Modelling Marine Recreation Potential in England

Annex Volume 2
(Technical Annexes: E to K)

MMO Project No: MMO1064

Disclaimer

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Project Resources External to the Main Report

Annexes

The project annexes consist of two volumes. The first volume comprises the non-technical annexes, including a map annex, activity preferences and stakeholder consultation. The second volume comprises the technical annexes, including detail on input data and data layer processing, model development, confidence assessment and Marine Recreation Model User Guide.

These annex volumes are separate documents and are referenced in the main report. Only the Vol. 2 Technical Annex is stand alone and can be used separately from the main project report to inform the model development. The annexes are structured as follows:

Annex volume 1

Annex A: **Guide and References** - provides a reference list of acronyms and terminology descriptions, as well as references cited throughout the project report and appendices.

Annex B: Modelled Activity Maps - provides maps of the activities modelled in this study, presented at the national scale.

Annex C: Activity Preferences - provides further detail on the activities selected to model and the influencing user preferences, or parameters. This includes the approach taken to prioritising the parameters and a more detailed breakdown of the varying elements of the Activity Matrix (activity preferences).

Annex D: Activity Consultation - gives further description to the stakeholder consultation steps taken and stakeholder feedback.

Annex volume 2

Annex E: Model Baseline and Definition - technical annex detailing the baseline model and its definitions.

Annex F: Input Data Processing - technical annex detailing the input data processing, including the input data catalogue.

Annex G: Common/Multi Layer Processing – technical annex providing a description of the Tool 1 Gridding Tools and their use

Annex H: Model Methodology - is a technical annex describing the model methodology, detailing Tool 2, the 'Union Tool', Tool 3, the model ready Activity Matrix and Tool 4, the model.

Annex I: Confidence Assessment - provides an assessment of the model outputs, including the confidence assessment of the input data (not sourced from the MMO) and the confidence assessment of the input data layers.

Annex J: Future application of the model – provides recommendations for future use and evolution of the model

Annex K: MMO1064 Marine Recreation Model User Guide – step by step instructions on processing data suitable for the model and rerunning the model.

Electronic deliverables

Below is a complete list of electronic deliverables with this project.

- Final report
- Vol. 1 Report Annex
- Vol. 2 Technical Annex, including model guidance
- Project research flier
- Data processing logs, including flow diagrams
- GIS data layers
- XML metadata
- Model Tools 1, 2, 3 and 4
- Combined Consultation Activity Matrix spreadsheet
- Data confidence assessments
- Input data catalogue.

All associated documents for the MMO1064 project can be found in the MMO website evidence pages at
http://www.marinemanagement.org.uk/evidence/1064.htm

Annex E: Model Baseline and Definition

E1. Model overview

The MMO1064 model predicts the potential for marine recreation activities in England's marine areas from 500m inshore of Mean High Water to the outer limits of the Marine Plan Areas. Figure 1 shows an overview of the model stages and the tools corresponding provided for each stage of the models.

Figure 1: Model Process Overview.
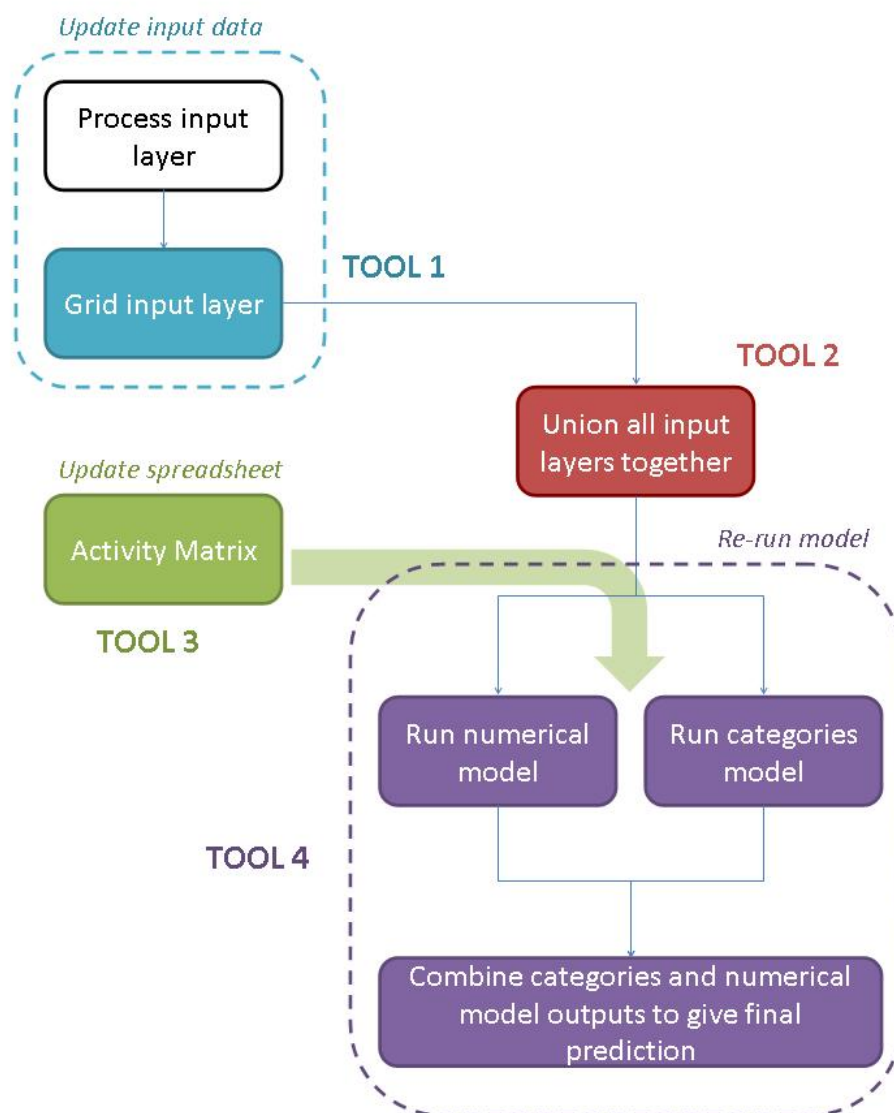
As depicted in Figure 1 the model can be updated by changing the input data layers, e.g. as new data becomes available or regular datasets updated and rerunning the grid Tool 1 (in blue) and union Tool 2 (in red) to incorporate the data.

The model can also be updated by amending the activity preferences in the Activity Matrix Tool 3 (in green).

The data or matrix modifications can be implemented independently of each other, or together if required e.g. if the data attributes of replacement parameter data are different and these need to be reflected in preferences in the matrix.

These annexes describe in more detail the model process and constituents and are aimed at the technical user. Table 1 below summarises the purpose of each tool provided.

Table 1: Tool summary table.

Tool	Description
Tool 1: Grid Analysis Tool	Grids the input parameter data using the defined analysis grid shape file for the model. Essentially the data attributes are assigned to the grid cell for a given data dimension e.g. average water depth.
Tool 2: Union Tool	Joins all of the required gridded input parameter data into one unioned grid shape file with attributes from all the input data assigned to the grid cells as applicable.
Tool 3: Activity Matrix	Clean format spreadsheet of the Activity Matrix (MATRIX worksheet). The MATRIX contains the configuration for Tool 4 and the condition parameters for the activities which will be used by Tool 4 to score the unioned grid shape file.
Tool 4: Model	Utilises the configuration and settings from Tool 3 to select data from the unioned grid and apply the scores based on that selection. Also contains a utility to create a copy of the unioned grid tool for each activity.

The model baseline and definition includes the software and projection specification; production of the model area extent; the model grid; and the baseline 'zoning' parameter, i.e. areas of wet, dry or intertidal. These are described in the following annex sections.

E2. Software and projection specification

ArcGIS version

The model has been built in ArcGIS v9.3 to comply with the MMO's software requirements. An ArcGIS v10.2 version of Tool 4 has also been provided in order to provide forward compatibility and take advantage of the additional tools provided by v10.2.

Projection

The model has been developed using the coordinate system ETRS 89 UTM Zone 30 North to comply with MMO standard projection practice for England wide data. A projected coordinate system was chosen for ease of explaining and deducing distance measurements to project stakeholders. Using non-projected data would have added an additional level of complexity to the model and it was felt that this would be difficult to communicate. This coordinate system was utilised in project data processing and to compute grid distances for the model.

The transformation OSGB_1936_To_WGS_1984_Petroleum (EPSG:1314) was used to transform OSGB 36 coordinates to WGS84 in compliance with MMO practices. This was used in composite with transformation ETRS_1989_To_WGS_1984 (EPSG:1149) to convert OSGB 36 coordinates to ETRS 89; however ETRS 89 is considered coincident with WGS84 in this transformation.

Format

The model is built as and outputs a vector grid shape file. However the interim processes that inform this final product do use geodatabases, rasters and the Spatial Analyst ArcGIS extension. All can be used by ArcGIS v9.3 or ArcGIS v10.2.

E3. Extent

The model covers the whole of the Marine Plan Areas of England from between mean high water, or the tidal limit of estuaries, out to the offshore extents of England's Marine Area. In addition, the model area has been extended inshore by 1km to allow for any activities that straddle the inshore extent of the Marine Plan Areas, e.g. beach activities. In addition this 1km inshore extent informs the access parameters, e.g. roads and footpaths. Therefore a single model mask was created to cover this whole area as one.

E4. Grid

The analysis grid required definition for gridding data layers for input to the MMO1064 modelling process and the final model predictions. The MMO have developed four ETRS89 vector grids in this system to the following resolutions:

- 0.1 degree
- 0.01 degree
- 0.05 degree
- 0.025 degree.

The overall extent of these grids were utilised to define the extent for the analysis grid.

Originally a 100m grid was proposed; however ArcGIS and ET Geowizards could not handle this resolution due to limits on the number of grid squares that could be processed for the extent, and memory limitations. Therefore the current model grid is defined with a grid size of 1km which was considered suitable for the purposes of marine planning. This was projected in ETRS 89 UTM Zone 30N, Central Meridian 3 degrees west. This resolution accords approximately with the 0.01 degree MMO vector grid resolution. The grid was reduced to the model extent using intersect operations with the model extent as defined in Appendix F3.

To deduce a suitable start extent for the grid the MMO degree vector grid extents were captured and projected to UTM Zone 30N and the corner coordinates deduced (eastings, northings). The projection process does not produce a square, but trapezoid, which cannot be used for defining regular 1km grid squares. Therefore the grid extents are defined based on the maximal East, West, North and South extents, rounded to the nearest kilometre as appropriate. Table 2 summarises the extents used for the final grid extents.

Table 2: Grid extent derivation summary.

