



# Seascape Complete User's Guide v3.2

## Segmentation and Cover Classification Analyses of Seabed Images

*Please use the following citation in published literature using Seascape:*

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### **License**

Seascape is an open-source platform and the compiled software, source code, developer guide, and user manual are available online at this site (<http://www.seascapesoft.com/documentation>). Seascape is available as free software under the terms of the [Free Software Foundation's](http://www.gnu.org/) (<http://www.gnu.org/>) GNU [General Public License \(GPLv3\)](http://www.gnu.org/licenses/gpl.html) (<http://www.gnu.org/licenses/gpl.html>) in source code form.

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## 1. Overview of Seascape

•Seascape is a free software application to generate semi-automatically segmented images (homogenous regions) from underwater photographs of benthic communities and compute for each individual patch its cover area and perimeter. Seascape works on GNU/Linux and Windows platforms (XP/Windows 7) and is easily portable to Macintosh. We developed Seascape due to the greater use of underwater digital photos combined with the increasing demand to better understand ecosystem function, change, health and services. This combination produces a growing need for automatic or semi-automatic analytical methods to obtain ecological relevant data (cover area and perimeter) from benthic images. For more scientific information about quantifying areal coverage of benthic communities, please read the article (Teixidó et al 2011).

•Seascape is a simple, robust, and high resolution software that is based on hierarchical segmentation algorithms (Guigues 2003, Guigues et al. 2006). Seascape consists of two main components: a graphical user interface and the core program (Visual Studio 2003, written in C++), which contains libraries that are invoked during the execution of a run. Two main libraries involved are Lgl (an image analysis library) and SxS (Segmentation x Scale: segmentation library) (Guigues 2003, Guigues et al. 2006).

## 2. What includes Seascape?

- 1) Multiplatform: as open source software, can be installed in different operating systems (mainly GNU/Linux, MS Windows (XP/Windows 7) and is easily portable to Macintosh;
- 2) As image input accepts many common formats such as tiff, jpeg, png, bmp;
- 3) Flexible species/category list database management through Excel Spreadsheet files;
- 4) Hierarchical segmentation of grey and colour images;
- 5) Dynamic selection of working segmentation scales;
- 6) Flexible colour labelling code management through colour maps for species/categories;
- 7) Easy image scaling and calibration options;
- 8) Powerful and usable segmenting interface with selectable zoom and navigation window;
- 9) Friendly labelling and classification of polygons of the segmented image;
- 10) Automatic descriptors of planar area and perimeter for individually classified polygons. Results exported to Excel spreadsheets;
- 11) Automatic generation of export data (separately or included in previous datasheets) in Excel and ASCII files, with different options for further statistical analyses (region, locality, date, depth);
- 12) Exporting classified images into bitmap and tiff files.

### 3. Seascape operation

#### 3.1 How do I install Seascape for Windows?

- Current binary version of Seascape runs on Windows XP and Windows 7, including on 64-bit versions.
- We only tested on versions of Windows currently supported by Microsoft, mainly on 32-bit XP and 32-bit Windows 7 Pro.
- A typical install takes 5Mb of disk space.
- Download the file “SeaScape-bin-win32-3.2.4.zip” to your computer. Extract the zip file with a decompression software.



Unzipping the file with a zip software

Figure 1. Unzipping the Seascape folder

- Install Seascape in any area of your computer (Program Files, Desktop etc...). On recent versions of Windows you may need to confirm that you want to proceed with installing a program from an 'unidentified publisher'.

### 3.2 Contents of Seascope

• The folder Seascope contains the following files, which are necessary to run the software. Do not change the file locations. **The integrity of the format is mandatory for the execution of the application.** Therefore, it is highly recommended to the user to keep a working copy prior to any modification that might be done.

#### Contents:

- Seascope : just double-click on the icon to run the software. It is the application
- msvcp71.dll (library wxwdigets )
- msucr71.dll (library wxwdigets )
- “Data” directory. This folder contains files related to the settings and strings of the application, the input image, and the species list.

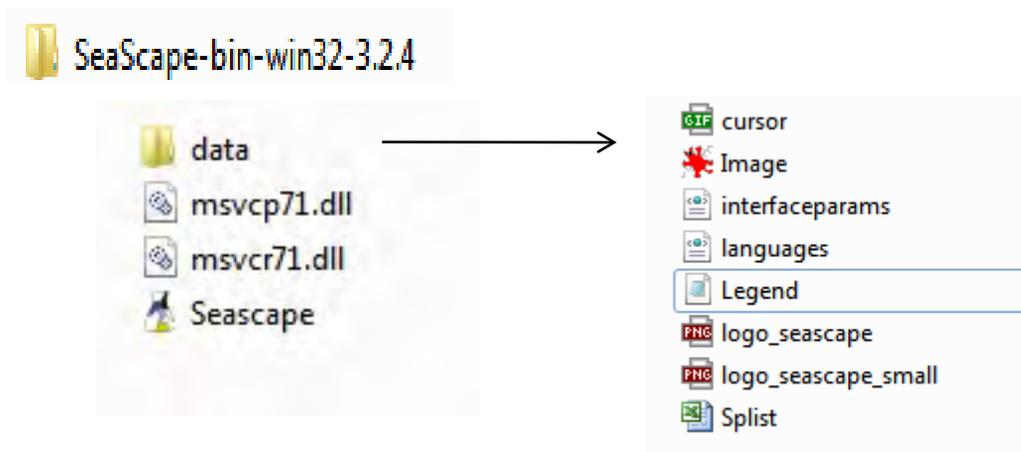


Figure 2. Folders and Files in Seascope. Remember that the integrity of the file locations is mandatory for the proper performance of Seascope..

•**Interfaceparams:** The settings of the application are stored in this file. This is an XML database where the values for those settings can be set and they will be load on launch time. If you do not have expertise, don't modify this file.

•**Languages:** The strings of the application are stored on a file that contains an XML database with an entry for each available language. The name and path of this language file is specified on the settings file. Inside each entry of the language file, there is an object for each string, specifying the string id and the string value. If you do not have expertise, don't modify this file.

