

Loxahatchee River-Lake Worth Creek Aquatic Preserve

SEACAR Habitat Analyses

Last compiled on 08 October, 2025

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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

<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

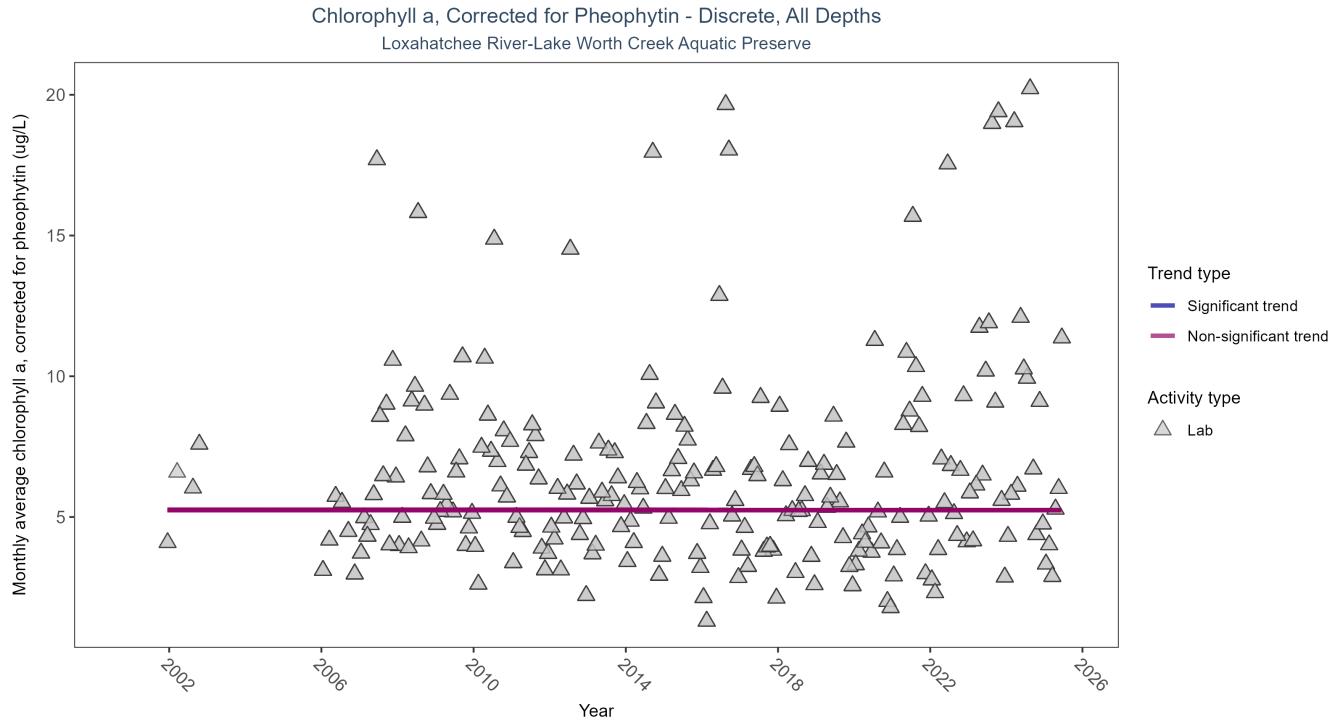


Figure 1: Scatter plot of monthly average levels of chlorophyll a, corrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles) 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	No significant trend	4570	22	2001 - 2025	4.5	0.0007	5.2493	-0.0002	1

Chlorophyll a, corrected for pheophytin, showed no detectable trend between 2001 and 2025.

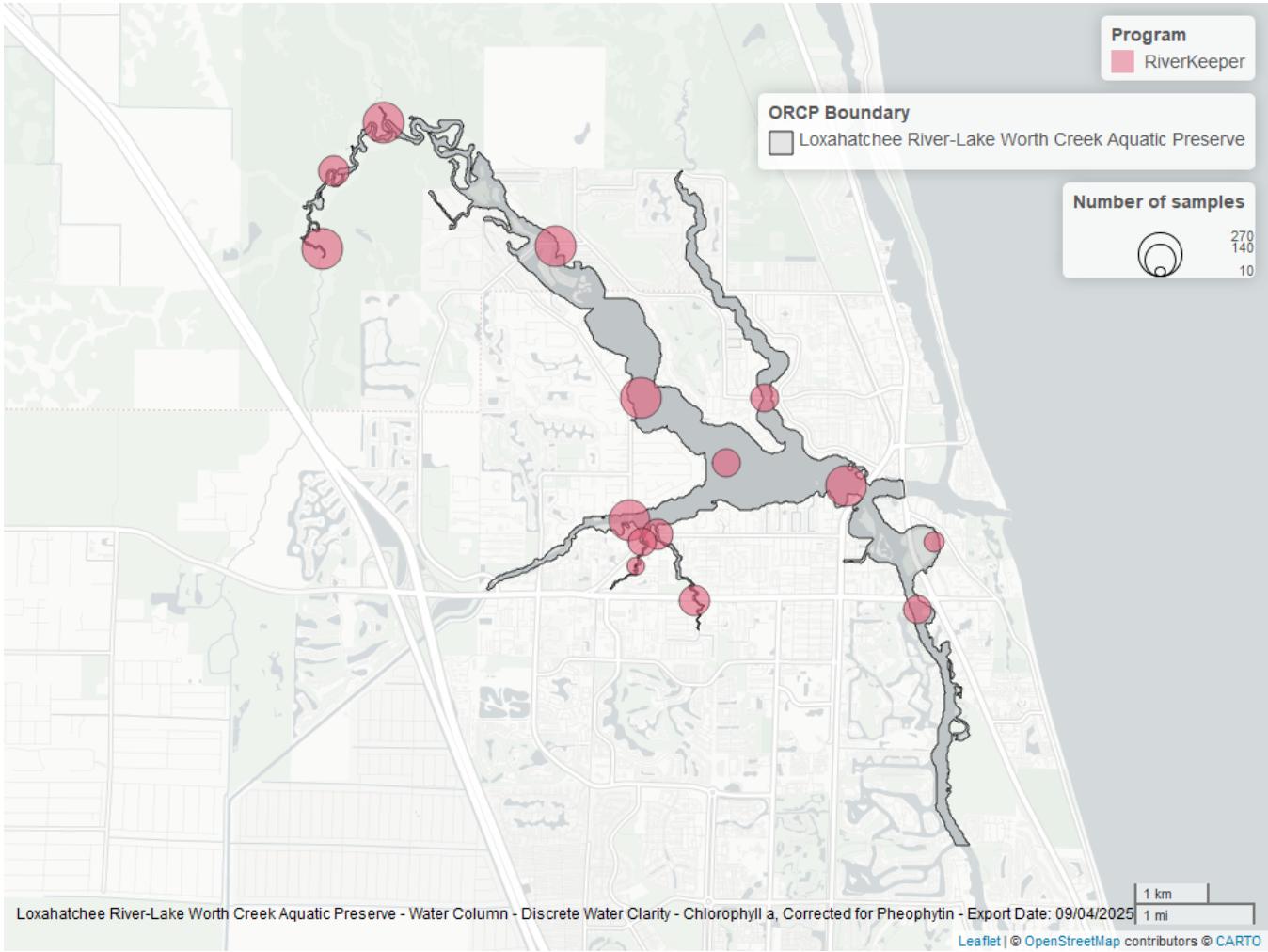


Figure 2: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
10000	2754	2006	2025
5002	1814	2001	2024
514	46	2018	2024

Program names:

514 - Florida LAKEWATCH Program¹

5002 - Florida STORET / WIN²

10000 - RiverKeeper³

Chlorophyll a, Uncorrected for Pheophytin - Discrete

Seasonal Kendall-Tau Trend Analysis

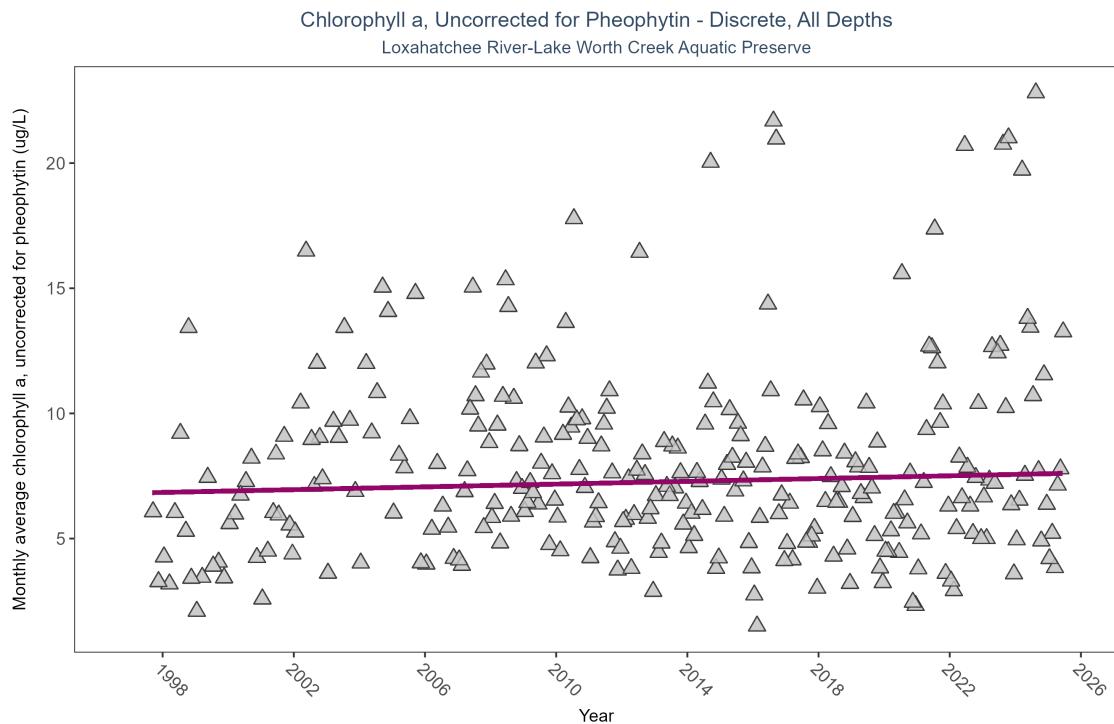


Figure 3: Scatter plot of monthly average levels of chlorophyll a, uncorrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles) 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	No significant trend	5939	29	1997 - 2025	5.6	0.0478	6.8153	0.0277	0.2409

Chlorophyll a, uncorrected for pheophytin, showed no detectable trend between 1997 and 2025.

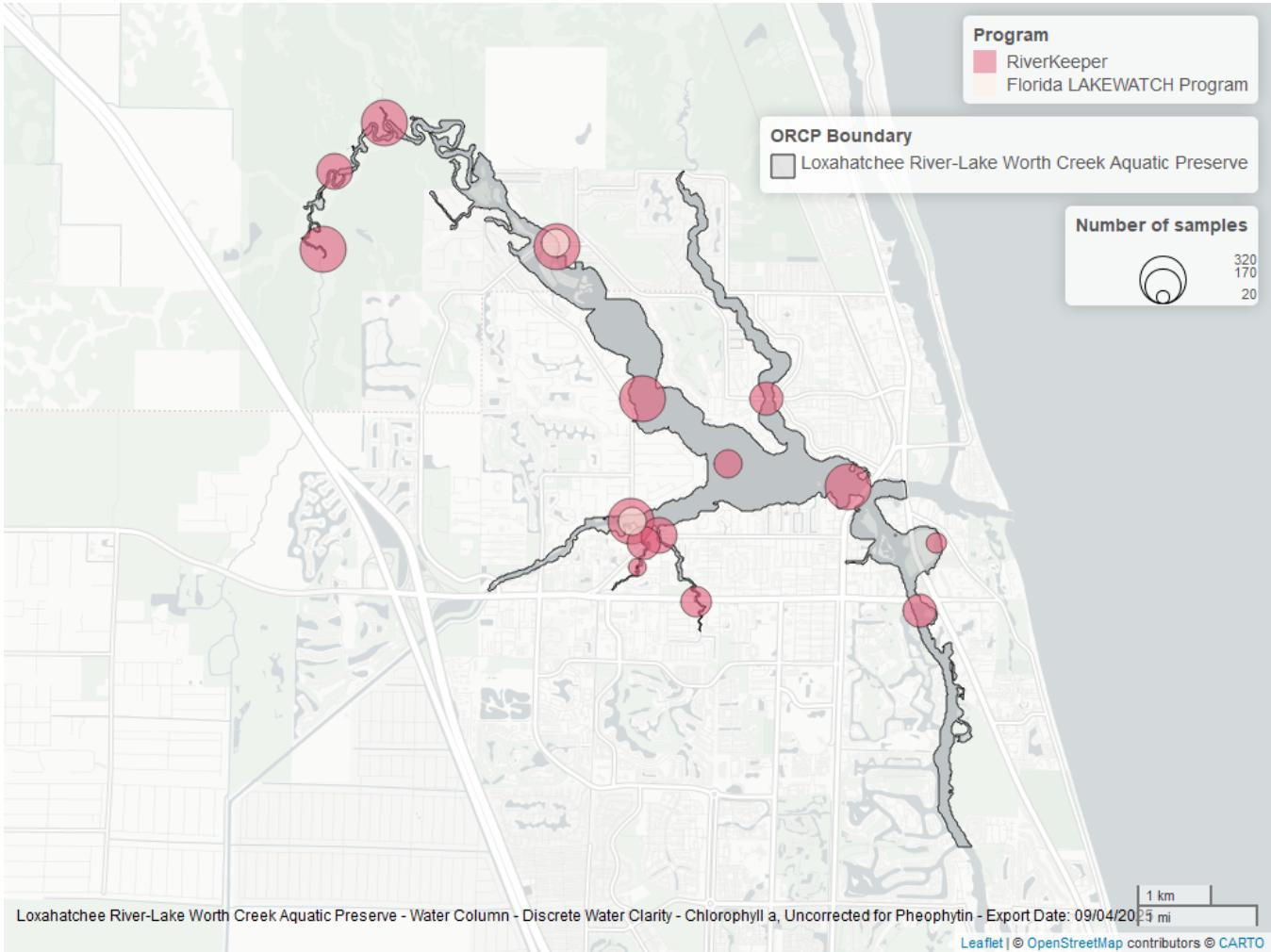


Figure 4: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
10000	3311	1997	2025
5002	2387	1997	2024
514	298	2001	2024

Program names:

514 - Florida LAKEWATCH Program¹

5002 - Florida STORET / WIN²

10000 - RiverKeeper³

Colored Dissolved Organic Matter - Discrete

Seasonal Kendall-Tau Trend Analysis

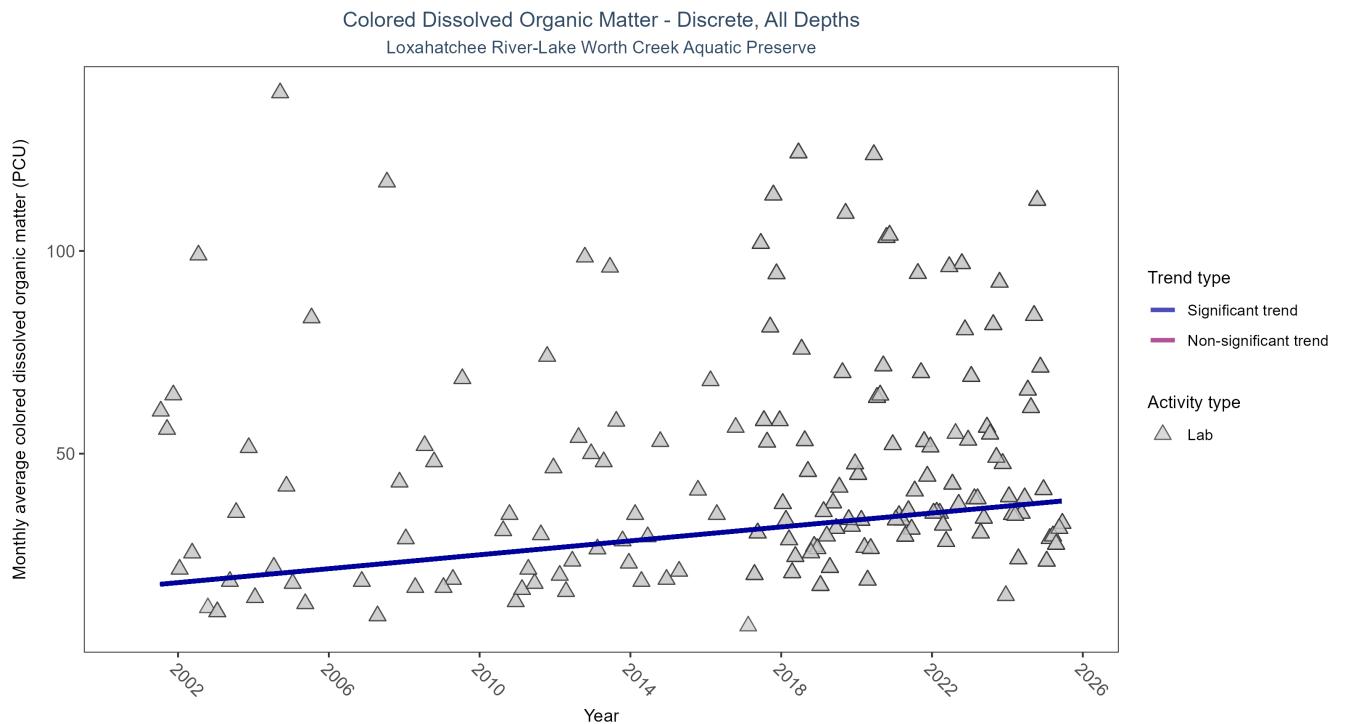


Figure 5: Scatter plot of monthly average colored dissolved organic matter (CDOM) over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed CDOM (triangles) is included in the 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	1227	25	2001 - 2025	45	0.2735	17.3382	0.8583	0

Monthly average colored dissolved organic matter increased by 0.86 PCU per year, indicating a decrease in water clarity.

