SPATIAL MODELLING OF BLUE MUSSEL FARM PRODUCTION POTENTIAL IN THE WESTERN BALTIC SEA

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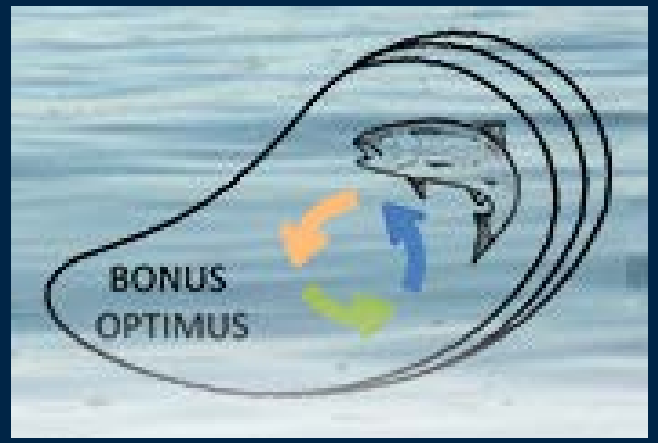
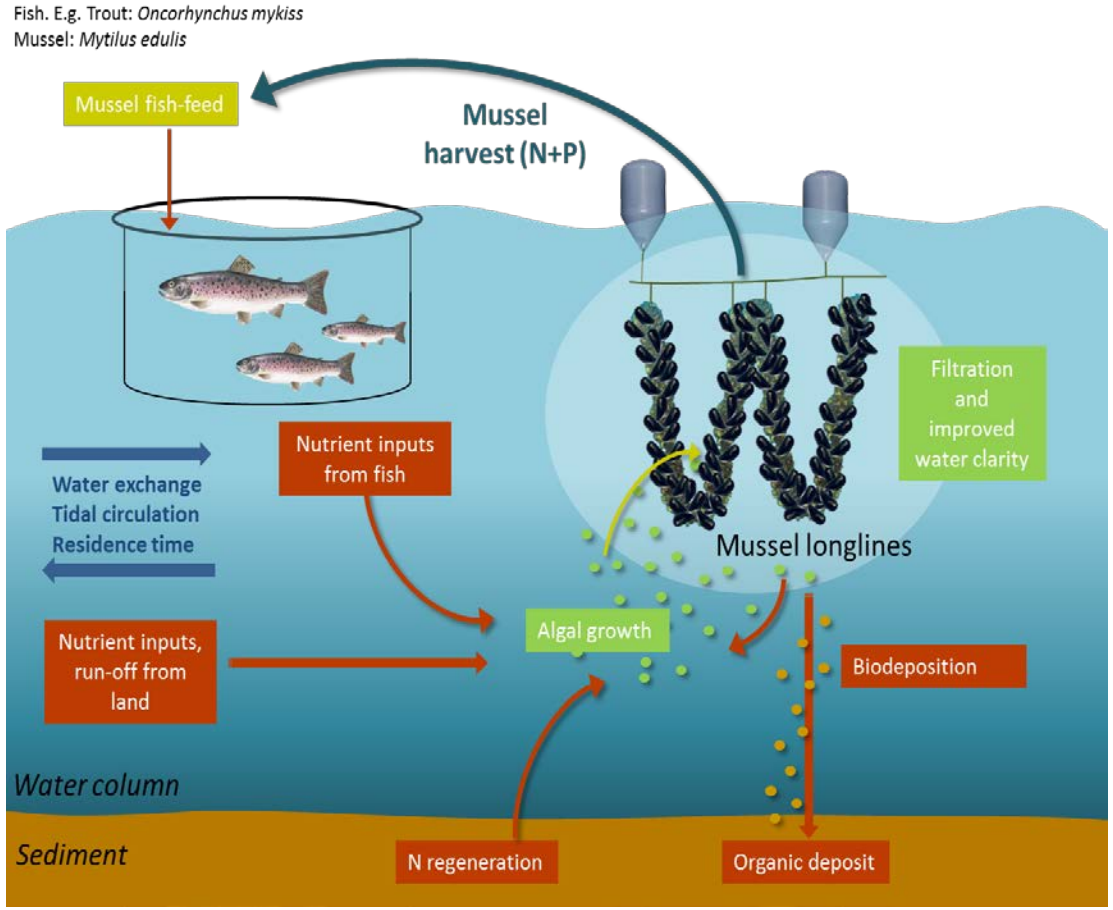
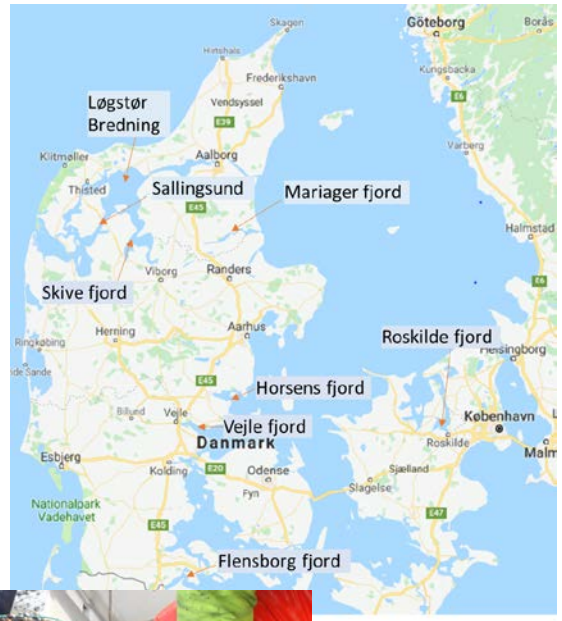


CONCEPT OF MUSSEL MITIGATION CULTURES

- **Eutrophication** of coastal waters is a worldwide problem
- Mussel **mitigation cultures** have been suggested as a tool to remove nutrients
- **Site selection** for mitigation cultures is an important part of sustainable marine spatial planning (MSP)
- Mussel **farm production potential** can provide input to MSP

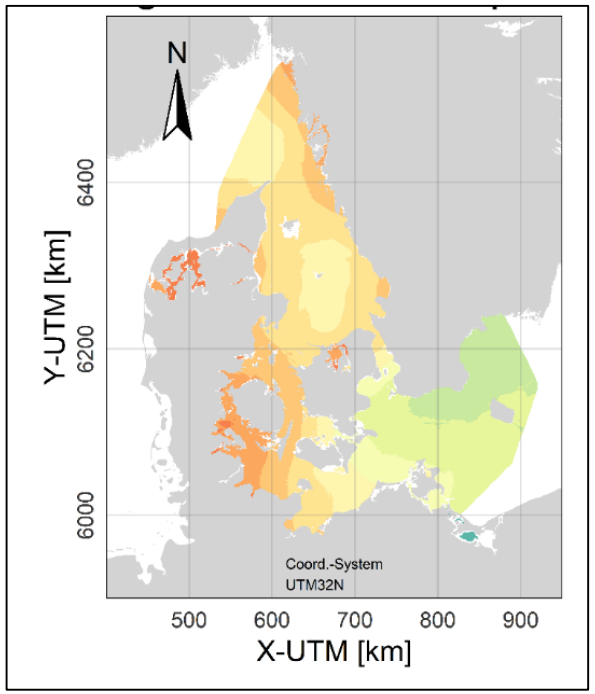


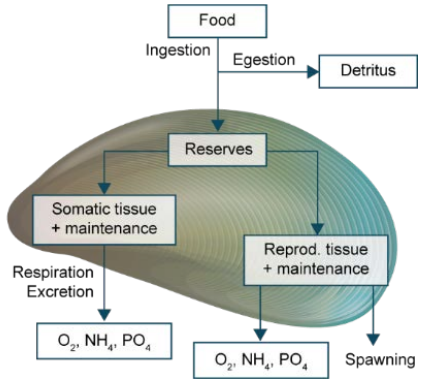
APPROACH



Growth data

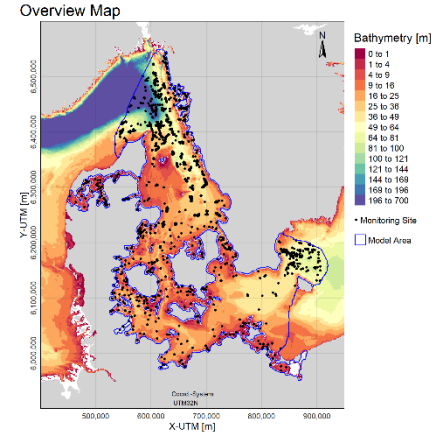
T, S, Chl a data



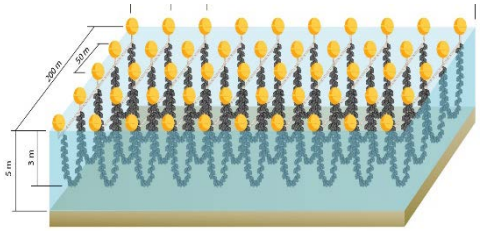


DEB growth model

Spatial model of T, S and Chl a data



Statistical farm production model



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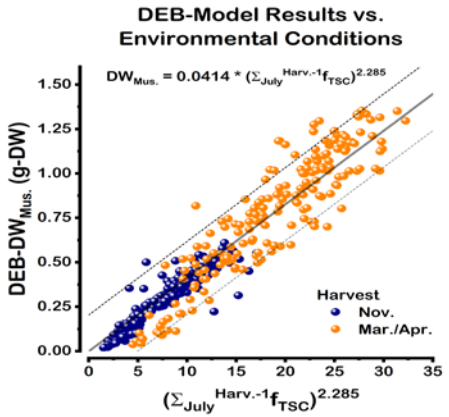

