MYTIGATE — *Mytilus edulis* (Blue Mussel) Mitigation Farm Site Selection Tool for the Western Baltic Sea

User Manual

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URL:

https://mytigate.shinyapps.io/SiteSelectionTool/

Short summary

The *Mytilus edulis* (Blue Mussel) Mitigation Farm Site Selection Tool for the Western Baltic Sea (MYTIGATE) is meant to be a decision-support tool providing stakeholders with a science-based platform that offers flexible site selection solutions. Site selection is based on customized input criteria and, therefore fully dynamic with respect to the user's selections. MYTIGATE is based on 'a spatial model for nutrient mitigation potential of blue mussel farms in the western Baltic Sea' (Holbach et al., 2020) and a thorough selection of available spatial data about utilization of the respective marine areas. It works on a spatial resolution of 1x1 km^2 pixels. Within the tool, users can select specific areas of interest, investigate the model input parameters and results, adapt aquaculture farm setup, specify criteria for site-exclusion, set individual weights on potential conflict criteria, and define a specific criterion for the generated site-selection scenario. MYTIGATE uses an algorithm that integrates the spatial model result for the selection criterion (e.g. mussel weight, farm harvest) with locally applying exclusion and weighted conflict criteria. The algorithm then generates a ranking among all available sites, and selects the adequate number of most suitable sites until the selection target (e.g. no. of farms, nitrogen reduction) is reached. MYTIGATE will always only place one mitigation farm within each 1x1 km^2 pixel. A summary of the selection results is reported, a respective map is created, and detailed information on the selected sites can be downloaded as a table.

Users are encouraged to apply different sets of criteria and so to generate several selection scenarios. These can subsequently be used as decision-support prior to a final site-selection decision. Users should be aware that the authors are not the originators of the spatial data on marine utilization and that they cannot be held responsible for their correctness and integrity. Data provided within MYTIGATE, is not necessarily comprehensive and we strongly recommend to acquire further information on relevant specific local conditions and knowledge, prior to decision-making and establishing mussel mitigation farms at the selected sites. Currently, MYTIGATE is spatially limited to the western Baltic Sea.

Purpose of MYTIGATE

MYTIGATE is a publicly available platform that can be used in the process of marine spatial planning (MSP) with respect to establishing mussel mitigation aquaculture for nutrient reduction. It is addressed to all kinds of stakeholders involved in MSP and mitigation aquaculture and should be used as a scientific basis for discussion, when it is considered to implement mussel mitigation aquaculture. MYTIGATE enables stakeholders to interactively generate several site-selection scenarios by applying variable settings. The site selection output provides users with potential solutions, but these must not be seen as any form of advice for implementation. We strongly recommend to acquire further information on relevant specific local conditions and knowledge, prior to decision-making.

Background and data used

The core of MYTIGATE is a 'spatial model for nutrient mitigation potential of blue mussel farms in the western Baltic Sea' (Holbach et al., 2020, link). This scientific paper is published open access and publicly available. All details and relevant information regarding the calculation of this spatial model are given in the paper, and readers may want to refer to this publication for a more extensive background.

In short, the spatial model is a modular setup (Figure 1), which links in situ monitoring data, blue mussel growth experiments in the field, an eco-physiological dynamic energy budget model (DEB-model) for blue mussels, and information on bathymetry and the intended farm setup by the following 4 modules:

Module 1 provides spatial and temporal models of the long-term average pelagic habitat factors temperature, salinity, and chlorophyll-*a* concentration along with estimates of their natural variability. This module is based on data from the operationally performed monitoring programs of Denmark (NOVANA), Germany (LUNG, LLUR), and Sweden (SharkWEB).

Module 2 contains a blue mussel growth model based on inputs of Module 1. This model was fit to results of DEB-model runs and validated with data from blue mussel growth experiments in the field. This module is used to estimate biomass of individual blue mussels at harvest in November throughout the whole model domain.

Module 3 contains a statistical model function to up-scale biomass of individual blue mussels to the farm-scale and delivers respective biomass harvest and nutrient reduction potentials. This function is based on blue mussel growth experiments in the field and describes different types of mitigation farm setups in relation to local bathymetry.

Module 4 contains a simplified model to estimate locally required hydrodynamics to avoid food limitation for the mussel growth (Module 2) under the given farm setup (Module 3). Due to the lack of consistent and area-wide hydrodynamic reference data for the whole model domain, this module has not yet been implemented in MYTIGATE.

