FINAL REPORT

National Estuarine Research Reserve
System-Wide Monitoring Program
Data Synthesis Needs Assessment

June 2017

Eastern Research Group, Inc. (ERG)

ERG

Eastern Research Group, Inc., prepared this report under contract to NOAA's Office for Coastal Management. ERG's project manager (Arleen O'Donnell) and staff (Charles Goodhue, Rena Kieval, Jenny Helmick, Cara Ehlenfeldt, Mara Tzizik, and Brielle Meade) worked closely with the NOAA project team (Mary Culver [Task Order Manager], Dwight Trueblood, Sandra Erdle, and Brandon Puckett) throughout this project. In this report, "Project Team" refers to the ERG and NOAA staff involved in this project.

NOAA's Office for Coastal Management

"Coastal management" is the term used by communities and organizations striving to keep the nation's coasts safe from storms, rich in natural resources, and economically strong. The national lead for these efforts is NOAA's Office for Coastal Management, an organization devoted to partnerships, science, and good policy. This agency, housed within the National Ocean Service, oversees major initiatives that include the National Coastal Zone Management Program, Coral Reef Conservation Program, Digital Coast, and National Estuarine Research Reserve System.

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1 Executive Summary

SWMP Data Synthesis Needs Assessment Overview
NOAA's National Estuarine Research Reserve System (NERRS) System-Wide Monitoring Program (SWMP) provides long-term water quality, meteorological, and nutrient monitoring data across 28 of the system's 29 reserves. SWMP data are available from the NOAA-funded Centralized Data Management Office, which also conducts extensive data quality control. The 28 reserves participating in SWMP have at least one water quality station and one weather station providing near-real-time information.

From September 2016 to June 2017, NOAA conducted a needs assessment to identify how the synthesis and analysis of SWMP data can better address priority coastal and estuarine management questions at national, regional, and local levels. The results of the needs assessment are intended to help NOAA and the reserve system guide investments in research, education products, and training activities for coastal decision-makers and demonstrate the value of investing in long-term monitoring efforts such as SWMP.

Approach
The needs assessment consisted of a three-part approach:

- A literature review of 66 brochures, reports, journal articles, websites, and other monitoring data synthesis materials. The goals of the literature review were to identify attributes of successful data syntheses, identify synthesis authors for interviews, and inform the development of a survey of reserve system stakeholders.

- In-depth interviews with authors of six selected monitoring data synthesis products. The interviews explored connections among the monitoring data, coastal management issues, content/format of the synthesis, and target audiences. Interviews further informed survey development.

- A survey of more than 1,000 reserve system stakeholders to identify priority coastal management issues, coastal monitoring parameters that best inform decision-making, familiarity with and use of SWMP data, and preferred format and delivery of coastal monitoring synthesis data.

Findings
An analysis of the interviews and survey results yielded the following findings:

Coastal Management Issues

- **Finding 1:** The top three priority issues identified by stakeholders around the country—water quality, habitat, and climate—are consistent with the reserve system's strategic areas of focus and investment.

SWMP Data
- **Finding 2:** There is an opportunity to increase the awareness of SWMP data and how it can be used, as most respondents were unaware of or had not used SWMP data.

- **Finding 3:** The SWMP monitoring parameters identified by stakeholders as being most important for addressing priority management needs are daily precipitation, percent cover and density of vegetation species, dissolved oxygen, salinity, water temperature, turbidity, pH, wind speed and direction, and chlorophyll.

Data Synthesis Preferences
- **Finding 4:** Stakeholders find local data, followed by regional data, most important in making management decisions.

- **Finding 5:** The top three ways in which stakeholders would like to receive SWMP information are technical reports, executive summaries, and interactive websites.

- **Finding 6:** Stakeholders would like to see SWMP data reflect temporal trends, information that links conditions to causes, and information that links the causes of problems to possible solutions.

- **Finding 7:** When looking across a variety of coastal monitoring reports, status reports tend to be published annually, while more comprehensive syntheses tend to be published every five years.

- **Finding 8:** Two ways to effectively target multiple audiences are 1) a "tiered" approach with specific report sections or data visualizations that resonate with each type of audience, and 2) the development of multiple products within a series, each targeted toward a specific audience.

Options for Future Work

The needs assessment revealed some options for:

- Enhancing the use of SWMP data.

- Expanding SWMP data collection to help address priority management questions.

- Developing useful synthesis and status reports.

- Raising awareness of SWMP data through partnerships, education, and outreach.

Examples of these options include:

- **Trend analyses using SWMP data:** The NERRS SWMP data are unique in that data are collected using uniform national protocols across each reserve. To help address key management questions, standardized data across regions could be used to document trends for various water quality indicators. Potential areas for trend analysis include sea level rise, nutrients, land use, and occurrence of harmful algal blooms.

- **Expanded vegetation monitoring:** A handful of reserves already monitor submerged aquatic and emergent vegetation. Expanded vegetation monitoring could lead to a better understanding of the relationship between climate change and changes in habitat/land cover, as well as the impacts of acute or chronic pollution on vegetation.

- **New SWMP products:** The needs assessment identified several products and outreach strategies to facilitate the use of SWMP data in research and decision-making. Among these options are synthesis reports summarizing key findings and trends at the regional and local levels, local status reports to help stakeholders make management decisions, and an interactive website to make SWMP data easily accessible to researchers, decision-makers, and other stakeholders.

- **Challenge to researchers to answer key management questions:** NERRS Science Collaborative requests for proposals can more specifically allot funding for the use of SWMP data to help answer a management or research question. This could promote the integration of SWMP data with other data sets to address complex management questions.

- **NERRS training and outreach:** The reserves can build on the success of their education programs and their connections with coastal decision-makers and other potential data users by the continued use of SWMP data in training and education programs; providing training on the use of SWMP data for specific coastal issues; and obtaining and communicating input on how the data could be more useful. Other outreach mechanisms can be used to inform stakeholders what SWMP data are indicating about the condition of the reserves and how the data can be used to inform coastal management decisions.

- **Partnerships with other organizations:** To increase the use and awareness of SWMP data, NERRS could share its data on existing data-sharing platforms (such as EPA's Water Quality Portal). In addition, because SWMP monitoring is continuously implemented at specific locations in 28 reserves, it can be leveraged with other data collected in the same geographic area (e.g., Chesapeake Bay) or integrated with other local- and regional-level data to broaden its reach and strengthen data sharing and resource protection partnerships.

2 Introduction

This needs assessment was conducted to examine needs for data from NOAA's National Estuarine Research Reserves System (NERRS) System-Wide Monitoring Program (SWMP), produce findings, and suggest recommendations for how best to synthesize and present SWMP data so that they can more effectively reach key audiences. By more directly linking SWMP to the issues that stakeholders and partners care about, SWMP data can become more relevant—which, in turn, can lead to increased public support for the reserve system.

This needs assessment provides information and an analysis gathered from national and regional syntheses of water quality, habitat, and climate change monitoring data from a variety of sources; subsequent interviews; and a survey that was disseminated to more than 1,000 reserve system stakeholders. The results of the needs assessment are intended to help NOAA and the reserve system guide investments in research, education products, and training activities for coastal decision-makers and demonstrate the value of investing in long-term monitoring efforts such as SWMP.

Methodology Overview
Eastern Research Group (ERG) conducted the needs assessment using the following approach:

- Researched and documented examples from national or regional synthesis efforts with relevant monitoring data to gather key information about the purpose, geography, audience, content, communication techniques, and other information from each source.

- Interviewed authors and contributors from six priority synthesis products to obtain information unavailable from the documents and associated websites.

- Drafted a preliminary needs assessment to inform survey development and present interview findings.

- Surveyed more than 1,000 coastal decision-makers, scientists, and educators to gather information specific to these reserve system stakeholders.

- Analyzed survey data and developed findings, which are presented in this report.

Organization of This Report
The **Executive Summary** provides a high-level overview of the assessment's objectives, methodology, and key findings from the literature review, interviews with synthesis authors, and needs assessment survey. The **Methodology** section details steps taken and analyses performed during the literature review, interviews, and needs assessment survey. The **Findings** section presents key findings from the literature review, interviews, and survey. It provides supporting tables, graphs, and discussion organized around the key findings. The **Options for SWMP Products and Future Work** section provides education and outreach ideas to help people use SWMP data, data analyses to be performed with existing data, possible research projects, pilot monitoring projects, and additional SWMP data that can be collected based on stakeholder needs and preferences identified in the survey and interviews. **Appendix A** provides a list of and links to 17 monitoring data syntheses that ERG reviewed in detail during the literature review. **Appendix B** presents the needs assessment survey. **Attachment 1** is a separate standalone document with results from the survey across all respondents. **Attachment 2** is a separate standalone Excel file with raw results from the survey. **Attachment 3** is a communications strategy to help the Office for Coastal Management and the reserves communicate these findings. It includes a dissemination plan and timeline. **Attachment 4** is an Excel file with the raw notes from the interviews and other data from the literature review. **Attachment 5** is a preliminary needs assessment with the literature review results and interviews with synthesis authors. All attachments are available from NOAA upon request; contact Mary Culver (mary.culver@noaa.gov).

3   Methodology

ERG completed a three-part process to implement the needs assessment outlined in Sections 3.1 through 3.3 below.

3.1   Literature Review

ERG collected examples from national and regional synthesis efforts from a variety of sources with relevant monitoring data to gather key information about the purpose, geography, audience, content, communication techniques, and other topics from each source. This search included brochures, reports, journal articles, websites, and other monitoring data synthesis materials. ERG augmented a list of documents provided by NOAA to include monitoring synthesis documents from other federal and state agencies, non-governmental organizations, and academic institutions that use national or regional monitoring data to produce national or regional synthesis reports. Using the process described below, ERG identified 66 data synthesis products and identified 17 of these sources as the best examples of synthesis products for more in-depth exploration, which ERG validated by using polling during a webinar of reserve system stakeholders. Criteria for these best examples included: (1) including water quality, habitat, and climate change data; (2) including superior data visualizations; and (3) presenting content that was not overly specialized for highly technical audiences.

The key outputs from the literature review included:

- A literature review report (Attachment 4, which is available from NOAA upon request).

- A list of synthesis authors to contact for further information.

3.2   Interviews with Authors of Priority Literature Sources

For the 17 priority sources identified, ERG reached out to the authors to further explore connections among the monitoring data, source of the data, coastal management issues, content/format of the synthesis, and target audiences—much of which could not be easily extracted by reviewing the literature. ERG also collected information about the frequency of each publication and qualitative and quantitative information about the level of effort required to produce each synthesis to help NOAA better understand the resources that may be needed for future synthesis efforts. Interviews were conducted with representatives from six organizations that produced priority synthesis products identified by the literature review, as well as a point of contact from the U.S. Environmental Protection Agency's (EPA's) Water Quality Portal. ERG asked report authors the following questions, which resulted in discussions of the purpose of the synthesis products, their effectiveness, and the coastal management needs that the products were attempting to address:

- What is your major coastal issue that this product was trying to address?

- What were your objectives in developing this synthesis?

- Was this product effective at accomplishing its objectives (and how do you know)?

- What is the source of your data?

- Who is your target audience?

- Do you plan on updating this product at regular intervals and if so, at what frequency?

- Given our interest in possibly using your product as a model for future SWMP synthesis products, it would be helpful to have an estimate of the level of effort that it took to compile your product. Can you give us some idea of the magnitude of the effort?

The key output from these interviews included a preliminary needs assessment report (Attachment 5, which is available from NOAA upon request).

3.3   Survey Design and Implementation

Using information extracted during the literature review and interviews, the project team focused the survey on identifying:

- Top coastal management issues.
- Key questions and gaps within each management issue.
- Coastal monitoring parameters that best inform decision-making.
- Preferred format and delivery needs of syntheses using coastal monitoring data.
- SWMP data familiarity, obstacles, and utility.

ERG developed the draft survey with three rounds of feedback from the project team and submitted the survey package to the Office of Management and Budget for approval. Once approved, the survey was administered through Qualtrics as a web-based survey. The final survey questions are shown in Appendix B.

Coastal Training Program coordinators from 28 reserves provided lists of stakeholders for the survey. Additionally, NOAA provided some national-level stakeholders as contacts for the survey distribution list. In total, ERG sent the survey to 1,036 stakeholders and received 404 submitted responses, which are characterized in Figures 1 through 4. ERG sent the initial email to survey participants, which consisted of a brief overview, a link to the survey, contact information for the NOAA lead, and information for an ERG contact to help with any technical issues.

Three reminder emails were sent. At approximately the same time as the survey distribution email, Coastal Training Program coordinators sent a direct email to their stakeholders reminding them to complete the survey. Additionally, ERG sent two reminder emails approximately two weeks and three weeks after the survey's distribution to those who had not completed the survey at that point.

