

How spatial planning constrains transnational fisheries: the bio-economic DISPLACE evaluation on the Baltic Sea



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Keywords for a socio-economic impact evaluation

- Descriptive vs. Model-based approach
- Static vs. dynamic evaluation
- Short-, medium-, long-term effects
- Homogeneous vs. spatially structured
- Aggregated into fleets (average) vs. Individual vessels
- Simple vs. Full complexity
- Qualitative vs. quantitative
- Determinist vs. Handling uncertainties
- CFP vs. MSFD vs. MSP

Competition for marine space and fisheries – A summary

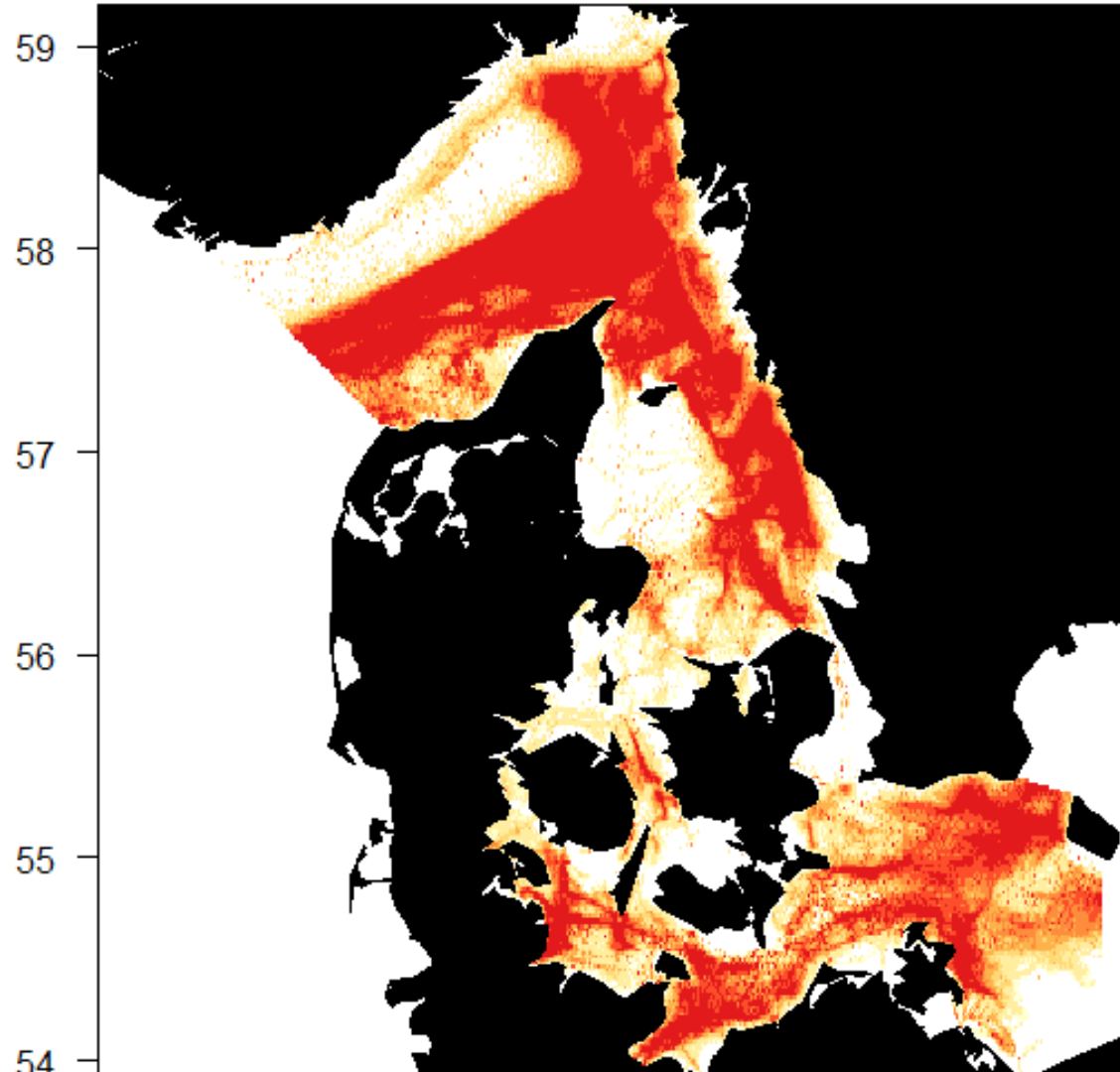
- **Maritime spatial planning (MSP) constrains fisheries** which require empowering the fishing industry and managers with the right tools and knowledge to engage in MSP dialogues.
- **Impact assessment** of planned offshore windmills farms and conservation zonation in the Baltic Sea is conducted with the DISPLACE model-based, dynamic, complex, stochastic individual-based approach.
- **Interlinked dynamic of vessels and stocks** show higher revenue from catches over the medium term which offset the additional costs from effort displacement, with released pressure on the stocks and habitats.
- **At the individual scale**, some vessels are strongly affected, not able to maintain catch rates, also creating new opportunities for competitors.

Newest available data

**Fine scale mapping of
fishing pressure**

**DEN+GER+SWE
In Western Baltic**

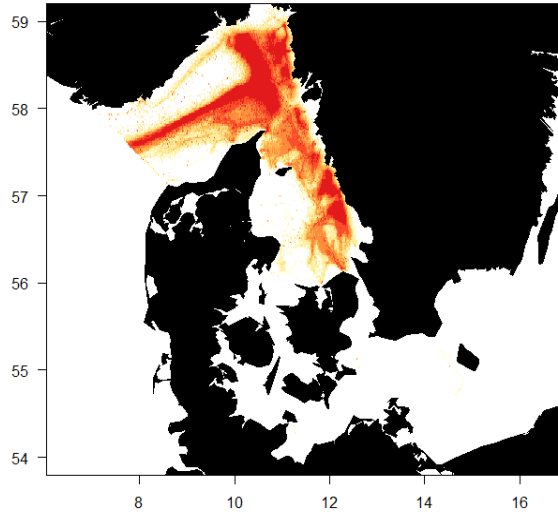
VMStools in 



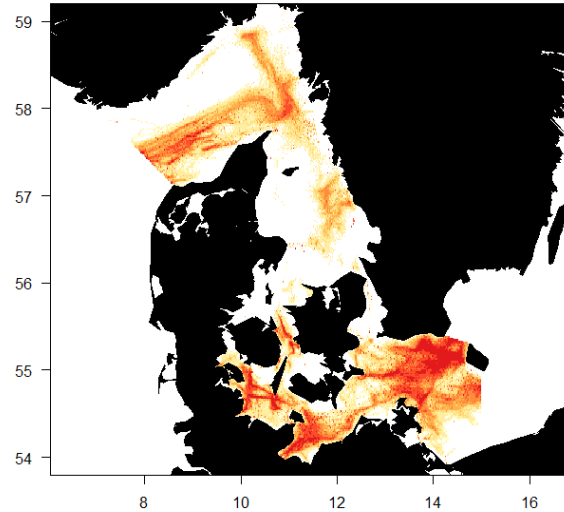
Newest available data



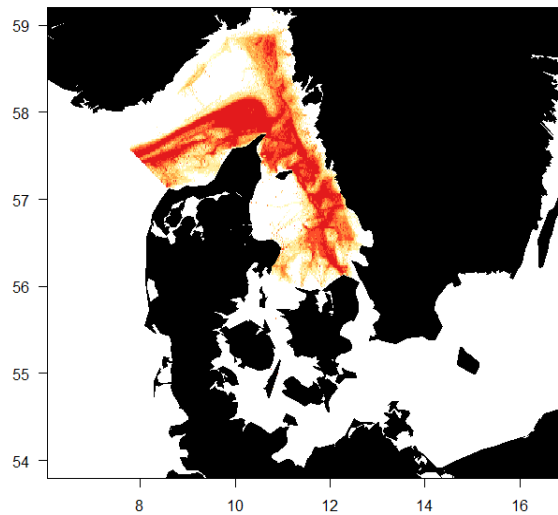
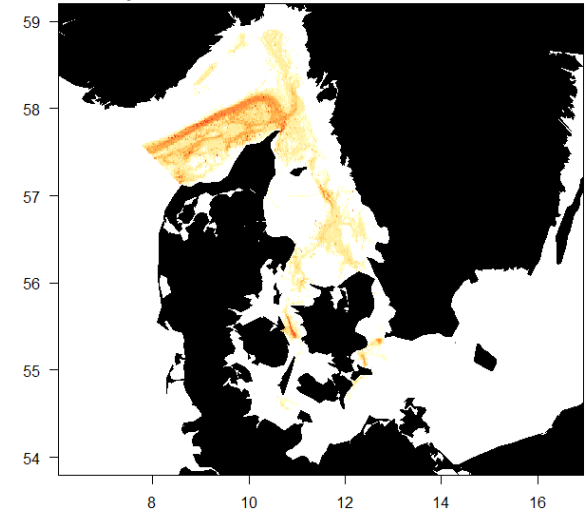
OT_CRU (single-species fishery for *Pandalus* and *Nephrops*)



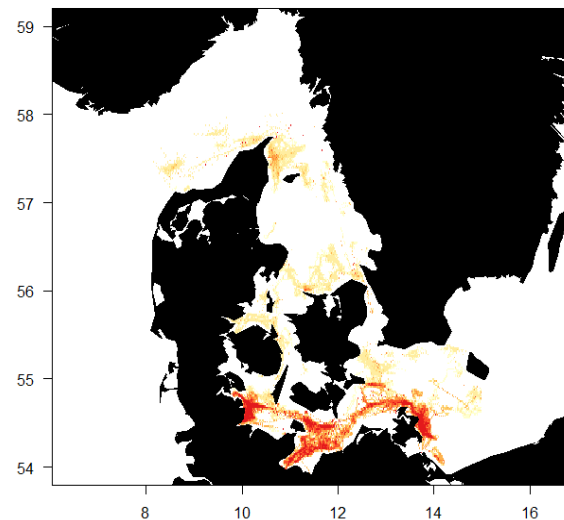
OT_DMF (single species fishery for demersal fish like cod and plaice)



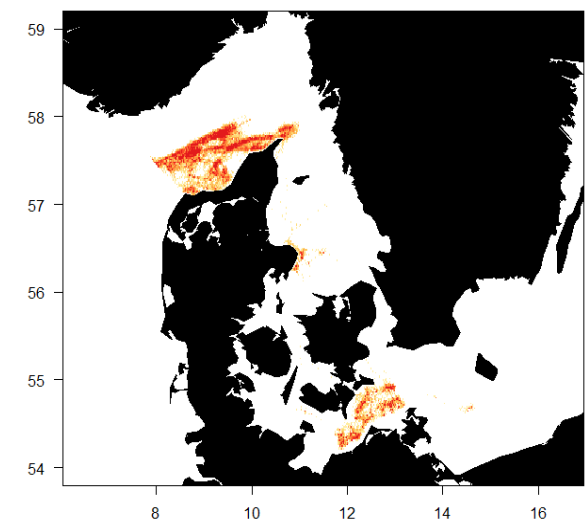
OT_MIX_DMF (mixed fishery for demersal fish such as haddock and cod)



OT_MIX_NEP (mixed fishery for *Nephrops* and demersal fish)



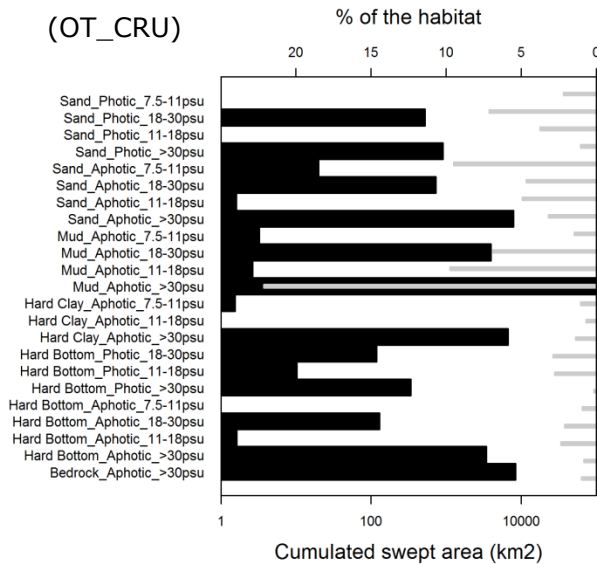
OT_SPF (single-species fishery for small pelagic fish such as sprat and



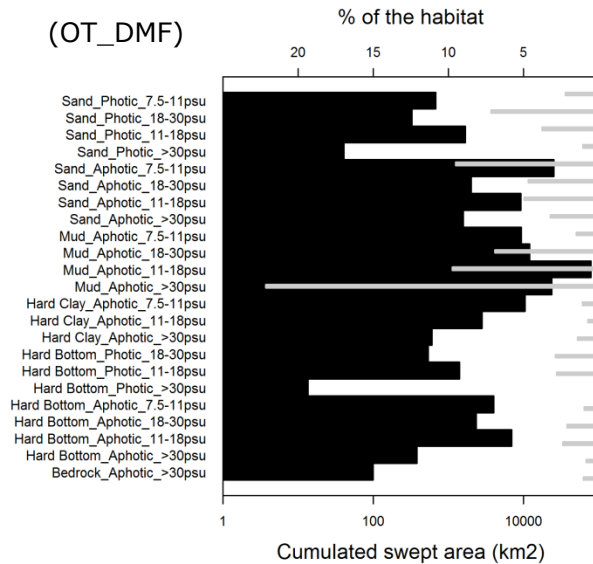
SDN_DEM (single species fishery for demersal fish like cod and plaice)

