Banana River Aquatic Preserve

SEACAR Habitat Analyses

Last compiled on 08 October, 2025

Contents

Funding & Acknowledgements

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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; 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

Qualifier Source	*Value Qualifier*	*Include*	*Description*
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 $p >= 0.05$). 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-Sep-04.txt*
- *Combined_WQ_WC_NUT_Chlorophyll_a_uncorrected_for_pheophytin-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Colored_dissolved_organic_matter_CDOM-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Dissolved_Oxygen-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Dissolved_Oxygen_Saturation-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_pH-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Salinity-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Secchi_Depth-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Total_Nitrogen-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Total_Phosphorus-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Total_Suspended_Solids_TSS-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Turbidity-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Water_Temperature-2025-Sep-04.txt*

Chlorophyll a, Corrected for Pheophytin - Discrete

Seasonal Kendall-Tau Trend Analysis

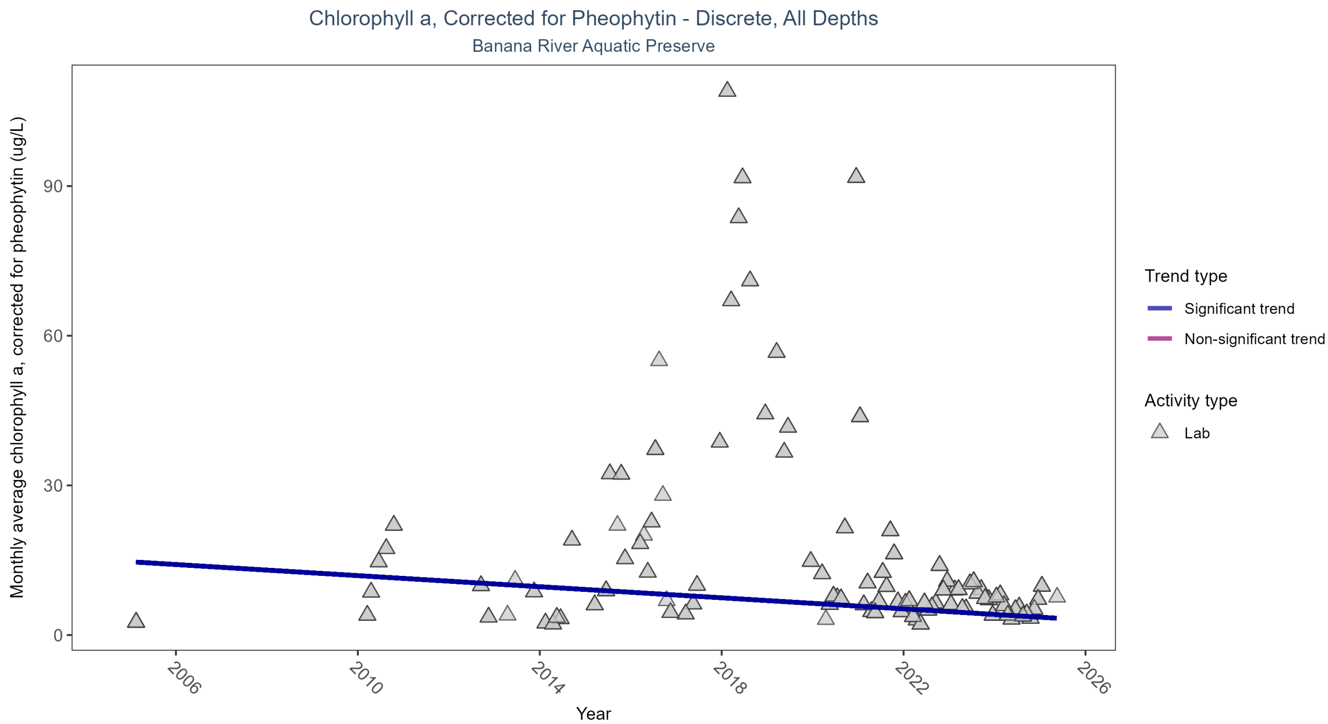

Figure 1: Scatter plot of monthly average levels of chlorophyll a, corrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles) 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	Significantly decreasing trend	552	16	2005 - 2025	6.4347	-0.2372	14.6885	-0.5556	0.0035

Monthly average chlorophyll a, corrected for pheophytin, decreased by 0.56 µg/L per year, indicating an increase in water clarity.

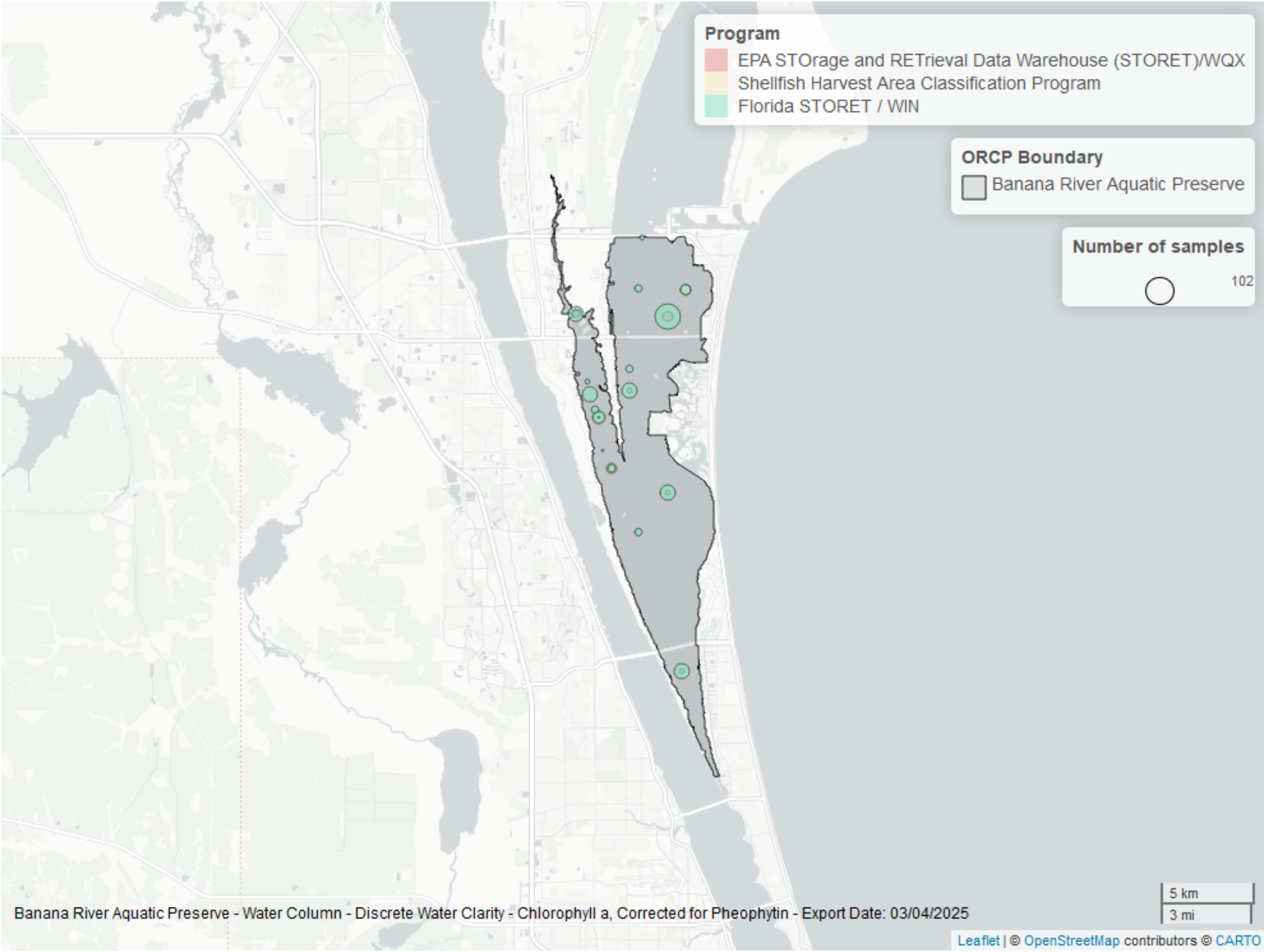

Figure 2: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	530	2005	2025
540	42	2016	2020

Program names:

540 - Shellfish Harvest Area Classification Program[1]
5002 - Florida STORET / WIN[2]

Chlorophyll a, Uncorrected for Pheophytin - Discrete

Seasonal Kendall-Tau Trend Analysis

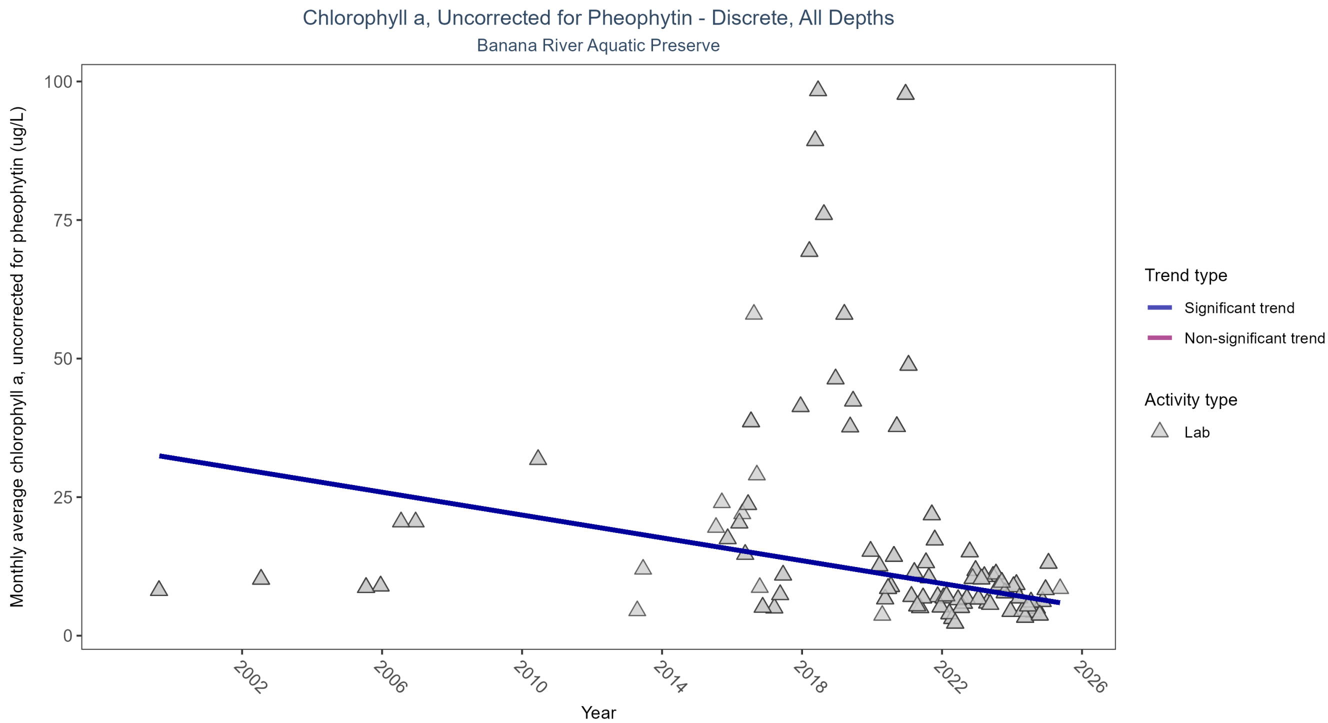

Figure 3: Scatter plot of monthly average levels of chlorophyll a, uncorrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles) 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 decreasing trend	515	17	1999 - 2025	7.5477	-0.3616	33.101	-1.0298	0

Monthly average chlorophyll a, uncorrected for pheophytin, decreased by 1.03 µg/L per year, indicating an increase in water clarity.

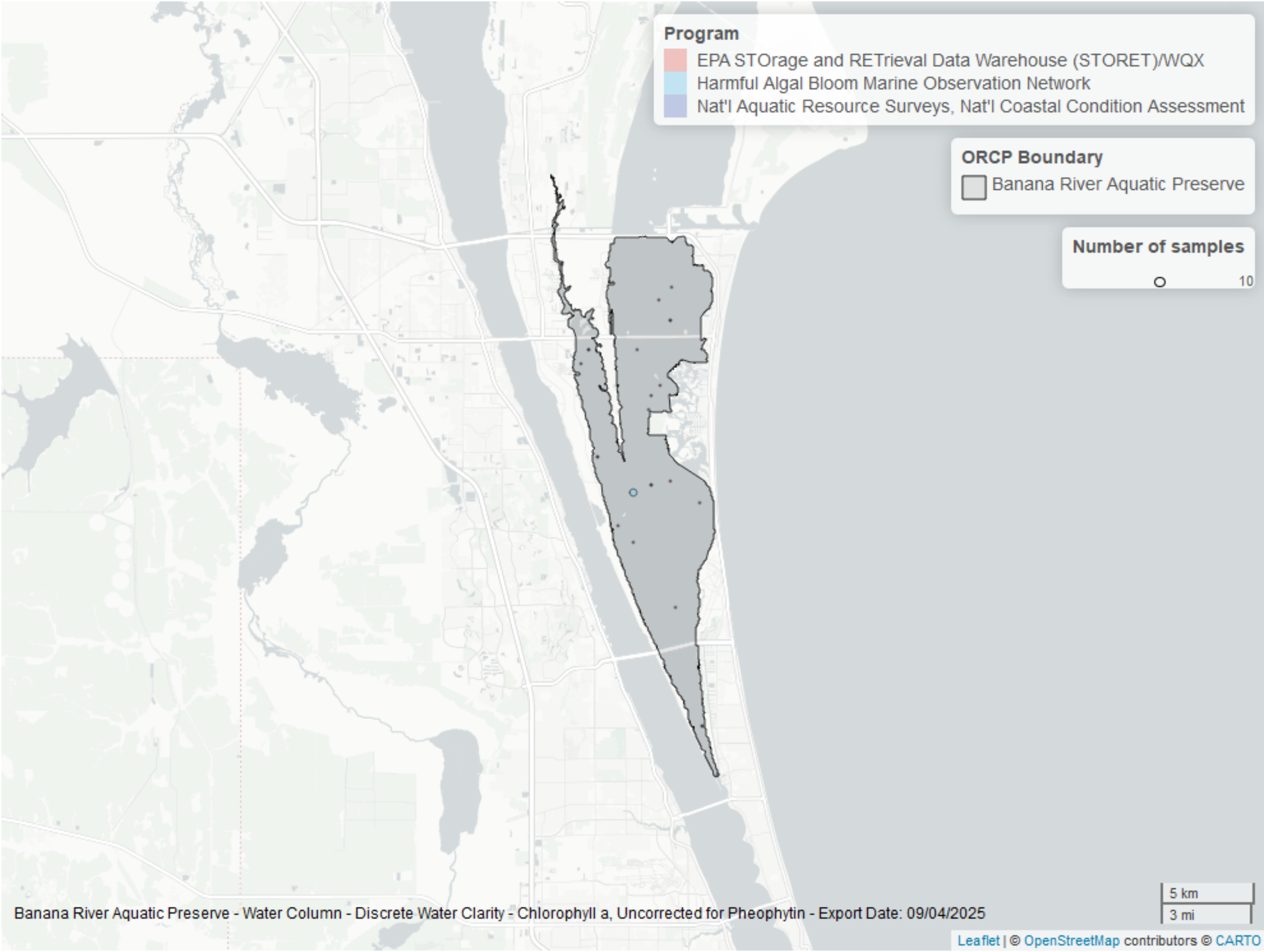

Figure 4: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	454	1999	2025
540	44	2016	2020
95	17	2010	2018
103	13	2002	2015
118	8	2005	2010

Program names:

95 - Harmful Algal Bloom Marine Observation Network[3]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[4]
118 - National Aquatic Resource Surveys, National Coastal Condition Assessment[5]
540 - Shellfish Harvest Area Classification Program[1]
5002 - Florida STORET / WIN[2]

Colored Dissolved Organic Matter - Discrete

Seasonal Kendall-Tau Trend Analysis

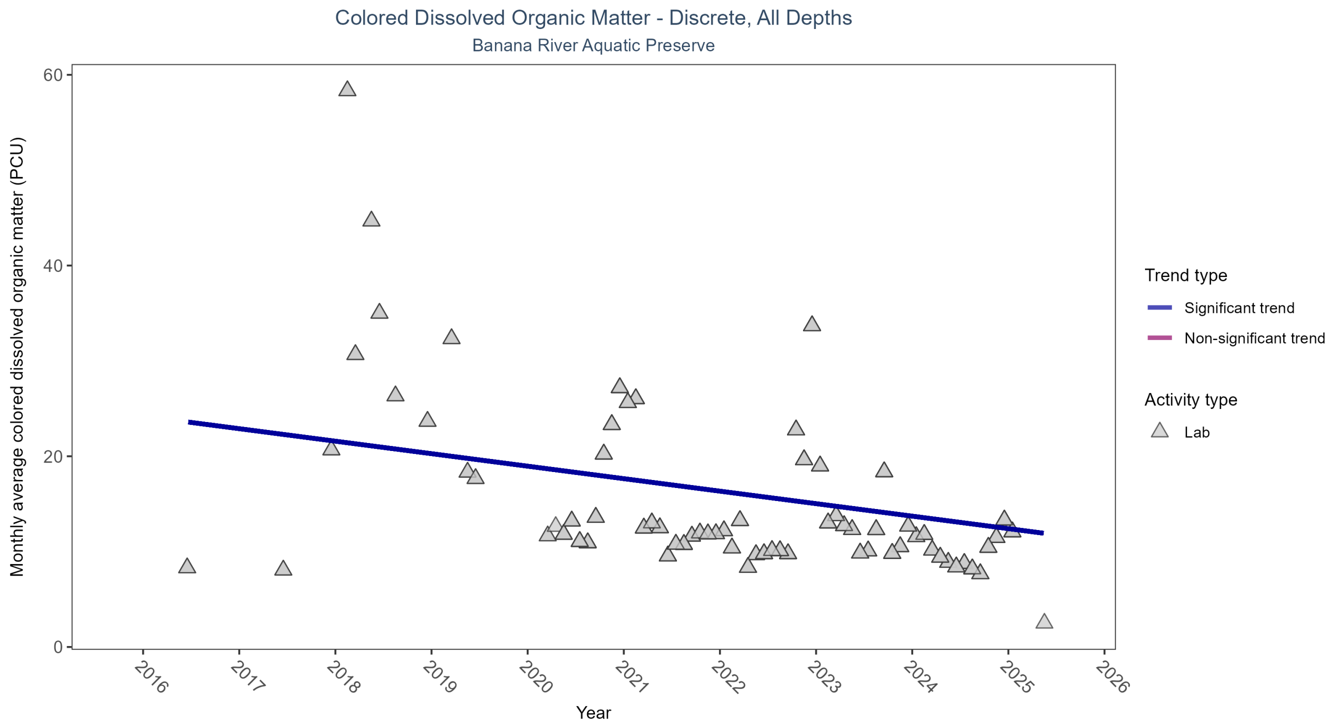

Figure 5: Scatter plot of monthly average colored dissolved organic matter (CDOM) over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed CDOM (triangles) is included in the plot.

Table 10: Seasonal Kendall-Tau Trend Analysis for Colored Dissolved Organic Matter

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Lab	Significantly decreasing trend	452	10	2016 - 2025	11.3605	-0.4452	24.2022	-1.3102	0.0001

Monthly average colored dissolved organic matter decreased by 1.31 PCU per year, indicating an increase in water clarity.

