Terra Ceia Aquatic Preserve

SEACAR Habitat Analyses

Last compiled on 08 October, 2025

Contents

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	mˆ-1	-	-
NO2+3, Filtered	mg/L	-	-
Nitrate (NO3)	mg/L	-	-
Nitrite (NO2)	mg/L	-	-
Nitrogen, organic	mg/L	-	-
Phosphate, Filtered (PO4)	mg/L	-	-
Salinity	ppt	-0.000001	70
Secchi Depth	m	0.000001	50
Specific Conductivity	mS/cm	0.005000	100
Total Kjeldahl Nitrogen	mg/L	-	-
Total Nitrogen	mg/L	-	-
Total Nitrogen	mg/L	-	-
Total Phosphorus	mg/L	-	-
Total Suspended Solids	mg/L	-	-
Turbidity	NTU	-	-
Water Temperature	Degrees C	3.000000	40
pH	None	2.000000	13

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

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

Value Qualifiers

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

STORET and WIN value qualifier codes

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

Table 4: Value Qualifier codes excluded from analysis

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

Discrete Water Quality Value Qualifiers

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

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

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

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

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

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

Systemwide Monitoring Program (SWMP) value qualifier codes

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

Table 5: SWMP Value Qualifier codes

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

Water Column

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

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

Seasonal Kendall-Tau Analysis

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

Water Quality - Discrete

The following files were used in the discrete analysis:

- *Combined_WQ_WC_NUT_Chlorophyll_a_corrected_for_pheophytin-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Chlorophyll_a_uncorrected_for_pheophytin-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Colored_dissolved_organic_matter_CDOM-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Dissolved_Oxygen-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Dissolved_Oxygen_Saturation-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_pH-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Salinity-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Secchi_Depth-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Total_Nitrogen-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Total_Phosphorus-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Total_Suspended_Solids_TSS-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Turbidity-2025-Sep-04.txt*
- *Combined_WQ_WC_NUT_Water_Temperature-2025-Sep-04.txt*

Chlorophyll a, Uncorrected for Pheophytin - Discrete

Seasonal Kendall-Tau Trend Analysis

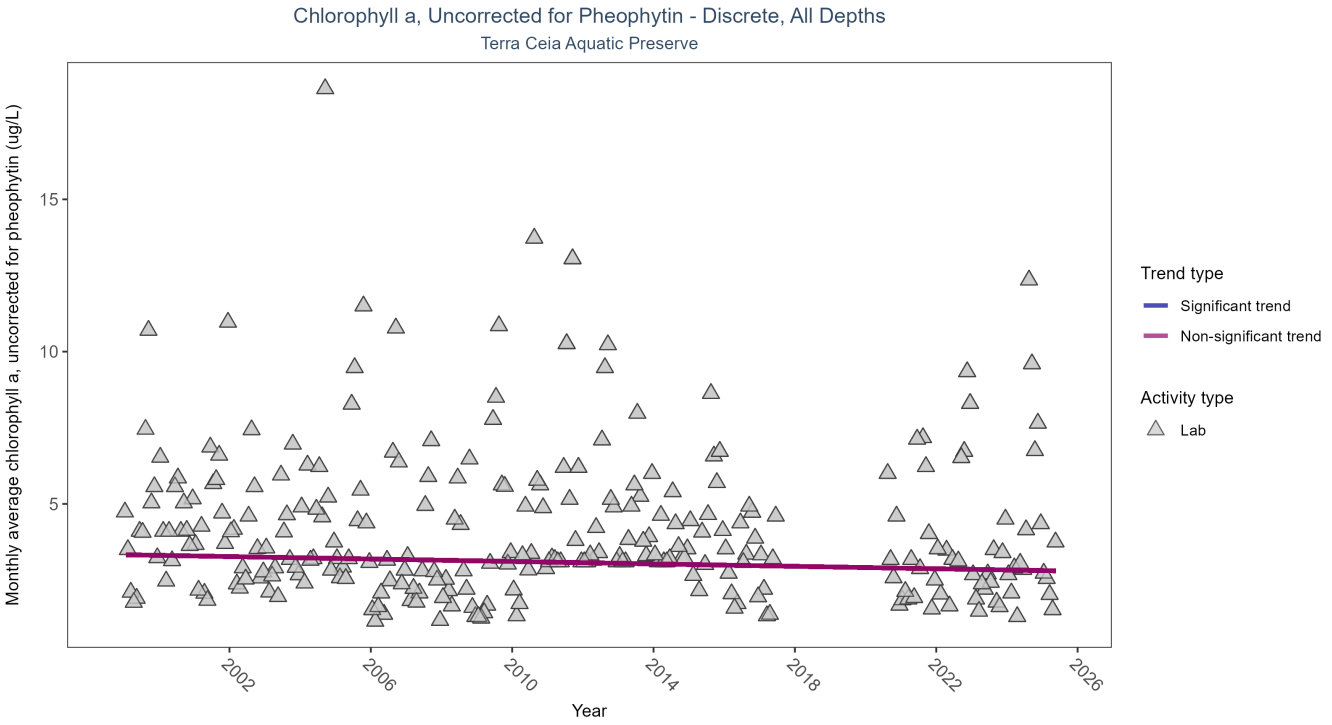

Figure 1: Scatter plot of monthly average levels of chlorophyll a, uncorrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles)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

Table 6: 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	1073	25	1999 - 2025	3.2	-0.0807	3.3306	-0.02	0.0636

Chlorophyll a, uncorrected for pheophytin, showed no detectable trend between 1999 and 2025.

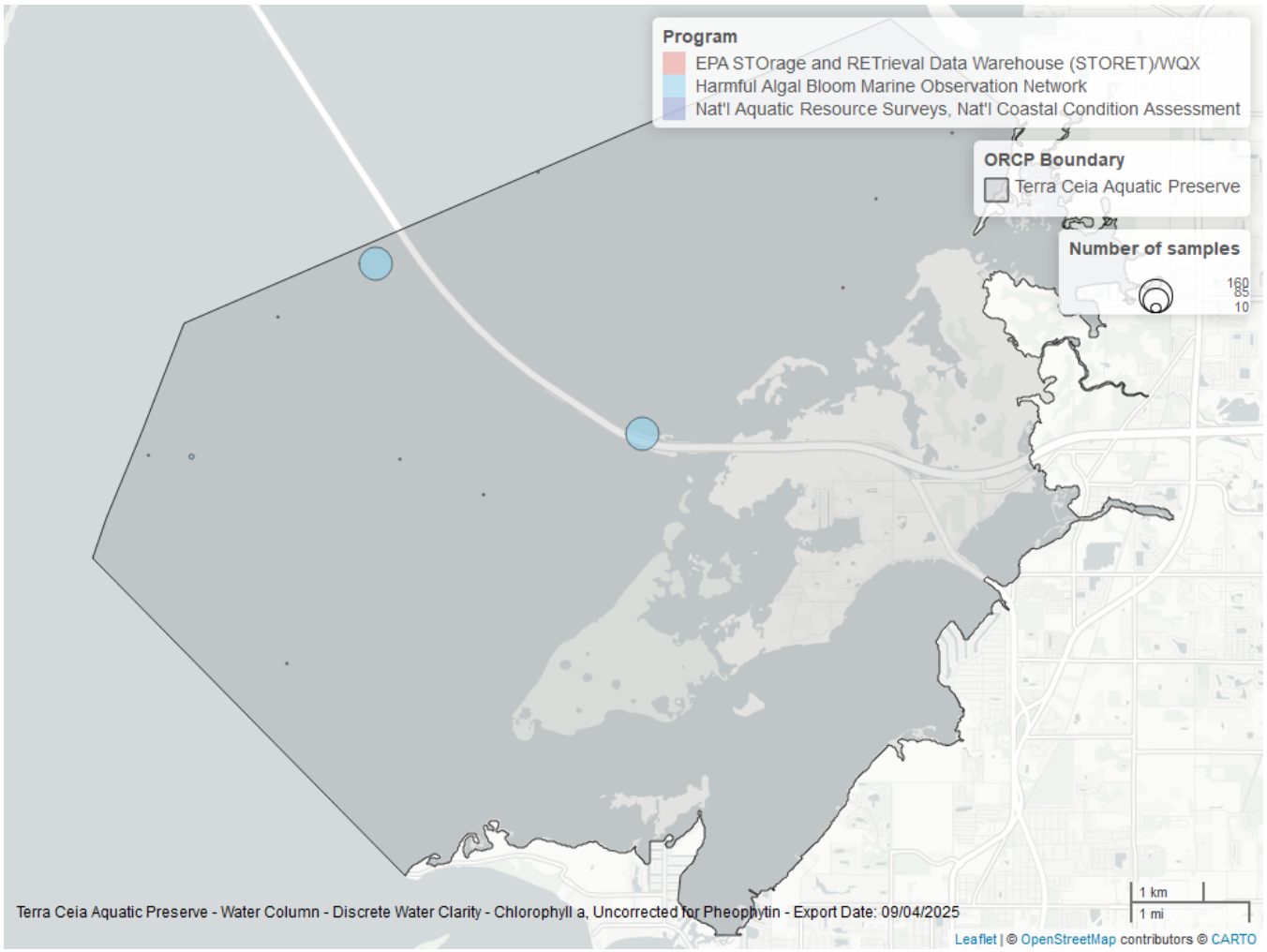

Figure 2: Map showing location of discrete water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	1077	1999	2025
95	336	2004	2018
103	3	2000	2015
118	1	2010	2010

Program names:

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

Dissolved Oxygen - Discrete

Seasonal Kendall-Tau Trend Analysis

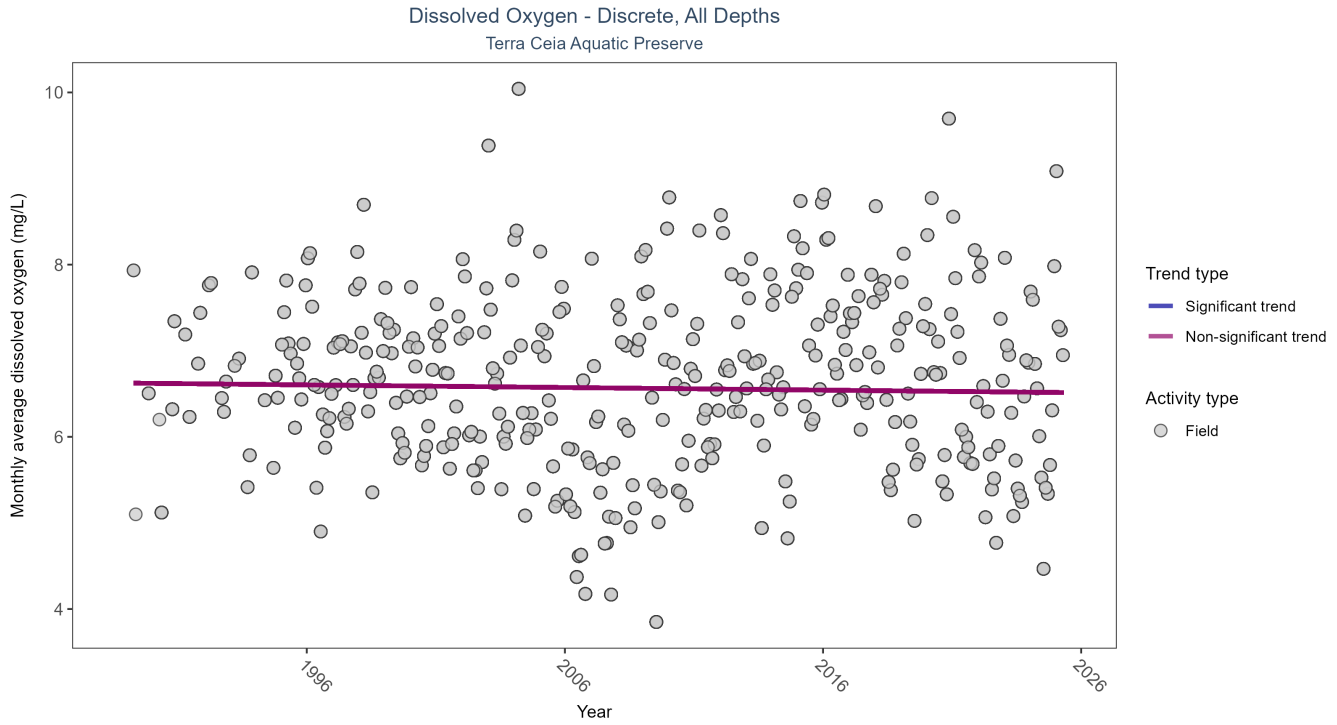

Figure 3: Scatter plot of monthly average dissolved oxygen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen values measured in the field (circles) are included in the plot.

Table 8: Seasonal Kendall-Tau Trend Analysis for Dissolved Oxygen

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Field	No significant trend	25012	37	1989 - 2025	6.53	-0.0291	6.6241	-0.003	0.4097

Dissolved oxygen showed no detectable trend between 1989 and 2025.

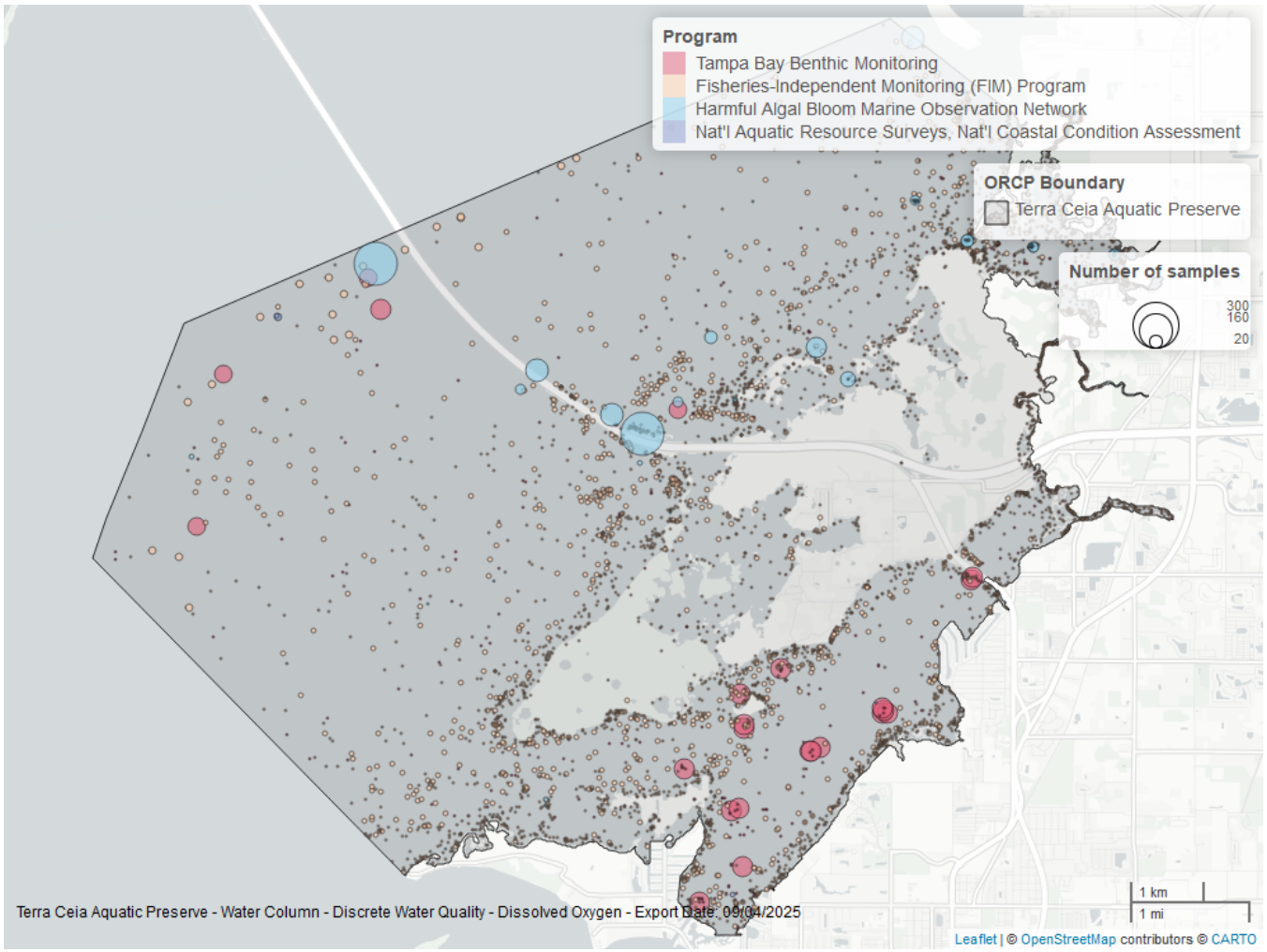

Figure 4: Map showing location of discrete water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 9: Programs contributing data for Dissolved Oxygen

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	11492	1995	2025
69	10597	1989	2024
4067	1869	1993	2023
95	1260	1999	2018
118	19	2015	2020
103	3	2015	2015

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program[5]
95 - Harmful Algal Bloom Marine Observation Network[1]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[2]
118 - National Aquatic Resource Surveys, National Coastal Condition Assessment[3]
4067 - Tampa Bay Benthic Monitoring[6]
5002 - Florida STORET / WIN[4]

Dissolved Oxygen Saturation - Discrete

Seasonal Kendall-Tau Trend Analysis

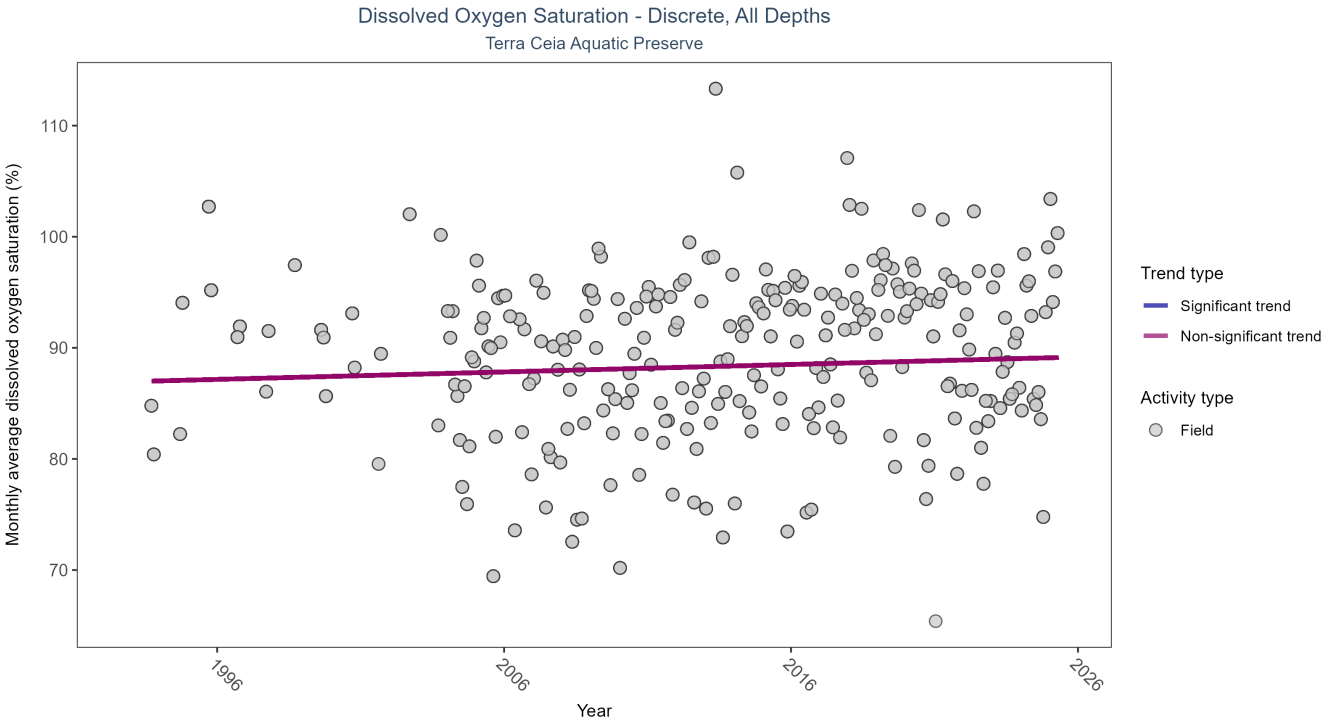

Figure 5: Scatter plot of monthly average dissolved oxygen saturation over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen saturation values measured in the field (circles)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

Table 10: 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	5126	33	1993 - 2025	90.2	0.0757	86.9585	0.0671	0.2626

Dissolved oxygen saturation showed no detectable trend between 1993 and 2025.

