

Exercise One: Creating A Custom Tool For Plotting Species Locational Data

In marine biology, information on the locations where a species has been recorded are often stored in a spreadsheet where each line represents an individual record with the positional information held in separate fields for latitude and longitude. In order for these to be used in GIS, these data generally have to be plotted to create a point data layer. In addition, before the point data layer can be used for any other GIS-based tasks, they will usually need to be transformed from the geographic projection/coordinate system (which uses decimal degrees as its map units) into another more suitable projection/coordinate system, such as the custom transverse mercator projection which will be used in this exercise. This is because the geographic projection/coordinate system is not appropriate for GIS-based tasks which involve measuring distances and areas (see exercise three), or creating many types of raster data layers (see exercise two).

The chances are if you are working on a specific GIS project, you will use the same projection/coordinate system throughout it, and you will find that every time you need to add species locational data from a spreadsheet, you will have to repeatedly go through the same steps over and over again. Under these circumstances, it is worth creating a customised GIS tool which allows you to do all these steps by clicking on a single tool rather than having to do each step manually every time.

In this exercise, you will create a custom GIS tool, based on two existing tools, which will allow you to automatically plot species locational data and transform it into a specific projection/coordinate system. These two existing tools are the MAKE XY EVENT LAYER tool (DATA MANAGEMENT TOOLS> LAYERS AND TABLE VIEWS> MAKE XY EVENT LAYER) and the PROJECT tool (DATA MANAGEMENT

TOOLS> PROJECTIONS AND TRANSFORMATIONS> PROJECT). Thus, this custom GIS tool will consist of two modules, each of which has a single component.

Before you start this exercise, you will first need to create a new folder on your C: drive called GIS_EXERCISES_6. To do this on a computer with the Windows 7 operating system, click on the START menu and select MY COMPUTER. In the window which opens, double-click on the icon for your C: drive (this may be called WINDOWS (C:)). This will open a window which displays the contents of your C: drive. To create a new folder, right click on this window and select NEW> FOLDER. This will create a new folder. Now call this folder GIS_EXERCISES_6 by typing this into the folder name to replace what it is currently called (which will most likely be NEW FOLDER). This folder, which has the address C:\GIS_EXERCISES_6, will be used to store all files and data for the exercises in this book.

Next, you need to download the source files for three data sets from www.gisinecology.com/books/data/marinebiology-supplementary-workbook. To download these files, follow the instructions on the webpage, then unzip the compressed folder and save the files into the folder C:\GIS_EXERCISES_6 which you have just created. These data sets are:

1. Harbour_Porpoise.xls: This is a spreadsheet file which has latitudes and longitudes for locations of harbour porpoise sightings recorded during surveys conducted in northeast Scotland. **NOTE:** The latitude and longitude have already been converted into decimal degrees. If you are doing this for your own data set, you would need to make sure that all your latitude and longitude values have been correctly converted into decimal degrees before you start.

