NEAT – Nested Environmental status Assessment Tool

Manual – Version 1.3

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Contents

1. Introduction

1.1. Overview

The NEAT (Nested Environmental status Assessment Tool) software is a flexible and user-friendly desktop application implementing the biodiversity assessment tool developed in work package 6 (Integrative assessment of biodiversity) of the DEVOTES project (http://www.devotes-project.eu).

The current version integrates an indicator catalogue (Teixeira et al. 2014) as a source for choosing predefined indicators for the biodiversity assessment. These indicators are the same as those present in the version 7 of the DEVOTool software (http://www.devotes-project.eu/devotool). Four different setups are preconfigured for the use in the four European Regional Seas, showing only the indicators which have been assigned to the respective Sea according to Teixeira et al. (2014). A custom configuration is also possible.

The software will be continuously enhanced with features allowing users to modify various aspects of how the tool arrives at the environmental status of a given spatial assessment unit (SAU). This requires knowledge of the inner workings of the tool and an understanding of the assessment method. Users, who just want to use the tool with the predefined settings, can arrive at the environmental status of a SAU by choosing the marine region, entering the assessment values for the indicators chosen (along with an uncertainty measure and the classification scale) and hitting a button which then starts the calculations and shows the resulting status assessment. The mechanics (algorithms and intermediate calculations) behind this are partly hidden from the user, although future version will allow viewing these data.

The name of the tool „NEAT Nested Environmental status Assessment Tool" is a reflection on the adjective „neat" which can have meanings such as „clean", „bright" or „shining". This reflects the fact that NEAT is a step forward compared to other holistic assessment systems in that it goes a long way to ensure a clean implementation of aggregating various different indicators in a comparable and systematic way. As an example, NEAT avoids the dominance of certain indicators or habitats or spatial units by a proper weighting procedure. Thus, no bias is introduced into the assessment by the choice of the indicators.

Although this version is implemented with biodiversity status assessment in mind, it is, however, not principally restricted to status assessment. The assessment principles used in NEAT are universal and can easily be adapted to other assessment types such as pressure assessments. Further details on the assessment method behind NEAT can be found in Andersen et al. (2017).

1.2. Principles of NEAT

1.2.1. Weighting

The central principle in the NEAT method is a hierarchical, nested structure of spatial assessment units (called SAU in the software and the remainder of the report) and habitats. In later releases, this will be expanded to ecosystem components. The order of these hierarchies is such that the assessment begins with the hierarchically nested SAUs. Figure 1 shows an example of such a hierarchy.
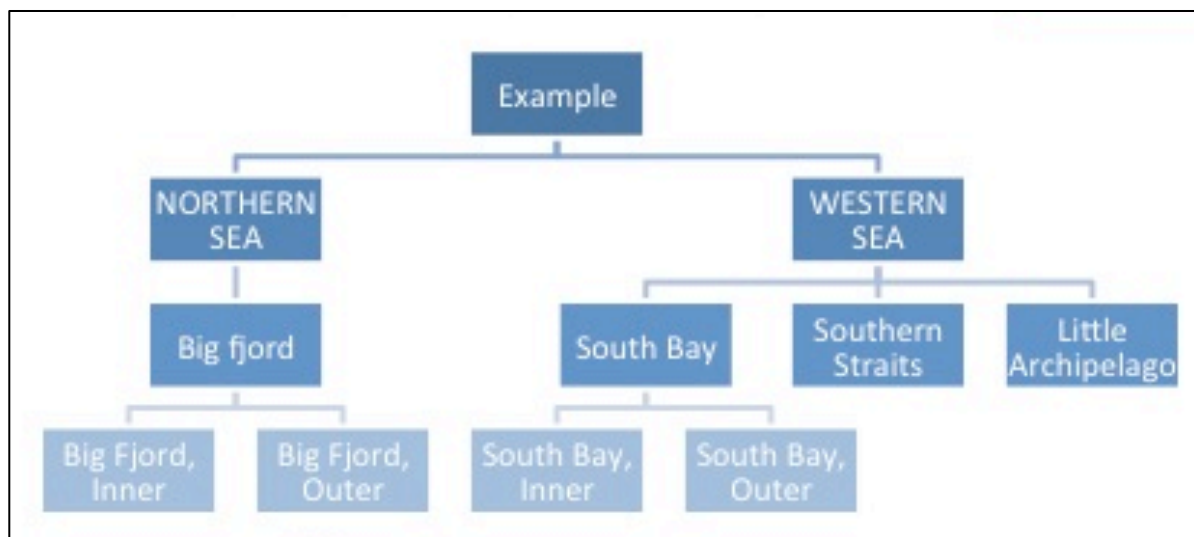
Figure 1. Example of spatial assessment units (SAUs) that are nested and hierarchically structured. The SAUs on the higher level always comprise all the units below in the hierarchy.

For each of these SAUs, one or more habitats can be assigned. Thus, a specific SAU (e.g. a regional sea or an individual bay) can be divided into several adjacent or disparate habitats. These habitats are themselves nested and hierarchically structured so an indicator can be assigned to one individual habitat or to more than one habitat comprising all habitats from the hierarchical levels below. As such, the habitats can be seen as special kinds of SAUs that are not solely geographically defined but additionally carry information about the abiotic conditions which are the basis for the animal or plant communities inhabiting them. This is important since indicators on biodiversity typically are designed around specific species or communities which spatially are located in their own habitats.

Each of the habitats (or rather SAU/habitat combinations) is then used to assign various indicators to. These indicators are often specific to individual species or biotic communities.

In this way, the assessment uses the natural order of different levels of detail on ecosystem features, and „zooms in" on the interesting features. On the highest level is the SAU that is of interest as the unit of assessment. The assessment will always strive to assess a geographically bounded space. Within this space, several living spaces can be delineated, which have different characteristics and behave in specific ways. These are the habitats within the SAU. Inside these habitats, the living organisms are found, interacting with their habitat and with each other. These are the targets of the indicators. As biodiversity is an abstract concept that cannot be measured directly, we use indicators instead to measure various aspects of what biodiversity is being represented by.

When the assessment structure is designed in the way described, the indicators are the leaves of a larger tree-like structure where the SAUs are the roots and the habitats connect the ecosystem components assessed by the indicators with their SAUs. A special weighting procedure then makes sure that no individual branch of this tree can dominate the others. This weighting is done on all levels of the tree. It can be done using the area of the SAUs and their habitats or by weighting these equally. As an example, in typical indicator aggregation, having four indicators on benthic fauna and one on plankton, means that the plankton indicator typically is not able to have a larger influence on the result anymore. The assessment would be dominated by the many benthos indicators. In NEAT, the weighting is not on the indicators, but instead on the SAUs and habitats as the important ecosystem features to assess.

At the same time, NEAT reduces the risk of bias in an assessment coming from the use of many tightly correlated indicators on the same issue, because the weighting is hierarchical. If there is more than one indicator on a SAU/habitat-combination of an ecosystem component, the weight is evenly

distributed among those indicators to make sure that the total weight of this SAU/habitat-combination is not exceeded.

The nestedness and the hierarchical structure also make sure that NEAT by design can cope with different spatial scales for the individual indicators. Each indicator can be attached to any of the SAUs regardless of its position in the hierarchy.

1.2.2. Aggregation

In order to aggregate all these individual indicators, their measured values must be on the same scale. This version only allows the use of a 5-class scale (bad, poor, moderate, good, high). Future releases will be more flexible with respect to the choice of assessment class boundaries. Each indicator can have its own set of class boundaries and its own specific indicator scale. It is even possible to have individual indicator scales for every SAU and every habitat. This is often needed when the area to be assessed is large and comprises many biogeographically different parts. Then, typically the indicator scale and class boundaries are individually adapted to the local situation.

A common scale is achieved by using the custom boundaries of the indicators and transforming them piecewise (linearly) onto a normalized common scale. This common assessment scale is defined as follows:

$0 <= bad < 0.2 <= poor < 0.4 <= moderate < 0.6 <= good < 0.8 <= high <= 1$

On the common assessment scale all five classes are equally broad (0.2 units) and e.g. the moderate class contains all values equal or above 0.4 and all values less than 0.6. This compact notation is also used in the NEAT software. Later versions of the software will also allow for other classification schemes and numbers of classes. The Good Environmental Status (GEnS) threshold on the common assessment scale is the boundary between the moderate and the good status.

By default, aggregation is done across all indicators belonging to a SAU. However, NEAT is designed to do aggregation to any other entity. For example, the method can be used to aggregate all indicators of a SAU and show the status divided among the different ecosystem components of the SAU. Also, the order of aggregation is in principle not a fixed one. While currently the weighting, and thus the aggregation, is done from the SAU, to the habitat and finally to the ecosystem component, other orders are possible.

1.2.3. The resulting NEAT value

In essence, the NEAT value is the weighted average of all indicators belonging to a specific group. The normalized indicator values are weighted according to the principles described above and finally their average (arithmetical mean) is taken. Future versions will also support other aggregation rules. The NEAT value can be calculated at different levels. E.g. it can contain all indicators belonging to a certain set of descriptors. The NEAT value is interpreted as the environmental status for this specific descriptor(s). Another result can be the NEAT value of a specific ecosystem component, habitat or SAU.

1.2.4. Uncertainty propagation

Alongside the indicator value, an estimate or calculated value of the error of the indicator value must be entered. This error value is interpreted as the standard error by NEAT. The indicator value and its standard error are used to perform a Monte Carlo simulation and repeat the assessment multiple times using these simulated values. The error then propagates through the assessment scheme and leads to different NEAT values in each simulation. As a result, this leads to a quantitative estimate of uncertainty for the original NEAT value, expressed e.g. as the percentage of values falling into the five different assessment classes.

1.3. A word of caution

This report describes the version 1.3 of the NEAT software. Although it has been created using great care and extensive testing, it is likely to still have bugs. Use this software at your own risk. Make backups of your data files regularly if you have entered large amounts of data which you do not want to corrupt due to bugs in the software.

Some (technical) issues and limitations are known and listed below. These will be addressed in the next releases:

- Forms for indicators, habitats, etc.: While these forms do show various metadata, stemming from DEVOTool, the editing capabilities of DEVOTool have not yet been transferred completely to NEAT. Especially, the "Analyses" features are not present. Use DEVOTool for this until those features have been included.
- When resizing the different windows with the mouse (e.g. making them smaller), certain control elements (such as buttons or entries) may disappear from the view.
- In the biodiversity assessment window, there is only space for 9 entries and any further items will be off the visible part of the window. You can make the window larger to see more entries or you can scroll through the list with the mouse wheel. This window layout is a draft and will be enhanced for better user experience in the next versions.
- In the application menu in the main window and its sub menus, when clicking into the white space below the last entry, the action from the last entry in the menu will be executed (thus, in the main menu, the application will quit).
- Tables: The separator lines between the columns do not update properly when using the scroll function of the Magic Mouse (on OS X). Workaround: either use the scrollbars or click onto the scrollbar to update the separators). A similar phenomenon is visible using the Windows version. This will be fixed in a future update.
- The software has not been optimized for speed yet.

