# Introduction

Fishery Analyst is an ArcGIS 9.x application developed to effectively analyze and visualize temporal and spatial patterns of fishery dynamics. It presents an innovative way to utilize the geographic information associated with fisheries data. The custom software component was developed using Visual Basic for Applications and ArcObjects within the Environmental System Research Institute ArcGIS software. The main functions are quantitative estimation and visualization of catch and effort and their variation in space and time, analysis of fishing vessel utilization, data quality control, and deriving information on the location of important economic and threatened species. The application provides a user-friendly analysis interface allowing for easy and diverse output production. The interface allows

the user to choose the analysis to perform (effort, catch density, catch per unit of effort etc) and to select data on criteria such as year, vessel name or size class, and fish species caught. The output can be generated as yearly, monthly, quarterly or user-defined date interval plots. Results can be plotted in pre-defined map layouts and saved in quantitative GIS data file formats (raster and vector) or as graphic maps and animations. The application provides an option to produce non-confidential plots for data protected by confidentiality policies.
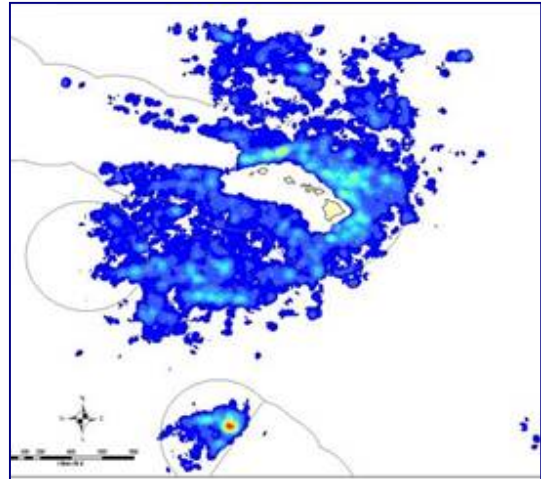
Software availability

Mappamondo GIS

URL http://www.mappamondogis.it/products.htm

Email: info@mappamondogis.com

Ph: +393386246285

Software required: Environmental System Research Institute's (ESRI) ARCGIS 8.3 or 9 with Spatial Analyst extension

Program language: Microsoft's Visual Basic for Application and ArcObjects Program size: 4.5MB (uncompressed)
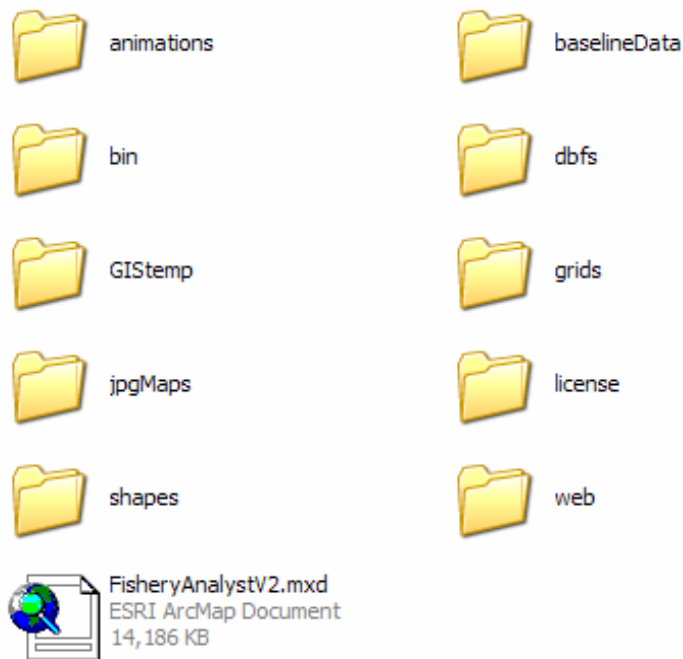
Related readings:

Francesca Riolo, 2006. A Geographic Information System for fishery management in American Samoa. Environmental Modeling and Software Volume/Issue 21/7 pp. 1025-1041.

Installation and licensing

To install Fishery Analyst double click on the self extracting archive FisheryAnalystV2.exe and follow the instructions on the screen. Install the application in a location on the PC where all users have writing permission (please note that users in the "restricted user" default group on Windows XP might not be able to run the application).

In the final installation directory you will find a series of sub-folders that will contain input data and outputs as well as other files necessary to run the application. A description of each folder can be found at the end of this section. Your installation directory should look like this:

animations	baselineData
bin	dbfs
GIStemp	grids
jpgMaps	license
shapes	web

FisheryAnalystV2.mxd
ESRI ArcMap Document
14,186 KB

To install the license you will need to be logged in as administrator of your machine. Copy the VBOLock.ocx file you find under the license folder to the C:\WINDOWS\system32 folder. Go back to the license folder and double click on the license.bat file. You should receive a message

saying that the license component was registered successfully. Now you are ready to start the application and order your license key (see next session). Skip the license installation if you are using the trial version and read last page of this manual.

The **baselineData** folder contains background data for the map like coastlines or EEZ boundaries. These data are by default included into the ArcMap projects. This is also the recommended directory to store any data you wish to add to the map layout (although this is optional).