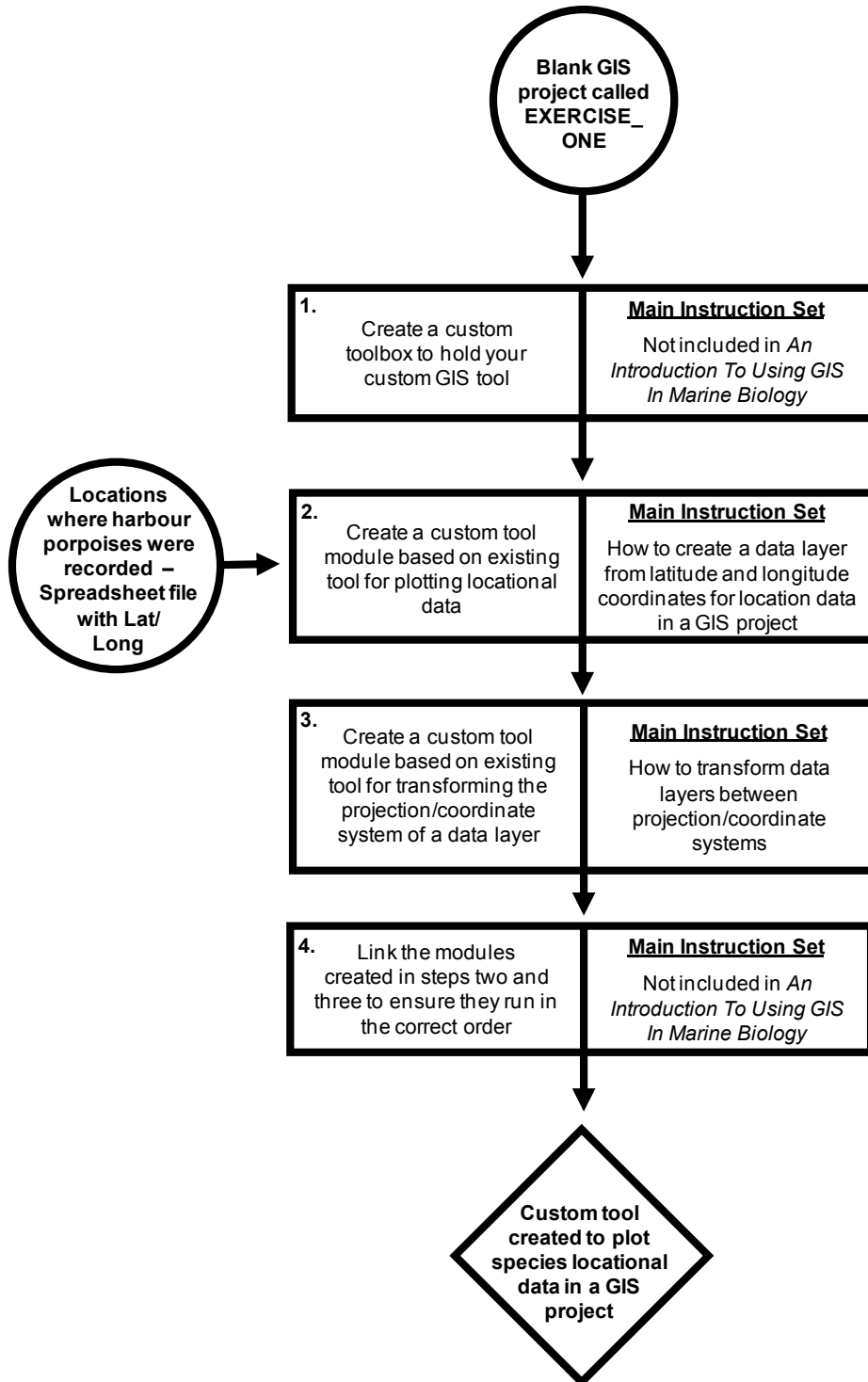
2. Bottlenose_Dolphin.xls: This is a spreadsheet file which has latitudes and longitudes for locations of bottlenose dolphin sightings from surveys conducted in northeast Scotland. **NOTE:** The latitude and longitude have already been converted into decimal degrees. If you are doing this for your own data set, you would need to ensure that all your latitude and longitude values have been correctly converted into decimal degrees before you start.

3. Land_North_Sea_Project.shp: This is a polygon data layer which contains information on land in the region where the surveys were conducted. You will need to download all the files called Land_North_Sea_Project (each with a different extension) in order to be able to use it. This data layer is in the same custom transverse mercator projection which the point data layers generated by the custom tool will be transformed into as part of the automation process. **NOTE:** The land information is not accurate and is only provided here as an approximation of the actual land. As a result, it should not be used for any purpose other than these exercises.

Once you have all these files downloaded into the correct folder on your computer, and understand what is contained within each data set, you can move onto creating your first custom GIS tool. The starting point for this is a blank GIS project. To create a blank GIS project, first, start the ArcGIS software by opening the ArcMap module. When it opens, you will be presented with a window which has the heading ARCMAP – GETTING STARTED. In this window, you can either select an existing GIS project to work on, or create a new one. To create a new blank GIS project, click on NEW MAPS in the directory tree on the left hand side and then select BLANK MAP in the right hand section of the window. Now, click OK at the bottom of this window. This will open a new blank GIS project. (**NOTE:** If this window does not appear, you can start a new project by clicking on FILE in the main menu bar area, and selecting NEW. When the NEW DOCUMENT window opens, select NEW MAPS and then BLANK MAP in the order outlined above.) Once you have opened your new GIS project, the first thing you need to do is save it under a new, and meaningful, name. To do this, click on FILE in the main menu bar area, and select SAVE AS. Save it as EXERCISE_ONE in the folder C:\GIS_EXERCISES_6. The next thing you need to do is add a data layer called LAND_NORTH_SEA_PROJECT to your GIS project. This will allow you to put the data layers of species distribution which you will create during this exercise in a wider context, and, specifically, it will allow you to check that they have been plotted in the right place.

