

GORWIND

WP4 progress

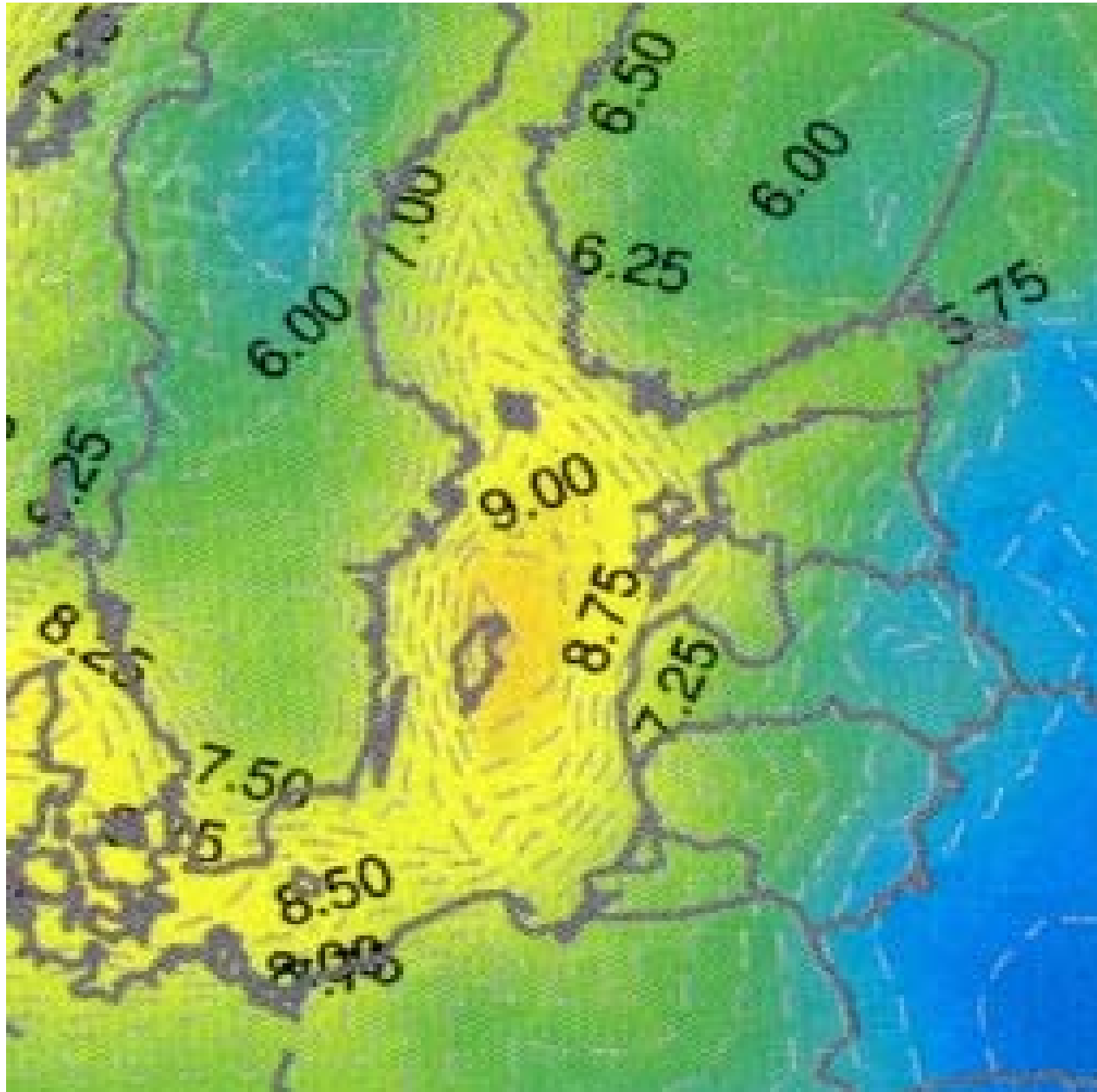
June 4-5, 2012

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Wind resource ...



