

**DEVELOPMENT OF COAST MODELS OF THE WATERSHED GAME:  
A REPORT SUMMARIZING THE METHODS AND DATA CAPTURED TO  
IDENTIFY AND SYNTHESIZE PRIORITY COASTAL ISSUES**

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**Water Resources Center**  

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## EXECUTIVE SUMMARY

The purpose of this report is to summarize how priority coastal issues were identified for inclusion in the development of the Coast Models of the Watershed Game. The Watershed Game is an interactive engagement tool that educates participants on the connection between land use and water quality. The original tool was developed for headwaters streams, lakes, and rivers. To better address water resource challenges in coastal environments, this scoping study sought to understand and identify the critical water-related challenges faced in coastal areas to inform the development of Coast Models of the tool.

Through a multi-pronged approach to gather information, the authors, as the product development team, collected data to identify and describe priority coastal issues to inform the development of the Coast Models of the Watershed Game. Each data collection approach was designed to build off the previous and inform the development of the next to verify previous results and corroborate findings. Four methods were used in this process: a review of reports on coastal issues in the Gulf of Mexico and South Atlantic regions, a survey targeting coastal professionals along the Gulf of Mexico and South Atlantic coastlines, a focus group with coastal professionals in the Gulf of Mexico and South Atlantic, and a survey targeting the National Sea Grant Network. The methods and descriptive elements differed somewhat among the four approaches. Table 1 groups the top coastal issues within general categories for each approach.

**Table 1.** Summary of Priority Coastal Issues by Data Collection Approach

	Review of Reports	Gulf of Mexico & South Atlantic Survey	Focus Group	Sea Grant Survey
<b>Excess Nutrients</b>				
• Water quality degradation	X			
• Excess nutrients		X	X	X
• Harmful Algal Blooms (HABs)		X		
<b>Excess Sediment</b>				
• Land use changes & development	X			
• Stormwater management runoff	X			
• Coastal erosion			X	
<b>Resilience to Flooding</b>				
• Flooding	X	X	X	X
• Impact of storms	X			
• Climate change & sea level rise			X	
• Resilience (lack of)				X

In summary, the results from these combined approaches revealed recurring patterns that provided a greater understanding of, and thus increased confidence in, priority coastal issues on which to focus the Coast Models of the Watershed Game. Overall, the findings point strongly toward the importance of two key concepts that have been integrated into the development of the Coast Models: water quality, as it relates to excess sediment and nutrients (specifically nitrogen and phosphorus), and resilience to flooding. This work was conducted through a collaboration of the Mississippi-Alabama Sea Grant Consortium, Minnesota Sea Grant, University of Minnesota Water Resources Center, The University of Alabama’s Alabama Water Institute, NOAA’s Office for Coastal Management, and the Dauphin Island Sea Lab.

## INTRODUCTION

Water resource challenges are increasing in severity and frequency, resulting in negative ecological, social, and economic impacts to communities. Relative to other areas, coastal environments are among the most densely populated, biologically rich, and economically important. They are also highly vulnerable to water-related threats (Gray, 1997; & Lotze, et al., 2006). Managers of complex coastal ecosystems—like the Gulf of Mexico (Gulf) and Southeast coasts—often struggle to balance the competing and sometimes divisive interests, cultures, and perspectives of different stakeholder groups while seeking to sustain and improve the health of water resources.

Small-group simulations encourage teamwork and cooperation by enhancing understanding of management challenges and solutions while building collaboration skills across various stakeholder groups (Bathke, et al., 2019). The Watershed Game, a proven nonpoint source water pollution educational program and interactive simulation, helps break down barriers among diverse participants to enable dialogue, civility, and mutual respect. The Watershed Game, available in both a Local Leader Version and a Classroom Version, increases understanding of how human alterations to lands within a watershed impact downstream water quantity and quality and illustrates ways to prevent or alleviate those impacts. The Watershed Game program was developed by Minnesota Sea Grant and the University of Minnesota Extension over 12 years ago, and the game is now in use in 22 states.

In the Watershed Game, participants work in “land use” teams around a large, stylized watershed “map.” As participants play through the simulation, they learn how a variety of land uses impact water

### **Watershed Game Learning Objectives:**

- Understand that all land uses within a watershed contribute pollutants and impact water quality.
- Identify specific sources of pollutants from each land use.
- Apply plans, practices, and policies to prevent or reduce impacts.
- Choose solutions based on available funds, benefits, and feasibility.

resources, increase their knowledge of best management practices (BMPs) (represented by “Tool Cards”), and learn how specific choices can reduce adverse impacts. The Local Leader Version of the tool is designed for use with elected and appointed officials, community leaders, watershed organizations, and other adult audiences who have a role in developing plans, applying practices, or

adopting policies integral to water resource management. This version is currently available in three models: headwaters stream, lake, and large river. The Classroom Version is a modification of the

headwaters stream model of the Local Leader Version that has been adapted for use with middle to high school students in formal and informal learning settings.

The object of the established games is to use limited financial resources to reduce excess sediment and/or phosphorus to levels that meet a clean water goal, even as participants encounter “Unanticipated Events” such as severe storms. The final round of play requires participants to work cooperatively across land use teams to meet the watershed “Clean Water Goal” and collectively “win” the game. In so doing, participants learn to consider, involve, and cooperate with all land uses within a watershed. The game illustrates that cooperation at a watershed scale is an essential part of effectively managing water and land use.

**Key Components of the Watershed Game:**

Watershed Game Board: The game board is a fictional landscape used to represent key impacts and possible solutions across land uses often encountered along different waterbodies.

Clean Water Goal: The goal of the game is to reduce nonpoint source pollution. This is achieved by selecting and implementing tools to meet a “clean water goal” that represents the types of water quality standards set by the Federal Clean Water Act as well as local and state governments to protect human health and aquatic ecosystems.

Tool Cards: Tool Cards represent various policies, plans, and practices (often referred to as best management practices) that improve land use management and reduce nonpoint source pollution. Each land use has a set of Tool Cards, and each tool card fits in a specific location on the game board to show what implementation might look like.

Plan Cards: Plan Cards are used in the game to introduce the concept of planning and its benefits and costs.

Unanticipated Event Cards: Unanticipated Event Cards include unplanned incidents that can impact work toward meeting a Clean Water Goal. Examples can include floods or other natural disasters as well as negligence or mismanagement that result in resources being diverted away from water quality work to address a different, urgent issue.

Water resource professionals recognize the value of the Watershed Game as an education and engagement tool. Groups in several coastal regions requested a coast model of the tool in both Local Leader and Classroom versions (Bilotta & Hagley, 2017; & Minnesota Sea Grant, 2020). In direct response to this request, the Mississippi-Alabama Sea Grant Consortium, Minnesota Sea Grant, the University of Minnesota Water Resources Center, The University of Alabama’s Alabama Water Institute, NOAA’s Office for Coastal Management, and the Dauphin Island Sea Lab collected data to inform the development of the Coast Models. The data collection included four approaches that built upon one another: a review of reports, a focus group, and two surveys. The review of reports, the first survey, and the focus group concentrated on the Gulf and South Atlantic coastlines (including Louisiana, Mississippi, Alabama, Florida, Georgia, and South Carolina). A second survey was distributed to Sea Grant programs

nationwide to verify that the data collected from the Gulf and South Atlantic regions were relevant to all coastal areas and to identify opportunities for improvement or expansion.

