eo4 Sustainable Aquaculture

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NERSC
NANSEN ENVIRONMENTAL AND REMOTE SENSING CENTER
THE NANSEN CENTER · BERGEN · NORWAY

Sustainable Blue Economy

Aquaculture

Earth Observation for Sustainable Aquaculture

a project study under the ESA call EO for Sustainable Blue Economy (EXPRO+) s for Sustainable Aquaculture

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ESA Sustanaible Blue Economy Collocation meeting 1. July 2026

https://eo4sa.nersc.no

EO4SA Use Cases for Aquaculture

1. Predicting risks of salmon lice infestation.
2. Forecasting toxic algal blooms (HABs) impacting shellfish farms.
3. Optimizing shellfish farming by high resolution NPP and mussel growing maps
4. Mapping aquaculture structures and use of marine resources.

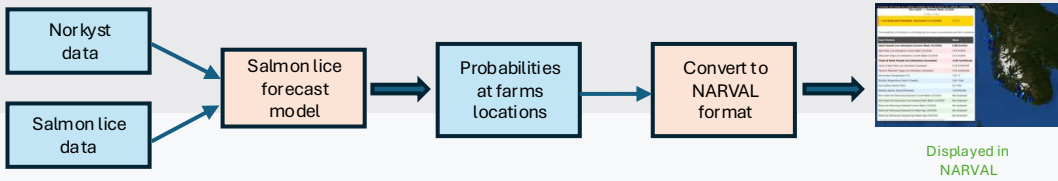






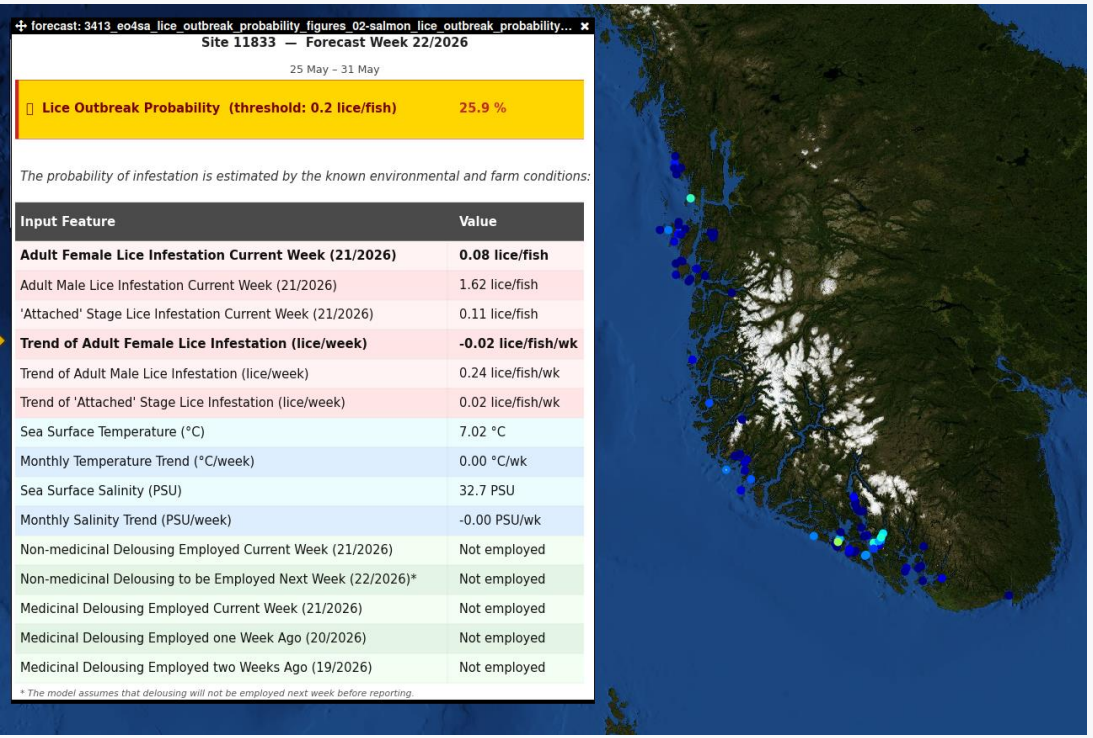


NERSC Forecasts processing chains



The processing chains are similar for both use cases:

1. Download input data (e.g. EO based Norkyst-800 model output)
2. Apply the forecast model (trained beforehand) to derive the forecasts
3. Convert the forecast data to a format compatible with NARVAL
4. Integrate and visualize in NARVAL


forecast: 3413_eo4sa_lice_outbreak_probability_figures_02-salmon_lice_outbreak_probability...

Site 11833 — Forecast Week 22/2026

25 May – 31 May

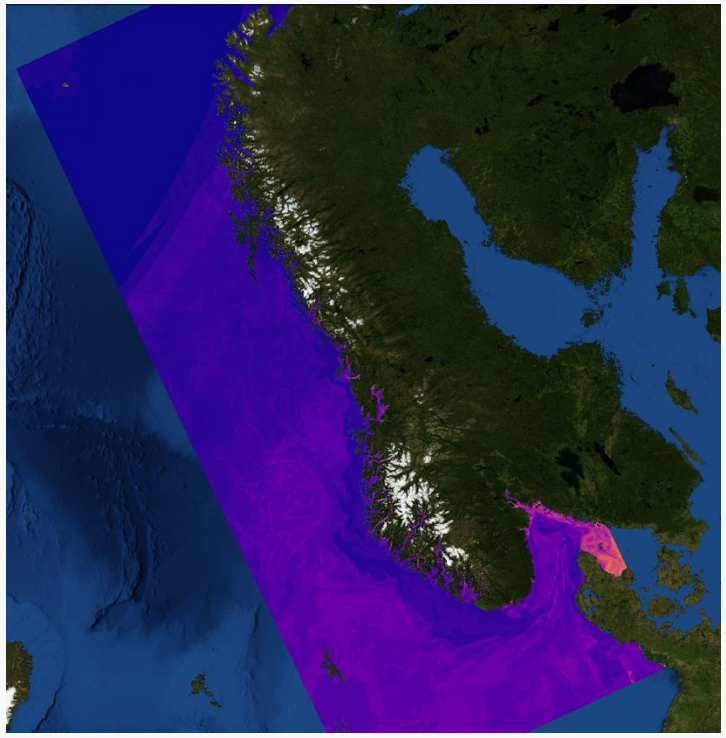
Lice Outbreak Probability (threshold: 0.2 lice/fish) 25.9 %

The probability of infestation is estimated by the known environmental and farm conditions:

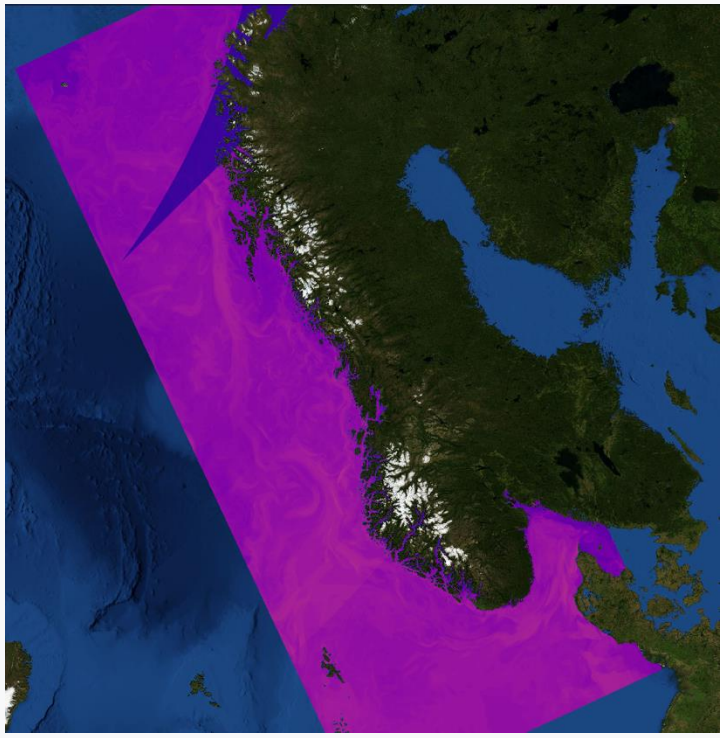
Input Feature	Value
Adult Female Lice Infestation Current Week (21/2026)	**0.08 lice/fish**
Adult Male Lice Infestation Current Week (21/2026)	1.62 lice/fish
'Attached' Stage Lice Infestation Current Week (21/2026)	0.11 lice/fish
Trend of Adult Female Lice Infestation (lice/week)	**-0.02 lice/fish/wk**
Trend of Adult Male Lice Infestation (lice/week)	0.24 lice/fish/wk
Trend of 'Attached' Stage Lice Infestation (lice/week)	0.02 lice/fish/wk
Sea Surface Temperature (°C)	7.02 °C
Monthly Temperature Trend (°C/week)	0.00 °C/wk
Sea Surface Salinity (PSU)	32.7 PSU
Monthly Salinity Trend (PSU/week)	-0.00 PSU/wk
Non-medicinal Delousing Employed Current Week (21/2026)	Not employed
Non-medicinal Delousing to be Employed Next Week (22/2026)*	Not employed
Medicinal Delousing Employed Current Week (21/2026)	Not employed
Medicinal Delousing Employed one Week Ago (20/2026)	Not employed
Medicinal Delousing Employed two Weeks Ago (19/2026)	Not employed