Once you have your GIS project set up, you need to read over the summary flow diagram for this exercise. This will help you identify all the major steps you need to carry out and the individual instruction sets you will need to follow to do them. The summary flow diagram for this exercise is provided on the next page.

*Summary Flow Diagram For Creating A Custom GIS Tool For Plotting Species
Locational Data*



Once you have familiarised yourself with the summary flow diagram outlining the major steps you will need to complete, and which instruction sets can be used to complete them, you need to read through the instruction set for the first of these major steps in its entirety (see below), before working through it stage by stage. When you have completed the first major step, read through the instructions again to check that you have completed it properly. It is important to do this at this stage as you need to use the results of one major step as the starting point for the next, and it is much easier to spot where you have gone wrong at the end of an individual major step, rather than trying to work it out later when you get stuck as a result of a mistake made at this stage. Once you are happy that you have completed the first major step successfully, move onto the second major step and repeat this process, and so on until you have completed all the steps in the summary flow diagram.

At various points throughout the exercise, images of the contents of the MAP window, the MODELBUILDER window, the LAYOUT window, the TABLE OF CONTENTS window and/or the TABLE window will be provided so that you have an idea of what your project should look like at that specific point. Check your GIS project against these images. If they do not match up, you will need to go back and work out where you have gone wrong. **NOTE:** It is important that you save your GIS project after completing each major step. This can be done by going to the FILE menu on the main menu bar and selecting SAVE.

Instruction Sets For The Individual Steps Identified In The Summary Flow Diagram:

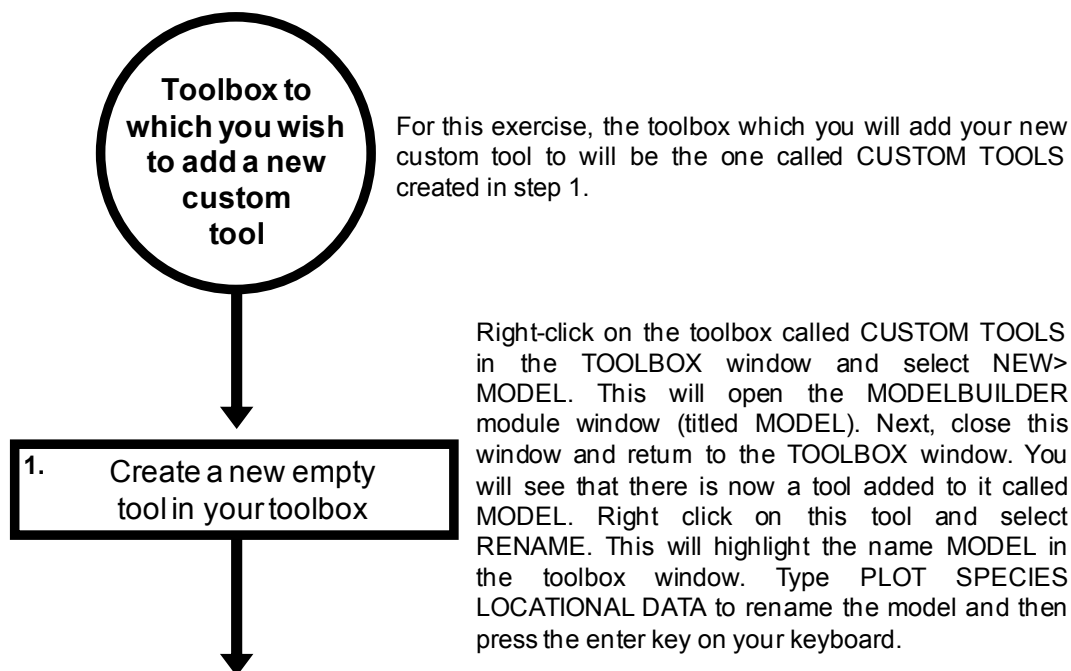
STEP 1: CREATE A CUSTOM TOOLBOX TO HOLD YOUR CUSTOM TOOLS:

Before you can start creating your custom tools using the MODELBUILDER module of the ArcGIS 10.2 software, you first need to create a custom toolbox in the TOOLBOX window to hold them. This is very easy to do. Simply right-click anywhere in the TOOLBOX window and select ADD TOOLBOX. When the ADD TOOLBOX window opens, browse to the location C:\GIS_EXERCISES_6 and then click on the NEW TOOLBOX button in the top right hand corner (it has a picture of a red toolbox on it).

This will create a new toolbox called TOOLBOX.TBX. When you first create it, its name will be selected and highlighted in blue, and this allows you to change its name. To do this, type CUSTOM TOOLS.TBX and then click on OPEN. This will add your new toolbox, called CUSTOM TOOLS, to the TOOLBOX window. **NOTE:** The toolboxes are listed in alphabetical order and you may need to scroll up or down to find your CUSTOM TOOLS toolbox. You are now ready to create your first custom GIS tool.

STEP 2: CREATE A CUSTOM TOOL MODULE BASED ON EXISTING TOOL FOR PLOTTING LOCATIONAL DATA:


Once you have created a new toolbox to hold your custom GIS tools, you can move onto creating the first one. This tool will be called PLOT SPECIES LOCATIONS. This tool will consist of two modules, the first of which will be created in this step. This module is based on an existing tool from the TOOLBOX window called MAKE XY EVENT LAYER, and you will customise this tool to recognise the format that your locational data are in. This includes setting the tool to automatically recognise which fields contain the latitude and longitude information, and what projection/coordinate system these coordinates are based on.






2. Add the MAKE XY
EVENT LAYER tool to
your new custom tool


Right-click on the PLOT SPECIES LOCATIONAL DATA tool name in the TOOLBOX window and select EDIT. This will open the MODELBUIDLER window (which will now be titled PLOT SPECIES LOCATIONAL DATA). Move this window to the side so that you can see the TOOLBOX window. In the TOOLBOX window, navigate to DATA MANAGEMENT TOOLS> LAYERS AND TABLE VIEWS> MAKE XY EVENT LAYER. Click on the name of this tool and while holding down the left mouse button, drag it into the window titled PLOT SPECIES LOCATIONAL DATA. This will add this tool to the custom tool you are making and it will be represented by two white boxes (one rectangular and one oval) linked together by an arrow.



3. Set the MAKE XY
EVENT LAYER tool to use a
specific table


Once you have the MAKE XY EVENT LAYER tool added to your custom tool, you can start customising it. To do this, first right-click on the rectangle with the text MAKE XY EVENT LAYER in it and select MAKE VARIABLE> FROM PARAMETER> XY TABLE. This will add a new oval box to your model called XY TABLE. Right-click on this oval and select OPEN. In the window which opens, click on the browse button at the end of the XY section. Browse to C:\GIS_EXERCISES_6\ HARBOUR_PROPOISE.XLS\SHEET1\$ and then click ADD. This tells the tool that this is the table which contains the XY data you wish to plot. Now click OK to close the XY table window. You will notice that the XY TABLE box will turn BLUE and has been renamed SHEET1\$. This tells you this parameter has been set correctly. You will also notice that the MAKE XY EVENT LAYER box and the LAYER NAME OR TABLE VIEW boxes will change colour. This is okay and it tells you that you have set the minimum number of parameters needed for this tool to work. Finally, click on this box and while holding down the left mouse button drag it upwards.