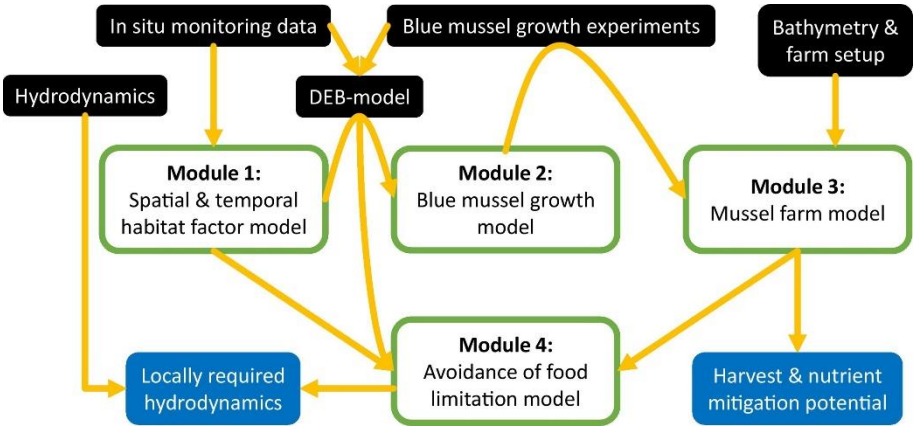

Figure 1: Flow diagram of the spatial modular modelling approach to estimate harvest and nutrient reduction potentials and locally required hydrodynamics for Mussel Mitigation Farms on trans-national scale in the western Baltic Sea. Black: inputs to the spatial model; green: modules of the spatial model; blue: outputs of the spatial model (from Holbach et al., 2020).

In MYTGATE, users can visualize and investigate the parameters of Modules 1, 2, and 3. For the site selection, however, MYTIGATE only uses the outputs of Module 2 (Weight of individual blue mussels) and 3 (farm harvest and nutrient reduction) in the form of long-term averages of a standard longline mitigation farm at harvest in November. The standard mitigation farm is based on longline farms, already applied in the field and is schematically shown in Figure 2.

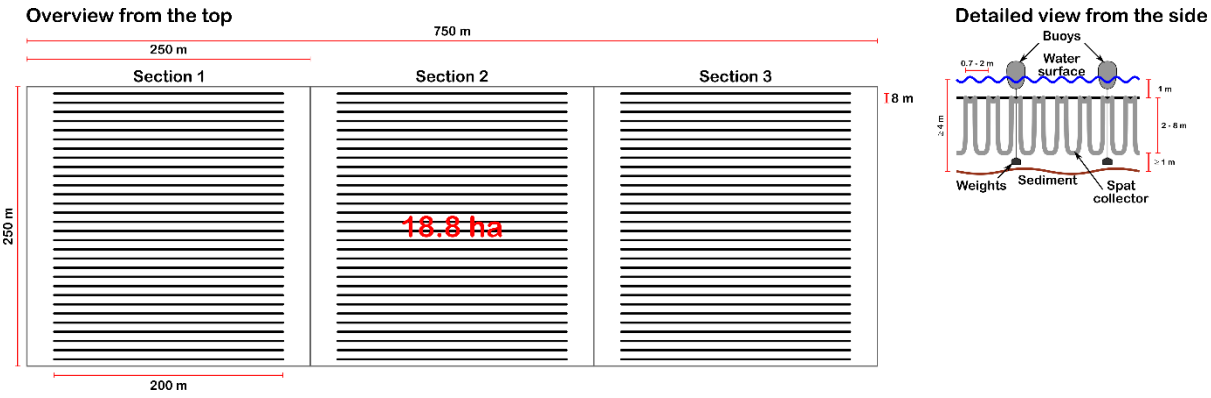

Figure 2: Layout of a standard model mitigation farm. The farm layout in the model is kept flexible with respect to the depth-range of spat collectors and the horizontal density of collector loops (from Holbach et al., 2020).

Structure of MYTIGATE

Layout

The MYTIGATE webtool is structured into several fields, which are illustrated in Figure 3 and Figure 4.

