Florida Keys National Marine Sanctuary

SEACAR Habitat Analyses

Last compiled on 08 January, 2025

Contents

Funding & Acknowledgements

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Threshold Filtering

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

Table 1: Continuous Water Quality threshold values

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

Table 2: Discrete Water Quality threshold values

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

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

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

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

Value Qualifiers

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

STORET and WIN value qualifier codes

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

Table 4: Value Qualifier codes excluded from analysis

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

Discrete Water Quality Value Qualifiers

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

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

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

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

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

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

Systemwide Monitoring Program (SWMP) value qualifier codes

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

Table 5: SWMP Value Qualifier codes

Qualifier Source	*Value Qualifier*	*Include*	*Description*
SWMP	-1	Yes	Optional parameter not collected
SWMP	-2	No	Missing data
SWMP	-3	No	Data rejected due to QA/QC
SWMP	-4	No	Outside low sensor range
SWMP	-5	No	Outside high sensor range
SWMP	0	Yes	Passed initial QA/QC checks
SWMP	1	No	Suspect data
SWMP	2	Yes	Reserved for future use
SWMP	3	Yes	Calculated data: non-vented depth/level sensor correction for changes in barometric pressure
SWMP	4	Yes	Historical: Pre-auto QA/QC
SWMP	5	Yes	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, andwater quality assessments of salinity, dissolved oxygen, pH, and water temperature. Water clarity is evaluated with Secchi depth, turbidity, levels of chlorophyll a, total suspended solids, and colored dissolved organic matter. Additionally, the richness of nekton is indicated by the abundance of free-swimming fishes and macroinvertebrates like crabs and shrimps.

Seasonal Kendall-Tau Analysis

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

Water Quality - Discrete

The following files were used in the discrete analysis:

- *Combined_WQ_WC_NUT_Chlorophyll_a_corrected_for_pheophytin-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_Chlorophyll_a_uncorrected_for_pheophytin-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_Colored_dissolved_organic_matter_CDOM-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_Dissolved_Oxygen-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_Dissolved_Oxygen_Saturation-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_pH-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_Salinity-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_Secchi_Depth-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_Total_Nitrogen-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_Total_Phosphorus-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_Total_Suspended_Solids_TSS-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_Turbidity-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_Water_Temperature-2024-Dec-08.txt*

Chlorophyll a, Corrected for Pheophytin - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

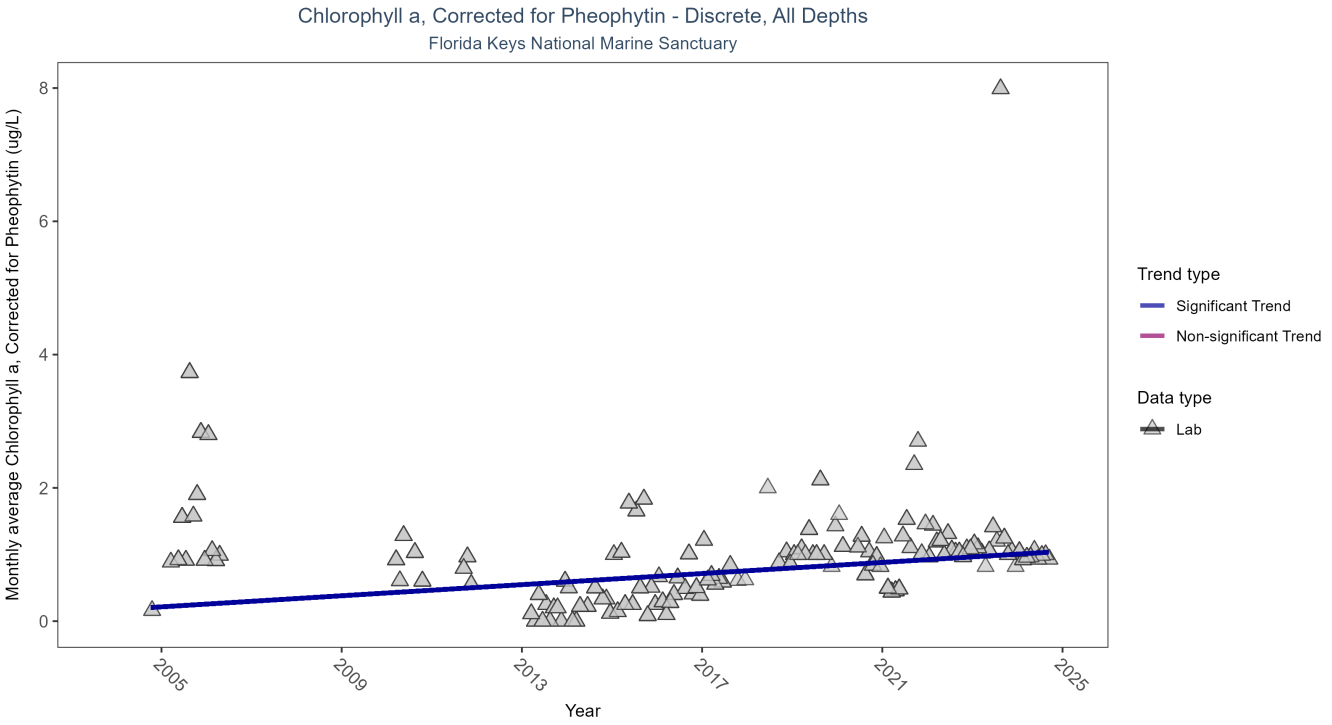

Figure 1: Seasonal Kendall-Tau Results for Chlorophyll a, Corrected for Pheophytin - Discrete

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

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	2040	17	0.62	TRUE	0.2839	0	0.0417	0.1727	4.0921	0.9671	1

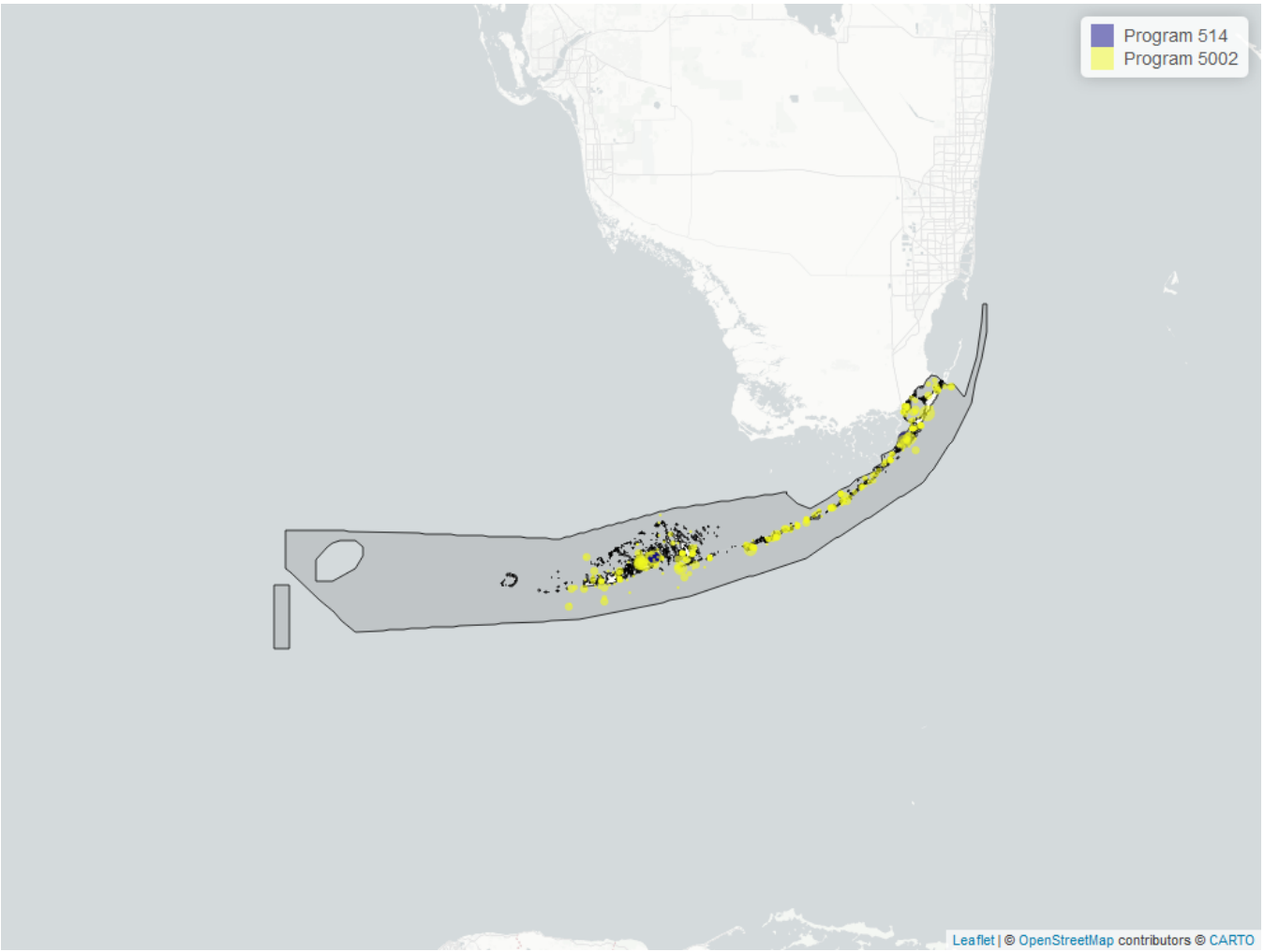

Figure 2: Map showing location of Discrete sampling sites for Chlorophyll a, Corrected for Pheophytin. The bubble size on the maps below reflect the amount of data available at each sampling site.

