BALANCE

Modelling of exposed reefs in SE Baltic coastal waters

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Denmark
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Finland
Germany
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Lithuania
Norway
Poland
Sweden

Talk Outline

Introduction: terms and aims

Methodology

- approach
- input data

Results

- developed models: shaping factors and response curves
- validation of models
- generated habitat distribution maps
- model errors and applicability

Conclusions

Introduction

According to the Habitat Directive conservation of marine biological diversity should be ensured by NATURA 2000 network consisting of natural habitat types

The term “habitat” denotes a seabed area with a distinct combination of abiotic conditions and associated community of species, which regularly occurs at a defined spatial scale.

Therefore defining key habitats and mapping of their spatial distribution is an important prerequisite for adequate and efficient conservation of marine environment

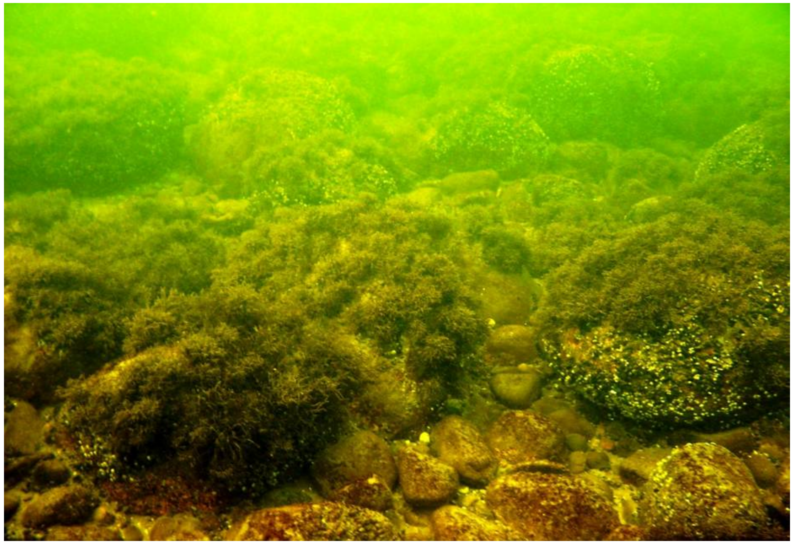
Introduction

Reefs are listed among the habitat types, which should be included into NATURA 2000 network:

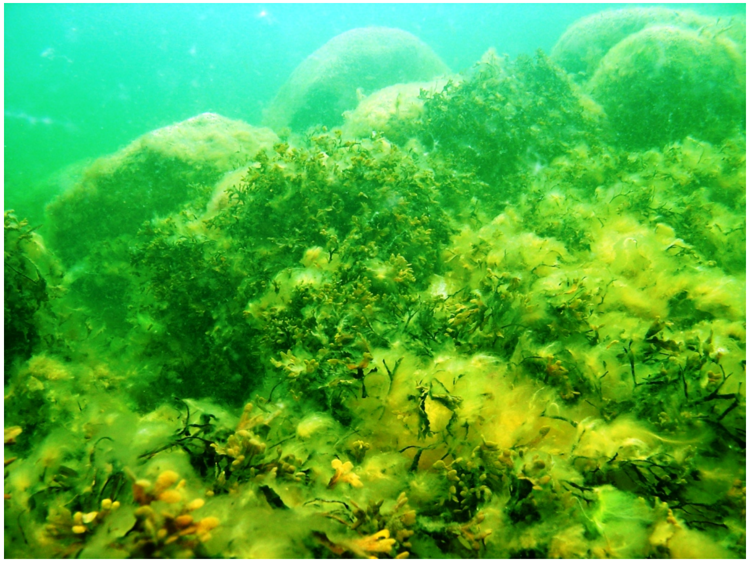
> Reefs are hard compact substrata (biogenic concretions or of geogenic origin) on solid and soft bottoms, which arise from the sea floor in the sublittoral and littoral zone. Reefs may support a zonation of benthic communities of algae and animal species …
>
> (Guidelines for the establishment of the Natura 2000 network in the marine environment…, 2007)

Introduction

In our study area (Pilot Area 4 within BALANCE) we focused on reefs formed by brown algae *Fucus vesiculosus* (less exposed sites along the Estonian coast) and red algae *Furcellaria lumbricalis* (in exposed coastal waters of Lithuania and Latvia)



Reef formed by *F. lumbricalis*

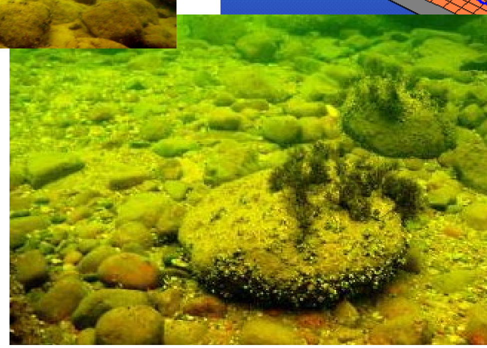


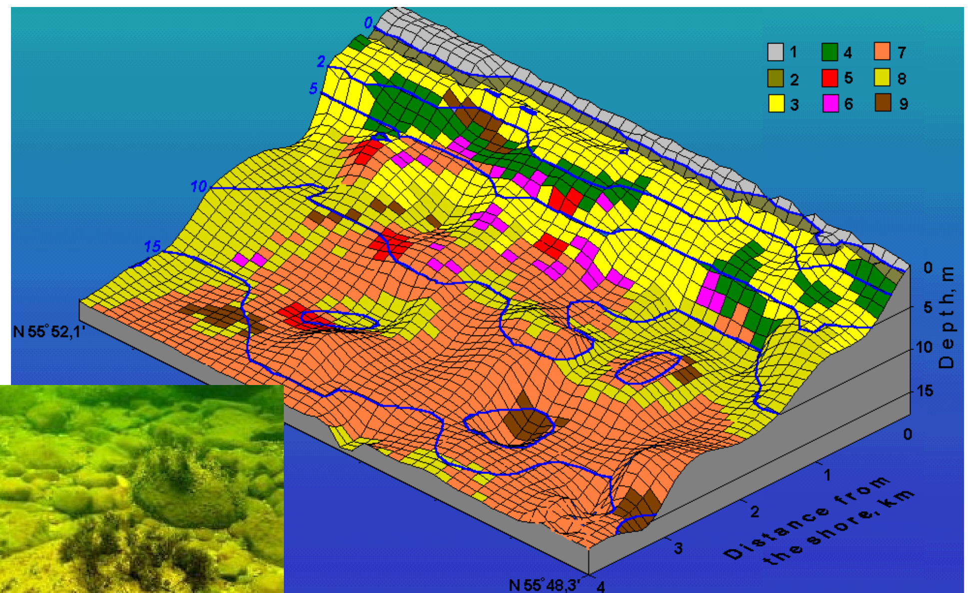
Reef formed by *F. vesiculosus*

Introduction

Aim of teams working on habitats within the BALANCE:

to explore tools of habitat modeling and using existing data predict habitat distribution in selected areas of the Baltic Sea





