

St. Joseph Bay Aquatic Preserve

SEACAR Habitat Analyses

Last compiled on 08 October, 2025

Contents

Funding & Acknowledgements	2
Threshold Filtering	2
Value Qualifiers	3
Water Column	5
Seasonal Kendall-Tau Analysis	5
Water Quality - Discrete	5
Chlorophyll a, Corrected for Pheophytin - Discrete	6
Chlorophyll a, Uncorrected for Pheophytin - Discrete	7
Colored Dissolved Organic Matter - Discrete	10
Dissolved Oxygen - Discrete	11
Dissolved Oxygen Saturation - Discrete	14
pH - Discrete	15
Salinity - Discrete	18
Secchi Depth - Discrete	20
Total Nitrogen - Discrete	22
Total Phosphorus - Discrete	25
Turbidity - Discrete	27
Water Temperature - Discrete	28
Water Quality - Continuous	32
Dissolved Oxygen - Continuous	34
Dissolved Oxygen Saturation - Continuous	36
pH - Continuous	38
Salinity - Continuous	40
Turbidity - Continuous	42
Water Temperature - Continuous	44
Submerged Aquatic Vegetation	46
Parameters	46
Species	46
Notes	46
SAV Water Column Analysis	51
Species list	53
References	54

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.

With respect to documents and information available from SEACAR DDI, neither the State of Florida nor the Florida Department of Environmental Protection makes any warranty, expressed or implied, including the warranties of merchantability and fitness for a particular purpose arising out of the use or inability to use the data, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.

This report was funded in part, through a grant agreement from the Florida Department of Environmental Protection, Florida Coastal Management Program, by a grant provided by the Office for Coastal Management under the Coastal Zone Management Act of 1972, as amended, National Oceanic and Atmospheric Administration. The views, statements, findings, conclusions and recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of the State of Florida, NOAA or any of their sub agencies.

Published: 2025-10-08



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

<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-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

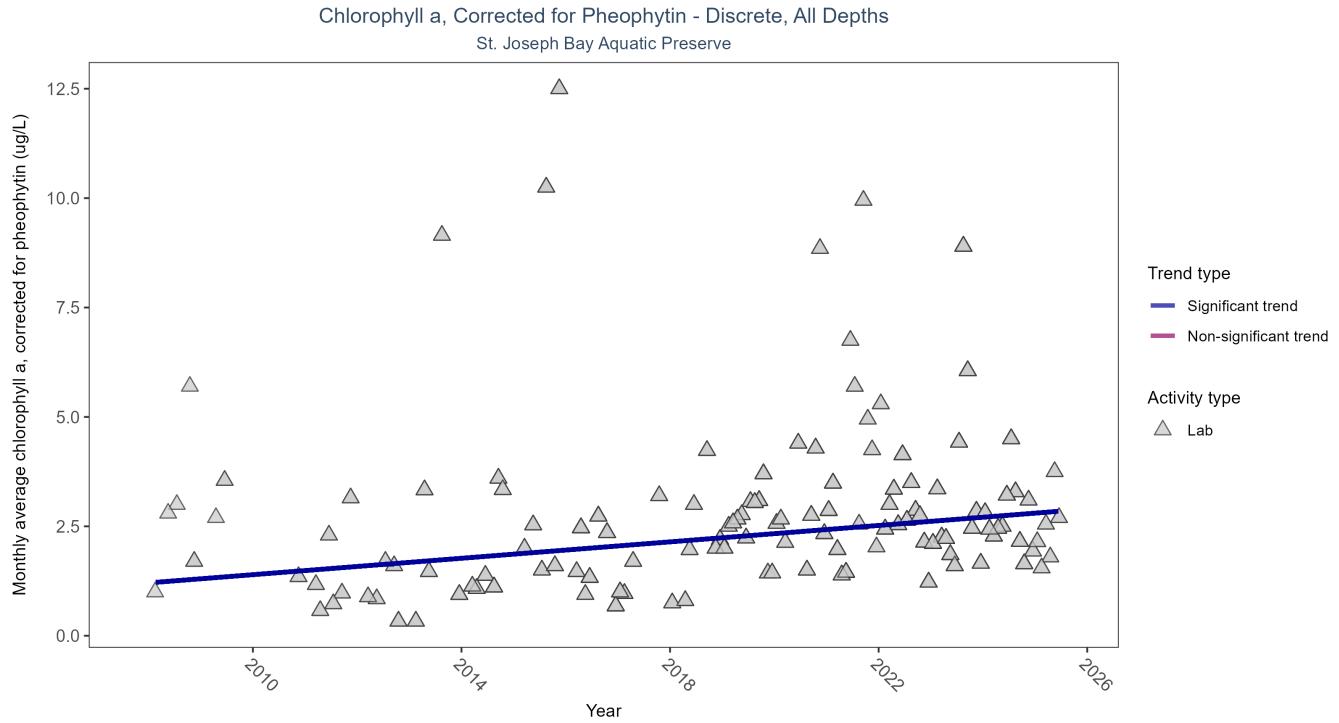


Figure 1: Scatter plot of monthly average levels of chlorophyll a, corrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles) 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 increasing trend	662	18	2008 - 2025	2.05	0.2369	1.2077	0.0938	0.001

Monthly average chlorophyll a, corrected for pheophytin, increased by 0.09 µg/L per year, indicating a decrease in water clarity.

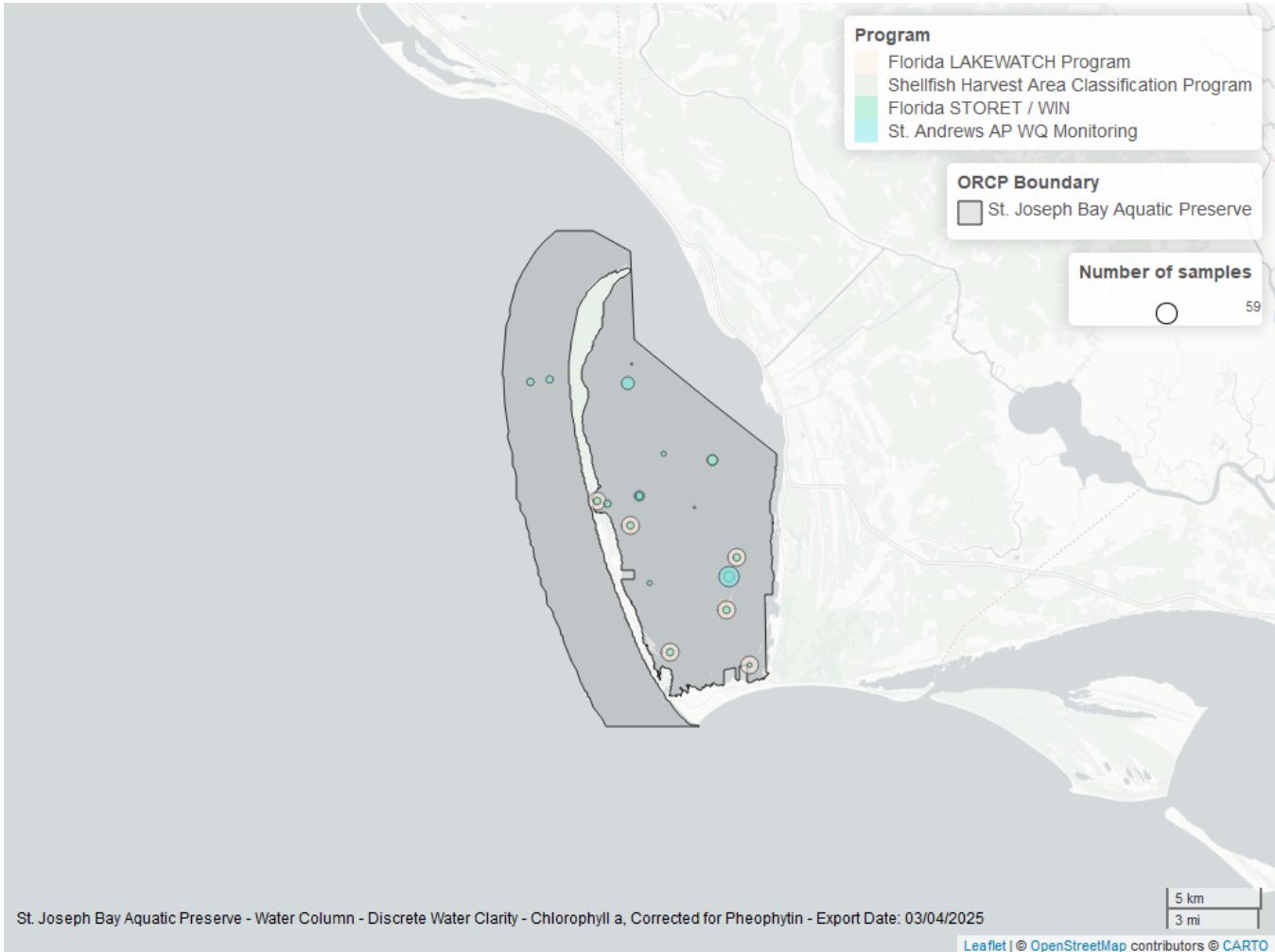


Figure 2: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
514	306	2018	2024
470	174	2019	2025
5002	145	2008	2017
540	39	2015	2019

Program names:

470 - St. Andrews Aquatic Preserve Water Quality Monitoring¹

514 - Florida LAKEWATCH Program²

540 - Shellfish Harvest Area Classification Program³

5002 - Florida STORET / WIN⁴

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

Chlorophyll a, Uncorrected for Pheophytin - Discrete, All Depths
St. Joseph Bay Aquatic Preserve

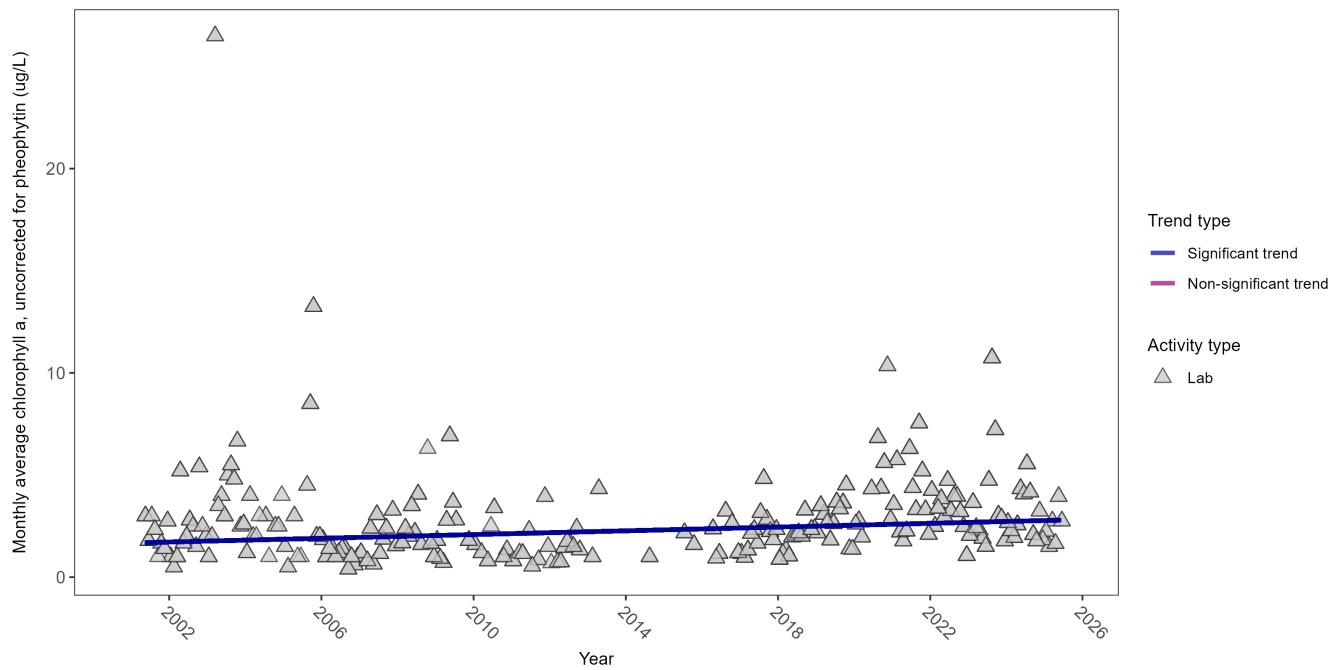


Figure 3: Scatter plot of monthly average levels of chlorophyll a, uncorrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles) 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	1278	25	2001 - 2025	2	0.1853	1.6738	0.0458	0.0002

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

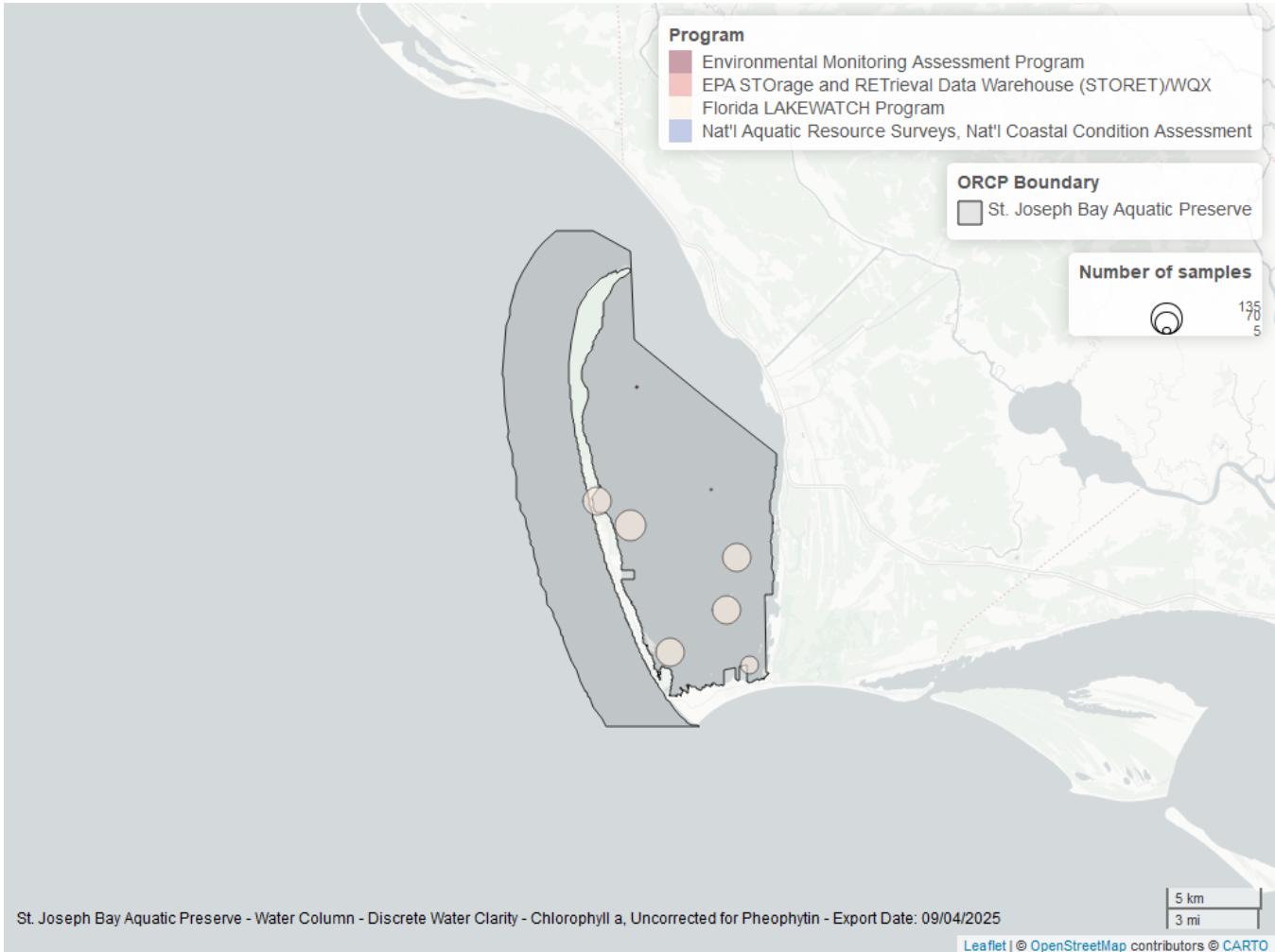


Figure 4: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
514	1020	2001	2024
470	174	2019	2025
5002	49	2008	2017
540	35	2017	2019
103	2	2002	2015
60	2	2009	2009
115	1	2002	2002
118	1	2010	2010

Program names:

- 60 - Southeast Area Monitoring and Assessment Program (SEAMAP) - Gulf of Mexico Fall & Summer Shrimp/Groundfish Survey⁵
- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX⁶
- 115 - Environmental Monitoring Assessment Program⁷
- 118 - National Aquatic Resource Surveys, National Coastal Condition Assessment⁸

470 - St. Andrews Aquatic Preserve Water Quality Monitoring¹

514 - Florida LAKEWATCH Program²

540 - Shellfish Harvest Area Classification Program³

5002 - Florida STORET / WIN⁴

Colored Dissolved Organic Matter - Discrete

Seasonal Kendall-Tau Trend Analysis

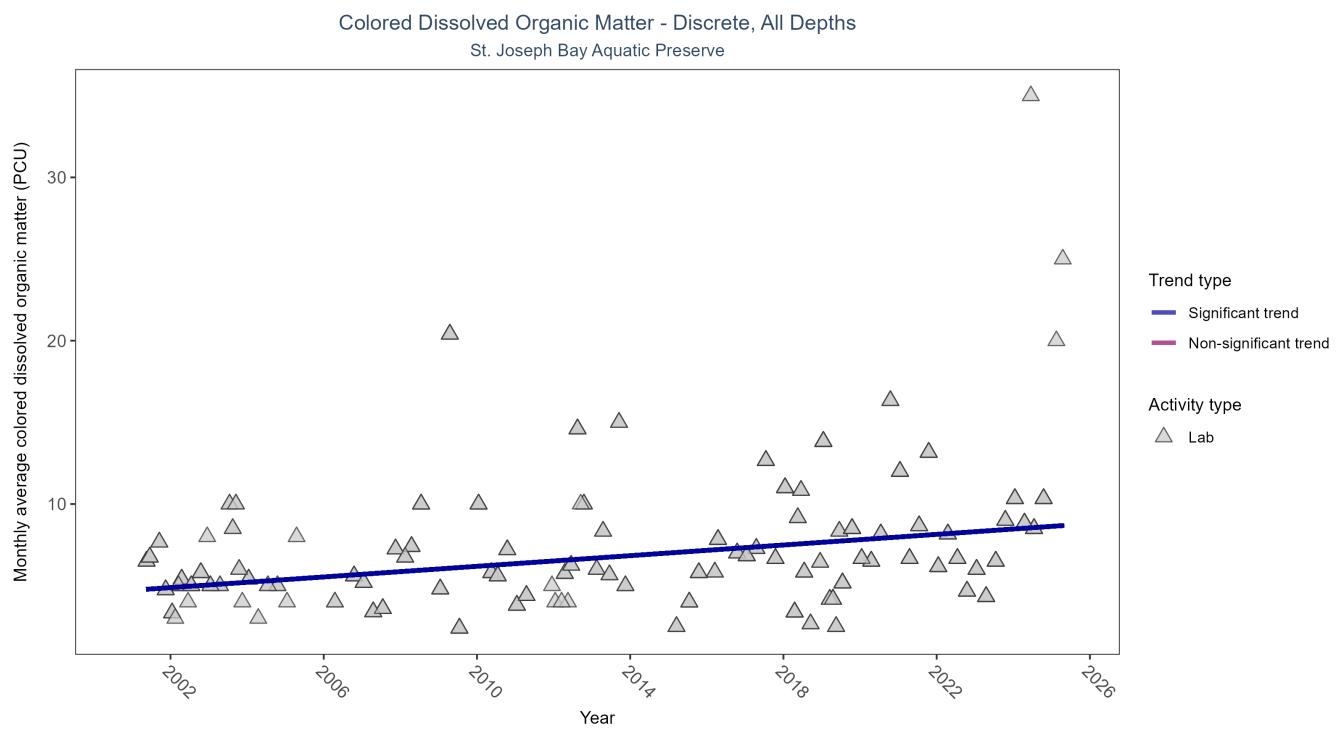


Figure 5: Scatter plot of monthly average colored dissolved organic matter (CDOM) over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed CDOM (triangles) is included in the 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 increasing trend	456	24	2001 - 2025	6	0.2829	4.7194	0.163	0.0002

Monthly average colored dissolved organic matter increased by 0.16 PCU per year, indicating a decrease in water clarity.