•**Cursor, logo\_seascape, logo\_seascape\_small:** They are files used in this application. Don't modify or change them. They are necessary.

•**Image:** The image to be analyzed. We provide a template. The user has to copy in this folder "Data" the images to be analyzed. **These files are provided by the user.**

•**Species list:** The list containing the information of species names that will use the application. **This file is provided by the user.**

### 3.3 Basic steps to use Seascape

- 1) To create the species list in Excel spreadsheet
- 2) To import the species list
- 3) To create the color map for each species
- 4) To import and segment an image
- 5) To define the image dimension (known distance, n pixels/cm)
- 6) To label the polygons. Seascape calculates automatically planar area and perimeter for individually classified polygons.
- 7) To export the results to Excel or ASCII files.
- 8) To export the classified images to bitmap and tiff files.

### 3.4 Seascape program controls

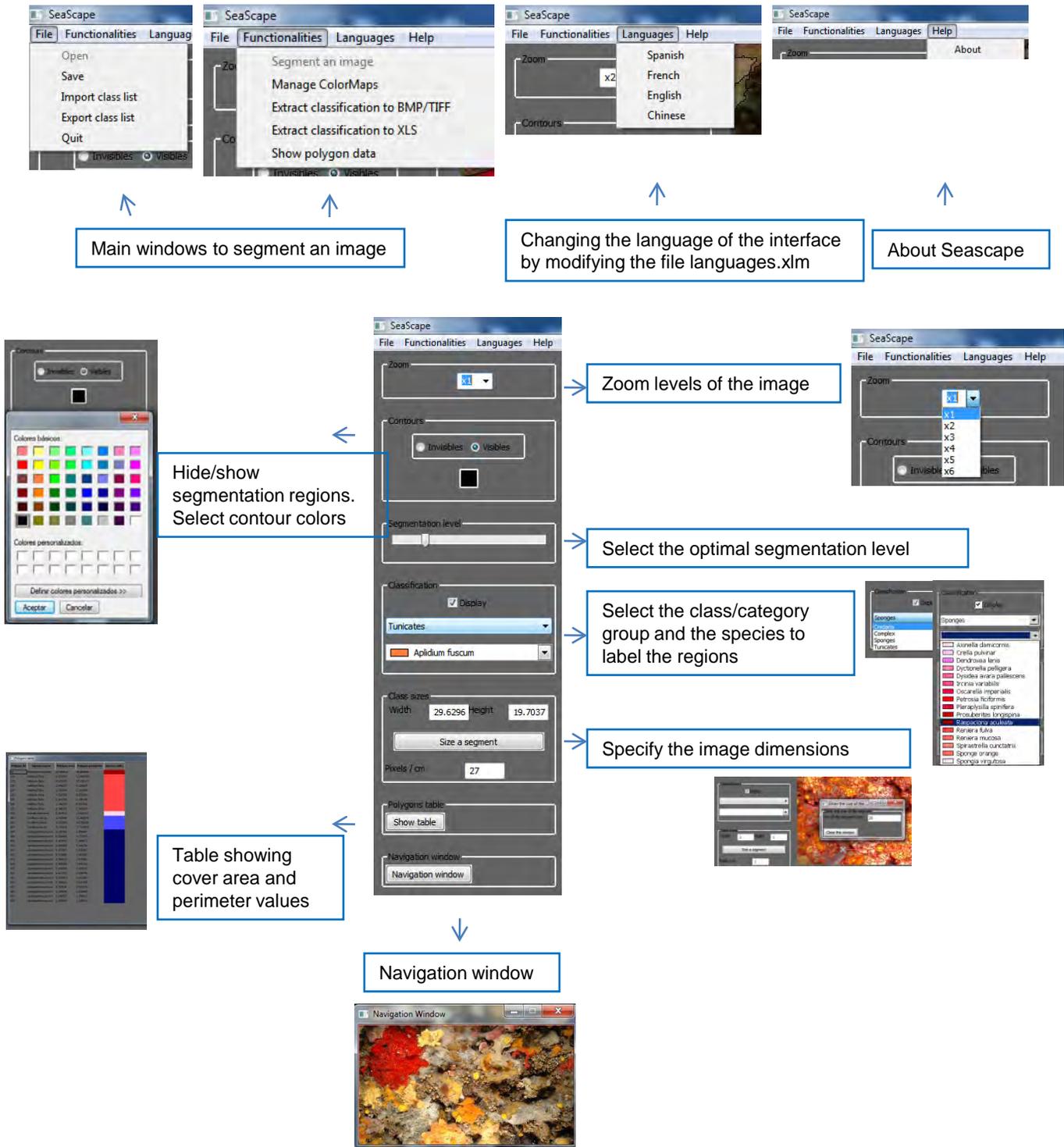


Figure 3. Overview of Seascape program controls and windows

### 3.5 Species list data format in Excel spreadsheet

- The file format of the Species list is an **Excel 1997-2003 spreadsheet** . Seascape does not accept other versions of Excel.
- The **species list file** has to be located in “**Data**” Directory. Otherwise, Seascape will not run properly.
- The data will be taken from the sheet labeled as 'Sheet1' (the common default name for the first sheet on an XLS file). It is mandatory to be written in English. A sample species list file, Splist.xls, is provided with Seascape and contains common species names from the coralligenous Mediterranean Sea.
- The user needs to create a customized file with the species appropriate for the specific analysis.
- Within this sheet, the first three columns will be used. First column is the species list classified in different Groups or Categories (e.g. Group 1 Sponges, Group 2 Cnidaria...). The second column is the Code Group or Category (e.g. S for sponges, C for Cnidaria, Co for Complex forms...). The third column is the label species ID. This last value must be within the range between 1 and 255. Note: Cell A1 hast to be empty as well as cells B and C corresponding with the Group/Category heading.