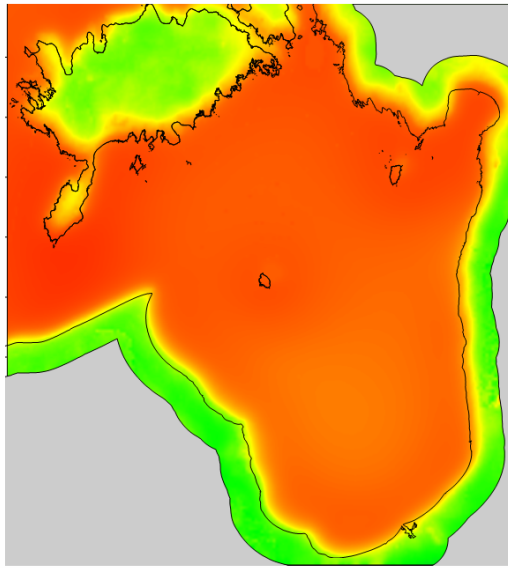
+ Physical limitations

+ Nature / Wildlife

+ Legal restrictions

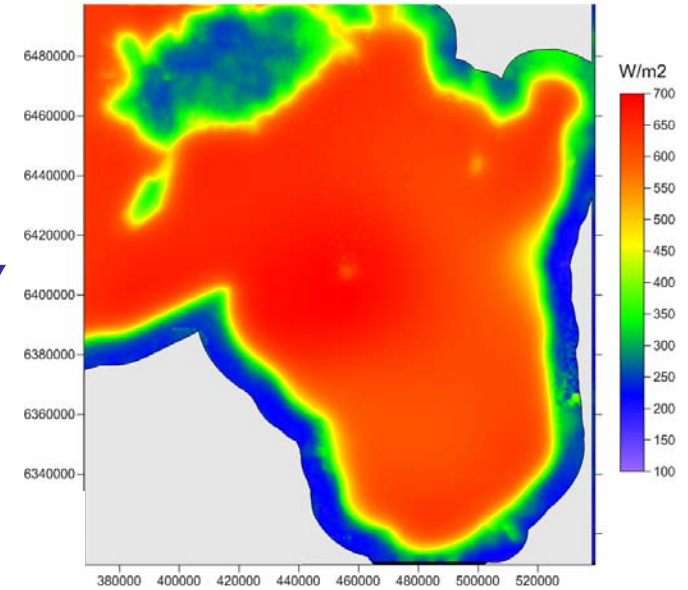
+ Socio-economical limitations

= Suitability rate

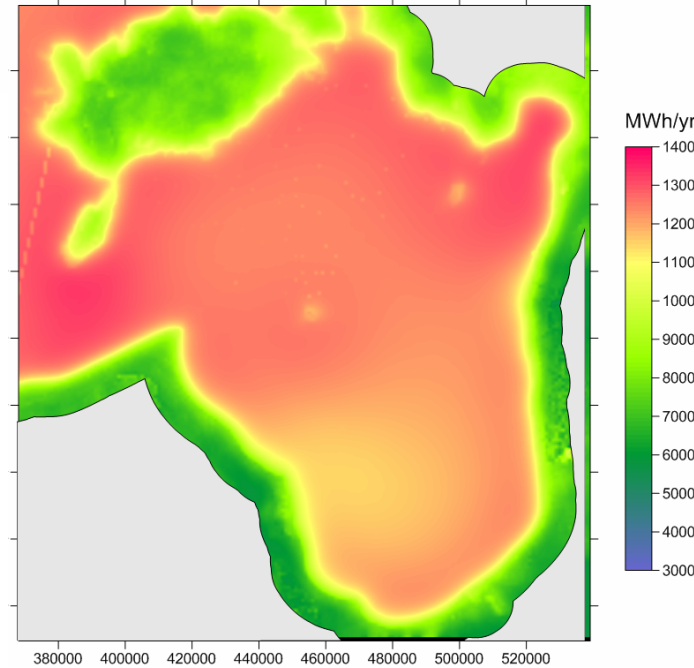


*Mean
annual
wind
speed
m/s*

*Mean
annual
energy
density
W/m²*



*Mean annual
energy production
by SWT-3.6-107*

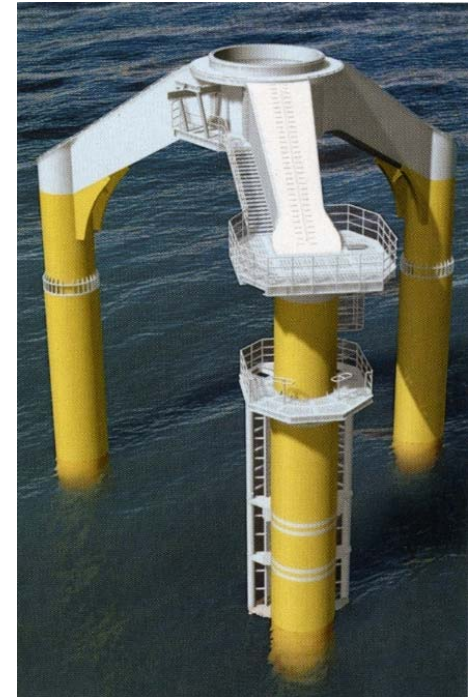
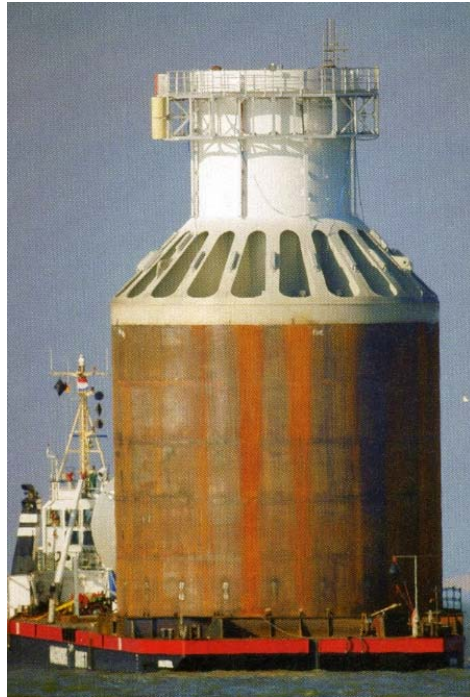


Wind energy in off-shore is nearly 40% higher than on coast but...

Physical limitations

- Bathymetry → “water depth suitability”
- Bottom substrate
- Ice cover
 - = Ice cover spatial probability
 - = Number of days with ice cover

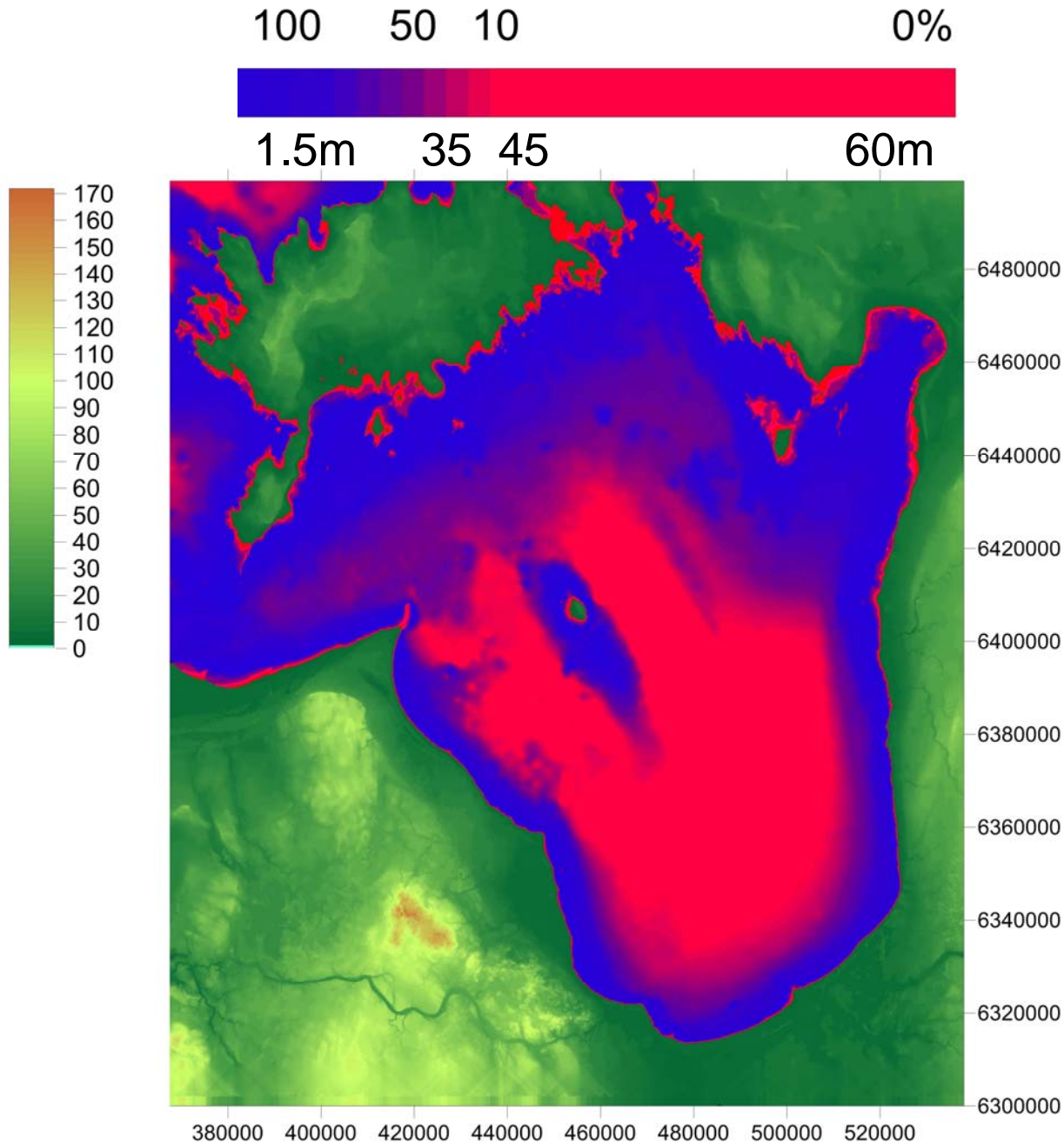
Water depth (5-30 m)



- Currently maximum depth for off-shore wind turbine with fixed foundation < 45 m (*Beatrice, UK*);
 - Floating wind turbine test-model in 220m (*Hywind, NOR*)
- ... but not in ice conditions like in Gulf of Riga*



Water depth suitability for offshore wind farm development



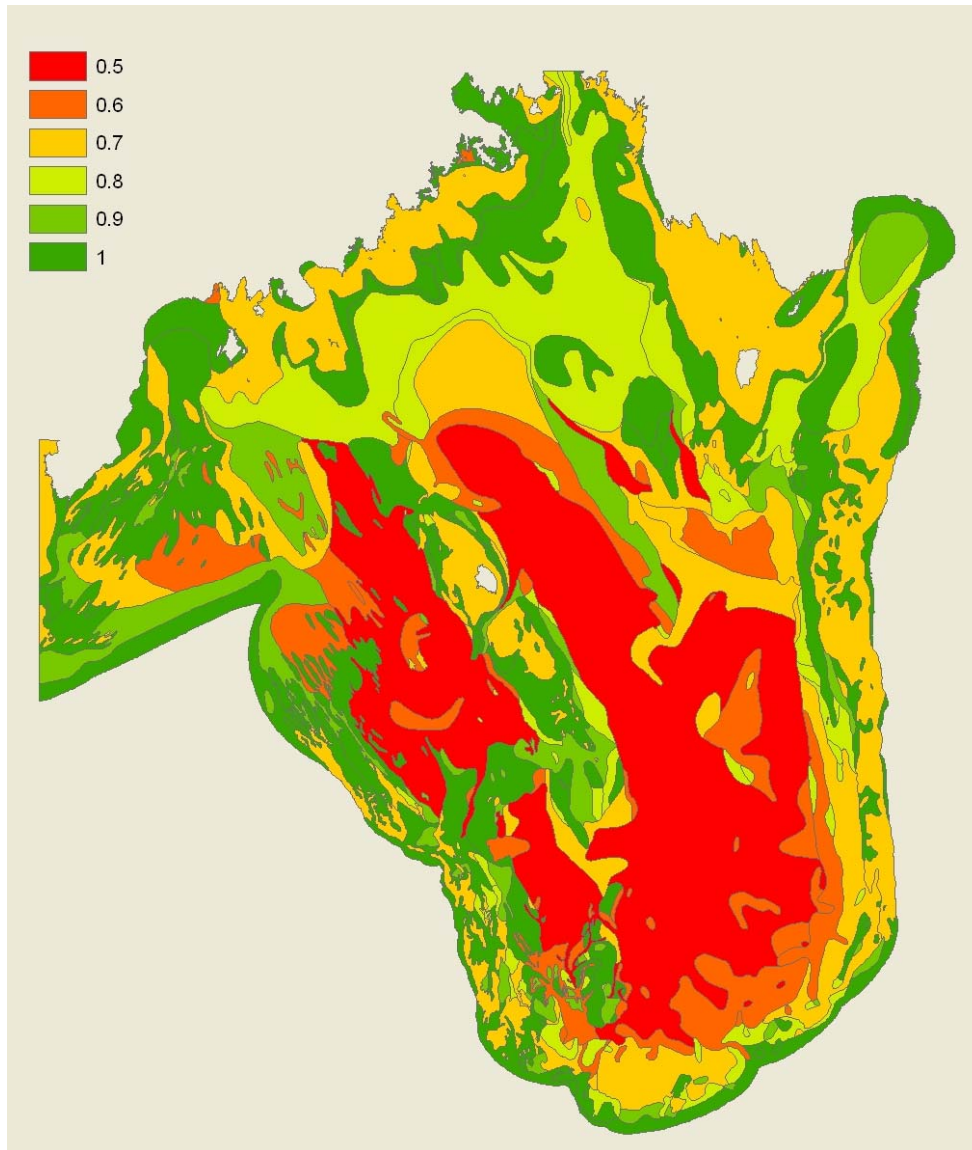
Water depth is one of the most critical limitations:

very shallow water <1.5 m is not accessible for installation ships and barges;
deeper than 35 m water is too costly to develop, especially in ice-covered waterbodies.

Normally developed at depth between 8-16 m

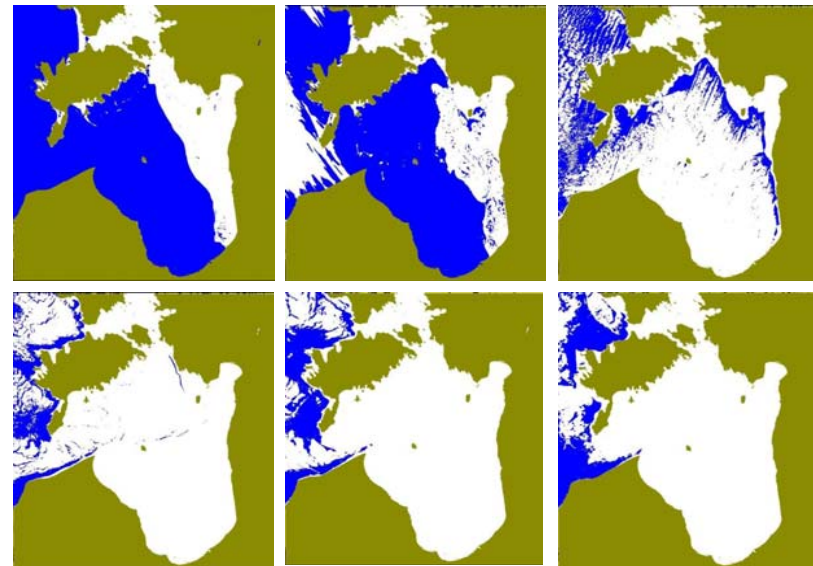
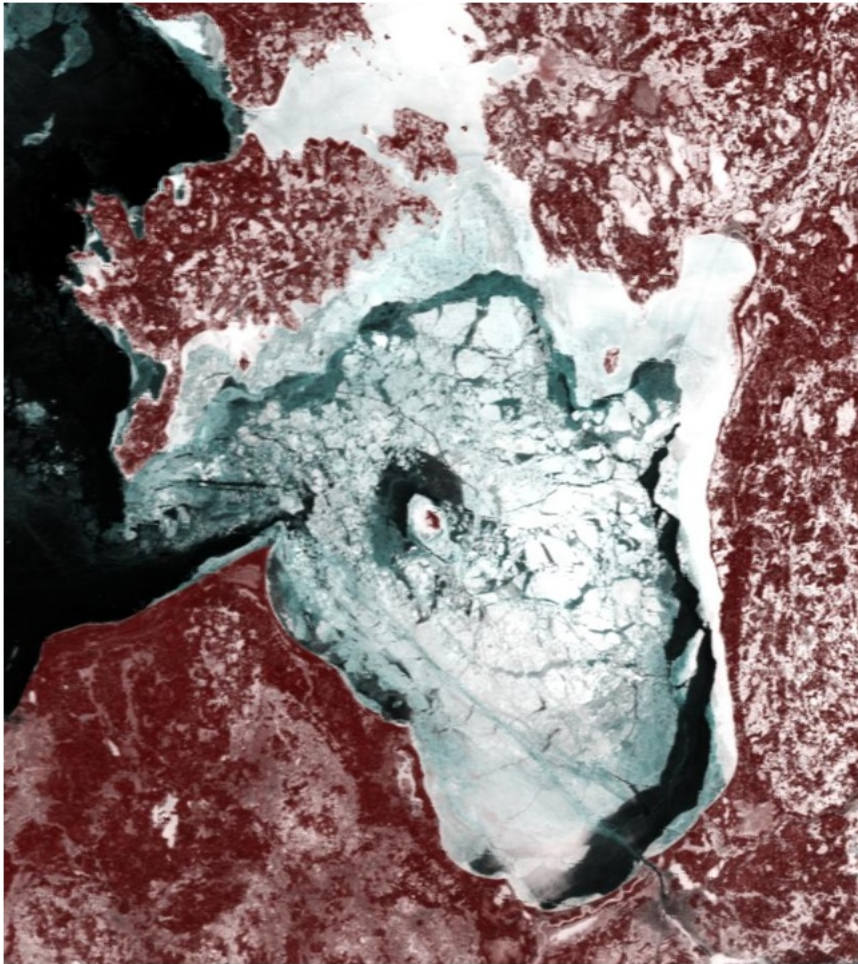
Suitability assessment is based on database of all installed or under construction off-shore wind farms in the whole world (mainly

Bottom substrate



bedrock	1
mixed sediments	0.8
mud	0.5
muddy sand	0.7
muddy silt	0.6
sand	1
sand medium grained	1
sand variable grained	1
sandy gravel and gravel vith pebbles and boulder:	0.7
sandy gravel vith pebbles	1
sandy mud	0.7
sandy silt	0.9
silt	0.7
silty sand	0.8
silty mud	0.6
silty sand	0.9
variable grained sand with gravel	1

Ice cover probability, number of days with ice cover



(source: MSI)

Impact on wind farm development costs and stability, operation and seals habitats

