

# Biscayne Bay Aquatic Preserve

## SEACAR Habitat Analyses

Last compiled on 22 May, 2025

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## Funding & Acknowledgements

The data used in this analysis is from the Export Standardized Tables in the SEACAR Data Discovery Interface (DDI). Documents and information available through the SEACAR DDI are owned by the data provider(s) and users are expected to provide appropriate credit following accepted citation formats. Users are encouraged to access data to maximize utilization of gained knowledge, reducing redundant research and facilitating partnerships and scientific innovation.

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## Threshold Filtering

Threshold filters, following the guidance of Florida Department of Environmental Protection's (*FDEP*) Division of Environmental Assessment and Restoration (*DEAR*) are used to exclude specific results values from the SEACAR Analysis. Based on the threshold filters, Quality Assurance / Quality Control (*QAQC*) Flags are inserted into the *SEACAR\_QAQCFlagCode* and *SEACAR\_QAQC\_Description* columns of the export data. The *Include* column indicates whether the *QAQC* Flag will also indicate that data are excluded from analysis. No data are excluded from the data export, but the analysis scripts can use the *Include* column to exclude data (1 to include, 0 to exclude).

Table 1: Continuous Water Quality threshold values

| Parameter Name              | Units     | Low Threshold | High Threshold |
|-----------------------------|-----------|---------------|----------------|
| Dissolved Oxygen            | mg/L      | -0.000001     | 50             |
| Dissolved Oxygen Saturation | %         | -0.000001     | 500            |
| Salinity                    | ppt       | -0.000001     | 70             |
| Turbidity                   | NTU       | -0.000001     | 4000           |
| Water Temperature           | Degrees C | -5.000000     | 45             |
| pH                          | None      | 2.000000      | 14             |

Table 2: Discrete Water Quality threshold values

| Parameter Name                            | Units | Low Threshold | High Threshold |
|---|-------|---------------|----------------|
| Ammonia, Un-ionized (NH3)                 | mg/L  | -             | -              |
| Ammonium, Filtered (NH4)                  | mg/L  | -             | -              |
| Chlorophyll a, Corrected for Pheophytin   | ug/L  | -             | -              |
| Chlorophyll a, Uncorrected for Pheophytin | ug/L  | -             | -              |
| Colored Dissolved Organic Matter          | PCU   | -             | -              |

| Parameter Name                       | Units     | Low Threshold | High Threshold |
|--------------------------------------|-----------|---------------|----------------|
| Dissolved Oxygen                     | mg/L      | -0.000001     | 25             |
| Dissolved Oxygen Saturation          | %         | -0.000001     | 310            |
| Fluorescent Dissolved Organic Matter | QSE       | -             | -              |
| Light Extinction Coefficient         | m^-1      | -             | -              |
| NO2+3, Filtered                      | mg/L      | -             | -              |
| Nitrate (NO3)                        | mg/L      | -             | -              |
| Nitrite (NO2)                        | mg/L      | -             | -              |
| Nitrogen, organic                    | mg/L      | -             | -              |
| Phosphate, Filtered (PO4)            | mg/L      | -             | -              |
| Salinity                             | ppt       | -0.000001     | 70             |
| Secchi Depth                         | m         | 0.000001      | 50             |
| Specific Conductivity                | mS/cm     | 0.005000      | 100            |
| Total Kjeldahl Nitrogen              | mg/L      | -             | -              |
| Total Nitrogen                       | mg/L      | -             | -              |
| Total Nitrogen                       | mg/L      | -             | -              |
| Total Phosphorus                     | mg/L      | -             | -              |
| Total Suspended Solids               | mg/L      | -             | -              |
| Turbidity                            | NTU       | -             | -              |
| Water Temperature                    | Degrees C | 3.000000      | 40             |
| pH                                   | None      | 2.000000      | 13             |

Table 3: Quality Assurance Flags inserted based on threshold checks listed in Table 1 and 2

| SEACAR QAQC Description                  | Include | SEACAR QAQCFlagCode |
|--|---------|---------------------|
| Exceeds maximum threshold                | 0       | 2Q                  |
| Below minimum threshold                  | 0       | 4Q                  |
| Within threshold tolerance               | 1       | 6Q                  |
| No defined thresholds for this parameter | 1       | 7Q                  |

## Value Qualifiers

Value qualifier codes included within the data are used to exclude certain results from the analysis. The data are retained in the data export files, but the analysis uses the *Include* column to filter the results.

### STORET and WIN value qualifier codes

Value qualifier codes from *STORET* and *WIN* data are examined with the database and used to populate the *Include* column in data exports.

Table 4: Value Qualifier codes excluded from analysis

| Qualifier Source | Value Qualifier | Include | MDL | Description   |
|------------------|-----------------|---------|-----|---|
| STORET-WIN       | H               | 0       | 0   | Value based on field kit determination; results may not be accurate         |
| STORET-WIN       | J               | 0       | 0   | Estimated value   |
| STORET-WIN       | V               | 0       | 0   | Analyte was detected at or above method detection limit                     |
| STORET-WIN       | Y               | 0       | 0   | Lab analysis from an improperly preserved sample;<br>data may be inaccurate |

### Discrete Water Quality Value Qualifiers

The following value qualifiers are highlighted in the Discrete Water Quality section of this report. An exception is made for **Program 476 - Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network** and data flagged with Value Qualifier **H** are included for this program only.

**H** - Value based on field kit determiniation; results may not be accurate. This code shall be used if a field screening test (e.g., field gas chromatograph data, immunoassay, or vendor-supplied field kit) was used to generate the value and the field kit or method has not been recognized by the Department as equivalent to laboratory methods.

**I** - The reported value is greater than or equal to the laboratory method detection limit but less than the laboratory practical quantitation limit.

**Q** - Sample held beyond the accepted holding time. This code shall be used if the value is derived from a sample that was prepared or analyzed after the approved holding time restrictions for sample preparation or analysis.

**S** - Secchi disk visible to bottom of waterbody. The value reported is the depth of the waterbody at the location of the Secchi disk measurement.

**U** - Indicates that the compound was analyzed for but not detected. This symbol shall be used to indicate that the specified component was not detected. The value associated with the qualifier shall be the laboratory method detection limit. Unless requested by the client, less than the method detection limit values shall not be reported

### Systemwide Monitoring Program (SWMP) value qualifier codes

Value qualifier codes from the *SWMP* continuous program are examined with the database and used to populate the *Include* column in data exports. *SWMP* Qualifier Codes are indicated by *QualifierSource=SWMP*.

Table 5: SWMP Value Qualifier codes

| <i>Qualifier Source</i> | <i>Value Qualifier</i> | <i>Include</i> | <i>Description</i>   |
|-------------------------|------------------------|----------------|--|
| SWMP                    | -1                     | 1              | Optional parameter not collected   |
| SWMP                    | -2                     | 0              | Missing data   |
| SWMP                    | -3                     | 0              | Data rejected due to QA/QC   |
| SWMP                    | -4                     | 0              | Outside low sensor range   |
| SWMP                    | -5                     | 0              | Outside high sensor range  |
| SWMP                    | 0                      | 1              | Passed initial QA/QC checks  |
| SWMP                    | 1                      | 0              | Suspect data   |
| SWMP                    | 2                      | 1              | Reserved for future use  |
| SWMP                    | 3                      | 1              | Calculated data: non-vented depth/level sensor correction for changes in barometric pressure |
| SWMP                    | 4                      | 1              | Historical: Pre-auto QA/QC   |
| SWMP                    | 5                      | 1              | Corrected data   |

## Water Column

The water column habitat extends from the water's surface to the bottom sediments, and it's where fish, dolphins, crabs and people swim! So much life makes its home in the water column that the health of marine and coastal ecosystems, as well as human economies, depend on the condition of this vulnerable habitat. Local patterns of rainfall, temperature, winds and currents can rapidly change the condition of the water column, while global influences such as [El Niño/La Niña](#), large-scale fluctuation in sea temperatures and climate change can have long-term effects. Inputs from the prosperity of our day-to-day lives including farming, mining and forestry, and emissions from power generation, automobiles and water treatment can also alter the health of the water column. Acting alone or together, each input can have complex and lasting effects on habitats and ecosystems.

SEACAR evaluates water column health with several essential parameters. These include nutrient surveys of nitrogen and phosphorus, and water quality assessments of salinity, dissolved oxygen, pH, and water temperature. Water clarity is evaluated with Secchi depth, turbidity, levels of chlorophyll a, total suspended solids, and colored dissolved organic matter. Additionally, the richness of nekton is indicated by the abundance of free-swimming fishes and macroinvertebrates like crabs and shrimps.

## Seasonal Kendall-Tau Analysis

Indicators must have a minimum of five to ten years, depending on the habitat, of data within the geographic range of the analysis to be included in the analysis. Ten years of data are required for discrete parameters, and five years of data are required for continuous parameters. If there are insufficient years of data, the number of years of data available will be noted and labeled as "insufficient data to conduct analysis". Further, for the preferred Seasonal Kendall-Tau test, there must be data from at least two months in common across at least two consecutive years within the RCP managed area being analyzed. Values that pass both of these tests will be included in the analysis and be labeled as *Use\_In\_Analysis = TRUE*. Any that fail either test will be excluded from the analyses and labeled as *Use\_In\_Analysis = FALSE*. The points for all Water Column plots displayed in this section are monthly averages. Trend significance will be denoted as "Significant Trend" (when  $p < 0.05$ ), or "Non-significant Trend" (when  $p \geq 0.05$ ). Any parameters with insufficient data to perform Seasonal Kendall-Tau test will have their monthly averages plotted without a corresponding trend line.

## Water Quality - Discrete

The following files were used in the discrete analysis:

- *Combined\_WQ\_WC\_NUT\_Chlorophyll\_a\_corrected\_for\_pheophytin-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_Chlorophyll\_a\_uncorrected\_for\_pheophytin-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_Colored\_dissolved\_organic\_matter\_CDOM-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_Dissolved\_Oxygen-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_Dissolved\_Oxygen\_Saturation-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_pH-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_Salinity-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_Secchi\_Depth-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_Total\_Nitrogen-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_Total\_Phosphorus-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_Total\_Suspended\_Solids\_TSS-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_Turbidity-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_Water\_Temperature-2025-Mar-06.txt*

## Chlorophyll a, Corrected for Pheophytin - Discrete

### Seasonal Kendall-Tau Trend Analysis

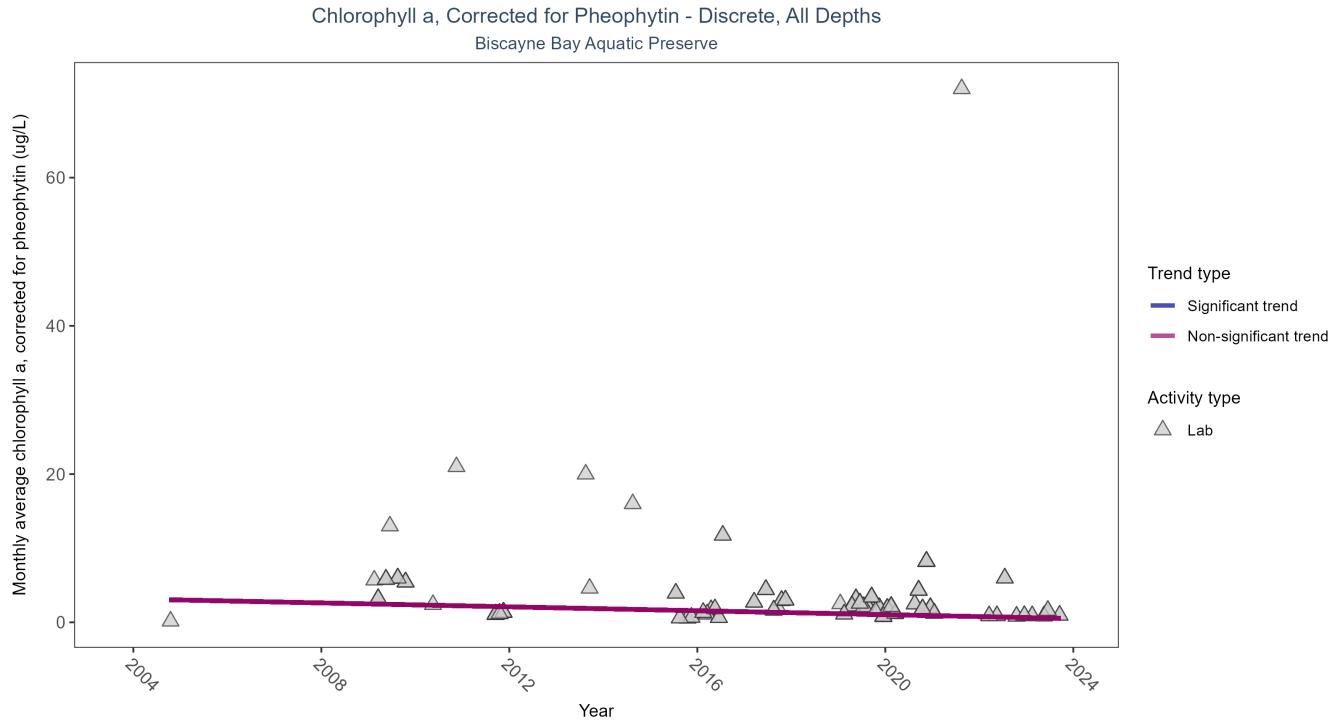


Figure 1: Scatter plot of monthly average levels of chlorophyll a, corrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles) is included in the plot.

Table 6: Seasonal Kendall-Tau Trend Analysis for Chlorophyll a, Corrected for Pheophytin

| Activity Type | Statistical Trend    | Sample Count | Years with Data | Period of Record | Median | tau     | Sen Intercept | Sen Slope | p      |
|---------------|----------------------|--------------|-----------------|------------------|--------|---------|---------------|-----------|--------|
| Lab           | No significant trend | 470          | 14              | 2004 - 2023      | 1.4    | -0.1845 | 3.148         | -0.1318   | 0.1713 |

Chlorophyll a, corrected for pheophytin, showed no detectable trend between 2004 and 2023.

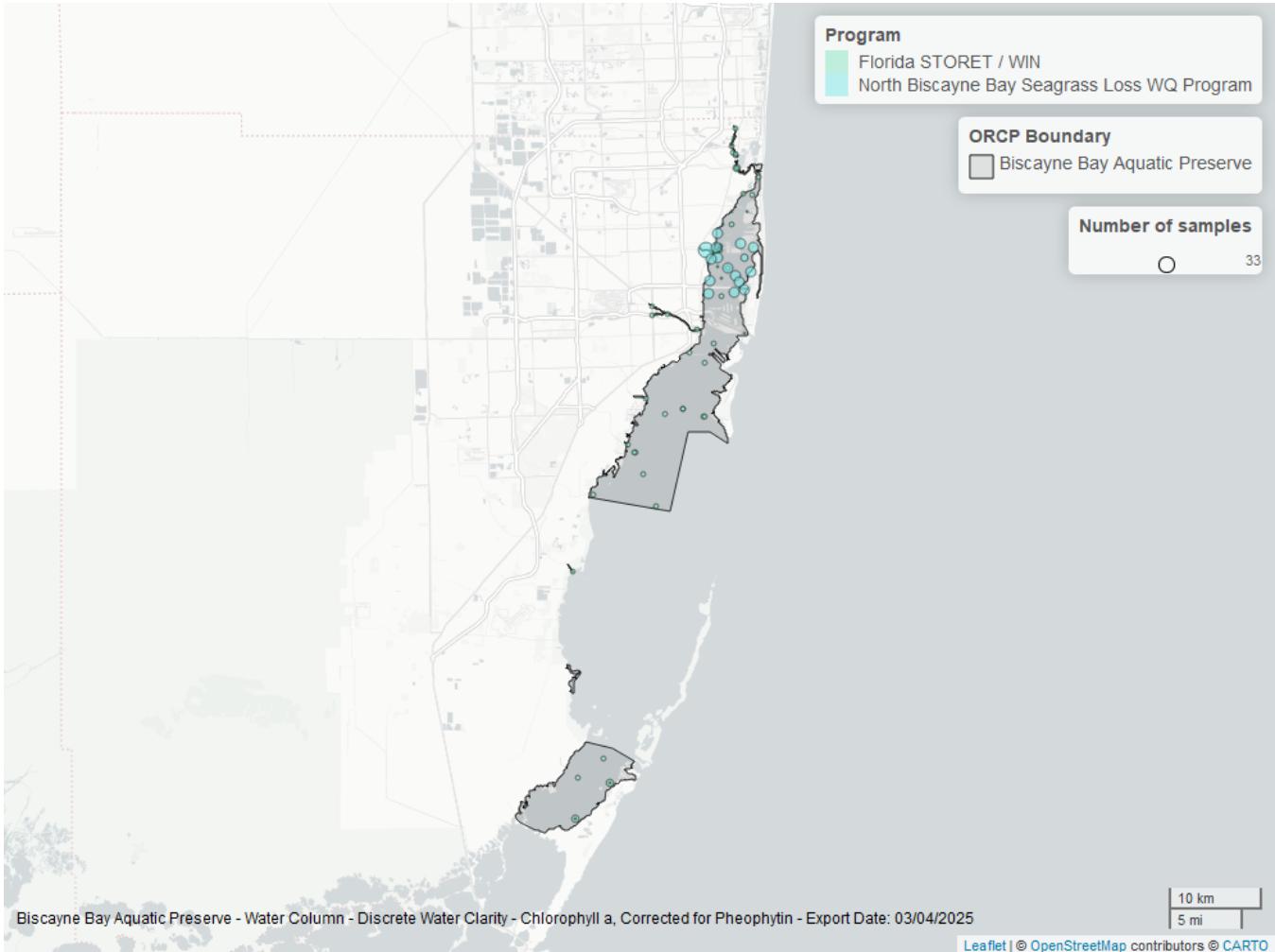


Figure 2: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 7: Programs contributing data for Chlorophyll a, Corrected for Pheophytin

| <i>ProgramID</i> | <i>N_Data</i> | <i>YearMin</i> | <i>YearMax</i> |
|------------------|---------------|----------------|----------------|
| 5026             | 287           | 2019           | 2021           |
| 5002             | 184           | 2004           | 2023           |

#### Program names:

5002 - Florida STORET / WIN<sup>1</sup>

5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

#### Chlorophyll a, Uncorrected for Pheophytin - Discrete Seasonal Kendall-Tau Trend Analysis

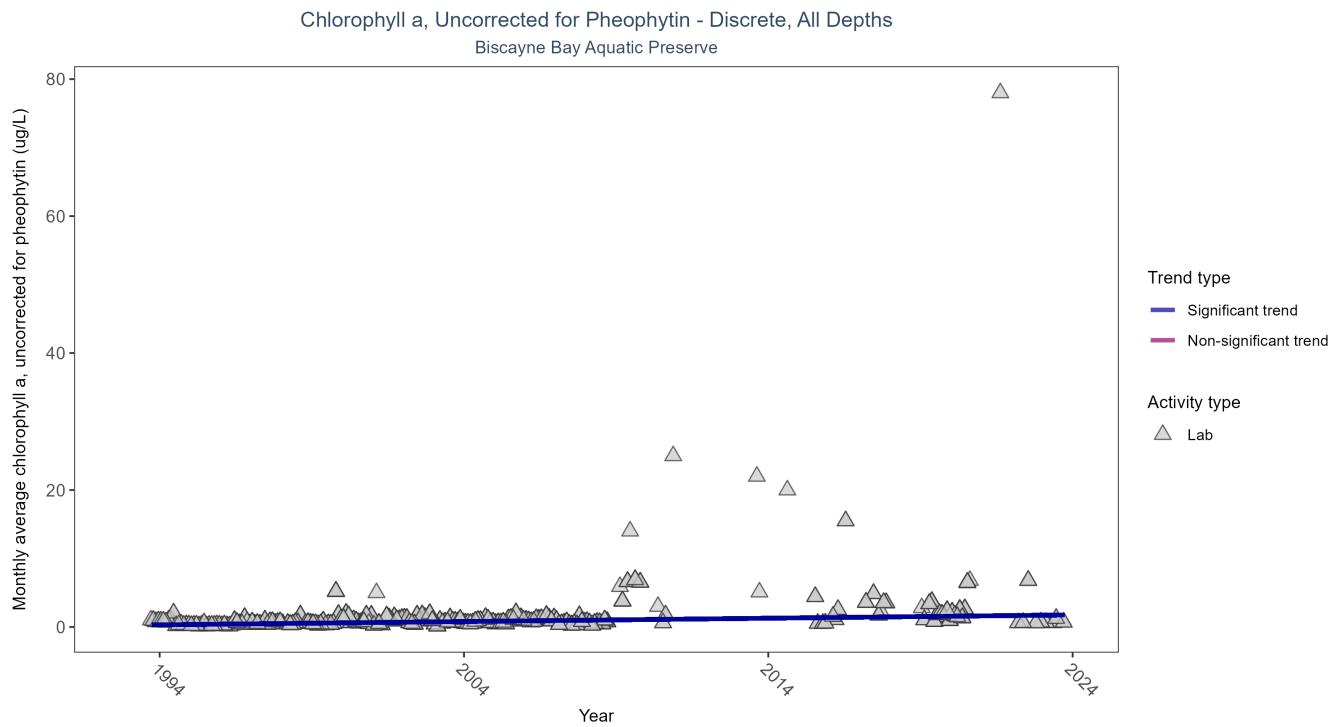


Figure 3: Scatter plot of monthly average levels of chlorophyll a, uncorrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles) is included in the plot.

Table 8: Seasonal Kendall-Tau Trend Analysis for Chlorophyll a, Uncorrected for Pheophytin

| Activity Type | Statistical Trend              | Sample Count | Years with Data | Period of Record | Median | tau    | Sen Intercept | Sen Slope | p |
|---------------|--------------------------------|--------------|-----------------|------------------|--------|--------|---------------|-----------|---|
| Lab           | Significantly increasing trend | 2254         | 28              | 1993 - 2023      | 0.6666 | 0.3904 | 0.2649        | 0.0484    | 0 |

Monthly average chlorophyll a, uncorrected for pheophytin, increased by 0.05  $\mu\text{g}/\text{L}$  per year, indicating a decrease in water clarity.