Corner Extent	Original Vector Grid ETRS 89	Projected Vector Grid ETRS 89 UTM Z30N	Adjusted Extent Grid Coordinates Used ETRS 89 UTM Z30N
SE	4 E, 47 N	1032085 E, 5228993 N	1033000 E, 5228000 N
SW	11 W, 47 N	-108064 E, 5236309 N	-109000 E, 5228000 N
NW	11 W, 57 N	14663 E, 6345876 N	-109000 E, 6346000 N
NE	4 E, 57 N	924803 E, 6339193 N	1033000 E, 6346000 N

To aid data processing in Tool 1 where there is a raster input, a raster version of the grid was also created. (Even where a raster grid is used in the input to the model, the output always remains a vector grid). The centroids of the vector grid were also created to assist with data processing in Tool 1. If a new analysis grid is defined for the model in the future then these two additional versions of the grid will also have to be created for inclusion in Tool 1.

E5. Zoning

Zoning took place in two stages:

1. General zoning for the model extent and to inform input layers
2. Specific baseline activity areas input layer as defined by project stakeholders.

General zoning

The Marine Plan Areas boundary polygons were used in the processing as they presented a simpler Mean High Water (MHW) line than OS Boundary Line; ArcGIS could not handle the complexity of the OS Boundary Line data when generating buffers and performing polygon splitting operations. OS Vector Map district Tidal Boundary Mean Low Water (MLW) and Mean High Water (MHW) were used to split the intertidal from the subtidal marine area: the lines were used to intersect the combined Marine Plan Areas and then all marine area offshore off the lines was depicted as subtidal ('wet'); and all other areas taken as intertidal.

The following zones were created for the overall baseline parameter:

- **Dry zone** 1km inland from Mean High Water (MHW) limit as defined from the MMO supplied Marine Plan Areas
- An **intertidal zone** between the mean high water limit as defined from the MMO supplied Marine Plan Areas and the MLW / Extent of the Realm limit defined from Ordnance Survey Vector Map District foreshore data
- A full extent **wet zone** from the Mean Low Water (MLW) / Extent of the Realm limit defined from Ordnance Survey (OS) Vector Map District foreshore data to the offshore extent of the MMO Marine Plan Areas
- **Coastal wet zones** were created using the 3 Nautical Mile limit supplied by MESL Ltd, the 6 Nautical Mile limit supplied by the MMO/UKHO and the 12 Nautical Mile inshore marine plan area extents supplied by the MMO.

Baseline activity areas zoning

The MHW limit as defined from the MMO supplied Marine Plan Areas and the intertidal zone as deduced for the overall baseline parameter were used to create the initial buffers to delimit the stakeholder defined Baseline Activity Areas. Table 3 below summarises these and their attribute value used within the model.

The zoning operations are detailed in the data processing logs.

Table 3: Baseline activity areas.

Input	Baseline Activity Area	Attribute Value
MHW, 20m buffer	MHW to 20m inland	MHW-20 IS
MHW-20 IS, 80m buffer	20 to 100m inland	20-100 IS
20-100 IS, 400m buffer	100 to 500m inland	100-500 IS
Intertidal Zone	MHW to MLW	MHW-MLW
Intertidal Zone, MHW, 100m buffer	MLW to 100m offshore	MLW-100 OS
MLW-100 OS, 400m buffer	100 to 500m offshore	100-500 OS
100-500 OS, 500m buffer	500 to 1000m offshore	500-1000 OS
500-1000 OS, 5000m buffer	1000 to 6000m offshore	1000-6000 OS

Input	Baseline Activity Area	Attribute Value
1000-6000 OS, 4000m buffer	6000 to 10000m offshore	6000-10000 OS
6000-10000 OS, buffer to extent	10000 to extent offshore	10000-1000000 OS

E6. Model filing structure

The model is filed in a standardised filing structure; with the intention that this collection of directories can be moved anywhere together and the relative paths used in the ArcToolboxes and ArcGIS Map Documents will still be valid. Table 4 below summarises the filing structure used.

Table 4: Project GIS filing structure.

Directory	Description
00_Documents	Documentation i.e. processing logs, data catalogues, confidence assessments, etc.
01_DataSupply	Contains input data for model in original supplied format
02_DataProc	Contains processed input data for model
03_DataTools	Contains the ArcToolboxes for the model tools, Excel model spreadsheets for Tool 3 and staging geodatabases accompanying the tools.
04_DataBase	Contains the base data used for the model; Analysis Grid, Baseline, Gridded input data, Limits (baseline activity areas) and Unioned Grid
05_DataAnalysis	Contains the output activity shape files (the models)
06_DataAux	Contains auxillary data not covered by the rest of the filing structure, in this case map files
07_MapDocuments	Contains the ArcGIS Map Documents and layers files, plus any graphics produced
08_Metadata	Contains any standalone metadata *.xml files produced

Annex F: Input Data Processing

Data processing was undertaken to prepare data for input to gridding operations. The following processes were commonly performed on the various parameter data sets in readiness for gridding in Tool 1:

- Transformation of data and/or projection of data to ETRS 89 UTM Zone 30N
- Compilation of data to one cohesive feature class or data set, for example where raster data was supplied as tiles these were mosaicked into one continuous raster layer
- Extracting subsets of data to depict the features of interest e.g. shipping density data where total sightings are above the average for the whole data set
- Derivation of representative data for geoprocessing, for example creating station points along the MHW line and roads and footpaths
- Geoprocessing - assigning heights, buffering, merging of features by attribute (for simplification), spatial joins based on closest feature to deduce distance
- Calculations and ranking based on geoprocessing results, for example distance of land access point to a car park
- Amalgamation of attributes and/or data sets, for example several habitats as one desirable habitat classification.

Below provides a brief description of each data layer generated to inform the selected parameters and the input datasets used to derive them. These are fully supported by processing logs (Annex J) and a summary of the data sources is shown in Table 5.

Table 5: Input data summary.

Parameter	Source	Gridding Process
Baseline Activity Area	- OS boundary line MHW and MLW tidal boundaries - Marine Plan Areas	See processing log
Land Access	- MHW line from MMO Marine Plan Areas - OS VectorMap District (Polyline) - PROW dataset (Polyline) - OpenStreetMap - OS VectorMap (Polyline) - rowmaps.com (Polyline) - OS Boundary Line (county, district and unitary authority boundaries) - Elevation	See processing log / Closest
Car Parks	- data.gov.uk (Transport Direct Journey Planner) (Point)	See processing log / Closest
Marinas	- Boatlaunch Marinas (Point)	Proximity
Slipways	- Boatlaunch Slipways (Point)	Proximity
Moorings	- UKHO S57	Proximity
Land Habitats	- Priority Habitat Inventory (Natural England)	Presence
Intertidal Habitats	- MB102 Defra intertidal data layer	Presence

Parameter	Source	Gridding Process
Birds on Land	- Waders and Wildfowl Survey Data (BTO) - 2000011/25 SPAs/mSPAs (JNCC) Seabird Nesting Counts (JNCC) - Seabird Colony Data (JNCC) - 900008 Bird Reserves (MMO)	Presence
Land Reserves	- 1500020 Local Nature Reserves (MMO) - NE NNR - JNCC SSSIs and SACs	Presence
Depth	- Defra Astrium (Grid)	Summary Statistics
Wind magnitude	- BERR Renewable Atlas (12km grid)	Summary Statistics
Wave height	- BERR Renewable Atlas (12km grid)	Summary Statistics
Water quality	- Bathing Water Directive, EA Geostore (Point)	Closest
Reefs and hard substrate	- BGS hard substrate - Natural England Annex 1 Reefs	Presence
Seahorses	- Defra MB0102 semi-mobile species	Presence
Seals at Sea	- SCANS II (SMRU St Andrews)	Presence
Birds at Sea	- WWT summer and winter densities	Presence
Cetaceans	- JNCC Cetaceans Atlas	Presence
Basking Sharks	- Defra MB0102 mobile species	Presence
Accessible Wrecks	- EH Protected - MOD Protected - EH Historic - S57 and Seasearch	Presence
Leisure Navigation	- UKHO S57 S57	Presence
Restricted Areas	- Anatec 90th percentile shipping density - UKHO S57 shipping lanes and zones - UKHO S57 prohibited/ restricted areas - UKHO S57 military practice areas	Presence

Baseline activity area
The baseline activity area data layer defines the areas inshore and offshore where activities can take place and limits the model results to these areas only, as agreed with stakeholders to conform to individual activity requirements.

This extent of this data layer is of the amalgamated MMO Marine Plan Area boundaries plus 1000m inshore (calculated). This area was then divided into areas of increasing distance inshore of MHW and offshore of MLW. MLW and MHW were defined by the OS boundary line datasets. The series of areas defined were in categories differentiated by 500, 100 and 20m inshore of MHW; MHW – MLW; and 100, 500,1000, 6000, 10000 and 1000000m offshore of MLW.

Estuary
The estuary data layer defines presence of an estuary to inform those activities that normally avoid, e.g. beach activities, diving and surfing.

This was formed from the WFD transitional water bodies (Cycle 2, which divides large estuaries into sections) dataset, with removal of the outer Humber, outer Thames and outer Severn, due to the reduced 'estuary impact' to recreation there.

Land access

Land access is an essential data layer to informing access to the coast and shoreline, in particular for those not using marinas, slipways and moorings (which are accommodated by other parameters). However the land access parameter was not available as a ready dataset and had to be created for the project.

This data layer was derived from five core datasets: roads, footpaths, elevation, the MHW line and 1km2 gird. The roads dataset (hard/tarmacked and soft/4WD) was compiled from OS VectorMap; however as this has poor coverage of soft roads they were gapfilled with OpenStreetMap. The footpaths dataset was compiled from OS VectorMap; however as this didn't have full coverage of smaller footpaths (e.g. as seen on OS Explorer range Scale 1:25000 paper copies or www.bing.com/), it was infilled with the rowmaps.com PROW dataset. PROW may contain data from Ordnance Survey, OpenStreetMap, Google or Bing and is not complete for all counties (missing along England's coastal strip in Suffolk, Kent, Cumbria and a very small part of Yorkshire) so some areas are better represented than others in the level of detail. Elevation was sourced from OS Terrain 50 DTM. The MHW line was extracted from the MMO Marine Plan Areas and the 1km2 grid was developed in the MMO1064 project.

Firstly, access was allocated to points every 100m along the MHW line. Each point was classified in terms of access where:

- 0 = No footpath or road 0-500m from MHW
- 1 = Footpath 0-500m distance and 0.25 slope (where slope is elevation / distance) from MHW AND road >3000m from MHW
- 2 = Footpath 0-500m distance and 0.25 slope from MHW AND road 1000-3000m from MHW
- 3 = Footpath 0-500m distance and 0.25 slope from MHW AND road 500-1000m from MHW
- 4 = Road 0-500m distance and 0.25 slope from MHW
- 5 = Road 0-100m distance and 0.25 slope from MHW.