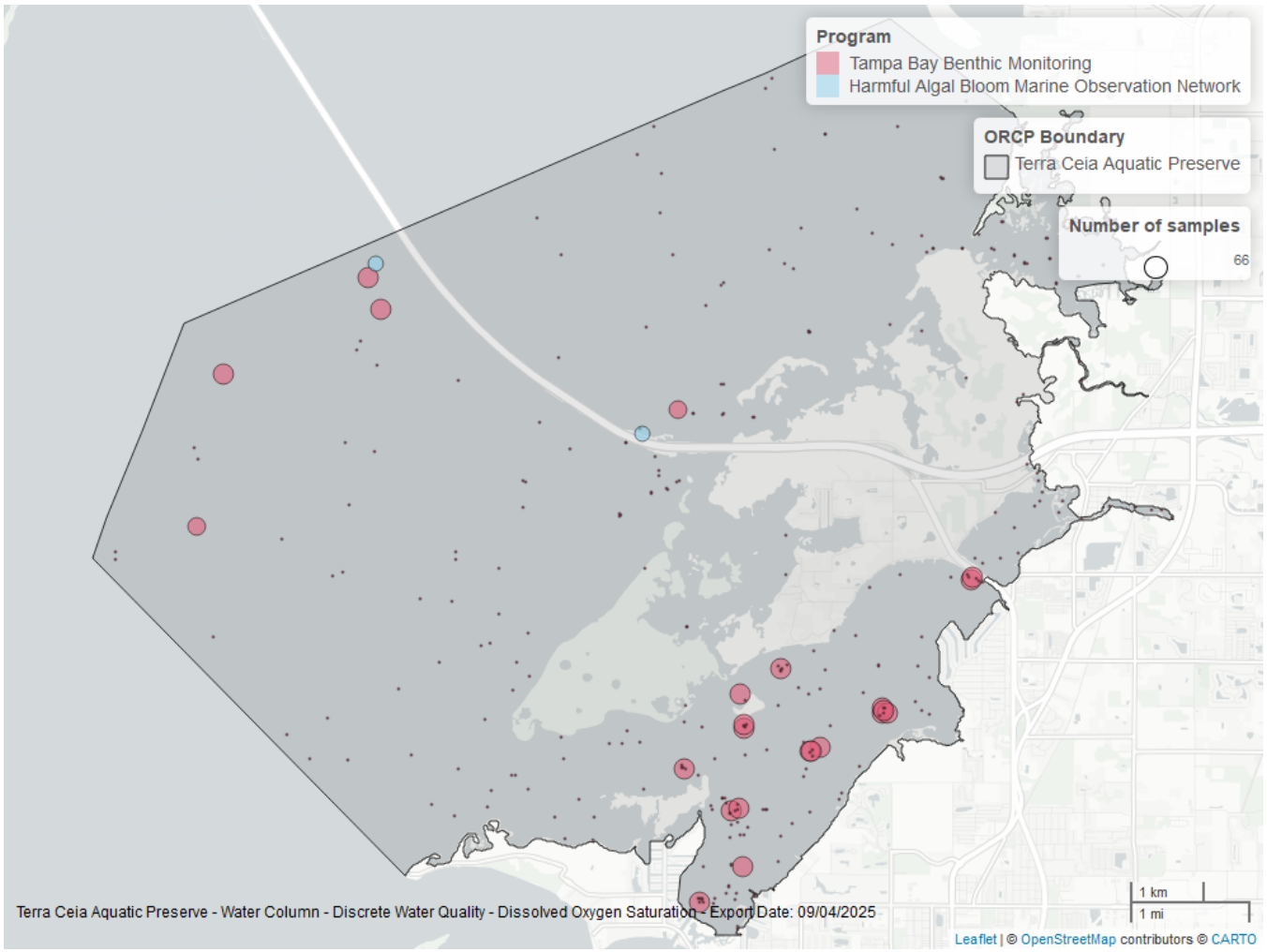

Figure 6: Map showing location of discrete water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 11: Programs contributing data for Dissolved Oxygen Saturation

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	3393	2004	2025
4067	1894	1993	2023
95	67	2014	2018

Program names:

95 - Harmful Algal Bloom Marine Observation Network[1]
4067 - Tampa Bay Benthic Monitoring[6]
5002 - Florida STORET / WIN[4]

pH - Discrete

Seasonal Kendall-Tau Trend Analysis

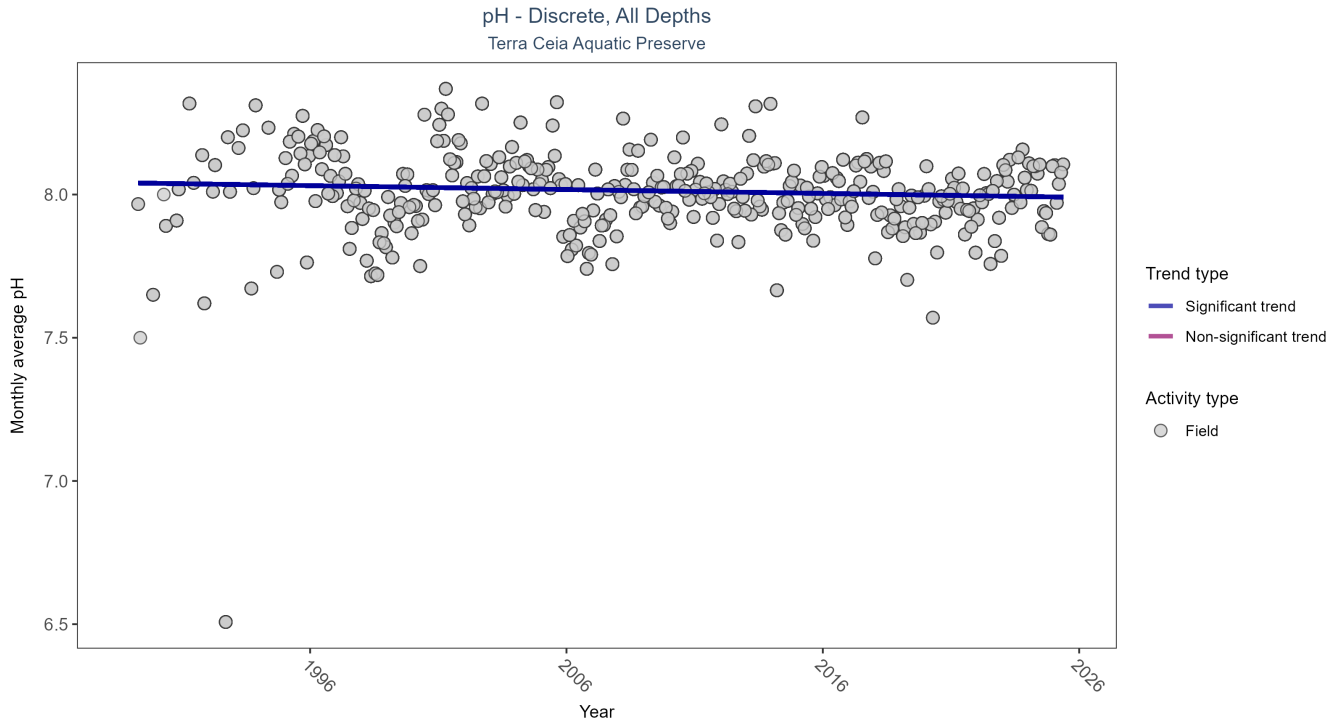

Figure 7: Scatter plot of monthly average pH over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only pH values measured in the field (circles) are included in the plot.

Table 12: Seasonal Kendall-Tau Trend Analysis for pH

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Field	Significantly decreasing trend	23249	37	1989 - 2025	8	-0.0805	8.0405	-0.0014	0.0273

Monthly average pH decreased by less than 0.01 pH units per year.

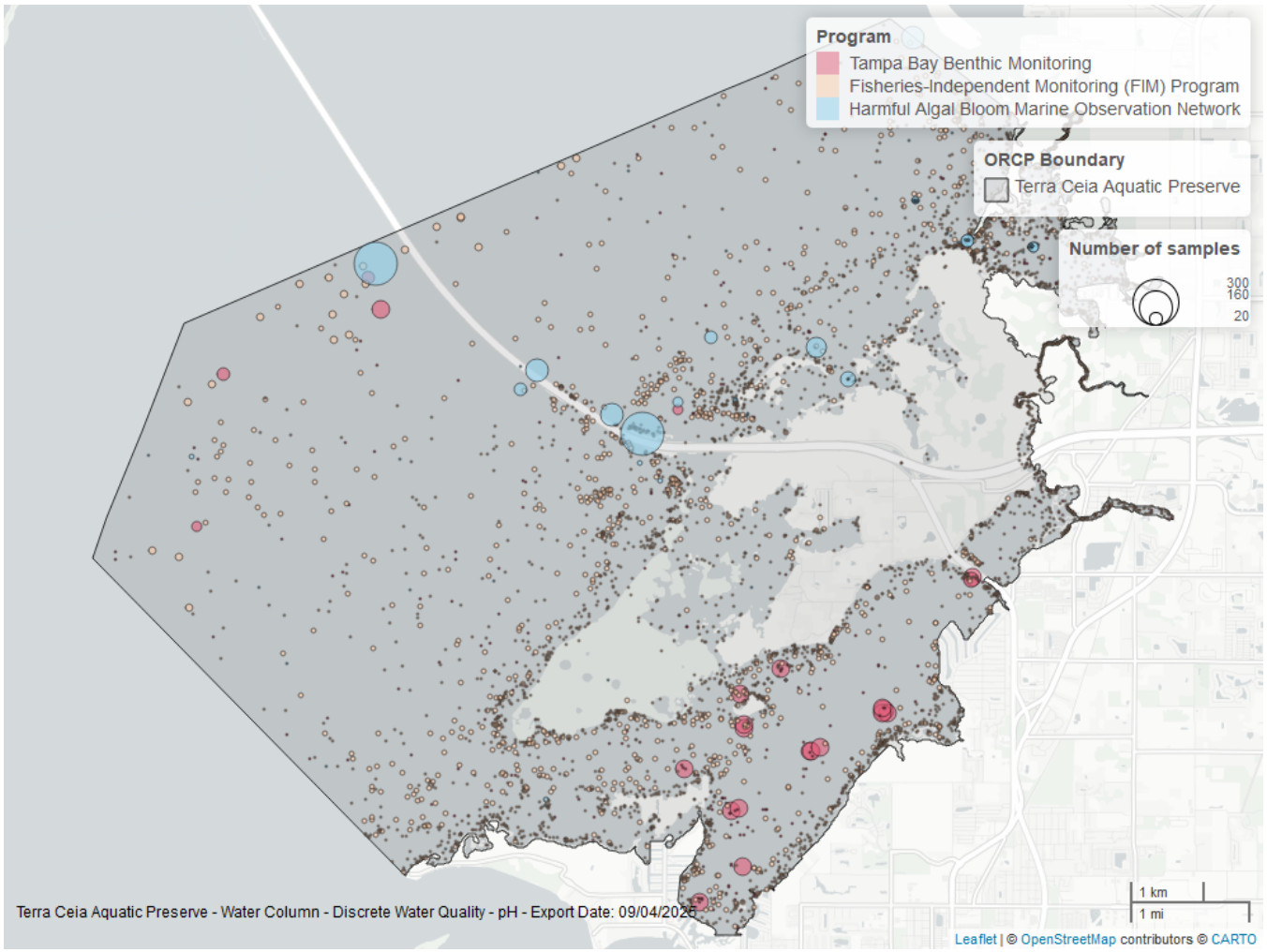

Figure 8: Map showing location of discrete water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 13: Programs contributing data for pH

ProgramID	*N_Data*	*YearMin*	*YearMax*
69	10503	1989	2024
5002	9962	1995	2025
4067	1596	1993	2023
95	1255	1999	2018
103	5	2015	2015

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program[5]
95 - Harmful Algal Bloom Marine Observation Network[1]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[2]
4067 - Tampa Bay Benthic Monitoring[6]
5002 - Florida STORET / WIN[4]

Salinity - Discrete

Seasonal Kendall-Tau Trend Analysis

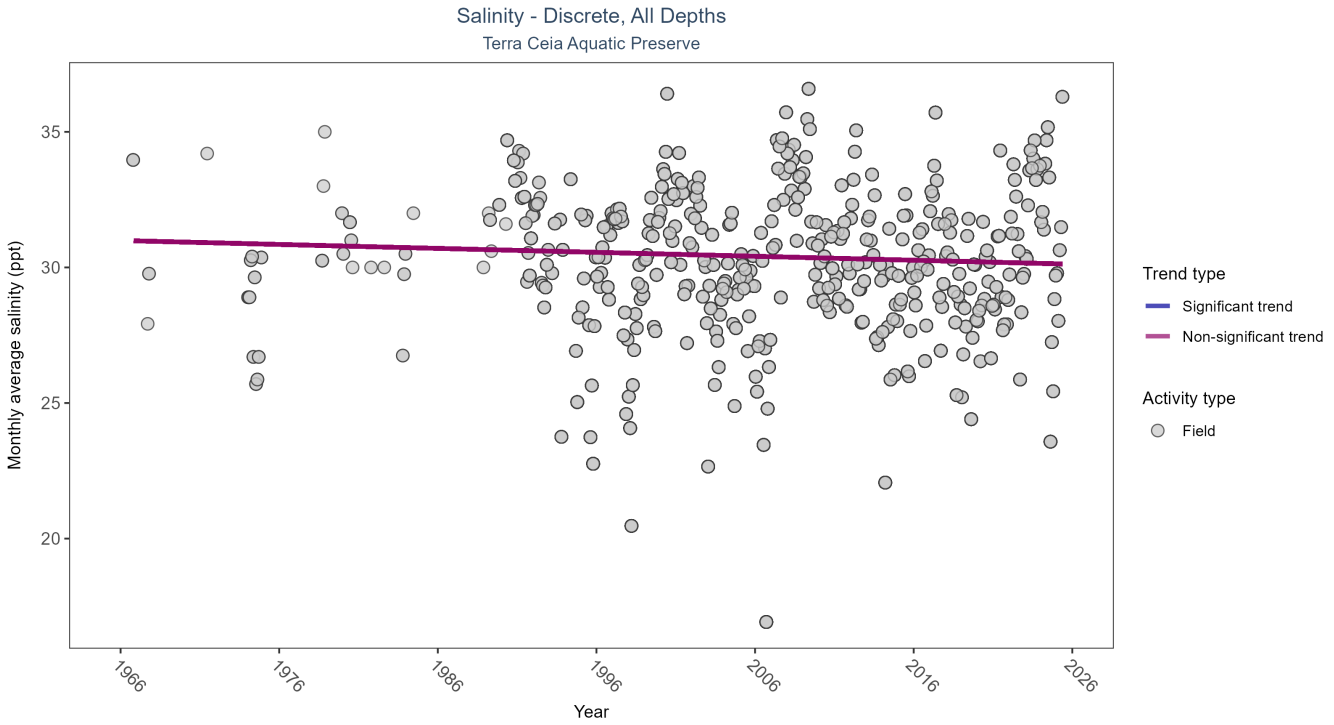

Figure 9: Scatter plot of monthly average salinity over time. If the time series included ten or more years of discrete observations, significant (blue) or non-significant (magenta) trend lines are also shown. Discrete salinity values derived from grab samples analyzed in the field (circles) or the laboratory (triangles) are both included in the plot.

Table 14: 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	25426	49	1966 - 2025	30.6	-0.0513	30.9931	-0.0146	0.1191

Salinity showed no detectable trend between 1966 and 2025.

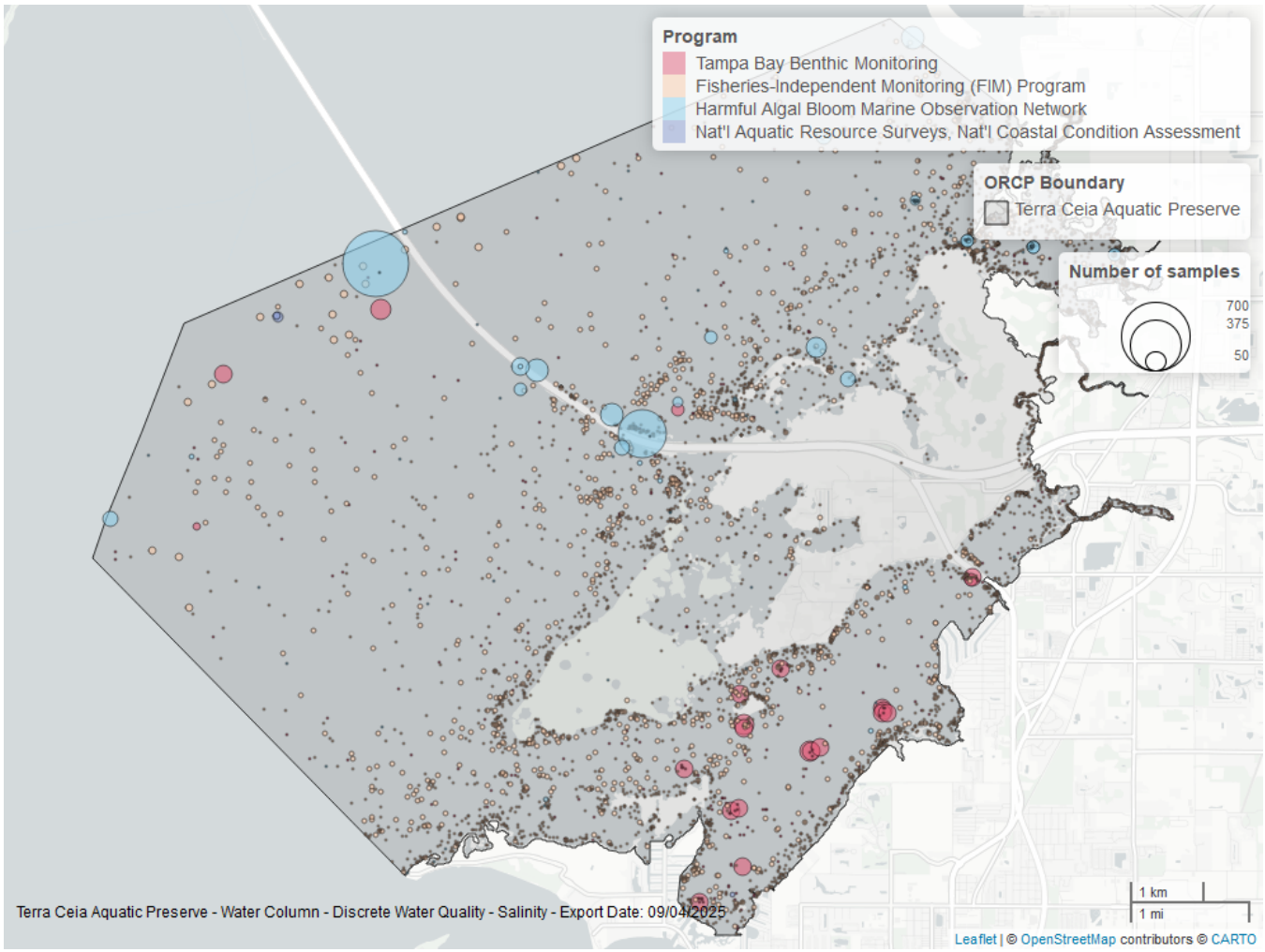

Figure 10: Map showing location of discrete water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 15: Programs contributing data for Salinity

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	11184	1995	2025
69	10660	1989	2024
95	1976	1966	2018
4067	1609	1993	2023
118	30	2015	2020

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program[5]
95 - Harmful Algal Bloom Marine Observation Network[1]
118 - National Aquatic Resource Surveys, National Coastal Condition Assessment[3]
4067 - Tampa Bay Benthic Monitoring[6]
5002 - Florida STORET / WIN[4]

Secchi Depth - Discrete

Seasonal Kendall-Tau Trend Analysis

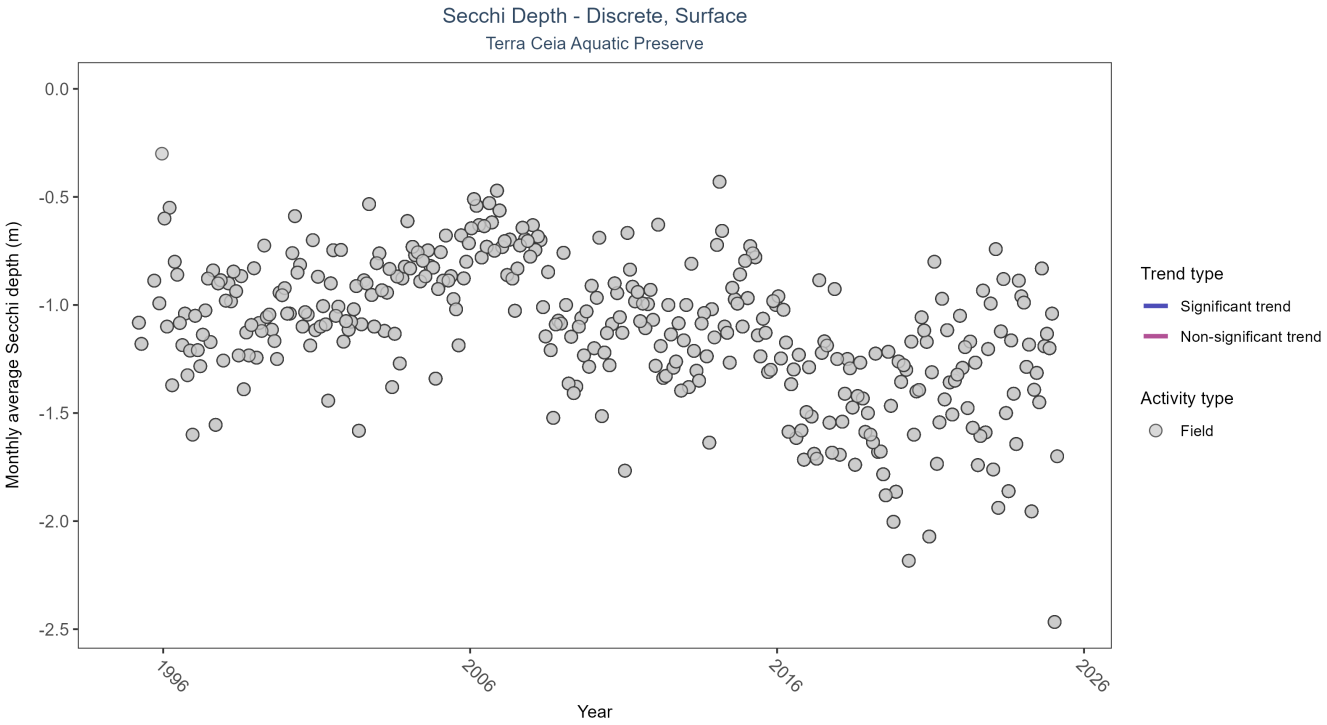

Figure 11: Scatter plot of monthly average Secchi depth over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Secchi depth is only measured in the field (circles).

