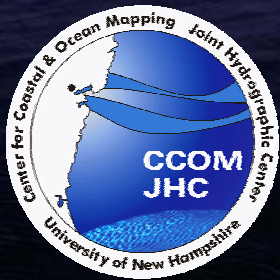


e-Navigation, ECDIS and MIOS: At Present and in the Future



Dr. Lee Alexander
lee.alexander@unh.edu

UNIVERSITY of NEW HAMPSHIRE



Definition of e-Navigation*

*"E-Navigation is the harmonized collection, integration, exchange and presentation of maritime information onboard and ashore by electronic means to **enhance** berth to berth navigation and related services, for safety and security at sea and protection of the marine environment"*

- Not new type of equipment, but a "concept" that involves a broad range navigation systems and services.
- "**e**" stands for: electronic → "**enhanced**"
 - also: essential, efficient, exceptional, extraordinary, "everything"....

* IMO MSC 81st Session, May 2007

E-Nav Objectives/Benefits

- Safety-of-Navigation
- Efficiency of Maritime Transportation
- Marine Environmental Protection
- Port/Coastal Security

Components:

AIS

Radar/ARPA

ECDIS

GNSS

LRIT

Aton

VTS

MIOs

MEH

"Others" (TBD)

PPU

Brief History of e-Navigation

2005

- e-Navigation concept first proposed to IMO by UK

2006

- IMO NAV discussed strategic vision/concept
- IALA established e-Navigation Committee to facilitate development and provide input

2007

- IMO NAV & COMSAR began discussions on “Development of e-Navigation Strategy”
- IALA conducted two e-Nav Seminars (London and Tokyo)

2008

- IMO to agreed on e-Navigation Strategy and means/process for implementation

e-Navigation

AIM: To integrate existing/new shipboard and shore-based navigational tools and services into an “all embracing system”.

Main challenges:*

- *"ensuring the availability of all components of the system and using them effectively in order to simplify, to the benefit of the mariner, the display of the occasional local navigational environment."*
- *"incorporate new technologies in a structured way and ensure their use is compliant with various communication technologies and services already available."*

* IMO MSC 81st Session, May 2007

Expectations for e-Navigation *

.1 Onboard:

Navigation systems that benefit from the integration of own ship sensors, supporting information, a standard user interface, and a comprehensive system for managing guard zones and alerts. Core elements of such a system will include, actively engaging the mariner in the process of navigation while preventing distraction and overburdening,

.2 Ashore:

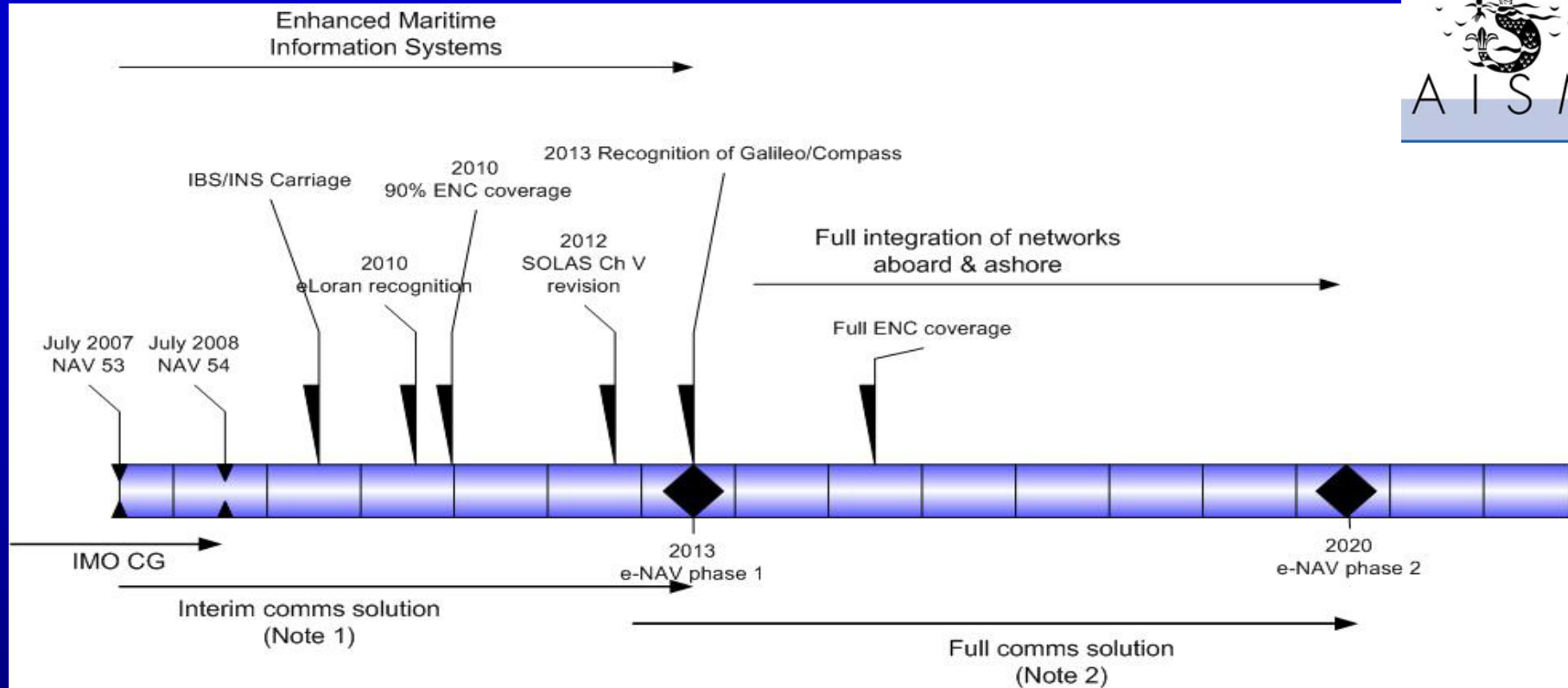
The management of vessel traffic and related services from ashore enhanced through better provision, co-ordination, and exchange of comprehensive data in formats that will be more easily understood and utilized by shore-based operators in support of vessel safety and efficiency, and

.3 Communications:

An infrastructure providing authorized seamless information transfer onboard ship, between ships, between ship and shore and between shore authorities and other parties with many related benefits, including a reduction of single person error.

* IMO NAV54/WP.2, para. 4.2

e-Navigation Timeline *



E-Navigation timeline

Note 1: Current systems enhanced with limited broadband & wi-fi services

Note 2: Global broadband & WiMax replacing most current systems

* Source: IALA e-Navigation Committee

Changing Times

- Like organisms, navigation equipment and systems are evolving.
 - Increasingly more complex and sophisticated
- System: [definition]
"a group or combination of interrelated, interdependent, or interacting elements forming a collective entity"

ECDIS: The Original Vision

- Display real-time positioning
- Provide increased functionality
- Integrate other navigation information
- Improve route planning and monitoring
- Intended to replace paper charts

ECDIS: The Reality

- Data is static
- Does not make use of full density hydrographic data
- Limited to 2-D view
- Does not incorporate the “fourth dimension”...time
- Integration of other navigation information considered secondary

Separate Equipment → INS

IMO Performance Standards

ECDIS (1995, rev 2006)

ARPA (Nov 1995)

Radar (Dec 1996)

IBS (Dec 1996)

AIS (May 1998)

INS (Dec 1998)

SOLAS Chap V (Dec 2000)

Ergonomic Criteria for Bridge Equipment (Dec 2000)

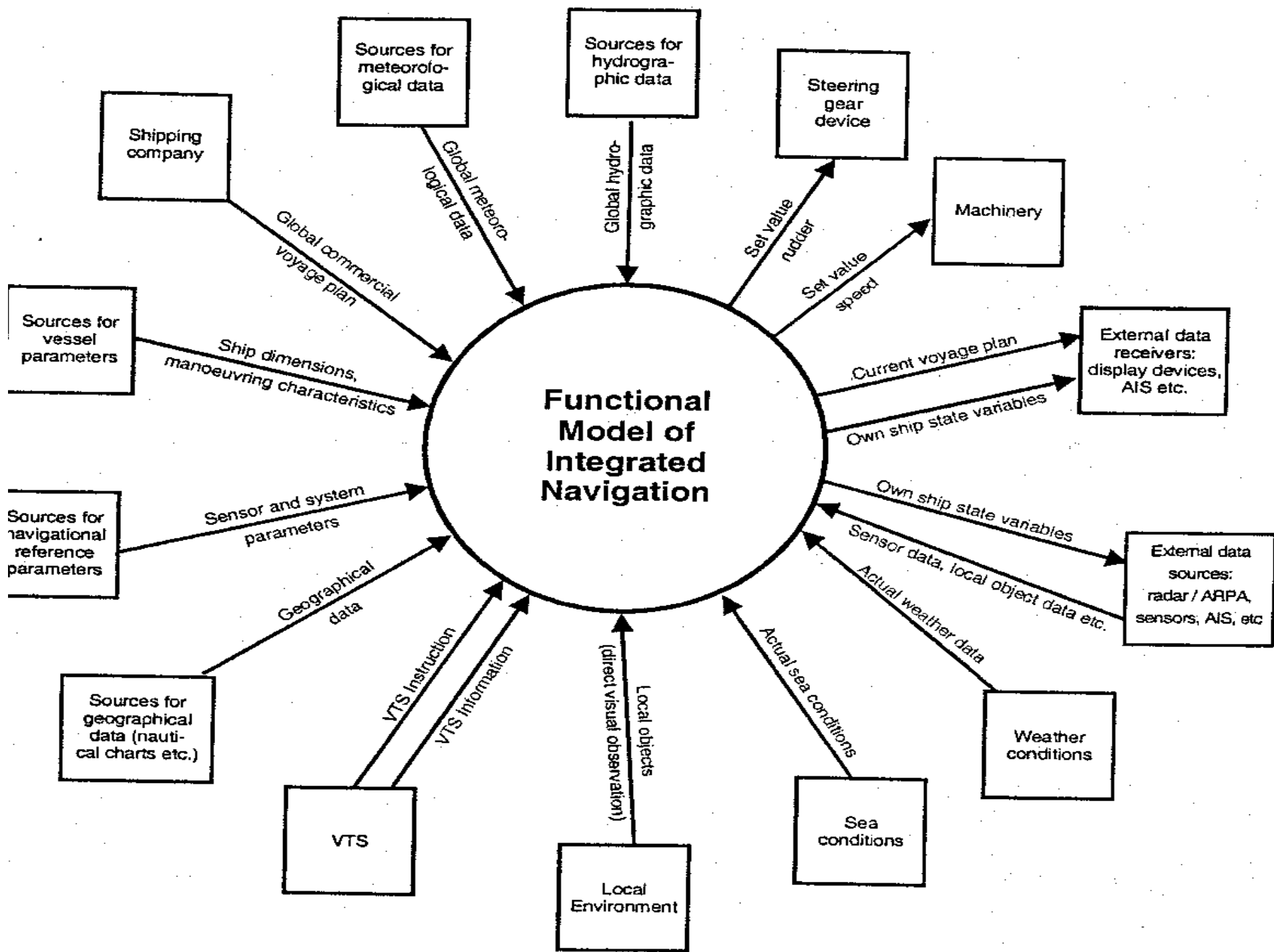
Provision and Organization of Navigation-related Information

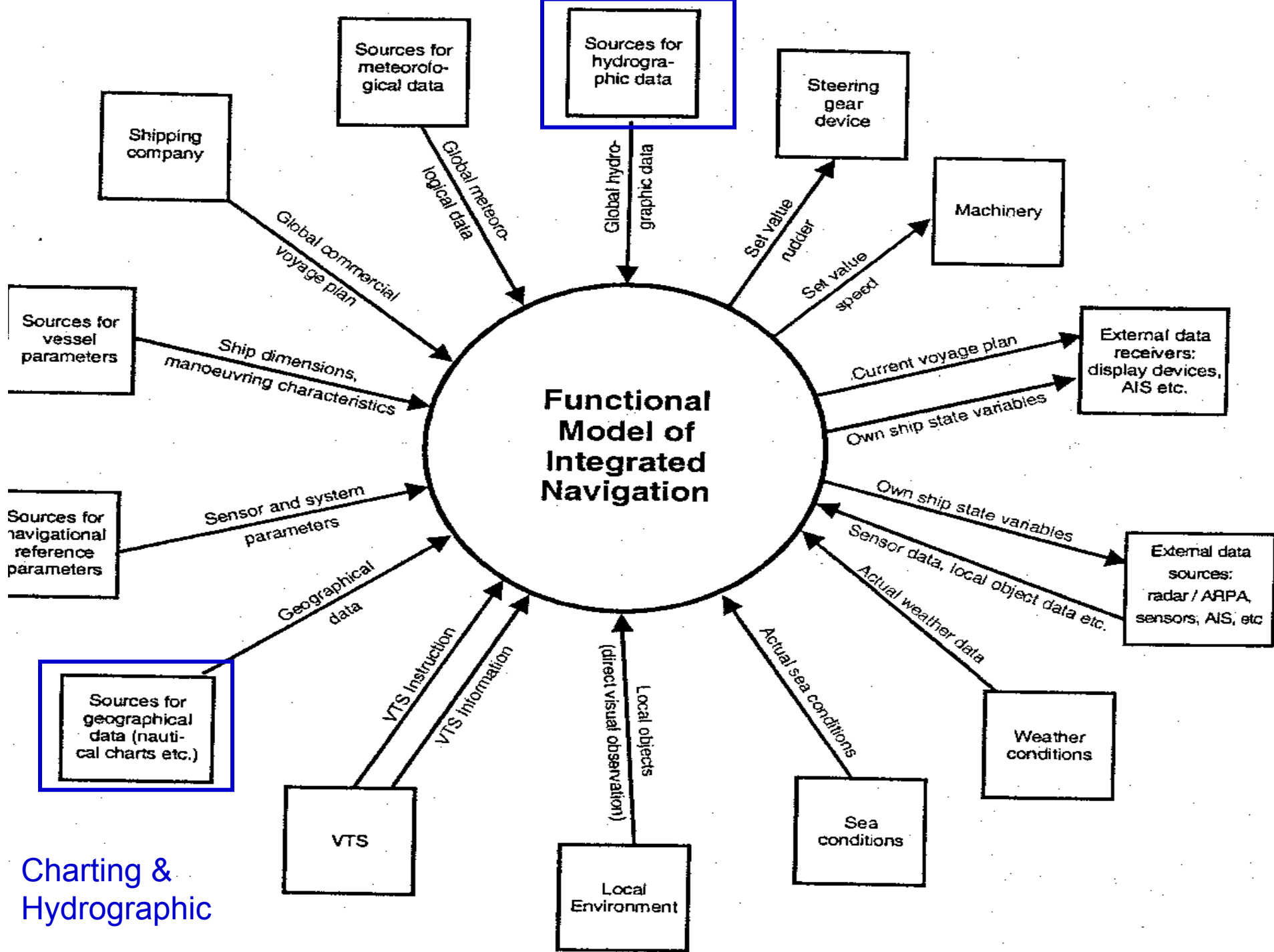
BSH (Germany) Report: *“Functional Scope and Model of INS”*

- Prepared by ISSUS to develop a framework for testing

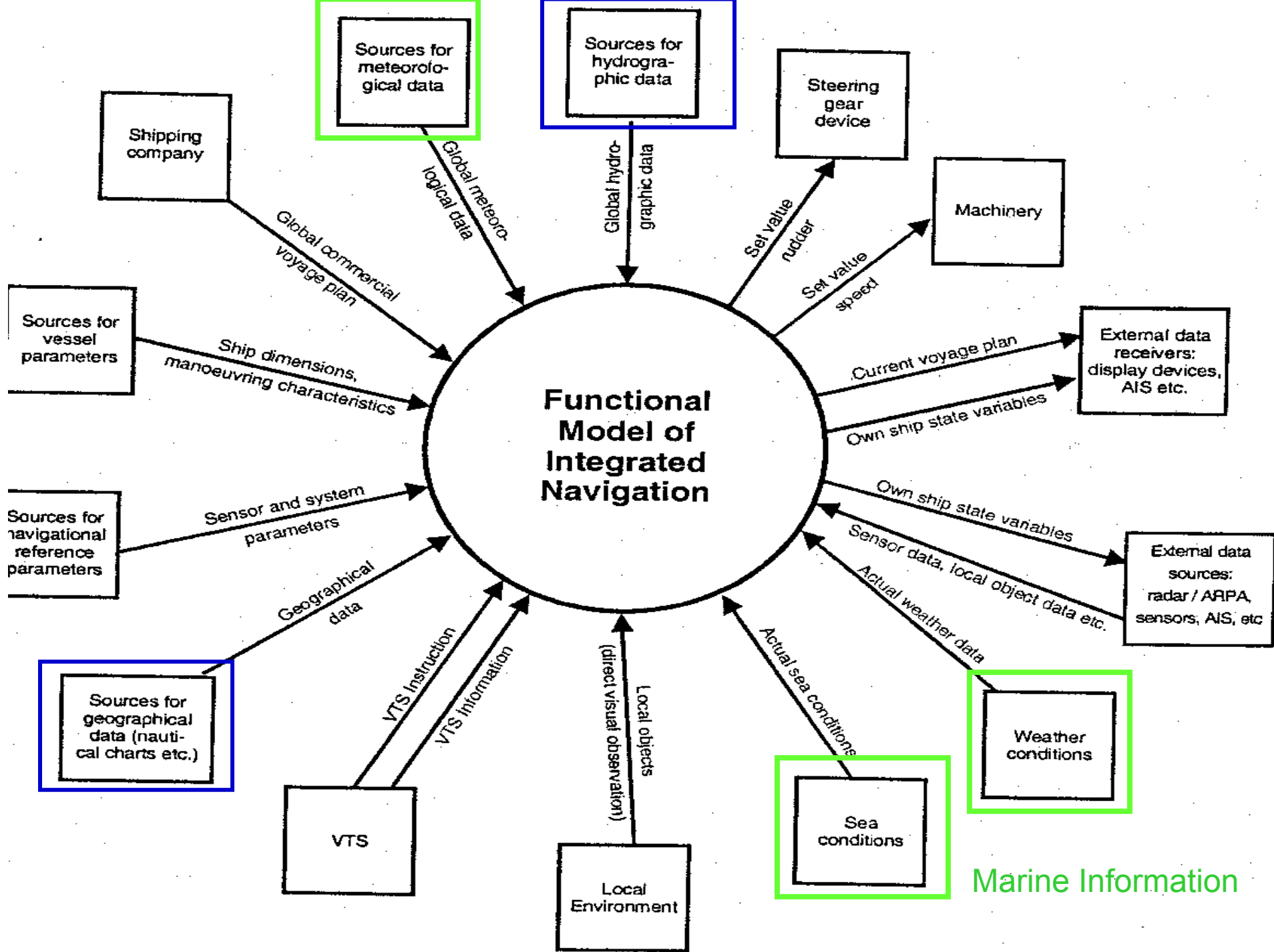
Part B - Functional model of integrated navigation process

- Functions and information flows between various components are identified

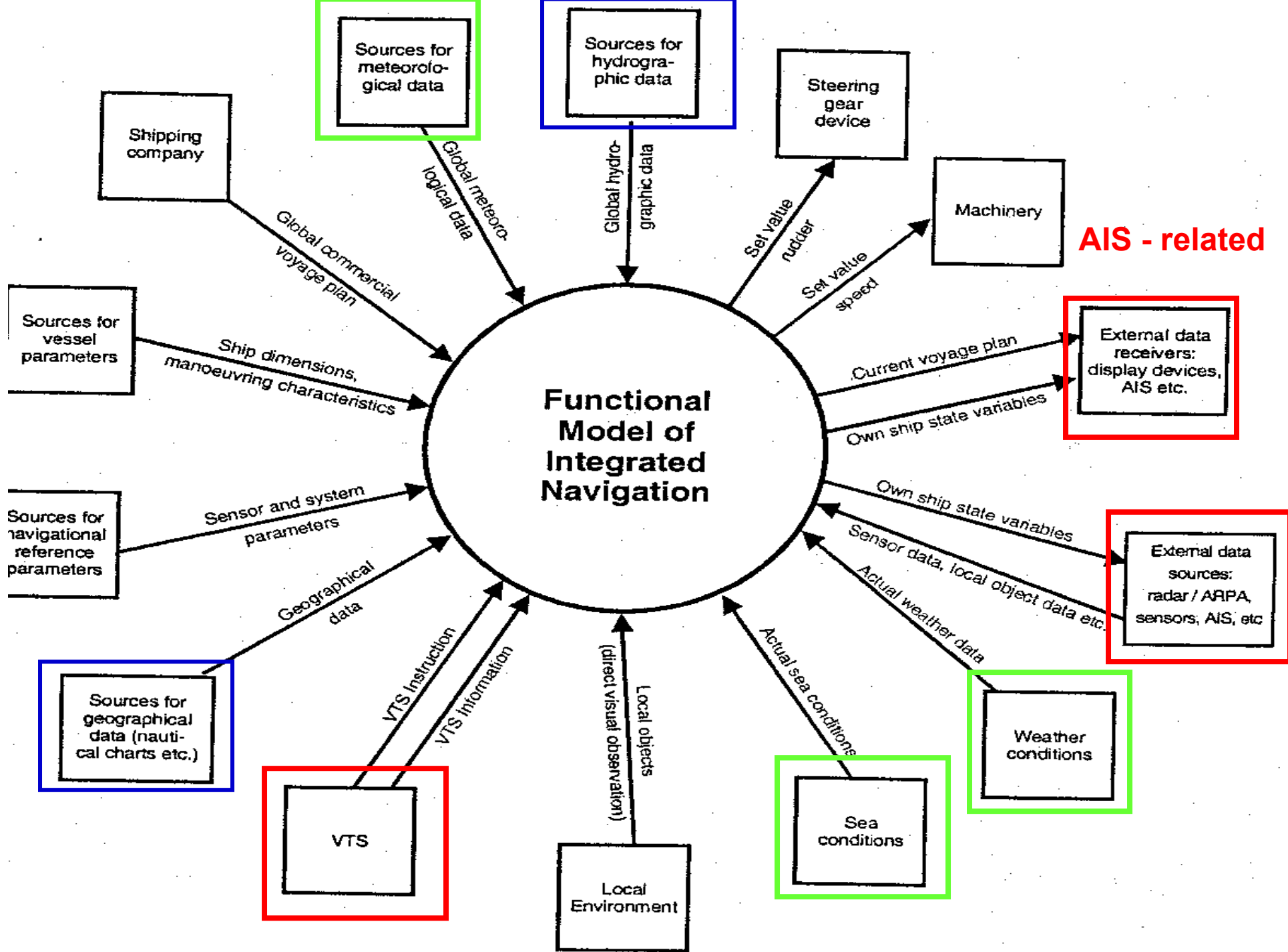




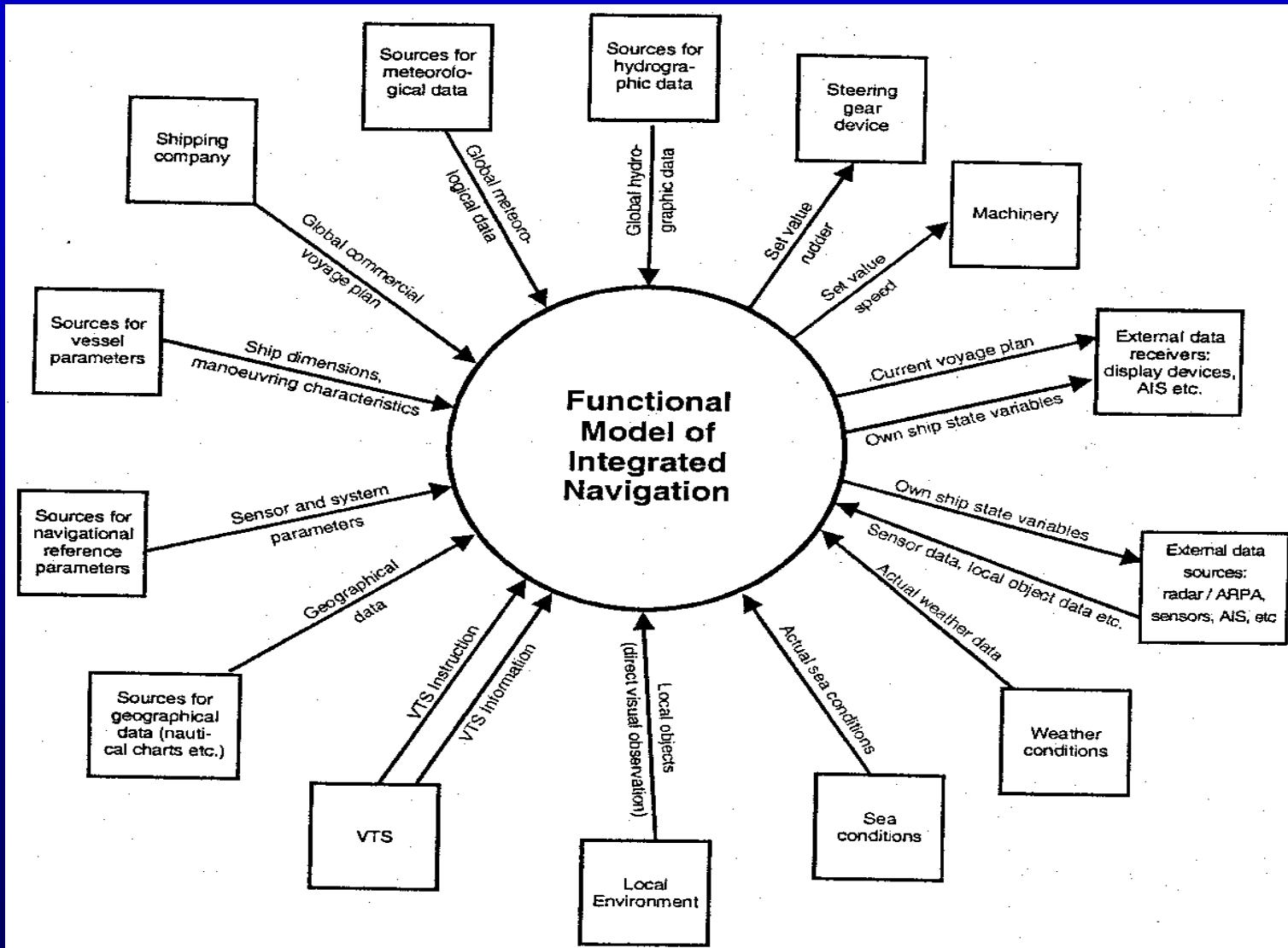
Charting & Hydrographic



Marine Information



What Mariners Need to Know About



IMO-compliant ECDIS

ENC Definition:

*"all the chart information necessary for safe navigation and may contain **supplementary information** in addition to that contained in the paper chart which may be considered necessary for safe navigation."*