Secondly, areas of the model analysis grid were allocated access categories. For cells that contained MHW points, the highest access category of the contained points was assigned to that cell. For cells up to 1, 6, 10 and 60km offshore, a 1.333, 8, 13.333 and 80km search radius (respectively) was applied to obtain the highest access category at MHW. This is equivalent to a search radius of a third greater than the maximum distance away. Any less than this provided spurious results from tests carried out. Beyond 60km no access category was applied.

Car parks

As with roads and footpaths, car parks form an essential element to informing access to shoreline and water to be able to conduct activities. Car park accessibility categories were not combined with land access categories as this would have

produced a very complex category system of limited value and not all participants require car parks as may use public transport / walk from their homes.

This dataset was created in a similar approach to land access where the MHW points were allocated categories of:

- 0 = no car park within 1000m of MHW
- 1 = car park within 500-1000m of MHW
- 2 = car park 250-500m of MHW
- 3 = car park 0-250m of MHW.

The car parks dataset was derived from the Department for Transport and clipped to 0-1km inshore. The data does not include the small car parks in rural areas and is more biased towards town / village car parks. However this was the best available dataset.

Marinas
As well as land access and car parks, another important aspect to allowing activities to take place are vessel launch locations such as marinas.

This data layer was derived from the independent Boatlaunch marina location dataset and the distance of each grid cell to the nearest marina was assigned.

Slipways
This data layer was derived from the independent Boatlaunch slipways location dataset and the distance of each grid cell to the nearest slipway was assigned.

Moorings
As with slipways and marinas, moorings provide an important function to allowing certain activities entry into the marine environment.

This data layer was derived by extracting mooring point and line data layers from UKHO S57 data layer including:

- Shoreline_constructions_line
- Shoreline_constructions_point
- Obstructions_line
- TransportationAndRoutes_polygon
- TransportationAndRoutes_point.

The distance of each grid cell to the nearest mooring was assigned.

Land habitats
Land habitats were used in the model to define areas of attraction to certain activities.

Coastal land habitats were extracted from Natural England's Priority Habitat Inventory from MHW (derived from MMO Marine Plan Areas) up to 1km inshore. The defined habitat descriptions in the dataset were simplified to landscape (including sand dunes and cliffs only); and waterscape (including mudflats, saltmarsh, saline

lagoons and reefbeds only). This simplification addressed the activity preferences in MMO1064. Other habitats listed were not extracted.

Intertidal habitats
Intertidal habitats were used as a proxy to inform the model of beach and coastal composition, which are suitable and preferred by beach goers and other activities, as well as areas to attract wildlife for shore angling.

This data layer was derived from JNCC's UK combined marine habitat map, issued in draft format by JNCC for the MMO1064 project. The source data provides full-coverage EUNIS[1] level 3 habitats integrating maps from over 200 bespoke surveys/models and the EUSeaMap[2] broad-scale model. The dataset was clipped to the intertidal area and the EUNIS level 3 categories were simplified to a general category of: Rock, Coarse and mixed sediment, Sand or Mud (for EUNIS categories without features or vegetation / biological communities at Level 3); Coastal saltmarshes and saline reefbeds; and Substrata with features or vegetation / biological communities, (all other remaining categories) e.g. biogenic reefs.

Birds on land
Birds on land were included as a potential attraction for wildlife watchers and other activity users.

This data layer was derived by combining 1) bird areas from: RSPB Reserves, JNCC Seabird Colony Areas (seabird colony register), JNCC SPAs/mSPAs; and 2) point data from JNCC seabird nesting counts (seabird 2000). The dataset was clipped to the intertidal area provided by MMO1064 (defined by MHW from the MMO Marine Plan Areas and MLW from OS OS boundary line) and up to 1km inshore. Any area with a reserve or count greater than zero were input as areas of birds on land to inform the model.

Land reserves
Areas of conservation importance and known reserves are seen as attractions to wildlife watchers and coastal visitors. The presence of these sites is a proxy to wildlife watching activity and other relevant activities attracted to these sites.

This data layer was derived from Natural England created datasets Local Nature Reserves, National Nature Reserves, SSSI and JNCC SACs. These were combined to denote presence of a reserve of wildlife interest. The dataset was clipped to the intertidal area provided by MMO1064 and 1km inshore. And area with a reserve simply informed the model by 'presence'.

Depth
A number of activities require a minimum water depth to occur, whilst for diving it has also been important to set a maximum depth to which recreation diving will occur to.

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[1] European nature information system, http://eunis.eea.europa.eu/
[2] http://jncc.defra.gov.uk/euseamap

This data layer was derived from the Defra Astrium Bathymetry dataset which was provided in separate tiles (regional datasets). All tiles were combined and the mean depth at the new grid size was derived. Due to errors in ArcGIS software, it was not possible to calculate the minimum depth which would have been useful as this defines many activities.

Wind magnitude

Ascertaining some quantification of wind speeds around the country is important to defining where a number of activities will take place, both in terms of needing wind, e.g. windsurfing, or not wanting much wind, e.g. beach activities.

In the short timescales of this project it was necessary to acquire existing data rather than create any new modelled wind data of England's marine area. The data used was however one of the highest resolution for national coverage, despite being 12km gridded data (the only other data identified at a better resolution was 8km, Met Office, and this was not considered significant enough to warrant the costs). In addition, as summary information was required for the model grid cells, it was not possible to carry out temporal changes through the day, month, season or year and instead an annual summary value was adopted.

This data layer was derived from the Department for Business, Enterprise and Regulatory Reform (BERR) renewable energy resource wind atlas, to provide a summary of the mean annual wind speed which is provided at 80m height above sea level. Although wind data at 0-5m would be most relevant for the intended use of the data layer, wind speed at 80m is considered suitable as it only needs to show the relative variation of wind speed across England's Marine Areas. As the source data did not cover inshore waters, e.g. 0-1km offshore, as well as larger marine areas, e.g. Outer Thames Estuary, this was gapfilled up to 30km inshore by taking the closest value of the source data. It is clear that this is a gross generalisation and the resulting dataset is not accurate inshore; however this was necessary to avoid bias in the intended use of the dataset towards areas of the source data.

Wave height

Wave height was an important parameter to inform activities that require waves, e.g. surfing, though also for those that avoid larger waves, e.g. jet skiing.

Similar to wind data, certain limitations existed in availability of data though the best known dataset made available within the project timescales was used, as informed through Government agency experts and lead wave modellers at the national NERC laboratories.

This data layer was derived from BERR energy resource wave atlas and processed similarly to the wind data.

Water quality

Water quality was an important parameter to inform those that physically get in / are exposed to the water. It does not include visibility.

This data layer was derived from Environment Agency Bathing Water monitoring results of annual summary beach status. Results were aggregated over 4 years from

2010-2013 to compensate for heavy rainfall and influence of improved infrastructure, in line with the EA's own approach. Results of fail, imperative and guideline were assigned scores of 0, 1 and 2 respectively then each site's set of scores for 2010-1013 averaged and rounded to the nearest integer. Point data were converted to full coverage by assigning the nearest value.

Reefs and hard substrate
The seabed habitats are an important attraction to wildlife and therefore activities such as diving and angling. The most comprehensive full coverage dataset available is the JNCC's UK combined marine habitat map, issued in draft format by JNCC for the MMO1064 project (see intertidal parameter). However this caused significant set backs in the project from processing time and software crashes which were in part due to the 'slivers' formed in the complex polygon data. Therefore this could not be used.

Instead this data layer combined the BGS Hard Substrate layer and Natural England Annex I Reefs.

Seahorses
Seahorses were used to inform areas of attraction to wildlife. This data layer was derived from the Defra MB0102 project of *Hippocampus guttulatus* and *Hippocampus hippocampus* species. The two datasets were combined to inform presence and clipped to the subtidal part of the Marine Plan Areas.

Seals at Sea
This data layer was derived from the Sea Mammal Research Unit (SMRU) at the University of St Andrews. This combines the two datasets of species harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypusand*), assigning the mean intensity.

Birds at sea
This data layer was derived from combining Summer and Winter Seabird Densities data from the Wetland and Wildfowl Trust. The two sources were summarised by taking the maximum at any one location and using any areas of >0 as birds present.

Cetaceans
The Cetacean sightings data layer was another identified target species and informs wildlife watching and can also be an attraction for other activities. This data layer was derived from the JNCC Cetacean Atlas dataset 2003 and clipped to the subtidal part of the Marine Plan Areas. Sightings of all species were summed together where multiple values were present to provide a total intensity of number of animals per hour.

Basking sharks
This data layer was derived from the Defra MB0102 project Mobile Species dataset and clipped to the subtidal part of the Marine Plan Areas.

Accessible wrecks
This data layer combines various sources of wrecks and classifies them for ease of access with 4 = excellent and 1 = poor as follows:

- 1 = EH Protected - Protected wreck requires permission to access
- 2 = MOD Protected - Protected wreck requires permission to access
- 3 = EH Historic - Historic wreck
- 4 = S57 and Seasearch - Other accessible wrecks without status.

Leisure navigation

Leisure navigation was sourced primarily to inform small leisure craft but also acts as a deterrent to some activities, e.g. angling. This data layer was derived from the UKHO S57 Transportation and Routes polyline dataset which was buffered by 50m to define presence.

Restricted areas

There are many types are of areas that activities are restricted in either through management practice or a participant's own choice. Unfortunately there are very few sources of national spatial data on restricted areas and many are imposed at the local level, e.g. jet-ski restrictions or designated conservation zone restrictions.

This data layer was created from the sources:

- Anatec 90th percentile shipping density, from which above average shipping density was extracted
- UKHO S57 shipping lanes and zones
- UKHO S57 prohibited/ restricted areas
- UKHO S57 military practice areas as defined by electronic nautical chart data.

Annex G: Common/Multi-Layer Processing ('Tool 1')

The analysis grid detailed in **Annex F3** has been created for the project to provide a framework for the development of the model. The grid is 1km x 1km in dimension and is projected to ETRS89 UTM Zone 30 North. Tool 1 essentially performs a spatial join between the analysis grid and the processed parameter data. There are several variants of Tool 1 due to the different dimensionality of the data and what needs to be summarised from the data. For example, a continuous data set will cover the whole of the grid cells, but a biotope data set will delineate an area within the grid cell, and these will need to be summarised differently.

In Tool 1 the analysis grid is used to grid the data and provides a unique reference (GID) for each grid square. A value from the data is assigned to each grid square to provide the characteristics, summarised from the input data attributes, for that grid square. Using the value assignation in the tool configuration, categorisation and combination can take place to represent the inputs to be tested against the stakeholder primary and secondary conditions (Tools 3 and 4).

The parameter data sets offer different dimensionality and this has to be handled in different ways in the Tool 1 processing tools for summarising the data to the analysis grid. The different scenarios accommodated by the Tool 1 grid tools are divided into three types: presence, summary statistics and proximity. These scenarios are summarised below with bullet points showing the name of the tools, for which a detailed account follows.

