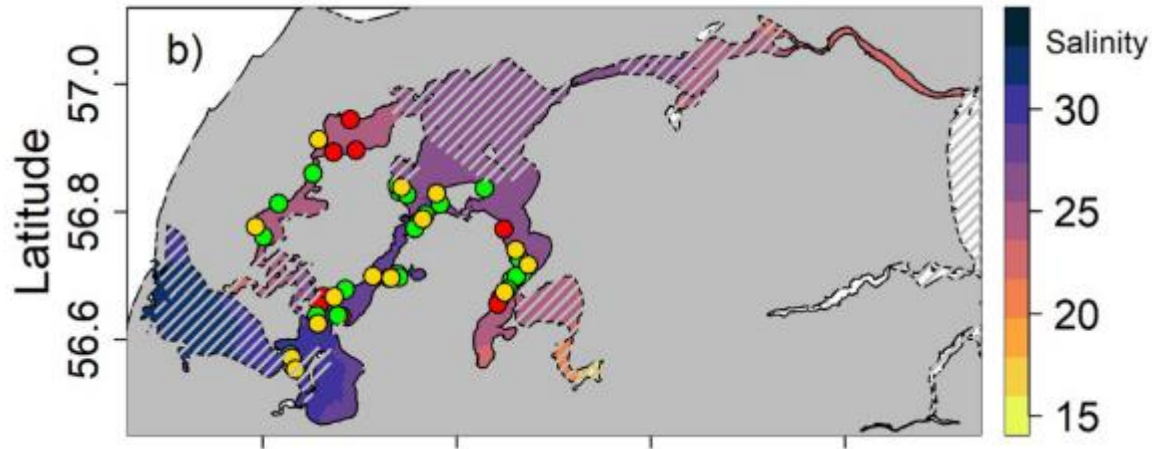


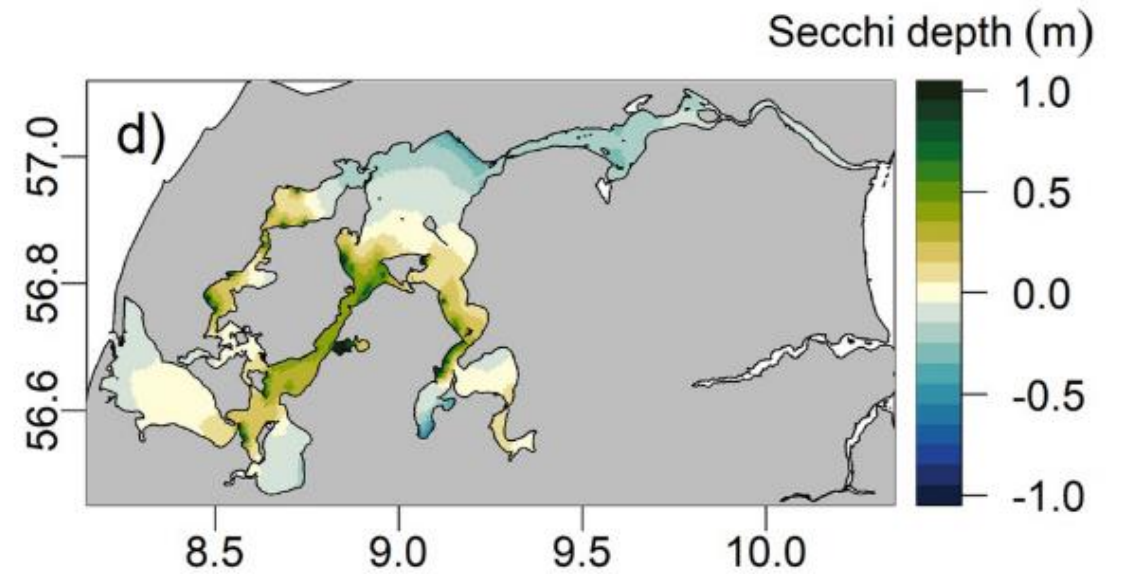
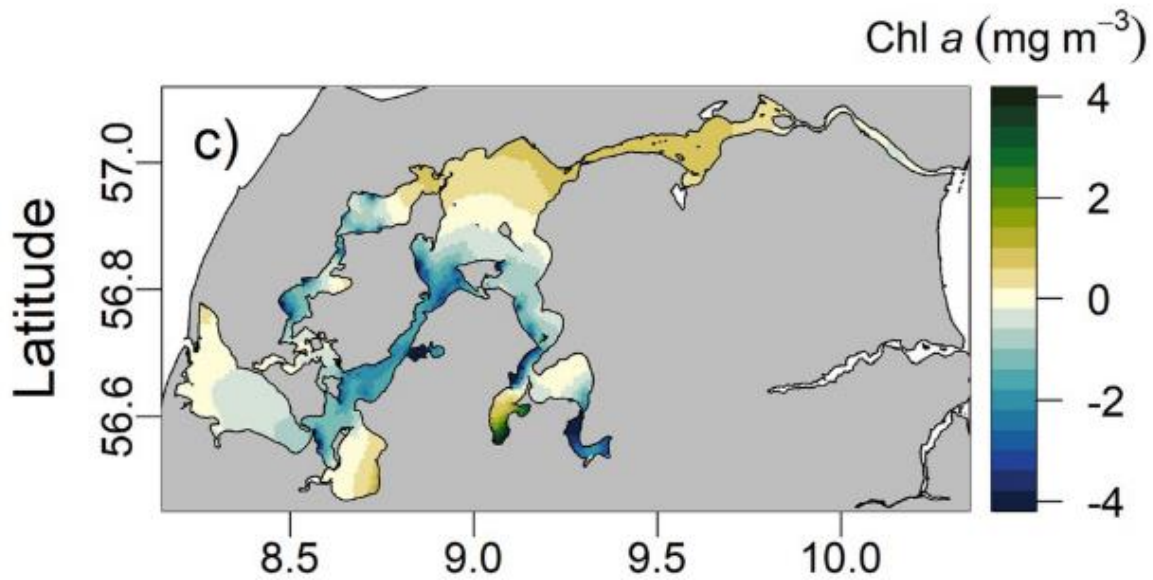
Fig. 5. Modelled spatial effects of mitigation mussel filtration with either 1 large farm (top panels) or 2 smaller farms (bottom panels), resulting in (A) reduction in summer chl *a* concentration and (B) reduction in light attenuation (K_d). Results are shown as the nominal relative change (%) between simulations without and with a mussel mitigation farm. Positive values indicate that chl *a* and K_d are reduced in the farm scenario compared to a scenario without mussel mitigation farms