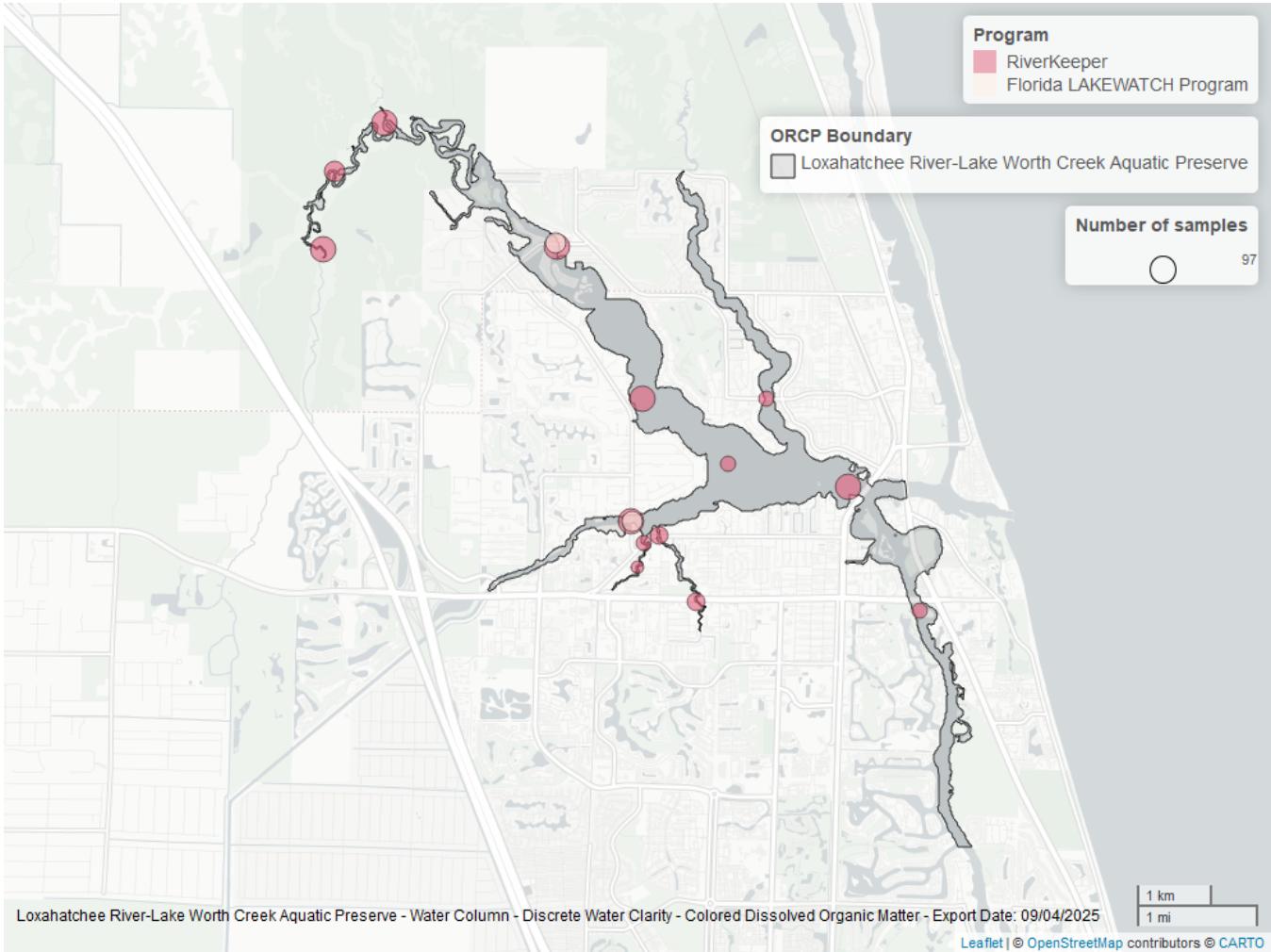


Figure 6: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 11: Programs contributing data for Colored Dissolved Organic Matter

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
10000	1064	2017	2025
514	140	2001	2020
5002	23	2017	2024

Program names:

514 - Florida LAKEWATCH Program¹

5002 - Florida STORET / WIN²

10000 - RiverKeeper³

Dissolved Oxygen - Discrete

Seasonal Kendall-Tau Trend Analysis

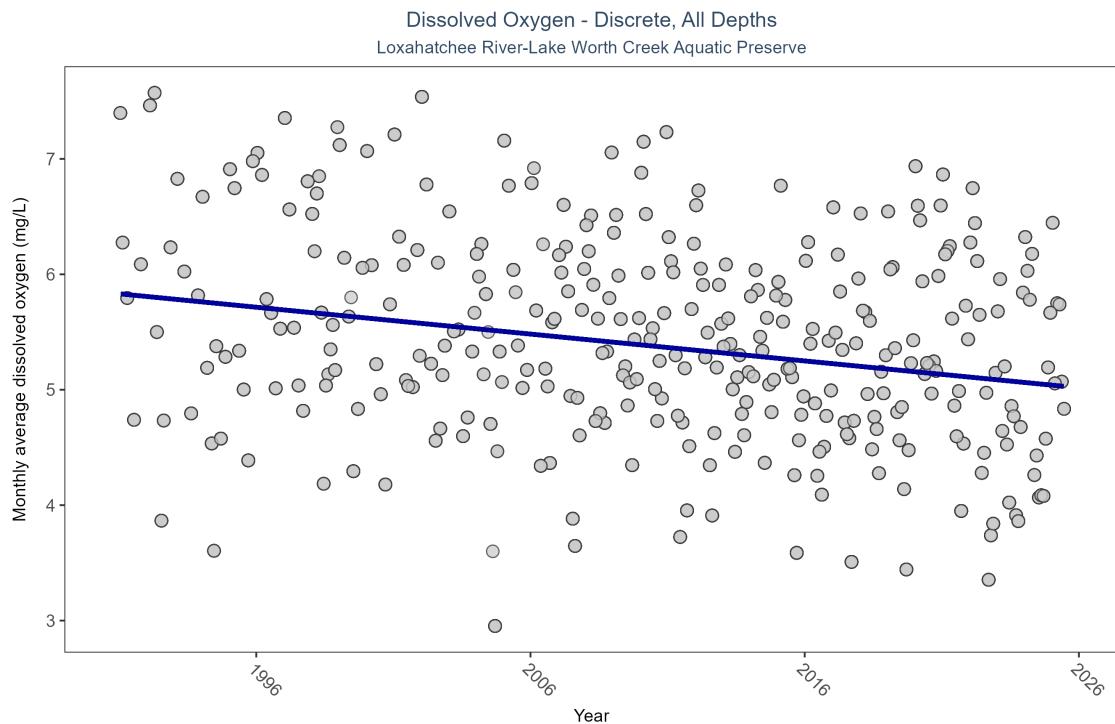


Figure 7: Scatter plot of monthly average dissolved oxygen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen values measured in the field (circles) are included in the plot.

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	Significantly decreasing trend	13060	35	1991 - 2025	5.6	-0.2612	5.8313	-0.0233	0

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

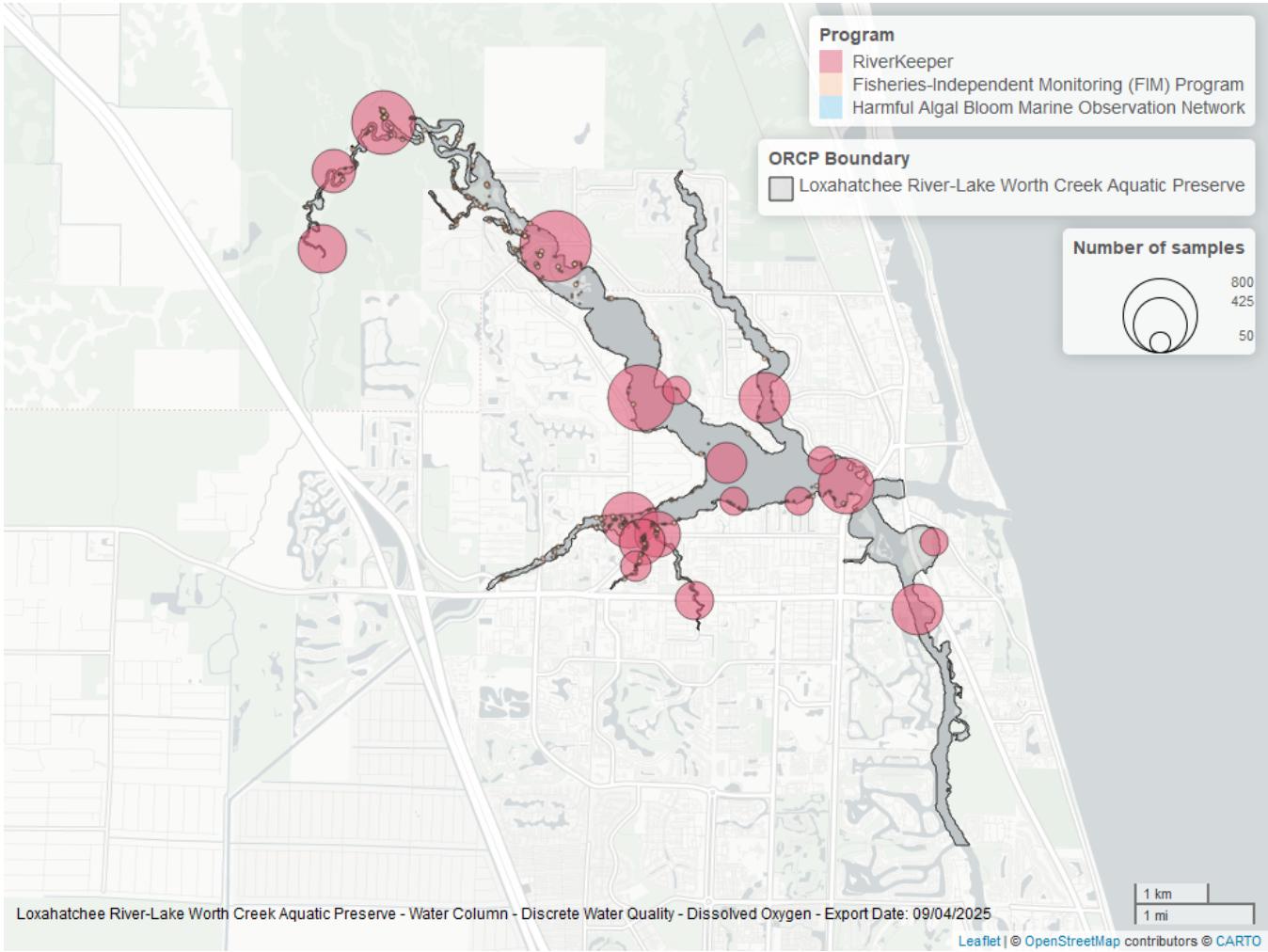


Figure 8: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 13: Programs contributing data for Dissolved Oxygen

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
10000	6544	1991	2025
5002	5387	1991	2024
69	1071	2014	2024
3013	67	2004	2023
103	2	2021	2022
95	2	2016	2016

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program⁴

95 - Harmful Algal Bloom Marine Observation Network⁵

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX⁶

3013 - Seagrass (SJRWMD)⁷

5002 - Florida STORET / WIN²

10000 - RiverKeeper³

Dissolved Oxygen Saturation - Discrete

Seasonal Kendall-Tau Trend Analysis

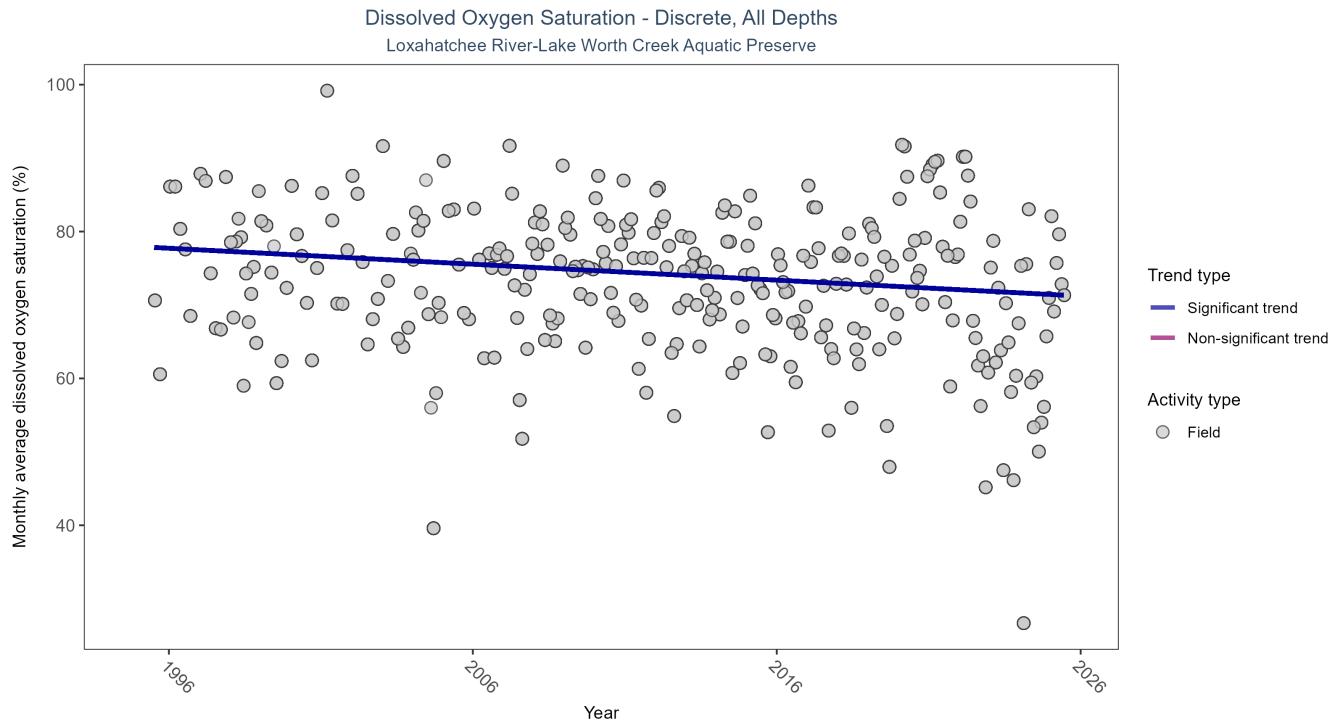


Figure 9: Scatter plot of monthly average dissolved oxygen saturation over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen saturation values measured in the field (circles) 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 decreasing trend	11076	31	1995 - 2025	76.1	-0.1551	77.9417	-0.2171	0.0001

Monthly average dissolved oxygen saturation decreased by 0.22% per year.

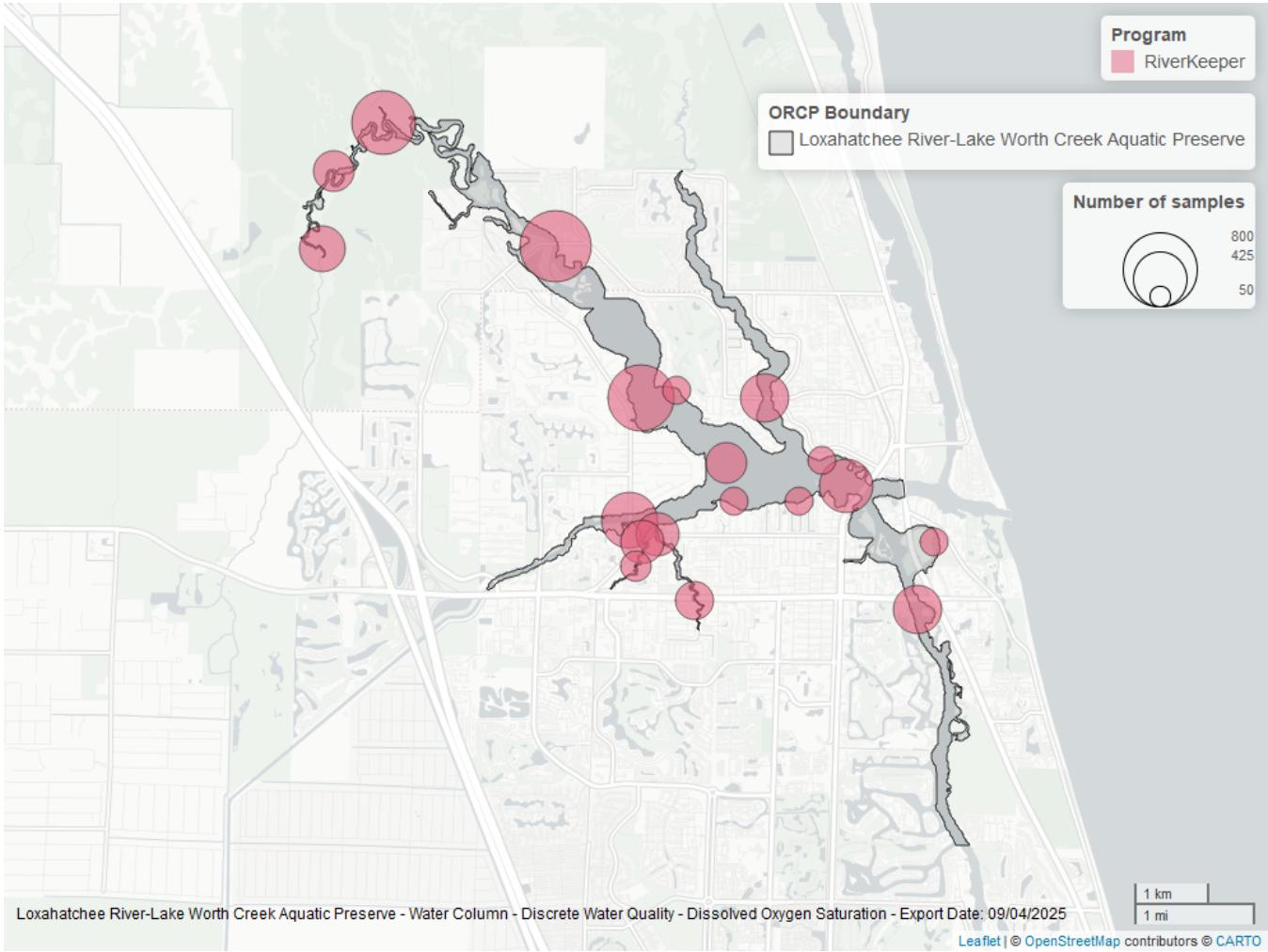


Figure 10: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 15: Programs contributing data for Dissolved Oxygen Saturation

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
10000	6264	1995	2025
5002	4781	1995	2024
3013	31	2014	2023

Program names:

- 3013 - Seagrass (SJRWMD)⁷
- 5002 - Florida STORET / WIN²
- 10000 - RiverKeeper³

pH - Discrete

Seasonal Kendall-Tau Trend Analysis

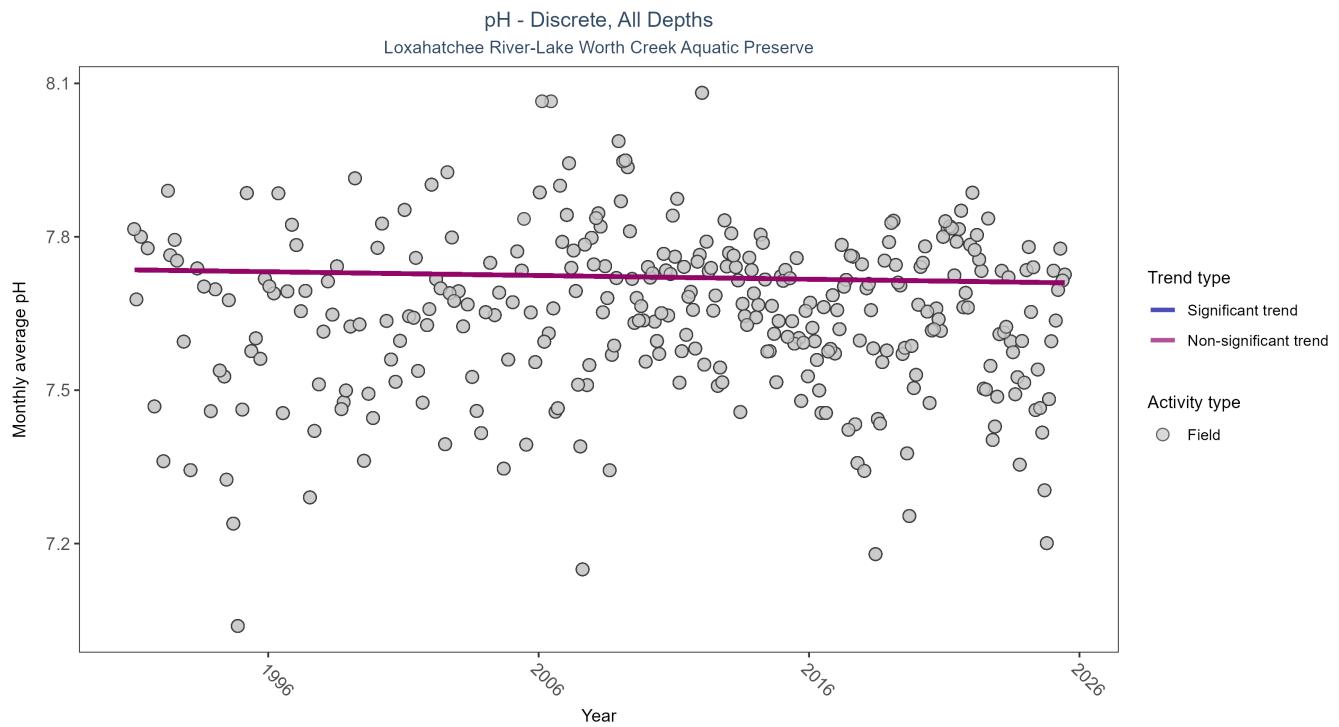


Figure 11: Scatter plot of monthly average pH over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only pH values measured in the field (circles) are included in the plot.

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	12766	35	1991 - 2025	7.7	-0.05	7.7353	-0.0007	0.431

pH showed no detectable trend between 1991 and 2025.

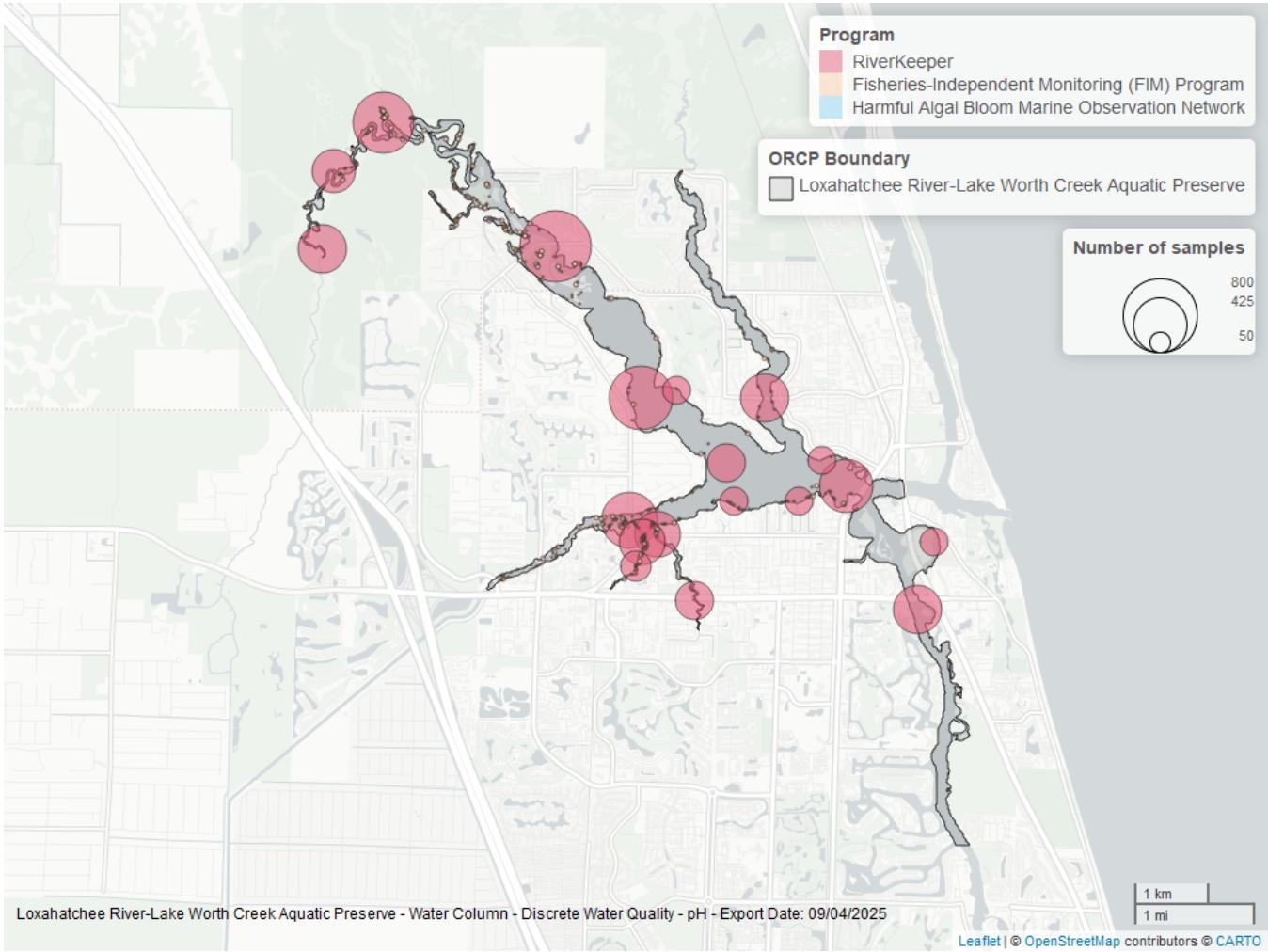


Figure 12: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 17: Programs contributing data for pH

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
10000	6342	1991	2025
5002	5285	1991	2024
69	1076	2014	2024
3013	59	2004	2023
103	3	2021	2022
95	2	2016	2016

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program⁴

95 - Harmful Algal Bloom Marine Observation Network⁵

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX⁶

3013 - Seagrass (SJRWMD)⁷

5002 - Florida STORET / WIN²

10000 - RiverKeeper³

Salinity - Discrete

Seasonal Kendall-Tau Trend Analysis

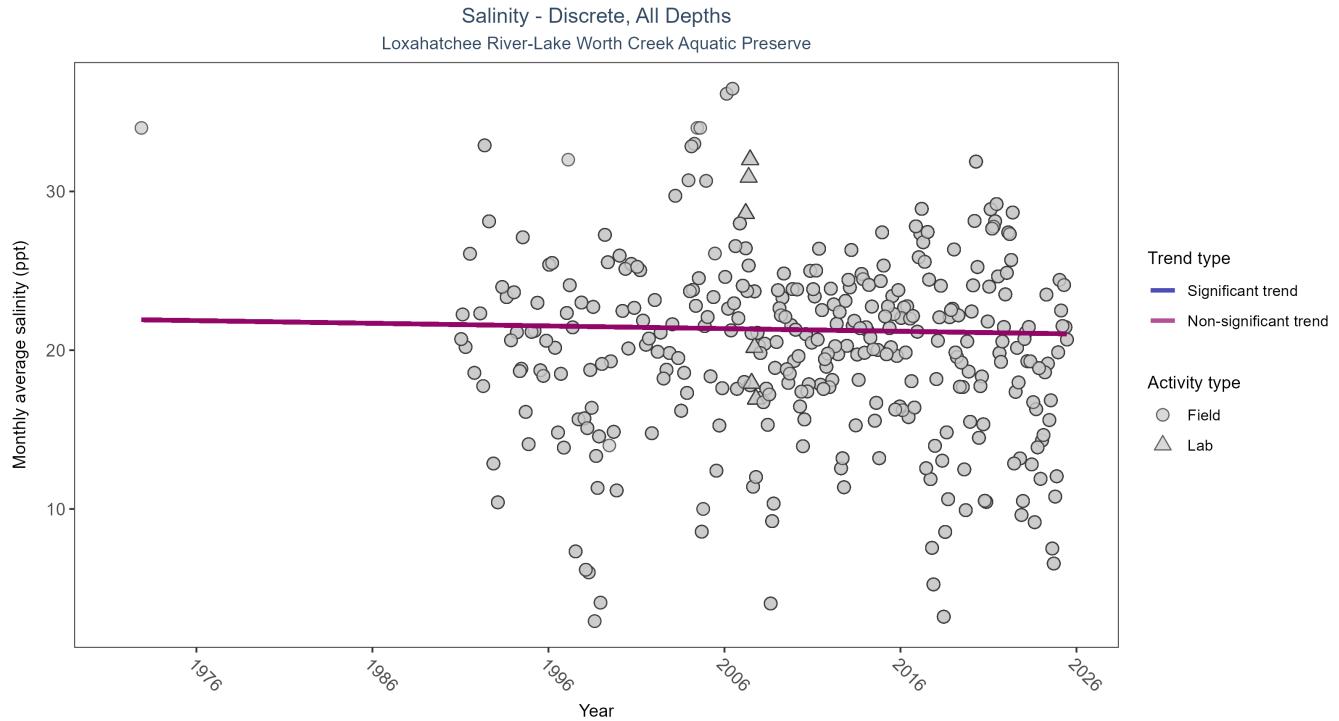


Figure 13: Scatter plot of monthly average salinity over time. If the time series included ten or more years of discrete observations, significant (blue) or non-significant (magenta) trend lines are also shown. Discrete salinity values derived from grab samples analyzed in the field (circles) or the 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	No significant trend	12160	36	1972 - 2025	24.5	-0.0224	21.9303	-0.0168	0.6149

Salinity showed no detectable trend between 1972 and 2025.

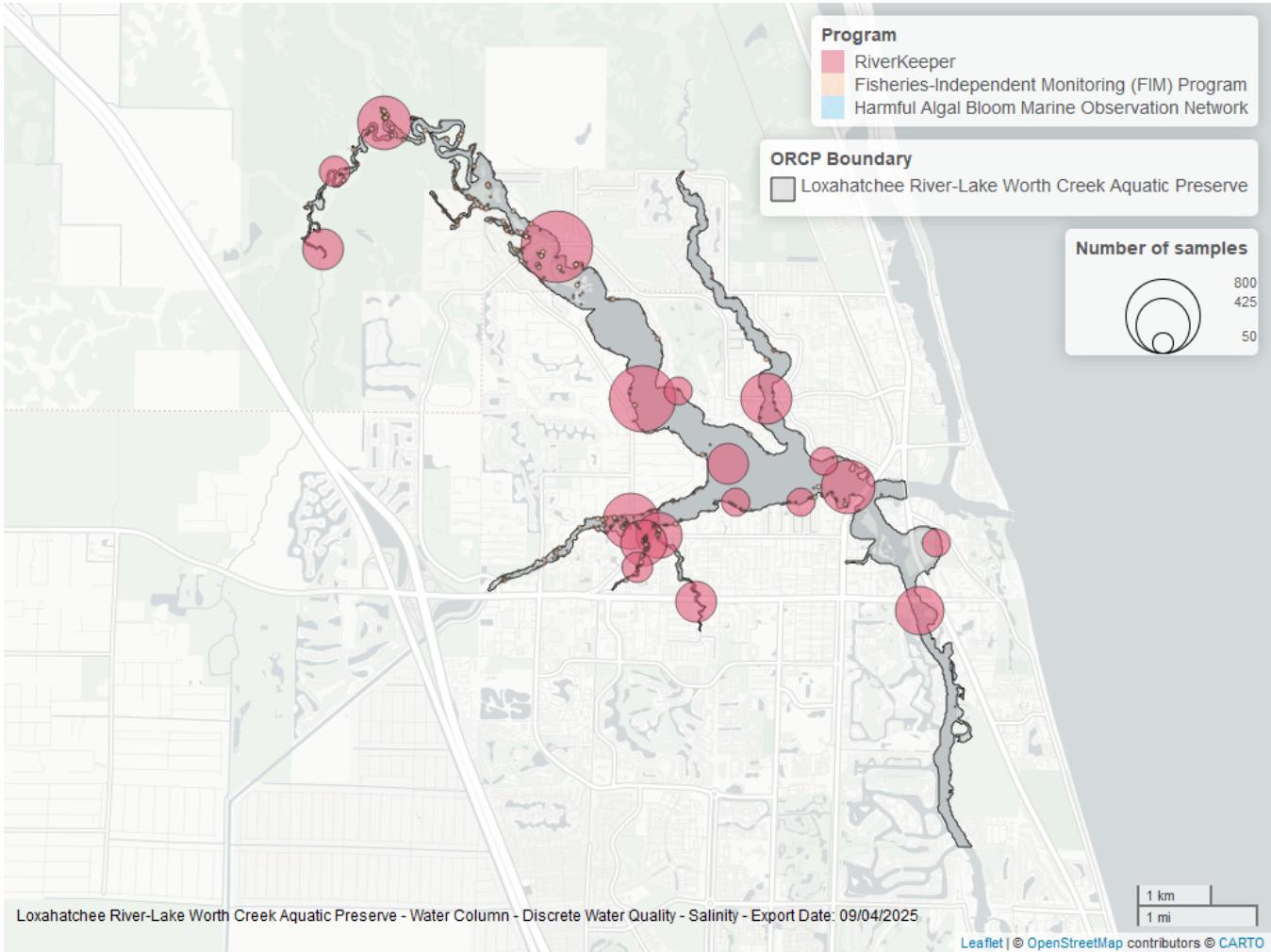


Figure 14: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 19: Programs contributing data for Salinity

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
10000	6067	1991	2025
5002	4942	1991	2023
69	1079	1997	2024
3013	67	2004	2023
95	3	1972	2016
103	2	2021	2022

Program names:

- 69 - Fisheries-Independent Monitoring (FIM) Program⁴
- 95 - Harmful Algal Bloom Marine Observation Network⁵
- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX⁶
- 3013 - Seagrass (SJRWMD)⁷
- 5002 - Florida STORET / WIN²
- 10000 - RiverKeeper³

Secchi Depth - Discrete

Seasonal Kendall-Tau Trend Analysis

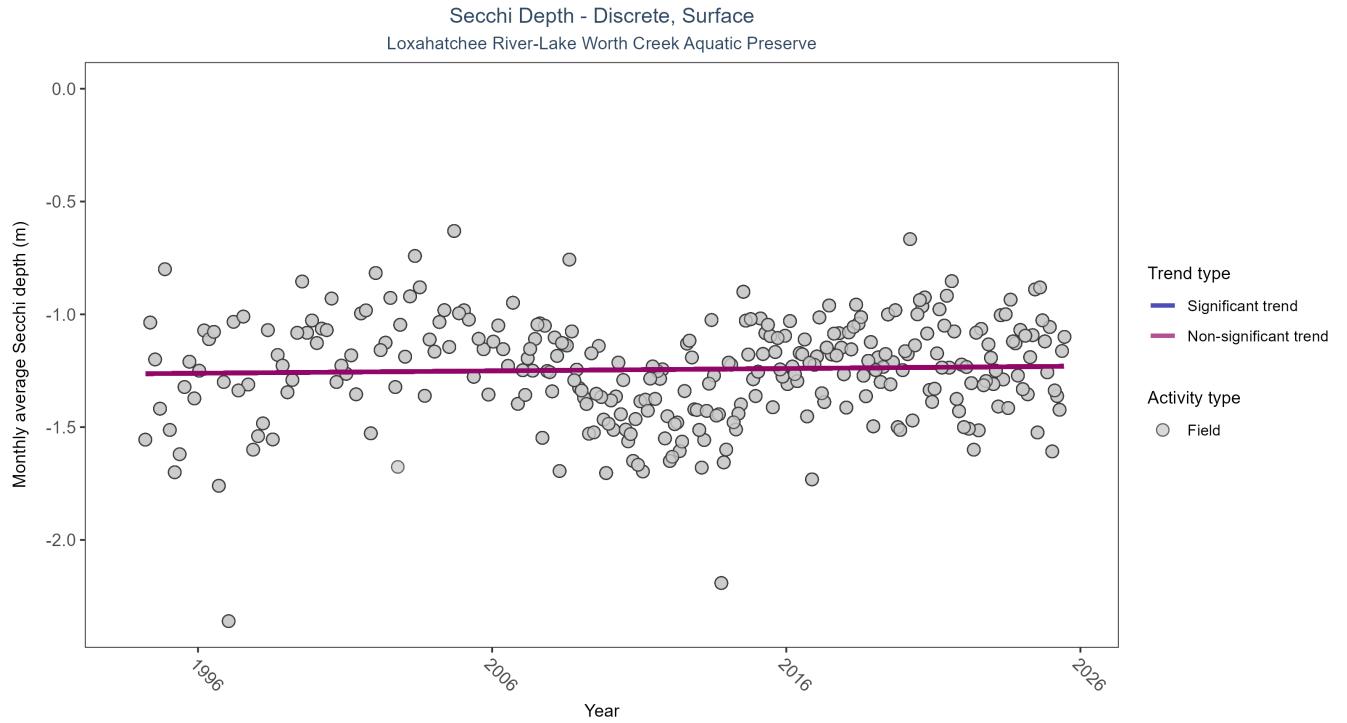


Figure 15: Scatter plot of monthly average Secchi depth over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Secchi depth is only measured in the field (circles).