1. **Presence**: Discrete data locations within the model extent which represent single or multiple dimensions (raster or vector) e.g. reef biotopes, navigation routes

   a. **Presence: Points, Lines and Polygons** - one-to one join used for counts only

   b. **Presence: Lines** - one-to-many join which splits lines by grid cells and lengths can be calculated using the field map

   c. **Presence: Area (Polygons)** - one-to-many join which splits areas by grid cells and calculates a percentage occupancy

   d. **Presence: Area (Raster)** – Requires ESRI Spatial Analyst Extension - as for c, but converts the raster to polygons prior to processing

2. **Summary statistics**: Raster or vector data covering the extent of the model e.g. bathymetry, wind speed; line and point data

   a. **Summary Statistics: Lines, Points, Areas** – one-many-join which allows the user to summarise data statistically with the field map

   b. **Summary Statistics: Raster** – Requires ESRI Spatial Analyst Extension – uses the raster and centroid version of the analysis grid to summarise continuous raster data at the grid cell level

    c. **Summary Statistics: Vector Grid** – re-grids continuous vector grid data; the field map allows the user to summarise the attribute values statistically

3. **Proximity**: Discrete data locations onshore whose presence impacts on the entire model extent in relation to their proximity e.g. marinas, car parks

    a. **Proximity: Point (Euclidean Distance up to a search radius)** – one-to-one spatial join where the user enters a search radius to assign the closest value to the grid square, defined by the stakeholder consultation, and the highest value can be selected using the field map

    b. **Proximity: Point (Path Distance) – Requires ESRI Spatial Analyst Extension** – a path distance raster is computed using the model extent and input point data, and the values sampled using the raster and centroid version of the analysis grid

The following sections summarise these grid tools and the scenarios they process. In the diagrams data inputs and outputs are in red boxes and processing steps in the black boxes. All tools assume input data in coordinate reference system ETRS89 UTM Zone 30N. A staging geodatabase (ArcGIS version 9.3) is also provided within the tool directory to generate repeatable interim feature classes with the tools.

- **In the following sections the tools are labelled according to the scenarios described above, and this labelling is also used in the Tool 1 ArcToolbox**

- **The ArcGIS Geoprocessing overwrite must be on for the tools to be reusable and repeatable.**

- **The ArcGIS ModelBuilder model for Tool 1 is contained in 03_DataTools\MMO1064_TOOL1.tbx.**

- **A staging database for Tool 1 is also provided in 03_DataTools\TOOL1_Staging.gdb**

Presence (scenario 1a): points, lines and polygons (for feature counts)

This tool summarises data that provides discrete locations (point, line or polygon) with one dimension/type where only feature counts within a grid cell are required, for example the presence of reefs.

**Figure 2: Presence of points, lines and polygons: process flow diagram.**
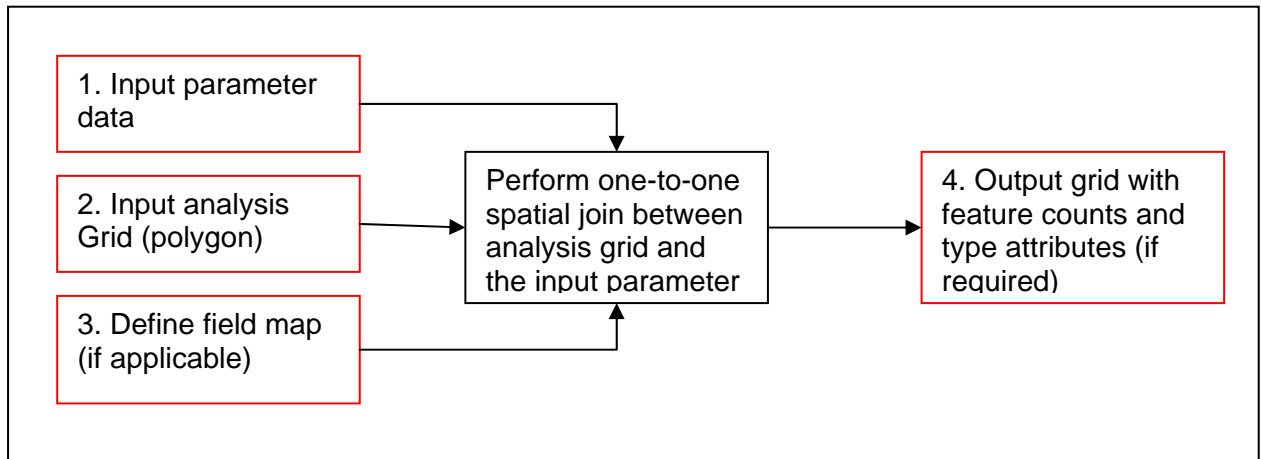
Input files: Parameter data (point, line or polygon), analysis grid polygons, data field map - optional, delete all fields to just retain join count (feature count)

Output files: Populated analysis grid with feature counts and nominated attributes (some cells will be empty)

Presence (scenario 1b): lines

This tool summarises data where a line data set crosses areas within the model extent, for example leisure navigation routes.

**Figure 3: Presence of lines: process flow diagram.**
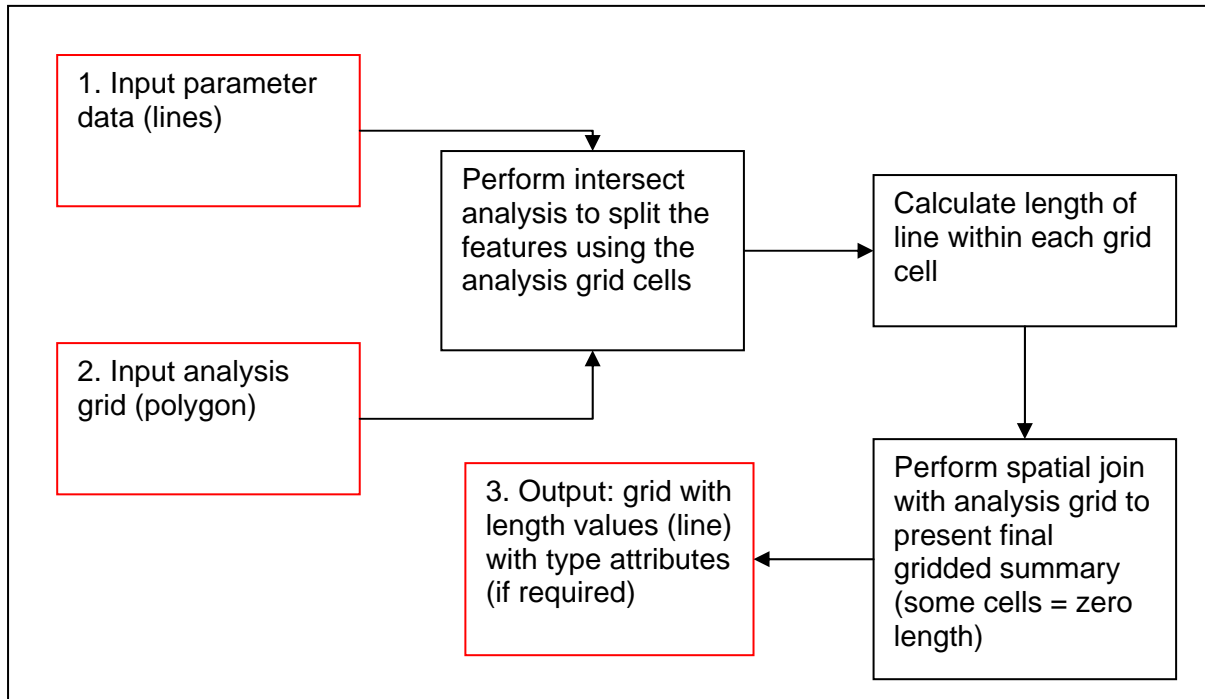
Input Files: Line parameter data and analysis grid (polygon)

Output Files: Populated analysis grid with line lengths and summary attributes of the data being analysed.

Presence (scenario 1c): area (polygon)

This tool summarises a polygon data set to delineate areas within the model extent with not only join counts but also attribute information, e.g. bird reserves and bird count data.

