# Stressor Matrix Evaluation

# 2023 Summary Report

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## Report Intent

This report contains the results and analysis of data from opinion-based surveys of the scientific community on stressors affecting coastal habitats and ecosystem services. It is important to note that this report is not intended to be an empirical determinant of which habitats and ecosystem services are the most stressed – outcomes of the stressor matrix surveys are used to understand perspectives of the scientific community and to help prioritize action items for the Mobile Bay National Estuary Program (MBNEP). The views expressed within are not intended to substitute empirical evidence, nor are they necessarily representative of the collective views of the MBNEP Management Conference.

## Introduction

The Management Conference of the MBNEP consists of multiple committees, including a Science Advisory Committee (SAC) representing multiple scientific disciplines. The SAC is charged with providing guidance on priority setting by the MBNEP based on scientific understanding of the issues at-hand and to recommend necessary monitoring and research activities to inform the development of status and trends of the estuarine environment.

Over the last decade, the SAC has grown its membership and participation, spanning multiple scientific disciplines and professional appointments. With such a large group, it can be challenging to capture and consolidate diverse viewpoints on the large number of potential issues encountered throughout coastal Alabama. One way the MBNEP has attempted to extract the professional knowledge of our members is through the implementation of an environmental stressor evaluation matrix (matrix). The matrix concept was first developed and deployed in 2012 when the MBNEP was beginning the process of writing the 2013-2018 Comprehensive Conservation Management Plan (CCMP). The matrix is a modified example of a "wisdom of the crowds" data collection approach, described in Aminpour et al. 2020, where stakeholders are asked to give input to create a causal model for complex socio-ecological systems.

Though the 2012 effort was considered a success and provided valuable insights into which habitats and ecosystem services (ES) should be prioritized for protection and/or restoration, it also afforded the opportunity to examine which potential environmental and/or anthropogenic stressors were currently causing or are projected to cause the greatest impacts to those priority areas over the coming decades. However, ongoing changes to the estuarine landscape—both positive and negative from a combination of successful restoration activities, land conversion, policy reform, and climate change—and large turnover in the SAC membership since 2012 indicated that it was time to redeploy the matrix with current members. The CCMP is also undergoing a full rewrite in 2025, so the information collected from this iteration of the matrix is incredibly valuable in shaping strategy for the upcoming document.

## Methods

The original matrix was composed of 11 habitats, 12 ES, and 13 potential stressors, organized within an Excel spreadsheet with a cell for each unique combination of these three components (n=1,716).

Each participant was asked to consider only the combinations of which they have/had professional or academic experience and understanding, thereby greatly reducing the total number of cells a given individual would have to complete. Participants were asked to score each combination from zero to three, with zero meaning no negative impact of the stressor on that ES provided by each habitat and three meaning a large negative impact from the combination. They were also asked to leave blank any combinations that they were unfamiliar with, unsure of, or found non-applicable.

### 2021/2022 Respondents

The matrix was first distributed to the SAC membership via email (n=84) in October of 2021. The initial low response rate (n=6) necessitated several follow-up requests and personal appeals for participation. In 2012, the SAC determined a requirement of at least seven responses for each cell to be considered valid. When there were not the requisite number of responses either due to poor participation or lack of a particular expertise within the

SAC, the MBNEP reached out to the broader scientific community for insight and support. A similar approach was employed for this replicate effort; however, no minimum response quota was set.

Continued low participation led to multiple efforts to reach out to the broader scientific community, including the deployment of a survey asking scientists and researchers to self-identify their areas of expertise and acknowledge their willingness to join the matrix evaluation efforts. The survey was promoted by presentations to the academic community of the Dauphin Island Sea Lab and a professional talk at the Gulf of Mexico Conference (GOMCON) on the preliminary results of these efforts, all with the hopes of improving matrix participation. These efforts yielded 12 additional responses, for a total of 18.

Once received, matrices were evaluated for errors, inconsistencies, or missing information. When discrepancies were found, the respondent was contacted to provide clarification or revision. Responses of all participants were merged into a single datasheet with the inclusion of a new column identifying the respondent.

For ease of interpretation, data were summarized by habitat and stressor (aggregated by ES) or by ES and stressor (aggregated by habitat). If the median value of a combination equaled or exceeded two, the combination was considered to have a high potential impact and be of elevated priority. Specifically, the total number of stressor categories scoring highly (median ≥2) for a given habitat or ES were summed and those values, in combination with the total number of responses, were used to rank/prioritize the habitats or ES. Summary results can be found in Tables 1 and 2. This process was also completed for the unaggregated data within each habitat; these results can be found in Table 5 and Appendix A.

2023 Respondents

Following the close of the 2021/2022 data collection, it was noted that few of the original 2012 participants responded to the matrix (n=3). An additional outreach effort was extended to respondents in the original 2012 cohort. Where respondents of the original cohort had retired or moved on in their careers, contemporaries were identified and asked to participate in their stead (n=3). In the additional outreach process, many members of the SAC mentioned the stressor matrix was valuable, but incredibly cumbersome to fill out in the Excel sheet format; the form-factor of the exercise likely impacted response rates. To address low participation, the stressor matrix was adapted from an Excel sheet format to a Mentimeter poll. Mentimeter is an online polling and surveying platform. The poll was sent to members of the original 2012 cohort (and appointed contemporaries) following outreach ($n_{response}$ =14). The poll was designed to not interfere with the integrity of the data collected; all habitats, ES, and stressor combinations in the original excel format were represented in the poll and participants could skip habitats, ES, and stressors that fell outside of their professional expertise. Many respondents to the Mentimeter poll mentioned they preferred the poll presentation over the Excel sheet and appreciated the ease of participating. However, it is important to note the change in survey administration could have unknown confounding effects on the data.

Additional Methodology Notes:

- Data from the 2021/2022 and 2023 cohorts were collated and analyzed via medians as the central tendency metric (Tables 2 and 3). Possible responses to the survey are not continuous and should be treated as discrete, ordinal values according to current statistical literature. This method is a departure from the method used to evaluate results in 2012, where averages across respondents were used.
- In 2012, the proctors calculated arithmetic means for each combination of habitat, ES, and stressor. Those means were then summed across either habitat or ES, and then summed again across all stressors. One issue with this approach is that matrix scores are ordinal—or rank— numbers. This means the numbers themselves do not have value, but the order of the numbers has meaning. In other words, a score of three has a higher rank than two which has a higher rank than one, but a three isn't three times as impactful as a one. Because of this, the arithmetic mean is not the most appropriate measure of central tendency.
- For continuity, it was requested that the data also be analyzed via averages (the methodology used in the 2012 prior stressor evaluation analysis). Outcomes from this methodology are provided in Appendix B.

Differences in interpretation of results between the two methodologies are minor; for more information, please see the data distribution diagrams in Figures 1 and 2.

- 2012 data was reanalyzed using medians and a comparison of ES medians in 2012 vs 2021-2023 is shown in Table 4.
- Out of all possible responses to the stressor evaluation (0,1,2, or 3), 2 is the threshold for responses indicating higher perceptions of stress.

## Results & Discussion

Eighteen respondents participated in the 2021-2022 environmental stressor evaluation matrix efforts providing more than 2,300 scores based on their professional and academic experiences. This is lower than the participation in the 2012 effort which saw 26 participants providing more than 3,400 scores. However, some of this disparity is likely the result of the areas of expertise solicited and the types of habitats, ES, and stressors included in the matrix.

Following the additional outreach to members of the 2012 cohort, 14 additional respondents (11 from the original cohort, 3 appointed contemporaries of a 2012 cohort member) participated in the matrix. For this report, data from the 2021 and 2023 respondents were aggregated into one dataset, henceforth referred to as the 2021-2023 cohort, resulting in 32 participants total. Participation for each habitat type is detailed in Table 1.

**Table 1**. Numbers of respondents (n -value) across the 2021-2023 cohort for each habitat. The highest participation was seen in Freshwater Wetlands, Beaches and Dunes, and Intertidal Marshes and Flats; the lowest participation was seen in upland habitats like Maritime Forest, Pine Savannas, and Longleaf Pine Habitat.

| Habitat | Number of Respondents |
|---|---|
| Freshwater Wetlands | 18 |
| Beaches and Dunes | 17 |
| Intertidal Marsh and Flats | 17 |
| Oyster Reefs | 16 |
| Streams and Rivers | 16 |
| Submerged Aquatic Vegetation | 14 |
| Subtidal Habitats | 13 |
| Riparian Buffers | 7 |
| Pine Savanna Forest | 6 |
| Longleaf Pine Habitat | 6 |
| Maritime Forest | 6 |

**Stressor Evaluation By Habitat (across all ES):**

**Table 2.** Median Values of Habitat Responses. Median values show the central tendency of the ordinal and discrete data set; high values are highlighted, 2 (yellow) and 3 (orange).

| Impacted Habitats | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea level rise | Climate variability | Freshwater discharge | Resource extraction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beaches and Dunes | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 2 | 2 | 0 | 0 |
| Freshwater Wetlands | 0 | 1 | 0 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| Intertidal Marshes and Flats | 0 | 2 | 0 | 1 | 1 | 2 | 0 | 0 | 1 | 2 | 2 | 1 | 0 |
| Longleaf Pine Habitat | 0 | 0 | 1 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Maritime Forest | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Oyster Reefs | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1.5 | 1 |
| Pine Savanna | 0 | 0 | 1 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| Riparian Buffers | 0 | 1 | 0 | 1 | 1 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| Streams and Rivers | 1 | 1 | 0 | 1 | 0 | 2 | 1 | 0 | 2 | 1 | 1 | 1 | 1 |
| Submerged Aquatic Vegetation | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |
| Subtidal Habitats | 0.5 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |

*Habitats ranked by number of stressors with median responses ≥2:*

- 4 stressors - Intertidal Marshes and Flats
- 3 stressors - Beaches and Dunes, Pine Savannas
- 2 stressors - Streams and Rivers, Freshwater Wetlands, Longleaf Pine Habitat
- 1 stressor - Maritime Forest, Riparian Buffers
- 0 stressors - Oyster Reefs, SAV, Subtidal Habitats

*Stressors ranked by number of habitats that had median responses ≥2:*

- 8 habitats – Land Use Change
- 3 habitats – Climate Variability, Fragmentation
- 2 habitats – Sea Level Rise
- 1 habitat – Dredging/Filling, Sedimentation
- 0 habitats – Chemical Contamination, Fire Suppression, Invasive/Exotic Species, Nutrient Enrichment, Pathogens, Freshwater Discharge, Resource Extraction

**Stressor Evaluation By ES (across all habitats):**

**Table 3.** Median Values of ES Responses. Median values show the central tendency of the ordinal and discrete data set; medians of 2 are highlighted in yellow.