Table 16: 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	10340	31	1995 - 2025	-1	-0.334	-0.9289	-0.0225	0

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

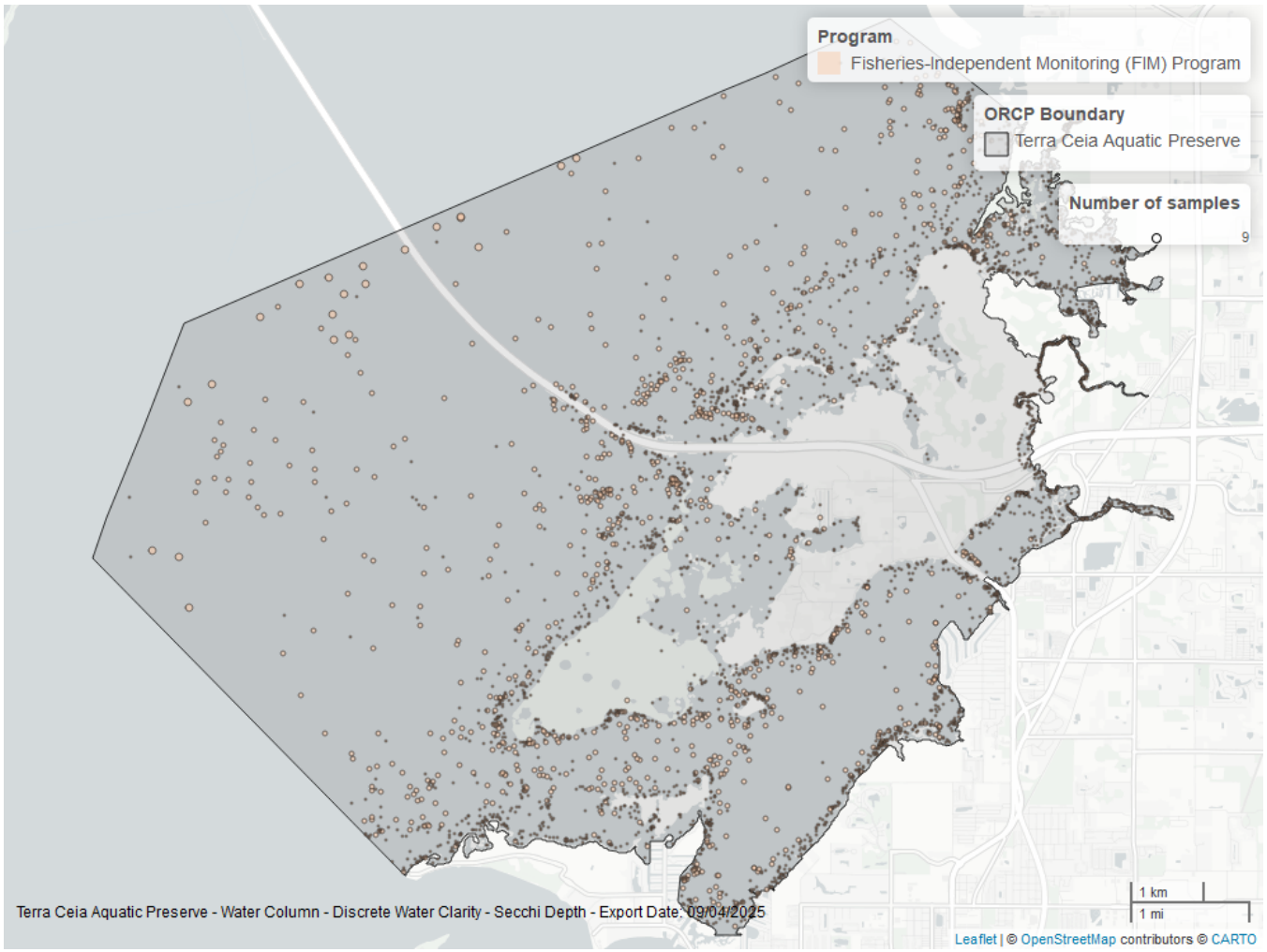

Figure 12: Map showing location of discrete water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 17: Programs contributing data for Secchi Depth

ProgramID	*N_Data*	*YearMin*	*YearMax*
69	9612	1995	2024
5002	727	2000	2025
103	1	2015	2015

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program[5]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[2]
5002 - Florida STORET / WIN[4]

Total Nitrogen - Discrete

Total Nitrogen Calculation:

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

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

Additional Information:

- Rules for use of sample fraction:
  - Florida Department of Environmental Protection (FDEP) report that if both "Total" and "Dissolved" components are reported, only "Total" is used. If the total is not reported, then the dissolved components are used as a best available replacement.
  - Total nitrogen calculations are done using nitrogen components with the same sample fraction, nitrogen components with mixed total/dissolved sample fractions are not used. In other words, total nitrogen can be calculated when TKN and NO3O2 are both total sample fractions, or when both are dissolved sample fractions. *Future calculations of total nitrogen values may be based on components with mixed sample fractions.*
- Values inserted into data:
  - ParameterName = "Total Nitrogen"
  - SEACAR_QAQCFlagCode = "1Q"
  - SEACAR_QAQC_Description = "SEACAR Calculated"

Seasonal Kendall-Tau Trend Analysis

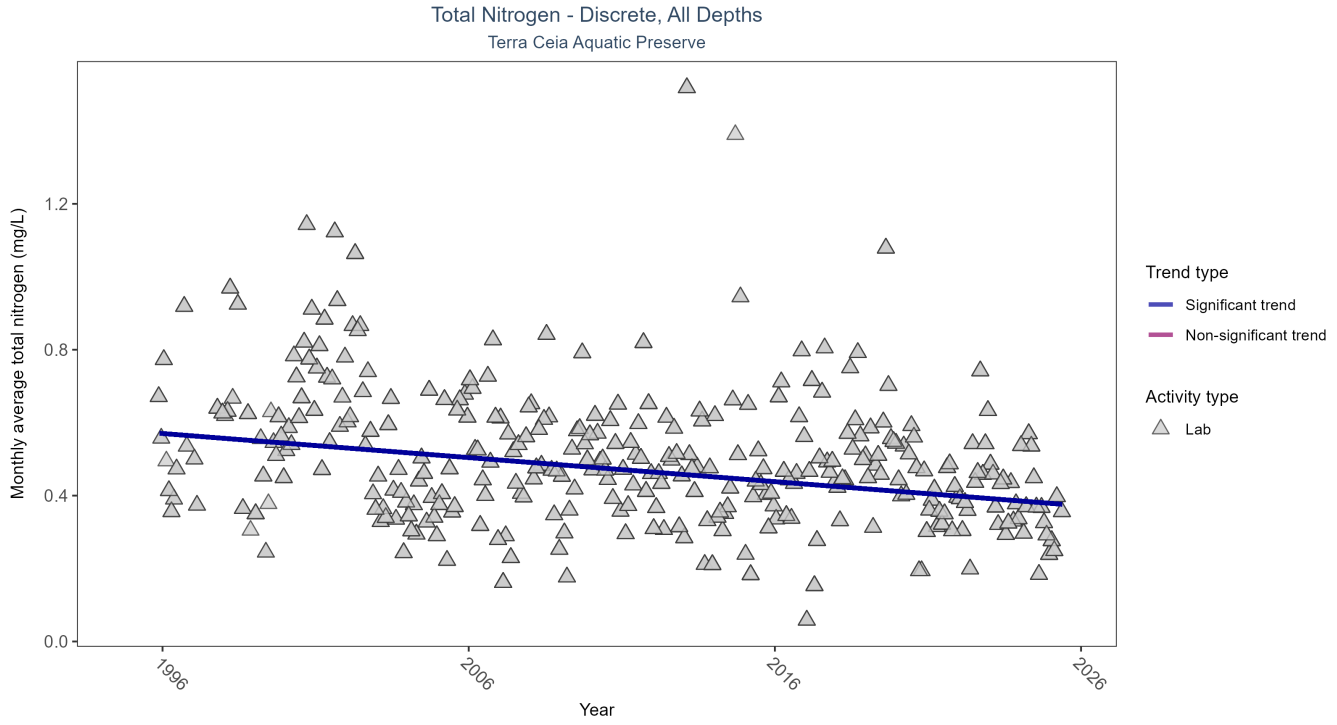

Figure 13: Scatter plot of monthly average total nitrogen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only nitrogen values obtained from laboratory analyses (triangles) are included in the plot.

Table 18: 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	2388	31	1995 - 2025	0.379	-0.2363	0.5768	-0.0066	0

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

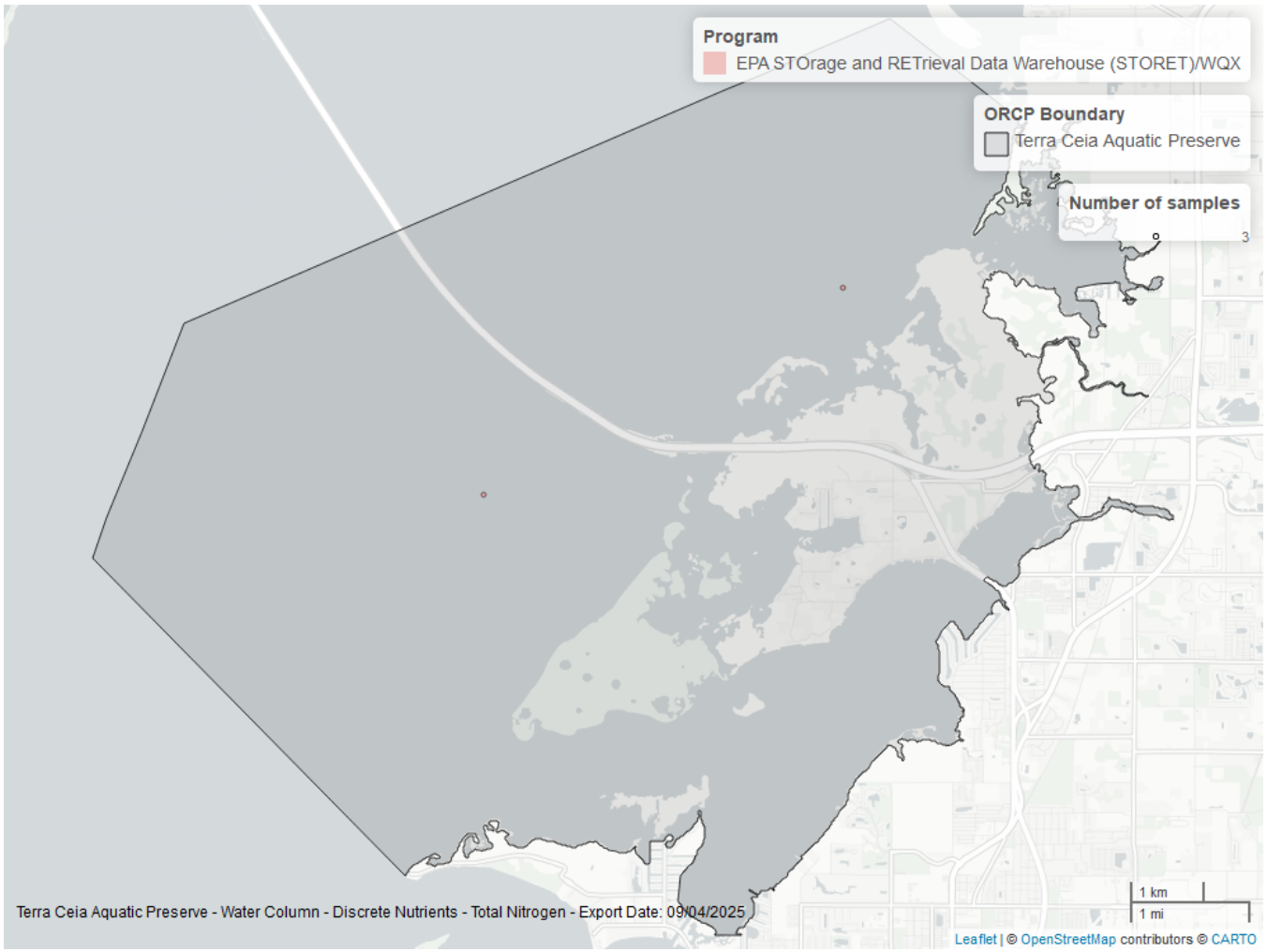

Figure 14: Map showing location of discrete water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 19: Programs contributing data for Total Nitrogen

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	2406	1995	2025
103	6	2000	2000

Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[2]
5002 - Florida STORET / WIN[4]

Total Phosphorus - Discrete

Seasonal Kendall-Tau Trend Analysis

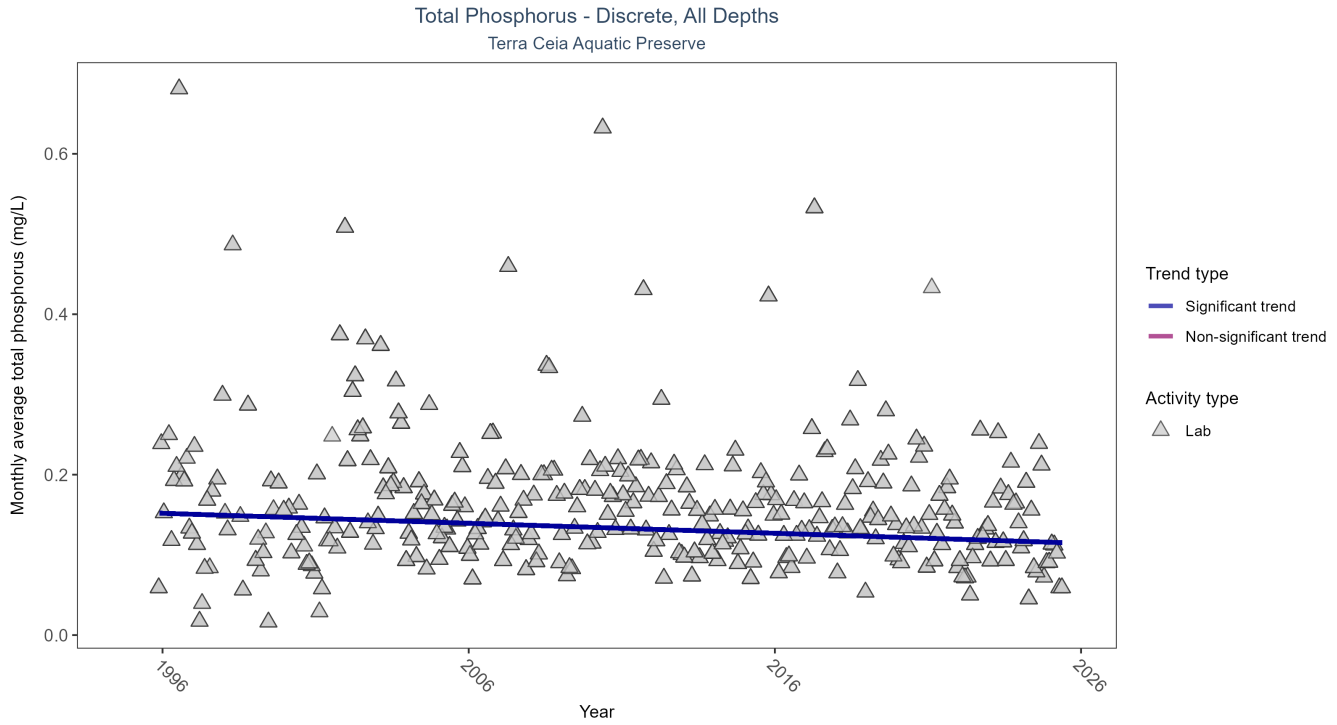

Figure 15: Scatter plot of monthly average total phosphorus over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only phosphorus values obtained from laboratory analyses (triangles) are included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

Table 20: 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 decreasing trend	3088	31	1995 - 2025	0.1085	-0.125	0.1531	-0.0013	0.0009

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

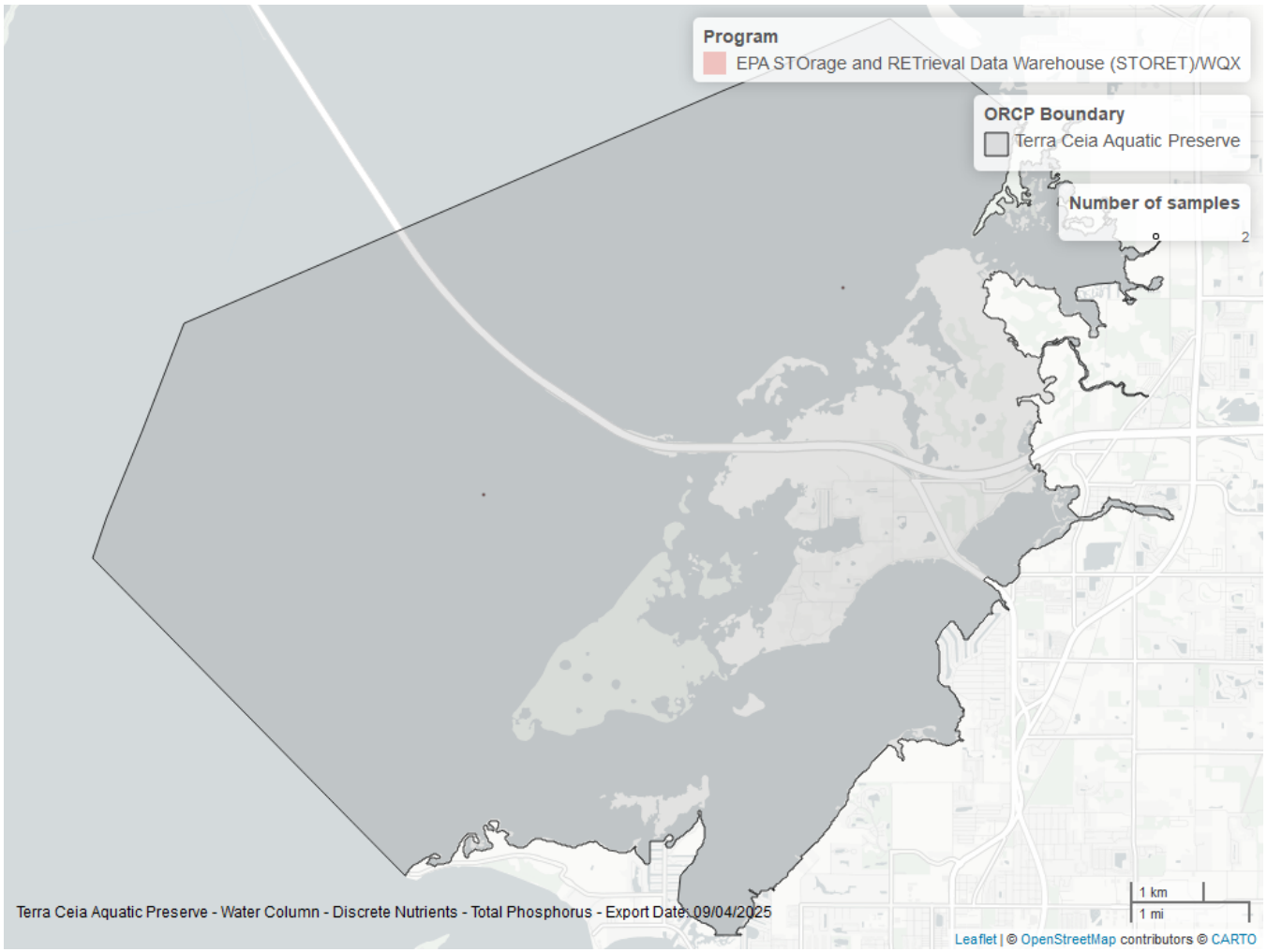

Figure 16: Map showing location of discrete water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 21: Programs contributing data for Total Phosphorus

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	3201	1995	2025
103	5	2000	2015

Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[2]
5002 - Florida STORET / WIN[4]

Total Suspended Solids - Discrete

Seasonal Kendall-Tau Trend Analysis

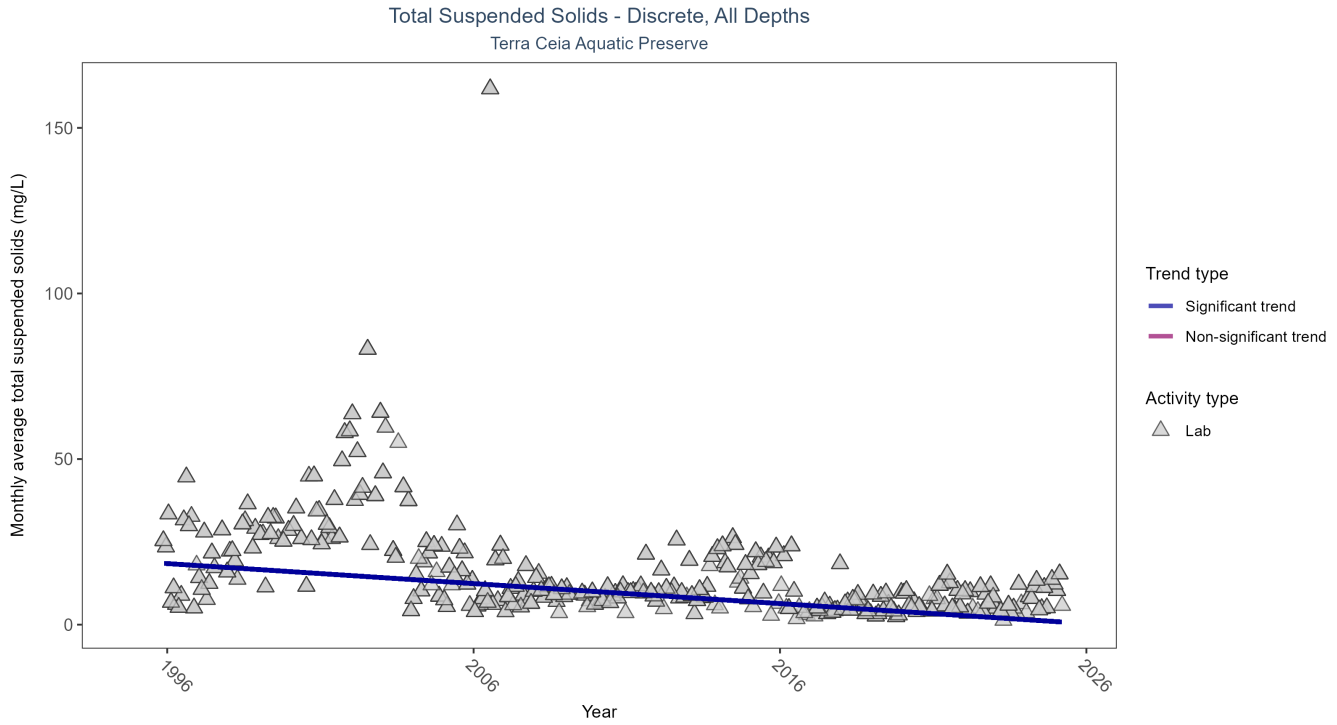

Figure 17: Scatter plot of monthly average total suspended solids (TSS) over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only TSS values obtained from laboratory analyses (triangles) are included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

Table 22: Seasonal Kendall-Tau Trend Analysis for Total Suspended Solids

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Lab	Significantly decreasing trend	1688	31	1995 - 2025	10.6	-0.4216	19.0462	-0.6042	0

Monthly average total suspended solids decreased by 0.6 mg/L per year, indicating an increase in water clarity.

