Content

1 Location of tool

Available here: https://github.com/IdaMBonnevie/SEANERGY.git with a readme file
A pre-processing tool is available here: https://github.com/IdaMBonnevie/SEANERGY-preprocessing.git

2 Overall introduction

This SEANERGY tool package contains the ArcMap-based toolbox called 'SEANERGY'. The toolbox can be accessed from ArcMap after download. It contains the tools:

- 'Calculate Score Map' (using Python script producescoremap.py): Can be used to calculate one total score raster with sum of all pairwise marine use conflict-synergy scores for each raster cell.
- 'Calculate Count Map' (using Python script producecountmap.py): Can be used to calculate one total raster with count of all pairwise marine use overlaps for each raster cell.
- 'Conflict Synergy Matrix Lookup' (using Python script matrixlookup.py): Can be used to lookup the specific content of a pairwise use-use interaction and print it.
- 'Find Synergy Potential Scores For New Marine Use' (using Python script scoresynergypotentialfornewmarineuse.py): Can be used to calculate one total raster with scores of all the marine uses that a given new marine use might experience synergies with due to a positive score in the matrix.
- 'Find Synergy Potential Counts For New Marine Use' (using Python script countsynergypotentialfornewmarineuse.py): Can be used to calculate one total raster with count of all the marine uses that a given new marine use might experience synergies with due to a positive score in the matrix.
- 'Monte Carlo Score Map Iteration' (using Python script montecarlotest.py): It can be used to iteratively change the synergy-score-conflict values. Iterate through the solutions a certain time and output for each raster cell the number of times that raster cell returns overall positive (+) minus the times it turns overall negative (-). Two different tests with different types of changes can be run individually or combined. 'Test sensitivity of score inputs' changes the input scores with a value between -1 and 1 in order to test synergy-conflict class uncertainty. 'Test sensitivity of ranking method' changes the values of all scores that are not -3 and 3 to test the relative importance of different synergy-conflict classes.

Further metadata describing the purpose of each tool and how to use each tool is included for each tool in the toolbox when opening that specific tool from ArcMap after installation.

3 Installing requirements

Requirements for the toolbox to succeed in running is the following:

- having an ArcMap installed with a basic and Spatial Analyst license (SEANERGY has been tested for ArcMap version 10.7.1 with Python version 2.7.16).
- having installed all the Python modules in the ArcGIS environment (Python27\ArcGIS[versionnumber]\Lib\site-packages) that are mentioned in the python scripts (.py) in this main folder. The python modules that are mentioned are: arcpy + os + pandas + numpy + collections + time + datetime

- It is likely that the Python modules in the attached folder called "pythonmodules_that_arcgis_might_miss" need to be installed manually.
- In this main folder in the default installation will be and should be:
    - the six python scripts (matrixlookup.py, and producescoremap.py, producecountmap.py, scoresynergypotentialfornewmarineuse.py, countsynergypotentialfornewmarineuse.py, and montecarlotest.py)
    - an inputfolder called "data_inputs" with all the Baltic Sea marine uses as binary input raster datasets (binary implying present vs. not-present in cell). This can be changed with own data (see section “Options to change case study” for a guide to change the default data to own data).
    - a folder called “extra_inputs” with a Baltic Sea ocean raster template as well as relevant lyrfiles for optional symbology settings. These datasets can be changed with own data (see section “Options to change case study” for a guide to change the default data to own data).
    - three excel files that are required inputs in the tools; an excel file with all marine use categories linked to raster data names (marine_uses_linked_to_rasternames.xlsx), an excel file with spatial-temporal data for each marine use category (marine_use_attributes.xlsx), and an excel file with pairwise marine use conflict-synergy descriptions and scores (matrix_conflicts_synergies.xlsx). These excel files can be updated with own data (see section “Options to change case study” for a guide to change the default data to own data).

4 Quick presentation of SEANERGY

4.1 Tools in SEANERGY:

SEANERGY is an ArcMap toolbox that been developed with ArcMap version 10.7.1 and Python version 2.7.16. The toolbox consists of six tools; a non-spatial tool called ‘Synergy-Conflict Matrix Lookup’, and five spatial tools called respectively 'Calculate Score Map', 'Calculate Count Map', 'Find Synergy Potential Scores For New marine Use', 'Find Synergy Potential Counts For New marine Use', and ‘Monte Carlo Score Map Iteration’. Metadata describing purposes and parameter choices is provided within the tools. User interfaces and running time examples are provided in other sections in this ‘read me’ guide.

4.2 Inputs:

By downloading the current version of the SEANERGY tool, the pre-processed Baltic Sea input data is part of the tool package, available as raster data. It can be replaced by other marine use raster datasets if a user wishes to focus on another area than the Baltic Sea demonstration area chosen in the SEANERGY basic package (see section “Options to change case study” for a guide to change the default data to own data).

Knowledge inputs to all the SEANERGY tools are provided in three input excel tables; a synergy-conflict matrix, a list over spatial and temporal attributes for each marine use, and a list of how marine use matrix categories are linked to pre-processed marine use raster datasets. The latter list is always case-specific, since the pre-processed marine use raster datasets are case-specific, for which reason that list as well as the pre-processed data should be adjusted to match the specific area that is in focus before the tool is run (see section “Options to change case study” for a guide to change the default data to own data).

The ‘Monte Carlo Score Map Iteration’ provides two different uncertainty tests that can be individually chosen or combined into one third test, see the two figures below.

```
# test score input variability:
if changeScoreInputs == "true":
    if spec_score == -3.00:
        spec_score = (spec_score + np.random.choice([0.00, 1.00]))
    elif spec_score == -2.00:
        spec_score = (spec_score + np.random.choice([-1.00, 0.00, 1.00]))
    elif spec_score == -1.00:
        spec_score = (spec_score + np.random.choice([-1.00, 0.00, 2.00]))
    elif spec_score == 1.00:
        spec_score = (spec_score + np.random.choice([-2.00, 0.00, 0.25, 0.50, 0.75, 1.00]))
    elif spec_score == 1.25:
        spec_score = (spec_score + np.random.choice([-2.25, -0.25, 0.00, 0.25, 0.50, 0.75]))
    elif spec_score == 1.50:
        spec_score = (spec_score + np.random.choice([-0.50, -0.25, 0.00, 0.25, 0.50, 1.00, 1.25, 1.50]))
    elif spec_score == 1.75:
        spec_score = (spec_score + np.random.choice([-0.75, -0.50, -0.25, 0.00, 0.25, 0.75, 1.00, 1.25]))
    elif spec_score == 2.00:
        spec_score = (spec_score + np.random.choice([-1.00, -0.75, -0.50, -0.25, 0.00, 0.50, 0.75, 1.00]))
    elif spec_score == 2.50:
        spec_score = (spec_score + np.random.choice([-1.50, -1.25, -1.00, -0.75, -0.50, 0.00, 0.25, 0.50]))
    elif spec_score == 2.75:
        spec_score = (spec_score + np.random.choice([-0.75, -0.25, 0.00, 0.25]))
    elif spec_score == 3.00:
        spec_score = (spec_score + np.random.choice([-1.00, -0.50, -0.25, 0.00]))
```

***First Monte Carlo uncertainty test**: It iteratively tests how the total score map result from the tool 'Calculate Score Map' would change regarding its positive and negative tendencies, if the experts' uncertainty regarding each input score would span to the closest neighbour input scores on the scoring scale. It can be combined with the second Monte Carlo uncertainty test, providing a third Monte Carlo uncertainty test.*

```
# test relative difference of scores:
if changeRankingMethod == "true":
    if (spec_score == 2.75):
        spec_score = 3.0*factor_2_75
    elif (spec_score == 2.50):
        spec_score = (3.0*factor_2_75)*factor_2_50
    elif (spec_score == 2.00):
        spec_score = ((3.0*factor_2_75)*factor_2_50)*factor_2_00
    elif (spec_score == 1.75):
        spec_score = (((3.0*factor_2_75)*factor_2_50)*factor_2_00)*factor_1_75
    elif (spec_score == 1.50):
        spec_score = ((((3.0*factor_2_75)*factor_2_50)*factor_2_00)*factor_1_75)*factor_1_50
    elif (spec_score == 1.25):
        spec_score = (((((3.0*factor_2_75)*factor_2_50)*factor_2_00)*factor_1_75)*factor_1_50)*factor_1_25
    elif (spec_score == 1.00):
        spec_score = ((((((3.0*factor_2_75)*factor_2_50)*factor_2_00)*factor_1_75)*factor_1_50)*factor_1_25)*factor_1_00
    elif (spec_score == -2.00):
        spec_score = ((-3.0*factor_2_75)*factor_2_50)*factor_2_00
    elif (spec_score == -1.00):
        spec_score = ((((((-3.0*factor_2_75)*factor_2_50)*factor_2_00)*factor_1_75)*factor_1_50)*factor_1_25)*factor_1_00
```

***Second Monte Carlo uncertainty test**: It iteratively tests how the total score map result from the tool 'Calculate Score Map' would change regarding its positive and negative tendencies, if the relative ranking scale for the input scores is uncertain while the order of input scores is fixed. It can be combined with the first Monte Carlo uncertainty test, providing a third Monte Carlo uncertainty test.*

4.3 Mandatory map outputs:

The main map outputs from the tools 'Calculate Score Map' and 'Find Synergy Potential Scores For New Marine Use' are total score maps, while the main map outputs from the tools 'Calculate Count Map' or 'Find Synergy Potential Counts For New Marine Use' are total count maps.

The tool 'Monte Carlo Score Map Iteration' provides map outputs describing how robust the positive and negative patterns from the 'Calculate Score Map' are based on iterative changes in score inputs due to score uncertainties. Three mandatory Monte Carlo raster output maps are returned from this tool. The first Monte Carlo output map sums up across all chosen iterations the number of times each raster cell returns a positive total score per iteration minus the number of times it returns a negative total score per iteration. The closer the first Monte Carlo output map is to 0 for a specific raster cell with score-experiencing pairwise combinations, the more sensitive that raster cell is to the uncertainty of the inputted pairwise conflict-

synergy scores, since it will both have many iterations returning a positive total score and many iterations returning a negative total score. The second and third Monte Carlo output maps are derived from the first Monte Carlo output map, reflecting robustness and high uncertainty respectively. The second Monte Carlo output map shows raster cells where the positive and negative score patterns seem to be more robust to synergy-conflict score input changes. It maps all the raster cells where the positive/ negative sign of the first Monte Carlo output map have the same positive/ negative sign in the basis total score raster without score modifications. On the other hand, the third Monte Carlo output map shows raster cells where a higher total score uncertainty is registered. It maps all the raster cells where the positive/ negative sign of the first Monte Carlo output map differs from the positive/ negative sign in the basis total score raster without score modifications.

4.4 Voluntary map outputs:

SEANERGY furthermore provides options to output some extra map layers below the main map. In the tools 'Calculate Score Map' and 'Calculate Count Map', it is possible to output a polygon showing all area where both potential conflicts and potential synergies exist at once. In the same two tools it is possible to create and view all pairwise use combinations as polygons with the matrix description as attribute metadata. In 'Calculate Score Map', the attribute 'final value' contains the input score, and in 'Calculate Count Map', the same attribute contains a count of number 1. In both tools, the attributes with a name starting with 'full_desc' contains the matrix description. Instead of viewing all pairwise polygons which is the default setting, it is also possible to view only a subset of the pairwise polygons. In the tool 'Calculate Score Map', the subset is the pairwise polygons with the lowest total score sum (most conflicts) and the pairwise polygons with the highest total score sum (most synergies). In the tool 'Calculate Count Map', the subset consists of the pairwise polygons with the highest spatial area.

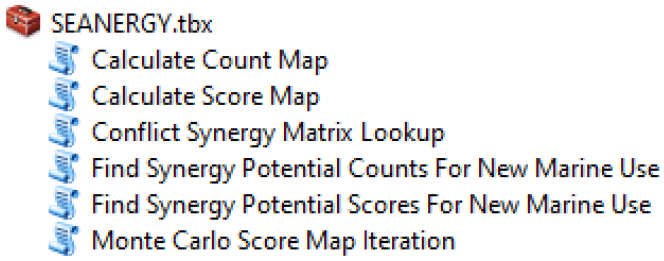
In the tool 'Find Synergy Potential Scores For New Activity' tool and the tool 'Find Synergy Potential Counts For New Activity', it can be chosen to view the pairwise polygons which contain conflicts as well as overlap the potential synergic area for the explored new activity.

Three optional map outputs are also available in the tool 'Monte Carlo Score Map Iteration'. The three optional outputs has a resemblance with the mandatory Monte Carlo map outputs, outputting similar maps for the basis total score raster as for the Monte Carlo results; a main output (which is also the total score raster output in the tool 'Calculate Score Map'), a robust pattern map, and a high uncertainty map.

4.5 Voluntary table outputs:

In the tools 'Calculate Score Map' and 'Calculate Count Map' it is also possible to get optional table outputs. Table output option 1 creates an excel table that summarises all matrix-based input scores or counts for each marine use. Table output option 2 creates an excel table that summarises all map-based total scores or counts for each marine use. Table output option 3 creates an excel table that summarises all map-based total pairwise scores or counts for each pairwise marine use combination.

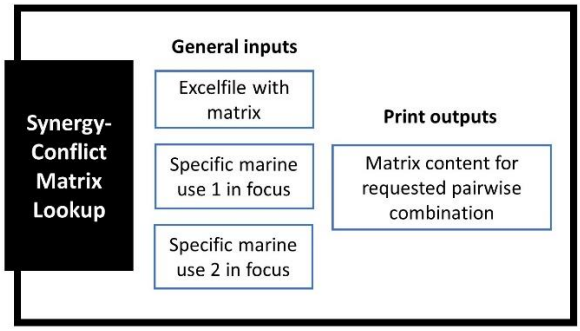
5 User interfaces of tools



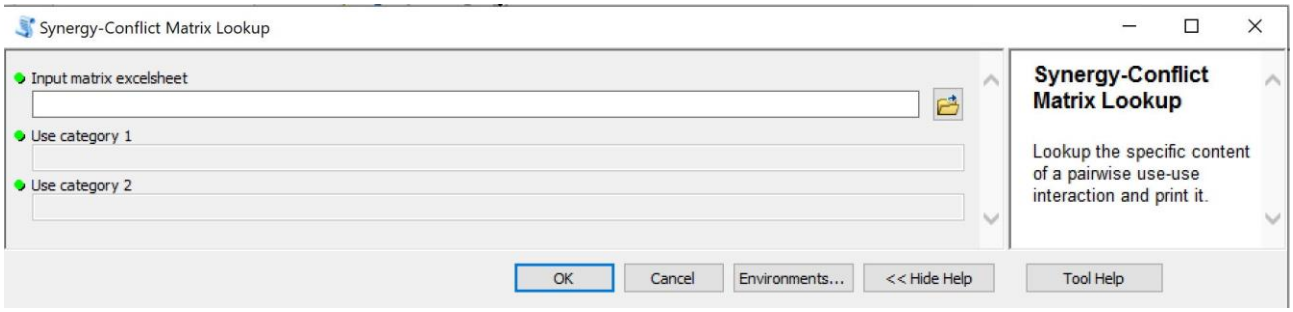
SEANERGY toolbox overview: *Figure providing an overview over the SEANERGY toolbox.*

5.1 User interface for the tool 'Synergy-Conflict Matrix Lookup':

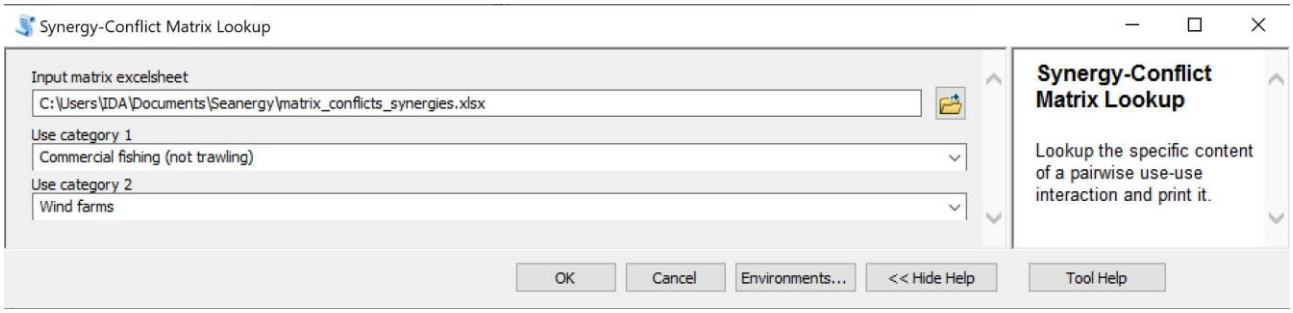
See the figures below for user interface examples for the tool 'Synergy-Conflict Matrix Lookup'.



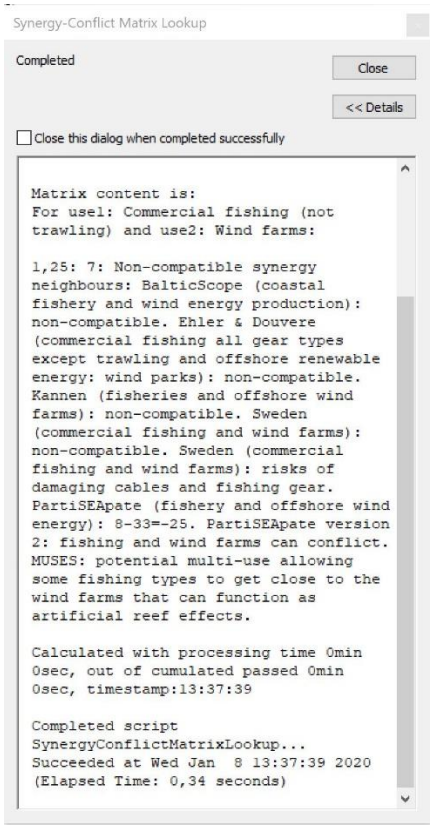
User interface model for 'Synergy-Conflict Matrix Lookup'*: Model over the user interface for the tool 'Synergy Conflict Matrix Lookup'. Each blue, solid line indicates a mandatory tool requirement.*



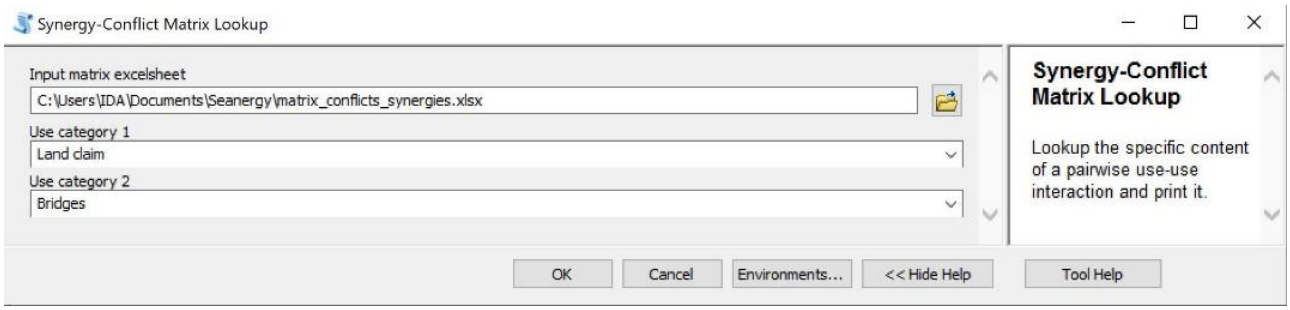
User interface for 'Synergy-Conflict Matrix Lookup' without inputs*: The user interface for the tool 'Synergy-Conflict Matrix Lookup' without any chosen inputs.*



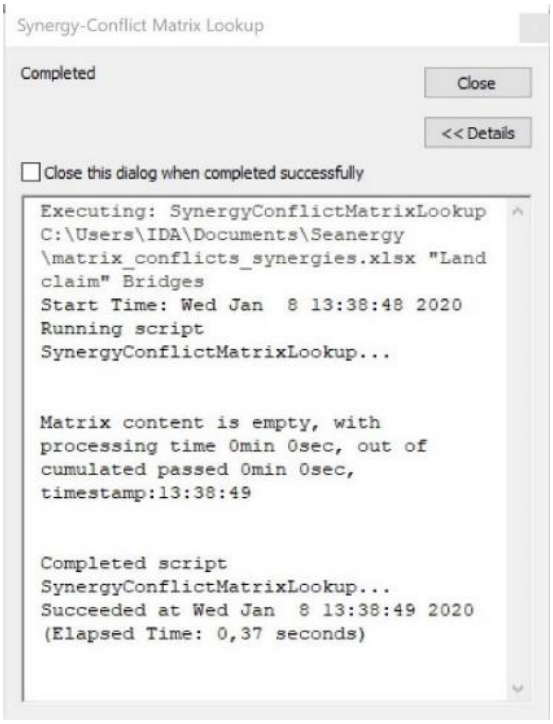
User interface for 'Synergy-Conflict Matrix Lookup' with inputs example 1*: The user interface for the tool 'Synergy-Conflict Matrix Lookup' with example 1 of chosen inputs.*



Print result for 'Synergy-Conflict Matrix Lookup' with inputs example 1*: The print result for the tool 'Synergy-Conflict Matrix Lookup' with the inputs in example 1.*



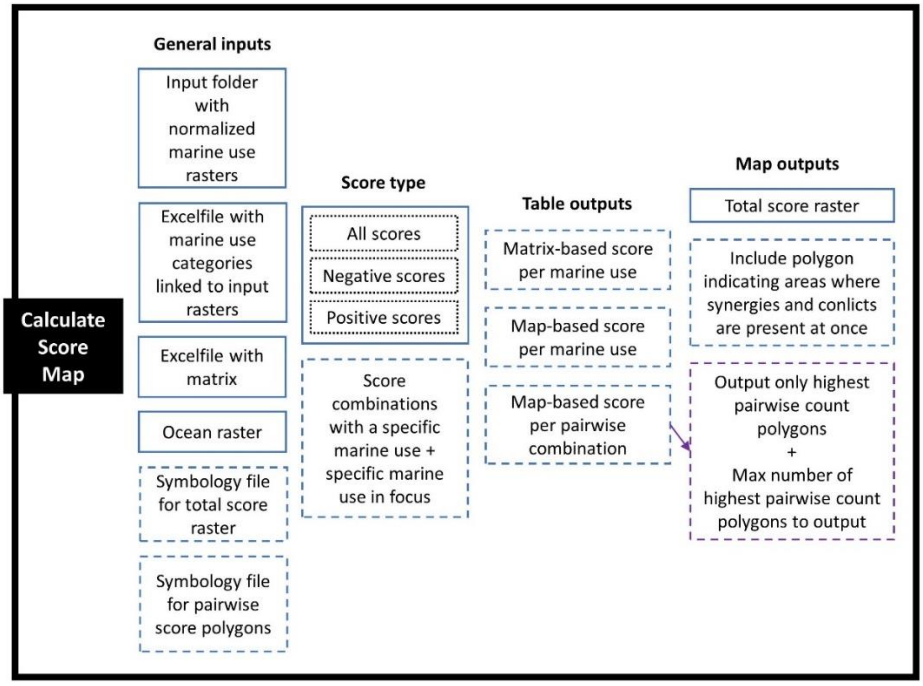
User interface for 'Synergy-Conflict Matrix Lookup' with inputs example 2*: The user interface for the tool 'Synergy-Conflict Matrix Lookup' with example 2 of chosen inputs.*