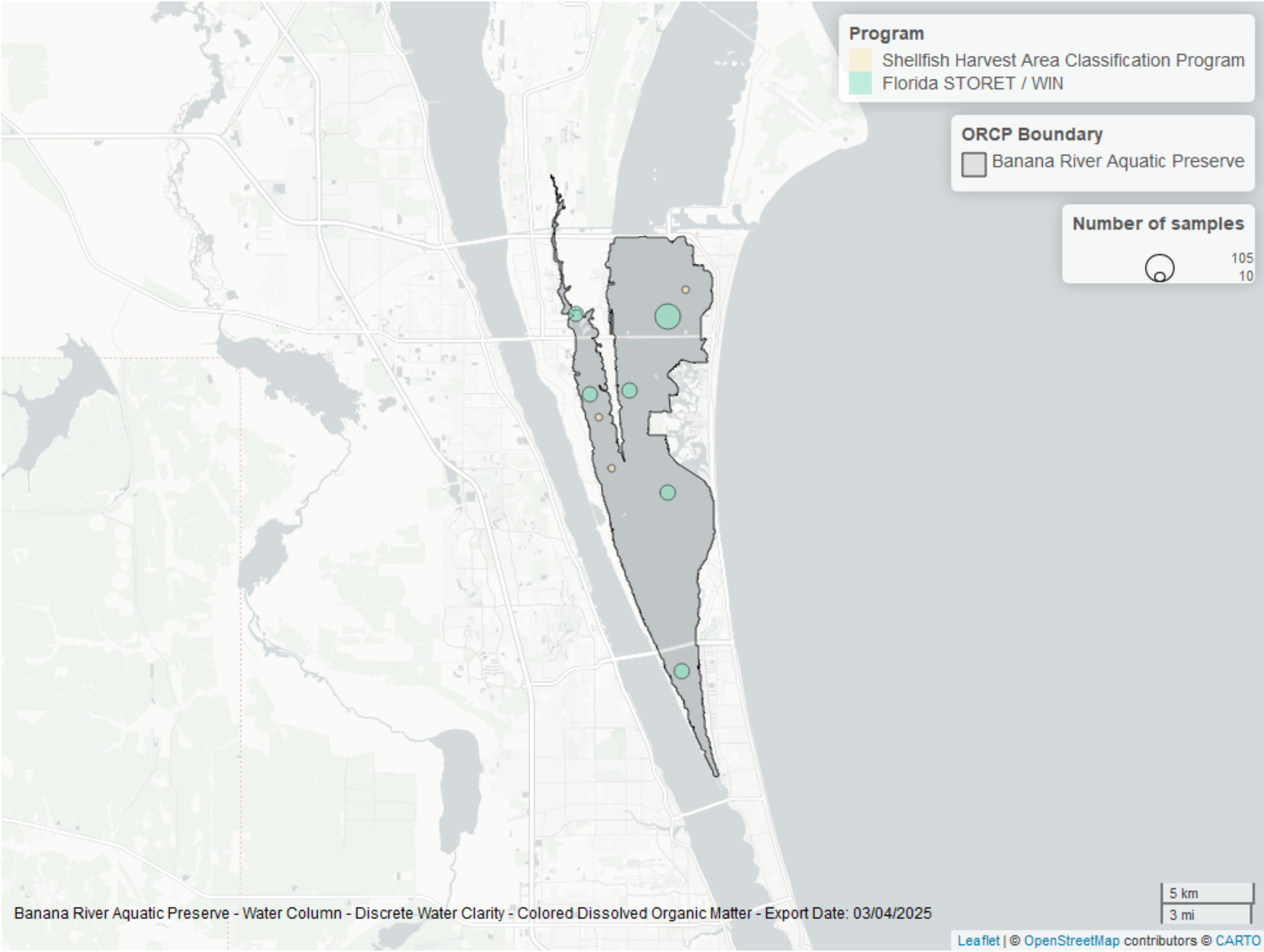

Figure 6: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 11: Programs contributing data for Colored Dissolved Organic Matter

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	419	2020	2025
540	36	2016	2019

Program names:

540 - Shellfish Harvest Area Classification Program[1]
5002 - Florida STORET / WIN[2]

Dissolved Oxygen - Discrete

Seasonal Kendall-Tau Trend Analysis

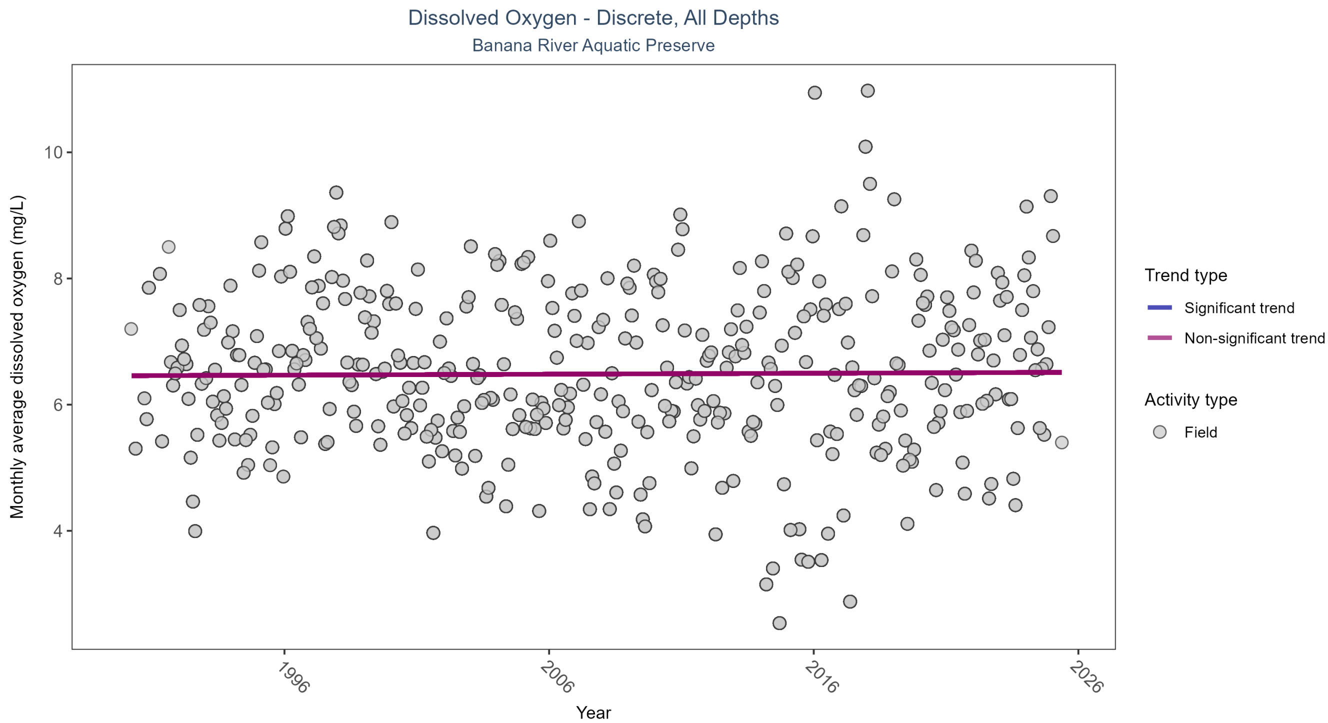

Figure 7: Scatter plot of monthly average dissolved oxygen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen values measured in the field (circles) are included in the plot.

Table 12: 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	No significant trend	30065	36	1990 - 2025	6.5	0.0121	6.459	0.0015	0.7632

Dissolved oxygen showed no detectable trend between 1990 and 2025.

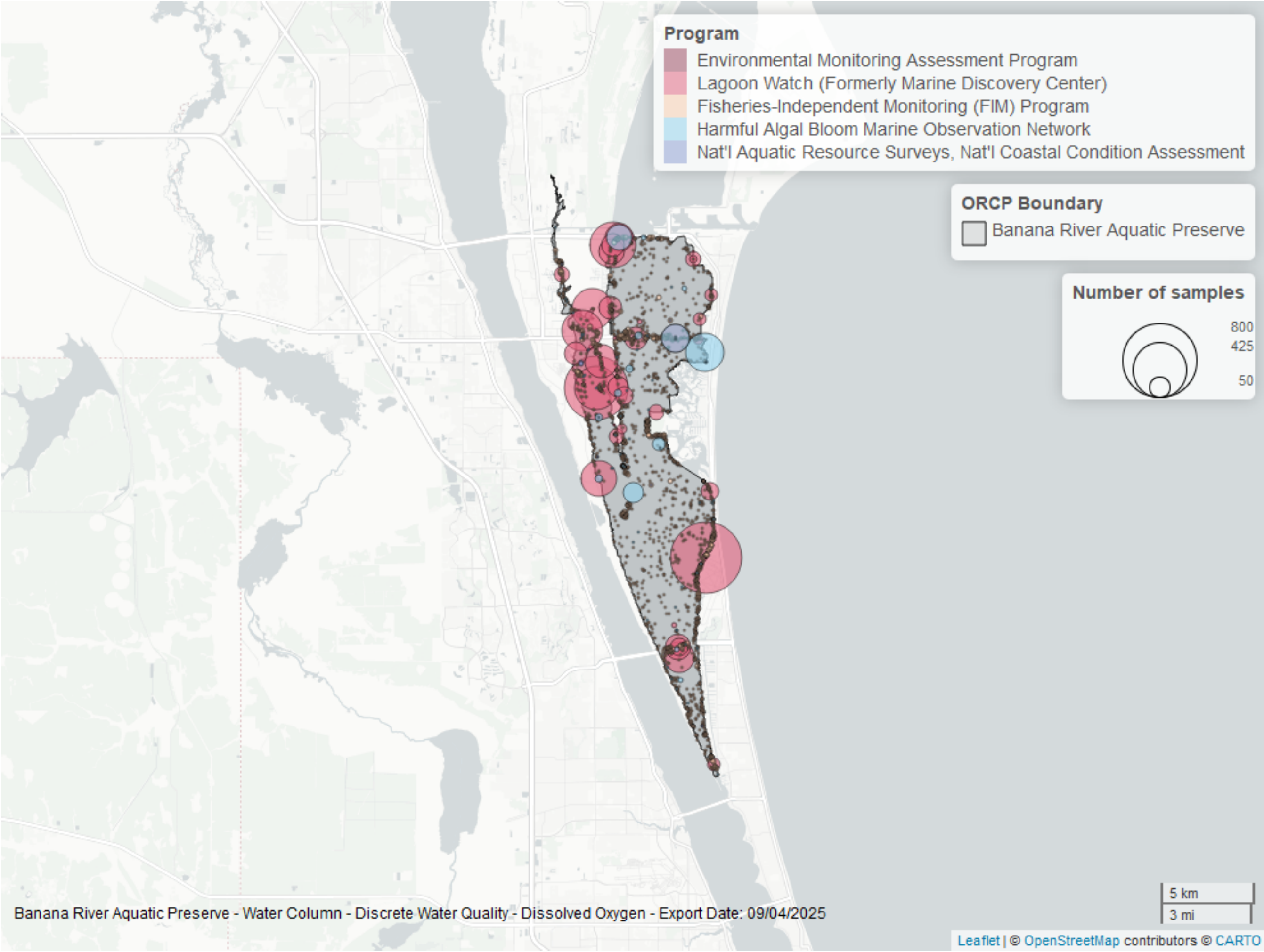

Figure 8: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 13: Programs contributing data for Dissolved Oxygen

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	20390	1991	2025
69	4520	1990	2024
3001	4249	1991	2023
95	668	2006	2018
3013	338	2003	2024
540	42	2016	2020
118	17	2005	2020
115	8	1995	1995
103	5	2015	2015

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program[6]
95 - Harmful Algal Bloom Marine Observation Network[3]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[4]
115 - Environmental Monitoring Assessment Program[7]

118 - National Aquatic Resource Surveys, National Coastal Condition Assessment[5]
540 - Shellfish Harvest Area Classification Program[1]
3001 - Lagoon Watch (Formerly Marine Discovery Center)[8]
3013 - Seagrass (SJRWMD)[9]
5002 - Florida STORET / WIN[2]

Dissolved Oxygen Saturation - Discrete

Seasonal Kendall-Tau Trend Analysis

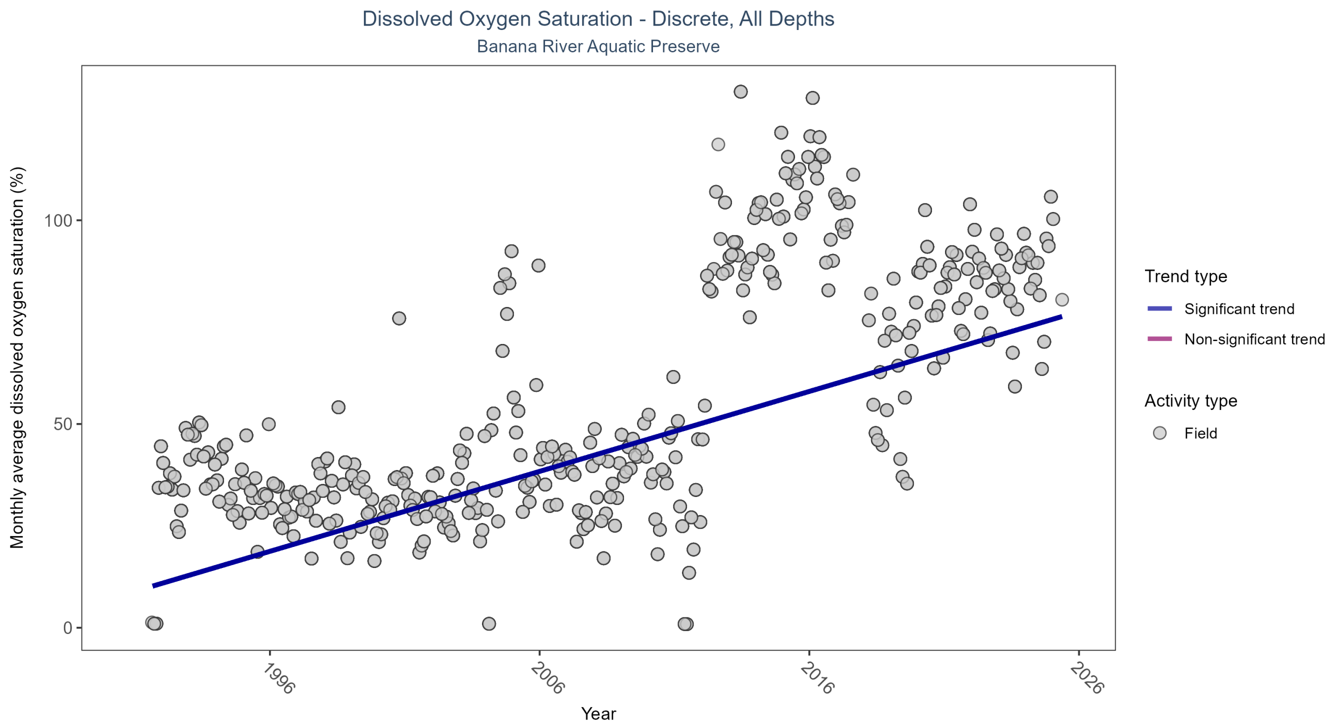

Figure 9: Scatter plot of monthly average dissolved oxygen saturation over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen saturation values measured in the field (circles)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

Table 14: 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	7653	35	1991 - 2025	60	0.461	8.9431	1.9622	0

Monthly average dissolved oxygen saturation increased by 1.96% per year.

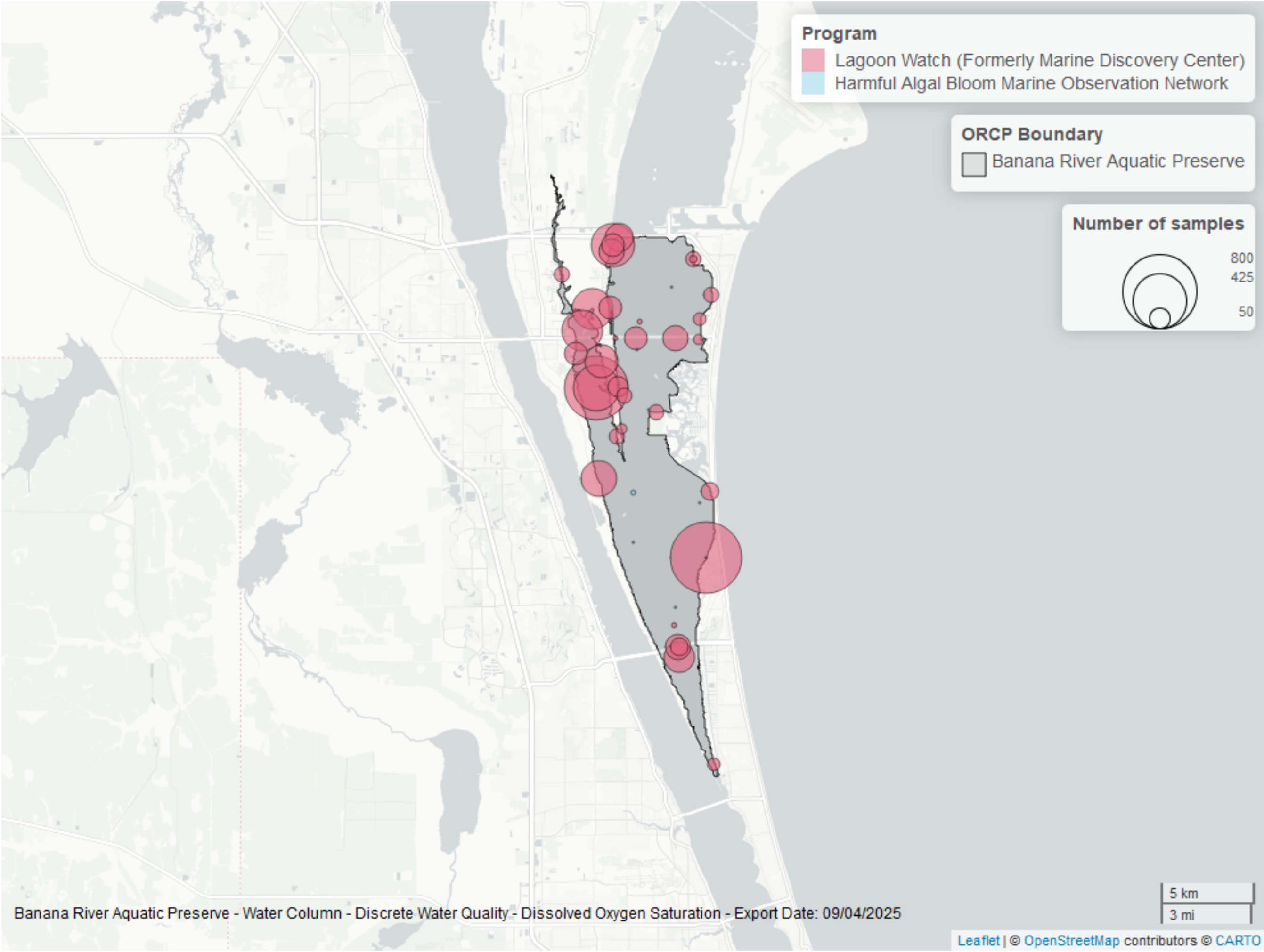

Figure 10: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 15: Programs contributing data for Dissolved Oxygen Saturation

ProgramID	*N_Data*	*YearMin*	*YearMax*
3001	4238	1991	2024
5002	3254	1991	2025
3013	172	2012	2024
95	11	2014	2018

Program names:

95 - Harmful Algal Bloom Marine Observation Network[3]
3001 - Lagoon Watch (Formerly Marine Discovery Center)[8]
3013 - Seagrass (SJRWMD)[9]
5002 - Florida STORET / WIN[2]

pH - Discrete

Seasonal Kendall-Tau Trend Analysis

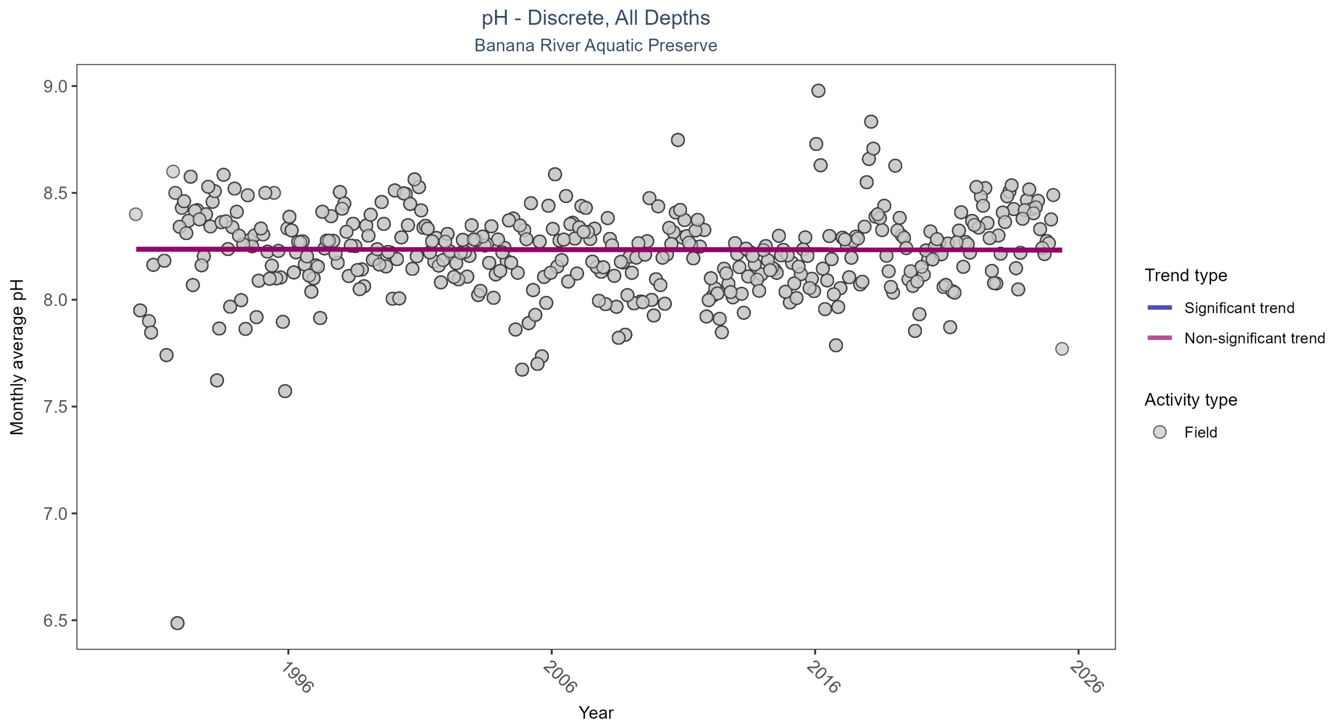

Figure 11: Scatter plot of monthly average pH over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only pH values measured in the field (circles) are included in the plot.

Table 16: 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	No significant trend	23010	36	1990 - 2025	8.2	-0.0059	8.2364	-0.0001	0.9088

pH showed no detectable trend between 1990 and 2025.