Overlaying effort and habitat

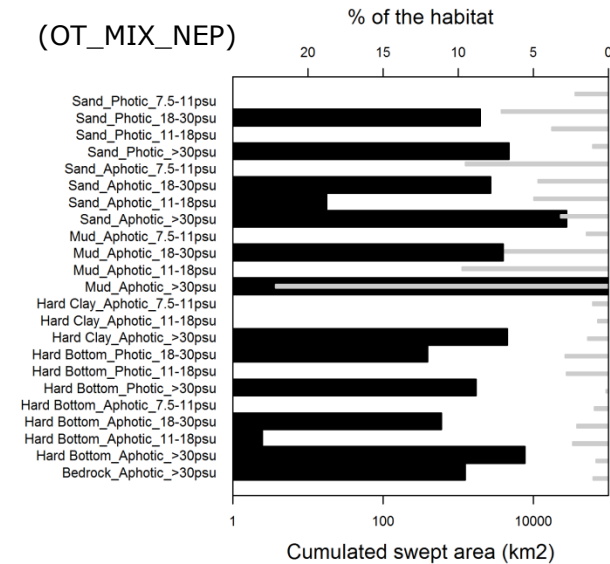
(OT_CRU)



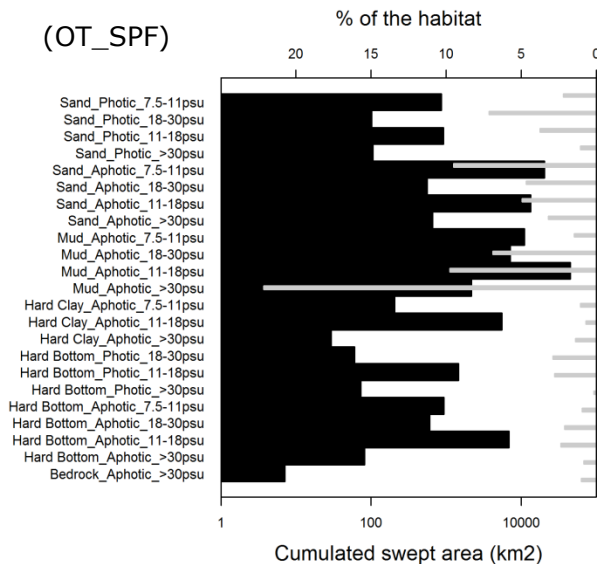
(OT_DMF)



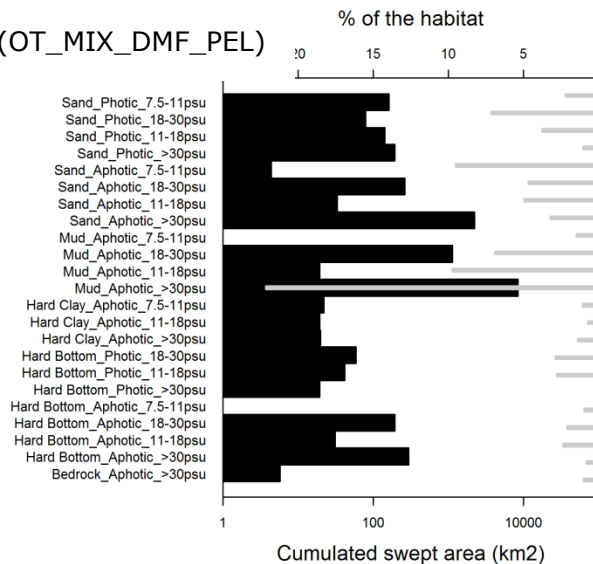
(OT_MIX_NEP)



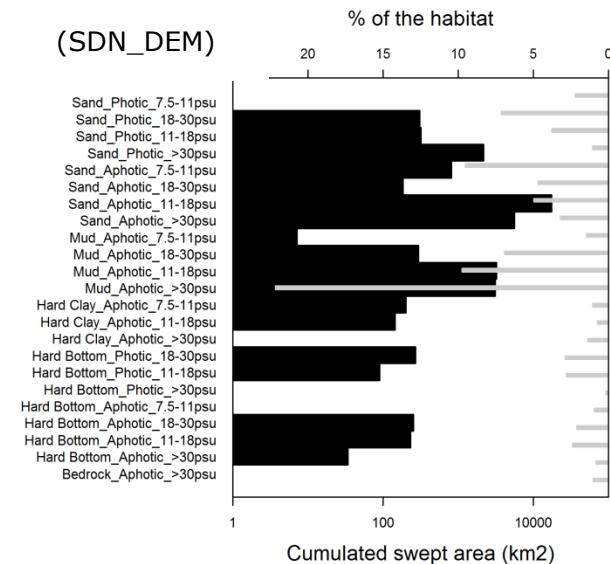
(OT_SPF)



(OT_MIX_DMF_PEL)

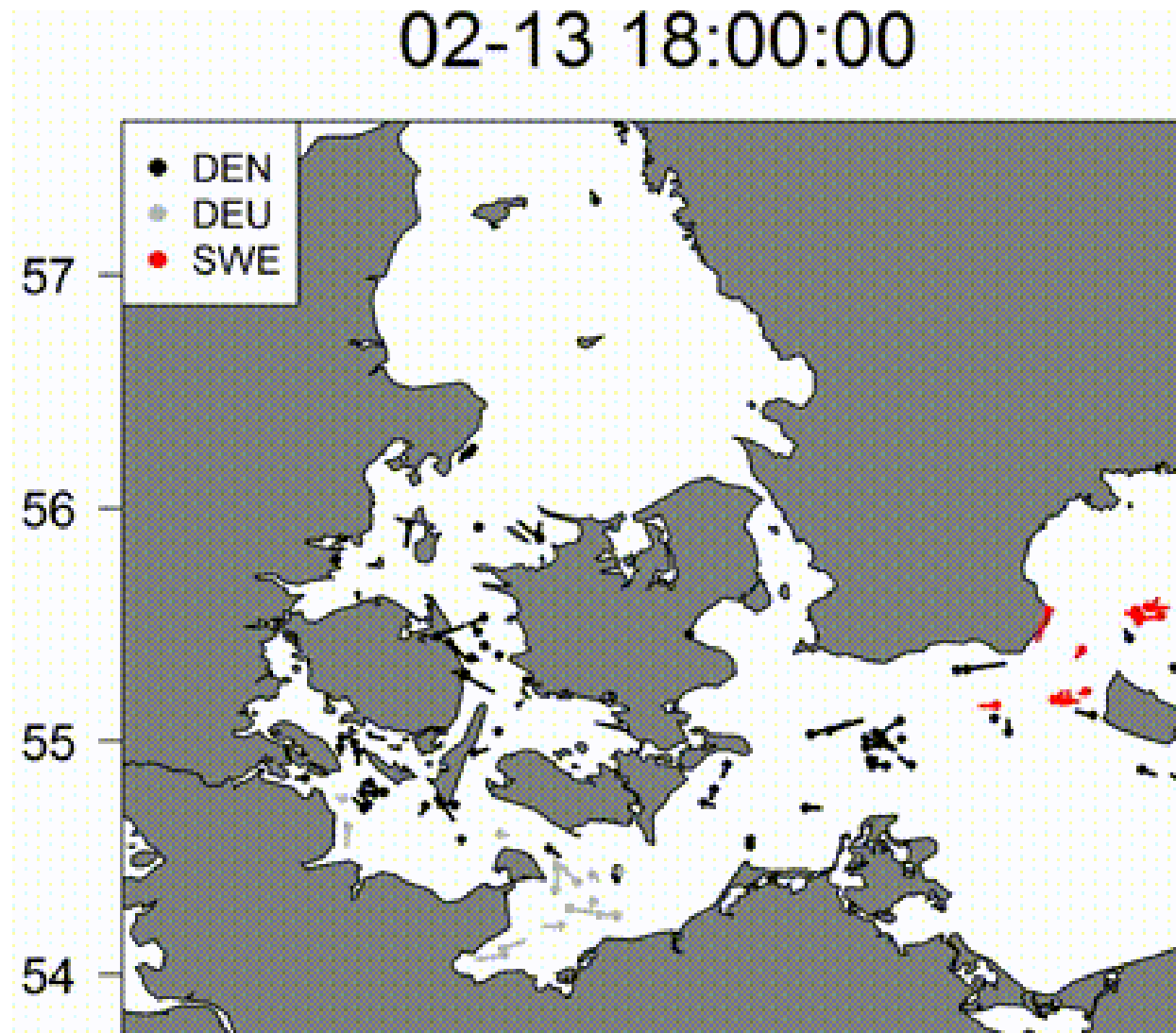


(SDN_DEM)



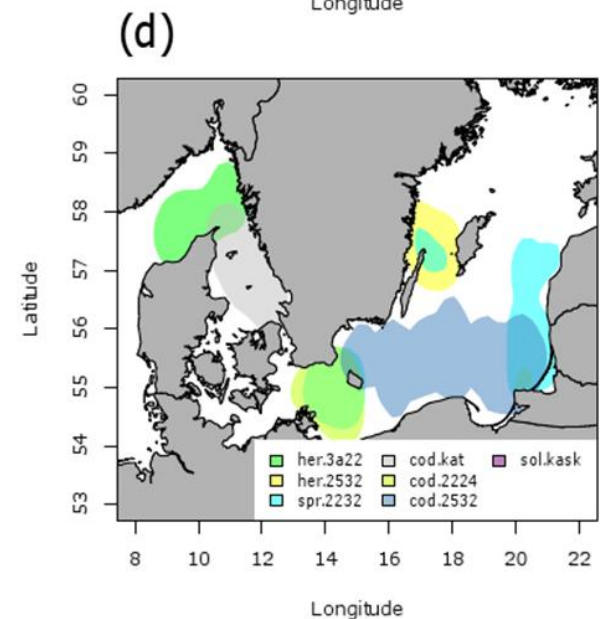
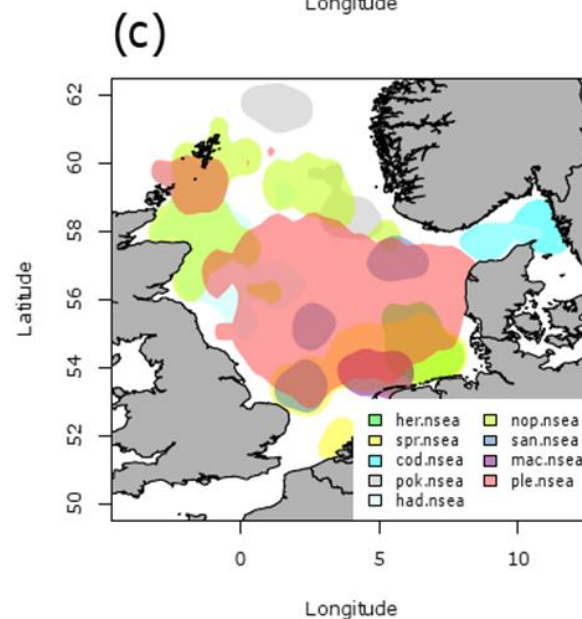
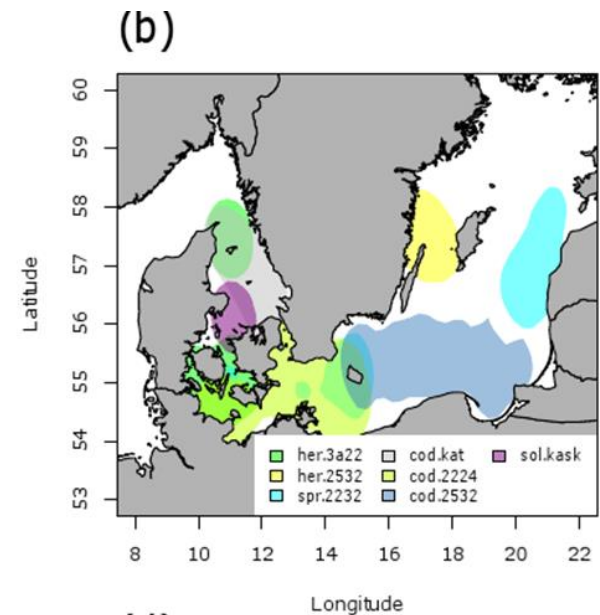
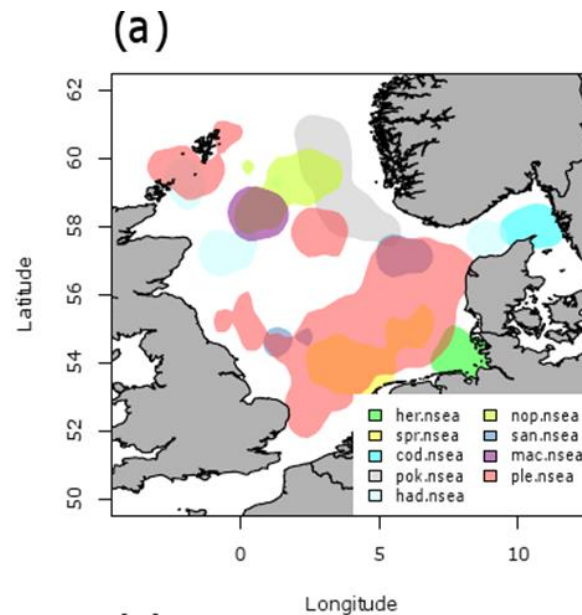
Newest available data