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

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	1935	2004	2024
514	198	2018	2024

Program names:

514 - Florida LAKEWATCH Program[1]
5002 - Florida STORET / WIN[2]

Chlorophyll a, Uncorrected for Pheophytin - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

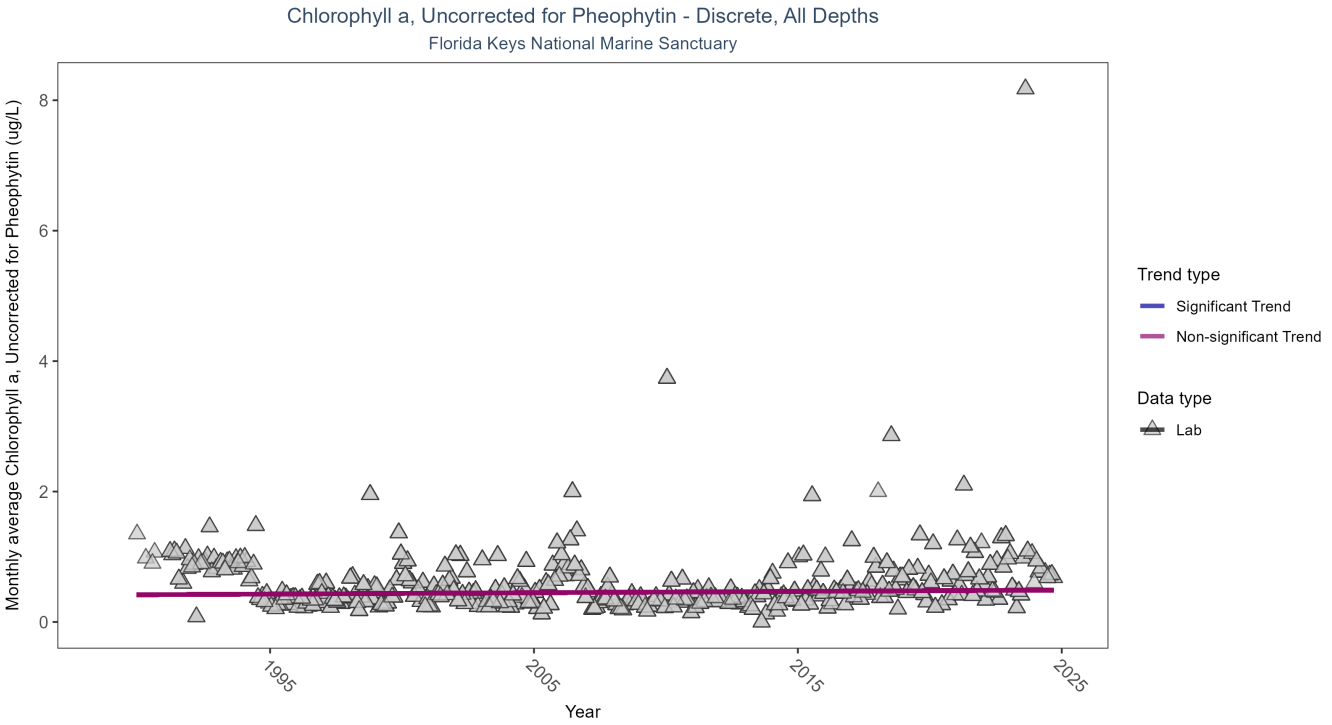

Figure 3: Seasonal Kendall-Tau Results for Chlorophyll a, Uncorrected for Pheophytin - Discrete

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

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	21241	36	0.2973	TRUE	0.0523	0.1458	0.0021	0.4152	11.2221	0.4248	0

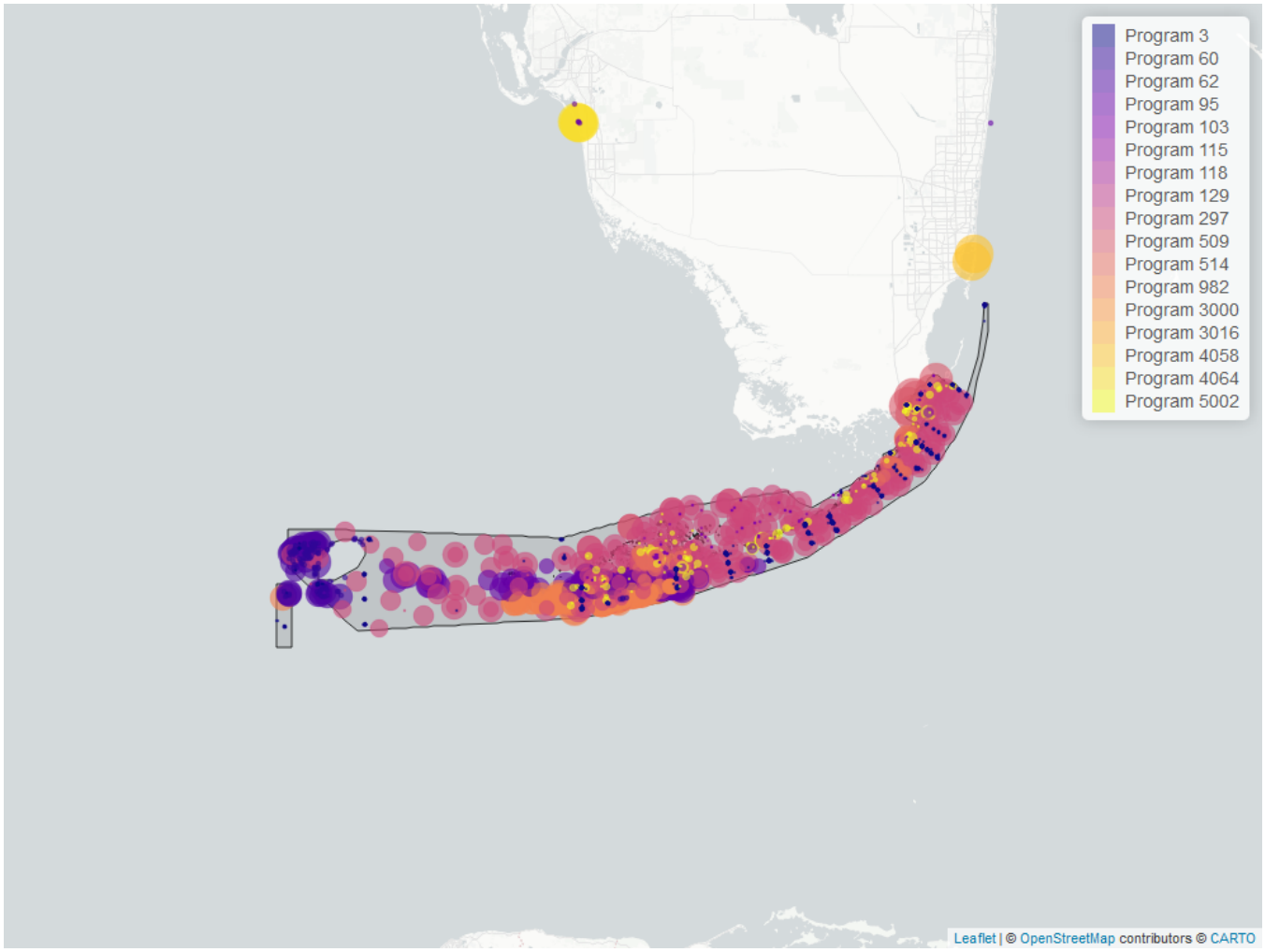

Figure 4: Map showing location of Discrete sampling sites for Chlorophyll a, Uncorrected for Pheophytin. The bubble size on the maps below reflect the amount of data available at each sampling site.

