AIS Data Handler

Installation and Application Walk-Through

MarineCadastre.gov
January 2013

Automatic Identification System (AIS)

BOEM
Bureau of Ocean Energy Management

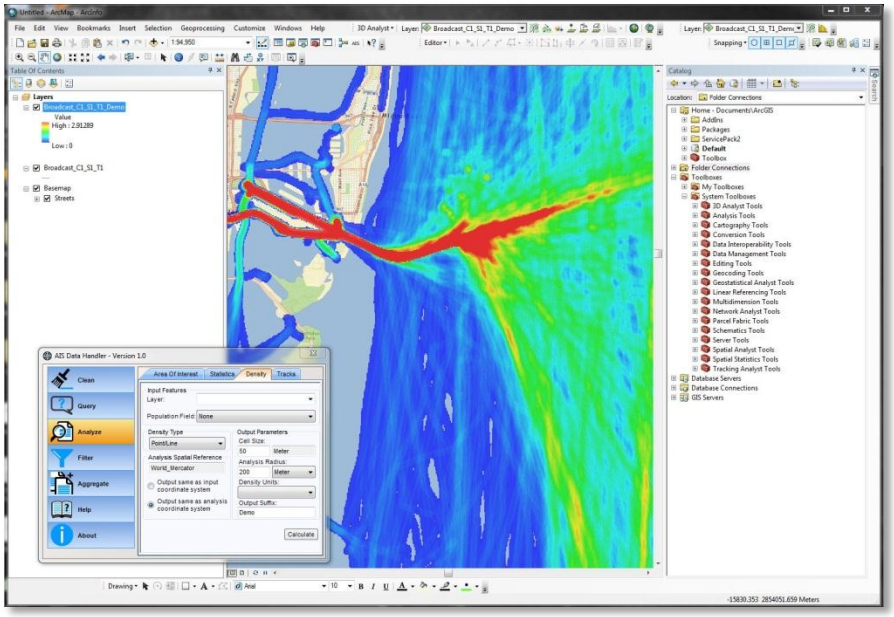
Introduction to AIS

Automatic identification systems monitor ship traffic for the purpose of improving safety of navigation worldwide. These systems also provide coastal planners with insight into marine transportation patterns over long periods of time.

The AIS Data Handler

- To make these data more accessible to users, the AIS Data Handler website provides software and ready-to-use data for coastal planners.

- The AIS Data Handler can be used to perform quality-control checks on the raw data, query the data to meet particular user needs, and analyze the marine transport patterns in a given region.



AIS Data Handler Website

- *http://marinecadastre.gov/ais*

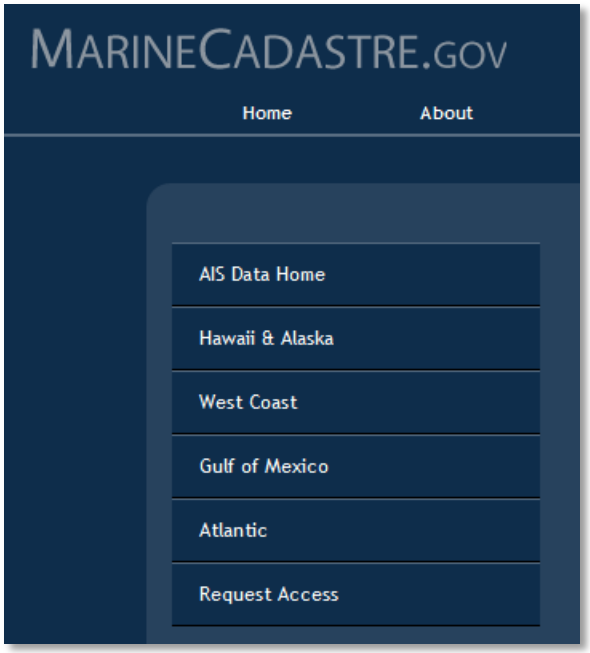
- Downloads available to the public:
  - AIS Data Handler ArcMap Add-In
  - AIS Data Handler Pre-Processor
  - AIS Data Metadata
  - AIS Data Handler Source Code (for developers)
  - AIS Tutorial (this document)
  - AIS Sample Data for the Miami Port Area

- For an account to download data, request a user name and password by email: *nos.csc.aisdata@noaa.gov*

Data Access: AIS Data Handler Website

To download data:

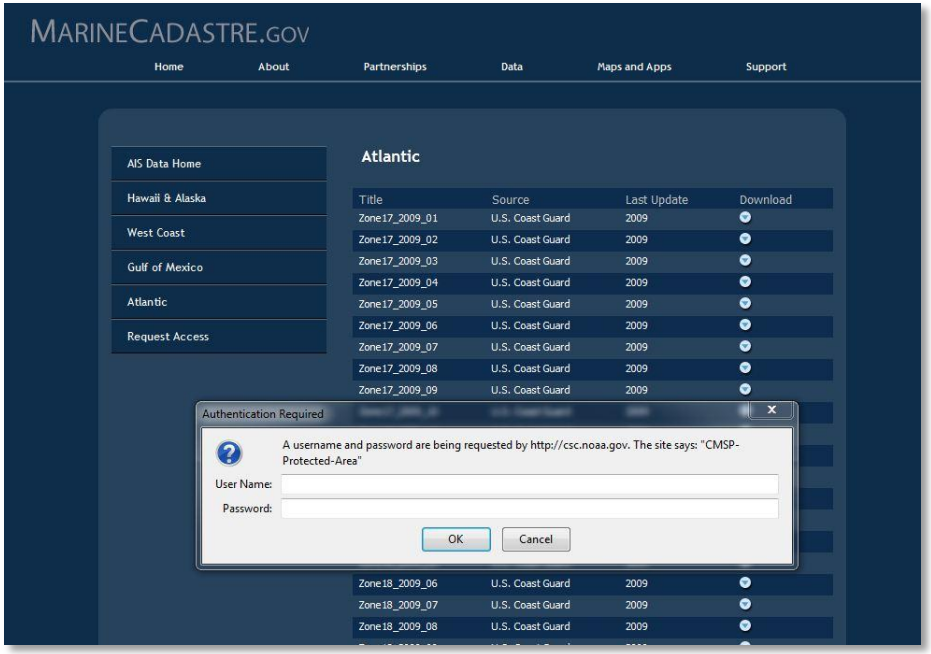
- *http://marinecadastre.gov/ais*
- Choose your area of interest



Data Access: AIS Data Handler Website

- You will be redirected to a table of datasets, organized by month and UTM zone for that region.

- Select a dataset for the timeframe and UTM zone of interest (datasets range from 100 MB to 1.5 GB) by clicking on the download link and entering your user name and password.



AIS Data Structure

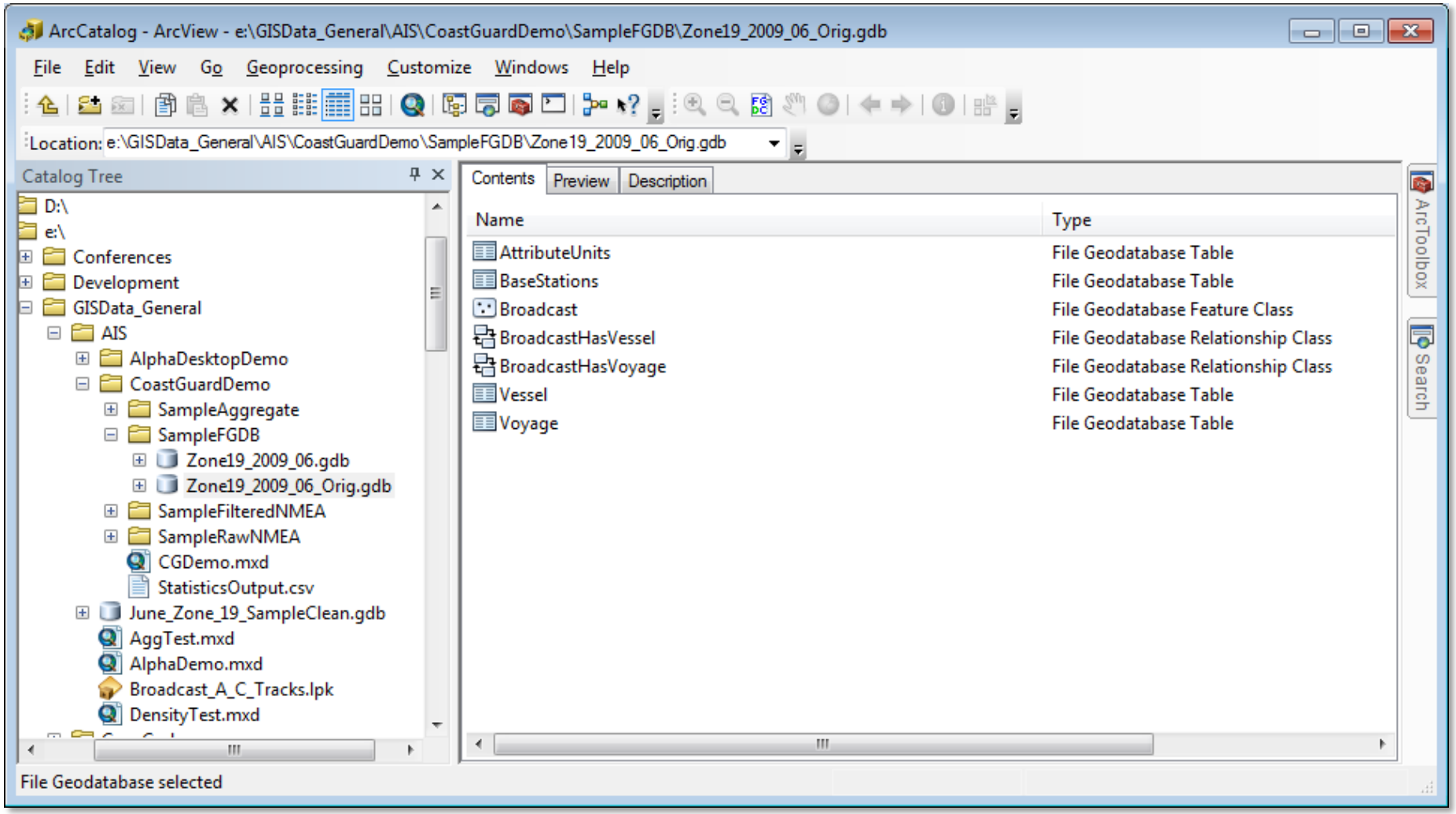
File Geodatabase (FGDB) Structure

- An Esri file structure that can efficiently store large amounts of data and is contained within a single folder structure for manageable access.
- All data processed with the AIS Data Handler must be in FGDB format (tools are provided to process raw data into this format).
- FGDB's are subset by month and UTM zone to account for file size.
- Voyages were created using unique combinations of vessel IDs, or MMSIs (maritime mobile service identities) and destination values.

Relationship Class

- A method of linking data tables using common attribute values.
- The AIS FGDBs contain two relationship classes linking the Broadcast feature class to the vessel and voyage data.

AIS Data Structure



AIS Data Structure

Voyage Table

Voyage ID
Destination
Cargo
Draught
ETA
Start Time
End Time
MMSI

Broadcast Features

Speed Over Ground
Course Over Ground
Heading
Rate of Turn
DateTime
Status
MMSI
Voyage ID
Receiver Type
Receiver ID

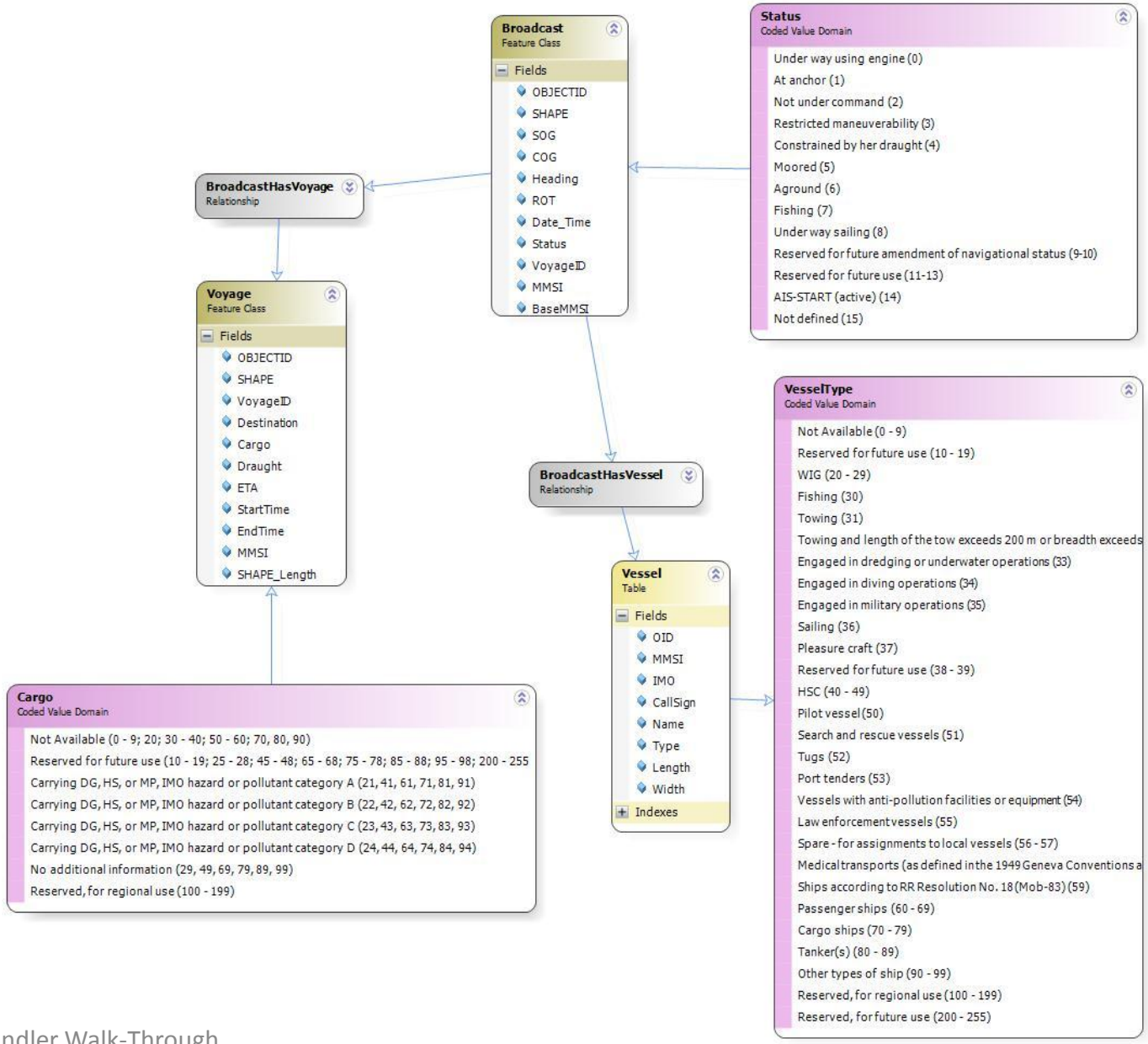
Vessel Table

MMSI
International Maritime Organization
Call Sign
Name
Type
Length
Width
Dimension
Components

BroadcastHasVoyage
Relationship Class
Key = VoyageID

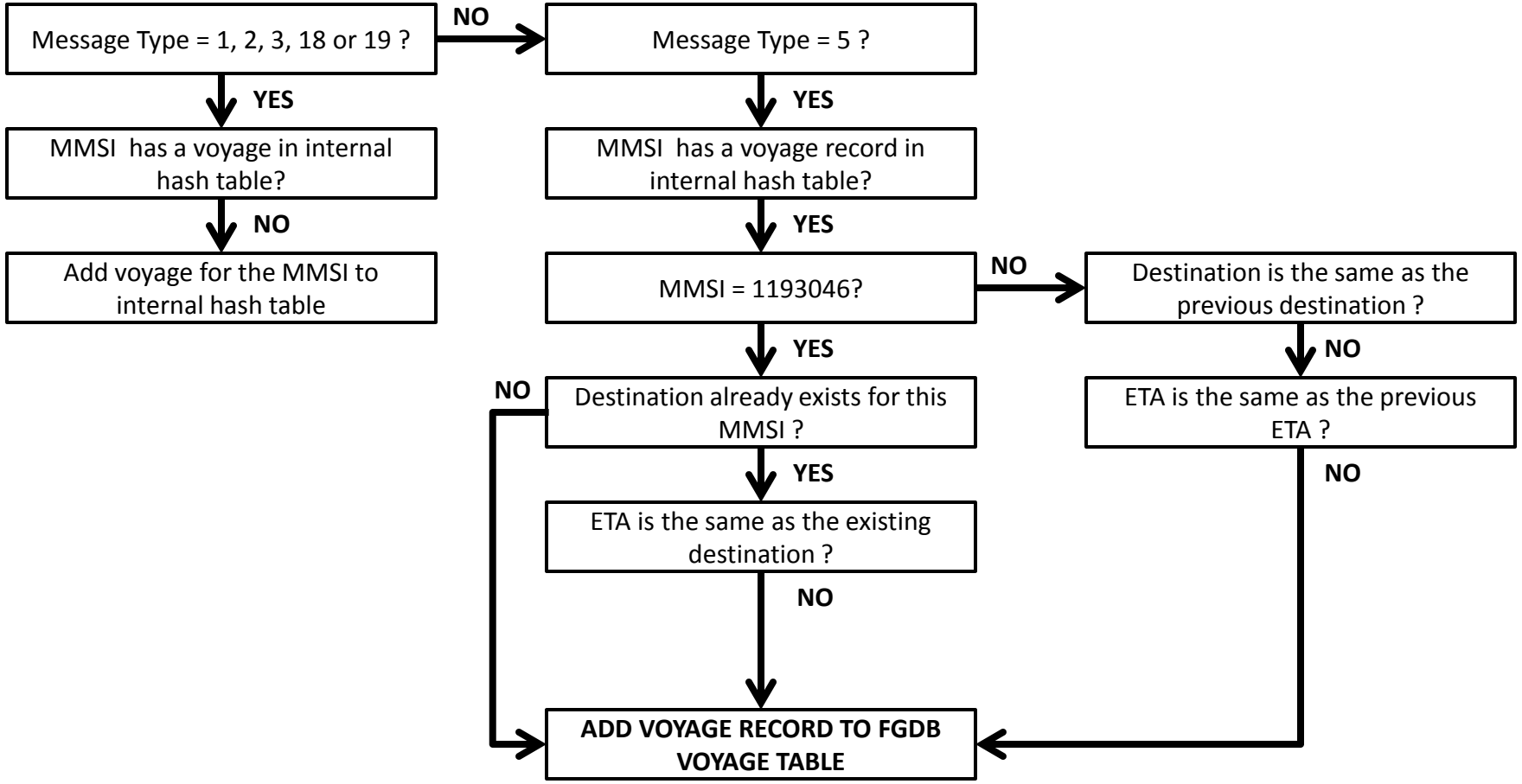
BroadcastHasVessel
Relationship Class
Key = MMSI

AIS Data Structure



AIS Voyage Creation

Voyages are defined using a combination of vessel destination and ETA (estimated time of arrival) updates as follows:



AIS Data Confidentiality

Four fields in the logical AIS data record have been identified as confidential information by the U.S. Coast Guard:

- MMSI
- IMO
- Call Sign
- Vessel Name

The MMSI record values have been encoded to mask the vessel identity. The International Maritime Organization (IMO), Call Sign, and Vessel Name have been removed. This modification to the data pertains to the 2010 data and not to the 2009 data. U.S. federal government users of these data may request access to decode the MMSI values for official use only.