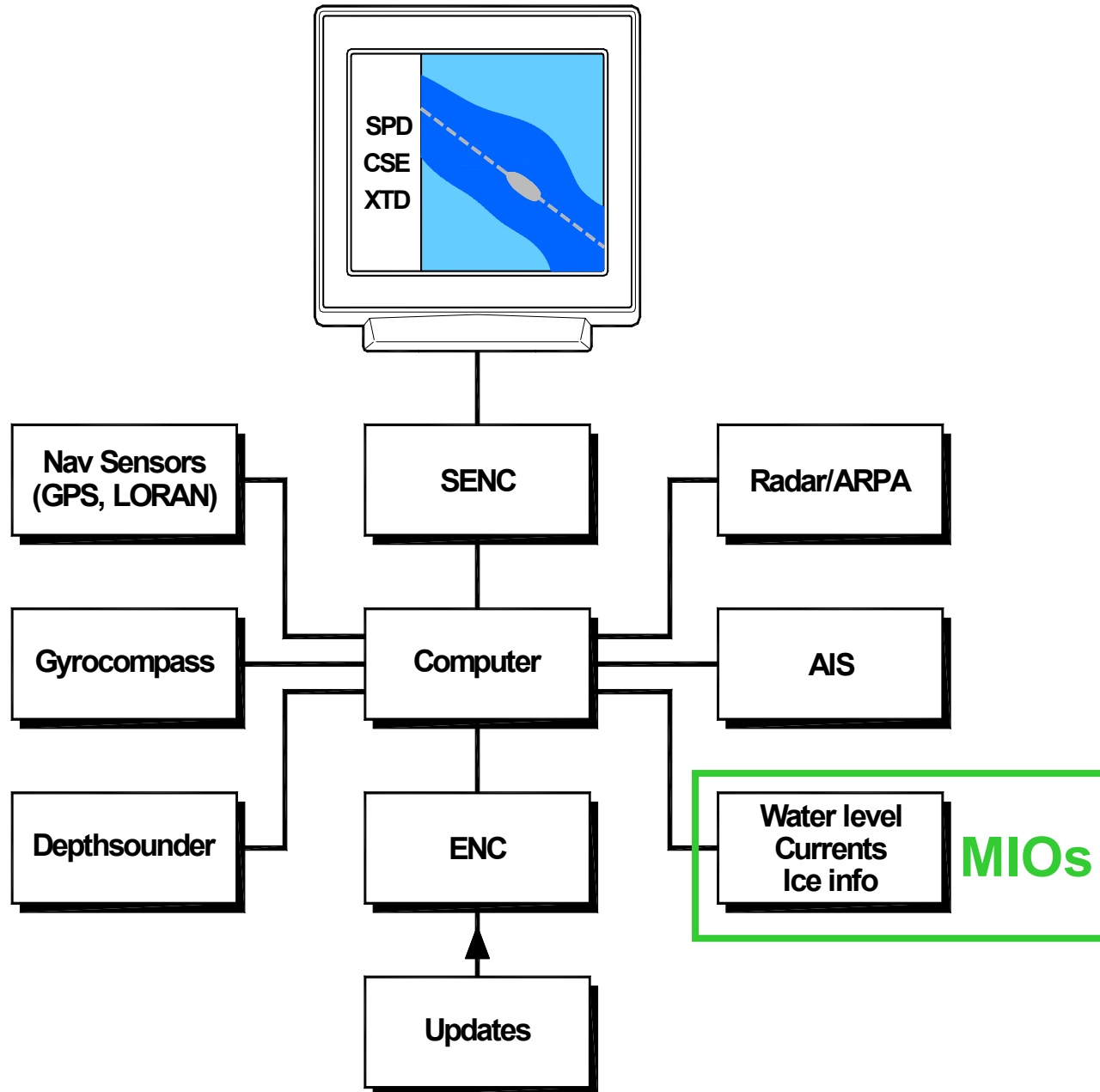
Marine Information Overlays (MIOs)

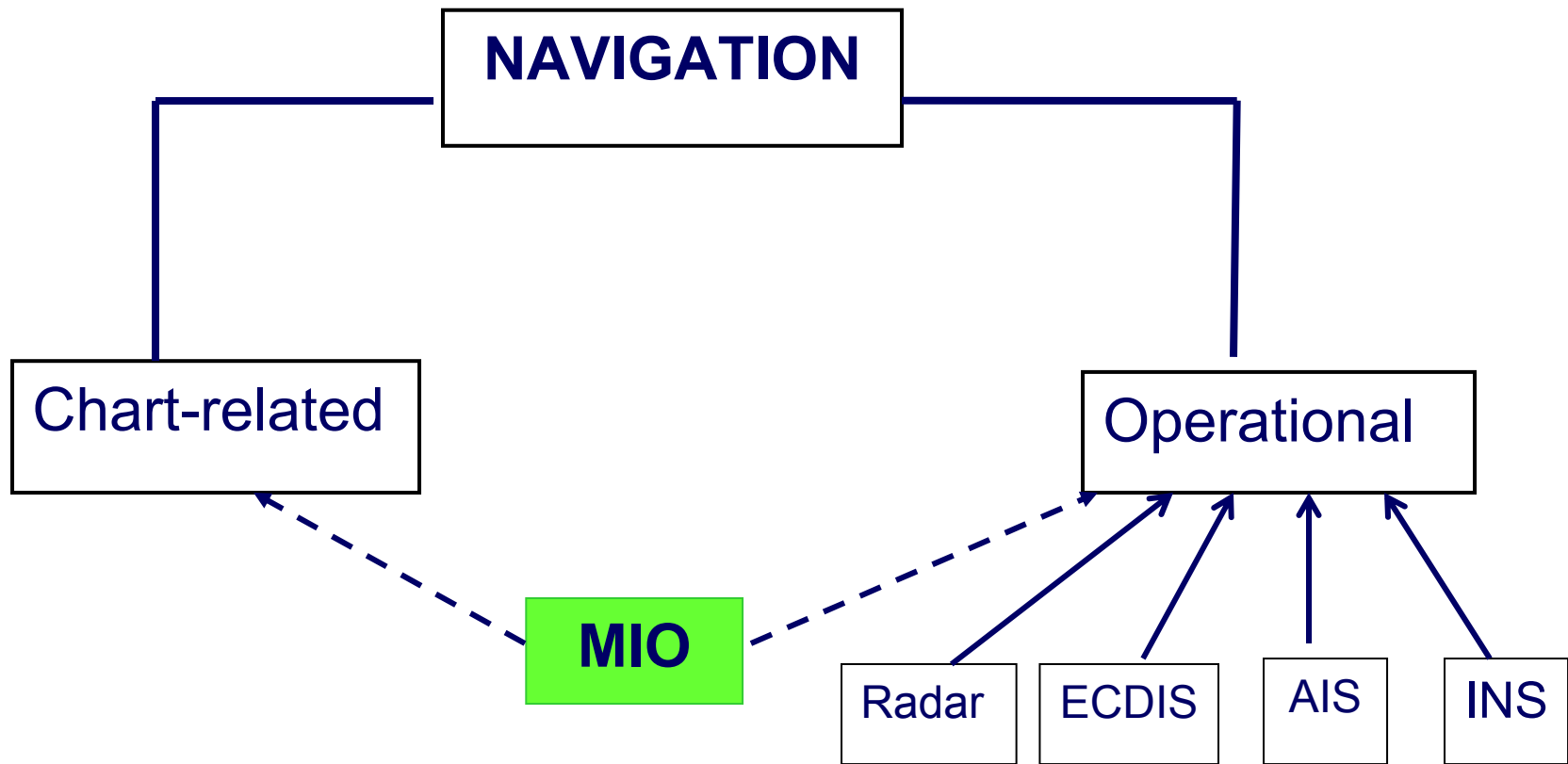
Chart and navigation-related information that **supplement** the minimum information required by IMO ECDIS.

- Additional, non-mandatory
- Not covered by existing standards (e.g., IHO S-57, IHO S-52, IEC 61174, IEC 62288)
- The “everything else”
- Primarily, points, lines, areas, features

ECDIS COMPONENTS

Color Display





Relationship of chart and operational to Navigation-related information

[Source: IEC Report to IMO NAV48]

Two basic types of MIOs

Static

Bathymetric (e.g., gridded data)

Regulatory Zones/Areas

Seafloor classification/physiography

Archeological (wrecks, heritage sites)

Critical Habitats (e.g., fish spawning, coral reefs, nesting sites)

Seafloor cables/pipelines

Dynamic

Tides (predicted, real-time, forecast)

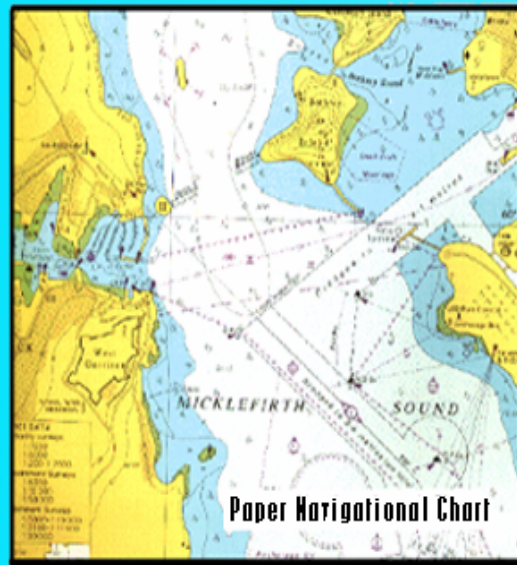
Current flow (speed, direction, time of occurrence)

Meteorological (wind speed/direction)

Oceanographic (wave height/direction, salinity, temp)

Marine Mammals (e.g., endangered whales)

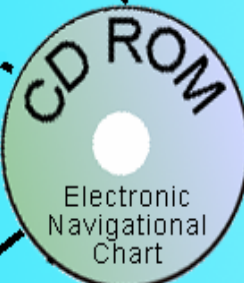
COLLECTION AND USE OF HYDROGRAPHIC DATA



IHO Paper Chart
Standard. M-4

IHO
TRANSFER
STANDARD
S-57

DIGITAL
HYDRO-
GRAPHIC
DATA
BASE



OTHER GIS APPLICATIONS



MONITORING
HUMAN
ACTIVITIES
AND
DEVELOPMENT

Coastal Zone
Management

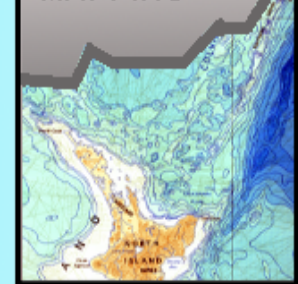
LONG TERM
MANAGEMENT
(Erosion,
Pollution,
Water Levels etc)
DISASTER-
MANAGEMENT
(Accidental
Pollution)

Environmental
Management

BIOLOGICAL
PHYSICAL

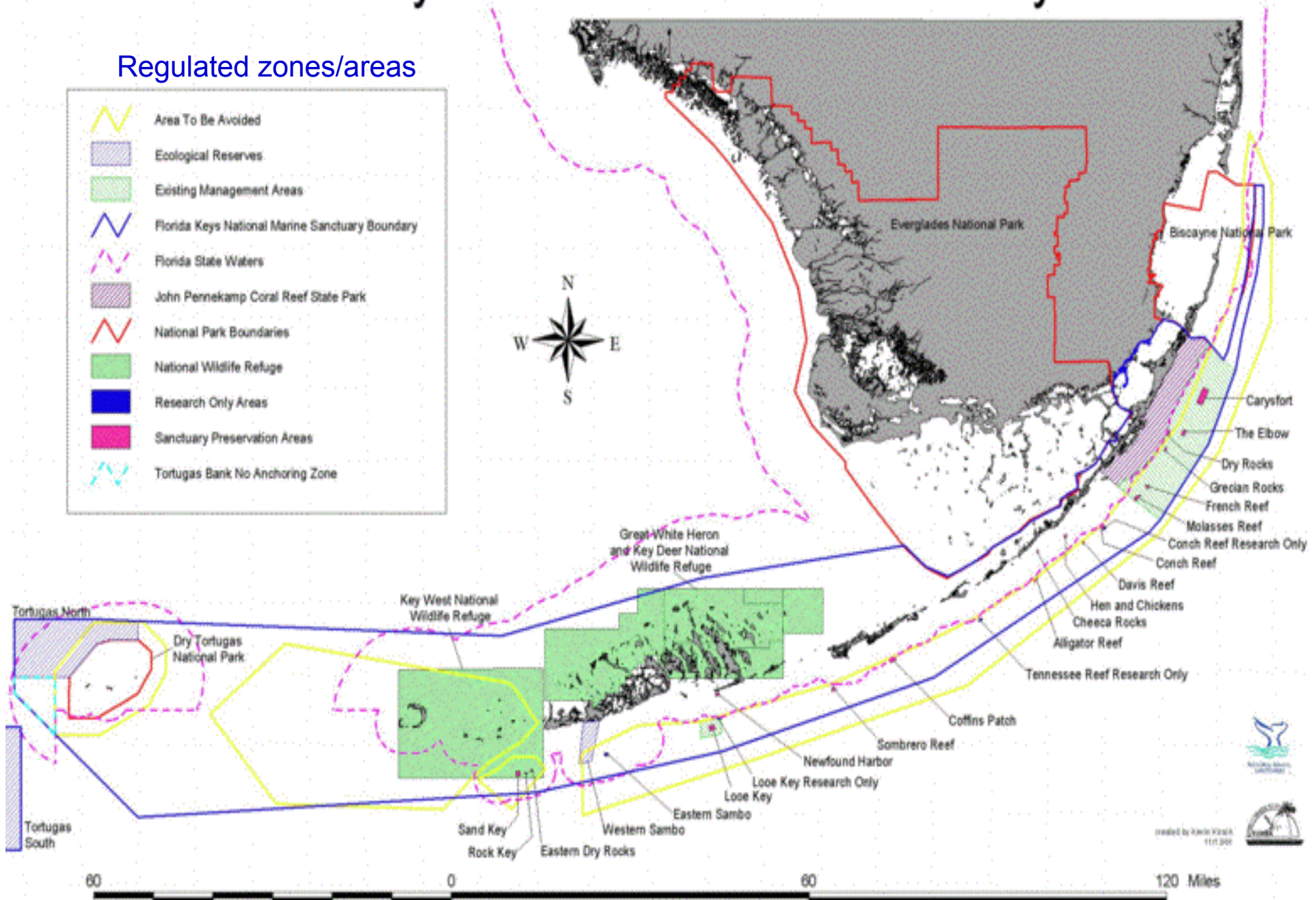
Resource
Management

BATHYMETRIC
MAPPING



Florida Keys National Marine Sanctuary

Regulated zones/areas



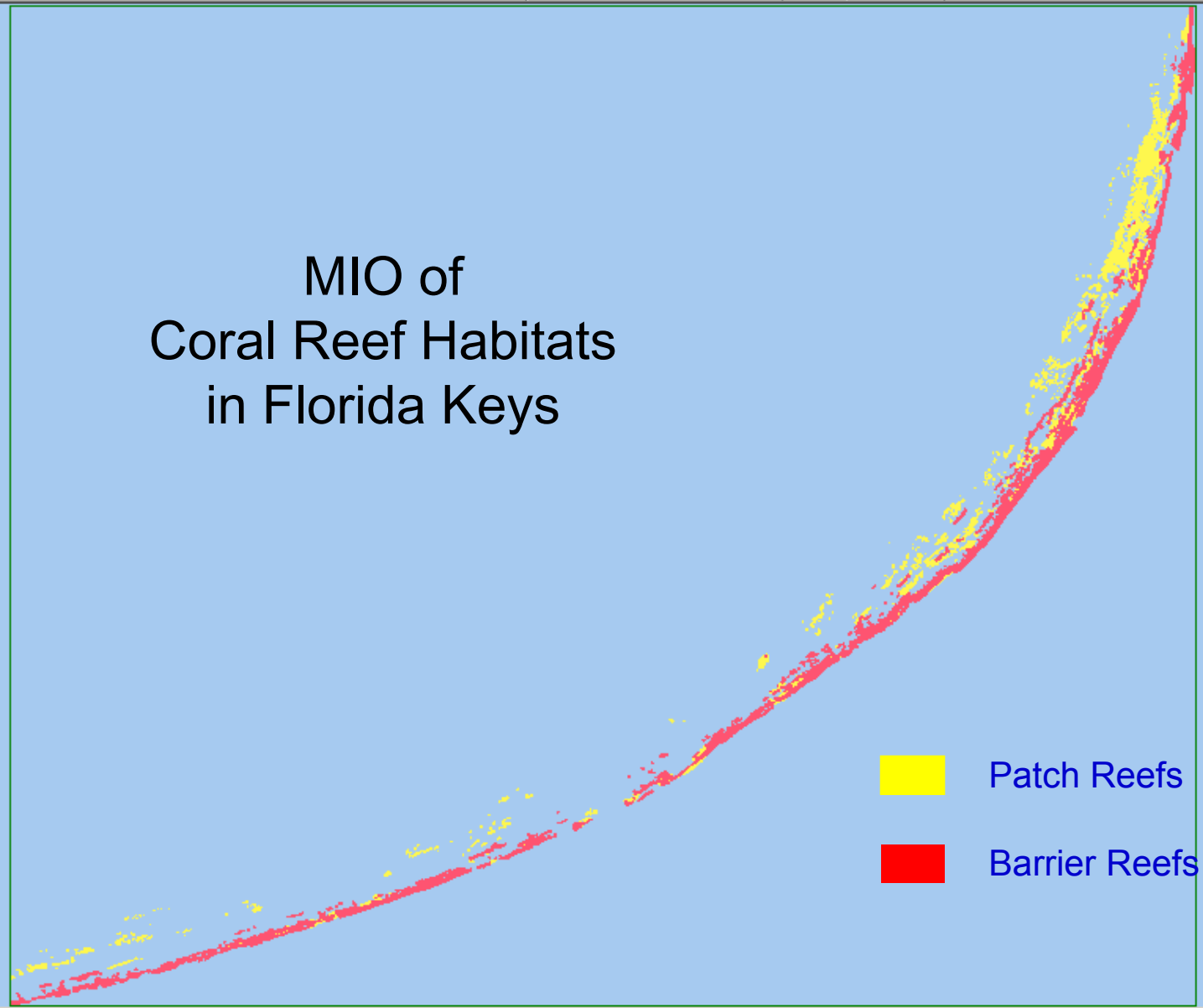
Created by Kevin Kline, 11/1/2007



Benthic Habitat Mapping








Seagrass Habitats In Florida Bay, USA

MIO of Coral Reef Habitats in Florida Keys

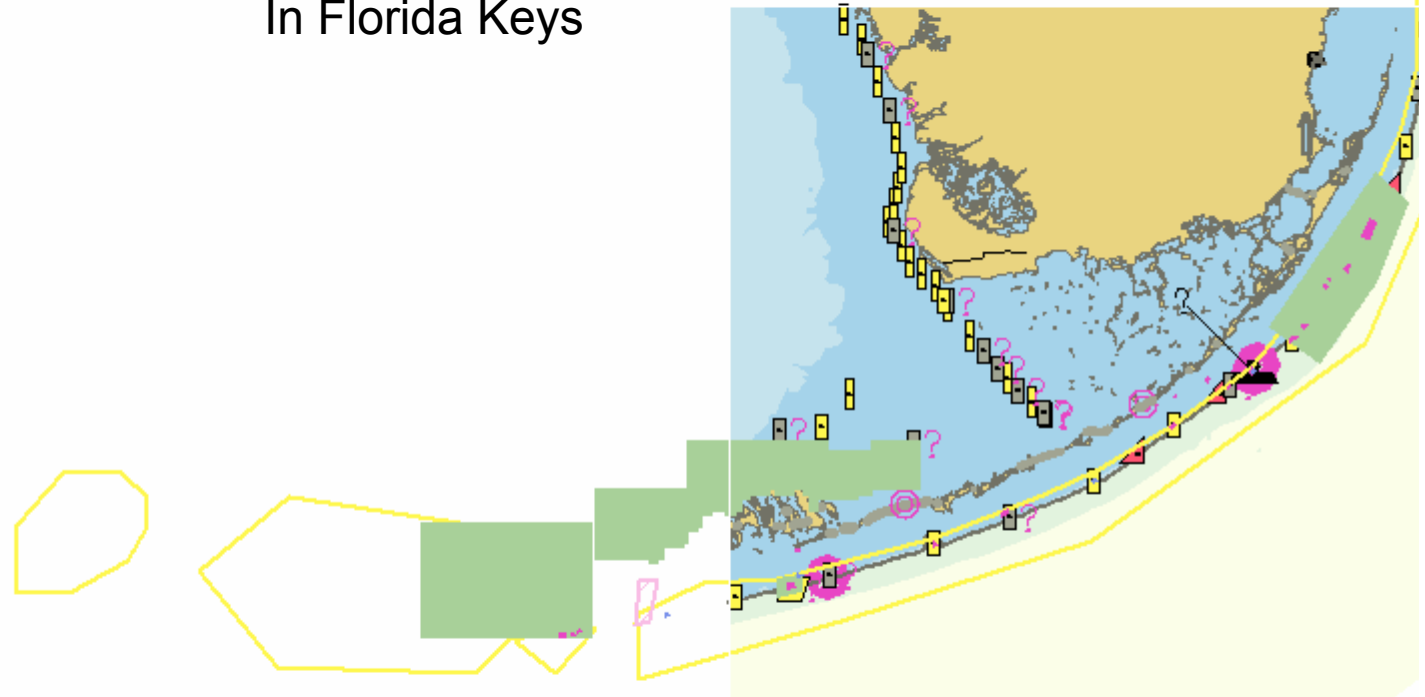


 Patch Reefs
 Barrier Reefs



-  US3FL28M
-  US410100
-  US410300
-  US410400
-  US410500
-  US410600

ENC with MIOs of Coral Reef/Marine Environmental Zones/Areas In Florida Keys



ssion [Attributes](#)

ID Number	ID Subdivisio	Object Acron	Object Description	Geometry Ty	Object Type	Source ID
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[Output](#) [Query](#)



Task Group 1: MesoAmerican Pilot Project

[home](#)
[Project Description](#)
[Meetings](#)
[Documents](#)
[Links and Contacts](#)
[Maps and Photos](#)
[index](#)


ECWG TG1 is committed to providing regional hydrographic expertise for the development and execution of an implementation plan for all of the Gulf of Honduras Project's hydrography related sub-components



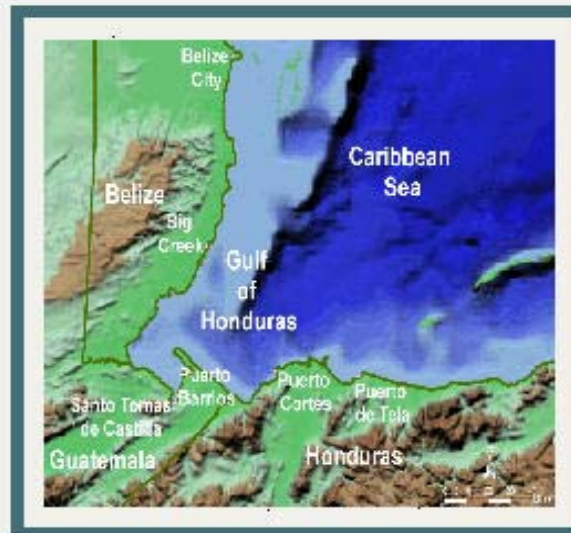
PROJECT

International Hydrographic Organization (IHO)
 MesoAmerican Caribbean Sea Hydrographic Commission (MACHC)
 Electronic Chart Working Group (ECWG)
 Task Group 1: MesoAmerica Pilot Project
 Gulf of Honduras Project - Component 3

[Español](#)

Purpose

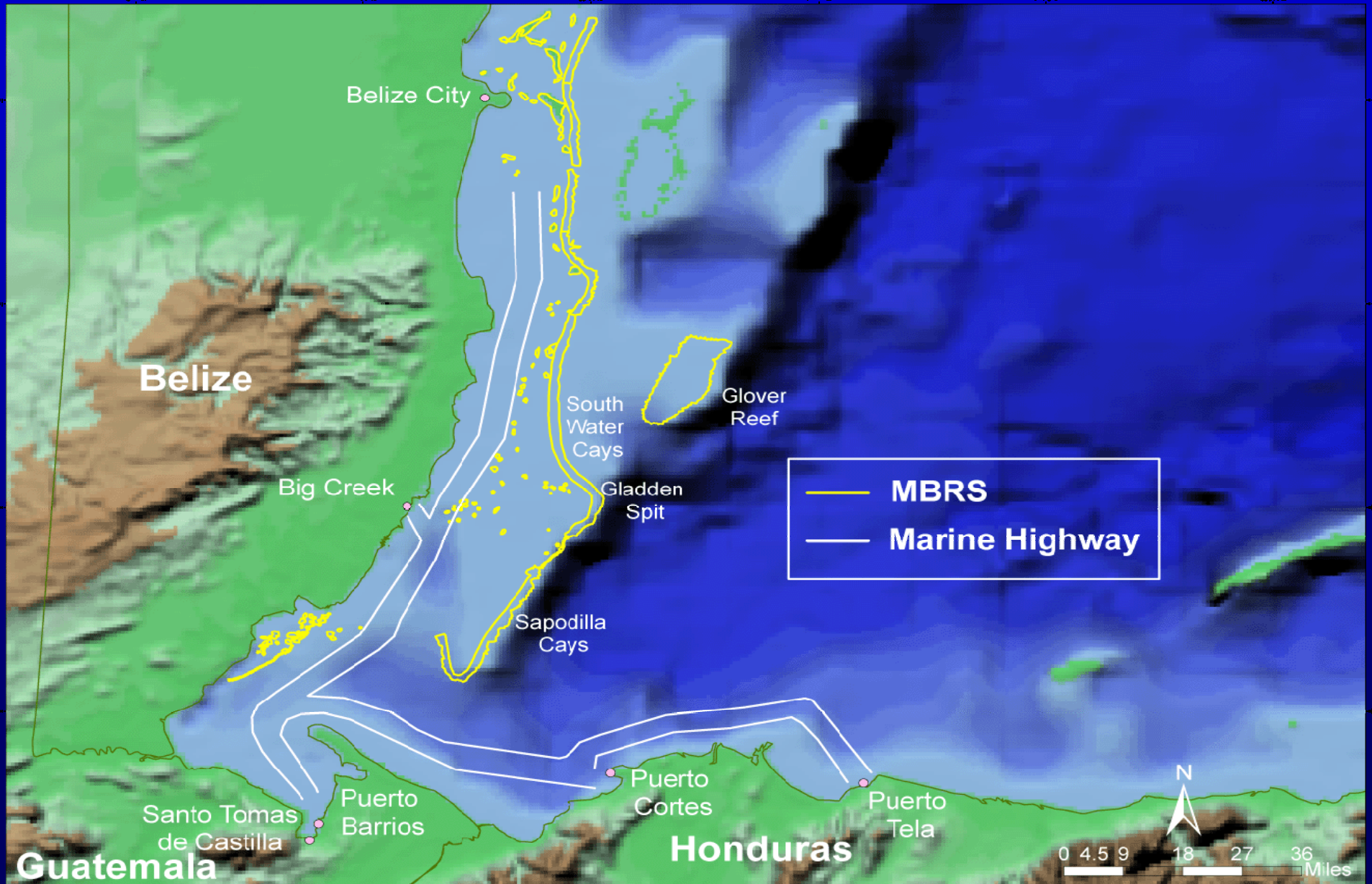
The purpose of this web site is to facilitate communications and organize the materials being produced by the MACHC Electronic Chart Working Group's ([ECWG](#)) Task Group 1 (TG1): Meso-American Capacity Building Pilot Project. The TG goal is to improve capacity of coastal states in a defined area by conducting a pilot project that



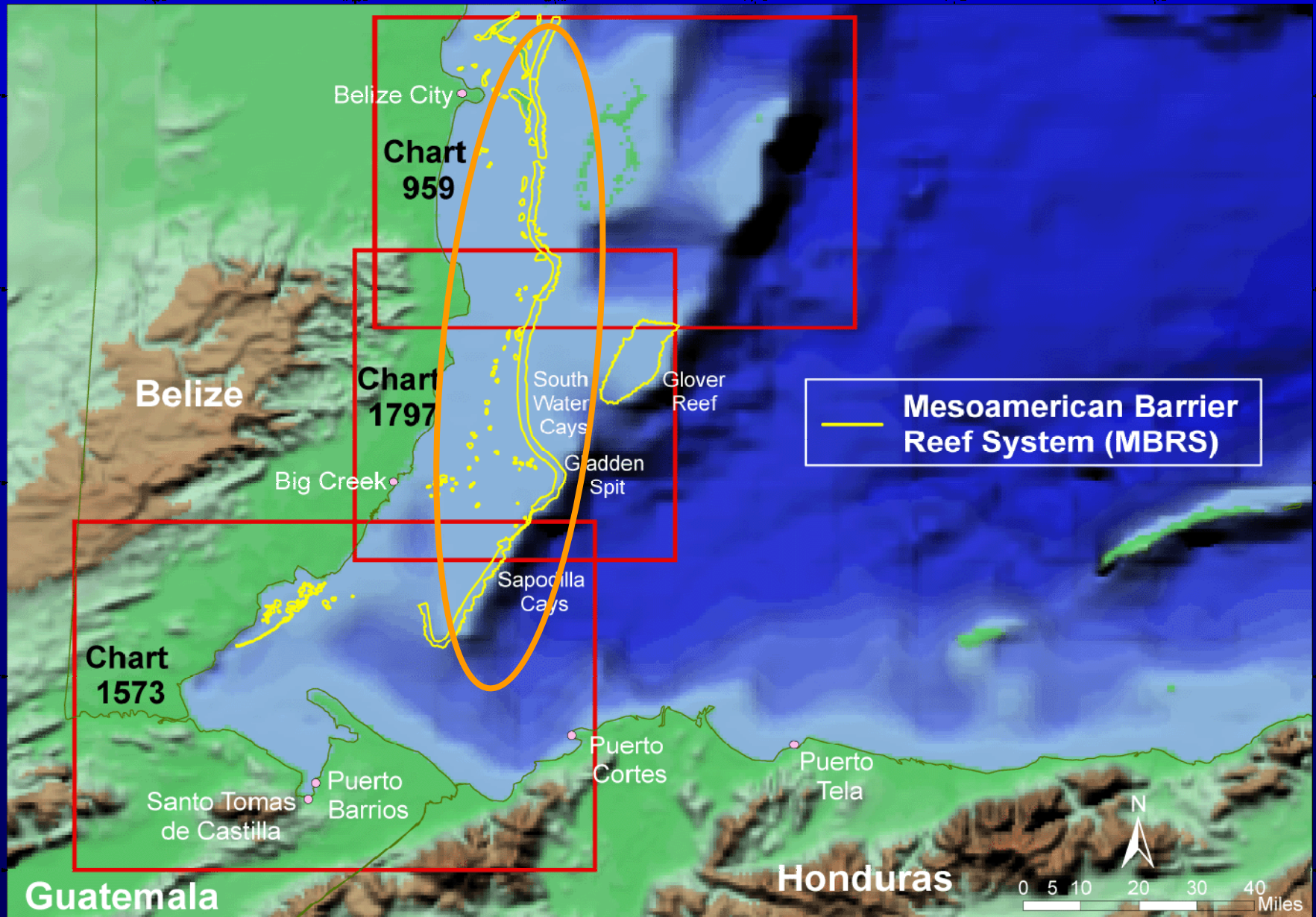
Map of the Gulf of Honduras Watershed.

