

# Cape Romano-Ten Thousand Islands Aquatic Preserve

## SEACAR Habitat Analyses

Last compiled on 02 July, 2025

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## Funding & Acknowledgements

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

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## Threshold Filtering

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

Table 1: Continuous Water Quality threshold values

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

Table 2: Discrete Water Quality threshold values

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

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

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

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

## Value Qualifiers

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

### STORET and WIN value qualifier codes

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

Table 4: Value Qualifier codes excluded from analysis

Qualifier Source	Value Qualifier	Include	MDL	Description
STORET-WIN	H	0	0	Value based on field kit determination; results may not be accurate
STORET-WIN	J	0	0	Estimated value
STORET-WIN	V	0	0	Analyte was detected at or above method detection limit
STORET-WIN	Y	0	0	Lab analysis from an improperly preserved sample; 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 determination; results may not be accurate. This code shall be used if a field screening test (e.g., field gas chromatograph data, immunoassay, or vendor-supplied field kit) was used to generate the value and the field kit or method has not been recognized by the Department as equivalent to laboratory methods.

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

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

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

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

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

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

Table 5: SWMP Value Qualifier codes

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

## Water Column

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

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

## Seasonal Kendall-Tau Analysis

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

## Water Quality - Discrete

The following files were used in the discrete analysis:

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

## Chlorophyll a, Corrected for Pheophytin - Discrete

### Seasonal Kendall-Tau Trend Analysis

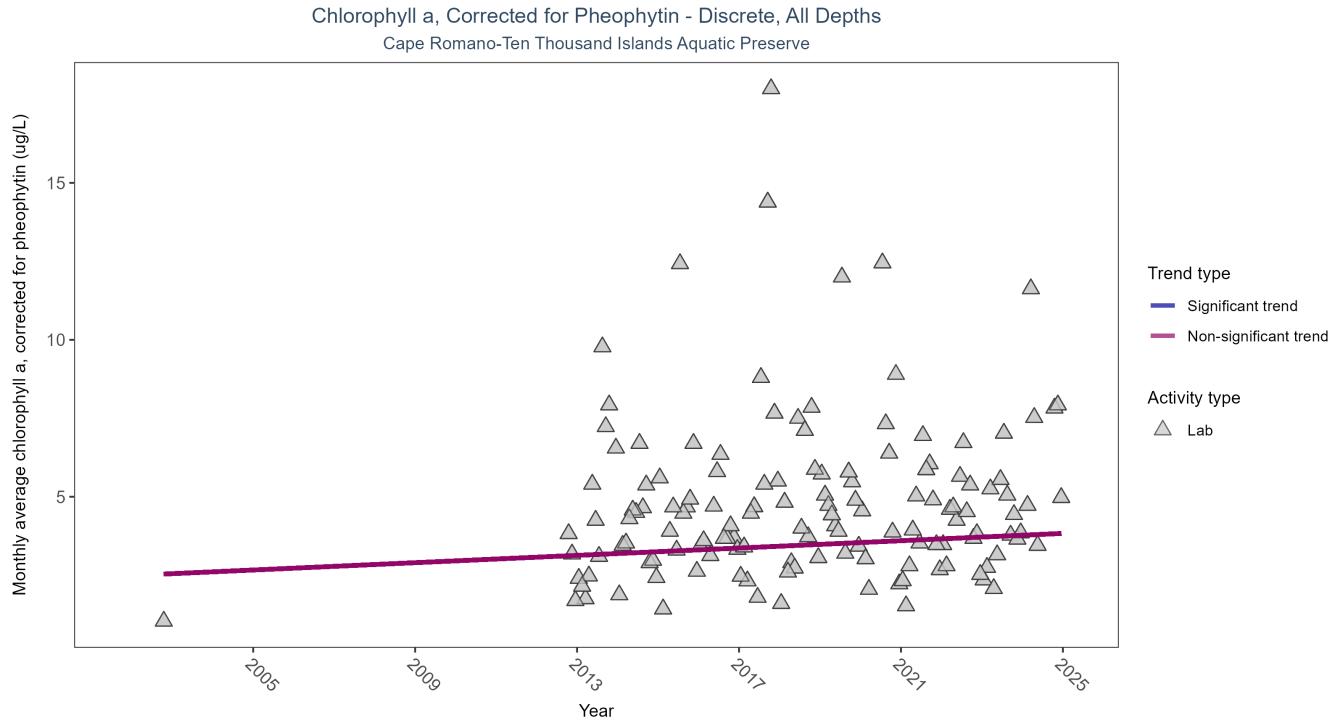


Figure 1: Scatter plot of monthly average levels of chlorophyll a, corrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles)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

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

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Lab	No significant trend	605	14	2002 - 2024	3.8	0.1008	2.491	0.0583	0.1184

Chlorophyll a, corrected for pheophytin, showed no detectable trend between 2002 and 2024.

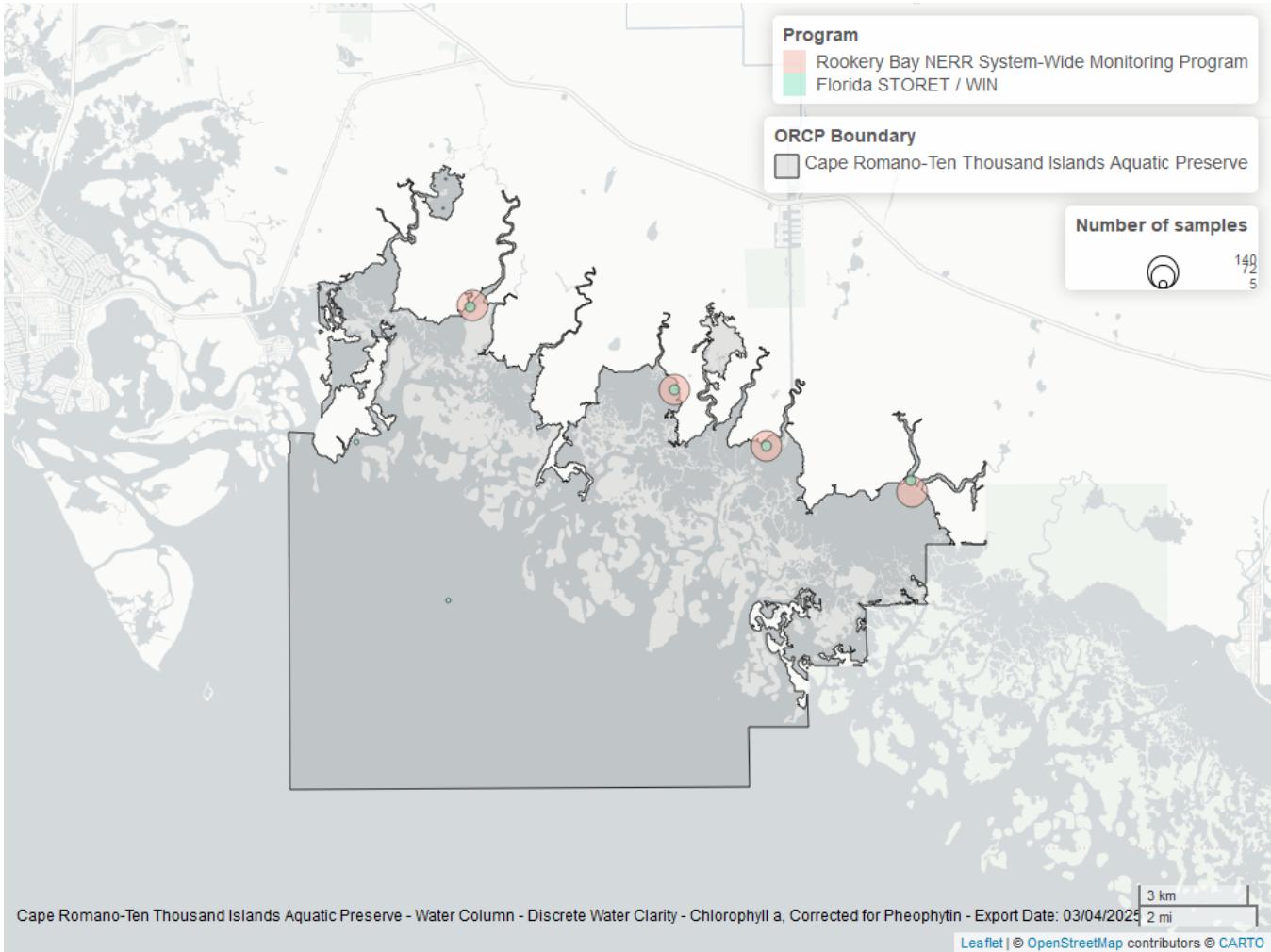


Figure 2: Map showing location of discrete water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
354	549	2012	2024
5002	68	2002	2021

#### Program names:

354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>  
 5002 - Florida STORET / WIN<sup>2</sup>

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

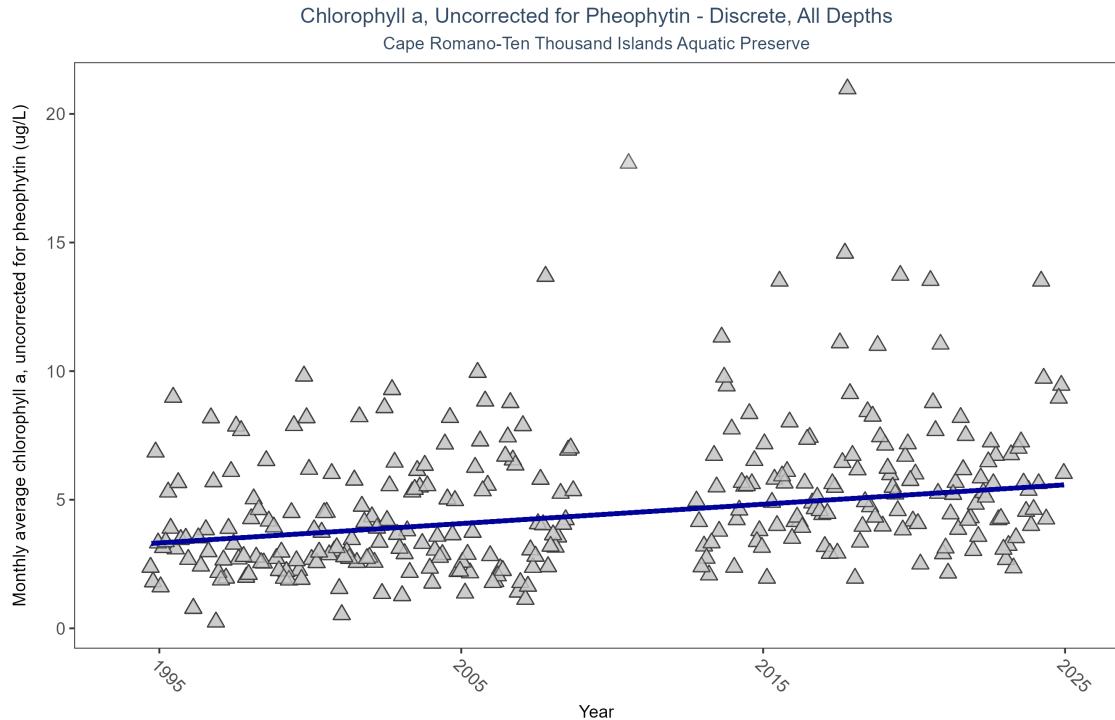


Figure 3: Scatter plot of monthly average levels of chlorophyll a, uncorrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles)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

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

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Lab	Significantly increasing trend	2162	29	1994 - 2024	3.6389	0.2729	3.2457	0.0753	0

Monthly average chlorophyll a, uncorrected for pheophytin, increased by  $0.08 \mu\text{g/L}$  per year, indicating a decrease in water clarity.

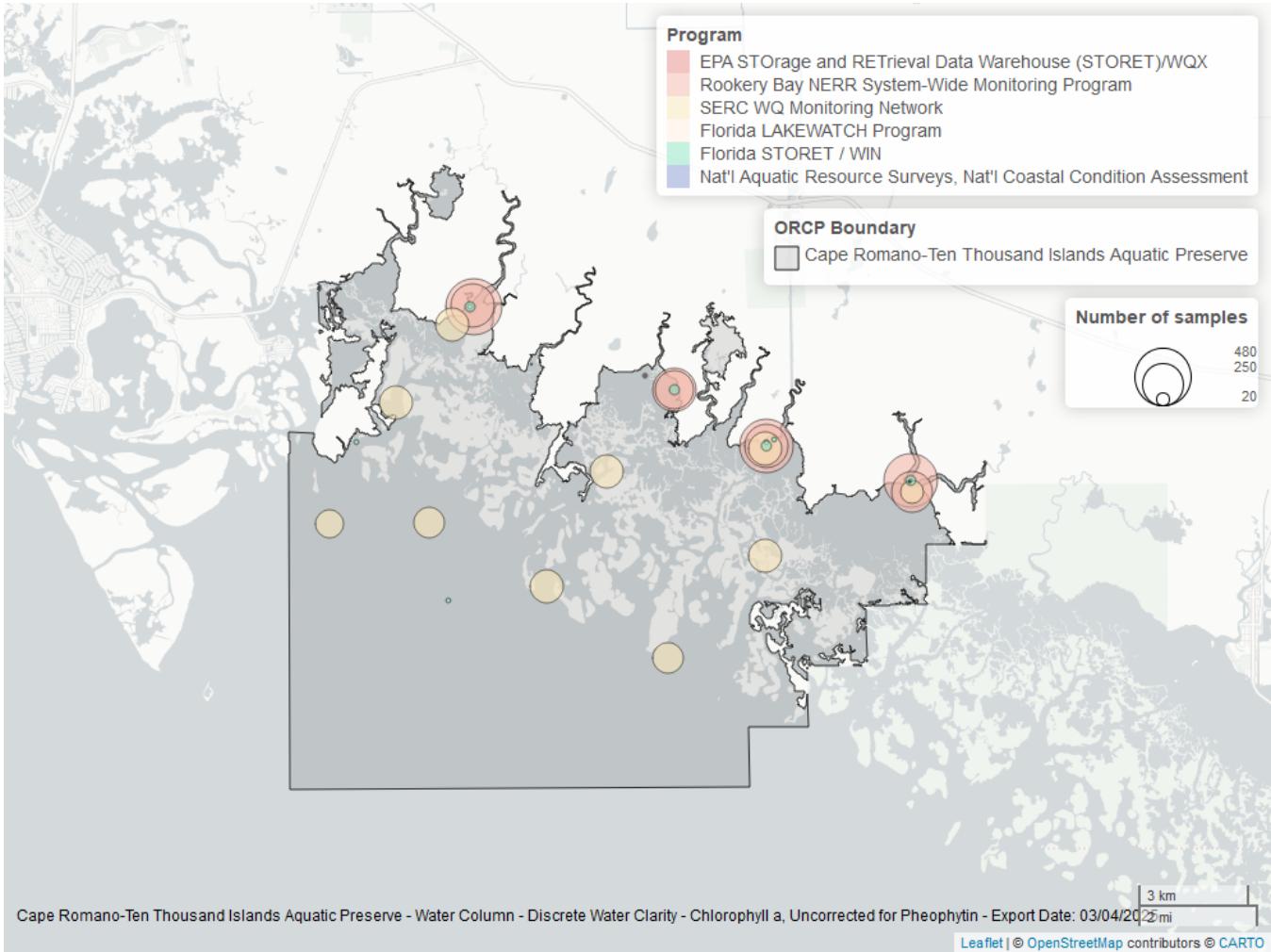


Figure 4: Map showing location of discrete water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
354	2722	2002	2024
509	1512	1994	2008
5002	72	2001	2021
103	24	2021	2021
514	15	2001	2001
118	1	2010	2010

#### Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>3</sup>

118 - National Aquatic Resource Surveys, National Coastal Condition Assessment<sup>4</sup>

354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>

509 - SERC Water Quality Monitoring Network<sup>5</sup>

514 - Florida LAKEWATCH Program<sup>6</sup>

5002 - Florida STORET / WIN<sup>2</sup>

## Dissolved Oxygen - Discrete

### Seasonal Kendall-Tau Trend Analysis

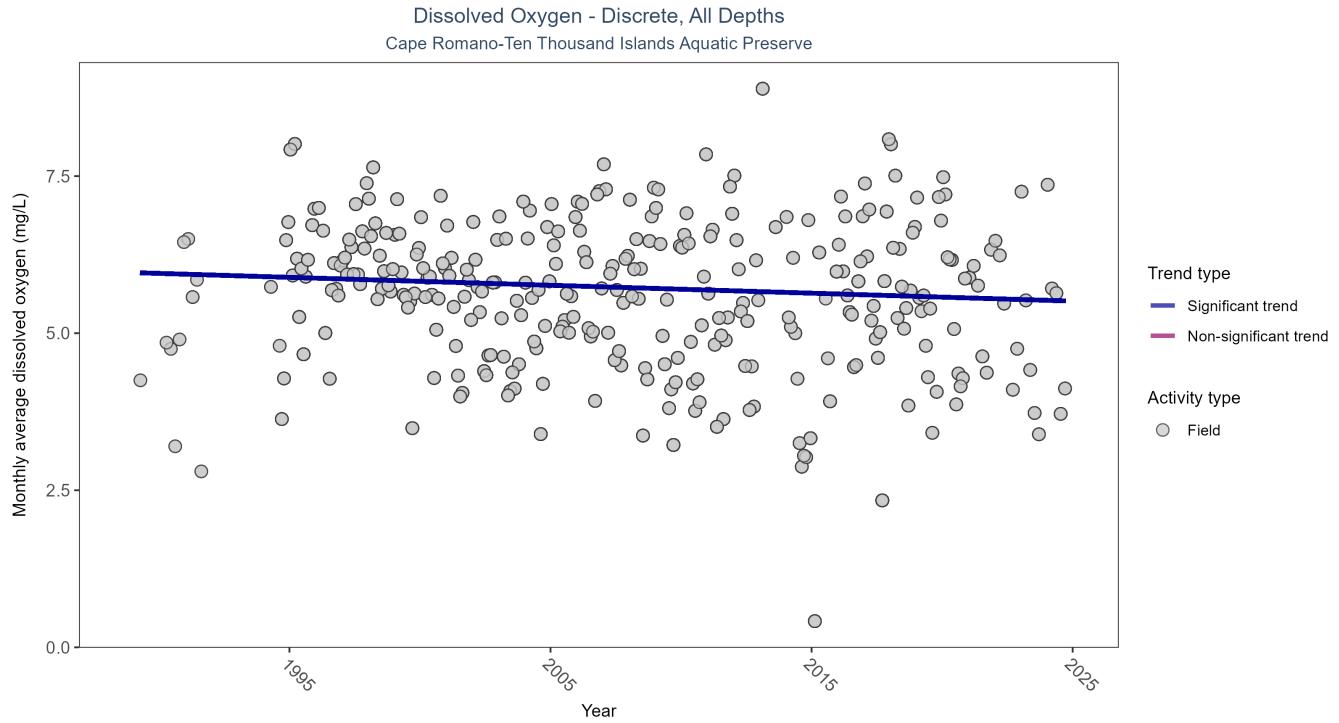


Figure 5: Scatter plot of monthly average dissolved oxygen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen values measured in the field (circles) are included in the plot.

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

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Field	Significantly decreasing trend	10675	34	1989 - 2024	5.8	-0.0864	5.9642	-0.0126	0.0261

Monthly average dissolved oxygen decreased by 0.01 mg/L per year.