Column A: Species name classified by groups

Column B: Code Group

Column C: Label Species

: Empty cells

**Only Sheet1 and written in English is functional. Delete the other sheets**

	A	B	C	D
1		Code Group	Label species	
2	Group 1 Sponges			
3	Axinella damicornis	S		1
4	Crella pulvinar	S		2
5	Dendroxea lenis	S		3
6	Dyctionella sp.	S		4
7	Dysidea avara pallescens	S		5
8	Ircinia variabilis	S		6
9	Oscarella imperialis	S		7
10	Petrosia ficiformis	S		8
11	Pleraplysis spinifera	S		9
12	Prosuberites longispinus	S		10
13	Raspaciona aculeata	S		11
14	Haliclona fulva	S		12
15	Haliclona mucosa	S		13
16	Sponge orange non iden	S		14
17	Spongia virgultosa	S		15
18	Group 2 Cnidaria			
19	Caryophyllia inornata	C		16
20	Hoplangia durotrix	C		17
21	Corallium rubrum	C		18
22	Leptopsammia pruvoti	C		19
23	Group 3 Tunicates			
24	Aplidium fuscum	A		20
25	Group 4 Complex			
26	Animal complex	Co		21
27	Bare space	Co		22
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				

Figure 4. Format of the Species list in Excel spreadsheet 1997-2003.

### 3.6 Import species list

1) From the SeascapE menus select File > Import Class List.

2) A dialog window will pop-up, requiring you to browse and select the XLS file created by the user.

3) Once the file is selected, another dialog window will pop-up, presenting a list of all the species found on the Excel file.

•Within this list, you can select all or a subset of species. Four buttons are presented : '**Select all**': to select all the items of the list; '**Select none**': to un-select all of the items of the list; '**Use selected classes**': use the selected items of the list; '**Use all classes**': to directly use all the classes of the list. You will only be able to work with the selected ones. After selecting the species, close the window.

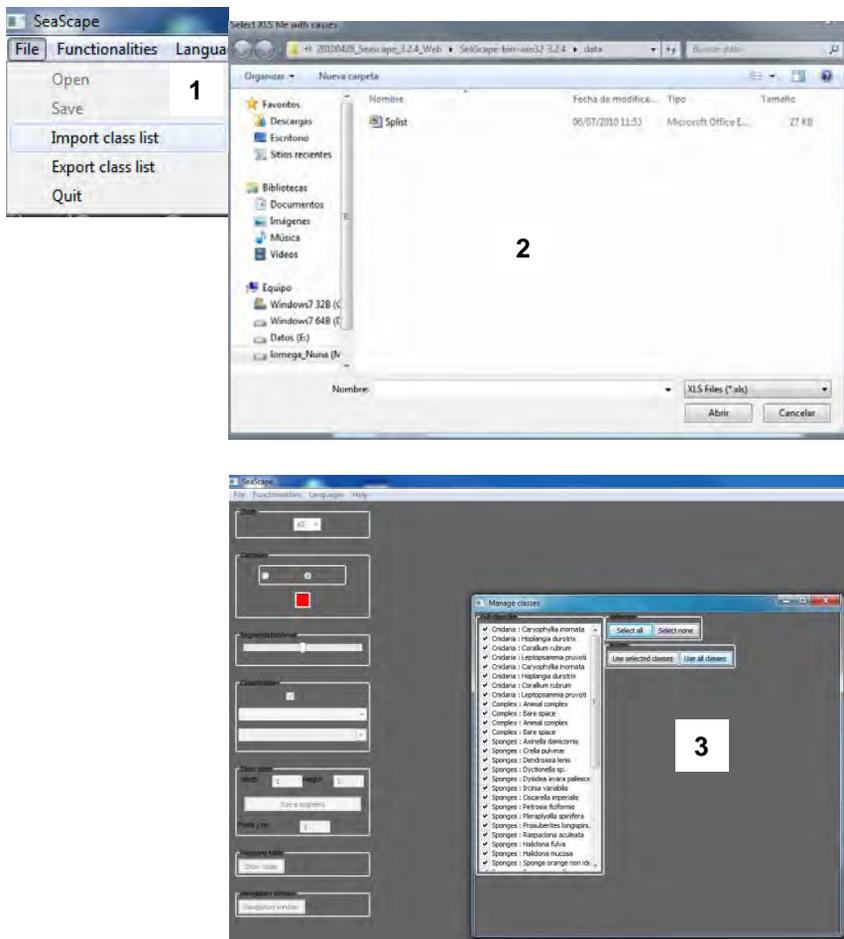


Figure 5. Different dialog windows to import the species list into SeascapE

### 3.7 Defining the color code of species list

- 1) From the menu select Functionalities> Manage ColorMaps.
- 2) A dialog window will pop up, with the fields Class Id, Red, Green, Blue, Color, and Species name.
- 3 & 4) Double-click in the color cell of each species to define the desired color. The values will be coded in Ascii representing the hexadecimal value of a value in the range between 0 and 255. Each species has to be a unique code .
  - When all the species are labeled with their color, close the window.
- 5) The user can save the color codes of the species list for further analysis by clicking Save ColorMap (Figure 7) . This will be an Ascii file with 768 lines, where a set of three lines will correspond to a value.
- 6) The user can load the color code file created by clicking Load ColorMap (Figure 6).