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	No significant trend	4973	32	1994 - 2025	-1.2	0.0604	-1.2633	0.001	0.5816

Secchi depth showed no detectable trend between 1994 and 2025.

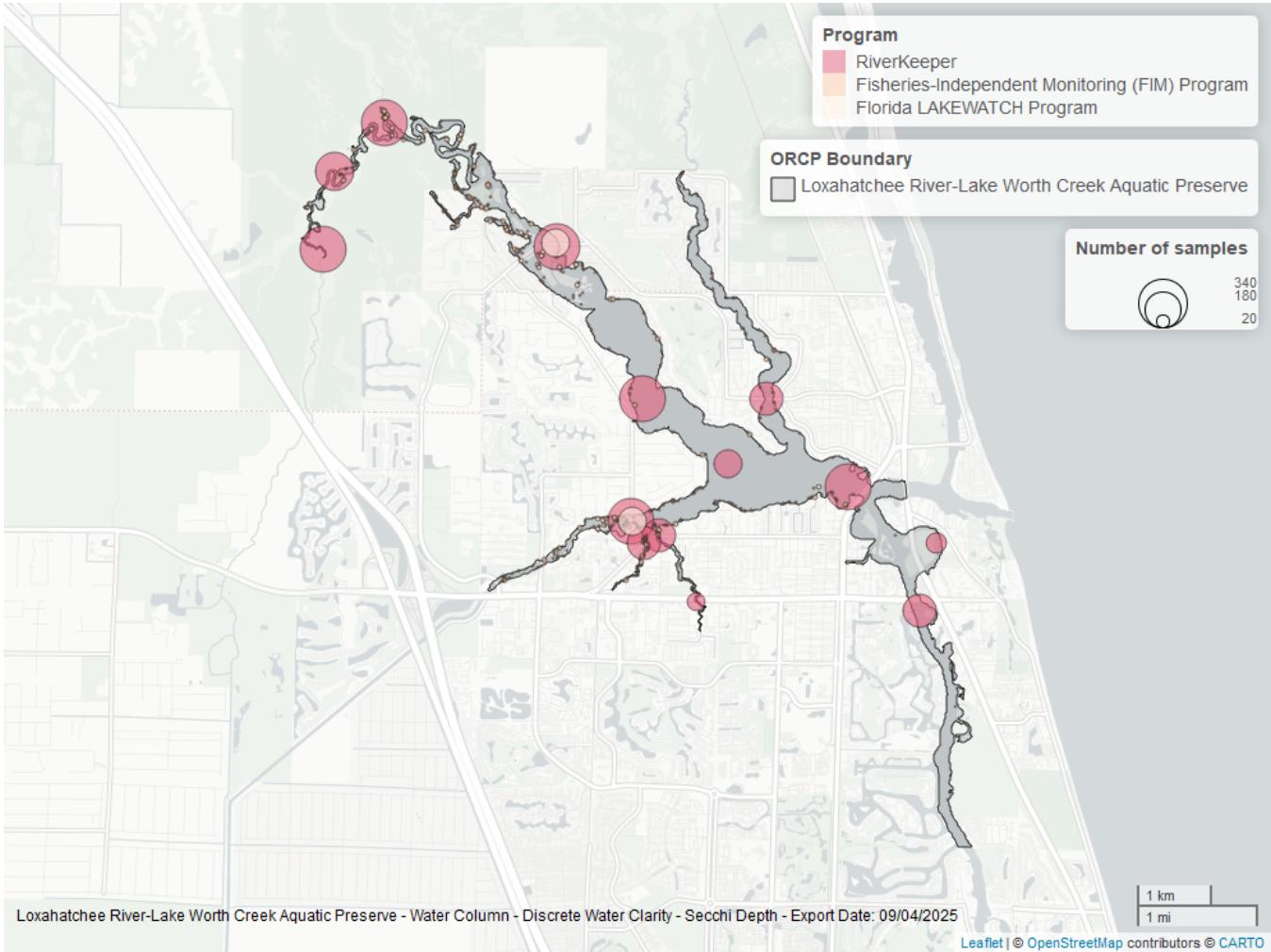


Figure 16: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 21: Programs contributing data for Secchi Depth

ProgramID	N_Data	YearMin	YearMax
10000	3233	1994	2025
69	1068	1997	2024
5002	312	2007	2024
514	300	2001	2024
3013	63	2004	2024

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program⁴

514 - Florida LAKEWATCH Program¹

3013 - Seagrass (SJRWMD)⁷

5002 - Florida STORET / WIN²

10000 - RiverKeeper³

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

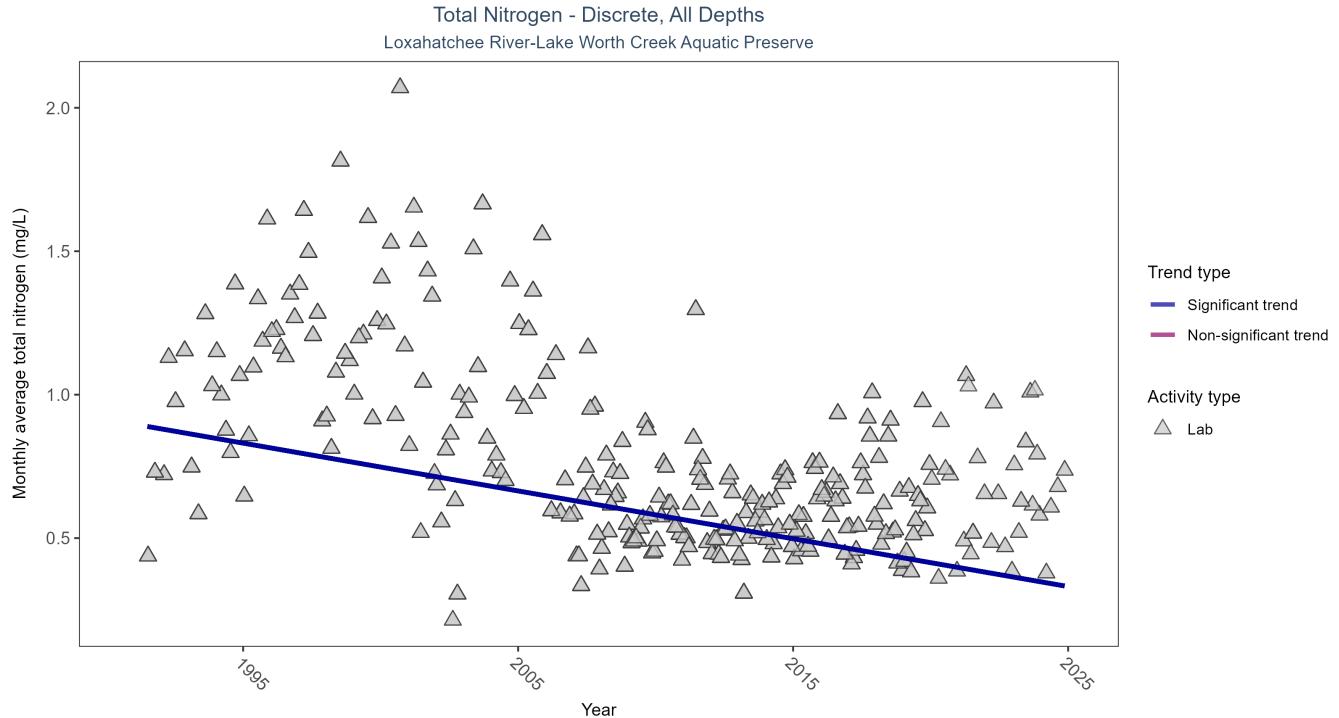


Figure 17: Scatter plot of monthly average total nitrogen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only nitrogen values obtained from laboratory analyses (triangles) are included in the 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 decreasing trend	4771	34	1991 - 2024	0.706	-0.2741	0.8978	-0.0167	0

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

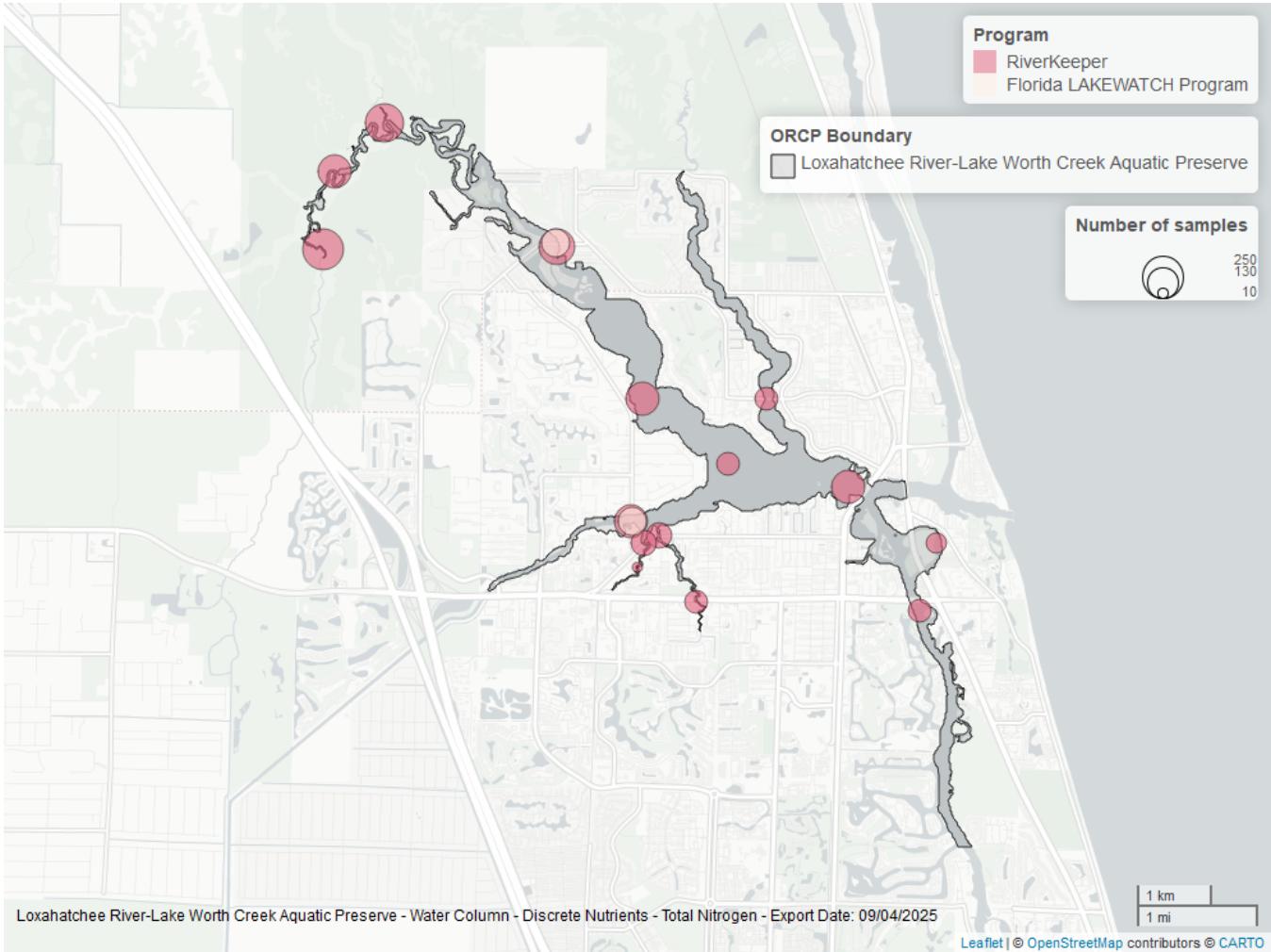


Figure 18: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 23: Programs contributing data for Total Nitrogen

ProgramID	N_Data	YearMin	YearMax
5002	3060	1991	2023
10000	1993	1991	2021
514	304	2001	2024

Program names:

514 - Florida LAKEWATCH Program¹

5002 - Florida STORET / WIN²

10000 - RiverKeeper³

Total Phosphorus - Discrete

Seasonal Kendall-Tau Trend Analysis

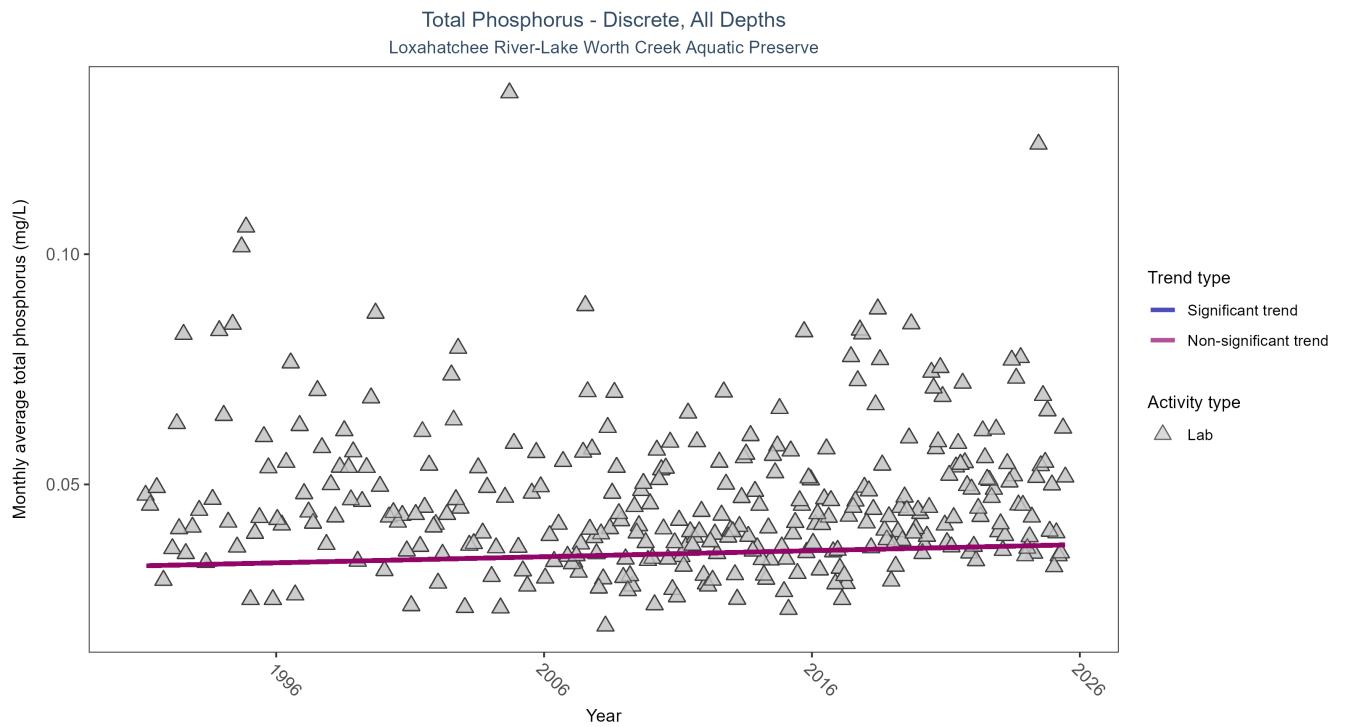


Figure 19: Scatter plot of monthly average total phosphorus over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only phosphorus values obtained from laboratory analyses (triangles) are included 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	No significant trend	6692	35	1991 - 2025	0.042	0.0837	0.0323	0.0001	0.1088

Total phosphorus showed no detectable trend between 1991 and 2025.

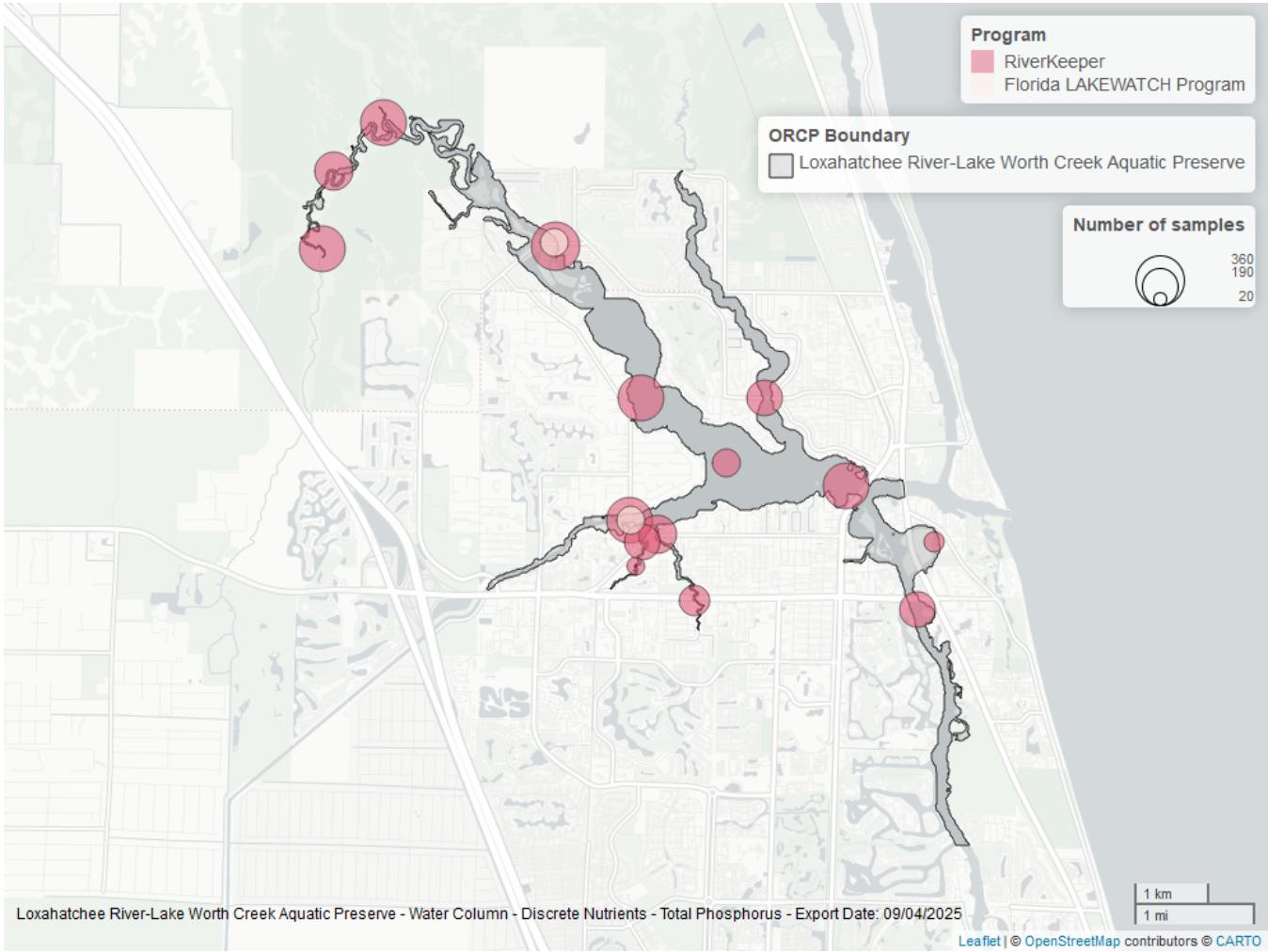


Figure 20: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 25: Programs contributing data for Total Phosphorus