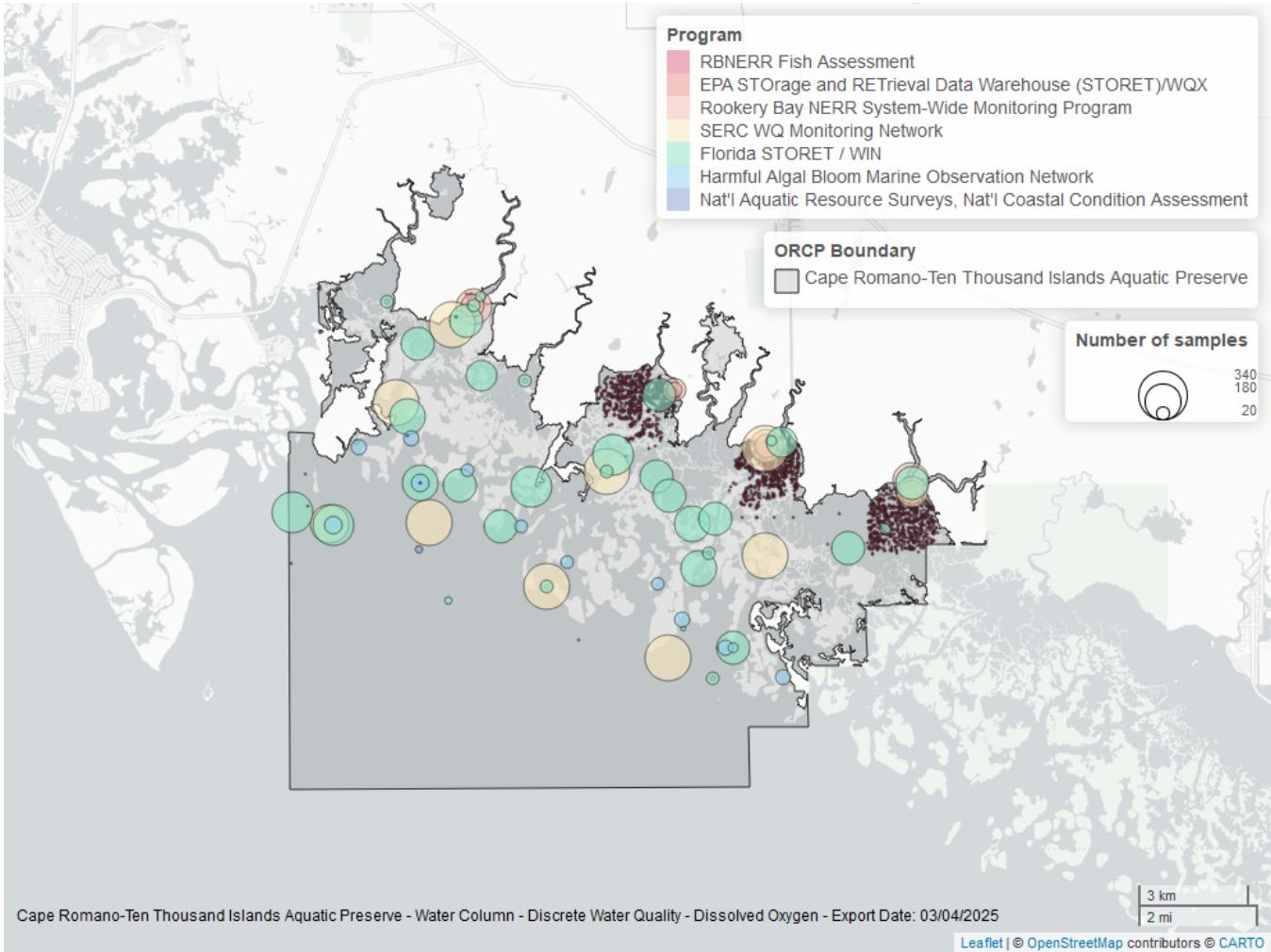


Figure 6: Map showing location of discrete water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 11: Programs contributing data for Dissolved Oxygen

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	4190	1989	2024
509	2974	1994	2008
4043	2481	1999	2020
354	917	2002	2023
95	390	1997	2018
103	48	2021	2021
118	10	2015	2021

#### Program names:

95 - Harmful Algal Bloom Marine Observation Network<sup>7</sup>

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>3</sup>

118 - National Aquatic Resource Surveys, National Coastal Condition Assessment<sup>4</sup>

354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>

509 - SERC Water Quality Monitoring Network<sup>5</sup>

## Dissolved Oxygen Saturation - Discrete

### Seasonal Kendall-Tau Trend Analysis

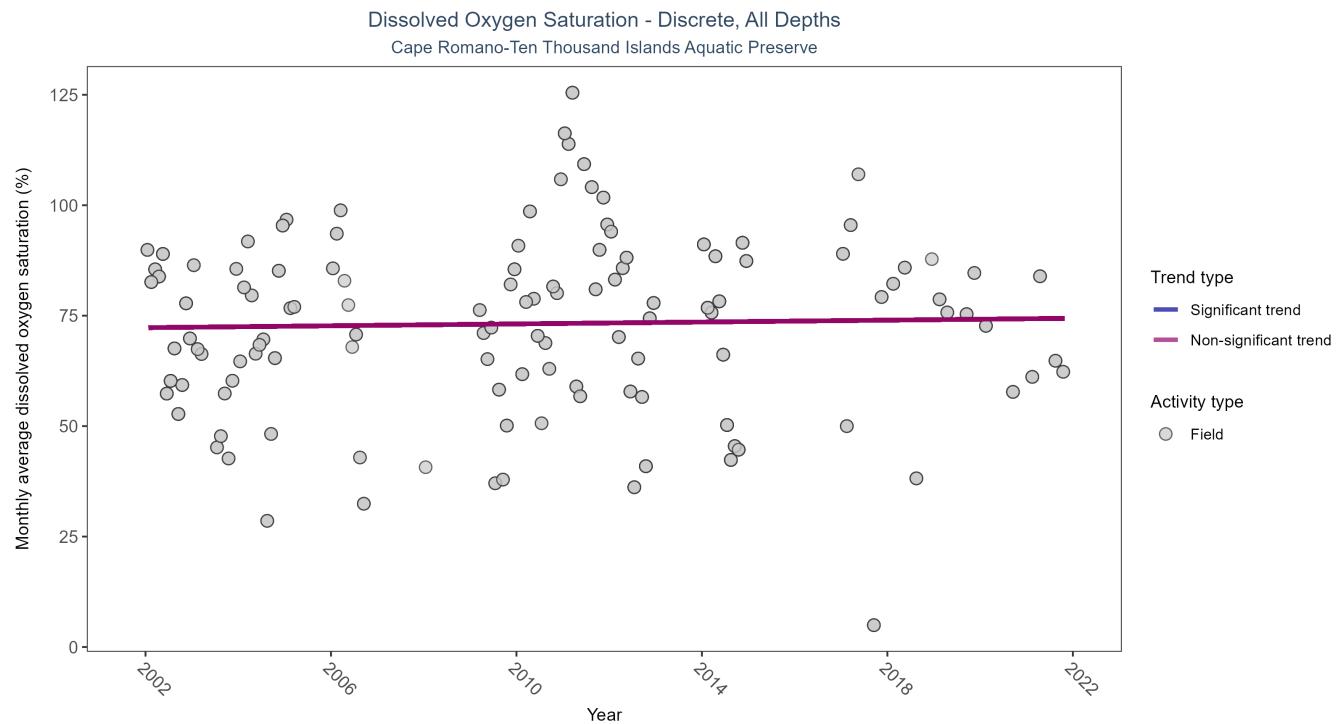


Figure 7: Scatter plot of monthly average dissolved oxygen saturation over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen saturation values measured in the field (circles)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

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

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Field	No significant trend	570	16	2002 - 2021	74.75	0.0495	72.2842	0.1062	0.597

Dissolved oxygen saturation showed no detectable trend between 2002 and 2021.

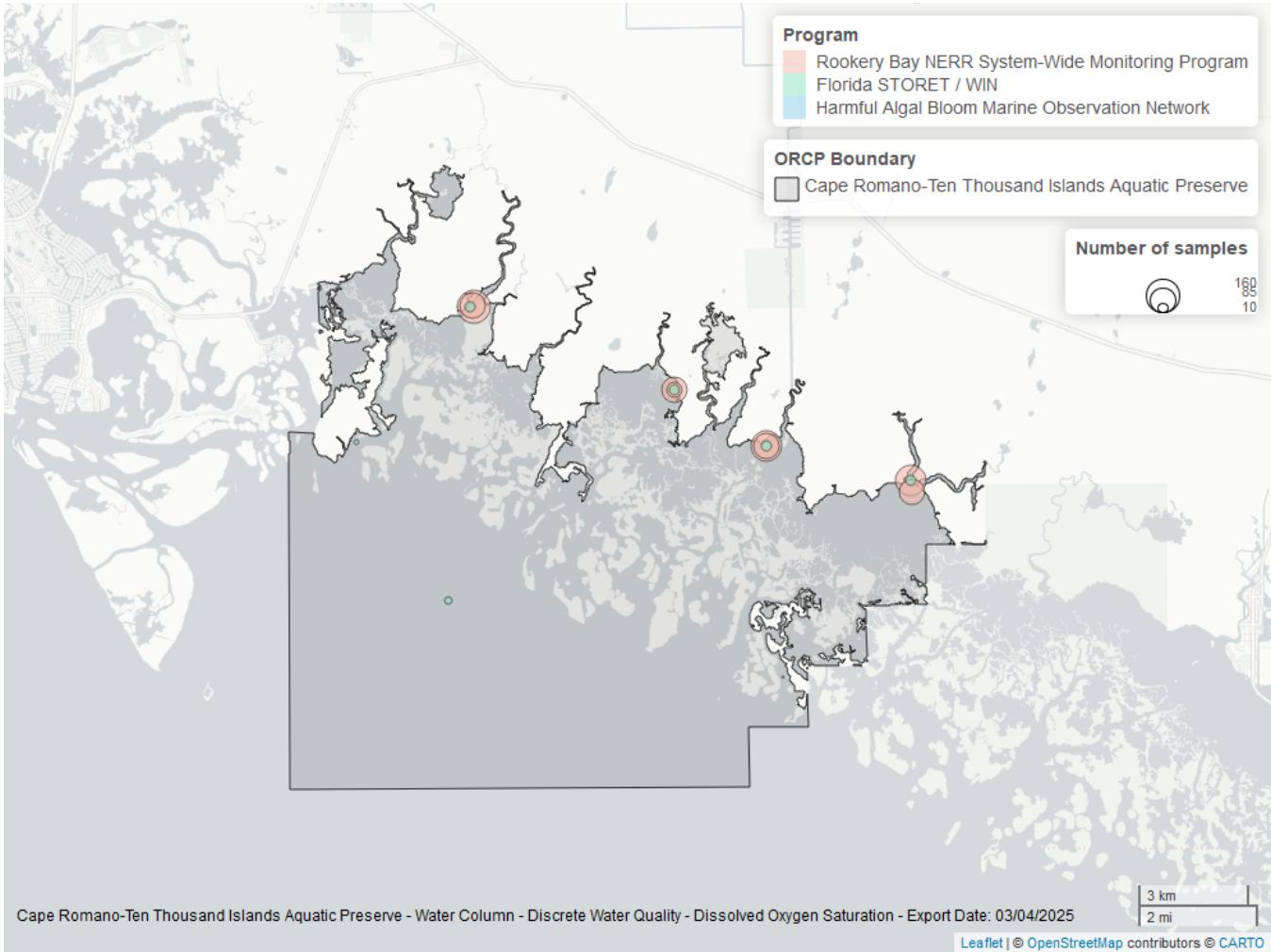


Figure 8: Map showing location of discrete water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 13: Programs contributing data for Dissolved Oxygen Saturation

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
354	869	2002	2024
5002	71	2017	2021
95	1	2008	2008

#### Program names:

95 - Harmful Algal Bloom Marine Observation Network<sup>7</sup>

354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>

5002 - Florida STORET / WIN<sup>2</sup>

#### pH - Discrete

#### Seasonal Kendall-Tau Trend Analysis

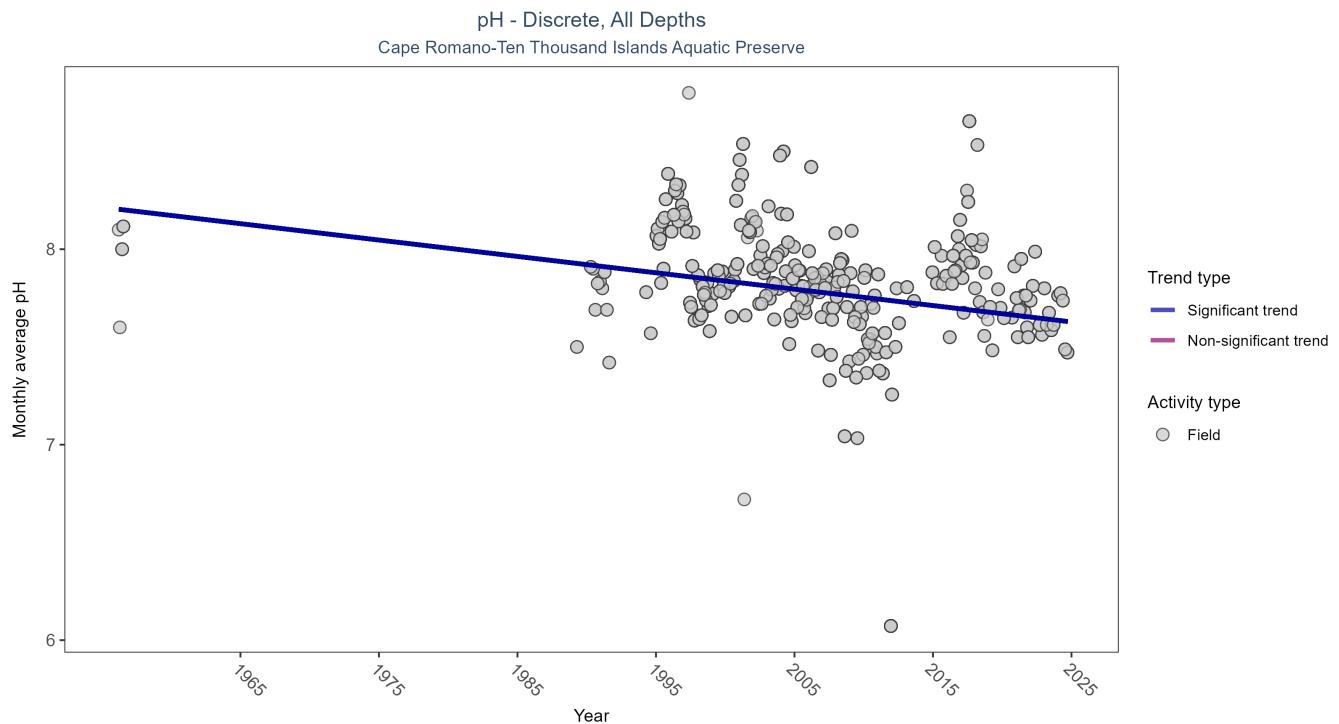


Figure 9: Scatter plot of monthly average pH over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only pH values measured in the field (circles) are included in the plot.

Table 14: Seasonal Kendall-Tau Trend Analysis for pH

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Field	Significantly decreasing trend	4612	35	1956 - 2024	7.865	-0.2348	8.2061	-0.0084	0

Monthly average pH decreased by 0.01 pH units per year.

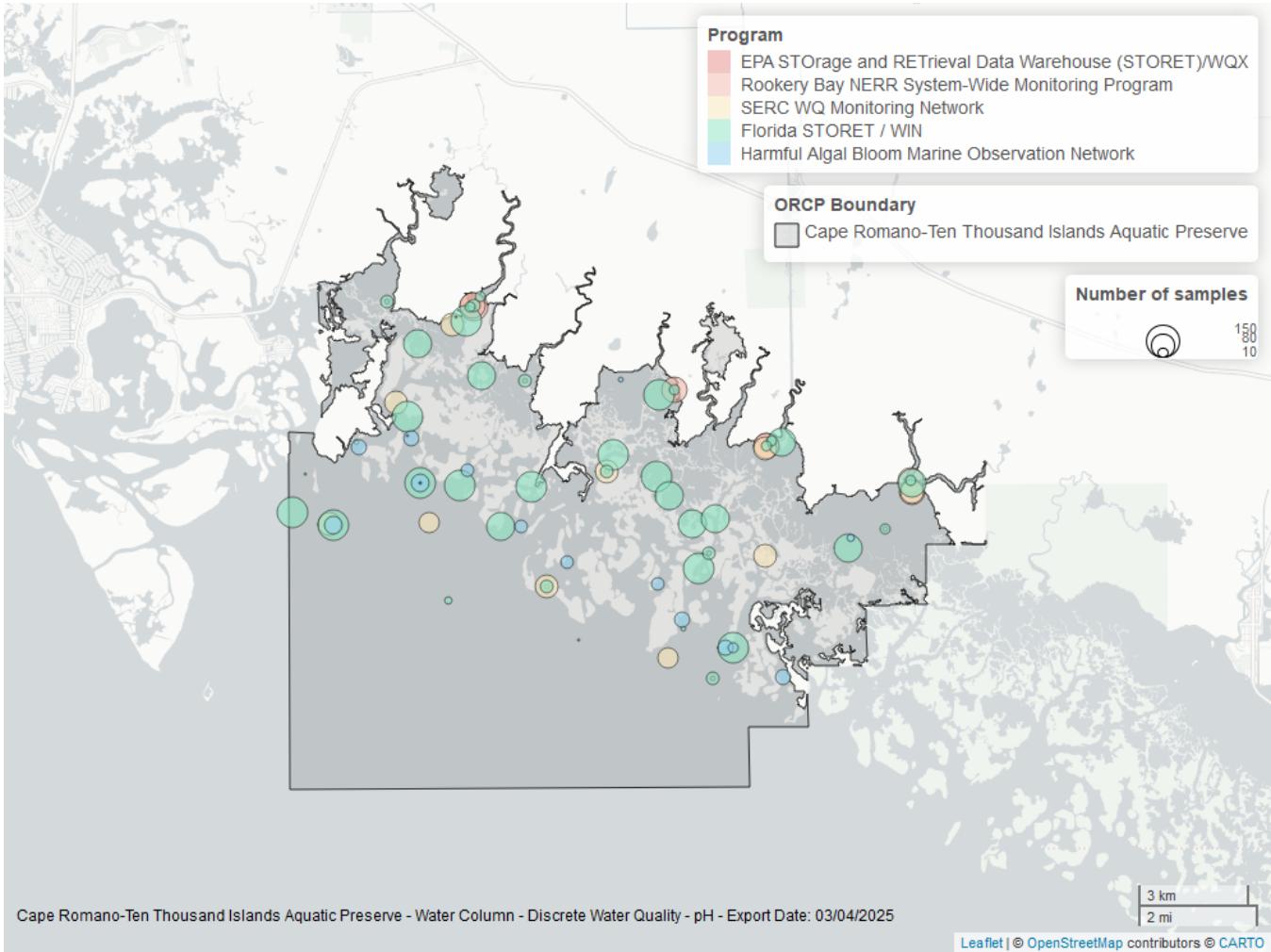


Figure 10: Map showing location of discrete water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 15: Programs contributing data for pH

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	3089	1989	2024
509	748	2001	2008
354	726	2002	2024
95	395	1956	2018
103	63	2021	2021

