

# Indian River-Vero Beach to Ft. Pierce Aquatic Preserve

## SEACAR Habitat Analyses

Last compiled on 22 May, 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 determiniation; results may not be accurate. This code shall be used if a field screening test (e.g., field gas chromatograph data, immunoassay, or vendor-supplied field kit) was used to generate the value and the field kit or method has not been recognized by the Department as equivalent to laboratory methods.

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

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

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

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

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

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

Table 5: SWMP Value Qualifier codes

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

## Water Column

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

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

## Seasonal Kendall-Tau Analysis

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

## Water Quality - Discrete

The following files were used in the discrete analysis:

- *Combined\_WQ\_WC\_NUT\_Chlorophyll\_a\_corrected\_for\_pheophytin-2025-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

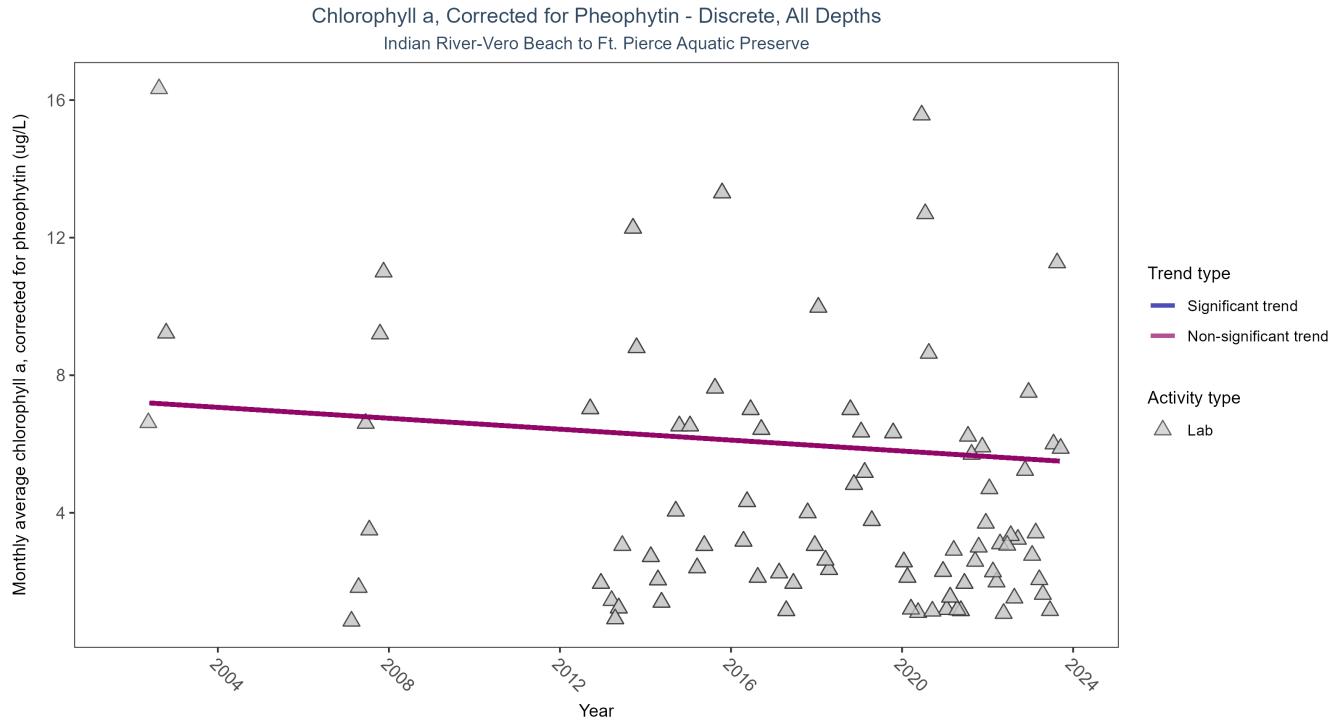


Figure 1: Scatter plot of monthly average levels of chlorophyll a, corrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles) 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	258	14	2002 - 2023	2.9103	-0.1647	7.2253	-0.0794	0.0552

Chlorophyll a, corrected for pheophytin, showed no detectable trend between 2002 and 2023.

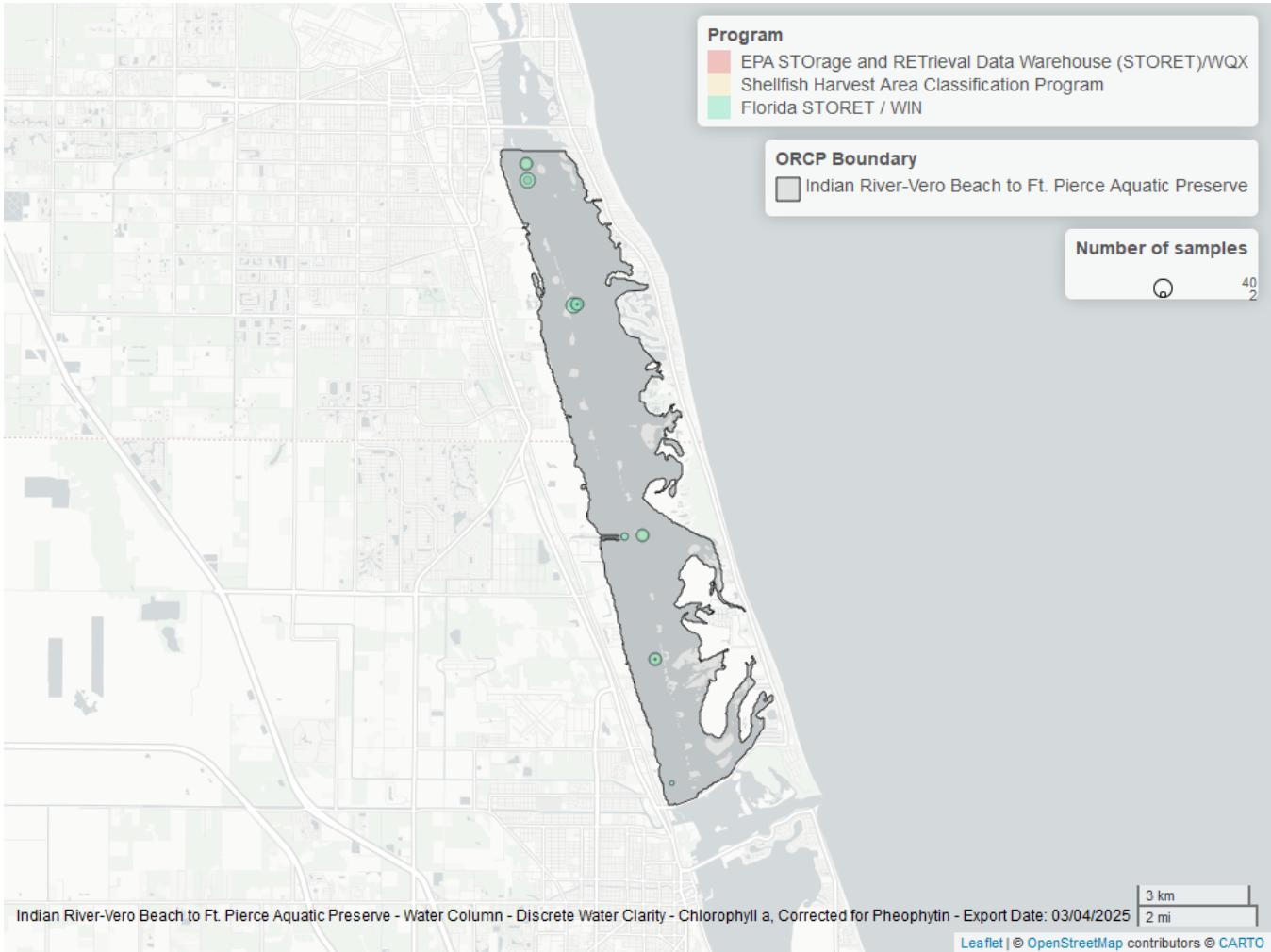


Figure 2: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	189	2002	2023
540	60	2016	2020
103	13	2020	2021

#### Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>1</sup>

540 - Shellfish Harvest Area Classification Program<sup>2</sup>

5002 - Florida STORET / WIN<sup>3</sup>

#### Chlorophyll a, Uncorrected for Pheophytin - Discrete

#### Seasonal Kendall-Tau Trend Analysis

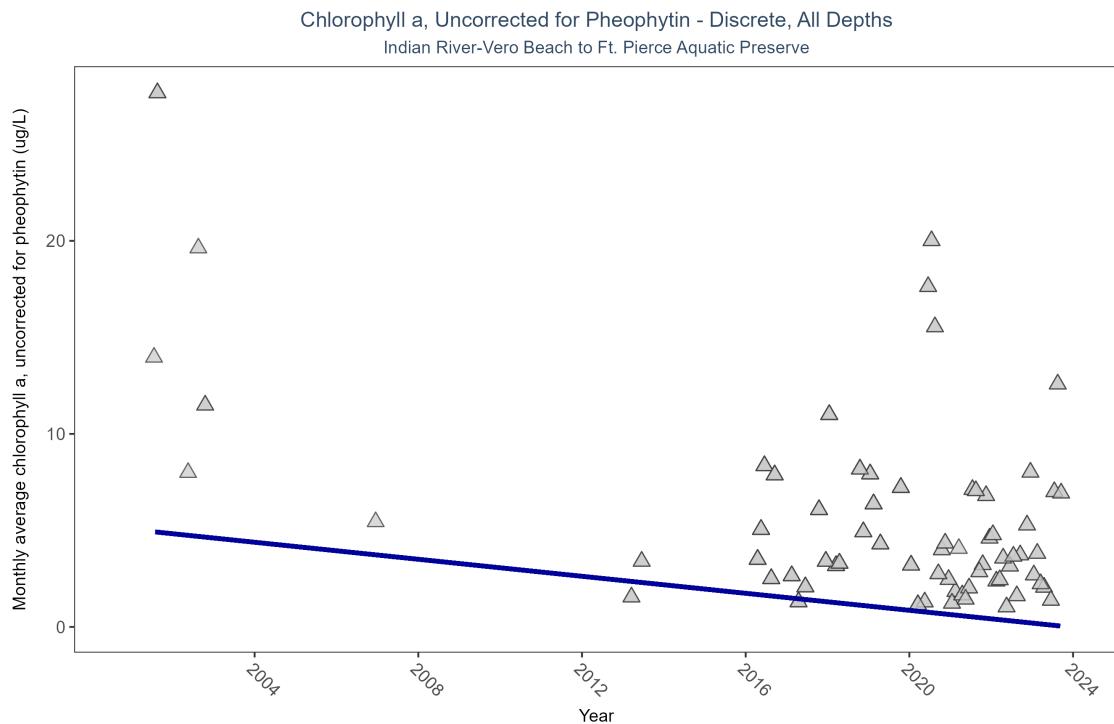


Figure 3: Scatter plot of monthly average levels of chlorophyll a, uncorrected for pheophytin, over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only laboratory-analyzed chlorophyll a (triangles) 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 decreasing trend	174	12	2001 - 2023	3.8	-0.2588	5.0473	-0.2203	0.0106

Monthly average chlorophyll a, uncorrected for pheophytin, decreased by 0.22  $\mu\text{g}/\text{L}$  per year, indicating an increase in water clarity.

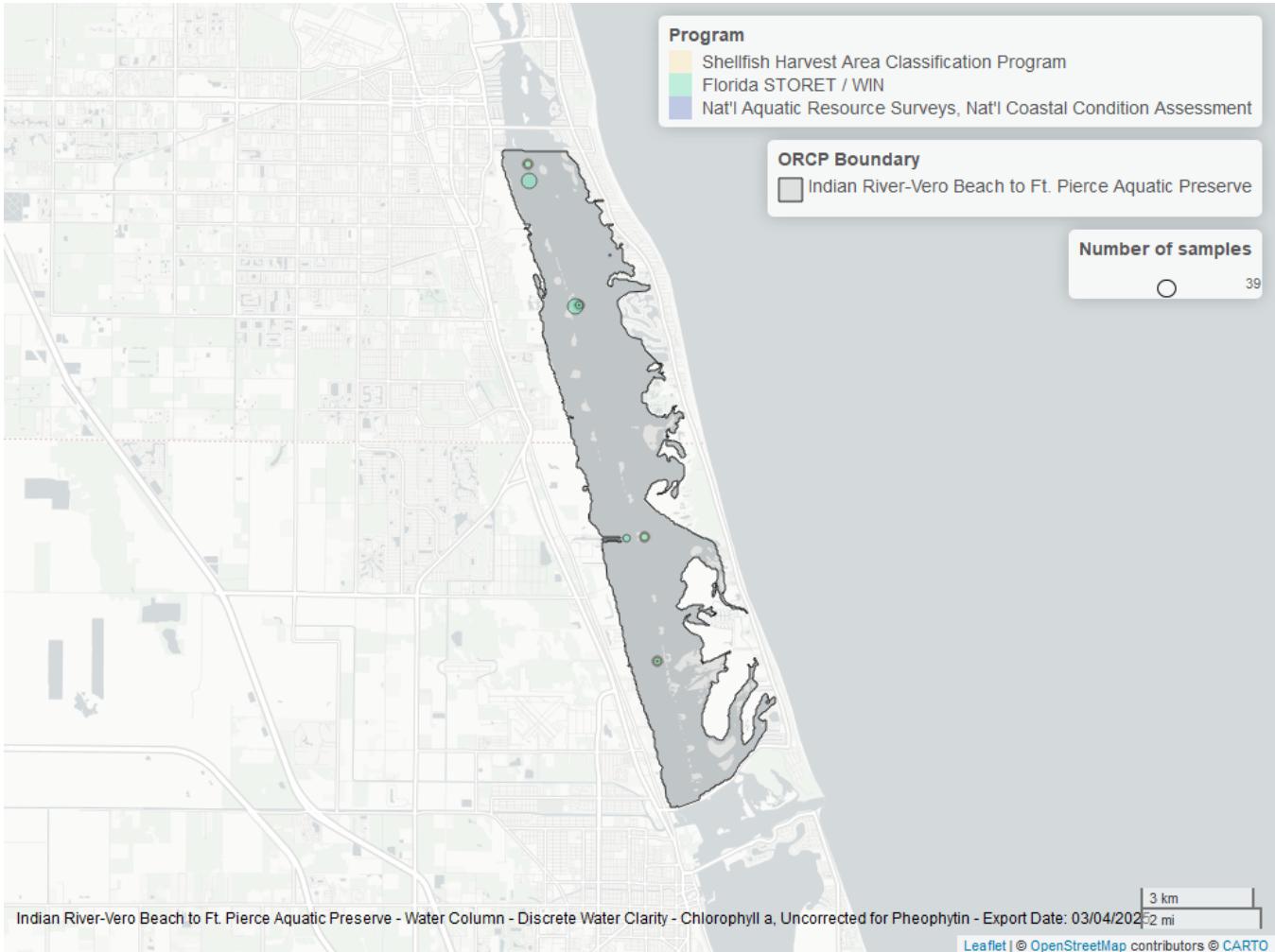


Figure 4: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

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

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	117	2001	2023
540	64	2016	2020
118	1	2006	2006

#### Program names:

- 118 - National Aquatic Resource Surveys, National Coastal Condition Assessment<sup>4</sup>
- 540 - Shellfish Harvest Area Classification Program<sup>2</sup>
- 5002 - Florida STORET / WIN<sup>3</sup>

#### Dissolved Oxygen - Discrete

#### Seasonal Kendall-Tau Trend Analysis

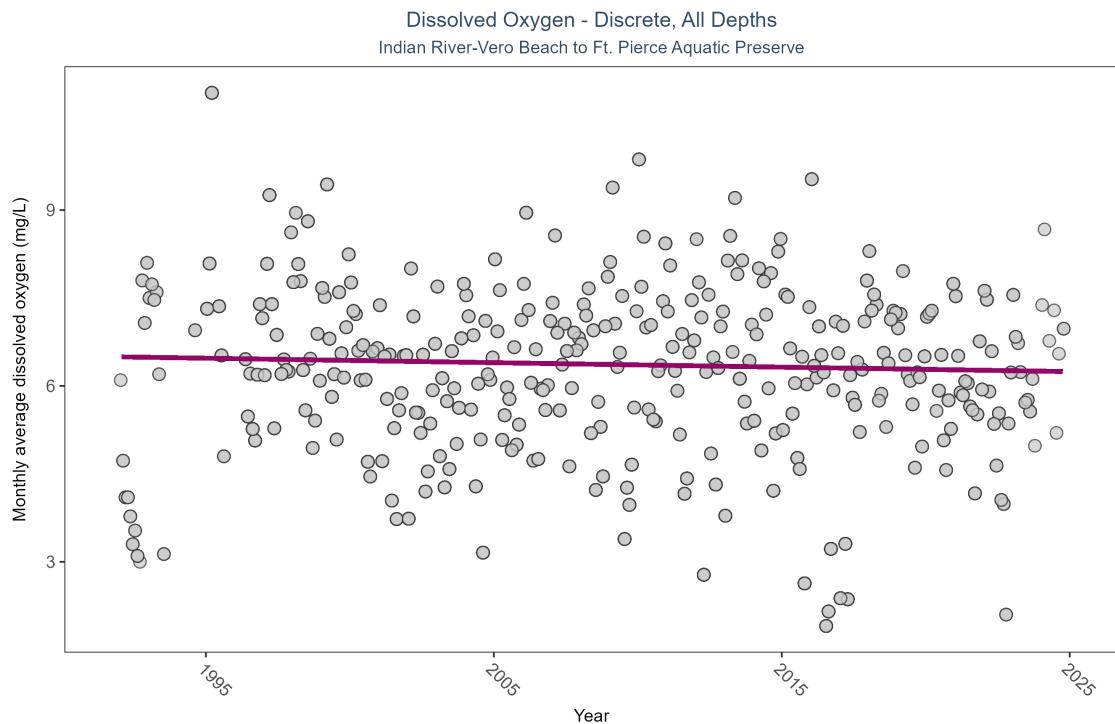


Figure 5: Scatter plot of monthly average dissolved oxygen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen values measured in the field (circles) are included in the plot.

