Information Paper for Consideration by the S-101PT

Efforts for Developing Symbology for New S-1xx PS

Submitted by:	UNH Center for Coastal and Ocean Mapping (UNH/CCOM)
Executive Summary:	Efforts for developing new symbology for S-1xx PS

Introduction

The new S-1xx product specifications being developed by IHO WGs enrich the navigation related information on Electronic Chart Display and Information System (ECDIS). However, many of them do not yet have defined symbology, e.g., the S-122 Marine Protected Areas (IHO, 2019), S-126 Marine Physical Environment (under development), S-127 Marine Traffic Management (IHO, 2018), and S-131 Marine Harbour Infrastructure (under development). Therefore, as S-122 Edition 1.0.0 explains, implementers are allowed to select the technique and style of representation that they believe is most suited to their requirements, but they should plan for future versions that may contain a portrayal catalogue by making adequate preparations in the system (IHO, 2019).

Identifying the need, the Center for Coastal and Ocean Mapping of the University of New Hampshire (UNH/CCOM), in collaboration with the National Technical University of Athens (NTUA), initiated a research work toward the development of new symbology for the recently developed / under development S-1xx Product Specifications. This paper presents the purpose of the research, what has been done so far, future work, and seeks feedback / guidance / collaborators.

Analysis

Symbology is an essential part of the cartographic profession as it helps humans to decode the mapped real-world features. Our work for the development of new S-1xx symbology follows a user-centered design. The first broad phase comprises the understanding of context of use, the user requirements, and the symbology design (Figure 1). The second phase focuses on making improvements to the initially developed symbology based on feedback by stakeholders and user surveys.

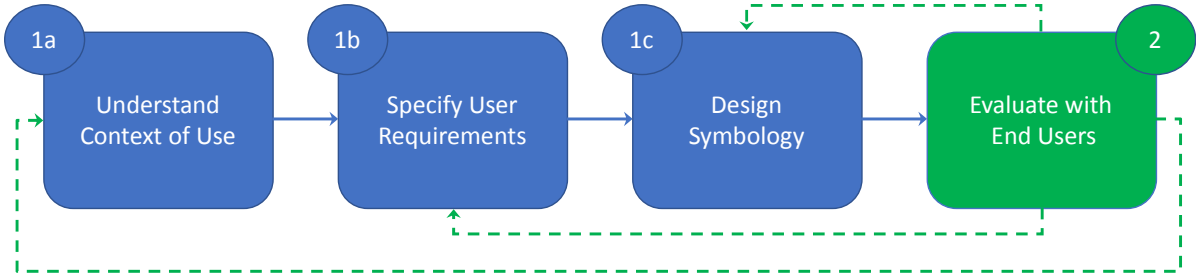

Figure 1. User Centered Design Methodology. (Contarinis, Kastrisios, and Nakos., n.d.)

Nautical charts are a product highly regulated by various IHO publications. For example, Publication S-4 Regulations for International (INT) Charts and Chart Specifications (IHO, 2021) provides guidelines for every aspect of chart compilation, including chart construction, utilized units, use of color, requirements for the representation of topography, hydrography and aids to navigation, generalization guidelines for various chart features, text, chart maintenance, etc. (Kastrisios et al., 2022).

This high level of standardization takes away some flexibility from symbology design (e.g., due to specific colors being reserved for specific uses) but, on the other hand, provides a wealth of information that largely answers the first two aspects of the design process, i.e., the Context of Use and User Requirements. Things such as the use of color and enclosing shapes may be mostly derived from the long-lasting practice in the nautical charting profession. We also reviewed MPAs portrayal methods in national thematic maps.