The **dbfs** folder contains the fisheries data tables in dBase format that will be the input to the application. For technical specification about the input data requirements please see the document "Fishery Analyst data technical specifications".

The **grids** folder will contain all the quantitative raster data output, for example the data layers of effort, catch and CPUE surfaces in geo-referenced GEOTIFF format.

The **jpgMaps** folder contains the output map layout of each analysis in jpg format. The map layout includes a representation of the data (e.g. effort) with a legend, a north arrow, a title, description etc. These jpg files can be used in reports.

The **animation** folder will contain a PDF animated sequence of the generated output series.

The **shapes** folder contains the point and line representation of the fishing locations in a GIS vector format called shapefile.

The **web** folder contains jpgs plots designated to be published to the web.

The **GISTemp** folder contains temporary files

The **license** folder contains the license file and information

The **bin** folder contains file needed by the application to run

It is recommended to empty the grids, shapes, animations, GISTemp, jpgMaps folders now and then. Keeping too many files on these folders will slow down the application. Output meant to be stored permanently should be moved to another location on your machine once it has been produced.

The FisheryAnalystV2.mxd file is the ArcMap (ArcGIS) project that gives access to the graphical user interface (GUI) of the Fishery Analyst application. Double click this file to start ArcMap and move to the next paragraph to find your way around from now on!

The interface

Now you are in ArcMap. Please refer to the image below to become familiar with the various parts of the project.
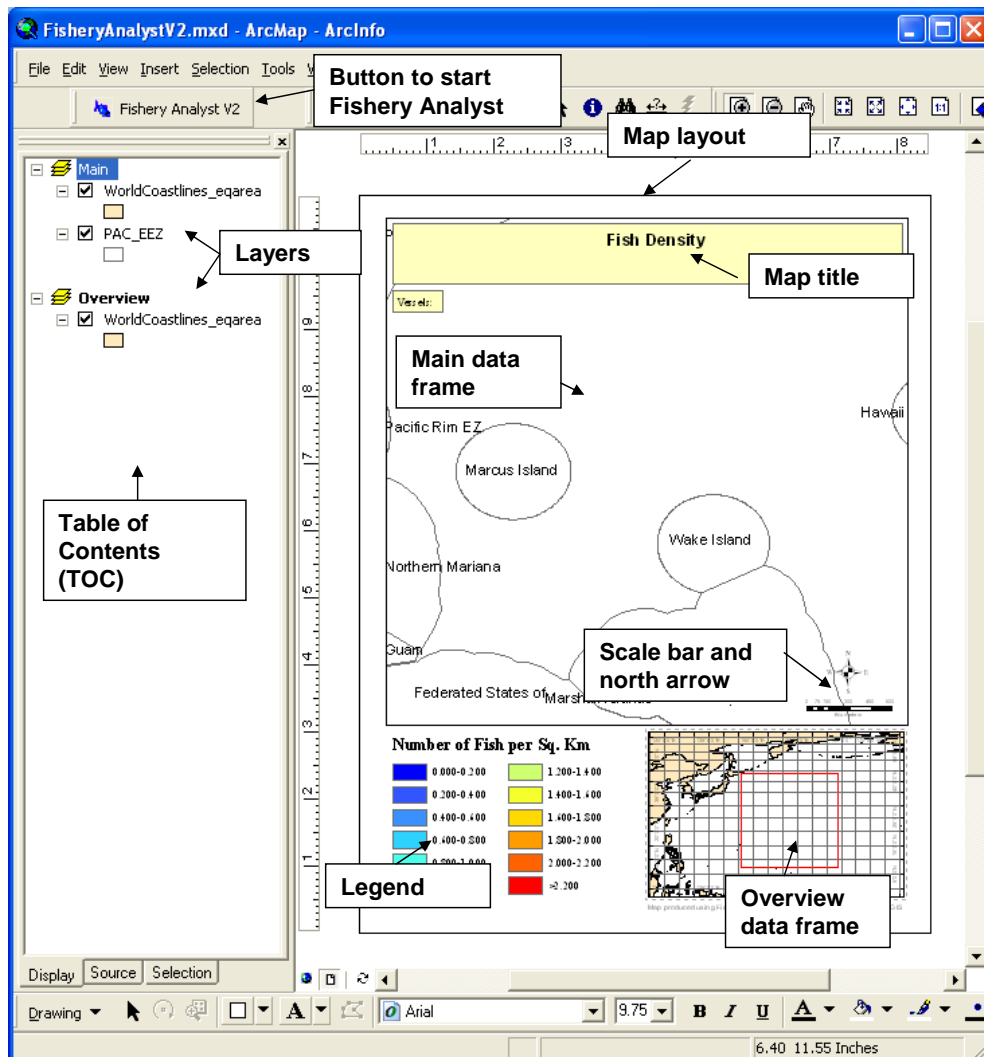
The Table Of Contents (TOC) shows the list of data layers represented in the map layout. **The map layout** is the combination of all elements on a map. On a single map layout you can represent more then one **"data frame"** each with its own list of data layers. In our map we have a **Main data frame** and an **Overview data frame** (you can see them listed in the TOC). The Main data frame displays the data zoomed in on our area of interest (e.g. Hawaii) while the overview map displays the same data but on a smaller scale (e.g. the entire South Pacific Ocean). A red rectangle on the Overview frame shows the extent of the world represented in the Main data frame.

