



Fisheries and Oceans  
Canada

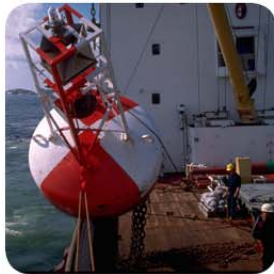
Pêches et Océans  
Canada

Canadian  
Coast Guard

Garde côtière  
canadienne



Safety First, Service Always



# Results of the AIS AtoN International Survey Conducted by the Canadian Coast Guard November 2016

Canada 

# Canadian Context



## CCG AIS Stations

113 shore based stations  
including 2 sites in the Arctic.



Data: Canadian Coast Guard, 2015.





# Canadian Context

- **Canada is among the largest countries in the world with an extensive coastline bordering 3 different oceans.**
- **Transit distance to reach an AtoN for repair or maintenance is often costly.**
- **Over 17,000 AtoNs are in service. Monitoring is a challenge due to the vast communication links required.**
- **Seasonal climatic conditions are extremely variable: ice, harsh Arctic conditions, storms, low temperature, etc.**



# Objectives of the Questionnaire

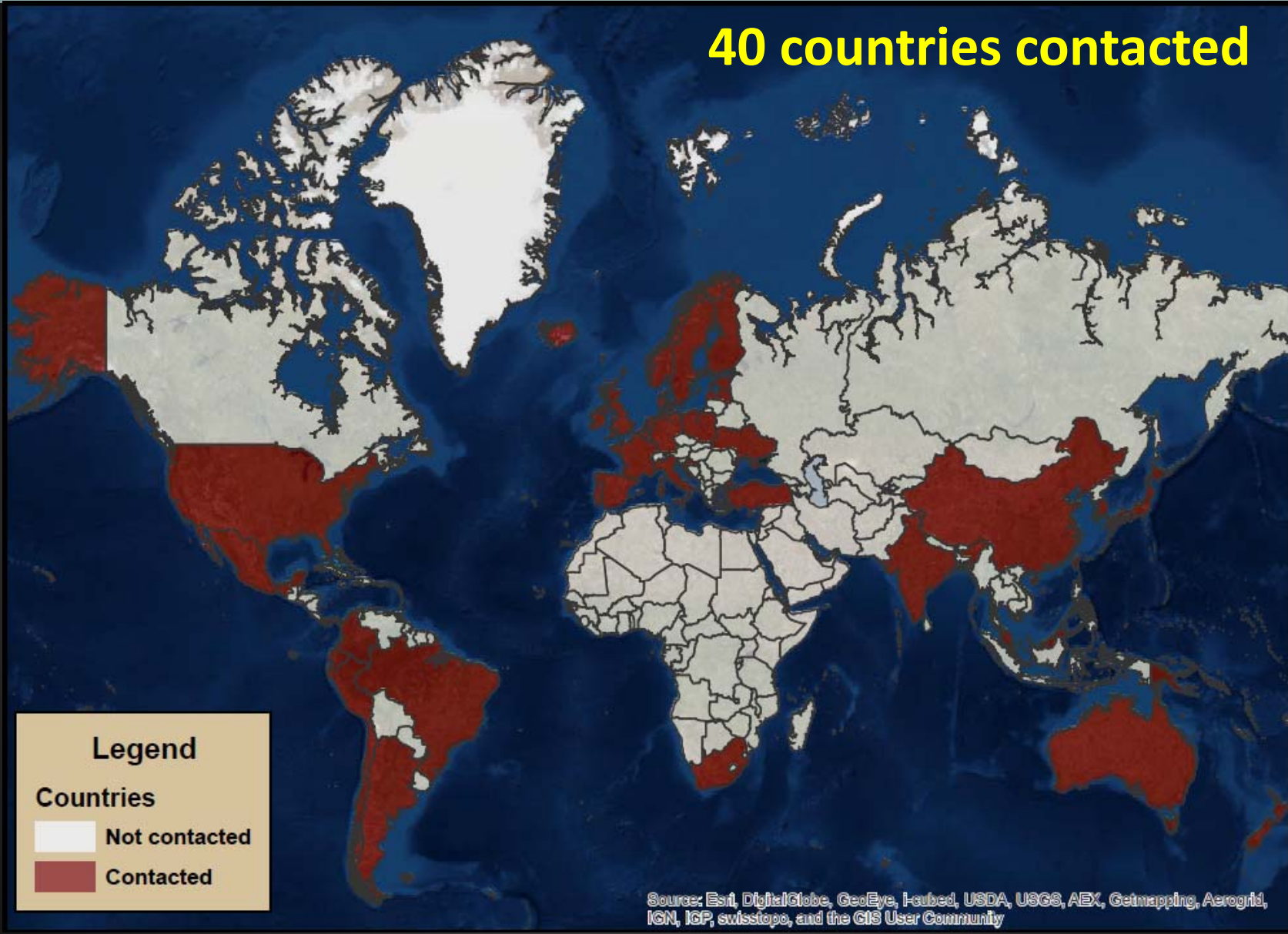


- **Evaluate the international trend with regard to AIS AtoN.**
- **Identify situations where each type of AIS AtoN is used.**
- **Analyze feedback/comments received from users.**
- **Benefit from other countries' experience to develop a consistent national approach.**