In designing symbology for the S-122 Marine Protected Areas (MPAs), we focused on developing icons representative of the MPA type (Figure 2) and regulations (Figure 3), rather than abstract symbols, and the selection of effective symbol color, enclosing shape, and size. In terms of enclosing shape, various different shapes are used in nautical charting, i.e., circles, triangles, squares, diamonds, and hexagons. Considering that shapes often carry specific connotations, to maintain consistency for all MPAs symbols and avoid confusion

with existing chart symbols without an enclosing shape (see e.g., a generic anchorage symbol) as well as any quantitative differences among them, we developed the symbols using a circular enclosing shape. A review of existing symbols shows that the physical size of symbols with an enclosing shape varies from 6 to 12mm; the presented preliminary symbols are 9mm at chart scale. In terms of color, magenta is used on charts for dangers and other information. Magenta has the advantage of being one of the four ENC basic colors and is established as the color utilized to attract mariners' attention to important information. Therefore, for the symbols in the following sections we use saturated magenta to denote restricted and prohibited activities (thus informing mariners about the MPA becomes important) and less saturated magenta (*magenta faint*) for the less important (visually and navigationally), permitted activities (IHO 2015). Figures 4, 5, and 6, illustrate the sample symbol over two web-based chart (Contarinis et al. 2022) test beds in Greece. The MPA type and regulations symbols are used in groups as necessary to provide the respective information.

Figure 2. Sample ENC Symbology for MPAs types (attribute categoryOfRestrictedArea).

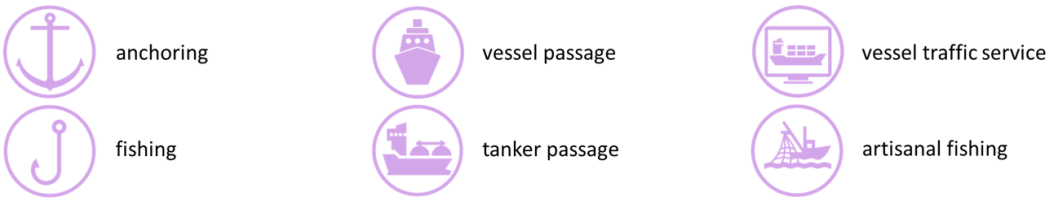

Figure 3. Sample ENC Symbols for permitted activities in MPAs.

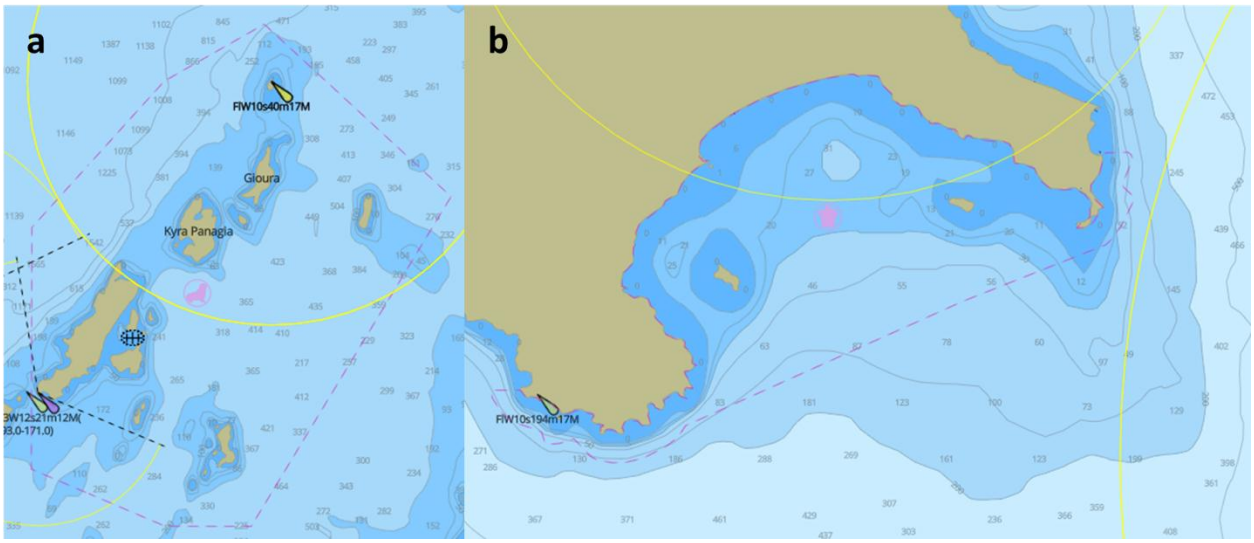

Figure 4. Overview of (a) the Alonnisos and (b) the Zakynthos MPAs Charting Testbeds in Greece.