The survey was open from February 15 to March 10, 2017. The final statistics are:

- Surveys distributed: 1,036
- Completed responses: 404
- Partial responses (subset of completed): 104
- Response rate: 39 percent

The key outputs from the survey include:

- This needs assessment report, including findings and options for future work.
- A communications strategy based on survey responses and findings (available from NOAA upon request).
- Needs assessment survey data (Attachment 2, available from NOAA upon request).

4 Findings

The following findings, based on the interviews and stakeholder survey, are grouped by category and appear in no order of importance. Each is presented in more detail in Sections 4.2 through 4.4 of this report. These findings helped inform options for synthesis documents and other products, which can be found in Section 5.4.

Coastal Management Issues
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SWMP Data
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4.1 Survey Respondent Characterization

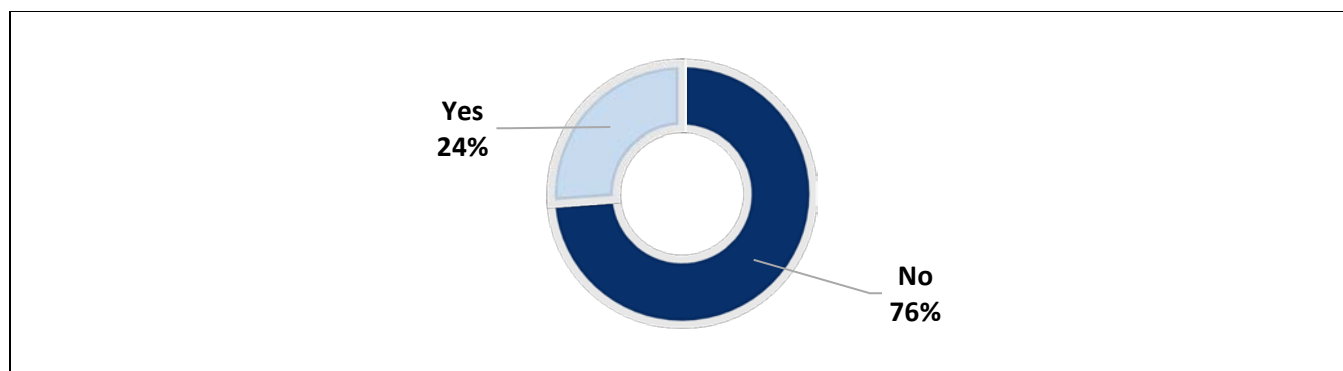Figures 1 through 4 characterize the 404 survey respondents.

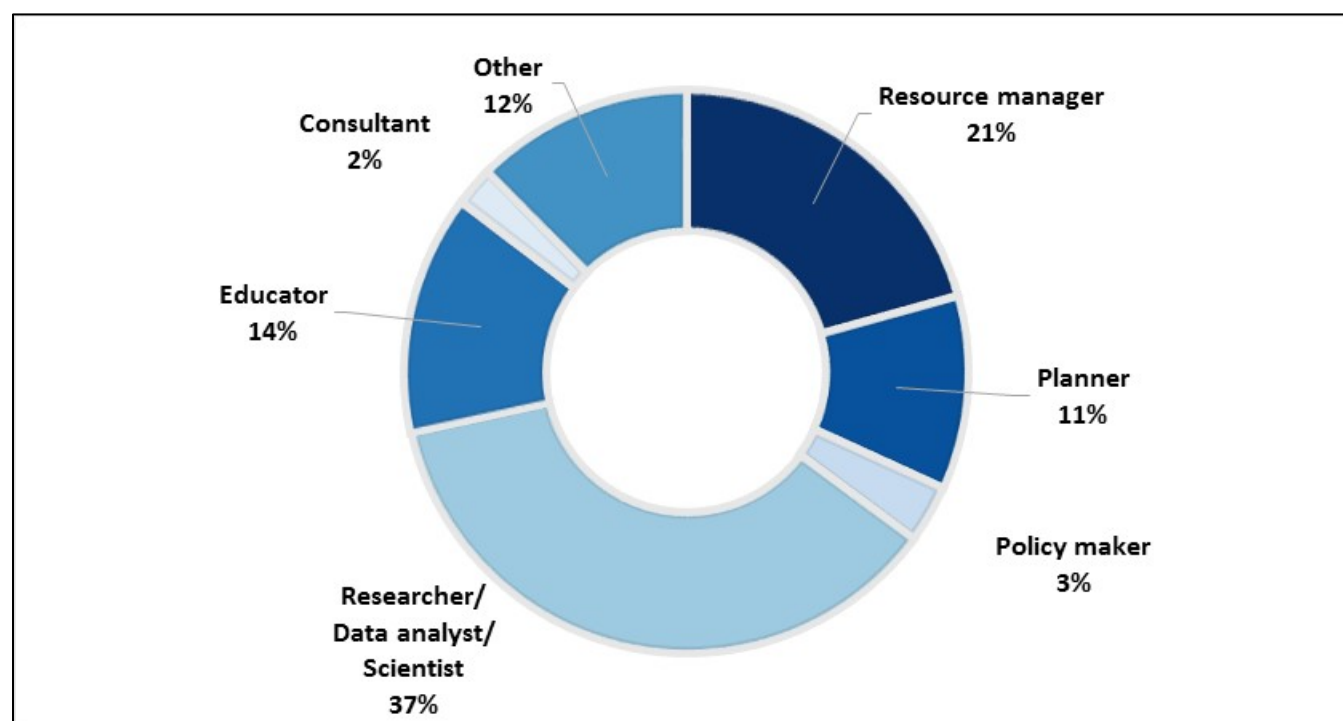**Figure 1. Are you an employee of a National Estuarine Research Reserve?**

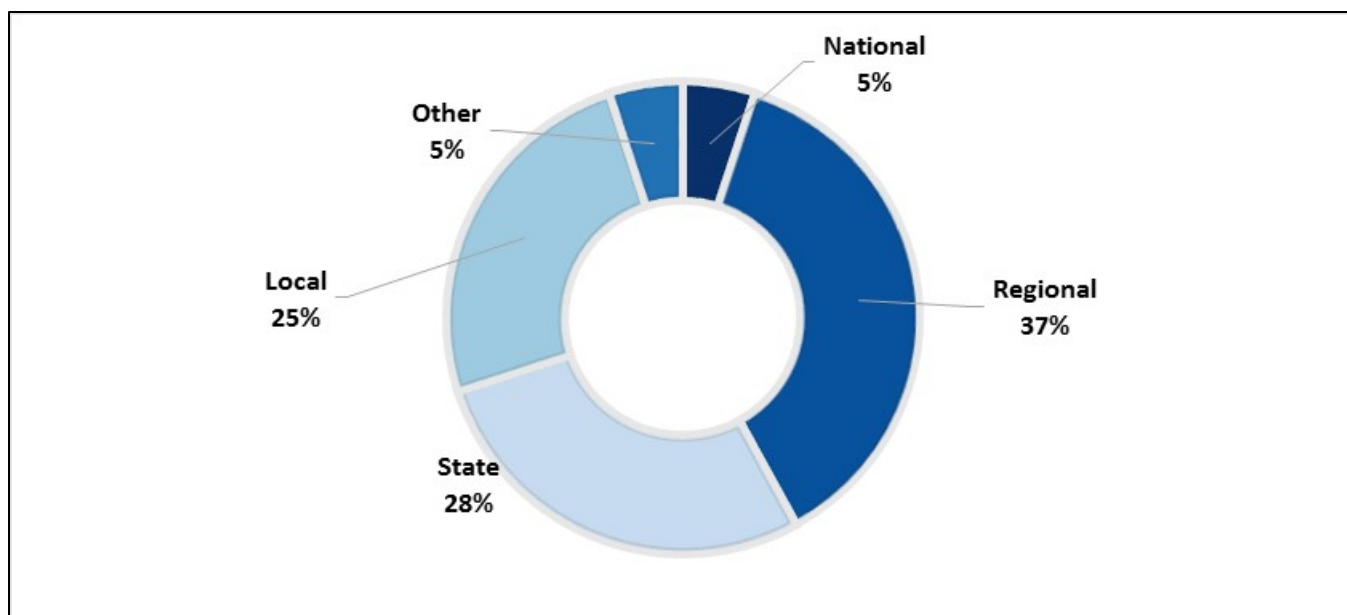**Figure 2. Which category best describes your occupation?**

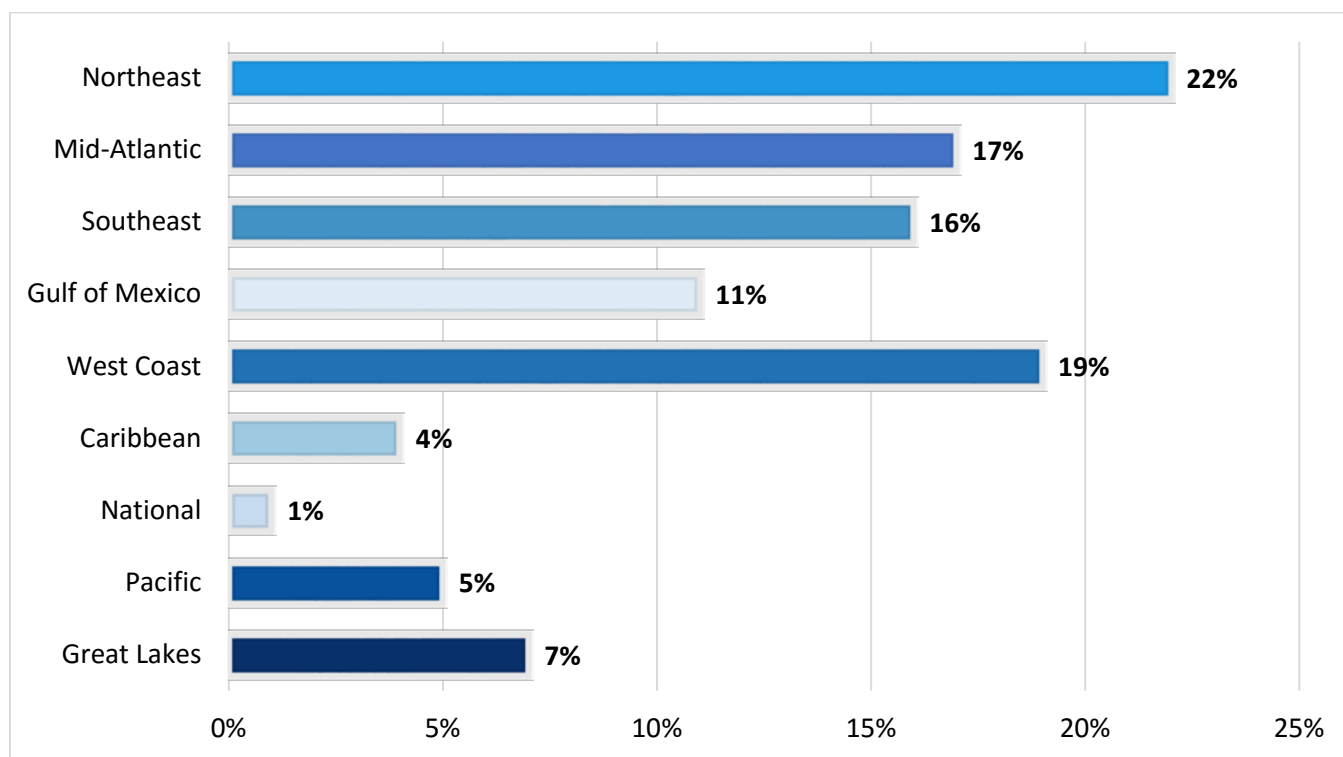**Figure 3. Which category best describes the scale at which you work?**

Figure 4. Select the geographical region in which you do the most work.