7 aktive lang-linje anlæg

Sammenligning med andre model studier

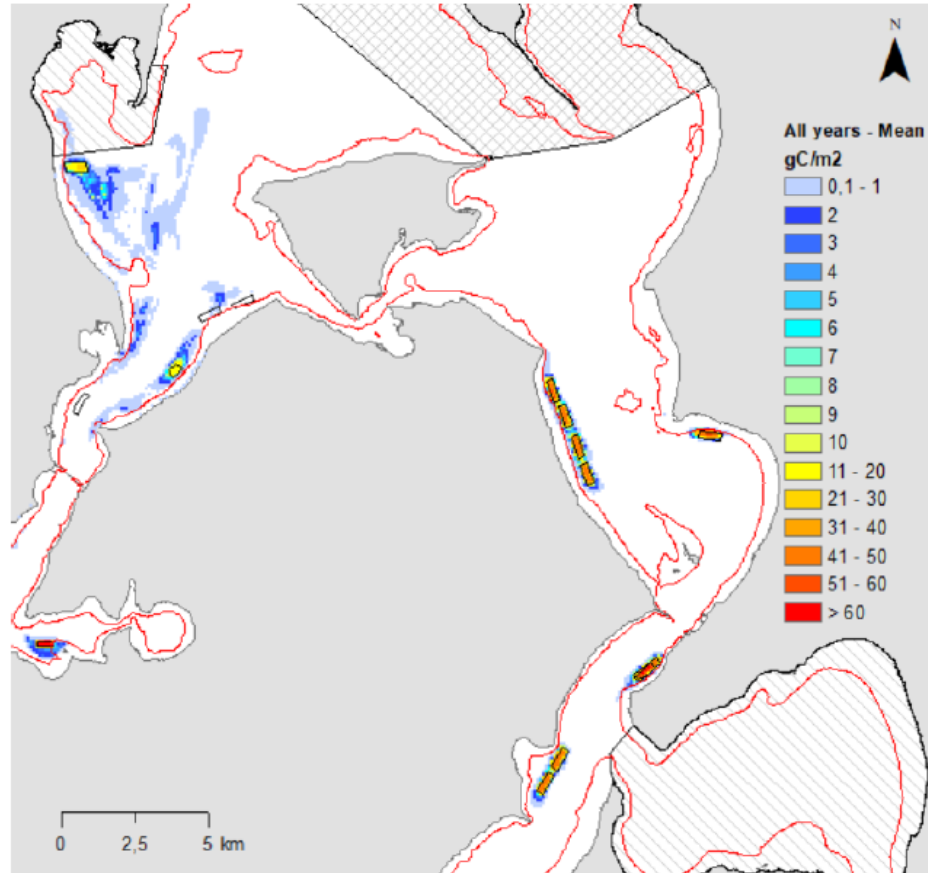


Modellerer effekt af 52 aktive anlæg i hele Limfjorden.
 Modelleret total høstet muslingebiomass på 104 ± 7 kt våd vægt (inkl. skal)



Maar et al. (2023)

Spredning af muslingefækalier



Figur 10. Modelberegnet akkumuleret organisk kulstof fra muslingefækalier i g C/m² som gennemsnit af gennemsnit for maj og oktober for all år 2014, 2015 og 2016 i Skive Fjord og Løgstør Bredning. Med resuspension. Rød linje angiver ålegræssets målsatte dybdegrænse for god/moderate økologisk tilstand for vandplansperioden 2016-2021 baseret på DTU AQUA's egne dybdeedata med en rumlig opløsning på 100x100 m.



Notat vedr. værktøj til miljøvurdering af muslingeopdræt (DTU Aqua og DHI, 2022)