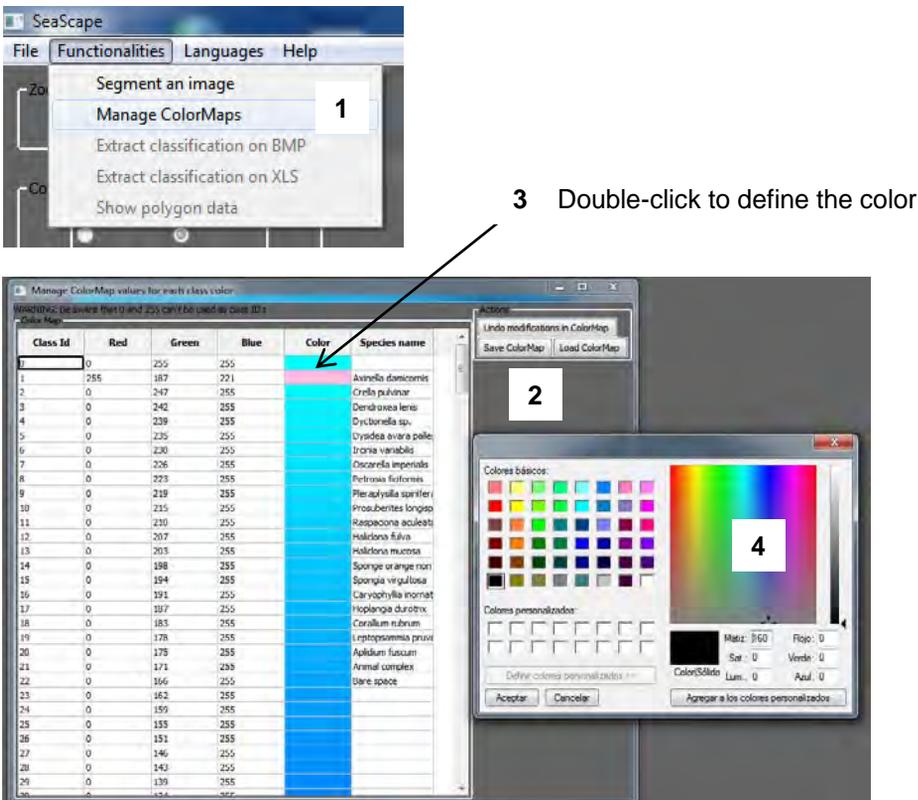


Figure 6. Different dialog windows to define the color for the species.

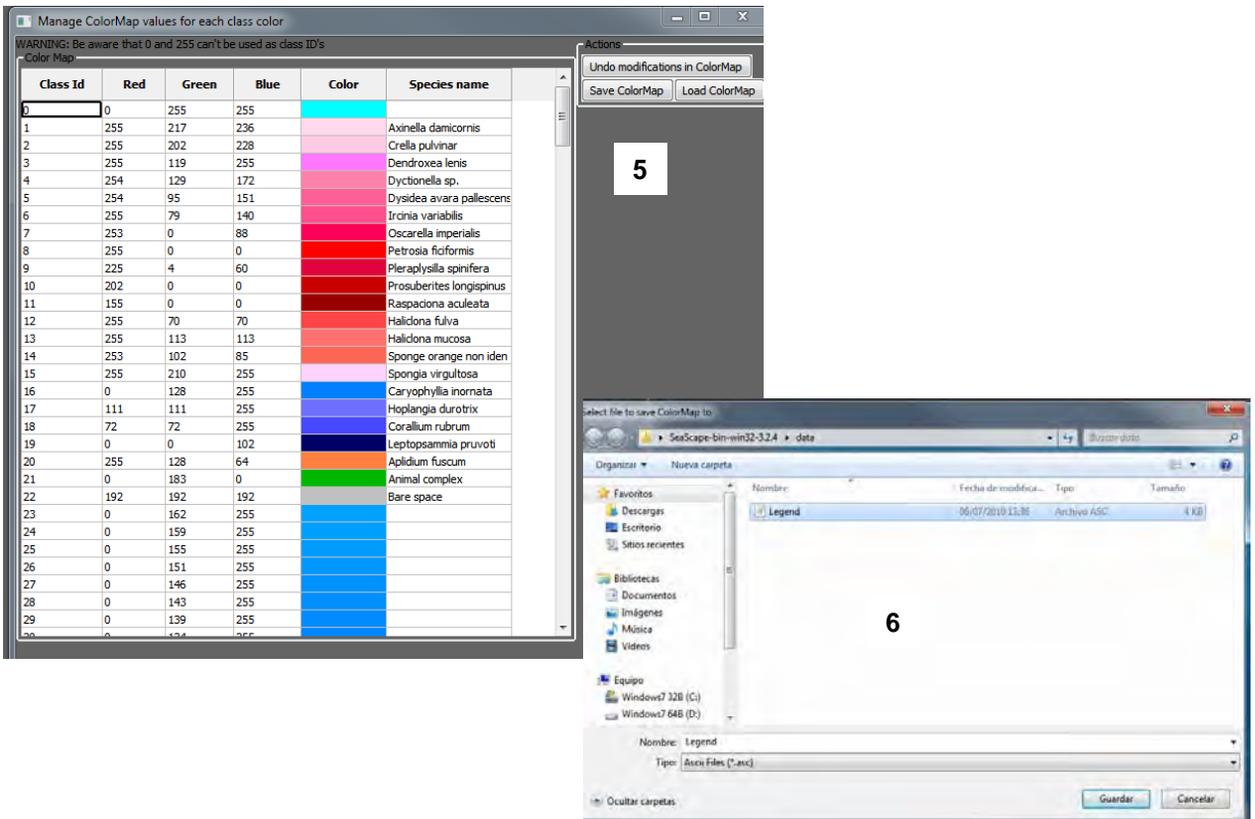


Figure 7. Saving the legend of color map for the species. A dialog window will pop up, requiring the user to enter the name for the color map file.

## 3.8 Importing and segmenting an image

- Seascape accepts images with the formats .jpg and tiff. files. Other formats such as png and bmp should also work. Seascape only opens one file at a time.
- Seascape can segment images approximately until approximately 3000\*2000 pixels . However, high resolution images demand high computational resources. We recommend to work with images around 1000\*700 pixels for Windows 32-bits and 4 GB RAM.
- It is mandatory that the **image file** has to be located in the “**Data**” directory.

- 1) To segment an image select Functionalities>Segment an image.
- 2) A dialog window will pop- up, requiring you to set the value for three segmentation parameters (Figure 8). See more information below . Close the window
- 3) A dialog window will pop- up, requiring you to select the image. Press ok and the segmentation process will start.