| Ecosystem Services | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea level rise | Climate variability | Freshwater discharge | Resource extraction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 0 |
| Carbon Sequestration | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| Fisheries Habitat | 1 | 2 | 0 | 1 | 1 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 0 |
| Flood Control | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| Groundwater Replenishment | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nesting habitat for birds and turtles | 0 | 1 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| Oyster production | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| Primary production | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| Sediment and nutrient retention | 0 | 1 | 0 | 1 | 0 | 2 | 1 | 0 | 2 | 1 | 2 | 1 | 0 |
| Storm buffer/hazard protection | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| Water quality enhancement | 1 | 1 | 0 | 1 | 0 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 0 |
| Wildlife habitat | 1 | 1 | 0 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 2 | 1 | 0.5 |

*ES ranked by number of stressors with median responses ≥ 2:*

- 4 stressors – Biodiversity
- 3 stressors – Fisheries Habitat, Sediment and Nutrient Retention, Water Quality Enhancement, Wildlife Habitat
- 1 stressor – Carbon Sequestration, Nesting Habitat for Birds and Turtles, Storm Buffering/ Hazard Protection
- 0 stressors – Flood Control, Groundwater Replenishment, Oyster Production, Primary Production

*Stressors ranked by number of ES that had median responses ≥ 2:*

- 8 ES – Land Use Change
- 4 ES – Climate Variability
- 2 ES – Sedimentation, Fragmentation
- 1 ES – Dredging/Filling, Invasive/Exotic Species, Nutrient Enrichment

- 0 ES – Chemical Contamination, Fire Suppression, Pathogens, Sea Level Rise, Freshwater Discharge, Resource Extraction

**2021-2023 Medians Summary:**

- Habitats considered most under stress across ES: Intertidal Marshes and Flats, Beaches and Dunes, Pine Savannas, Stream and Rivers, Freshwater Wetlands, and Longleaf Pine Habitat
- ES considered most under stress across habitat types: Biodiversity, Fisheries Habitat, Sediment and Nutrient Retention, Water Quality Enhancement, and Wildlife Habitat
- Stressors ranked highest across habitat and ES: Land Use Change, Climate Variability, Fragmentation, Sedimentation, Sea Level Rise

**Data Distribution Diagrams:**

Figures 1 and 2 show data distributions for habitat and ES responses, organized by stressor. Each stressor has a unique bar color that will be the same across all graphs. The data distributions are shown using box and whisker plots. Box and whisker plots show the central 50% of data for each parameter within the “box” and the whiskers indicate the lower and upper 25% of the data. The line in the middle of the box indicates the median value. The x icons indicate averages. Depending on how the data is distributed, the median line may not be visible (equivalent to the upper or lower quartile lines of the box). Outliers are indicated by individual dots.

In reviewing the following figures, take note of where the medians and averages fall on the y- (vertical) axis. Two is the threshold for medians. Additionally, the higher the box is on the y-axis, the more the response distribution skews to higher values. For parameters without a box, most responses were 0, with or without outliers.

The n-value for each category can be found underneath each box plot. The n-value describes the number of responses collected for each ES: stressor or habitat: stressor combination, not the number of respondents.

**Figure 1. Distributions of ES Responses by Stressor**

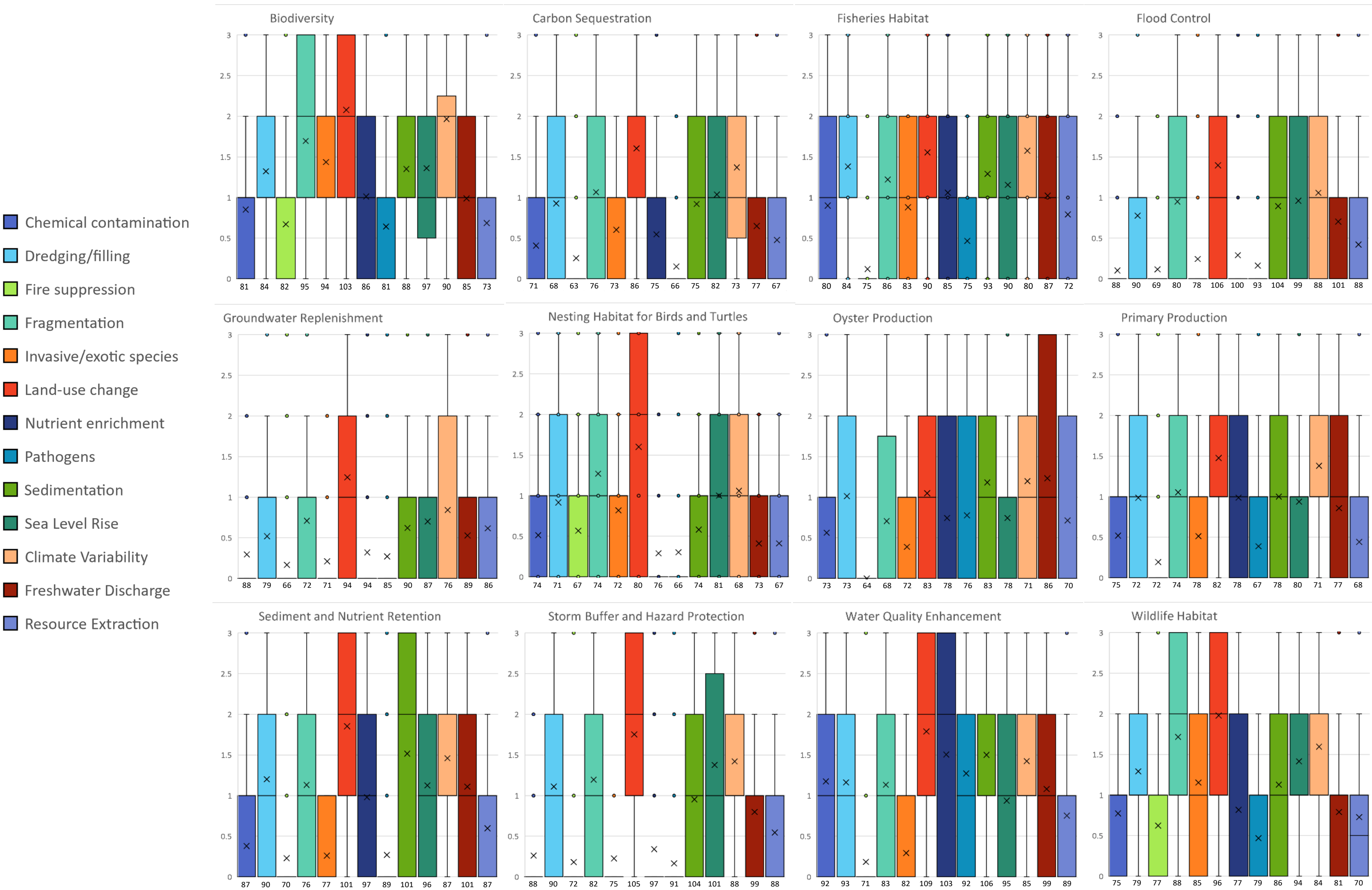
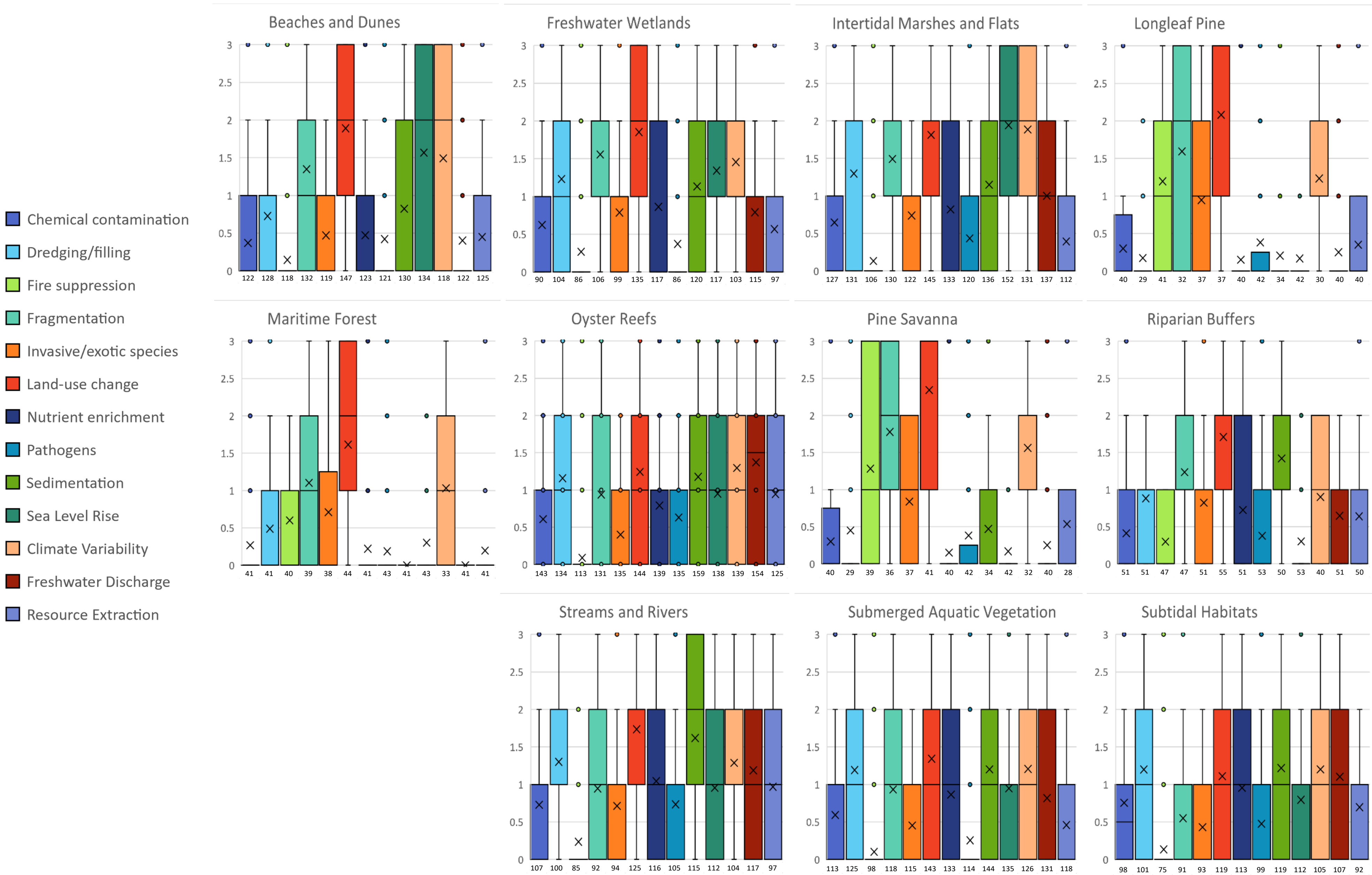



**Figure 2. Distributions of Habitat Responses by Stressor**



Chemical contamination
Dredging/filling
Fire suppression
Fragmentation
Invasive/exotic species
Land-use change
Nutrient enrichment
Pathogens
Sedimentation
Sea Level Rise
Climate Variability
Freshwater Discharge
Resource Extraction
Beaches and Dunes
122 128 118 132 119 147 123 121 130 134 118 122 125
Freshwater Wetlands
90 104 86 106 99 135 117 86 120 117 103 115 97
Intertidal Marshes and Flats
127 131 106 130 122 145 133 120 136 152 131 137 112
Longleaf Pine
40 29 41 32 37 37 40 42 34 42 30 40 40
Maritime Forest
41 41 40 39 38 44 41 43 41 43 33 41 41
Oyster Reefs
143 134 113 131 135 144 139 135 159 138 139 154 125
Pine Savanna
40 29 39 36 37 41 40 42 34 42 32 40 28
Riparian Buffers
51 51 47 47 51 55 51 53 50 53 40 51 50
Streams and Rivers
107 100 85 92 94 125 116 105 115 112 104 117 97
Submerged Aquatic Vegetation
113 125 98 118 115 143 133 114 144 135 126 131 118
Subtidal Habitats
98 101 75 91 93 119 113 99 119 112 105 107 92

**Comparisons with 2012:**

There were many similarities between the findings of the 2012 matrix evaluation and the 2021-2023 evaluation (Table 4).