#### Program names:

95 - Harmful Algal Bloom Marine Observation Network<sup>7</sup>

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>3</sup>

354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>

509 - SERC Water Quality Monitoring Network<sup>5</sup>

5002 - Florida STORET / WIN<sup>2</sup>

## Salinity - Discrete

### Seasonal Kendall-Tau Trend Analysis

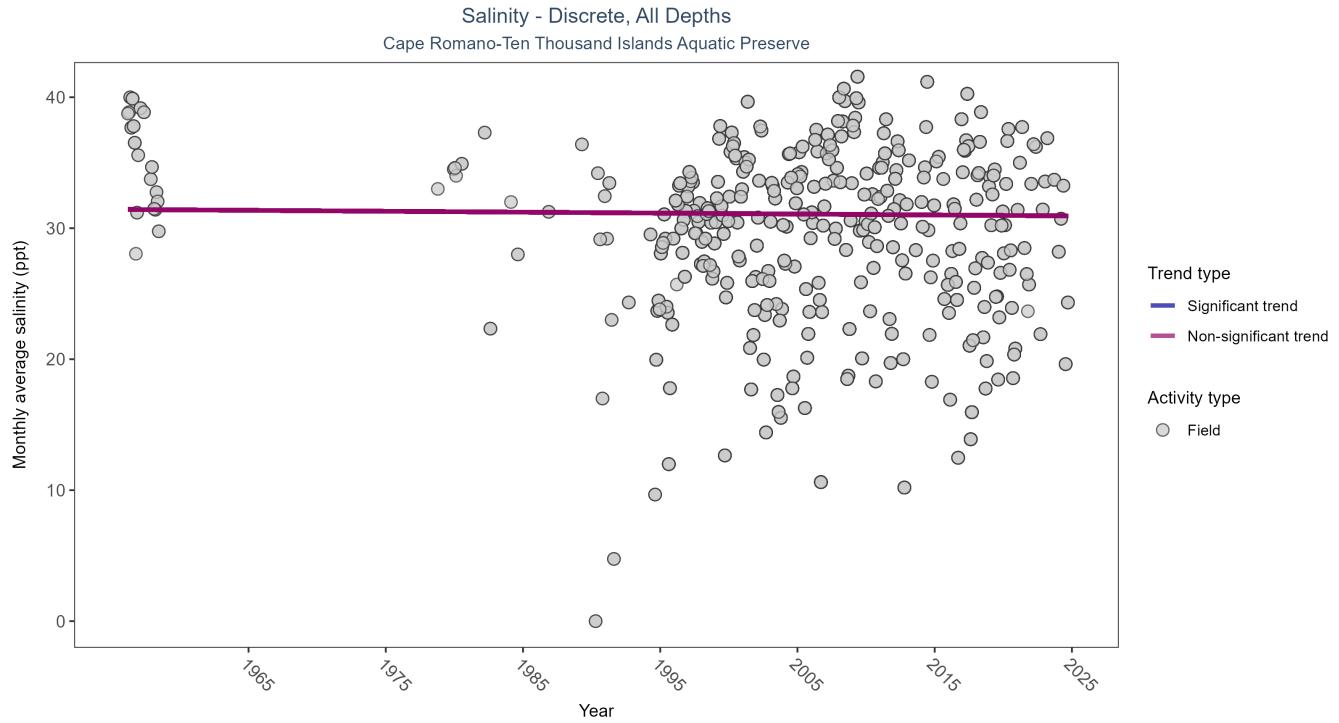


Figure 11: Scatter plot of monthly average salinity over time. If the time series included ten or more years of discrete observations, significant (blue) or non-significant (magenta) trend lines are also shown. Discrete salinity values derived from grab samples analyzed in the field (circles) or the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

Table 16: Seasonal Kendall-Tau Trend Analysis for Salinity

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
All	No significant trend	10985	44	1956 - 2024	31.9	-0.0129	31.4304	-0.0071	0.761

Salinity showed no detectable trend between 1956 and 2024.

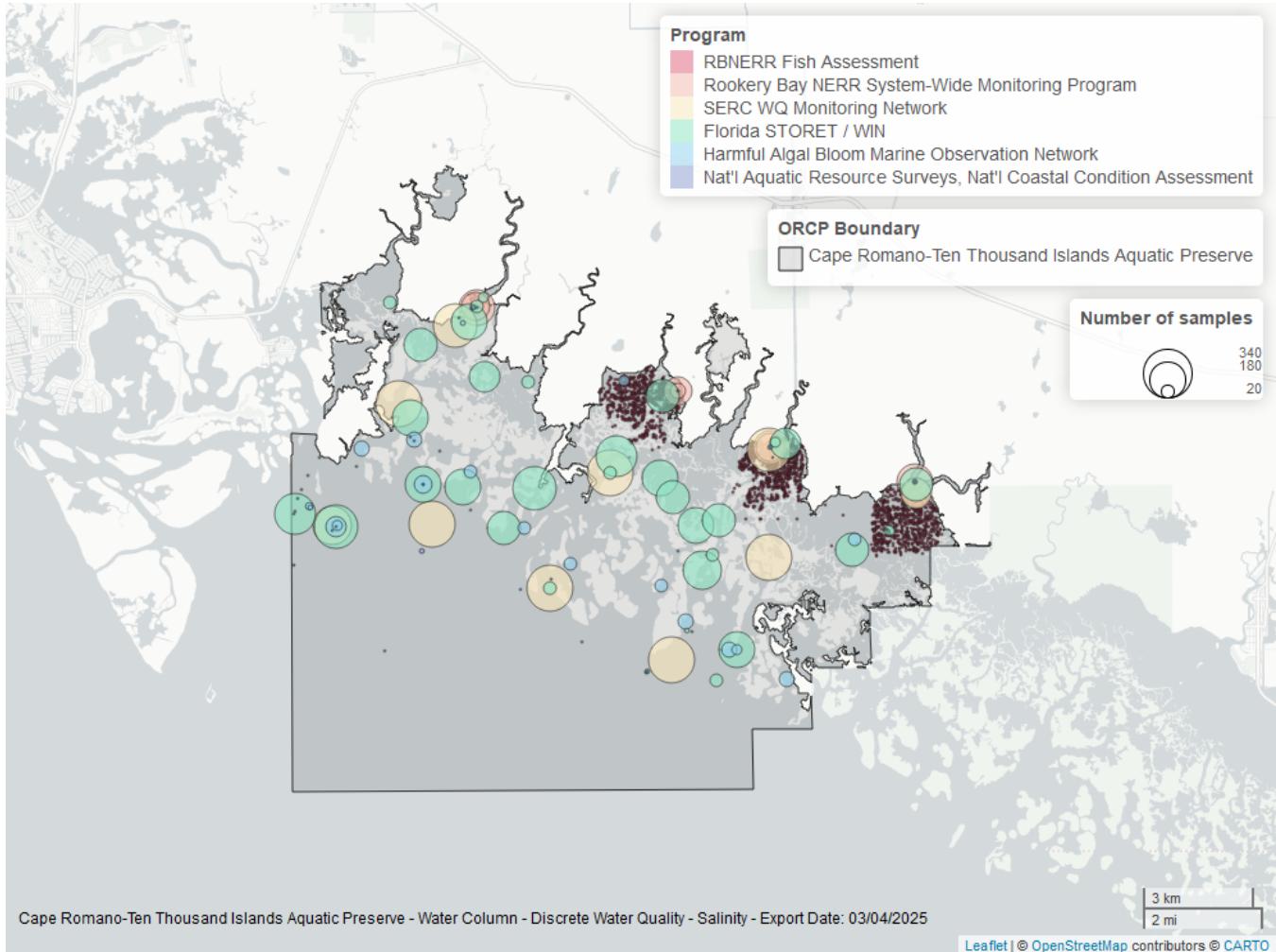


Figure 12: Map showing location of discrete water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 17: Programs contributing data for Salinity

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	4377	1989	2024
509	2948	1994	2008
4043	2540	1999	2020
354	1113	2002	2024
95	532	1956	2018
118	8	2015	2021

#### Program names:

95 - Harmful Algal Bloom Marine Observation Network<sup>7</sup>

118 - National Aquatic Resource Surveys, National Coastal Condition Assessment<sup>4</sup>

354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>

509 - SERC Water Quality Monitoring Network<sup>5</sup>

4043 - RBNERR Fish Assessment<sup>8</sup>

5002 - Florida STORET / WIN<sup>2</sup>

## Total Nitrogen - Discrete

### Total Nitrogen Calculation:

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

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

### Additional Information:

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

## Seasonal Kendall-Tau Trend Analysis

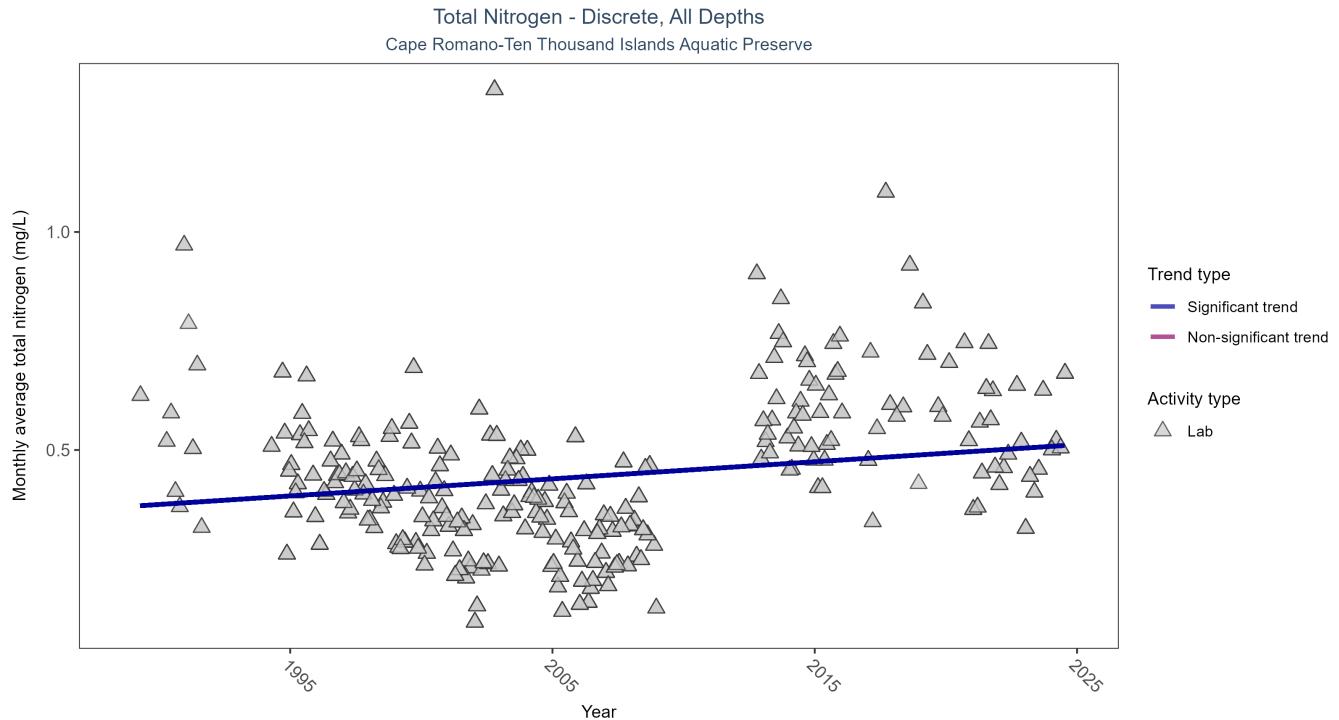


Figure 13: Scatter plot of monthly average total nitrogen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only nitrogen values obtained from laboratory analyses (triangles) are included in the 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 increasing trend	2468	31	1989 - 2024	0.3761	0.1385	0.3711	0.0039	0.0016

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

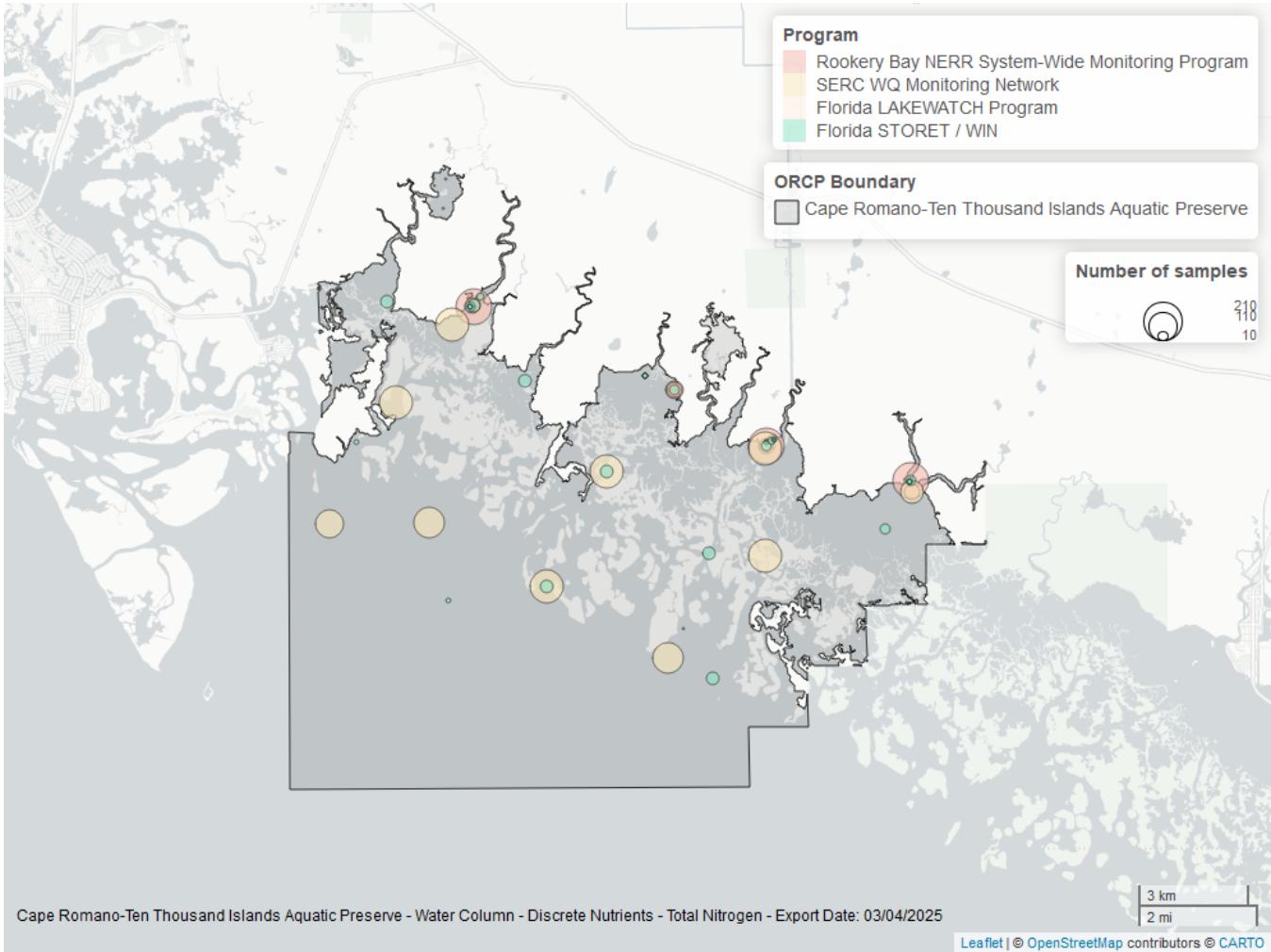


Figure 14: Map showing location of discrete water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 19: Programs contributing data for Total Nitrogen

ProgramID	N_Data	YearMin	YearMax
509	1512	1994	2008
354	812	2002	2018
5002	300	1989	2024
514	35	2001	2001

#### Program names:

354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>

509 - SERC Water Quality Monitoring Network<sup>5</sup>

514 - Florida LAKEWATCH Program<sup>6</sup>

5002 - Florida STORET / WIN<sup>2</sup>

#### Total Phosphorus - Discrete

#### Seasonal Kendall-Tau Trend Analysis

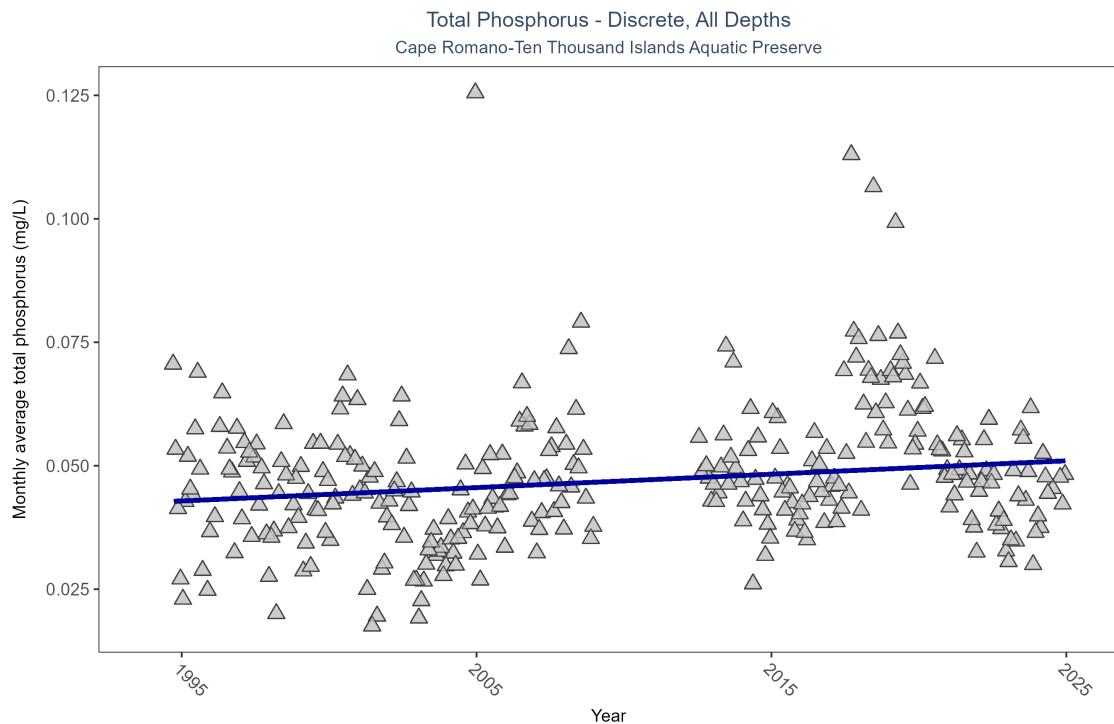


Figure 15: Scatter plot of monthly average total phosphorus over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only phosphorus values obtained from laboratory analyses (triangles) are included 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 increasing trend	2977	28	1994 - 2024	0.0431	0.1575	0.0426	0.0003	0.0001

