

Exercise One: Estimating The Home Range Of An Individual Animal Using A Minimum Convex Polygon (MCP)

In many populations, different individuals will use different parts of its range. This may be because different individuals occupy different territories or it may be because different individuals have slightly different habitat preferences. The spatial area used by each individual is known as its home range and it is often useful to be able to identify and compare the home ranges of individual animals within a specific study area to explore why these differences exist. This is done by gathering data on the locations different individual use throughout the duration of a study. However, even with satellite or radio tags, it is unlikely that researchers can track every single location each individual uses. Thus, it becomes important to be able to estimate an individual's home range from the available sample of locations an individual uses

There are two basic ways that an individual's home range can be estimated from a sample of locations that it uses. These are using a minimum convex polygon (MCP) and kernel density analysis (KDE). An MCP is estimated by working out the smallest polygon that can be drawn that will enclose all the locations where an individual has been recorded, and it is this approach to estimating the home range of an individual that will be covered in this exercise. While MCPs are useful in identifying the total area that an individual uses, they do not provide any information about whether the individual uses all of this area equally or whether it spends more time in some parts of the MCP in comparison to others. In addition, MCPs can be skewed by the presence of outliers where one location where the individual was apparently recorded lies well away from all others. These outliers can be the result of errors in data collection, mis-identification of individuals or because an individual

animals has, for some reason, strayed far from its usual range. Thus, before using the MCP approach to estimate the home range of an individual animal, it is important to examine your data set for outliers and, if any are present, that they are investigated to determine whether they represent a real variation in the spatial movements of an individual (and so should be left in), or whether they represent some sort of error (and so should be excluded).

Before you start this exercise, you will first need to create a new folder on your C: drive called GIS_EXERCISES_4. 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_4 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_4 will be used to store all files and data for the exercises in this book.

Next, you need to download the source files for two data sets from www.gisinecology.com/books/data/marinebiologysupplementaryworkbook. When you download these files, save them into the folder C:\GIS_EXERCISES_4 which you have just created. These data sets are:

1. Land_North_Sea.shp: This is a polygon data layer which contains information on land in this region which you can use to create your map. You will need to download all the files called Land_North_Sea (each with a different extension) in order to be able to use it. This data layer is in the geographic projection and uses the WGS 1984 datum. **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.

2. Individual_1.xls: This exercise will be based on a study area in the northeast of Scotland than encompasses the Moray Firth. This is home to a more or less resident population of bottlenose dolphin. Individual animals from this population can be identified based on

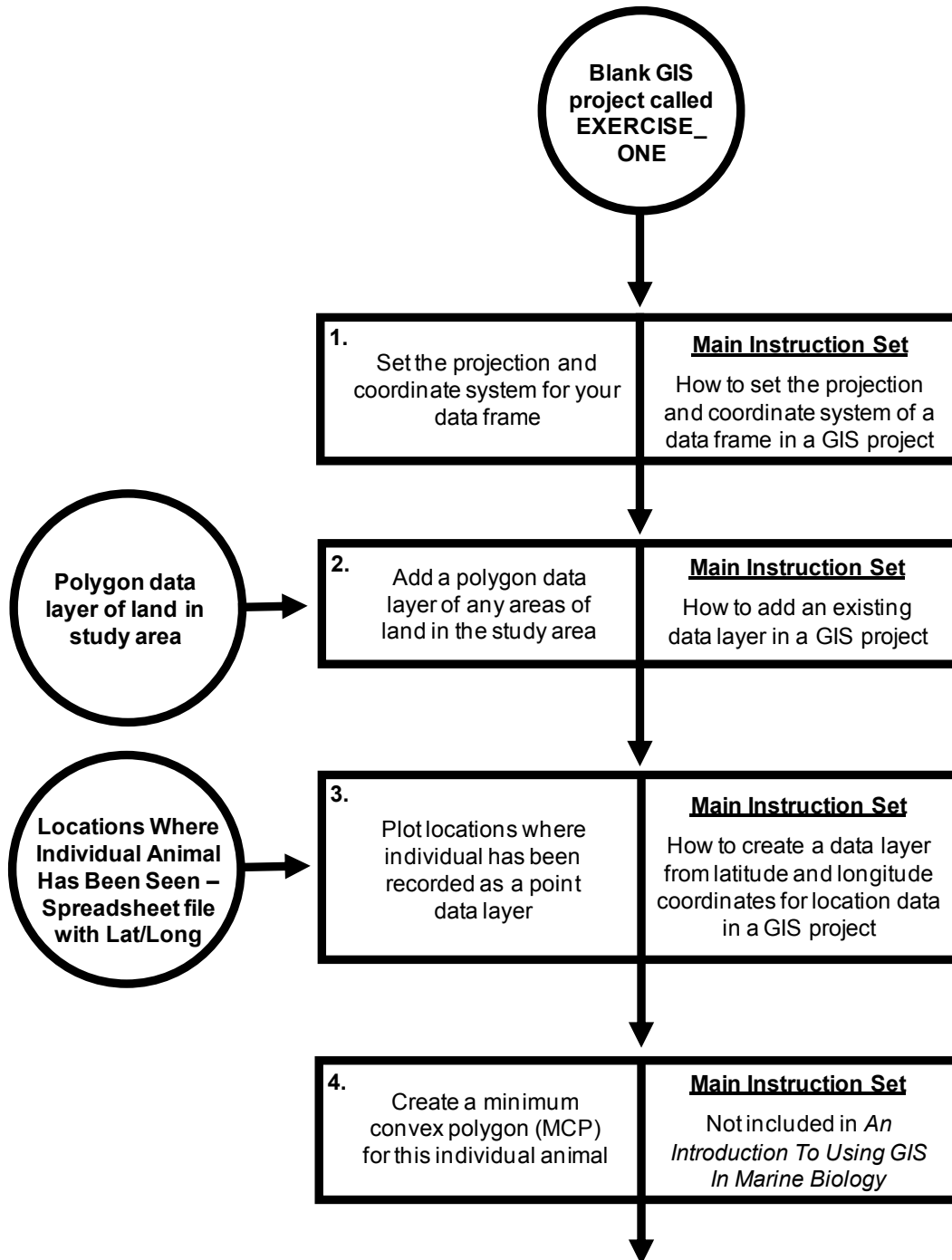
nicks and cuts on the trailing edge of their dorsal fin. This means that information can be collected on the locations where individual animals are recorded which can be used to estimate the home ranges of these individuals. This file contains 137 locations for a fictitious individual from this population. However, while they do not represent records on the occurrence of a real individual, these locations have been selected to represent the likely distribution of some real animals in this population. The latitude and longitude information is provided in decimal degrees and is based on the WGS 1984 datum.