Streams and Rivers, Intertidal Marshes and Flats, and Freshwater Wetlands remain habitats of elevated concern amongst the respondents; Beaches and Dunes, Pine Savannas, and Longleaf Pine joined the priority habitats in 2023. Biodiversity, Water Quality, and Wildlife Habitat remained as the highest ranked ES vulnerable to the stressors in this matrix, with the addition of Sediment and Nutrient Retention and Fisheries Habitat in 2023. While the perceived impacts for individual stressors have changed over the past decade, outcomes are also likely driven by differences in the backgrounds of the participants. Land Use Change, Climate Variability, Fragmentation, and Sedimentation remain the top stressors of primary concern, along with Sea Level Rise and Dredging/Filling. Given the increased development pressure, rapidly changing land-use, and accelerated sea level rise impacting coastal Alabama, it is unsurprising to see vulnerable terrestrial habitats and beaches added to the list of priority habitats.

**Table 4.** Comparison of ES stressor medians from 2012 cohort results and 2021-2023 cohort results. Blue cells indicate medians lower in 2023 than 2012. Fuchsia cells indicate higher medians in 2023 than 2012. Note the higher median trends in the Climate Variability and Sea Level Rise columns, as well as the Oyster Production row.

| Ecosystem Service | Chemical Contamination | Dredging/Filling | Fire Suppression | Fragmentation | Invasive/Exotic Species | Land Use Change | Nutrient Enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 Biodiversity | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1.5 |
| 2023 Biodiversity | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 0 |
| 2012 Carbon Sequestration | 0 | 1 | 0 | 1 | 1 | 2 | 1 | 0 | 1 | 0.5 | 1 | 1 | 1 |
| 2023 Carbon Sequestration | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| 2012 Fisheries Habitat | 1 | 2 | 0 | 1.5 | 1 | 1 | 1.75 | 0.75 | 2 | 1 | 1 | 1 | 1 |
| 2023 Fisheries Habitat | 1 | 2 | 0 | 1 | 1 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 0 |
| 2012 Flood Control | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2023 Flood Control | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 2012 Groundwater Replenishment | 0 | 0 | 0 | 0.5 | 0 | 1.5 | 0 | 0 | 0 | 0 | 1 | 0 | 0.5 |
| 2023 Groundwater Replenishment | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2012 Nesting Habitat for Birds and Turtles | 1 | 1 | 0.5 | 2 | 1 | 2 | 0 | 0 | 0.5 | 0.5 | 1 | 0.5 | 1 |
| 2023 Nesting Habitat for Birds and Turtles | 0 | 1 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 2012 Oyster Production | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2023 Oyster Production | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| 2012 Primary Production | 1 | 1 | 0 | 2 | 1 | 2 | 1 | 0 | 2 | 1 | 1 | 1 | 1 |
| 2023 Primary Production | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| 2012 Sediment and Nutrient Retention | 0 | 2 | 0 | 1.5 | 0 | 2 | 1 | 0 | 2 | 0.5 | 1 | 1 | 1 |
| 2023 Sediment and Nutrient Retention | 0 | 1 | 0 | 1 | 0 | 2 | 1 | 0 | 2 | 1 | 2 | 1 | 0 |
| 2012 Storm Buffer / Hazard Protection | 0 | 1 | 0 | 1.5 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| 2023 Storm Buffer / Hazard Protection | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| 2012 Water Quality Enhancement | 1 | 2 | 0 | 1 | 0 | 1.5 | 2 | 0.5 | 1.5 | 0 | 1 | 2 | 1 |
| 2023 Water Quality Enhancement | 1 | 1 | 0 | 1 | 0 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 0 |
| 2012 Wildlife Habitat | 1 | 2 | 0 | 2 | 1.5 | 2 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 |
| 2023 Wildlife Habitat | 1 | 1 | 0 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 2 | 1 | 0.5 |

**Habitat – Specific Analysis:**

To enhance the specificity of the evaluation, top stressed ES and priority stressors were identified within the top six habitats perceived as most under stress (Table 5). Stressed ES were classified as having the greatest frequency of medians greater than or equal to 2. Unsurprisingly, Land Use Change was the top priority stressor identified in all 6 habitats. Similarly, Biodiversity was identified as a stressed ES in all 6 habitats. Although there are many similarities between them, each habitat has a unique suite of stressors and impacted ES. See Appendix A for additional details and all habitats.

**Table 5.** Summary table of top stressed habitats, top stressed ES, and priority stressors within each identified habitat, per responses from the 2021-2023 cohort.

| Top Stressed Habitat | Top Stressed ES within Habitat<br>(# of medians ≥ 2, out of 13) | Priority Stressors on Habitat<br>(# of medians ≥ 2, out of 12) |
|---|---|---|
| **Intertidal Marshes and Flats**<br>*Respondents = 17* | Storm Buffering/ Hazard Protection (6)<br>Water Quality Enhancement (6)<br>Biodiversity (5)<br>Sediment and Nutrient Retention (5)<br>Wildlife Habitat (5) | Land Use Change (10)<br>Sea Level Rise (10)<br>Climate Variability (10)<br>Dredging/Filling (7) |
| **Beaches and Dunes**<br>*Respondents = 17* | Nesting Habitat for Birds and Turtles (5)<br>Biodiversity (4)<br>Storm Buffering/Hazard Protection (4)<br>Wildlife Habitat (4) | Land Use Change (8)<br>Sea Level Rise (6)<br>Climate Variability (6) |
| **Pine Savannas**<br>*Respondents = 6* | Biodiversity (5)<br>Wildlife Habitat (5) | Land Use Change (10)<br>Fragmentation (8)<br>Climate Variability (6) |
| **Streams and Rivers**<br>*Respondents = 16* | Biodiversity (5)<br>Fisheries Habitat (4)<br>Water Quality Enhancement (4) | Land Use Change (7)<br>Sedimentation (5) |
| **Freshwater Wetlands**<br>*Respondents = 18* | Water Quality Enhancement (5)<br>Biodiversity (5)<br>Flood Control (5)<br>Storm Buffering/Hazard Protection (4) | Land Use Change (8)<br>Fragmentation (7)<br>Dredging/Filling (5) |
| **Longleaf Pine Habitat**<br>*Respondents = 6* | Biodiversity (5)<br>Nesting Habitat for Birds and Turtles (4)<br>Wildlife Habitat (4) | Land Use Change (8)<br>Fragmentation (7) |

## Conclusions

Based on the feedback of SAC members and some respondents, additional categories are needed to fully explore the potential interacting impacts our coastal resources and services are likely to experience in the coming years (e.g., understanding the impacts of stressors on human-centric services like tourism or recreation; the expansion of additional known stressors such as pharmaceuticals, microplastics, and hypoxia, etc.). This exercise, though challenging, has provided valuable insight into the educated opinions of regional practitioners and researchers on the severity of current and future stressors in Mobile Bay and the surrounding region. Henceforth, utilizing medians as the central tendency metric should be the standard methodology in analysis of stressor matrix results, to align with current statistical literature and methods. Future iterations of this exercise may wish to solicit additional expertise on upland ecosystems, as these habitats generally had the lowest response numbers and participation. The updated Mentimeter format of the stressor matrix will likely be retained to aid in ease of participation.

Results from this exercise will aid the MBNEP management conference in determining potential focus areas for projects and plans for the upcoming CCMP. These data are one component of the ongoing 2025 CCMP rewrite process. Results from the evaluation suggest that future MBNEP projects and planning efforts should address land use change and fragmentation, effects of climate change (climate variability and sea level rise), declining water quality, and loss of biodiversity and critical habitats (fisheries and wildlife). MBNEP should also seek to add additional expertise in upland habitats to the management conference. While the number of responses for these habitats were low, the responses that were collected ranked the uplands habitats as highly stressed – thus meriting additional investigation and attention.

Literature Cited:

Aminpour, P., Gray, S.A., Jetter, A.J., Introne, J.E., Singer, A. and Arlinghaus, R., 2020. Wisdom of stakeholder crowds in complex social–ecological systems. *Nature Sustainability*, *3*(3), pp.191-199.