It is possible to **add or remove layers** from the TOC. If you wish to add your own layers of data you will need to rename the layer and add **"BL_"** (BaseLine) at the beginning of the layer's name or it will be removed by the application at the end of each run. To add a layer press the "Add data" button in ArcMap (+). To rename a layer, single click on its name in the TOC and type in the new name.

The legend explains what data each color is representing in the map. In our map we have a "color ramp" color system that goes from blue (low values) to red (high values) using 12 classes of values (data classification). Now that we are familiar with the different part of the map layout and TOC we are ready to start the Fishery Analyst graphical user interface (GUI).

Click the FisheryAnalyst button (the one with the blue fish on it) on the ArcMap toolbar. Click start on the "About" window. If you haven't registered your license yet you will see the license dialog box:
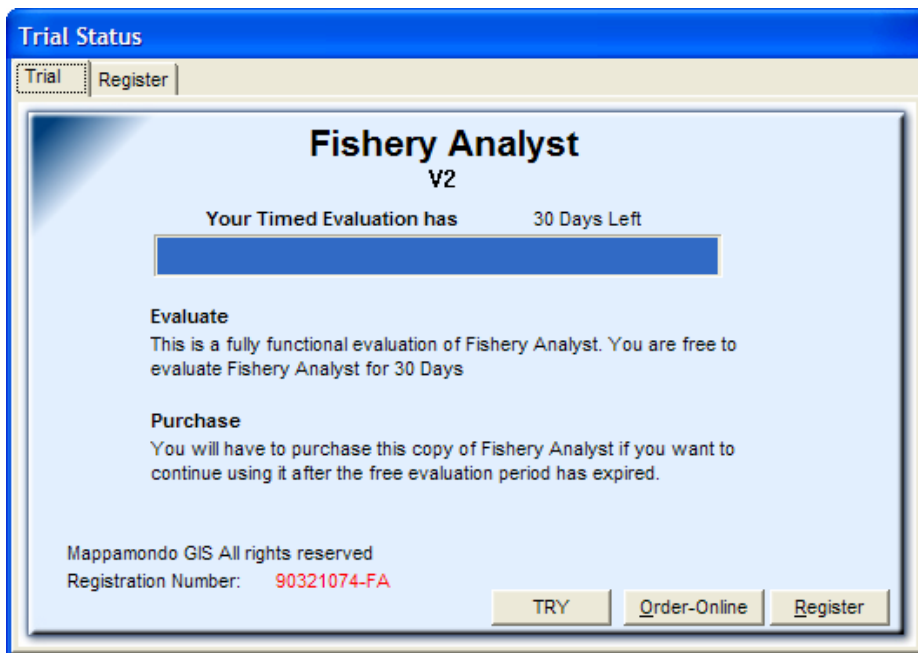
Click on register
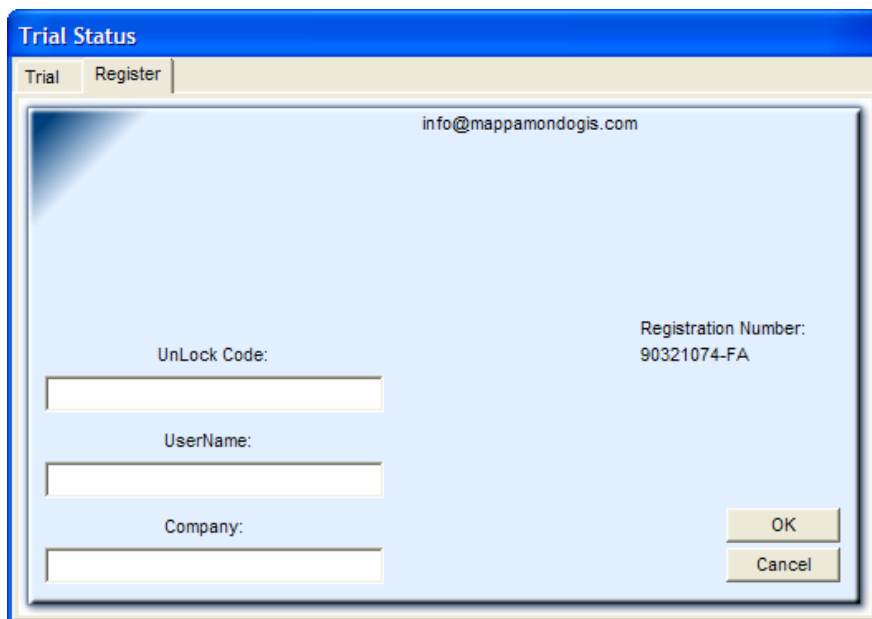
You will need to send us (info@mappamondogis.com) the Registration Number you read on the dialog and we will send you the unlock code and user name to be inserted in the relevant text areas. Once you filled in the information you can click OK. You won't need to go through this process again next time you will run the application on this machine. The GUI will open and will look like this:
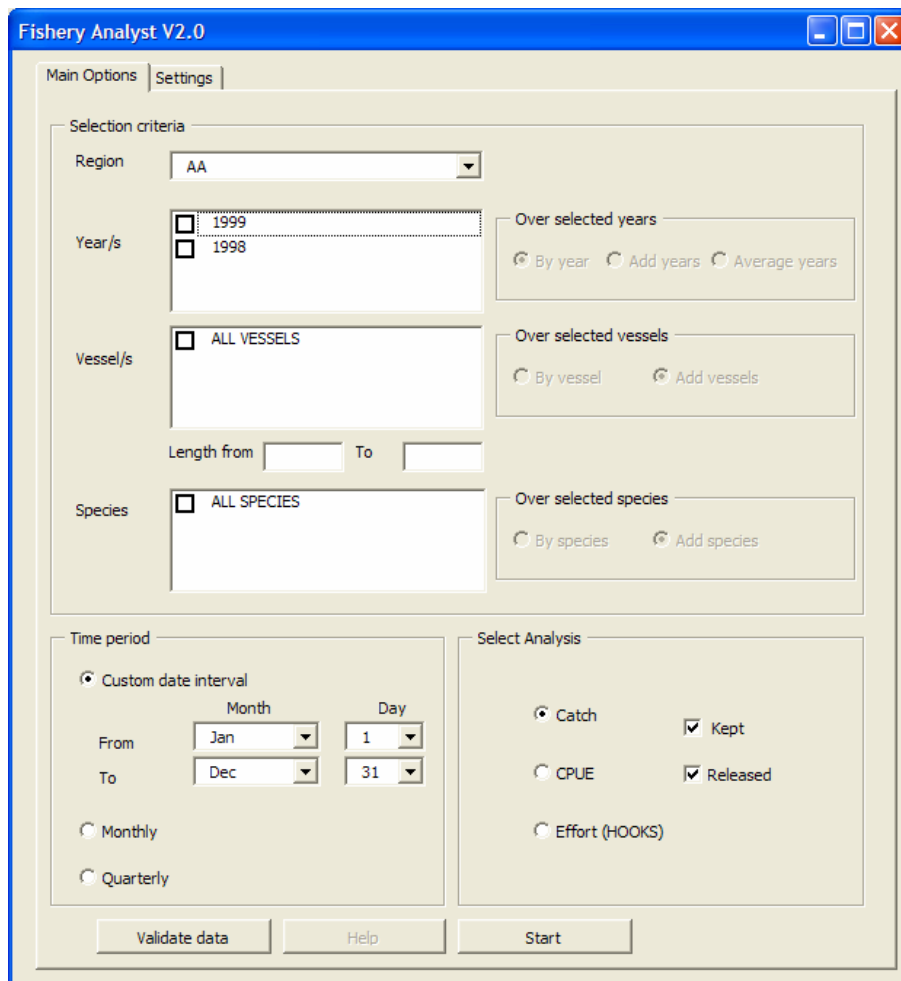
On this interface you will be able to perform 3 types of analysis on the fisheries data: **Effort (density), Catch (density) and CPUE** (catch per unit of effort) and to select the sub-set of data you want to include based on a number of criteria. The **Region** pull down menu allows you to choose one of the countries, region or states where fishery data are available. Once you select the desired region a list of years for which data for that region are available (in the dbfs folder) is displayed in the **Year/s** list. The first selection criterion to be selected is the *years* of data you want to include in the analysis. Once you select a number of years (by checking the box next to the year number) the list of **vessels** and **fish species** caught in those years is displayed in the corresponding lists. These lists are updated every time you change your selected years to display only the vessels and catch present in the currently selected years. The vessels and fish species list include some general category like "ALL" to select all vessels in the fleet and TOTCATCH to select alla available fish species . If you select the more general options you can not select the