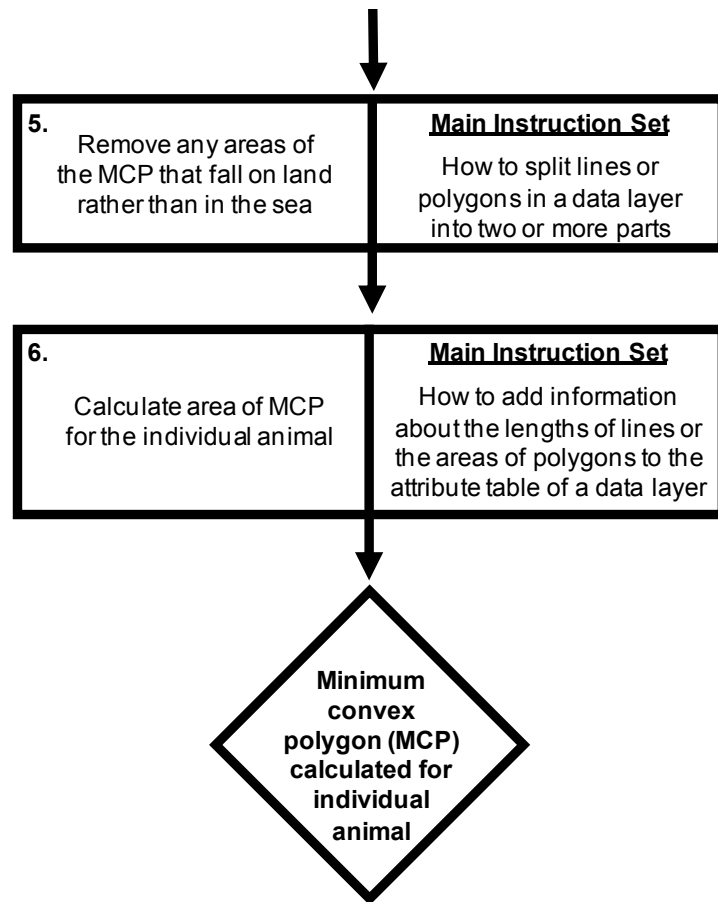
Once you have all these files downloaded into the correct folder on your computer, and understand what is contained within each file, you can move onto creating your minimum convex polygon (MCP) for an individual animal. The starting point for this is a blank GIS project. To create a blank GIS project, 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 from 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 from the main menu bar area, and select SAVE AS. Save it as EXERCISE_ONE in the folder C:\GIS_EXERCISES_4.

The next step is 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 two pages.