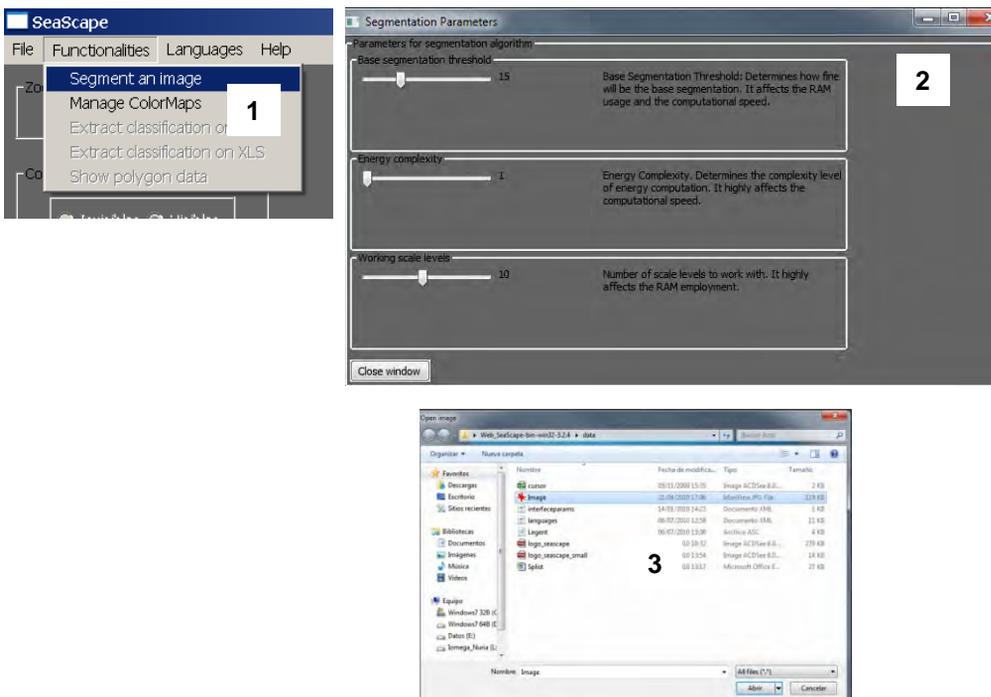
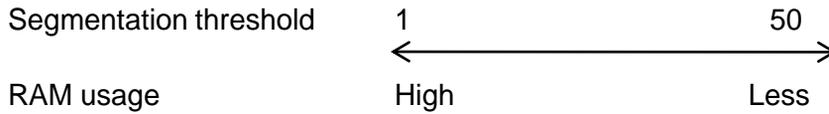
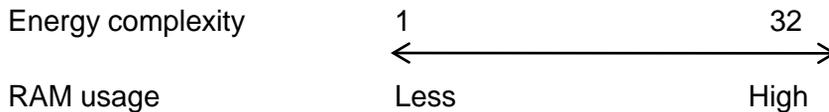


Figure 8. Segmentation parameters that the user can modify. These parameters modify the RAM usage of the computer.

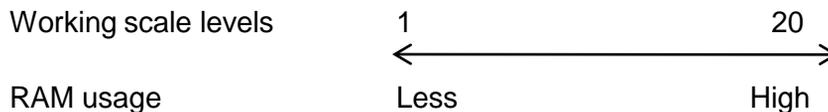
- **Base segmentation threshold.** This value will set the criteria used to decide the division of the image on small regions on the first step of the segmentation algorithm. The lower the value, the more strict the criteria will be and, thus, the finer the segmentation. This would mean more and smaller initial segments. This parameter is related with the RAM usage of the application.



- **Energy complexity.** This value will set the complexity used for the energy computation in the main step of the segmentation algorithm. The higher this value is set, the more computationally expensive the segmentation will be. This value highly affects the computational speed of the algorithm. In high resolution images this parameter has to be carefully chosen, as it exponentially increases the computational time.



- **Working scale levels.** This value will set the number of segmentation scale levels that the application will work with. As for each scale level, the program has to create a segment image. This number highly affects the RAM usage of the application. If you need to intensively modify the segmentation scale while classifying regions, set this parameter moderately high. Otherwise, set it low in order to keep the application response time quick.



**We recomend you to work with the default values, Threshold: 15, Energy complexity :1, Working scale levels: 10 and with images of approximately 1000\*700 pixels.**

### 3.9 RAM requirements

Seascope needs RAM memory to segment the images. See the following table for examples of computational demands: it comprises the number of pixels (horizontal\*vertical), zoom levels (horizontal\*vertical), 4 Bytes per pixels, and Number of indeterminate images that corresponds to Working scale levels of the segmentation parameters (default value 10).

Examples	Pixels	Pixels	Zoom 1	Zoom 2	4Bytes* pixels	N levels	Bytes	MB or GB required (Bytes/1024 *1024)	Minimum RAM demands for PC computer
1 example with 3 levels segmentation 3347*2276 pixels	3347	2276	2	2	4	3	365653056	366MB	1-2GB (32 bytes, 64 bytes)
1 example with 5 levels segmentation 3347*2276 pixels	3347	2276	2	2	4	5	609421760	581.19	2 GB (32 bytes, 64 bytes)
1 example with 15 levels segmentation 3347*2276 pixels	3347	2276	2	2	4	15	1828265280	1743.57	6GB (64 bytes)
1 example with 15 levels segmentation 1000*700 pixels	1000	700	2	2	4	15	168000000	160.22	1 GB (32 bytes, 64 bytes)

We highly recommend working with images with intermediate number of pixels (e.g. approximately 1000\* 900 pixels) and the default segmentation values (e.g. Working scale levels of 10). It is more relevant to have a standard image of 1000\*900 pixels, to choose a working scale levels of 10-15 (meaning 10-15 intermediate images) and to adjust dynamically the optimal level of segmentation rather than to have a large image (3347\*2276 pixels) with a working scale of 3-5.