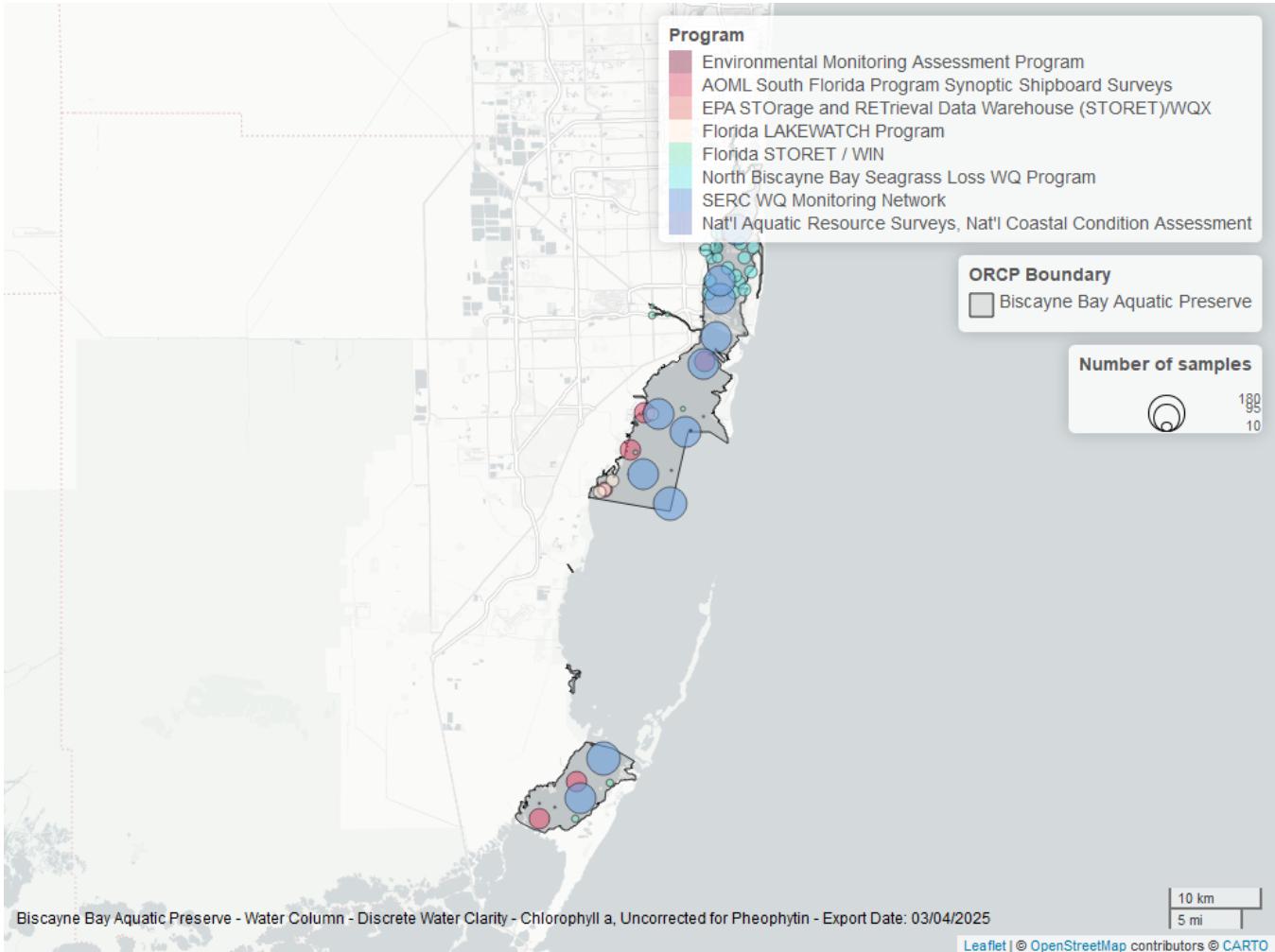


Figure 4: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 9: Programs contributing data for Chlorophyll a, Uncorrected for Pheophytin

| <i>ProgramID</i> | <i>N_Data</i> | <i>YearMin</i> | <i>YearMax</i> |
|------------------|---------------|----------------|----------------|
| 509              | 1636          | 1993           | 2008           |
| 5026             | 410           | 2019           | 2020           |
| 3                | 385           | 2002           | 2012           |
| 5002             | 103           | 2001           | 2023           |
| 514              | 92            | 2000           | 2005           |
| 103              | 7             | 2002           | 2006           |
| 118              | 6             | 2006           | 2010           |
| 115              | 1             | 2004           | 2004           |

#### Program names:

- 3 - Atlantic Oceanographic and Meteorological Laboratory (AOML) South Florida Program Synoptic Shipboard Surveys<sup>3</sup>
- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>4</sup>
- 115 - Environmental Monitoring Assessment Program<sup>5</sup>
- 118 - National Aquatic Resource Surveys, National Coastal Condition Assessment<sup>6</sup>

509 - SERC Water Quality Monitoring Network<sup>7</sup>

514 - Florida LAKEWATCH Program<sup>8</sup>

5002 - Florida STORET / WIN<sup>1</sup>

5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

## Dissolved Oxygen - Discrete

### Seasonal Kendall-Tau Trend Analysis

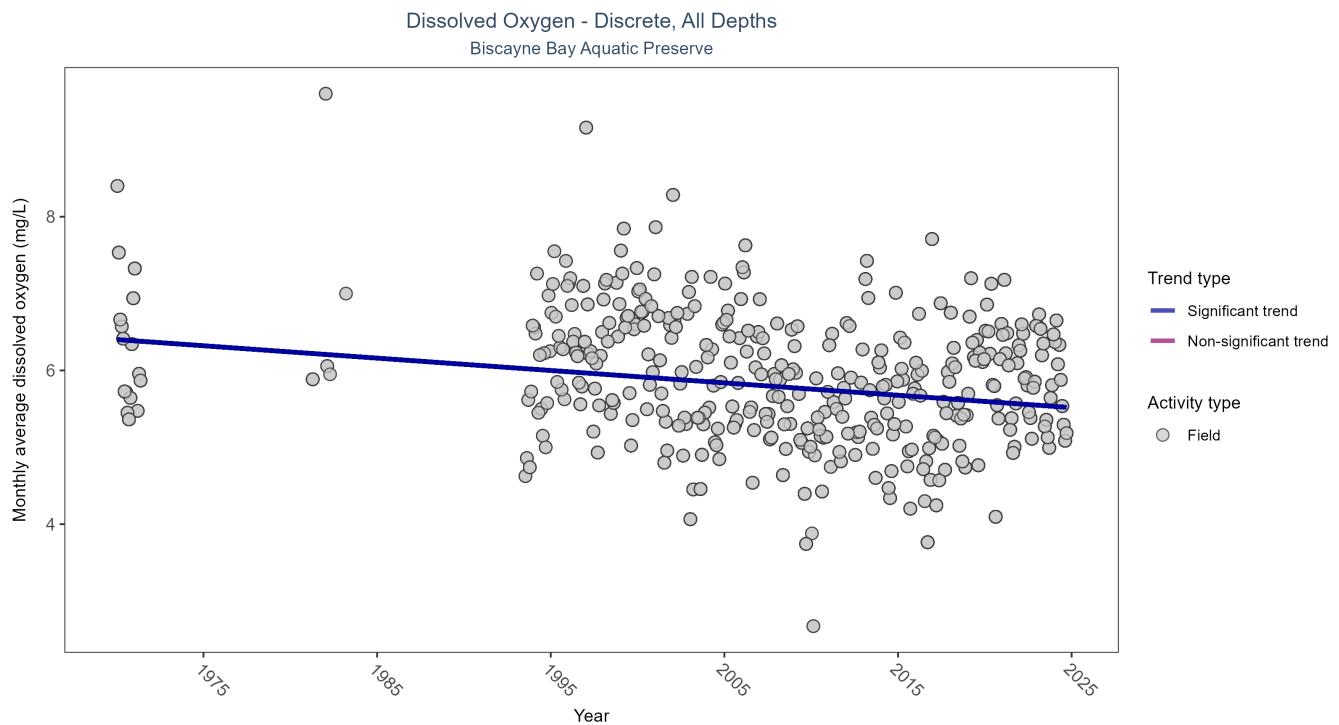


Figure 5: Scatter plot of monthly average dissolved oxygen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen values measured in the field (circles) are included in the plot.

Table 10: Seasonal Kendall-Tau Trend Analysis for Dissolved Oxygen

| Activity Type | Statistical Trend              | Sample Count | Years with Data | Period of Record | Median | tau     | Sen Intercept | Sen Slope | p |
|---------------|--------------------------------|--------------|-----------------|------------------|--------|---------|---------------|-----------|---|
| Field         | Significantly decreasing trend | 21185        | 37              | 1970 - 2024      | 6      | -0.2291 | 6.4017        | -0.0161   | 0 |

Monthly average dissolved oxygen decreased by 0.02 mg/L per year.

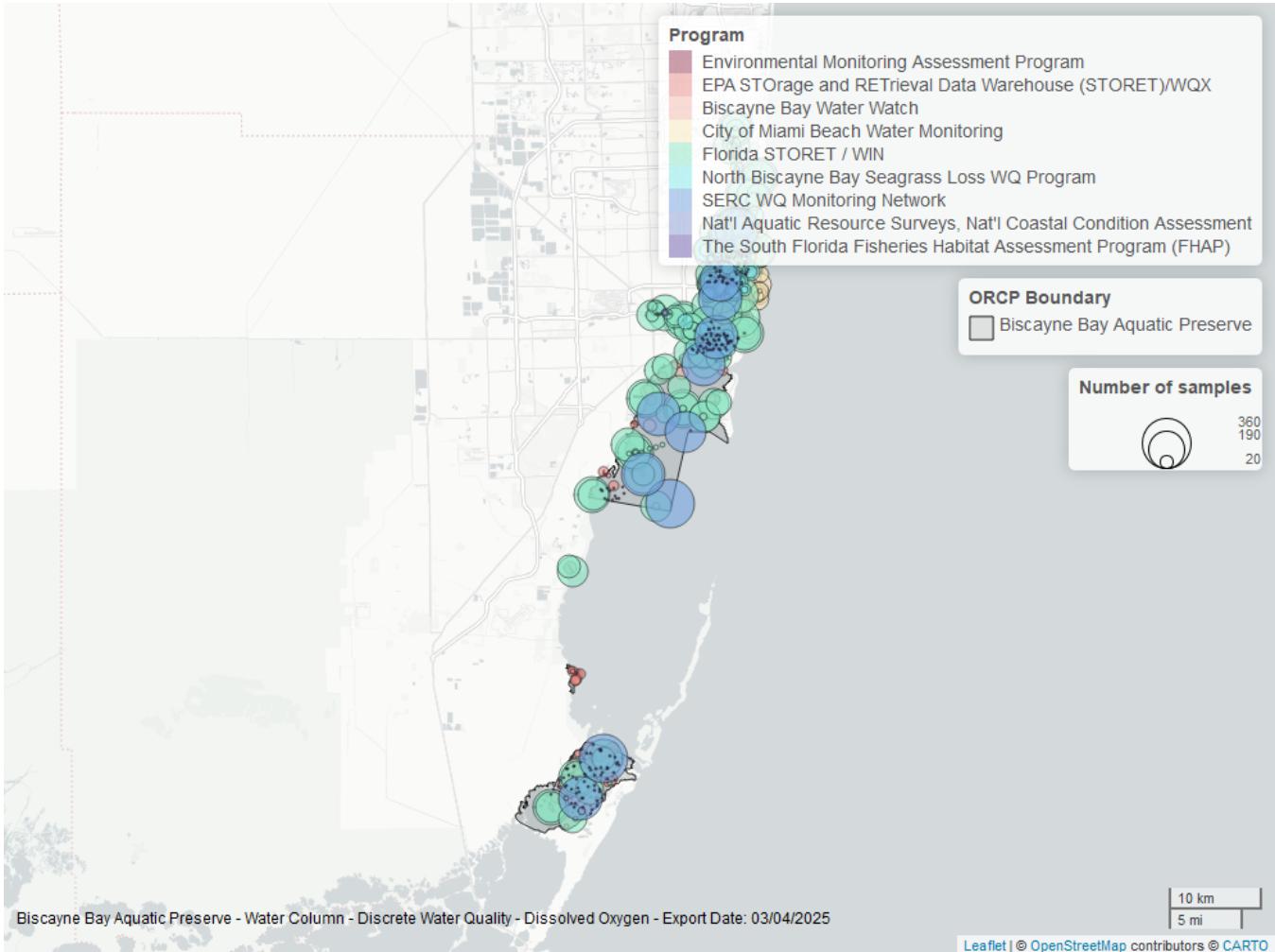


Figure 6: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 11: Programs contributing data for Dissolved Oxygen

| <i>ProgramID</i> | <i>N_Data</i> | <i>YearMin</i> | <i>YearMax</i> |
|------------------|---------------|----------------|----------------|
| 5002             | 13987         | 2001           | 2024           |
| 509              | 3316          | 1993           | 2008           |
| 4058             | 2322          | 2016           | 2023           |
| 5026             | 1442          | 2019           | 2024           |
| 103              | 775           | 1970           | 2020           |
| 4049             | 192           | 2006           | 2008           |
| 4057             | 166           | 2015           | 2019           |
| 118              | 28            | 2006           | 2020           |
| 115              | 3             | 2004           | 2004           |

#### Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>4</sup>

115 - Environmental Monitoring Assessment Program<sup>5</sup>

118 - National Aquatic Resource Surveys, National Coastal Condition Assessment<sup>6</sup>

509 - SERC Water Quality Monitoring Network<sup>7</sup>

4049 - The South Florida Fisheries Habitat Assessment Program (FHAP)<sup>9</sup>

4057 - Biscayne Bay Water Watch<sup>10</sup>

4058 - City of Miami Beach Water Monitoring<sup>11</sup>

5002 - Florida STORET / WIN<sup>1</sup>

5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

## Dissolved Oxygen Saturation - Discrete

### Seasonal Kendall-Tau Trend Analysis

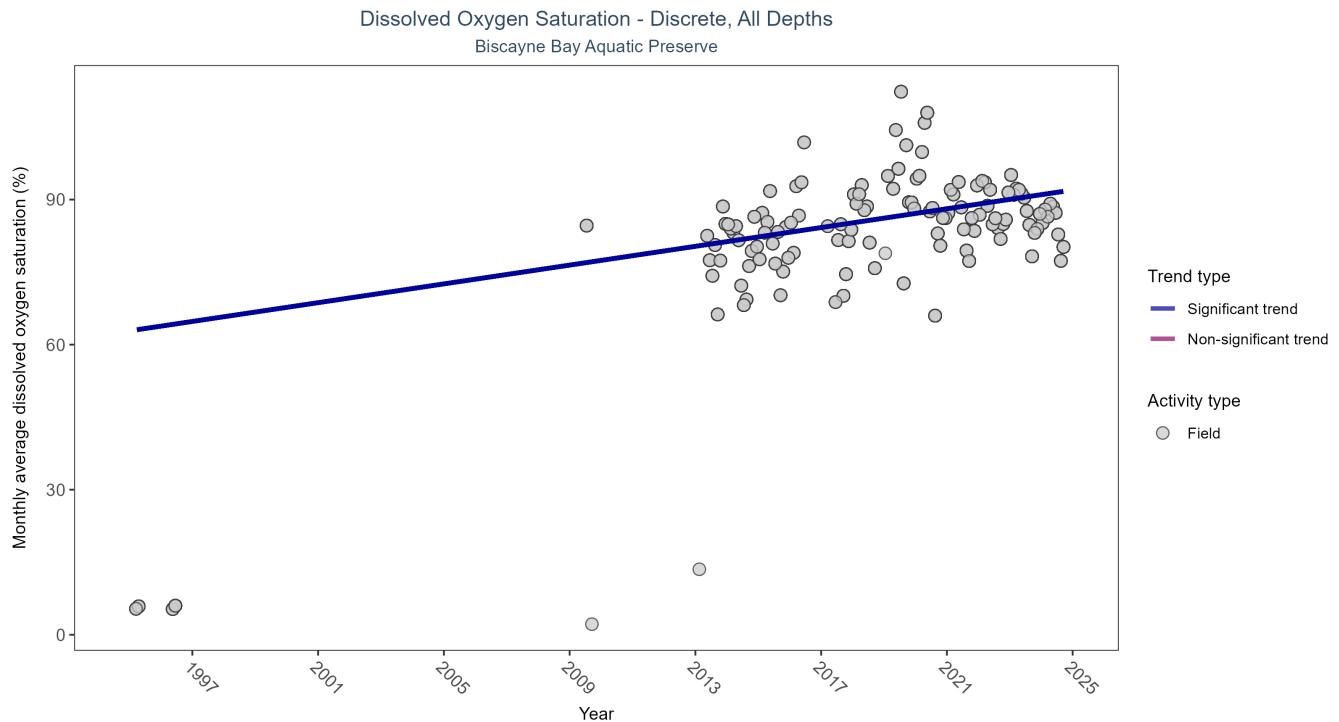


Figure 7: Scatter plot of monthly average dissolved oxygen saturation over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen saturation values measured in the field (circles) are included in the plot.

Table 12: Seasonal Kendall-Tau Trend Analysis for Dissolved Oxygen Saturation

| Activity Type | Statistical Trend              | Sample Count | Years with Data | Period of Record | Median | tau   | Sen Intercept | Sen Slope | p |
|---------------|--------------------------------|--------------|-----------------|------------------|--------|-------|---------------|-----------|---|
| Field         | Significantly increasing trend | 9895         | 15              | 1995 - 2024      | 90.3   | 0.332 | 62.8535       | 0.9711    | 0 |

Monthly average dissolved oxygen saturation increased by 0.97% per year.

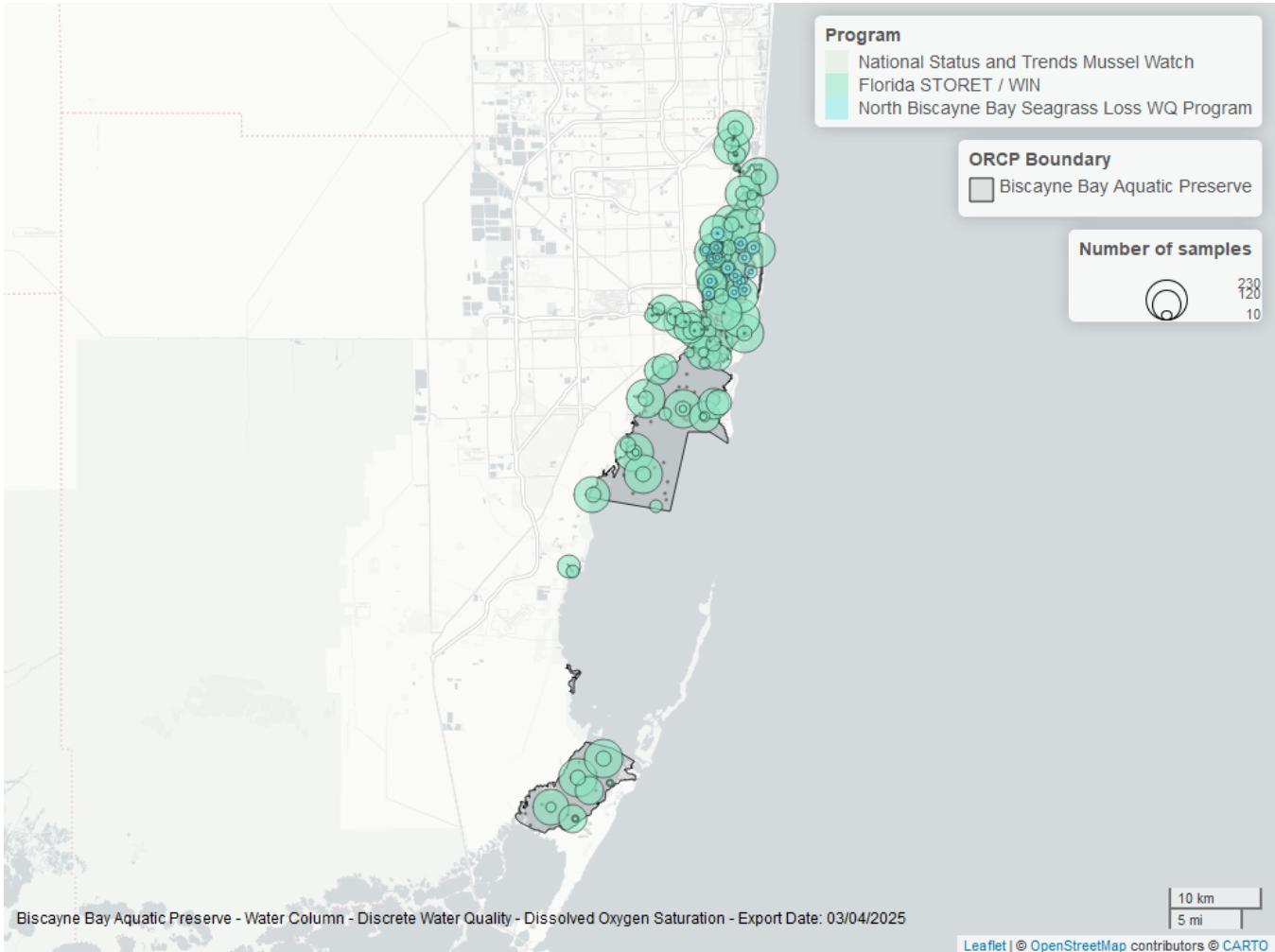


Figure 8: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 13: Programs contributing data for Dissolved Oxygen Saturation

| <i>ProgramID</i> | <i>N_Data</i> | <i>YearMin</i> | <i>YearMax</i> |
|------------------|---------------|----------------|----------------|
| 5002             | 9231          | 2009           | 2024           |
| 5026             | 491           | 2019           | 2023           |
| 102              | 259           | 1995           | 1996           |

#### Program names:

102 - National Status and Trends Mussel Watch<sup>12</sup>

5002 - Florida STORET / WIN<sup>1</sup>

5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

#### pH - Discrete

#### Seasonal Kendall-Tau Trend Analysis

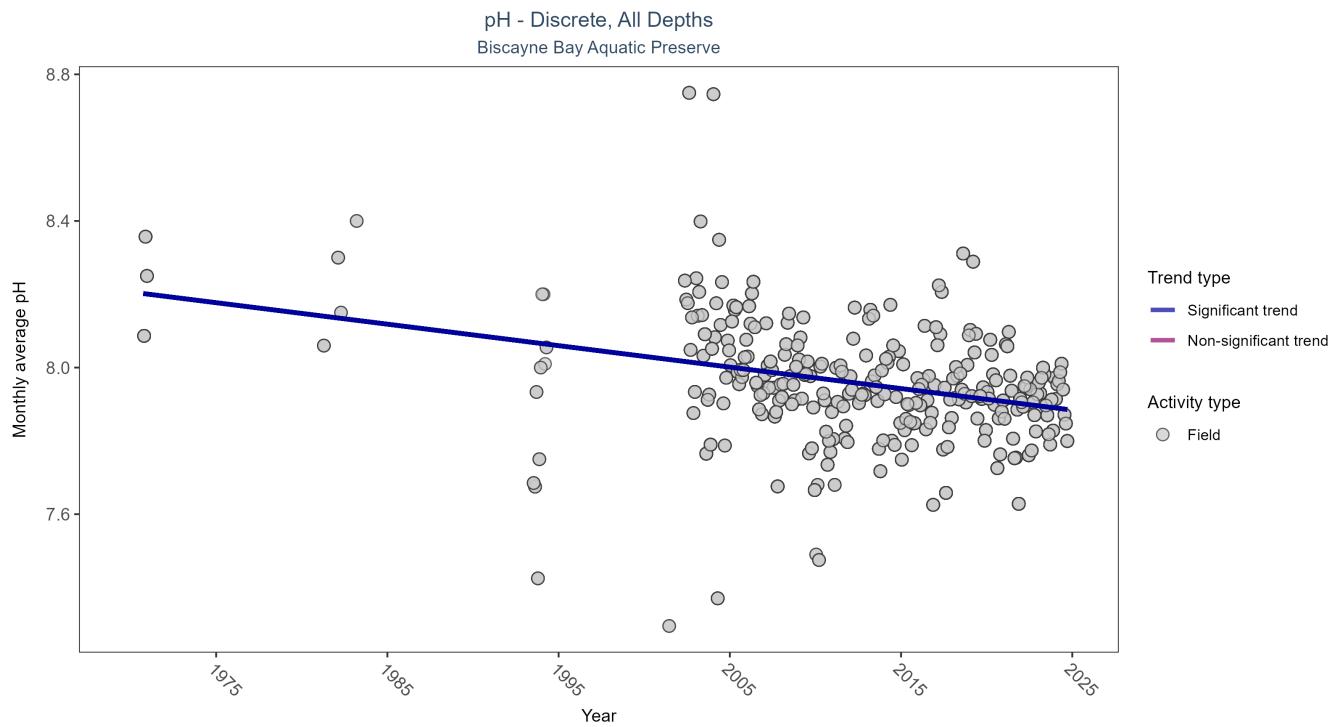


Figure 9: Scatter plot of monthly average pH over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only pH values measured in the field (circles) are included in the plot.

Table 14: Seasonal Kendall-Tau Trend Analysis for pH

| Activity Type | Statistical Trend              | Sample Count | Years with Data | Period of Record | Median | tau     | Sen Intercept | Sen Slope | p |
|---------------|--------------------------------|--------------|-----------------|------------------|--------|---------|---------------|-----------|---|
| Field         | Significantly decreasing trend | 17425        | 30              | 1970 - 2024      | 7.97   | -0.2891 | 8.2063        | -0.0059   | 0 |

Monthly average pH decreased by 0.01 pH units per year.

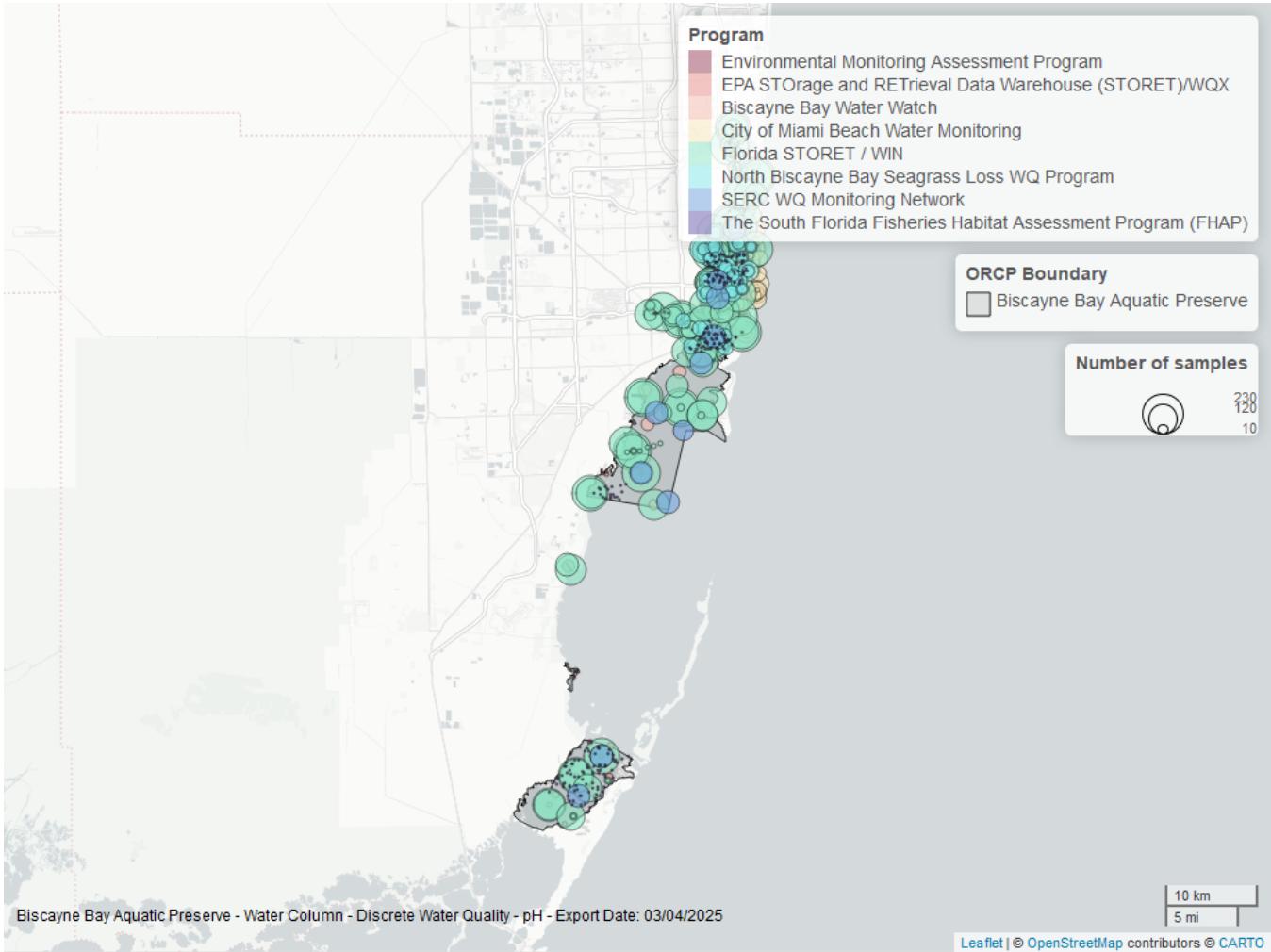


Figure 10: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 15: Programs contributing data for pH

| <i>ProgramID</i> | <i>N_Data</i> | <i>YearMin</i> | <i>YearMax</i> |
|------------------|---------------|----------------|----------------|
| 5002             | 13061         | 2001           | 2024           |
| 4058             | 2365          | 2016           | 2023           |
| 5026             | 1528          | 2019           | 2024           |
| 509              | 822           | 2002           | 2008           |
| 4049             | 247           | 2005           | 2008           |
| 4057             | 169           | 2015           | 2019           |
| 103              | 166           | 1970           | 2020           |
| 115              | 3             | 2004           | 2004           |

#### Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>4</sup>

115 - Environmental Monitoring Assessment Program<sup>5</sup>

509 - SERC Water Quality Monitoring Network<sup>7</sup>

4049 - The South Florida Fisheries Habitat Assessment Program (FHAP)<sup>9</sup>

4057 - Biscayne Bay Water Watch<sup>10</sup>

4058 - City of Miami Beach Water Monitoring<sup>11</sup>

5002 - Florida STORET / WIN<sup>1</sup>

5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

## Salinity - Discrete

### Seasonal Kendall-Tau Trend Analysis

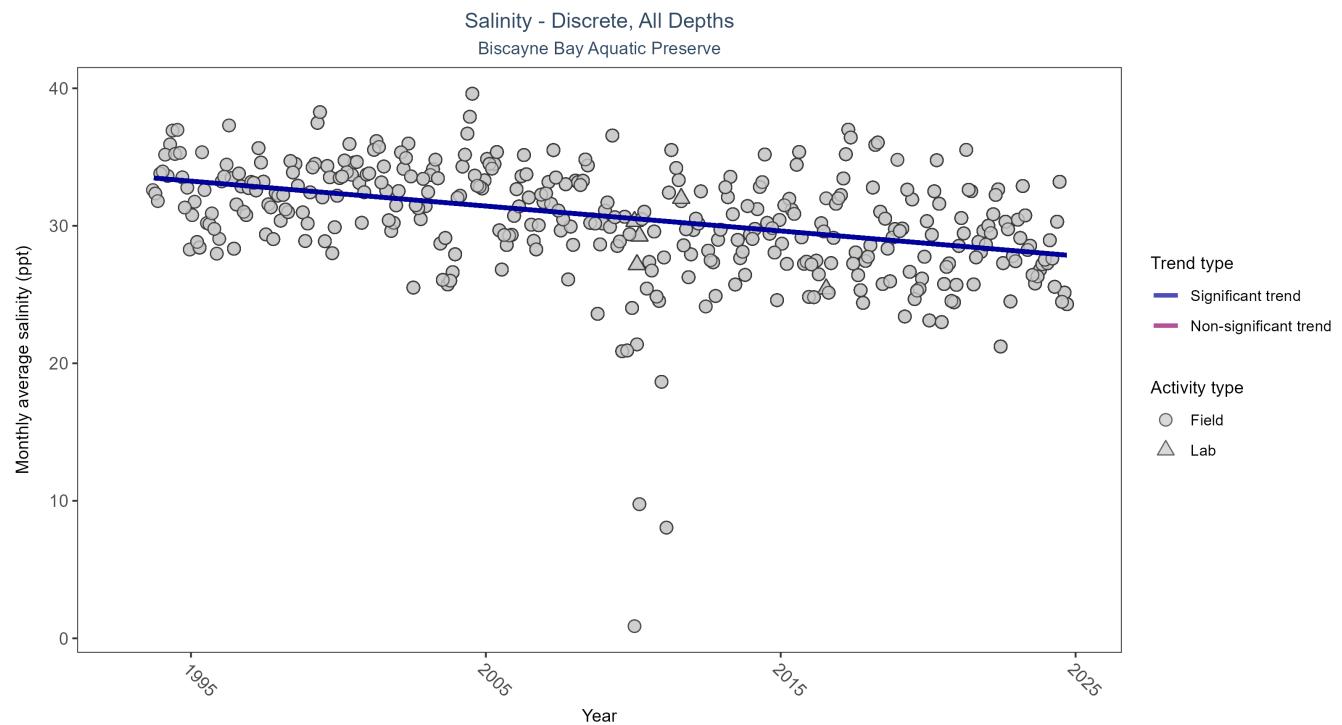


Figure 11: Scatter plot of monthly average salinity over time. If the time series included ten or more years of discrete observations, significant (blue) or non-significant (magenta) trend lines are also shown. Discrete salinity values derived from grab samples analyzed in the field (circles) or the laboratory (triangles) are both included in the plot.

Table 16: Seasonal Kendall-Tau Trend Analysis for Salinity

| Activity Type | Statistical Trend              | Sample Count | Years with Data | Period of Record | Median | tau     | Sen Intercept | Sen Slope | p |
|---------------|--------------------------------|--------------|-----------------|------------------|--------|---------|---------------|-----------|---|
| All           | Significantly decreasing trend | 23969        | 32              | 1993 - 2024      | 32     | -0.4135 | 33.6113       | -0.1812   | 0 |

Monthly average salinity decreased by 0.18 ppt per year.

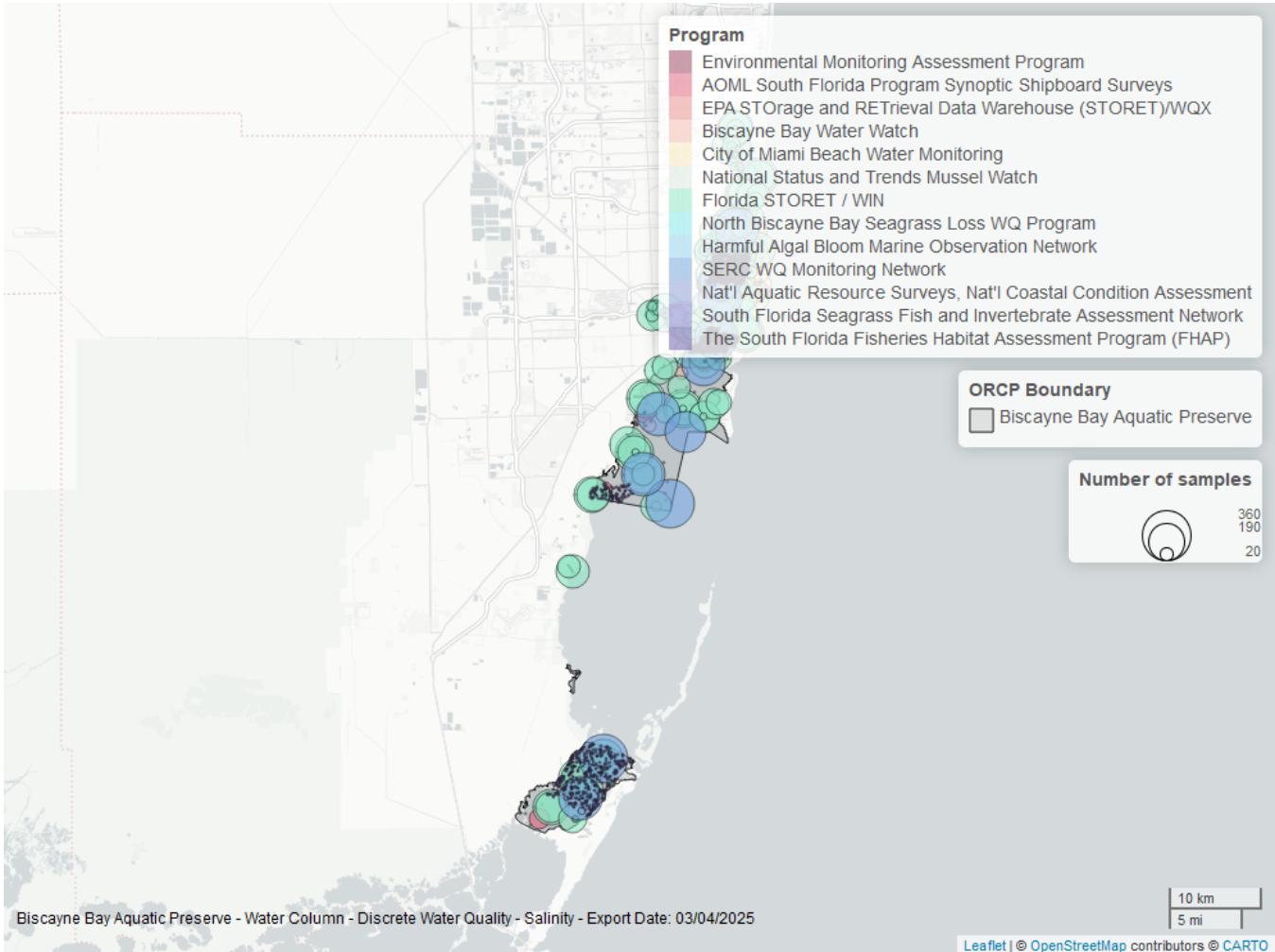


Figure 12: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 17: Programs contributing data for Salinity

| ProgramID | N_Data | YearMin | YearMax |
|-----------|--------|---------|---------|
| 5002      | 14251  | 2003    | 2024    |
| 509       | 3316   | 1993    | 2008    |
| 965       | 2512   | 2005    | 2011    |
| 4058      | 2361   | 2016    | 2023    |
| 5026      | 436    | 2019    | 2024    |
| 3         | 392    | 2002    | 2012    |
| 4049      | 271    | 2005    | 2008    |
| 102       | 263    | 1995    | 1996    |
| 4057      | 171    | 2015    | 2019    |
| 118       | 29     | 2015    | 2020    |
| 95        | 7      | 2013    | 2013    |
| 115       | 3      | 2004    | 2004    |
| 103       | 3      | 2003    | 2003    |

Program names:

- 3 - Atlantic Oceanographic and Meteorological Laboratory (AOML) South Florida Program Synoptic Shipboard Surveys<sup>3</sup>
- 95 - Harmful Algal Bloom Marine Observation Network<sup>13</sup>
- 102 - National Status and Trends Mussel Watch<sup>12</sup>
- 103 - EPA STORET and RETrieval Data Warehouse (STORET)/WQX<sup>4</sup>
- 115 - Environmental Monitoring Assessment Program<sup>5</sup>
- 118 - National Aquatic Resource Surveys, National Coastal Condition Assessment<sup>6</sup>
- 509 - SERC Water Quality Monitoring Network<sup>7</sup>
- 965 - South Florida Seagrass Fish and Invertebrate Assessment Network<sup>14</sup>
- 4049 - The South Florida Fisheries Habitat Assessment Program (FHAP)<sup>9</sup>
- 4057 - Biscayne Bay Water Watch<sup>10</sup>
- 4058 - City of Miami Beach Water Monitoring<sup>11</sup>
- 5002 - Florida STORET / WIN<sup>1</sup>
- 5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

## Secchi Depth - Discrete

### Seasonal Kendall-Tau Trend Analysis

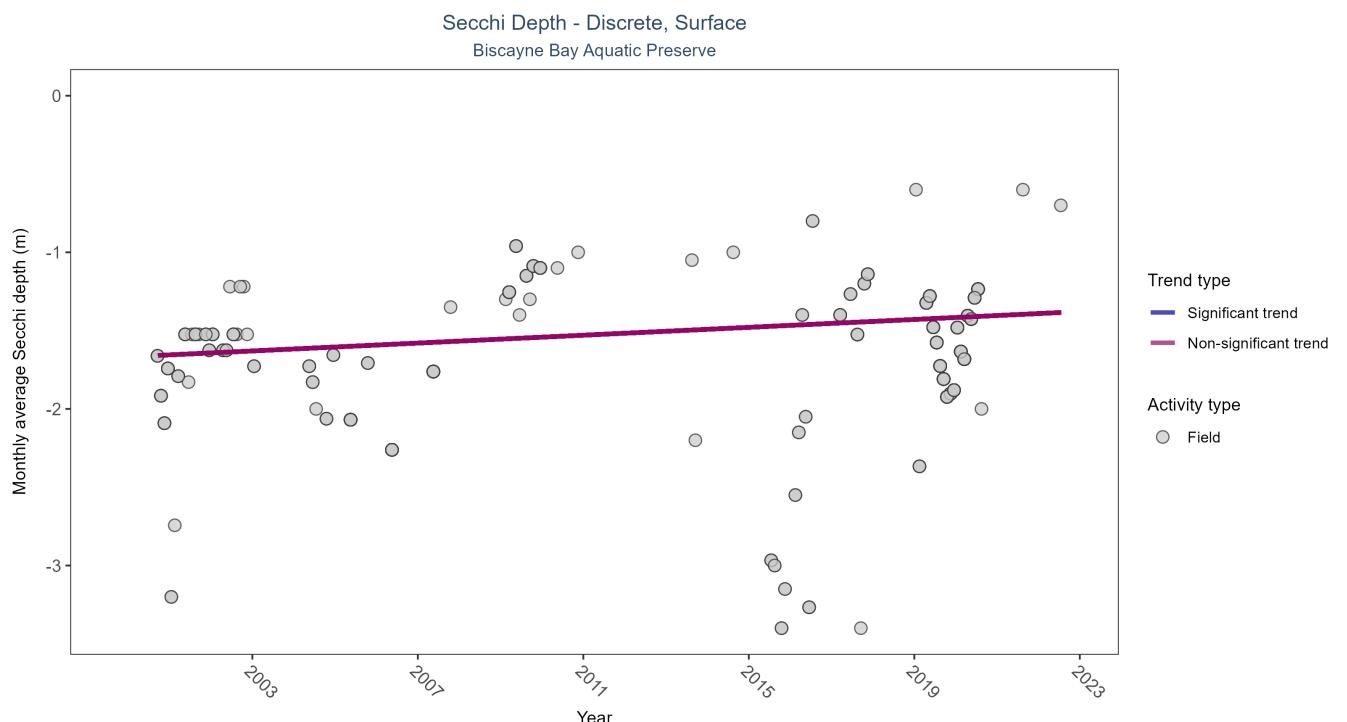


Figure 13: Scatter plot of monthly average Secchi depth over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Secchi depth is only measured in the field (circles).

Table 18: Seasonal Kendall-Tau Trend Analysis for Secchi Depth

| Activity Type | Statistical Trend    | Sample Count | Years with Data | Period of Record | Median | tau    | Sen Intercept | Sen Slope | p      |
|---------------|----------------------|--------------|-----------------|------------------|--------|--------|---------------|-----------|--------|
| Field         | No significant trend | 686          | 19              | 2000 - 2022      | -1.524 | 0.1156 | -1.6676       | 0.0126    | 0.3365 |

Secchi depth showed no detectable trend between 2000 and 2022.

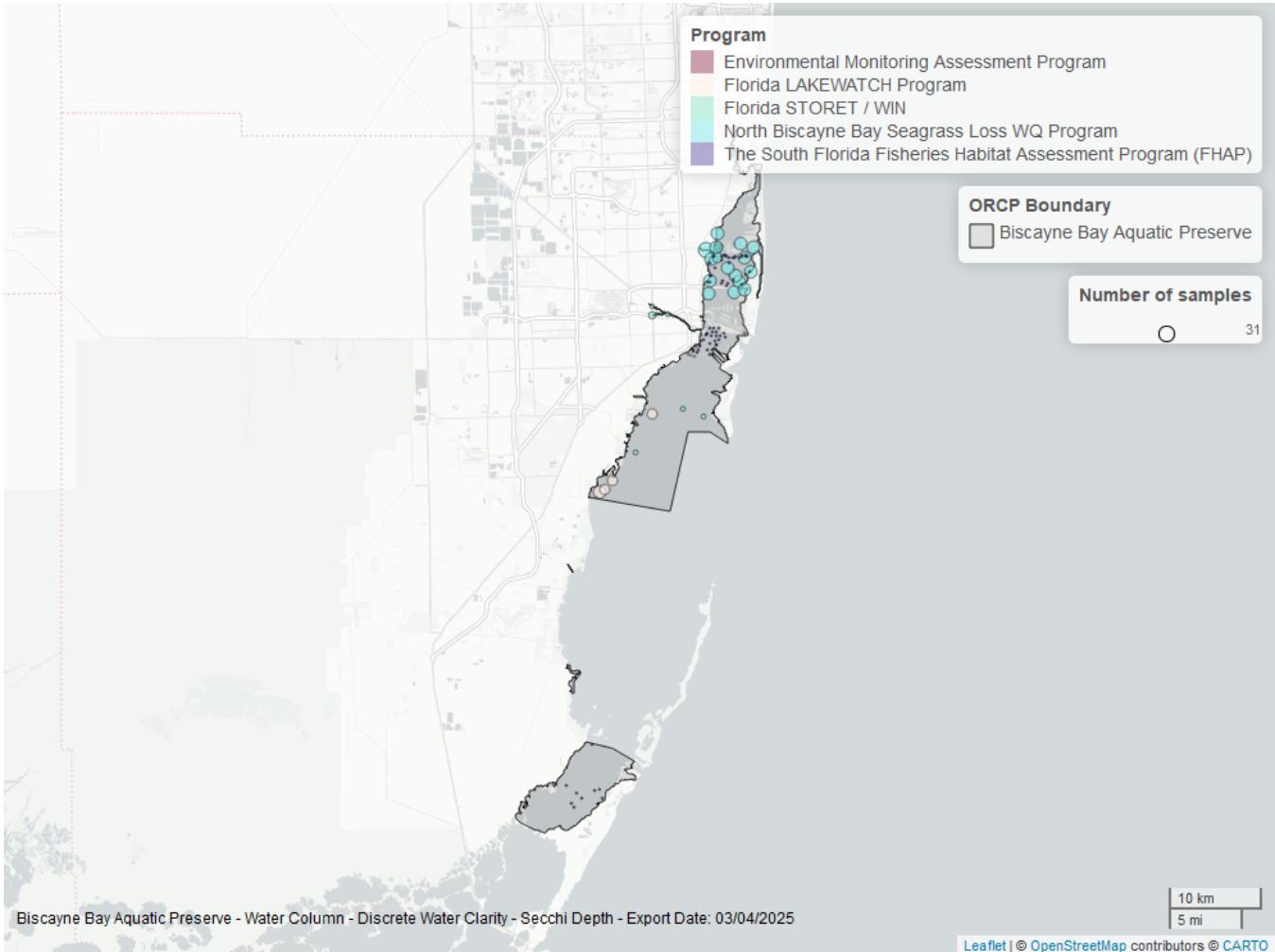


Figure 14: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 19: Programs contributing data for Secchi Depth

| ProgramID | N_Data | YearMin | YearMax |
|-----------|--------|---------|---------|
| 5026      | 426    | 2019    | 2020    |
| 5002      | 101    | 2007    | 2022    |
| 514       | 86     | 2000    | 2005    |
| 4049      | 73     | 2005    | 2007    |
| 115       | 1      | 2004    | 2004    |

#### Program names:

115 - Environmental Monitoring Assessment Program<sup>5</sup>

514 - Florida LAKEWATCH Program<sup>8</sup>

4049 - The South Florida Fisheries Habitat Assessment Program (FHAP)<sup>9</sup>

5002 - Florida STORET / WIN<sup>1</sup>

5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

#### Total Nitrogen - Discrete

#### Total Nitrogen Calculation:

The logic for calculated Total Nitrogen was provided by Kevin O'Donnell and colleagues at FDEP (with the help of Jay Silvanima, Watershed Monitoring Section). The following logic is used, in this order, based on the availability of specific nitrogen components.

- 1)  $TN = TKN + NO_3O_2;$
- 2)  $TN = TKN + NO_3 + NO_2;$
- 3)  $TN = ORGN + NH_4 + NO_3O_2;$
- 4)  $TN = ORGN + NH_4 + NO_2 + NO_3;$
- 5)  $TN = TKN + NO_3;$
- 6)  $TN = ORGN + NH_4 + NO_3;$

Additional Information:

- Rules for use of sample fraction:
  - Florida Department of Environmental Protection (FDEP) report that if both “Total” and “Dissolved” components are reported, only “Total” is used. If the total is not reported, then the dissolved components are used as a best available replacement.
  - Total nitrogen calculations are done using nitrogen components with the same sample fraction, nitrogen components with mixed total/dissolved sample fractions are not used. In other words, total nitrogen can be calculated when TKN and NO<sub>3</sub>O<sub>2</sub> are both total sample fractions, or when both are dissolved sample fractions. *Future calculations of total nitrogen values may be based on components with mixed sample fractions.*
- Values inserted into data:
  - ParameterName = “Total Nitrogen”
  - SEACAR\_QAQCFlagCode = “1Q”
  - SEACAR\_QAQC\_Description = “SEACAR Calculated”

## Seasonal Kendall-Tau Trend Analysis

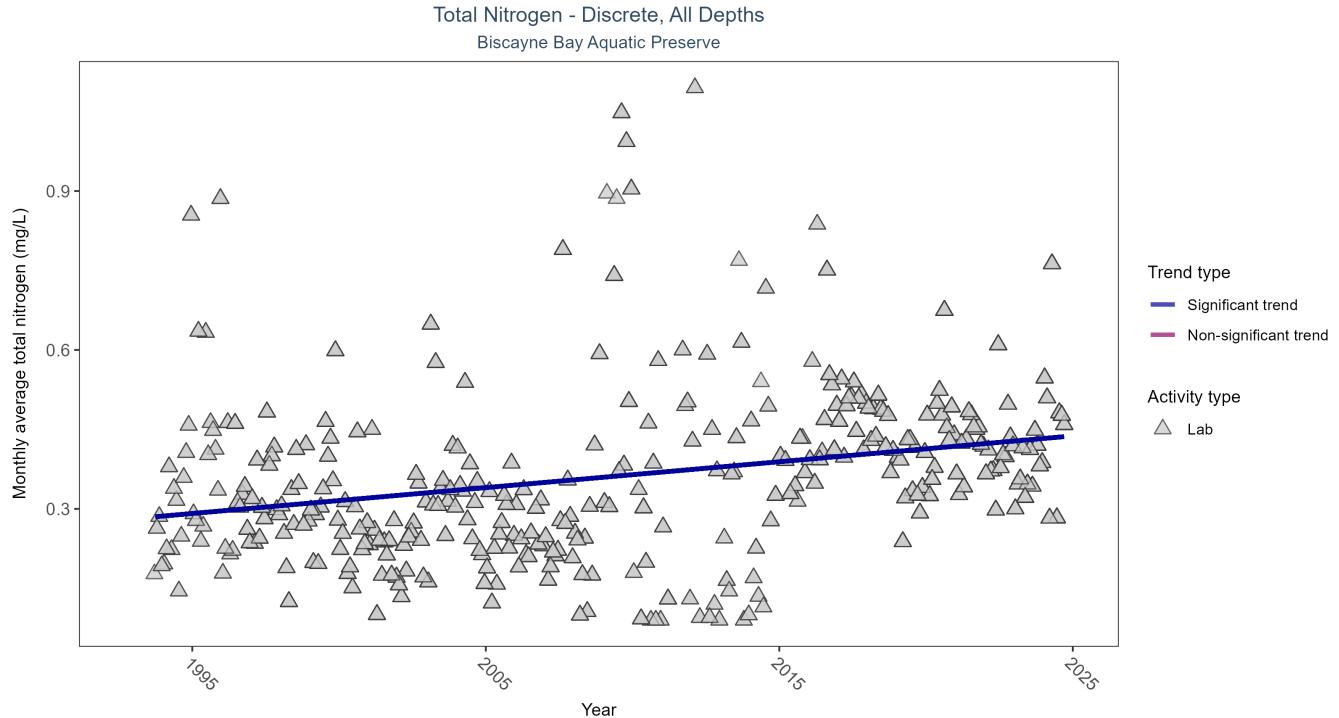


Figure 15: Scatter plot of monthly average total nitrogen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only nitrogen values obtained from laboratory analyses (triangles) are included in the plot.

Table 20: Seasonal Kendall-Tau Trend Analysis for Total Nitrogen

| Activity Type | Statistical Trend              | Sample Count | Years with Data | Period of Record | Median | tau    | Sen Intercept | Sen Slope | p |
|---------------|--------------------------------|--------------|-----------------|------------------|--------|--------|---------------|-----------|---|
| Lab           | Significantly increasing trend | 7918         | 32              | 1993 - 2024      | 0.334  | 0.2298 | 0.2816        | 0.0049    | 0 |

Monthly average total nitrogen increased by less than 0.01 mg/L per year.