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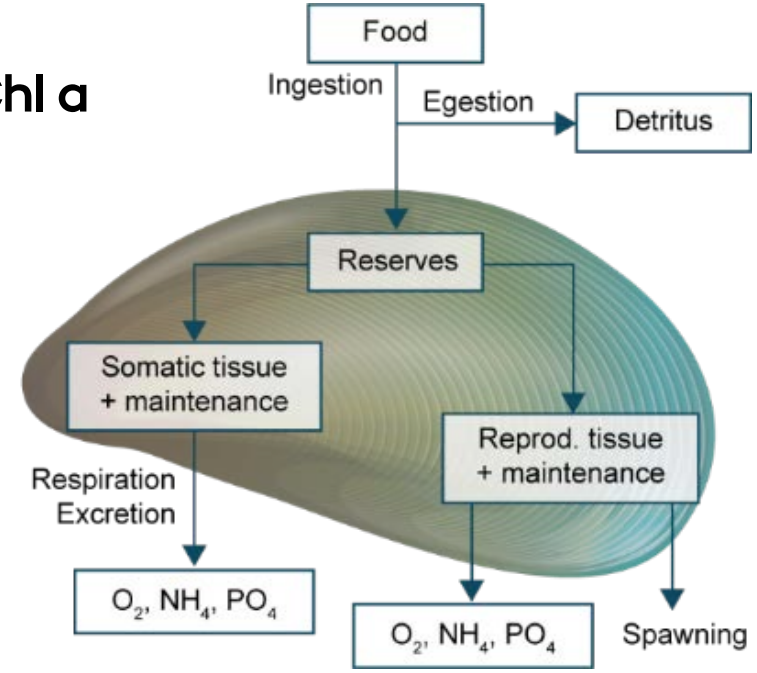
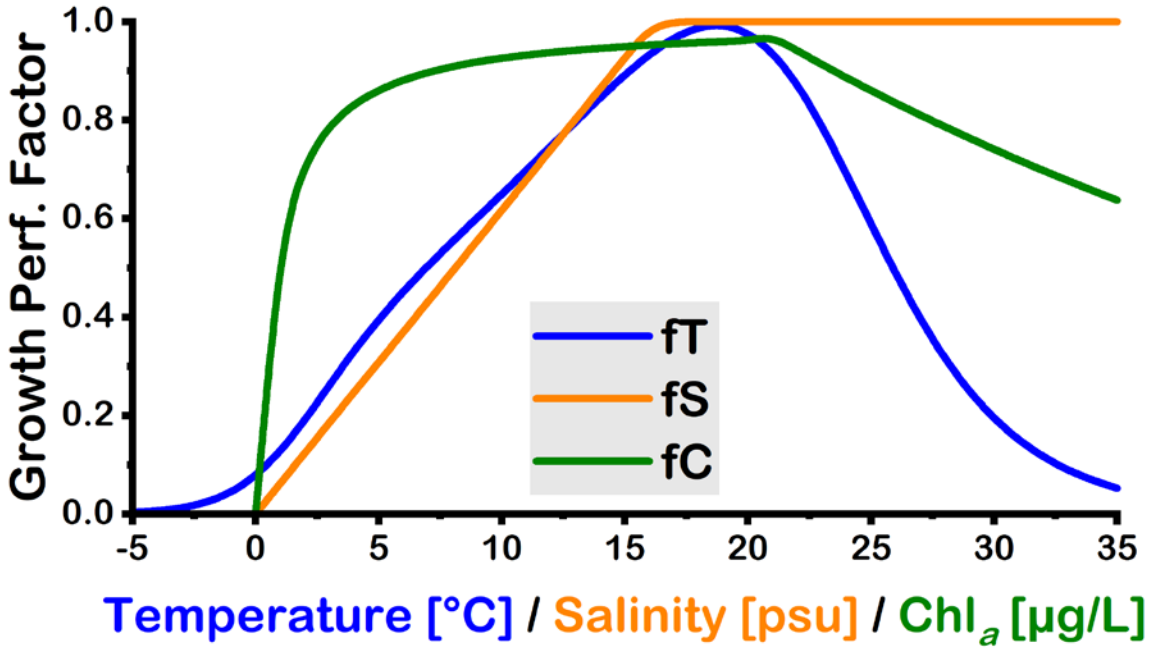
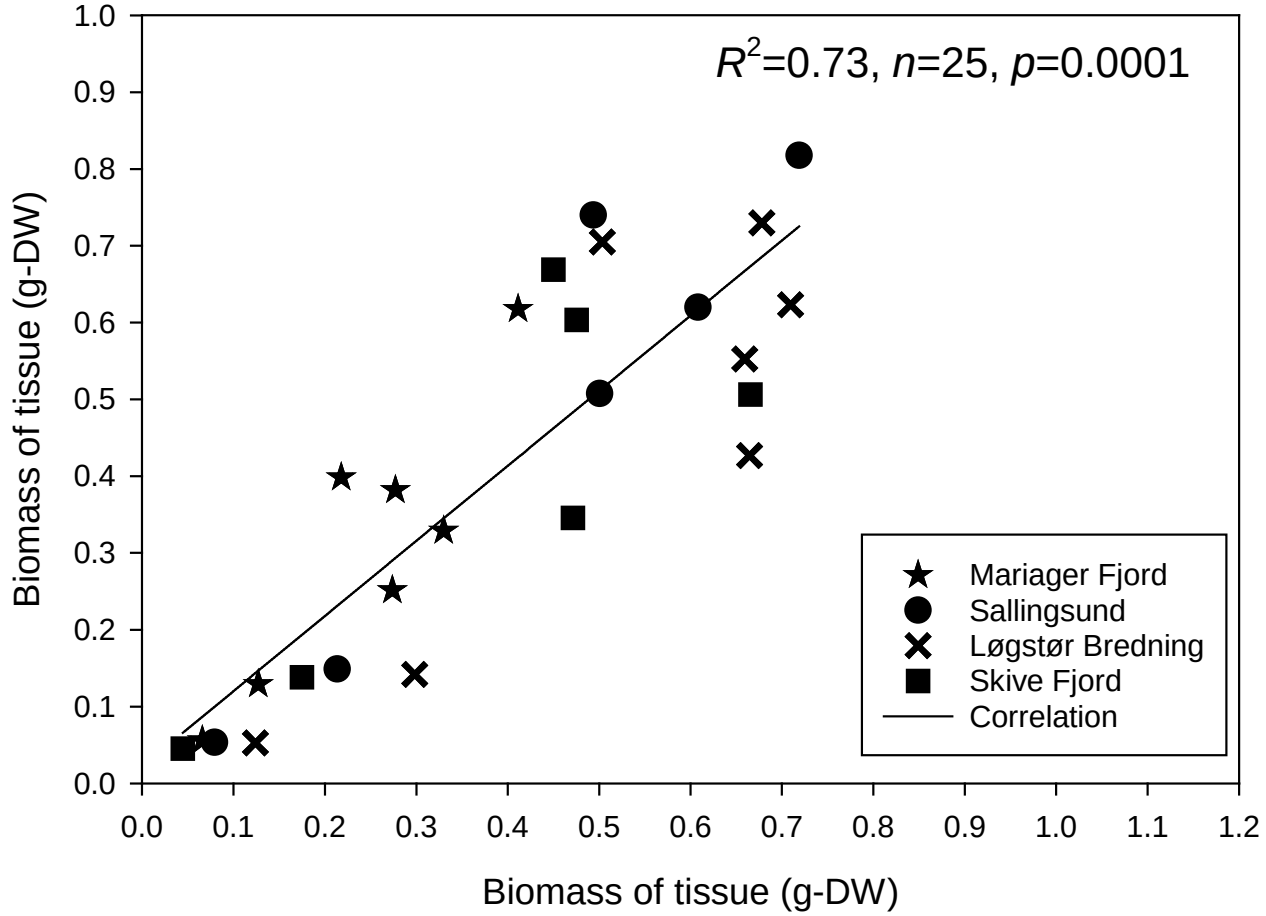
DYNAMIC ENERGY BUDGET MODEL