Usikkerheder i modelleret økosystem respons

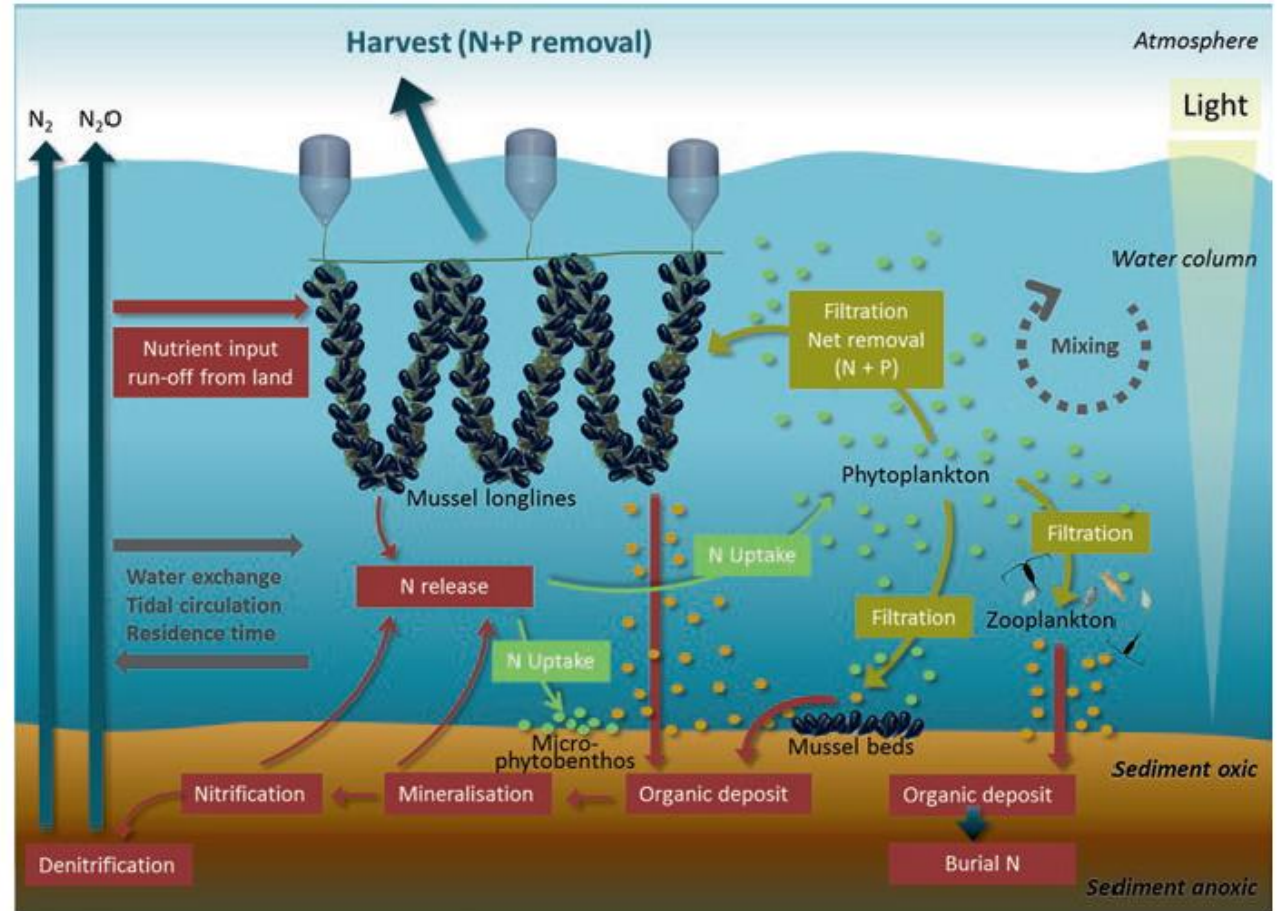