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

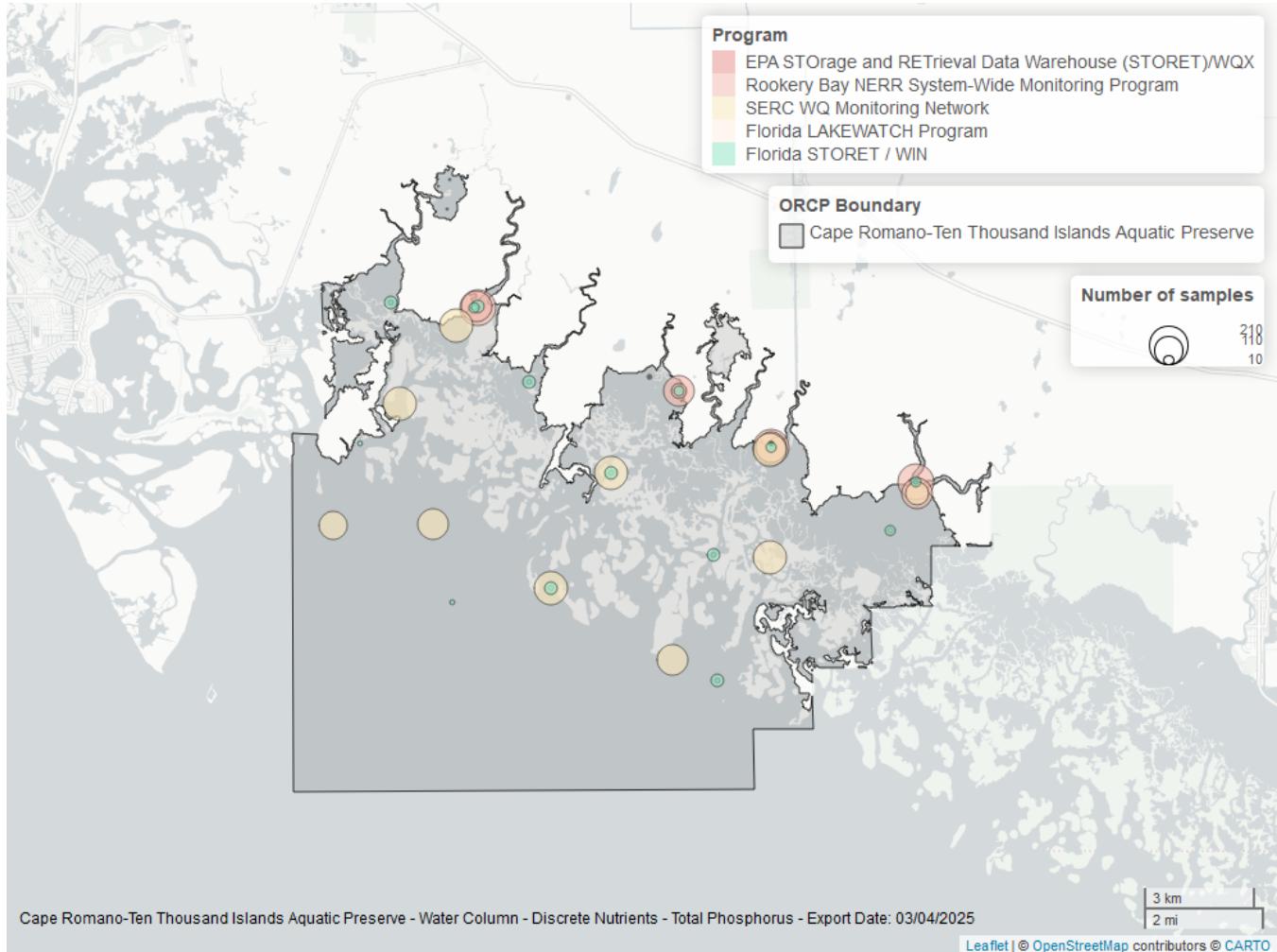


Figure 16: Map showing location of discrete water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 21: Programs contributing data for Total Phosphorus

ProgramID	N_Data	YearMin	YearMax
509	1499	1994	2008
354	1167	2002	2024
5002	246	2002	2024
103	64	2021	2021
514	31	2001	2001

#### Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>3</sup>

354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>

509 - SERC Water Quality Monitoring Network<sup>5</sup>

514 - Florida LAKEWATCH Program<sup>6</sup>

5002 - Florida STORET / WIN<sup>2</sup>

## Total Suspended Solids - Discrete

### Seasonal Kendall-Tau Trend Analysis

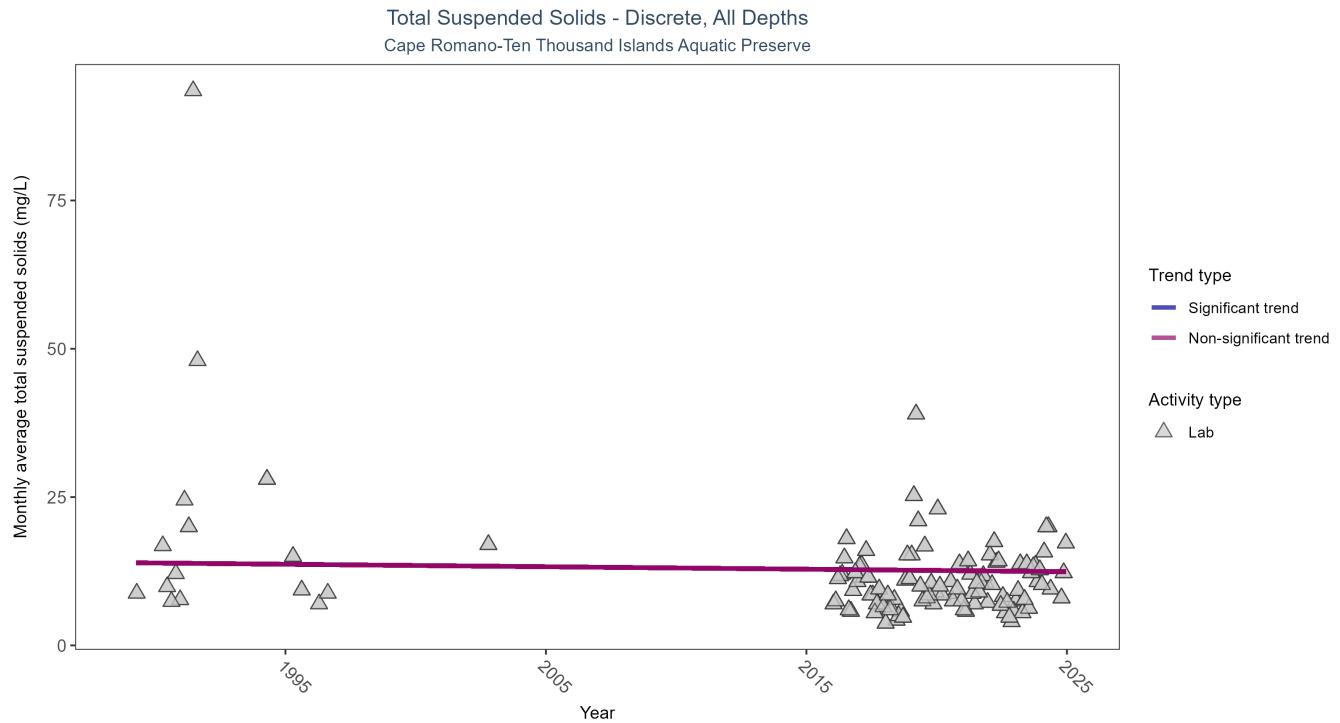


Figure 17: Scatter plot of monthly average total suspended solids (TSS) over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only TSS values obtained from laboratory analyses (triangles) are included 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	No significant trend	449	16	1989 - 2024	10	-0.0308	13.93	-0.0419	0.59

Total suspended solids showed no detectable trend between 1989 and 2024.

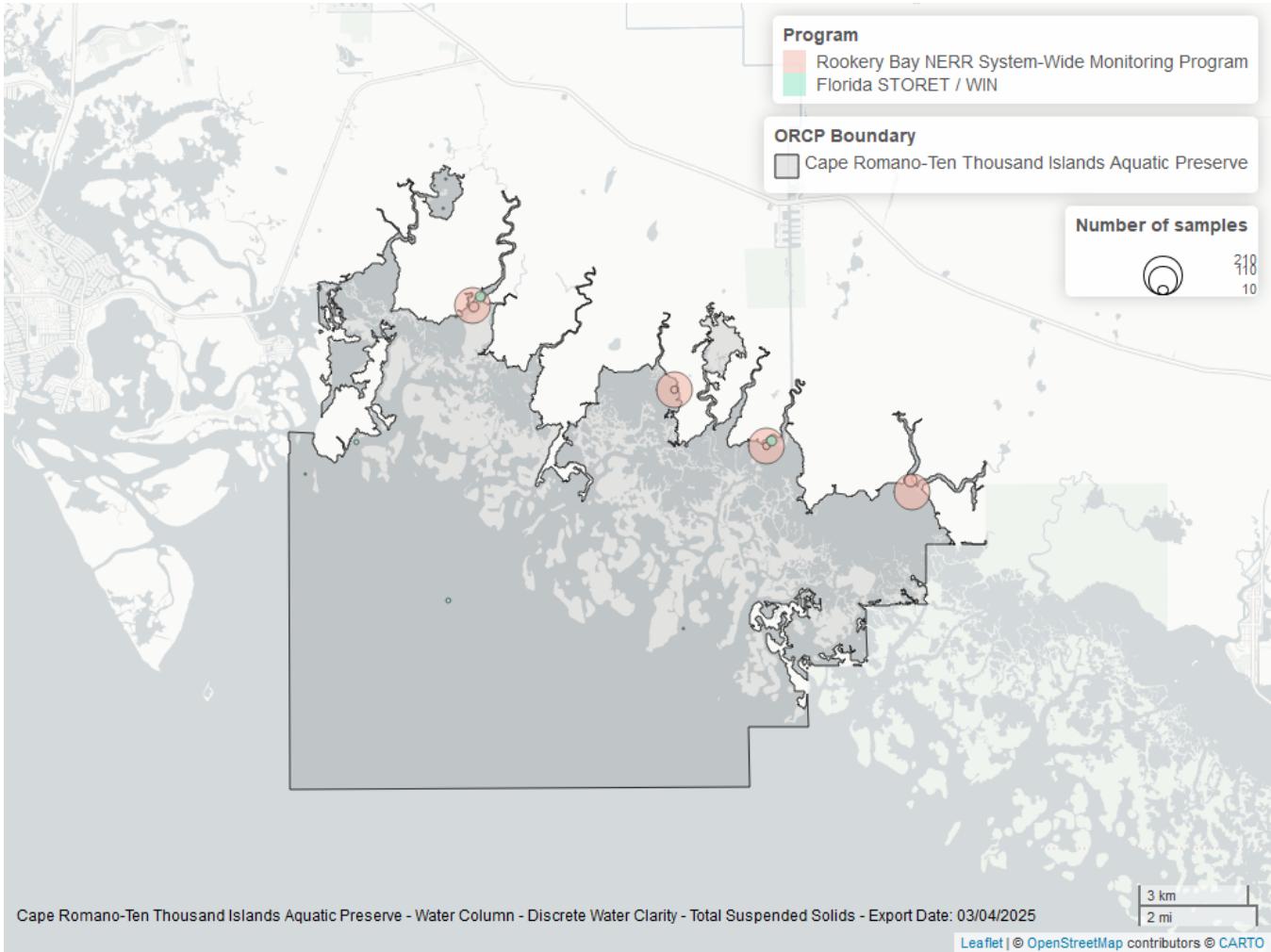


Figure 18: Map showing location of discrete water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 23: Programs contributing data for Total Suspended Solids

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
354	859	2016	2024
5002	46	1989	2017

#### Program names:

354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>  
 5002 - Florida STORET / WIN<sup>2</sup>

#### Turbidity - Discrete

#### Seasonal Kendall-Tau Trend Analysis

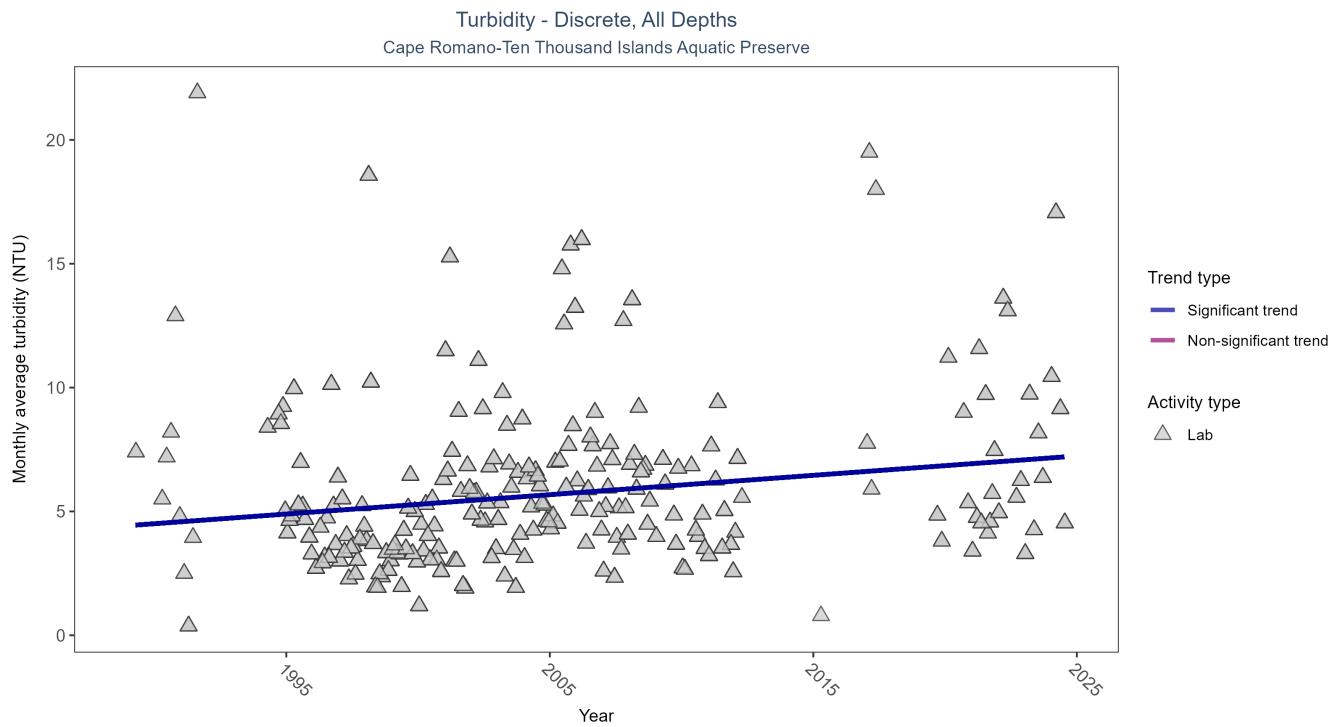


Figure 19: Scatter plot of monthly average turbidity over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only turbidity values measured in the laboratory (triangles) are included in the plot.

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	Significantly increasing trend	4652	30	1989 - 2024	4	0.1546	4.4264	0.0781	0.0007

Monthly average turbidity increased by 0.08 NTU per year, indicating a decrease in water clarity.

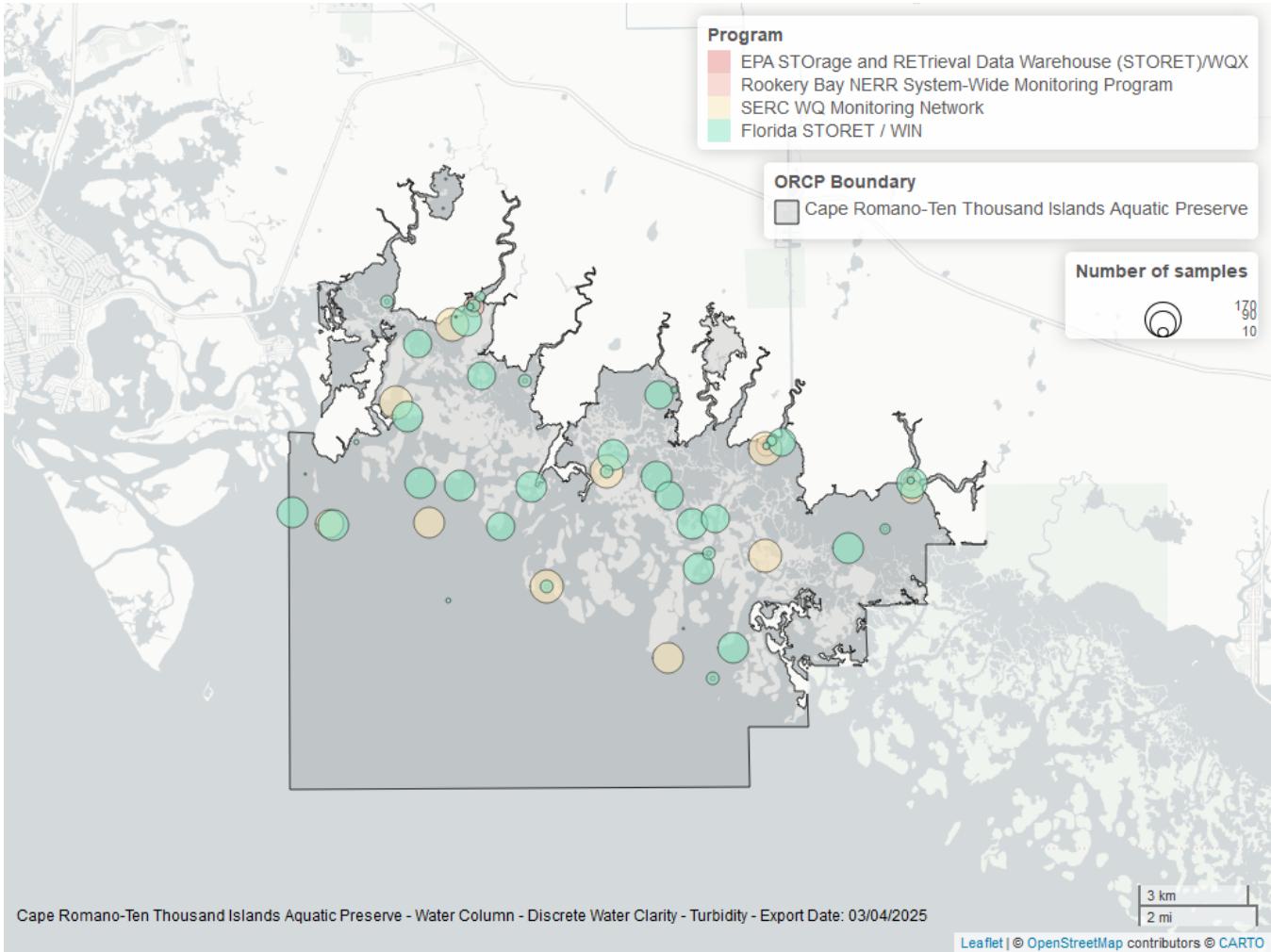


Figure 20: Map showing location of discrete water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 25: Programs contributing data for Turbidity

ProgramID	N_Data	YearMin	YearMax
5002	3149	1989	2024
509	1510	1994	2008
354	207	2002	2006
103	60	2021	2021

#### Program names:

- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>3</sup>
- 354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>
- 509 - SERC Water Quality Monitoring Network<sup>5</sup>
- 5002 - Florida STORET / WIN<sup>2</sup>

#### Water Temperature - Discrete

#### Seasonal Kendall-Tau Trend Analysis

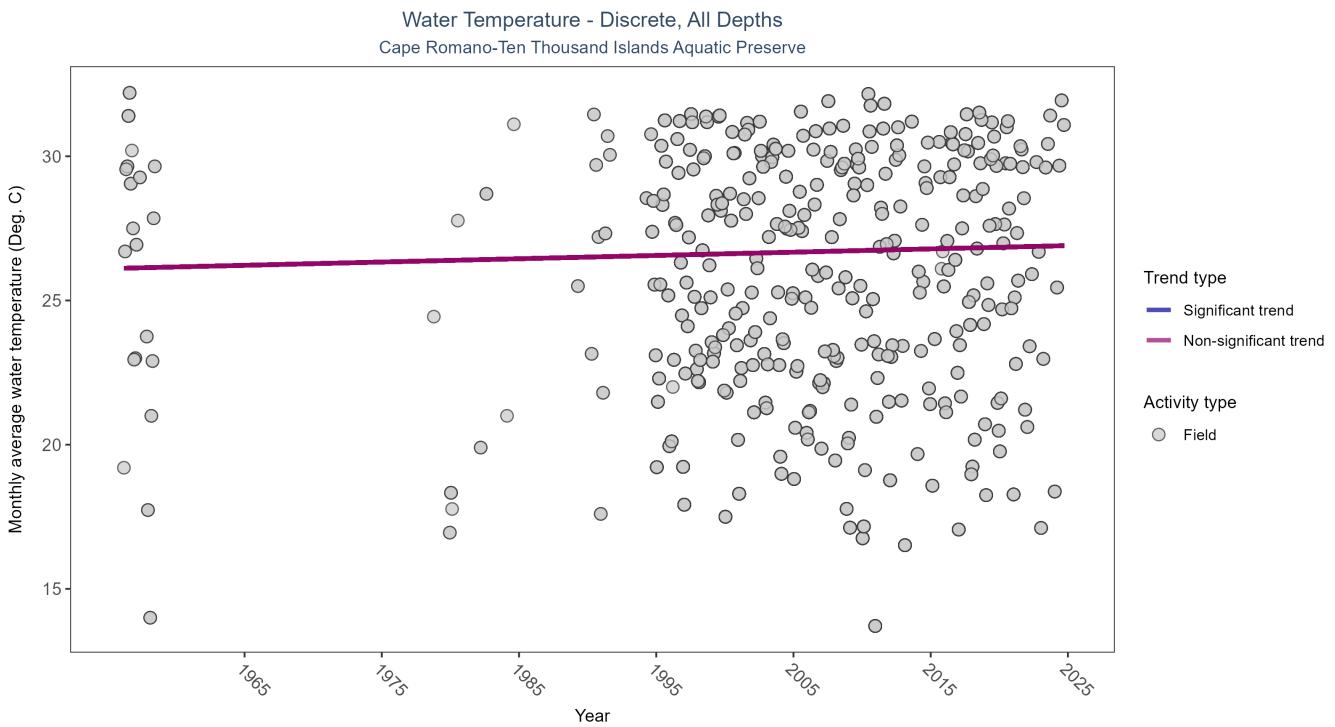


Figure 21: Scatter plot of monthly average water temperature over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only water temperature measurements taken in the field (circles) are included in 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	No significant trend	11203	42	1956 - 2024	26.7	0.0635	26.1169	0.0114	0.078

Water temperature showed no detectable trend between 1956 and 2024.