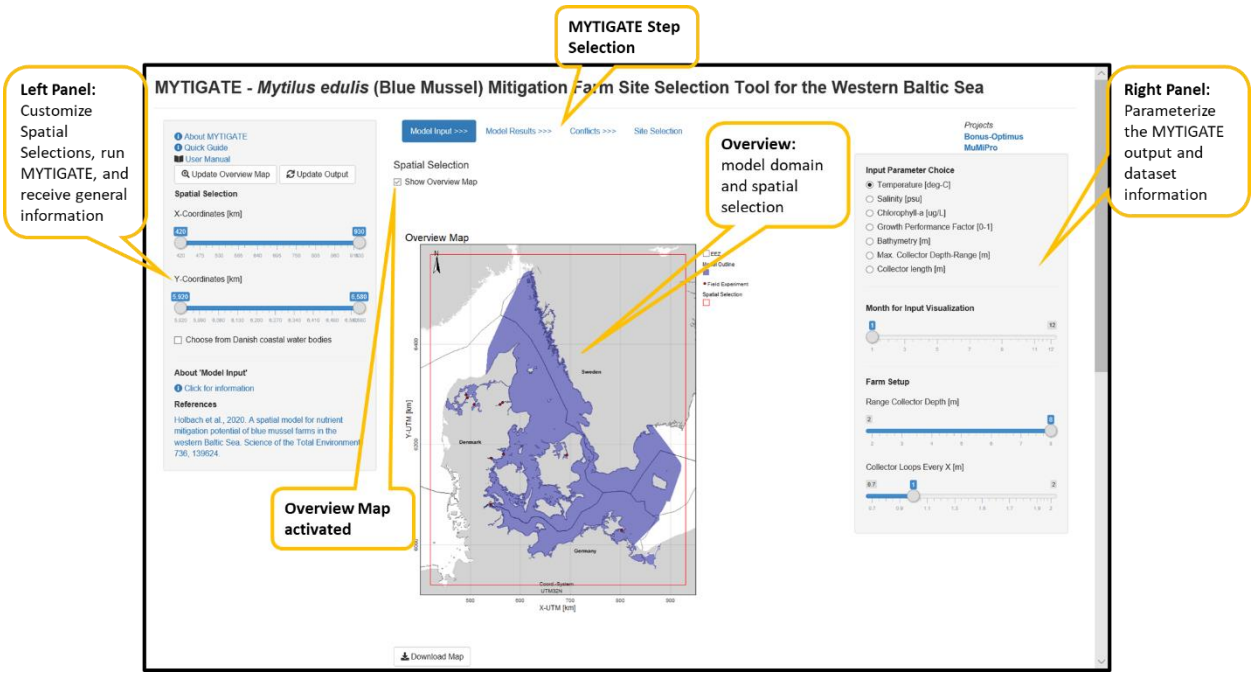

Figure 3: Screenshot of the MYTIGATE entrance page. Yellow boxes give information about the different parts.