Summary Flow Diagram For Estimating The Home Range Of An Individual Animal Using A Minimum Convex Polygon (MCP)





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 the flow diagram in its entirety (see below), before working through it stage by stage. Once 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 trying to work it out later when you get stuck as a result of a mistake made at this stage. Once you have completed the first major step, 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.

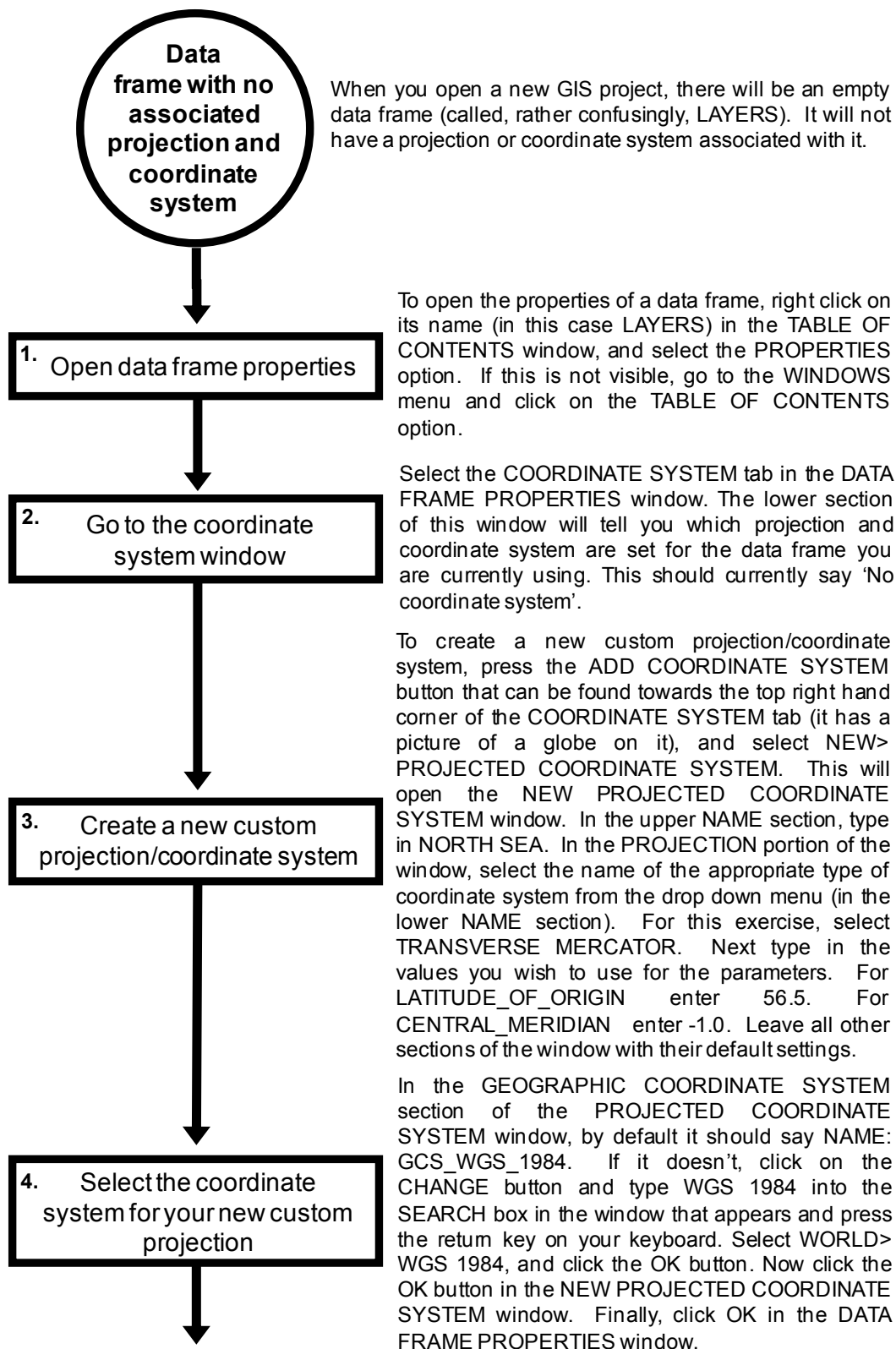
At various points throughout the exercise, images of the contents of the MAP window, the LAYOUT window, the TABLE OF CONTENTS window and/or the TABLE window will be provided so that you have an idea of what your project should look like at that specific point. Check your GIS project against these images. If they do not match up, you will need to go back and work out where you have gone wrong.