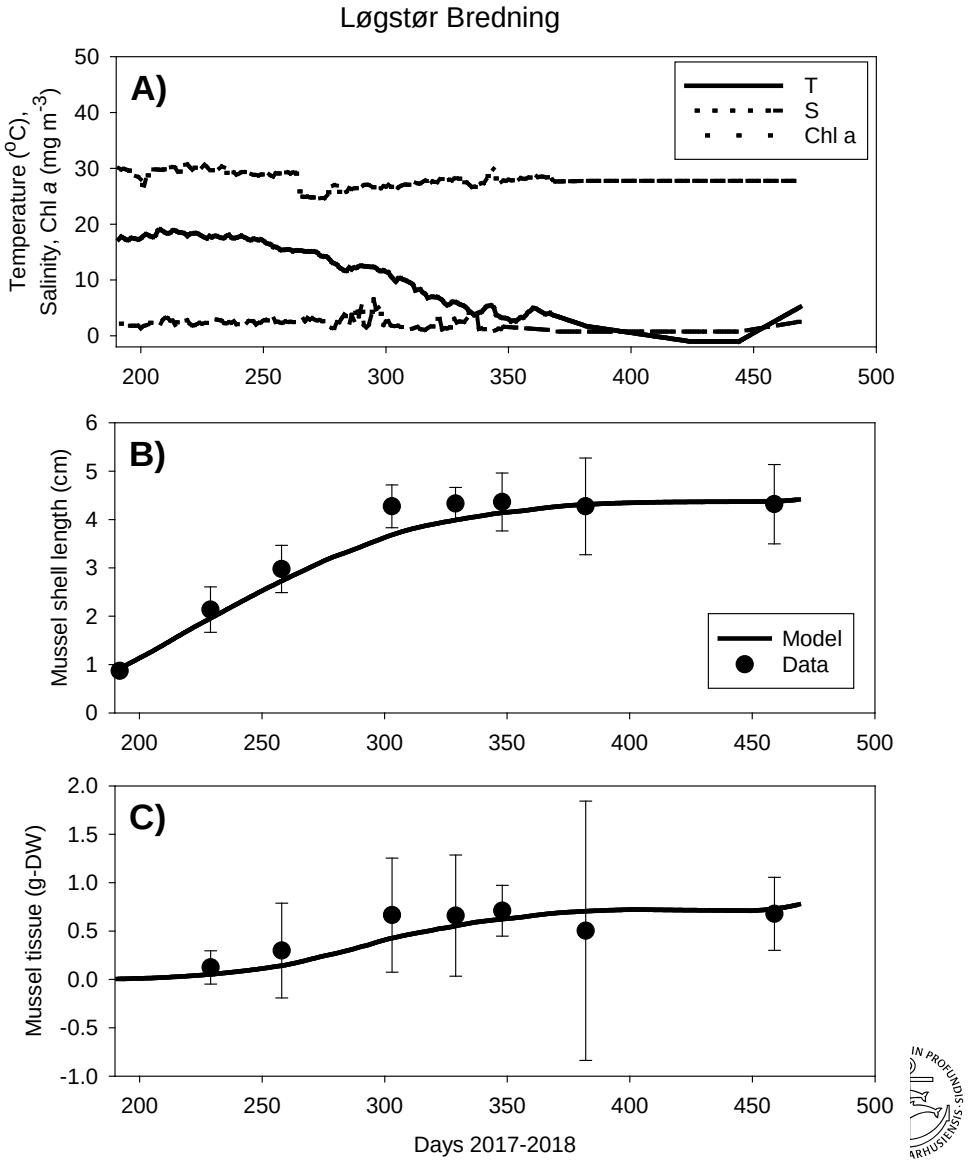
T, S, Chl a



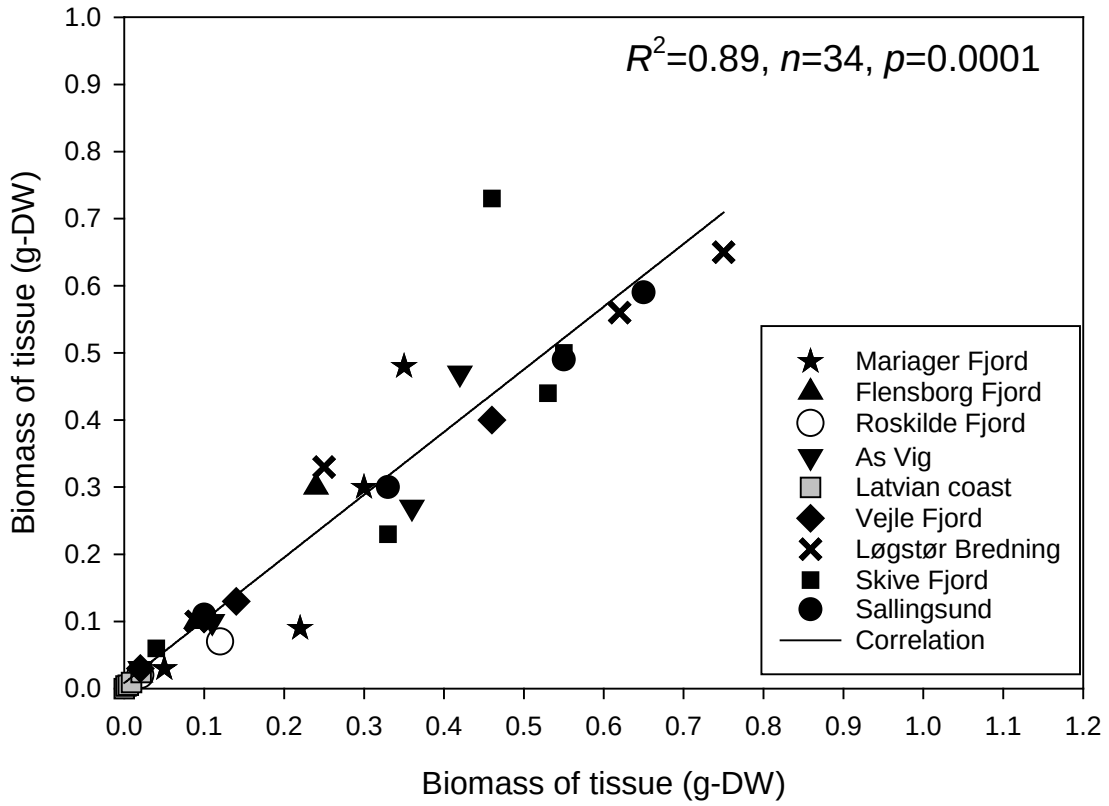


DEB MODEL CALIBRATION 2017-2018

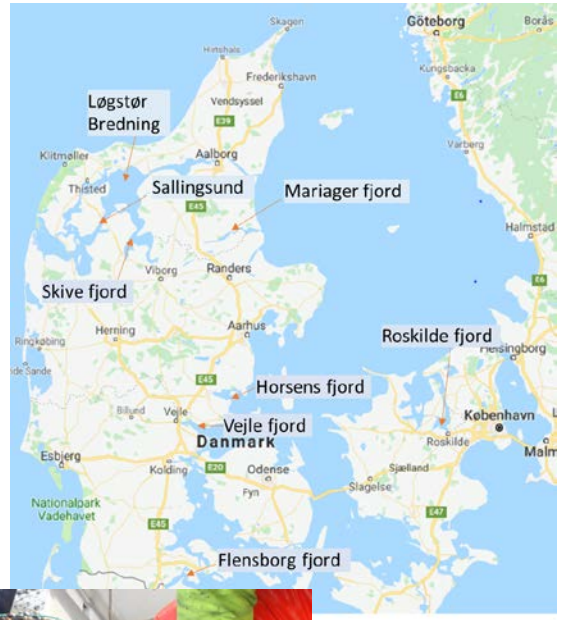




DEB MODEL VALIDATION 2018-2019



APPROACH



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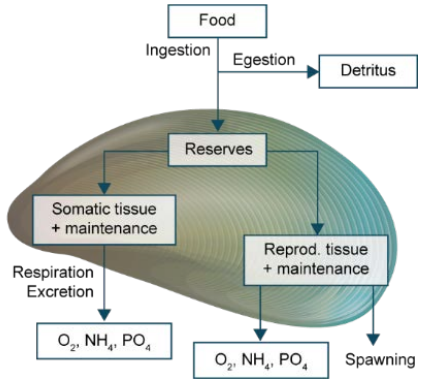
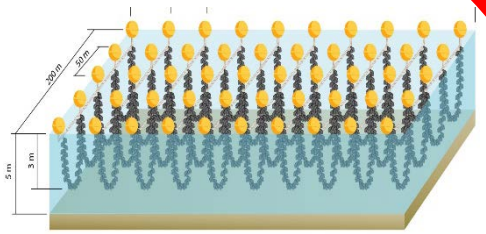


DEB growth model

Statistical farm production model



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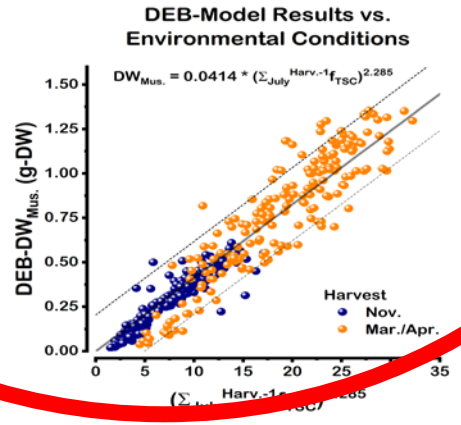


FROM ENVIRONMENTAL DATA TO MUSSEL GROWTH

Linear fit: $\Sigma(fTSC)^x$ vs. biomass dry-weight for two harvest times

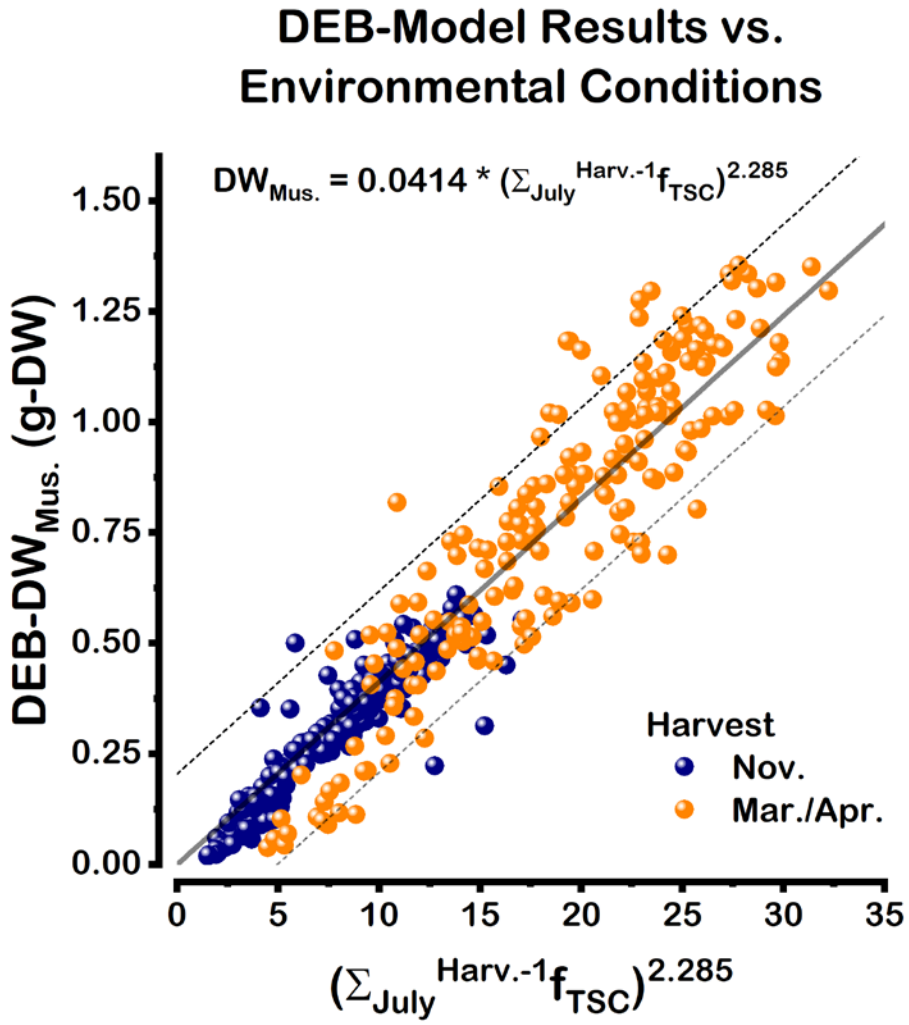
- November
- March / April

Fit-function forced through 0

- No negative biomass is modelled

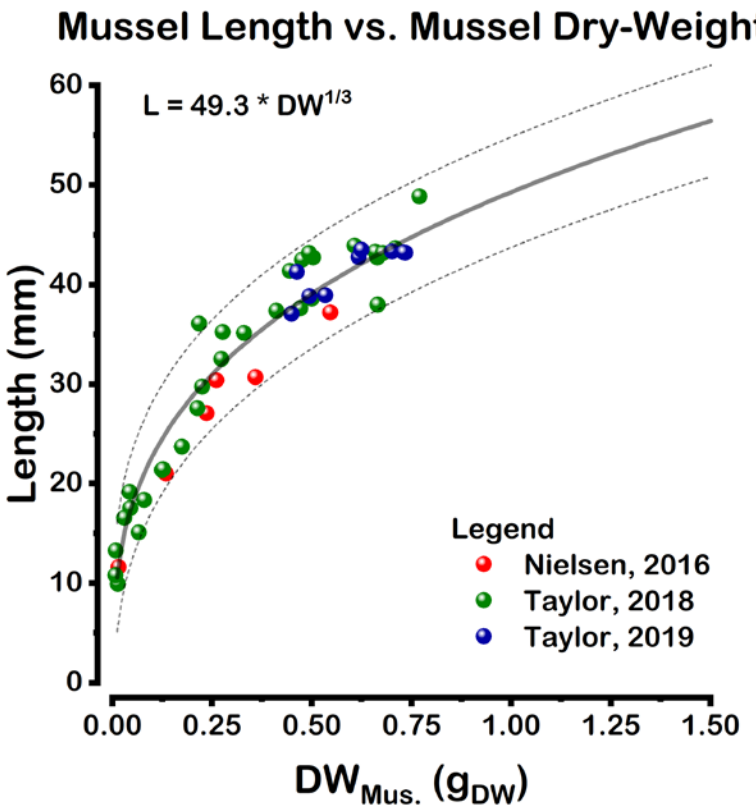
Monthly average conditions describe mussel growth in DEB-model well

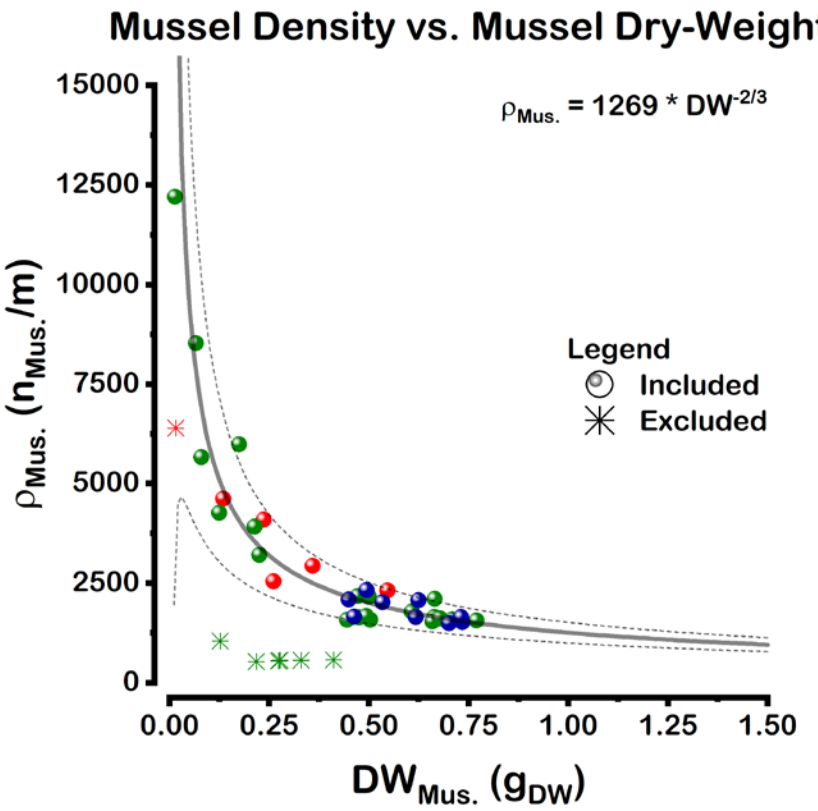
- Uncertainty: ~± 0.2 g-DW
  (95% prediction interval)