Figure 4: Presence of areas (polygons): process flow diagram.
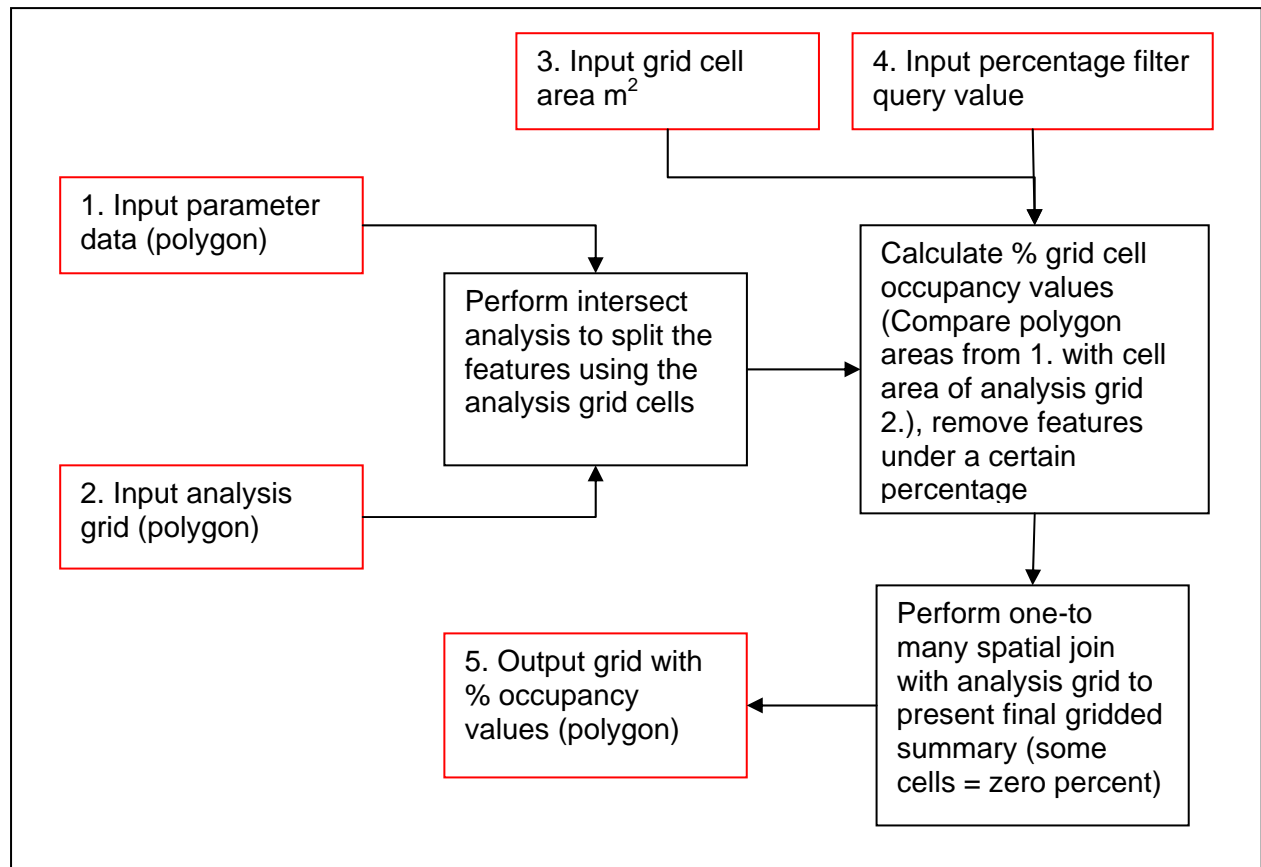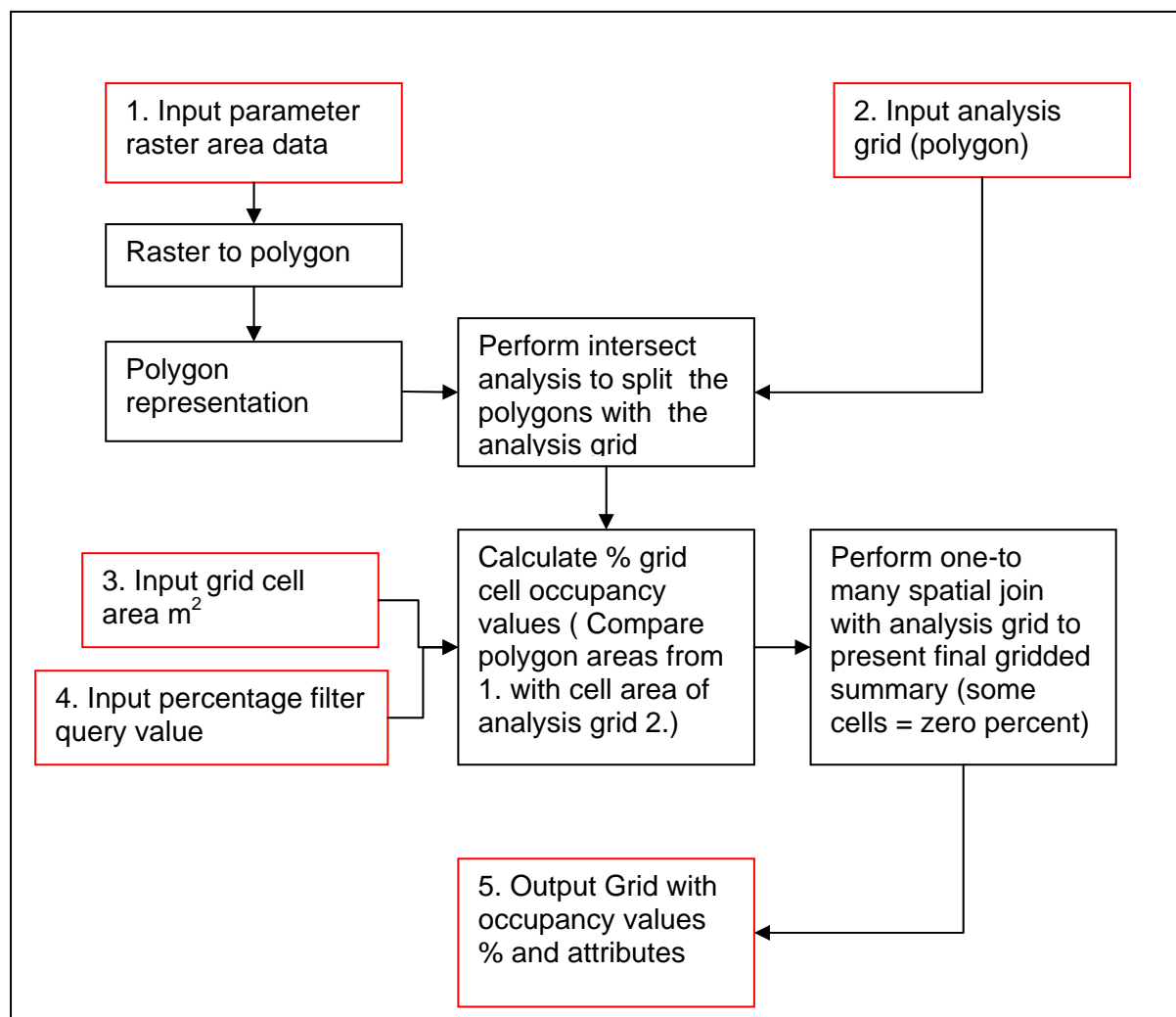

Input Files: Polygon parameter data to be summarised, the analysis grid polygons, the grid cell area in square metres, and the percentage value below which polygons should be used; this is designed to remove any slivers. created by the intersect process

Output Files: Populated analysis grid with percentage occupancy and attributes of the data being analysed (one-to-many join)

Presence (scenario 1d): area (raster) – requires ESRI spatial analyst extension

This tool summarises a raster data set to delineated areas within the model extent. The tool effectively adds an additional step to the Presence: Area (polygon) tool described in the previous section. This tool requires ESRI Spatial Analyst Extension.

Figure 5: Presence of areas (raster): process flow diagram.


Input data: Raster representation of areas, analysis grid polygons the grid cell area in square metres, and the percentage value below which polygons should be used; this is designed to remove any slivers created by the intersect process

Output data: Populated analysis grid with percentage occupancy and values of the raster data being analysed (one-to-many join).

Summary statistics (scenario 2a): lines, points or polygons

This tool summarises data (lines, points or polygons) that provides locations for multiple dimensions.

Figure 6: Summary statistics of lines, points or polygons: process flow diagram.
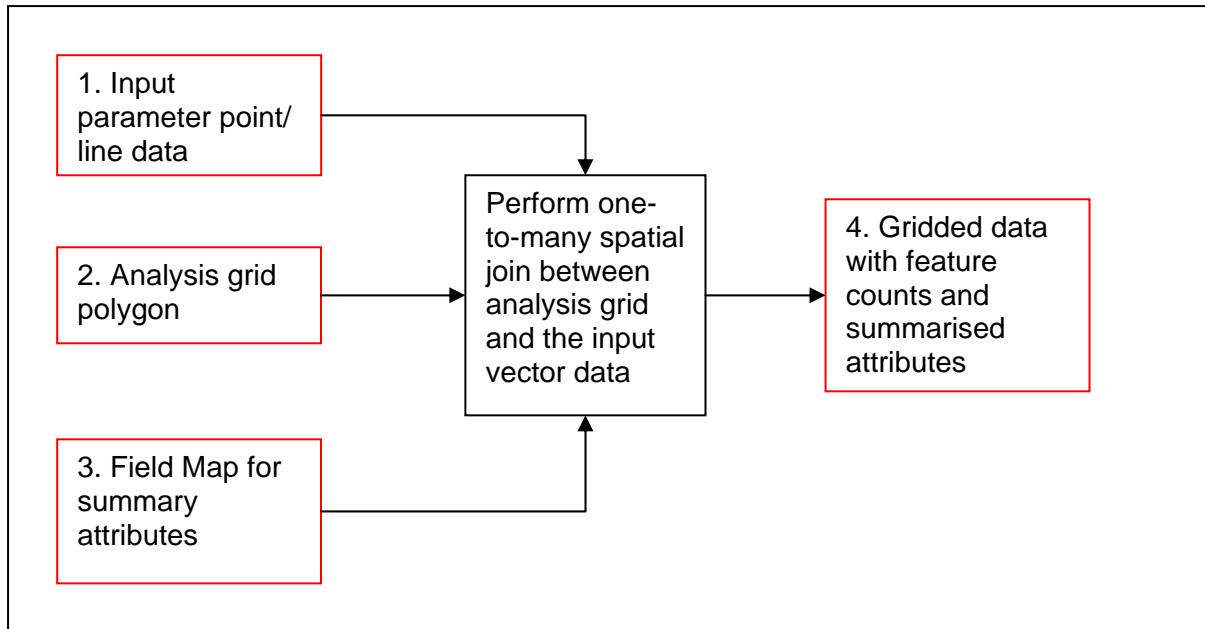
Input files: Point, line or polygon parameter data, analysis grid polygons, data field map; the field map can be used to generate statistics for numeric fields.

Output files: Populated analysis grid with feature counts and summarised attributes

Summary statistics (scenario 2c): areas (re-grid)

This tool summarises data from scenario 2c, where polygon data provides continuous coverage over the extent of the model for one or more data dimensions.

Figure 8: Summary statistics of areas (polygon): process flow diagram.
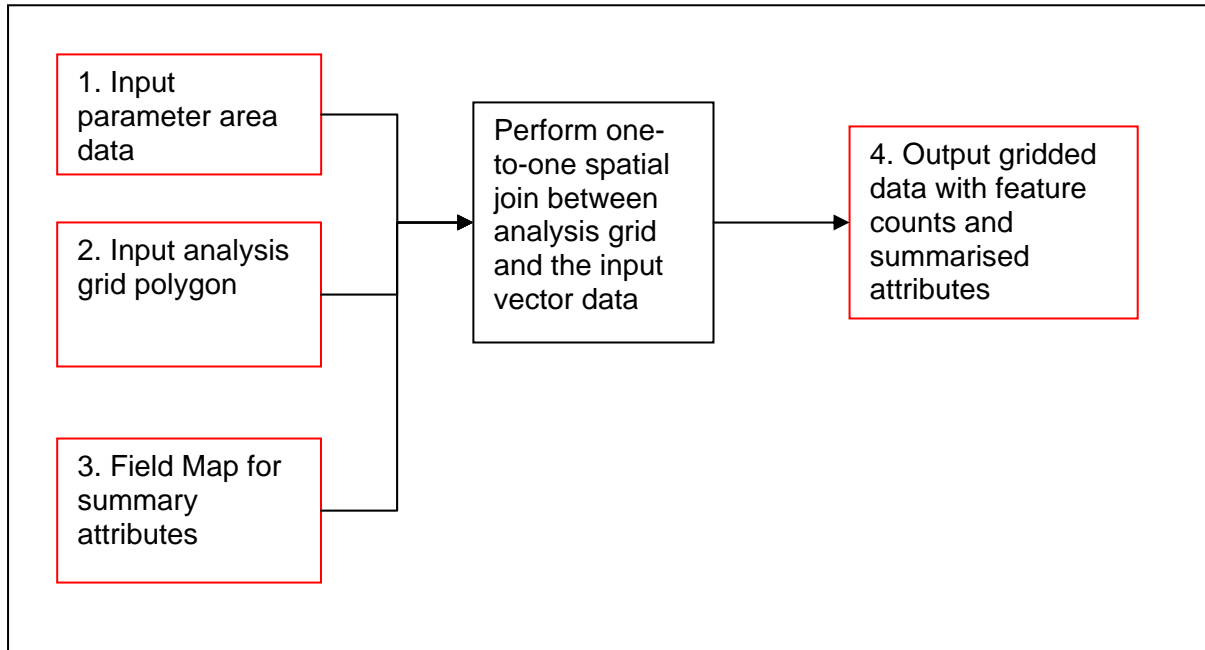
Input files: Continuous area parameter data i.e. gridded vector, analysis grid polygons, data field map; the field map can be used to generate statistics for numeric fields.