** The model assumes that delousing will not be employed next week before reporting.*

Salmon lice forecast in NARVAL



PST forecast in NARVAL



DST forecast in NARVAL

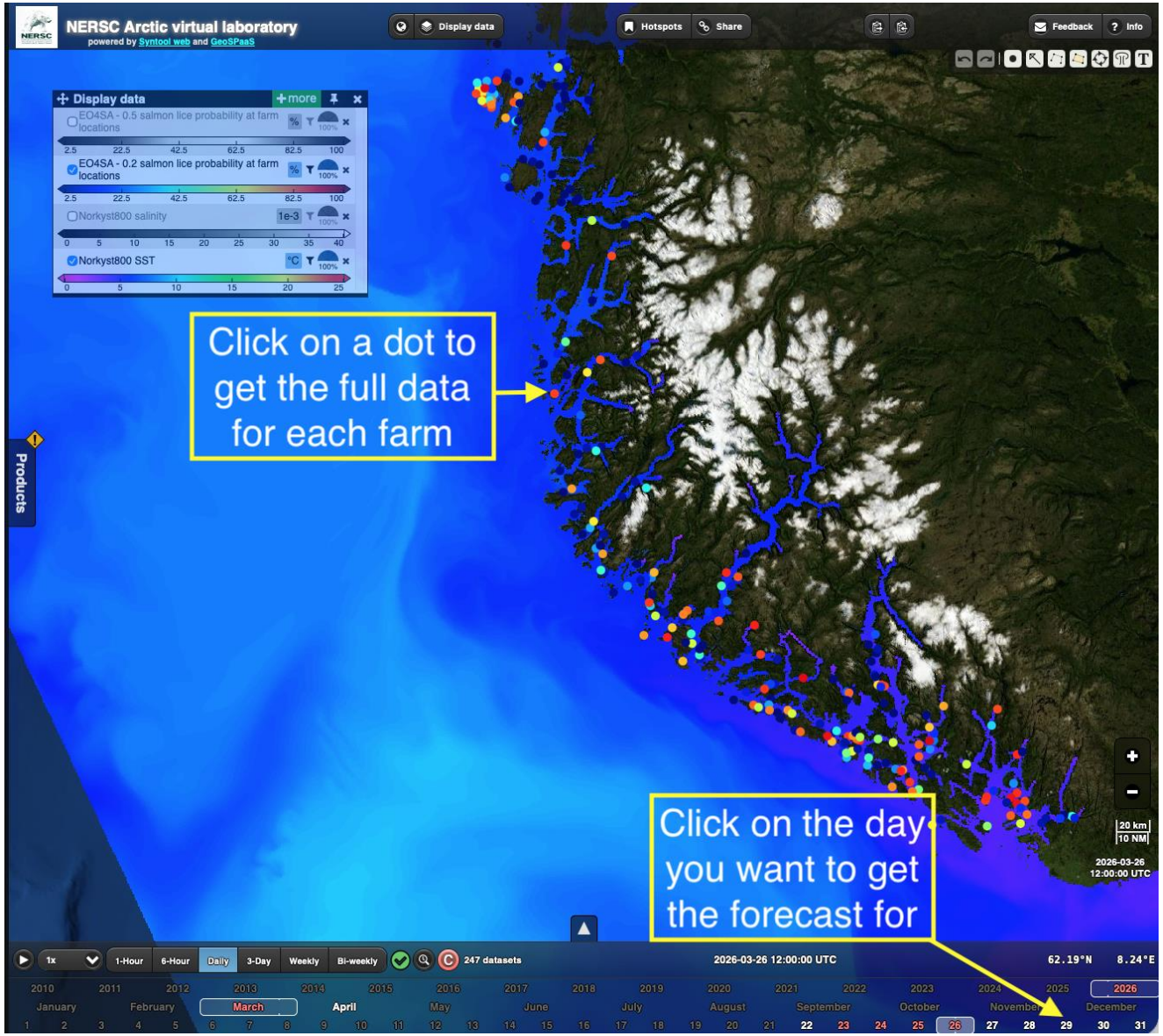
Salmon lice products publicly available

- Salmon lice forecasts can now be accessed via NERSC's visualisation platform, NARVAL, which can display and overlay multiple data products at a specified time and area.

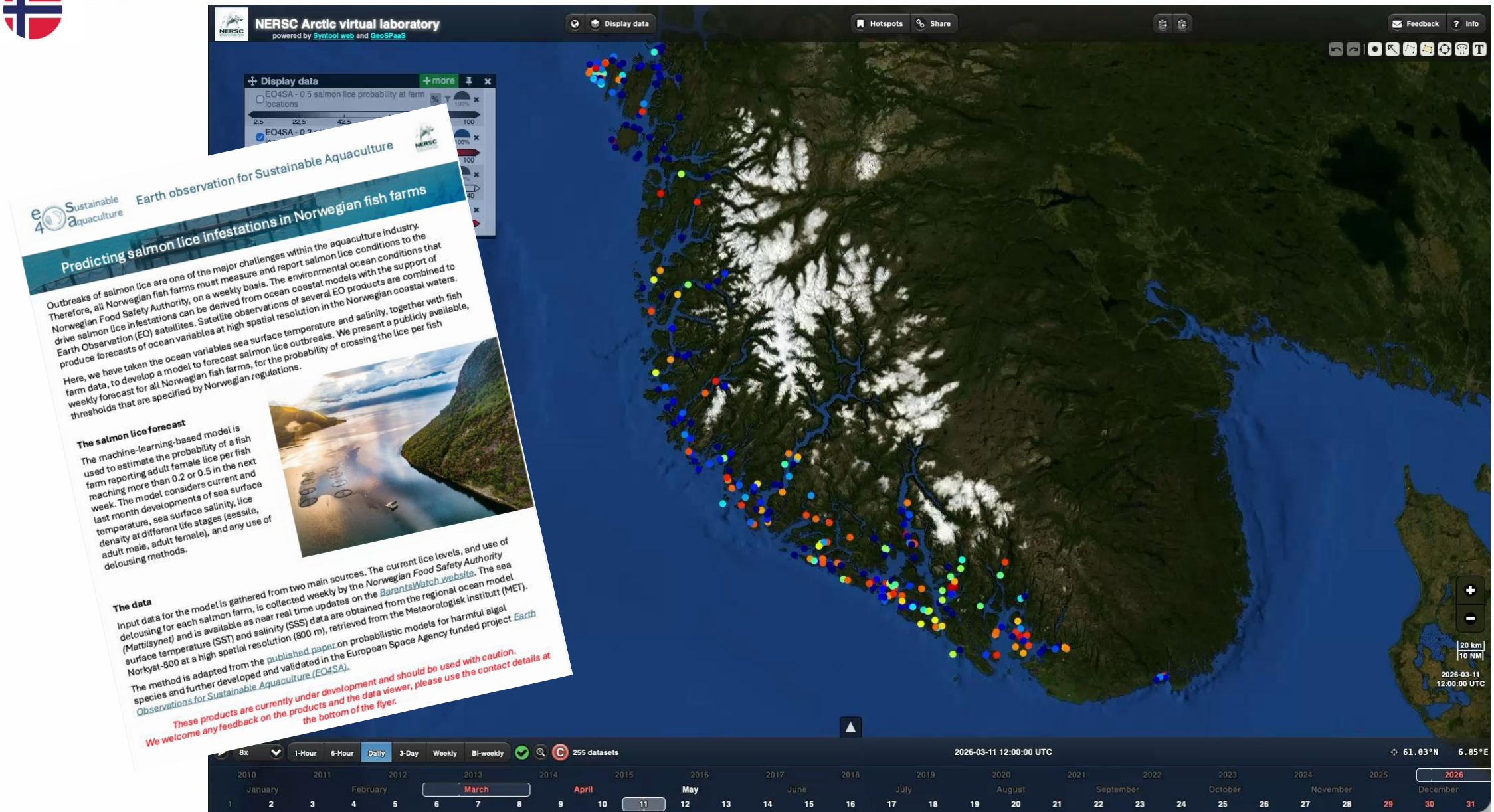
- The forecast products show the probability of a fish farm reporting adult female lice per fish reaching more than
  - 0.2 lice per fish or
  - 0.5 lice in the next week.

- A one-page flyer has been developed in both English and Norwegian with a summary of the forecast and information on how to access and use the NARVAL platform.

- The flyer and links have been sent to the Early Adopters in mid April. We have asked for feedback and will follow up with specific meetings to discuss the forecasts.