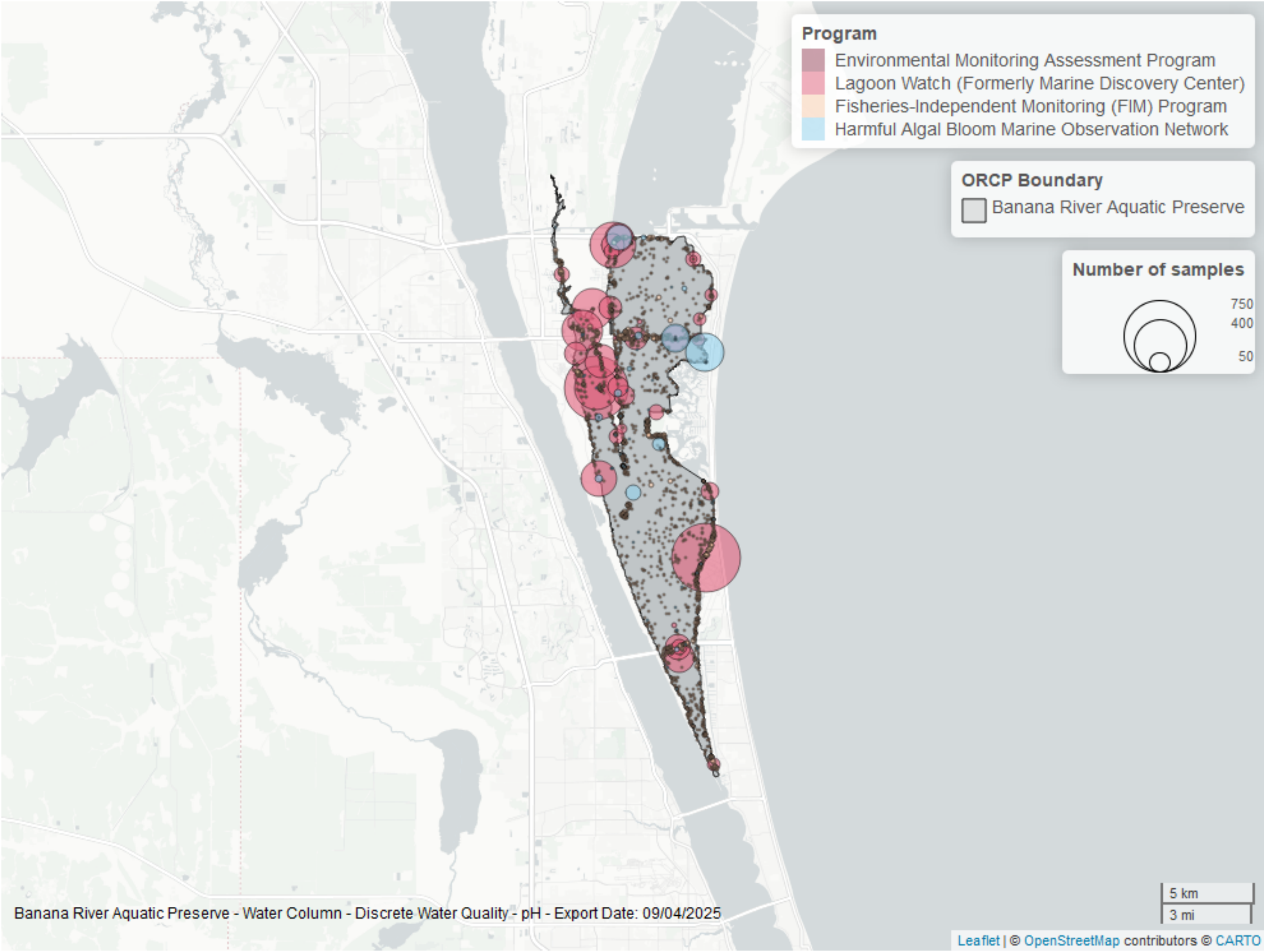

Figure 12: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 17: Programs contributing data for pH

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	13882	1996	2025
69	4484	1990	2024
3001	4169	1991	2024
95	624	2006	2018
3013	337	2003	2024
540	42	2016	2020
115	7	1995	1995
103	2	2015	2015

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program[6]
95 - Harmful Algal Bloom Marine Observation Network[3]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[4]
115 - Environmental Monitoring Assessment Program[7]
540 - Shellfish Harvest Area Classification Program[1]

3001 - Lagoon Watch (Formerly Marine Discovery Center)[8]
3013 - Seagrass (SJRWMD)[9]
5002 - Florida STORET / WIN[2]

Salinity - Discrete

Seasonal Kendall-Tau Trend Analysis

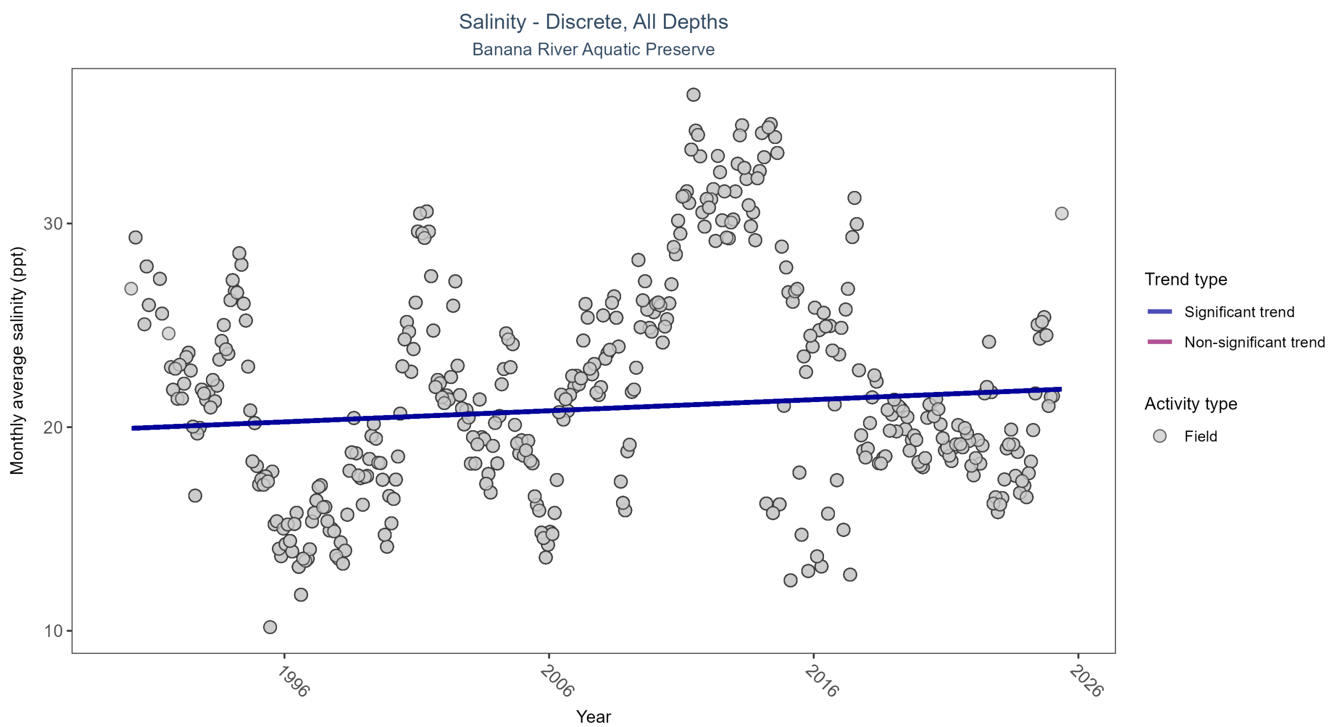

Figure 13: Scatter plot of monthly average salinity over time. If the time series included ten or more years of discrete observations, significant (blue) or non-significant (magenta) trend lines are also shown. Discrete salinity values derived from grab samples analyzed in the field (circles) or the laboratory (triangles) are both included in the plot.

Table 18: 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 increasing trend	31759	36	1990 - 2025	19.8	0.076	19.931	0.0546	0.0295

Monthly average salinity increased by 0.05 ppt per year.

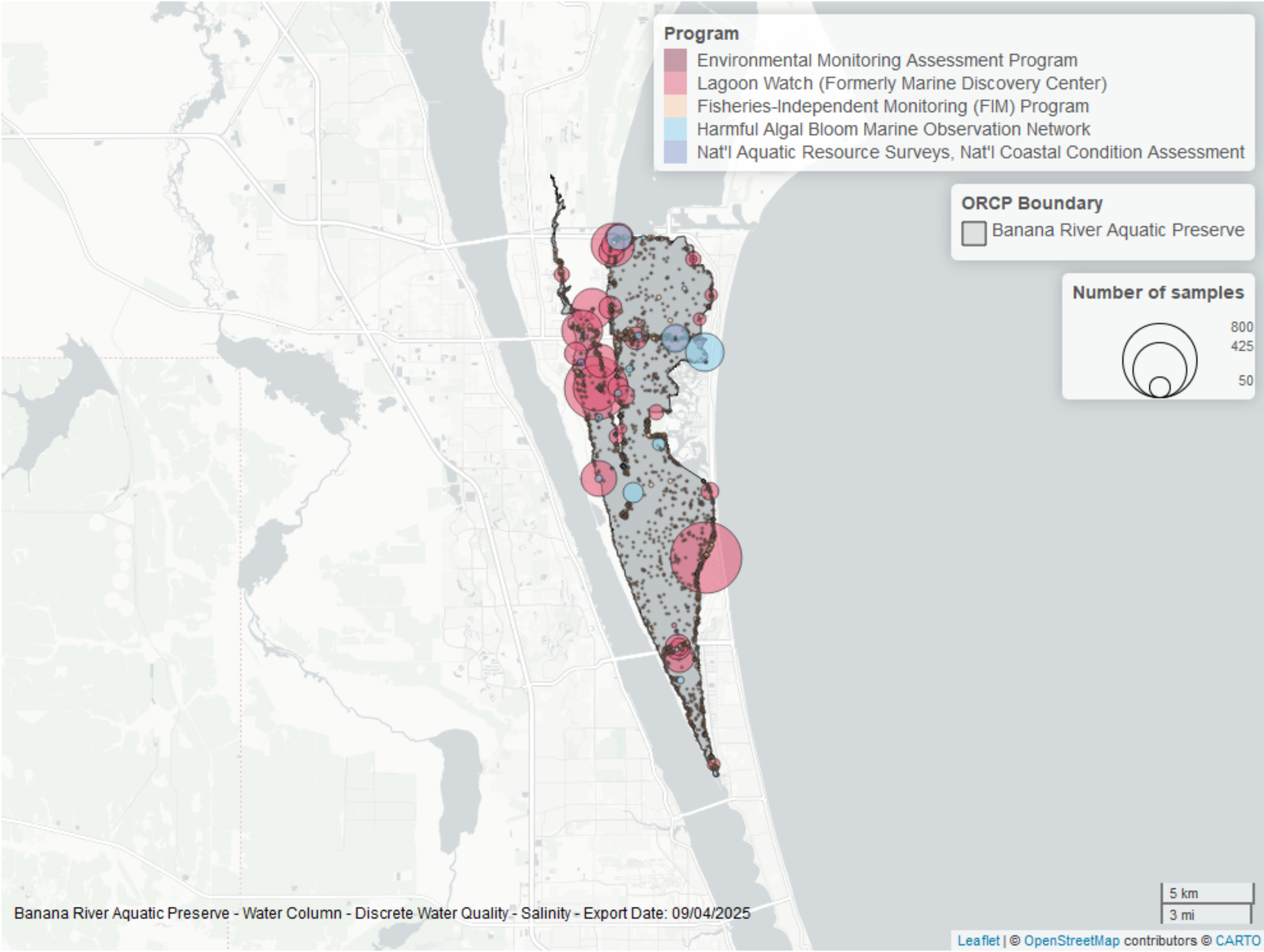

Figure 14: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 19: Programs contributing data for Salinity

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	21852	1991	2025
69	4525	1990	2024
3001	4317	1991	2024
95	681	2006	2018
3013	339	2003	2024
540	42	2016	2020
118	11	2015	2020
115	6	1995	1995

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program[6]
95 - Harmful Algal Bloom Marine Observation Network[3]
115 - Environmental Monitoring Assessment Program[7]
118 - National Aquatic Resource Surveys, National Coastal Condition Assessment[5]
540 - Shellfish Harvest Area Classification Program[1]

3001 - Lagoon Watch (Formerly Marine Discovery Center)[8]
3013 - Seagrass (SJRWMD)[9]
5002 - Florida STORET / WIN[2]

Secchi Depth - Discrete

Seasonal Kendall-Tau Trend Analysis

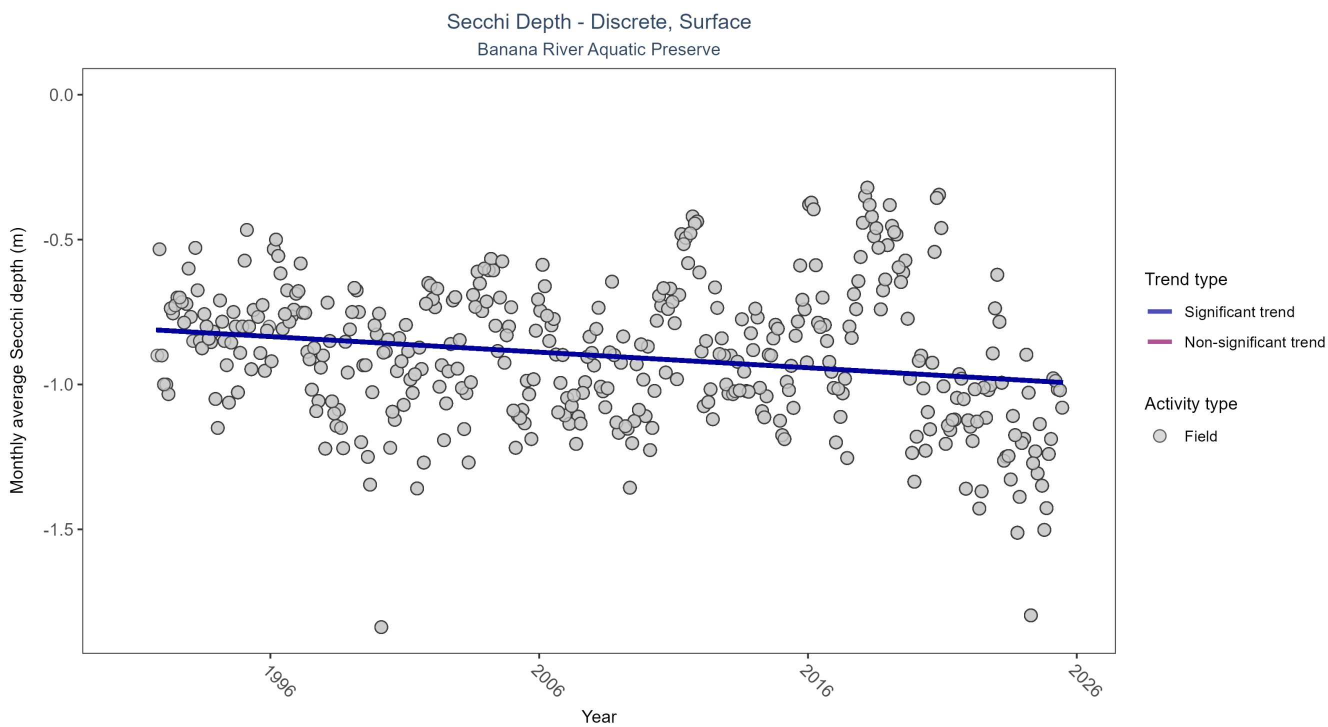

Figure 15: Scatter plot of monthly average Secchi depth over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Secchi depth is only measured in the field (circles).

Table 20: 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	Significantly decreasing trend	9199	35	1991 - 2025	-0.9	-0.1331	-0.8078	-0.0054	0.0001

Monthly average Secchi depth became deeper by 0.01 m per year, indicating an increase in water clarity.

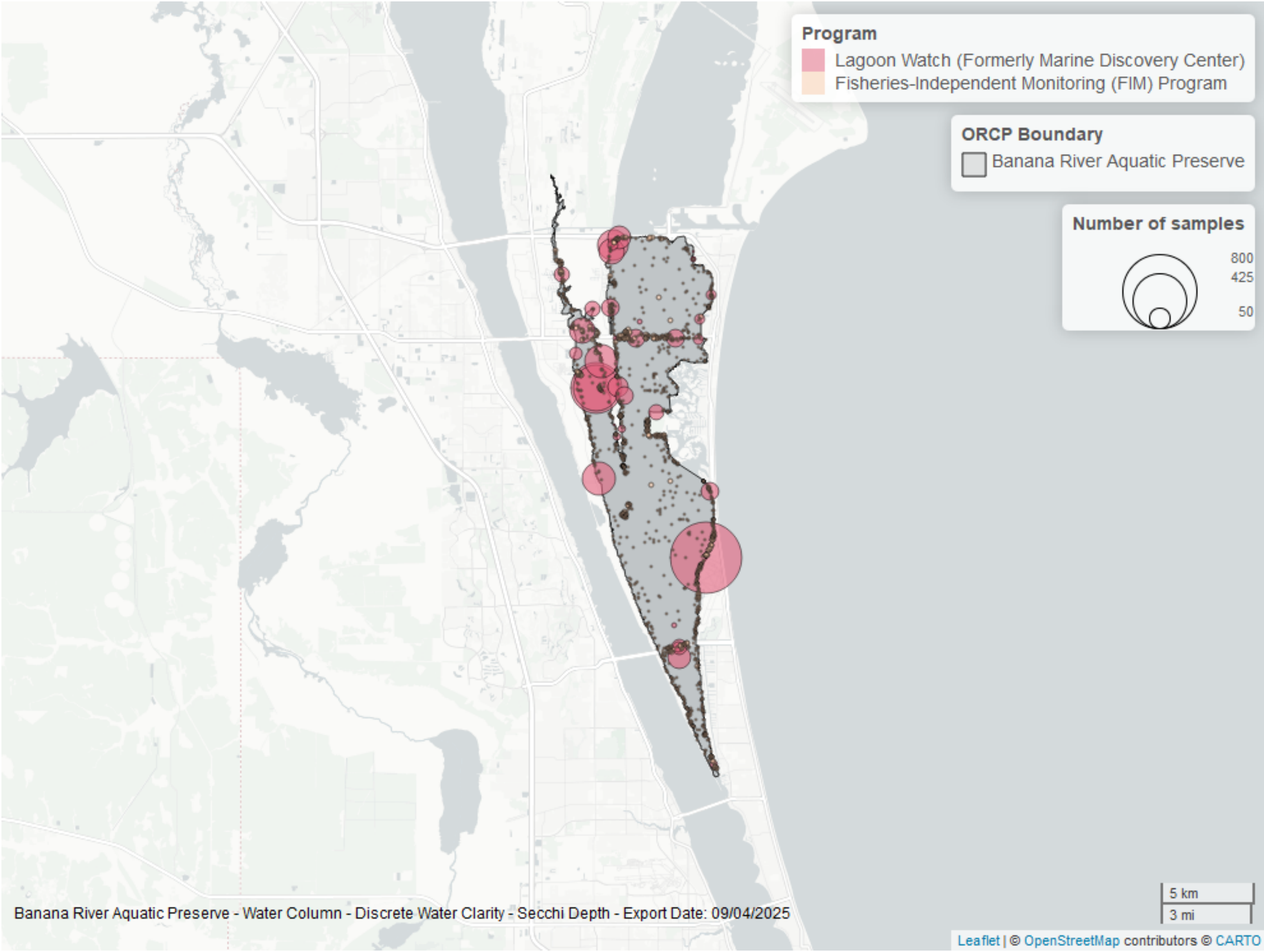

Figure 16: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 21: Programs contributing data for Secchi Depth

ProgramID	*N_Data*	*YearMin*	*YearMax*
69	3481	1994	2024
3001	2982	1991	2024
5002	2479	1999	2025
3013	332	2003	2024

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program[6]
3001 - Lagoon Watch (Formerly Marine Discovery Center)[8]
3013 - Seagrass (SJRWMD)[9]
5002 - Florida STORET / WIN[2]

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 + NO3O2;
2) TN = TKN + NO3 + NO2;
3) TN = ORGN + NH4 + NO3O2;
4) TN = ORGN + NH4 + NO2 + NO3;
5) TN = TKN + NO3;
6) TN = ORGN + NH4 + NO3;

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 NO3O2 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

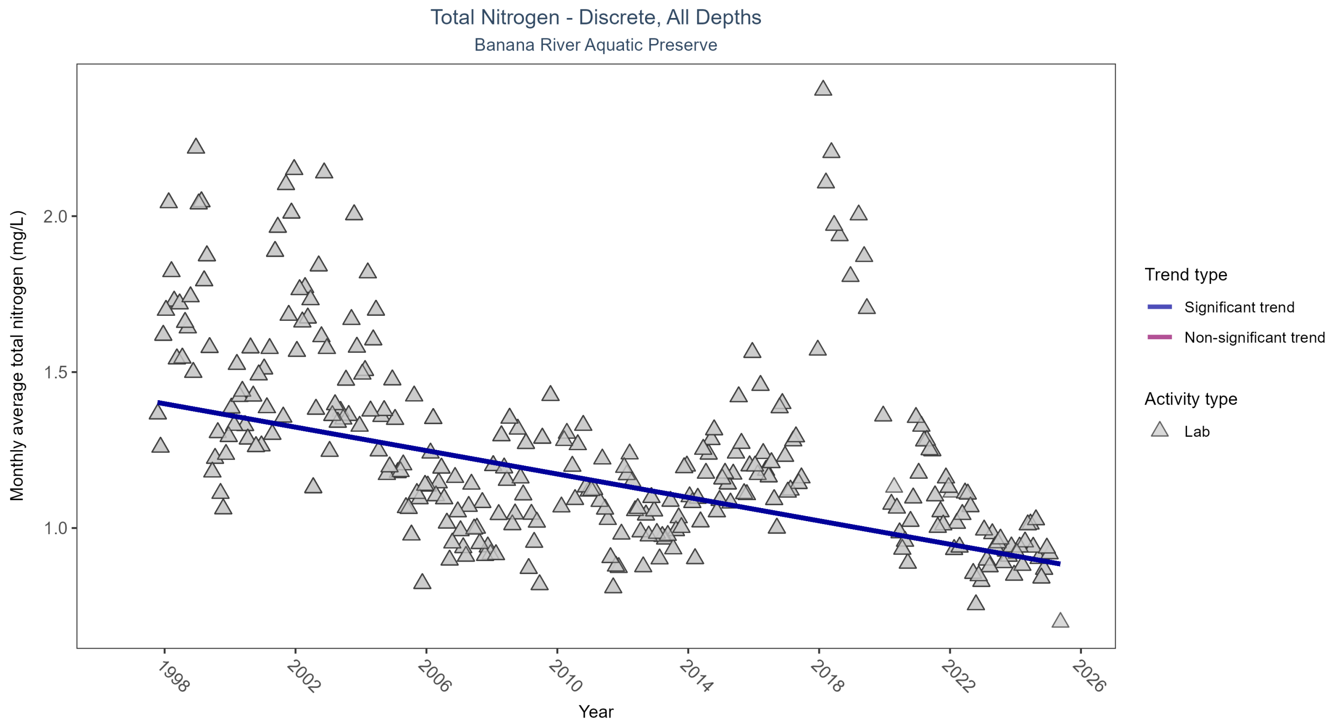

Figure 17: Scatter plot of monthly average total nitrogen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only nitrogen values obtained from laboratory analyses (triangles) are included in the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

Table 22: 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 decreasing trend	2331	29	1997 - 2025	1.2066	-0.4218	1.4172	-0.0188	0

Monthly average total nitrogen decreased by 0.02 mg/L per year.