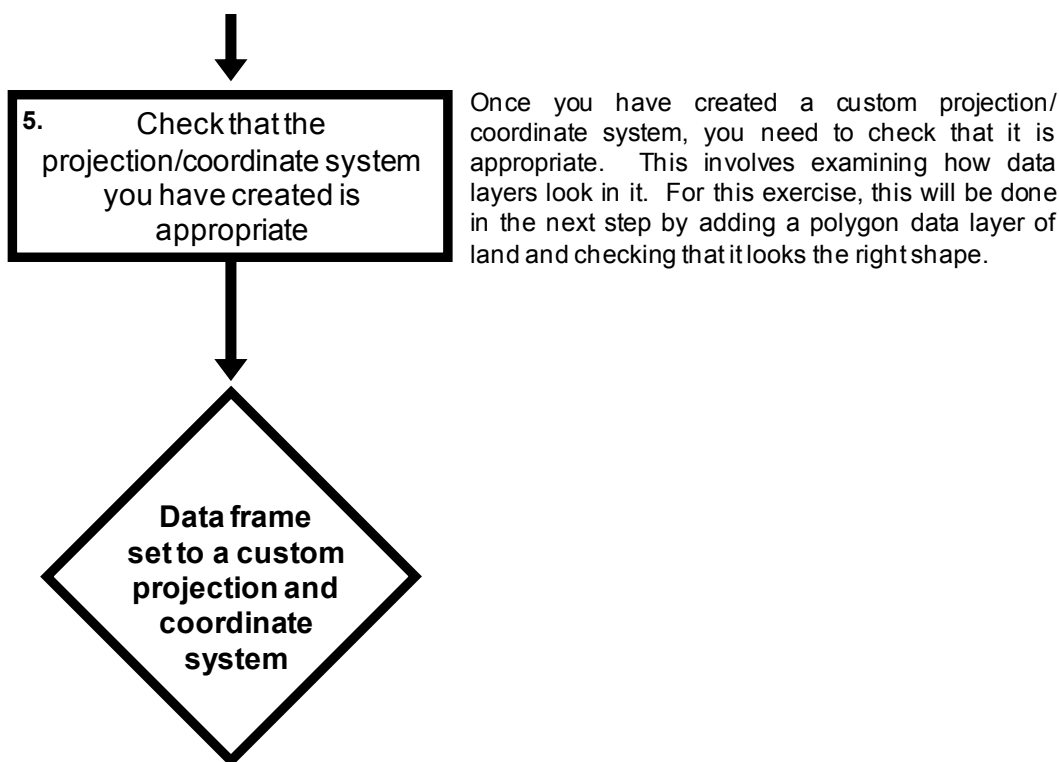
NOTE: It is important that you save your GIS project after completing each major step. This can be done by going to the FILE menu on the main menu bar and selecting SAVE.

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

STEP 1: SET THE PROJECTION AND COORDINATE SYSTEM OF YOUR DATA FRAME:

These instructions are based on the instructions set *How to set the projection and coordinate system for a data frame in a GIS project* (from *An Introduction To Using GIS In Marine Biology*). For this exercise, the projection and coordinate system will be set to a custom transverse mercator centred on the middle of the area of data collection. This central position is latitude 56.5°N and longitude 1.0°W (or latitude 56.5° and longitude -1.0° in decimal degrees). This projection was chosen as it provides an accurate representation of the shape and relative positions of features in the study area. In addition, it can also be used to accurately measure distances and areas in real world units, which is important for this exercises. This custom transverse mercator projection will use the WGS 1984 datum. This datum is used because it is the same as that used during data collection and for the existing data layers. The instructions for setting the projection/coordinate system of your data frame to this custom projection/coordinate system start at the top of the next page.





To check that you have done this step properly, right click on the name of your data frame (LAYERS) in the TABLE OF CONTENTS window and select PROPERTIES. Click on the COORDINATE SYSTEM tab of the DATA FRAME PROPERTIES window and make sure that contents of the CURRENT COORDINATE SYSTEM section of the window has the following text at the top of it:

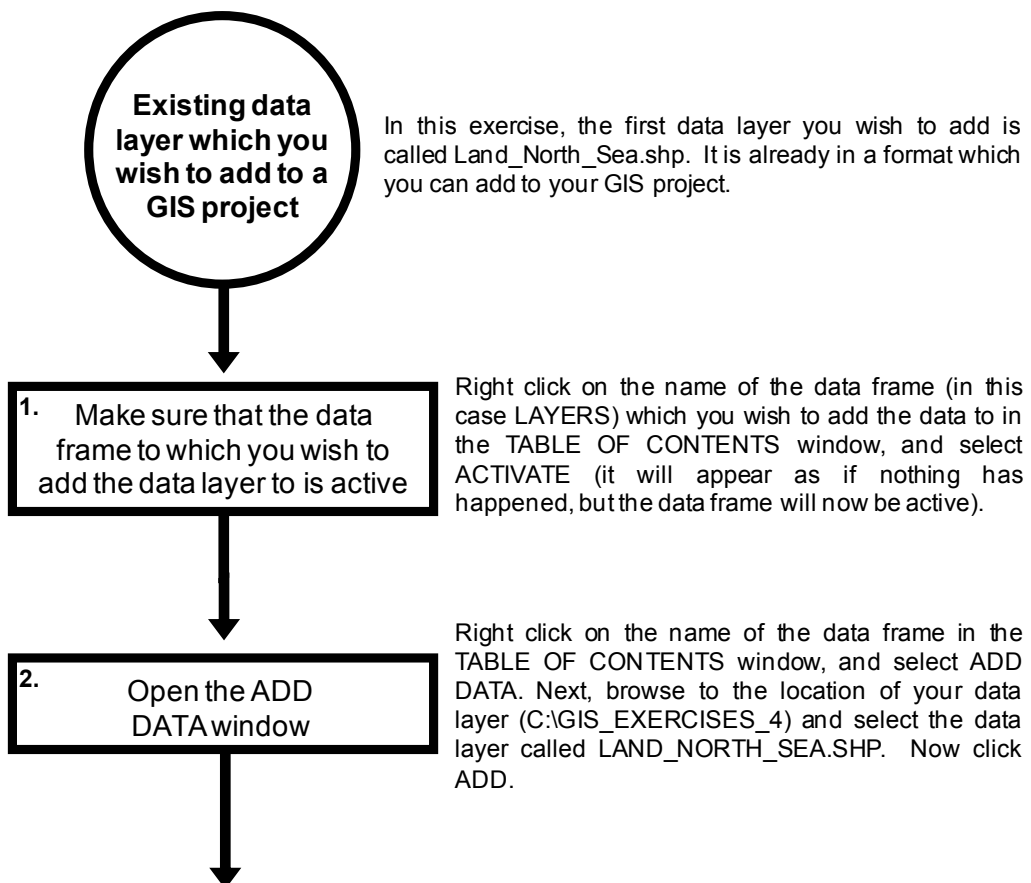
North Sea
Authority: Custom


Projection: Transverse_Mercator
False_Easting: 0.0
False_Northing: 0.0
Central_Meridian: -1.0
Scale_Factor: 1.0
Latitude_Of_Origin: 56.5
Linear Unit: Meter (1.0)

If it does not, you will need to repeat this step until you have assigned the correct projection/coordinate system to your data frame.

STEP 2: ADD A POLYGON DATA LAYER OF ANY AREAS OF LAND IN THE STUDY AREA:

It is usually useful to show any areas of land within your study area. This will help anyone looking at the map work out exactly what part of the world is represented by your map. It will also help you work out whether any other data you add to your GIS project plot in the right place. Finally, it will allow you to assess whether the projection/coordinate system you are using for your data frame is appropriate as you can use it to get an idea of whether any features in the data frame have undue levels of distortion. This instruction set is based on one called *How to add an existing data layer to a GIS project* (from *An Introduction To Using GIS In Marine Biology*).





3. Transform the newly added data layer into the custom projection/coordinate system being used for this exercise



Existing data layer added to GIS project

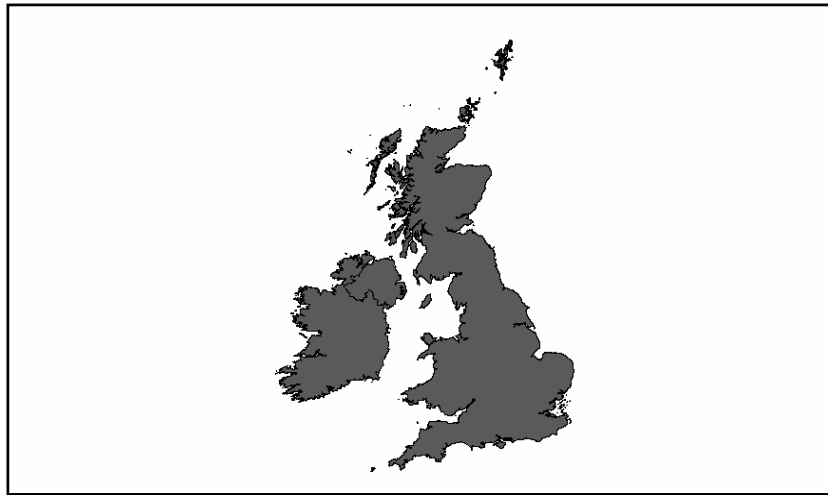
In the TOOLBOX window, select DATA MANAGEMENT TOOLS> PROJECTIONS AND TRANSFORMATIONS> FEATURE> PROJECT. This will open the PROJECT window. Select LAND_NORTH_SEA from the drop down menu in the INPUT DATASET OR FEATURE CLASS window. In the OUTPUT DATASET OR FEATURE CLASS window enter C:\GIS_EXERCISES_4\LAND_NORTH_SEA_PROJECT.