# National Authorities Contacted



40 countries contacted

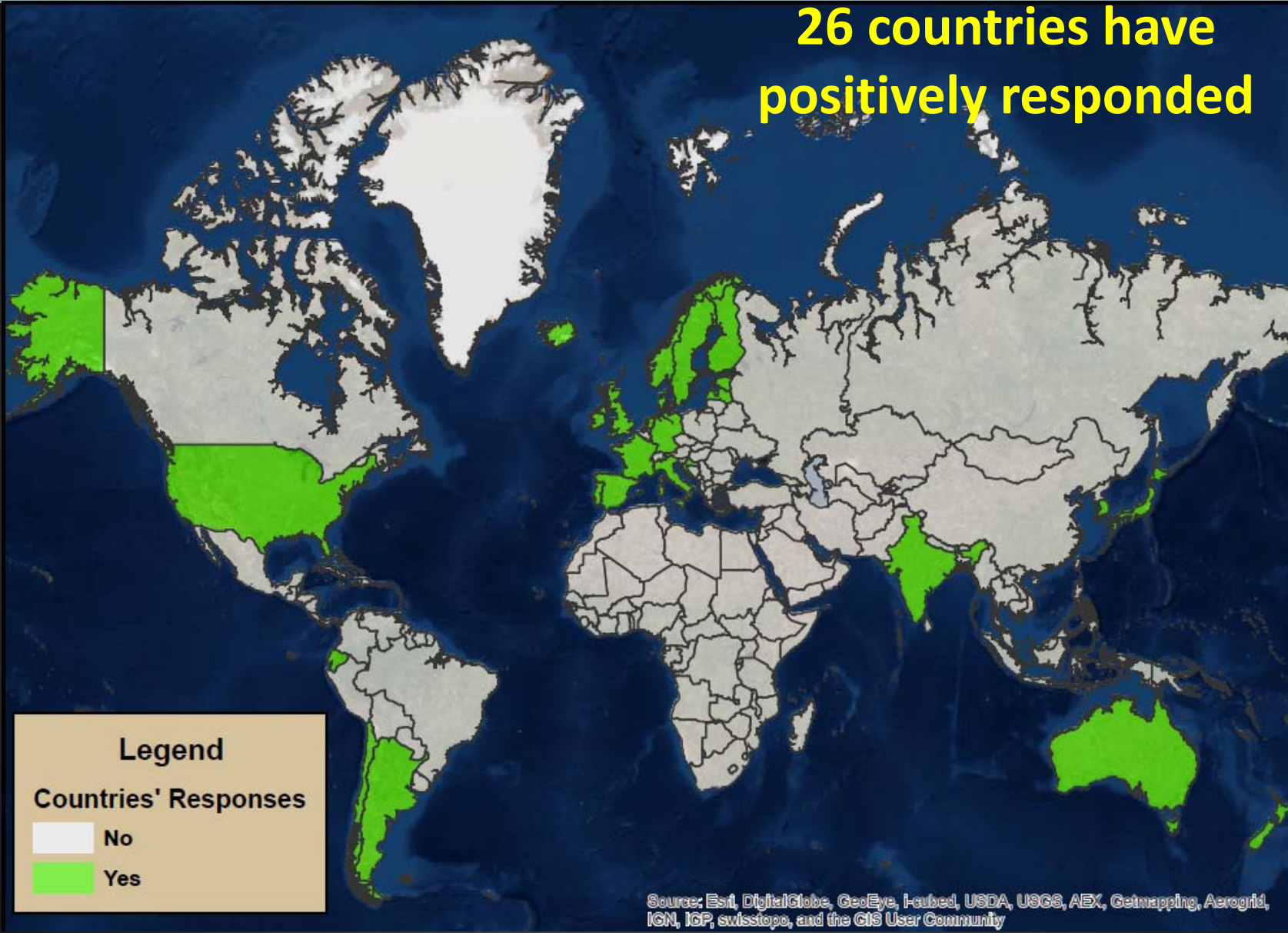




# Respondents



26 countries have positively responded

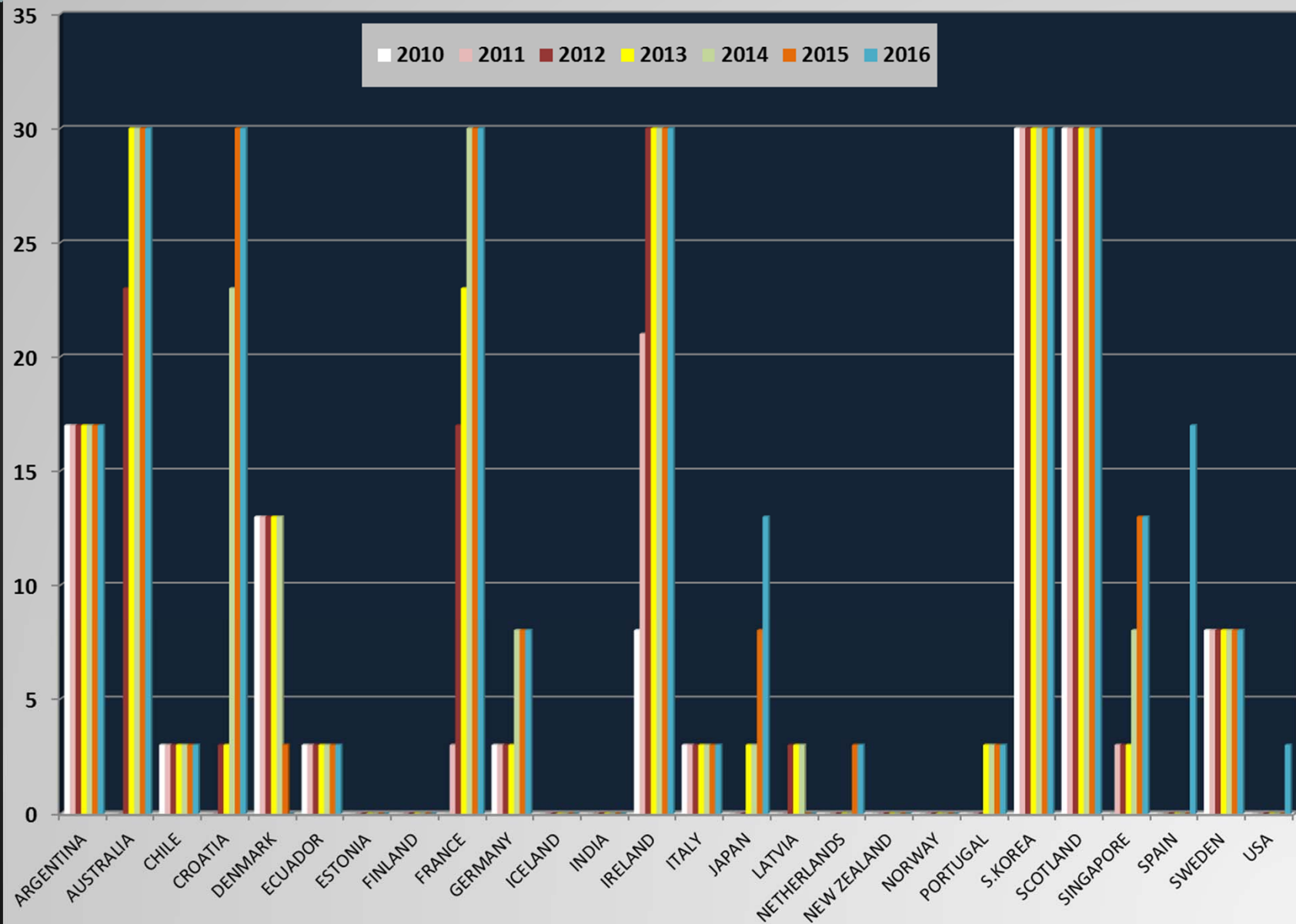


# Methodology



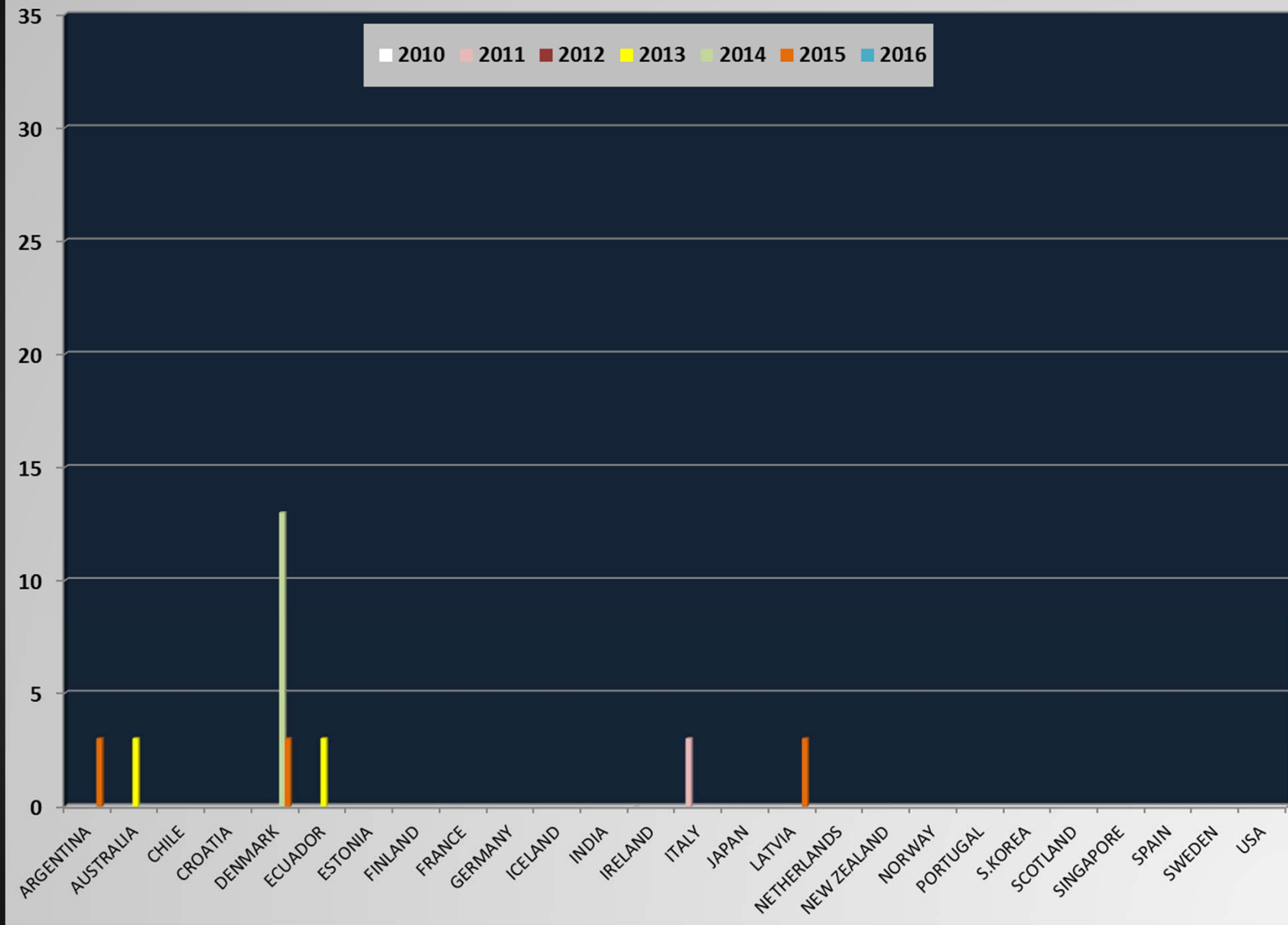
- **Information sought was mainly on permanent/semi-permanent utilization, excluding time-critical situations.**
- **AIS Applications Specific Messages, such as Met/Hydro, were not considered.**
- **National Authorities were the target audience but third parties have been occasionally included.**
- **In the questionnaire, number of AIS Atons deployed annually were reported by ranges (0-5; 6-10; etc.; and > 25). In the following graphics, the median value of each range was used.**
- **For countries reporting quantity over 25, number on the graphics was rounded up to 30.**
- **Misinterpretation of Synthetic Monitored vs Predicted 7 may have happened in some cases.**

# Real AIS AtoN Deployed





# Real AIS AtoN Removed



# Real AIS AtoN Findings



		# of Responses
<u>Reason for not using</u>	Worry about power management for floating AtoN&remote site	3
	Not convinced of added-value over actual visual/radar AtoN	1
	Costly	1
	Low range	1
	Weak monitoring & control capabilities	1
	Failed at lower temperature	1
<u>Feature monitored</u>	Dynamic position	<b>16</b>
	Lantern operation	7
	Power system	7
	Racon	2
	MetHydro	2
<u>Feature broadcasted</u>	Dynamic position	<b>15</b>
	Lantern operation	3
	Power system	1
	Racon	1
	MetHydro	3
	Static position	1
	Info about fixed mark (name, posn)	3
<u>Situations/conditions for using it</u>	Mark hazard near route	<b>9</b>
	Isolated danger	<b>10</b>
	Delineate tracks	<b>10</b>
	Leading mark	<b>7</b>
	Anchorage area	4
	Mark shoal inside channel	3
	Mark overhead clearance	1
	Mark underwater assets	1
	Mark obstacles	1
	Mark offshore structure	7
	TSS	6
	Landfall	<b>12</b>
	Wreck	1
	Buoy with inconsistant radar detection	2
	Assess drift	1

# Real AIS AtoN Findings



<u>Reason for removal</u>	Power consumption	0
	Faulty device	<b><u>3</u></b>
	Interference	2
	Water ingress	0
	Underused by the client	1
	Not linked to a network	1
	Hit by vessel	1
<u>SOLAS users satisfied feedback</u>	Provide dynamic posn critical floating	<b><u>6</u></b>
	Provide status critical floating	<b><u>5</u></b>
	Provide status critical fixed	3
	Provide status electronic aid	1
<u>SOLAS users Not satisfied feedback</u>	Intermittent operation	0
	Add cluttering in ECDIS/ECS/Radar	<b><u>3</u></b>
	Dependency radionav system	0
	Lack security signal protection	0
	Overload VHF data link	1
	Not detectable on some ships	1



# Real AIS AtoN – Other Benefits and Limitations



## Benefits:

- ✓ Enhances situational awareness in conditions of low visibility/radar detection.
- ✓ Assists in safe navigation in heavy traffic areas.
- ✓ Complements marking in sensitive areas.
- ✓ Allows provision of service outside an AIS base network.
- ✓ Allows cross-checking different sources of information (visual, radar and dynamic AIS).

# Real AIS AtoN – Other Benefits and Limitations



## Limitations:

- ✓ Increases reliability issues (power consumption, equipment failure, interference).
- ✓ Increases costs of maintenance by adding an asset on an existing one.
- ✓ Cannot be used now as a Racon replacement as AIS input on radar is not yet mandatory.

