MEESO Modelling & stakeholder concern workshop

Tuesday 21 June 2022

Please note that this meeting will be recorded

MEESO has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817669.

MEESO

MEESO

Ecologically and Economically Sustainable Mesopelagic Fisheries

MEESO

Source: www.meeso.org

Stakeholder concerns

Industry workshop march 2021
Stakeholder workshop September 2021

Who will really profit from this?

There is so much we don't know yet...

Can we actually do this fishery, economically?

If we use this fish for fishmeal, their will be more anchovy to eat directly!

But will fishing actually effect carbon sequestration?

How can we sustainably fish this resource?

We are not good in governing fisheries, we'll probably also do this badly...

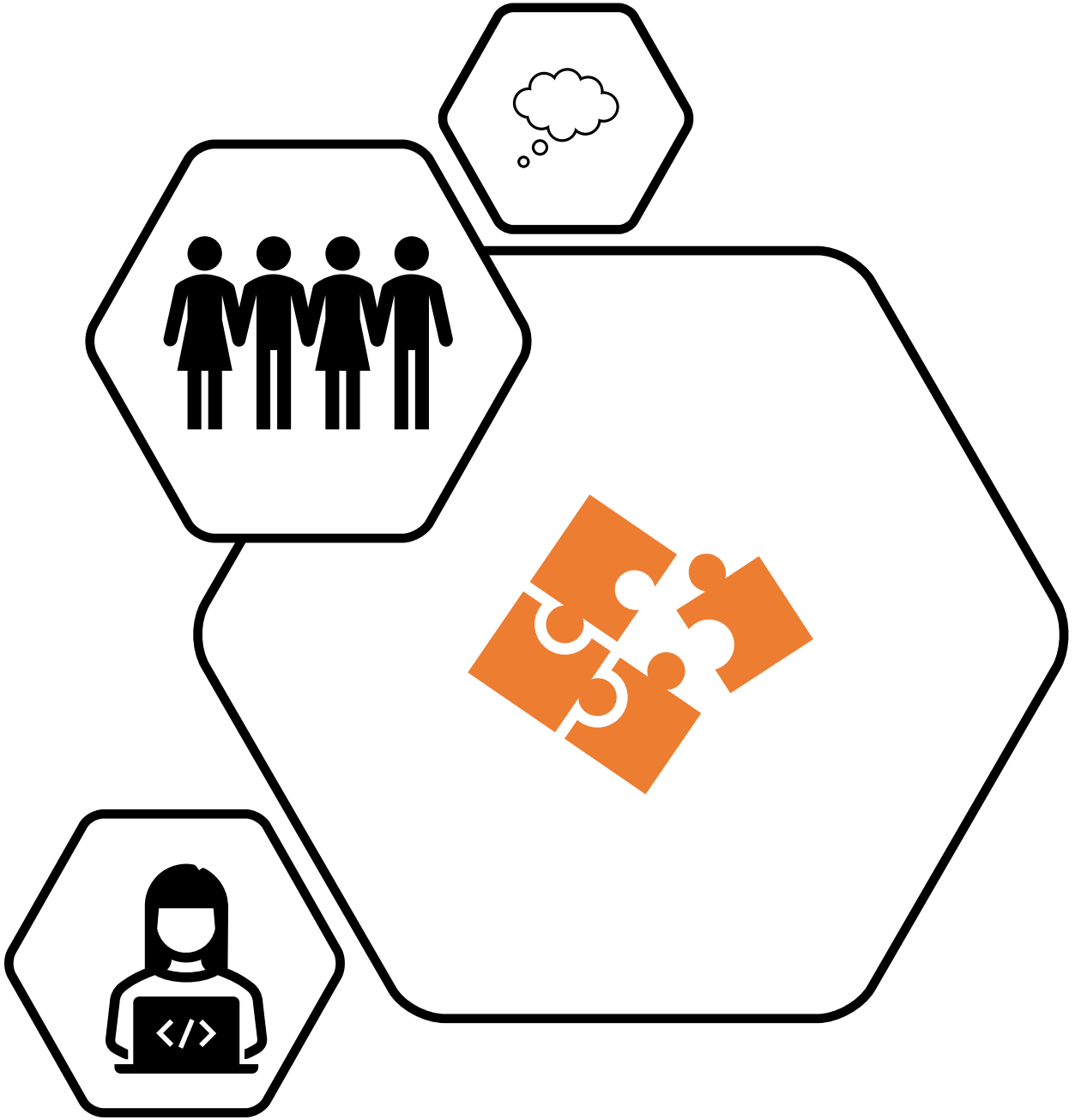
With climate change we cannot afford to loose this carbon sequestration capacity

Fishing
Governance
Economics
Ecology
Food security
Carbon flux

MEES

Agenda

- 15.00-15.30 presentation
- 15.30-16.00 Q&A
- 16.00-16.45 Break out groups
- 16.45-17.00 Plenary

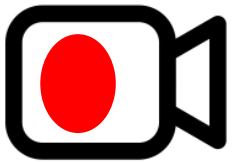


Please make a choice for the break out
See link in chat

Break out groups

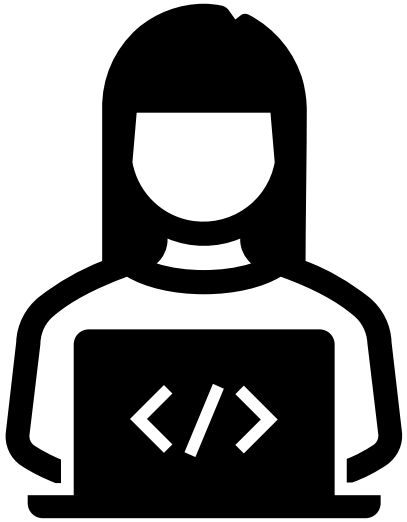
	Models	Who	Chair
Fishing + Economics + Food security		Marga, Rolf, Rasmus, Francois	Berthe
Governance + interplay between concerns; i.e. carbon flux		Mary, Anna	Maartje
Ecology		Douglas	Marloes