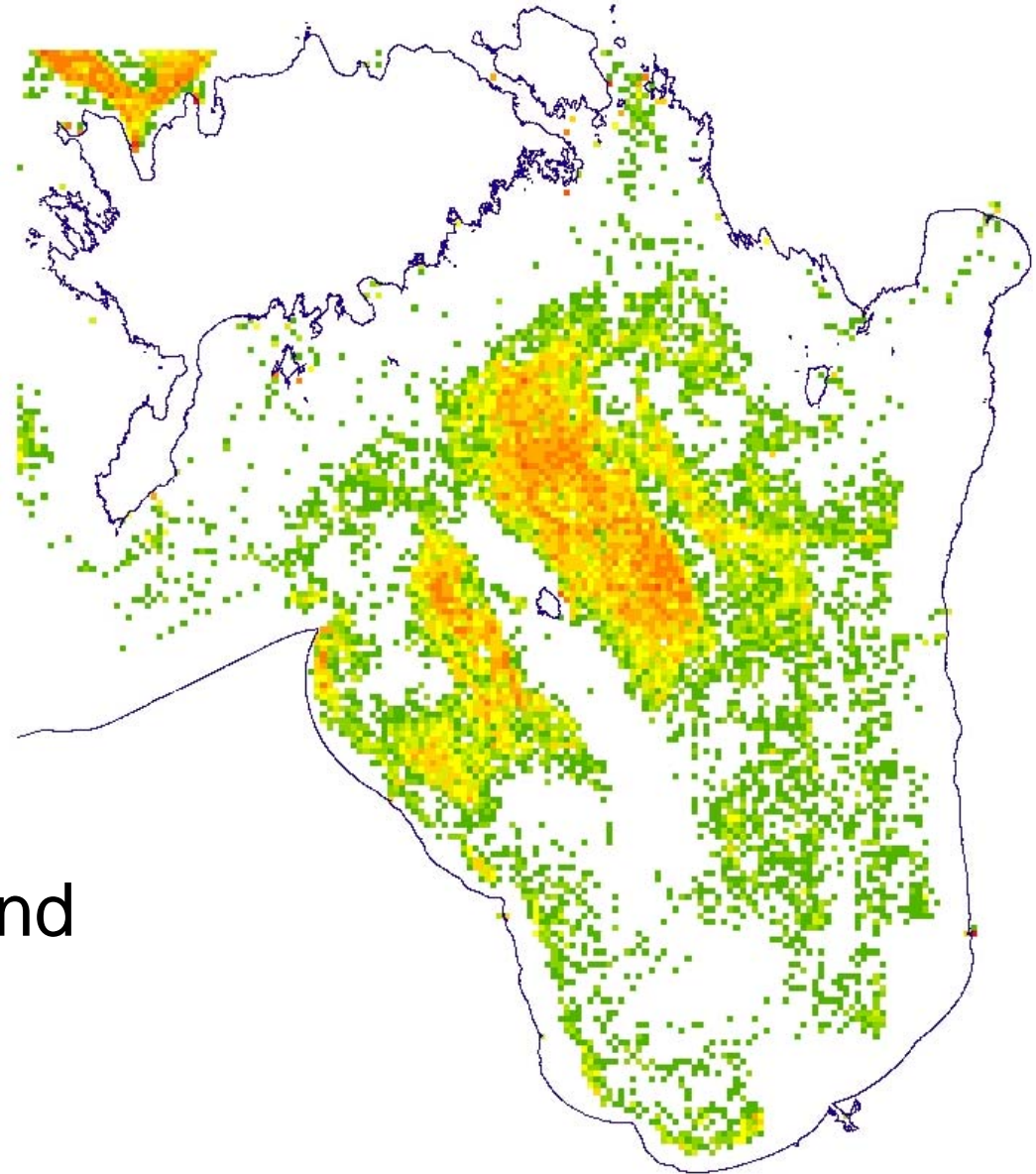
Ice cover probability



Nature / wildlife

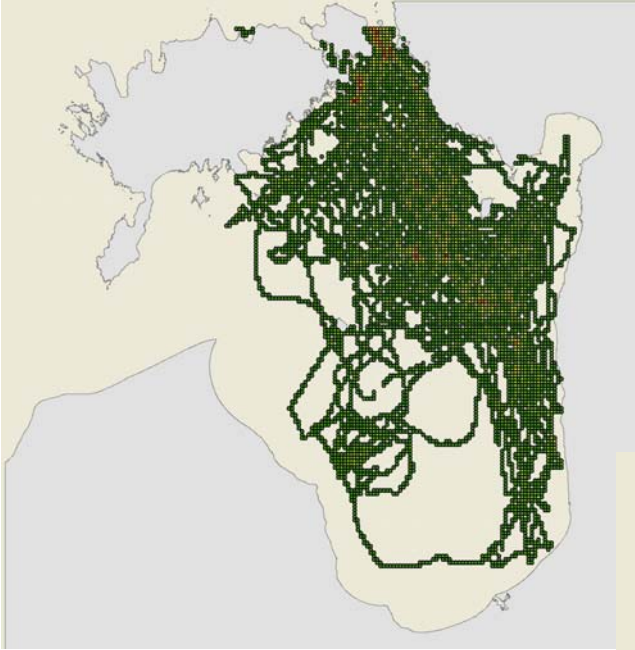
- Commercial fishing intensity
- Seal vulnerability area
 - = migration routes
 - = feeding areas
 - = breeding areas
- Birds vulnerability area