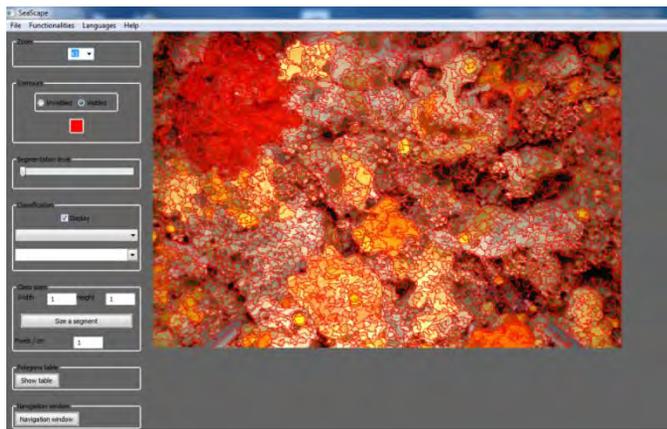


Figure 9. Result of the segmentation process with the finest level of segmentation.

### 3.10 Specifying the image scaling (known distance, n pixels/cm)

- It is necessary to calibrate an image to be able to calculate the cover area and perimeter of patches. Seascope has the ability to calibrate an image by 2 ways: defining a known distance or indicating the number of pixels per cm

- **Defining a know distance:** 1) Click the bottom “Size a segment”. Two points that separated by a known distance are marked. 2) Then click one point and after the second point. 3) A window will pop–up requiring the user to enter the distance spanned (**in cm**) by the points. Close the window and the scaling resolution will be calculated.

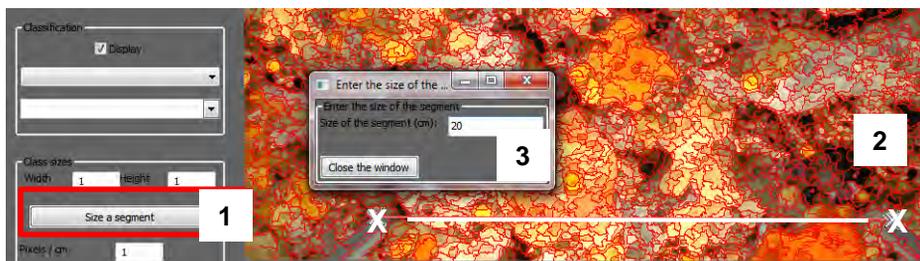


Figure 10. Defining a known distance

- **Defining the number of pixels per cm.** The user directly indicates the known number of pixels/cm inside of the window. Then, Width and Height will be automatically calculated.

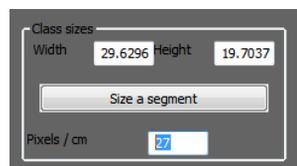


Figure 11. Indicating the number of pixels/cm

### 3.11 Labeling a region

1) To calculate areas of selected regions, select a group from the first drop list of the Classification section.

2) Then, the user selects the species name to be labeled from the second drop list.

3) Once the species is selected, the user can go to the segmented image and label the region.

- If the user **simply clicks on a point with the left button of the mouse**, the region encompassing that point will be labeled.

- If the user **holds the left button of the mouse down and move the cursor around the region**, a line will be drawn following the path. Once you release the mouse button, all the regions will be labeled.

- To label a region with another species label, simply select the new species label. If the species belongs to other group or category, first choose the adequate group and after the species.

- Once a region is labeled, a process will convert raster data into polygonal data. Metrics of each individual polygon (surface and perimeter) are computer.

- If the user needs to **un-label a region**, just **press the right button** of the mouse over the target region and it will be un-labeled.