Please report the bugs you find to neat@marilim.de, best accompanied with a detailed description of the steps reproducibly leading to the error and the numerical error information presented when the error is reported by the application (Figure 2). We will try to solve issues as quickly as possible and release updates regularly as needed.
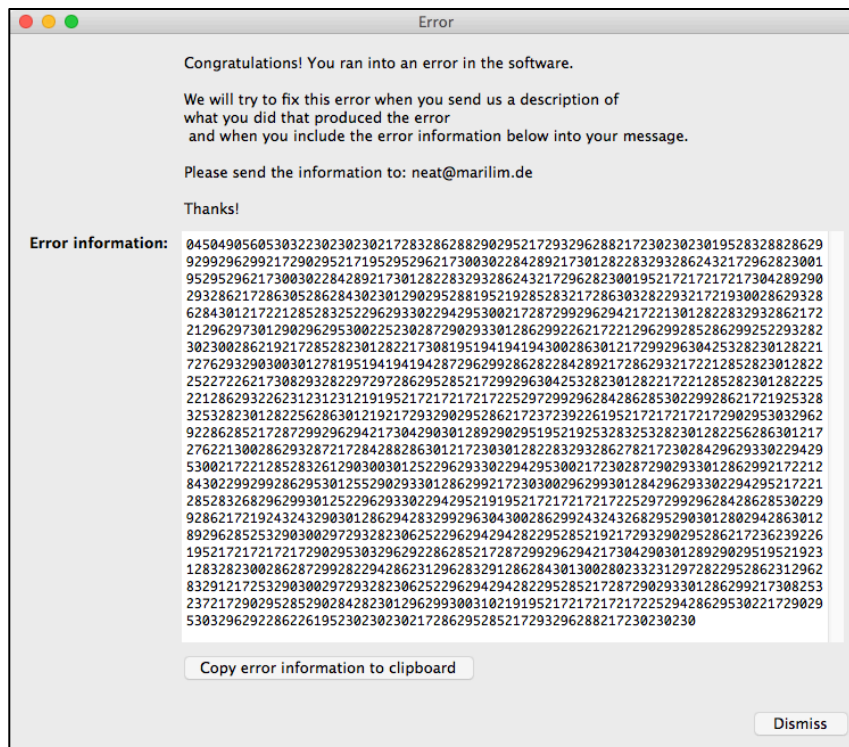
Figure 2. Window in the application showing the error information. When you run into errors, please include the numerical error information along with your error description. You can copy the numerical error information to the clipboard for easy transfer into your mail program by clicking on the button under the information field.

1.4. Version history

1.4.1. Changes from version 1.2 to 1.3

- Change: Greatly simplified adding/editing new indicators and their classifications (e.g. no need to enter habitat/ecosystem components separately)
- Change: Changed appearance of the assessment form to reflect simplifications
- New: Added support for indicators having bell-shaped functions
- Change: Changed wording of 'uncertainty' in assessment result since the bars represent 'confidence'
- New: Show individual uncertainty data for assessment results (the numbers making up the confidence bars)
- New: The confidence bars can now be displayed having colours according to the class they belong to
- New: Show indicator name in indicator's edit window
- New: Added indication on main window about the open dataset (internal dataset or externally opened file)
- New: It is now possible to switch back to the internal dataset when an external data file was opened
- New: Added a new choice in the main menu to view and edit the (literature) references
- Fixed: Corrected errors when editing indicators and closing windows using the buttons in the title bar (thanks to the users reporting this issue)
- Clearer specification of software licence terms (see section 2 for the current licence)

1.4.2. Changes from version 1.1 to 1.2

- Update: software tested under Windows 10 and running fine
- New: assessment aggregation to higher-level SAUs (this is now the default, while in version 1.1 the (invisible) default was no aggregation)
- New: display NEAT values aggregated to the habitats (in version 1.1 only aggregation to ecosystem components was possible)
- New: it is now possible to do sensitivity analyses of the results of an assessment (see section 5.5 in this manual)
- New: interface for the deployment of separate Add-ons providing specific functionality
- Fixed: double-cklicking on an item in the SAU/habitat/eco forms would raise an error, now it starts editing the item
- Change: the menu item "Import data …" has been renamed to "Open external data file …" as it does not import (i.e. merge) data into the users data pool
- Fixed: the deletion of more than one indicator failed, but is now possible
- Fixed: importing an external data file would sometimes fail due to a missing modification time stamp in the date, this is now fixed
- Fixed: in complex assessments, some NEAT values for certain ecosystem components would not be shown in the results table, this is now fixed
- Fixed: using the right mouse button on Windows to manage assessments (copy, rename, delete) did not work with 3-button mice, this is now corrected
- Fixed: it was not possible to type a minus sign as the first character of a class boundary when adding a negative value to an assessment scale, this is now allowed
- Fixed: The handling of indicator combinations when editing them in an assessment was not properly updating in the list view of the combinations
- Fixed: Online update did not work properly, especially on Windows

1.4.3. Changes from version 1.0 to 1.1

- New: online update and version history functionality
- Fixed: wrong uncertainty calculation when more than one indicator was assigned to the same SAU in an assessment

2. Licence agreement

Under this Software Licence Agreement, the DEVOTES project grants the licensee, herein also called the "user", a non-exclusive and non-transferable licence to use the NEAT software, herein called the "software".

The NEAT software includes the executable computer program, its executable software libraries and data files and any related printed, electronic and online documentation and any other files that may accompany the product.

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DEVOTES and MariLim warrants that the software will provide the features and functions generally described in the product specification on our website and in the product documentation.

DEVOTES and MarLim have taken reasonable steps to keep the software free of viruses, spyware, "back door" entrances, or any other harmful code. DEVOTES and MarLim will not track or collect any information about the users of the software, the data used, or the use of the software except when specifically authorized, e.g. when submitting bug reports. The software will not install patches, upgrades or any third party software without explicit permission.

If any part of this licence agreement is found to be invalid or unenforceable, the remaining terms will stay in effect. This agreement does not prejudice the statutory rights of any party dealing as a consumer.

In any publication or report, produced by the user and using the software, the author of the publication must include an acknowledgment section with this text: "We thank DEVOTES (DEVelopment Of innovative Tools for understanding marine biodiversity and assessing good Environmental Status) project, funded by the European Union under the 7th Framework Programme, 'The Ocean of Tomorrow' Theme (grant agreement no. 308392, www.devotes- project.eu) for the permission of use of NEAT and associated data".

This agreement will apply from the date of the installation of the software.

3. Installation

The NEAT software is provided as a zip file for the Windows operating system (Windows XP and newer) and as a dmg (disk image) for the OS X operating system (versions 10.5 to 10.11; 10.12 not yet tested).

No special installation is needed, the software is self-contained. To install, follow the steps below for the platform you are working on:

For Windows:
- Unpack the zip file
- Save the application file „NEAT.exe" somewhere (just where you like, typically the application folder)
- You can now delete the zip file, as it is no longer needed

For OS X:
- Mount the dmg file (by double-clicking)
- Drag the application file „NEAT" to your Applications folder (or wherever you like)
- Unmount the dmg when the copying has finished. You can now delete the dmg file, as it is no longer needed

The next steps are the same for both platforms:
- Start NEAT (e.g. by double-clicking the application icon)
- The program should start and show the main window

Removing the software

The software leaves no trace on the hosting computer apart from the application file, one library file, the data files of the user (default data file: neatdata.db) and one configuration file. If you wish to remove the software from your computer, just delete the executable application file, your data files and the „neat" folder located here, that holds the configuration file, the application library and the standard data file:

Windows: $env(APPDATA)/MariLim/neat/
Typical location: C:\Documents and Settings\your username\Application Data\MariLim\neat
(The location on Windows will vary, but you can identify the right folder by searching for the string '%appdata%' in the address box of the Windows Explorer)

OS X: $env(HOME)/Library/Application Support/MariLim/neat/

If you do not use other software from MariLim, you can also remove the „MariLim" folder.

3.1. Updates

New versions of the software will be made available on the DEVOTES project webpage http://www.devotes-project.eu/neat. When you have installed the software, it will check for updates on the update server using the internet connection of the computer (if available) every time the software is launched. When updates are available, they can (by choice of the user) be downloaded and installed from within the application. The application may need to restart after the update process.

In addition, you can always manually check for updates, choosing "Software update …" from the main menu. A version history, showing all the installed updates with their details can be shown by clicking the menu item "Version history …".

Important note for users of version 1.1: Due to an error in version 1.1, the version 1.2 is *not* available via online update (if you have version 1.1 installed already). This is also stated in the corresponding window when trying to update from within the software. You will need to download the version 1.2 directly from the DEVOTES website at http://www.devotes-project.eu/neat and install it using the instructions in section 3. This new complete version will automatically install over your previous version 1.1, keeping all your data, but updating the software to version 1.2. This will ensure that online update is working properly for all newer versions.

4. Main window

The main window of the NEAT software is kept very simple by design (Figure 3). It gives you direct access to the main functions of the software. Clicking on one of the entries in the menu on the right will bring you either to another menu level (menu items with an „>" arrow right of the text) or to another window (menu items with „…" right of the text). When another window opens, the current window (including the main window) will be hidden so the user does not end up with a cluttered set of windows. Closing a window will take the user back to the previous or the main window. Clicking the last menu item named "Exit" on the main menu will quit the application. Closing the main window will also quit the application.
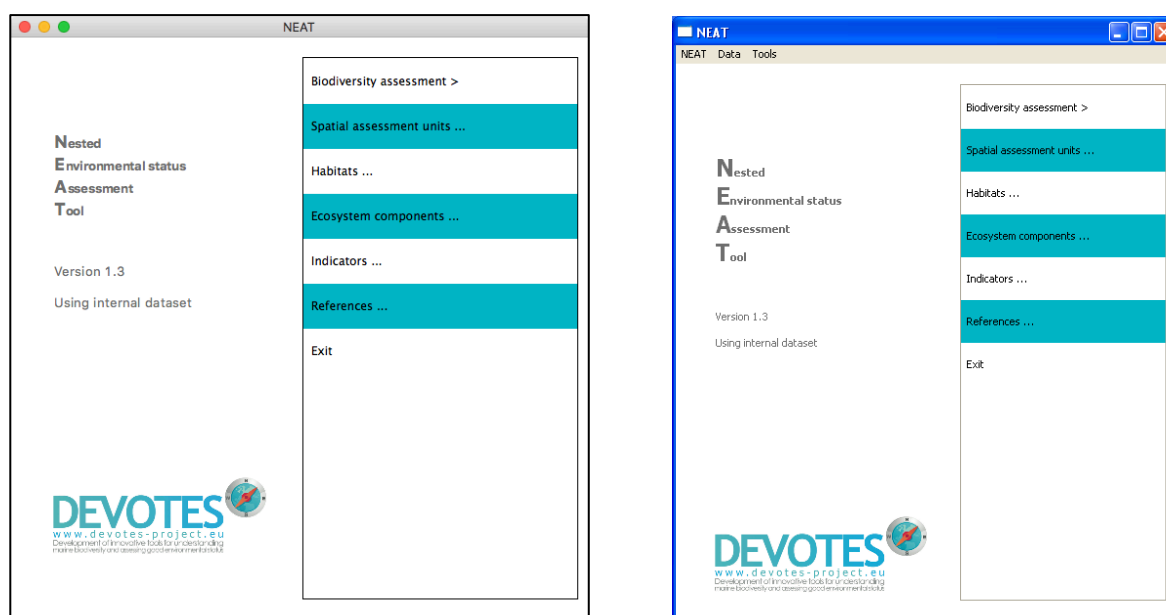

Figure 3. Main window of the NEAT application (OS X version on the left, Windows version (XP) on the right). All further screenshots (sometimes taken from older NEAT versions) are taken from the OS X version but look similar and work identically on Windows.