4. Set the MAKE XY EVENT LAYER tool use a specific field for the X coordinates


To add the next parameter to your module, right-click on the rectangle with the text MAKE XY EVENT LAYER in it again and select MAKE VARIABLE> FROM PARAMETER> X FIELD. This will add a new oval box to your model called X FIELD. Right-click on this oval and select OPEN. In the X FIELD window which opens, click on the small black arrow at the right hand end of the X FIELD section and select LONGITUDE from the drop down menu (you have to do this even if LONGITUDE is already selected in this box when you first open the X FIELD window). Now click OK to close the X Field window. You will notice that the X FIELD box is coloured BLUE. This tells you this parameter has been set correctly. Finally, click on this box and while holding down the left mouse button drag it upwards.



5. Set the MAKE XY EVENT LAYER tool use a specific field for the Y coordinates


To add the next parameter to your module, right-click on the rectangle with the text MAKE XY EVENT LAYER in it again and select MAKE VARIABLE> FROM PARAMETER> Y FIELD. This will add a new oval box to your model called Y FIELD. Right-click on this oval and select OPEN. In the Y FIELD window which opens, click on the small black arrow at the right hand end of the Y FIELD section and select LATITUDE from the drop down menu (you have to do this even if LATITUDE is already selected in this box when you first open the Y FIELD window). Now click OK to close the Y Field window. You will notice that the Y FIELD box is coloured BLUE. This tells you this parameter has been set correctly. Finally, click on this box and while holding down the left mouse button drag it downwards.






6. Set the projection/
coordinate system for your XY
coordinates

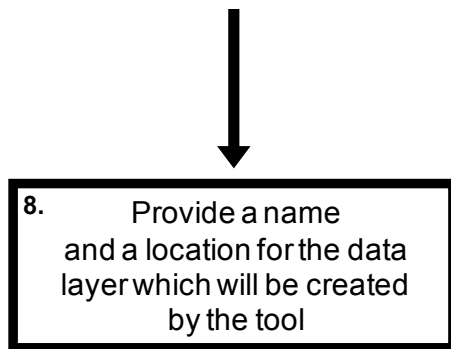
To add the last parameter to your module, right-click on the rectangle with the text MAKE XY EVENT LAYER in it again and select MAKE VARIABLE> FROM PARAMETER> SPATIAL REFERENCE. This will add a new oval box to your model called SPATIAL REFERENCE. Right-click on this oval and select OPEN. In the SPATIAL REFERENCE window which opens, click on the browse button at the right hand end of the SPATIAL REFERENCE section. This will open the SPATIAL REFERENCE PROPERTIES window. In the upper section of this window, select GEOGRAPHIC COORDINATE SYSTEMS> WORLD> WGS 1984. **NOTE:** This is being selected because the coordinates are provided as latitude and longitude values based on the WGS 1984 datum. If your coordinates were based on a different projection/coordinate system, you would need to select a different option. Click OK to close the SPATIAL REFERENCE PROPERTIES window and then OK to close the SPATIAL REFERENCE window. You will notice that the SPATIAL REFERENCE box will turn BLUE. This tells you this parameter has been set correctly. Finally, click on this box and while holding down the left mouse button drag it downwards.



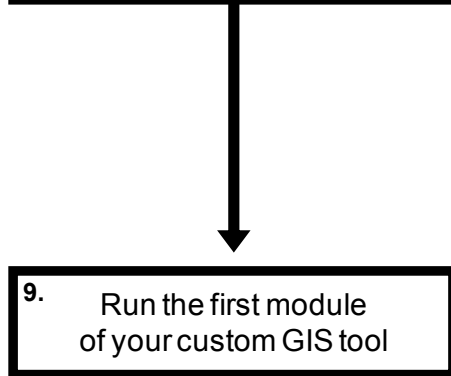
7. Set which variables
will be user-defined
parameters

Once you have set all your input parameters for a module, you will need to decide which will be user-defined each time you run your custom tool, and which will use the pre-set values you have just selected. For this exercise, the only variable you will set to user defined will be XY TABLE. This will allow you to select any XY table you want when you run the tool. To set XY TABLE to be user-defined, right click on the oval called SHEET1\$ and select MODEL PARAMETER. The letter P will now appear beside this box, telling you it has been set to be a user-defined parameter.