Output files: Populated analysis grid feature counts and summarised attributes

Proximity (scenario 3a): proximity point (Euclidean distance)

This tool summarises data from scenario 3a, where point data provides input to computation of distances across the grid, but this is only required up to a certain distance offshore as defined by the stakeholders.

Figure 9: Proximity point (euclidean distance): process flow diagram.
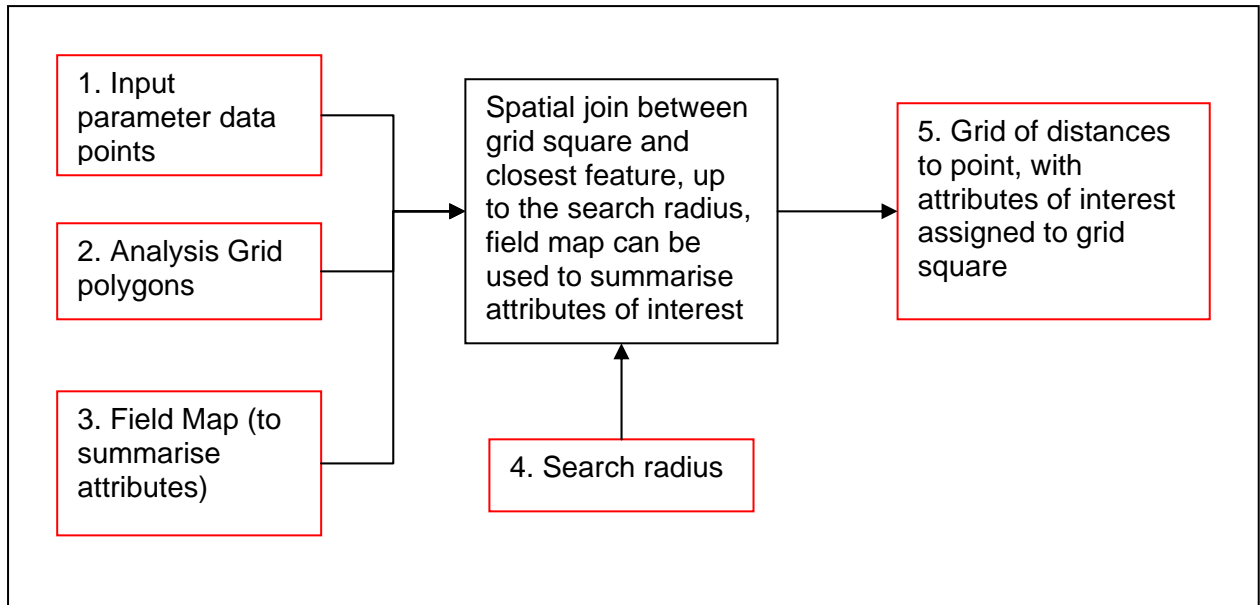
Input Files: Data parameter points, analysis grid polygons, a search radius and field map to summarise attributes of interest

Output Files: Populated analysis grid with distance to the nearest point and summary attributes e.g. maximum rank

Proximity (scenario 3b): proximity point (path distance) – requires ESRI spatial analyst extension

This tool summarises data where point data provides input to computation of distances across the grid. This tool requires ESRI Spatial Analyst Extension.

Figure 10: Proximity point (path distance): process flow diagram.
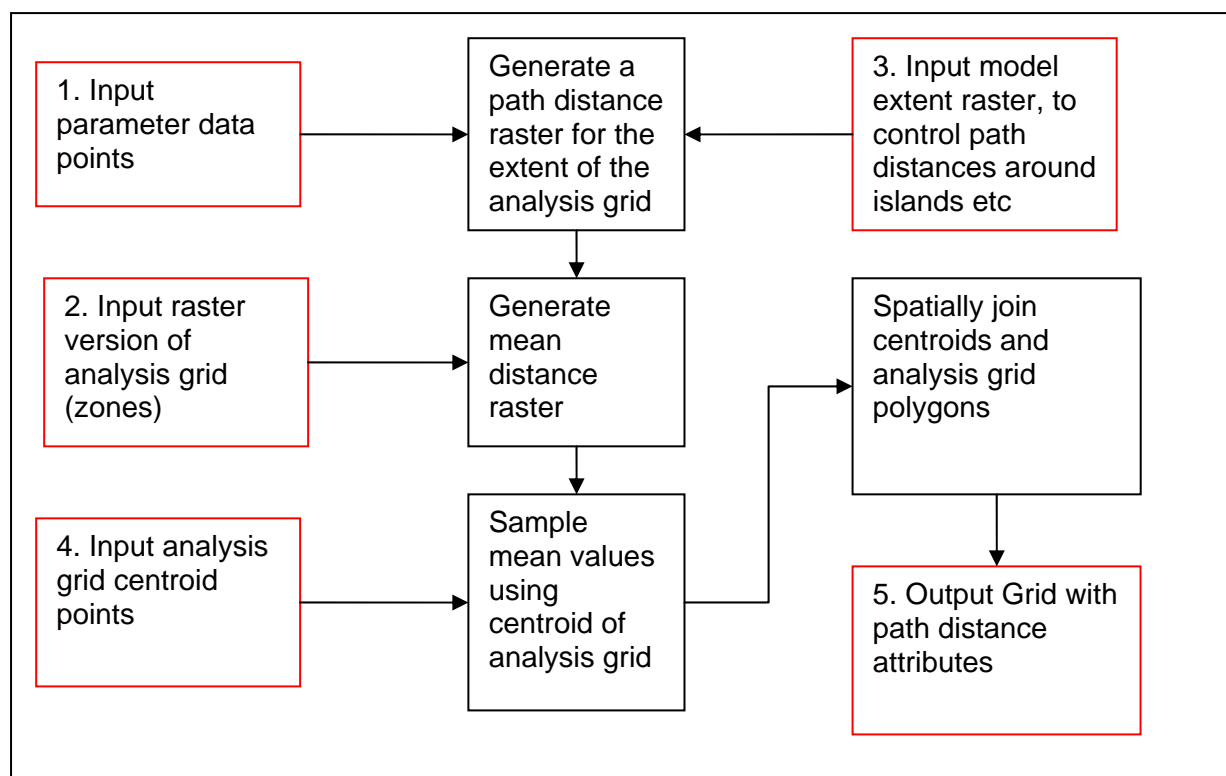
Input Files: The parameter data points, a raster version of the analysis grid used as a zone raster, analysis grid polygons and analysis grid centroid points

Output Files: Populated analysis grid with mean path distance to the locations for each grid cell.

Note: False outliers are required to be inserted into the point data to ensure that path distances are calculated up to the model extent. These are placed at just over twice the maximum distance of the extent boundary i.e. to the North East and South West of the model. The ETRS 89 UTM Zone 30N coordinates used are:

North East: 989500E 6670600 N   South West: -373000E 5161500 N

For lines and polygons a small 1m sized feature is created at these locations to create false outliers.

Annex H: Model Methodology

H1. Combining input layers ('Tool 2')

- **The ArcGIS ModelBuilder model for Tool 2 is contained in 03_DataTools\MMO1064_TOOL2.tbx.**

- **A staging database for Tool 2 is also provided in 03_DataTools\TOOL2_Staging.gdb**

The aim of Tool 2 is to populate the attribute values from gridded parameter data layers for each grid square, in effect joining these together into one definitive grid. Each grid square has a unique identifier GID which is gained from the defined analysis grid stored in 04_DataBase\AnalysisGrid. Figure 12 below shows the overall process for Tool 2.

Figure 11: Union tool process flow diagram.
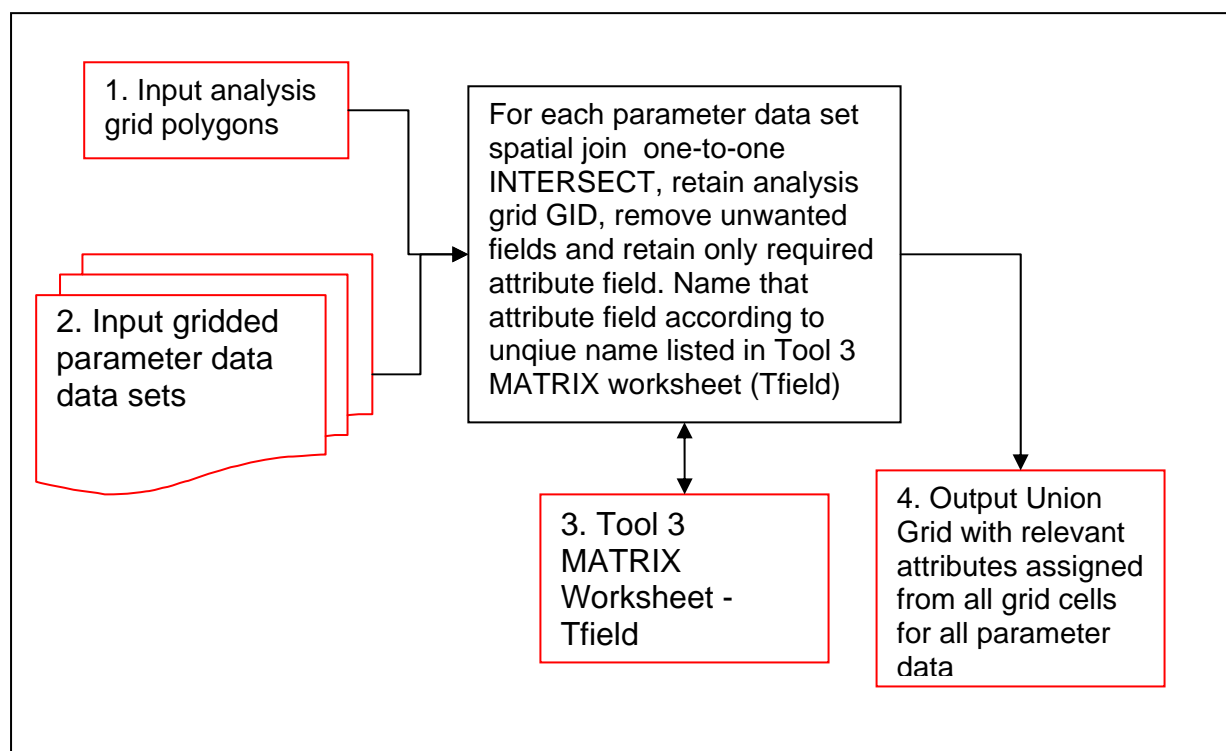
Input Files: The gridded parameter data sets, analysis grid

Output Files: Unioned analysis grid with attributes for each parameter stored in defined attribute fields ready for testing with the model.