## REVIEW OF REPORTS

### Methods

In fall 2018, a review of reports (coastal reports, studies, and documents from the Gulf and South Atlantic) was conducted to gain a foundational understanding of regional priority coastal issues. The selection of documents was based on web-based research and specific recommendations from individuals supporting the development of the Coast Models. A total of 30 documents were reviewed (see Appendix A for the full list). The initial internet search

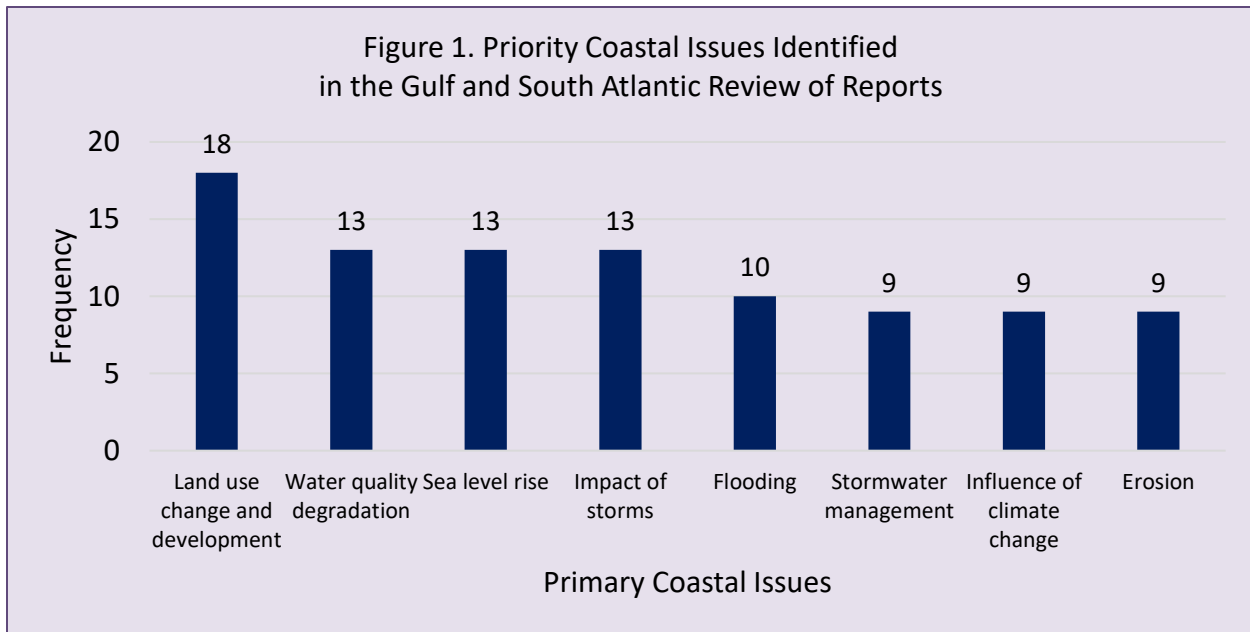
#### Objectives of the review of reports:

- Identify priority coastal issues in the Gulf and South Atlantic regions.
- Gather information to help inform the subsequent focus group and survey activities.

for reports used a range of keywords to maximize results (e.g., coastal stressors, coastal drivers, coastal impacts, coastal zone), along with the individual state names (i.e., Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, and South Carolina). Sources were chosen according to their potential relevance and usefulness in shaping the future focus of the tool. Examples of reports reviewed include National Estuarine Research Reserve Management Plans, State Coastal Management Program Section 309 Assessment and Strategies, the Gulf of Mexico Alliance Governors' Action Plan III, and local watershed management plans. Key Information from each report was gathered and organized by title, year, geographic scope, purpose, and priority coastal issues identified. This information was extracted, summarized, grouped, and coded to generate a broad understanding of regional priorities.

### Findings

Of the 30 documents, 25 were state-specific resources, three that focused on the Gulf region, and two were national resources. Most data sources identified multiple coastal challenges as priority issues. Researchers documented the number of times a topic was identified and the percentage of the 30 sources that included the topic. In total, the reports identified 25 priority issues (see Appendix B for full list). Five topics were identified in at least 10 of 30 reports, including land use change and development (18, 60%), water quality degradation (13, 43%), sea level rise (13, 43%), impact of storms (13, 43%), and flooding (10, 33%) (see Figure 1). An additional three topics, including stormwater management-runoff, the influence of climate change, and erosion, were identified in nine reports (9, 30%).



**Figure 1.** Priority Coastal Issues Identified in the Gulf of Mexico and South Atlantic Review of Reports

The complex nature of coastal issues results in interdependence between many of the top challenges identified. Further, impacts associated with each of these issues are compounded by climate change. The existing information on coastal stressors is extensive. This review did not represent a comprehensive analysis of all coastal impact assessments and reports but served as an initial guide and baseline of information for the subsequent investigations.

### GULF OF MEXICO AND SOUTH ATLANTIC SURVEY

#### Methods

A survey was administered to coastal professionals in the Gulf and South Atlantic regions via the Qualtrics survey platform in the fall of 2018. Survey respondents were solicited to participate in the survey via personal email invitations from the project development team and at the Bays and Bayous Symposium in Mobile, Alabama, November 28-29, 2018.

#### Objectives of the Gulf and South Atlantic survey:

- Identify critical water-related environmental challenges in estuaries and coastal areas.
- Identify the primary land uses contributing to the identified challenges.

In total, 117 coastal professionals participated in the survey, which included 11 questions (see Appendix C for full survey). Survey participants were provided a list of 14 coastal issues and were asked to mark all they considered to be critical challenges impacting the lands and waters along their coasts. Of the challenges identified in the first question, participants were then asked to use their best professional



judgement to identify the first, second, and third most critical challenges in terms of overall potential impacts to the natural and socioeconomic environments along their coasts. Participants were then asked to identify the primary land uses they believed contributed to each of the top three challenges they had identified in the previous step. There were two open-ended questions to provide clarifying comments and solicit opinions on the highest priority practices, plans, or policies that are, or should be, used to address these challenges. Finally, participants were asked to describe their professional affiliation and role.

### Findings

Survey respondents self-reported their professional affiliation, with the ability to offer multiple answers. Relative to all the responses received on this question, 45 (34%) indicated affiliation with a governmental organization, 40 (30%) with Sea Grant or Cooperative Extension, 29 (22%) with research or academia, and 19 (14%) with non-profit organizations. Participants were also asked to define their professional role, again with the ability to offer multiple answers. The results included 52 (31%) teachers or educators, 44 (26%) outreach specialists, and 31 (18%) research scientists. In addition, the results included 13 (8%) stakeholders or residents, 13 (8%) natural resource managers, 11 (6%) environmental consultants, and 6 (4%) planners.

All respondents answered Question 1. Seven of the 14 challenges included in the question were rated as “critical” by 50% or more of the respondents (see Table 2). Note that respondents could select multiple answers in Question 1.