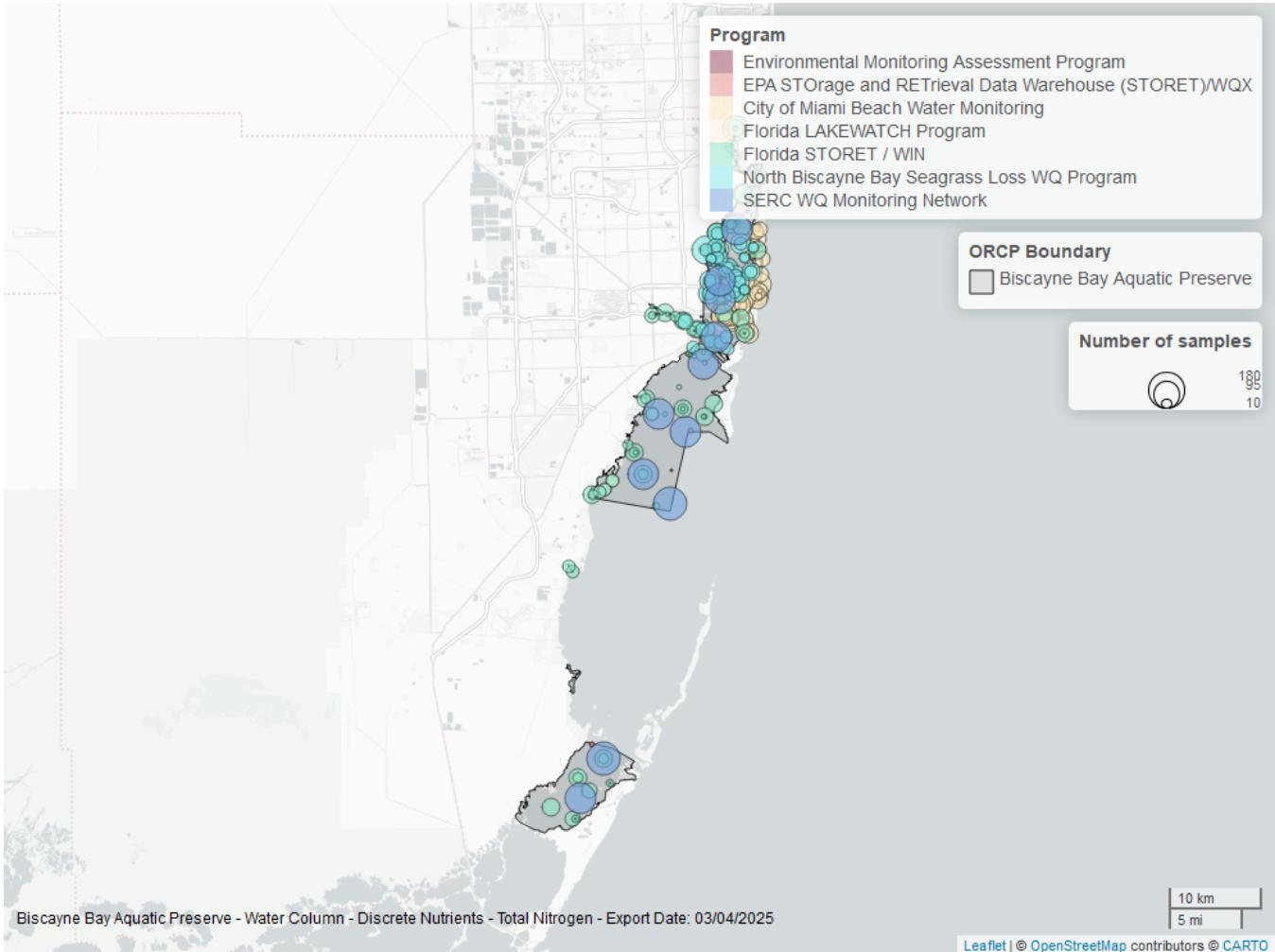


Figure 16: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 21: Programs contributing data for Total Nitrogen

| ProgramID | N_Data | YearMin | YearMax |
|-----------|--------|---------|---------|
| 5002      | 2613   | 1994    | 2024    |
| 4058      | 2166   | 2016    | 2023    |
| 509       | 1654   | 1993    | 2008    |
| 5026      | 1416   | 2019    | 2024    |
| 514       | 104    | 2000    | 2005    |
| 103       | 20     | 2002    | 2006    |
| 115       | 1      | 2004    | 2004    |

#### Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>4</sup>

115 - Environmental Monitoring Assessment Program<sup>5</sup>

509 - SERC Water Quality Monitoring Network<sup>7</sup>

514 - Florida LAKEWATCH Program<sup>8</sup>

4058 - City of Miami Beach Water Monitoring<sup>11</sup>

5002 - Florida STORET / WIN<sup>1</sup>

5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

## Total Phosphorus - Discrete

### Seasonal Kendall-Tau Trend Analysis

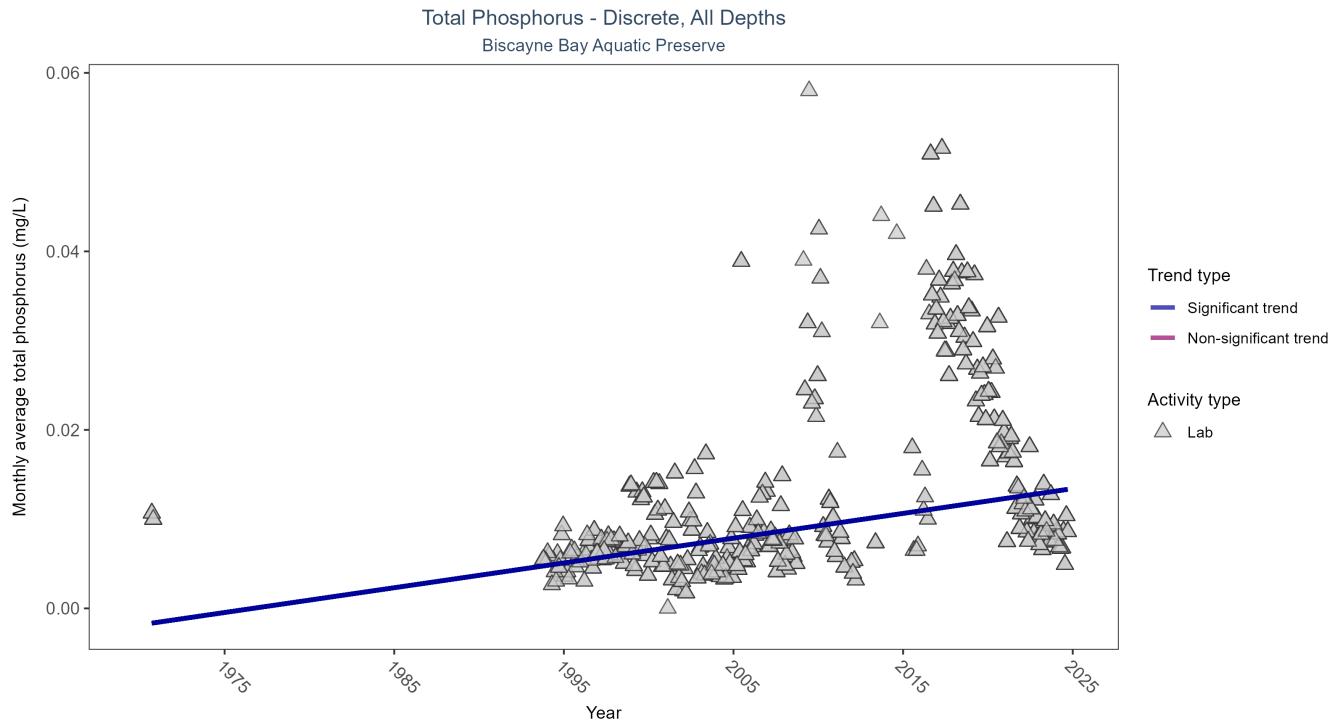


Figure 17: Scatter plot of monthly average total phosphorus over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only phosphorus values obtained from laboratory analyses (triangles) are included in the plot.

Table 22: Seasonal Kendall-Tau Trend Analysis for Total Phosphorus

| Activity Type | Statistical Trend              | Sample Count | Years with Data | Period of Record | Median | tau   | Sen Intercept | Sen Slope | p |
|---------------|--------------------------------|--------------|-----------------|------------------|--------|-------|---------------|-----------|---|
| Lab           | Significantly increasing trend | 8031         | 33              | 1970 - 2024      | 0.009  | 0.362 | -0.0019       | 0.0003    | 0 |

Monthly average total phosphorus increased by less than 0.01 mg/L per year.

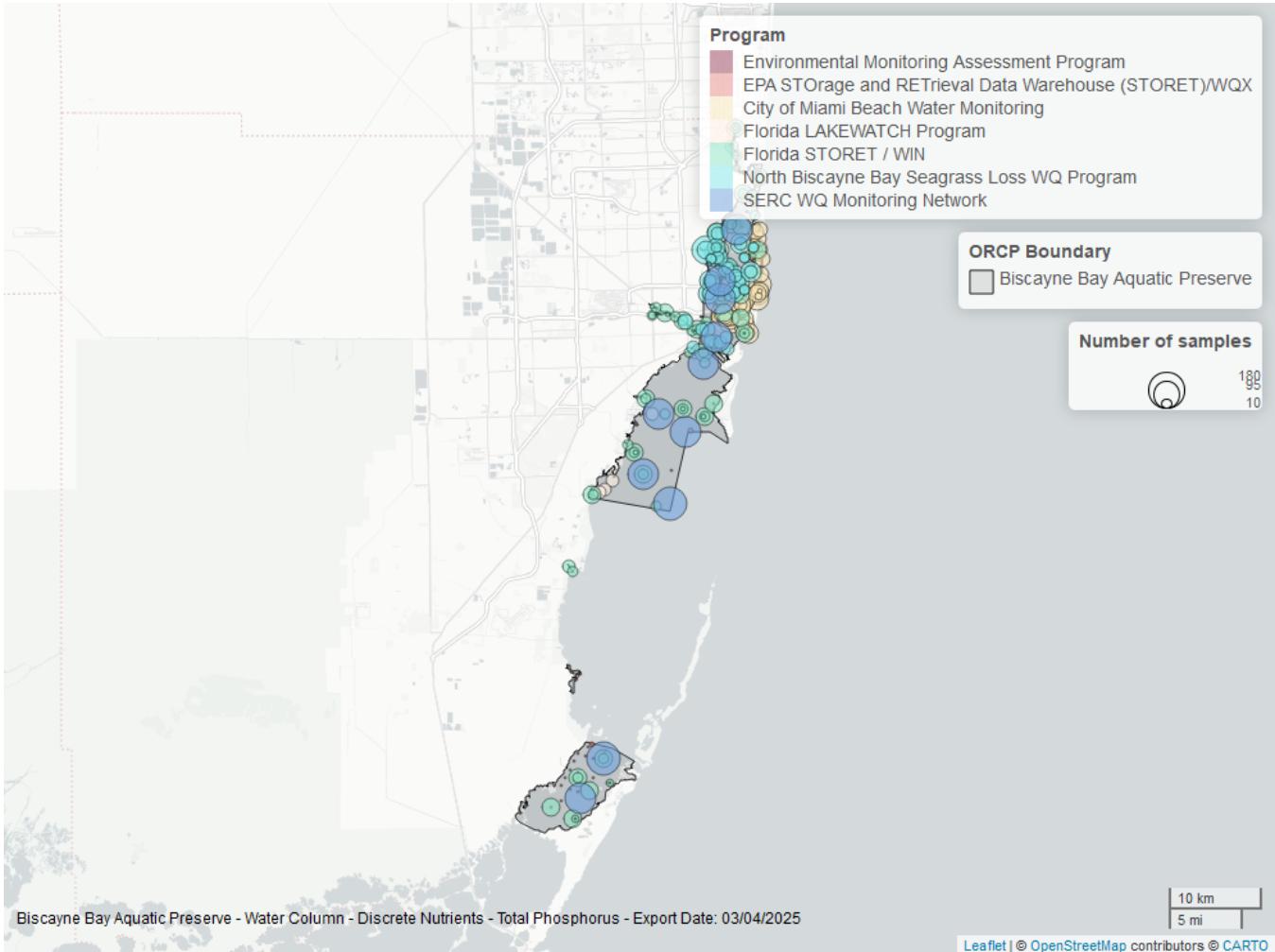


Figure 18: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 23: Programs contributing data for Total Phosphorus

| <i>ProgramID</i> | <i>N_Data</i> | <i>YearMin</i> | <i>YearMax</i> |
|------------------|---------------|----------------|----------------|
| 5002             | 2600          | 2001           | 2024           |
| 4058             | 2243          | 2016           | 2023           |
| 509              | 1655          | 1993           | 2008           |
| 5026             | 1462          | 2019           | 2024           |
| 514              | 103           | 2000           | 2005           |
| 103              | 75            | 1970           | 2020           |
| 115              | 1             | 2004           | 2004           |

#### Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>4</sup>

115 - Environmental Monitoring Assessment Program<sup>5</sup>

509 - SERC Water Quality Monitoring Network<sup>7</sup>

514 - Florida LAKEWATCH Program<sup>8</sup>

4058 - City of Miami Beach Water Monitoring<sup>11</sup>

5002 - Florida STORET / WIN<sup>1</sup>

5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

## Total Suspended Solids - Discrete

### Seasonal Kendall-Tau Trend Analysis

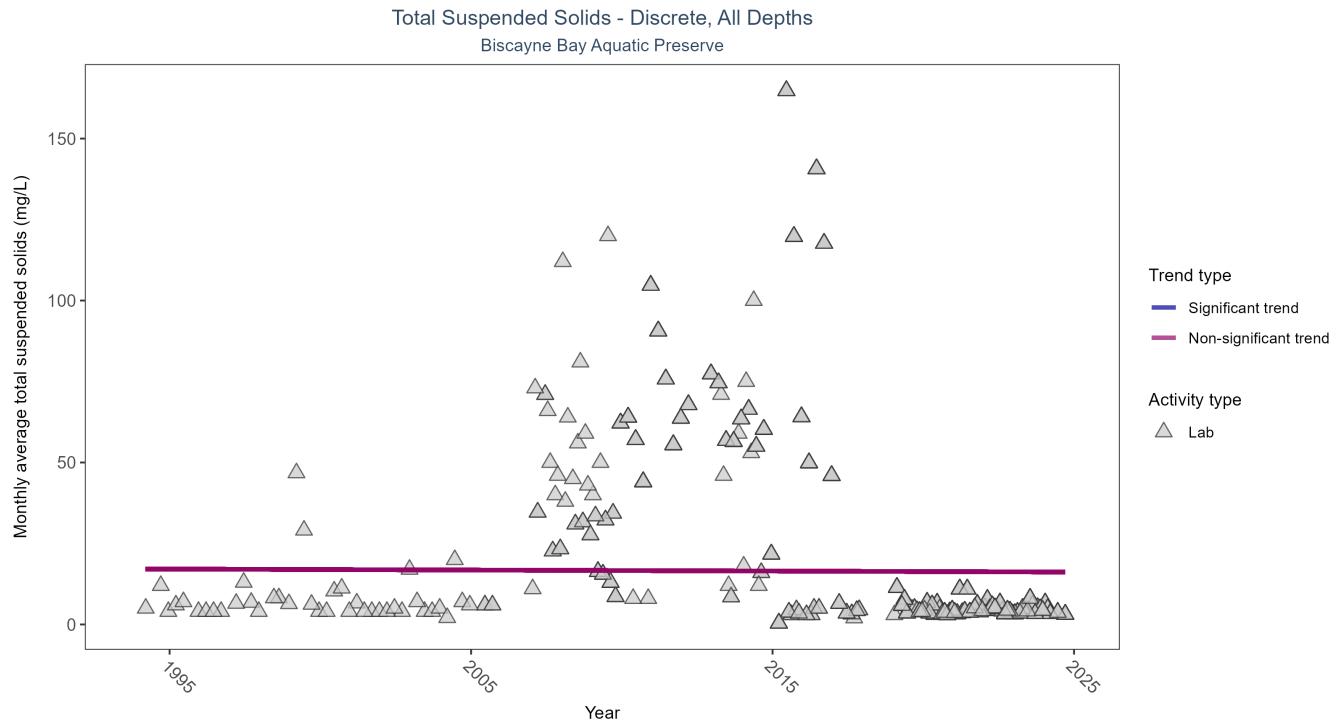


Figure 19: Scatter plot of monthly average total suspended solids (TSS) over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only TSS values obtained from laboratory analyses (triangles) are included in the plot.

Table 24: Seasonal Kendall-Tau Trend Analysis for Total Suspended Solids

| Activity Type | Statistical Trend    | Sample Count | Years with Data | Period of Record | Median | tau     | Sen Intercept | Sen Slope | p      |
|---------------|----------------------|--------------|-----------------|------------------|--------|---------|---------------|-----------|--------|
| Lab           | No significant trend | 2221         | 29              | 1994 - 2024      | 4.9    | -0.1596 | 17.1354       | -0.0308   | 0.2724 |

Total suspended solids showed no detectable trend between 1994 and 2024.

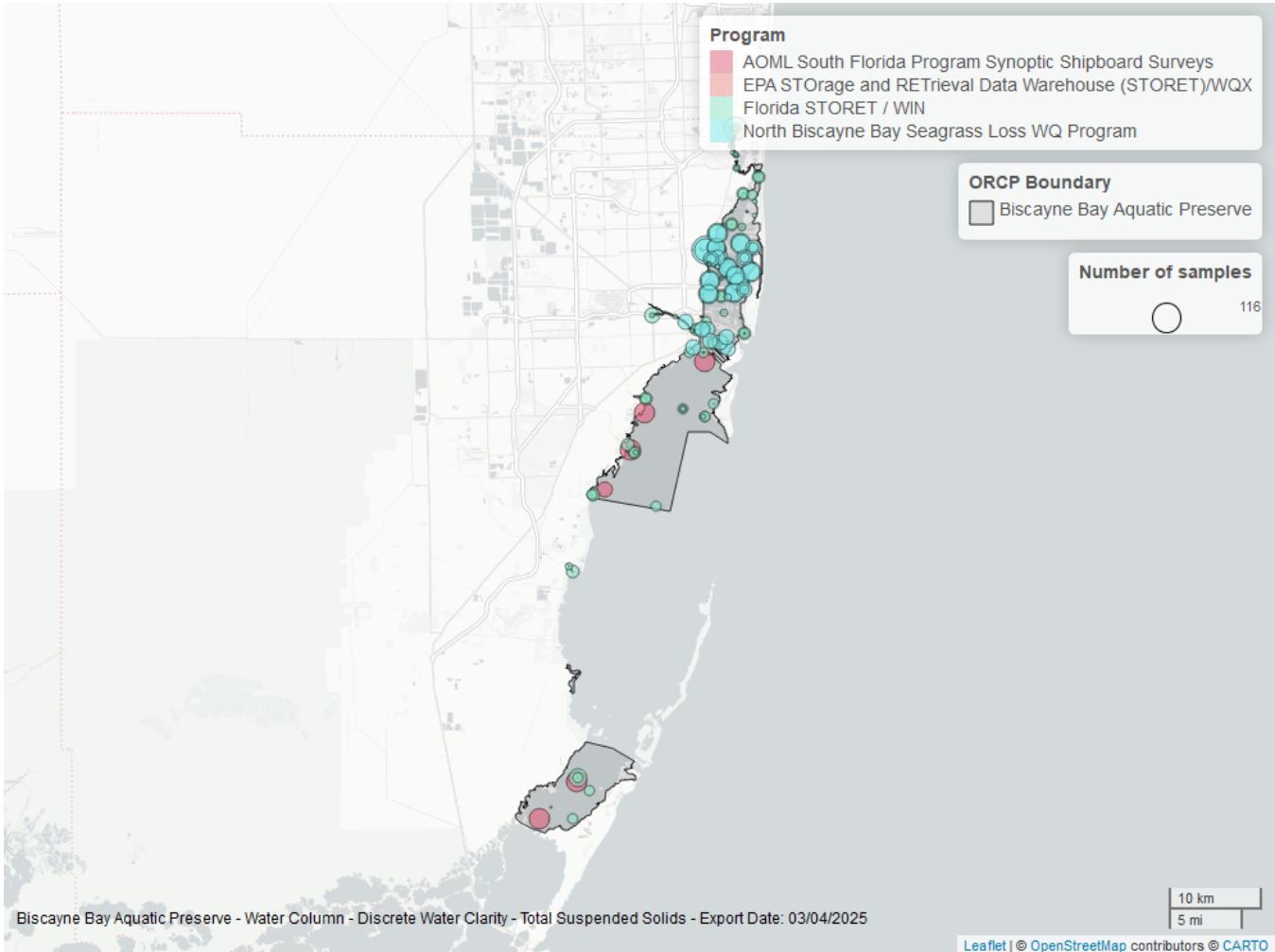


Figure 20: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 25: Programs contributing data for Total Suspended Solids

| <i>ProgramID</i> | <i>N_Data</i> | <i>YearMin</i> | <i>YearMax</i> |
|------------------|---------------|----------------|----------------|
| 5026             | 1917          | 2019           | 2024           |
| 5002             | 1193          | 1994           | 2024           |
| 3                | 370           | 2002           | 2012           |
| 103              | 19            | 2020           | 2020           |

#### Program names:

3 - Atlantic Oceanographic and Meteorological Laboratory (AOML) South Florida Program Synoptic Shipboard Surveys<sup>3</sup>

103 - EPA STOrage and RETriev Data Warehouse (STORET)/WQX<sup>4</sup>

5002 - Florida STORET / WIN<sup>1</sup>

5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

#### Turbidity - Discrete

#### Seasonal Kendall-Tau Trend Analysis

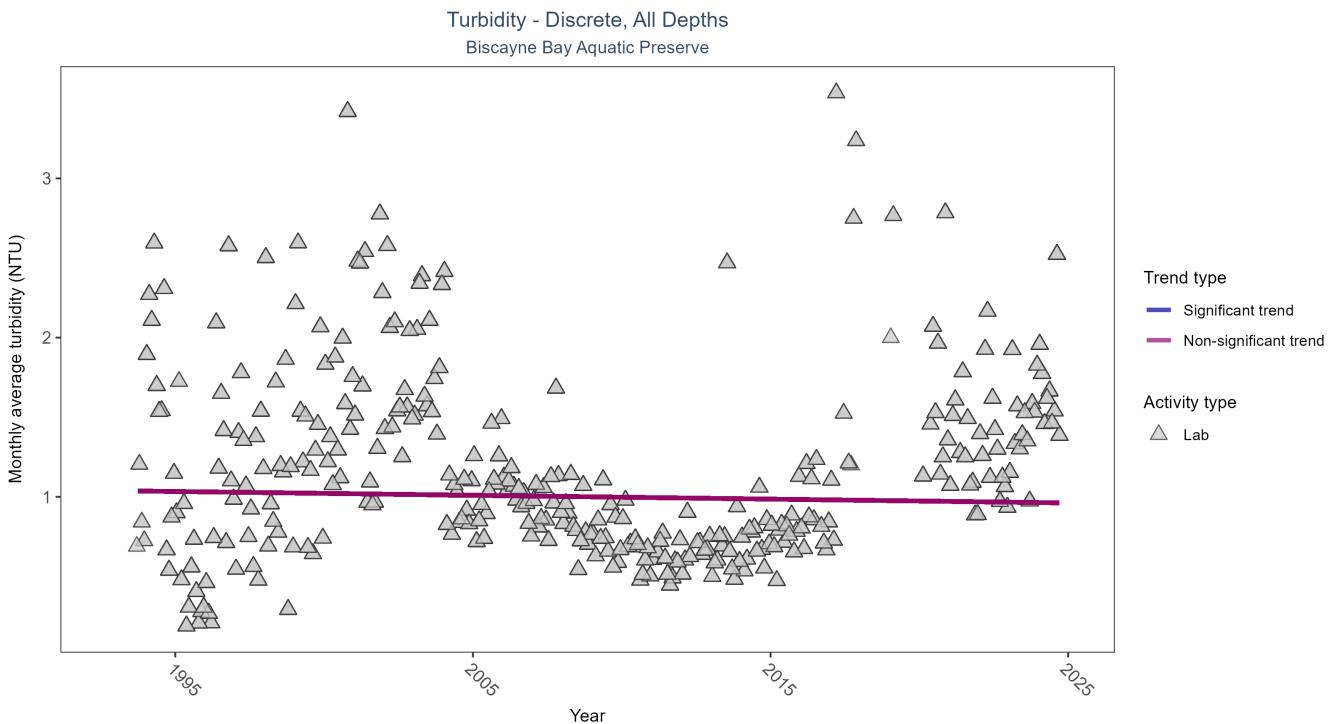


Figure 21: Scatter plot of monthly average turbidity over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only turbidity values measured in the laboratory (triangles) are included in the plot.

Table 26: Seasonal Kendall-Tau Trend Analysis for Turbidity

| Activity Type | Statistical Trend    | Sample Count | Years with Data | Period of Record | Median | tau    | Sen Intercept | Sen Slope | p      |
|---------------|----------------------|--------------|-----------------|------------------|--------|--------|---------------|-----------|--------|
| Lab           | No significant trend | 11884        | 31              | 1993 - 2024      | 0.8    | -0.027 | 1.0383        | -0.0024   | 0.4931 |

Turbidity showed no detectable trend between 1993 and 2024.