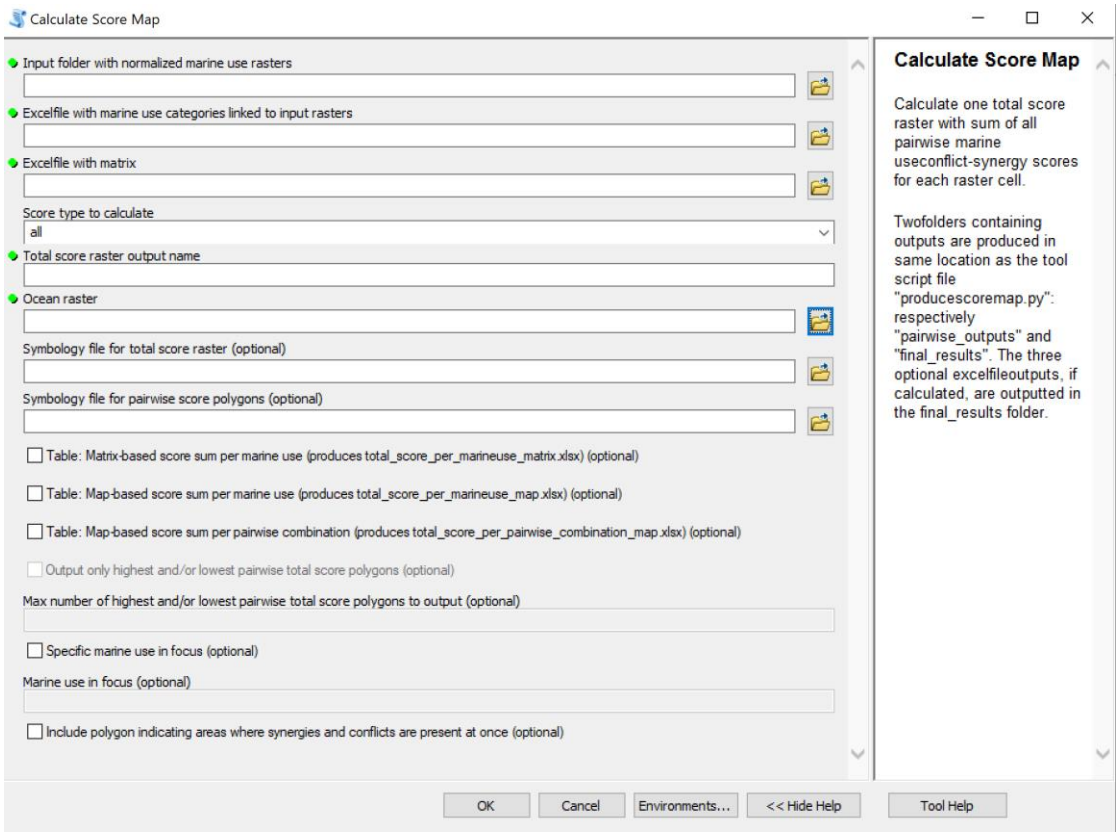
Print result for 'Synergy-Conflict Matrix Lookup' with inputs example 2*: The print result for the tool 'Synergy-Conflict Matrix Lookup' with the inputs in example 2.*

5.2 User interface for the tool 'Calculate Score Map':

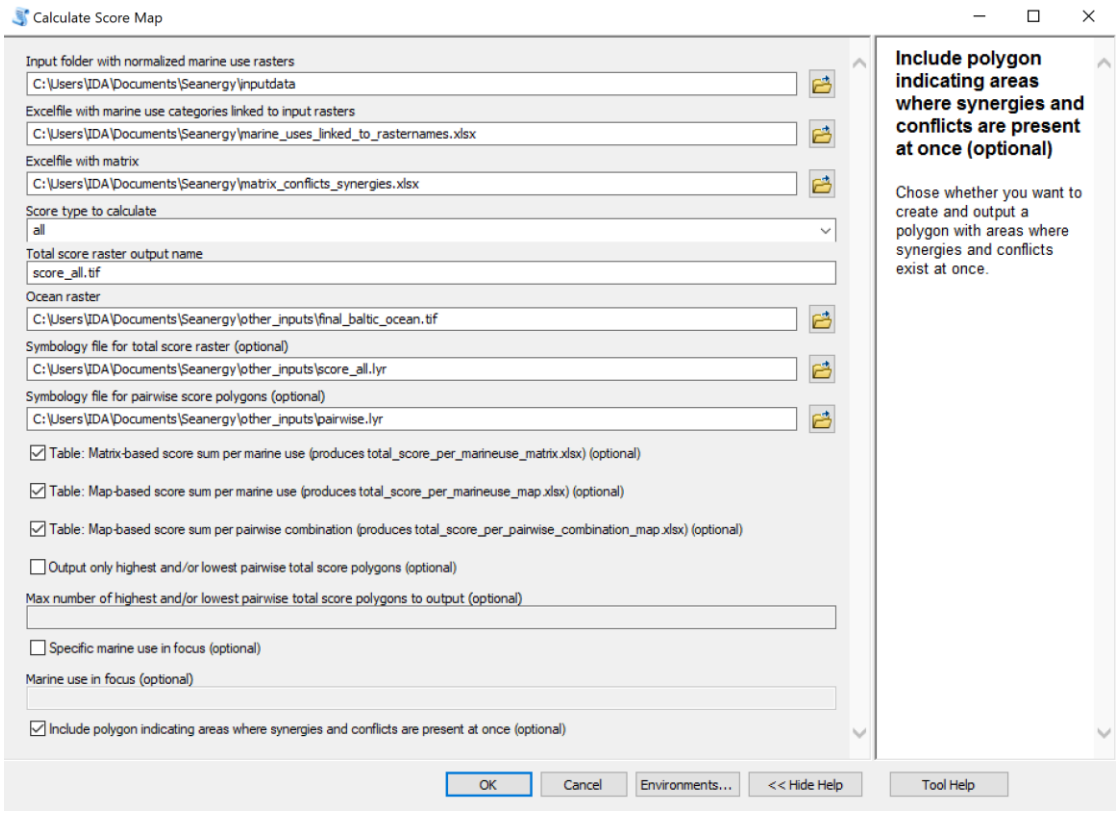
See the figures below for user interface examples for the tool 'Calculate Score Map'.



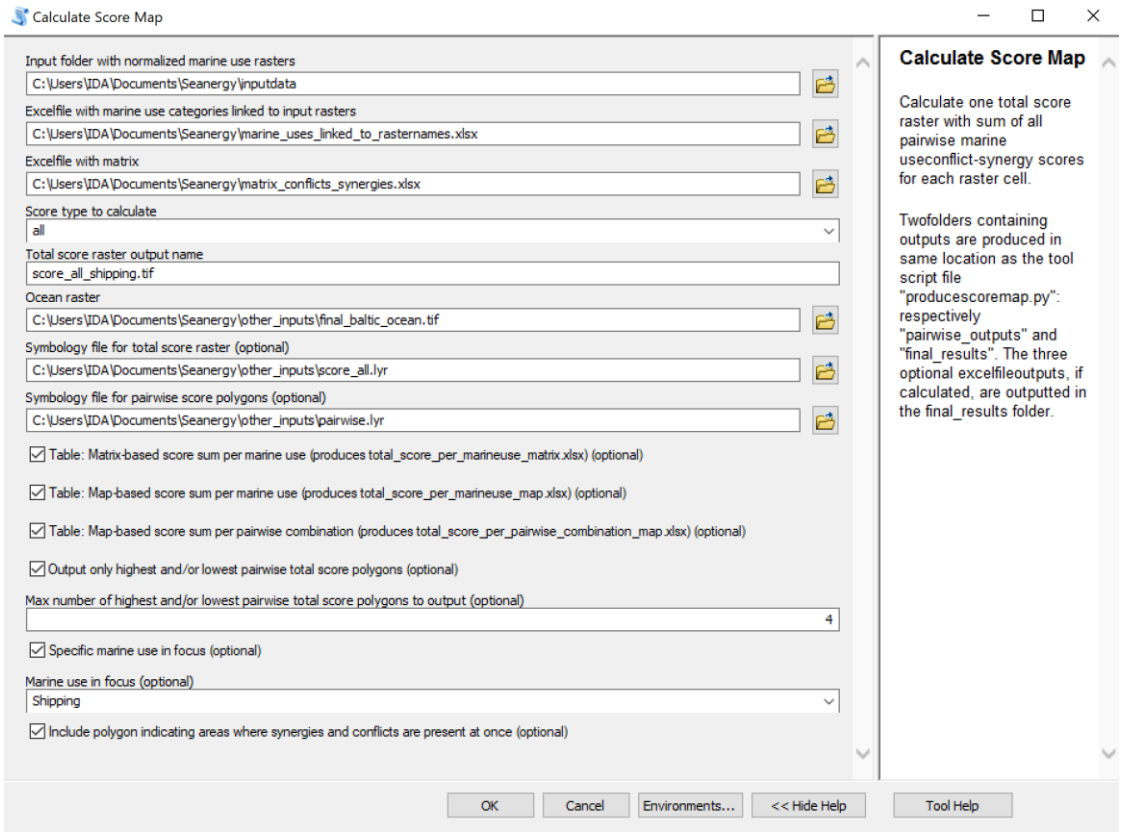
User interface model for 'Calculate Score Map'*: Model over the user interface for the tool 'Calculate Score Map'. The blue line colour indicates separate input choices. The purple line colour indicates choices that require a specific input setting pointed out with a purple arrow. Mandatory input requirements are shown with solid lines. Mandatory either-or choices are shown with dotted black lines inside a solid blue line, the latter indicating the required either-or choice package. Optional extra choices are shown with dashed lines.*



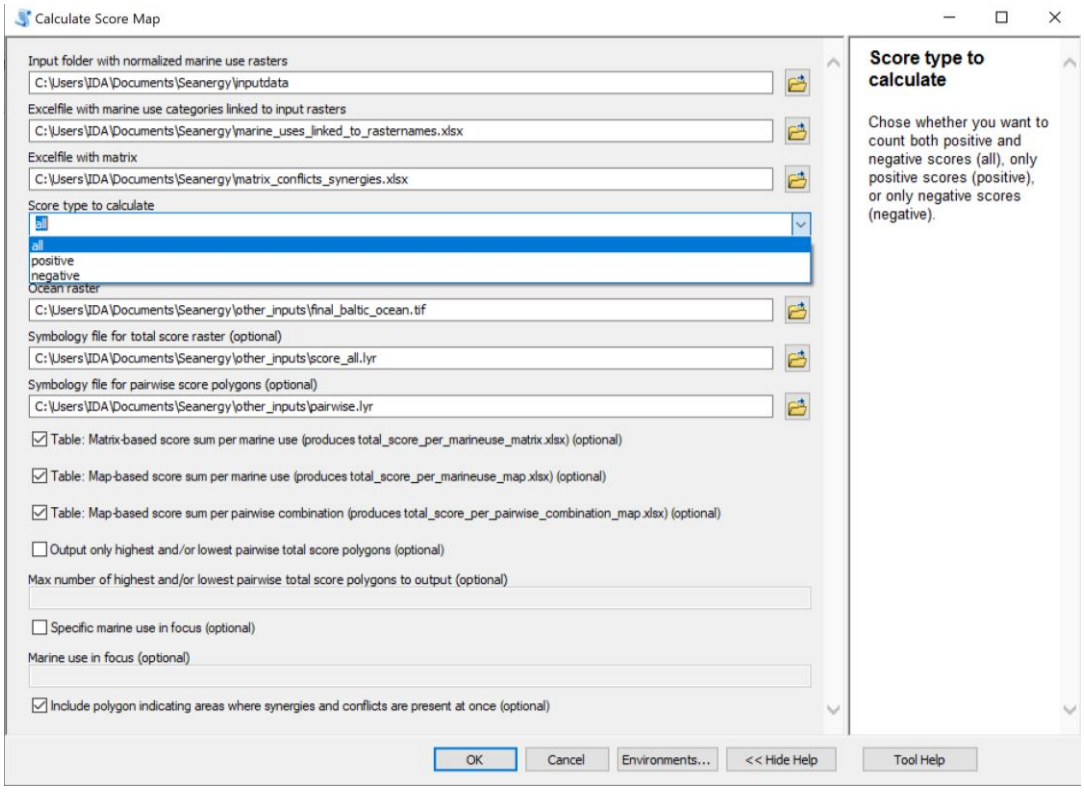
User interface for 'Calculate Score Map' without inputs*: The user interface for the tool 'Calculate Score Map' without any chosen inputs.*



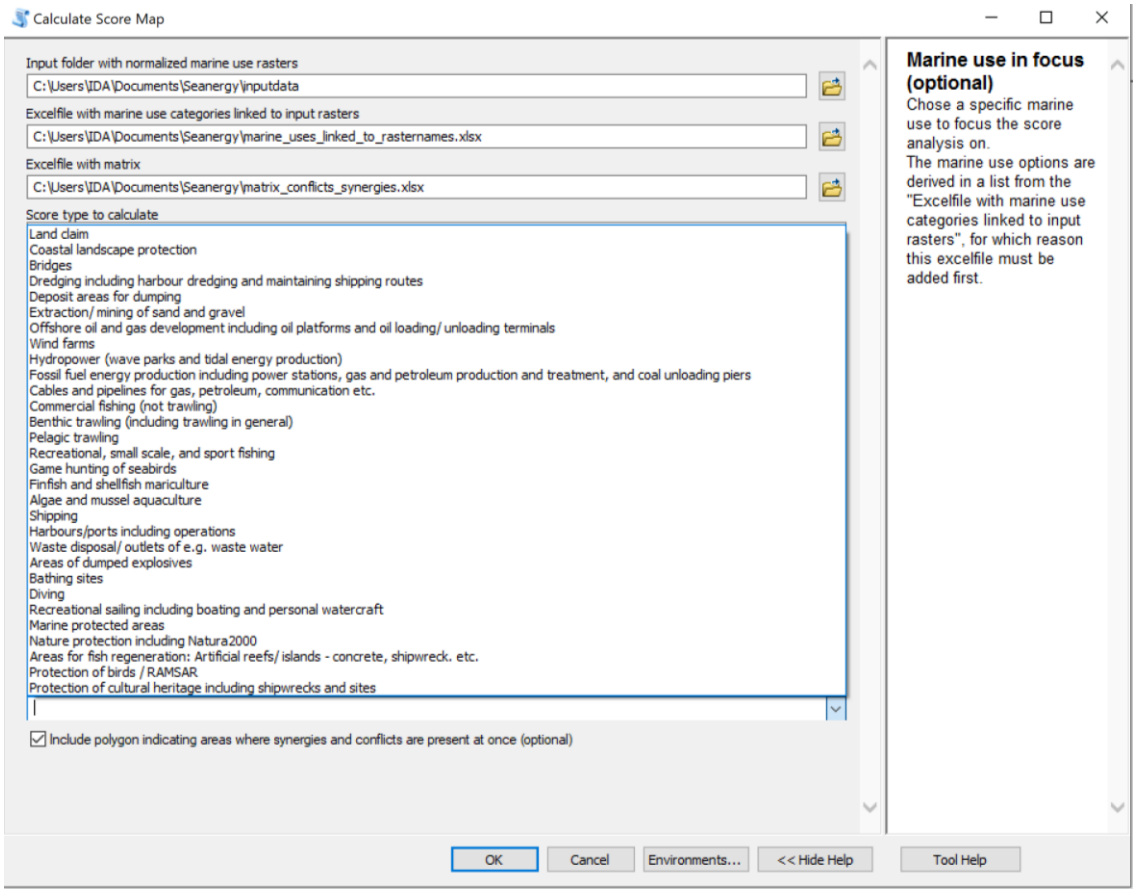
User interface for 'Calculate Score Map' with inputs example 1*: The user interface for the tool 'Calculate Score Map' with example 1 of chosen inputs.*



***User interface for 'Calculate Score Map' with inputs example 2**: The user interface for the tool 'Calculate Score Map' with example 2 of chosen inputs.*



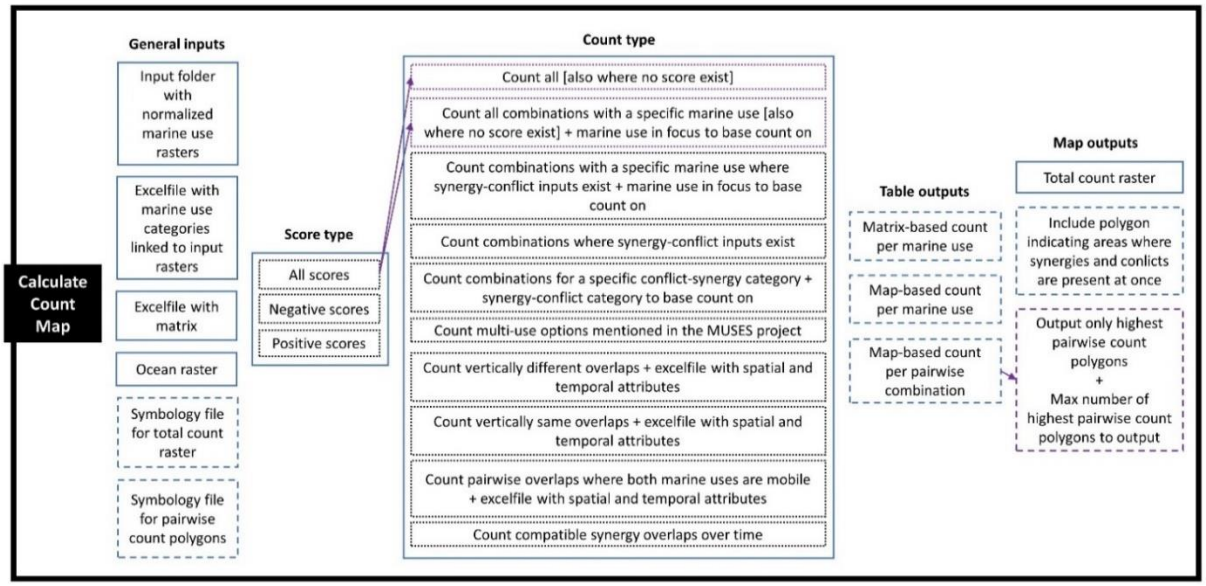
***User interface for 'Calculate Score Map' with 'Score type to calculate' choices**: The user interface for the tool 'Calculate Score Map' with 'Score type to calculate' choices.*



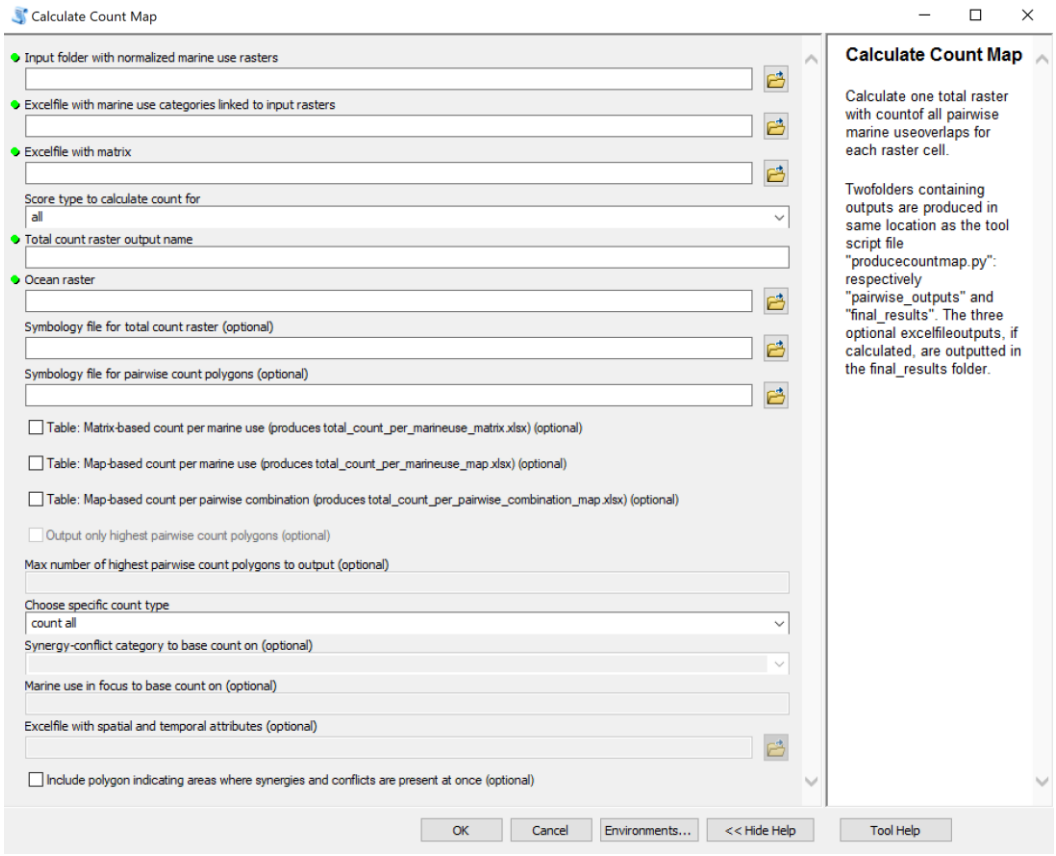
***User interface for 'Calculate Score Map' with 'Marine use in focus' choices**: The user interface for the tool 'Calculate Score Map' with 'Marine use in focus' choices.*

5.3 User interface for the tool 'Calculate Count Map':

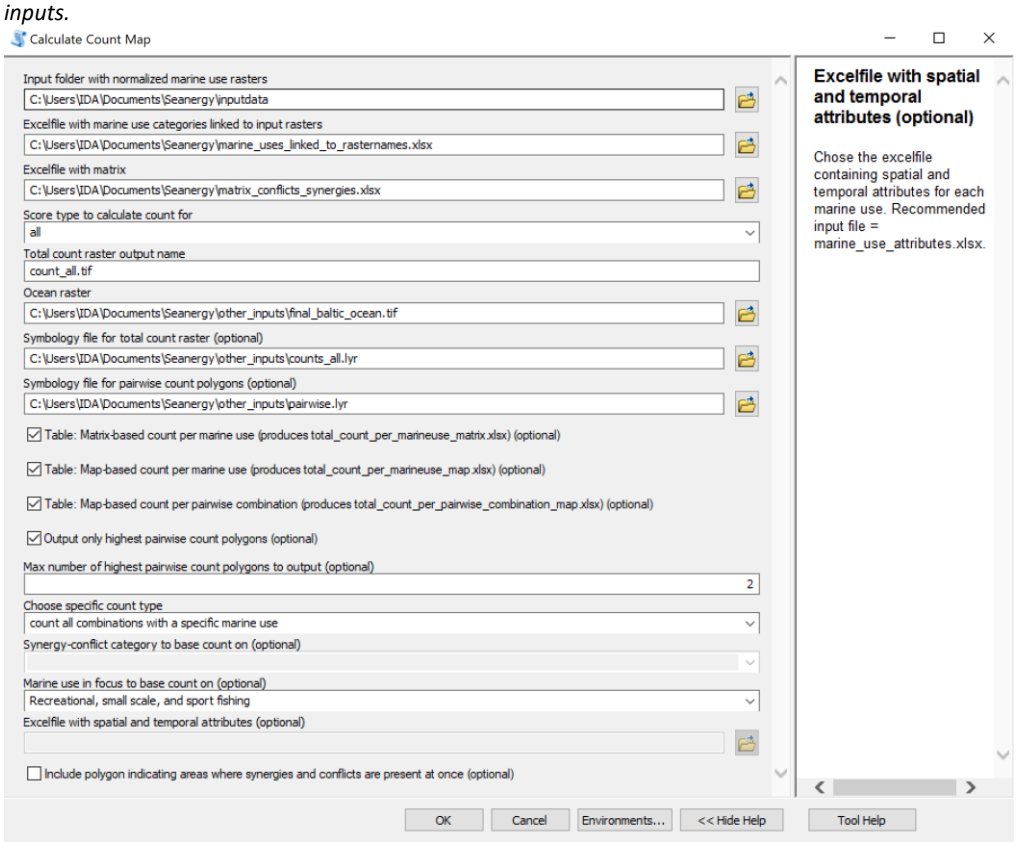
See the figures below for user interface examples for the tool 'Calculate Count Map'.