Individual vessel activities

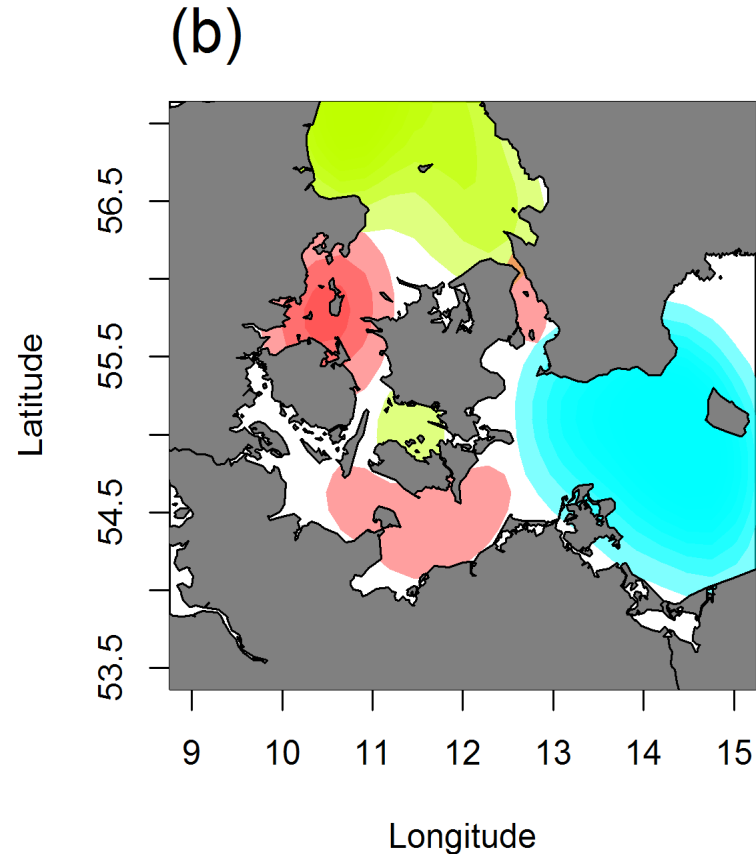
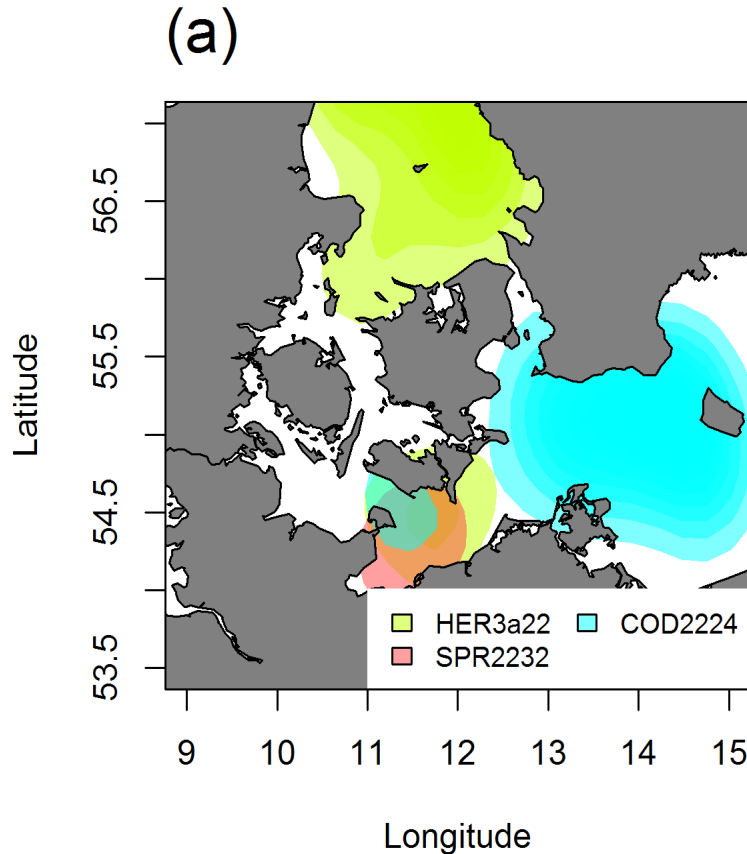


Newest available data

**Spatial
resource
availability
of different
stocks based
on research
surveys data**



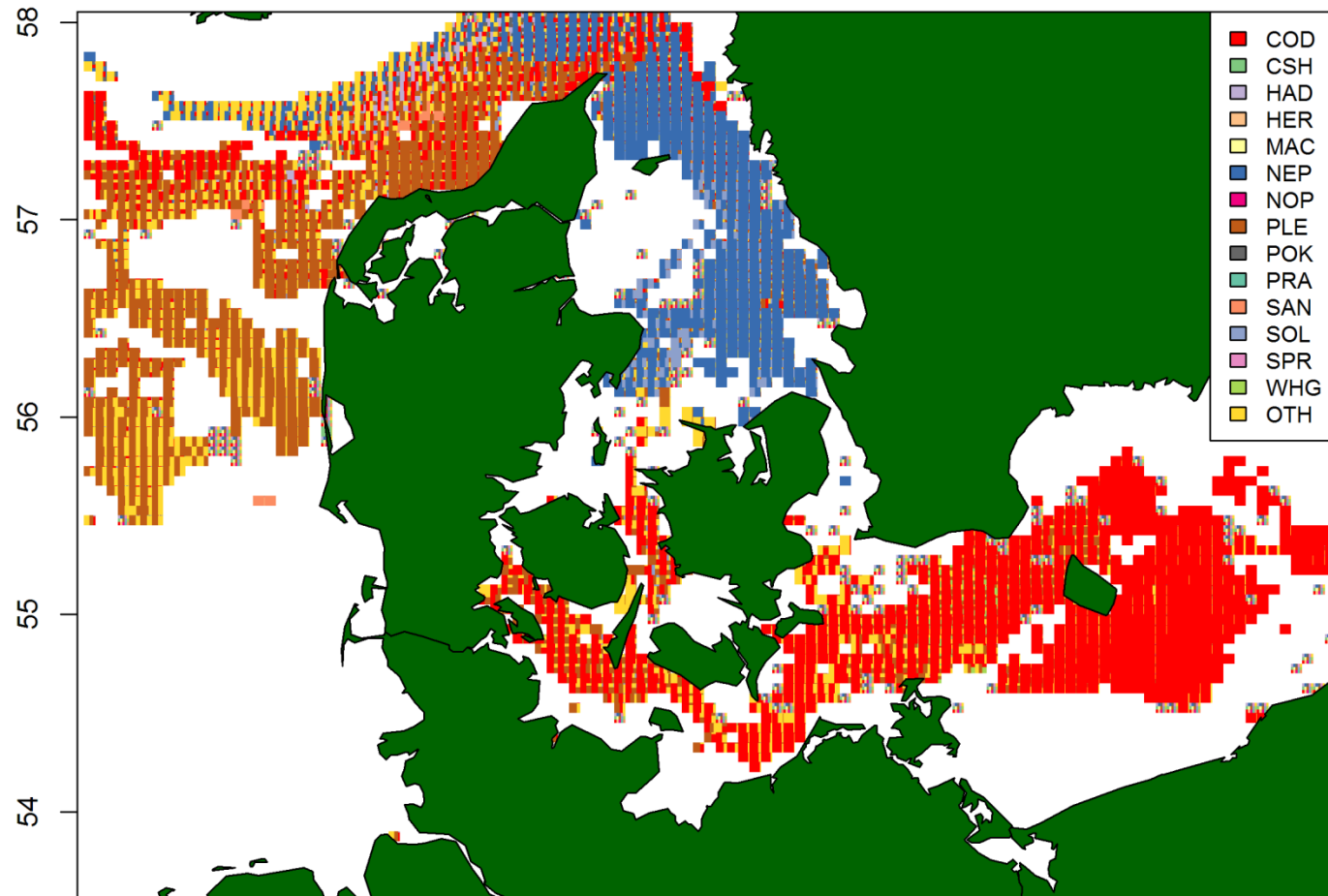
Newest available data



Cod, herring and sprat, the most commercially important stocks in the Baltic Sea area

Newest available data

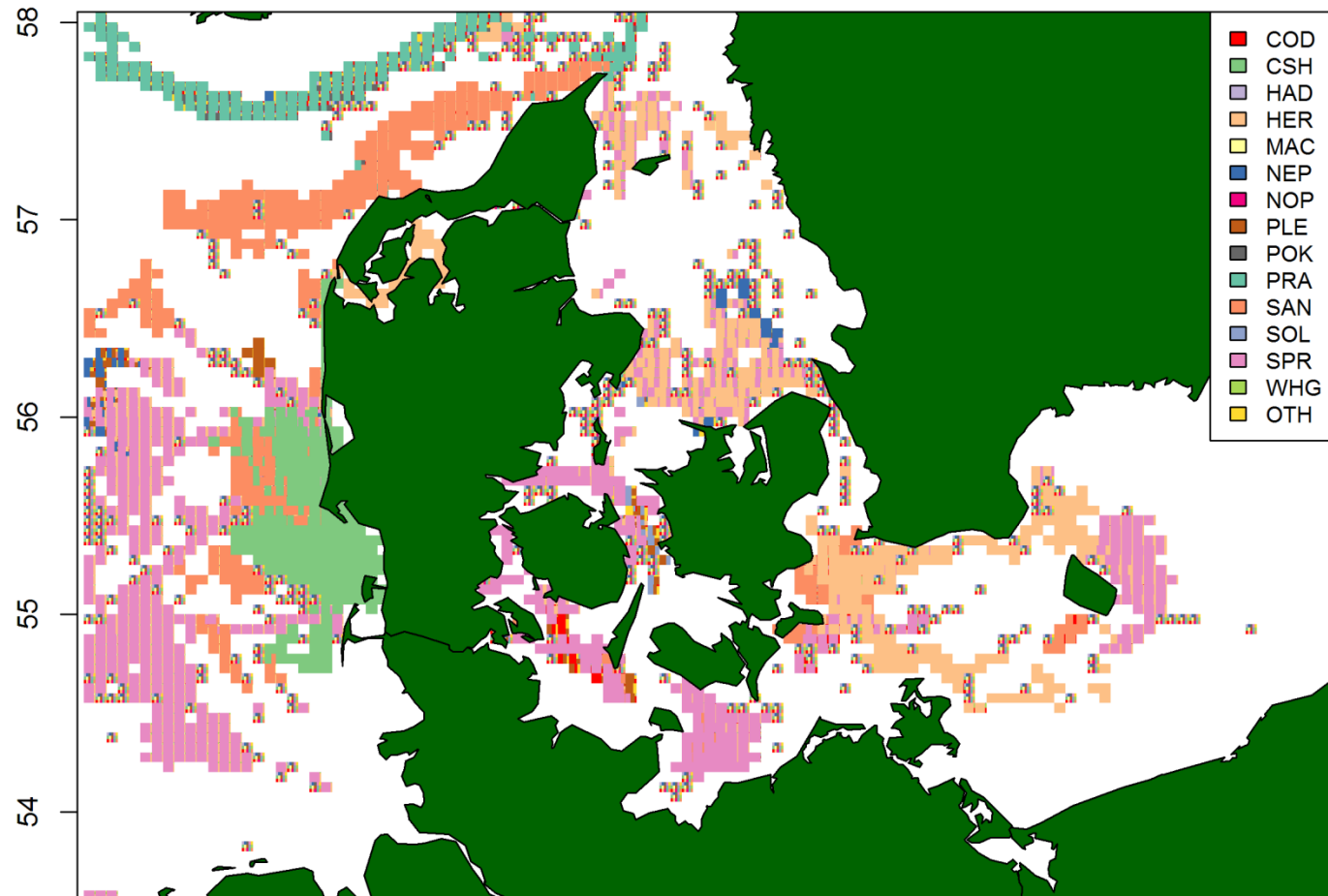
Mapping origin of landings x effort to deduce spatial catch rates