## Appendix A. Habitat-specific analysis for 2021-2023 cohort responses

**Table AA1a-b**. a) Median values of ES responses within the Beaches and Dunes habitat type. b) Number of responses for each ES: stressor interaction within the Beaches and Dunes habitat.

a)

| Beaches and Dunes | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction | *# of medians ≥ 2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 0 | 1 | 0 | 2 | 1 | 2.5 | 0 | 0 | 0 | 2 | 2.5 | 0 | 0 | 4 |
| Carbon sequestration | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 0.5 | 0 | 0 | 1 |
| Fisheries habitat | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | 1.5 | 0 | 0 | 1 |
| Flood control | 0 | 0 | 0 | 1.5 | 0 | 2 | 0 | 0 | 0 | 1.5 | 2 | 0 | 0 | 2 |
| Groundwater replenishment | 0 | 0 | 0 | 0 | 0 | 1.5 | 0 | 0 | 0 | 1.5 | 1 | 0 | 0 | 0 |
| Nesting habitat for birds & turtles | 0.5 | 2 | 0 | 2 | 0.5 | 3 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 5 |
| Oyster production | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Primary production | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| Sediment and nutrient retention | 0 | 0 | 0 | 1 | 0 | 2.5 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 3 |
| Storm buffer/ hazard protection | 0 | 1 | 0 | 2 | 0 | 3 | 0 | 0 | 0 | 3 | 2.5 | 0 | 0 | 4 |
| Water quality enhancement | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| Wildlife habitat | 0 | 1 | 0 | 2 | 1 | 3 | 0 | 0 | 0 | 3 | 2 | 0 | 0.5 | 4 |
| *# of medians* ≥ 2 | 0 | 1 | 0 | 4 | 0 | **8** | 0 | 0 | 0 | **6** | **6** | 0 | 0 | |

b)

| n values | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 11 | 11 | 11 | 12 | 13 | 14 | 11 | 9 | 10 | 13 | 10 | 9 | 10 |
| Carbon sequestration | 8 | 9 | 9 | 11 | 9 | 11 | 8 | 9 | 9 | 11 | 10 | 9 | 9 |
| Fisheries habitat | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 11 | 11 | 10 | 11 | 9 |
| Flood control | 11 | 13 | 10 | 12 | 10 | 15 | 12 | 12 | 15 | 12 | 12 | 13 | 13 |
| Groundwater replenishment | 10 | 11 | 8 | 10 | 9 | 12 | 10 | 10 | 10 | 10 | 9 | 10 | 11 |
| Nesting habitat for birds & turtles | 10 | 11 | 10 | 11 | 10 | 12 | 10 | 9 | 10 | 12 | 9 | 9 | 9 |
| Oyster production | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 10 | 9 | 11 | 11 |
| Primary production | 9 | 9 | 10 | 10 | 9 | 10 | 8 | 8 | 9 | 9 | 8 | 8 | 9 |
| Sediment and nutrient retention | 10 | 10 | 9 | 10 | 9 | 12 | 11 | 11 | 11 | 11 | 10 | 11 | 11 |
| Storm buffer/ hazard protection | 11 | 12 | 10 | 12 | 9 | 14 | 11 | 11 | 13 | 13 | 10 | 12 | 12 |
| Water quality enhancement | 11 | 11 | 9 | 11 | 9 | 13 | 11 | 11 | 12 | 10 | 10 | 10 | 11 |
| Wildlife habitat | 10 | 10 | 11 | 12 | 11 | 12 | 9 | 10 | 9 | 12 | 11 | 9 | 10 |

Within Beach and Dunes, Land Use Change, Sea Level Rise, and Climate Variability were the greatest identified stressors (highest number of medians greater than or equal to 2). ES under greatest stress in this habitat include Nesting Habitat for Birds and Turtles, Wildlife Habitat, Biodiversity, and Storm Buffering/Hazard Protection. Medians for ES: Stressor interactions in this habitat type were determined from a minimum of 8 responses to a maximum of 15 responses.

**Table AA2a-b**. a) Median values of ES responses within the Freshwater Wetlands habitat type. b) Number of responses for each ES: stressor interaction within the Freshwater Wetlands habitat.

a)

| Freshwater Wetlands | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction | *# of medians ≥ 2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 1 | 1.5 | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 2 | 2 | 1 | 0 | 5 |
| Carbon sequestration | 0 | 0 | 0 | 2 | 1 | 1.5 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| Fisheries habitat | 1 | 2 | 0 | 1.5 | 1 | 1 | 1 | 0 | 1 | 1 | 2 | 1 | 0 | 2 |
| Flood control | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 2 | 2 | 1 | 0 | 5 |
| Groundwater replenishment | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| Nesting habitat for birds & turtles | 1 | 2 | 0.5 | 2 | 1 | 2 | 0.5 | 0 | 1 | 1 | 1 | 0 | 0.5 | 3 |
| Oyster production | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Primary production | 0 | 0 | 0 | 1 | 0.5 | 1 | 0.5 | 0 | 1 | 1 | 1 | 0.5 | 0 | 0 |
| Sediment and nutrient retention | 0 | 1 | 0 | 1 | 0 | 2 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| Storm buffer/ hazard protection | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 2 | 2 | 1 | 0 | 4 |
| Water quality enhancement | 1.5 | 2 | 0 | 2 | 1 | 2 | 2 | 1.5 | 2 | 1 | 1 | 0.5 | 1 | 5 |
| Wildlife habitat | 1 | 2 | 0.5 | 2 | 1 | 2 | 1 | 0 | 1 | 1 | 1 | 0.5 | 0 | 3 |
| *# of medians ≥ 2* | 0 | 5 | 0 | **7** | 1 | **8** | 1 | 0 | 1 | 3 | 4 | 0 | 0 | |

b)

| n values | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 8 | 10 | 9 | 11 | 10 | 13 | 9 | 8 | 10 | 11 | 11 | 9 | 9 |
| Carbon sequestration | 8 | 8 | 7 | 9 | 9 | 12 | 9 | 6 | 8 | 10 | 9 | 9 | 8 |
| Fisheries habitat | 8 | 10 | 8 | 10 | 9 | 11 | 10 | 7 | 12 | 11 | 9 | 10 | 9 |
| Flood control | 8 | 9 | 7 | 10 | 8 | 13 | 11 | 9 | 13 | 11 | 9 | 12 | 9 |
| Groundwater replenishment | 9 | 9 | 8 | 9 | 8 | 12 | 12 | 8 | 11 | 10 | 8 | 10 | 10 |
| Nesting habitat for birds & turtles | 6 | 7 | 6 | 8 | 7 | 9 | 8 | 5 | 7 | 9 | 7 | 7 | 6 |
| Oyster production | 7 | 8 | 6 | 7 | 8 | 9 | 9 | 7 | 9 | 8 | 7 | 10 | 7 |
| Primary production | 7 | 7 | 7 | 7 | 8 | 9 | 8 | 5 | 8 | 8 | 8 | 8 | 6 |
| Sediment and nutrient retention | 7 | 9 | 7 | 8 | 7 | 11 | 10 | 8 | 10 | 9 | 9 | 11 | 8 |
| Storm buffer/ hazard protection | 7 | 10 | 7 | 9 | 7 | 12 | 10 | 8 | 12 | 11 | 10 | 11 | 9 |
| Water quality enhancement | 8 | 9 | 6 | 8 | 9 | 13 | 12 | 8 | 11 | 9 | 7 | 10 | 9 |
| Wildlife habitat | 7 | 8 | 8 | 10 | 9 | 11 | 9 | 7 | 9 | 10 | 9 | 8 | 7 |

Within Freshwater Wetlands, Land Use Change, Fragmentation, and Dredging/Filling were the greatest identified stressors (highest number of medians greater than or equal to 2). ES under greatest stress in this habitat include Biodiversity, Flood Control, and Water Quality Enhancement. Medians for ES: Stressor interactions in this habitat type were determined from a minimum of 5 responses to a maximum of 13 responses.

**Table AA3a-b**. a) Median values of ES responses within the Intertidal Marshes and Flats habitat type. b) Number of responses for each ES: stressor interaction within the Intertidal Marshes and Flats habitat.

a)

| Intertidal Marshes and Flats | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction | *# of medians* ≥ 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 1 | 1 | 0 | 2 | 2 | 2.5 | 1 | 0 | 1 | 2 | 2 | 1 | 0 | 5 |
| Carbon sequestration | 0.5 | 1 | 0 | 1 | 1 | 2 | 0.5 | 0 | 1 | 2 | 2 | 1 | 0 | 3 |
| Fisheries habitat | 1 | 2 | 0 | 1 | 1 | 2 | 1 | 0 | 1 | 2 | 2 | 1 | 0 | 4 |
| Flood control | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 2.5 | 1.5 | 1 | 0 | 2 |
| Groundwater replenishment | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0.5 | 0 | 0 | 0 |
| Nesting habitat for birds & turtles | 1 | 2 | 0 | 1.5 | 1 | 2 | 0 | 0 | 1 | 2 | 2 | 1 | 0 | 4 |
| Oyster production | 0 | 1 | 0 | 1.5 | 0 | 1 | 0 | 0 | 1.5 | 1 | 2 | 2 | 0 | 2 |
| Primary production | 0.5 | 2 | 0 | 1 | 1 | 2 | 1 | 0 | 1 | 2 | 2 | 1 | 0 | 4 |
| Sediment and nutrient retention | 0 | 2 | 0 | 1 | 0.5 | 2 | 1 | 0 | 2 | 2 | 2 | 1 | 0 | 5 |
| Storm buffer/ hazard protection | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 0 | 2 | 3 | 2 | 1 | 0 | 6 |
| Water quality enhancement | 1 | 2 | 0 | 1 | 0 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 0 | 6 |
| Wildlife habitat | 1 | 2 | 0 | 2 | 1 | 2 | 1 | 0 | 1 | 2 | 2 | 1 | 0 | 5 |
| *# of medians* ≥ 2 | 0 | **7** | 0 | 3 | 1 | **10** | 1 | 0 | 3 | **10** | **10** | 1 | 0 | |

b)

| n values | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 10 | 11 | 9 | 12 | 12 | 12 | 11 | 10 | 11 | 14 | 12 | 12 | 8 |
| Carbon sequestration | 10 | 10 | 7 | 10 | 9 | 11 | 10 | 8 | 10 | 12 | 10 | 11 | 8 |
| Fisheries habitat | 10 | 11 | 9 | 11 | 11 | 11 | 11 | 9 | 11 | 13 | 11 | 11 | 9 |
| Flood control | 11 | 12 | 9 | 11 | 11 | 13 | 12 | 11 | 13 | 14 | 12 | 12 | 10 |
| Groundwater replenishment | 11 | 9 | 8 | 9 | 9 | 11 | 11 | 10 | 11 | 11 | 10 | 11 | 9 |
| Nesting habitat for birds & turtles | 10 | 10 | 9 | 10 | 10 | 11 | 10 | 9 | 10 | 12 | 10 | 11 | 9 |
| Oyster production | 10 | 11 | 9 | 10 | 9 | 11 | 10 | 10 | 10 | 11 | 10 | 10 | 9 |
| Primary production | 10 | 10 | 9 | 10 | 10 | 11 | 10 | 9 | 11 | 11 | 10 | 11 | 9 |
| Sediment and nutrient retention | 11 | 12 | 9 | 11 | 10 | 13 | 11 | 11 | 12 | 14 | 11 | 13 | 10 |
| Storm buffer/ hazard protection | 11 | 11 | 9 | 11 | 9 | 13 | 12 | 11 | 11 | 14 | 12 | 11 | 10 |
| Water quality enhancement | 12 | 12 | 9 | 12 | 10 | 14 | 14 | 11 | 13 | 13 | 11 | 12 | 11 |
| Wildlife habitat | 11 | 12 | 10 | 13 | 12 | 14 | 11 | 11 | 13 | 13 | 12 | 12 | 10 |

Within Intertidal Marshes and Flats, Land Use Change, Sea Level Rise, and Climate Variability were the greatest identified stressors (highest number of medians greater than or equal to 2). ES under greatest stress in this habitat include Storm Buffer/ Hazard Protection, Water Quality Enhancement, Biodiversity, Sediment and Nutrient Retention, and Wildlife Habitat. Medians for ES: Stressor interactions in this habitat type were determined from  a minimum of 7 responses to a maximum of 14 responses.