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

ProgramID	*N_Data*	*YearMin*	*YearMax*
297	16110	1995	2023
3	3701	1998	2024
514	2819	1998	2024
509	1418	1989	2008
5002	979	2001	2024
60	345	1993	2016
103	154	2000	2021
118	28	2000	2010
115	28	2000	2004

Program names:

3 - Atlantic Oceanographic and Meteorological Laboratory (AOML) South Florida Program Synoptic Shipboard Surveys[3]
60 - Southeast Area Monitoring and Assessment Program (SEAMAP) - Gulf of Mexico Fall & Summer

Shrimp/Groundfish Survey[4]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[5]
115 - Environmental Monitoring Assessment Program[6]
118 - National Aquatic Resource Surveys, National Coastal Condition Assessment[7]
297 - Florida Keys National Marine Sanctuary Water Quality Monitoring Project[8]
509 - SERC Water Quality Monitoring Network[9]
514 - Florida LAKEWATCH Program[1]
5002 - Florida STORET / WIN[2]

Colored Dissolved Organic Matter - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

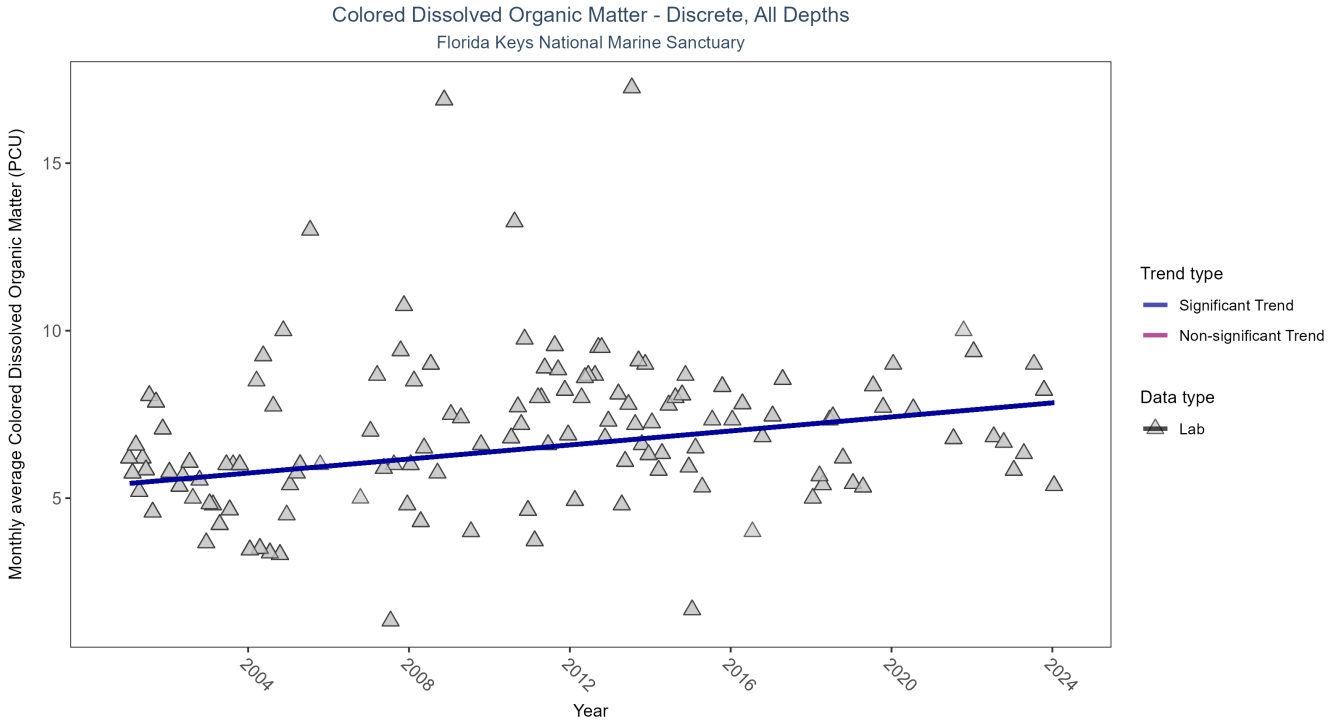

Figure 5: Seasonal Kendall-Tau Results for Colored Dissolved Organic Matter - Discrete

Table 10: Seasonal Kendall-Tau Trend Analysis for Colored Dissolved Organic Matter

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	1025	24	6	TRUE	0.2457	0.0003	0.1048	5.4354	13.4097	0.2674	1

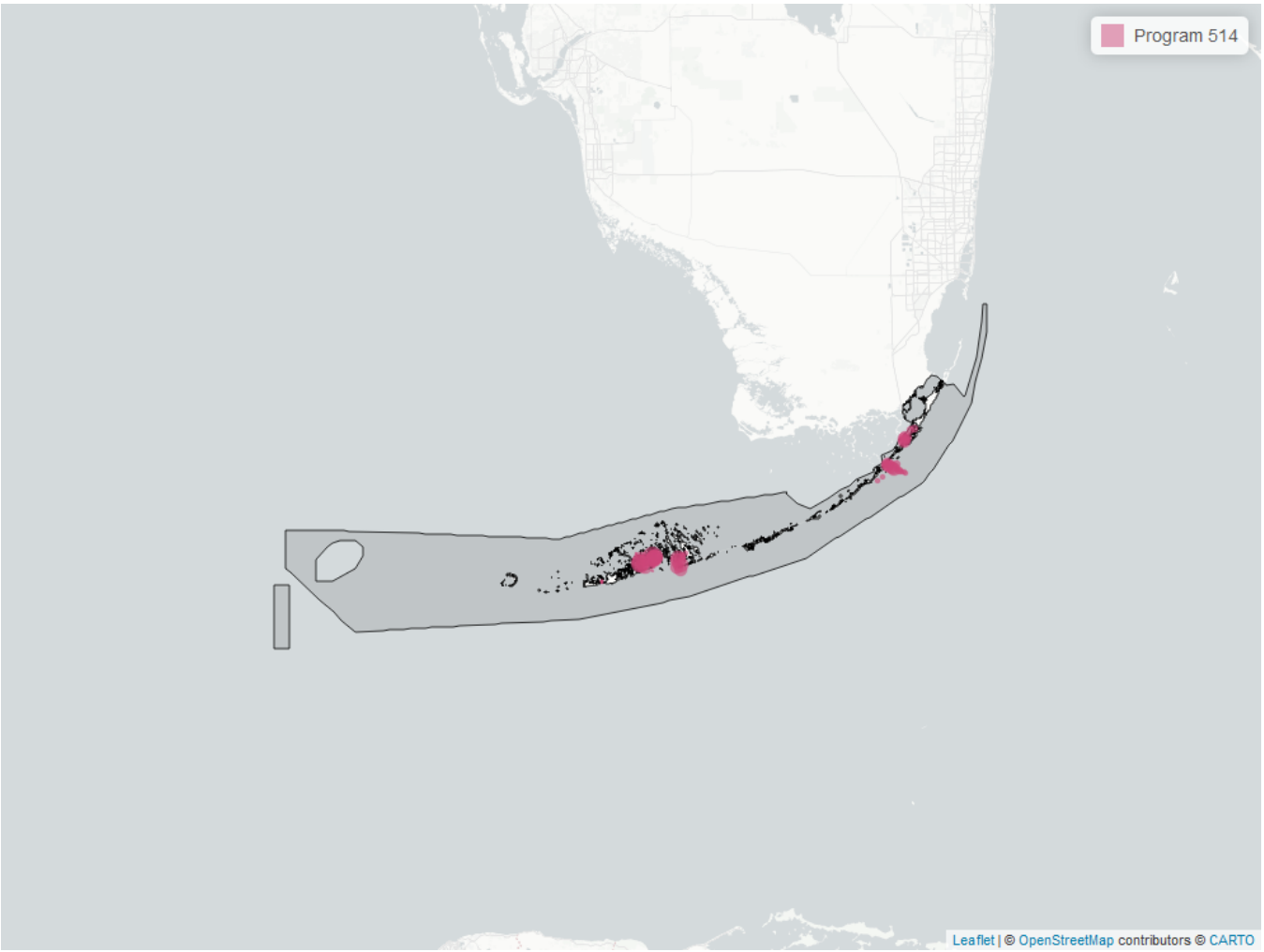

Figure 6: Map showing location of Discrete sampling sites for Colored Dissolved Organic Matter. The bubble size on the maps below reflect the amount of data available at each sampling site.