Methods [study area and polygons]

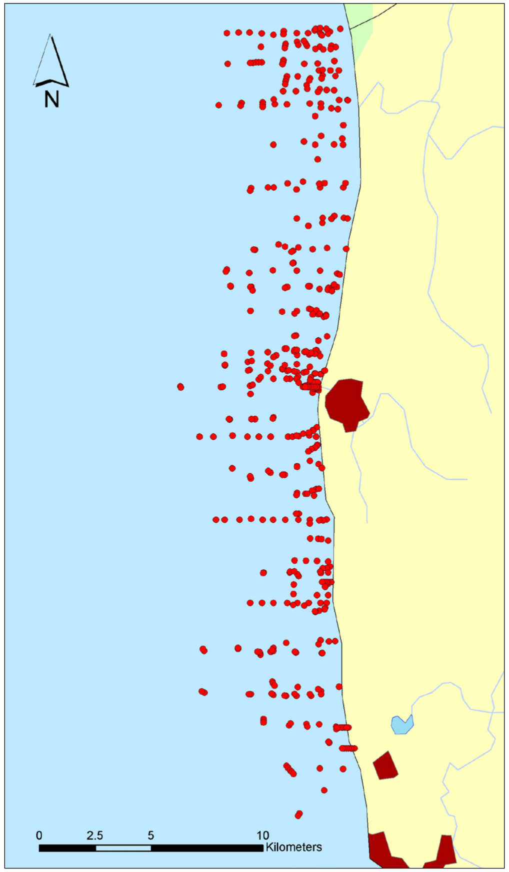
Estonian coastal waters:
Stony bottoms with perennial brown algae F. vesiculosus

Latvian coastal waters:
Stony bottoms dominated by perennial red algae F. lumbricalis

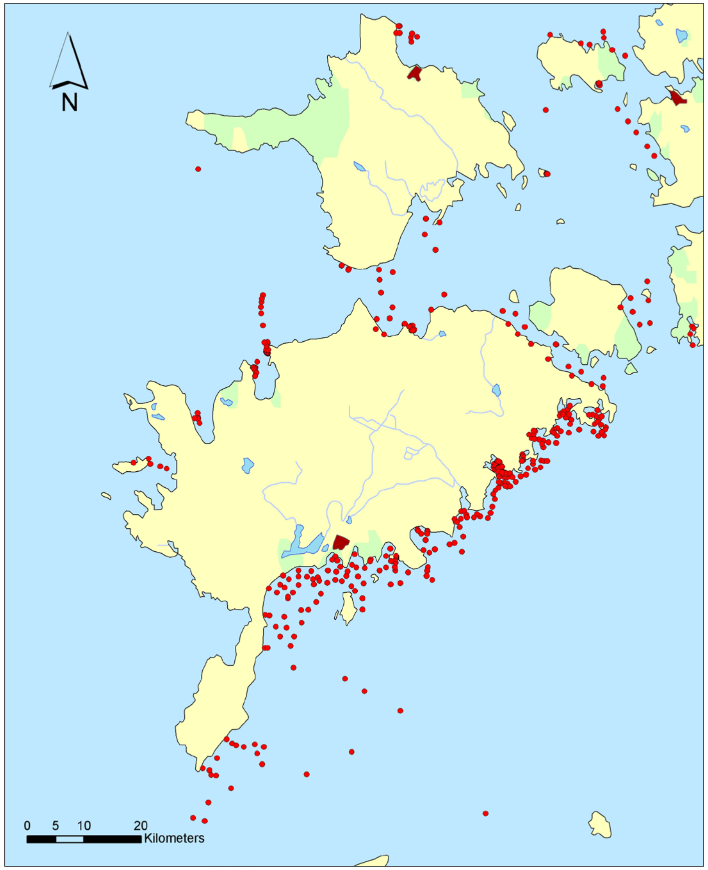
Lithuanian coastal waters:
Stony bottoms dominated by perennial red algae F. lumbricalis

Methods [sampling stations]

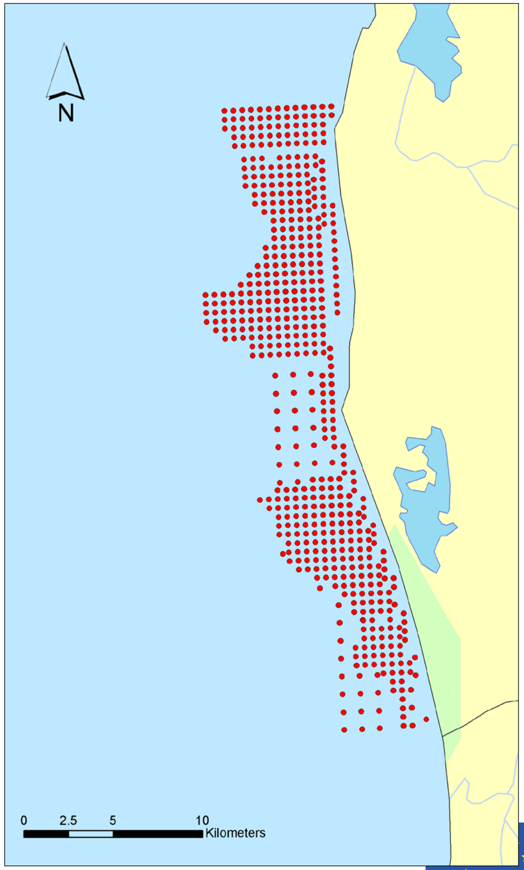
Lithuanian waters
[~420 points, ~3 points/km²]