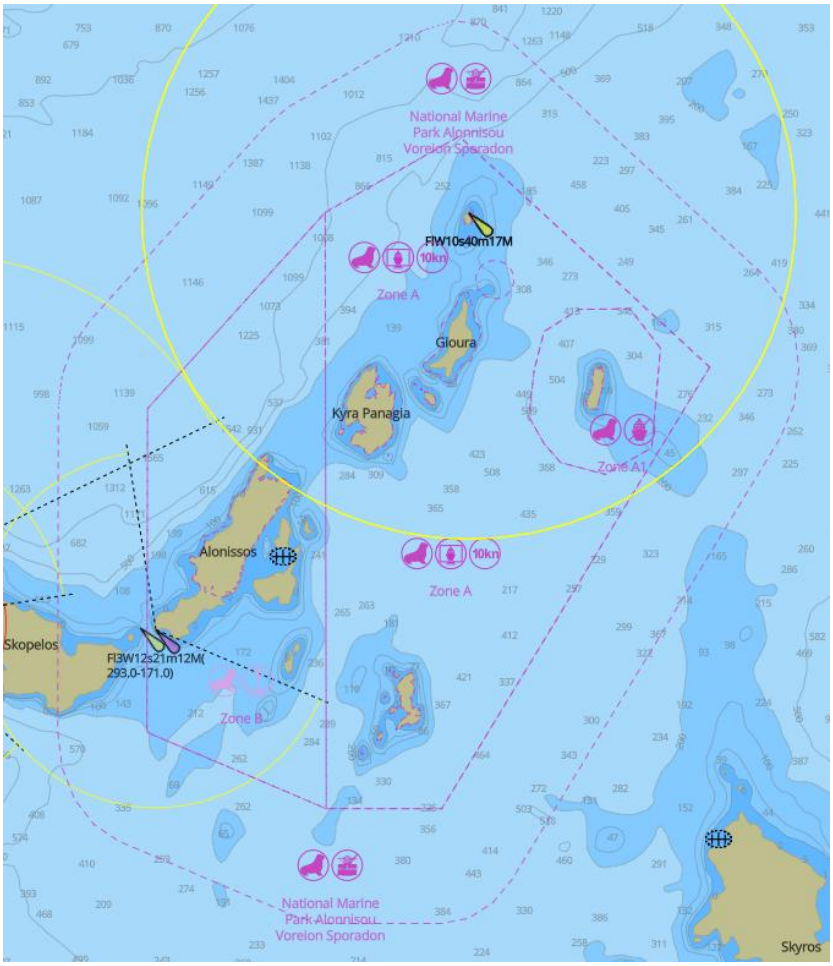

Figure 5. Larger scale view of the Alonnisos Monk Seal MPA Charting Testbed.

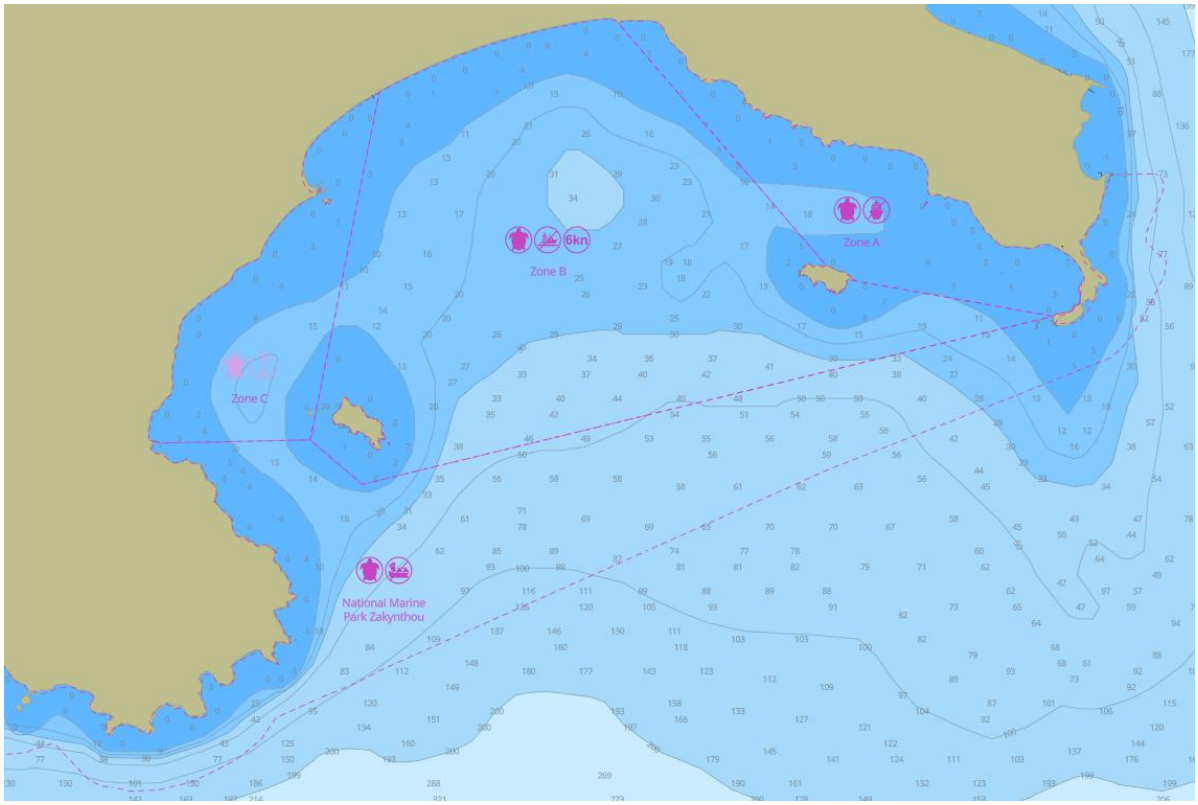

Figure 6. Larger scale view of the Zakynthos Monachus Turtle MPA Charting Testbed.

For the S-126, S-127, S-131 we, likewise, focused on developing symbols representative of the feature mapped, utilizing existing chart symbols where available / possible. In terms of the shape and color, the current bold black and white markers containing these symbols (illustrated in Figure 7) were purposefully designed in order to contrast with ENC basemap and overlayed lidar and other data in 3D web-based applications, so that they clearly stand out as interactive elements (see Butkiewicz et al., 2022).

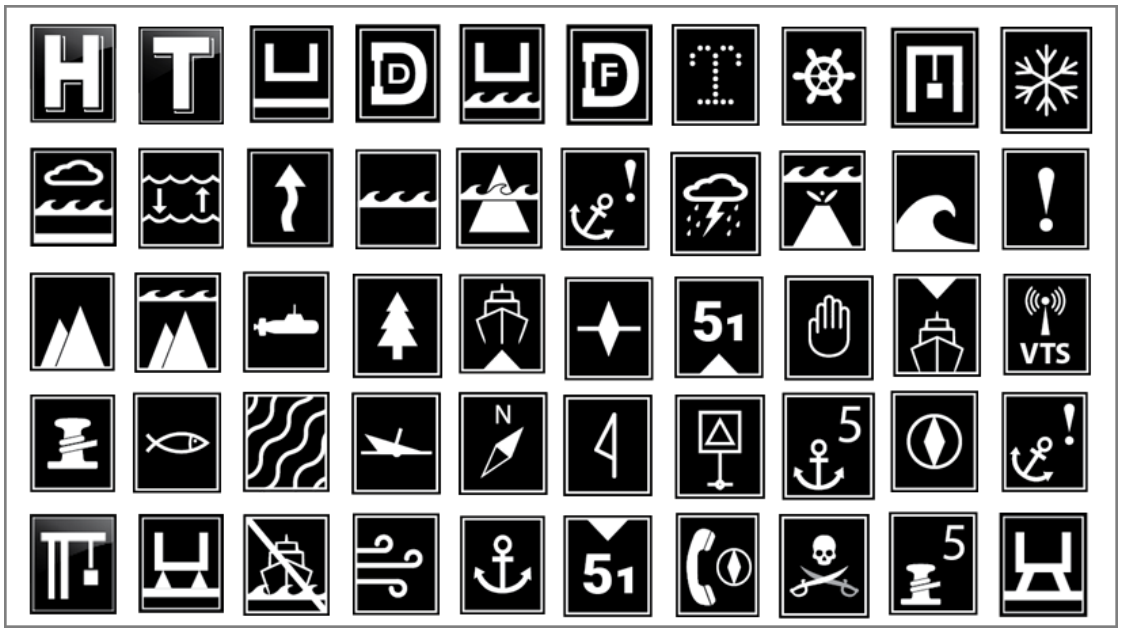

Figure 7. Preliminary symbols for the new feature types in S-126, S-127, and S-131, built for 3D interactive web- based applications.

Future work

The symbols presented in this paper are only preliminary results of this developing project. Various changes, smaller or greater, are expected to their iconography, color, and enclosing shapes (if any) to achieve a good visual hierarchy and become effective for particular applications. For instance, the S-122 symbols are the most advanced from a development perspective among those presented in this paper. For these we are considering making improvements to the iconography based on human factors (viewing distance, perception limits), potential use of green color (saturated and faint) to denote restricted and permitted activities, grouping symbols and leveraging the pick-report for clarification (e.g., one symbol for commercial vessels and one for recreational, rather than separate symbols for the various ship categories), etc. There is only a limited number of different symbols one can remember / understand, thus to minimize the cognitive load we plan to reduce the number of symbols to the fewest necessary, particularly for features that do not pose a danger to navigation.

Similar improvements to the iconography, color, shapes, and grouping of symbols are also under consideration for the S-126, S-127, and S-131 symbols presented herein. As explained, the bold black and white rectangular symbols are intended for experimental use in 3D web- based applications and, as such, they must be modified for use with nautical charts. Changes to the color will be made since black is a strong color, mainly used on charts for dangers to navigation symbols, that attracts map reader's attention, which seems unnecessary. Modifications to the enclosing shapes will also be investigated, including the use of single enclosing shape for each S-1xx to make them discernible or removing them (where possible) to save map space, etc. Figure 8 illustrates samples of modified symbols.

In the last phase of the work, we plan to develop user surveys to test alternative symbols and their performance, and, based on the survey results, make improvements following an iterative approach.

Figure 8. Modified symbols with changes in iconography, color, and enclosing shapes.

Action Required by the S-101PT

The NCWG is invited to:

a. Note this paper,
b. Discuss the proposal,
c. Collaborate with UNH/CCOM on the development of new symbology for S-1xx PS.

References

Contarinis, S., Kastrisios, C., and Nakos, B. (n.d.). Marine Protected Areas and Electronic Navigational Charts: Legal foundation, Mapping Methods, Portrayal for IHO S-122 Standard and Integration Services. Euro-Mediterranean Journal for Environmental Integration, Springer. (Under Review)

Contarinis, S., Nakos, B., Tsoulos, L., & Palikaris, A. (2022). Web-based nautical charts automated compilation from open hydrospatial data. Journal of Navigation, 1-21. http://dx.doi.org/10.1017/S0373463322000327

IHO (2018). IHO Geospatial Standard for Marine Traffic Management. Special Publication No. S-127 Marine Traffic Management Product Specification (Edition 1.0.0). International Hydrographic Organization, Monaco.

IHO (2019). Marine Protected Areas Product Specification. IHO Publication S-122 (Edition 1.0.0). International Hydrographic Organization, Monaco.

Kastrisios, C., Sullivan, B., Powell, J., & Baek, Y. (2022). Marine Spatial Data Infrastructure. *The Geographic Information Science & Technology Body of Knowledge*. (2nd Quarter 2022 Edition), J. P. Wilson (Ed.). https://doi.org/10.22224/gistbok/2022.2.5.

Butkiewicz, T., I. Atkin, B. Sullivan, C. Kastrisios, A. Stevens, and K. Beregovyi. 2022. Web-based Visualization of Integrated Next Generation S-100 Hydrographic Datasets. 2022 Oceans Conference, 17-20 October 2022, Hampton Roads, VA, USA.