Table 11: Programs contributing data for Colored Dissolved Organic Matter

ProgramID	*N_Data*	*YearMin*	*YearMax*
514	1025	2001	2024

Program names:

514 - Florida LAKEWATCH Program[1]

Dissolved Oxygen - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

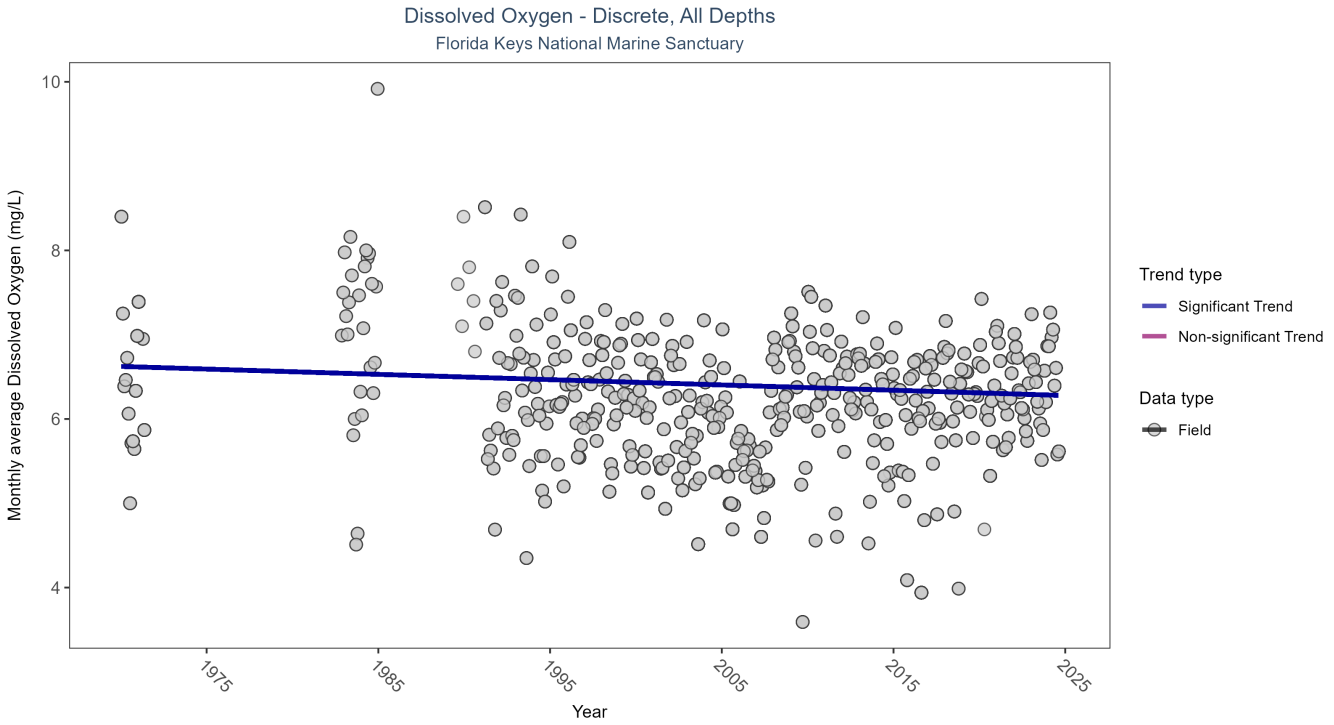

Figure 7: Seasonal Kendall-Tau Results for Dissolved Oxygen - Discrete

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

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	47232	41	6.3	TRUE	-0.0912	0.0051	-0.0063	6.6235	10.8294	0.4577	-1

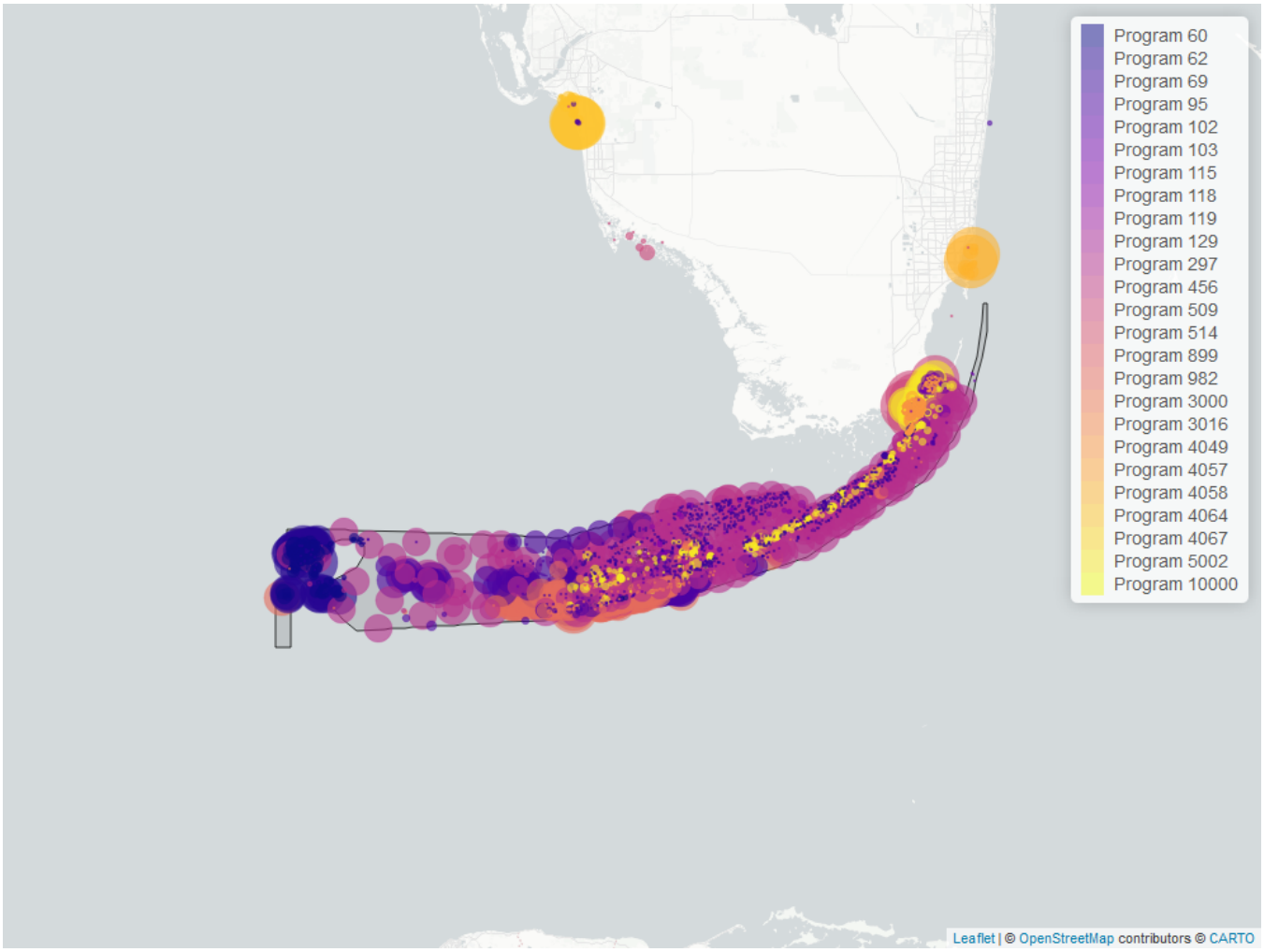

Figure 8: Map showing location of Discrete sampling sites for Dissolved Oxygen. The bubble size on the maps below reflect the amount of data available at each sampling site.