[CLICK HERE](#) to see a chart

Mesoamerican Barrier Reef System (MBRS) and Gulf of Honduras Marine Highway



Proposed ENC_s as base for MIO_s For Mesoamerican Barrier Reef System



Electronic Chart - Marine Protected Area Initiatives

- Gulf of Honduras Project
 - Belize, Guatemala, and Honduras
 - MesoAmerican Barrier Reef System
- Cuba
 - Sabana-Camaguey Archipelago
- Australia
 - Great Barrier Reef
- Ecuador
 - Galapagos Islands

Marine Electronic Highway Project Straits of Malacca/Singapore



Marine Electronic Highway Demonstration Project

- IMO organized, World Bank funded project in Straits of Malacca and Singapore.
- AIM: Establish a regional mechanism for enhanced maritime safety and marine environmental protection.
- Includes production of ENCs, establishment of shore-based AIS stations, and development of MIOs for Environment and Natural Resource Conservation and Management (ENRCM MIO).

MIO Content Specification - File Naming Scheme

HO/ENC: IHO S-62
Non-HO/S-57: OEF → IHO website

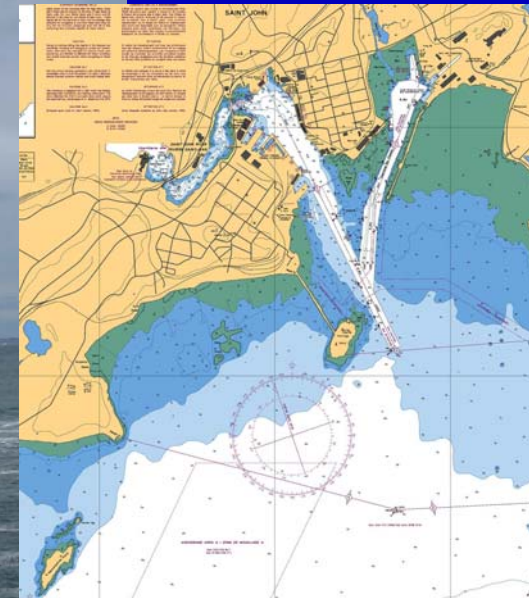
char

2 Producer Code
2 MIO category (M + Sub-cat)
1 Scale band
3 Unique MIO cell number

Sub-category:

A Aids-to-navigation
B Benthic Habitats
C Current flow
D sailing **D**irections
E Emergency Management
I Ice coverage
L Logistics
M Marine Protected Areas
O Oceanographic
P Pipelines/cables
Q Data **Q**uality
S Security
T Tide/water level
U UNCLOS Law of the Sea
V Viewpoint (as for AMLs)
W Weather/meteorological

Sailing Directions in Digital Formats: The Real-World in Video

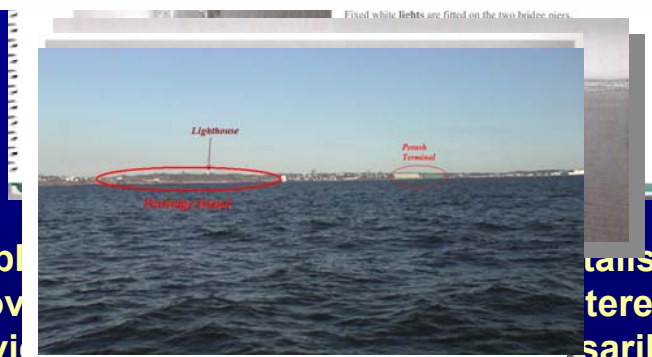


LCDR Andres Millan
Royal Spanish Navy
University of New Brunswick
Fredericton, CANADA

Concept of “Sailing Directions”

35 **Inner approach to Saint John.** — The channel into the harbour lies to the east of **Partridge Island** ($45^{\circ}14'N$, $66^{\circ}03'W$), 24 m high, which is situated 2.6 miles NE of Manawagonish Island. A drying reef surrounds the island, and a rock breakwater joins the west side of the island to **Negro Point**, 0.5 mile NNW. Fairway light and whistle **buoy J (145)** is moored 1.3 miles SSE of Partridge Island. A **racon** (—•) operates from this buoy. A **light (100)** is shown from a tower 13.6 m high, with red and white vertical stripes, on the highest point of the island.

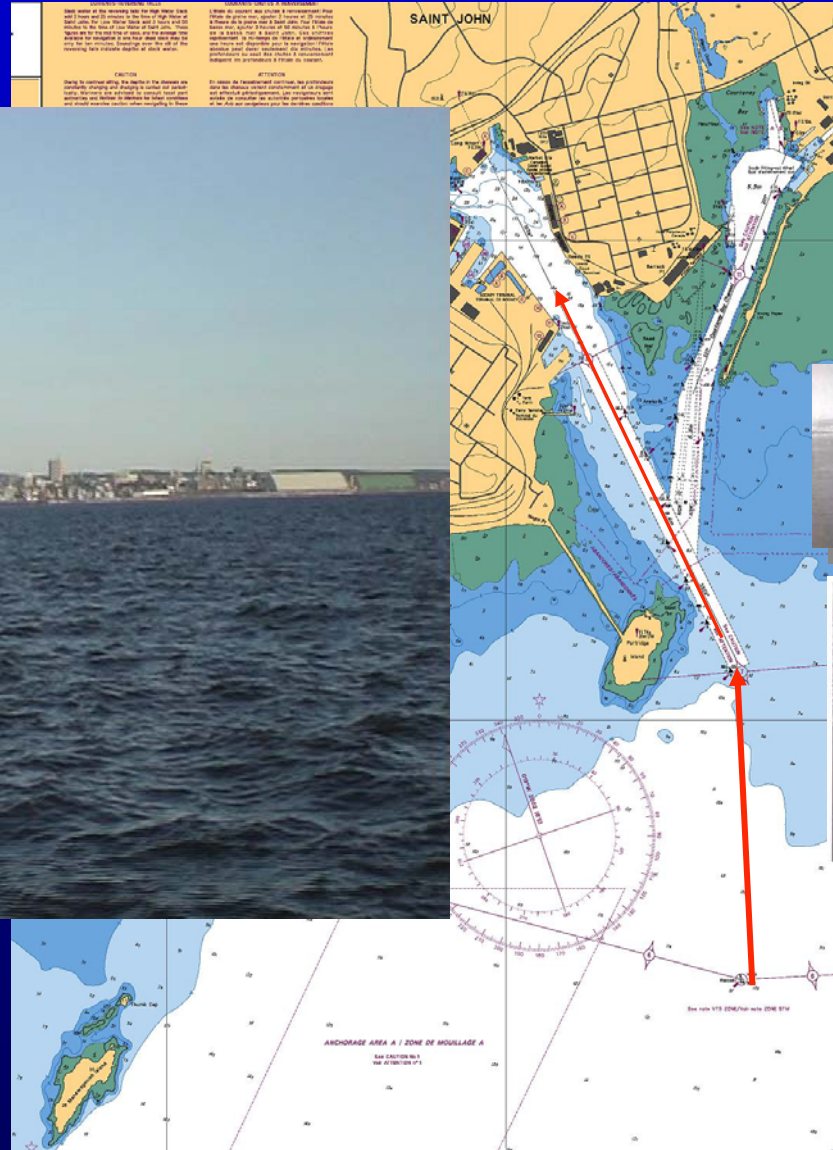
56 The *Bay Ferries* terminal is situated at the south end of the west side of the main harbour, 0.9 mile from Partridge Island. The wharf is 253 m long. The *M/V Princess of Acadia* makes scheduled crossings of the Bay of Fundy to Digby, Nova Scotia.



Publications and charts of interest to mariners can be found on charts or in other marine publications. It is intended to be read in conjunction with the charts quoted in the text.

(From *Canadian Sailing Directions* publication)

Video edition: a highly accurate depiction of real world

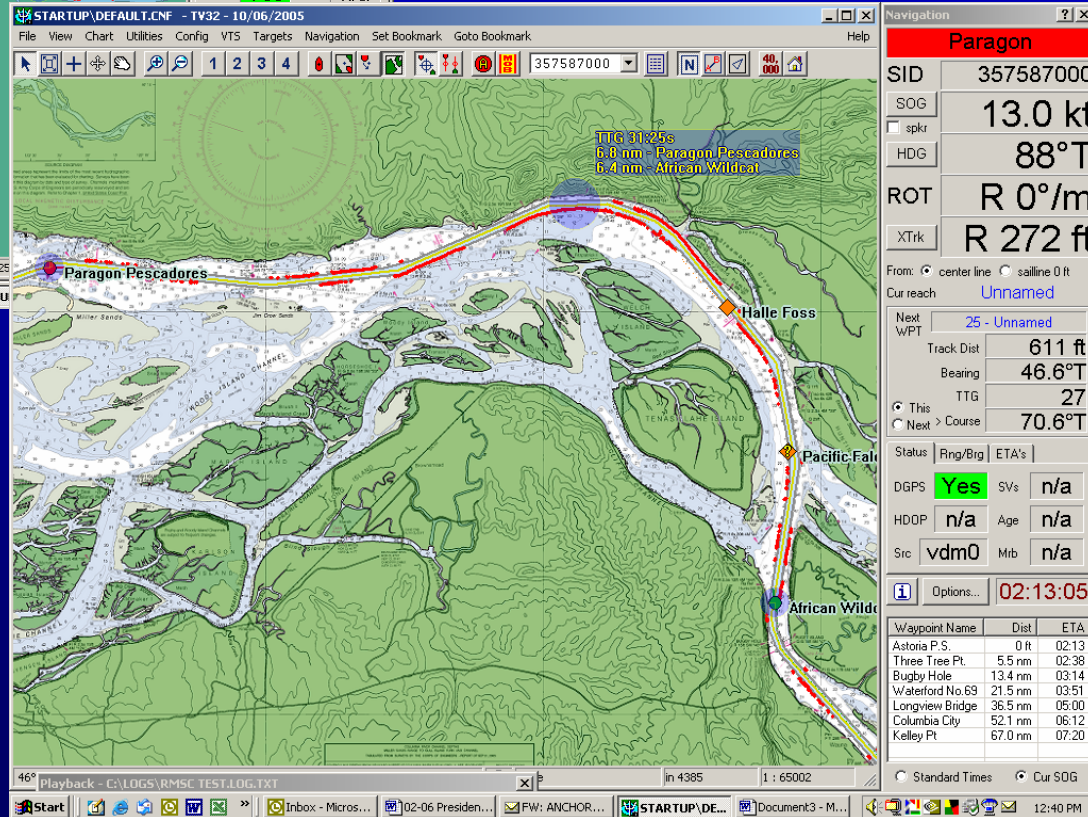
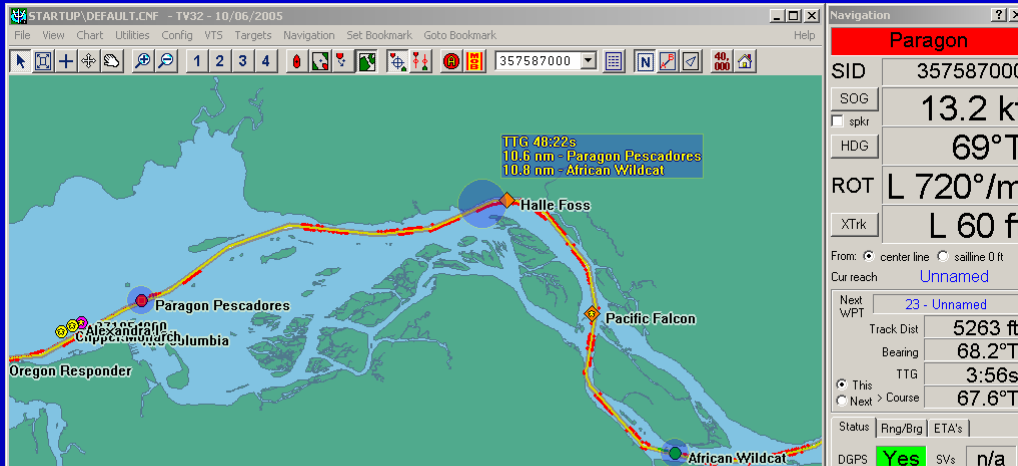


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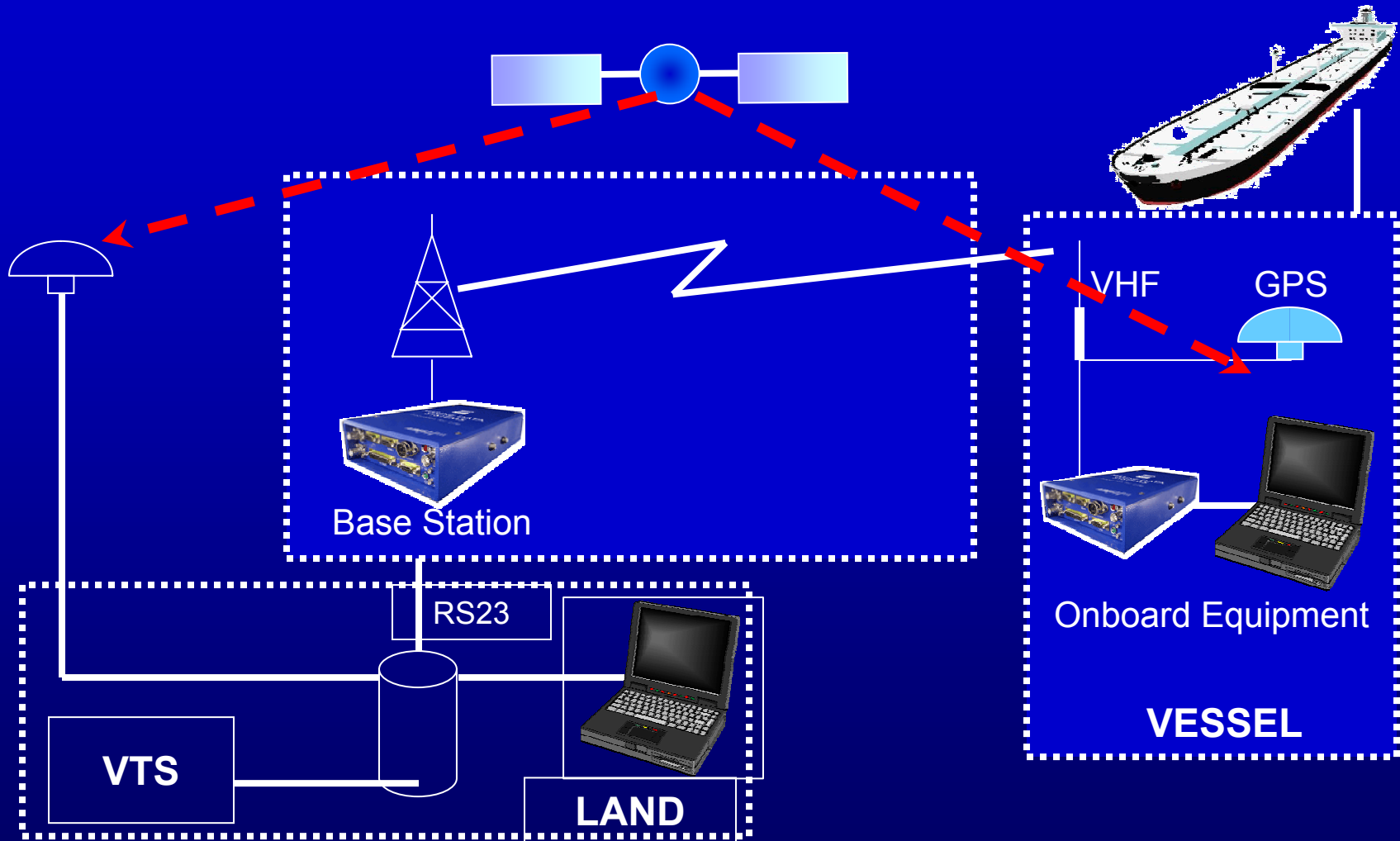


Electronic Chart + AIS = Decision Support



Display of Portable Pilot Unit (PPU) used by Columbia River Pilots, Oregon, USA

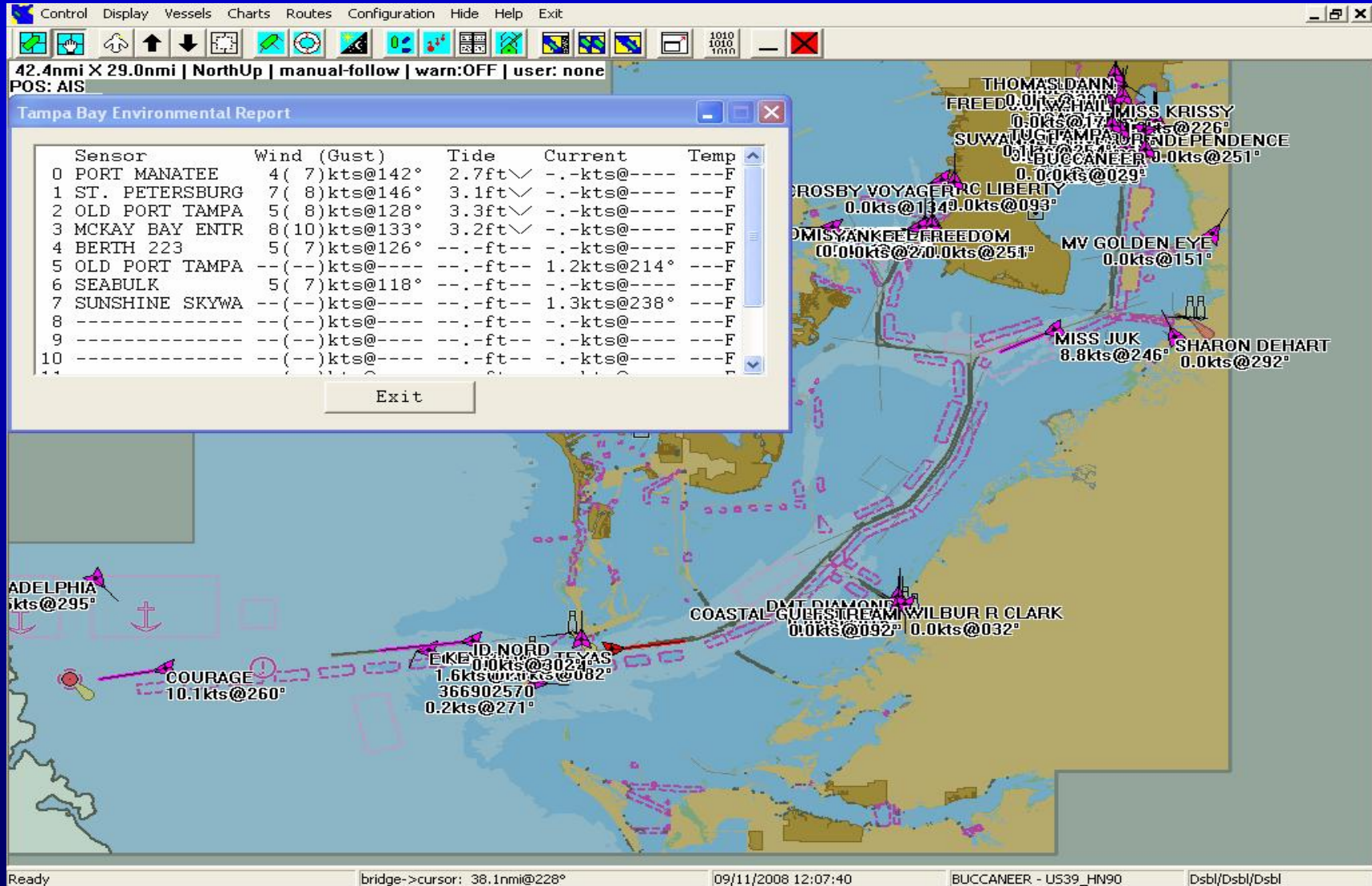
AIS Broadcast



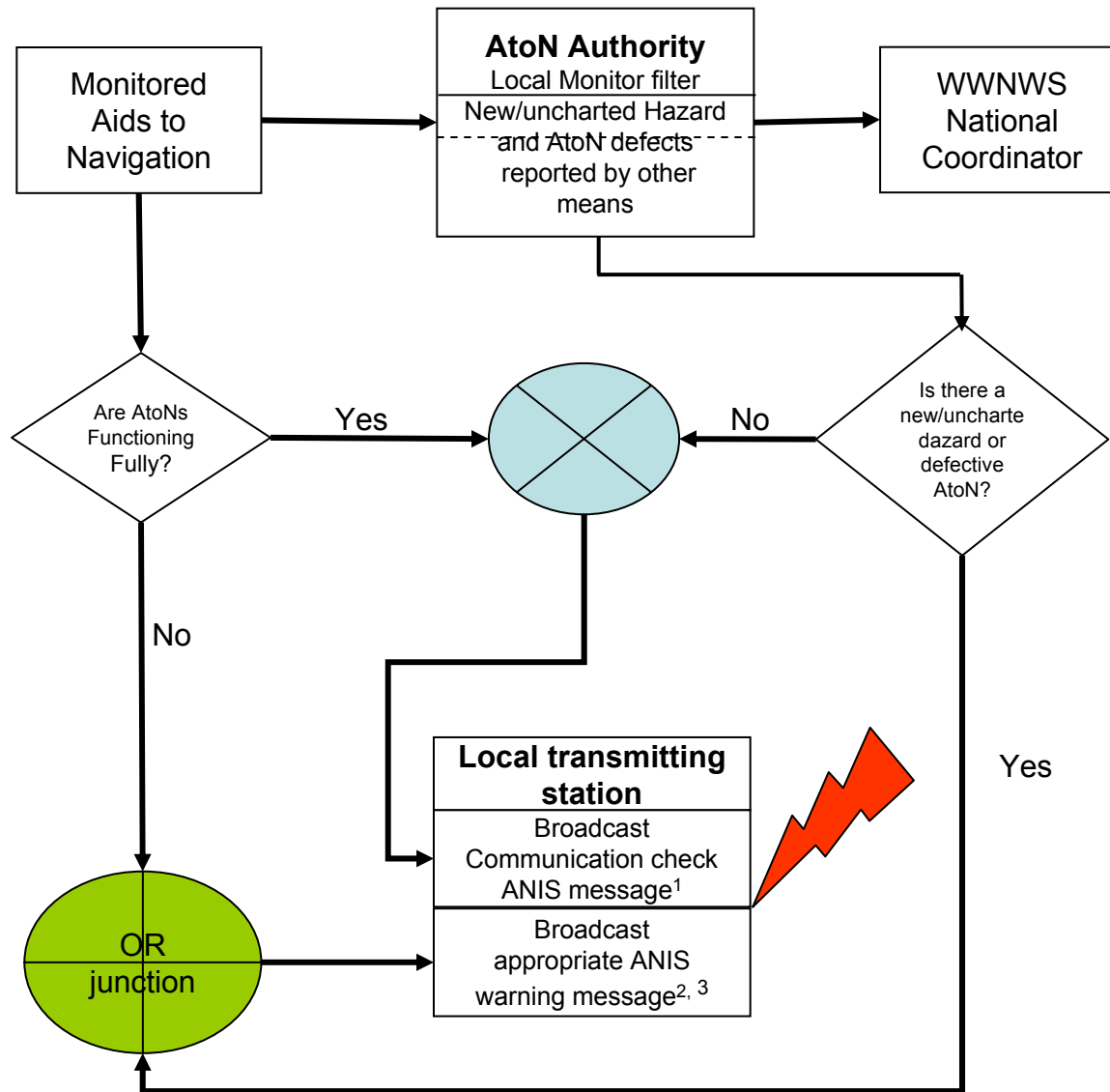
AIS Binary Messages

- IMO Meteorology and Hydrology Message as specified in IMO.
- SN/Circ.236, Annex 2, Application 1 .
- Also described in AIS, Vol. 1, Part 1, Operational Issues, Ed. 1.3. IALA Guideline No 1028, p. 131.
- Will be an AIS Binary Message Register maintained by IALA.