AIS Data Handler Add-In

The AIS Data Handler is an ArcGIS Desktop Add-In that allows users to display, clean, filter, and analyze the AIS data extracted from the AIS Data Handler website.

Cleaning tools allow users to read, edit, create, and delete records based on a set of rules involving spatial, temporal, and attribute properties.

Filter and query tools allow users to subset data in space, time, or by attribute for further analysis.

Analytical tools include the ability to create derived products such as vessel tracks and vessel densities and to calculate summary statistics for the AIS datasets.

Installation of AIS Data Handler Add-In

Step 1. Download the AIS Data Handler from the website (*http://marinecadastre.gov/ais*) by clicking on the AIS Data Handler ArcMap Add-In link and following your browser's instructions.

Step 2. Once downloaded, double-click on AISDataHandlerSetup.exe to install. In the installation dialog, click the Next button to accept default installation parameters and Finish to open the ArcMap customization instructions. Steps 3 through 7 provide an overview of these instructions.

Step 3. Open ESRI ArcMap 10.0*

* This Add-In application ONLY works with ArcMap 10.0; version 9.3 is unsupported. Use of an ArcEditor- or ArcInfo-level license is strongly recommended.

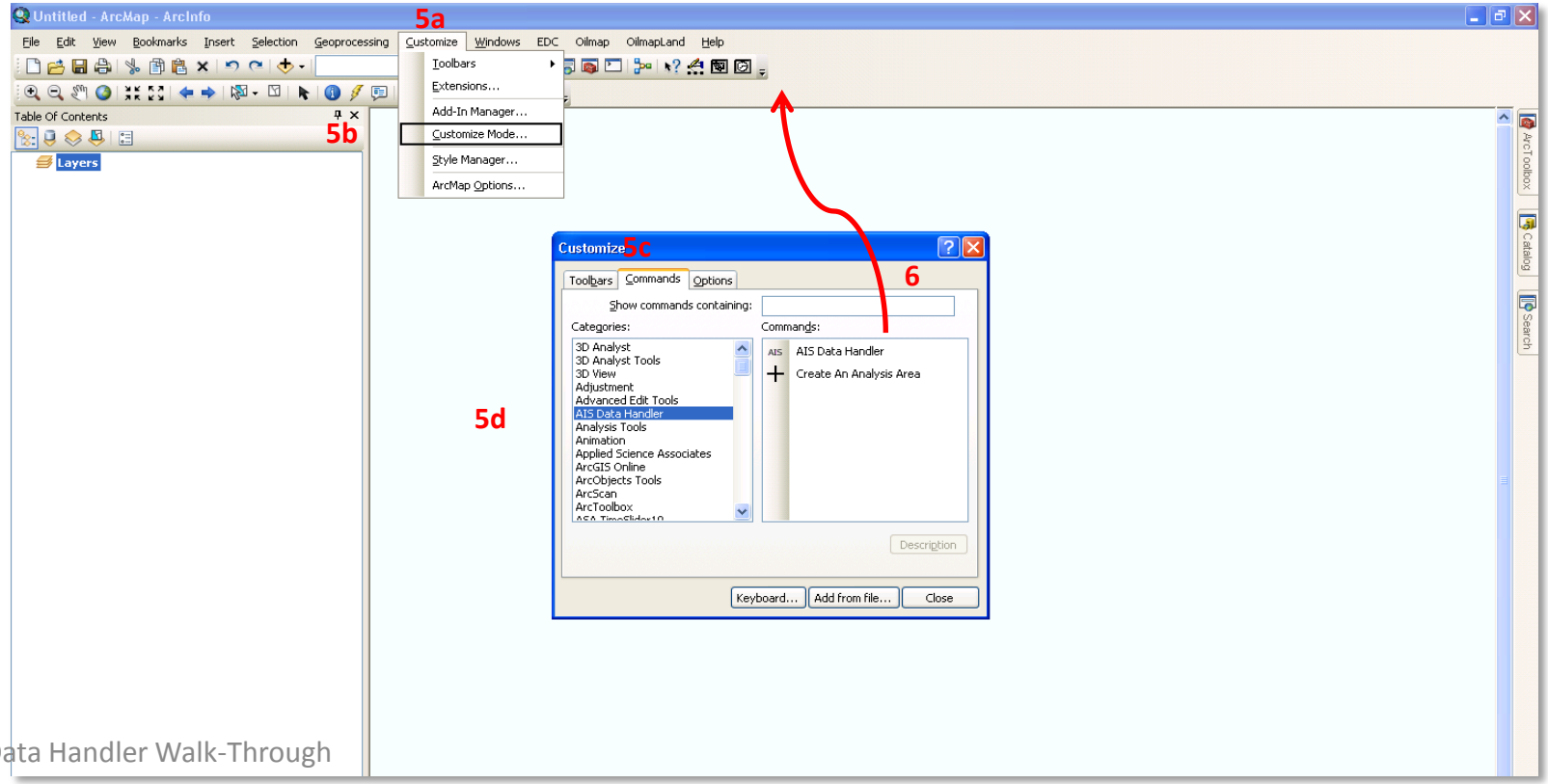
Installation of Data Handler Add-In

Step 4. In ArcMap, choose the following:

- Customize (on task bar) [5a]
- Customize Mode [5b]
- Commands (middle tab) [5c]
- AIS Data Handler (under “Categories” in the left column) [5d]

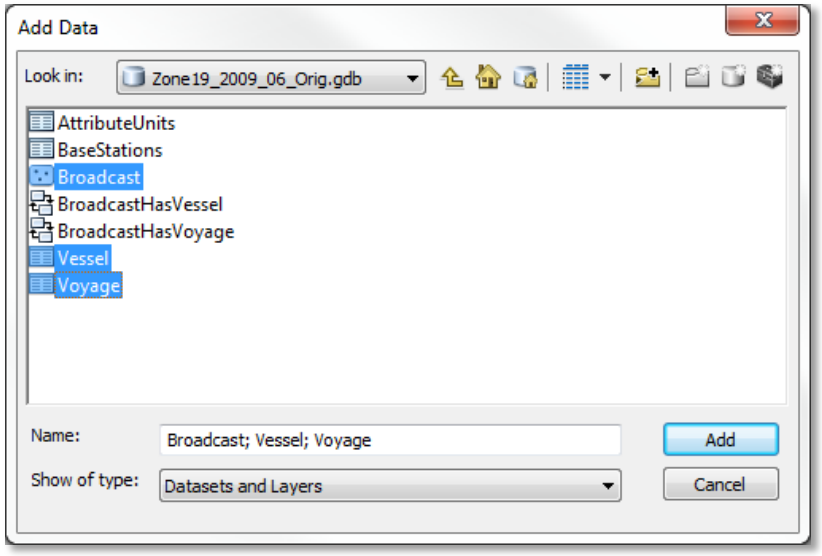
Step 5. Drag the “AIS Data Handler ” from “Commands” in the right column onto a toolbar in ArcGIS [6]

Step 6. Close the customize window



Installation of AIS Data Handler Add-In

Step 7. Load AIS data into ArcMap from a File Geodatabase by pressing Add Data button (to begin the Broadcast feature class and Vessel and Voyage tables should be loaded; relationship classes are not added as layers to the map).

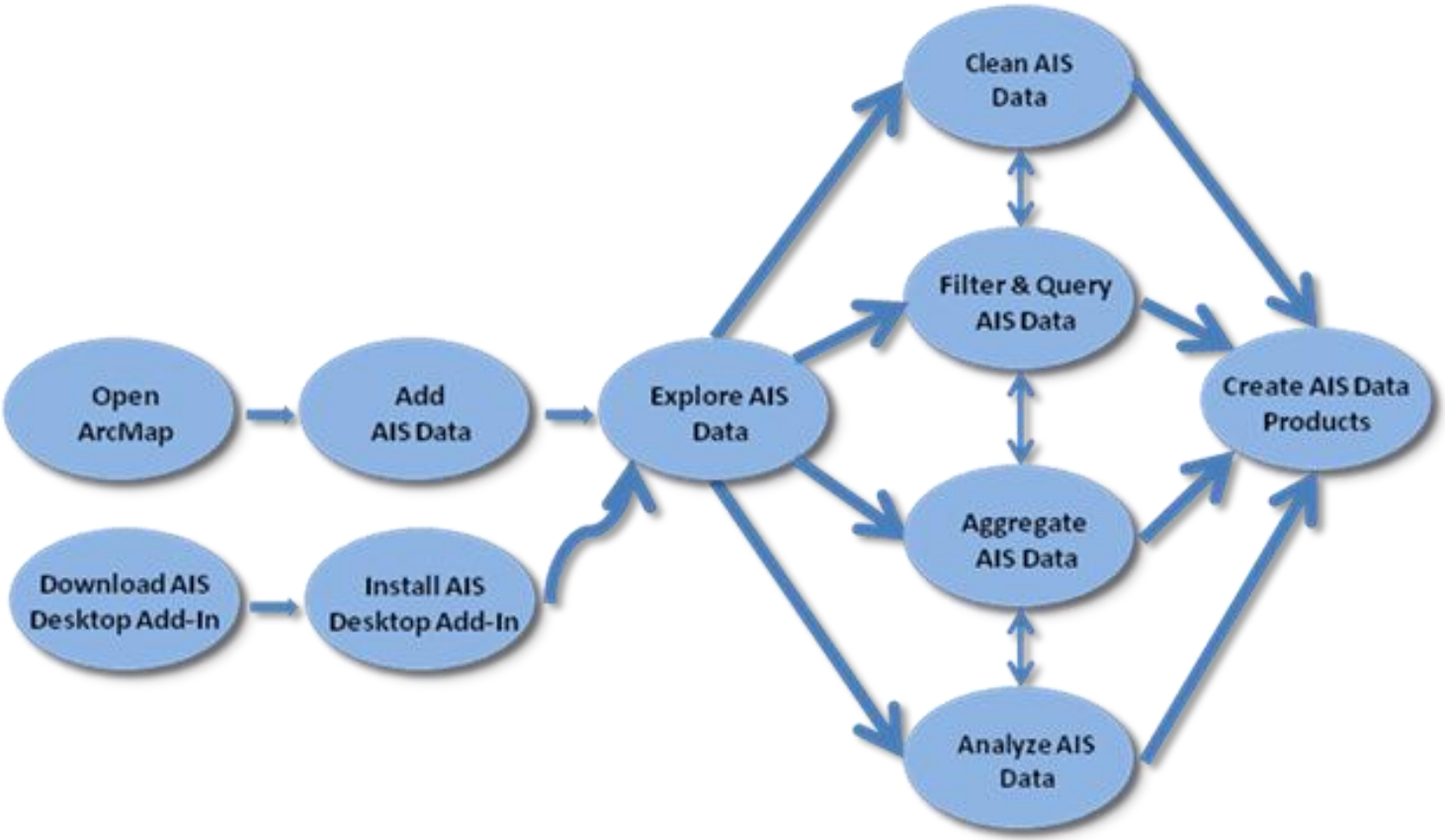


Step 8. Press the AIS button to open the AIS Data Handler dialog.

Installation Files

File Name	Description
SandDock.xml	Form rendering configuration file
SandDock.dll	Form rendering controls
Gigasoft.ProEssentials.xml	Graphing configuration file
Gigasoft.ProEssentials.dll	Graphing controls
ESRI.ArcGIS.Desktop.AddIns.dll	ESRI desktop Add-Ins classes
AISDataHandler.tlb	Type library to deploy com components from C#
AISDataHandler.esriAddIn	AIS Add-In installation file
AISDataHandler.dll	AIS Handler Interface and Functions
AISDataHandler.mdb	AIS configuration file
Clean_FeatureClass.py	Functions for cleaning broadcast
Clean_Table.py	Functions for cleaning vessel and voyage
filter_fortrackgen.py	Filter functions
PurposefulMotion.py	Purposeful Motion track generation

AIS Data Handler: Sample Work Flows



Subsetting Data

AIS datasets can be very large, and process times can often run in the range of several hours.

Consider working with a sample of Broadcast records (under 1,000,000) to develop your methods and workflows. Use one of the following native ArcGIS tools to make your sample:

- System Toolboxes > Editing Tools > Erase Point
- An edit session
- System Toolboxes > Data Management Tools > Features > Copy Features (with geoprocessing (GP) extent set)
- The Copy Features command will require new relationship classes to be built for the new feature classes and tables, and the Erase Point command can take many hours to reduce a 12 million record set to 1 million.

Subsetting Data

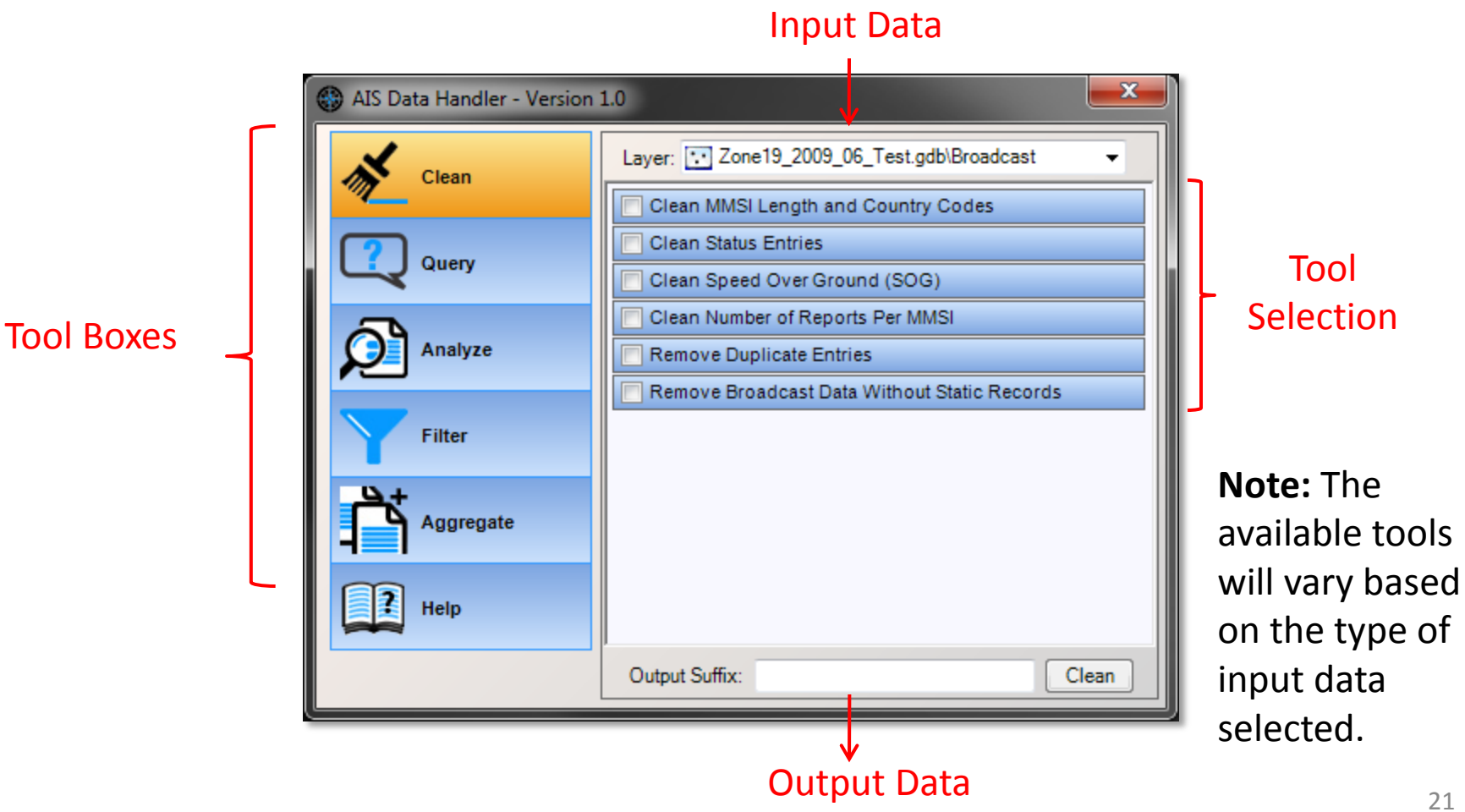
- When subsetting data, it is important to preserve the relationship classes between the Broadcast feature class and the Vessel and Voyage tables.

- The easiest way to preserve the relationships is to delete data directly from the existing feature classes in an edit session (this may take a long time for larger datasets).

- To create copies of related data, use ArcCatalog to select all participants in the relationship, including the relationship class itself, and use the copy/paste utilities in ArcCatalog.

The AIS Data Handler Interface

The AIS Data Handler is divided into five functional areas, each with multiple tools. This tutorial will explain the purpose of each tool.



Note: The available tools will vary based on the type of input data selected.

Clean Toolbox

Some of the data broadcast via AIS is updated automatically (e.g. position, time, speed, and heading), and other records are operator provided and therefore subject to human error. Operators may not understand how to define parameters correctly, may not update time-varying parameters with enough frequency, or may disregard the importance of providing accurate information.

Users of AIS data may not be able to properly characterize messages with incomplete vessel or voyage information and therefore may want to remove this information from the dataset.

The Clean Toolbox allows the user to eliminate data from an AIS dataset that does not meet quality control requirements. This toolbox consists of 14 individual tools, each of which can be applied to some or all portions of the individual dataset (i.e., Broadcast, Vessel, or Voyage information).

Clean Toolbox

Clean tools can be applied individually or batched together depending on user preference. Batch-clean operations will be significantly faster than running sequential individual operations in because the AIS dataset is only read once for a batch operation. When records are discarded from one dataset, related records in the other tables are also discarded.

When a clean operation is applied, copies of the dataset, the related tables, and the relationship classes are also created and records are removed according to the cleaning operations selected.

Note: Maintenance of relationship classes during cleaning operations requires an ArcInfo license.

Tool Overview:

Cleaning Tools by Data Type

Broadcast	Vessel	Voyage	Tracks
Clean MMSI Length and Country Codes	Clean MMSI Length and Country Codes	Clean MMSI Length and Country Codes	Clean MMSI Length and Country Codes
Clean Status Entries	Clean Vessel Name Entries	Clean Voyage ETA and End Times	Clean Voyage ETA and End Times
Clean Speed Over Ground (SOG)	Clean Vessel IMO Entries	Clean Voyage Cargo Entries	Clean Voyage Cargo Entries
Clean Number of Reports Per MMSI	Clean Vessel Call Sign Entries		
Remove Duplicate Entries	Clean Vessel Shiptype Entries		
Remove Broadcast Data Without Static Records	Clean Vessel Dimensions		
	Remove Inconsistent Static Data		

Tool Overview:

Clean MMSI Length and Country Codes

Tool Description:

A maritime mobile service identity (MMSI) is a nine-digit number used to uniquely identify a vessel. Base stations also have MMSIs, which should consist of seven digits. The first three digits of all MMSIs consist of maritime identification digits (MID) which are used to identify the region and country of origin of a ship.

While these MMSI numbers are vessel and base station specific, they often are invalid in that they do not consist of the appropriate number of digits. This tool removes all entries that do not have the appropriate number of digits or that do not have valid MIDs.

Applicable Datasets:

Broadcast, BaseStations, Vessel, Voyage, Tracks

Tool Implementation Steps:

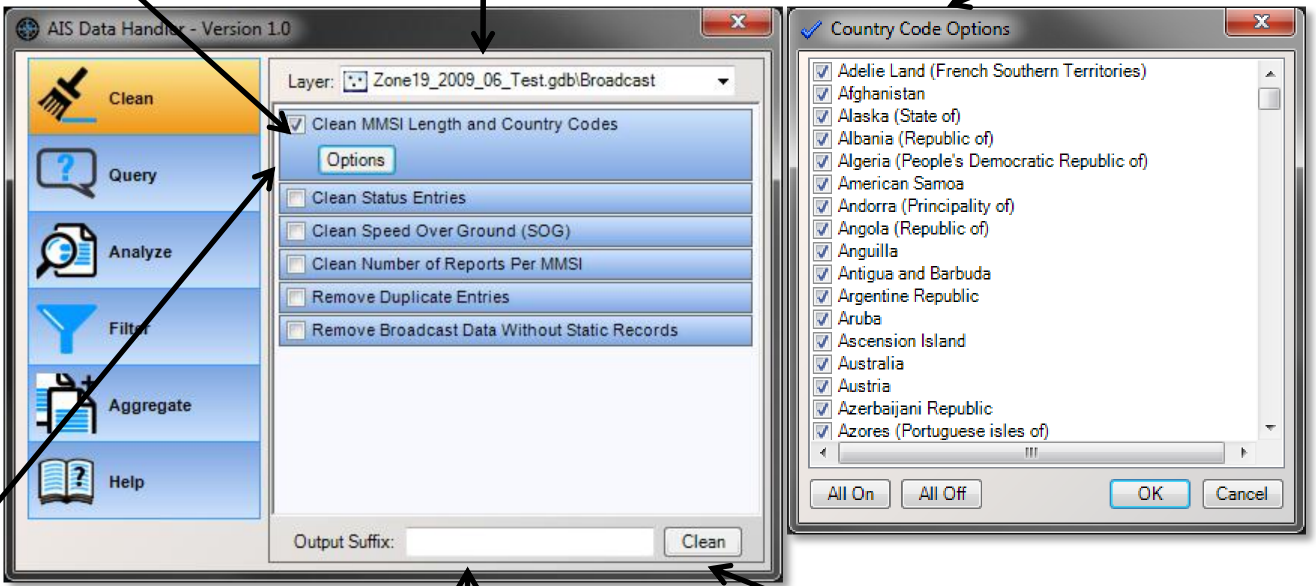
Clean MMSI Length and Country Codes

1. Select the desired AIS input dataset

2. Check the **Clean MMSI Length and Country Codes** box

3. Press **Options** (will appear when box is checked)

4. Select data by the country of origin in the pop-up Country Code Options Box

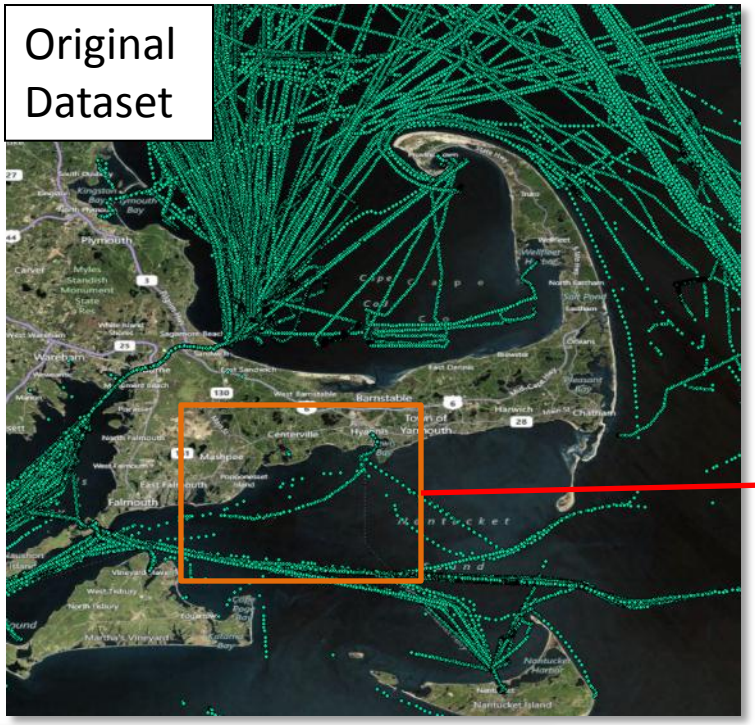


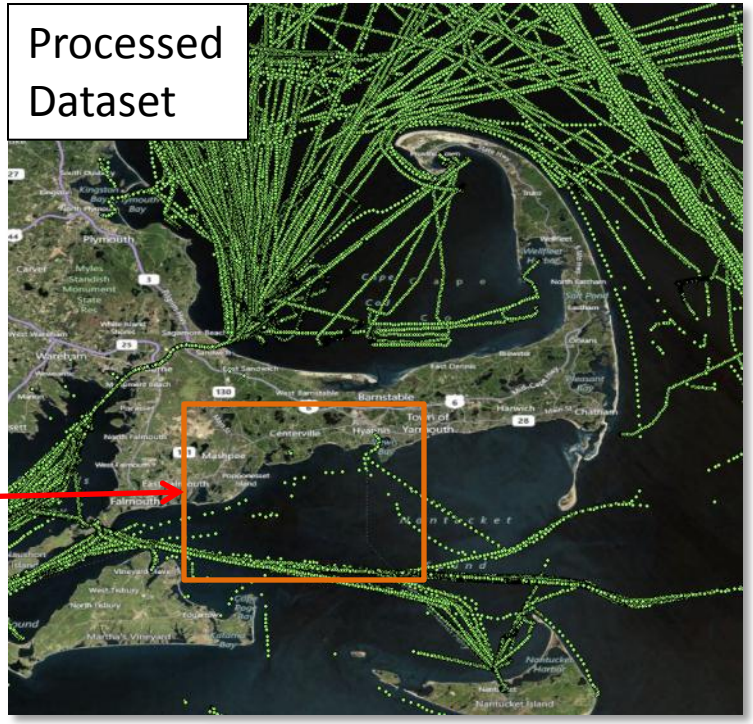
5. Define the suffix of the subset data to be output (will not overwrite original data)

6. Press **Clean**

Output Overview:

Clean MMSI Length and Country Codes





Table

Broadcast

OID	Shape	MMSI	SOG	COG	Heading	ROT
690784	Point	0	15	85	511	128
694386	Point	0	15	93	511	128
694487	Point	0	15	92	511	128
697636	Point	0	15	90	511	128
698677	Point	0	15	91	511	128
777708	Point	0	14	335	511	128
786189	Point	0	15	325	511	128
786756	Point	0	14	322	511	128

1 (0 out of 3910040 Selected)

Points that did not satisfy the requirements are removed, as is evident on the map and in the tables.

Table

Broadcast_

OID	Shape	MMSI	SOG	COG	Heading	ROT
2712359	Point	775324000	12	44	43	15
2713019	Point	775324000	12	47	38	245
2714197	Point	775324000	1	47	40	0
2715420	Point	775324000	12	43	43	0
2715775	Point	775324000	12	45	42	241
2716158	Point	775324000	12	43	42	11
2716716	Point	775324000	1	44	40	0
2716913	Point	775324000	12	45	44	241

6 (0 out of 3396501 Selected)

Tool Overview:

Clean Status Entries

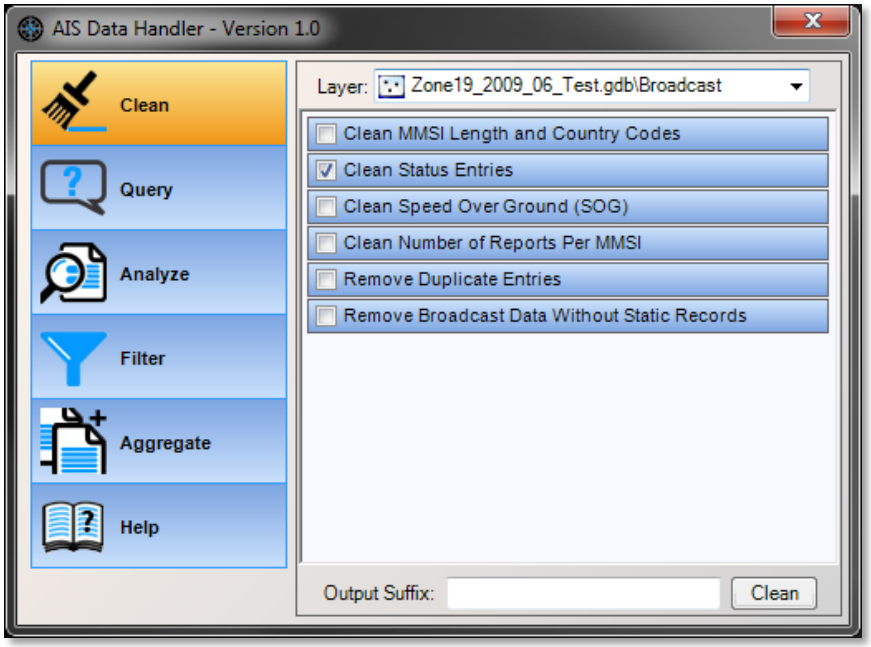
Tool Description:

The navigational status of a vessel is conveyed in each position report through one of 15 codes, which include “under way using engine” (code 0), “at anchor” (code 1), and “fishing” (code 7).

User error may cause an invalid navigational status to be included in the position report. This tool removes all entries with invalid navigational status codes.

Applicable Datasets:

Broadcast



Tool Overview:

Clean Speed Over Ground (SOG)

Tool Description:

In each position report, the speed of the vessel is conveyed and is reported as speed over ground (SOG). Errors in dynamic data such as SOG are possible due to faulty GPS or AIS transmitter equipment. This tool allows the user to define lower and upper thresholds for the speed over ground category.

Many types of analyses are directed as moving vessels; for theses situations, it may be useful to remove SOG values of 0. Removing these values is particularly useful for density grid generation.

Applicable Datasets:

Broadcast

Tool Overview:

Clean Number of Reports per MMSI

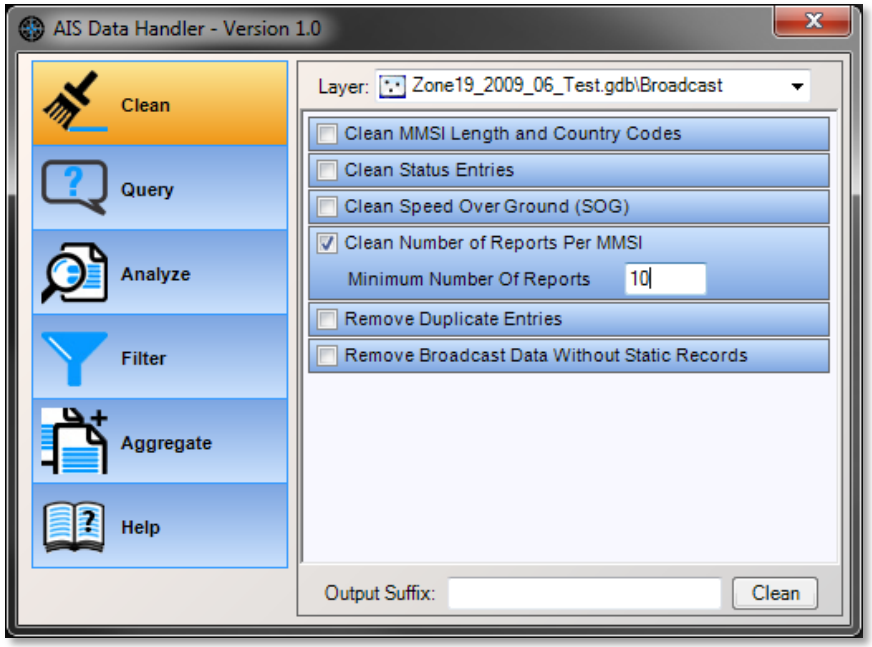
Tool Description:

MMSI values are transmitted multiple times per minute. Therefore there are typically many records tagged with a single MMSI in each dataset.

In some cases there may be very few records with a particular MMSI, especially if the vessel remains far offshore and its signal is not always recorded. In this case, the user can eliminate any vessel from the dataset which does not have greater than the specified number of reports.

Applicable Datasets:

Broadcast



Tool Overview:

Remove Duplicate Entries

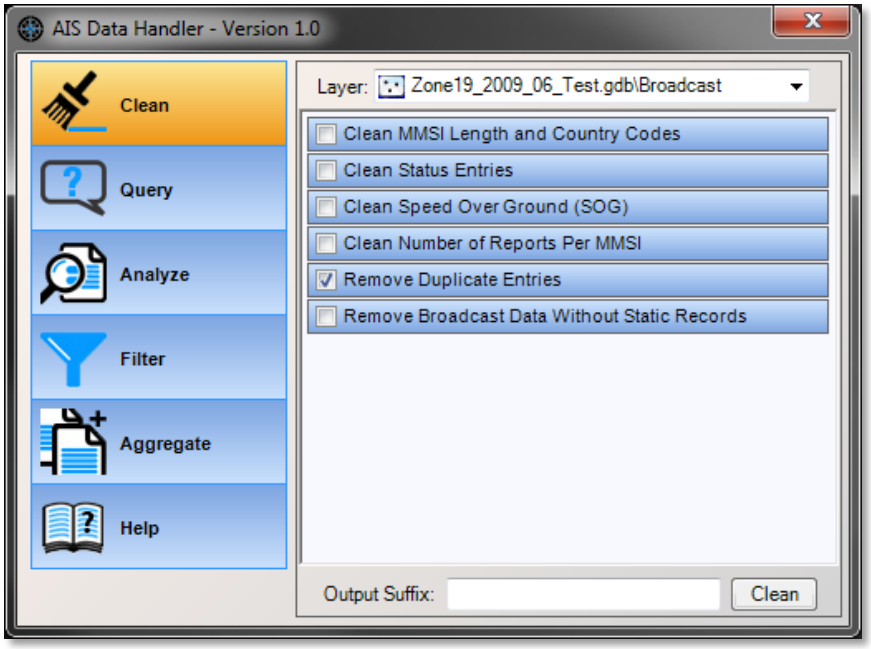
Tool Description:

Land-based receivers record the broadcasted AIS information. Depending on the location of the vessel, more than one receiver may record the same position report.

Duplicate data points may affect further processing of the AIS data, and it is advisable to remove them. This tool removes all duplicate position reports.

Applicable Datasets:

Broadcast



Tool Overview:

Remove Broadcast Data without Static Records

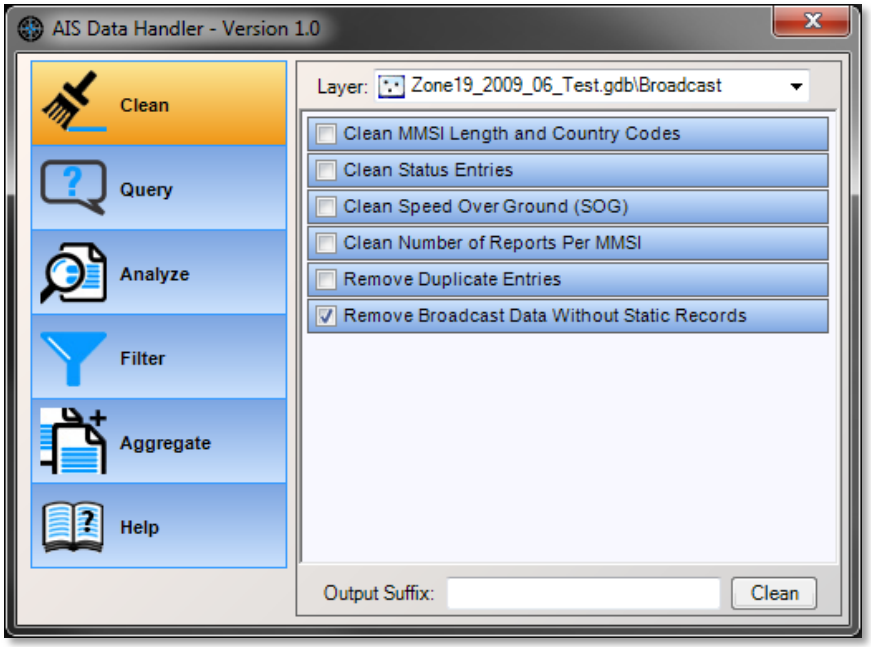
Tool Description:

MMSI values are included in both position messages and in static data reports. A clear picture of the ship's purpose and movements therefore cannot be attained without both message types.

It may be desirable for some users to ensure that they are only dealing with vessels that are broadcasting both position and static data reports. This tool allows the user to remove position reports that don't have corresponding static data reports.

Applicable Datasets:

Broadcast



Tool Overview:

Clean Vessel Name Entries

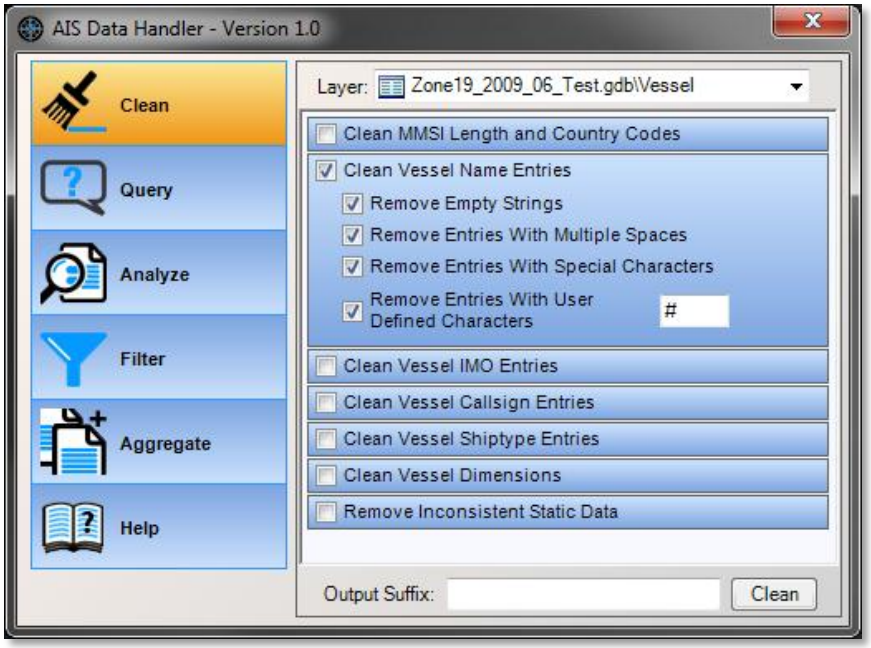
Tool Description:

Vessel information such as the vessel name is specified by the vessel operator and should correspond to the documented name of the craft.

User error may cause issues with the vessel name entry. This tool can identify and remove records when the vessel name is empty, has multiple spaces, has special (non-Latin) characters, or has a user-defined character included.

Applicable Datasets:

Vessel



Tool Overview:
Clean IMO Entries

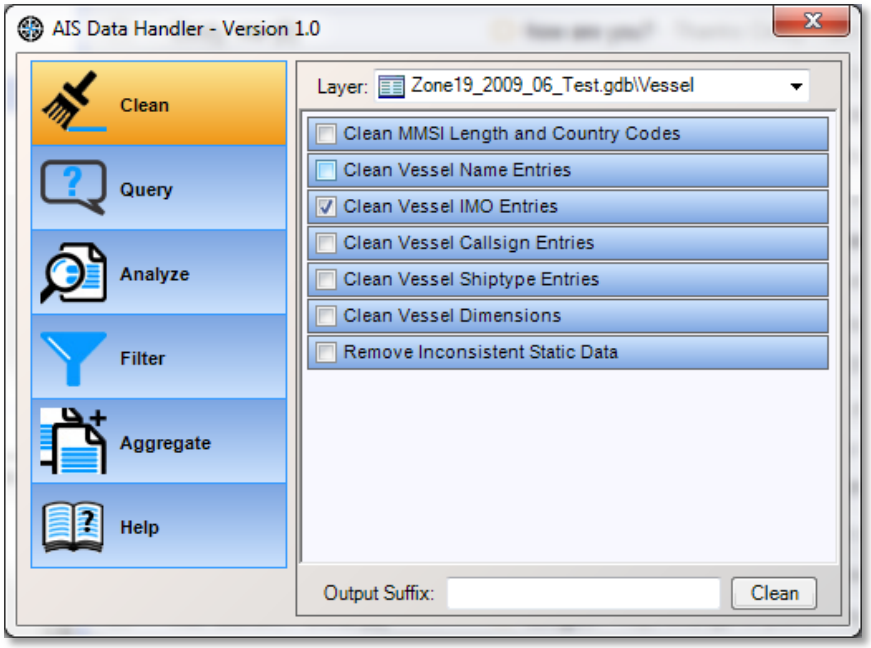
Tool Description:

Vessel information such as the International Maritime Organization (IMO) ship identification number is specified by the vessel operator.

User error may cause issues with the IMO entry. This tool can identify if the IMO entry is invalid and removes the noncompliant data.

Applicable Datasets:

Vessel



Tool Overview:

Clean Call Sign Entries

Tool Description:

Vessel information such as the call sign is specified by the vessel operator.

User error may cause issues with the call sign entry. This tool can identify and remove invalid call sign entries using four criteria that can be selected by the user.

Applicable Datasets:

Vessel

Tool Overview:

Clean Shiptype Entries

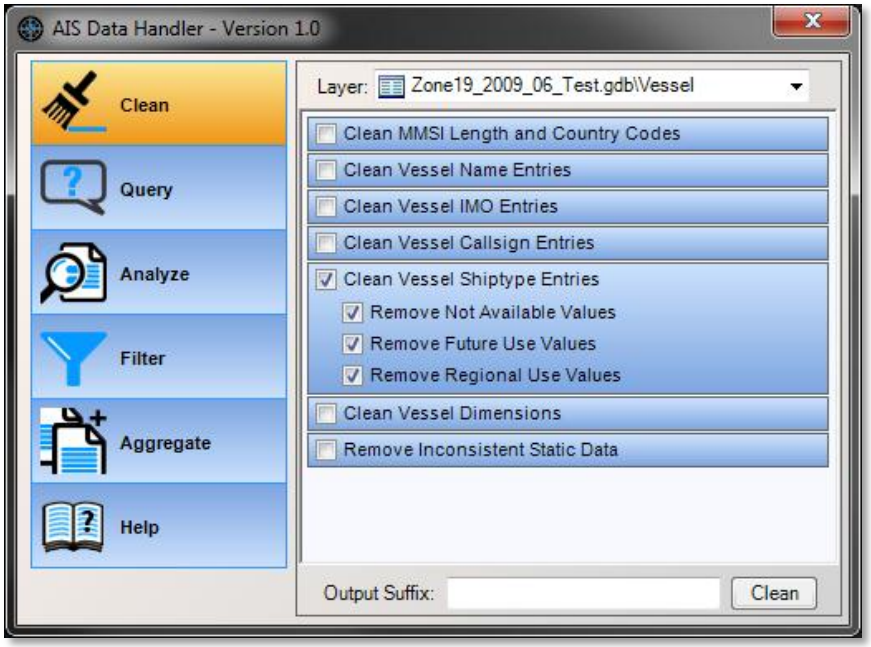
Tool Description:

Vessel information such as the ship type are sent out with each report. This attribute is particular to the vessel and should remain consistent throughout the voyage.

Inconsistent values for the ship type may indicate a larger problem in the data associated with a particular vessel, since the information is expected to change very infrequently. This tool removes data when the ship type is inconsistent.

Applicable Datasets:

Vessel



Tool Overview:

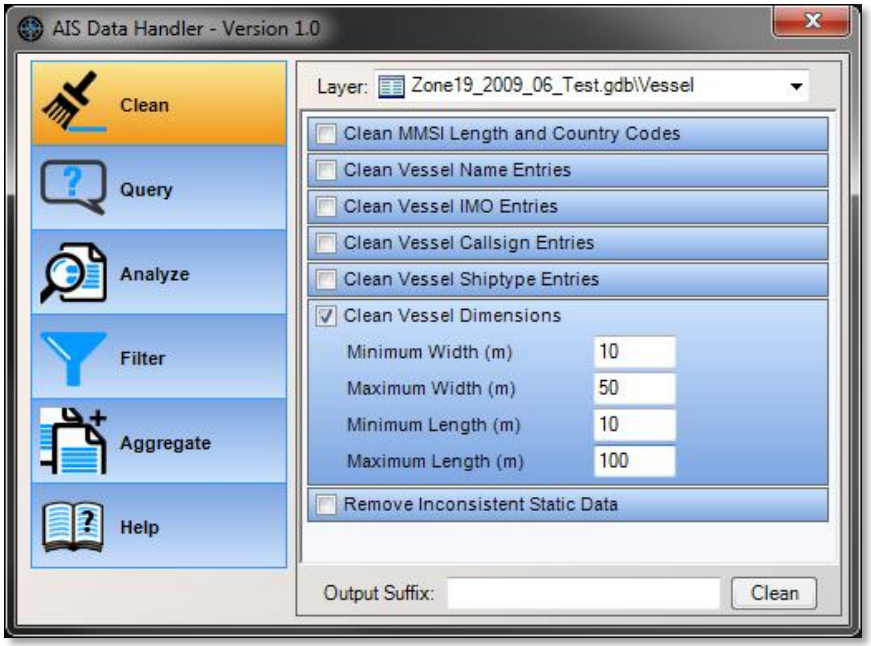
Clean Vessel Dimensions

Tool Description:

Vessel information such as the vessel dimensions is defined by vessel operators sent out with each static data report. Users can clean the vessel table based on vessel dimensions by setting length and width thresholds.

Applicable Datasets:

Vessel



Tool Overview:

Remove Inconsistent Static Data

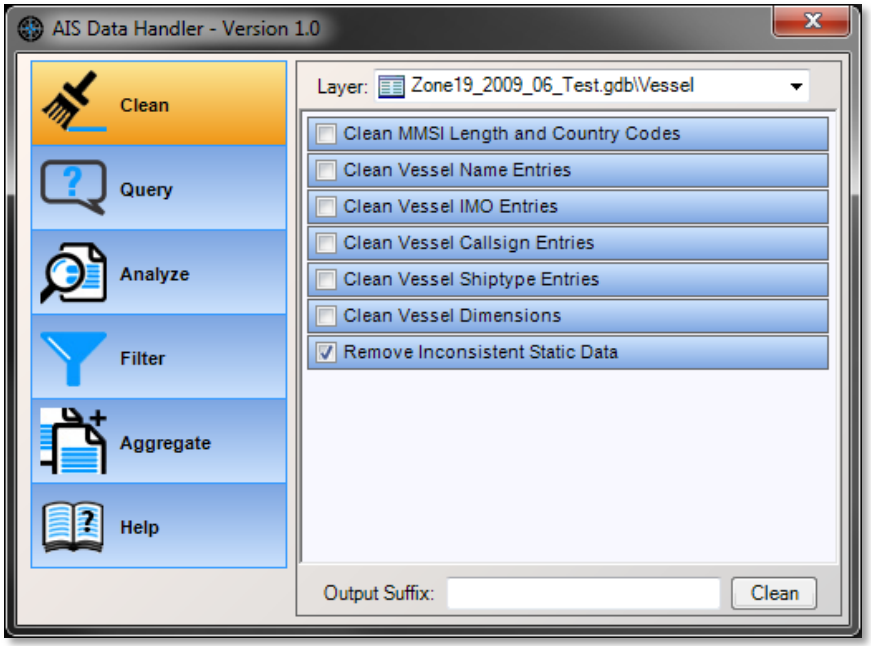
Tool Description:

Vessel information such as MMSI, IMO, name, call sign, and dimensions are sent out with each report. These types of data are particular to the vessel and should remain consistent throughout the voyage.

Inconsistent values for these static parameters may indicate a larger problem in the data associated with a particular vessel, since the information is expected to change very infrequently. This tool removes data where this vessel information is inconsistent.

Applicable Datasets:

Vessel



Tool Overview:

Clean Voyage ETA and End Times

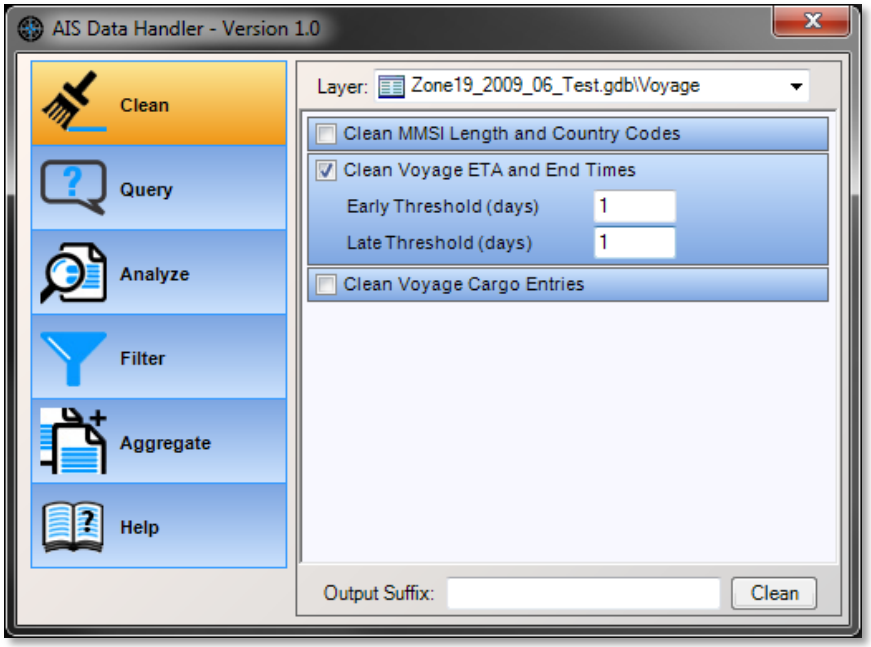
Tool Description:

Each vessel provides information on the expected time of arrival (ETA) to its destination; voyage start and end times are estimated based on broadcast destination changes.

The user may specify to limit the data based on the ETA and start or end times of the voyage. By setting the early and late thresholds, uses can identify ships that arrive at their destinations within a certain period of time from their ETA.

Applicable Datasets:

Voyage



Tool Overview:

Clean Voyage Cargo Entries

Tool Description:

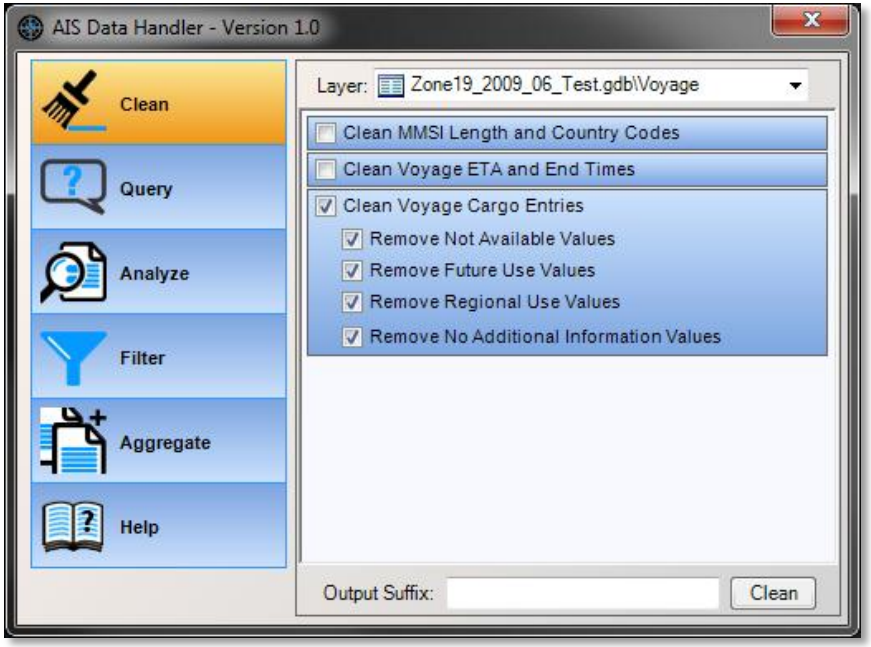
Each vessel provides information on the type of cargo that is being transported.

The user can eliminate all data that has non-valid or non-descriptive values for voyage cargo using the following four criteria:

- No Additional Information Values
- Not Available Values
- Future Use Values
- Regional Use Values

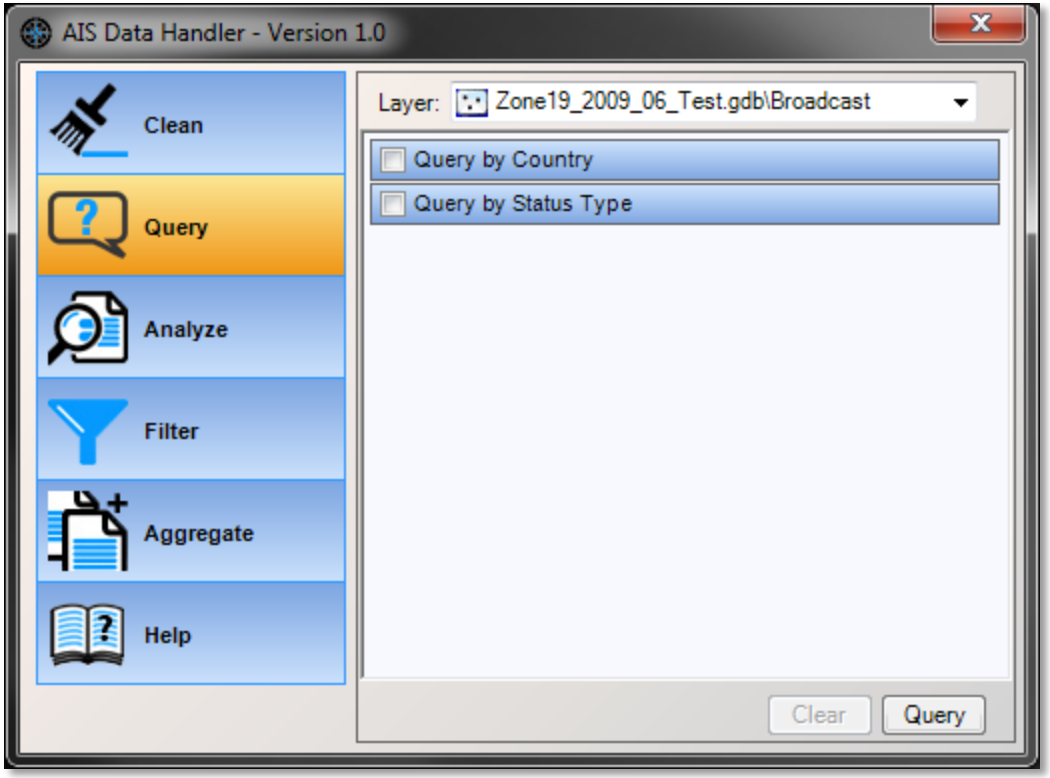
Applicable Datasets:

Voyage



Query Toolbox

Because AIS datasets are typically very large, it can be beneficial to subset the feature classes using varying techniques. This toolbox consists of four individual tools, each of which can be applied to some or all portions of an individual dataset (i.e., Broadcast, Vessel, or Voyage information). A query may be performed on the data to select values based on the country of origin, the navigational status of the vessel, the vessel type, or the cargo type.



The query process will not create a new dataset, nor will it delete values; it will simply select the entries that comply with the requested criteria.

This process is equivalent to using the definition query in the ArcMap Layer Properties, and these definition queries can be viewed from the layer properties dialog.

Tool Overview:

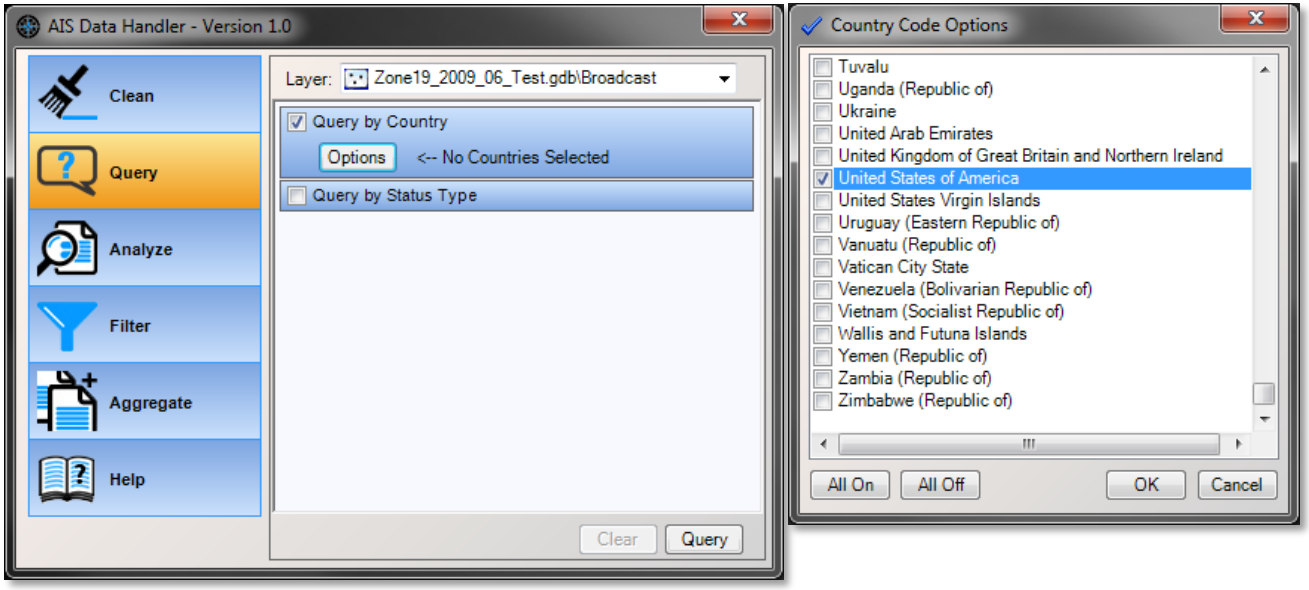
Query by Country

Tool Description:

The purpose of this tool is to limit the selection to vessels from a specified country of origin. A pop-up box appears when using this tool that enables the user to choose which countries of origin to use in the selection.

Applicable Datasets:

Broadcast, Vessel, Voyage



Tool Overview:

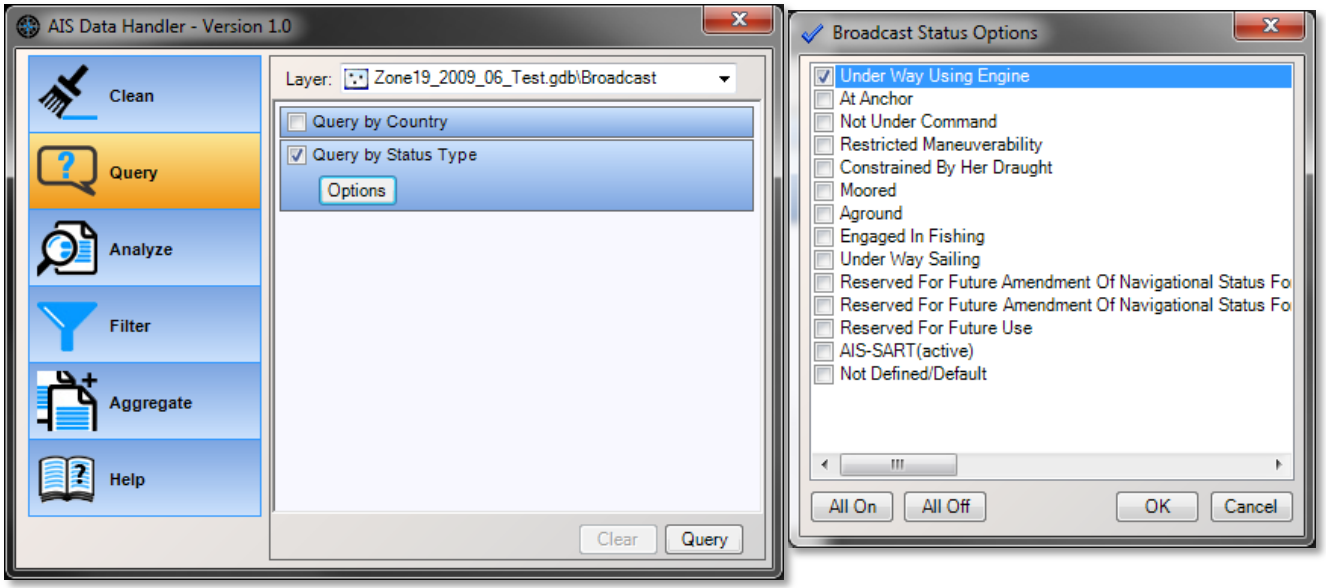
Query by Status Type

Tool Description:

The purpose of this tool is to select broadcast points according to vessel status. Users can select vessel statuses of interest using the Broadcast Status Options dialog.

Applicable Datasets:

Broadcast



Tool Overview:

Query by Vessel Type

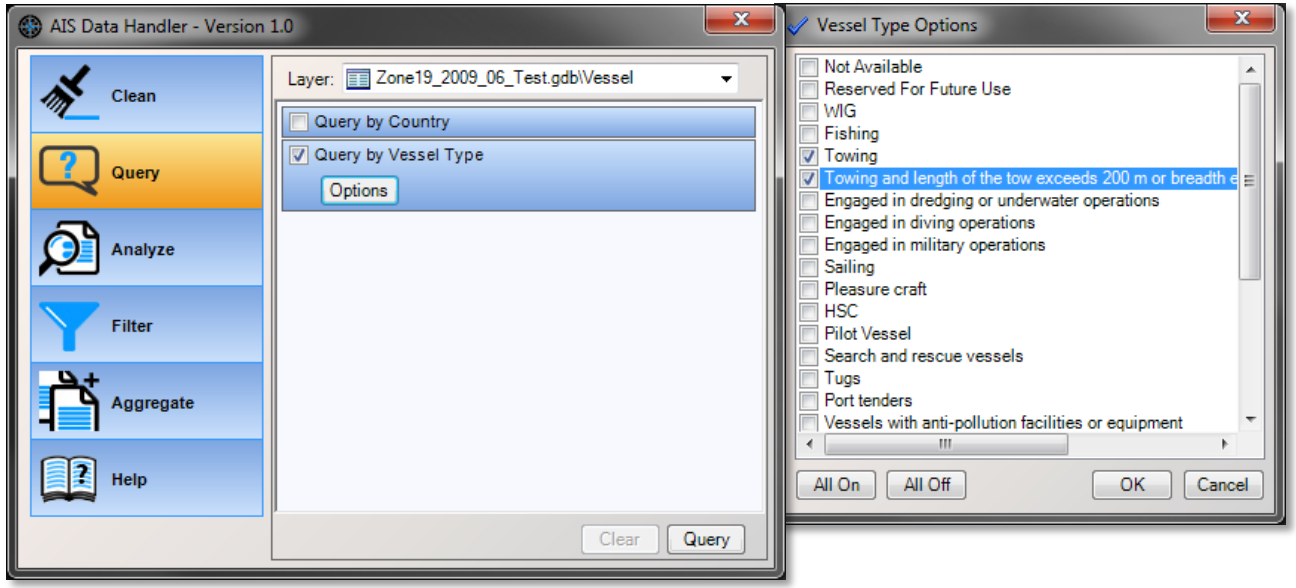
Query

Tool Description:

The purpose of this tool is to select vessels based on vessel type. Users can select vessel types of interest using the Vessel Type Options dialog.

Applicable Datasets:

Vessel



Tool Overview:

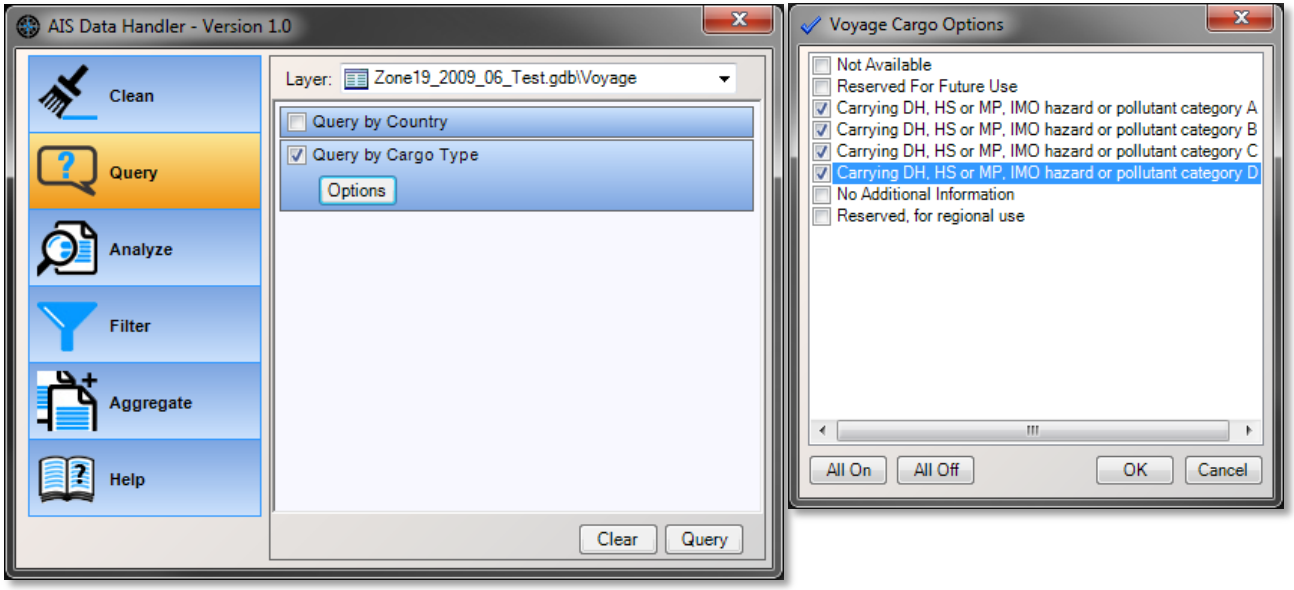
Query by Cargo Type

Tool Description:

The purpose of this tool is to select voyages based on cargo type. Users can select cargos of interest using the Voyage Cargo Options dialog.

Applicable Datasets:

Voyage



Tool Overview:

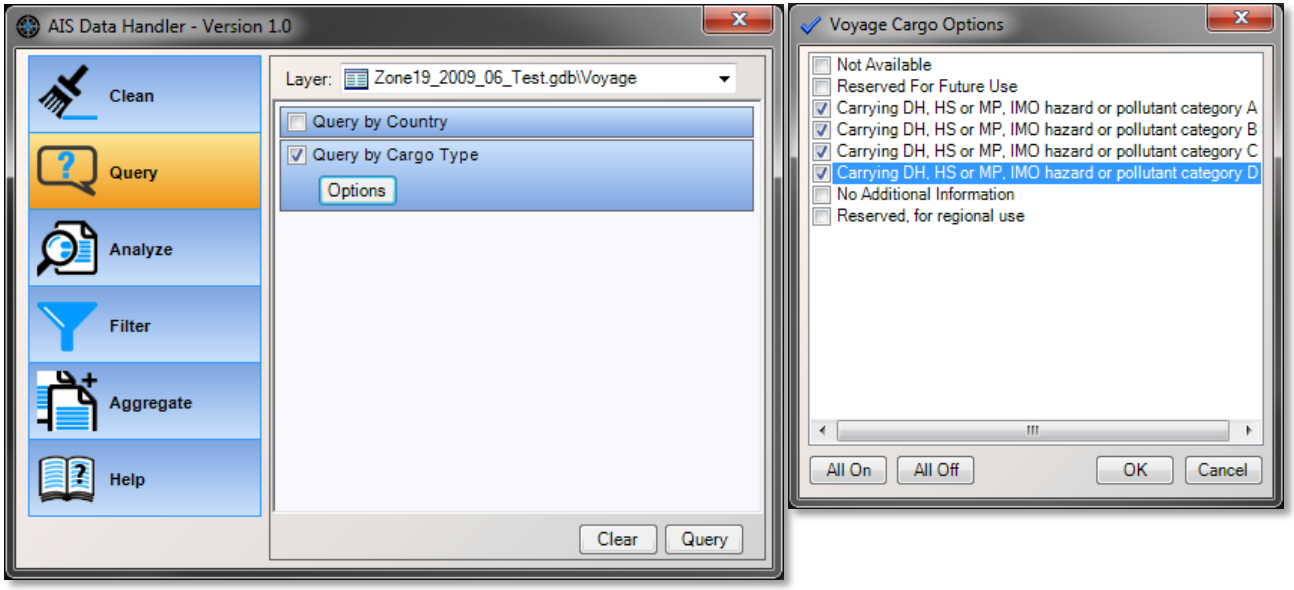
Removing Queries

Tool Description:

Queries can be removed in two ways. Users can either click the Clear button or uncheck the selected query and press the Query button.

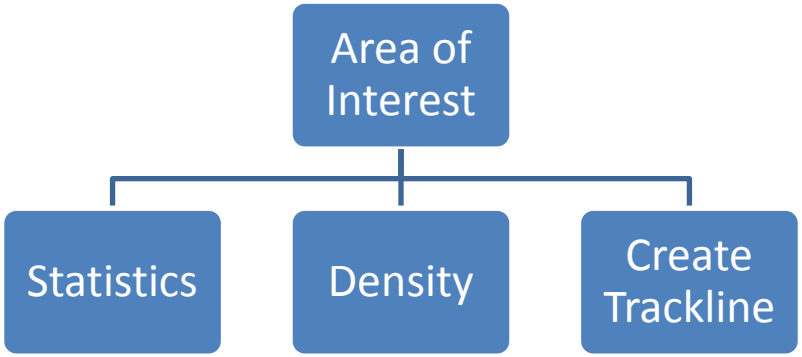
Applicable Datasets:

Broadcast, Voyage, Vessel



Analyze Toolbox

This toolbox allows the user to analyze the vessel traffic in three modes. First, statistics can be calculated on features, tables, and subsets of records. Second, vessel tracklines can be created from the Broadcast records. Third, raster density maps can be created from either the Broadcast or the trackline values.



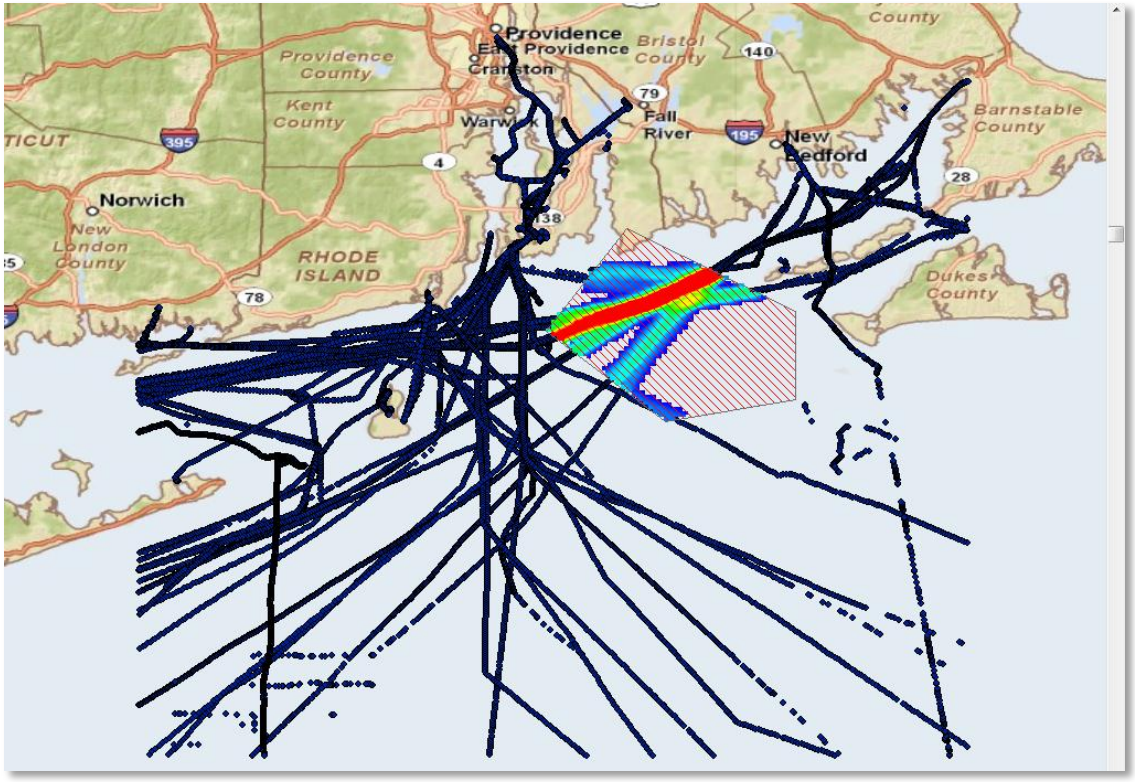
The Analyze Toolbox also provides an Area of Interest tool to select a focus area that the statistics, the tracklines, and density functions will operate within.

Tool Overview:

Area of Interest

Analyze

The Area of Interest (AOI) function is part of the Analyze tools. It is best used after the Broadcast records have been cleaned. An AOI will not limit the geographic extent of a clean operation. It will act as an analysis mask and is respected by the following analysis functions:



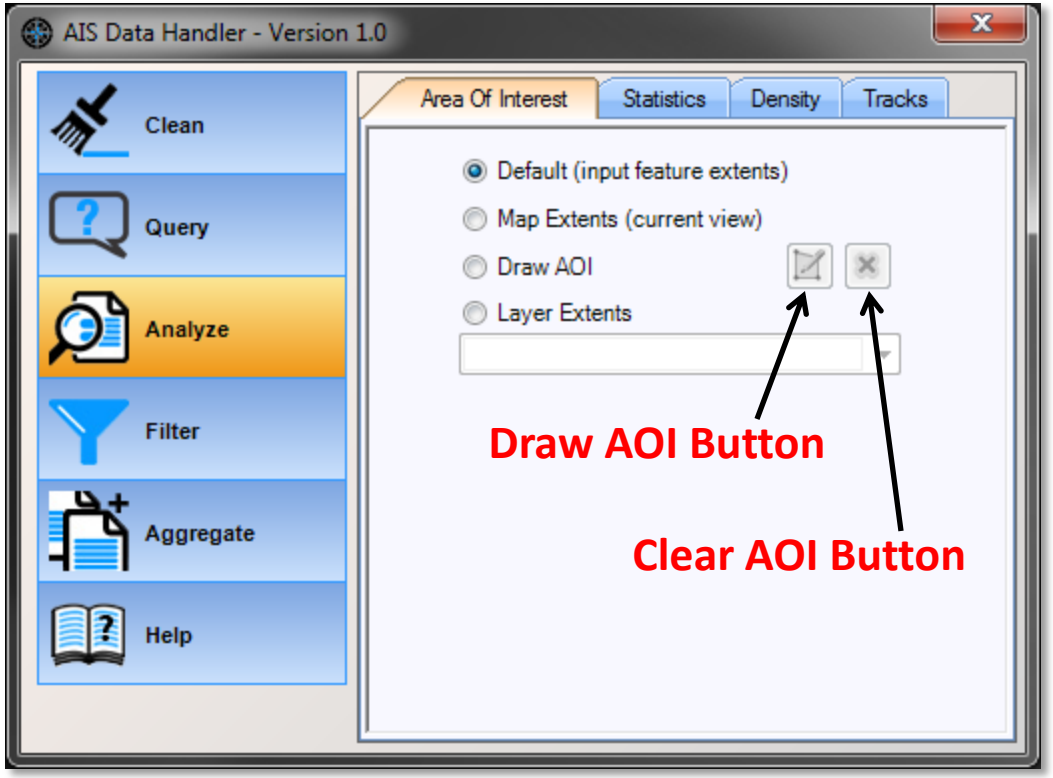
- Statistics – tabular and graphical statistics for Broadcast points and tracks
- Density – all options
- Tracks – create from all data options

Tool Overview:

Area of Interest

Analyze

Four options are provided to build an AOI for subsequent analyses:



Input Feature Extents
Uses the extent of the input dataset defined in other Analyze tabs.

Map Extents
Uses the current map extent within ArcMap.

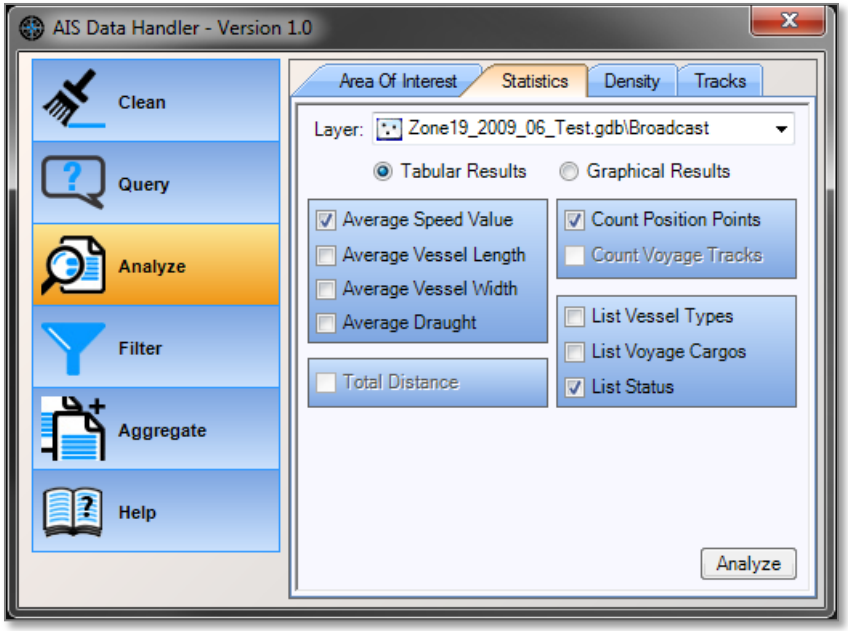
Draw AOI
Allows the drawing of a polygon directly on the map. This AOI option can be cleared by using the Clear AOI button.

Layer Extents
Uses the extent of any dataset that is loaded into ArcMap.

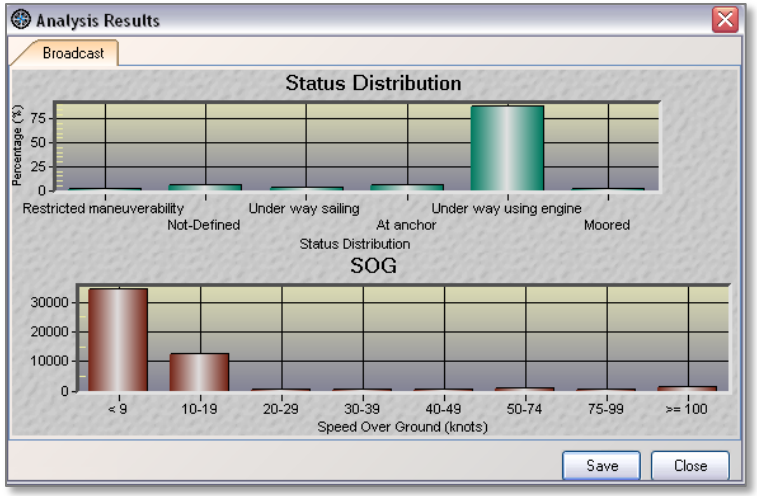
Tool Overview:
Statistics

Statistics can be generated for each data type selected in the layer menu and for the area defined in the Area of Interest tab.

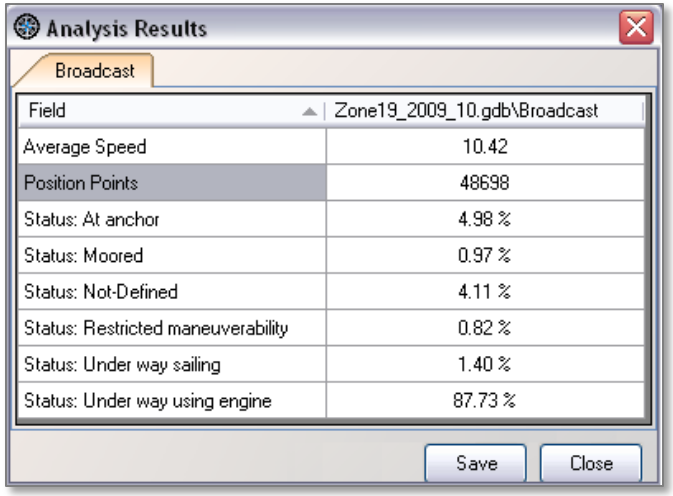
Depending on the user settings, graphical or tabular results can be generated as shown below. For both types of information, the data can be saved to a CSV file by pressing the Save button on the lower right-hand side.



Graphical Result



Tabular Result



Statistics Available by Data Type

Data Type	Statistic	Type of Statistic	
		Graph	Value (Tabular)
Broadcast	Count Position Points		X
	Average Speed Value	X	X
	Speed Distribution	X	
	List of Statuses	X	X
Vessel	Average Vessel Length		X
	Vessel Length Distribution	X	
	Average Vessel Width		X
	Vessel Width Distribution	X	
	List of Vessel Types	x	X
Voyage	Average Vessel Draught		X
	Vessel Draught Distribution	X	
	List of Voyage Cargos	X	X
Tracks (this data type can be created with the Analyze Tools)	Count Voyage Tracks		X
	Average Vessel Draught		X
	Vessel Draught Distribution	X	
	Total Distance		X

Tool Overview:
Density

The purpose of this tool is to generate a raster-based density map. The following information must be provided:

Information	What It Means
Layer	Select the Broadcast or Tracks input layer from the geodatabase.
Population Field	This option can be used to add a weighted factor to the broadcast points or vessel tracks. Users can add fields defining these weights to the feature class attribute table and then set one of those fields as the Population Field. Setting a Population Field of “none” will ensure that no weighting factor is used.
Density Type	**Point/Line**: Density calculated within a neighborhood around each raster cell center; the number of points that fall within the neighborhood is totaled and divided by the area of the neighborhood. **Kernel**: Density is calculated using a neighborhood function that spreads the value of each point over the given radius according to a quadratic formulation.

Note: Spatial Analyst must be installed and enabled to use this tool.

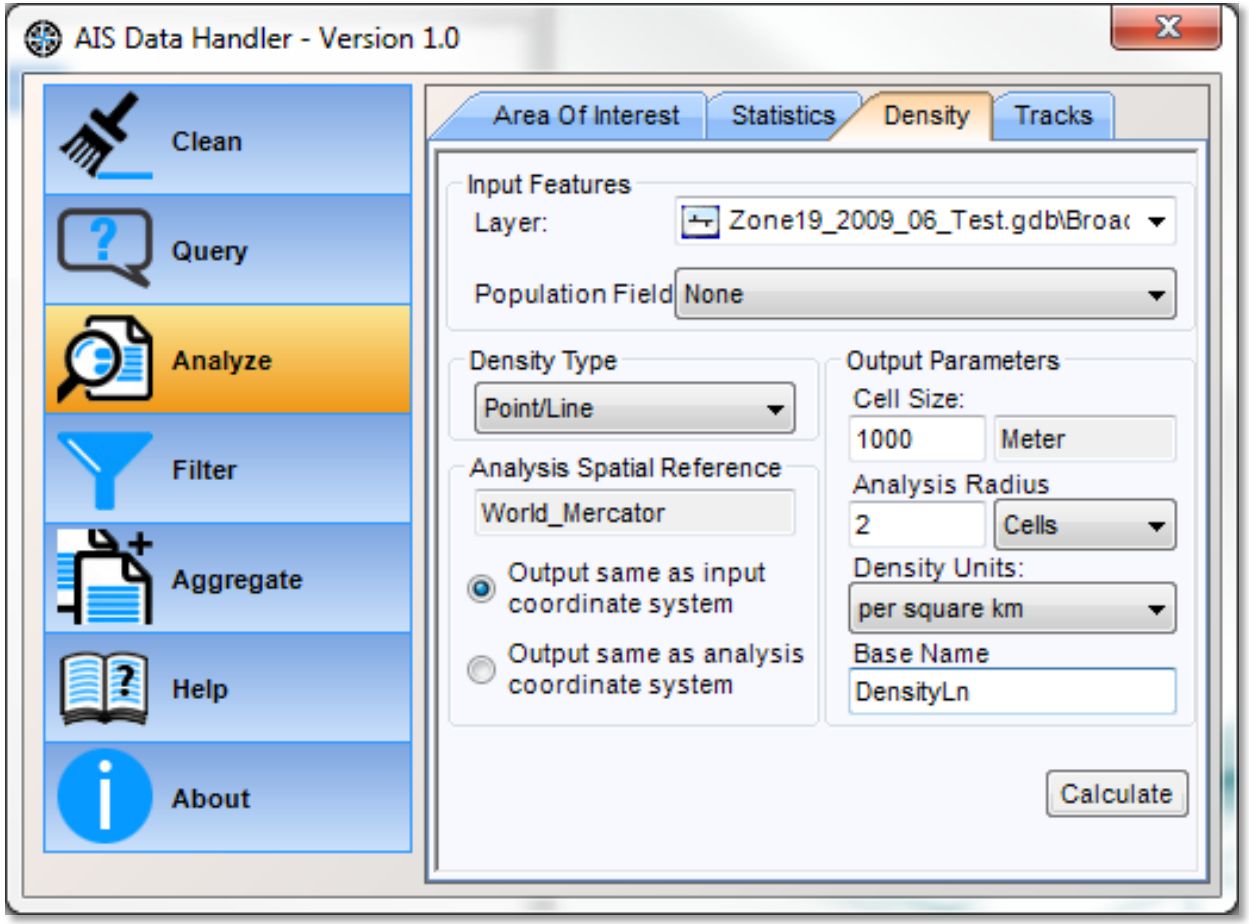
Tool Overview:
Density

Information	What It Means
Analysis Radius	The search radius with which to calculate density.
Output Cell Size	The cell size desired in the output raster dataset.
Density Units	Option to calculate the density units in terms of number per square kilometer or per square mile.
Base Name	Suffix assigned to input file name to identify the output file.
Analysis Spatial Reference	A user-defined spatial reference for the density tool calculation. The default is “World_Mercator.” The user can also decide whether to have the output projected into the same coordinate system as the input file or into the coordinate system as defined for the density analysis.

Note: Spatial Analyst must be installed and enabled to be able to use this tool.

Tool Overview:
Density

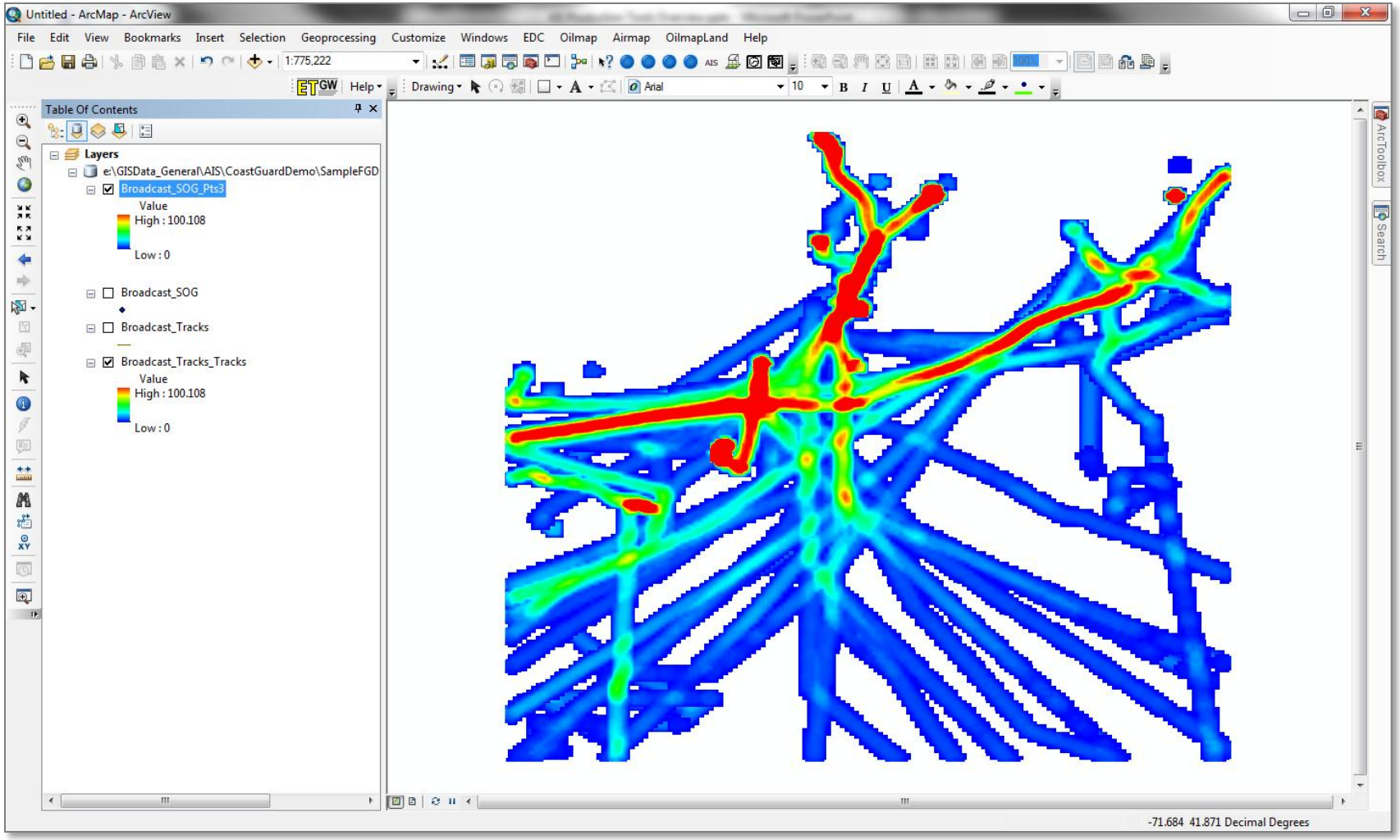
Example of Density Inputs for Broadcast Points



Tool Overview:
Density

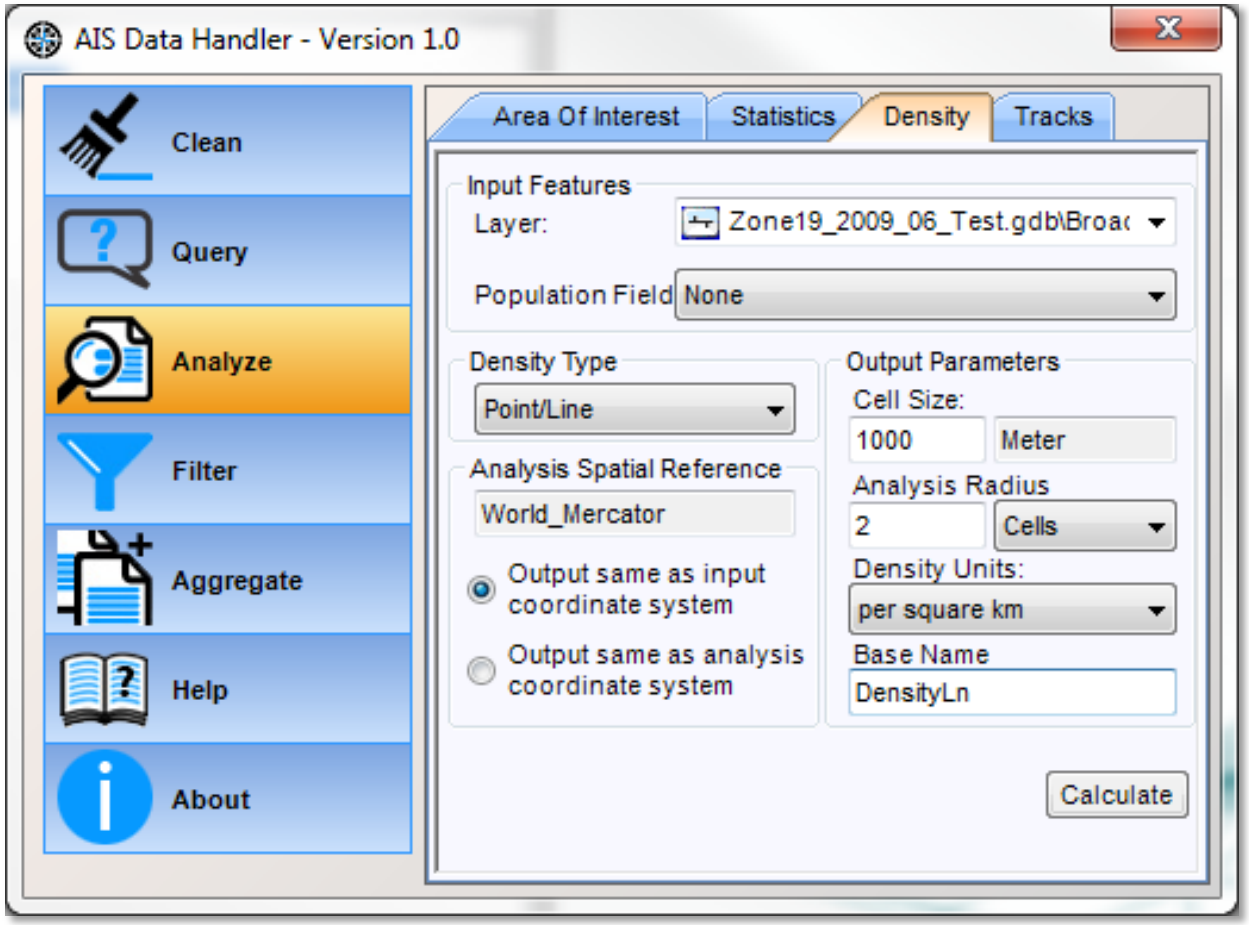
Analyze

Example of Density Output from Broadcast Points



Tool Overview:
Density

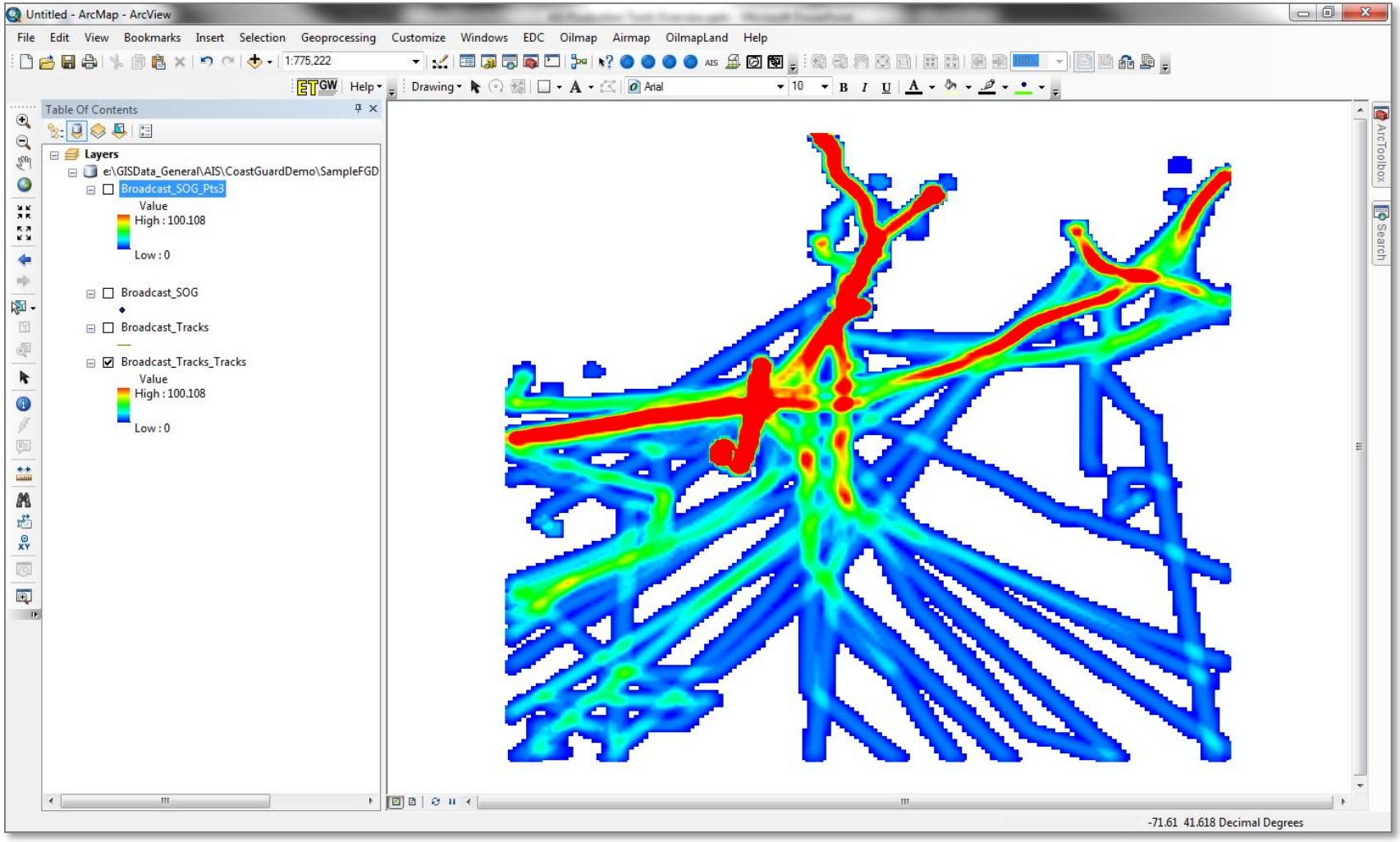
Example of Density Inputs for Tracks



Tool Overview:
Density

Analyze

Example of Density Output from Tracks

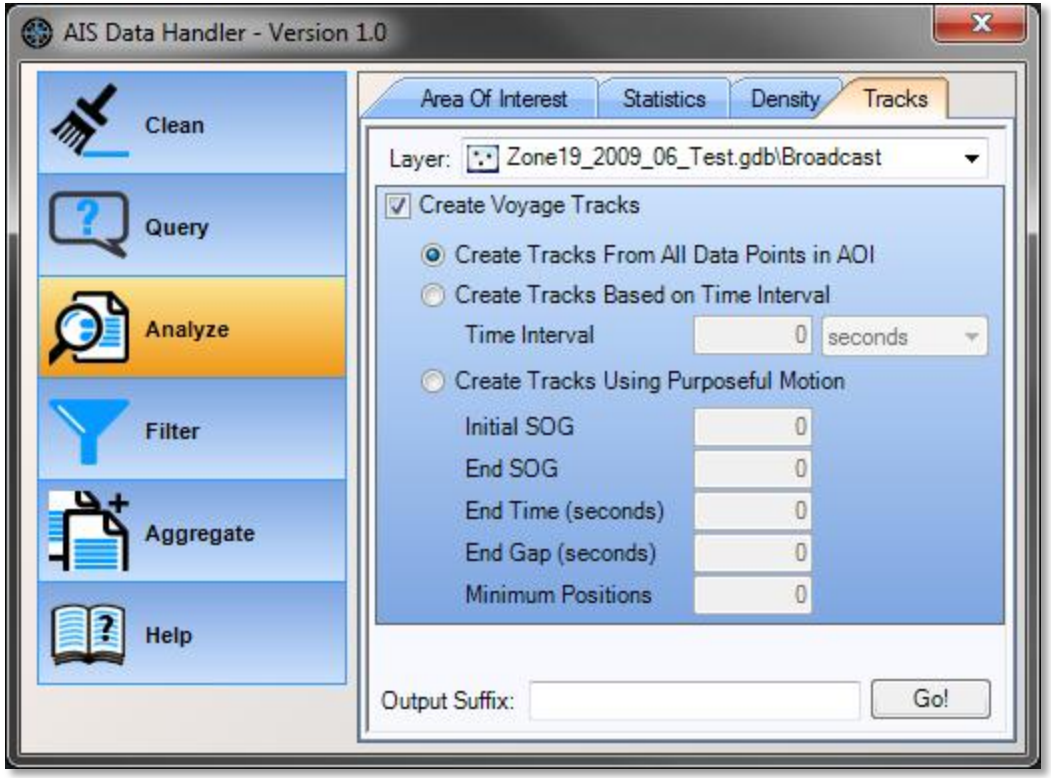


Tool Overview:

Tracks

Analyze

The purpose of this tool is to generate tracklines from Broadcast points. Vessel tracklines can be easier and faster to display then Broadcast points and can result in higher quality density analysis than with Broadcast points. In conjunction with the cleaning and filtering tools, smooth and logical vessel tracklines can be created from the AIS data.



Tool Overview:
Tracks

Options for the Creation of Tracks

1. Create Tracks from All Data Points

   ***Input Data*:** feature class containing position reports and maximum time allowed between sequential track points. Broadcast points will be linked into tracklines using VoyageID and the time between points. If the time between points exceeds the threshold set, a new trackline will be generated. A threshold setting of 60 minutes is recommended.

2. Create Tracks Based on Time Interval

   Input Data: feature class containing position reports and user-defined time interval. Tracks will be created using a position report's MMSI and time stamp.

Tool Overview:
Tracks

3. Create Tracks Using Purposeful Motion (Calder and Schwehr 2009).

Input Data: feature class containing position reports and user-defined speed and timing thresholds. Tracks will be created based on vessel's MMSI, speeds, and time between broadcasts.

Processing: Five thresholds are used to initiate and end voyages. When the speed over ground (SOG) is greater than the (1) *Initial SOG* threshold, a transit is started. If the SOG falls below the (2) *End SOG* threshold for a length of time longer than the (3) *End Time* threshold, voyages are considered over. Voyages are also considered over if the (4) *End Gap* threshold is exceeded, and once a set of voyages is produced, the (5) *Minimum Positions* threshold is used to eliminate those voyages made up of a small number of position reports.

Recommended Values:
Initial SOG: 0.5 knots
End SOG: 0.2 knots
End Time: 300 seconds (5 minutes)
End Gap: 600 seconds (10 minutes)

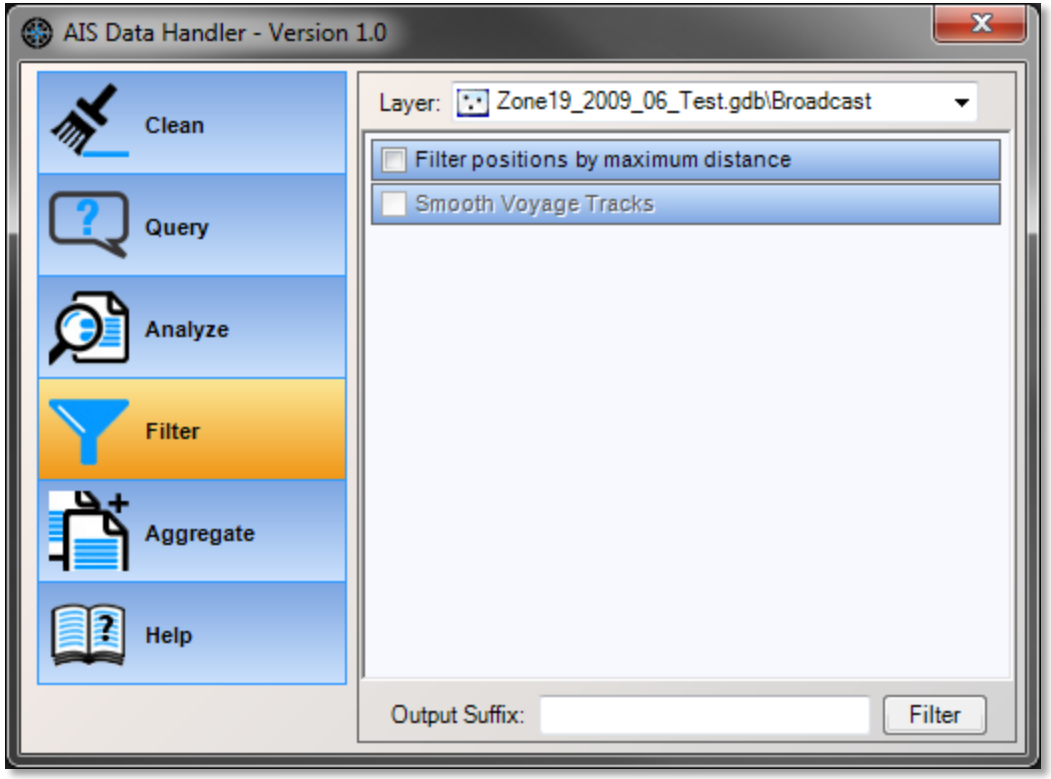
Tool Overview:
Tracks

Analyze

Example of Creating Tracklines from Point Data for a Single Vessel

Filter Toolbox

The filter toolbox contains two tools that enable the user to remove outlier positions. This results in more realistic ship tracks by removing points that clearly should not be associated with a given track. Each point associated with a voyage can be tested to see if the distance between points exceeds a user-defined value. The filter tools can also be used to smooth existing tracklines.



Tool Overview:

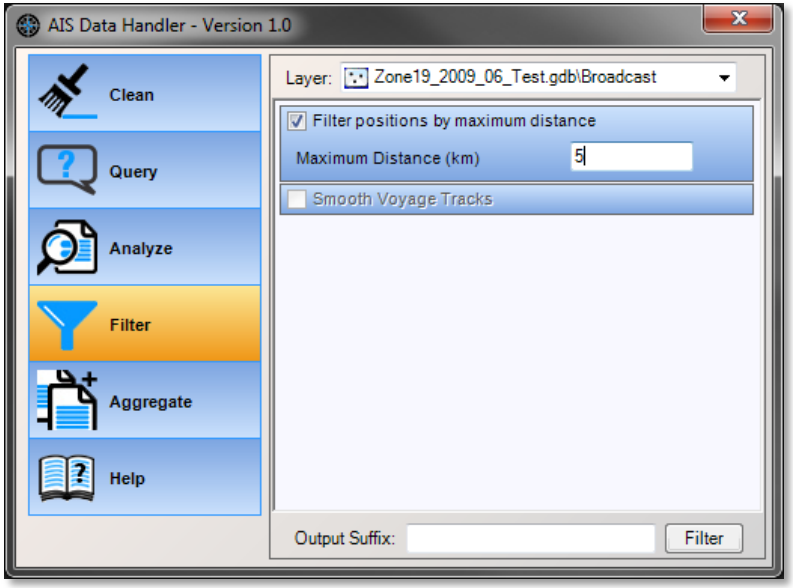
Filter positions by maximum distance

Tool Description: Use this to specify a maximum distance between Broadcast points that are associated with a specific voyage.