4.2 Coastal Management Needs

Survey respondents provided the top three management issues from a list of options, with the ability to select "other." As shown in Figure 5, the top three management issues for survey respondents are the same as the three reserve strategic areas. Additionally, the degree to which they were named as top management issues is

> **Finding: The top three priority issues identified by stakeholders—water quality, habitat, and climate—are consistent with NERRS' strategic areas of focus and investment.**
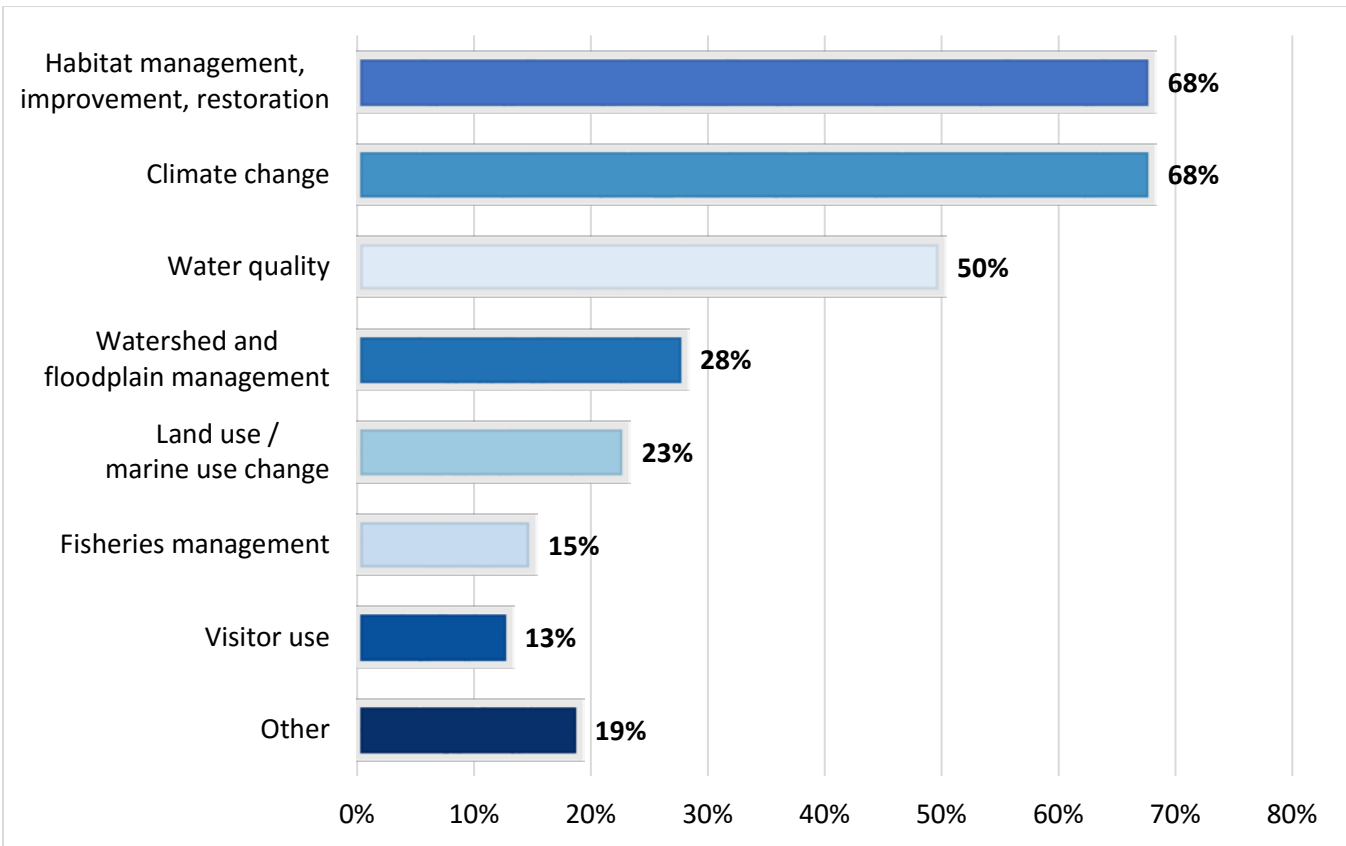
comparable between stakeholders and reserve employees; climate change (68 percent across all respondents, 65 percent for non-NERRS employees), habitat management (68 percent across all respondents, 65 percent for non-NERRS employees), and water quality (50 percent across all respondents, 48 percent for non-NERRS employees) were the top three issues identified across all respondents. ERG analyzed these management issues across self-identified occupation, geographic region, and spatial scope (coverage) of work and found they were generally consistent across the various subcategories of audiences.

Figure 5. What are the top three coastal management issues you face in your work?

Respondents were asked to provide specific management questions within each of their top three management issues. Table 1 shows common types of management questions associated with each identified management issue. The bottom row of the table provides some direct quotes (sometimes paraphrased) to provide additional context for these management questions.

Table 1. Most Frequent Types of Management Question by Coastal Management Issue

Coastal Management Issue	Most Frequent Types of Management Questions
Habitat Management	• How should we address invasive species? • What are the most effective processes for restoring wetlands, and what are the impacts of restoration? • What are the most effective adaptation strategies/restoration methods for maintaining habitats/establishing resilient ecosystems?
Climate Change	• How to adapt/become more resilient? • What will be the sea level rise/storm vulnerabilities or general impacts? • What will be the impacts to or responses from the natural environment? • What will be the impact of ocean acidification?
Water Quality	• What affects nutrient levels, and/or what are the impacts from nutrients? • How should we manage stormwater, and/or what are the impacts of stormwater? • How can we better contain, predict, and understand harmful algal blooms?
Watershed/Floodplain Management	• How can we better manage floodplains to minimize impacts? • Where can I get better data, and/or what data can I use to better understand my floodplain? • What are the impacts of flooding, specifically with regard to risks to the public?
Land Use/Marine Use Change	• What are the impacts of construction and other activities on wetlands, water quality, vegetation, and species? • How do we steer future development?
Fisheries Management	• How do we maintain fish stocks and identify sustainable rates of fishing? • What environmental factors are impacting fisheries?
Visitor Use Issues	• How can visitors be educated to promote the sustainable use of local resources? • What are the adverse impacts to the ecosystem from visitor use/tourism, and how can they be mitigated?

Select Related (Paraphrased) Management Questions/Needs from Survey Respondents
- *What are the climate change impacts on ocean water quality, temperatures, nutrient dynamics, chemistry, and the food chain for ocean productivity, biodiversity, and human harvest?*
- *What are the most important issues affecting water quality within the reserves we manage? Is water quality improving or declining? What is causing this improvement or decline in water quality? And how do we maintain/improve water quality in the face of increasing nutrients, sediment, and temperature?*
- *How are ecosystems changing from increased storm intensity?*
- *What are the cumulative impacts of stormwater management on coastal water quality and ecosystems?*
- *Better understanding habitat changes in relation to climate change.*
- *Effect of climate change on invasive species and management options.*
- *Effective wetlands management, including climate adaptation.*
- *Best way to eradicate invasive plant species in estuaries and wetlands.*
- *High-resolution maps of the distribution and change of habitats, invasive species, and condition.*

4.3   SWMP Data

4.3.1   SWMP Priority Parameters

This section presents survey respondents' views on SWMP monitoring parameters that can help them make management decisions.

Figure 6 shows that respondents generally found water quality trends, meteorological trends, vegetation monitoring data, and land use or land cover data very important. Respondents found real-time data slightly less important to making decisions compared to non-real-time data.

> **Finding: The SWMP monitoring parameters most important for addressing priority management needs are daily precipitation, percent cover and density of vegetation species, dissolved oxygen, salinity, water temperature, turbidity, pH, wind speed and direction, and chlorophyll.**
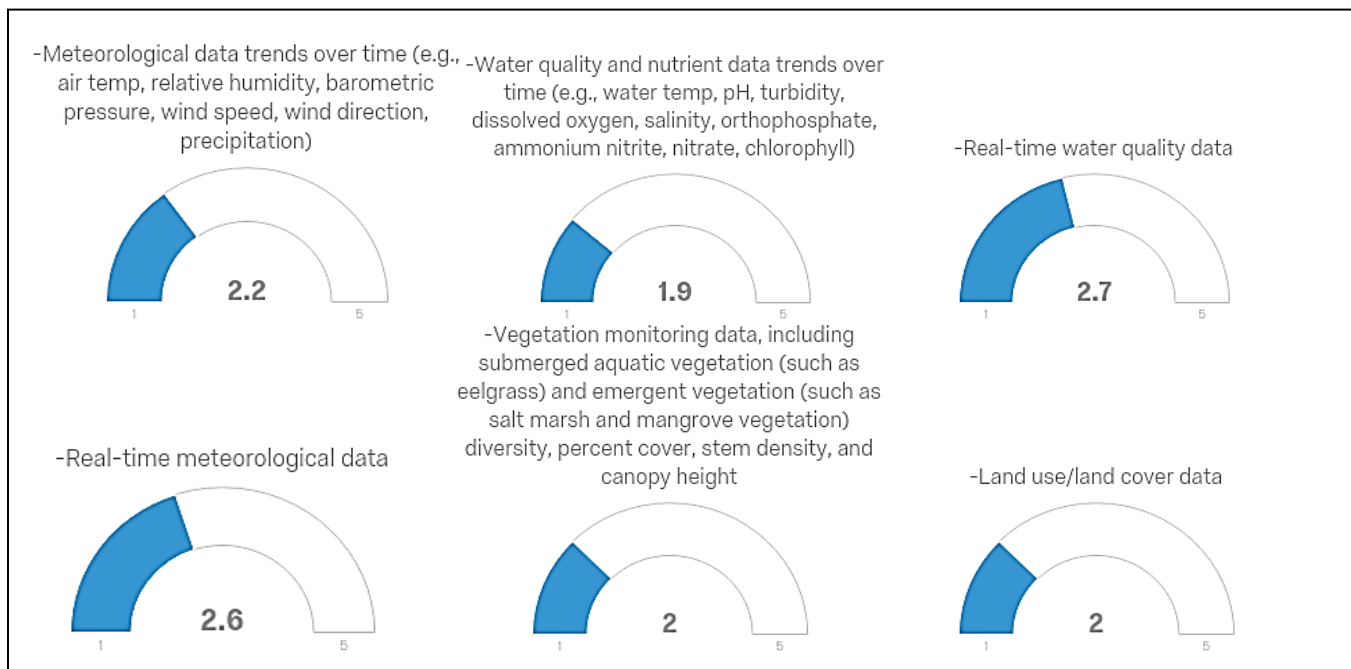

Figure 6. Please rate the importance of each category in informing how you use the data to address your coastal resource management needs, from "extremely important" (1) to "not at all important" (5).

Figure 7 shows the respondents' answers to whether specific water quality monitoring, meteorological monitoring, and vegetation monitoring parameters could help them make management decisions. While it was not specified in the survey instrument, these are all parameters that SWMP collects. Across the water monitoring, meteorological monitoring, and vegetation monitoring parameters, respondents ranked the following to be the top 10 most important to helping them make management decisions (presented in descending order of affirmative responses): daily precipitation, percent cover by species, dissolved oxygen, salinity, species density, water temperature, turbidity, pH, wind speed and direction, and chlorophyll.
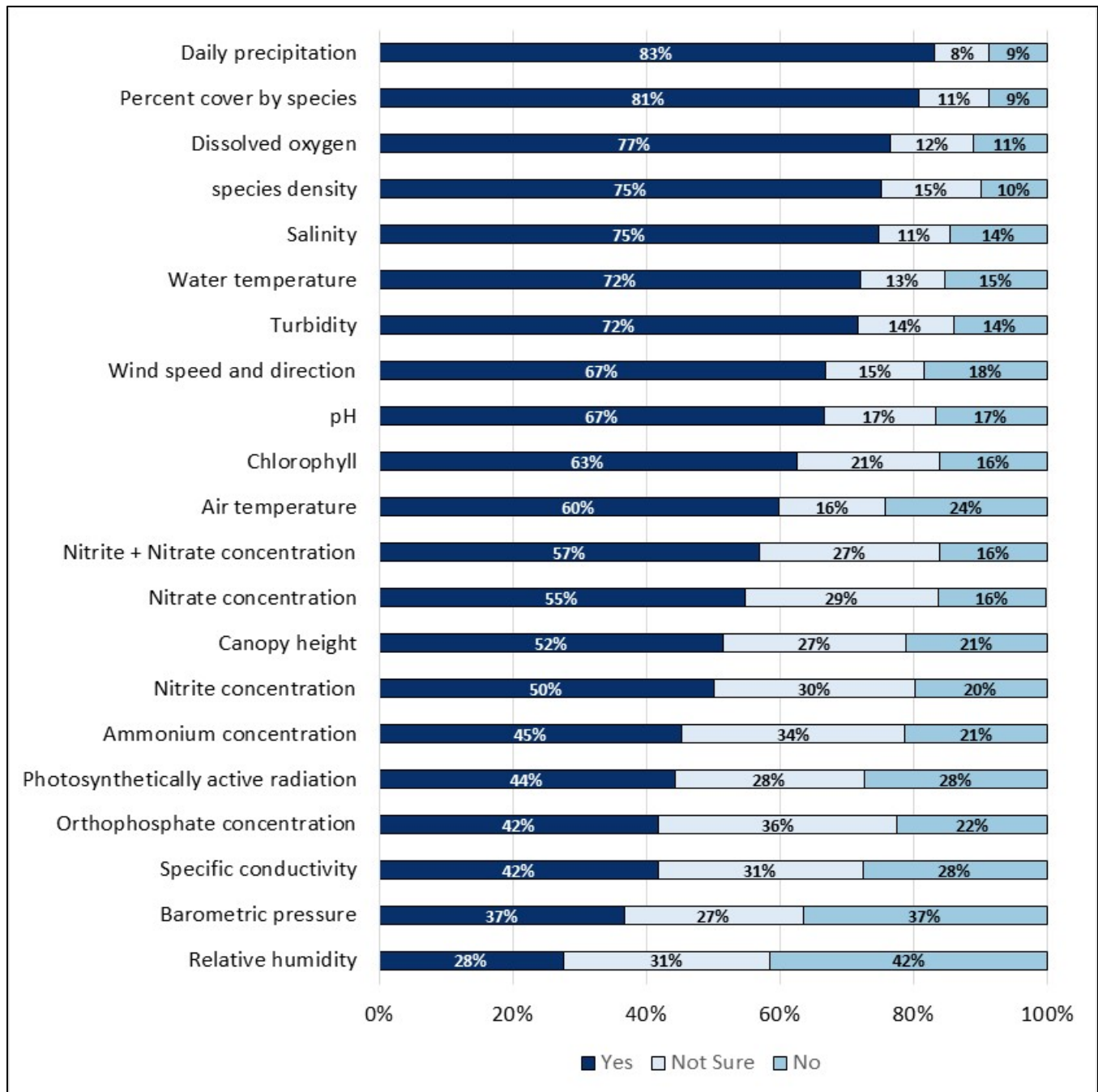
Figure 7. Please indicate whether the following types of data could help you make management decisions.