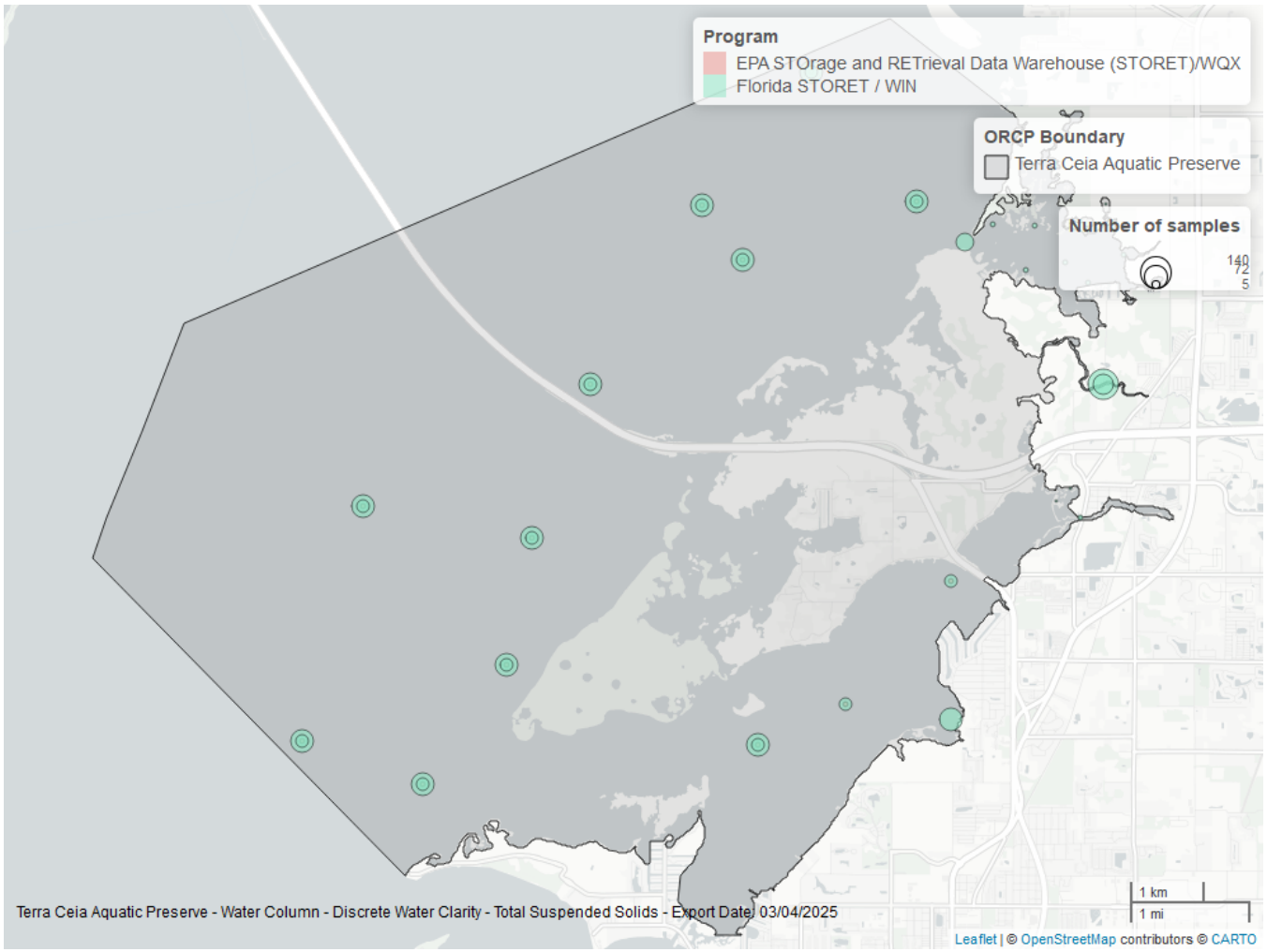

Figure 18: Map showing location of discrete water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 23: Programs contributing data for Total Suspended Solids

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	1702	1995	2025

Program names:

5002 - Florida STORET / WIN[4]

Turbidity - Discrete

Seasonal Kendall-Tau Trend Analysis

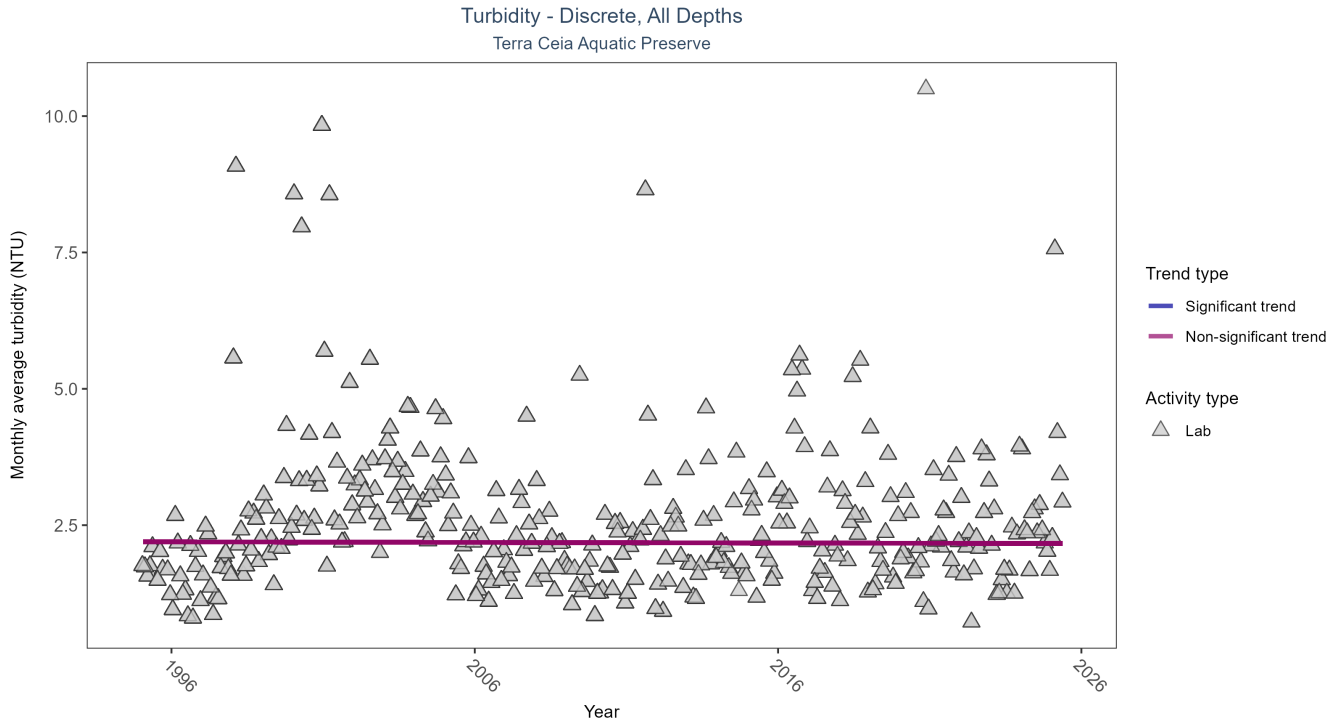

Figure 19: Scatter plot of monthly average turbidity over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only turbidity values measured in the laboratory (triangles) are included in the plot.

Table 24: 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	8075	31	1995 - 2025	1.9	-0.0072	2.195	-0.001	0.8628

Turbidity showed no detectable trend between 1995 and 2025.

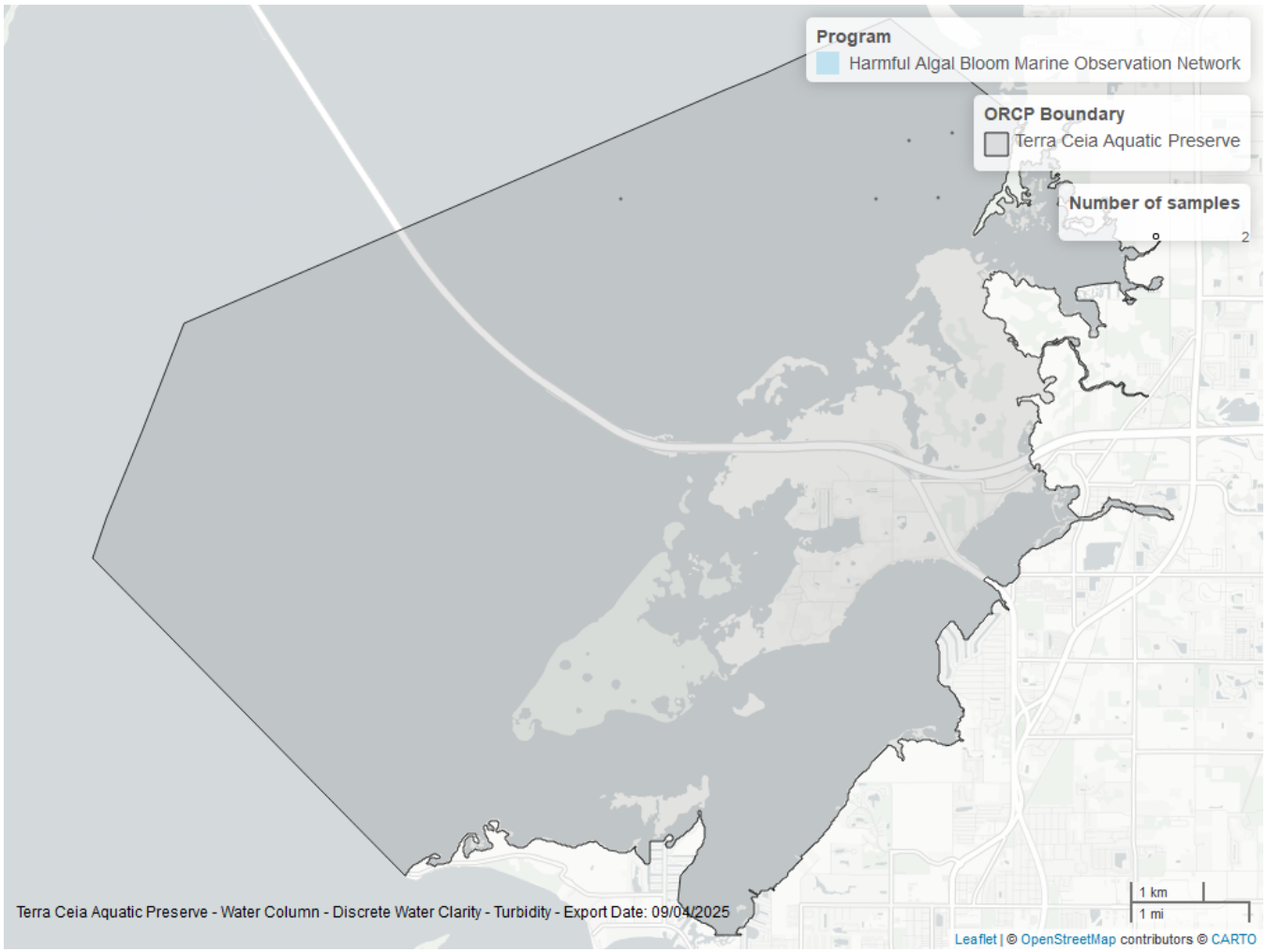

Figure 20: Map showing location of discrete water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 25: Programs contributing data for Turbidity

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	8140	1995	2025
95	8	2002	2004

Program names:

95 - Harmful Algal Bloom Marine Observation Network[1]
5002 - Florida STORET / WIN[4]

Water Temperature - Discrete

Seasonal Kendall-Tau Trend Analysis

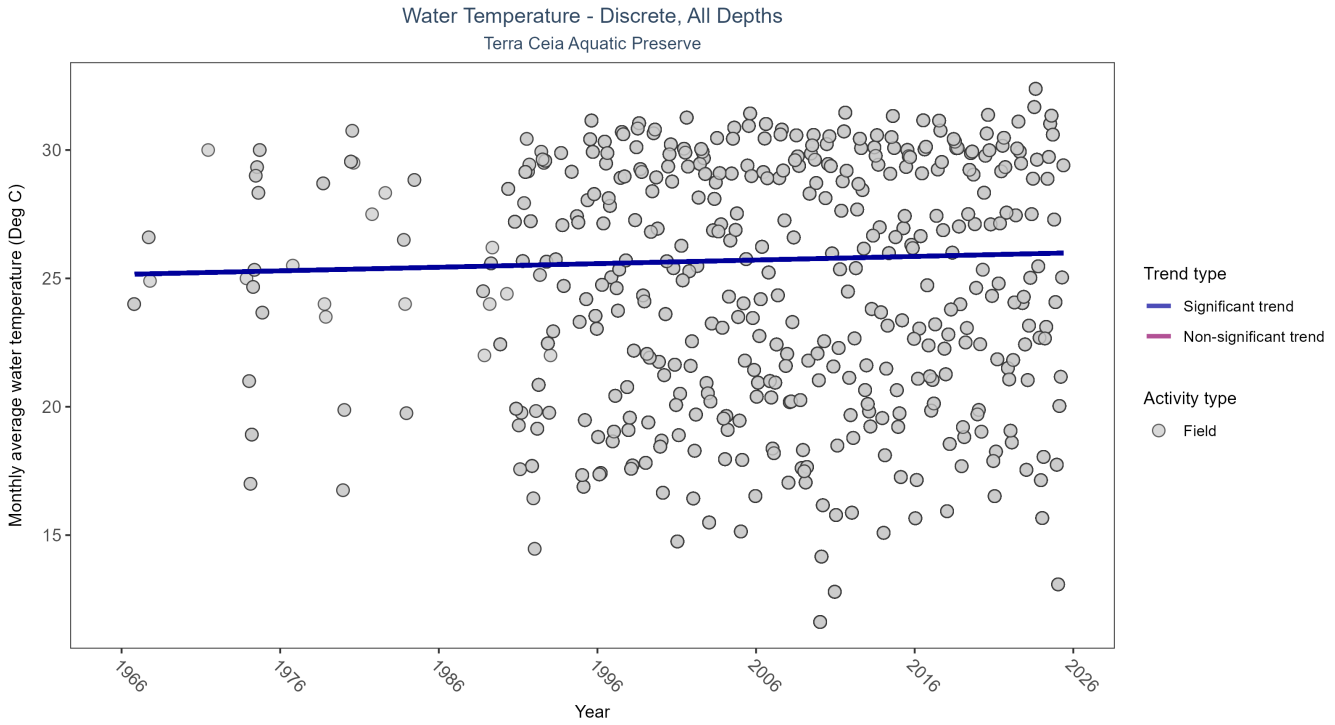

Figure 21: Scatter plot of monthly average water temperature over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only water temperature measurements taken in the field (circles) are included in the plot.

Table 26: 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	26174	51	1966 - 2025	26.7	0.0939	25.1534	0.014	0.0059

Monthly average water temperature increased by 0.01°C per year.

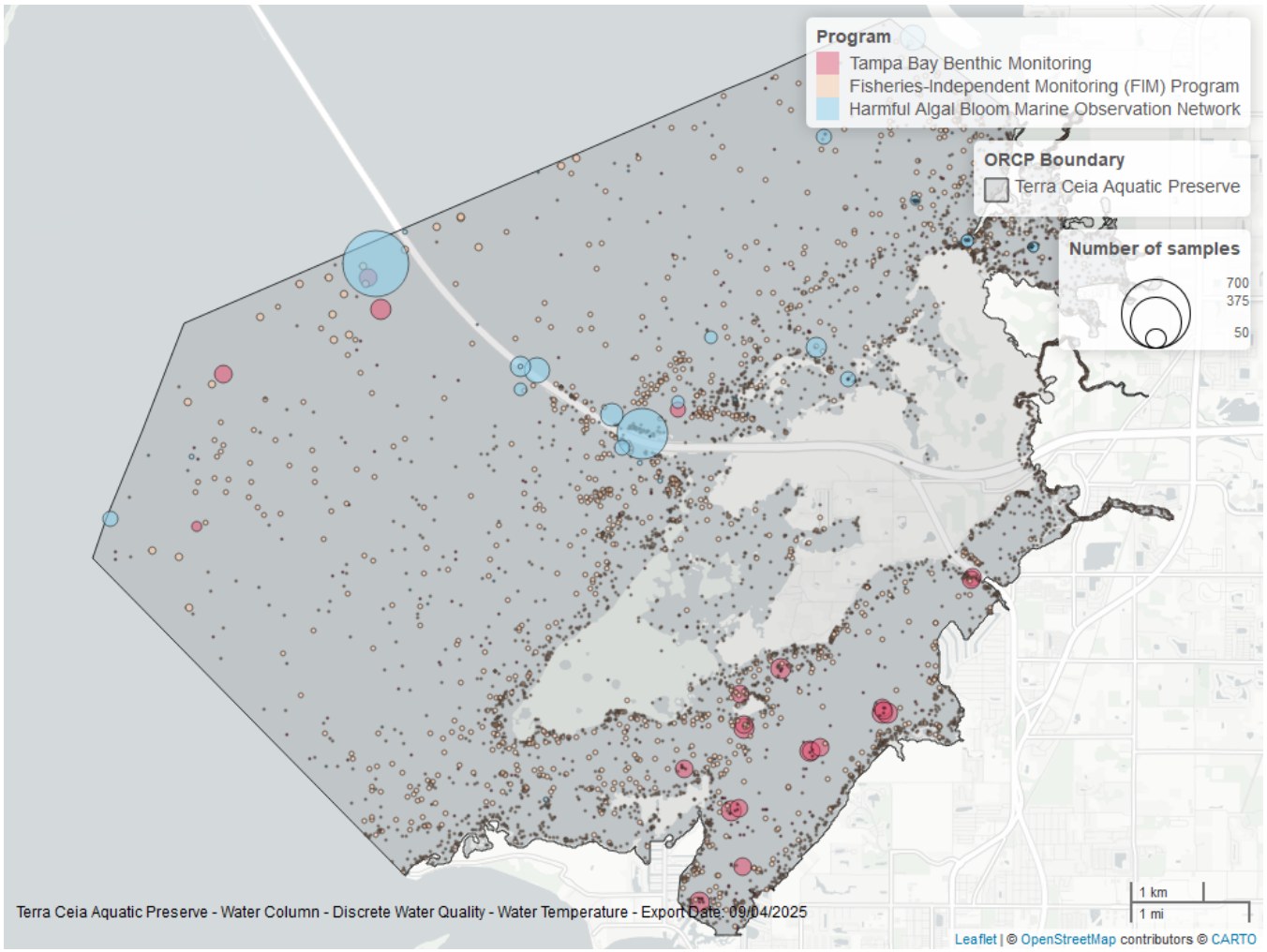

Figure 22: Map showing location of discrete water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 27: Programs contributing data for Water Temperature