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
10000	3620	1991	2025
5002	2913	1991	2024
514	304	2001	2024

Program names:

514 - Florida LAKEWATCH Program¹

5002 - Florida STORET / WIN²

10000 - RiverKeeper³

Total Suspended Solids - Discrete

Seasonal Kendall-Tau Trend Analysis

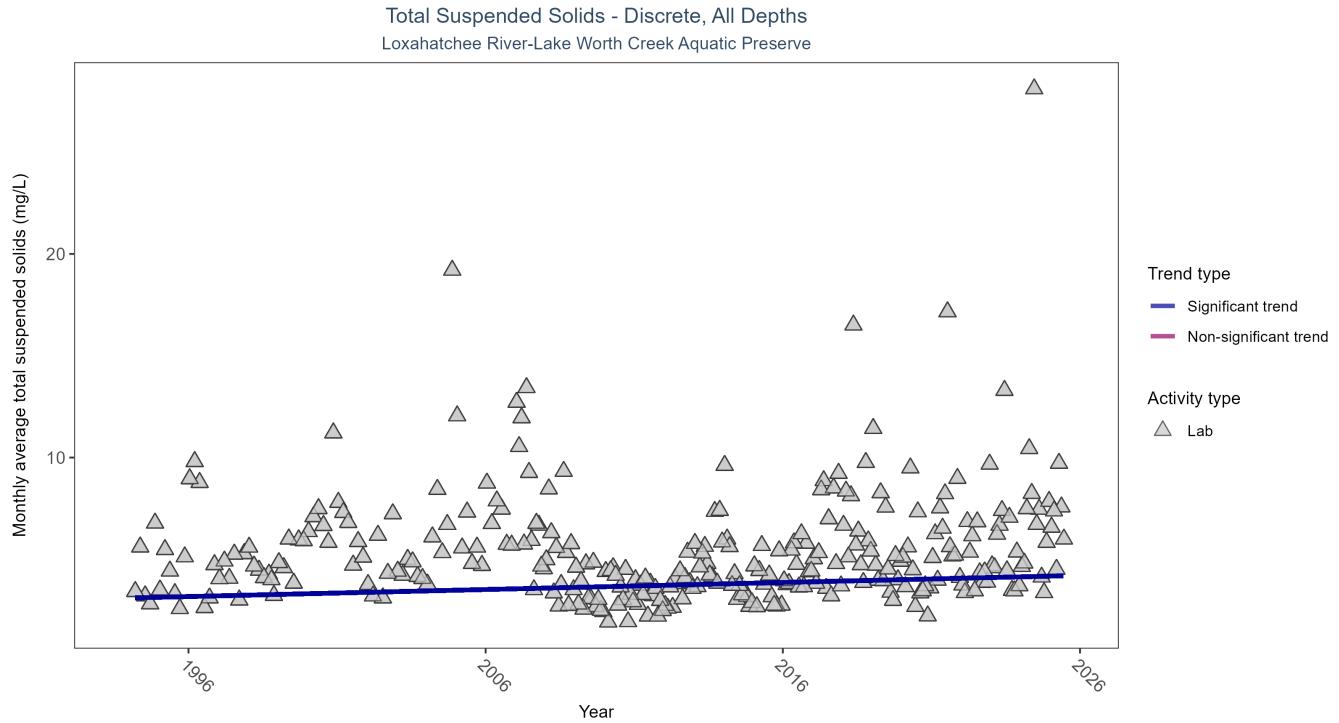


Figure 21: Scatter plot of monthly average total suspended solids (TSS) over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only TSS values obtained from laboratory analyses (triangles) are included 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 increasing trend	6200	32	1994 - 2025	4	0.1454	3.1025	0.0346	0.0067

Monthly average total suspended solids increased by 0.03 mg/L per year, indicating a decrease in water clarity.

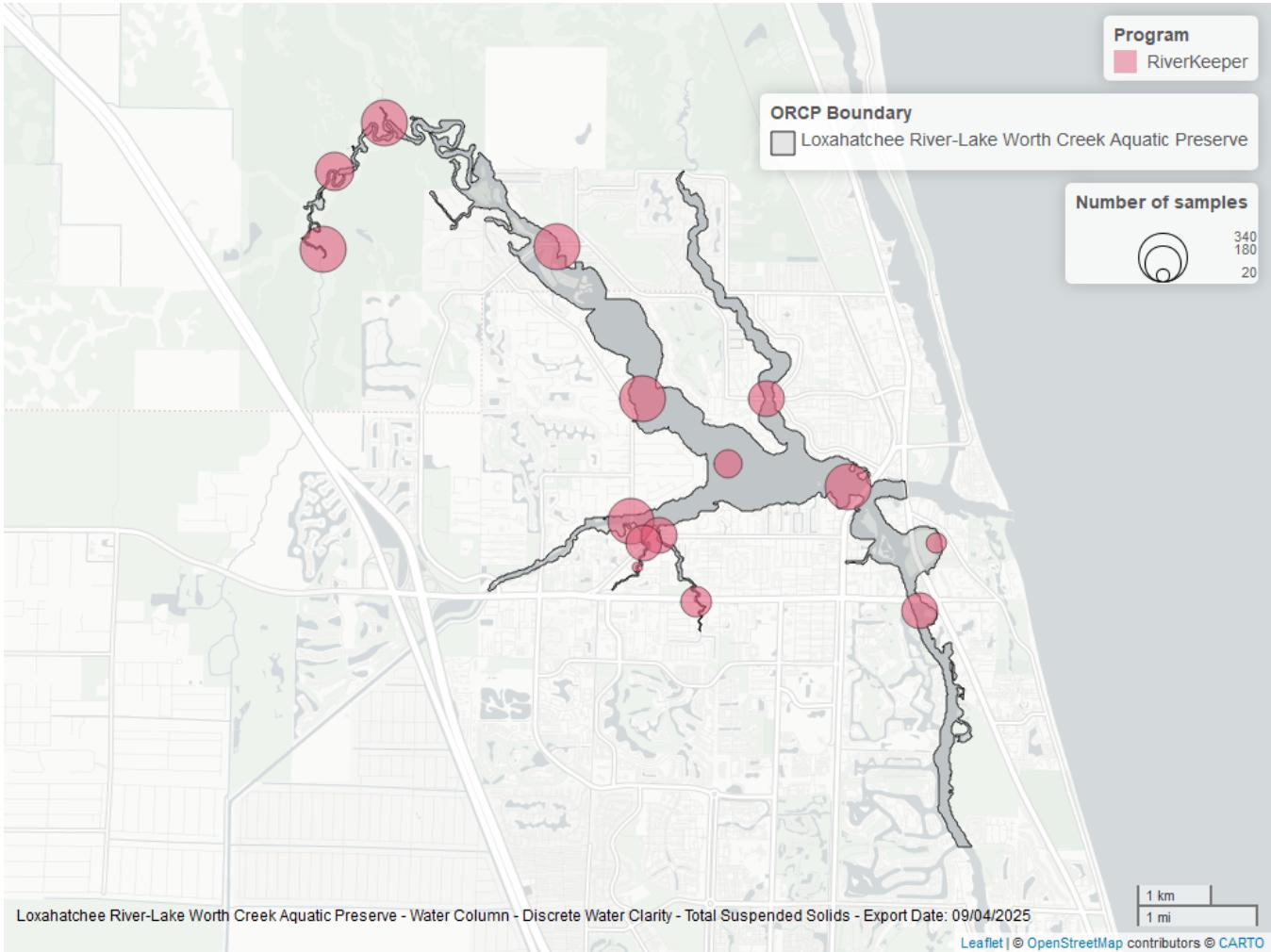


Figure 22: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 27: Programs contributing data for Total Suspended Solids

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
10000	3479	1994	2025
5002	2761	1994	2024

Program names:

5002 - Florida STORET / WIN²

10000 - RiverKeeper³

Turbidity - Discrete

Seasonal Kendall-Tau Trend Analysis

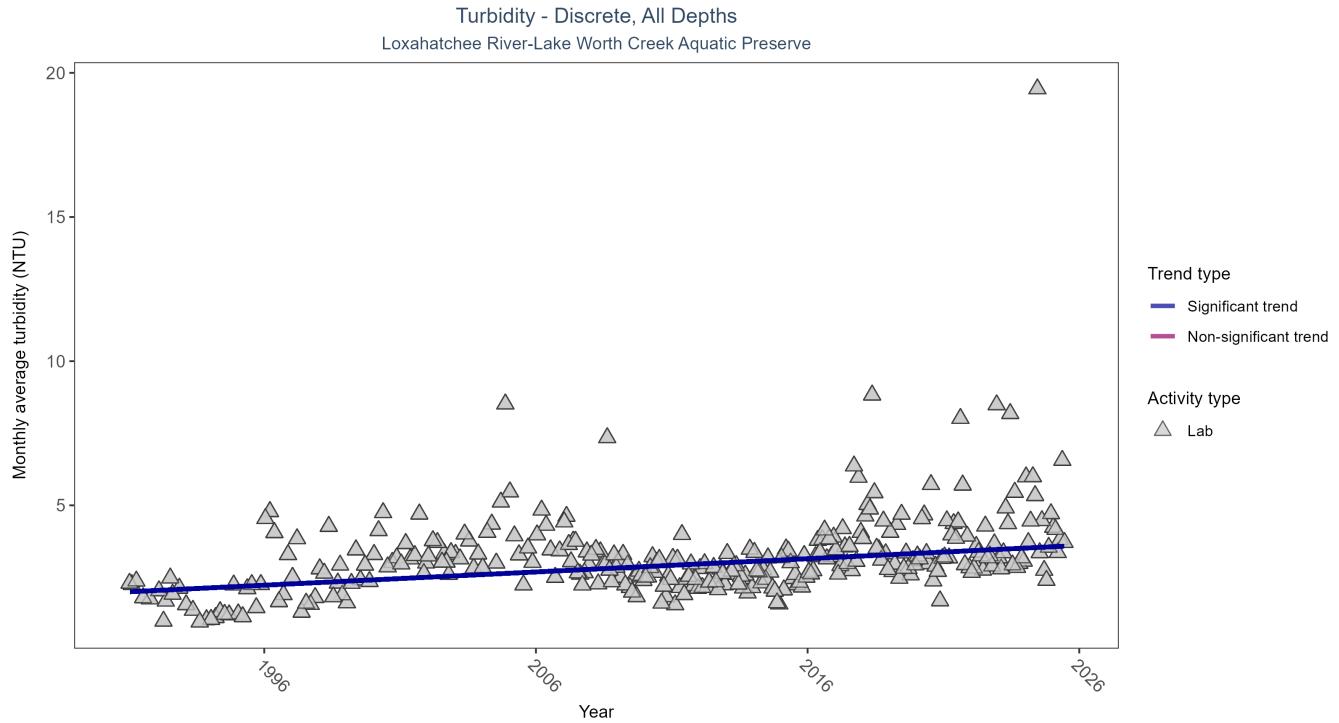


Figure 23: Scatter plot of monthly average turbidity over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only turbidity values measured in the laboratory (triangles) are included in the plot.

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 increasing trend	6568	35	1991 - 2025	2.7	0.3293	2.0002	0.046	0

Monthly average turbidity increased by 0.05 NTU per year, indicating a decrease in water clarity.

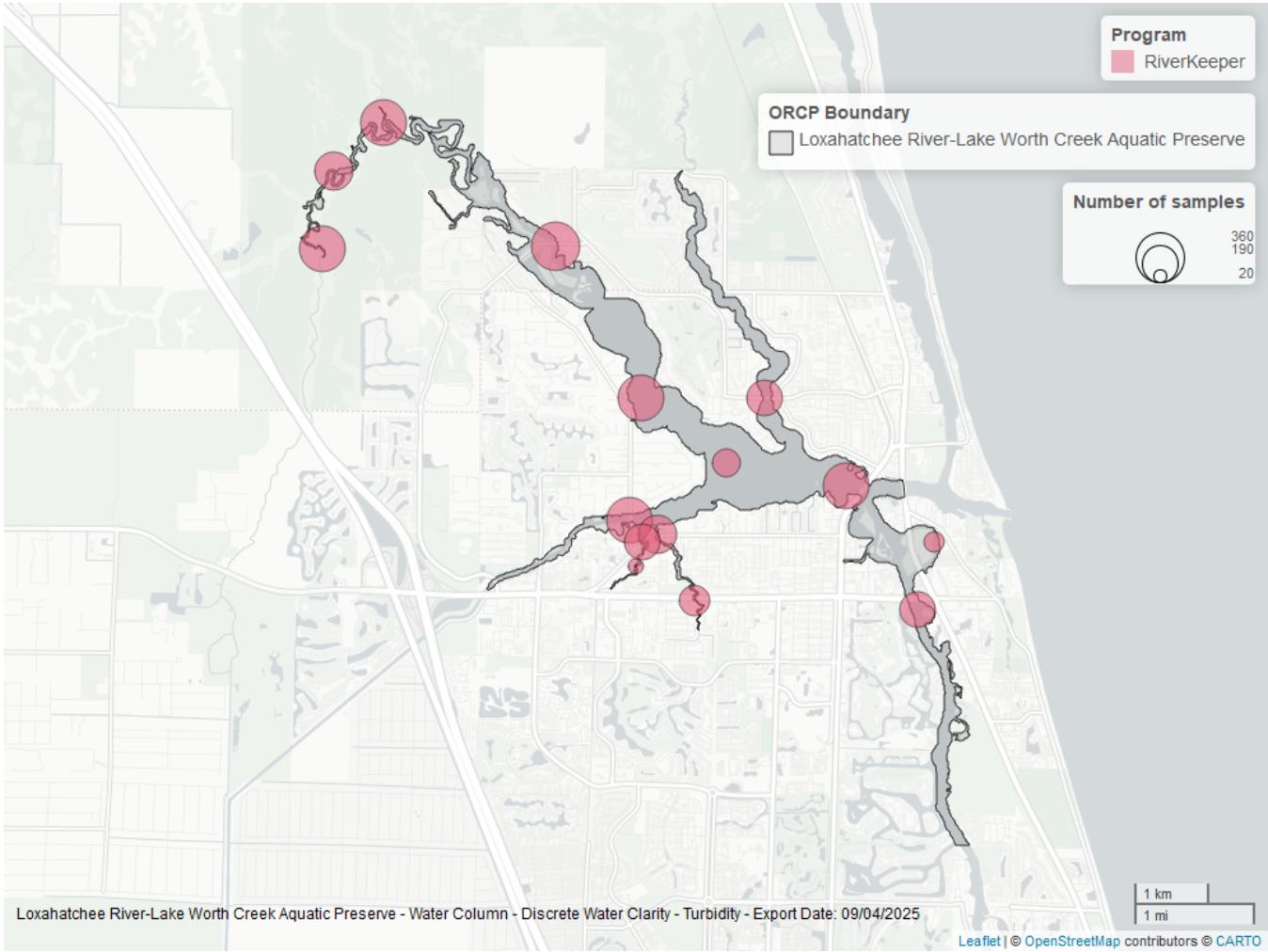


Figure 24: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 29: Programs contributing data for Turbidity

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
10000	3647	1991	2025
5002	2923	1991	2024
3013	26	2004	2018

Program names:

- 3013 - Seagrass (SJRWMD)⁷
- 5002 - Florida STORET / WIN²
- 10000 - RiverKeeper³

Water Temperature - Discrete

Seasonal Kendall-Tau Trend Analysis

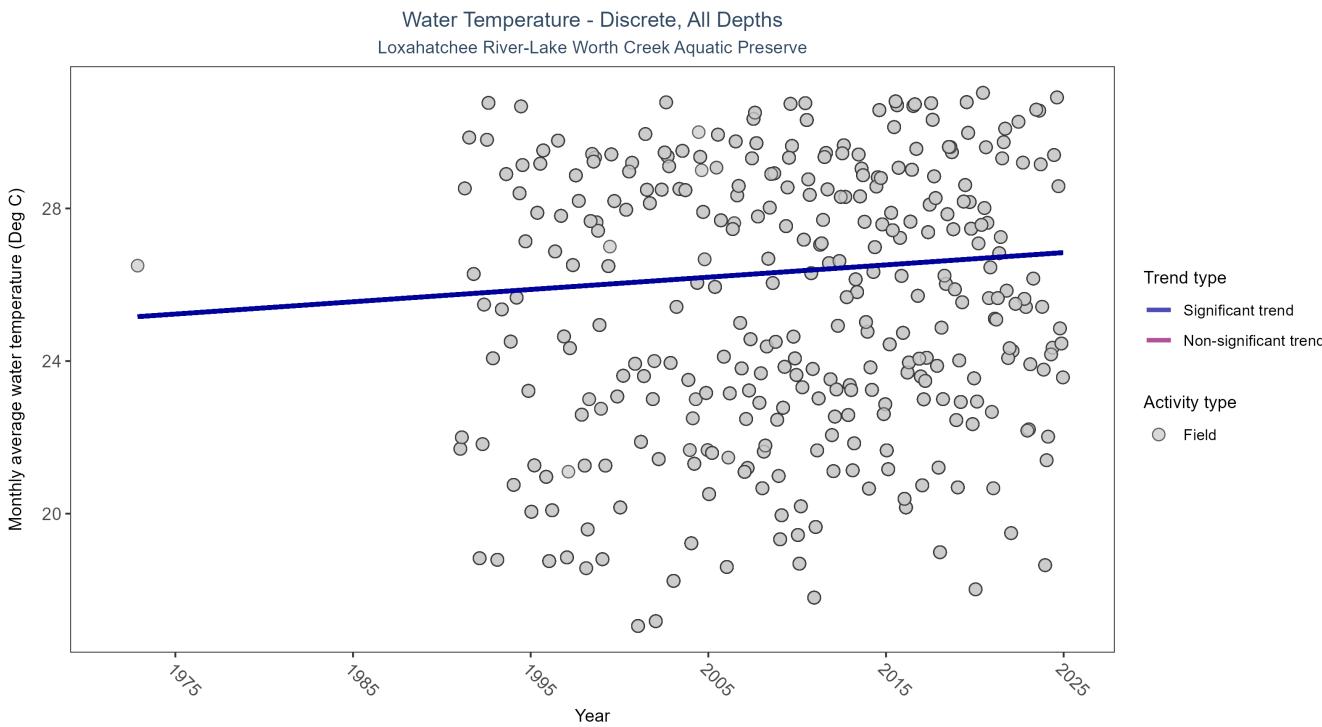


Figure 25: Scatter plot of monthly average water temperature over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only water temperature measurements taken in the field (circles) are included in 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	10839	35	1972 - 2024	25.6	0.1487	25.1353	0.0322	0.0002