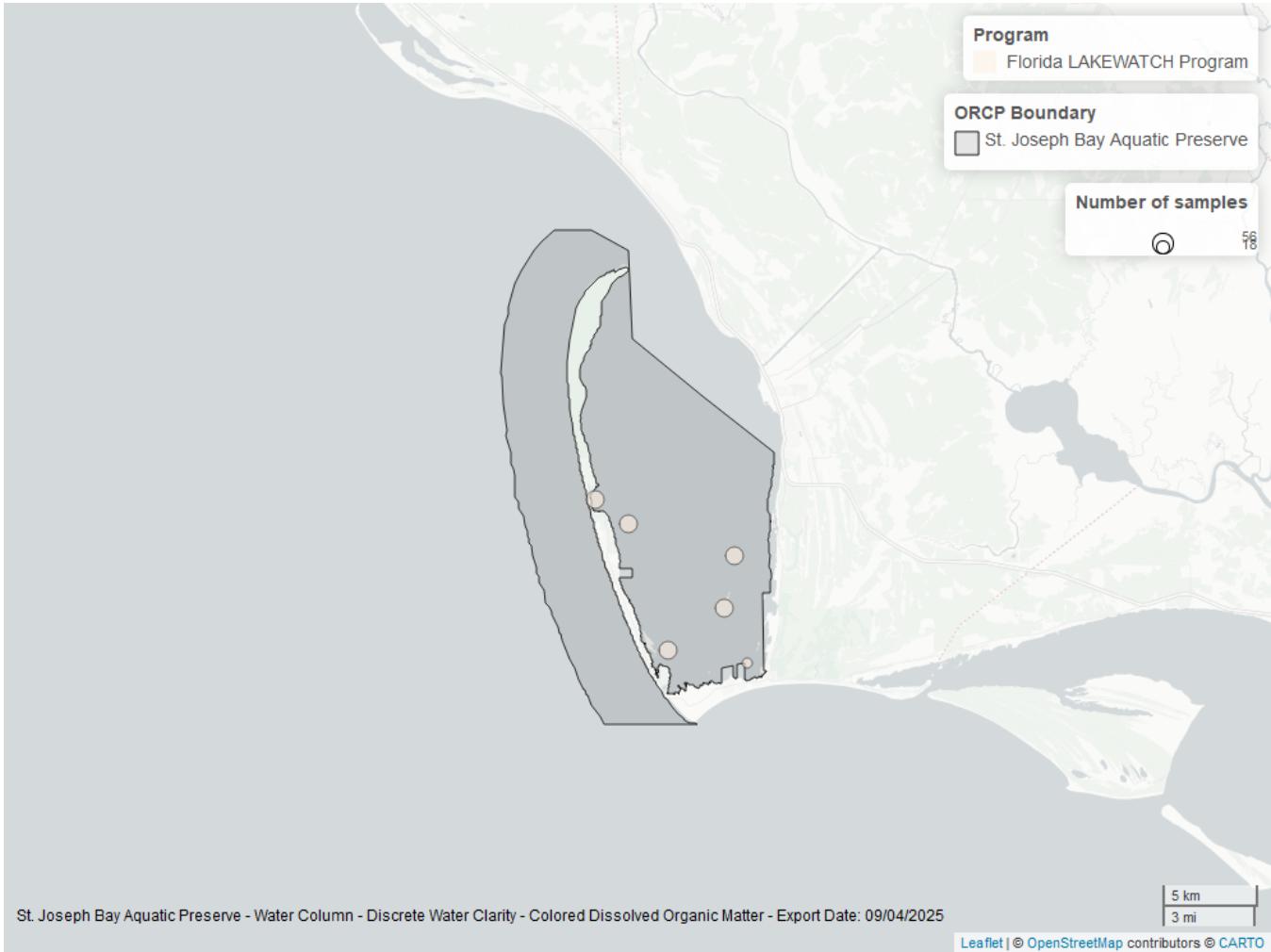


Figure 6: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 11: Programs contributing data for Colored Dissolved Organic Matter

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
514	414	2001	2024
540	39	2015	2019
5002	3	2024	2025

Program names:

514 - Florida LAKEWATCH Program²

540 - Shellfish Harvest Area Classification Program³

5002 - Florida STORET / WIN⁴

Dissolved Oxygen - Discrete

Seasonal Kendall-Tau Trend Analysis

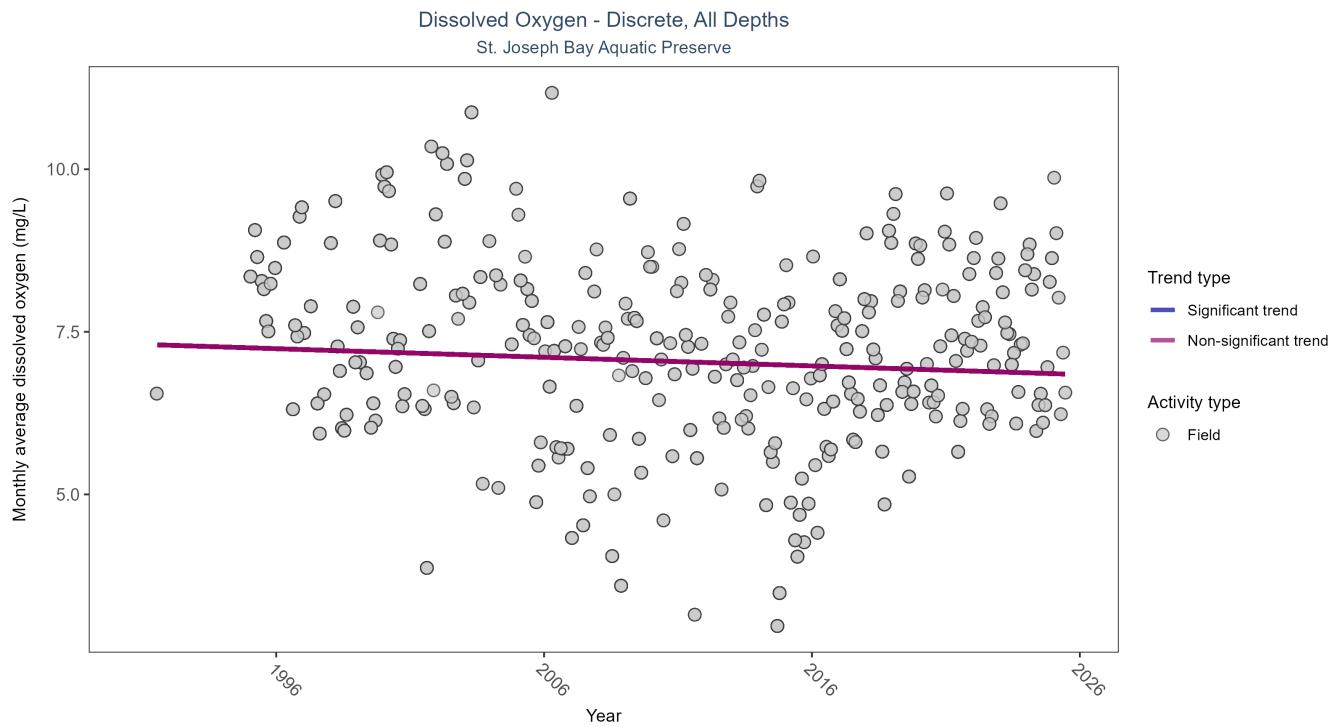


Figure 7: Scatter plot of monthly average dissolved oxygen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen values measured in the field (circles) are included in the plot.

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

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	τ	Sen Intercept	Sen Slope	p
Field	No significant trend	6345	32	1991 - 2025	7.14	-0.0651	7.3071	-0.0132	0.0638

Dissolved oxygen showed no detectable trend between 1991 and 2025.

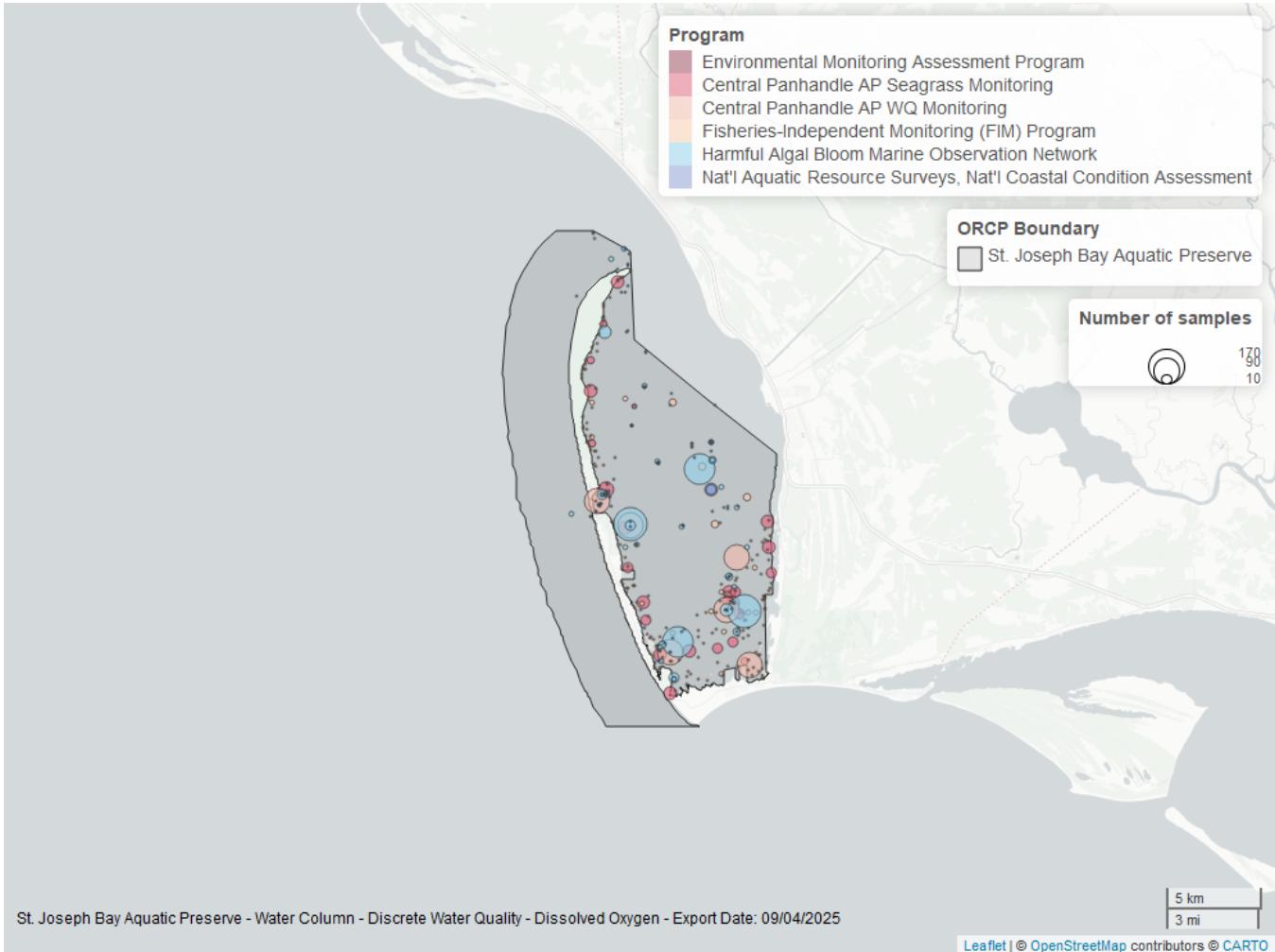


Figure 8: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 13: Programs contributing data for Dissolved Oxygen

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	3680	1995	2025
95	962	1997	2018
469	594	2016	2024
557	474	2003	2023
69	381	2001	2019
470	174	2019	2025
540	39	2015	2019
118	39	2015	2021
103	15	2015	2015
60	8	2009	2015
115	4	1991	1991

Program names:

60 - Southeast Area Monitoring and Assessment Program (SEAMAP) - Gulf of Mexico Fall & Summer Shrimp/Groundfish Survey⁵

- 69 - Fisheries-Independent Monitoring (FIM) Program⁹
 95 - Harmful Algal Bloom Marine Observation Network¹⁰
 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX⁶
 115 - Environmental Monitoring Assessment Program⁷
 118 - National Aquatic Resource Surveys, National Coastal Condition Assessment⁸
 469 - Central Panhandle Aquatic Preserve WQ Monitoring¹¹
 470 - St. Andrews Aquatic Preserve Water Quality Monitoring¹
 540 - Shellfish Harvest Area Classification Program³
 557 - Central Panhandle Aquatic Preserves Seagrass Monitoring¹²
 5002 - Florida STORET / WIN⁴

Dissolved Oxygen Saturation - Discrete

Seasonal Kendall-Tau Trend Analysis

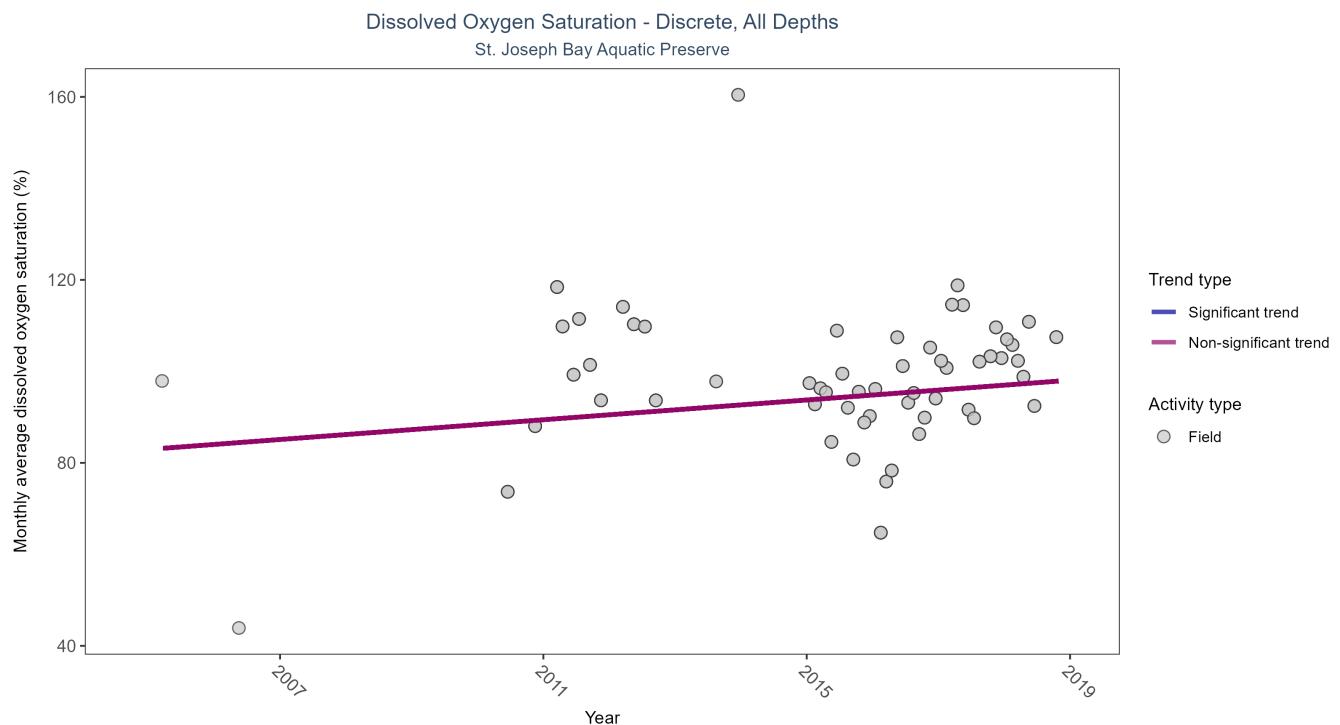


Figure 9: Scatter plot of monthly average dissolved oxygen saturation over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen saturation values measured in the field (circles) 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	No significant trend	274	10	2005 - 2018	99.9	0.1494	82.9424	1.08	0.3258

Dissolved oxygen saturation showed no detectable trend between 2005 and 2018.

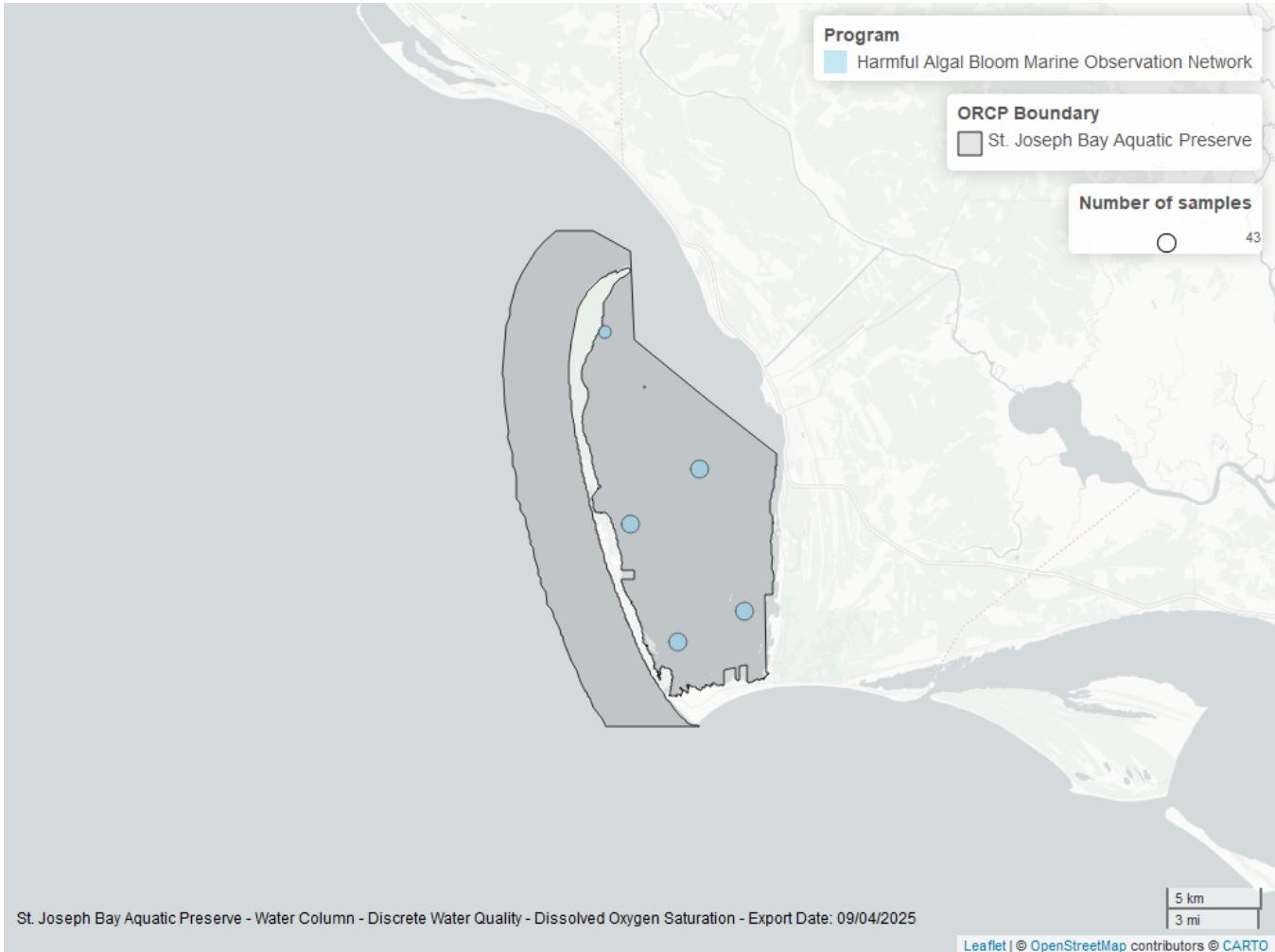


Figure 10: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 15: Programs contributing data for Dissolved Oxygen Saturation

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
95	202	2006	2018
5002	76	2005	2016

Program names:

95 - Harmful Algal Bloom Marine Observation Network¹⁰

5002 - Florida STORET / WIN⁴

pH - Discrete

Seasonal Kendall-Tau Trend Analysis

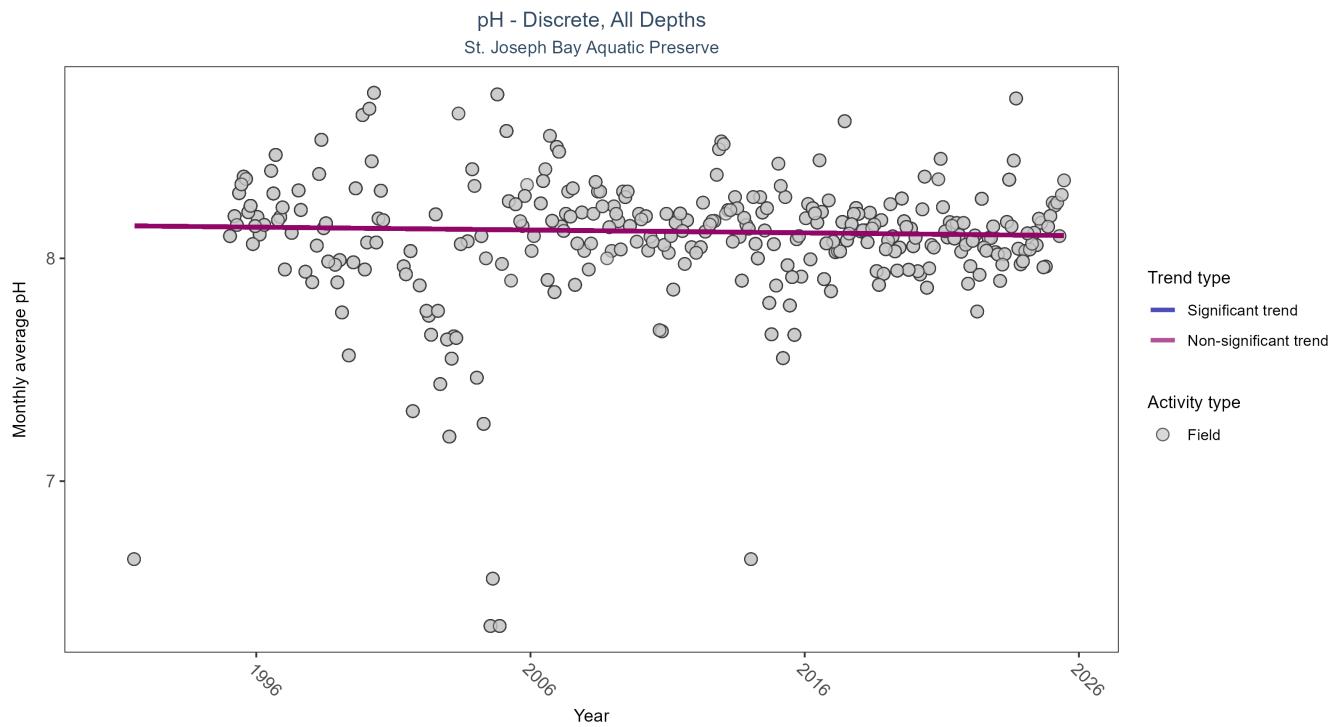


Figure 11: Scatter plot of monthly average pH over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only pH values measured in the field (circles) are included in the plot.