Next, click on the button at the end of the OUTPUT COORDINATE SYSTEM section of the window to open the SPATIAL REFERENCE PROPERTIES window. To create the custom projection/coordinate system being used for this exercise, click on the ADD COORDINATE SYSTEM button towards the top right hand corner of the SPATIAL REFERENCE PROPERTIES window and select NEW> PROJECTED COORDINATE SYSTEM. This will open the NEW PROJECTED COORDINATE SYSTEM window. In the NAME window, type in NORTH SEA. In the PROJECTION portion of the window, select TRANSVERSE MERCATOR from the drop down menu. Next type 56.5 for LATITUDE_OF_ORIGIN and -1.0 for CENTRAL_MERIDIAN.

In the GEOGRAPHIC COORDINATE SYSTEM section of the NEW 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. Next click the OK button in the SPATIAL REFERENCE PROPERTIES window. Finally, click OK in the PROJECT window. **NOTE:** If the transformed data layer is not automatically added to your GIS project, you will need to do this manually by right-clicking on the name of your data frame (LAYERS) in the TABLE OF CONTENTS window and selecting ADD DATA. In the ADD DATA window, browse to C:\GIS_EXERCISES_4 and select LAND_NOth_SEA_PROJECT before clicking the ADD button.

You can now remove the data layer called LAND_NORTH_SEA from your GIS project by right-clicking on its name in the TABLE OF CONTENTS window and selecting REMOVE.

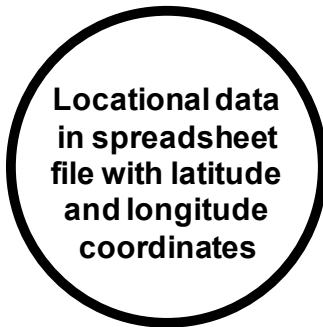
At the end of this step, the contents of your MAP window should look like this:



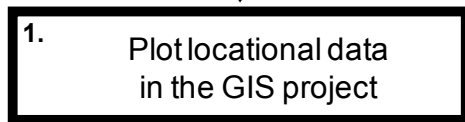
If it does not look like this, try right-clicking on the name of the LAND_NORTH_SEA_PROJECT data layer in the TABLE OF CONTENTS window and select ZOOM TO LAYER. If it still does not look right, remove the data layer LAND_NORTH_SEA_PROJECT from your GIS project by right-clicking on its name in the TABLE OF CONTENTS window and selecting REMOVE. Next, go back to step one and ensure that you have set the projection/coordinate system properly and then repeat step two.

STEP 3: PLOT SPECIES LOCATIONS DATA AS A POINT DATA LAYER:

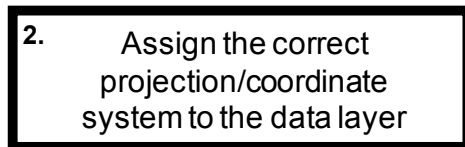
This will use the instruction set *How to create a data layer from latitude and longitude coordinates for locational data in a GIS project* (from *An Introduction To Using GIS In Marine Biology*). This step uses the file Individual_1.xls and assumes that you have saved it with the following address: C:\GIS_EXERCISES_4\INDIVIDUAL_1.XLS. It will create a point data layer called INDIVIDUAL_1_PROJECT which will be stored as a shapefile in the folder C:\GIS_EXERCISES_4.



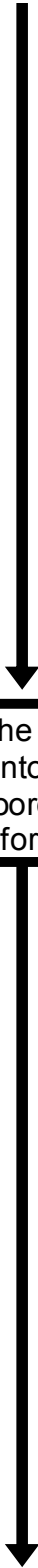
The locational data for Individual 1 is in the file C:\GIS_EXERCISES_4\INDIVIDUAL_1.XLS



In the TOOLBOX window, select DATA MANAGEMENT TOOLS> LAYERS AND TABLE VIEWS> MAKE XY EVENT LAYER. Once the MAKE XY EVENT LAYER tool is open, you need to select the file which contains the data you wish to plot by clicking on the browse button at the right hand end of the XY TABLE section of the tool window. In this case, browse to C:\GIS_EXERCISES_4\INDIVIDUAL_1.XLS. Click on it, and then select Sheet1. Next, select the field LONGITUDE from the drop down menu in the X FIELD section, and LATITUDE from the drop down menu in the Y FIELD section of the window. Before you close the MAKE XY EVENT LAYER window, go on to stage 2 of this instruction set and set the projection/coordinate system for this data layer.