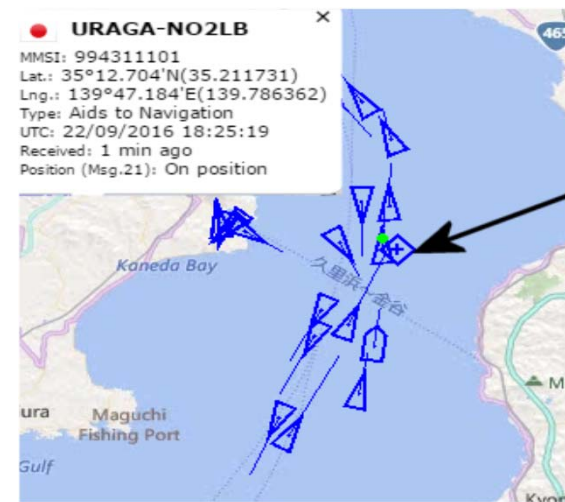


# Real AIS AtoN – Examples

## Pohang – South Korea



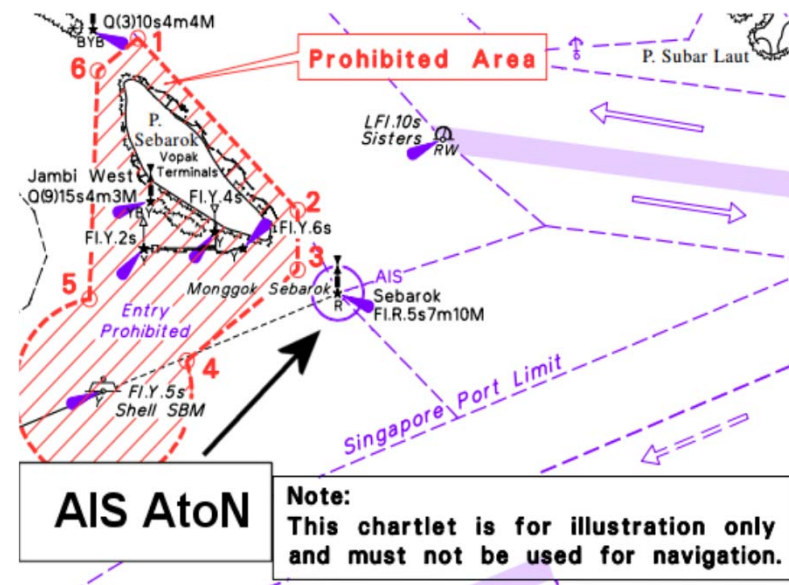
## Tokyo Bay - Japan



## Antarctica base - Argentina

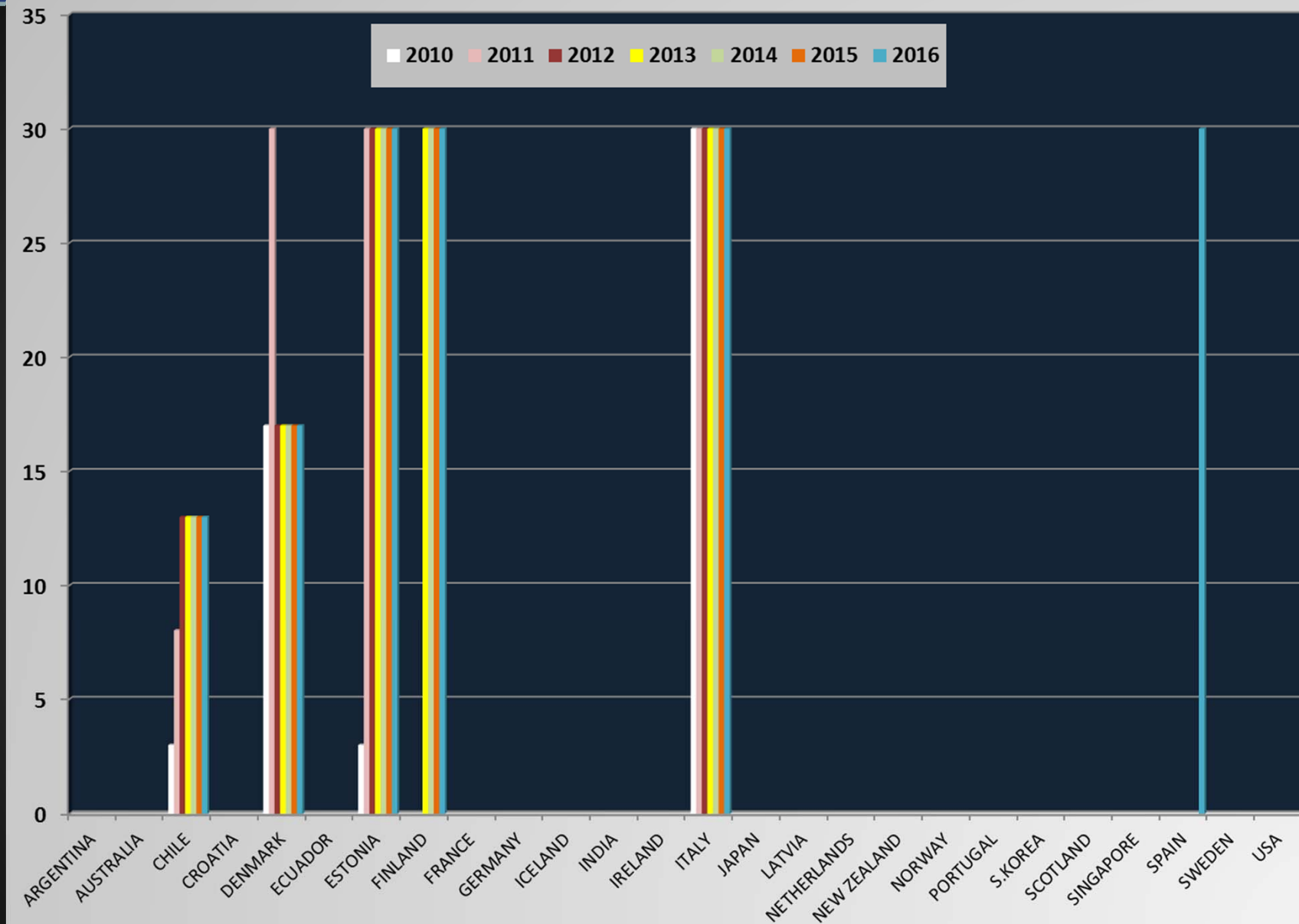


## Singapore Port

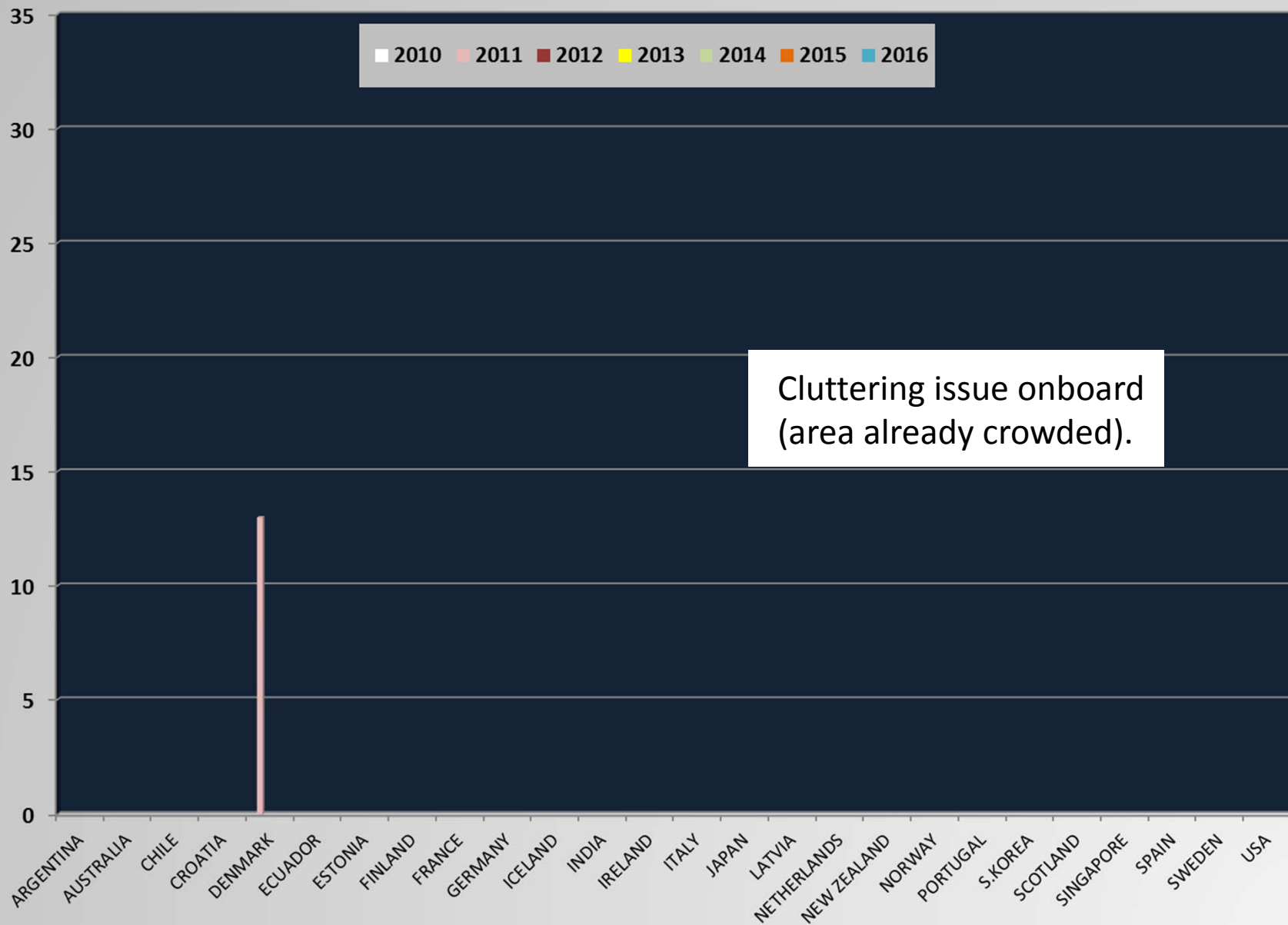




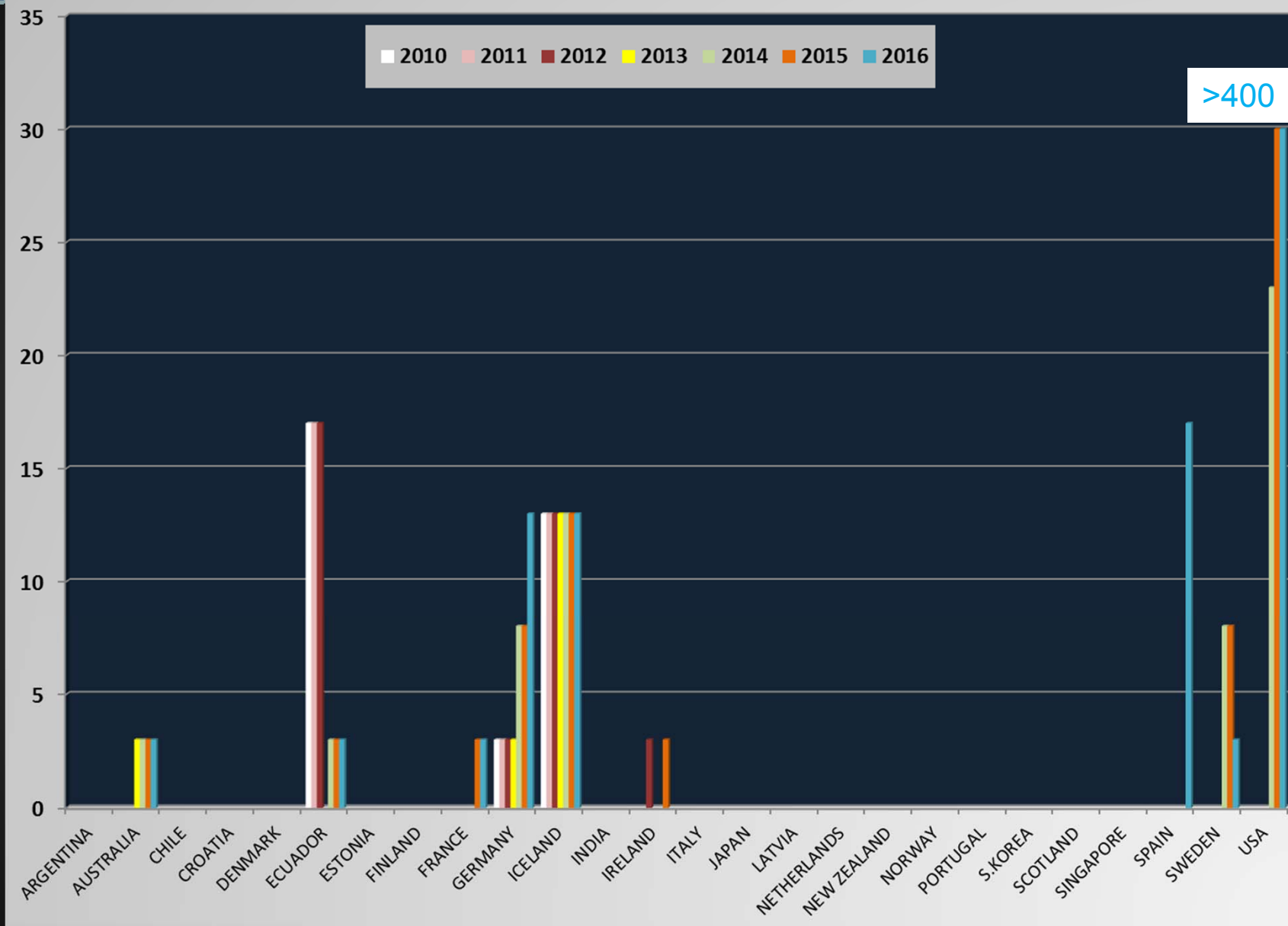
# Synthetic AIS AtoN Deployed - Monitored



# Synthetic AIS AtoN - Monitored Removed



# Synthetic AIS AtoN Deployed - Predicted





# Synthetic AIS AtoN – Predicted Removed



# Synthetic AtoN Findings



		# of Responses
<b>Reason for not using Synthetic</b>	Availability&efficiency of other AtoNs	1
	Too many AtoN in our country	1
	Not convinced of added-value over actual visual/radar AtoN	1
	Deployment policy to be developed	1
	No VDL data slots reserved for that	1
<b>Feature monitored</b>	Dynamic position	2
	Lantern operation	<b>5</b>
	Power system	<b>3</b>
	Racon	1
	MetHydro	1
<b>Feature broadcasted</b>	Dynamic position	1
	Lantern operation	2
	Power system	0
	Racon	1
	MetHydro	1
	Static position	<b>7</b>
	Off position alarm only	1

# Synthetic AtoN Findings



<b>Situations/conditions for using it (Monitored)</b>	Mark hazard near route	1
	Isolated danger	1
	Delineate tracks	1
	Leading mark	0
	Anchorage area	0
	Mark shoal inside channel	1
	Mark overhead clearance	0
	Mark underwater assets	0
	Mark obstacles	2
	Mark offshore structure	1
	TSS	1
	Landfall	2
	Wreck	0
	<b>Situations/conditions for using it (Predicted)</b>	Mark hazard near route
Isolated danger		2
Delineate tracks		2
Leading mark		3
Anchorage area		1
Mark shoal inside channel		1
Mark overhead clearance		0
Mark underwater assets		0
Mark obstacles		0
Mark offshore structure		1
TSS		0
Landfall		3
Wreck		0
Fixed aid unable to retain AtoN device		1

# Synthetic Monitored – Other Benefits and Limitations



## Benefits (monitored):

- ✓ Complements Notice To Mariners broadcast in targeted area.
- ✓ Used to monitor/broadcast selective features (status of position, light, racon, extended usage, etc.).
- ✓ Unlike real AIS AtoN, consumes less power, allows better range, easier to control, and less expensive.

## Limitations:

- ✓ Requires a second asset on an existing one (e.g. a position fixing device + communication device).



# Synthetic Predicted – Other Benefits and Limitations



## Benefits (monitored):

- ✓ Physical AtoN visual/radar detection is impaired by ice and an AIS AtoN displayed on the radar would indicate the right spot to look for echo.
- ✓ Area with limited capacity to deploy (real) or monitor.
- ✓ Enhances situational awareness and may help prevent collisions with buoys.
- ✓ Allows for easy and early identification of AtoN.

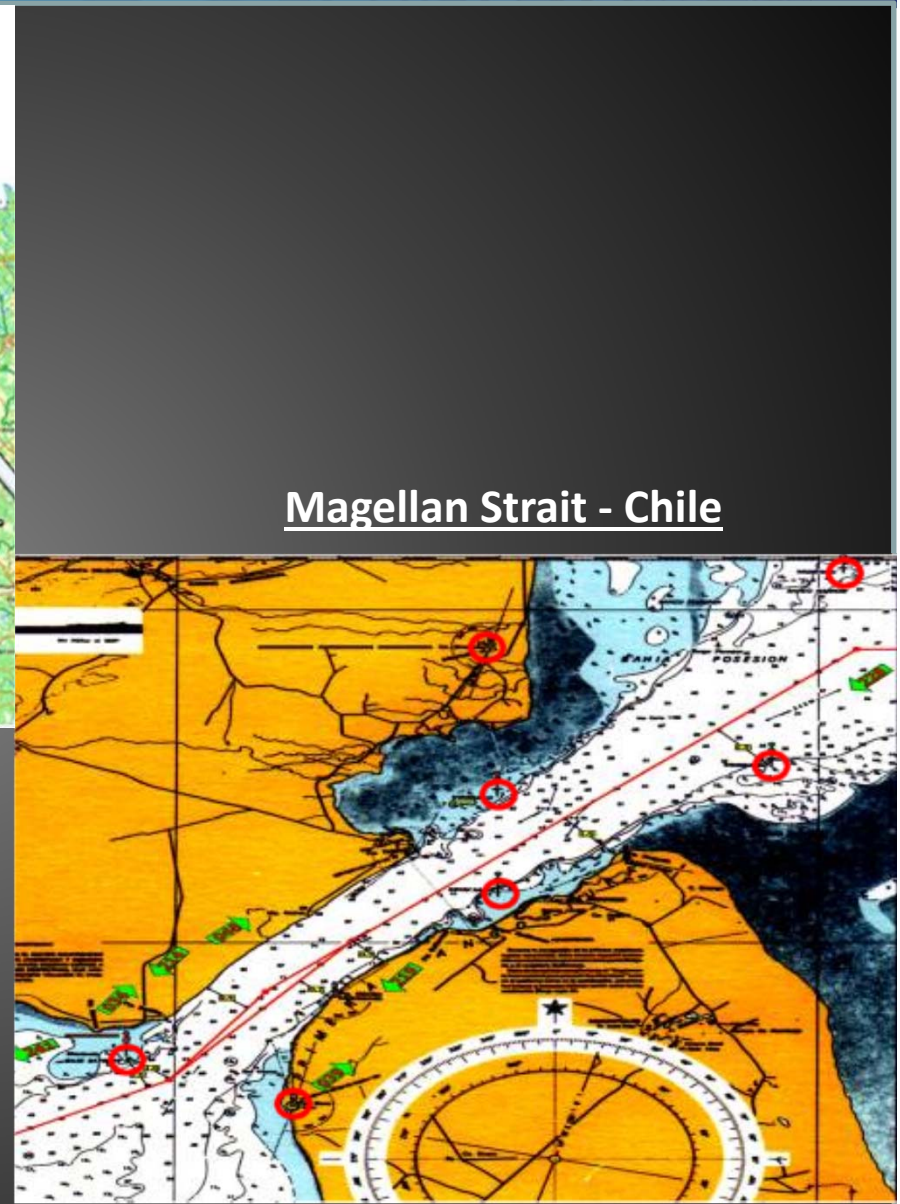
## Limitations:

- ✓ Overlaying Virtual AtoN symbol on existing ENC symbols was not perceived as an added value by some mariners .
- ✓ Portrayal may confuse mariners:
  - Real AIS AtoN symbol used but static position & no status broadcast.
  - In Msg 21, virtual flag 0 (real) or 1 (virtual) are incorrectly used.
  - Symbol (type code) is changed according to the season (R → V → R).