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	4543	32	1991 - 2025	8.1	-0.0523	8.1464	-0.0013	0.2039

pH showed no detectable trend between 1991 and 2025.

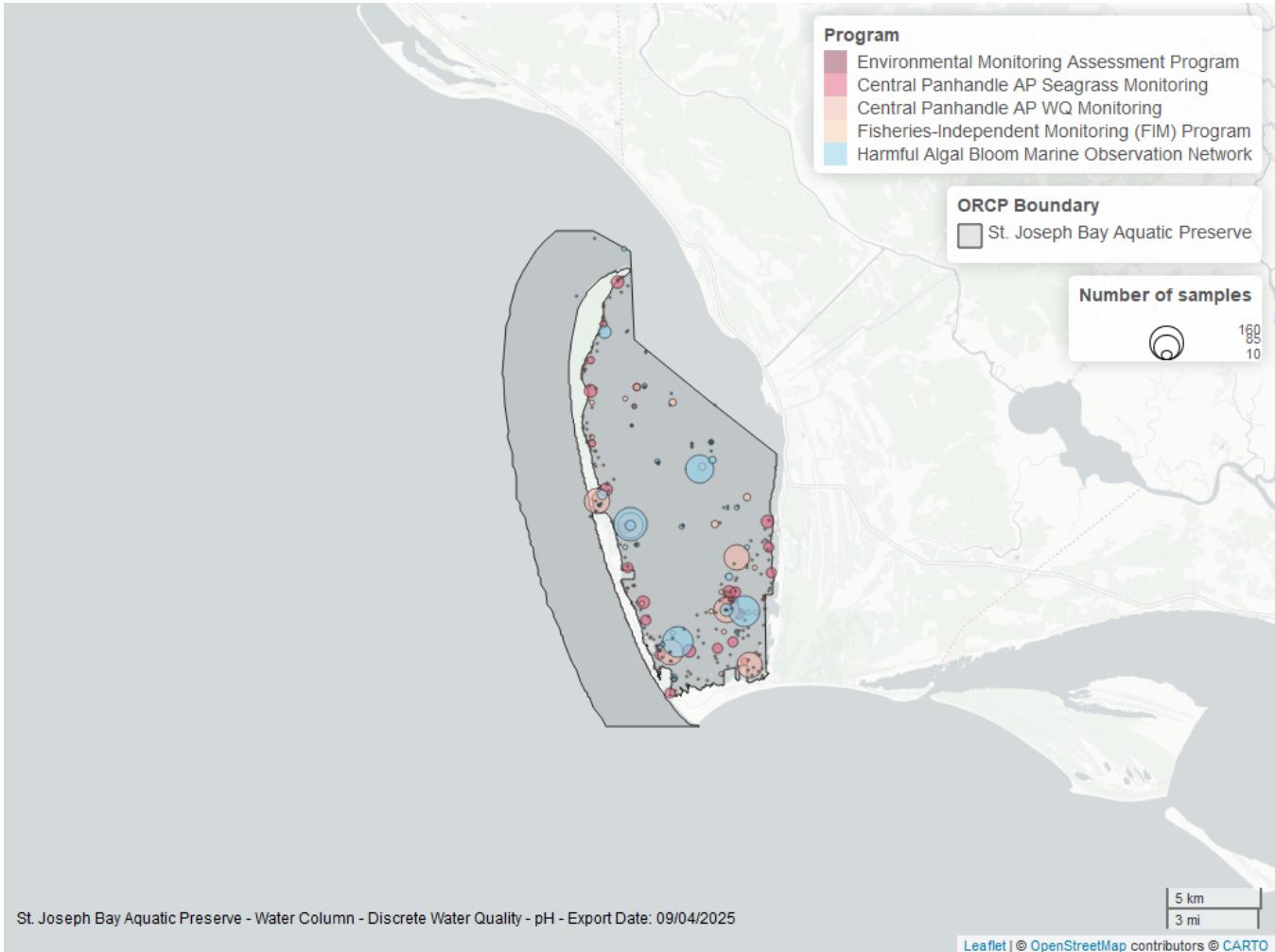


Figure 12: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 17: Programs contributing data for pH

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	2043	1995	2025
95	867	2003	2018
469	594	2016	2024
69	409	2001	2019
557	399	2003	2023
470	174	2019	2025
540	39	2015	2019
115	16	1991	2002
103	9	2015	2015

Program names:

- 69 - Fisheries-Independent Monitoring (FIM) Program⁹
- 95 - Harmful Algal Bloom Marine Observation Network¹⁰
- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX⁶
- 115 - Environmental Monitoring Assessment Program⁷

- 469 - Central Panhandle Aquatic Preserve WQ Monitoring¹¹
 470 - St. Andrews Aquatic Preserve Water Quality Monitoring¹
 540 - Shellfish Harvest Area Classification Program³
 557 - Central Panhandle Aquatic Preserves Seagrass Monitoring¹²
 5002 - Florida STORET / WIN⁴

Salinity - Discrete

Seasonal Kendall-Tau Trend Analysis

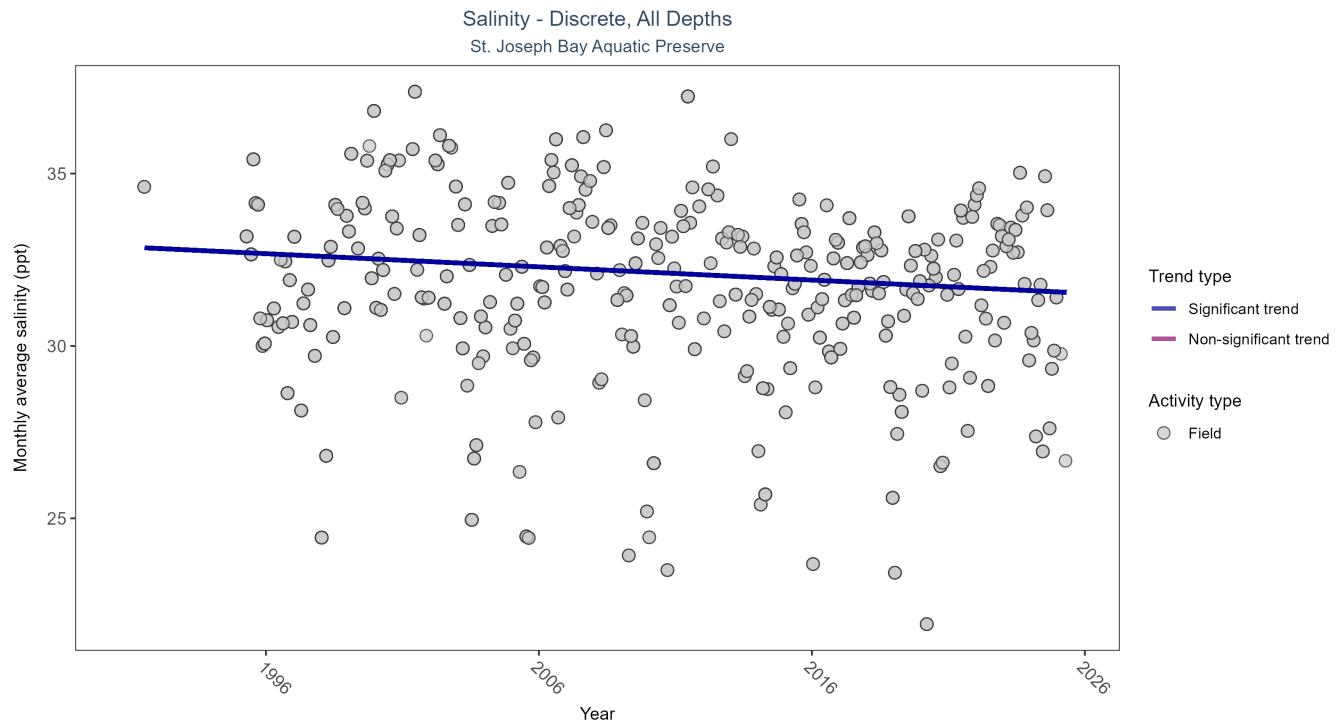


Figure 13: Scatter plot of monthly average salinity over time. If the time series included ten or more years of discrete observations, significant (blue) or non-significant (magenta) trend lines are also shown. Discrete salinity values derived from grab samples analyzed in the field (circles) or the 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 decreasing trend	6864	32	1991 - 2025	32.2	-0.1049	32.8688	-0.0383	0.0105

Monthly average salinity decreased by 0.04 ppt per year.

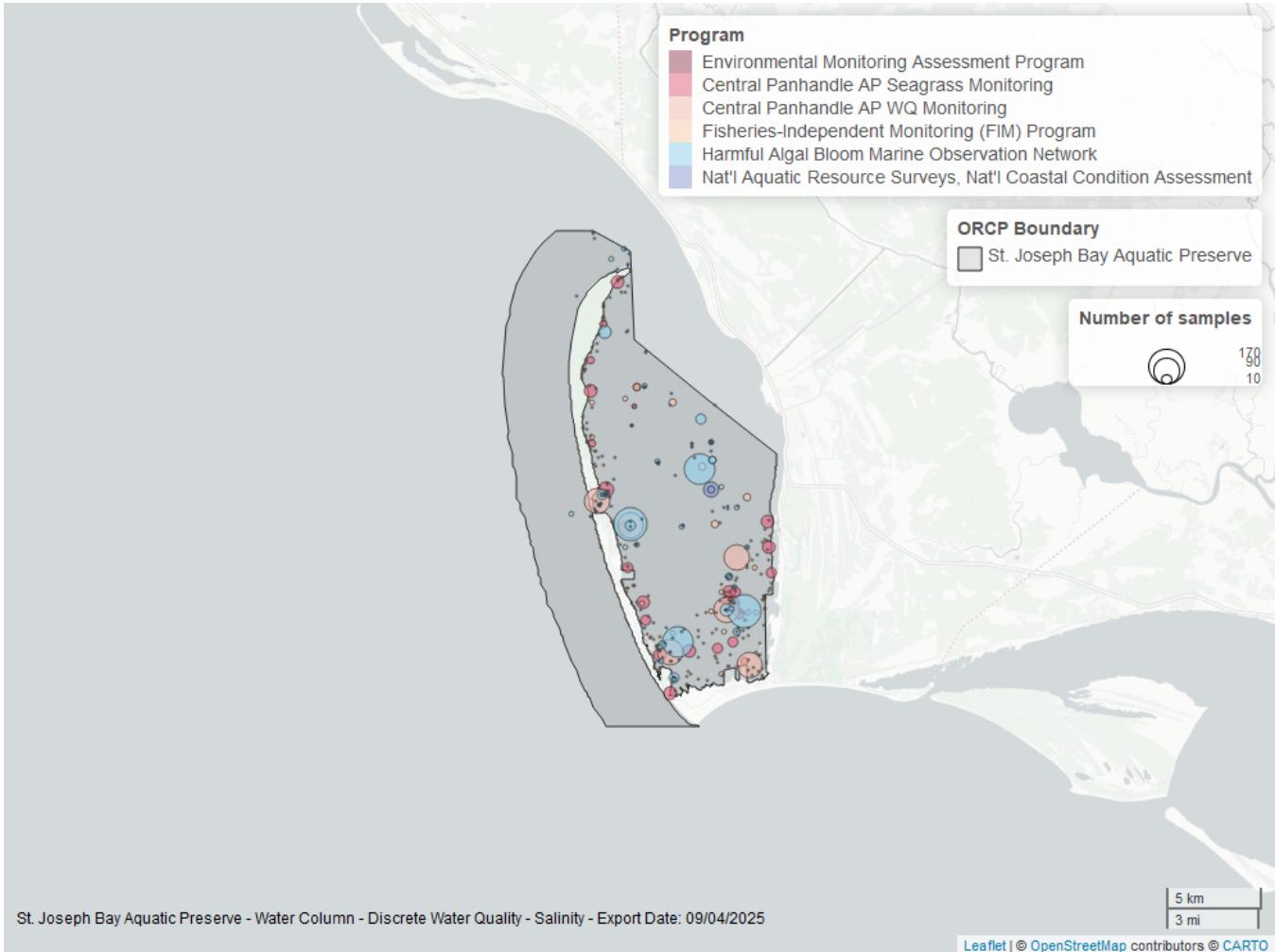


Figure 14: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 19: Programs contributing data for Salinity

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	4278	1995	2025
95	1011	1995	2018
469	593	2016	2024
557	473	2003	2023
69	410	2001	2019
118	39	2015	2021
540	36	2015	2019
115	16	1991	2002
60	8	2009	2015
470	1	2023	2023

Program names:

60 - Southeast Area Monitoring and Assessment Program (SEAMAP) - Gulf of Mexico Fall & Summer Shrimp/Groundfish Survey⁵

69 - Fisheries-Independent Monitoring (FIM) Program⁹

- 95 - Harmful Algal Bloom Marine Observation Network¹⁰
 115 - Environmental Monitoring Assessment Program⁷
 118 - National Aquatic Resource Surveys, National Coastal Condition Assessment⁸
 469 - Central Panhandle Aquatic Preserve WQ Monitoring¹¹
 470 - St. Andrews Aquatic Preserve Water Quality Monitoring¹
 540 - Shellfish Harvest Area Classification Program³
 557 - Central Panhandle Aquatic Preserves Seagrass Monitoring¹²
 5002 - Florida STORET / WIN⁴

Secchi Depth - Discrete

Seasonal Kendall-Tau Trend Analysis

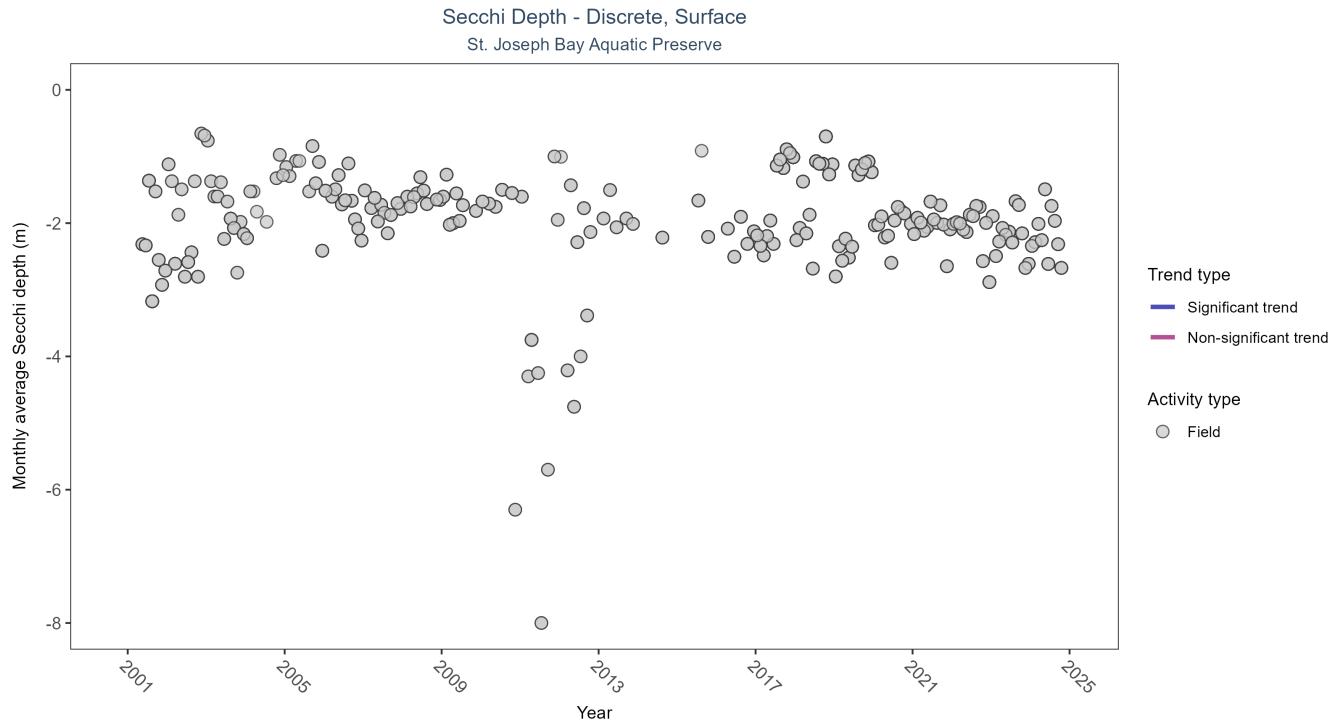


Figure 15: Scatter plot of monthly average Secchi depth over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Secchi depth is only measured in the field (circles).

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	1774	25	1991 - 2024	-1.3	-0.1517	-1.4886	-0.0179	0.0035

Monthly average Secchi depth became deeper by 0.02 m per year, indicating an increase in water clarity.