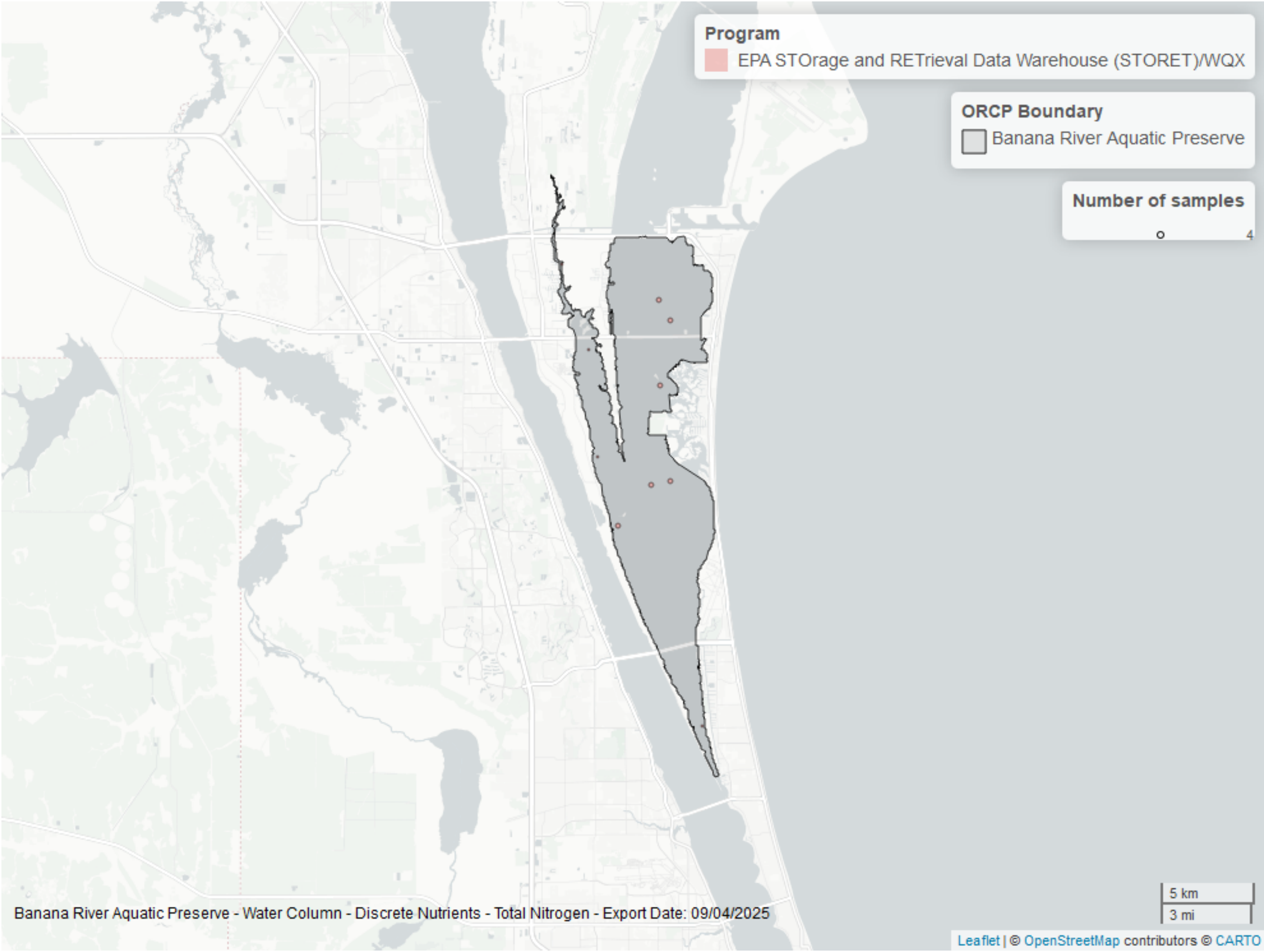

Figure 18: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 23: Programs contributing data for Total Nitrogen

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	2261	1997	2025
540	42	2016	2020
103	28	2002	2006

Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[4]
540 - Shellfish Harvest Area Classification Program[1]
5002 - Florida STORET / WIN[2]

Total Phosphorus - Discrete

Seasonal Kendall-Tau Trend Analysis

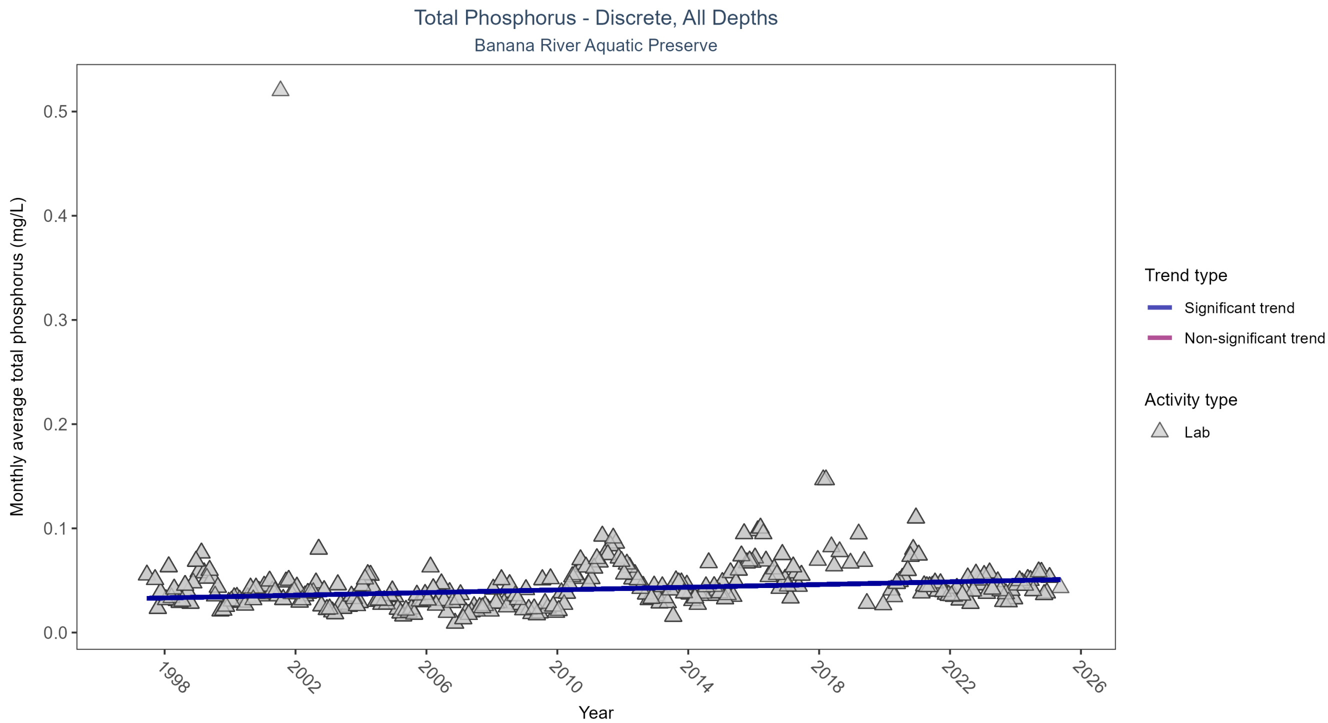

Figure 19: Scatter plot of monthly average total phosphorus over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only phosphorus values obtained from laboratory analyses (triangles) are included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

Table 24: 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	4819	29	1997 - 2025	0.0356	0.2307	0.0326	0.0006	0

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

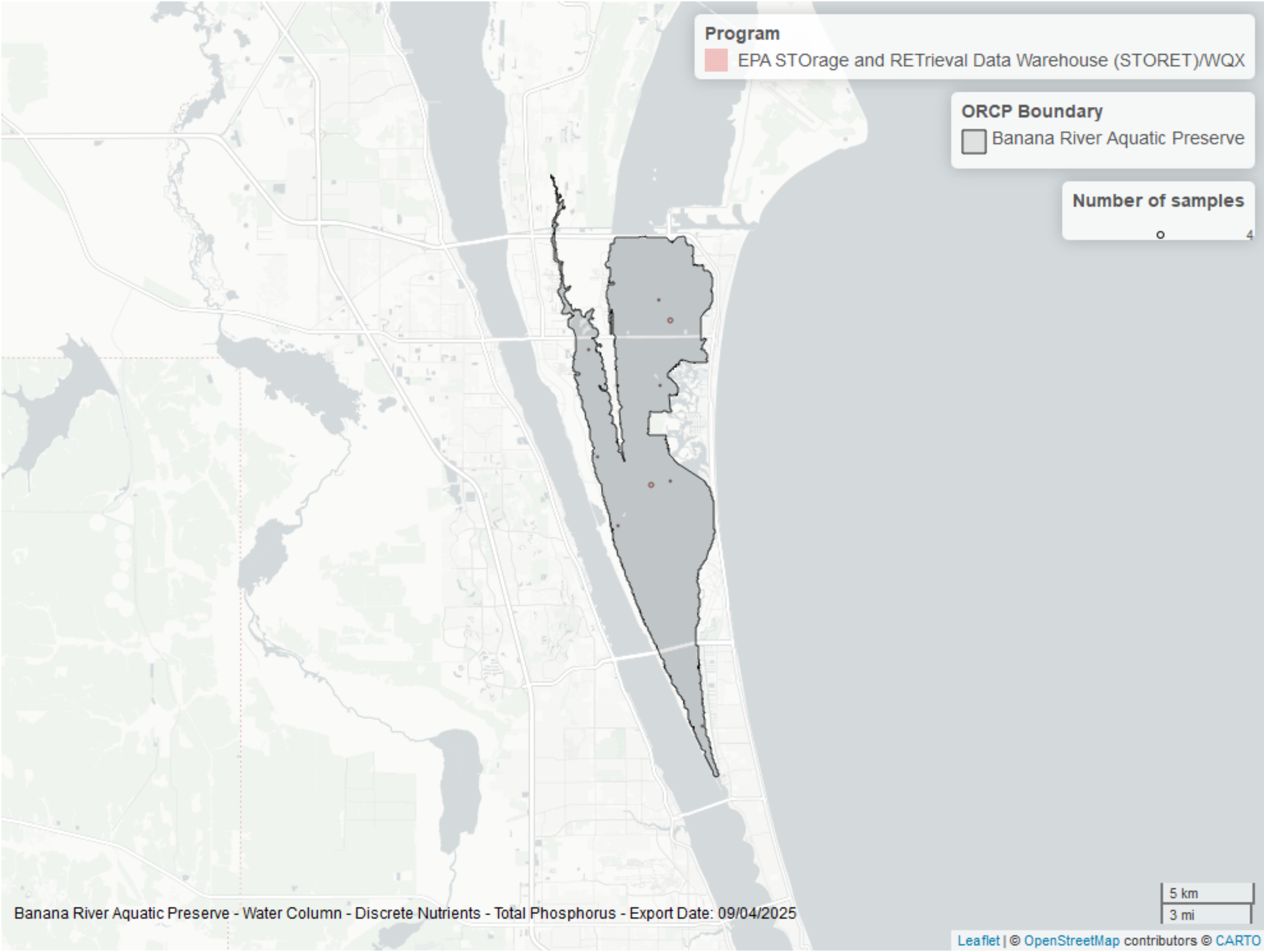

Figure 20: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 25: Programs contributing data for Total Phosphorus

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	4785	1997	2025
540	42	2016	2020
103	25	2002	2015

Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[4]
540 - Shellfish Harvest Area Classification Program[1]
5002 - Florida STORET / WIN[2]

Total Suspended Solids - Discrete

Seasonal Kendall-Tau Trend Analysis

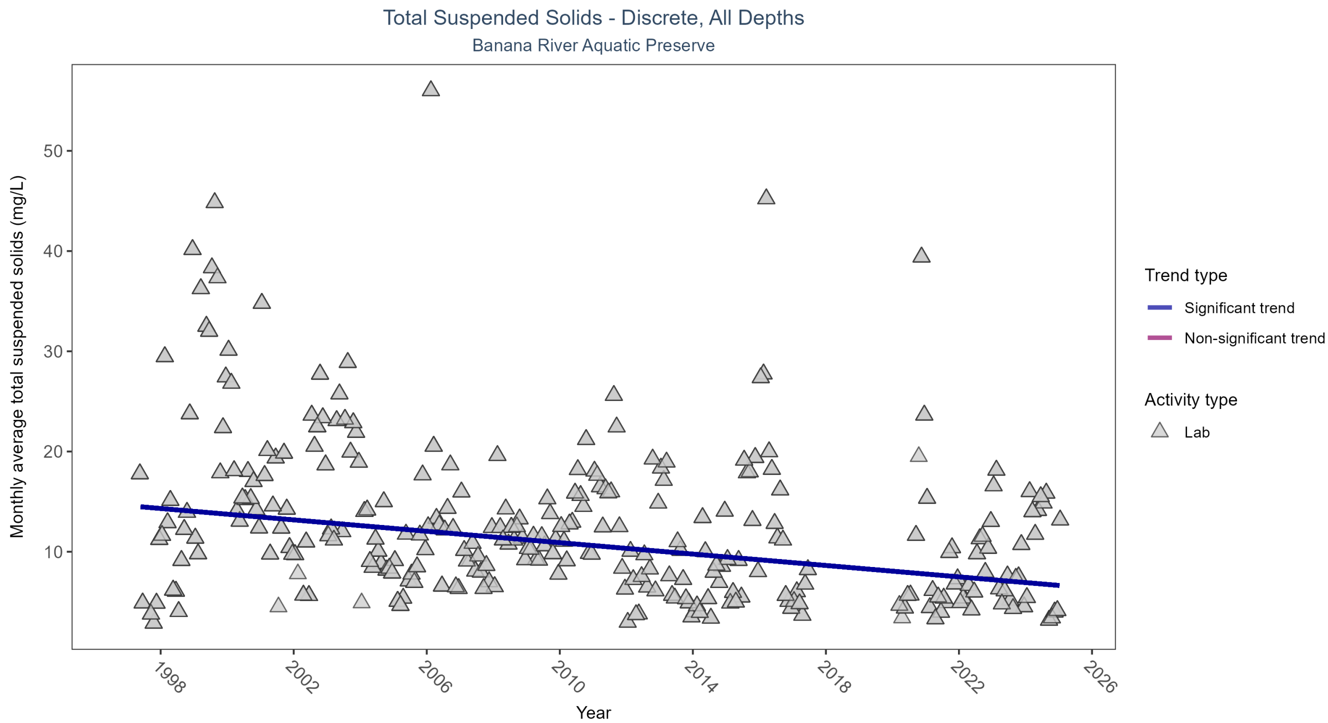

Figure 21: Scatter plot of monthly average total suspended solids (TSS) over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only TSS values obtained from laboratory analyses (triangles) are included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

Table 26: 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	Significantly decreasing trend	2535	27	1997 - 2025	10	-0.2488	14.6	-0.2843	0

Monthly average total suspended solids decreased by 0.28 mg/L per year, indicating an increase in water clarity.

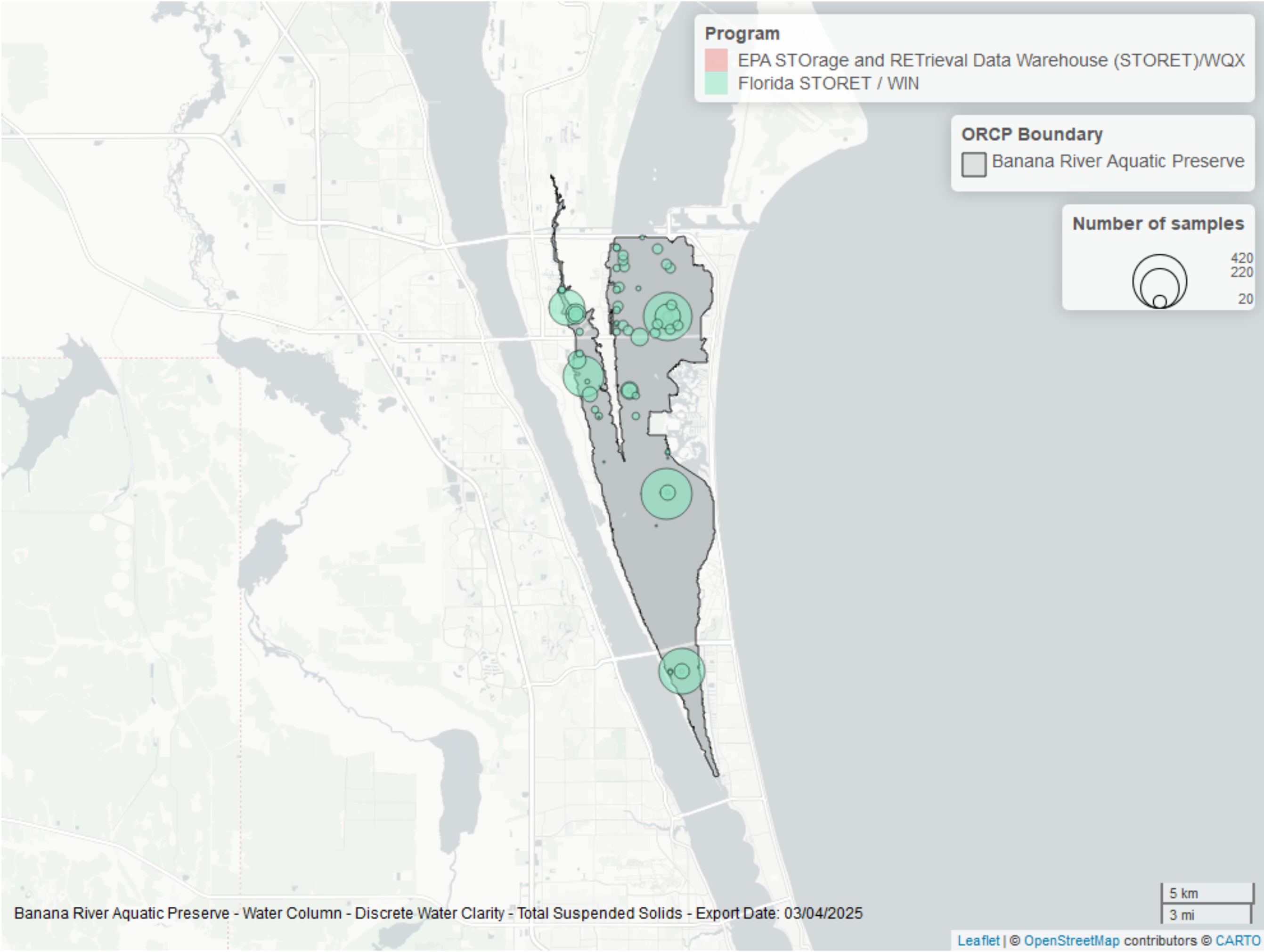

Figure 22: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 27: Programs contributing data for Total Suspended Solids

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	2561	1997	2025

Program names:

5002 - Florida STORET / WIN[2]

Turbidity - Discrete

Seasonal Kendall-Tau Trend Analysis

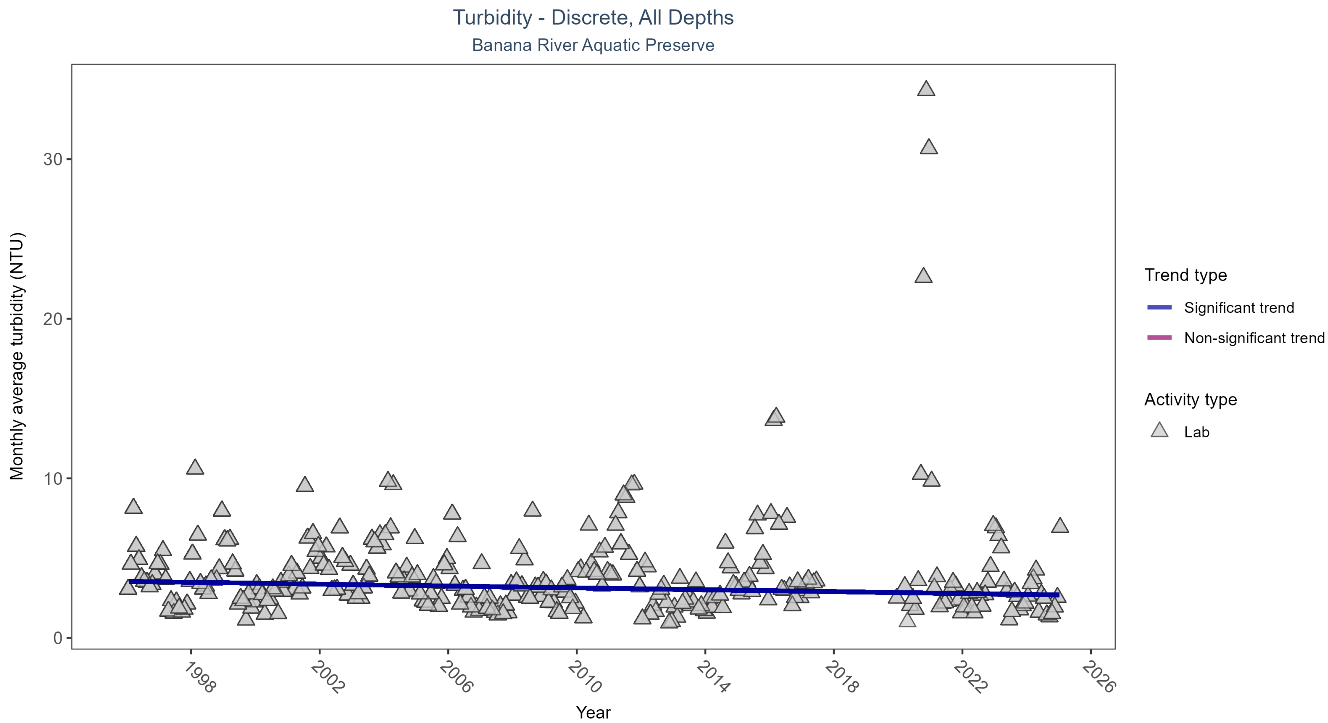

Figure 23: Scatter plot of monthly average turbidity over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only turbidity values measured in the laboratory (triangles) are included in the plot.