In the MAKE XY EVENT LAYER window, click on the button at the right hand end of the SPATIAL REFERENCE (OPTIONAL) section. This will open the SPATIAL REFERENCE PROPERTIES window. In this window select GEOGRAPHIC COORDINATE SYSTEMS> WORLD> WGS 1984, then click on the OK button. You are selecting this projection/coordinate system because you are using latitude and longitude values with the WGS 1984 datum to plot your species locations. **NOTE:** If your coordinates were in a different projection/coordinate system, you would set this different system here. Next, click on OK in the SPATIAL REFERENCE PROPERTIES window. The SPATIAL REFERENCES (OPTIONAL) section should now contain the text GCS_WGS_1984. Finally, click on OK to close the MAKE XY EVENT LAYER window.



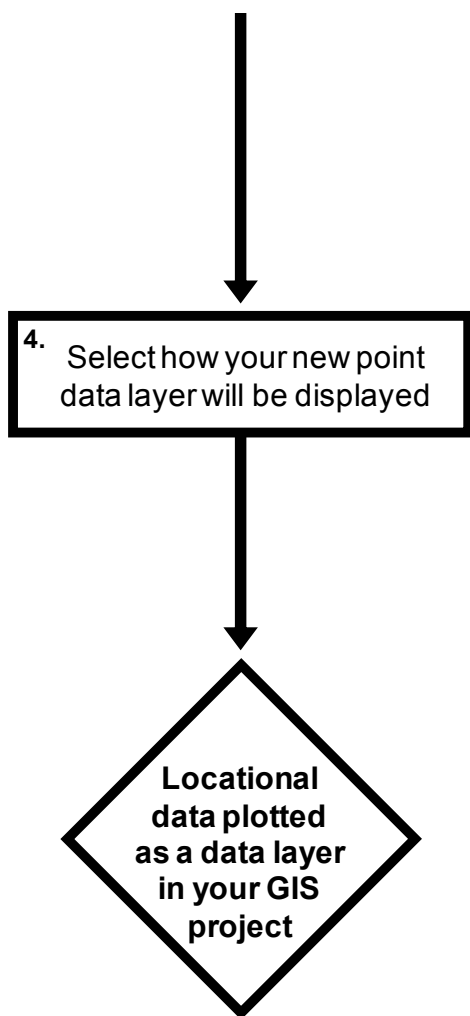
3. Transform the newly added data layer into the custom projection/coordinate system being used for this exercise

In the TOOLBOX window, select DATA MANAGEMENT TOOLS> PROJECTIONS AND TRANSFORMATIONS> FEATURE> PROJECT. This will open the PROJECT window. Select SHEET1\$EVENTS from the drop down menu in the INPUT DATASET OR FEATURE CLASS window. In the OUTPUT DATASET OR FEATURE CLASS window enter the address C:\GIS_EXERCISES_4\INDIVIDUAL_1_PROJECT.

Next, click on the button at the end of the OUTPUT COORDINATE SYSTEM section of the window to open the SPATIAL REFERENCE PROPERTIES window. To create the custom projection/coordinate system being used for this exercise, click on the ADD COORDINATE SYSTEM button towards the top right hand corner of the SPATIAL REFERENCE PROPERTIES window and select NEW> PROJECTED COORDINATE SYSTEM. This will open the NEW PROJECTED COORDINATE SYSTEM window. In the NAME window, type in NORTH SEA. In the PROJECTION portion of the window, select TRANSVERSE MERCATOR from the drop down menu. Next type 56.5 for LATITUDE_OF_ORIGIN and -1.0 for CENTRAL_MERIDIAN.

In the GEOGRAPHIC COORDINATE SYSTEM section of the NEW 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. Next click the OK button in the SPATIAL REFERENCE PROPERTIES window. Finally, click OK in the PROJECT window.