more detailed ones (e.g. you can not select the option ALL for vessels and then pick also a specific vessel name).

You can select fish species from the list only for Catch and CPUE analysis as Effort analysis doesn't relay on catch information. When you perform Catch or CPUE analysis you are able to perform it on catch that was **kept, released** or both by selecting the corresponding options (if this information is available in your database).

For vessels there is the option to include only vessels that are within a certain length interval by filling the **"Length from" "To"** information.

Leaving one of the two Length input empty will leave the interval open on the relevant side. This option is meant to be used on the "ALL" vessel selection but it will apply also on sets of individual vessels if filled in.

Once you picked the vessels and fish species, you have to select the interval of time to be used in the analysis and how you want to combine data from different years. You can choose the following options:

- o **A custom date interval** by selecting the day and month from and to for which your data need to be analysed. This is also the option you want to use for a Yearly plot, then you will select a date interval from the 1st of January to the 31st of December. The number of iterations n over date in this case is 1.

- o The **Monthly** option. This will perform the analysis on each month of the year separately (January through December). The number of date iteration n in this case is 12.

- o The **Quarterly** option. This will perform the analysis on each quarter (1st through 4th) of the year separately. The number of date iteration n in this case is 4.

Now you have to choose one of the **"Over selected years"** options.

- If you select **"By year"** the output will be produced for each selected year showing the results of the analysis calculated on data collected in the specified date interval (number of output = n * number of selected year).