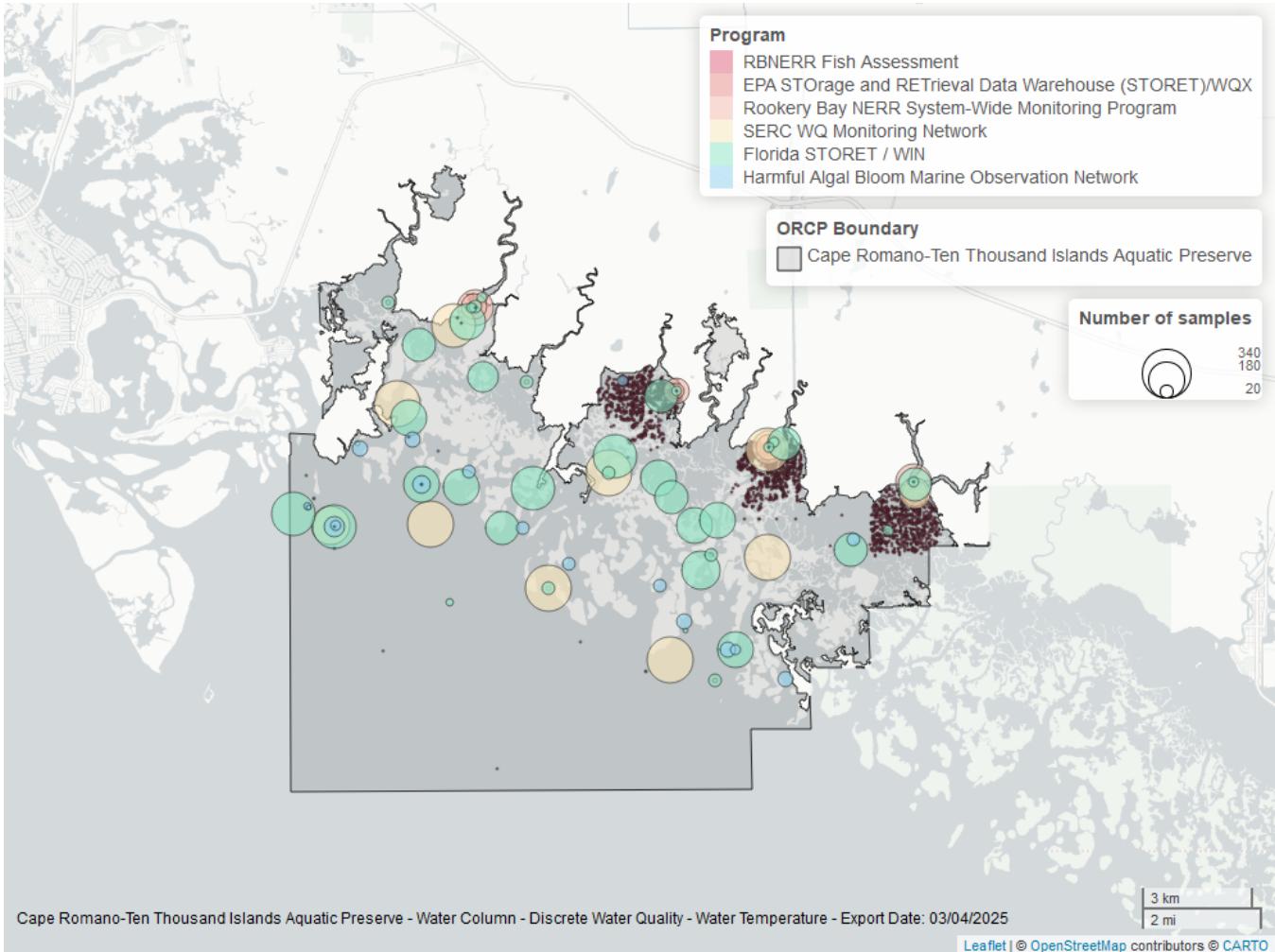


Figure 22: Map showing location of discrete water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 27: Programs contributing data for Water Temperature

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	4588	1989	2024
509	2944	1994	2008
4043	2534	1999	2020
354	1011	2002	2024
95	482	1956	2018
103	63	2021	2021

#### Program names:

95 - Harmful Algal Bloom Marine Observation Network<sup>7</sup>

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>3</sup>

354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>

509 - SERC Water Quality Monitoring Network<sup>5</sup>

4043 - RBNERR Fish Assessment<sup>8</sup>

5002 - Florida STORET / WIN<sup>2</sup>

## Water Quality - Continuous

The following files were used in the continuous analysis:

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

### Continuous monitoring locations in Cape Romano-Ten Thousand Islands Aquatic Preserve

Table 28: Station overview for Continuous parameters by Program

ProgramID	ProgramLocationID	Years of Data	Use in Analysis	Parameters
7	255123081321300	11	TRUE	Sal , TempW
7	255138081321701	9	TRUE	Sal , TempW
7	255432081303900	20	TRUE	Sal , TempW
7	255443081314700	5	FALSE	Sal , TempW
7	255532081314300	3	FALSE	Sal , TempW
7	255534081324000	19	TRUE	Sal , TempW
7	255654081350200	19	TRUE	Sal , TempW
7	255732081363700	5	TRUE	Sal , TempW
354	rkbfbwq	24	TRUE	DO , DOS , pH , Sal , Turb , TempW
354	rkbfwq	24	TRUE	DO , DOS , pH , Sal , Turb , TempW
354	rkbmbwq	25	TRUE	DO , DOS , pH , Sal , Turb , TempW
354	rkbpbwq	9	TRUE	DO , DOS , pH , Sal , Turb , TempW

#### Program names:

7 - National Water Information System<sup>9</sup>

354 - Rookery Bay National Estuarine Research Reserve System-Wide Monitoring Program<sup>1</sup>

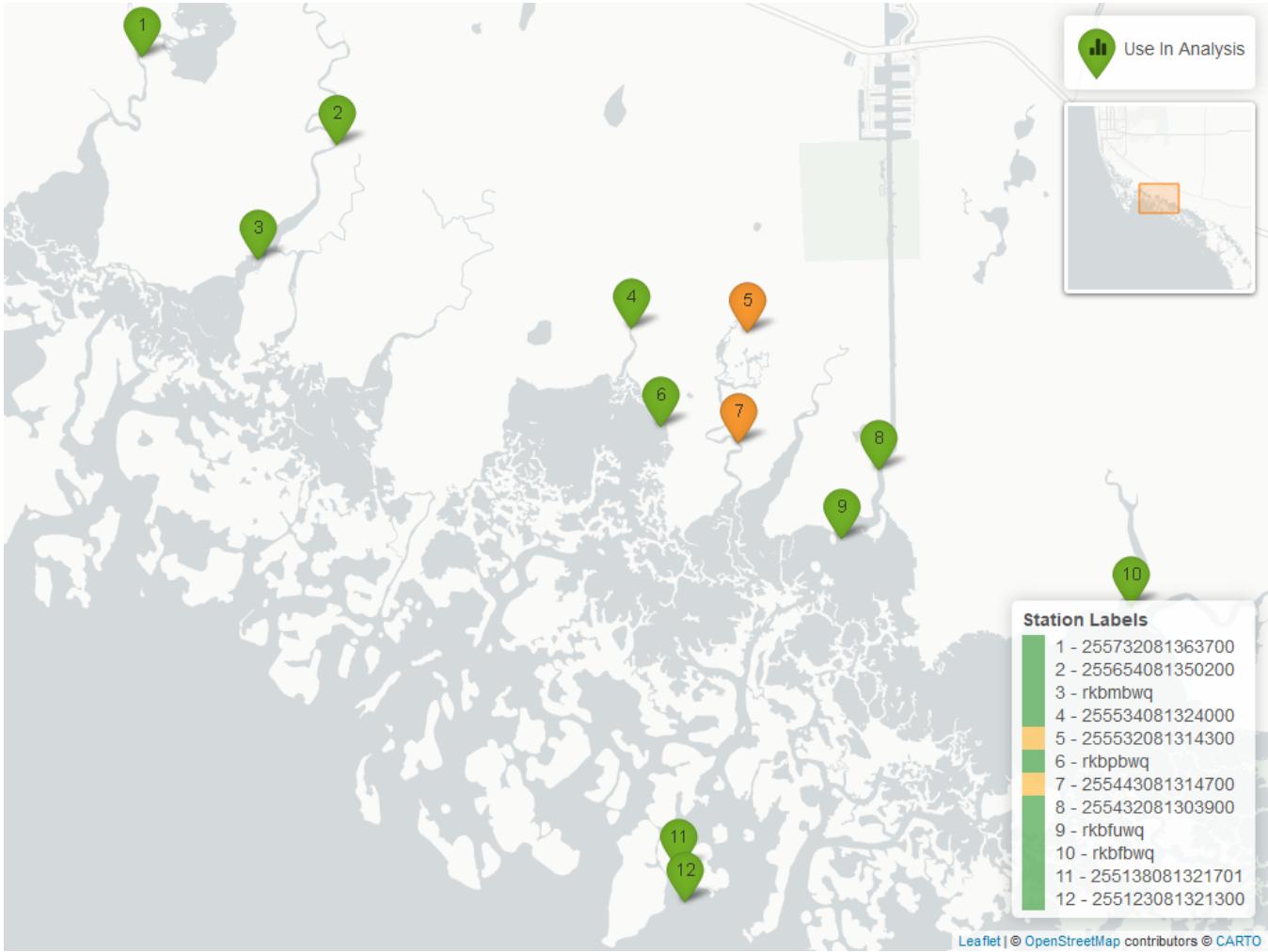


Figure 23: Map showing continuous water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. Sites marked as *Use In Analysis* (green) are featured in this report.

## Dissolved Oxygen - Continuous

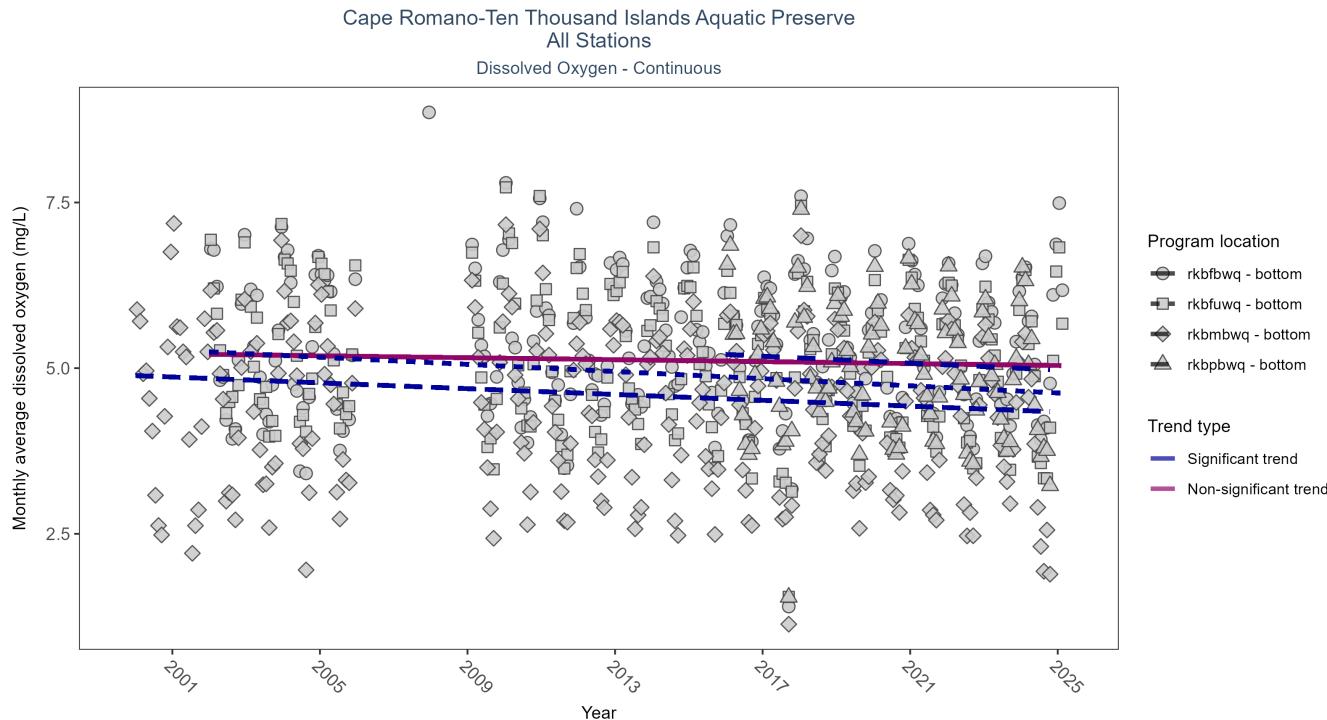


Figure 24: Scatter plot of monthly average dissolved oxygen over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

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
rkbfbwq	No significant trend	570320	22	2002 - 2025	5.4	-0.06	5.21	-0.01	0.19
rkbfuwq	Significantly decreasing trend	605519	21	2002 - 2025	5.1	-0.32	5.25	-0.03	0.00
rkbmbwq	Significantly decreasing trend	613238	22	2000 - 2024	4.4	-0.26	4.89	-0.02	0.00
rkpbwq	Significantly decreasing trend	289726	9	2016 - 2024	4.9	-0.18	5.21	-0.03	0.02

At three program locations, monthly average dissolved oxygen decreased between 0.02 and 0.03 mg/L per year. No detectable change in monthly average dissolved oxygen was observed at one location.

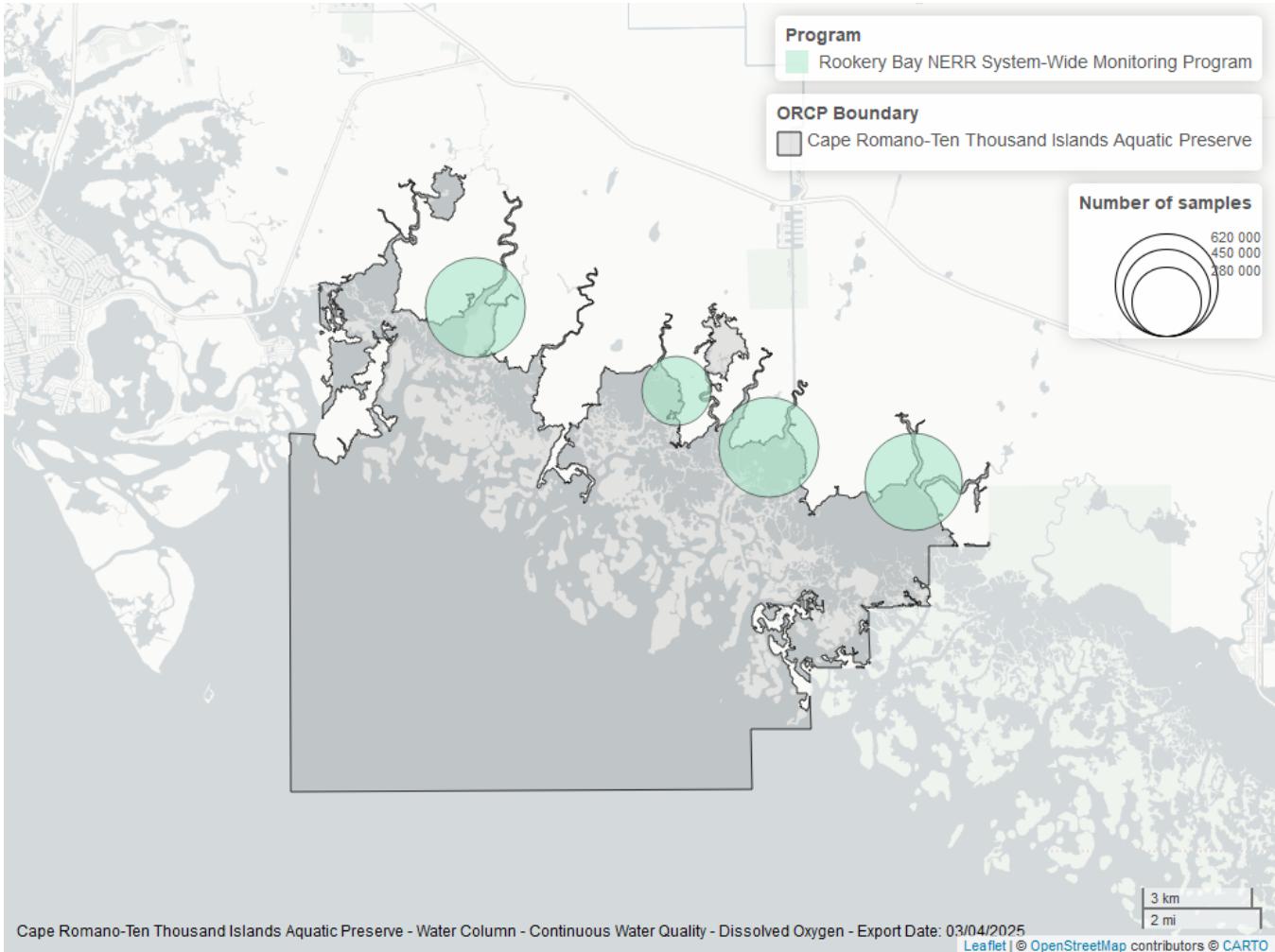


Figure 25: Map showing location of dissolved oxygen continuous water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Dissolved Oxygen Saturation - Continuous