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	11785	1995	2025
69	10669	1989	2024
95	1971	1966	2018
4067	1775	1993	2023

Program names:

69 - Fisheries-Independent Monitoring (FIM) Program[5]
95 - Harmful Algal Bloom Marine Observation Network[1]
4067 - Tampa Bay Benthic Monitoring[6]
5002 - Florida STORET / WIN[4]

Water Quality - Continuous

The following files were used in the continuous analysis:

- *Combined_WQ_WC_NUT_cont_Dissolved_Oxygen_SW-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Dissolved_Oxygen_Saturation_SW-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_pH_SW-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Salinity_SW-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Turbidity_SW-2025-Sep-19.txt*
- *Combined_WQ_WC_NUT_cont_Water_Temperature_SW-2025-Sep-19.txt*

Continuous monitoring locations in Terra Ceia Aquatic Preserve

Table 28: Station overview for Continuous parameters by Program

ProgramID	*ProgramLocationID*	*Years of Data*	*Use in Analysis*	*Parameters*
7	023000825	2	FALSE	Sal , TempW
7	02300084	2	FALSE	Sal , TempW
7	023000842	2	FALSE	Sal , TempW
473	TCBH	2	FALSE	DO , DOS , pH , Sal , Turb , TempW

Program names:

7 - National Water Information System[7]
473 - Terra Ceia Aquatic Preserve Continuous Water Quality Monitoring[8]

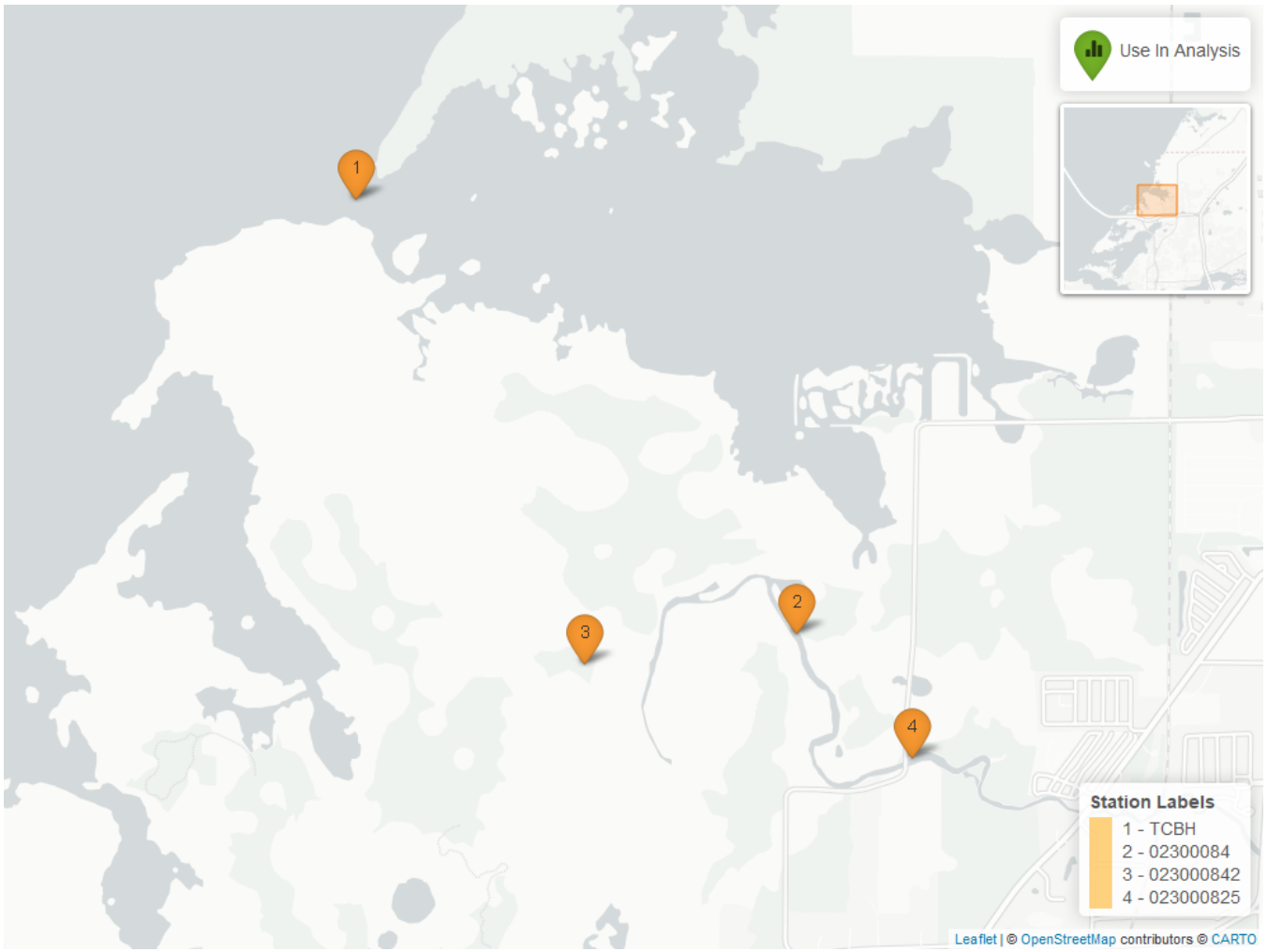

Figure 23: Map showing continuous water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. Sites marked as *Use In Analysis* (green) are featured in this report.

Dissolved Oxygen - Continuous

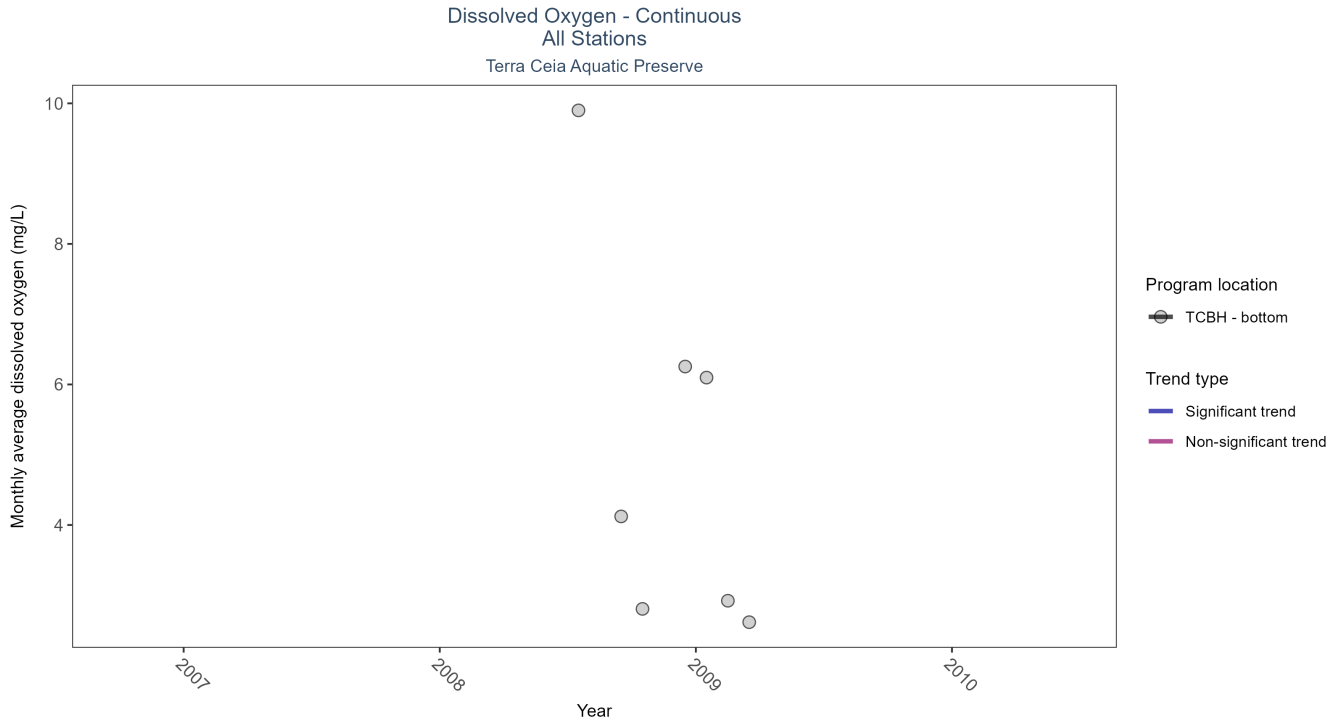

Figure 24: Scatter plot of monthly average dissolved oxygen over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 29: 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
TCBH	Insufficient data to calculate trend	8153	2	2008 - 2009	4.2	-	-	-	-

There was insufficient data to fit a model for one location.

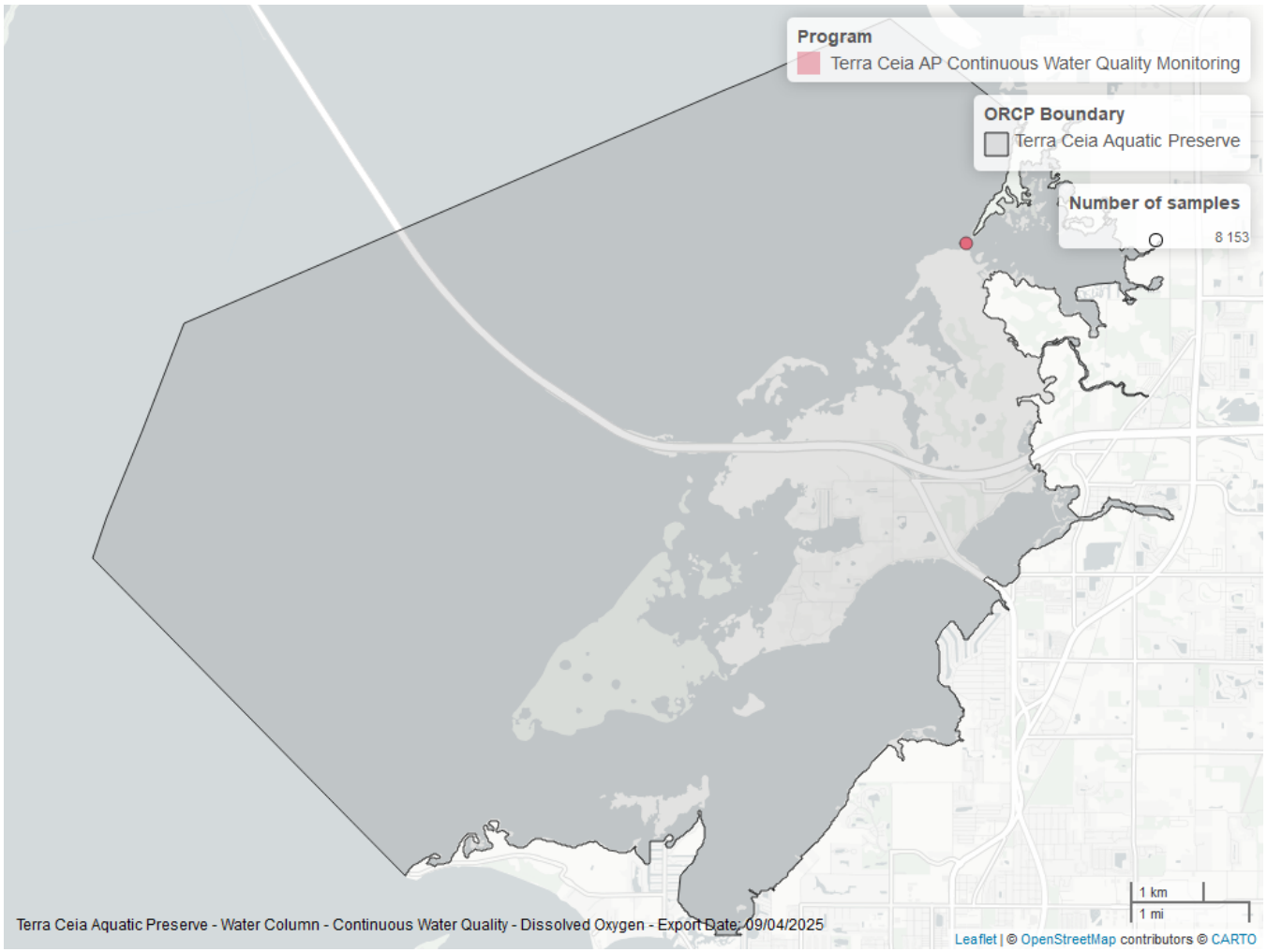

Figure 25: Map showing location of dissolved oxygen continuous water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Dissolved Oxygen Saturation - Continuous

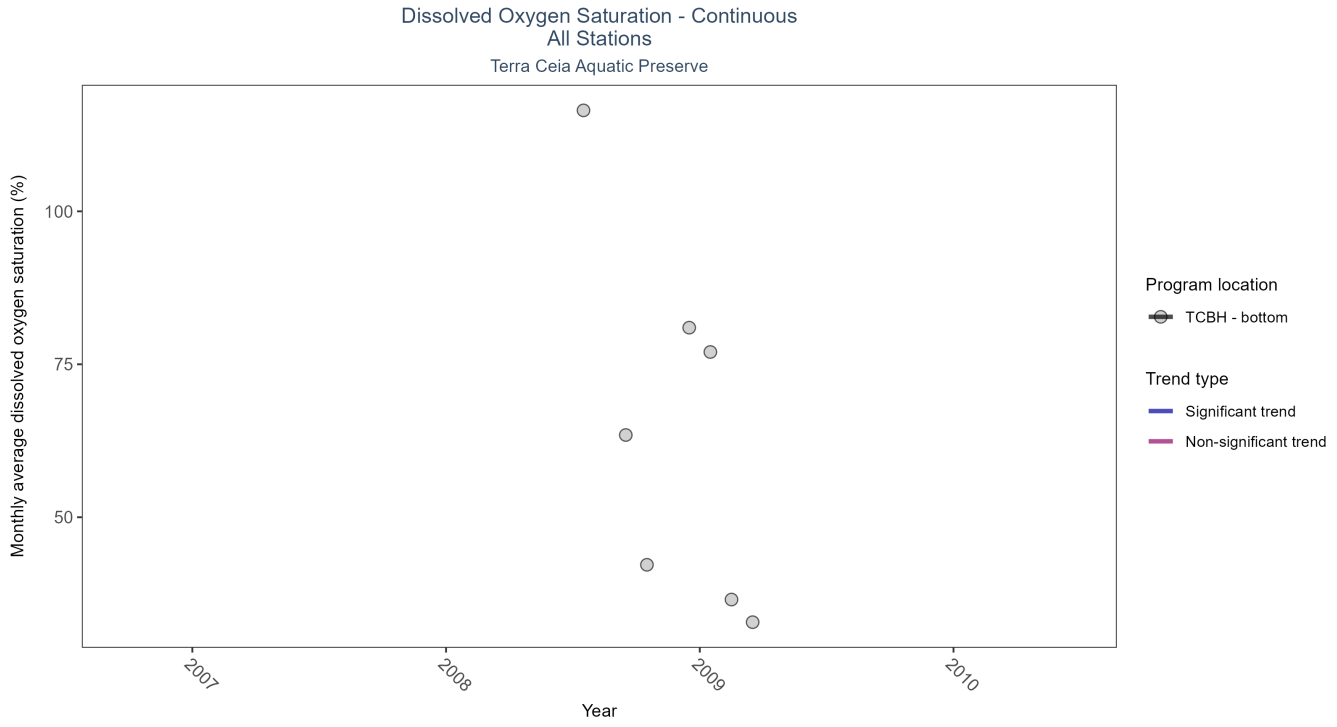

Figure 26: Scatter plot of monthly average dissolved oxygen saturation over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 30: 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
TCBH	Insufficient data to calculate trend	8153	2	2008 - 2009	59.5	-	-	-	-

There was insufficient data to fit a model for one location.

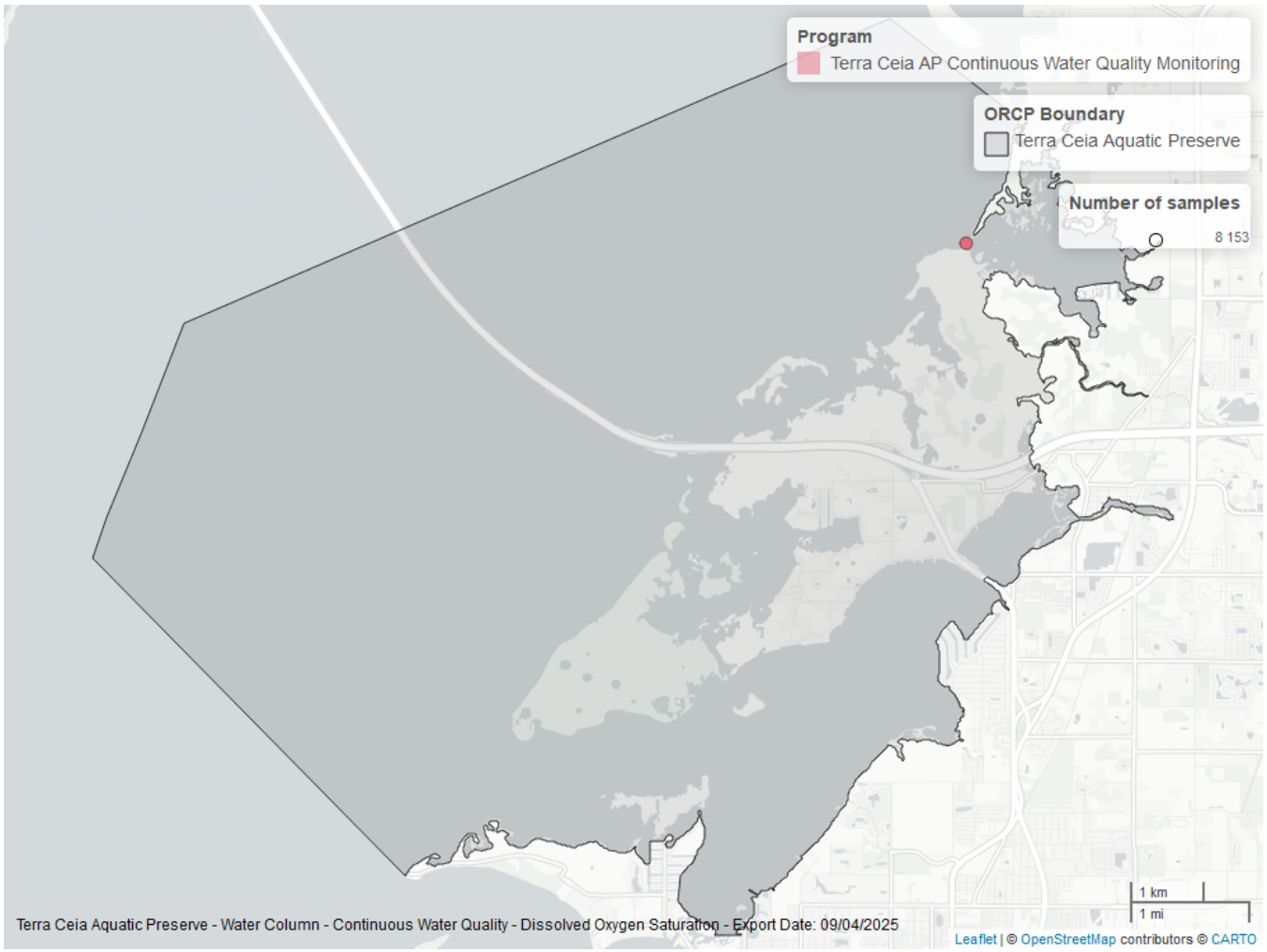

Figure 27: Map showing location of dissolved oxygen saturation continuous water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

pH - Continuous

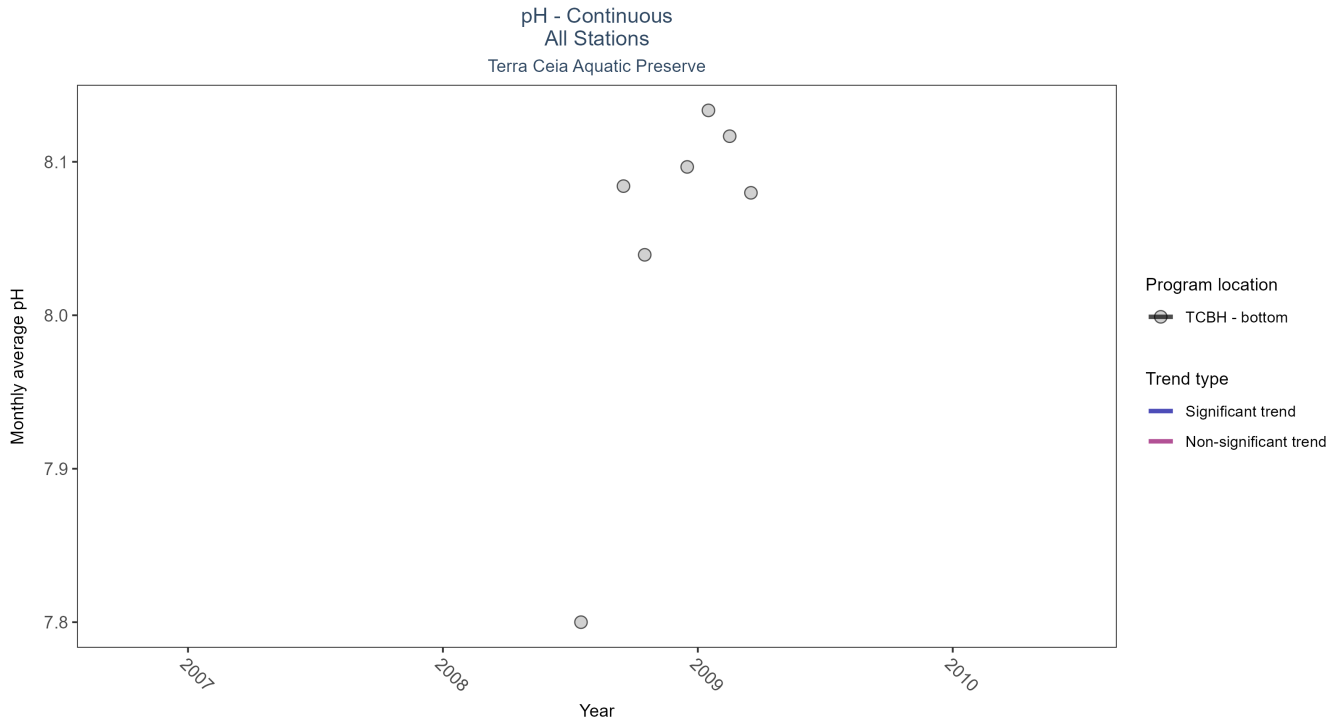

Figure 28: Scatter plot of monthly average pH over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 31: 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
TCBH	Insufficient data to calculate trend	8306	2	2008 - 2009	8.1	-	-	-	-

There was insufficient data to fit a model for one location.