# Synthetic Monitored – Examples



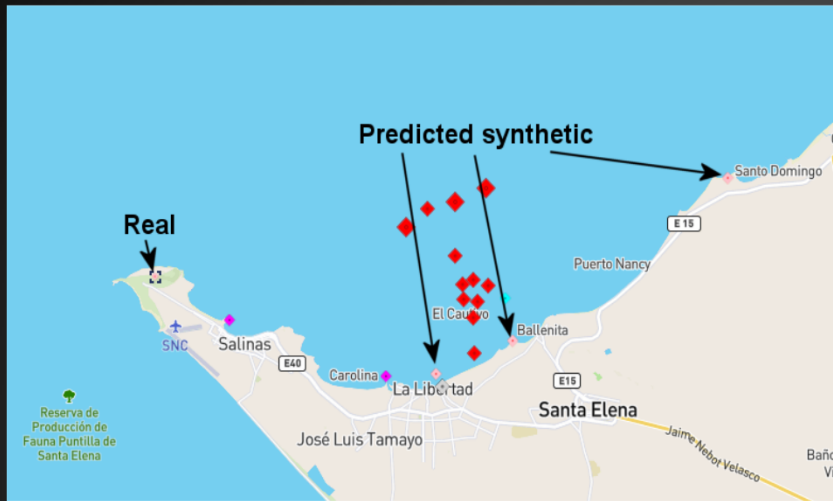
Estonia



# Synthetic Predicted – Examples



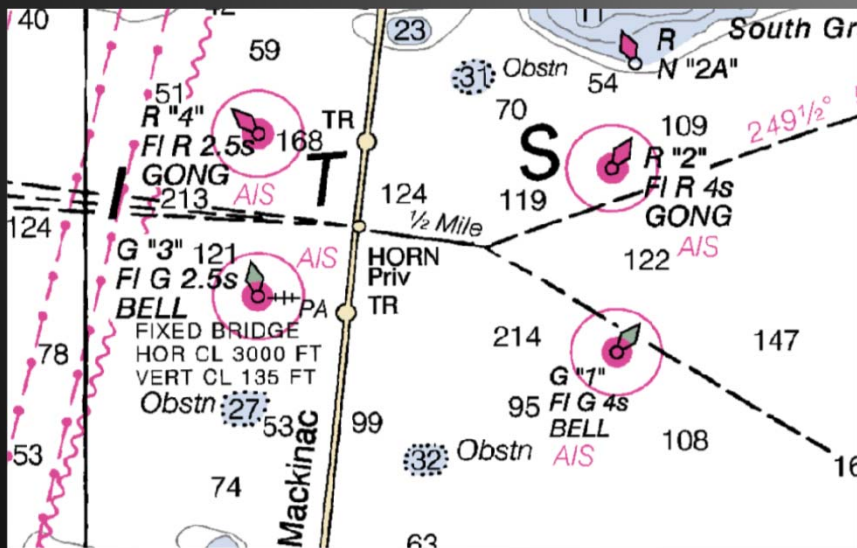
## Ecuador



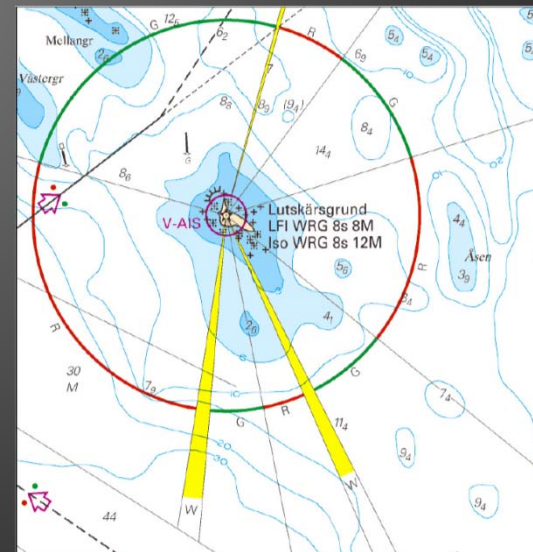
## Quiberon - France



## Great Lakes - USA

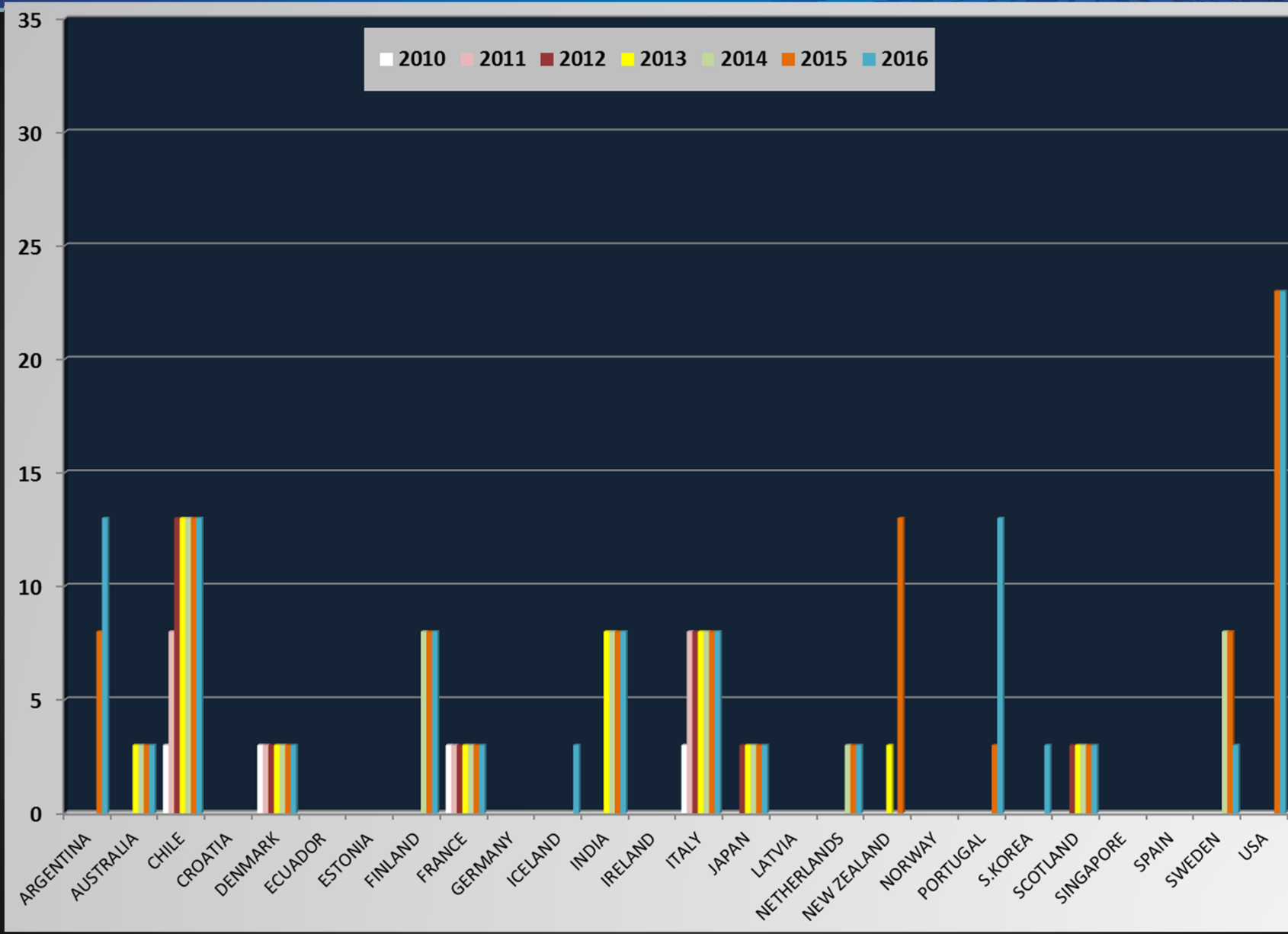


## Kalix - Sweden



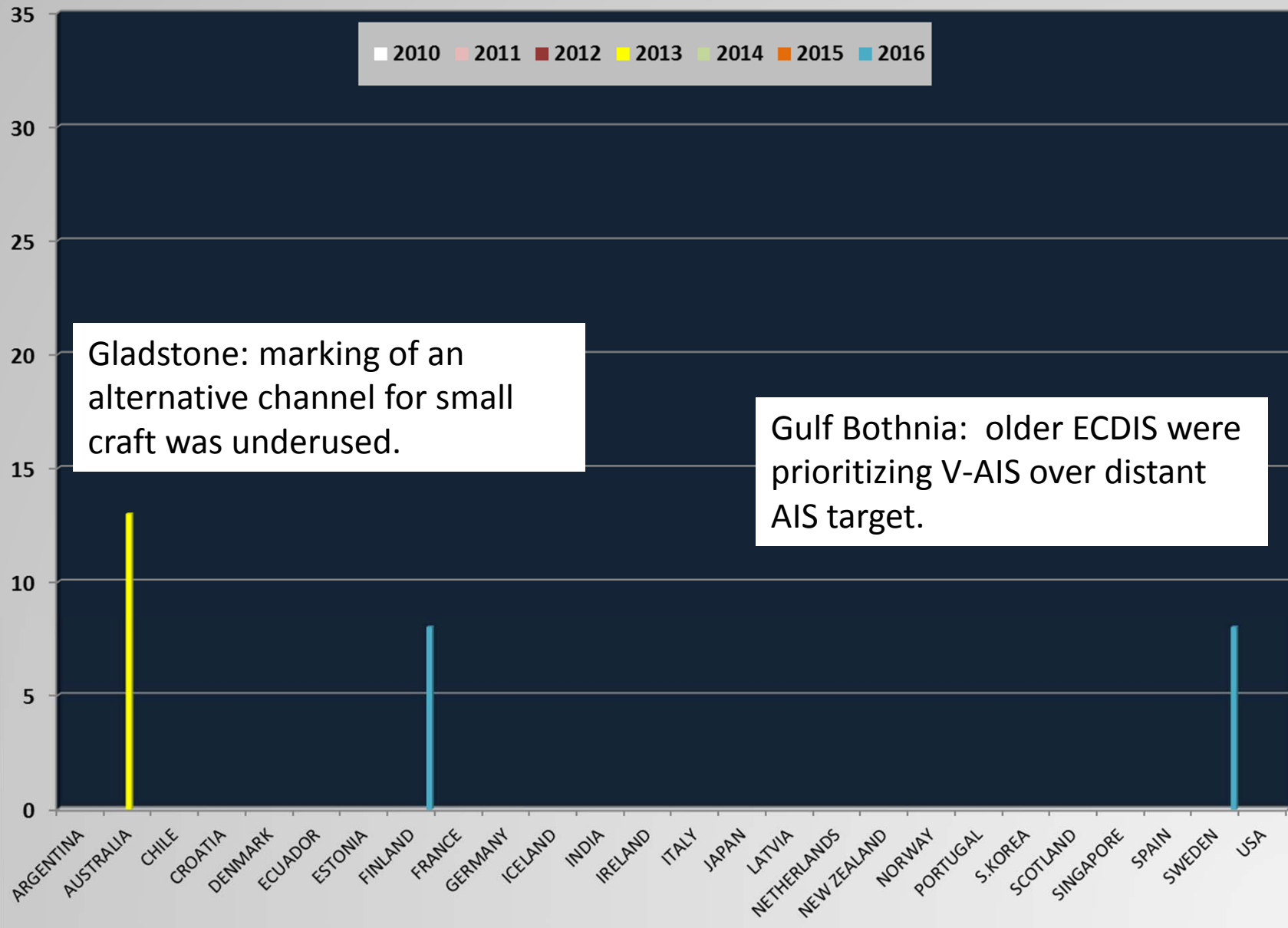


# Virtual AIS AtoN - Deployed





# Virtual AIS AtoN - Removed



# Virtual AIS AtoN - Findings



		# of Responses
<b>Situations/conditions for using it</b>	Mark hazard near route	<u>7</u>
	Isolated danger	<u>6</u>
	Delineate tracks	<u>4</u>
	Leading mark	1
	Anchorage area	1
	Mark shoal inside channel	1
	Mark overhead clearance	1
	Mark underwater assets	1
	Mark obstacles	2
	Mark offshore structure	2
	TSS	<u>5</u>
	Landfall	2
	Wreck	2
	Delineate area	1
	Replace removed seasonal buoy	1
<b>SOLAS users satisfied feedback</b>	Marking/delineating dynamic areas	<u>4</u>
	Allow marking in tight areas thus preventing hitting AtoNs	<u>3</u>
	Complement system where physical AtoN can't be justified	<u>3</u>
	No notable changes in the followed routes	1
	Effective way to indicate shipping lane	1
<b>SOLAS users Not satisfied feedback</b>	Proper voyage planning makes virtual AtoN unnecessary	1
	Lack consistency in ship ECDIS/ECS/Radar display	0
	Dependency radionav system	0
	Lack security signal protection	0
	Overload VHF data link	1
AIS target overload in ECDIS/Radar	<u>2</u>	
<b>Justification for using virtual as the only solution</b>	Deep water	<u>7</u>
	Sea state	<u>6</u>
	Sensitive area	<u>5</u>
	Physical AtoN not economically viable	<u>9</u>
	Physical AtoN not meeting reliability target	<u>5</u>
	Physical AtoN regularly displaced by ice	<u>4</u>
	Shoal applicable only to SOLAS deep draft vessel	1
	Physical AtoN not considered essential	1

# Virtual AIS AtoN – Other Benefits and Limitations



## Benefits:

- ✓ Provide AtoN in areas not previously feasible.
- ✓ Allows quick marking of sudden hazards.
- ✓ Reinforces navigation in proper channels/entry in TSS zones.

## Limitations:

- ✓ Marking of a secondary channel was removed after a two year trial as it was duplicating a path adjacent to the main channel.
- ✓ In one case, it cluttered older ECDIS/ARPA and prioritized V-AIS over distant AIS vessel targets.