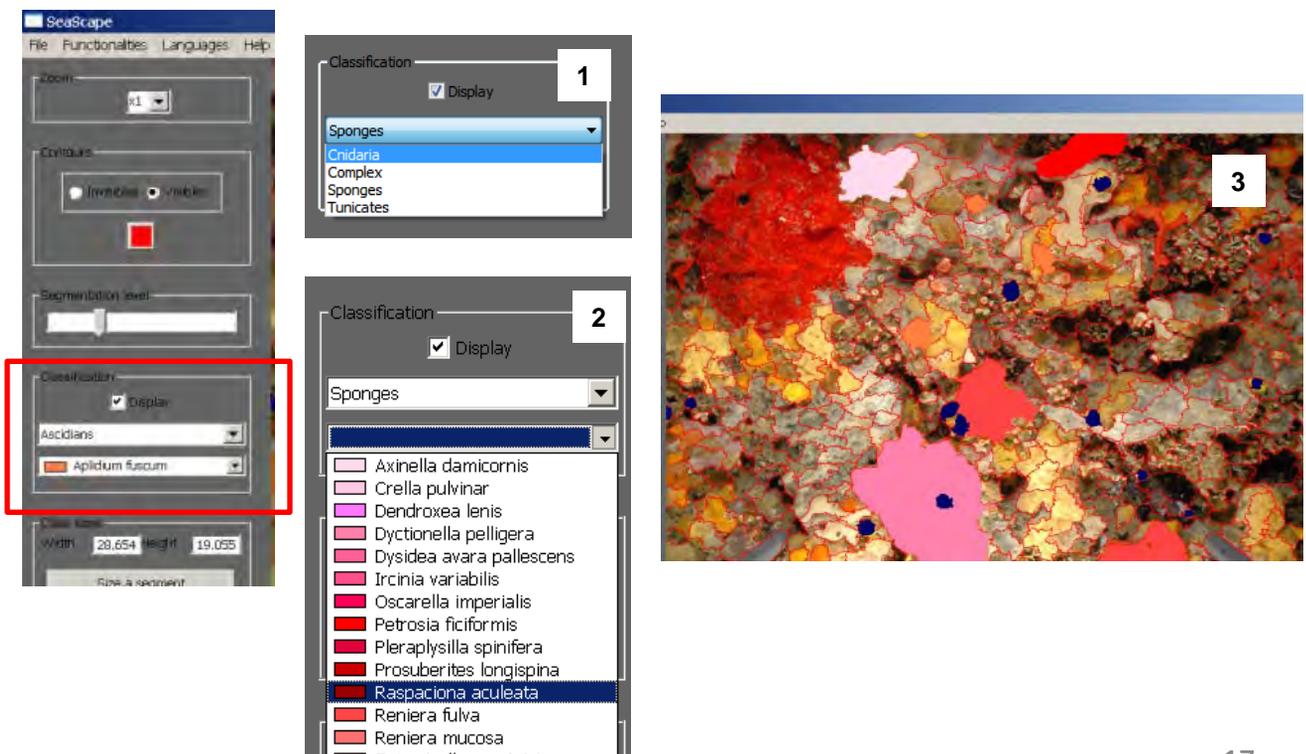


Figure 12. Select the group and the species within it to label the regions

### 3.12 Changing the segmentation scale

- It is highly recommendable to change the segmentation level in function of the image complexity. This is a dynamical procedure.
- To change the segmentation scale, just move the slider at the segmentation level desired at the “Segmentation level” section.
- Users can combine different segmentations levels to label a single polygon. For example, inner parts of a region can be label with coarse segmentation level whereas the borders can be done with more detailed and finer level.



Figure 13. Changing the segmentation scale for the same image.

### 3.13 Classification table

- At any time during the labeling process, the user can press “Show table” button to observe the area (cm<sup>2</sup>) and perimeter (cm) values for each polygon labeled.

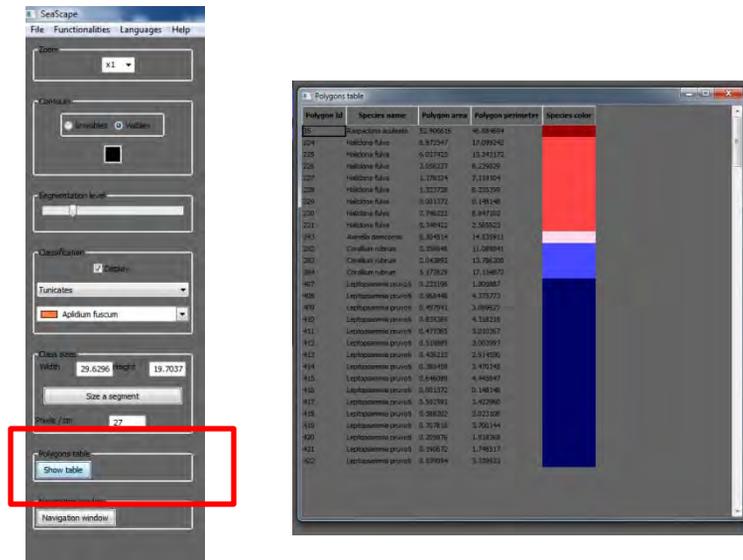


Figure 14. General classification table showing area and perimeter values for each polygon.

### 3.14 Showing information of a specific polygon

At any time during the labeling process, the user can check the area and perimeter values of a specified polygon.

- 1) Select Functionalities > Show Polygon data and click the corresponding polygon of the main segmented image.
- 2) A window will pop up and the selected polygon will be highlighted.

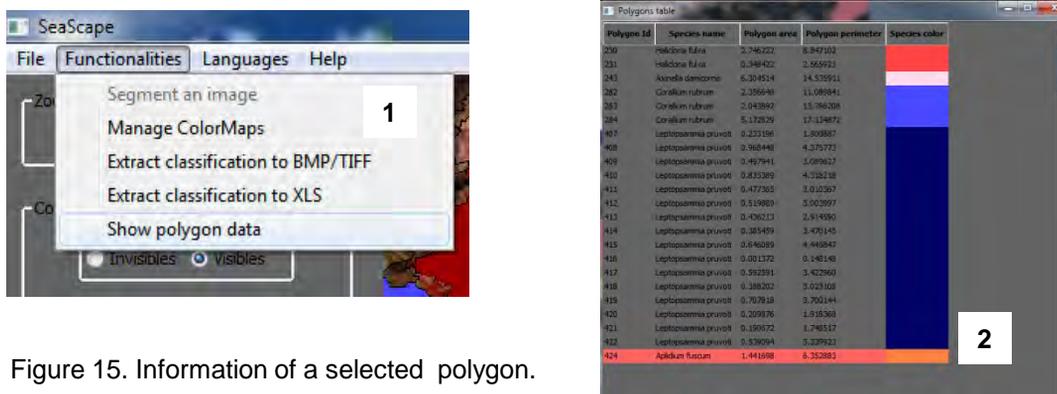
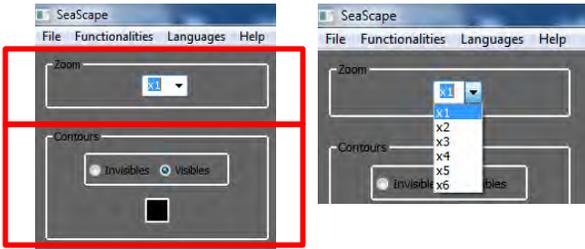


Figure 15. Information of a selected polygon.

### 3.15 More program tools

#### Zoom

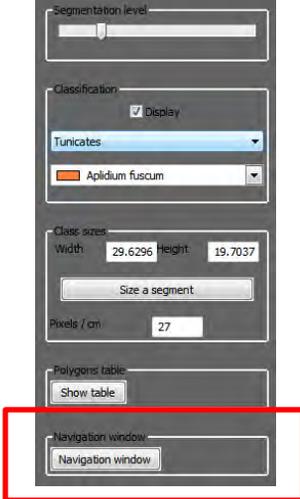


Zoom the image at the optimal zoom level by selecting the zoom window

#### Segments color



Hide/show the region contours and to select the optimal color for the segments



#### Navigation Window



Show the Navigation window by clicking the Navigation window button

### 3.16 Exporting the classification to bitmaps or tiff files

Seascape includes the capacity to export the classification of the polygons to bitmap and tiff files.