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	No significant trend	7886	33	1992 - 2024	6.3	-0.0471	6.4962	-0.0076	0.2196

Dissolved oxygen showed no detectable trend between 1992 and 2024.

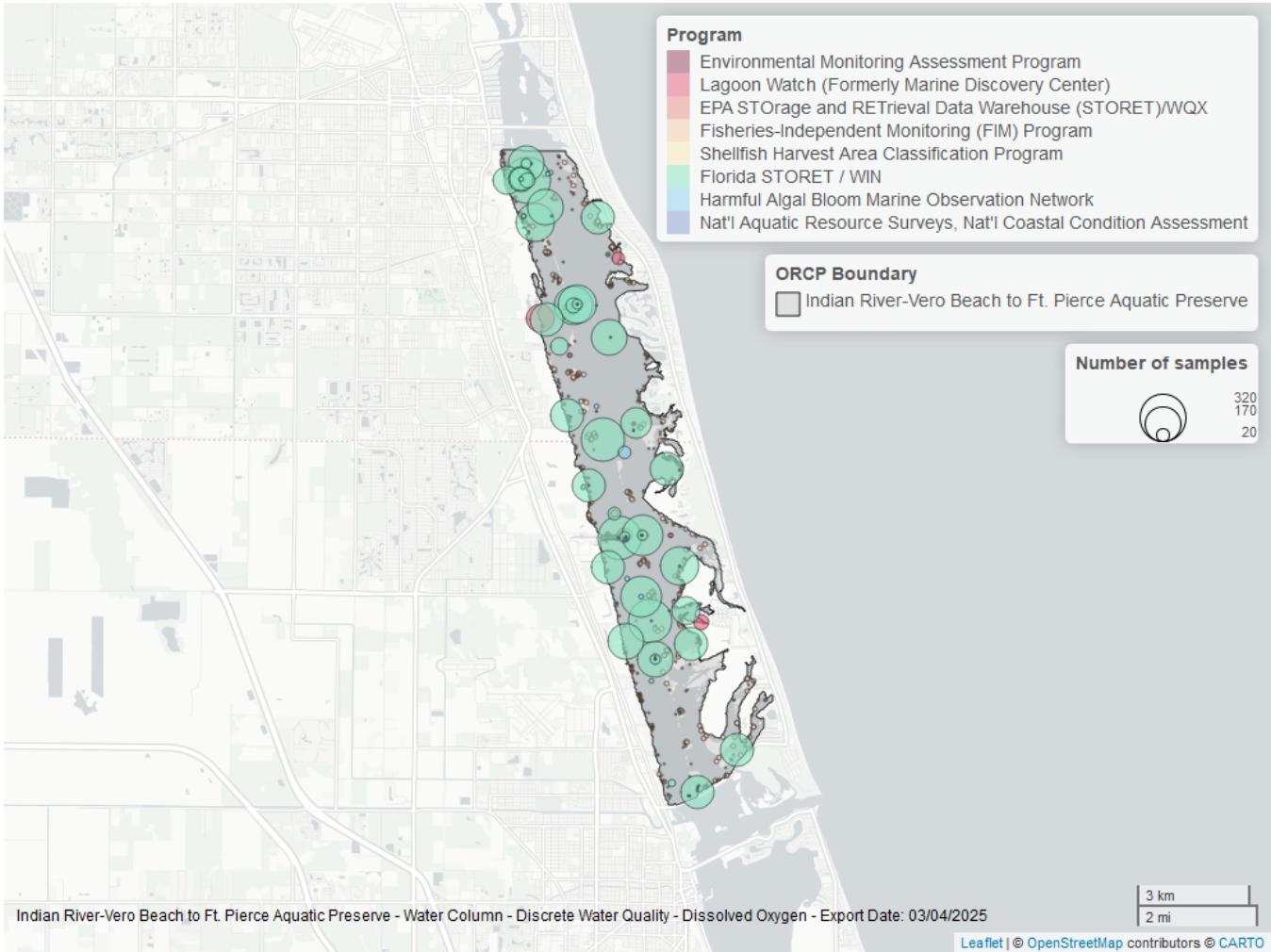


Figure 6: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 11: Programs contributing data for Dissolved Oxygen

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	5925	1995	2024
69	1230	1998	2022
3013	376	1999	2023
3001	224	1992	2023
95	68	1996	2018
540	56	2016	2020
103	21	2020	2021
115	8	1994	1995
118	1	2006	2006

#### Program names:

69 - Fisheries-Independent Monitoring (FIM) Program<sup>5</sup>

95 - Harmful Algal Bloom Marine Observation Network<sup>6</sup>

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>1</sup>

115 - Environmental Monitoring Assessment Program<sup>7</sup>

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

540 - Shellfish Harvest Area Classification Program<sup>2</sup>

3001 - Lagoon Watch (Formerly Marine Discovery Center)<sup>8</sup>

3013 - Seagrass (SJRWMD)<sup>9</sup>

5002 - Florida STORET / WIN<sup>3</sup>

## Dissolved Oxygen Saturation - Discrete

### Seasonal Kendall-Tau Trend Analysis

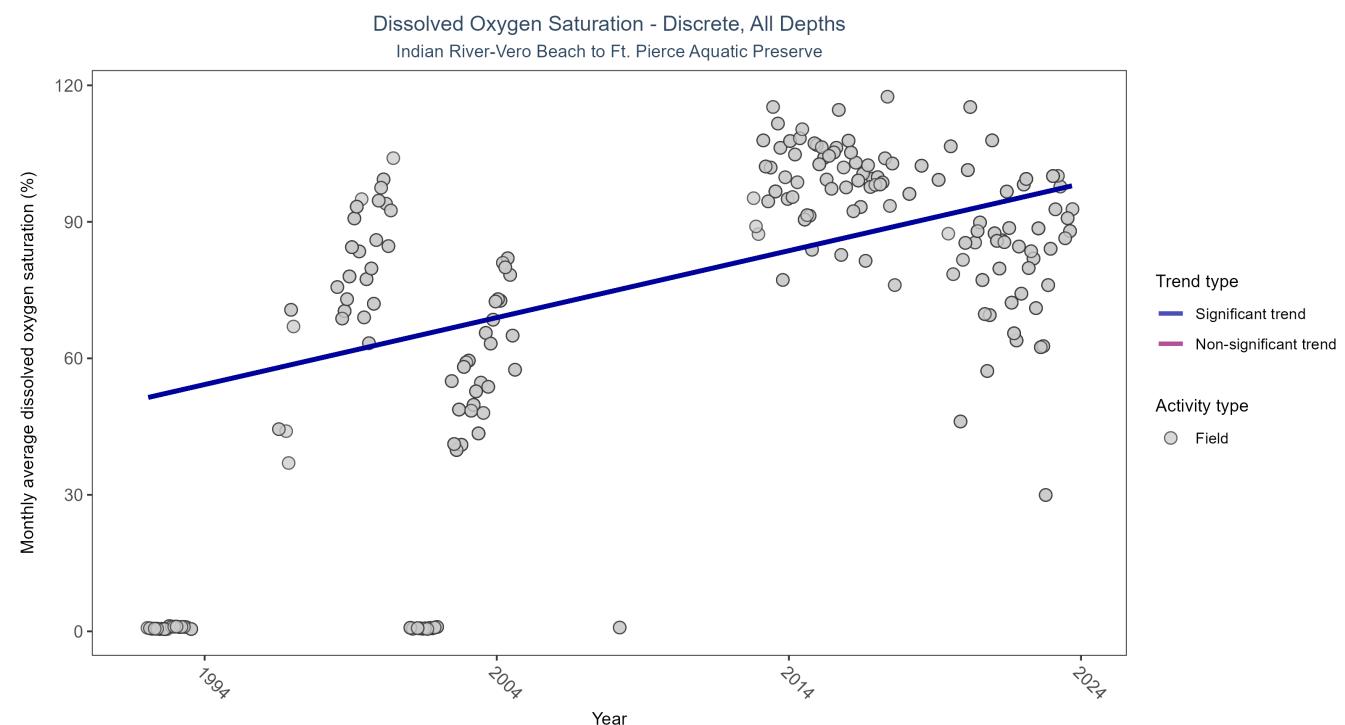


Figure 7: Scatter plot of monthly average dissolved oxygen saturation over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only dissolved oxygen saturation values measured in the field (circles) 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	Significantly increasing trend	814	24	1992 - 2023	83.05	0.3613	51.3079	1.4706	0

Monthly average dissolved oxygen saturation increased by 1.47% per year.

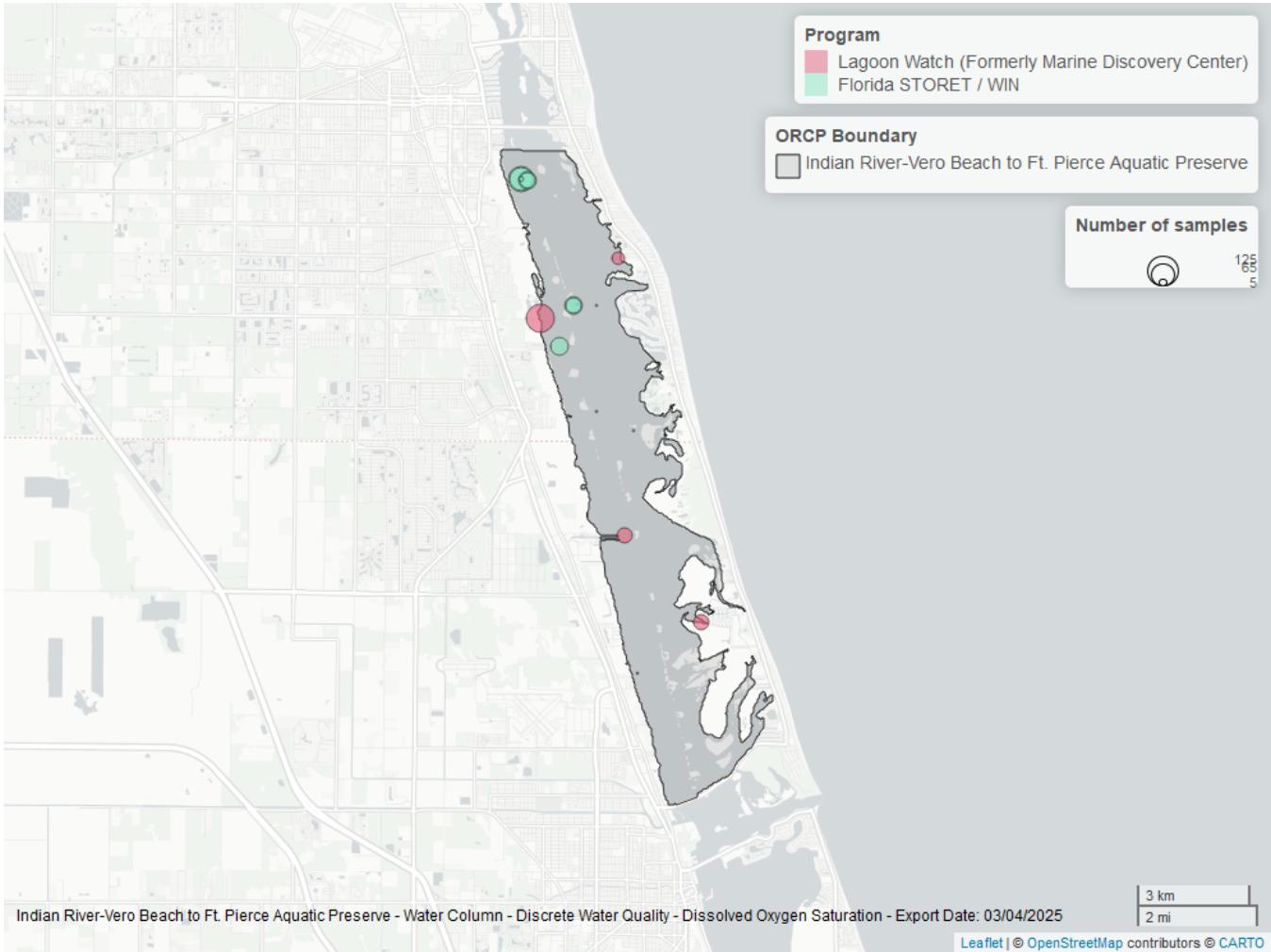


Figure 8: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 13: Programs contributing data for Dissolved Oxygen Saturation

ProgramID	N_Data	YearMin	YearMax
5002	410	1996	2023
3001	220	1992	2023
3013	186	2012	2023

#### Program names:

3001 - Lagoon Watch (Formerly Marine Discovery Center)<sup>8</sup>

3013 - Seagrass (SJRWMD)<sup>9</sup>

5002 - Florida STORET / WIN<sup>3</sup>

#### pH - Discrete

#### Seasonal Kendall-Tau Trend Analysis

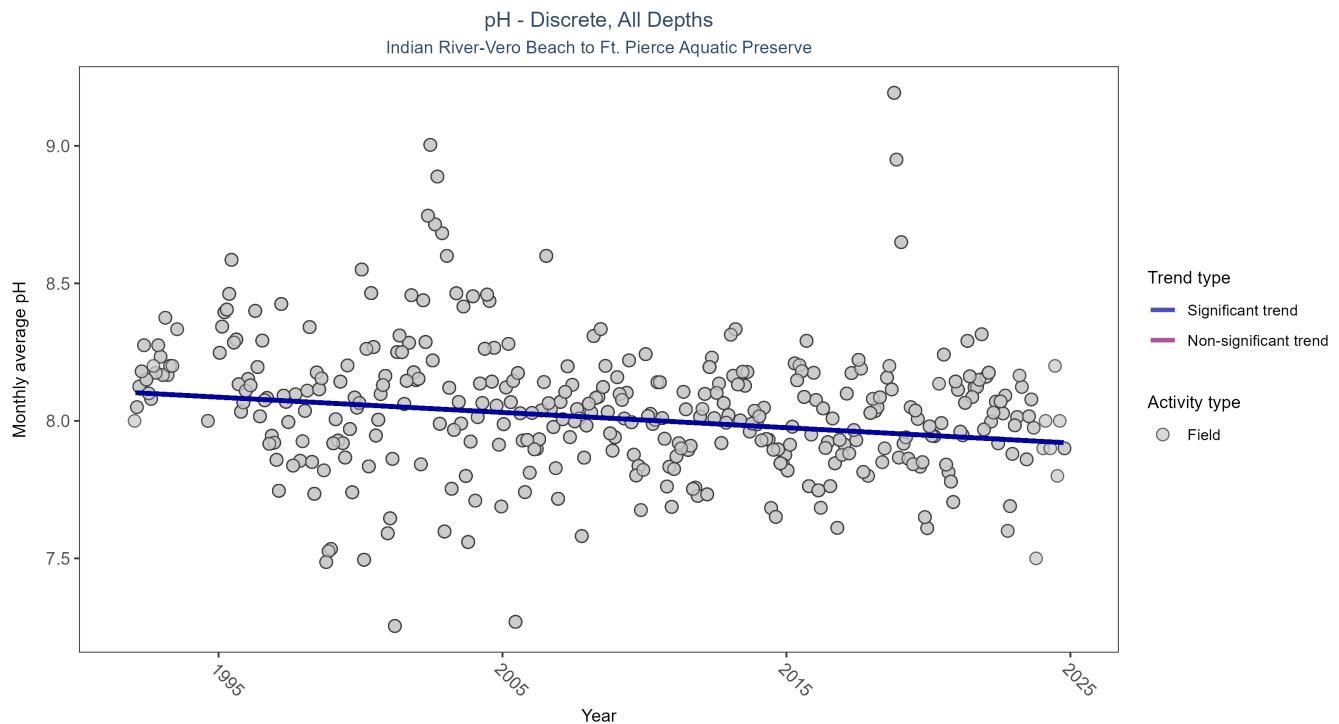


Figure 9: Scatter plot of monthly average pH over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only pH values measured in the field (circles) are included in the plot.

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	5925	33	1992 - 2024	8.02	-0.1652	8.1028	-0.0056	0

Monthly average pH decreased by 0.01 pH units per year.

