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Short communication

Inventory and comparative evaluation of seabed mapping, classification and modeling activities in the Northwest Atlantic, USA to support regional ocean planning

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ABSTRACT

Efforts are in motion globally to address coastal and marine management needs through spatial planning and concomitant seabed habitat mapping. Contrasting strategies are often evident in these processes among local, regional, national and international scientific approaches and policy needs. In answer to such contrasts among its member states, the United States Northeast Regional Ocean Council formed a Habitat Working Group to conduct a regional inventory and comparative evaluation of seabed characterization, classification, and modeling activities in New England. The goals of this effort were to advance regional understanding of ocean habitats and identify opportunities for collaboration. Working closely with the Habitat Working Group, we organized and led the inventory and comparative analysis with a focus on providing processes and tools that can be used by scientists and managers, updated and adapted for future use, and applied in other ocean management regions throughout the world. Visual schematics were a critical component of the comparative analysis and aided discussion among scientists and managers. Regional consensus was reached on a common habitat classification scheme (U.S. Coastal and Marine Ecological Classification Standard) for regional seabed maps. Results and schematics were presented at a region-wide workshop where further steps were taken to initiate collaboration among projects. The workshop culminated in an agreement on a set of future seabed mapping goals for the region. The work presented here may serve as an example to other ocean planning regions in the U.S., Europe or elsewhere seeking to integrate a variety of seabed characterization, classification and modeling activities.

1. Introduction

Marine spatial planning initiatives are being conducted across the globe to reduce conflicts in human uses of coastal and offshore ocean environments (Collie et al., 2012). An ecosystem-based approach to marine spatial planning is essential for achieving resource conservation and management goals across geographic boundaries (McLeod and Leslie, 2009; Samhouri et al., 2014), and requires knowledge of both human uses and ecological characteristics in order to prioritize activities (Crowder and Norse, 2008; Halpern et al., 2008; Baker and Harris, 2012; Menzel et al., 2013). Maps of natural resource distribution are essential tools for spatial planning in the terrestrial and marine realms. However, high resolution mapping of marine resources has only recently been possible at relatively broad scales. Recent advances in marine mapping technology have led to a proliferation of marine resource characterization, modeling and classification techniques (Brown et al., 2011).

Although there have been recent efforts to map marine resources on a global scale (e.g., Halpern et al., 2012; Harris and Whiteway, 2009), most active marine spatial planning initiatives that utilize resource maps have taken place at regional or finer scales (Collie et al., 2012). It is at these scales that the political mechanisms needed to implement marine spatial plans are cohesive. For example, within the European Union, the Marine Strategy Framework Directive, Common Fisheries Policy and Thematic Strategy for Marine Protection provide the policy to implement spatial management and the framework to integrate marine resource data to support regional planning goals (EC, 2008). Similarly, Australia has developed bioregional plans for each of its four bioregions to improve the way decisions are made under the

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Environment Protection and Biodiversity Conservation Act 1999 (Australian Government, 2013). In the U.S., the National Ocean Policy (Obama, 2010) provides the framework for a regional approach to ocean planning by designating 9 regional planning zones and encouraging independent plan development in each of these (NOC, 2013). Within these national frameworks, smaller entities have implemented marine spatial plans, such as the Scottish National Marine Plan (Marine Scotland, 2013), the Massachusetts Ocean Plan in the U.S. (MA EOEEA, 2009) and in English waters, plans for 10 areas designated by the Marine Management Organisation, two of which are already complete (DEFRA, 2014). Although resource characterizations at these fine scales may be more robust because the study areas are smaller and thus logistically easier to map, the fine scale plans can limit broad applicability of the data by considering only observations within political boundaries. Taking a more regional approach can eliminate these "artificial" political boundaries that do not relay ecological information.

The Northeast Regional Ocean Council (NROC) is a United States state–federal partnership that seeks to find and implement solutions to New England's most pressing regional coastal and ocean issues such as climate change/adaptation, energy siting, and fisheries management. The NROC domain includes the member states of Connecticut, Rhode Island, Massachusetts, New Hampshire, Maine, and Vermont and the state and federal waters in the Northwest Atlantic (Fig. 1). Transboundary ocean planning issues addressed by NROC in the Gulf of Maine involve close coordination with Canadian Maritime provinces as well. NROC's support for ocean planning includes comprehensive commercial fishing activity maps, recreational boating surveys, and creation of a Northeast Ocean Data Portal with data viewer and interactive thematic maps (www.northeastoceandata.org). Further, NROC has created several working groups to more fully understand issues in the region and to work with constituents toward effective and efficient regional collaboration. Seabed classification and mapping together is one such topic.