4.3.2   SWMP Data Awareness

This section presents results related to the awareness of SWMP data, the obstacles to using data, how data are used, and the limitations of use.

> **Finding: There is an opportunity to increase the awareness of SWMP data and how it can be used, as most respondents were unaware of or had not used SWMP data.**
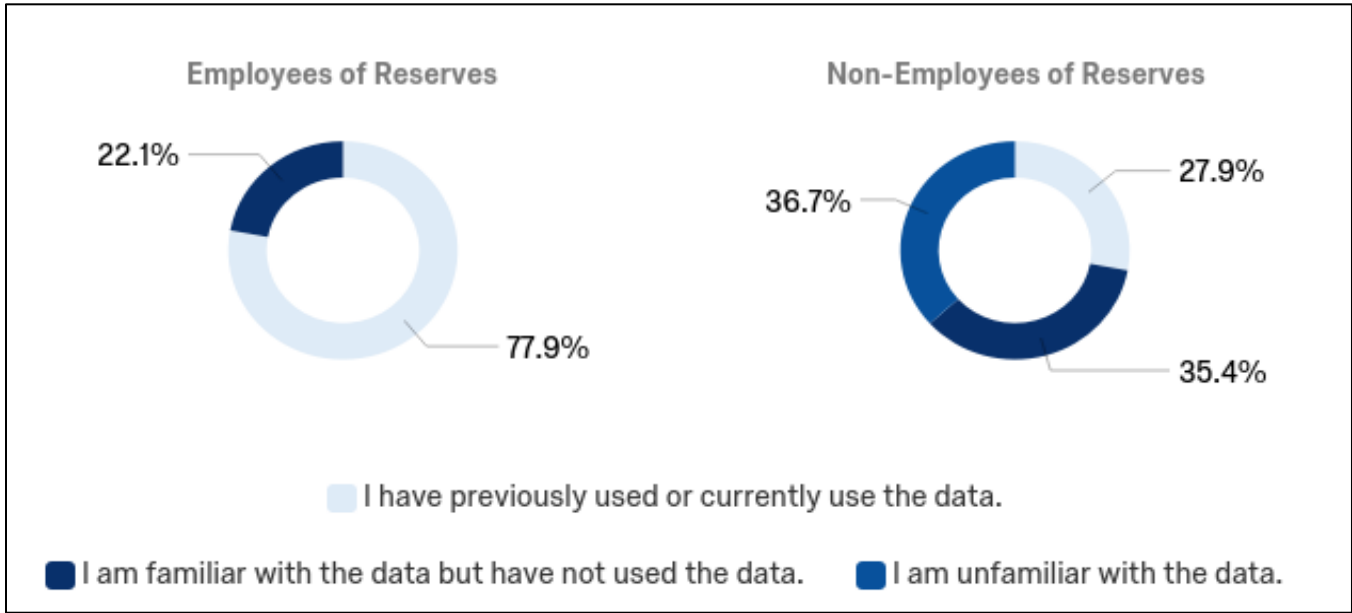
Respondents were asked whether they have used SWMP data, were familiar with the data but never used them, or were unfamiliar with the data. Figure 8 shows that employees of reserves typically had used the data before (78 percent), and the remaining 22 percent were familiar with the data. Of those outside of reserves (non-employees of reserves in the figure below), 37 percent stated they were unfamiliar with the data. An additional 35 percent noted they were familiar with but had not used the data. These non-employees of reserves were mostly, but not exclusively, reserve system stakeholders whose contact information came from reserve employees.

Figure 8. What best describes your familiarity with System-Wide Monitoring Program (SWMP) data from the National Estuarine Research Reserves?

To explore whether the relatively low familiarity and use of SWMP data were limited to certain types of respondents, ERG characterized the familiarity of non-NERRS-employee respondents with the data by geographic location, the spatial scope of their work, and occupation. ERG found that for every categorization with a sample size of at least 15 responses, 40 percent or fewer had previously used the data, and 25 percent or more (with the exception of educators) were unfamiliar with the SWMP data. This demonstrates that there is an opportunity for the reserves to do more outreach on the availability and use of SWMP data across all audience types.

In considering how to increase SWMP data awareness and use via outreach, ERG assessed how data were currently being used, the limitations of use (for those using data), and obstacles to using the data (for those familiar with the data but not using them).

Figure 9 presents survey results on how data are being used. The most prevalent uses of SWMP data appear to be for habitat management, water quality management, and general climate trends/sea level rise.
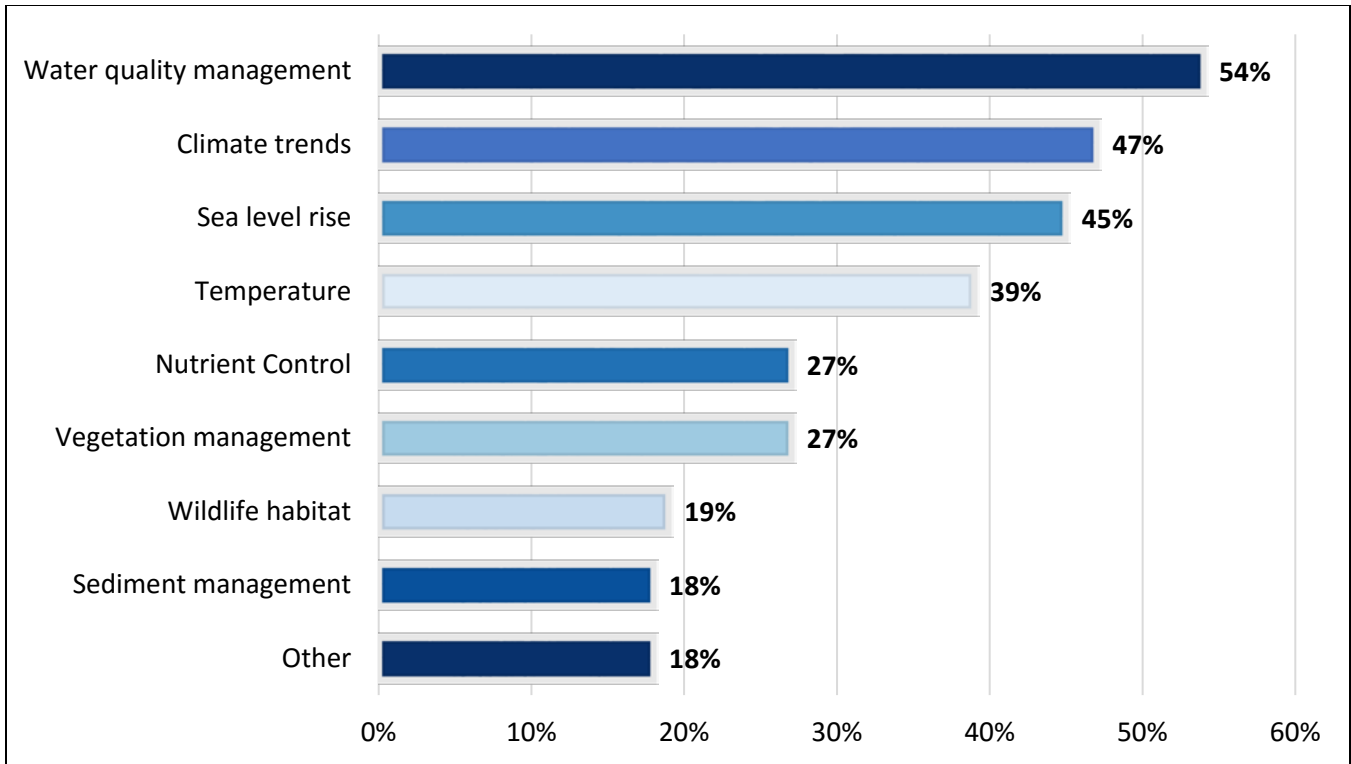
Figure 9. Please select how you are applying or using SWMP data in your decision-making (check all that apply). [Note: This question was answered by those who responded that they have used SWMP data.]

For all respondents who indicated that they have used SWMP data, Figure 10 shows that the top three limitations of using SWMP data are spatial issues, temporal issues, and missing parameters. Respondents were asked to elaborate on the limitations by providing examples. Some representative examples of limitations are shown in the text box following the figure.
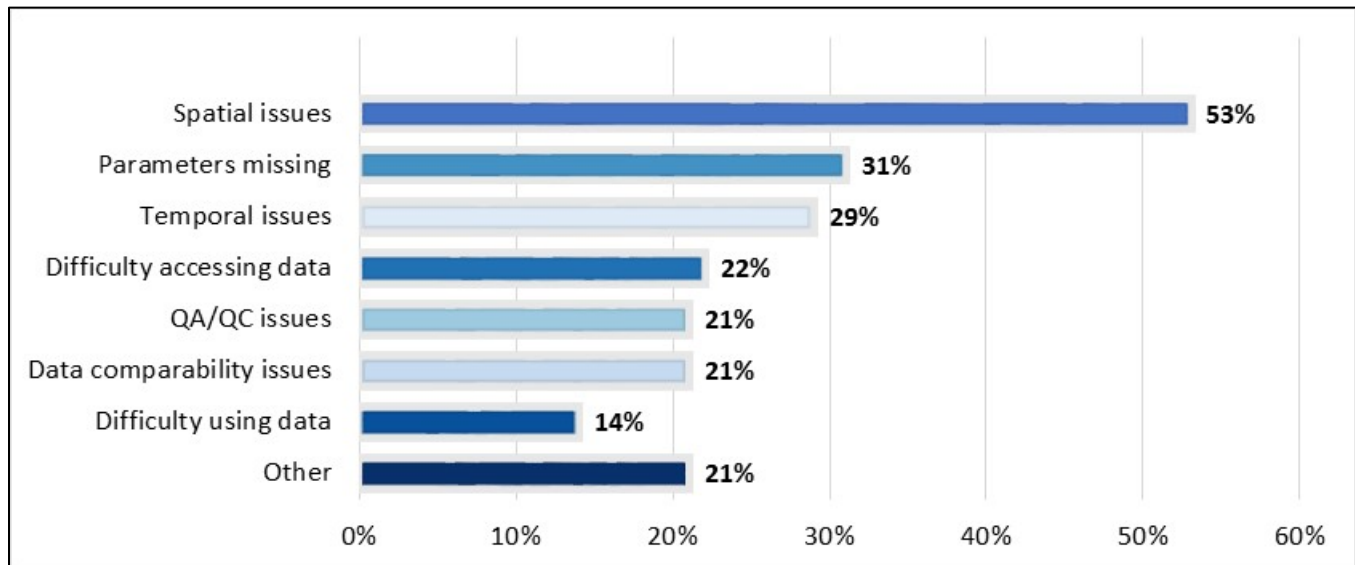

Figure 10. Please select any limitations or gaps you have noted when using SWMP data (check all that apply). [Note: This question was answered by those who responded that they have used SWMP data.]