Table 13: Programs contributing data for Dissolved Oxygen

ProgramID	*N_Data*	*YearMin*	*YearMax*
297	32169	1995	2023
5002	5155	2003	2024
509	2701	1989	2008
69	1743	1997	2022
60	1592	1993	2016
95	1560	1994	2018
4049	1024	2006	2023
103	601	1970	2021
3000	377	2015	2018
118	104	2000	2021
899	93	2014	2015
115	89	2000	2004
4057	59	2015	2018
102	42	1996	2000

Program names:

60 - Southeast Area Monitoring and Assessment Program (SEAMAP) - Gulf of Mexico Fall & Summer Shrimp/Groundfish Survey[4]
69 - Fisheries-Independent Monitoring (FIM) Program[10]
95 - Harmful Algal Bloom Marine Observation Network[11]
102 - National Status and Trends Mussel Watch[12]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[5]
115 - Environmental Monitoring Assessment Program[6]
118 - National Aquatic Resource Surveys, National Coastal Condition Assessment[7]
297 - Florida Keys National Marine Sanctuary Water Quality Monitoring Project[8]
509 - SERC Water Quality Monitoring Network[9]
899 - USGS Coral Reef Ecosystem Studies (CREST) Project[13]
3000 - Florida Keys Water Watch[14]
4049 - The South Florida Fisheries Habitat Assessment Program (FHAP)[15]
4057 - Biscayne Bay Water Watch[16]
5002 - Florida STORET / WIN[2]

Dissolved Oxygen Saturation - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

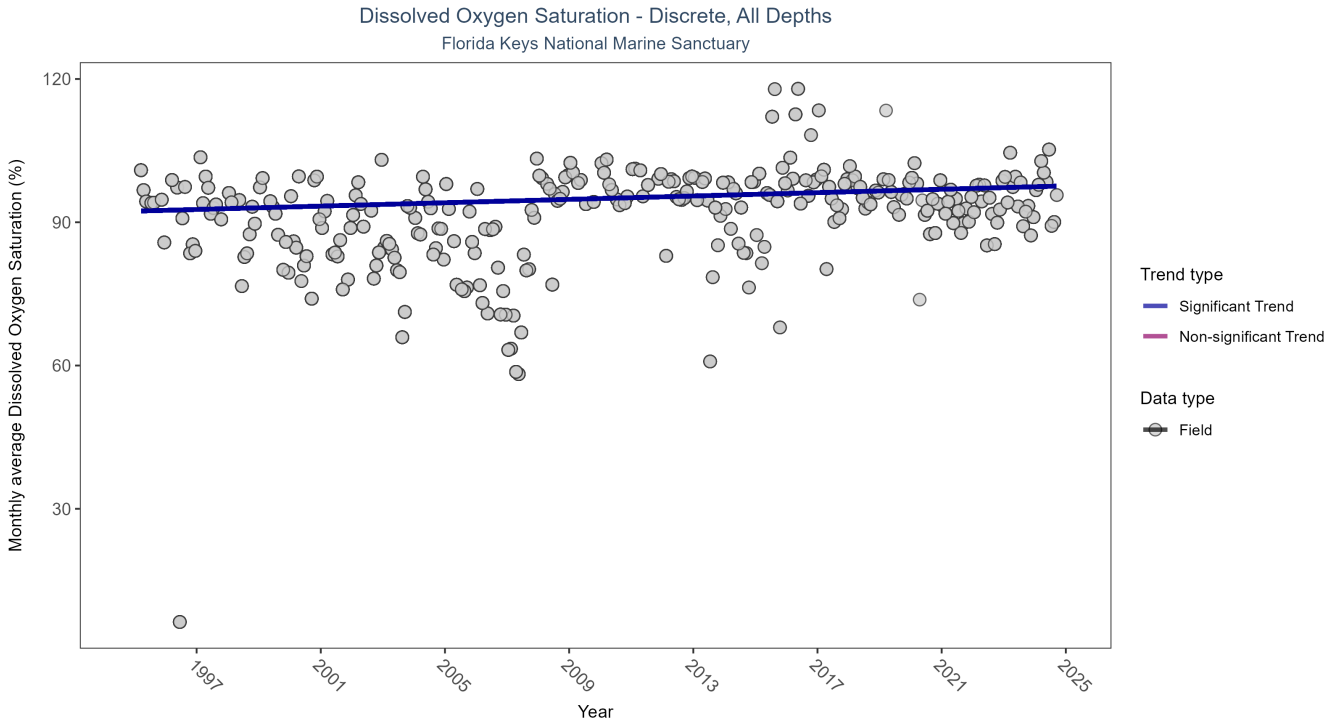

Figure 9: Seasonal Kendall-Tau Results for Dissolved Oxygen Saturation - Discrete

Table 14: Seasonal Kendall-Tau Trend Analysis for Dissolved Oxygen Saturation

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	29278	30	94.7734	TRUE	0.1878	0	0.1763	92.3237	8.7389	0.646	1

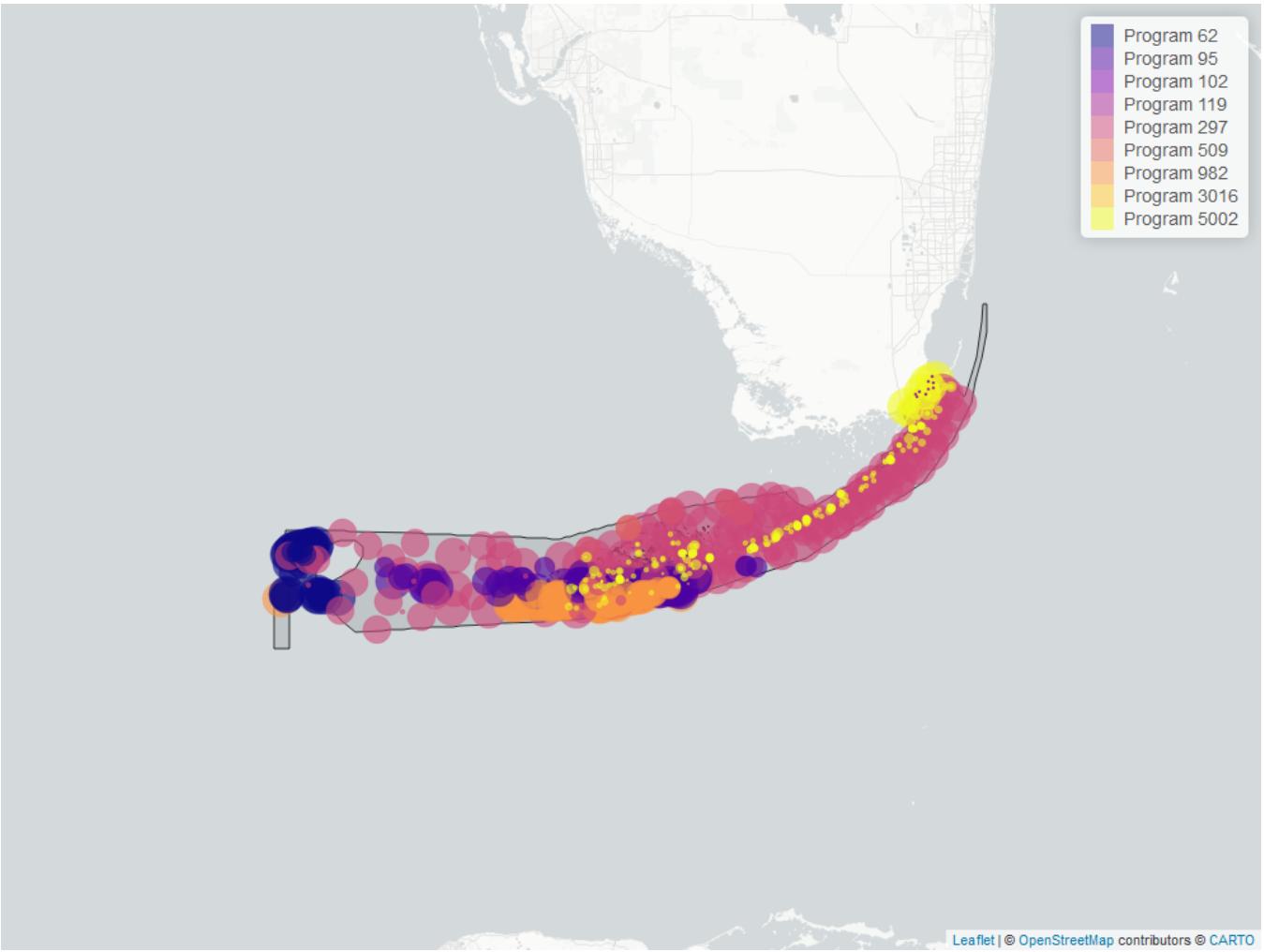

Figure 10: Map showing location of Discrete sampling sites for Dissolved Oxygen Saturation. The bubble size on the maps below reflect the amount of data available at each sampling site.