Table 28: 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	Significantly decreasing trend	13554	29	1996 - 2025	3.135	-0.1173	3.545	-0.0293	0.0032

Monthly average turbidity decreased by 0.03 NTU per year, indicating an increase in water clarity.

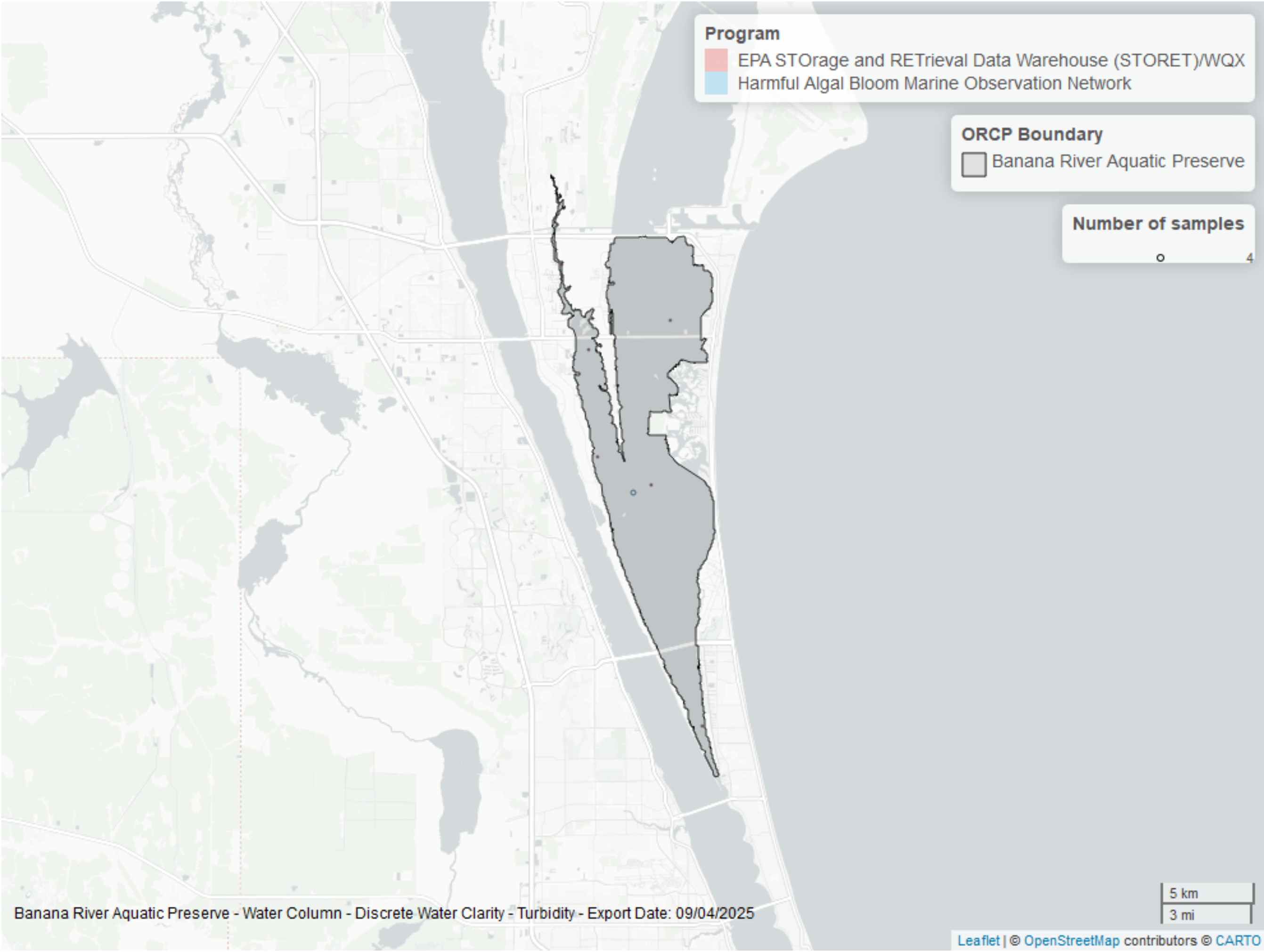

Figure 24: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 29: Programs contributing data for Turbidity

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	13783	1996	2025
3013	271	2004	2019
103	8	2005	2006
540	6	2019	2020
95	4	2009	2010

Program names:

95 - Harmful Algal Bloom Marine Observation Network[3]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[4]
540 - Shellfish Harvest Area Classification Program[1]
3013 - Seagrass (SJRWMD)[9]
5002 - Florida STORET / WIN[2]

Water Temperature - Discrete

Seasonal Kendall-Tau Trend Analysis

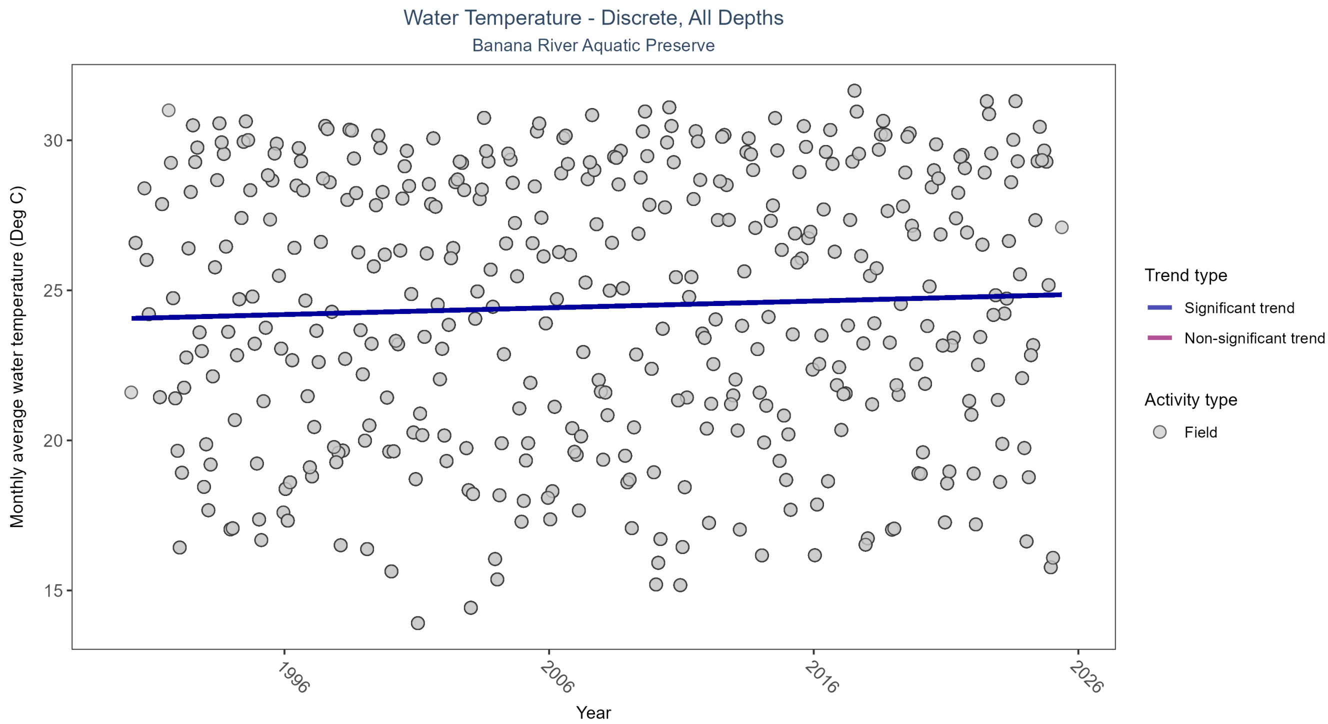

Figure 25: Scatter plot of monthly average water temperature over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only water temperature measurements taken in the field (circles) are included in the plot.

Table 30: 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	31598	36	1990 - 2025	25.5	0.1273	24.0598	0.0225	0.0002

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

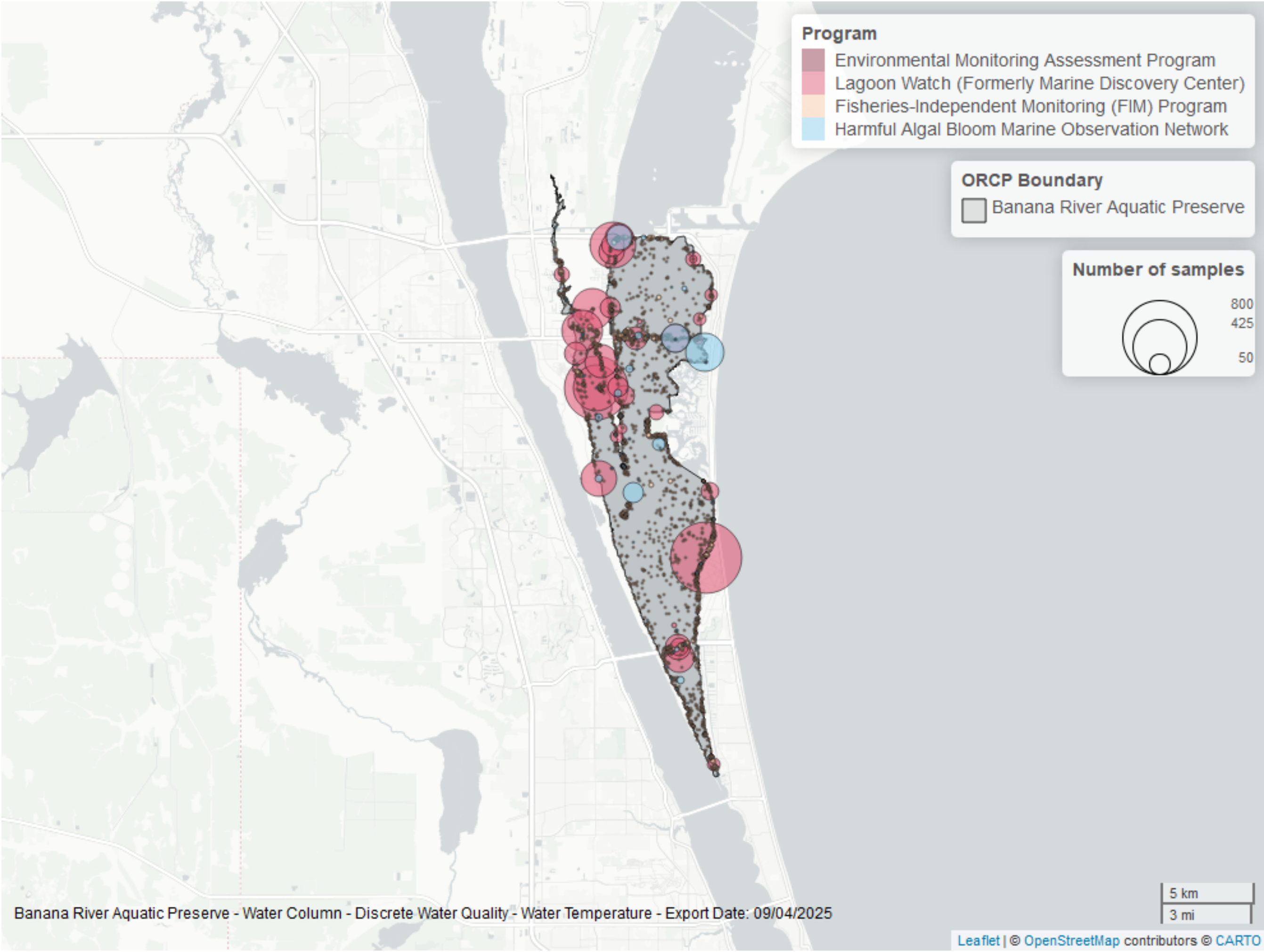

Figure 26: Map showing location of discrete water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 31: Programs contributing data for Water Temperature

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	22209	1991	2025
69	4548	1990	2024
3001	4346	1991	2024
95	680	2006	2018
3013	339	2003	2024
540	42	2016	2020
115	7	1995	1995

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program[6]
95 - Harmful Algal Bloom Marine Observation Network[3]
115 - Environmental Monitoring Assessment Program[7]
540 - Shellfish Harvest Area Classification Program[1]
3001 - Lagoon Watch (Formerly Marine Discovery Center)[8]

3013 - Seagrass (SJRWMD)[9]
5002 - Florida STORET / WIN[2]

Water Quality - Continuous

The following files were used in the continuous analysis:

- *Combined_WQ_WC_NUT_cont_Dissolved_Oxygen_NE-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Dissolved_Oxygen_Saturation_NE-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_pH_NE-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Salinity_NE-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Turbidity_NE-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Water_Temperature_NE-2025-Sep-19.txt*

Continuous monitoring locations in Banana River Aquatic Preserve

Table 32: Station overview for Continuous parameters by Program

ProgramID	*ProgramLocationID*	*Years of Data*	*Use in Analysis*	*Parameters*
5061	CMMerritt	3	FALSE	Turb
5061	CMMerritt	4	FALSE	DO , DOS , pH , Sal , TempW
5061	IRLB04	9	TRUE	DO , DOS , pH , Sal , Turb , TempW

Program names:

5061 - St. Johns River Water Management District Continuous Water Quality Programs[10]

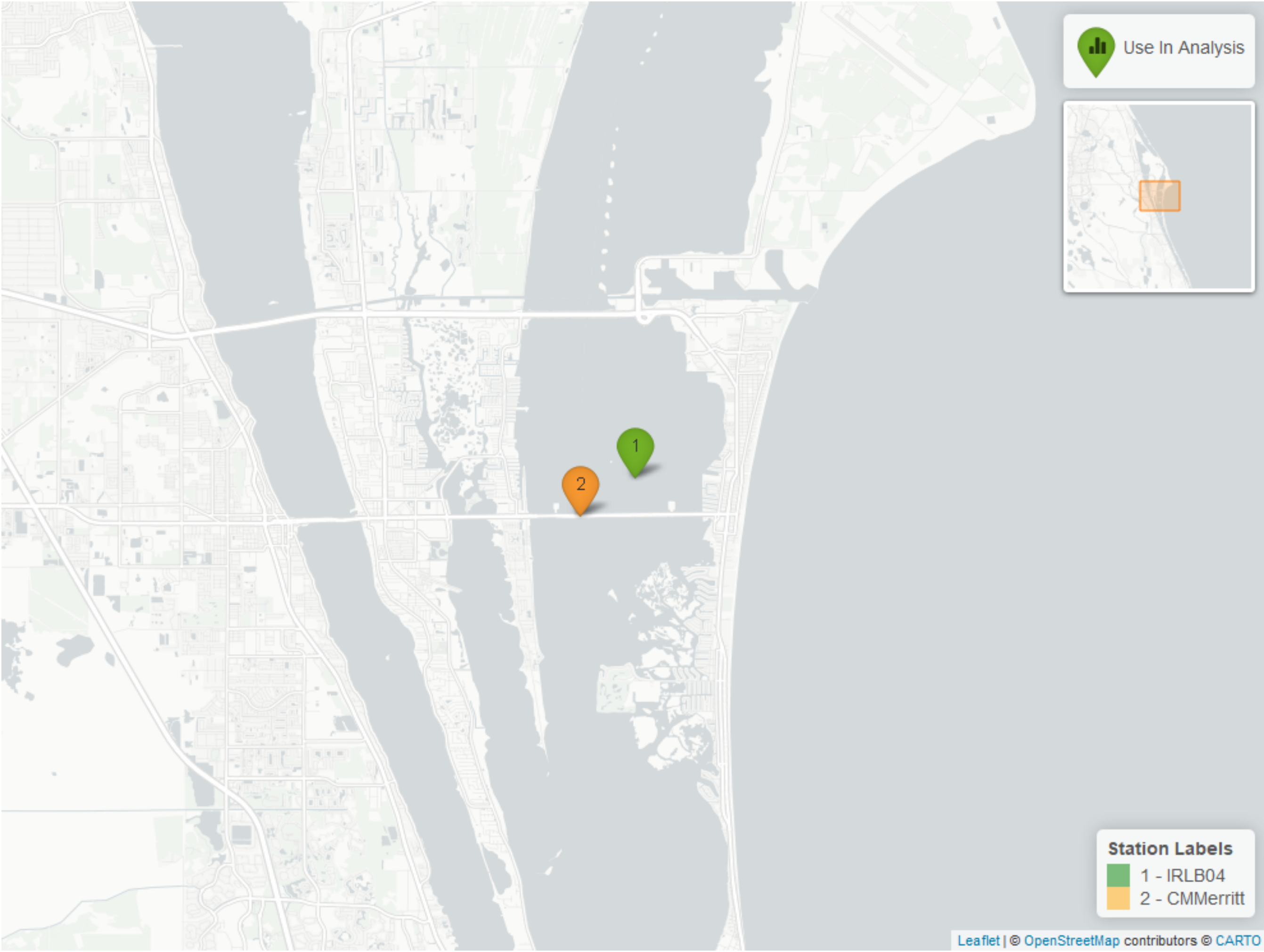

Figure 27: Map showing continuous water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. Sites marked as *Use In Analysis* (green) are featured in this report.