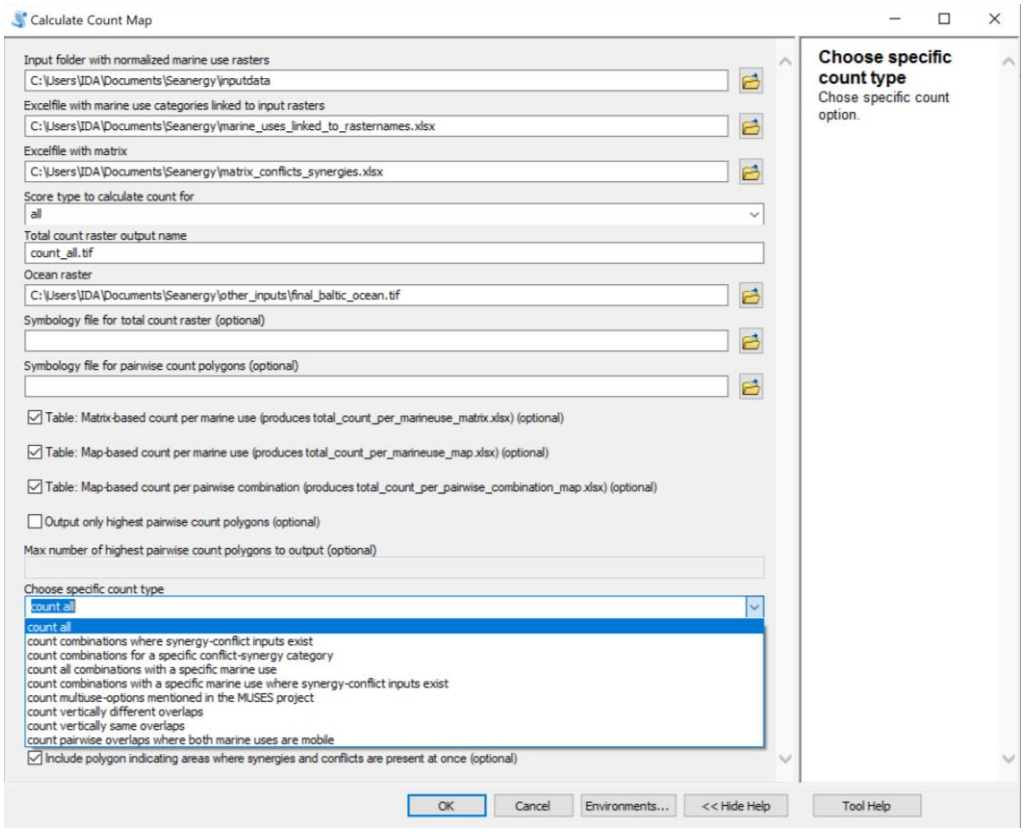
***User interface model for 'Calculate Count Map'**: Model over the user interface for the tool 'Calculate Count Map'. The blue line colour indicates separate input choices. The purple line colour indicates choices that require a specific input setting pointed out with purple arrows. Mandatory input requirements are shown with solid lines. Mandatory either-or choices are shown with dotted black lines inside a solid blue line, the latter indicating the required either-or choice package. Optional extra choices are shown with dashed lines.*



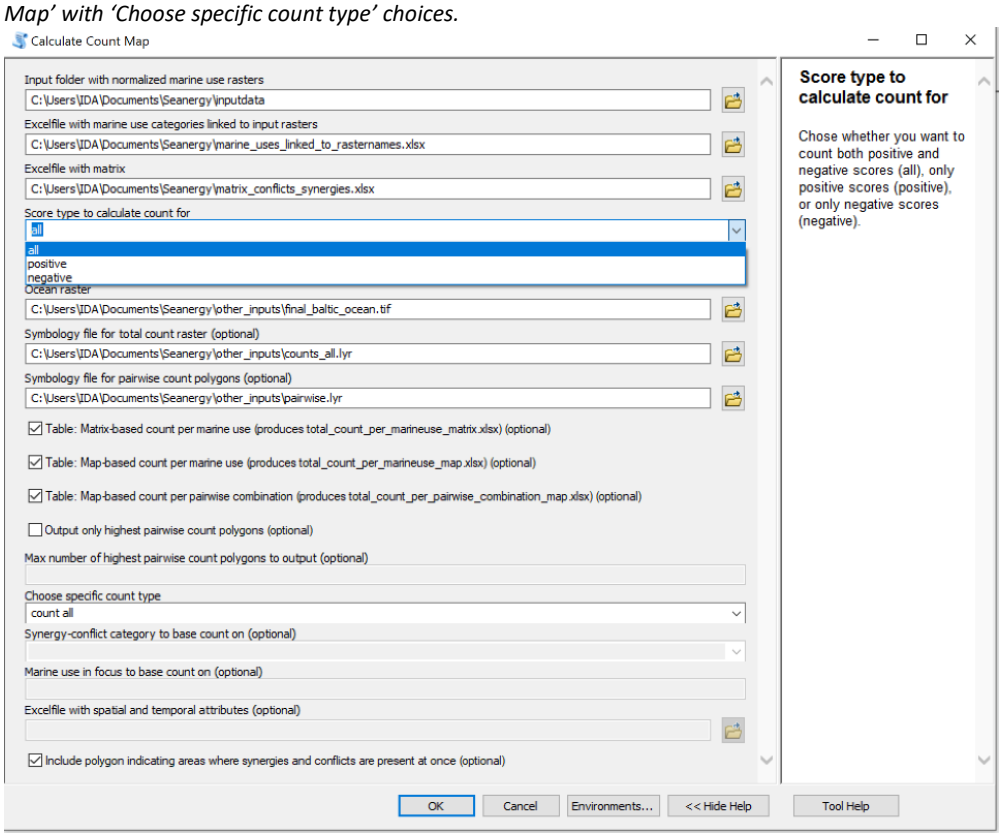
***User interface for 'Calculate Count Map' without inputs**: The user interface for the tool 'Calculate Count Map' without any chosen inputs.*



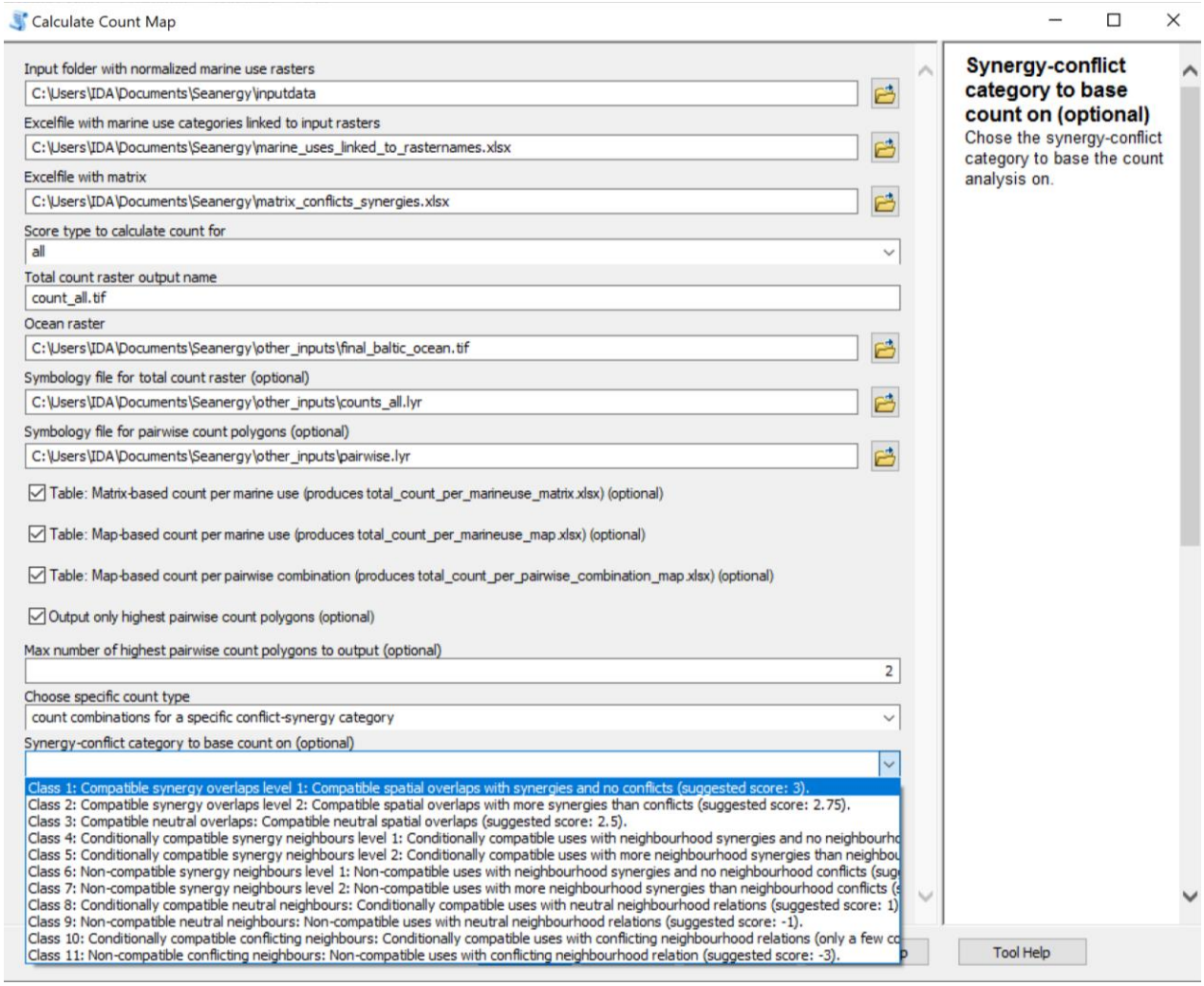
***User interface for 'Calculate Count Map' with inputs example 1**: The user interface for the tool 'Calculate Count Map' with example 1 of chosen inputs.*



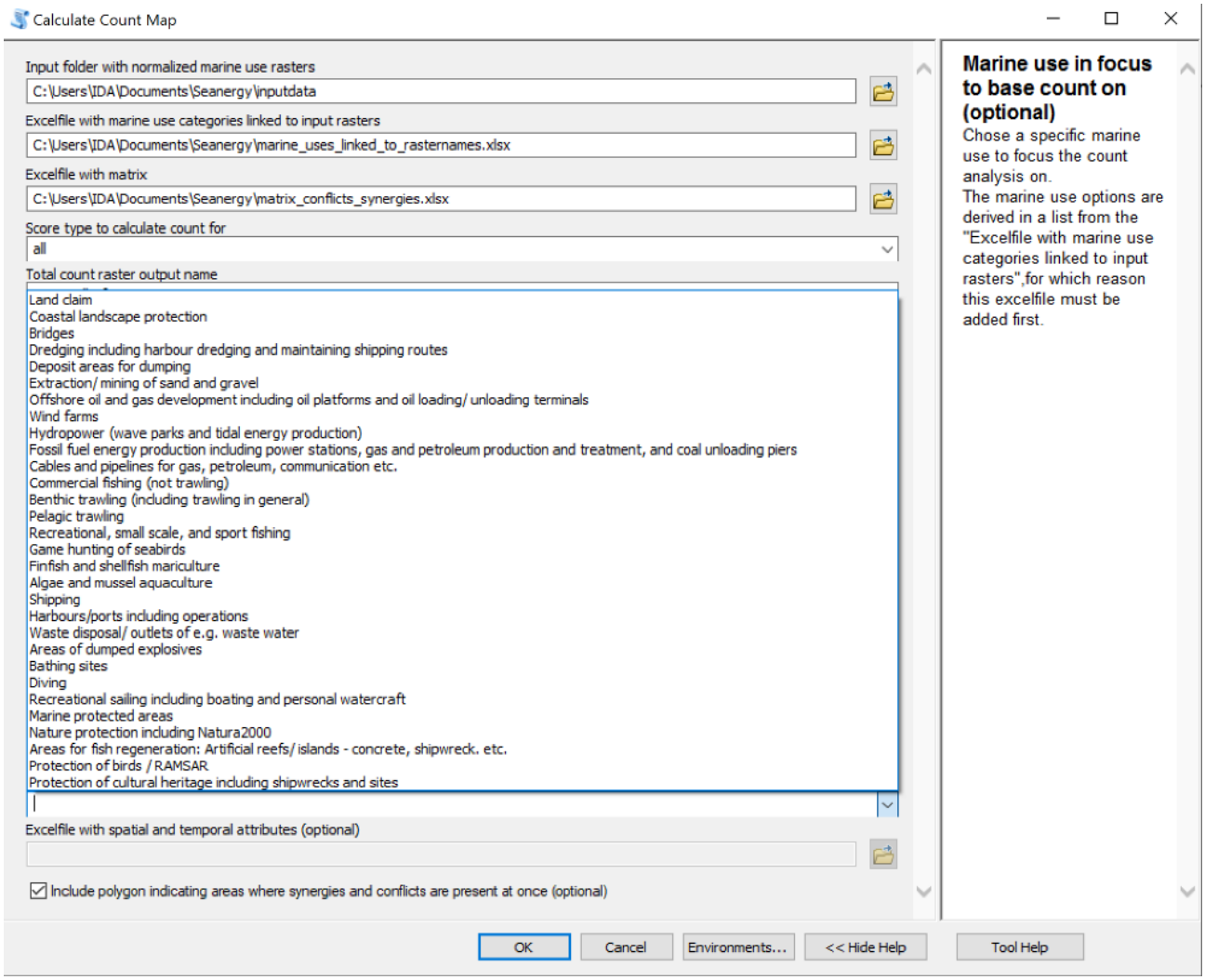
***User interface for 'Calculate Count Map' with 'Choose specific count type' choices**: The user interface for the tool 'Calculate Count Map' with 'Choose specific count type' choices.*



***User interface for 'Calculate Count Map' with 'Score type to calculate count for' choices**: The user interface for the tool 'Calculate Count Map' with 'Score type to calculate count for' choices.*



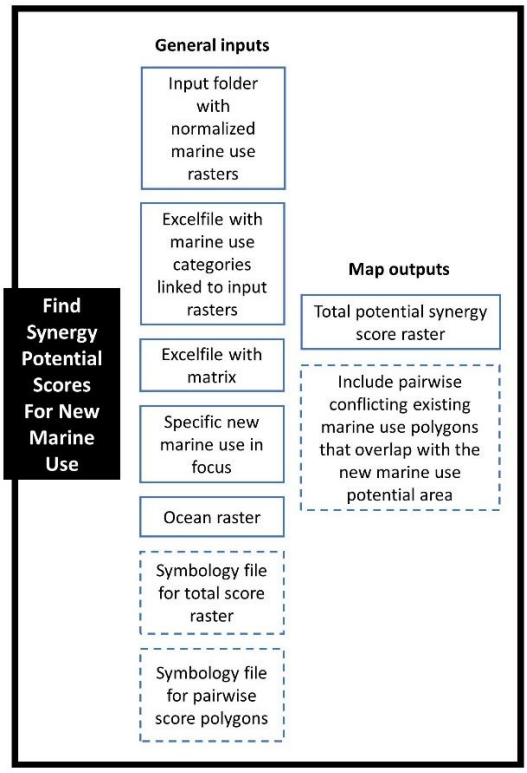
User interface for 'Calculate Count Map' with 'Synergy-conflict category to base count on' choices*: The user interface for the tool 'Calculate Count Map' with 'Synergy-conflict category to base count on' choices.*



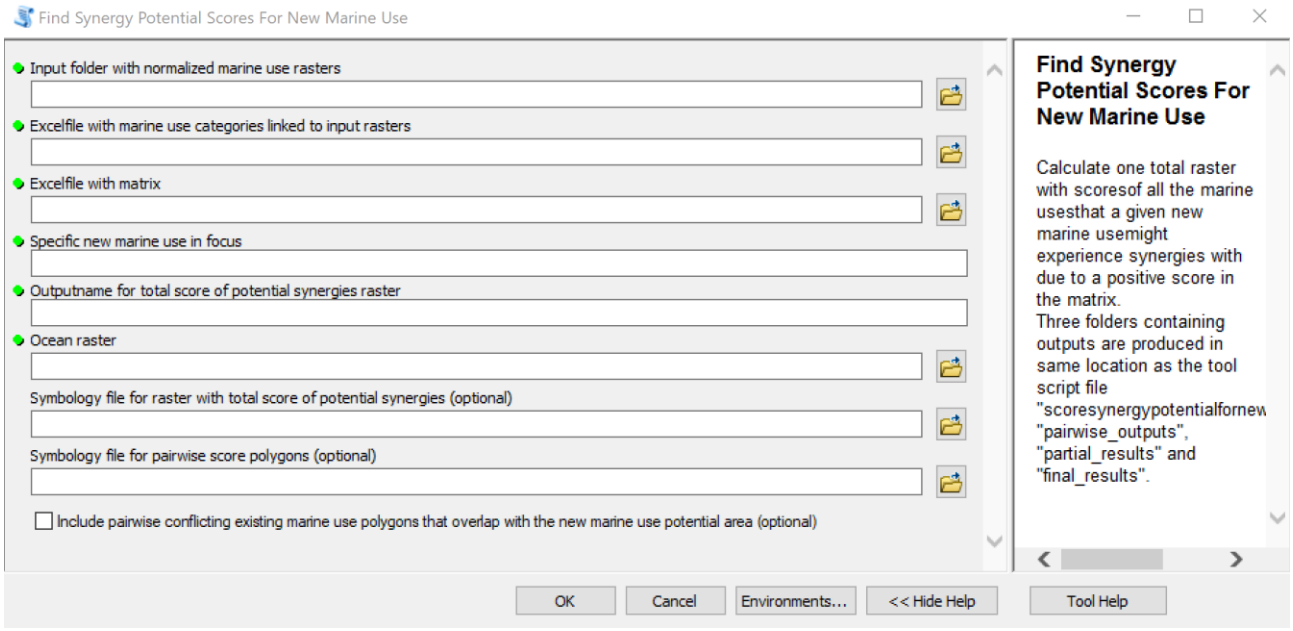
***User interface for 'Calculate Count Map' with 'Marine use in focus to base count on' choices**: The user interface for the tool 'Calculate Count Map' with 'Marine use in focus to base count on' choices.*

5.4 User interface for the tool 'Find Synergy Potential Scores For New Marine Use':

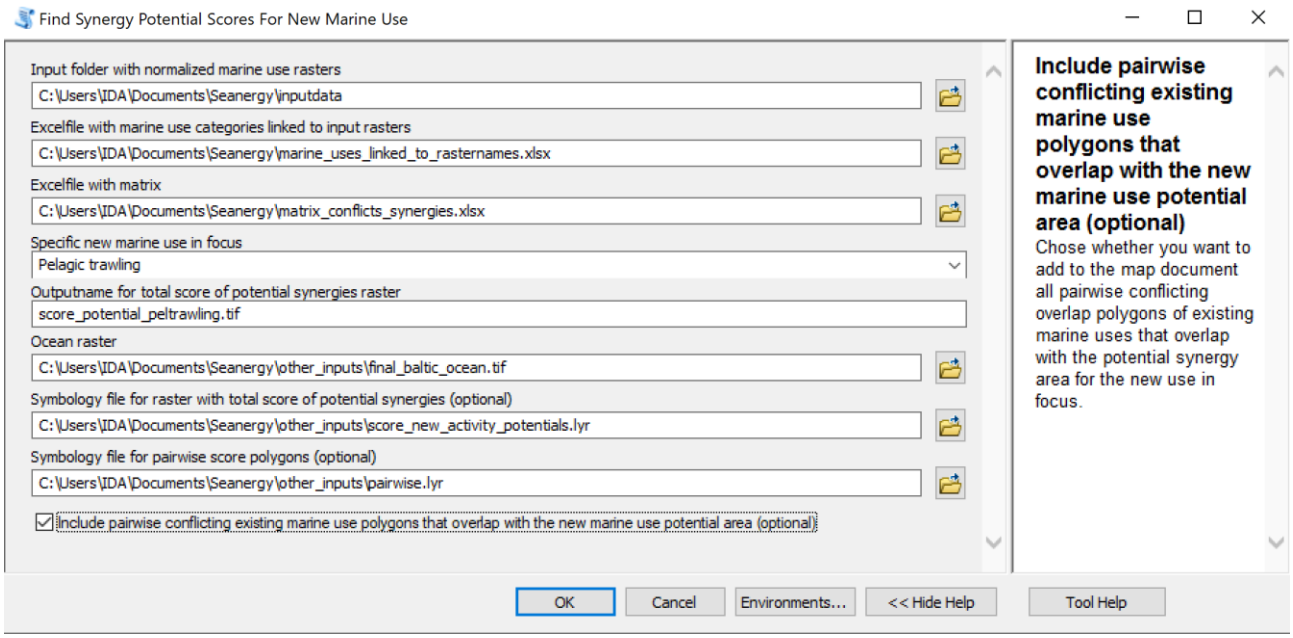
See the figures below for user interface examples for the tool 'Find Synergy Potential Scores For New Marine Use'.



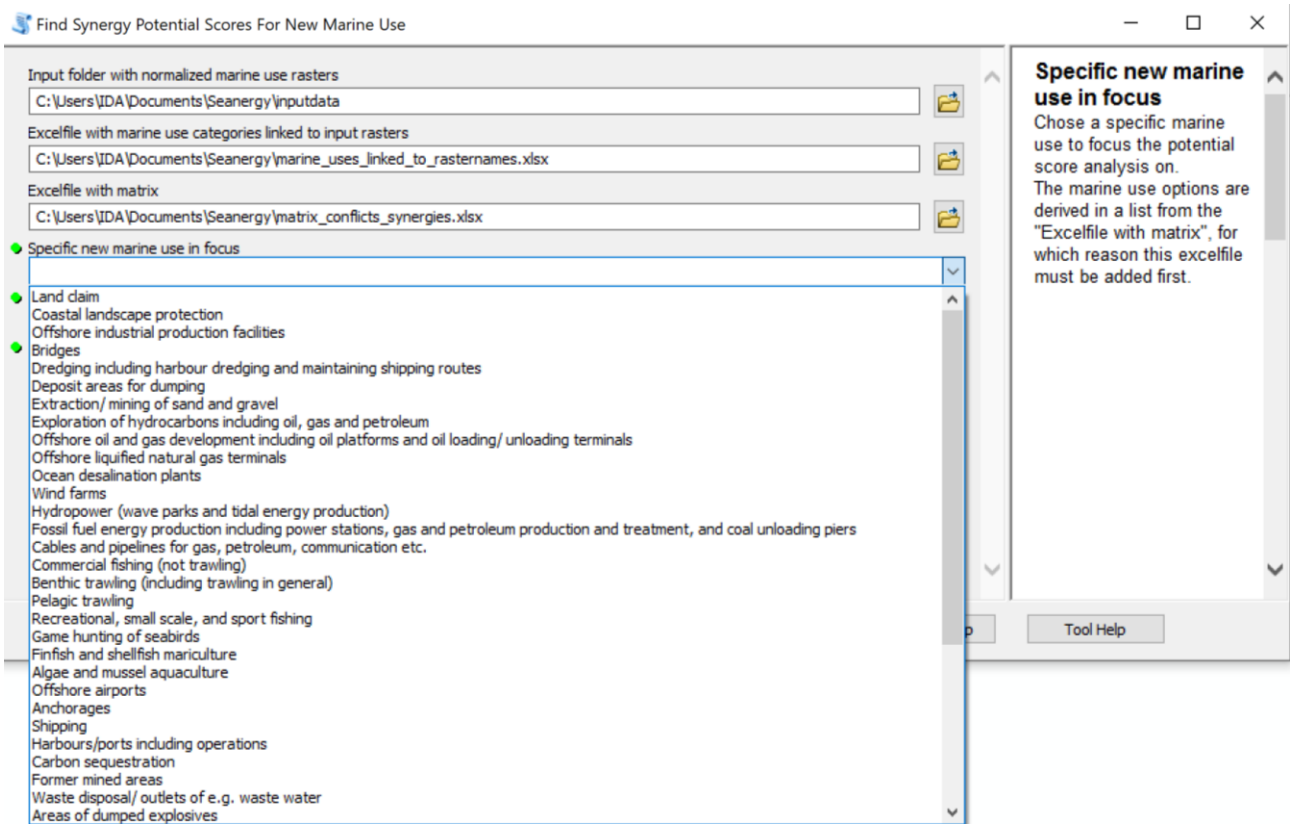
***User interface model for 'Find Synergy Potential Scores For New Marine Use'**: Model over the user interface for the tool 'Find Synergy Potential Scores For New Marine Use'. The blue line colour indicates separate input choices. Mandatory input requirements are shown with solid lines. Optional extra choices are shown with dashed lines.*



***User interface for 'Find Synergy Potential Scores For New Marine Use' without inputs**: The user interface for the tool 'Find Synergy Potential Scores For New Marine Use' without any chosen inputs.*



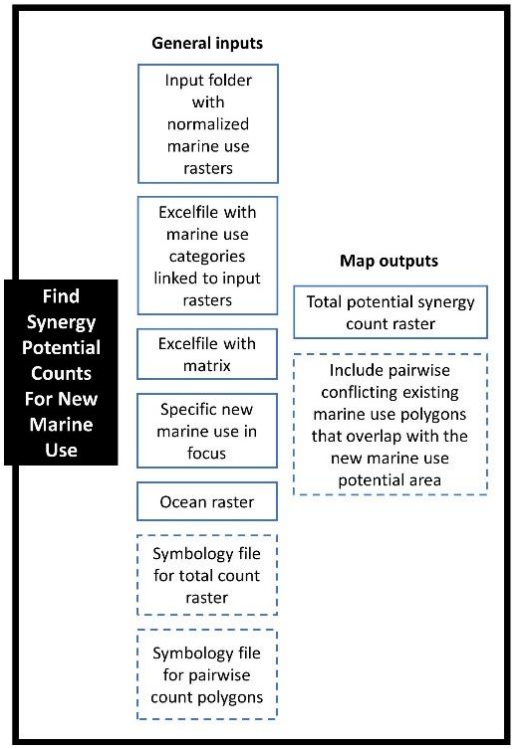
User interface for 'Find Synergy Potential Scores For New Marine Use' with inputs example 1*: The user interface for the tool 'Find Synergy Potential Scores For New Marine Use' with example 1 of chosen inputs.*