# Virtual AIS AtoN – TSS Application



## Portugal

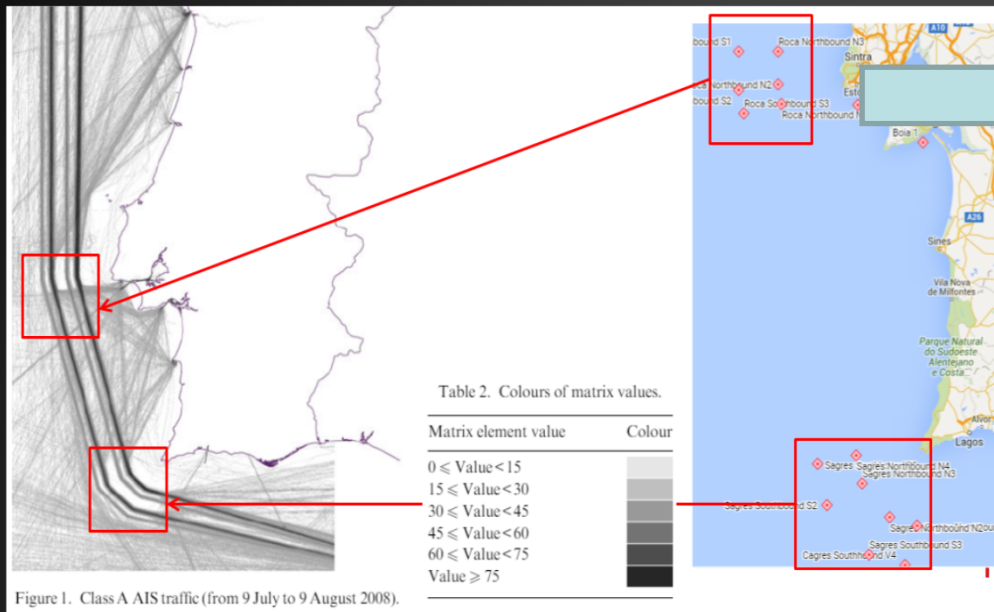
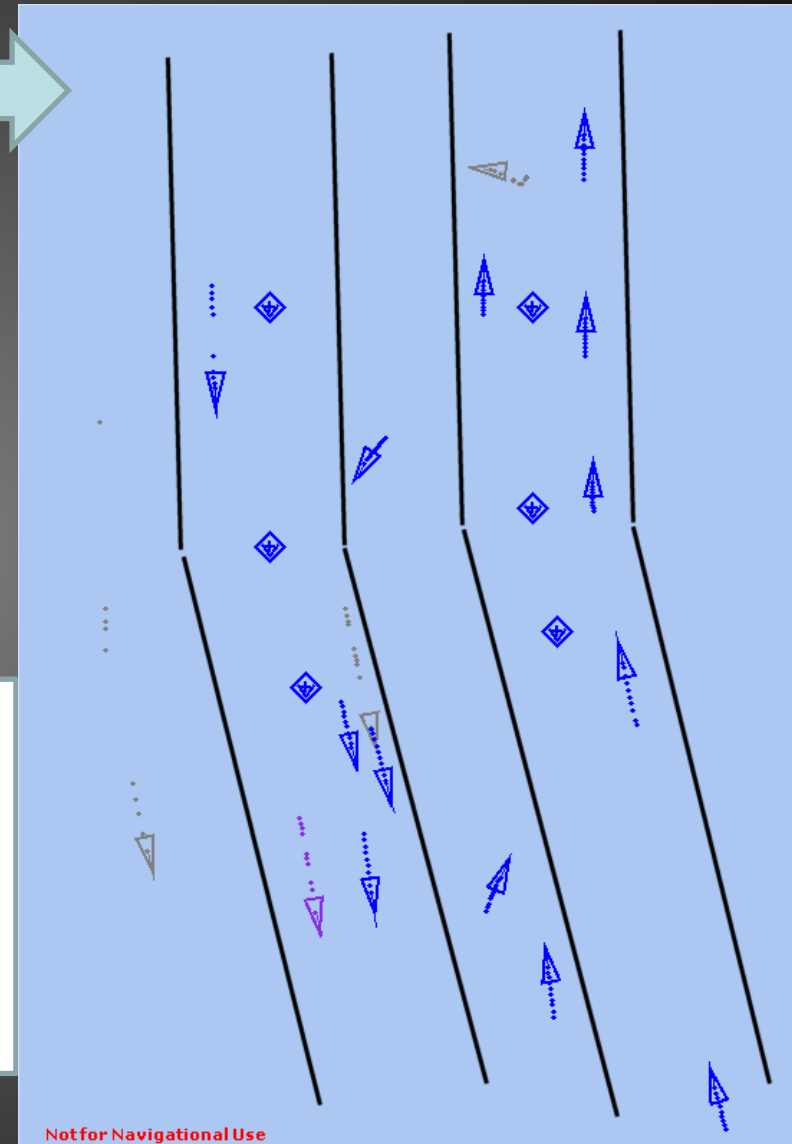


Figure 1. Class A AIS traffic (from 9 July to 9 August 2008).



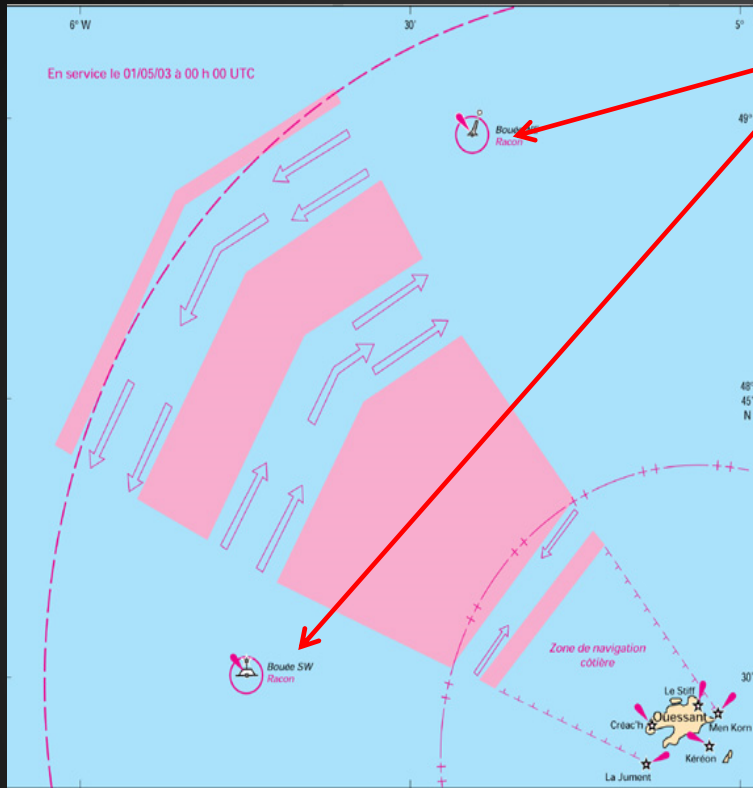
View of the upper section of the TSS where traffic (ship icons) appears to follow the northbound and southbound lanes marked by the 6 Virtual AtoNs. (The black lines were inserted to highlight the respective lanes).



# Virtual AIS AtoN – TSS Application

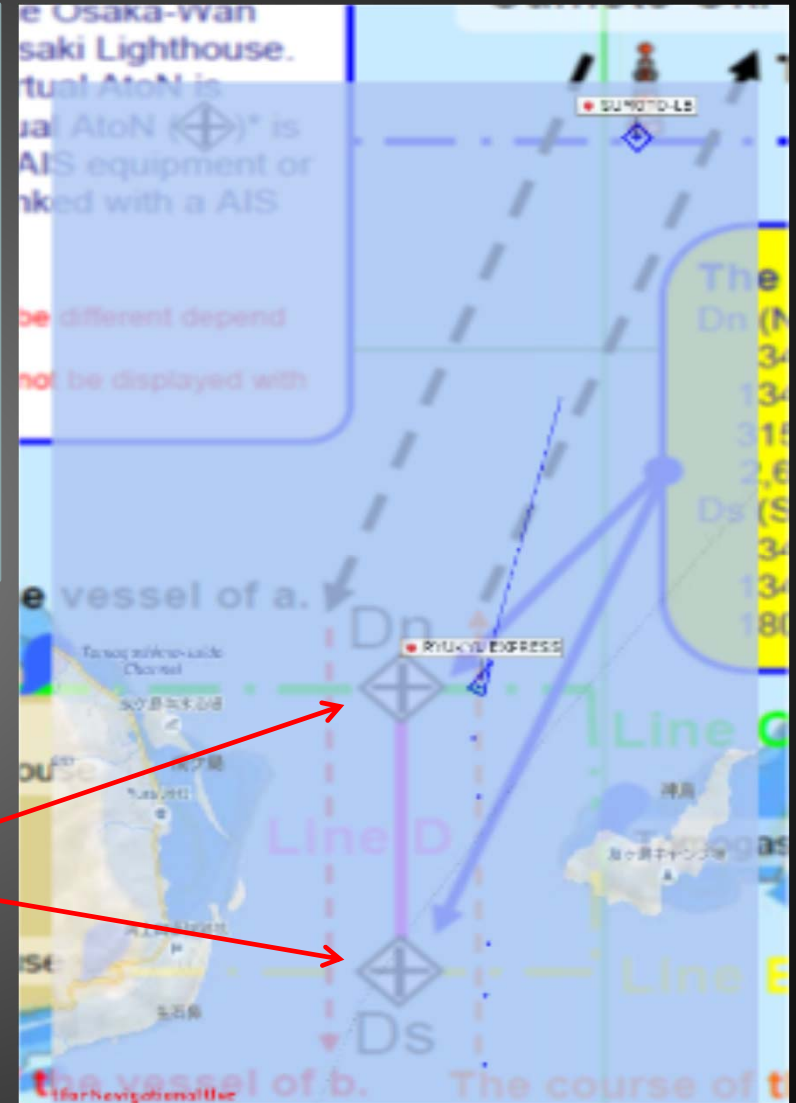


## Ouessant - France



Ouessant:  
Two large buoys were difficult to maintain in high seas and were replaced by V-AIS.

## Akashi Strait - Japan



Akashi: Two Virtual AtoNs shown as Dn and Ds mark the end of an imaginary line separating traffic flow. Actual traffic is displayed over the background image. The Real AIS AtoN buoy Sumoto can be seen on top.

# Virtual AIS AtoN – Other Examples

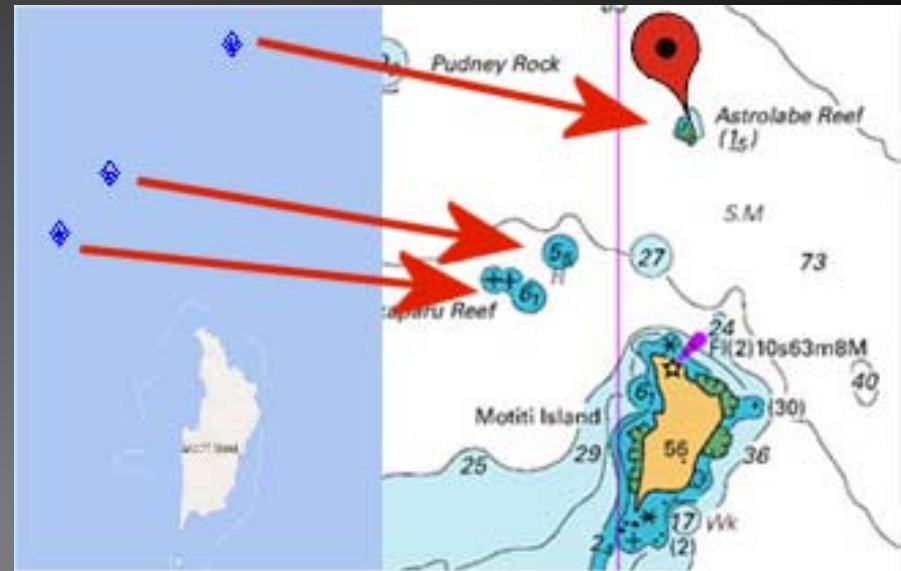
## Reefs; Non-Navigable areas; Sensitive zones