**Table 2.** Critical Coastal Challenges Impacting Coastal Lands and Waters  
Chosen in Question 1 of the Gulf and South Atlantic Survey

Critical Challenges	Times Chosen	Percentage
Erosion	83	71%
Coastal land loss	80	68%
Flooding	80	68%
Nutrients	78	67%
Harmful Algal Blooms (HABs)	77	66%
Saltwater intrusion	71	61%
Excess nitrogen	64	55%
Fecal coliform	55	47%
Resilience	50	43%
Pathogens	47	40%
Excess phosphorus	44	38%

There is significant overlap among the list of challenges presented to survey respondents. For example, regarding nutrients, respondents could select any or all of the following challenges: nutrients (78, 67%), excess nitrogen (64, 55%), and excess phosphorus (44, 38%). Clearly excess nutrients is a critical challenge identified by survey respondents. It is interesting to note that excess phosphorus was listed as a critical challenge by 38% of respondents, despite traditionally being considered less important as a limiting factor in coastal waters, relative to inland areas. Nitrogen has long been considered a more critical limiting factor along the coast. Survey data show that respondents considered both nitrogen and phosphorus as important challenges, suggesting that there is value in careful consideration of how best to represent nutrients in the game. In addition, Harmful Algal Blooms (HABs), which are tied to nutrients, were also considered to be a critical challenge by 77 (66%) respondents.

Questions 2 through 4 asked the respondents to consider the list of challenges they identified in Question 1, and then choose and rank their top three in terms of the overall potential impacts to the natural and socioeconomic environments along the coast in their area. Table 3 indicates the four issues most often ranked as the number one challenge in Question 2. Coastal land loss, nutrients, flooding, and HABs were most often identified.

**Table 3.** Issues Identified Most Frequently as the Number One Challenge in the Gulf and South Atlantic Survey

<b>Issue Type</b>	<b>Respondents identifying this as an issue in Question 1 (see Table 2)</b>	<b>Respondents identifying issue as the number one challenge in Question 2</b>	<b>Percent of respondents identifying issue as the number one challenge in Question 2</b>
Coastal Land Loss	80 (68%)	48	41%
Nutrients	78 (67%)	15	13%
Flooding	80 (68%)	11	9%
Harmful Algal Blooms (HABs)	77 (66%)	11	9%

Coastal land loss is a complex issue with a variety of causes that vary across regions. However, it is often manifested as flooding. Thus, the product development team decided to capture coastal land loss as a function of flooding. This limited the top-ranked critical challenges for further analysis to three: nutrients, flooding, and HABs.

Table 4 combines the results of Questions 2 through 4 to evaluate the number and percent of respondents who selected any of the three most often identified issues (nutrients, flooding, or HABs) as their first, second, or third most critical challenge impacting the coasts.

**Table 4.** Top Ranking Issues Across Questions 2-4 From the Gulf and South Atlantic Survey

<b>Issue Type</b>	<b>Respondents identifying this as an issue in Question 1 (see Table 2)</b>	<b>Respondents identifying this as a top issue in Questions 2-4</b>	<b>Percent of respondents identifying this as a top issue in Questions 2-4</b>
Nutrients	78 (67%)	44	38%
Flooding	80 (68%)	40	34%
Harmful Algal Blooms (HABs)	77 (66%)	35	30%

Questions 5 through 7 asked the respondents to consider the top challenges they identified in Questions 2 through 4, and then identify the primary land uses that contribute to those challenges (see Tables 5-7). Tables 5 through 7 only report the top five land uses associated with the top three challenges, except where the fifth and sixth land uses were tied. Respondents were provided 11 land use options to select from (see Appendix C for full list of options). In total, 44 people (38%) identified nutrients as one of their top three issues impacting coasts (in Questions 2-4). Those individuals identified six land uses as top contributors to nutrients (see Table 5).

**Table 5.** Primary Land Uses Contributing to Nutrients from the Gulf and South Atlantic Survey

<b>Top land uses identified as contributors to nutrients</b>	<b>Respondents identifying this as a land use contributing to nutrients</b>	<b>Percentage of respondents identifying this as a land use contributing to nutrients</b>
Urban and residential, including wastewater	36	82%
Agriculture	32	73%
Heavy industry	19	43%
Forestry/silviculture	9	20%
Ports and harbors	8	18%
Recreation and tourism	8	18%

In total, 40 people (34%) identified flooding as one of their top three issues impacting coasts (in Questions 2-4). Those individuals identified six land uses as top contributors to flooding (see Table 6).

**Table 6.** Primary Land Uses Contributing to Flooding from the Gulf and South Atlantic Survey

<b>Top land uses identified as contributors to flooding</b>	<b>Respondents identifying this as a land use contributing to flooding</b>	<b>Percentage of respondents identifying this as a land use contributing to flooding</b>
Urban and residential, including wastewater	23	58%
Flood control	20	50%
Agriculture	6	15%
Heavy industry	6	15%
Ports and harbors	4	10%
Oil and gas exploration and extraction	4	10%

In total, 35 people (30%) identified HABs as one of their top three issues impacting coasts (in Questions 2-4). Those individuals identified five land uses as top contributors to HABs (see Table 7).

**Table 7.** Primary Land Uses Contributing to HABs from the Gulf and South Atlantic Survey

<b>Top land uses identified as contributors to HABs</b>	<b>Respondents identifying this as a land use contributing to HABs</b>	<b>Percentage of respondents identifying this as a land use contributing to HABs</b>
Agriculture	30	86%
Urban and residential, including wastewater	30	86%
Heavy industry	13	37%
Forestry/silviculture	7	20%
Recreation and tourism	6	17%

Questions 8 and 9 were open-ended questions that respectively asked respondents to share clarifying comments or descriptions of the challenges of concern to them and the highest priority practices, plans, or policies used to address these challenges. This information was grouped and coded and used to help further organize concepts that might be critical in the development of the Coast Models. Four concepts rose to the top of the responses:

1. Development is a key issue of concern.
2. Many coastal issues are interrelated.
3. Human actions and choices in how and where homes are built and land is developed contribute to increased vulnerability.
4. Long-term strategies (e.g., planning, conservation, restoration, and development practices) are important to addressing the concerns.

The Gulf and South Atlantic survey results provide insight into the most critical regional coastal challenges. Issues identified were nutrients, flooding, and HABs. HABs are often the result of excess nutrient pollution, particularly nitrogen and phosphorus (Anderson, Glibert, & Burkholder, 2002). As such, nutrients, and HABs—identified as two of the top three issues—were combined into one issue for the purpose of game development. Interestingly, the primary land uses identified as contributors for all three top coastal issues included urban and residential, agriculture, and heavy industry. Other land uses that were documented in two of the three top coastal issues included recreation and tourism, ports and industry, and forestry/silviculture. This information highlights key land uses critical for consideration in the game based on their utility for addressing multiple coastal and water resources challenges.

## FOCUS GROUP

### Methods

In December 2019, the project development team conducted a two-hour, virtual focus group with coastal professionals and practitioners from the Gulf and South Atlantic regions. Twelve individuals participated representing four coastal states

(Louisiana, Mississippi, Alabama, and Florida) from backgrounds including academia, federal, state, local government, and nonprofit organizations.