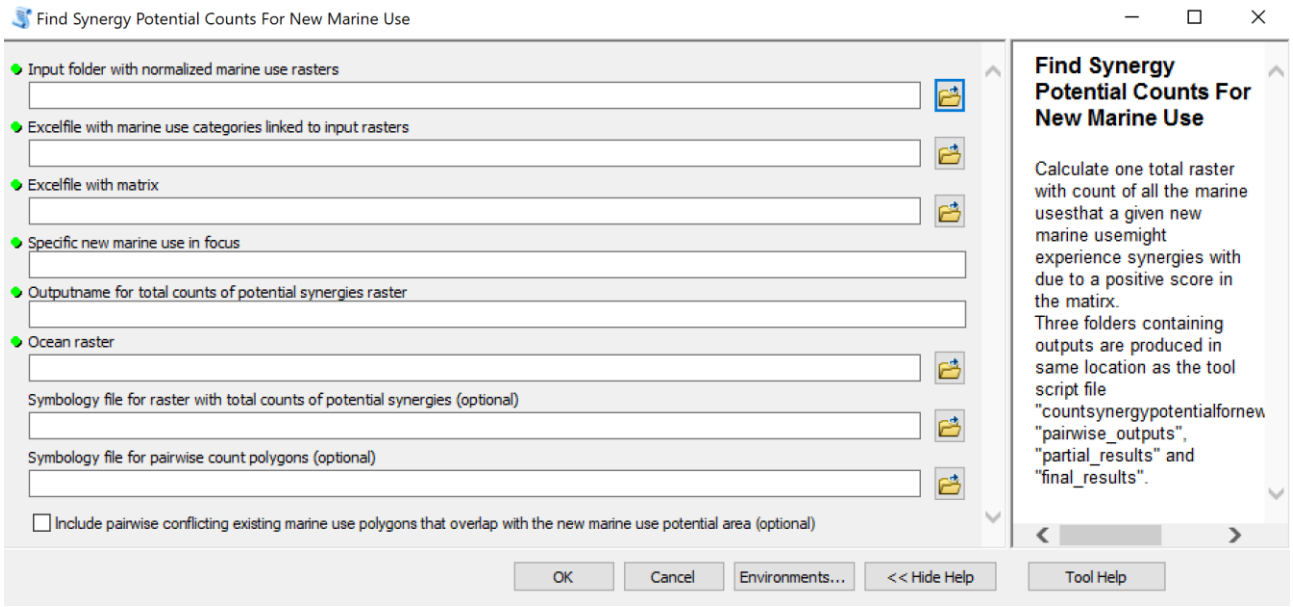
User interface for 'Find Synergy Potential Scores For New marine Use' with 'Specific new marine use in focus' choices*: The user interface for the tool 'Find Synergy Potential Scores For New marine Use' with 'Specific new marine use in focus' choices.*

5.5 User interface for the tool 'Find Synergy Potential Counts For New Marine Use':

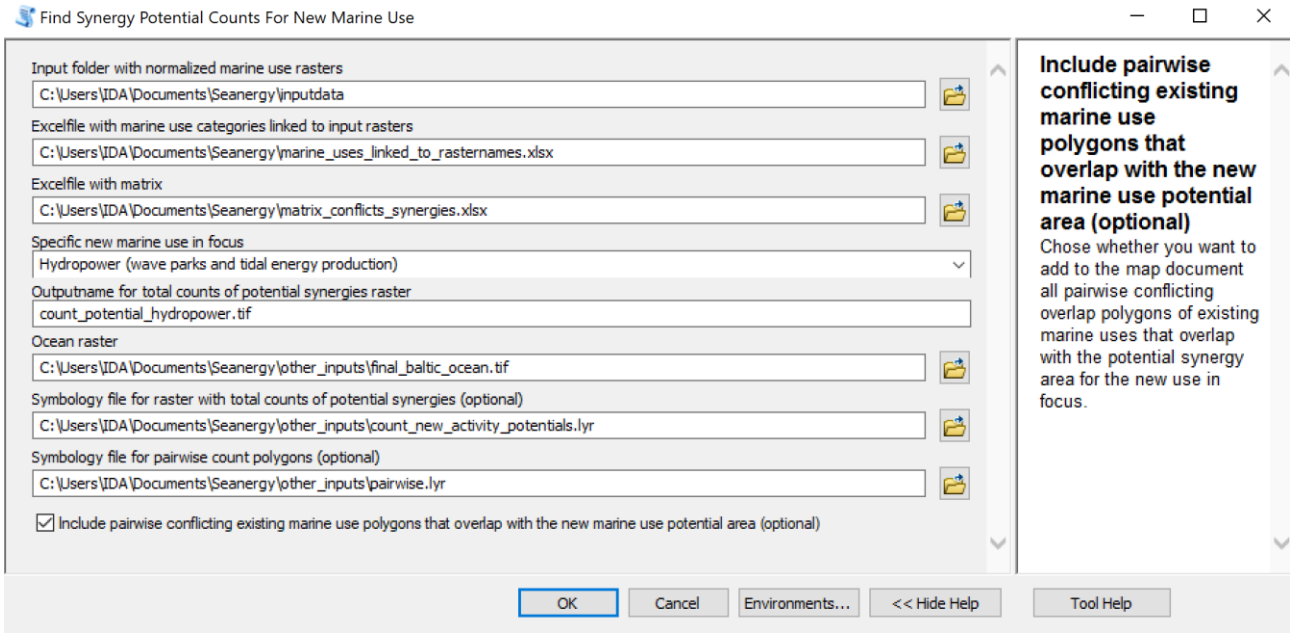
See the figures below for user interface examples for the tool 'Find Synergy Potential Counts For New Marine Use'.



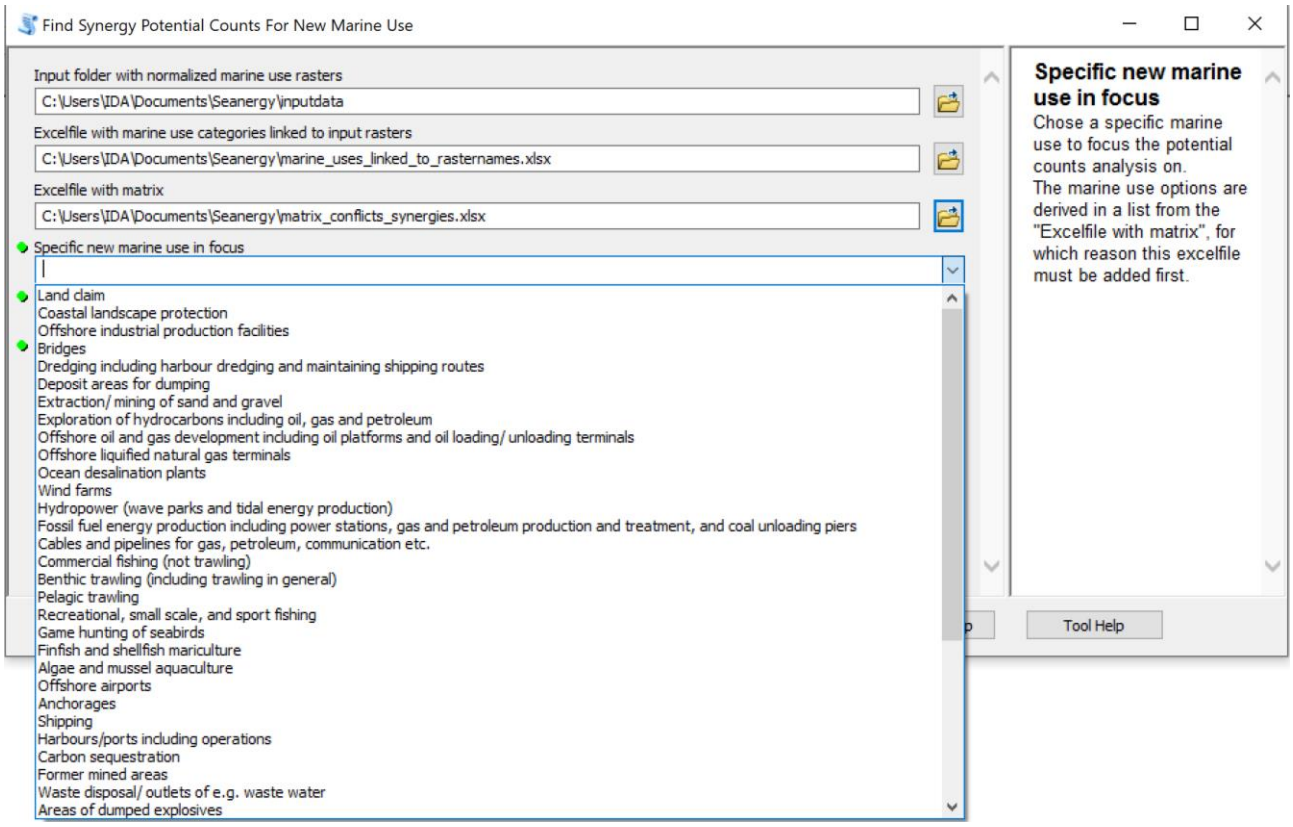
***User interface model for 'Find Synergy Potential Counts For New Marine Use'**: Model over the user interface for the tool 'Find Synergy Potential Counts For New Marine Use'. The blue line colour indicates separate input choices. Mandatory input requirements are shown with solid lines. Optional extra choices are shown with dashed lines.*



***User interface for 'Find Synergy Potential Counts For New Marine Use' without inputs**: The user interface for the tool 'Find Synergy Potential Counts For New Marine Use' without any chosen inputs.*



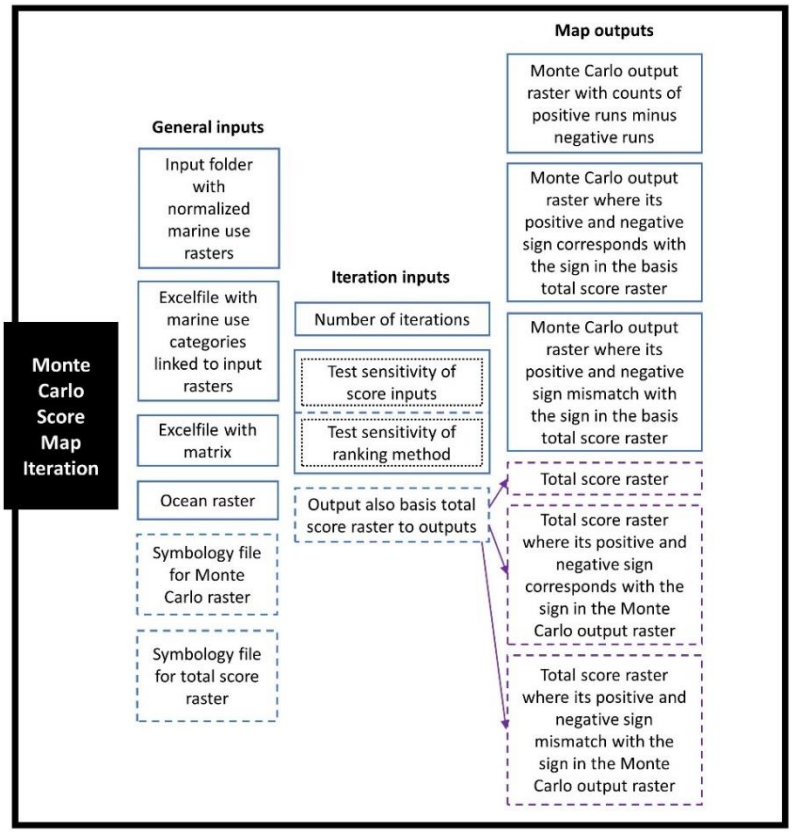
User interface for 'Find Synergy Potential Counts For New Marine Use' with inputs example 1*: The user interface for the tool 'Find Synergy Potential Counts For New Marine Use' with example 1 of chosen inputs.*



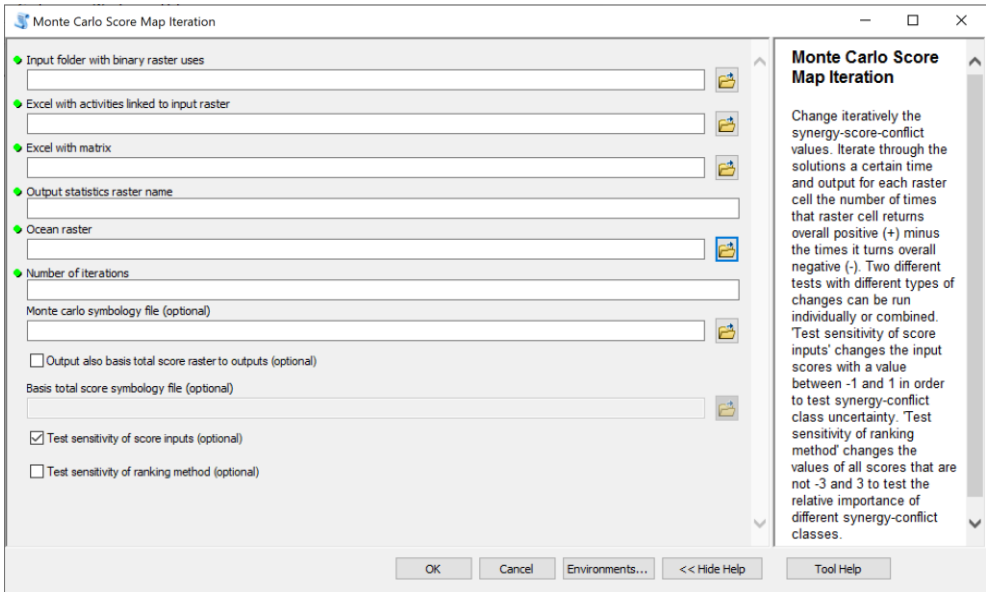
User interface for 'Find Synergy Potential Counts For New marine Use' with 'Specific new marine use in focus' choices*: The user interface for the tool 'Find Synergy Potential Counts For New marine Use' with 'Specific new marine use in focus' choices.*

5.6 User interface for the tool 'Monte Carlo Score Map Iteration':

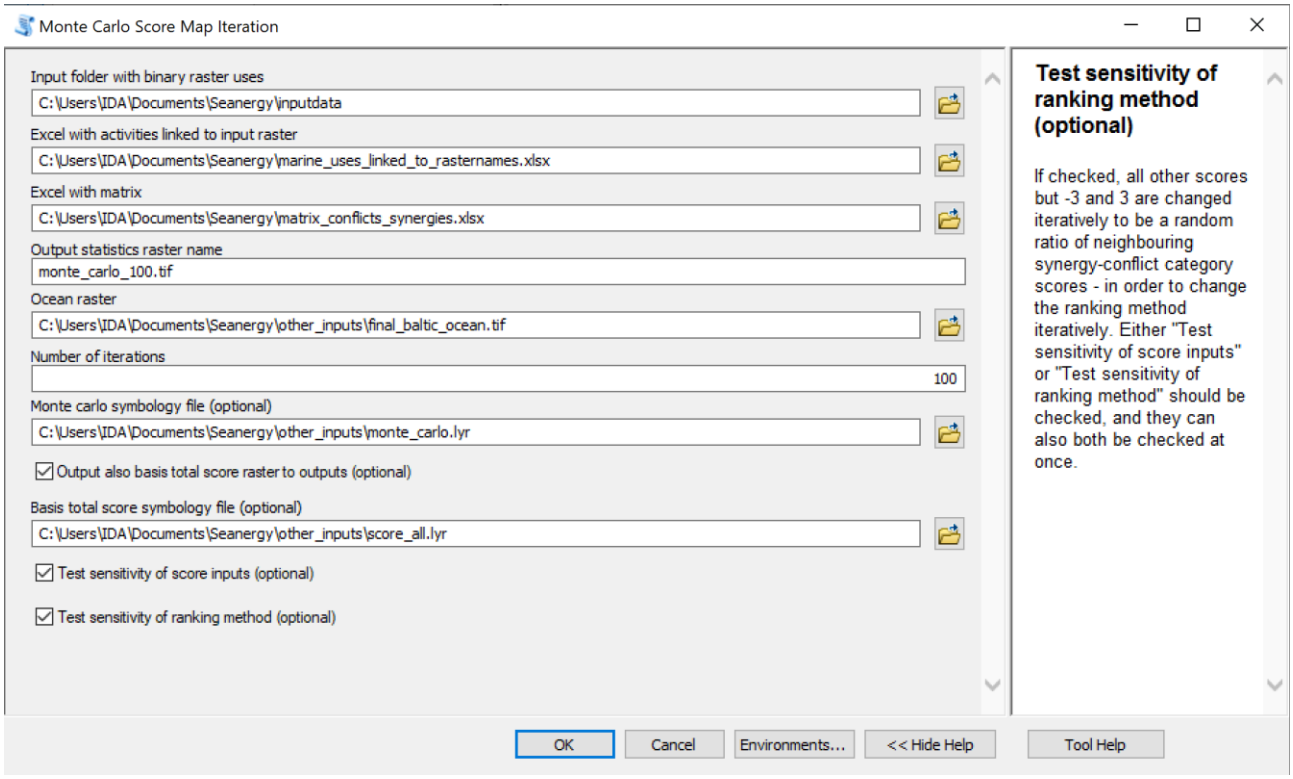
See the figures below for user interface examples for the tool 'Monte Carlo Score Map Iteration'.



***User interface model for 'Monte Carlo Score Map Iteration'**: Model over the user interface for the tool 'Monte Carlo Score Map Iteration'. The blue line colour indicates separate input choices. The purple line colour indicates choices that require a specific input settings pointed out with purple arrows. Mandatory input requirements are shown with solid lines. Optional extra choices are shown with dashed lines. One mandatory either-or choice is shown with dotted black lines inside a solid blue line, the latter indicating the required either-or choice package. However, the dashed line between the two test choices here indicate that they do not have to be an either-or choice package, since they can instead both be selected at the same time if preferred by the user.*



***User interface for 'Monte Carlo Score Map Iteration' without inputs**: The user interface for the tool 'Monte Carlo Score Map Iteration' without any chosen inputs.*



***User interface for 'Monte Carlo Score Map Iteration' with inputs example 1**: The user interface for the tool 'Monte Carlo Score Map Iteration' with example 1 of chosen inputs.*

6 Running time examples

Running time typically spans across the SEANERGY tools from 20 seconds to 14 minutes depending on the parameter settings, except the sixth uncertainty tool which takes approximately 1 hour to run for 100 iterations.

***Running time examples of the tool 'Synergy-Conflict Matrix Lookup'**. Running time examples for different settings of the tool 'Synergy-Conflict Matrix Lookup'.*

'Synergy-Conflict Matrix Lookup' tool settings example	**Run time**
"Use category 1" is chosen to be 'Commercial fishing (not trawling)' and "Use category 2" is chosen to be 'Wind farms'.	0.37 sec
"Use category 1" is chosen to be 'Land claim' and "Use category 2" is chosen to be 'Bridges'.	0.43 sec

***Running time examples of the tool 'Calculate Score Map'**. Running time examples for different settings of the tool 'Calculate Score Map'.*

'Calculate Score Map' tool settings example	**Run time**
All scores and the choice "Specific marine use in focus" is ticked with the choice "Mctivity in focus" to be 'Wind farms'.	21.56 sec
All scores including table 1, table 2, and table 3, and the choice "Output only highest and/ or lowest pairwise total score polygons" is ticked with the choice of 0 as "Max number of highest and/ or lowest pairwise total score polygons to output".	01 min 19 sec
All scores including table 1, table 2, and table 3, and the choice "Include polygon indicating areas where synergies and conflicts are present at once" is ticked as well as the choice "Output only highest and/ or	01 min 29 sec

lowest pairwise total score polygons“ with the choice of 0 as “Max number of highest and/ or lowest pairwise total score polygons to output”.	
Negative scores without extra choices.	02 min 44 sec
All scores including table 1, table 2, and table 3, and the choice “Output only highest and/ or lowest pairwise total score polygons“ is ticked with the choice of 4 as “Max number of highest and/ or lowest pairwise total score polygons to output”.	03 min 13 sec
All scores including table 1, table 2, and table 3, and the choice “Output only highest and/ or lowest pairwise total score polygons“ is ticked with the choice of 12 as “Max number of highest and/ or lowest pairwise total score polygons to output”.	03 min 21 sec
Positive scores without extra choices.	05 min 22 sec
All scores without extra choices.	09 min 34 sec
All scores including table 1, table 2, and table 3.	09 min 47 sec
All scores with the choice “Include polygon indicating areas where synergies and conflicts are present at once” ticked.	09 min 57 sec
All scores including table 1, table 2, and table 3, and the choice “Include polygon indicating areas where synergies and conflicts are present at once” is ticked.	11 min 14 sec
All scores without extra choices where its outputs already exist in the MXD document.	12 min 20 sec

Running time examples of the tool 'Calculate Count Map'. *Running time examples for different settings of the tool 'Calculate Count Map'.*

'Calculate Count Map' tool settings example	**Run time**
All scores and the count type “count multi-use options mentioned in the MUSES project” is chosen.	19.42 sec
All scores and the count type “count pairwise overlaps where both marine uses are mobile” is chosen, and excelfile with spatial and temporal attributes is set to be “marine_use_attributes.xlsx”.	28.44 sec
All scores and the count type “count all combinations with a specific marine use” is chosen and “Marine use in focus to base count on” is chosen to be 'Bridges'.	31.03 sec
All scores and the count type “count combinations with a specific marine use where synergy-conflict inputs exist” is chosen and “Marine use in focus to base count on” is chosen to be 'Shipping'.	35.62 sec
All scores and the count type “count vertically different overlaps” is chosen, and excelfile with spatial and temporal attributes is set to be “marine_use_attributes.xlsx”.	36.33 sec
All scores and the count type “count combinations for a specific conflict-synergy category” is chosen and the “Synergy-conflict category to base count on” is chosen to be “Class 3: Compatible neutral overlaps: Compatible neutral spatial overlaps (suggested score: 2.5).” is chosen.	56.49 sec
All scores including table 1, table 2, and table 3, and the count type “count all” is chosen, and the choice “Output only highest pairwise count polygons“ is ticked with the choice of 0 as “Max number of highest pairwise count polygons to output”.	01 min 02 sec
All scores including table 1, table 2, and table 3, and the count type “count all” is chosen, and the choice “Output only highest pairwise count polygons“ is ticked with the choice of 0 as “Max number of highest pairwise count polygons to output”, and the choice “Include polygon indicating areas where synergies and conflicts are present at once” is ticked.	01 min 48 sec
Negative scores and the count type “count combinations where synergy-conflict inputs exist” is chosen.	02 min 26 sec
All scores including table 1, table 2, and table 3, and the count type “count all” is chosen, and the choice “Output only highest pairwise count polygons“ is ticked with the choice of 4 as “Max number of highest pairwise count polygons to output”.	03 min 13 sec
Negative scores and the count type “count combinations where synergy-conflict inputs exist” is chosen, and the choice “Include polygon indicating areas where synergies and conflicts are present at once” is ticked.	03 min 34 sec
All scores and the count type “count vertically same overlaps” is chosen, and excelfile with spatial and temporal attributes is set to be “marine_use_attributes.xlsx”.	03 min 41 sec
All scores including table 1, table 2, and table 3, and the count type “count all” is chosen, and the choice “Output only highest pairwise count polygons“ is ticked with the choice of 4 as “Max number of highest pairwise count polygons to output” , and the choice “Include polygon indicating areas where synergies and conflicts are present at once” is ticked.	03 min 42 sec

Positive scores and the count type “count combinations where synergy-conflict inputs exist” is chosen.	04 min 53 sec
Positive scores and the count type “count combinations where synergy-conflict inputs exist” is chosen, and the choice “Include polygon indicating areas where synergies and conflicts are present at once” is ticked.	05 min 56 sec
All scores and the count type “count combinations where synergy-conflict inputs exist” is chosen.	09 min 24 sec
All scores and the count type “count all” is chosen.	12 min 11 sec
All scores including table 1, table 2, and table 3, and the count type “count all” is chosen	12 min 50 sec
All scores including table 1, table 2, and table 3, and the count type “count all” is chosen, and the choice “Include polygon indicating areas where synergies and conflicts are present at once” is ticked.	13 min 34 sec