**Table AA4a-b**. a) Median values of ES responses within the Longleaf Pine habitat type. b) Number of responses for each ES: stressor interaction within the Longleaf Pine habitat.

a)

| Longleaf Pine Habitat | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction | *# of medians ≥ 2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 0 | 1 | 2 | 2 | 2 | 3 | 0 | 0.5 | 0 | 0 | 2 | 0 | 0 | 5 |
| Carbon sequestration | 0 | 0.5 | 1.5 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 1.5 | 0 | 0 | 2 |
| Fisheries habitat | 0 | 0 | 0.5 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Flood control | 0 | 0 | 0 | 0 | 0 | 1.5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Groundwater replenishment | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0.5 | 2 |
| Nesting habitat for birds & turtles | 0 | 0 | 2 | 2 | 2 | 3 | 0 | 0 | 0 | 0 | 1.5 | 0 | 0 | 4 |
| Oyster production | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Primary production | 0 | 0 | 1 | 2.5 | 2 | 3 | 0 | 0 | 0 | 0 | 1.5 | 0 | 0 | 3 |
| Sediment and nutrient retention | 0 | 0 | 1 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 3 |
| Storm buffer/ hazard protection | 0 | 0 | 0 | 0 | 0 | 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Water quality enhancement | 0.5 | 0 | 0 | 1.5 | 0 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Wildlife habitat | 0 | 0 | 2.5 | 2.5 | 2 | 2.5 | 0 | 0.5 | 0 | 0.5 | 1 | 0 | 0 | 4 |
| *# of medians ≥ 2* | 0 | 0 | 3 | **7** | 4 | **8** | 0 | 0 | 0 | 0 | 2 | 0 | 0 | |

b)

| n values | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 3 | 2 | 5 | 4 | 4 | 4 | 3 | 4 | 2 | 4 | 3 | 3 | 3 |
| Carbon sequestration | 3 | 2 | 4 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| Fisheries habitat | 3 | 2 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| Flood control | 4 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 4 | 3 | 4 | 4 |
| Groundwater replenishment | 4 | 3 | 3 | 2 | 3 | 3 | 4 | 4 | 3 | 4 | 3 | 4 | 4 |
| Nesting habitat for birds & turtles | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| Oyster production | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 |
| Primary production | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| Sediment and nutrient retention | 4 | 3 | 3 | 2 | 3 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| Storm buffer/ hazard protection | 4 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| Water quality enhancement | 4 | 3 | 3 | 2 | 3 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| Wildlife habitat | 3 | 2 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 4 | 3 | 3 | 3 |

Within Longleaf Pine Habitat, Land Use Change, Fragmentation, and Invasive/Exotic Species were the greatest identified stressors (highest number of medians greater than or equal to 2). ES under greatest stress in this habitat include Biodiversity, Wildlife Habitat, and Nesting Habitat for Birds and Turtles. Medians for ES:Stressor interactions in this habitat type were determined from a minimum of 1 response to a maximum of 5 responses.

**Table AA5a-b**. a) Median values of ES responses within the Maritime Forest habitat type. b) Number of responses for each ES: stressor interaction within the Maritime Forest habitat.

a)

| Maritime Forest | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction | *# of medians ≥ 2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 0 | 2 | 2 | 3 | 2 | 3 | 0 | 0 | 0 | 0.5 | 2 | 0 | 0 | 6 |
| Carbon sequestration | 0 | 1 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Fisheries habitat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Flood control | 0 | 0.5 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Groundwater replenishment | 0.5 | 0 | 0 | 0 | 0 | 1.5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Nesting habitat for birds & turtles | 0 | 1 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 3 |
| Oyster production | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Primary production | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sediment and nutrient retention | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Storm buffer/ hazard protection | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Water quality enhancement | 0 | 0 | 0 | 1 | 0 | 1.5 | 0.5 | 0.5 | 0 | 0 | 1 | 0 | 0 | 0 |
| Wildlife habitat | 0 | 1 | 1.5 | 2.5 | 2 | 2.5 | 0 | 0 | 0 | 0.5 | 2 | 0 | 0 | 4 |
| *# of medians ≥ 2* | 0 | 1 | 1 | 2 | 3 | **6** | 0 | 0 | 0 | 0 | 3 | 0 | 0 | |

b)

| n values | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 3 | 3 | 5 | 5 | 4 | 5 | 3 | 4 | 3 | 4 | 4 | 3 | 3 |
| Carbon sequestration | 3 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Fisheries habitat | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| Flood control | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| Groundwater replenishment | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| Nesting habitat for birds & turtles | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| Oyster production | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| Primary production | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| Sediment and nutrient retention | 4 | 4 | 3 | 2 | 3 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| Storm buffer/ hazard protection | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| Water quality enhancement | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| Wildlife habitat | 3 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 4 | 3 | 3 | 3 |

Within Maritime Forest, Land Use Change, Climate Variability, and Invasive/Exotic Species were the greatest identified stressors (highest number of medians greater than or equal to 2). ES under greatest stress in this habitat include Biodiversity, Wildlife Habitat, and Nesting Habitat for Birds and Turtles. Medians for ES:Stressor interactions in this habitat type were determined from a minimum of 2 responses to a maximum of 5 responses.

**Table AA6a-b**. a) Median values of ES responses within the Oyster Reef habitat type. b) Number of responses for each ES: stressor interaction within the Oyster Reef habitat.

a)

| Oyster Reefs | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction | *# of medians ≥ 2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 1 | 2 | 0 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 5 |
| Carbon sequestration | 0 | 2 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 2 | 0.5 | 3 |
| Fisheries habitat | 1 | 2 | 0 | 1 | 0.5 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1.5 | 5 |
| Flood control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Groundwater replenishment | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nesting habitat for birds & turtles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oyster production | 1 | 2 | 0 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2.5 | 3 | 2 | 8 |
| Primary production | 0 | 1 | 0 | 0.5 | 0 | 1 | 1.5 | 0.5 | 1 | 1 | 1.5 | 2 | 1 | 1 |
| Sediment and nutrient retention | 0 | 0.5 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 1 | 2 | 2 | 1 | 3 |
| Storm buffer/ hazard protection | 0 | 1 | 0 | 0.5 | 0 | 1.5 | 0 | 0 | 1 | 1 | 1 | 1 | 0.5 | 0 |
| Water quality enhancement | 1 | 2 | 0 | 1.5 | 0 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 5 |
| Wildlife habitat | 0 | 2 | 0 | 1 | 0 | 1 | 0.5 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| *# of medians ≥ 2* | 0 | **6** | 0 | 2 | 0 | 3 | 0 | 2 | 5 | 0 | 5 | **7** | 1 | |

b)

| n values | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 12 | 12 | 10 | 12 | 13 | 12 | 11 | 11 | 14 | 11 | 12 | 13 | 10 |
| Carbon sequestration | 12 | 10 | 9 | 11 | 11 | 11 | 11 | 10 | 11 | 11 | 11 | 11 | 10 |
| Fisheries habitat | 12 | 12 | 10 | 12 | 12 | 12 | 11 | 11 | 14 | 12 | 12 | 14 | 10 |
| Flood control | 12 | 11 | 9 | 10 | 11 | 13 | 13 | 12 | 13 | 12 | 12 | 13 | 11 |
| Groundwater replenishment | 11 | 9 | 8 | 9 | 9 | 11 | 11 | 10 | 12 | 10 | 10 | 11 | 10 |
| Nesting habitat for birds & turtles | 11 | 10 | 9 | 10 | 10 | 10 | 10 | 10 | 11 | 10 | 10 | 10 | 9 |
| Oyster production | 12 | 12 | 10 | 11 | 13 | 13 | 12 | 12 | 15 | 12 | 12 | 15 | 11 |
| Primary production | 11 | 10 | 9 | 10 | 10 | 10 | 10 | 10 | 11 | 10 | 10 | 10 | 9 |
| Sediment and nutrient retention | 13 | 12 | 10 | 11 | 12 | 14 | 14 | 13 | 14 | 13 | 13 | 14 | 12 |
| Storm buffer/ hazard protection | 13 | 12 | 10 | 12 | 11 | 14 | 13 | 13 | 15 | 13 | 13 | 15 | 12 |
| Water quality enhancement | 13 | 13 | 10 | 12 | 12 | 13 | 13 | 13 | 16 | 13 | 13 | 16 | 12 |
| Wildlife habitat | 11 | 11 | 9 | 11 | 11 | 11 | 10 | 10 | 13 | 11 | 11 | 12 | 9 |

Within Oyster Reefs, Freshwater Discharge, Dredging/Filling, Sedimentation, and Climate Variability were the greatest identified stressors (highest number of medians greater than or equal to 2). ES under greatest stress in this habitat include Oyster Production, Biodiversity, Fisheries Habitat, and Water Quality Enhancement. Medians for ES:Stressor interactions in this habitat type were determined from a minimum of 8 responses to a maximum of 16 responses.