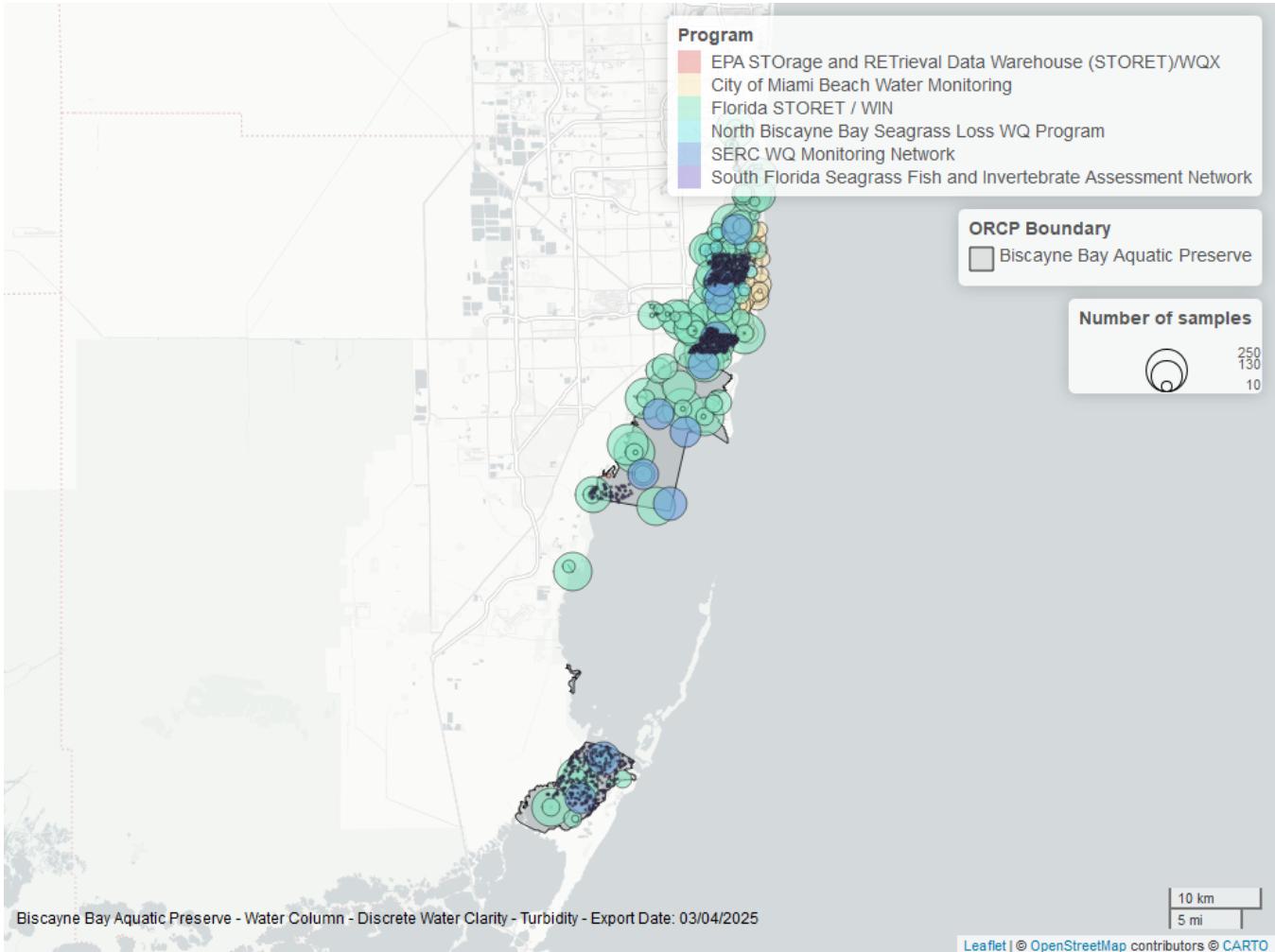


Figure 22: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 27: Programs contributing data for Turbidity

| <i>ProgramID</i> | <i>N_Data</i> | <i>YearMin</i> | <i>YearMax</i> |
|------------------|---------------|----------------|----------------|
| 5002             | 11080         | 1994           | 2024           |
| 4058             | 2367          | 2016           | 2023           |
| 509              | 1658          | 1993           | 2008           |
| 965              | 1254          | 2005           | 2011           |
| 5026             | 410           | 2019           | 2020           |
| 103              | 32            | 1982           | 2020           |

#### Program names:

- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>4</sup>
- 509 - SERC Water Quality Monitoring Network<sup>7</sup>
- 965 - South Florida Seagrass Fish and Invertebrate Assessment Network<sup>14</sup>
- 4058 - City of Miami Beach Water Monitoring<sup>11</sup>
- 5002 - Florida STORET / WIN<sup>1</sup>
- 5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

## Water Temperature - Discrete

### Seasonal Kendall-Tau Trend Analysis

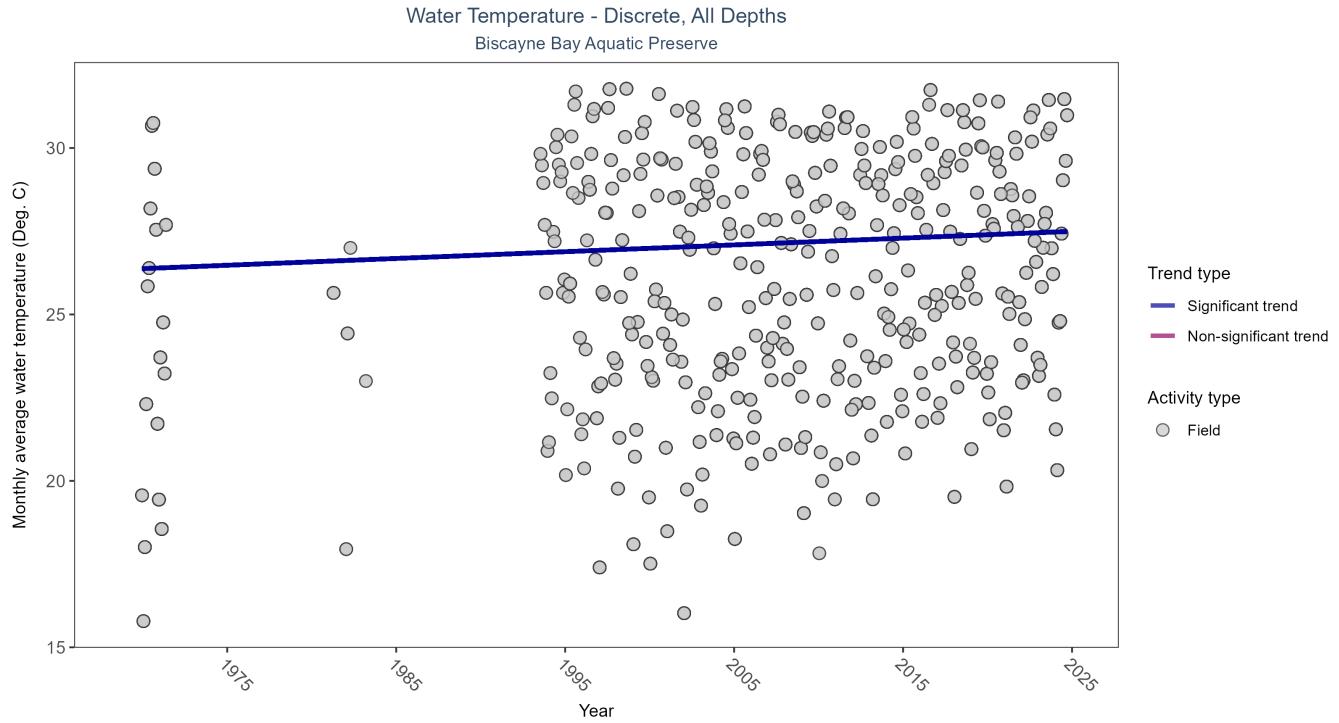


Figure 23: Scatter plot of monthly average water temperature over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only water temperature measurements taken in the field (circles) are included in the plot.

Table 28: Seasonal Kendall-Tau Trend Analysis for Water Temperature

| Activity Type | Statistical Trend              | Sample Count | Years with Data | Period of Record | Median | tau   | Sen Intercept | Sen Slope | p      |
|---------------|--------------------------------|--------------|-----------------|------------------|--------|-------|---------------|-----------|--------|
| Field         | Significantly increasing trend | 25079        | 38              | 1969 - 2024      | 27     | 0.131 | 26.3559       | 0.0204    | 0.0003 |

Monthly average water temperature increased by 0.02°C per year.

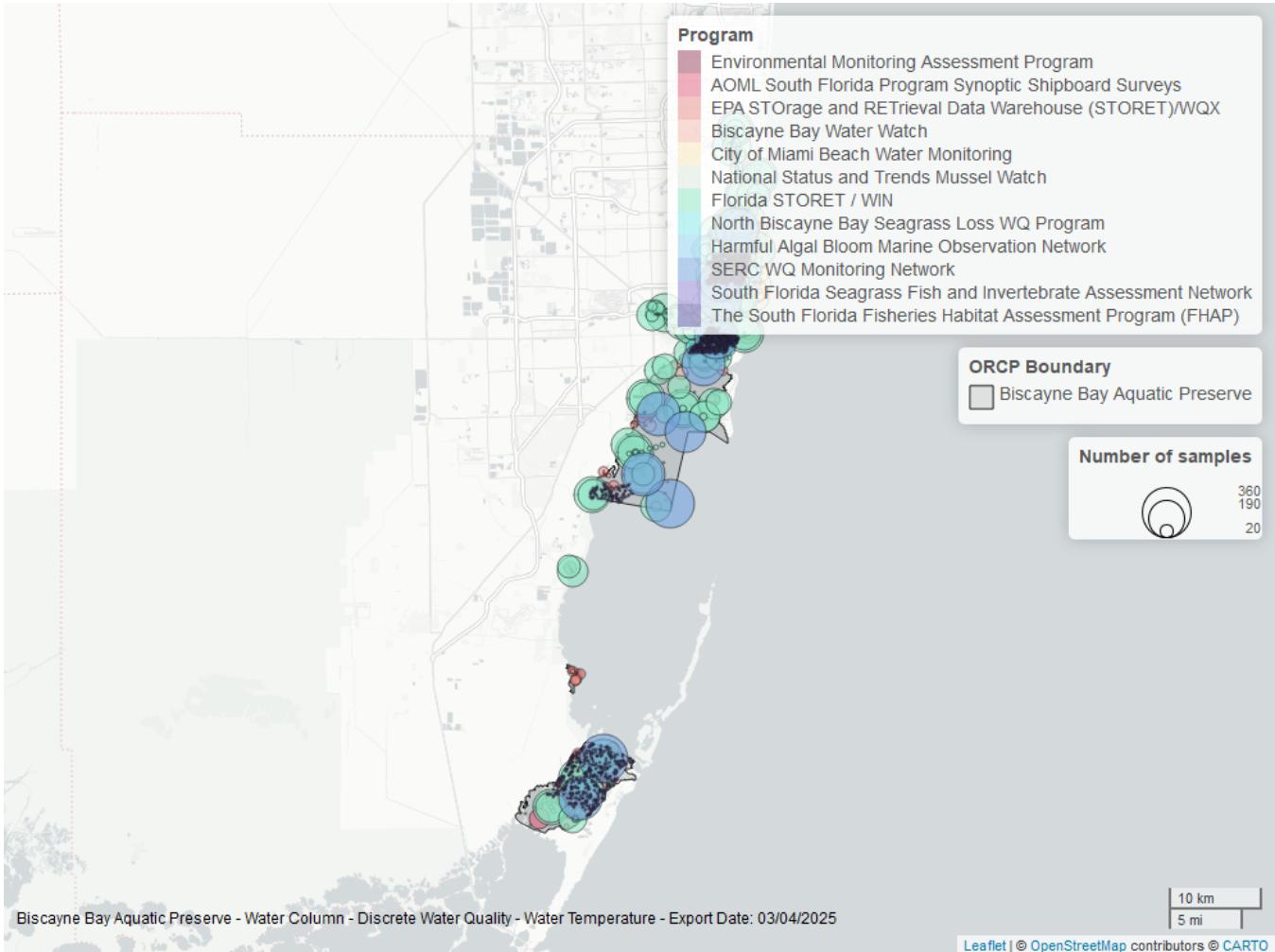


Figure 24: Map showing location of discrete water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 29: Programs contributing data for Water Temperature

| <i>ProgramID</i> | <i>N_Data</i> | <i>YearMin</i> | <i>YearMax</i> |
|------------------|---------------|----------------|----------------|
| 5002             | 13945         | 2001           | 2024           |
| 509              | 3316          | 1993           | 2008           |
| 965              | 2512          | 2005           | 2011           |
| 4058             | 2352          | 2016           | 2023           |
| 5026             | 1535          | 2019           | 2024           |
| 103              | 1089          | 1969           | 2020           |
| 3                | 392           | 2002           | 2012           |
| 4049             | 271           | 2005           | 2008           |
| 102              | 263           | 1995           | 1996           |
| 4057             | 168           | 2015           | 2019           |
| 95               | 9             | 2012           | 2015           |
| 115              | 3             | 2004           | 2004           |

#### Program names:

3 - Atlantic Oceanographic and Meteorological Laboratory (AOML) South Florida Program Synoptic Shipboard

Surveys<sup>3</sup>

95 - Harmful Algal Bloom Marine Observation Network<sup>13</sup>

102 - National Status and Trends Mussel Watch<sup>12</sup>

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>4</sup>

115 - Environmental Monitoring Assessment Program<sup>5</sup>

509 - SERC Water Quality Monitoring Network<sup>7</sup>

965 - South Florida Seagrass Fish and Invertebrate Assessment Network<sup>14</sup>

4049 - The South Florida Fisheries Habitat Assessment Program (FHAP)<sup>9</sup>

4057 - Biscayne Bay Water Watch<sup>10</sup>

4058 - City of Miami Beach Water Monitoring<sup>11</sup>

5002 - Florida STORET / WIN<sup>1</sup>

5026 - North Biscayne Bay Seagrass Loss Water Quality Program<sup>2</sup>

## Water Quality - Continuous

The following files were used in the continuous analysis:

- *Combined\_WQ\_WC\_NUT\_cont\_Dissolved\_Oxygen\_SE-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_cont\_Dissolved\_Oxygen\_Saturation\_SE-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_cont\_pH\_SE-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_cont\_Salinity\_SE-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_cont\_Turbidity\_SE-2025-Mar-06.txt*
- *Combined\_WQ\_WC\_NUT\_cont\_Water\_Temperature\_SE-2025-Mar-06.txt*

### Continuous monitoring locations in Biscayne Bay Aquatic Preserve

Table 30: Station overview for Continuous parameters by Program

| <i>ProgramID</i> | <i>ProgramLocationID</i> | <i>Years of Data</i> | <i>Use in Analysis</i> | <i>Parameters</i>                  |
|------------------|--------------------------|----------------------|------------------------|------------------------------------|
| 5077             | BBBB14                   | 6                    | TRUE                   | DO , DOS , pH , Sal , Turb , TempW |
| 5077             | BBCWA4                   | 3                    | FALSE                  | DO , DOS , pH , Sal , Turb , TempW |
| 5077             | BBJT71                   | 6                    | TRUE                   | DO , DOS , pH , Sal , Turb , TempW |
| 5077             | BBLR03                   | 5                    | TRUE                   | DO , DOS                           |
| 5077             | BBLR03                   | 6                    | TRUE                   | pH , Sal , Turb , TempW            |
| 5077             | BBMRDW                   | 4                    | FALSE                  | DO , DOS , pH , Sal , Turb , TempW |
| 5077             | BBMRRB                   | 3                    | FALSE                  | DO , DOS , pH , Sal , Turb , TempW |

### Program names:

5077 - Biscayne Bay Aquatic Preserves Continuous Water Quality Monitoring<sup>15</sup>

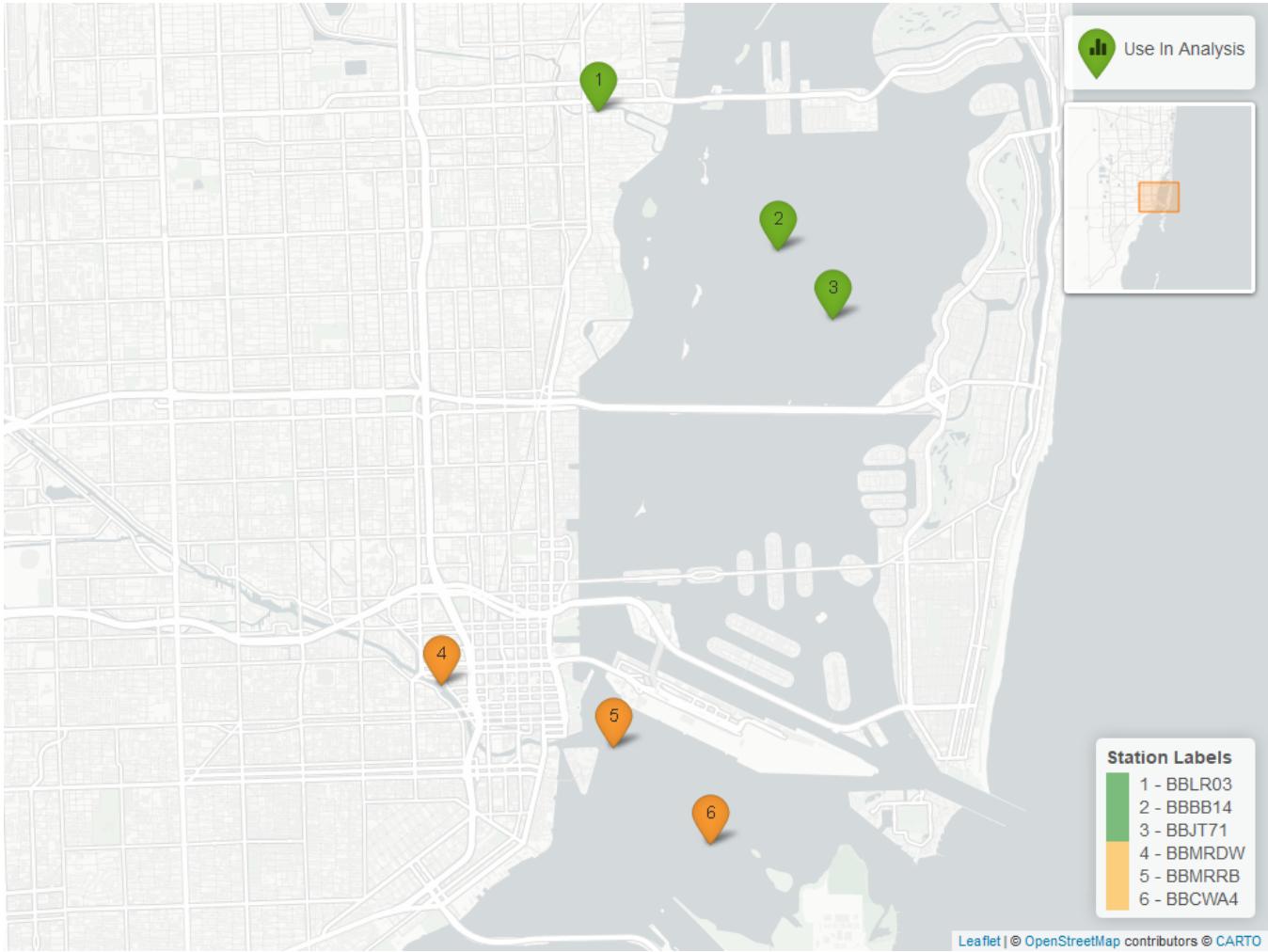


Figure 25: Map showing continuous water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. Sites marked as *Use In Analysis* (green) are featured in this report.

## Dissolved Oxygen - Continuous

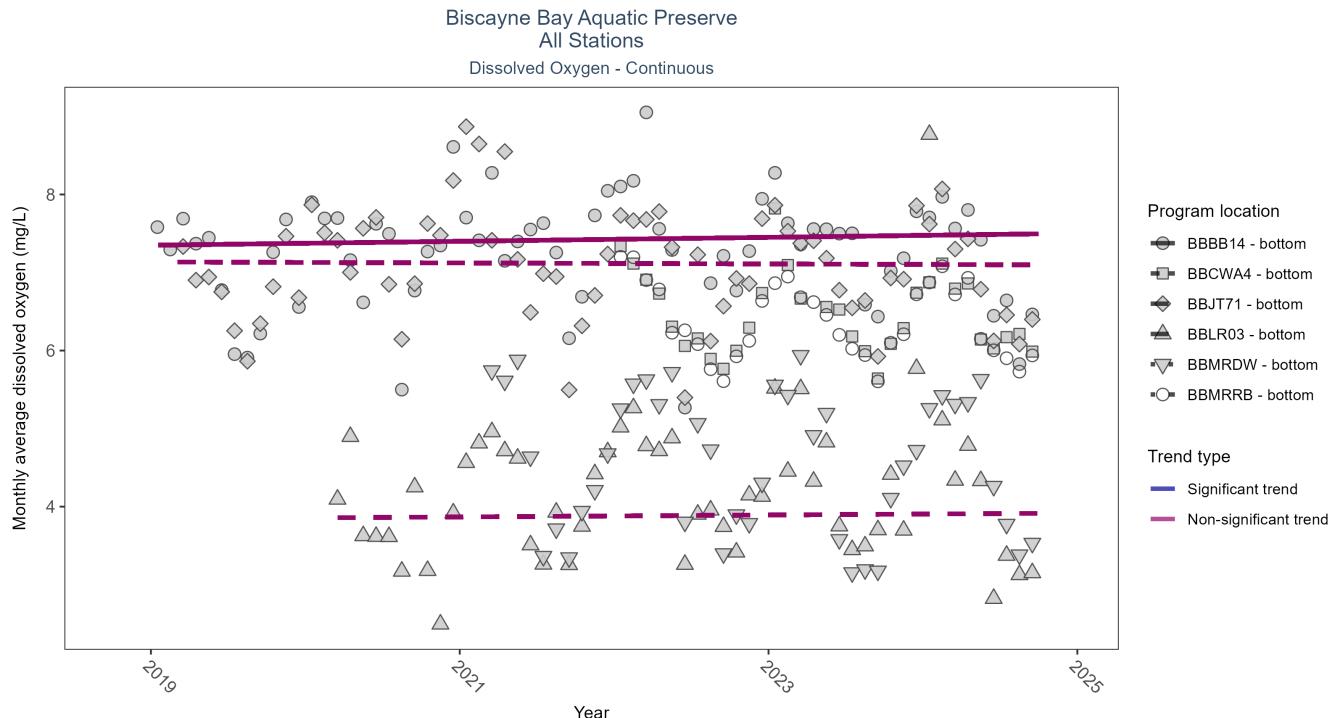


Figure 26: Scatter plot of monthly average dissolved oxygen over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 31: Seasonal Kendall-Tau Results for Dissolved Oxygen - All Stations

| Station | Statistical Trend                    | Sample Count | Years with Data | Period of Record | Median | tau   | Sen Intercept | Sen Slope | p    |
|---------|--------------------------------------|--------------|-----------------|------------------|--------|-------|---------------|-----------|------|
| BBBB14  | No significant trend                 | 174312       | 6               | 2019 - 2024      | 7.2    | 0.06  | 7.35          | 0.03      | 0.52 |
| BBCWA4  | Insufficient data to calculate trend | 89025        | 3               | 2022 - 2024      | 6.5    | -     | -             | -         | -    |
| BBJT71  | No significant trend                 | 192461       | 6               | 2019 - 2024      | 7.0    | -0.02 | 7.14          | -0.01     | 0.91 |
| BBLR03  | No significant trend                 | 148009       | 5               | 2020 - 2024      | 4.1    | 0.06  | 3.86          | 0.01      | 0.94 |
| BBMRRB  | Insufficient data to calculate trend | 92591        | 3               | 2022 - 2024      | 6.4    | -     | -             | -         | -    |
| BBMRDW  | Insufficient data to calculate trend | 116315       | 4               | 2021 - 2024      | 4.5    | -     | -             | -         | -    |

No detectable change in monthly average dissolved oxygen was observed at three locations. There was insufficient data to fit a model for three locations.

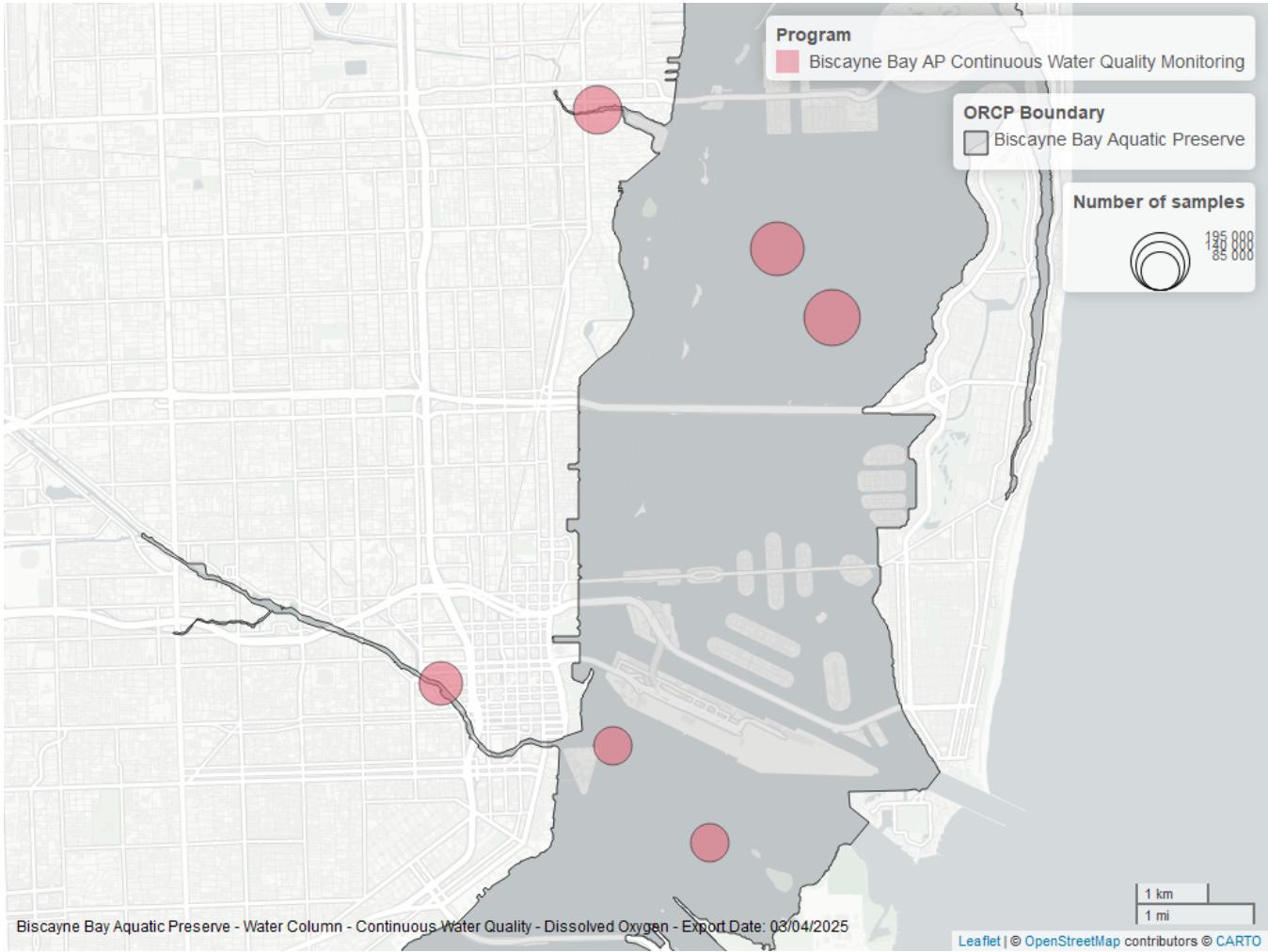


Figure 27: Map showing location of dissolved oxygen continuous water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Dissolved Oxygen Saturation - Continuous

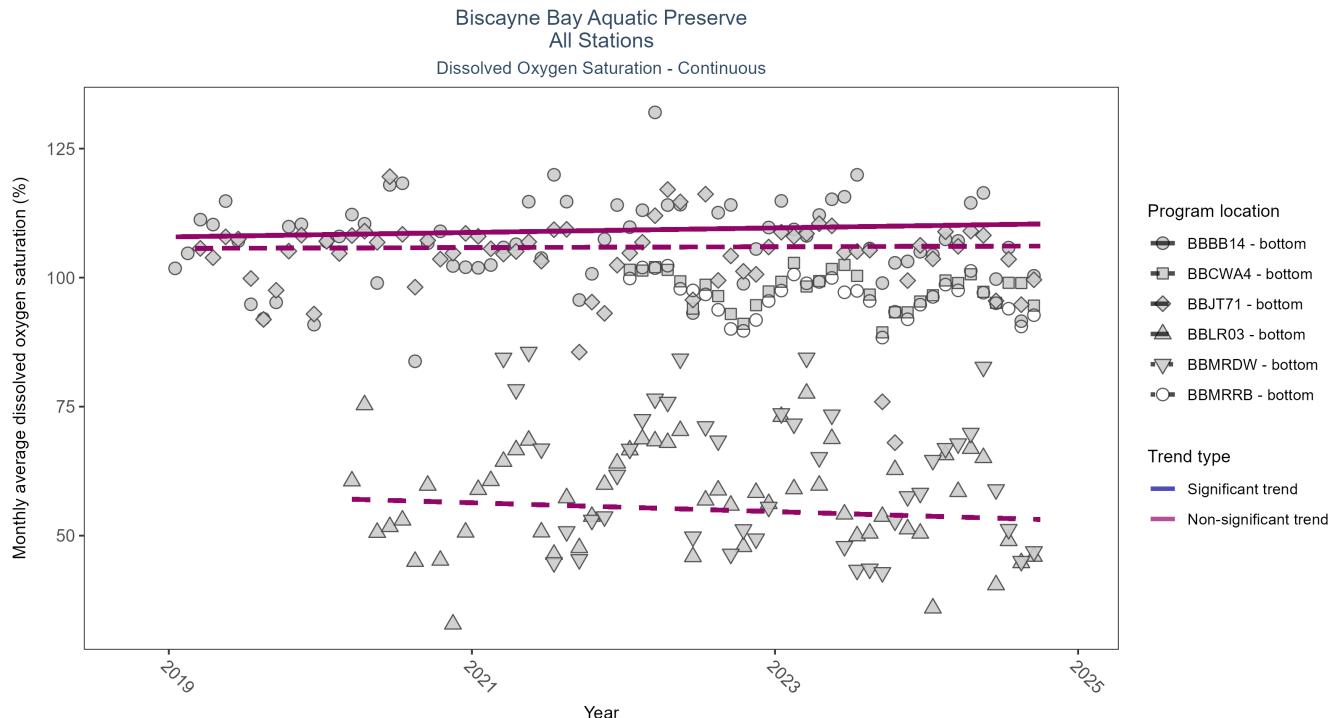


Figure 28: Scatter plot of monthly average dissolved oxygen saturation over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 32: Seasonal Kendall-Tau Results for Dissolved Oxygen Saturation - All Stations

| Station | Statistical Trend                    | Sample Count | Years with Data | Period of Record | Median | tau  | Sen Intercept | Sen Slope | p    |
|---------|--------------------------------------|--------------|-----------------|------------------|--------|------|---------------|-----------|------|
| BBBB14  | No significant trend                 | 174052       | 6               | 2019 - 2024      | 104.8  | 0.1  | 107.88        | 0.44      | 0.32 |
| BBCWA4  | Insufficient data to calculate trend | 92748        | 3               | 2022 - 2024      | 97.4   | -    | -             | -         | -    |
| BBJT71  | No significant trend                 | 193612       | 6               | 2019 - 2024      | 101.8  | 0.03 | 105.66        | 0.08      | 0.81 |
| BBLR03  | No significant trend                 | 148008       | 5               | 2020 - 2024      | 56.4   | -0.1 | 57.24         | -0.86     | 0.38 |
| BBMRRB  | Insufficient data to calculate trend | 92599        | 3               | 2022 - 2024      | 95.7   | -    | -             | -         | -    |
| BBMRDW  | Insufficient data to calculate trend | 116316       | 4               | 2021 - 2024      | 60.0   | -    | -             | -         | -    |

No detectable change in monthly average dissolved oxygen saturation was observed at three locations. There was insufficient data to fit a model for three locations.