VMStools
>100mm,
0-24m

Newest available data

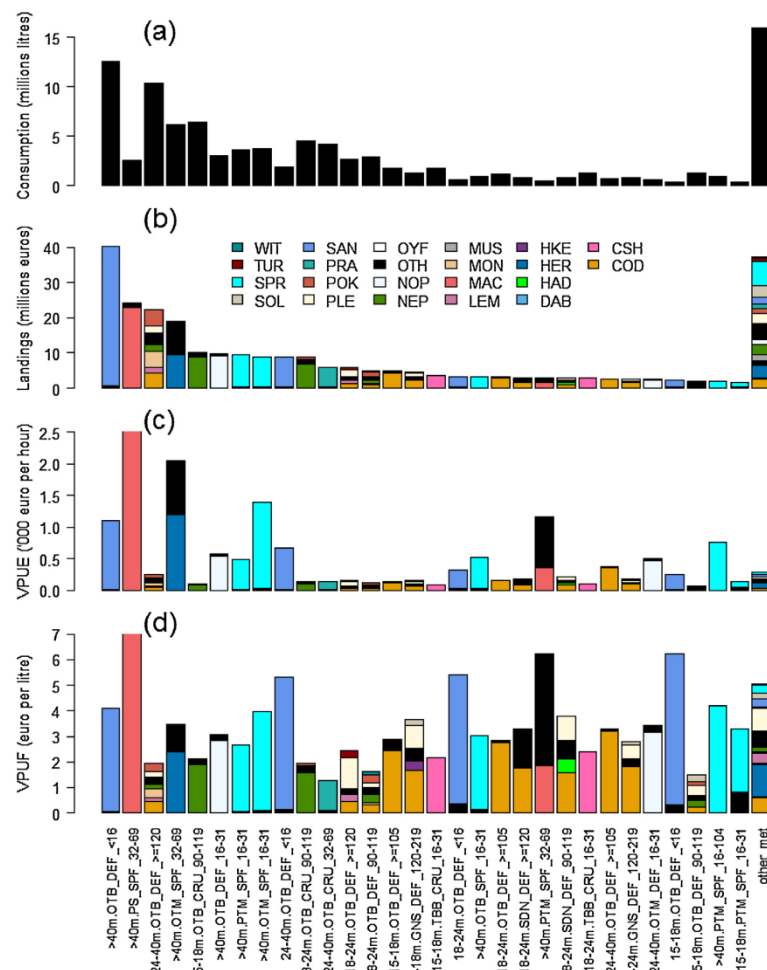
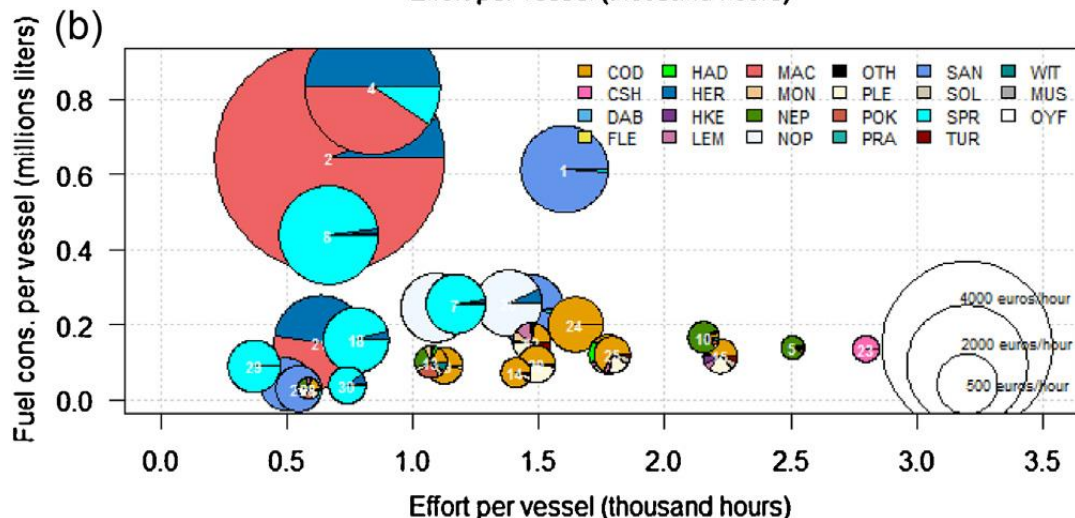
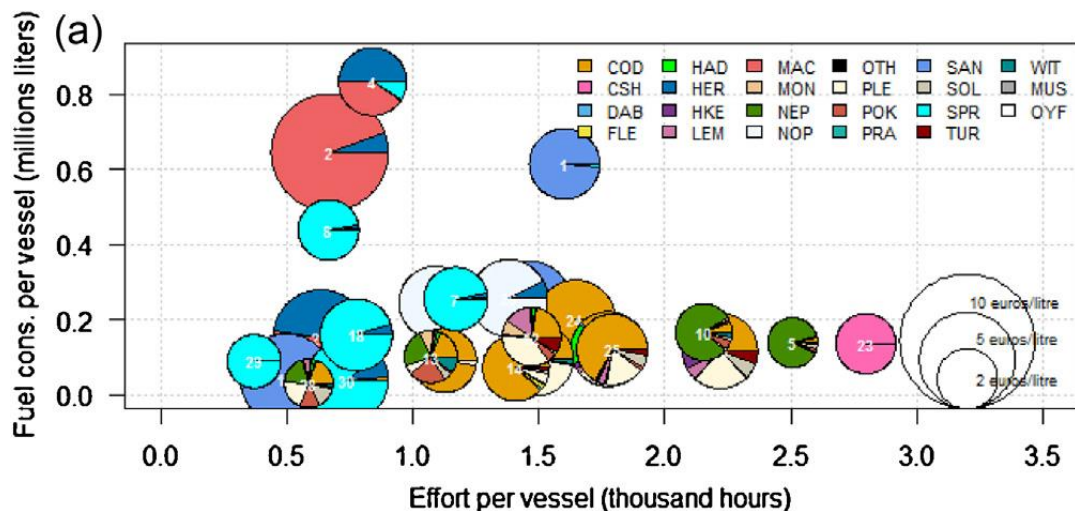
Mapping origin of landings x effort to deduce spatial catch rates



VMStools
<100mm,
0-24m

Evaluation of fisheries energy efficiency

2005-2010



A static evaluation – W. Baltic Sea



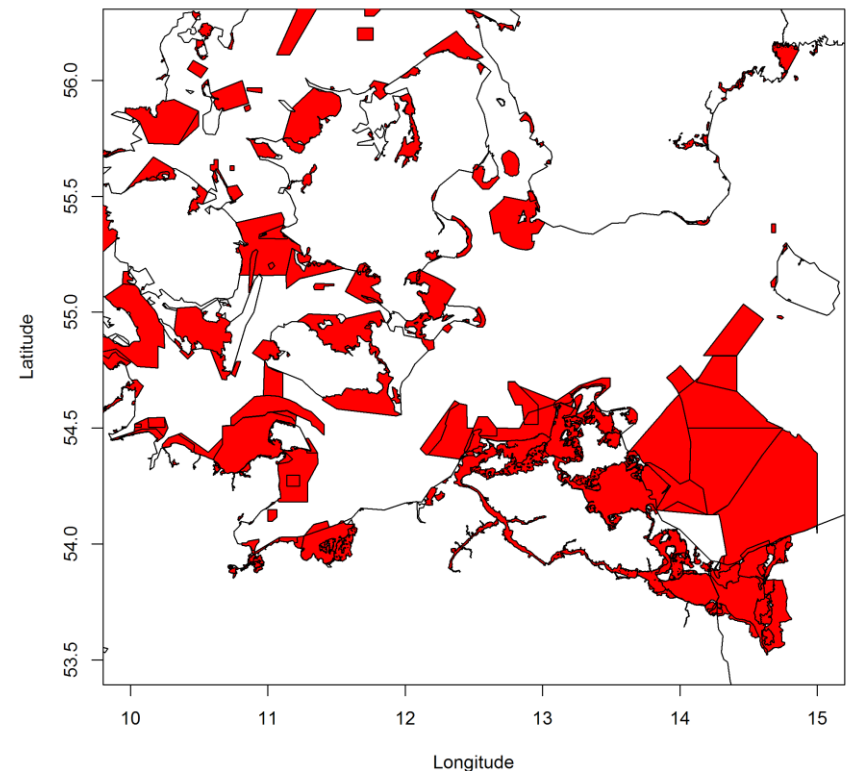
Fishing activities constrained by the BSAPs/NATURA 2000 sites (seabirds directive; habitat directive)

Reduced fishing activities within the areas?

(...to be defined among

- * Strict nature reserve,
- * Protected areas with sustainable use of natural resources,
- * etc.)

Target is to develop and apply by 2015, management plans and/or measures for already existing BSAPs.



A static evaluation – W. Baltic Sea



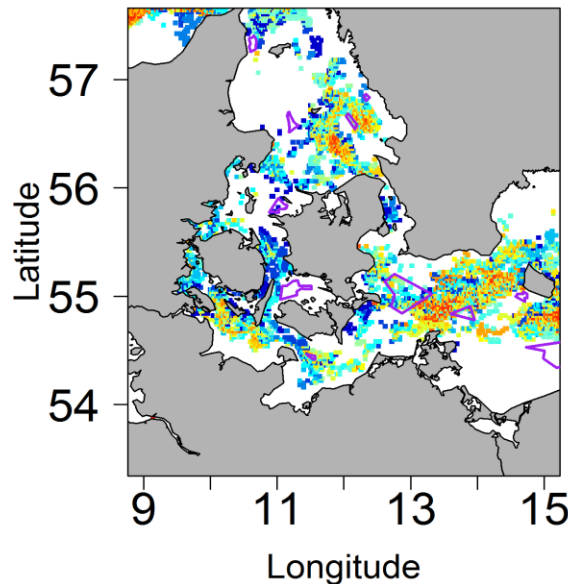
Displacement from implementation
offshore windmill parks

Sustainability of the cod, sprat and
herring exploitation (mngt targets)
and evaluation of the economic
viability including consequences on
cost for fishing

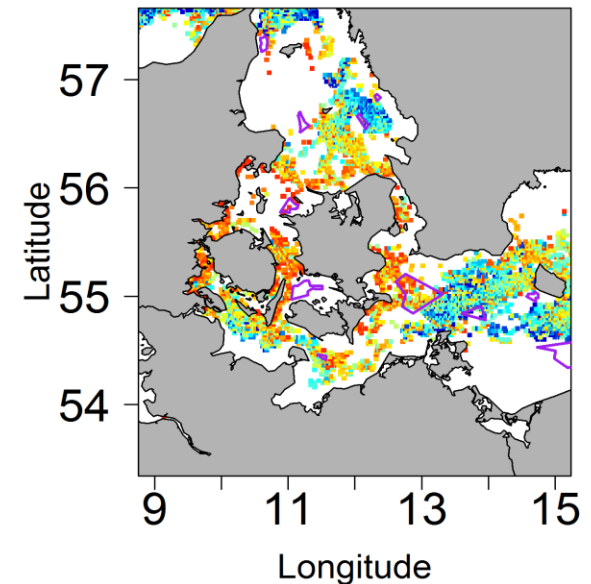
Here, a static view
at time $t...$

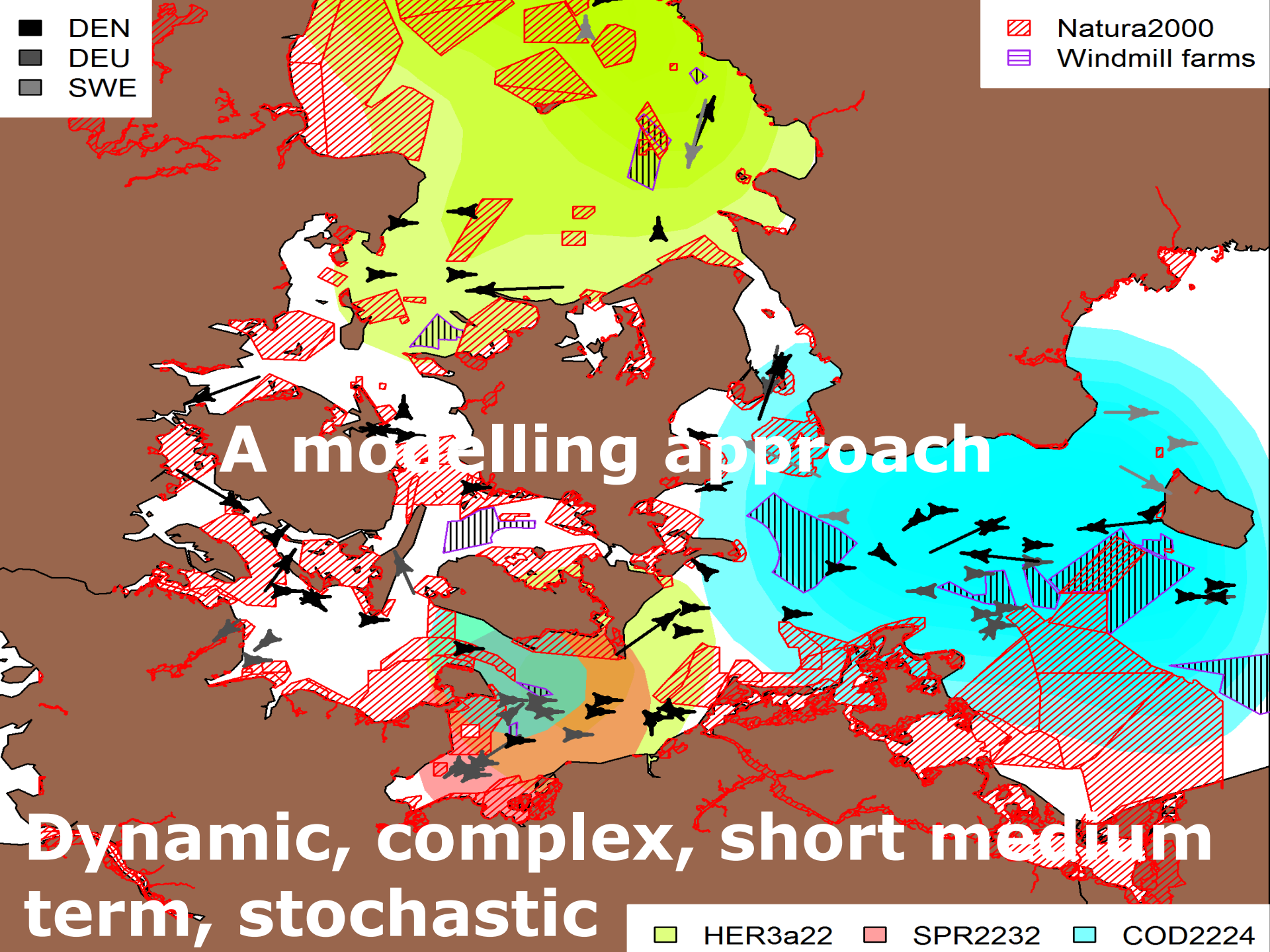
...but can the
closures be
compensated when
accounting for
medium-long term
dynamics?