Running time examples of the tool ‘Find Synergy Potential Scores For New Marine Use’*. Running time examples for different settings of the tool ‘Find Synergy Potential Scores For New Marine Use’.*

‘Find Synergy Potential Scores For New Marine Use’ tool settings example	**Run time**
Synergy potential scores for ‘specific new marine use in focus’ = Benthic trawling (including trawling in general)”.	30.60 sec
Synergy potential scores for ‘specific new marine use in focus’ = “Bathing sites”.	42.71 sec
Synergy potential scores for ‘specific new marine use in focus’ = Benthic trawling (including trawling in general)”, and the choice “Include pairwise conflicting existing marine use polygons that overlap with the new marine use potential area” is ticked.	48.91 sec

Running time examples of the tool ‘Find Synergy Potential Counts For New Marine Use’*. Running time examples for different settings of the tool ‘Find Synergy Potential Counts For New Marine Use’.*

‘Find Synergy Potential Counts For New Marine Use’ tool settings example	**Run time**
Synergy potential counts for ‘specific new marine use in focus’ = “Benthic trawling (including trawling in general)”.	29.79 sec
Synergy potential counts for ‘specific new marine use in focus’ = “Finfish and shellfish mariculture”.	39.10 sec
Synergy potential counts for ‘specific new marine use in focus’ = “Benthic trawling (including trawling in general)”, and the choice “Include pairwise conflicting existing marine use polygons that overlap with the new marine use potential area” is ticked.	48.79 sec

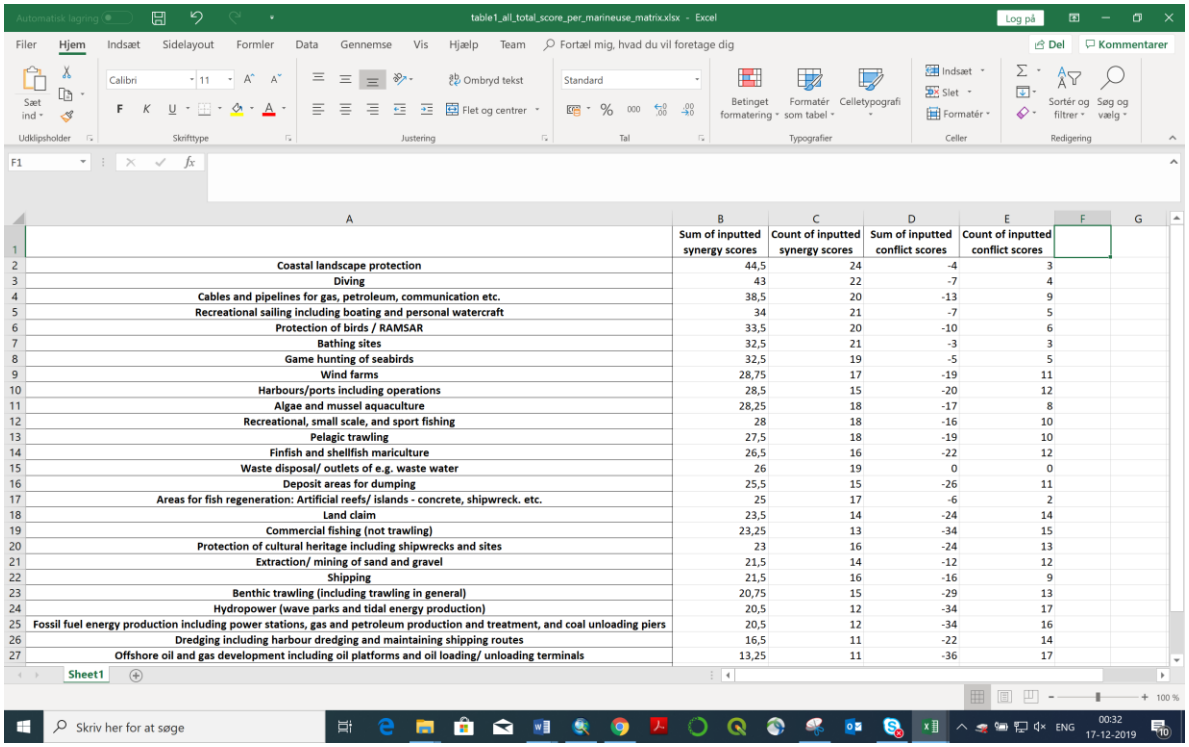
Running time examples of the tool ‘Monte Carlo Score Map Iteration’*. Running time examples for different settings of the tool ‘Monte Carlo Score Map Iteration’.*

‘Monte Carlo Score Map Iteration’ with 100 runs	**Run time**
100 runs of the total score map to get the sensitivity of positive and negative score patterns to noise variation due to uncertainty in the inputted scores. App. 5 min 34 sec per run.	53 min 21 sec.

7 Output table statistics examples

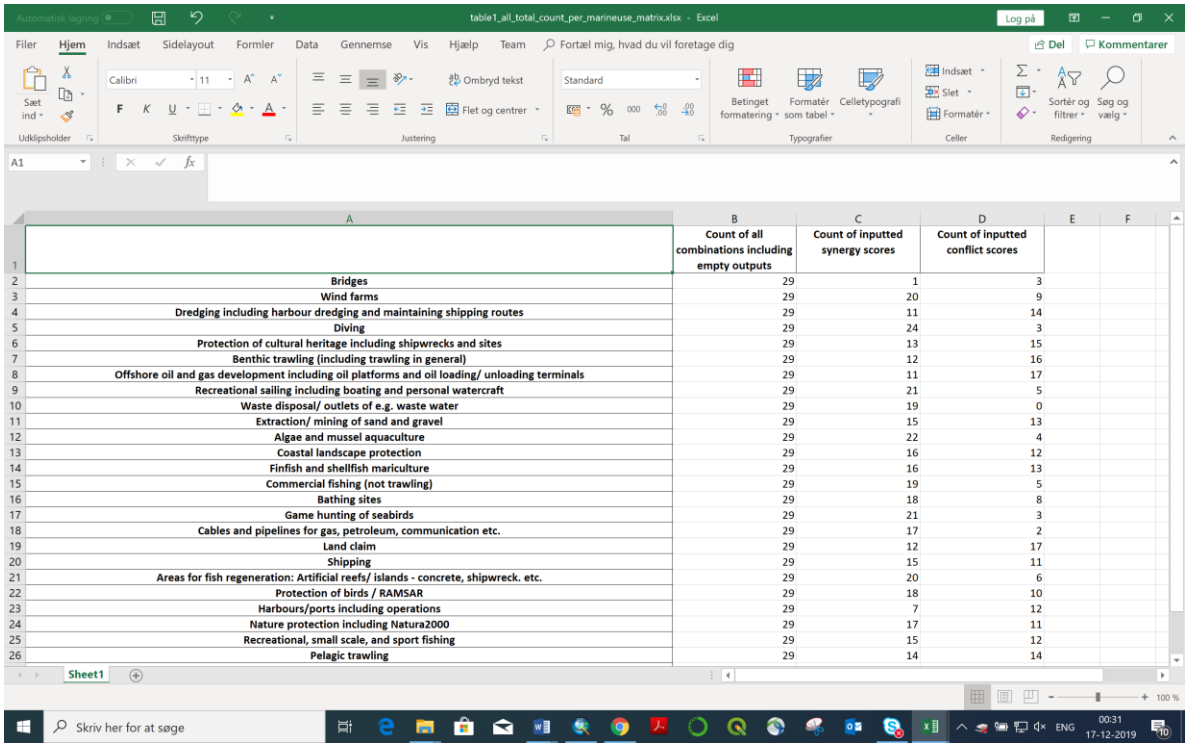
Examples of table outputs based on the provided HELCOM marine use raster data is provided in this section.

7.1 Matrix-based statistics per marine use:



	A	B	C	D	E	F	G
1		Sum of inputted synergy scores	Count of inputted synergy scores	Sum of inputted conflict scores	Count of inputted conflict scores		
2	Coastal landscape protection	44,5	24	-4	3		
3	Diving	43	22	-7	4		
4	Cables and pipelines for gas, petroleum, communication etc.	38,5	20	-13	9		
5	Recreational sailing including boating and personal watercraft	34	21	-7	5		
6	Protection of birds / RAMSAR	33,5	20	-10	6		
7	Bathing sites	32,5	21	-3	3		
8	Game hunting of seabirds	32,5	19	-5	5		
9	Wind farms	28,75	17	-19	11		
10	Harbours/ports including operations	28,5	15	-20	12		
11	Algae and mussel aquaculture	28,25	18	-17	8		
12	Recreational, small scale, and sport fishing	28	18	-16	10		
13	Pelagic trawling	27,5	18	-19	10		
14	Finfish and shellfish mariculture	26,5	16	-22	12		
15	Waste disposal/ outlets of e.g. waste water	26	19	0	0		
16	Deposit areas for dumping	25,5	15	-26	11		
17	Areas for fish regeneration: Artificial reefs/ islands - concrete, shipwreck. etc.	25	17	-6	2		
18	Land claim	23,5	14	-24	14		
19	Commercial fishing (not trawling)	23,25	13	-34	15		
20	Protection of cultural heritage including shipwrecks and sites	23	16	-24	13		
21	Extraction/ mining of sand and gravel	21,5	14	-12	12		
22	Shipping	21,5	16	-16	9		
23	Benthic trawling (including trawling in general)	20,75	15	-29	13		
24	Hydropower (wave parks and tidal energy production)	20,5	12	-34	17		
25	Fossil fuel energy production including power stations, gas and petroleum production and treatment, and coal unloading piers	20,5	12	-34	16		
26	Dredging including harbour dredging and maintaining shipping routes	16,5	11	-22	14		
27	Offshore oil and gas development including oil platforms and oil loading/ unloading terminals	13,25	11	-36	17		

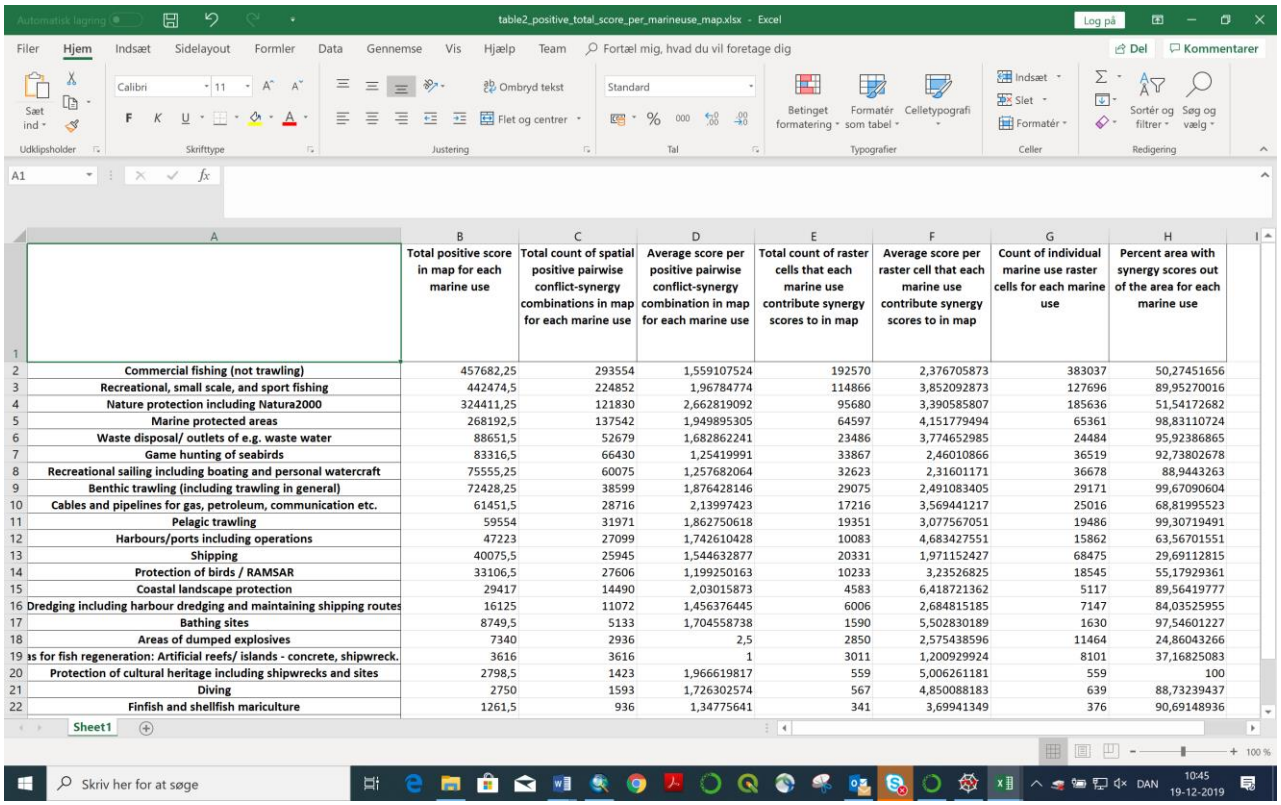
***Example of table output option 1 from 'Calculate Score Map'**: Printscreen of an excel table output with matrix-based marine use statistics from the tool 'Calculate Score Map' (table output option 1).*



	A	B	C	D	E	F
1		Count of all combinations including empty outputs	Count of inputted synergy scores	Count of inputted conflict scores		
2	Bridges	29	1	3		
3	Wind farms	29	20	9		
4	Dredging including harbour dredging and maintaining shipping routes	29	11	14		
5	Diving	29	24	3		
6	Protection of cultural heritage including shipwrecks and sites	29	13	15		
7	Benthic trawling (including trawling in general)	29	12	16		
8	Offshore oil and gas development including oil platforms and oil loading/ unloading terminals	29	11	17		
9	Recreational sailing including boating and personal watercraft	29	21	5		
10	Waste disposal/ outlets of e.g. waste water	29	19	0		
11	Extraction/ mining of sand and gravel	29	15	13		
12	Algae and mussel aquaculture	29	22	4		
13	Coastal landscape protection	29	16	12		
14	Finfish and shellfish mariculture	29	16	13		
15	Commercial fishing (not trawling)	29	19	5		
16	Bathing sites	29	18	8		
17	Game hunting of seabirds	29	21	3		
18	Cables and pipelines for gas, petroleum, communication etc.	29	17	2		
19	Land claim	29	12	17		
20	Shipping	29	15	11		
21	Areas for fish regeneration: Artificial reefs/ islands - concrete, shipwreck. etc.	29	20	6		
22	Protection of birds / RAMSAR	29	18	10		
23	Harbours/ports including operations	29	7	12		
24	Nature protection including Natura2000	29	17	11		
25	Recreational, small scale, and sport fishing	29	15	12		
26	Pelagic trawling	29	14	14		

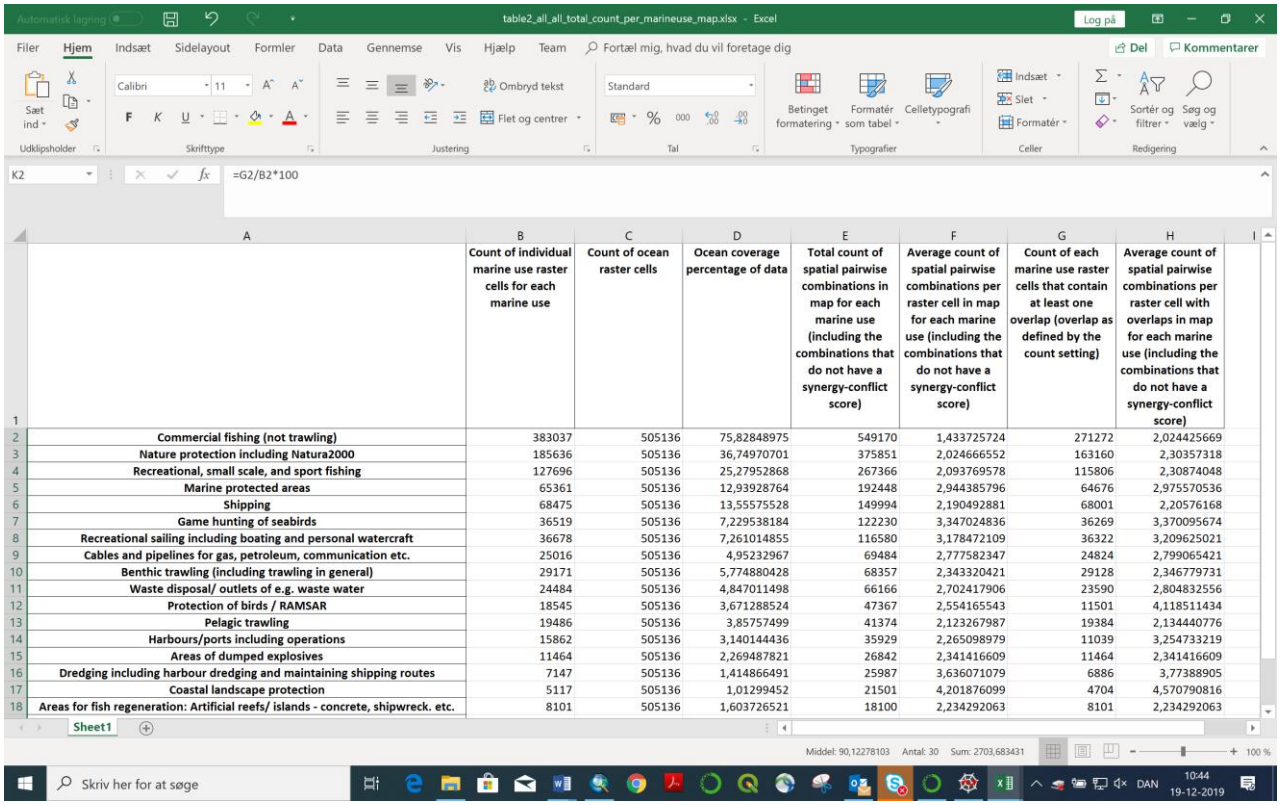
***Example of table output option 1 from 'Calculate Count Map'**: Printscreen of an excel table output with matrix-based marine use statistics from the tool 'Calculate Count Map' (table output option 1).*

7.2 Map-based statistics per marine use:



	A	B	C	D	E	F	G	H
1		Total positive score in map for each marine use	Total count of spatial positive pairwise conflict-synergy combinations in map for each marine use	Average score per positive pairwise conflict-synergy combination in map for each marine use	Total count of raster cells that each marine use contribute synergy scores to in map	Average score per raster cell that each marine use contribute synergy scores to in map	Count of individual marine use raster cells for each marine use	Percent area with synergy scores out of the area for each marine use
2	Commercial fishing (not trawling)	457682,25	293554	1,559107524	192570	2,376705873	383037	50,27451656
3	Recreational, small scale, and sport fishing	442474,5	224852	1,96784774	114866	3,852092873	127696	89,95270016
4	Nature protection including Natura2000	324411,25	121830	2,662819092	95680	3,390585807	185636	51,54172682
5	Marine protected areas	268192,5	137542	1,949895305	64597	4,151779494	65361	98,83110724
6	Waste disposal/ outlets of e.g. waste water	88651,5	52679	1,682862241	23486	3,774652985	24484	95,92386865
7	Game hunting of seabirds	83316,5	66430	1,25419991	33867	2,46010866	36519	92,73802678
8	Recreational sailing including boating and personal watercraft	75555,25	60075	1,257682064	32623	2,31601171	36678	88,9443263
9	Benthic trawling (including trawling in general)	72428,25	38599	1,876428146	29075	2,491083405	29171	99,67090604
10	Cables and pipelines for gas, petroleum, communication etc.	61451,5	28716	2,13997423	17216	3,569441217	25016	68,81995523
11	Pelagic trawling	59554	31971	1,862750618	19351	3,077567051	19486	99,30719491
12	Harbours/ports including operations	47223	27099	1,742610428	10083	4,683427551	15862	63,56701551
13	Shipping	40075,5	25945	1,544632877	20331	1,971152427	68475	29,69112815
14	Protection of birds / RAMSAR	33106,5	27606	1,199250163	10233	3,23526825	18545	55,17929361
15	Coastal landscape protection	29417	14490	2,03015873	4583	6,418721362	5117	89,56419777
16	Dredging including harbour dredging and maintaining shipping routes	16125	11072	1,456376445	6006	2,684815185	7147	84,03525955
17	Bathing sites	8749,5	5133	1,704558738	1590	5,502830189	1630	97,54601227
18	Areas of dumped explosives	7340	2936	2,5	2850	2,575438596	11464	24,86043266
19	as for fish regeneration: Artificial reefs/ islands - concrete, shipwreck.	3616	3616	1	3011	1,200929924	8101	37,16825083
20	Protection of cultural heritage including shipwrecks and sites	2798,5	1423	1,966619817	559	5,006261181	559	100
21	Diving	2750	1593	1,726302574	567	4,850088183	639	88,73239437
22	Finfish and shellfish mariculture	1261,5	936	1,34775641	341	3,69941349	376	90,69148936

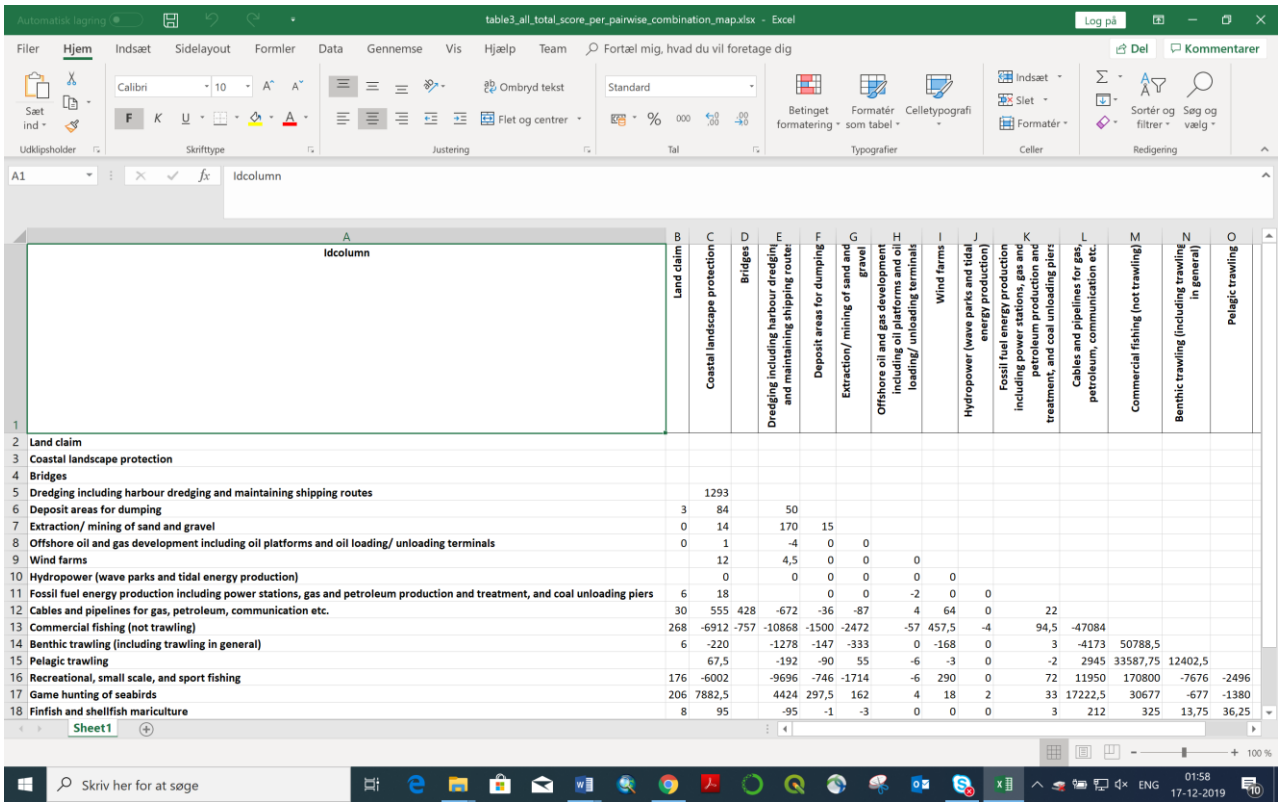
***Example of table output option 2 from 'Calculate Score Map'**: Printscreen of an excel table output with map-based marine use statistics from the tool 'Calculate Score Map' (table output option 2).*