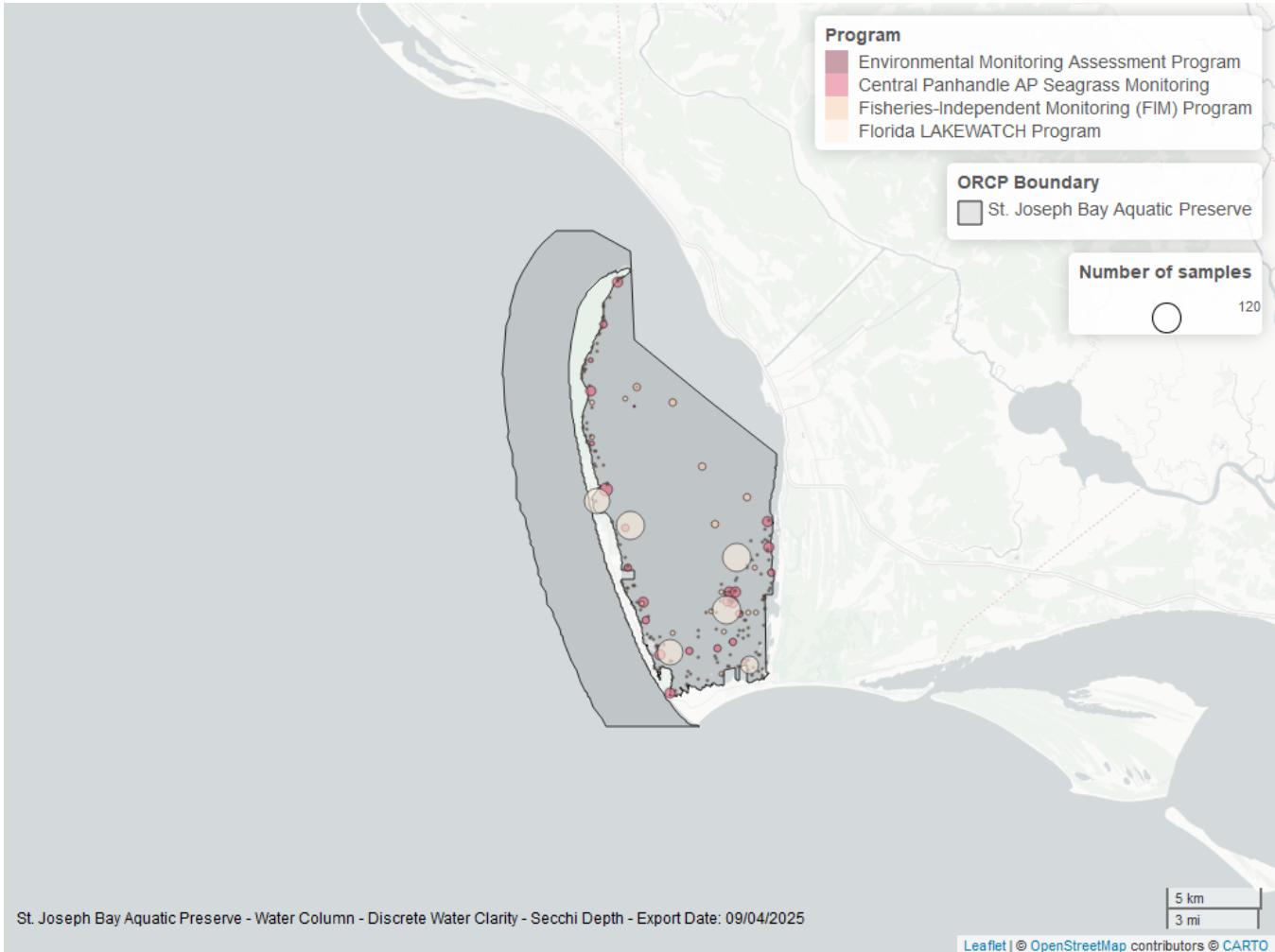


Figure 16: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 21: Programs contributing data for Secchi Depth

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
514	1023	2001	2024
69	410	2001	2019
557	309	2003	2023
5002	26	2005	2012
115	3	1991	2002
60	2	2015	2024
103	1	2015	2015

Program names:

- 60 - Southeast Area Monitoring and Assessment Program (SEAMAP) - Gulf of Mexico Fall & Summer Shrimp/Groundfish Survey⁵
- 69 - Fisheries-Independent Monitoring (FIM) Program⁹
- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX⁶
- 115 - Environmental Monitoring Assessment Program⁷
- 514 - Florida LAKEWATCH Program²

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 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

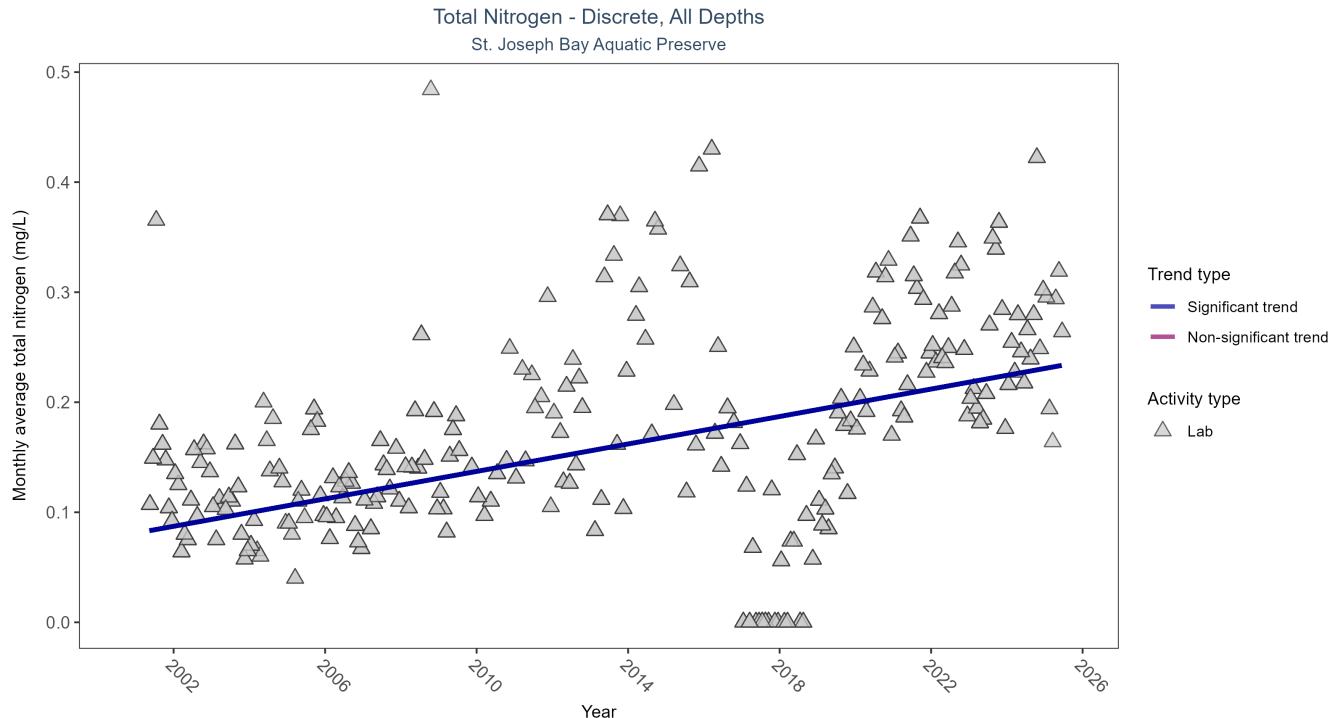


Figure 17: Scatter plot of monthly average total nitrogen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only nitrogen values obtained from laboratory analyses (triangles) are included in the 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 increasing trend	1815	25	2001 - 2025	0.18	0.3905	0.081	0.0062	0

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

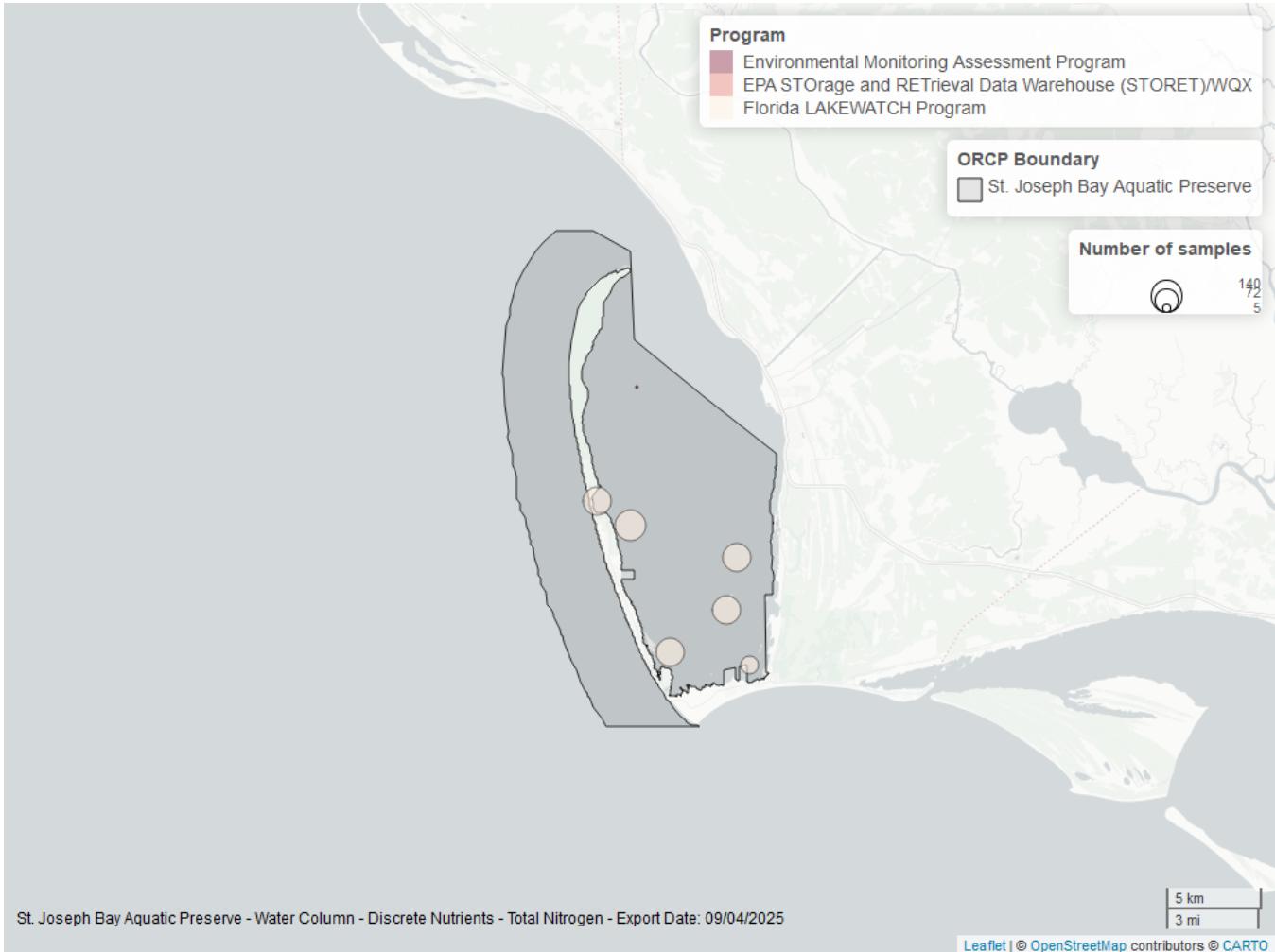


Figure 18: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 23: Programs contributing data for Total Nitrogen

ProgramID	N_Data	YearMin	YearMax
514	1075	2001	2024
5002	552	2001	2017
470	171	2019	2025
540	38	2015	2019
115	1	2002	2002
103	1	2002	2002

Program names:

- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX⁶
- 115 - Environmental Monitoring Assessment Program⁷
- 470 - St. Andrews Aquatic Preserve Water Quality Monitoring¹
- 514 - Florida LAKEWATCH Program²
- 540 - Shellfish Harvest Area Classification Program³
- 5002 - Florida STORET / WIN⁴

Total Phosphorus - Discrete

Seasonal Kendall-Tau Trend Analysis

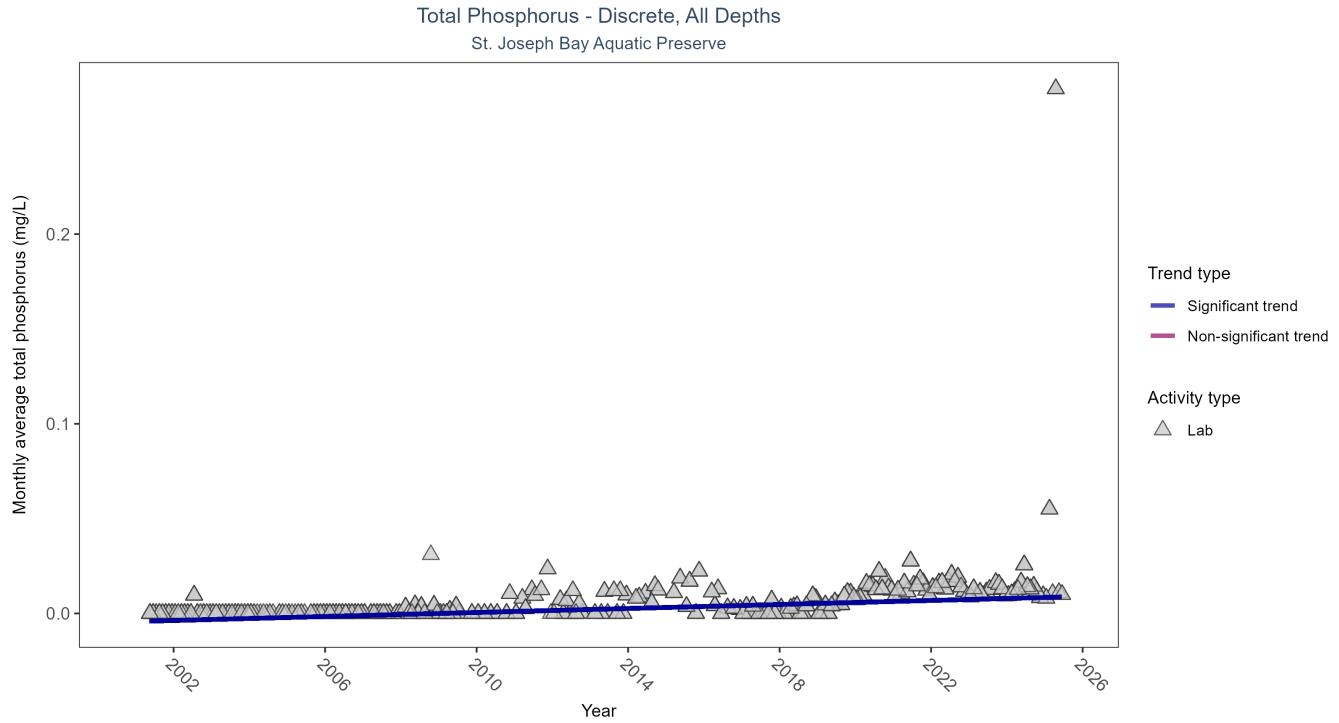


Figure 19: Scatter plot of monthly average total phosphorus over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only phosphorus values obtained from laboratory analyses (triangles) are included 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	1288	25	2001 - 2025	0	0.5512	-0.0043	0.0005	0

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

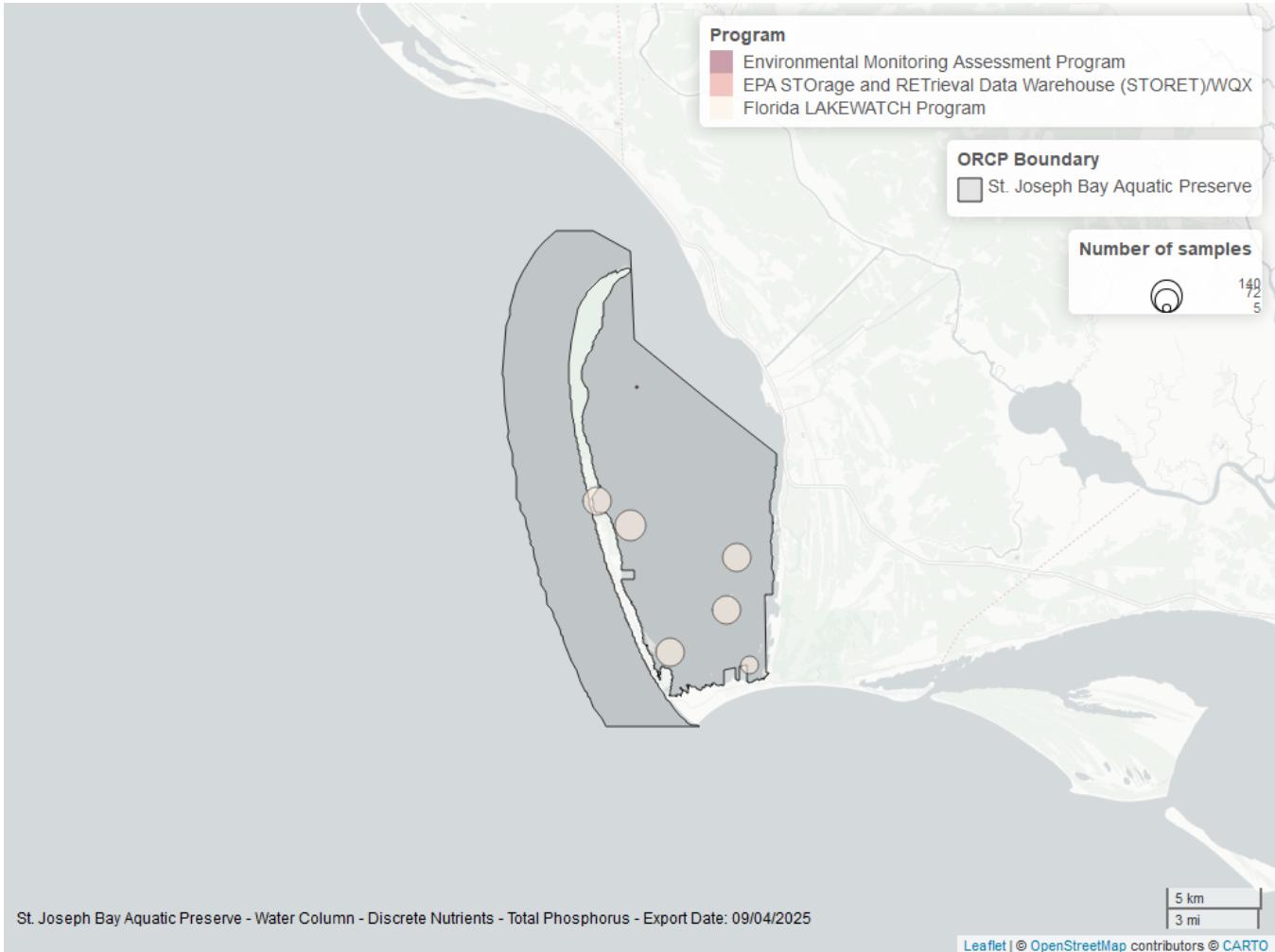


Figure 20: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 25: Programs contributing data for Total Phosphorus

ProgramID	N_Data	YearMin	YearMax
514	1060	2001	2024
470	174	2019	2025
5002	92	2008	2025
540	39	2015	2019
103	2	2002	2015
115	1	2002	2002

Program names:

- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX⁶
- 115 - Environmental Monitoring Assessment Program⁷
- 470 - St. Andrews Aquatic Preserve Water Quality Monitoring¹
- 514 - Florida LAKEWATCH Program²
- 540 - Shellfish Harvest Area Classification Program³
- 5002 - Florida STORET / WIN⁴

Turbidity - Discrete

Seasonal Kendall-Tau Trend Analysis

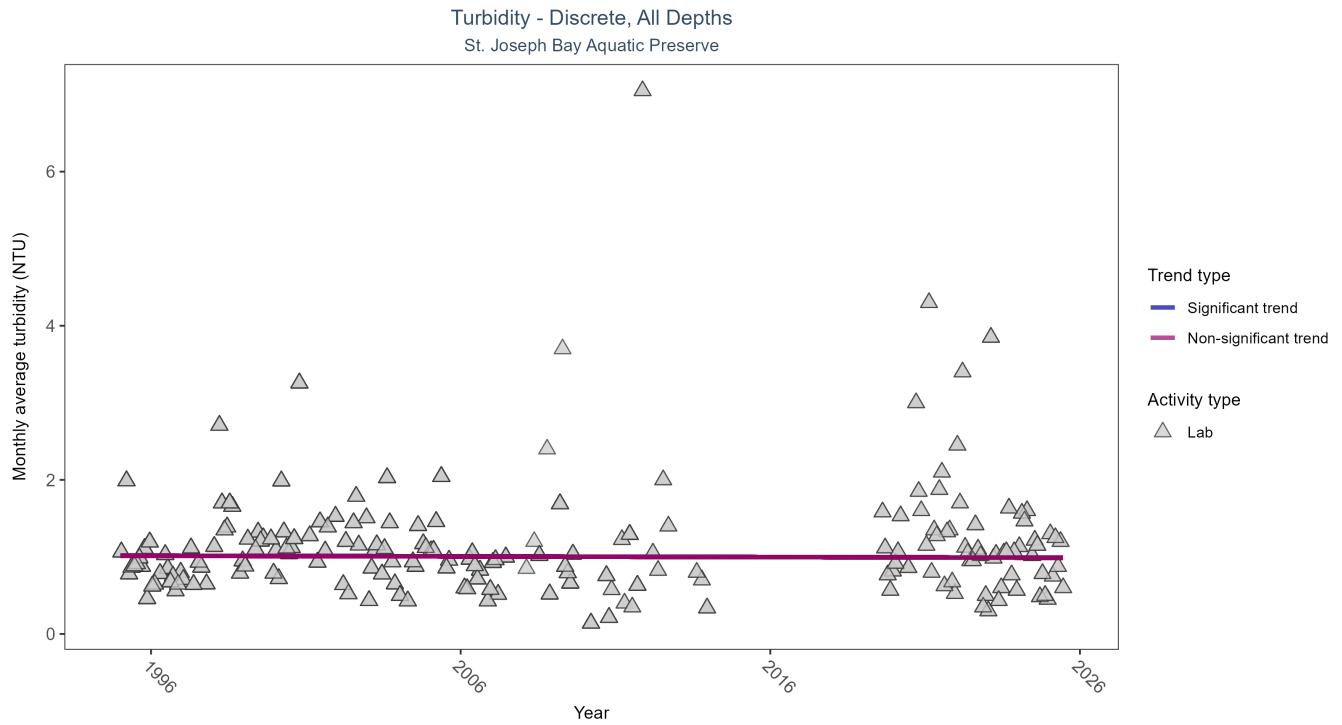


Figure 21: Scatter plot of monthly average turbidity over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only turbidity values measured in the laboratory (triangles) are included in the plot.