Participants were provided a short presentation on the Watershed Game, the review of reports, and the results of the first survey, before participating in a facilitated group discussion. During the

discussion, participants were able to offer input by speaking or via the chat function of the webinar software. Participants were asked if the preliminary research results resonated with their understanding of local coastal issues, what primary impacts the Watershed Game should focus on, and what four or five land uses should be emphasized in the Coast Models of the Watershed Game (see Appendix D for a full list of discussion questions).

#### Objectives of the focus group:

- Identify water-related environmental concerns in estuaries and coastal areas.
- Identify the primary land uses contributing to the challenges identified.
- Identify the community leaders and other stakeholders involved in these issues and the barriers and challenges to working with them.
- Determine the potential management practices and tools to address these issues.

### Findings

During the discussion individuals shared a variety of information about local and regional coastal issues and had a rich discussion about the associated impacts. Key topics from the discussion are listed and grouped in Table 8. Excess nutrients was the most discussed coastal issue, followed by flooding, climate change and sea level rise, coastal erosion, and marine debris and pollution. Some topics raised were highly localized, state-specific issues (e.g., phosphate mining in Florida). Participants were not in agreement that these were high priorities in all regions. There was general recognition that to ensure applicability of the Coast Models of the Watershed Game to coastal professionals across regions, the highly localized topics should not be considered as a primary focus of the game. Upon reflection after the focus group, the project development team decided that some topics that were actionable, or specific to one locality, could be best addressed either through Tool Cards or as Unanticipated Events.

**Table 8.** Top Coastal Issues Collected from the Focus Group

<b>Top Coastal Issues Identified</b>	<b>Frequency (Participants who Identified Issue)</b>
Excess nutrients	4
Flooding	3
Climate change/sea level rise	3
Coastal erosion	3
Marine debris/pollution	3
Harmful Algal Blooms/red tide/hypoxia	2
Agricultural land use	2
Excess sediment	2
Coastal land use change and development	2
Freshwater diversions	2
Port and harbor activity/shipping	2
<b>“Actionable” Items for Possible Use as Tool Cards</b>	
Personal use & consumption of water	3
Land use & local ordinances in headwaters	2
Green infrastructure/low impact development	1
Reducing nutrients from fertilization to lawns, gardens, and agriculture	1
Raising awareness across the basin with local community stakeholders	1
Education to address erosion issues	1
<b>Issues for Possible Use as Unanticipated Events</b>	
Harmful Algal Blooms aka red tide	1
Storm events and upstream action	1
Hurricane, drought, or major disasters, such as an oil spill	1

Participants brought attention to the need to consider “actionable items” with short-term and long-term impacts that could be used as Tool Cards. The discussion revealed that from an education perspective, the topics of flooding and sea level rise are complicated and require a well-rounded conversation—particularly with students who typically require a personal connection to the impacts for the topic to resonate. There was general agreement that excess nutrients, flooding, climate change/sea level rise, and coastal erosion were common problems across multiple states in the Gulf and South Atlantic regions. As discussed in the findings associated with the Gulf and South Atlantic survey results, since HABs are often the result of excess nutrient pollution, particularly nitrogen and phosphorus, the HABs topic is considered captured within the impacts of nutrients. Further, since sea level rise often results in flooding of coastal areas, the project development team decided to address all types of flooding together (including riverine flooding, flooding due to sea level rise, flooding from storm surge, etc.).

Further, the team agreed to approach flooding in terms of helping communities increase their ability to plan for, respond to, and recover from flooding events—to increase their resilience to flooding.

## NATIONAL SEA GRANT NETWORK SURVEY

### Methods

A second survey was distributed to professionals across the Sea Grant Network via the Qualtrics survey platform in the spring of 2019. The survey built off the objectives and outcomes of the review of reports, the Gulf and South Atlantic survey, and the focus group, and served as a way to verify that the data collected from the Gulf and South Atlantic regions were relevant to other areas of our coast, as well as to identify opportunities for expansion that might increase the relevancy of the tool in other regions. To allow for parallel

#### Objectives of the National Sea Grant Survey:

- Identify critical water-related environmental challenges in estuaries and coastal areas.
- Identify the primary land uses contributing to the identified challenges.
- Verify that the data collected from the Gulf and South Atlantic regions were relevant to other areas of our coast.
- Identify opportunities for expansion that might increase the relevancy of the tool in other.

analyses and maximum comparability between the results from the two surveys, the team retained and re-administered the same questions with only slight modifications. It should be noted that a minor mistake from the first survey was corrected in the second. In the Gulf and South Atlantic survey, the first question included the option to select “resilience” as a critical coastal challenge; however, in subsequent questions (2-5), resilience was not included as an option. This oversight was addressed in the second survey. Additionally, there were minor changes in survey questions regarding demographic information.

The survey was distributed to Sea Grant professionals only due to their capacity to represent the breadth of coastal issues across a number of regions, which allowed a reduced distribution list while still covering most of the U.S. coastline. The survey included 10 questions (see Appendix E for full survey) and was distributed via email to contacts within the Sea Grant network. In total, 30 Sea Grant professionals participated in the survey.

### Findings

Of the 30 responses received, four individuals indicated they were from Ohio; three from Texas; two from Georgia, Michigan, and North Carolina; and one from Alabama, Alaska, California, Delaware, Florida, Hawai'i, Louisiana, Minnesota, Mississippi, Pennsylvania, Vermont, and Wisconsin. One respondent indicated they primarily work in the Great Lakes (state not indicated). Four individuals did

not respond to this question. Subsequently, the responses were reviewed for regional coverage, which showed 12 from the Great Lakes; seven from the Gulf; five from the Southeast; four from the Northeast; and three from the Pacific (the states of Florida and Pennsylvania are included in two Sea Grant regions).

All respondents answered Question 1. Ten of the 14 challenges included in the question were rated as “critical” by 50% or more of the respondents (see Table 9). Note that respondents could select multiple answers in Question 1. As discussed previously, HABs are often the result of excess nutrient pollution, particularly nitrogen and phosphorus, thus the project development team considered the topic captured within the impacts of nutrients.

**Table 9.** Critical Coastal Challenges Impacting Coastal Lands and Waters Chosen in Question 1 of the National Sea Grant Survey

<b>Critical Challenges</b>	<b>Times Chosen</b>	<b>Percentage (%)</b>
Nutrients	26	87%
Harmful Algal Blooms	26	87%
Erosion	22	73%
Flooding	22	73%
Resilience	20	67%
Excess sediment	18	60%
Coastal land loss	17	60%
Excess phosphorus	17	57%
Excess nitrogen	17	57%
Fecal coliform	15	50%

Parallel to the first survey, it is interesting to note that a majority (26, 87%) identified nutrients as an issue, and a significant number also selected excess nitrogen and excess phosphorus. In contrast to the Gulf and South Atlantic survey, however, phosphorus was rated critical by the same number of individuals as nitrogen (17, 57%). The inclusion of the Great Lakes in the National Sea Grant survey probably explains the higher ranking of phosphorus relative to nitrogen than in the Gulf and South Atlantic survey (55% nitrogen, 38% phosphorus). Phosphorus, rather than nitrogen, has historically been the limiting nutrient in the Great Lakes region (see Tables 2 and 9). These results across both surveys suggest that both nitrogen and phosphorus are important nutrients to consider for coast models of the game. In addition, the inclusion of HABs and the role of nutrients in their formation increases the recognition of excess nutrients as a common challenge in coastal areas.