Commercial off-shore fishing

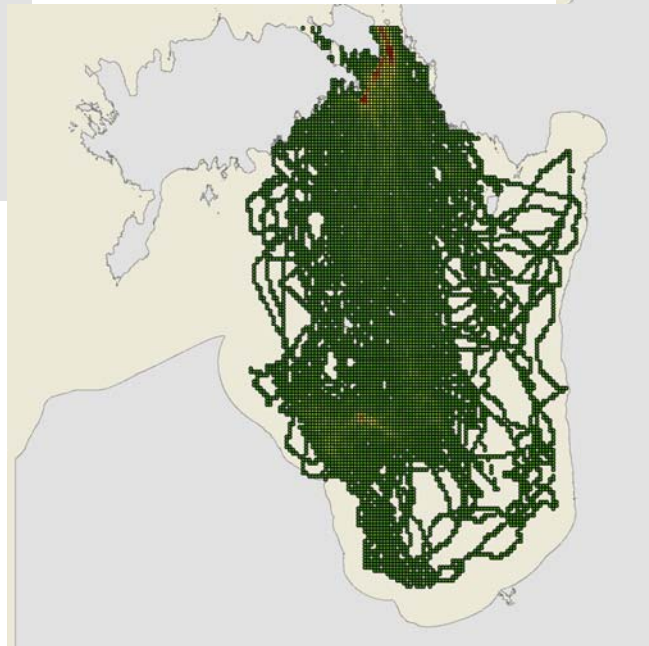


Intensity of trawling and
trawlers movement
2009-2012

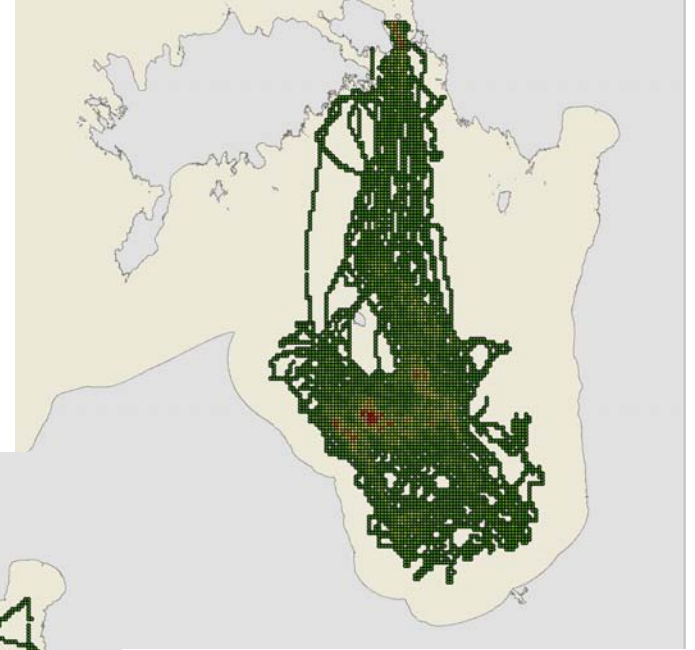
Seasons in seal-life



Seals in winter

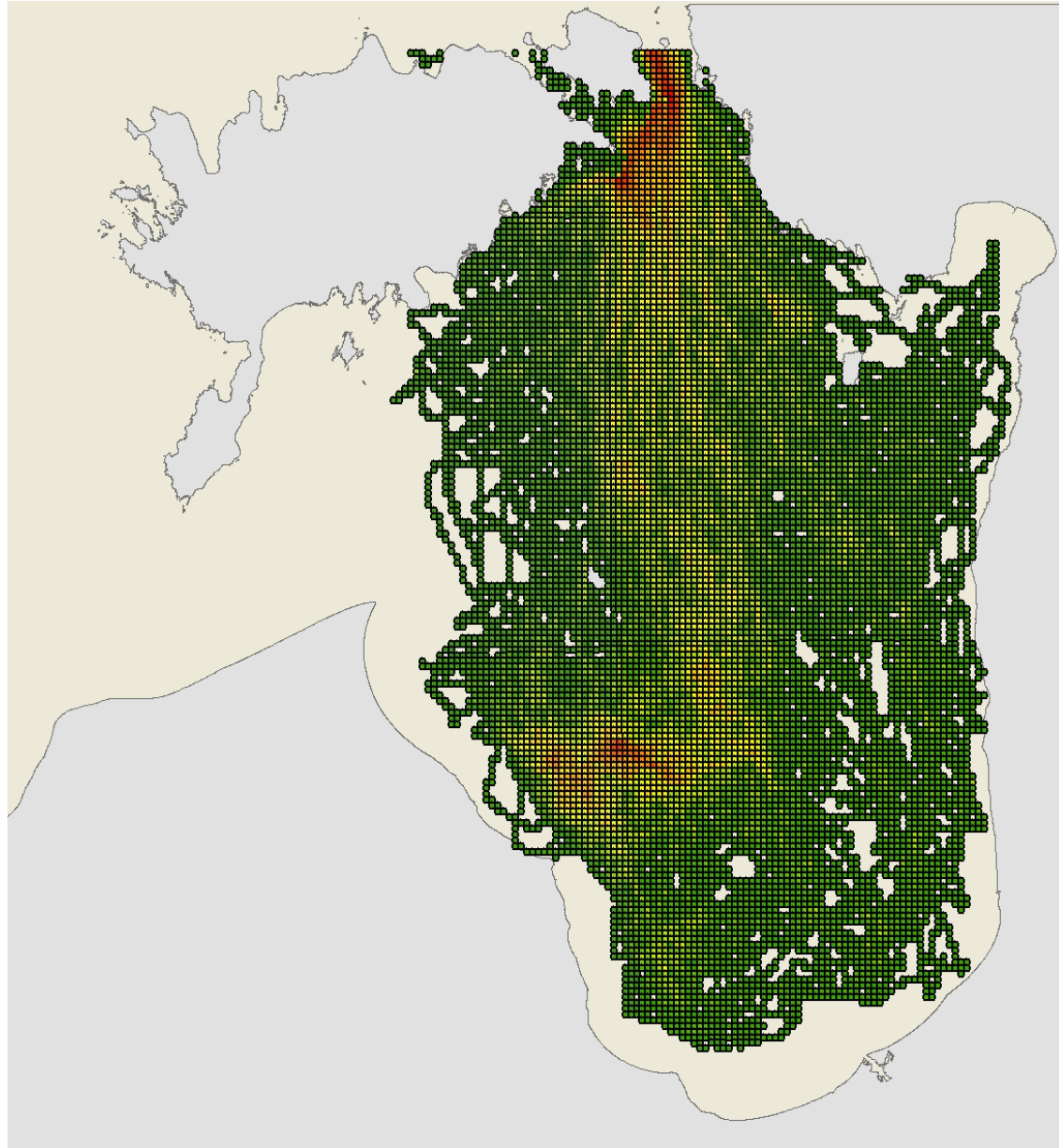


Seals in autumn



Seals in summer

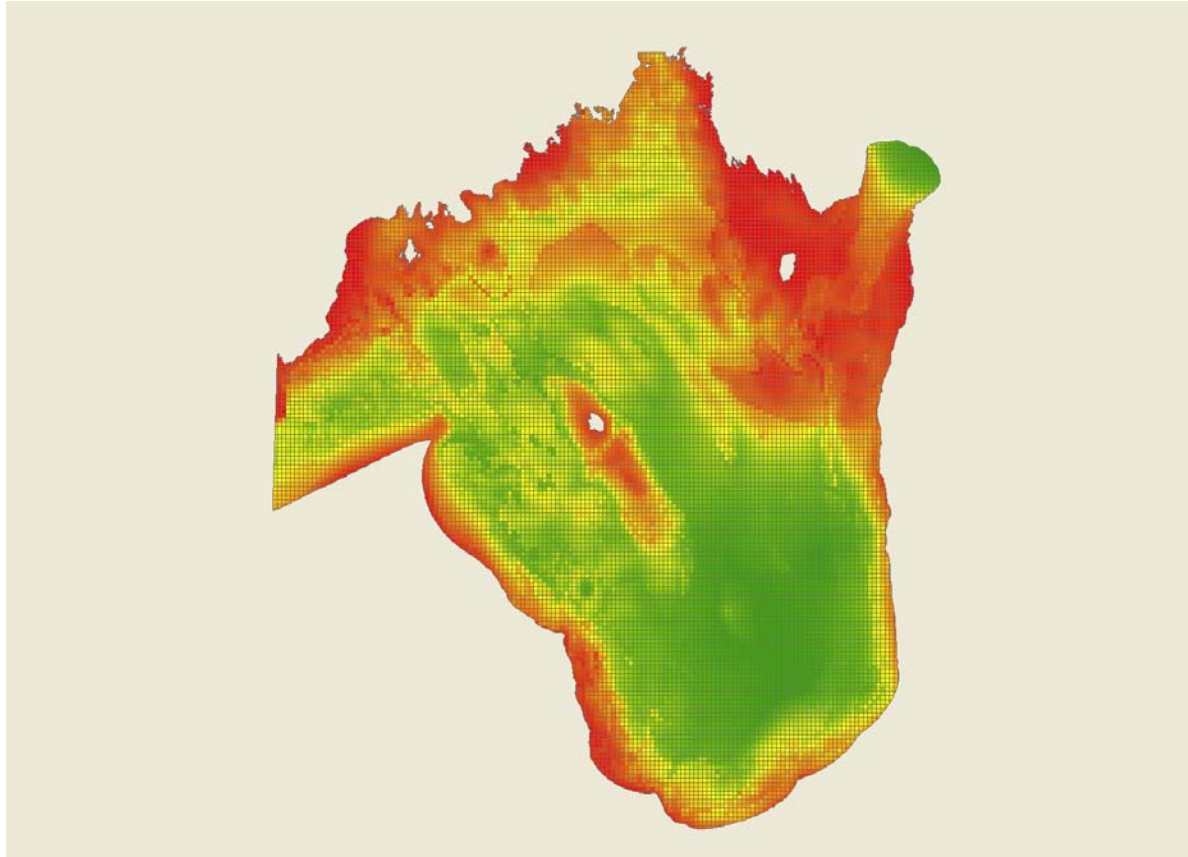
Seals



Birds

6a. Maximum abundance (or density) of protected waterbirds (divers, little gulls, terns; from all seasons)

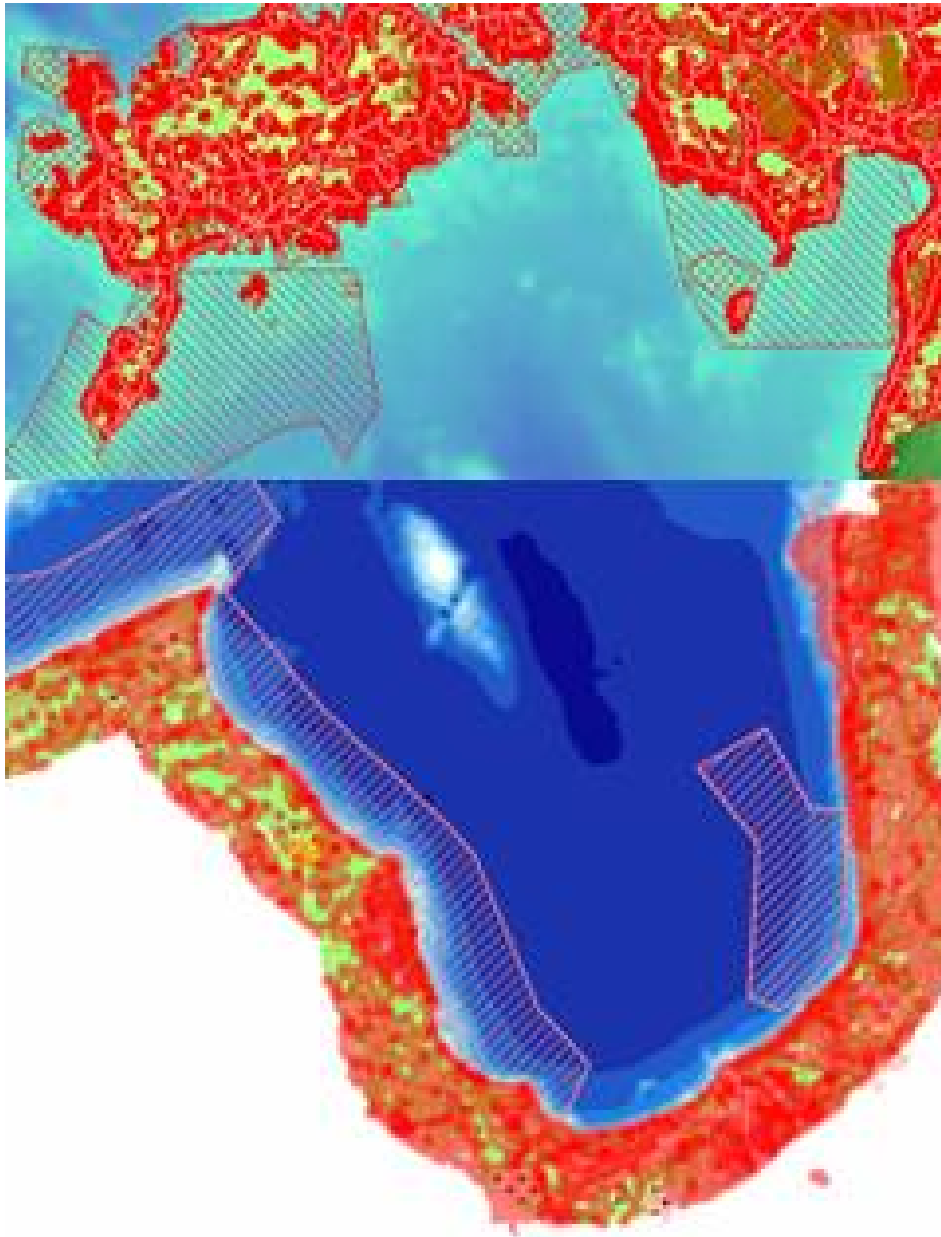
9. Relative maximum importance for all waterbirds (all ducks, geese, swans, divers, grebes and auks + little gulls) from all seasons (the maximum value from No.7 maps combined with No. 8 maps)