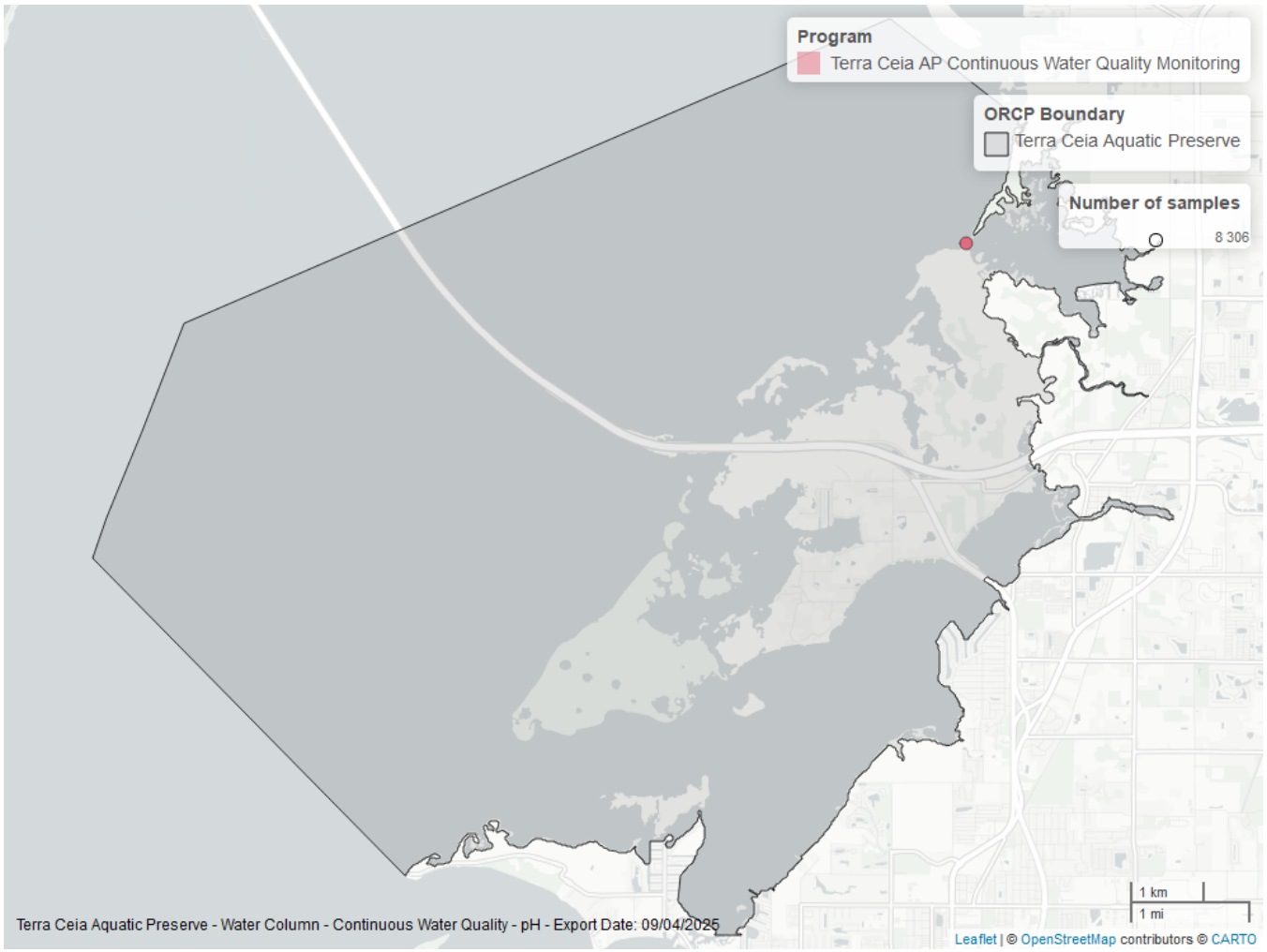

Figure 29: Map showing location of ph continuous water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Salinity - Continuous

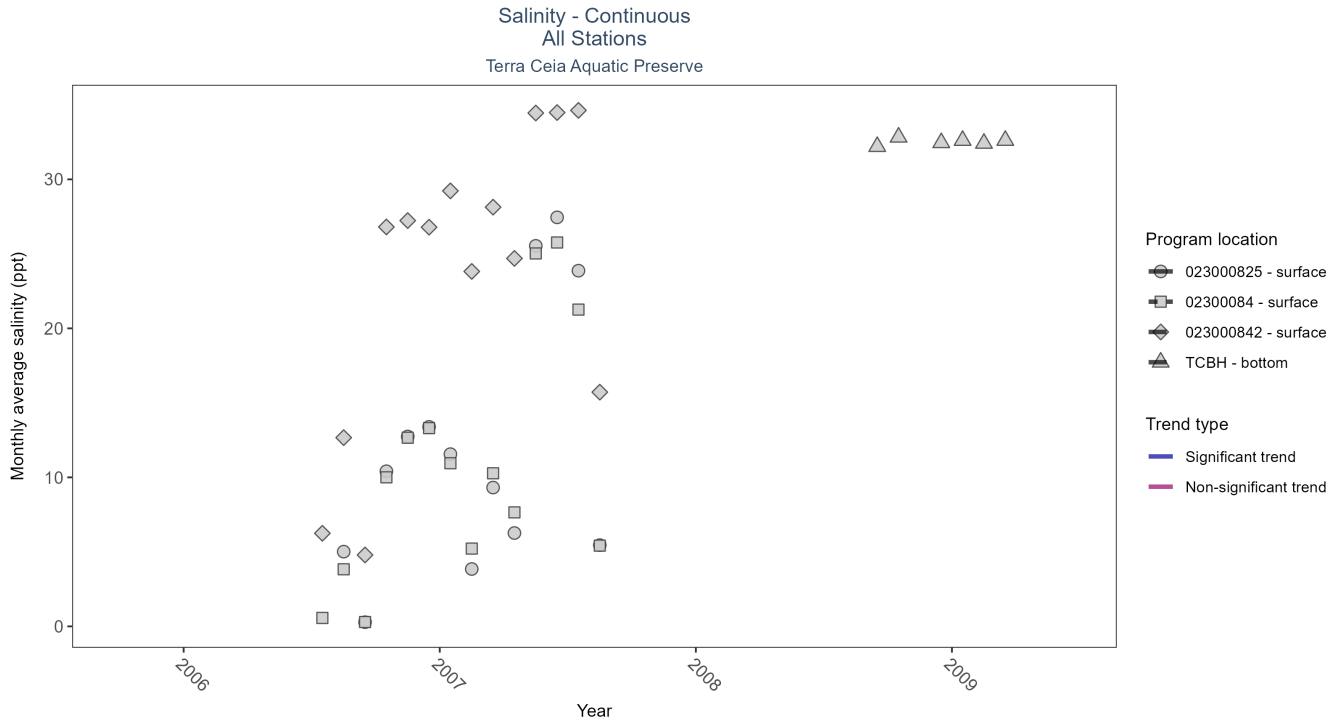

Figure 30: Scatter plot of monthly average salinity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 32: 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
02300084	Insufficient data to calculate trend	696	2	2006 - 2007	11.0	-	-	-	-
023000842	Insufficient data to calculate trend	578	2	2006 - 2007	28.0	-	-	-	-
023000825	Insufficient data to calculate trend	645	2	2006 - 2007	12.0	-	-	-	-
TCBH	Insufficient data to calculate trend	8304	2	2008 - 2009	32.6	-	-	-	-

There was insufficient data to fit a model for four locations.

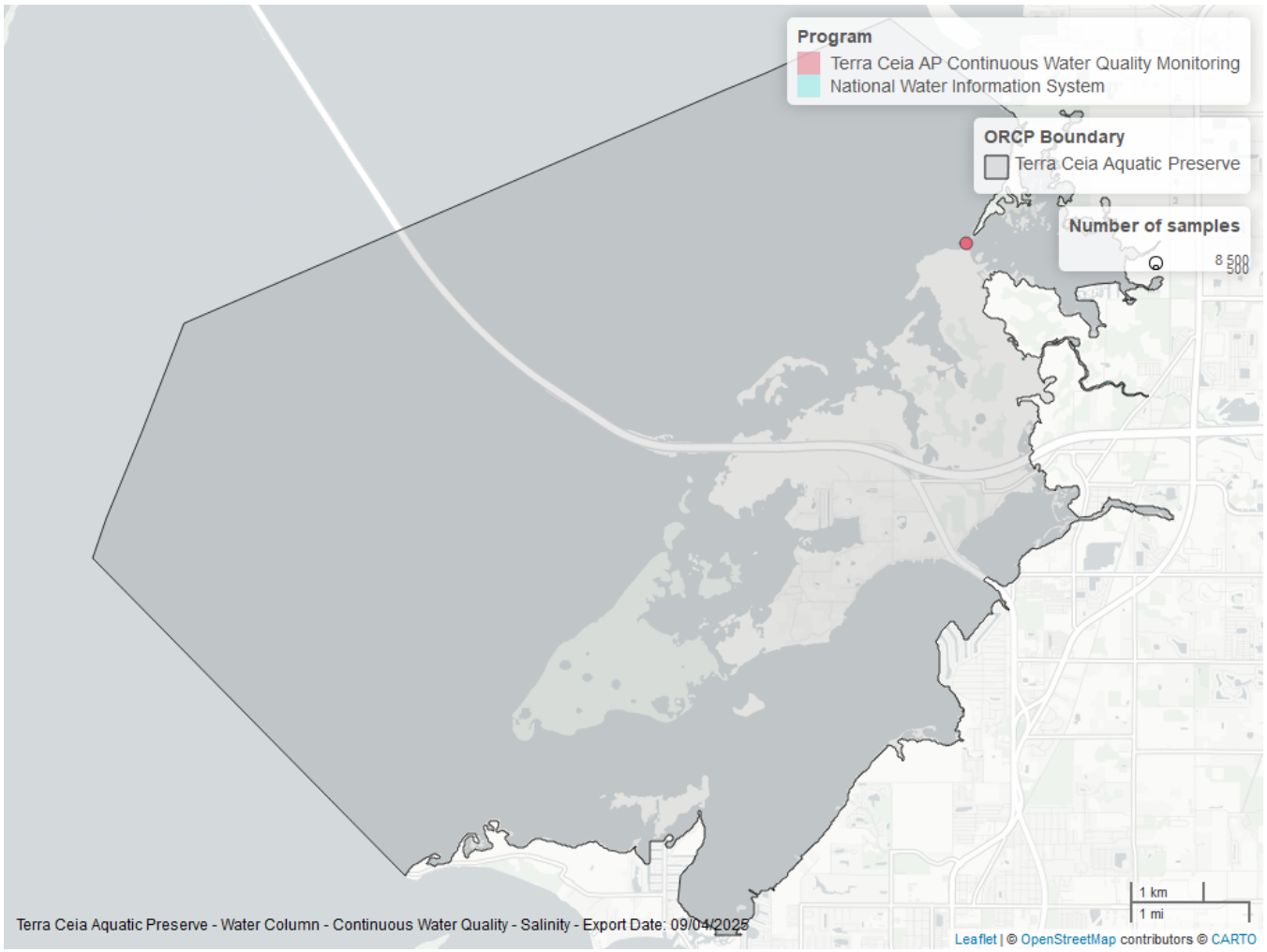

Figure 31: Map showing location of salinity continuous water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Turbidity - Continuous

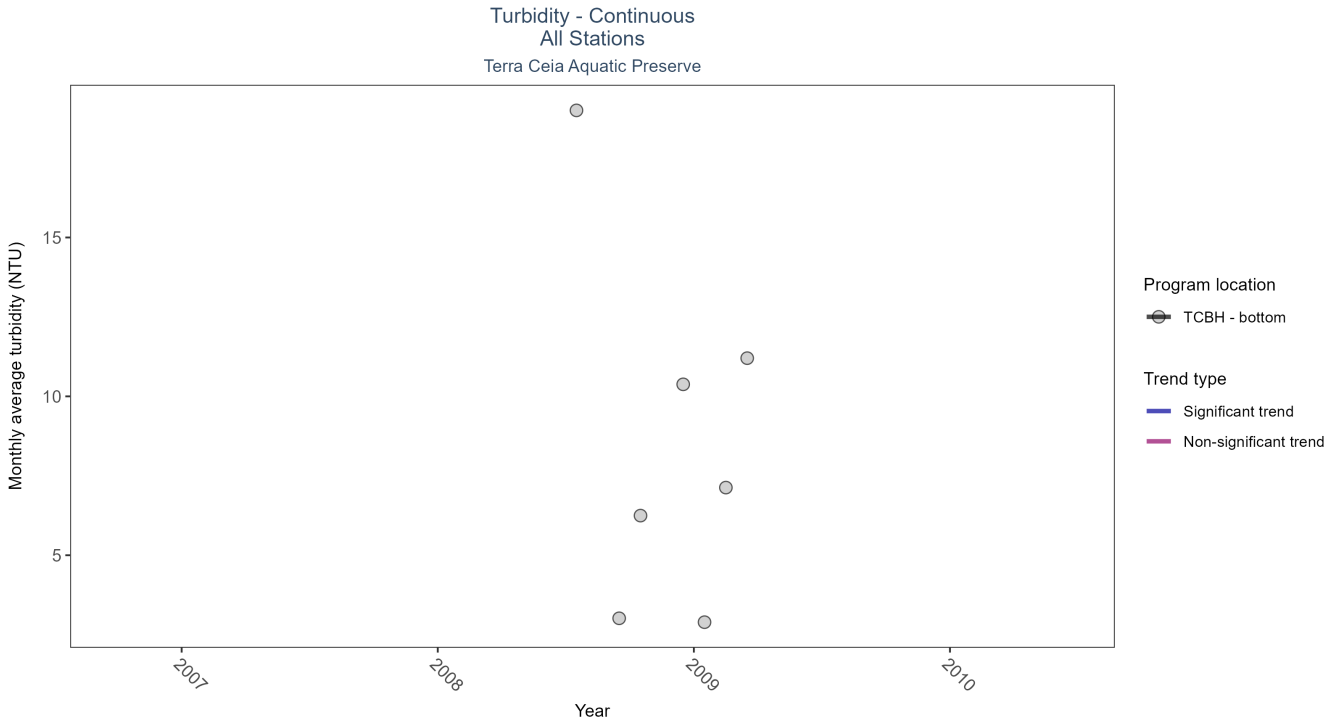

Figure 32: Scatter plot of monthly average turbidity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 33: 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
TCBH	Insufficient data to calculate trend	8263	2	2008 - 2009	2	-	-	-	-

There was insufficient data to fit a model for one location.

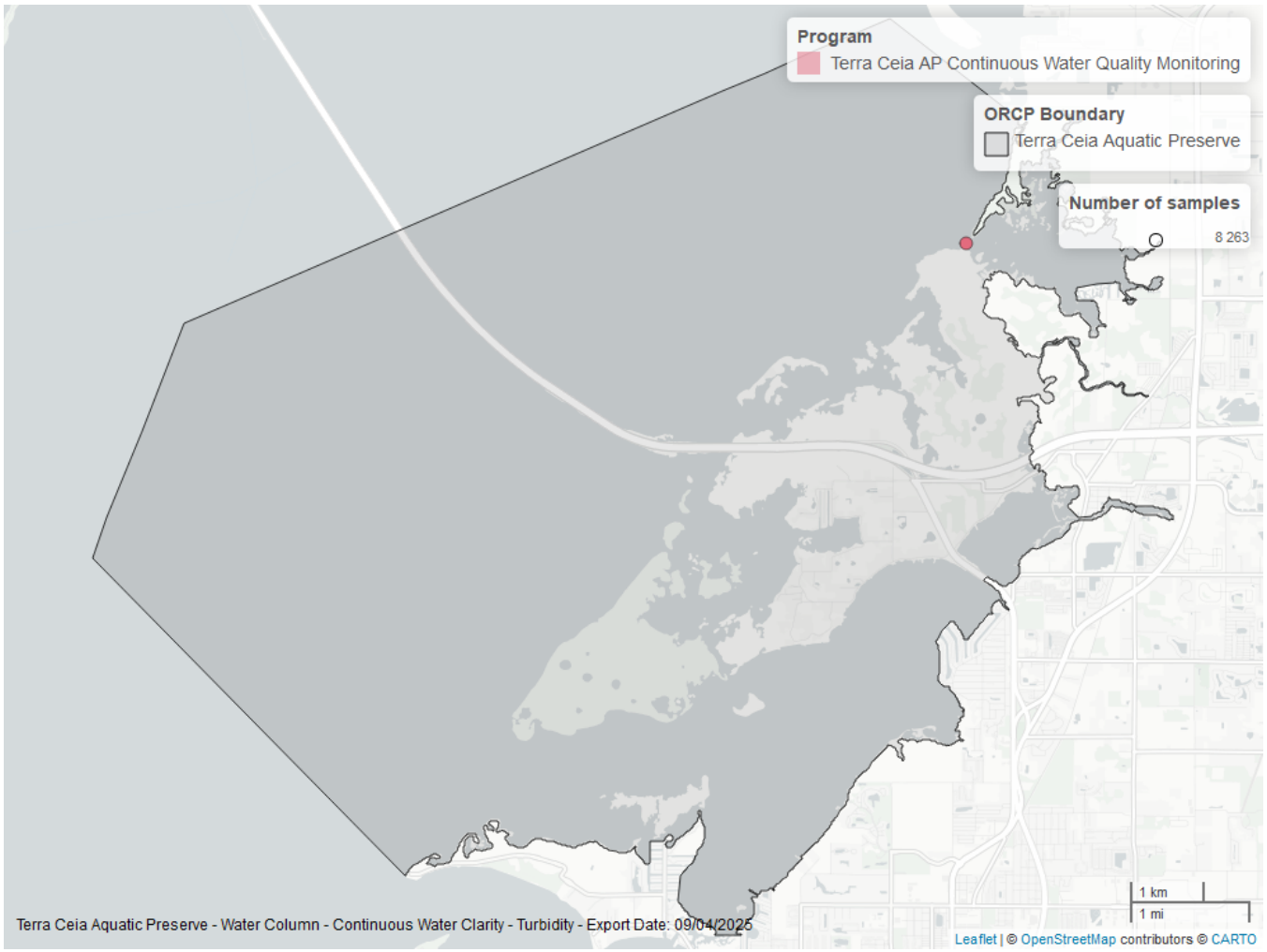

Figure 33: Map showing location of turbidity continuous water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Water Temperature - Continuous

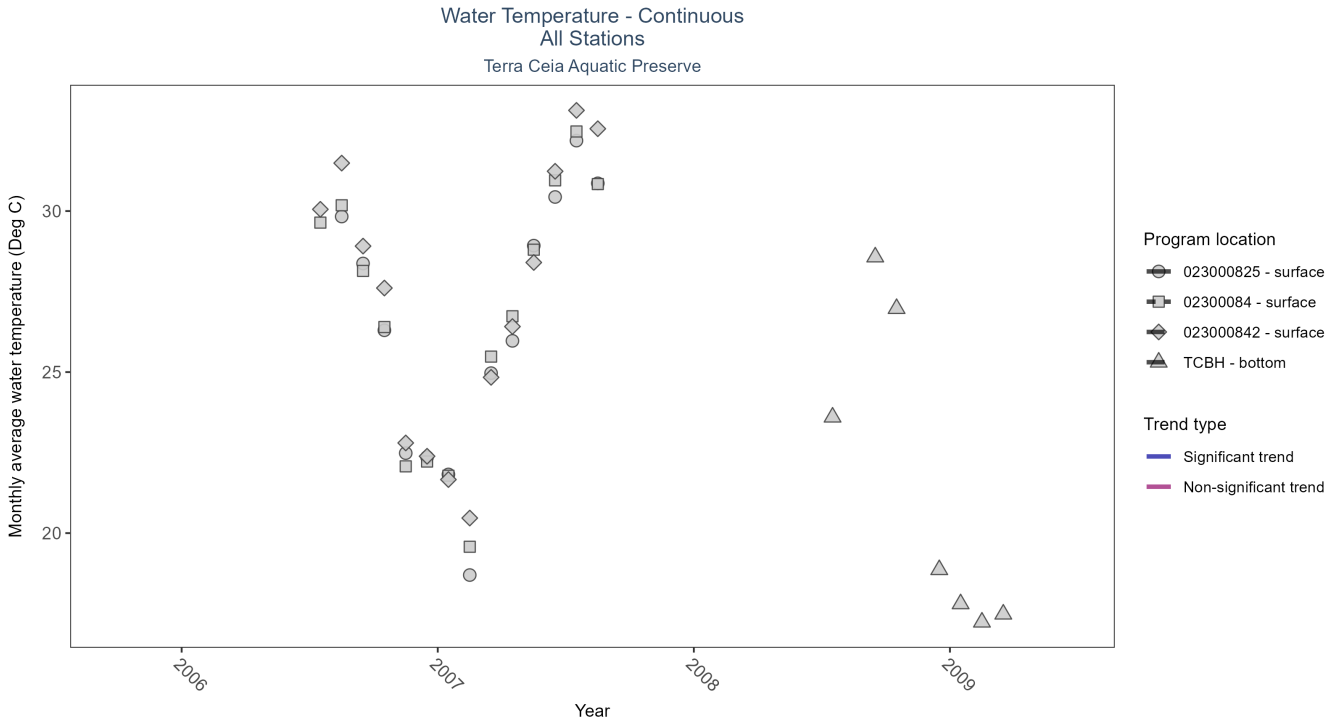

Figure 34: Scatter plot of monthly average water temperature over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

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
023000842	Insufficient data to calculate trend	571	2	2006 - 2007	27.7	-	-	-	-
02300084	Insufficient data to calculate trend	717	2	2006 - 2007	27.5	-	-	-	-
023000825	Insufficient data to calculate trend	659	2	2006 - 2007	26.6	-	-	-	-
TCBH	Insufficient data to calculate trend	8305	2	2008 - 2009	20.0	-	-	-	-

There was insufficient data to fit a model for four locations.