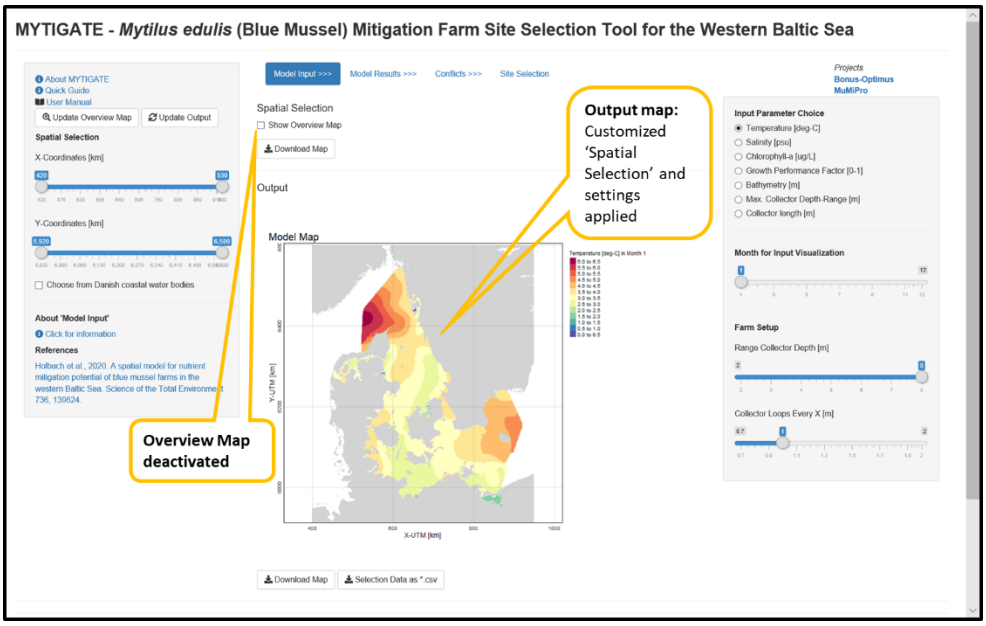

Figure 4: Screenshot of the MYTIGATE page after clicking on 'Update Output' and deactivating 'Show Overview Map'. Long-term average temperature distribution in January (default) is shown in the Output map.

Help and Information

At several locations throughout MYTIGATE, you will find links to relevant additional information. E.g. on the left panel you always find a link to a summary 'About MYTIGATE', a 'Quick Guide' and to this 'User Manual'. Further, you will detect blue hyperlinks to information indicated by a circled 'i', which you can click to access them.

Spatial Selection

The current 'Spatial Selection' is always displayed as a red polygon in the Overview Map. The Output Map will always zoom in, to the extent of the selected area. There are two ways of customizing your 'Spatial Selection' in MYTIGATE:

1. You can shift the sliders for X- and Y-Coordinates in the left panel in 5 km steps. The coordinate system used is UTM32N. You can conveniently use the 'Overview Map' to read the coordinates you need. The maps themselves are not directly interactive.
2. You can choose specific marine water bodies and/or catchments from the Danish River Basin Management Plans for the years 2015–2021 (EPA, 2016) by clicking the checkbox for 'Choose from Danish coastal water bodies' and select the desired water bodies from the appearing dropdown list. Selection of several water bodies/catchments is possible. Selections from Danish coastal water bodies will always overrule the selection by coordinate sliders.

Recommendation: Click on 'Update Overview Map' first to apply the new 'Spatial Selection' to the Overview Map only, for validation. After the selection fits, click on 'Update Output'. This can save some computation time.

Farm setup

The dynamic parameters in the farm setup are 'Max. Loop Depth [m]' and the 'Loop Interval [m]'. The 'Max. Loop Depth' ranges between 2-8 m, and is reactive to local bathymetry. The model will always restrict the loop depth to 2 m less than local bathymetry to ensure no bottom contact of the loops, which are placed 1 m below the water surface. The 'Loop Interval' ranges between 0.7-2.0 m and is independent of other local parameters. A farm with 2 m loop depth and 1 m loop interval will yield a total collector length of 90.000 m, while a farm with 8 m loop depth and 1 m loop interval will yield 306.000 m.

Model Input

As model input, users can choose from the relevant pelagic habitat factors temperature, salinity, and chlorophyll-*a* concentration. These are integrated to a growth performance factor between 0 and 1 (Holbach et al., 2020). Those parameters are available as long-term averages (2007-2017) at monthly resolution, and the specific month is selected by the slider 'Month for Input Visualization'.

Further, local bathymetry, collector depth, and total collector length can be chosen. Collector depth and collector length are dependent on local bathymetry and the chosen farm setup (see 'Farm setup'). These parameters are time independent, and the slider 'Month for Input Visualization' does not affect respective outputs.

Model Results

Conflicts

Site Selection

Export of Tool Outputs

The outputs of MYTIGATE can be saved in two ways:

1. Each map can be downloaded as a '*.png' image.

2. Detailed information on all the selected sites within a specific scenario can be downloaded as a '*.csv' table.

Limitations and Liability

The spatial model for nutrient mitigation potential of blue mussel farms in the western Baltic Sea is subject to several limitations and underlying assumptions. These are thoroughly discussed in Holbach et al., 2020.

Users should further be aware that the authors are not the originators of the spatial data on marine utilization and that they cannot be held responsible for their correctness and integrity. Data provided within MYTIGATE, is not necessarily comprehensive and we strongly recommend to acquire further information on relevant specific local conditions and knowledge, prior to decision-making and establishing mussel mitigation farms at the selected sites. Currently, MYTIGATE is spatially limited to the western Baltic Sea.

References

Holbach A, Maar M, Taylor D, Timmermann K, 2020. A spatial model for nutrient mitigation potential of blue mussel farms in the western Baltic Sea. Science of the Total Environment 736, 139624, https://doi.org/10.1016/j.scitotenv.2020.139624.

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