ADRIENNE

Mapping biota and predicting future changes

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Stakeholder conference, 28 September 2021

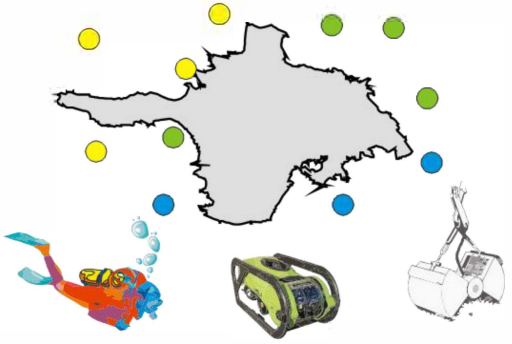
Mapping and modeling in ADRIENNE

Why spatial predictive modelling?

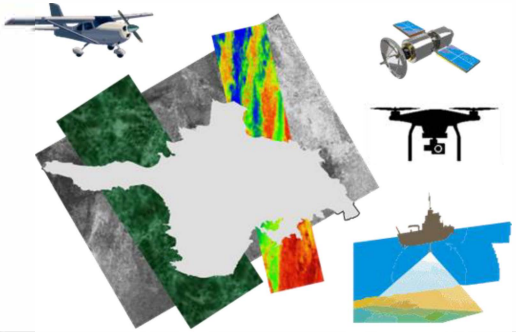
- Generate spatially continuous map layers
- Quantify changes in the distribution of species, habitats or ecosystem services due to climate change and human impact
- Generate spatially continuous input for the GIS Assessment Portal

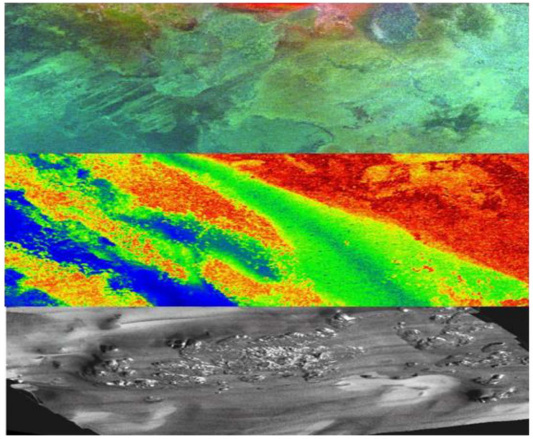
- Distribution modeling of macroscopic seabed plants and invertebrates

On-site sampling: point-wise data of substrate, biota

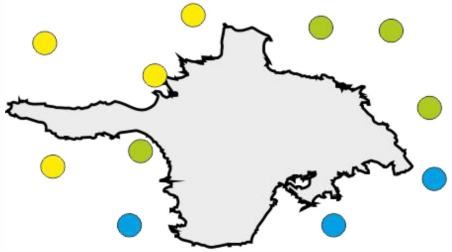


Remote sensing, hydrodynamic modeling: continuous layers of physical variables





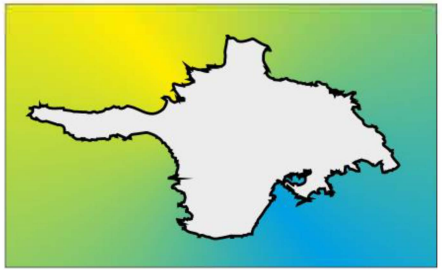
Response variable
point data of species



Predictor variables
GIS layers of environmental data

Model
GAM
BRT
RF

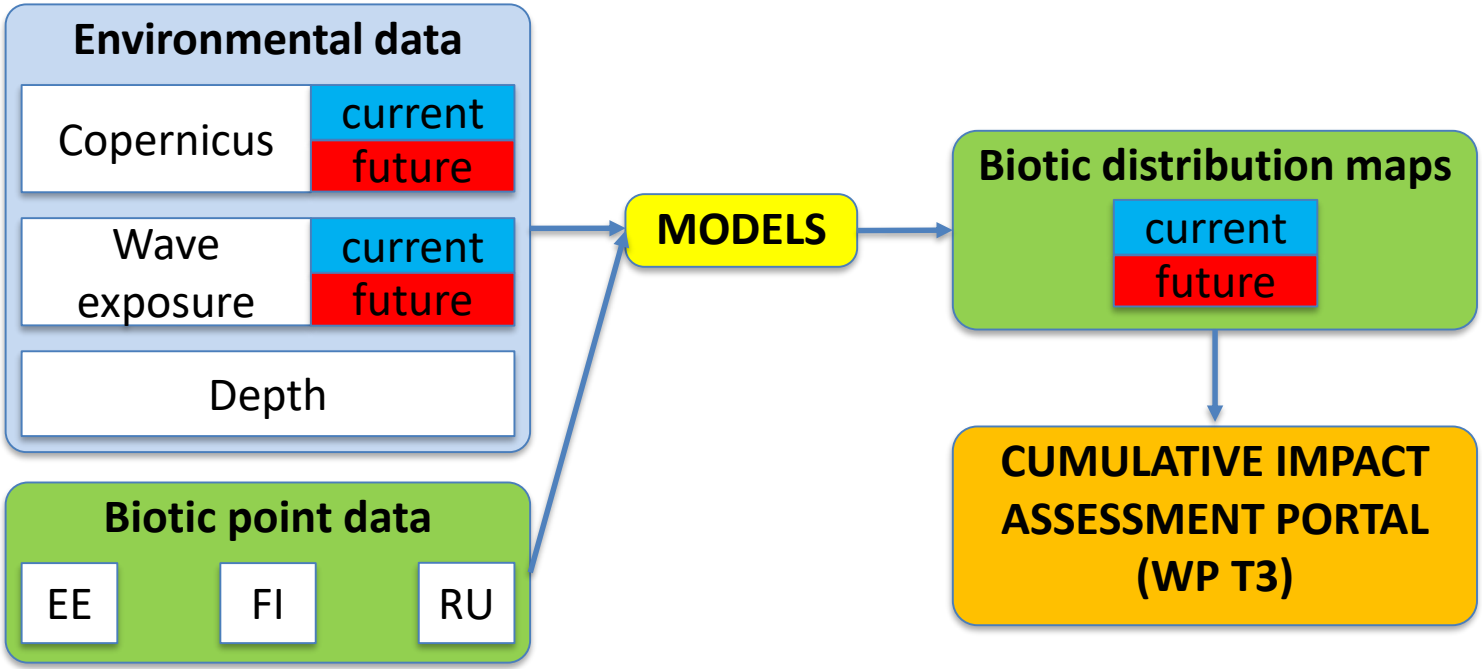
Prediction
occurrence of species



Model assessment

- validation (model accuracy)
- importance of predictiors
- shape of relationships