Spatial joins (one-to-one) between the analysis grid polygons and the gridded data are used to combine the data into one unified grid. The spatial join mechanism is used as opposed to table joins (Add Join) as it allows for the output fields and their names to be controlled. At ArcGIS v9.3 the Add Join tool assigns arbitrary field names which cannot be controlled and are difficult to trace back.

For each spatial join, the output is written to the Tool 2 staging geodatabase, with only the required fields retained. After the final spatial join, the Feature Class to Feature Class tool is used to provide the final Union Grid shape file output, stripping the final Join_Count field from the final spatial join output.

The field names used for the attributes in the spatial join are then listed next to the relevant parameter in the control matrix for Tool 3 (see Annex H2) for subsequent SQL query building within Tool 4 (see Annex H3).

New shape files can be added to the tool by adding them to the tool and adding another spatial join prior to the Feature Class to Feature Class function at the end of the tool. Care must be taken when modifying or deleting existing data to ensure that the field maps are updated in the Spatial Joins.

H2. Combining activity preferences ('Tool 3')

The control matrix Microsoft Excel 2003 for Tool 3 is contained in 03_DataTools\MMO1064_TOOL3.xls.

The control matrix spreadsheet is a plain format representation of the activity preferences transcribed from the stakeholder consultation, configured to describe the relevant attribute values contained within the data. The primary worksheet used is called MATRIX, and a secondary worksheet ACTIVITY is provided as a reference for activity codes that are used in the MATRIX worksheet.

The table below describes the schema and content of the MATRIX worksheet:

Table 6: Tool 3 schema and content of the MATRIX worksheet.

Column	Description
Parameter	Parameter title
Type	Category (Cat) or Numeric (Num)
Units	Units – for user information only
TField	Test attribute field held in the union grid (can be repeated to test a parameter twice)
SField	UNIQUE score attribute field to add to union grid and populate
Wpri	Primary condition weighting
Wsec	Secondary condition weighting
<Activity Code>Score	Confidence of Influence Score for activity (denoted by code)
<Activity Code>Pri1	Primary condition 1 for activity (denoted by code)
<Activity Code>Pri2	Primary condition 2 for activity (denoted by code)
<Activity Code>Pri3	Primary condition 3 for activity (denoted by code)
<Activity Code>Pri4	Primary condition 4 for activity (denoted by code)
<Activity Code>Sec1	Secondary condition 1 for activity (denoted by code)
<Activity Code>Sec2	Secondary condition 2 for activity (denoted by code)
<Activity Code>Sec3	Secondary condition 3 for activity (denoted by code)
<Activity Code>Sec4	Secondary condition 4 for activity (denoted by code)

For numeric based parameters, Pri1 and Pri2 provide a numerical range, as do Pri3 and Pri4, Sec1 and Sec2, Sec3 and Sec4. For categories based parameters, Pri1, 2, 3, and 4 provide individual categories in the attribute data, as do Sec1, 2, 3, 4.

For primary and secondary conditions, a NULL input is denoted by -999999.

The table below describes the schema and content of the ACTIVITY worksheet:

Table 7: Tool 3 schema and content of the ACTIVITY worksheet.

Column	Description
Code	UNIQUE two letter activity code used in the MATRIX worksheet
OutShape	Suggested output shape file name for the activity grid

When the main Model Scores spreadsheet is updated then the plain format version must be updated to reflect the changes. This applies both to the schema of the spreadsheet and the content.

H3. Prediction rules ('Tool 4')

- **The ArcGIS ModelBuilder models for Tool 4 are contained in 03_DataTools\MMO1064_TOOL4.tbx.**

- **ArcGIS v10.2 ModelBuilder models for Tool 4 are provided in 03_DataTools\MMO1064_TOOL4v10.tbx.**

- **For ArcGIS v9.3 a staging database for Tool 4 is also provided in 03_DataTools\TOOL4_Staging.gdb.**

Figure 12 overleaf shows the overall process for Tool 4.

Tool 4 provides the following model parts, which also signifies the running order for each activity:

4-1a   Prepare activity grid, which makes a copy of the union grid to a suitably named shape file and adds a TSCORE column in readiness for population with the total score

4-1b   (ArcGIS v9.3 only) Prepare Lookup Tables which runs a select query on the MATRIX worksheet and writes them out to category and numeric lookup tables

4-2a&b   Population of the grid with the relevant scores for category (text) and numeric attributes, using the MATRIX worksheet provided as Tool 3

4-3   Computation of the totals for the computed scores in 2); the expression is provided as a parameter so that it can be changed if new fields are added in the MATRIX worksheet. The tool will test if the grid square has been

scored for a baseline activity area and will then compute the score for that cell; cells outside the baseline activity area will be set to null: -999999

Figure 12: Model tool process flow diagram.
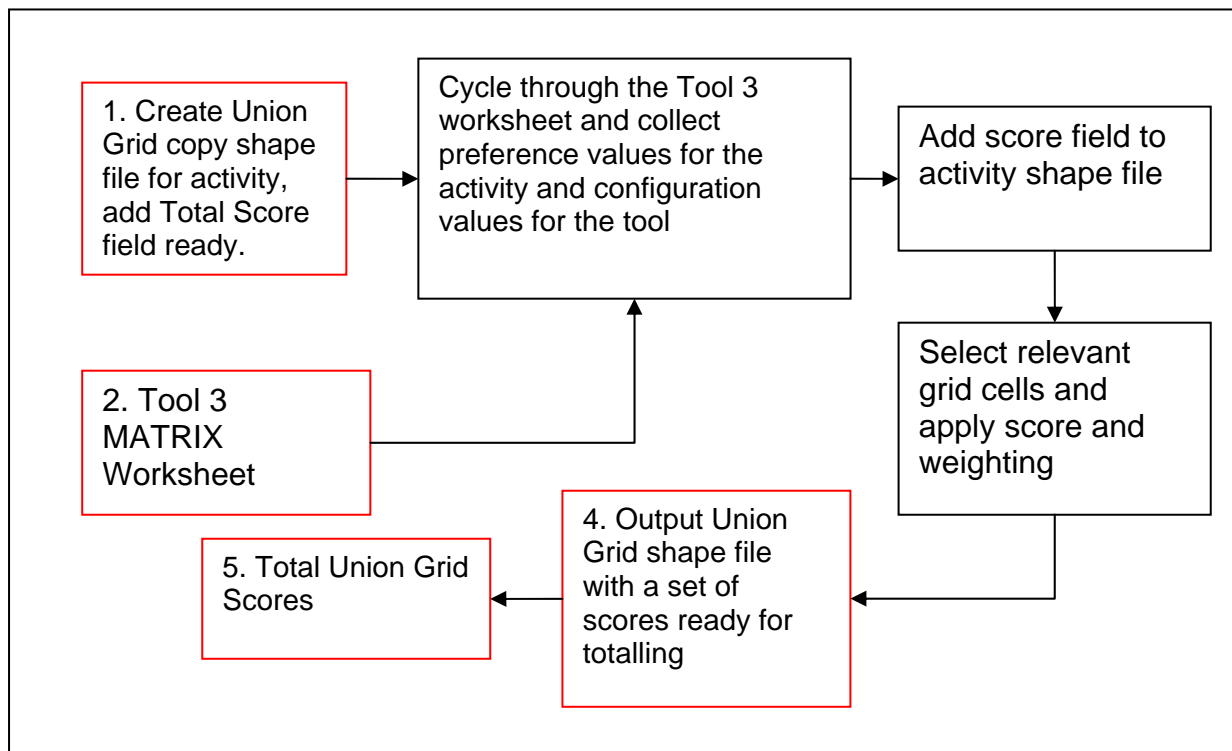
Input Files: The union grid shape file (copied per activity) and the Tool 3 MATRIX spreadsheet.

Output Files: Unioned analysis grid with scores for each parameter and totalled scores.

Each part 4-2 of model Tool 4 is also labelled with the relevant number from the original User Friendly Tool 3 spreadsheet for example for surfing is activity 4:

- 4_2a_SurfingCategory
- 4_2b_SurfingNumeric.

The prediction rules of the tool lies within part 2 of the toolbox and are described here. Part 2 of the Tool 4 toolbox is designed to:

- Create a view/ lookup table of the spreadsheet based on Category (text) or Numeric values for testing
- Iterate through the MATRIX spreadsheet view/lookup table
- Add the relevant score field to the activity grid shape file
- Select the relevant grid squares based on the primary and secondary conditions; a SQL query is generated from the values in the MATRIX spreadsheet
- Calculate the scores in the relevant score field based on the primary or secondary weighting multiplied with the score.

Tool 4 is divided into 3 parts due to the iterative nature of the main model, where the model is run for each row in the MATRIX view or lookup tables. Parts 4-1 and 4-3 are run once and if combined into Part 4-2 will be run each time the model iterates, which causes non accumulation of scores, and in some cases recursive actions in the model. The activity grid shape file is also exposed as a parameter for part two of the toolbox to allow flexibility for the user in the naming of the file in the process.

Part 2 of the Tool 4 toolbox is divided into (4-2a) category (string) and (4-2b) numeric models. This is to simplify the approach to generating SQL queries from the primary and secondary conditions for string and numeric conditions, as they will be different.

The category (4-2a) and numeric models (4-2b) select records from the MATRIX spreadsheet views or lookup tables using Type='Num' and Type='Cat' respectively. It is recommended that models these could be combined at ArcGIS v10 if a decision tree could be enforced using the Type selection.

The following table lists the variables used in Tool 4-2 of the model to compile SQL queries to select data and compute scores. The field values used from the table are listed; the example used here is for surfing (SU).

Table 8: Variables used in Tool 4 part 2 (4-2).

Variable	Field Used
FieldNm	Tfield*
Pri1	SUPri1
Pri2	SUPri2
Pri3	SUPri3
Pri4	SUPri4
Score	SUscore
Sec1	SUSec1
Sec2	SUSec2
Sec3	SUSec3
Sec4	SUSec4
SField	Sfield*
WPri	Wpri*
WSec	Wsec*

* These fields are the same for all activities; the score, primary conditions (Pri) and secondary conditions (Sec) are activity specific.

H4. Additional notes on Tools 1-4

Several limitations have been encountered in ArcGIS ModelBuilder v9.3 and v10.2 during the compilation of the model and are documented here for reference. They are mainly due to lack of automatic data refresh in the software, which leads to the wrong schema and data being held in the ModelBuilder tools.