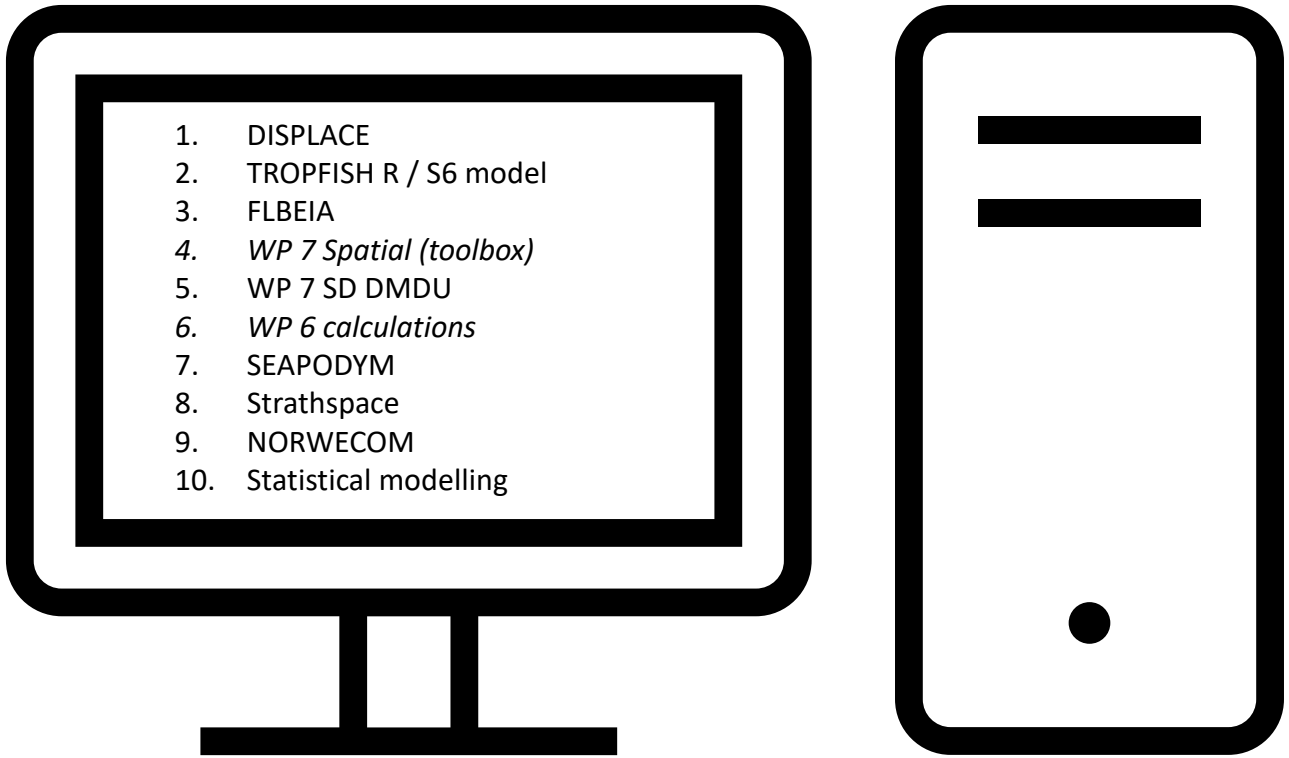
Please make a choice for the break out
See link in chat



- Reminder to record

Models used in MEESO

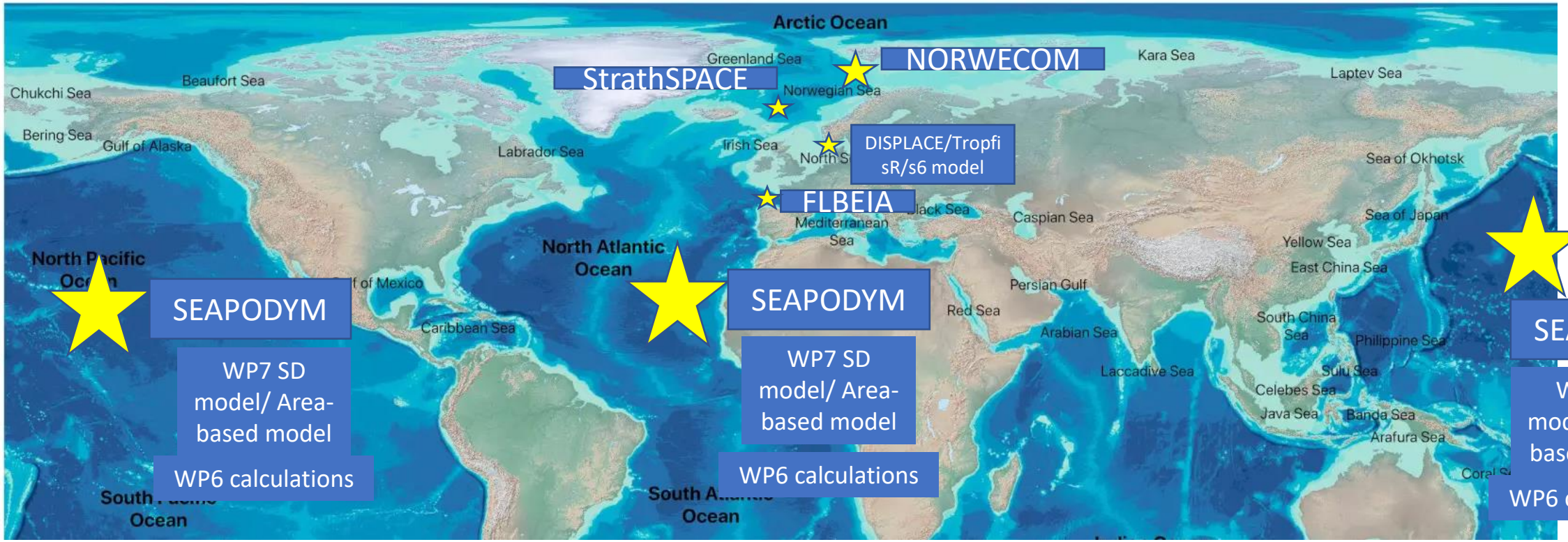




Models related to concerns

Models	fishing	governance	economics	ecology	Food security	Carbon flux
DISPLACE						
TROPFISH R / S6 model						
FLBEIA						
WP 7 Spatial						
WP 7 SD DMDU						
WP 6 calculations						
SEAPODYM						
Strathspace						
NORWECOM						
Statistical modelling						