When a new menu level is chosen (in the case of the main window, this is only „Biodiversity assessment"), the menu changes and shows the items of the sub-menu. At the top of the menu, some of the items will have an orange background. These items refer back to the previous and the top-level menu.
In this version, six functions are available from the main menu (apart from quitting the application). Future versions will have more functions (e.g. other kinds of assessments) or other entry points into the assessment functionality (such as „environmental pressures").

4.1. Sharing assessments

The data you have stored in NEAT can be shared with other users and the data can also be backed up. To do this, you must choose „Data > Export data …" from the application's menu bar (Figure 4). To load another user's data or previously exported data, choose „Data > Open external data file …".
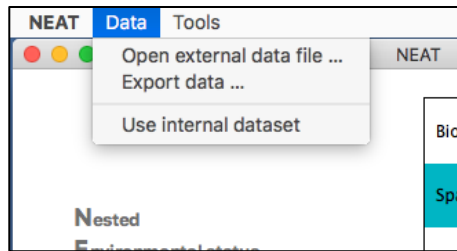
Figure 4. Menu bar function to load external data files, to export data and to go back to the internal data if some external file had been opened.

Note: This function is only possible when the main menu is chosen in the main window. Otherwise, the function is disabled. This is in order to ensure all changes to assessments have been saved before changing the data file.

4.1.1. Opening external data file

When loading an external data, you will be asked to pick the data file. Before loading other's data, your own database will be closed. Opening another user's data does not mean that those data will be merged with your own. When finished with the external data, changes will be saved to the original external file. To return to your builtin data, just quit the application and restart it.

4.1.2. Exporting data

When exporting data, you will be asked for the location where the data file should be saved. All data in your database will be exported, including all indicators, assessments, SAUs, etc. Thus, another user will, when loading your data file, see exactly the same data and menu items as you do.
Note: If you have confidential data in your database that no-one should see, make sure they are deleted in the exported file, otherwise these will also be visible to other users. You can achive that by opening the exported data file and removing any unwanted content. (This will leave your own builtin data untouched).

4.1.3. Reverting to the original dataset

Once an external data file has been opened, you can go back to the internal data by choosing "Use internal dataset". On the left side of the main window, the name of the currently used dataset will always be displayed.

4.2. Ad-ons

The "Tools" menu has an entry for providing Add-ons that enhance NEAT with specific functionality not needed by all users. In later versions, some add-ons may be supplied along the NEAT software itself. Currently, there is only one add-on available internally in DEVOTES for easy import of legacy data from the software prototype.

5. Biodiversity assessment window

The „Biodiversity assessment" window of the NEAT software looks exactly like the main window apart from the changed menu items (Figure 5):
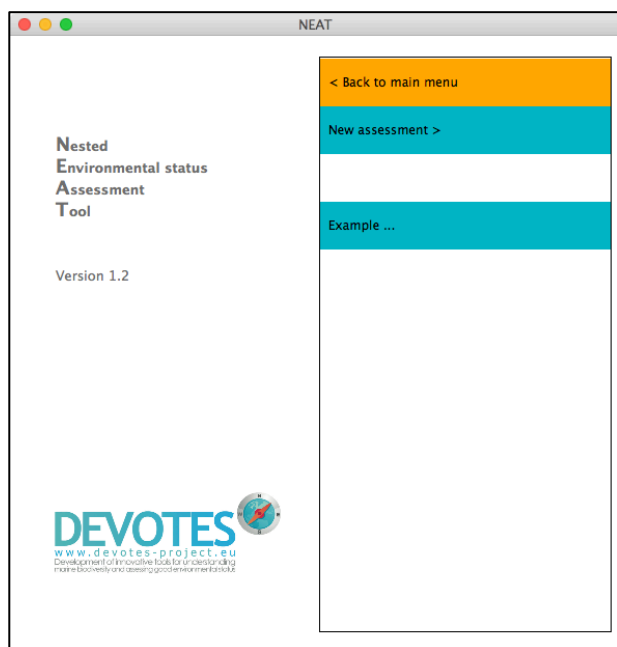
Figure 5. Main window with the menu for biodiversity assessments.

Note that the navigation items in the menu which refer back to higher-level menus, have an orange background colour. Below the two menu items that refer back to the main menu and to the sub-menu for creating a new assessment, initially only one additional entry is present named „Example …". This is a ready to use assessment with some example data. These data are shown in this manual to explain how the software is used. The data behind this example are fictional.

When you have created a new assessment and it has been saved later, it will be listed in this menu for easy access.

5.1. Managing existing assessments

Clicking on the entries with the names of the assessments using the right mouse button will show a small context menu (Figure 6). It allows you to copy, rename and delete assessments.
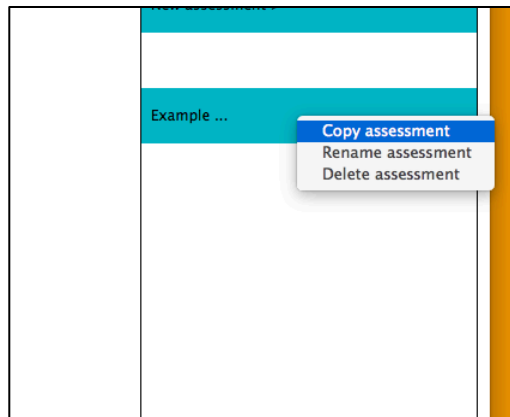
Figure 6. Context menu for existing assessments.

You can copy an existing assessment together with all the associated indicators, values and settings by choosing „Copy assessment". A new assessment will be added at the end of the list and its name will start with „Copy of „ followed by the name of the copied assessment.

Renaming an assessment is as easy as choosing „Rename assessment" and providing a new name for it. The old name will be shown in the entry field as a starting point for the new name.

Deleting an assessment and all its indicator data and settings is done by clicking on „Delete assessment". A dialog will appear to ask you whether you are sure and really want to delete. Note, that deleting an assessment will not delete any indicators (nor their classifications settings) that have been added from within the assessment. The indicators are stored centrally (see section 6.4) and are kept unless explicitly deleting them.

5.1.1. New assessments

In order to perform a NEAT assessment, three step need to be completed in the application:

1. Setup (see section 5.2)
In step 1, the configuration of the assessment is done. For the pre-configured assessment setups (one for each Regional Sea) this only involves defining the top-level SAU to use. For custom assessments, also the habitat hierarchy and the ecosystem components to use must be defined.
2. Indicator entry (see section 5.3)
In step 2, the indicator data must be entered. Either the pre-defined indicators can be used or new custom indicators can be entered. For each indicator used in the assessment, the measured/observed value and its standard error must be supplied. Further, the classification scale used for the indicator in each combination of SAU, habitat and ecosystem component must be present or entered once.
3. NEAT calculation (see section 5.4)
In step 3, the actual assessment is performed. Initially, a default set of options will be applied here. These can be altered (such as the weighting scheme or a filter setting) and the assessment is automatically repeated with these changed settings.
These three steps will be explained in detail in the next sections.

5.2. Creating a new assessment

A new assessment is created by choosing „New assessment >" in the „Biodiversity" sub-menu of the main menu. A new menu appears, where the type of assessment can be chosen.
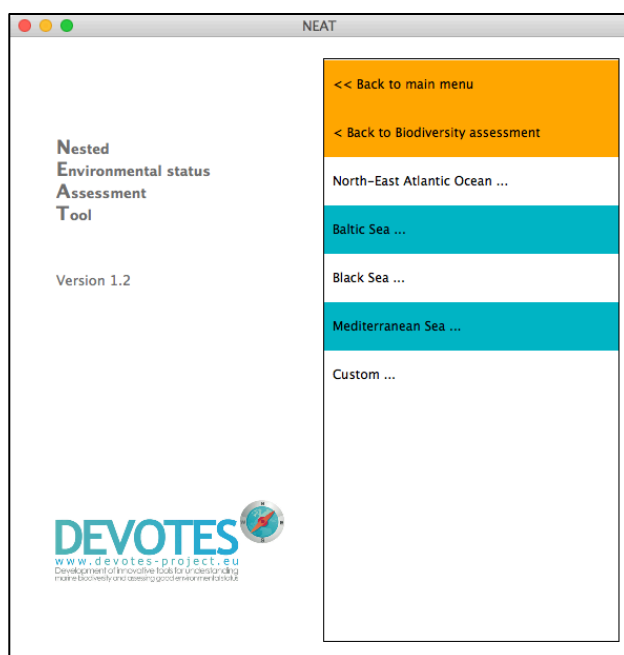
Figure 7. Main window with the menu to create a new biodiversity assessment.

5.2.1. Pre-defined biodiversity assessments

There are four pre-defined assessments, named after the four European Regional Seas. These are already set up for the user to contain the SAUs of the respective Regional Sea and the habitats used in DEVOTool and originally coming from the MSFD task group 1 report (Cochrane et al. 2010) (predominant habitat types). The ecosystem components are also set to the ones used in DEVOTool which are based on Cochrane et al. (2010) but supplemented with the non-mobile components used for descriptors other than D1 (Biodiversity).

The set of indicators presented for the pre-defined assessments is not restricted to the ones that are specifically associated to the respective Regional Sea although this association is available in the indicator catalogue. However, at the current stage these metadata are partly incomplete and many indicators will probably be useful for other regions as well.

Choosing one of these pre-defined assessments will take you directly to step 2 where data can be entered.

5.2.2. Custom biodiversity assessments

If none of the pre-defined settings are suitable, a custom set of settings can be used. For this, click the menu item named „Custom …".