Questions 2 through 4 asked the respondents to consider the list of challenges they identified in Question 1, and then choose and rank their top three challenges in terms of the overall potential impacts to the natural and socioeconomic environments along the coast in their area. Table 10 indicates the three issues most often ranked as the number one challenge in Question 2. Nutrients, flooding, and resilience were most often identified.

**Table 10.** Issues Identified Most Frequently as the Number One Challenge in the National Sea Grant Survey

<b>Issue Type</b>	<b>Respondents identifying this as an issue in Question 1 (see Table 9)</b>	<b>Respondents identifying issue as the number one challenge in Question 2</b>	<b>Percent of respondents identifying issue as the number one challenge in Question 2</b>
Nutrients	26 (87%)	5	17%
Flooding	22 (73%)	4	13%
Resilience	20 (67%)	3	10%

Table 11 combines the results of Questions 2 through 4 to evaluate the number and percent of respondents who selected any of the three most often identified issues (nutrients, flooding, or resilience) as their first, second, or third most critical challenge impacting the coasts.

**Table 11.** Top Ranking Issues Across Questions 2-4 From the National Sea Grant Survey

<b>Issue Type</b>	<b>Respondents identifying this as an issue in Question 1 (see Table 9)</b>	<b>Respondents identifying this as a top issue in Questions 2-4</b>	<b>Percent of respondents identifying this as a top issue in Questions 2-4</b>
Flooding	22 (73%)	16	53%
Nutrients	26 (87%)	10	34%
Resilience	20 (67%)	8	34%

Questions 5 through 7 asked the respondents to consider the top challenges they identified in Questions 2 through 4, and then identify the primary land uses that contribute to those challenges (see Tables 12-14). Tables 12 through 14 only report the top five land uses associated with the top challenges, except where the fifth and sixth land uses were tied. Respondents were provided 11 land use options to select from (see Appendix E for full list of options). In total, 16 people (53%) identified flooding as one of their top three issues impacting coasts (in Questions 2-4). Those individuals identified five land uses as contributors to flooding (see Table 12).

**Table 12.** Primary Land Uses Contributing to Flooding From the National Sea Grant Survey

<b>Top land uses identified as contributors to flooding</b>	<b>Respondents identifying this as a land use contributing to flooding</b>	<b>Percentage of respondents identifying this as a land use contributing to flooding</b>
Flood control	9	56%
Urban and residential, including wastewater	8	50%
Heavy industry	6	38%
Agriculture	5	31%
Ports and harbors	4	25%

In total, 10 people (34%) identified nutrients as one of their top three issues impacting coasts (in Questions 2-4). Those individuals identified six land uses as contributors to nutrients (see Table 13).

**Table 13.** Primary Land Uses Contributing to Nutrients From the National Sea Grant Survey

<b>Top land uses identified as contributors to nutrients</b>	<b>Respondents identifying this as a land use contributing to nutrients</b>	<b>Percentage of respondents identifying this as a land use contributing to nutrients</b>
Agriculture	8	80%
Urban and residential, including wastewater	8	80%
Heavy industry	4	40%
Recreation and tourism	3	30%
Ports and harbors	2	20%
Flood control	2	20%

In total, 8 people (34%) identified resilience as one of their top three issues impacting coasts (in Questions 2-4). Those individuals identified six land uses as contributors to resilience (see Table 14).

**Table 14.** Primary Land Uses Contributing to Resilience From the National Sea Grant Survey

<b>Top land uses identified as contributors to resilience</b>	<b>Respondents identifying this as a land use contributing to resilience</b>	<b>Percentage of respondents identifying this as a land use contributing to resilience</b>
Flood control	7	88%
Urban and residential, including wastewater	6	75%
Recreation and tourism	5	63%
Agriculture	4	50%
Heavy industry	4	50%
Ports and harbors	4	50%

Questions 8 and 9 mirrored the Gulf and South Atlantic survey and asked respondents to share clarifying comments or descriptions of the challenges of concern to them and the highest priority practices, plans, or policies used to address these challenges. This information was grouped and coded and used to help

further organize concepts that might be critical in the development of the Coast Models. Two concepts rose to the top of the responses:

1. Coastal flooding is compounded by continued development in the floodplain and increasing pressures from climate change (i.e., greater precipitation, sea level rise); and
2. As identified in the Gulf and South Atlantic survey, long-term strategies (e.g., planning, conservation, restoration, and development practices) are important to addressing concerns.

The National Sea Grant survey results provide insight into the most critical coastal challenges faced across various geographic areas. Issues identified were flooding, nutrients, and resilience. The primary land uses identified as contributors to all three top coastal issues showed even greater consistency than the Gulf and South Atlantic survey and included urban and residential, flood control, agriculture, ports and harbors, and heavy industry. The recreation and tourism land use was also identified for two of the top issues.

## **COMPARISON OF SURVEY FINDINGS**

Researchers were interested in determining whether the perspectives on coastal issues from the Gulf and South Atlantic regions were shared more broadly by the National Sea Grant survey respondents. As a result, this section briefly discusses the areas of congruence and divergence between the regionally and nationally based surveys. Overall, the findings from both surveys revealed remarkable similarities with only minor inconsistencies.

### **Coastal Issues**

Parallels emerged between the surveys that helped independently verify that excess nutrients and flooding are common challenges across many U.S. coasts. Excess nutrients and flooding were both identified among the top three coastal issues of the surveys. Discrepancy existed on the third issue identified. In the Gulf and South Atlantic, HABs were singled out whereas in the National Sea Grant survey it was resilience. The team decided that HABs are often a consequence of excess nutrients, and thus covered. The team decided to address resilience and flooding together, as resilience to flooding.

### **Land Use**

The results also indicate overlap between the primary land uses that contribute to the priority critical issues. Primary land uses identified by respondents from both surveys include urban and residential,

agriculture, and heavy industry. This information demonstrates the importance of these land uses in negatively impacting coastal resources for a variety of reasons, and thus the importance of integrating the land uses into the game.

### **SYNTHESIS OF ALL FINDINGS**

Used in combination, multiple data collection methods provide a greater range and depth of information for enhanced understanding and credibility of findings. For this effort, the results from the four approaches helped identify issues common across coastal areas and resulted in a more complete understanding of primary coastal issues. The findings revealed specific topics that would be most relevant and applicable for coastal communities, decision makers, and other local leaders.