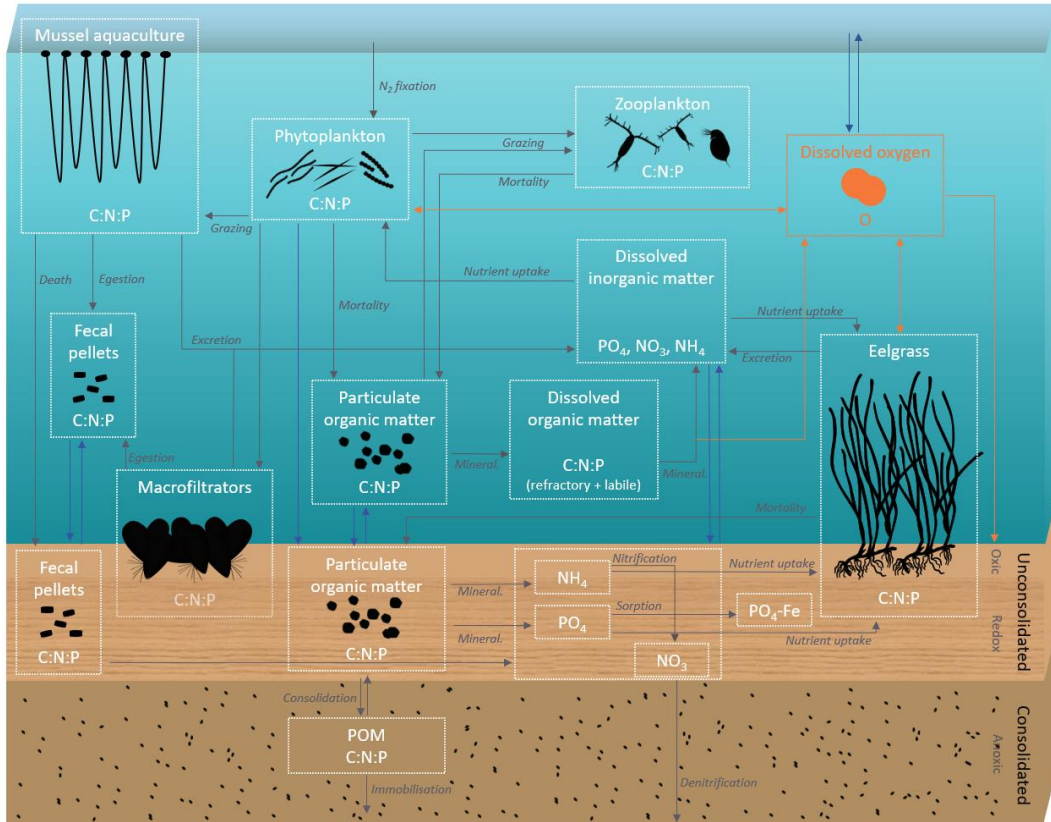
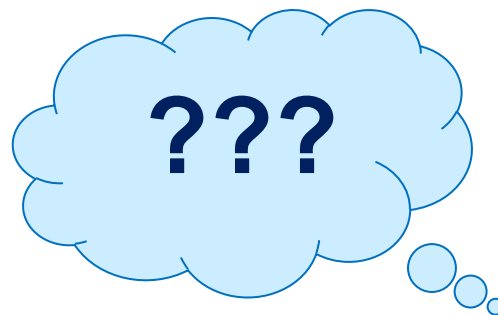