(a) Importance of the grid cell



(b) Contribution of the grid cell



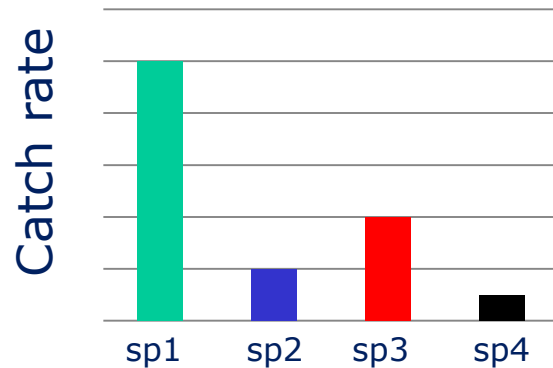


A DISPLACE evaluation – Baltic Sea

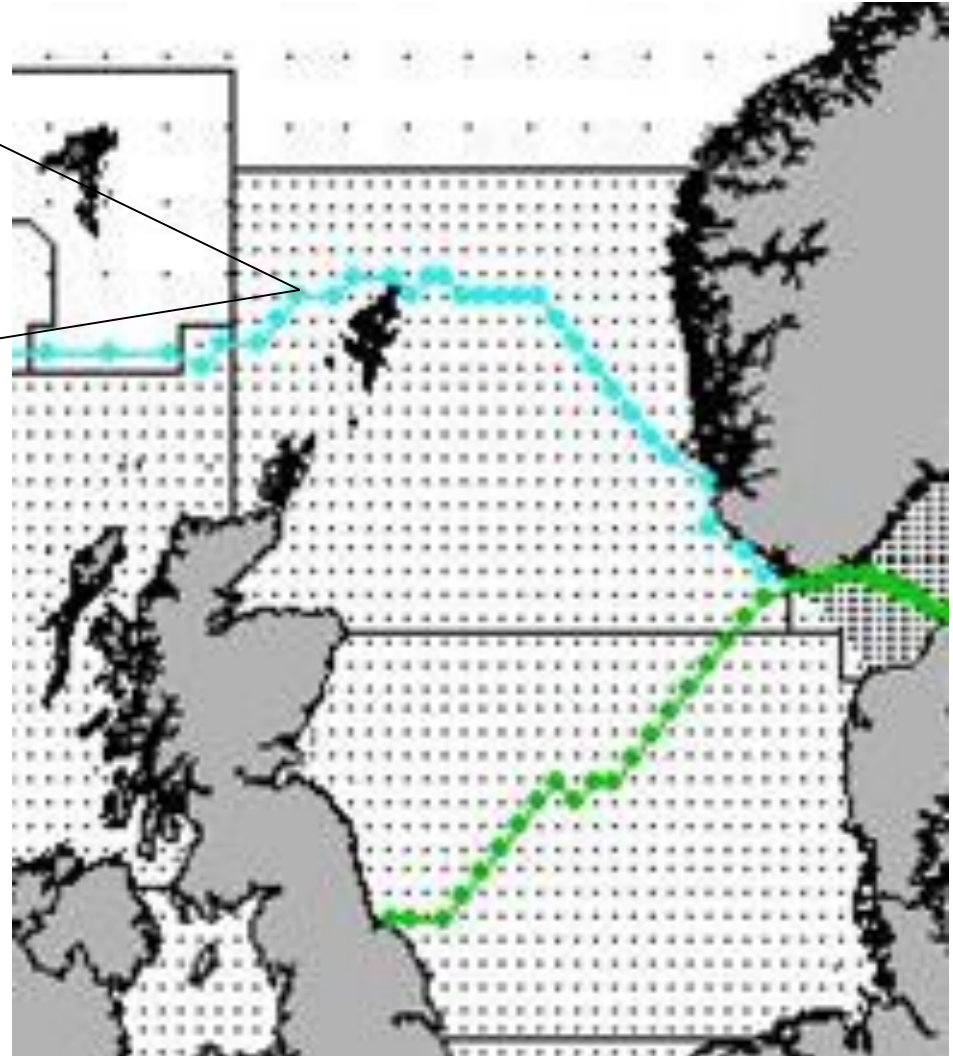
- Parameterization of DISPLACE for the international western Baltic Sea fisheries (>12m, DEN, SWE and GER)
- Scenario evaluation under spatial constraints from offshore windmill plans and NATURA 2000 zonation
- Sustainability of the cod, sprat and herring exploitation and evaluation of the economic viability including consequences on cost for fishing
- (MSE framework incorporating trophic interactions with coupling to the SMS multistock stochastic model)



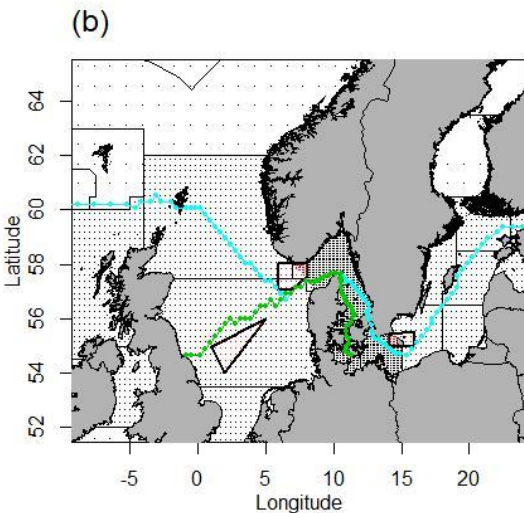
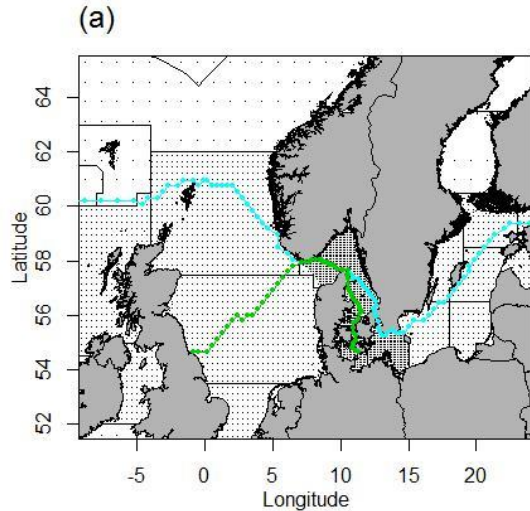
Designing an individual based simulation model of vessel catch



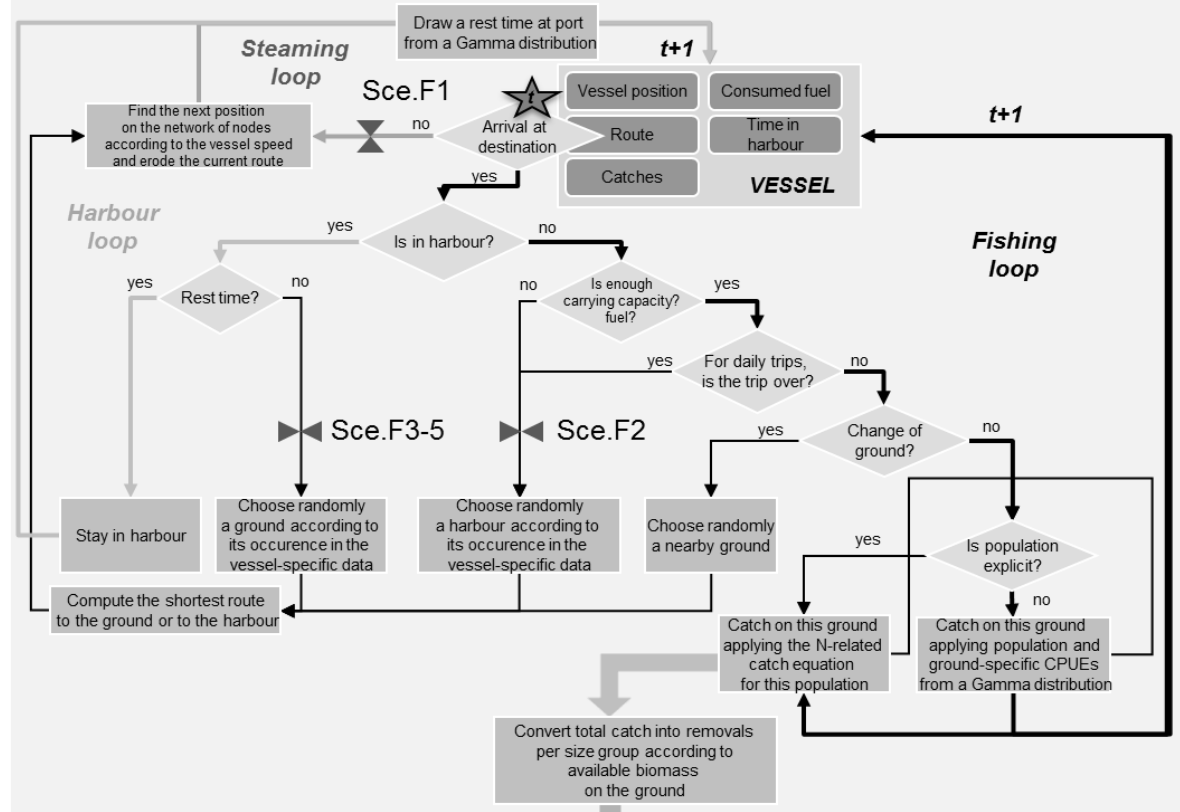
Each vessel has seasonal- activity- and species-specific CPUEs on each node which vary with the underlying available biomasses



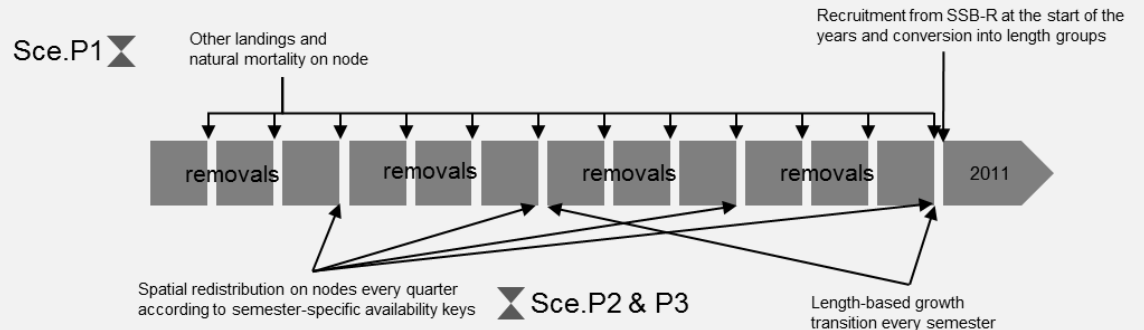
Bio-economic IBM DISPLACE Model



(a) VESSEL DYNAMICS ON NODES



(b) POPULATION DYNAMICS TIMELINE ON NODES



Major model assumptions

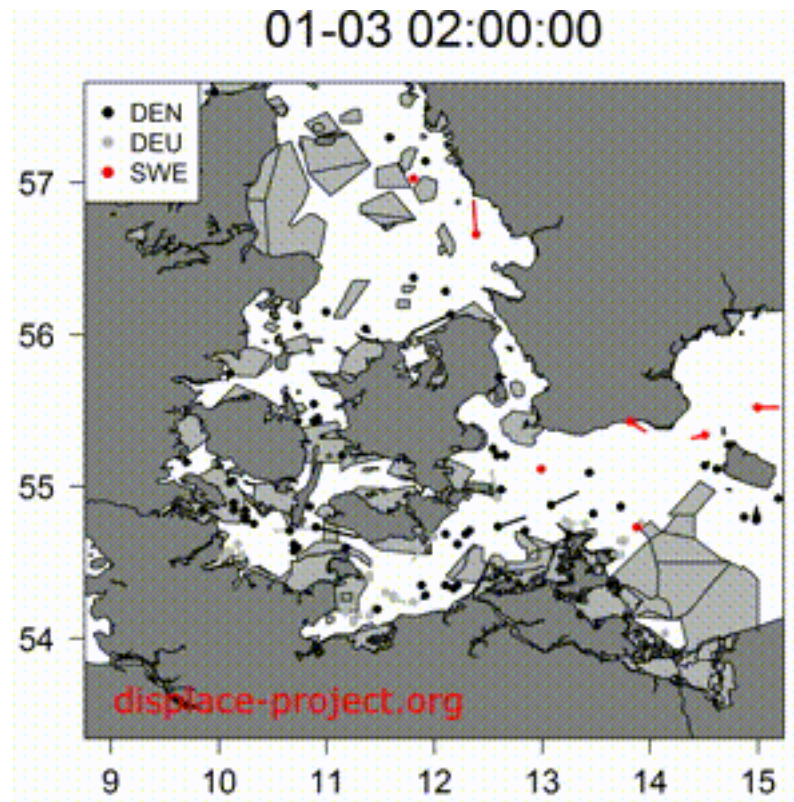
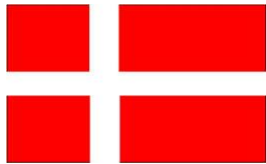
- Effort allocation are stable patterns (i.e. grounds and ports visited) and a given vessel change habits only if it is forced to do so
- The total active number of vessels is constant over the projection period
- Individual quota allocation is constant (and indexed on the global TAC) and the trade of individual quota is not handled
- Ending a trip is only the consequence of one of the three events listed: no more catch storage, running out of fuel, the vessel use to conduct daily trip.
- The baseline scenario assumes that the vessels adapt their visits toward the grounds with the highest perceived expected profit they can make out of it.
- Constant harbour- and size specific fish and constant fuel price