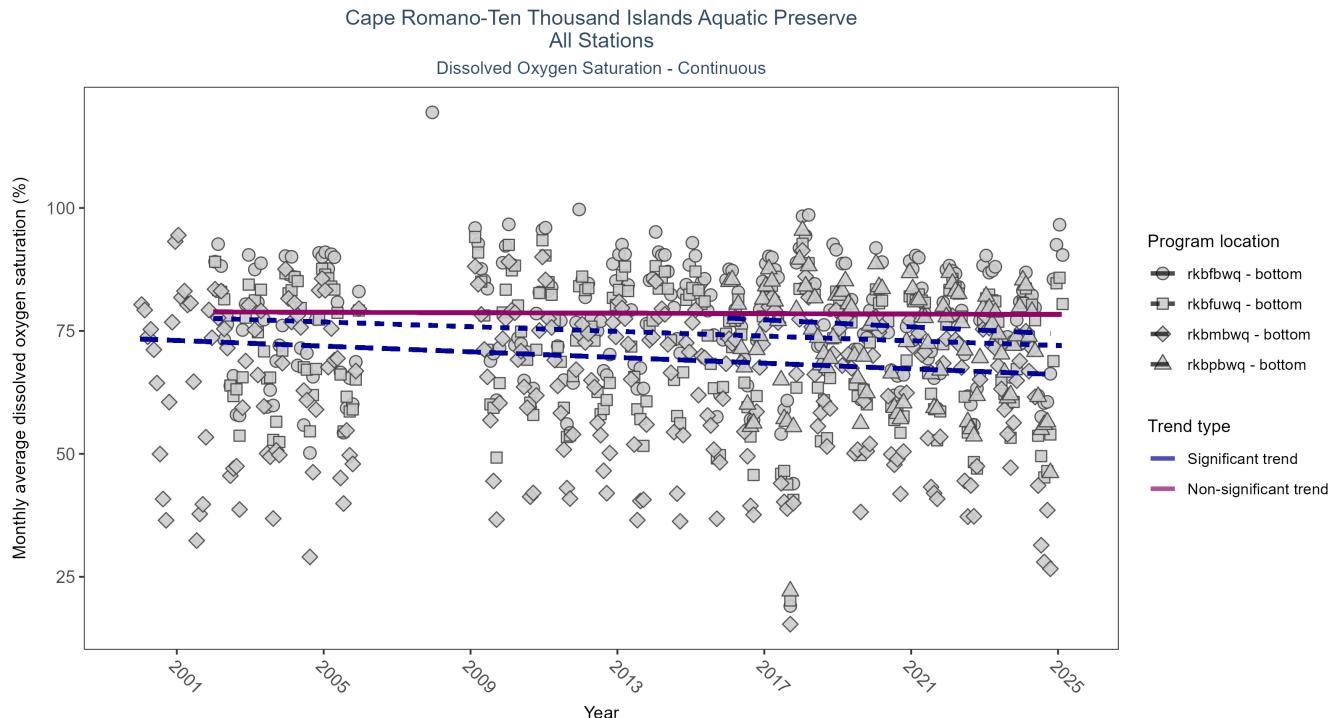


Figure 26: Scatter plot of monthly average dissolved oxygen saturation over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

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
rkbfbwq	No significant trend	574626	22	2002 - 2025	78.7	-0.01	78.85	-0.02	0.79
rkbfuwq	Significantly decreasing trend	605778	21	2002 - 2025	72.4	-0.25	77.54	-0.24	0.00
rkbmbwq	Significantly decreasing trend	619562	22	2000 - 2024	65.1	-0.23	73.35	-0.29	0.00
rkbpbwq	Significantly decreasing trend	291357	9	2016 - 2024	72.3	-0.18	77.60	-0.36	0.03

At three program locations, monthly average dissolved oxygen saturation decreased between 0.24 and 0.36% per year. No detectable change in monthly average dissolved oxygen saturation was observed at one location.

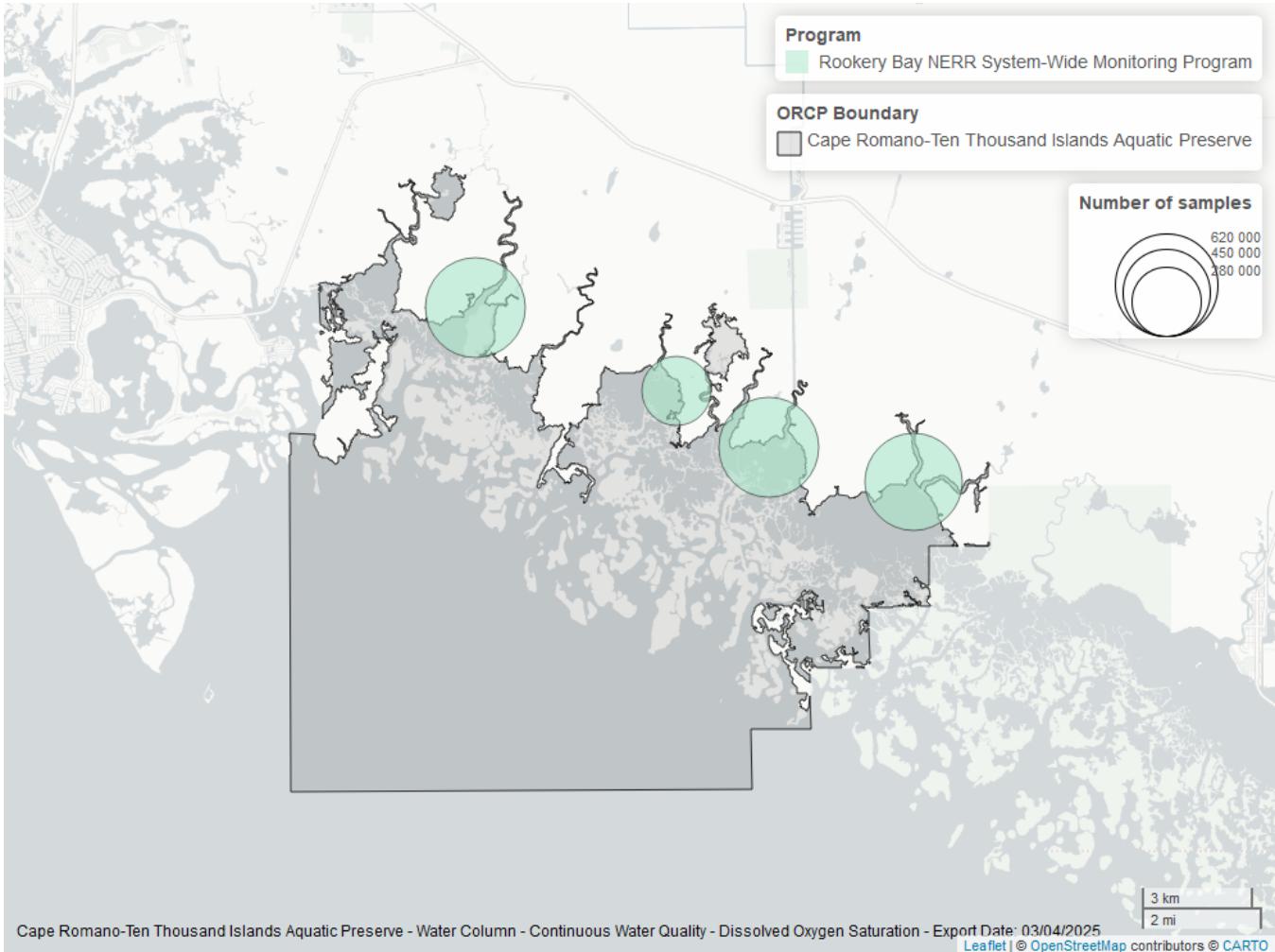


Figure 27: Map showing location of dissolved oxygen saturation continuous water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## pH - Continuous

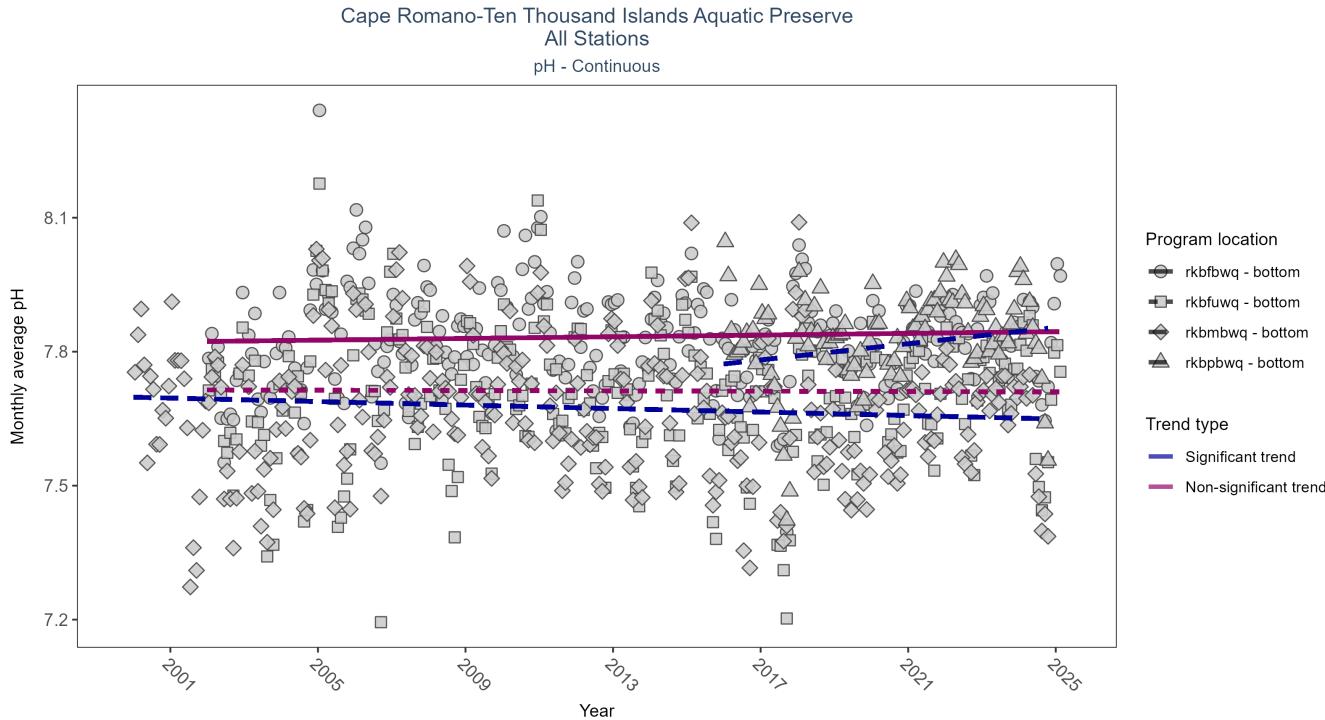


Figure 28: Scatter plot of monthly average pH over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

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
rkbfbwq	No significant trend	637095	24	2002 - 2025	7.8	0.05	7.82	0.00	0.23
rkbfuwq	No significant trend	660818	24	2002 - 2025	7.7	-0.01	7.71	0.00	0.79
rkbmbwq	Significantly decreasing trend	683502	25	2000 - 2024	7.7	-0.09	7.70	0.00	0.03
rkbpbwq	Significantly increasing trend	283219	9	2016 - 2024	7.8	0.20	7.77	0.01	0.02

At one program location, monthly average pH increased by 0.01 pH units per year. At one program location, monthly average pH decreased by less than 0.01 pH units per year. No detectable change in monthly average pH was observed at two locations.

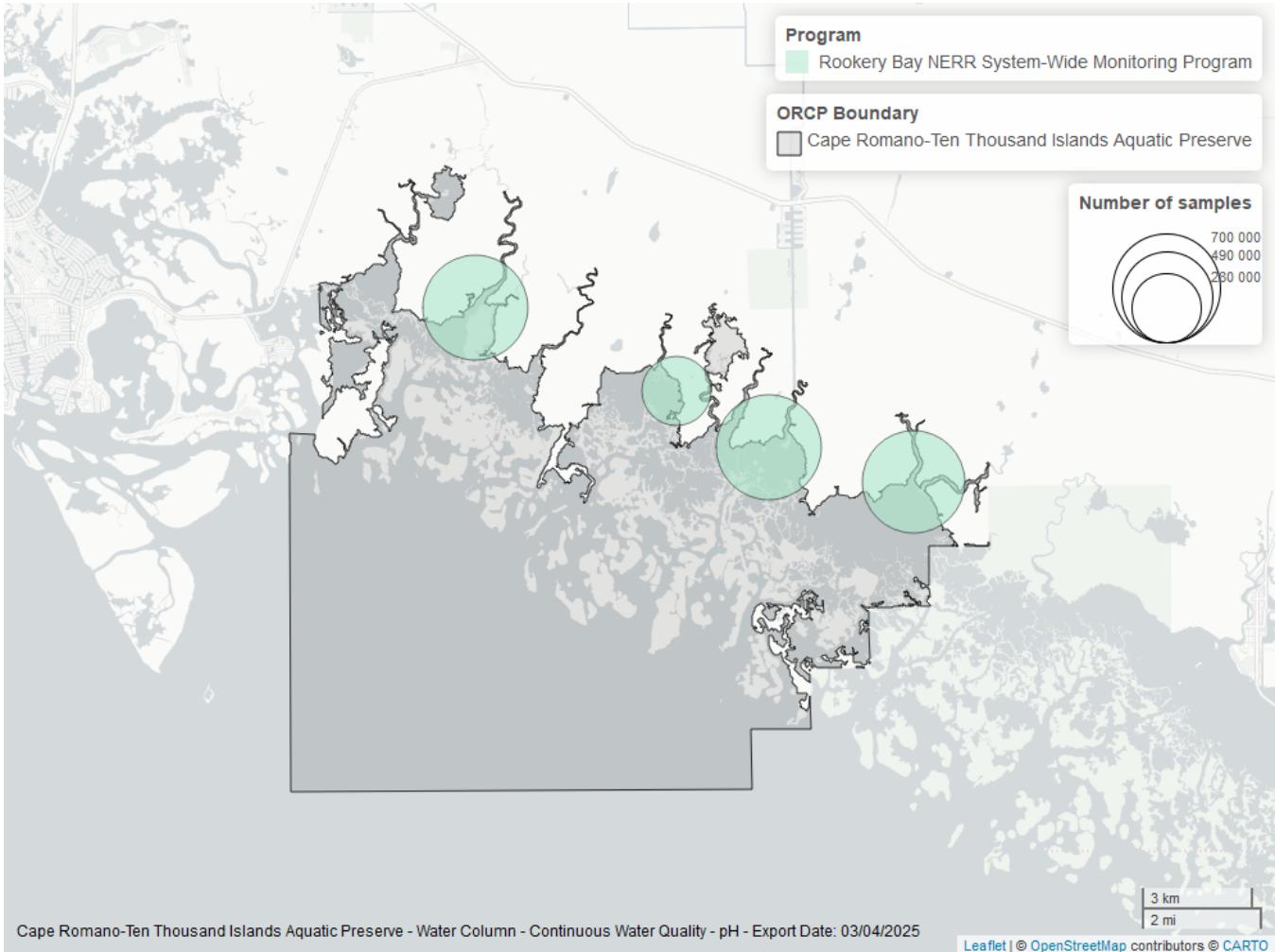


Figure 29: Map showing location of ph continuous water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Salinity - Continuous - Program 7

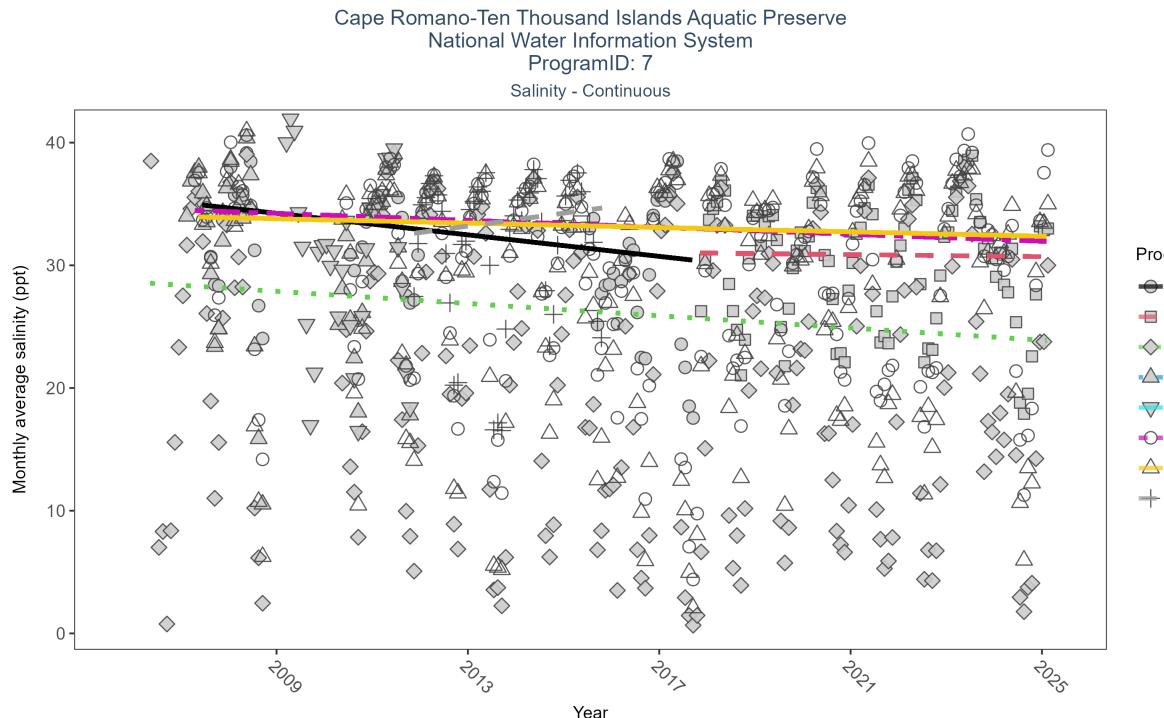


Figure 30: Scatter plot of monthly average salinity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 32: Seasonal Kendall-Tau Results for Salinity - Program 7

Station	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
255532081314300	Insufficient data to calculate trend	902	3	2009 - 2011	31	-	-	-	-
255534081324000	Significantly decreasing trend	5789	18	2007 - 2025	32	-0.12	34.52	-0.14	0.02
255654081350200	No significant trend	5802	18	2007 - 2025	32	-0.09	33.97	-0.09	0.08
255732081363700	No significant trend	1434	5	2011 - 2015	34	0.25	32.15	0.52	0.1
255443081314700	Insufficient data to calculate trend	1465	4	2007 - 2011	32	-	-	-	-
255432081303900	Significantly decreasing trend	6087	19	2006 - 2025	21	-0.2	28.63	-0.25	0
255138081321701	No significant trend	2608	9	2017 - 2025	31	-0.04	31.04	-0.04	0.69
255123081321300	Significantly decreasing trend	1809	8	2007 - 2017	32	-0.23	35.11	-0.44	0.02

At four program locations, monthly average salinity decreased between 0.08 and 0.44 ppt per year. No detectable change in monthly average salinity was observed at six locations. There was insufficient data to fit a model for two locations.