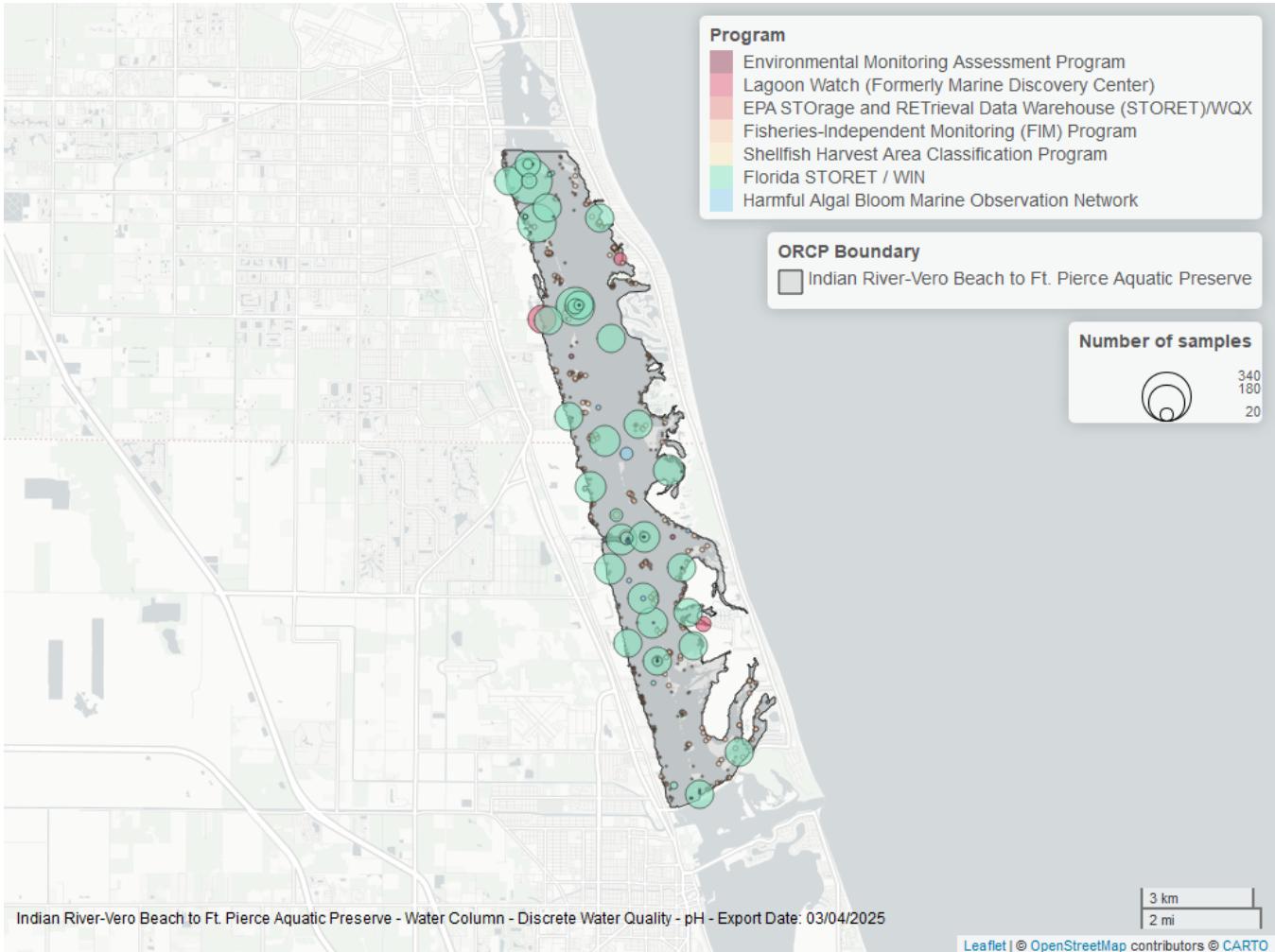


Figure 10: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 15: Programs contributing data for pH

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	4116	1995	2024
69	1208	1998	2022
3013	374	2003	2023
3001	224	1992	2023
95	60	2002	2018
540	48	2016	2020
103	21	2020	2021
115	6	1994	1995

#### Program names:

69 - Fisheries-Independent Monitoring (FIM) Program<sup>5</sup>

95 - Harmful Algal Bloom Marine Observation Network<sup>6</sup>

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>1</sup>

115 - Environmental Monitoring Assessment Program<sup>7</sup>

- 540 - Shellfish Harvest Area Classification Program<sup>2</sup>  
 3001 - Lagoon Watch (Formerly Marine Discovery Center)<sup>8</sup>  
 3013 - Seagrass (SJRWMD)<sup>9</sup>  
 5002 - Florida STORET / WIN<sup>3</sup>

## Salinity - Discrete

### Seasonal Kendall-Tau Trend Analysis

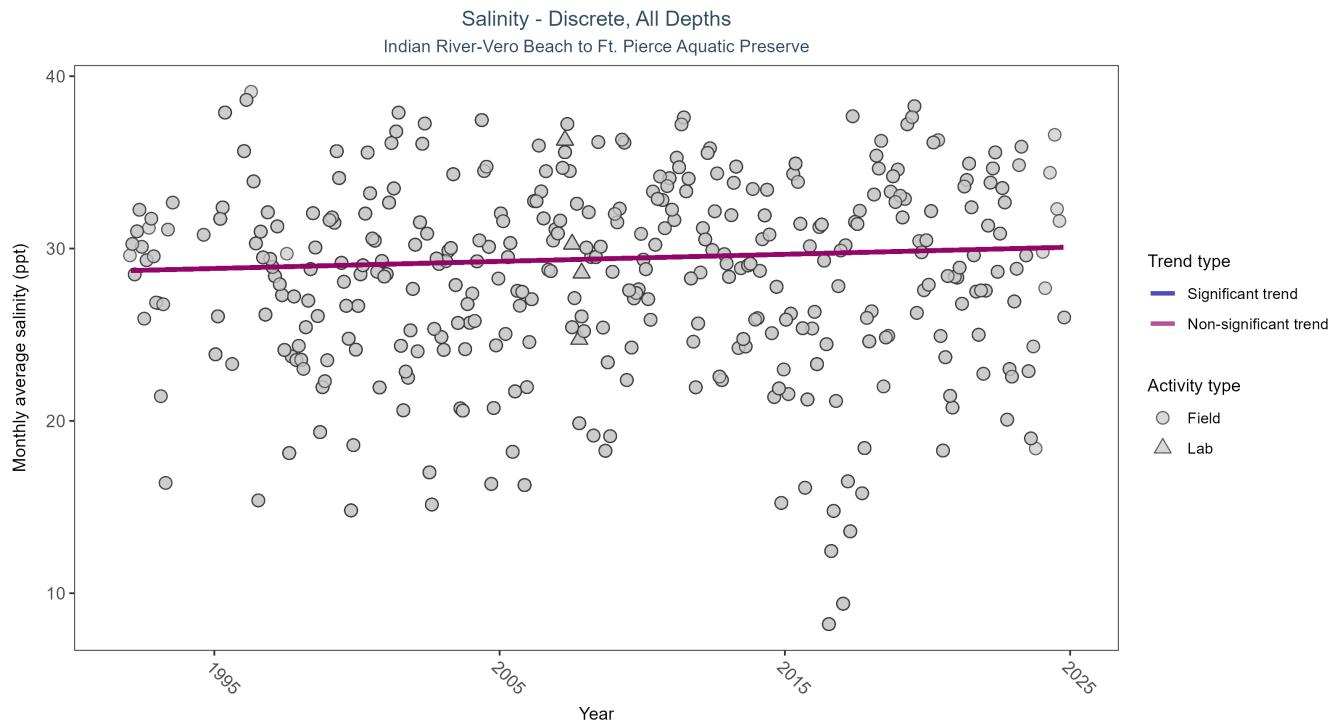


Figure 11: Scatter plot of monthly average salinity over time. If the time series included ten or more years of discrete observations, significant (blue) or non-significant (magenta) trend lines are also shown. Discrete salinity values derived from grab samples analyzed in the field (circles) or the 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	8648	33	1992 - 2024	29.1	0.0561	28.7186	0.0412	0.1293

Salinity showed no detectable trend between 1992 and 2024.

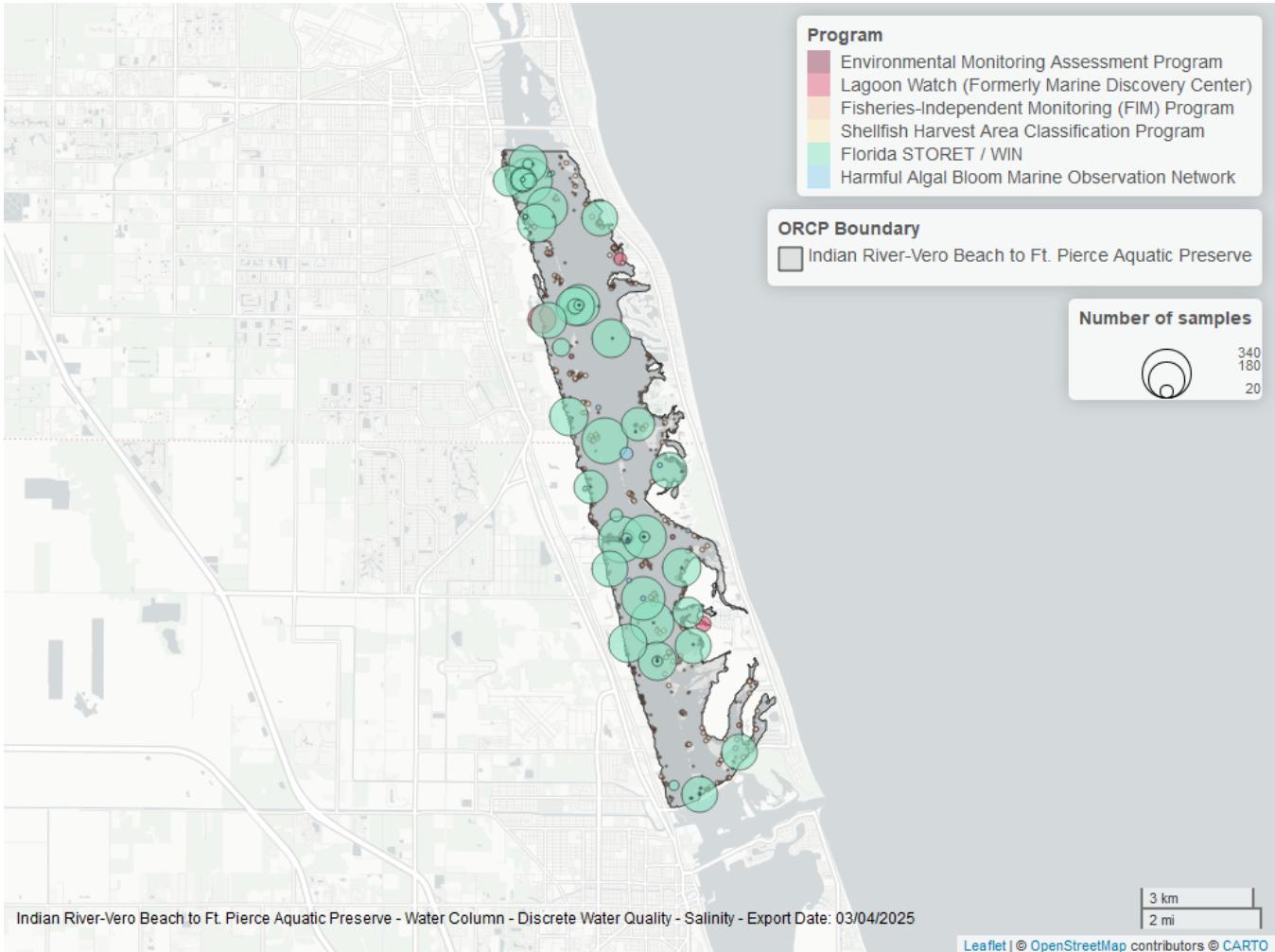


Figure 12: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 17: Programs contributing data for Salinity

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	6604	1995	2024
69	1314	1997	2022
3013	376	2003	2023
3001	222	1992	2023
95	76	1996	2018
540	60	2016	2020
115	7	1994	1995

#### Program names:

- 69 - Fisheries-Independent Monitoring (FIM) Program<sup>5</sup>
- 95 - Harmful Algal Bloom Marine Observation Network<sup>6</sup>
- 115 - Environmental Monitoring Assessment Program<sup>7</sup>
- 540 - Shellfish Harvest Area Classification Program<sup>2</sup>
- 3001 - Lagoon Watch (Formerly Marine Discovery Center)<sup>8</sup>

3013 - Seagrass (SJRWM)<sup>9</sup>  
 5002 - Florida STORET / WIN<sup>3</sup>

## Secchi Depth - Discrete

### Seasonal Kendall-Tau Trend Analysis

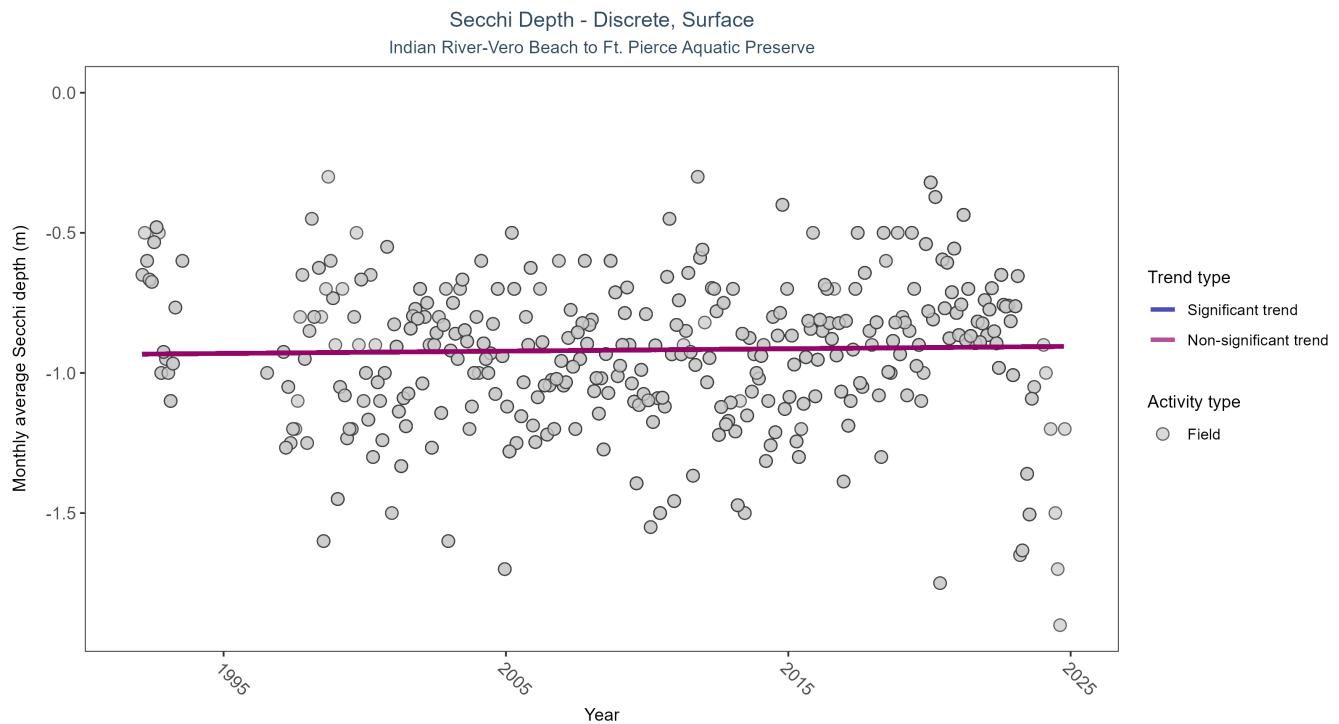


Figure 13: Scatter plot of monthly average Secchi depth over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Secchi depth is only measured in the field (circles).

Table 18: Seasonal Kendall-Tau Trend Analysis for Secchi Depth

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Field	No significant trend	2167	31	1992 - 2024	-0.9	0.0281	-0.933	0.0008	0.5154

Secchi depth showed no detectable trend between 1992 and 2024.