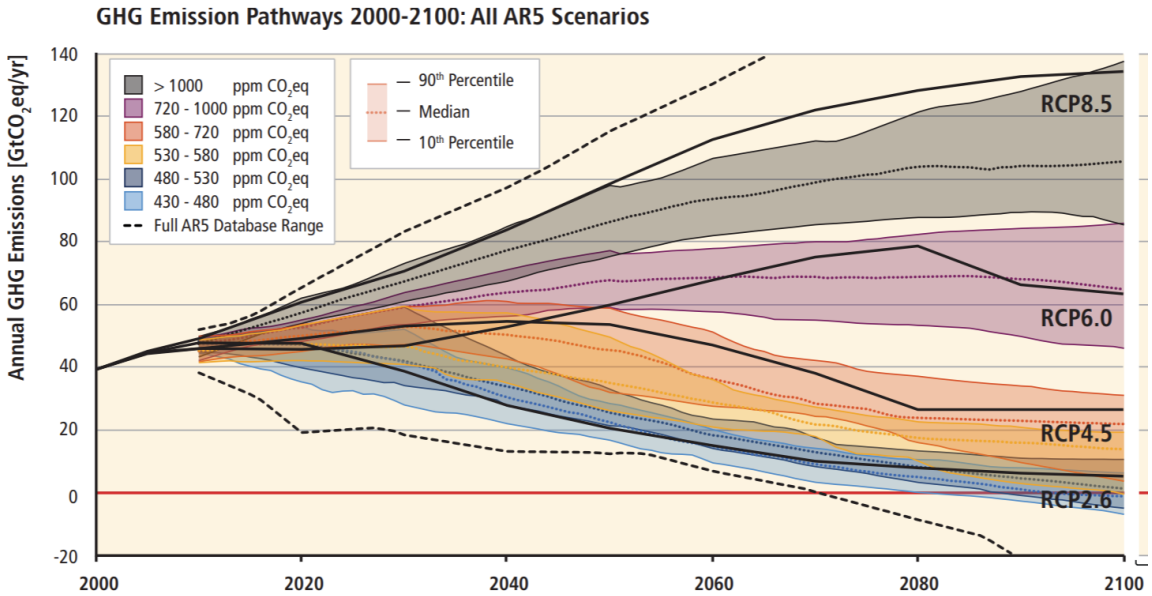
Concept



- What is the impact of human activities on biota today and in future?
- What groups of biota and where are positively/negatively affected by climate change?

Scenarios of climate change and human pressure

- Climate scenario IPCC RCP6.0
- Warmer winters in the northern Europe, increased storminess

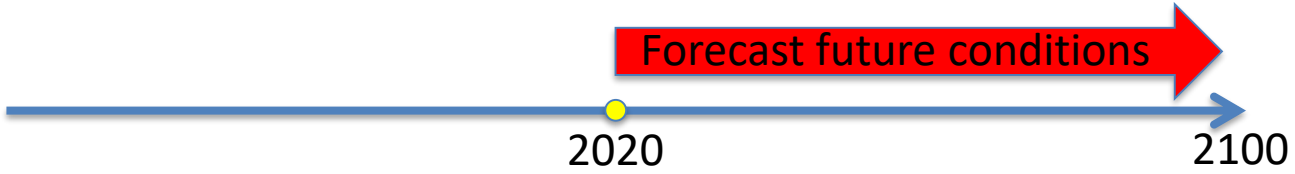


IPCC, 2014: Summary for Policymakers

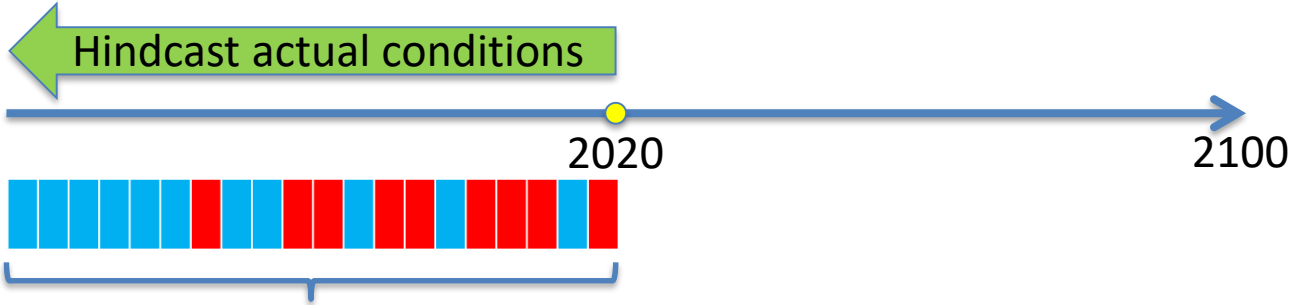
ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

2 approaches to model future distribution of species:

- Forecast environmental variables based on future climate



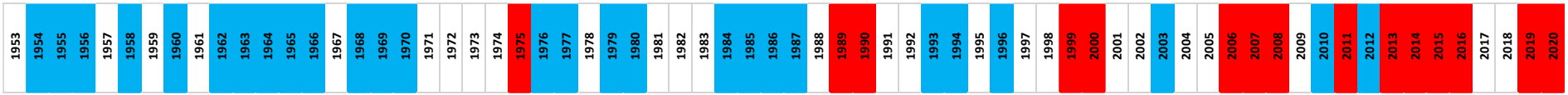
- Hindcast environmental variables based on real climate data → select the years of „current“ and „future“ climate based on resemblance



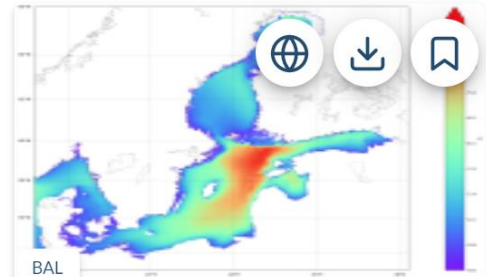
Select data from years resembling „**current**“ or „**future**“ conditions