- If you choose **"Add year"** the output will show the total (addition) of the analysis results of each selected year. For example the Effort value in one point (cell) will be the sum of the effort in that point in each selected year. (Number of output = n) . The

value of CPUE in one point will be the sum of catch in all years divided by the sum of effort in all years (multiplied by the chosen effort multiplier, e.g. 1000).

- If you select "**Average year**" the value of Catch, Effort, CPUE in one point (cell) will be the sum of those values in each year of available data in that cell divided by the number of years for which data were available for that cell. (Number of output = n)

To have a in depth explanation of the methodology behind the 3 analysis performed by the Fishery Analyst application please refer to the additional reading refereed at the beginning of this manual and to the appendixes.

Additional settings

You can find additional settings by clicking the "Settings" tab.
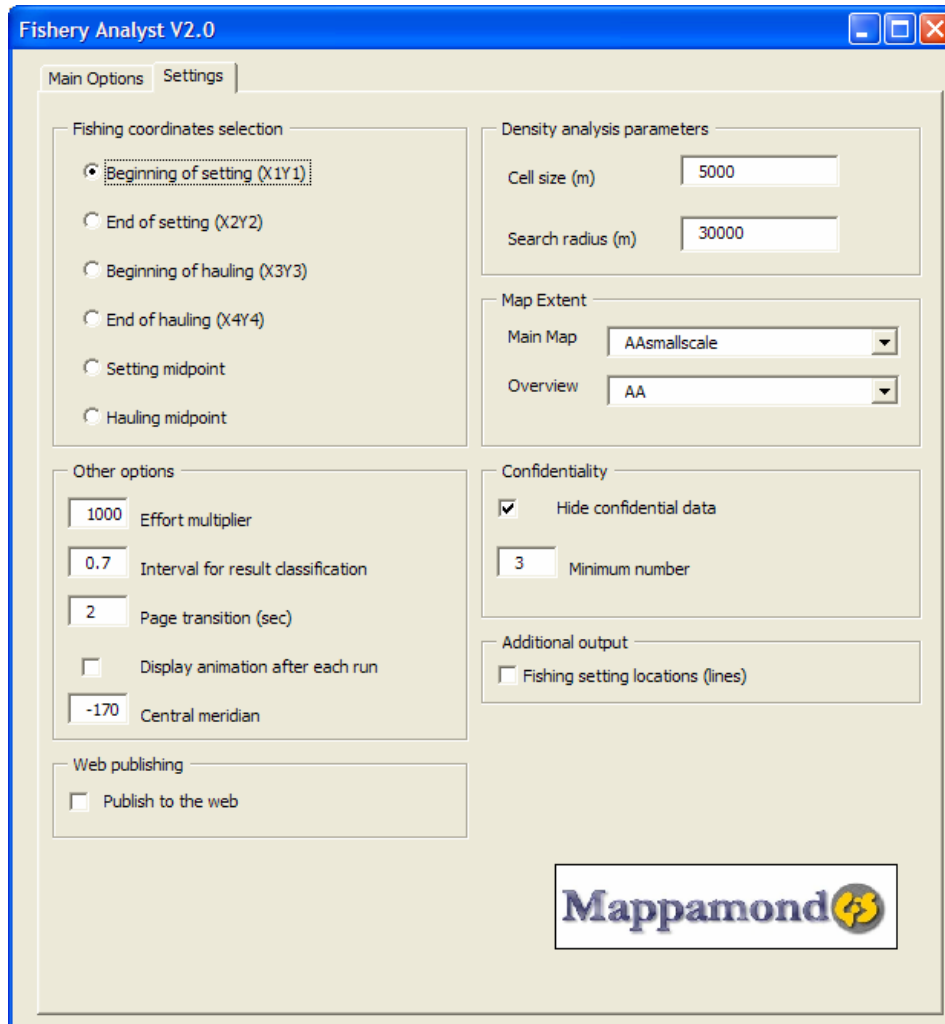

Fishing Coordinates selection

If more than one coordinate information is available for each fishing set, the user can select which one to be used for the analysis. Options include Beginning or Ending of set, Beginning or Ending of Hauling, Setting or Hauling Midpoint.

Density analysis parameters

By setting the **Cell Size** and **Search Radius** the user will affect the resolution and scale of the density analysis. In general smaller cell size provide a smoother surface but increase processing

time, smaller search radius highlight local variation and bigger radius generate a smoother surface and show more generalized patterns. It follows an example of the effect of cell size and search radius:

Cell size effect:
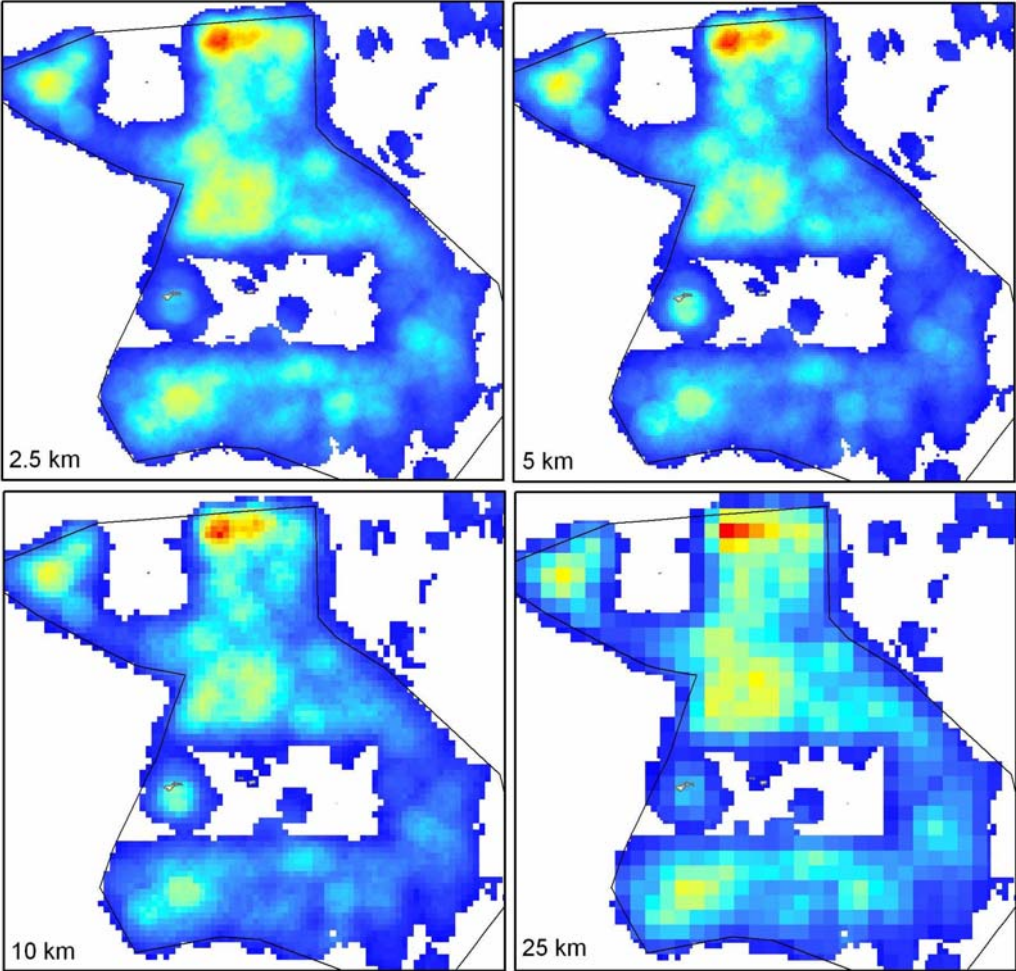
Search Radius effect:
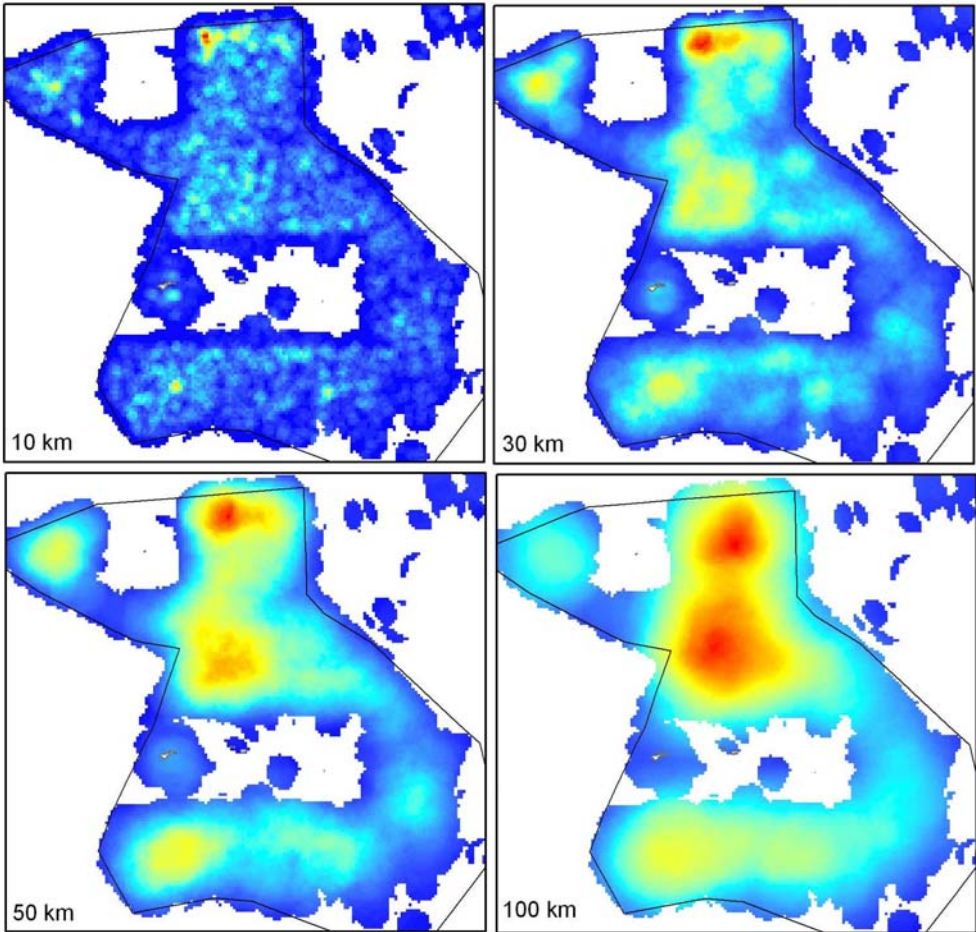
Confidentiality

Fisheries data are often protected by confidentiality policies. By ticking the **"Hide Confidentiality"** option confidential data will be hidden in the final plots. Often fisheries data are considered confidential if they are derived from data that involve less then a certain number of data points (e.g. vessels or owners). If you tick this option all values in the plots that were derived from less than the number of "confcode unique values" specified in the "**Minimum number**" options will not be displayed. Confcode values need to be provided in the input data tables in the appropriate field.