Iceland



New Zealand – Bay of Plenty



New Zealand – Fiordland Park



Italy – Cinq Terre

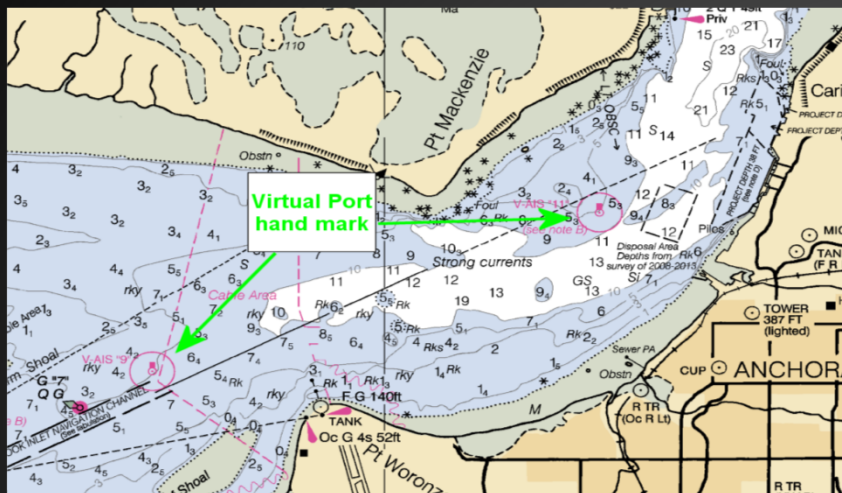




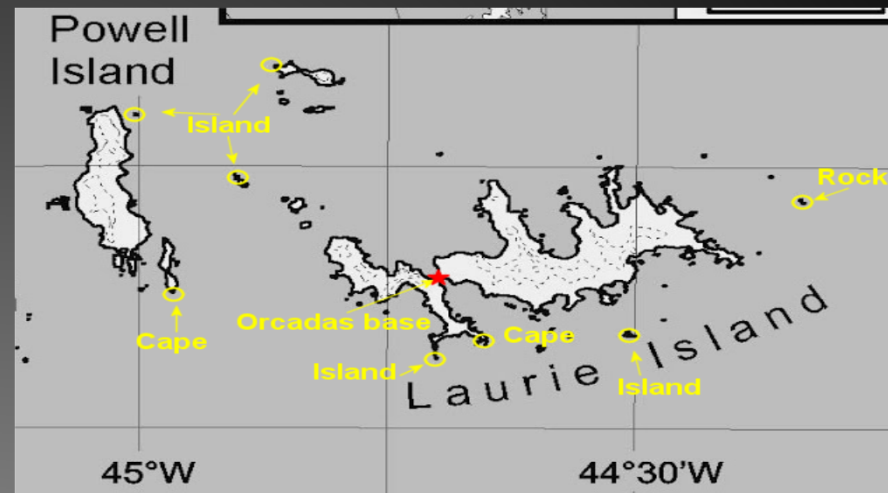
# Virtual AIS AtoN – Other Examples



Alaska - USA



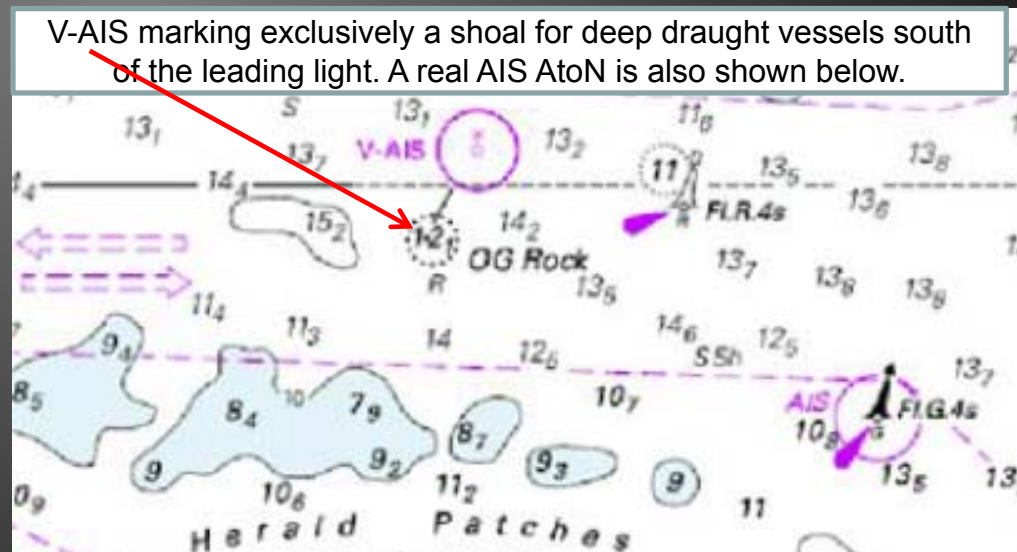
Antarctica - Argentina



Malmö - Sweden



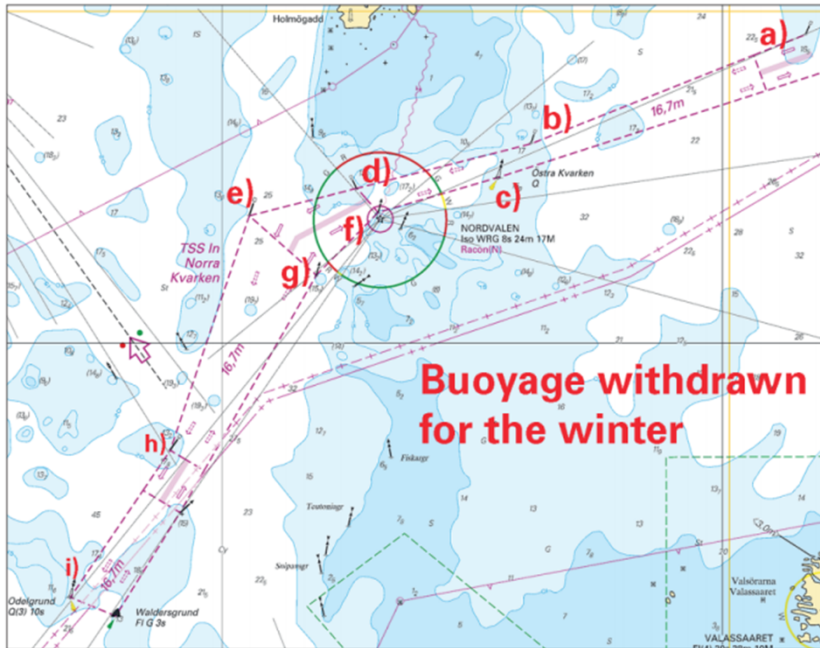
Australia



# Virtual AIS AtoN – Removal

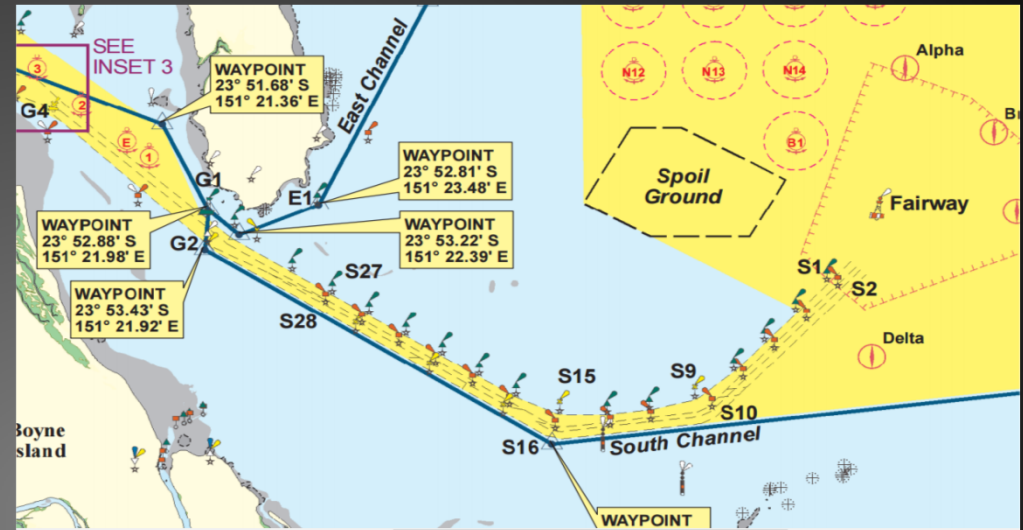


## Gulf of Bothnia – Finland/Sweden



Indragen utmärkning / Withdrawn buoyage

## Gladstone - Australia

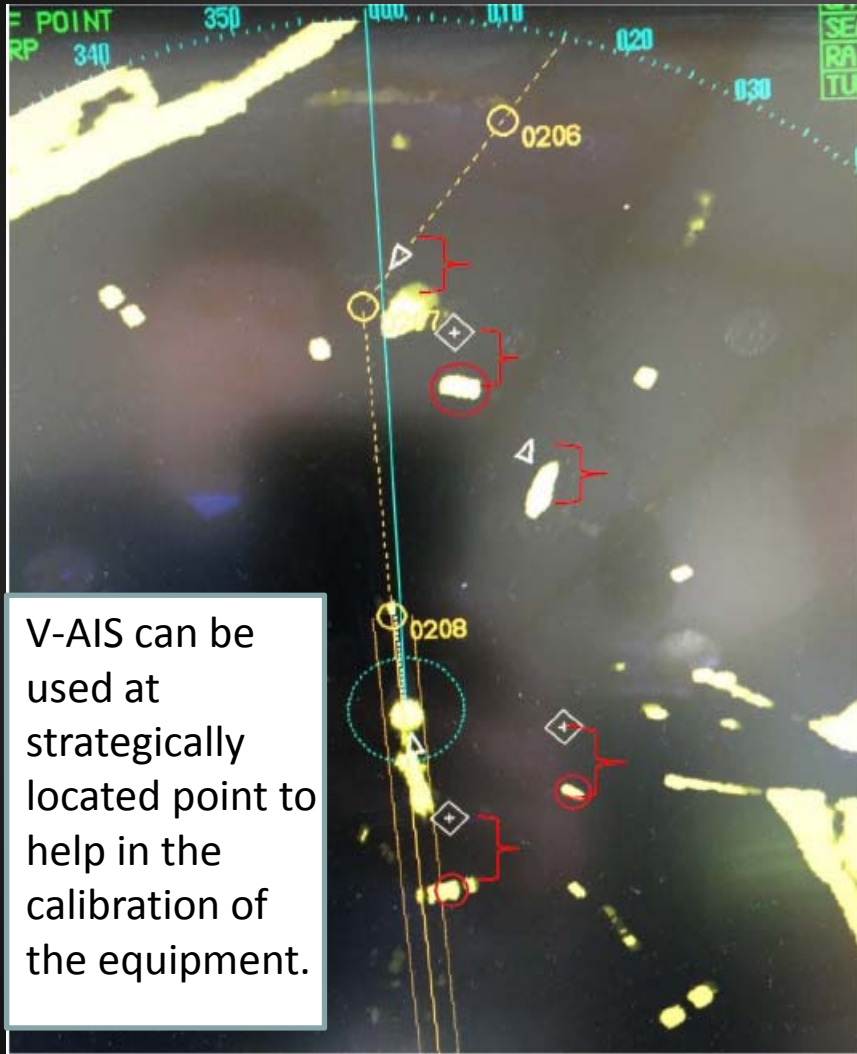




# Virtual AIS AtoN – Other application

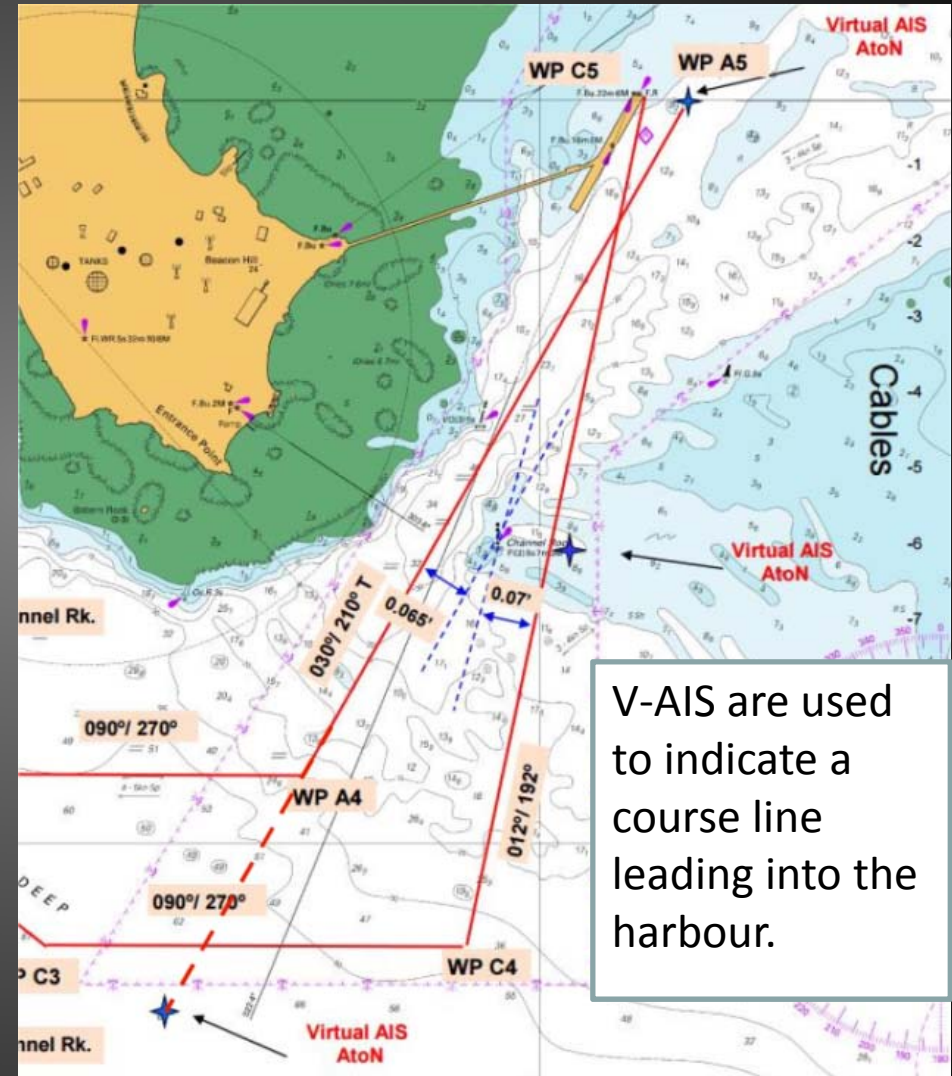


## Reference point for calibration



V-AIS can be used at strategically located point to help in the calibration of the equipment.

## Broome - Australia



V-AIS are used to indicate a course line leading into the harbour.

# Private Aids



		<u># of Responses</u>
<b>Issues experienced with private AIS AtoN</b>	Spectrum issue	2
	Not issued/wrong Notice to Mariners	3
	Overload	0
	No authorization given by authority	5
	Erroneous information transmitted	0
	No integrity check made by the owner	2
	Creates clutter on ENC	1
	Acknowledged it is a problem	1
	Licensing	1

# Way Forward



		<u># of Responses</u>
<b>Deployment of Real AIS AtoN over the next 5 years</b>	Yes	18
	No	4
	Don't know	3
<b>Deployment of Synthetic AIS AtoN over the next 5 years</b>	Yes	12
	No	5
	Don't know	8
<b>Deployment of Virtual AIS AtoN over the next 5 years</b>	Yes	15
	No	6
	Don't know	4

# General Findings



- ✓ **Inconsistencies in the International deployment approach:**
  - Benefits are not recognized by all national authorities :
    - Lack of capacity to display onboard and/or improper settings.
    - No clear international strategy and harmonization.
  - As opposed to physical AtoN, AIS isn't used by all mariners.
  
- ✓ **Some countries are deploying AIS Atons proactively:**
  - Users are informed about the potential benefits of this technology.
  - Such experiences may force international organizations to review regulations/guidelines.
  - A positive appreciation by some users may incite others to request similar equipment.
  
- ✓ **Monitoring of message 21 is challenging (quality control):**
  - Wrong MMSI, AtoN type code 0 (not specified).
  - Use of fixed AtoN instead of floating.
  - VDL overload.
  - Etc.