Table 15: Programs contributing data for Dissolved Oxygen Saturation

ProgramID	*N_Data*	*YearMin*	*YearMax*
297	25419	1995	2020
5002	3902	2009	2024
102	18	1996	1996
95	1	2017	2017

Program names:

95 - Harmful Algal Bloom Marine Observation Network[11]
102 - National Status and Trends Mussel Watch[12]
297 - Florida Keys National Marine Sanctuary Water Quality Monitoring Project[8]
5002 - Florida STORET / WIN[2]

pH - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

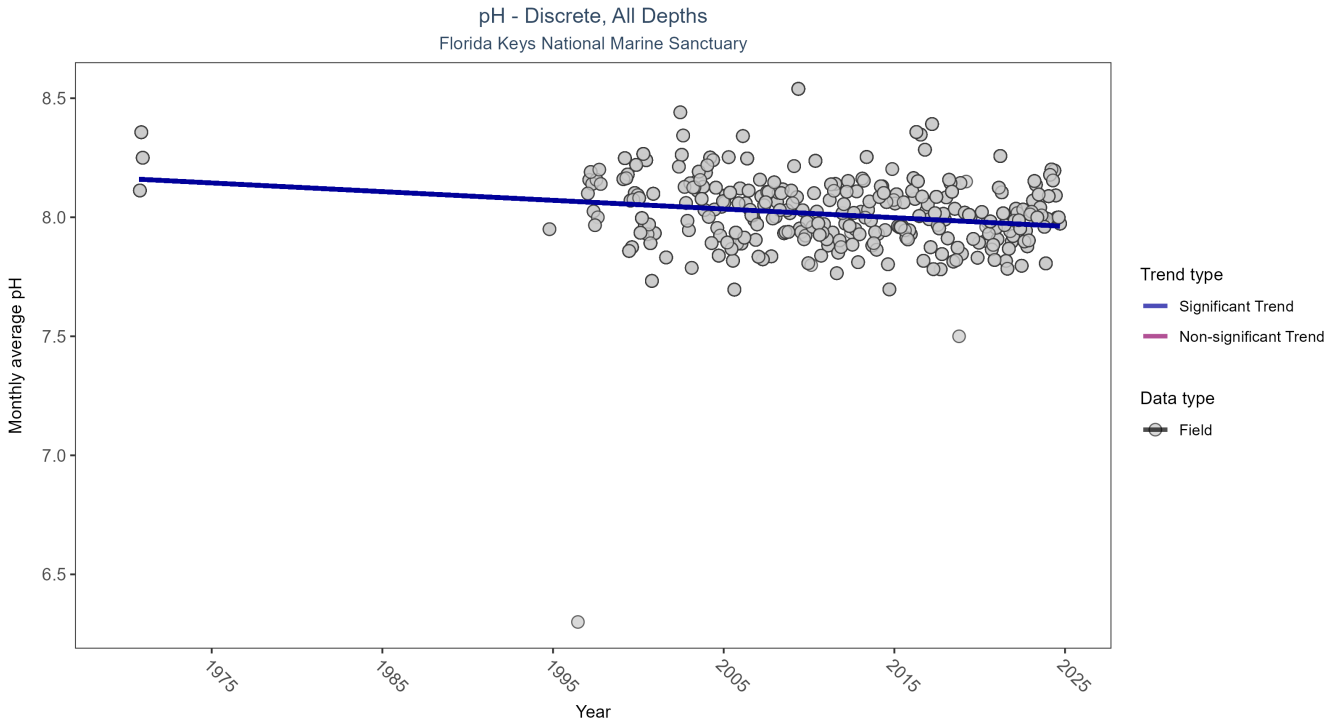

Figure 11: Seasonal Kendall-Tau Results for pH - Discrete

Table 16: Seasonal Kendall-Tau Trend Analysis for pH

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	9511	30	8.04	TRUE	-0.1678	0	-0.0036	8.1624	16.1306	0.1364	-1

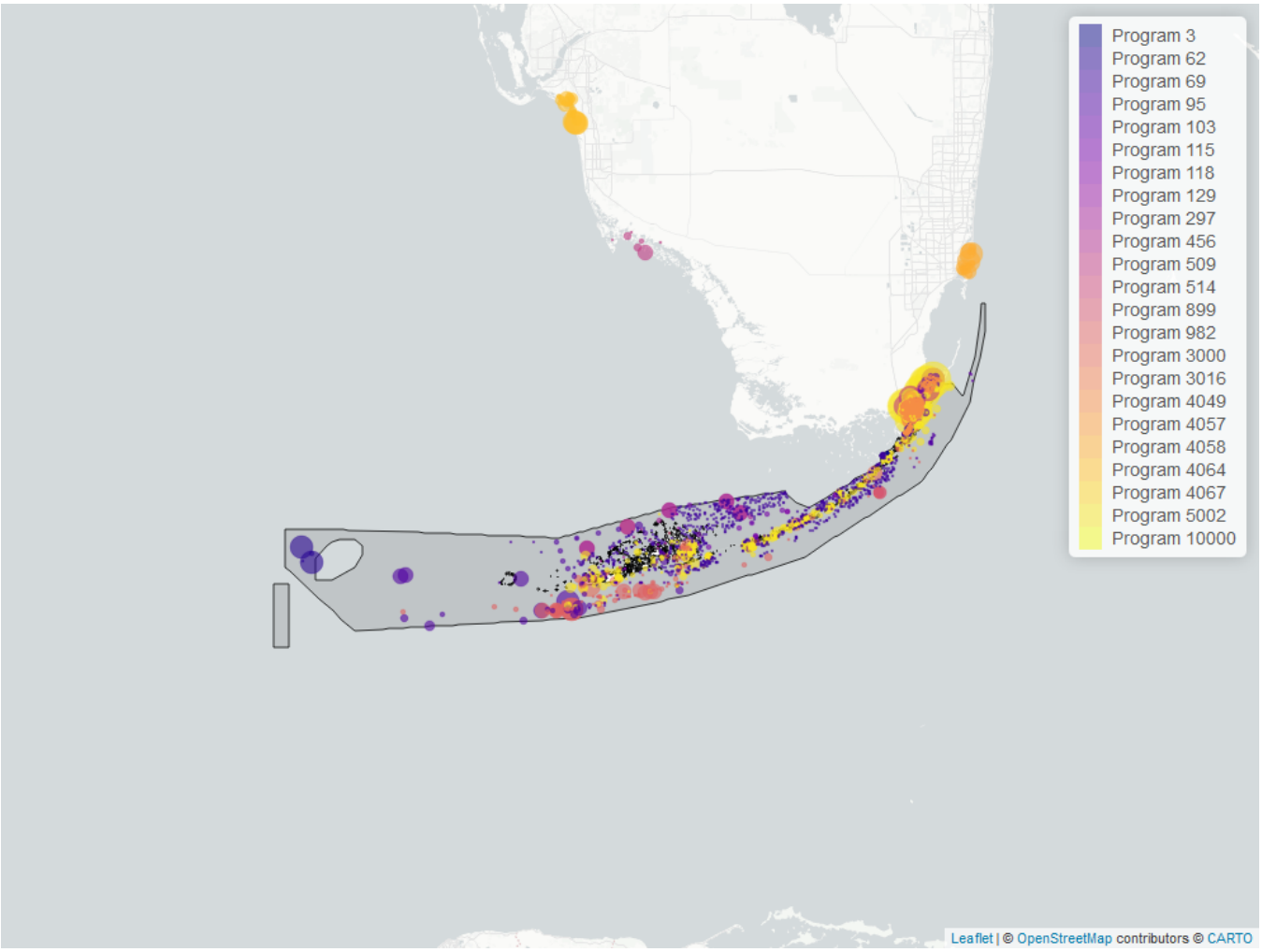

Figure 12: Map showing location of Discrete sampling sites for pH. The bubble size on the maps below reflect the amount of data available at each sampling site.