Categorical limitations

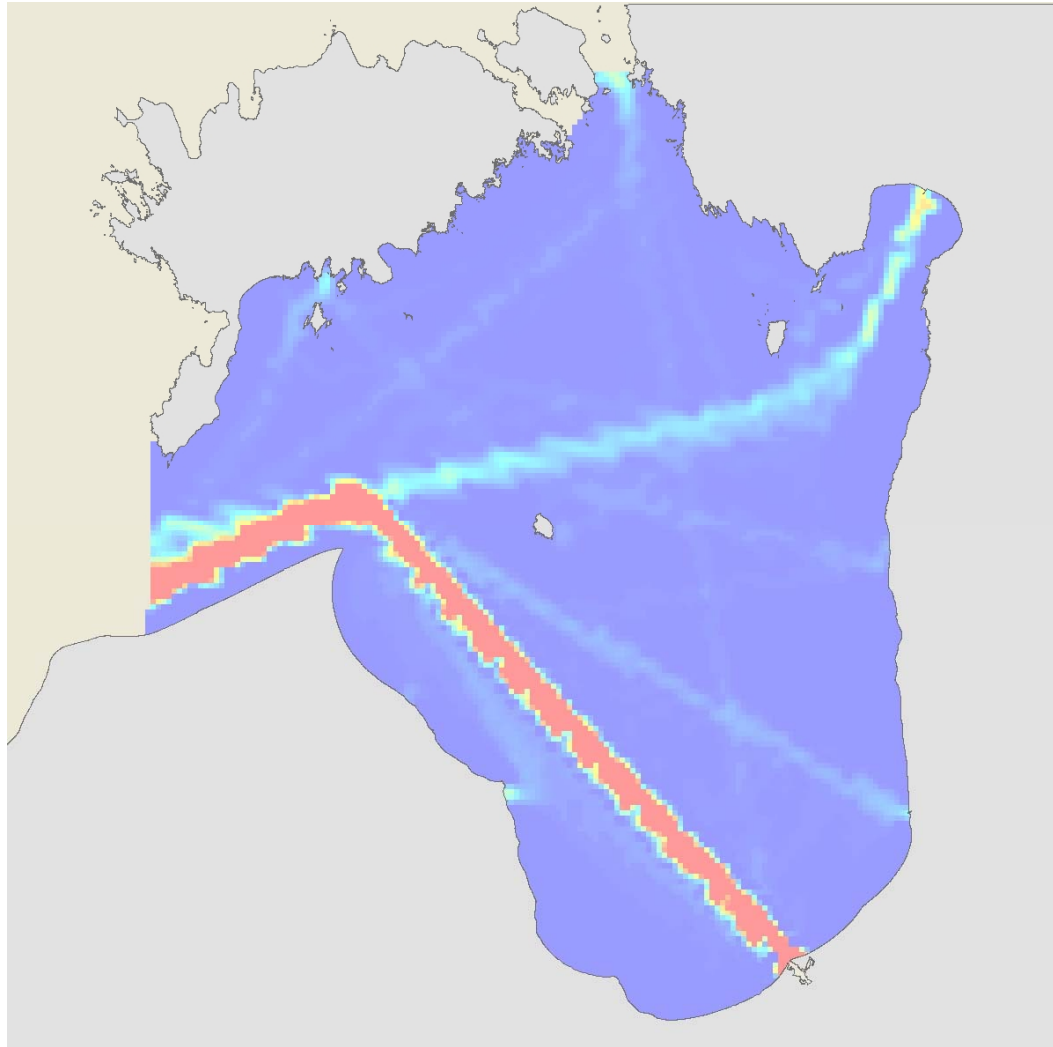
- All legally binding limitations, e.g.
 - noise prevention zone
 - safety zone around infrastructure
 - coastal building restriction zone etc.
 - (total appr. 60 legal restrictions)
- Exclusive use areas, e.g.
 - military training areas
 - navigation routes
 - lighthouses light sectors etc.

Legal restrictions on land



Almost no space for wind farm development in coastal zone, only few stand-alone wind turbine sites available

Economic aspects: Marine traffic



HELCOM marine traffic intensity data

Socio-economic limitations

(soft restrictions/suggestions)

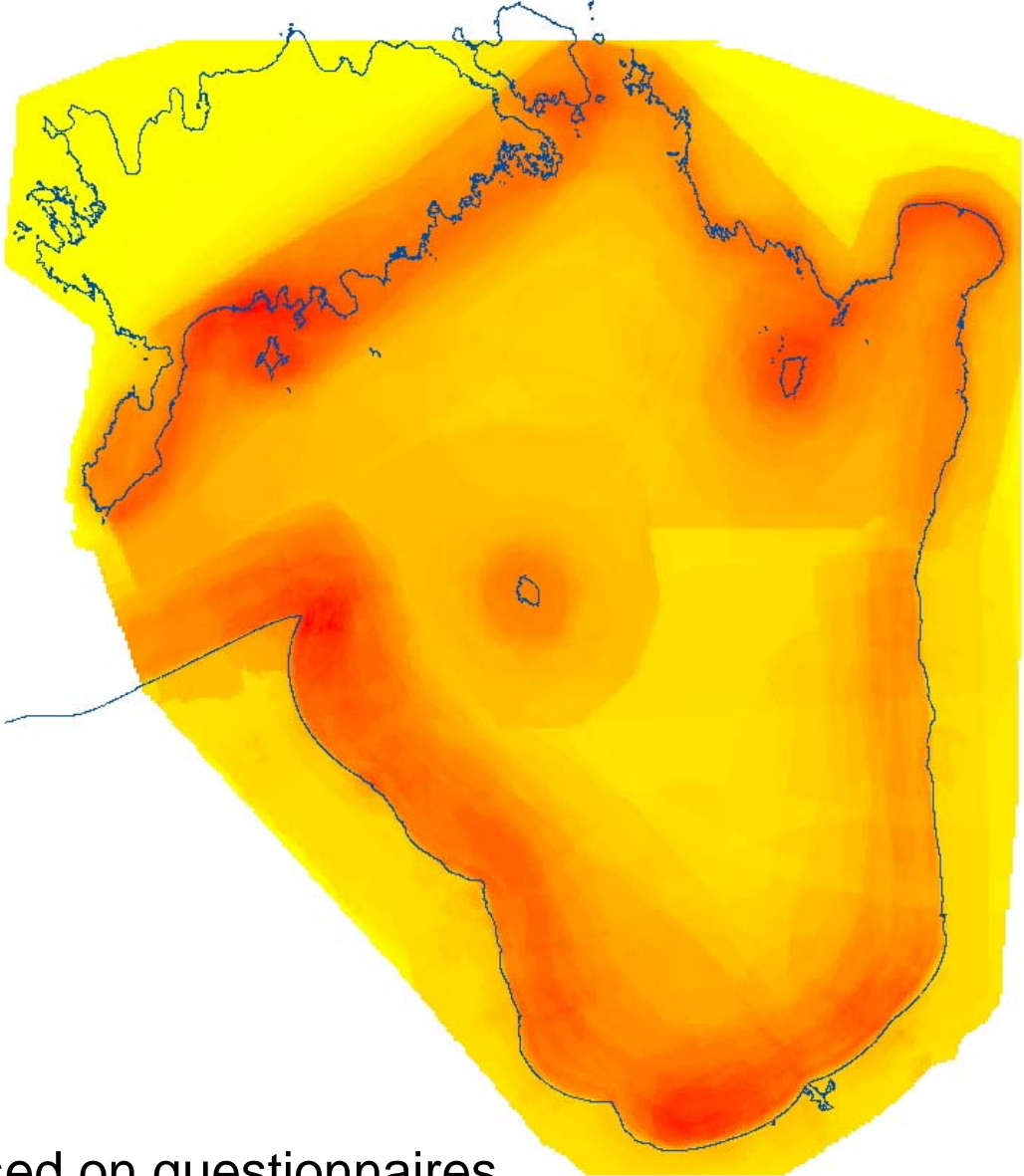
- Natura 2000 areas,
- IBA areas
- Heritage values