This opens a dialog window with three choices to be made (Figure 8).
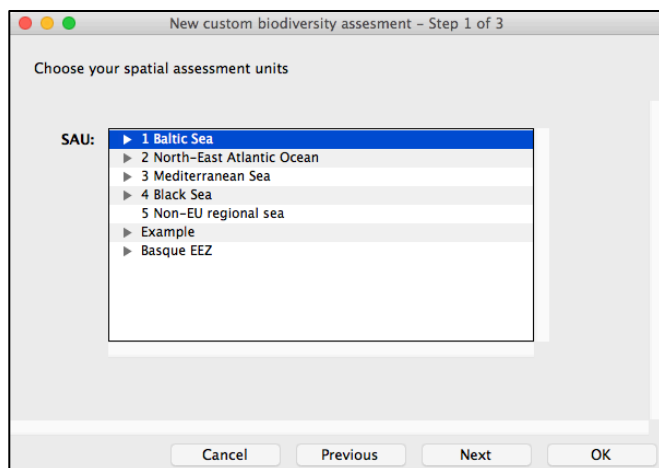
Figure 8. Step 1 of 3 when setting up a new custom assessment.

First, the SAU to be used for the assessment needs to be chosen. Here, you can choose any SAU hierarchy shown in the tree. Besides the four Regional Seas, this includes one entry for „Non-EU regional seas" that, however, does not have any subregions defined. The only other setting is the „Example" SAU which we will choose for this manual.

Note: You can also pick any other entry inside the different top-level SAUs. For example, you could choose the „3.2 Adriatic Sea" within the Mediterranean Sea and the resulting assessment would only consist of this SAU and its two subordinate entries (Northern and Southern Adriatic Sea). In general, picking a SAU means to include all subordinate, nested SAUs and exclude the ones not belonging to this particular branch.

Hint: You can define your own custom hierarchies of SAUs (see section 6), habitats (section 6.2) and ecosystem components (section 6.3).

Next, the kind of habitats to use needs to be specified (Figure 9). The choice follows the same principle as the choice of the SAUs. Besides the pre-defined set of habitats, only the „Example" habitats are initially available.
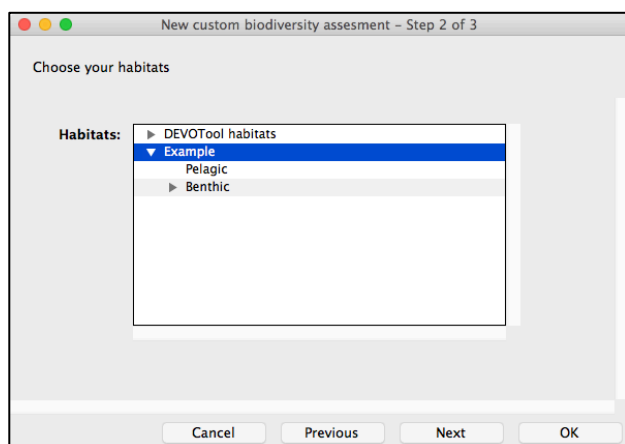
Figure 9. Step 2 of 3 when setting up a new custom assessment.

Last, the kinds of ecosystem components are to be specified (Figure 10). Again, the same principle as for the two former entities applies. Besides the pre-defined set of ecosystem components, only the „Example" set is initially available.
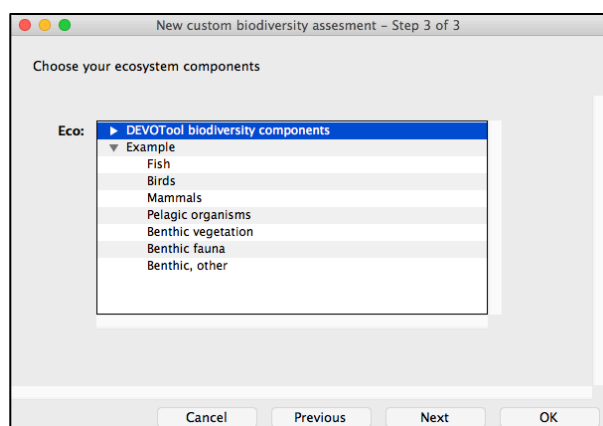
Figure 10. Step 3 of 3 when setting up a new custom assessment.

When you arrive at „step 3 of 3" in the dialog, the OK button can be pressed and the assessment is set up accordingly and opened for you.

At this stage, the assessment will not be saved yet. Only when closing the window that opens after this procedure (either by choosing „Close assessment" or by just closing the window using the window controls in the header), the application will ask, whether to save the assessment or not. Saving the assessment must only be done once, after creating a new assessment. When loading this assessment later and changing it, the assessment will automatically be saved when closing it.

5.3. Working with assessment items

When a new or existing assessment has been opened, a window appears. The upper part shows the assessment settings, i.e. the top-most SAU, habitat and ecosystem component chosen for the assessment. The lower part shows which indicators, habitats, SAUs and ecosystem compontens can be used in the assessment (left side of the window) and the value and standard error of the currently entered assessment items, if any (right side of the window) (Figure 11). For a new assessment, the list on the right side (assessment items) is initially empty.
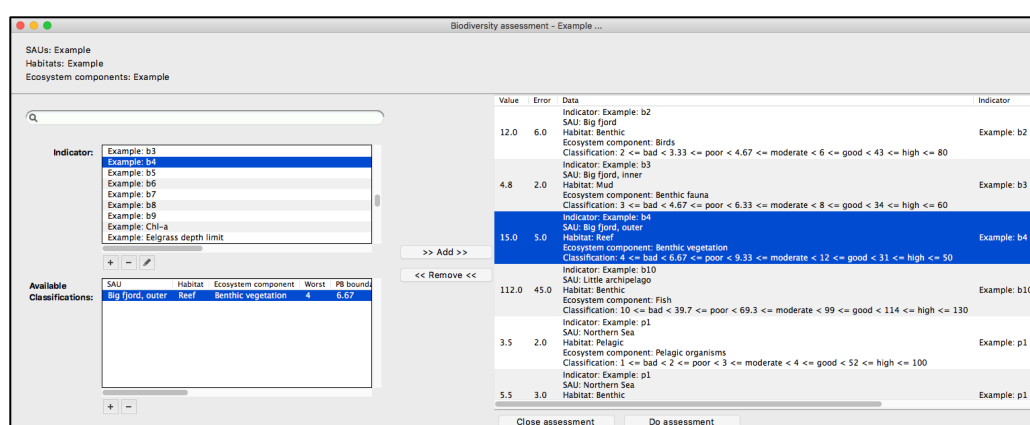
Figure 11. Window showing an assessment with a number of entered assessment items.

Every assessment item is a combination of one indicator assigned to a combination of one SAU, one habitat and one ecosystem compontent. For each of these combinations, a value and its standard error must be given, reflecting the value the indicator took when used in the specified SAU within the given habitat and applied to the chosen ecosystem component.

5.3.1. Adding existing assessment items

Adding an item to the assessment is done by picking the individual parts from the two fields on the left side of the form. For this, click on the indicator you want to use in the upper left field. Then choose the combination of SAU, habitat, ecosystem component (abbreviated as „Eco" in various places in the software) and indicator classification you want to associate to the specific indicator, and finally press the „>> Add >>" button. This will add the data to the list on the right (at the end of the list).

Above the list of indicators a search field is located. Here, you can search for a specific indicator and locate it quickly instead of scrolling or browsing through the list of indicators. You can type the first few letters of the indicator name into the search field and see what happens. The list below will show all indicators containing the typed characters. This is a live search. The search is case-insensitive. You can also add wildcards: * = any number of characters, ? = one single wildcard character). The search implicitly adds a * before and after the search string.

The right side of the form displays the assessment items chosen. In the „Data" column you will see a compact listing of each entry and the columns to the right of this contain the individual fields. Thus, you can quickly see all relevant data in the „Data" column and still be able to sort the list by individual columns when the list is growing larger.

Hint: In order to sort by a column, click on the column header. Pressing the „Shift" key while clicking on another column will add this column as secondary sort column and small numbers in the column headers will show the sort order while the arrows in the header will show the direction of the ordering.

Although the application comes with a large number of pre-defined indicators, these are not ready for use in an assessment since no information on their classification (class boundaries and reference values) is present yet. Since the assessment can only be performed when all used indicator combinations have a classification, you need to add the classification before the assessment can be performed (see next sections).

Note: The software does not check, whether the indicator boundaries entered are within the bounds of the given classification. However, values out of bounds will silently be truncated to either the maximum of minimum value on the classification scale.
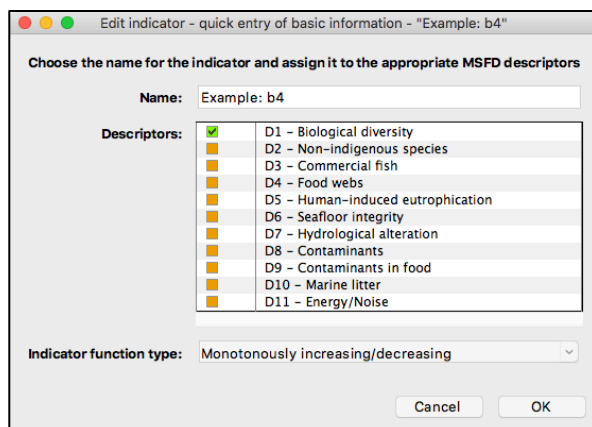
5.3.2. Adding new and editing existing indicators

When an indicator is selected in the list on the left, you can edit it using the „pen" button below the list. If none of the pre-defined indicators suit the needs, new indicators can be added and the basic information needed for an assessment can be entered. To add a new indicators, click on the „+" button below the indicator list.

In both cases, a dialog appears that allows you to enter/alter all data of the indicator that are relevant for the assessment (Figure 12).

In the entry field „Name:", type the name of the indicator. The application will not check whether this name is already present and choosing an existing name will result in two indicators not discernible anymore (this may change in the future).

The list „Descriptors:" is used to assign the indicator to one or more of the 11 MSFD descriptors. This is needed when filtering the assessment result by descriptor and when aggregating indicators to descriptors. To select a descriptor, tick the red box in the first column. It then becomes green and has a tick mark to indicate that the descriptor has been assigned to the indicator.

Figure 12. Dialog for creating a new indicator or editing an existing indicator.

The last field "Indicator function type:" indicates what type of numerical function is underlying the indicator. Most indicators are monotonously increasing or decreasing. This means the indicator value is higher (increasing) the better the status class is and the reference value carries the highest possible indicator value. In the case of a decresing indicator function the opposite is true. The other type of indicator is an indicator with a bell-shaped function. This type is used when the reference value is somewhere in the middle of the scale and both extremes represent the worst indicator values. As an example, a value of 1 might represent the bad status, a value of 5 is the high status and a value of 10 is again a bad status.

This distinction between the indicator types is needed so the assessment knows how to assign status classes to specific indicator values. A monotonous scale has only one value for each status class boundary. A bell-shaped scale has two values for all class boundaries except the reference value.

5.3.3. Adding and deleting indicator classifications

The field on the lower left of the assessment form shows the classifications (i.e. class boundaries) assigned to a selected indicator, if any. Classifications can differ with respect to the SAU, habitat or ecosystem component assessed with this method. Every entry in this list is one of those settings. To add or delete a setting, use the buttons below the list.