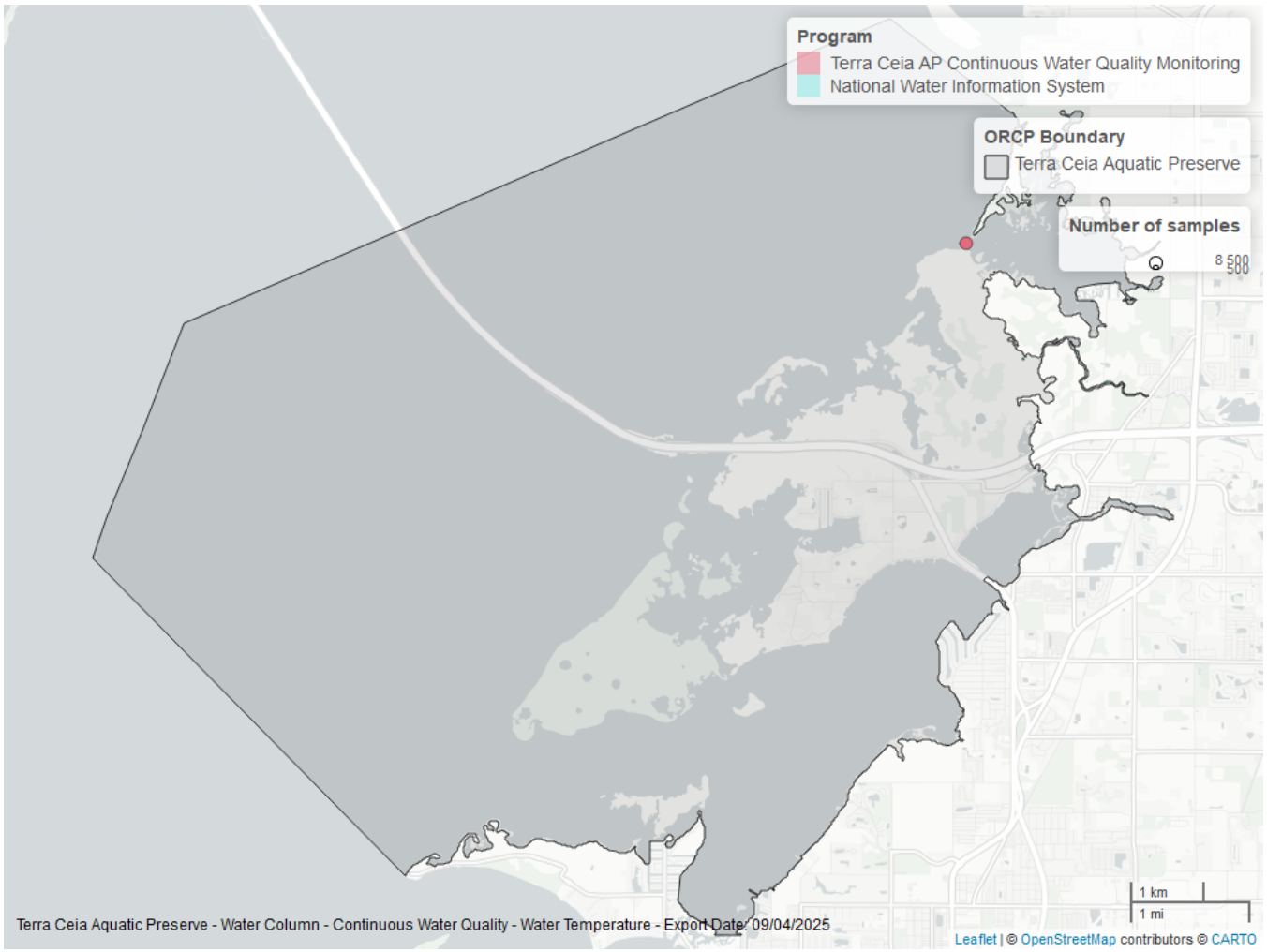

Figure 35: Map showing location of water temperature continuous water quality sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Submerged Aquatic Vegetation

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

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

Parameters

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

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

Species

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

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

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

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

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

Notes

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

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

- Biscayne Bay Aquatic Preserve
- Florida Keys National Marine Sanctuary

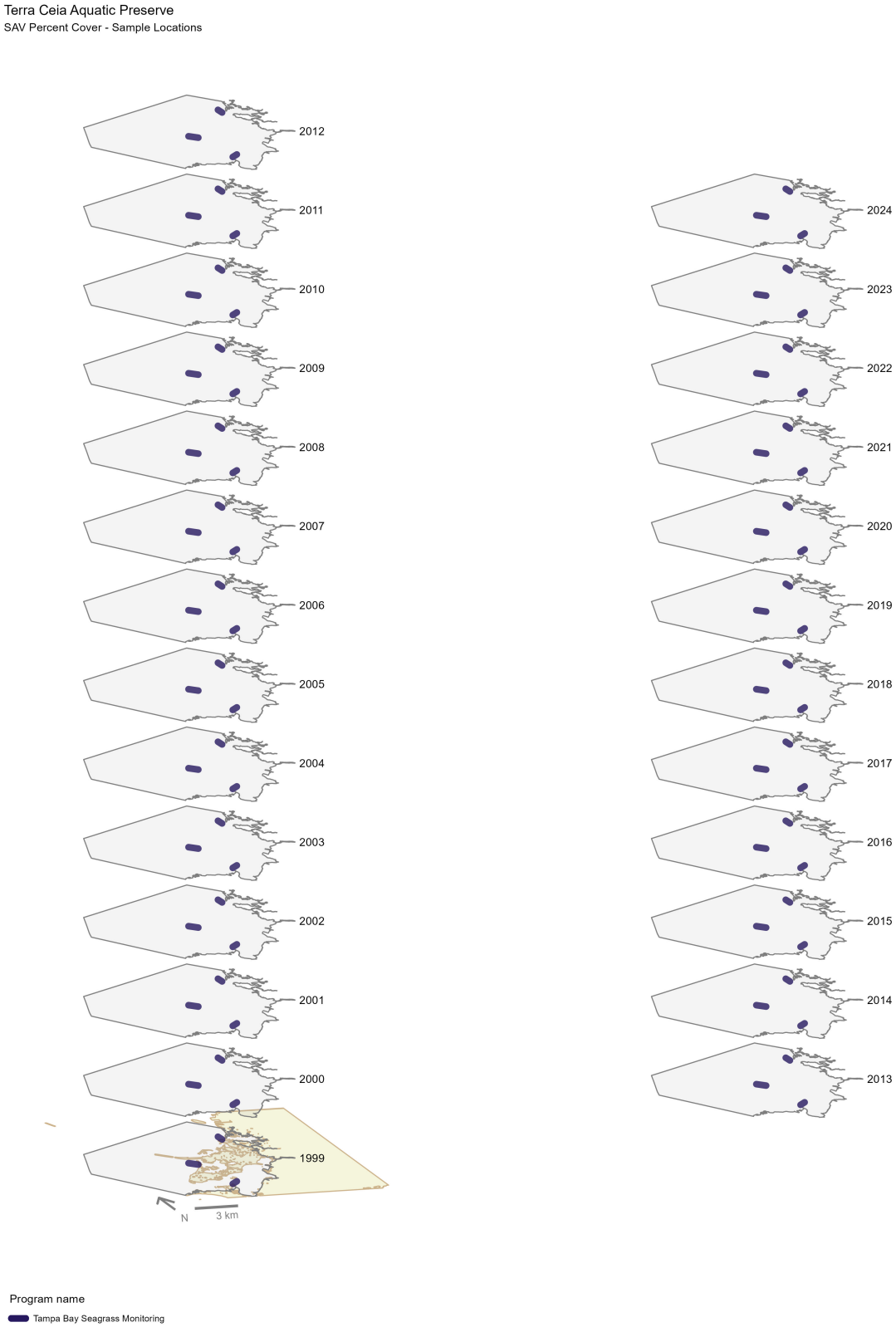

Figure 36: Maps showing the temporal scope of SAV sampling sites within the boundaries of *Terra Ceia Aquatic Preserve* by Program name.

Click here to view spatio-temporal plots on GitHub.

Sampling locations by Program:

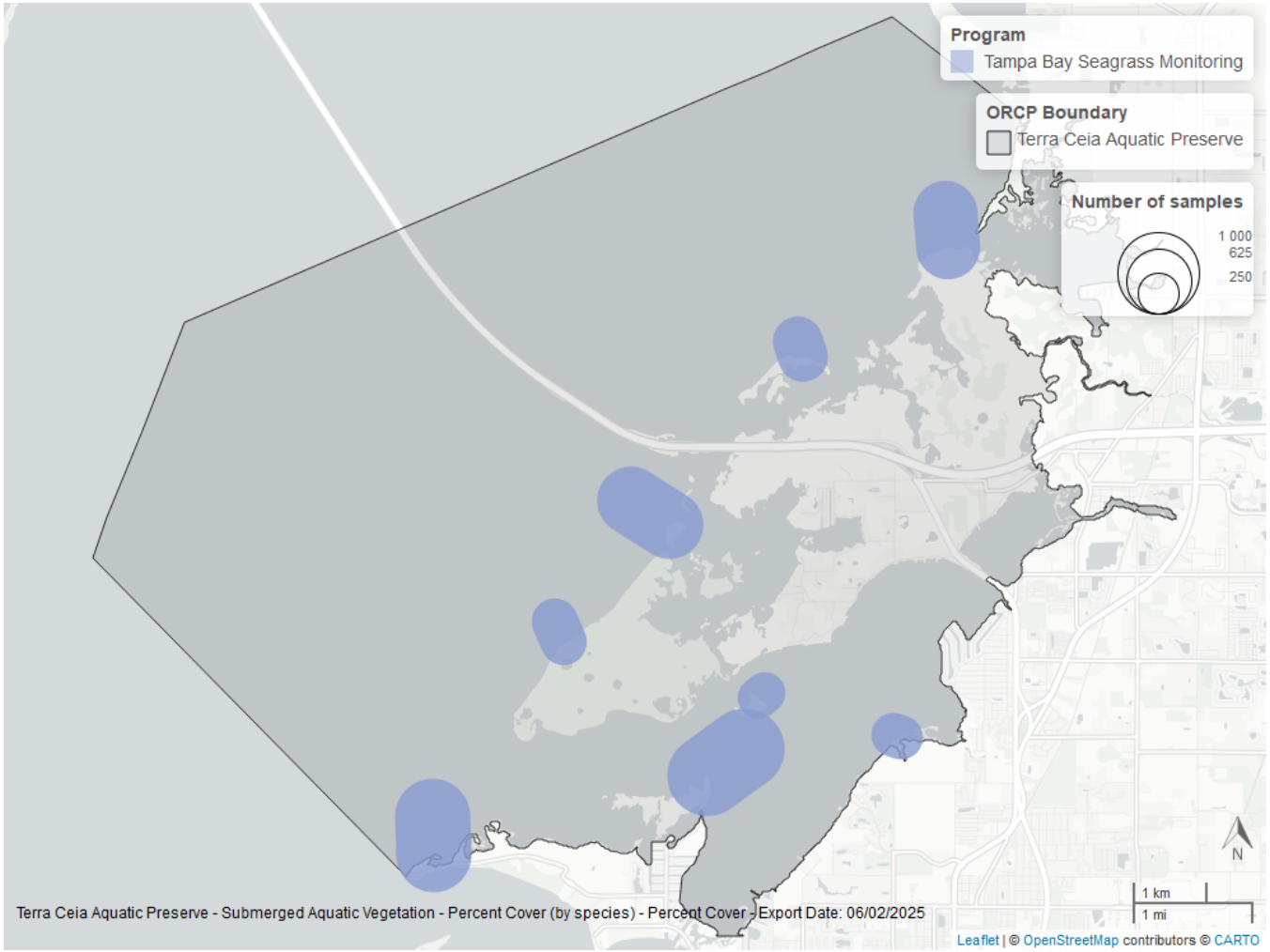

Figure 37: Map showing SAV sampling sites within the boundaries of *Terra Ceia Aquatic Preserve*. The point size reflects the number of samples at a given sampling site.

Table 35: Program Information for Submerged Aquatic Vegetation

ProgramID	*N-Data*	*YearMin*	*YearMax*	*method*	*Sample Locations*
565	4017	1999	2024	Braun Blanquet	8

Program names:

565 - Tampa Bay Seagrass Monitoring[9]

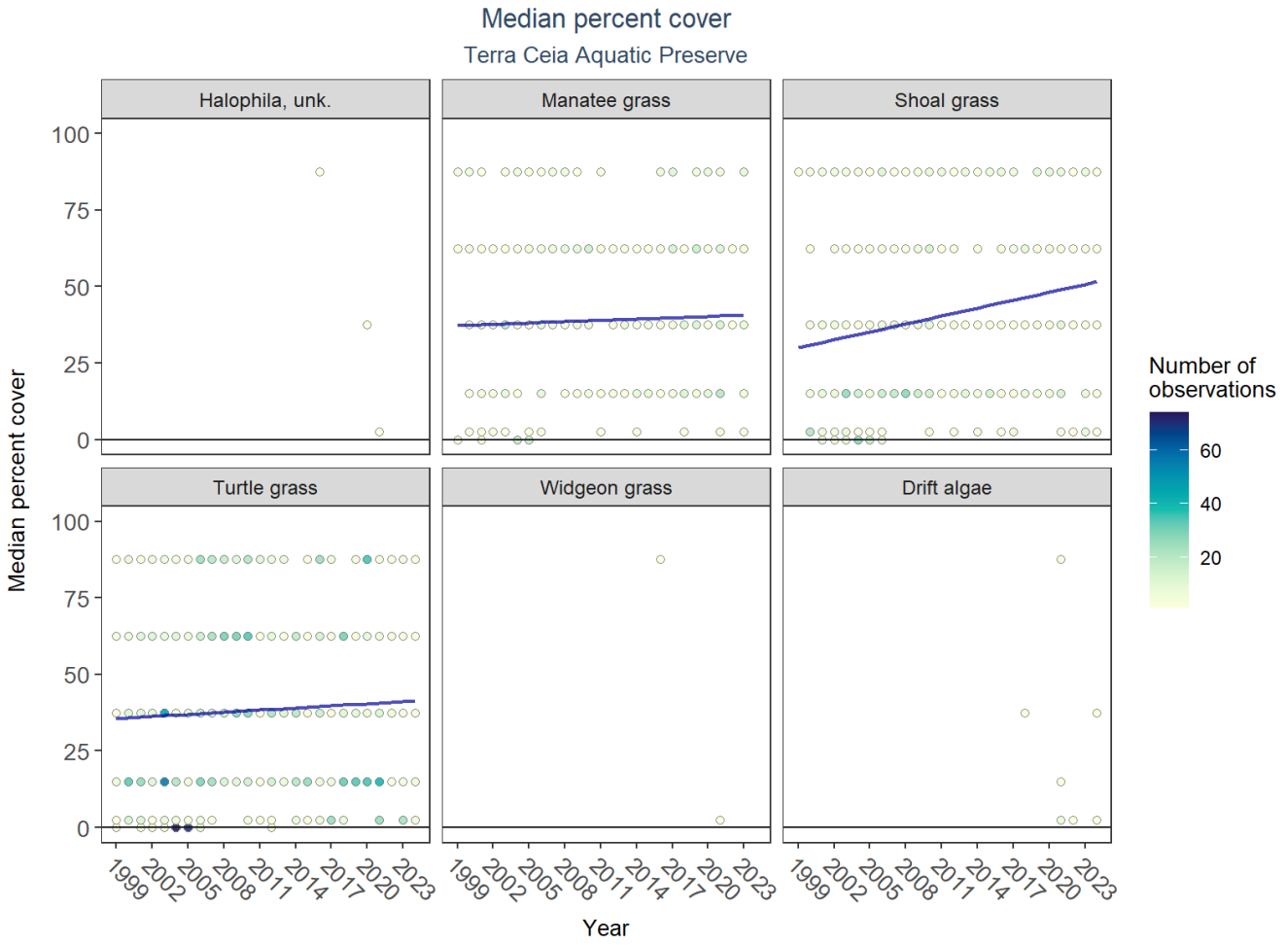

Figure 38: Scatter plots of median percent cover of submerged aquatic vegetation over time by group. Plots for time series that included five or more years of observations show the estimated trend as a blue line.