	A	B	C	D	E	F	G	H
1		Count of individual marine use raster cells for each marine use	Count of ocean raster cells	Ocean coverage percentage of data	Total count of spatial pairwise combinations in map for each marine use (including the combinations that do not have a synergy-conflict score)	Average count of spatial pairwise combinations per raster cell in map for each marine use (including the combinations that do not have a synergy-conflict score)	Count of each marine use raster cells that contain at least one overlap (overlap as defined by the count setting)	Average count of spatial pairwise combinations per raster cell with overlaps in map for each marine use (including the combinations that do not have a synergy-conflict score)
2	Commercial fishing (not trawling)	383037	505136	75,82848975	549170	1,433725724	271272	2,024425669
3	Nature protection including Natura2000	185636	505136	36,74970701	375851	2,024666552	163160	2,30357318
4	Recreational, small scale, and sport fishing	127696	505136	25,27952868	267366	2,093769578	115806	2,30874048
5	Marine protected areas	65361	505136	12,93928764	192448	2,944385796	64676	2,975570536
6	Shipping	68475	505136	13,55575528	149994	2,190492881	68001	2,20576168
7	Game hunting of seabirds	36519	505136	7,229538184	122230	3,347024836	36269	3,370095674
8	Recreational sailing including boating and personal watercraft	36678	505136	7,261014855	116580	3,178472109	36322	3,209625021
9	Cables and pipelines for gas, petroleum, communication etc.	25016	505136	4,95232967	69484	2,777582347	24824	2,799065421
10	Benthic trawling (including trawling in general)	29171	505136	5,774880428	68357	2,343320421	29128	2,346779731
11	Waste disposal/ outlets of e.g. waste water	24484	505136	4,847011498	66166	2,702417906	23590	2,804832556
12	Protection of birds / RAMSAR	18545	505136	3,671288524	47367	2,554165543	11501	4,118511434
13	Pelagic trawling	19486	505136	3,85757499	41374	2,123267987	19384	2,134440776
14	Harbours/ports including operations	15862	505136	3,140144436	35929	2,265098979	11039	3,254733219
15	Areas of dumped explosives	11464	505136	2,269487821	26842	2,341416609	11464	2,341416609
16	Dredging including harbour dredging and maintaining shipping routes	7147	505136	1,414866491	25987	3,636071079	6886	3,77388905
17	Coastal landscape protection	5117	505136	1,01299452	21501	4,201876099	4704	4,570790816
18	Areas for fish regeneration: Artificial reefs/ islands - concrete, shipwreck. etc.	8101	505136	1,603726521	18100	2,234292063	8101	2,234292063

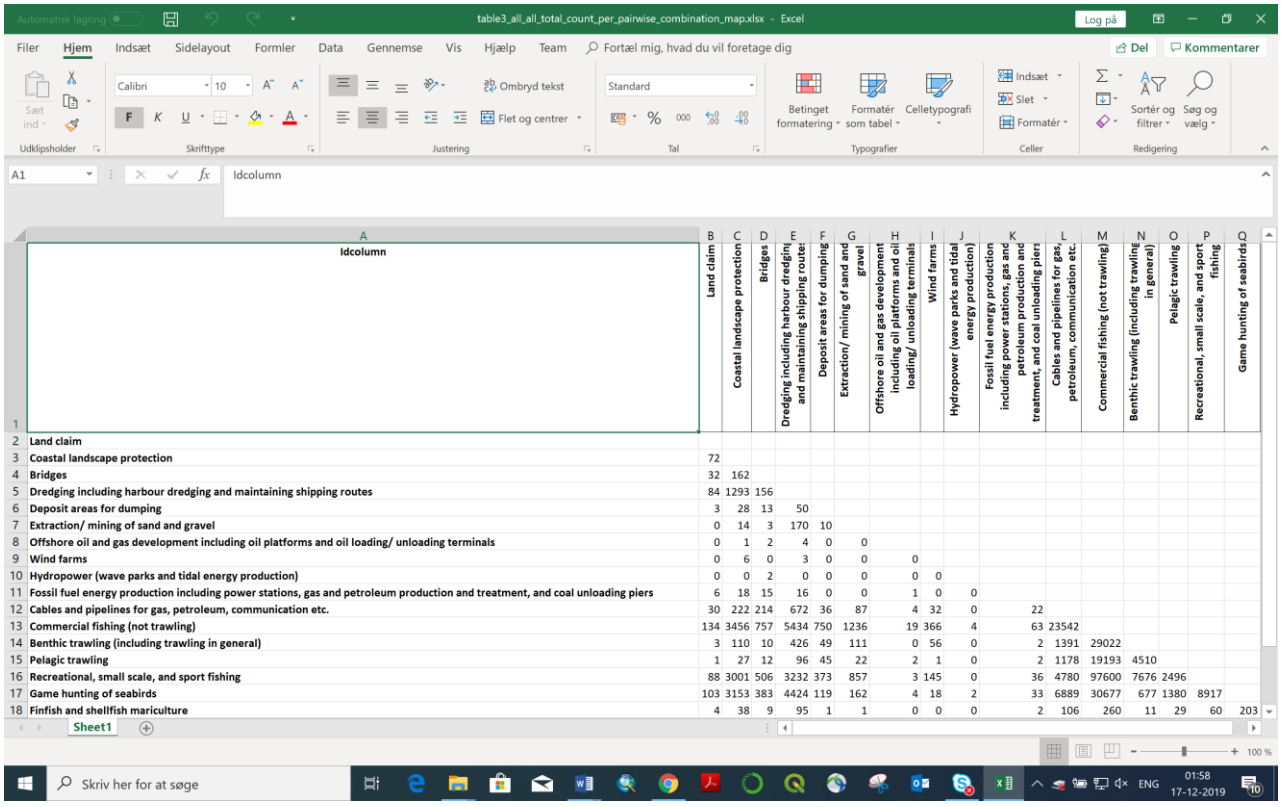
***Example of table output option 2 from 'Calculate Count Map'**: Printscreen of an excel table output with map-based marine use statistics from the tool 'Calculate Count Map' (table output option 2).*

7.3 Map-based statistics per pairwise marine use combination:



Idcolumn	Land claim	Coastal landscape protection	Bridges	Dredging including harbour dredging and maintaining shipping routes	Deposit areas for dumping	Extraction/ mining of sand and gravel	Offshore oil and gas development including oil platforms and oil loading/ unloading terminals	Wind farms	Hydropower (wave parks and tidal energy production)	Fossil fuel energy production including power stations, gas and petroleum production and treatment, and coal unloading piers	Cables and pipelines for gas, petroleum, communication etc.	Commercial fishing (not trawling)	Benthic trawling (including trawling in general)	Pelagic trawling
Land claim														
Coastal landscape protection														
Bridges														
Dredging including harbour dredging and maintaining shipping routes		1293												
Deposit areas for dumping	3	84		50										
Extraction/ mining of sand and gravel	0	14		170	15									
Offshore oil and gas development including oil platforms and oil loading/ unloading terminals	0	1		-4	0	0								
Wind farms		12		4,5	0	0	0							
Hydropower (wave parks and tidal energy production)		0		0	0	0	0	0						
Fossil fuel energy production including power stations, gas and petroleum production and treatment, and coal unloading piers	6	18			0	0	-2	0	0					
Cables and pipelines for gas, petroleum, communication etc.	30	555	428	-672	-36	-87	4	64	0	22				
Commercial fishing (not trawling)	268	-6912	-757	-10868	-1500	-2472	-57	457,5	-4	94,5	-47084			
Benthic trawling (including trawling in general)	6	-220		-1278	-147	-333	0	-168	0	3	-4173	50788,5		
Pelagic trawling		67,5		-192	-90	55	-6	-3	0	-2	2945	33587,75	12402,5	
Recreational, small scale, and sport fishing	176	-6002		-9696	-746	-1714	-6	290	0	72	11950	170800	-7676	-2496
Game hunting of seabirds	206	7882,5		4424	297,5	162	4	18	2	33	17222,5	30677	-677	-1380
Finfish and shellfish mariculture	8	95		-95	-1	-3	0	0	0	3	212	325	13,75	36,25

***Example of table output option 3 from 'Calculate Score Map'**: Printscreen of an excel table output with map-based pairwise marine use statistics from the tool 'Calculate Score Map' (table output option 3).*



Idcolumn	Land claim	Coastal landscape protection	Bridges	Dredging including harbour dredging and maintaining shipping routes	Deposit areas for dumping	Extraction/ mining of sand and gravel	Offshore oil and gas development including oil platforms and oil loading/ unloading terminals	Wind farms	Hydropower (wave parks and tidal energy production)	Fossil fuel energy production including power stations, gas and petroleum production and treatment, and coal unloading piers	Cables and pipelines for gas, petroleum, communication etc.	Commercial fishing (not trawling)	Benthic trawling (including trawling in general)	Pelagic trawling	Recreational, small scale, and sport fishing	Game hunting of seabirds
Land claim																
Coastal landscape protection	72															
Bridges	32	162														
Dredging including harbour dredging and maintaining shipping routes	84	1293	156													
Deposit areas for dumping	3	28	13	50												
Extraction/ mining of sand and gravel	0	14	3	170	10											
Offshore oil and gas development including oil platforms and oil loading/ unloading terminals	0	1	2	4	0	0										
Wind farms	0	6	0	3	0	0	0									
Hydropower (wave parks and tidal energy production)	0	0	2	0	0	0	0	0								
Fossil fuel energy production including power stations, gas and petroleum production and treatment, and coal unloading piers	6	18	15	16	0	0	1	0	0							
Cables and pipelines for gas, petroleum, communication etc.	30	222	214	672	36	87	4	32	0	22						
Commercial fishing (not trawling)	134	3456	757	5434	750	1236	19	366	4	63	23542					
Benthic trawling (including trawling in general)	3	110	10	426	49	111	0	56	0	2	1391	29022				
Pelagic trawling	1	27	12	96	45	22	2	1	0	2	1178	19193	4510			
Recreational, small scale, and sport fishing	88	3001	506	3232	373	857	3	145	0	36	4780	97600	7676	2496		
Game hunting of seabirds	103	3153	383	4424	119	162	4	18	2	33	6889	30677	677	1380	8917	
Finfish and shellfish mariculture	4	38	9	95	1	1	0	0	0	2	106	260	11	29	60	203

***Example of table output option 3 from 'Calculate Count Map'**: Printscreen of an excel table output with map-based pairwise marine use statistics from the tool 'Calculate Count Map' (table output option 3).*

8 Matrix content documentation

The literature sources used as inputs in the the pairwise marine use conflict-synergy matrix are presented in the "matrix documentation table" below.

***Matrix documentation table**. Matrix input literature and its provided matrix content. In cases with contradicting information, inputs related to the Baltic Sea region have been prioritized higher, and the newer the input information, the higher priority.*

Input literature	Literature description	Code in matrix	Provided matrix content
PartiSEApate (2014)	PartiSEApate flyer on workshop results from MSP stakeholder dialogue.	PartiSEApate2014	Compatibility degree information.
Veidemane et al. (2017)	Report on the Latvian case of the Baltic SCOPE project.	VeidemaneEtAl2017	
Backer et al. (2013)	Report on outcomes from the Plan Bothnia project for the Swedish-Finnish Bothnian Bay.	BackerEtAl2013	
Kannen (2014)	Academic article with a general draft compatibility matrix.	Kannen2014	
Ehler & Douvere (2009).	A general compatibility matrix from the UNESCO step-by-step approach.	Ehler&Douvere2009	
Gimpel et al. (2018).	Article from the AquaSpace project with a case on the German part of the North Sea.	GimpelEtAl2018	
SwAM (The Swedish Agency for Marine and Water Management) (2015).	Report on the status of the Swedish marine spatial plan in 2014.	SwAM2015	
Technion (Israel Institute of Technology) (2015).	An unofficial draft marine spatial plan for Israel.	Technion2015	
Ruskule et al. (2014)	PartiSEApate synthesis report on pan-Baltic MSP stakeholder dialogue.	RuskuleEtAl2014	A count of registered synergies and conflicts.
COEXIST project (2013)	Expert-derived spatial and temporal attributes for different marine uses found in the EU-financed COEXIST project for a case study from the Coastal North Sea and a case study from the Algarve Coast.	Not inputted in the matrix, but in another excelsheet called marine_use_attributes	Spatial and temporal marine use attributes.
Schultz-Zehden et al. (2018)	The multi-use action plan from the MUSES project.	Schultzzehden2018MUSES	Multi-use knowledge.

References for the input literature in the above matrix documentation table:

- PartiSEApate project (2014). Flyer on workshop results: Stakeholder dialogue on Maritime Spatial Planning. Last accessed 22th January 2020 from: https://www.partiseapate.eu/results/
- Veidemane, K., Ruskule, A. & Sprukta, S. (2017). Development of a maritime spatial plan: The Latvian recipe. Last accessed 22th January 2020 from: http://www.balticscope.eu/events/final-reports/
- Backer, H., Bergström, U., Fredricsson, C., Fredriksson, R., Frias, M., Hämäläinen, J. et al. (2013). Planning the Bothnian Sea: Outcome of Plan Bothnia – a transboundary Maritime Spatial Planning pilot in the Bothnian Sea (Digital Edition 2013). Last accessed 22th January 2020 from: https://www.helcom.fi/wp-content/uploads/2019/08/Planning-the-Bothnian-Sea.pdf
- Kannen, A. (2014). Challenges for marine spatial planning in the context of multiple sea uses, policy arenas and actors based on experience from the German North Sea. Regional Environmental Change, Vol. 14, Issue 6, pp. 2139-2150, https://doi.org/10.1007/s10113-012-0349-7.

- Ehler, C & Douvere, F. (2009). Marine Spatial Planning: A step-by-step approach toward ecosystem-based management. Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. IOC Manual and Guides No. 53, ICAM Dossier No. 6 Paris. UNESCO. Last accessed 22th January 2020 from: http://msp.ioc-unesco.org/msp-guides/msp-step-by-step-approach/
- Gimpel, A., Stelzenmüller, V., Töpsch, S., Galparsoro, I., Gubbins, M., Miller, D. et al. (2018). A GIS-based tool for an integrated assessment of spatial planning trade-offs with aquaculture, Vol. 627, pp. 1644-1655, https://doi.org/10.1016/j.scitotenv.2018.01.133.
- SwAM (The Swedish Agency for Marine and Water Management) (2015). Marine spatial planning – current status 2014: National planning in Sweden's territorial waters and exclusive economic zone (EEZ). Last accessed 22th January 2020 from: https://tethys.pnnl.gov/publications/marine-spatial-planning-current-status-2014-national-planning-swedens-territorial
- Technion (Israel Institute of Technology) (2015). The Israel marine plan. Last accessed 22th January 2020 from: https://msp-israel.net.technion.ac.il/en/
- Ruskule A., Kalvane, I., Veidemane, K., Przedrzymirska, J., Schultz-Zehden, A., Depellegrin, D. et al. (2014). Pan-Baltic stakeholders' dialogue on MSP: Synthesis report from PartiSEApate single-sector workshops held in 2013. Last accessed 22th January 2020 from: https://commons.wmu.se/partiseapate/1/
- COEXIST EU project (2013), financed by the European Union. The results from the Coastal North Sea and the Algarve Coast for tool 3: Analysis of Conflict Scores. Last accessed 22th January 2020 from: https://www.coexistproject.eu/coexist-results/tool
- Schultz-Zehden, A., Lukic, I., Ansong, J.O., Altvater, S., Bamlett, R., Barbanti, A. et al. (2018). Ocean Multi-Use Action Plan. Project MUSES (Multi-Use in European Seas), Edinburgh. Last accessed 22th January 2020 from: https://muses-project.com/downloads/

The preliminary scores that have been deduced from the sources in the "matrix documentation table" are listed in the "synergy-conflict score table" below.

***Synergy-conflict score table**. Preliminary conflict-synergy scores based on a ranking of conflict-synergy information deduced from the sources listed in the "matrix documentation table".*

Conflict-synergy categories	Category description	Preliminary score
Compatible synergy overlaps	Compatible spatial overlaps with synergies and no conflicts.	3
Compatible mostly synergy overlaps	Compatible spatial overlaps with more synergies than conflicts.	2.75
Compatible neutral overlaps	Compatible neutral spatial overlaps.	2.5
Conditionally compatible synergy neighbours.	Conditionally compatible uses with neighbourhood synergies and no neighbourhood conflicts.	2
Conditionally compatible mostly synergy neighbours	Conditionally compatible uses with more neighbourhood synergies than neighbourhood conflicts.	1.75
Non-compatible synergy neighbours	Non-compatible uses with neighbourhood synergies and no neighbourhood conflicts.	1.5
Non-compatible mostly synergy neighbours	Non-compatible uses with more neighbourhood synergies than neighbourhood conflicts.	1.25
Conditionally compatible neutral neighbours	Conditional compatible uses with neutral neighbourhood relations.	1
Non-compatible neutral neighbours	Non-compatible uses with neutral neighbourhood relations.	-1
Conditionally compatible conflicting neighbours	Conditionally compatible uses with conflicting neighbourhood relations.	-2
Non-compatible conflicting neighbours	Non-compatible uses with conflicting neighbourhood relations.	-3

9 Marine use GIS raster data documentation

This section provides documentation on the marine use GIS-input data provided in SEANERGY for the Baltic Sea area (it can be changed with other raster data, if the SEANERGY user wants to focus on another area).

***Marine use data table**. The first three columns contain marine use inputs to the synergy-conflict matrix from the Marine Strategy Framework Directive (MSFD): MSFD theme, MSFD use category, and how the MSFD use category has been interpreted into a matrix use category. The four last columns match the MSFD-matrix-inputs with marine use data from HELCOM. The threshold value column describes whether a threshold has been used to convert the HELCOM origin dataset (metadata provided in the metadata column) into a pre-processed, binary marine use raster dataset inputted in the Seanergy toolbox as example data. The user can choose to use own marine use data instead of this marine use data.*

MSFD theme	MSFD use category	Matrix use category	HELCOM origin dataset	Metadata of HELCOM origin dataset	Threshold value	Pre-processsed dataset
Physical restructuring of rivers, coastline or seabed (water management)	Land claim	Land claim	Land_claim.shp [lines].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/79f6cb3c-b7f4-4ea7-8b36-59945602a221	None	landclaim.tif
	Canalisation and other watercourse modifications	Coastal landscape protection	Watercourse_modification_trenching.shp [lines]. Watercourse_modifications.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/c1d21d0b-baf9-4429-86be-9e1570c574ef	None None	coastprotection.tif
	Coastal defence and flood protection*		Coastal_defense.shp [lines].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/2d47c5ea-4590-465f-a462-60ef59d3d7d3	None	
	Offshore structures (other than for oil/gas/renewables)*	Offshore industrial production facilities	No data.	-	-	-
		Bridges	Bridges_and_other_constructions.shp [lines].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/8a4b2ff4-30a1-430a-ba55-dfec57ebed97	None	bridges.tif
	Restructuring of seabed morphology, including dredging and depositing of materials* Non-compatible uses with neighbourhood synergies	Dredging including harbour dredging and maintaining shipping routes	Dredging_areas.shp [polygons]. Dredg_points.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/2a0fbdfd-9aef-4d2e-9129-2d1cc3b4943b http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/bb6622b7-e5df-4637-8ebe-c2736e705a70	None None	dredging.tif

	and no neighbourhood conflicts.		Mussel_and_scallop_dredging.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/e57dfe9f-2bb1-4c30-9033-8d45e30672ee	Minimum 0.1 % (= 331936.1) of the total amount of dredged blue mussels OR minimum 0.1 % (= 19654.0) of the total amount of dredged common cockle.	
		Deposit areas for dumping	deposit_areas_11_16.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/0eebe008-aed9-461a-8c85-e7b32bdab822	None	dumping.tif
			deposit_points_11_16.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/34bf84a1-1f04-40c7-99dd-9b9aff4523ea	Dumped amount more than 0 in 2011, 2012, 2013, 2014, 2015 OR 2016.	
Extraction of non-living resources	Extraction of minerals (rock, metal ores, gravel, sand, shell)*	Extraction/ mining of sand and gravel	Extraction_of_sand_and_gravel.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/683224c3-2fb9-4f2f-b748-bf5ad712d708	None	sandextract.tif
	Extraction of oil and gas, including infrastructure*	Exploration of hydrocarbons including oil, gas and petroleum	No data.	-	-	-
		Offshore oil and gas development including oil platforms and oil loading/ unloading terminals	OilTerminals.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/47120944-1b8e-4d47-832a-7f502d22ad88	None	oilgasdev.tif
			OilGasRefineries.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/58e115bd-2f98-49f5-a65e-720b95e8d536	None	

			Oil_platforms.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/fddc27ec-b6ae-407b-9dd8-f31a42d75412	None	
		Offshore liquified natural gas terminals	No data.	-	-	-
	Extraction of salt*	No matrix input	No data.	-	-	-
	Extraction of water*	Ocean desalination plants	No data.	-	-	-
Production of energy	Renewable energy generation (wind, wave and tidal power), including infrastructure*	Wind farms	wind_turbines.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/80de3bc3-e3ec-474e-8ae8-4b29c205eb0a	None	windfarms.tif
		Hydropower (wave parks and tidal energy production)	hydropower_dams.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/585a20d9-125f-4ac0-b515-699f28422a36	None	hydropower.tif
	Non-renewable energy generation	Fossil fuel energy production including power stations, gas and petroleum production and treatment, and coal unloading piers	Fossil_fuel_energy_production.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/3e587c54-8cc8-48a2-82f0-ffd71bf679e6	None	fossilprod.tif
	Transmission of electricity and communications (cables)*	Cables and pipelines for gas, petroleum, communication etc.	Cables.shp [lines].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/c0e73e71-cafb-4422-a3a3-115687fd5c49	None	cablesPipelines.tif
			Pipelines.shp [lines].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/5260249e-5850-431a-b130-3a096abac852	None	
Extraction of living resources	Fish and shellfish harvesting (professional, recreational)*	Commercial fishing (not trawling)	Fish_extraction_commercial_fisheries_-_cod.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/7a1389b3-382a-487f-8888-ac45c94c5a97	Minimum 0.05 % (=164.8) of the total tonne value of fished cod	comFish.tif
			Fishextraction_herring.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/		

		Fish_extraction_sprat.shp [polygons].	metadata/a3b67a55-7c1e-469e-b692-58c4e7b79279 http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/1fb1bd2d-8dff-493a-9ed3-a278aec8f371	(= 329664). Minimum 0.05 % (= 699.0) of the total tonne value of fished sprat (= 1398030). Minimum 0.05 % (=764.1) of the total tonne value of fished herring (= 1528298).	
	Benthic trawling (including trawling in general)	HELCOM_effort_year_MBCG_VMS_2013.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/6902f0eb-9fc3-4bf7-904e-6203524de57d	At least three full days and nights = 72 hours of trawling.	benthicTrawling.tif
	Pelagic trawling	HELCOM_effort_year_Midwater_trawl_VMS_2013.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/49fe4828-be70-4108-9098-381690afa0cd	At least three full days and nights = 72 hours of trawling.	pelagicTrawling.tif
	Recreational, small scale, and sport fishing	Recreational_fishing.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/debeafcd-948b-4455-88ae-7a3d1618f5a8	Minimum 5 tons of yearly recreational cod catch.	recFish.tif
Fish and shellfish processing*	No matrix input	No data.	-	-	-
Marine plant harvesting*	No matrix input	furcellaria_harvesting.xlsx	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/e72b634a-e4ca-4c1d-a3af-99a24aa10be8	-	-
Hunting and collecting for other purposes*	Game hunting of seabirds	game_hunting_of_seabirds.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/81c917ea-492d-48e2-9f00-e1bb7fe3e4fc	Minimum 0.1 % (=1719.18765577) of the total	gamehuntingSeabirds.tif

					amount of hunted eiders OR minimum 0.1 % (=557.66800858) of the total amount of hunted long tailed duck OR minimum 0.1 % (=105.00) of the total amount of hunted velvet scoters OR minimum 0.1 % (=278.77691672) of the total amount of hunted scoters.	
		No matrix input	Hunting of seals: Grey seals: GS.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/3ccc8a4c-4988-4380-afdd-d9bd7752c3fb	-	-
			Harbouur seals: HS.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/7695c830-db56-4322-98d2-8af607ca48e4		
			Ringed seals: RS.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/609dbe11-b466-4dc7-bcfa-c68485dd72ec		
Cultivation of living resources	Aquaculture — marine, including infrastructure*	Finfish and shellfish mariculture	Finfish_mariculture.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/3cfa469a-6a78-4913-b82f-57fd0e7f4dc0	None	fishAquaculture.tif
			Shellfish_mariculture_areas.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv	None	