Respondent Examples of Limitations to Using SWMP Data

Temporal Issues
- *"Icing problems leading to temporal gaps in SWMP data"*
- *"No winter monitoring"*
- *"Data from early in the program has data quality issues"*

Spatial Issues
- *"Limited spatial coverage given the size of our reserve"*
- *"The limited distribution can make it hard to incorporate in broader regional analysis, though good for local information"*
- *"The sediment elevation tables at the SWMP sites do not give a really representative picture of the entire watershed or even a larger area within a watershed—we need to know areas (across the NERR) of concern for impacts on salt marsh from sea level rise"*
- *"Spatial intensity often falls short of needs (e.g., bottom data only, few stations), and especially the need for local-scale GIS mapping information (e.g., local watershed, town)"*

Gaps in Parameters
- *"Sediment related parameters (TSS, etc.)"*
- *"POC and PON, Total nitrogen, and chlorophyll-a"*
- *"Ecosystem indicators, especially those with high community diversity (phytoplankton, periphyton, benthos, fish) and productivity"*
- *"Ocean current velocity, stream gauge data"*
- *"More frequent fecal coliform"*

Difficulty Accessing
- *"The SWMP website could be more user friendly. Fewer steps to get data would be nice."*
- *"Some tools are difficult to learn how to use"*
- *"Need summary table for all 28 x 4 WQ sites that can easily be searched by classification category: vegetation type, salinity range, depth, tidal range, etc."*

Difficulty Using
- *"I need more options for user friendly interpretive and visualization tools."*
- *"I'd like to create graphs with more than two parameters"*
- *"Hard to summarize/analyze so much data"*

Data Comparability Issues
- *"How to match monthly parameters to 15-min parameters"*
- *"Historical data files seem different from those today"*

QA/QC Issues
- *"Historical data not coded and flagged"*
- *"Historical data files seem different from those today"*
- *"I don't know how accurate chlorophyll data are"*

Other
- *"We need to continue focusing on data products; very few people are skilled in the analytical methods to do the necessary time series analyses with the data at present."*
- *"There should be a way to plot the real-time data."*
- *"Need more robust vegetation datasets from around the country"*
- *"Need a national synthesis to make sure the data are comparable over broad spatial scales"*

Respondents who answered that they were familiar with but had not used SWMP data were asked about obstacles. Figure 11 presents the top three obstacles: SWMP monitoring sites do not align with needs; water quality or meteorological data are not needed; and not knowing enough about the data to understand if they could be useful.
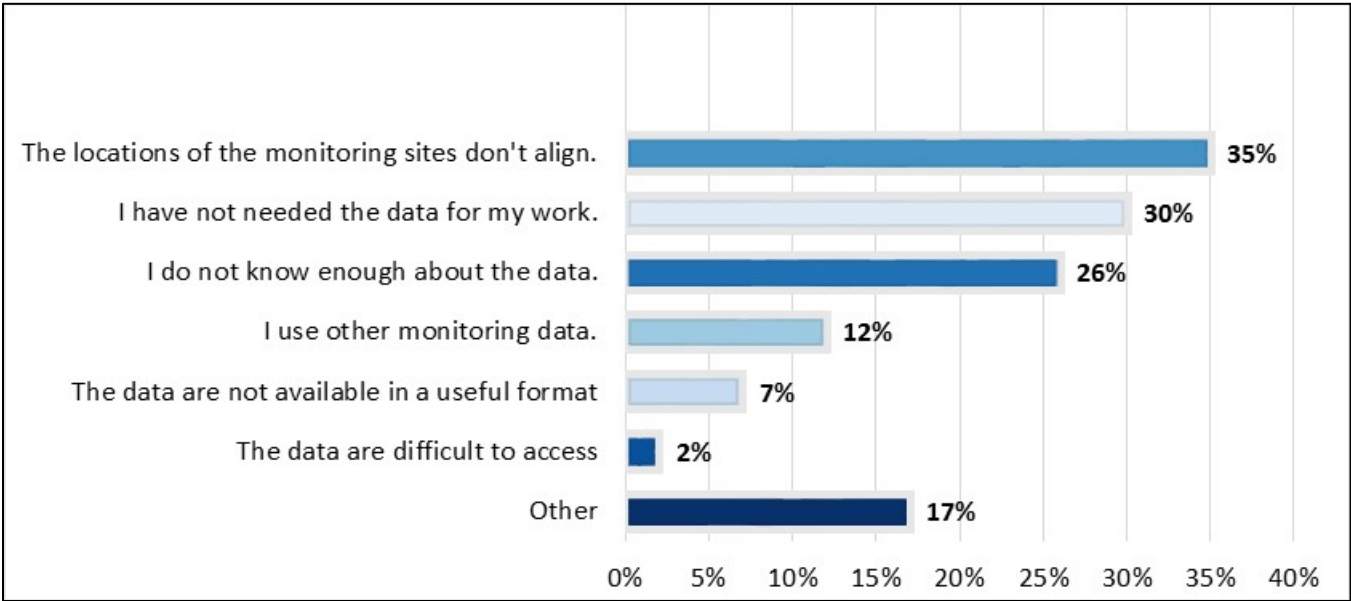
Figure 11. What are the reasons you have not used System-Wide Monitoring Program (SWMP) data? (check all that apply). [Note: This question was answered by those who responded that they were familiar with but had not used SWMP data.]

4.4   Data Synthesis Preferences

ERG reviewed monitoring data syntheses during the literature review stage of this project to assess some of the preferred types of data communication. Based on the types of synthesis and frequency of data found in these syntheses, ERG designed questions to ask about respondents' preferences for the scale, frequency, type, and packaging of data within monitoring data synthesis products. The results from the survey and literature review are presented in the following sections. Throughout this section, mentions of syntheses reviewed are in bold with an index number in parentheses to connect them to where they are found in Appendix A.

4.4.1   Preferred Spatial Scale and Frequencies of Data

Figure 12 presents the importance to respondents of various scales and frequencies of data within data summaries to inform coastal management decisions. In terms of the spatial scale, local was the most important, followed by regional, and then national. It should be noted that most respondents were local- and state-

> **Finding: Stakeholders find local data, followed by regional data, most important in making management decisions.**

level stakeholders, so results reflect the spatial scale in which most respondents are operating. However, there is some indication that this holds true for national-level stakeholders as well. The small handful (approximately 15) of national-level stakeholders who answered these questions noted that local data, followed by regional data, followed by national data, were the most important to making management decisions (in line with local, state, and regional stakeholders). This was supported by the findings in our interviews because interviewees noted that estuary-specific, local-scale monitoring data (e.g., **Save the Sound: Water Quality Monitoring [17]**) are more useful to resource managers and decision-makers for linking problems to causes and targeting solutions. Interviewees did note that there is an important function for larger-scale (regional and national) monitoring, which can be an effective way to measure regional trends and compare regions of the United States to help funders and national officials understand where to focus resources.

Figure 12. How important are the following data summaries in helping you make coastal management decisions? (1 = extremely important; 5 = not at all important)

As shown in Figure 13, there was also an indication that more data synthesized at annual and seasonal scales were slightly more important to decision-making than daily and real-time data.
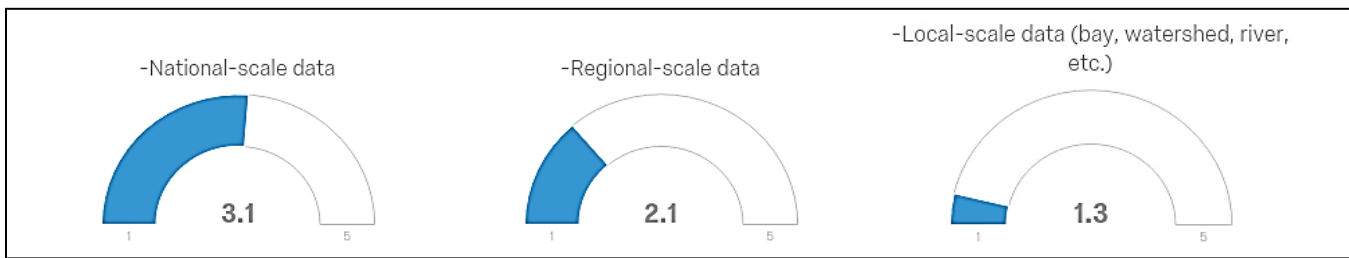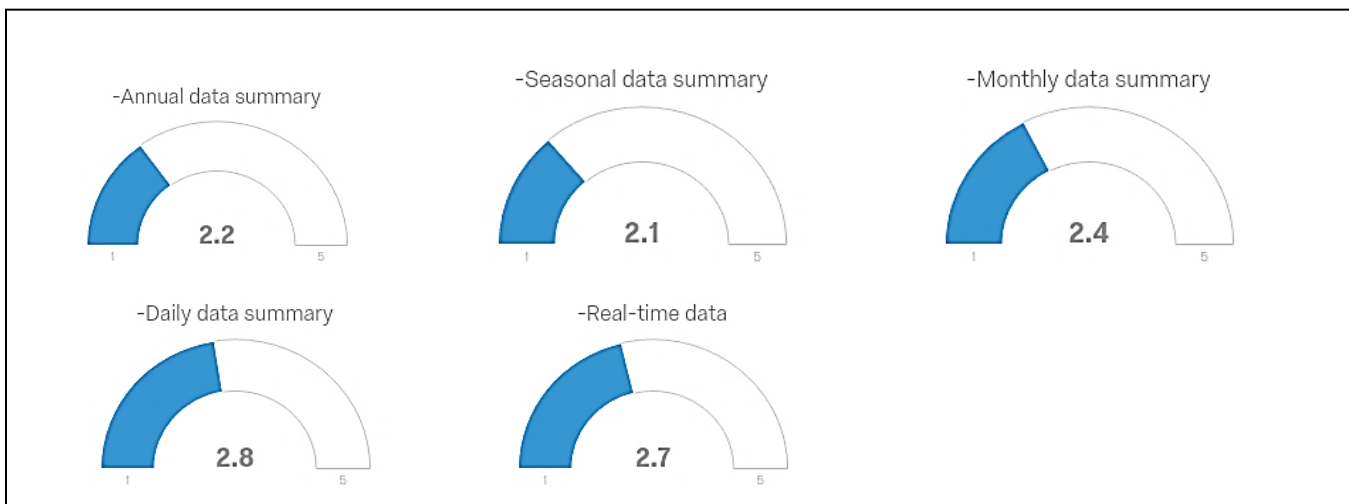

Figure 13. How important are the following data summaries in helping you make coastal management decisions? (1 = extremely important; 5 = not at all important)

4.4.2   Reaching Multiple Audiences and the Data

Several of the interview contacts noted the importance of being able to target multiple audiences (e.g., the informed or general public, researchers, and decision-makers) and have researched approaches to doing so. Two approaches are to create 1) a single tiered product with specific sections or data visualizations that resonate with each type of reader, or 2) multiple products within a publication, targeting specific audiences with each product.

> **Finding: Two ways to effectively target multiple audiences are 1) a "tiered" approach with specific report sections or data visualizations that resonate with each type of audience, and 2) the development of multiple products within a series, each targeted toward a specific audience.**

- **The State of the Estuary Report 2015 (1)** used a tiered approach and multiple products. The report included technical appendices to target scientists and coastal managers, a core report to target the informed public as well as scientists and coastal managers, and the executive summary to target decision-makers and the informed public. In addition, separate associated story maps targeted toward elected officials were generated for the website.

- The **State of Our Estuaries 2013 (13)** used a multiple-products approach. Their primary report is intended for a broad, but not technical, audience. They created a separate citizens' guide focused on what citizens

can do, and a policymakers' guide with examples of model communities that made decisions to improve water quality.

4.4.3   Preferred Synthesis Types

Figure 14 presents the usefulness to respondents of various types of products to help make coastal management decisions. Technical reports, executive summaries, and interactive websites were closely ranked (between "very useful" and "moderately useful") and were found to be more useful than brochures and videos (ranked between "moderately useful" and "slightly useful"). While a plurality of survey respondents were researchers/data analysts, there was a similar finding in the preferred types of syntheses for all respondents who

> **Finding: The top three ways in which stakeholders would like to receive SWMP information are technical reports, executive summaries, and interactive websites.**

indicated they were not researchers/data analysts/scientists; technical reports, executive summaries, and interactive websites were preferred to help make management decisions and ranked closely together, and brochures and videos were considered relatively less useful to making management decisions. This was the same for the small number of policymakers who answered these questions; however, given the small sample size (nine respondents), there needs to be some caution in interpreting this as definitive.
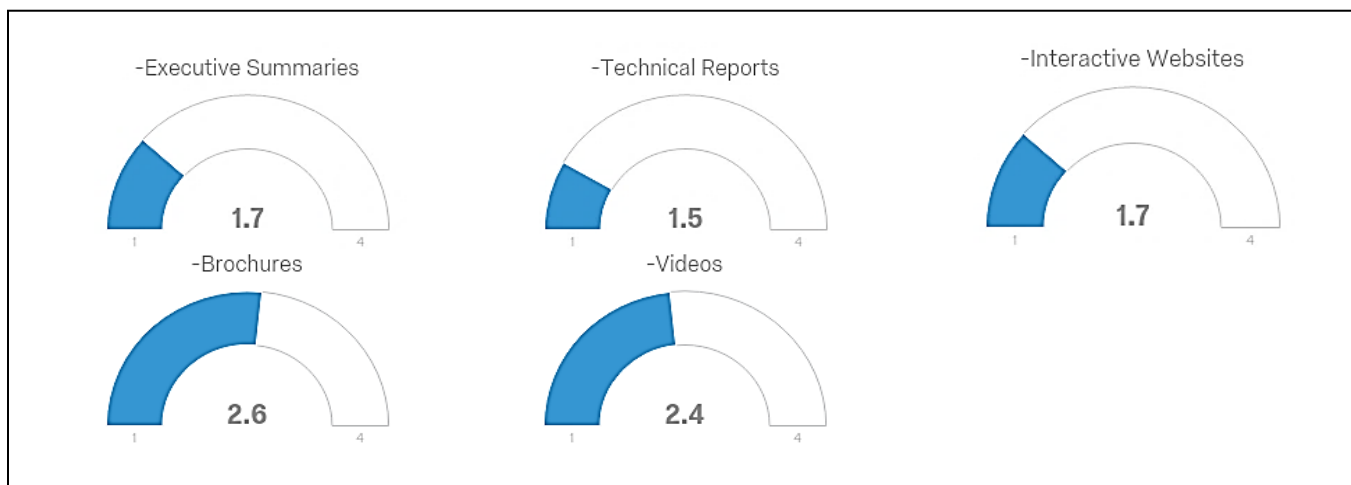

Figure 14. How useful are the following types of data and information products in helping you make management decisions? (1 = very useful; 4 = not at all useful)

4.4.4   Preferred Types of Analysis in Syntheses

During the literature review and preliminary needs assessment that preceded the survey, ERG performed an in-depth exploration of 17 priority synthesis documents. Documents that the ERG team rated highly (based on the judgment of our communications experts) had most of the following characteristics:

> **Finding: Stakeholders would like to see SWMP data reflect temporal trends, information that links conditions to causes, and information that links the causes of problems to possible solutions.**

- Identified clear coastal management goals, highlighted progress toward meeting the goals, and answered the following questions:
    - What is the status?
    - What are the main problems?