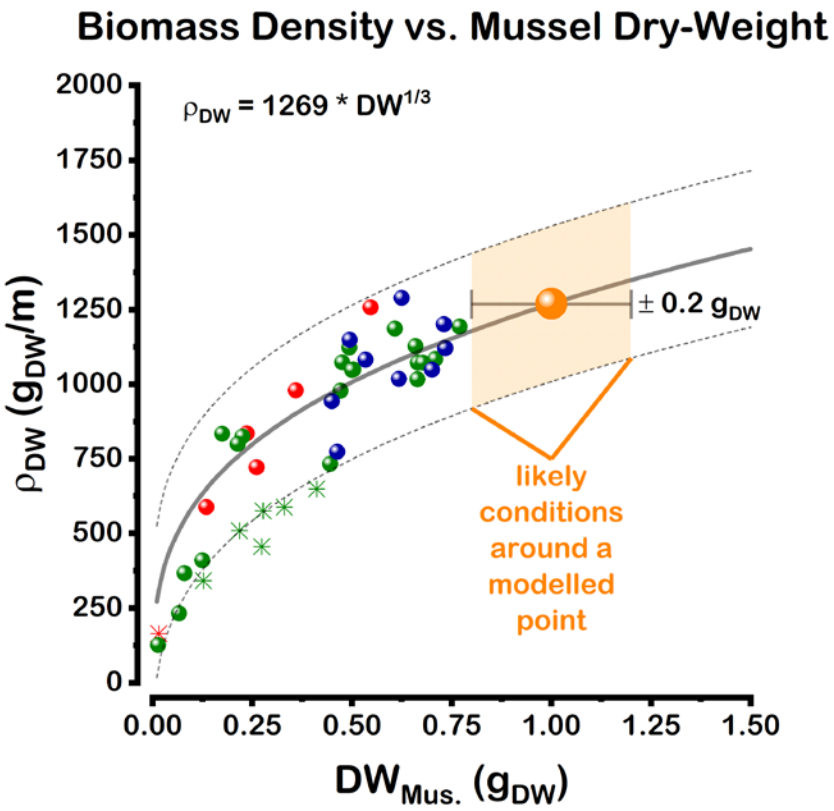


FROM SINGLE MUSSELS TO FARM-SCALE

- Functional decrease of mussel density on collector-substrate with mussel growth
- Competition for space → Fit to optimal settling conditions
- Mussel & biomass densities depend on mussel size







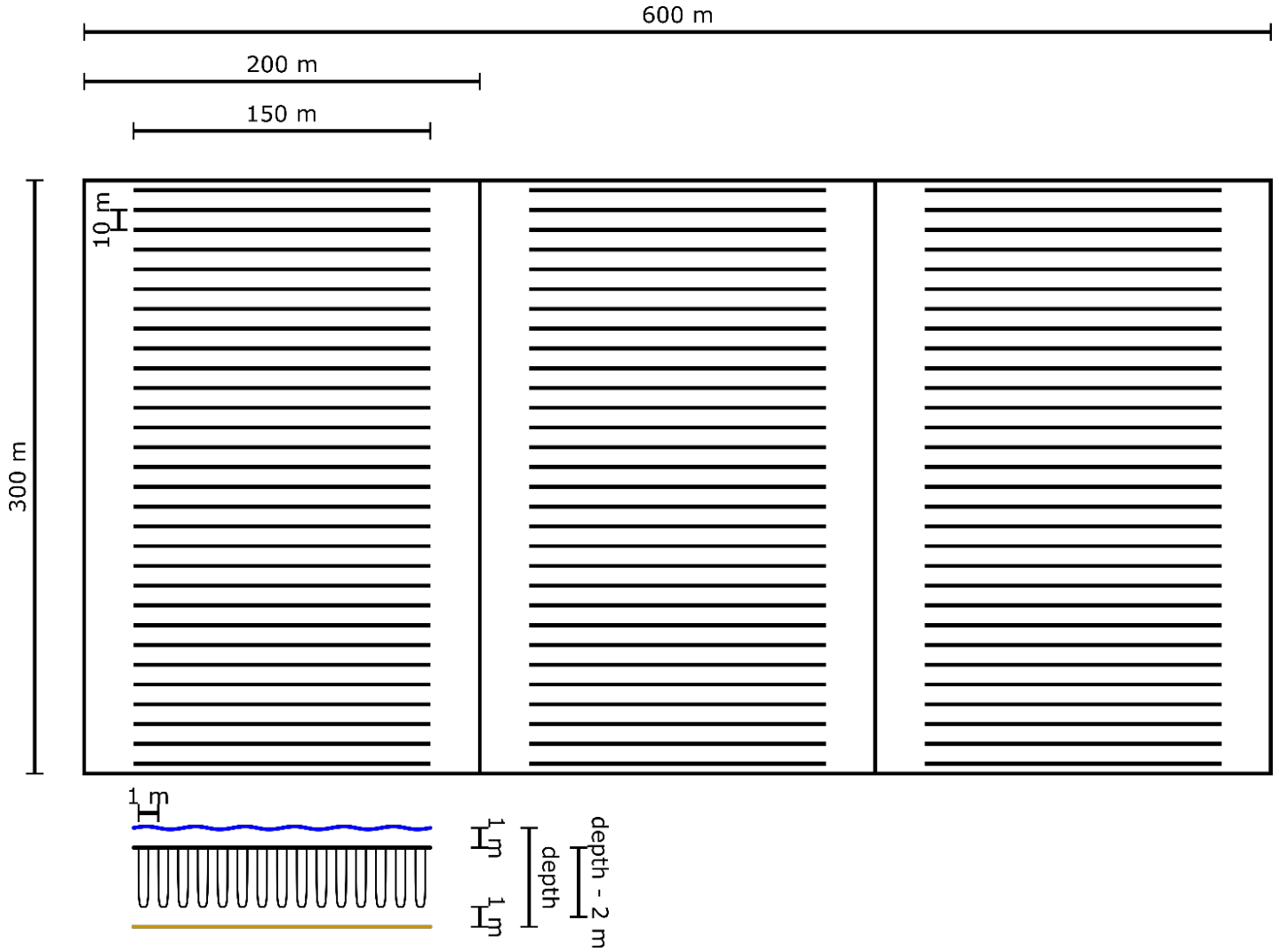
THE MODEL-FARM SETUP

Structure

- 3 sections
- 30 long-lines / section
- 150 m line-length
- 1 loop collector / 1 m long-line
- Loop length: 2 * (depth - 2 m); max: 2 * 8 m

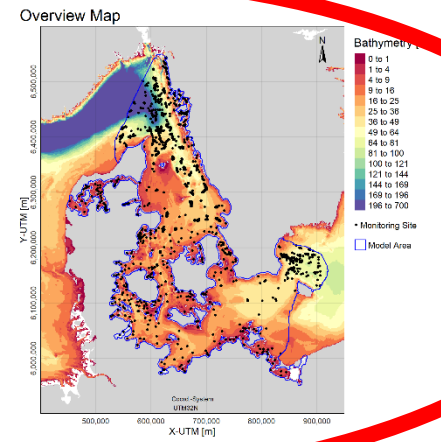
Measures

- Area: 18 ha
- Collector length at water depth
  - 4 m: 54,000 m
  - 8 m: 216,000 m



APPROACH

Spatial model of T, S and Chl a data



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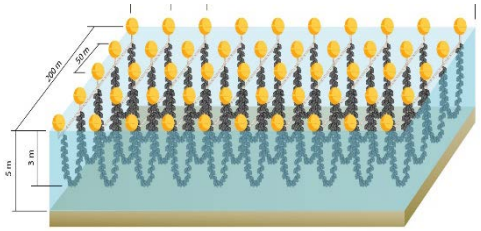

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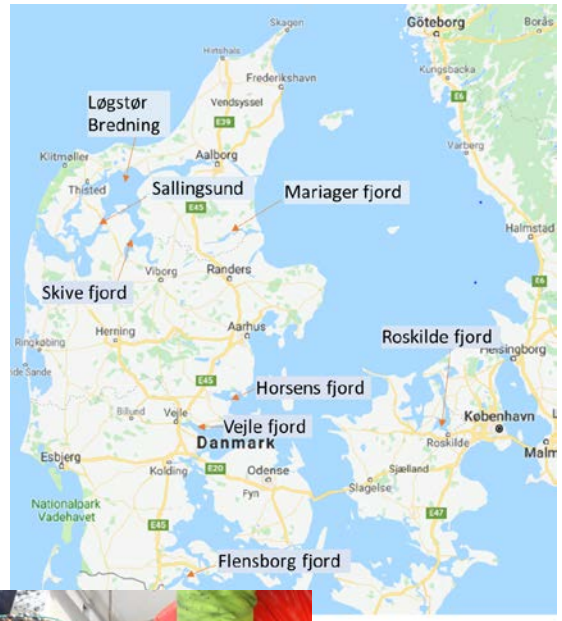

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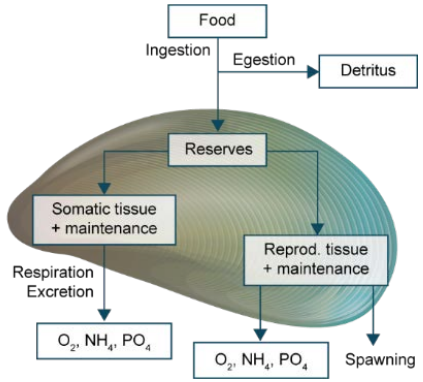
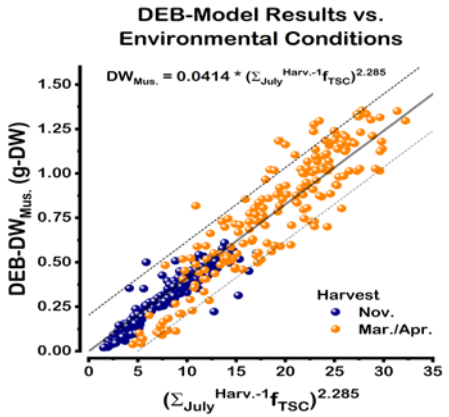