We use the „hindcast“ approach

- Hindcast data is based on real measured atmospheric and marine data → adequate realization of interplay of different parameters (e.g. salinity, temperature, oxygen, chlorophyll, nutrients)
- There have been many years similar to what is projected in IPCC RCP6.0 in the recent 30 years (i.e. warm, moist winters)



- Copernicus hindcast data: salinity, temperature, oxygen, ice, current velocity, nutrients, chlorophyll, Secchi depth, wave height



BAL

Baltic Sea Wave Hindcast

BALTICSEA_REANALYSIS_WAV_003_015

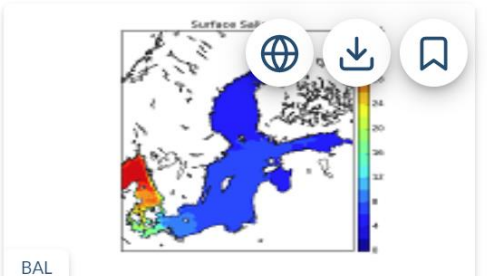
SWH MWT VMDR VSDXY WW SW1 SW2

From 1993-01-01 To 2020-06-30

2 km x 2 km

Model assimilation: None

Surface only
hourly instantaneous
Sub-setting WMS



BAL

Baltic Sea Physics Reanalysis

BALTICSEA_REANALYSIS_PHY_003_011

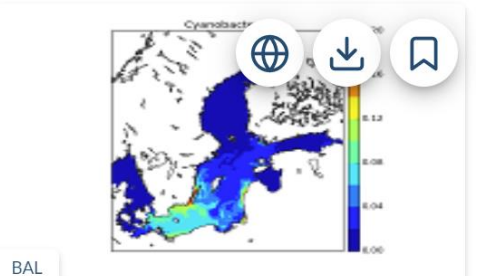
T bottomT S SSH UV MLD SIC SIT

From 1993-01-01 To 2019-12-31

4 km x 4 km

Model assimilation

56 depths level
hourly instantaneous - daily mean - monthly mean
Sub-setting WMS



BAL

Baltic Sea Biogeochemistry Reanalysis

BALTICSEA_REANALYSIS_BIO_003_012

CHL O2 NO3 PO4 NH4

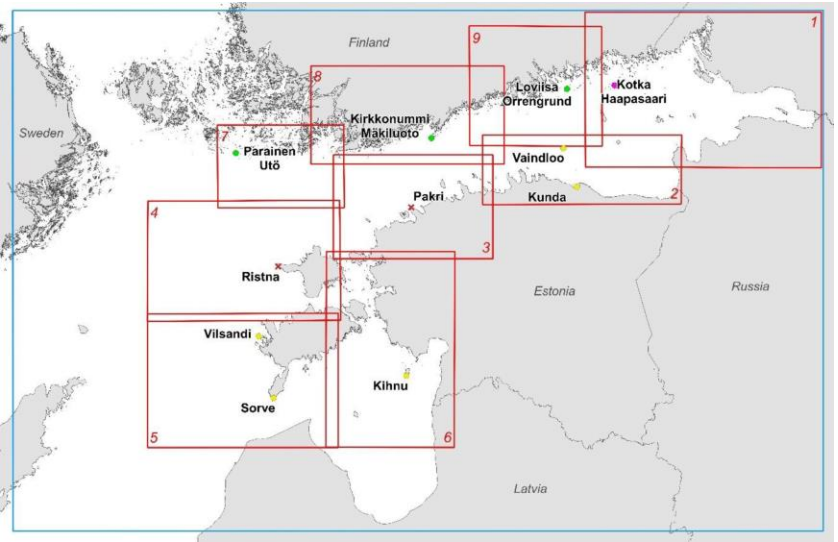
From 1993-01-01 To 2019-12-31

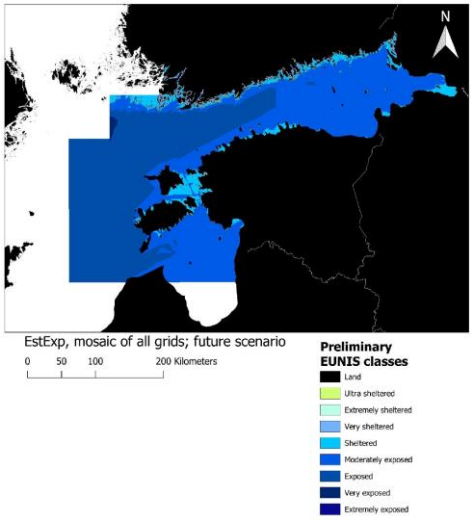
4 km x 4 km

Model assimilation

56 depths level
daily mean - monthly mean
Sub-setting WMS

- Simplified wave model for current and future climate
  - Modeling by AquaBiota Water Research (Sweden)
  - Based on Estonian and Finnish wind data

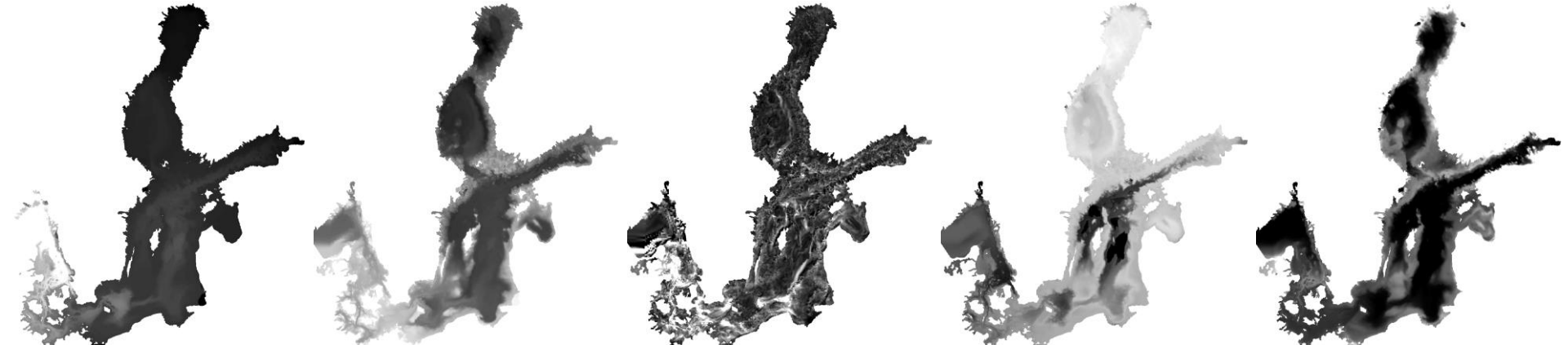




- Human pressure scenario - eutrophication
  - Current
  - Eutrophication mitigation: 25% reduction of nutrient concentrations (HELCOM BSAP)
- Full set of scenarios
  - Current
  - Climate change
  - Eutrophication mitigation
  - Climate change + eutrophication mitigation