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	2650	26	1995 - 2025	0.9	-0.0109	1.0162	-0.0009	0.8613

Turbidity showed no detectable trend between 1995 and 2025.

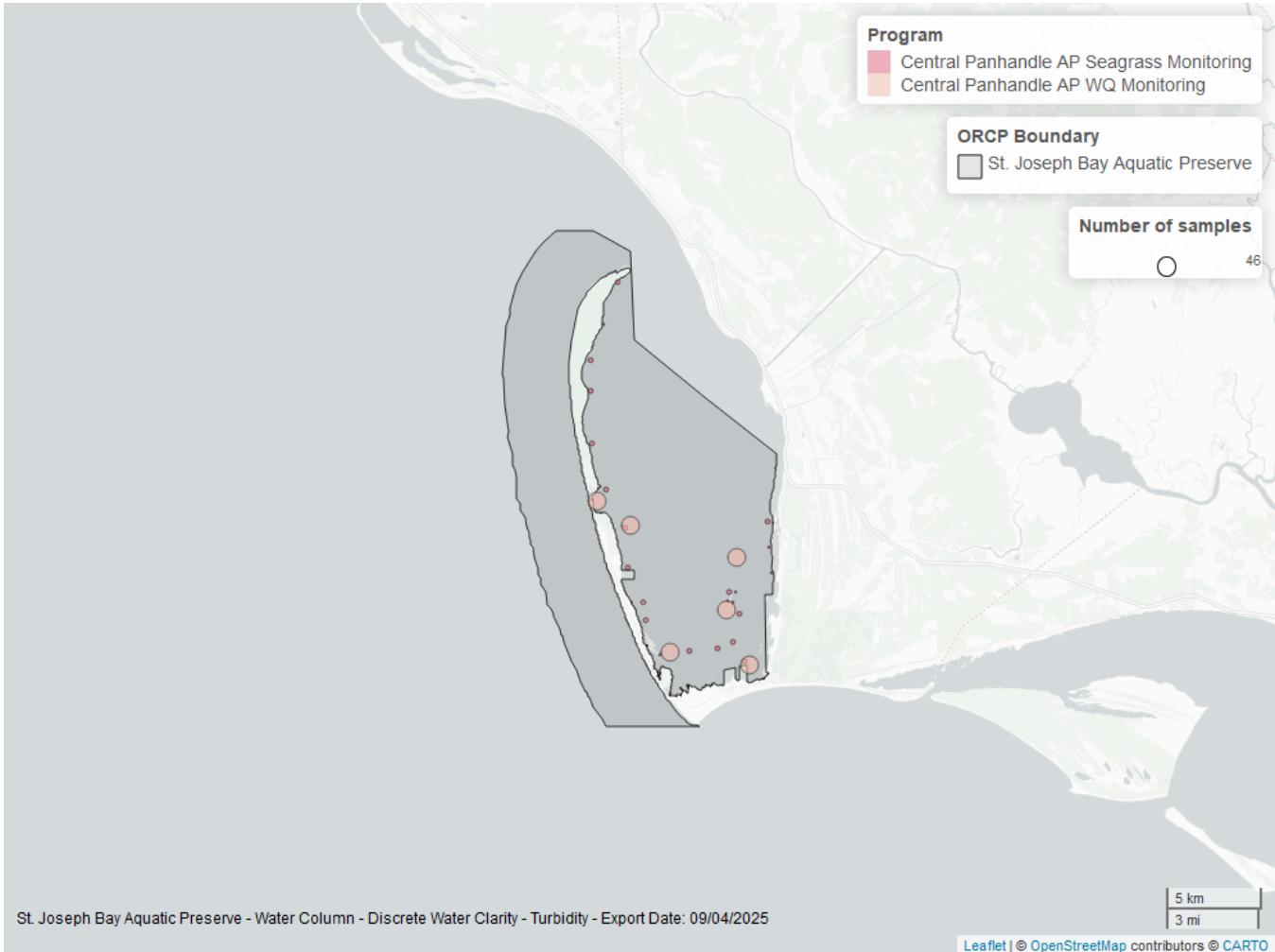


Figure 22: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 27: Programs contributing data for Turbidity

ProgramID	N_Data	YearMin	YearMax
5002	2487	1995	2025
469	276	2021	2024
470	168	2019	2025
557	64	2022	2023

Program names:

- 469 - Central Panhandle Aquatic Preserve WQ Monitoring¹¹
- 470 - St. Andrews Aquatic Preserve Water Quality Monitoring¹
- 557 - Central Panhandle Aquatic Preserves Seagrass Monitoring¹²
- 5002 - Florida STORET / WIN⁴

Water Temperature - Discrete Seasonal Kendall-Tau Trend Analysis

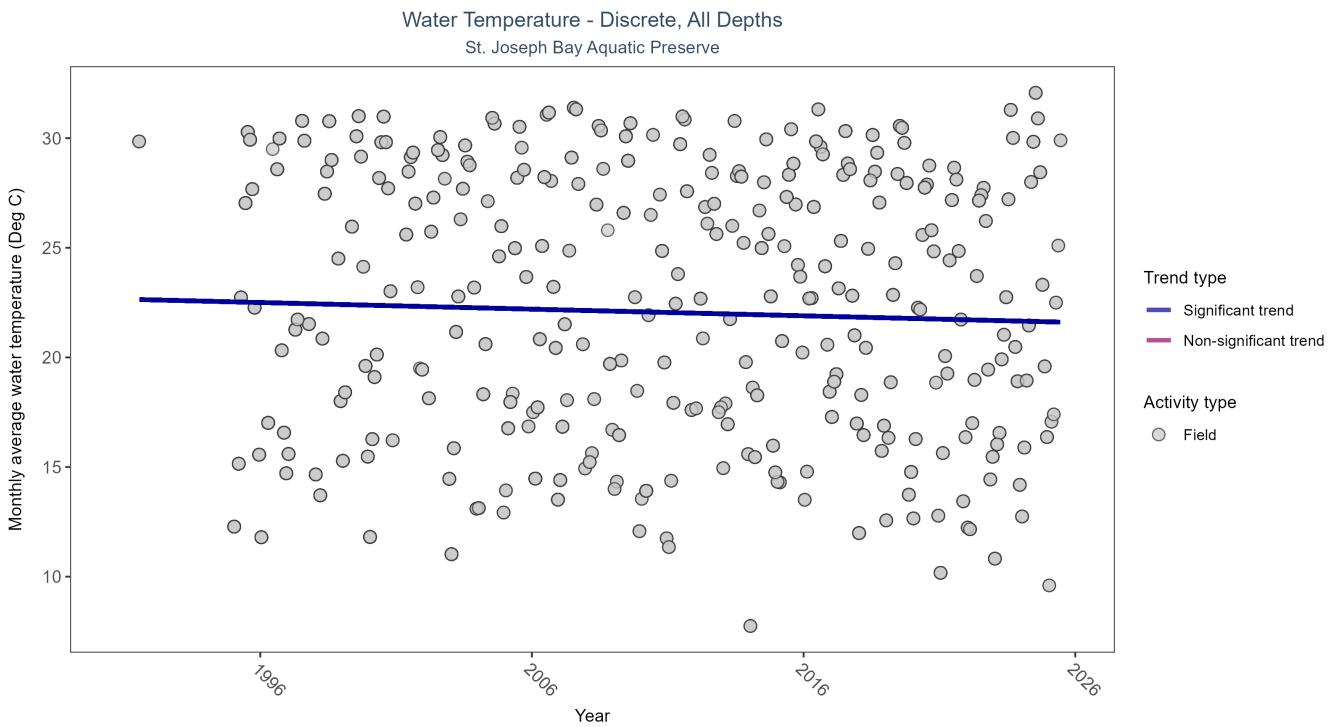


Figure 23: Scatter plot of monthly average water temperature over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only water temperature measurements taken in the field (circles) are included in 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 decreasing trend	7157	32	1991 - 2025	25.5	-0.0826	22.6543	-0.0303	0.032

Monthly average water temperature decreased by 0.03°C per year.

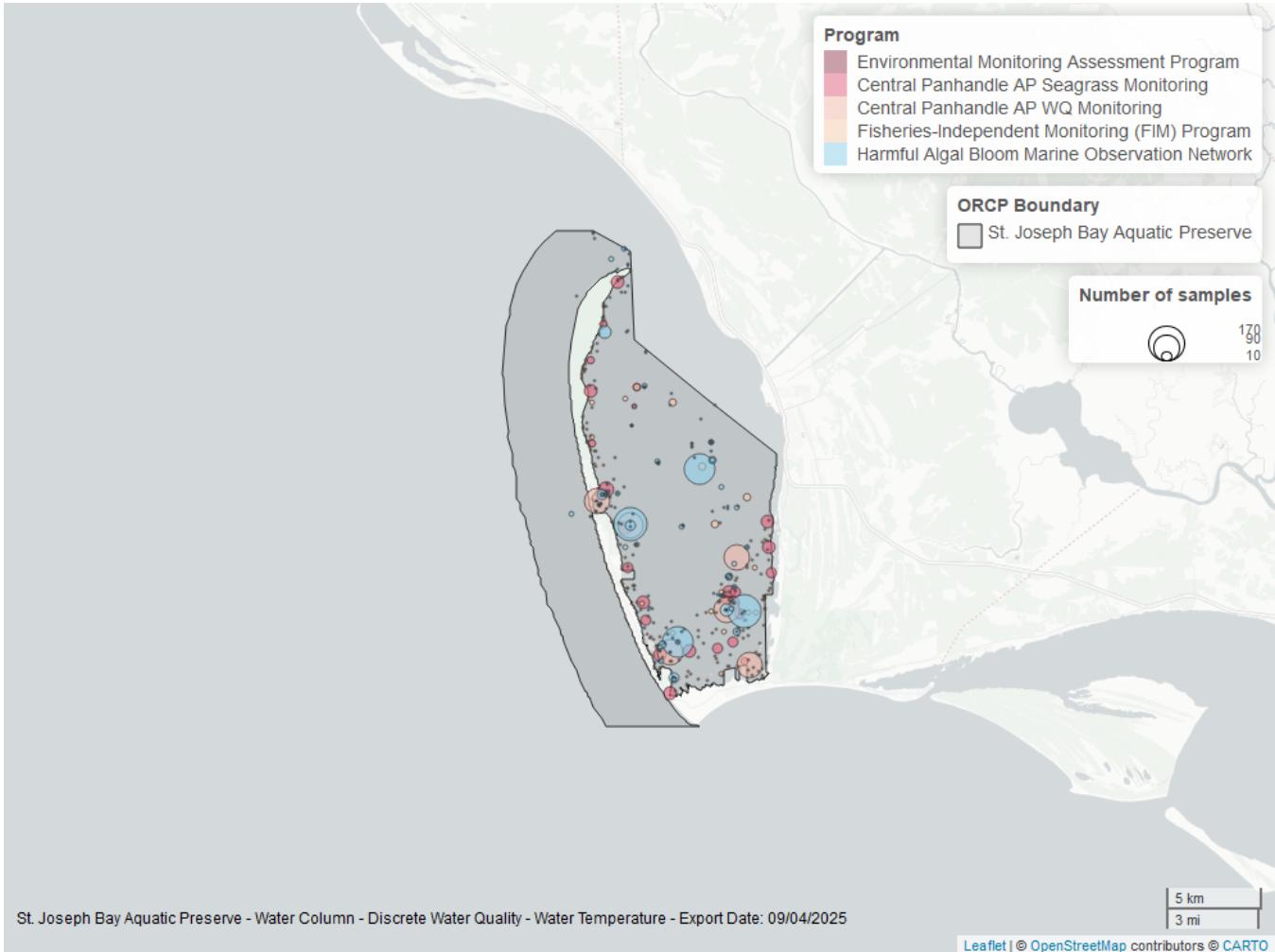


Figure 24: Map showing location of discrete water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 29: Programs contributing data for Water Temperature

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	4409	1995	2025
95	1037	1996	2018
469	594	2016	2024
557	474	2003	2023
69	410	2001	2019
470	174	2019	2025
540	39	2015	2019
115	16	1991	2002
60	7	2009	2015

Program names:

- 60 - Southeast Area Monitoring and Assessment Program (SEAMAP) - Gulf of Mexico Fall & Summer Shrimp/Groundfish Survey⁵
 69 - Fisheries-Independent Monitoring (FIM) Program⁹
 95 - Harmful Algal Bloom Marine Observation Network¹⁰

- 115 - Environmental Monitoring Assessment Program⁷
- 469 - Central Panhandle Aquatic Preserve WQ Monitoring¹¹
- 470 - St. Andrews Aquatic Preserve Water Quality Monitoring¹
- 540 - Shellfish Harvest Area Classification Program³
- 557 - Central Panhandle Aquatic Preserves Seagrass Monitoring¹²
- 5002 - Florida STORET / WIN⁴

Water Quality - Continuous

The following files were used in the continuous analysis:

- *Combined_WQ_WC_NUT_cont_Dissolved_Oxygen_NW-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Dissolved_Oxygen_Saturation_NW-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_pH_NW-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Salinity_NW-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Turbidity_NW-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Water_Temperature_NW-2025-Sep-19.txt*

Continuous monitoring locations in St. Joseph 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>
468	CPRH	6	TRUE	DO
468	CPRH	7	TRUE	DOS , pH , Sal , Turb , TempW

Program names:

468 - Central Panhandle Aquatic Preserves Continuous Water Quality Monitoring¹³

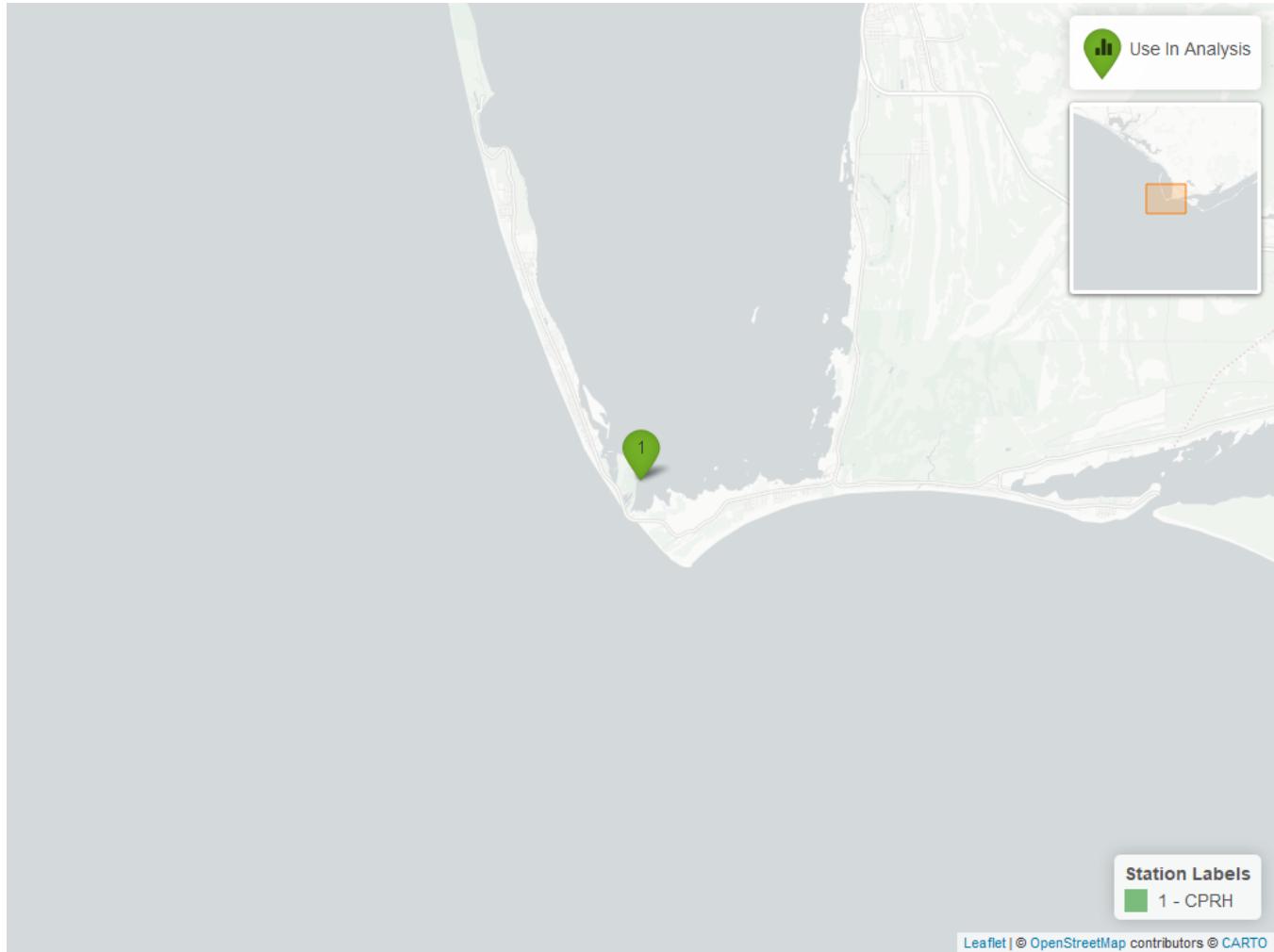


Figure 25: Map showing continuous water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. Sites marked as *Use In Analysis* (green) are featured in this report.

Dissolved Oxygen - Continuous

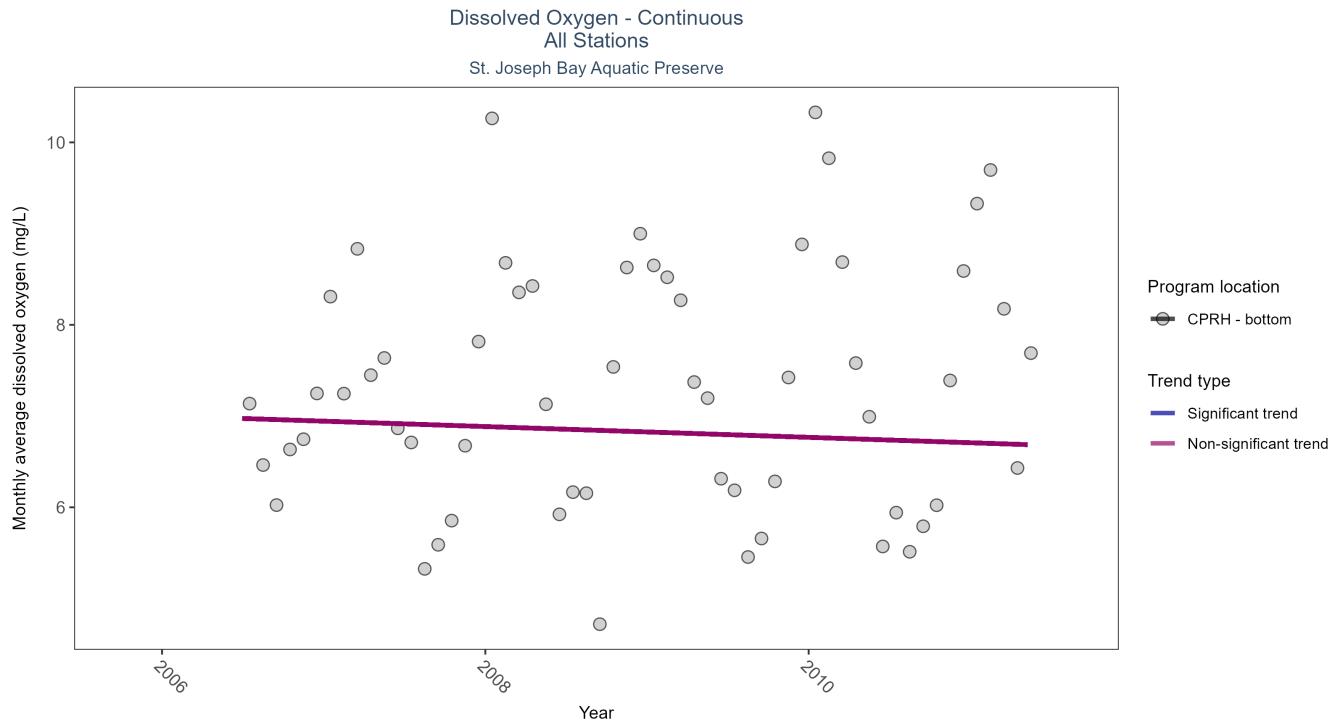


Figure 26: Scatter plot of monthly average dissolved oxygen over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

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
CPRH	No significant trend	73589	6	2006 - 2011	7.3	-0.1	7	-0.06	0.52

No detectable change in monthly average dissolved oxygen was observed at one location.