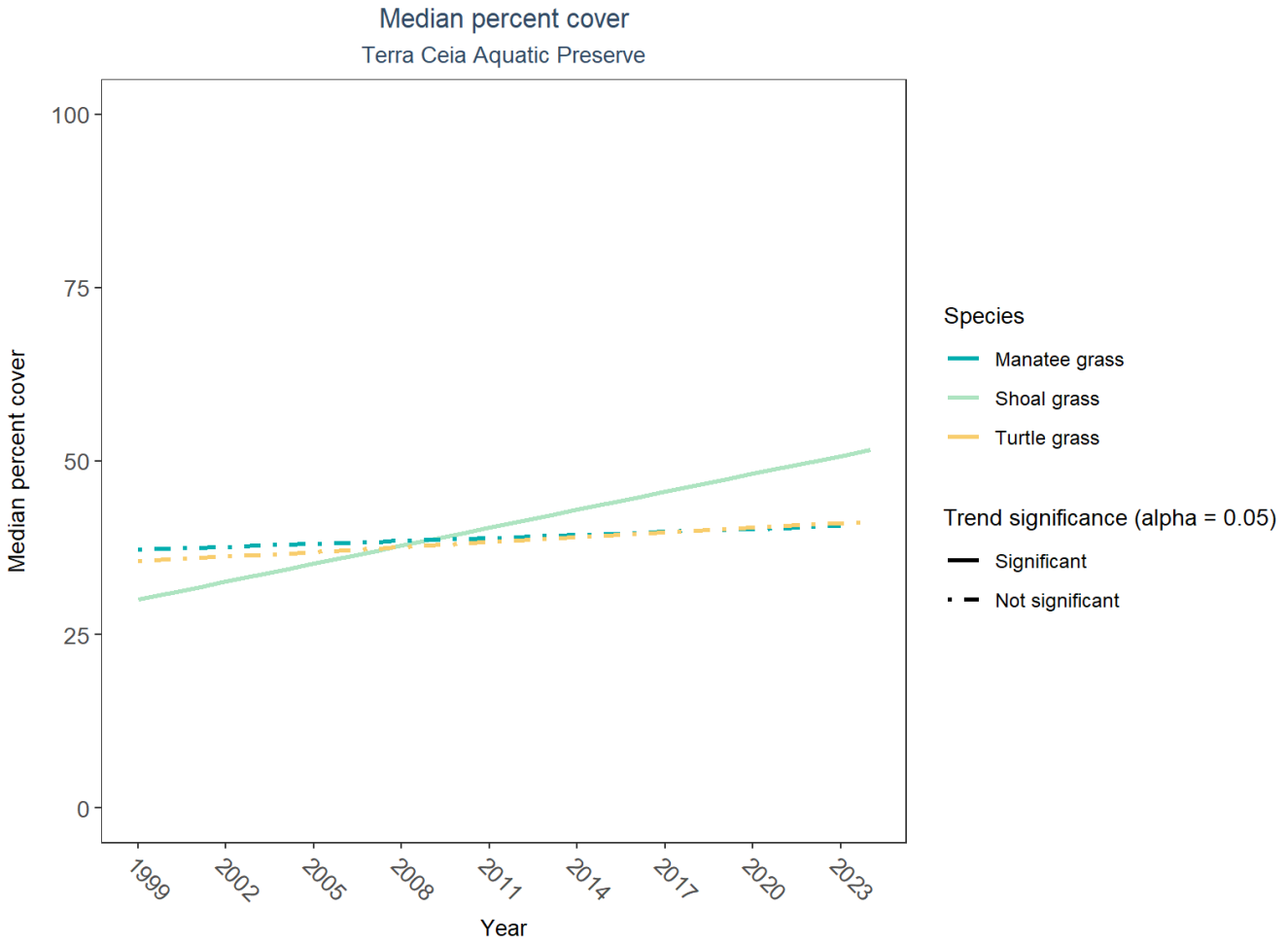

Figure 39: Trends in median percent cover for various seagrass species in Terra Ceia Aquatic Preserve - simplified

Table 36: Percent Cover Trend Analysis for Terra Ceia Aquatic Preserve

CommonName	*Trend Significance (0.05)*	*Period of Record*	*LME-Intercept*	*LME-Slope*	*p*
Drift algae	Insufficient data to calculate trend	-	-	-	-
Shoal grass	Significantly increasing trend	1999 - 2024	25.73515	0.862849	0.0041757
No grass in quadrat	Model did not fit the available data	1999 - 2024	-	-	-
Widgeon grass	Insufficient data to calculate trend	-	-	-	-
Manatee grass	No significant trend	1999 - 2023	36.53748	0.141925	0.7081145
Turtle grass	No significant trend	1999 - 2024	34.43132	0.229663	0.4469083
Halophila, unk.	Insufficient data to calculate trend	-	-	-	-

An annual increase in percent cover was observed for shoal grass (0.9%). No detectable change in percent cover was observed for manatee grass and turtle grass. Trends in percent cover could not be evaluated for unknown *Halophila*, widgeon grass, and drift algae due to insufficient data.

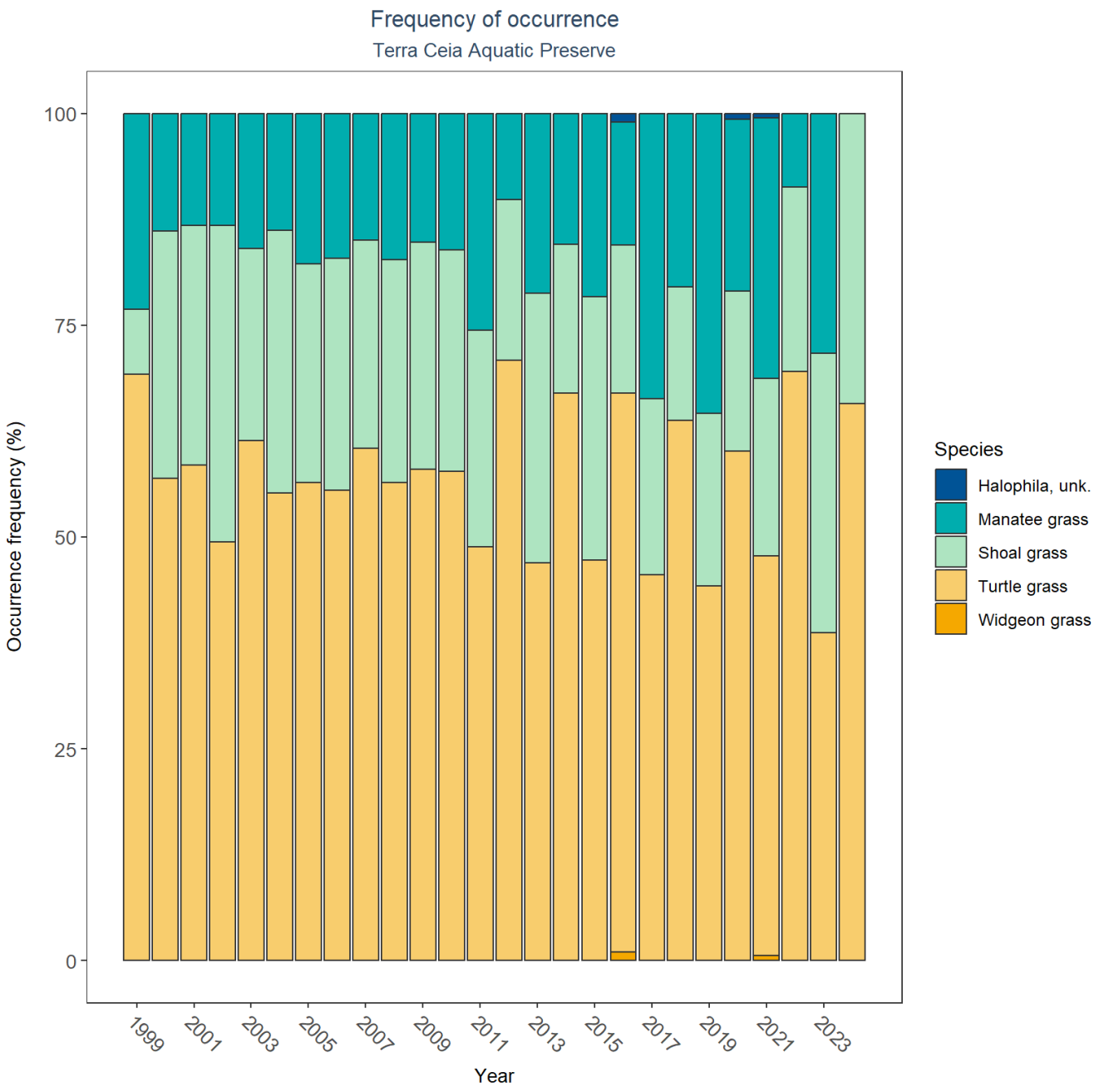

Figure 40: Frequency of occurrence for various seagrass species in Terra Ceia Aquatic Preserve

SAV Water Column Analysis

The following parameters are available for Terra Ceia Aquatic Preserve within the SAV_WC_Report:

- 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

Nekton

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

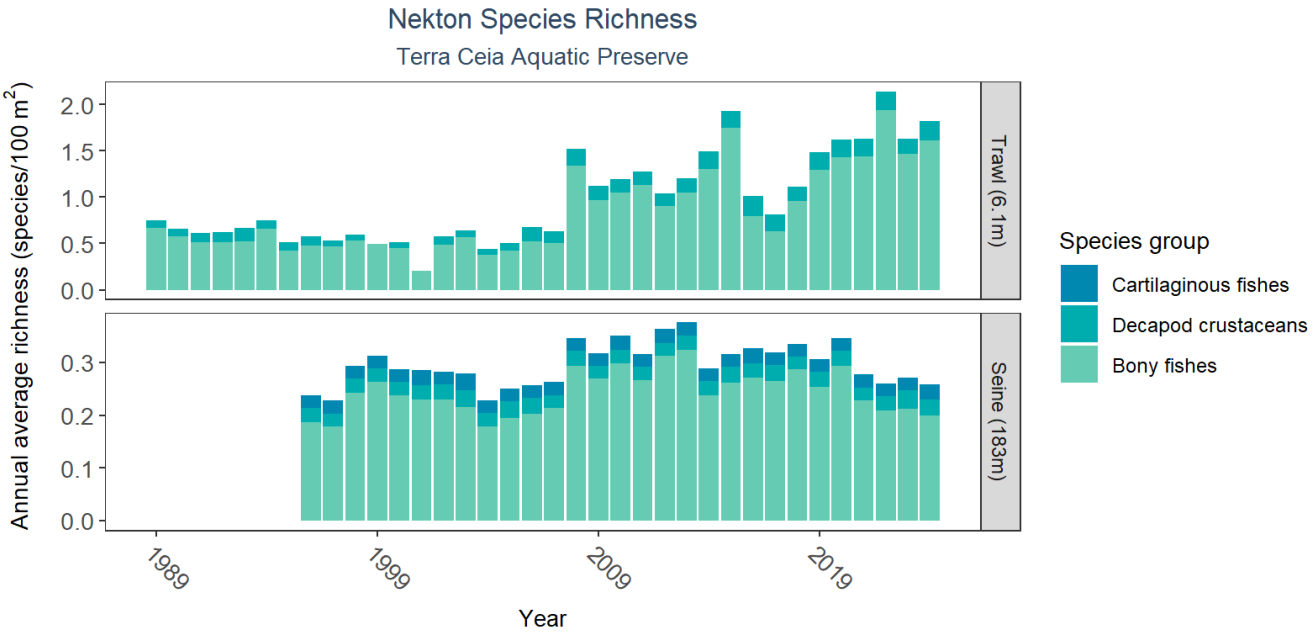

Figure 41: Bar graph(s) of annual average nekton richness over time for species groups occurring in at least 1% of samples. The bar colors represent species groups including bony fishes, cartilaginous fishes, decapod crustaceans (e.g., shrimps, crabs, and lobsters), and cephalopods (e.g., squid). Gear types and sizes are indicated in the panel label.

Table 37: Nekton Species Richness

Gear Type	*Sample Count*	*Number of Years*	*Period of Record*	*Median N of Taxa*	*Mean N of Taxa*
Trawl (6.1)	1382	36	1989 - 2024	0.32	0.65
Seine (183)	1543	29	1996 - 2024	0.17	0.17

The median annual number of taxa was 0.17 based on 1,543 observations collected by 183-meter seine between 1996 and 2024, and the median annual number of taxa was 0.32 based on 1,382 observations collected by 6.1-meter trawl between 1989 and 2024.

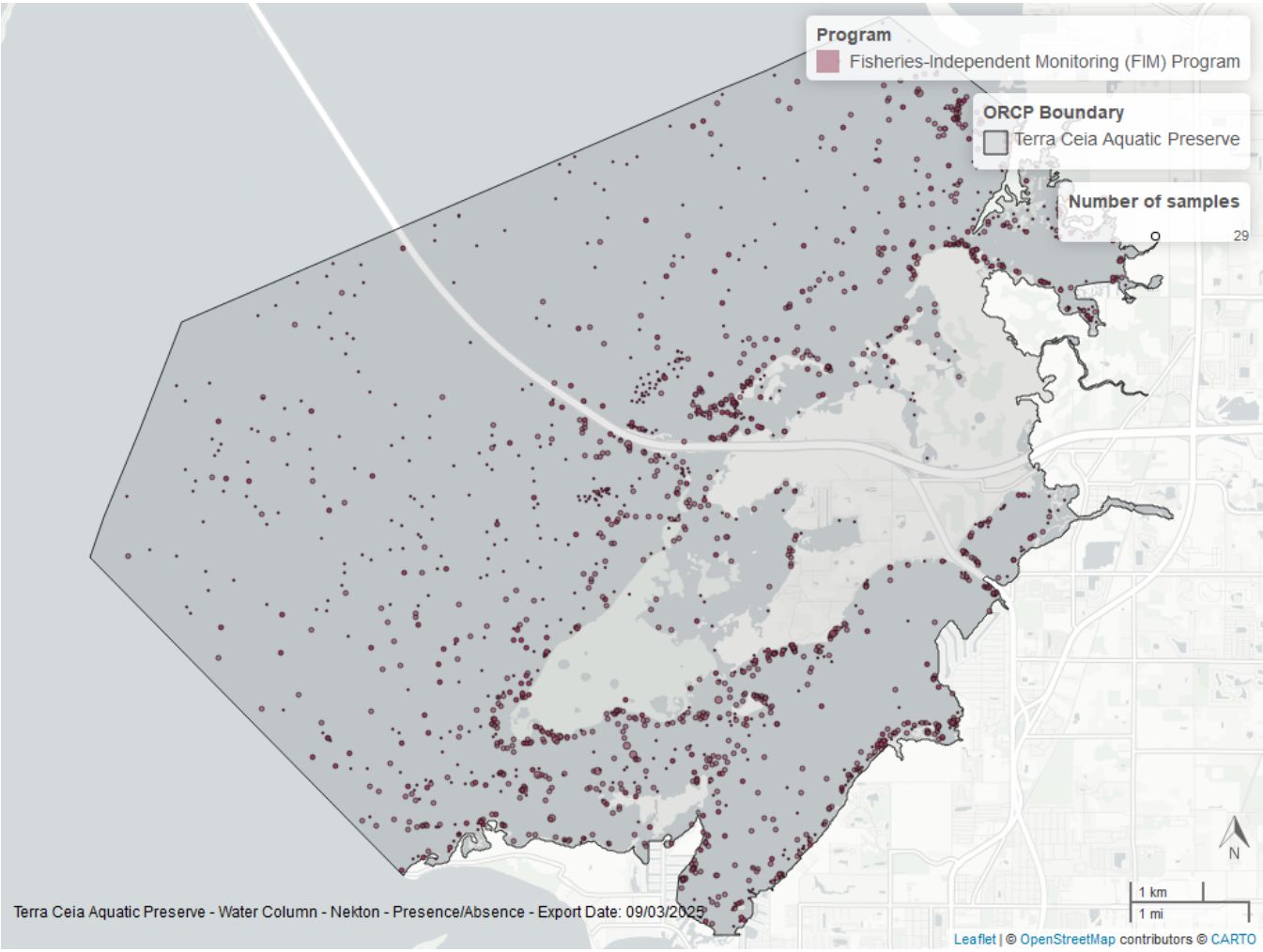

Figure 42: Map showing location of nekton sampling locations within the boundaries of *Terra Ceia Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Species list

Acanthophora sp.[1]
Acanthostracion quadricornis[2]
Achirus lineatus[2]
Aetobatus narinari[2]
Albula vulpes[2]
Alpheidae spp.[2]
Aluterus schoepfii[2]
Aluterus scriptus[2]
Anarchopterus criniger[2]
Anchoa cubana[2]
Anchoa hepsetus[2]
Anchoa mitchilli[2]
Anchoa spp.[2]
Ancylopsetta quadrocellata[2]
Archosargus probatocephalus[2]
Archosargus rhomboidalis[2]
Argopecten irradians
Argopecten spp.
Ariopsis felis[2]
Astroscopus ygraecum[2]
Bagre marinus[2]
Bairdiella chrysoura[2]
Brevoortia spp.[2]
Calamus arctifrons[2]
Calamus bajonado[2]
Calamus penna[2]
Calamus spp.[2]
Callinectes ornatus[2]
Callinectes sapidus[2]
Callinectes spp.[2]
Caranx crysos[2]
Caranx hippos[2]
Caranx latus[2]
Caranx spp.[2]
Carcharhinus limbatus[2]
Caulerpa mexicana[1]
Caulerpa prolifera[1]
Caulerpa sertularioides[1]
Centropomus undecimalis[2]
Centropristis striata[2]
Chaetodipterus faber[2]
Chasmodes saburrae[2]
Chelonia mydas[2]
Chilomycterus schoepfii[2]
Chloroscombrus chrysurus[2]
Citharichthys macrops[2]
Cynoscion arenarius[2]
Cynoscion nebulosus[2]
Cyprinodon variegatus[2]
Decapterus punctatus[2]
Diapterus auratus[2]
Diodon spp.[2]
Diplectrum formosum[2]
Diplectrum spp.[2]
Eucinostomus argenteus[2]
Eucinostomus gula[2]
Eucinostomus harengulus[2]
Eucinostomus spp.[2]
Eugerres plumieri[2]
Floridichthys carpio[2]
Fundulus grandis[2]
Fundulus similis[2]
Gerres cinereus[2]
Gobiosoma bosc[2]
Gobiosoma longipala[2]
Gobiosoma robustum[2]
Gobiosoma spp.[2]
Gracilaria sp.[1]
Haemulon aurolineatum[2]
Haemulon plumierii[2]
Halichoeres bivittatus[2]
Halodule wrightii[1]
Halophila sp.[1]
Harengula jaguana[2]
Hemiramphidae spp.[2]
Hemiramphus brasiliensis[2]
Hippocampus erectus[2]
Hippocampus zosterae[2]
Hypleurochilus caudovittatus[2]
Hypleurochilus geminatus[2]
Hypnea[1]
Hyporhamphus meeki[2]
Hyporhamphus spp.[2]
Hyporhamphus unifasciatus[2]
Hypsoblennius hentz[2]
Lachnolaimus maximus[2]
Lactophrys trigonus[2]
Lagocephalus laevigatus[2]
Lagodon rhomboides[2]
Leiostomus xanthurus[2]
Lepisosteus osseus[2]
Limulus polyphemus
Lucania parva[2]
Lutjanus analis[2]
Lutjanus griseus[2]
Lutjanus synagris[2]
Lyngbya sp.
Malaclemys terrapin[2]
Menidia spp.[2]
Menippe mercenaria[2]
Menippe spp.[2]
Menticirrhus americanus[2]
Menticirrhus saxatilis[2]
Menticirrhus spp.[2]
Microgobius gulosus[2]
Microgobius thalassinus[2]
Micropogonias undulatus[2]
Monacanthus ciliatus[2]
No grass in quadrat[1]
Ocyurus chrysurus[2]
Ogcocephalus cubifrons[2]
Oligoplites saurus[2]
Ophidiidae spp.[2]
Opisthonema oglinum[2]
Opistognathus spp.[2]
Opsanus beta[2]
Oreochromis aureus[2]
Oreochromis niloticus[2]
Orthopristis chrysoptera[2]
Ostraciidae spp.[2]
Other green algae[1]
Paraclinus marmoratus[2]
Paralichthys albigutta[2]
Penaeus duorarum[2]
Poecilia latipinna[2]
Pogonias cromis[2]
Pomatomus saltatrix[2]
Portunidae spp.[2]
Portunus spp.[2]
Prionotus scitulus[2]
Prionotus tribulus[2]
Pseudocrenilabrinae[2]
Rachycentron canadum[2]
Rhinoptera bonasus[2]
Rimapenaeus constrictus[2]
Rimapenaeus spp.[2]
Ruppia maritima[1]
Sardinella aurita[2]
Sarotherodon melanotheron[2]
Sciaenops ocellatus[2]
Scomberomorus maculatus[2]
Scorpaena brasiliensis[2]
Selene vomer[2]
Serraniculus pumilio[2]
Serranus subligarius[2]
Sicyonia brevirostris[2]
Sicyonia laevigata[2]
Sicyonia typica[2]
Sphoeroides nephelus[2]
Sphoeroides spengleri[2]
Sphyraena barracuda[2]
Sphyraena borealis[2]
Sphyrna tiburo[2]
Stomolophus meleagris
Strongylura marina[2]
Strongylura notata[2]
Strongylura timucu[2]
Syacium papillosum[2]
Symphurus plagiusa[2]
Syngnathus floridae[2]
Syngnathus louisianae[2]
Syngnathus scovelli[2]

Diplodus holbrookii[2]	Monacanthus spp.[2]	Syngnathus spp.[2]
Dorosoma petenense[2]	Mugil cephalus[2]	Synodus foetens[2]
Drift algae[1]	Mugil curema[2]	Syringodium filiforme[1]
Drift red algae[1]	Mugil spp.[2]	Thalassia testudinum[1]
Echeneis naucrates[2]	Mugil trichodon[2]	Trachinotus carolinus[2]
Echeneis neucratoides[2]	Mycteroperca microlepis[2]	Trachinotus falcatus[2]
Elops saurus[2]	Myrophis punctatus[2]	Trinectes maculatus[2]
Epinephelus itajara[2]	Negaprion brevirostris[2]	Tylosurus crocodilus[2]
Epinephelus morio[2]	Nicholsina usta[2]	Urophycis floridana[2]
Etropus crossotus[2]	No fish	Acanthophora sp.[1]

1 - Submerged Aquatic Vegetation, 2 - Nekton

References

1. Florida Fish and Wildlife Conservation Commission (FWC); Florida Fish and Wildlife Research Institute (FWRI). Harmful Algal Bloom Marine Observation Network. (2018).
2. U.S. Environmental Protection Agency (EPA). EPA STOrage and RETrieval Data Warehouse (STORET)/WQX. (2023).
3. 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).
4. Florida Department of Environmental Protection (DEP). Florida STORET / WIN. (2024).
5. Florida Fish and Wildlife Conservation Commission (FWC). Fisheries-Independent Monitoring (FIM) Program. (2022).
6. Tampa Bay Estuary Program. Tampa Bay Benthic Monitoring. (2022).
7. U.S. Geological Survey (USGS). National Water Information System. (2024).
8. Florida Department of Environmental Protection (DEP); Office of Resilience and Coastal Protection (RCP); Tampa Bay Aquatic Preserves; University of South Florida. Terra Ceia Aquatic Preserve Continuous Water Quality Monitoring. (2009).
9. Tampa Bay Interagency Seagrass Monitoring Program; Tampa Bay Estuary Program (TBEP). Tampa Bay Seagrass Monitoring. (2023).