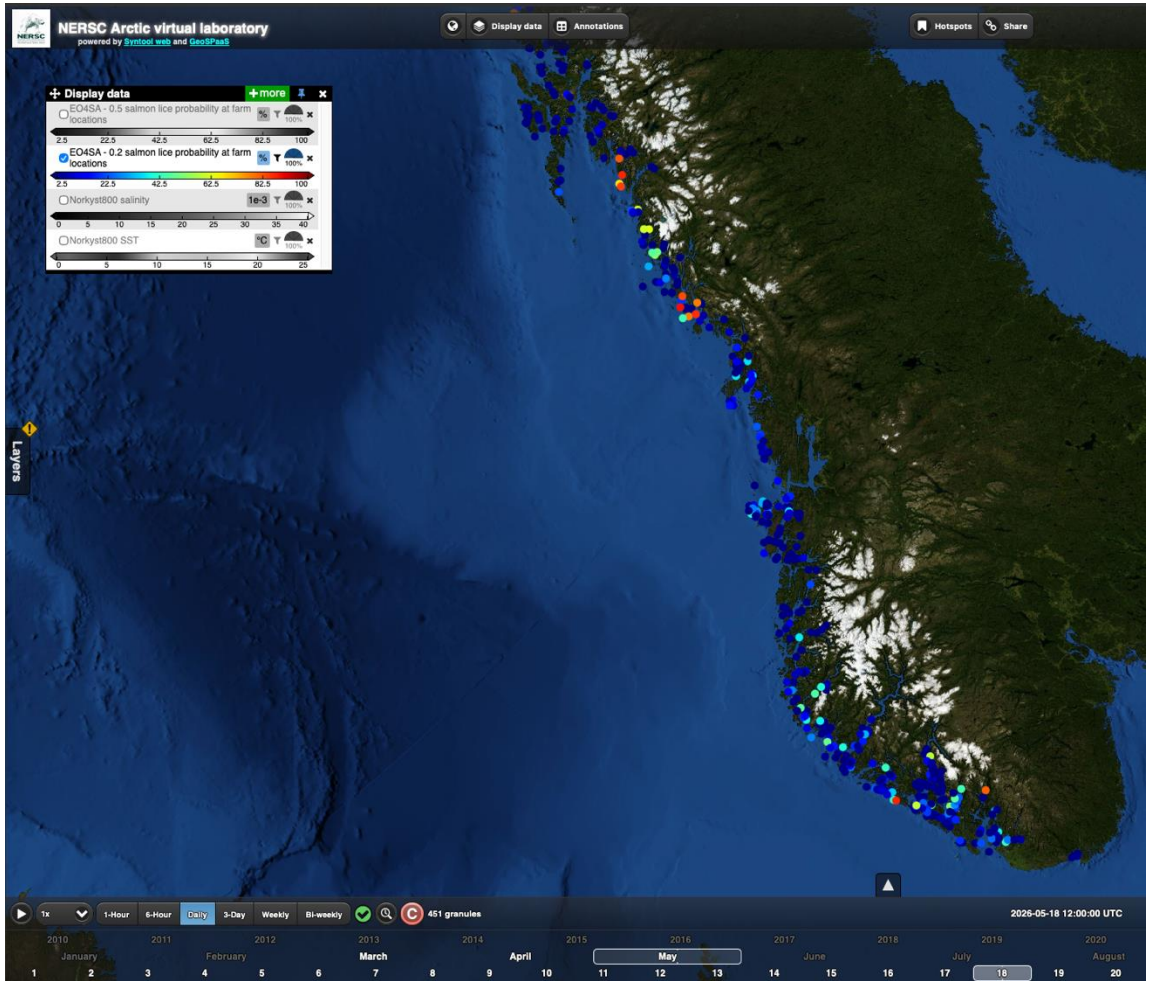


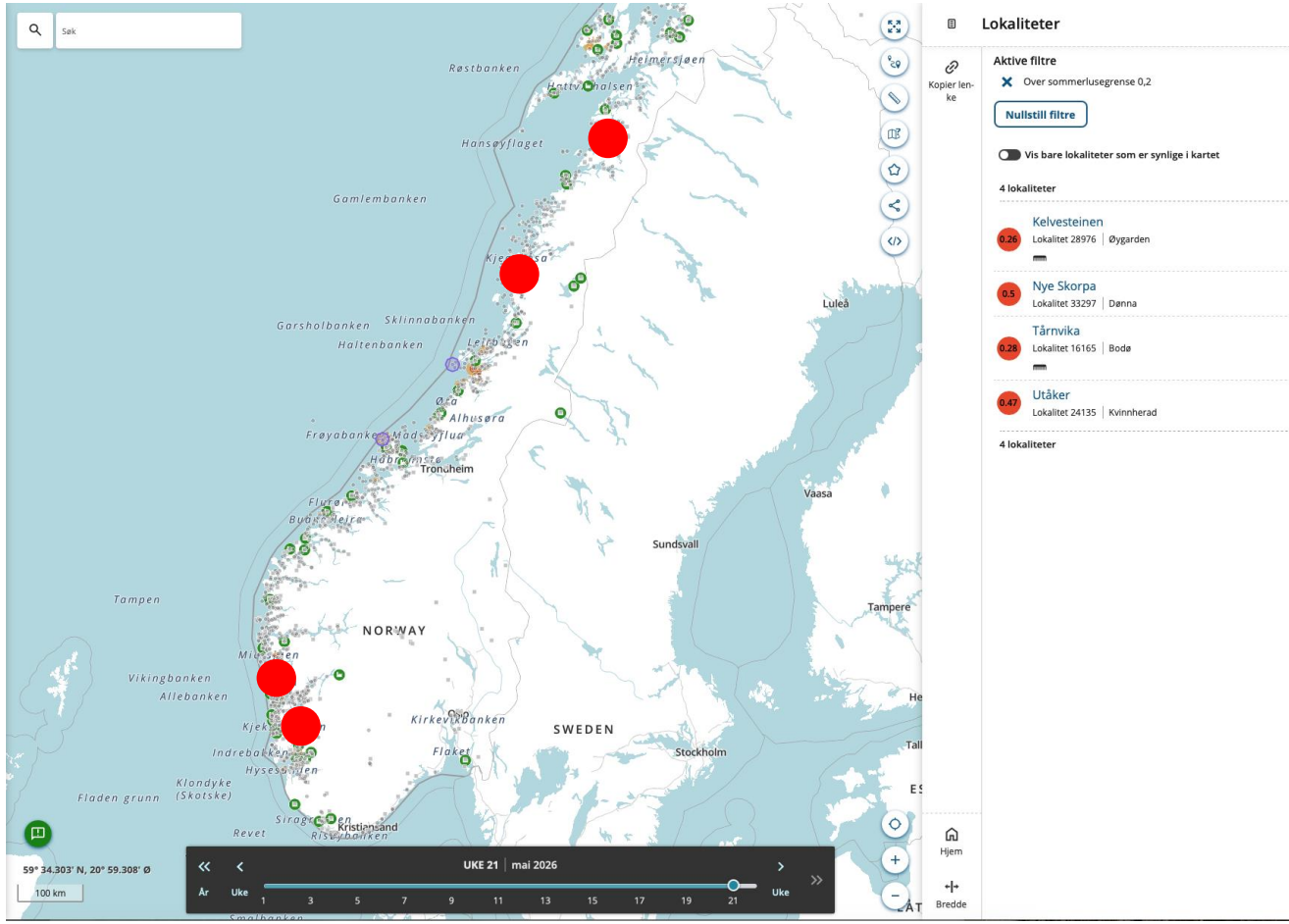
The salmon lice forecast on NARVAL



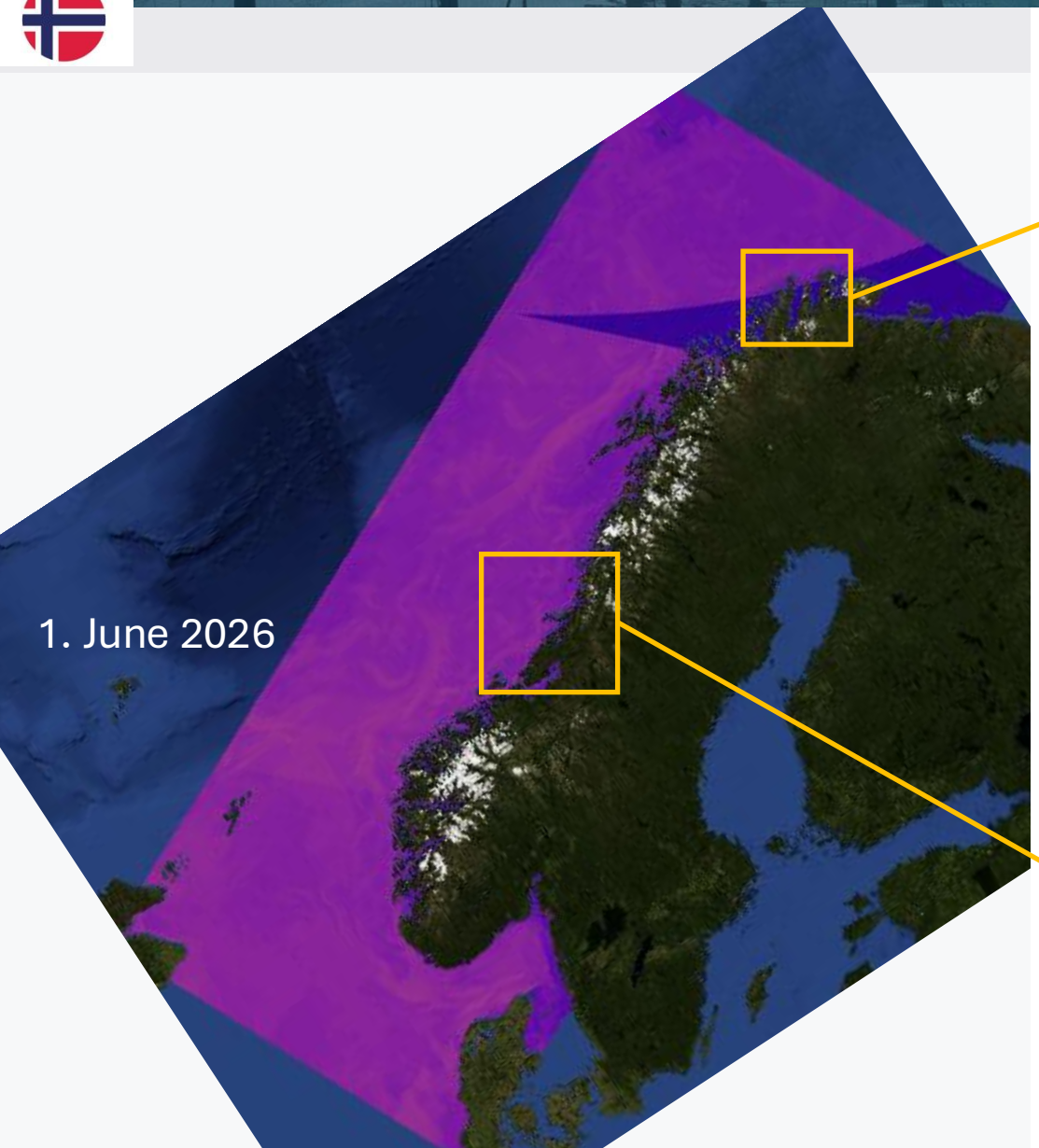
The salmon lice forecast: validation

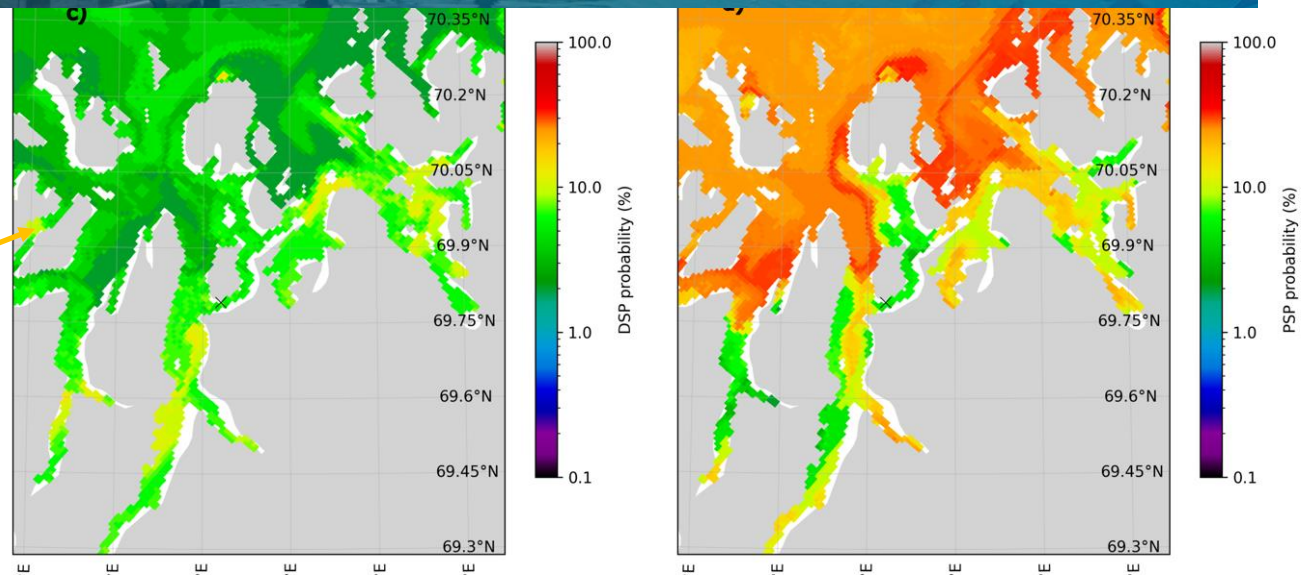
EO4SA forecast from 18th May probability of a fish farm reporting more than 0.2 adult female lice per fish vs BarentsWatch report of the 0.2 threshold for the week of 18 May 2026 – 25 May 2026