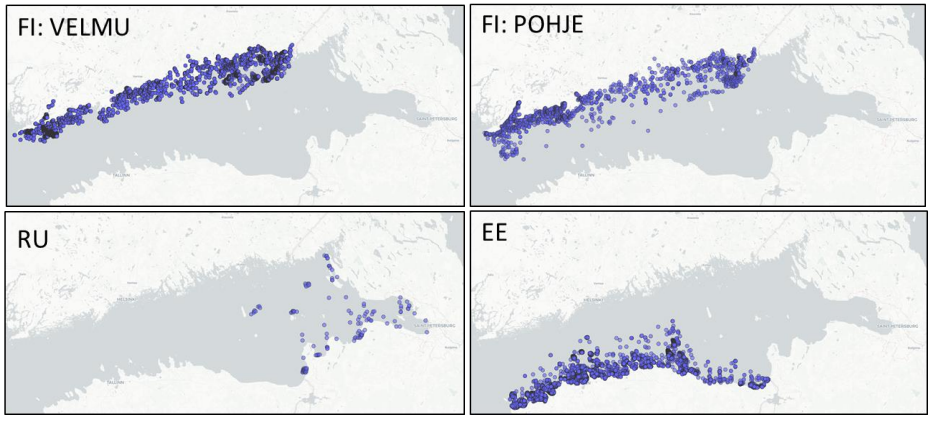
Environmental data

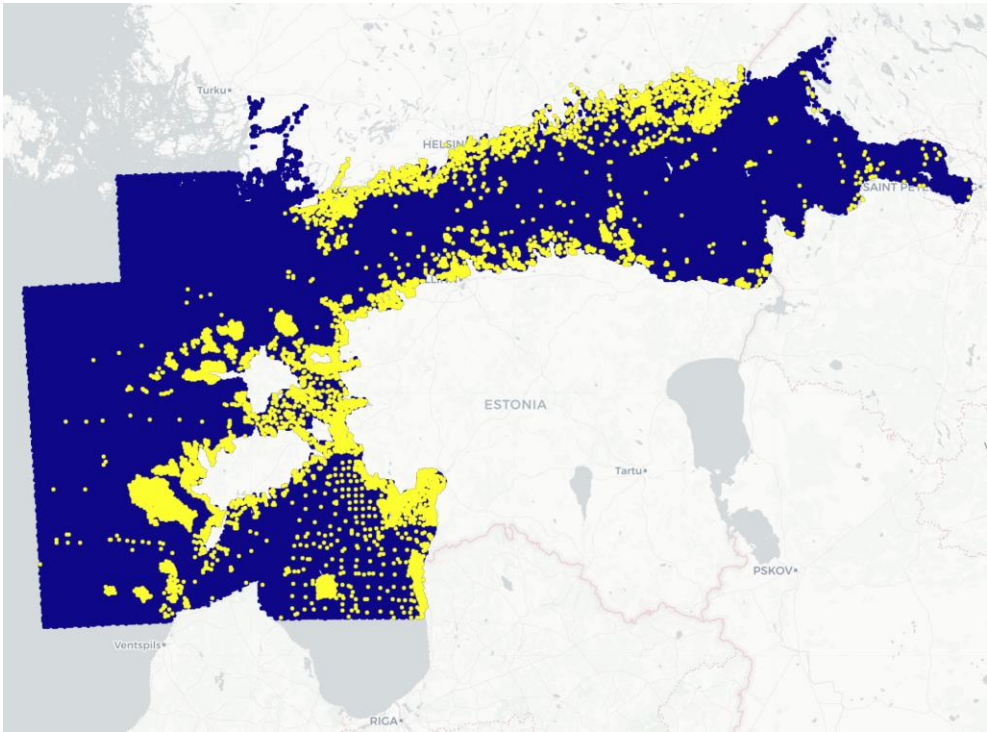
- Final selection of variables: depth, wave exposure, salinity, temperature, Secchi depth, wave height, nitrates, phosphates, ice cover, chlorophyll
- All data aggregated to 1 km grid
- Values for climate change (all except depth) and eutrophication mitigation (nitrates, phosphates) scenarios



Benthos data

- Data from FI, RU, EE, LV sources
- All data aggregated to 1 km grid, full grid 77495 cells
- 6770 cells with benthos data



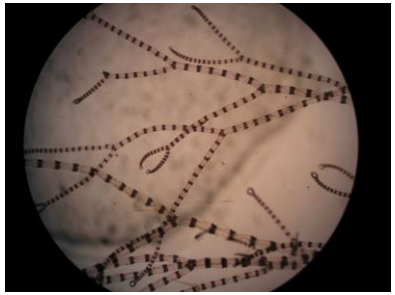


Selection of species/groups for modeling

- Groups selected based on occurrence rate and ecological relevance
- 3 levels of groups
  - Group 1 (n = 42): lowest level, mainly species or genus
    Amphibalanus improvisus, Ampullaceana balthica, Battersia arctica, Ceramium, Cerastoderma, Ceratophyllum demersum, charophytes*, Chironomidae, Chorda filum, Cladophora glomerata, Cladophora rupestris, Coccotylus truncatus, Dictyosiphon foeniculaceus, Dreissena polymorpha, Fucus, Furcellaria lumbricalis, Gammarus, Halicryptus spinulosus, Hediste diversicolor, Hildenbrandia, Idotea, Jaera, Limecola balthica, Marenzelleria, Monoporeia affinis, Mya arenaria, Myriophyllum, Mytilus trossulus, Najas marina, Oligochaeta, Potamogeton perfoliatus, PylaiellaEctocarpus, Rhodomela confervoides, Ruppia, Saduria entomon, Stictyosiphon tortilis, Stuckenia, Theodoxus, Ulva, Vertebrata fucoides, Zannichellia, Zostera marina*
  - Group 2 (n = 14): class, life form, freshwater groups
    drifting macrophytes, epifaunal bivalves fresh, filamentous brown algae, filamentous green algae, filamentous red algae, hydrozoa, infaunal bivalves, infaunal bivalves fresh, other *Polychaeta*, snails, snails fresh, thick brown algae, thick red algae, vascular plants
  - Group 3 (n = 1): filamentous algae