## Salinity - Continuous - Program 354

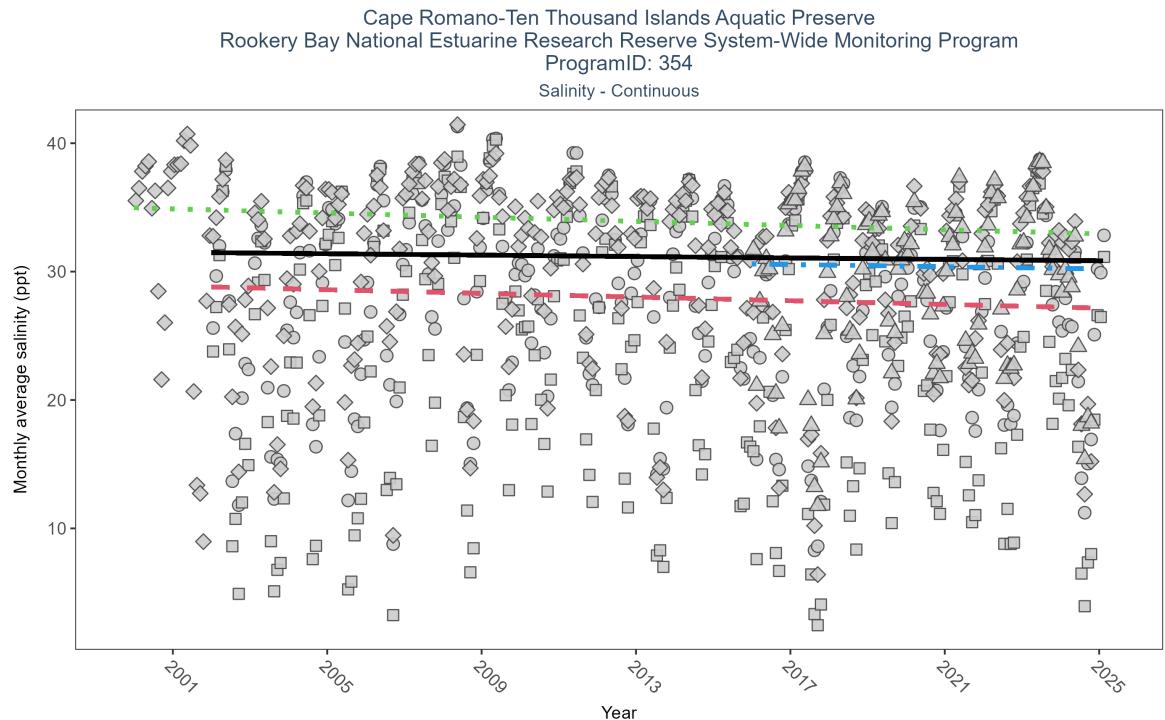


Figure 31: Scatter plot of monthly average salinity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 33: Seasonal Kendall-Tau Results for Salinity - Program 354

Station	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
rkbfbwq	No significant trend	669593	24	2002 - 2025	29.6	-0.03	31.48	-0.03	0.47
rkbfuwq	No significant trend	686073	24	2002 - 2025	26.0	-0.06	28.81	-0.07	0.15
rkmbbwq	Significantly decreasing trend	694825	25	2000 - 2024	33.3	-0.12	34.97	-0.08	0.00
rkbpbwq	No significant trend	290041	9	2016 - 2024	30.2	-0.01	30.60	-0.04	0.92

At four program locations, monthly average salinity decreased between 0.08 and 0.44 ppt per year. No detectable change in monthly average salinity was observed at six locations. There was insufficient data to fit a model for two locations.

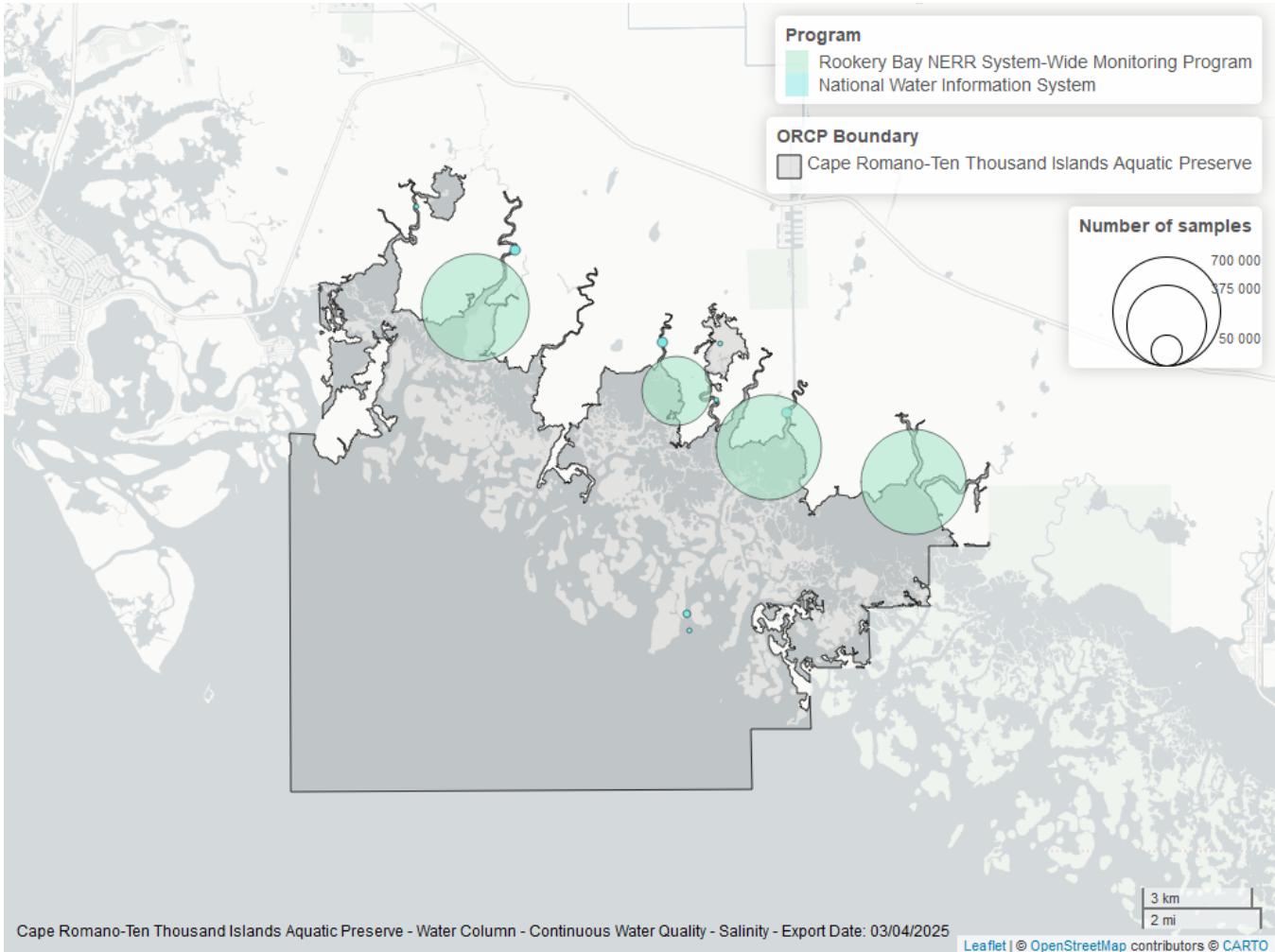


Figure 32: Map showing location of salinity continuous water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Turbidity - Continuous

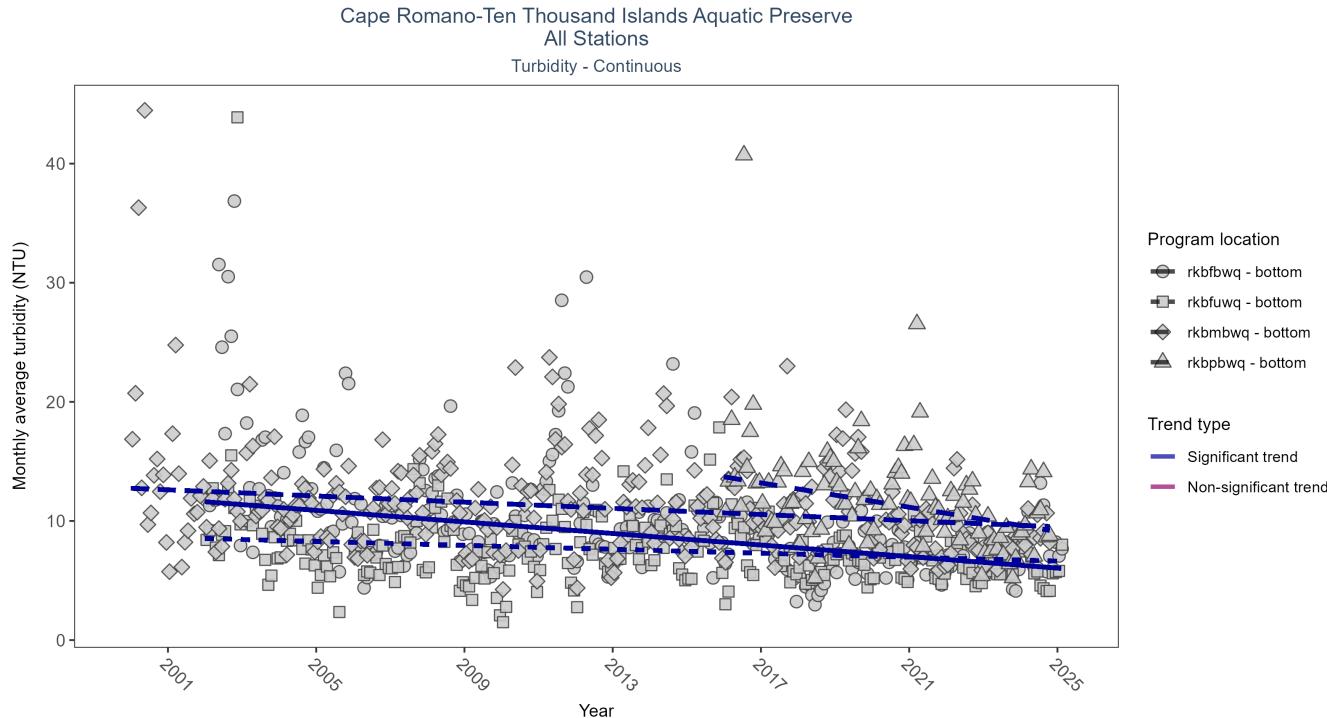


Figure 33: Scatter plot of monthly average turbidity over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 34: 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
rkbfbwq	Significantly decreasing trend	649336	24	2002 - 2025	7	-0.39	11.61	-0.24	0
rkbfuwq	Significantly decreasing trend	626788	24	2002 - 2025	6	-0.20	8.53	-0.08	0
rkbmbwq	Significantly decreasing trend	670439	25	2000 - 2024	9	-0.22	12.74	-0.13	0
rkbpbwq	Significantly decreasing trend	286433	9	2016 - 2024	10	-0.37	13.71	-0.51	0

At four program locations, monthly average turbidity decreased between 0.08 and 0.51 NTU per year.

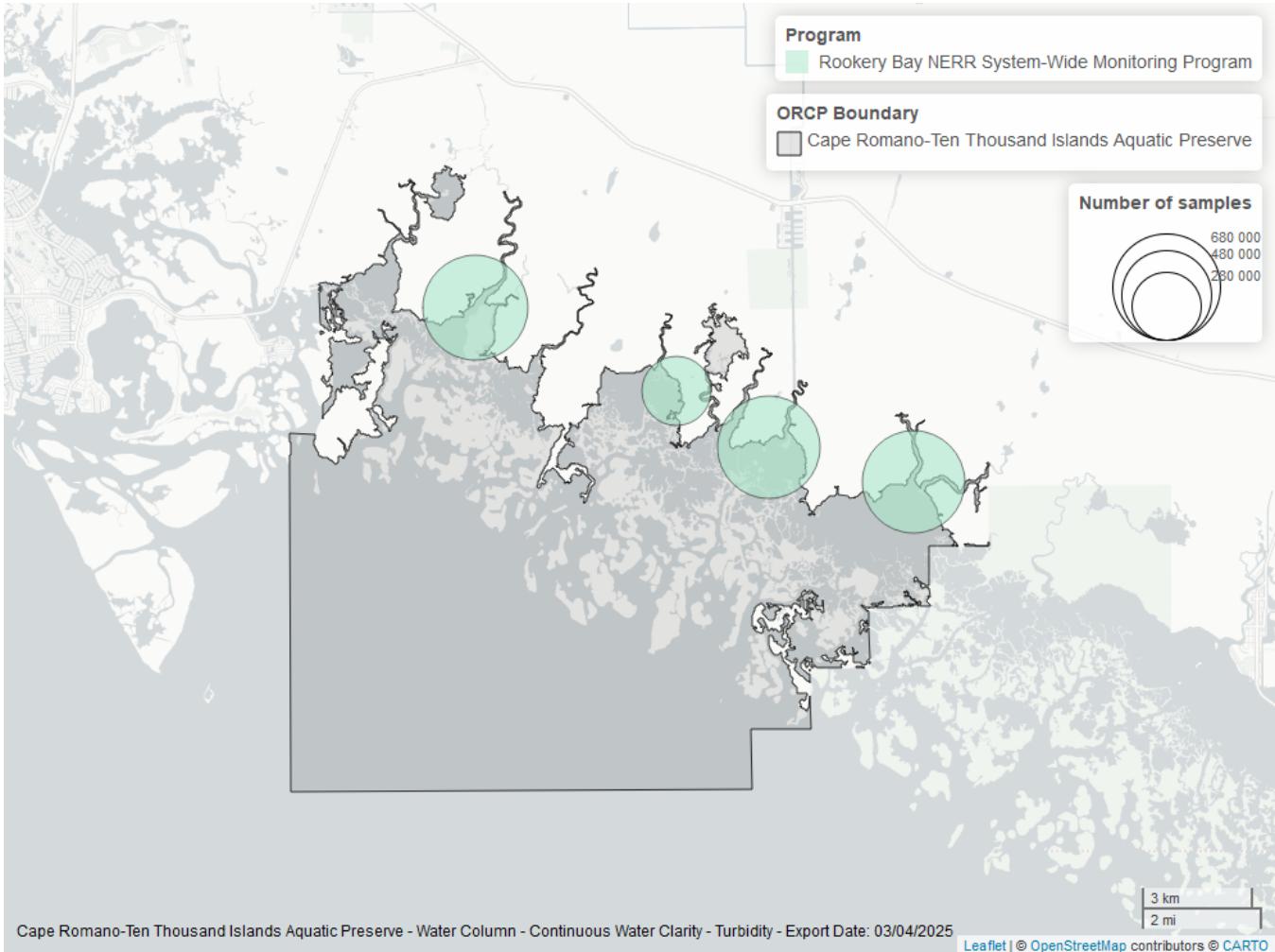


Figure 34: Map showing location of turbidity continuous water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Water Temperature - Continuous - Program 7

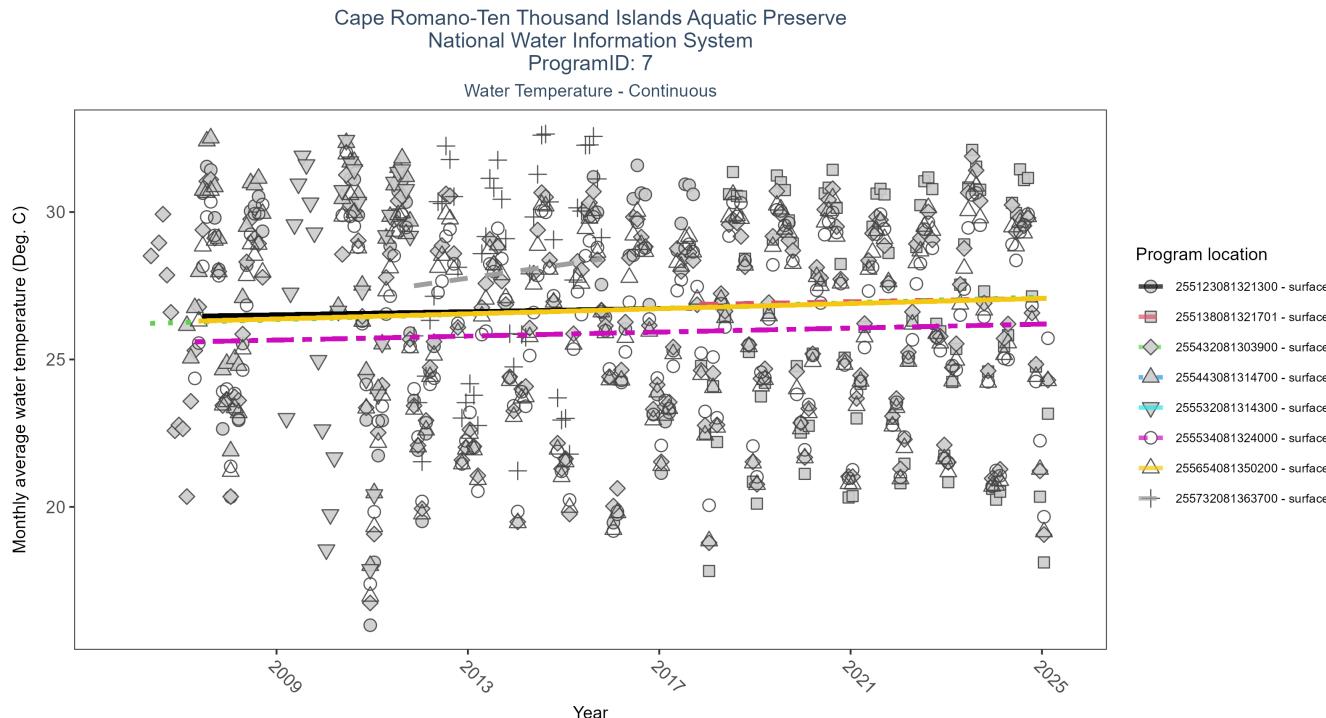


Figure 35: Scatter plot of monthly average water temperature over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 35: Seasonal Kendall-Tau Results for Water Temperature - Program 7

Station	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
255443081314700	Insufficient data to calculate trend	2011	4	2007 - 2011	29.30	-	-	-	-
255532081314300	Insufficient data to calculate trend	906	3	2009 - 2011	29.30	-	-	-	-
255534081324000	Significantly increasing trend	5845	18	2007 - 2025	26.60	0.14	25.59	0.03	0.01
255732081363700	No significant trend	1435	5	2011 - 2015	28.40	0.24	27.3	0.23	0.11
255654081350200	Significantly increasing trend	5840	18	2007 - 2025	26.75	0.14	26.29	0.04	0.01
255123081321300	No significant trend	1818	8	2007 - 2017	27.30	0.1	26.46	0.03	0.38
255432081303900	Significantly increasing trend	6146	19	2006 - 2025	27.00	0.16	26.21	0.05	0
255138081321701	No significant trend	2626	9	2017 - 2025	27.00	0.07	26.85	0.03	0.55

At six program locations, monthly average water temperature increased between 0.03 and 0.07°C per year. No detectable change in monthly average water temperature was observed at four locations. There was insufficient data to fit a model for two locations.