Depending on the general setting of the assessment, i.e. the chosen top-most SAU, habiat and ecosystem component, some entries will appear with a grey font. These are entries that represent existing classifications for the selected indicator, but cannot be used in the current assessment because the SAU, habitat or ecosystem component assignet of the classification does not match the assessment settings. For example, an indicator classification assigned to the Baltic Sea cannot be used in an assessment for the Black Sea.

A setting consists of several parameters (Figure 13). Each setting must be assigned to a SAU, a habitat and an ecosystem component which you select from the three upper lists of the dialog. The classification (class boundaries) is entered into entry fields of the fourth list in the dialog as integer or floating point numbers. As a minimum, the best possible indicator value (the reference value), the worst indicator value and the GEnS boundary (good/moderate boundary) value must be entered. The rows in the table for those values have a blue background colour. The application will then provide the other values using linear interpolation. If special values for the other class boundaries are present, these should be entered instead of letting the application find them since custom boundary values will be more reliable (rows in the table with a green background colour). The software uses the worst and the reference values to determine whether the indicator scale is numerically increasing or decreasing. After hitting the OK button, the classification setting is added to the selected indicator. It will appear in the list on the form including the interpolated boundaries and can now be used in this and other assessments using the same SAU/habitat/ecosystem component (it is a property of the indicator itself and stored to gether with the other indicator data).

In the case of bell-shaped indicator functions, two values need to be entered for the worst state, the GenS boundary and the best state. Note, that you must enter the values in a way that one end of the values (e.g. the lowest ones) are entered as "1st value" (left column) and the other end of the scale (e.g. the highest ones) are entered as "2nd value". Also note, that there is no 2nd value for the reference as there only is one best state.

Figure 13. Data to enter for the classification of a new indicator (of the type monotonously increasing/decreasing).

5.3.4. Deleting indicators

Clicking on the „-" button under the indicator list will delete the indicator together with all metadata from the indicator catalogue. This action cannot be un-done.
Note: Deleting an indicator, currently does not delete the corresponding entry in the assessment. You need to manually remove the combinations using this indicator from the right list in the window.

5.4. Running the assessment

When a set of indicators has been added to an assessment and the indicator values and error values have been provided, the assessment can be performed by clicking the „Do assessment" button. The assessment will be calculated with some default settings.
The window shown is separated into two parts (Figure 14). The upper part contains the settings that influence how the NEAT calculations are done. The lower part presents the assessment results in a table. The assessment will automatically by recalculated when a setting has been changed.
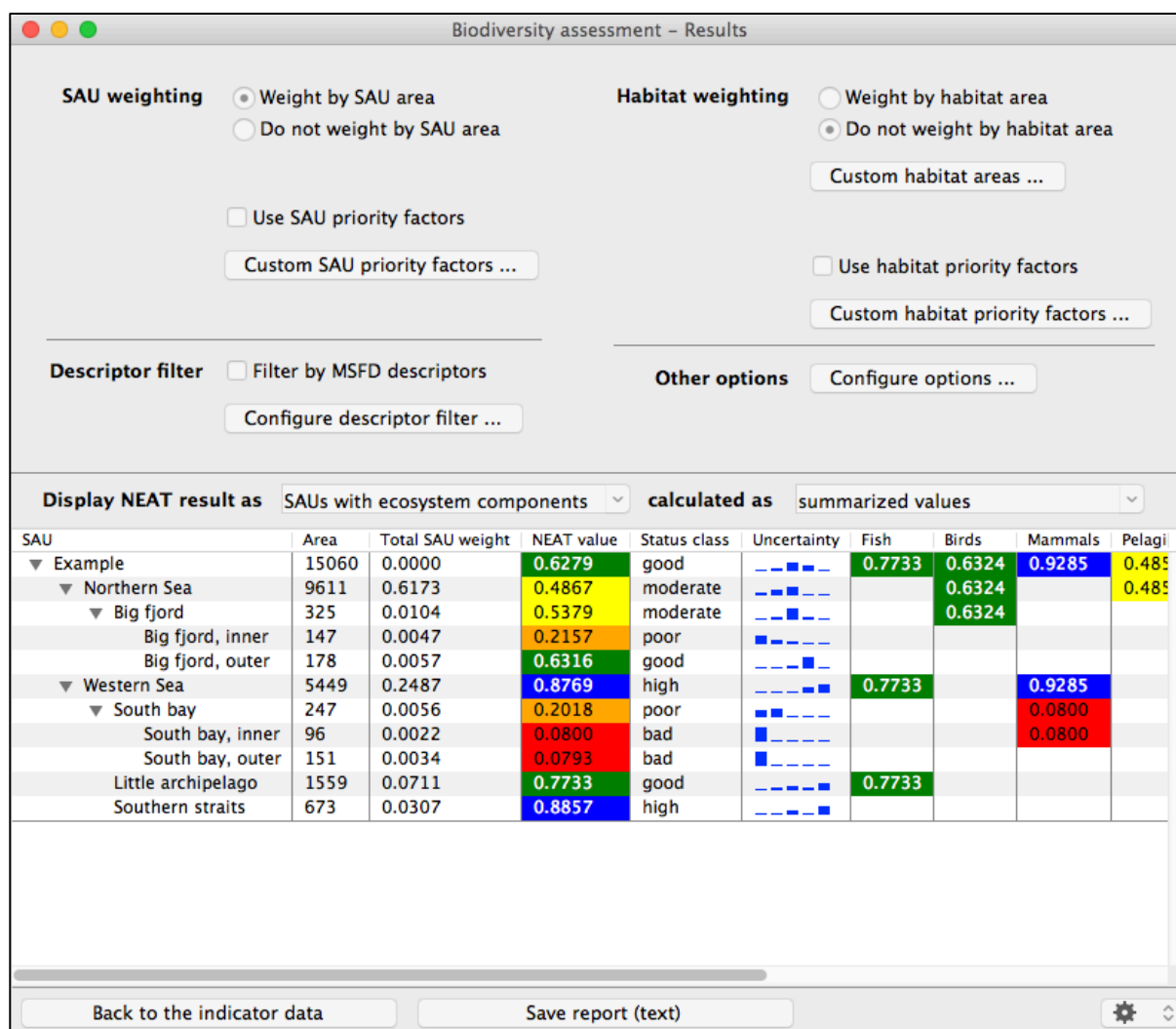
Figure 14. Window containing the results of an assessment.

5.4.1. Assessment settings

The first block of settings influences the way in which the assessment does the weighting. The second block is used to filter the assessment by descriptor and to configure some auxiliary settings.

5.4.2. SAU weighting

The SAUs are either weighted using their respective areas (the default setting) or the SAUs are not weighted. No weight on the SAUs is equivalent to giving all SAUs a weight of 1 or setting their area to 1. Apart from the area, an additional weight can be given to SAUs when they should have priority over others. These are factors applied to the initial weight, so the total weight is the product of the initial weight (by area or equally) and the priority factor. Each SAU can have its own priority defined using the „Custom SAU priority factors …" button and the default weight is 1 (Figure 15).
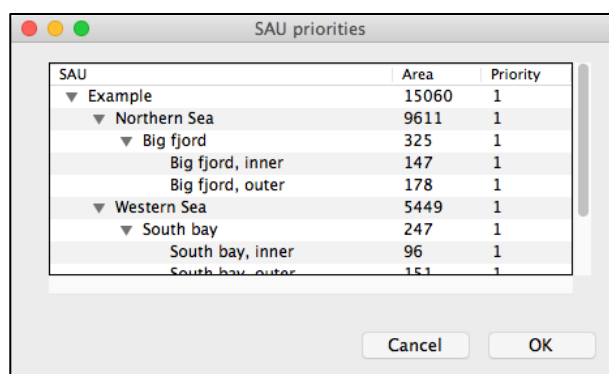
Figure 15. Dialog window to enter the priority factors of the SAUs

Note: A given priority on a higher level in the hierarchy influences the weight of the subordinate SAUs and, to a lesser degree, of the subsequent habitats attached to these SAUs.
Note: Weighting by area is possible without actually assigning an area to the SAUs. However, this is not useful since missing areas will implicitly be set to 1, leading to equal weighting.

5.4.3. Habitat weighting

The same weighting scheme that is used for the SAUs can also be applied to habitats. By default, habitats are not weighted by their area, but equally. The areas of the habitats are not properties of the habitats themselves (as is the case for the SAUs). Habitats are always used in the context of a specific SAU. Therefore, assigning areas to habitats involves doing this per SAU. In the dialog window that opens when clicking on „Custom habitat areas …", the SAU/habitat combinations which have indicators associated with them are shown with a yellow background colour (Figure 16). Areas not specified are marked with a dash. The same scheme is true for the priority factors which are also valid for individual SAU/habitat combinations.
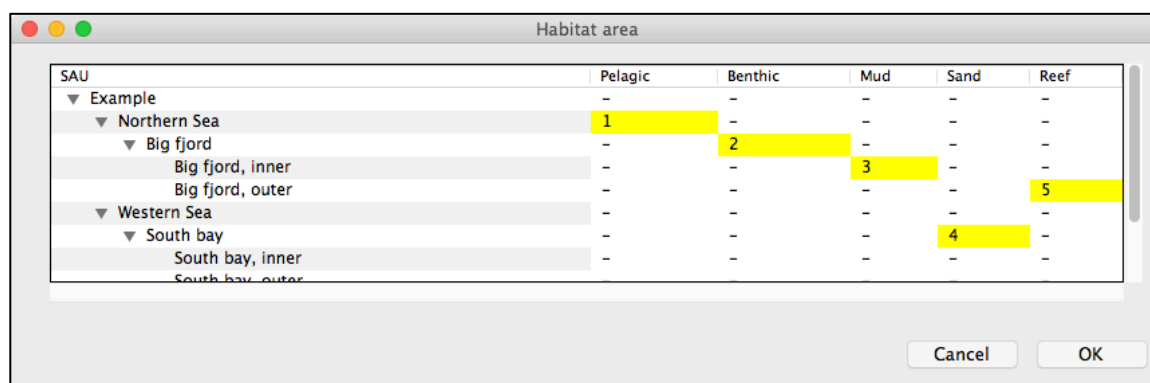
Figure 16. Dialog window to enter the area of SAU/habitat-combinations.

5.4.4. Descriptor filter

All descriptors are assigned to one or more MSFD descriptor for which they are relevant. In order to only use the indicators assigned to a particular set of descriptors, this filter can be set. In the list shown when clicking on „Configure descriptor filter …", just tick the descriptors to use. All indicators not assigned to the chosen indicators will then be ignored.
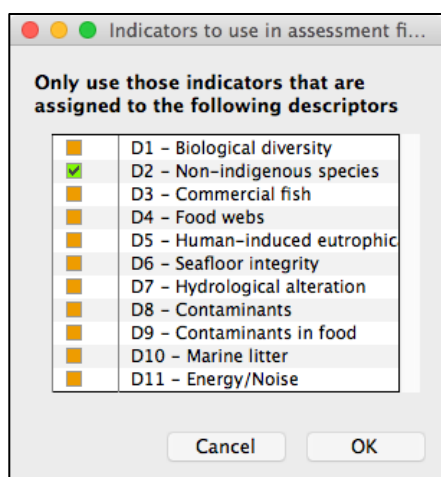
Figure 17. Dialog window to filter an assessment by MSFD descriptors.