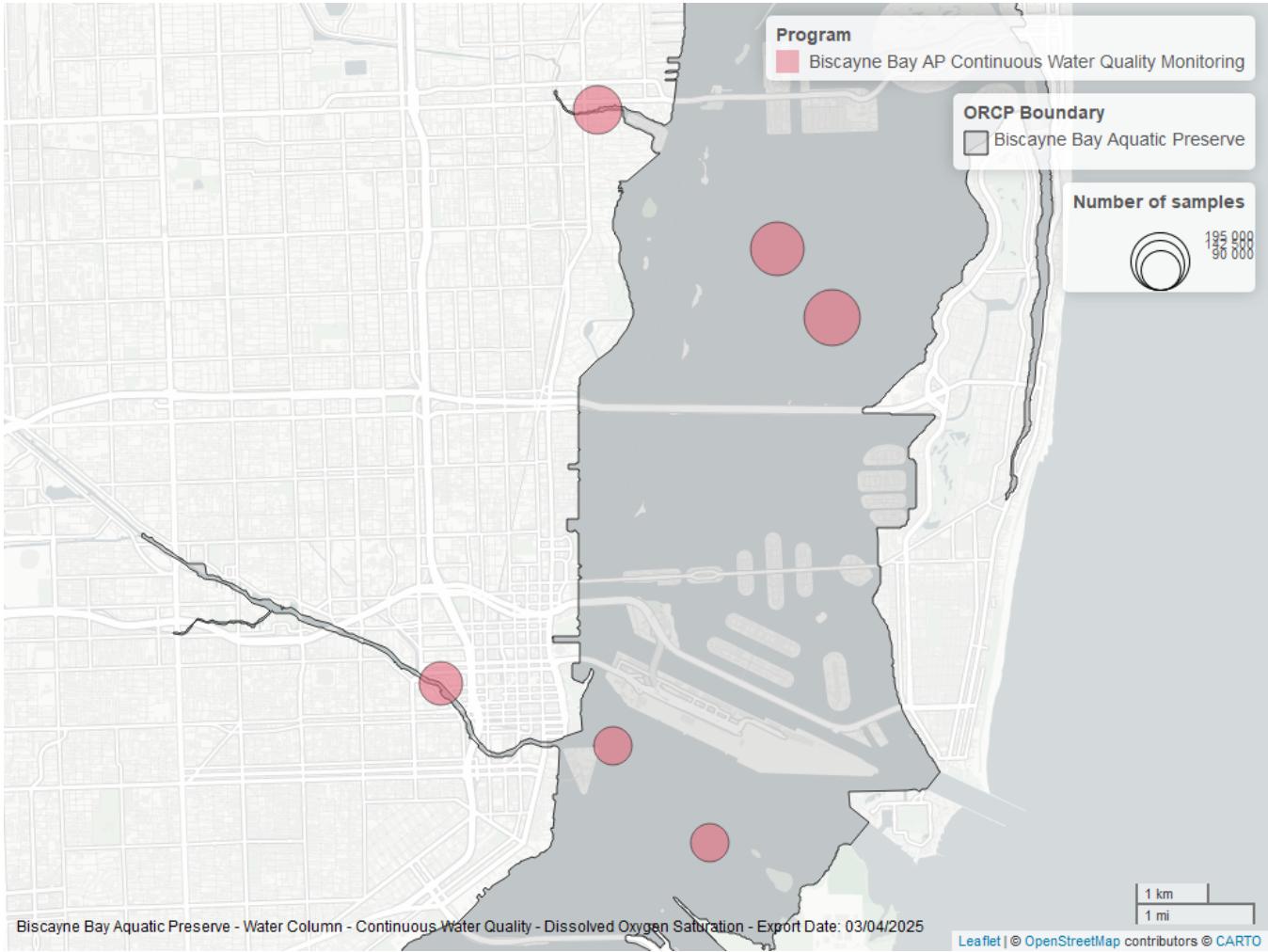


Figure 29: Map showing location of dissolved oxygen saturation continuous water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## pH - Continuous

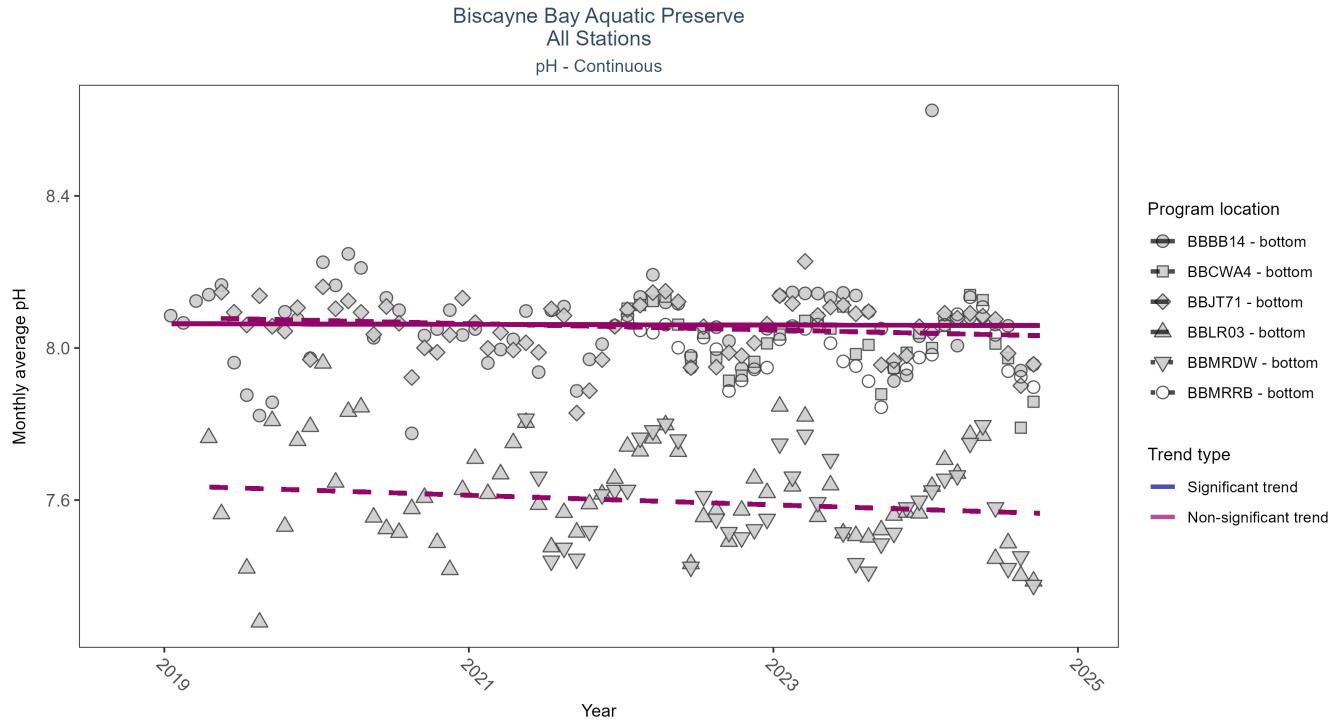


Figure 30: Scatter plot of monthly average pH over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 33: Seasonal Kendall-Tau Results for pH - All Stations

| Station | Statistical Trend                    | Sample Count | Years with Data | Period of Record | Median | tau   | Sen Intercept | Sen Slope | p    |
|---------|--------------------------------------|--------------|-----------------|------------------|--------|-------|---------------|-----------|------|
| BBBB14  | No significant trend                 | 170239       | 6               | 2019 - 2024      | 8.1    | -0.03 | 8.06          | 0         | 0.95 |
| BBCWA4  | Insufficient data to calculate trend | 92930        | 3               | 2022 - 2024      | 8.0    | -     | -             | -         | -    |
| BBJT71  | No significant trend                 | 180871       | 6               | 2019 - 2024      | 8.1    | -0.21 | 8.08          | -0.01     | 0.06 |
| BBLR03  | No significant trend                 | 163519       | 6               | 2019 - 2024      | 7.6    | -0.18 | 7.64          | -0.01     | 0.14 |
| BBMRRB  | Insufficient data to calculate trend | 92643        | 3               | 2022 - 2024      | 8.0    | -     | -             | -         | -    |
| BBMRDW  | Insufficient data to calculate trend | 111368       | 4               | 2021 - 2024      | 7.6    | -     | -             | -         | -    |

No detectable change in monthly average pH was observed at three locations. There was insufficient data to fit a model for three locations.

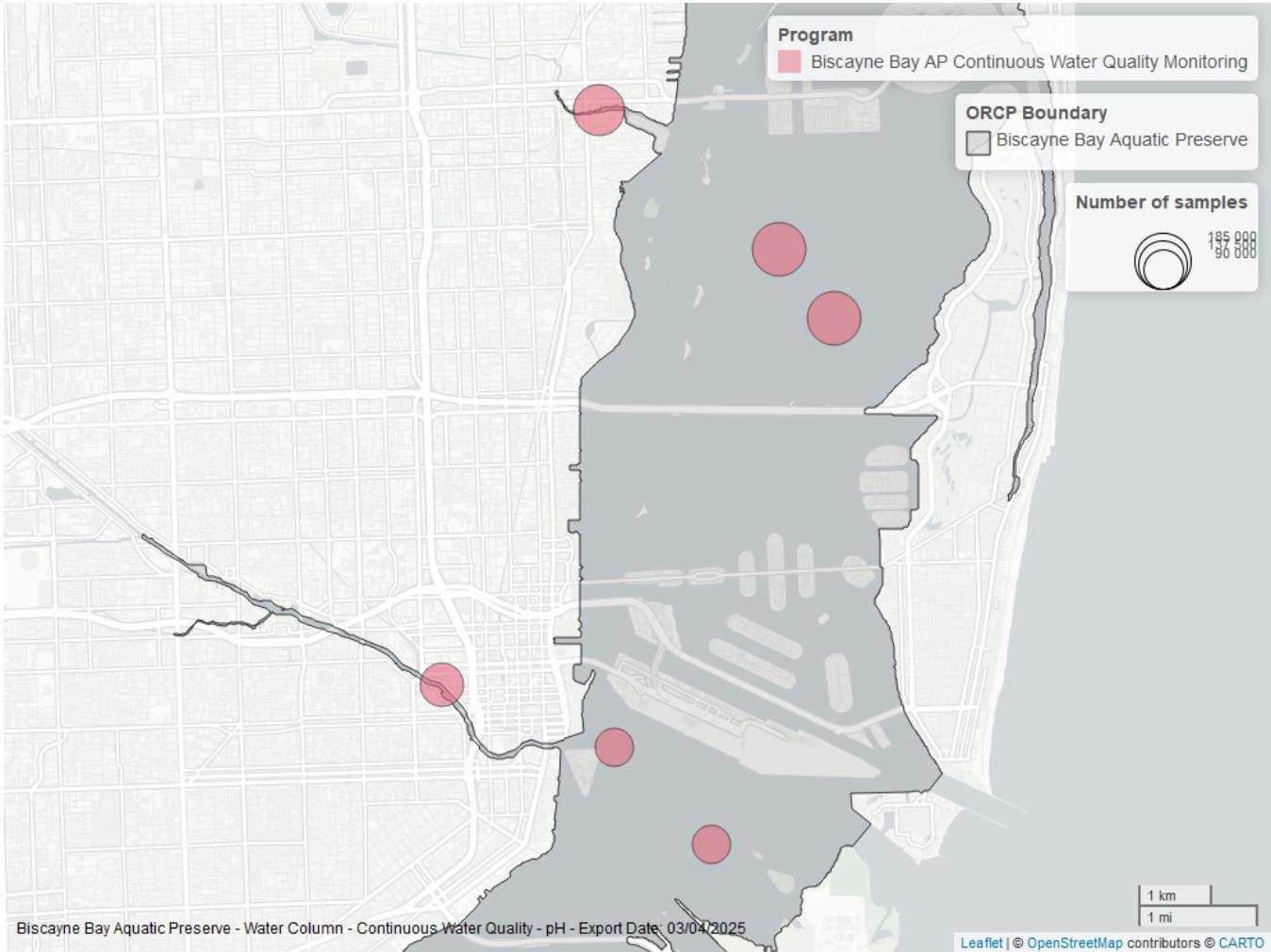


Figure 31: Map showing location of ph continuous water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Salinity - Continuous

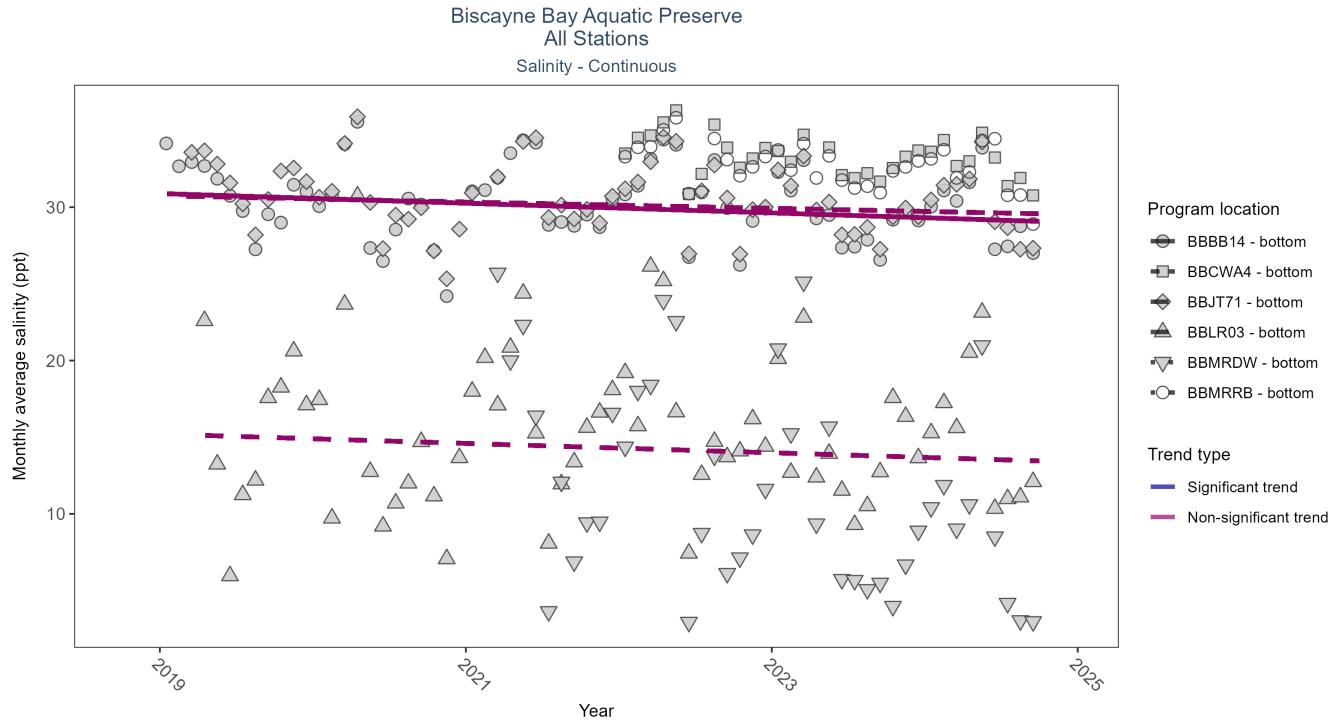


Figure 32: Scatter plot of monthly average salinity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 34: Seasonal Kendall-Tau Results for Salinity - All Stations

| Station | Statistical Trend                    | Sample Count | Years with Data | Period of Record | Median | tau   | Sen Intercept | Sen Slope | p    |
|---------|--------------------------------------|--------------|-----------------|------------------|--------|-------|---------------|-----------|------|
| BBBB14  | No significant trend                 | 163926       | 6               | 2019 - 2024      | 30.1   | -0.23 | 30.89         | -0.32     | 0.05 |
| BBCWA4  | Insufficient data to calculate trend | 87140        | 3               | 2022 - 2024      | 33.4   | -     | -             | -         | -    |
| BBJT71  | No significant trend                 | 178697       | 6               | 2019 - 2024      | 30.8   | -0.16 | 30.75         | -0.2      | 0.12 |
| BBLR03  | No significant trend                 | 168006       | 6               | 2019 - 2024      | 16.2   | -0.15 | 15.2          | -0.3      | 0.16 |
| BBMRRB  | Insufficient data to calculate trend | 92599        | 3               | 2022 - 2024      | 33.0   | -     | -             | -         | -    |
| BBMRDWB | Insufficient data to calculate trend | 114444       | 4               | 2021 - 2024      | 9.0    | -     | -             | -         | -    |

No detectable change in monthly average salinity was observed at three locations. There was insufficient data to fit a model for three locations.

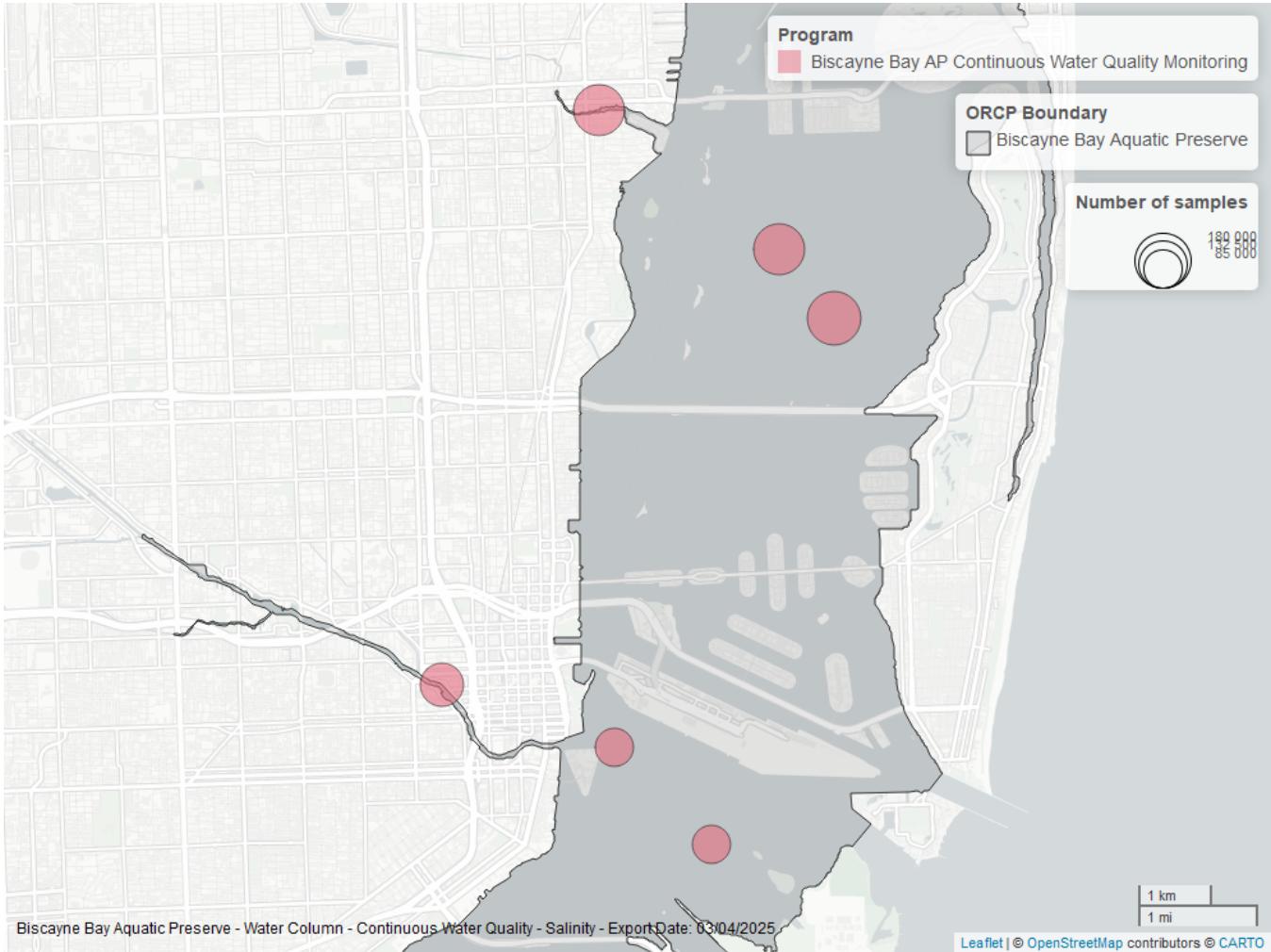


Figure 33: Map showing location of salinity continuous water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Turbidity - Continuous

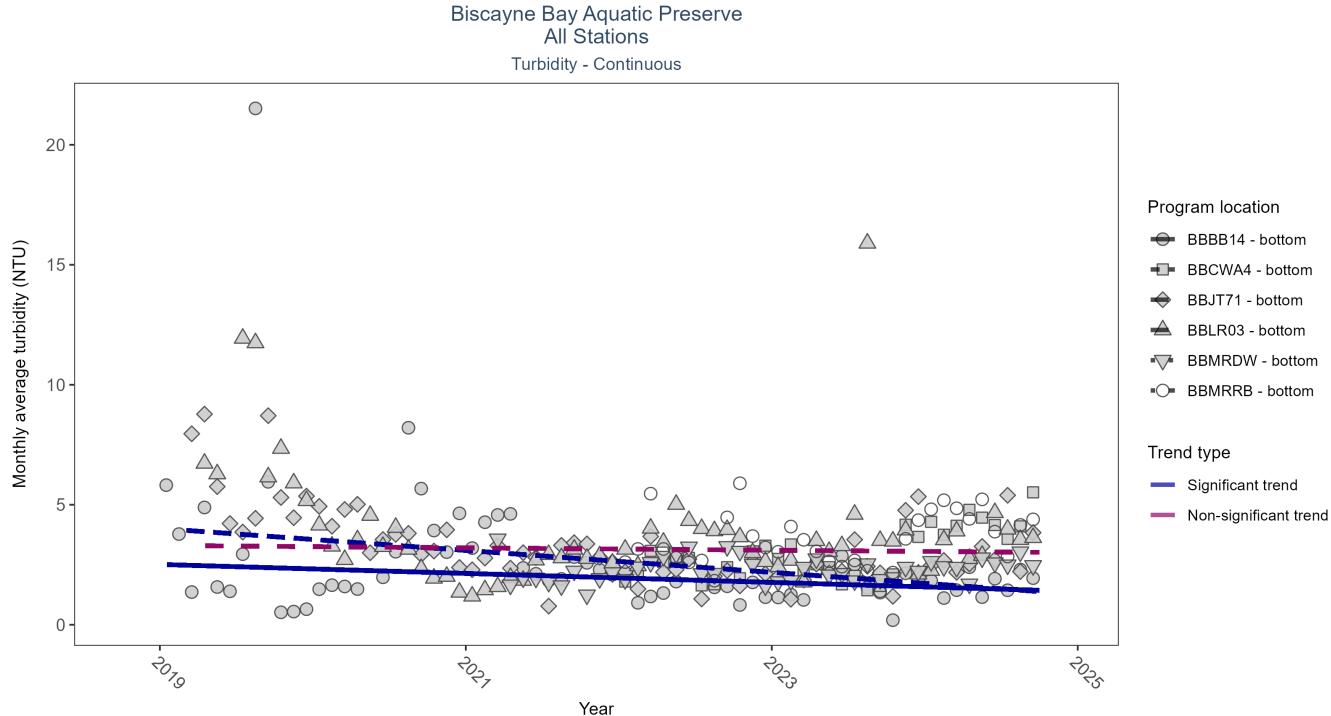


Figure 34: Scatter plot of monthly average turbidity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 35: Seasonal Kendall-Tau Results for Turbidity - All Stations

| Station | Statistical Trend                    | Sample Count | Years with Data | Period of Record | Median | tau   | Sen Intercept | Sen Slope | p    |
|---------|--------------------------------------|--------------|-----------------|------------------|--------|-------|---------------|-----------|------|
| BBBB14  | Significantly decreasing trend       | 163375       | 6               | 2019 - 2024      | 2      | -0.3  | 2.51          | -0.19     | 0.01 |
| BBCWA4  | Insufficient data to calculate trend | 90269        | 3               | 2022 - 2024      | 3      | -     | -             | -         | -    |
| BBJT71  | Significantly decreasing trend       | 186564       | 6               | 2019 - 2024      | 3      | -0.46 | 4.01          | -0.46     | 0    |
| BBLR03  | No significant trend                 | 170459       | 6               | 2019 - 2024      | 3      | -0.04 | 3.3           | -0.05     | 0.62 |
| BBMRRB  | Insufficient data to calculate trend | 91453        | 3               | 2022 - 2024      | 3      | -     | -             | -         | -    |
| BBMRDW  | Insufficient data to calculate trend | 116032       | 4               | 2021 - 2024      | 2      | -     | -             | -         | -    |

At two program locations, monthly average turbidity decreased by 0.19 NTU per year at one site and by 0.46 NTU per year at the other. No detectable change in monthly average turbidity was observed at one location. There was insufficient data to fit a model for three locations.