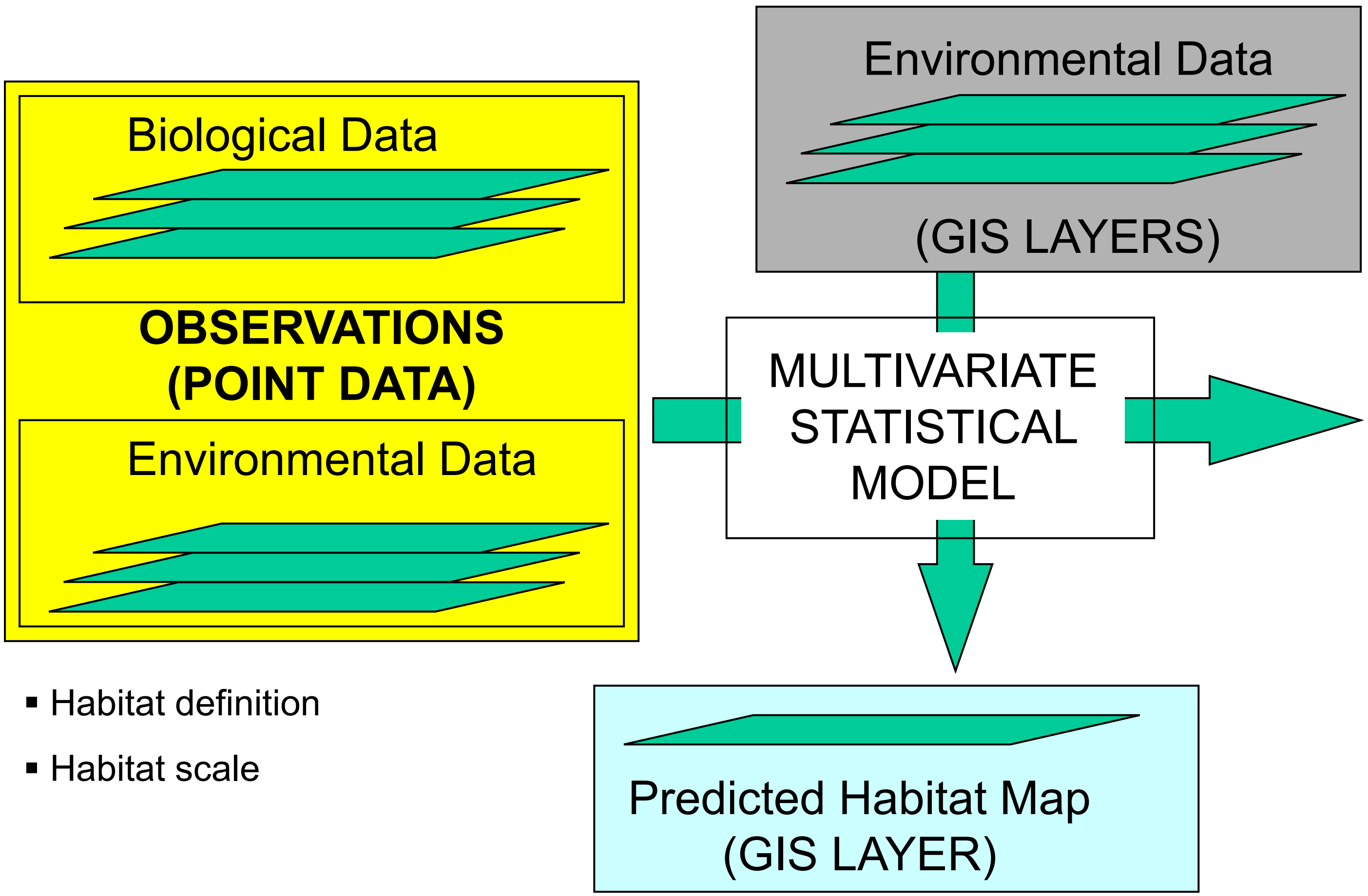
Estonian waters
[870 points, ~1 point /km²]



Latvian waters
[480 points, ~4 points/km²]



Methods [modeling approach]



- Resolution (does it match habitat scale?)

- Deviance explained
- Response curves
- Contribution of factors
- Validation

- Habitat definition
- Habitat scale

Methods [input data]

Input data for model development:

Biology: diver observations / underwater video data (species coverage)

Sediment: diver observations / underwater video data (type and coverage)

Depth: diver / echosounders

Exposure: estimated or modelled

Input data for model predictions:

Sediment: geological maps or extrapolated data from video / diver observations

Bathymetry: sea charts

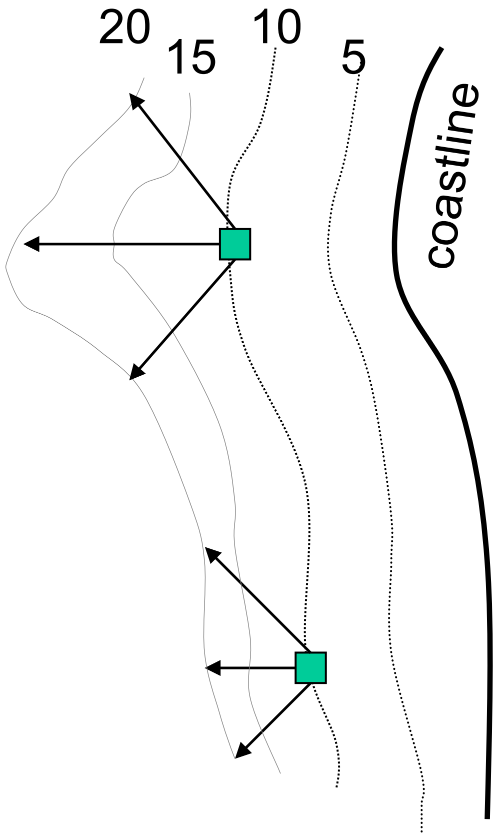
Exposure: estimated or modelled

Methods [exposure 1]

Exposure (Lithuanian waters):

Should reflect shelter provided by bottom topography rather than islands or complex coastline configuration

"Underwater Fetch": minimum distance between each cell and 20/30 m depth isobath averaged for three dominant wind directions