Dissolved Oxygen - Continuous

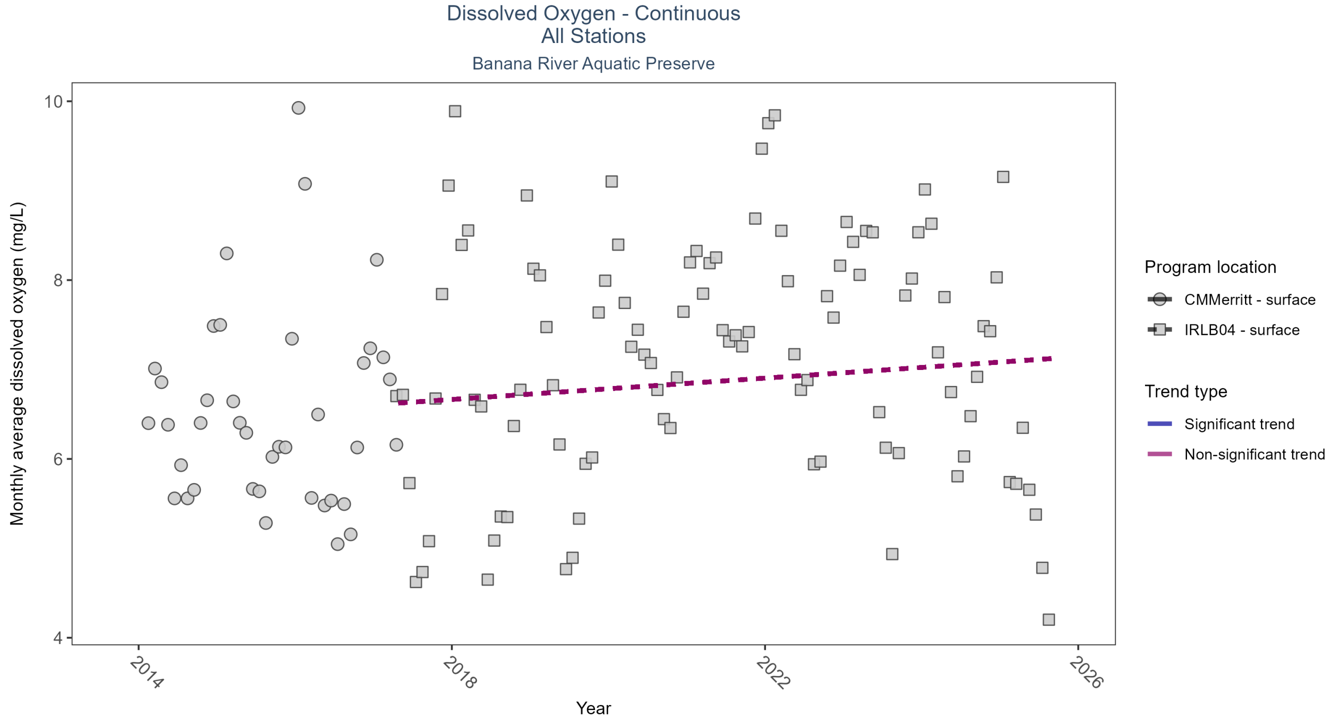

Figure 28: Scatter plot of monthly average dissolved oxygen over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 33: 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
IRLB04	No significant trend	72841	9	2017 - 2025	7.21	0.11	6.61	0.06	0.2
CMMerritt	Insufficient data to calculate trend	27378	4	2014 - 2017	6.51	-	-	-	-

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

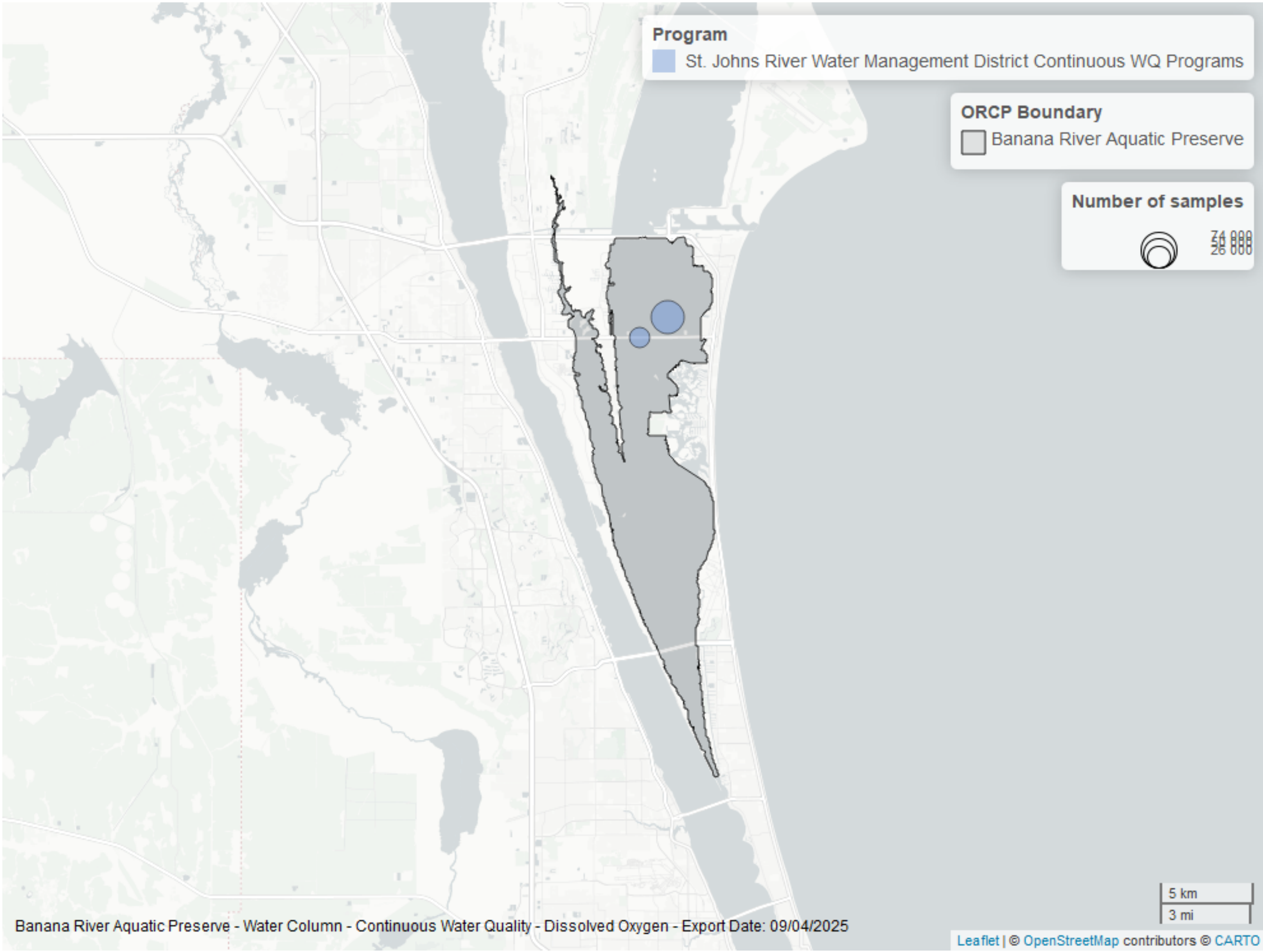

Figure 29: Map showing location of dissolved oxygen continuous water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Dissolved Oxygen Saturation - Continuous

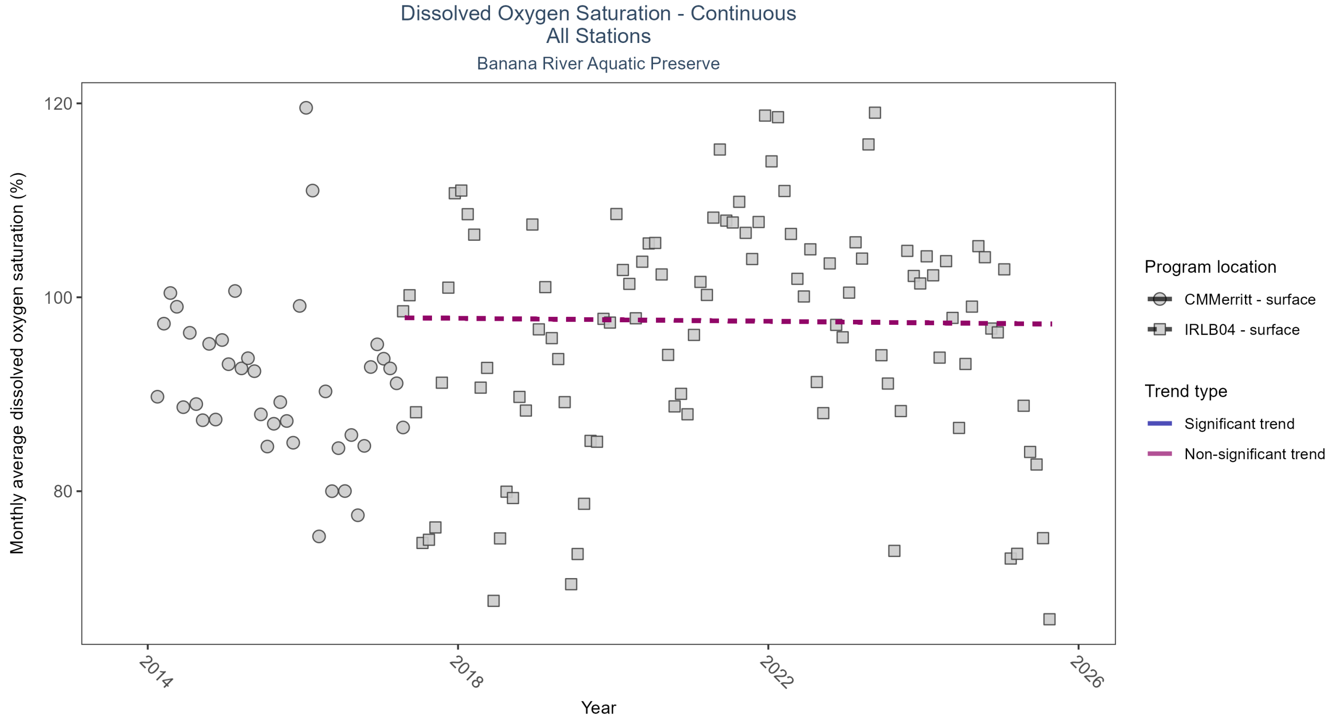

Figure 30: Scatter plot of monthly average dissolved oxygen saturation over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 34: 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
IRLB04	No significant trend	85440	9	2017 - 2025	100.53	0	97.91	-0.08	0.97
CMMerritt	Insufficient data to calculate trend	25864	4	2014 - 2017	91.03	-	-	-	-

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

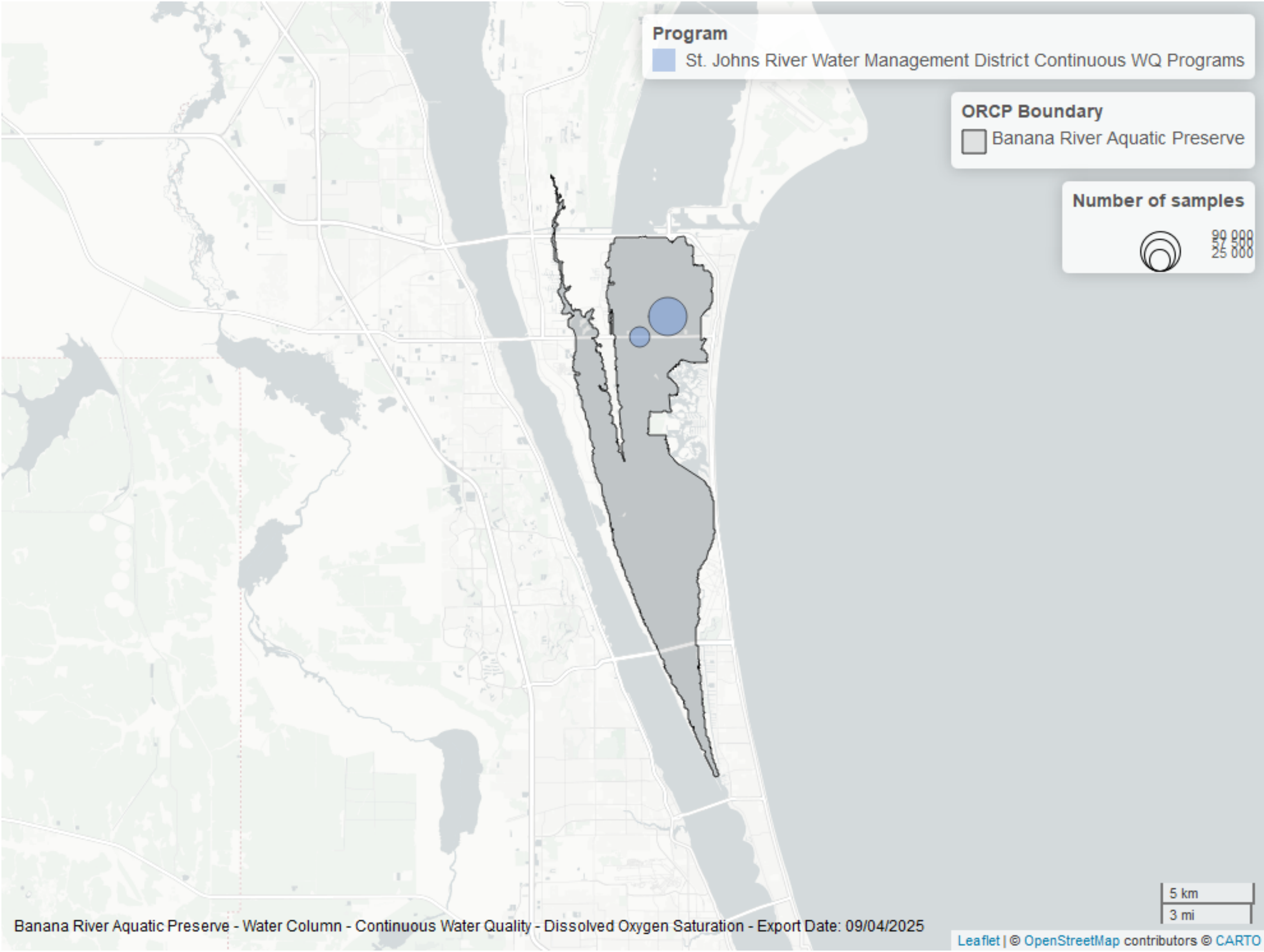

Figure 31: Map showing location of dissolved oxygen saturation continuous water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

pH - Continuous

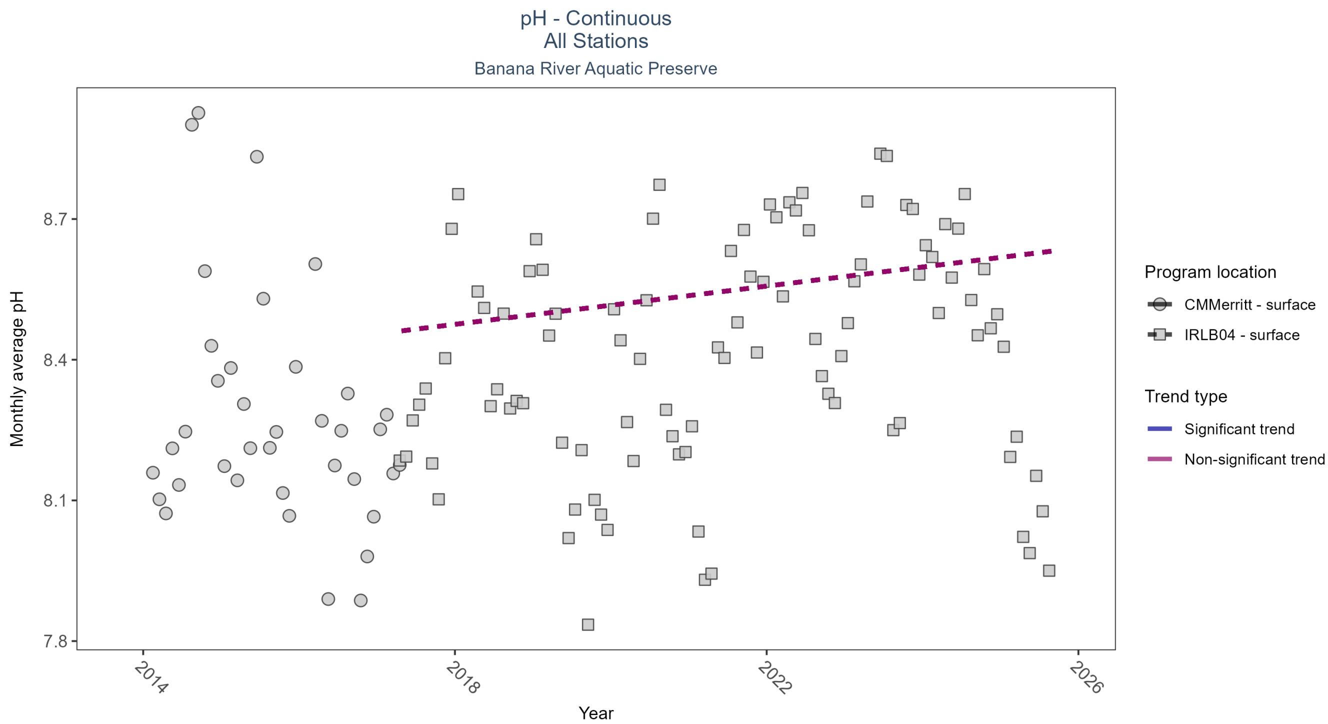

Figure 32: Scatter plot of monthly average pH over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 35: 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
IRLB04	No significant trend	72757	9	2017 - 2025	8.45	0.1	8.46	0.02	0.22
CMMerritt	Insufficient data to calculate trend	27417	4	2014 - 2017	8.22	-	-	-	-

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

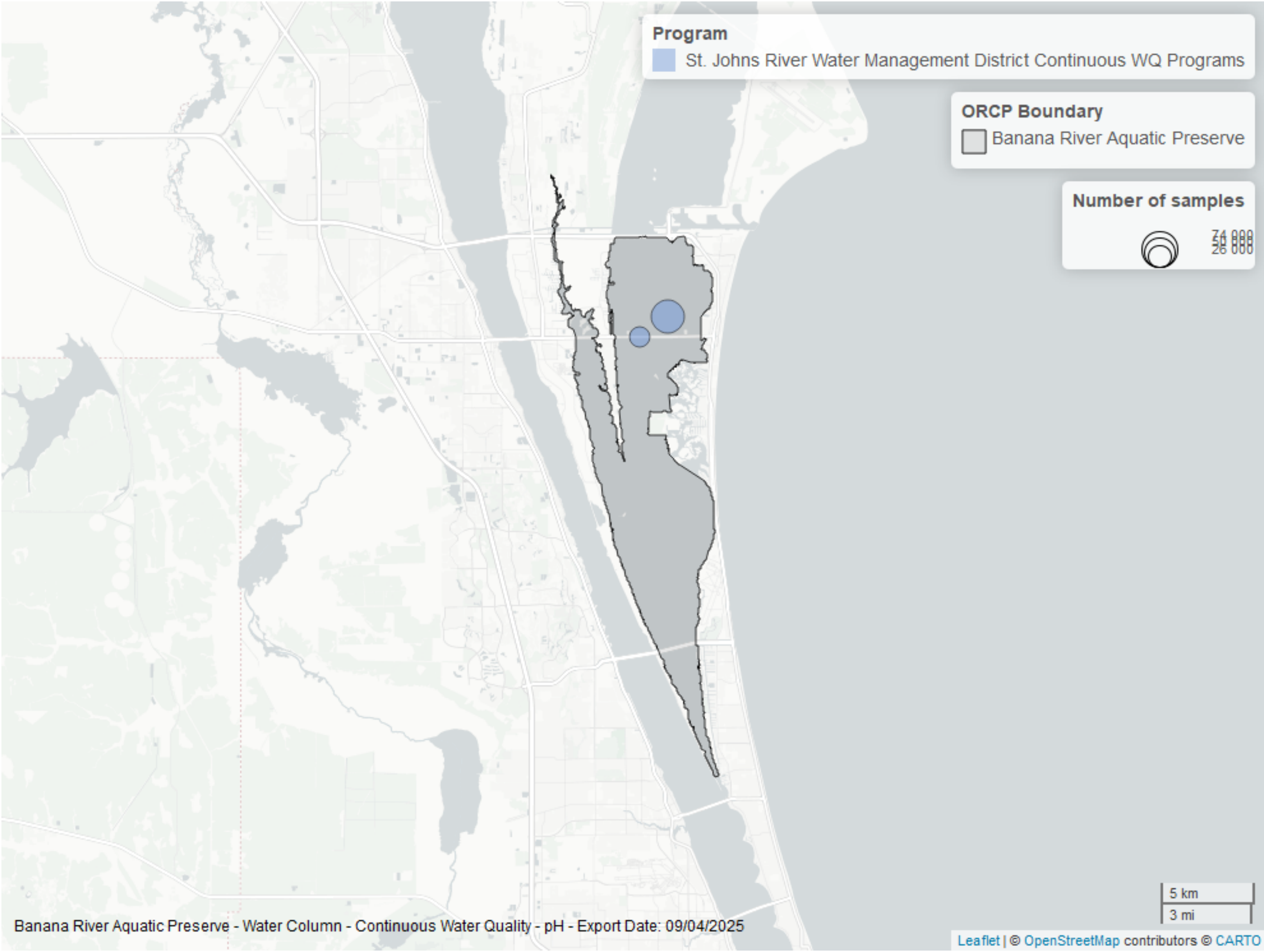

Figure 33: Map showing location of ph continuous water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Salinity - Continuous

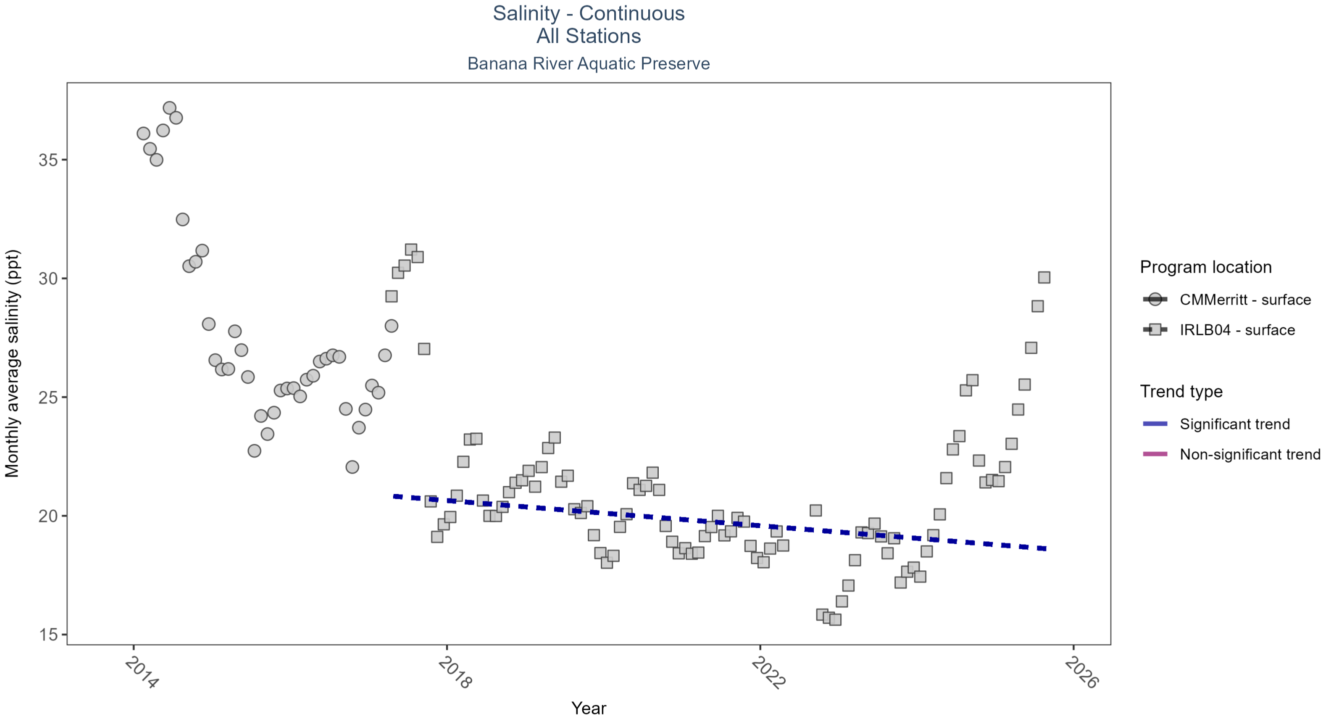

Figure 34: Scatter plot of monthly average salinity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 36: 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
IRLB04	Significantly decreasing trend	68975	9	2017 - 2025	20.12	-0.21	20.91	-0.27	0.01
CMMerritt	Insufficient data to calculate trend	25902	4	2014 - 2017	26.40	-	-	-	-

At one program location, monthly average salinity decreased by 0.27 ppt per year. There was insufficient data to fit a model for one location.