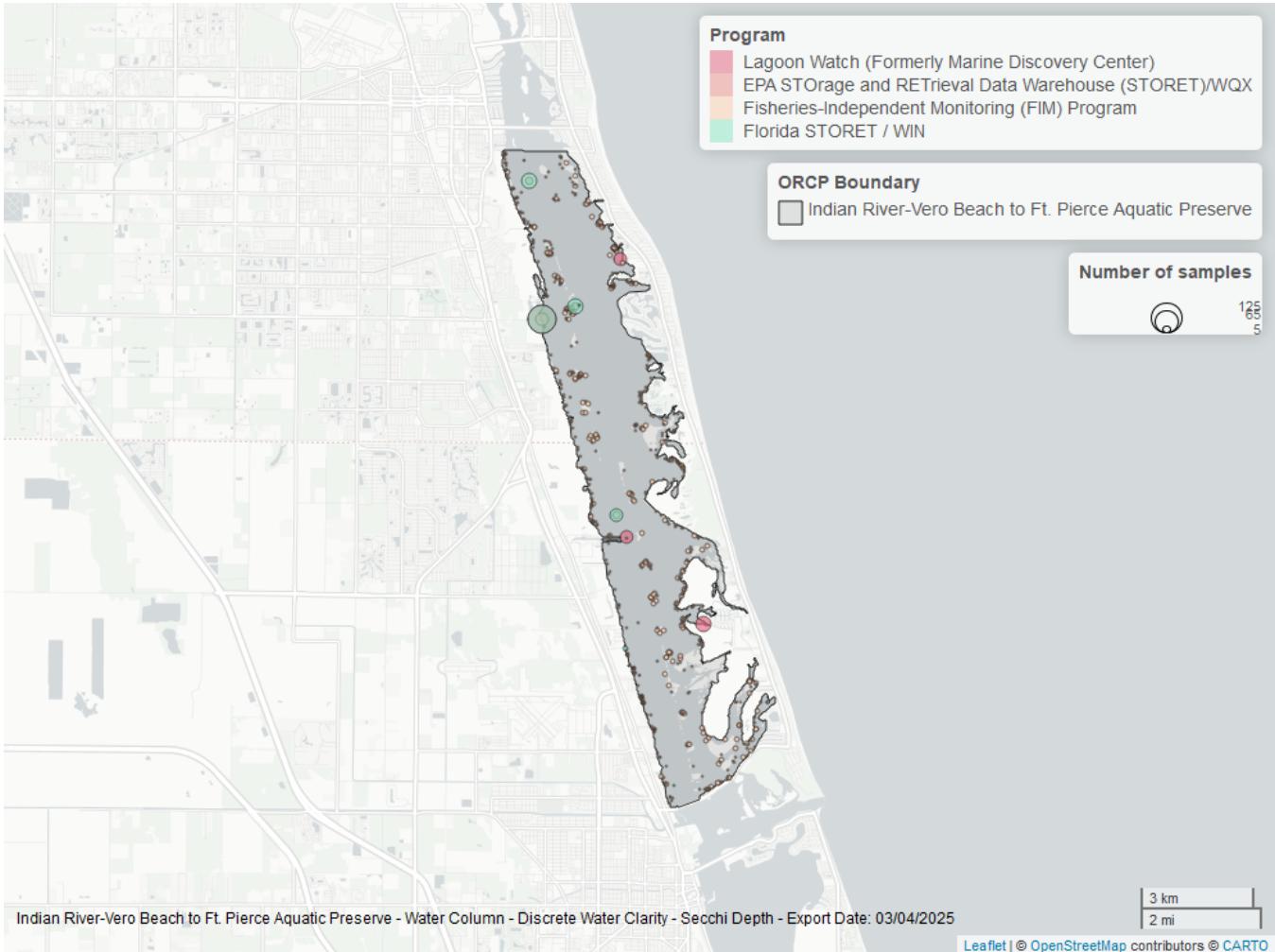


Figure 14: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 19: Programs contributing data for Secchi Depth

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
69	1316	1997	2022
3013	369	2003	2023
5002	230	2007	2024
3001	209	1992	2023
103	46	2020	2021

#### Program names:

- 69 - Fisheries-Independent Monitoring (FIM) Program<sup>5</sup>
- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>1</sup>
- 3001 - Lagoon Watch (Formerly Marine Discovery Center)<sup>8</sup>
- 3013 - Seagrass (SJRWMD)<sup>9</sup>
- 5002 - Florida STORET / WIN<sup>3</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

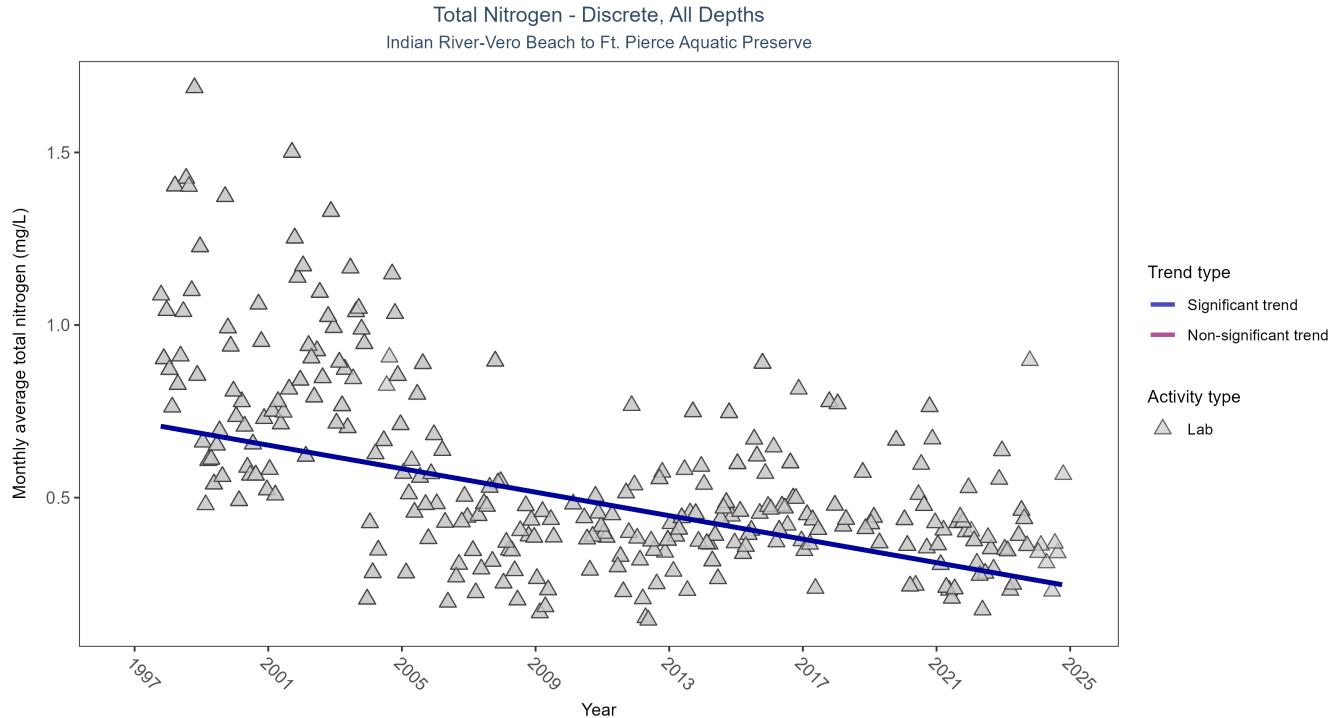


Figure 15: Scatter plot of monthly average total nitrogen over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only nitrogen values obtained from laboratory analyses (triangles) are included in the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

Table 20: 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	1012	28	1997 - 2024	0.5306	-0.4306	0.7201	-0.017	0

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

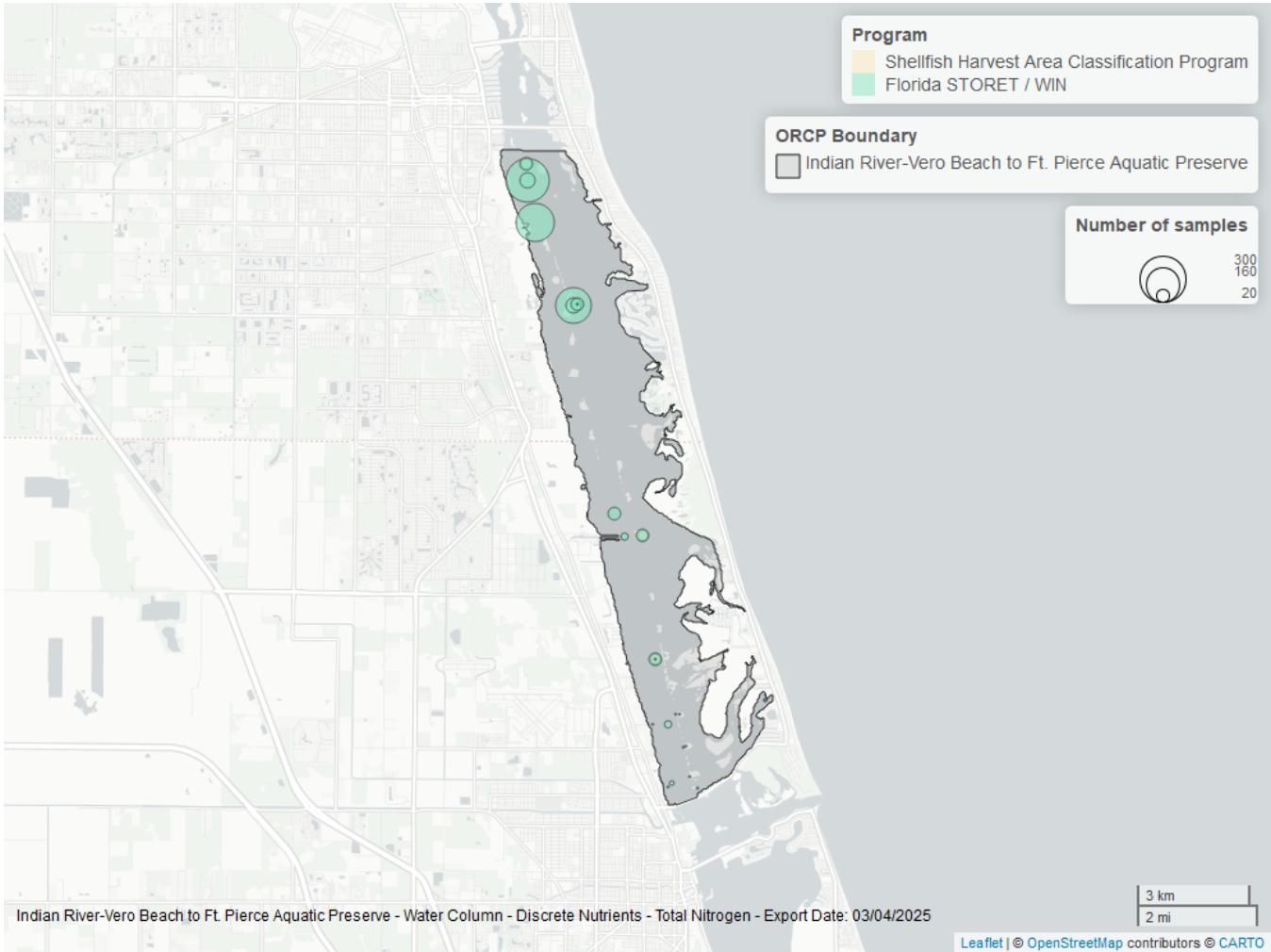


Figure 16: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 21: Programs contributing data for Total Nitrogen

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	952	1997	2024
540	60	2016	2020

#### Program names:

540 - Shellfish Harvest Area Classification Program<sup>2</sup>  
 5002 - Florida STORET / WIN<sup>3</sup>

#### Total Phosphorus - Discrete

Seasonal Kendall-Tau Trend Analysis

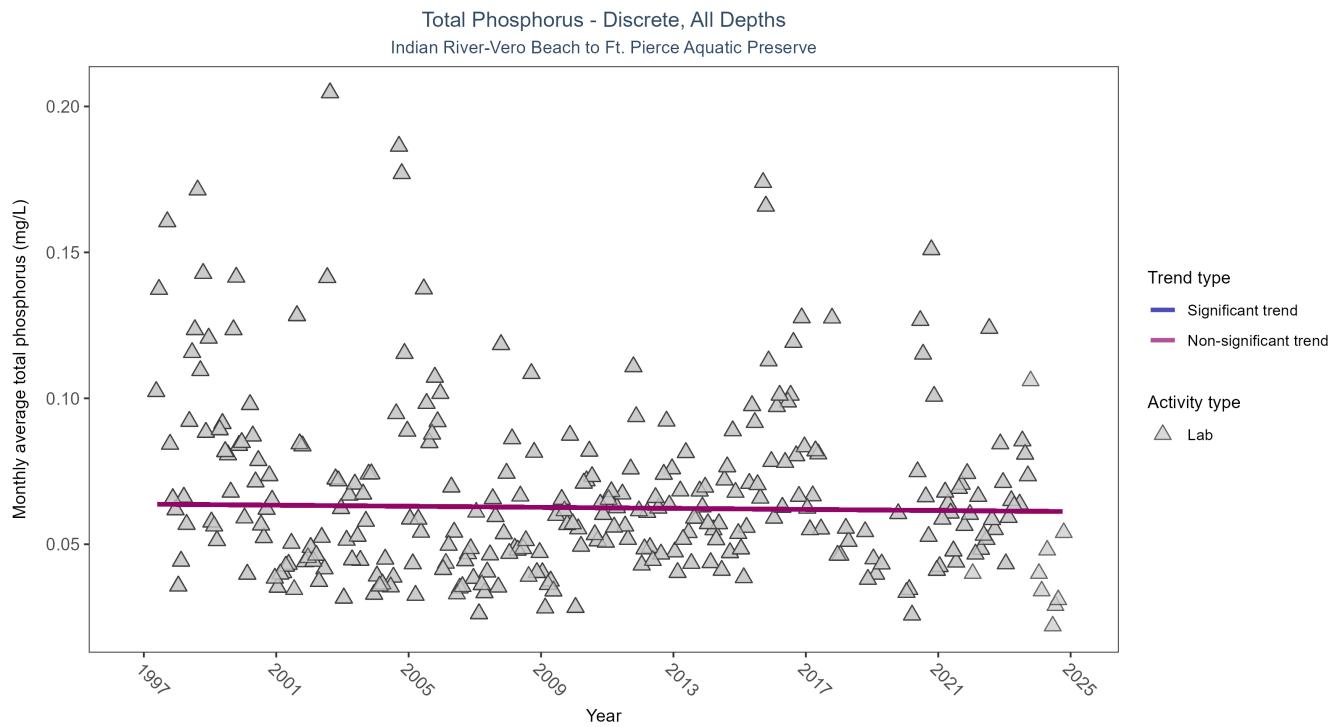


Figure 17: Scatter plot of monthly average total phosphorus over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only phosphorus values obtained from laboratory analyses (triangles) are included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

Table 22: Seasonal Kendall-Tau Trend Analysis for Total Phosphorus

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Lab	No significant trend	2088	28	1997 - 2024	0.06	-0.0347	0.0638	-0.0001	0.4125

Total phosphorus showed no detectable trend between 1997 and 2024.