Multiple independent seabed classification and modeling projects have been completed or are in progress in the Northeast region, ranging from academic studies (e.g., Zajac et al., 2013) to resource-inventory habitat mapping (e.g., NEFMC, 2011) to siting studies for renewable energy (e.g., LaFrance et al., 2010). Even though these activities occur in neighboring, adjacent and sometimes overlapping study areas, each is designed to address a different research, management or policy objective. NROC recognized the potential for and value of coordination if these activities could be aligned or related using a common framework of regional ocean management goals. To these ends, NROC

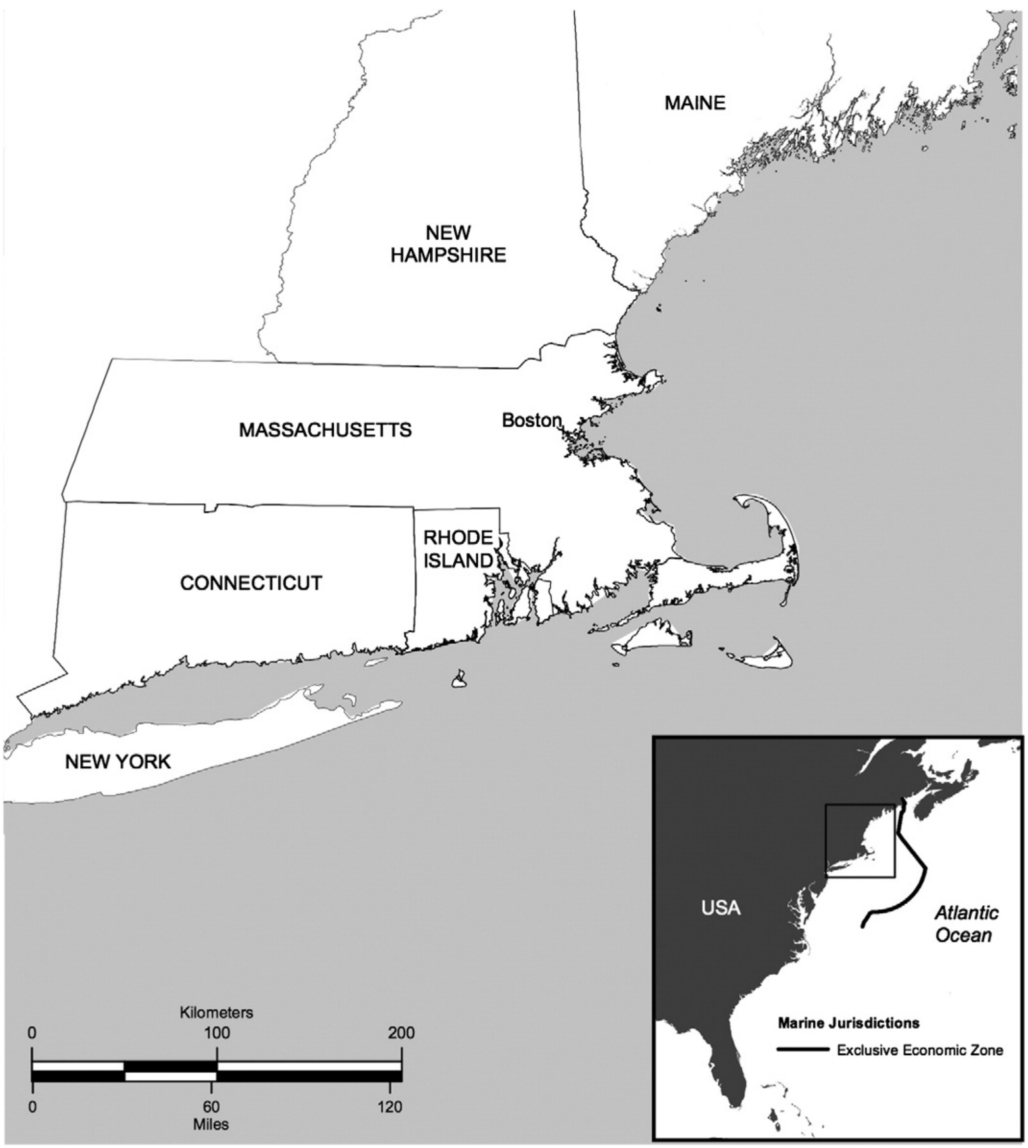

Fig. 1. Location map of the study domain for the Northeast Regional Ocean Council's Habitat Working Group — the Northeast USA.

convened a Habitat Working Group (HWG) comprised of regional state, federal, and academic seabed habitat experts to contribute to an inventory and comparative evaluation of seabed characterization, classification and modeling activities in the Northeast region.

Working in support of NROC, we served as facilitators of the HWG's effort to review seabed characterization, classification, and modeling efforts in the region, compare and contrast active approaches and to identify opportunities for future collaboration. Our intention was to facilitate pragmatic and informed dialogue about how the processes and methods related to seabed characterization, classification and modeling can best address regional ocean planning needs. We developed products and a framework that NROC can use to leverage existing, ongoing, and future seabed classification, characterization, and modeling projects to implement solutions to marine issues that require a regional response. The purpose of this study was to 1) increase the understanding of seabed mapping and classification methods being used in the U.S. Northeast region; 2) increase dialogue between mappers and managers; and 3) identify common ground and potential collaborations within the U.S. Northeast region.

2. Materials and methods

NROC assembled the HWG in 2012 to undertake a yearlong effort to review existing seabed characterization and mapping projects and to make recommendations to NROC regarding attainable goals for the region. The HWG consists of individuals engaged in seabed mapping and classification efforts from the scientific and management communities in the Northeast region. The HWG met four times in person and once virtually between November 2012 and July 2013 and was composed of 25 individuals representing the states of Maine, New Hampshire, Massachusetts, Rhode Island and Connecticut, as well as the U.S. Geological Survey, the U.S. National Oceanic and Atmospheric Administration, the U.S. Bureau of Ocean Energy Management, the U.S. Environmental Protection Agency and The Nature Conservancy (see Appendix A for complete list of members). We communicated frequently with HWG members between meetings and relied on members' knowledge of seabed habitat-related projects within the region as well as their expertise on the science and management behind seabed characterization, modeling and classification. HWG members' data and ideas were incorporated throughout the inventory and comparison of seabed characterization, modeling and classification projects.

2.1. Inventory

To review active and recently completed seabed characterization, modeling and classification activities in the Northeast region, we compiled an inventory in two stages. First, we obtained information on all known active projects in the region from NROC leadership and from each member state and federal organization. Each active project was entered into a matrix and identified by its geographic location, responsible entities, and several descriptive attributes (Table 1). Descriptive attributes included project goals, guiding legislation, mapping scale, underlying data and resulting data products. We also organized projects based on whether they were “data generators” (e.g., mapping projects) “data consumers” (e.g., modeling projects) or “classifiers” (e.g., scheme building projects). In the second stage, we worked with the HWG to prioritize projects for more detailed inventory descriptions and evaluation and comparison.

2.2. Evaluation and comparison

We created a survey for the HWG to determine project attributes (metrics) that would be of interest and importance toward a detailed evaluation and comparison of high-priority projects (Table 2). The metrics in the survey were drawn from HWG member feedback as well as the international seabed habitat mapping inventory of Brown

Table 1
Attributes of state and regional seabed characterization, modeling and classification efforts that were assembled in the inventory matrix.

Attribute	Explanation
Project type	*Classification scheme*: an existing scheme used to classify habitat data *Classifier/synthesizer*: a project that is only classifying or synthesizing existing data *Data consumer*: a project that needs classified data *Data producer*: a project that will produce/is producing data that could be classified *Model*: a model that could be used in a habitat mapping project or uses habitat mapping data *Workshop*: a workshop that needs a classification, data or model
Website	Dedicated website displaying static maps or map viewer, along with descriptive text about the project
Purpose/goal	Legislation/science or management sector
Users/audience	State and/or federal agencies/coastal managers/industry/public
Responsible entities	Group or individuals that conducted the mapping
Budget	Cost of all mapping activities and/or amount of funding received
Scope & extent	Spatial and temporal
Scale	Minimum mapping unit, pixel size, map scale
Classification scheme used	Name of existing scheme or description of project-specific scheme
Output suitable for ecosystem valuation?	Yes/no; brief explanation
Products	Data, metadata, maps, tools, reports, papers
Biological data	Techniques/technologies, processing/analysis steps, models, assumptions
Geological data	Techniques/technologies, processing/analysis steps, models, assumptions
Physical/chemical data	Techniques/technologies, processing/analysis steps, models, assumptions
Interview questions	Key challenges, key limitations, lessons learned, recommendations

Table 2
Survey given to the Habitat Working Group to determine which metrics of seabed characterization, modeling and classification projects would best facilitate a detailed comparison of activities in the Northeast region.

Metric	Score
Project spatial extent Project resources Project timeline Legislation	1 = essential for a thorough regional comparison 2 = useful for a thorough regional comparison 3 = not important for a thorough regional comparison
Specific research question	
Preconceived definition of habitat	
Species or habitat targeted for mapping	
Minimum mapping unit	
Smallest scale of habitat defined	
Sampling type and spacing	
Habitat linkages to data	
Mapping strategy (abiotic surrogates, top-down, bottom-up)	
Acoustic instrumentation type	
Acoustic metrics used (bathymetry, backscatter, slope, aspect, rugosity, curvature, BPI)	
Acoustic processing method (signal-based, image-based, expert judgment)	
Oceanographic instrumentation type	
Oceanographic metrics used (temperature, salinity, currents)	
Oceanographic processing method (annual seasonal means/max/min, categorization)	
Ground-truthing instrumentation type	
Ground-truthing metrics used (geological, infauna, epifauna/flora, fish)	
Ground-truthing processing method (habitat delineation by heads-up digitization, habitat proxies, predictive modeling)	
Outputs (shapefile, raster, webmap, static maps)	
Other attributes that are not on this list: [to be filled in by respondent]	

et al. (2011). The survey asked each HWG member to rank project metrics on a scale of 1 to 3: 1 = the metric is essential for a thorough regional comparison; 2 = the metric is useful for a thorough regional comparison; and 3 = the metric is not important for a thorough regional comparison. We then calculated the average score of each metric and retained the top ten for incorporation into the evaluation and comparison. We invited the high-priority project representatives to give presentations of their work to the HWG addressing the ten metrics identified by the survey. We provided PowerPoint templates to the presenters to ensure comparable information was obtained. We incorporated the information from these presentations into a detailed comparative matrix of high-priority seabed characterization, modeling and classification activities in the region.

In order to highlight the important project metrics, to compare them among projects, and to facilitate understanding and interpretation by both scientists and managers, we created quantitative graphical representations of the information in the inventory matrix in the form of maps, coded tables and charts. We created visual comparisons of 1) spatial extent of each high-priority active project in the region; 2) high-priority project planning, mapping strategy, data interpretation, results; and 3) high-priority project area, relative coverage and pixel size.

2.3. Northeast Regional Ocean Council habitat mapping and classification workshop

The purpose of the final workshop was to bring HWG members together with managers, regulators and scientists in the region to present the results of the evaluation and comparison, as well as to agree on a set of regional seabed mapping and classification goals. We contributed to the agenda and recommended invitees based on the findings and discussions that took place during the HWG meetings over the previous year. Several ongoing (and therefore incomplete) projects were identified by the HWG as being timely and potentially very informative to states' and the region's future seabed characterization, classification and modeling plans. We invited representatives from these projects to present their ongoing work to the workshop audience. In addition, we planned a panel discussion among state, regional and federal marine resource managers focused on using managers' policy and planning needs as drivers for planning and executing seabed characterization, classification and modeling projects. Throughout the workshop, participants were encouraged to write thoughts and recommendations for the region on sticky-notepads and to hang them in designated areas of the workshop room. The workshop culminated with a review, organization and discussion of these sticky-notes into discrete categories of recommendations for NROC. The workshop participants all agreed that the resulting list provided essential guidance for moving forward with regional seabed characterization, classification and modeling.

3. Results

3.1. Inventory

In the first stage of the inventory we assembled information on 23 active seabed characterization, modeling and/or classification projects in the Northeast region. We documented a wide array of projects, ranging from efforts focusing on species of importance and their habitats (e.g., scallop mapping by University of Massachusetts Dartmouth) to ecoregional assessments (e.g., The Nature Conservancy's Northwest Atlantic Marine Ecoregional Assessment, NAMERA). The full inventory matrix is provided in Appendix A. For the second stage of the inventory, the HWG identified a high-priority project from each NROC member state as well as two regional-scale projects. These included the Maine Coastal Mapping Initiative (MCMI), mapping conducted by the New Hampshire Coastal Program (NHCP) and the Center for Ocean and Coastal Mapping (CCOM), the Massachusetts Office of Coastal Zone Management (MA CZM), the Massachusetts Division of Marine Fisheries (MA DMF), the Rhode Island Ocean Special Area Management Plan (OSAMP) (RICRMC, 2010), the Long Island Sound Study Seafloor Mapping (LISS; a Connecticut–New York partnership), the Swept-Area-Seabed-Impact Model (SASI) developed by the New England Fisheries Management Council (NEFMC, 2011), and the NAMERA (Greene et al., 2010). The final inventory matrix was provided to HWG members as a way to review and revise the information collected. Once HWG members verified the information in the matrices, we proceeded with the evaluation and comparison.

3.2. Evaluation and comparison

We received responses to our survey from half (13) of the HWG members. This low response is a testament to the limited available time of coastal researchers and managers to actively participate in new regional ocean planning efforts. Nevertheless, we considered the responses valid and necessary for prioritizing future work. From these responses, we identified ten metrics that were considered most important to a thorough regional comparison of seabed characterization, modeling and classification projects (Table 3). The two most important metrics were “Species or habitat targeted for mapping” and “Mapping strategy”. The “Classification scheme” metric was not identified as essential for a thorough regional comparison through the survey. HWG members acknowledged that individual projects would continue to use their own local or custom habitat classification schemes in order to meet their specific management goals or answer their own research questions. However, HWG members also committed to supporting “crosswalk” projects for translating the many local habitat classification schemes in the region to the U.S. Coastal and Marine Ecological Classification Standard (CMECS) (FGDC, 2012). In addition, HWG members agreed that member states and organizations would use CMECS as the unifying habitat classification scheme for the region when it is appropriate to create regional maps using multiple states' data.

The first step of the evaluation and comparison was to assess the spatial extent and overlap of all of the high-priority projects (Fig. 2). The spatial extent of the study area domain of each project depended on the research questions or management goals of the individual states or organizations. For example, the New England Fisheries Management Council used the U.S. Exclusive Economic Zone as study boundaries for their model of habitats that are sensitive to fishing impacts whereas the Long Island Sound Study committed to mapping small areas within Long Island Sound that were identified as high priority by local stakeholders. Study area domains for Rhode Island, Massachusetts and Maine were similar or the same as those designated for their individual ocean or coastal management plans, whereas the spatial extent of

Table 3
The ten most important seabed characterization, modeling and classification project metrics identified from a survey of Northeast Regional Ocean Council Habitat Working Group members (n = 13). Metrics were ranked by average score where 1 = essential, 2 = useful, or 3 = not important for a thorough regional comparison.

Rank	Metric	Average score
1	Species or habitat targeted for mapping	1.17
2	Mapping strategy (abiotic surrogates, top-down, or bottom-up)	1.23
3	Ground-truthing processing method (habitat delineation by heads-up digitization, habitat proxies, predictive modeling)	1.33
4	Acoustic metric used (bathymetry, backscatter, slope, aspect, rugosity, curvature, Bathymetric Position Index)	1.36
5	Habitat linkages to data	1.38
6	Ground-truthing metrics used (geological, infauna, epifauna/flora, fish)	1.42
7	Preconceived definition of habitat	1.46
8	Sampling type and spacing	1.46
9	Specific research question	1.50
10	Smallest scale of habitat defined	1.50

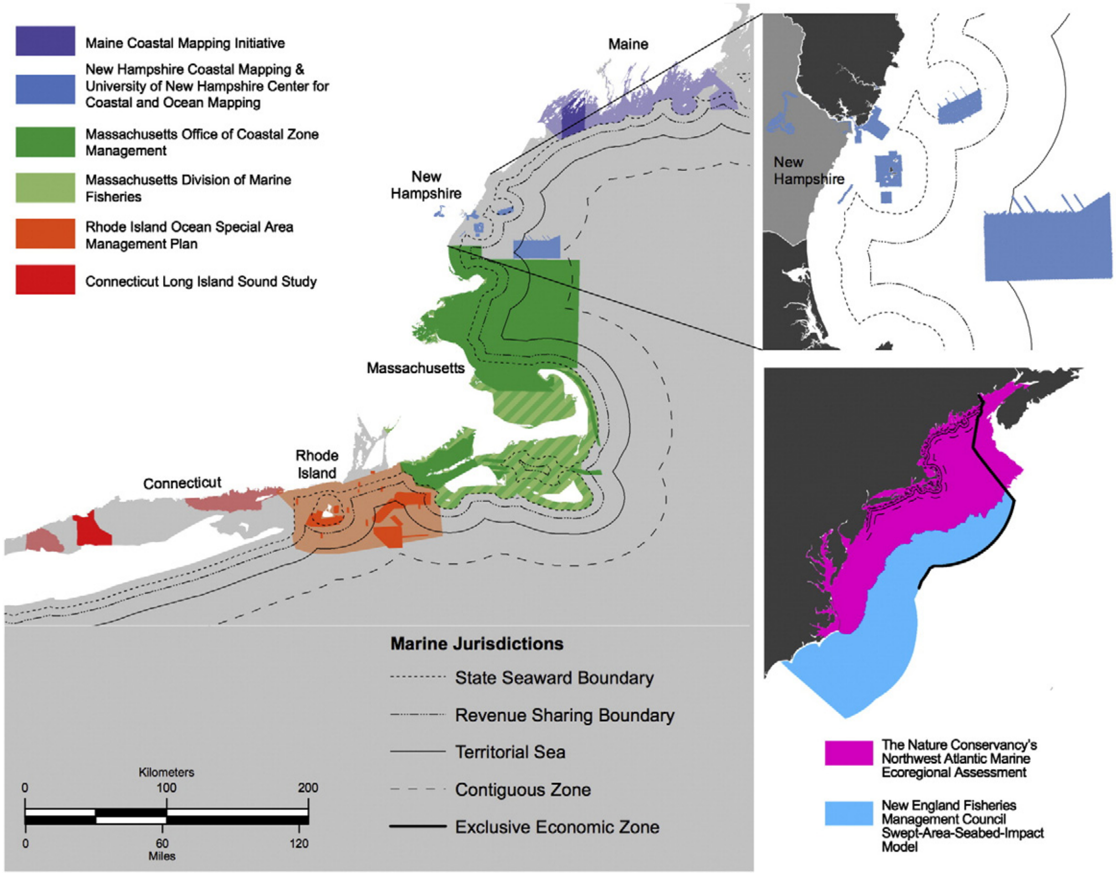

Fig. 2. The spatial extent of seabed mapping projects within the U.S. Northeast region. Bold colors indicate areas completed or in pilot mapping phases; faded colors indicate areas not yet complete. The state of Massachusetts has two active seabed mapping programs with full jurisdictional overlap, but only the Office of Coastal Zone Management has conducted mapping to date. Areas not yet mapped in Massachusetts' waters are shown with a hatch symbol.

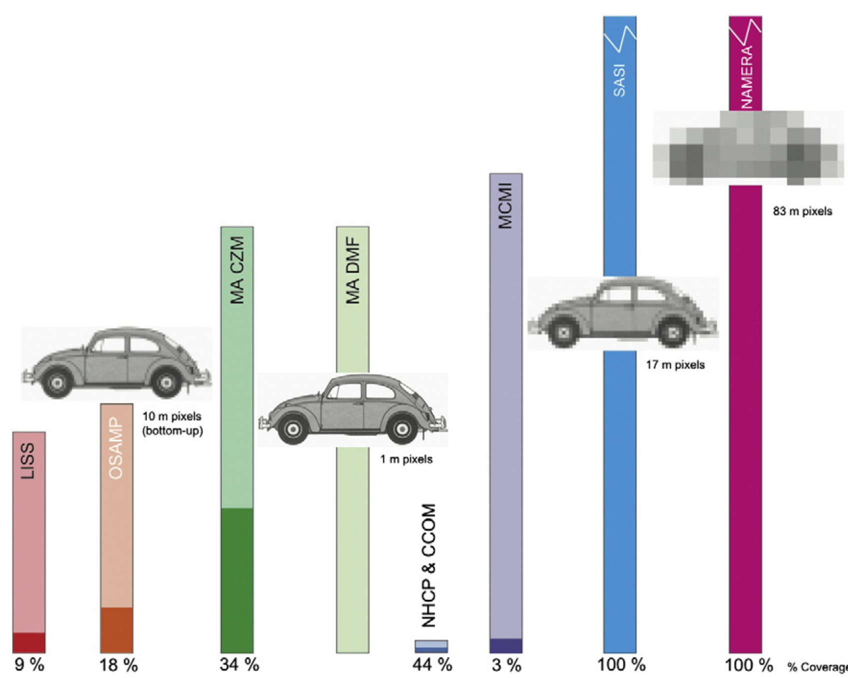

Fig. 3. Comparison of total project area, mapping area completed with respect to total project area, and project pixel size for eight seabed mapping projects in the U.S. Northeast region. The size of each bar represents the total area of state waters relative to Maine, which has the largest area. Dark areas in each of the bars represent relative percentage of area mapped using program protocols. The resolution of each Volkswagen Bug is representative of the resolution of the maps created by each project relative to the 1-meter pixel Bug.

mapping in New Hampshire reflected opportunistic mapping efforts over the past several years.

Similarly, each high-priority project had completed mapping a different percentage of their study area domain and had adopted different habitat mapping resolutions depending on research questions or management objectives (Fig. 3). The graphical representation of these spatial metrics was guided by feedback from the HWG, who noted that managers often cited the need to detect objects on the seafloor that are "the size of a Volkswagen Bug." Therefore, the seabed mapping resolution (pixel size) for each project is represented by an adjusted image of a Volkswagen Bug, where the Bugs' resolution is adjusted relative to the 1-meter pixel Bug. The NAMERA used a relatively large pixel size (83 m) but achieved 100% coverage of their study domain throughout the Northeast region (as well as throughout the Mid-Atlantic region). On the opposite side of the scale, the Massachusetts Division of Marine Fisheries has a goal of mapping state waters at 1-meter resolution, but has made little progress toward that goal. The Long Island Sound Study, Massachusetts Office of Coastal Zone Management, New Hampshire Coastal Program and the Maine Coastal Mapping Initiative all reported that they used variable seabed map resolutions depending on the particular research question or management objective, or had not yet decided on a standard operational pixel size.

The detailed comparison of seabed mapping metrics among state and regional projects highlighted several commonalities as well as major differences (Fig. 4). The objective of six of the eight projects was to map benthic habitat and/or significant and sensitive habitats. Project objectives drove which species or habitats were targeted for mapping as well as which tools were used. All projects used acoustic data whereas the particular acoustic metric or suite of metrics used by each project differed. Geological ground-truthing was another standard practice by all projects, but biological ground-truthing of metrics was more varied. While all projects began with the premise that physical and biological habitat features are linked, the strategies used to integrate physical and biological datasets differed. The most widely used strategy was also the least sophisticated; abiotic surrogacy is a broad scale technique that delineates patterns in physical data with little to no integration of ground-truthing data. The final step for all projects was to set boundaries for habitat units. All projects accomplished this by either supervised, heads-up delineation of habitat units or by using the existing geological boundaries as proxies for habitat. Only the Rhode Island OSAMP (LaFrance et al., 2010) utilized predictive modeling. This detailed comparison also revealed a typical project "trajectory," i.e., the major steps involved in completing a seabed mapping project (Fig. 4). Projects began with a planning stage, followed by data collection, then data integration, production of draft maps, and followed by the publishing or online posting of maps and data for public use. At the time of the evaluation and comparison, the high-priority projects were at different points on this trajectory, with several projects iterating a particular step (e.g., revising or improving their physical–biological integration mapping strategy).

3.3. Northeast Regional Ocean Council habitat mapping and classification workshop

The final workshop, held on September 25, 2013 in Charlestown, Rhode Island, was facilitated by the Coastal Resources Center at the University of Rhode Island. Thirty-six seabed mapping scientists and coastal managers from state, federal and academic programs were in attendance.

After presenting the results of the inventory, evaluation and comparison, several invited experts discussed topics critical to making progress in seabed mapping in the Northeast. Mark Finkbeiner from the NOAA Coastal Services Center spoke about CMECS status and recent updates. Vince Guida from the NOAA Northeast Fisheries Science Center

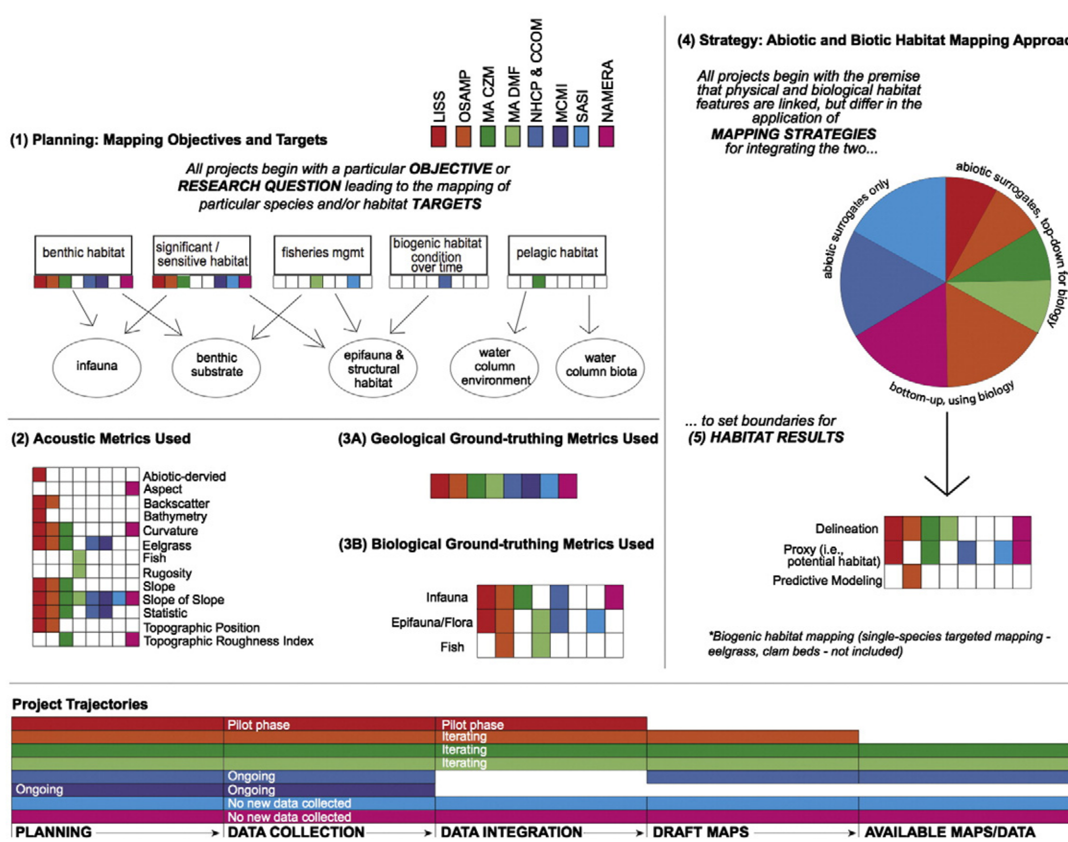

Fig. 4. Final schematic comparing mapping metrics among eight seabed mapping projects in the U.S. Northeast region. Stages 1 through 5 of seabed habitat mapping projects range from the planning and formulation of a research question to creation of results. At the bottom of the schematic, project timelines among projects are compared on a common project trajectory.

reported that his team's experience in using CMECS terminology in the field showed that further work needed to be done to translate terms that are specific to marine sampling tools and methods in order to achieve coherence with CMECS. Kathryn Ford from the Massachusetts Division of Marine Fisheries described an in-progress effort to crosswalk several seabed classification schemes throughout the Northeast to CMECS. Although her team looked at existing schemes and maps at multiple scales, there were several common lessons learned from which future cross-walking efforts could benefit. Overall, this dialogue promoted recognition that a national standard (CMECS) can co-exist with distinctive state and institutional efforts.

A panel of four coastal managers representing federal (Brian Hooker, U.S. BOEM), regional (Michelle Bachman, NEFMC) and state agencies (Bruce Carlisle, MA CZM; Grover Fugate, RI CRMC) responded to questions from Emily Shumchenia (CoastalVision) about the results of the seabed characterization, classification and modeling activities inventory, evaluation and comparison. The resulting discussion among the moderator, panel members and the audience emphasized that most management decisions in the U.S. are at the state level but highlighted the value of regional maps in providing context for state-based decisions. Panel and audience members also agreed on several regional needs:

- Products that support decision-making by prioritizing habitats, documenting use conflicts and providing guidance for how to interpret what maps can and cannot tell managers
- To include fishermen and other users with local knowledge in habitat classification efforts
- Efforts to derive ecosystem function from habitat data
- An understanding of why high-value fisheries areas are productive
- More ground-truth data.

4. Discussion

Using a creative schematic and visual comparative methodology, our results highlight elements of seabed classification, characterization, and modeling projects critical to implementing solutions to regional ocean planning issues. There was a general consensus that the inventory, project presentations, and comparative visual schematics were useful in identifying commonalities, documenting a shared understanding of critical mapping issues, and providing a basis for comparing projects. Well-designed seabed classification, characterization, and modeling projects can be used to increase the understanding of ecological patterns and processes critical for effective management of ocean resources and to translate between scales of interest (Guarinello et al., 2010; Brown et al., 2012). The variety of sampling and modeling scales represented by projects within the region may assist NROC in identifying regional patterns and processes.

Scientists and managers used our conceptual figures to match ocean planning and management goals with elements of existing seabed mapping projects. These figures rapidly fostered communication among participants at the September workshop and helped them identify synergies between current projects and opportunities for future coordination. Our final schematic (Fig. 4) showcased the drivers of interpretation for each project. Drivers of interpretation are the variables (e.g., rugosity and slope, biological cluster analysis results) used to set thematic classes and are applied to derive meaning from the results. Drivers of interpretation are critical because they set the potential for, and limit the scope of, scientific and management applications of the data products. By highlighting relationships between methodologies, scale and drivers of interpretation, the schematics provide ocean planners with an understanding of the capabilities of seabed mapping data.

The comparison of projects led to a common understanding that individual states/projects have different resources, objectives, and mandates. We acknowledged these differences and agreed to a common classification language and mapping terminology (i.e., map scale and resolution, approaches to integrating physical/biological habitat attributes) that continues to allow flexibility at the project level. Importantly, we recognized that a national standard (CMECS) can co-exist with distinctive state and institutional efforts. Likewise, the methodology for creating regional-scale maps of seabed habitats may be informed by, but also stand apart from, the methods currently used by fine-scale state and institutional projects.

The most important outcome of our work was a set of regional goals that were assembled after extensive examination of the products presented here and agreed upon by the HWG, and the scientists, managers and practitioners who attended the final Habitat Classification Workshop in September 2013. The HWG recommended that the NROC Steering Committee take the steps necessary to meet these goals in the near future.

1. Keep a regional working group like the HWG active.
2. Secure resources for conducting crosswalks between CMECS and existing state- and agency-based classification schemes in the region.
3. Develop a plan for documenting best practices for the planning and design phases of habitat mapping.
4. Begin creating regional habitat datasets, beginning with geological (e.g., geoform, substrate) maps.
5. Identify and prioritize habitat mapping data gaps (e.g., water column, ecosystem function, sentinel ecosystems).
6. Make a plan and secure resources to address mapping needs.

Overall, our work lowered barriers to implementing these regional goals. We have initiated the processes necessary to “edge-match” adjacent and/or spatially nested projects within an ocean planning region and perhaps across regions. The lessons-learned from this inventory and comparative evaluation of active New England seabed mapping projects can inform similar regional-scale ocean planning efforts elsewhere in the U.S., Europe and beyond. In the U.S., for example, several other regions have recently formed Regional Planning Bodies (RPBs) under the National Ocean Policy (e.g., Mid-Atlantic RPB, West Coast Governor's Alliance) and are actively collecting new or collating existing seabed datasets. By using our framework, process and key variables as a template, these RPBs could accelerate their progress on mapping and assessing seabed resources in their region. Europe, where several countries share shorelines along ocean basins, is not unlike a U.S. region with respect to the spatial planning challenges that emerge with multiple agencies, institutions and stakeholders influencing a single water body. We have indeed already applied a lesson learned here from the European seabed mapping community in supporting a single classification scheme (i.e., CMECS in the U.S.; the European Nature Information System scheme in Europe). We have much to learn from each other and the lines of communication are already open — this special issue is a testament to that fact. Beyond the U.S. and Europe, we hope that our approach inspires other groups to evaluate and unite potentially complementary seabed mapping and assessment efforts, despite contrasting goals and management or policy needs.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.seares.2014.09.010.

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