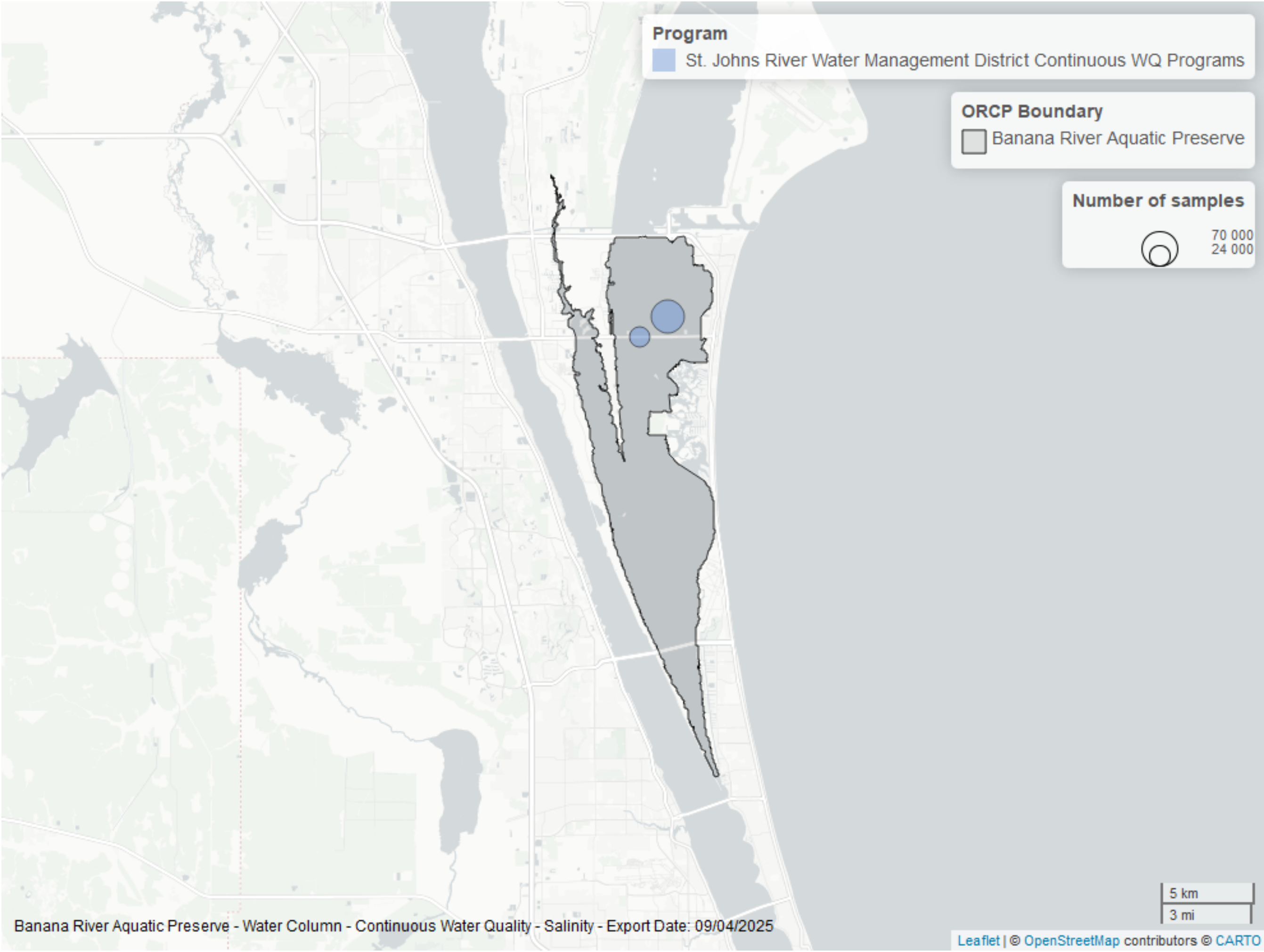

Figure 35: Map showing location of salinity continuous water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Turbidity - Continuous

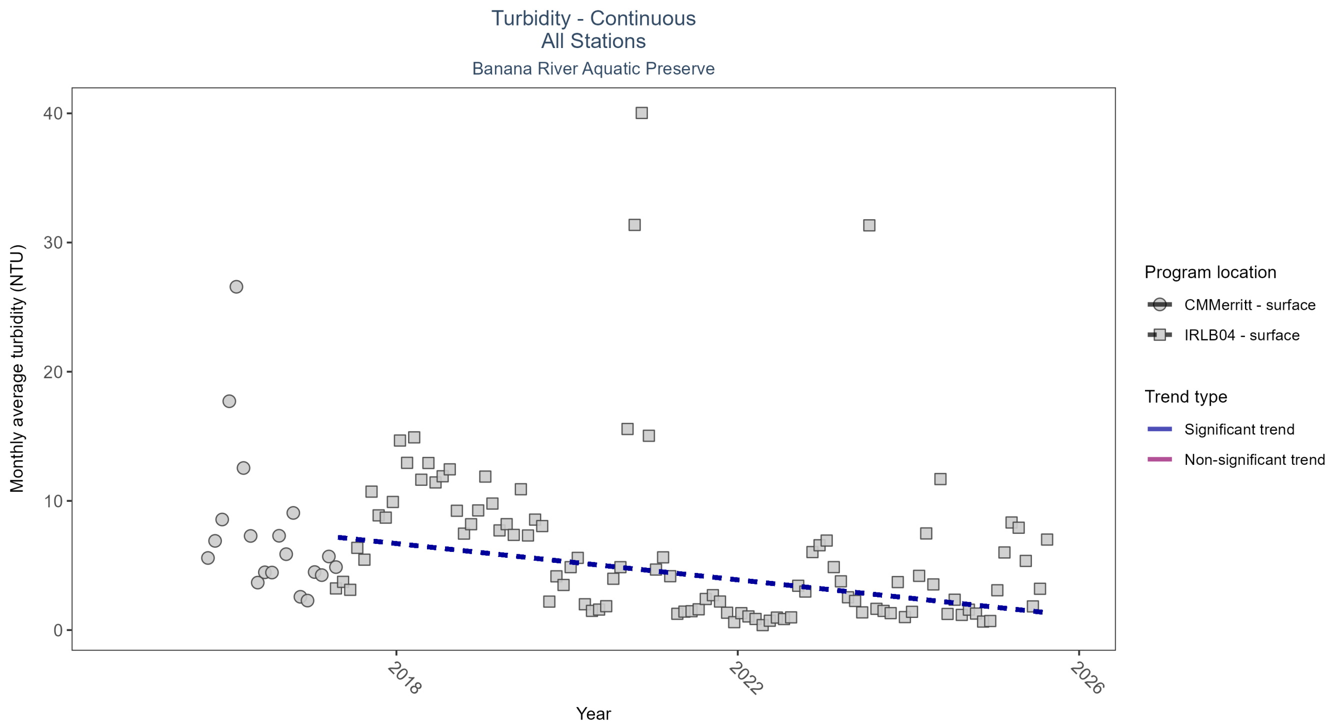

Figure 36: Scatter plot of monthly average turbidity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 37: 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
CMMerritt	Insufficient data to calculate trend	12912	3	2015 - 2017	5.29	-	-	-	-
IRLB04	Significantly decreasing trend	69928	9	2017 - 2025	3.15	-0.4	7.4	-0.7	0

At one program location, monthly average turbidity decreased by 0.70 NTU per year. There was insufficient data to fit a model for one location.

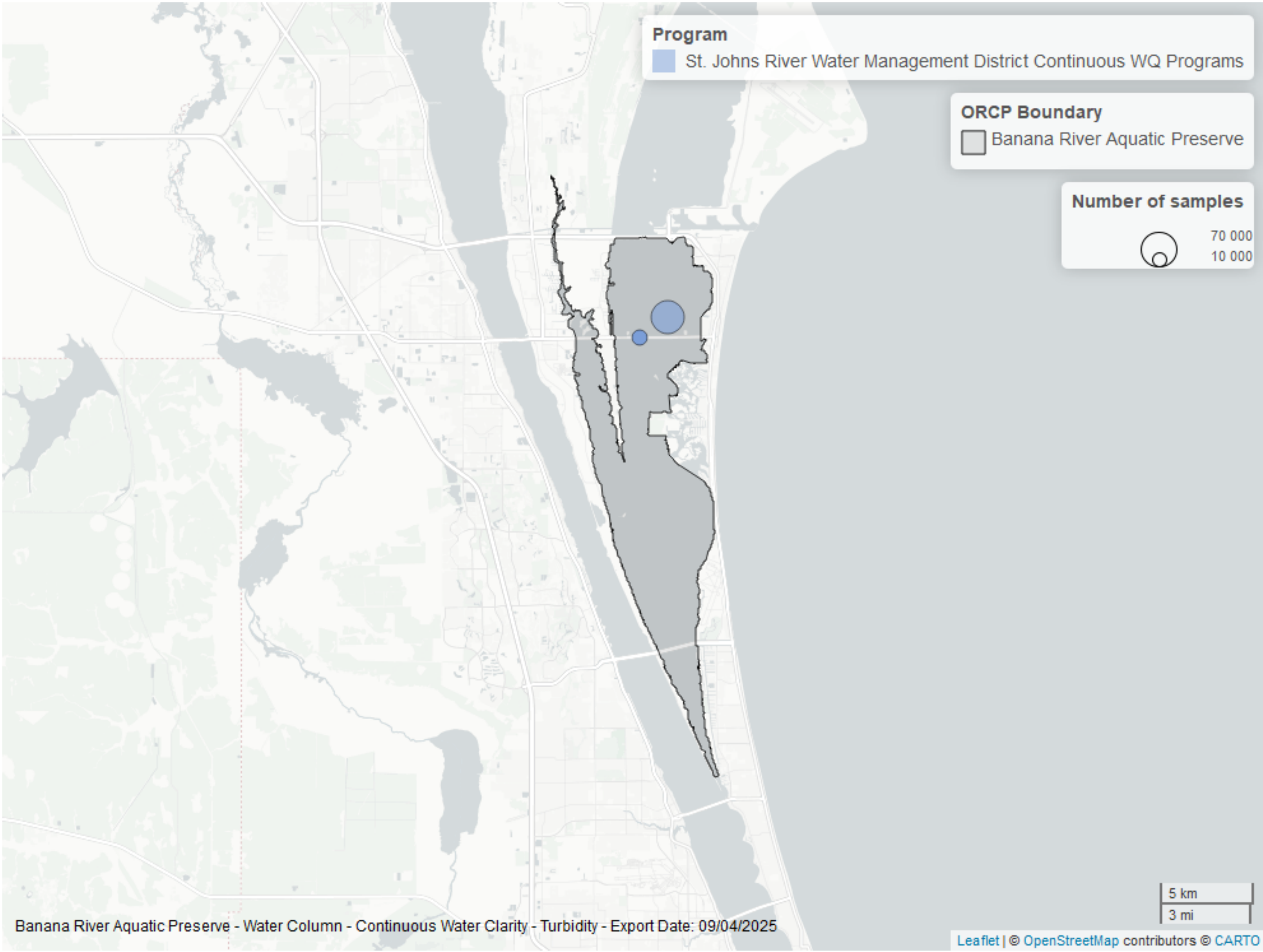

Figure 37: Map showing location of turbidity continuous water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Water Temperature - Continuous

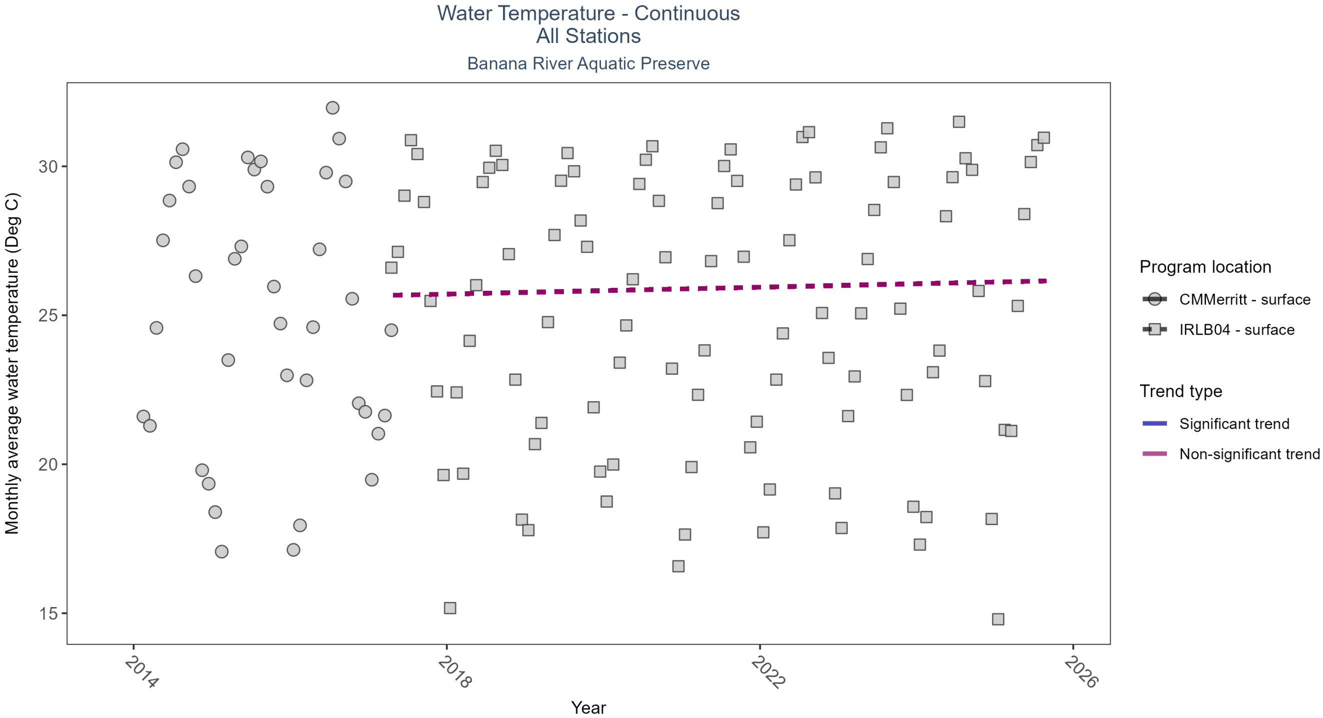

Figure 38: Scatter plot of monthly average water temperature over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 38: 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
CMMerritt	Insufficient data to calculate trend	27484	4	2014 - 2017	25.43	-	-	-	-
IRLB04	No significant trend	72845	9	2017 - 2025	25.82	0.09	25.65	0.06	0.22

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

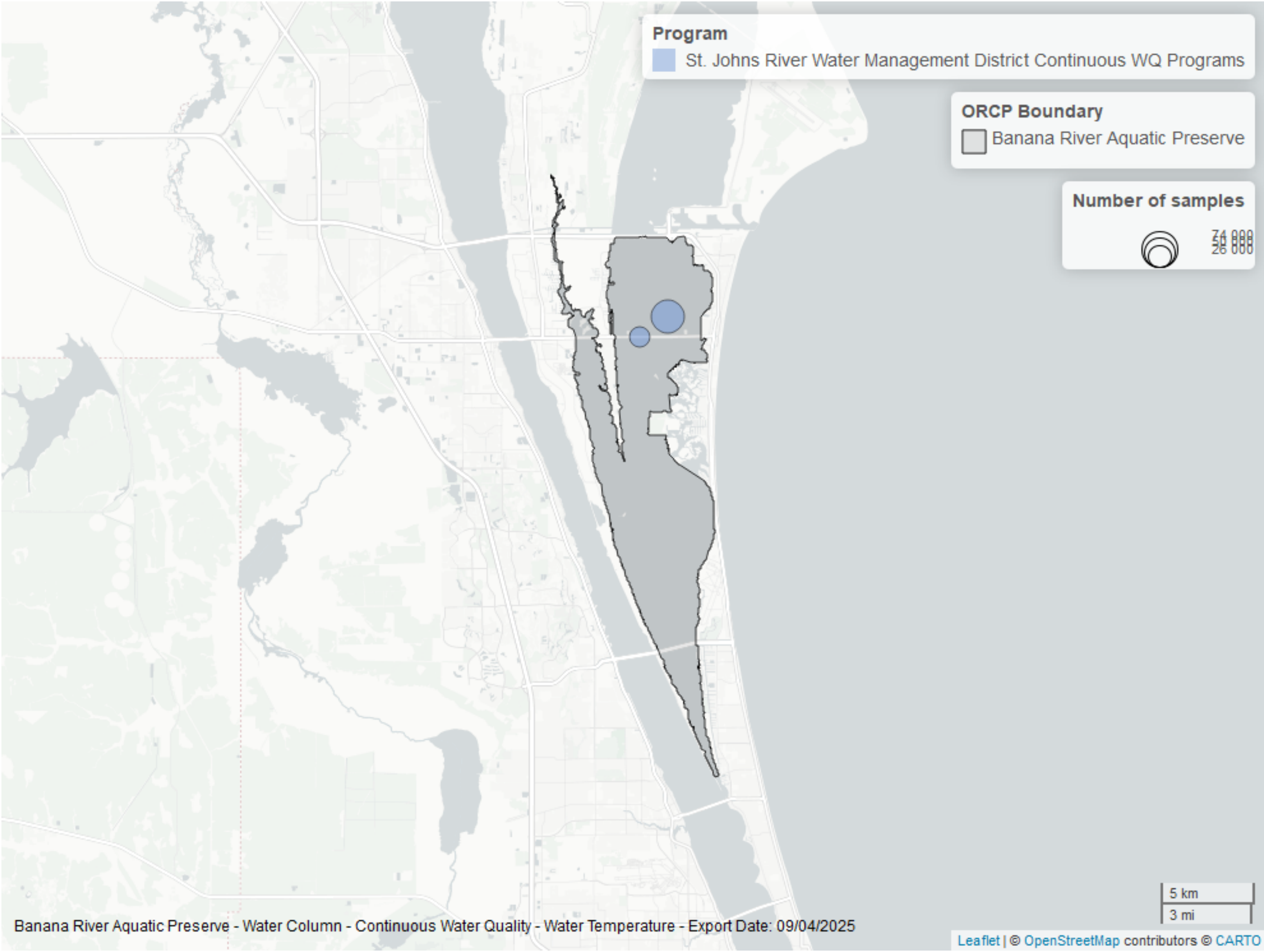

Figure 39: Map showing location of water temperature continuous water quality sampling locations within the boundaries of *Banana River Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Submerged Aquatic Vegetation

The data file used is: **All_SAV_Parameters-2025-Sep-04.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

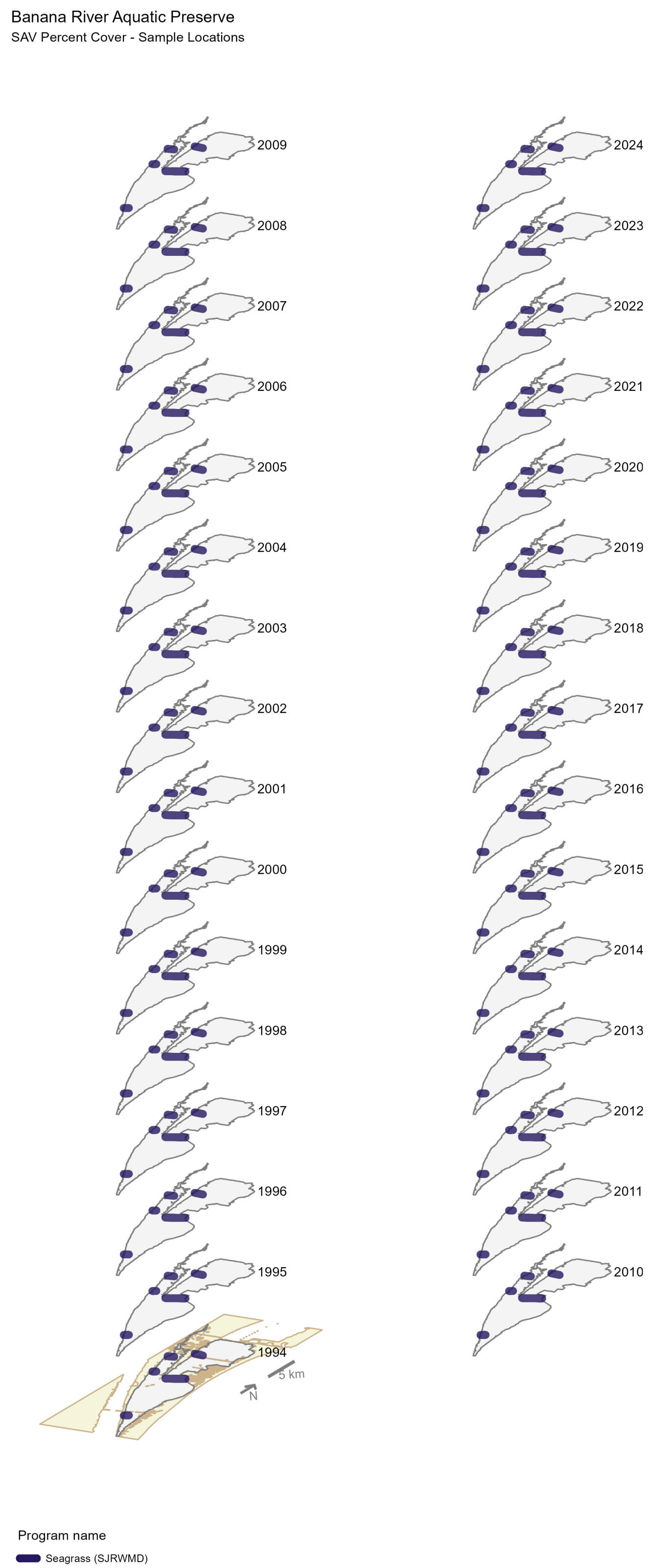

Figure 40: Maps showing the temporal scope of SAV sampling sites within the boundaries of *Banana River Aquatic Preserve* by Program name.