Models and space



Speed dating with models…

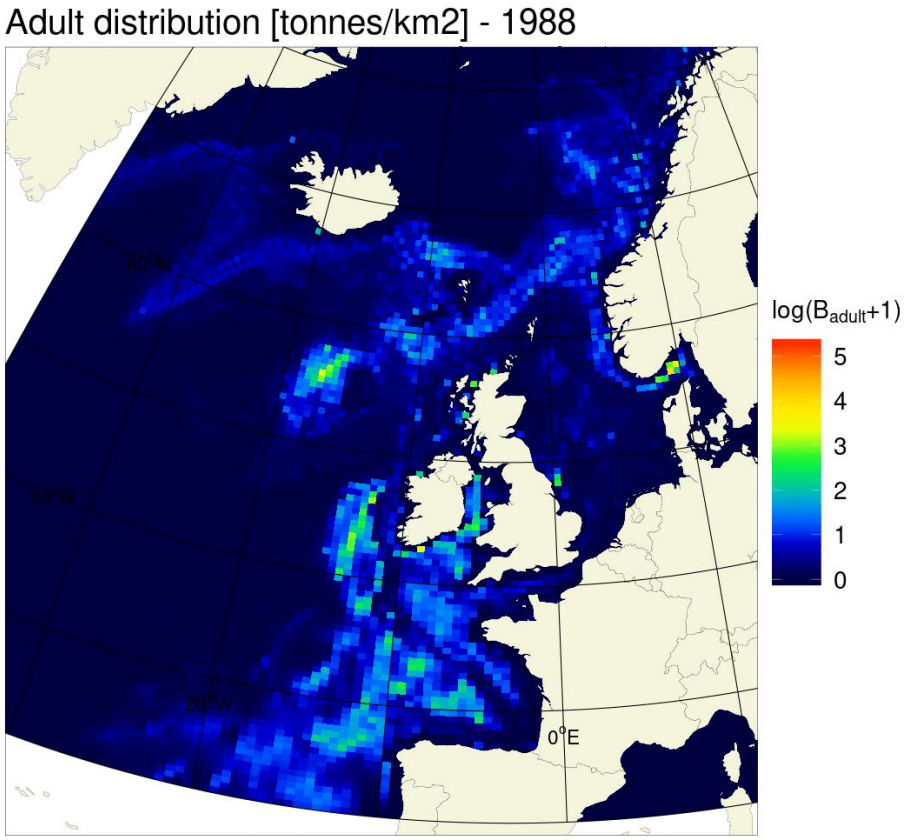
The StrathSPACE spatial population dynamics model

Key features:

- Closed life-cycle population model
- Length structured population
- Planktonic larvae and Biodiffusive adults
- Temperature-dependent mortality
- Physical environment from NEMO model, National Oceanography Centre (NOC), Southampton, for 1980-2099, with RCP 8.5 for forward run.

Key outputs:

- Hindcast and forecast (climate change) biomass
- Stock length structure
- Potential yield curves
- Explore spatial management strategies



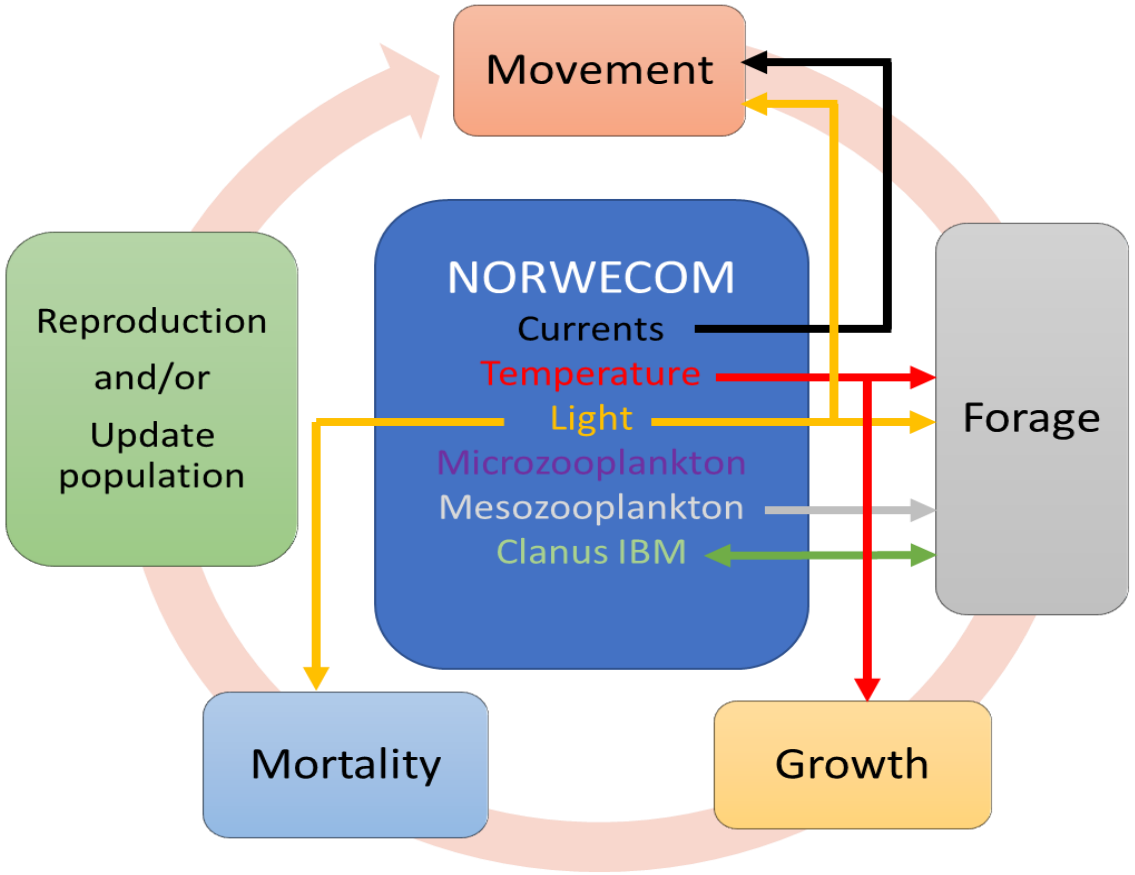
Preliminary results from StrathSPACE *Benthosema* model