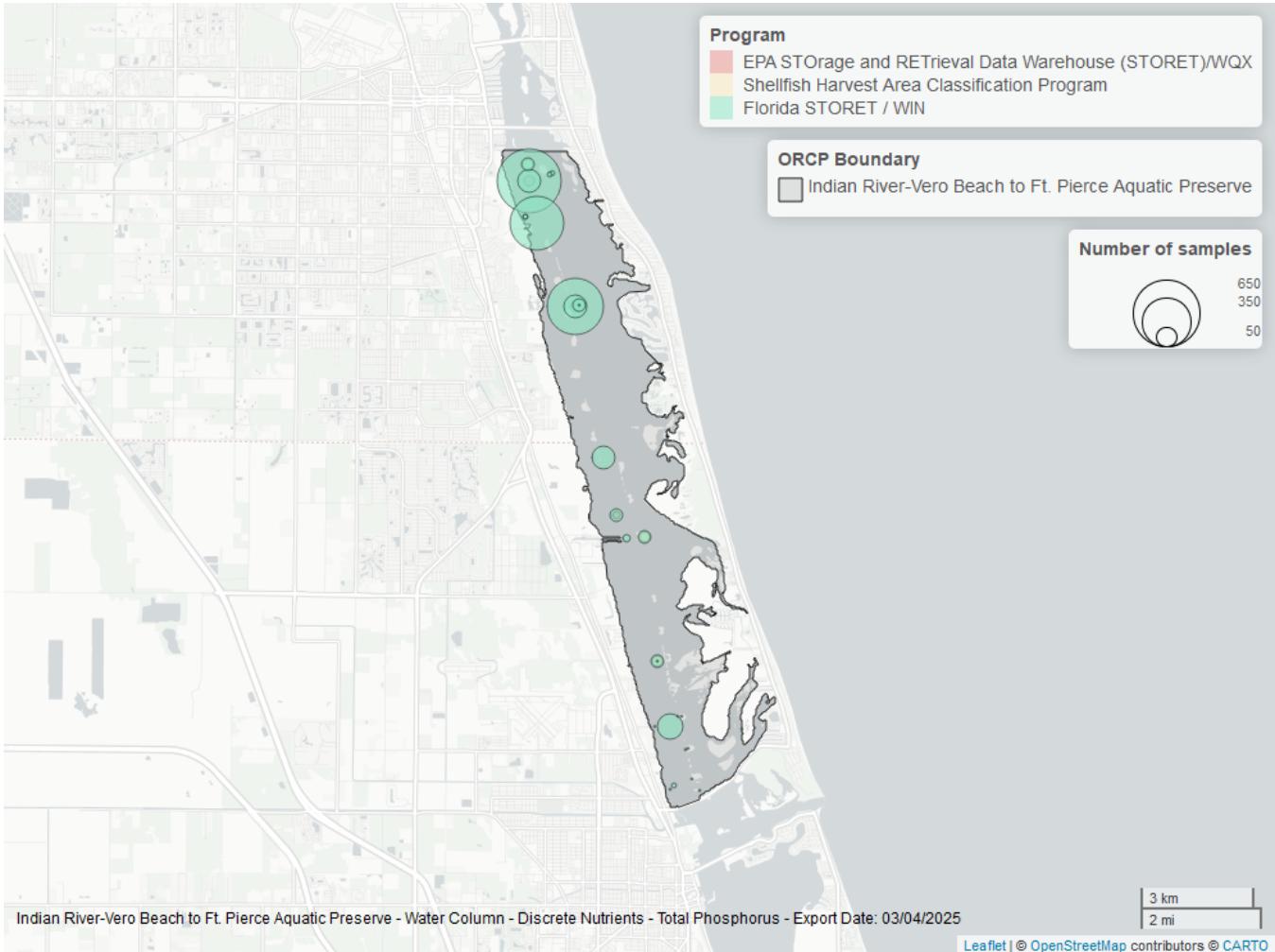


Figure 18: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 23: Programs contributing data for Total Phosphorus

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	2067	1997	2024
540	60	2016	2020
103	35	2020	2021

#### Program names:

- 103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>1</sup>
- 540 - Shellfish Harvest Area Classification Program<sup>2</sup>
- 5002 - Florida STORET / WIN<sup>3</sup>

#### Total Suspended Solids - Discrete

#### Seasonal Kendall-Tau Trend Analysis

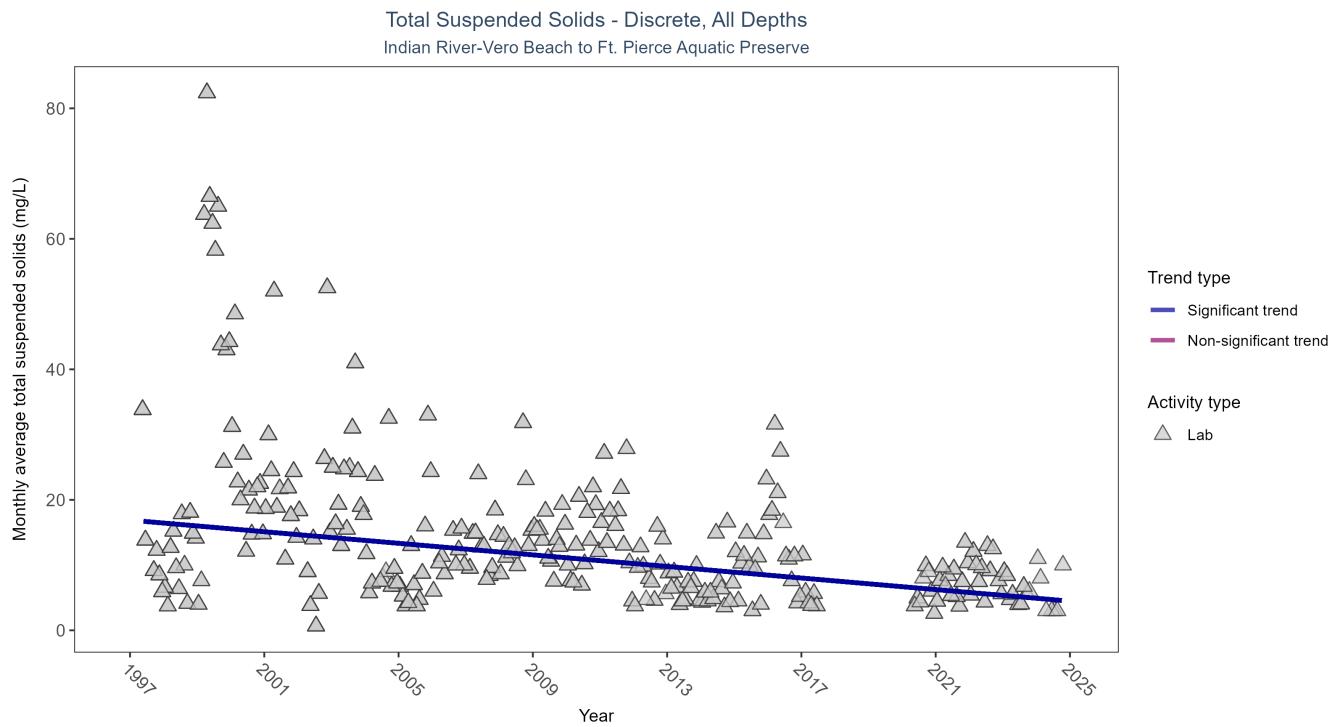


Figure 19: Scatter plot of monthly average total suspended solids (TSS) over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only TSS values obtained from laboratory analyses (triangles) are included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

Table 24: 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	874	26	1997 - 2024	12	-0.3305	16.8853	-0.4433	0

Monthly average total suspended solids decreased by 0.44 mg/L per year, indicating an increase in water clarity.

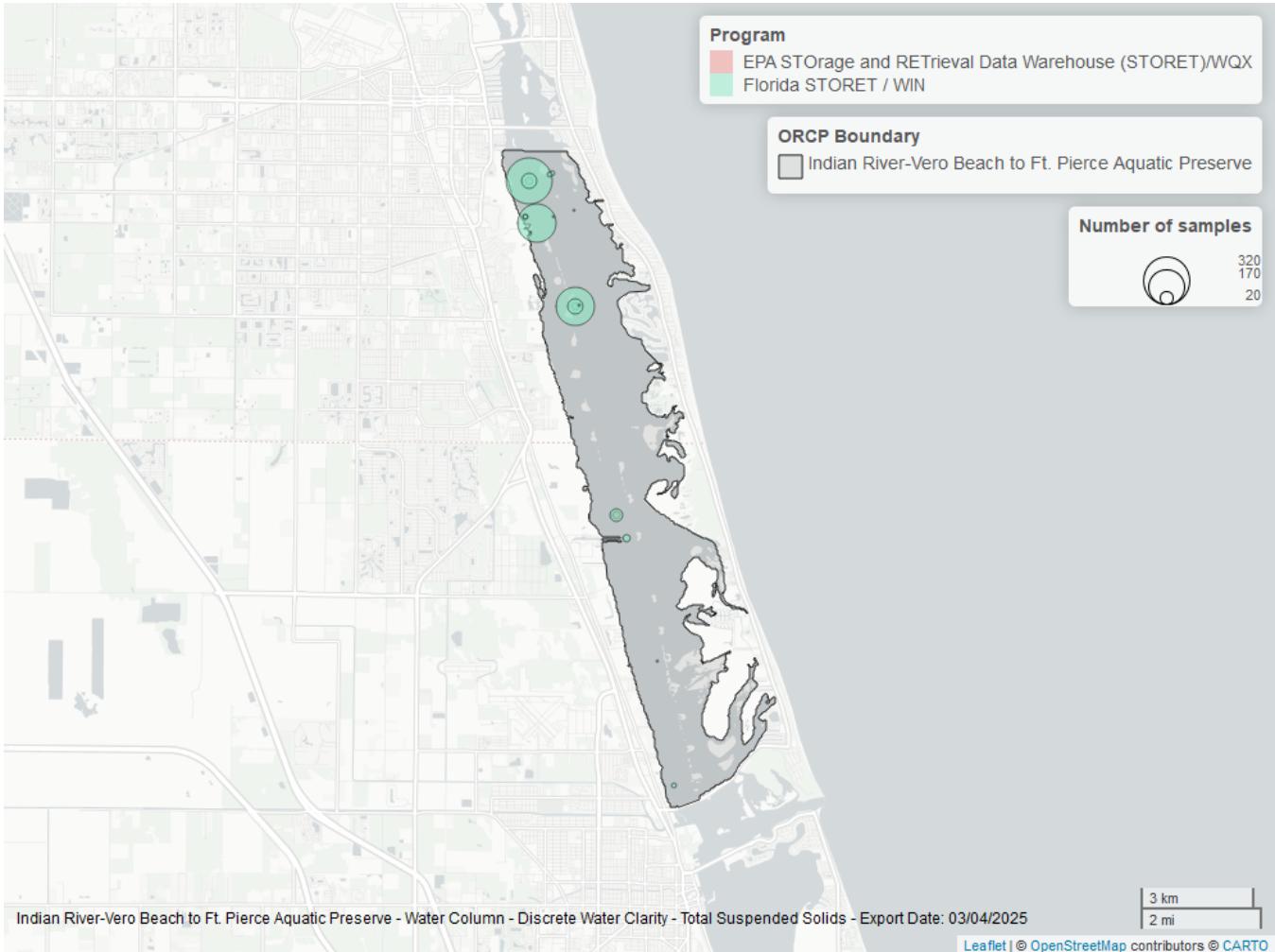


Figure 20: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 25: Programs contributing data for Total Suspended Solids

ProgramID	N_Data	YearMin	YearMax
5002	907	1997	2024
103	21	2020	2021

#### Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>1</sup>  
 5002 - Florida STORET / WIN<sup>3</sup>

#### Turbidity - Discrete

Seasonal Kendall-Tau Trend Analysis

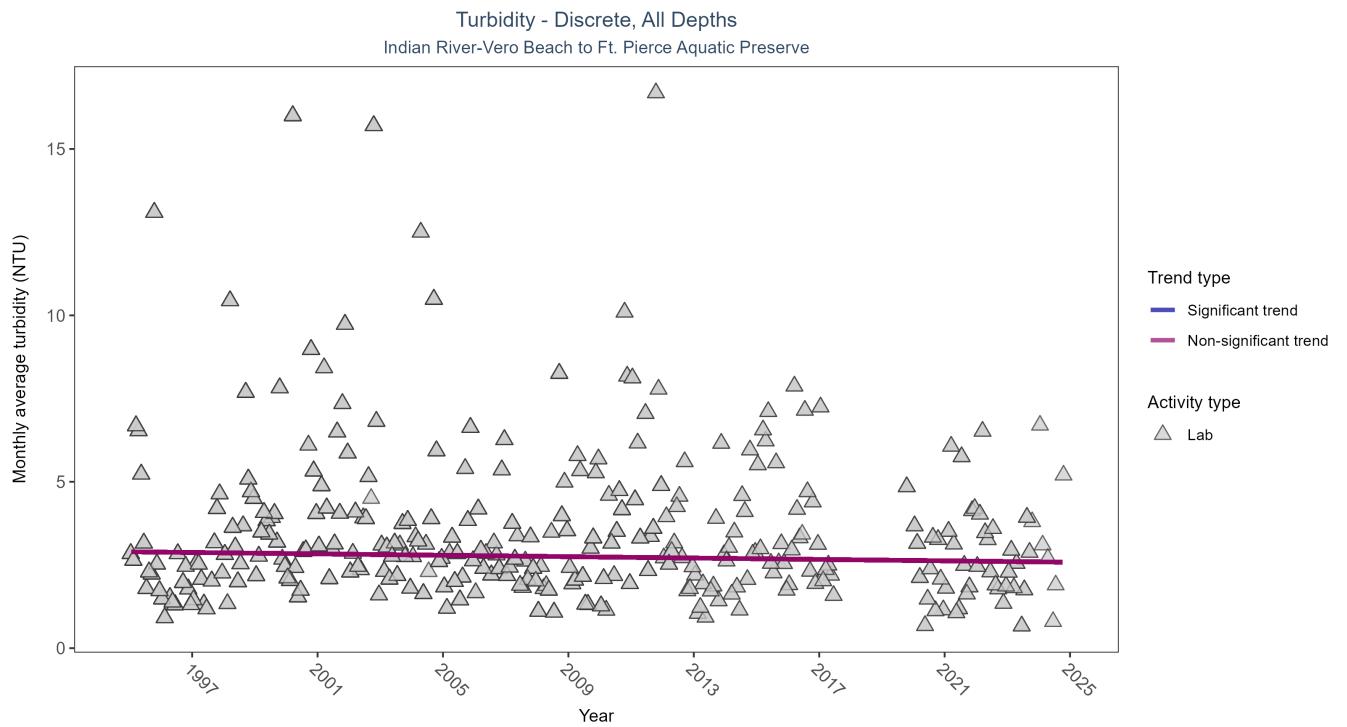


Figure 21: Scatter plot of monthly average turbidity over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only turbidity values measured in the laboratory (triangles) are included in the plot.

Table 26: Seasonal Kendall-Tau Trend Analysis for Turbidity

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Lab	No significant trend	3940	29	1995 - 2024	2.6	-0.0361	2.8958	-0.0104	0.4082

Turbidity showed no detectable trend between 1995 and 2024.

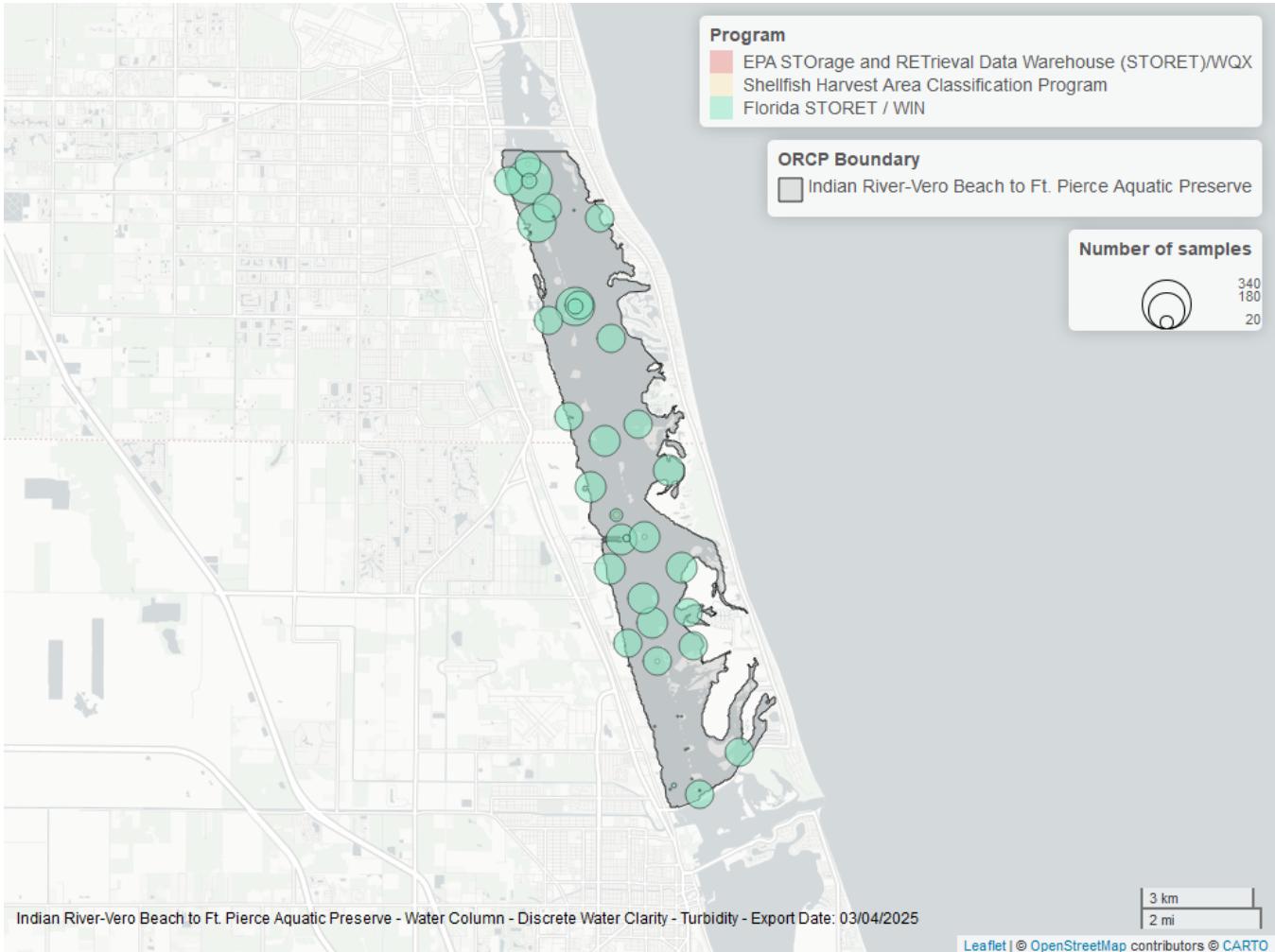


Figure 22: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 27: Programs contributing data for Turbidity

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	3976	1995	2024
3013	304	2004	2019
103	21	2020	2021
540	17	2019	2020

#### Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>1</sup>

540 - Shellfish Harvest Area Classification Program<sup>2</sup>

3013 - Seagrass (SJRWMD)<sup>9</sup>

5002 - Florida STORET / WIN<sup>3</sup>

#### Water Temperature - Discrete

#### Seasonal Kendall-Tau Trend Analysis

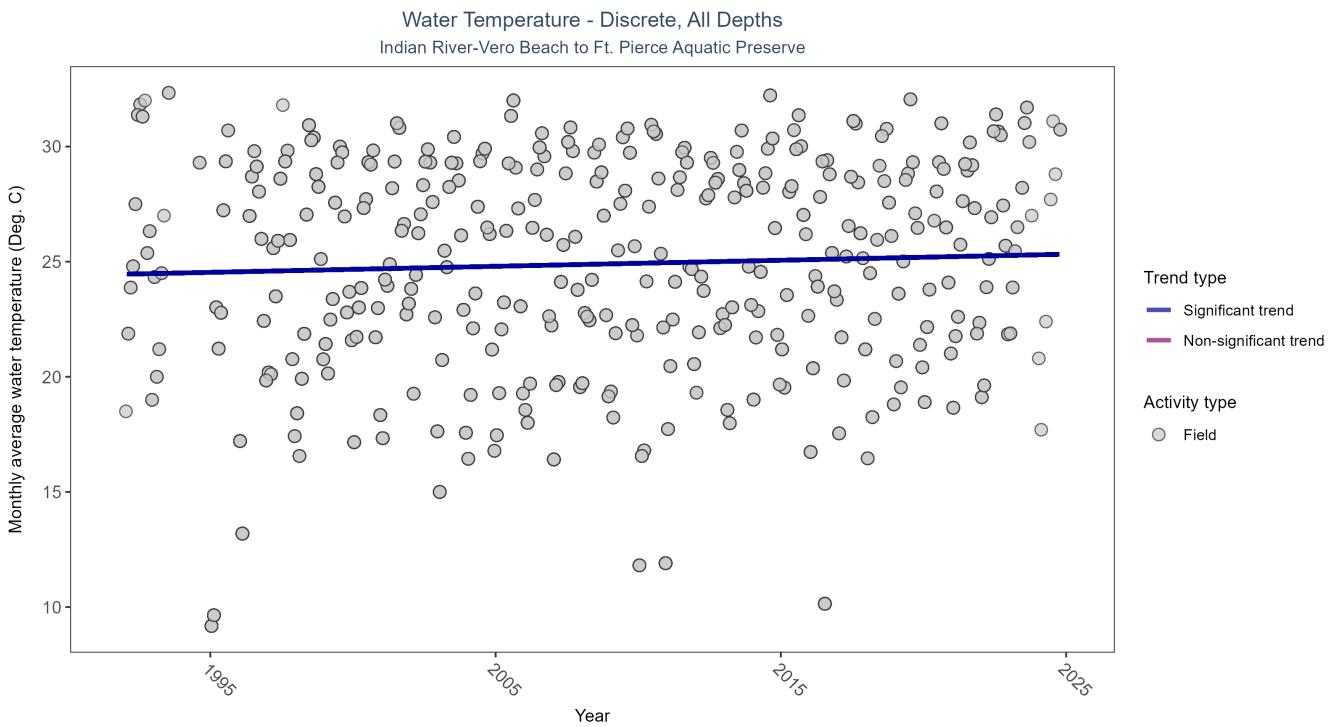


Figure 23: Scatter plot of monthly average water temperature over time. If the time series included ten or more years of discrete observations, a significant (blue) or non-significant (magenta) trend line is also shown. Only water temperature measurements taken in the field (circles) are included in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

Table 28: Seasonal Kendall-Tau Trend Analysis for Water Temperature

Activity Type	Statistical Trend	Sample Count	Years with Data	Period of Record	Median	tau	Sen Intercept	Sen Slope	p
Field	Significantly increasing trend	8674	33	1992 - 2024	25.5	0.1214	24.4574	0.0263	0.0012

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

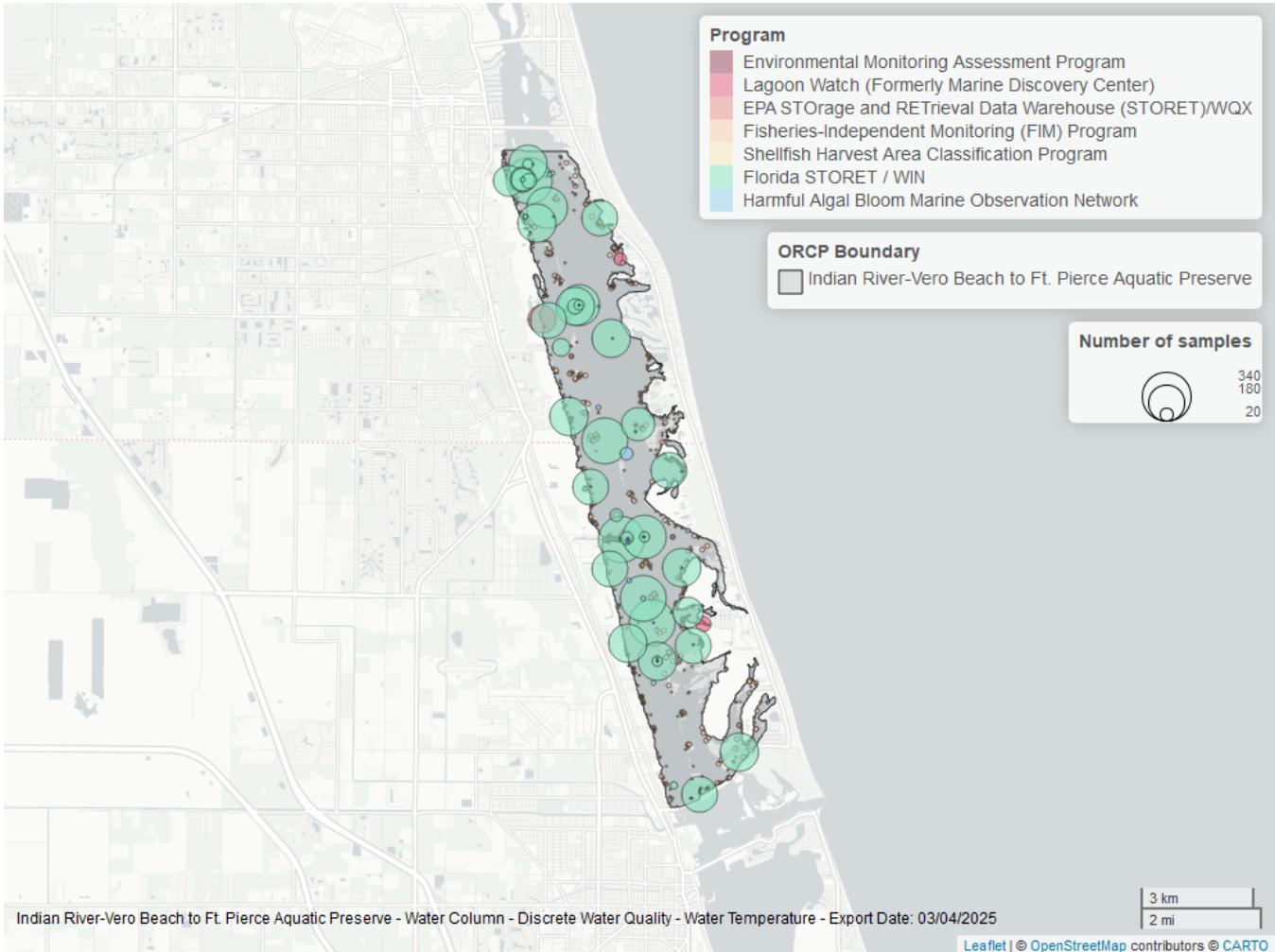


Figure 24: Map showing location of discrete water quality sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

Table 29: Programs contributing data for Water Temperature

<i>ProgramID</i>	<i>N_Data</i>	<i>YearMin</i>	<i>YearMax</i>
5002	6726	1995	2024
69	1314	1997	2022
3013	376	1999	2023
3001	224	1992	2023
95	72	1996	2018
540	60	2016	2020
103	21	2020	2021
115	7	1994	1995

#### Program names:

69 - Fisheries-Independent Monitoring (FIM) Program<sup>5</sup>

95 - Harmful Algal Bloom Marine Observation Network<sup>6</sup>

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX<sup>1</sup>

115 - Environmental Monitoring Assessment Program<sup>7</sup>

540 - Shellfish Harvest Area Classification Program<sup>2</sup>

3001 - Lagoon Watch (Formerly Marine Discovery Center)<sup>8</sup>

3013 - Seagrass (SJRWMD)<sup>9</sup>

5002 - Florida STORET / WIN<sup>3</sup>

# Submerged Aquatic Vegetation

The data file used is: All\_SAV\_Parameters-2025-Mar-06.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

Indian River-Vero Beach to Ft. Pierce Aquatic Preserve  
SAV Percent Cover - Sample Locations

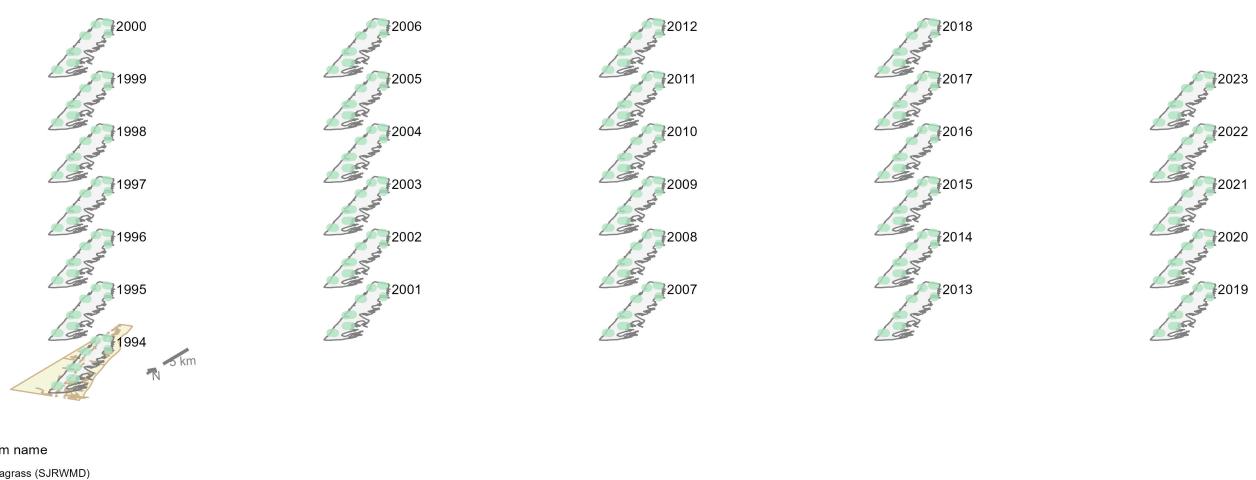


Figure 25: Maps showing the temporal scope of SAV sampling sites within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve* by Program name.

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

#### Sampling locations by Program:

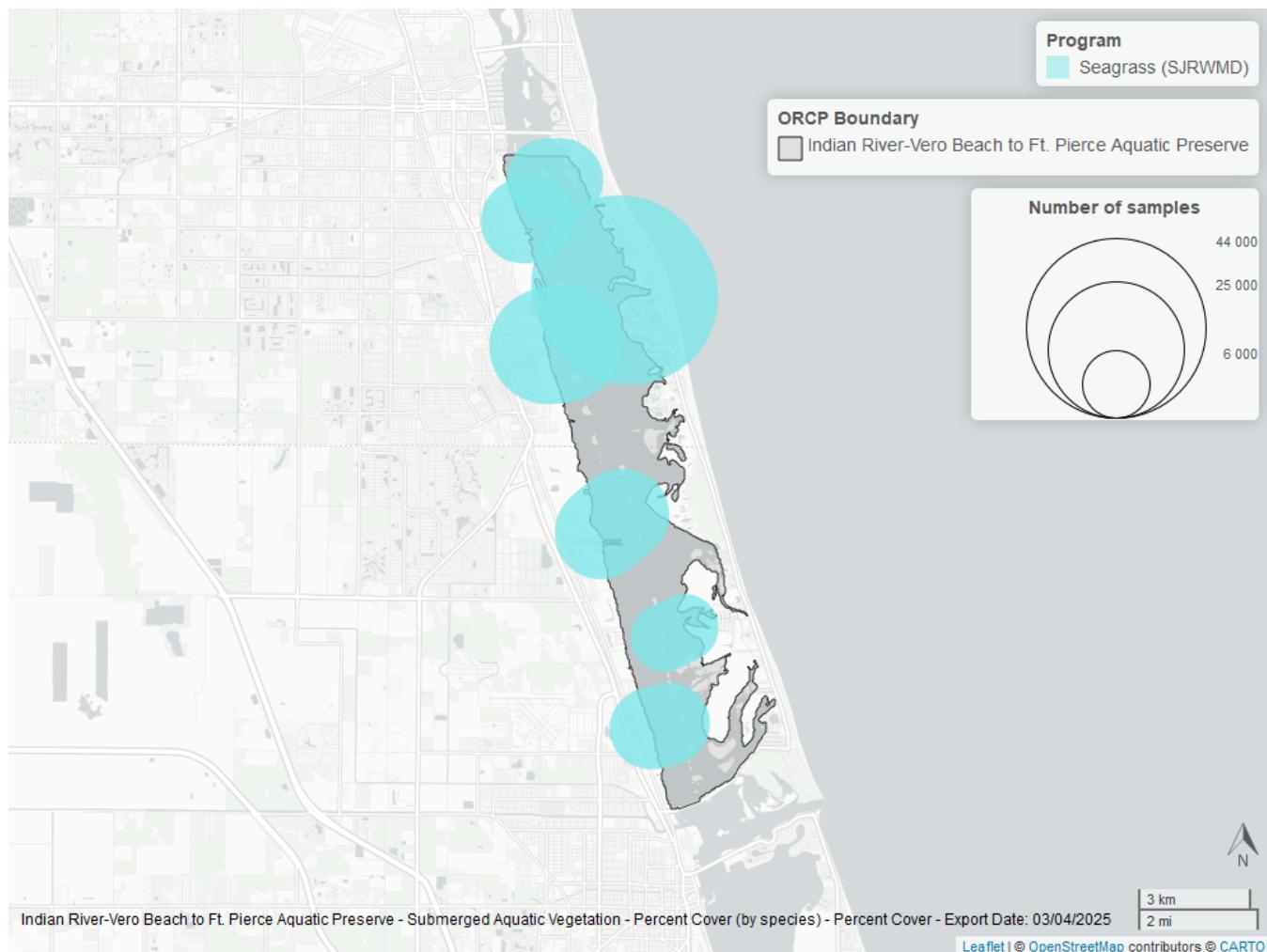


Figure 26: Map showing SAV sampling sites within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The point size reflects the number of samples at a given sampling site.

Table 30: Program Information for Submerged Aquatic Vegetation

ProgramID	N-Data	YearMin	YearMax	method	Sample Locations
3013	49427	1994	2023	Percent Cover	7
3013	58571	1994	2023	Percent Occurrence	7

#### Program names:

3013 - Seagrass (SJRWMD)<sup>9</sup>  
3013 - Seagrass (SJRWMD)<sup>9</sup>

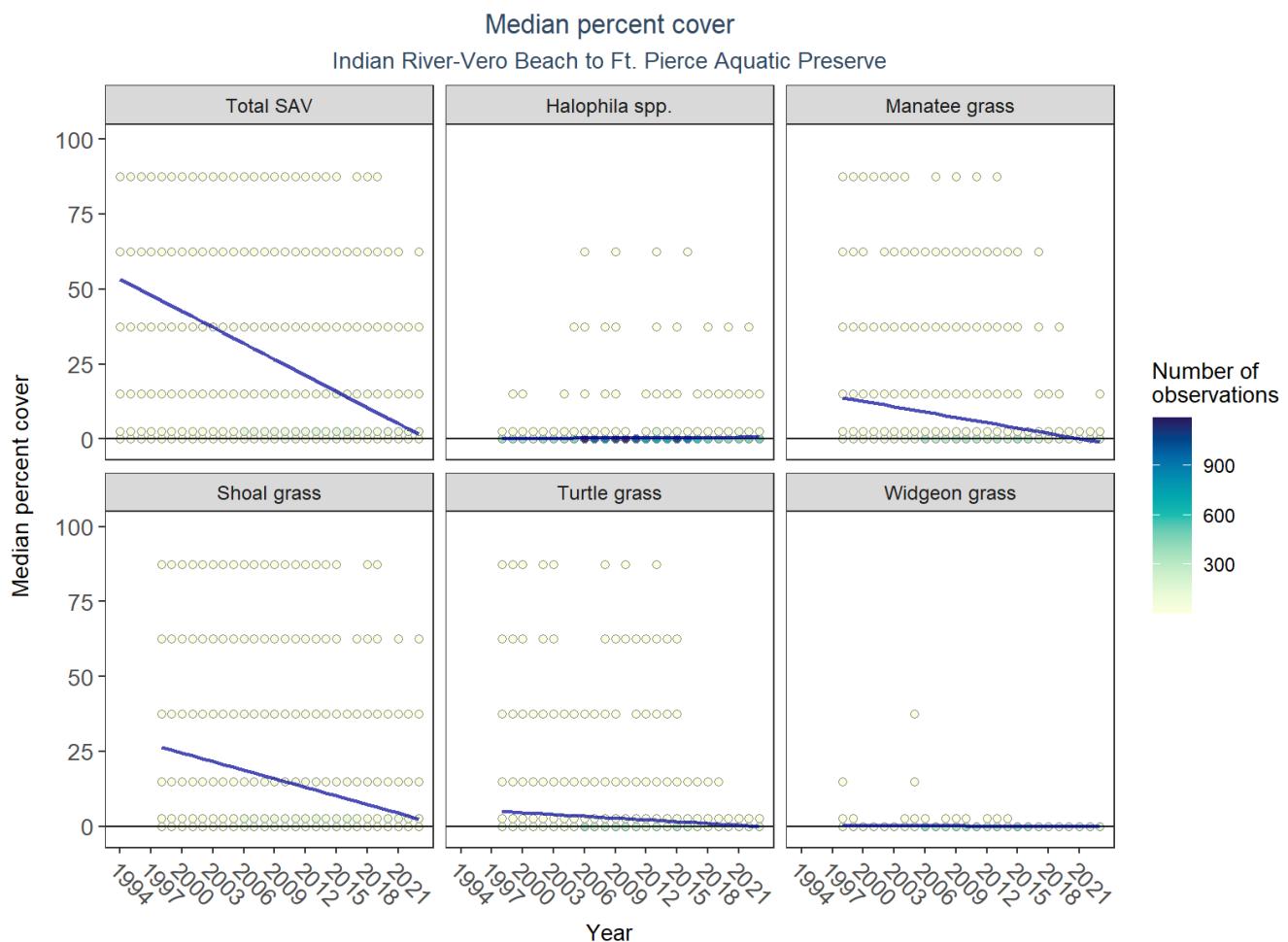


Figure 27: Scatter plots of median percent cover of submerged aquatic vegetation over time by group. Plots for time series that included five or more years of observations show the estimated trend as a blue line.