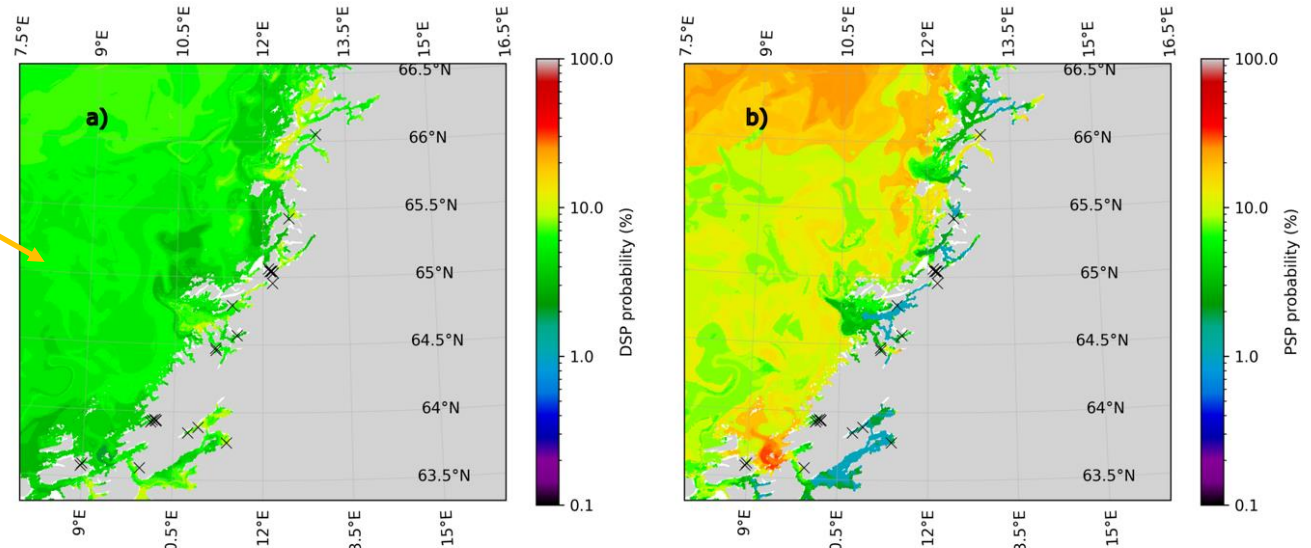




Algae toxins - Geographical Scope



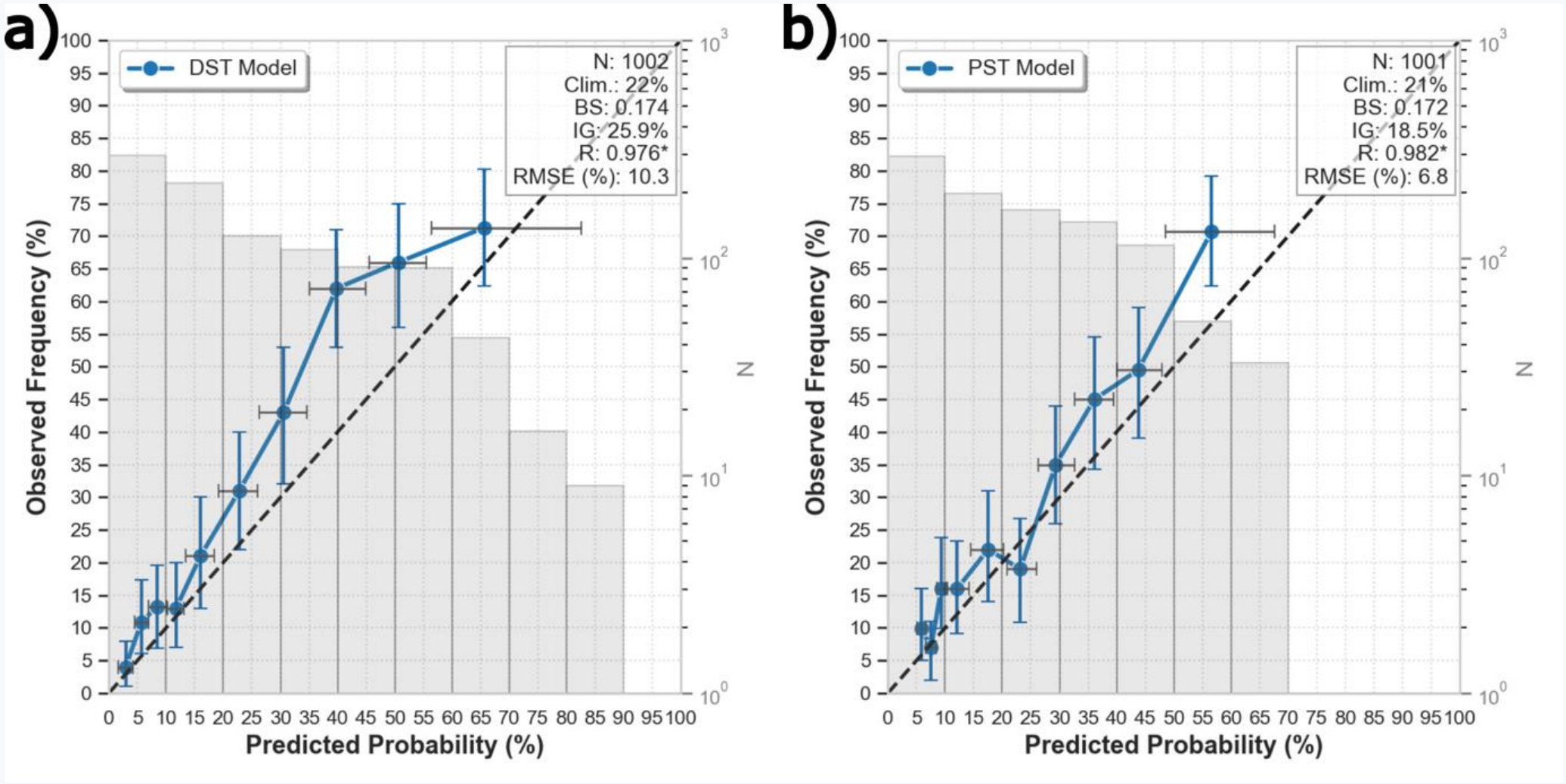




Accuracy – Algae toxins

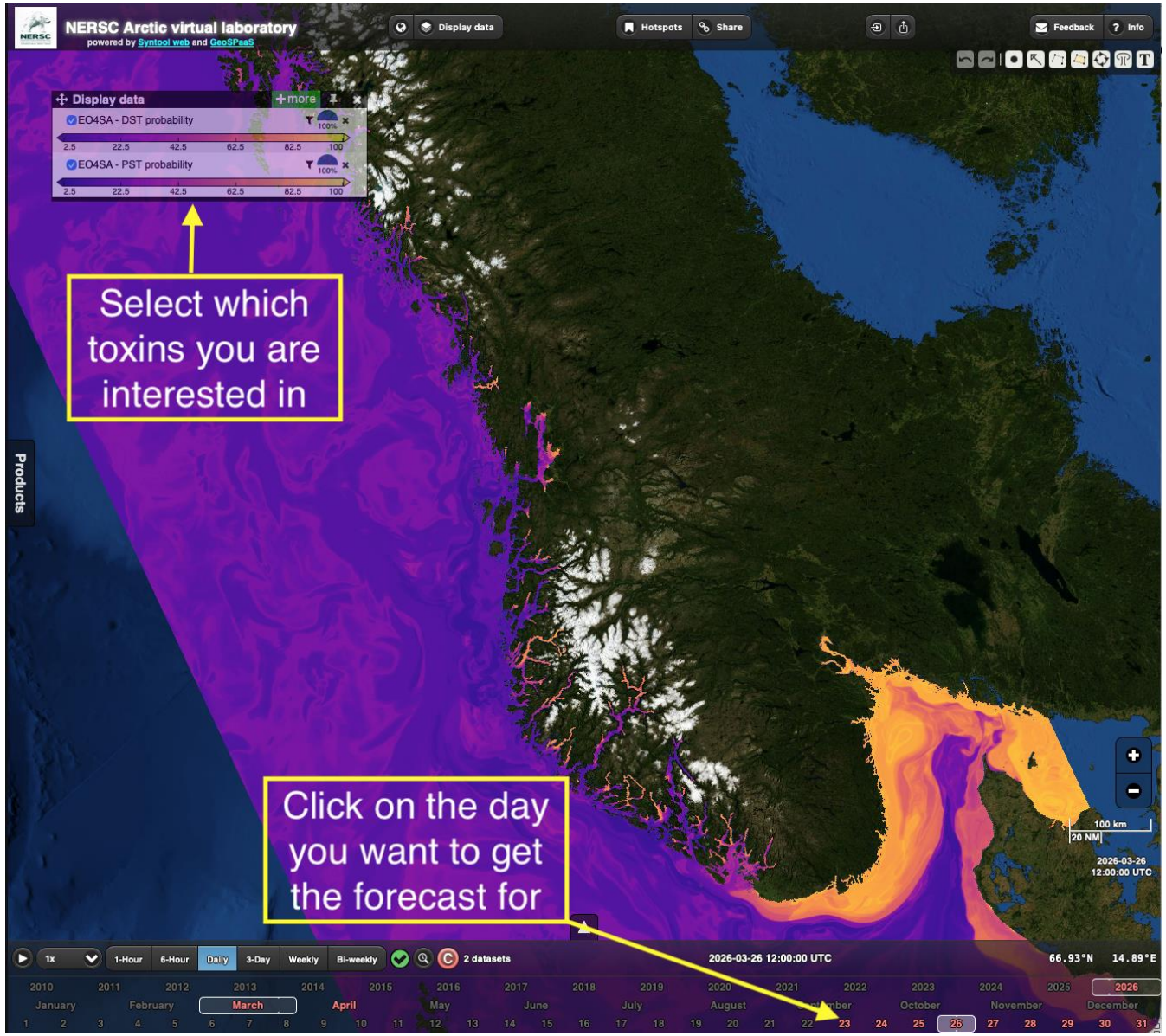
DST

PST

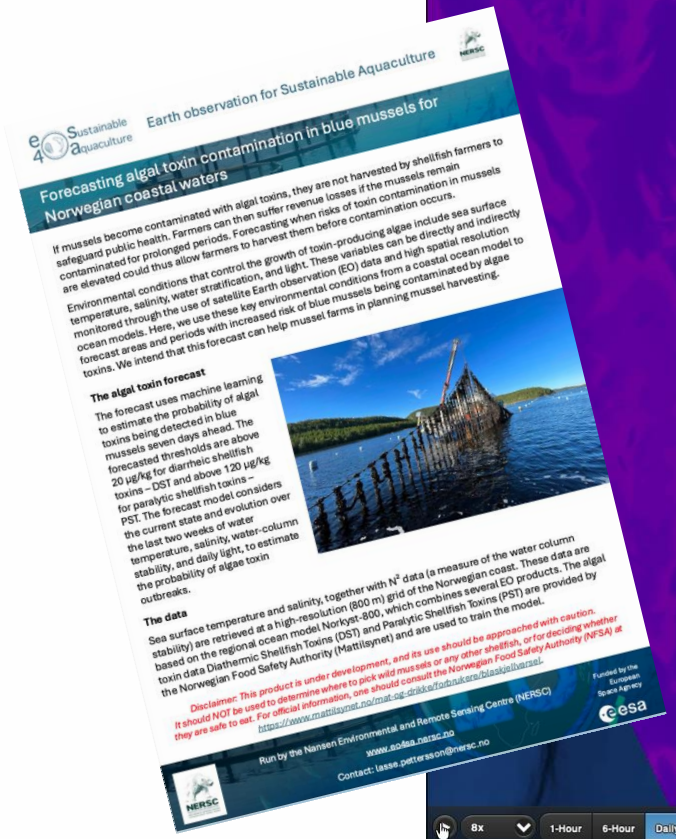


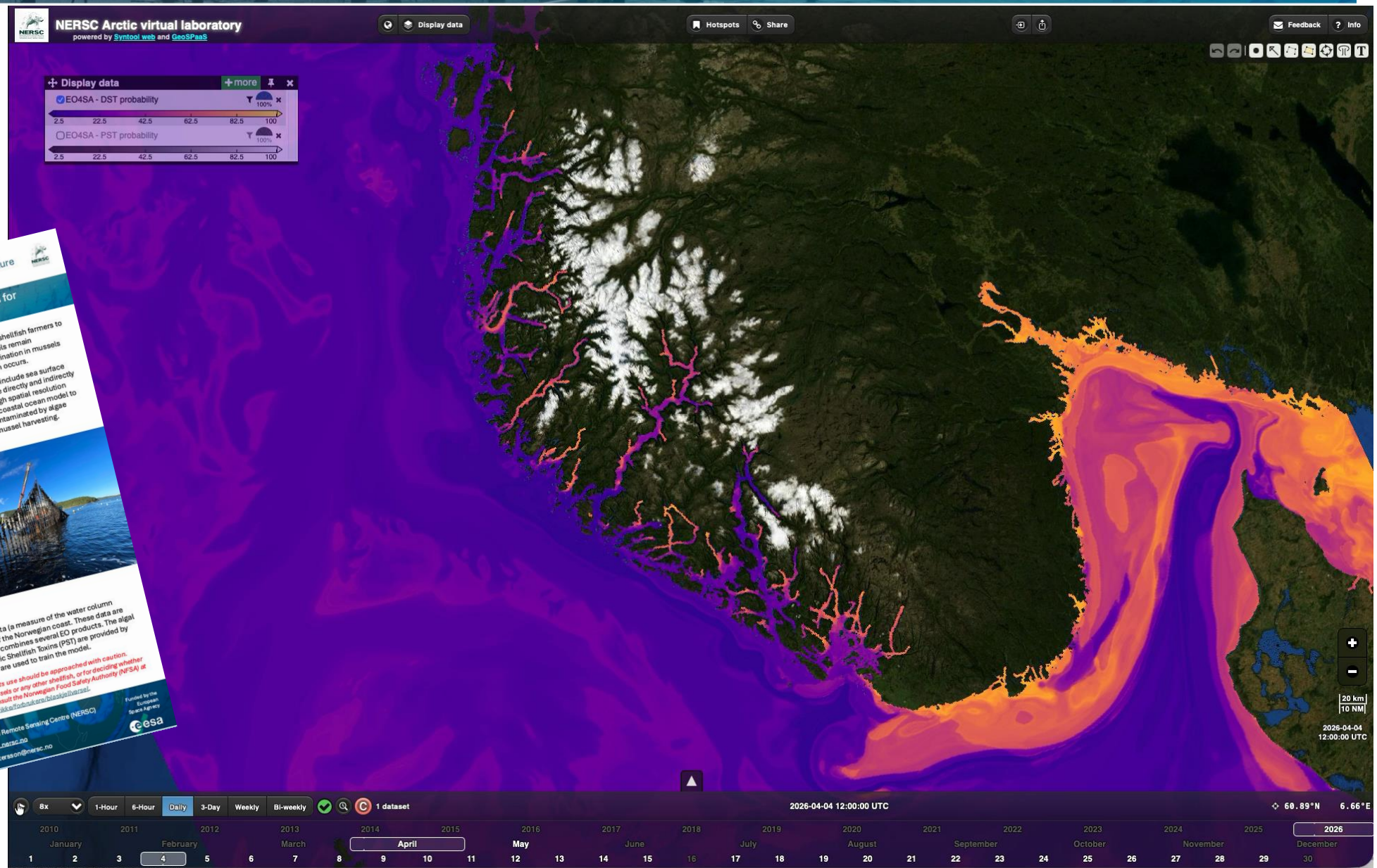
Algal toxin forecast publicly available

- Algal toxin forecasts are also available on the NARVAL platform.
- The forecast uses machine learning to estimate the probability of algal toxins being detected in blue mussels seven days ahead. The forecasted thresholds are:
  - above 20 µg/kg for diarrheic shellfish toxins – DST and
  - above 120 µg/kg for paralytic shellfish toxins – PST.
- The forecast is updated every weekday and is available for one week ahead.
- The forecast has been sent to the Early Adopters with a one-page flyer in both English and Norwegian about the forecast.
- Feedback has been received from EA´s.