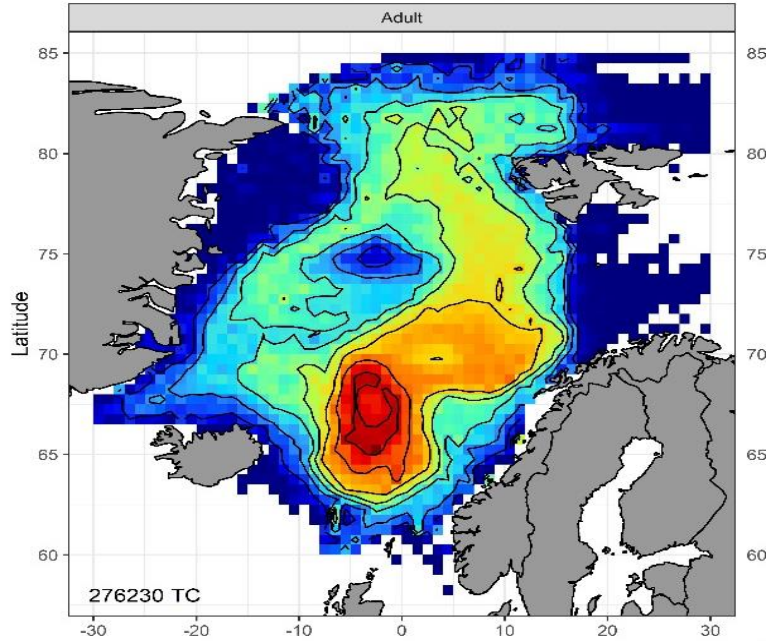
University of Strathclyde

Douglas C. Speirs

d.c.speirs@strath.ac.uk

The NORWECOM.E2E *Benthosema* IBM structure and process flow





Modelled (log) biomass

Key IBM features:

- 1 hour timesteps
- ~20.000? super-individuals
- Horizontal movement by drift only
- Vertical movment according to “light comfort zone” theory and temperature preference.
- Foraging and growth based on first principle equations of visual range and bioenergetics with input based on spatial (x,y,z) position in the model.
- Feedback on prey availability
- Mortality affected by vertical position due
- Reproduction as function of acquired surplus energy

SEAPODYM-LMTL, a global ecosystem model to model micronekton

Lehodey et al, 2010, 2015; Conchon, 2016

Ocean Global Circulation Model

Ocean color

CURRENTS

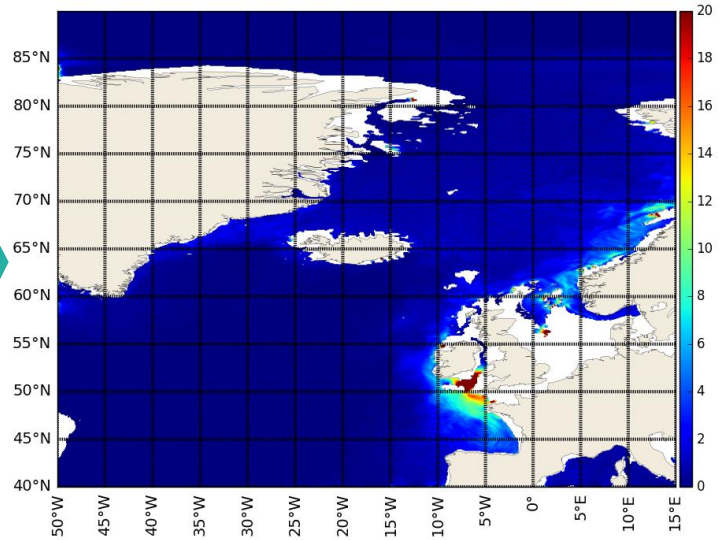
TEMPERATURE

NET PRIMARY PRODUCTIVITY

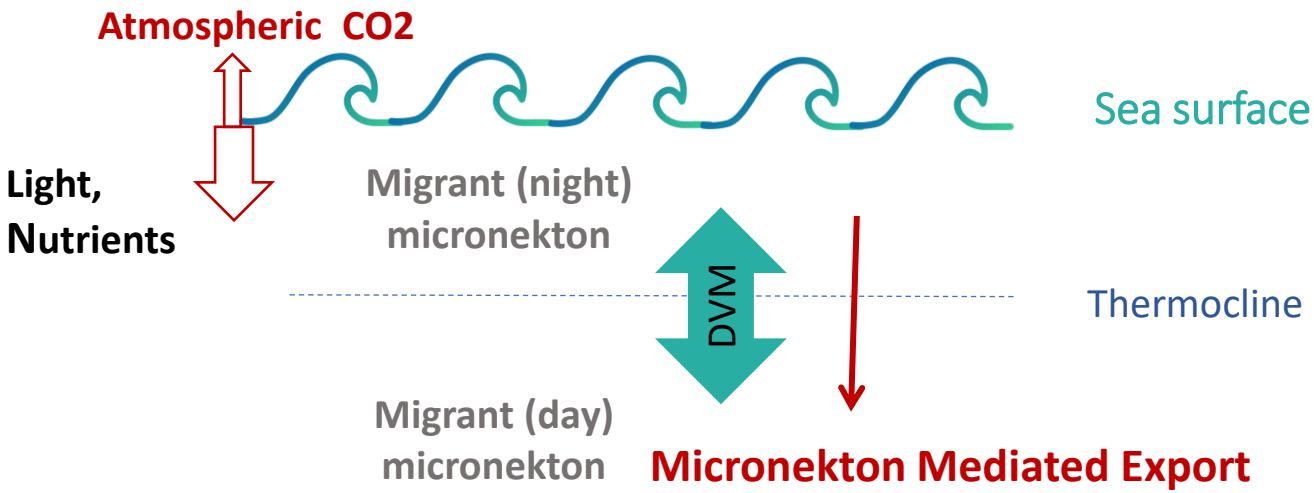
SEAPODYM-LMTL

(biomass density predicted over time and space)

Biomass of Maurolicus (g.m-2)



Carbon export by micronekton based on their diel vertical migration (DVM)



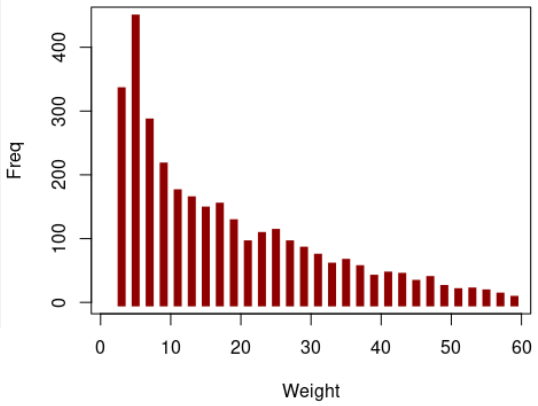
s6 model: Single-Species, Size-Structured, Steady-State model – a data-limited assessment method that uses size distributions from the catch or surveys