DEB growth model



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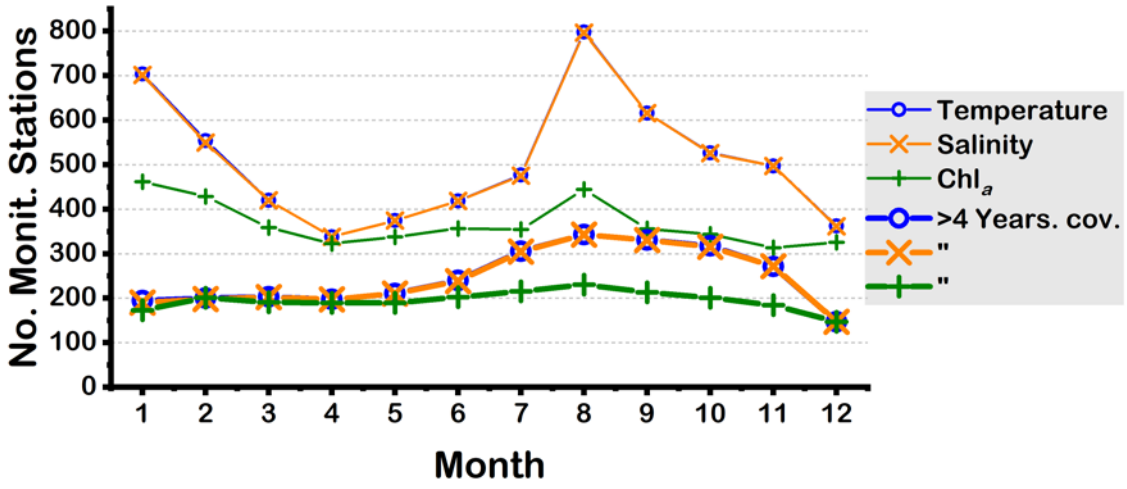
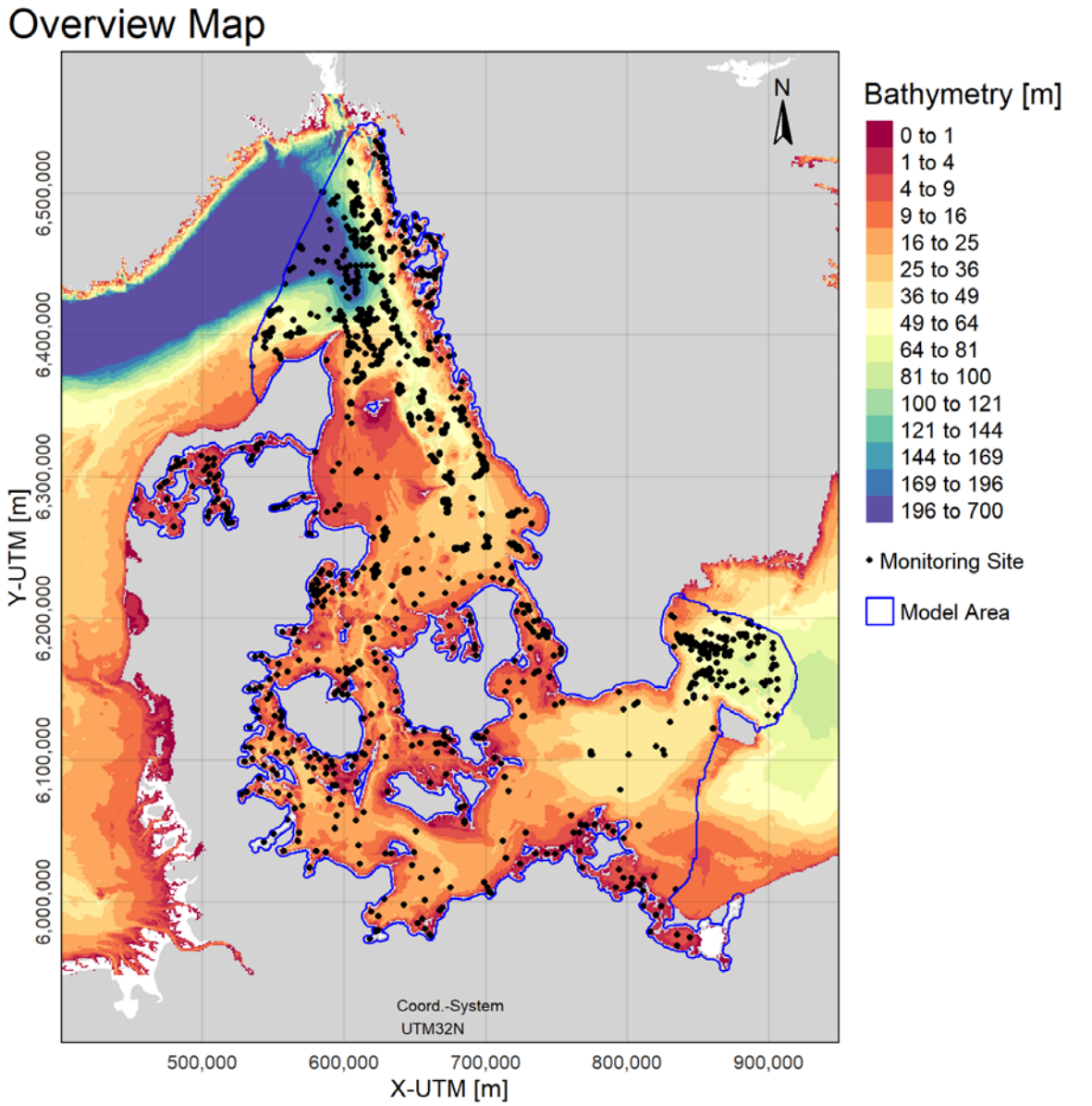
MONITORING DATA

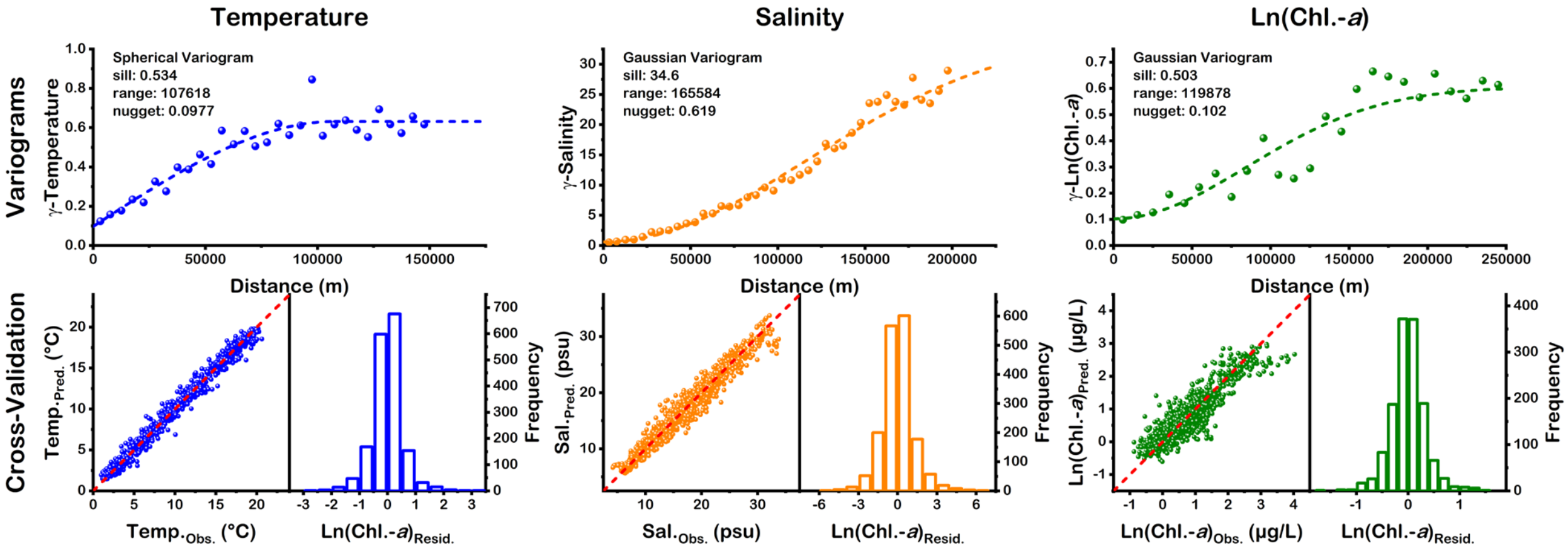
2007 - 2017

- ODA Database (Danish NOVANA program)
- LLUR / LUNG (German monitoring program)
- SHARKweb (Swedish monitoring program)