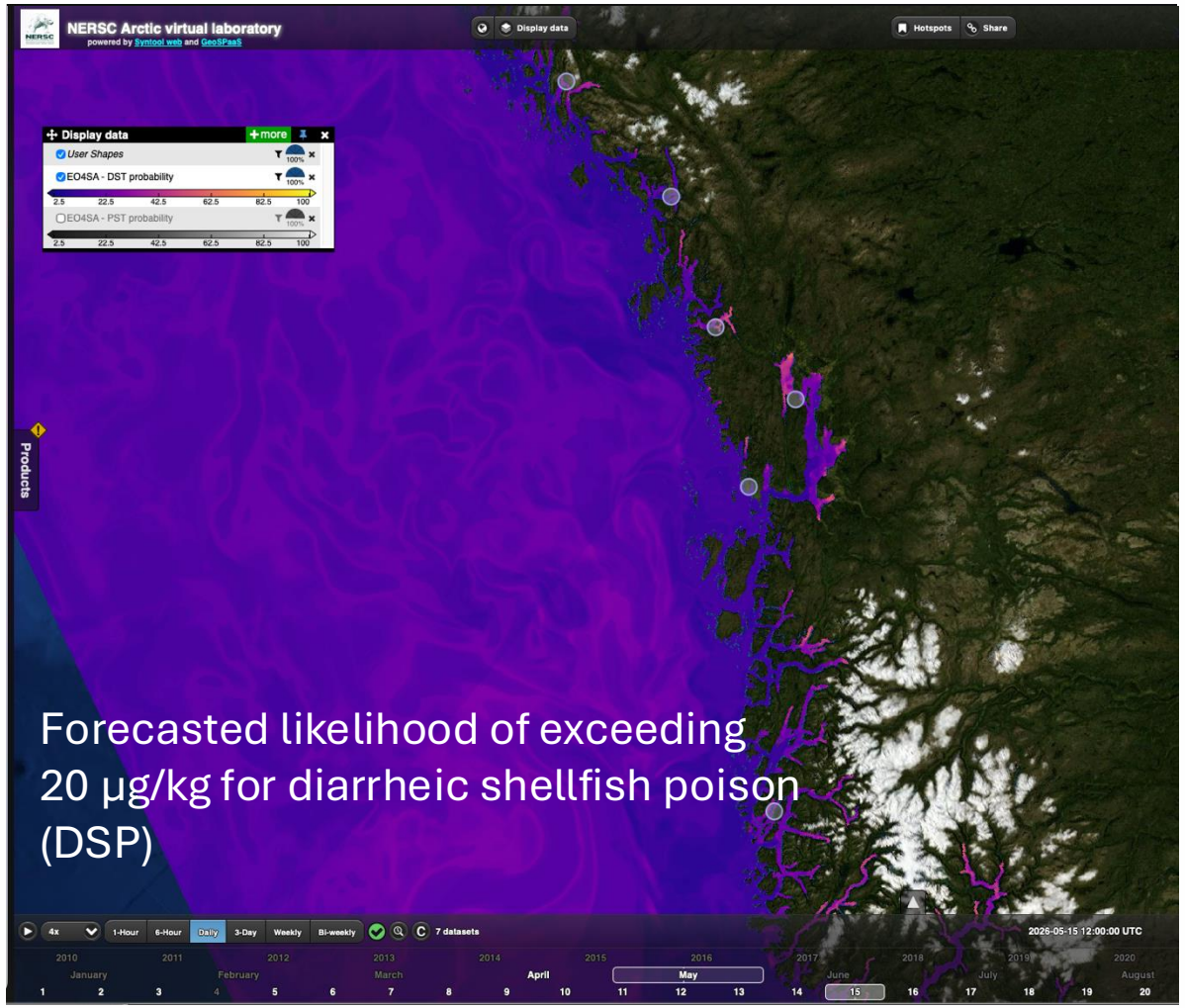
The Algae Toxin forecast on NARVAL

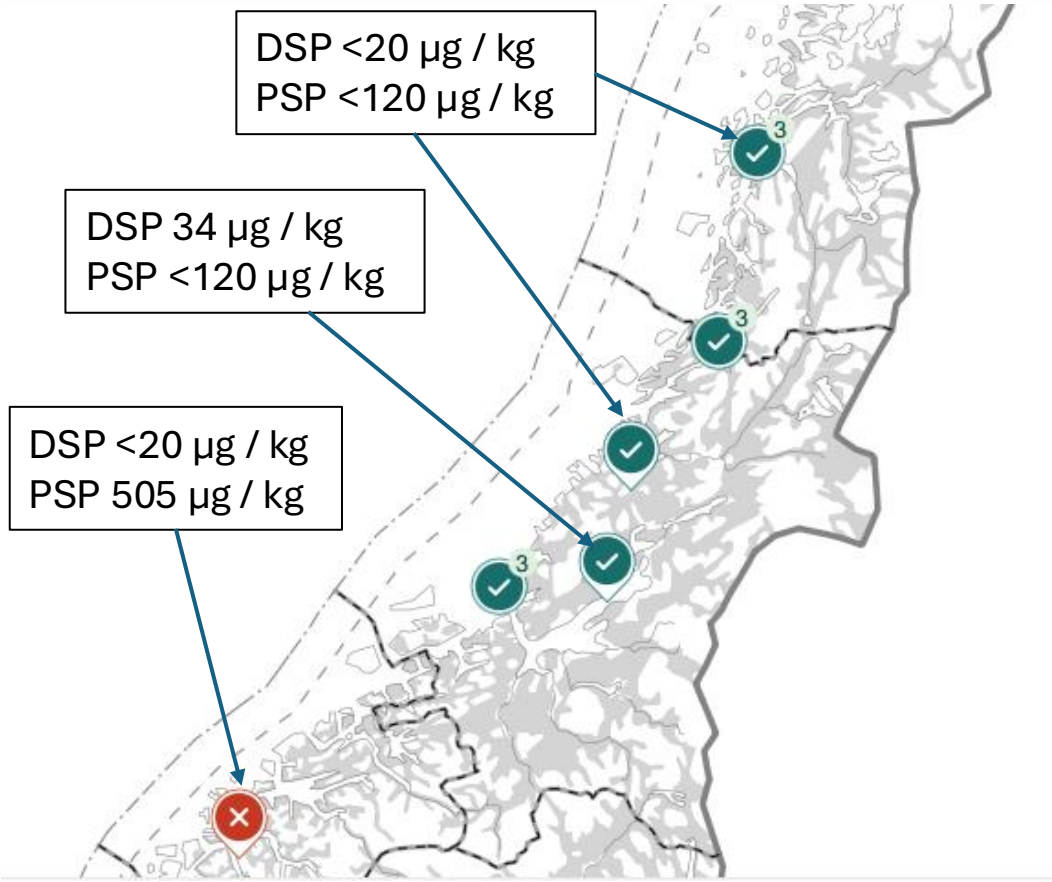




The Algae Toxin forecast validation

- Comparison with measurements from the Norwegian Food Safety Authority “blåskjellvarsel” : 15th May 2026





Optimizing shellfish farming, NPP maps

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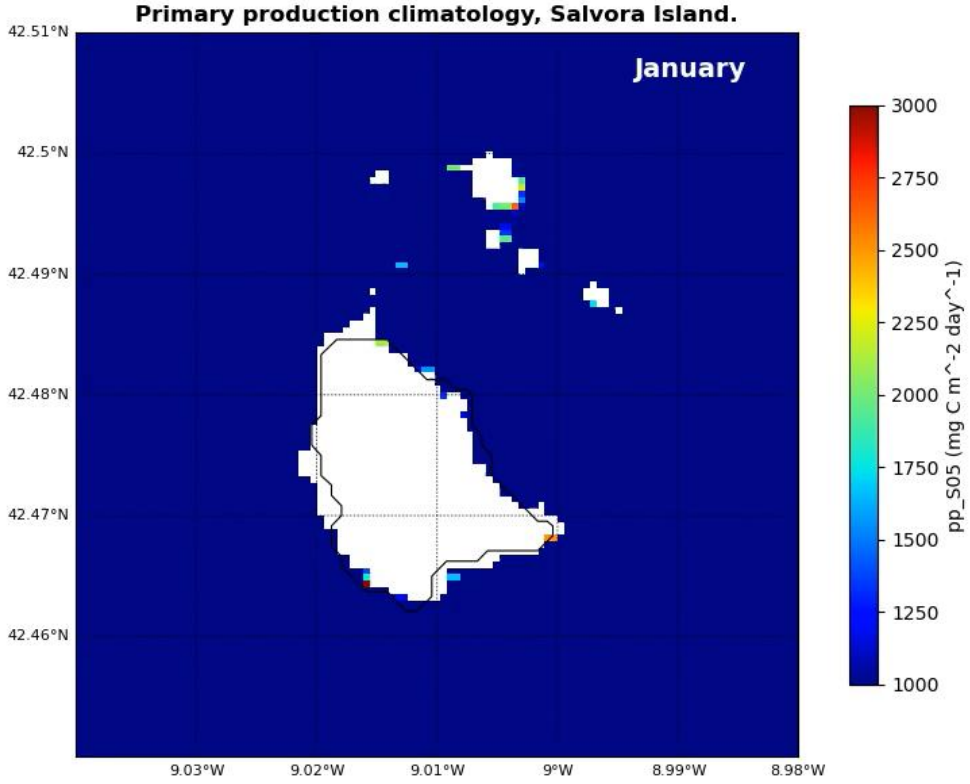
- The key innovation is the use of a Chl-a product **at 60 m spatial resolution to compute Primary production.**
- A **high-resolution NPP** (Net Primary Production) product has been generated for the period **2016 to 2026**.
- Will be provided through the PML Web-Portal to Early Adopters

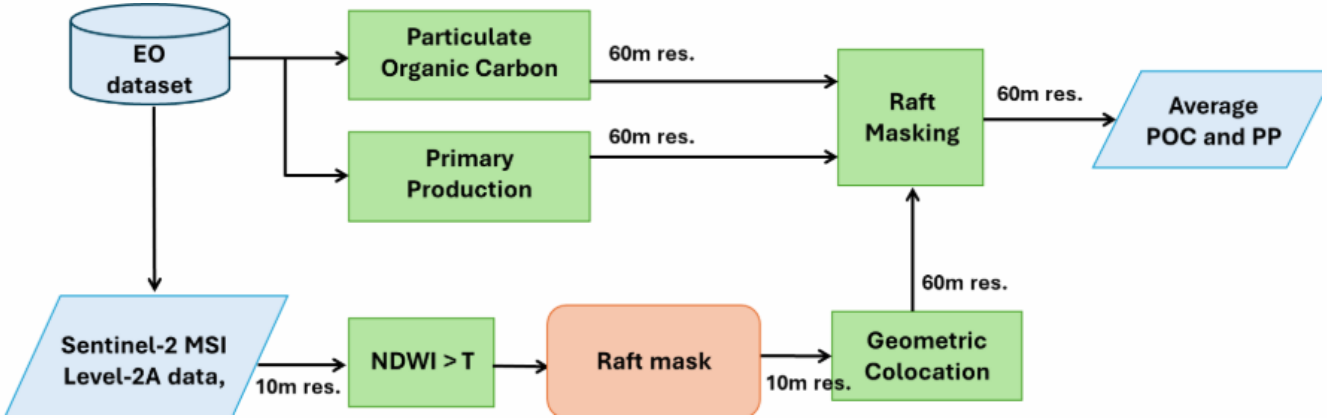




- Red polygons: mussel farms
- Blue polygons: Marine Protected areas
- Markers: early adopters' sampling sites

Algorithm investigation: The Effect of Mussel Rafts

- Sentinel-2 MSI Level-2A data were used to mask out locations of mussel rafts.
- The masks were generated at a 10 m spatial resolution and then collocated with POC and PP products at 60 m resolution.
- The masks were applied to flag pixels with mussel rafts.