Fucus vesiculosus

Furcellaria lumbricalis

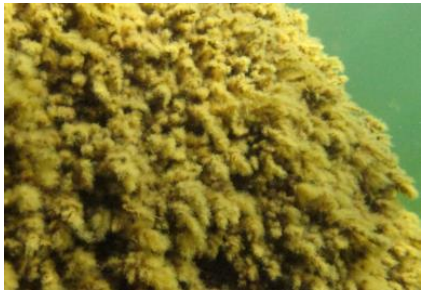


Ceramium spp

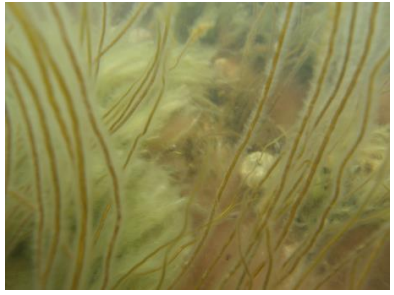
Ulva spp

Cladophora spp

Vertebrata fucoides



Pylaiella/Ectocarpus



Chorda filum

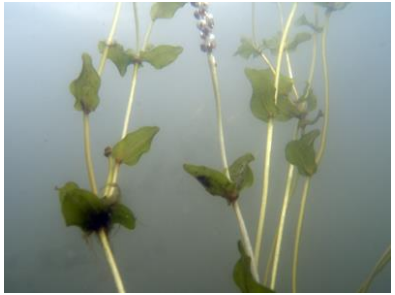
Mytilus trossulus

Dreissena polymorpha

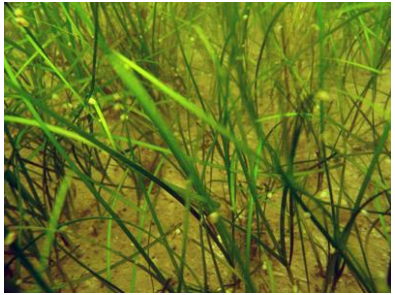
Amphibalanus improvisus

Gammarus spp

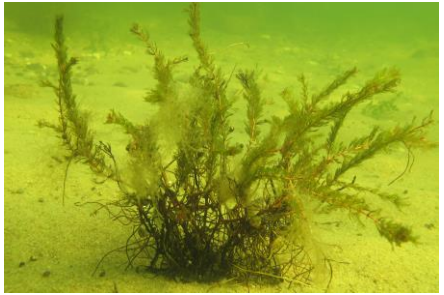
charophytes



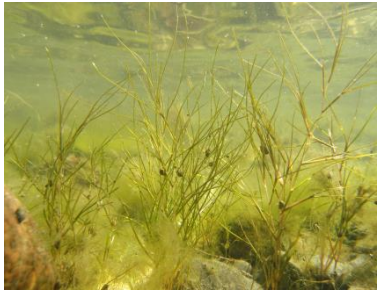
Potamogeton perfoliatus



Zostera marina

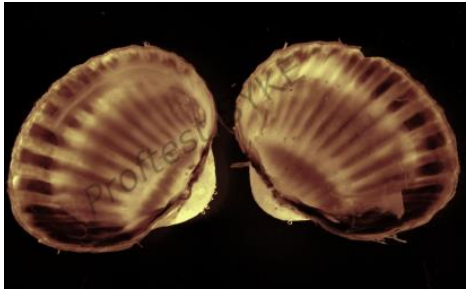


Myriophyllum spicatum



Stuckenia pectinata

Ruppia maritima

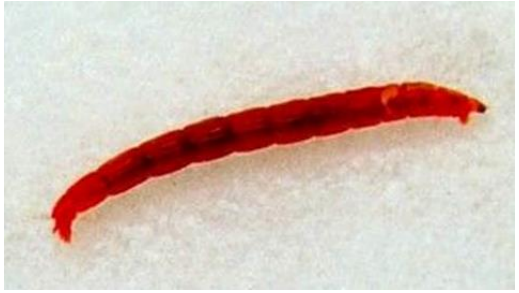


Cerastoderma glaucum

Mya arenaria

Limecola balthica

Heiste diversicolor

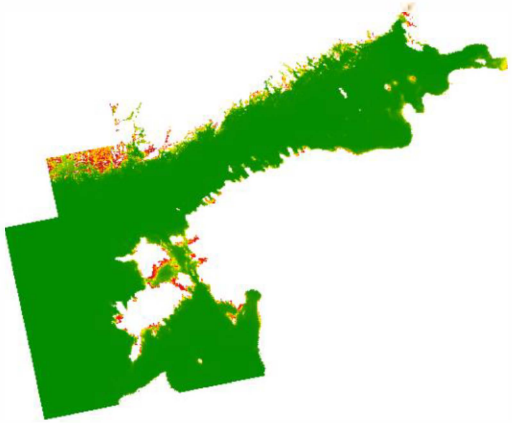


Chironomidae

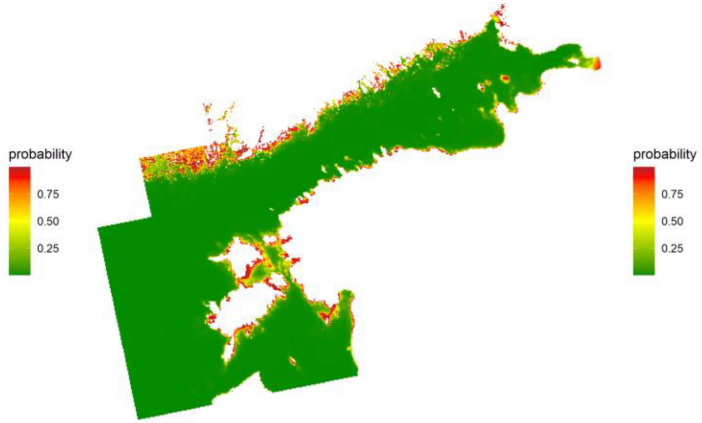
Distribution modeling