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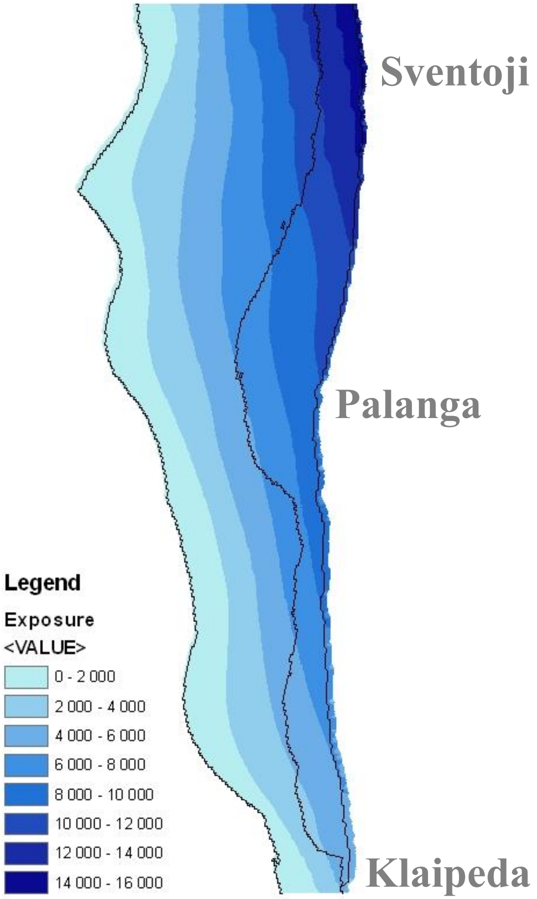
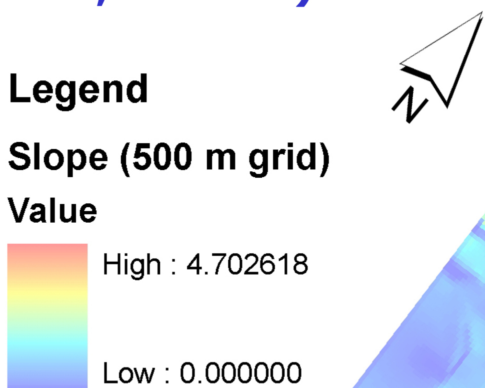
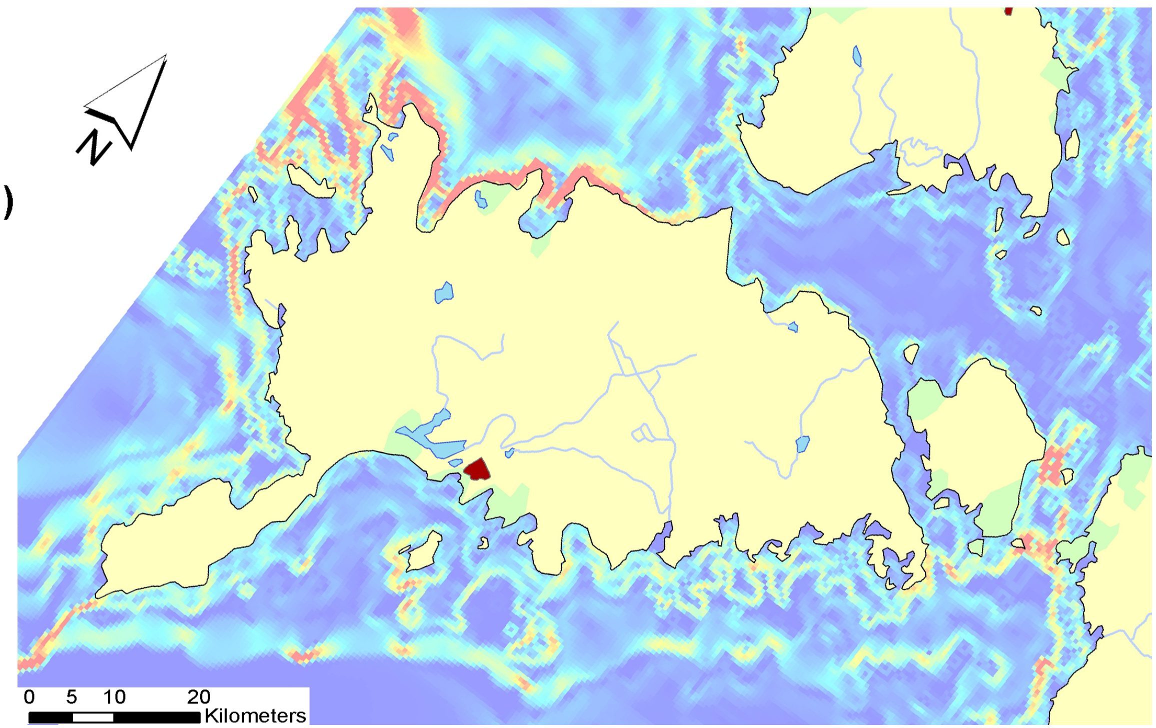


Methods [exposure 2]

Exposure (Estonian waters):

Slope: **standard GIS function based on maximum change in depth (degrees) between each grid cell and its neighbours (100m, 500m, 1000m, 5000m)**





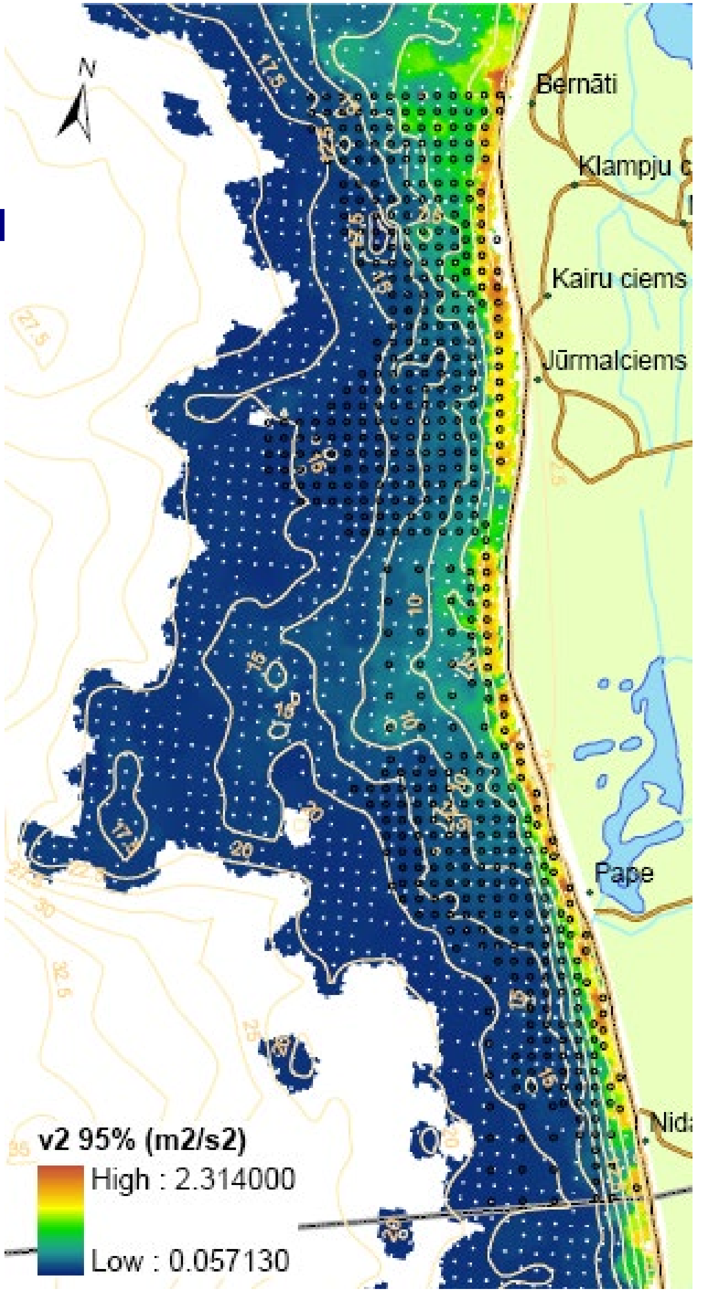
Methods [exposure 3]