Other options

Effort Multiplier

CPUE is calculated as the ration between the Catch (number of fish caught) and the Fishing Effort (e.g. hooks or number of hours fished) and then referred to a specific unit (e.g. 1000 hooks or 24 hours). This option allows changing the unit of effort multiplier.

Interval for result classification

As we have previously seen the data are plotted using a color ramp system based on 12 value classes. The **Interval for result classification** is where you set the interval that defines the 12 classes. For example if you choose an interval of 15 the values in your outputs will be classified in 12 classes as follows: 0-15, 15-30, 30-45, 45-60, 60-75, 7590, 90-105,105-120, 120-135, 135-150, 150-165,165-180 and displayed with according colors. If the default interval is not adequate to represent the data in your selected time series you will likely wish to adjust the interval value close to the one suggested in the log window at the end of the run (that is equal to the maximum value identified in the current series / 12).

Page transition

This represents the plot transition speed in seconds with which each the final pdf animation will run, or better the time each plot will be displayed during the animation.

Display animation after each run

If this option is checked the animation file will automatically open at the end of each run. If the

option is disabled to see the animation it is necessary to search the right file in the animation folder. While all other output (shapefiles, rasters, jpg files) have a naming convention that allows easily recognizing them, for technical limitations animation files are named with a unique ID every time they are generated. Thus if you are interested in storing the animation it is better to re name it appropriately.

Central Meridian

This allows centering the projection system to the specified meridian to reduce projection distortion. Distortion increases with distance from the central meridian. You should choose a meridian central to the region your are working on.

Web publishing

If this option is checked, output jpg files will be stored in the web folder rather then the jpgMaps folder. Some settings will be automatically applied such as "Hiding confidentiality" will be set to true.

Map Extent and Bookmarks

The two map extent pull down menus are populated with the currently available bookmarks for the main map and overview map data frame respectively. These are the steps necessary to create a new bookmark for a specific region:

1) Activate the data frame for which you wish to define a new bookmark by right clicking on its name (Main or Overview) and selecting "Activate"

2) Using the zooming and panning tools in ArcMap move to the wished extent.

3) Then go under the menu View/Bookmarks/Create and type in a name for the newly created bookmark. The name must begin with the region code as it is listed in the Region pull down menu.

4) Press the save button. Next time the Fishery Analyst interface will be started the new
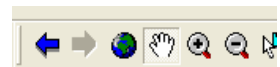
bookmark will be listed in the Map Extent pull down menu.

Additional Output

By checking this option an additional vector output will be produced that is the line representation of each fishing set if more than one coordinate information was available. The coordinates in the fields named X1-Y1 and X2-Y2 will be used.

Output

Once you selected the necessary criteria you are ready to run the analysis by pressing the **Start** button. A progress dialog will appear informing you on the progress of the processing. Each run will produce 3 different types of output.

- **Raster output.** These are geo-referenced TIFF files stored in the **grids** folder. They contain the quantitative values of the analysis (effort, catch or CPUE)

- **Point vector output**. These are shapefiles (a common GIS file format) stored in the **shapes** folder. They contain the punctual representation of the fishing locations and associated attributes (e.g. vessel name, catch, effort)

- **JPEG maps**. These are graphic files (images) stored in the JPGMaps folder. They represent the above mentioned raster data into a map layout with a title, north arrow, scale bar and legend. They can be for example inserted in a report in a word document.

- **PDF Animated sequence.** This is a PDF document containing the animated sequence of a time series run (e.g. a monthly sequence obtained by a monthly analysis. It is stored in the **Animation**s folder.

Output name conventions

The file name of each output contains information about the user selection criteria, for example vessel names chosen, dates and type of analysis (effort vs. catch). The file names will contain the following information:

| Information	Example of possible character values
Information	Example of possible character values
[confidentiality]	Conf (if plots display confidential data)
[country code]	AA, BB
[Analysis type]	Catch, Effort, CPUE
[Vessel list]	ALL, [vessel name list] , [length interval]
[Fish species caught]	ALL, [species lists]
[Kept or Released]	K,R,KR
[Fishing coordinates selection]	BS (beginning of set), ES (ending of set), BH (beginning of hauling), EH (ending of hauling), SM (setting midpoint), HM (hauling midpoint)
[EXTENT]	The name of the map extent used (see map extent section in this manual)
[YEAR]	Yyyy (4 digit year) , preceded by summary options SUMOF or AVGOF if relevant.
[DATE]	This could be a date interval, a month or quarter