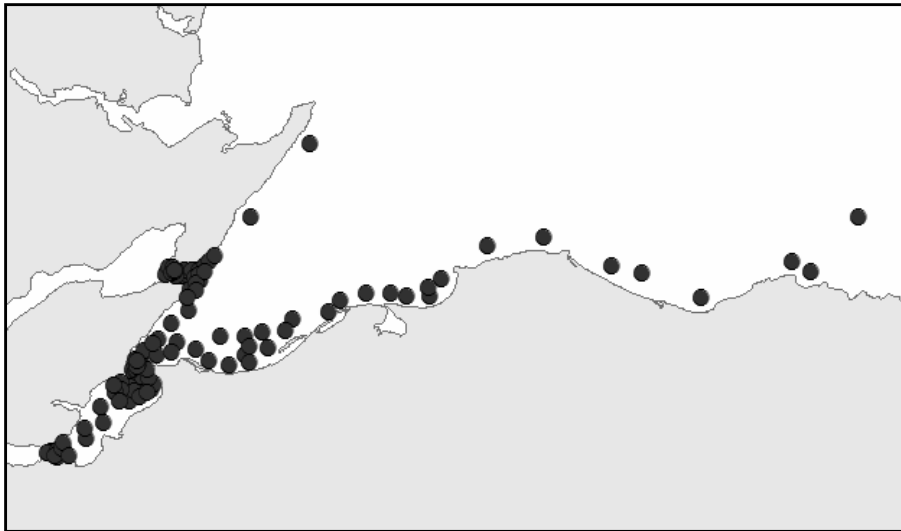
NOTE: If the transformed data layer is not automatically added to your GIS project, you will need to do this manually by right-clicking on the name of your data frame (LAYERS) in the TABLE OF CONTENTS window and selecting ADD DATA. In the ADD DATA window, browse to C:\GIS_EXERCISES_4 and select INDIVIDUAL_1_PROJECT before clicking the ADD button.



Right click on the name of the INDIVIDUAL_1_PROJECT data layer in the TABLE OF CONTENTS window, and select PROPERTIES. In the LAYER PROPERTIES window, click on the SYMBOLOGY tab. On the left-hand side, under SHOW select FEATURES> SINGLE SYMBOL. Next, under SYMBOL in the top middle of the LAYER PROPERTIES window, click on the button with the coloured circle on it. This will open the SYMBOL SELECTOR window. Select CIRCLE 2 for the symbol by clicking on it in the left hand section of the window. Then, on the right hand side of the SYMBOL SELECTOR window, click on the button next to COLOR and hover the cursor over fourth red box down. This will tell you that this colour's name is PONSETTIA RED. Select this by clicking on it. Next, select 12.0 for size. Finally, click OK to close the SYMBOL SELECTOR window and then OK to close the LAYER PROPERTIES window.

Once you have completed this instruction set, right-click on the data layer name SHEET1\$_LAYER and select REMOVE. Finally, select INDIVIDUAL_1_PROJECT data layer in the TABLE OF CONTENTS window and select ZOOM TO LAYER.

The contents of your MAP window, should now look like the image at the top of the next page.



STEP 4: CREATE MINIMUM CONVEX POLYGON (MCP) FOR THIS INDIVIDUAL ANIMAL:

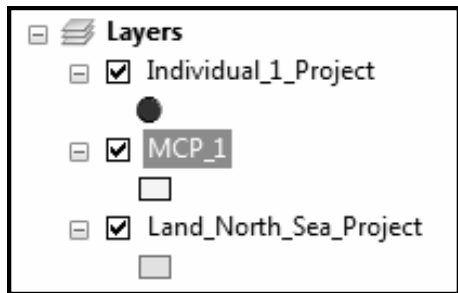
While some GIS software packages will specifically have a tool that refers to the creation of a minimum convex polygon (MCP), within ArcGIS 10.2, the tool that is used to create an MCP is called the MINIMUM BOUNDING GEOMETRY tool. This tool is relatively simple to use and does not require a flow diagram. In the TOOLBOX window, select DATA MANAGEMENT TOOLS> FEATURES> MINIMUM BOUNDING GEOMETRY. In the MINIMUM BOUNDING GEOMETRY window that will open, select INDIVIDUAL_1_PROJECT in the INPUT FEATURE section. Next in the OUTPUT FEATURE CLASS, type C:\GIS_EXERCISES_4\MCP_1. For GEOMETRY TYPE (OPTIONAL), select CONVEX HULL. Finally, click OK to run this tool.

Once you have created your MCP for individual one, right-click on the data layer called MCP_1 in the TABLE OF CONTENTS window and select PROPERTIES. In the LAYER PROPERTIES window, click on the SYMBOLOGY tab. Next, click on the coloured rectangle under SYMBOL on the middle of the window and select AUTUNITE YELLOW (the second yellow shade from the top of the column of yellows) from the FILL COLOR drop down menu on the right-hand side of the SYMBOL SELECTER window. Now click OK to close the SYMBOL SELECTOR window and then OK to close the

Exercise One: Estimating The Home Range Of An Individual Animal Using An MCP

LAYER PROPERTIES window. Finally, click on the data layer called INDIVIDUAL_1_PROJECT in the TABLE OF CONTENTS window and while holding down the shift key, move it upwards so that it is on top of the data layer called MCP_1.

Your TABLE OF CONTENTS window should now look like this:



While the contents of your MAP window should look like this:

