

# MARIS - Capabilities and Applications for Security and Risk Analysis

Technical Report

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## **Summer Research Project – Final Report**

This report contains a description of goals accomplished over the course of the project. It also contains descriptions of ideas for data analysis and progress made regarding these goals. New data that was created is described, including how it was generated, where it is stored and some particular goals that it may prove useful for. Finally, some figures are included to illustrate some of the uses of both ArcGIS and MARIS for the display and analysis of data with the goals of risk analysis and security.

### **Progress – Goals Accomplished**

- studied background information in GIS, computational geometry and marine safety and security in order to gain the knowledge necessary to understand and work with shipping data and GIS methodology.
- performed a literature review of methods used in outlier and abnormal behavior detection and prepared a paper containing an overview of these various approaches.
- performed a literature review of methods used in modeling, storing and analyzing route data and prepared a paper containing an overview of these approaches.
- obtained and installed MARIS software for use in displaying and analyzing shipping track and incident data.
- gained familiarity with the data included with the MARIS software through study of its accompanying metadata as well as additional research, and prepared a short summary describing this data and its potential uses.
- gained familiarity with the MARIS software including its capabilities and functionality and prepared a short summary of these, as well as some potential uses.

- explored the use of ArcGIS for displaying and analyzing shipping tracks and incident data, for example by creating maps of useful data and by using the Intersect tool to determine points where tracks cross each other.
- performed various queries using MARIS, in order to isolate and store useful data.
- identified potential ideas for the analysis of data.

The focus of the project has been on marine security and risk analysis, making use of data accompanying the MARIS software and including information about shipping tracks for various vessels, as well as data regarding marine incidents. Particular goals discussed included the identification of problematic areas, understanding the causes of accidents, coastal security, vessel movement and identifying deviations from routes. The following ideas were developed with these goals in mind and the ideas, as well as progress made, are described.

### **MARIS – Ideas for Analysis**

Where progress was made, I have described what was done. All data created was stored and information about this can be found under *Descriptions of Data Created and Stored*.

#### **1. Does a FOC (Flag of Convenience) for merchant ships correspond to higher incident rates?**

**Progress:** The queries made on the merchant shipping tracks included one for tracks where the value for FOC was 1 (there is a FOC) and another for tracks where the value was 0 (there is not a FOC). For each there are now corresponding files and these could potentially be used to look into differences between ships with or without a Flag of Convenience, including perhaps which ones and how many were involved in incidents.

#### **2. Which SAR and NAFO areas have the highest incident rates?**

**Progress:** Queries have been made to isolate incidents and traffic within the various SAR and NAFO regions. These have been stored as well as exported to Excel or text files. These queries could be used to look at the numbers of incidents and traffic in the different regions. As well, since the records are stored in tables, other information about the ships themselves or the incidents is available

for different types of further analysis, for example comparing types of incidents between different regions.

**3. Which SAR and NAFO areas have the highest traffic counts?**

**Progress:** see above.

**4. Where do tracks cross each other?**

**Progress:** The Intersect tool in ArcGIS was used to create layers of point data showing points where tracks cross each other. These were then saved as ArcMaps and MARIS viewfiles (in addition to the shapefiles). Because the original tracks data is so large, this was done for smaller queries only, for example to determine where the tracks of merchant vessels carrying passengers intersect with the tracks of merchant tankers carrying crude oil.

**5. Which incidents correspond to which tracks?**

**Progress:** In some cases, incident data and track data contains identical fields. This can be used to attempt to match incidents with corresponding tracks. MS Access was used to identify these relationships and tables were built up containing the records that match each other. The more fields that match the more likely it is that the incident and the track do in fact correspond to each other. These tables could prove useful in matching incidents with the ships and tracks that were involved.

**6. Which ports are the busiest or have the most traffic?**

**7. Does the country of registration impact incident rates?**

**Progress:** Some queries were done to isolate merchant shipping tracks where the ships were registered to certain countries or regions, for example the Middle East, Canada, Africa or the U.S. Attempting to match tracks with their corresponding incidents (as described above) may prove useful towards this goal. Incident records contain a field called *Nation* but it is often blank making it difficult to determine the country of registration of ships based solely on the incident data.

**8. Do certain countries of registration correspond more often to certain types of incidents?**

**9. Identify entire routes of each particular ship, combining adjacent tracks into a route.**

**Progress:** I attempted to do this for some of the files by looking at tracks with matching fields as well as looking at source and destination ports. I added a column to keep track of the route number so that routes could be mapped and kept track of. I am unsure of the accuracy of this method, but did manage to map some routes using ArcMap and MARIS.

**10. Examine distance between different tracks - calculate nearest track for each track and its distance.**

**Progress:** ArcGIS has a relevant function (*near*) however this seems to be limited to calculating nearest points rather than nearest lines. I used this function instead to calculate the nearest SAR resource to incidents, creating a new column in their tables that stores this information.

**11. Examine causes of incidents, group and look at most common causes.**

**Progress:** Some queries have isolated incidents based on their types, for example suspicious or illegal activity, fires, suicide attempts, etc. This data could be further used to determine the most common types of incidents and other goals for analysis. The data is stored and exported to Excel files.

**12. Which types of vessels are most prone to incidents, and which types of incidents tend to be associated with which types of vessels?**

**13. Which types of vessels were most often involved in illegal or suspicious activities?**

**Progress:** Queries have isolated the incidents where suspicious or illegal activities were involved, and these have been stored. Further analysis could involve looking at the records to determine the most common vessels involved.

**14. Look at numbers of incidents for each month of the year.**

### **Descriptions of Data Created and Stored**

A number of queries were done in order to isolate useful data such as certain types of incidents or tracks. This may prove useful for further analysis with a number of goals in mind. Maps were also created for use in displaying data both in ArcMap and in MARIS. The following describes data that has been created and stored using the original MARIS data that came with the MARIS software.

### **MARIS Queries**

The MARIS queries are stored as shapefiles in C:\Program Files\MARIS\user\queries and each has a corresponding exported Excel file stored in C:\Program Files\MARIS\exports, where possible (queries that exceed 65 000 records do not include an exported Excel file but include a text file instead which is stored in the folder *Text Exports*). Queries and exports are stored in folders corresponding to *Gridded Data*, *Merchant Shipping*, *Incidents*, and *Other Tracks*, in the *Queries* and *Exports* folders respectively. A short description of each query and what it contains is included in this document.

### **Incidents**

<b>Query Name</b>	<b>Query Description</b>	<b>Excel File (Y/N)</b>	<b>Number of Records</b>
marineAll	Only marine incidents.	N	133 412
marineNoFalse	Only marine incidents, no false alarms.	N	133 409
suspIllegalAll	All incidents involving suspicious/illegal activities.	Y	185
suspIllegalMarine	All marine incidents involving suspicious/illegal activities.	Y	117
suicidesAttemptsAll	All incidents involving suicides or attempts.	Y	1 030
suicidesAttemptsMarine	All marine incidents involving suicides or attempts.	Y	3

falseAlarmsMarine	All marine false alarm incidents.	Y	16 541
firesAll	All incidents involving fires.	Y	1 646
firesMarine	All marine incidents involving fires.	Y	1 502
M1Distress	All marine M1 distress incidents.	Y	5 944
peopleLostMarine	Marine incidents with at least 1 person lost.	Y	834
peopleMissingMarine	Marine incidents with at least 1 person missing.	Y	311
crashMarine	Marine incidents involving a crash.	Y	3
forcedLandingMarine	Marine forced landing incidents.	Y	1
personOverboard	Person overboard incidents.	Y	865
medicalMarine	Medical marine incidents.	Y	1 612
capsized	Incidents involving capsize.	Y	3 897
grounded	Marine grounding incidents.	Y	11 214
waterFoundered	Marine incidents involving taking on water or foundered.	Y	4 186
marineFirstAid	Marine incidents, first aid given.	Y	134
marineRescue	Marine rescue incidents.	Y	2 595
marineEvac	Marine evacuations incidents.	Y	1 841
cruise	Assisted type cruiseship.	Y	317
ferry	Assisted type ferry.	Y	346
merchVarious	Merchant assisted types, eg. cargo, tanker, etc.	Y	4 997
recVarious	Various recreational eg. personal, canoe, kayak, hovercraft, sailboat.	Y	63 729
personMarine	Assisted type person, marine incidents.	Y	195
sail	Assisted type sail craft or sail board.	Y	17 273
sub	Assisted type submarine.	Y	5
fishing	Assisted type fishing vessel or boat.	Y	27 742
personalWatercraft	Assisted type personal watercraft.	Y	1 547
more100People	More than 100 people on board, marine.	Y	211
aeronautical	Aeronautical incidents.	Y	8 275
sisarIDLess100	Incidents with UNQ_ID less than 100 (used for ArcGIS testing purposes).	N	99

### **Gridded Data**

Query Name	Query Description	Excel File (Y/N)	Number of Records
highestIncRates	Cells with highest incident rates (highest class when rendered in MARIS), all.	Y	15
highestIncRatesMerch	Cells with highest incident rates when	Y	8

	rendered in MARIS, merchant.		
highTrafficAll	Cells with highest traffic counts when rendered in MARIS.	Y	52
highCruiseTraffic99	Highest traffic counts when rendered, for 1999, cruise tracks.	Y	30
highTrafficFishing	Highest fishing traffic counts when rendered, 1997-1999.	Y	33
highIncRatesFishing	Highest incident rate cells, fishing, 1997-1999, when rendered.	Y	7
highCruiseIncs99	Highest incident rate cells, cruise, 1999.	Y	2
highPOBAll99	Highest POB cells, all tracks, sum, 1999.	Y	75
highPOBFishing99	Highest POB cells, fishing, sum, 1999.	Y	26
highPOBCruise99	Highest POB cells, cruise, sum, 1999.	Y	30
highPOBMerch99	Highest POB cells, sum of all POB, merchant, 1999.	Y	75
highMerchTraffic	Highest merchant traffic count cells, 1997-1999.	Y	60

**Note:** In MARIS, when rendering a gridded layer using the *class breaks* option, the data is divided into 5 classes, and displayed with a different color for each class. The “high” values here are routes which correspond to the 5<sup>th</sup> class (highest numbers).

### **Merchant Shipping Tracks**

Query Name	Query Description	Excel File (Y/N)	Number of Records
merchAll	All merchant shipping tracks.	N	176 172
merchCrudeTank	Vessels of type crude tanker.	Y	432
merchChem	Vessels of type chemical tanker.	Y	8 245
merchLiqGasTank	Vessels of type liquified gas tanker.	Y	78
merchGasoline	Commodity type gasoline.	Y	1 024
merchContainers	Commodity type containers.	Y	35 139
merchSupertanker	Vessels of type supertanker.	Y	285
merchOre	Commodity type ore.	Y	4 890
merchGasOilPetrol	Commodity type gas, crude oil, or petroleum.	Y	8 667
merchPassengers	Commodity type passengers.	Y	1 048
merchCrude	Commodity type crude oil.	Y	3 343
merchPetrol	Commodity type petroleum.	Y	4 300
merchFOC	Operating under flag of convenience.	Y	64 683
merchNoFOC	Not operating under a flag of convenience.	N	109 042
merchIn	Inbound tracks.	Y	60 346
merchOut	Outbound tracks.	N	175 980

merchOilGasChem	Vessel types involving oil, gas or chemicals.	Y	9 042
merchRegAfrica	Vessels registered to African countries.	Y	13 389
merchRegCanada	Vessels registered to Canada.	Y	39 002
merchHighIncs	Tracks passing through high incident cells.	Y	5 068
merchIDLess100	Tracks with ID less than 100.	Y	98
merchFIDLess200	Tracks with ID less than 200.	Y	198
merchRegMidEast	Vessels registered in the Middle East.	Y	3 151
merchRegUSA	Vessels registered to the U.S.	Y	620

### **Other Tracks**

Query Name	Query Description	Excel File (Y/N)	Number of Records
cruiseAll	All cruiseship tracks.	Y	5 194
commFishAll	All commercial fishing tracks.	N	1 032 336
aquacultureAll	All aquaculture tracks.	N	1 248 006
ferryAll	All ferry tracks.	N	798 573
commRecAll	All commercial recreation tracks.	N	117 432
cruiseIDLess200	Cruise tracks, ID less than 200.	Y	616
cruiseLess100	Cruise tracks, ID less than 100.	Y	313

### **SAR and NAFO Spatial Queries**

These queries were generated using the simple spatial query in MARIS. The incident queries isolate incidents occurring within the particular SAR or NAFO boundary. The traffic queries isolate merchant traffic passing through each boundary. Each has a shapefile, viewfile and corresponding exported Excel or text file, stored in the appropriate folders. Boundaries are represented hierarchically in these tables, for example *Area010* is within *JRCCHalifaxAll*. The SAR and NAFO queries are stored in C:\Program Files\MARIS\user\queries in their corresponding folders.

### **SAR Incident Queries**

Query Name			Number of Records
JRCCHalifaxAll			40 256
		area010sisar	216
		area011sisar	784
		area004sisar	8 968
		area005sisar	1 537

		area008sisar	1 712
		area007sisar	5 224
		area006sisar	2 390
	MRSCStJohnsAll		7 035
		area033sisar	2 428
		area032sisar	1 811
		area034sisar	1 734
		area031sisar	516
		area009sisar	545
	MRSCQuebecAll		12 393
		area001sisar	1 696
		area002sisar	2 083
		area140sisar	7 321
		area141sisar	1 314
JRCCTrentonAll			14 699
		area155sisar	56
		area260sisar	101
		area103sisar	1 575
		area104sisar	517
		area109sisar	1 145
		area110sisar	924
		area259sisar	428
		area108sisar	3 380
		area105sisar	1 310
		area106sisar	892
		area107sisar	2 400
		area101sisar	59
		area102sisar	994
		area200sisar	478
		area100sisar	440
JRCCVictoriaAll			41 423
		area305sisar	6 228
		area306sisar	3 949
		area304sisar	7 228
		area303sisar	13 206
		area302sisar	2 027
		area301sisar	4 513
		area307sisar	3 765
		area308sisar	520

### **SAR Merchant Traffic Queries**

Query Name	Number of Records
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JRCCVictoriaAllEcareg			4
		area305ecareg	2
		area306ecareg	0
		area304ecareg	2
		area303ecareg	4
		area302ecareg	0
		area301ecareg	0
		area307ecareg	0
		area308ecareg	0
JRCCHalifaxAllEcareg			176 172
		area010ecareg	3 506
		area011ecareg	44 369
		area004ecareg	?
		area005ecareg	?
		area008ecareg	?
		area007ecareg	63 284
		area006ecareg	22 593
	MRSCStJohnsAllEcareg		?
		area033ecareg	46 425
		area032ecareg	16 933
		area034ecareg	55 843
		area031ecareg	25 908
		area009ecareg	5 695
	MRSCQuebecAllEcareg		?
		area001ecareg	62 953
		area002ecareg	?
		area140ecareg	10 433
		area141ecareg	47 602
JRCCTrentonAllEcareg			8 351
		area155ecareg	1 634
		area260ecareg	954
		area103ecareg	128
		area104ecareg	741
		area109ecareg	1 644
		area110ecareg	1 599
		area259ecareg	775
		area108ecareg	3 156
		area105ecareg	648
		area106ecareg	250
		area107ecareg	951
		area101ecareg	653
		area102ecareg	103
		area200ecareg	0
		area100ecareg	475

### NAFO Incident Queries

Query Name			Number of Records
Subarea0All			156
	division0Asisar		41
	division0Bsisar		114
Subarea1All			88
	division1Asisar		2
	division1Bsisar		1
	division1Csisar		5
	division1Dsisar		5
	division1Esisar		3
	division1Fsisar		71
Subarea2All			803
	division2Gsisar		58
	division2Hsisar		186
	division2Jsisar		558
Subarea3All			7 748
	division3PSsisar		1 891
	division3PNsisar		291
	division3Lsisar		2 854
	division3Osisar		239
	division3Nsisar		255
	division3Ksisar		1 988
	division3Msisar		256
Subarea4All			32 629
	division4Tsisar		16 250
	division4Ssisar		1 437
	division4Xsisar		9 789
	division4Wsisar		2 830
	division4VNsisar		1 083
	division4Rsisar		771
	division4VSsisar		468
Subarea5All			579
	division5Ysisar		186
	division5ZEsisar		390
	division5ZWsisar		2
Subarea6All			58
	division6Asisar		17
	division6Bsisar		14
	division6Csisar		5
	division6Dsisar		3

	division6Esisar		1
	division6Fsisar		4
	division6Gsisar		3
	division6Hsisar		10

### **NAFO Merchant Traffic Queries**

Query Name			Number of Records
Subarea0AllEcareg			2 421
	division0Aecareg		1 055
	division0Becareg		1 961
Subarea1AllEcareg			6 581
	division1Aecareg		640
	division1Becareg		700
	division1Cecareg		696
	division1Decareg		717
	division1Eecareg		691
	division1Fecareg		6 361
Subarea2AllEcareg			11 049
	division2Gecareg		2 170
	division2Hecareg		3 201
	division2Jecareg		10 755
Subarea3AllEcareg			176 171
	division3PSecareg		59 856
	division3PNecareg		36 995
	division3Lecareg		41 492
	division3Oecareg		28 133
	division3Necareg		28 882
	division3Kecareg		18 594
	division3Mecareg		42 106
Subarea4AllEcareg			176 172
	division4Tecareg		?
	division4Secareg		?
	division4Xecareg		?
	division4Wecareg		?
	division4VNecareg		?
	division4Recareg		24 710
	division4VSecareg		47 559

Subarea5AllEcareg		53 391
	division5Yecareg	39 320
	division5ZEcareg	53 341
	division5ZWecareg	2
Subarea6AllEcareg		176 172
	division6Aecareg	47 157
	division6Becareg	3 861
	division6Cecareg	3 913
	division6Decareg	7 566
	division6Eecareg	6 774
	division6Fecareg	3 872
	division6Gecareg	2 227
	division6Hecareg	2 625

### **MARIS Viewfiles**

Viewfiles (.vwf) are used by MARIS to display data as a map. They are saved by default into C:\Program Files\MARIS\User\Views. The following is a description of the viewfiles created and stored (in addition to the ones for NAFO and SAR queries). Other than the SAR and NAFO queries, each viewfile has a corresponding JPEG image stored in MARIS\User\Images.

<b>Viewfile Name</b>	<b>Viewfile Description</b>
cruiseRoutesIncs	A map of cruise routes and cruise incidents.
ferryTracksIncs	A map of ferry tracks and ferry incidents.
fishingTracksIncs	A map of commercial fishing tracks and fishing incidents.
merchTracksIncs	Merchant tracks and various merchant incidents.
cruiseIncsHighTraffic	Cruise incidents, cells with highest traffic.
merchHighTrafficIncs	High traffic merchant cells, various merchant incidents.
highIncsHighTraffic	Highest traffic cells – all, highest incident cells – all.
suspllegalAll	All suspicious or illegal activities (from incident data).
suspllegalMarine	Suspicious or illegal marine incidents.
grounding	All incidents involving grounding.
NafoSubIncidents	All marine incidents and NAFO subareas.
SARIncidents	All marine incidents and SAR boundaries.
NAFOBoundariesLabelled	NAFO boundaries with labels.
SARareasData	JRCCs, labelled, with data plotted.
SARareasLabelled	JRCCs, labelled, no data.
SARareasNames	Areas with names, no data.

### **ArcGIS Maps**

In ArcGIS, ArcMap documents correspond to Viewfiles in MARIS. They contain information about a map, which may contain a number of layers, and their settings for display. The ArcMap files have a “.mxd” extension and have been stored in C:\MARIS\_project\ArcMap files. These files can be exported to JPEGs as well and these are stored in the folder C:\MARIS\_Project\JPEGs.

<b>ArcMap File Name</b>	<b>ArcMap File Description</b>
cruiseRoutesIncidents	A map of cruise routes and cruise incidents.
merchRoutesSisar	A map of merchant shipping tracks and all incidents.
merchTracksMerchSisar	Merchant tracks and merchant incidents.
merchPassengersMerchSupertanker	Point intersect of merchPassengers and merchSupertanker.
merchLess100cruiseLess100	Point intersect of merchIDLess100 and cruiseLess100.
merchPassengersMerchCrudeTank	Point intersection of merchPassengers and merchCrudeTank.
merchIDLess100Routes	Merchant tracks with ID less than 100, displaying different entire ship routes in different colors.

### **ArcGIS Layers**

Layer files contain features, and are stored in C:\MARIS\_project\Layers. They have a “.lyr” extension, and can be loaded into ArcMap. The following describes the stored layer files.

<b>Layer File Name</b>	<b>Layer File Description</b>
cruiseTracksThruHighInc	Cruise tracks passing through high incident grid cells.
merchTracksIncsIntersect	Merchant tracks that intersect an incident.

### **MS Access Queries**

MS Access can be used to select fields in 1 or more tables, and find records with matching values in these fields. This is useful, for example, in trying to match incidents with particular ships’ tracks. Relationships are defined between the 2 tables, and queries are then performed and exported. Other types of queries can be performed as well. Queries are stored as Excel files in C:\MARIS\_Project\Queries-Access and are described in the following table. There is a limit of 65 536 records in each table.

Query Name	Query Description	Number of Records
merchSisarTracksGrossTonn	Merchant incidents and corresponding merchant tracks where tonnage fields match.	4 220
merchSisarTracksAgeTonn	Merchant incidents and corresponding merchant tracks where gross tonnage and age fields match.	381
merchSisarTracksNTGTAge	Merchant incidents and corresponding merchant tracks where net tonnage, gross tonnage and age match.	359
merchSisarTracksAgeNTGTFOC	Merchant incidents and merchant tracks where net tonnage, gross tonnage, age and FOC match.	278
merchSisarTracksGTAgeFOC	Merchant incidents and merchant tracks where gross tonnage, age and FOC match.	290
merchSisarTracksGTNTAgeFOCYOB	Merchant incidents and merchant tracks where Gross Tonnage, Net Tonnage, age, FOC and YOB match.	277
fishingSisarTracksLength	Fishing incidents and fishing tracks where length matches.	65 536
fishingSisarTracksTonn	Fishing incidents and fishing tracks where tonnage matches.	65 536
fishingSisarTracksTonnLen	Fishing incidents and fishing tracks where tonnage and length match.	952
sisarCruiseTracksPOB	All incidents and cruise tracks where POB matches.	1 935
sisarCruiseTracksTonn	All incidents and cruise tracks where tonnage matches.	3 345
sisarCruiseTracksPOBTonn	All incidents and cruise tracks where POB and tonnage match.	0
sisarFerryTracksTonn	All incidents and ferry tracks where tonnage matches.	65 536
sisarFerryTracksPOB	All incidents and ferry tracks where POB matches.	65 536
sisarFerryTracksTonnPOB	All incidents and ferry tracks where tonnage and POB match.	0

**Note:** Unless otherwise specified, these contain only the records that have a corresponding record that matches it.

### **Intersects**

Intersects are performed in ArcGIS. They take 2 layers as input and create a new layer showing where features in the input layers intersect (for example where ship tracks cross each other), either in the form of points or lines. These are stored in C:\MARIS\_Project\Intersects.

Name	Description
merchLess100cruiseLess100	Point intersection of merchIDLess100 and cruiseIDLess100.
merchPassengersMerchSupertanker	Point intersection of merchPassengers and merchSupertanker tracks.
merchPassengersMerchCrudeTank	Point intersection of merchPassengers and merchCrudeTanker.

### **Near**

The near function in ArcGIS takes in a layer of point data and a layer of point or line data. It then finds, for each point in the first layer, its nearest point or line in the second layer. As output it appends 2 columns to the original attribute table of the first input layer. These columns contain the ID of the nearest feature from the second input layer, as well as the distance to it.

This has been done for each of the MARIS incident queries (except the SAR and NAFO spatial queries) in order to compute the nearest SAR resource according to the data in the folder MARIS\System\Data\Primary\_SAR\_Stations. It has also been done to the original Sisar file in the System folder (the file containing all the incidents). Each of these files now has a column containing the nearest SAR resource for each incident, and the distance to that resource for each.

### **Routes**

Attempting to identify individual ships and their routes (made up of adjacent tracks) could perhaps be done by looking for matching values in various fields, as well as the source and destination ports. With the merchant shipping tracks, for example, it is possible to look at the fields for vessel age, gross tonnage, net tonnage and maximum draft. If these match they could possibly represent the same ship. If the destination for one track is also the source for the next, it could be assumed that the 2 tracks form a route for that particular ship.

This has been done for each of the following files: cruiseAll (all cruiseship routes), merchCrude, merchSupertanker, merchRegMiddleEast, merchCrudeTank and merchLiqGasTank. For each, a column called routeNum has been added to their table, containing a number corresponding to the possible route. This was done manually so is subject to human error. As well, the accuracy of this method is not known. It is an attempt to construct routes from

adjacent tracks, but depends for example on the tracks being in order based on their feature ID.

Once this column is added, these files can be loaded into either ArcMap or MARIS and rendered to show each route in a different color, displaying each different ship with its route. This can work for small numbers of routes, however with larger files may not be as illustrative due to the large number of different colors needed to display the larger number of different routes.

### **Other Data – Miscellaneous**

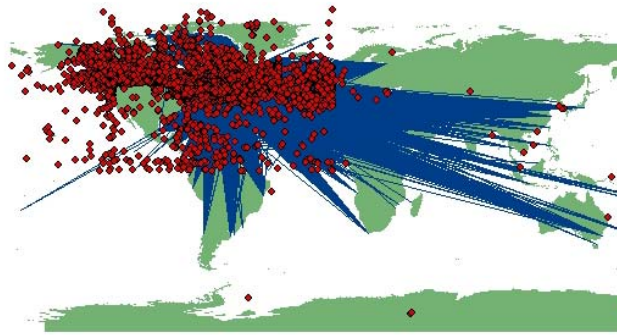
These papers, among others related to the project, are stored in the folder Papers under C:\MARIS\_Project. A description of each is included here.

<b>Name</b>	<b>Description</b>
NormalAbnormal	An overview of various methods of outlier and abnormal behavior detection.
Routes	An overview of the representation and analysis of routes data.
MARIS data	A summary of the data included with MARIS, as described in the metadata.
MARIS_Report	An overview of the capabilities of the MARIS software, as well as some possible applications for risk and security analysis.
MARIS Metadata 2005-03-05	Descriptions of the data included with the MARIS software.

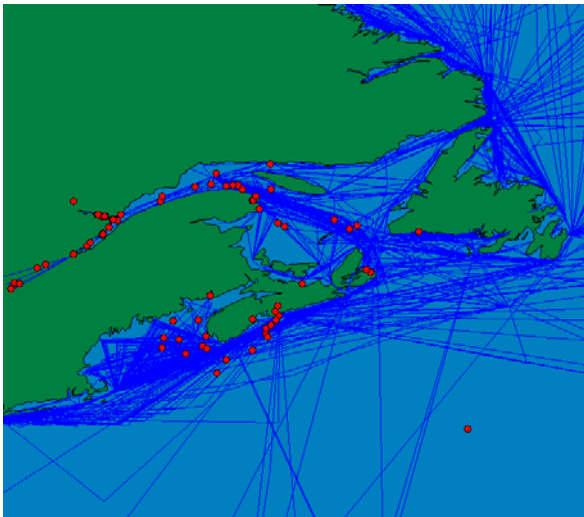
### **Notes**

1. Excel files are limited to 65536 records so exports may not contain all tracks. To avoid this, in MARIS it is possible to export to a text file. In ArcGIS it is possible to right click on a layer in ArcMap and view its attribute table, which will contain all records.
2. MARIS has a limit of 65000 records that can be exported to an Excel file. If a layer exceeds this, it can be exported instead to a text file, which does not have this limit.
3. ArcGIS and MARIS both make use of shapefiles so the files are interchangeable between these 2 programs. Shapefiles can be used to display data as maps in either MARIS or ArcMap.
4. Since the original tracks files are very large, some operations, such as intersect, will take a very long time.