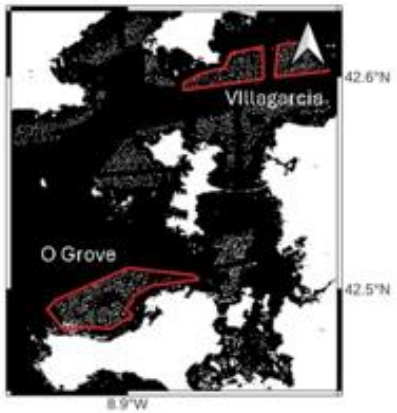
Processing chain for masking out mussel rafts in POC and PP products at 60m resolution.

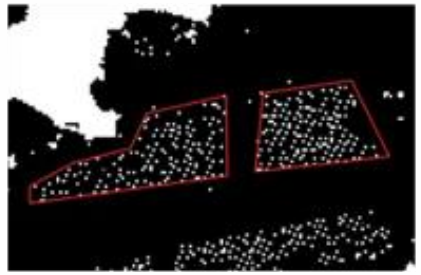
Detection of raft pixels

- applying a modified Normalized Difference Water Index (NDWI) (McFeeters, 1996)

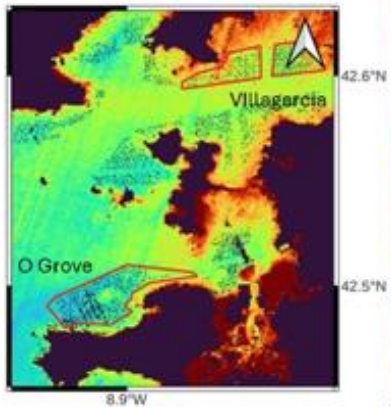
$$MNDWI = (Band\ 2 - Band\ 8) / (Band\ 2 + Band\ 8) > 0$$

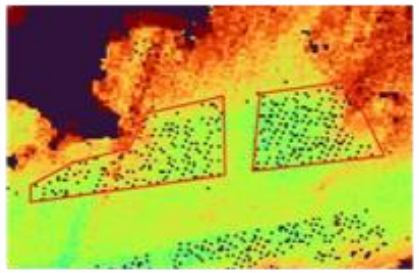
Algorithm Investigation: The Effect of Mussel Rafts





Masked mussel rafts and land pixels







NPP (mg C m^{-2} d^{-1})

Pobra (inner Ria de Arousa)

- Diff. = 0.03 ± 0.11 mg m^{-3}
- % diff. = 0.6% ± 3.4%

O Grove (outer Ria de Arousa)

- Diff. = 0.03 ± 0.07 mg m^{-3}
- % diff. = 1.5% ± 2.6%

- **The impact of mussel rafts on Chl-a estimates is insignificant.**
- Correction is not necessary

Ria de Arousa (Galicia, NW Spain)

where 70% of mussel aquaculture concentrates



- Red polygons: mussel farms
- Blue polygons: Marine Protected areas
- Markers: early adopters' sampling sites

Optimizing shellfish farming

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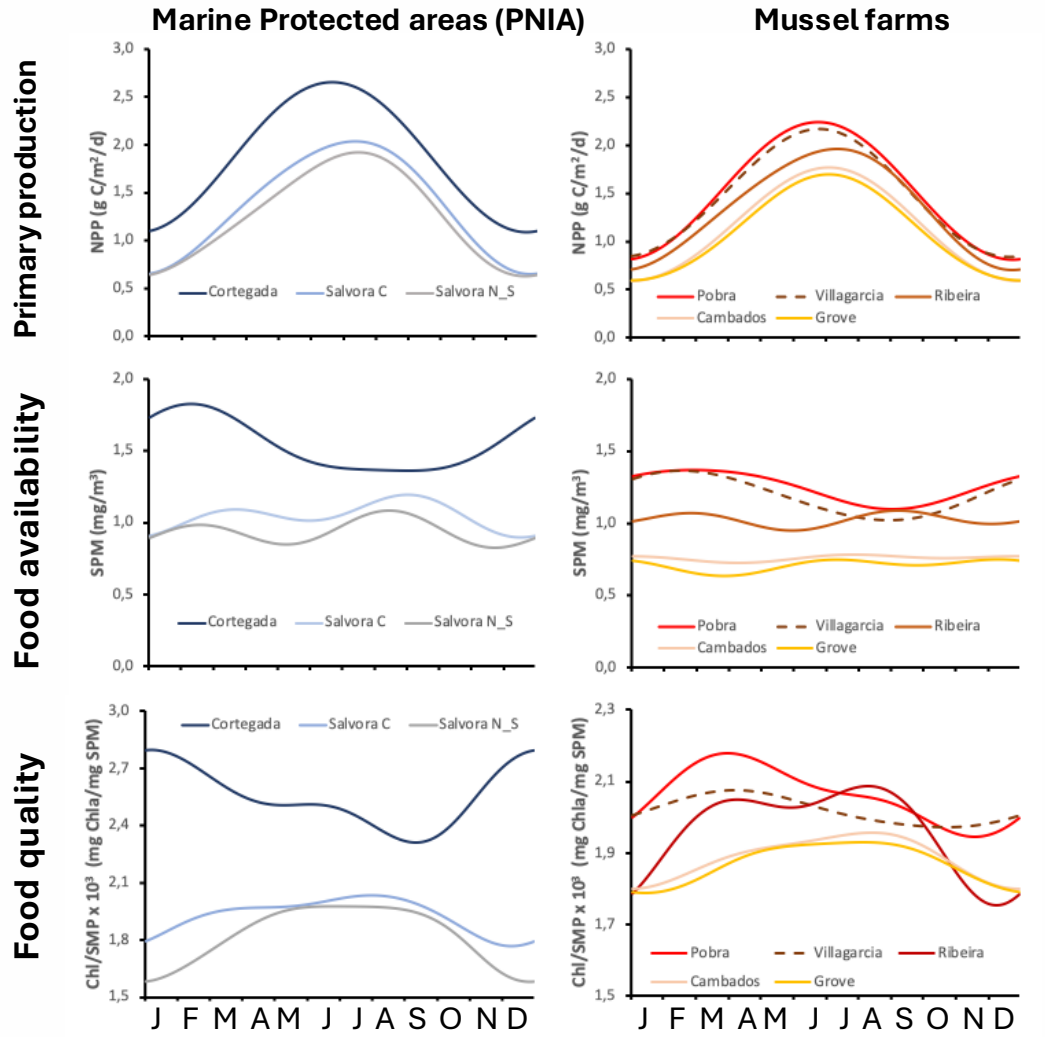
Mussel food availability and quality from the space: inputs to mussel growth model



- 2016-2025 average annual cycles of **satellite-derived** primary production, suspended particulate matter concentration (= food availability) and Chl-a/SPM (= food quality).
- Significant differences are observed in the three parameters within and between marine protected areas and mussel rafts.
- Simulations of a mussel biomass model for Early Adopters

Ria de Arousa (Galicia, NW Spain)

where 70% of mussel aquaculture concentrates



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Mapping aquaculture structures

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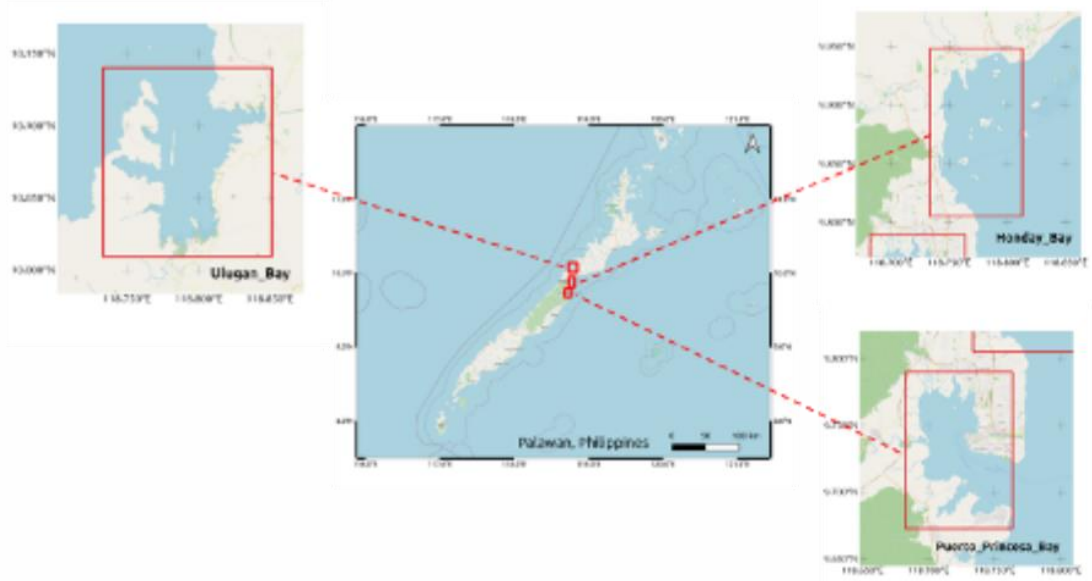
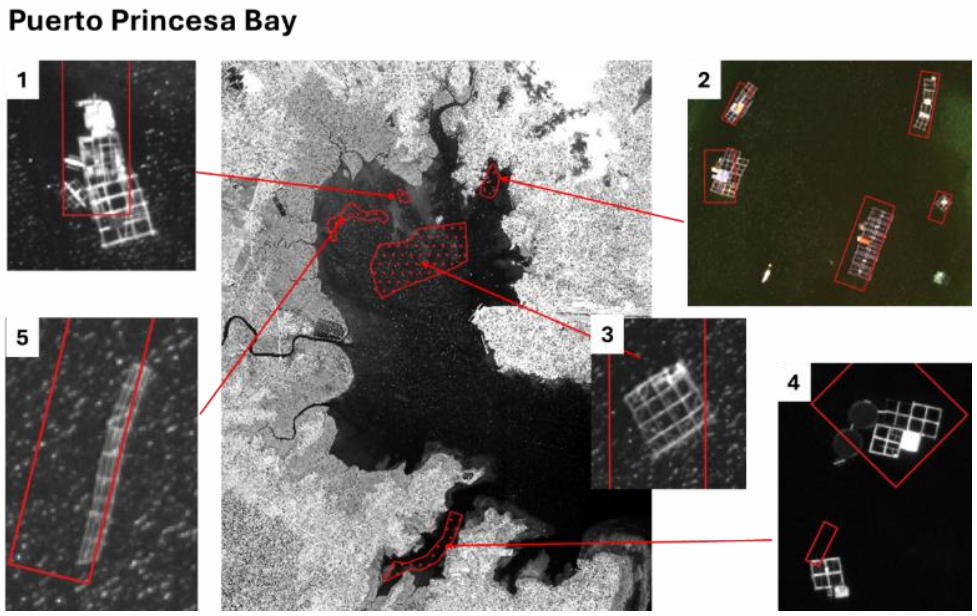
- The aquaculture object mapping product provides **high-resolution spatial datasets** for three key sites in Palawan, Philippines: **Puerto Princesa City, Honda Bay, and Ulugan Bay**.
- The product has been **validated** using WorldView very high-resolution satellite images, ensuring high spatial accuracy and reliability.