1. Geoprocessing overwrite needs to be ON to run all models successfully; this can be changed in ArcCatalog options

2. Changes to the data or spreadsheets schema/content requires that the existing data needs to be deleted out of the model and completely reloaded into the model by drag and drop or the add data mechanism. This is because ArcGIS ModelBuilder has a tendency to load feature classes and tables into memory and does not automatically update changes:

   a. Tool 1 - GRID Line Length and GRID Polygons Percentage; the staging feature class has been made a parameter of the second part of these tools so that it can reloaded and the field map reset (updated).

   b. Union Tool 2 - when adding/ removing data care must be taken to ensure that all the required field headings perpetuate through to the end of the model. If necessary data must be re-added and field maps reset and re-edited to ensure the fields are updating throughout the model.

   c. Tools 3 and 4 in ArcGIS 9X then the series variables will need to be updated by reloading the data from the generated tables in the Tool 4 staging geodatabase when changes are made to the matrix spreadsheet.

   d. Tool 3 and 4 in ArcGIS 10X - changes in schema and values in the MATRIX spreadsheet Tool 3 require reloading of the spreadsheet into Tool 4 (ArcGIS v10.2). For this reason the MATRIX spreadsheet is exposed as a model parameter for Part 2 of the toolbox.

3. If running the models in edit mode, use 'Run Entire Model' to ensure all variables are refreshed and collected

4. The time to process datasets, primarily in Tool 1 and in the pre-processing stage prior to this, were significant in some cases. It is recommended that future users have 4-10GB of RAM.

Annex I: Confidence Assessment

Gridded input data

A confidence rating has been supplied to each dataset where the data has been sourced. This is closely aligned to the MMO confidence rating method with minor adaptations. These have then been amalgamated where multiple datasets inform one parameter. The final parameter confidence is provided as an average and minimum of the source data confidence as shown in Table 9.

Table 9: Combined confidence of input layers.

Parameter/Data Layer	Average Confidence	Minimum Confidence
Baseline Activity Area	100%	100%
Estuary	100%	100%
Land Access	97%	80%
Car parks	98%	93%
Marinas	67%	67%
Slipways	67%	67%
Moorings	78%	67%
Land habitats (PHI)	80%	80%
Intertidal habitat (MB102)	87%	87%
Birds on land	93%	87%
Land reserves	92%	80%
Water depth	100%	100%
Wind magnitude	93%	93%
Wave height	87%	87%
Water quality	93%	93%
Reef and Hard Substrate	97%	93%
Seahorses	93%	93%
Cetaceans	80%	80%
Basking sharks	60%	60%
Birds at sea	100%	100%
Seals at sea	73%	73%
Accessible Wrecks	82%	80%
Leisure navigation	80%	80%
Restricted Area	83%	80%

Model predicted output data

The model predictions are given by a total score per grid cell for each activity. This score provides a measure of confidence as to how likely recreation is expected to occur at that location. Due to the multiple number of datasets used in the prediction it is not possible to provide a breakdown of confidence otherwise. However the activity Matrix (Tool 3) informs on what parameters have been used and therefore can relate back to the input data layer confidence in Table 9 above.

Annex J: Future Application of the Model

J1. Altering input scores

Scoring within the model can be altered as further information and evidence is gathered from stakeholders in preparation for marine plans. Scores can simply be altered within the model scores spreadsheet and the model re-run to apply the scores. More information is provided in Annexes H2 and K.

J2. Improving input data

Data sourcing for the model can be considered a continuous process as new and improved data sets become available. More information about adding new data into the model is provided in Annexes F, G and K.

The processing of very large data sets was out with the scope and budget of this project. Therefore the following recommendations are made with respect to improving data:

- Obtain better data for land access points. This was modelled based on heights, slope and proximity of roads and paths. This modelling could be greatly improved using high resolution terrain data such as Lidar data, use of detailed footpaths and incorporating proximity of public transport. Alternatively a data set on accessible beaches could be sourced/ compiled; this data does not exist at the time of writing. Land access points are critical to the success of the model as they form the basis for a wide range of marine leisure activities.

- Utilise the OSMasterMap (OSMM) dataset to inform a wide range of parameters. OSMM contains the relevant cartographic and textual descriptions to inform certain parameters (e.g. land entry points, car parks, jetties, groynes). However, the project team have run scripts to deal with the 30 data tiles and these have crashed, potentially due to the file sizes, as well as taken extremely long times to process. As result OSMM was not used in this project. MPC are able to offer processing to inform certain parameters as an add-on to this project and with certain parameters may be able to do these in this financial year, with production to inform future runs of the model.

- Obtain / commission production of more suitable wind and wave summary data. This was very difficult to obtain in a suitably processed form and the BERR Renewables Atlas was used, which is very general in nature. A better data set should be sourced to provide minima and maxima as well as mean wind speeds at or near the sea surface, for inshore and offshore areas (the Marine Plan Areas could provide a definition for summary areas). JBA Consulting have near complete coverage of England's marine nearshore areas for wave data but combining this would require time. Also Magic Seaweed reportedly have good (nearshore) data and may be able to respond on a longer timescale than this project allowed; and Surfers Against Sewage report that they can suggest other valid sources.

- The Subtidal habitats provided by the EUSeaMap / MESH combined map produced by JNCC and provided to the project team as draft format pre publishing could not be processed within the timescales due to the significant geometric errors and overlap in areas mapped which lengthened all processes applied in GIS up to a point that this was un-workable in the timescales. Cleaning, dissolving and correcting this dataset on a PC with significant RAM (over 4GB) may allow it to be included in this model.

J3. ArcGIS recommendations

Modelling was developed in ArcGIS 9.3 as requested by the MMO. Multi-criteria evaluation modelling requires iteration through value tables in order to select and denote applicable data. The iteration mechanisms offered in ArcGIS 9.3 are static in nature, i.e. series variables have to be dimensioned with lists of data loaded into them, but these have to be updated manually when changes are made to the score spreadsheet. Also, numeric and string values cannot be read on the fly and static tables of each need to be created for loading values into the series variables. For 12 marine recreation activities this numbers 216 reload operations.

These issues are addressed by ArcGIS 10.2 ModelBuilder, where iterator tools are provided for looping through tables, and model specific tools are provided so that Get Field Value can be used to obtain the value of a field in the current row of the table. A view of the table can also be created for numeric and string variables, and the iterator tools will work from this. In general the whole arrangement is more dynamic, in that if the scores matrix (Tool 3) is changed it just has to be reloaded once and re-incorporated to the model.

In general the ArcGIS 10 ModelBuilder models run twice as fast as the ArcGIS 9 models.

Within the Tool 1 proximity path distance tool it would be safer to generate a raster and centroid version of the analysis grid at each run of the tool to ensure consistency between the three in the case of analysis grid change.

Within Tool 2 the data and the field names are statically dimensioned, an approach which again was taken due to time constraints and requirement to stay within v9.3 where possible. It is anticipated that this process could be controlled using a spreadsheet containing source field name, destination field name and file name. It is recommended that this approach be implemented in ArcGIS 10 ModelBuilder as this will be easier due to the improved iterator and model specific tools described in this section.

At present Tool 4 is divided into several tools, due to limitations with using iterators and dividing between numeric and category modelling. This approach was taken due to time constraints and an initial aim to use v9.3; however it is anticipated that numeric and category models could be combined using branching/ decision tools within ArcGIS 10 ModelBuilder and it is recommended that this approach is examined.

Annex K: MMO1064 Marine Recreation Model User Guide

K1. Updating the input data layers

The input data layers represent the different characteristics, e.g. depth, land access, subtidal habitats. These steps should be followed when updating a layer:

1. Once data is in ArcGIS, reproject to ETRS89 UTM Zone 30N
2. Clean input data so only attributes required remain in table
3. Follow relevant processing log (see project webpage[3])
4. Apply the relevant grid tool (Tool 1)

K2. Creating a Unioned Data Grid

The data is combined using a Union tool, Tool 2. All data is joined to the analysis grid, and for each grid cell the data values summarised into a uniquely named field for testing the Activity Matrix scores and conditions against (see below).

K3. Changing the Activity Matrix scores

The Activity Matrix scores may be changed simply by opening the spreadsheet and amending scores. A guide to changing scores is given below:

1. The Activity Matrix is provided in a coded format as shown in the worksheet Model Key, e.g. SA = sailing, SAPri = sailing primary condition. If a field is numeric (see column B, Type = Num) then Pri1 and Pri 2 are the upper and lower ranges of the primary condition and Sec1 and Sec2 for the secondary conditions. If the field is a category (Cat) then Pri1, Pr2, Pr3 and Pri4 are all categories that satisfy the primary conditions and Sec1, Sec2, Sec3, Sec4 are all categories that satisfy the secondary conditions.

2. The model score is the score from -3 to 0 to 3 of whether how strongly this influences the model. It may be positive (attracts recreation) or negative (users avoid).

3. The primary and secondary conditions must be selected from those shown in the Worksheet "Parameter Categories". Note these may require updating if the input data has changed.

4. Enter -999999 for any cells where nothing is entered.

5. The weights may also be changed, however care is advised if doing this as all activities will be affected and the pros and cons of doing so need to be assessed in detail beforehand.

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[3] http://www.marinemanagement.org.uk/evidence/1064.htm

K4. Re-running the model

Before re-running the model a simple format version of the Activity Matrix should be created in the MATRIX worksheet of MMO1064_TOOL3.xls. This is done by simply copying the value grid from the activity matrix and using paste special to paste only the values into the MATRIX worksheet.

The model can then be re-run by using the model toolbox Tool 4 to:

1. Make a new copy of the activity grid shape file (to re-zero all of the scores)

2. Run the numeric and category models, taking care to re-select the MATRIX spreadsheet and select the new activity grid shape file

3. Compute the totals for the new activity grid shape file

K5. Changing the model

To add more parameter data layers to the model:

1. Create the new data as described in 'Updating the input data layers'

2. Edit the Union Tool 2 to add in the new data, assigning a unique field name for the data attributes; re-run the Union Tool

3. Add a new row in the Activity Matrix, as described in section 'Changing the Activity Matrix Scores'.

4. Rerun the model as described in the section 'Rerunning the Model', ensuring the Tool 3 MATRIX worksheet is reloaded

To remove parameter data layers from the model:

1. Remove the relevant row from the Activity Matrix

2. Edit the Union Tool 2 to remove the data; re-run the Union Tool

3. Rerun the model as described in the section 'Rerunning the Model', ensuring the Tool 3 MATRIX worksheet is reloaded

To add a new activity to the model:

1. Add a new set of activity columns in the Activity Matrix, as described in section 'Changing the Activity Matrix Scores', creating a new unique code for the activity.

2. Rerun the model as described in the section 'Rerunning the Model', ensuring the Tool 3 MATRIX worksheet is reloaded