Note: This does not change the weighting of the different SAUs and habitats. The filter does not act in a way as if the ignored indicators are non-existent and thus also their corresponding SAUs or habitats. The ignored indicators are just not used for the calculation of the weighted average, but the weights of the remaining indicators do not change.

5.4.5. Other options

In the dialog that opens when clicking on „Configure options …" two additional settings can be configured (Figure 18).

Figure 18. Options for Monte Carlo simulations, the precision of numbers shown in the assessment and for coloured confidence bars.

The number of iterations for Monte Carlo simulations influences the accuracy of the uncertainty estimation of the resulting assessment. As a default, 1000 simulated assessments will be performed in order to derive the uncertainty of the overall result. If your computer is slow to compute these simulations, the number of iterations can be set to a low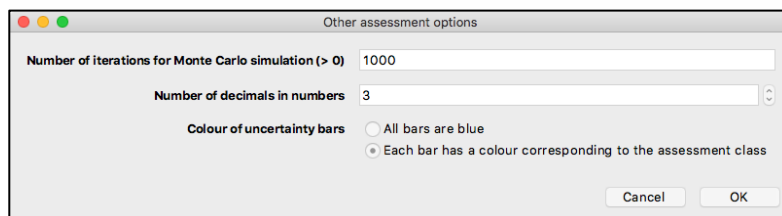er value. However, the lower this value, the higher is the imprecision of the uncertainty assessment and a bias may be introduced.
The number of decimals in numbers influences the accuracy with which floating point numbers are shown in the assessment and also the indicator classification. The default value is 3.

5.4.6. Assessment results display

The assessment results are shown in a tabular format. Each row in the table represents an individual SAU and either its associated ecosystem components or its habiats (for which indicators have been selected). This is determined by choosing either "SAUs with ecosystem components" or "SAUs with habitats" as NEAT values to display (listbox above the results table).
The displayed NEAT values can be calculated in two different ways. The default is "**summarized values**". This means NEAT values of a specific SAU include the assessment of all subordinate SAUs

and these are aggregated into the final result. This fully utilizes the defined weightings. The second calculation mode is "**individual values**". In this mode all NEAT values are only representing the individual SAUs without aggregating their subordinate SAUs into the final value. This can e.g. be used to evaluate the individual contributions of the SAUs to the overall summarized NEAT result.
Note: the toplevel SAUs only show NEAT values when either summarized values are calculated or (also in "individual values" mode) when indicators have been assign to them.

The **first column** shows the name of the SAU, the **second column** the area of the SAU.
The **third column** lists the total weight of the SAU. However, this is not simply the product of its area and its priority factor. The weighting algorithm is designed in a way that the sum of the weights of all SAUs used in the assessment is 1. Thus, it is easy to see what contribution the individual SAUs have compared to the used set. SAUs not used in the assessment have a weight of 0.
The **fourth column** shows the assessment result of the SAU, i.e. the NEAT value. This value is between 0 and 1 and uses the normalized assessment scale (see section 5.3).
The corresponding status class in indicated in the **fifth column** and the background colour of the NEAT value corresponds to the class using the colour scheme from the WFD (bad = red, poor = orange, moderate = yellow, good = green, high = blue).
The **sixth column** shows the uncertainty assessment in the form of a so-called spark line. There are 5 small vertical bars, one for each status class. The height of the bar indicates the confidence in terms of the percentage with which the classification ended up in a particular class when doing simulated assessments based on the indicators' error values and a Monte Carlo simulation. From left to right the bars indicate the bad, poor, moderate, good and high classes.
The **remaining columns** list the ecosystem components or habitat and show their NEAT value. This is done by performing the assessment only for those indicators within a SAU belonging to the respective component/habitat. Again the NEAT value is a normalized value from 0 through 1 and the class is indicated by the colour the table cell.
The buttons below the table either close this assessment result window or save the assessment table and the used assessment configuration in a text file for reference or for import into other applications.
When saving the assessment results, you have the opportunity to specify which character should be used for the decimal point. This setting is used to save the numbers into the file either with a dot (typical for English-speaking countries) or with a comma (typical for many European countries). The values in the table are separated using „tab" (tabulator) characters so the table is easily imported into a spreadsheet. Also, you can choose whether you want to have the detailed weights and confidence values included.
Note: The colours are not saved to the file, since the data format is plain text (using the utf-8 codemap). Also the uncertainty bars are not saved in the file since they cannot be represented as text. Other formats for saving the assessment will be implemented in later releases of the NEAT software in order to allow a more complete extract of the assessment results.

5.5. Sensitivity analysis

In the lower right corner of the result window (see Figure 14), an action menu is included, providing additional assessment functionality.
The sensitivity of the current assessment to subsequent removal of indicators can be tested with this sensitivity analysis (Figure 19). For this, the settings as defined for the actual assessment are applied and the NEAT values for the SAUs are recalculated a number of times for each reduced set of indicators. The final NEAT value in the sensitivity analysis is the arithmetic mean of all recalculations per specific reduced set.
In the upper part of the window, the analysis can be configured. The "**Item Removal**" determines which items will be removed subsequently during the analysis. This can either be complete indicators (i.e. all assessment items/combinations of SAU/habitat/ecosysetm component/indicator) and

corresponds to all rows in the window showing the assessment items where a specific indicator is used. The other possibility is to only remove one individual assessment item at once, leaving other items using the same indicator in place.

The "**# of simulations per iteration**" determines how often the NEAT calculation will be repeated per set of assessment items. The default value is 100. This setting influences to a large degree how long the whole analysis takes since it is a multiplicator of the number of recalculations needed.

The "**# of items to remove per iteration**" determines how many items are removed from the full set at one. By default, only one item will be removed per iteration.

The analysis will typically continue until there is is only one item left in the assessment. This can be changed by setting "**Stop, when # of items are left**". When this threshold is exceeded the analysis will finish.
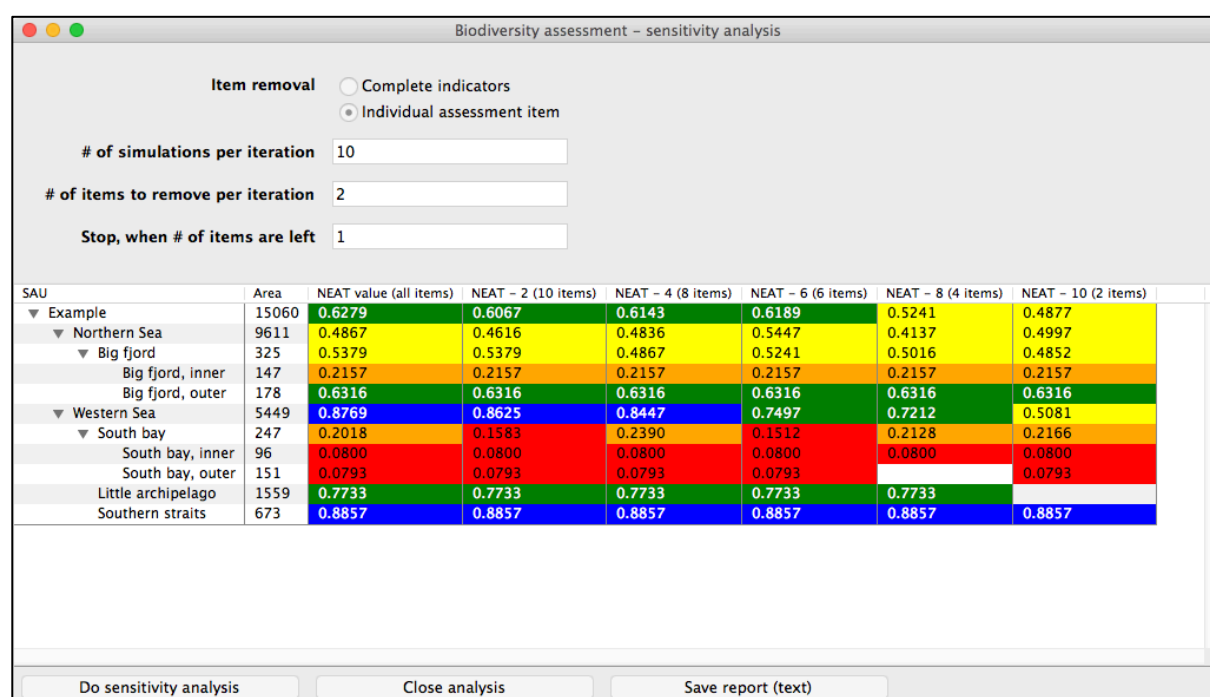
Figure 19. Window with the results of a sensitivity analysis using the example assessment.

The lower part of the window shows the results of the analysis per SAU (using the settings determined for the assessment as such).
The **first column** shows the name of the SAU, the **second column** the area of the SAU.
The **third column** shows the original NEAT result of the corresponding SAU (without any item removal).
The **remaining columns** show the results corresponding to the individual reduced sets of assessment items. The header states how many items were removed and how many items in total were used in that column.

Note: The more items are removed the higher the probability will be that empty cells appear in the resulting data. These are SAUs which were left out completely, because the random sampling of assessment items did not pick these items. The lower the number of simulations per iteration and the lower the number of assessment items in the reduced set, the higher the probability of these empty cells.

Unlike the full assesment, sensitivity analysis will not start automatically when the window is opened or settings are changed. This is because the calculation can be a long-running process that needs

proper setup before it is started. Click on "Do sensitivity analysis" below the result table will manually start the analysis. Just like the assessment itself, it is possible to export the analysis data to a text file. This file will not only contain the shown data, but also the individual results of all iterations. This makes it possible to continue working with the simulation data in other ways.

5.6. Detailed data on the assessment

In the lower right corner of the result window (see Figure 14), an action menu is included, providing additional assessment functionality. Beside the sensitivity analysis (see section 5.5), it is possible to view the individual weights used for the combinations of the SAU with a habitat. It is also possible to show the confidence data for all SAUs as numerical values in relation to the maximum possible count for the Monte Carlo simulations. All these data can also be exportet into the assessment report (see section 5.4.6).