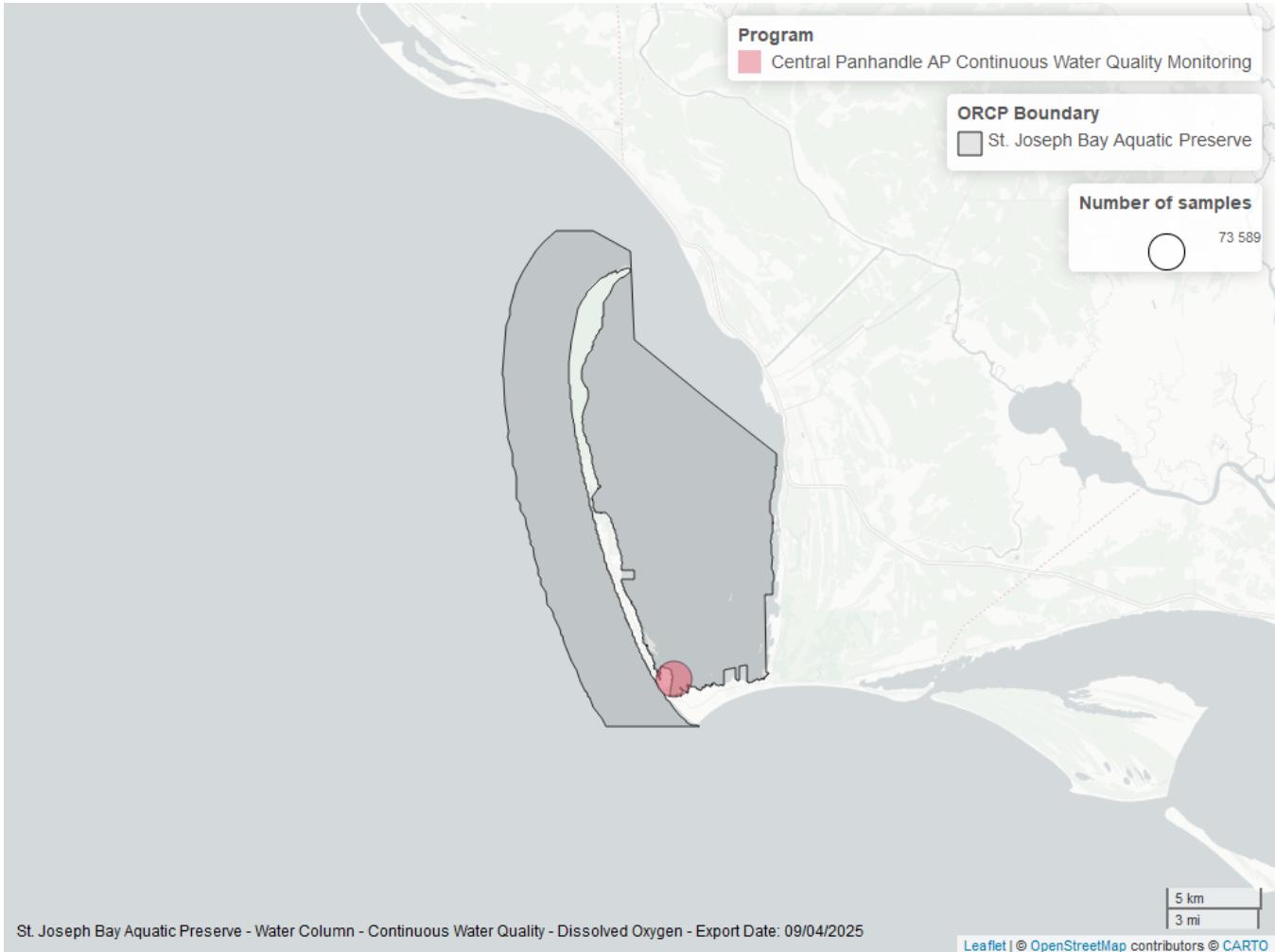


Figure 27: Map showing location of dissolved oxygen continuous water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Dissolved Oxygen Saturation - Continuous

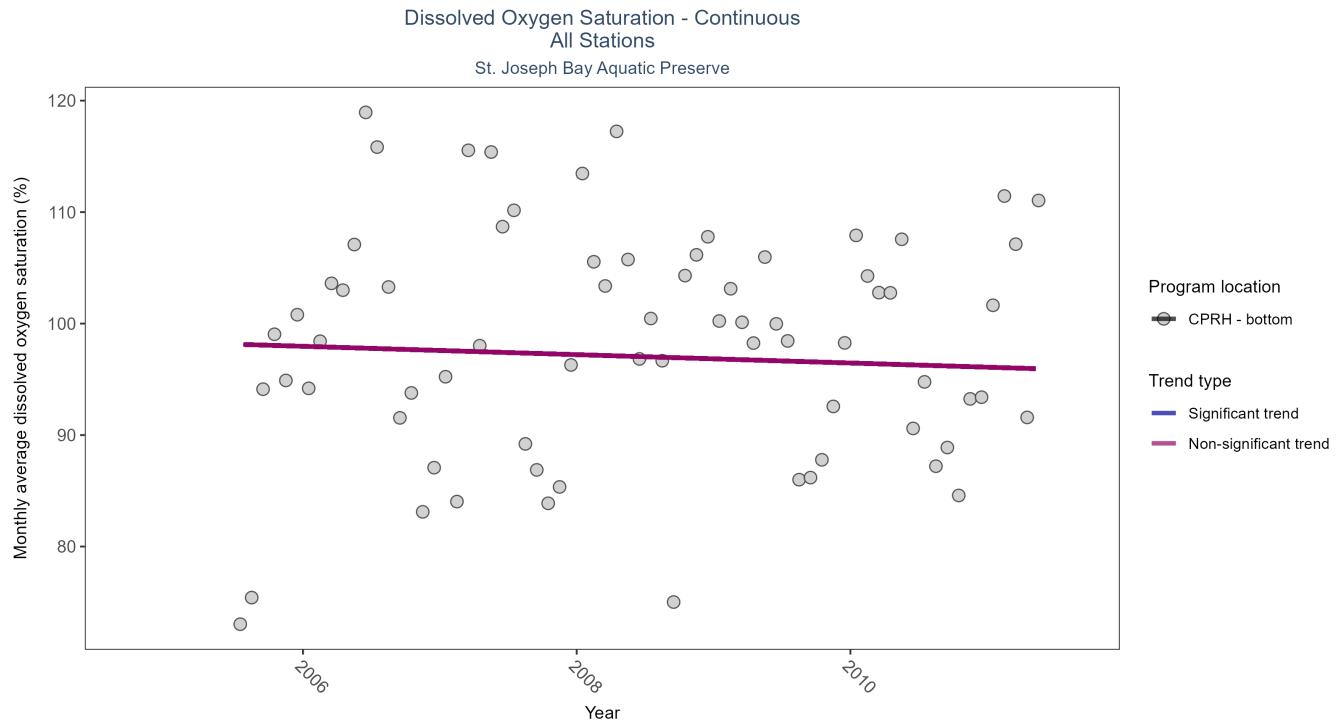


Figure 28: Scatter plot of monthly average dissolved oxygen saturation over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

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
CPRH	No significant trend	89684	7	2005 - 2011	98.3	-0.08	98.34	-0.37	0.51

No detectable change in monthly average dissolved oxygen saturation was observed at one location.

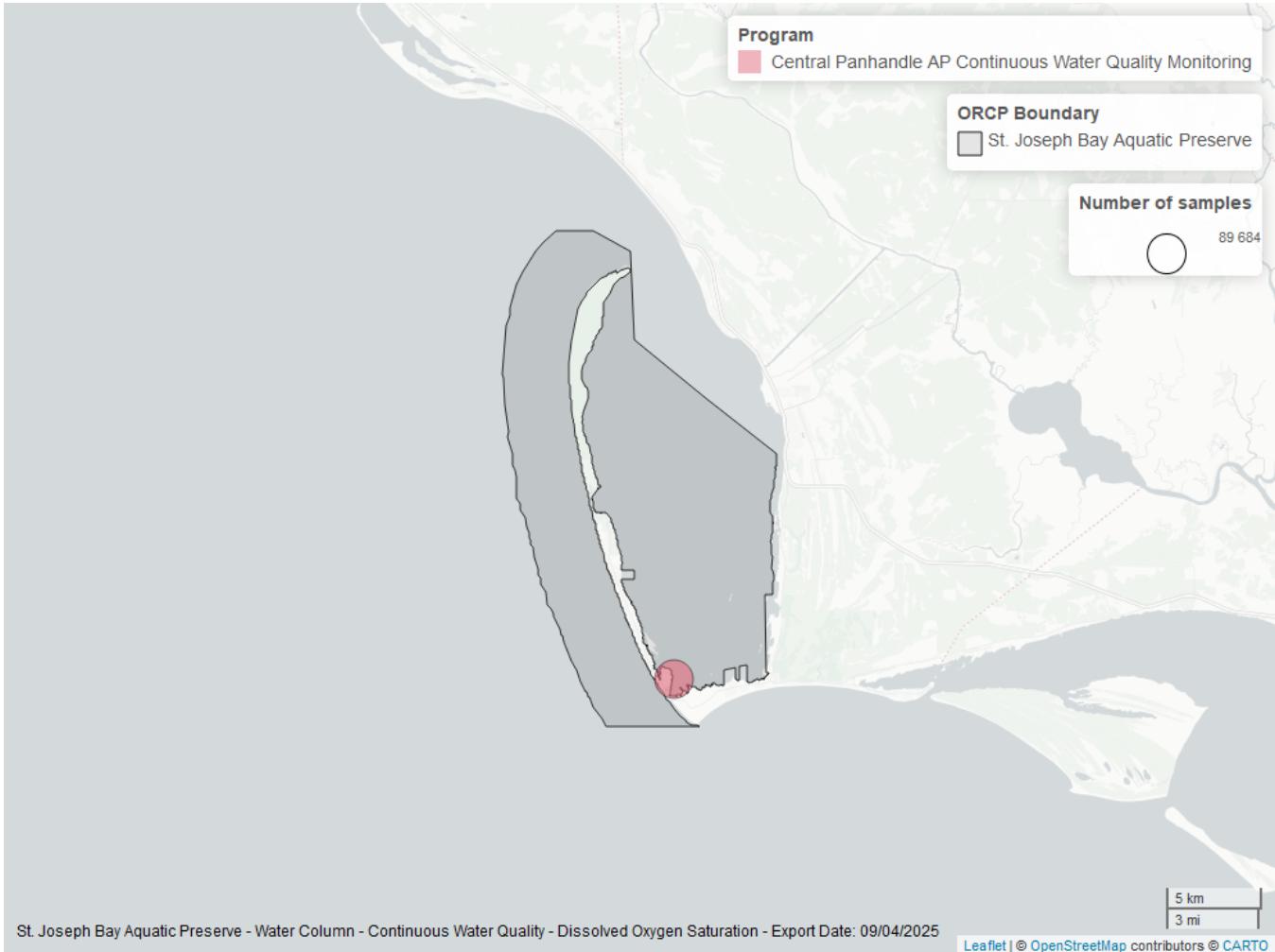


Figure 29: Map showing location of dissolved oxygen saturation continuous water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

pH - Continuous

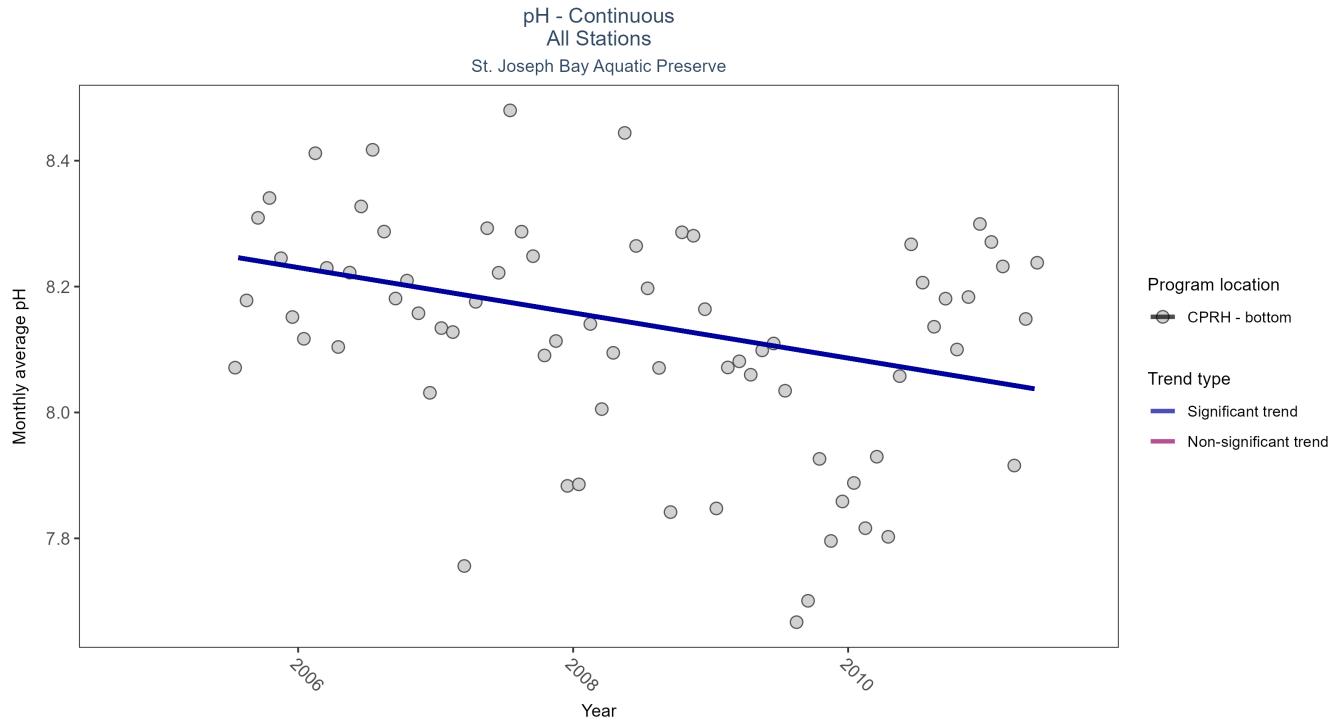


Figure 30: Scatter plot of monthly average pH over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

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
CPRH	Significantly decreasing trend	92953	7	2005 - 2011	8.1	-0.26	8.27	-0.04	0.02

At one program location, monthly average pH decreased by 0.04 pH units per year.

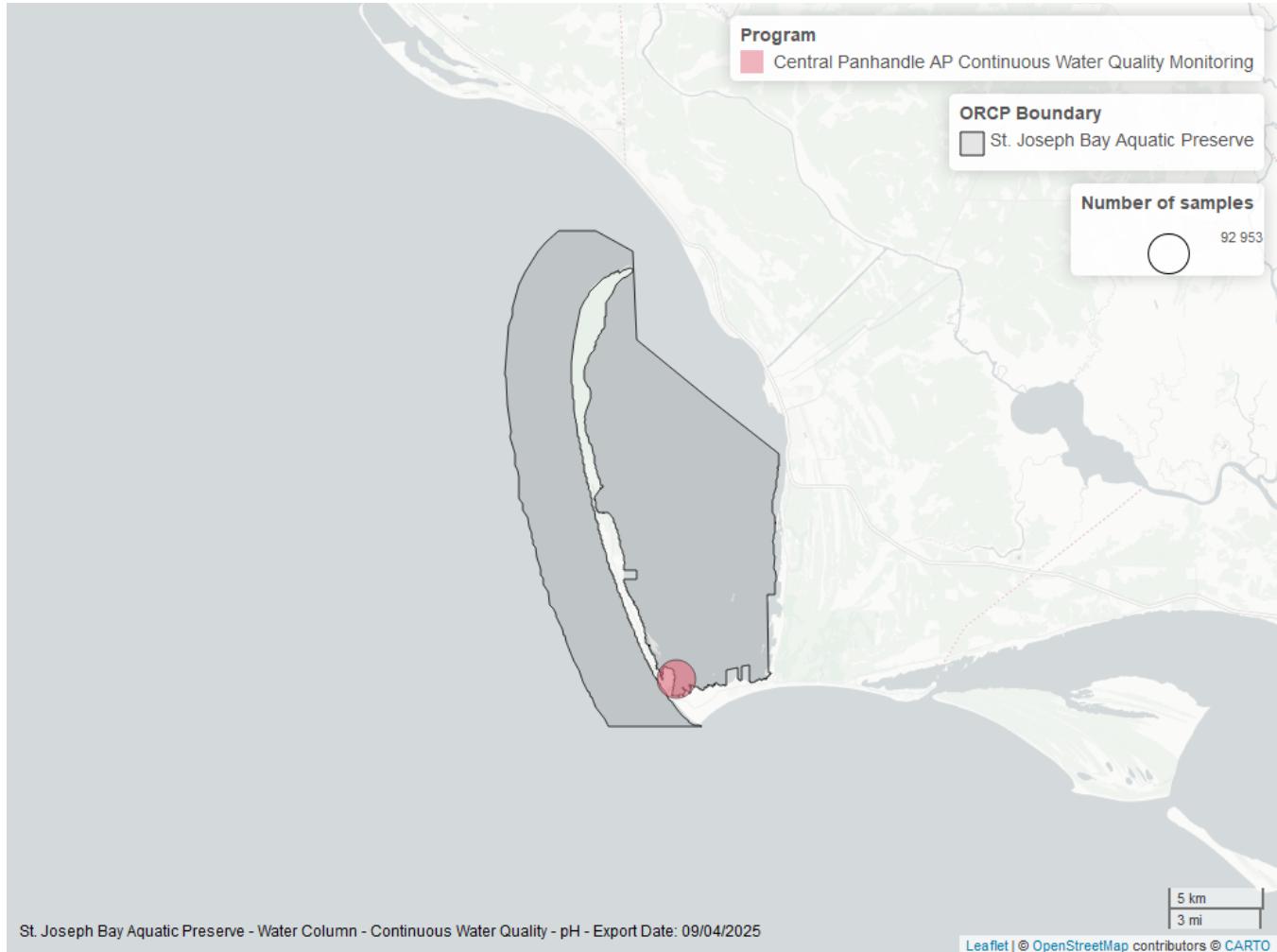


Figure 31: Map showing location of ph continuous water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Salinity - Continuous

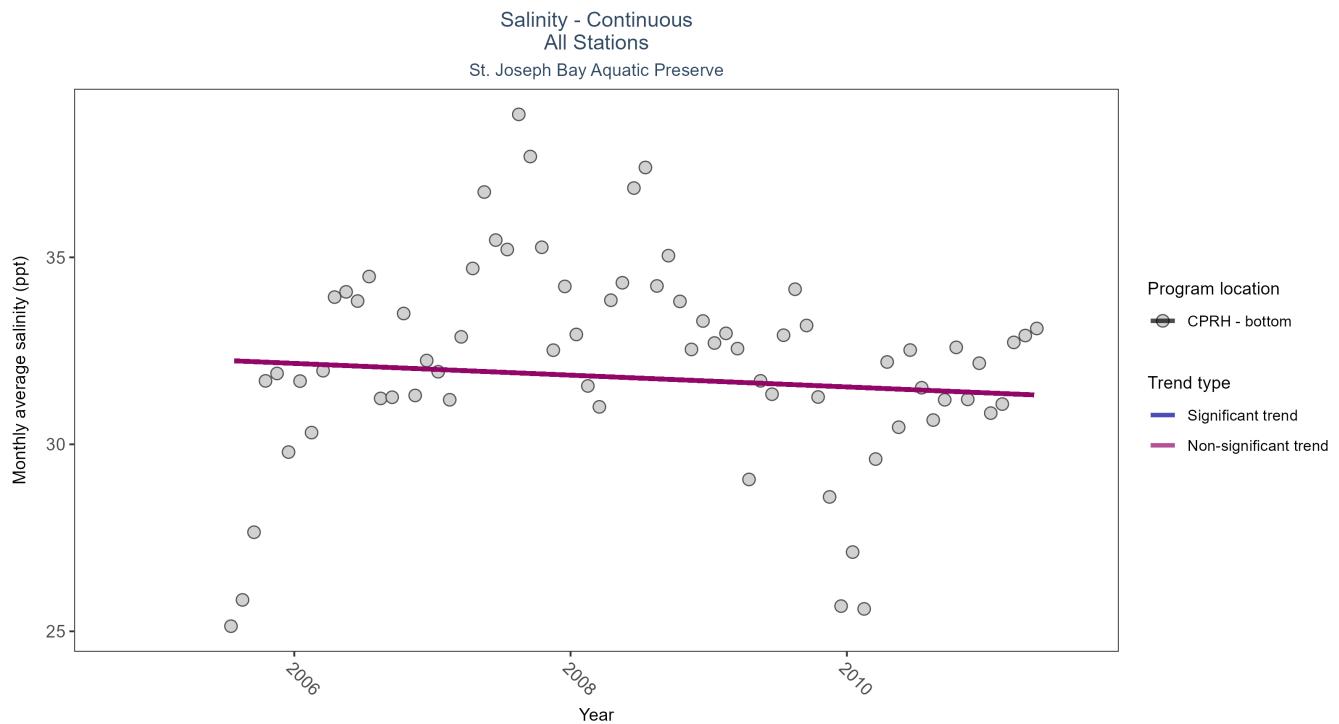


Figure 32: Scatter plot of monthly average salinity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

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
CPRH	No significant trend	90747	7	2005 - 2011	32.4	-0.12	32.32	-0.16	0.27

No detectable change in monthly average salinity was observed at one location.