Default names can not exceed 100 characters. If the name results to be longer (due to the selection criteria used) the user is prompted to insert a base name for the output reflecting the selection criteria for the vessel list and/or fish species caught. The rest of the information will be automatically appended (e.g. dates, type of analysis etc).
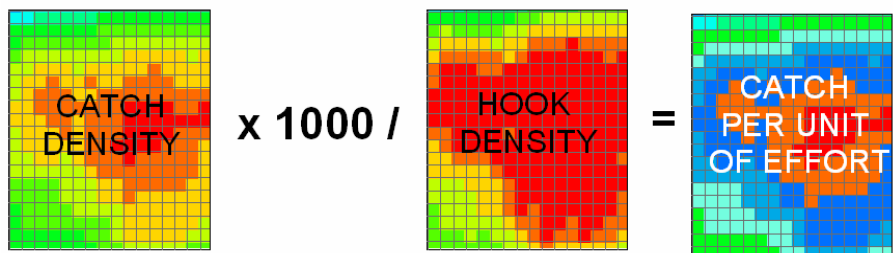
Calculations

For a detailed description of effort and catch density analysis and CPUE plots please refer to the reading cited at the beginning of this manual. A summary of the calculations behind the application are here presented.

Density of Catch and Effort values for each cell are calculated by summing catch and effort of fishing set falling within a distance from the cell equal to the search radius and dividing the value by the area of the circle defined by the search radius itself.

Looking at the graphic below the value of the highlighted cell in an effort density plot will be determined by the sum of the effort (e.g. hooks or hours) of the four vessels within the search radius distance (r) from the cell divided by the area of the circle ($3.14*r^2$). Analogous calculation is performed for the catch density.
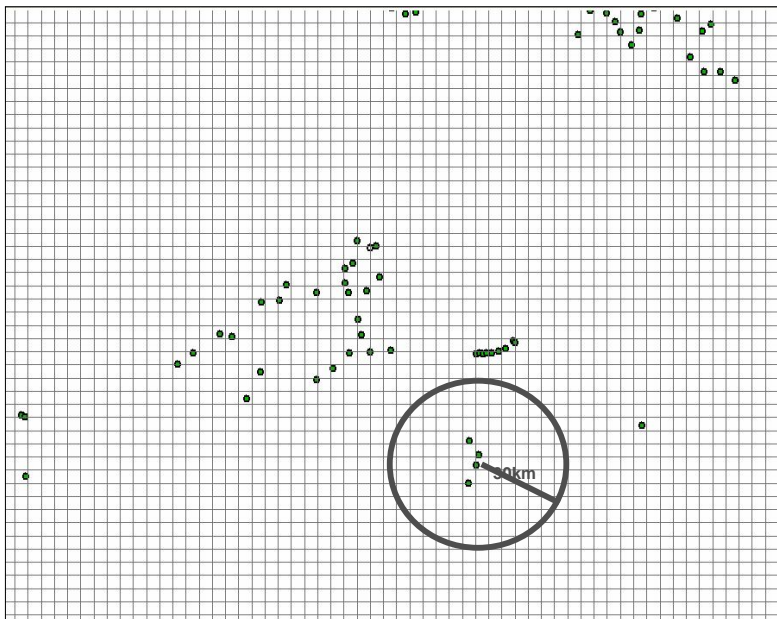
Cell values in CPUE plots are obtained by dividing the catch density value by the effort density values of each corresponding cell multiplied by the effort multiplier parameter (e.g. 1000):

Calculations over years are done as follows:

When the option "Add years" is selected:

Catch and Effort plots: Total catch and effort is calculated for all selected years around each cell and divided by the area of the circle.

CPUE plots: (Total catch for all selected year / Total effort for all selected years) * effort multiplier

When the option "Average years" is selected:

Catch and Effort plots: Values of catch and effort density for individual years are summed for each cell and divided by the number of selected years for which fishing activity occurred in that cell.

CPUE plots: Values of CPUE for individual years are summed for each cell and divided by the number of selected years for which fishing activity occurred in that cell.

Tutorial dataset

The datasets provided are composed by randomly generated data. All fields contain fictional information. The data were created with the only purpose of providing a demonstrative dataset to the Fishery Analyst application users.

The tutorial datasets consist of the following 3 tables:

1998AA.dbf (4814 records)

1999AA.dbf (61042 records)

1997BB.dbf (37289 records)

In these dataset the effort can be expressed in number of deployed hooks, and the catch per unit of effort could be expressed as number of fish caught by 1000 hooks.

Have your first run

Access the Fishery Analyst interface as detailed above. Select the *AA* **Region**, then select **year** *1999* and the *Quarterly* option for the **time interval**. Select *ALL* **Vessels** and **Species** options. Perform a **catch** analysis on the selected data by pressing **START**. All outputs will be saved under the relevant subfolders in the installation directory.

Keep practicing by changing your selection criteria.

Using the application on your dataset/acquiring a license

Contact us to receive the necessary technical specification: info@mappamondogis.com

Please note that the TRIAL version of Fishery Analyst is meant to be used only on the provided demo dataset for evaluation purposes and will introduce random data modifications on any other input dataset.

To acquire a license (commercial or educational) please contact us.