The results of the review of reports identified broadly the top issues to focus on of land use change and development, water quality degradation, the impact of storms, flooding, and stormwater management runoff. The Gulf and South Atlantic survey results identified issues of key importance as flooding, excess nutrients, and HABs, which are often tied to nutrients. From this baseline understanding, the top issues discussed in the focus group pinpointed more specific priority coastal issues of flooding, excess nutrients, climate change and sea level rise, and coastal erosion. The results of the national survey identified top issues of flooding, excess nutrients, and resilience (see Table 1 on page 4). These results independently confirm the coastal issues that would be of greatest value for use in the Coast Models of the Watershed Game. When viewed together, the combined results depict a high level of agreement across methodologies and reveal important opportunities to facilitate the integration of water quality and flooding. The synthesized results from the review, focus group, and survey activities strengthen the team's decision to move forward with the development of the Coast Models focused on water quality, as it relates to excess sediment and nutrients (specifically nitrogen and phosphorus) and resilience to flooding.

### **CONCLUSIONS AND NEXT STEPS**

This report summarizes the methods and results of the effort to identify and synthesize priority coastal issues to be incorporated into the development of Coast Models of the Watershed Game. The information gathered through four approaches added value by explaining different aspects of coastal issues from varying perspectives and provided an enhanced understanding of the nuances of the challenges related to coastal environments. The results of the review, focus group, and surveys provided

valuable information to guide game development. The results informed and continue to support our decision to move forward with Coast Models of the Watershed Game that integrate water quality, as it relates to excess sediment and nutrients (specifically nitrogen and phosphorus) and resilience to flooding.

In line with Sea Grant's mission to support and communicate science in a practical, actionable manner integrating research into engagement, it is the intent that the Coast Models of the Watershed Game will be used to help decision makers and students learn how land uses impact water quality and community resilience to flooding in coastal areas. We envision the Watershed Game will be used as a tool for resource managers, planners, and educators to empower communities by helping individuals learn about practices, plans, and policies that improve and protect the health of the environment, the quality of the water, and the ability of communities to prepare for, respond to, and recover from flooding in coastal areas.

The information collected through the methods documented in this paper informed the development of all aspects of the draft Coast Models of the Watershed Game. This included a game board and tool cards that specifically target the issues identified through this investigation. The Watershed Game Coast Models focus on improving water quality (nitrogen, phosphorus, and sediment) while increasing community resilience to flooding. The five land uses featured are: industrial port, agriculture, urban center, residential, and rural coast. Pilot workshops were held in New Orleans, Louisiana, and Mobile, Alabama, in February 2020 to test the game and gather input to inform further refinement of the game components and the process of game play. Forty-one participants provided critical feedback. Final revisions to the game materials are underway with the anticipation of hosting train-the-trainer workshops and distributing copies of the game to educators and coastal professionals in 2021. (Pending restrictions on travel and group gatherings, trainings and distribution may start earlier or be further delayed.) The project development team looks forward to sharing the Coast Models of the Watershed Game with our partners and local communities to assist in educating residents and youth about how to better manage complex coastal ecosystems through collaborative, informed problem-solving.

## APPENDICES

### APPENDIX A

#### REVIEW OF REPORTS CITED

Alabama Coastal Management Program. (2015). Alabama Coastal Area Management Program Section 309 Assessment and Strategies 2016-2021.

The Coastal Protection and Restoration Authority (CPRA). (2017). Louisiana's Comprehensive Master Plan for a Sustainable Coast.

The Coastal Regional Commission. (2014). Regional Assessment of Coastal Georgia.

The Coastal Zone Management Program. (2017). National Coastal Zone Management Program Enhancement Program Synthesis (2016-2020).

Eastern Research Group, Inc. (ERG). (2014). Insights into Coastal Management Needs: Results from the NOAA Coastal Services Center and Office of Ocean and Coastal Resource Management Customer Survey.

Florida Coastal Management Program. (2015). Florida Coastal Management Program Section 309 Assessment and Strategies 2016-2020.

Florida Department of Environmental Protection's Office of Coastal and Aquatic Managed Areas. (2013). Apalachicola National Estuarine Research Reserve Management Plan.

Florida Department of Environmental Protection's Office of Coastal and Aquatic Managed Areas. (2009). Guana Tolomato Matanzas National Estuarine Research Reserve Management Plan 2009-2015.

Georgia Coastal Management Program. (2015). Georgia Coastal Management Program Section 309 Assessment and Strategy 2016 to 2020.

Georgia Department of Natural Resources: Coastal Resources Division. (2012). Accomplishments of the Georgia Coastal Management Program Report.

The Gulf of Mexico Alliance. (2016). Governors' Action Plan III for Healthy and Resilient Coasts (2016-2021).

Grand Bay National Estuarine Research Reserve. (2013). Grand Bay NERR Management Plan 2013-2018.

Louisiana Coastal Management Program. (2015). Louisiana Coastal Management Program Section 309 Assessment and Strategy 2016-2020.

Louisiana State University Coastal Sustainability Studio- Community Planning & Louisiana Sea Grant. Vulnerability and Resilience in Threatened Coastal Louisiana Communities.

Mission Aransas NERR prepared by University of Texas Marine Science Institute. (2015). Mission Aransas National Estuarine Research Reserve Management Plan 2015-2020.

Mississippi Coastal Program. (2015). Mississippi Coastal Program Coastal Zone Management Act & 309 Assessment and Strategy 2016-2020.

Mississippi Department of Environmental Quality. (2015). Watershed Implementation Plan Rotten Bayou.

The Mobile Bay National Estuary Program. (2013). Comprehensive Conservation and Management Plan for Alabama's Estuaries & Coasts 2013-2018.

The Nature Conservancy Florida. (2014). Perdido Bay Community Based Watershed Plan.

National Oceanic and Atmospheric Administration. (2015). A Strategy for a Healthy Gulf of Mexico: Resilience Through Ecosystem Restoration.

NOAA's National Marine Fisheries and the Environmental Protection Agency's Wetland Division. (2015). Coastal Wetlands Initiative: Gulf of Mexico Review.

North-Inlet Winyah Bay NERR. (2011). North Inlet- Winyah Bay National Estuarine Research Reserve Management Plan 2011-2016.

Office of Governor John Bel Edwards. (2018). Louisiana Watershed Initiative: A Long-term Vision for Statewide Sustainability and Resilience.

R.F. Van Dolah, D.M. Sanger, G.H.M. Riekerk, S.E. Crowe, M.V. Levisen, D.C. Bergquist, D.E. Chestnut, W. McDermott, M.H. Fulton, E. Wirth. (2013). The Condition of South Carolina's Estuarine and Coastal Habitats During 2009-2010. (Technical Report No. 107). Charleston, SC: South Carolina Marine Resources Division.

Sapelo Island National Estuarine Research Reserve (NOAA). (2007). Sapelo Island National Estuarine Research Reserve Management Plan (2008-2013).

South Carolina Coastal Management Program. (2015). South Carolina Coastal Area Management Program Section 309 Assessment and Strategies 2016-2022.

South Carolina Sea Grant. (2017). The Changing Face of Coastal South Carolina: Building a Resilient Future Strategic Plan FY2018-FY2021.