Inputs

Size distributions

Life-history information

It does not require time-series



Main outputs

Total mortality

Asymptotic weight

Reference points: F_{MSY}

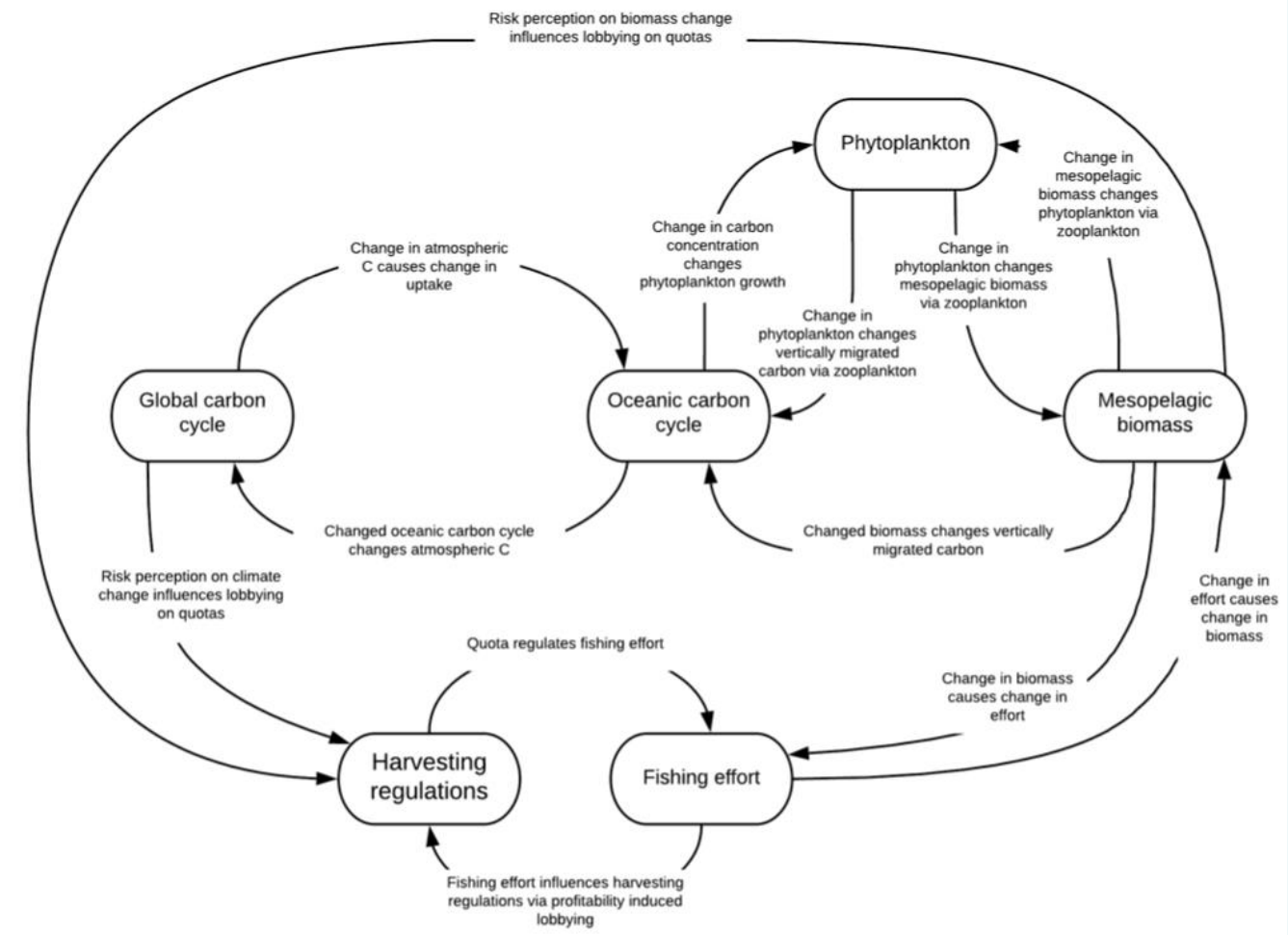
In the MEESO project, s6 will be used to estimate natural mortality and reference points for *Maurolicus muelleri* and *Benthosema glaciale.*

It will take as input life-history information (e.g. growth) from TropFishR and/or from the literature.

Extensions of the model are being implemented to accommodate for non-exploited fish stocks and to estimate the uncertainty of all important estimates – most importantly the fishing mortality reference point F_{MSY}.

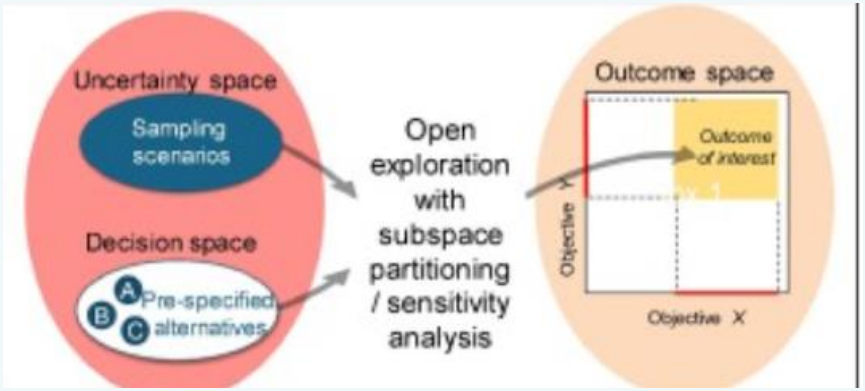
R-package available on GitHub: https://github.com/alko989/s6model

WP7 Decision making under deep uncertainty System Dynamics Model



- Participatory model development
- Collaboration with expert/ stakeholder panels

- Identification of scenarios through participatory methods with stakeholders and quantitatively through scenario discovery (example below)