6. Assessment entities

6.1. Spatial assessment units

This window shows the SAUs which have been defined in the application (Figure 20). There can be several SAU hierarchies defined, all starting with a top-level item giving the name of the overarching hierarchy. By default, there is one hierarchy for each of the four European Regional Seas and one for „Non-EU regional seas" (not having any subregions defined). The only other setting is the „Example" hierarchy for demonstration purposes.
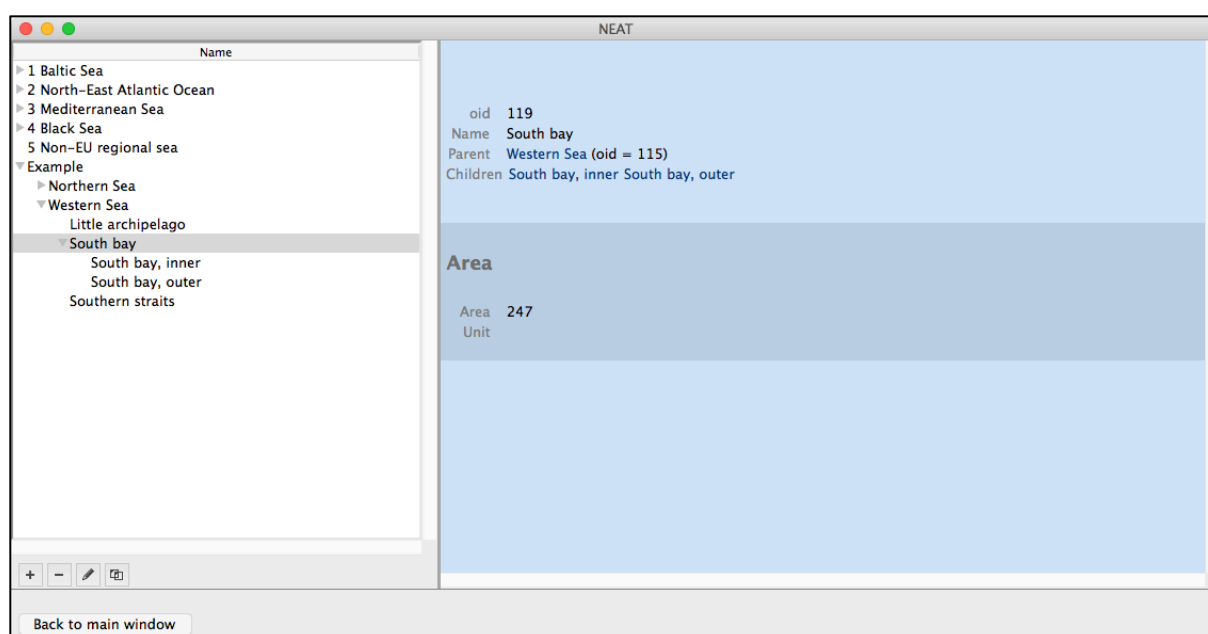
Figure 20. Window showing the defined SAU hierarchies.

Clicking on an entry in the hierarchical list on the left will display the properties of the SAU. Clsing the window or clicking on "Back to main window" will remove this window and show the main menu again. All changes are saved automatically.

6.1.1. Adding a new SAU

Adding a new SAU is as simple as clicking on the „+" button below the list. A dialog will appear and the name of the SAU must be entered (Figure 21). Also, it must be specified where in the hierarchy the new SAU should be located. When an SAU was selected before adding a SAU, the new SAU can either be placed as a new top-level entry (and thus defining a whole new hierarchy) or as a child entry (a subordinate entry) of the selected SAU. Thus, in order to insert new subordinate SAUs, the parent SAU must be selected first. When no SAU is selected, any new SAU can only be added as a new top-level SAU. Clicking on the tab „Area" allows the user to enter the area of the SAU and the unit in which the area is specified (default is km^2).

Figure 21. Dialog window to enter the data for a new SAU.

Since the areas of higher-level SAUs are sums of their subordinate SAUs (assuming that subordinate SAUs have been specified at all), the user must make sure that the numbers add up to the correct sums. Later versions of the software may do this automatically or provide means to do error checking on this field.

Note: If you add a whole new SAU hierarchy, start off with one top-level item that has no parent. Then, add the subordinate items by first selecting the parent item and then clicking "+".

6.1.2. Editing an existing SAU

Editing an existing SAU is very much like adding a new SAU. Click on the "pen"-button or double-click the item in order to edit it. The name can be changed and the values of the other properties. Also, the item can be re-parented. This means, that a new parent SAU can be specified instead of the one it is currently attached to. This will then move the SAU onto another branch in the hierarchy. If the SAU should become a top-level SAU, choose „-no parent-".

Note: Changing the position within the hierarchy typically means the area should also be adjusted to fit into the changed hierarchy.

6.1.3. Deleting a SAU

Deleting a SAU is done by simply clicking the „-" button. After confirming the deletion, the SAU will be removed and this action cannot be undone. You can select more than one entry using the Shift/ Ctrl/Command buttons and then delete all selected entries at once.

Note: Any deleted SAU means potentially leaving orphan assessment entries in assessments using this SAU. This is currently not automatically detected by the application.

6.1.4. Copying a SAU

An individual SAU can be copied by clicking the [copy icon] (copy) button. The copy of the SAU will be renamed by putting „COPY OF: " in front of the original name.

6.2. Habitats

This window shows the habitat types which have been defined in the application. There can be several habitat hierarchies defined, all starting with a top-level item giving the name of the overarching hierarchy. By default, there is one hierarchy for the categories which have been used in DEVOTool and one hierarchy with the „Example" for demonstration purposes.

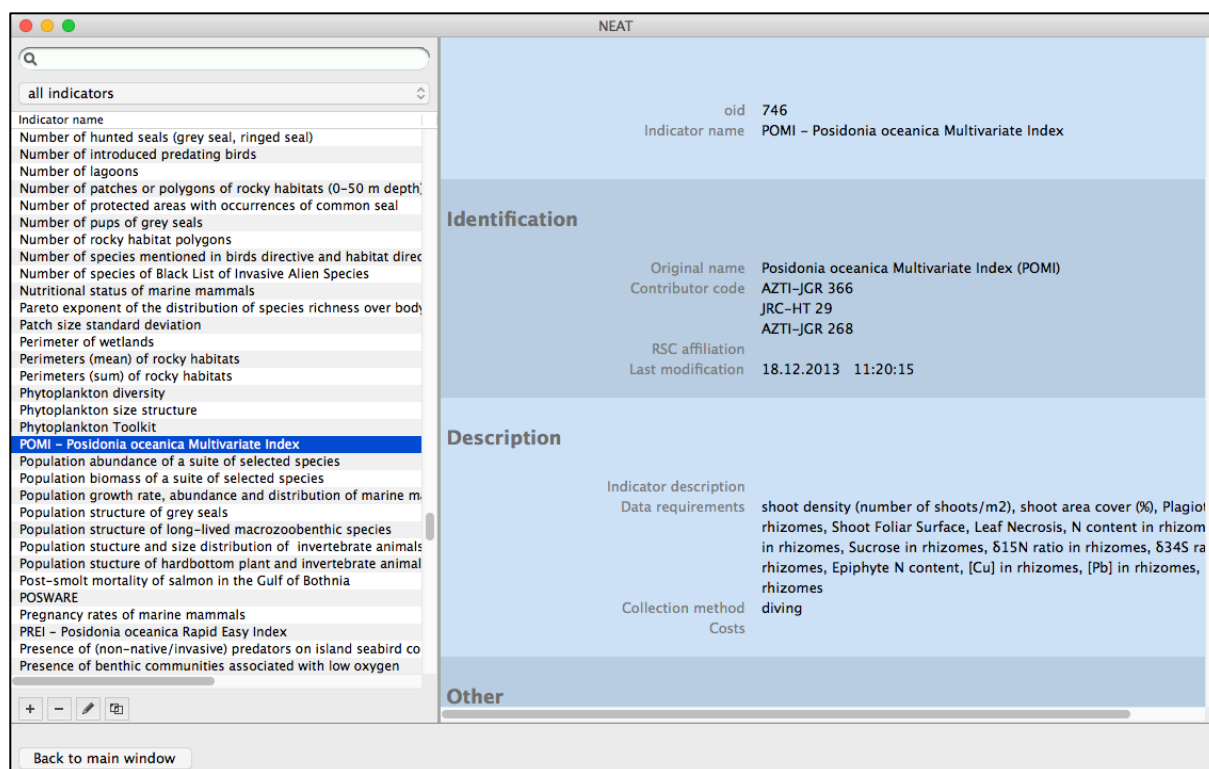Adding, editing, deleting and copying a habitat is done in the same way as for the SAUs (see section 6).

6.3. Ecosystem components

This window shows the ecosystem components which have been defined in the application. Typically these are biodiversity components but they can also be other ecosystem features of interest. There can be several hierarchies defined, all starting with a top-level item giving the name of the overarching hierarchy. By default, there is one hierarchy for the categories which have been used in DEVOTool and one hierarchy with the „Example" for demonstration purposes.

Adding, editing, deleting and copying an ecosystem component is done in the same way as for the SAUs (see section 6)).

6.4. Indicators

This window shows the indicators which have been defined in the application (Figure 22). These do not form a hierarchy but are organized as a flat list. Some of the indicators start with „Example:". These are fictional indicators used for demonstration purposes.

Figure 22. Window with the included indicators. As an example, the indicator POMI can be seen.

Adding, editing, deleting and copying an indicator is done in the same way as for the SAUs (see section 6). The only difference is that indicators have a far more complex data structure. Since not all functionality has been transferred from DEVOTool to NEAT yet, not all fields can currently be edited from within NEAT. This concerns all table-like data of indicators. In this window, some of the data relevant for an assessment cannot be edited here for now. Nonetheless, all indicator data needed for an assessment can be added, edited and deleted from the biodiversity assessment windows.

The metadata shown for the individual pre-defined indicators corresponds to the ones listed in DEVOTool. Only the table „Classifications" has been added.