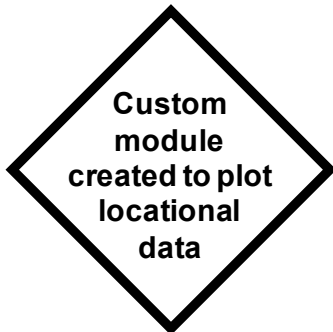




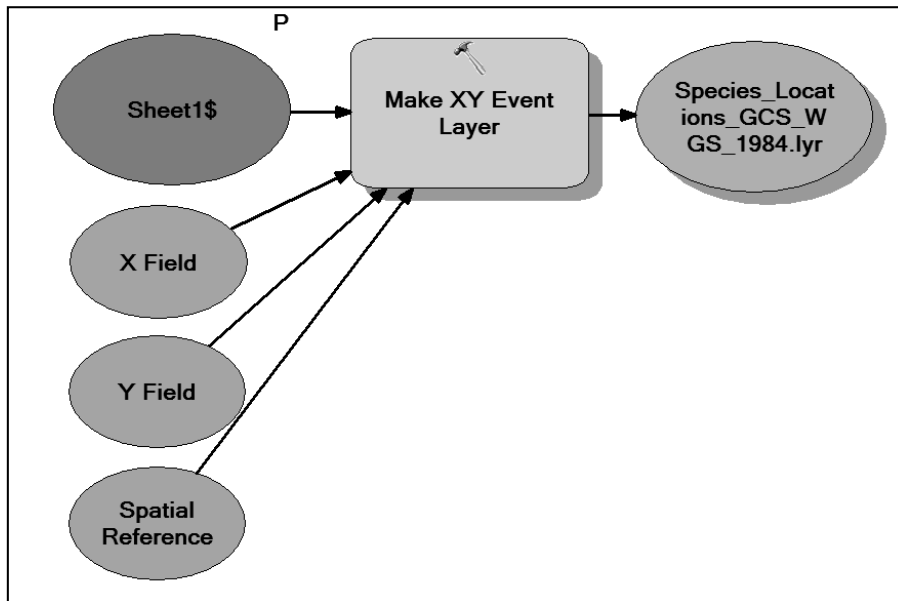
Right-click on the LAYER NAME OR TABLE VIEW box and select OPEN. In the window which opens, type in C:\GIS_EXERCISES_6\SPECIES_LOCATIONS_GCS_WGS_1984.LYR. This will save the layer created by the tool in this folder under this name. This is just a temporary file which is needed by the tool to run. Therefore, it doesn't matter that it has a generic name. You can now click OK to close this window. Finally, right-click on the box now called SPECIES_LOCATIONS_GCS_WGS_1984.LYR and select ADD TO DISPLAY.



Now that you have created the first module of your model, you need to run it to check that it is working. To run the module, right click on the MAKE XY EVENT LAYER box and select RUN. If everything goes okay with your model, a point data layer with the porpoise locations will be added to your GIS project (see page 29 for how the contents of the MAP window should look at this stage). If, however, you get an error message, you will need to go back and check that the model parameters have been set correctly.



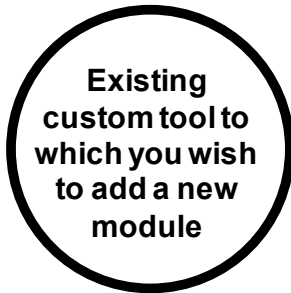
At the end of this step, the contents of the window called PLOT SPECIES LOCATIONAL DATA should look like the image at the top of the next page.



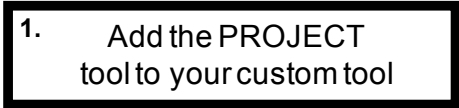
NOTE: You may have to move the window around, or zoom out to see the entire module. In addition, you may have to re-arrange the boxes to get this exact layout. This can be done by clicking on individual boxes and dragging them to their new positions before releasing the mouse button again.