- 57 species/groups
- Boosted regression trees (BRT) modeling algorithm
- Models trained on „current“ dataset
- 4 spatial predictions for each species/groups
  - Current
  - Climate change DRAFT
  - Eutrophication mitigation DRAFT
  - Climate change + eutrophication mitigation DRAFT
- Output of model predictions: probability of occurrence (0…1)
- Probability of occurrence converted to binary presence-absence

charophytes
current | mean prob. 0.052



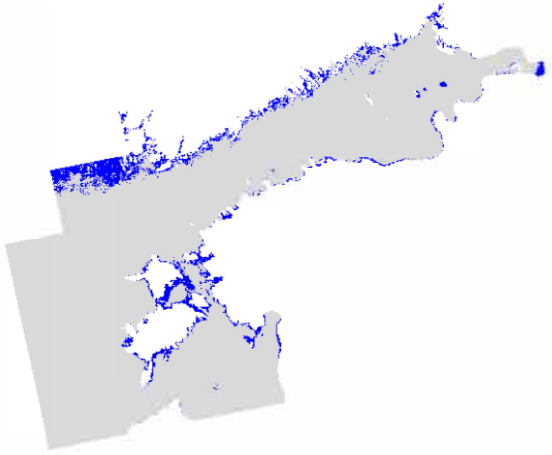
charophytes
eutrophication mitigation | mean prob. 0.083



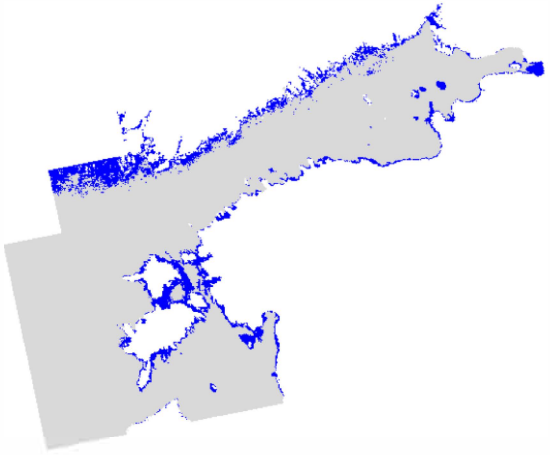
charophytes
climate change | mean prob. 0.083

charophytes
climate change + eutrophication mitigation | mean prob. 0.117

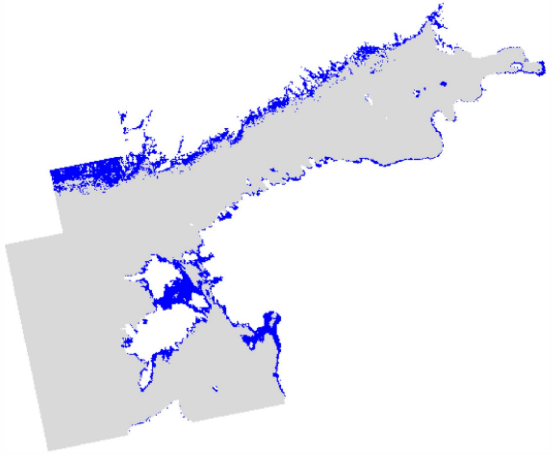
charophytes
current | 5310 km2



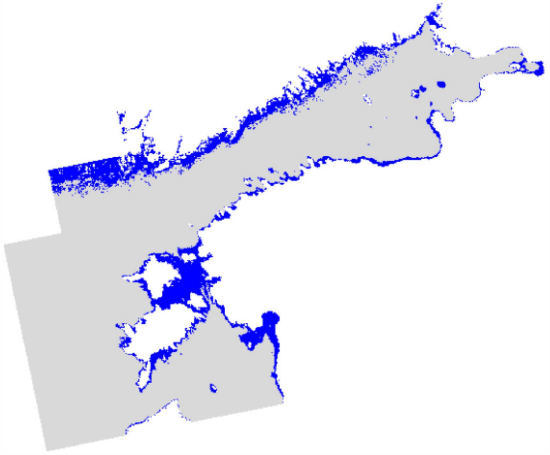
charophytes
eutrophication mitigation | 8291 km2