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

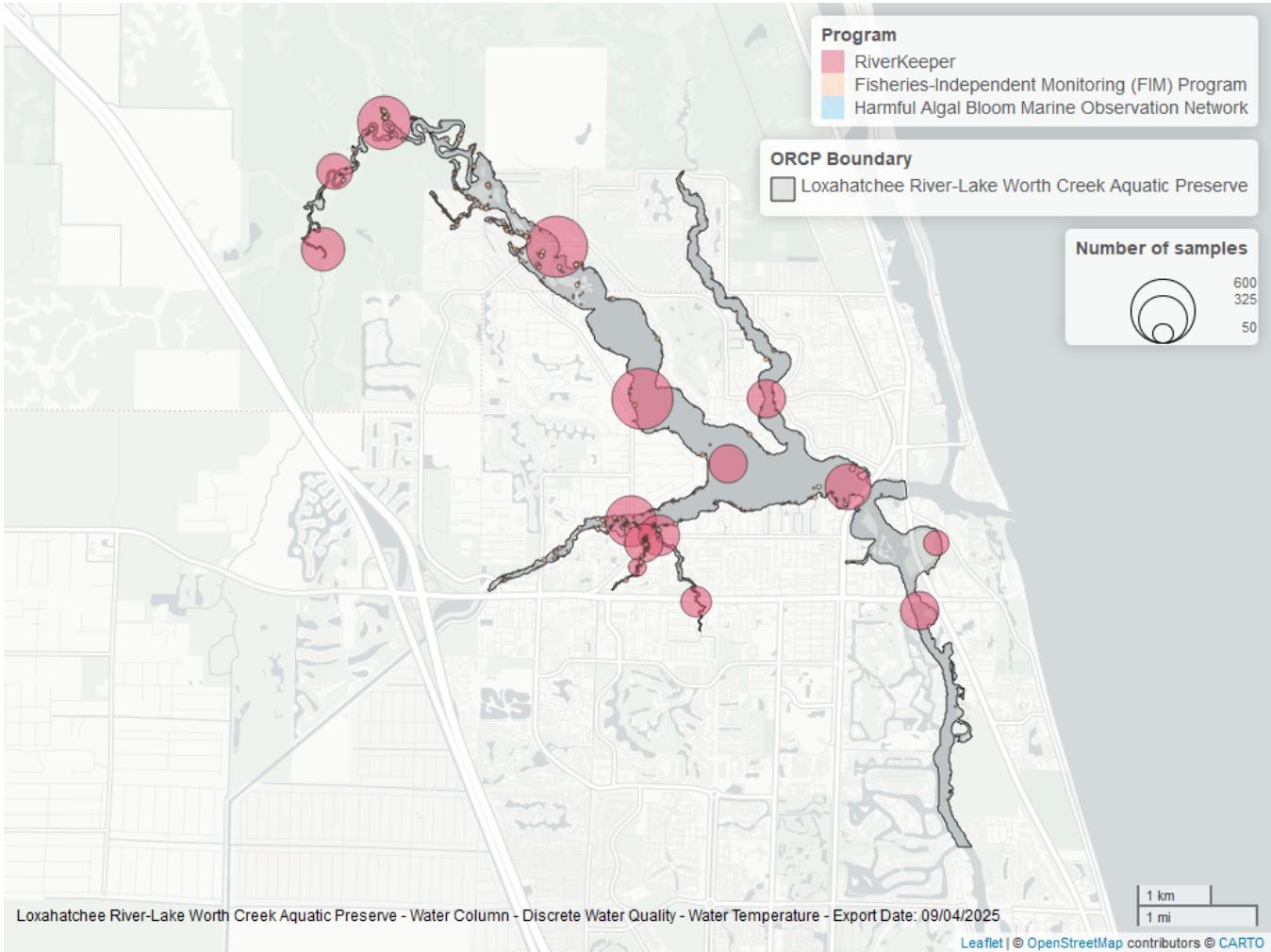


Figure 26: Map showing location of discrete water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 31: Programs contributing data for Water Temperature

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	5374	1991	2024
10000	4314	1991	2019
69	1080	1997	2024
3013	66	2004	2023
95	3	1972	2016
103	2	2021	2022

Program names:

- 69 - Fisheries-Independent Monitoring (FIM) Program⁴
- 95 - Harmful Algal Bloom Marine Observation Network⁵
- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX⁶
- 3013 - Seagrass (SJRWMD)⁷
- 5002 - Florida STORET / WIN²
- 10000 - RiverKeeper³

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 Loxahatchee River-Lake Worth Creek Aquatic Preserve

Table 32: 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>
7	02277743	3	FALSE	Sal , TempW
7	265645080055900	5	TRUE	Sal , TempW
7	265656080063500	5	TRUE	Sal , TempW
7	265906080093500	23	TRUE	Sal , TempW
7	265929080091800	24	TRUE	Sal , TempW

Program names:

7 - National Water Information System⁸

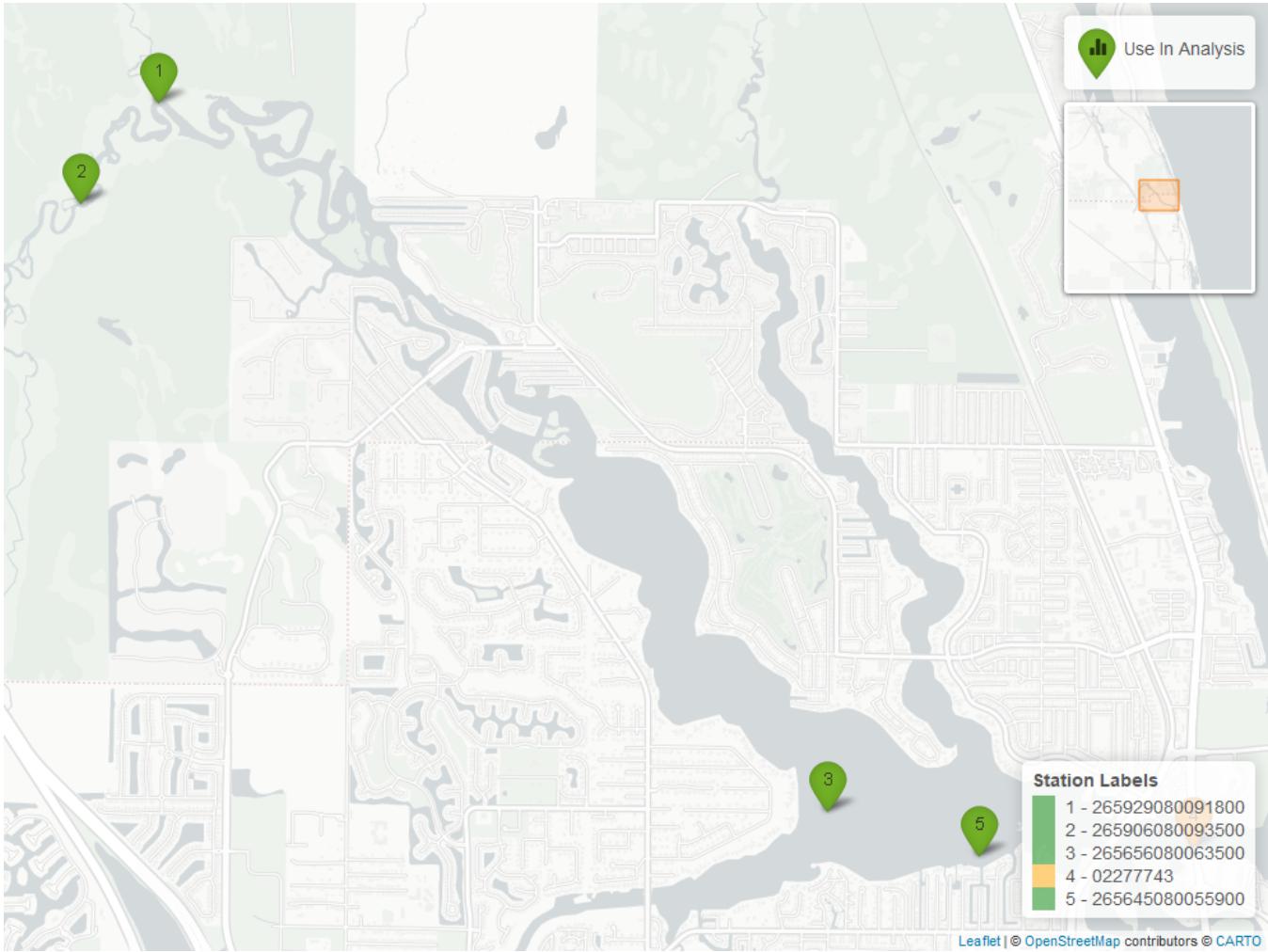


Figure 27: Map showing continuous water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. Sites marked as *Use In Analysis* (green) are featured in this report.

Salinity - Continuous

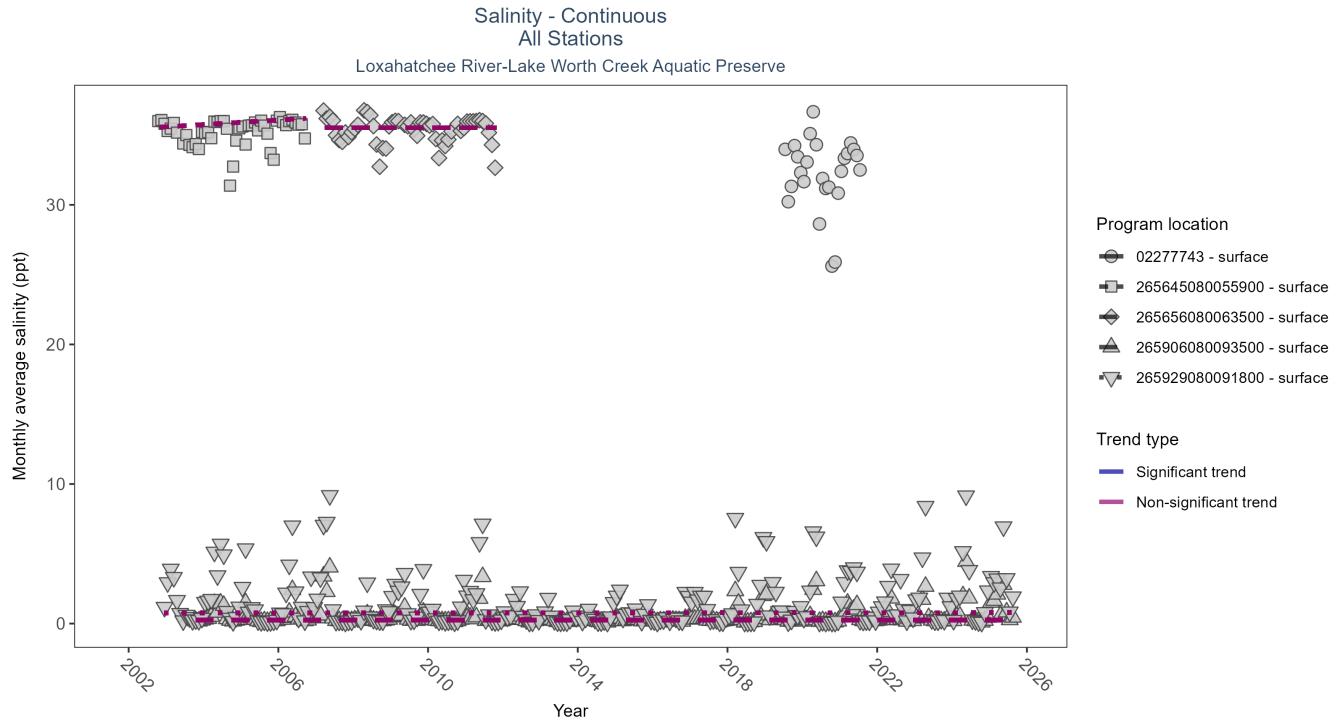


Figure 28: Scatter plot of monthly average salinity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 33: 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
265906080093500	No significant trend	9312	23	2003 - 2025	0.3	0.03	0.25	0	0.49
02277743	Insufficient data to calculate trend	1144	3	2019 - 2021	32.0	-	-	-	-
265929080091800	No significant trend	8103	24	2002 - 2025	0.4	0.02	0.76	0	0.63
265656080063500	No significant trend	2046	5	2007 - 2011	36.0	0.01	35.53	0	1
265645080055900	No significant trend	1354	5	2002 - 2006	36.0	0.22	35.43	0.16	0.16

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

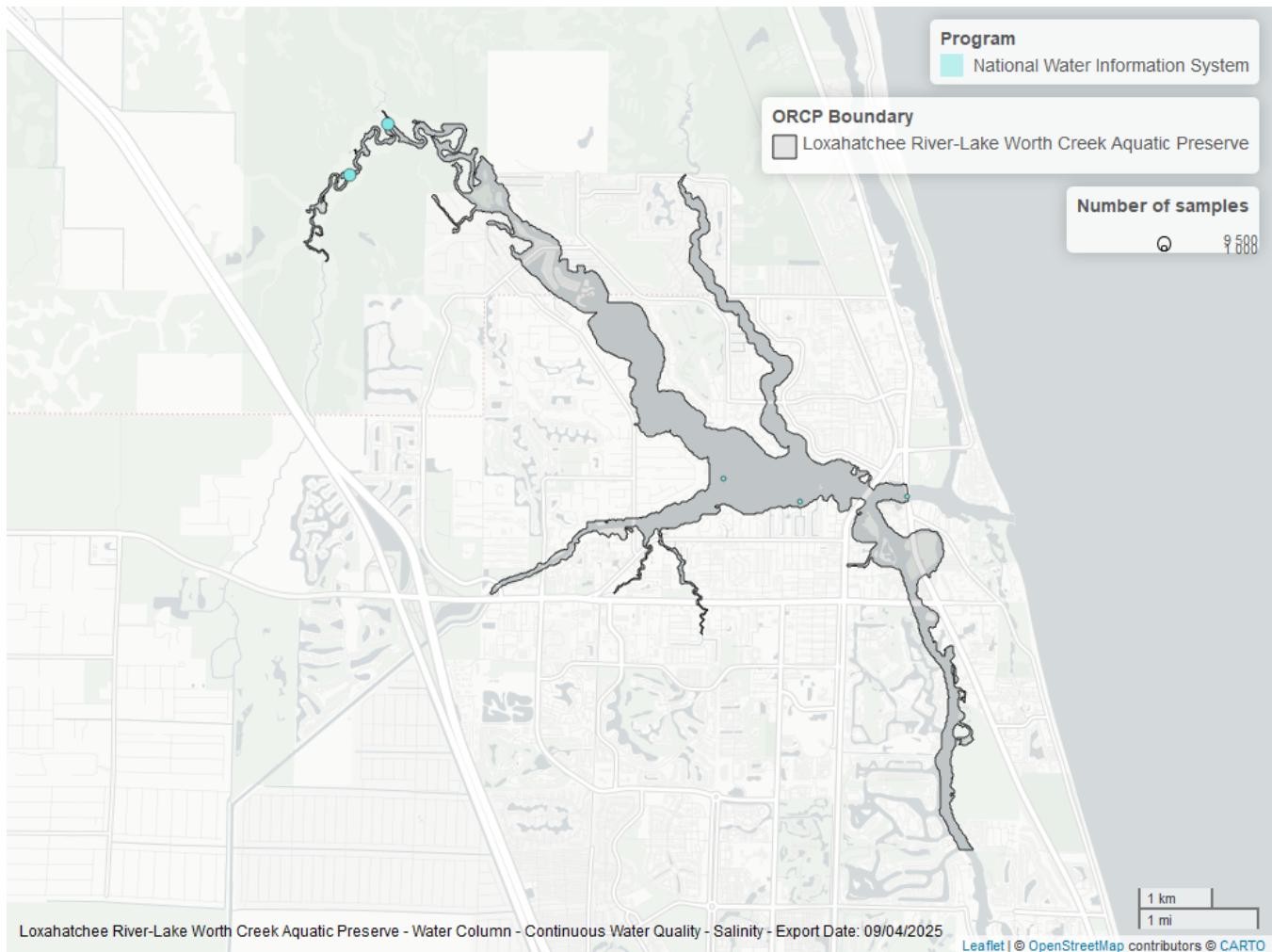


Figure 29: Map showing location of salinity continuous water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Water Temperature - Continuous

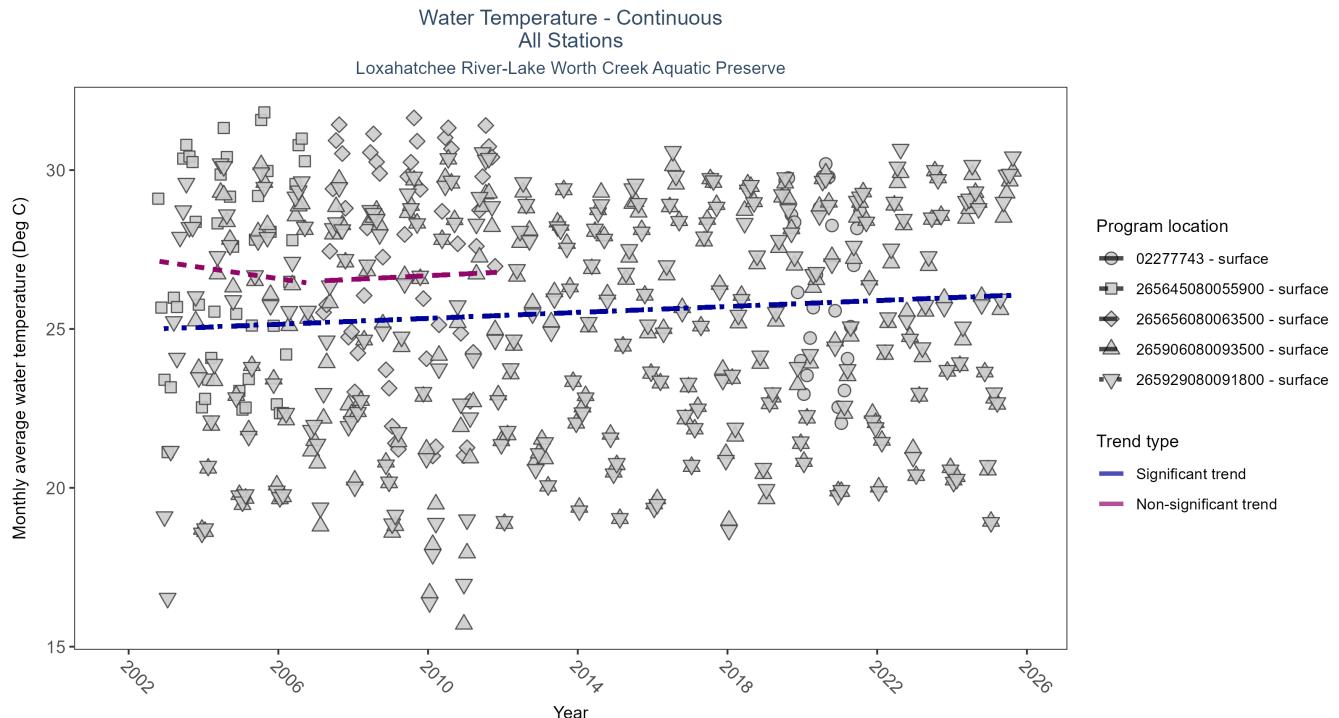


Figure 30: Scatter plot of monthly average water temperature over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 34: 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
265929080091800	Significantly increasing trend	8122	24	2002 - 2025	25.8	0.25	24.97	0.05	0
265906080093500	Significantly increasing trend	12333	23	2003 - 2025	25.7	0.29	25	0.05	0
02277743	Insufficient data to calculate trend	1122	3	2019 - 2021	26.3	-	-	-	-
265645080055900	No significant trend	1354	5	2002 - 2006	26.6	-0.29	27.27	-0.17	0.07
265656080063500	No significant trend	2664	5	2007 - 2011	27.6	0.08	26.5	0.06	0.45

At two program locations, monthly average water temperature increased by 0.05°C per year. No detectable change in monthly average water temperature was observed at two locations. There was insufficient data to fit a model for one location.