AIS Binary Broadcast Testbed – Tampa Bay

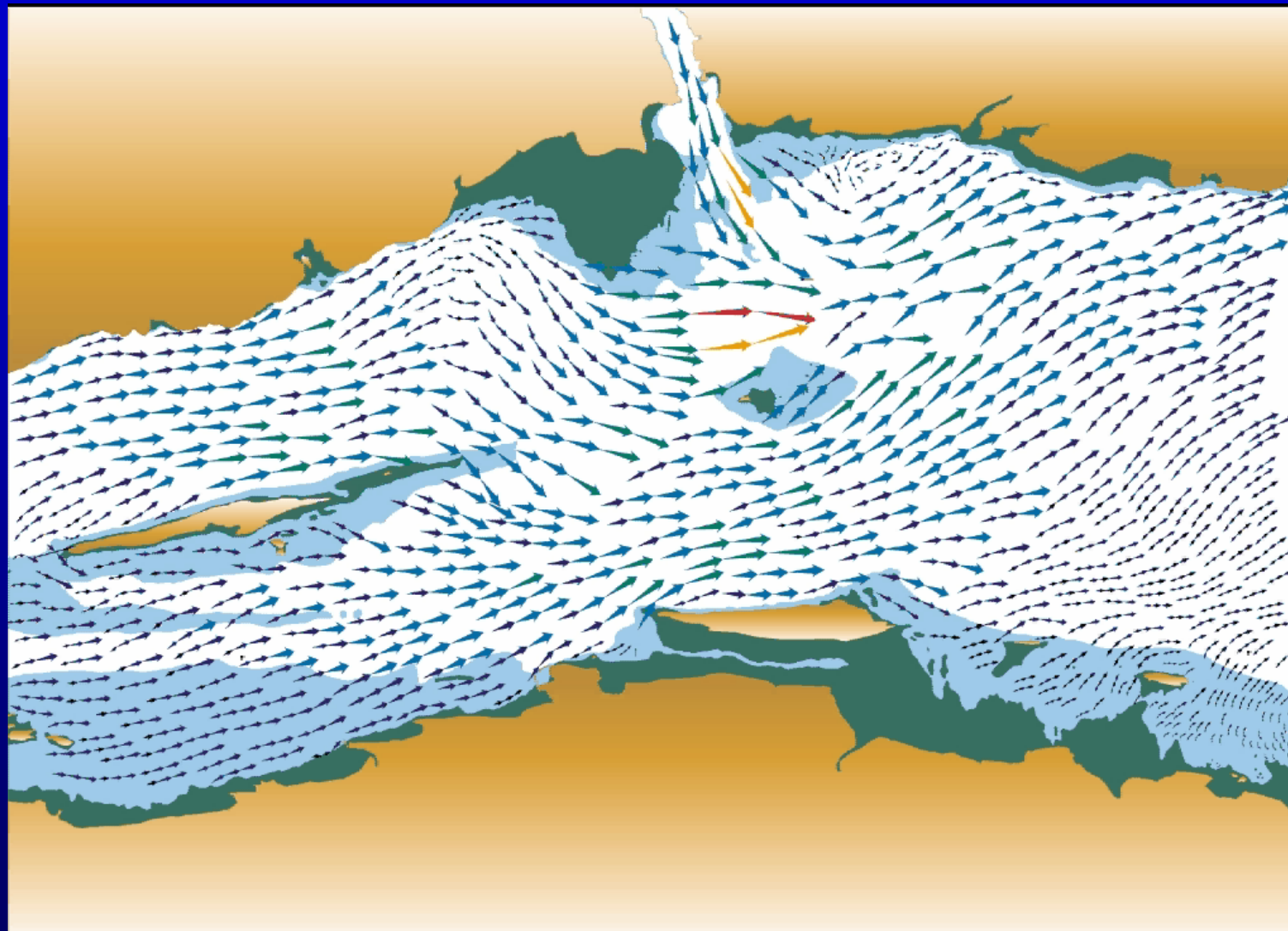


Aids-to-Navigation Information Service (e-ANSI)



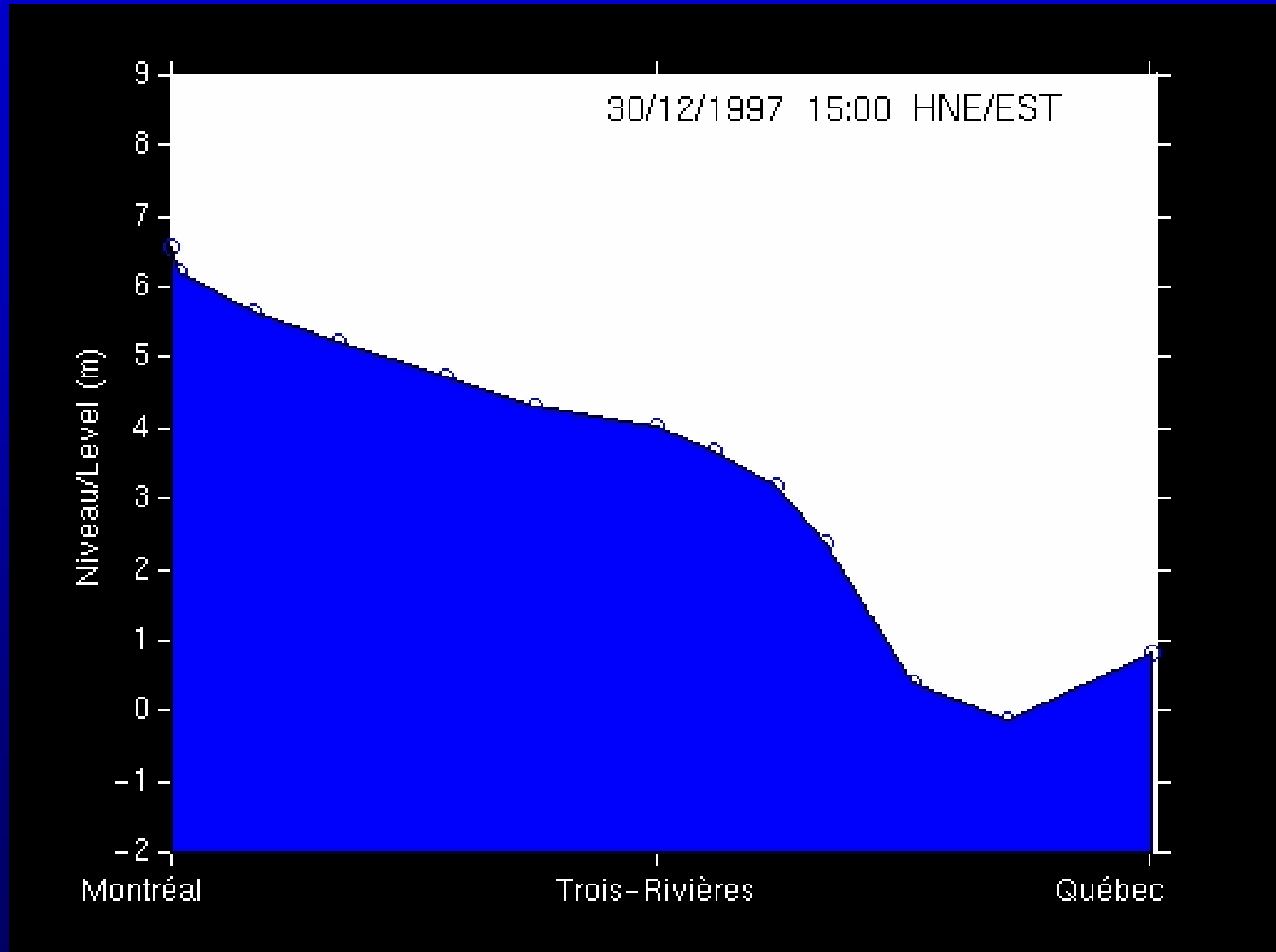
Tidal Currents in the St. Lawrence River, Canada

- **Predicted**
(current tables)
- **Real-time**
(via AIS Broadcast)



Source: *Atlas of Tidal Currents – St. Lawrence Estuary*, Department of Fisheries and Oceans, Canada
Simulation provided by: Canadian Hydrographic Service - Maurice Lamontagne Institute, Mont-Joli, Quebec

Tidal Levels in St. Lawrence River, Canada

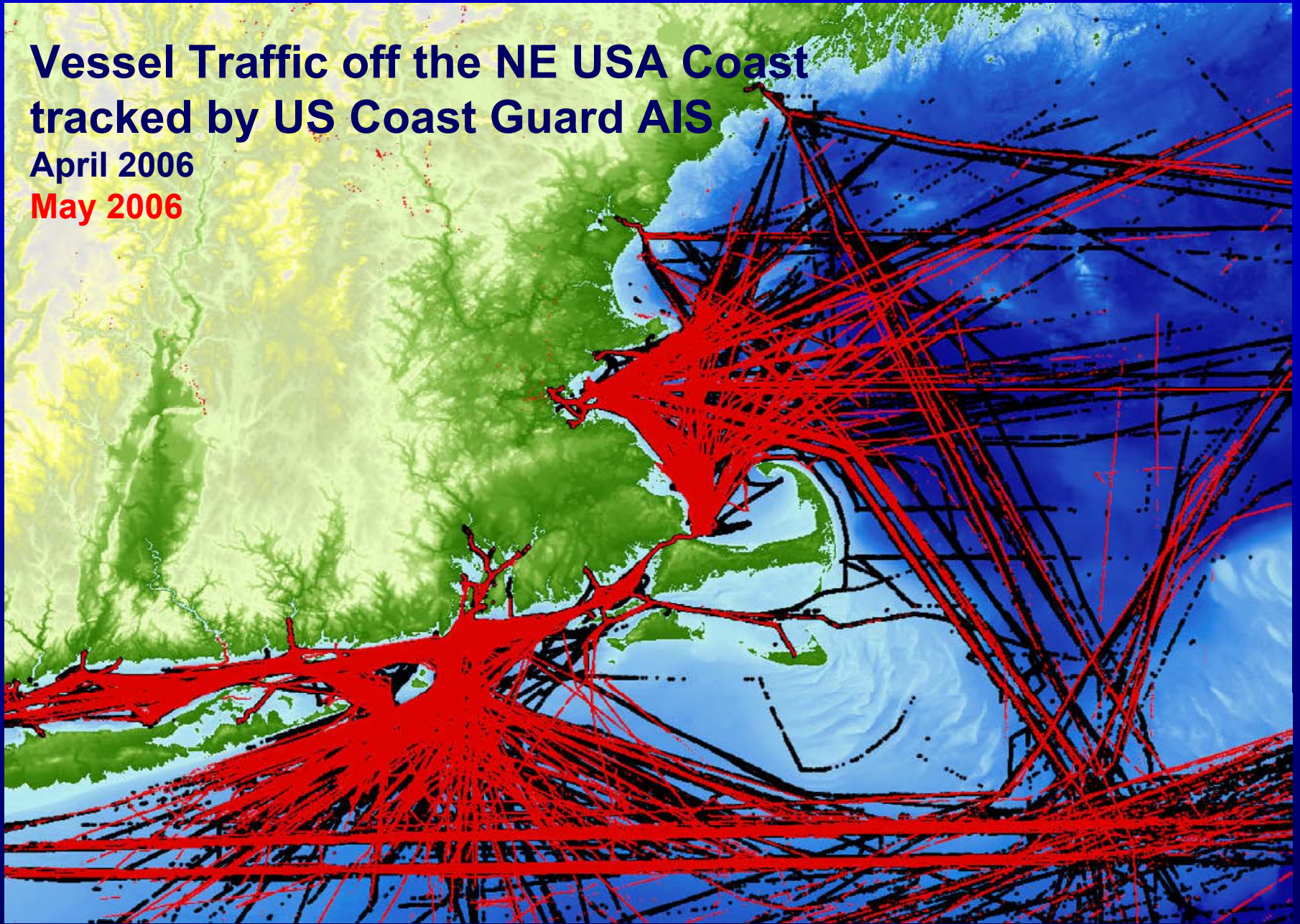


Source: Gilles Ringuette, Canadian Coast Guard, Quebec

Vessel Traffic off the NE USA Coast tracked by US Coast Guard AIS

April 2006

May 2006

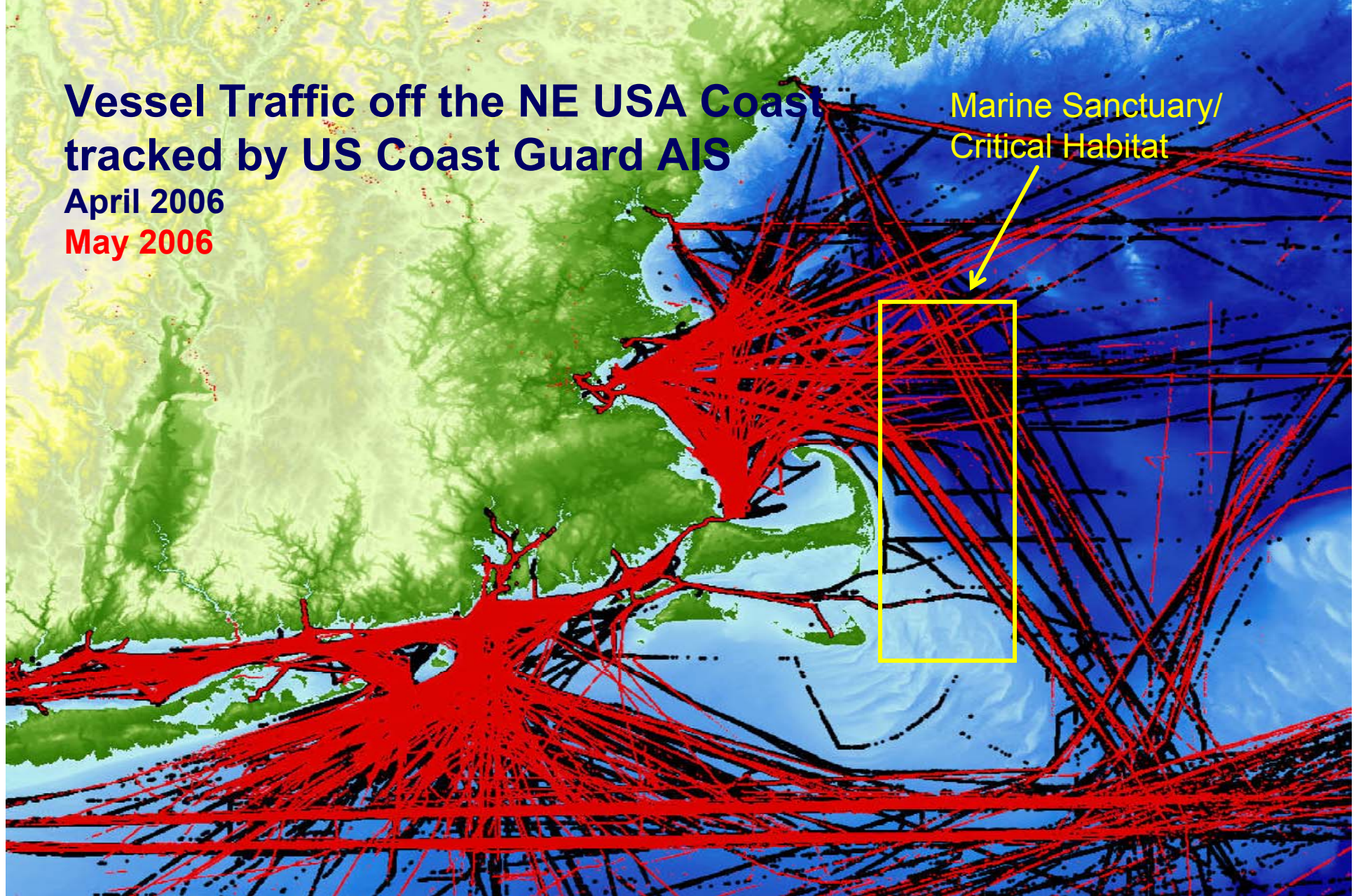


Vessel Traffic off the NE USA Coast tracked by US Coast Guard AIS

April 2006

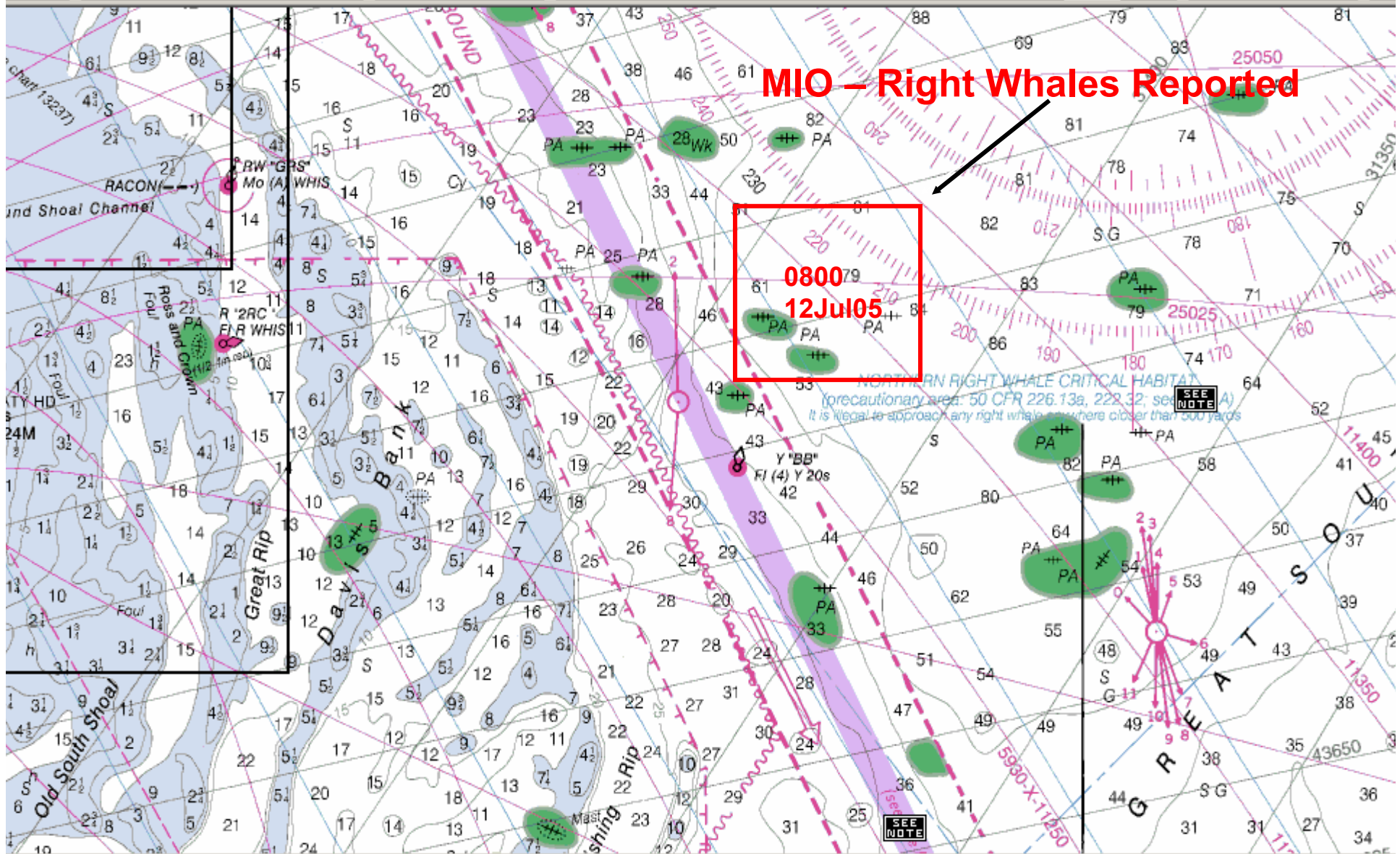
May 2006

Marine Sanctuary/
Critical Habitat





North Atlantic Right Whales:
An Endangered Species

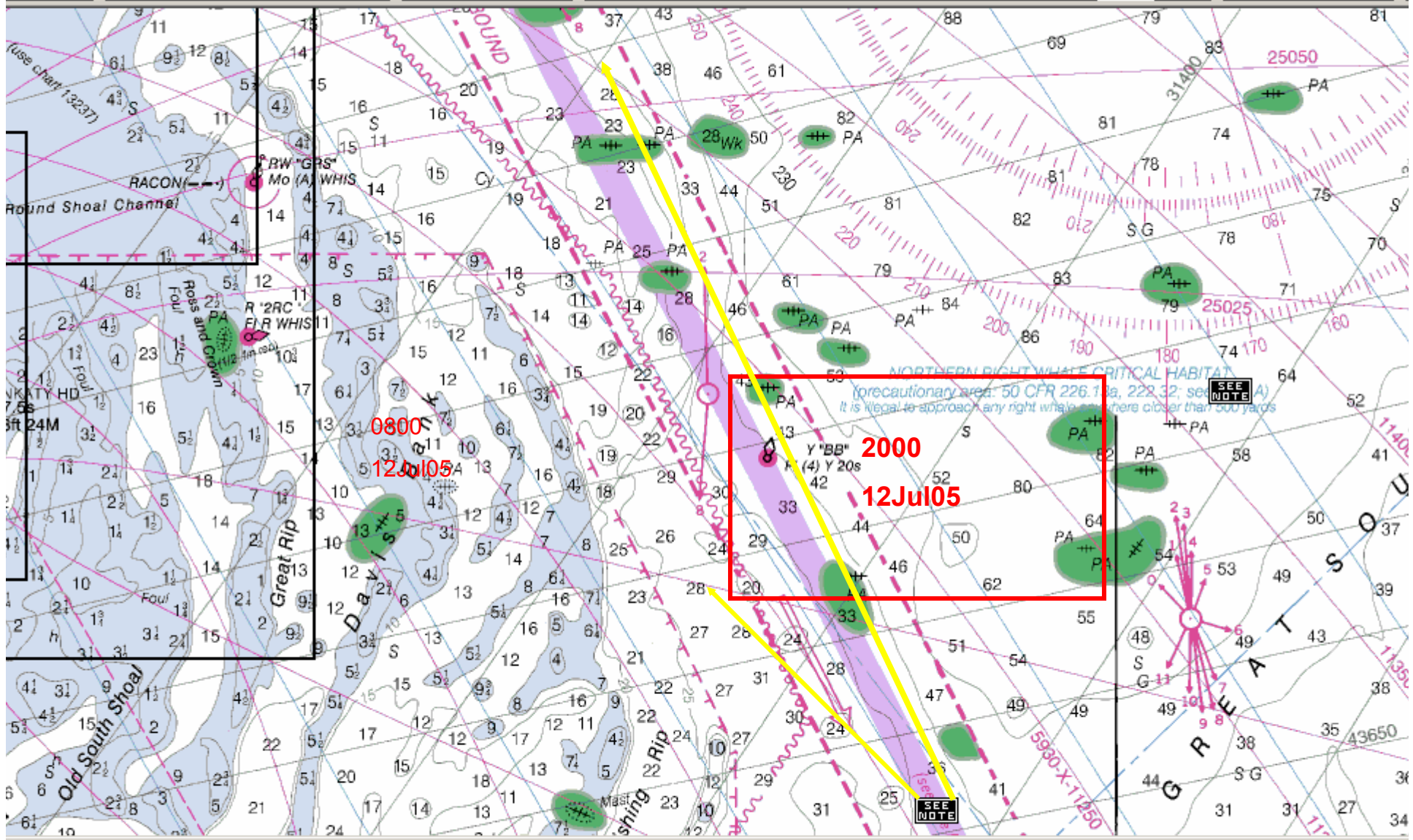


MIO - Right Whales Reported

**0800
12 Jul 05**
PA PA PA

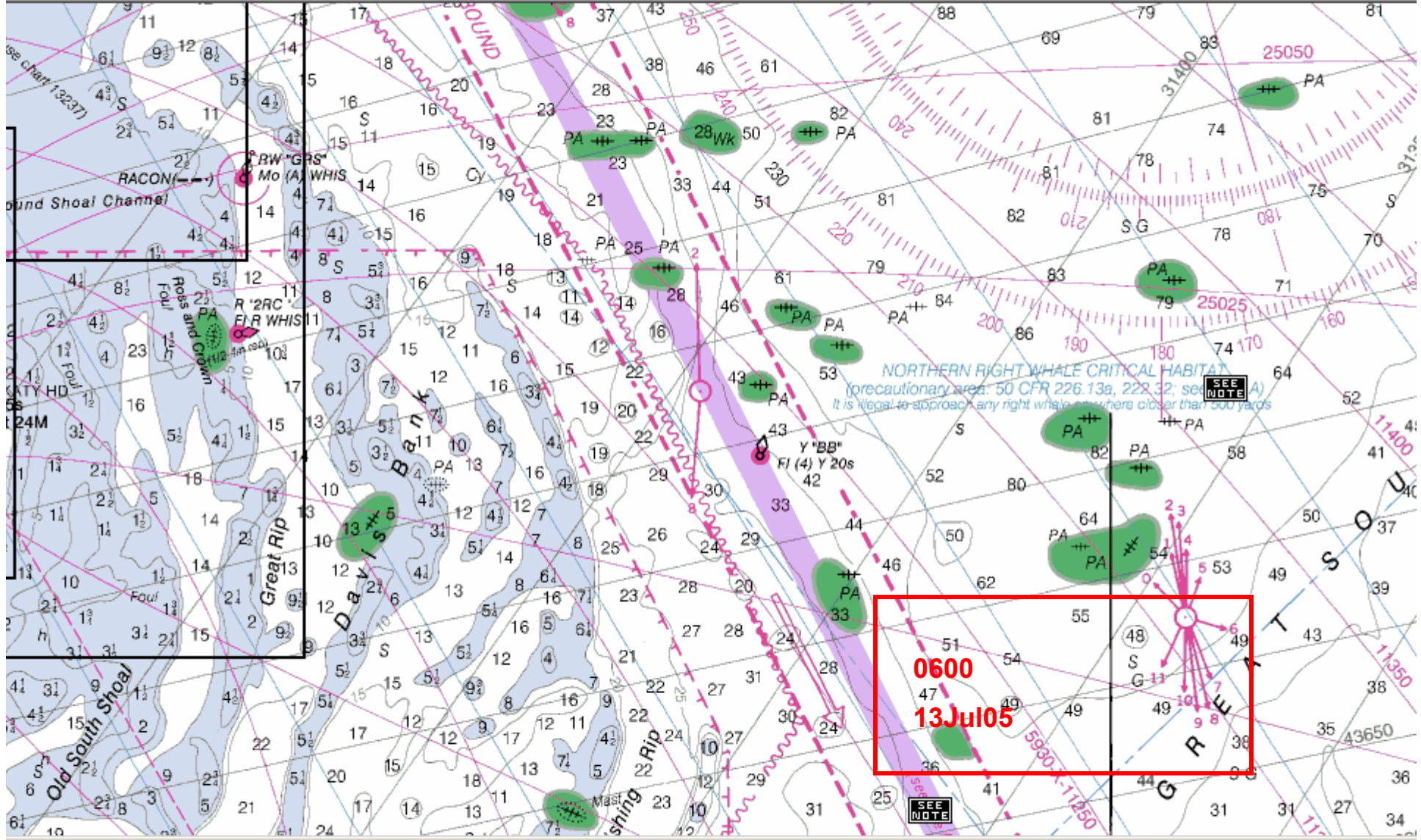
View Vessel Relative Link Charts North Up No NTMs Found 56.40 NM 1:500000 0.50 X

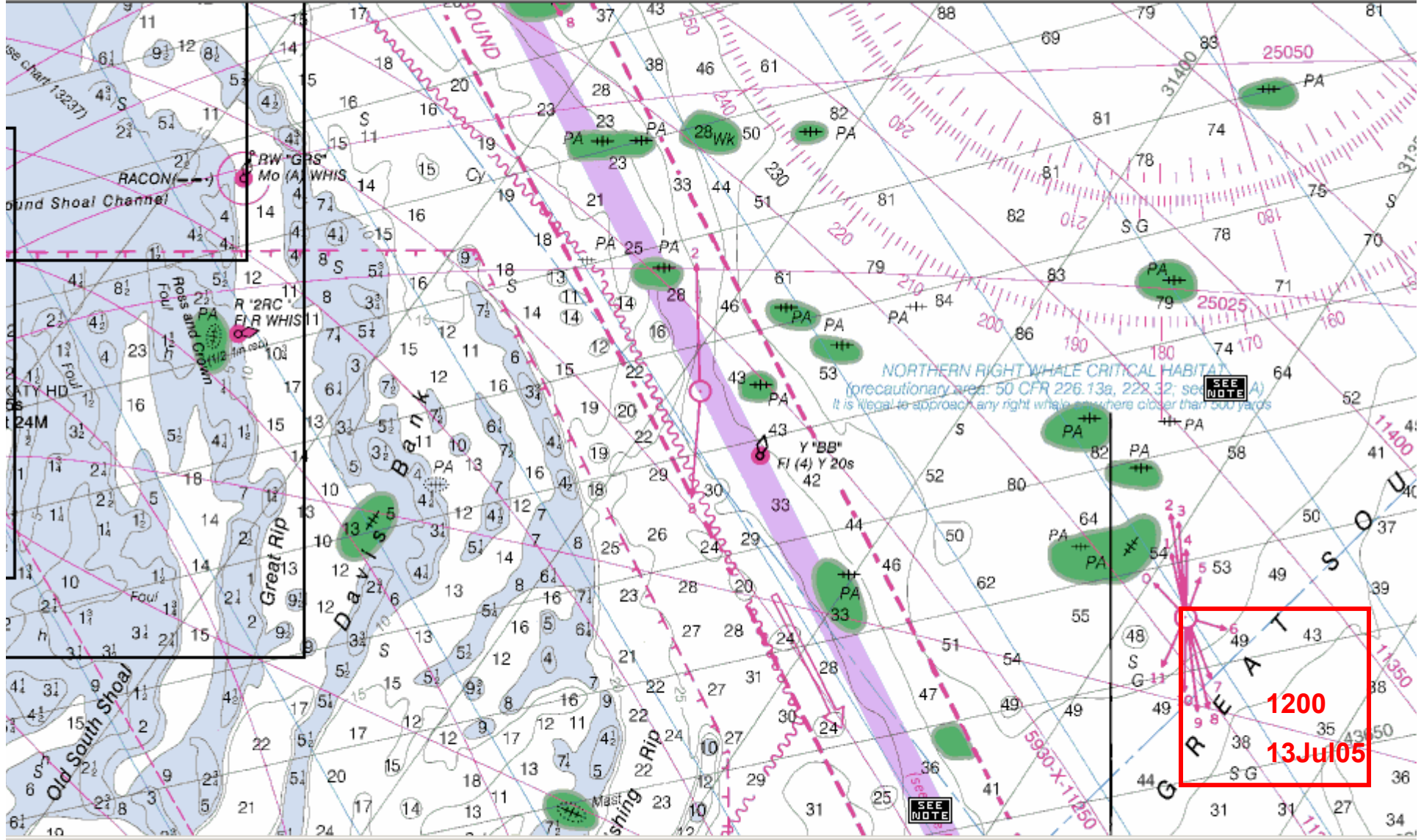
13009_1 GULF OF MAINE AND GEORGES BANK 1:500000 Lat: 41° 02.959' N Lon: 069° 11.750' W Rng: 1181.0 NM L O C A T I O N Vessel Position: Simulator



Follow Vessel Relative Link Charts North Up No NTMs Found 56.40 NM 1:500000 0.50 X

13009_1		GULF OF MAINE AND GEORGES BANK		1:500000	Lat: 41° 02.959' N	LOCAL + Datum OK
					Lon: 069° 11.750' W	
					Rng: 1181.0 NM	
					Brg: 37° Magnetic	





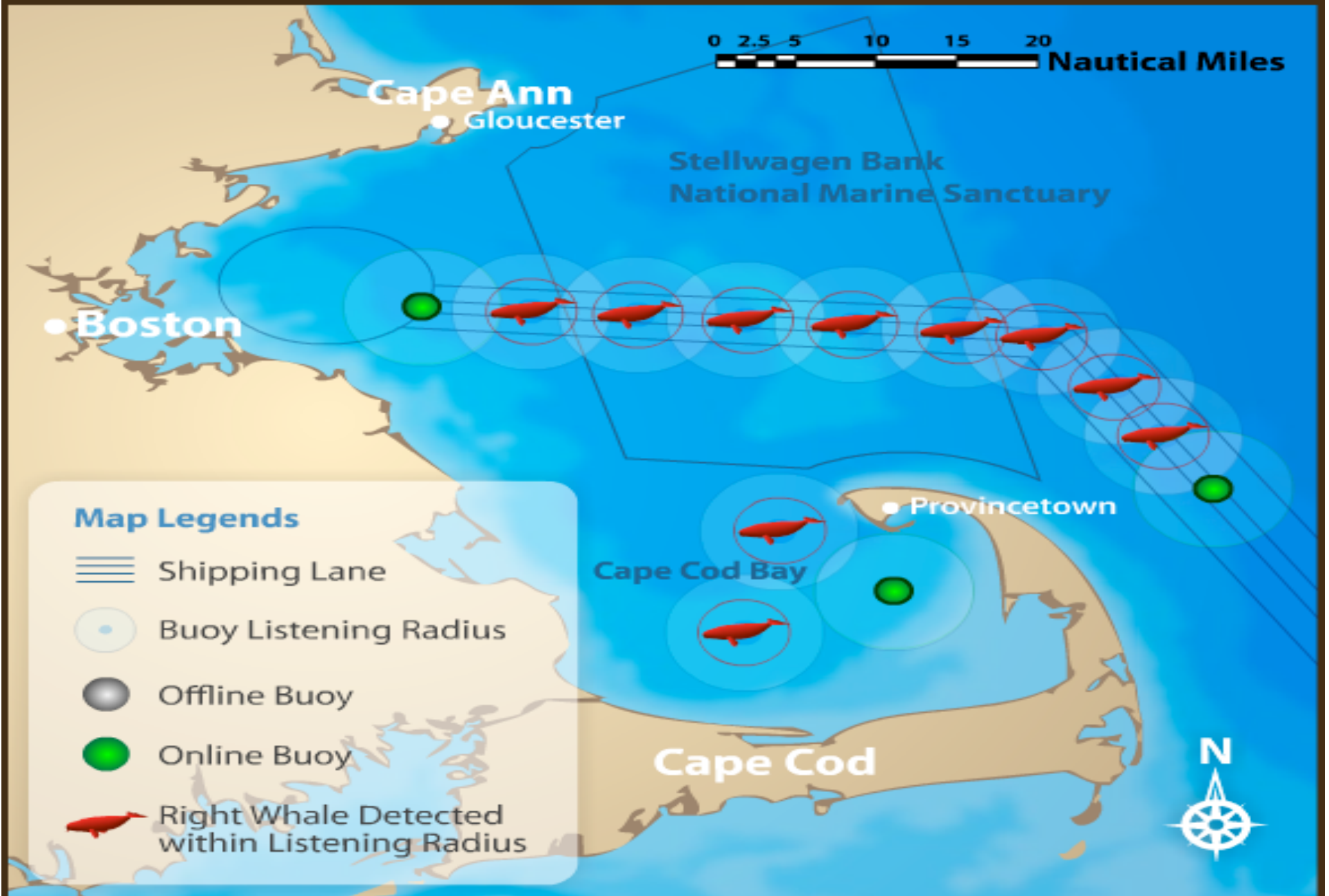
Allow Vessel Relative Link Charts North Up No NTMs Found 56.40 NM 1:500000 0.50 X

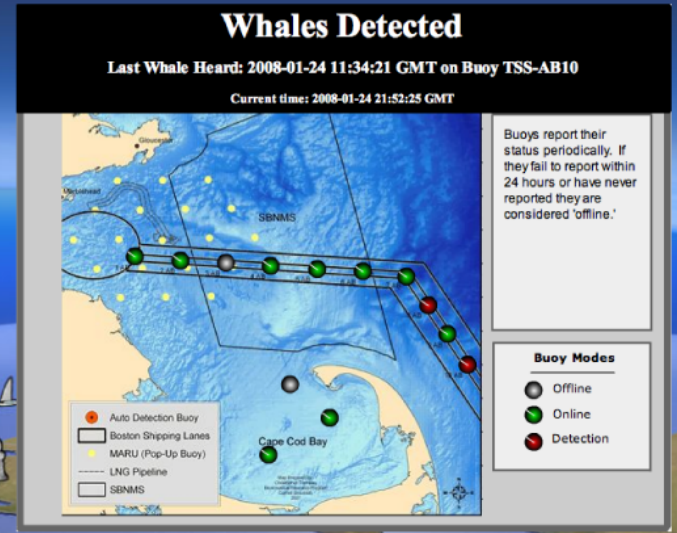
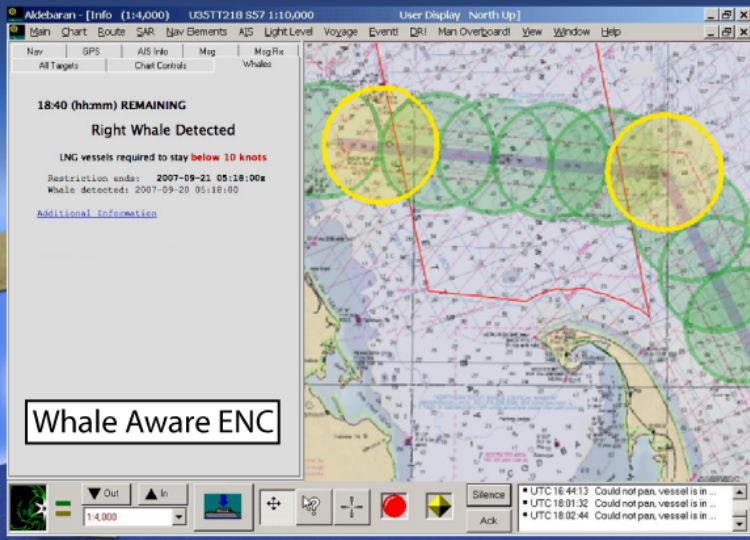
13009_1 GULF OF MAINE AND GEORGES BANK

Lat: 41° 02.959' N
Lon: 069° 11.750' W
Rng: 1181.0 NM
Brg: 37° Magnetic

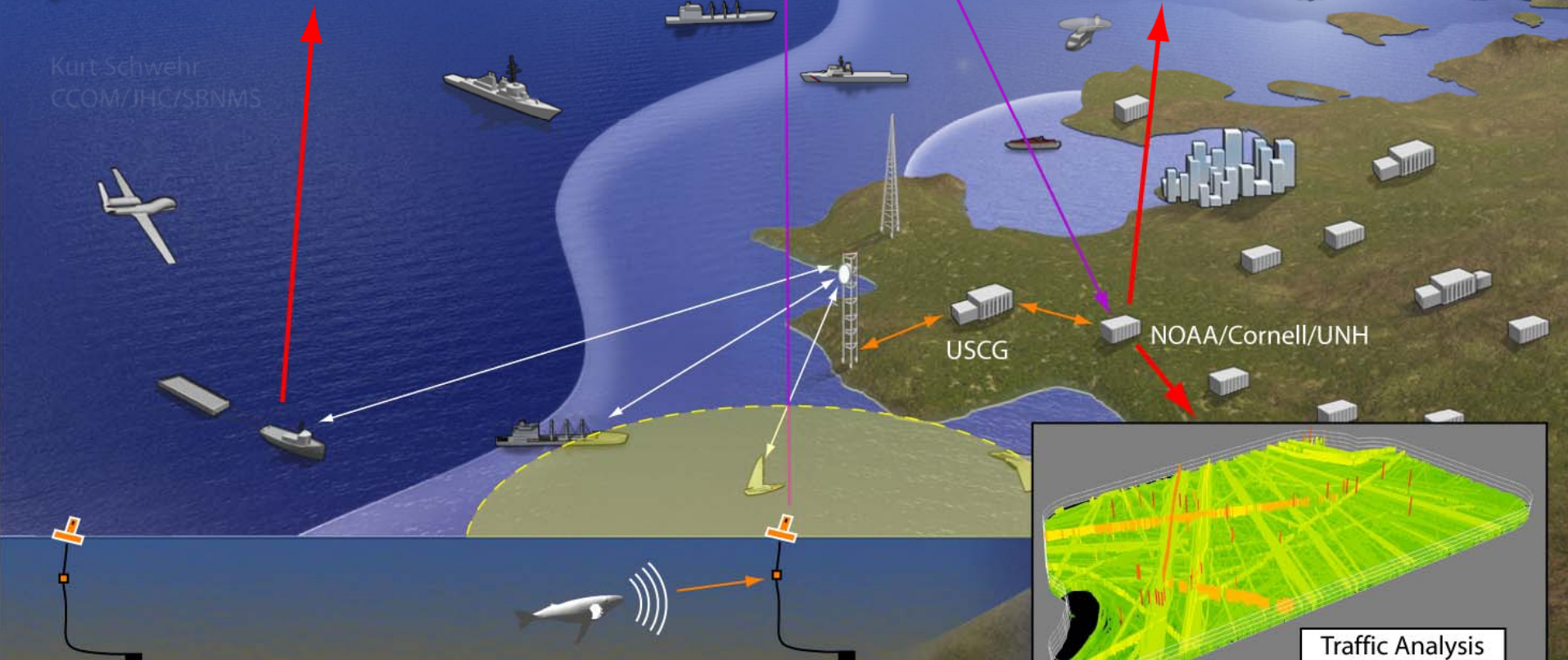
LOCAL Vessel Position: Simulator Datum OK 0.50

227 Right Whale Calls Detected Within 24 Hours.

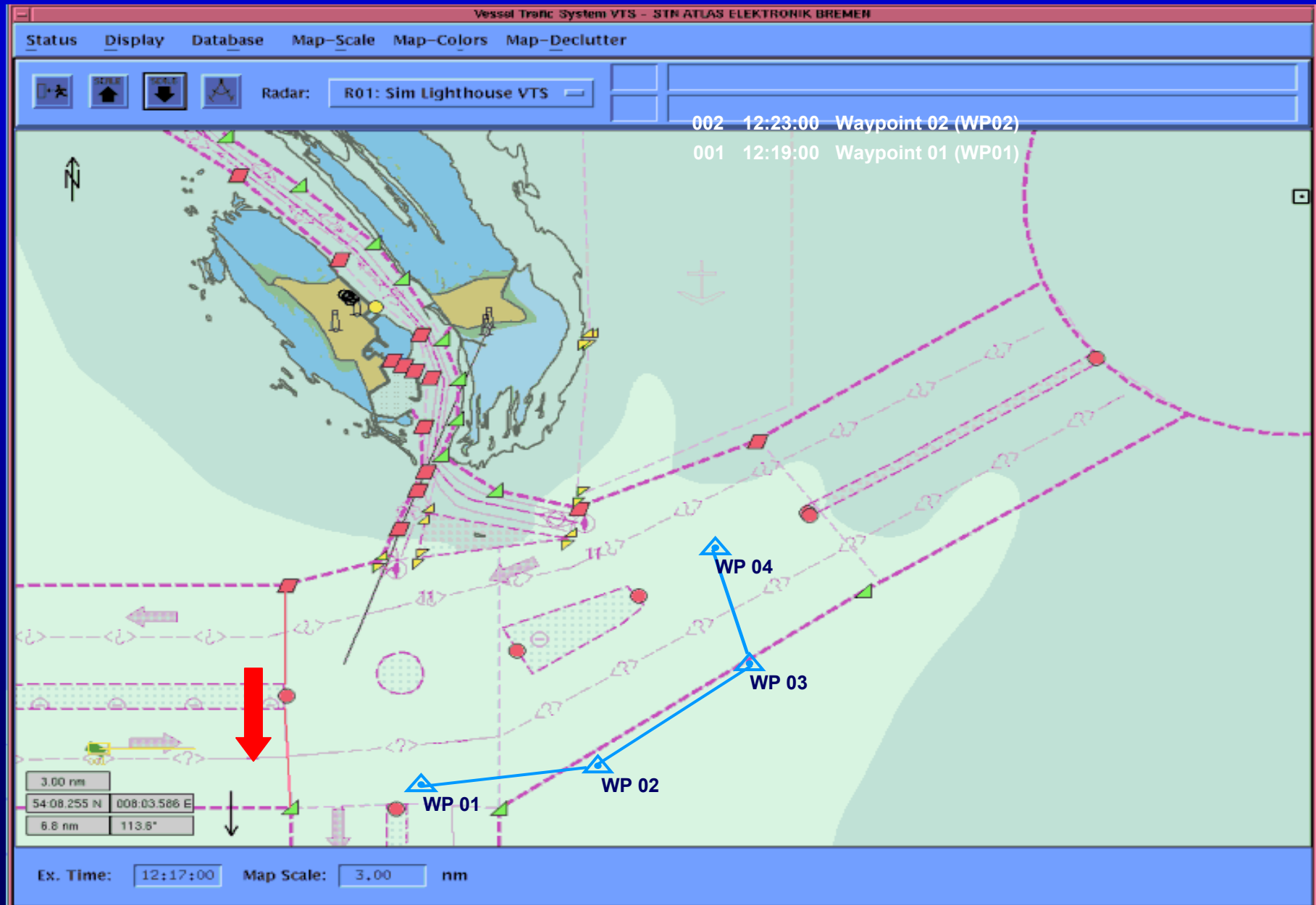




Kurt Schwehr
 CCOM/JHC/SBNMS



ECDIS with VTS



Air Draft – Powerline Clearance

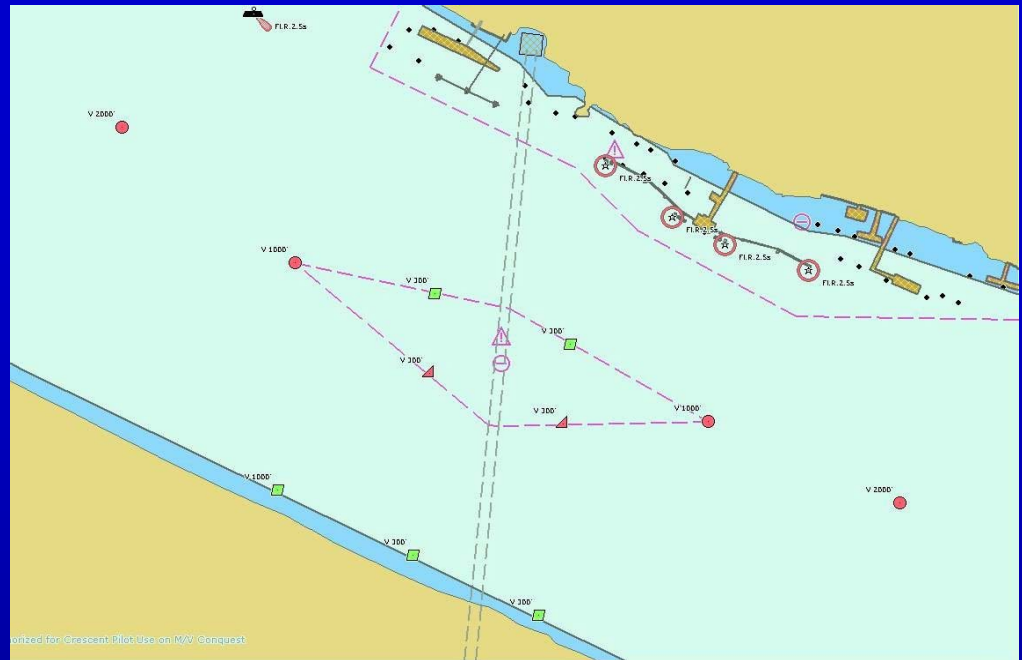
Mississippi River: Chalmette Power line (Mile 89.2)



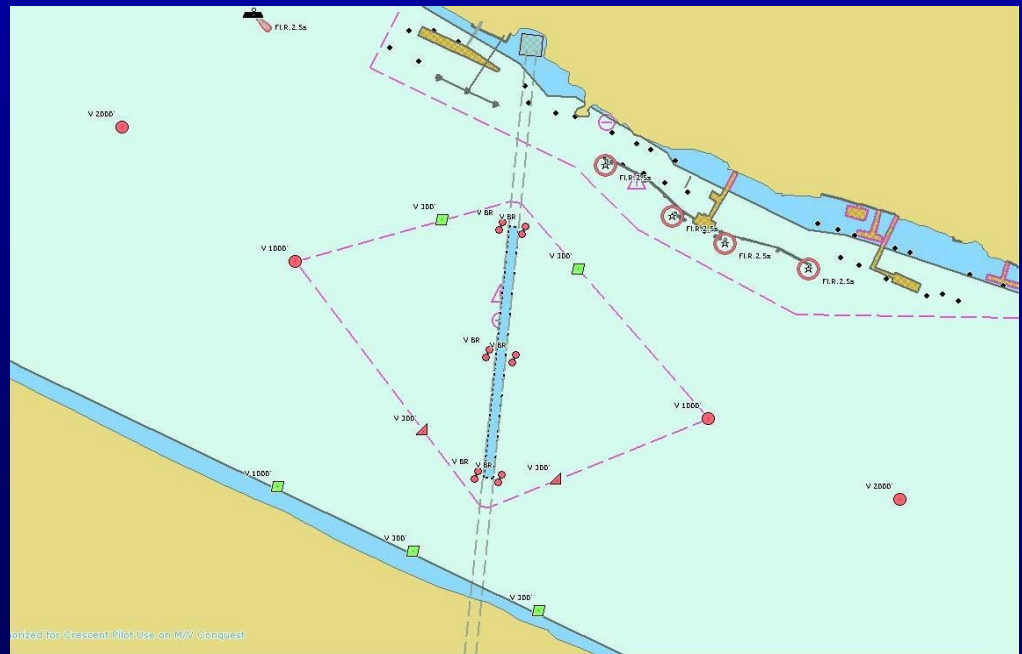
Source: Ralph Schied, US Army Corps of Engineers New Orleans District

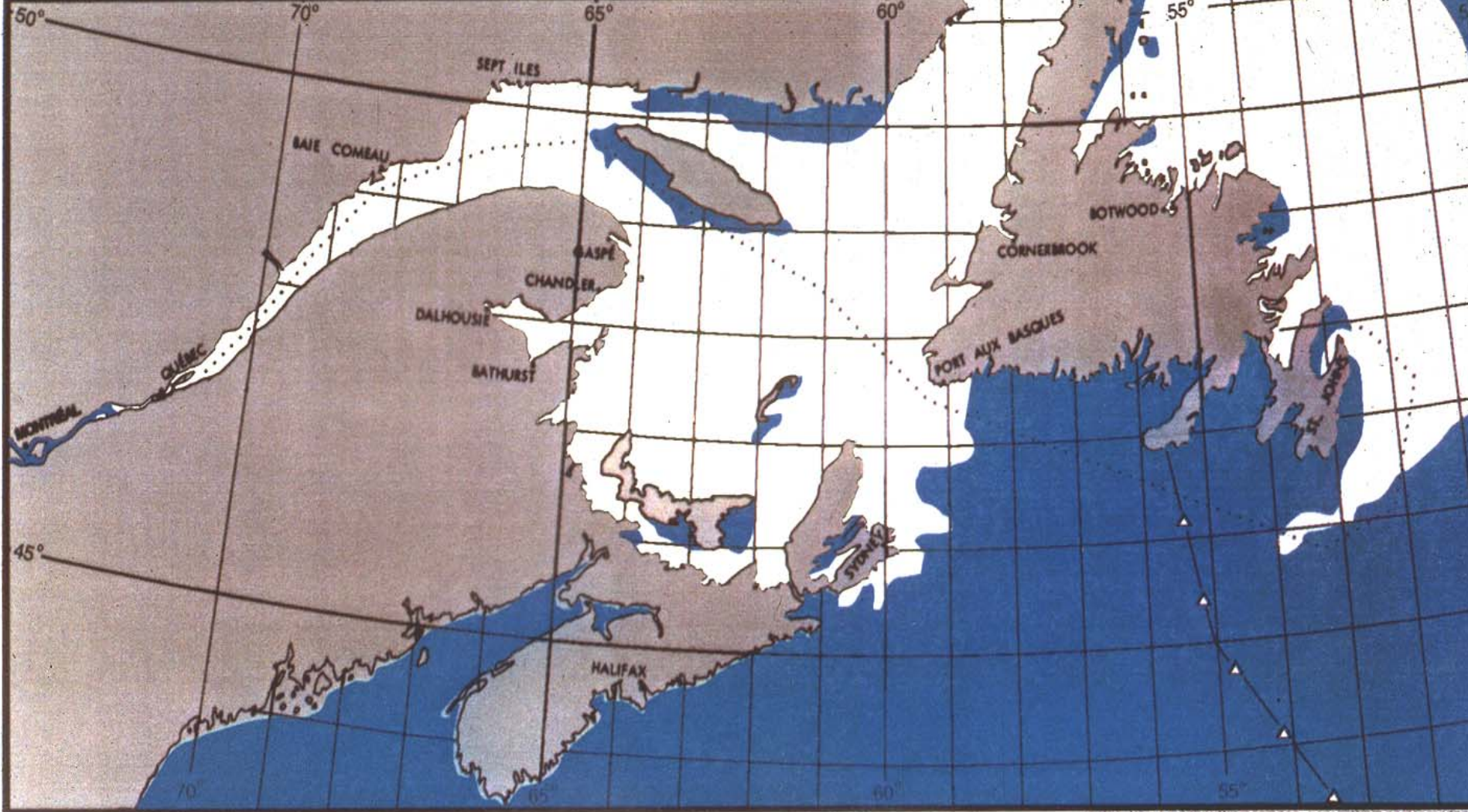
“Virtual AtoN”

Lower river stage
&/or
less powerline sag



Higher river stage
&/or
more powerline sag









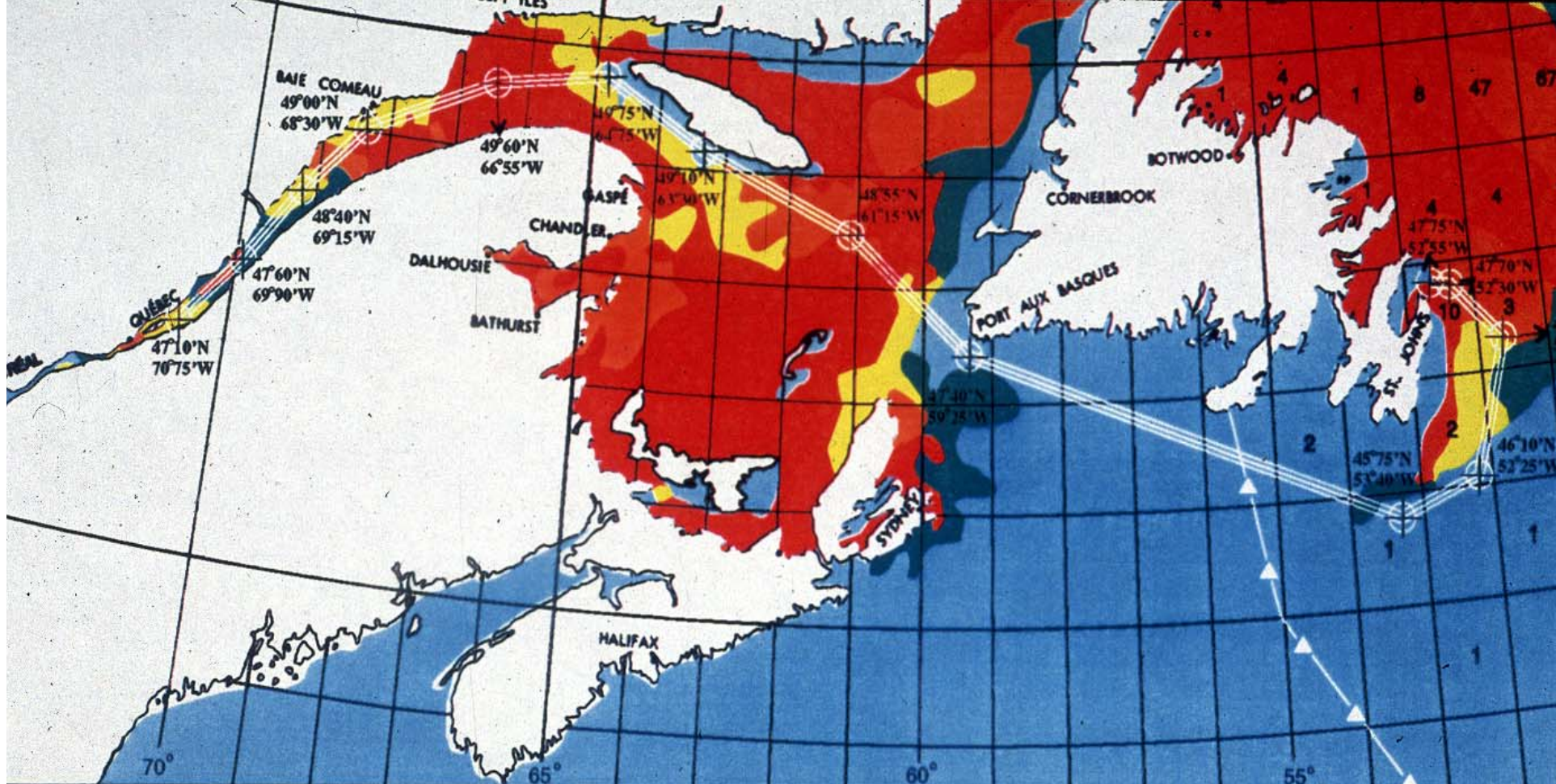
ATMOSPHERIC ENVIRONMENT SERVICE - DEPARTMENT OF THE ENVIRONMENT
 SERVICE DE L'ENVIRONNEMENT ATMOSPHERIQUE - MINISTÈRE DE L'ENVIRONNEMENT

DAILY ICE
 MARCH

LEGEND

	NO ICE		CCG RECOMMENDED ROUTE
	ICE		ICEBERG LIMIT

PROTO



RECOMMENDED ROUTE



ICEBERG COUNTS



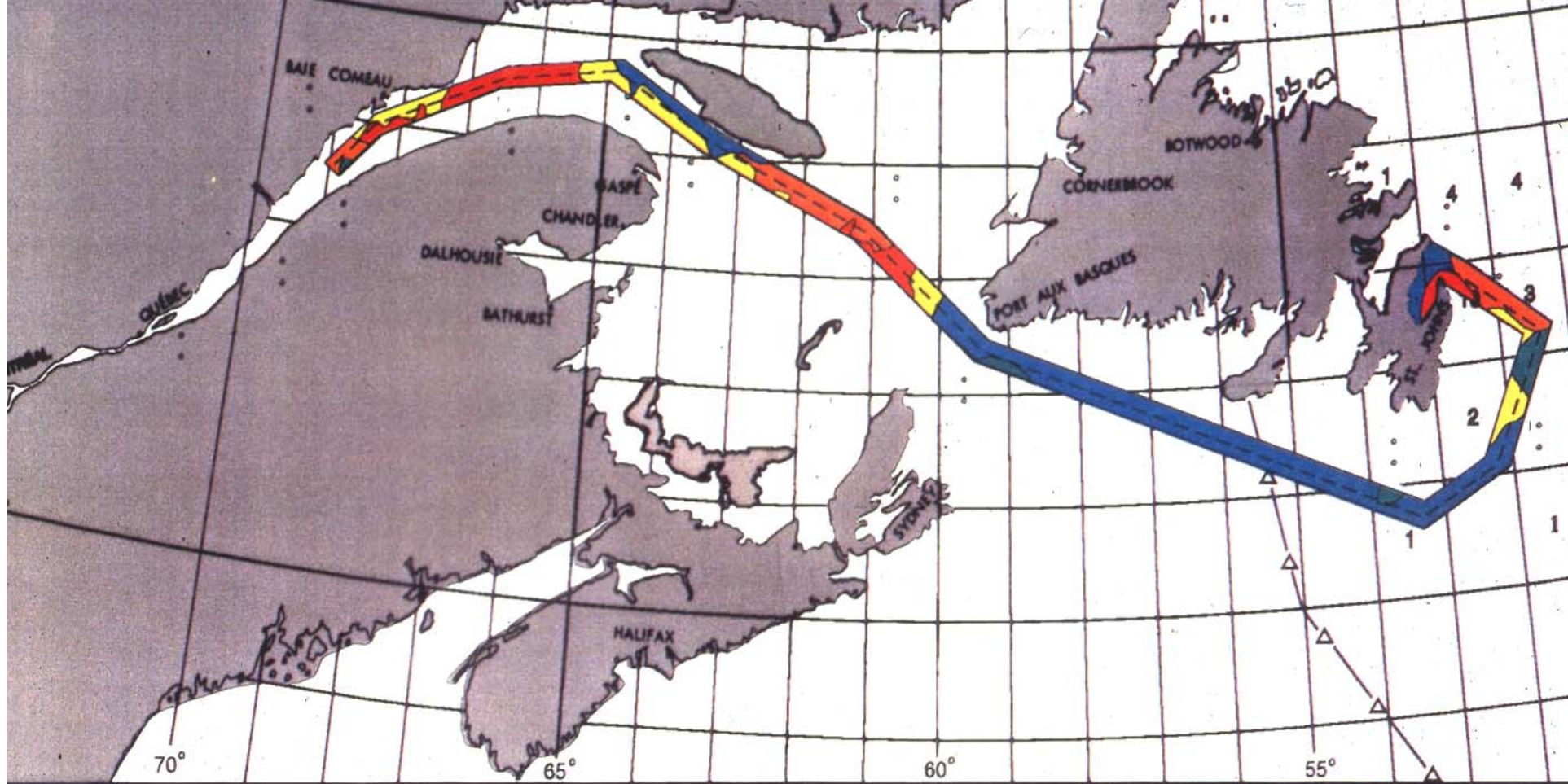
ICE CONCENTRATIONS



ATMOSPHERIC ENVIRONMENT SERVICE - DEPARTMENT OF THE ENVIRONMENT
 SERVICE DE L'ENVIRONNEMENT ATMOSPHERIQUE - MINISTÈRE DE L'ENVIRONNEMENT

**DAILY ICE
 MARCH :**

PROTO



ATMOSPHERIC ENVIRONMENT SERVICE - DEPARTMENT OF THE ENVIRONMENT
 SERVICE DE L'ENVIRONNEMENT ATMOSPHERIQUE - MINISTÈRE DE L'ENVIRONNEMENT

RECOMMENDED ROUTE



ICEBERG COUNTS



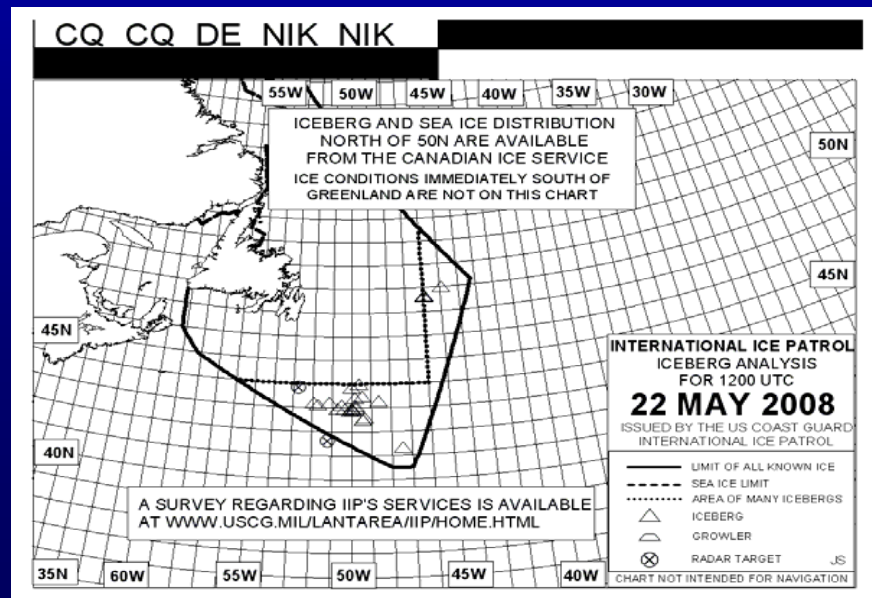
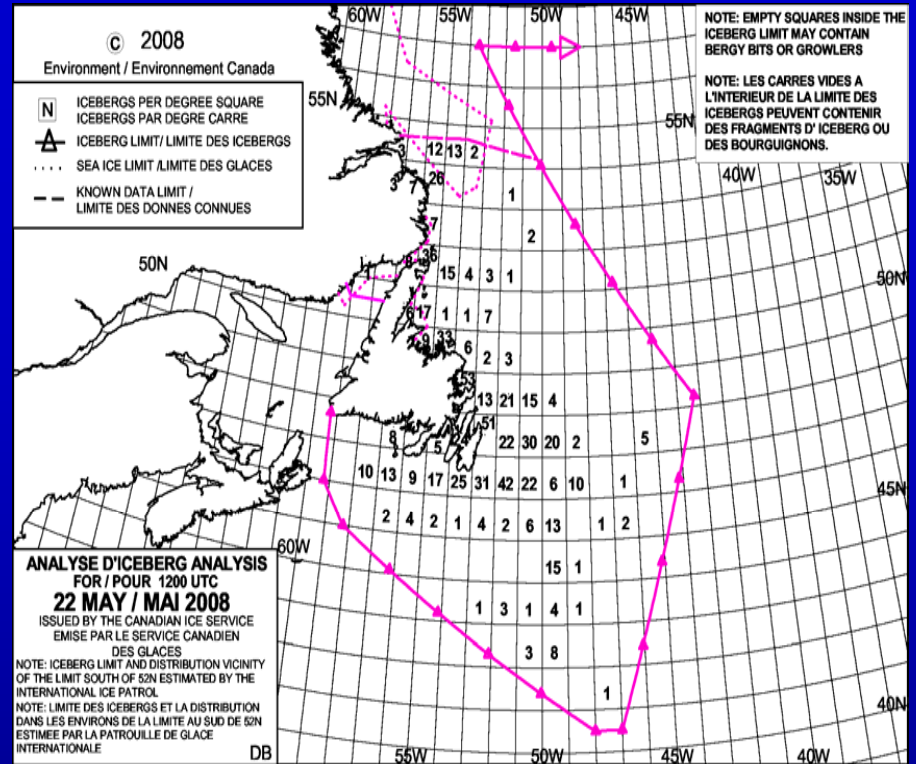
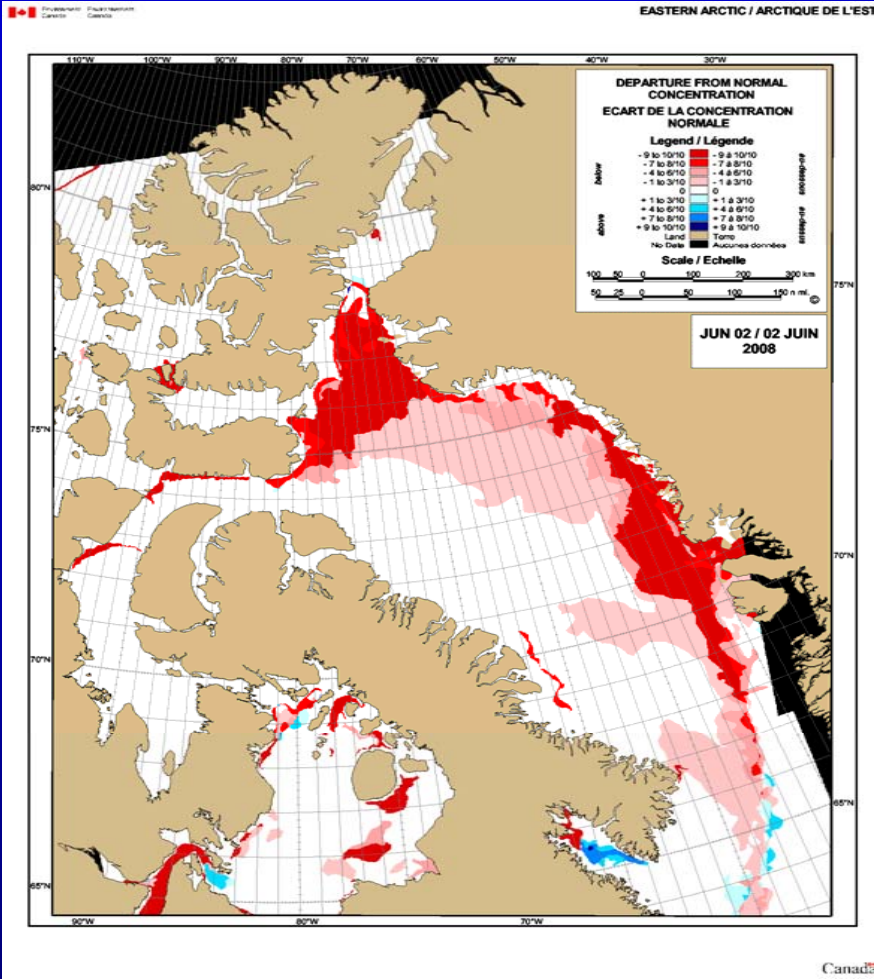
ICE CONCENTRATIONS

- OPEN WATER (> 1/10 ICE)
- 1/10 - 3/10 ICE
- 4/10 - 6/10 ICE
- 7/10 - 8/10 ICE
- 9/10 - 10/10 ICE

DAILY
MARCH

PROTC





Sea Ice Information → MIOs

Source: Bruce Ramsey, Canadian Ice Service

Goal for MIOs

- Supplemental information for “decision support”
 - In addition to that contained in an ENC
 - Right information for **current situation** & **task-at-hand**
 - Voyage planning & route monitoring
- How displayed less important than data format and content
- Instead:
 - Data must be accurate, timely, and useable
 - Display should be consistent in appearance

Task-oriented Composite Display

Navigation Situation:

The current conditions (situation or task-at-hand) that influence what information a mariner requires.

Dedicated Display

- Specific equipment (ECDIS, radar, ARPA, etc.)

Task-oriented Composite Display

- Equipment that displays selected information from one or more **nav systems/equipment*** or info sources (e.g., MIOs)

From Individual equipment & systems

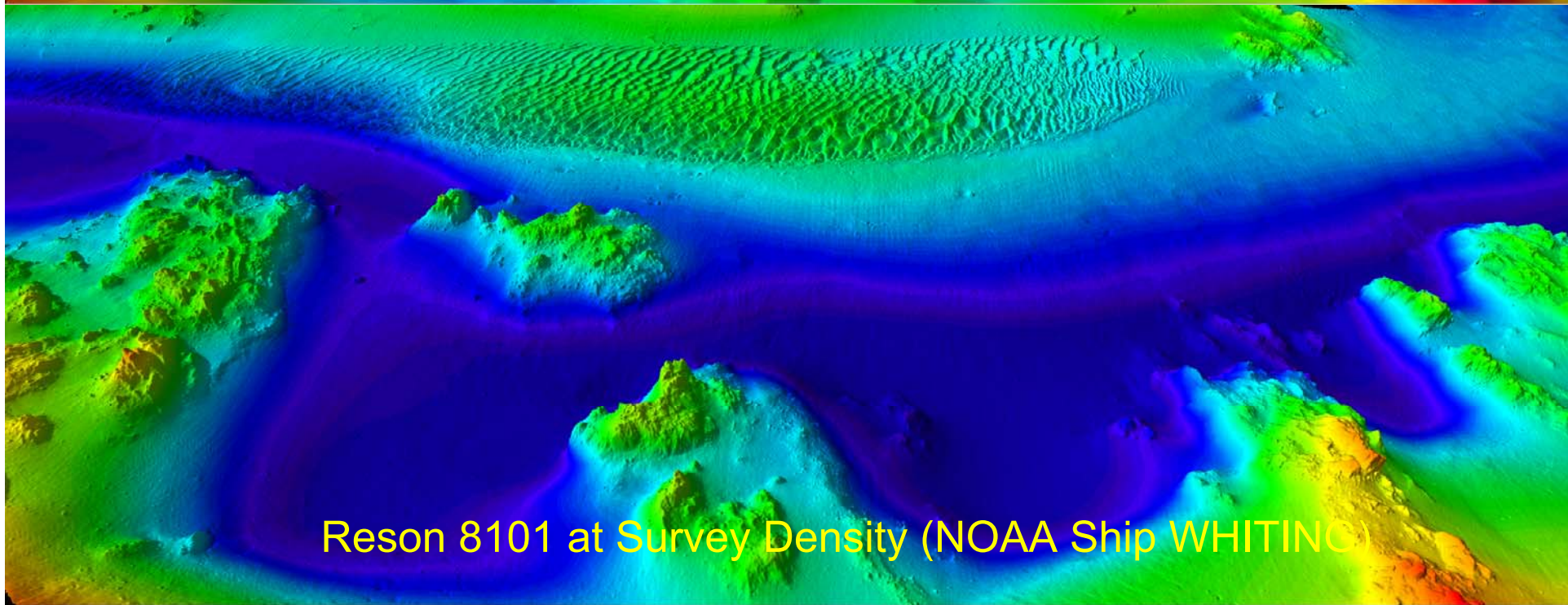
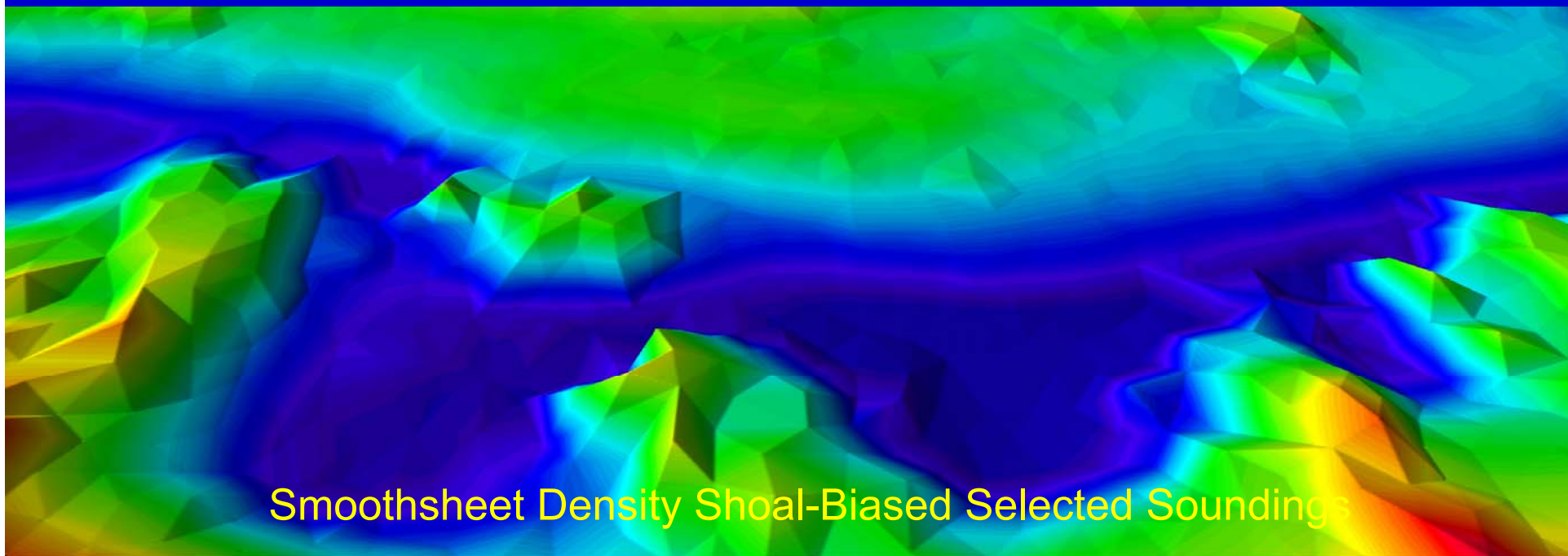


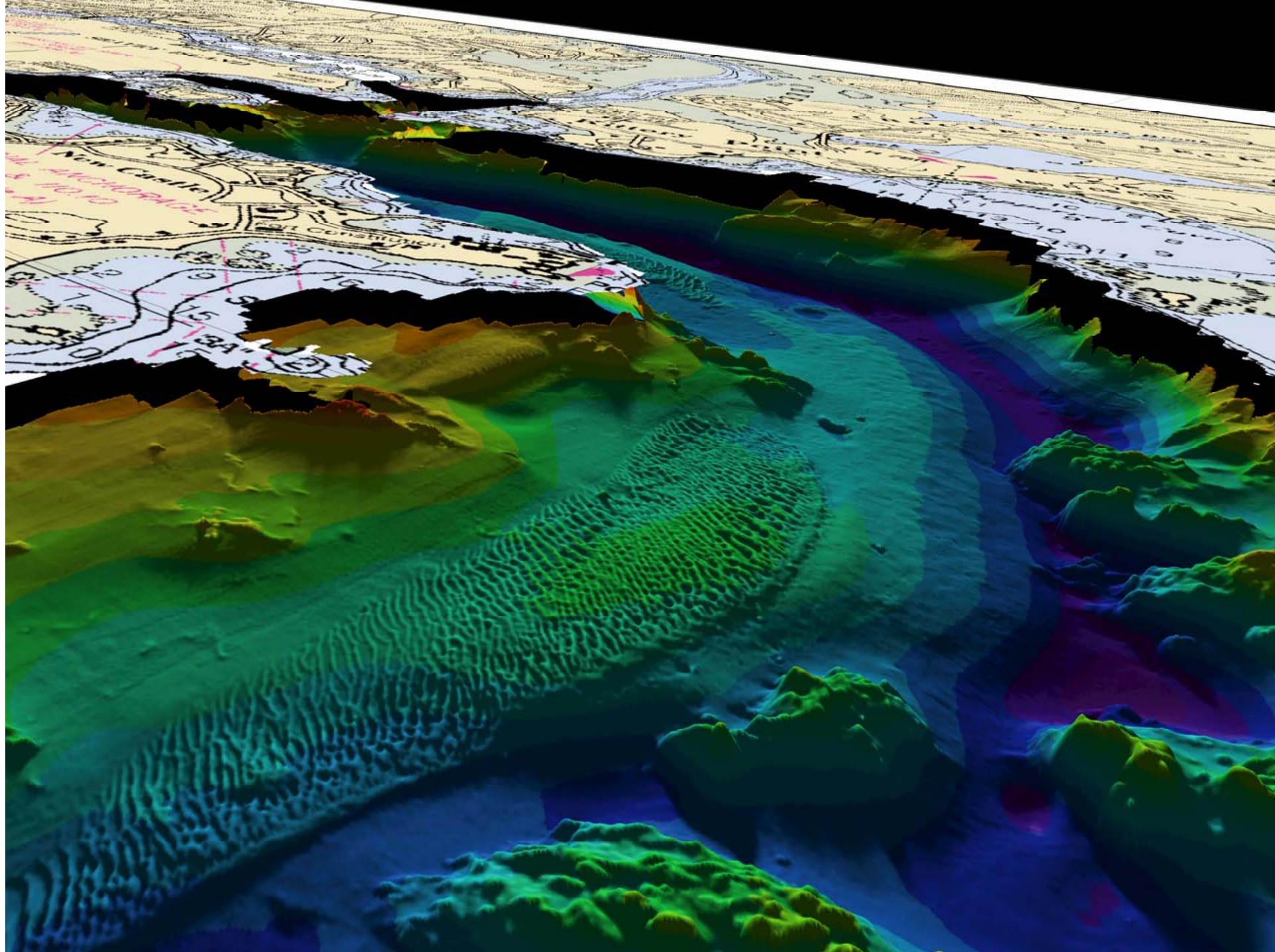
To Modern INS/IBS



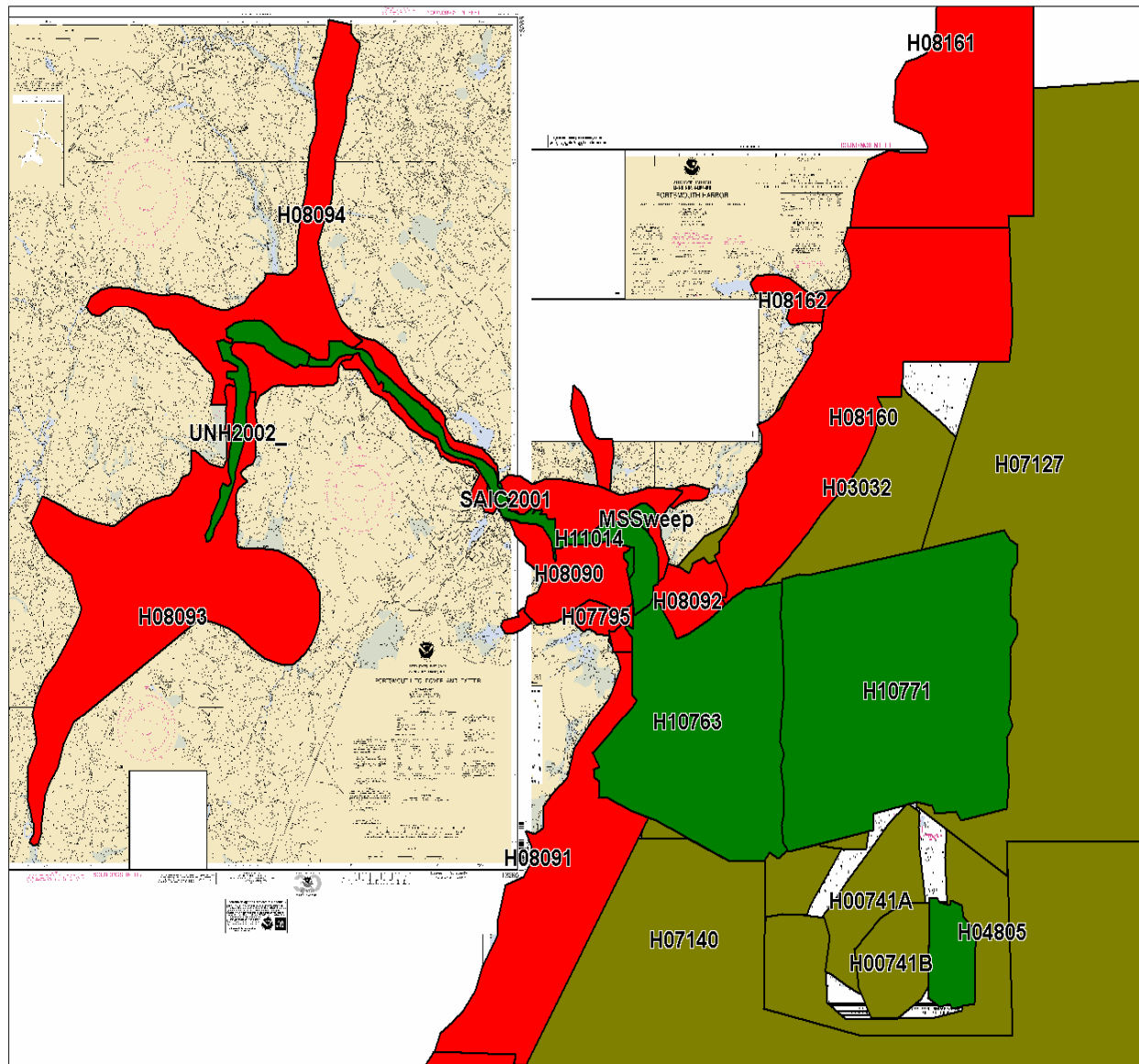
The "Next Generation" ENC

- Use functions that exist in current ECDIS/ECS systems.
- Explore methods for combining the best available data for a given area.
- The bathymetric foundation of this new ENC will be based on a "*Navigation Surface*" concept.
- Capable of incorporating time-varying data.





Surveys Used in Navigation Surface Database Testbed Project

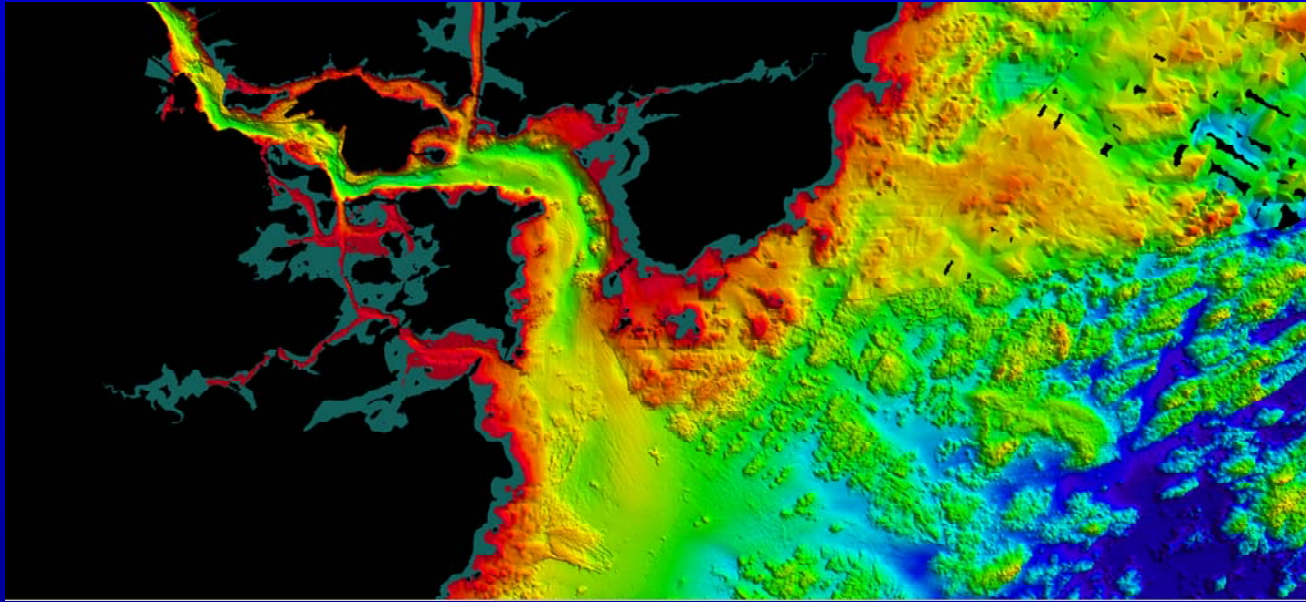


Survey Type

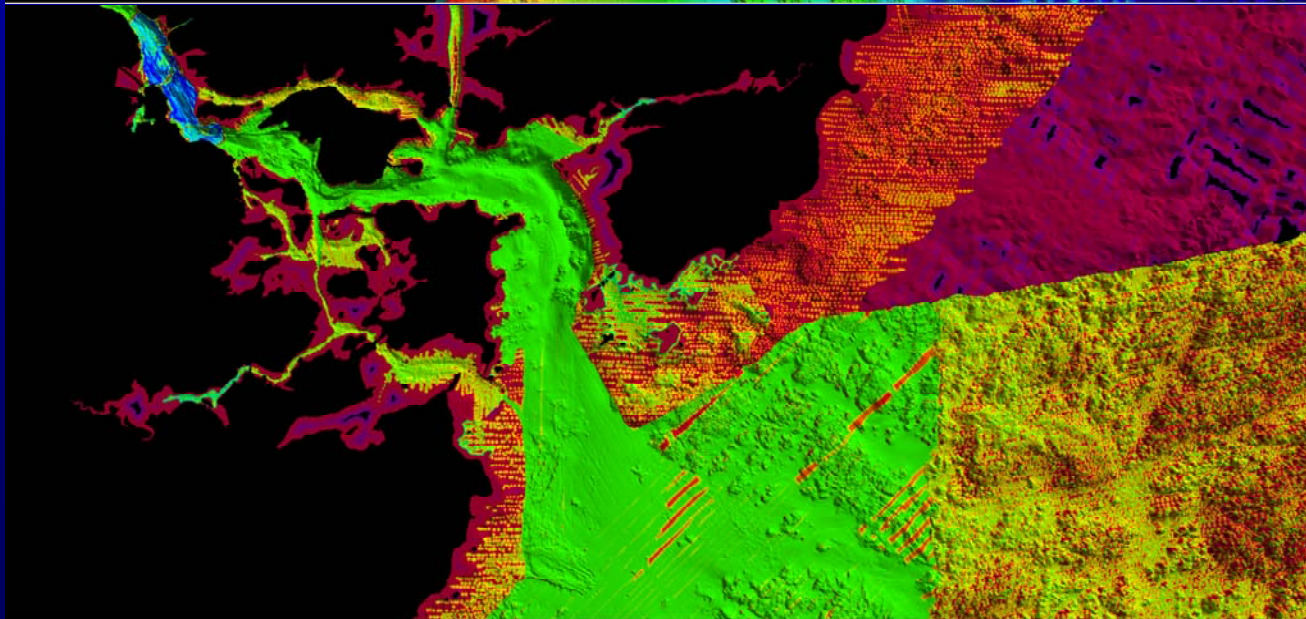
- Multibeam/Sweep
- Singlebeam
- Reconnaissance

Survey	Scale	Year	Svy_type
H00741A	10,000	1,859	Leadline
H00741B	10,000	1,874	Leadline
H03032	20,000	1,909	Leadline
H04805	40,000	1,928	Leadline
H07127	40,000	1,947	Singlebeam
H07140	40,000	1,947	Singlebeam
H07795	5,000	1,950	Singlebeam
H08090	5,000	1,955	Singlebeam
H08091	10,000	1,953	Singlebeam
H08092	10,000	1,954	Singlebeam
H08093	10,000	1,954	Singlebeam
H08094	10,000	1,954	Singlebeam
H08096	10,000	1,954	Singlebeam
H08097	10,000	1,953	Singlebeam
H08160	10,000	1,955	Singlebeam
H08161	10,000	1,955	Singlebeam
H08162	5,000	1,954	Singlebeam
H10129	5,000	1,983	Singlebeam
H10763	10,000	1,997	Partial Multibeam
H10771	10,000	1,997	100% Multibeam
H11014	10,000	2,001	100% Multibeam
MSSweep	5,000	2,001	Sweep
SAIC2001	5,000	2,000	100% Multibeam
UNH2002	10,000	2,002	100% Multibeam

Depth & Uncertainty Overlay

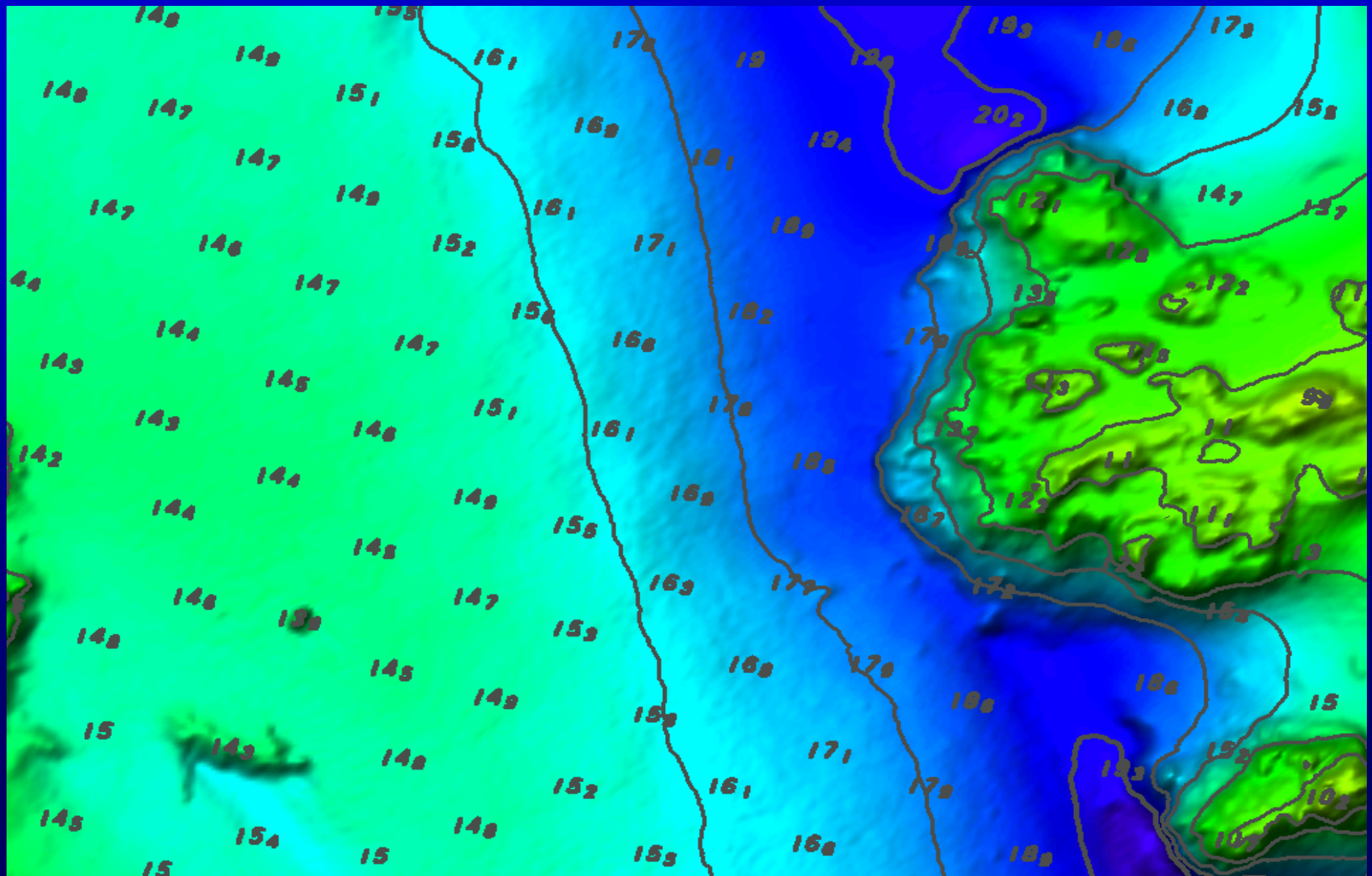


Combined
Depth
Grid

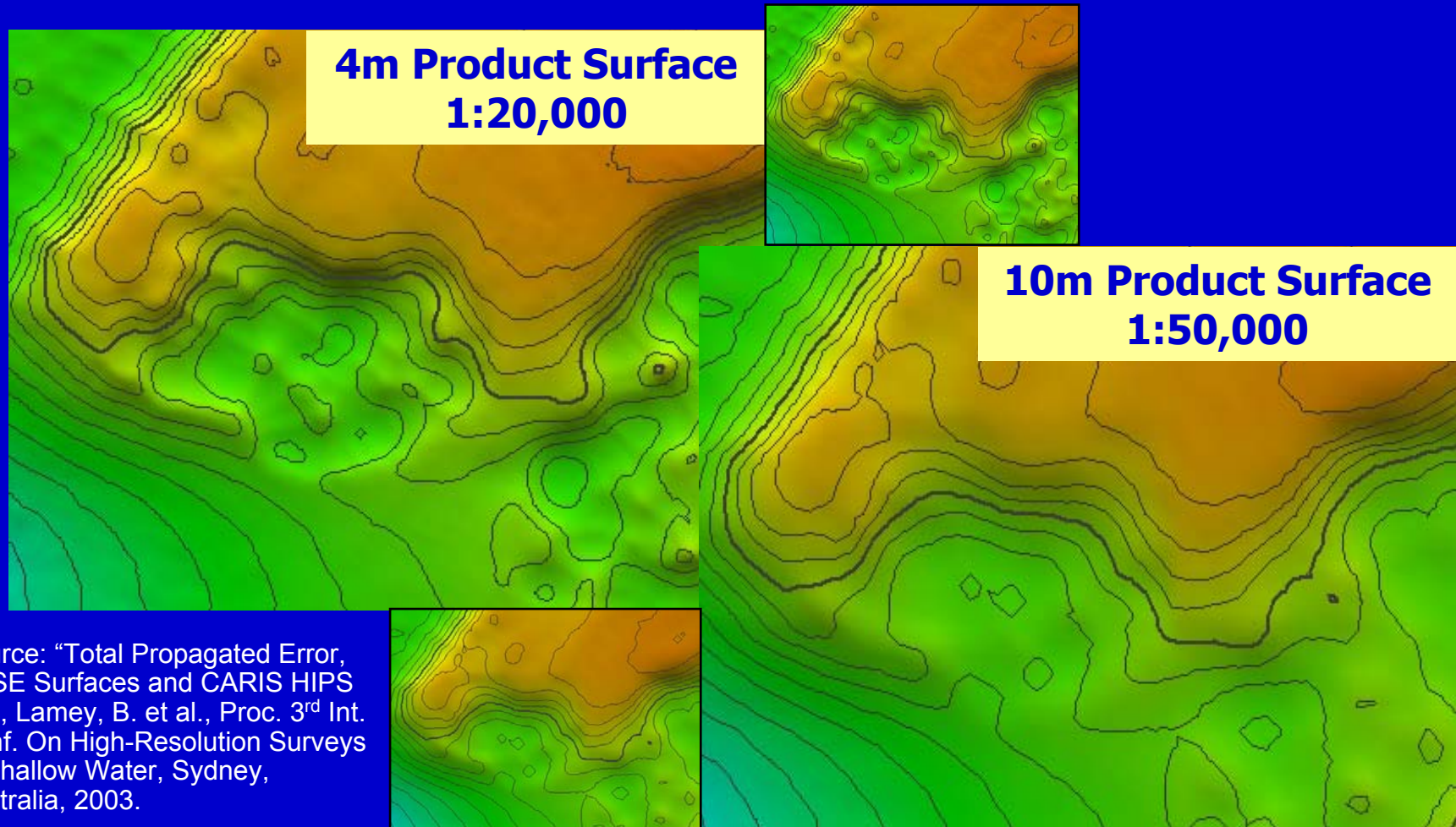


Companion
Uncertainty
Grid

Decimeter Soundings and Depth Contours produced from a *Navigation Surface*

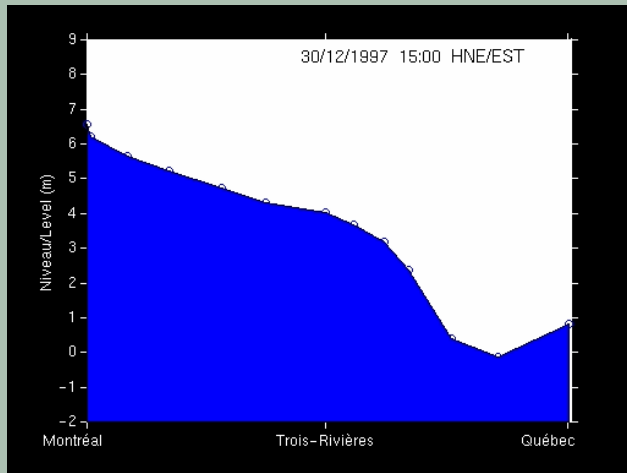


Generalization

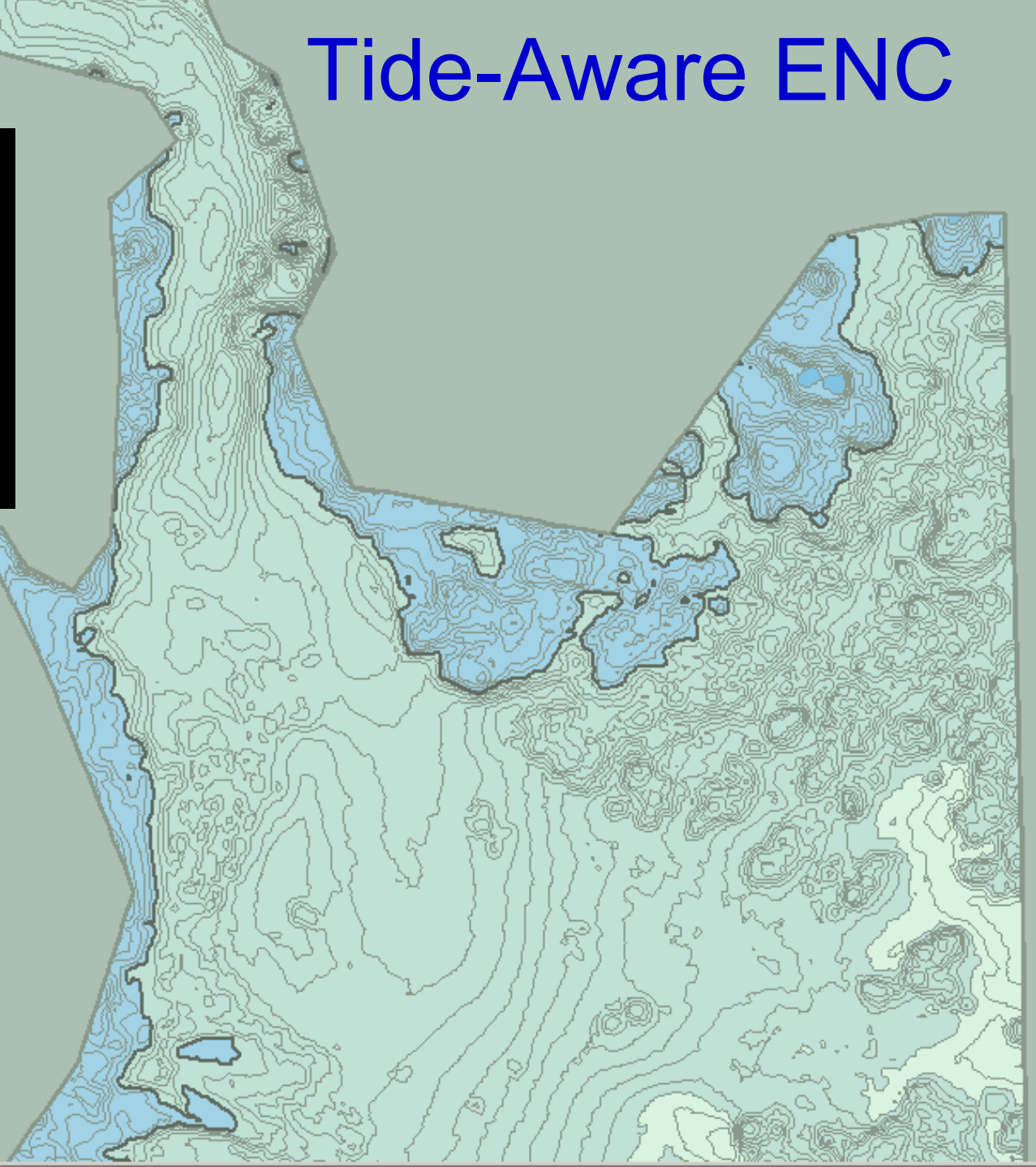


Source: "Total Propagated Error, BASE Surfaces and CARIS HIPS 5.4", Lamey, B. et al., Proc. 3rd Int. Conf. On High-Resolution Surveys in Shallow Water, Sydney, Australia, 2003.

Tide-Aware ENC



Approach to Portsmouth,
New Hampshire, USA



Entrance to River Scheldt, Antwerp

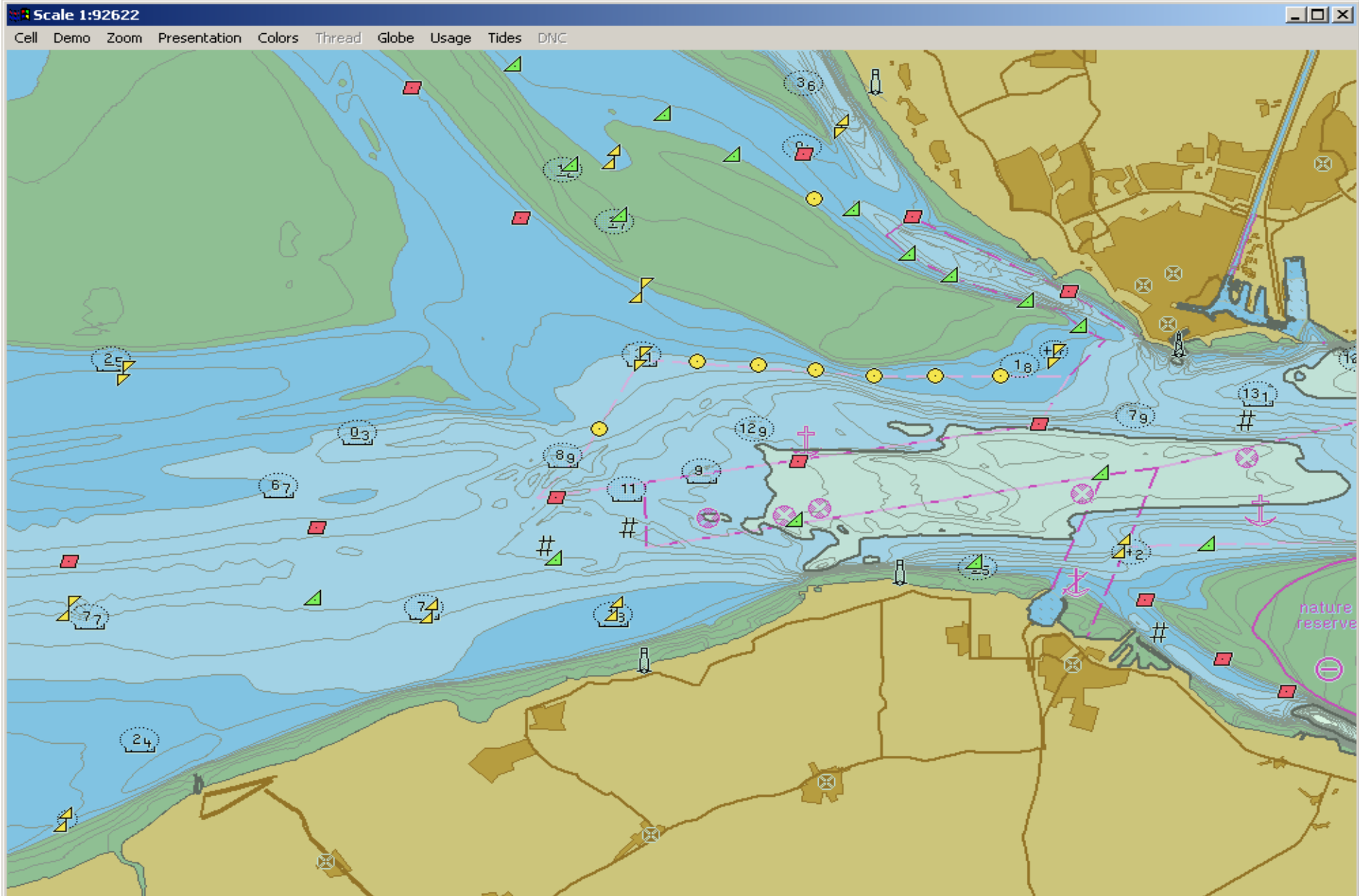
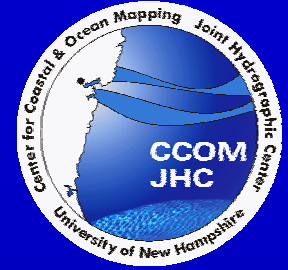


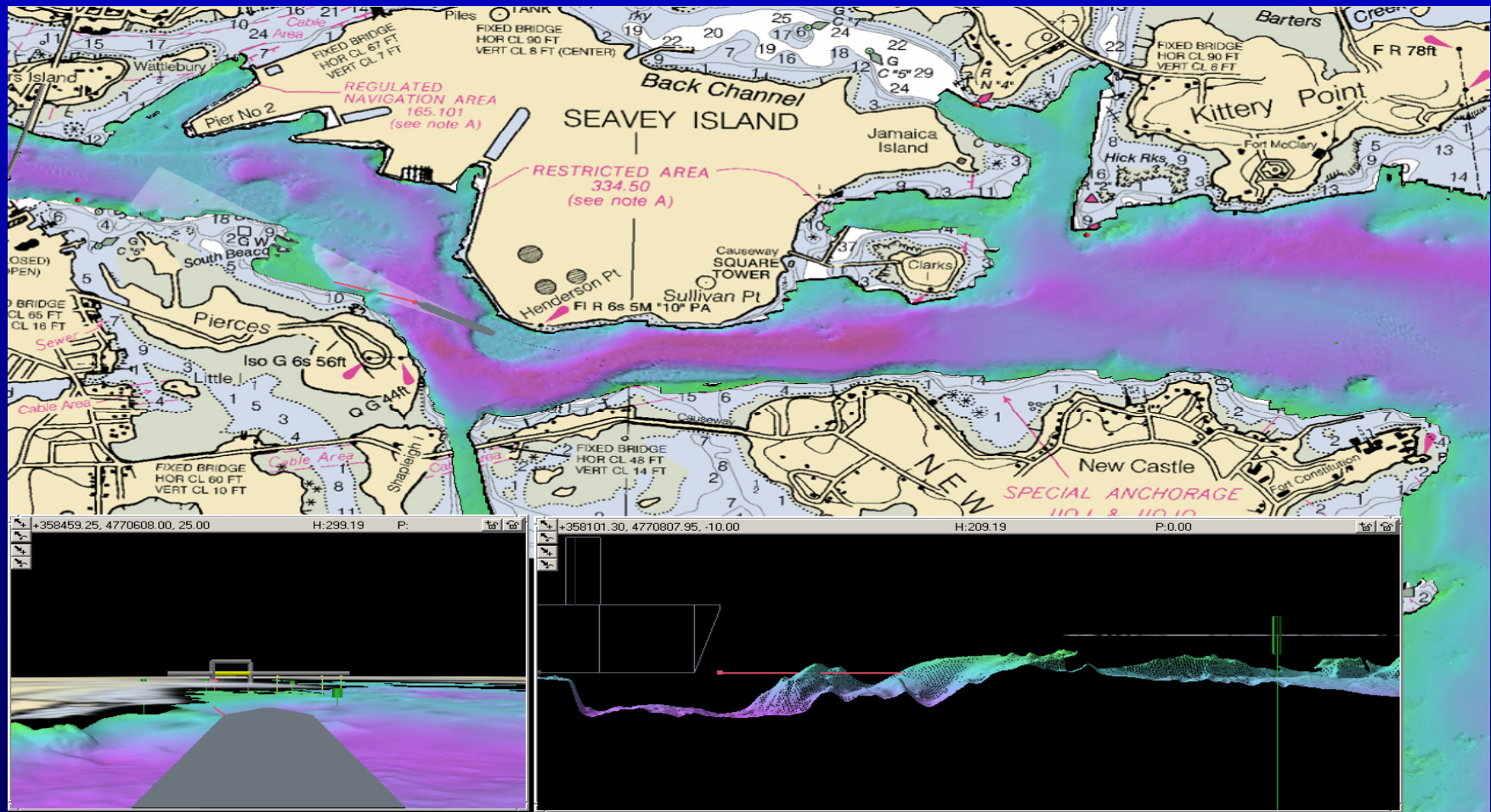
Chart-of-the-Future Project at University of New Hampshire



- Primary focus:
- Investigating the Human-Chart-Computer interface.
- Improved means to use and display various types and sources of data.
 - 3-D plus Time
 - More intuitive colour schemes
- Research unconstrained by existing standards.

Chart-of-the-Future

- Not a replacement for paper charts...
- Instead, new **Decision Support System** for mariners.

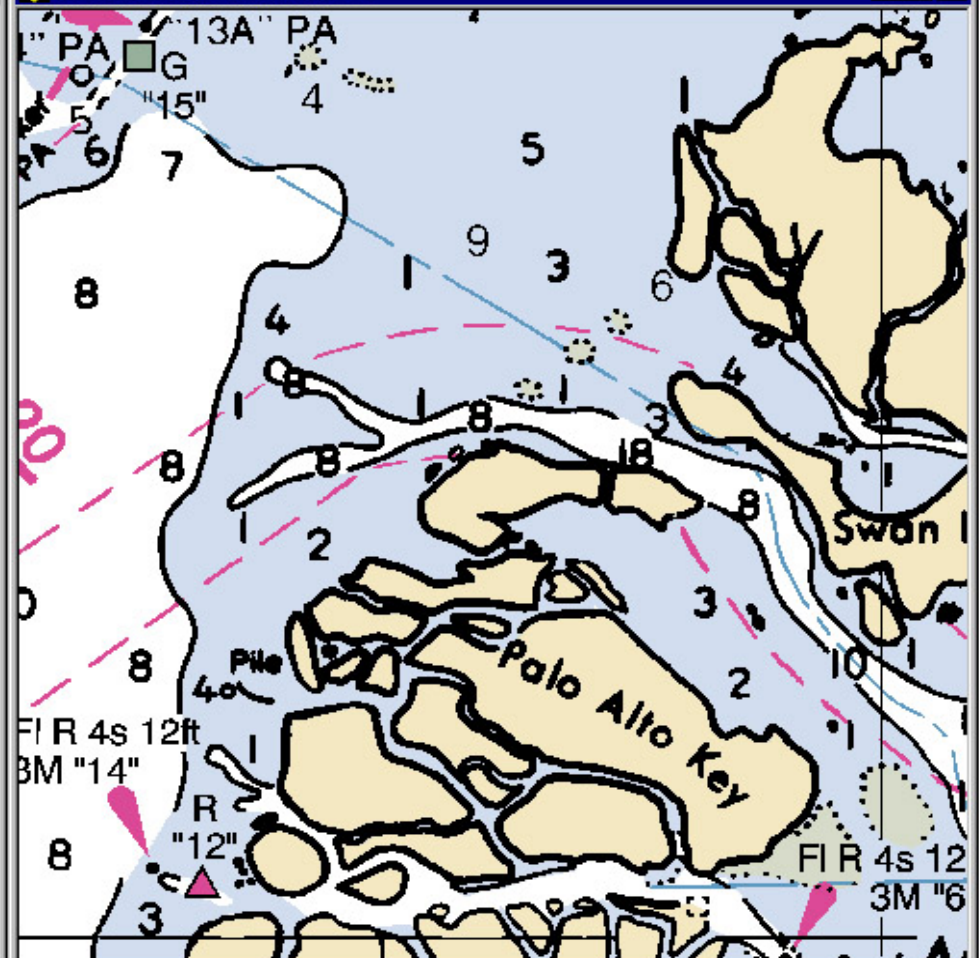




NOT FOR NAVIGATION NavPhoto



11451_2 Soundings in : FEET



Sync to Vessel Relative Link Charts North Up No NTMs Found 3.94 KM

Sync to Vessel Relative Link Charts North Up No NTMs Found 3.95 KM

OB: Course: 000 Mag Range: 0000.0 Mi Lat: xxxxxxxxxxxx Lon: xxxxxxxxxxxx Elapsed Time: 00:00:00 Time To: 00:00:00

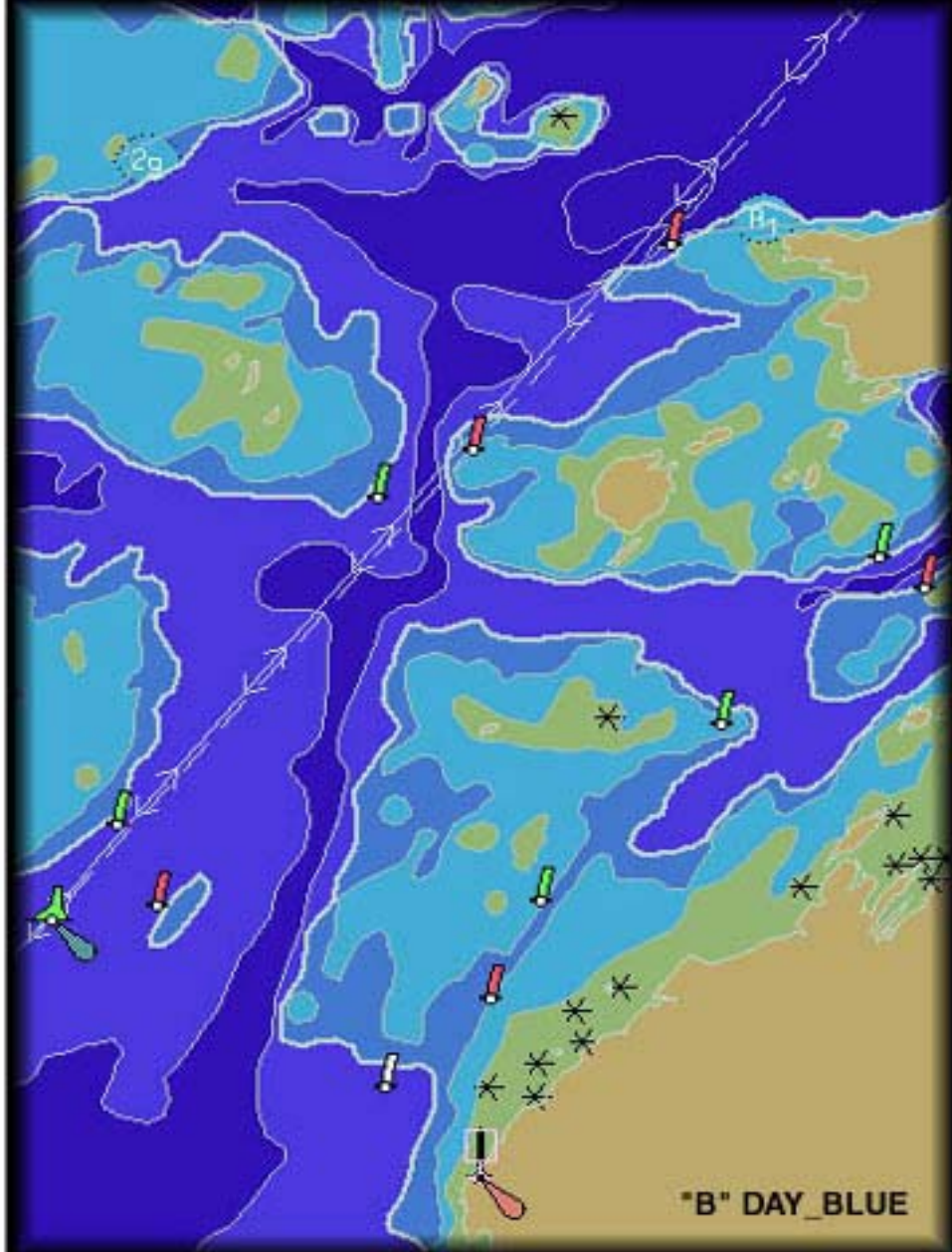
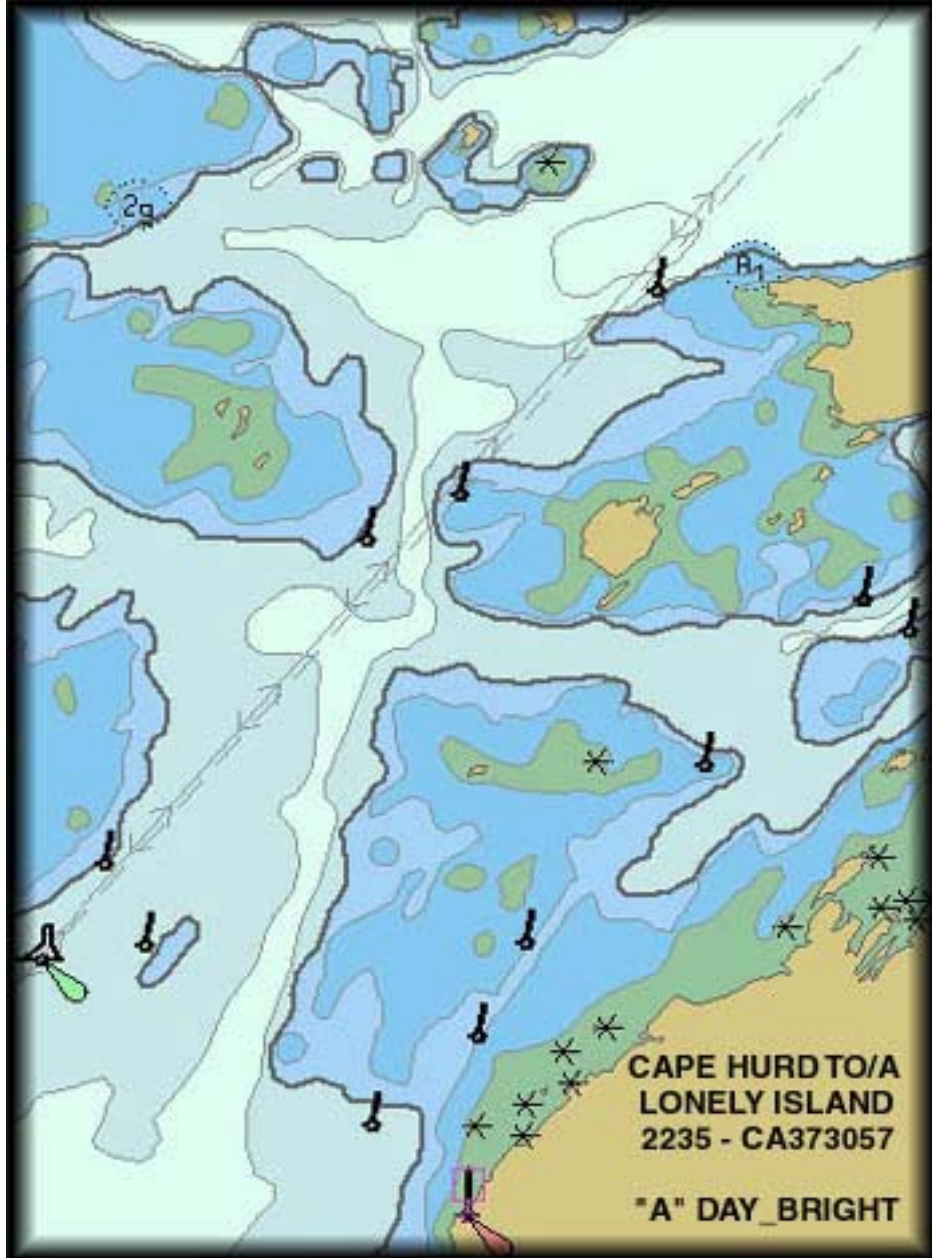
ady Datum OK NONE

Color calibration bar with scale 1:80000 1.00X

Lat: 25° 20' 05" N
Lon: 080° 16' 16" W
Rng: 7783.4 KM
Brg: 115° True

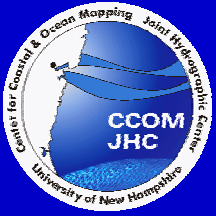
LOCAL zoom controls with buttons for +, 1X, and -

Compass rose showing magnetic variation (5.4° W) and rotation (0°)



IHO S-52 Colours and Symbols

"Bathymetric Blue"



Two short videos:

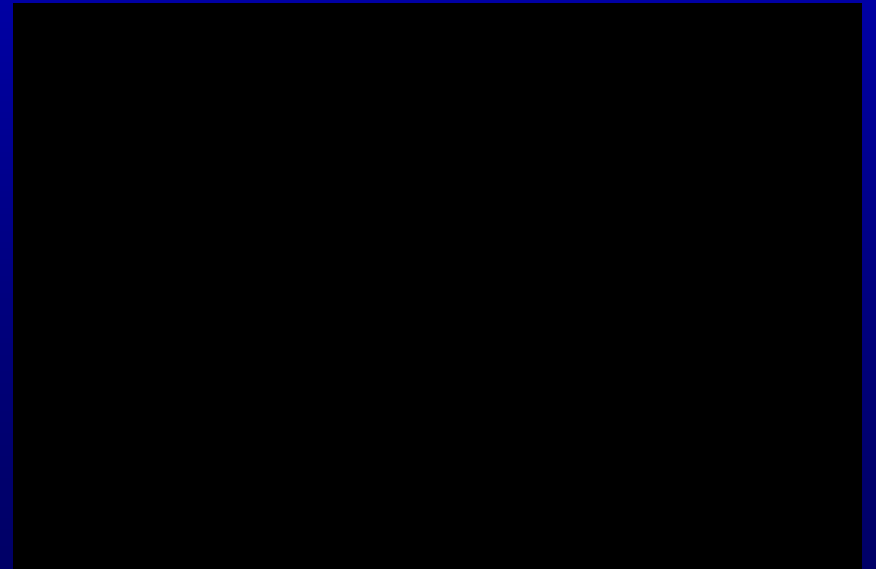


Panoramic Images for Voyage
Simulation and Situational
Awareness

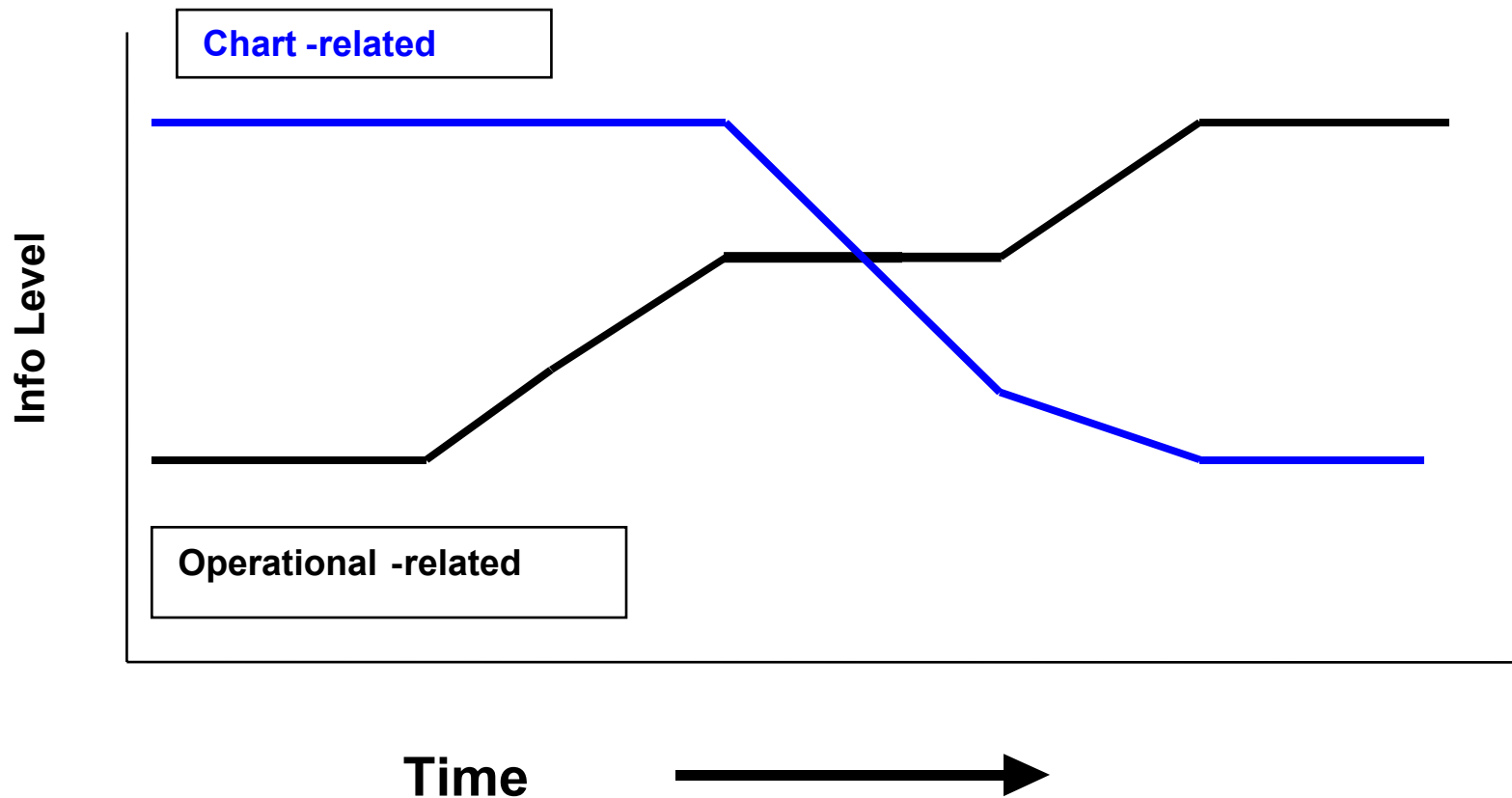
Waypoint Planning in a
Tide-Aware Display

*Coastal Images for Preparation and
Situational Awareness*

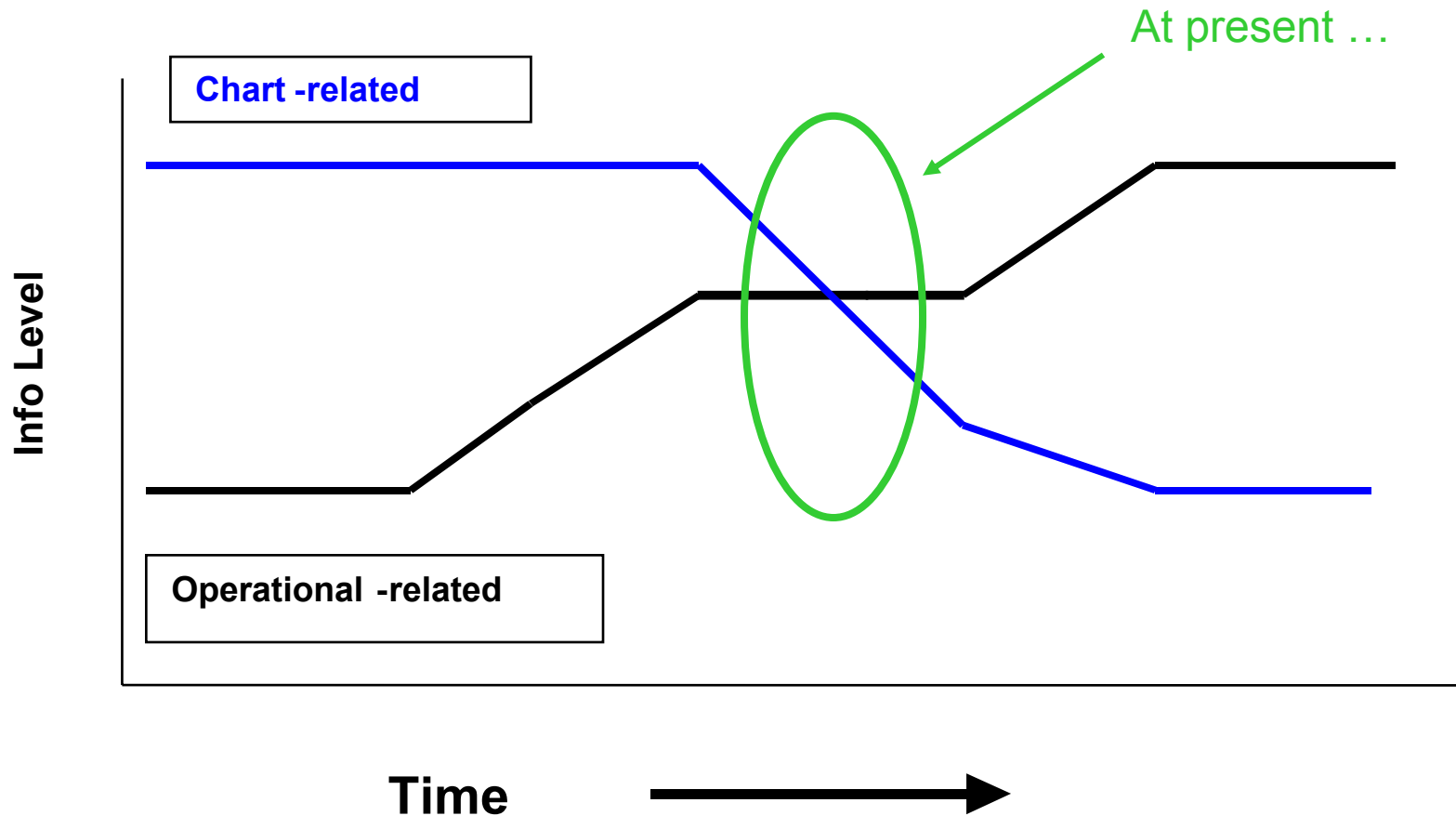
Center for Coastal & Ocean Mapping/JHC
UNH



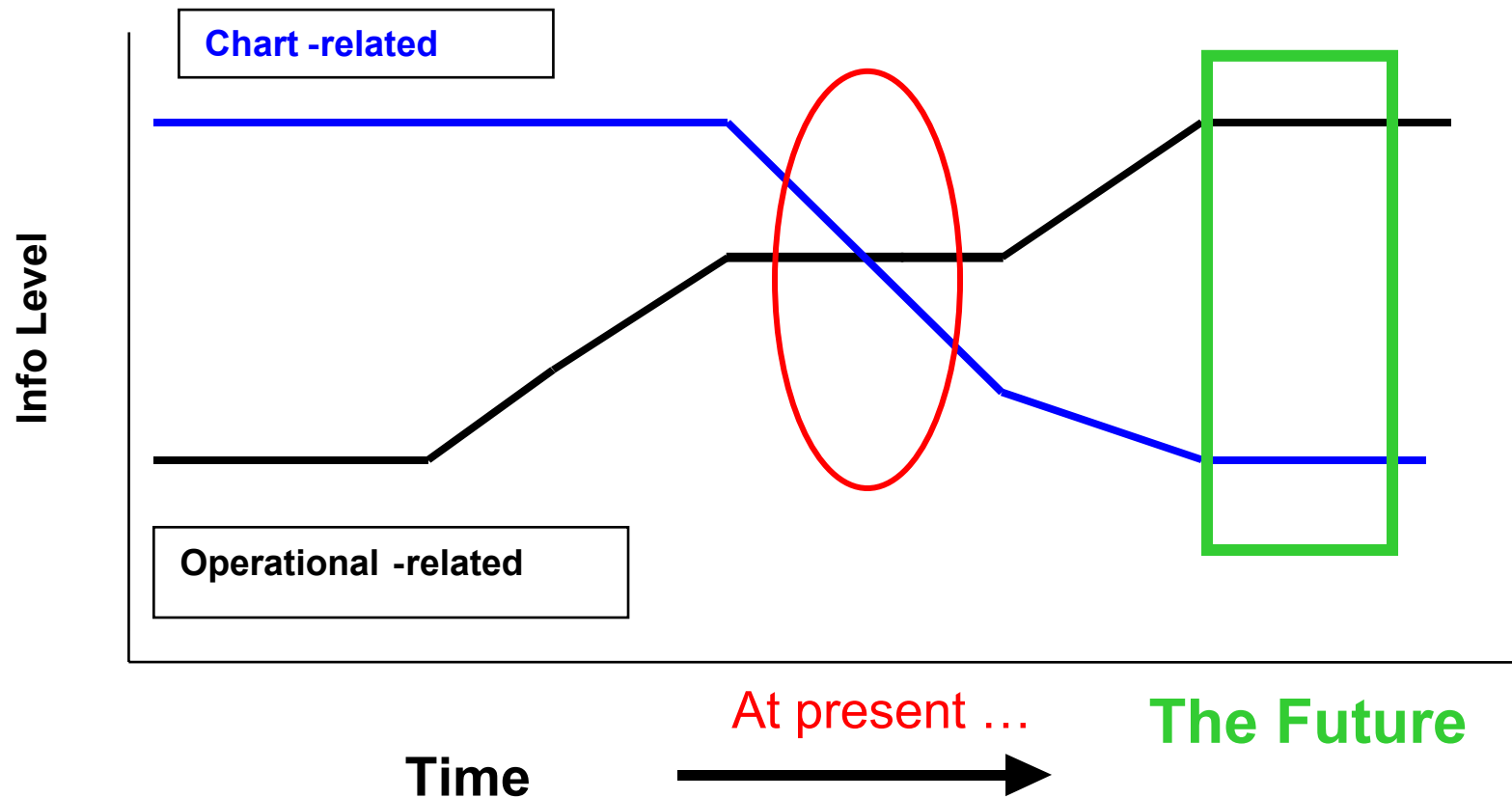
Trend in Display of Navigation-related Information



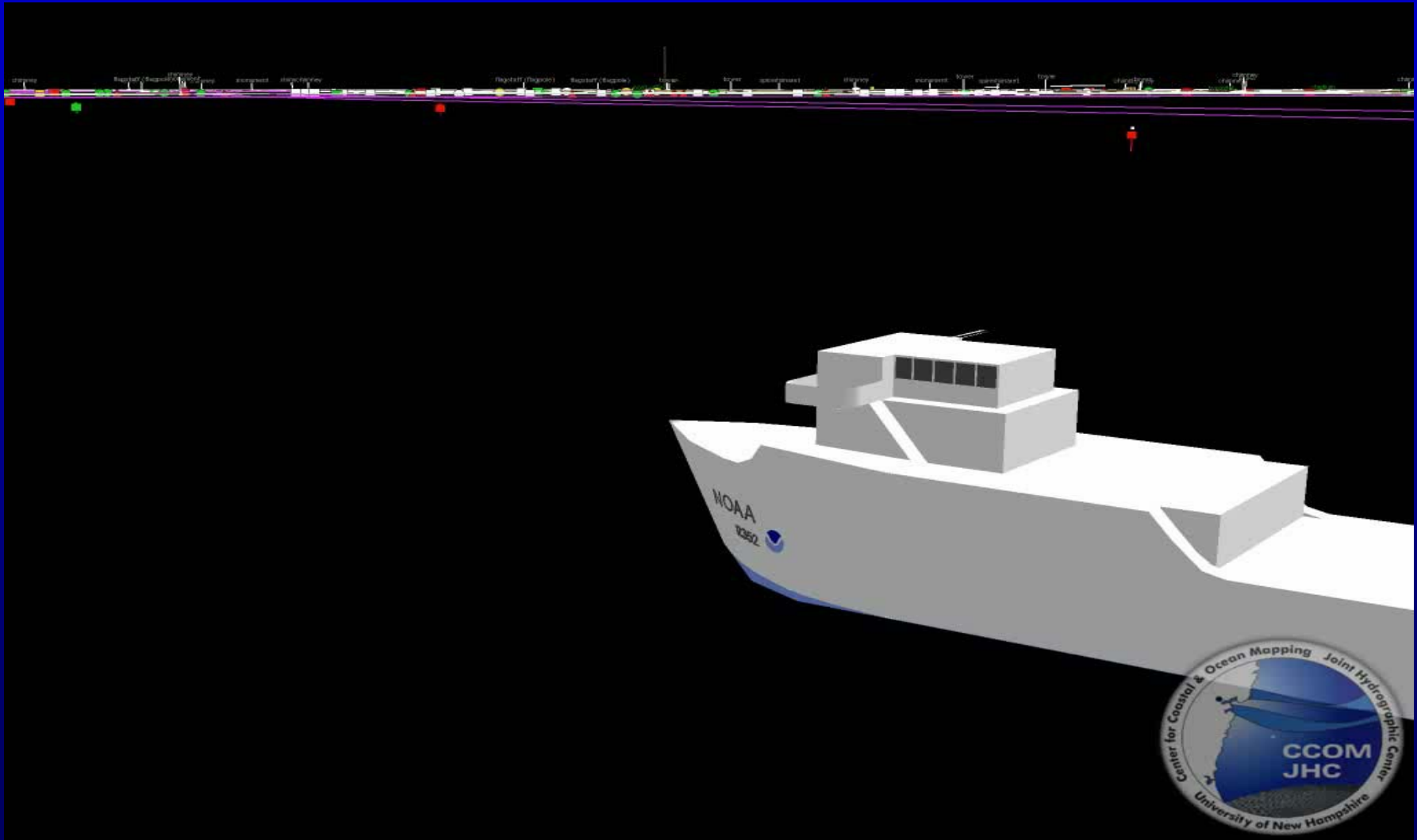
Trend in Display of Navigation-related Information



Trend in Display of Navigation-related Information



Video of AtoN vs. Boston City Lights

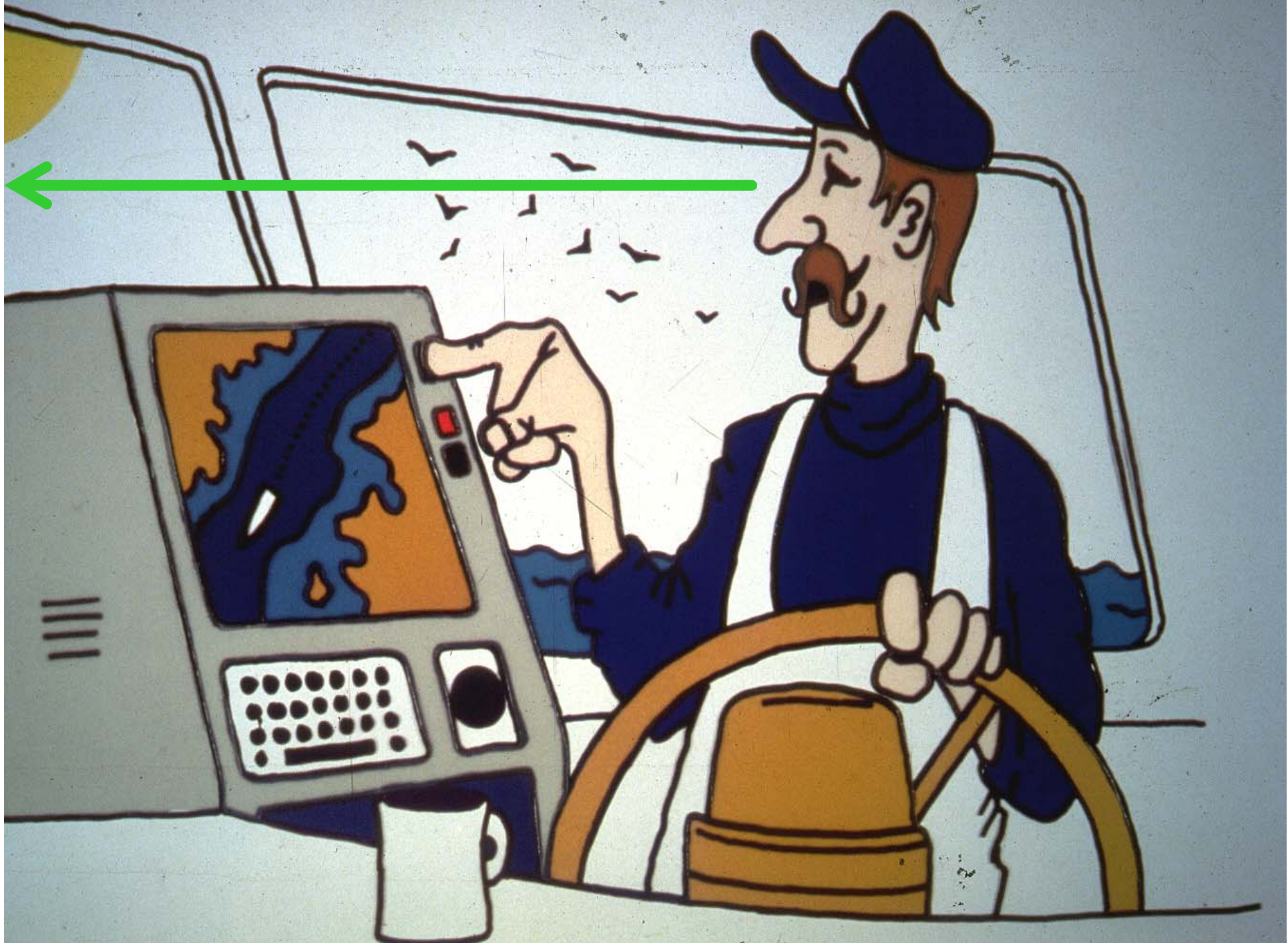


Simulated Voyage - Portsmouth, NH









e-Navigation: Implications for HOs

- This is a major initiative that receiving a high level of attention and involvement.
- Get involved: participate in its development/implementation.
- Achieving required ENC coverage and availability will be crucial in terms meeting mariner expectations.
- e-Navigation ought to provide “better” – not more information.

Further Information:

E-Navigation

- Frequently Asked Questions (FAQ)

Version 1.2, 19 Sept 2008

IALA e-Navigation Committee, 5th Meeting, Paris

Marine Information Overlays (MIOs)

- *Seaways* article (October 2008)

Nautical Institute, London