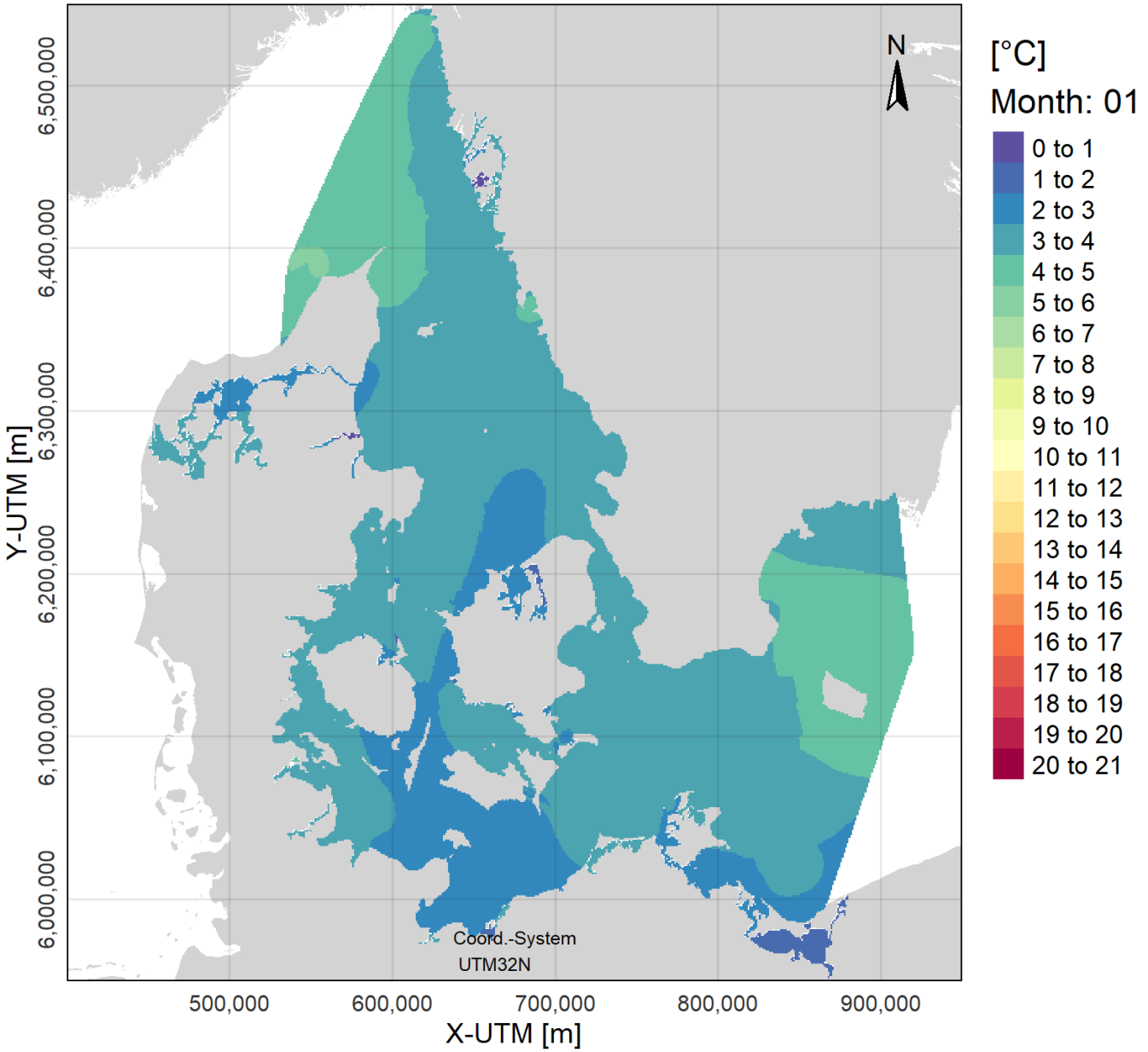


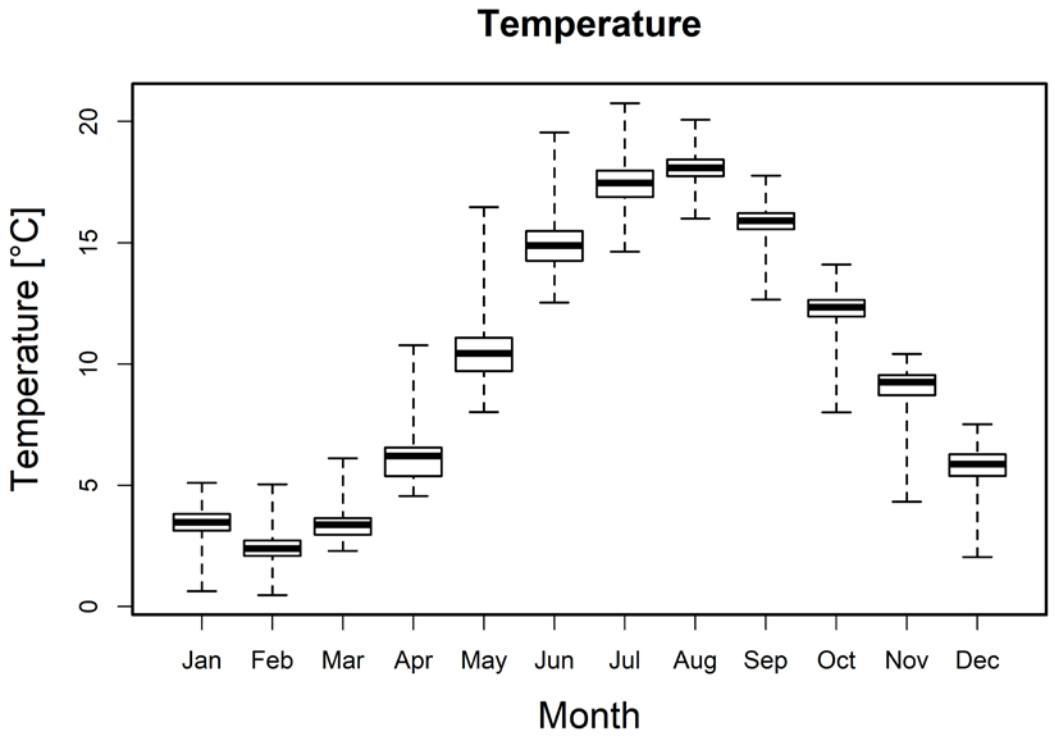


SPATIAL MODELLING AND VALIDATION

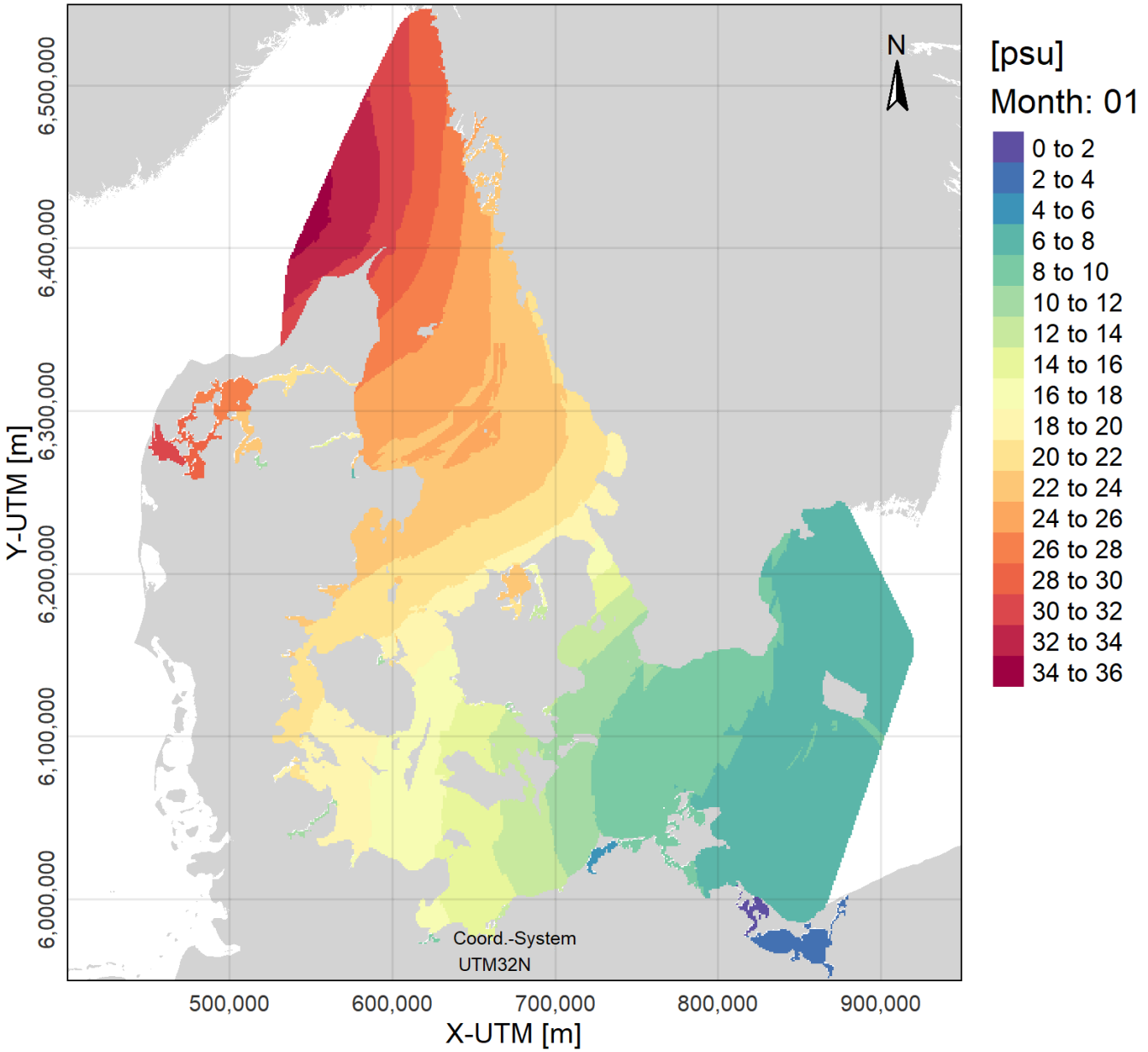


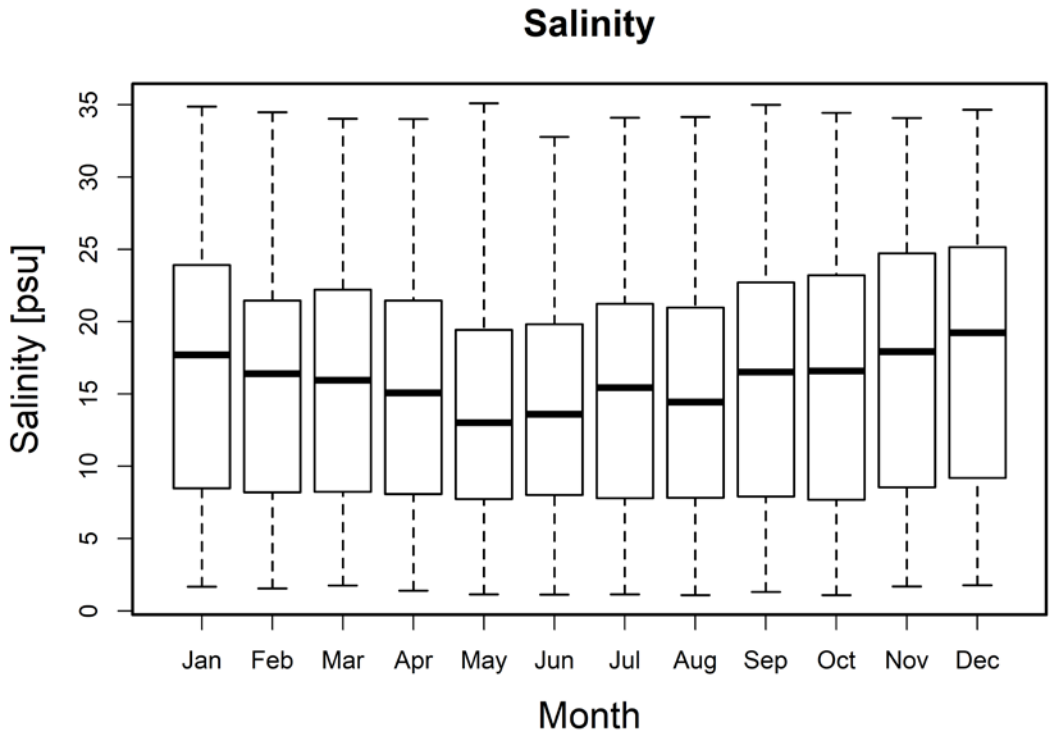
Mean Temperature



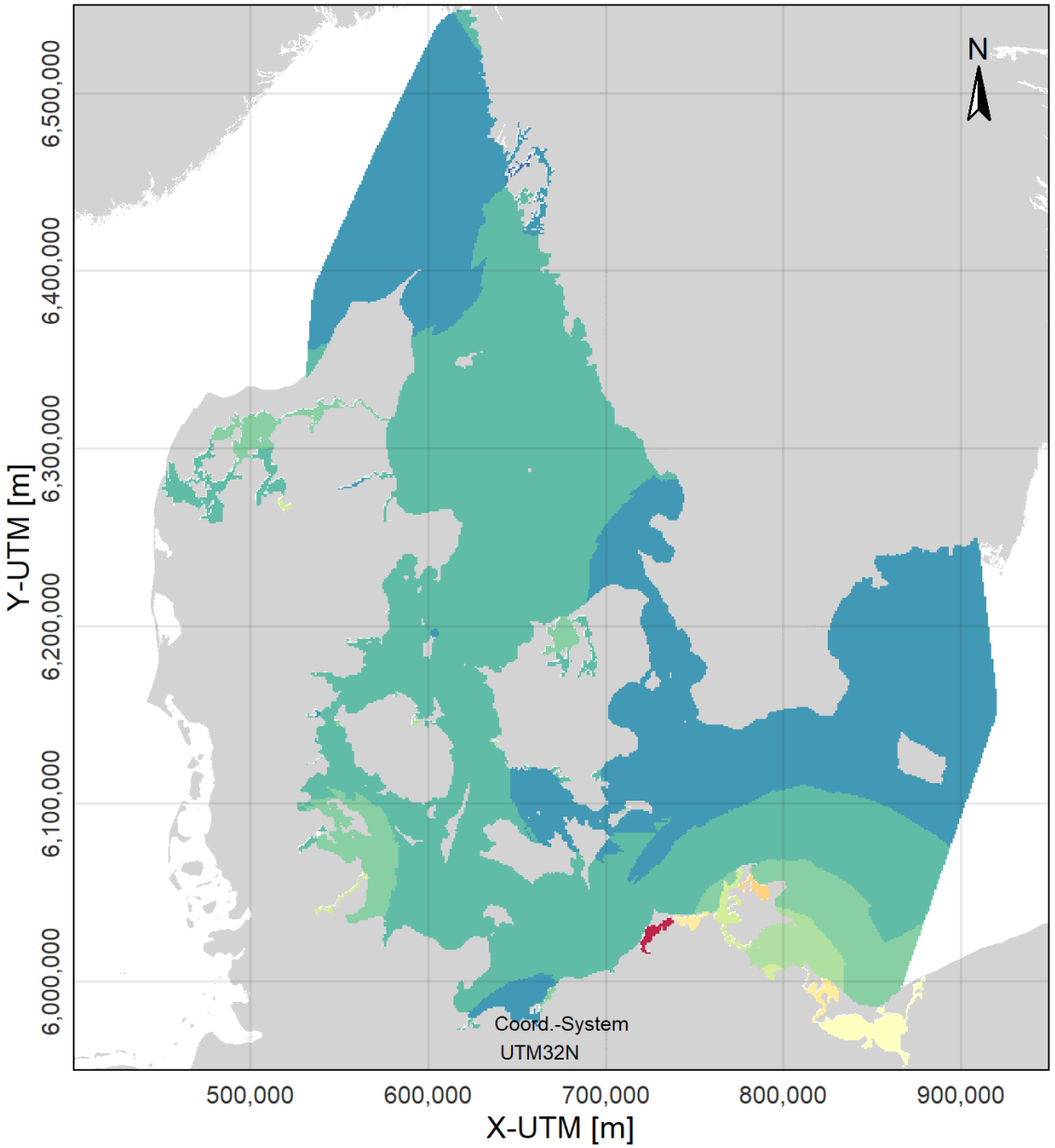


Mean Salinity



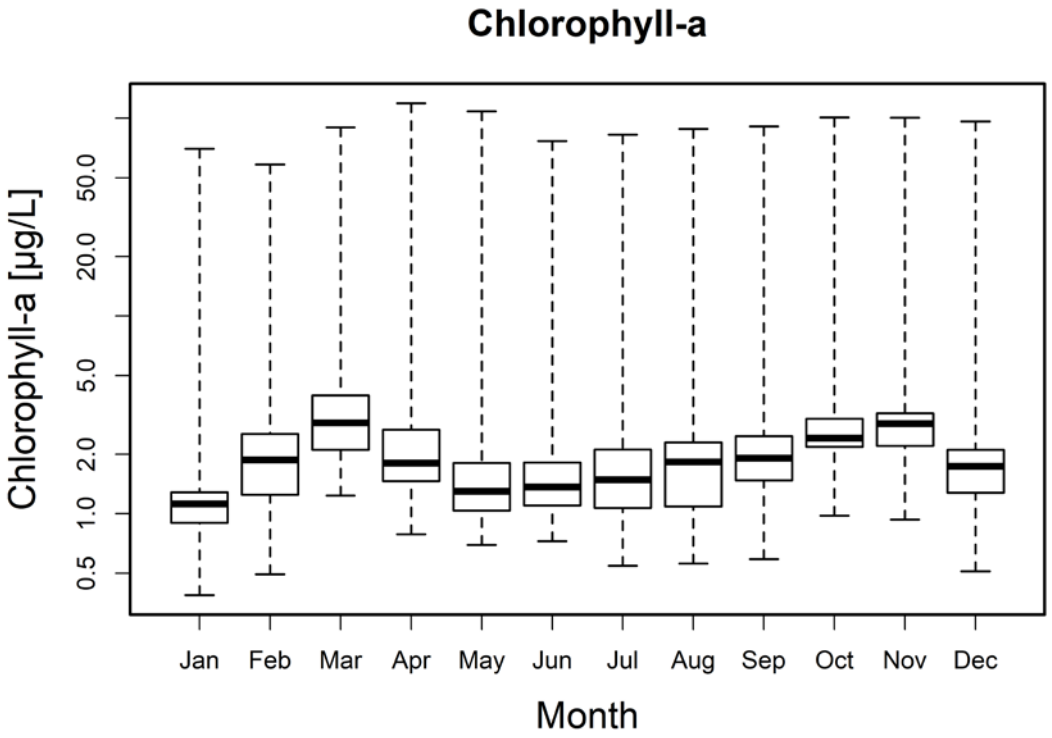


Mean Chlorophyll-a



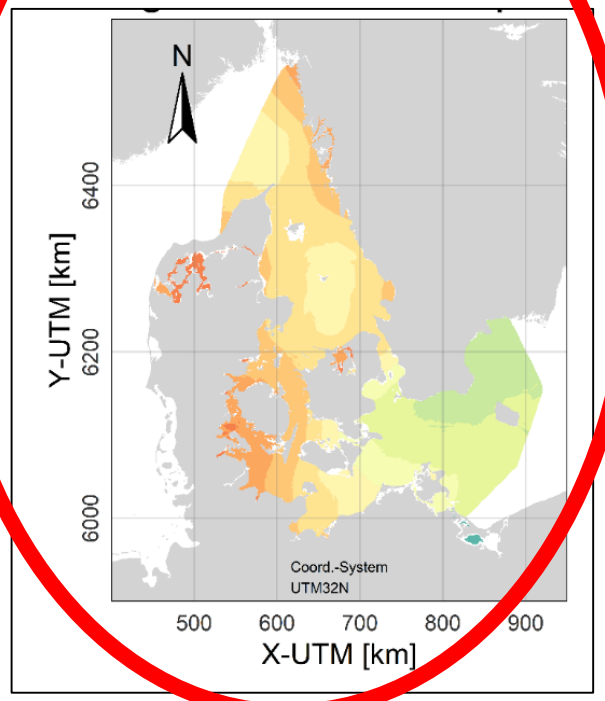
[µg/L]
Month: 01

- 0.02 to 0.12
- 0.12 to 0.42
- 0.42 to 1
- 1 to 1.95
- 1.95 to 3.38
- 3.38 to 5.36
- 5.36 to 8
- 8 to 11.39
- 11.39 to 15.6
- 15.62 to 20.8
- 20.8 to 27