**Table AA7a-b**. a) Median values of ES responses within the Pine Savanna habitat type. b) Number of responses for each ES: stressor interaction within the Pine Savanna habitat.

a)

| Pine Savannas | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction | *# of medians ≥ 2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 0 | 1.5 | 3 | 2 | 2 | 3 | 0 | 0.5 | 1 | 0 | 2 | 0 | 1 | 5 |
| Carbon sequestration | 0 | 1.5 | 1.5 | 2 | 1 | 3 | 0 | 0 | 1 | 0 | 2 | 0 | 0.5 | 3 |
| Fisheries habitat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.5 | 0 |
| Flood control | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 3 |
| Groundwater replenishment | 0 | 0 | 0 | 2.5 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 3 |
| Nesting habitat for birds & turtles | 0 | 1 | 1 | 3 | 1 | 3 | 0 | 0 | 1 | 0 | 1.5 | 0 | 0.5 | 2 |
| Oyster production | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Primary production | 0 | 1 | 1 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 1.5 | 0 | 0.5 | 2 |
| Sediment and nutrient retention | 0 | 0 | 1 | 2 | 1 | 3 | 0 | 0 | 0.5 | 0 | 1 | 0 | 0 | 2 |
| Storm buffer/ hazard protection | 0 | 0 | 0 | 1.5 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Water quality enhancement | 0.5 | 0 | 0 | 1 | 0 | 2.5 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 2 |
| Wildlife habitat | 0 | 0 | 3 | 3 | 2 | 3 | 0 | 0.5 | 0 | 0.5 | 2 | 0 | 0.5 | 5 |
| *# of medians ≥ 2* | 0 | 0 | 2 | **8** | 2 | **10** | 0 | 0 | 0 | 0 | **6** | 0 | 0 | |

b)

| n values | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 3 | 2 | 5 | 5 | 4 | 5 | 3 | 4 | 2 | 4 | 4 | 3 | 2 |
| Carbon sequestration | 3 | 2 | 4 | 4 | 3 | 4 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| Fisheries habitat | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 |
| Flood control | 4 | 3 | 3 | 2 | 3 | 3 | 4 | 4 | 3 | 4 | 3 | 4 | 3 |
| Groundwater replenishment | 4 | 3 | 3 | 2 | 3 | 3 | 4 | 4 | 3 | 4 | 3 | 4 | 3 |
| Nesting habitat for birds & turtles | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 |
| Oyster production | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 |
| Primary production | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 |
| Sediment and nutrient retention | 4 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 |
| Storm buffer/ hazard protection | 4 | 3 | 3 | 2 | 3 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 3 |
| Water quality enhancement | 4 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 |
| Wildlife habitat | 3 | 2 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 4 | 3 | 3 | 2 |

Within Pine Savannas, Land Use Change, Fragmentation, and Climate Variability were the greatest identified stressors (highest number of medians greater than or equal to 2). ES under greatest stress in this habitat include Biodiversity, Wildlife Habitat, Carbon Sequestration, Flood Control, and Groundwater Replenishment. Medians for ES:Stressor interactions in this habitat type were determined from a minimum of 1 response to a maximum of 5 responses.

**Table AA8a-b**. a) Median values of ES responses within the Riparian Buffer habitat type. b) Number of responses for each ES: stressor interaction within the Riparian Buffer habitat.

a)

| Riparian Buffers | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction | *# of medians ≥ 2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 0 | 1 | 1 | 2 | 2 | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 0.5 | 5 |
| Carbon sequestration | 0 | 1 | 0 | 1 | 1.5 | 1.5 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Fisheries habitat | 0 | 1 | 0.5 | 1 | 1 | 1.5 | 1 | 0.5 | 1.5 | 0 | 2 | 0.5 | 1 | 1 |
| Flood control | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0.5 | 1 | 1 | 0 |
| Groundwater replenishment | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| Nesting habitat for birds & turtles | 0 | 1 | 0 | 1.5 | 1.5 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0.5 | 1 |
| Oyster production | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Primary production | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.5 | 0.5 | 0 |
| Sediment and nutrient retention | 0 | 1 | 0 | 1 | 0.5 | 2 | 0 | 0 | 2 | 0 | 1.5 | 1 | 0 | 2 |
| Storm buffer/ hazard protection | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| Water quality enhancement | 0 | 1 | 0 | 1 | 0 | 1.5 | 2 | 1 | 2 | 0 | 0.5 | 1 | 0 | 2 |
| Wildlife habitat | 0 | 1 | 0 | 1 | 1 | 2 | 1 | 0 | 1.5 | 0 | 1 | 0 | 1 | 1 |
| *# of medians ≥ 2* | 0 | 0 | 0 | 1 | 1 | 5 | 1 | 0 | 3 | 0 | 2 | 0 | 0 | |

b)

| n values | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 4 | 4 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 5 | 4 | 4 | 4 |
| Carbon sequestration | 3 | 3 | 2 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 1 | 3 | 3 |
| Fisheries habitat | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 |
| Flood control | 5 | 5 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 |
| Groundwater replenishment | 5 | 5 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 |
| Nesting habitat for birds & turtles | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| Oyster production | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| Primary production | 4 | 4 | 4 | 4 | 5 | 5 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| Sediment and nutrient retention | 5 | 5 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 |
| Storm buffer/ hazard protection | 5 | 5 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 |
| Water quality enhancement | 5 | 5 | 4 | 4 | 5 | 6 | 5 | 5 | 5 | 5 | 4 | 5 | 5 |
| Wildlife habitat | 4 | 4 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 5 | 4 | 4 | 4 |

Within Riparian Buffers, Land Use Change, Sedimentation, and Climate Variability were the greatest identified stressors (highest number of medians greater than or equal to 2). ES under greatest stress in this habitat include Biodiversity, Sediment and Nutrient Retention, and Water Quality Enhancement. Medians for ES:Stressor interactions in this habitat type were determined from a minimum of 1 response to a maximum of 6 responses.

**Table AA9a-b**. a) Median values of ES responses within the Streams and Rivers habitat type. b) Number of responses for each ES: stressor interaction within the Streams and Rivers habitat.

a)

| Streams and Rivers | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction | *# of medians ≥ 2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 0 | 2 | 1.5 | 2 | 1 | 1 | 5 |
| Carbon sequestration | 0 | 0.5 | 0 | 0 | 0 | 1.5 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| Fisheries habitat | 1 | 1 | 0 | 2 | 1.5 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1.5 | 4 |
| Flood control | 0 | 1 | 0 | 0.5 | 0 | 2 | 0 | 0 | 2 | 1 | 1.5 | 1 | 1 | 2 |
| Groundwater replenishment | 0 | 1 | 0 | 1 | 0 | 1.5 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| Nesting habitat for birds & turtles | 0.5 | 1 | 0 | 1 | 1 | 2 | 0 | 0 | 1.5 | 1 | 1 | 1 | 1 | 1 |
| Oyster production | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.5 | 1 | 0 | 1 | 0 | 0 | 0 |
| Primary production | 0.5 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| Sediment and nutrient retention | 0 | 1.5 | 0 | 1 | 0 | 2 | 1 | 0 | 2.5 | 1 | 1.5 | 2 | 1 | 3 |
| Storm buffer/ hazard protection | 0 | 1 | 0 | 0.5 | 0 | 2 | 0 | 0 | 1 | 1 | 1.5 | 1 | 0 | 1 |
| Water quality enhancement | 2 | 1 | 0 | 0.5 | 0 | 1 | 2 | 2 | 2 | 0 | 1 | 1 | 1 | 4 |
| Wildlife habitat | 1 | 1 | 0 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *# of medians ≥ 2* | 1 | 0 | 0 | 2 | 1 | **7** | 2 | 1 | 5 | 0 | 1 | 1 | 0 | |

b)

| n values | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 10 | 9 | 8 | 10 | 10 | 11 | 10 | 9 | 10 | 10 | 10 | 9 | 8 |
| Carbon sequestration | 5 | 4 | 4 | 5 | 6 | 8 | 7 | 6 | 7 | 7 | 6 | 7 | 5 |
| Fisheries habitat | 9 | 9 | 7 | 9 | 8 | 10 | 9 | 8 | 10 | 9 | 9 | 9 | 8 |
| Flood control | 10 | 11 | 8 | 8 | 8 | 12 | 11 | 11 | 11 | 11 | 10 | 12 | 9 |
| Groundwater replenishment | 11 | 10 | 8 | 9 | 8 | 12 | 12 | 11 | 11 | 10 | 9 | 11 | 11 |
| Nesting habitat for birds & turtles | 8 | 7 | 7 | 7 | 7 | 8 | 8 | 6 | 8 | 7 | 7 | 8 | 7 |
| Oyster production | 7 | 5 | 5 | 5 | 6 | 7 | 8 | 8 | 7 | 8 | 7 | 8 | 6 |
| Primary production | 8 | 7 | 8 | 8 | 9 | 10 | 9 | 7 | 9 | 9 | 8 | 9 | 7 |
| Sediment and nutrient retention | 10 | 10 | 7 | 8 | 8 | 12 | 11 | 10 | 12 | 10 | 10 | 12 | 10 |
| Storm buffer/ hazard protection | 10 | 9 | 8 | 8 | 8 | 12 | 11 | 10 | 11 | 11 | 10 | 12 | 9 |
| Water quality enhancement | 12 | 11 | 8 | 8 | 9 | 13 | 12 | 11 | 11 | 10 | 9 | 11 | 10 |
| Wildlife habitat | 7 | 8 | 7 | 7 | 7 | 10 | 8 | 8 | 8 | 10 | 9 | 9 | 7 |

Within Streams and Rivers, Land Use Change, Sedimentation, Nutrient Enrichment, and Fragmentation were the greatest identified stressors (highest number of medians greater than or equal to 2). ES under greatest stress in this habitat include Biodiversity, Fisheries Habitat, and Water Quality Enhancement. Medians for ES:Stressor interactions in this habitat type were determined from a minimum of 4 responses to a maximum of 13 responses.

**Table AA10a-b**. a) Median values of ES responses within the Submerged Aquatic Vegetation habitat type. b) Number of responses for each ES: stressor interaction within the Submerged Aquatic Vegetation habitat.

a)

| Submerged Aquatic Vegetation | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction | *# of medians ≥ 2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 1 | 1 | 0 | 1 | 1 | 2 | 2 | 0 | 1.5 | 1 | 2 | 1 | 0 | 3 |
| Carbon sequestration | 0 | 1 | 0 | 0.5 | 0 | 1 | 1 | 0 | 1 | 1 | 1.5 | 0.5 | 0 | 0 |
| Fisheries habitat | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 1 | 1 | 1 | 1 | 0 | 3 |
| Flood control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Groundwater replenishment | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nesting habitat for birds & turtles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oyster production | 0 | 1 | 0 | 0 | 0.5 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| Primary production | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 1 | 0 | 1 |
| Sediment and nutrient retention | 0 | 1 | 0 | 1 | 0 | 2 | 1 | 0 | 2 | 1 | 2 | 1 | 0 | 3 |
| Storm buffer/ hazard protection | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Water quality enhancement | 1 | 1.5 | 0 | 1 | 0 | 2 | 1.5 | 1 | 2 | 1 | 1.5 | 1.5 | 0 | 2 |
| Wildlife habitat | 1 | 1 | 0 | 1.5 | 1 | 1.5 | 1 | 0 | 1 | 1 | 2 | 1 | 0 | 1 |
| *# of medians ≥ 2* | 0 | 1 | 0 | 0 | 0 | 4 | 2 | 0 | 2 | 0 | 4 | 0 | 0 | |

b)

| n values | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 9 | 11 | 9 | 11 | 11 | 12 | 11 | 9 | 12 | 12 | 11 | 11 | 9 |
| Carbon sequestration | 9 | 10 | 8 | 10 | 10 | 11 | 10 | 8 | 11 | 11 | 10 | 10 | 9 |
| Fisheries habitat | 9 | 11 | 9 | 11 | 11 | 12 | 11 | 9 | 12 | 12 | 11 | 11 | 9 |
| Flood control | 10 | 10 | 7 | 9 | 9 | 13 | 13 | 11 | 13 | 12 | 11 | 12 | 11 |
| Groundwater replenishment | 10 | 9 | 7 | 8 | 8 | 11 | 11 | 10 | 11 | 10 | 9 | 10 | 10 |
| Nesting habitat for birds & turtles | 9 | 9 | 8 | 9 | 9 | 10 | 10 | 8 | 10 | 10 | 9 | 9 | 9 |
| Oyster production | 9 | 9 | 7 | 9 | 8 | 12 | 10 | 10 | 12 | 11 | 11 | 12 | 10 |
| Primary production | 9 | 10 | 9 | 10 | 10 | 11 | 11 | 8 | 11 | 11 | 10 | 10 | 9 |
| Sediment and nutrient retention | 10 | 12 | 8 | 10 | 9 | 12 | 12 | 10 | 13 | 11 | 11 | 12 | 11 |
| Storm buffer/ hazard protection | 10 | 11 | 8 | 10 | 9 | 13 | 12 | 11 | 13 | 11 | 10 | 11 | 11 |
| Water quality enhancement | 10 | 12 | 9 | 11 | 10 | 14 | 12 | 11 | 14 | 12 | 12 | 12 | 11 |
| Wildlife habitat | 9 | 11 | 9 | 10 | 11 | 12 | 10 | 9 | 12 | 12 | 11 | 11 | 9 |

Within Submerged Aquatic Vegetation, Land Use Change, Climate Variability, Sedimentation, and Nutrient Enrichment were the greatest identified stressors (highest number of medians greater than or equal to 2). ES under greatest stress in this habitat include Biodiversity, Fisheries Habitat, and Sediment and Nutrient Retention. Medians for ES:Stressor interactions in this habitat type were determined from a minimum of 7 responses to a maximum of 14 responses.