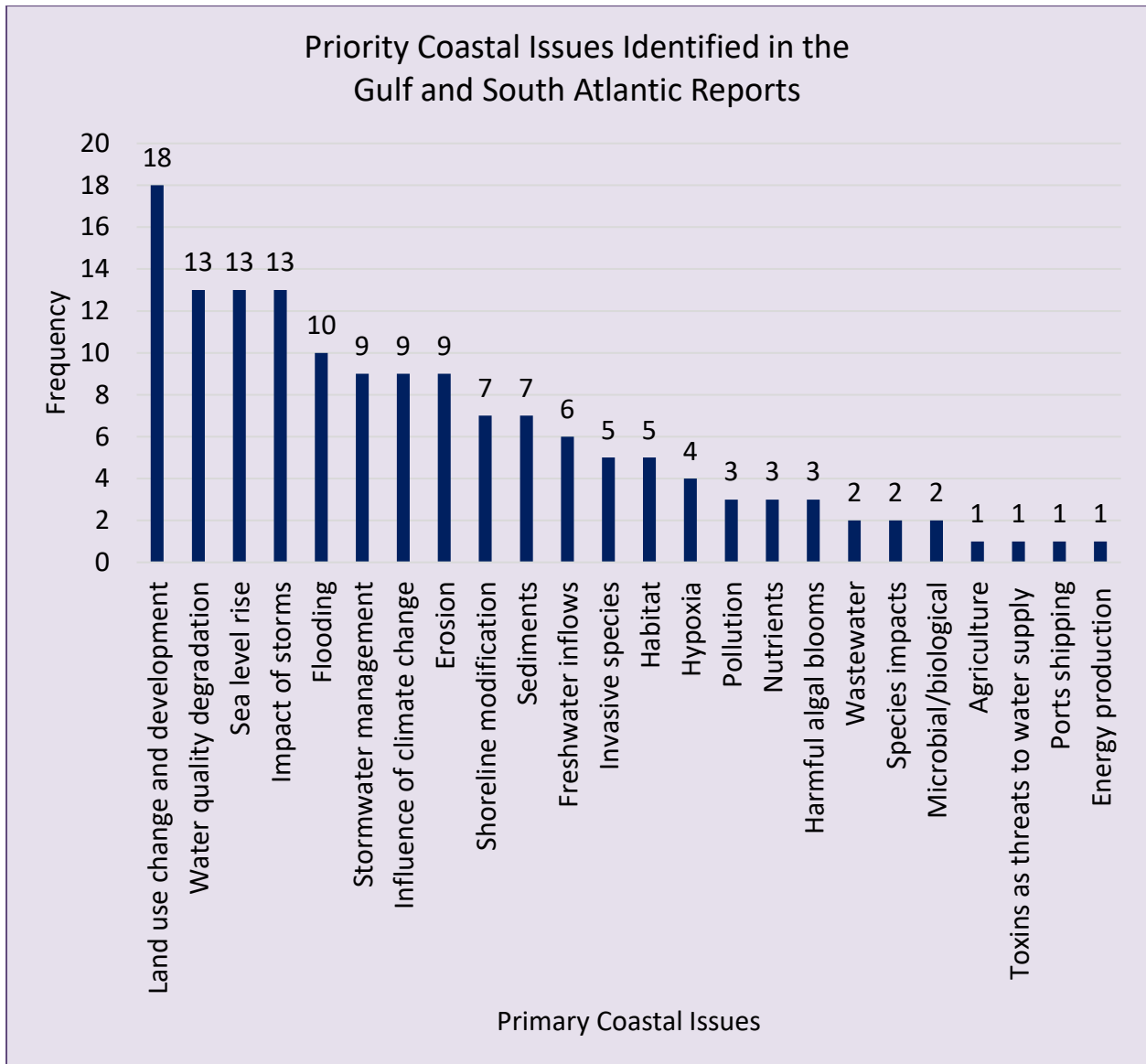
The University of Georgia Marine Extension and Georgia Sea Grant. (2016). The University of Georgia Marine Extension and Georgia Sea Grant's 2018-2021 Strategic Plan.

Volkert, Inc. contracted by Mobile Bay National Estuary Program prepared for the City of Foley, City of Gulf Shores, Mobile Bay NEP. (2017). Bon Secour River, Oyster Bay, Skunk Bayou Watershed Management Plan.

Weeks Bay NERR. (2017). Weeks Bay National Estuarine Research Reserve Management Plan 2017-2022.

APPENDIX B

PRIORITY ISSUES FROM THE GULF OF MEXICO AND SOUTH ATLANTIC REVIEW OF REPORTS





## APPENDIX C

### GULF OF MEXICO AND SOUTH ATLANTIC SURVEY INSTRUMENT

Q1: Which of the following items do you consider to be critical challenges currently impacting the lands and waters along your coast? (check ALL that apply)

- Excess sediment
- Coastal land loss
- Excess phosphorus
- Excess nitrogen
- Nutrients
- Pathogens
- Harmful algal blooms
- Fecal coliform
- Erosion
- Flooding
- Excess flow
- Resilience
- Elevated water temperatures
- Salt water intrusion
- Other (please specify)

Q2: Of the challenges you identified in Question One, which do you consider to be the NUMBER 1 CHALLENGE in terms of overall potential impacts to the natural and socioeconomic environments along your coasts? (choose ONE)

- Excess sediment
- Coastal land loss
- Excess phosphorus
- Excess nitrogen
- Nutrients
- Pathogens
- Harmful algal blooms
- Fecal coliform
- Erosion
- Flooding
- Excess flow
- Elevated water temperatures
- Salt water intrusion
- Other (please specify)

Q3: Of the challenges you identified in Question One, which do you consider to be the NUMBER 2 CHALLENGE in terms of overall potential impacts to the natural and socioeconomic environments along your coasts? (choose ONE)

- Excess sediment
- Coastal land loss
- Excess phosphorus
- Excess nitrogen
- Nutrients
- Pathogens
- Harmful algal blooms
- Fecal coliform
- Erosion
- Flooding
- Excess flow
- Elevated water temperatures
- Salt water intrusion
- Other (please specify)

Q4: Of the challenges you identified in Question One, which do you consider to be the NUMBER 3 CHALLENGE in terms of overall potential impacts to the natural and socioeconomic environments along your coasts? (choose ONE)

- Excess sediment
- Coastal land loss
- Excess phosphorus
- Excess nitrogen
- Nutrients
- Pathogens
- Harmful algal blooms
- Fecal coliform
- Erosion
- Flooding
- Excess flow
- Elevated water temperatures
- Salt water intrusion
- Other (please specify)

Q5: Considering the #1 challenge you identified in Question Two, what are the primary land uses that contribute to this challenge? (check ALL that apply)

- Agriculture
- Forestry/silviculture
- Heavy industry
- Urban and residential, including wastewater
- Aquaculture
- Fishing (subsistence, recreational, or commercial)
- Ports and harbors
- Beaches and marinas
- Oil and gas exploration and extraction
- Flood control
- Recreation and tourism
- Other (please specify)

Q6: Considering the #2 challenge you identified in Question Three, what are the primary land uses that contribute to this challenge? (check ALL that apply)

- Agriculture
- Forestry/silviculture
- Heavy industry
- Urban and residential, including wastewater
- Aquaculture
- Fishing (subsistence, recreational, or commercial)
- Ports and harbors
- Beaches and marinas
- Oil and gas exploration and extraction
- Flood control
- Recreation and tourism
- Other (please specify)

Q7: Considering the #3 challenge you identified in Question Four, what are the primary land uses that contribute to this challenge? (check ALL that apply)

- Agriculture
- Forestry/silviculture
- Heavy industry
- Urban and residential, including wastewater
- Aquaculture
- Fishing (subsistence, recreational, or commercial)
- Ports and harbors
- Beaches and marinas

- Oil and gas exploration and extraction
- Flood control
- Recreation and tourism
- Other (please specify)

Q8: Please share any other clarifying comments about or descriptions of the challenges that concern you relative to coastal environments.