Exposure (Latvian coastal waters):

95 percentile of squared orbital velocity at the bottom: parameter estimated from wave model, which reflects boundary of 5% highest wave energy values occurring at the seabed

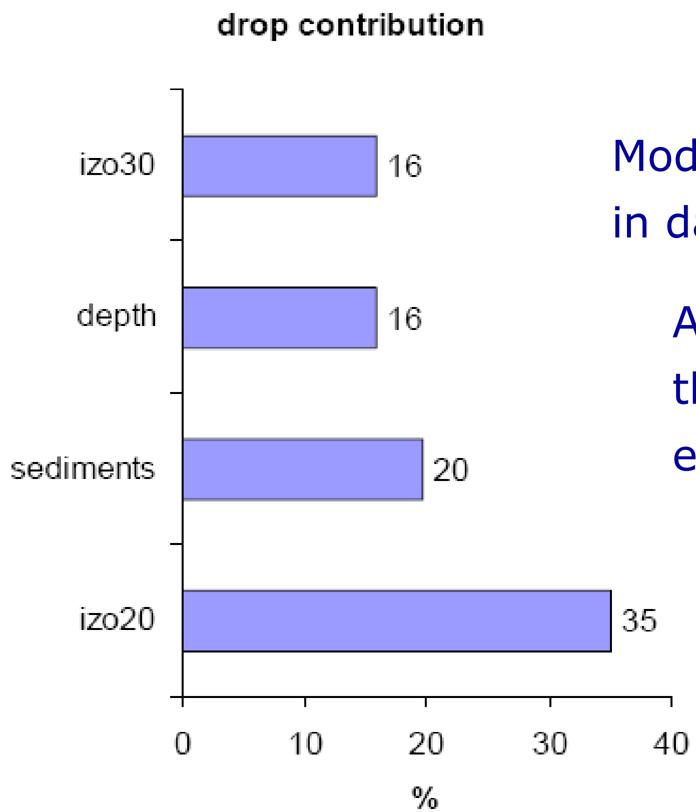
$$V_{orb(95\%)} = \frac{\pi Hs}{Ts} \frac{100}{\sinh(2\pi H/L)}$$

where: H – depth; L – wave length



Results (Lithuanian coastal waters)

Model: Furcellaria reefs ~ sediment + s(depth) + s(exp20) + s(exp30)

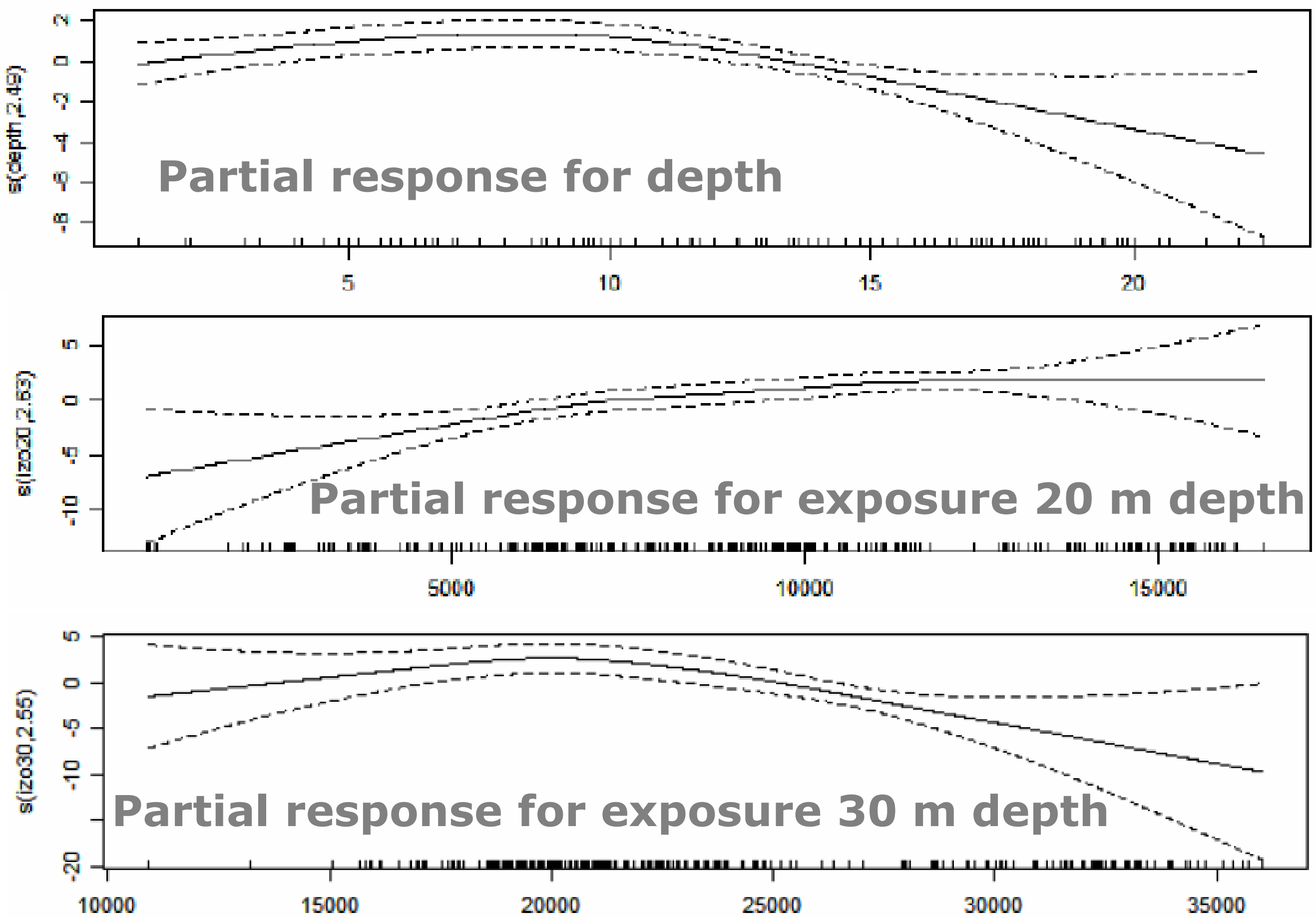


Model explained 52% of the total deviance in data

All factors were retained in the model and their drop resulted in significant reduction of explained deviance