STEP 3: CREATE A CUSTOM MODULE BASED ON EXISTING TOOL FOR TRANSFORMING THE PROJECTION/COORDINATE SYSTEM OF A DATA LAYER:

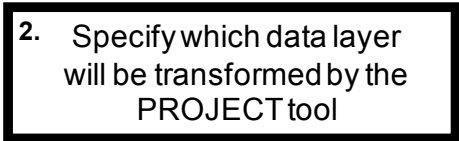
Once you have created a module which will make a layer based on your locational data from your spreadsheet, you will need to add a second module which will transform it into the projection/coordinate system which you are using for your GIS project. This module is based on an existing tool from the TOOLBOX window called PROJECT, and in this step, you will customise this tool so that it will transform the layer created by the first module into the required projection/coordinate system without you needing to select it each time you use the tool. The flow diagram outlining how you can create this module starts on the next page.



For this exercise, the tool which you will add a new module to will be the one called PLOT SPECIES LOCATIONAL DATA created in step 2.

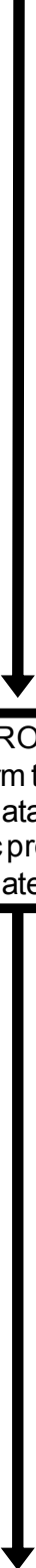


In the TOOLBOX window, navigate to DATA MANAGEMENT TOOLS> PROJECTIONS AND TRANSFORMATIONS> PROJECT. Click on the name of this tool and while holding down the left mouse button, drag it into the window titled PLOT SPECIES LOCATIONAL DATA. This will add this tool to the custom tool you are making, and it will be represented by two white boxes (one rectangular and one oval) linked together by an arrow. Finally, click on the box called PROJECT and drag it down so it is below the MAKE XY EVENT LAYER tool.



Once you have the PROJECT tool added to your custom GIS tool, you can start customising it. To do this, first right-click on the rectangle with the text PROJECT in it and select MAKE VARIABLE> FROM PARAMETER> INPUT DATA SET OR FEATURE CLASS. This will add a new oval box to your model called INPUT DATA SET OR FEATURE CLASS. Right-click on this oval and select OPEN.

In the INPUT DATA SET OR FEATURE CLASS window which opens, select SPECIES_LOCATIONS_GCS_WGS_1984.LYR from the drop down menu. Now click OK to close the INPUT DATA SET OR FEATURE CLASS window. You will notice that the INPUT DATA SET OR FEATURE CLASS box will have been renamed and turned BLUE. This tells you this parameter has been set correctly. Finally, click on this box and while holding down the left mouse button drag it upwards.