Table 17: Programs contributing data for pH

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	5279	2003	2024
69	1733	1997	2022
4049	1103	2005	2023
509	545	2002	2008
3000	377	2015	2018
95	142	1994	2018
297	114	2003	2011
115	89	2000	2004
899	88	2014	2015
103	86	1970	2021
4057	59	2015	2018
3	21	2009	2012

Program names:

3 - Atlantic Oceanographic and Meteorological Laboratory (AOML) South Florida Program Synoptic Shipboard

Surveys[3]
69 - Fisheries-Independent Monitoring (FIM) Program[10]
95 - Harmful Algal Bloom Marine Observation Network[11]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[5]
115 - Environmental Monitoring Assessment Program[6]
297 - Florida Keys National Marine Sanctuary Water Quality Monitoring Project[8]
509 - SERC Water Quality Monitoring Network[9]
899 - USGS Coral Reef Ecosystem Studies (CREST) Project[13]
3000 - Florida Keys Water Watch[14]
4049 - The South Florida Fisheries Habitat Assessment Program (FHAP)[15]
4057 - Biscayne Bay Water Watch[16]
5002 - Florida STORET / WIN[2]

Salinity - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

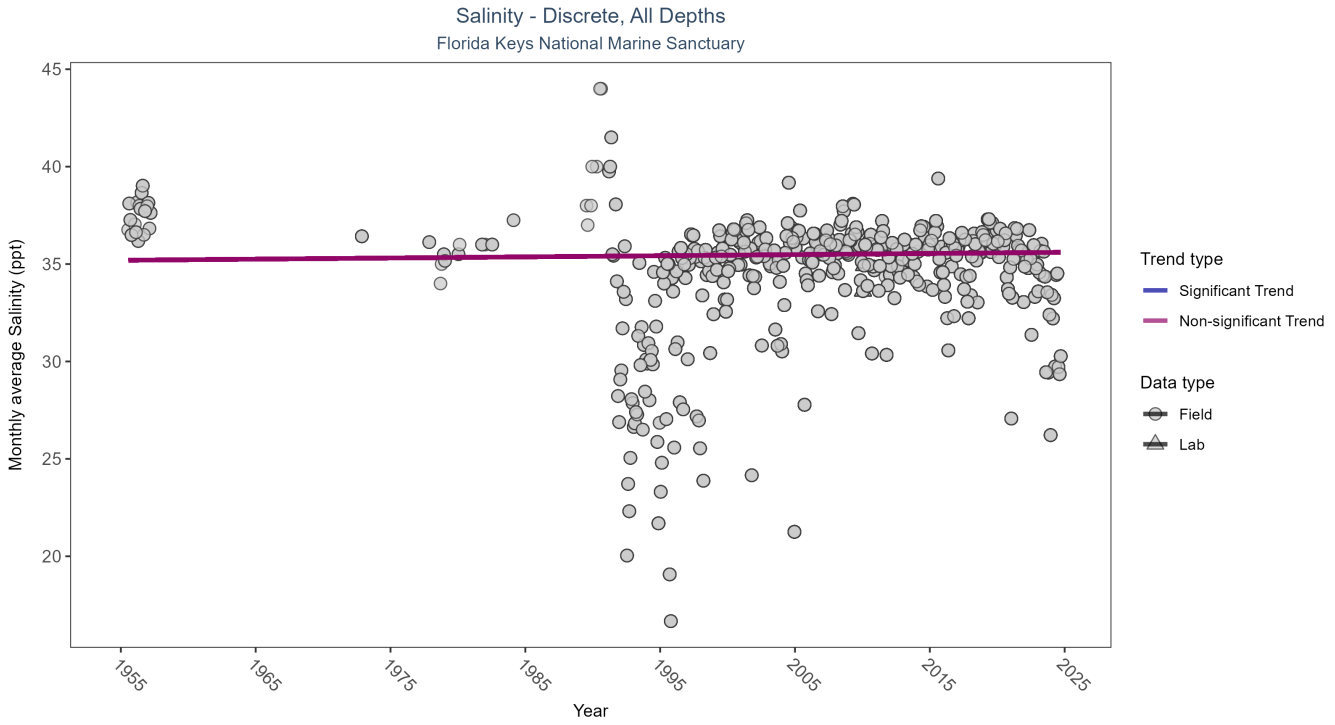

Figure 13: Seasonal Kendall-Tau Results for Salinity - Discrete

Table 18: Seasonal Kendall-Tau Trend Analysis for Salinity

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	54396	47	36.196	TRUE	0.0225	0.5258	0.0058	35.1934	6.5765	0.8323	0

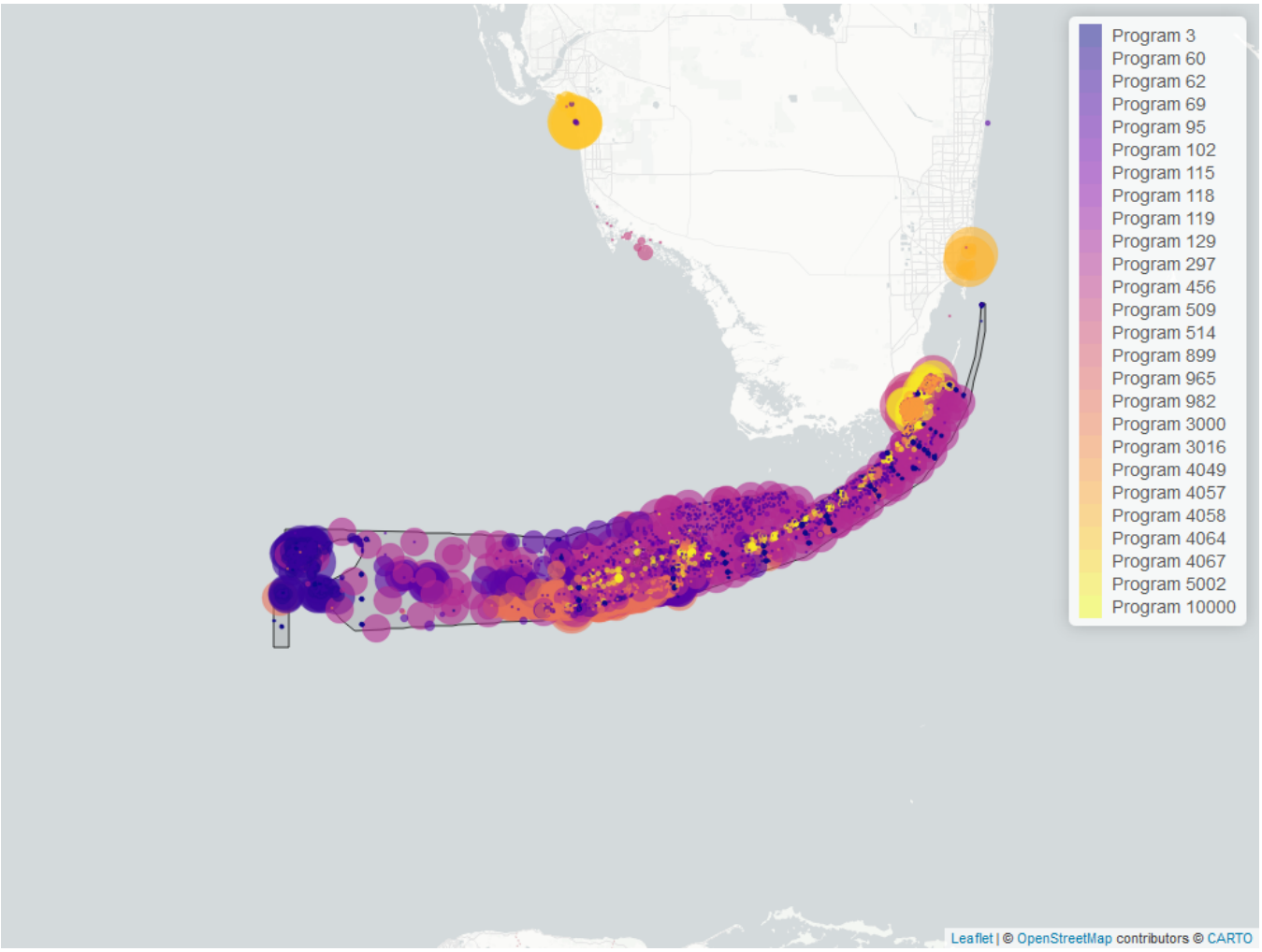

Figure 14: Map showing location of Discrete sampling sites for Salinity. The bubble size on the maps below reflect the amount of data available at each sampling site.