- Public acceptance /rejectance areas based on questionnaire

Nature reserves/protection/MAB



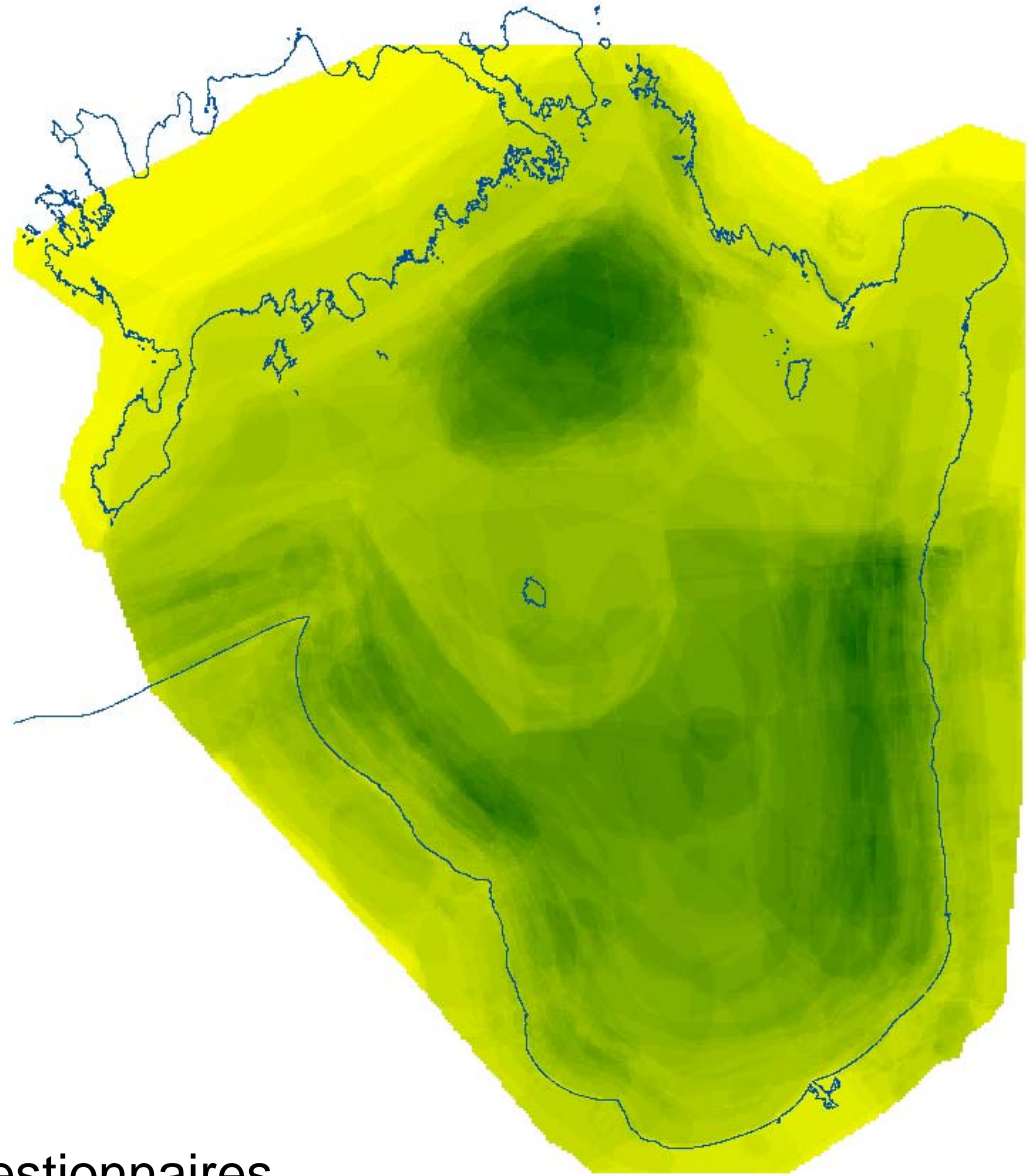
Public rejectance to offshore development



*As drawn on questionnaire maps,
normalized values (grid cell value
divided by number of
respondents)*

Public rejectance based on questionnaires

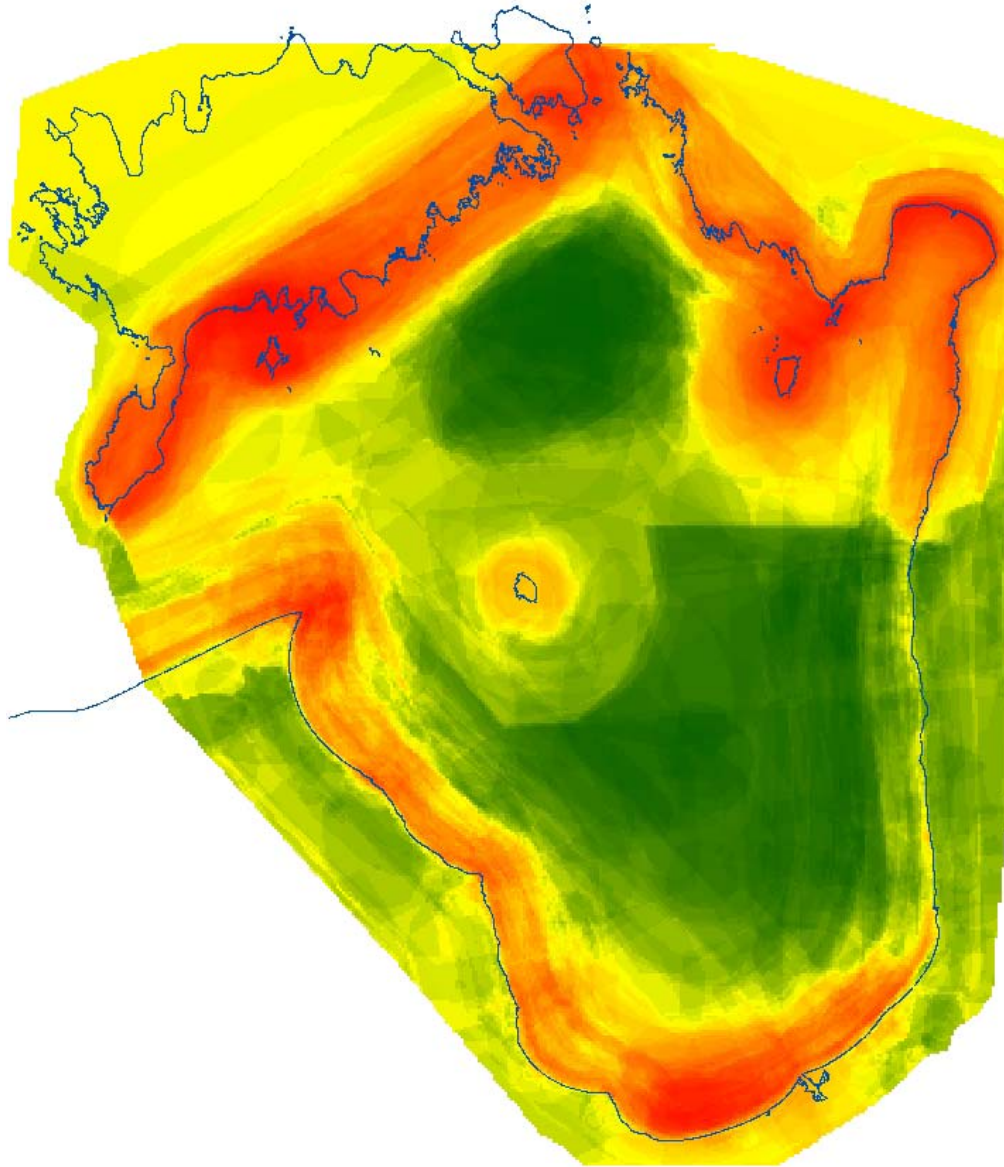
Public acceptance to offshore development