Q9: In your opinion, what are the highest priority practices, plans, or policies that are used or should be used to address these challenges (e.g., restoration of impacted habitats, improved resiliency planning, pollution trading, etc.)? Please be brief with your answers.

Q10: How would you best characterize your professional or organizational affiliation? (check ALL that apply)

- Sea Grant or Cooperative Extension
- Research/Academia
- NGO/Non-Profit
- State Government
- Private Sector
- County Government
- Federal Government
- Local Government
- National Estuary Program
- Regional Government
- National Estuarine Research Reserve
- Media
- Military
- International
- Tribal Government
- Other

Q11: How would you describe your professional role? (check ALL that apply)

- Teacher/Educator
- Outreach Specialist
- Research Scientist
- General Stakeholder/Resident
- Natural Resource Manager
- Environmental Consultant
- Planner
- Journalist/Communications Specialist
- Policymaker
- Tourism Specialist
- Business Owner
- Land Conservation Specialist
- Member of the Fishing Community or Industry
- Public Land Manager
- Agricultural Community Member
- Emergency Responder/Manager
- Elected Official
- Energy Industry Member
- Health Professional
- Port or Harbor Manager
- Public Health Official
- Tribal Representative
- Other

**APPENDIX D**  
**FOCUS GROUP QUESTIONS**

1. How well do the data mining and survey results resonate with your understanding of the issues?  
Comments? Questions?
2. How well do these data set us up for choosing:
  - a) Primary impacts to focus on?
  - b) 4-5 land uses to emphasize?
3. What is missing?
4. Which 2 to 4 primary impacts rise to the top?
5. Who is missing? Have we reached out to the right regions? People?

## APPENDIX E

### SEA GRANT NETWORK SURVEY INSTRUMENT

Q1: Which of the following items do you consider to be critical challenges currently impacting the lands and waters along your coast? (check ALL that apply)

- Excess sediment
- Coastal land loss
- Excess phosphorus
- Excess nitrogen
- Nutrients
- Pathogens
- Harmful algal blooms
- Fecal coliform
- Erosion
- Flooding
- Excess flow
- Resilience
- Elevated water temperatures
- Salt water intrusion
- Other (please specify)

Q2: Of the challenges you identified in Question One, which do you consider to be the NUMBER 1 CHALLENGE in terms of overall potential impacts to the natural and socioeconomic environments along your coasts? (choose ONE)

- Excess sediment
- Coastal land loss
- Excess phosphorus
- Excess nitrogen
- Nutrients
- Pathogens
- Harmful algal blooms
- Fecal coliform
- Erosion
- Flooding
- Excess flow
- Resilience
- Elevated water temperatures
- Salt water intrusion
- Other (please specify)

Q3: Of the challenges you identified in Question One, which do you consider to be the NUMBER 2 CHALLENGE in terms of overall potential impacts to the natural and socioeconomic environments along your coasts? (choose ONE)

- Excess sediment
- Coastal land loss
- Excess phosphorus
- Excess nitrogen
- Nutrients
- Pathogens
- Harmful algal blooms
- Fecal coliform
- Erosion
- Flooding
- Excess flow
- Resilience
- Elevated water temperatures
- Salt water intrusion
- Other (please specify)

Q4: Of the challenges you identified in Question One, which do you consider to be the NUMBER 3 CHALLENGE in terms of overall potential impacts to the natural and socioeconomic environments along your coasts? (choose ONE)

- Excess sediment
- Coastal land loss
- Excess phosphorus
- Excess nitrogen
- Nutrients
- Pathogens
- Harmful algal blooms
- Fecal coliform
- Erosion
- Flooding
- Excess flow
- Resilience
- Elevated water temperatures
- Salt water intrusion
- Other (please specify)

Q5: Considering the #1 challenge you identified in Question Two, what are the primary land uses that contribute to this challenge? (check ALL that apply)

- Agriculture
- Forestry/silviculture
- Heavy industry
- Urban and residential, including wastewater
- Aquaculture
- Fishing (subsistence, recreational, or commercial)
- Ports and harbors
- Beaches and marinas
- Oil and gas exploration and extraction
- Flood control
- Recreation and tourism
- Other (please specify)

Q6: Considering the #2 challenge you identified in Question Three, what are the primary land uses that contribute to this challenge? (check ALL that apply)

- Agriculture
- Forestry/silviculture
- Heavy industry
- Urban and residential, including wastewater
- Aquaculture
- Fishing (subsistence, recreational, or commercial)
- Ports and harbors
- Beaches and marinas
- Oil and gas exploration and extraction
- Flood control
- Recreation and tourism
- Other (please specify)

Q7: Considering the #3 challenge you identified in Question Four, what are the primary land uses that contribute to this challenge? (check ALL that apply)

- Agriculture
- Forestry/silviculture
- Heavy industry
- Urban and residential, including wastewater
- Aquaculture

- Fishing (subsistence, recreational, or commercial)
- Ports and harbors
- Beaches and marinas
- Oil and gas exploration and extraction
- Flood control
- Recreation and tourism
- Other (please specify)

Q8: Please share any other clarifying comments about or descriptions of the challenges that concern you relative to coastal environments.

Q9: In your opinion, what are the highest priority practices, plans, or policies that are used or should be used to address these challenges (e.g. restoration of impacted habitats, improved resiliency planning, pollution trading, etc.)? Please be brief with your answers.

Q10: What state do you primarily work in?

**APPENDIX F**  
**LITERATURE CITED**

- Anderson, D. M., Glibert, P. M., & Burkholder, J. M. (2002). Harmful algal blooms and eutrophication: nutrient sources, composition, and consequences. *Estuaries*, 25(4), 704-726.
- Bathke, D. J., Haigh, T., Bernadt, T., Wall, N., Hill, H., & Carson, A. (2019). "Using Serious Games to Facilitate Collaborative Water Management Planning Under Climate Extremes." *Journal of Contemporary Water Research & Education* 167.1: 50-67.
- Bilotta, J. & Hagley, C. (2017). *The Watershed Game Generating Public Value for Over Ten Years*. Retrieved from <http://hdl.handle.net/11299/193355>.
- Gray, J.S. (1997) Marine biodiversity: patterns threats and conservation needs. *Biodiversity and Conservation* 61:153-175
- Lotze, H.K., Lenihan, H.S., Bourque, B.J., Bradbury, R.H., Cooke, R.G., Kay, M.C., Jackson, J.B., (2006) Depletion degradation and recovery potential of estuaries and coastal seas. *Science* 3125781:1806-1809
- Minnesota Sea Grant. (2020). *Minnesota Sea Grant Site Review Briefing Book*. Retrieved from <http://www.seagrants.umn.edu/downloads/2019-SeaGrantBriefingBook.pdf>