## Water Temperature - Continuous - Program 354

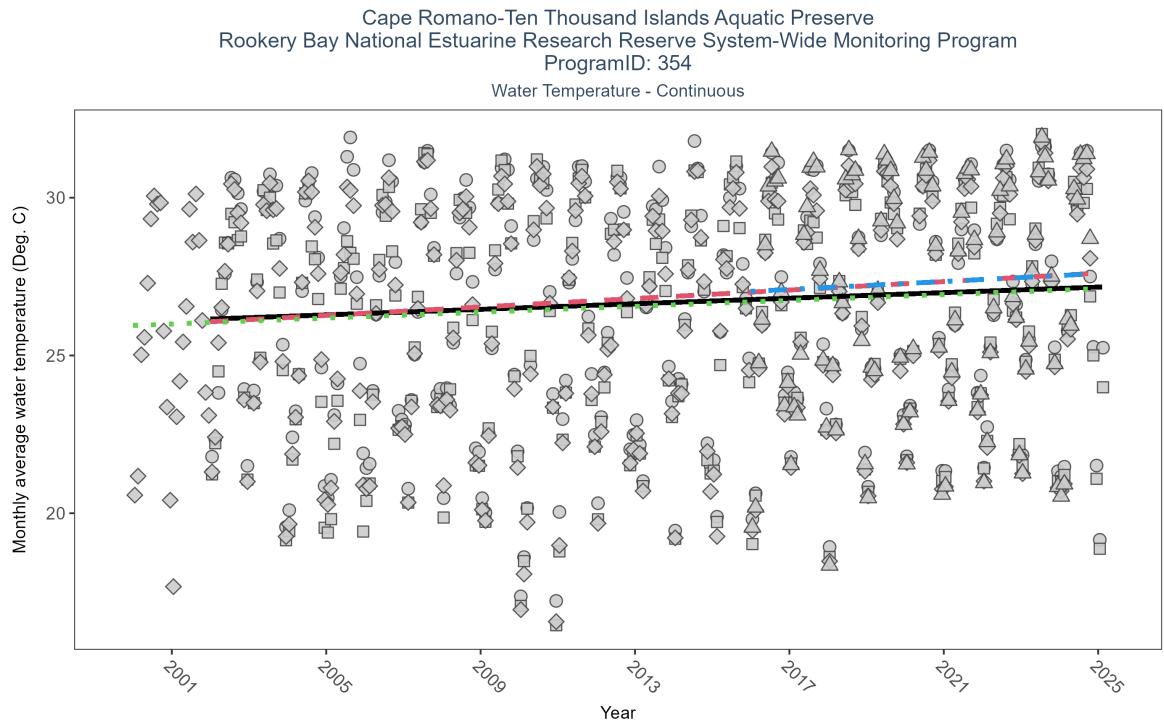


Figure 36: Scatter plot of monthly average water temperature over time at continuously monitored program locations. Each location is analyzed separately, with significant (blue) or non-significant (magenta) trend lines shown for time series that included five or more years of observations.

Table 36: Seasonal Kendall-Tau Results for Water Temperature - Program 354

Station	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
rkbfbwq	Significantly increasing trend	685432	24	2002 - 2025	27.0	0.23	26.15	0.04	0.00
rkbfuwq	Significantly increasing trend	696504	24	2002 - 2025	26.9	0.26	26.07	0.07	0.00
rkmbbwq	Significantly increasing trend	718152	25	2000 - 2024	26.9	0.26	25.95	0.05	0.00
rkbpbwq	No significant trend	292925	9	2016 - 2024	27.6	0.14	27.03	0.06	0.07

At six program locations, monthly average water temperature increased between 0.03 and 0.07°C per year. No detectable change in monthly average water temperature was observed at four locations. There was insufficient data to fit a model for two locations.

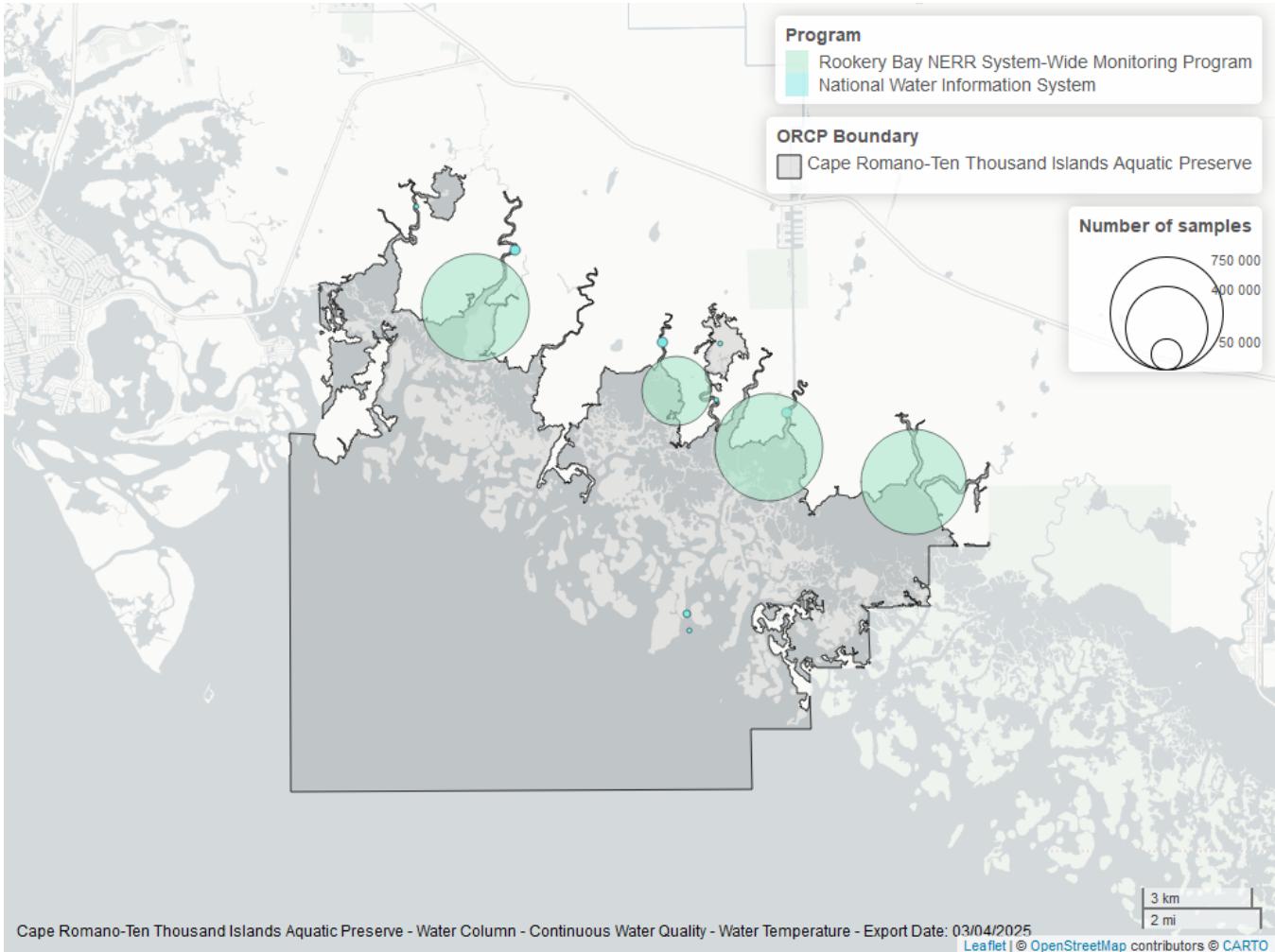


Figure 37: Map showing location of water temperature continuous water quality sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Nekton

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

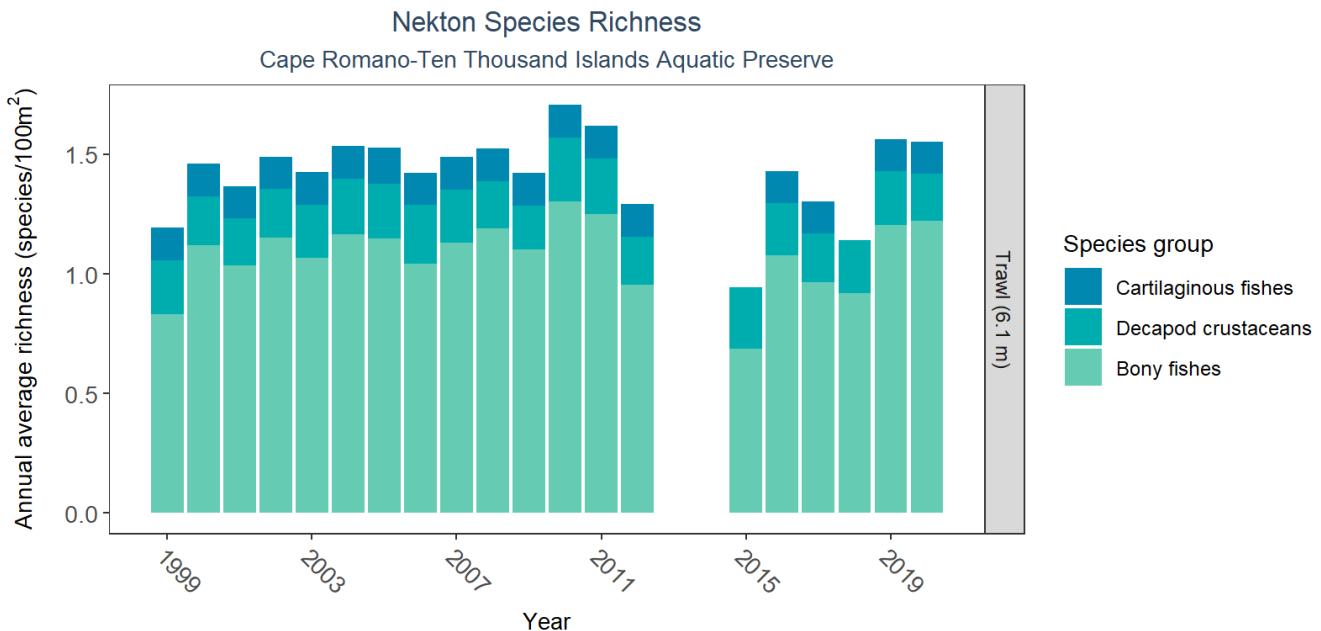


Figure 38: Bar graph(s) of annual average nekton richness over time for species groups occurring in at least 1% of samples. The bar colors represent species groups including bony fishes, cartilaginous fishes, decapod crustaceans (e.g., shrimps, crabs, and lobsters), and cephalopods (e.g., squid). Gear 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)	5002	20	1999 - 2020	0.4	0.67

The median annual number of taxa was 0.40 based on 5,002 observations collected by 6.1-meter trawl between 1999 and 2020.

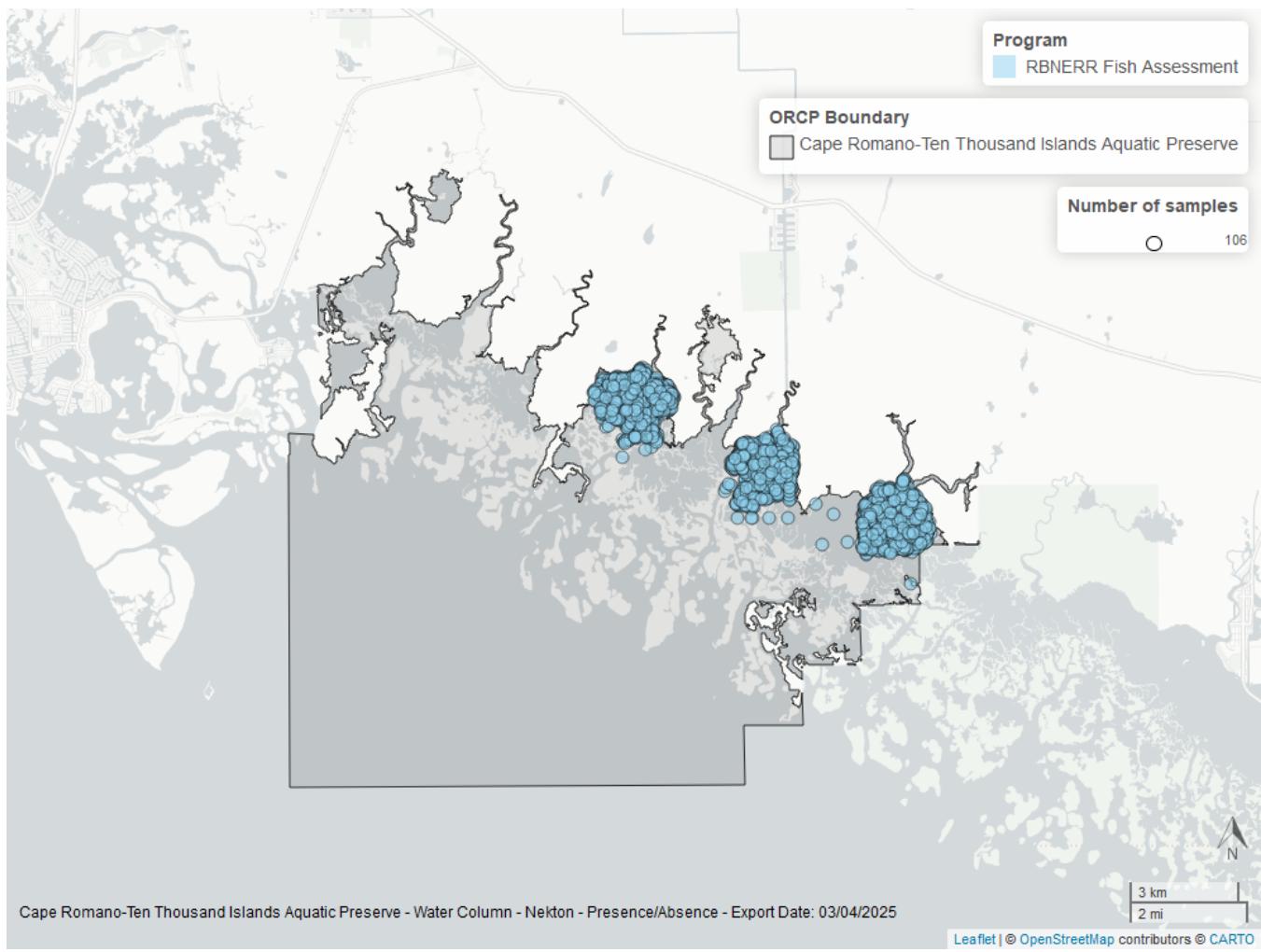


Figure 39: Map showing location of nekton sampling locations within the boundaries of *Cape Romano-Ten Thousand Islands Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Species list

Acanthostracion quadricornis <sup>1</sup>	Etropus crossotus <sup>1</sup>	Mugil cephalus <sup>1</sup>
Achirus lineatus <sup>1</sup>	Eucinostomus spp. <sup>1</sup>	Mugil spp. <sup>1</sup>
Albula vulpes <sup>1</sup>	Eugerres plumieri <sup>1</sup>	Mycteroperca microlepis <sup>1</sup>
Aluterus schoepfii <sup>1</sup>	Floridichthys carpio <sup>1</sup>	Myrophis punctatus <sup>1</sup>
Anarchopterus criniger <sup>1</sup>	Ginglymostoma cirratum <sup>1</sup>	Nicholsina usta <sup>1</sup>
Anchoa spp. <sup>1</sup>	Gobiesox strumosus <sup>1</sup>	Ogcoccephalus cubifrons <sup>1</sup>
Ancylopsetta quadrocellata <sup>1</sup>	Gobionellus oceanicus <sup>1</sup>	Ogilbia cayorum <sup>1</sup>
Archosargus probatocephalus <sup>1</sup>	Gobiosoma bosc <sup>1</sup>	Oligoplites saurus <sup>1</sup>
Archosargus rhomboidalis <sup>1</sup>	Gobiosoma robustum <sup>1</sup>	Opisthonema oglinum <sup>1</sup>
Ariopsis felis <sup>1</sup>	Gunterichthys longipenis <sup>1</sup>	Opsanus beta <sup>1</sup>
Bagre marinus <sup>1</sup>	Gymnura micrura <sup>1</sup>	Orthopristis chrysoptera <sup>1</sup>
Bairdiella chrysoura <sup>1</sup>	Harengula jaguana <sup>1</sup>	Paralichthys alboguttata <sup>1</sup>
Brevoortia smithi <sup>1</sup>	Hippocampus erectus <sup>1</sup>	Penaeus spp. <sup>1</sup>
Brevoortia spp. <sup>1</sup>	Hippocampus zosterae <sup>1</sup>	Pogonias cromis <sup>1</sup>
Calamus arctifrons <sup>1</sup>	Hoplosternum littorale <sup>1</sup>	Prionotus scitulus <sup>1</sup>
Callinectes sapidus <sup>1</sup>	Hypanus americanus <sup>1</sup>	Prionotus tribulus <sup>1</sup>
Caranx spp. <sup>1</sup>	Hypanus sabinus <sup>1</sup>	Rachycentron canadum <sup>1</sup>
Centropomus undecimalis <sup>1</sup>	Hypostomus plecostomus <sup>1</sup>	Rhinoptera bonasus <sup>1</sup>
Chaetodipterus faber <sup>1</sup>	Hypsoblennius hentz <sup>1</sup>	Sciaenops ocellatus <sup>1</sup>
Chasmodes saburrae <sup>1</sup>	Lagodon rhomboides <sup>1</sup>	Scorpaena brasiliensis <sup>1</sup>
Chilomycterus schoepfii <sup>1</sup>	Leiostomus xanthurus <sup>1</sup>	Selene vomer <sup>1</sup>
Chloroscombrus chrysurus <sup>1</sup>	Lepomis spp. <sup>1</sup>	Serraniculus pumilio <sup>1</sup>
Cichlidae spp. <sup>1</sup>	Leptocephalus larvæ <sup>1</sup>	Sphoeroides nephelus <sup>1</sup>
Citharichthys macrops <sup>1</sup>	Lophogobius cyprinoides <sup>1</sup>	Sphoeroides spengleri <sup>1</sup>
Citharichthys spilopterus <sup>1</sup>	Lucania parva <sup>1</sup>	Stephanolepis hispida <sup>1</sup>
Clupeidae <sup>1</sup>	Lutjanus analis <sup>1</sup>	Sympodus plagiusa <sup>1</sup>
Ctenogobius boleosoma <sup>1</sup>	Lutjanus griseus <sup>1</sup>	Syngnathus louisianae <sup>1</sup>
Ctenogobius smaragdus <sup>1</sup>	Lutjanus synagris <sup>1</sup>	Syngnathus scovelli <sup>1</sup>
Cynoscion arenarius <sup>1</sup>	Menippe mercenaria <sup>1</sup>	Synodus foetens <sup>1</sup>
Cynoscion nebulosus <sup>1</sup>	Menticirrhus spp. <sup>1</sup>	Trachinotus falcatus <sup>1</sup>
Diplectrum formosum <sup>1</sup>	Microgobius gulosus <sup>1</sup>	Trinectes maculatus <sup>1</sup>
Echeneis neucratoides <sup>1</sup>	Microgobius thalassinus <sup>1</sup>	Urophycis floridae <sup>1</sup>
Elops saurus <sup>1</sup>	Micropterus salmoides <sup>1</sup>	Acanthostracion quadricornis <sup>1</sup>
Epinephelus itajara <sup>1</sup>	Monacanthus ciliatus <sup>1</sup>	Achirus lineatus <sup>1</sup>

1 - Nekton

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