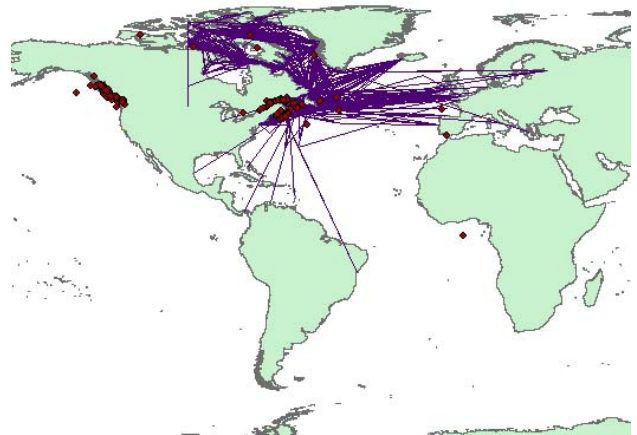
## Figures



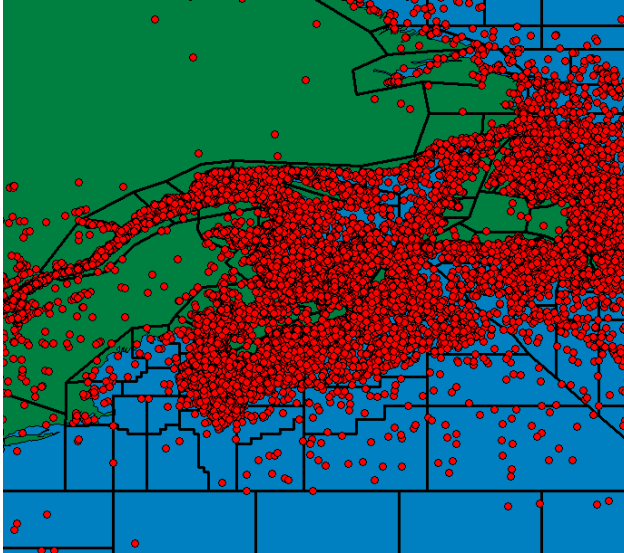
**Figure 1:** Merchant shipping tracks and incidents in ArcMap.



**Figure 2:** Cruiseship tracks and incidents in MARIS, zoomed.

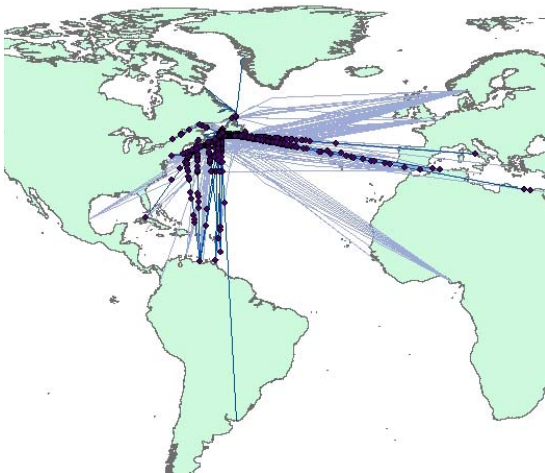


**Figure 3:** Cruiseship tracks and incidents in ArcMap.

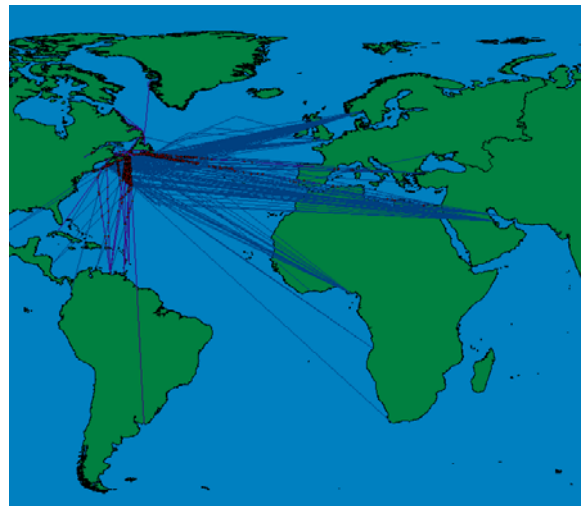


**Figure 5:** Incidents involving suspicious or illegal activity, MARIS.

**Figure 4:** Incidents and NAFO borders, in MARIS.



**Figure 6:** Point intersection of merchant crude tanker tracks (light blue) and merchant passenger vessel tracks (dark blue), in ArcMap.



**Figure 7:** Point intersection of merchant crude tanker tracks (light blue) and merchant passenger vessel tracks (dark blue) in MARIS.