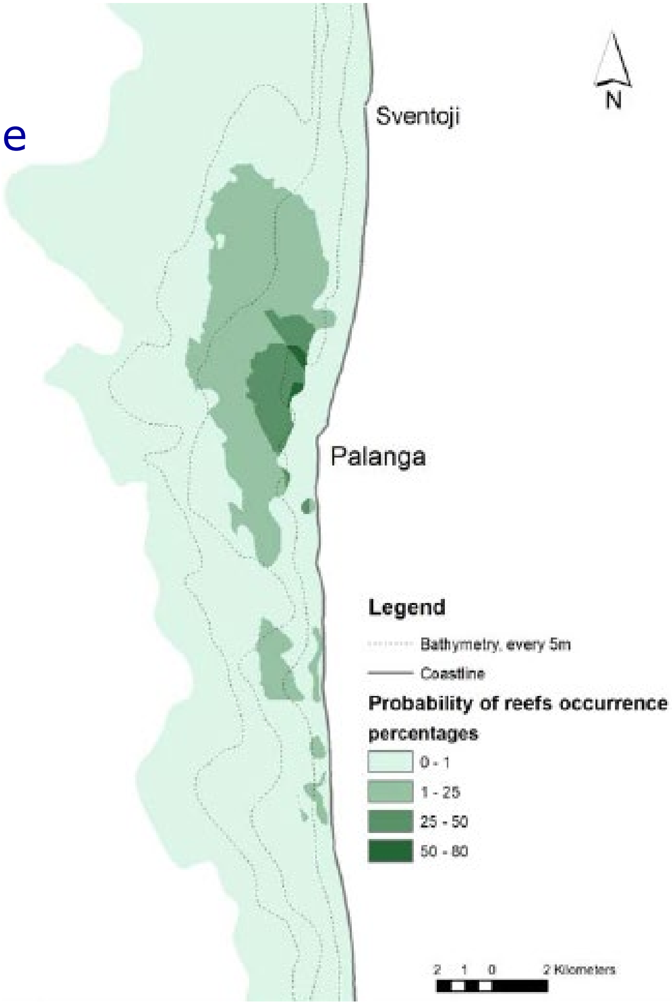
Sand and gravel had much higher importance in the model than pebble, cobble and boulders

Results (Lithuanian coastal waters)



Results (Lithuanian coastal waters)

Most of the studied area is not suitable for formation of reefs shaped by red algae and this generally coincides with low occurrence of reefs according to field observations



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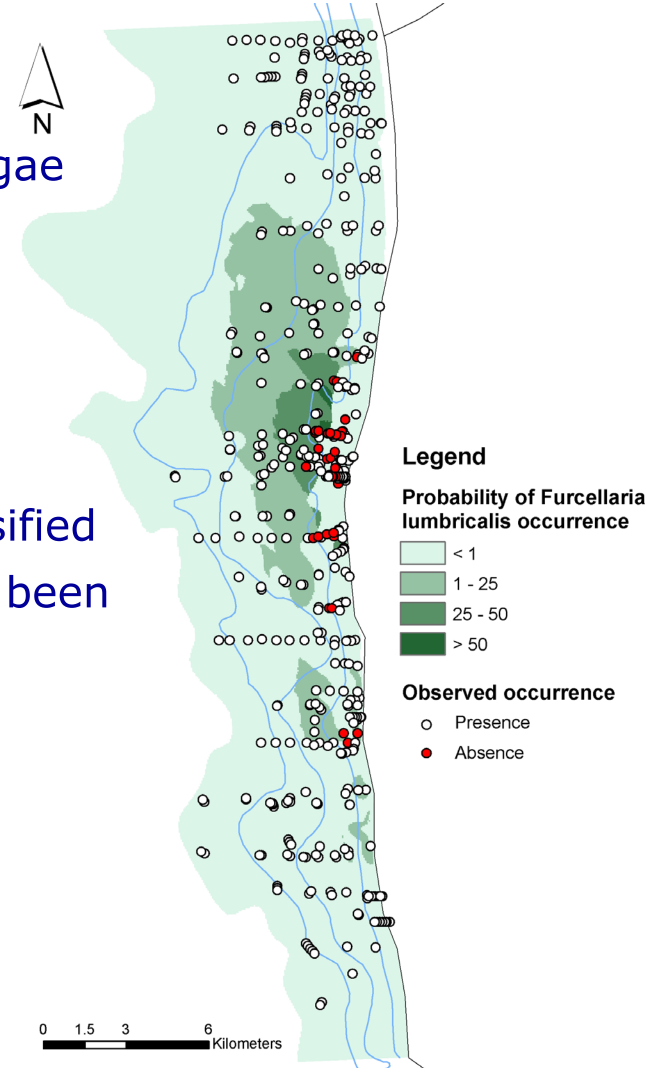
Model predictions generally correspond actual distribution of reefs and misclassified 27% of sites, where observations have been carried out



Results (Lithuanian coastal waters)