Click here to view spatio-temporal plots on GitHub.

Sampling locations by Program:

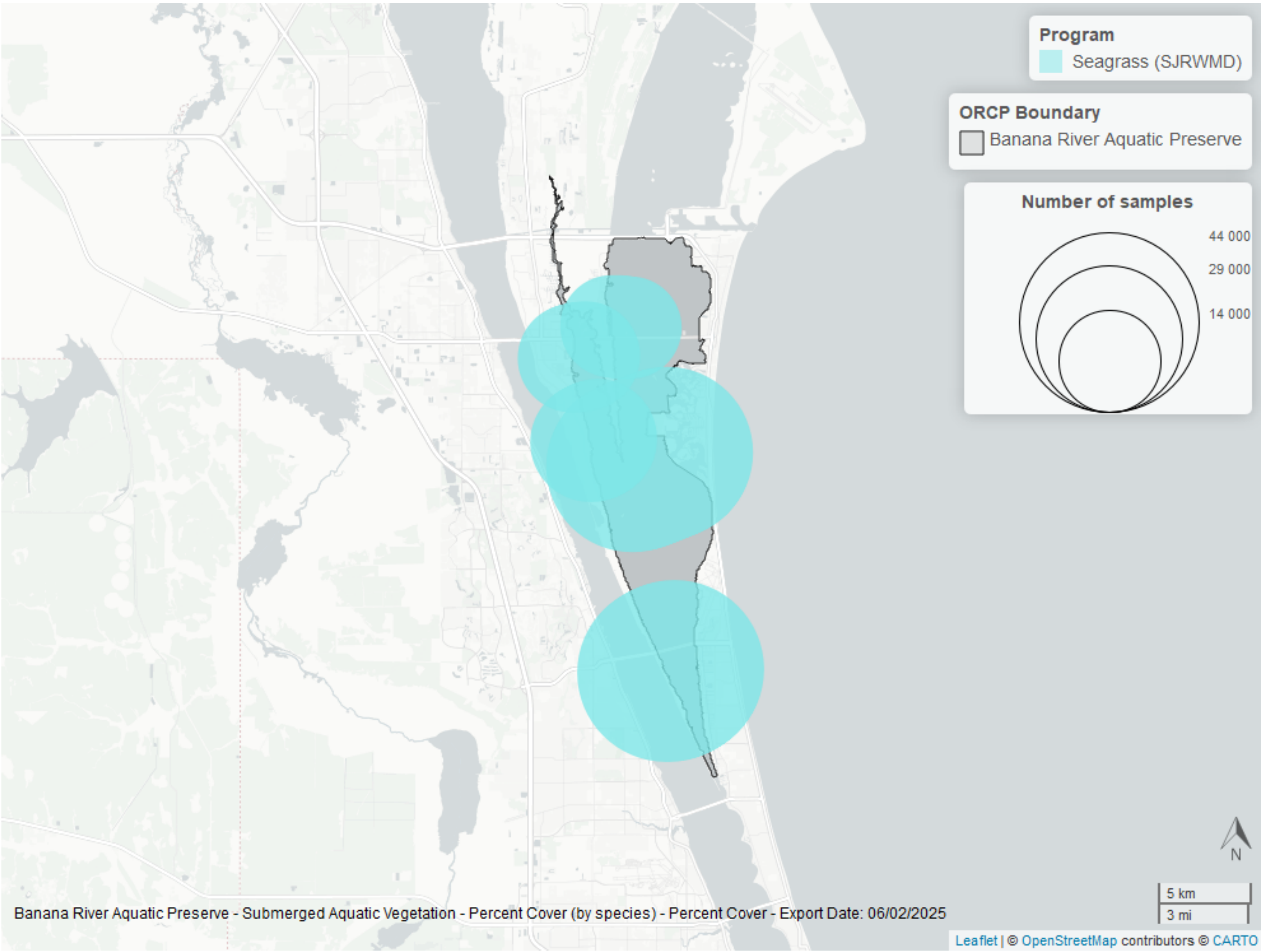

Figure 41: Map showing SAV sampling sites within the boundaries of *Banana River Aquatic Preserve*. The point size reflects the number of samples at a given sampling site.

Table 39: Program Information for Submerged Aquatic Vegetation

ProgramID	*N-Data*	*YearMin*	*YearMax*	*method*	*Sample Locations*
3013	40465	1994	2024	Percent Cover	5
3013	46903	1994	2024	Percent Occurrence	5

Program names:

3013 - Seagrass (SJRWMD)[9]
3013 - Seagrass (SJRWMD)[9]

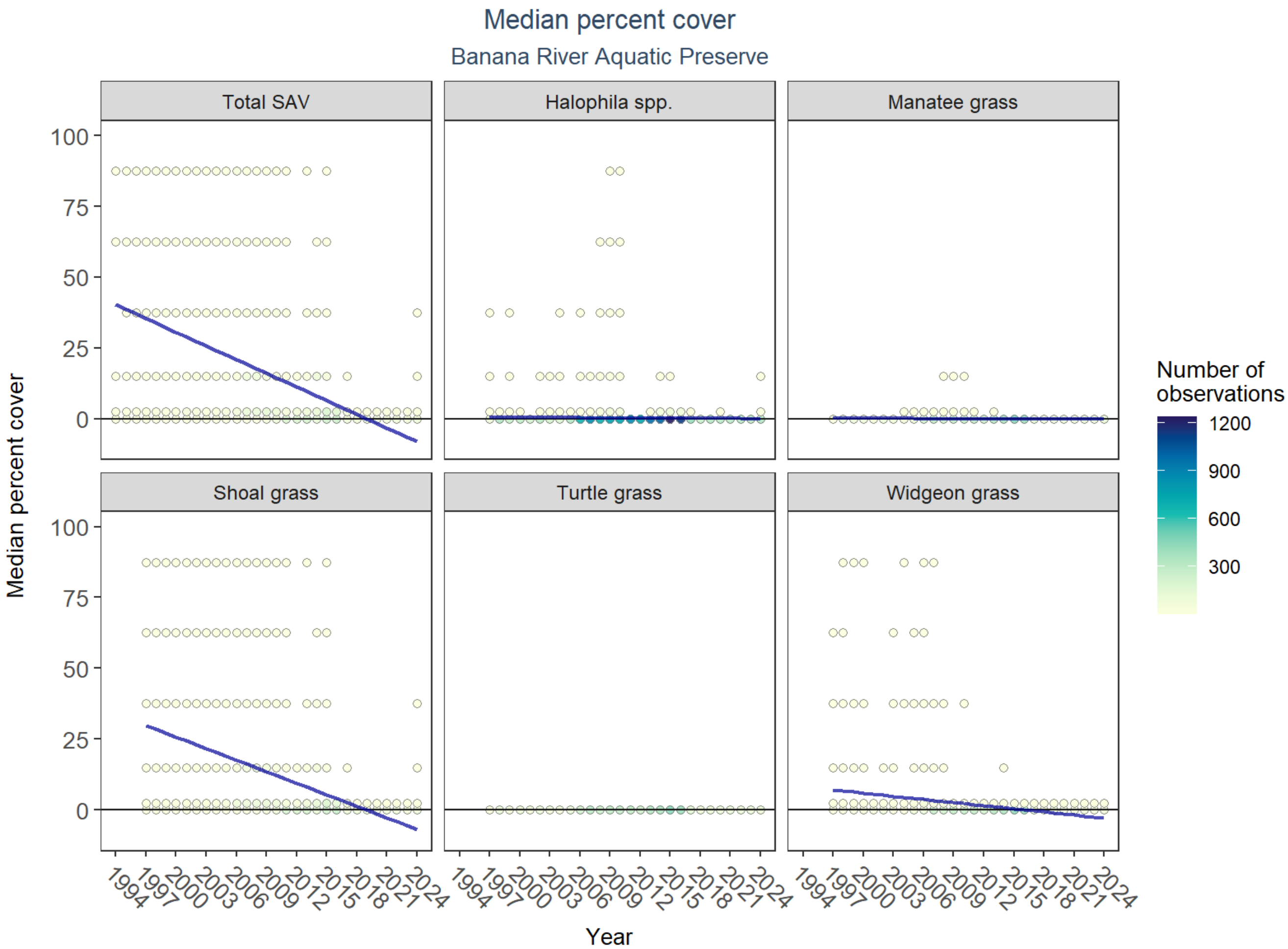

Figure 42: Scatter plots of median percent cover of submerged aquatic vegetation over time by group. Plots for time series that included five or more years of observations show the estimated trend as a blue line.

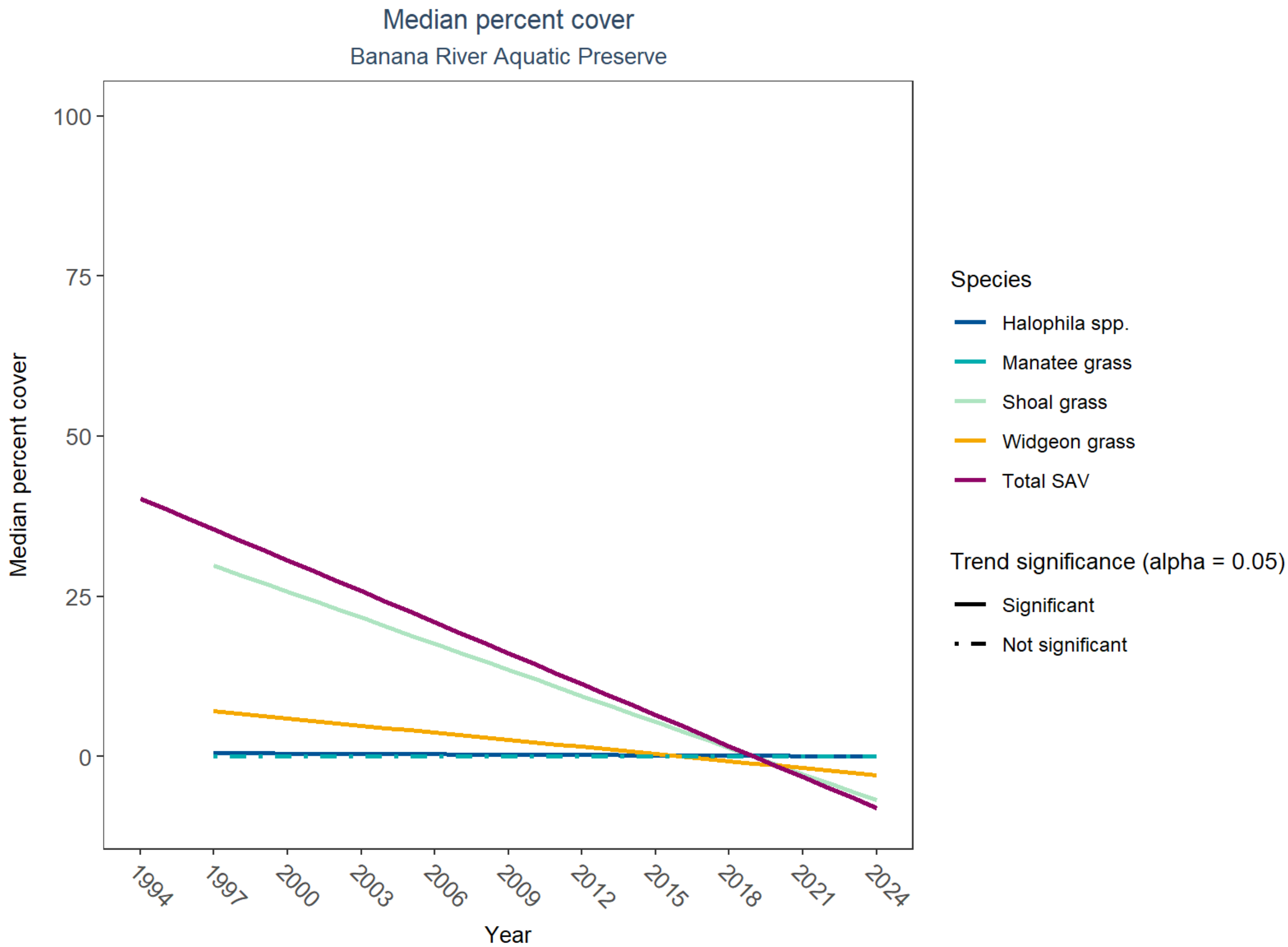

Figure 43: Trends in median percent cover for various seagrass species in Banana River Aquatic Preserve - simplified

Table 40: Percent Cover Trend Analysis for Banana River Aquatic Preserve

CommonName	*Trend Significance (0.05)*	*Period of Record*	*LME-Intercept*	*LME-Slope*	*p*
Drift algae	Insufficient data to calculate trend	-	-	-	-
Shoal grass	Significantly decreasing trend	1997 - 2024	33.9007874	-1.3574256	0.0000000
Halophila spp.	Significantly decreasing trend	1997 - 2024	0.5864381	-0.0187455	0.0026034
Widgeon grass	Significantly decreasing trend	1997 - 2024	8.1349573	-0.3681282	0.0002202
Manatee grass	No significant trend	1997 - 2024	0.0920067	-0.0028189	0.0740554
Turtle grass	Model did not fit the available data	1997 - 2024	-	-	-
Total SAV	Significantly decreasing trend	1994 - 2024	40.2866138	-1.6105869	0.0000000
Total seagrass	Insufficient data to calculate trend	-	-	-	-

Annual decreases in percent cover were observed for total SAV (-1.6%), *Halophila* spp. (-0.0%), shoal grass (-1.4%), and widgeon grass (-0.4%). No detectable change in percent cover was observed for manatee grass. Trends in percent cover could not be evaluated for total seagrass and drift algae due to insufficient data, and the model could not be fitted for turtle grass.

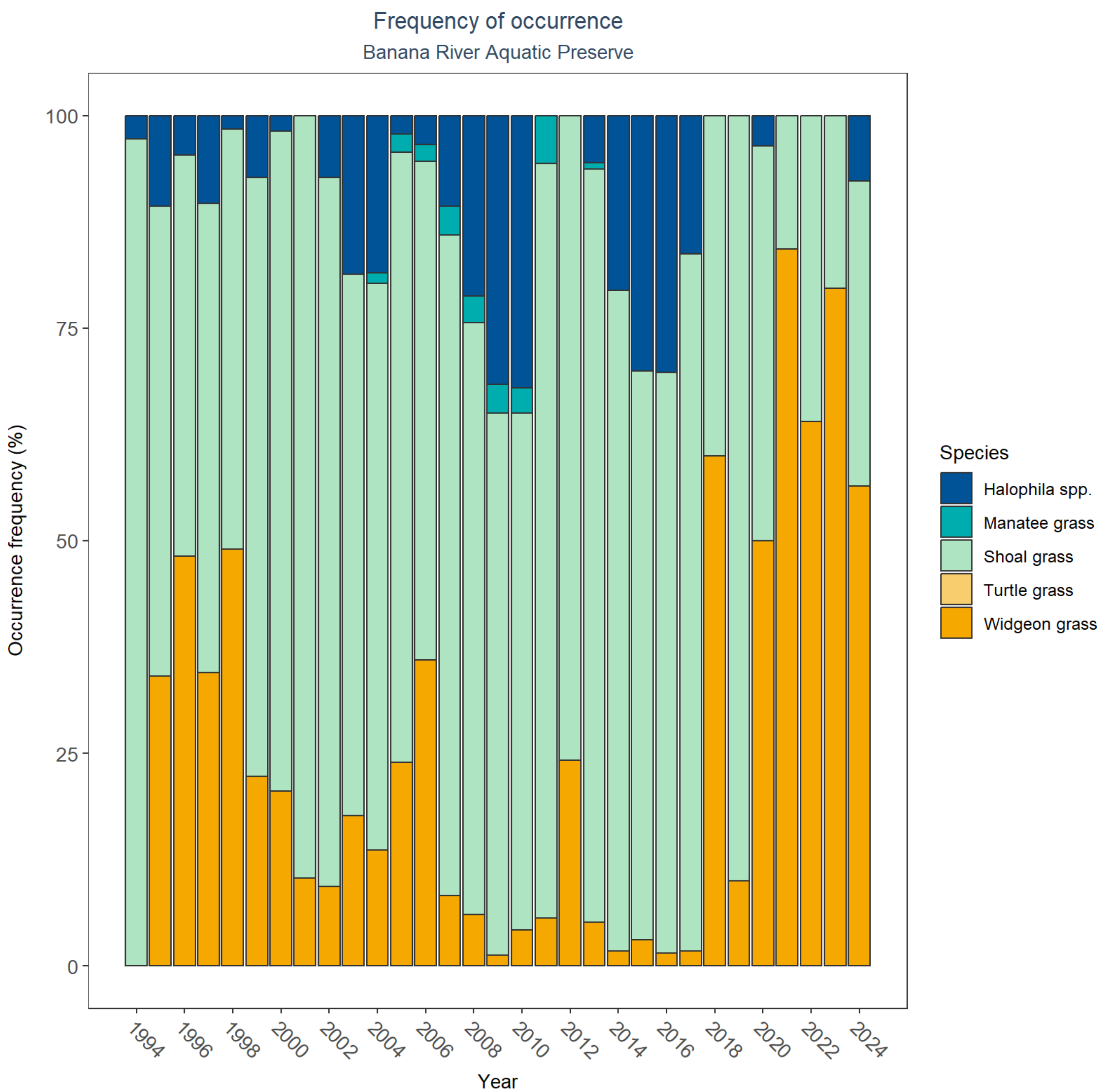

Figure 44: Frequency of occurrence for various seagrass species in Banana River Aquatic Preserve

SAV Water Column Analysis

The following parameters are available for Banana River Aquatic Preserve within the SAV_WC_Report:

- Colored Disolved Organic Matter
- Chlorophyll a
- Dissolved Oxygen
- Dissolved Oxygen Saturation
- pH
- Salinity

- Secchi Depth
- Water Temperature
- Total Nitrogen
- Total Suspended Solids
- Turbidity

Access the reports here: DRAFT_SAV_WC_Report_2024-11-20.pdf

Species list

Caulerpa[1]	Halophila engelmannii[1]	Thalassia testudinum[1]
Drift algae[1]	Halophila johnsonii[1]	Total SAV[1]
Halodule wrightii[1]	Ruppia maritima[1]	Total seagrass[1]
Halophila decipiens[1]	Syringodium filiforme[1]	Caulerpa[1]

1 - Submerged Aquatic Vegetation

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10. St. Johns River Water Management District (SJRWMD). St. Johns River Water Management District Continuous Water Quality Programs. (2024).