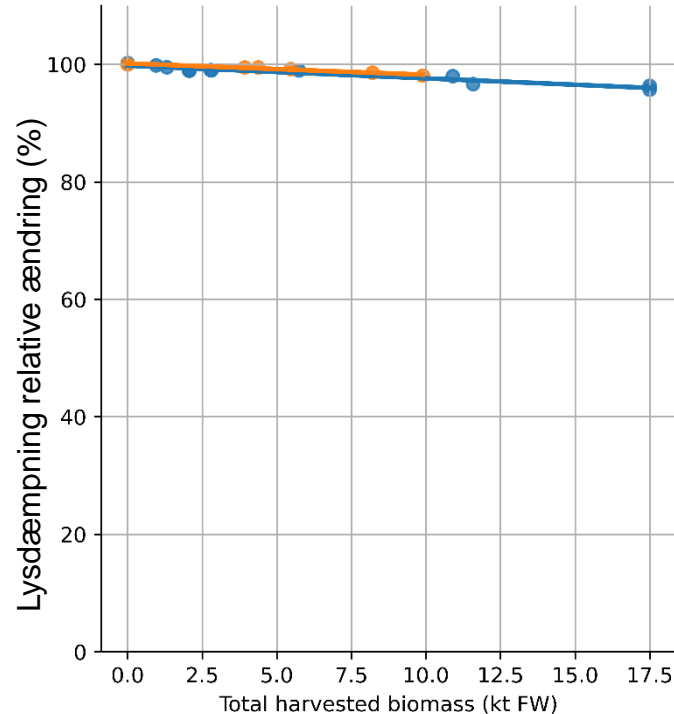
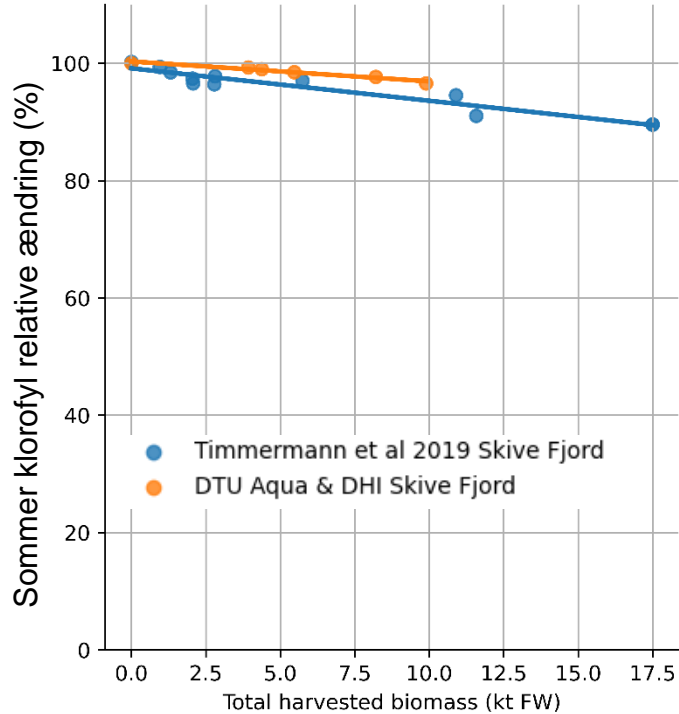
Fig. 10.1 Nutrient extraction services provided by bivalves. Blue mussels are used as examples but other bivalves like oysters can also provide these nutrient extraction services