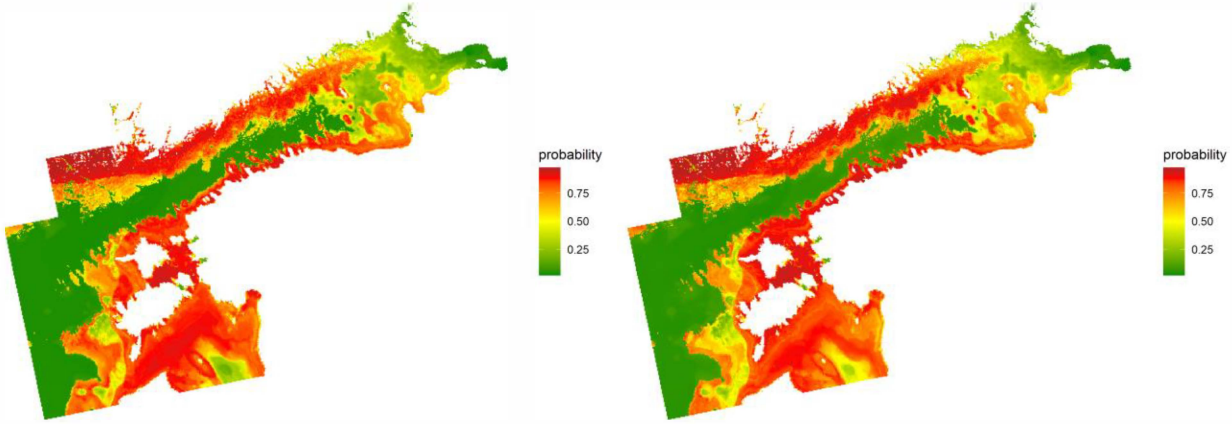
charophytes
climate change | 8240 km2



charophytes
climate change + eutrophication mitigation | 11113 km2

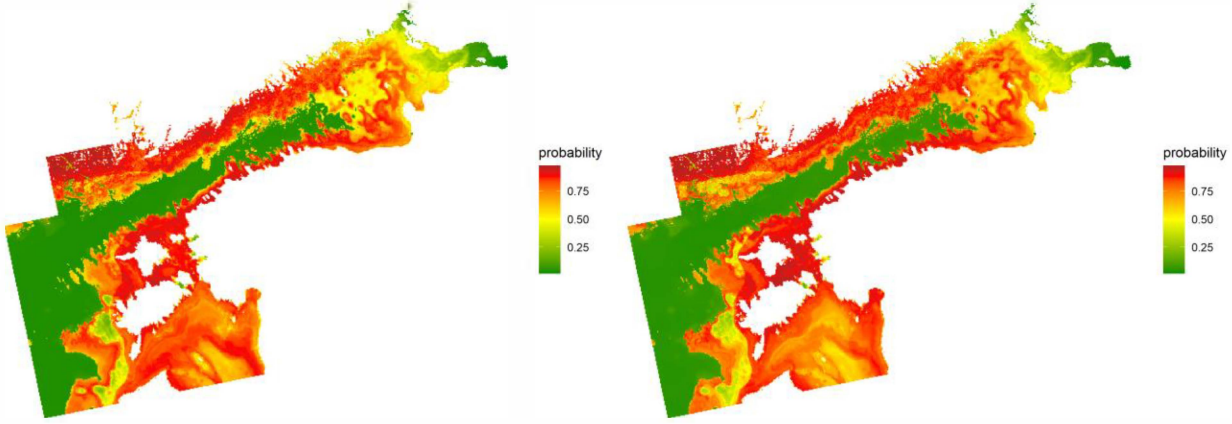


limecola_balthica
current | mean prob. 0.493



limecola_balthica
eutrophication mitigation | mean prob. 0.504

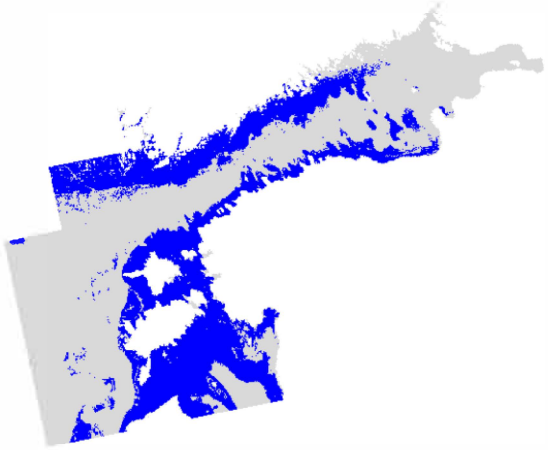
limecola_balthica
climate change | mean prob. 0.524



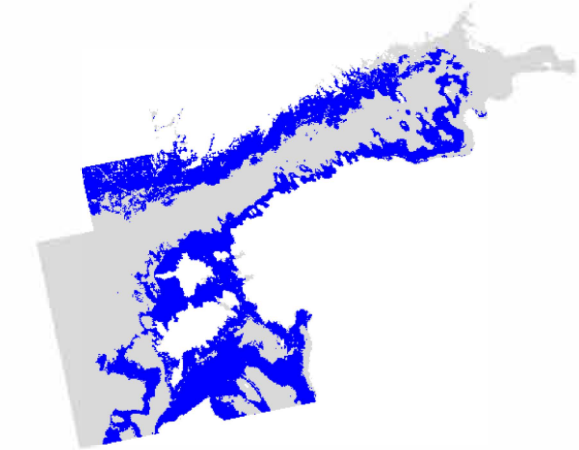
limecola_balthica
climate change + eutrophication mitigation | mean prob. 0.535

limecola_balthica
current | 28750 km2

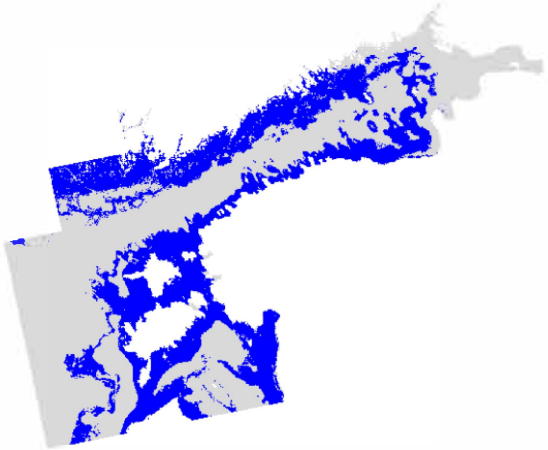
limecola_balthica
eutrophication mitigation | 27759 km2

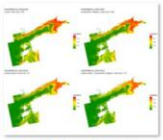


limecola_balthica
climate change | 30777 km2

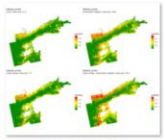


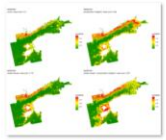
limecola_balthica
climate change + eutrophication mitigation | 30579 km2