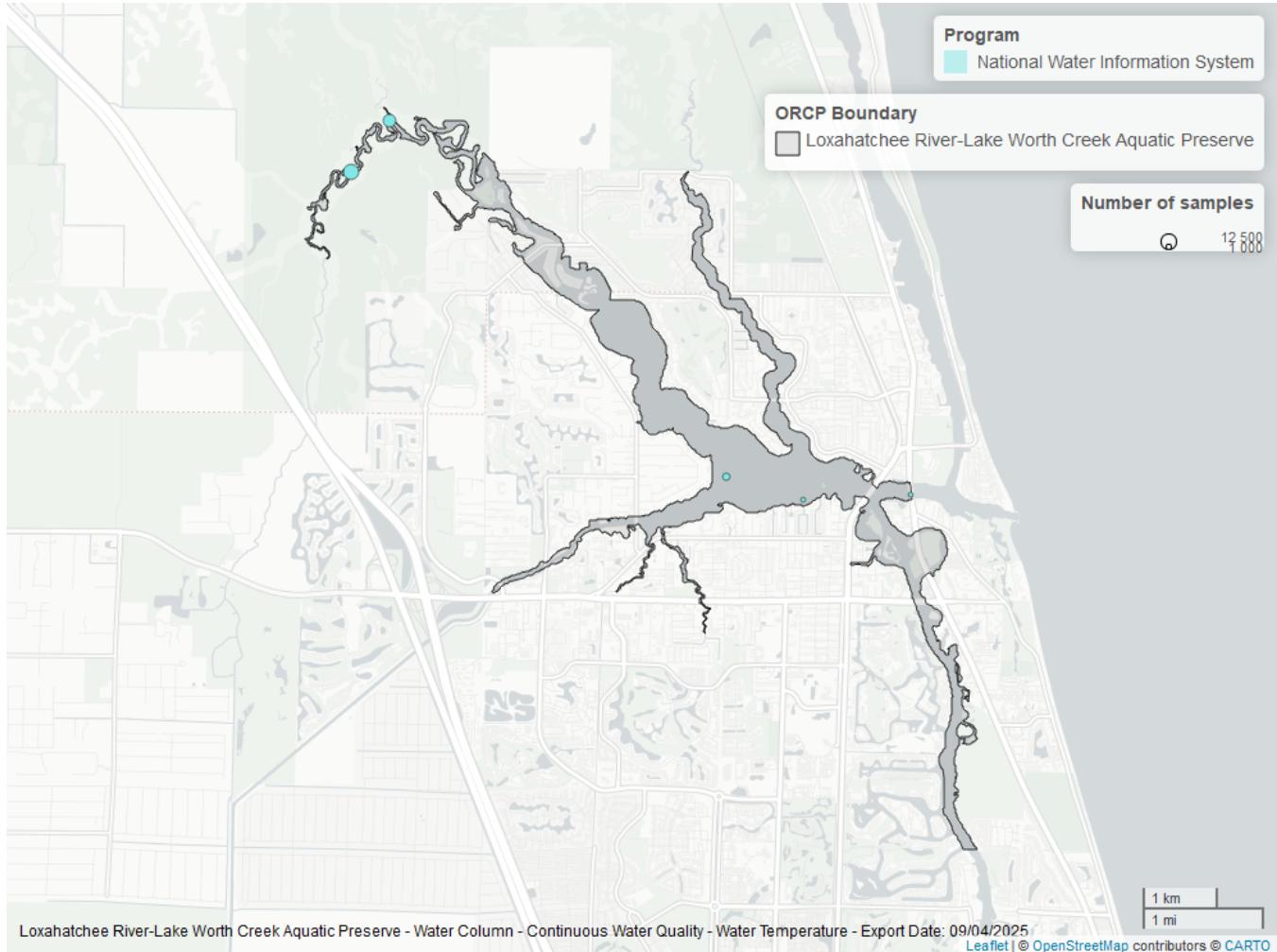


Figure 31: Map showing location of water temperature continuous water quality sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

Loxahatchee River-Lake Worth Creek Aquatic Preserve
SAV Percent Cover - Sample Locations

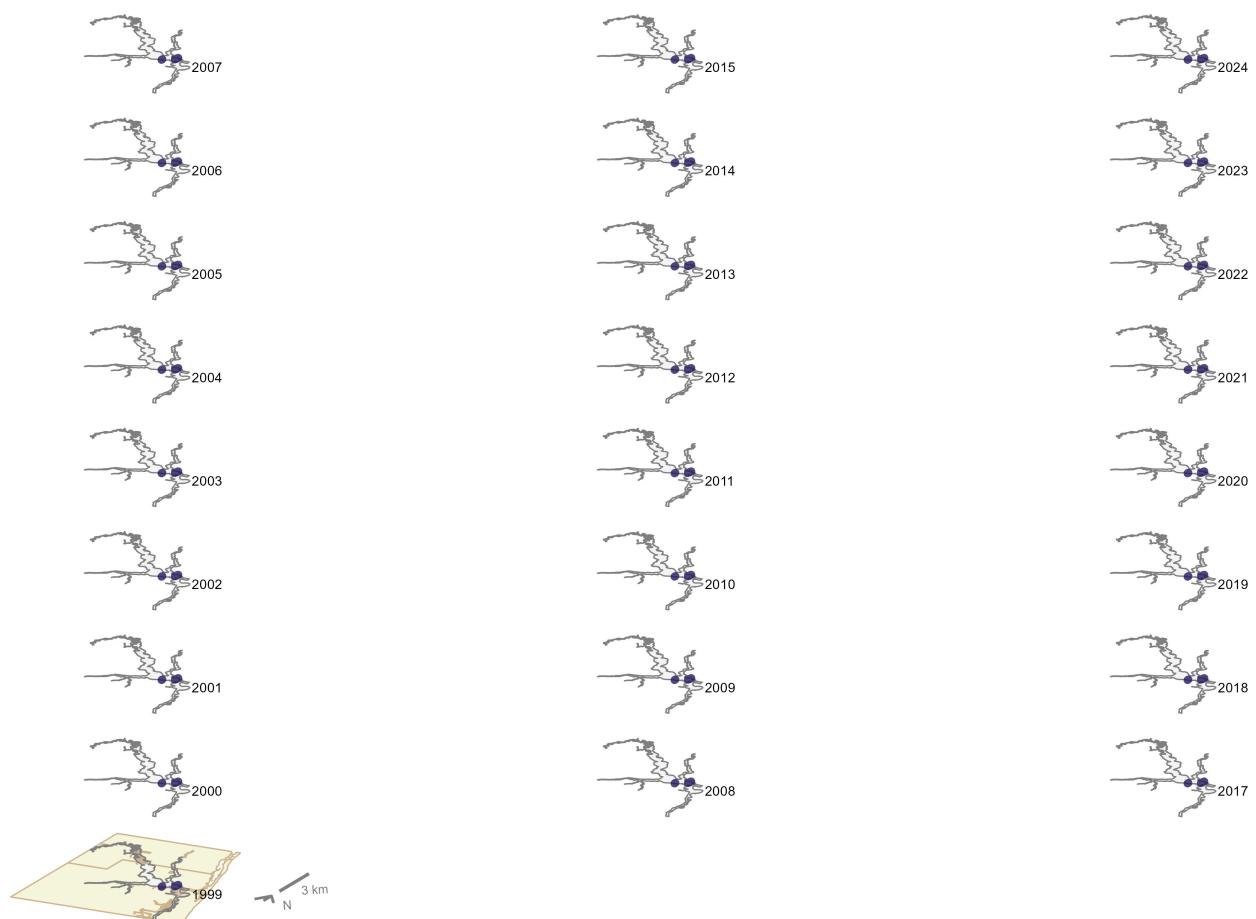


Figure 32: Maps showing the temporal scope of SAV sampling sites within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve* by Program name.

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

Sampling locations by Program:

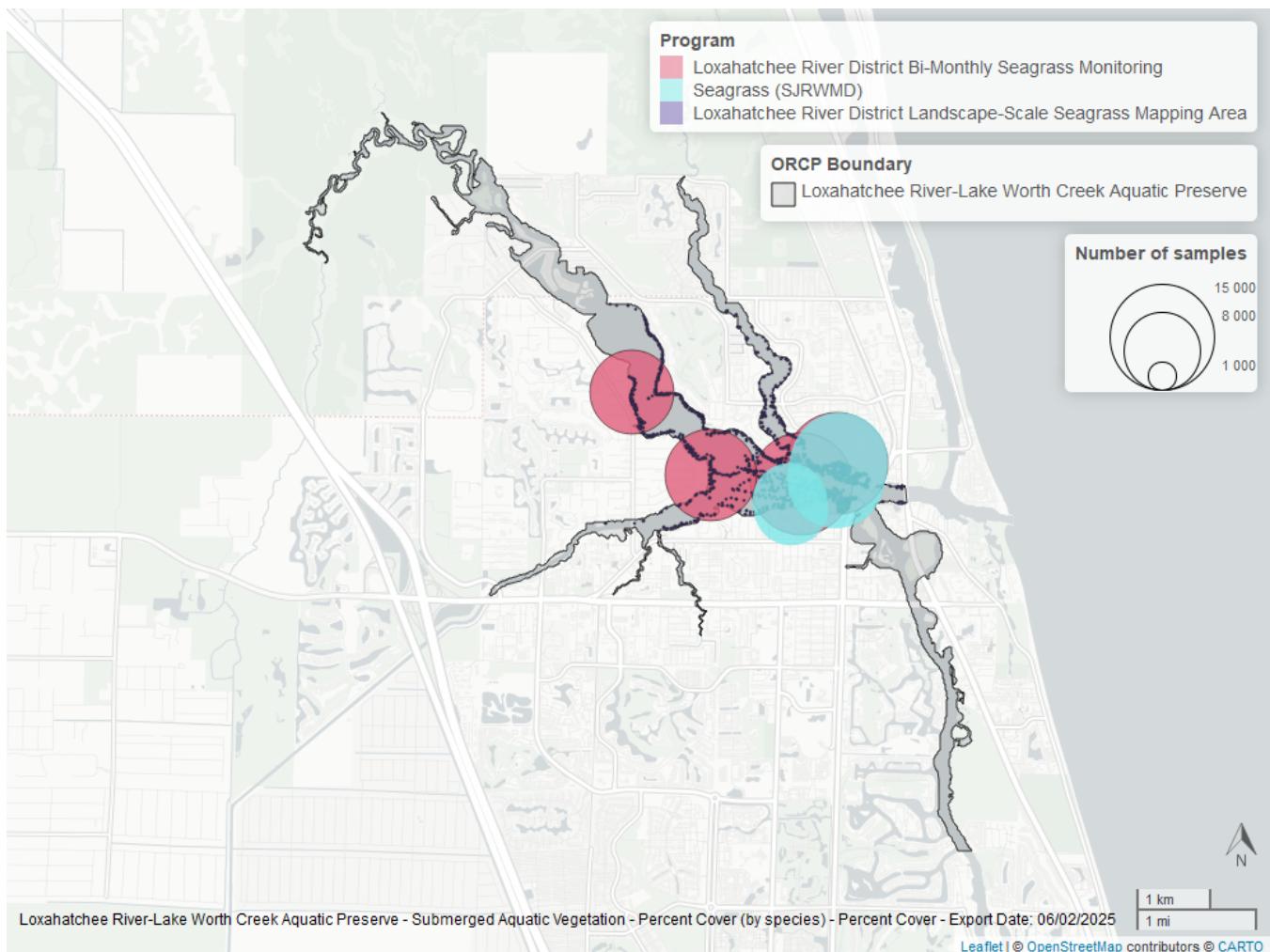


Figure 33: Map showing SAV sampling sites within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The point size reflects the number of samples at a given sampling site.

Table 35: Program Information for Submerged Aquatic Vegetation

ProgramID	N-Data	YearMin	YearMax	method	Sample Locations
3013	6349	1999	2024	Percent Cover	2
3013	7026	1999	2024	Percent Occurrence	2
3017	40636	2007	2024	Percent Occurrence	4
10001	9672	2007	2007	Percent Occurrence	1612

Program names:

3013 - Seagrass (SJRWMD)⁷

3013 - Seagrass (SJRWMD)⁷

3017 - Loxahatchee River District Bi-Monthly Seagrass Monitoring⁹

10001 - Loxahatchee River District Landscape-Scale Seagrass Mapping Area¹⁰

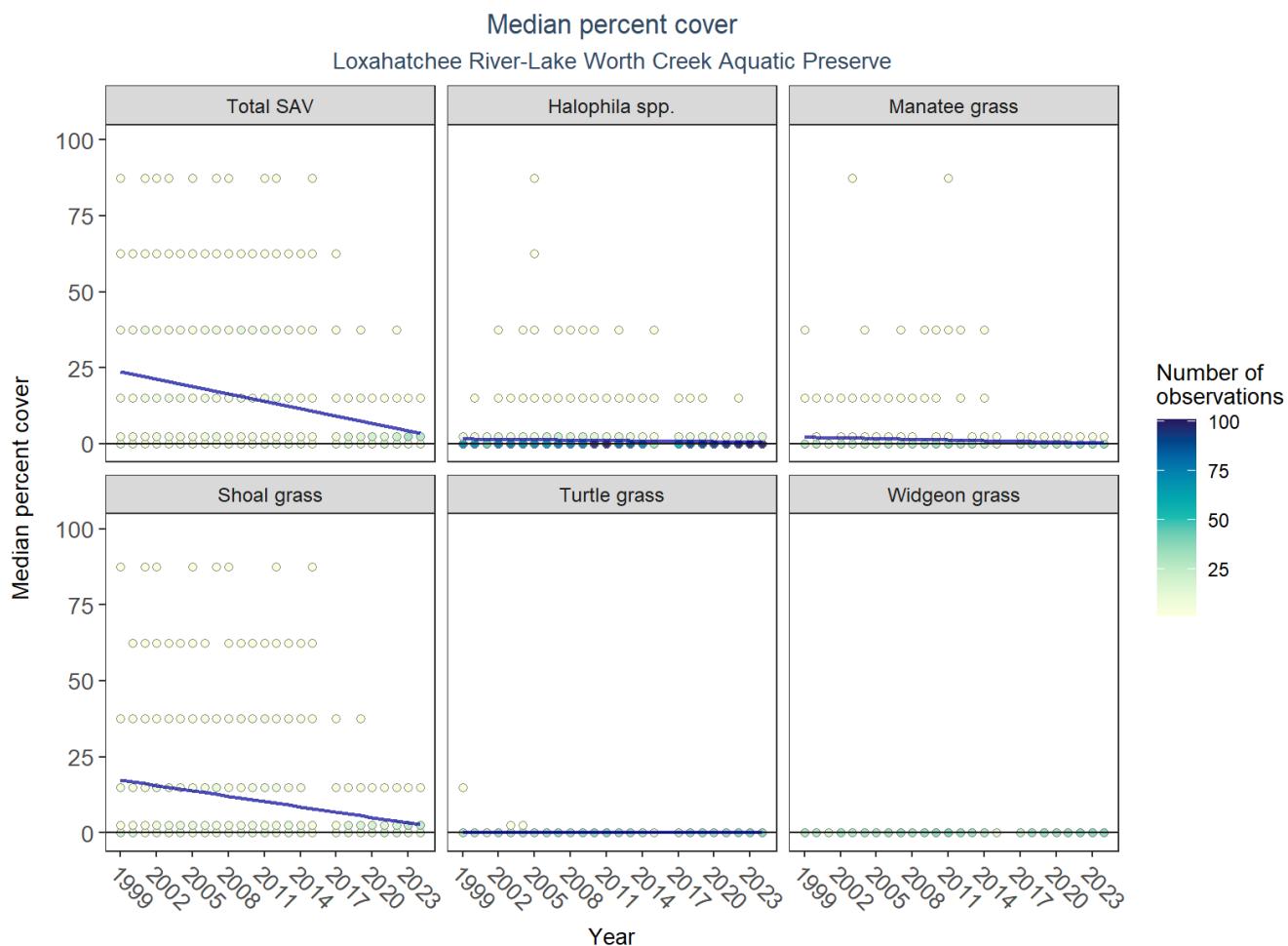


Figure 34: Scatter plots of median percent cover of submerged aquatic vegetation over time by group. Plots for time series that included five or more years of observations show the estimated trend as a blue line.