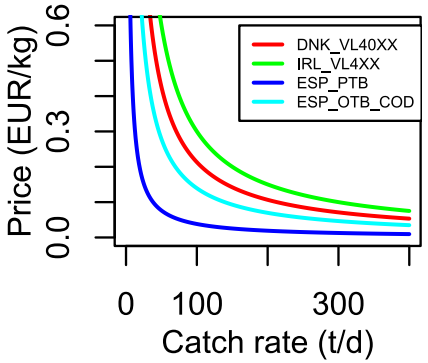
Moallemi et al., 2020

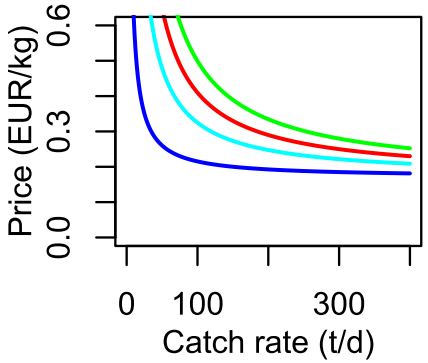
WMU+ Delft University
Oostdijk, Elsler, Wisz and
J. Van Deelen, W. Auping &
J. Kwakkel

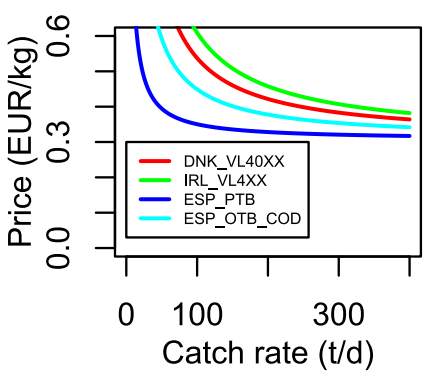
what is the best short- medium term decision for our long term goal?

Cost-benefit analysis Deliverable 6.3

- Scenario 1: Only spare capacity utilized
  - Private CBA: variable costs, GHG permits
  - Public CBA: shadow prices, Social Cost of Carbon





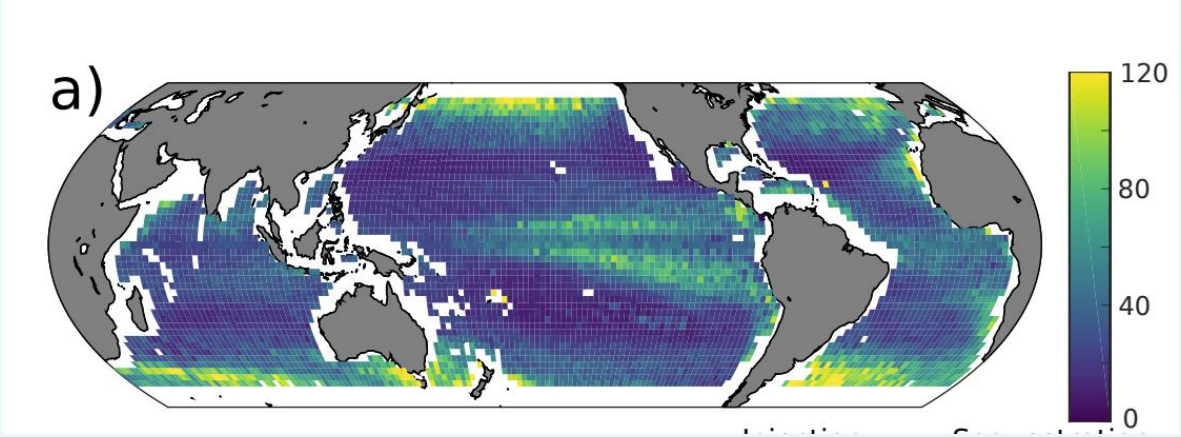


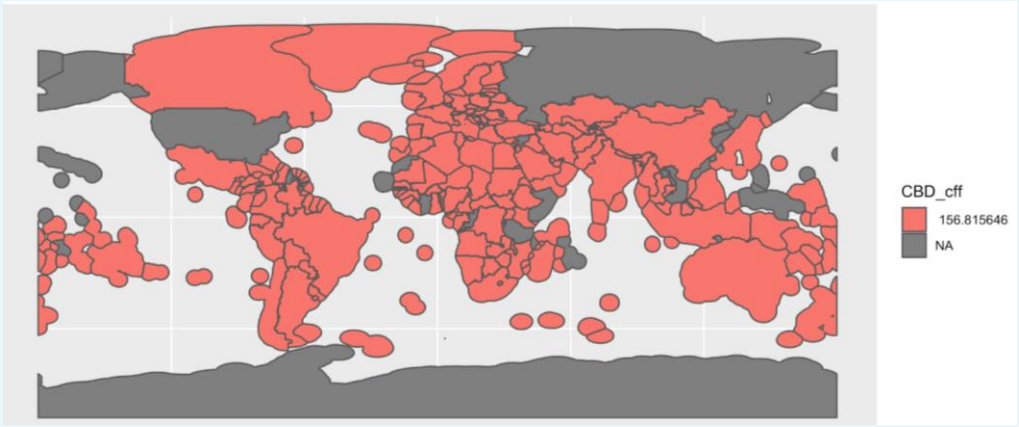
- Scenario 2: No limits on capacity
  - What is then the limit? Resource availability? Market saturation?

WP7 Use of spatial models for trade-off analysis between carbon sequestration and fishing

•Global spatial model of DVM (coupled physical data & biological model) (from other project, Pinti et al., 2021)
•Models carbon injection & sequestration
•**Can be used to map trade-offs between carbon sequestering and fishing**
•SEAPODYM will be available later in the project, covers north Atlantic

Pinti, J., et al. "Metazoans, migrations, and the ocean's biological carbon pump." *bioRxiv* (2021).





•Carbon sequestering maps can be overlaid with governance maps such as:
•Mapping of agreements, and governance focus factors
•Example: CBD climate focus factor red

Operating Model

Management procedure model

Fish stocks
Maurolicus Muelleri

Effort

Catch

Covariates

Fleets

Observation model

Data

Assessment model

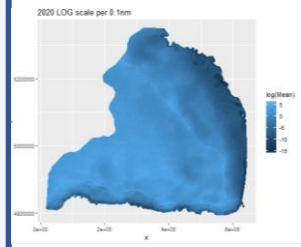
Perceived
System

Harvest control rule

Implementation model

Advice

Biomass Predictors:
Space-time + bathymetric effect



Uncertanties

- biomass
- production model
- catchabilities
- prices ….