- 27 to 34.33
- 34.33 to 42.8
- 42.88 to 52.7
- 52.73 to 64
- 64 to 76.77
- 76.77 to 91.1

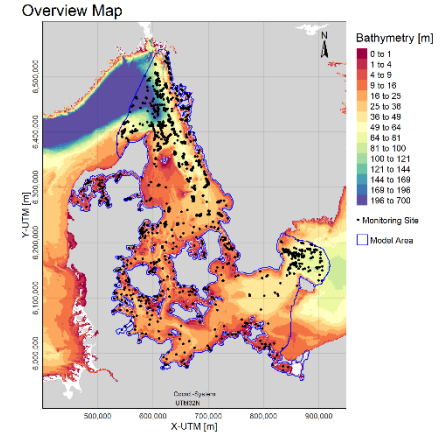


APPROACH

Spatial model of farm production



Spatial model of T, S and Chl a data



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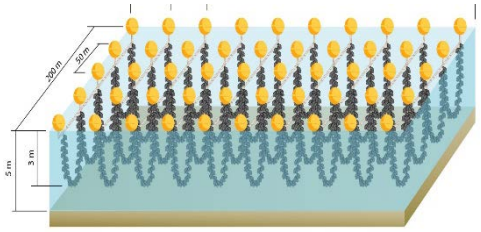
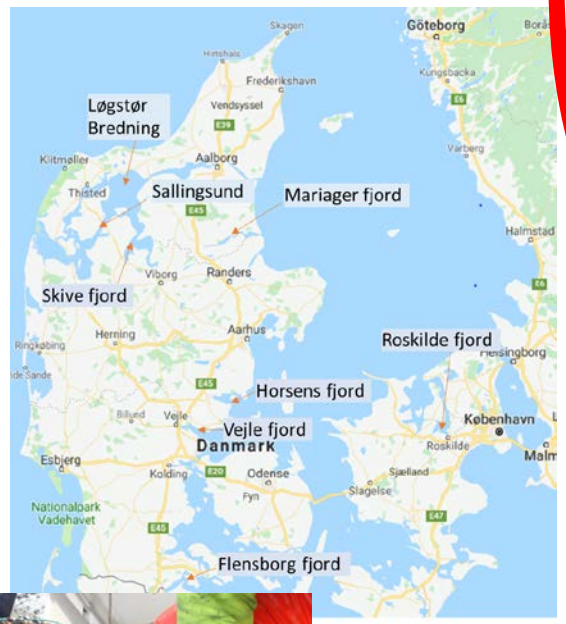


Statistical growth model



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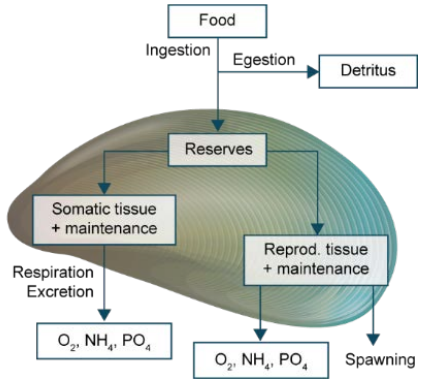

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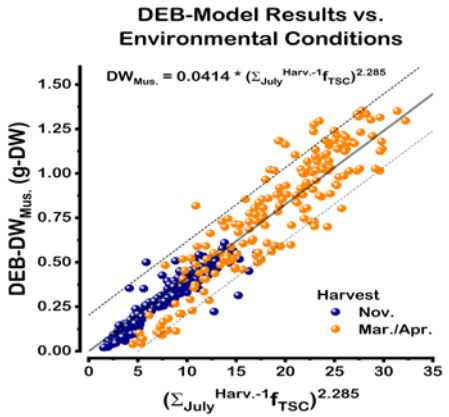