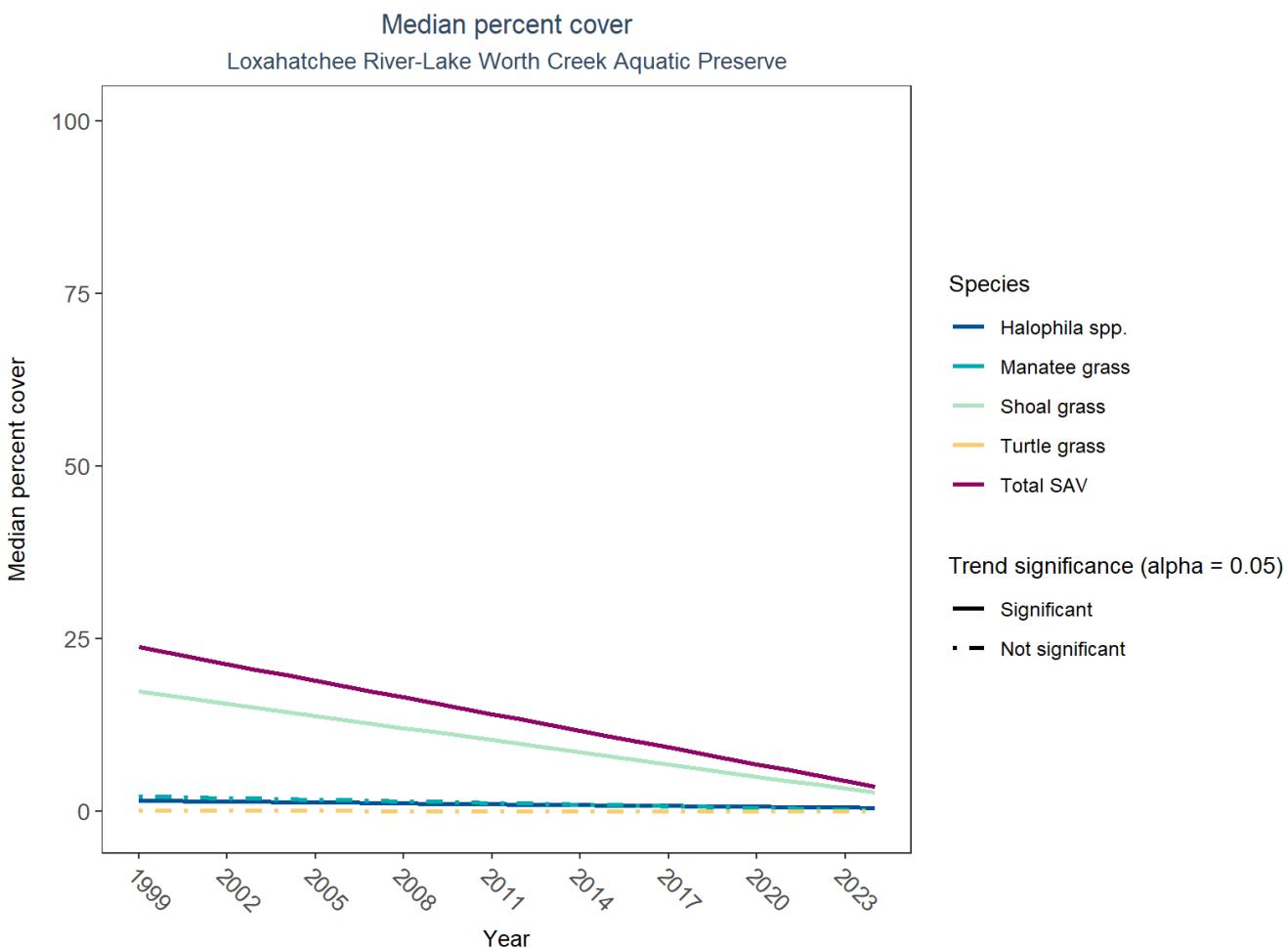


Figure 35: Trends in median percent cover for various seagrass species in Loxahatchee River-Lake Worth Creek Aquatic Preserve - simplified

Table 36: Percent Cover Trend Analysis for Loxahatchee River-Lake Worth Creek Aquatic Preserve

Common Name	Trend Significance (0.05)	Period of Record	LME-Intercept	LME-Slope	p
Drift algae	Insufficient data to calculate trend	-	-	-	-
Shoal grass	Significantly decreasing trend	1999 - 2024	20.2590676	-0.5856512	0.0000000
Halophila spp.	Significantly decreasing trend	1999 - 2024	1.7376606	-0.0414814	0.0008954
Widgeon grass	Model did not fit the available data	1999 - 2024	-	-	-
Manatee grass	No significant trend	1999 - 2024	2.5466110	-0.0783803	0.3410344
Turtle grass	No significant trend	1999 - 2024	0.0982782	-0.0043366	0.3007580
Total SAV	Significantly decreasing trend	1999 - 2024	27.7613215	-0.8054161	0.0000000
Total seagrass	Insufficient data to calculate trend	-	-	-	-

Annual decreases in percent cover were observed for total SAV (-0.8%), *Halophila* spp. (-0.0%), and shoal grass (-0.6%). No detectable change in percent cover was observed for manatee grass and turtle 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 widgeon grass.

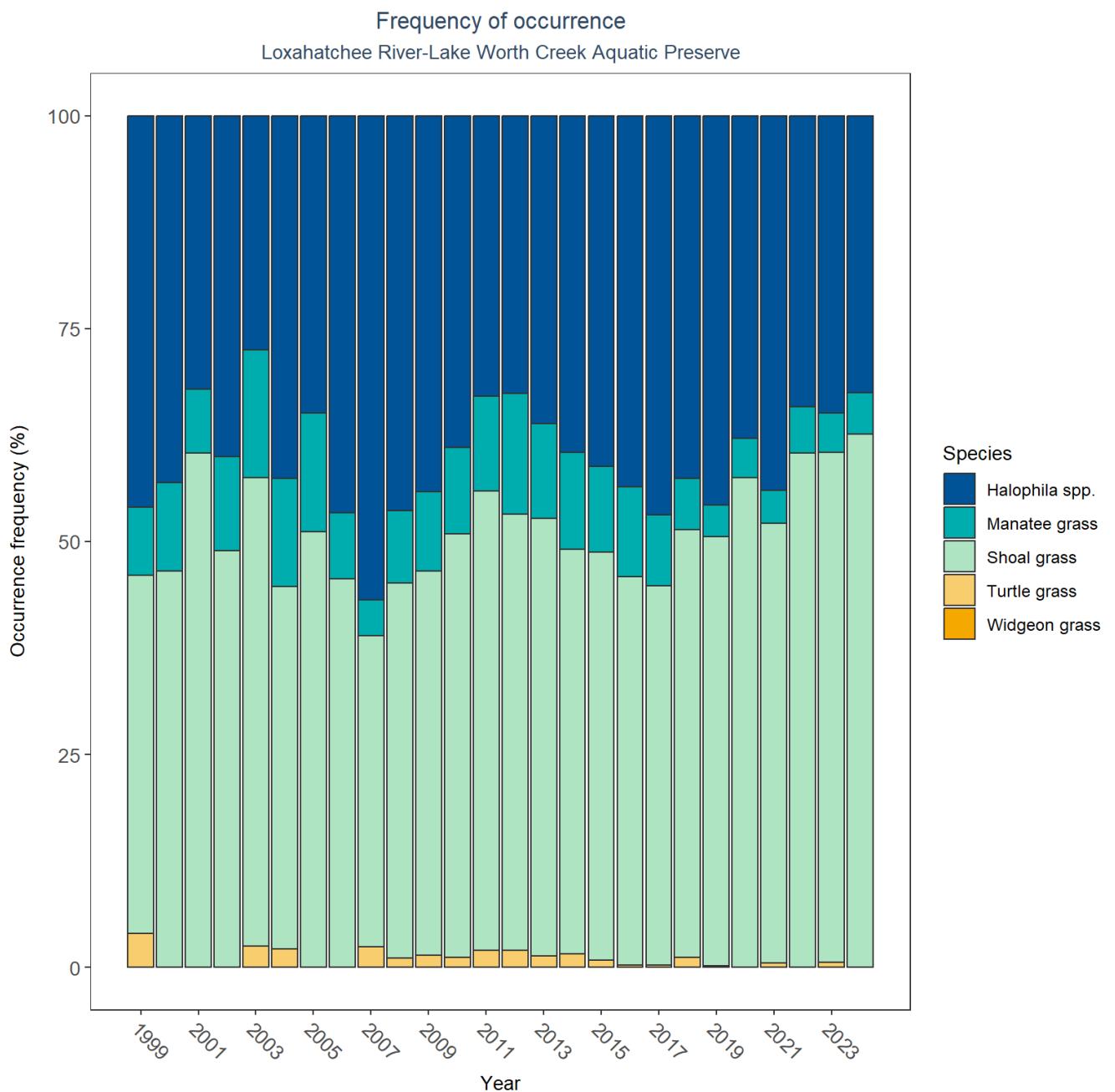


Figure 36: Frequency of occurrence for various seagrass species in Loxahatchee River-Lake Worth Creek Aquatic Preserve

SAV Water Column Analysis

The following parameters are available for Loxahatchee River-Lake Worth Creek 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
- Total Suspended Solids
- Turbidity

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

Coral Reef

The data file used is: All_CORAL_Parameters-2025-Sep-04.txt

Species Richness

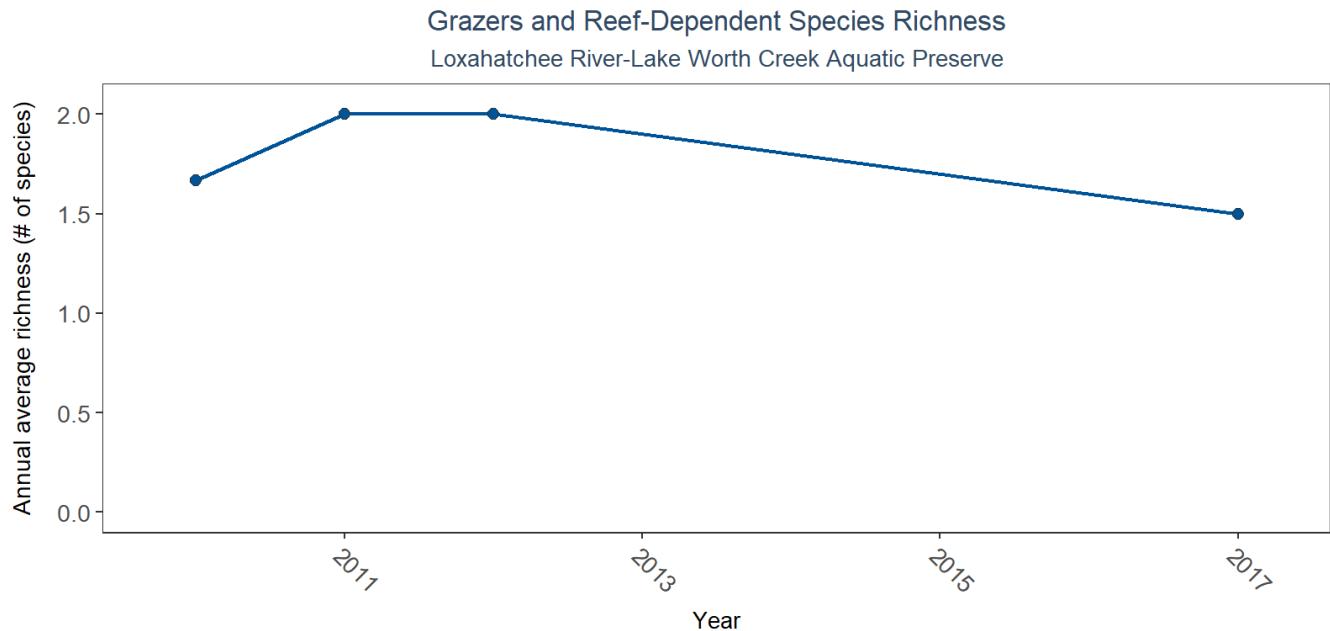


Figure 37: Line graph of annual average species richness of grazers and reef-dependent species over time. If the time series included more than one year of observations, a line connects the data points for visualization.

Table 37: Coral Species Richness

Sample Count	Number of Years	Period of Record	Median N of Taxa	Mean N of Taxa
11	4	2010 - 2017	2	1.72727

The median annual number of taxa was 2 based on 11 observations collected between 2010 and 2017.

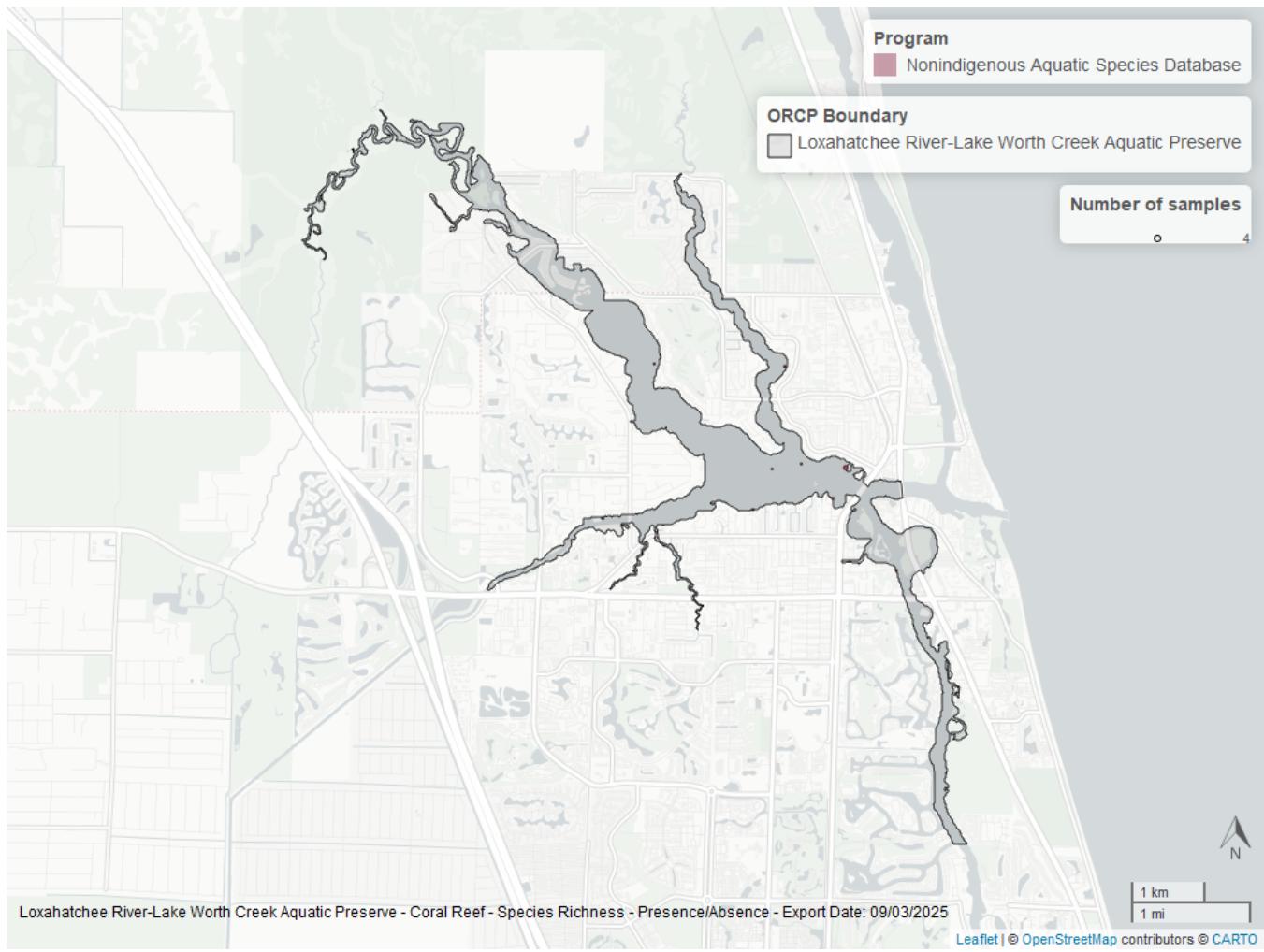


Figure 38: Map showing location of coral species richness sampling locations within the boundaries of *Loxahatchee River-Lake Worth Creek Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Species list

Bare substrate	<i>Halophila engelmannii</i> ¹	<i>Syringodium filiforme</i> ¹
Caulerpa ¹	<i>Halophila johnsonii</i> ¹	<i>Thalassia testudinum</i> ¹
Drift algae ¹	<i>Pterois miles</i> ²	Total macroalgae ¹
Halodule wrightii ¹	<i>Pterois volitans</i> ²	Total SAV ¹
Halophila decipiens ¹	<i>Ruppia maritima</i> ¹	Total seagrass ¹

1 - Submerged Aquatic Vegetation, 2 - Coral Reef - Species Richness, 3 - Coral Reef - Percent Cover

References

1. University of Florida (UF); Institute of Food and Agricultural Sciences. [Florida LAKEWATCH Program](#). (2024).
2. Florida Department of Environmental Protection (DEP). [Florida STORET / WIN](#). (2024).
3. Loxahatchee River District. [RiverKeeper](#). (2024).
4. Florida Fish and Wildlife Conservation Commission (FWC). [Fisheries-Independent Monitoring \(FIM\) Program](#). (2022).
5. Florida Fish and Wildlife Conservation Commission (FWC); Florida Fish and Wildlife Research Institute (FWRI). [Harmful Algal Bloom Marine Observation Network](#). (2018).
6. U.S. Environmental Protection Agency (EPA). [EPA STOrage and RETrieval Data Warehouse \(STORET\)/WQX](#). (2023).
7. St. Johns River Water Management District (SJRWMD). [Seagrass \(SJRWMD\)](#). (2023).
8. U.S. Geological Survey (USGS). [National Water Information System](#). (2024).
9. Loxahatchee River District; Wildpine Ecological Laboratory. [Loxahatchee River District Bi-Monthly Seagrass Monitoring](#). (2023).
10. Loxahatchee River District; Wildpine Ecological Laboratory. [Loxahatchee River District Landscape-Scale Seagrass Mapping Area](#). (2022).