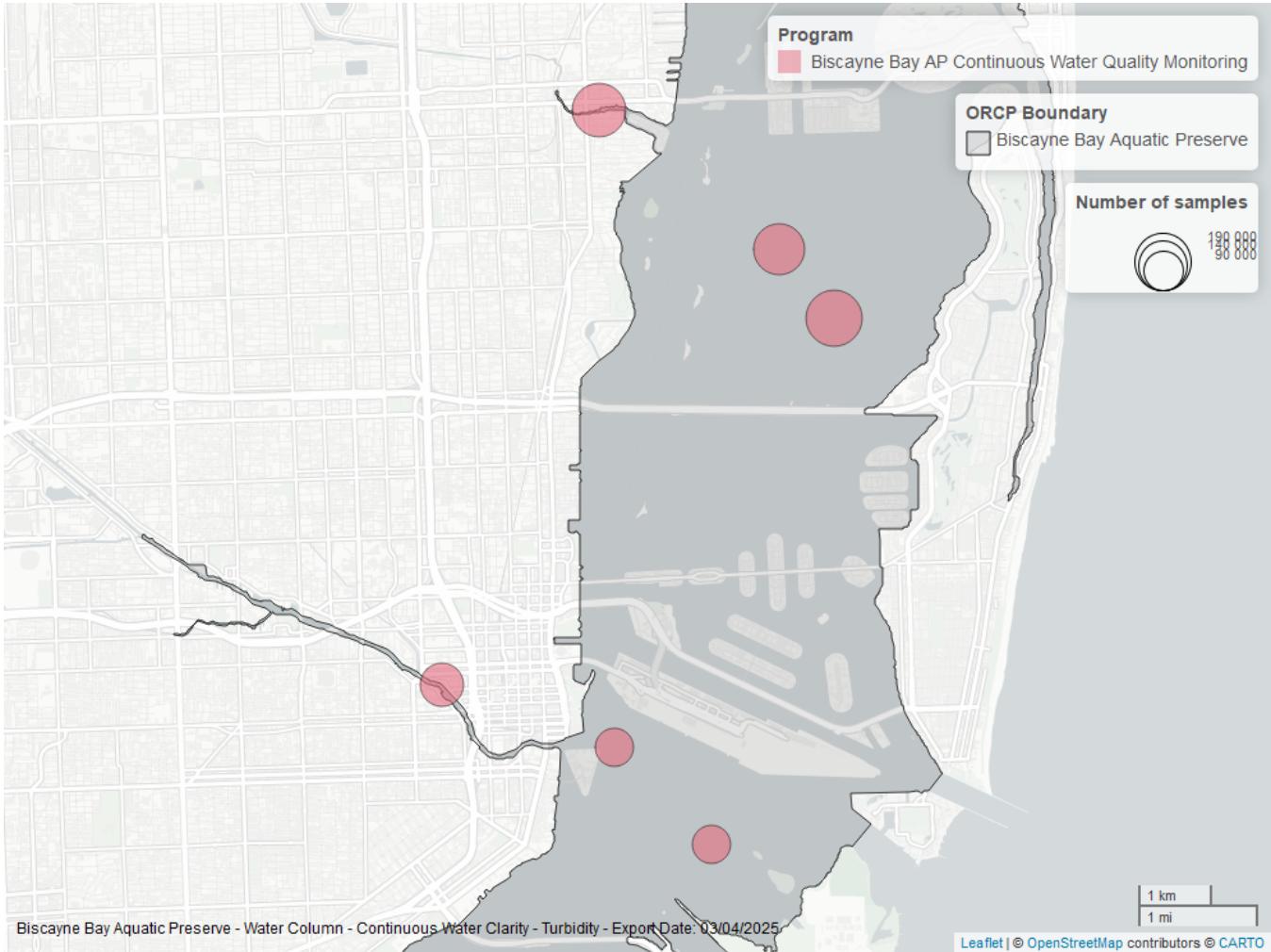


Figure 35: Map showing location of turbidity continuous water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Water Temperature - Continuous

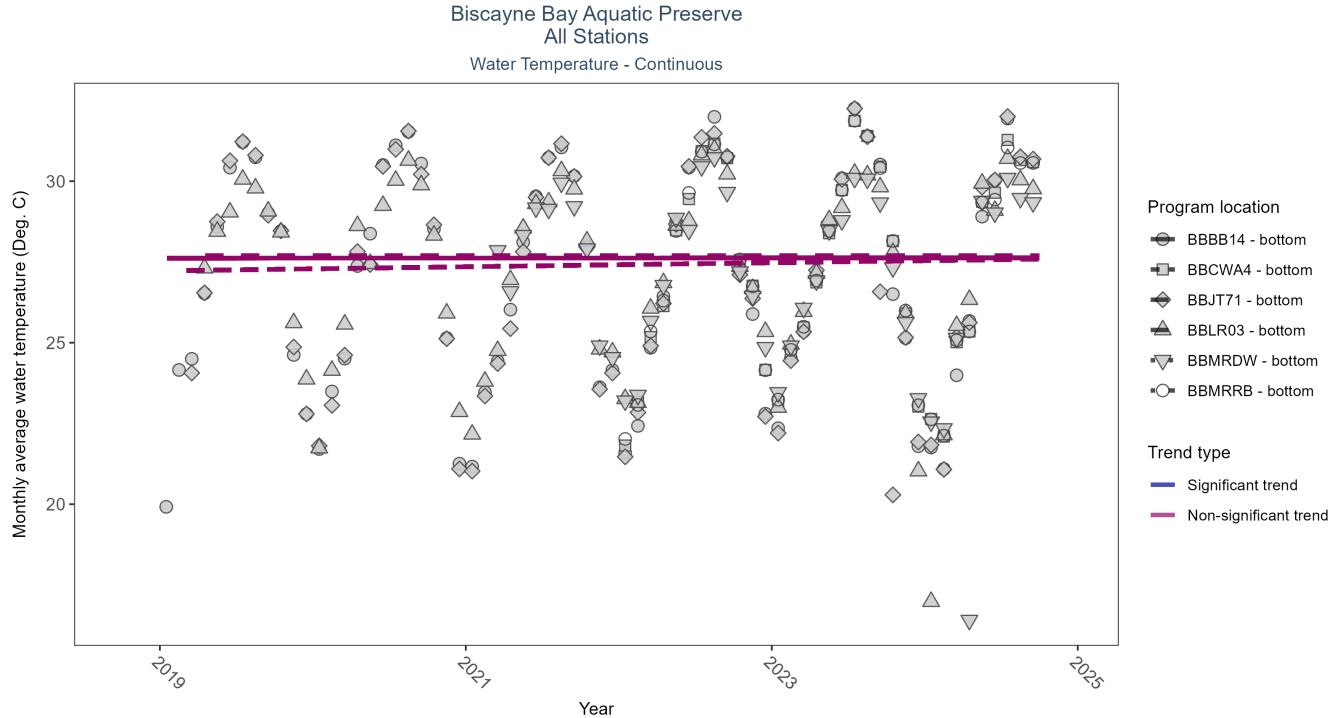


Figure 36: Scatter plot of monthly average water temperature over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 36: Seasonal Kendall-Tau Results for Water Temperature - All Stations

| Station | Statistical Trend                    | Sample Count | Years with Data | Period of Record | Median | tau   | Sen Intercept | Sen Slope | p    |
|---------|--------------------------------------|--------------|-----------------|------------------|--------|-------|---------------|-----------|------|
| BBBB14  | No significant trend                 | 174424       | 6               | 2019 - 2024      | 27.3   | 0.01  | 27.62         | 0         | 0.95 |
| BBCWA4  | Insufficient data to calculate trend | 93693        | 3               | 2022 - 2024      | 27.3   | -     | -             | -         | -    |
| BBJT71  | No significant trend                 | 193964       | 6               | 2019 - 2024      | 27.5   | 0.05  | 27.22         | 0.06      | 0.63 |
| BBLR03  | No significant trend                 | 174275       | 6               | 2019 - 2024      | 27.9   | -0.02 | 27.69         | 0         | 1    |
| BBMRRB  | Insufficient data to calculate trend | 93407        | 3               | 2022 - 2024      | 27.4   | -     | -             | -         | -    |
| BBMRDW  | Insufficient data to calculate trend | 116327       | 4               | 2021 - 2024      | 27.9   | -     | -             | -         | -    |

No detectable change in monthly average water temperature was observed at three locations. There was insufficient data to fit a model for three locations.

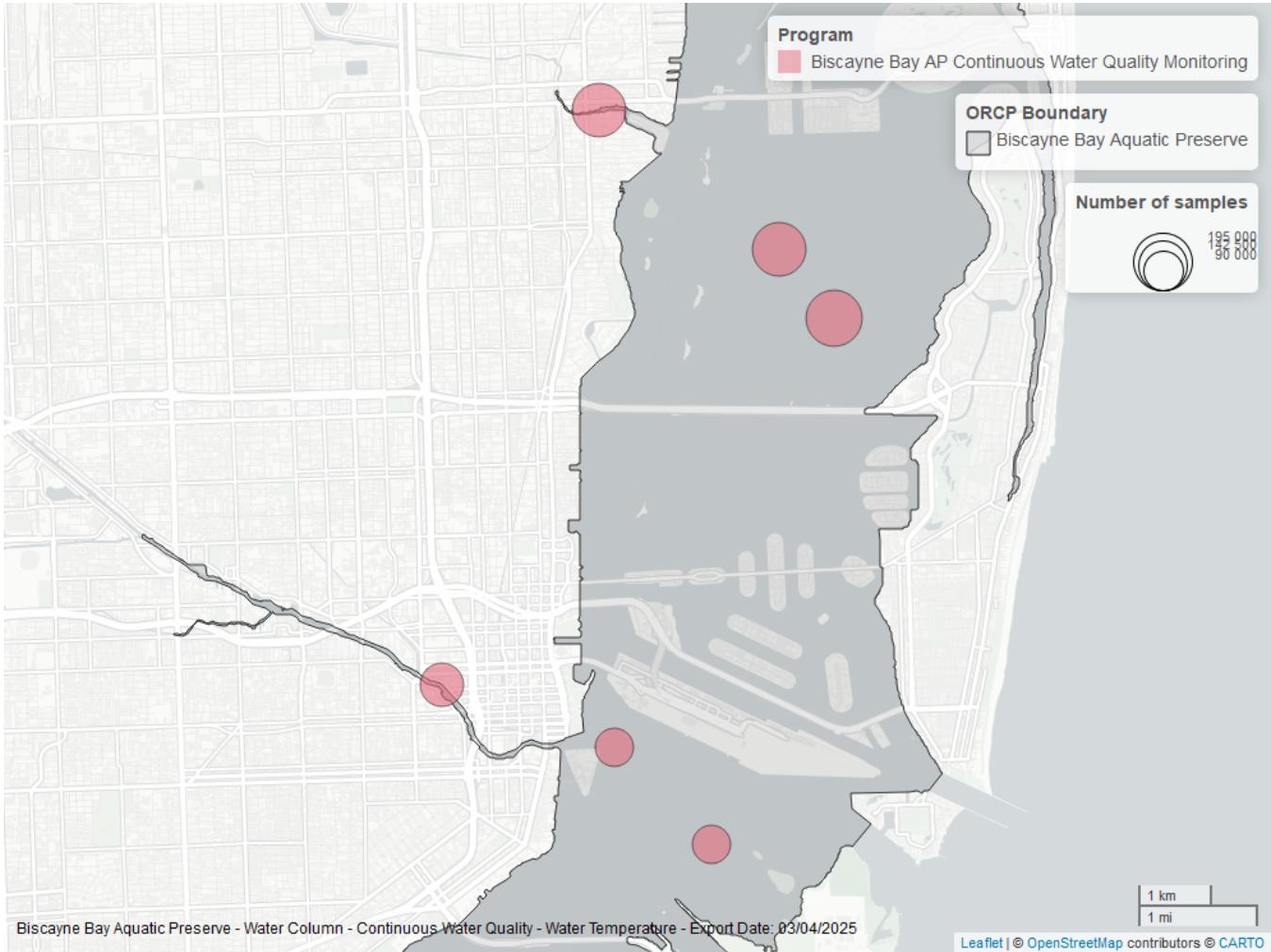


Figure 37: Map showing location of water temperature continuous water quality sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

# Submerged Aquatic Vegetation

The data file used is: All\_SAV\_Parameters-2025-Mar-06.txt

**Submerged aquatic vegetation (SAV)** refers to plants and plant-like macroalgae species that live entirely underwater. The two primary categories of SAV inhabiting Florida estuaries are *benthic macroalgae* and *seagrasses*. They often grow together in dense beds or meadows that carpet the seafloor. *Macroalgae* include multicellular species of green, red and brown algae that often live attached to the substrate by a holdfast. They tend to grow quickly and can tolerate relatively high nutrient levels, making them a threat to seagrasses and other benthic habitats in areas with poor water quality. In contrast, *seagrasses* are grass-like, vascular, flowering plants that are attached to the seafloor by extensive root systems. *Seagrasses* occur throughout the coastal areas of Florida, including protected bays and lagoons as well as deeper offshore waters on the continental shelf. *Seagrasses* have taken advantage of the broad, shallow shelf and clear water to produce two of the most extensive seagrass beds anywhere in continental North America.

## Parameters

**Percent Cover** measures the fraction of an area of seafloor that is covered by SAV, usually estimated by evaluating multiple small areas of seafloor. Percent cover is often estimated for total SAV, individual types of vegetation (seagrass, attached algae, drift algae) and individual species.

**Frequency of Occurrence** was calculated as the number of times a taxon was observed in a year divided by the number of sampling events, multiplied by 100. Analysis is conducted at the quadrat level and is inclusive of all quadrats (i.e., quadrats evaluated using Braun-Blanquet, modified Braun-Blanquet, and percent cover.)

## Species

**Turtle grass** (*Thalassia testudinum*) is the largest of the Florida seagrasses, with longer, thicker blades and deeper root structures than any of the other seagrasses. It is considered a climax seagrass species.

**Shoal grass** (*Halodule wrightii*) is an early colonizer of vegetated areas and usually grows in water too shallow for other species except *widgeon grass*. It can often tolerate larger salinity ranges than other seagrass species. *Shoal grass* is characterized by thin, flat blades, that are narrower than *turtle grass* blades.

**Manatee grass** (*Syringodium filiforme*) is easily recognizable because its leaves are thin and cylindrical instead of the flat, ribbon-like form shared by many other seagrass species. The leaves can grow up to half a meter in length. *Manatee grass* is usually found in mixed seagrass beds or small, dense monospecific patches.

**Widgeon grass** (*Ruppia maritima*) grows in both fresh and salt water and is widely distributed throughout Florida's estuaries in less saline areas, particularly in inlets along the east coast. This species resembles *shoal grass* in certain environments but can be identified by the pointed tips of its leaves.

Three species of *Halophila spp.* are found in Florida - **Star grass** (*Halophila engelmannii*), **Paddle grass** (*Halophila decipiens*), and **Johnson's seagrass** (*Halophila johnsonii*). These are smaller, more fragile seagrasses than other Florida species and are considered ephemeral. They grow along a single long rhizome, with short blades. These species are not well-studied, although surveys are underway to define their ecological roles.

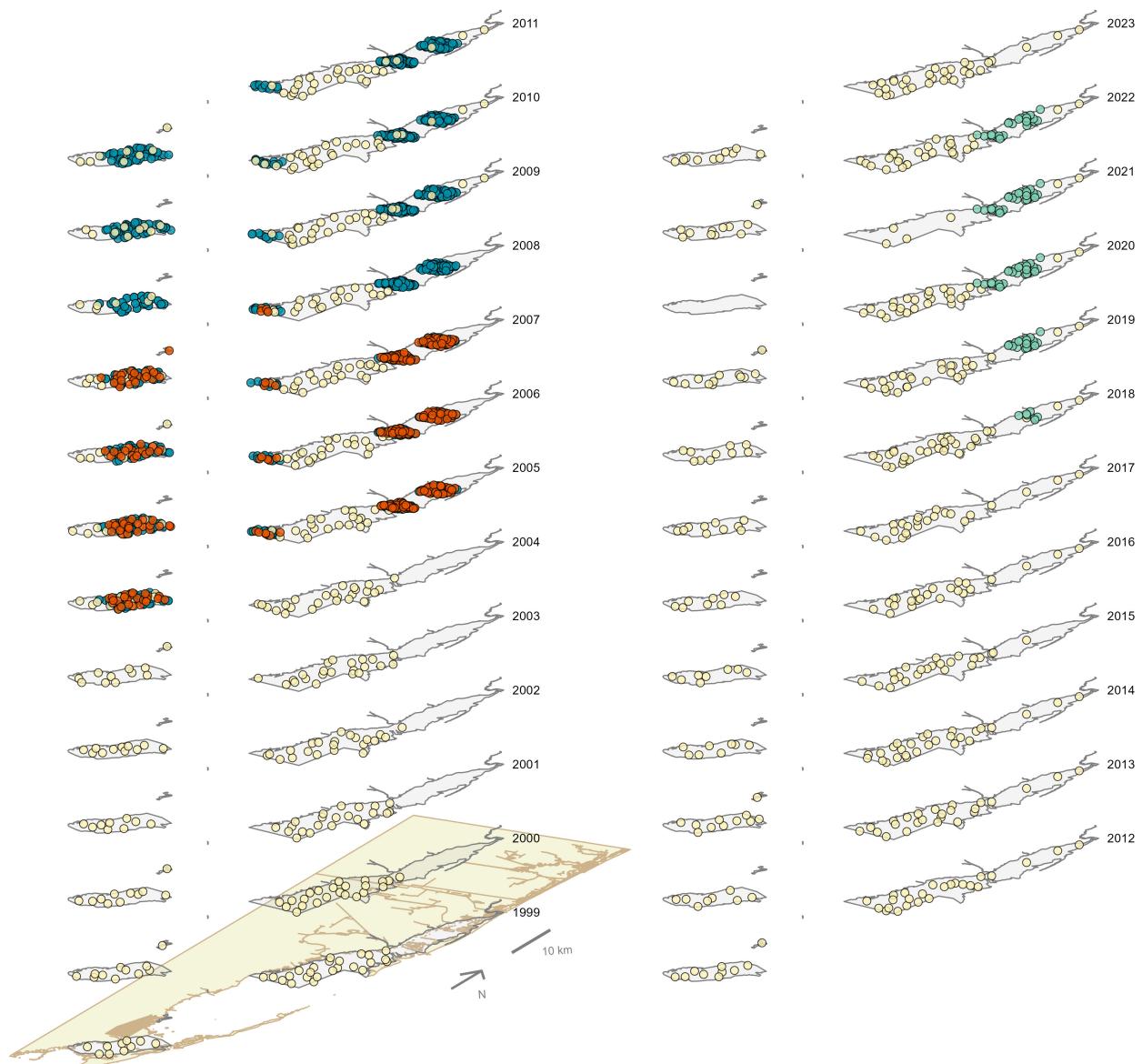
## Notes

*Star grass*, *Paddle grass*, and *Johnson's seagrass* will be grouped together and listed as **Halophila spp.** in the following managed areas. This is because several surveys did not specify to the species level:

- Banana River Aquatic Preserve
- Indian River-Malabar to Vero Beach Aquatic Preserve
- Indian River-Vero Beach to Ft. Pierce Aquatic Preserve
- Jensen Beach to Jupiter Inlet Aquatic Preserve
- Loxahatchee River-Lake Worth Creek Aquatic Preserve
- Mosquito Lagoon Aquatic Preserve

- Biscayne Bay Aquatic Preserve
- Florida Keys National Marine Sanctuary

Biscayne Bay Aquatic Preserve  
SAV Percent Cover - Sample Locations



Program name

- Miami-Dade County DERM Benthic Habitat Monitoring Program
- South Florida Seagrass Fish and Invertebrate Assessment Network
- The South Florida Fisheries Habitat Assessment Program (FHAP)
- North Biscayne Bay Seagrass Loss Monitoring Program

Figure 38: Maps showing the temporal scope of SAV sampling sites within the boundaries of *Biscayne Bay Aquatic Preserve* by Program name.

Click [here](#) to view spatio-temporal plots on GitHub.

### Sampling locations by Program:

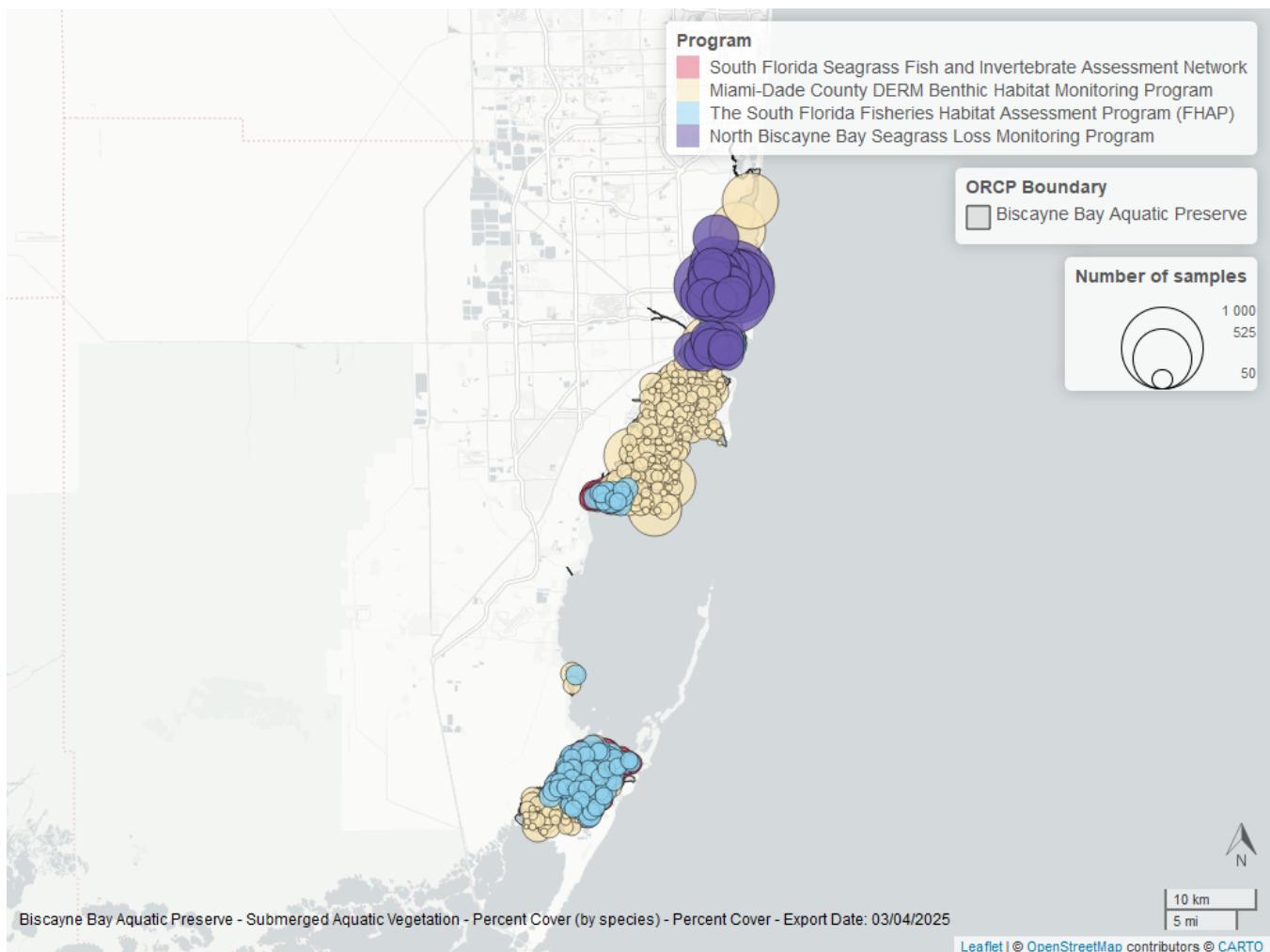


Figure 39: Map showing SAV sampling sites within the boundaries of *Biscayne Bay Aquatic Preserve*. The point size reflects the number of samples at a given sampling site.