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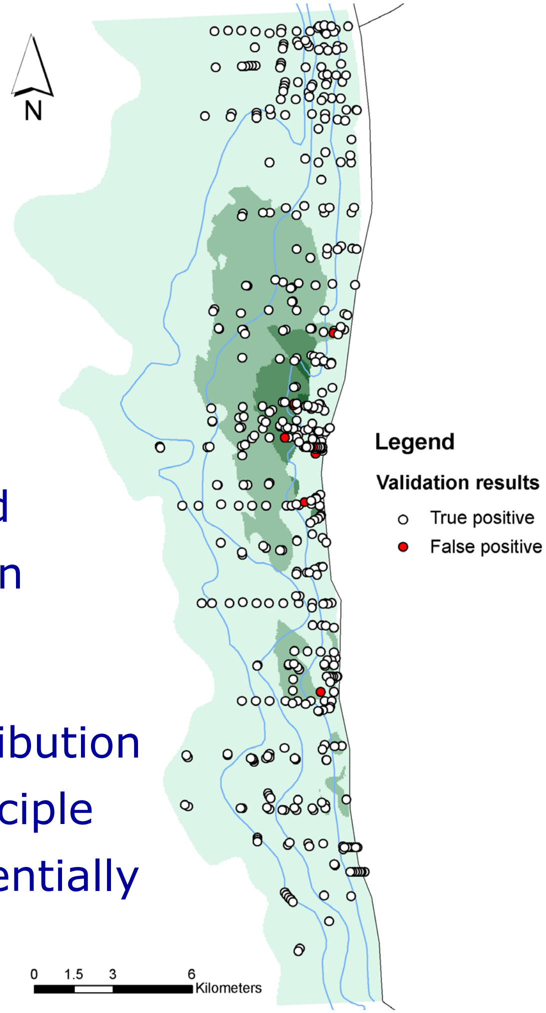
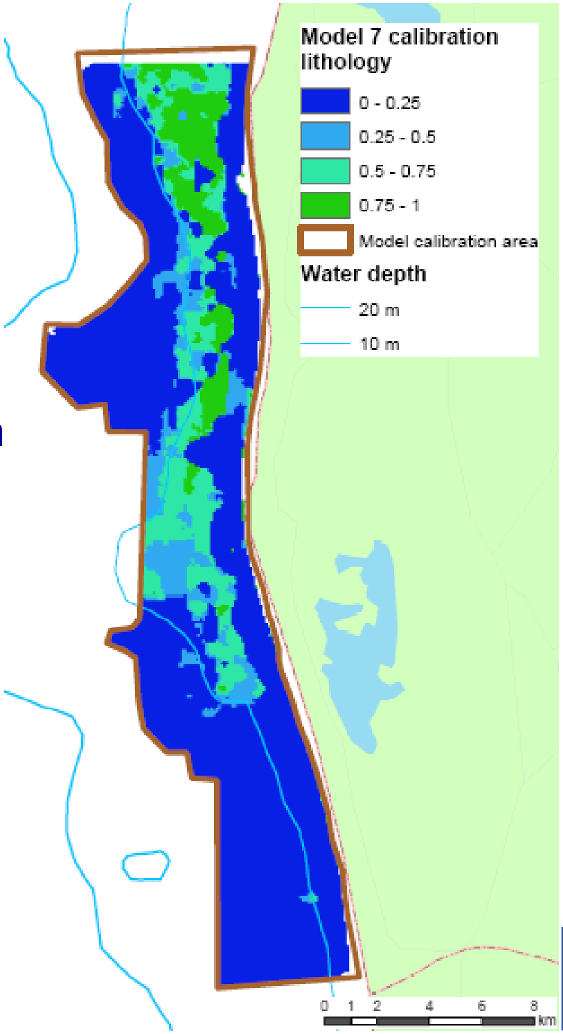
Model validation shows overestimated distribution of reefs, but this follows precautionary principle to not overlook areas where reefs may potentially occur



Results (Latvian coastal waters)

Model: Furcellaria stands ~ sand coverage +
+ boulder presence + s(depth) +
+ s(wave energy)

Model correctly classifies occurrence of Furcellaria reefs in 87% of the sampling sites



Results (Latvian coastal waters)

Model: Furcellaria stands ~ sand coverage +
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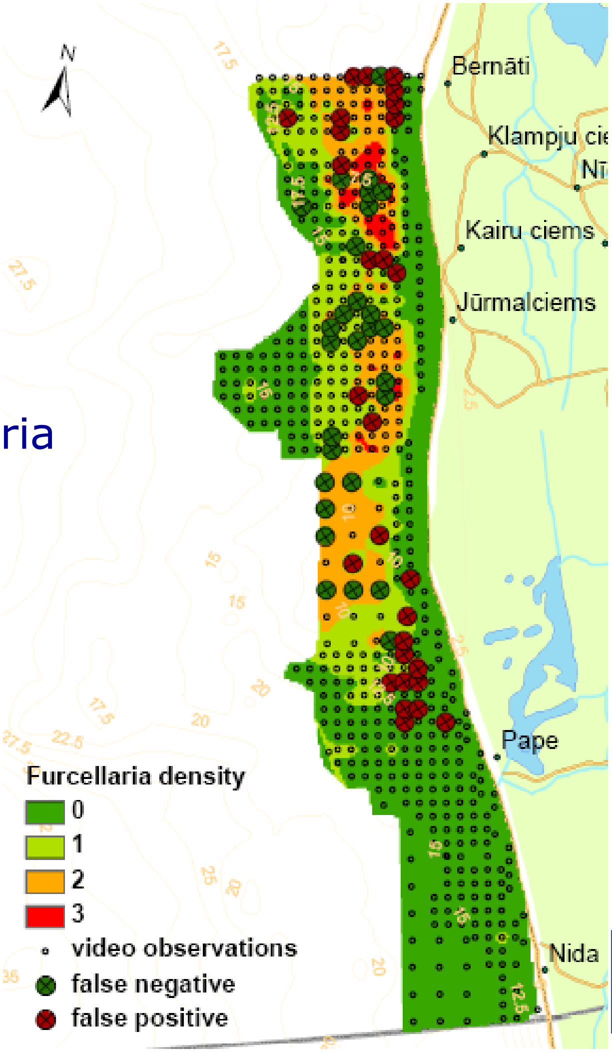
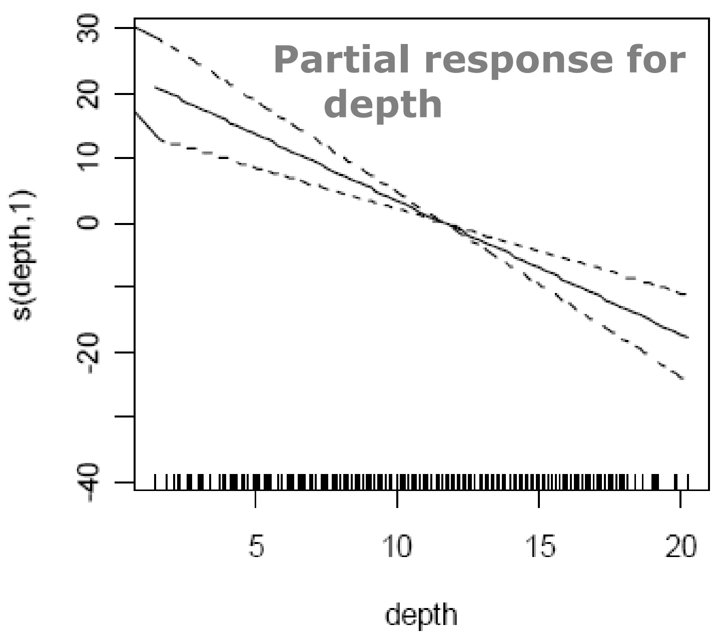
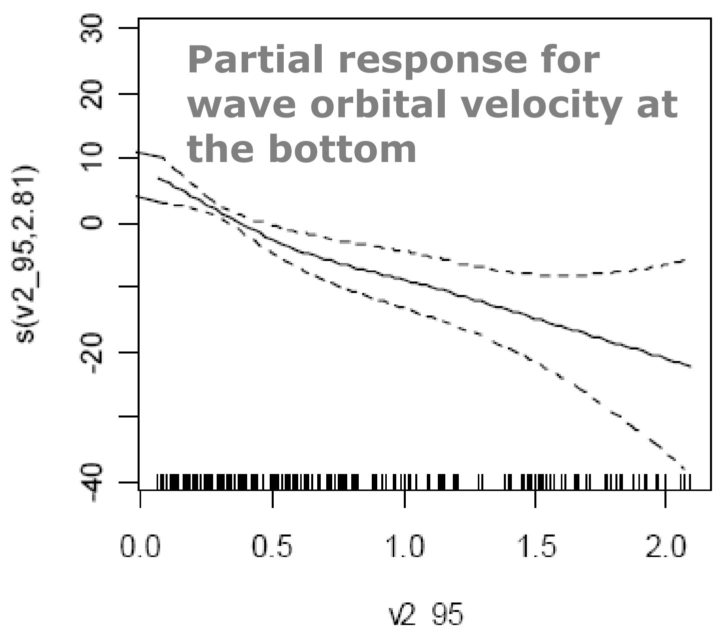
Relative number of false positive predictions (~30%) largely exceeds the number of false negative (~9%) predictions, therefore there is also tendency to overestimate the distribution of reefs