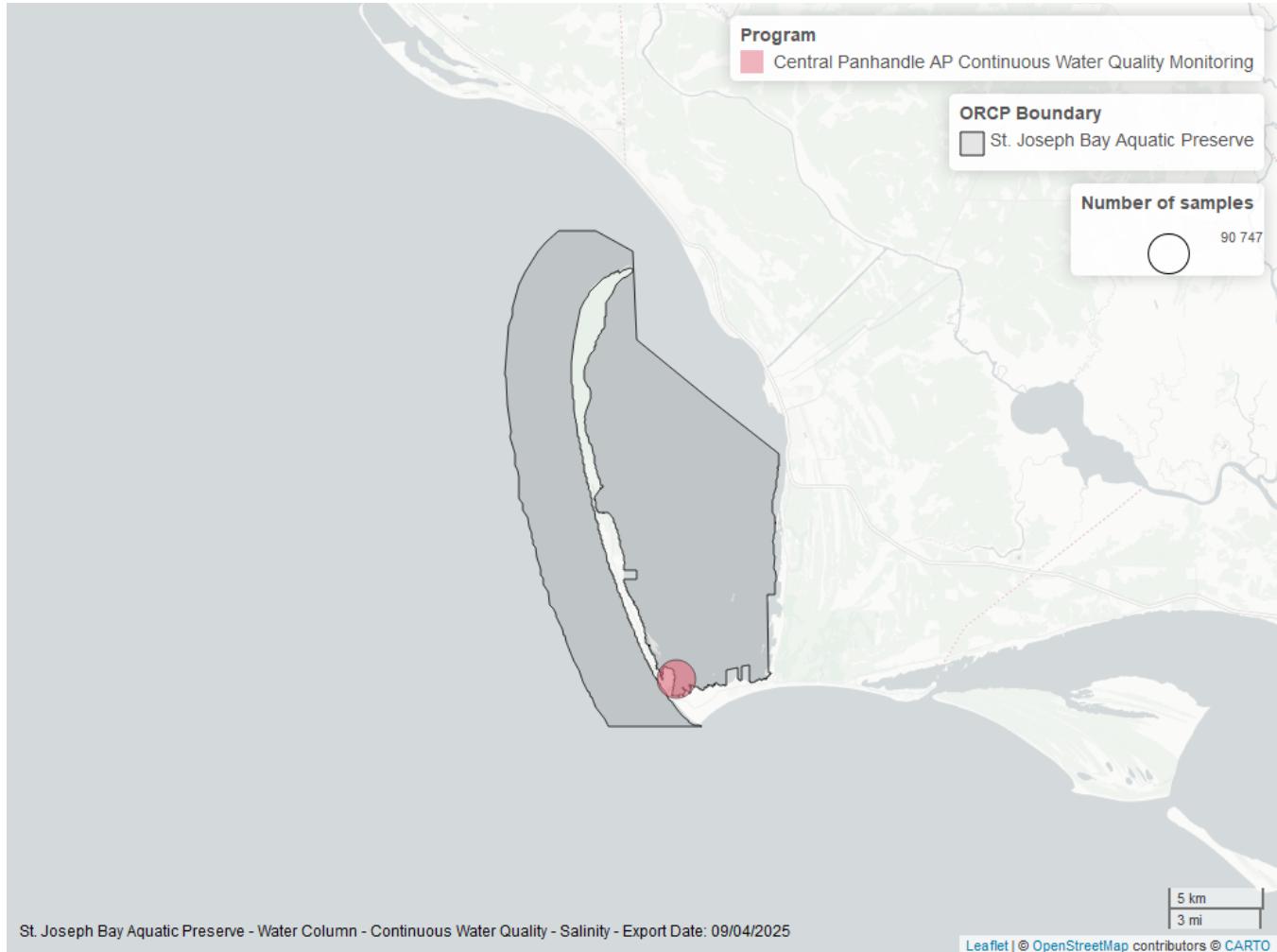


Figure 33: Map showing location of salinity continuous water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Turbidity - Continuous

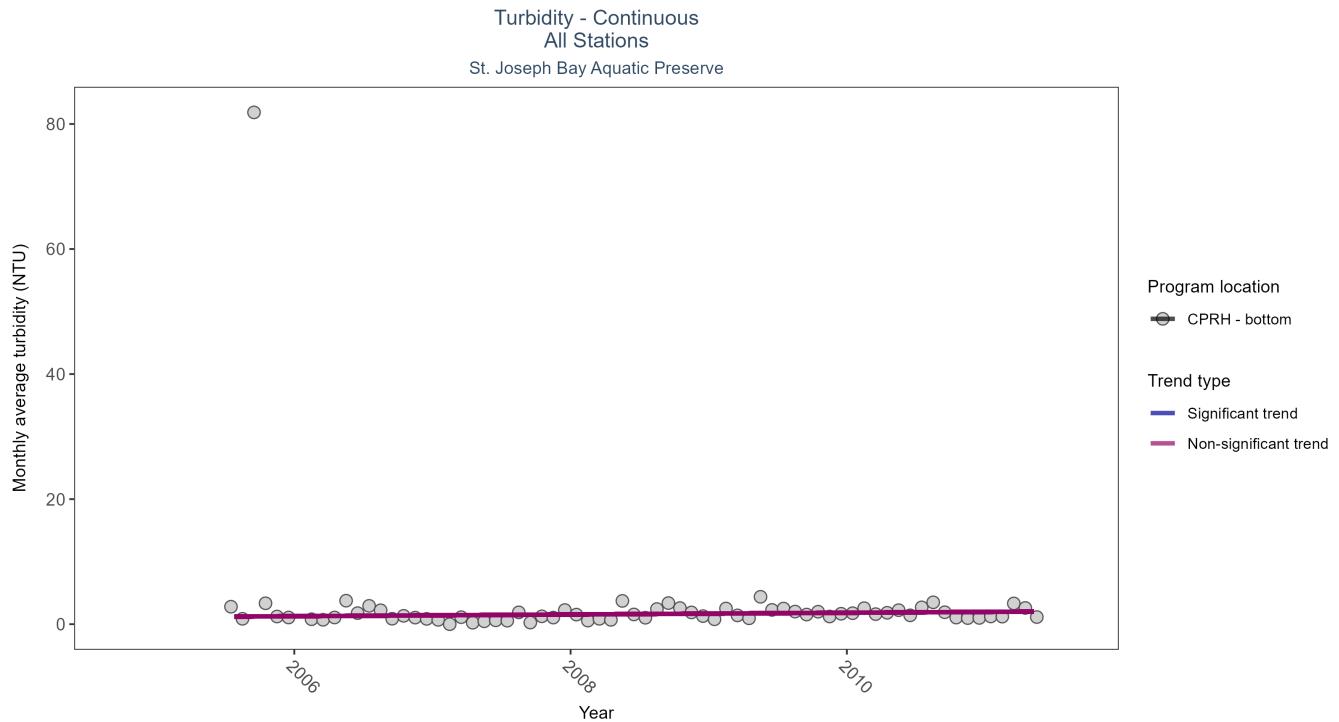


Figure 34: Scatter plot of monthly average turbidity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

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
CPRH	No significant trend	53062	7	2005 - 2011	1	0.18	1.14	0.14	0.1

No detectable change in monthly average turbidity was observed at one location.

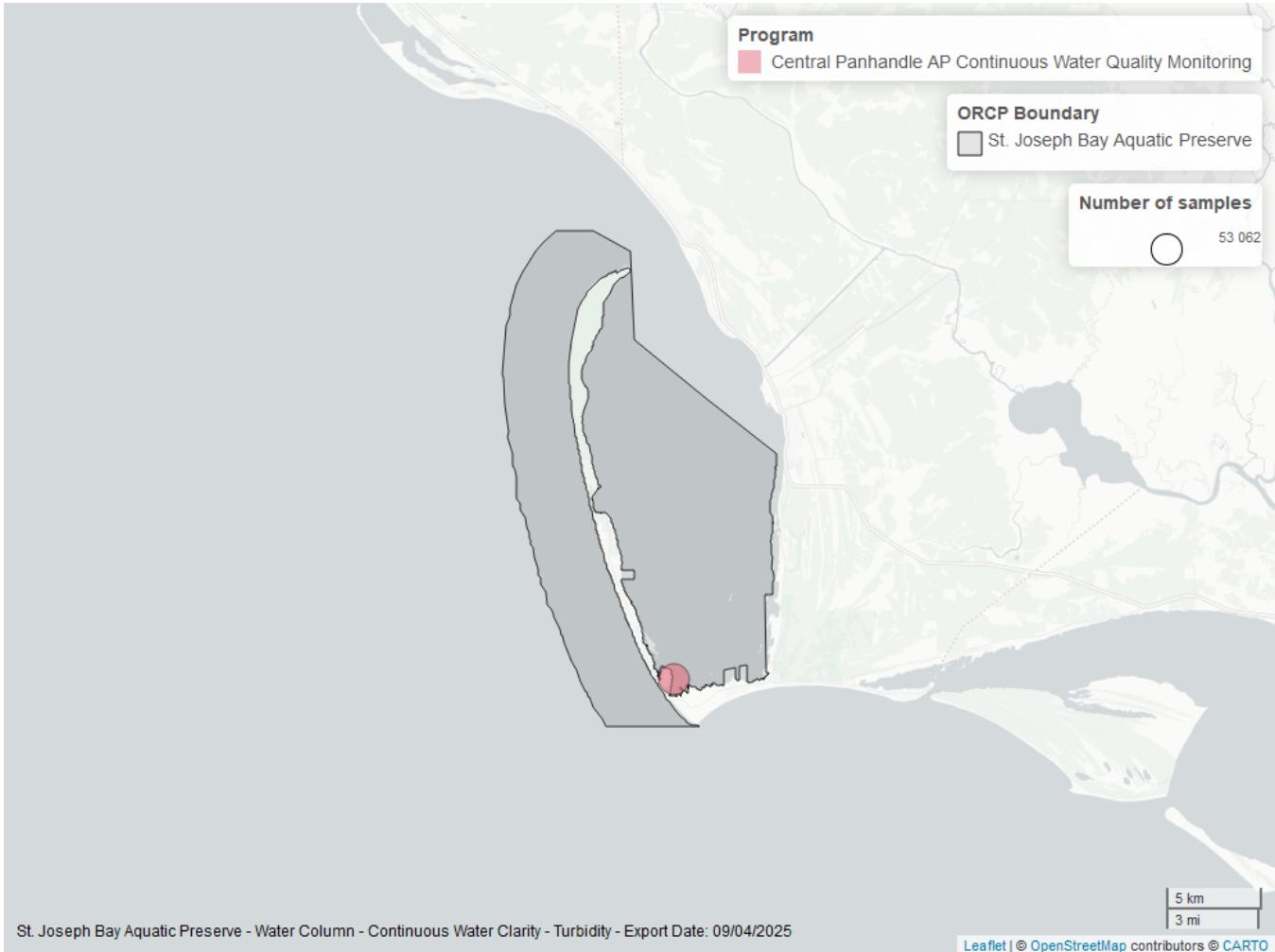


Figure 35: Map showing location of turbidity continuous water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Water Temperature - Continuous

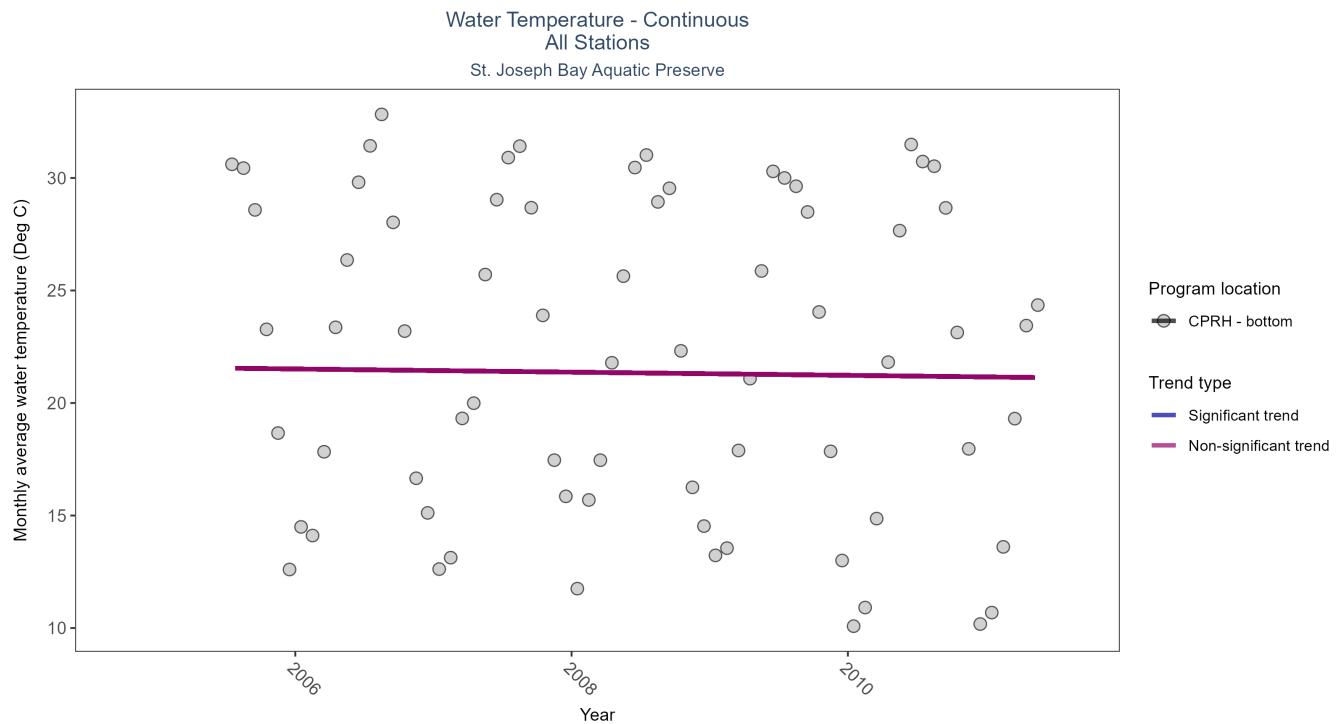


Figure 36: Scatter plot of monthly average water temperature over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

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
CPRH	No significant trend	97321	7	2005 - 2011	22.6	-0.06	21.58	-0.07	0.51

No detectable change in monthly average water temperature was observed at one location.

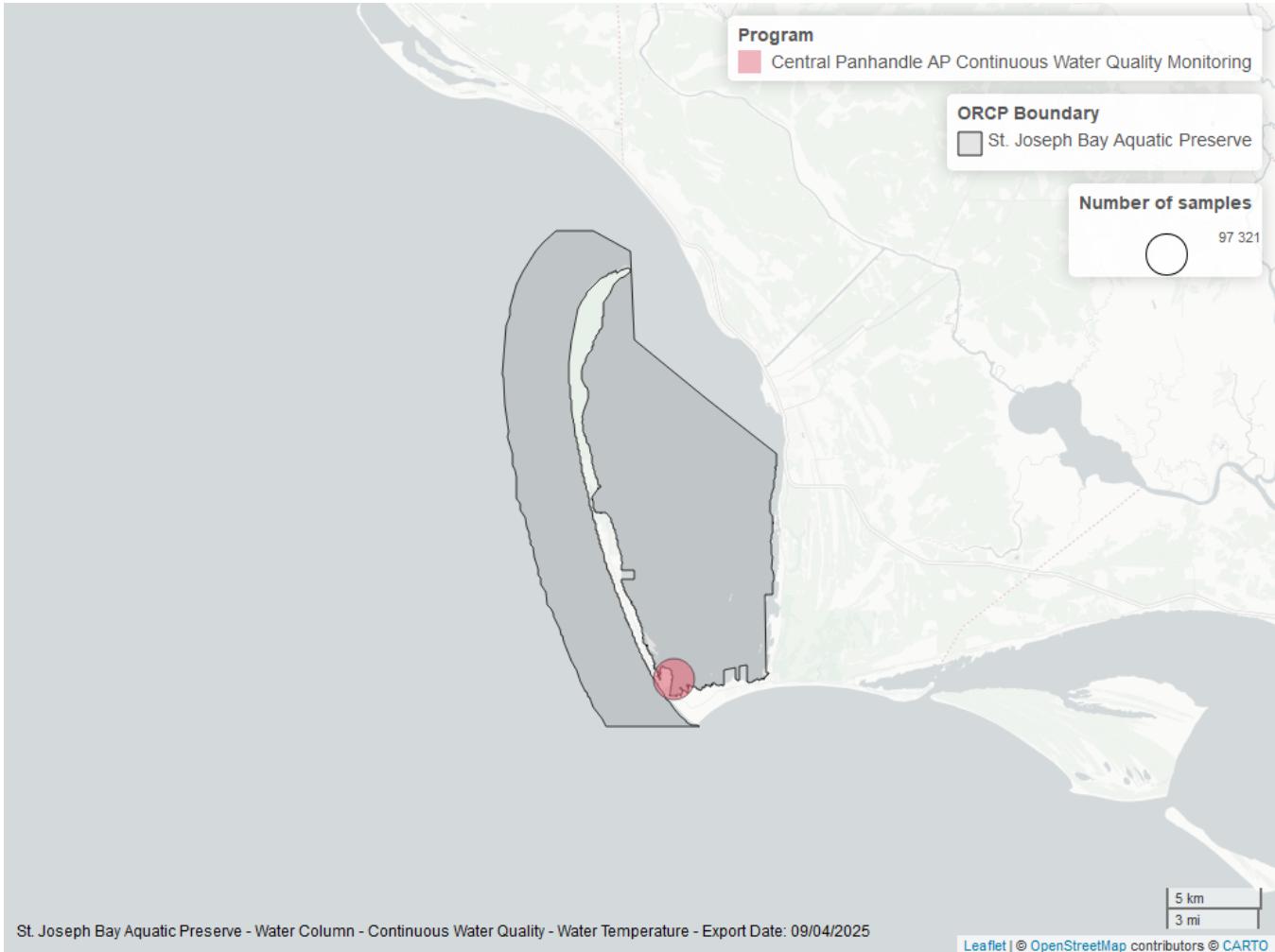


Figure 37: Map showing location of water temperature continuous water quality sampling locations within the boundaries of *St. Joseph Bay Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Submerged Aquatic Vegetation

The data file used is: All_SAV_Parameters-2025-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.