# General Findings



- ✓ **Management of Private AIS AtoN represents a challenge.**
- ✓ **Concerns with regard to the potential cluttering of ENC:**
  - Several Private AIS AtoN used in non-critical situations:
    - Aquaculture sites.
    - Fishnet buoy.
    - AIS class-B units used on fishnet buoys.
    - Etc.
- ✓ **Difficulties in collecting feedback from users:**
  - User consultation process needs improvement.
- ✓ **Most countries reported to be in a trial mode.**

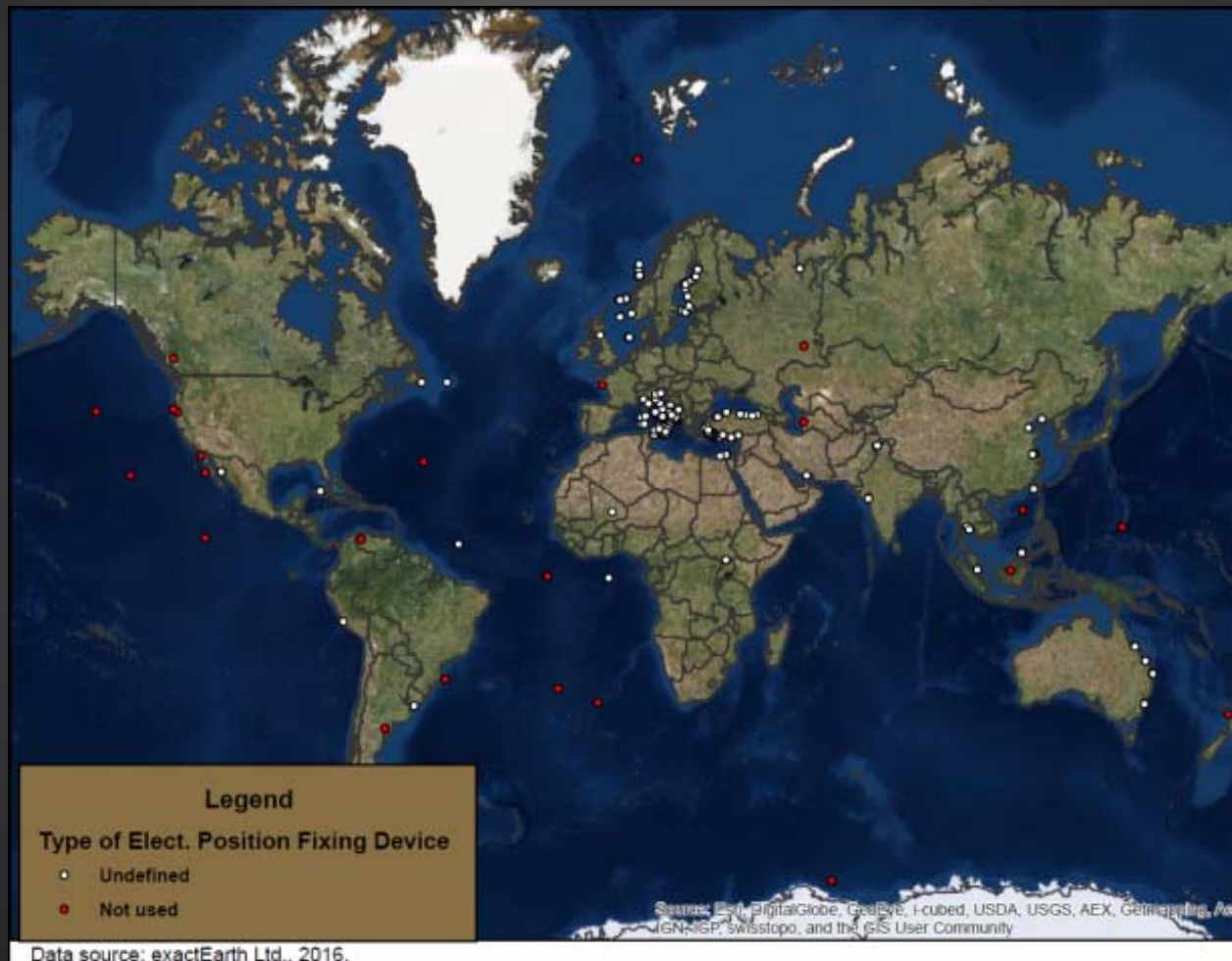
**End of International Survey**



# ANNEX 1



## ANALYSIS OF AIS AtoN SATELLITE DATA



# Methodology



- ✓ A review of AIS AtoN Message 21 captured by satellite (exactEarth) was used to complement information.
- ✓ Data provided is a snapshot covering the period January to September, 2016.
- ✓ There is no discrimination with respect to the type of utilization:
  - Test.
  - Time critical situations.
  - Permanent use.
  - Etc.
- ✓ Information is reported by AtoN type and an overview of deployment by continent is provided.
- ✓ AtoN type/flag code refer to the ITU-R M.1371-5 Recommendation.

# Satellite Data - Floating Aids

## Type of Utilization



- ✓ Virtual Flag 0 = Real AIS AtoN
- ✓ Virtual Flag 1 = Virtual AIS Aton

Definition	ATON Type Code	Virtual Flag = 0	Virtual Flag = 1	TOTAL
Cardinal Mark N	20	42	6	
Cardinal Mark E	21	23	2	
Cardinal Mark S	22	40	3	
Cardinal Mark W	23	37	5	
Port hand Mark	24	225	43	
Starboard hand Mark	25	233	60	
Preferred Channel Port hand	26	45	11	
Preferred Channel Starboard hand	27	11		
Isolated danger	28	54	101	
Safe Water	29	54	28	
Special Mark	30	155	233	
Light Vessel/LANBY/Rigs	31	24	7	
<b>Total Floatings:</b>		<b>943</b>	<b>499</b>	<b>1442</b>

# Satellite Data - Fixed Aids

## Type of utilization



- ✓ Virtual Flag 0 = Real AIS AtoN
- ✓ Virtual Flag 1 = Virtual AIS Aton

Definition	ATON Type Code	Virtual Flag = 0	Virtual Flag = 1
Light, without sectors	5	312	19
Light, with sectors	6	129	4
Leading Light Front	7	34	4
Leading Light Rear	8	36	6
Beacon, Cardinal N	9	7	5
Beacon, Cardinal E	10	4	7
Beacon, Cardinal S	11	6	7
Beacon, Cardinal W	12	5	3
Beacon, Port hand	13	204	44
Beacon, Starboard hand	14	201	38
Beacon, Preferred Channel port hand	15	12	11
Beacon, Preferred Channel starboard hand	16	21	4
Beacon, Isolated danger	17	35	6
Beacon, Safe water	18	120	19
Beacon, Special mark	19	26	30
<b>Total Fixed:</b>		<b>1152</b>	<b>207</b>



# Satellite Data - Other Utilization



- ✓ Virtual Flag 0 = Real AIS AtoN
- ✓ Virtual Flag 1 = Virtual AIS Aton

Definition	ATON Type Code	Virtual Flag = 0	Virtual Flag = 1	TOTAL
RACON	2	5	11	16
Fixed structures off-shore, such as oil platforms, wind farms.	3	181	29	210
Reference point	1	236	360	596
Emergency Wreck Marking Buoy	4	2	1	3
Default, Type of AtoN not specified	0	189	157	346

# Satellite Data - MMSI



Definition	%	TOTAL
Valid MMSI (99201XXXX to 99775XXXX)	80.3	3191
Non valid MMSI	19.7	783
All MMSI		3974

# Satellite Data – Identification of Type



- ✓ **Type of AtoN (Real, Synthetic (Monitored & Predicted), Virtual) was attributed according to the information provided in the few fields available, mainly Fixing Device and Virtual AtoN Flag.**
- ✓ **In some case, coding errors made by the original broadcaster impacted the results. For example, some synthetic AtoNs are illustrated as virtual because the Virtual AtoN Flag = 1.**

# Satellite Data – Identification of Type



Fixing Device Code and Virtual AtoN Flag used for each type of AtoN.

Type of electronic position fixing device	4	<ul style="list-style-type: none"> <li>0 = Undefined (default)</li> <li>1 = GPS</li> <li>2 = GLONASS</li> <li>3 = Combined GPS/GLONASS</li> <li>4 = Loran-C</li> <li>5 = Chayka</li> <li>6 = Integrated Navigation System</li> <li>7 = surveyed. For fixed AtoN and virtual AtoN, the charted position should be used. The accurate position enhances its function as a radar reference target</li> <li>8 = Galileo</li> <li>9-14 = not used</li> <li>15 = internal GNSS</li> </ul>
Virtual AtoN flag	1	<ul style="list-style-type: none"> <li>0 = default = real AtoN at indicated position; 1 = virtual AtoN, does not physically exist<sup>(2)</sup>.</li> </ul>

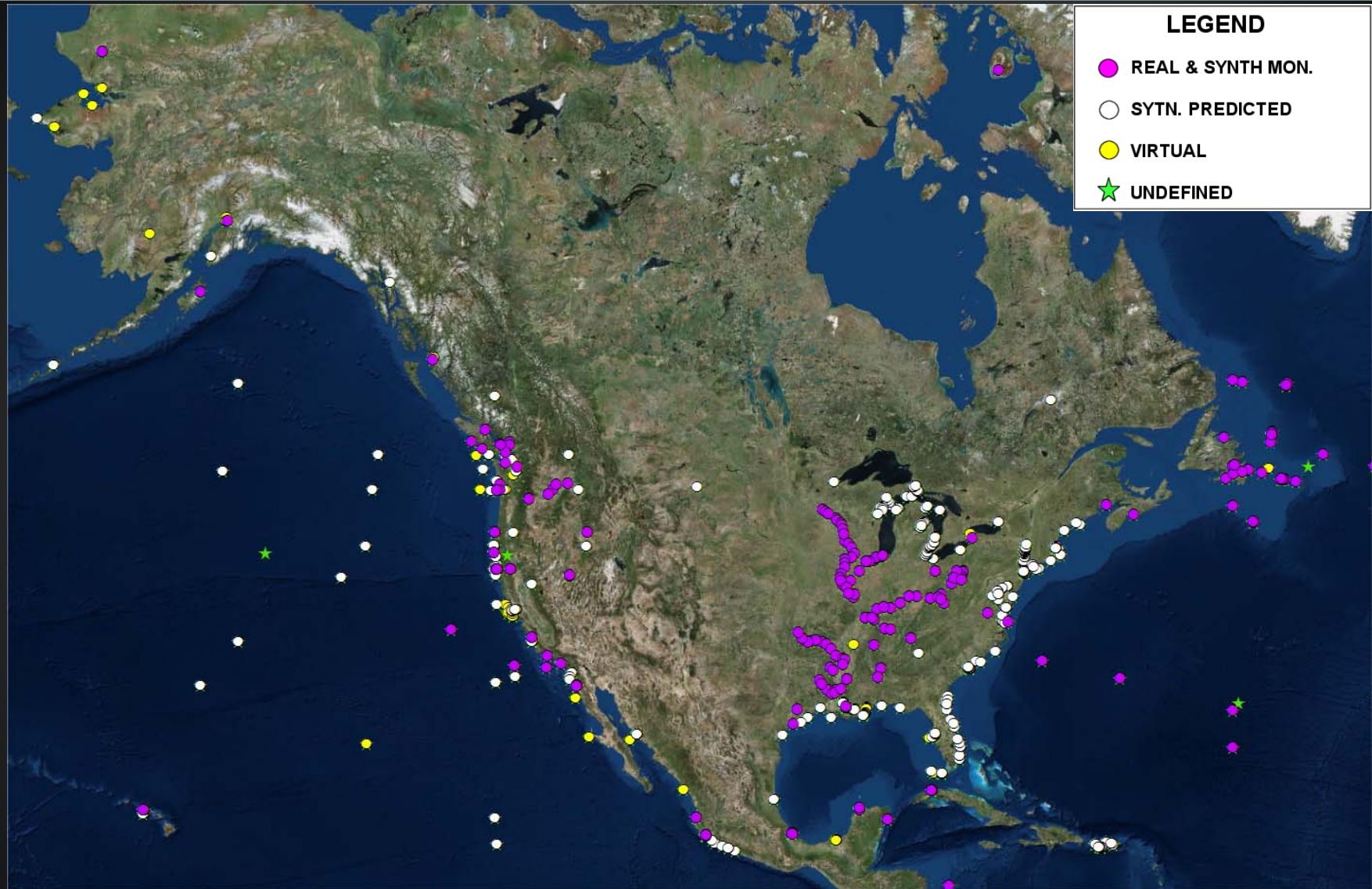
**REAL&Synt.Mon.**

**PREDICTED**

**VIRTUAL**



# Satellite Data - North America



Data source: exactEarth Ltd., 2016.

# Satellite Data - South America

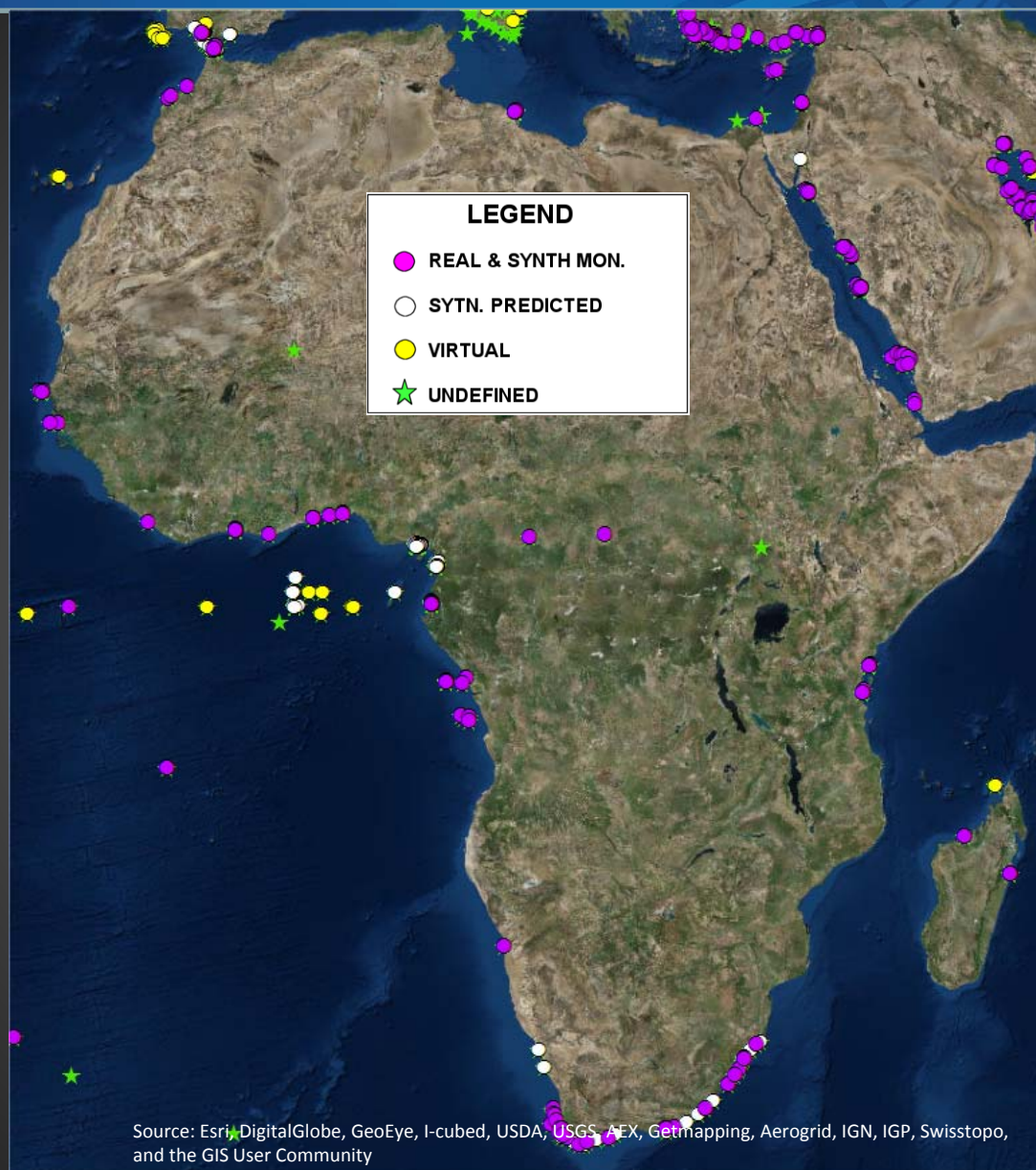


Data source:  
exactEarth Ltd., 2016.

Source: Esri, DigitalGlobe, GeoEye, I-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, Swisstopo, and the GIS User Community



# Satellite Data - Africa

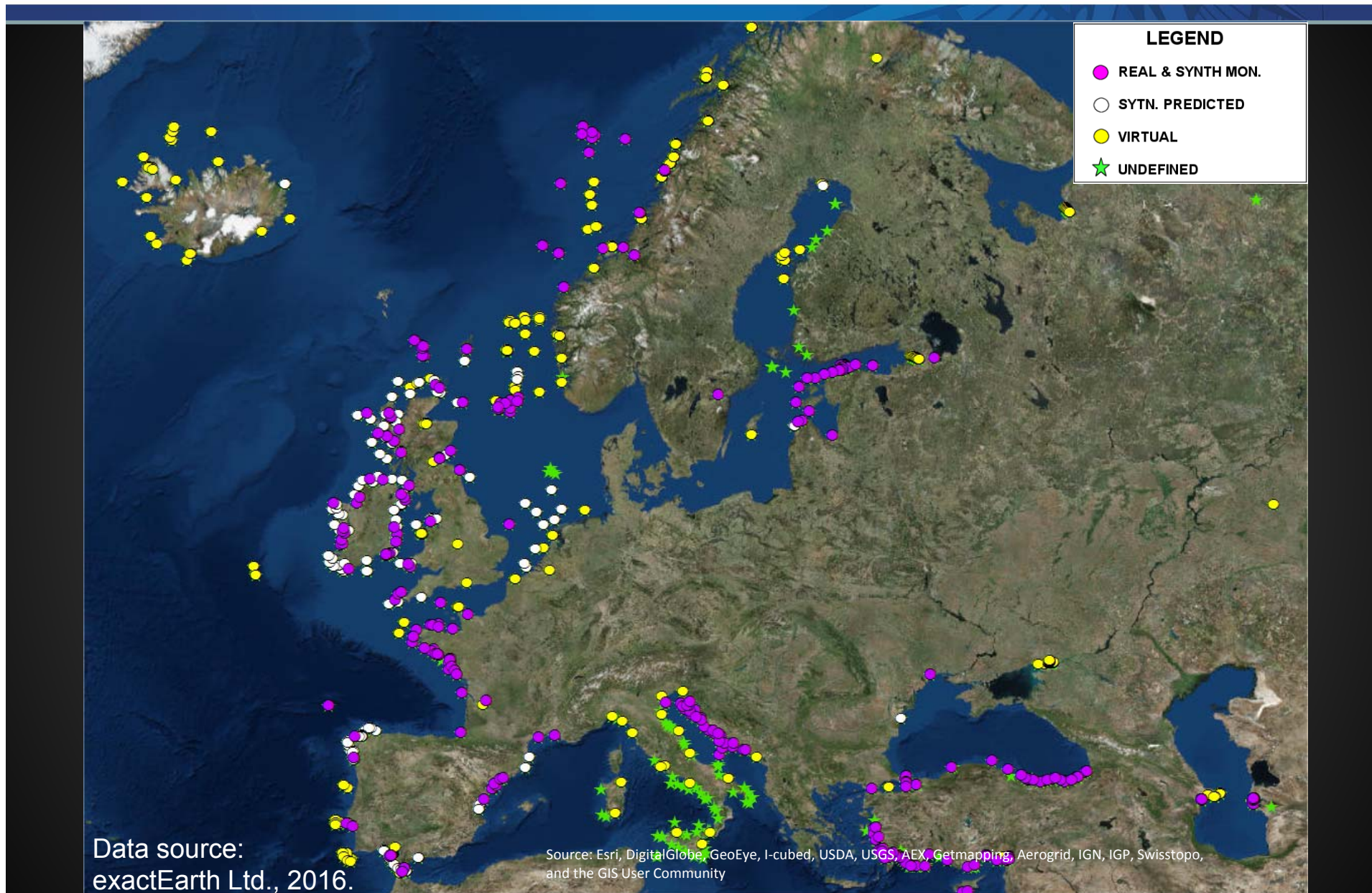


Data source:  
exactEarth Ltd., 2016.

Source: Esri, DigitalGlobe, GeoEye, I-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, Swisstopo, and the GIS User Community

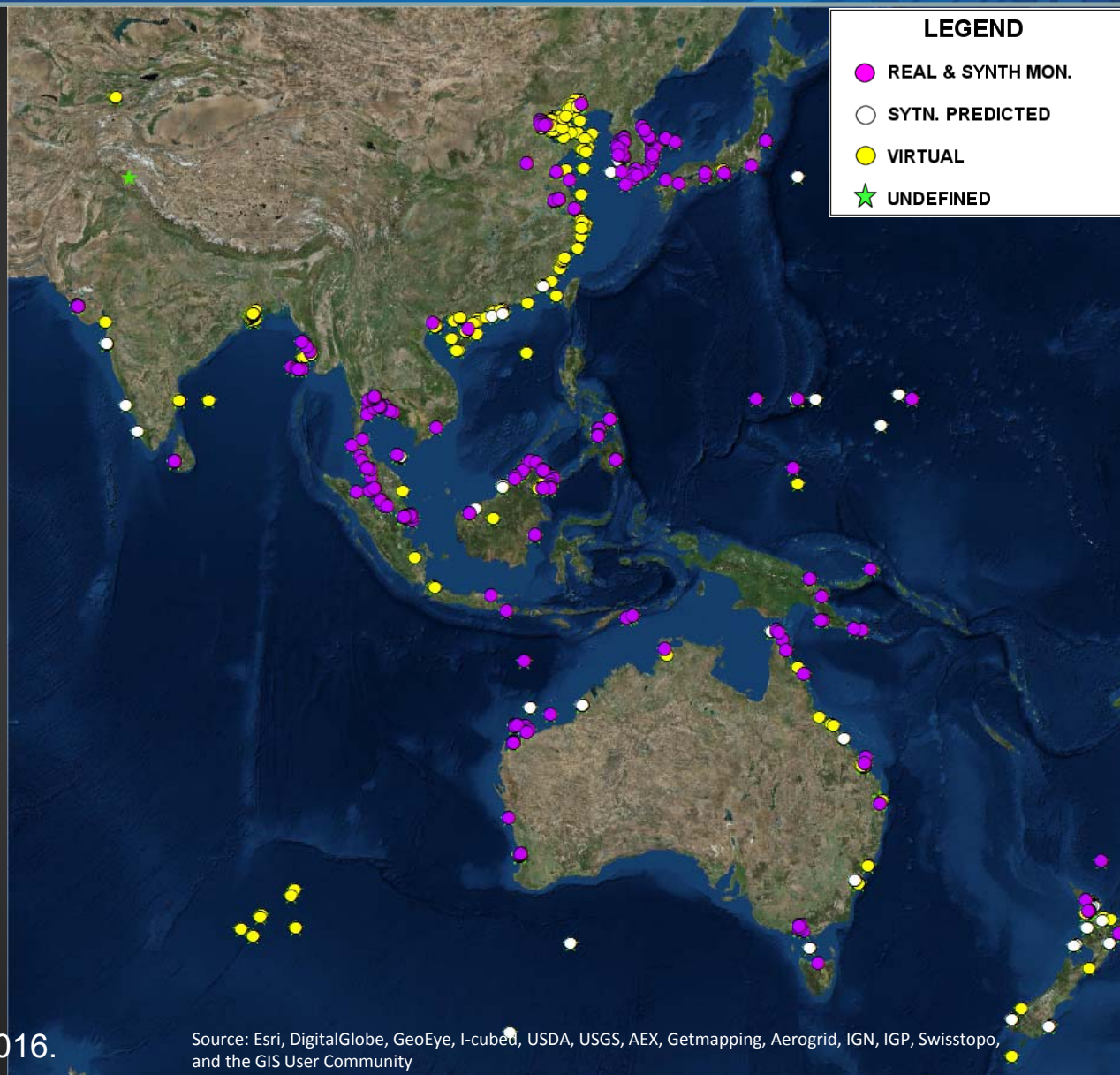


# Satellite Data - Europe





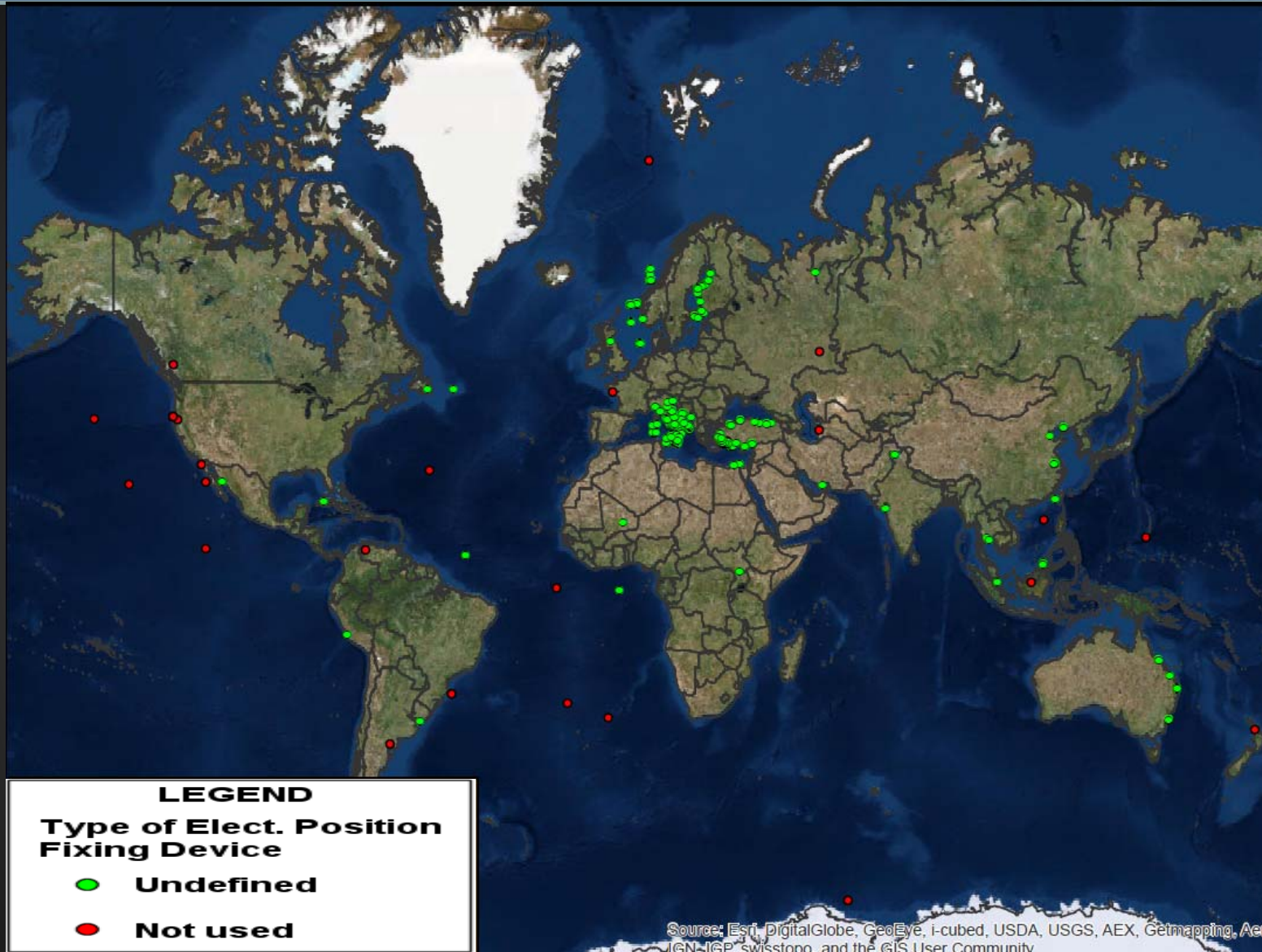
# Satellite Data - Asia & Oceania



Data source:  
exactEarth Ltd., 2016.

Source: Esri, DigitalGlobe, GeoEye, I-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, Swisstopo, and the GIS User Community

# Coding Issue – Satellite Data



Data source: exactEarth Ltd., 2016.



# Canadian Coast Guard Base – Quebec City