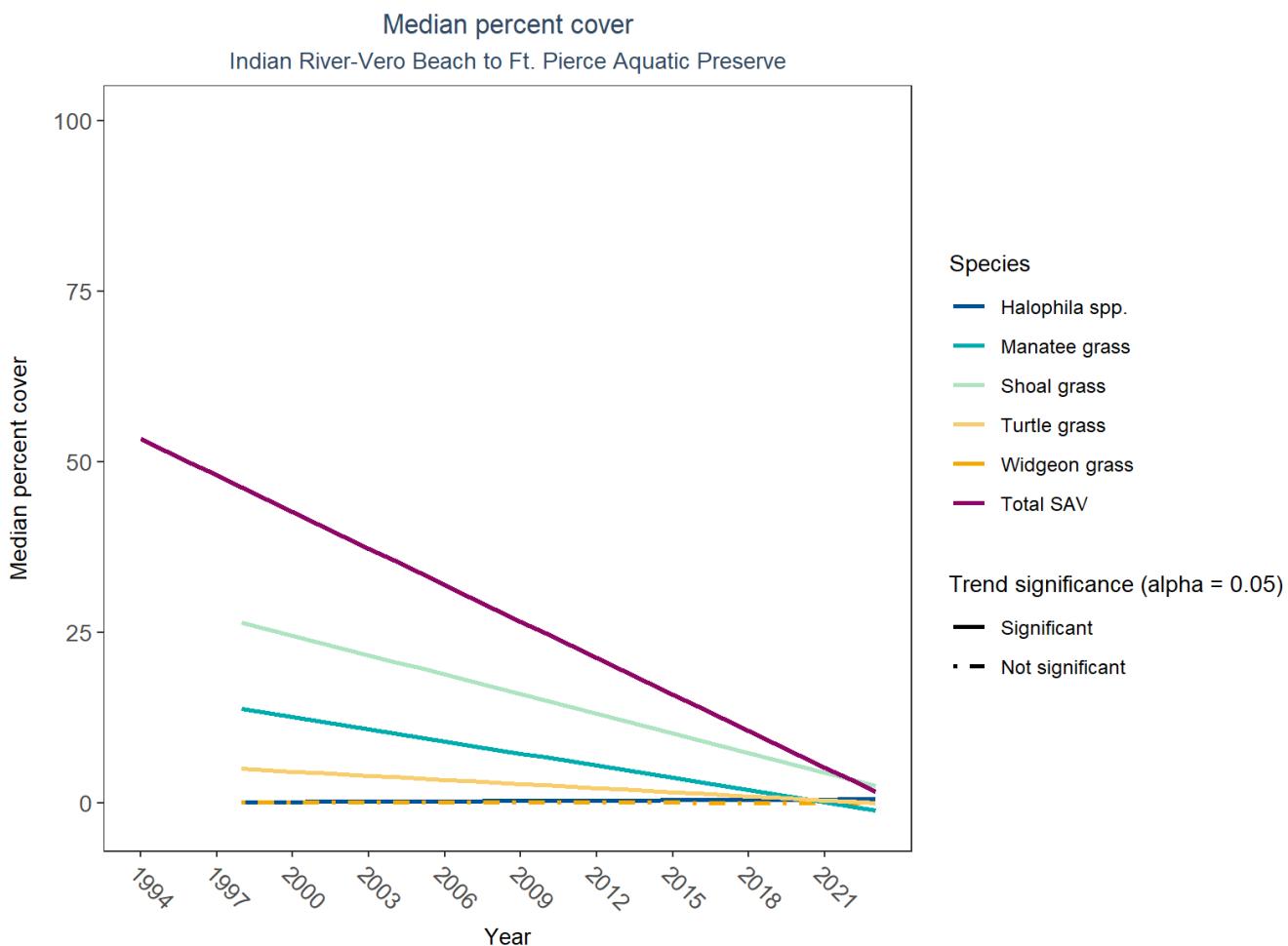


Figure 28: Trends in median percent cover for various seagrass species in Indian River-Vero Beach to Ft. Pierce Aquatic Preserve - simplified

Table 31: Percent Cover Trend Analysis for Indian River-Vero Beach to Ft. Pierce Aquatic Preserve

Common Name	Trend Significance (0.05)	Period of Record	LME-Intercept	LME-Slope	p
Drift algae	Insufficient data to calculate trend	-	-	-	-
Shoal grass	Significantly decreasing trend	1998 - 2023	30.2600732	-0.9574129	0.0005056
Halophila spp.	Significantly increasing trend	1998 - 2023	0.0351223	0.0166105	0.0307204
Widgeon grass	No significant trend	1998 - 2023	0.1352761	-0.0053556	0.1202211
Manatee grass	Significantly decreasing trend	1998 - 2023	16.1459733	-0.5948736	0.0420163
Turtle grass	Significantly decreasing trend	1998 - 2023	5.7711991	-0.2009556	0.0150449
Total SAV	Significantly decreasing trend	1994 - 2023	53.3243550	-1.7835918	0.0000000
Total seagrass	Insufficient data to calculate trend	-	-	-	-

An annual increase in percent cover was observed for *Halophila* spp. (0.0%). Annual decreases in percent cover were observed for total SAV (-1.8%), manatee grass (-0.6%), shoal grass (-1.0%), and turtle grass (-0.2%). No detectable change in percent cover was observed for widgeon grass. Trends in percent cover could not be evaluated for total seagrass and drift algae due to insufficient data.

**Frequency of occurrence**  
Indian River-Vero Beach to Ft. Pierce Aquatic Preserve

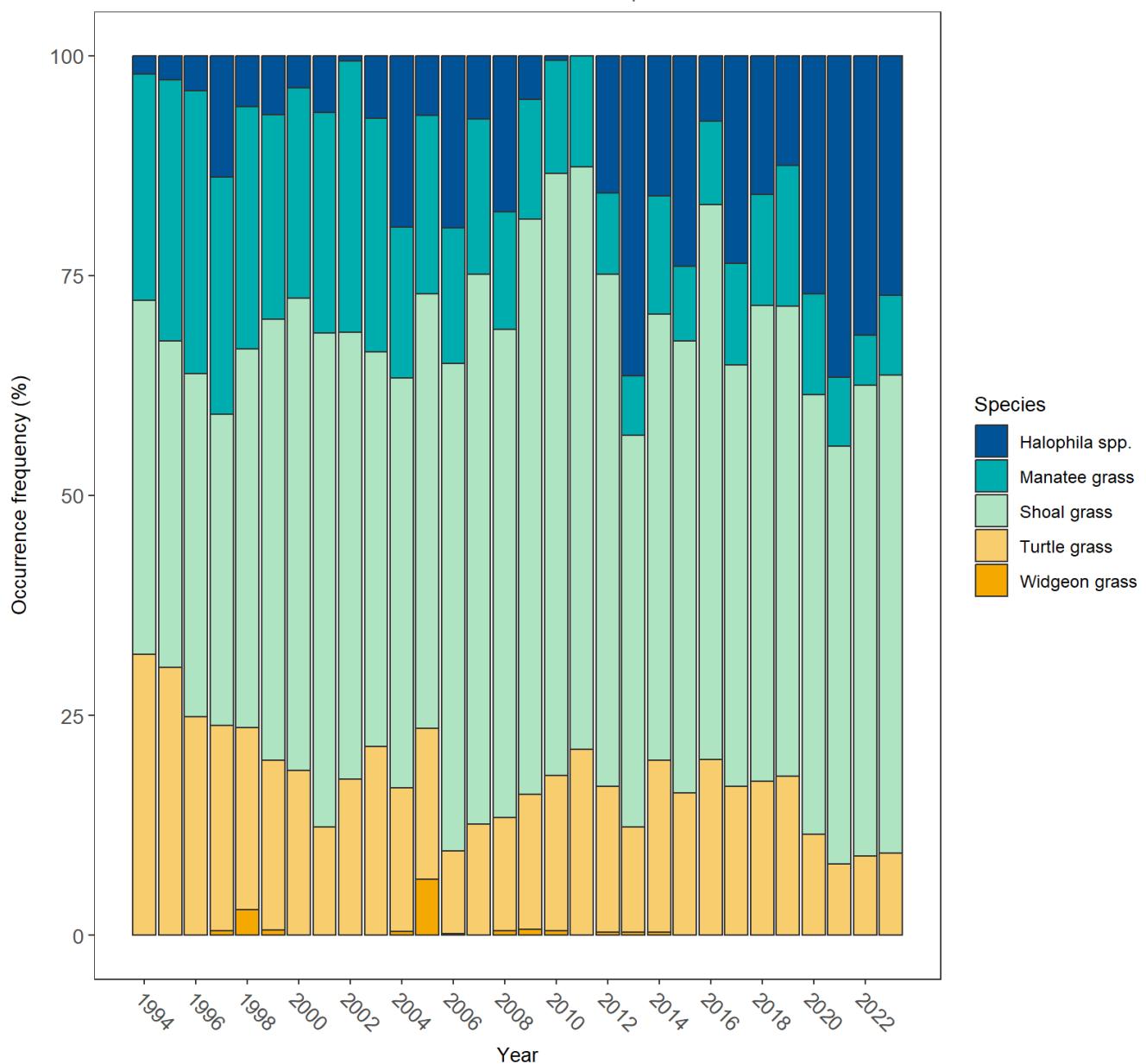


Figure 29: Frequency of occurrence for various seagrass species in Indian River-Vero Beach to Ft. Pierce Aquatic Preserve

# Oyster

The data file used is: All\_OYSTER\_Parameters-2025-Apr-24.txt

## Density

### Natural

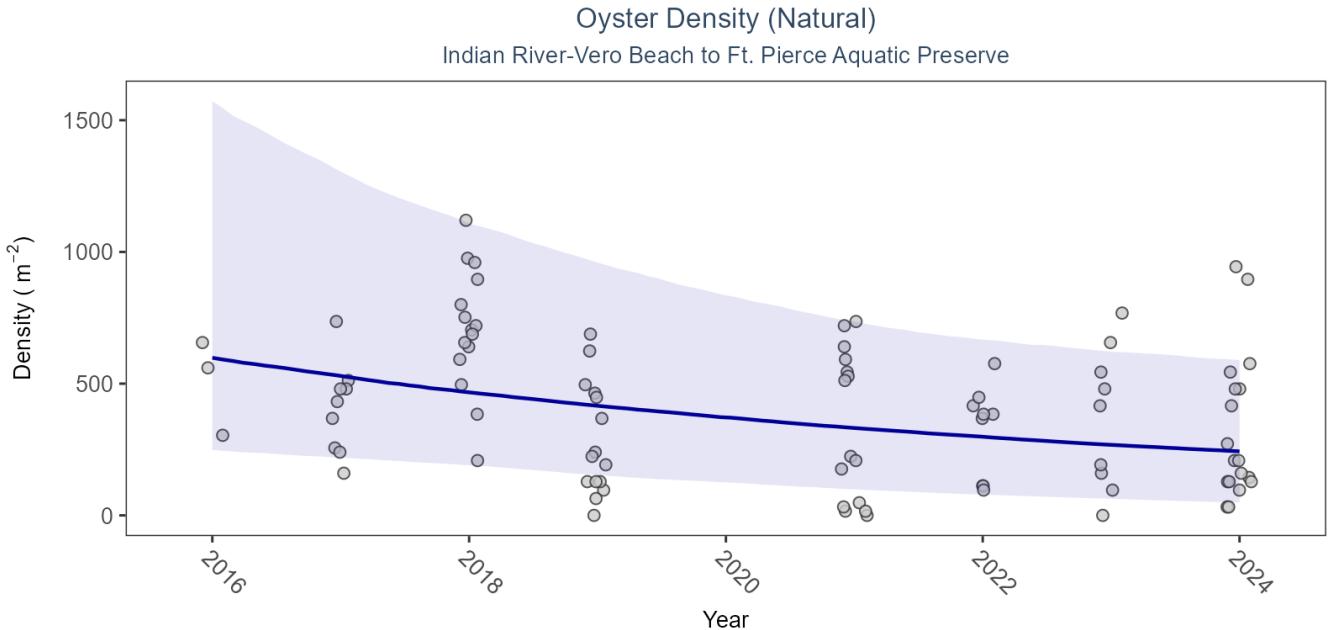


Figure 30: Scatter plot of oyster density over time. If the time series included five or more years with observations, an estimated trend (blue line) and a 95% credible interval (purple band) may also be plotted. Data points are jittered horizontally to reduce overlap.

Table 32: Model results for Oyster Density - Natural

Shell Type	Habitat Type	Trend Status	Estimate	Standard Error	Credible Interval
Live Oysters	Natural	Significantly decreasing trend	-44.2	220.81	-23.86 to -119.22

For natural reefs, density decreased by an average of 44.2 oysters per square meter per year.