Scenarios

Fish vs No fish

Indicators

Stock: catch, biomass, F, etc.
Fleet: effort, catches, costs, grossSurplus, grossValue, net profit, effort, profit, etc…
Fleet & metiers & stock: catches, landings, quota,price, effort share, gross value, vcosts, etc…

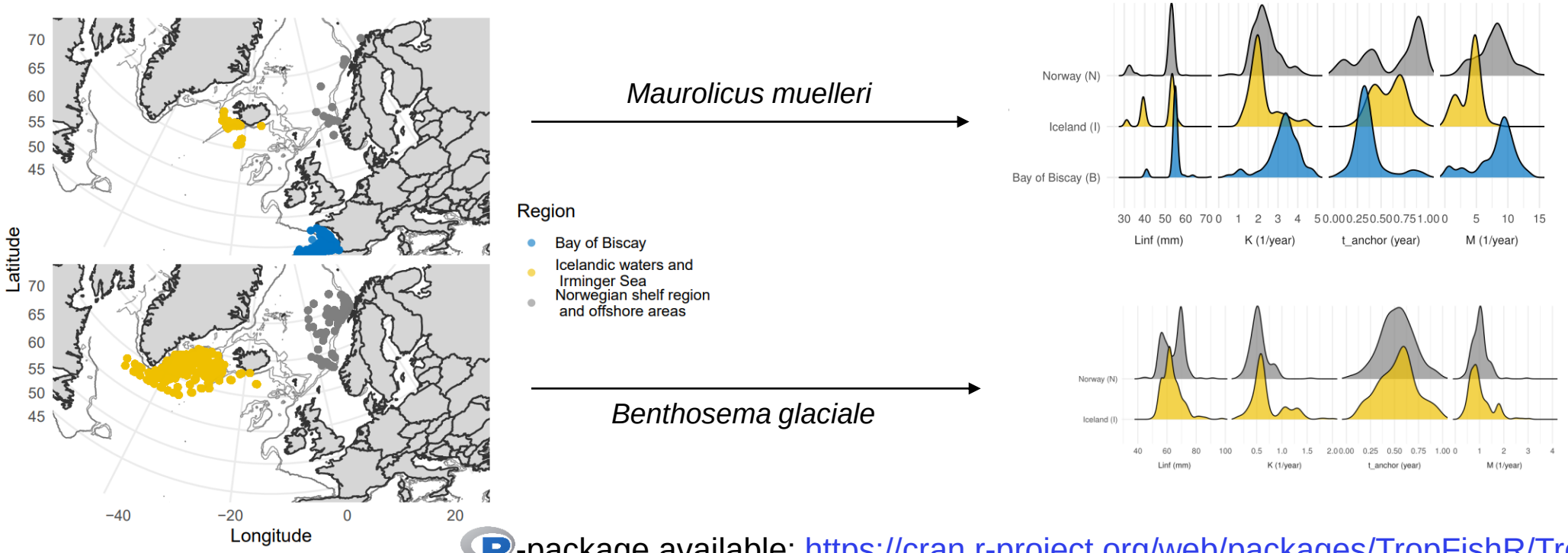
TropFishR model

Data-limited model where fish lengths are used to estimate *fish growth*, *natural fish mortality*, *selectivity* and the uncertainty of those parameters.

The model can also be used for length based assessment of abundance relative to maximum sustainable yield (MSY).

Here used to investigate spatial and temporal patterns in population dynamic parameters, e.g. growth and mortality, as well as selectivity according to stock specific patterns of *Maurolicus muelleri* and *Benthosema glaciale*

Information on growth and mortality is essential input for stock assessment models (e.g. s6model).

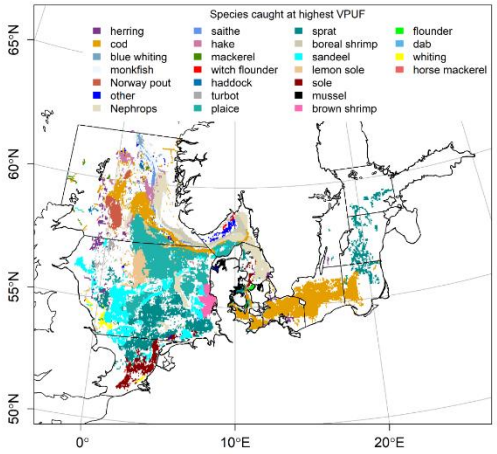


R-package available: https://cran.r-project.org/web/packages/TropFishR/TropFishR.pdf

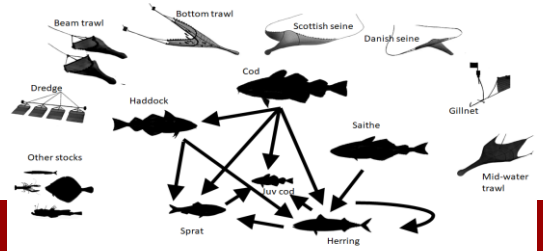
DISPLACE – A spatial multi-agents bio-economic model combined to spatial population dynamics to support achieving economically viable, profitable fisheries by testing management scenarios

- In Management Strategy Evaluation (MSE) we create mathematical models of the full fisheries system & represent each step of the management process with its own set of equations to provide output on fisheries economic indicators;
- We then create feedback to the fish population model by using the results of the management decision in the fishing model to provide output on biological population dynamic indicators;
- We can make each of our computer worlds slighlty different to represent the uncertainty about the real world system dynamics and project forward to a 10y horizon for each alternative scenario.