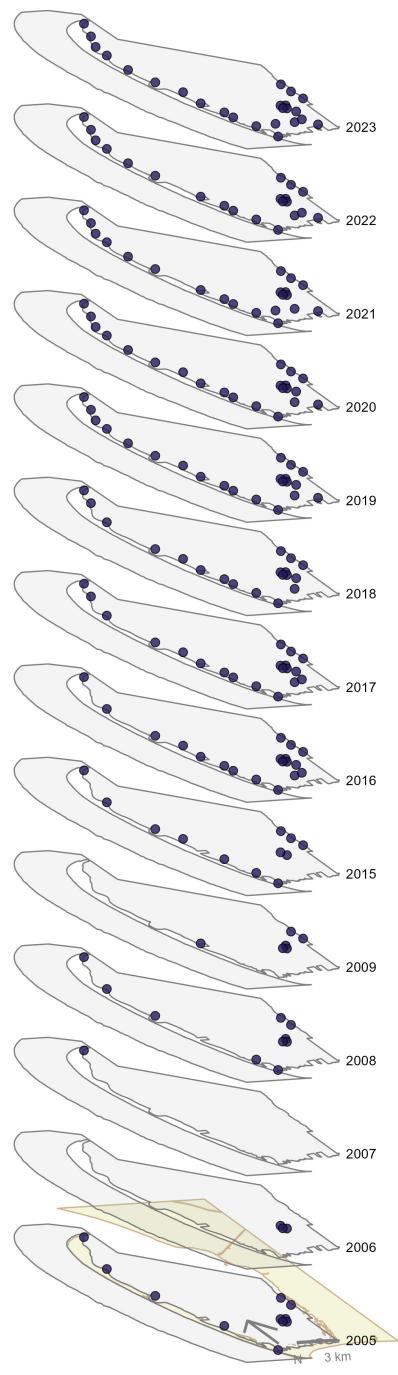
Notes

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

St. Joseph Bay Aquatic Preserve
SAV Percent Cover - Sample Locations



Program name
● Central Panhandle Aquatic Preserves Seagrass Monitoring

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

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

Sampling locations by Program:

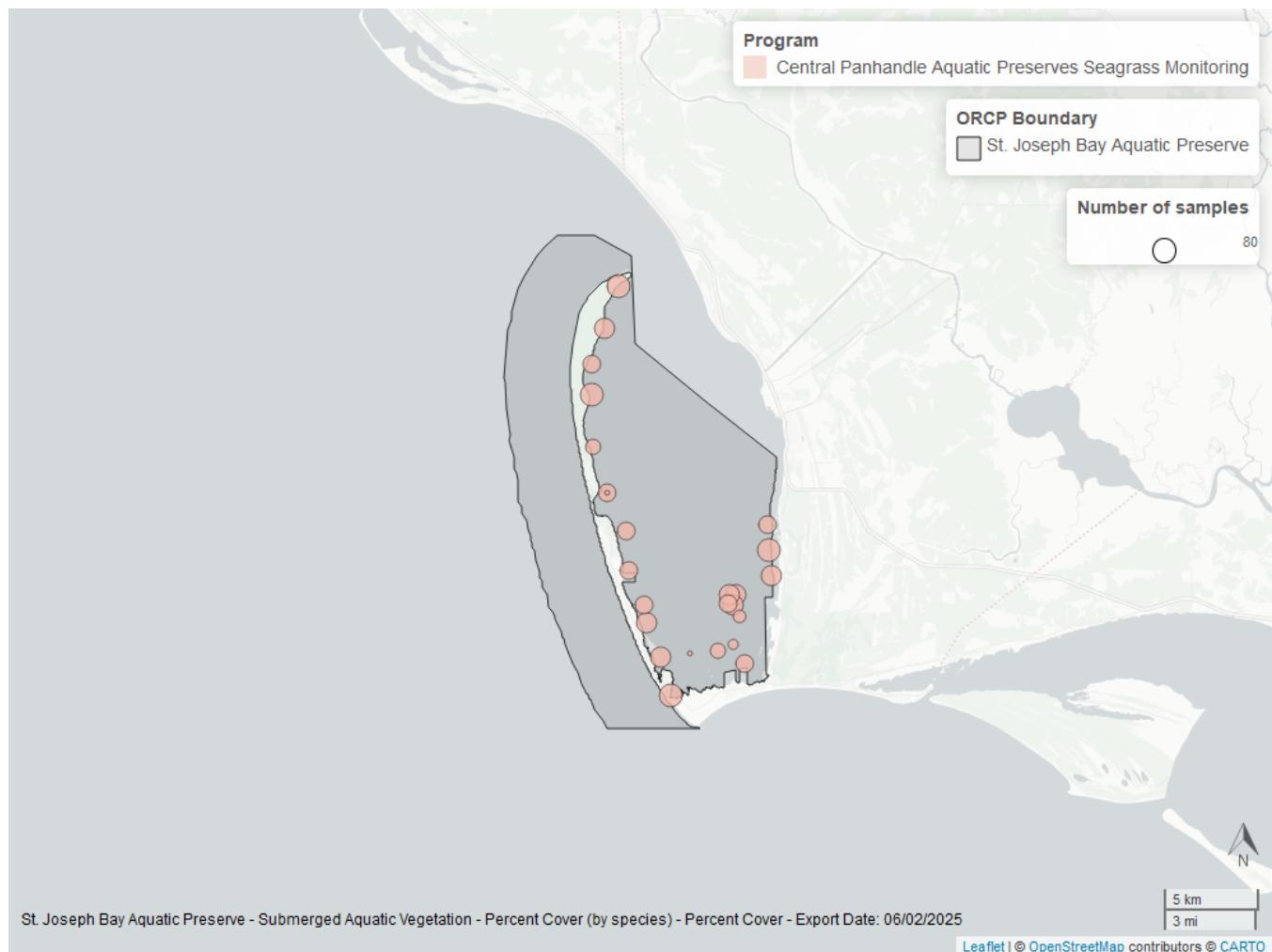


Figure 39: Map showing SAV sampling sites within the boundaries of *St. Joseph Bay Aquatic Preserve*. The point size reflects the number of samples at a given sampling site.

Table 37: Program Information for Submerged Aquatic Vegetation

ProgramID	N-Data	YearMin	YearMax	method	Sample Locations
557	1272	2005	2023	Braun Blanquet	25

Program names:

557 - Central Panhandle Aquatic Preserves Seagrass Monitoring¹²

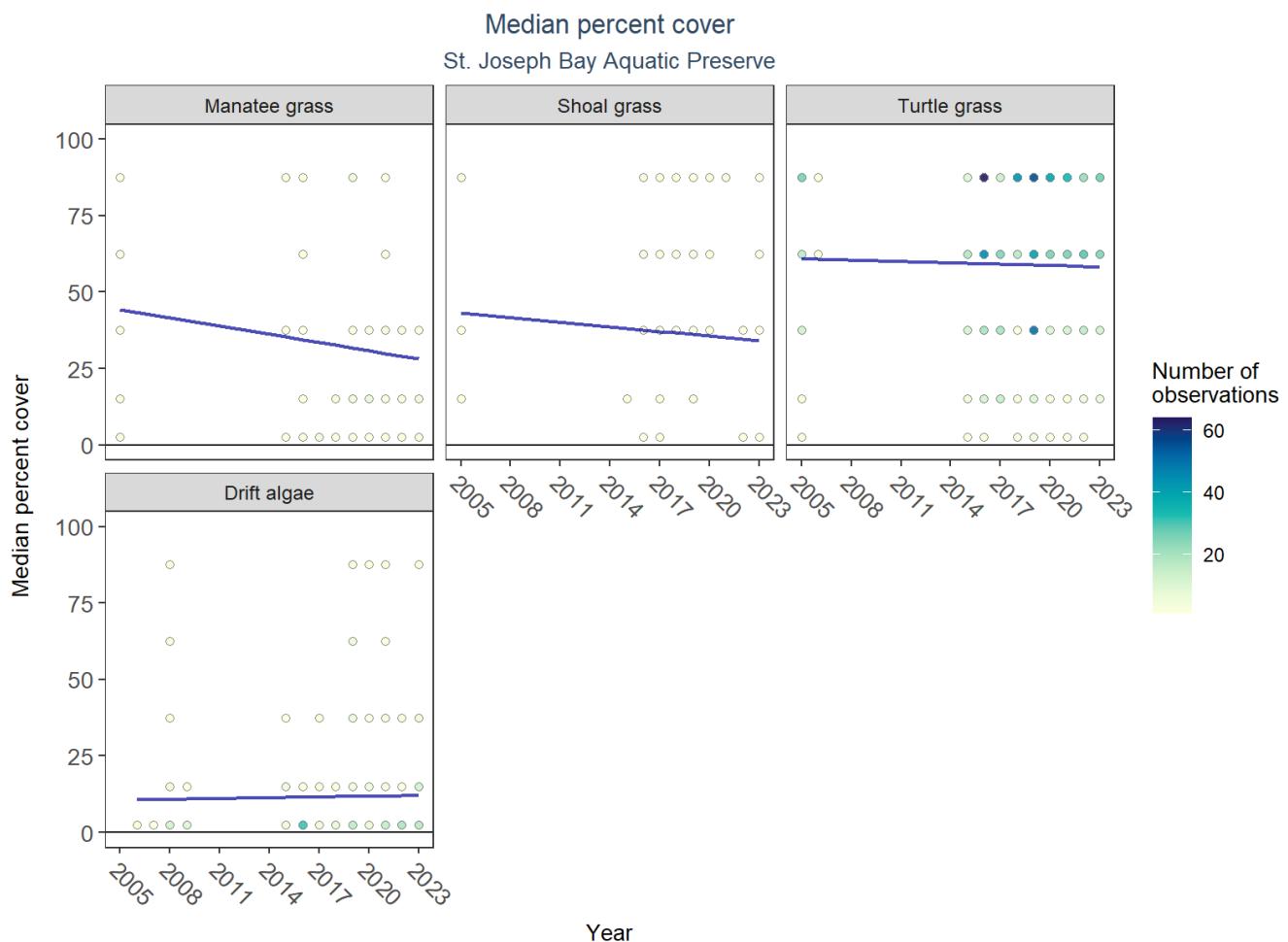


Figure 40: Scatter plots of median percent cover of submerged aquatic vegetation over time by group. Plots for time series that included five or more years of observations show the estimated trend as a blue line.

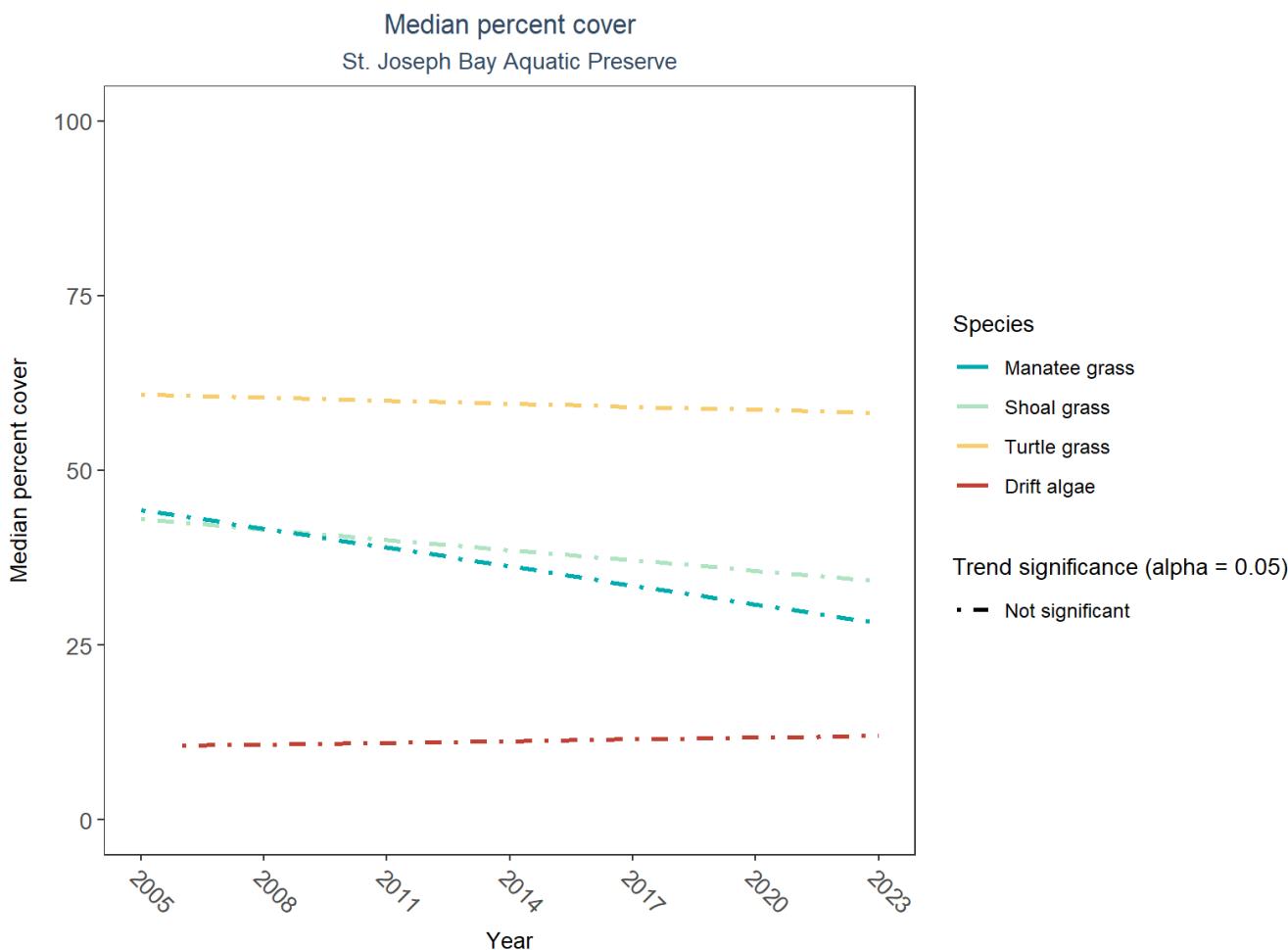


Figure 41: Trends in median percent cover for various seagrass species in St. Joseph Bay Aquatic Preserve - simplified

Table 38: Percent Cover Trend Analysis for St. Joseph Bay Aquatic Preserve

CommonName	Trend Significance (0.05)	Period of Record	LME-Intercept	LME-Slope	p
Drift algae	No significant trend	2006 - 2023	9.612037	0.0838013	0.8313898
Shoal grass	No significant trend	2005 - 2023	48.448323	-0.4914521	0.5032213
No grass in quadrat	Insufficient data to calculate trend	-	-	-	-
Manatee grass	No significant trend	2005 - 2023	54.197753	-0.8986159	0.2566824
Turtle grass	No significant trend	2005 - 2023	62.380385	-0.1420936	0.6874761

Manatee grass, shoal grass, turtle grass, and drift algae showed no detectable change in percent cover.

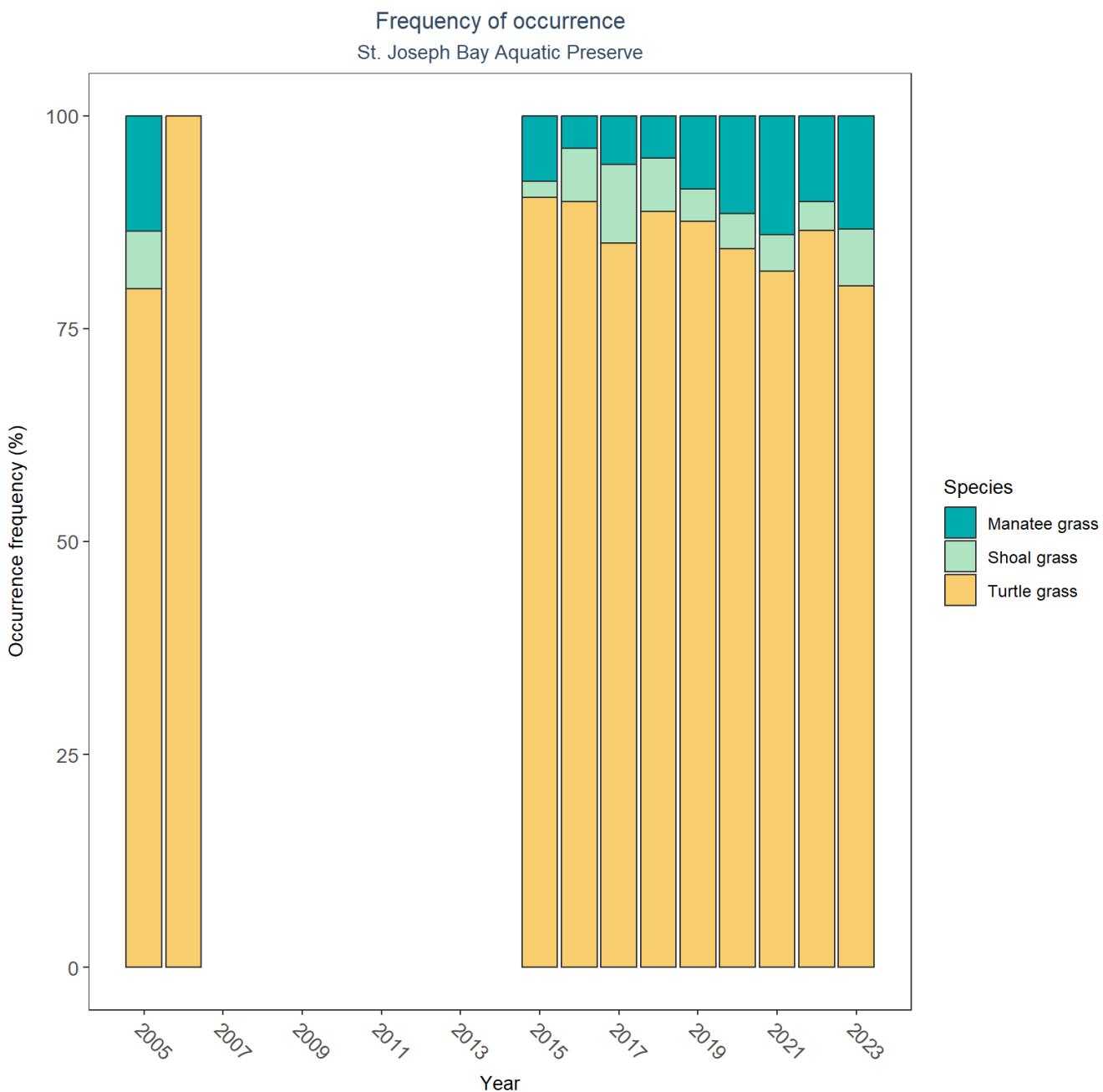


Figure 42: Frequency of occurrence for various seagrass species in St. Joseph Bay Aquatic Preserve

SAV Water Column Analysis

The following parameters are available for St. Joseph Bay Aquatic Preserve within the SAV_WC_Report:

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

- Secchi Depth
- Water Temperature
- Total Nitrogen
- Turbidity

Access the reports here: [DRAFT_SAV_WC_Report_2024-11-20.pdf](#)

Species list

Acetabularia crenulata ¹	Gracilaria sp. ¹	Syringodium filiforme ¹
Batophora spp. ¹	Halodule wrightii ¹	Thalassia testudinum ¹
Caulerpa lanuginosa ¹	No grass in quadrat ¹	Ulva prolifera ¹
Caulerpa spp. ¹	Other red algae ¹	Acetabularia crenulata ¹
Drift algae ¹	Sargassum spp. ¹	Batophora spp. ¹

1 - Submerged Aquatic Vegetation

References

1. Florida Department of Environmental Protection (DEP); Office of Resilience and Coastal Protection (RCP); Central Panhandle Aquatic Preserves. [St. Andrews Aquatic Preserve Water Quality Monitoring](#). (2024).
2. University of Florida (UF); Institute of Food and Agricultural Sciences. [Florida LAKEWATCH Program](#). (2024).
3. Florida Department of Agriculture and Consumer Services (FDACS) - Division of Aquaculture. [Shellfish Harvest Area Classification Program](#). (2022).
4. Florida Department of Environmental Protection (DEP). [Florida STORET / WIN](#). (2024).
5. Gulf States Marine Fisheries Commission. [Southeast Area Monitoring and Assessment Program \(SEAMAP\) - Gulf of Mexico Fall & Summer Shrimp/Groundfish Survey](#). (2016).
6. U.S. Environmental Protection Agency (EPA). [EPA STOrage and RETrieval Data Warehouse \(STORET\)/WQX](#). (2023).
7. U.S. Environmental Protection Agency (EPA); Office of Research and Development. [Environmental Monitoring Assessment Program](#). (2004).
8. 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).
9. Florida Fish and Wildlife Conservation Commission (FWC). [Fisheries-Independent Monitoring \(FIM\) Program](#). (2022).
10. Florida Fish and Wildlife Conservation Commission (FWC); Florida Fish and Wildlife Research Institute (FWRI). [Harmful Algal Bloom Marine Observation Network](#). (2018).
11. Florida Department of Environmental Protection (DEP); Office of Resilience and Coastal Protection (RCP); Central Panhandle Aquatic Preserves. [Central Panhandle Aquatic Preserve WQ Monitoring](#). (2024).
12. Florida Department of Environmental Protection (DEP); Office of Resilience and Coastal Protection (RCP); Central Panhandle Aquatic Preserves. [Central Panhandle Aquatic Preserves Seagrass Monitoring](#). (2023).
13. Florida Department of Environmental Protection (DEP); Office of Resilience and Coastal Protection (RCP); Central Panhandle Aquatic Preserves. [Central Panhandle Aquatic Preserves Continuous Water Quality Monitoring](#). (2024).