Table 37: Program Information for Submerged Aquatic Vegetation

| <i>ProgramID</i> | <i>N-Data</i> | <i>YearMin</i> | <i>YearMax</i> | <i>method</i>  | <i>Sample Locations</i> |
|------------------|---------------|----------------|----------------|----------------|-------------------------|
| 965              | 71071         | 2005           | 2011           | Braun Blanquet | 94                      |
| 4018             | 17330         | 1999           | 2023           | Braun Blanquet | 365                     |
| 4049             | 18891         | 2005           | 2008           | Braun Blanquet | 273                     |
| 5027             | 5414          | 2018           | 2022           | Braun Blanquet | 31                      |
| 4018             | 966           | 1999           | 2007           | Percent Cover  | 232                     |
| 5027             | 5457          | 2018           | 2022           | Percent Cover  | 31                      |

### Program names:

965 - South Florida Seagrass Fish and Invertebrate Assessment Network<sup>14</sup>

4018 - Miami-Dade County DERM Benthic Habitat Monitoring Program<sup>16</sup>

4018 - Miami-Dade County DERM Benthic Habitat Monitoring Program<sup>16</sup>

4049 - The South Florida Fisheries Habitat Assessment Program (FHAP)<sup>9</sup>

5027 - North Biscayne Bay Seagrass Loss Monitoring Program<sup>17</sup>

5027 - North Biscayne Bay Seagrass Loss Monitoring Program<sup>17</sup>

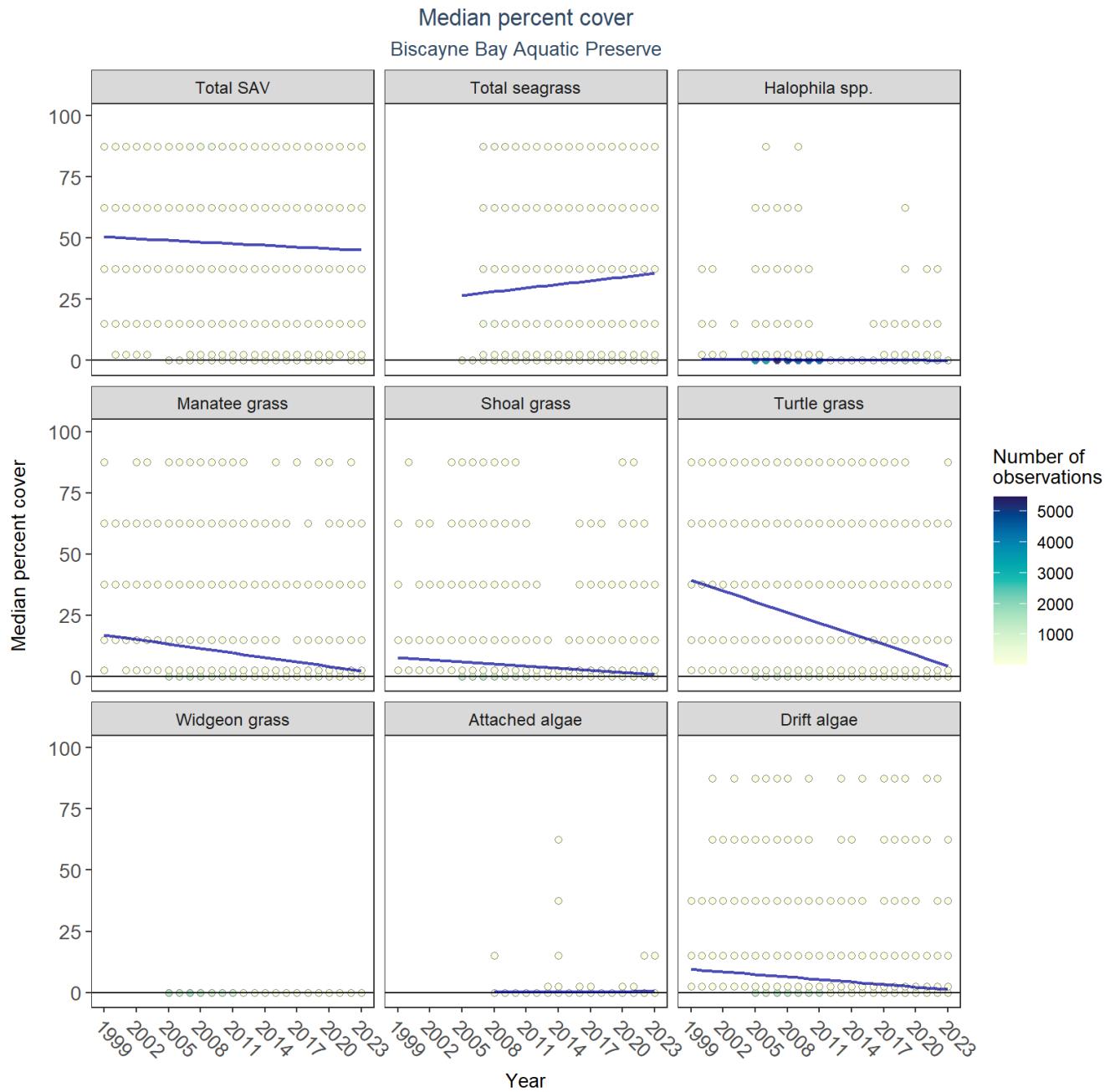


Figure 40: Scatter plots of median percent cover of submerged aquatic vegetation over time by group. Plots for time series that included five or more years of observations show the estimated trend as a blue line.

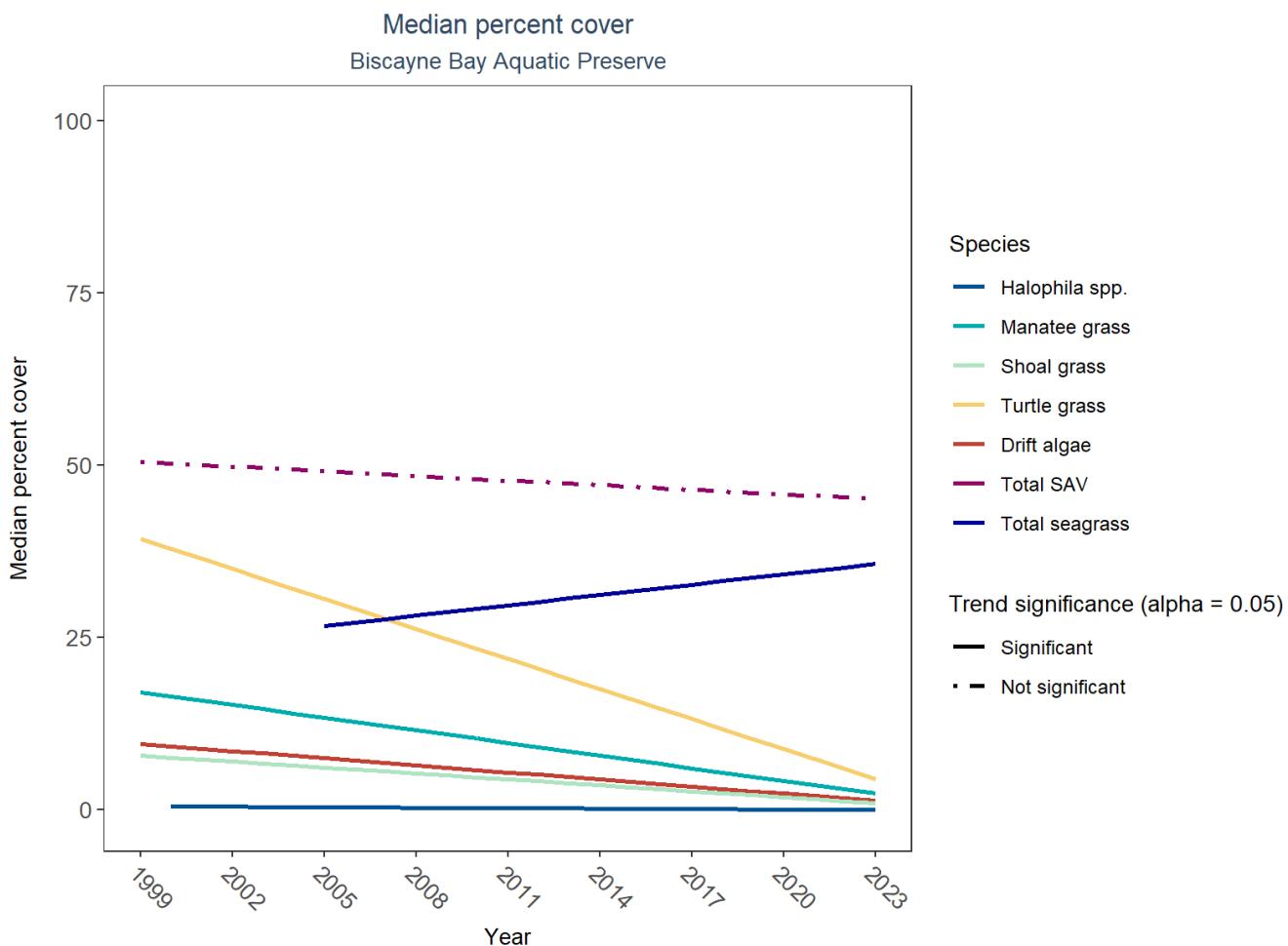


Figure 41: Trends in median percent cover for various seagrass species in Biscayne Bay Aquatic Preserve - simplified

Table 38: Percent Cover Trend Analysis for Biscayne Bay Aquatic Preserve

| CommonName     | Trend Significance (0.05)            | Period of Record | LME-Intercept | LME-Slope  | p         |
|----------------|--------------------------------------|------------------|---------------|------------|-----------|
| Attached algae | Significantly increasing trend       | 2008 - 2023      | -0.2513798    | 0.0221077  | 0.0410380 |
| Drift algae    | Significantly decreasing trend       | 1999 - 2023      | 11.2382127    | -0.3433916 | 0.0000002 |
| Shoal grass    | Significantly decreasing trend       | 1999 - 2023      | 9.2639104     | -0.2869642 | 0.0000005 |
| Halophila spp. | Significantly decreasing trend       | 2000 - 2023      | 0.5904439     | -0.0219982 | 0.0249535 |
| Widgeon grass  | Model did not fit the available data | 2005 - 2023      | -             | -          | -         |
| Manatee grass  | Significantly decreasing trend       | 1999 - 2023      | 20.0834242    | -0.6125839 | 0.0000000 |
| Turtle grass   | Significantly decreasing trend       | 1999 - 2023      | 46.5547420    | -1.4527012 | 0.0000000 |
| Total SAV      | No significant trend                 | 1999 - 2023      | 51.5763088    | -0.2246881 | 0.2445087 |
| Total seagrass | Significantly increasing trend       | 2005 - 2023      | 21.1534670    | 0.4993131  | 0.0107796 |

Annual increases in percent cover were observed for total seagrass (0.5%) and attached algae (0.0%). Annual decreases in percent cover were observed for *Halophila* spp. (-0.0%), manatee grass (-0.6%), shoal grass (-0.3%), turtle grass (-1.4%), and drift algae (-0.3%). No detectable change in percent cover was observed for total SAV. The model could not be fitted for widgeon grass.

Frequency of occurrence  
Biscayne Bay Aquatic Preserve

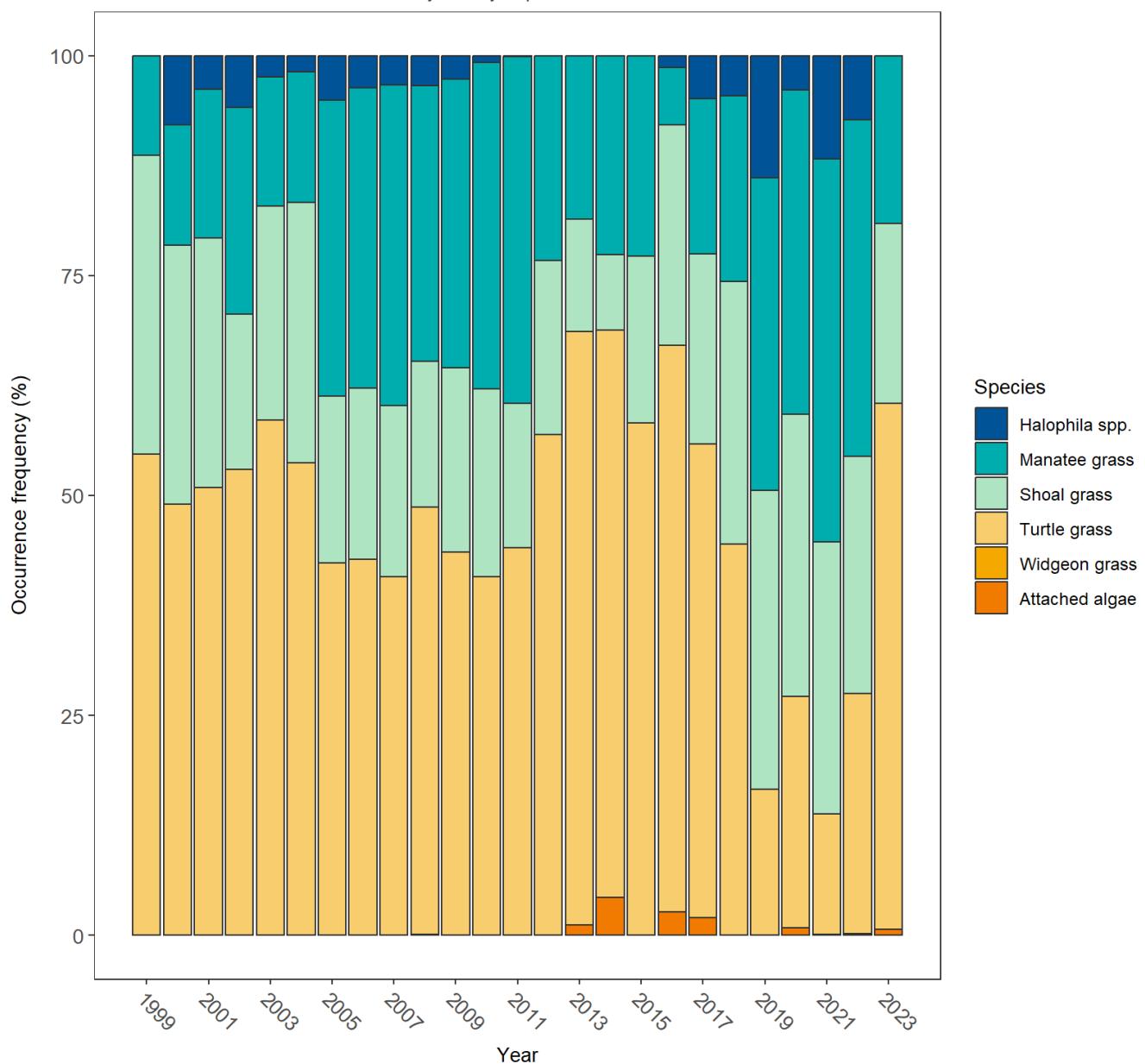


Figure 42: Frequency of occurrence for various seagrass species in Biscayne Bay Aquatic Preserve

## Coral Reef

The data file used is: All\_CORAL\_Parameters-2025-Mar-06.txt

### Species Richness

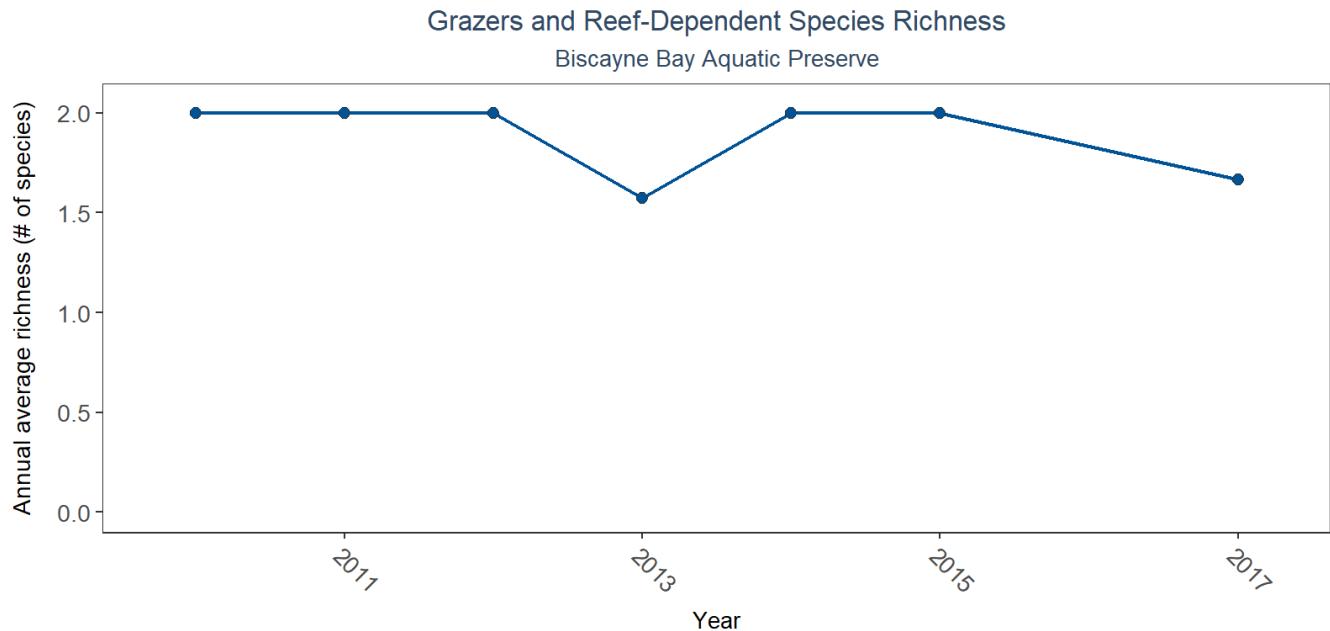


Figure 43: Line graph of annual average species richness of grazers and reef-dependent species over time. If the time series included more than one year of observations, a line connects the data points for visualization.

Table 39: Coral Species Richness

| Sample Count | Number of Years | Period of Record | Median N of Taxa | Mean N of Taxa |
|--------------|-----------------|------------------|------------------|----------------|
| 23           | 7               | 2010 - 2017      | 2                | 1.82609        |

The median annual number of taxa was 2 based on 23 observations collected between 2010 and 2017.

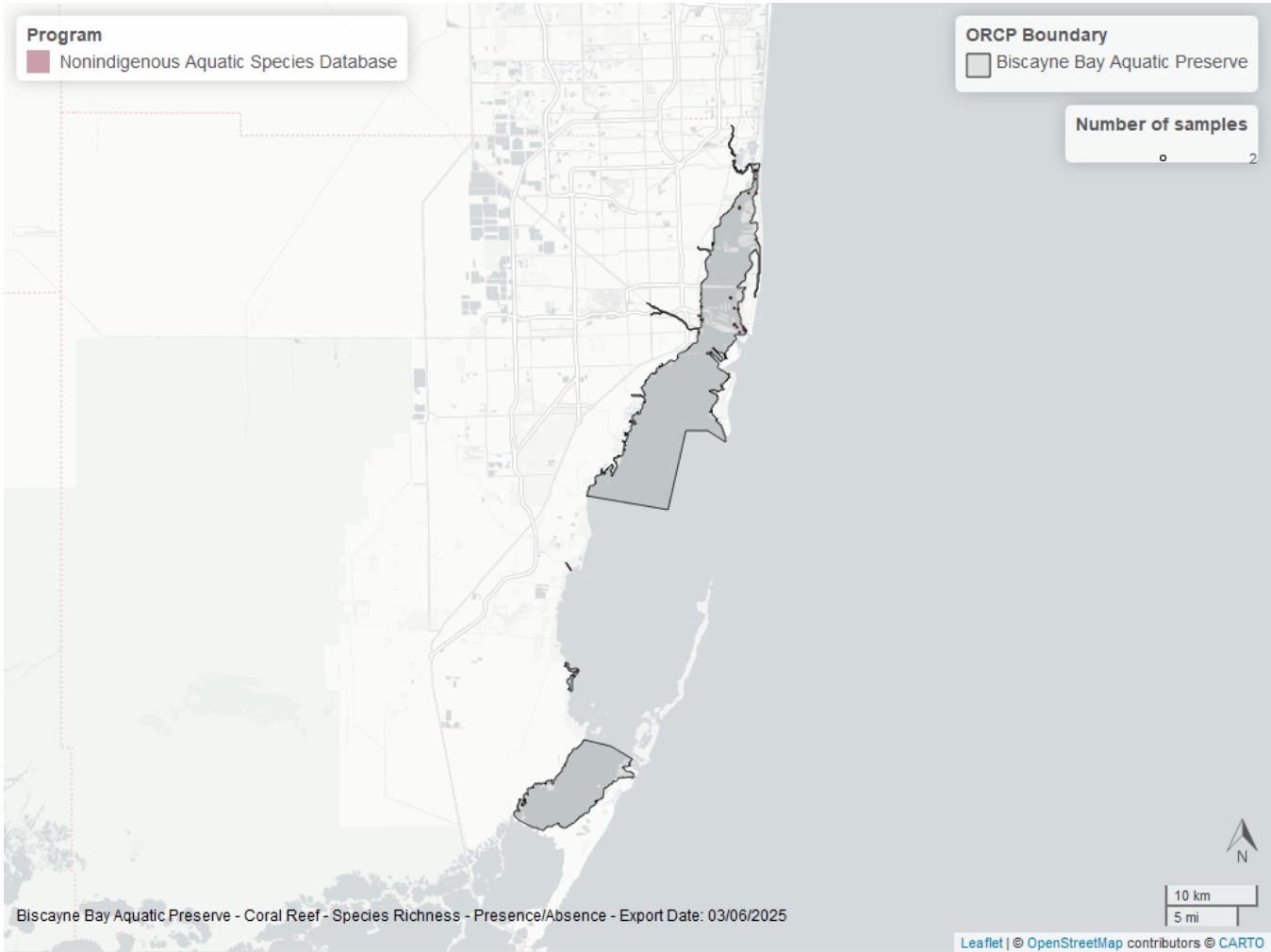


Figure 44: Map showing location of coral species richness sampling locations within the boundaries of *Biscayne Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## References

1. Florida Department of Environmental Protection (DEP). [Florida STORET / WIN](#). (2024).
2. Florida Department of Environmental Protection (DEP); Office of Resilience and Coastal Protection (RCP); Biscayne Bay Aquatic Preserves. [North Biscayne Bay Seagrass Loss Water Quality Program](#). (2024).
3. National Oceanic and Atmospheric Administration (NOAA); Atlantic Oceanographic and Meteorological Laboratory. [Atlantic Oceanographic and Meteorological Laboratory \(AOML\) South Florida Program Synoptic Shipboard Surveys](#). (2024).
4. U.S. Environmental Protection Agency (EPA). [EPA STOrage and RETrieval Data Warehouse \(STORET\)/WQX](#). (2023).
5. U.S. Environmental Protection Agency (EPA); Office of Research and Development. [Environmental Monitoring Assessment Program](#). (2004).
6. U.S. Environmental Protection Agency (EPA); Office of Water; National Oceanic and Atmospheric Administration (NOAA); U.S. Geological Survey (USGS); U.S. Fish and Wildlife Service (USFWS); National Estuary Program (NEP); coastal states. [National Aquatic Resource Surveys, National Coastal Condition Assessment](#). (2021).
7. Florida International University (FIU); Southeastern Environmental Research Program. [SERC Water Quality Monitoring Network](#). (2008).
8. University of Florida (UF); Institute of Food and Agricultural Sciences. [Florida LAKEWATCH Program](#). (2024).
9. Florida Fish and Wildlife Conservation Commission (FWC); Florida Fish and Wildlife Research Institute (FWRI). [The South Florida Fisheries Habitat Assessment Program \(FHAP\)](#). (2024).
10. University of Florida; Florida Sea Grant; UF/IFAS Extension Miami-Dade County; Miami Waterkeeper . [Biscayne Bay Water Watch](#) . (2019).
11. City of Miami Beach. [City of Miami Beach Water Monitoring](#). (2023).
12. National Oceanic and Atmospheric Administration (NOAA); Center for Coastal Monitoring and Assessment. [National Status and Trends Mussel Watch](#). (2000).
13. Florida Fish and Wildlife Conservation Commission (FWC); Florida Fish and Wildlife Research Institute (FWRI). [Harmful Algal Bloom Marine Observation Network](#). (2018).
14. U.S. Geological Survey (USGS). [South Florida Seagrass Fish and Invertebrate Assessment Network](#). (2011).
15. Florida Department of Environmental Protection (DEP); Office of Resilience and Coastal Protection (RCP); Biscayne Bay Aquatic Preserves. [Biscayne Bay Aquatic Preserves Continuous Water Quality Monitoring](#). (2024).
16. Miami-Dade County Division of Environmental Resources Management (DERM). [Miami-Dade County DERM Benthic Habitat Monitoring Program](#). (2023).
17. Florida Department of Environmental Protection (DEP); Office of Resilience and Coastal Protection (RCP); Biscayne Bay Aquatic Preserves. [North Biscayne Bay Seagrass Loss Monitoring Program](#) . (2022).