- o   What is causing these problems?
- o   What are the solutions, and are they making a difference/what else needs to be done?
- Highlighted indicators of coastal condition that people care about.
- Addressed multiple parameters but were not overloaded with too many metrics.
- Related ecological condition to human uses (e.g., recreation, fishing, shellfishing) and socioeconomic health.
- Showed progress or setbacks in meeting goals.

ERG found that the most engaging examples **link condition to the reasons for the condition** and **impacts on human uses** (socioeconomic). Most examples are short on the specifics of what needs to be done beyond building awareness and taking individual actions, but a few **address specific actions (e.g., strategies, plans, programs) to address the coastal issue**, **monitor/report effectiveness in meeting goals,** and **link progress or lack thereof to funding gaps**.

To facilitate the analysis of the synthesis reports, ERG binned the documents along a continuum of "levels of sophistication." These levels range from a simple presentation of conditions to a robust and meaningful condition report linking the data to issues that specific audiences care about and demonstrating temporal context (trends, progress toward meeting goals over time, etc.). Specifically, the three levels ERG used were:

- Level 1: Condition report—a snapshot of the data in time.
- Level 2: Level 1 plus conditions linked to causes, solutions suggested, and trends often included.
- Level 3: Level 2 plus strong links to what people care about (human uses, socioeconomic values, co-benefits of actions) and programmatic goals, funding, and governance (management decisions).

ERG used this assessment to develop questions to ground-truth the types of reports that are most important to the work of the survey audience. As shown in Figure 15, survey respondents generally indicated that a "Level 1" condition report was useful, but that the components that make up "Level 2" and "Level 3" syntheses were more useful to their work.

Figure 15. Please rank the importance of each of the following types of monitoring data synthesis products to your work (1 = extremely important; 5 = not at all important).

Some examples from the literature that approached "Level 3" include the **2015 State of the Sound reports (syntheses 2, 3, and 4 in Appendix A),** though they had limited information on future state; the **Chesapeake Bay Report Card (6),** though it similarly had limited information on future state; and the **Pulse of the Bay (11),** which was somewhat limited in scope but contained water quality predictions. The **State of the Delaware Bay (14)** is also notable for its "no action" outlook. The level that ERG assigned to each synthesis is presented in the second column of Table 2, below.

Table 2. Category of Resource for Priority Syntheses

Publication (Index # in Appendix A)	Level	Other Comments
Audience: Coastal Managers, General Public		
State of the Estuary 2015 (1)	3	Combines easy-to-follow indicators, executive summary, and technical appendices to appeal to tiered audiences.
2015 State of the Sound—Puget Sound (2)	3	Addresses where we want to be and how are we doing in meeting specific goals.
2015 State of the Sound—Puget Sound (3)	3	Addresses where we want to be and how are we doing in meeting goal
Bay Barometer 2014–2015 (5)	3	Limited future possibilities, but clear management targets.
Chesapeake Bay Report Card (6)	3	Shows program effectiveness in reaching goals.
Mississippi River Report Card (8)	3	Measures how the government is doing to meet goals.
The Pulse of the Bay (11)	3	Blends data-driven formats, interviews, and graphics to appeal to a variety of audiences.
State of Our Estuaries 2013—Piscataqua River Estuary (13)	3	Effectively presents the link between ecological condition and socioeconomics.
State of the Delaware Estuary (14)	3	Discusses balancing economic uses with restoration needs; includes "no action" outlook.
State of the Estuary Report 2015 (15)	2	Video summary of State of the Estuary 2015 (1).
Save the Sound: Water Quality Monitoring (17)	2	Features easy-to-follow data visualizations of beach health; regularly updated.
Great Barrier Reef Report Card 2014 (7)	2	Alludes to programmatic goals detailed elsewhere.
EPA's Report on the Environment: Coastal Waters Chapter (12)	1	Includes trends.
Audience: Funders and Decision-Makers with Budgetary Authority		
2015 State of the Sound—Puget Sound (4)	3	Shows progress toward implementing action agenda; discusses funding gaps.
National Coastal Condition Report IV (9)	3	Connects condition to socioeconomic demands on the resource.
The State of San Francisco Bay 2011 (16)	3	Emphasizes socioeconomic impacts/benefits.
2016 Action Agenda Report Card (10)	1	Compares indicators with progress made by specific recovery programs and actions.

4.4.5   Frequency of Publication

During the interview phase of the project, all interviewees reported updating their synthesis products on a regular basis. **Bay Barometer 2014–2015 (5), EPA's Report on the Environment (12),** and **Save the Sound: Water Quality Monitoring (17)** are updated annually. **EPA's Report on the Environment (12)** is now web-based, so that the level of effort required to update data in the report is relatively minimal. Therefore, the associated indicators can be easily updated when data are available. The **National Coastal Condition Report IV (9), State of Our Estuaries 2013 (13),** and **State of the Estuary Report 2015 (1)** are updated every five years. For the **National Coastal Condition Report IV (9),** the accompanying data collection effort is enormous, which may contribute to the lesser frequency of this publication. Contacts for the reports published every five years noted that they felt users still found value in the syntheses many years after publication.

> **Finding: When looking across a variety of coastal monitoring reports, status reports tend to be published annually, while more comprehensive syntheses tend to be published every five years.**

4.5   Measuring Effectiveness in Accomplishing Synthesis Objectives

Interviewees noted that measuring the effectiveness of their synthesis in accomplishing its objectives was a major gap in their monitoring program. Some methods and indicators of the effectiveness of syntheses are below with the associated objective(s) in parentheses:

- Number of rack cards handed out (measure number of people reached).
- Website analytics (measure number of people reached).
- Conversations with audience (gather qualitative information and stories showing how the synthesis made an impact; obtain feedback on quality of synthesis and how to refine synthesis in future years).
- Surveys (understand whether synthesis meets audience needs).

Overall, interviewees reported some forms of quantitative evaluation (web analytics, surveys, meeting attendance, demand for products, improved grades). However, they all cited limited resources as a major barrier to more consistently and quantitatively evaluating the impact of their synthesis products.

4.6   Level of Effort to Develop Syntheses

Of the six interviews conducted, we received a varying amount of information regarding the level of effort associated with each publication. Below are a few key points on the level of effort:

- The **State of the Estuary Report 2015 (1)** is an approximately 100-page synthesis with photos and a variety of indicators, the status and trends, and threats and challenges for each issue looked at, which was supported by a $380,000 grant.
- The **National Coastal Condition Report IV (9),** which has more than 300 pages with four high-level indicators over multiple regions and other location-specific data to provide context, is a large lift requiring the equivalent of seven to nine full-time employees working for a year.
- The **Bay Barometer 2014–2015 (5)** was a big lift that included a very lengthy discovery process and a web content strategist, an indicators coordinator, data providers and subject matter experts, a web designer, a web developer, and GIS staff.
- The **State of Our Estuaries 2013 (13)** is 50 pages and includes 22 indicators; each page is loaded with multiple tables, indicators, and photos. It cost approximately $130,000.

5 Options for SWMP Products and Future Work

Drawing from the above analysis and comparing needs identified by stakeholders to the current SWMP data collection efforts, this section offers a number of options for making existing information more accessible and using the data to develop synthesis products in response to the identified management needs. Where management needs are not aligned with existing data collection efforts, modifications or additions to the existing SWMP monitoring program are suggested.

Table 1 in Section 4.2 of this report provides common management questions identified by the survey. Management questions are grouped according to the top three management issues. The bottom row of the table provides some direct quotes (sometimes paraphrased) to provide additional context for these management questions. Section 5.1 shows examples of how SWMP data are being used to address some of these management issues, and Sections 5.2 through 5.4 address ways that some of these management questions can be addressed or supported with SWMP data by:

- Using existing SWMP data for trend analyses.
- Expanding vegetation monitoring.
- Enhancing SWMP products and outreach.

5.1 Existing Uses of SWMP Data to Address Management Issues

NOAA SWMP data are primarily used to understand issues and trends impacting each reserve. Table 3 provides some examples of studies in which reserves are currently using SWMP data to address priority management issues. These studies have focused on the abiotic parameters collected, and they help detect changes in baseline water quality conditions over time and space to detect localized impacts, seasonal patterns, and multi-year trends. These examples represent opportunities upon which the reserves can build to address priority coastal management questions identified in the survey and summarized in Table 1.

Table 3. Examples of Current Uses of SWMP Data to Address Management Issues

Priority Topic	Priority Management Issue	Example Current Uses of SWMP Data
Habitat Management	• Address invasive species • Wetland restoration methods and impacts • Adaptation strategies/restoration methods for maintaining resilient ecosystems	• Use SWMP habitat mapping data to inform the management of *Phragmites australis* (Hudson River NERR). • Document effectiveness of large-scale restoration using habitat mapping to document marsh loss and monitor restoration success (Elkhorn Slough NERR). • Compare data with South Carolina Department of Natural Resources' South Carolina Estuarine and Coastal Assessment Program to better explain changes in coastal habitat quality (ACE Basin and North Inlet-Winyah Bay NERRs).
Climate Change	• How to adapt/become more resilient? • Sea level rise/storm impacts and vulnerabilities • Sea level rise impacts to/responses from habitats • Impact of ocean acidification	• Monitor sea level change using surface elevation table data, salt marsh vegetation biomonitoring data, and salinity data in concert with the relevant SWMP water quality data (Gulf of Mexico and Apalachicola NERRs). • Use pH SWMP data trends to understand acidification in estuaries (South Slough NERR).
Water Quality	• Nutrient level drivers and impacts of high nutrient levels • Stormwater impacts/effective stormwater management • Understand, predict, and contain harmful algal blooms	• Use shallow water salinity, chlorophyll, temperature, and turbidity data to evaluate seagrass and submerged aquatic vegetation changes with respect to anthropogenic and climate change effects (Chesapeake Bay NERR, Virginia). • Use SWMP data to assess the environmental conditions contributing to the potential outbreaks of harmful algal blooms (Chesapeake Bay, Maryland, and Kachemak Bay NERRs). • Use SWMP data in combination with volunteer-collected stream water quality data to develop watershed "report cards" (Old Woman Creek NERR). • Use SWMP data with regional monitoring partnership program to access indicators of eutrophication and target management efforts (Wells NERR). • Use SWMP data with other data partnerships to develop indicators used in the State of Our Estuaries report (Great Bay NERR).

5.2   Using Existing SWMP Data for Trend Analyses at Regional and Local Levels

The NERRS SWMP data are unique in that the data are collected using a uniform national protocol across each reserve. To help address key management questions such as climate change, standardized data across regions could be used to document similar or dissimilar trends for various water quality indicators. These studies could also be used to compare results at reserves, and they could help elucidate the complexities in documenting climate change impacts or identifying key parameters of climate change. While some of this could be done in the ongoing development of the reserve status reports, NOAA should consider this type of analysis for broader NOAA

SWMP synthesis reporting.

Conducting a trend analysis of a few priority (and related) parameters such as nutrients, salinity, and water temperature at each reserve, and then comparing results across reserves in a region, might be one way to communicate changes in water quality conditions spatially and temporally, and to identify localized impacts, seasonal patterns, and longer-term trends. Analyzing this data set could also inform relationships among water quality, habitat, and climate change. A good start to addressing this need is the development of SWMP water quality status reports for each reserve that was initiated earlier this year. This needs assessment highlights the potential value of a routine analysis of the SWMP data, particularly at regional scales, focused on one or two management issues identified in Table 4. For example:

- **Sea level rise:** Many of the climate change impact questions are based on sea level rise. The NERRS SWMP monitoring locations along estuarine environments could provide information on salinity encroachment over time. Rises in salinity in relation to other parameters (e.g., water temperature, species changes) could help document sea level rise and its effects on water quality and habitat. Reserves could analyze data sets between reserves to see if there are regional or even national trends. Similarly, reserves can incorporate NOAA tide level data or SWMP sentinel-site station water level monitoring (if available) to model actual sea level rise across latitudes.