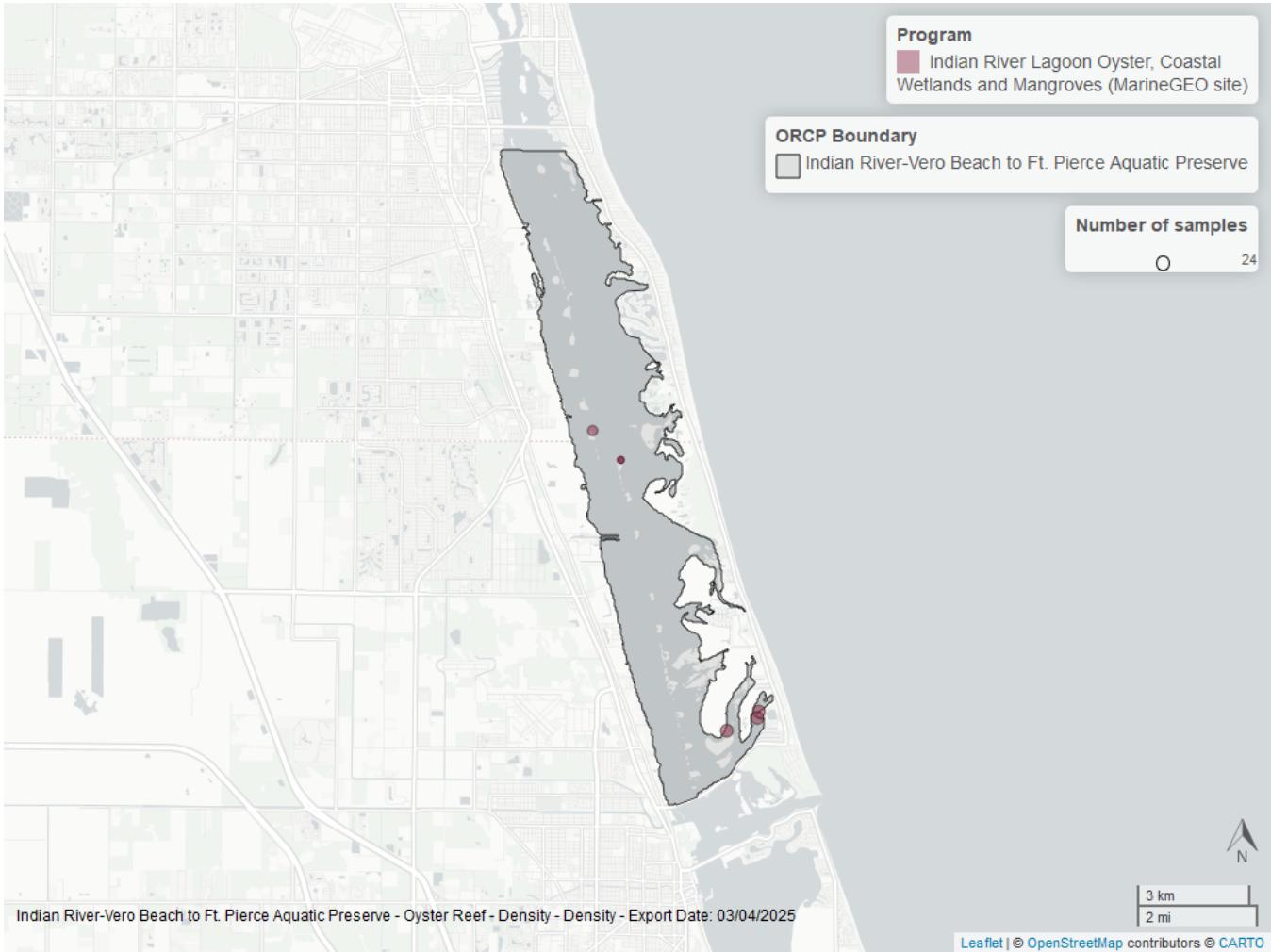


Figure 31: Map showing location of oyster density sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Percent Live

### Natural

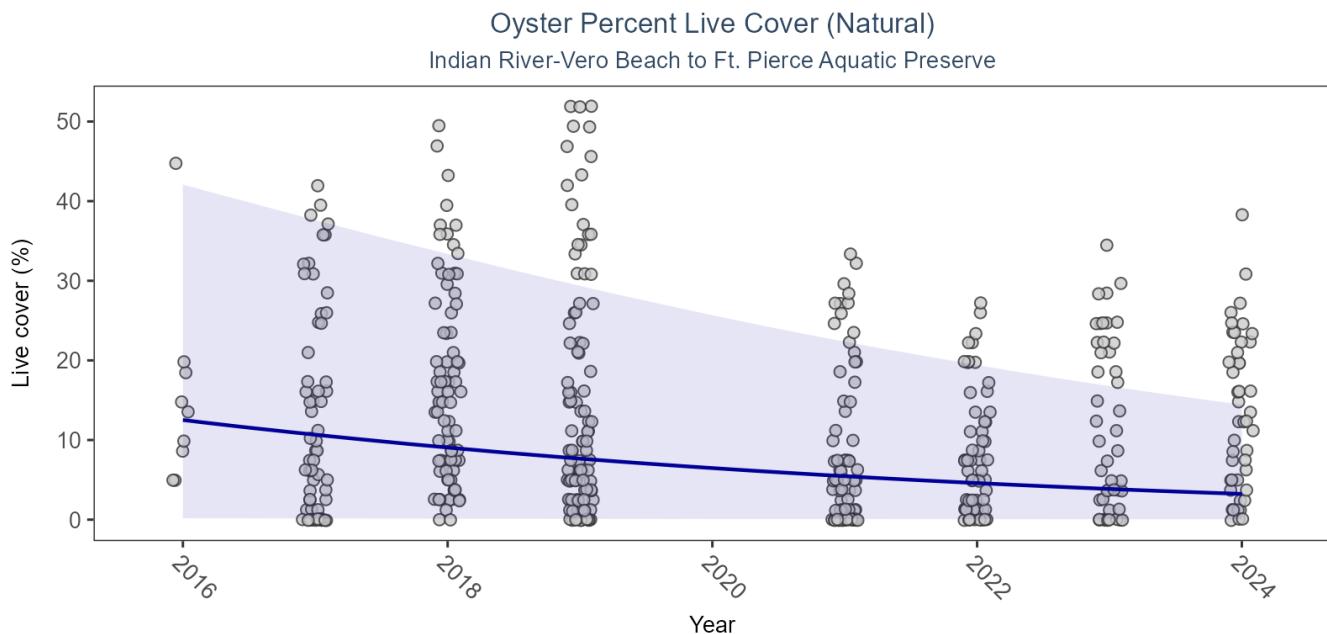


Figure 32: Scatter plot of percent live oysters over time. If the time series included five or more years with observations, an estimated trend (blue line) and a 95% credible interval (purple band) may also be plotted. Data points are jittered horizontally to reduce overlap.

Table 33: Model results for Oyster Percent Live - Natural

<i>Shell Type</i>	<i>Habitat Type</i>	<i>Trend Status</i>	<i>Estimate</i>	<i>Standard Error</i>	<i>Credible Interval</i>
Live Oysters	Natural	Significantly decreasing trend	-1.17	9.86	-0.02 to -3.47

For natural reefs, percent live cover decreased by an average of 1.17% per year.

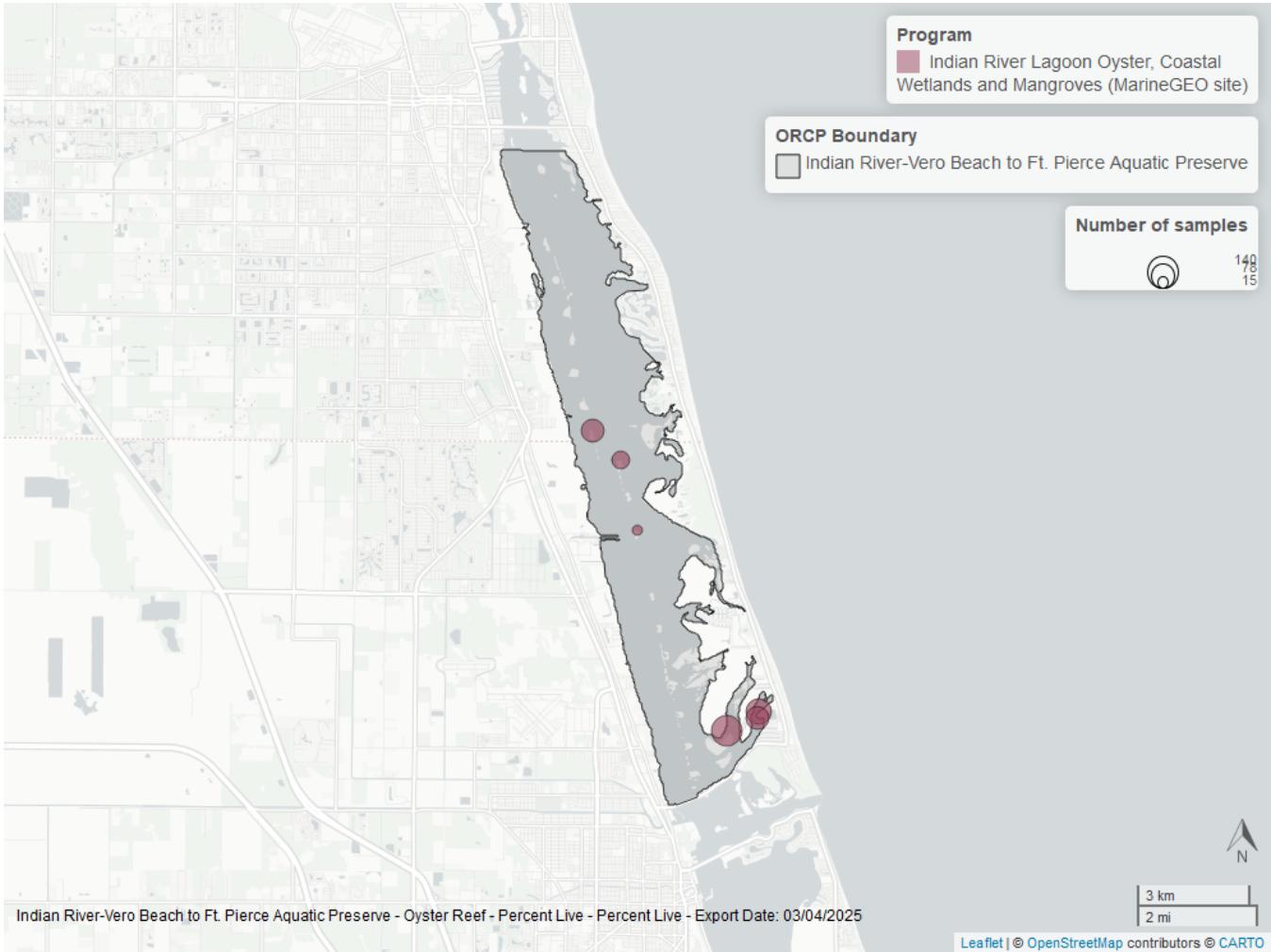


Figure 33: Map showing location of oyster percent live sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## Shell Height

### Natural

Oyster Size Class (Natural)  
Indian River-Vero Beach to Ft. Pierce Aquatic Preserve

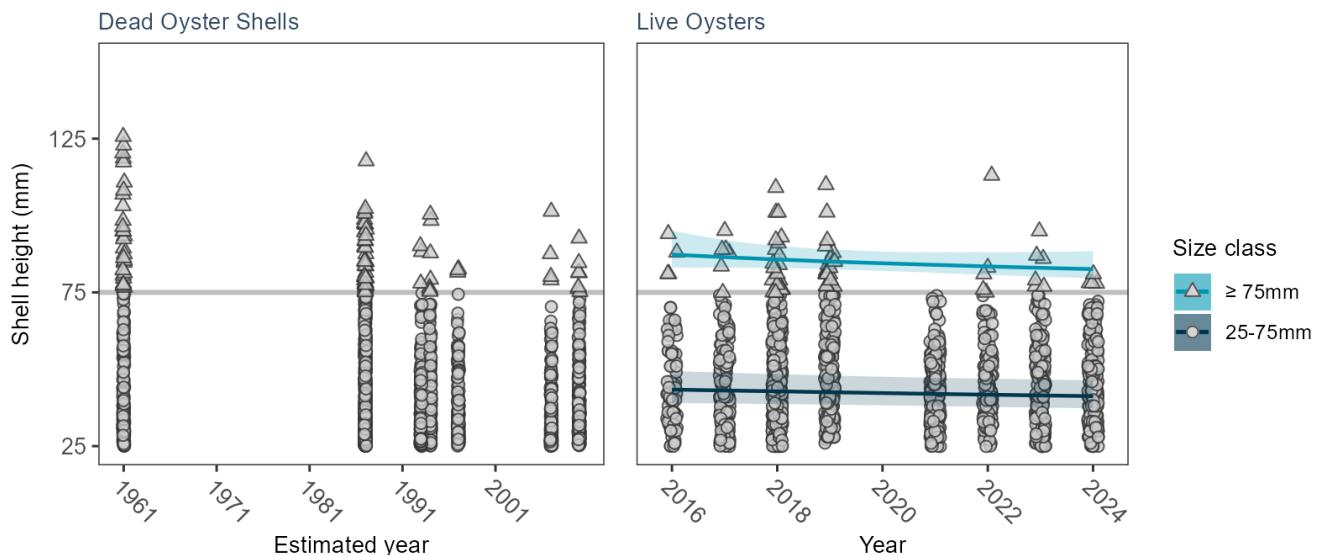


Table 34: Model results for Oyster Shell Height - Natural

Shell Type	SizeClass	Habitat Type	Trend Status	Estimate	Standard Error	Credible Interval
Dead Oyster Shells	>75mm	Natural	-	-	-	-
Dead Oyster Shells	25-75mm	Natural	-	-	-	-
Dead Oyster Shells		Natural	-	-	-	-
Live Oysters	>75mm	Natural	No significant change	-2.71	2.59	-8.62 to 1.51
Live Oysters	25-75mm	Natural	Significantly decreasing trend	-0.75	0.34	-1.44 to -0.07
Live Oysters		Natural	-	-	-	-

For natural reefs, annual average live oyster shell height in the 25-75mm and  $\geq 75\text{mm}$  size classes decreased by 0.75mm per year and 2.71mm per year, respectively. Models are not run on dead oyster shell measurements.

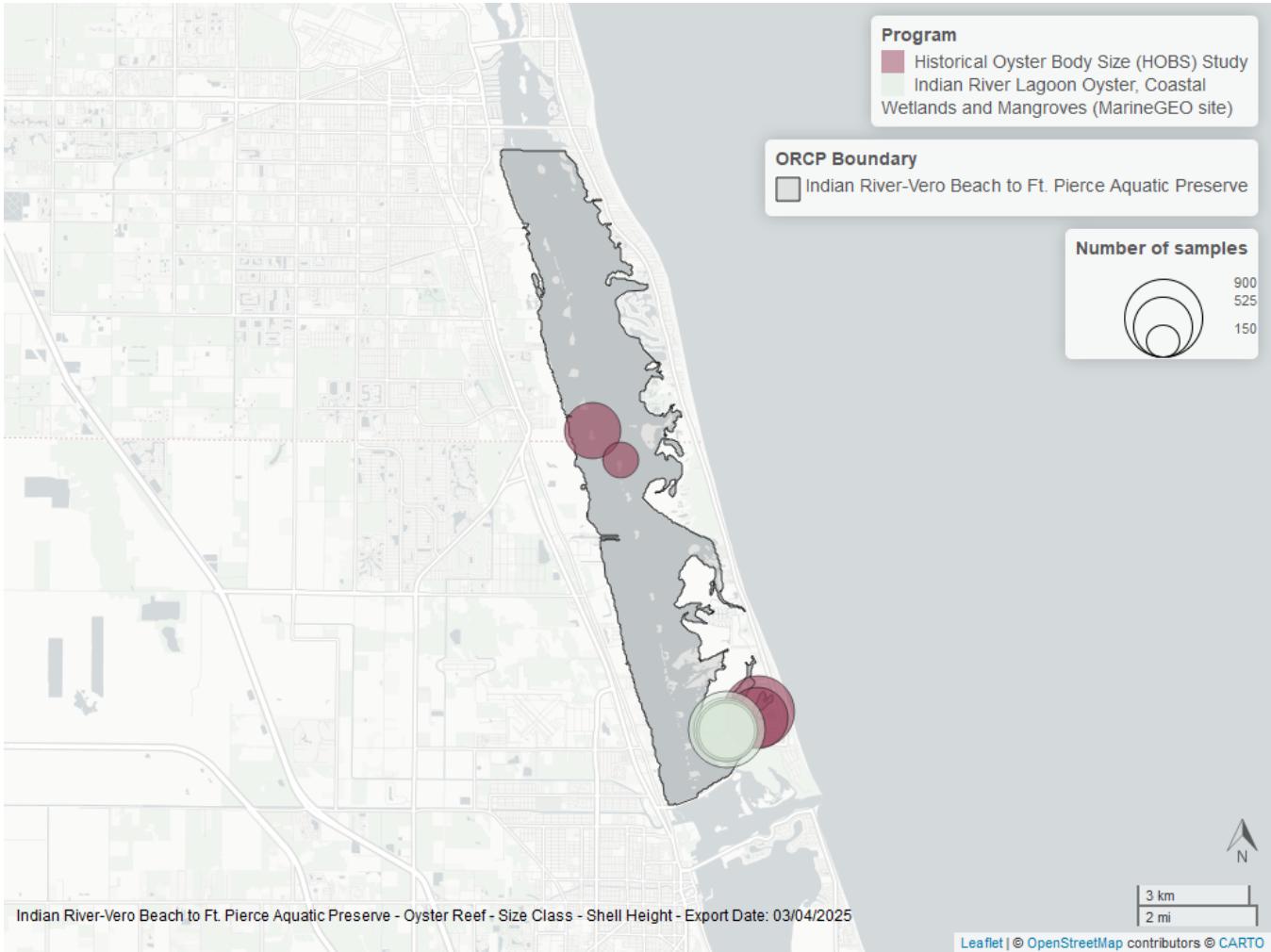


Figure 34: Map showing location of oyster shell height sampling locations within the boundaries of *Indian River-Vero Beach to Ft. Pierce Aquatic Preserve*. The bubble size on the maps above reflect the amount of data available at each sampling site.

## References

1. U.S. Environmental Protection Agency (EPA). [EPA STOREt and RETrieval Data Warehouse \(STORET\)/WQX](#). (2023).
2. Florida Department of Agriculture and Consumer Services (FDACS) - Division of Aquaculture. [Shellfish Harvest Area Classification Program](#). (2022).
3. Florida Department of Environmental Protection (DEP). [Florida STORET / WIN](#). (2024).
4. 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).
5. Florida Fish and Wildlife Conservation Commission (FWC). [Fisheries-Independent Monitoring \(FIM\) Program](#). (2022).
6. Florida Fish and Wildlife Conservation Commission (FWC); Florida Fish and Wildlife Research Institute (FWRI). [Harmful Algal Bloom Marine Observation Network](#). (2018).
7. U.S. Environmental Protection Agency (EPA); Office of Research and Development. [Environmental Monitoring Assessment Program](#). (2004).
8. Volusia County (Florida); Marine Discovery Center. [Lagoon Watch \(Formerly Marine Discovery Center\)](#). (2023).
9. St. Johns River Water Management District (SJRWMD). [Seagrass \(SJRWMD\)](#). (2023).