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Coral Reef – Electronic Chart Initiative: Protecting Corals, Saving Ships

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Abstract: The Office of Coast Survey, NOAA is conducting a pilot project in the Florida Keys National Marine Sanctuary to convert existing coral, marine protected areas (MPA) and other marine GIS information into a format suitable for use with shipboard Electronic Chart Display and Information Systems (ECDIS). Specifically, existing data will be converted into Marine Information Objects (MIOs) conforming to IHO S-57 data standards that become a supplemental information layer to be used with Electronic Navigational Charts (ENC) in ECDIS. The project goal is to strengthen marine resource conservation by bringing critical coral, MPA, and other environmental protection-related information to the mariner. This effort will also contribute to an initiative by the International Maritime Organization (IMO) and International Hydrographic Organization (IHO) to incorporate nautical chart symbology for coral reefs and MPAs. In particular, designated areas will be symbolized as Particularly Sensitive Sea Areas (PSSAs). This project involves a number of stakeholders (e.g., mariners, hydrographers, conservationists, scientists, and resource managers) who are interested in both safety of navigation and marine environmental conservation.

Background

Coral reefs are among the most biologically diverse ecosystems on earth and are inhabited by 25% of all known marine species of fish. Within the Caribbean – Gulf of Mexico Region, the economic and environmental benefits are estimated to be \$375 billion a year. Maritime accidents as well as routine ship operations (e.g., discharge and anchoring) can cause significant loss or injury to coral reefs, resulting in habitat damage that adversely impacts the tourism industry, and the communities that depend on coral reef sustainability for their livelihoods. The economic cost of such damage can be millions of dollars per incident. During 1984-1987, the financial consequences to ship owners and/or insurers exceeded \$16 Million in U.S. alone.

The Office of Coast Survey, NOAA is conducting a pilot project in the Florida Keys National Marine Sanctuary (FKNMS) to convert existing coral reef mapping data into a format suitable for use with maritime Electronic Chart Display and Information Systems (ECDIS). Specifically, Marine Protected Areas (MPAs) and other marine GIS information will be converted into so-

called Marine Information Objects (MIOs) conforming to International Hydrographic Organization (IHO) data standards. The project goal is to strengthen marine resource conservation by bringing critical coral, MPA, and other marine environmental protection-related information to the mariner such that informed decisions can be made to avoid environmental degradation. This effort will also contribute to an initiative by both the International Maritime Organization (IMO) and IHO to introduce nautical chart symbology for corals and MPAs that can be implemented in other regions of the world.

Special Areas and Particularly Sensitive Sea Areas

The International Maritime Organization (IMO) in Annexes I, II and V, of MARPOL 73/78 defines certain sea areas as "**special areas**" in which, for technical reasons relating to their oceanographic and ecological condition and to their sea traffic, the adoption of special mandatory methods for the prevention of sea pollution is required. Under the Convention, these special areas are provided with a higher level of protection than other areas of the sea.

A **Particularly Sensitive Sea Area (PSSA)** is an area that needs special protection through action by IMO because of its significance for recognized ecological or socio-economic or scientific reasons and which may be vulnerable to damage by international maritime activities. The criteria for the identification of particularly sensitive sea areas and the criteria for the designation of special areas are not mutually exclusive. In many cases a Particularly Sensitive Sea Area may be identified within a Special Area and vice versa.

Currently, there are currently six designated PSSAs, worldwide:

- Great Barrier Reef, Australia (1990)
- Sabana-Camagüey Archipelago, Cuba (1997)
- Malpelo Island, Colombia (2002)
- Florida Keys National Marine Sanctuary, USA (2002)
- Wadden Sea, Denmark, Germany, Netherlands (2002)
- Paracas National Reserve, Peru (2003).

In 2004, three additional areas were nominated and await formal designation:

- Baltic Sea area (except Russian waters)
- Galapagos Archipelago (Ecuador)
- Canary Isles archipelago (Spain)

Marine Information Objects (MIOs)

Marine Information Objects (MIOs) are chart- and navigation-related information that supplement the minimum information required by an Electronic Chart Display and Information System (ECDIS). As related to the use of Electronic Navigational Chart (ENC) data, MIOs are additional, non-mandatory information not already covered by existing IMO, IHO, or International Electrotechnical Commission (IEC) standards. This includes ice coverage, tide/water level, current flow, meteorological, oceanographic, and marine habitats. Since the ENC Product Specification contained IHO S-57 Edition 3.0/3.1 is currently "frozen," MIOs are an interim means to include important supplemental information. Ideally, this process of "freezing" standards will no longer be necessary with the release of IHO S-57 Edition 4.0 (IHO 2004).

Supplemental information to be used in conjunction with an existing ENC can be in a variety of formats. This includes imagery, graphics, or additional IHO S-57 objects/attributes. In 2001, a Harmonization Group on MIOs (HGMIO) was established between IHO and IEC to recommend additional data and display specifications that may be incorporated into future editions of IHO and IEC standards (Alexander 2003). To date, new IHO S-57 object classes/attributes for MIOs have been developed for Ice Coverage, Oceanographic, and Weather information. However, none have been developed for Marine Habitats.

Converting Benthic Habitat Data into MIOs

In 1998, NOAA and the Florida Department of Environmental Protection produced a CD-ROM of the *Benthic Habitats of the Florida Keys* (NOAA 1998). The Atlas contains color imagery and GIS files that describe and show the location of shallow seafloor habitats, such as coral reefs (See Figure 1). In cooperation with the Center for Coastal and Ocean Mapping – Joint Hydrographic Center (CCOM-JHC) at the University of New Hampshire, CARIS[®] prepared a brief report on how this benthic habitat mapping data could be converted into IHO S-57 feature objects using *CARIS HOM* ENC software tools (Duguid 2004). The process described in the report clearly indicates that *ArcView*® “Shapefile” data can be used to create IHO S-57 objects, but that further testing/refinement is needed to develop new IHO S-57 objects classes for coral reef habitats. These new MIOs would also need to have suitable attributes to describe the different coral reef habitat designations, and for any other criteria related to regulated activities.



Figure 1 – A map showing benthic habitats near Big Pine Key Florida. Habitats were classified into 24 different types by marine ecologists. Their boundaries were then geo-referenced and incorporated into a GIS database.

MIOs and Electronic Charting Systems with MIO

The primary goal of the project is to provide critical coral habitat and other marine environmental protection information to the maritime user to be used in conjunction with a variety of electronic charting systems. Specifically, it will facilitate the integration of coral and other Marine Protection Area (MPA) information with Electronic Navigational Chart (ENC) data that is required for Electronic Chart Display and Information Systems (ECDIS) that are installed onboard large, ocean-going vessels. The project will also contribute to an on-going initiative by NOAA to introduce nautical chart symbology for coral and MPAs suitable for international adoption and implementation. The initial focus will be on large vessels since that is where national/international regulations are applicable. However, it is expected that this type of information will become widely available and used in conjunction with electronic navigation systems used by most commercial and recreational boaters. Potentially, carriage and use of this information will become mandatory for some PSSAs or MPAs, particularly as it relates to permitted activities.

The basic approach is to provide a supplemental layer of information (e.g., points, lines or areas) to be displayed in conjunction with existing electronic chart information. Using this data, the electronic navigation equipment (e.g., GPS chart plotters or more advanced electronic chart systems) can be programmed to provide an indication or alarm indicating that there is something the mariner needs to be aware of or concerned about.

Florida Key National Marine Sanctuary

More than 40% of the world's shipping commerce transits through the Florida Straits each year. Since 1984, 10 large ship groundings have occurred in the Florida Keys and the Tortugas. Coral reef damage by large ships anchoring has occurred at least 17 times since 1997.

The Florida Keys are the third largest barrier reef ecosystem in the world, and the only barrier reef ecosystem in the United States. Recognizing the importance of this marine habitat, the Florida Keys National Marine Sanctuary (FKNMS) was officially designated as a PSSA on 13 November 2003. As shown in Figure 2, the FKNMS is over 3000 square nautical miles in area and extends from the Dry Tortugas National Park over 150 miles east to Biscayne National Park. Starting on 1 December 2002, ships greater than 50 meters (164 feet) in length are required to avoid transiting certain areas within the zone, and to comply with three no-anchoring areas. Key to the development of MIOs for coral reef areas, are determinations of what is the appropriate level of biological and regulatory information that should be provided to the mariner.

Florida Keys National Marine Sanctuary

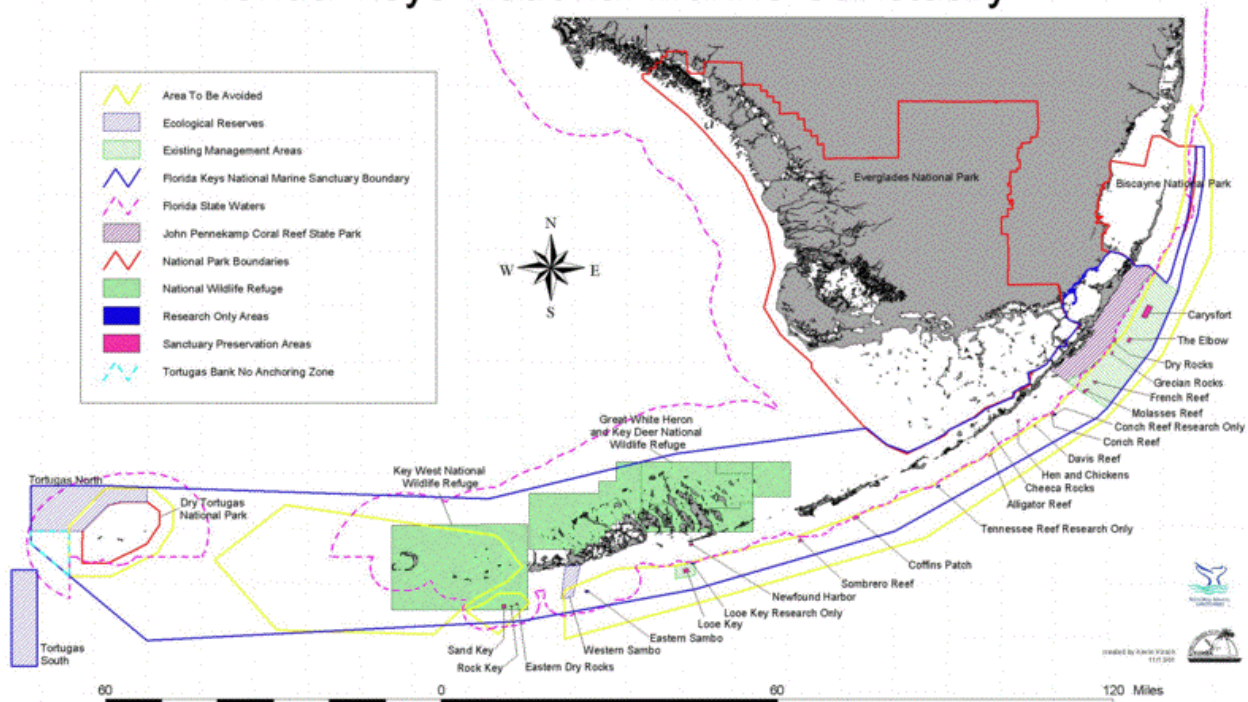


Figure 2 – Florida Key National Marine Sanctuary

Project Participants

An important aspect of the project is the involvement of the FKNMS and its Sanctuary Advisory Council (SAC). Based on the outcome of the 14 December 2004 Meeting of the FKNMS SAC, a Working Group is being formed to help determine:

- What coral reef areas and/or critical habitats with in the FKNMS warrant focus?
- What type of large vessel operations/activities are of particular concern?
- How should critical coral reef habitats be classified and used with paper and electronic charts ENC's?
- How should coral reef information be displayed on ECDIS?
- Who are the relevant stakeholders who should be encouraged to participate in the project?

A number of stakeholders who are interested in both safety of navigation and marine environmental conservation will be encouraged to become involved in the project. This will likely include mariners, hydrographers, conservationists, scientists, and resource managers. Potentially, this would include:

- Federal/State Government (NOAA, Coast Guard, US Geological Survey, State of Florida)
- International Organizations (IMO, IHO, World Conservation Union, World Resource Institute, and UN Environmental Programme)
- Maritime Industry (International Council of Cruise Lines, Caribbean Shipping Association, and American Pilots Association)
- Academia
- General Public

Expected Outcomes

There are a number of expected outcomes that should result from this project.

- Improved dialogue and coordination between data producers and users
- Increased awareness by the maritime community of coral reefs and other MPAs
- Incorporation of marine environmental information into vessel navigation systems. This includes ECDIS, electronic chart systems, and other types of integrated navigation systems (INS).
- Decreased risks of coral damage due to availability of critical information for making informed decisions, and availability of such information for automated voyage planning
- Development of international standards for the production and use of critical marine environment information onboard vessels.

This project will also establish linkages with Global Environment Facility (GEF)-funded international waters initiatives, such as the Gulf of Honduras and the South East Asia Marine Electronic Highway Projects.

Summary

This initiative aims to bring critical coral habitat and other marine environmental protection information to the mariner, and to enhance the flow of key geospatial information to/from conservation and natural resource managers. More specifically, it will facilitate the integration of coral and other MPA information with Electronic Navigational Charts (ENC). The project will also contribute to an on-going initiative by NOAA to introduce nautical chart symbols for coral and MPAs suitable for international adoption and implementation.

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