Results (Latvian coastal waters)

Partial response curves indicate typical niche of reefs formed by vegetation: occurrence is reduced with depth (light limitation) and with increasing values of wave energy (hydrodynamic effects).





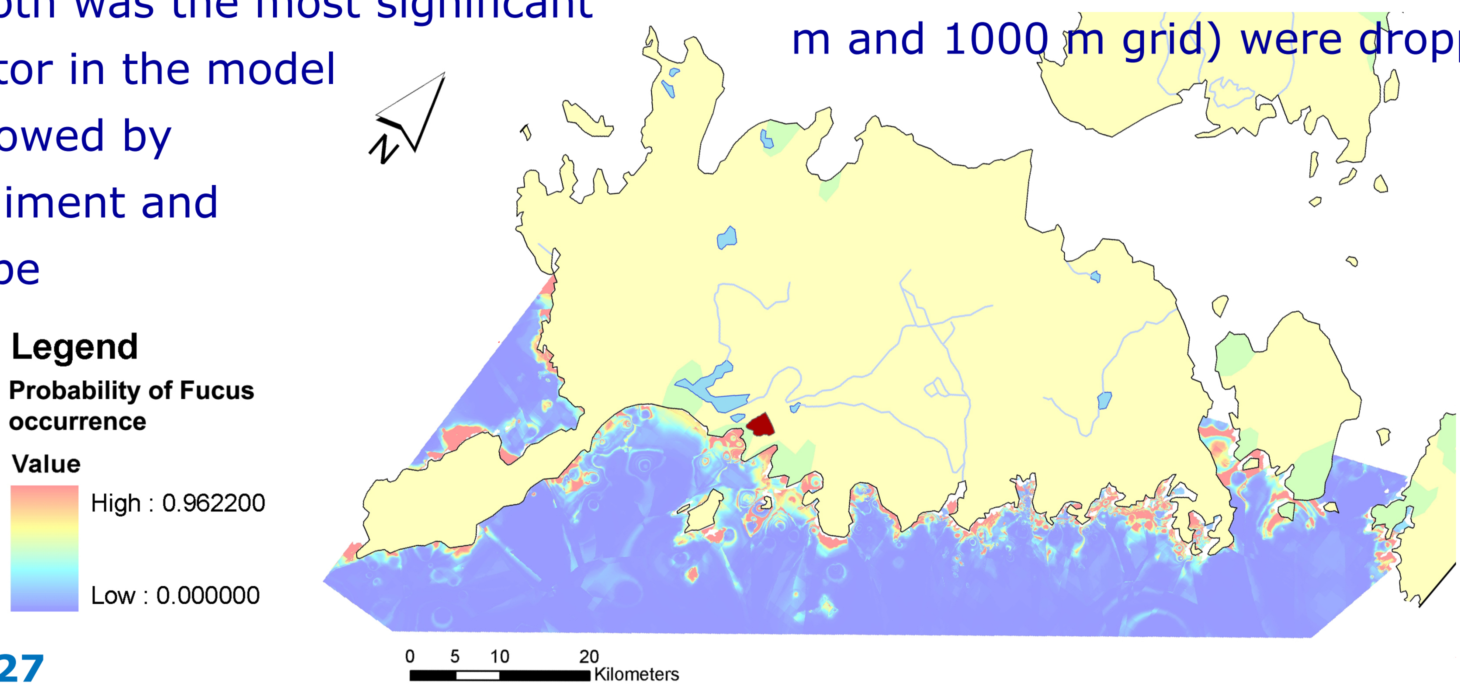
Results (Estonian coastal waters)

Model: Fucus occurrence ~ s(depth) + s(slope5000) + s(sediment)

Model explained 32% of the total deviance in data

Depth was the most significant factor in the model followed by sediment and slope

All key factors were retained in the model during their selection, however higher resolution slopes (100 m, 500 m and 1000 m grid) were dropped out



Conclusions & perspectives

Key messages

Modelling of reefs was relatively successful with three main factors - depth, sediment and exposure (biological processes are driven by physical forcing rather than biological interactions in the Baltic).

Models have higher predictability at more exposed coast in comparison to relatively sheltered sites with higher coastline complexity.

Better spatial resolution of environmental information (sediment and bathymetry) would significantly increase confidence of model predictions.

Conclusions & perspectives

Next steps?

Common habitat classification and harmonisation of definitions between countries are required for consistent modelling of the Baltic Sea habitats

Salinity should be tested as modifying factor in order to apply the models at the scale of the Baltic Sea

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- ►Petras Zemlys (Coastal Research & Planning Institute, Klaipeda University)

Thank you for your attention