			Shellfish_mariculture_points.shp [points].	/eng/catalog.search#/metadata/8fbf946a-18d2-4b24-98ad-1327ba2820a8 http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/21efdecc-2fd7-4bfb-9832-68c995291bf7	None	
		Algae and mussel aquaculture	musselfarms_app_areas.shp [polygons] - not HELCOM data. Locations are approximated by the author of this article based on musselfarm map information from the EU SUBMARINER network.	https://www.submariner-network.eu/42-projects/baltic-blue-growth/mussel-farms	Buffers used (the size is not due to farm size but due to difficulties reading farm locations from maps): Coast of Kurzeme: 2850 meters. Kalmarsund: 500 meters. Vormsi island: 1190 meters. Sankt Anna: 535 meters. Musholm Bay: 208 meters. Kiel Bay: 1190 meters.	musselfarms.tif
Transport	Transport infrastructure*	Offshore airports	No data.	-	-	-
		Anchorages	No data.	-	-	-
	Transport — shipping*	Shipping	2011-2015_all_ship_types_SUM.tif	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/1fd5298f-d3be-4c5f-bb05-3dc66a8eea6b	Minimum 1 % of maximum shipping route overlap (=160829).	shipping.tif
Urban and	Industrial uses	Harbours/ports including operations	Harbours.shp [points]. Harbour_polygons.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/	For all harbours: Buffer =	harbours.tif

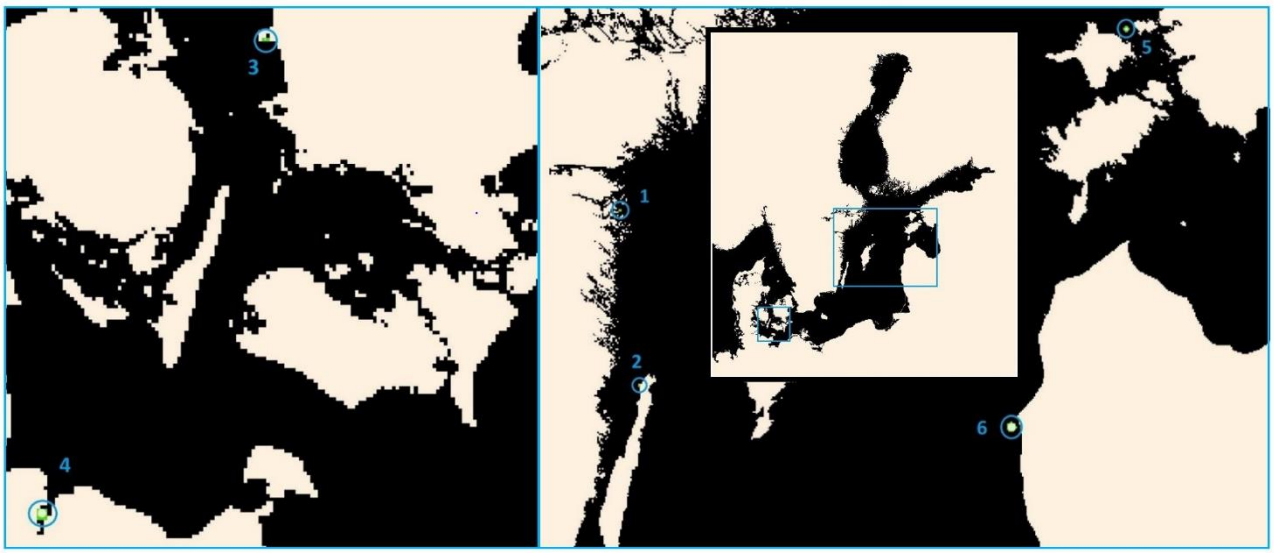
industrial uses				metadata/e2a3a104-a7aa-49c9-bc2c-47845b3a322f	3000 meters.	
	Waste treatment and disposal*	Carbon sequestration	No data.	-	-	-
		Former mined areas	No data.	-	-	-
		Waste disposal/ outlets of e.g. waste water	Discharge_of_warm_water_from_nuclear_power_plants_points.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/60f5e958-328e-4cae-9719-64b7911c92c0	For all waste disposal: Buffer = 3000 meters.	wastedisposal.tif
			radioact_discharge_active.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/ee036b10-1045-430a-a9fa-b37fbb23d744		
			Illegal_oil_2011_2016.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/6ed3a23f-8019-4959-ac1e-34c27070feab		
		Areas of dumped explosives	Chemical_Munition_Dumpsites.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/b55b508d-3c40-484c-8c7f-38869a8df368	None	explosives.tif
			Areas where sea dumped chemical warfare materials have been encountered.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/5724455d-4589-4b00-b255-c1989742a4ed	None	
Tourism and leisure	Tourism and leisure infrastructure*	Bathing sites	Bathing_sites2011_2014.shp [points].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/28f8019f-66f1-4fa5-87e0-d6e34f0ff695	None	bathing.tif
	Tourism and leisure activities*	Diving	potential_marinepark_sites2014.shp [points] - not HELCOM data. Data is created by the author of this article based on marine park information from the Nordic Blue Parks project.	https://www.norden.org/en/publication/nordic-blue-parks	Buffer = 1500 meters.	diving.tif
		Recreational sailing including boating and	Recreational_boating_2018.tif.	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/8c30e828-	minimum 0.25 out of a maximum	boating.tif

		personal watercraft		1340-4162-b7f9-254586ae32b6	of 1 (normalized intensity).	
		Recreational wildlife watching	No data.	-	-	-
		Tourism and recreation	No data.	-	-	-
Security/defence	Military operations (subject to Article 2(2))	Military training and activities	No data.	-	-	-
Education and research	Research, survey and educational activities*	Scientific research	No data.	-	-	-
		Coastal observation system	No data.	-	-	-
		Marine protected areas	HELCOM_MPAs.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/d27df8c0-de86-4d13-a06d-35a8f50b16fa	None	MPAs.tif
		Nature protection including Natura2000	Natura 2000 sites.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/47a94309-c72b-4a1a-8982-ed24ae829220	None	natureProtection.tif
			UNESCO sites.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/78e50e17-0049-4212-8288-922ba6f32e4f	Type='Biosphere reserve' OR 'World heritage sites, natural'.	
			Baltic_Sea_EBSA.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/828468c6-dd88-408c-97d3-ce9c926681f0		
		Areas for fish regeneration: Artificial reefs/ islands - concrete, shipwreck. etc.	Baltic Sea fisheries closure.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/b046f761-b6f5-44cd-a079-6d94d25a8f63	None	fishClosure.tif
			Cod fisheries closures.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/42f9583a-505b-411e-8ade-b2f10e03610b	None	
		Protection of benthic habitats	No data.	-	-	-

	Protection of birds / RAMSAR	Ramsarsites.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/91bfbaea-c586-4178-8c2d-16fbba5aea8b	None	birdProtection.tif
	Protection of cultural heritage including shipwrecks and sites	UNESCO sites.shp [polygons].	http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/78e50e17-0049-4212-8288-922ba6f32e4f	Type='World heritage sites, cultural'.	cultHeritage.tif
		Base raster for the Baltic Sea Region with raster values = 0. It is not HELCOM data, but adjusted from the base raster in the MYTILUS toolbox. Cellsize: 1 km2 (1624 rows * 1430 columns cells).	Contact Henning Sten Hansen, Aalborg University Copenhagen, for access to MYTILUS.		basearea_final.tif
		Base raster for the Baltic Sea with ocean cells = 1 in value. It is not HELCOM data. European Environment Agency's Europe coastline shapefile has been converted to raster based on basearea_final.tif as raster template.	https://www.eea.europa.eu/data-and-maps/data/eea-coastline-for-analysis-1/gis-data/europe-coastline-shapefile		final_baltic_ocean.tif

9.1 Musselfarm data from EU Submariner network:

Musselfarm data from the EU Submariner network have manually been digitalized based on the online musselfarm location maps from the project (https://www.submariner-network.eu/42-projects/baltic-blue-growth/mussel-farms). The location of the digitalized musselfarm data used in SEANERGY is shown in the musselfarm figure below, and they are listed in the musselfarm table below.



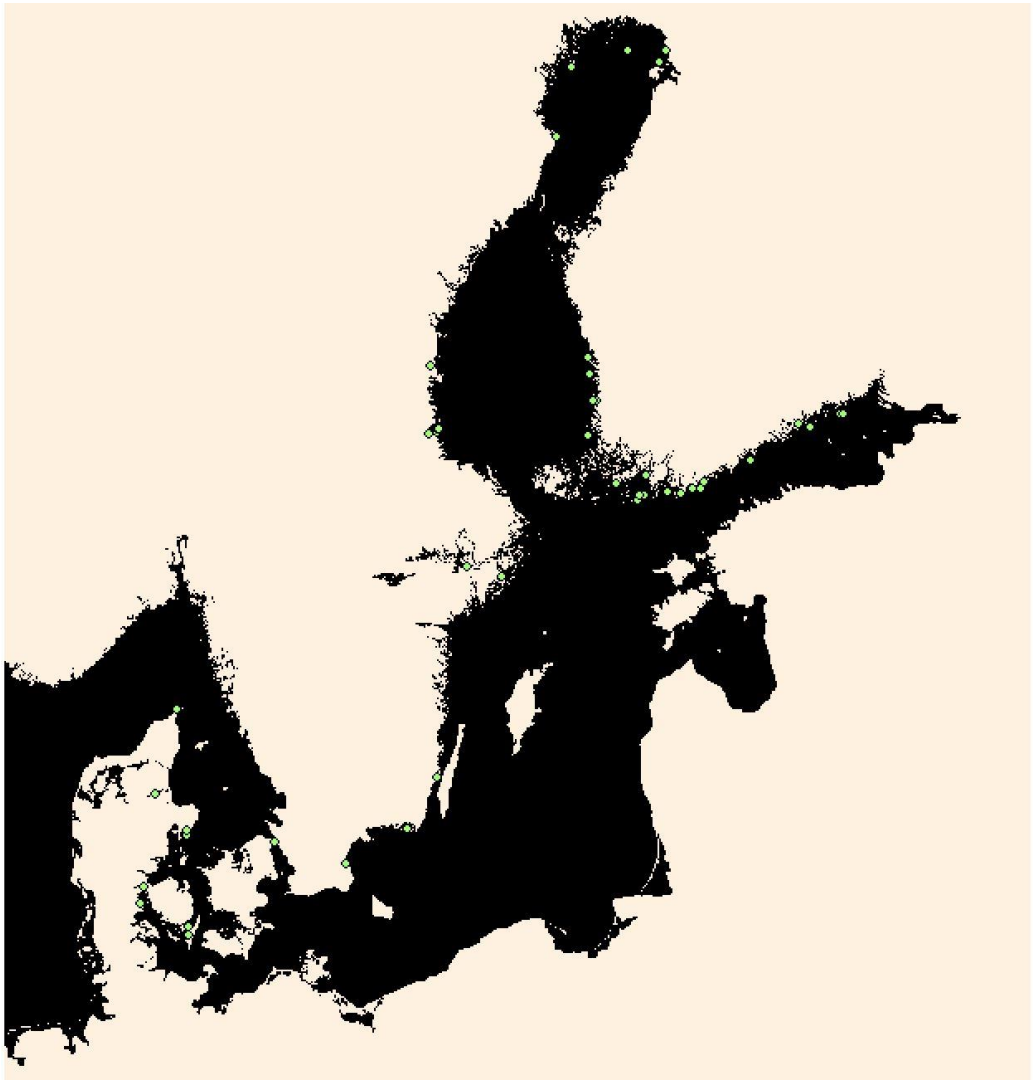
***Musselfarm figure**: Locations of the musselfarm data from the EU Submariner network.*

***Musselfarm table**. Musselfarms from the EU SUBMARINER network.*

ID	Name	Status	Ownership	Described surface [ha]	Link	Circle size in this analysis [m]
1	Sankt Anna, Sweden	Existing pilot farm		0.5	https://www.submariner-network.eu/projects/balticbluegrowth/mussel-farms/sankt-anna-archipelago-sweden	500
2	Kalmarsund, Sweden	Existing farm	Bohus Havsbruk	1	https://www.submariner-network.eu/projects/balticbluegrowth/mussel-farms/kalmarsund-sweden	500
3	Musholm Bay, Denmark	Existing farm	Musholm	1	https://www.submariner-network.eu/projects/balticbluegrowth/mussel-farms/musholm-bay-denmark	200
4	Kiel Bay, Germany	Planned farm	MELUR ministry	0.32	https://www.submariner-network.eu/projects/balticbluegrowth/mussel-farms/kiel-bay-germany	1200
5	Vormsi island, Estonia	Existing pilot farm	Vormsi Agar	0.004	https://www.submariner-network.eu/projects/balticbluegrowth/mussel-farms/vormsi-island-estonia	1200
6	Coast of Kurzeme, Latvia	Planned pilot farm	Latvian institute of Planned Aquatic Ecology	1	https://www.submariner-network.eu/projects/balticbluegrowth/mussel-farms/coast-of-kurzeme-latvia	3000

9.2 Data about marine parks from the Nordic Blue Park project:

Based on coordinates provided by the Nordic Blue Park project (2014), potential diving marine parks have been digitized. The location of the digitalized marine park diving data used in SEANERGY is shown in the marine park figure below, and they are listed in the marine park table below.



***Marine park figure**: Locations of the marine parks for diving from the Nordic Blue Park project.*

***Marine park table**. Marine parks for diving from the Nordic Blue Parks project (2014).*

ID	Name	Status	Coordinates	Link
1	The wreck of the Osborne & Elizabeth, Finland	potential underwater cultural trail	(WGS84: N59.861232, E22.768964)	https://www.norden.org/en/publication/nordic-blue-parks
2	The Wreck of the Alfred, Finland	potential underwater cultural trail	(WGS84: N59.873167, E22.167749)	https://www.norden.org/en/publication/nordic-blue-parks
3	The Wreck of the Sophia Maria, Finland	potential underwater cultural trail	(WGS84: N65.141270, E24.954352)	https://www.norden.org/en/publication/nordic-blue-parks
4	Jussarö II/Hopeapriki (Graf Nikita 1784 or Constant Trader 1785), Finland	potential underwater cultural trail	(WGS84: N 59.832583, E23.567130)	https://www.norden.org/en/publication/nordic-blue-parks

5	The Esselholmen Wreck, Finland	potential underwater cultural trail	(WGS84: N 59.898398, E23.689189)	https://www.norden.org/en/publication/nordic-blue-parks
6	The Wreck of the Siiwo, Finland	potential underwater cultural trail	(WGS84: N61.139570, E21.400061)	https://www.norden.org/en/publication/nordic-blue-parks
7	The Wreck of the Nordstiernan, Finland	potential underwater cultural trail	(WGS84: N 59.824212, E21.974566)	https://www.norden.org/en/publication/nordic-blue-parks
8	The Punapartojen Wreck, Finland	potential underwater cultural trails	(WGS84: N60.360780, E27.396542)	https://www.norden.org/en/publication/nordic-blue-parks
9	The Wreck of the Fortuna, Finland	potential underwater cultural trail	(WGS84: N60.359303, E26.308932)	https://www.norden.org/en/publication/nordic-blue-parks
10	The Wreck of the Mulan, Finland	potential underwater cultural trails	(WGS84: N59.807334, E23.065136)	https://www.norden.org/en/publication/nordic-blue-parks
11	Högland, NE Archipelago Sea, Finland	potential underwater nature trail	(WGS84: N60.105433, E22.312778)	https://www.norden.org/en/publication/nordic-blue-parks
12	Trelänningen, Ekenäs National Park, Ekenäs, Finland	potential underwater nature trail	(WGS84: N59.84050, E23.38299)	https://www.norden.org/en/publication/nordic-blue-parks
13	Ulko-Tammio, National Park of the Eastern Gulf of Finland	potential underwater nature trail	(WGS84: N60.350274, E27.464792)	https://www.norden.org/en/publication/nordic-blue-parks
14	Mustaviiri/Svartviran, Finland	potential underwater nature trail	(WGS84: N60.274905, E26.598650)	https://www.norden.org/en/publication/nordic-blue-parks
15	Röyttä, Oulu, Finland	potential underwater nature trail	(WGS84: N65.276230, E25.211940)	https://www.norden.org/en/publication/nordic-blue-parks
16	Kylmä-Pihlaja, Rauma, Finland1	potential underwater nature trail	(WGS84: N61.144407, E21.299670)	https://www.norden.org/en/publication/nordic-blue-parks
17	Iso-Enskeri, Pori, Finland	potential underwater nature trail	(WGS84: N61.680960, E21.373590)	https://www.norden.org/en/publication/nordic-blue-parks
18	Säppi, Pori, Finland	potential underwater nature trail	(WGS84: N61.480795, E21.339484)	https://www.norden.org/en/publication/nordic-blue-parks
19	Yxskär, SE Archipelago Sea, Finland	potential underwater nature trail	(WGS84: N59.875800, E22.052427)	https://www.norden.org/en/publication/nordic-blue-parks
20	Isokari, Uusikaupunki, Finland	potential underwater nature trail	(WGS84:N60.72241, E21.01782)	https://www.norden.org/en/publication/nordic-blue-parks
21	Kronprins Gustaf Adolf Dive Park surrounding the Kronprins Gustaf Adolf wreck, Finland	underwater cultural trail since 2000	(WGS84: N60.050, E24.921)	https://www.museovirasto.fi/en/cultural-environment/archaeological-cultural-heritage/underwater-cultural-heritage-in-finland/helsingin-hylkypuisto2
22	Stora Hästö, Finland's first underwater nature trail	underwater nature trail since 2005	(app. WGS84: N60.066319, E21,532683)	https://www.nationalparks.fi/archipelagonp/trails/underwaternaturetrail
23	In the northwestern end of Selkä-Sarvi archipelago, Perämeri National Park, Bay of Bothnia, Finland	underwater nature trail	(app. WGS84: N65,22,12, E24,6,36)	https://www.luontoon.fi/perameri/reitit
24	Axmar, Sweden	potential underwater trail	(WGS84: N61.054931, E17.165483)	https://www.norden.org/en/publication/nordic-blue-parks
25	Mellersta Kalmarsund, Kalmar strait, Sweden	potential underwater trail	(WGS84: N56.705442, E16.378298)	https://www.norden.org/en/publication/nordic-blue-parks
26	Djupasund, Sweden	potential underwater trail	(WGS84: N56.105239, E15.635954)	https://www.norden.org/en/publication/nordic-blue-parks

27	Bjuröklubb, Sweden	potential underwater trail	(WGS84: N64.470551, E21.573736)	https://www.norden.org/en/publication/nordic-blue-parks
28	Rödkallen, Sweden	potential underwater trail	(WGS84: N65.313502, E22.377423)	https://www.norden.org/en/publication/nordic-blue-parks
29	Dalarö, Sweden	potential underwater trail	(WGS84: N59.132630, E18.426355)	https://www.norden.org/en/publication/nordic-blue-parks
30	Vitemöllan – Haväng, Sweden	potential underwater trail	(WGS84: N55.729656. E14.188265)	https://www.norden.org/en/publication/nordic-blue-parks
31	Södra Björkfjärden, Sweden	potential underwater trail	(WGS84: N59.298473, E17.610355)	https://www.norden.org/en/publication/nordic-blue-parks
32	Axmar Blue Park: Granskär & Högrabben, Sweden	existing underwater cultural trail since 2010	(WGS84: N61,2,24-75, E17,12,29-68)	http://www.axmarbluepark.se/pages.asp?PageID=3649 http://www.axmarbluepark.se/pages.asp?PageID=3650
33	Axmar Blue Park: Lenängsviken, Sweden	existing underwater cultural trail since 2010	(WGS84: N61,3.12-91, E17,9,36-15)	http://www.axmarbluepark.se/pages.asp?PageID=3651
34	Axmar Blue Park: Malmharen, Sweden	existing underwater cultural trail since 2010	(WGS84: N61,2.58-65, E17,9,58-32)	http://www.axmarbluepark.se/pages.asp?PageID=3652
35	Axmar Blue Park: Oxelharen, Sweden	existing underwater cultural trail since 2010	(WGS84: N61,0.22-21, E17,0,17-42)	http://www.axmarbluepark.se/pages.asp?PageID=3653
36	Axmar Blue Park: Sandbanken, Sweden	existing underwater cultural trail since 2010	(WGS84: N61,3.43-60, E17,14,23-56)	http://www.axmarbluepark.se/pages.asp?PageID=3654
37	Axmar Blue Park: Simpviken, Sweden	existing underwater cultural trail since 2010	(WGS84: N61,3.22-68, E17,10,30-76)	http://www.axmarbluepark.se/pages.asp?PageID=3655
38	Axmar Blue Park: Sundmar, Sweden	existing underwater cultural trail since 2010	(WGS84: N61,0.32-57, E17,12,38-24)	http://www.axmarbluepark.se/pages.asp?PageID=3682
39	Axmar Blue Park: Svartstensudden, Sweden	existing underwater cultural trail since 2010	(WGS84: N61,049.70, E17,13,54-74)	http://www.axmarbluepark.se/pages.asp?PageID=3657
40	Axmar Blue Park: Tokharen, Sweden	existing underwater cultural trail since 2010	(WGS84: N61,2.53-1, E17,13,51-2)	http://www.axmarbluepark.se/pages.asp?PageID=3658
41	Axmar Blue Park: Västerhamn, Sweden	existing underwater cultural trail since 2010	(WGS84: N61,3.34-86, E17,15,59-06)	http://www.axmarbluepark.se/pages.asp?PageID=3659
42	Stinesminde, Mariager Fjord, Denmark	potential underwater trail	(WGS84: 56.665407, E9.964280)	https://www.norden.org/en/publication/nordic-blue-parks
43	Margrethes Bro/Æ Lei, Haderslev Fjord, Denmark	potential underwater trail	(WGS84: N55.285075, E9.658892)	https://www.norden.org/en/publication/nordic-blue-parks
44	Torpedo boats, Lunkebugten Bay, wreck 1, Denmark	potential underwater trail	(WGS84: Wreck 1: N55.013167, E10.694017)	https://www.norden.org/en/publication/nordic-blue-parks
45	Torpedo boats, Lunkebugten Bay, wreck 2, Denmark	potential underwater trail	(WGS84: Wreck 2: N55.016867, E10.700933)	https://www.norden.org/en/publication/nordic-blue-parks
46	Torpedo boats, Lunkebugten Bay, wreck 3, Denmark	potential underwater trail	(WGS84: Wreck 3: N55.016083, E10.682650)	https://www.norden.org/en/publication/nordic-blue-parks
47	Torpedo boats, Lunkebugten Bay, wreck 4, Denmark	potential underwater trail	(WGS84: Wreck 4: N55.001967, E10.685367)	https://www.norden.org/en/publication/nordic-blue-parks
48	Helligkilde, Fænø Sound, Denmark	potential underwater trail	(WGS84: N55.493299, E9.714009)	https://www.norden.org/en/publication/nordic-blue-parks
49	The Gåsehage Wreck-Moesgaard, Denmark	potential underwater trail	(WGS84: N56.137646, E10.692405)	https://www.norden.org/en/publication/nordic-blue-parks
50	The Campsite Wrecks, Ebeltoft Vig, Denmark	potential underwater trail	(WGS84:N56.209491, E10.673205)	https://www.norden.org/en/publication/nordic-blue-parks

51	The Spees, North Sea, Tannis Bay, Denmark	potential underwater trail	(WGS84: N57.723167, E10.495250)	https://www.norden.org/en/publication/nordic-blue-parks
52	The wreck of the Disken, Denmark	potential underwater trail	(WGS84: N56.027962, E12.648271)	https://www.norden.org/en/publication/nordic-blue-parks
53	Højklint Blue Trail, Denmark	existing underwater cultural trail since 2009	(app. WGS84: N54.892541, E10.709641)	https://www.langelandsmuseum.dk/dykkerstien-engelsk

10 Matrix input source distribution

This section provides documentation on the matrix conflict-synergy score input source distribution.