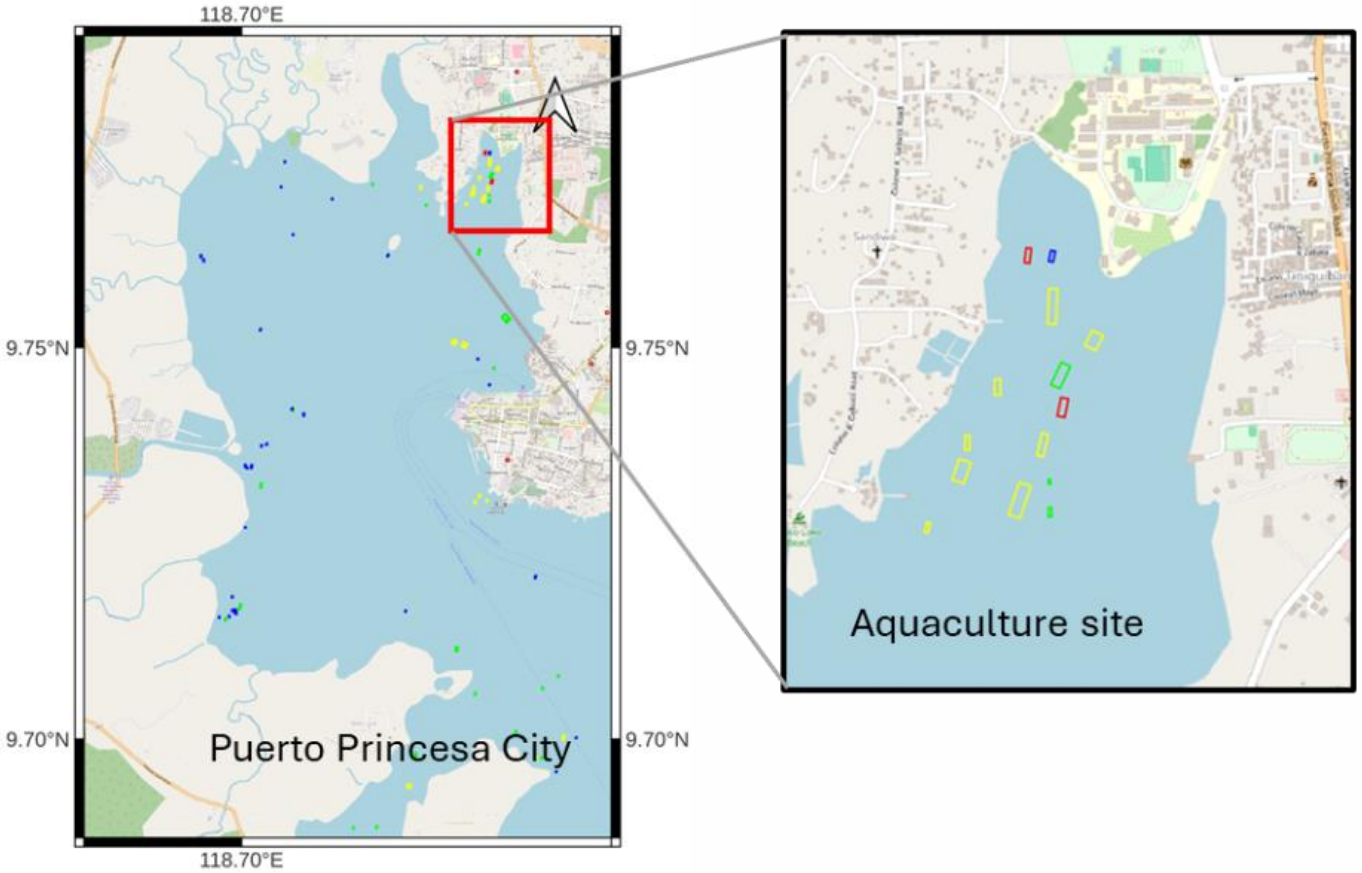
- Time-series maps are available covering the past **five years**, enabling multi-temporal analysis of aquaculture development and dynamics.
- The datasets are delivered in Google Earth KML format for easy visualization and integration into standard geospatial workflows.
- Each detected aquaculture object includes key attributes such as **geographic coordinates, estimated size**, and a **confidence score** for detection quality assessment.

Detection Confidence Levels

The colour scheme

Object colour	Confidence level	False alarm rate	Confidence threshold T_c
Blue	Low	$<10^{-5}$	4.9578 … 4.9578
Green	Medium	10^{-5} … 10^{-6}	6.0379 … 7.6314
Yellow	High	10^{-6} … 10^{-7}	7.6314 … 10.0371
Red	Very high	$<10^{-7}$	>10.0371

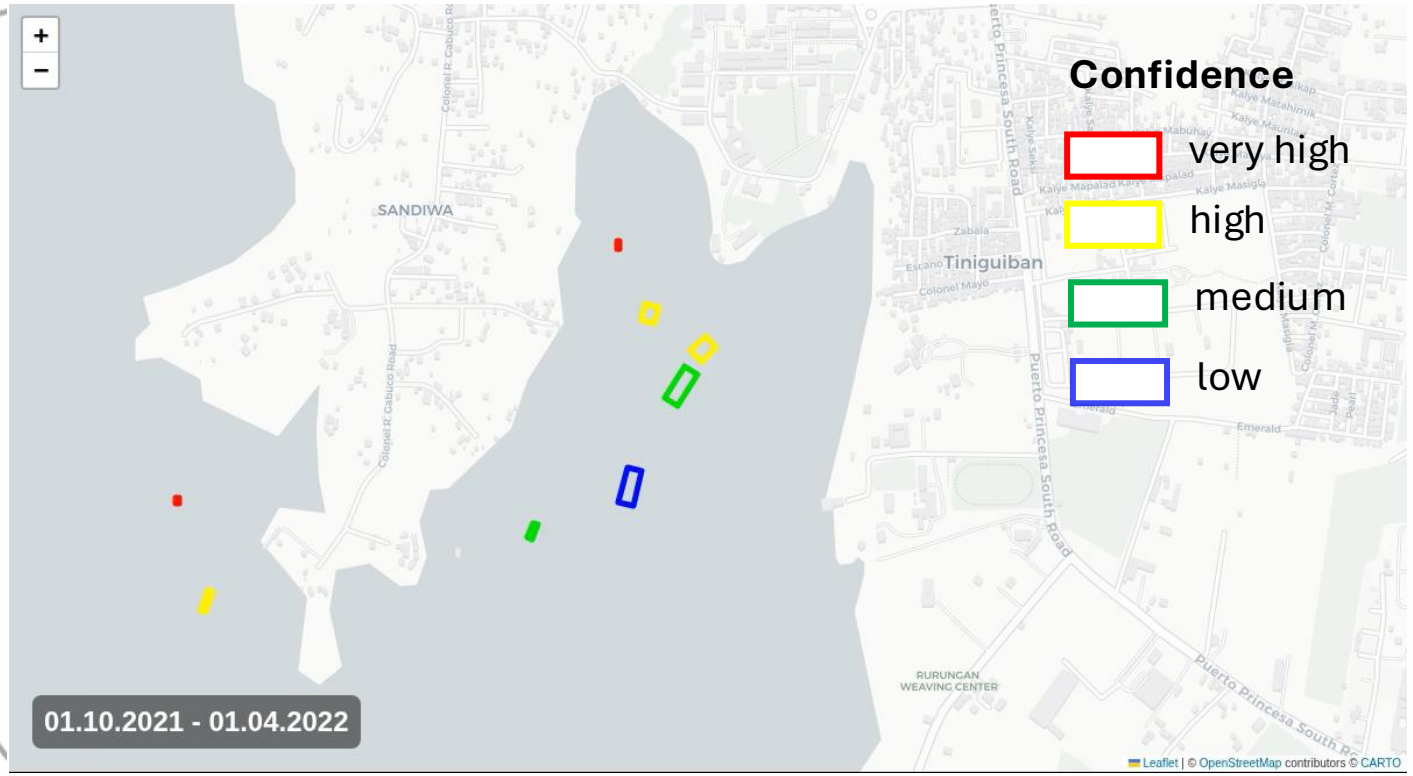
- The **false alarm** rates for different confidence levels were estimated for the area free of aquaculture objects in the central part of Puerto Princesa City
- In total, 8,777,160 samples in this area were used to estimate the percentiles of signature distribution



Aquaculture map of Puerto Princesa City with colour-coded confidence levels

Mapping aquaculture structures





Aquaculture objects in Puerto Princesa City.

Mapping aquaculture structures

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Monitoring Structural Damage of Aquaculture Cages

- Typhoon Tino hit Palawan in **November 2025**, Total Philippine agricultural damage P2.5 billion, including crops, livestock, fisheries and infrastructure
- **June 2026** Mindanao earthquake and tsunami. The official reports have not yet published a detailed monetary estimate of aquaculture losses
- *The aquaculture maps have been extended to June 2026 to study the impact of these events*







Earth Observation for Sustainable Aquaculture

a project study under the ESA call EO for Sustainable Blue Economy (EXPRO+) s for Sustainable Aqua

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Thank you for your attention – Questions?