- 1) To export the image: select Functionalities > Extract classification to BMP/TIFF.
- 2) A window dialog will pop-up requiring the user to browse the path and enter the filename.
- 3) **Labeled polygons** will present the previous **selected color** whereas **regions not labeled** will appear **in black**. By default, files will be **save in the Data directory**

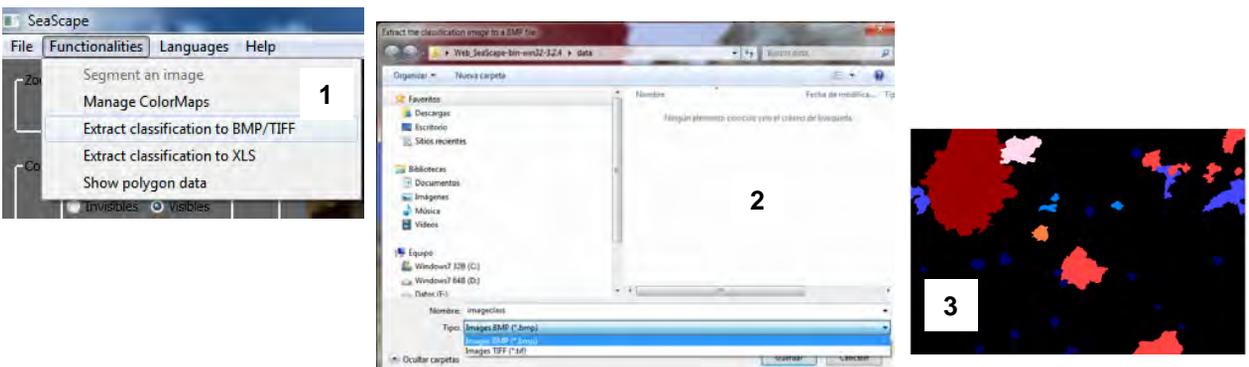


Figure 15. Overview to export the classification to bitmap and tiff files.

### 3.17 Exporting the classification to Excel spreadsheet files

- 1) Select Functionalities>Extract classification to XLS.
- 2) The user can choose the optional fields containing information of region, locality, date, and depth. The user can also choose to export the data to ASCII file or chose to export the data to an existing Excel file for statistical analysis (e.g. all the data from several images of the same transect in the same file).
- 3) After clicking Save export button, a dialog will pop-up requiring to browse the path and to enter the filename. By default, the Excel file will have the same name as the image file. If the user select to attach the current data to an existing file, the user will need to select the existing file.
- 4) The data is automatically assembled into an Excel spreadsheet containing information on Image Id, Species name, Polygon id, Species id, Surface (cm<sup>2</sup>), and Perimeter (cm).

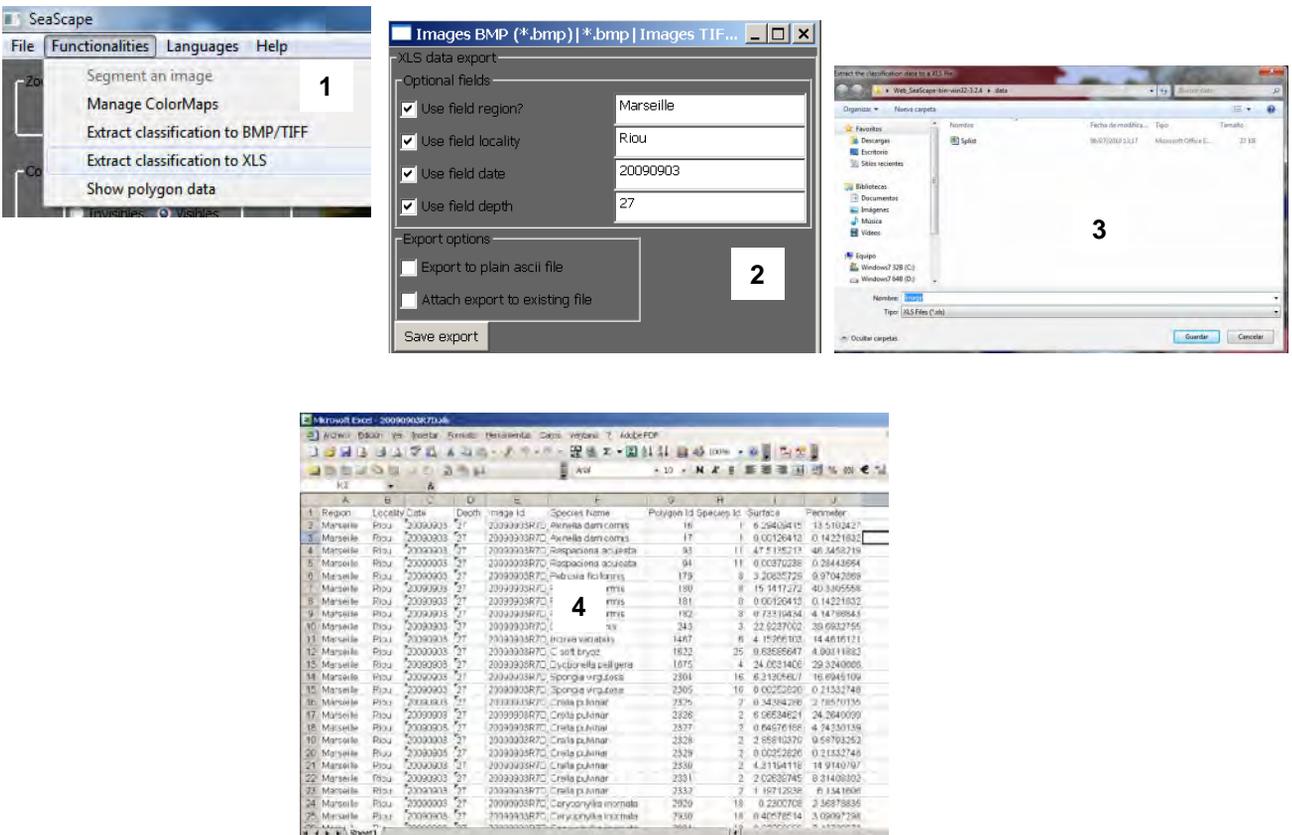


Figure 16. Overview to export the classification data to Excel files.