You can sort the indicators by clicking on the header label (which is where the title is). Clicking on an entry will display some basic properties of the indicator. The properties are divided into groups, shown with headers and alternating background colours. These are the fields currently used:

- Oid – this is a unique numeric identifier for each record
- Indicator name – the name of the indicator
- Original name – the original name of the indicator when submitted by the contributor
- Contributor code – the code which the contributor gave the indicator when submitting it
- RSC affiliation – indicates, whether the indicator is part of HELCOM corset, OSPAR common indicator set, Barcelona convention set or Bucharest convention set
- Last modification – automatically filled as soon as the dataset changes and show the date of the last change made
- Indicator description – general description of the indicator in order to understand what it covers
- Data requirements – which kind of data is needed for calculating the indicator
- Collection method – the field method or other method to apply when collecting the data for calculating the index
- Costs – qualitative indication of the costs associated with doing the data collection, analysis and evaluation
- DPSIR stage – indication of where in the DPSIR (or DAPSI(W)R(M)) model, the indicator is located. This can be 'pressure' (P), 'state' (S) or 'impact' (I).
- Main attribute – indication of the main attribute used in the indicator. This can be e.g. indicator species, population ecology, production, biotope features, life traits.
- Underlying variable types – the type of variables used for the indicator, e.g. abundance, biomass, taxonomic composition, spatial distribution, biochemical markers etc.
- Algorithm type – rough classification into the groups 'Categorical', ' Simple statistics', 'Complex statistics', 'Modelling' as indication of the complexity of the math involved
- Overall indicator status – automatically filled with the highest status from the set of metadata added under the "Metadata" form (section "Targets -> Settings")
- Unit – the unit of the resulting value of the indicator (typically some SI unit or a unitless Ecological Quality Ration (EQR))
- Confidence/uncertainty – qualitative description of the confidence or uncertainty connected to the resulting indicator value but also the field methods, etc.
- Sources – one or more reference to the indicator and its metadata from literature or other sources
- Observations/Remarks – free field for any information not covered by the other fields
- Descriptor coverage – the list of MSFD descriptors the indicator is associated with together with a remark field, the contributor's code and possibly a reference for the assignment
- biodiversity related MSFD criteria/indicators - this table lists the MSFD criteria/indicators under the descriptors, that have been associated with the indicator
- biodiversity components - the biodiversity components from the „ecosystem components" hierarchy that are assigned to the indicator
- Pressures - a list of the pressures relevant for this indicator
- settings - this is the various settings in which the indicator is applied (i.e. in which region and habitat, etc.)
- classification -the classification settings used in the biodiversity assessment

If you are searching for a specific indicator, you can type the first few letters of its name into the search field above the list and see what happens. The list below will show all indicators beginning with the typed characters. This is a live search. The search is case-insensitive. You can also add wildcards: * = any amount of characters, ? = one single wildcard character). If you start your search string with the * wildcard followed by some letters, you will get all indicators containing the typed

letters. You can also get a filtered list of indicators by using the combo box below the search field. Click on it to see the options.

Note: The search field and the filter act together, not independently from each other.

6.5. References

This window shows the references which have been used for the metadata of the indicators. References can be journal articles, books or links to internet websites, among others. When clicking on a reference in the Indicator window, the corresponding references will automatically be shown in this window.

Adding, editing, deleting and copying a reference is done in the same way as for the SAUs (see section 6) apart from the fact that the references are not hierarchically structured but presented as a flat list.

7. Guideline for the usage of NEAT

7.1.   Unexpected results

You may, under certain settings, get unexpected results when performing a NEAT assessment compared with other assessment tool you might have used before. This will often be the case when using only a small number of indicators and with indicators differing widely in their individual assessment. The reason could be that other assessment systems may not pay much attention to weighting. So, when these assessment systems are given a biased set of indicators, this bias will typically be reflected in the final assessment value. As an example, having 4 indicators from soft bottom habitats showing a good status combined with one indicator from hard bottom habitats showing moderate status, will typically result in assessments biased towards the good status due to the numerical overweight of the soft bottom indicators. In NEAT, this will not necessarily be the case, especially if the hard bottom is present in a large habitat compared to a small habitat with soft bottom. Weighting by area here means to give more weight to the dominant habitat and less to the smaller habitat. If you do not want to give more weight to dominant habitats, you must turn habitat weighting off.

7.2.   How should the SAUs be assigned spatially?

Typically, you will want to use the whole area of interest (typically a regional sea) as the top-level SAU (there must always be one top-level SAU). Then, divide this area of interest into smaller parts using biogeographic or environmental criteria. This ensures that your SAU division is a meaningful one in terms of the assessment. Weighting is done on the entities of interest, i.e. the SAUs and the habitats, not on the indicators as such. However, the indicators represent aspects of the environmental status of those SAUs and habitats. Therefore, as SAUs are weighted by their area as a default, the larger an area is, the more it will influence the resulting assessment value. If the SAU division is only done through e.g. administrative borders without any biological meaning, the resulting assessment may be biased towards is reflecting the importance of the administrative areas, not the importance of the underlying biology.

7.3.   How should I use the priority factors?

The priority factors give the possibility to give extra weight to specific ecosystem features (SAUs or habitats). This can be reasonable when certain SAUs or habitats have a special importance in terms of the environmental status. For example, this can be the case when a habitat is rare and very vulnerable and you want to specifically reflect this in the final assessment. A bad status of this habitat will then more likely move the assessment value towards the indicator value of this habitat. Especially when using many indicators and having small habitats, their indicator value does not contribute much to the final result, even when weighting by area is applied. In order to give those habitats extra weight for the final assessment, set their priority to some value above 1. You will typically need to use factors above 2 in order to see a real change in the NEAT value. Another reason for introducing a priority factor could be that data is scarce for certain SAUs or for habitats within them. This may give grounds for reduced confidence in the results of the habitat in question. Although this will also be reflected in the overall assessment uncertainty, you may want to down-weight the priority/importance of such SAUs/habitats, so they do not have a too large influence on the final result, especially if these SAUs/habitats are dominant or unintentionally lead to greatly biased indicator results because of the bad data quality.

7.4. How do I find the right minimum and maximum values for indicator classification?

In some cases, indicators might not have been assigned a minimum or maximum (reference) value since only the GEnS threshold is important for them. A reference may not have been defined in such cases. In order to use such indicators in NEAT, you will need to find reasonable values for the minimum or maximum. Use the practically or theoretically achievable value including uncertainty. As an example, for breeding success indicators, a value of 0 % breeding success will be a minimum value. On the other hand, the typical maximum breeding success found under undisturbed conditions may be a good practical reference value. A theoretical one would be 100 %. In population size indicators, the same scheme can be use with 0 (population not present) as minimum.

7.5. Double counting

Currently, the application does not check whether a combination of SAU/habitat/ecosystem component has been assigned to one or more than one indicator. Having more than one indicator may lead to double counting when the same feature (e.g. the same MSFD criterion) has been used multiple times for the indicators. Since there certainly are situations like this where multiple indicators per combination are useful and even necessary, a check for double counting must also include at least the MSFD criteria to which the indicators are assigned.

7.6. The MSFD does not prescribe 5 status classes. Why does NEAT use five status classes?

The number of status classes is adopted from the assessment scheme of the Water Framework Directive (WFD). Since many indicators used in the MSFD have their origin in the WFD, it is easy to use those indicators in NEAT. Nonetheless, in one of the next releases of NEAT, the number of classes can be changed by the user in order to allow e.g. a 2-class scheme such as „below GEnS" and „above GEnS". The only restriction currently is that both the upper and the lower limit of the classification scale must be present besides the GEnS boundary. This is needed for the transformation to the common assessment scale.

7.7. What should I do if I do not have an uncertainty value for my indicator?

The default value will typically be 50–100 % if you have no other information. This is a precautionary value and reflects the fact that uncertainty is typically strongly underestimated. Having a data set for the indicator, you can run a bootstrapping procedure or do a Monte Carlo simulation in order to find out how much your indicator value varies when the underlying data is changing. This can subsequently be transformed to the standard error used in the assessment. Other possibilities to determine uncertainty can be found in Carstensen & Lindegarth (2016).
Note: Small datasets result in underestimated uncertainty.

7.8. What should I do when I have an indicator that applies to several species?

The correct way of handling such situations is to use the hierarchy of ecosystem components to include an entry for each species. For every species, the indicator can thus use specific indicator classifications. Other approaches such as creating identical indicators for each species and using the species name as part of the indicator are not a good option because they clutter the list of indicators with duplicates and you cannot, e.g. in a sensitivity analysis, benefit from the possible grouping of the indicators.

8. Outlook

Version 1.2 of the NEAT software is the second public version, implementing the conceptual NEAT tool from the DEVOTES project as a stand-alone software. The remaining time of the DEVOTES project will be used to substantially enhance the software and to add more features. This work will partly be driven by the remaining tasks in the DEVOTES work packages as needs arise for specific functionality. Further, some functionality has already been requested by users of the conceptual NEAT tool and will be added. The following list gives an (incomplete) overview of the enhancements planned:

- more consistent user interface
- full integration of DEVOTool (needs a restructuring of the metadata)
- more import and export formats
- weighting of ecosystem components
- central online assessment repository for easy sharing of data and assessments
- integration of GEnS criteria
- use of a different number of assessment classes (other than 5)
- use of a different standardized assessment scale, such as 0–100 (instead of 0–1)
- use of various other indicator types (apart from monotonously in- or decreasing indices) such as trend indicators, (presence-absence indicators?)
- more error checking during data entry and user alerts
- integration of other catalogues, such as key species and habitats (from other DEVOTES deliverables)
- more introspection capabilities, to see which numbers are the basis of the NEAT value (specifically planned for version 1.4 is to show the Monte Carlo simulation data)
- other aggregation rules and different order of aggregation (instead of the built-in order of SAU, habitat, ecosystem component)
- ability to disable individual indicators in an assessment without removing them (using a checkbox)

9. References

Andersen JH, Berg T, Borja A, Carstensen J, Cochrane S, Elliott M, Murray C (2017, in preparation) Assessing biodiversity status sensu the EU Marine Strategy Framework Directive. Part 1: Concept, principles and methodology.

Berg T, Fürhaupter K, Teixeira H, Uusitalo L, Zampoukas N (2015) The Marine Strategy Framework Directive and the ecosystem-based approach – pitfalls and solutions. Marine Pollution Bulletin, 96(1-2), 18–28. doi:10.1016/j.marpolbul.2015.04.050

Carstensen J, Lindegarth M (2016) Confidence in ecological indicators: A framework for quantifying uncertainty components from monitoring data. Ecological Indicators 67, 306–317.

Cochrane SKJ, Connor DW, Nilsson P, Mitchell I, Reker J, Franco J, Valavanis V, Moncheva S, Ekebom J, Nygaard K, Serrão Santos R, Narberhaus I, Packeiser T, van de Bund W, Cardoso AC (2010) Marine Strategy Framework Directive – Task Group 1 Report Biological diversity. EUR 24337 EN – Joint Research Centre.

Cochrane S, Andersen JH, Berg T, Blanchett H, Borja A, Carstensen J, Elliott M, Renaud P, et al. (2016, in preparation) Towards a conceptual understanding of marine biodiversity for assessment of Good Environmental Status.

Teixeira H, Berg T, Fürhaupter K, Usitalo L, Papadopoulou N, Bizsel KC, Cochrane S, Churilova T, Heiskanen AS, Uyarra MC, Zampoukas N, Borja A, Akcali B, Andersen JH, Beauchard O, Berzano M, Bizsel N, Bucas M, Camp J, Carvalho S, Flo E, Garces E, Herman P, Katsanevakis S, Kavcioglu R, Krause-Jensen D, Kryvenko O, Lynam C, Mazik K, Moncheva S, Neville S, Ozaydinli M, Pantazi M, Patricio J, Piroddi C, Queirós AM, Ramsvatn S, Rodriguez JG, Rodriguez-Ezpeleta N, Smith C, Stefanova K, Tempera F, Vassilopoulou V, Verissimo H, Yılmaz EH, Zaiko A, Zenetos A (2014) Existing biodiversity, non-indigenous species, food web and seafloor integrity GEnS indicators. Deliverable D3-1 within the DEVOTES project.