- **Nutrient impacts:** Nutrient trend analyses could help stakeholders understand nutrient impacts, which is a key management question identified by survey respondents. Nutrient trends over time can tell us about the changes occurring to a receiving water body. Reviewing the timing of spikes in nutrients with precipitation data, particularly at a regional scale, could help document water quality changes due to the impacts of increased storm frequency and strength of storms (climate change-related factors) on estuaries.

- **Land use impacts:** To begin to understand and ultimately inform decisions regarding nutrient pollution and impacts on habitat, NERRS might consider evaluating nutrients at reserves (which may require other sources of nutrient data across the watershed) and documenting how land use changes within a reserve's watershed are impacting nutrient runoff into estuaries. Studies could correlate salinity, dissolved oxygen, nitrogen loading, and chlorophyll data with rapidly developing or intensively farmed watersheds (associated with high levels of nutrient runoff) to depict anthropogenic impacts. Documenting correlations between nutrient level and percent of developed land in the watershed over time could help link condition to cause.

- **Harmful algal blooms (HABs):** Improved prediction of HABs and other aquatic toxins was another water quality management need noted, particularly in the Great Lakes. The SWMP data currently include nutrient, water temperature, and chlorophyll data that, in combination with information about the timing and severity of HAB outbreaks, can aid in understanding the conditions that favor outbreaks and when such outbreaks are likely to occur. One could also review long-term nutrient trends and examine variability between reserves. For example, comparing nitrogen versus phosphorous ratios is an indicator of which nutrient drives primary production at a reserve, especially those with major freshwater resources like the Great Lakes. This information could assist with identifying HAB drivers at reserves with freshwater mixing zones or sites within the Great Lakes. Linking the timing of HAB outbreaks with nutrient levels/ratios, temperature, and other parameters might provide some useful insights into the timing of HAB outbreaks for improved predictability in the future. Because HABs are a growing national concern, SWMP data could become more visible and more relevant to national audiences and policies by focusing in this manner.

5.3   Expanding Vegetation Monitoring
Expanded vegetation monitoring, coupled with habitat mapping data from existing non-SWMP data sources, could help address the following management questions:

- **Climate change impacts on habitat**: Many of the abiotic indicators used to depict climate change impacts could be better quantified and understood in relation to changes in habitat. Climate change impacts such as increased storm frequency and intensity, extreme wet and dry periods, and increased salinity and tidal range can change vegetative species composition and invasive species coverage. Exploring the relationship between these changes could provide useful insights for understanding climate impacts on habitat, as informed by changes in vegetation.

- **Chronic and acute pollution:** While abiotic parameters are important to understanding water chemistry changes in an estuarine environment and can detect pollution episodes or changes over time, biotic changes help quantify the actual impact of pollution on the habitat. Providing baseline data on vegetation allows for pre- and post-documentation of episodic impacts, as well as landscape-level changes to biota over time.

- **Emergent vegetation and submerged aquatic vegetation (SAV)**: Understanding the interaction between climate and changes in vegetation and invasive species were common management questions identified by survey respondents. SAV and emergent vegetation monitoring data, as well as correlating that data to nutrient data and parameters indicative of climate change (e.g., temperature, salinity) will allow researchers to better study this interaction and measure the effectiveness of invasive species management initiatives.

The addition of emergent vegetation and SAV data at all reserves should be a priority to answer major management questions and identified management gaps, including wetlands change/restoration, invasive species presence and changes over time (percent cover, percent native species, and height classes), and climate change prediction activities. The SWMP ecosystem "Phase 2—Biological Monitoring" and "Phase 3—Watershed and Land Use Classifications" are key components for evaluating habitat changes as a result of climate change. These additional phases could be implemented across all reserves moving forward. Some options for implementing these evaluations include:

- Implementing emergent and SAV monitoring at all reserves and making the protocols easily accessible.

- Recommending where data users can access watershed maps (C-CAP) and existing land use data.

- Continuing to update Google Earth and GIS layers at the reserve level with new data as they become available.

5.4   Enhancing SWMP Products and Outreach

As noted in Section 4 (Findings), 37 percent of non-NERRS respondents indicated they are not familiar with SWMP data, and 35 percent indicated they are familiar with the data but have not used the data. The options below should be considered for increasing familiarity with SWMP data and promoting its use.

5.4.1   Synthesis Report and Executive Summary

As noted in the "Findings" section, technical reports and executive summaries were both identified as products that are useful in making coastal management decisions [Finding 5 of this report]. Additionally, based on ERG's literature review and interviews with synthesis authors, tiered products (i.e., ones that target specific audiences using assorted types of data visualizations and other communication strategies) are an ideal way to strongly engage key audiences.

Recommendations for the types of content to be included in a synthesis report and summarized in an executive summary (with the basis of the recommendation in brackets) include the following:

- Summarize key findings at both a local and regional level to target policymakers, funders, and decision-makers, selecting priority parameters (listed in Section 4.3.1) that can provide insight into priority management topics related to water quality, habitat, and climate [based on Finding 4 from this report]. Incorporate other data sets (e.g., from NOAA tide level gauges, NOAA Integrated Ocean Observing System

Regional Associations, EPA's National Estuary Programs) when they can supplement the data to more thoroughly address management questions.

- Ensure that the core of the report includes trends over time, since these were deemed important to help make management decisions per the survey results. Where possible, link site condition to causes and solutions, and encourage reserves to contribute by providing specific issues or a case example [based on Finding 6 from this report and Finding 4—importance of local data].

- Highlight reserve-level examples of issues people care about in the area of each reserve and, if possible, link to priority management needs identified in the survey that are most relevant to reserves [related to Finding 6 from this report; these two attributes were deemed very important, but not quite as important as the three attributes in the bullet immediately above].

- The level of effort that would likely go into a report of this nature would be in line with related efforts for reports that were published every five years [based on Finding 7 from this report].

- Adopt a hybrid approach whereby the core of the report could use easy-to-understand data visualizations readable by an informed public, while keeping or pointing to data more useful to technical audiences [based on Finding 8 from this report].

5.4.2   Local Status Reports

Based on the survey results, status reports were identified as a useful way to help stakeholders make management decisions and could also serve as a tool to show the value of SWMP data. A good start to addressing this need is the development of SWMP water quality status reports for each reserve, initiated earlier this year. The reserve system should make it a priority to routinely analyze and summarize the SWMP data, creating templates for both local and regional reports [based on Finding 4 of this report] focused around one or two management issues. Recommendations include:

- Include a few priority parameters (listed in Section 4.3.1) that can provide insight into priority management topics related to water quality, habitat, and climate [based on Findings 1 and 3 of this report].

- The level of effort that would likely go into a report of this nature would be in line with related efforts for reports that were published annually [based on Finding 7 from this report].

- Use a tiered approach (i.e., include both data and indicators to reveal what the data mean) to target both technical and non-technical audiences [based on Finding 8 from this report].

5.4.3   Interactive Website

The needs assessment survey identified an interactive website as a useful product to inform management decisions [Finding 5 of this report]. Both the Centralized Data Management Office website (http://cdmo.baruch.sc.edu/) and SWMPrats.net (http://swmprats.net/) serve as portals to access and analyze data. Compared to other websites reviewed during the literature review portion of this project, they are geared toward a substantially more technical and data-driven audience. Further development of the https://coast.noaa.gov/nerrs website could be an important option to help other audiences find and learn more about SWMP data and how they can use the data. This could potentially include revising the dropdown menu to make sure the monitoring (under research) comes up as a level on the menu.

ERG recommends a SWMP central landing page to which NOAA and the reserves can refer all audiences. The creation of a new website or an update to the landing page of the existing Centralized Data Management Office website could be a way to accomplish this. Here are some ideas for the interactive website (with the basis for the finding in brackets):

- Challenge each reserve to come up with an issue at the reserve they have been monitoring for SWMP data, similar to what was done in the *10th Anniversary Report on the System-wide Monitoring Program*

(https://www8.nos.noaa.gov/reserves/Doc/PDF/Research/SWMPReport.pdf). This would provide a compelling case study for how SWMP data are used to understand problems and generate possible solutions [based on Finding 6 of this report—linking data to issues and possible solutions].

- Consider generating a few indicator-type summaries (e.g., high, medium, low; green, yellow, red; improving, getting worse) for each reserve and region for a few key parameters (perhaps as a product of the SWMP status report summaries being developed). This will help generate interest and understanding without the need to download and analyze data sets. [This is based on 14 percent of SWMP users reporting trouble accessing data and comments such as "I need more options for user-friendly interpretation…" and "hard to summarize/analyze so much data."]

- Consider a way to make the data more easily accessible. Requiring users to enter an email to get data downloads may be a barrier. [This is based on 22 percent of SWMP data users reporting difficulty accessing data and on survey comments.]

5.4.4 Challenge and Incentivize Researchers to Use SWMP Data to Answer Key Management Questions

Section 4 (Findings) of this report identified key management questions and gaps by coastal management issue. These needs could be presented in a more targeted manner in Science Collaborative requests for proposals alongside a challenge to incorporate SWMP data as part of the answer to the question. This may involve the need to use outside data sets or collect some primary data to combine with SWMP data to address these key needs and gaps. In line with information that survey respondents found important for decision-making, the challenge could ask researchers to look at trends over time, identify information that links conditions to causes, and identify information that links causes of problems to solutions [based on Finding 5 in this report]. This could also be promoted in universities to develop research projects using SWMP data and incentivize research opportunities.

5.4.5 NERRS Training and Outreach

Reserves have cultivated important connections with coastal decision-makers as well as other potential data users. NOAA could consider developing and expanding coastal training and education programs on SWMP data to educate these users on the data and how they can be used, get users' input on how the data could be more useful, and challenge them to use the data. Drawing on the key management issues identified in this needs assessment, reserve staff can identify the management issues and questions that are applicable to their communities, perhaps using a template developed by a team of Coastal Training Program coordinators that can be refined and adapted for regional or specific reserve uses that can be addressed using SWMP data. Perhaps this training could help inform the Science Collaborative Challenge to apply SWMP data, mentioned in Section 5.4.4 [based on Finding 2 and on more than 26 percent of survey respondents who have heard of but have not used SWMP data and don't know whether the data could be useful; also based on Finding 5—importance of linking data to issues and solutions].

5.4.6 Outreach Documents and Emails

To increase the awareness and use of the data, outreach documents (such as one-page handouts) and emails could be created to show what SWMP data are, why they are important, what they are telling us, and how they can be used. These products could be disseminated to audiences such as NOAA offices and programs that conduct monitoring or can use monitoring data; national and regional partners (e.g., EPA, U.S. Geological Survey, volunteer water quality monitoring programs); state agencies; and non-governmental organizations. These audiences can also be pointed to the new interactive website (suggested above). Promotion of the SWMP Real-Time Web App could be included as part of this outreach campaign.

5.4.7 Potential Partnerships with Other Monitoring Efforts

To increase the use and awareness of SWMP data [per Finding 2], NERRS could share its data on existing data-sharing platforms (e.g., EPA's Water Quality Portal; Consortium of Universities for the Advancement of Hydrologic

Science, Inc.; WaterKeepers). The EPA Water Quality Portal is an example of a central database where users can download water quality data from EPA, the U.S. Geological Survey, and state and local partners. Discrete sampling data (like the NERRS nutrient sampling data) can be can be included with metadata, and users can access that data directly there. A continuous data portal (interoperable watershed initiative) allows users to access live data through an appliance set up on NOAA's website. This could be a good opportunity to make SWMP data available to a large audience already using the Water Quality Portal.

NERRS could also consider ways to combine SWMP data sets with other data sets (e.g., NOAA Integrated Ocean Observing System Regional Associations, EPA's National Estuary Programs) to address additional management questions. For example, interviewees who work on the **National Coastal Condition Report IV (9)** and **EPA's Report on the Environment (12)** independently mentioned that the EPA monitoring data and NOAA SWMP monitoring data have some commonalities, and NOAA and EPA might want to have collaborative discussions about how these data could be used together. EPA monitoring tends to be done at a single point in time across randomly selected sites in a region during each monitoring effort (e.g., every five years for the National Coastal Condition Report), and many of these monitoring sites change between monitoring episodes. This is done to get an unbiased sample of a large region; however, these data can't be used to tell a more local story, and they cannot tell stories about events such as large storms because the data are pulled infrequently. SWMP monitoring is continuously implemented at 28 individual locations, and thus can complement EPA data to help audiences observe what is happening over more precise spatial and temporal scales.

Appendix A: Resource Summaries

Table A-1 presents links to summaries for the 17 priority data syntheses. ERG examined these summaries in detail to ascertain target audience(s), coastal management questions addressed, types of monitoring data used, and approaches to data visualization.

Table A-1. List of 17 Priority Studies

Index	Title, author, year, lead organization	Link
1	State of the Estuary Report 2015: Status and Trends Updates on 33 Indicators of Ecosystem Health; 2015; San Francisco Estuary Partnership	http://ebooks.sfei.org/soter2015/files/52.html http://www.sfestuary.org/wp-content/uploads/2015/10/SOTER_2.pdf
2	2015 State of the Sound: Report on Puget Sound Vital Signs; 2015; Puget Sound Partnership	https://pspwa.app.box.com/v/2015-sos-vitalsigns-report
3	2015 State of the Sound: Report to the Community; 2015; Puget Sound Partnership	https://pspwa.app.box.com/v/2015-sos-community-report
4	2015 State of the Sound: Report to the Governor and Legislature; 2015; Puget Sound Partnership	https://pspwa.app.box.com/v/2015-sos-governor-report
5	Bay Barometer 2014-2015: Health and Restoration in the Chesapeake Bay Watershed; 2016; Chesapeake Bay	http://www.chesapeakebay.net/documents/2014-2015_Bay_Barometer_FINAL_02.02.2016.pdf
6	Chesapeake Bay Report Card, 2015, University of Maryland Center for Environmental Science	http://ecoreportcard.org/site/assets/files/1627/2015-chesapeake-bay-report-card.pdf
7	Great Barrier Reef Report Card 2014: Reef Water Quality Protection Plan; 2014; Australian Government	http://www.reefplan.qld.gov.au/measuring-success/report-cards/2014/assets/gbr-2014report-card.pdf
8	Mississippi River Report Card, America's Watersheds, 2014	http://americaswatershed.org/reportcard/
9	National Coastal Condition Report IV; 2012; U.S. EPA, Office of Research and Development, Office of Water	https://www.epa.gov/sites/production/files/2014-10/documents/0_nccr_4_report_508_bookmarks.pdf
10	2016 Action Agenda Report Card; 2016; Puget Sound Partnership	http://psp.wa.gov/gis/ReportCard/
11	Pulse of the Bay: State of the Bay Water Quality, 2015 and 2065, 2015, San Francisco Estuary Institute	http://www.sfei.org/sites/default/files/biblio_files/2015_RMP_PULSE.pdf
12	EPA's Report on the Environment: Coastal Waters; 2016; U.S. EPA	https://cfpub.epa.gov/roe/chapter/water/coastal.cfm
13	State of Our Estuaries 2013; 2013; Piscataqua Region Estuaries Partnership	http://prep.unh.edu/resources/pdf/2013%20SOOE/SOOE_2013_FA2.pdf
14	State of the Delaware Estuary 2012 (Estuary News, Vol. 22, Issue 4); Jennifer Adkins; 2012; Partnership for the Delaware Estuary	https://s3.amazonaws.com/delawareestuary/pdf/EstuaryNews/2012/SummerNews12.pdf
15	State of the Estuary Report 2015; 2015; San Francisco Estuary Institute	https://www.youtube.com/watch?v=5MAePbPZx48
16	The State of San Francisco Bay 2011; 2011; San Francisco Estuary Partnership	http://sfestuary.org/wp-content/uploads/2012/12/11SFEP_STATEofSFBAY2011.pdf
17	Water Quality Monitoring: 2015 Save the Sound Water Quality Data; 2015; Connecticut Fund for the Environment/Save the Sound	http://www.ctenvironment.org/wq-2015-data

Appendix B: Survey Questions

Needs Assessment Survey for Monitoring Data Synthesis

Introduction

This is a voluntary survey.

Welcome! Thank you for participating in this survey on coastal management issues and the use of monitoring data. The purpose of this survey is to understand how long-term estuarine monitoring programs can better address regional and national coastal management needs. NOAA will use these survey results to help guide investments in monitoring data synthesis for research, education, and outreach programs. For more information about research and monitoring conducted at the National Estuarine Research Reserve System, please visit: https://coast.noaa.gov/nerrs/research/.

Your responses to this survey will be kept anonymous and any published results of the survey will be summarized in a manner that does not identify individuals. The survey should take about 20 minutes, from beginning to end. Send any comments regarding this estimate of time, or any other suggestions for reducing this burden to: Mary Culver, 2234 South Hobson Ave. Charleston, SC 29405, mary.culver@noaa.gov.

Notwithstanding any other provisions of the law, no person is required to respond to, nor shall any person be subjected to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid Office of Management and Budget (OMB) Control Number. OMB Control No. 0648-0342.

First, please tell us a little about yourself.

1. **Are you an employee of a National Estuarine Research Reserve?**
    a. Yes (please indicate which one) [Dropdown]
    b. No

2. **Which category best describes the sector in which you work?**
    a. Federal government
    b. State/territorial government
    c. Local government (e.g., county/municipality)
    d. Academia
    e. Non-governmental organization
    f. Private sector
    g. Other? Please describe:_____

3. **Which category best describes your occupation?**
    a. Resource manager
    b. Planner
    c. Policy maker
    d. Researcher/Data analyst/Scientist
    e. Educator (including outreach, communication of information)
    f. Consultant
    g. Other? Please describe:_____

4. **Which category _best_ describes the scale at which you work?**
    a. National
    b. Regional (multi-jurisdictional)
    c. State
    d. Local
    e. Other? Please describe:_____

5. **Select the geographic region in which you do the _most_ work:**
    a. Northeast
    b. Mid-Atlantic
    c. Southeast
    d. Gulf of Mexico
    e. West Coast (including Alaska)
    f. Caribbean
    g. Great Lakes
    h. National

6. **How many years have you been working on coastal-related issues?**
    a. Less than 5 years

b. 5 to 10 years

c. 11 to 15 years

d. More than 15 years

e. Prefer not to answer

Coastal Management Issues

7. **What are the top three coastal management issues you face in your work?**

    a. Climate change (e.g. climate adaptation, climate mitigation, coastal hazards and disasters, sea-level modeling, risk, or resiliency)

    b. Fisheries management

    c. Visitor use (e.g. ecotourism, recreation)

    d. Habitat management, improvement and/or restoration (e.g. invasive species, wetlands restoration, managing for specific species, biodiversity conservation)

    e. Land use / marine use change (watershed/port development and resultant impacts)

    f. Water quality (e.g. storm water, nutrients, toxics, sediment, temperature, harmful algal blooms)

    g. Watershed and floodplain management (watershed-wide management planning)

    h. Other _____

    i. Other _____

    j. Other _____

8. **[For the Top 3 in #7, ask the following open ended] What is the primary or most important management question you need to answer in [INSERT NAME FROM 7]?**

    a. **[Asked in reference to the management question they fill in above – so will be answered 3 times] Is this coastal management question in response to specific mandate(s) (i.e. a requirement from an agency, government or other entity)?**

        i. Yes (please describe)

        ii. No

        iii. I don't know

9. **[For the Top 3 in #7, ask the following open ended] Where do you find data/information that are important to answer questions about [INSERT NAME FROM 7] (check all that apply)?**

    a. Local or regional organization (please describe data)_____

    b. State environmental agency (please describe data)_____

    c. Other federal environmental agency (please describe data)_____

    d. Non-governmental organization (please describe data)_____

    e. Academic institution (please describe data)_____

    f. Other (please describe data)_____

10. **[For the Top 3 in #7, ask the following open ended] What are the most critical gaps in information you need to answer management questions about [INSERT NAME FROM 7]?**

Coastal Monitoring Data Needs and Management Issues

11. **The table below lists general <u>categories</u> of coastal monitoring data. Please rate the importance of each category in informing how you use the data to address your coastal resource management needs from "Not at all important" to "Extremely important."**

Categories	Extremely Important This type of data is essential to my work	Very Important	Moderately Important	Slightly Important	Not at all Important I do not need these data
Water quality and nutrient data trends over time (e.g., water temp, pH, turbidity, dissolved oxygen, salinity, orthophosphate, ammonium nitrite, nitrate, chlorophyll)	O	O	O	O	O
Real-time water quality data	O	O	O	O	O
Meteorological data trends over time (e.g., air temp, relative humidity, barometric pressure, wind speed, wind direction, precipitation)	O	O	O	O	O
Real-time meteorological data	O	O	O	O	O
Vegetation monitoring data, including submerged aquatic vegetation (such as eelgrass) and emergent vegetation (such as salt marsh and mangrove vegetation) diversity, percent cover, stem density, and canopy height	O	O	O	O	O
Land use/land cover data	O	O	O	O	O

12. **Please indicate whether or not the following types of data could help you make management decisions:**

Categories	Yes	No	Not Sure
Water temperature	O	O	O
Specific conductivity	O	O	O
Salinity	O	O	O
Dissolved oxygen	O	O	O
pH	O	O	O
Turbidity	O	O	O
Chlorophyll	O	O	O
Orthophosphate concentration	O	O	O
Ammonium concentration	O	O	O
Nitrite concentration	O	O	O
Nitrate concentration	O	O	O
Nitrite + nitrate concentration	O	O	O

13. **Please indicate whether the following types of meteorological data could help you make management decisions:**

Categories	Yes	No	Not Sure
Air temperature	O	O	O
Relative humidity	O	O	O
Barometric pressure	O	O	O
Wind speed and direction	O	O	O
Photosynthetically active radiation	O	O	O
Daily precipitation	O	O	O

14. **Please indicate whether the following types of vegetation data could help you make management decisions:**

Categories	Yes	No	Not Sure
Percent cover by species	O	O	O
Species density	O	O	O
Canopy height	O	O	O

15. **What types of data, if any, do you use in combination with coastal monitoring data to answer management questions (select all that apply)?**
    a. **Land-use/land-cover data**
    b. **Impervious surface data**
    c. **Wastewater or sewer data**
    d. **Population data**
    e. **Economic data**
    f. **Level of human development data**
    g. **Other (please describe) _____**
    h. **None or N/A**

Overall Data Format and Delivery Needs

16. **How important are the following data summaries in helping you make coastal management decisions:**

Categories	Extremely Important This type of data is essential to my work	Very Important	Moderately Important	Slightly Important	Not at all Important I do not need these data
National-scale data	O	O	O	O	O
Regional-scale data	O	O	O	O	O
Local-scale data (bay, watershed, river, etc.)	O	O	O	O	O

Categories	Extremely Important This type of data is essential to my work	Very Important	Moderately Important	Slightly Important	Not at all Important I do not need these data
Annual data summary	O	O	O	O	O
Seasonal data summary	O	O	O	O	O
Monthly data summary	O	O	O	O	O
Daily data summary	O	O	O	O	O
Real-time data	O	O	O	O	O

17. **How useful are the following types of data and information products in helping you make management decisions:**

Categories	Very Useful	Moderately Useful	Slightly Useful	Not at all Useful
Executive Summaries	O	O	O	O
Technical Reports	O	O	O	O
Brochures	O	O	O	O
Videos	O	O	O	O
Interactive Websites	O	O	O	O

18. **Please rank the importance of each of the following types of monitoring data synthesis products to your work:**

Categories	Extremely Important	Very Important	Moderately Important	Slightly Important	Not at all Important
Current conditions report that provides a snapshot in time	O	O	O	O	O
Conditions report that includes trends over time	O	O	O	O	O
Information that links conditions to causes	O	O	O	O	O
Information that links causes of problems to possible solutions	O	O	O	O	O
Information that links conditions to what people care about (e.g., human uses, socio-economic values)	O	O	O	O	O
Information that links conditions to management goals and performance measures	O	O	O	O	O

SWMP Data Feedback

19. **What best describes your familiarity with System-Wide Monitoring Program (SWMP) data from the National Estuarine Research Reserves?**
    a. I have previously used or currently use the data. [Skip to #21]
    b. I am familiar with the data but have not used the data. [Continue to #20]
    c. I am unfamiliar with the data. [Skip to #23]

20. **What are the reason(s) you have not used System-Wide Monitoring Program (SWMP) data (check all that apply)?** [Skip to #23 regardless of answer]
    a. I have not needed water/nutrient monitoring or meteorological data in my work.
    b. The locations of the monitoring sites do not align with my needs.
    c. I use water/nutrient monitoring data from other sources (please note source_____)
    d. I do not know enough about the data to understand if they could be useful to me.
    e. The data are not available in a format that is useful to my work.
    f. The data are difficult to access.
    g. Other (please describe)_____

21. **Please select how you are applying or using SWMP data in your decision-making. (check all that apply)**
    a. General habitat management
    b. Fisheries habitat
    c. Wildlife habitat
    d. Vegetation management
    e. General water quality management
    f. Nutrient control
    g. Sediment management
    h. General climate trends
    i. Sea level rise
    j. Temperature
    k. Other (please describe)_____

22. **Please select any limitations or gaps you have noted when using SWMP data. (check all that apply)**
    a. Temporal issues (please describe)_____
    b. Spatial issues (please describe)_____
    c. Parameters missing (please describe)_____
    d. Difficulty accessing (please describe)_____
    e. Difficulty using data (please describe)_____
    f. Data comparability issues (please describe)_____
    g. QA/QC issues (please describe)_____
    h. Other (please describe)_____

Additional Comments

23. **Please let us know if you have any additional comments about the use and synthesis of monitoring data to address coastal management issues. [Open Ended]**

Thank you for participating in this survey on coastal management issues and monitoring data needs. We appreciate your time and feedback!