**Table AA11a-b**. a) Median values of ES responses within the Subtidal habitat type. b) Number of responses for each ES: stressor interaction within the Subtidal habitat.

a)

| Subtidal Habitats | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction | *# of medians ≥ 2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 1 | 2 | 0 | 0.5 | 1 | 2 | 2 | 0.5 | 2 | 1 | 2 | 1 | 1 | 5 |
| Carbon sequestration | 1 | 1 | 0 | 0 | 0.5 | 1 | 1 | 0 | 2 | 0.5 | 2 | 1.5 | 1 | 2 |
| Fisheries habitat | 2 | 2 | 0 | 1 | 1 | 1.5 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 5 |
| Flood control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Groundwater replenishment | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nesting habitat for birds & turtles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oyster production | 1 | 2 | 0 | 1 | 0 | 1 | 2 | 1 | 2 | 0.5 | 1 | 2 | 1 | 4 |
| Primary production | 0.5 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1.5 | 1 | 0 |
| Sediment and nutrient retention | 0 | 2 | 0 | 0 | 0 | 1.5 | 0 | 0 | 2 | 1 | 1.5 | 2 | 1 | 3 |
| Storm buffer/ hazard protection | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Water quality enhancement | 2 | 1.5 | 0 | 0 | 0 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 4 |
| Wildlife habitat | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| *# of medians ≥ 2* | 2 | 4 | 0 | 0 | 0 | 1 | 3 | 0 | **6** | 0 | 3 | 4 | 0 | |

b)

| n values | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 8 | 9 | 6 | 8 | 8 | 10 | 10 | 8 | 10 | 9 | 9 | 9 | 7 |
| Carbon sequestration | 7 | 7 | 5 | 7 | 6 | 8 | 8 | 7 | 9 | 8 | 8 | 8 | 7 |
| Fisheries habitat | 8 | 9 | 7 | 9 | 8 | 10 | 9 | 8 | 10 | 9 | 9 | 8 | 7 |
| Flood control | 9 | 9 | 6 | 8 | 8 | 11 | 11 | 10 | 11 | 10 | 9 | 10 | 9 |
| Groundwater replenishment | 9 | 7 | 6 | 7 | 7 | 10 | 10 | 9 | 9 | 9 | 8 | 9 | 9 |
| Nesting habitat for birds & turtles | 7 | 6 | 5 | 6 | 6 | 7 | 7 | 6 | 7 | 8 | 7 | 6 | 6 |
| Oyster production | 8 | 8 | 6 | 7 | 8 | 11 | 8 | 8 | 10 | 8 | 9 | 10 | 7 |
| Primary production | 8 | 8 | 7 | 7 | 8 | 8 | 9 | 7 | 8 | 9 | 8 | 8 | 7 |
| Sediment and nutrient retention | 9 | 10 | 7 | 7 | 9 | 12 | 11 | 9 | 12 | 11 | 10 | 11 | 9 |
| Storm buffer/ hazard protection | 9 | 10 | 7 | 8 | 9 | 11 | 11 | 10 | 12 | 11 | 10 | 10 | 9 |
| Water quality enhancement | 9 | 10 | 7 | 9 | 9 | 12 | 12 | 10 | 12 | 11 | 10 | 11 | 9 |
| Wildlife habitat | 7 | 8 | 6 | 8 | 7 | 9 | 7 | 7 | 9 | 9 | 8 | 7 | 6 |

Within Subtidal Habitats, Sedimentation, Dredging/Filling, and Freshwater Discharge were the greatest identified stressors (highest number of medians greater than or equal to 2). ES under greatest stress in this habitat include Biodiversity, Fisheries Habitat, Oyster Production, and Water Quality Enhancement. Medians for ES:Stressor interactions in this habitat type were determined from a minimum of 5 responses to a maximum of 12 responses.

# Appendix B: 2021-2023 Cohort Averages (Old Methodology)

**Stressor Evaluation By Habitat (across all ecosystem services): 2012 Methodology**

**Table AB1.** Bulk Average Values of Habitat Responses. Averages are typically used to determine the central tendency of continuous, interval data sets. Using a bulk average approach, 1.5 would be the threshold for responses indicating higher perceptions of stress. Averages ≥ 1.5 are highlighted in yellow cells, averages ≥ 2 are highlighted in orange cells. Please note that pale yellow cells indicate averages that are near 1.5 (rounds up to 1.5). Coral text indicates values where averages are less than 1.5, but median values are ≥ 2; this is likely an artifact of the distribution of responses and/or outliers. Please see the data distribution figures (Figures 1 and 2) for more information.

| Impacted Habitats | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beaches and Dunes | 0.386 | 0.727 | 0.144 | 1.348 | 0.471 | 1.891 | 0.472 | 0.421 | 0.823 | 1.567 | 1.492 | 0.402 | 0.448 |
| Freshwater Wetlands | 0.622 | 1.231 | 0.267 | 1.557 | 0.788 | 1.852 | 0.863 | 0.372 | 1.133 | 1.342 | 1.456 | 0.791 | 0.567 |
| Intertidal Marsh and Flats | 0.646 | 1.298 | 0.132 | 1.492 | 0.738 | 1.814 | 0.82 | 0.433 | 1.147 | 1.941 | 1.885 | 1 | 0.393 |
| Longleaf Pine Habitat | 0.3 | 0.172 | 1.195 | 1.594 | 0.946 | 2.081 | 0.15 | 0.381 | 0.206 | 0.167 | 1.233 | 0.25 | 0.35 |
| Maritime Forest | 0.268 | 0.488 | 0.6 | 1.103 | 0.711 | 1.614 | 0.22 | 0.186 | 0 | 0.302 | 0.102 | 0 | 0.195 |
| Oyster Reefs | 0.608 | 1.157 | 0.088 | 0.939 | 0.4 | 1.243 | 0.791 | 0.63 | 1.176 | 0.949 | 1.295 | 1.37 | 0.944 |
| Pine Savanna Forest | 0.3 | 0.448 | 1.282 | 1.778 | 0.838 | 2.341 | 0.15 | 0.381 | 0.471 | 0.167 | 1.563 | 0.25 | 0.536 |
| Riparian Buffers | 0.412 | 0.882 | 0.298 | 1.234 | 0.824 | 1.709 | 0.725 | 0.377 | 1.42 | 0.302 | 0.9 | 0.647 | 0.64 |
| Streams and Rivers | 0.722 | 1.3 | 0.235 | 0.946 | 0.713 | 1.736 | 1.043 | 0.733 | 1.617 | 0.955 | 1.288 | 1.188 | 0.969 |
| Submerged Aquatic Vegetation | 0.593 | 1.192 | 0.102 | 0.932 | 0.452 | 1.343 | 0.865 | 0.254 | 1.201 | 0.948 | 1.206 | 0.817 | 0.458 |
| Subtidal habitats | 0.755 | 1.198 | 0.133 | 0.549 | 0.43 | 1.109 | 0.956 | 0.475 | 1.218 | 0.795 | 1.2 | 1.103 | 0.696 |

*Habitats ranked by number of stressors with average responses ≥ 1.5 (including pale yellow cells):*

- 4 stressors- Intertidal Marshes and Flats
- 3 stressors - Beaches and Dunes, Freshwater Wetlands, Pine Savannas
- 2 stressors - Longleaf Pine Habitat, Streams and Rivers
- 1 stressor - Maritime Forest, Riparian Buffers
- 0 stressors – Oyster Reefs, SAV, Subtidal Habitats

*Stressors ranked by number of habitats with average responses ≥ 1.5 (including pale yellow cells):*

- 8 habitats – Land Use Change
- 4 habitats – Fragmentation, Climate Variability
- 2 habitats – Sea Level Rise
- 1 habitat –Sedimentation
- 0 habitats – Dredging/Filling, Chemical Contamination, Fire Suppression, Invasive/Exotic Species, Nutrient Enrichment, Pathogens, Freshwater Discharge, Resource Extraction

**Stressor Evaluation By Ecosystem Service (across all habitats): 2012 Methodology**

**Table AB2.** Bulk Average Values of Ecosystem Service Responses. Averages are typically used to determine the central tendency of continuous, interval data sets. Using a bulk average approach, 1.5 would be the threshold for responses indicating higher perceptions of stress. Averages ≥ 1.5 are highlighted in yellow cells, averages ≥ 2 are highlighted in orange cells. Please note that pale yellow cells indicate averages that are near 1.5 (rounds up to 1.5). Coral text indicates values where averages are less than 1.5, but median values are ≥ 2; this is likely an artifact of the distribution of responses and/or outliers. Please see the data distribution figures (Figures 1 and 2) for more information.