Petersen et al (2019)

Spørgsmål



Sammenligning med andre model studier



Marin virkemiddel (Taylor et al., 2019)

Langlinje produktion* 770-1700 t
 Net produktion* 2100-2600 t

Nielsen et al., 2016

Langlinje produktion*
 28 Oktober 855 ± 315 t
 Maj høst 1098 ± 188 t

* Standard anlæg på 18.8 ha

Produktionsforskelle

Timmermann et al. (2019)	Juni til Maj	1-10 anlæg
Aqua+DHI	Juni til December	7-14 anlæg

GETM-DANECO-DEB (Timmermann et al, 2019)

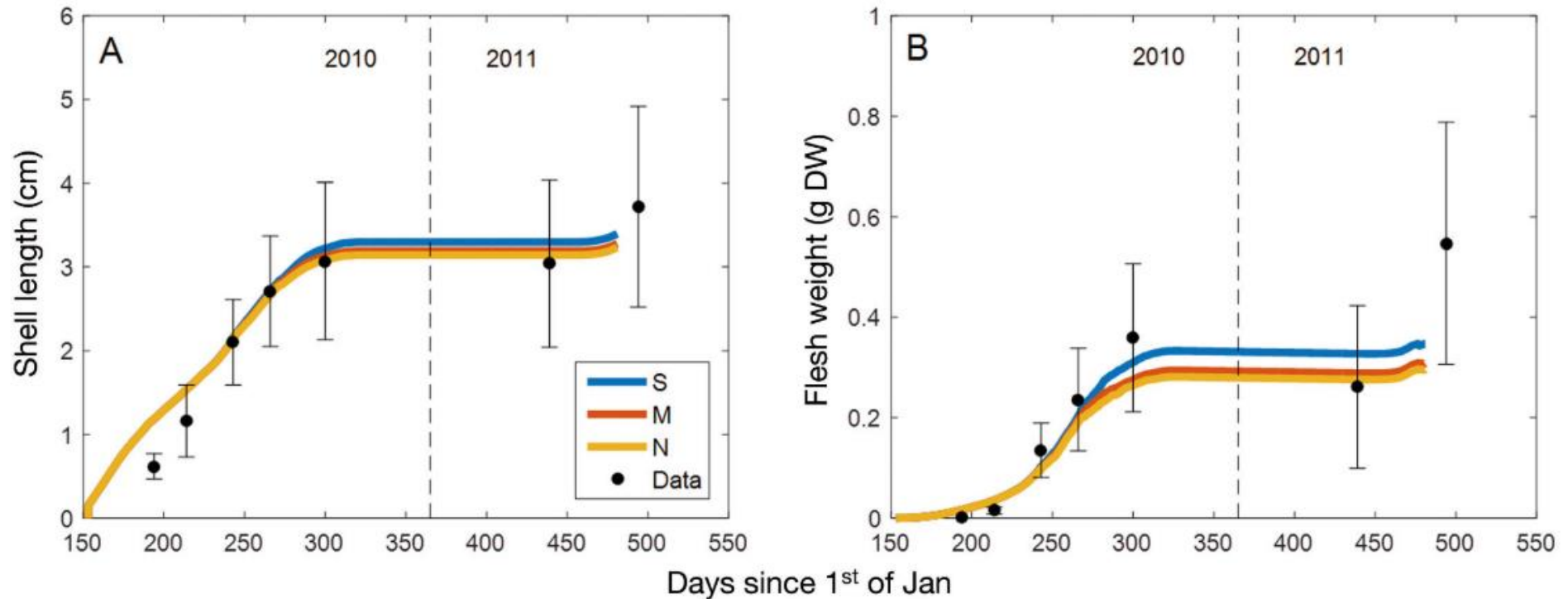


Fig. 4. Measured data and modelled (A) shell length and (B) biomass of individual blue mussels from the southern (S), middle (M) and northern (N) sections of the mussel mitigation culture unit from June 2010 to May 2011. Measured data represent a mixture of mussels from sections S, M and N, as no significant difference between sections was detected. Data are mean \pm SD