Scenario evaluation

Management Option	Risk factor 0	Risk factor 1	Risk factor 2
Status Quo	Baseline		
Alternative 1	Wind		
Alternative 2	Natura2000	Natura2000+LowProd	
Alternative 3	Wind+Natura2000	Wind+Natura2000+LowProd	Wind+Natura2000+20%FuelPrice

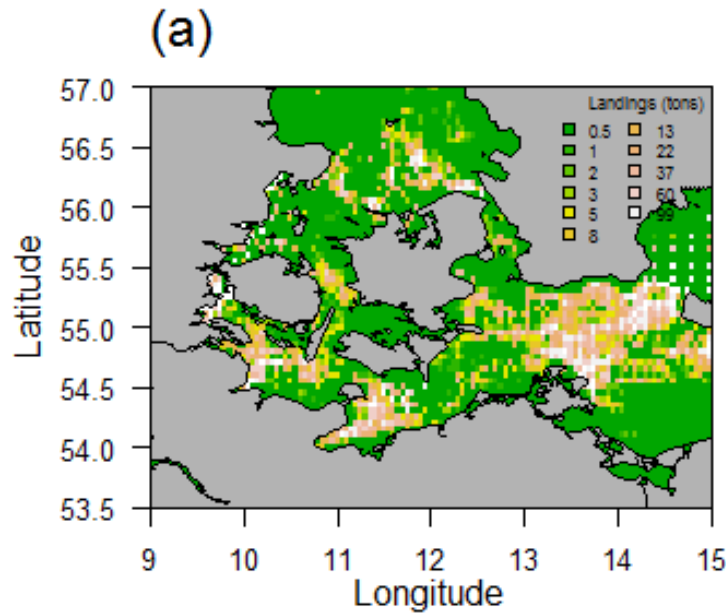
A DISPLACE evaluation – Baltic Sea

- Parameterization of DISPLACE for the international western Baltic Sea fisheries (>12m, DEN, SWE and GER)

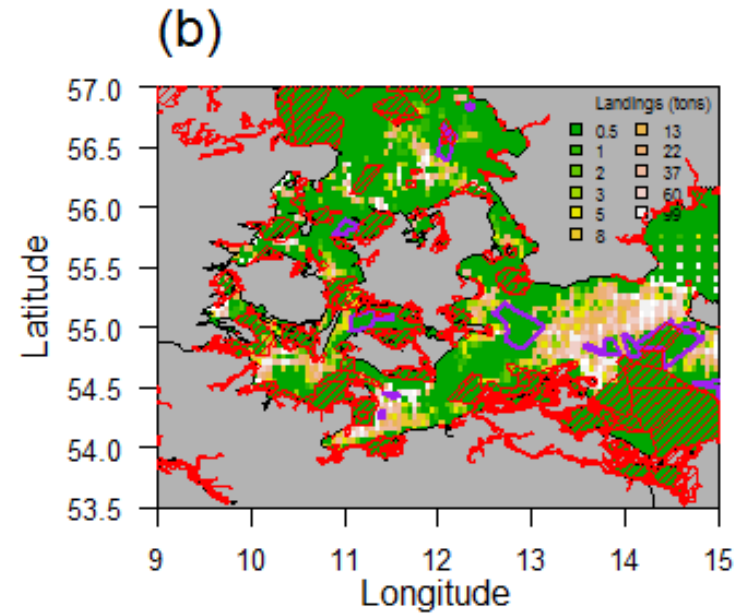


A DISPLACE evaluation – Baltic Sea

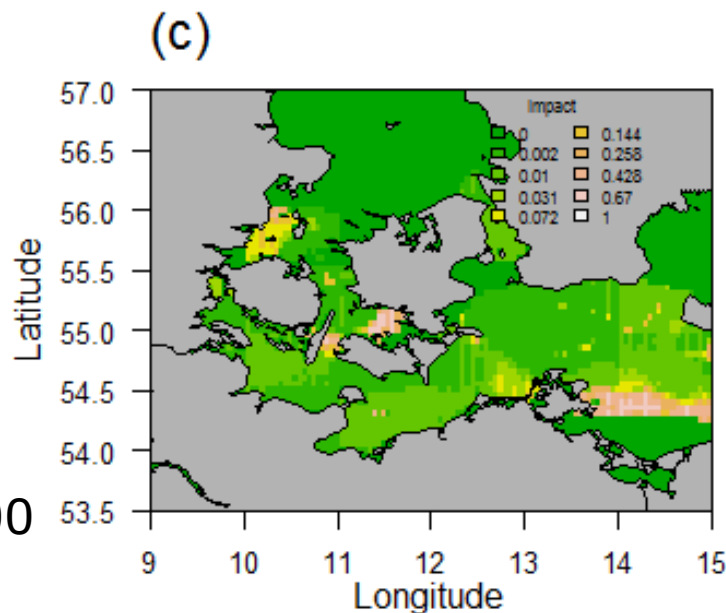
(a) Origin of landings



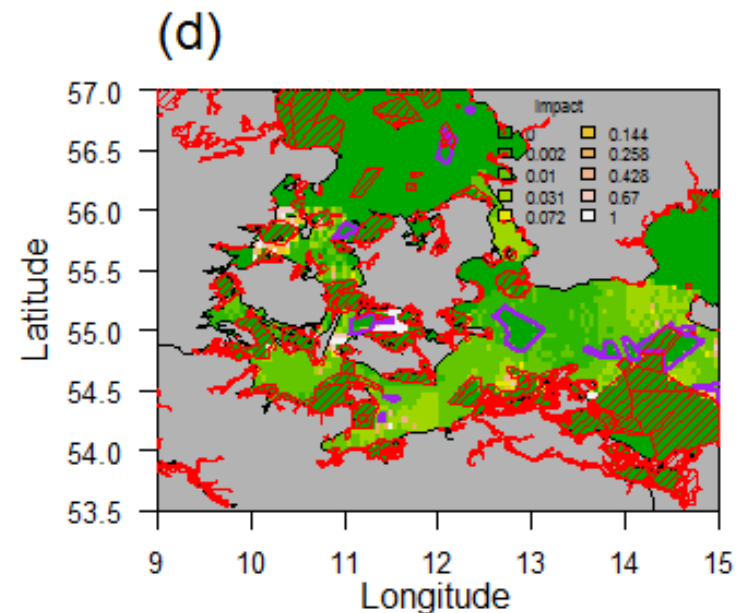
(b) Origin of landings with spatial restrictions



(c) Ratio harvest/avai. biomass



(d) Ratio harvest/avai. Biomass with spatial restrictions



Wind+Nat2000
and cod

Consequences on fisheries of alternative scenarios – trip patterns

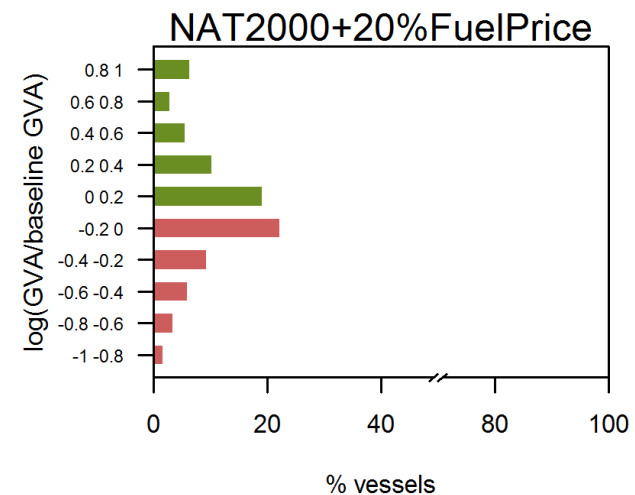
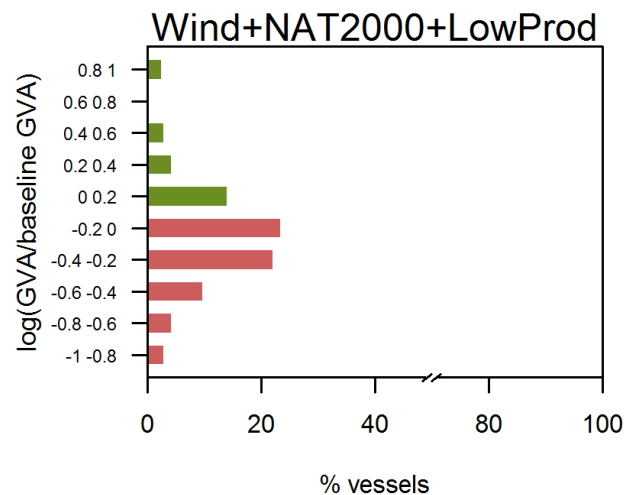
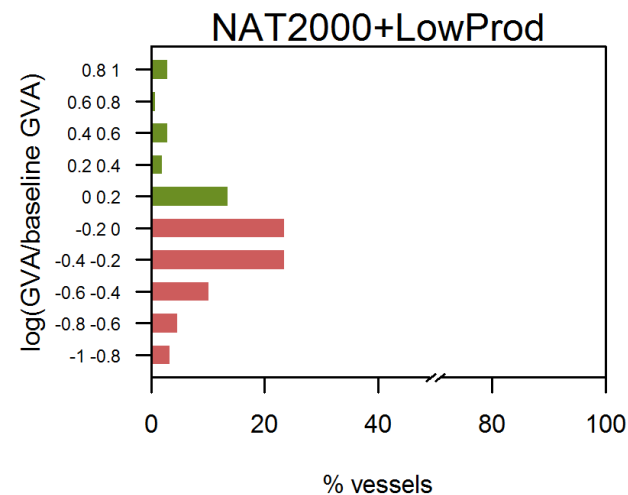
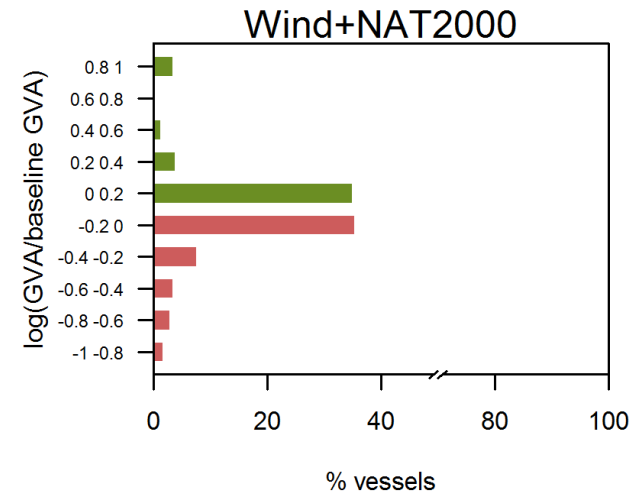
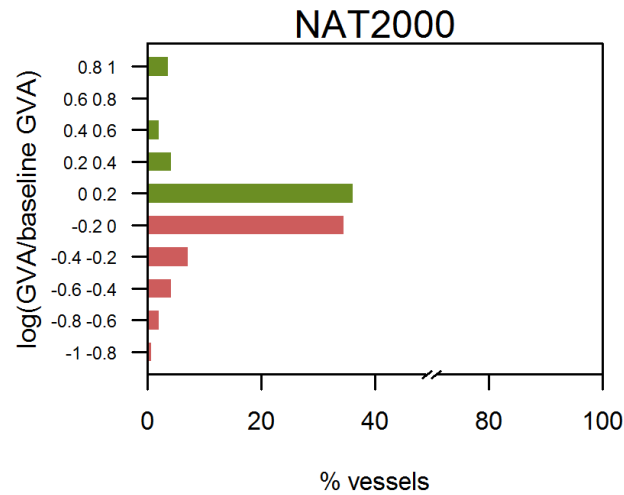
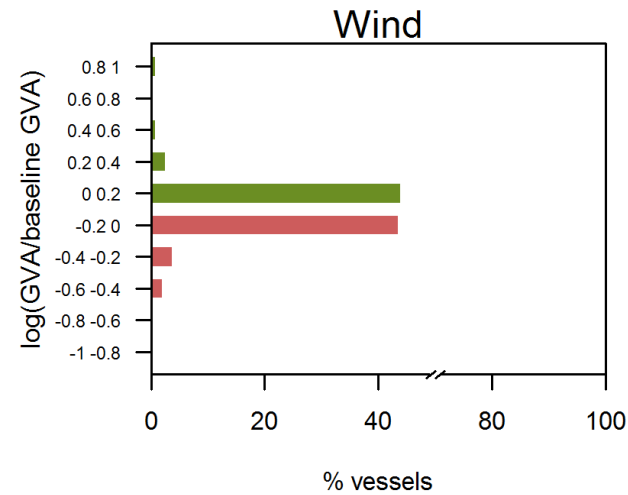
Scenario	Total effort (%)	Steaming Effort (%)	Number of trips (%)	Average trip duration (%)
Wind	$-1.0 \pm 0.5^{**}$	$0.2 \pm 0.2^{**}$	$-0.5 \pm 0.2^{***}$	-0.2 ± 0.3
NAT2000	$-1.9 \pm 0.5^{***}$	$1.0 \pm 0.2^{***}$	$-4.8 \pm 0.2^{***}$	$4.5 \pm 0.3^{***}$
Wind+NAT2000	$-2.5 \pm 0.6^{***}$	$1.1 \pm 0.2^{**}$	$-4.7 \pm 0.2^{***}$	$4.0 \pm 0.3^{***}$
<u>LowProd</u>	0.5 ± 0.5	0.1 ± 0.2	$-0.3 \pm 0.2^{**}$	$0.6 \pm 0.3^{**}$
NAT2000+LowProd	$-1.8 \pm 0.5^{***}$	$+1.0 \pm 0.2^{***}$	$-5.2 \pm 0.2^{**}$	$4.9 \pm 0.3^{**}$
Wind+NAT2000+LowProd	$-2.2 \pm 0.6^{***}$	$1.2 \pm 0.3^{***}$	$-5.1 \pm 0.2^{***}$	$4.7 \pm 0.4^{***}$
Wind+NAT2000+20%FuelPrice	$-1.3 \pm 0.4^{***}$	$-0.9 \pm 0.2^{***}$	$-4.7 \pm 0.2^{***}$	$3.8 \pm 0.3^{***}$

50 runs per scenario

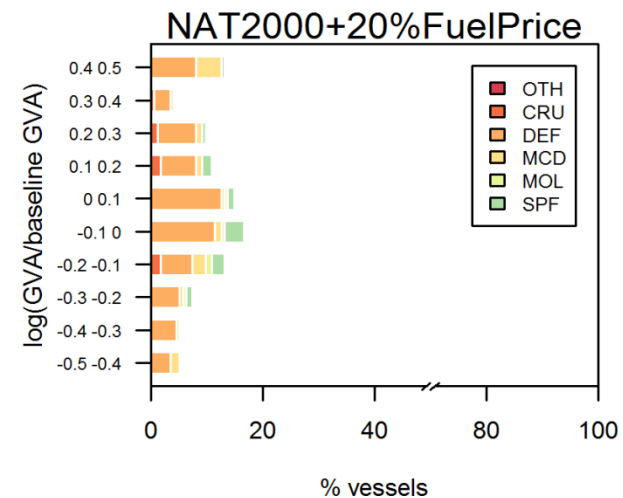
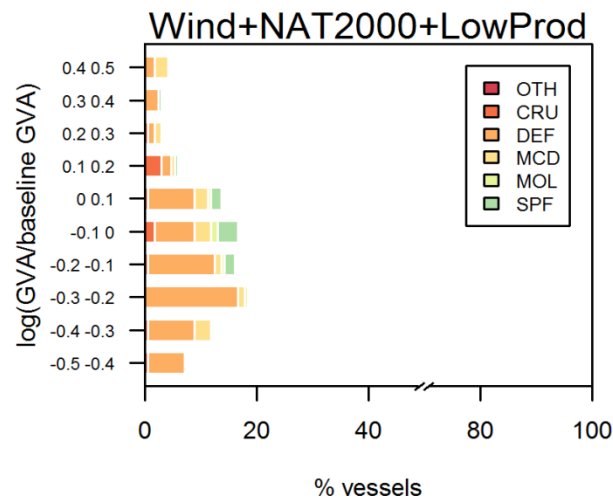
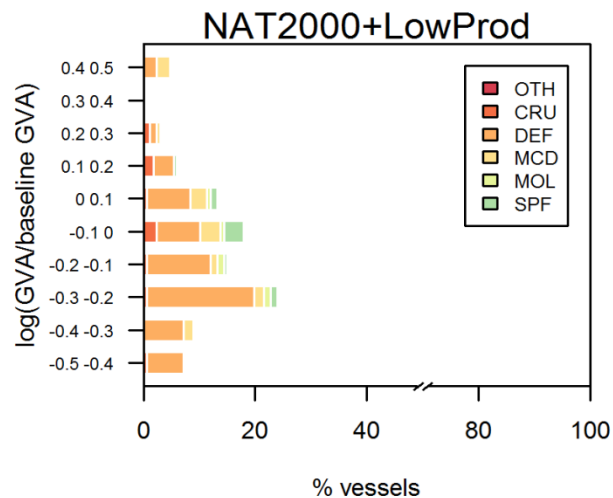
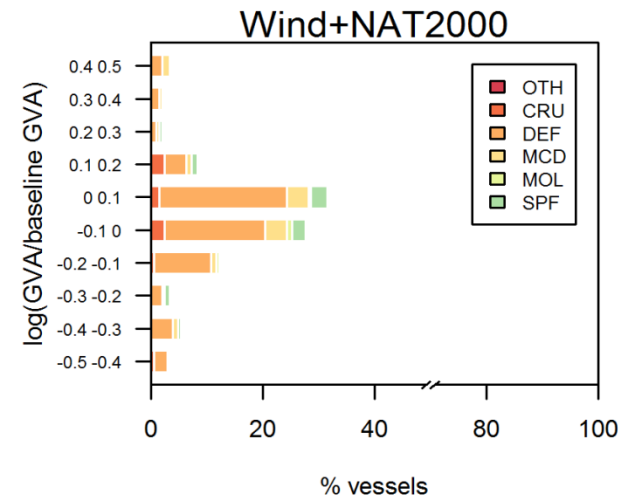
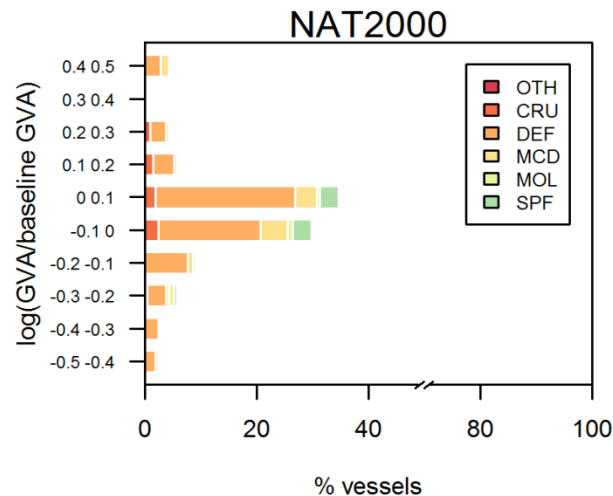
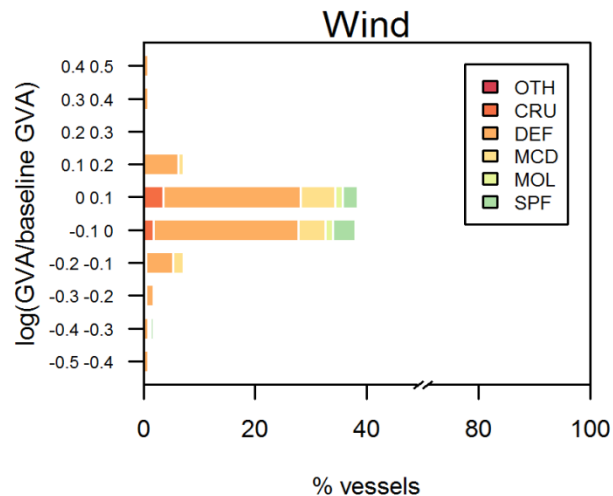
Consequences on fisheries of alternative scenarios – revenue, cost and energy efficiency

Scenario	Revenue (%)	Fuel cost (%)	CPUE cod only	CPUE cod sprat herring stocks (%)	CPUE other stocks (%)	GVA (%)	VPUF (%)
Wind	1.0 ± 1.6	0.1 ± 0.5	-1.1 ± 0.7**	2.2 ± 3.2	-0.8 ± 1.2	1.3 ± 2.0	1.7 ± 1.8
NAT2000	-2.4 ± 2.0*	-0.5 ± 0.5*	-2.4 ± 0.7***	5.9 ± 3.4**	-15.0 ± 1.2***	-2.8 ± 2.6**	-8.9 ± 1.8***
Wind+NAT2000	-1.2 ± 1.8	-0.9 ± 0.5**	-2.7 ± 0.7***	8.4 ± 3.1***	-13.7 ± 1.4***	-1.2 ± 2.5	-4.6 ± 2.0***
<u>LowProd</u>	-13.0 ± 1.9***	-0.1 ± 0.6	-21.0 ± 0.6***	-34.6 ± 1.7***	-1.0 ± 1.5	-16.3 ± 2.3***	-7.5 ± 1.4***
NAT2000+LowProd	-15.3 ± 1.3***	-0.6 ± 0.5*	-22.3 ± 0.5***	-33.4 ± 1.6***	-14.5 ± 1.3***	-19.0 ± 1.5***	-14.7 ± 1.6***
Wind+NAT2000+LowProd	-13.4 ± 1.7***	-0.5 ± 0.5*	-22.6 ± 0.5***	-32.8 ± 1.6***	-13.0 ± 1.2***	-16.6 ± 2.1***	-11.0 ± 2.0***
Wind+NAT2000+20%FuelPrice	-4.3 ± 1.6***	18.3 ± 0.7***	5.5 ± 0.7***	31.2 ± 3.4***	-19.2 ± 1.2***	-9.9 ± 1.8***	-8.9 ± 1.4***