***Matrix input source distribution table**. For each marine use category in the matrix, the number of missing pairwise matrix inputs are stated and the data source distribution of existing matrix inputs are listed. The marine use categories are ranked after the missing pairwise matrix input percentage to highlight the marine use categories that to the highest degree need more conflict-synergy input information. Marine use categories that have not been provided data for in the HELCOM data-based Baltic Sea case study is coloured grey.*

Marine use category	Number of missing pairwise matrix inputs	Pairwise inputs with Baltic Sea area synergy-conflict knowledge as the best	Pairwise inputs with general synergy-conflict knowledge as the best	Pairwise inputs with only non-Baltic-Sea area synergy-conflict knowledge as the best
Bridges	88.4 % (38 out of 43)	5	0	0
Land claim	44.2 % (19 out of 43)	0	0	24
Nature protection including Natura2000	44.2 % (19 out of 43)	23	1	0
Waste disposal/ outlets of e.g. waste water	41.9 % (18 out of 43)	0	2	23
Offshore liquified natural gas terminals	39.5 % (17 out of 43)	0	26	0
Anchorages	39.5 % (17 out of 43)	1	0	25
Offshore airports	37.2 % (16 out of 43)	0	27	0
Carbon sequestration	37.2 % (16 out of 43)	0	27	0
Recreational wildlife watching	37.2 % (16 out of 43)	2	25	0
Coastal observation system	34.9 % (15 out of 43)	28	0	0
Game hunting of seabirds	32.6 % (14 out of 43)	28	0	1
Former mined areas	32.6 % (14 out of 43)	28	1	0
Areas of dumped explosives	32.6 % (14 out of 43)	29	0	0
Bathing sites	32.6 % (14 out of 43)	29	0	0
Marine protected areas	30.2 % (13 out of 43)	2	28	0
Offshore industrial production facilities	30.2 % (13 out of 43)	21	9	0
Scientific research	30.2 % (13 out of 43)	21	9	0
Dredging including harbour dredging and maintaining shipping routes	23.3 % (10 out of 43)	28	5	0
Tourism and recreation	20.5 % (9 out of 44 - conflicts with itself)	24	1	10
Fossil fuel energy production including power stations, gas and petroleum production and treatment, and coal unloading piers	20.5 % (9 out of 44 - conflicts with itself)	25	0	10

Protection of birds / RAMSAR	20.9 % (9 out of 43)	27	0	7
Areas for fish regeneration: Artificial reefs/ islands – concrete, shipwreck. etc.	20.5 % (9 out of 44 - conflicts with itself)	28	0	7
Protection of benthic habitats	20.9 % (9 out of 43)	28	0	6
Coastal landscape protection	20.9 % (9 out of 43)	31	3	0
Ocean desalination plants	18.6 % (8 out of 43)	0	29	6
Hydropower (wave parks and tidal energy production)	9.30 % (4 out of 43)	34	5	0
Recreational sailing including boating and personal watercraft	9.30 % (4 out of 43)	21	11	7
Wind farms	9.30 % (4 out of 43)	35	4	0
Diving	4.65 % (2 out of 43)	28	9	4
Pelagic trawling	4.65 % (2 out of 43)	33	6	2
Benthic trawling (including trawling in general)	4.65 % (2 out of 43)	34	5	3
Offshore oil and gas development including oil platforms and oil loading/ unloading terminals	2.33 % (1 out of 43)	32	6	4
Finfish and shellfish mariculture	2.27 % (1 out of 44 - conflicts with itself)	32	8	2
Algae and mussel aquaculture	2.33 % (1 out of 43)	32	8	2
Protection of cultural heritage including shipwrecks and sites	2.33 % (1 out of 43)	33	7	2
Deposit areas for dumping	2.33 % (1 out of 43)	33	5	4
Extraction/ mining of sand and gravel	2.33 % (1 out of 43)	33	5	4
Exploration of hydrocarbons including oil, gas and petroleum	2.33 % (1 out of 43)	33	6	3
Recreational, small scale, and sport fishing	2.33 % (1 out of 43)	33	6	3
Harbours/ ports including operations	2.33 % (1 out of 43)	33	6	3
Military training and activities	2.33 % (1 out of 43)	33	6	3
Commercial fishing (not trawling)	2.33 % (1 out of 43)	35	5	3
Cables and pipelines for gas, petroleum, communication etc.	0 % (0 out of 44 - conflicts with itself)	32	8	4
Shipping	0 % (0 out of 43)	36	4	3

11 Ocean coverage of marine use data

This section provides documentation on the ocean coverage of the inputted HELCOM Baltic Sea marine use GIS-data.

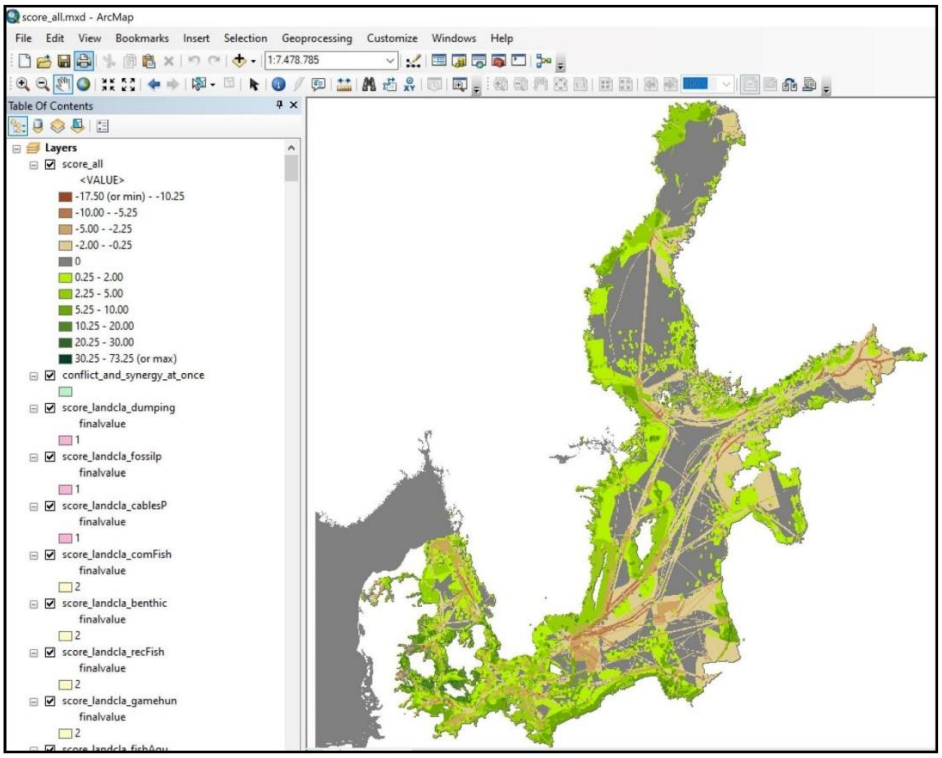
***Marine use ocean coverage table**. Marine use ocean coverage of the individual marine uses in the HELCOM-based Baltic Sea case study. The full Baltic Sea is made up by 505,136 raster cells, covering 21.75 % of the whole template raster of the Baltic Sea Region (the rest of the 1624 rows x 1430 column template raster cells are land).*

Marine use raster	Coverage in absolute number of raster cells	Percent ocean coverage
Commercial fishing (not trawling): comFish.tif	383,037	75.83 %
Nature protection including Natura2000: natureProtection.tif	185,636	36.75 %
Recreational, small scale, and sport fishing: recFish.tif	127,696	25.28 %

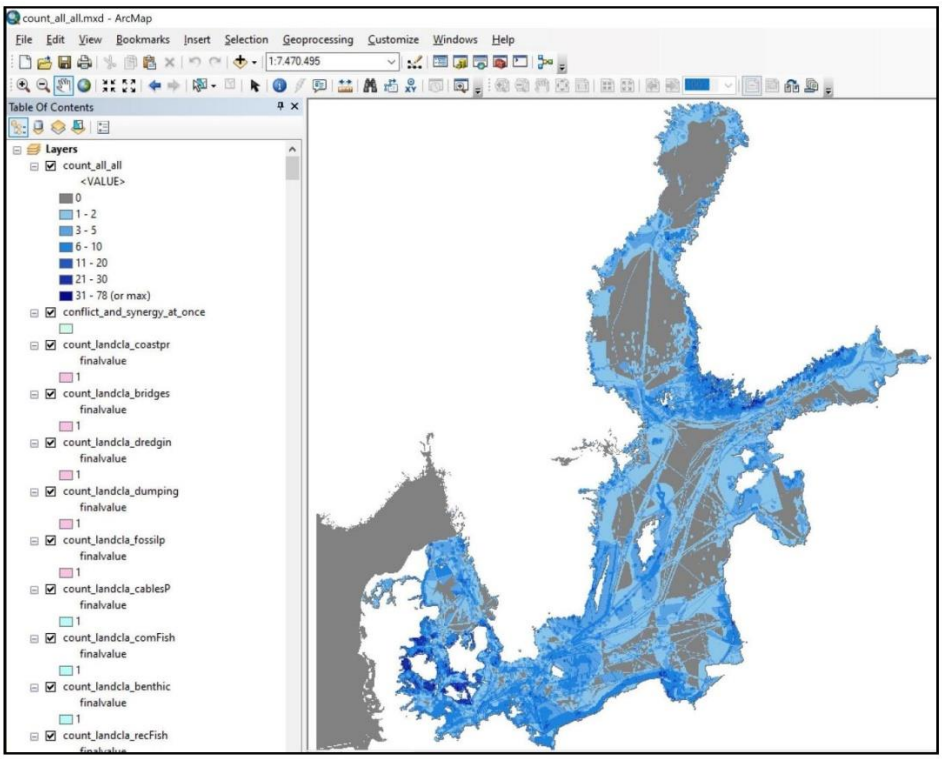
Shipping: shipping.tif	68,475	13.56 %
Marine protected areas: MPAs.tif	65,361	12.94 %
Recreational sailing including boating and personal watercraft: boating.tif	36,678	7.26 %
Game hunting of seabirds: gamehuntingSeabirds.tif	36,519	7.23 %
Benthic trawling (including trawling in general): benthicTrawling.tif	29,171	5.77 %
Cables and pipelines for gas, petroleum, communication etc.: cablesPipelines.tif	25,016	4.95 %
Waste disposal/ outlets of e.g. waste water: wastedisposal.tif	24,484	4.85 %
Pelagic trawling: pelagicTrawling.tif	19,486	3.86 %
Protection of birds / RAMSAR: birdProtection.tif	18,545	3.67 %
Harbours/ports including operations: harbours.tif	15,862	3.14 %
Areas of dumped explosives: explosives.tif	11,464	2.27 %
Areas for fish regeneration: Artificial reefs/ islands - concrete, shipwreck. etc.: fishClosure.tif	8,101	1.60 %
Dredging including harbour dredging and maintaining shipping routes: dredging.tif	7,147	1.41 %
Coastal landscape protection: coastprotection.tif	5,117	1.01 %
Bathing sites: bathing.tif	1,630	3.23 ‰
Extraction/ mining of sand and gravel: sandextract.tif	1,269	2.51 ‰
Bridges: bridges.tif	1,093	2.16 ‰
Deposit areas for dumping: dumping.tif	852	1.69 ‰
Diving: diving.tif	639	1.27 ‰
Protection of cultural heritage including shipwrecks and sites: cultHeritage.tif	559	1.10 ‰
Finfish and shellfish mariculture: fishAquaculture.tif	376	0.744 ‰
Wind farms: windfarms.tif	372	0.736 ‰
Fossil fuel energy production including power stations, gas and petroleum production and treatment, and coal unloading piers: fossilprod.tif	339	0.671 ‰
Land claim: landclaim.tif	183	0.362 ‰
Algae and mussel aquaculture: musselfarms.tif	69	0.137 ‰
Hydropower (wave parks and tidal energy production): hydropower.tif	54	0.107 ‰
Offshore oil and gas development including oil platforms and oil loading/ unloading terminals: oilgasdev.tif	41	0.0812 ‰

12 Map output examples

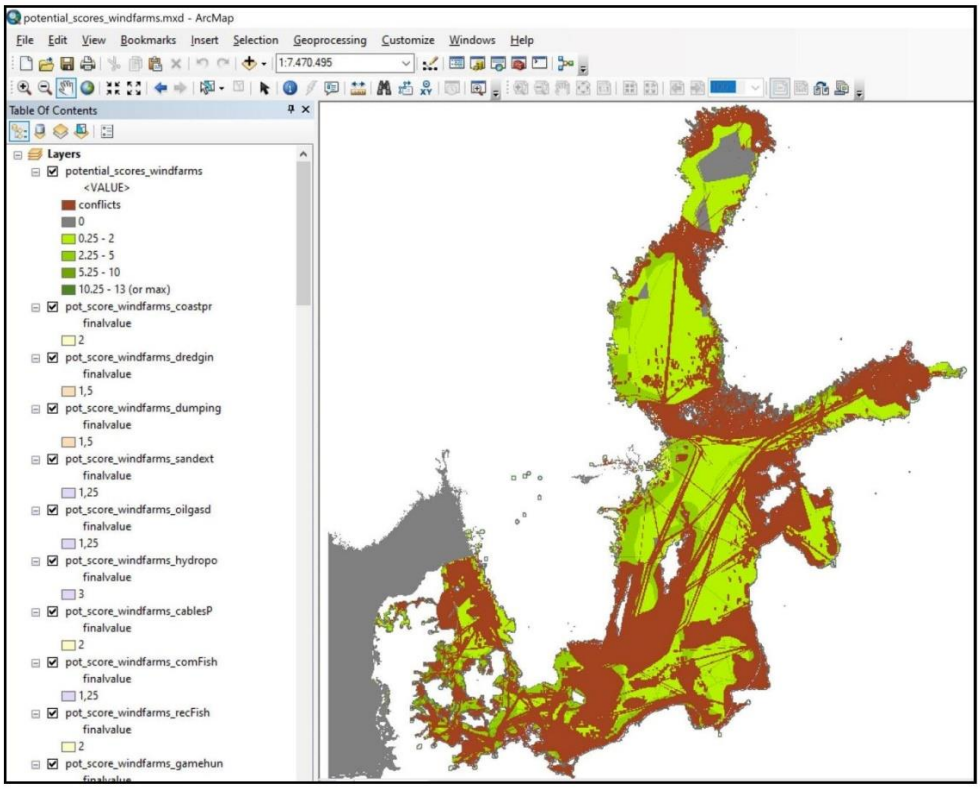
This section provides examples of map outputs of the five spatial SEANERGY tool.



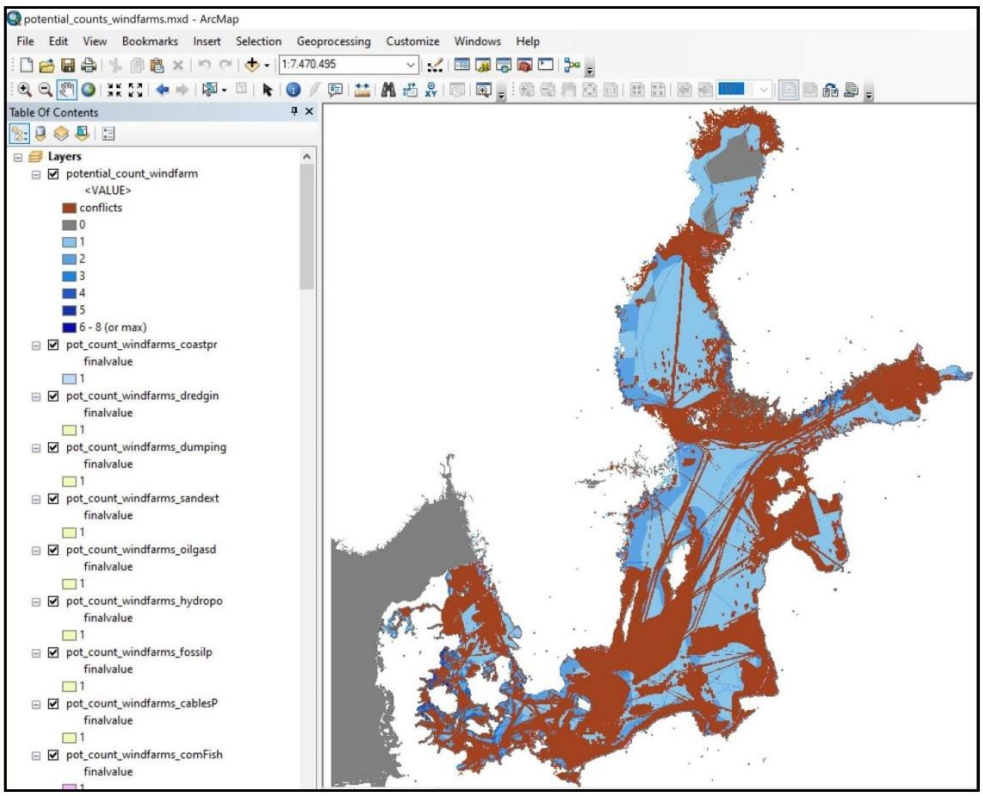
***Total conflict-synergy score map example**: Total conflict-synergy score map calculated for the Baltic Sea area based on the inputted HELCOM marine use data with the tool 'Calculate Score Map'.*



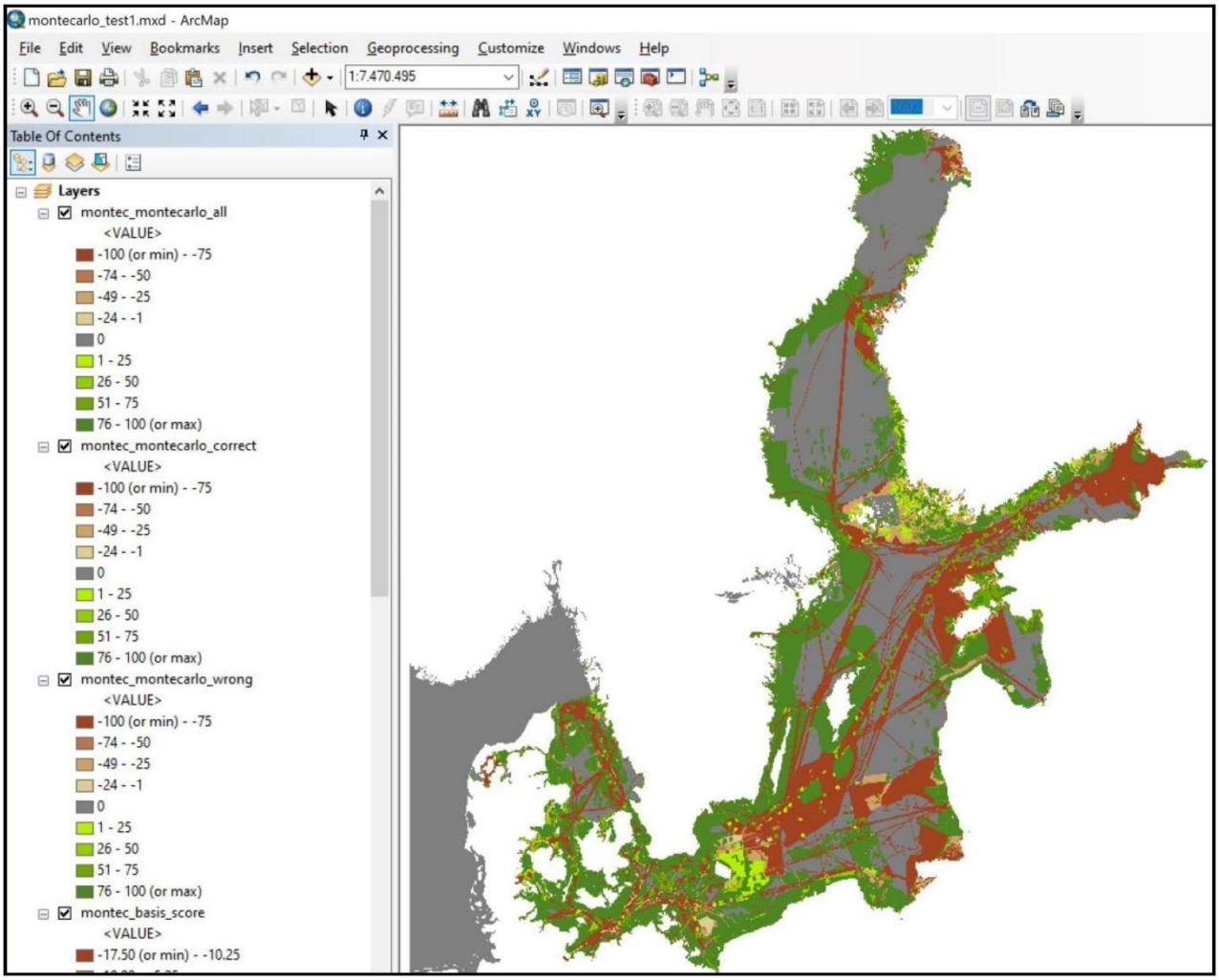
***Total pairwise overlap count map example**: Total pairwise overlap counts calculated for the Baltic Sea area based on the inputted HELCOM marine use data with the tool 'Calculate Count Map'.*



***Total potential synergy score map for locating new wind farms example**: Total potential synergy score map for new wind farms calculated with the tool 'Find Synergy Potential Scores For New Marine Use'. The darker the green, the higher total potential synergies. The red areas mark areas where windfarms would experience potential conflicts.*



***Total potential synergy count map for locating new wind farms example**: Total potential synergy count map for new wind farms calculated with the tool 'Find Synergy Potential Counts For New Marine Use'. The darker the blue, the more potential synergies. The red areas mark areas where windfarms would experience potential conflicts.*



***Monte Carlo output example**: Monte Carlo output example from the tool 'Monte Carlo Score Map Iteration'. The scale from -100 to 100 represents the times each raster cell has returned a positive total conflict-synergy score minus the times it has returned a negative total conflict-synergy score. In this case, the first Monte Carlo uncertainty test option was chosen.*

13 Options to change case study and/or conflict-synergy inputs

To change case study, the following information needs to be changed:

- The marine use raster data in the folder "data_inputs" should be replaced with marine use raster data for the new case study are.
- The Baltic Sea ocean raster template in the folder "extra_inputs" should be replaced with a similar template for the new case study area.
- The excel file "marine_uses_linked_to_rasternames.xlsx" should be updated so the raster names listed in the file match the raster names of the chosen input data.
- If other data is used, the lyrfiles in the folder "extra_inputs" might need to be changed with new, more suitable symbology styles. However, these are voluntary inputs, so they can also just be ignored by the user.

To change conflict-synergy score inputs in the excel file matrix, the following information needs to be updated:

- The matrix descriptions and scores can be updated manually by the user in the excel file “matrix_conflicts_synergies.xlsx”. It is a requirement that the scores are listed as the first thing in each description cell, and that conflicting scores are stated as negative numbers.
- If the scoring scale presented in the “synergy-conflict score table” in the “matrix content documentation” section is changed, the new scores are all required to have a comma as decimal separator as well as specifically three numbers in total before/after the decimal separator. Otherwise the Python codes need to be updated to handle other types of score formats – specifically this code snippet would then need to be changed all the times it occurs in the five following Python scripts; producescoremap.py, producecountmap.py, scoresynergypotentialfornewmarineuse.py, countsynergypotentialfornewmarineuse.py, and montecarlotest.py. The code snippet that would need to be changed: *spec_score = float(alldesc[:x].replace(",","."))* where x is the number of signs in the score.
- If the scoring scale presented in the “synergy-conflict score table” in the “matrix content documentation” section is changed, the following might need adjustments to the new chosen scoring scale:
    - If the tool “Calculate Count Map” should be run, the Python code part #parameter14 = chosen category” in the Python script “producecountmap.py” should be updated to match the new scoring scale. Furthermore, the “value list” for the parameter “Synergy-conflict category to base count on” for the tool “Calculate Count Map” should be changed to match the new scoring scale.
    - If the tool “Monte Carlo Score Map Iteration” should be run, the Python code parts “# test score input variability” and “# test relative difference of scores” in the Python script “montecarlotest.py” should be updated to match the new scoring scale.

To change marine use categories in the excel file matrix, the following information needs to be updated:

- The marine use categories can be updated manually by the user in the excel file “matrix_conflicts_synergies.xlsx”. It is important that the new category names are the same in the horisontal marine use category column and in the vertical marine use category column. Furthermore, the order of marine use category list should be the same for both the vertical column and the horizontal column, a rule that is in place for the currently listed categories.
- If the marine use categories are updated in the matrix excel file, they should also be updated in the excel file “marine_uses_linked_to_rasternames.xlsx”.