| Ecosystem Services | Chemical contamination | Dredging/filling | Fire suppression | Fragmentation | Invasive/exotic species | Land-use change | Nutrient enrichment | Pathogens | Sedimentation | Sea Level Rise | Climate Variability | Freshwater Discharge | Resource Extraction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity | 0.852 | 1.321 | 0.671 | 1.695 | 1.436 | 2.078 | 1.012 | 0.642 | 1.352 | 1.361 | 1.967 | 0.988 | 0.685 |
| Carbon sequestration | 0.408 | 0.926 | 0.254 | 1.066 | 0.603 | 1.605 | 0.547 | 0.152 | 0.92 | 1.037 | 1.37 | 0.649 | 0.478 |
| Fisheries habitat | 0.9 | 1.381 | 0.12 | 1.221 | 0.88 | 1.556 | 1.059 | 0.467 | 1.29 | 1.156 | 1.575 | 1.023 | 0.792 |
| Flood control | 0.102 | 0.778 | 0.116 | 0.95 | 0.244 | 1.396 | 0.29 | 0.161 | 0.894 | 0.96 | 1.057 | 0.703 | 0.42 |
| Groundwater replenishment | 0.295 | 0.519 | 0.167 | 0.708 | 0.211 | 1.245 | 0.319 | 0.271 | 0.622 | 0.701 | 0.842 | 0.528 | 0.616 |
| Nesting habitat for birds and turtles | 0.514 | 0.915 | 0.567 | 1.27 | 0.819 | 1.6 | 0.289 | 0.303 | 0.581 | 1 | 1.059 | 0.411 | 0.412 |
| Oyster production | 0.562 | 1.014 | 0 | 0.706 | 0.389 | 1.048 | 0.744 | 0.776 | 1.181 | 0.744 | 1.197 | 1.233 | 0.714 |
| Primary production | 0.52 | 0.986 | 0.194 | 1.054 | 0.513 | 1.48 | 0.987 | 0.388 | 1 | 0.938 | 1.38 | 0.857 | 0.441 |
| Sediment and nutrient retention | 0.379 | 1.2 | 0.229 | 1.132 | 0.26 | 1.851 | 0.979 | 0.27 | 1.515 | 1.125 | 1.46 | 1.109 | 0.598 |
| Storm buffer/hazard protection | 0.261 | 1.111 | 0.181 | 1.195 | 0.227 | 1.752 | 0.34 | 0.165 | 0.952 | 1.376 | 1.42 | 0.798 | 0.545 |
| Water quality enhancement | 1.174 | 1.161 | 0.183 | 1.133 | 0.293 | 1.789 | 1.505 | 1.272 | 1.5 | 0.937 | 1.424 | 1.081 | 0.753 |
| Wildlife habitat | 0.773 | 1.291 | 0.623 | 1.716 | 1.153 | 1.979 | 0.818 | 0.468 | 1.128 | 1.415 | 1.595 | 0.79 | 0.729 |

*Ecosystem services ranked by number of stressors with average responses ≥ 1.5 (including pale yellow cells):*

- 3 stressors – Biodiversity, Sediment and Nutrient Retention, Water Quality Enhancement, Wildlife Habitat
- 2 stressors – Fisheries Habitat
- 1 stressor –Carbon Sequestration, Nesting Habitat for Birds and Turtles, Primary Production, Storm Buffering/ Hazard Protection
- 0 stressors – Flood Control, Groundwater Replenishment, Oyster Production

*Stressors ranked by number of ecosystem services with average responses ≥ 1.5 (including pale yellow cells):*

- 9 ecosystem services – Land Use Change
- 4 ecosystem services – Climate Variability
- 2 ecosystem services – Sedimentation, Fragmentation
- 1 ecosystem service –Nutrient Enrichment

0 ecosystem services – Chemical Contamination, Dredging/Filling, Fire Suppression, Invasive/Exotic Species, Pathogens, Sea Level Rise, Freshwater Discharge, Resource Extraction

**Averages Summary:**

- Habitats considered most under stress: Intertidal Marshes and Flats, Beaches and Dunes, Freshwater Wetlands, Pine Savannas, Stream and Rivers, and Longleaf Pine Habitat
- ES considered most under stress: Biodiversity, Sediment and Nutrient Retention, Water Quality Enhancement, Wildlife Habitat, and Fisheries Habitat,
- Stressors ranked highest across habitat and ES: Land Use Change, Climate Variability, Fragmentation, Sedimentation, Sea Level Rise

## Appendix C. Responses from 30-day anonymous comment period (4.17.2024)

**In-line edits – responses are provided in green italics underneath the original comment**

1. 81 and 82: We should update how the matrix is summarized, weighted and ranked to more appropriate measures. Staying consistent for consistency sake when the methodology is incorrect seems like a poor choice, especially coming from the SAC.

***Agreed. Data from the 2011-2012 cohort was reanalyzed using medians, and the corrected/updated methodology yielded no major changes to the prior matrix outcomes. Moving forward, medians will be the standard methodology for analyzing data collected in stressor evaluations. Results using the old methodology can be found in Appendix B.***

2. 91-93: Is it possible to be provided with a percent representation of expertise? I am shocked at the lack of responses tied to more acute anthropogenic stressor categories (examples include chemical contamination, pathogens, and sedimentation). If this is tied to a lack of representation in these categories then further outreach/solicitation is strongly needed. Otherwise, this stressor matrix is more appropriately a LULC/climate/habitat stressor matrix.

***Agreed. Respondents were asked to fill out all cells/interactions that they felt that they had professional expertise in. We know that we need additional coverage in uplands systems, beaches/dunes, freshwater wetlands, and anthropogenic impacts. Low response rates could be reflective of low expertise presence or folks choosing to not weigh in on those particular topics.***

3. 141 - 142: Same comment as lines 91-93 listed in response #2.

***See above response.***

Line 32 - Indicate the method of delivery. (e.g., The matrix was first distributed [by email] to the SAC membership (n=84) in October of 2021.)

***Method of delivery was added to the sentence for context (Line 41).***

Line 43 - Although stated on Line 89, it would be helpful to describe the result of the outreach efforts here as well (increase in response rate).

***I am unsure if we have documented numbers of participants before and after extensive outreach occurred. This round of surveying was done before I joined the staff of the MBNEP.***

Line 62 - A very brief description of Mentimeter tool would be helpful for readers who are unfamiliar with this format.

***A sentence to describe the Mentimeter platform was added (Lines 70-71).***

Tables: Tables rely on color palette alone to convey information. Including symbols would increase accessibility for readers who are colorblind.

***Color scales and symbology of tables have been updated to be more accessible for folks with colorblindness.***

Other Comments:

- I would like to know what the outcomes of this approval are and believe that they should include a designation of choosing average or median methodology to simplify the review of the matrix in the future. I also think that further solicitation is needed for stressor categories and would like to ensure the SAC is a part of recruiting experts to fill in the gaps on stressor representation. If neither of these options are available, I will designate this as "do not approve".

- I feel that there is no reason the the habitats "beaches and dunes", freshwater wetlands, intertidal marsh and flats, and riparian buffers warrented at 0 with the chemical contaminate stressor (see 100 +). All marsh in this system is a sink for organic and inorganic constituents. Many beaches are still impacted but tar from the 2010 oil spill. I will also add that the pathogen stressor is currently monitored on gulf- and bay-front beaches will have required closure. Beginning at or around line 121, the flood control ecosystem services have a low score in the stressors of sea level rise, climate variablity, and freshwater discharge which makes little sense. Flooding causes extreme impacts where the only flood control is a function of engineering design and its failure greatly exposes development and water quality to be constrained. It is very likely that chemical contamination has a negative impact to oyster and primary production. I have no earthly idea why this was not flagged by someone and given a value of o. Also in question is water quality enhancements - is there data to suggest that chemical contamination and pathagens warranted a low impact? If so, either no one understands what water quality enhancement means or is not aware of what has been done to limit their impact. The fisheries habitat seems more of a localized eco service to me and I know that chemical contamination can significantly impact fish and their taking. I believe that saltwater intrusion should have been a stressor. Freshwater discharge was included and saltwater intrusion has negative impacts as well - think oysters, wetlands, geochemical processes, and degradation of pine and other coastal flora. I believe this stressor matrix was well compiled based on input but feel input was inadequate which to me is actually surprising. The SAC should care enough to feedback thus is the SAC purpose. I am concerned about this matrix - ecosystem service vs stress because, simply that some areas are likely not valued accordingly or participants in its development and evaluating was inadequate. I will stop there

- This types of exercises are not easy to do due to low or mixed response rate and the challenges of analyzing and drawing conclusions from qualitative data. I think the analysis and report handles the challenges well. I have not specific line edits.

- This report is well-written. Similarities in the results of the 2012 and 2021/2022 evaluations suggest retaining some level of continuity in program focus and management approach moving forward.

- I have reviewed the report and have no additional comments. The results were as I would expect from what I know of the habitats, ecosystems, and stressors. It is a good product and I thank you for your extensive efforts.

- The 2023 Stressor Matrix comprehensively covers the 13 stressors impact on 12 Ecosystem Services. In my field of expertise, I think the scores are accurately described. The impacts of land use change are seen across the ES.

- This report highlights opinions, not necessarily facts based on scientific studies. Coupling these opinions and surveys with scientific data (i.e. showing the changes in land use/showing the impacts of climate change on marshes/showing the impacts of fire suppression, etc) would make this document much more meaningful. I realize this may be outside of the original scope of the report, but there is nothing truly groundbreaking here. We all know what the local stressors are, but the rankings are just opinions, nothing more. This is still a good tool to help guide priorities and the CCMP.

- I understand the challenges with getting follow through on participation in the Matrix. I was one of those that have genuine interest and want to fill out and submit the matrix, however, it was overwhelming and after an hour of time spent and still being very early on in the matrix, I simply gave up. I think a potential incentive, $100 for submitted matrix for instance, would be substantial for completion. If I knew I could $100 for sitting on a Sunday morning and completing the matrix, I likely would have done so. Given that, I am not sure how much credence that can really be given to 18 responses. At most, there were 3 responses for any category, which does not feel very substantial at all. I would be hesitant to draw any conclusions from this matrix. The information here, does not really provide any new insights on top of what has been synthesized in scientific literature over the last 40 years. Land use change is the biggest impact driving ecosystems and is leading to substantial changes in biodiversity. How much is your output driven by independent assessments of systems being worked in versus folks being familiar with the scientific literature? I know the efforts that have been put in to synthesis, advertising, etc, but I am curious if a targeted incentivized campaign could quickly generate responses for the matrix. In my opinion, there just has not been enough participation for any conclusions to be drawn or any comparisons to be made against the 2012 version.

- Given the small sample sizes, it is no small feat to extract the results as presented. I think it pushes the limits of what is possible from the limited data. Since the results are based on survey/opinions, often with limited or no data to rely on, I think we need to point this out clearly. We should also point out which habitats status are likely to have some possibility of a quantitative basis (reality?) where ongoing monitoring is available, such as SAV and oysters as compared to habitats such as long leaf pine and maritime forests. This may also explain why some respondents chose to not score the latter habitats (Table 1, line 97)

- It’s not entirely clear if the methods employed were appropriate. This analysis needs “appropriate” measures. Would like to see the tables as tables and not inserted images…this document is very light on conclusions and what recommendations would be appropriate given this analysis.