The only information that needs to be input for this tool is the maximum allowable distance between points.

Applicable Datasets:

Broadcast



Tool Overview:

Smooth Voyage Tracks

Tool Description: This tool provides capabilities to smooth voyage tracks that have already been created using the Analyze toolbox.

Two methods of smoothing are enabled within this tool, as described below:

PAEK: uses a parametric continuous averaging technique to smooth the tracklines. When using the PAEK smoothing, a tolerance must be defined, which is the length of a moving path along the line segments which is used in the smoothing algorithm.

Bezier Interpolation: fits Bezier curves through each line segment such that all vertices are maintained. No tolerance setting is required.

Two additional pieces of information may also be input into the tool. The first keeps the endpoints in fixed positions (i.e., not re-interpolating the start and end positions). Additionally, the tool can flag potential topological errors.

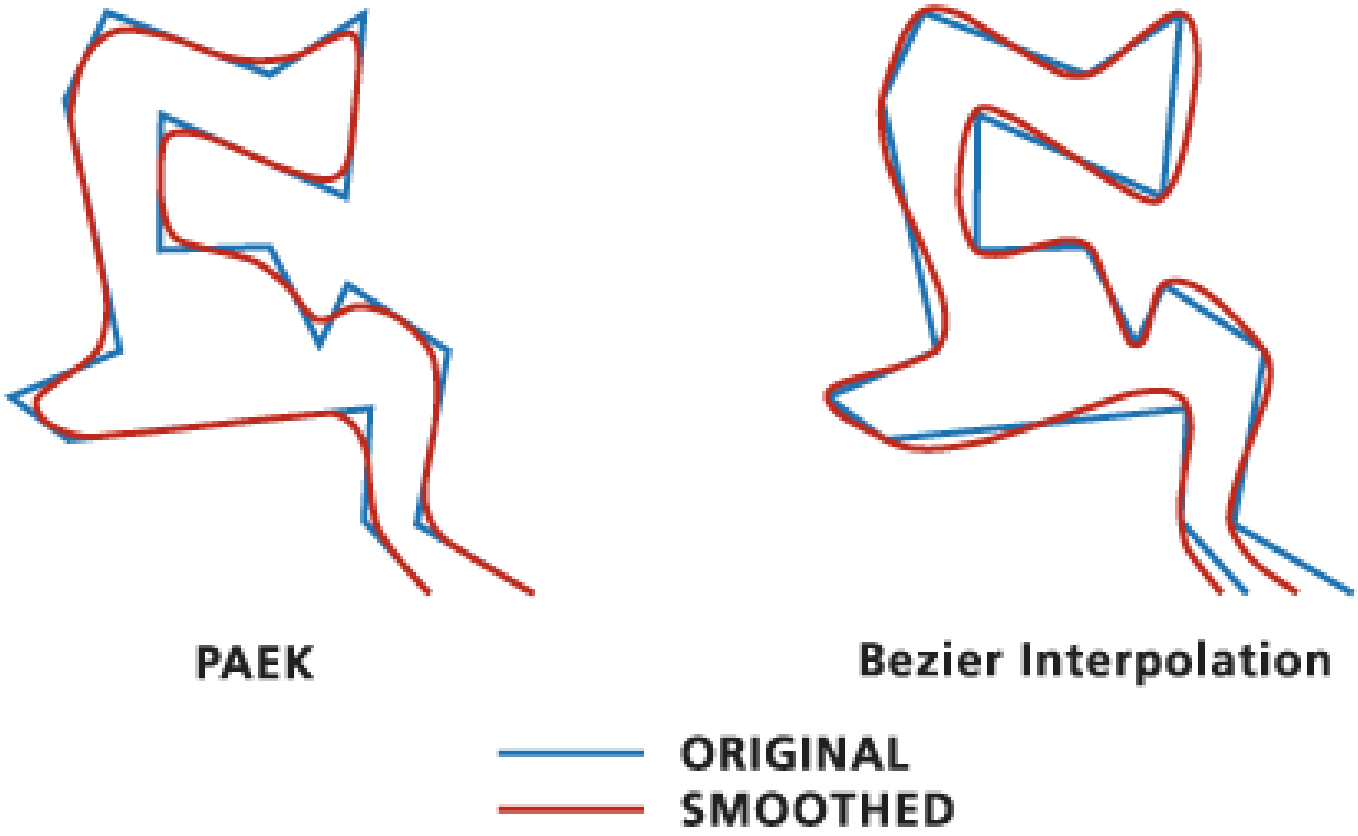
Applicable Datasets:

Tracks

Tool Overview:

Smooth Voyage Tracks

Example of Smoothing Techniques



Source: ArcGIS Desktop Help Online

Tool Overview:

Smooth Voyage Tracks

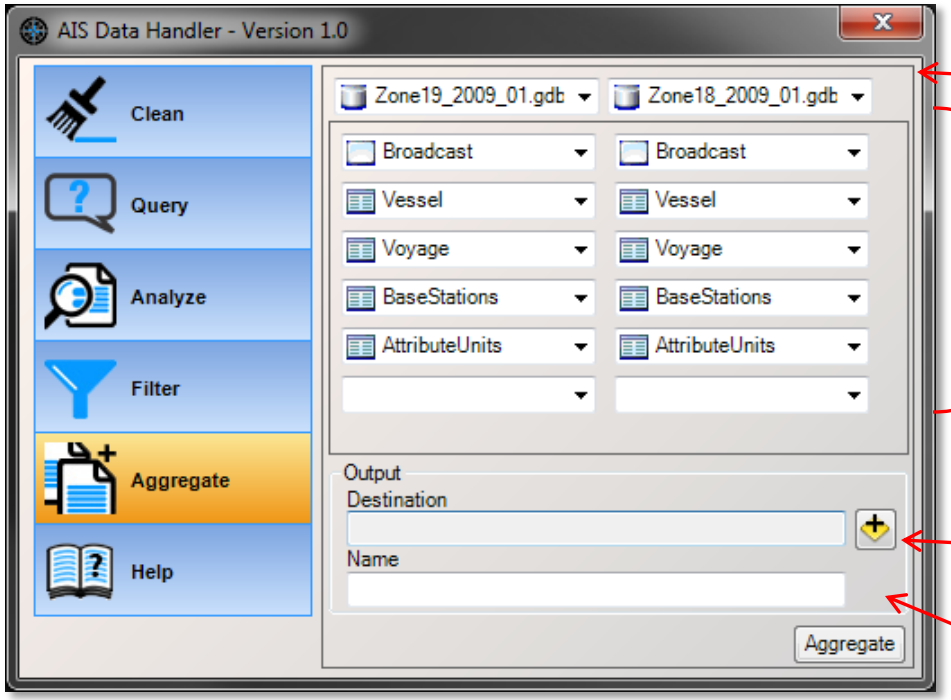
Smoothing of Actual Voyage Track

PAEK

BEZIER Interpolation

Aggregate Toolbox

The processing and analysis of the AIS data may result in a collection of individual data products that span a large geographic area or time frame. This tool is specifically designed to aggregate these multiple AIS products into one dataset. This new dataset can then be further processed using other tools in the AIS Data Handler.



File Geodatabase of Sources to Merge

Individual Datasets to Merge

Output Destination Folder

Name of Geodatabase to Create

AIS Pre-Processing Tools
(for advanced users)

Preparing raw AIS data in the National Marine Electronics Association (NMEA) format for use in the AIS Data Handler is a two-step process. Records must first be filtered and then translated.

- Filtering AIS data reduces the position message frequency from 3 to 8 seconds down to a user-defined frequency.
- The AIS pre-processing tools contain an executable file called AISFilter that can be used to filter raw AIS data.
- See Appendix A for a flow chart of the filter logic.
- Translating the filtered NMEA data into the File Geodatabase (FGDB) requires several of the AIS messages and results in a new set of records based on the data model described earlier in this tutorial.
- The AIS pre-processing tools contain an ArcMap add-in called ConvertAISToFGDB to convert raw AIS data into a FGDB format.

AIS Pre-Processing Tools

Installation

Step 1. Download and the AIS pre-processing tools from the AIS Data Handler website, (*http://marinecadastre.gov/ais/addin.php*); save to the ArcGIS \\Bin\AddIns folder.

Step 2. Navigate to the ArcGIS \\Bin\AddIns folder and unzip AISPreprocessingTools.zip

Note: Use of AISFilter.exe (for filtering raw AIS data) does not require any further installation. Instructions for use of AISFilter.exe are provided in a following slide.

Step 3. Double-click ConvertAISToFGDB.exe; click Next button and then the Finish button.

Step 4. Open ArcMap and add the ConvertAISToFGDB tool to an ArcMap toolbar using the Customize dialog and instructions provided earlier in this tutorial.

AIS Pre-Processing Tools

Filtering with AISFilter.exe

Parameters:

- Input directory containing raw data files
- File name pattern (to specify a subset of input files if desired)
- Output directory with file name prefix
- Filter interval in seconds
- Comma-delimited list of UTM zones

AIS Pre-Processing Tools

Filtering with AISFilter.exe

Sample .bat file

```
"C:\Program Files (x86)\ArcGIS\Desktop10.0\Bin\Add-Ins\ ConvertAISToFGDB
    \AISFilter.exe"
    E:\GISData_General\AIS\SampleRawNMEA 2009_06*.txt
    E:\GISData_General\AIS\Test\June 60 1,2

rem E:\GISData_General\AIS\SampleRawNMEA          //Input directory containing raw data files

rem 2009_06*.txt                    //file name pattern - used to specify a subset of the input files

rem E:\GISData_General\AIS\Test\June                    //output directory with file name prefix

rem 60                                                          //filter interval in seconds

rem 1,2                                                  //comma delimited list of UTM zone
```

AIS Pre-Processing Tools

Converting to FGDB

To convert from raw AIS data format to FGDB:

1. Click the ConvertAISToFGDB button in ArcMap.
2. Browse to the directory of AIS files.
3. Click OK.
4. The ConvertAISToFGDB add-in will automatically convert each input file to an individual FGDB following the data model described above.

AIS Processing Tips and Troubleshooting

- Make sure to select the correct input table for each Clean function; selecting a Broadcast feature class to clean a vessel record requires the function to unnecessarily traverse the relationship classes, which is time intensive.
- The Input Layer field has a fixed field length for display, long file names may make it difficult to use.
- Triggering the Clear Query function will clear the query; it does not remove the check from the query list of options that would effect future queries.
- After clearing a Query, toggle the draw button in the ArcMap table of contents to refresh your view.
- Smoothing tracklines relies on a map unit value; consider working in projected coordinates.
- To build your own relationship classes between the Broadcast, Vessel, and Voyage tables, use ArcToolbox > Data Management Tools > Relationship Classes > Create Relationship Class.

AIS Processing Tips and Troubleshooting

- Correct relationship class settings can be found by reading the property values in one of the original relationship classes.

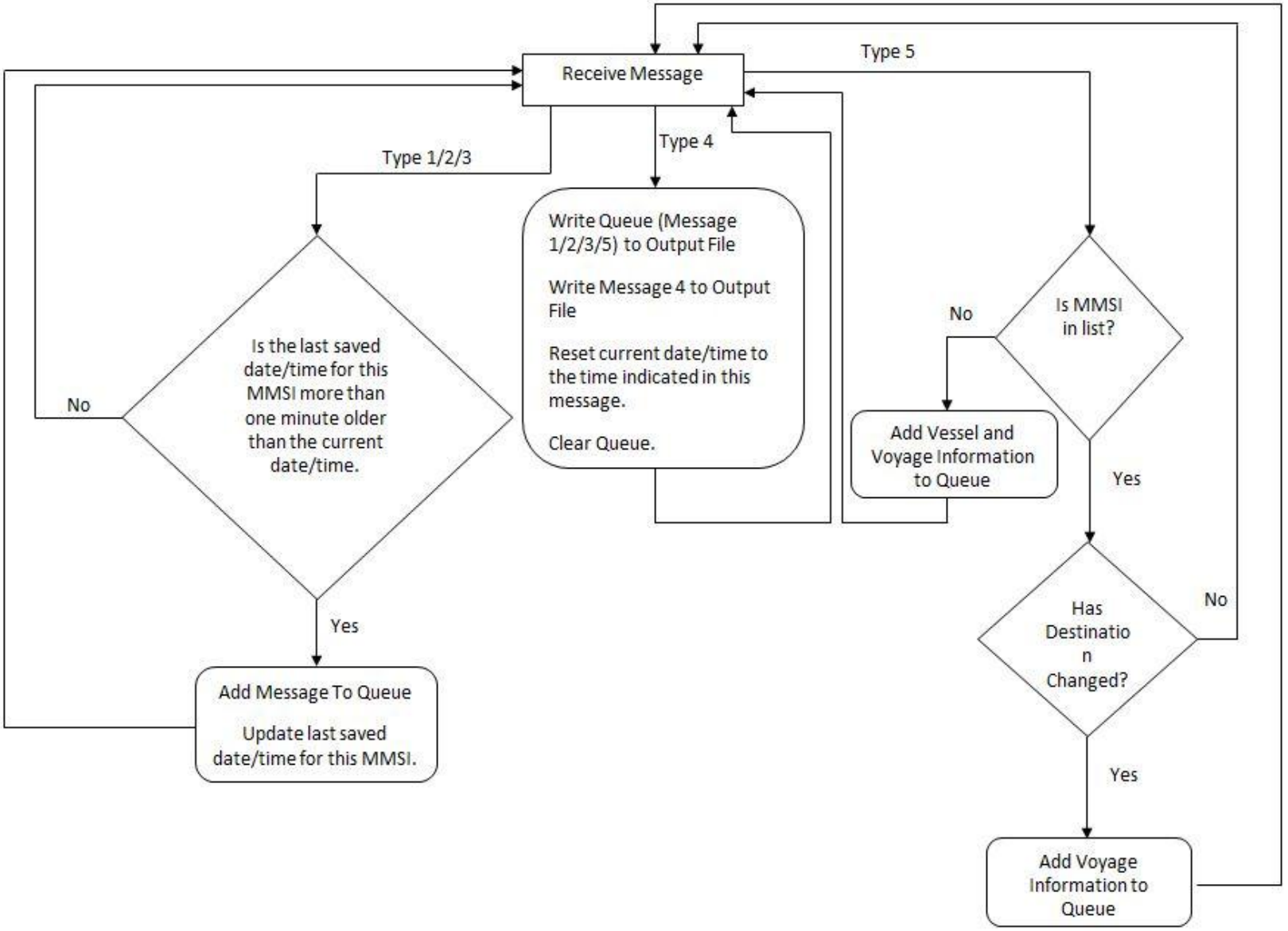
- When removing a large number of records from a feature class, ArcGIS may leave behind orphan empty records. The new feature class will function, but it will retain the overall file size of the original. Exporting the new feature class to a new FGDB will remove the orphan records.

- The Filter Positions by Maximum Distance function is intended to remove outliers. If a voyage has a significant break in its broadcast records, the later records may be removed with this filter.

- To improve performance, always include in the table of contents the tables needed for each process.

- If the add-in does not appear in the Customize > Customize Mode > Commands listing in ArcMap, double-click the “AISDataHandler.esriAddIn” file in the ArcGIS install directory under Desktop > AISDataHandler.

Appendix A: NMEA Filter Logic



Appendix B: Miami Sample Data

Specifications and example processing times

January 1-31 2009
Approximately 750 square miles
33 MB

1,365,578 Broadcast records
188,583 Voyage records
2,584 Vessel records

802 unique MMSIs in the Broadcast records
31 unique MMSIs in Vessel records with 2,550 null values
2,141 unique MMSIs in the Voyage records (17,833 with 0 values and 1,448 with 999999999 values)

1,444 unique VoyageIDs in the Broadcast records
157,015 unique VoyageIDs in Voyage records with 5,020 null values

Clean for MMSI length and valid country codes: 15 minutes (reduced to:1,333,431 records)
Clean to remove <1 knot records: 13 minutes (reduced to 192,062 records)
Analyze>Statistics>List Vessel Types in Vessel: under 1 minute
Analyze>Statistics>List Voyage Cargos in Voyage: under 1 minute
Analyze>Statistics>Average Draught in Voyage: under 1 minute
Analyze to build tracks from all data using a 60 minute maximum gap: 1 minute (2,318 new tracks)
Analyze>Statistics>Sum Distance using Tracks: under 1 minute (583 degree units)
Analyze>Statistics>Density using Tracks: under 1 minute

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Calder, B., and K. Schwehr, 2009. "Traffic Analysis for the Calibration of Risk Assessment Methods." Technical Paper. U.S. Hydro 2009 Conference, May 11-14, Norfolk, VA. Accessed at *www.thsoa.org/us09papers.htm*.

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Silber, G.K., and S. Bettridge. 2010. "Vessel Operations in Right Whale Protection Areas in 2009." U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR-44. Accessed at *www.nmfs.noaa.gov/pr/pdfs/shipstrike/opr44.pdf*.

United States Coast Guard (USCG) Navigation Center. "Automated Information System (AIS): AIS Messages." Website. Accessed October 15, 2010, at *www.navcen.uscg.gov/?pageName=AISMessages*.

Hatch L.T., C. Clark, R. Merrick, S. Van Parijs, D. Ponirakis, K. Schwehr, M. Thompson, and D. Wiley. 2008. "Characterizing the Relative Contributions of Large Vessels to Total Ocean Noise Fields: A Case Study Using the Gerry E. Studds Stellwagen Bank National Marine Sanctuary." *Environmental Management*. Volume 42, Number 5. DOI 10.1007/s00267-008-9169-4. Accessed at *www.springerlink.com/content/u1p51226016240lp/*.

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