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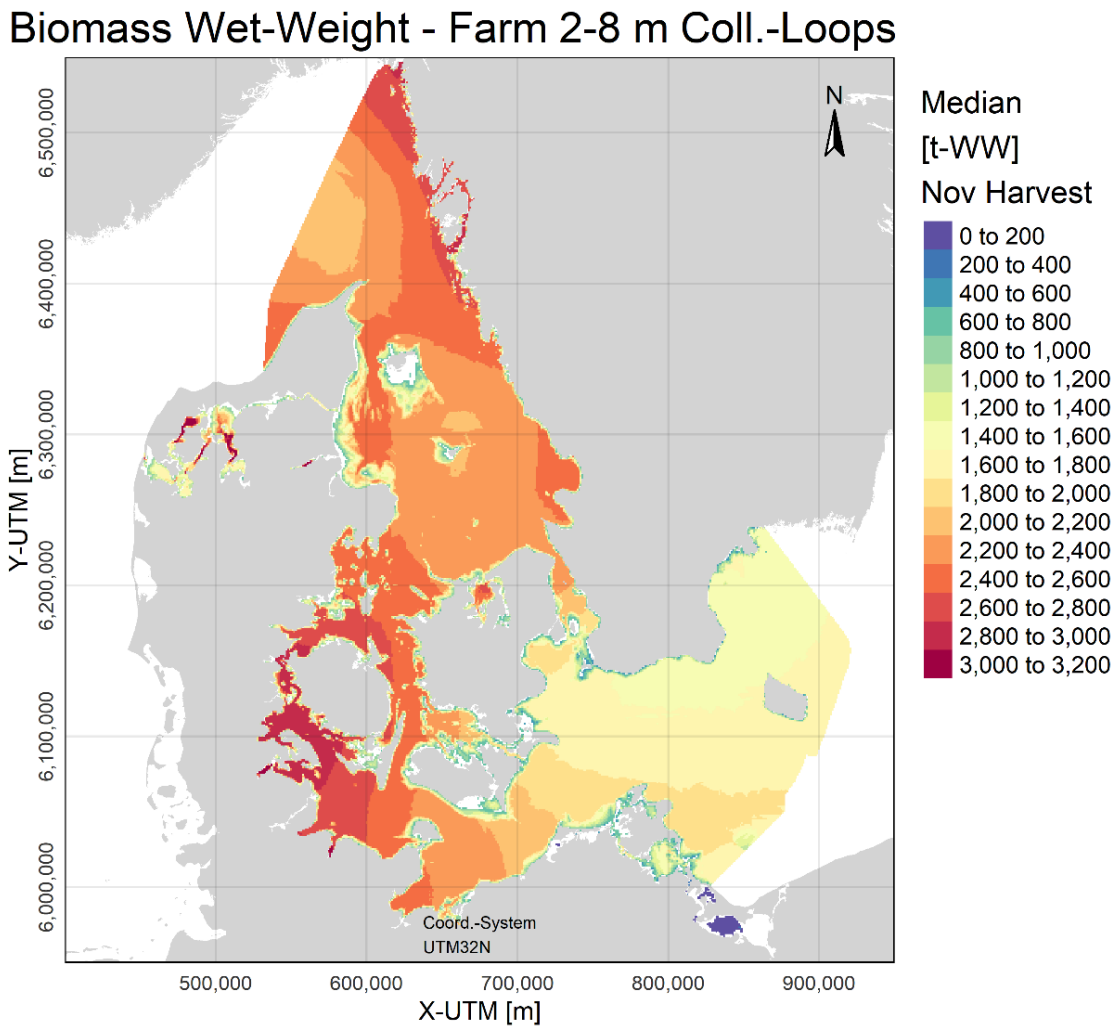
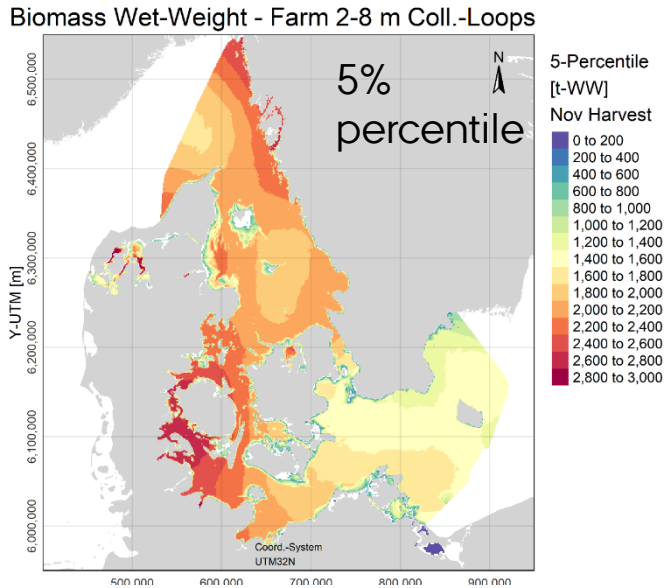
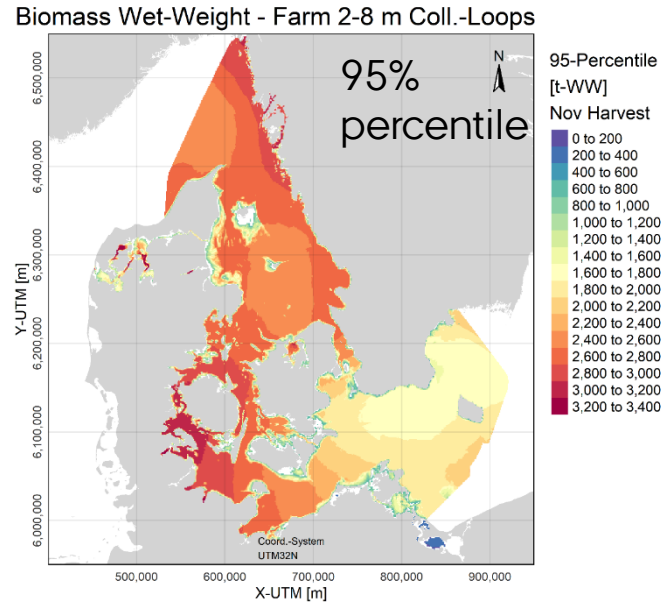
SOLIDUM PETIT IN PROFUNDIS UNIVERSITAS ARHUSIENSIS

POTENTIAL HARVEST (T-WW)

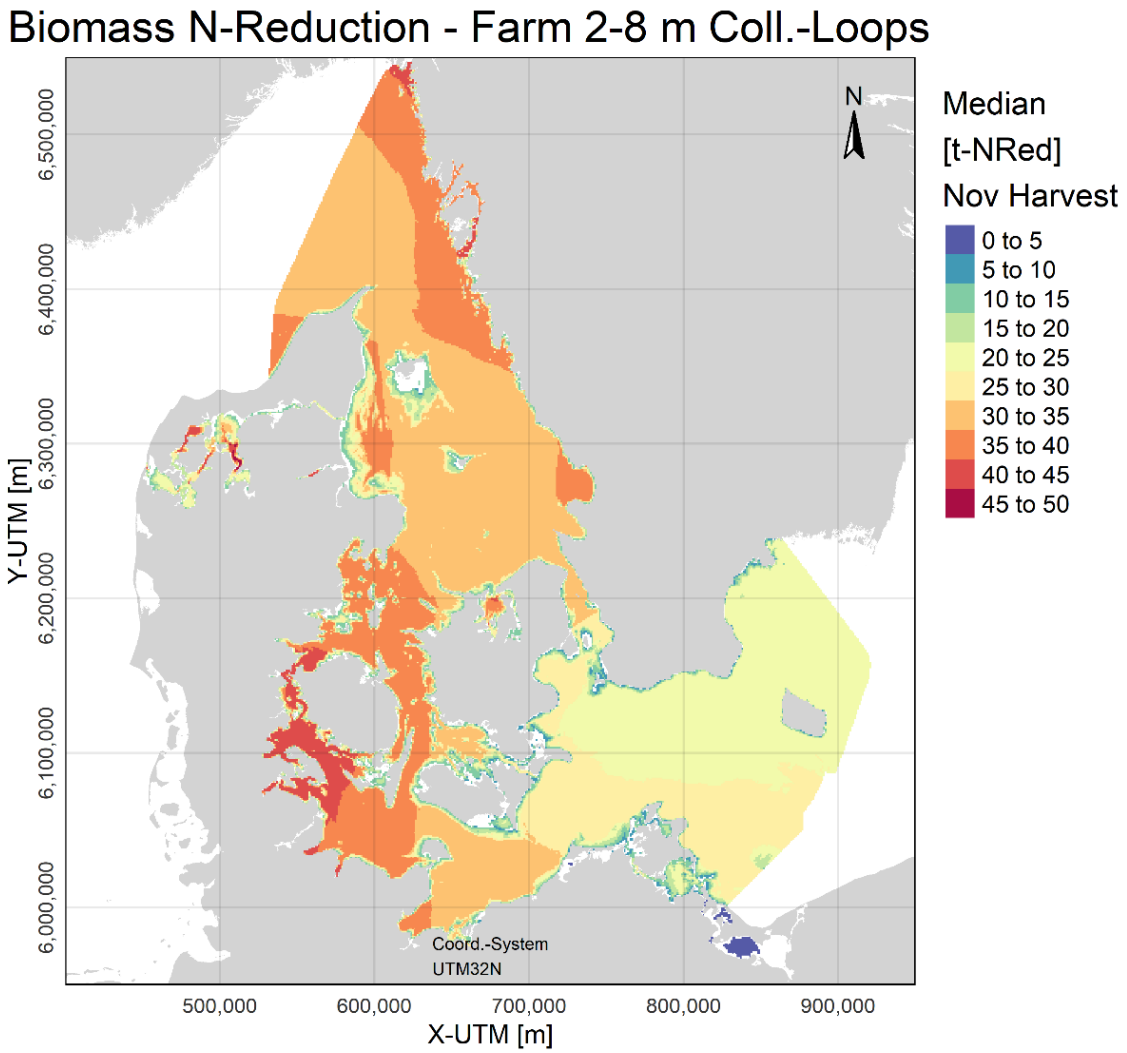


- Percentiles based on 500 simulations of random Temp, Sal, and Chl a distributions
- Extr. 5% - 95% quantile-range for each raster cell





POTENTIAL N-REMOVAL PER FARM



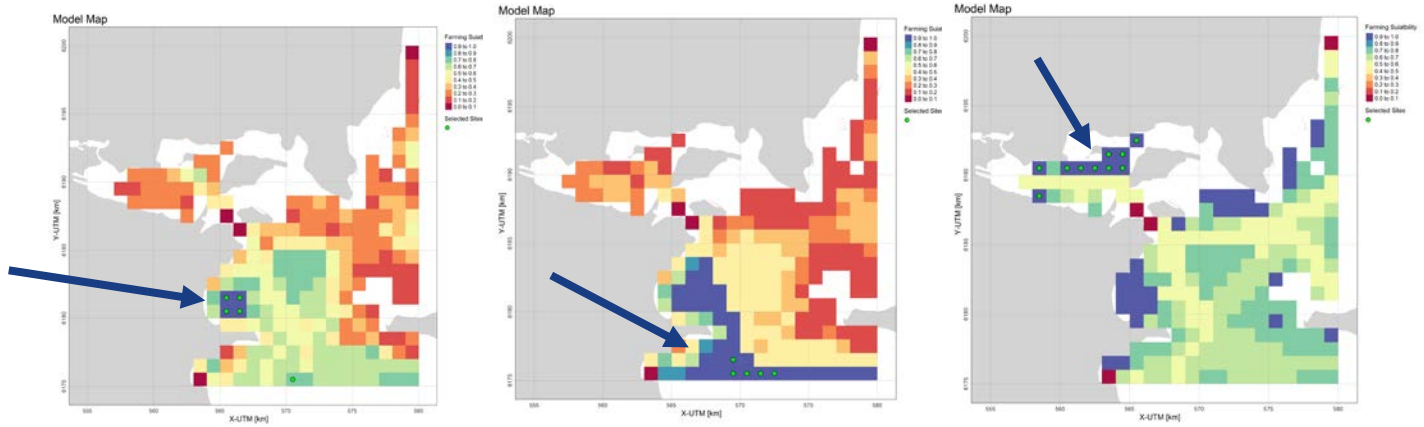
- Increased removal with water depth 2-8 m
- Up 45 t-N removal per farm (2.5 t-N/ha)
- Highest removal in fjords and coastal areas
- Strong response to salinity gradient
- Salinity>Chl a> temperature responses

NEXT STEPS...

Identify risks of failure:

- Natural variability
- Food depletion
- predation by eiders
- ice cover
- physical exposure
- Hypoxia
- Heat waves

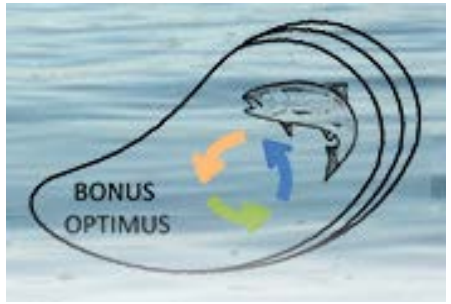
Horsens Fjord



Spatial planning:

- Environmental protection
- Recreational activities
- Other economic activites
- Farm costs
- Visual pollution
- Environmental impacts
- Socal acceptance

CONCLUSIONS



- Highest 5% farm production potential is in the Limfjorden, Mariager Fjord, Isefjord, NW coast of Sweden and from the Little Belt to Kiel Bay in Germany
- Salinity gradient important for production potential
- High Chl a values in fjords and coastal areas promotes high production
- Maps of production potential and N-removal can be used in multi-criteria site selections of mussel mitigation cultures