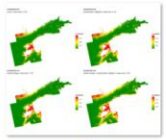



amphibalanus_improvisus


ampullaceana_balthica

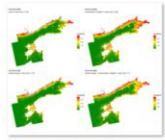

battersia_arctica

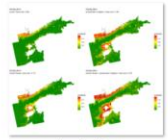

ceramium

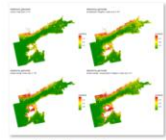

cerastoderma

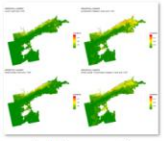

ceratophyllum_demersum

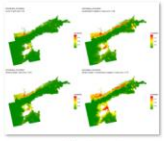

charophytes


chironomidae


chorda_filum


cladophora_glomerata


cladophora_rupestris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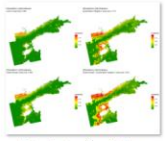
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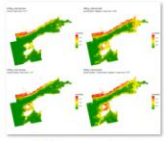
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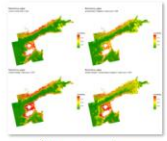
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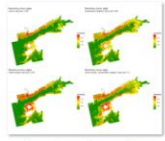
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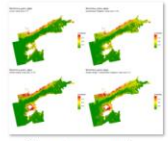
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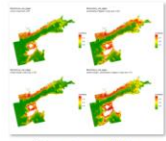
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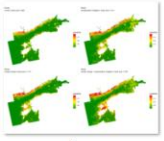
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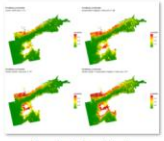
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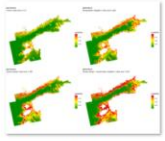
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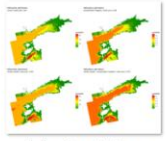
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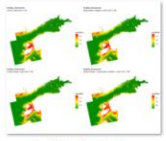
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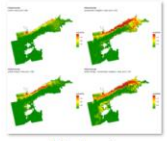
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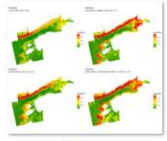
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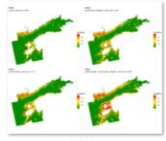
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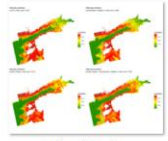
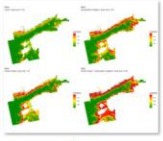

infaunal_bivalves


infaunal_bivalves_fresh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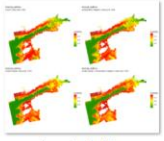
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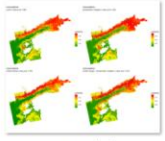
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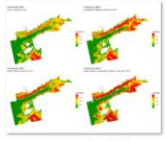
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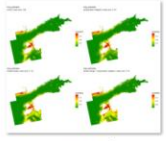
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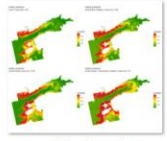
myriophyllum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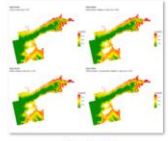
najas_marina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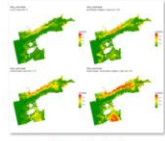
other_polychaeta

potamogeton_perfoliatus

pylaiella_ectocarpus

rhodomela_confervoides

ruppia

saduria_entomon

snails

snails_fresh

stictyosiphon_tortilis

stuckenia

theodoxus

thick_brown_algae

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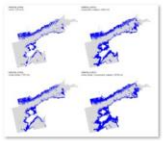
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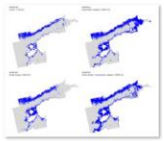
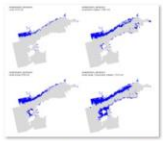

ceramium


cerastoderma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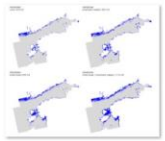
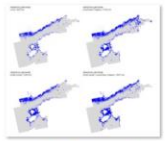

charophytes


chironomidae


chorda_filum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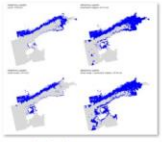
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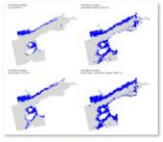
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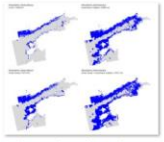
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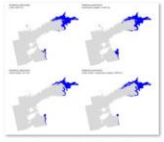
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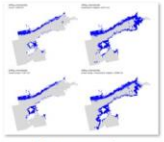
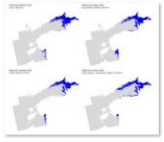
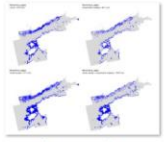
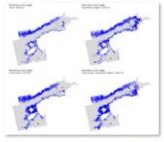

drifting_macrophytes


epifaunal_bivalves_fresh


filamentous_algae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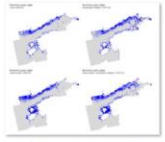
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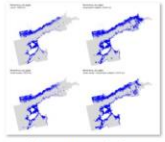
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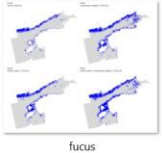
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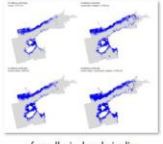
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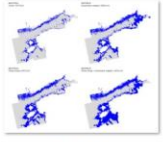
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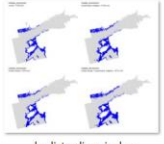
halicryptus_spinulosus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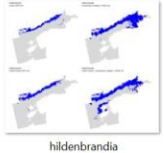
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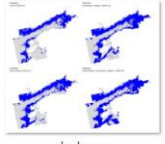
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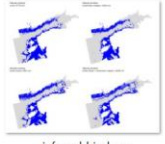
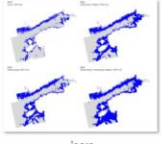
idotea


infaunal_bivalves


infaunal_bivalves_fresh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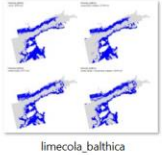
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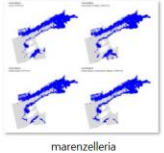
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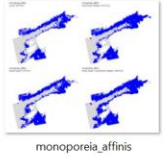
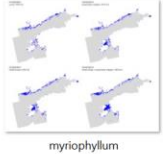

monoporeia_affinis


mya_arenaria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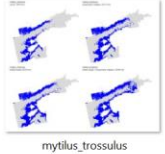
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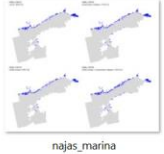
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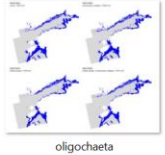
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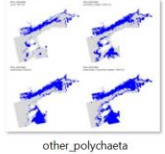
other_polychaeta

potamogeton_perfoliatus

pylaiella_ectocarpus

rhodomela_confervoides

ruppia

saduria_entomon

snails

snails_fresh

stictyosiphon_tortilis

stuckenia

theodoxus

thick_brown_algae

thick_red_algae

ulva

vascular_plants

vertebrata_fucoides

zannichellia

zostera

THANK YOU!

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