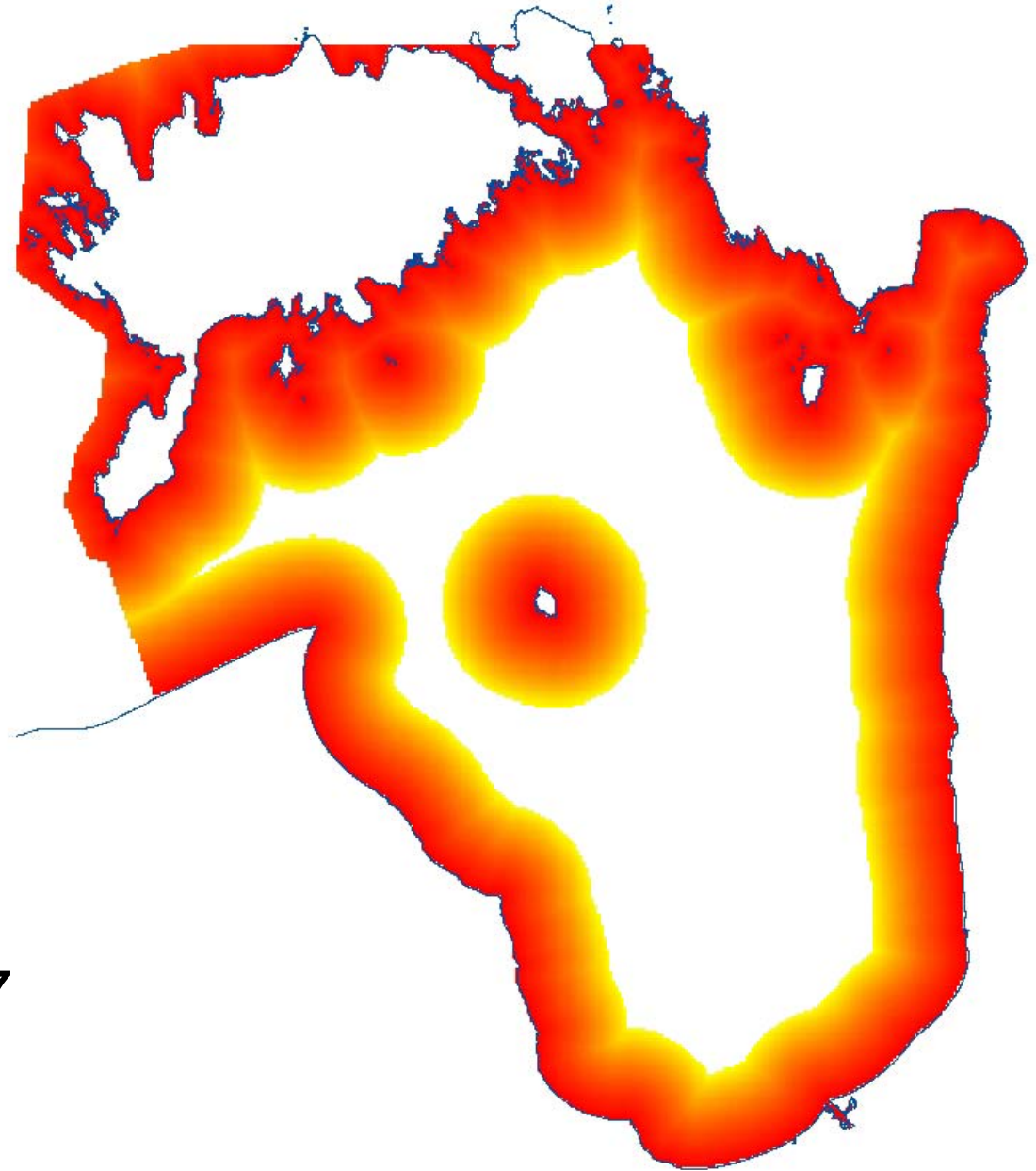
*As drawn on questionnaire maps,
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divided by number of
respondents)*

Public acceptance based on questionnaires

Public opinion in off-shore



Public opinion near coast

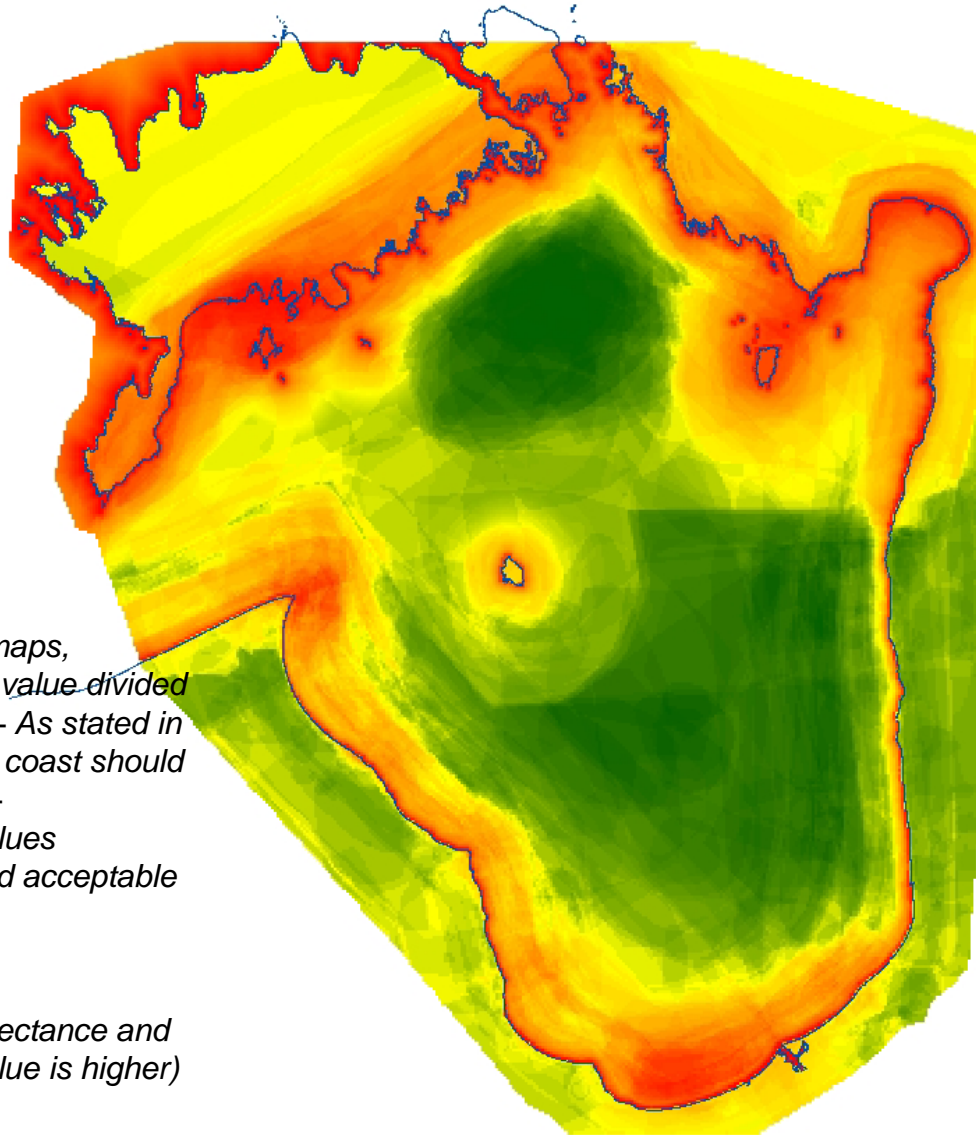


As stated in questionnaire "how far from coast should be the closest wind turbine + visualization), normalized values (distribution function of stated acceptable distance)

$$18.757 * (\ln(x)) + 24.87$$

$$R^2 = 0.89$$

Public acceptance: summary



*As drawn on questionnaire maps,
(normalized values grid: cell value divided
by number of respondents) + As stated in
questionnaire ("how far from coast should
be the closest wind turbine +
visualization), normalized values
(distribution function of stated acceptable
distance)*

Result is a sum of:

*maximum value of drawn rejectance and
coastal rejectance (which value is higher)
and*

value of drawn acceptance map