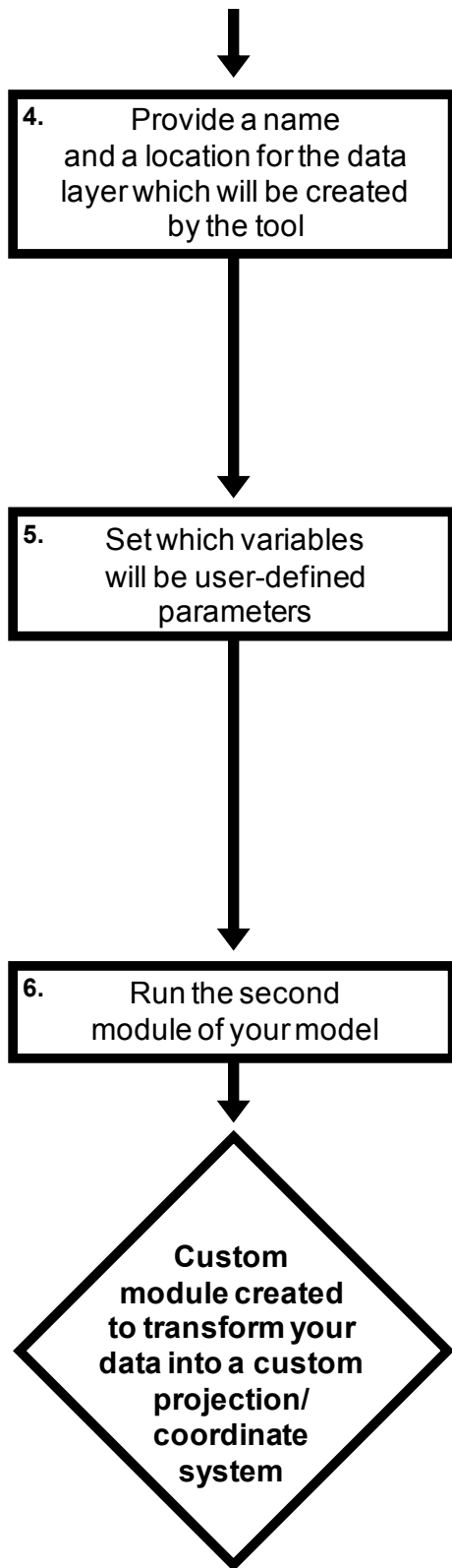


3. Set the PROJECT tool to transform the species locations data layer into a specific projection/ coordinate system

Next, right-click on the rectangle with the text PROJECT in it and select MAKE VARIABLE> FROM PARAMETER> OUTPUT COORDINATE SYSTEM. This will add a new oval box to your model called OUTPUT COORDINATE SYSTEM. Right-click on this oval and select OPEN.

In the OUPUT COORDINATE SYSTEM window which opens, click on the button at the right hand end to open the SPATIAL REFERENCE PROPERTIES window. In the SPATIAL REFERENCE PROPERTIES window, press the ADD COORDINATE SYSTEM button that can be found towards the top right hand corner of the COORDINATE SYSTEM tab (it has a picture of a globe on it), and select NEW> PROJECTED COORDINATE SYSTEM. This will open the NEW PROJECTED COORDINATE SYSTEM window. In the upper NAME section, type in NORTH SEA. In the PROJECTION portion of the window, select the name of the appropriate type of coordinate system from the drop down menu (in the lower NAME section). For this exercise, select TRANSVERSE MERCATOR. Next, type in the values you wish to use for the parameters. For LATITUDE_OF _ORIGIN enter 56.5. For CENTRAL_ MERIDIAN enter -1.0. Leave all other sections of the window with their default settings.

In the GEOGRAPHIC COORDINATE SYSTEM section of the PROJECTED COORDINATE SYSTEM window, by default it should say NAME: GCS_WGS_1984. If it doesn't, click on the CHANGE button and type WGS 1984 into the SEARCH box in the window that appears and press the return key on your keyboard. Select WORLD> WGS 1984, and click the OK button. Now click the OK button in the NEW PROJECTED COORDINATE SYSTEM window, and then click OK in the SPATIAL REFERENCE PROPERTIES window before clicking OK to close the OUTPUT COORDINATE SYSTEM window. You will notice that the OUTPUT COORDINATE SYSTEM box will turn BLUE. This tells you this parameter has been set correctly. The other boxes will also change colour indicating that the minimum number of required parameters have been set. Finally, click on this box and while holding down the left mouse button drag it downwards.



Right click on the OUTPUT DATA SET OR FEATURES box and select OPEN. In the window which opens, type C:\GIS_EXERCISES_6\HARBOUR_PORPOISE_PROJECT.SHP. This will save the layer created by the tool in this folder under this name. You can now click OK to close this window. Finally, right-click on the box now called HARBOUR_PORPOISE_PROJECT.SHP and select ADD TO DISPLAY.

Once you have set all your input parameters for a tool, you will need to decide which will be user-defined each time you run your custom tool, and which will use the pre-set values you have just selected. For this exercise, the only variable you will set to user-defined will be the name of the transformed data layer. This will allow you to give the transformed data layer any name you want, and for you to save it in any location on your computer, when you run the tool. To set the transformed data layer to be user-defined, right click on the box that is now called HARBOUR_PORPOISE_PROJECT.SHP and select MODEL PARAMETER. The letter P will now appear beside the OUTPUT DATASET OR FEATURE CLASS box, telling you it has been set to be a user-defined parameter.

Now that you have created the second module of your model, you need to run it to check that it is working. However, before you run it, you must save the changes you have made to the custom tool by clicking the SAVE button. Next, to run the module, right click on the PROJECT box and select RUN. If everything goes okay with your model, a data layer called HARBOUR_PORPOISE_PROJECT will be added to your GIS project. If, however, you get an error message, you will need to go back and check that model parameters have been set correctly.

At the end of this step, the contents of the window called PLOT SPECIES LOCATIONAL DATA should look like this:

