Options for indicator development, monitoring, assessment, and reporting for the Mid-Atlantic regional ocean ecosystem

To support Mid-Atlantic Regional Ocean Action Plan Healthy Ocean Ecosystem Action 5

Final report prepared for the Mid-Atlantic Regional Council on the Ocean

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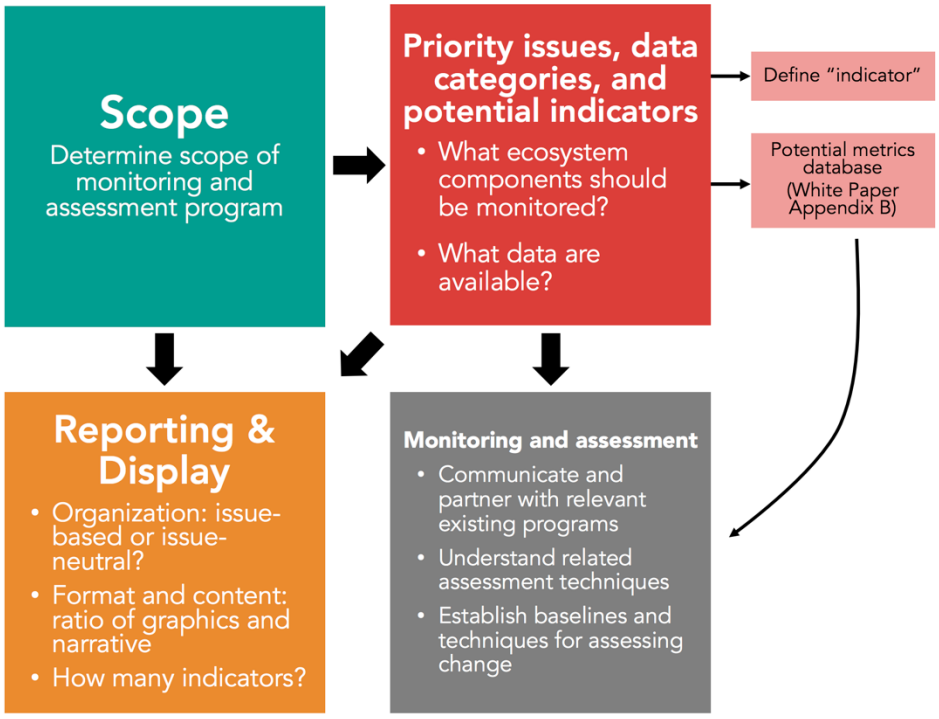
EXECUTIVE SUMMARY

The Mid-Atlantic Regional Ocean Action Plan (OAP) Healthy Ocean Ecosystem Action 5 establishes that a healthy ocean ecosystem indicator monitoring and assessment program is needed to better understand ecosystem changes as they occur, and how those changes impact and are impacted by human activity.

A project to begin to address this need was initiated in February 2017, with the goal of informing the development of a program for the Mid-Atlantic region that relies on existing data collection and monitoring efforts and is tied to ocean planning goals. This project engaged Mid-Atlantic Regional Planning Body (RPB) members and stakeholders in the evaluation of potential indicator themes and data, and identified key options and decision criteria for defining the scope and outputs of an indicator monitoring and assessment program.

In the first phase of the project, the consulting team conducted outreach to RPB members and stakeholders to obtain input on potential indicator themes and data. This initial phase resulted in a white paper (Appendix A) that integrated this feedback and presented a draft indicator framework including draft themes and data categories, options for indicator reporting, a review of existing indicator programs relevant to the Mid-Atlantic region, and an inventory of data to support potential indicators. The white paper also summarized key questions related to the overall scope of the program that emerged in outreach discussions. The white paper served as the foundation for further discussion and consideration in the second phase of the project, at a public workshop held in Baltimore in July 2017. The goal of the workshop was to receive input on the overall scope of an indicator program, including approaches to report and display indicator data, and to further hone priority themes, data categories, and potential indicators.

In the final phase of this project, the white paper and workshop summary (Appendix B) were used to develop this final report, which summarizes the project process and presents refined and constrained options and decision criteria for 3 out of the 4 key decision steps for indicator program development identified by the consulting team (represented by boxes below).



Options for indicator development, monitoring, assessment, and reporting

Section 2 of this report describes options for overall program scope (top left in diagram), including indicator reporting/display (bottom left in diagram). Section 3 of this report summarizes priority issues, data categories, and potential indicators (top right in diagram), including existing efforts to be leveraged, potential data gaps, and options for growing the program in the future. Where applicable, this report provides general budget/capacity considerations and other criteria for deciding on possible approaches. Considerations for monitoring and assessment (bottom right) should be discussed once the program advances to considering specific indicators and underlying datasets.

A primary challenge is to balance the manageability of the indicator program with the need to communicate a comprehensive view of the state of the ecosystem. A reasonable potential Mid-Atlantic ocean ecosystem indicators program would:

- Be targeted at the general public, but retain the option to develop more technical content for certain indicators
- Be organized by three core themes, which are issues that resonate with the public: Living Ocean, Ocean Conditions, and Human Footprint
- Contain 5-10 indicators per each theme, supported by existing data and partnerships with data providers, managers, and stewards
- Report indicator results via a dashboard that is displayed either on the Mid-Atlantic Ocean Data Portal or within the Mid-Atlantic Regional Ocean Assessment
- Track ocean ecosystem change
- Scientifically vet indicators
- Convey neutrality, by not favoring one interest over another or using value-laden language
- Be updated annually if the data allow it

Questions for further consideration remain:

- Under which theme a priority issue like water quality belongs, since it represents Ocean Conditions and some elements of Human Footprint
- If/how to represent overlap, interactions, and linkages between/among Living Ocean, Ocean Conditions, Human Footprint
- Whether Driver-Pressure-State-Impact-Response (DPSIR) relationships are important to convey
- How/whether to incorporate case studies and narratives
- How far to develop Human Footprint in the initial program versus future iterations (e.g., whether and how ocean uses should be tracked, and if and how to take an ecosystem services/benefits or socioeconomic approach to characterize them)

Suggested next steps include:

1. Confirm the target audience
2. Decide on a location for the reporting tool or dashboard
3. Confirm an issue-based approach starting with the three broad proposed themes and their titles, “Living Ocean”, “Ocean Conditions”, and “Human Footprint”
4. Review and confirm the top 5-10 issues identified within each theme
5. Continue work within the bounds described above to:
    - Help to determine/decide on specific indicators within each theme and issue
    - Develop a reporting tool mockup
    - Begin drafting data agreements and maintenance plans for each indicator
    - Draft products for each indicator

CONTENTS

Options for indicator development, monitoring, assessment, and reporting

1 Introduction

1.1 Project background and objectives

In February 2017, the Mid-Atlantic Regional Council on the Ocean (MARCO) contracted with a team led by the Consensus Building Institute[1] (CBI team) to develop options and recommendations for an ocean ecosystem monitoring and assessment program to support the implementation of Mid-Atlantic Regional Ocean Action Plan (OAP) Healthy Ocean Ecosystem Action 5. The OAP establishes that the project will be informed by the Mid-Atlantic Regional Planning Body (RPB) members, MARCO, technical experts, and OAP stakeholders. In addition, the project leverages the data and other information included in the OAP, the Mid-Atlantic Regional Ocean Assessment (ROA), the MARCO Ocean Data Portal (Portal), the Marine-life Data and Analysis Team (MDAT), and the numerous other data collection, monitoring, and assessment efforts in the region.

The CBI team is directed by a project Steering Committee that is composed of RPB members and led by representatives from the New York Department of Environmental Conservation. The OAP is serving as the guiding document for this project; in particular, the following key principles from Healthy Ocean Ecosystem Action 5:

Key Principles from Mid-Atlantic OAP Healthy Ocean Ecosystem Action 5:

"Need to better understand ecosystem changes as they occur, and how those changes impact and are impacted by human activity"

"Ocean health indicators will focus on the Mid-Atlantic region and, to the extent feasible, be derived from existing data collection and monitoring efforts"

"Scientists, fishermen, other stakeholders, and Traditional Knowledge holders will be engaged at key points in this action, including during design and evaluation of indicators"

The purpose of this final report is to summarize the process to identify options for indicator development, monitoring, assessment, and reporting for the Mid-Atlantic regional ocean ecosystem since project initiation in February 2017. As such, this report integrates feedback and input from stakeholders, the Steering Committee, and RPB members, obtained from February 2017 through August 2017, including during targeted outreach meetings conducted in April and May 2017, as well as from a dedicated 2-day public workshop held in Baltimore in July 2017.

[1] The CBI Team included Pat Field and Rebecca Gilbert from CBI, Emily Shumchenia, and Nick Napoli

The report begins by presenting important background information and key principles, and then describes the processes used to conduct project outreach and develop a white paper (Appendix A) to support the two-day public workshop. After a brief explanation of workshop outcomes (see Appendix B for the full workshop summary), two broad topics for indicator program development are described: "overall scope, including indicator reporting/display" and "priority issues, data categories, and potential indicators." In the two subsequent sections of this report, each of these topics are described, and options and considerations that could guide decision-making for each are presented.

1.2 Geographic and thematic scope

This project adopts the geographic focus of the OAP, which includes "the ocean waters of the region…the shoreline seaward to 200 nautical miles..." "northern limit is the New York/Connecticut and New York/Rhode Island border; southern limit is the Virginia/North Carolina border"[2].

The Steering Committee acknowledges the linkages among important coastal habitats, coastal processes, and ocean health, and the numerous existing monitoring and assessment efforts occurring in the coastal region, including within state programs, National Estuary Programs (NEPs), National Estuarine Research Reserves (NERRs), and many others. This project references those existing data collection and reporting streams for topics in the coastal domain that are relevant to the monitoring and assessment of ocean health (e.g., wetland habitats, eutrophication).

As noted in the OAP, this project focuses primarily on indicators of healthy ocean ecosystems. However, throughout the project, the Steering Committee and stakeholders noted linkages between ecosystem components, human uses, and anthropogenic stressors. Therefore, this project resulted in discussions about options for addressing the human component of the ocean ecosystem.

1.3 Project outreach

In early April 2017, MARCO, in consultation with the Steering Committee, arranged several webinars with ocean planning participants and stakeholders to share a project overview, report on progress to date, and obtain feedback on initial draft indicator themes and data categories for a healthy ocean ecosystem monitoring and assessment program. Over 50 individuals were invited to participate (based on Steering Committee nomination) within the following groups:

- Academic and agency science/research
- Commercial and recreational fishing
- Environmental non-governmental organizations
- Non-consumptive recreation

[2] Mid-Atlantic Regional Ocean Action Plan, page 24; https://www.boem.gov/Ocean-Action-Plan/

- Aquaculture
- Tribes
- Maritime commerce
- Energy
- Sand management

The CBI team and MARCO hosted seven 90-minute webinars between April 27 and May 15, 2017. Invitees and participants were asked to provide input, such as whether proposed indicator themes and data categories were appropriate for ocean planning goals, if there were additional categories or data to consider, and which indictors or metrics should be prioritized. Details about the stakeholder outreach webinars were described and the input received was integrated into a white paper (Appendix A).

1.4 White paper: "Developing an indicator monitoring and assessment program to support the Mid-Atlantic Regional Ocean Action Plan Healthy Ocean Ecosystem Action 5"

The white paper was written after completing preliminary work to identify key data and information to inform an indicator monitoring and assessment program, and after engaging the Mid-Atlantic RPB and numerous stakeholders in the initial evaluation of potential indicator themes and data. The white paper provides background information, potential options, and important considerations for decision-making to advance a healthy ocean ecosystem indicator monitoring and assessment program as described by Mid-Atlantic Regional Ocean Action Plan Healthy Ocean Ecosystem Action 5 (Appendix A).

While the white paper was not intended to be a comprehensive inventory of every available option for developing an extensive monitoring and assessment program, it did serve to create a common understanding of work accomplished to-date to articulate options for a Mid-Atlantic program for participants at the July 2017 Healthy Ocean Ecosystem Indicators Workshop. Specifically, the white paper focused on the issues and priorities expressed in the OAP and presented:

- A potential indicator framework, including important themes and potential data categories that likely need to be prioritized in order to identify those data streams and indicators which are most relevant to the OAP
- An appendix containing key characteristics of datasets relevant to each potential data category and contact information for data stewards
- Options and key decision points for monitoring, assessment, reporting, and display of indicators, including references to example programs
- Feedback integrated from the RPB, numerous stakeholders, the project Steering Committee, and the MARCO Management Board into the background information, options, and key considerations

In these ways, the white paper supported the July workshop objectives, which were to:

- Obtain public input and engage participants in the OAP to inform next steps for developing a healthy ocean ecosystem monitoring and assessment program to support OAP implementation.

- Consider the scope of a healthy ocean ecosystem monitoring and assessment program, inform the prioritization of potential indicators, and identify options for indicator reporting and communication.

1.5 Public workshop: Mid-Atlantic Regional Council on the Ocean Healthy Ocean Ecosystem Indicators

On July 19 and 20, 2017, MARCO hosted a two-day public workshop on the implementation of OAP Action 5 to "develop, monitor, and assess indicators of the health of the Mid-Atlantic regional ocean ecosystem." The goal of the workshop was to receive input and identify options for key elements of a healthy ocean indicator monitoring and assessment program that can help guide the RPB's deliberations with respect to:

- Overall scope of an indicator program, including approaches to report and display indicator data
- Priority themes, data categories, and potential indicators

The workshop was highly interactive, and engaged about 45 participants in-person (majority) and via webinar. Workshop attendees participated in several large- and small-group discussions and collaborated to develop program options that could then be advanced for future consideration. The perspectives of workshop participants were integrated into this final report in the form of options and considerations for each of the major topics below. Details regarding workshop discussions and participant input/feedback are described in the Workshop Summary (Appendix B). Below, the workshop discussion of these major topics is briefly described.

Overall scope, including indicator reporting and display

Participants noted that the potential scope of the project and any potential approaches to report and display indicators are interdependent, and they struggled to identify priorities for one without first establishing priorities for the other. For example, potential approaches to indicator reporting and display are likely dependent on the total number of indicators suggested in a project scope. Participants discussed a range of options that could be binned into the following categories:

- General scope, relationship of scope to OAP Actions, concept of ocean health, objectivity and transparency
- Program funding, RPB capacity, program stewards, maintenance and updates, longevity
- Audience, number of indicators, reporting tool format and organization, reporting tool location and design

Priority themes, data categories, and potential indicators

Following a full day of discussion, workshop participants collaborated to describe a revised draft indicator framework, which was similar to several other approaches including the framework proposed in the white paper and the organizing framework used in the Mid-Atlantic Regional Ocean Assessment. Participants identified a number of priority indicators within this framework, but disagreed on the exact set of indicators that belong in this program and the

level of priority assigned to each indicator or category. The framework is described briefly below:

1. *Living ocean* – includes distribution and abundance of native species/populations, biodiversity, habitats, food webs
2. *Ocean conditions* – includes physical conditions like temperature, patterns and cycles such as El Niño/La Niña and the North Atlantic Oscillation, and also water quality, which could include anthropogenic pressures/human inputs like contaminants and marine debris
3. *Human footprint* – includes anthropogenic pressures/human inputs like contaminants and marine debris, human uses, and could include system outputs like ecosystem services, jobs created, economics, etc.

A fourth potential theme, called “Interactions” was proposed and discussed. Participants recognized that interactions among indicators are important and that the ocean is a dynamic system but also concluded it would be difficult to build quantitative indicators of such complex interactions.

1.6 Final project phase

The feedback and input obtained at the workshop, as well as all feedback collected by the CBI team in spring 2017 have been integrated into the next two report sections. These sections represent the next key decision topics, or steps, in indicator program development.

The CBI team developed a diagram to illustrate the suggested decisions or steps that could be taken toward more fully describing a future indicator program (Figure 1).

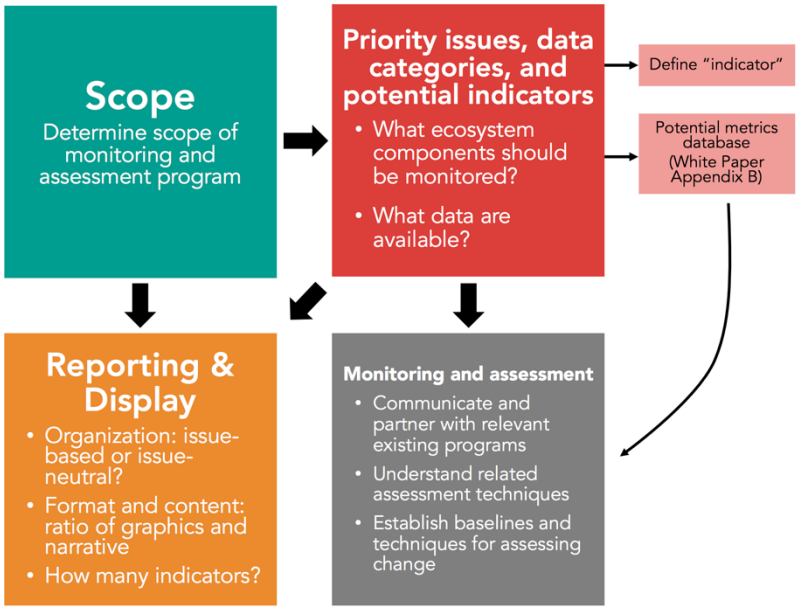


Figure 1. General steps (boxes) for developing a Mid-Atlantic ocean ecosystem indicator program. Relationships among topics are shown with arrows. The "Monitoring and assessment" topic box is grey because potential actions related to this step depend on the prioritization of indicators.

Each box represents an important topic with a range of options. The boxes can be considered in any order, but arrows indicate how they may be related or interdependent. For the purposes of this report, "Determine scope…" and "Reporting tool" (left side of Figure 1) are grouped because they are related and overlapping. These topics are discussed together in Section 2. "Prioritize indicators" is a separate but related topic discussed in Section 3. Either topic could be undertaken first, however, constraints regarding program scope could inform indicator prioritization, and so scope is discussed here first.

2 Scope and indicator reporting/display

The scope of a future Mid-Atlantic ocean ecosystem monitoring and assessment program is briefly described in OAP Healthy Ocean Ecosystem Action 5:

> This action will identify measures of ocean ecosystem health, and develop a program for monitoring those indicators over time and displaying them in one easily accessible location. Ocean health indicators will focus on the Mid-Atlantic region and, to the extent feasible, be derived from existing data collection and monitoring efforts. Where practicable, priority data collection and monitoring needs will be identified. Scientists, fishermen, other stakeholders, and Traditional Knowledge holders will be engaged at key points in this action, including during design and evaluation of indicators to ensure that appropriate indicators are selected for the Mid-Atlantic.

In addition to the broad purpose described above, several additional factors relating to program scope were identified throughout this project, including the imagined funding level

and funding possibilities, potential partnerships, and the desired output(s) and communication product(s). To determine the desired outputs and communication products, the amount and type of content, target audience, location or format, frequency of maintenance and updates, and the organization of the output, should all also be considered.

Generally, there is a need to consider what additional value a Mid-Atlantic ocean ecosystem indicator program would bring to the region. There are several existing efforts to describe and/or track the Mid-Atlantic ocean ecosystem (e.g., the NOAA Northeast Fisheries Science Center Ecosystem Status Reports and the Mid-Atlantic Regional Ocean Assessment), and any new effort should clearly articulate its potential value to entities and stakeholders. The program's stated purpose could be to track "ocean health", or to track "ecosystem change". It is important that the program portrays data and information in an objective way, and that underlying data, information, and interpretations are scientifically sound and transparent. A program structure that can adapt to new and/or shifting regional priorities would enable continued relevance.

1.1 Content

According to Healthy Ocean Ecosystem Action 5, a future program will be focused on indicators of ecosystem condition in the Mid-Atlantic ocean. The program could report on indicators that reflect goals expressed in the OAP and/or Healthy Ocean Ecosystem Actions, or bring together material on a wider range of ocean ecosystem topics, some of which might not be explicitly mentioned in the OAP (e.g., ocean sound/noise).

An indicator program should also reflect the geographic scope of the OAP by focusing on data from the open-ocean, but also acknowledging relevant coastal linkages on topics such as water quality and sand management.

The program would not seek to collect new data, but rely on existing programs to provide data and aid in the display of that data in a centralized location (e.g., a reporting tool or dashboard). The program could communicate and identify important gaps for ecosystem elements for which data does not exist or is limited and therefore initiate new data collection or articulate funding priorities.

1.2 Audience

The CBI team identified two related options for program audience. The first option is to define the target audience as the general public. The intent would be to engage the general public in understanding and tracking the changes in the Mid-Atlantic ocean ecosystem while also providing high-level summaries for regional ocean policy issues and related communications to decision-makers. This option would translate to content that avoids jargon and distills technical concepts into easily-understood pieces of information. This option would have at least one challenge of frequently taking raw data from providers and developing highly interpretive products (e.g., graphics, visualizations). An indicator program dashboard would need to be simple and direct in order to appeal to the general public.

Alternatively, the program's audience could be defined as the general public, but with the additional capacity to be used by RPB entities as a management and/or regulatory tool. This option would result in a tool that has some information to appeal to the general public, but would also require significant attention to communicating technical details that are important to RPB entities and their existing authorities. A dashboard or other reporting tool for this audience may require multiple levels of information and therefore could be more complex.

Other options for target audience were considered. One of these options was to define the program audience as the RPB only, and to develop the program to be used exclusively for regulatory and management staff at RPB entities. This option, and other variations were dismissed in response to the preferences expressed by the RPB, Steering Committee, and the public.

1.3 Location

The reporting tool should be web-based and three options emerged for the potential location of the final indicator reporting tool or dashboard. The first option is for it to be housed on the Mid-Atlantic Ocean Data Portal, which would leverage the exposure and popularity of this existing resource. Stakeholders and agency staff already visit the Portal for Mid-Atlantic ocean data and information, much of it related to the priority themes considered in Section 3, and an indicator dashboard could be relatively visible and accessible at this location.

Another option for an indicator dashboard could be on or within the Mid-Atlantic Regional Ocean Assessment (ROA) website. The purpose of the ROA is to "summarize best available information on the ocean ecosystem and ocean uses from New York to Virginia, and…serve as a gateway to more in-depth information sources." Benefits to using the ROA as a location include that it is an existing resource, and that its structure/content is likely complementary to or even overlapping with that of an ocean ecosystem indicator program. A disadvantage to using the ROA would be that it could influence the structure and format of an indicator program that would otherwise develop independently.

Finally, the reporting tool or dashboard could be housed on a new, unique URL. By using a unique URL, the indicator program could be identified as a separate resource and product of the ocean planning effort. A unique URL would provide design flexibility and possibly greater support from a variety of organizations who might be interested in partnering on a new project. Conversely, using the Portal or ROA websites would place the final reporting tool within the ecosystem of ocean planning products and therefore might be immediately accessible and coordinated with existing tools.

1.4 Updating, maintenance, and budget

The effort required to update and maintain a program increases with program size, including the number of datasets and new graphics, tools, or products derived from those datasets. The budget for a program will be related to the program's size, update frequency, and degree of dependency on data partners. There may be opportunities for live-updates or for externally-

maintained data to be fed into a reporting tool—depending on the datasets incorporated into the program and partner agencies/groups—minimizing program effort. There will likely be significant additional capacity needs every time a dataset is updated if the program includes new tools and products that are derived from those datasets versus linking to other existing data and related products. Desired tools, products, and features, and their related capacity needs have obvious implications for a program's budget.

In order to accurately reflect ecosystem conditions, the program should maintain and update data regularly. Updates to the underlying data will influence, and in some cases, limit the frequency of updates for the reporting tool. An interval of 5 years was suggested to be too infrequent; annual updates could be a reasonable and more desirable frequency, but some datasets may not be updated annually. Therefore, the update frequency of any issue or dataset in the reporting tool may have a unique schedule. Despite the need for frequent updates in the future, it is important that an indicator program also acknowledges and describes the past or historical status of indicators to provide context for their interpretation and an objective characterization of trends.

Potential data partners, data sharing agreements, data management plans, metadata requirements, and reporting frequency are all topics requiring further discussion as the program advances to considering specific indicators and underlying datasets.

1.5 Organization

Participating RPB members and stakeholders repeatedly voiced similar priorities and preferences for a general framework to organize data and information that would then be reflected in program outputs and communication products. These preferences included organizing program information by "ocean issue", rather than by "data component". An issue-based organization would potentially have more appeal to the general public, whereas a data- or component-based organization scheme could appear too technical and not as engaging.

Regardless of the titles or names that project participants used to represent the themes in this general framework, it always included (1) living ocean, (2) ocean conditions, and (3) human footprint (these are discussed further in Section 3). These themes are very similar to the draft set of themes proposed in the white paper, and also closely resemble the structure of the ROA.

Each theme should contain a manageable number of indicators (e.g., 5-10 indicators per theme) representing important issue areas of interest to the general public. Within each theme, a layered or tiered approach would convey overview information up-front, and also offer the potential for interested users or practitioners to dig deeper into the details behind each indicator, including datasets and multitudes of sub-indicators available via other efforts.

Dashboard design should leverage the chosen organizational approach, and potentially tell engaging "stories" with the indicator data. For example, an issue-based organization would translate to a dashboard that conveys that shifting species and habitats (issue) are the result of increasing ocean temperatures, acidification, sea level rise, and other factors (data categories). In contrast, a dashboard could use the reverse format to convey that increasing sea surface temperatures (a data category) result in effects such as shifting species and habitats, changes in

water quality, and other ocean conditions (issues). Input to date suggests that the former, issue-based organization and dashboard design is preferred.

1.6 Summary of options for scope, and indicator reporting/display

A reasonable potential Mid-Atlantic ocean ecosystem indicators program would be targeted at the general public, but retain the option to develop more technical content for certain indicators or topics. The program's reporting tool would be a dashboard that is displayed either on the Portal, within the ROA, or at a unique URL. It would seek to track ocean ecosystem change, and indicators would be scientifically vetted. The dashboard and associated tools or graphics would be updated annually if the data allow it. The program would be organized by three core themes, which are issues that resonate with the public: Living Ocean, Ocean Conditions, and Human Footprint. Each theme would contain 5-10 indicators supported by existing data and partnerships with data providers, managers, and stewards. An example of an existing indicator program reporting tool/dashboard that has appealed to project participants and has priorities similar to those expressed for this project is Puget Sound Vital Signs (Figure 2; http://www.psp.wa.gov/vitalsigns/).

Figure 2. The Puget Sound Partnership's indicator program reports and communicates "Vital Signs" for the watershed.

2 Priority issues, data categories, and potential indicators

As described in Section 2, project participants generally agreed that a future ocean ecosystem indicator program should track aspects of (1) living oceans, (2) ocean conditions, (3) human footprint.

There are different possible approaches to frame each of these three themes, including how they are named, as well as a number of potential subcategories and priority indicators within each. Throughout the project, it was difficult for participants to articulate an exact set of indicators that they felt belonged in a future program and the level of priority assigned to each subcategory, indicator, or theme.

Prioritization is needed because there is a relatively large amount of ocean ecosystem data collected in the Mid-Atlantic region (see Appendix B, data inventory). A primary challenge is to balance the manageability of the indicator program with the need to communicate a comprehensive view of the state of the ecosystem.

The sections below identify 5-10 potential indicator categories for each of the three core themes, with options for how each topic could be framed. Framing decisions should consider the target audience, the form of indicator reporting, and potentially other factors. Suggested indicator categories under each topic reflect feedback and input from stakeholders and participating RPB agency staff. The following criteria should be considered when choosing indicator categories and potential supporting datasets:

- *Integrative:* Suitable for multiple sectors and issues; not too specific to a particular issue or constituency.
- *Understandable:* An entry point into more complexity if desired.
- *Regional:* Focused on the big picture across the spatial scale in which the RPB works.
- *Available:* Data is available or can be displayed to the greatest extent possible.
- *Neutral:* Not biased, value-laden or favoring one interest over another.

Within each of the suggested indicator categories, actual indicators and supporting datasets still need to be selected. The suggested categories simply identify the focal concept or issue, and do not necessarily imply what indicator or particular dataset should be used or how it could be interpreted. Some suggestions are provided where appropriate. It is expected that as the program advances, the process to select indicators and supporting datasets would occur once the core themes and indicator categories are agreed upon.

The full list of the draft themes and data categories considered at the workshop, as well as a table of existing datasets within each category for the Mid-Atlantic region can be found in Appendix A.

1.1 Living Ocean

Framing and organization: This theme is the most constrained of the three. “Living Ocean” “Marine life and habitats”, and “Ocean ecosystem and resources” are potential titles for this topic, which should contain indicator categories relating to the organisms and habitats in the Mid-Atlantic regional ocean. “Living Ocean” was suggested by workshop participants and would likely appeal most to the intended audience. “Marine life and habitats” is similar to wording currently used in the Ocean Data Portal. “Ocean ecosystem and resources” is a section of the ROA.

The white paper suggested organizing this theme by data component (e.g., lower trophic level organisms such as phytoplankton, upper trophic level organisms such as fish, and habitats). To be more understandable and relatable to the general public, this theme could be organized by issue (e.g., protected species). Another benefit to organizing by issue is that certain issues are already monitored and managed by entities who could provide relevant data.

Higher priority indicator categories (or issues): Six issues were identified as potentially higher priority than others, even despite known data gaps in some of them.

LIVING OCEAN:

1. Biodiversity, including functional diversity
2. Habitat diversity
3. Protected species
4. Deep sea corals
5. Shifts in species, habitats, community structure
6. Distribution/abundance of indicator species (e.g., menhaden, seabird community, North Atlantic right whale)

These six issues align well with OAP goals and other Healthy Ocean Ecosystem Actions. For example, all six issues likely overlap in some way with the five components of ecologically rich areas (Action 1). Existing MDAT datasets, as well as the draft datasets and methods compiled to support the five components, could be used to develop indicators.

Issue 5, “Shifts in species, habitats, and community structure”, overlaps with Action 2 “Map shifts in ocean species and habitats.” It is expected that existing MDAT datasets and other information resulting from work on this action could inform indicators for this issue. Several analyses described in the NOAA Ecosystem Status Reports are also relevant to this issue.

The distribution and abundance of protected species, deep sea corals, and potential indicator species, or “canaries in the coalmine” such as menhaden, seabird communities, and North Atlantic right whale are all supported in some way by MDAT, agency, or other existing OAP datasets (see Appendix A).

Other potential issues for which there are reliable data include Essential Fish Habitat and Critical Habitat. These issues were not included in the list above because there were concerns about what these categories, as human constructs, would indicate about ecosystem status. For example, an increase in designated critical habitat from one year to the next may be more reflective of a bureaucratic or regulatory process rather than a change in species vulnerability.

Several other data categories and issues were considered, such as anadromous fish, habitat-forming species such as shellfish and tilefish, submarine canyons, methane seeps, and the concept of resilience (see Appendices A and B for full list of considerations and discussion). It was agreed that some, like anadromous fish and habitat-forming species, could be captured within the priority issues above. For others, like submarine canyons, methane seeps, and resilience, it was unclear how indicators could be developed, either because the features were likely spatially-static (canyons, methane seeps), or it would be difficult to agree on an appropriate metric (e.g., resilience).

1.2 Ocean Conditions

Framing and organization: This theme is meant to capture the environmental factors that influence marine organisms, habitats, and humans. “Ocean Conditions” was suggested by workshop participants, and might resonate most with the intended audience. “Oceanographic and atmospheric drivers” is the wording proposed in the white paper. There is no clear match between this topic and an ROA section. The ROA covers some elements of this topic under “Oceanographic setting and processes” and “Biological, chemical, and physical attributes.”

Concepts to convey within this theme include environmental variability, patterns and cycles, and potentially, human inputs that affect the physical environment such as nutrients and marine debris. To appeal to the general public, this theme could be framed and organized by a few key issues, each of which could contain multiple indicators.

Higher priority indicator categories (or issues): The key issues of Physical conditions, Patterns and cycles, and Water quality cover a range of natural and human-influenced physical ocean conditions. Each of these issues is further described by 2-5 potential indicator categories.

OCEAN CONDITIONS:

1. Physical conditions – could include:
    a. Sea surface and bottom temperature
    b. Dissolved oxygen
    c. Acidification
    d. Sea level
2. Patterns and cycles – could include:
    a. El Niño/La Niña
    b. North Atlantic Oscillation
3. Water quality – could include:
    a. Nutrients and estuarine plumes
    b. Coastal discharges
    c. Contaminants
    d. Regional beach and shellfish closures
    e. Harmful algal blooms
    f. EPA Coastal Water Quality Index, adapted to ocean data

Several of these issues are referenced or implied within OAP Healthy Ocean Ecosystem Actions, including temperature and sea level; acidification is explicitly tied to Action 3. Each of these issues could reference data that are collected by NOAA and summarized in the Northeast Fisheries Science Center’s Ecosystem Status Reports.

Variability in ocean conditions was a concept that participants felt strongly should be conveyed by an indicator program. The issue “Patterns and cycles” is meant to capture this concept, and indicators within it should communicate the range of natural variability observed in the past, as it is relevant to present and future variability now influenced by climate change. Metrics and indicators of El Niño/La Niña and the North Atlantic Oscillation are available from the Northeast Fisheries Science Center’s Ecosystem Status Reports.

Other indicator categories in these issues are typically associated with nearshore or coastal processes, such as dissolved oxygen, nutrients and estuarine plumes, and beach and shellfish closures. Several are integrated into the EPA's Coastal Water Quality Index (which includes dissolved oxygen, chlorophyll a, nitrogen, phosphorus, and water clarity), and that methodology could be adapted for ocean data for an ocean indicator program.

The NOAA Ecosystem Status Reports contain information about trends in annual river flow and freshwater inputs from precipitation, which could be used to approximate coastal discharges. Contaminants indicators might include oil and other chemical releases (measured by NOAA and USCG), and indicators of other sediment and water column contaminants (measured by EPA). Regional beach and shellfish closures would likely need to be compiled from each Mid-Atlantic state. Harmful algal blooms are an indicator included in the NOAA Ecosystem Status Reports.

Indicator categories such as bottom temperature, Gulf Stream path and speed, precipitation (all monitored and reported by NOAA in Ecosystem Status Reports and elsewhere), and diseases may also be relevant to this topic, and could be integrated as supporting indicators within Ocean Conditions over time. Alternatively, these topics should be referenced as relevant to Ocean Conditions, but not formal indicators, using external information sources or links.

A few of these categories and issues could also be classified as anthropogenic pressures, such as acidification, Patterns and Cycles to a degree, and much of the Water quality issue. These could be assigned to a single theme (either Ocean Conditions or Human Footprint, which is described below), or a reporting tool/dashboard could cross-reference indicator categories between themes. Cross-referencing could also be used to acknowledge relationships among themes, for example, all Ocean Conditions indicators likely influence shifting species and habitats.

1.3 Human Footprint

Framing and organization: This theme has evolved the most since the beginning of the project. The first broad option to be considered is whether to include indicators of human uses, human activities, and their resulting influence on the ecosystem. With the guidance of the Steering Committee, this theme was covered in the white paper by "Anthropogenic pressures" and "Ocean uses." The OAP and ROA each contain "Ocean uses" sections, but they are mostly constrained to discussing the spatial footprint of discrete activities. Workshop participants suggested the title "Human Footprint" to represent both anthropogenic pressures (which they identified as higher priority; see below) and human use indicators.

Because the OAP and, by extension, the Data Portal, have already assembled available datasets on ocean uses in the region, an ocean indicator program could fill an existing gap by assembling available datasets on anthropogenic pressures or human "inputs" that result from human uses and activities (e.g., marine debris, sound). Many of these pressures are likely tied to multiple uses and could also be influenced by natural factors.

An integration of human aspects into an ecosystem indicator program may also include socioeconomic indicators or other ways to measure benefits that humans receive from the

ecosystem. This could include consideration of an ecosystem services approach, or an accounting of ecosystem "outputs" such as landings, jobs, and Gross Domestic Product (GDP). Economics, socioeconomics, and ecosystem services are all extensive topics that would likely require additional planning, prioritization, and stakeholder engagement to understand potential indicators.

Nevertheless, an indicator program could also add value to the OAP and Data Portal by tracking changes in the spatial footprint of ocean uses. Indicator metrics could take the form of "total area" for each use. There are options for how certain anthropogenic pressures or ocean uses indicators could be evaluated and interpreted. For example, would "area fished" be a positive indicator (e.g., assume abundant fish to catch), or a negative indicator (e.g., assume pressure on fish community)?

Higher priority indicator categories (issues): Indicators of anthropogenic pressures are generally higher priority than ocean uses because of the relative lack of data in the Data Portal.

HUMAN FOOTPRINT:

1. Marine debris
2. Water quality
    a. Nutrients and estuarine plumes
    b. Coastal discharges
    c. Contaminants
    d. Regional beach and shellfish closures
    e. Harmful algal blooms
    f. EPA Coastal Water Quality Index, adapted to ocean data
3. Sound
4. Ocean uses and socioeconomics
    a. Spatial footprint and changes
    b. Socioeconomics

The proposed issues represent concepts that can be characterized and understood regionally. The marine debris issue in this topic aligns with OAP Healthy Ocean Ecosystem Action 4. It is expected that work to support this action would inform the development of marine debris indicators. The NOAA marine debris program also hosts a tool to collect information about independent (non-NOAA) marine debris surveys.

Water quality is repeated from Ocean Conditions because of the diverse indicators and datasets that could be used to characterize water quality – it is both an ocean condition and a category heavily influenced by anthropogenic pressures and therefore it could go in either theme.

Anthropogenic sound does not fit clearly into any OAP Actions, but it is an issue acknowledged in MDAT products (abundance of cetaceans sensitive to high- medium- and low-frequency sounds). It could be supported by datasets such as modeled sound levels in the Mid-Atlantic from the NOAA CetSound project, and the NOAA Ocean Noise Reference Station Network.

Ocean uses and socioeconomics indicator categories could be used to track a subset of the ocean uses covered by the OAP and available in the Data Portal, particularly those supported by routinely-updated datasets that can easily be summarized by "total area" measures (e.g., active

wind lease and research areas, federal sand and gravel lease areas). Other uses without clear "total area" measures—or all uses—could also be integrated into the indicator program via socioeconomic measures. Examples of ocean uses not easily described with "total area" measures include commercial and recreational fishing, maritime commerce, and non-consumptive recreation.

There are a number of other potential issues that have a more local focus. These issues could be described in a reporting tool/dashboard as relevant, but for which formal indicators are not developed. For example, ocean disposal sites (data from EPA), electromagnetic fields (no data currently available), shoreline hardening (NOAA Habitat Conservation-Restoration Center), and seabed scour (no data currently available) were all identified as important, but difficult to summarize at the regional scale. Other indicators that may be relevant to this topic but for which new metrics and reporting may not be needed include bycatch and invasive species.

1.4 Summary of options for priority issues, data categories, and potential indicators

A Mid-Atlantic ocean indicator program should track indicators related to at least three themes: Living Ocean, Ocean Conditions, and Human Footprint.

Table 1. Suggested indicator themes, issues, and data categories.

LIVING OCEAN	OCEAN CONDITIONS	HUMAN FOOTPRINT
1. Biodiversity, including functional diversity 2. Habitat diversity 3. Protected species 4. Deep sea corals 5. Shifts in species, habitats, community structure 6. Distribution/abundance of indicator species (e.g., menhaden, seabird community, North Atlantic right whale)	1. Physical conditions a. Sea surface and bottom temperature b. Dissolved oxygen c. Acidification d. Sea level 2. Patterns and cycles a. El Niño/La Niña b. North Atlantic Oscillation 3. Water quality a. Nutrients and estuarine plumes b. Coastal discharges c. Contaminants d. Regional beach and shellfish closures e. Harmful algal blooms f. EPA Coastal Water Quality Index, adapted to ocean data	1. Marine debris 2. Water quality a. Nutrients and estuarine plumes b. Coastal discharges c. Contaminants d. Regional beach and shellfish closures e. Harmful algal blooms f. EPA Coastal Water Quality Index, adapted to ocean data 3. Sound 4. Ocean uses and socioeconomics a. Spatial footprint and changes b. Socioeconomics

There remains a question about where an issue like Water Quality belongs, since it represents Ocean Conditions and some elements of Human Footprint. In Table 1 Water Quality has been included in both Ocean Conditions and Human Footprint, but ultimately the indicators selected for the issues under Water Quality will dictate which issues are best categorized as Ocean Conditions and which are Human Footprint. There also remains a question about whether and how ocean uses should be tracked, and if and how to take an ecosystem services/benefits or

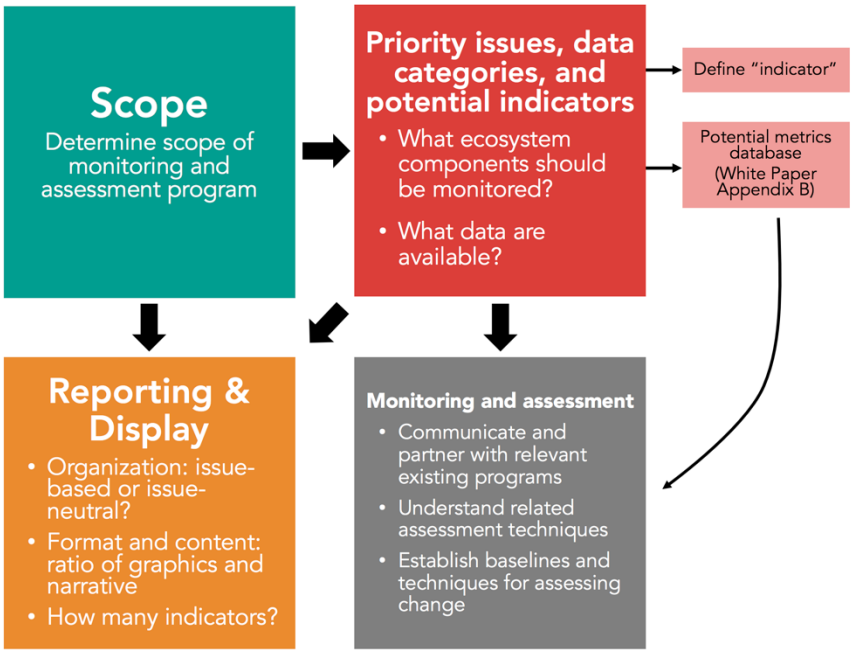
socioeconomic approach to characterize these. Options could include summarizing or simply linking to NOAA's Economics: National Ocean Watch dataset within the reporting tool/dashboard.

A few additional questions related to priority issues, data categories, and indicators arose as part of this project:

- If/how to represent overlap, interactions, and linkages between/among Living Ocean, Ocean Conditions, Human Footprint; see some options related to reporting tool organization, section 2.5.
- Whether to describe Driver-Pressure-State-Impact-Response (DPSIR[3]) relationships
- If/how to incorporate case studies and narratives
- How far to develop Human Footprint in the first phase of the program versus future iterations

2 Suggested next steps

This phase of the project accomplished the objective of developing options for an ocean ecosystem monitoring and assessment program to support OAP Healthy Ocean Ecosystem Action 5. The results of this phase were informed by Mid-Atlantic RPB members, technical experts, and stakeholders. Progress was made identifying and constraining options within each of the 3 out of the 4 key decision steps to develop an indicator program, as identified by the consulting team:



[3] Bradley, P. and S. Yee. 2015. Using the DPSIR Framework to Develop a Conceptual Model: Technical Support Document. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-15/154.

Section 2 of this report described options for overall program scope (top left in the diagram above), including indicator reporting/display (bottom left). Section 3 of this report summarized options for priority issues, data categories, and potential indicators (top right), including existing efforts to be leveraged, potential data gaps, and options for growing the program in the future. Where applicable, this report provided general budget/capacity considerations and other criteria for deciding on possible approaches. Considerations for monitoring and assessment (bottom right) should be discussed once the program advances to considering specific indicators and underlying datasets.

Specific next steps for the Steering Committee involve choosing from the options outlined in this report related to these 3 key decision steps described in the flow diagram above. These next steps include:

1. Confirming the target audience
2. Deciding on a location for the indicator program reporting tool or dashboard
3. Confirming an issue-based approach starting with the three broad proposed themes and their titles, “Living Ocean”, “Ocean Conditions”, and “Human Footprint”
4. Reviewing and confirming the top 5-10 issues identified within each theme

Then, work can be done within these bounds to develop the program further by:

- Helping to determine/decide on specific indicators within each theme and issue
- Identifying existing metrics and datasets as well as data gaps for indicators.
- Developing a reporting tool mockup
- Drafting data agreements and maintenance plans for each indicator
- Developing draft products for each indicator

Developing an indicator monitoring and assessment program to support the Mid-Atlantic Regional Ocean Action Plan Health Ocean Ecosystem Action 5

White paper prepared for the Mid-Atlantic Regional Council on the Ocean

June 2017

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EXECUTIVE SUMMARY

The Mid-Atlantic Regional Ocean Action Plan (OAP) Healthy Ocean Ecosystem Action 5 establishes that a healthy ocean ecosystem indicator monitoring and assessment program is needed to better understand ecosystem changes as they occur, and how those changes impact and are impacted by human activity.

A project to begin to address this need was initiated in February 2017, with the goal of informing the development of a healthy ocean ecosystem indicator monitoring and assessment program for the Mid-Atlantic region that relies on existing data collection and monitoring efforts and is tied to ocean planning goals. This project has completed preliminary work to identify key data and information to inform an indicator monitoring and assessment program, and to engage the Mid-Atlantic RPB and numerous stakeholders in the initial evaluation of potential indicator themes and data.

This white paper was written by the project team to provide background information, potential options, and important considerations for decision-making to advance a healthy ocean ecosystem indicator monitoring and assessment program as described by Mid-Atlantic Regional Ocean Action Plan Healthy Ocean Ecosystem Action 5.

This paper is written with the assumption that the scope of the monitoring and assessment program should still be considered, and is likely the first discussion point at the upcoming July 2017 Healthy Ocean Ecosystem Indicators Workshop.

Specifically, this white paper presents:

- A potential indicator framework, including important themes and potential data categories that likely need to be prioritized in order to identify those data streams and indicators which are most relevant to the OAP
- Options and key decision points for monitoring, assessment, reporting, and display of indicators, including references to example programs
- Feedback integrated from the RPB, numerous stakeholders, the project Steering Committee, and the MARCO Management Board into the background information, options, and key considerations

This white paper is not intended to be a comprehensive inventory of every available option for developing an extensive monitoring and assessment program for the Mid-Atlantic ocean.

The scope of this white paper is relatively narrow and focused on the issues and priorities expressed in the OAP, recognizing that there are extensive programs internationally, nationally, and within the region that have existed for many years with significant financial investments.

Therefore, the intent is to provide enough information to narrow in on those priorities which are most relevant to the OAP and to advance a framework and communication tool that is consistent with likely funding levels.

Target Audience: This white paper serves to create a common understanding of work accomplished to-date to articulate options for a Mid-Atlantic healthy ocean ecosystem indicator monitoring and assessment program for all participants at the July 2017 Healthy Ocean Ecosystem Indicators Workshop, as well as for other interested parties.

Workshop Objectives: consider the scope of a healthy ocean ecosystem indicator monitoring and assessment program; inform the prioritization of potential indicators; identify options for indicator reporting and communication

CONTENTS

1. Introduction

1.1 Project background and objectives

In February 2017, the Mid-Atlantic Regional Council on the Ocean (MARCO) contracted with a team led by the Consensus Building Institute[1] (CBI team) to develop options and recommendations for a healthy ocean ecosystem monitoring and assessment program to support the implementation of Mid-Atlantic Regional Ocean Action Plan (OAP) Healthy Ocean Ecosystem Action 5. The OAP establishes that the project will be informed by the Mid-Atlantic Regional Planning Body (RPB) members, MARCO, technical experts, and OAP stakeholders. In addition, the project leverages the data and other information included in the OAP, the Mid-Atlantic Regional Ocean Assessment (ROA), the MARCO Ocean Data Portal (Portal), the Marine-life Data and Analysis Team (MDAT), and the numerous other data collection, monitoring, and assessment efforts in the region (some of which are discussed below in Section 1.4).

The CBI team is directed by a project Steering Committee that is composed of RPB members and led by representatives from the New York Department of Environmental Conservation. The OAP is serving as the guiding document for this project; in particular, the following key principles from Healthy Ocean Ecosystem Action 5:

Key Principles from Mid-Atlantic OAP Healthy Ocean Ecosystem Action 5:

- "Need to better understand ecosystem changes as they occur, and how those changes impact and are impacted by human activity"
- "Ocean health indicators will focus on the Mid-Atlantic region and, to the extent feasible, be derived from existing data collection and monitoring efforts"
- "Scientists, fishermen, other stakeholders, and Traditional Knowledge holders will be engaged at key points in this action, including during design and evaluation of indicators"

The objective of this phase of the project is to engage the RPB and ocean planning stakeholders to obtain feedback, develop a potential overarching framework for a monitoring and assessment program, and make recommendations for communicating and displaying indicators by the Fall of 2017. A final report will be delivered to the RPB after a public workshop is held to review the contents in this white paper. The RPB will determine next steps based on the feedback received during the workshop and reflected in the final report.

1.2 Geographic scope

This project adopts the geographic focus of the OAP, which includes "the ocean waters of the region…the shoreline seaward to 200 nautical miles..." "northern limit is the New

[1] The CBI Team included Pat Field and Rebecca Gilbert from CBI, Emily Shumchenia, and Nick Napoli

York/Connecticut and New York/Rhode Island border; southern limit is the Virginia/North Carolina border"[2].

The Steering Committee acknowledges the linkages among important coastal habitats, coastal processes, and ocean health, and the numerous existing monitoring and assessment efforts occurring in the coastal region, including within state programs, National Estuary Programs (NEPs), National Estuarine Research Reserves (NERRs), and many others. This project references those existing data collection and reporting streams for topics in the coastal domain that are relevant to the monitoring and assessment of ocean health (e.g., wetland habitats, eutrophication).

1.3 Thematic scope

As noted in the OAP, this project focuses primarily on indicators of healthy ocean ecosystems. However, both the Steering Committee and stakeholders recognized that it may be important to also track aspects of ocean uses that are particularly relevant to the OAP. A number of additional potential data categories that relate to the sustainable ocean uses discussed in OAP section 2.4 were developed for this project given their relevance to healthy ocean ecosystems and OAP goals. Section 2.2 of this white paper (Key Themes) provides more detail on new considerations and recommendations related to these themes that resulted from discussions with Steering Committee members and through project outreach.

1.4 Existing data collection and monitoring efforts

The OAP establishes—and subsequent discussions with the Steering Committee and OAP stakeholders further reinforced—the importance of using existing data and monitoring efforts to the extent feasible to inform the development of a healthy ocean ecosystem monitoring and assessment program. Therefore, the CBI team considered a range of existing data collection and monitoring efforts in the region in order to propose a draft indicator framework for Mid-Atlantic ocean planning – a few of those are described in this section because they are most relevant to this project.

The CBI team and the Steering Committee also relied on the OAP, which included extensive public input from 2013 to 2016, to determine which ocean issues are most relevant for this effort. The OAP identifies several key issues for ocean planning, including climate change (ocean acidification, sea level rise, and warming water temperatures), increases in commercial shipping, commercial-scale renewable energy development, offshore carbon storage, demand for offshore sand and gravel for coastal restoration and shoreline protection, and access to commercial fishing grounds[3].

Mid-Atlantic Regional Ocean Action Plan Data Collection and Integration

[2] Mid-Atlantic Regional Ocean Action Plan, page 24; https://www.boem.gov/Ocean-Action-Plan/
[3] Mid-Atlantic Regional Ocean Action Plan, pages 10-11; https://www.boem.gov/Ocean-Action-Plan/

The Mid-Atlantic ROA and the Portal assembled existing data and information to address the issues identified in the OAP within the broad categories of ocean ecosystem and resources, and ocean uses (Tables 1 and 2, respectively). The Portal also includes datasets developed specifically to support ocean planning, including marine life data products and human use data synthesis products (Table 2). Also through the ocean planning process, Mid-Atlantic tribes identified several categories of information and data that should be considered in future data development, monitoring and assessment (Table 3).

Table 1. Categories of data and information in the Mid-Atlantic Regional Ocean Assessment as of June 2017. http://roa.midatlanticocean.org

Ocean ecosystem and resources	Ocean uses
• Oceanographic setting and processes • Important biological, chemical, and physical attributes • Living marine resources • Human settlements relative to the ocean • Ecosystem services • Ecosystem responses to climate change • Important or sensitive species, guilds, and habitats • Ecologically rich areas • Migration corridors and other region-wide features • Ocean acidification • Shifts in species distributions associated with climate change	• Overview of the Mid-Atlantic ocean economy • Tribal uses • Commercial and recreational fishing • Critical undersea infrastructure • Maritime commerce and navigation • National security and military issues • Non-consumptive recreation • Ocean aquaculture • Ocean energy • Offshore sand management • Scientific research • Cumulative impacts

Table 2. Categories and example data layers in the MARCO Ocean Data Portal as of June 2017. http://portal.midatlanticocean.org

Administrative
Includes administrative boundaries and jurisdictions, marine national monument boundaries, Outer Continental Shelf lease blocks, Tribal headquarters
Marine life
Includes individual species, abundance, occurrence, biomass for cetaceans, birds, and fish; marine life summary products; benthic habitats; essential fish habitats; sea turtles; corals habitat
Renewable energy
Includes BOEM active lease areas, wind planning areas; coastal energy facilities; wind resources
Fishing
Includes artificial reefs; Vessel Monitoring Systems (VMS) data; Vessel Trip Reports (VTR) data; management areas; party and charter boat fishing
Security
Includes military training and testing areas; unexploded ordnances
Recreation

Includes results of coastal recreation study, recreational boater survey, and individual state recreation workshops
Maritime
Includes shipping data, port facilities, cable routes, ocean disposal sites, sand and gravel lease areas
Socioeconomic
Includes population density, economics data
Oceanography
Includes bathymetry, oceanographic fronts, primary productivity, seabed forms, sediments, submarine canyons
Human use data synthesis
Includes results of Human Use Data Synthesis (HUDS) Project including maps by use theme (energy, fishing, maritime, recreation security), use type (number of activities, infrastructure, physical infrastructure, regulatory), and use intensity (fishing, maritime)

Table 3. Data topics relevant to Tribal uses (not necessarily for which data currently exist), derived from Tribal Listening Sessions conducted through the Mid-Atlantic Regional Council on the Ocean (MARCO) (Provided by Mid-Atlantic RPB Tribal Co-lead).

Economic data
• Protecting burial grounds and archeological sites • Charter fishing (large and small vessels) • Charter diving/snorkeling • Charter party cruises • Charter wildlife viewing • Charter scenic viewing • Charter transport • Wampum • Energy
Recreational fishing/hunting data
• Recreational fishing from non-motorized vessels • Recreational fishing from motorized vessels • Recreational dive fishing • Recreational shore fishing • Recreational shellfish harvesting • Recreational waterfowl hunting
General recreational data (non-consumptive)
• Motorized boating • Paddling • Sailing • Scuba/snorkeling/diving • Shore use • Surface water sports • Swimming • Harvesting/fishing from shore
Tribal cultural use

- Heritage sites
- Sacred places
- Submerged cultural resources
- Canoe journey routes
- Traditional routes
- Whales
- Climate change
- Subsistence fishing
- Customary fishing and gathering from shore
- Customary fishing and gathering offshore
- Customary hunting from shore
- Customary hunting offshore
- Related to ceremony
- Related to song
- Related to story
- Residence/village
- Training
- Place names
- Burial sites
- Safe anchorages
- Stewardship practices and areas of concern

Administrative attributes

- Tribal marine jurisdictions
- Ocean use (geographic description in treaties, deeds, etc.)
- Beach access (current restrictions, parking, permitting)

NOAA Northeast Fisheries Science Center

At the national level, agencies implement ecosystem monitoring and assessment programs that are relevant to Mid-Atlantic ocean planning. The National Oceanic and Atmospheric Administration (NOAA) is implementing Integrated Ecosystem Assessments to understand and monitor changes in ecosystem structure and function with the objective of informing management decisions. For the Northeast U.S. Continental Shelf Large Marine Ecosystem (which includes the Mid-Atlantic ocean planning area), NOAA publishes an Ecosystem Status Report[4], which provides basic information on fundamental ecosystem properties such as climate forcing, protected species, ecosystem services, and stressors and impacts (Table 4).

Table 4. Sections and contents of the NOAA Ecosystem Status Report for the Northeast U.S. Continental Shelf Large Marine Ecosystem. http://nefsc.noaa.gov/ecosys

Climate forcing
Atlantic Multidecadal Oscillation, North Atlantic Oscillation, Gulf Stream path, El Nino, ocean warming, ocean acidification
Physical pressures
Gulf stream, Labrador Current, river flow, winds, temperature, salinity, stratification
Production

[4] https://www.nefsc.noaa.gov/ecosys/

Primary production (phytoplankton), secondary production (zooplankton)
Benthic invertebrates
Temporal trends from bottom trawl surveys, fish diet analysis
Fish communities
Analysis for species groups, biodiversity, size, trophic level, condition, groundfish recruitment
Protected species
Marine mammals, sea turtles, sea birds, fish
Human dimensions
Coastal population, revenue and employment, community vulnerability, communities-at-sea, local ecological knowledge
Ecosystem services
Capture fisheries, recreational fisheries, mariculture, natural products, renewable energy, marine transportation
Stressors and impacts
Contaminants and water quality (heavy metals and pesticides, oil and chemical spills, eutrophication, hypoxia, algal blooms, bacteria); Climate change (sea level rise, ocean warming, ocean acidification, waterway obstruction); Fishing gear impacts (effects on benthic communities, ship strikes, entanglement, incidental catch, underwater noise, shifts in fish distribution)

National Coastal Condition Assessment

The Environmental Protection Agency (EPA) coordinates the National Coastal Condition Assessment (NCCA) among EPA, NOAA, the U.S. Geological Survey, the U.S. Fish and Wildlife Service, coastal states, and the National Estuary Program. The NCCA describes ecological and environmental condition in U.S. estuarine coastal waters using several indicators[5] (Table 5).

Table 5. Indicators evaluated for the 2010 National Coastal Condition Assessment (EPA 2015).

Biological	Chemical/toxicity	Physical
• Benthic macroinvertebrates • Chlorophyll a • Ecological fish tissue contaminants	• Dissolved oxygen • Nitrogen • Phosphorous • Salinity • Sediment contaminants • Sediment toxicity	• Water clarity • pH (measured but not evaluated) • Temperature (measured but not evaluated)

[5] U.S. Environmental Protection Agency. Office of Water and Office of Research and Development. (2015). National Coastal Condition Assessment 2010 (EPA 841-R-15-006). Washington, DC. December 2015. http://www.epa.gov/national-aquatic-resource-surveys/ncca

Chesapeake Bay Program, the National Estuary Program, and the National Estuarine Research Reserves

Monitoring and assessment at finer spatial scales occurs throughout the Mid-Atlantic region as well. The Chesapeake Bay Program is one of the most well-known long-term ecosystem monitoring and reporting efforts, and has recently been tracking progress according to the Chesapeake Bay Watershed Agreement[6] (Table 6). Other estuaries in the Mid-Atlantic are assessed as part of the NEPs and NERRs (Table 7).

Table 6. Indicators used by the Chesapeake Bay Program to track progress toward the goals and outcomes of the Chesapeake Bay Watershed Agreement. http://www.chesapeakeprogress.com

Abundant life
Sustainable fisheries (blue crab abundance, blue crab management, fish habitat, forage fish, oysters); Vital habitats (black duck, brook trout, fish passage, forest buffers, stream health, submerged aquatic vegetation, tree canopy, wetlands)
Clean water
Water quality (watershed implementation plans, water quality standards attainment and monitoring); Toxic contaminants (toxic contaminants research, toxic contaminants policy and prevention); Healthy watersheds
Conserved lands
Land conservation (land use methods and metrics development, land use options evaluation, protected lands)
Engaged communities
Public access (public access site development); Environmental literacy (environmental literacy planning, student, sustainable schools); Stewardship (citizen stewardship, diversity, local leadership)
Climate change
Climate resiliency (climate adaptation, climate monitoring and assessment)

Table 7. National Estuary Programs and National Estuarine Research Reserves in the Mid-Atlantic Region. See each program's website for information about ecosystem monitoring and assessment.

National Estuary Programs	National Estuarine Research Reserves
Long Island Sound Study http://longislandsoundstudy.net	Hudson River https://coast.noaa.gov/nerrs/reserves/hudson-river.html
Peconic Estuary Program http://www.peconicestuary.org	Jacques Cousteau https://coast.noaa.gov/nerrs/reserves/jacques-cousteau.html
NY-NJ Harbor Estuary Program http://www.harborestuary.org	Delaware https://coast.noaa.gov/nerrs/reserves/delaware.html
Barnegat Bay Partnership http://bbp.ocean.edu/pages/1.asp	Chesapeake Bay Maryland https://coast.noaa.gov/nerrs/reserves/chesapeake-bay-md.html

[6] Chesapeake Bay Program. 2014. Chesapeake Bay Watershed Agreement. http://www.chesapeakebay.net/documents/FINAL_Ches_Bay_Watershed_Agreement.withsignatures-HIres.pdf

Partnership for the Delaware Estuary
http://www.delawareestuary.org

Delaware Center for the Inland Bays
http://www.inlandbays.org

Maryland Coastal Bays Program
http://www.mdcoastalbays.org

Chesapeake Bay Virginia
https://coast.noaa.gov/nerrs/reserves/chesapeake-bay-va.html

State Programs

Coastal monitoring and assessment occurs at the state level within coastal programs at each Mid-Atlantic state (Table 8).

Table 8. Links to Mid-Atlantic state coastal management or planning programs. See each program's website for information about monitoring and assessment.

New York
http://www.dec.ny.gov/lands/207.html; https://www.dos.ny.gov/opd/

New Jersey
http://www.state.nj.us/dep/cmp/

Delaware
http://www.dnrec.delaware.gov/coastal/pages/coastalmgt.aspx

Maryland
http://dnr.maryland.gov/waters/Pages/default.aspx

Virginia
http://www.deq.virginia.gov/Programs/CoastalZoneManagement.aspx

The State of New York recently began work towards an ocean indicator system for assessing the ecosystem health of the New York Bight as part of the New York Ocean Action Plan[7]. The planning effort identified issues such as fisheries, shipping and transportation, offshore energy development, pathogens and toxic contaminants, habitat, water quality issues, aquatic invasive species, and climate change. Preliminary work toward an indicator system discussed indicators within several potential components and categories (Table 9).

Table 9. Initial draft components (bold headings) and indicator categories from preliminary work on an indicator system for the New York Bight (from material provided by NY-DEC).

Biological components
Species of concern, invasive species, habitat quality, biodiversity, habitats of concern, ecosystem maturity, ecosystem resilience
Physical and chemical components
Ecosystem productivity, oceanographic and atmospheric trends, climate, terrestrial inputs, nutrients, contaminants and pollutants
Socioeconomic components
Public access, resource-based industries and communities, coastal communities, ocean awareness and engagement

[7] New York Department of Environmental Conservation; http://www.dec.ny.gov/lands/84428.html

1.5 Project outreach

In early April 2017, MARCO, in consultation with the Steering Committee, arranged several webinars with ocean planning participants and stakeholders to share a project overview, report on progress to date, and obtain feedback on initial draft indicator themes and data categories for a healthy ocean ecosystems monitoring and assessment program. Over 50 individuals were invited to participate (based on Steering Committee nomination) within the following groups:

- Academic and agency science/research
- Commercial and recreational fishing
- Environmental non-governmental organizations
- Non-consumptive recreation
- Aquaculture
- Tribes
- Maritime commerce
- Energy
- Sand management

The CBI team and MARCO hosted seven 90-minute webinars between April 27 and May 15, 2017. Invitees and participants were asked to provide input, such as whether the proposed indicator themes and data categories were appropriate for ocean planning goals, if there were additional categories or data to consider, and which indictors or metrics should be prioritized. Details about the stakeholder outreach webinars can be found in Appendix A. The input received through these webinars is described and integrated into this white paper.

1.6 Purpose of this white paper

The purpose of this white paper is to support a public workshop to be held on July 19-20, 2017, by providing background information, presenting options, and identifying important considerations and decisions for advancing a healthy ocean ecosystem monitoring and assessment program as described by Mid-Atlantic Regional Ocean Action Plan Healthy Ocean Ecosystem Action 5. This white paper presents a potential indicator framework, including important themes and potential data categories that likely need to be prioritized in order to identify those data streams and indicators which are most relevant to the OAP. It also includes options and key decision points for monitoring, assessment, reporting, and display of indicators, including references to example programs. This white paper also incorporates feedback gathered from the RPB, numerous stakeholders, the project Steering Committee, and the MARCO Management Board to date into the background information, options, and key considerations.

This white paper is not intended to be a comprehensive inventory of every available option for developing an extensive monitoring and assessment program for the Mid-Atlantic ocean. The scope of this white paper is relatively narrow and focused on the issues and priorities expressed in the OAP, recognizing that there are extensive programs internationally, nationally, and within the region that have existed for many years with significant financial investments. Therefore, the intent is to provide enough information to narrow in on those priorities which are most relevant to the OAP and to advance a framework and communication tool that is consistent with likely funding levels.

This paper is also written with the assumption that the scope of the monitoring and assessment program should still be considered, and is likely the first discussion point at the upcoming workshop. Other workshop objectives include obtaining input on what components of the ecosystem should be monitored to support implementation of the OAP by reviewing categories of data and discussing the most relevant metrics or indicators of change, and obtaining feedback on options for assessing and communicating those indicators.

2. Draft Indicator Framework

Recognizing that there are likely hundreds of potential indicators that could be developed to characterize the Mid-Atlantic ocean ecosystem, this project team sought to use an organizing framework that groups similar potential indicators by theme and data category. The framework proposed here borrows elements from other frameworks discussed in Section 1.4, such as the NOAA Integrated Ecosystem Assessments and the draft indicator system for the New York Bight.

2.1 Framework structure

At the highest level or organization in the framework are themes, which represent broad groupings of ecosystem components. Within each theme, there are a number of data categories that represent attributes or processes that could be measured. Data categories were derived from data products developed and assembled as part of the ocean planning process in the OAP, the ROA, and the Portal. Steering Committee members provided feedback on potential data categories to the CBI team during monthly Steering Committee calls. Obtaining input from ocean planning stakeholders on potential themes and data categories was one of the primary goals of the project (see Section 1.5). Initial input was provided via the seven 90-minute webinars in April and May. Participants in the webinars provided input on how data categories were organized within themes, ways to potentially cross-reference data categories across themes, and new potential data categories.

Indicator Definition and Criteria

Adapted from U.S. EPA Report on the Environment: https://cfpub.epa.gov/roe/about.cfm

Indicator definition: An indicator is a numerical value derived from actual measurements* of a driver, stressor, state or ecological condition over a specified geographic domain, whose trends over time represent or draw attention to underlying trends in the condition of the environment.

Indicator criteria:

- The indicator is useful. It answers (or makes an important contribution to answering) a question.
- The indicator is objective. It is developed and presented in an accurate, clear, complete, and unbiased manner.
- The indicator is transparent and reproducible. The specific data used and the specific assumptions, analytic methods, and statistical procedures employed are clearly stated.
- The underlying data are characterized by sound collection methodologies, data management systems to protect their integrity, and quality assurance procedures.
- Data are available to describe changes or trends, and the latest available data are timely.
- The data are comparable across time and space, and representative of the target population. Trends depicted in this indicator accurately represent the underlying trends in the target population.

** There is some flexibility in this criterion; for example, some indicators could be based on estimation or partial estimation methodologies applied to the best available data.*

After integrating this feedback into the framework structure, the CBI team listed one or more possible metrics under each data category, based on datasets that were already assembled as part of the planning process (i.e., were mentioned in the OAP, in the ROA, or available on the Portal). Metrics are values or measures that could become candidate indicators. For example, a sea surface temperature data category could include “mean annual sea surface temperature”, “sea surface temperature anomalies”, and others as potential metrics. To be considered an indicator, a metric must be defined, communicated, and understood in the context of what it is meant to indicate or represent (among other potential indicator criteria; see box in this section). For example, a high incidence of positive “sea surface temperature anomalies” may indicate increased ocean warming. Potential metrics were not presented to the Steering Committee or to others during the webinars, but some metrics and indicators have been suggested and discussed as part of both of these processes. It is expected that further discussion on these details will occur at the July workshop.

2.2 Key Themes

As described in Section 1.3 of this white paper, the OAP focuses on "healthy ocean ecosystem" indicators for a potential monitoring and assessment program. Throughout discussions with the Steering Committee and through project outreach, the need to track some aspects of ocean uses was also apparent.

The consideration of ocean uses now manifests itself in two ways within the themes of the draft framework, and reflects input from Steering Committee members and feedback received through project outreach. First, while it is recognized that the effects of human activities could be reflected in almost any ecosystem indicator, the "Anthropogenic pressures" theme offers perhaps the most direct way in which these potential effects might be assessed. The data categories in this theme (e.g., marine debris, invasive species) represent inputs and effects that are likely driven by or originate from an array of human activities. As such, causal linkages between indicators and human activities would be difficult or impossible to determine using indicators in these data categories in the absence of additional studies. Second, the "Ocean uses" theme includes a number of data categories specific to aspects of ocean uses identified in the OAP (e.g., wind planning areas, sand resources). This theme would therefore track the incidence of ocean uses themselves, and indicators could potentially reflect economic conditions or the result of management decisions rather than suggesting specific ecosystem effects.

All of the following themes focus on open ocean but include data categories that may relate to datasets collected, maintained, and reported by state coastal programs, NEPs, NERRs, and other coastal and estuarine monitoring efforts.

Potential themes for a Mid-Atlantic healthy ocean ecosystem indicator program:

1. **Oceanographic and atmospheric drivers** – shape the physical environment of marine organisms; affect feeding, migration, reproduction
2. **Anthropogenic pressures** – includes those inputs and effects that likely are driven by or originate from an array of human activities
3. **Habitats** – include benthic vegetated and non-vegetated areas; habitat-forming species; pelagic habitats
4. **Lower trophic levels** – primary and secondary productivity; forage species
5. **Upper trophic levels** – all other marine life not included in Lower trophic levels
6. **Ocean uses** – aspects of ocean uses that are relevant to ocean planning

2.3 Data Categories

The following indicator themes (numbered, bold text) and data categories (each row of the tables) are relevant to the healthy ocean ecosystems and sustainable ocean uses sections of the Mid-Atlantic Regional Ocean Action Plan (OAP sections 2.3 and 2.4).

Data categories listed below are the result of Steering Committee and stakeholder input. These lists were not edited with respect to redundancy or continuity. For example, under Anthropogenic Pressures, "Coastal discharges" and "Eutrophication" may address similar or overlapping processes. In addition, some data categories within the same theme relate to drivers, processes, or inputs to the system, whereas others relate to outputs or the status of ecosystem components – e.g., "Eutrophication" and "Harmful algal blooms." It is expected that these organizational factors will be discussed at the July workshop.

The table columns to the right indicate whether each data category is present in the OAP, the ROA, and the Portal. Data categories in italics were added or revised as a result of feedback during the April-May project outreach webinars.

1. Oceanographic and Atmospheric Drivers – shape the physical environment of marine organisms; affect feeding, migration, reproduction

	OAP	ROA	Portal
Sea surface temperature Δ	X	X	
Bottom temperature Δ			
Sea surface temperature fronts		X	X
Gulf stream path		X	
Dissolved oxygen Δ		X	
pH Δ	X	X	
Carbonate system series		X	
North Atlantic Oscillation/Atlantic Multi-decadal Oscillation			
Water column stratification		X	
El Niño			
Sea level	X	X	
Wave height			
Tides and other currents			

Δ Categories that may be captured and reported by NEPs or other coastal programs

2. Anthropogenic Pressures – includes those inputs and effects that likely are driven by or originate from an array of human activities

	OAP	ROA	Portal
Marine debris	X		
Oil/chemical *releases*	X		
Contaminants Δ	X		
Harmful algal blooms[1]	X	X	
Coastal discharges (outward flow from embayments, estuaries, lagoons, canals, rivers, other outflows)	X	X	
Eutrophication Δ	X	X	
Sound			
Invasive species			
Shoreline hardening Δ	X	X	
Seabed scour or alteration			
Bycatch			
Ocean disposal sites			
Electromagnetic fields			

1. *Consider NOAA definition: colonies of marine algae that grow out of control while producing toxic or harmful effects on people, fish, shellfish, marine mammals, and birds (http://oceanservice.noaa.gov/hazards/hab/)*

Δ Categories that may be captured and reported by NEPs or other coastal programs

3. Habitats – include benthic vegetated and non-vegetated areas; habitat-forming species; pelagic habitats

	OAP	ROA	Portal
Critical Habitats (ESA)		X	X
Benthic habitats (includes structural habitats like submarine canyons, sand waves/ridges, and other soft-bottom habitats)*	X	X	X
Beaches Δ	X	X	
Benthic *infauna* Δ	X	X	
Habitat for soft corals	X	X	X
Deep sea corals	X	X	X
Submerged aquatic vegetation*Δ*	X		
Salt marsh/wetlands Δ	X	X	
Essential fish habitat**	X	X	X
Artificial reefs	X	X	X
Tilefish			
Methane seeps			

**also appears in Sand Management*

***also appears in Commercial and Recreational Fishing*

Δ Categories that may be captured and reported by NEPs or other coastal programs

4. Lower Trophic Levels – primary and secondary productivity, forage species

	OAP	ROA	Portal
Primary productivity		X	
Secondary productivity		X	
Forage species, small pelagic fish, and invertebrates	X	X	X

5. Upper Trophic Levels – all other marine life

	OAP	ROA	Portal
Protected species	X	X	X
Marine biodiversity	X	X	X
Highly migratory species	X		X
Changes in migration and habitat use	X	X	
Sea turtles	X	X	X
Seabirds, shorebirds, *passerines, and bats*	X	X	X
Fish (suggestion to use MAFMC FMPs as groups)	X	X	X
Large pelagic fish (sharks, billfish, etc.)	X	X	X
Marine mammals	X	X	X
Anadromous fish			X
Shellfish (includes sea scallops, clams, others)	X	X	X
Squid			X
Horseshoe crab		X	

6. Ocean uses

	OAP	ROA	Portal
National Security			
Military installations	X	X	X
Training and testing complexes and ranges	X	X	X
Unexploded ordnance			X
Ocean Energy (OAP focus on wind energy)			
Wind resources	X	X	X
Wind planning areas	X	X	X
Active wind lease and research areas	X	X	X
Electrical cable occurrence*			X

Commercial and Recreational Fishing			
Commercial landings (volume and revenue)	X	X	
Commercial trips		X	X
Commercial fish sales and processing		X	
Recreational landings (volume)		X	
Recreational trips (number and value)		X	X
Commercial and recreational access			
Essential Fish Habitat**	X	X	X
Ocean Aquaculture			
Aquaculture production (volume and value)		X	
Permitted and/or leased areas			
Maritime Commerce and Navigation			
Port cargo (volume and value) and ship calls	X	X	
Vessel trips and traffic patterns	X	X	X
Waterway maintenance and safety (routing measures, anchorages, pilot boarding, channel maintenance and deepening, aids to navigation (AtoN))	X		X
Sand Management			
Sand resources**	X	X	
Federal sand and gravel lease areas (area size, volume, placement area)			
Sand requirements	X		
Non-Consumptive Recreation			
Recreational visits or trips (volume, areas, value)	X	X	X
Recreational access			X
Tribal Interests and Uses			
Submerged cultural areas	X	X	
Tribal ceremonial areas	X	X	
Commercial and sustenance fishing and aquaculture	X	X	
Critical Undersea Infrastructure			
Telecommunication and electrical cable occurrence	X	X	X
Pipeline occurrence	X	X	X
Scientific equipment occurrence	X	X	X

**also appears in Critical Undersea Infrastructure*

***also appears in Habitats*

2.4 Common themes from stakeholder outreach

After reviewing the objectives of the project, draft indicator framework structure, key themes, and potential data categories with the Steering Committee and with members of the public through project outreach, the CBI team identified the following broad themes of feedback. In general, feedback was supportive of the draft framework structure and process to develop an indicator monitoring and assessment program. Participants offered the following ideas and input relevant to the framework and process:

- There was general agreement that these were the right themes, with some suggestions for modifications, such as establishing "Anthropogenic pressures" as a separate theme.
- There was general agreement that these were the right data categories and there were many recommended additions (see the tables in Section 2.3).
- There were several suggestions for specific metrics within data categories.
- There were also suggestions to consider identifying indicators that integrate across data categories and themes and therefore enable a greater understanding of ecosystem change with fewer metrics.

- There was discussion about whether it's necessary and practical to define ocean health, given the title of this project, and if so, how to define "ocean health", what makes the ocean "healthy", and what purpose a definition would serve.
- There was discussion about whether and how indicators will be prioritized given the extent of the themes and data categories in Section 2.3.
- Participants expressed the need to ensure the framework acknowledges the many scales of natural ecosystem variability.
- Participants expressed concern about the scope of the project and the decision to leave out coastal ecosystem components since they are essential to understanding changes in ocean health[8].
- There were suggestions to consider ways that the framework can track the effects of ocean activities (e.g., invasive species, sound, seabed disturbance).
- Participants recommended that the program should track indicators that relate to the Ecologically Rich Area Components, which are being developed by the RPB through a related process under the OAP.
- There were suggestions to consider tracking human well-being, ocean engagement, and other social/economic indicators in addition to the measures of ecosystem change.
- There were suggestions to consider tracking higher-order themes of ecosystem maturity, resilience, and vulnerability.

2.5 Potential metrics database

The CBI team assembled information about existing data collection efforts relevant to many draft indicator themes and data categories (full database in Appendix B). The purpose of this

[8] Note the geographic scope of the OAP "the ocean waters of the region…the shoreline seaward to 200 nautical miles..."; see Section 1.2.

database is to serve as an easily-updated set of information about datasets that could support potential future indicators in the Mid-Atlantic region. This database does not represent all of the data available on each topic. Instead, it is meant to assist the process for identifying which potential indicators are supported by existing data and information. This database could be revised, expanded, and updated over time.

For each data category identified in Section 2.3, the database lists potential metrics, their geographic scope, lead agency, program or source data, reporting interval, and contact information for the data provider. For many data categories, a description of how each metric is reported and/or interpreted by the data providers is included. Some data categories include data sources but a specific metric does not exist or is not suggested.

Additional work and discussion is needed to synthesize the information in this database to determine:

1. How many indicators are desired and practical to monitor?
2. What does a metric indicate (i.e., what is it an indicator of)?
3. How sensitive is it to ecosystem changes that we care about?
4. How representative is it of ecosystem changes that we care about?
5. How understandable is it to a broad audience?
6. What is the sustainability or longevity of the source data or program that supports the metric?

These questions are related to the definition of "indicator" and potential indicator criteria (see box in Section 2.1) that are anticipated to be a topic of discussion at the workshop.

2.6 Data gaps

Data gaps presented in this section are meant to highlight any discrepancies between the themes and data categories that the Steering Committee and stakeholders identified as potentially important to a Mid-Atlantic indicator monitoring and assessment program, and those existing data sources and metrics identified in the Potential metrics database (Appendix B).

In general, almost all of the suggested data categories could be linked to an existing data source. A few notable data gaps include:

- Seabed scour and alteration
- Electromagnetic fields
- Changes in migration and habitat use for some species
- Passerines and bats
- Submerged cultural areas
- Tribal ceremonial areas
- Tribal commercial and subsistence fishing and aquaculture
- Components of Ecologically Rich Areas (ERAs)

Some of these gaps are likely to be filled as information becomes available in the near future. For example, seabed scour and alteration is not currently monitored throughout the region (although perhaps some ocean disposal site monitoring could be relevant), but it is expected that as projects are permitted for seabed uses (e.g., sand resources, offshore wind energy development), new monitoring data may become available. In addition, as this effort begins to focus on specific indicators or metrics, there are likely to be temporal and spatial gaps that may affect the ability to assess and report change. Any gaps related to temporal and spatial resolution must be considered on a case-by-case basis.

3. Indicator monitoring, assessment, reporting, and display

3.1 Monitoring and assessment

Options for monitoring and assessment are important considerations that are specific to each indicator that is ultimately chosen. This entails an understanding of the relevant existing programs that are available to support monitoring and assessment of each indicator, the spatial and temporal resolution of existing data, data gaps, and the range of assessment techniques that could be used to combine multiple data streams (if appropriate). It also includes specific decisions around establishing a baseline for each indicator so that change can be monitored, assessed, and reported. Therefore, it is premature to suggest specific monitoring and assessment options since this project is at the stage of prioritizing data categories, determining what needs to be monitored for each of those priorities, and identifying ways to report on indicators.

Monitoring and Assessment Considerations

- Identify specific indicators based on priorities expressed through this phase of project
- Understand existing data & monitoring efforts, including spatial and temporal resolution, data gaps, etc.
- Communicate and partner with relevant existing programs
- Understand related assessment techniques, including establishing a baseline
- Establish a baseline and techniques for assessing change

Generally, the RPB has expressed an interest in relying on existing programs for monitoring and assessment, while noting there may be some important data gaps. This would require the RPB to communicate and partner with the supporting monitoring and assessment programs once priorities are established. The database of potential metrics provided in Appendix B identifies existing programs, their geographic scope, temporal considerations, and data gaps. This database will be an important supplement to the workshop, and it will be a critical information source for deciding on specific indicators and the monitoring and assessment programs and techniques that will support those indicators.

3.2 Options for reporting tool location

To be widely accessible and easily updated, an indicator reporting tool, display, or dashboard would likely need to be developed in a web-based format. Data and metadata standards would have to be developed since indicators will likely be based on datasets from multiple providers. Those standards would have to be clearly communicated through the website and via data agreements and trainings with each data provider. For each indicator and dataset, the standard should articulate the appropriate maintenance and update schedule. Indicators (and underlying data) could either be updated on a regular schedule (such as every five years) or at a frequency that is relevant to each individual indicator based on the temporal resolution of the underlying data and the appropriate time scale for monitoring change. A web based format with associated data and metadata standards would ensure that the contents of the tool are accessible, usable, searchable, and that the methods and updates are repeatable.

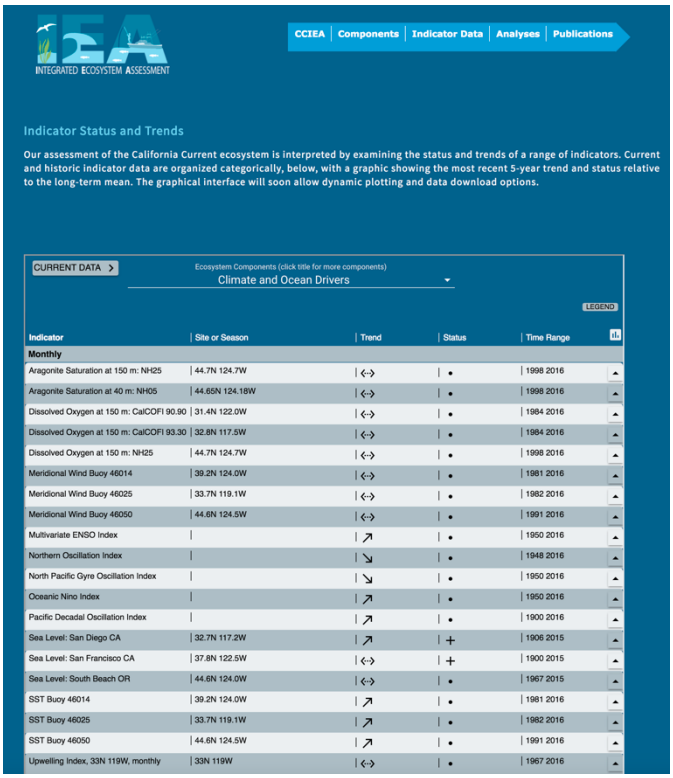
As discussed below with regard to options for indicator display, a web-based tool could be developed with consideration of the need or desire to easily print results or outputs. For example, the Mid-Atlantic Regional Ocean Assessment (http://roa.midatlanticocean.org) was developed as a web-based tool, but also one that could be printed and thus converted to a report-based product if desired. The tool itself could appear anywhere on the web (e.g., a unique URL) or be affiliated with any of the current websites that support regional ocean management (such as the Mid-Atlantic Ocean Data Portal). The tool could link to the other Mid-Atlantic ocean planning sites (e.g., Portal, ROA) to connect all of these efforts. The decision about where to host such a tool is informed by the different options for reporting and communicating indicators, including the general scope of the monitoring and assessment program, the intended audience, and relationships with existing and potential data providers.

3.3 Indicator display or dashboard tool

There are numerous existing indicator monitoring and assessment programs with web-based display or dashboard tools that can be used to help identify potential options for a Mid-Atlantic indicator display tool. This section presents screenshots and short descriptions of a few particularly relevant existing web-based indicator reporting tools for ocean, coastal, or aquatic indicator programs. It concludes with a few important considerations to be discussed at the July workshop that will help guide the development of a monitoring and assessment program to support the implementation of the OAP.

The NOAA Northeast Fisheries Science Center (NEFSC) Ecosystem Status Report (http://nefsc.noaa.gov/ecosys) is an example of a web-based report-style tool. The Executive Summary features expandable sections for major ecosystem components that include explanatory text and graphs showing status and trends. Status is summarized by graphics representing that the indicator is above (+), below (-) or within (.) long-term variability. Trends are summarized by graphics showing increasing (↗), decreasing (↘), or no (↔) trend. Inadequate recent data to determine status or trend is indicated by (x).

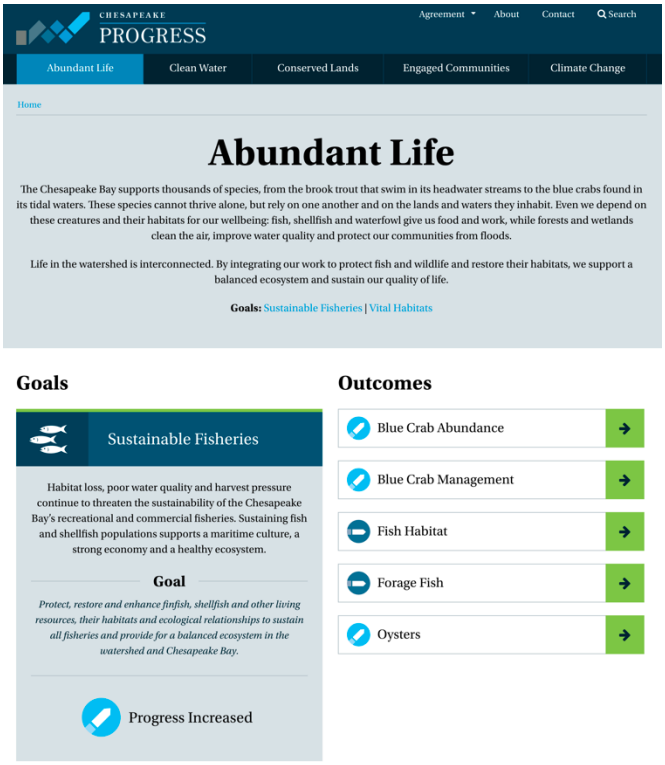
Several of the datasets summarized in the Ecosystem Status Report are generated by NEFSC, but many others are collected, maintained and summarized by other agencies or groups.



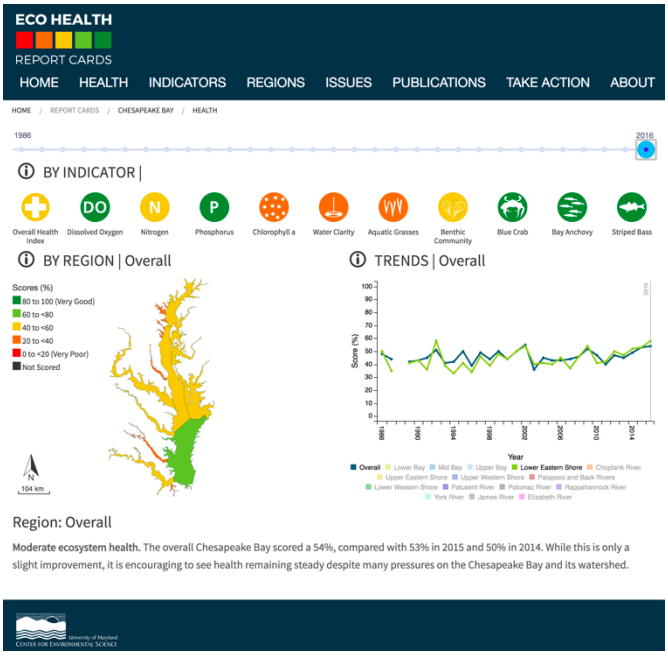
The California Current Integrated Ecosystem Assessment was developed by NOAA with other federal, state, tribal, and non-governmental partners. The website uses a combination of narrative and graphics to explain the importance of focal components and links between and among indicators. Indicator data are presented in large tables organized by ecosystem components such as “Coastal pelagic species”, “Habitat”, and “Climate and Ocean Drivers”. Rows of the tables include the indicator name, location of the observation(s), trend (↗, ↘, ↔) status (+, -, .), and time range of available data. Each row of the tables can be expanded to show trends graphs, citations to the source data, and data downloads. There are hundreds of individual indicators reported on this website.

The Puget Sound Partnership developed the Vital Signs tool (http://www.psp.wa.gov/vitalsigns) to display the measures for determining the health of Puget Sound. There are six statutory goals for the recovery of Puget Sound that are identified in the outer ring of the Vital Signs wheel. Each wedge in the wheel is a Vital Sign that relates to one primary goal, and likely others.

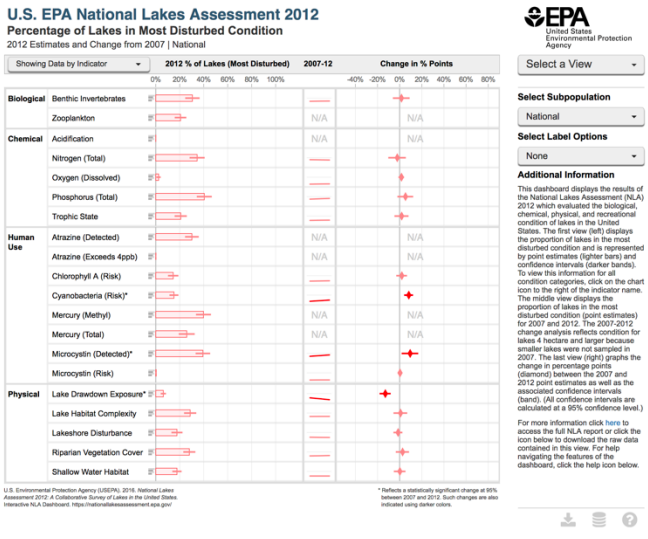
The data are compiled from state and federal agencies, tribes, local jurisdictions, and non-governmental organizations under the umbrella of the Puget Sound Ecosystem Monitoring Program. The experts from the source agencies provide the data, oversee the interpretation of the results, and maintain responsibility for data quality assurance and documentation.



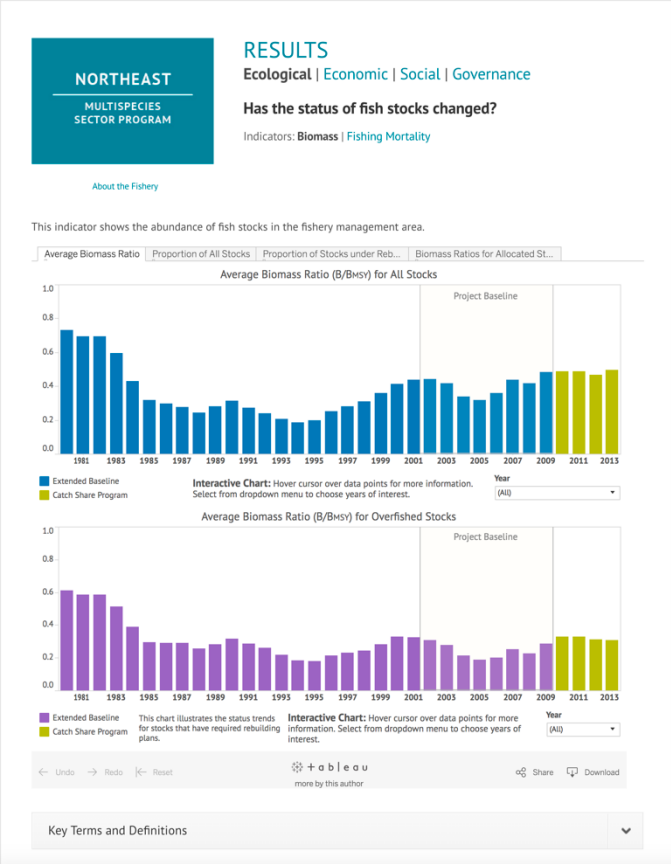
The new Chesapeake Bay Project reporting tool is called Chesapeake Progress (http://www.chesapeakeprogress.com). This tool displays outcomes for more than two dozen indicators under several goals that relate to five issues: "Abundant life", "Clean water", "Conserved lands", "Engaged communities", and "Climate change". The dashboard view shows up/down/static arrows for each indicator. Clicking on an indicator opens a page with narrative, graphs, and links to more information. The issues, goals, and indicators are all derived from the Chesapeake Bay Watershed Agreement that was signed in 2014. Data for each indicator are derived from state and federal agencies, academic institutions, and non-governmental organizations. The status and trends of the same indicators are also reported in a public-friendly "Bay Barometer" report, issued every few years.



Another tool that reports the health of the Chesapeake Bay ecosystem is the Chesapeake Bay Report Card, developed by the University of Maryland Center for Environmental Science (https://ecoreportcard.org/report-cards/chesapeake-bay). This website is centered on a set of interactive panels from which the user can select a year and an indicator. Changing the selection updates the score map and the graph panels. The navigation bar at the top of the page allows the user to read through narrative descriptions of the indicators, geographic profiles, and issues like fisheries and recreation. Individual datasets supporting each indicator are not clearly described within the tool, but an About section credits the Chesapeake Bay Program, and several governmental and academic partners for providing data and interpretation.



The EPA National Lakes Assessment dashboard (https://nationallakesassessment.epa.gov) displays the results of the 2012 assessment of biological, chemical, physical, and recreational condition of US lakes. The National Lakes Assessment is similar to the NCCA in that it is an EPA-led collaboration between multiple federal and state agencies, tribes, and other organizations. Within the display, users can view data by indicator or by EPA region. The dashboard displays status and trends with simple plots that use darker colors to represent statistically significant results. Hovering over a data point brings up a popup window with a summary and explanation of the data. Users can download the source report, raw data, and a static image of the dashboard.



The Catch Share Indicators Project website (www.catchshareindicators.org) displays quantitative results of several indicators in the form of interactive bar and line graphs and pie charts. The indicators are responsive to a set of questions asked by the research team to measure the effects of catch shares. These questions are separated into ecological, economic, social, and governance categories. Source data are from NOAA National Marine Fisheries Service and Fishery Management Councils. This website combines the interactive graphs (which summarize and report large volumes of data) with extensive narrative sections, links to methodological reports, and lists of references/citations.

Important display or reporting tool considerations

The previous examples provide a range of options for reporting and communicating indicators. They also highlight a few key questions and decisions the RPB will need to make with public and stakeholder input in order to take the next step in developing a monitoring and assessment program to support the OAP. These include:

1. Organization: The reporting tools included in this section, and others reviewed by the team, are all generally organized in one of two ways. Some of these tools are organized by ecosystem component, theme, or data category (similar to the presentation of themes and data categories in Section 2.2). The focus on ecosystem component, theme or data category enables a relatively issue-neutral tracking of change in the ecosystem. Examples of this include the two NOAA assessments and the EPA Lakes Assessment above. Other tools are organized by issue (e.g. climate change, water quality, protected species) with several relevant ecosystem components being categorized within each public policy or planning issue area. Examples of this include the Puget Sound Vital Signs and Chesapeake Bay Progress tools.
2. Format and content: The reporting tools presented in this section and available elsewhere demonstrate a range of approaches to communicating change through their respective monitoring and assessment programs. This range of approaches includes some tools that are more reliant on images, scoring mechanisms, classification, and symbols demonstrating trends. Conversely, it also includes tools that are more reliant on narratives to describe the status and trends associated with any indicator. Many programs utilize both approaches effectively, and while it is not critical to determine at this stage how this effort will ultimately be reported, it will be informative to understand stakeholder and RPB preferences to better understand the potential intent, scope and depth of a monitoring and assessment program to support the OAP. Critically, most of the content in these examples is compiled from many cooperating agencies and groups. Data generators may agree to follow consistent and/or common analysis methods, reporting standards, and delivery formats (see The Water Quality Portal at https://www.waterqualitydata.us/ as an example of how data can be aggregated over 400 programs into one reporting portal).
3. Total number of indicators: The number of indicators should ultimately be determined through the prioritization process which is a focus of this phase of the project and the July workshop. Nevertheless, initial stakeholder and RPB feedback on the general number of indicators that should be monitored and assessed will help inform the overall scope and intent of the project. Again, the indicator programs identified in this section demonstrate a range of options – some programs report on a small set of specific ecosystem components or issues, while others try to capture the range of issues and ecosystem components.

The three primary decisions expressed here – the organization by issue or component, formatting and content, and total number of indicators – will likely need to be considered together as they are linked. In addition, while initial feedback on the design and depth of a final

product will be helpful, ultimately the prioritization of themes and data categories will have greater influence on the structure of the communication and reporting tool.

4. Conclusion

The objective of this phase of the project is to engage the RPB and ocean planning stakeholders to obtain feedback, develop a potential overarching framework for a monitoring and assessment program, and make recommendations for communicating and displaying indicators by the Fall of 2017. This white paper presents the context and background information necessary to frame major discussion points to inform these objectives at the July workshop.

While the objectives and discussions do not necessarily need to occur in a linear, step-wise fashion, it is helpful to bin discussion topics and understand the dependencies of each potential decision (Figure 1).

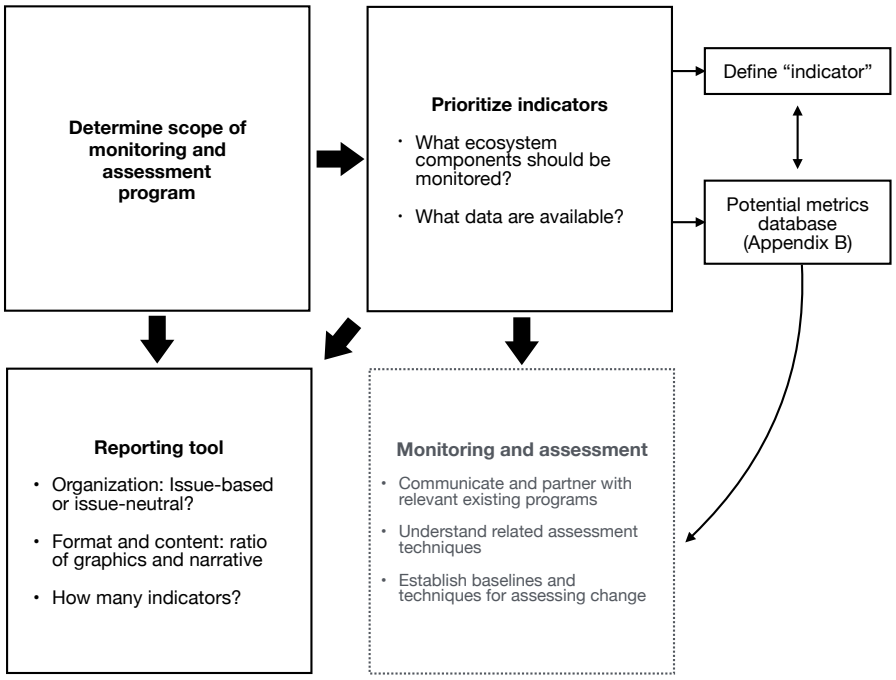


Figure 1. General discussion topics (boxes) for a Mid-Atlantic ocean ecosystem indicator workshop in July 2017. Relationships among topics are shown with arrows. The "Monitoring and assessment" topic box is grey because potential actions within that topic depend on the prioritization of indicators.

From this suite of topics, the CBI team proposes the following goals for the July workshop:

- Discuss the scope of a future Mid-Atlantic ocean ecosystem monitoring and assessment program, considering imagined funding level and possibilities, potential partnerships, desired output(s) and communication product(s)
- Obtain input on what ecosystem components and indicators should be monitored, considering intended definition and/or criteria for indicators
- Obtain feedback on options for assessing and communicating indicators, including reporting tool organization, format and content, total number of indicators

Appendix A: Project outreach webinars

Purpose

The purpose of the outreach component of this project was to obtain feedback from ocean planning stakeholders about the project itself and draft indicator themes and data categories to support a Mid-Atlantic healthy ocean ecosystem indicator monitoring and assessment program. This component of the project addressed a key principle described in the Mid-Atlantic Regional Ocean Action Plan (OAP):

> "Scientists, fishermen, other stakeholders, and Traditional Knowledge holders will be engaged at key points in this action, including during design and evaluation of indicators"

Outreach plan

The CBI team proposed to hold a number of 90-minute webinars based on the following criteria:

- Guidance from the project Steering Committee
- Greater focus on indicators of a healthy ocean ecosystem
- A suggestion to include a few calls to cover indicators related to sustainable ocean uses, while recognizing the focus of this project is on healthy ocean ecosystem indicators
- Grouping of individuals with similar expertise (see listing below) in order to use time efficiently (the workshop will provide opportunities for cross-sectoral discussions)

The project Steering Committee provided the CBI team with a list of potential participants across the following sectors and interest groups: the RPB, tribes, academic and agency scientists, environmental groups, commercial and recreational fishing, aquaculture, non-consumptive recreation, maritime commerce, energy and infrastructure, and offshore sand mining. The CBI team worked with MARCO staff to invite participants and schedule webinars.

General webinar agenda

The following information was provided to webinar participants to guide the discussion:

Materials provided to call participants: Project overview read-ahead (7-page pdf)

Objective:

- Introduce RPB members and stakeholders to the project and its intended goals and products
- Obtain detailed and robust feedback on proposed indicator themes and the data categories, and especially the types of metrics that are most relevant for each theme given the ocean planning context
- Include, connect with, and involve key ocean users and stakeholders

Agenda (90 minutes):

:05 Introductions

:10 Project overview

- Overview of Mid-Atlantic Regional Ocean Action Plan (OAP) and Healthy Ocean Ecosystem Action 5
- Project objectives, products, key principles and schedule
- Role of contract team
- Questions

:20 Proposed indicator themes

- Share initial themes - are these the right themes for measuring ecosystem health as it pertains to the OAP?
- Share the proposed structure for identifying potential indicators, etc.

:45 Data categories

- What aspects of this theme and the data categories are most relevant to ocean planning?
- Which metrics (if any) should be prioritized? What would those metrics indicate?

1:30 Conclude

- Feedback captured during webinars will be incorporated into draft white paper
- Discussion will be continued and advanced at July indicators workshop

Outreach results

From April 27 to May 4, the CBI team held seven outreach webinars with members of the following groups (total number of participants in parentheses):

- Scientists (9 total over two separate webinars)
- Commercial and recreational fishing (6)
- Tribes (5)
- eNGOs (3)
- Energy, sand (1 – representing BOEM Marine Minerals Program)
- Non-consumptive recreation (1 – representing Surfrider Foundation)

In general, feedback obtained through the webinars was supportive of the draft framework structure and process to develop an indicator monitoring and assessment program. Participants offered numerous ideas relevant to the framework structure, process, and specific indicators, metrics, and data streams (see Section 2.4). The CBI team incorporated all of this feedback into the draft white paper. Participants were encouraged to continue engaging with this project by attending the July workshop.

Appendix B: Potential metrics database

Regan Nelson, under contract to E&C Enviroscape

(see next 5-pages)

	Potential metric	Lead agency	Source data/Program	Geographic Extent	Reporting interval	Notes	Contact	Link
1. Oceanography and atmospheric drivers: shape the physical environment of marine organisms; affect feeding, migration, reproduction								
Sea surface temperature	Trends in mean annual SST	NOAA	National Climatic Data Center; Northeast Fisheries Science Center	Mid-Atlantic Bight	Monthy since 1854		Mike Fogarty; Boyin Huang, boyin.huang@noaa.gov	NOAA NEFSC summarizes these data in the Ecosystem status report
	Trends in mean annual SST anomaly	NOAA	National Climatic Data Center; Northeast Fisheries Science Center	Mid-Atlantic Bight	Presents anomolies compared to 1971-2000 monthly climatology		Mike Fogarty; Boyin Huang, boyin.huang@noaa.gov	NOAA NEFSC summarizes these data in the Ecosystem status report
	Trends in seasonal variability in SST	NOAA	Northeast Fisheries Science Center	Mid-Atlantic Bight	Spring/Fall		Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/current-conditions/
Bottom temperature	Trends in seasonal bottom temperatures	NOAA	Northeast Fisheries Science Center	Mid-Atlantic Bight	Spring/Fall		Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/current-conditions/survey-temp.html
Sea surface temperature fronts	Trends in CoastWatch Oceanic Front Probability Index	NOAA	CoastWatch	??	??	The index measures the probability of sea surface temperature front formation; currently an experimental dataset	Need to call to find out further info	
	Change in Frontal Strength	NOAA	Northeast Fisheries Science Center	Mid-Atlantic Bight	Annual		Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/current-conditions/frontal.html
Gulf stream path	Index of the position of the North Wall of the Gulf Stream	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Basin-wide	??	Shifts in the position of the north wall of the Gulf Stream are a leading indicator of conditions on the shelf and indirectly related to the distribution of some commercially important fish species as well as changes in plankton community composition.	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/climate-forcing.html
Dissolved oxygen	Dissolved oxygen status in Chesapeake Bay	Maryland Department of Natural Resources	Eyes on the Bay	Chesapeake Bay	??	Status (good/fair/poor) assigned based on most recent 3-year period. CAN'T FIND EVIDENCE THAT NOAA MONITORS DO2, BUT THAT SEEMS STRANGE	eyesonthebay.dnr@maryland.gov, 877-620-8DNR	http://eyesonthebay.dnr.maryland.gov/eyesonthebay/status_trends_methods.cfm
	Trends in extent of hypoxia in Chesapeake Bay	NOAA	Ecological Forecasting Site/National Ocean Service	Chesapeake Bay	Annually?	Partnership between NOAA/USGS/Maryland DNR and VA DEQ.	Ben Sherman, NOAA, 202-253-5256, ben.sherman@noaa.gov; Joel Blomquist, USGS, 443-498-5560, jdblomqu@usgs.gov	http://oceanservice.noaa.gov/ecoforecasting/
	Dissolved oxygen status in Mid-Atlantic estuaries	NOAA	National Estuarine Research Reserve System	Estuaries located in Mid-Atlantic	?	Water Quality Monitoring Data available on Digital Coast	cdmodata@belle.baruch.sc.edu	
pH						Need to call Rik to determine if pH is routinely monitored. I believe its opportunity-based currently.	Rik Wanninkhof, Lead Investigator, OA Observing Network East Coast, 305-361-4379, rik.wanninkhof@noaa.gov	https://www.nodc.noaa.gov/oceanacidification/stewardship/data_assets.html
	Surface and sub-surface trends in aragonite saturation state	NOAA	NOAA Ocean Acidification Program	Mid-Atlantic region	Surface trends reported seasonally; sub-surface trends reported every 3-5 years	Surface trends will be reported seasonally starting in 2016; sub-surface trends will be available on 3-5 year intervals	Rik Wanninkhof, Lead Investigator, OA Observing Network East Coast, 305-361-4379, rik.wanninkhof@noaa.gov	http://www.aoml.noaa.gov/ocd/ocdweb/occ_oa.html
North Atlantic Oscillation/Atlantic Multi-decadal Oscillation	North Atlantic Oscillation (NAO) Index	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Basin-wide		Considered to be correlated with Gulf stream position;	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/climate-forcing.html
Water column stratification	Annual mean density stratification (0-50 meters)	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Mid-Atlantic Bight	Annual	The Mid-Atlantic Bight is the most strongly stratefied in the Northeast, so "there is less scope for further increases in this area."	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/physical-pressures.html
El Niño	Predicted El Nino Southern Oscillation phase for current year	NOAA	Climate Prediction Center/National Weather Service	Nation-wide	Monthly	Multivariate ENSO index is used to discern between El Nino and La Nina phases in the eastern tropical Pacific Ocean.	??	http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml
Sea level	Mean Sea Level Trends	NOAA National Ocean Service	Tides & Currents/National Ocean Service	North Atlantic stations	"As needed"	Trends were calculated using monthly data up to the end of 2006, and all stations had data spanning a period of 30 yrs or more.	CO-OPS Water Level Program, 301-713-2815	https://tidesandcurrents.noaa.gov/sltrends/northatlantictrends.htm
	Rates of sea level change	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Northeast, but reporting can be done by states	Annual?	Part of Ecosystem Status Reports	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/stressors-impacts.html
Wave height		NOAA National Ocean Service	National Water Level Observation Network/Center for Operational Oceanographic Products and Services			Collects and provides real-time tide and other water level measurements, which inform NOAAs tide predictions	CO-OPS Resilience Program, 240-533-0548	https://tidesandcurrents.noaa.gov/water_level_info.html
Tides and other currents		NOAA National Ocean Service	National Water Level Observation Network/Center for Operational Oceanographic Products and Services			Collects and provides real-time tide and other water level measurements, which inform NOAAs tide predictions	CO-OPS Resilience Program, 240-533-0548	https://tidesandcurrents.noaa.gov/water_level_info.html
2. Anthropogenic Pressures: includes those inputs and effects that likely are driven by or originate from an array of human activities								
Marine debris	Cumulative abundance of marine debris by type	NOAA	Marine Debris Program	Mid-Atlantic Region	N/A	NOAA hosts an online database populated from groups conducting marine debris surveys. The database is public, and can support reporting of this metric, but NOAA does not publish reports	Jason Rolfe - 301-713-2989 x111	
	Trends in cumulative abundance or marine debris by type	NOAA	Marine Debris Program	Mid-Atlantic Region	N/A	NOAA hosts an online database populated from groups conducting marine debris surveys. The database is public, and can support reporting of this metric, but NOAA does not publish reports	Jason Rolfe - 301-713-2989 x111	
Oil/chemical releases	Number and cause of incidents	NOAA/USCG	Office of Response and Restoration - Marine	Mid-Atlantic Region	Annual	ORR tracks and publishes (through Incident News) spills and releases that NOAA responds to. The USCG maintains the Marine Casualty and Pollution Database that involves marine pollution incidents investigated by the Coast Guard. Not sure the extent of overlap.	Online databases	https://incidentnews.noaa.gov/ and https://catalog.data.gov/dataset/marine-casualty-and-pollution-data-for-researchers
	Cumulative amount of oil or chemicals that entered the environment	NOAA/USCG	Office of Response and Restoration - Marine	Mid-Atlantic Region	Annual	ORR tracks and publishes (through Incident News) spills and releases that NOAA responds to. The USCG maintains the Marine Casualty and Pollution Database that involves marine pollution incidents investigated by the Coast Guard. Not sure the extent of overlap.	Online databases	https://incidentnews.noaa.gov/ and https://catalog.data.gov/dataset/marine-casualty-and-pollution-data-for-researchers
Contaminants	Trends in heavy metal and DDT concentration anomalies	NOAA	Northeast Fisheries Science Center	Mid-Atlantic Bight	Annual		Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/stressors-impacts.html
Sediment Contamination	Trend in Sediment Quality Index	EPA	National Coastal Condition Assessment/Office of Water	Northeast/Mid-Atlantic	Every 5 years	Field crews are sent out every five years to do sampling. Hugh believes there are enough samples in the Mid-Atlantic region to have a high confidence level in reporting on these indices for the Mid-A. Note that offshore sediment samples are no longer collected	Hugh Sullivan 202-564-1763	
Fish Contamination	Trend in Fish Tissue Contamination Index	EPA	National Coastal Condition Assessment/Office of Water	Northeast/Mid-Atlantic	Every 5 years	A baseline ecological condition assessment was completed for the Mid-Atlantic Bight in 2006. At this time, on-going monitoring to track trends is not funded, but could potentially be if the Mid-A RPB requested it from the National Ocean Service	Cindy Cooksey, Marine Biologist 843-762-8653	
Harmful algal blooms		NOAA	National Ocean Service/National Centers for Coastal Ocean Science			An experimental forecasting system has been developed for Chesapeake Bay. The Northeast Fisheries Science Center include HABs as an indicator, but its not clear if monitoring is occuring in the Mid-Atlantic.	Robert Magnien, NOAA Center for Sponsored Coastal Ocean Research, 301-713-3338x159, rob.magnien@noaa.gov	http://oceanservice.noaa.gov/ecoforecasting/ https://www.nauticalcharts.noaa.gov/csdl/HABchesbay.html
Coastal discharge (outward flow from embayments, estuaries, lagoons, canals, rivers, other outflows)	Trends in annual river flow	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Mid-Atlantic Bight		Most freshwater enters marine systems through rivers, rather than direct precipitation or runoff.	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/physical-pressures.html
	Trends in annual freshwater input via precipitation	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Mid-Atlantic Bight		Precipitation affects a wide range of ocean processes such as salinity, water column stratification, coastal circulation, and nutrient supply.	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	

	Potential metric	Lead agency	Source data/Program	Geographic Extent	Reporting interval	Notes	Contact	Link
	Offshore discharge flow locations and flow values (million gallons/day)	EPA				Metadata from Data Portal	Don Evans, EPA, 215-814-5370, don@epamail.epa.gov	http://portal.midatlanticocean.org/static/data_manager/metadata/html/OffshoreDischargeLocations_MARCO.htm
Eutrophication	Euthrophication status	NOAA	Northeast Fisheries Science Center	Northeast	??	Reported in Ecosystem Status Report	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	
Sound/Underwater Noise	Modeled sound levels in the Mid-Atlantic	NOAA	CetSound Program	Mid-Atlantic	??	Reported in Ecosystem Status Report; CetSound: http://cetsound.noaa.gov/	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/stressors-impacts.html
	Trends in underwater ambient noise	NOAA	Ocean Noise Reference Station Network/Office of Science and Technology	Northeast region	TBD	New program initiated in 2015 - will redeploy sensors every 2 years, and being reporting trends within the next 5-6 years	Jason Gedamke, NOAA Fisheries Biologist, 301-427-8133	https://www.pmel.noaa.gov/acoustics/ocean-noise-reference.html
Aquatic Invasive Species	Total number and taxonomy of invasive species	USGS	Nonindigenous Aquatic Species Program	Can report by state	Ongoing/real-time	Online database	Pam Fuller, NAS Program Leader, pfuller@usgs.gov, 352-264-3481	http://nas.er.usgs.gov/about/default.aspx
	Source of introductions	USGS	Nonindigenous Aquatic Species Program	Can report by state	Ongoing/real-time	Online database	Pam Fuller, NAS Program Leader, pfuller@usgs.gov, 352-264-3481	http://nas.er.usgs.gov/about/default.aspx
Ocean Disposal Sites	Percentage of active dredged material ocean dumping sites that have achieved "environmentally acceptable" status	EPA	Office of Water	EPA Regions 2 & 3	Annual	Annual monitoring of active ocean dumping sites is required under the Marine Protection, Research, and Sanctuaries Act	Region 2: Charles LoBue, 212-637-3798, lobue.charles@epa.gov Region 3: Sherilyn Lau, 215-814-2786, lau.sherilyn@epa.gov	https://www.epa.gov/ocean-dumping/forms/regional-contacts-ocean-dumping-management-program
Shoreline hardening	Area of restored shoreline and change from previous year	NOAA	Habitat Conservation Restoration Center/Office of Habitat Conservation	??	??	NOAA Habitat Blueprint Living Shorelines Project Map tracks shoreline restoration projects	Office of Habitat Conservation, 301-713-0174	https://www.habitatblueprint.noaa.gov/living-shorelines/project-map/
	Total extent of hardened shoreline and change from previous year	Virginia Institute of Marine Science	Shoreline Inventories/Center for Coastal Resources Management	Chesapeake Bay	??	Shoreline inventories exist for Chesapeake Bay	VA Institute of Marine Science, 804-684-7380	http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/
Seabed scour or alteration								
Bycatch	Fishery bycatch ratio trends in Mid-Atlantic fisheries	NOAA National Marine Fisheries Service	National Bycatch Reporting/National Observer Program	Northeast region	Every 2 years	Fishery by-catch ratios are based on landings for the entire Northeast region and can't be broken out for just the Mid-Atlantic, although those fisheries that are predominantly prosecuted in the Mid-Atlantic can be the focus of the reporting	Lee Banaka, National Observer Program Lead, 301-427-8554	http://www.st.nmfs.noaa.gov/observer-home/first-edition-update-2
	Bycatch estimates and trends of marine mammals, sea turtles and seabirds by Mid-Atlantic fishery	NOAA National Marine Fisheries Service	National Bycatch Reporting/National Observer Program	Northeast region	Every 2 years		Lee Banaka, National Observer Program Lead, 301-427-8554	http://www.st.nmfs.noaa.gov/observer-home/first-edition-update-2
Electromagnetic fields								
3. Habitats: includes vegetated and non-vegetated areas; habitat-forming species; pelagic habitats								
HABITATS DELINEATED FOR MANAGEMENT PURPOSES								
North Atlantic Right Whale Seasonal Management Areas	Spatial locations of SMAs	NOAA	NMFS Protected Species Program	Atlantic	Updated "as needed"	Database is stored in Mid-Atlantic Data Portal, and represents Seasonal Management Area locations where regulations implement speed restrictions in shipping areas at certain time of the year to reduce the likelihood of vessel collisions with North Atlantic right whales	Barbara Zoodsma, Southeast U.S. Right Whale Recovery Program Coordinator, nmfs.ser.gis.coordinator@noaa.gov, 727-824-5312	http://portal.midatlanticocean.org/static/data_manager/metadata/html/SMA_all_po.html
Critical Habitats (ESA)	Spatial locations of existing and proposed coastal critical habitat designations	NOAA	Digital Coast/Office for Coastal Management	Spatial data covers Mid-Atlantic	Updated "as needed"	Digital Coast maintains current and proposed Coastal Critical Habitat Designations	Marine Cadastre Data Steward, 843-740-1202	https://coast.noaa.gov/dataregistry/search/dataset/DA8E098D-582C-47FA-97B6-32AB42836CFE
Deep-Sea Coral Protection Areas	Number and total area of Deep-Sea Coral Protection Areas	NOAA	NOAA Fisheries Greater Atlantic Regional Fisheries Office	Mid-Atlantic region	Upon request	This can be calculated from Frank Lautenberg Deep-Sea Coral Protection Area database on MidA Portal. Re-calculation would only be needed in the event that boundaries change or new areas are protected.	Doug Potts, GARFO, doug.potts@noaa.gov, 978-282-9341	
Essential fish habitat	EFH areas protected from fishing	NOAA	NMFS	Mid-Atlantic	Updated based on Council actions	Essential Fish Habitat Mapper displays EFH areas protected from fishing.		http://www.habitat.noaa.gov/protection/efh/habitatmapper.html
Artificial reefs	Number of artificial reefs in the Mid-Atlantic region	NOAA	Artifical Reefs Dataset/Office for Coastal Management	Mid-Atlantic	Update frequency: "as needed"	Data Portal dataset built by TNC, with no updates planned. Artifical Reefs dataset on Digital Coast is set to update "as needed"	Marine Cadastre Data Steward, 843-740-1202	https://coast.noaa.gov/dataservices/Metadata/TransformMetadata?u=https://coast.noaa.gov/data/Documents/Metadata/harvest/MarineCadastre/ArtificialReefs.xml&f=html
SPATIAL LOCATIONS OF HABITATS								
Benthic habitats (includes structural habitats like submarine canyons, sand waves/ridges, and other soft-bottom habitats)			Mid-Atlantic Data Portal	Mid-Atlantic		The Mid-Atlantic Data Portal contains spatial datasets showing the location of soft-sediment bottom habitats (from TNC NAMERA), and including major submarine canyons	Mid-Atlantic Data Poral	http://portal.midatlanticocean.org/data-catalog/oceanography/
Beaches	Percentage of days of beach season that coastal beaches monitored by state beach safety programs are open and safe for swimming	EPA	Beaches, Environmental Assessment, Closures and Health (BEACH) program	By State	Annual	EPA collects data on Beach Advisory and Closings from States. They have the ability to report on this indicator for the Mid-Atlantic region if asked	Samantha Fontenelle, 202-566-2083; Lisa Larimer, Team Lead BEACH Program	https://www.epa.gov/beach-tech
Benthic infauna	Benthic community condition in Chesapeake Bay		Chesapeake Bay Benthic Monitoring Program	Chesapeake Bay	Annual	http://www.baybenthos.versar.com/default.htm		http://www.baybenthos.versar.com/backgrou.htm
	Annual trends in Benthic Index	EPA	National Coastal Condition Assessment/Office of Water	Northeast/Mid-Atlantic	Every 5 years	NOAA has suspended the offshore sampling program unless/until it receives direction to re-initiate offshore sampling work, so this is largely a coastal water measure	Hugh Sullivan, National Coastal Condition Assessment Program Lead, 202-564-1763	
Habitat for soft corals	Spatial distribution of predicted habitat for soft corals	NOAA	National Centers for Coastal Ocean Science	Mid-Atlantic	Update frequency: "None planned"	Spatial dataset included in Mid-Atlantic Data Portal	NOS Biogeography Branch, 301-713-3028	http://portal.midatlanticocean.org/static/data_manager/metadata/html/US_Northeast_MidAtlantic_ALCY_Thresholded_Logistic_Prediction_Shapefile_Metadata.html
Deep sea corals	Percentage of observed and predicted deep sea coral habitats protected from bottom-tending gear	NOAA	National Geodatabase of Deep Sea Coral Observations/Deep Sea Coral Research and Technology Program	Mid-Atlantic region	Upon request	This indicator is not currently tracked or reported, but the data is available to calculate it. Reporting could be updated when new gear restrictions or closures are enacted.	Fan Tsao, Deep Sea Coral Research and Technology Program, 301-427-8650	https://deepseacoraldata.noaa.gov/
Submerged Aquatic Vegetation	Annual trends in SAV acreage	NOAA/EPA (?)	Virginia Institute of Marine Science	Chesapeake Bay	Annually	The VA Institute of Marine Science maps and measures SAV beds in the Chesapeake Bay annually and has produced reports most years since 1984.	Rich Batiuk, EPA, 410-267-5731	http://web.vims.edu/bio/sav/
Salt march/wetlands	Change in aereal extent of coastal wetlands	NOAA	Coastal Change Analysis Program	Mid-Atlantic	Change analysis conducted every 5 years	Status and trends of coastal wetlands habitats are analyzed every five years; the CCAP program could report on Mid-Atlantic region upon request	Nate Herold 843-740-1183 - EPA NWI Greg Serenbetz 202-566-1253	https://coast.noaa.gov/digitalcoast/tools/lca.html
Coastal Habitats	Annual number of acres of coastal habitat protected in the Mid-Atlantic region	NOAA	Coastal Zone Management Program	Mid-Atlantic states	Annual	The CZM program can provide monitoring results for the Mid-Atlantic states upon request	Allison Castellan allison.castellan@noaa.gov 301-563-1125	
	Annual number of acres of degraded coastal habitat under restoration	NOAA	Coastal Zone Management Program	Mid-Atlantic states	Annual	The CZM program can provide monitoring results for the Mid-Atlantic states upon request	Allison Castellan allison.castellan@noaa.gov 301-563-1125	
Tilefish	Sustainability of golden tilefish	NOAA	Stock Assessments/Northeast Fisheries Science Center	Mid-Atlantic	~3-5 years	Habitat forming species. Stock assessment sustainability = stock is not overfished and not subject to overfishing	Woods Hole MA Lab, (508) 495-2000	https://www.nefsc.noaa.gov/publications/crd/crd1403/
Methane seeps		NOAA	Office of Ocean Exploration and Research	Atlantic		USGS created a map of methane seeps discovered in 2012; also is building a database of "Worldwide Gas Hydrates" although I'm uncertain if that includes methane seeps: https://woodshole.er.usgs.gov/project-pages/hydrates/database.html		http://oceanexplorer.noaa.gov/explorations/17atlantic-margin/welcome.html
4. Lower trophic levels: primary and secondary productivity; forage fish								
Primary productivity	Annual trends in small phytoplankton (nano-picoplankton)	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Northeast shelf (not sure if they can report on Mid-A Bight?)	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/primary-secondary-production.html

	Potential metric	Lead agency	Source data/Program	Geographic Extent	Reporting interval	Notes	Contact	Link
	Annual trends in large phytoplankton (macroplankton)	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Northeast shelf (not sure if they can report on Mid-A Bight?)	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/primary-secondary-production.html
Secondary productivity	Annual trends in zooplankton abundance	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Mid-Atlantic Bight	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/primary-secondary-production.html
	Annual trends in copepod species composition	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Mid-Atlantic Bight	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/primary-secondary-production.html
Forage species, small pelagic fish, and invertebrates	Trends in biomass for small pelagic fish (herring, mackerel, others)	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Northeast shelf (not sure if they can report on Mid-A Bight?)	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/fish-communities.html
	Estimated forage fish species biomass	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Northeast shelf (not sure if they can report on Mid-A Bight?)	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/fish-communities.html
	Trends in biomass of benthic invertebrates	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Mid-Atlantic Bight	Every 2 years (with twice-annual updates for some metrics)	Species include American lobster; sea scallop; sea stars; ocean quahog; Atlantic surfclam); Based on both directed research vessel surveys and/or stock assessments	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/fish-communities.html
Trophic structure of fish in the ecosystem	Annual trends in mean trophic level of fish communities	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Mid-Atlantic Bight	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/fish-communities.html
Shifts in fish distributions	Trends in average position for a group of 48 species resident on the Northeast US Continental Shelf	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Northeast shelf (not sure if they can report on Mid-A Bight?)	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/stressors-impacts.html
5. Upper trophic levels: marine life								
Protected species	Location of core abundance areas for marine mammal species of concern	Navy, NOAA	MDAT	Mid-Atlantic	Update frequency: "irregular"	Synthetic base layer developed by MDAT	Jesse Cleary, jesse.cleary@duke.edu	http://seamap.env.duke.edu/models/mdat/MDAT-Technical-Report-v1_1.pdf
	Total relative abundance of roseate terns	BOEM, NOAA	MDAT	Mid-Atlantic	Update frequency: "irregular"	Synthetic base layer developed by MDAT	Jesse Cleary, jesse.cleary@duke.edu	http://seamap.env.duke.edu/models/mdat/MDAT-Technical-Report-v1_1.pdf
	Relative status (Recovery Factor) of marine mammals	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Northeast shelf (not sure if they can report on Mid-A Bight?)	?	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/protected-species.html
Marine biodiversity			MDAT	Mid-Atlantic	Update frequency: "irregular"	MarineLife Data and Analysis Team (MDAT) developed multiple spatial data layers showing abundance and distribution of marine species. All spatial data layers are stored in the Mid-Atlantic Data Portal	Jesse Cleary, jesse.cleary@duke.edu	http://seamap.env.duke.edu/models/mdat/MDAT-Technical-Report-v1_1.pdf
Changes in migration and habitat use								
Sea turtles	Sea turtle abundance	NOAA	NOAA NEFSC, AMAPPS					
	Number of sea turtle strandings by species and causes	NOAA	NMFS Sea Turtle Stranding and Salvage Network			Data summaries of number of strandings by species and cause can be produced annually upon request	Wendy Teas, STSSN Program Lead, Southeast Fisheries Science Center 305-361-4595; Kate Sampson, Greater Atlantic Stranding Network Program Lead, 978-282-8470	
	Spatial distribution of areas of common sea turtle sightings	The Nature Conservancy		Mid-Atlantic	Update frequency: "As needed"	Data set included in Mid-Atlantic Data Portal	Jennifer Greene, jgreene@tnc.org, 617-532-8353	http://portal.midatlanticocean.org/static/data_manager/metadata/html/MigratoryPortfolio.html
Seabirds	Mortality by focal species and location; year-to-year trends	SEANET	Citizen science beached bird surveys	East Coast Atlantic states	Annual	SEANET staff confirmed they could theoretically publish annual reports on Mid-Atlantic bird mortality counts by species and location; however, current coverage of Mid-Atlantic beaches by citizen scientists is extremely low. New recruitment through trainings would be requried to kick-start this effort in earnest in the Mid-Atlantic	Julie Ellis, SEANET Director, 508-887-4933	https://seanetters.wordpress.com/about/
	Trends in seabird bycatch by fishery	NOAA	National Bycatch Reporting/National Observer Program	?	Annual	The red-throated loon (Gavia stellata), red-necked grebe (Podiceps grisegena), greater shearwater (Puffinus gravis), northern gannet (Morus bassanus), thick billed murre (Uria lomvia), razorbill (Alca torda), black guillemot (Cepphus grille) and the Atlantic puffin (Fratercula artica) have been identified as species at risk due to fisheries bycatch	Lee Banaka, National Observer Program Lead, 301-427-8554	http://www.st.nmfs.noaa.gov/observer-home/first-edition-update-2
	Offshore/Pelagic Avian Abundance, Species Richness and Core Areas	MDAT	MDAT modeling	Mid-Atlantic	Update frequency: "Irregular"	Offshore/pelagic species include Atlantic puffin, Audubon's shearwater, Black-capped petrel, Common murre, Cory's shearwater, Dovekie, Great shearwater, Leach's storm-petrel, Manx shearwater, Northern fulmar, Pomarin jaeger, Rzorbill, Red phalarope, Red-necked phalarope, Sooty shearwater, and Wilson's storm-petrel	Jesse Cleary, jesse.cleary@duke.edu	http://seamap.env.duke.edu/models/mdat/MDAT-Technical-Report-v1_1.pdf
Shorebirds	Trends in annual counts of endangered shorebirds (Piping plover, Red knot; Roseate Tern)	US Fish and Wildlife Service	Endangered Species monitoring	Varies by species	Annual	Little ongoing monitoring of shorebirds occurs	Plover - Anne Hecht 978-443-4325; Roseate Tern - Caroline Mostello 508-389-6372 MA Division of Fisheries and Wildlife, compiles annual monitoring data on behalf of Recovery Team. Susie oettingen is Recovery Team Lead Biologist 603-223-2541 x6418 (USFWS); Red Knot - Wendy Walsh USFWS 609-383-3938x48, also Larry Niles monitors Delaware Bay	
	Coastal Waterfowl Abundance, Species Richness and Core Areas	MDAT	MDAT modeling	Mid-Atlantic	Update frequency: "Irregular"	Coastal waterfowl species include Black scoter, Common eider, Common loon, Long-tailed duck, Red-throated loon, Surf scoter, and White-winged scoter	Jesse Cleary, jesse.cleary@duke.edu	http://seamap.env.duke.edu/models/mdat/MDAT-Technical-Report-v1_1.pdf
Passerines and bats								
Fish (suggestion to use MAFMC FMPs as groups)	Total biomass, core areas and species richness	MDAT	MDAT modeling	Mid-Atlantic	Update frequency: "Irregular"	MDAT modeled 82 fish species	Jesse Cleary, jesse.cleary@duke.edu	http://seamap.env.duke.edu/models/mdat/MDAT-Technical-Report-v1_1.pdf
	Biomass of species under a MAFMC Fisheries Management Plan	MDAT	MDAT modeling	Mid-Atlantic	Update frequency: "Irregular"	Includes summer flounder, scup, black sea bass, spiny dogfish, Atlantic mackerel, longfin squid, northern shortfin squid, butterfish, bluefish, and golden tilefish	Jesse Cleary, jesse.cleary@duke.edu	http://seamap.env.duke.edu/models/mdat/MDAT-Technical-Report-v1_1.pdf
Groundfish	Trends in biomass	NOAA'	Ecosystem Assessment Program/ Northeast Shelf Ecosystem Status Report	Mid-Atlantic Bight region	Every 2 years	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	
	Recruitment Index Anomaly	NOAA	Integrated Ecosystem Assessment Program; Ecosystem Status Reports	Northeast shelf (not sure if they can report on Mid-A Bight?)	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	
Atlantic Highly Migratory Species	Status of Atlantic Highly Migratory Species	NOAA	Stock Assessment and Fisheries Evalutation Report/NMFS	Atlantic Ocean	Annual	NOAA Fisheries produces an annual Stock Assessment and Fisheries Evaluation (SAFE) Report that reviews the current status of Atlantic HMS fish stocks (tunas, swordfish, billfish, and sharks). The reports—which are required under the Magnuson-Stevens Fishery Conservation and Management Act—provide the status of each HMS stock (e.g., overfished, overfishing, rebuilding)	Highly Migratory Species Management Division, 301-427-8503	http://www.nmfs.noaa.gov/sfa/hms/documents/safe_reports/index.html and http://www.fisheries.noaa.gov/sfa/fisheries_eco/status_of_fisheries/index.html

	Potential metric	Lead agency	Source data/Program	Geographic Extent	Reporting interval	Notes	Contact	Link
Marine mammals (Cetaceans)	Population estimates and trends	NOAA NMFS/Northeast Fisheries Science Center	Annual Stock Assessments	Atlantic Ocean	Annual	Marine Mammal Protection Act requires NMFS and USFWS to update stock assessments annually for strategic stocks, every 3 years for non-strategic stocks. ESA-listed stocks are all considered strategic stocks	Allison Henry, Protected Species Branch, 508-495-2048	http://www.nmfs.noaa.gov/pr/sars/
	Reported mortalities and causes	NOAA NMFS/Northeast Fisheries Science Center	Annual Stock Assessments	Atlantic Ocean	Annual	Stock assessments include information on mortalities and causes (when known)	Allison Henry, Protected Species Branch, 508-495-2048	http://www.nmfs.noaa.gov/pr/sars/
Anadromous fish	Status of anadromous fish species in the Mid-Atlantic	NOAA NMFS/Northeast Fisheries Science Center	Atlantic Anadromous Fisheries	Mid-Atlantic	Varies	Anadromous fishes in the mid-Atlantic are managed either by the MAFMC, the ASFMC, or in the case of listed species, NMFS. "Our Living Oceans" reports include a chapter summarizing the status of Atlantic Anadromous Fisheries, and these reports are released on a multi-year cycle. In the interim, status reports could be compiled separately for each MidA anadromous species		http://spo.nmfs.noaa.gov/olo6thedition/14--Unit%203.pdf
	Species richness of diadromous fish	MDAT	MDAT modeling	Mid-Atlantic	Update frequency: "Irregular"	Diadromous species include alewife, American eel, American shad, Atlantic sturgeon, blueback herring, hickory shad, and shortnose sturgeon	Jesse Cleary, jesse.cleary@duke.edu	http://seamap.env.duke.edu/models/mdat/MDAT-Technical-Report-v1_1.pdf
Shellfish (sea scallops, clams, others)	Biomass trends of sea scallops, ocean quahogs and Atlantic surfclams	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Mid-Atlantic Bight	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	https://www.nefsc.noaa.gov/ecosys/ecosystem-status-report/benthic-invertebrates.html
Squid	Relative abundance and biomass of northern shortfin squid and longfin inshore squid	NOAA	Landings and Survey Data/Northeast Fisheries Science Center	Northeast	Annual?	Landings and Survey data are used to inform quotas. Last stock assessment was from 2006, and status cannot be determined	Jason Didden, 302-526-5254	http://www.mafmc.org/msb/
Horseshoe crab	Horseshoe crab population	USFWS, with Maryland Fishery Resources Office and Delaware Bay Estuary Project	Horseshoe Crab Tagging Program	Delaware Bay area	Annual		1-888-LIMULUS	https://www.fws.gov/northeast/marylandfisheries/projects/Horseshoe%20crab.html
	Horseshoe crab harvest levels	ASMFC	Horseshoe Crab Management Board	Delaware Bay area	Annual		Mike Schmidtke, FMP Coordinator, mschmidtke@asmfc.org	http://www.asmfc.org/species/horseshoe-crab
6. Ocean uses								
NATIONAL SECURITY								
Military installations	Spatial locations of military range complexes	Navy	Naval Facilities Engineering Command Atlantic	Mid-Atlantic	?	A range complex is a designated set of specifically bounded geographic areas and encompasses a water component (above and below the surface), airspace, and may encompass a land component where training and testing of military platforms, tactics, munitions, explosives, and electronic warfare systems occur.	Fleet Area Control and Surveillance Facility: FFAECC@navy.mil, 757.433.1211	http://portal.midatlanticocean.org/static/data_manager/metadata/pdf/NationalSecurityMidAMilitary_Range_Complex.pdf
Training and testing complexes and ranges	Spatial locations of Danger Zones and Restricted Areas	Department of Defense	?	Mid-Atlantic	Update frequency of data layer is biannual	Danger zones are a defined water area used for hazardous operations, normally for the armed forces. Danger zones may be closed to the public on a full-time or itermittent basis	Marine Cadastre Data Steward, 843.740.1202, coastal.info@noaa.gov	https://coast.noaa.gov/dataservices/Metadata/TransformMetadata?u=https://coast.noaa.gov/data/Documents/Metadata/harvest/MarineCadastre/DangerZonesAndRestrictedAreas.xml&f=html
Unexploded ordnance	Spatial locations of unexploded ordnances	NOAA	Office for Coastal Management	Mid-Atlantic	Update frequency: "as needed"	Explosive weapons on the seafloor that still pose a risk of detonation.	Marine Cadastre Data Steward, 843.740.1202, coastal.info@noaa.gov	https://coast.noaa.gov/dataservices/Metadata/TransformMetadata?u=http://coast.noaa.gov/data/Documents/Metadata/harvest/MarineCadastre/UnexplodedOrdnances.xml&f=html
OCEAN ENERGY (OAP FOCUS ON WIND)								
Wind resources	Area leased for wind energy development	BOEM	Office of Renewable Energy	Mid-Atlantic	"As needed"	Can be calculated from "Active wind lease and research areas" dataset	Branch Chief, BOEM, 703-787-13.5	https://metadata.boem.gov/geospatial/boem_renewable_lease_areas.xml
Wind planning areas	Number of wind planning areas by state	BOEM	Office of Renewable Energy	Mid-Atlantic	"As needed"	MidA Data Portal: Wind Planning Areas in this dataset represent up to seven different types of announcements within the US Federal Register (e.g. Call Area, Wind Energy Area, Request for Interest, Proposed Sale Notice Area) that can be used to show the current status of an area that is being considered for Wind Power Development.	Stephen Creed, stephen.creed@boem.gov, 703-787-1635	https://metadata.boem.gov/geospatial/BOEM_Wind_Planning_Areas.xml
	Total area of wind planning areas in Mid-Atlantic and change in total area from previous year	BOEM	Office of Renewable Energy	Mid-Atlantic	"As needed"	Wind planning areas are reported in acres and hectares.	Stephen Creed, stephen.creed@boem.gov, 703-787-1635	https://metadata.boem.gov/geospatial/BOEM_Wind_Planning_Areas.xml
Active wind lease and research areas	Number of active wind lease and research areas and change from previous year	BOEM	Office of Renewable Energy	Mid-Atlantic	"As needed"	These are blocks which have been leased by a company with the intent to build a wind energy facility. No projects are in the development stage at this time; permits may be issued for development provided further site assessment for each leased area.	Branch Chief, BOEM, 703-787-13.5	https://metadata.boem.gov/geospatial/boem_renewable_lease_areas.xml
Electrical cable occurrence	Locations of coastal energy facilities	EPA	Emissions & Generation Resource Integrated Database (eGRID)	Mid-Atlantic	"As needed"	Locations of facilities that generte electricity. THe presence of a facility may indicate that certain power transmission infrastructure exists nearby.	NOAA Office for Coastal Mgt, 843-740-1202	https://coast.noaa.gov/dataservices/Metadata/TransformMetadata?u=http://coast.noaa.gov/data/Documents/Metadata/harvest/MarineCadastre/CoastalEnergyFacilities.xml&f=html
COMMERCIAL AND RECREATIONAL FISHING								
Commercial landings (volume and revenue)	Trends in annual total commercial landings for the Mid-Atlantic Bight	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Mid-Atlantic Bight	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator; landings tracked since 1960	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	
	Trends in fishery revenues by gear type on the Northeast Shelf	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Northeast shelf (not sure if they can report on Mid-A Bight?)	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator; landings tracked since 1960	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	
Commercial trips	Location of "Communities at Sea"	Rutgers University	Northeast Fisheries Science Center	Mid-Atlantic	Update frequency: None noted	Commercial Fishing VTR maps represent the locations and intensity of fishing between 2011-2013. They are stored in the Mid-Atlantic Data Portal.	Contact Rutgers University for information on maps: info@crssa.rutgers.edu	http://portal.midatlanticocean.org/static/data_manager/metadata/html/CASMetadata.html
Fishing Effort	Trends in fishing efforts	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Northeast shelf (not sure if they can report on Mid-A Bight?)	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator; landings tracked since 1960	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	
Commercial fish sales and processing	Total landings (pounds) in the Mid-Atlantic region, and change from previous year	NOAA	Fisheries Economics/NMFS Office of Science and Technology	Mid-Atlantic	Annual	NOAA annually publishes Fisheries Economics reports with detailed information related to fisheries for each region, including the Mid-Atlantic	Rita Curtis, NMFS Supervisory Economist, rita.curtis@noaa.gov	http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2014/index
	Total landings revenue, and change from previous year	NOAA	Fisheries Economics/NMFS Office of Science and Technology	Mid-Atlantic	Annual	NOAA annually publishes Fisheries Economics reports with detailed information related to fisheries for each region, including the Mid-Atlantic	Rita Curtis, NMFS Supervisory Economist, rita.curtis@noaa.gov	http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2014/index
	Economics of living resources	NOAA	Economics: National Ocean Watch (ENOW)	Mid-Atlantic states	Annual	ENOW reports annually on the economics of "living resources", which includes jobs, wages, establishments and GDP contribution from all living resource sectors (defined as commercial fishing, fish hatcheries, aquaculture, seafood processing, and seafood markets)		https://coast.noaa.gov/digitalcoast/tools/enow.html
Recreational harvest (volume)	Harvest (in thousands of fish) of key species/species groups	NOAA	Fisheries Economics/NMFS Office of Science and Technology	Mid-Atlantic	Annual	NOAA annually publishes Fisheries Economics reports with detailed information related to fisheries for each region, including the Mid-Atlantic	Rita Curtis, NMFS Supervisory Economist, rita.curtis@noaa.gov	http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2014/index
	Release (in thousands of fish) of key species/species groups	NOAA	Fisheries Economics/NMFS Office of Science and Technology	Mid-Atlantic	Annual	NOAA annually publishes Fisheries Economics reports with detailed information related to fisheries for each region, including the Mid-Atlantic	Rita Curtis, NMFS Supervisory Economist, rita.curtis@noaa.gov	http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2014/index
	Trends in recreational harvest	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Northeast shelf (not sure if they can report on Mid-A Bight?)	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator; landings tracked since 1980	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	

	Potential metric	Lead agency	Source data/Program	Geographic Extent	Reporting interval	Notes	Contact	Link
	Trends in number of caught and released fish	NOAA	Ecosystem Status Reports/Integrated Ecosystem Assessment Program	Northeast shelf (not sure if they can report on Mid-A Bight?)	Every 2 years (with twice-annual updates for some metrics)	Ecosystem Status Report indicator; landings tracked since 1980	Michael Fogarty, michael.fogarty@noaa.gov 508-495-2000 x2386	
Recreational trips (number and value)	Total recreational angler trips by mode (e.g., for-hire, private, shore)	NOAA	Fisheries Economics/NMFS Office of Science and Technology	Mid-Atlantic	Annual	NOAA annually publishes Fisheries Economics reports with detailed information related to fisheries for each region, including the Mid-Atlantic	Rita Curtis, NMFS Supervisory Economist, rita.curtis@noaa.gov	http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2014/index
	Recreational fishing expenditures (including trips and durable equipment)	NOAA	Fisheries Economics/NMFS Office of Science and Technology	Mid-Atlantic	Annual	NOAA annually publishes Fisheries Economics reports with detailed information related to fisheries for each region, including the Mid-Atlantic	Rita Curtis, NMFS Supervisory Economist, rita.curtis@noaa.gov	http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2014/index
Commercial and Recreational access	Total amount ($) invested in recreational public access sites	NOAA	Coastal Zone Management Program	Mid-Atlantic States	Annual	The CZM program annually tracks several metrics related to the program's public access goals, and can provide results fro the Mid-Atlantic states upon request.	Allison Castellan, allison.castellan@noaa.gov, 301-563-1125	https://coast.noaa.gov/czm/performance/
	Commercial fishing vessel activity	NOAA	VMS data/NMFS Office of Law Enforcement	Mid-Atlantic	Update frequency: None noted	Spatial dataset characterizing the density of commercial fishing vessel activity for fisheries in the Mid-Atlantic. Dataset is stored on Mid-Atlantic Data Portal		http://www.northeastoceandata.org/files/metadata/Themes/CommercialFishing/VMSCommercialFishingDensity.pdf
	Port locations	ACOE	Navigation Data Center	Mid-Atlantic		Spatial dataset on the Mid-Atlantic Data Portal: This is a subset of the Port Facility database maintained by the US Army Corps of Engineers Navigation Data Center. This database contains all facility types that may be reported as the origin or destination of commercial waterborne vessel moves. Only those facilities relevant to the four major Mid-Atlantic ports of Virginia, Baltimore, Philadelphia and New York/New Jersey are included here. Information on ownership and commodities is also included.		http://portal.midatlanticocean.org/static/data_manager/metadata/html/port_points_metadata.html
Essential Fish Habitat*	EFH areas protected from fishing	NOAA	NMFS	Mid-Atlantic	Updated based on Council actions	Essential Fish Habitat Mapper displays EFH areas protected from fishing.		http://www.habitat.noaa.gov/protection/efh/habitatmapper.html
Habitat Areas of Particular Concern (a component of Essential Fish Habitat)	Number of managed fish stocks for which HAPCs have been designated	Mid-Atlantic Fishery Management Council	Fishery Management Plans	Mid-Atlantic	Varies	This is not something the Council or NMFS currently reports on, but it would be very easy to do.		
Fishery Resource Status	Number (and identity) of stocks classified as overfished	NOAA National Marine Fisheries Service	Stock Status Reports and Updates/Office of Sustainable Fisheries	Mid-Atlantic	Quarterly (4x/year)	Stock status reports are required under the Magnuson-Stevens Fish Conservation and Management Act, and are posted quarterly online		http://www.fisheries.noaa.gov/sfa/fisheries_eco/status_of_fisheries/index.html
	Number (and identity) of stocks classified as experiencing overfishing	NOAA National Marine Fisheries Service	Stock Status Reports and Updates/Office of Sustainable Fisheries	Mid-Atlantic	Quarterly (4x/year)	Stock status reports are required under the Magnuson-Stevens Fish Conservation and Management Act, and are posted quarterly online		http://www.fisheries.noaa.gov/sfa/fisheries_eco/status_of_fisheries/index.html
	Number (and identity) of stocks under a rebuilding plan	NOAA National Marine Fisheries Service	Stock Status Reports and Updates/Office of Sustainable Fisheries	Mid-Atlantic	Quarterly (4x/year)	Stock status reports are required under the Magnuson-Stevens Fish Conservation and Management Act, and are posted quarterly online		http://www.fisheries.noaa.gov/sfa/fisheries_eco/status_of_fisheries/index.html
OCEAN AQUACULTURE								
Aquaculture production	Total annual value, and change from previous year	NOAA National Marine Fisheries Service	Greater Atlantic Region Aquaculture Program			GARFO's Aquaculture homepage reports on value of aquaculture in the Greater Atlantic region, so its tracked, but I couldn't find any relevant reports. Need to call to track down more info.	Kevin Madley, 978-282-8494, NOAA GARFO	
Permitted and/or leased areas	Trends in leased acreage	NOAA National Marine Fisheries Service	Aquaculture in Coastal and Marine US Waters dataset/Office for Coastal Management	Mid-Atlantic	Update frequency: "as needed"	Dataset stored on Digital Coast, includes the presence and location of aquaculture sites in coastal and marine saltwater areas - datset considered a "work in progress" with some states not yet included	Marine Cadastre Data Steward, 843-740-1202	https://coast.noaa.gov/dataservices/Metadata/TransformMetadata?u=https://coast.noaa.gov/data/Documents/Metadata/harvest/MarineCadastre/Aquaculture.xml&f=html
MARITIME COMMERCE AND NAVIGATION								
Port cargo (volume and value) and ship calls	Principal ports	US ACO	Principal Ports	Large ports in Mid-Atlantic region	Annual	Principal Ports database reports commodity tonnage summaries by ports	Waterborne Commerce Statistics Center, 504-862-1426 or 504-862-1441	http://www.navigationdatacenter.us/data/datappor.htm
Vessel trips and traffic patterns	Spatial hotspots of vessel density	US Coast Guard	AIS Vessel Tracks	Mid-Atlantic	?	Vessel Tracks density data seems to be made available on MarineCadastre.gov every two years or so. AIS data can be requested by federal agencies (but not the public)	Marine Cadastre Data Steward, 843-740-1202	http://portal.midatlanticocean.org/static/data_manager/metadata/pdf/AtlanticVesselDensity2013Documentation_20150710.pdf
Waterway maintenance and safety (routing measures, anchorages, pilot boarding, channel maintenance and deepening, AtoN	Cubic yards dredged	US ACO	Dredging Information System	Mid-Atlantic	Datasets updated continuously	ACO maintains spatial databases on both Corps Owned Dredges and Dredging contracts, including actual quantity and cost of dredging	ACO Navigation Data Center	http://www.navigationdatacenter.us/data/datadrgsel.htm
	Funds spent on dredging	US ACO	Dredging Information System	Mid-Atlantic	Datasets updated continuously	ACO maintains spatial databases on both Corps Owned Dredges and Dredging contracts, including actual quantity and cost of dredging	ACO Navigation Data Center	http://www.navigationdatacenter.us/data/datadrgsel.htm
SAND MANAGEMENT								
Sand resources	Potential volumes and extent of sand resources	BOEM	Atlantic Sand Assessment Project	Atlantic coast	As needed	Assessment results expected in 2017-2018.	Jeff Reidenauer, Leasing Division Chief, 703-787-1851	https://www.boem.gov/Marine-Minerals-Program-offshore-sand-resources/
		The Nature Conservancy	Soft Sediments Data Layer/Mid-Atlantic Data Portal	Mid-Atlantic	Update frequency: Not specified	Dataset maps the distribution of soft sediments based on their grain size. Created by TNC for Northwest Atlantic Marine Ecoregional Assessment.	Mid-Atlantic Data Poral	http://portal.midatlanticocean.org/static/data_manager/metadata/html/SoftSediment_metadata.htm
Federal sand and gravel lease areas (area size, volume, restored area)	Total number and area of sand and gravel lease areas	BOEM	Offshore Sand and Gravel Leasing Program/Marine Minerals Program	Mid-Atlantic	Annual upon request	BOEM can report on this indicator annually upon request	Jeff Reidenauer, Leasing Division Chief, 703-787-1851	https://www.boem.gov/MMP-Current-Statistics/
	Total cubic yards of sand annually authorized for removal	BOEM	Offshore Sand and Gravel Leasing Program/Marine Minerals Program	Mid-Atlantic	Annual upon request	BOEM can report on this indicator annually upon request	Jeff Reidenauer, Leasing Division Chief, 703-787-1851	https://www.boem.gov/MMP-Current-Statistics/
Sand requirements	Cubic yards deposited for beach nourishment	Western Carolina University	Beach Nourishment Database/Program for the Study of Developed Shorelines	Mid-Atlantic	Continuous updates	This spatial database is maintained by the PSDS, and contains attribute information on the general location of sand placement, primary funding source and funding type, volume of sediment emplacement (in cubic yards), length of beach nourished in feet, and cost and inflated cost beach nourishment episodes dating back to 1923.	Andy Coburn, acoburn@wcu.edu, 828-227-3027	https://psds.wcu.edu/current-research/beach-nourishment/
NON-CONSUMPTIVE RECREATION								
Recreational visits or trips (volume, areas, value)		MARCO	Human Use Data Synthesis - Recreation Theme	Mid-Atlantic	??	Spatial dataset shows number of various types of recreation types occurring across the Mid-Atlantic, and is stored in Mid-Atlantic Data Portal	info@midatlanticocean.org	http://portal.midatlanticocean.org/static/data_manager/metadata/html/HUDS_Summary_Data_Presence.html
Recreational access	Trends in Tourism and Recreation Sector economics	NOAA	Economics: National Ocean Watch (ENOW)/Office for Coastal Management	State	Annual	Detailed economic data is made available by state on an annual basis. Tourism and Recreation sector is expansive, and includes restaurants/bars, hotels, marinas, boat dealers, charters, campsites, RV parks, scenic water tours, recreational fishing, zoos and aquariums.		https://coast.noaa.gov/digitalcoast/tools/enow.html
	Number of new and enhanced coastal public access sites	NOAA	Coastal Zone Management Program	Mid-Atlantic states	Annual	The CZM program annually tracks several metrics related to the program's public access goals, and can provide results fro the Mid-Atlantic states upon request.	Allison Castellan, allison.castellan@noaa.gov, 301-563-1125	https://coast.noaa.gov/czm/performance/
TRIBAL INTERESTS AND USES								
Submerged cultural areas								
Tribal ceremonial areas								
Commercial and sustenance fishing and aquaculture								
CRITICAL UNDERSEA INFRASTRUCTURE								
Telecommunication and electrical cable occurrence	Locations of NASCA Submarine Cables	N/A	North American Submarine Cable Association (NASCA)		Update frequency: "none planned"	Data portal dataset shows the locations of in-service and out-of-service submarine cables that are owned by members of NASCA	NASCA Secretariat, 973-615-2430	https://coast.noaa.gov/dataservices/Metadata/TransformMetadata?u=http://coast.noaa.gov/data/Documents/Metadata/harvest/MarineCadastre/NASCASubmarineCables.xml&f=html
Pipeline occurrence						Didn't see in Data Portal?		
Scientific equipment occurrence						MARACOOS perhaps could be a proxy for identifying location of buoys		

Mid-Atlantic Regional Council on the Ocean Healthy Ocean Ecosystem Indicators Public Workshop

July 19-20, 2017
Hyatt Regency Baltimore Inner Harbor, Baltimore, MD

WORKSHOP SUMMARY

Prepared by:

Consensus Building Institute

Table of Contents

Executive Summary

On July 19 and 20, 2017, the Mid-Atlantic Regional Council on the Ocean (MARCO) hosted a two-day Public Workshop on the implementation of the 2016 Mid-Atlantic Regional Ocean Action Plan's (OAP) Healthy Ocean Ecosystem Action 5 to "develop, monitor, and assess indicators of the health of the Mid-Atlantic regional ocean ecosystem", with the goal being to "Promote ocean ecosystem health, functionality, and integrity through conservation, protection, enhancement, and restoration." The Healthy Ocean Action 5 further states that "Monitoring and assessing the health of the Mid-Atlantic Ocean ecosystem over time are important ways for decision makers to better understand ecosystem changes as they occur, and how those changes impact and are impacted by human activity." During this workshop, the Mid-Atlantic Regional Planning Body's Healthy Ocean Indicators Steering Committee received input on options for key elements of a healthy ocean indicator monitoring and assessment program:

1. Overall scope of an indicator program, including approaches to report and display indicator data
2. Priority themes, data categories, and potential indicators

Overall scope of an indicator program, including approaches to report and display indicator data

In small table discussions on Day 1, participants discussed the potential scope of a monitoring and assessment program to support the OAP and likely funding scenarios. On Day 2, participants discussed ideas for indicator reporting and display in small groups. These conversations touched on elements of both scope and indicator reporting, and participants noted that the topics are related. Comments included the following:

Guiding scope

- *Audience* - The Mid-Atlantic Regional Planning Body (RPB) needs to determine who the audience is for the program before determining the scope. The overall consensus was that the program should be designed to convey ocean health issues and trends in a public-facing manner, while still ensuring that entities contributing to the program find the data being collected and presented in a way that's useful for their work.
- *Definitions* – The RPB should clarify how it defines "ocean health" to help inform the program's scope. Many participants urged the RPB to consider how to deliver a comprehensive, regional perspective of ocean health, accounting for cumulative impacts to the extent possible.
- *Manageability* - The program should have a manageable number of categories and indicators. It should identify the most critical data to convey a sense of the ocean's health and avoid having too many or too few indicators. Indicators should capture processes that underlie critical ecosystem dynamics and should be useful for better informing management of the ocean and its resources.
- *Linkages between coastal and open ocean ecosystems* - Although the RPB has expressed its desire to constrain this monitoring and assessment program to the geographic area

identified in the OAP – ocean waters extending 200 nautical miles from Long Island to the Virginia/North Carolina border– participants reiterated concerns about the difficulty and impracticality of segregating the open ocean from coastal ecosystems whose processes impact ocean health for all indicators.

- *Opportunities for cross-agency and stakeholder cooperation* - The process for gathering information for the program is an important opportunity for stakeholder cooperation. Much of the data required for the prioritized indicators already exist/are being collected by various agencies and existing programs, and therefore do not represent a heavy burden of new monitoring programs. The value of creating this new reporting mechanism should be in compiling these diverse datasets into a common place.
- *Flexibility for future adjustment* - The scope of the program should allow for future adjustments in the program pending the effectiveness of the program to achieve the goals in the OAP.

Funding, stewards, longevity

- *Transparency and credibility* - If a web platform, where indicator data could be consolidated and be the go-to first reference for the region's ocean users and regulators, and any potential indicator report will be used by regulatory entities, participants wanted the program's funding and data sources to be transparent and objective and government funded whenever possible.
- *Stewards* – Ongoing storage and reporting of relevant data-sets should be carried out by the entities most able to reliably provide it over the long-term.
- *Frequency of updates* – Data should be updated as frequently as possible with snapshot comprehensive reports on a regular timeframe preferably every five years or less.
- *RPB maintenance ability* – The RPB should consider their capacity and resources to maintain a monitoring and assessment program into the future when considering scope.
- *Leveraging existing data* – The RPB should leverage existing monitoring and data sources and ensure continued collection of these data.

Indicator reporting and display

- *Audience* – Participants noted that the end product should be useful to a wide range of stakeholders from RPB entities to the general public. (See above audience under guiding scope for more information.)
- *Organization of content* - There was a general sense that a "dashboard", which could display how ocean health is tracking for each selected indicator, should be organized by broad issue areas in order to be able to determine indicator priorities.
- *Number of indicators* - Participants generally felt that six indicators per theme (for a total of around 18 to 20) were the appropriate number for overall manageability, though numbers may vary per theme.
- *Format, content, and design* - Participants supported the development of an objective, multi-layer "dashboard" that would show how ocean health is tracking in the Mid-Atlantic. Data trends could be indicated by colors, charts, and other graphics, but should

avoid grading and appearing to make value judgments. Display should include layers of information that start with a public-facing and user-friendly level of detail, and provide increasing levels of detail for those who seek it. The Chesapeake Bay Report Card is a good model for this platform, though participants stressed that grading should not be done. Periodic updates (e.g. EPA's National Coastal Condition Assessment) could also be a good end product.

- *Location of platform* - Many participants felt that the dashboard should have its own web address with links to relevant sites. Other participants thought it would be sufficient to embed it in the MARCO Ocean Data Portal, which is already a well-known source for regional ocean information.

Priority themes, data categories, and potential indicators

Participants identified a number of priority indicators, but lacked the time necessary to find agreement, and in some cases disagreed, on an exact set of indicators that belong in this program and the level of priority assigned to each indicator or category. An overly wide scope may hinder the goal of tracking indicators of ocean health. Some participants questioned to what extent socioeconomic indicators should be part of this effort, though all acknowledged the importance of this kind of data. During the second half of Day 1, participants were rotated through each of the three discussion topics based on the priority themes identified in the white paper. The three topics were: Oceanographic and atmospheric drivers, Habitat and upper and lower trophic levels, Anthropogenic pressures and human uses. On Day 2, the group discussed key themes and prioritized data categories from each of the three breakout rooms on Day 1. The two days resulted in a rich dialogue and nuanced feedback regarding indictor categories and themes. Below are the categories prioritized by participants for each key theme:

Oceanographic and Atmospheric Drivers – prioritized categories such as sea surface temperature, dissolved oxygen, acidification, sea level, and water quality.

Habitat and Trophic Levels – prioritized categories such as biodiversity (including functional diversity); habitat diversity; protected species; deep sea corals; shifts in species, habitats, and community structure; and distribution and abundance of indicator species.

Anthropogenic Pressures and Human Uses – prioritized categories such as anthropogenic pressures over human uses, regional scale stressors, cumulative impacts, contaminants, water quality, marine debris, and ocean sound.

The consulting team noted that across all three topics, five qualities of a good indicator emerged during the breakout discussions:

- *Integrative:* Suitable for multiple sectors and issues; not too specific to a particular issue or constituency.
- *Understandable:* An entry point into more complexity if desired.
- *Regional:* Focused on the big picture across the spatial scale in which the RPB works.

- *Available:* Data is available or can be displayed to the greatest extent possible.
- *Neutral:* Not biased, value-laden or favoring one interest over another.

After discussing the three breakout group results, the full group synthesized the dialogue into the following revised draft framework:

1. *Living ocean* – includes distribution and abundance of native species/populations and habitats, biological and genetic diversity, food webs, species of concern/protected species

2. *Ocean conditions* – includes physical conditions like temperature, patterns and cycles such as El Niño/La Niña, and the North Atlantic Oscillation, and also water quality, which could include anthropogenic pressures/human inputs like contaminants and marine debris

3. *Human footprint* – includes anthropogenic pressures/human inputs like contaminants and marine debris, human uses, and could include system outputs like ecosystem services, jobs created, economics, etc.

Participants generally felt that indicators in the human uses category are readily available, and are related to but separate from ecosystem health. The participants thought the program should focus on ecosystem condition and highlight stressors at the regional scale and the cumulative impacts of diverse pressures. Some felt that while human uses are important for the RPB to consider, a parallel process that recognizes the inherent linkages across the system might be the best approach. Participants recognized that interactions among indicators are important and that the ocean is a dynamic system, but also concluded it would be difficult to build quantitative indicators of such complex interactions. The workshop ended by the organizers thanking participants for their feedback. This input gathered over the two-day workshop will be conveyed to the RPB as it considers options for designing and implementing a monitoring and assessment program.

Introduction

On July 19 and 20, 2017, the Mid-Atlantic Regional Council on the Ocean (MARCO) hosted a two-day Public Workshop on the implementation of the 2016 Mid-Atlantic Regional Ocean Action Plan's (OAP) Healthy Ocean Ecosystem Action 5 to "develop, monitor, and assess indicators of the health of the Mid-Atlantic regional ocean ecosystem." Approximately 45 participants from federal and state agencies, industry groups, academic institutions, nonprofit organizations, and elsewhere attended the workshop.[1] The objectives of this workshop were to:

- Obtain public input and engage participants in the OAP to inform next steps for developing a healthy ocean ecosystem monitoring and assessment program to support OAP implementation.
- Consider the scope of a healthy ocean ecosystem monitoring and assessment program, inform the prioritization of potential indicators, and identify options for indicator reporting and communication.

Staff from the Consensus Building Institute (CBI) facilitated the workshop and drafted this summary. Presentation slides from the workshop are available at the following URL: http://midatlanticocean.org/wp-content/uploads/2017/08/Mid-Atlantic-Healthy-Ocean-Indicators-Workshop-Presentation_v6.pdf

Day 1: Welcome and Purpose and Goals of Healthy Ocean Ecosystem Indicators within the OAP

Patrick Field, facilitator from CBI, welcomed participants to the workshop and reviewed the workshop agenda. On Day 1 of the workshop, participants discussed the scope of the proposed monitoring and assessment program. They also discussed prioritization of indicators and organization within themes and data categories in breakout groups. On Day 2 of the workshop, participants helped synthesize the previous day's discussions, explored alternative indicator frameworks, and provided input on indicator reporting and display.

Karen Chytalo, Mid-Atlantic Regional Planning Body (RPB) and New York Department of Environmental Conservation (NYDEC) lead for the Healthy Ocean Ecosystem Action 5, introduced the consulting team responsible for developing options for a healthy ocean ecosystem indicator program. Ms. Chytalo briefly reviewed how this workshop fits in the OAP implementation timeline. The OAP's Healthy Ocean Ecosystem Action 5 calls for the RPB to "develop, monitor, and assess indicators of the health of the Mid-Atlantic regional ocean ecosystem." Key principles of Action 5 include gaining a better understanding of ecosystem changes as they occur, focusing on the Mid-Atlantic region, and engaging diverse knowledge holders at key points in the initiative. The indicator program will focus on ocean health but the

[1] The full list of participants can be found in Appendix A.

project Steering Committee recognizes the linkages to coastal habitats and processes.

In March 2017, the consulting team developed draft indicator themes, a white paper outline, and an outreach plan. With input from a series of stakeholder outreach calls in April, the team developed a white paper, with the purpose of identifying key topics for discussion at the July workshop. The team will use the feedback gathered during this workshop to develop a final report that builds on the white paper and presents options and considerations for moving forward with the program. The RPB will consider the options laid out in the report. During this workshop, the team hopes to receive input and identify options for key elements of a healthy ocean indicator monitoring and assessment program that can help guide the RPB's deliberations in development of final healthy ocean ecosystem indicators:

- Overall scope of an indicator program, including approaches to report and display indicator data; and
- Priority themes, data categories, and potential indicators.

Ms. Chytalo reminded participants to set reasonable expectations for the quality and update frequency of this indicator program as they provide feedback over the course of the workshop.

Review of Indicators White Paper and Workshop Agenda Topics

Presentation

Emily Shumchenia, consultant, presented an overview of the white paper and outlined the project's workflow. The white paper informs discussions about how to develop a Mid-Atlantic healthy ocean ecosystem indicator monitoring and assessment program by:

- Providing relevant background information about existing efforts;
- Presenting a potential indicator framework, based on existing models and OAP goals;
- Identifying potential themes and data categories from RPB and stakeholder input;
- Describing options and key decision points for monitoring, assessment, reporting, and display of indicators.

The consulting team divided the effort to develop an indicator program into four components that are linked and can be tackled in any order:

1) *Determine scope of monitoring and assessment program* - The consulting team wants to help the RPB avoid duplication and improve on current programs. There are a number of assessments (e.g. Mid-Atlantic Regional Ocean Assessment) and relevant programs (e.g. draft indicators program for the New York Ocean Action Plan) which can serve as models for the Mid-Atlantic program.

2) *Prioritize indicators* - The team is interested in what ecosystem components should be

monitored and what data is currently available. The answers to these questions can inform indicator prioritization. The team began to develop a prioritization list by discussing an initial list of indicator themes and data categories, based on the OAP, with the RPB and other stakeholders in April 2017. The six initial organizing themes, reflected in the white paper, are oceanographic and atmospheric drivers, anthropogenic pressures, habitats, lower trophic levels, upper trophic levels, and ocean uses. Data categories (e.g. dissolved oxygen) are grouped under each theme. These groupings represent the consulting team's initial approach but they requested additional input from workshop participants on categorization and prioritization in this workshop. The goal was to eliminate redundancies and inconsistencies, and work to prioritize indicators.

3) *Develop reporting tool* - The consulting team operated with the assumption that the reporting tool will be web-based, require maintenance and updates, and be linked to all other Mid-Atlantic Ocean planning sites. The consulting team will make recommendations to the RPB about the reporting tool's organization (e.g. issue-based or issue-neutral) and format and content (e.g. ratio of graphics and narrative). In addition to these elements, the consulting team sought input on the appropriate number of indicators to include and who the intended audience of the reporting tool should be. The white paper contains examples of reporting tools.

4) *Conduct Monitoring and Assessment* - While not the focus of this workshop, the RPB will eventually need to make decisions on how it can best communicate and partner with relevant existing programs, understand related assessment techniques, and establish baselines and techniques for assessing change.

Discussion

Participants made the following comments and asked the following questions. Responses from the consulting team are italicized below.

- We should prioritize where the needs are and what data is available.
- It is important to have a conceptual model of the whole system when we are approaching the prioritization exercise.
- The most significant piece for telling the story of ocean health in the Mid-Atlantic is the interaction between pressure and drivers and the state response (DPSIR – Driver-Pressure-State-Impact-Response model). *Value of DPSIR is that it can create a conceptual model of the ecosystem, and help you understand and characterize changes in ecosystems and any linkages with human actions.*
- The consulting team should keep in mind how all of this is related to broader regional issues.
- I am concerned about anything related to setting up a monitoring and assessment program; I do not think the RPB has this bandwidth. How can we leverage existing efforts and capacities?

- I am concerned we are missing the system context in this exercise. We have a lot of static information but the connectors are the important part. This context is important when you are prioritizing indicators and we shouldn't lose those interactions. *This is a good reminder for us to be thinking system-wide as we move forward.*
- How are anthropogenic uses to be evaluated? For example, would heavy fishing use be a positive indicator of health (e.g. plenty of fish) or a negative indicator (e.g. stress on the biological community). *The meaning of different metrics will be a subject of discussion in our small group breakouts.*

Scope of a Monitoring and Assessment Program

In small table discussions, participants discussed the potential scope of a monitoring and assessment program to support the OAP and likely funding scenarios. They considered three key areas and reported back to the group on their discussions:

1) How key principles from the OAP and the geographic/thematic focus guide scope.
2) Potential funding levels, stewards, and longevity.
3) Given considerations 1 and 2, what an end product should look like.

The summary of the feedback is listed below without attribution by name or organization. Comments are not necessarily representative of all participants and may reflect one or more participant's advice.

Guiding scope

- *Actionable data* – It was recommended that the individual entities within the RPB should plan ahead to determine what actions they might take based on monitoring data, before the RPB launches the program, and to clearly convey this. Participants were concerned the RPB entities will not have a plan for what to do with the program when it is developed and had questions about how the program might be used. This issue should be resolved now. Clarity is needed around if this program will have descriptive data only or include prescriptive analyses as well. The program should measure change but not be prescriptive about any recommended actions. That task should be left to end users, including the RPB entities. The program will also need to be able to acknowledge and tell a story about shifting baselines.
- *Linkages between coastal and open ocean ecosystems* - Although the RPB has expressed its desire to constrain this monitoring and assessment program to the geographic region identified in the OAP – from shoreline to 200 miles – participants reiterated concerns about the difficulty and impracticality of segregating the open ocean from coastal ecosystems whose processes impact ocean health. Several participants stated that they supported adopting the geographic focus of the OAP, but noted the importance of acknowledging the links between coastal habitats and processes. For example, low

dissolved oxygen could be a good indicator for this program but it may need to be linked to the coastal processes behind it to track change accurately. Other participants stated they were comfortable excluding estuary.

- *Audience* - The RPB needs to determine who the audience is for the program before determining the scope. They may be able to determine the audience based on what data is currently available and what is practicable. Many participants suggested the audience should include both the interested public, and managers/practitioners who can use the information in their work.
- *Opportunities for cross-agency and stakeholder cooperation* - The process for gathering information for the program is an important opportunity for stakeholder cooperation. Much of the data required for the prioritized indicators already exist/are being collected by various agencies and existing programs, and therefore do not represent a heavy burden of new monitoring programs. The value of creating this new reporting mechanism should be in compiling these diverse datasets into a common place.
- *Manageability* - The program should have a manageable number of categories and indicators. It should avoid having too many or too few indicators.
- *Definitions* – The RPB needs to clarify how it defines "ocean health" to clarify the program's scope. Many participants urged the RPB to consider how to deliver a comprehensive, regional perspective of ocean health, accounting for cumulative impacts to the extent possible. Many participants
- *Flexibility for future adjustment* - The scope of the program should allow for future adjustments in the program pending the effectiveness of the program to achieve the goals in the OAP.

Funding, stewards, longevity

- *Transparency and credibility* - If the web platform and indicator reports will be used by regulatory entities, participants wanted the program's funding and data sources to be transparent and objective and government funded when possible. A concern was expressed that a platform billed as advisory could morph into a decision-making tool to the detriment of certain stakeholders.
- *Stewards* - Data should reside with an agency that can most reliably provide it going forward despite potential funding cuts at state, regional or federal level.
- *Frequency of updates* – Data should be updated as frequently as possible with snapshot comprehensive reports on a regular timeframe preferably every five years or less. This timeframe would be frequent enough to show incremental change but not overly burdensome on data managers. Agencies should keep their data updated and have it flow continuously to the program's web platform.
- *RPB maintenance ability* – The RPB should consider their capacity and resources to maintain a monitoring and assessment program into the future when considering scope. This is an important effort and they should be clear on their ability to commit to this effort in the long-term.

End product

- *Audience* – Participants noted that the end product should be useful to a wide range of stakeholders from agencies to the general public. For example, construction activity proponents or regulatory staff that are considering cumulative impacts of a construction activity could use this product. The web platform (i.e. dashboard) should be welcoming and understandable to the general public and reflect what issues they care about.
- *Models* - The Chesapeake Bay Report Card is a good model for this platform.
- *Dashboard design* - The dashboard should have both graphics and descriptive text. It should include layers of information that are adaptable to many audiences.
- *Periodic Determination of Trends* - Periodic updates on the general trend of indicators (e.g. EPA's National Coastal Condition Assessment) could also be a good end product.

Breakout Group Discussions

During the second half of Day 1 of the workshop, participants were divided into three groups and assigned to start in one of three breakout rooms. Participants were rotated through each of the three discussion topics over the course of the afternoon so they had an opportunity to comment on all topics. The three-room themes were:

1) Oceanographic and atmospheric drivers;
2) Habitat and upper and lower trophic levels; and
3) Anthropogenic pressures and human uses.

Six charts of potential indicator data categories (see white paper pages 16-19) were posted in the relevant breakout rooms. Each room was asked to (a) review the potential indicators identified in the draft white paper, (b) consider the issues and questions in the OAP that could be addressed by indicators in these categories, and (c) articulate indicator priorities. The consulting team reminded participants that the goal of this workshop was to generate options, not a single answer, for the RPB to consider at their next meeting.

Brief Reflections from Day 1

At the end of the three breakout group discussions, the consulting team concluded Day 1 of the workshop by briefly describing the themes and challenges they heard during the breakout discussions. The breakout discussions were reviewed in more depth on Day 2 as described further below. During the breakouts, participants struggled to prioritize indicators overall, in part, due to uncertainty about the specific issues the RPB wants to address with this monitoring and assessment program. Specifically, they were unsure of the best organizing principle for this effort. An indicators framework was proposed whereby each theme has subsequent prioritized data categories within that theme, which would then contain a suite of possible indicators. For example, Oceanographic and atmospheric drivers would be a theme, under which dissolved

oxygen could be a prioritized data category, under which an indicator would be a metric for the amount of dissolved oxygen present in a dataset or multiple coinciding datasets spanning the Mid-Atlantic region. Indicator themes might be what is displayed and used for navigation on an indicator dashboard/tool. Themes are topics that resonate with a broad audience. While the OAP lays out a set of desired actions, participants felt that more clarity was needed from the RPB to make this exercise productive. *Please note participants identified an emerging set of priorities on Day 2.*

Day 2: Summary and Discussion of Indicator Prioritization

The consulting team welcomed participants back for Day 2 of the workshop and reviewed the day's agenda. The consulting team stated that the day's goals were to synthesize the previous day's discussions, explore alternative indicator frameworks, and gather input on indicator reporting and display.

Summary of Breakout Discussions

The consulting team reviewed key themes from each of the three breakout rooms on Day 1. More detailed summaries of each room's discussion are included in Appendix B.

Oceanographic and Atmospheric Drivers
Participants thought the audiences for the end product should be the RPB, agency managers, decision makers, and the public. The product should follow a layered approach where users can explore the data in as much depth as they want. Participants in the three discussions jointly identified sea surface temperature, dissolved oxygen, acidification, and sea level as the highest priority parameters. The group had questions about including bottom temperature, gulf stream (e.g. path, speed), and precipitation in the initial program. Participants also identified some possible additional indicators: estuarine plumes, beach and shellfish closures regionally, water quality (e.g. EPA's Coastal Water Quality Index adapted beyond coastal-only data), open ocean nutrients, diseases, and species shifts.

Habitat and Trophic Levels
Participants identified six high priority indicators: biodiversity (including functional diversity); habitat diversity; protected species; deep sea corals; shifts in species, habitats, and community structure; and distribution and abundance of indicator species (e.g. seabird community). Low priority indicators included horseshoe crab, tilefish, static spatial categories (e.g. underwater canyons), and methane seeps. Participants were particularly critical about including single species as indicators because they seem inconsistent with the other indicators and might inadvertently aid politicization of this program. They agreed that "human constructs" like essential fish habitat and critical habitat designations were difficult to include because it is

unclear what these actually indicate about ocean health. Participants stressed the importance of scientific review of data categories and indicators that are advanced as part of an RPB program.

Anthropogenic Pressures and Human Uses

Participants generally felt that indicators in the anthropogenic pressures category are a higher priority than those in the human uses category, primarily because human use data exists, is readily available elsewhere, and is related to but separate from ecosystem health. The participants thought the program should focus on ecosystem condition and highlight stressors at the regional scale and the cumulative impacts of diverse pressures (e.g. ocean sound from a variety of sources/noise thresholds). Participants noted the relative lack of data about anthropogenic pressures on the Portal compared to human use data categories. Though other participants noted the human use data categories on the Portal may need further advancement in order to be used as indicators. Furthermore, human uses was an area in which participants emphasized the importance in gathering existing data. Some felt that while human uses are important for the RPB to consider, a parallel process that recognizes the inherent linkages across the system might be the best approach, and that defining clearly the possible uses of this indicators program by RPB entities may help to determine which approach to take. Within the anthropogenic pressures category, participants felt that the "contaminants" indicator should include oil and chemical releases as sub-indicators, along with many other contaminants. They also wanted to see a broader concept of water quality which includes eutrophication, coastal discharges, contaminants, and possibly harmful algal blooms. Under human uses, participants felt that this was a good context for ecosystem changes, and some uses are more susceptible to ecosystem change than others. Some participants felt that the ocean health indicators should include social and economic health.

Participants generally identified marine debris, water quality, and ocean sound as high priority indicators largely because they are region-wide issues of importance to the OAP while some felt bycatch, oil and chemical releases, invasive species, and ocean disposal sites were lower priorities largely because they are dealt with in other contexts. Participants discussed the challenges of reporting regional levels for electromagnetic fields, shoreline hardening, and seabed scour and alteration since they are very site-specific. While important to many participants, harmful algal blooms, coastal discharges, and eutrophication may be better categorized elsewhere because they are primarily coastal. Participants also identified some new indicators: ship strikes, offshore sand dredging, offshore wind energy siting, suitable dredge material for disposal sites, pharmaceuticals, and emerging diseases though some of these too are quite site-specific and might be hard to report on regionally.

The consulting team noted that across all three topics, five qualities of a good indicator emerged during the breakout discussions:

- *Integrative:* Suitable for multiple sectors and issues; not too specific to a particular issue or constituency.
- *Understandable:* An entry point into more complexity if desired.

- *Regional:* Focused on the big picture across the spatial scale in which the RPB works.
- *Available:* Data is available or can be displayed to the greatest extent possible.
- *Neutral:* Not biased, value-laden or favoring one interest over another.
- *Scientifically rigorous:* Indicators should capture key components of ecosystem health (structure, function, resilience).

Alternative Frameworks for Prioritization

Based on the progress made during the previous day, the consulting team altered the initial agenda to allow more time to discuss alternative frameworks which participants could use to prioritize indicators. Ms. Shumchenia reminded workshop participants that this effort is not a linear process; the program design can be approached from many different angles and is typically highly iterative.

Revised indicators framework for workshop consideration
The OAP lays out four issue areas that the RPB would like to address with this monitoring and assessment program: ecologically rich areas, shifting species and habitats, ocean acidification, and marine debris. The ecologically rich areas category includes productivity, biodiversity, abundance, vulnerability, and rarity. The consulting team used these issue areas to build the six-table framework they presented during the breakout discussions.

Recognizing participants' difficulty prioritizing indicators under the consulting team's proposed framework, the consulting team proposed a second sample framework for workshop participants' discussion. This new framework was composed of three issue areas, also derived from OAP priorities:

- Marine debris;
- Ocean chemistry; and
- Species and habitats abundance, diversity, and shifts.

Discussion of alternative frameworks
Participants were generally supportive of this approach to organizing and prioritizing indicators. It was considered to be approachable for the public while maintaining usefulness for managers and other stakeholders. Participants voiced particular concern about how the chosen framework and language could affect the effort's perceived neutrality and legitimacy. For example, word choice should not be value-laden and it should not point in a policy direction of prescription. Participants reminded the consulting team of the importance of cumulative impacts and compounding issues and noted that this particular framework may be insufficient for capturing those elements. Another participant commented that this framework seemed difficult to prioritize and may not be trackable.

Participants were concerned that end users, especially the public, would not find value in this

approach. In response, a participant proposed a different framework with six primary issue areas: access to safe and plentiful seafood, water quality, robust native populations of megafauna, coastal protection, abundant and diverse wildlife populations and habitats, and the ocean as a global oxygen pump. They felt such an approach might be more appealing to the public. Another participant suggested that the consulting team select issues where the RPB and other stakeholders could collaborate well. Participants also felt that marine debris seemed like an odd fit for the framework and might be better suited as a subcategory under water quality.

During the discussion of the initial revised indicator framework, a participant proposed a third framework for the workshop to consider, similar to the framework outlined in the Mid-Atlantic Regional Ocean Assessment. This proposed framework has three to four components:

1) Living ocean;
2) Ocean conditions;
3) Human footprint; and
4) Interactions among indicators (optional).

Participants preferred this approach so the consulting team asked the group to consider how key indicators could sort into these new categories. Proposed indicator groupings and participant feedback are synthesized under each component below.

Living ocean

- Populations of native species (abundance, distribution. etc.)
    - Food finfish and shellfish (including spawning biomass)
    - Forage fish
    - Marine mammals
    - Birds
    - Other protected species
- Biodiversity (and genetic diversity)
- Habitat quality and diversity
- Food webs[2]

Ocean conditions

- [2] Participants suggested the consulting team reference a paper that makes the following recommendations on indicators for food webs: Total biomass of small fish, Biomass of trophic guilds, Primary production required to support fishery, Seabird breeding success, Zooplankton spatial distribution and total biomass, mean trophic level of catch, Marine trophic index of the community, mean trophic level of the community, and Mean trophic links per species. This paper referenced is: Tam JC, JS Link, AG Rossberg, SI Rogers, PS. Levin, M-J Rochet, A Bundy, A Belgrano, S Libralato, M Tomczak, K van de Wolfshaar, F Pranovi, E Gorokhova, SI Large, N Niquil, SPR Greenstreet, J-N Druon, J Lesutiene, M Johansen, I Preciado, J Patricio, A Palialexis, P Tett, GO Johansen, J Houle, A Rindorf. 2017. Towards ecosystem-based management: identifying operational food-web indicators for marine ecosystems, *ICES Journal of Marine Science*, https://doi-org.uri.idm.oclc.org/10.1093/icesjms/fsw230.

- Physical conditions (could include an ocean acidification indicator)
- Water quality (alternatively this subcategory could include ocean acidification)
- Patterns and cycles (e.g. El Niño/La Niña, North Atlantic Oscillation)

Human footprint

- Items from the Bureau of Ocean Energy Management's list of ocean activities
- Anthropogenic system inputs
    - Physical alterations and the built environment (e.g. wind farms, sand mining)
    - Marine debris
    - Contaminants
    - Nutrients (e.g. including atmospheric deposition)
    - Ocean discharges from wastewater treatment discharge offshore and combined sewer overflows
    - Ocean acidification (*or* under ocean conditions)
    - Aquatic invasive species
    - Noise and sound
    - Vessel traffic
- Human uses
    - Aquaculture
    - Fisheries
    - Others, etc.
- System outputs (e.g. jobs created, ecosystem services, economics, extraction)[3]

Interactions among indicators

Participants recognized that interactions among indicators are important and that the ocean is a dynamic system but also concluded it would be difficult to build quantitative indicators of such complex interactions. Thus, participants offered more qualitative ideas for how to address these interactions:

- Storytelling around interconnections of the other three components;
- Cater to the public with choice of stories;
- Include links to programs working on specific interaction challenges;
- Address multiples uses and resource conflicts (e.g. microplastics, whale strikes, wind turbines); and
- Interactions with estuarine and nearshore habitats (e.g. seagrass bed health).

While acknowledging the importance of interaction narratives, some participants were unsure if this should be a standalone category.

[3] Participants suggested system outputs may need to be studied in a parallel process and were covered later in the discussion.

Incorporating economic indicators
While discussing the revised framework, participants identified challenges associated with incorporating economic indicators into the ocean health monitoring and assessment program. Examples of economic indicators include the value of surfing, beaches, community jobs, fishing jobs, community, and revenues. The consulting team asked for feedback on how to handle this challenge so they could include it in the final report to the RPB.

Some participants felt strongly that economic indicators should not be separated from healthy ocean ecosystem indicators. If the RPB left economic indicators out of the program, they could be perceived as making a value judgment that human use is not of importance to a healthy ecosystem. It should be noted that several of the participants who called for economics to be reported in a separate but parallel track expressly noted that humans are part of the ecosystem, but held concerns as to what the economic data would tell us about the natural system functioning.

Other participants felt that this data area would be better served by developing a parallel process to track economic indicators. However, maintaining a parallel process could be resource-intensive and would dilute the important interaction narratives the program is trying to tell.

The point was made that the OAP's Action #5 was designed to help achieve one of the RPB's two primary goals: "Promote ocean ecosystem health, functionality, and integrity through conservation, protection, enhancement and restoration" and that the economics element that falls under the RPB's second goal defines the rest of the report. Several participants requested that the program curtail the theme of ocean uses for which the data categories provided do not tell us something about the health of the natural system. If the program's goal is to track indicators that measure the benefits of a healthy ecosystem, some economic indicators may not be relevant to that goal. Much of the relevant economic data (e.g. NOAA's Economic: National Ocean Watch dataset) is readily available on different websites and could be linked to the end product. Some participants suggested pulling out a small economic piece (e.g. gross domestic product (GDP), money earned through tourism) while keeping other indicators of ocean use in the program. They argued that GDP does not tell us much about how the ocean is doing. Many things influence GDP that may not be directly related to improving ecosystem health.

Broad reflections on prioritization and framework exercise
In conclusion, participants grappled with the appropriate scope of this monitoring and assessment program, and largely agreed that the program should be designed to convey ocean health issues and trends in a public-facing manner, while still ensuring that agencies/practitioners be able to effectively use the information in their work. Participants identified a number of priority indicators, but lacked the time and clarity of goals to find agreement, and in some cases disagreed, on the exact set of indicators that belong in this program and the level of priority assigned to each indicator or category. An overly wide scope may hinder the OAP's Action 5

goal of tracking indicators of ocean health. Some participants questioned to what extent socioeconomic indicators should be included in the Healthy Ocean Ecosystem indicators program, or reported separately in a parallel process. The consulting team reminded the group that the RPB's goal is to establish an ocean health baseline.

Participants did identify general principles for prioritizing parameters as indicators through their discussion. Indicators should be unique rather than redundant of other efforts. They should reflect priorities. They should fit within the chosen framework. They should have existing data and metrics available. Importantly, they should not be prescriptive.

There was strong support for the below proposed framework – and the selected indicators discussed above:

1) Living ocean;
2) Ocean conditions;
3) Human footprint; and
4) Interactions among indicators (optional).

Indicator Reporting and Display

The consulting team presented sample reporting tools and important considerations for participants to keep in mind as they considered indicator reporting and display options. Participants were asked to consider the following design elements:

- *Organization of content* - By ecosystem component (e.g. Northeast Fisheries Science Center's Ecosystem Status Report) or by issue (e.g. Puget Sound Vital Signs).
- *Format and content* - Reliant on images, summaries, scoring, symbols (e.g. Chesapeake Bay Report Card) or narrative graphics and text (e.g. Measuring the Effects of Catch Shares Project).
- *Total number of indicators* - Exhaustive (e.g. NOAA's Integrated Ecosystem Assessment) or focal components/issues (e.g. EPA's National Coastal Condition Assessment).
- *Potential location for a dashboard or reporting tool* - Dedicated web address or embedded on an existing site.

The consulting team noted it was operating with the assumption that the end product will be web-based with widely accessible information and regularly updated datasets. Data agreements with government and research entities and links to all other Mid-Atlantic Ocean planning sites would make the web platform the go-to reference for the region's ocean users and regulators.

Participants discussed ideas for indicator reporting and display in small groups and had the following comments, grouped by theme:

- *Organization of content* - There was a general sense that the dashboard should be organized by broad issue areas in order to be able to determine indicator priorities. The dashboard should show how things are changing and be relevant to the work of RPB entities. The dashboard could use physical parameters such as sea surface temperature to tell stories (i.e. "bottom up" indicators, for example, increasing sea temperatures results in affects X, Y and Z) or use core outcomes such as beach closures to tell stories (i.e. "top down" indicators, for example closing beaches reflects water quality, biological health, shellfish availability for consumption, etc.). Participants highlighted the need to consider the value-add of this new tool and be strategic about marketing it. The RPB and the consulting team should consider what will draw agencies and other stakeholders to this dashboard rather than other platforms or their own data.
- *Format and content* - Participants supported the development of an objective "dashboard" that would show how ocean health is changing in the Mid-Atlantic. The Puget Sound Vital Signs dashboard was cited as a good model for this effort. The dashboard should be layered and allow users to dive as deep as they need or want to. It should have eye-catching graphics and themes that can be expanded for further exploration. Data trends could be indicated by colors, charts, and other graphics in order to tell a story about the trends of indicators, but should avoid grading or coloring that could appear to make value judgements. Text summaries of the indicator's status should also be provided. Lists of data sources and links to raw data and more information should be provided. The consulting team should also consider including a tool that would allow users to compare areas or sites to each other.
- *Number of indicators* - Participants generally felt that six indicators per theme (for a total or around 18 to 20) were the appropriate number for overall manageability, though numbers may vary per theme.
- *Location of platform* - Many participants felt that the dashboard should have its own web address with links to relevant sites. Other participants thought it would be sufficient to embed it in the MARCO Data Portal which is already well-known.
- *Audience* - Participants want the dashboard to be readily accessible to the general public while still relevant to regulators and ocean users. The RPB should consider its communication and marketing strategies to these potential end product users.

Next Steps

Nick Napoli, consultant, and Ms. Chytalo wrapped up the workshop by thanking the organizers for their work and thanking participants for their feedback. The input gathered over the two-day workshop will influence a final report written to the RPB as it considers options for designing and implementing a monitoring and assessment program. The consulting team emphasized that

further stakeholder outreach may be needed before or during the RPB's deliberations, particularly as it relates to unanswered questions from this workshop, though whose responsibility this would be remains to be determined. A scientific/technical review should also be undertaken at a future point to ensure that the final suite of indicators would appropriately capture ocean health. The Healthy Ocean Indicators Steering Committee will continue to discuss implementation of this action with the RPB at a future meeting and develop additional next steps for this OAP action item. The Steering Committee will include these next steps in a semi-annual report in the form of a work plan for January through June 2018 and will be available at the end of 2017.

Appendices

Appendix A: Workshop Attendance (In-Person and Webinar)

Name	Affiliation
Bennett Anderson	Affiliation Not Provided
Joe Atangan*	US Navy, Department of Defense
Helen Bailey	University of Maryland Center for Environmental Science
Mary Boatman*	Bureau of Ocean Energy Management
Bonnie Brady	Long Island Commercial Fishing Association
Peg Brady	National Oceanic and Atmospheric Administration
Tali Brennan	Natural Resources Defense Council
Leann Bullin*	Bureau of Ocean Energy Management
Marie Bundy	National Oceanic and Atmospheric Administration Office for Coastal Management
Merry Camhi	Wildlife Conservation Society
Charles Caruso	Affiliation Not Provided
Ali Chase	Natural Resources Defense Council
Kevin Chu*	National Oceanic and Atmospheric Administration NMFS/GARFO
Karen Chytalo*	New York Department of Environmental Conservation
Jessica Coakley	Mid-Atlantic Fishery Management Council
Fran Coid	Affiliation Not Provided
Corrie Curtice	Marine Geospatial Ecology Lab at Duke University
Jeff Deem	MARCO Stakeholder Liaison Committee
Al Dobbins	Affiliation Not Provided
Anthony Dvarskas	Stony Brook University
Pat Field**	Consensus Building Institute
Kim Fitzgibbons	Atkins
Mary Ford	Mid-Atlantic Coastal Ocean Observing System
Rebecca Gilbert**	Consensus Building Institute
Kaity Goldsmith**	Mid-Atlantic Regional Council on the Ocean
Matt Gove	Surfrider Foundation
Helen Grebe	Environmental Protection Agency, Region 2
Brent Greenfield	National Ocean Policy Coalition
Deena Hansen	Bureau of Ocean Energy Management
Kevin Hassell	New Jersey Department of Environmental Protection
Kim Hernandez	Maryland Department of Natural Resources
Lyndie Hice-Dunton	Ecology and Environment, Inc.
Sherryll Huber Jones	New York Department of Environmental Conservation
Todd Janeski	Virginia Commonwealth University
Michael Jones*	US Navy, Department of Defense

Lingard Knutson	US Environmental Protection Agency
Sherylin Lau	Environmental Protection Agency
Pam Lyons Gromen	Wild Oceans
Tony MacDonald	Monmouth University / Urban Coast Institute
Steve MacLeod	Ecology and Environment, Inc.
Megan Massaua	Meridian Institute
Jerry McCormick-Ray	University of Virginia
Laura McKay*	Virginia Coastal Zone Management Program
Stew Michels	Mid-Atlantic Fishery Management Council, Delaware
Kate Morrison**	Mid-Atlantic Regional Council on the Ocean
Nick Napoli**	Independent Contractor
Regan Nelson	Natural Resources Defense Council, Independent Contractor
Valerie Pinkerton	Natural Resources Defense Council
Meaghan Rickard	Affiliation Not Provided
Megan Rutkowski	New Jersey Department of Environmental Protection
Kristen Sebasky	Affiliation Not Provided
Rebecca Shuford	National Oceanic and Atmospheric Administration
Emily Shumchenia**	Independent Contractor
Kari St. Laurent*	DNREC/Delaware Coastal Programs
Hugh Sullivan*	US EPA Office of Water, Office of Wetlands, Oceans and Watersheds
Mark Swingle	Virginia Aquarium & Marine Science Center
Daniel Taylor	Affiliation Not Provided
Paul Ticco	National Oceanic and Atmospheric Administration
Megan Treml	National Oceanic and Atmospheric Administration, Marine Cadastre
Amy Trice	Ocean Conservancy
Judy Tucker	Mid-Atlantic Regional Council on the Ocean
Earl Waesche	National Boating Federation
David Wallace	Wallace & Associates
Cathy Wazniak*	Maryland Department of Natural Resources
Judith Weis	Rutgers University
Kate Wilke	The Nature Conservancy

*Mid-Atlantic Regional Planning Body (RPB) Healthy Ocean Ecosystem Indicators Steering Committee members
**Meeting coordinators

Appendix B: Workshop Agenda

Mid-Atlantic Healthy Ocean Ecosystem Indicators
Public Workshop
July 19 and 20th, 2017
Hyatt Regency
300 Light Street, Baltimore, MD 21202

Workshop Objectives

- To obtain public input and engage participants in the Mid-Atlantic Ocean Action Plan (OAP) to inform next steps for developing a healthy ocean ecosystem monitoring and assessment program to support OAP implementation.
- To consider the scope of a healthy ocean ecosystem monitoring and assessment program, inform the prioritization of potential indicators, and identify options for indicator reporting and communication.

Agenda

Day 1: July 19, 10:30 to 5:00

10:30 – 10:40 Welcome, Introductions, Agenda for the Workshop – *Pat Field, Consulting Team*

10:40 – 11:00 Purpose and Goals of Healthy Ocean Ecosystem Indicators within the Mid-Atlantic Regional Ocean Action Plan (OAP) – *Karen Chytalo, Mid-Atlantic Regional Planning Body, New York Department of Environmental Conservation*

- Brief reminder of the OAP, where and how indicators fit within the OAP, and relation to the MARCO Ocean Data Portal
- Role of workshop, the project, and the Mid-Atlantic Regional Planning Body (RPB) in finalizing indicators
- General questions

11:00 – 11:30 Review Indicators White Paper and Workshop Agenda Topics – *Consulting Team*

- Overview of project to date
- Examples of other relevant indicator programs
- Workshop agenda topics
    - Scope of the monitoring and assessment program
    - Prioritization of ecosystem components and potential indicators
    - Options for reporting and display

- Questions and discussion

11:30 – 12:15 Scope of the Monitoring and Assessment Program - *Consulting Team*

- Discussion about the potential scope of a monitoring and assessment program to support the OAP given the principles identified therein and likely funding scenarios

12:15 – 1:30 Lunch on your own

1:30 – 1:45 Plan for the Afternoon – *Pat Field*

- Break into three groups identified on name tags (mix of geography, affiliation, expertise)
- Each group will rotate through each of three major categories of indicators
- Each group has a technical lead and a note taker – *Consulting Team and MARCO*

1:45 – 2:45 First Round Small Groups

Three Groups (with recorders):

- Oceanographic and atmospheric drivers
- Habitat and lower and upper trophic levels
- Anthropogenic pressures and ocean uses

- In each round, participants will: 1) review the potential indicators identified in the white paper; 2) consider the issues and questions the OAP would seek to address with the development of indicators and questions specific to each category of indicators; 3) articulate indicator priorities to support monitoring and assessment
- Each round will be treated independently and flip charts of previous rounds' discussions will be posted on workshop walls for reference as needed.

2:45 – 3:45 Second Round

3:45 – 4:00 Break

4:00 – 5:00 Third Round

5:00 – 5:15 Brief Reflections from Day One

- What are insights, puzzles, or questions that arose from the three round break out groups?
- Quick review of Day 2

5:15 Adjourn

Day 2: July 20, 9:00 to 3:00

9:00 – 10:30 Summary and Discussion of Indicator Prioritization – *Consulting Team*

- Consulting team presents a summary of the key questions and indicator priorities expressed for each of the groups
- Continued discussion of each group

10:30 – 10:45 Break

10:45 – 11:30 Indicator Reporting and Display – *Consulting Team*

- Presentation of different display and reporting examples
- Identification of options and discussion topics
    - Indicator organization: Issue-specific or by ecosystem component
    - Format, content and total number of indicators
    - Potential locations for a dashboard
- Questions and discussion

11:30 – 12:15 Small table discussion and report out

12:15 – 1:30 Lunch on your own

1:30 – 2:30 Review workshop outcomes and revisit the overall scope of the monitoring and assessment program

2:30 – 3:00 Summary, Next Steps, and Thank You – *Consulting Team and RPB Members*

Appendix C: Detailed Breakout Discussion Summaries

Guiding Questions

1. What are the questions or issues in that OAP that could be addressed by this theme?
2. Which data categories are most relevant to the questions/issues identified above and should be prioritized?
3. Are there specific metrics from the white paper's Appendix B that seem most relevant to the priority data categories?
4. Are there specific metrics that we wish we could have?

Oceanographic and atmospheric drivers

Priorities and additional indicators

- High priority
  - Sea surface temperature
  - Dissolved oxygen
  - Ocean acidification
  - Sea level
- Lower priority
  - Freshwater seepages: but may have difficulty tracking that at a regional level.
  - Wave height
- Debated importance
  - Bottom temperature
  - Gulf stream (e.g. path, speed)
  - Precipitation
  - Oscillation strength
  - El Nino
- New indicators proposed and modifications
  - Estuarine plumes
  - Beach and shellfish closures regionally
  - Water quality
  - Open ocean nutrients
  - Diseases
  - Species shifts

Categorization and framework

- Proposed six issue areas to frame the program:
  - Safe and plentiful seafood
  - Recreational safety/water quality
  - Robust populations of native species
  - Coastal protection and armoring

    - Abundant marine wildlife
    - Diversity of unique habitat
    - Oceans are global oxygen pumps
- Data drivers should be categorized into ecosystem services benefits.
- Consider dividing issues into primary (e.g. beach water quality) and secondary or "under the hood" indicators (e.g. sea surface temperature).
- Consider which indicators help tell a regional story, rather than a very specific localized story. For example, wave height and bottom temperature are important locally while sea level rise is important at a regional level.
- We could develop a list of what we care about and then have 4 or 5 things under it that tell us about its status (e.g. changing oceans: ocean acidification, sea level rise, sea surface temperature, and the North Atlantic Oscillation).

<u>Key questions and comments</u>

- Definitions
    - How are we defining a "healthy ocean"? This definition may change based on who answers the question and how they want to use the ocean (e.g. someone who wants to swim at the beach may care about harmful algal bloom monitoring)
    - The suite of indicators the RPB chooses should be able to tell us if we are meeting the goal of a "healthy ocean".
- What are we tracking and why should we track it?
    - We should be tracking the intensity, duration, and rate of change of the indicators listed in the appendix. No change may also be important to track.
    - We should be tracking how these indicators relate to biological communities (e.g. how is shellfish recruitment changing?).
    - Should we track indicators that we (probably) cannot do anything about (e.g. North Atlantic Oscillation)?
    - Should we track indicators that do not impact species health in the ocean (e.g. wave height)?
    - Indicators are important to track only as they relate to shifts in biological processes and marine resources.
    - Are there indicators worth tracking regardless of what outcomes the RPB desires? Or do we need the RPB to clarify what societal benefits they hope to address with this program?
- Update schedule
    - Aim for annual updates but tell the story with larger time spans.
- Storytelling
    - Consider coupling these indicators to ecosystem services that the public cares about.
    - What other programs and sites can we link to or borrow from to tell important stories (e.g. EPA's water quality index, IOOS buoys)?

    - We should take guidance from what the public cares about and what data is currently available to include in this program. We need to clearly connect the line between the indicators (e.g. dissolved oxygen) and the ocean issues the public cares about (e.g. swimming).
    - What role can physical indicators play in educating the public about ocean changes?
    - Should the RPB create an index or set of indices rather than group indicators by themes (e.g. the dashboard could include a shellfish index that shows how different physical characteristics impact shellfish health)? This would allow site visitors to consider many elements at the same time.
    - There is enough in the OAP to tell a story based on what the plan prioritizes and works towards. For example, sustainable siting of wind sites is a goal in the OAP so we should be able to know if that is happening based on the indicators we choose to track.
- Dashboard design
    - Design should be based on the RPB's goal for this program.
    - Participants think the audiences for the end product should be the RPB, agency managers, decision makers, and the public.
    - The dashboard should show how the Mid-Atlantic is changing and should not be an assessment or interpretation of that information.
    - The dashboard should be layered to allow the public and other stakeholders to find the level of detail they are looking for.
    - The RPB should identify a few key stakeholders it wants to target with the indicator program and develop dashboard designs that speak to those user groups. They could test these beta dashboards with focus groups.
    - Should the goal be to identify indicators that are important across the board for a variety of user groups?
    - Should the dashboard design be based around ecosystem services?
- Other considerations
    - Do economic indicators require a parallel indicator program?
    - How can we create a program that is iterative in the future?

2. Habitat and Trophic Levels

Priorities and additional indicators

- High priority
    - Biodiversity: includes functional diversity
    - Habitat diversity
    - Protected species
    - Deep sea corals
    - Shifts in species, habitats, and community structure

    - Distribution and abundance of indicator species (e.g. seabird community)
- Lower priority
    - Horseshoe crabs
    - Tilefish
    - Static spatial categories (e.g. underwater canyons)
    - Methane seeps: no clear metric
    - Some anadromous fish
- Debated importance
    - "Human constructs" such as essential fish habitat and critical habitat designations: some participants expressed concern that EFH and critical habitat are some of the only ways we can track habitat protection right now. However, these "human constructs" are difficult to include because it is unclear what these actually indicate about ocean health.
    - Food web complexity
- New indicators proposed and modifications
    - Marine microbial data

Categorization and framework

- Participants sought an issue-based framework to prioritize indicators.
- Participants struggled with where to categorize ocean acidification.
- Marine debris can be a standalone indicator.
- Consider grouping species shifts and ERAs (static or dynamic).
- Consider categorizing by ecosystem services.

Key questions and comments

- What is the value-add of this program and this dashboard? Avoid re-inventing the wheel.
- We need to identify the issues the RPB and the public do care about, and then identify the right indicators and relevant drivers of change.
- Participants had difficulty prioritizing indicators when they were unsure what stories the RPB wants to tell with this program.
- Avoid including single species as indicators because they seem inconsistent with the other indicators and might inadvertently aid politicization of this program. On the other hand, other programs have used keystone species to examine and tell the story of change across assemblages or ecosystems. Species considered "canaries in the coal mine" may also have value for this program.
- Participants stressed the importance of scientific review of data categories and indicators that are advanced as part of an RPB program.
- Consider using three areas to prioritize indicators: lack of available data, unique and not redundant indicators, and no clear metrics available.
- How can we get at resilience with this indicator program? What are metrics for resilience? Or is "resilience" too subjective?
- Identify now what metrics might mislead us about the state of the system.

- Dashboard design
    - Layer the dashboard's information to allow stakeholders to find the subject and depth of information they are seeking.
    - The dashboard should track the state and extent of ocean uses and not make positive/negative determinations.

3. Anthropogenic Pressures and Human Uses

Priorities and additional indicators

- High priority
    - Anthropogenic Pressures category in general
    - Coastal discharges/eutrophication/HABs: debated priority due to OAP's ocean focus. These should be connected and reported out on as a package.
    - Marine debris
    - Contaminants: includes oil and chemical releases
    - Water quality: could include eutrophication, coastal discharges, marine debris, microplastics, HABs, hypoxia
    - Noise/ acoustic environment
- Lower priority or secondary indicators
    - Human Uses category in general: human use data exists, is readily available elsewhere, and is related to but separate from ecosystem health.
    - HABs
    - Electromagnetic fields: very localized/site specific; hard to get regional sense to show on a regional dashboard; debated whether really negative; cumulative impacts
    - Bycatch: maybe already monitored elsewhere
    - Seabed scour and alterations: unclear how to measure and also localized
    - Coastal discharges: unclear how to measure consistently across regions; other coastal programs may be measuring it under a very different framework (e.g. Coastal Condition Report))
    - Eutrophication: already counted in other categories (pH, DO); this is really a state of nature that you reach from a variety of inputs/activities that establish that state and not an indicator itself
    - Shoreline hardening
- Very low or not a priority
    - Introduced/invasive species
- Debated importance
    - Electromagnetic fields: too localized to resonate at regional scale
    - Shoreline hardening
    - Seabed scour and alterations

    - Where the largest impact is (e.g. ocean disposal sites, contaminants)
- New indicators proposed and modifications
    - Ship strikes: they are a pressure not an "ocean use" since no one wants it to happen
    - Offshore sand dredging (e.g. number of borrow sites)
    - Proportion of suitable dredge material for disposal sites
    - Pharmaceuticals
    - Emerging diseases and epidemics

Comments on word choice

- Modify "sound" to "high levels of sound"
- Suggest "stressors" or "externalities" instead of anthropogenic impacts
- On Ocean Uses list, recreational fishing landings (volume) should be re-termed as "recreational catch"

Categorization and framework

- Suggest re-framing issues into two bins:
    - Conflicts between uses and environment
    - Conflicts between human health and environment (e.g. contaminants)
- Use a societal benefits framework instead
- The program should have primary indicators & secondary or supporting information (e.g. sound to marine mammal mortality).
- The program should be organized by themes and issues (e.g. clean water, abundant habitats), rather than "anthropogenic pressures" as a standalone category.
- List could be limited to inadvertent activities (i.e. results of other activities)
- Ocean uses should be coupled with a biological element in the ocean.
- Suggestion to cut "ocean uses" section and focus solely on "anthropogenic pressures" to track ocean health.

Key questions and comments

- When considering ocean uses, what about that use tells you something about ocean health indicators?
- What is the intended outcome of collecting data on these indicators? (e.g. Is X important to understanding change in population Y?)
- How are these indicators going to provide information about the region as a whole?
- Prioritizing
    - Can we gain a comprehensive view of the state of the system if we prioritize indicators?
    - The extent to which an activity affects the open ocean vs. coastal environment can inform priority- setting.
    - The OAP expresses some priorities but perhaps not everything should be or can be tracked.

- Cautions
    - Including any indicators that could be naturally occurring.
    - Definition of bycatch as a metric; may be hard to categorize.
    - Differentiating between pressures and state indicators.
    - Redundancy between indicators across categories.
- The goal is not to define "ocean health" but to create an objective dashboard that shows how things are changing and how RPB entities are addressing these changes.
- This program and dashboard need to reflect things that are under the purview of RPB entities; not just the Actions articulated in the OAP (e.g. sound was not included but it could still be listed as a pressure)
- The program should include information on stressors at scale/cumulative impacts (e.g. total anticipated acreage with electromagnetic field potential impacts; sound thresholds).
- Some participants felt that ocean health should include social and economic health.