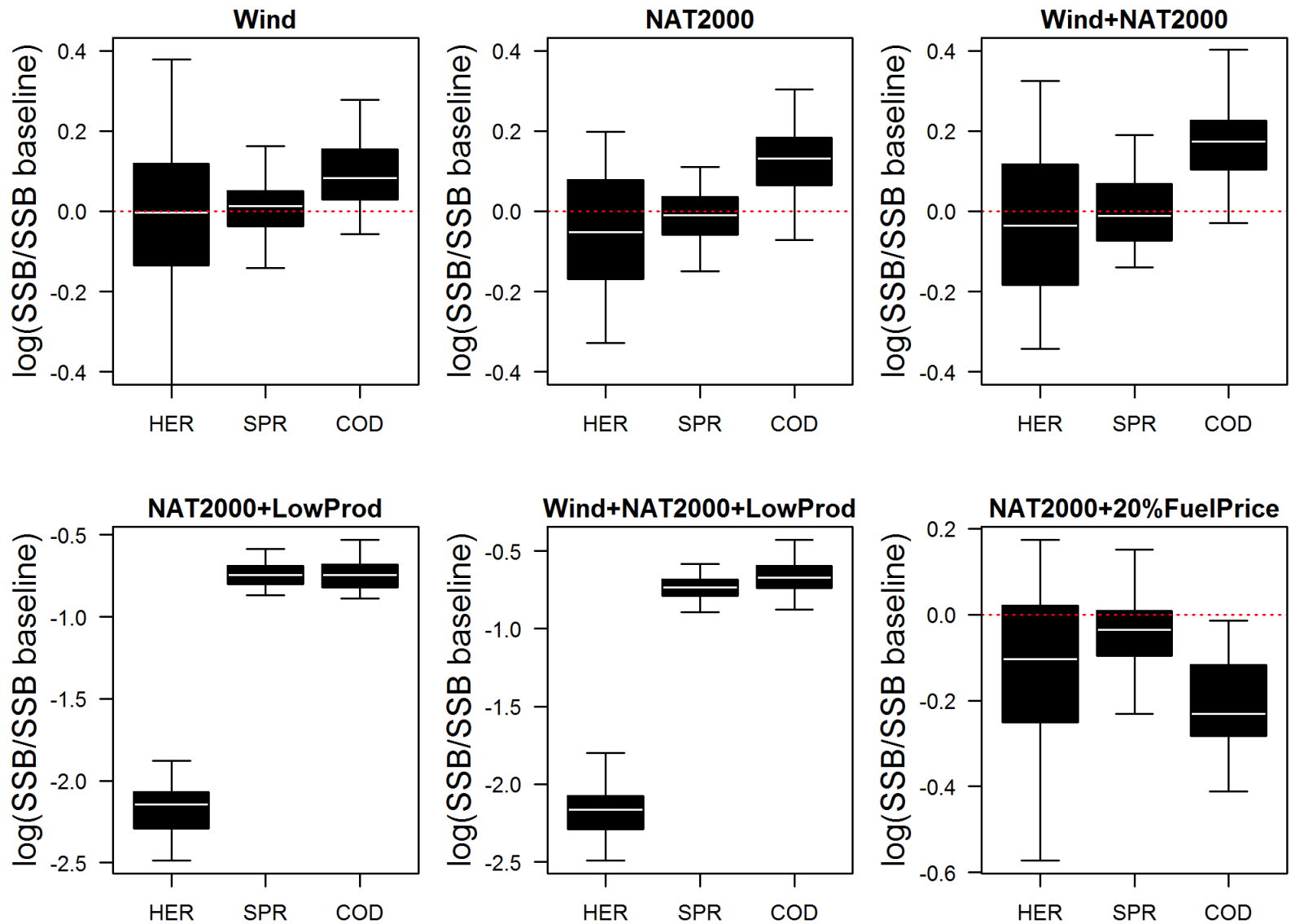
Individual consequences – stress levels



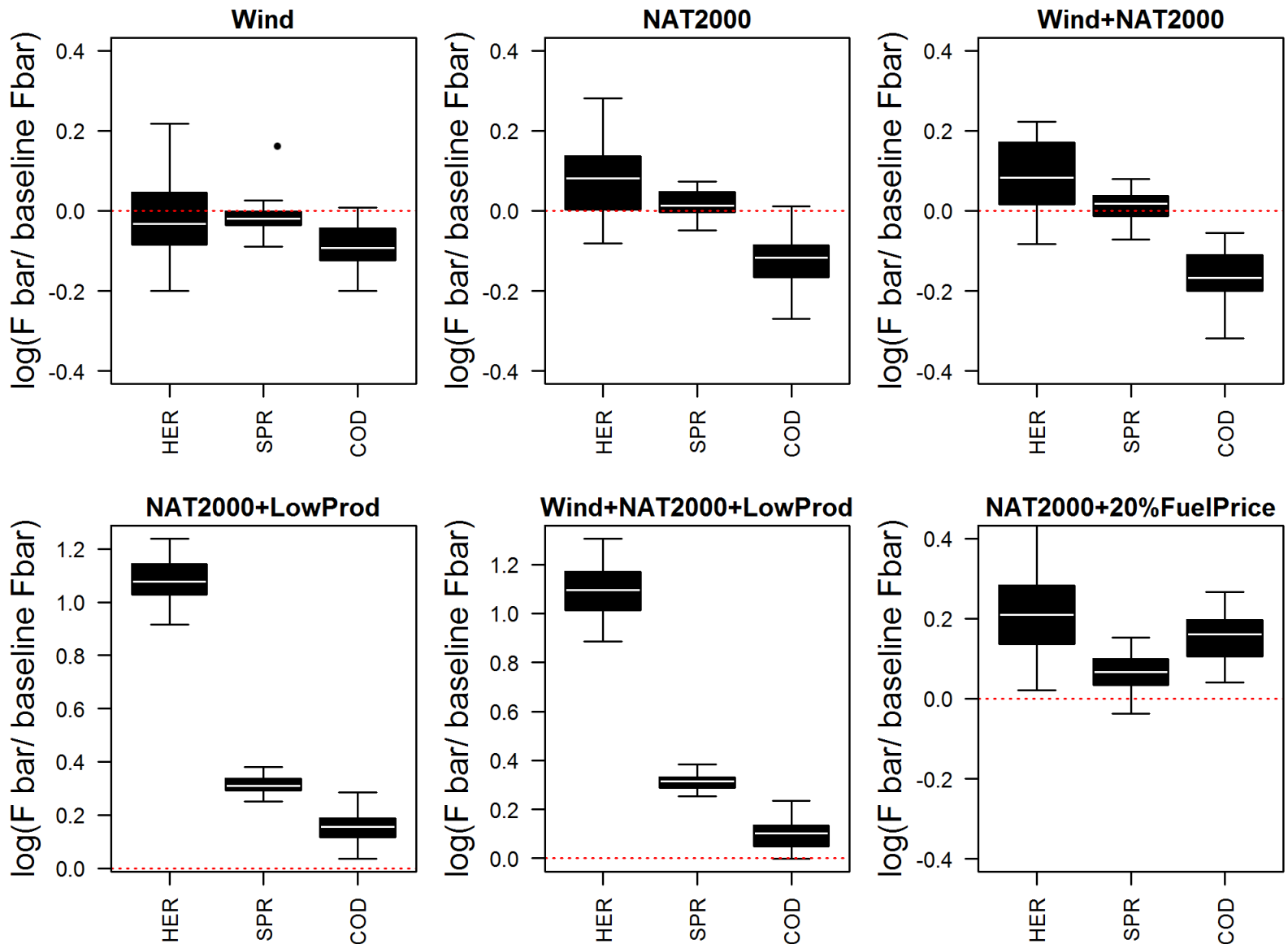
Individual consequences – stress levels per community – target assemblage



Biological sustainability - SSB



Biological sustainability - F



Is effort displaced on sensitive habitats?

BENTHIC MARINE LANDSCAPES

Bottom Substrate

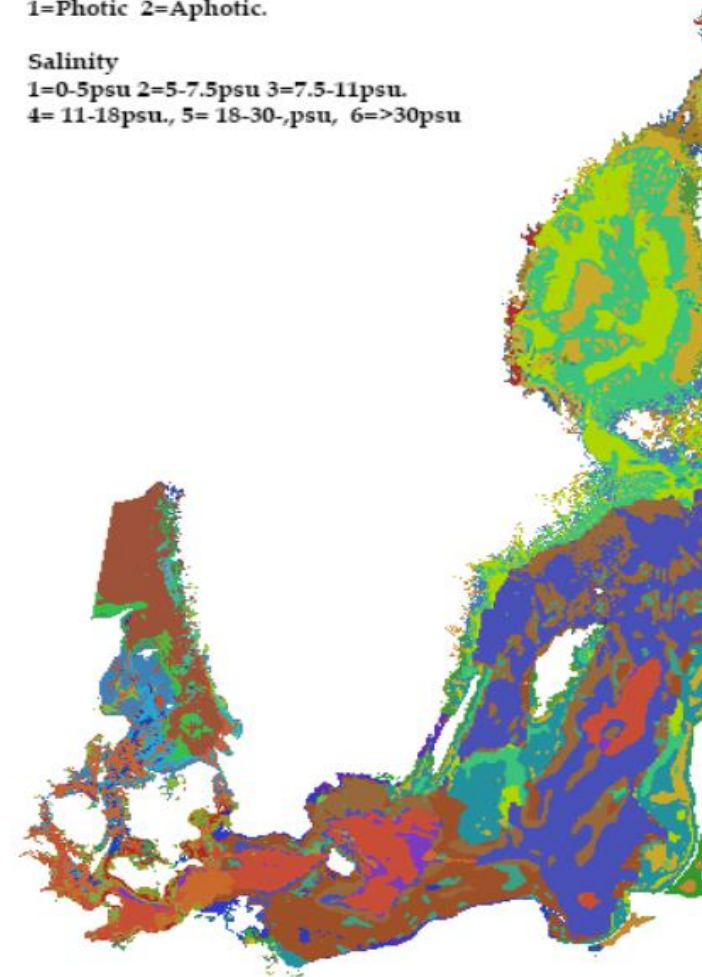
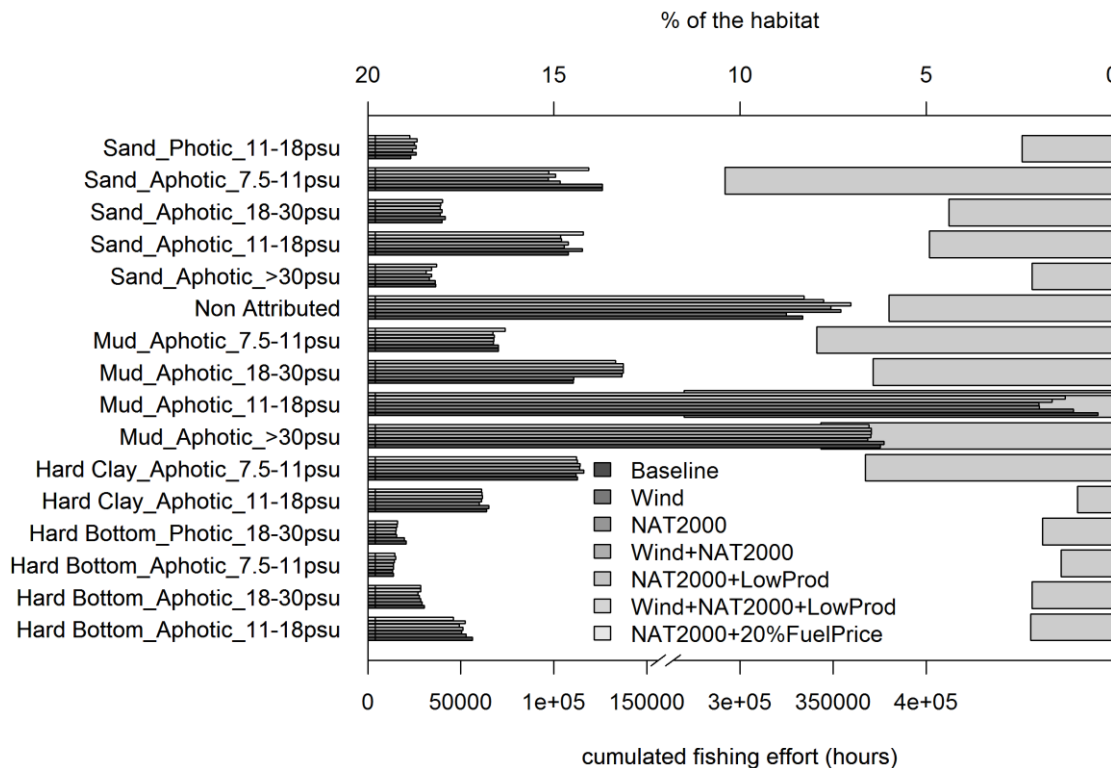
1=Bedrock 2=Hard Bottom
3=Sand 4=Hard Clay 5= Mud.

Photic zone

1=Photic 2=Aphotic.

Salinity

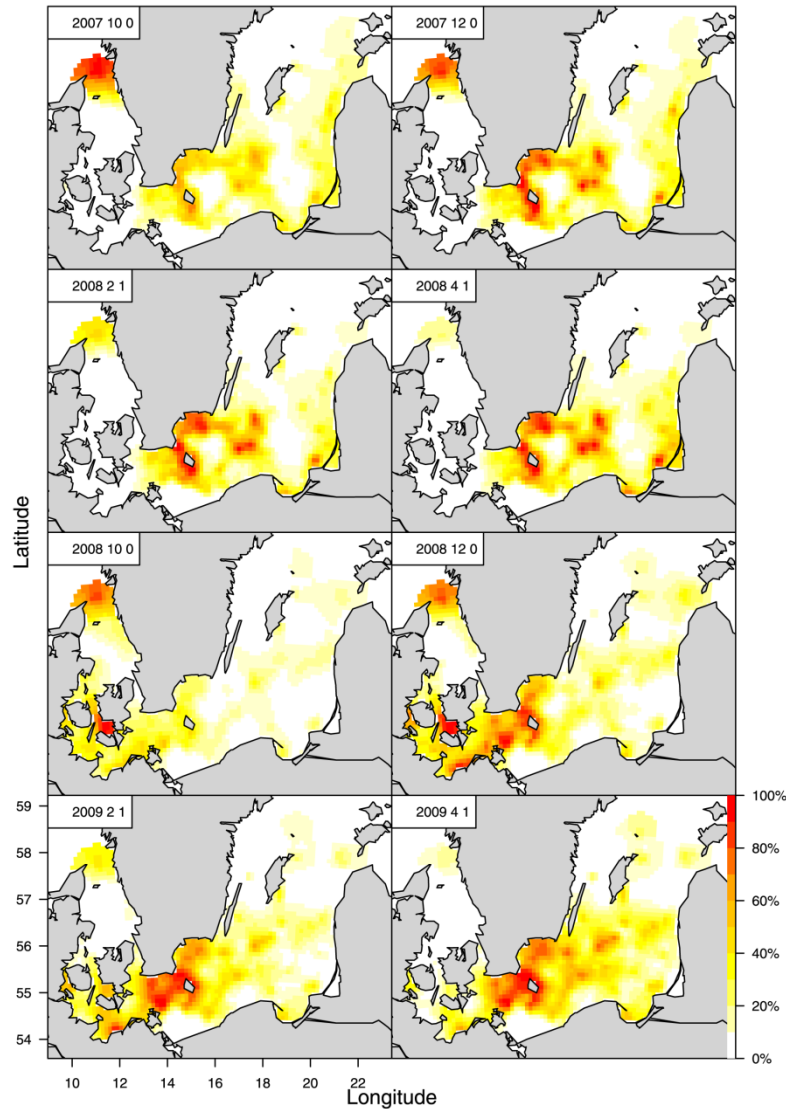
1=0-5psu 2=5-7.5psu 3=7.5-11psu.
4= 11-18psu., 5= 18-30-,psu, 6=>30psu



DISPLACE outcomes

- **Stable profit from compensation** are possible even if opportunities for fishing grounds are constrained
- Some **individual vessels strongly affected** by management while winners make profit to the detriment of others
- **Higher costs** from increased steaming time balanced out by higher revenue from healthier stocks, and **decreased energy efficiency**
- Redirection towards certain habitats from **effort displacement not impacting**
- **Positive global effect** on stocks and concentration of effort towards high catch rate grounds
- **DISPLACE = support tool** for fisheries and management for facilitating understanding of dynamics, reproducing observed patterns and evaluating alternative scenarios

Evaluate the robustness of the outcomes by investigating various productivity levels (...and impact of the trophic interactions on the system)



Toward ecosystem modelling, incl. benthic habitats

DISPLACE

A spatial model of fisheries to help maritime spatial planning

[About](#) [Code repository](#) [Contact](#) [Outreach](#) [Overview](#) [Wiki](#)

Have your say on how spatial restrictions affect your fishing

🕒 May 19, 2014 📁 displaced fishing effort 🗨 fishermen decisions, stakeholder engagement ✎
Edit



In relation to present simulations performed under the Baltic case study of the **SOCIOEC** project, the stakeholder feed-back is expected to provide information on (and contribute to) what the stakeholders consider to be the most important risk factors in such spatial management. Furthermore, they are expected to contribute with information on

navigate4sea

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Portugal bans deep-sea trawling
[/L2l3CMPNnC](#) & [http://t.co/...](#)
[@Oceana](#) [@osparcomm](#)

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Ports & blue economy - S...
ing in Cherbourg, FR, 18th
[http://t.co/Qlycf5189s](#)

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Effects of fishing on benthic
and ecosystem function
[/Cgyq7TJXB1](#) Tromsø, No...
June 2014 [@ICES_ASC](#)

How spatial planning constrains transnational fisheries: the bio-economic DISPLACE evaluation on the Baltic Sea



Francois Bastardie fba@aqua.dtu.dk [@navigate4sea](#)

www.displace-project.org