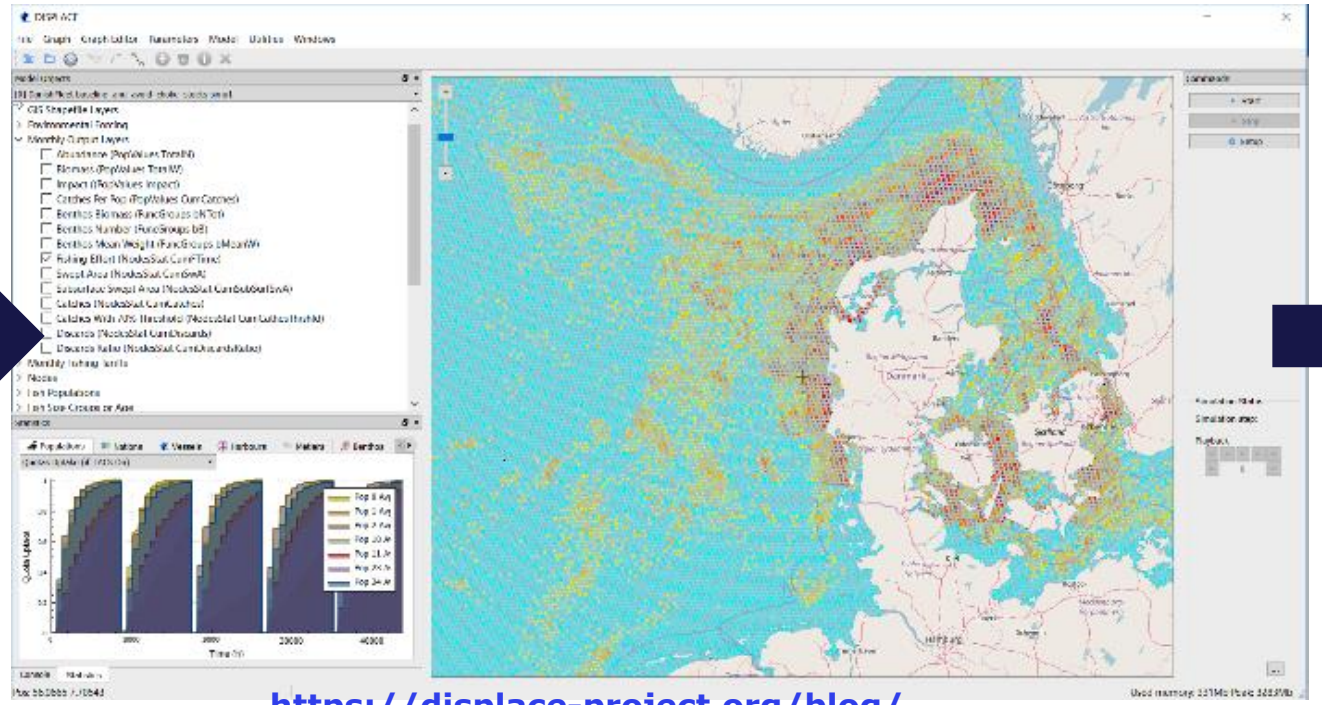
INPUT: VMS, Logbooks, Sales slips, Cost structure per fleet



INPUT: gear specifications, biological parameters, foodweb



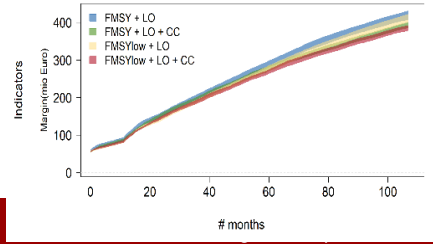
DISPLACE testing alternative worlds (policy options etc.)



https://displace-project.org/blog/

OUTPUT: time series of biological stock indicators (F, SSB, R)

OUTPUT: time series of economic indicators (GVA, fuel efficiency, etc.) for vessels, fisheries , fleets.



GAP analysis

Fishing/fisheries management

STAKEHOLDER CONCERN

Risk of stock collapse
Bycatch
1% catch of the mesopelagic biomass already extremely interesting
backed quota and adequate enforcement in the fishery

MEESO MODELS ADDRESS

DISPLACE (Stock collapse, management)
TROPFISH R / S6 model (Stock collapse, quota)
FLBEIA MODEL (Stock collapse, abundance, impact fishery)
WP7 Spatially explicit models to evaluate area-based management scenarios (Area based management)
NORWECOM (stock collapse, quota, bycatch possibly)
STRATHSPACE (stock collapse, quota)
SEAPODYM (stock collapse, quota)

GAP: bycatch (possibly)

Governance

STAKEHOLDER CONCERN

Lack of adequate institutions
Collaboration & enforcement in international waters
Sequential exploitation
The challenge for governance is that pending more knowledge about the ecosystem decisions need to be made (either fish for food or the role in carbon sequestration).

MEESO MODELS ADDRESS

WP7 SD DMDU model (strenght of governance/institutions, food security)

GAP: sequential exploitation, distinction inside & outside international waters, imperfect knowledge & need to decide regardless

Economics (incl. fisheries GHG emissions)

STAKEHOLDER CONCERN

Jobs, income, profits from a fishery
Who will profit – who has access?
Indirect effects?
At what scale it will be economically viable, considering the investments needed and the market
Large CO2 from fishing

MEESO MODELS ADDRESS

DISPLACE (income, profit, scale, GHG emissions)
WP7 SD DMDU model (profit, scale, market = exogenous, GHG emissions)
WP6 calculations (income, profit, scale, GHG emissions, market = exogenous)
FLBEIA (income, profit, scale, GHG emissions)

GAP: jobs (partially), indirect effects, market (partially), who has access

Ecology (Species distributions, biomass and biodiversity)

STAKEHOLDER CONCERN

We need a full understanding of what mesopelagic species exist, there:

- reproductive /lifecycle info,
- understanding of food web interactions, and
- processes that they contribute to
- Abundance

MEESO MODELS ADDRESS

SEAPODYM (Global distribution)
Strathspace (distribution, abundance, climate change)
NORWECOM (food web, abundance)
Statistical modeling (distributions)
TROPFISH R / S6 model (abundance, life history)
FLBEIA (abundance)

GAP none in relation to models, yet input of data is limited

Food security

STAKEHOLDER CONCERN

MP fish available for the poor and nutrient-deprived people
mesopelagic fish could be suitable for human nutrition (e.g. in soups or fortifying noodles). Protein and calcium can also be extracted for supplements for both humans and animal feeds.
fish for feed via aquaculture rather benefit the wealthier people
impact indirect; indeed these species fish for feed, but would thereby alleviate other fish for feed fisheries (anchovy)
rather than opening a new fishery it would perhaps be better to make food systems less wasteful

MEESO MODELS ADDRESS

WP7 SD DMDU model (viable harvest, waste, use for aquaculture production)
WP6 calculations

GAP: Distribution, food waste in general

Carbon flux

STAKEHOLDER CONCERN

Quantify carbon flux before exploitation
MSY+C approach
financially evaluate this ecosystem service
define mesopelagic areas as marine protected areas based on either biodiversity or carbon maps indicating areas with priority
Will fishing really impact this function?

MEESO MODELS ADDRESS

WP7 SD DMDU model (magnitude, fishing impacting C)
WP 7 Spatially explicit models (MPA's with carbon)
SEAPODYM (magnitude, fishing impacting C)
NORWECOM (magnitude, fishing impacting C)
*WP 6 calculations*magnitude, fishing impacting C, financial evaluation)

GAP: none?

Q&A

content questions for your topic of preference can be asked in break out rooms

Break-out groups

	Topic / Function 1	Topic 2	Topic 3	Topic 4
Model 1				
Model 2				
Model 3