Table 19: Programs contributing data for Salinity

ProgramID	*N_Data*	*YearMin*	*YearMax*
297	31815	1995	2023
5002	5283	2003	2024
3	4157	1998	2024
509	2607	1989	2008
965	2317	2005	2011
95	1889	1955	2018
69	1741	1997	2022
60	1524	1993	2016
4049	1168	2005	2023
62	1142	1993	2019
3000	379	2015	2018
118	109	2015	2021
115	89	2000	2004
899	82	2014	2015
102	60	1996	2000
4057	59	2015	2018

Program names:

3 - Atlantic Oceanographic and Meteorological Laboratory (AOML) South Florida Program Synoptic Shipboard Surveys[3]
60 - Southeast Area Monitoring and Assessment Program (SEAMAP) - Gulf of Mexico Fall & Summer Shrimp/Groundfish Survey[4]
62 - Southeast Area Monitoring and Assessment Program (SEAMAP) - Gulf of Mexico Reef Fish Survey[17]
69 - Fisheries-Independent Monitoring (FIM) Program[10]
95 - Harmful Algal Bloom Marine Observation Network[11]
102 - National Status and Trends Mussel Watch[12]
115 - Environmental Monitoring Assessment Program[6]
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509 - SERC Water Quality Monitoring Network[9]
899 - USGS Coral Reef Ecosystem Studies (CREST) Project[13]
965 - South Florida Seagrass Fish and Invertebrate Assessment Network[18]
3000 - Florida Keys Water Watch[14]
4049 - The South Florida Fisheries Habitat Assessment Program (FHAP)[15]
4057 - Biscayne Bay Water Watch[16]
5002 - Florida STORET / WIN[2]

Secchi Depth - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

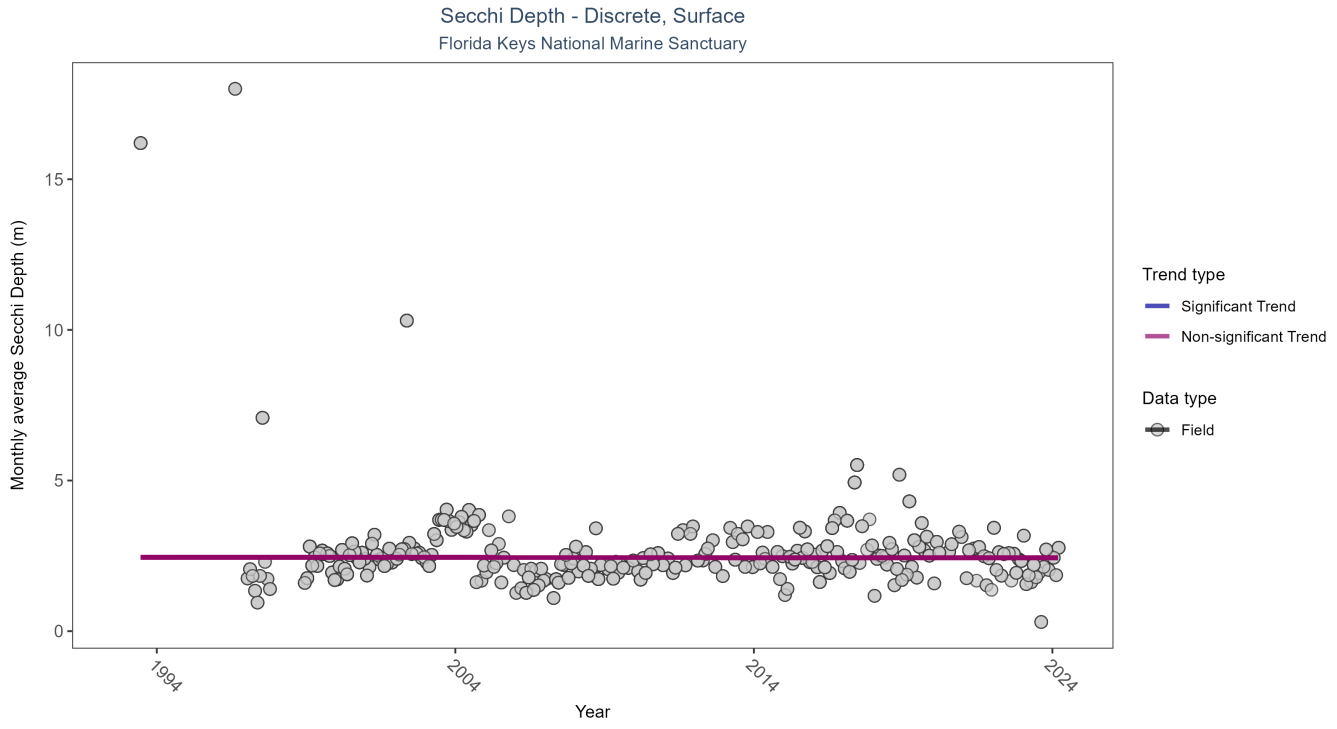

Figure 15: Seasonal Kendall-Tau Results for Secchi Depth - Discrete

Table 20: Seasonal Kendall-Tau Trend Analysis for Secchi Depth

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
Surface	5051	30	2.1336	TRUE	-0.0036	0.8805	-0.0007	2.4543	9.1289	0.61	0

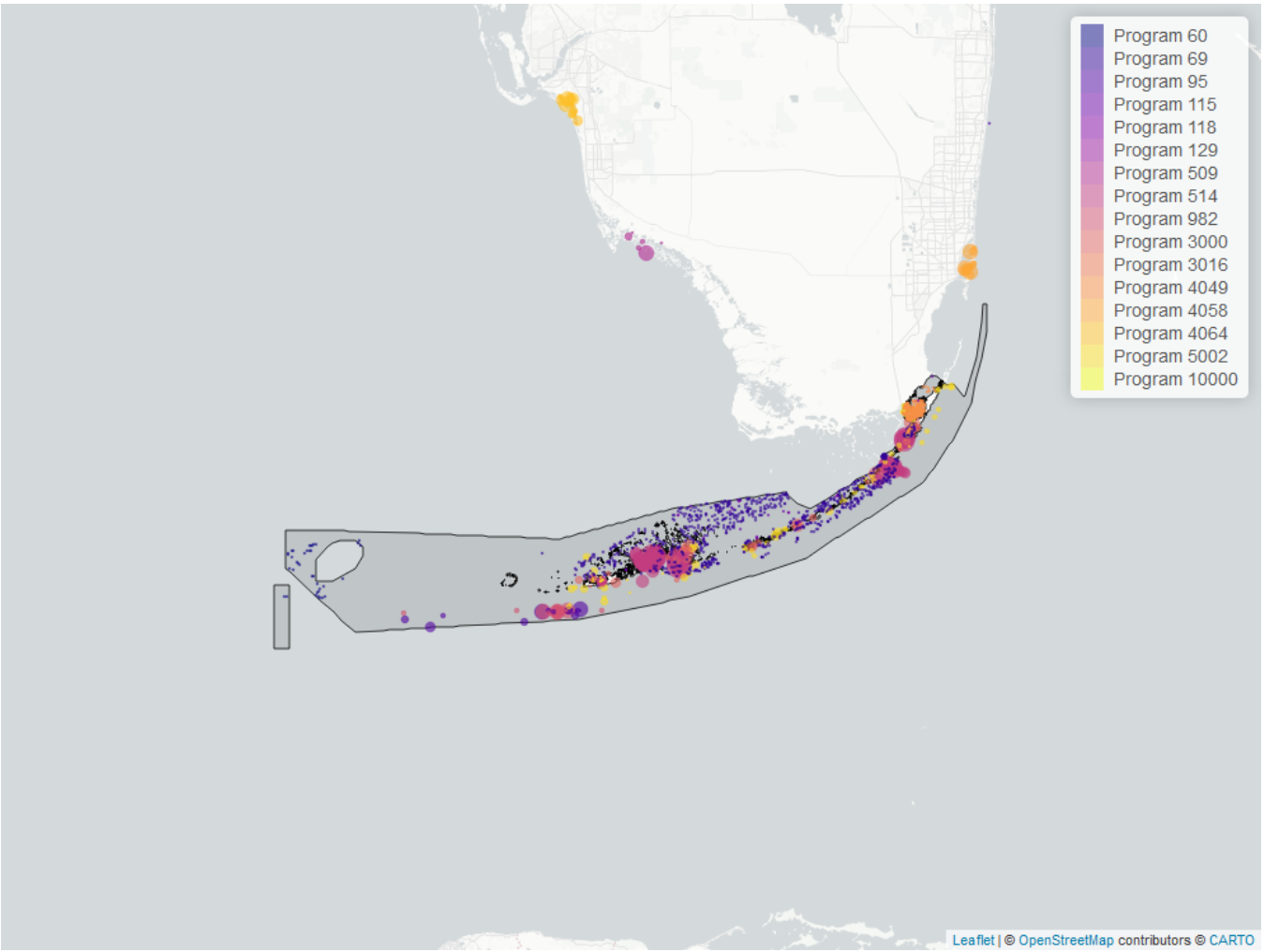

Figure 16: Map showing location of Discrete sampling sites for Secchi Depth. The bubble size on the maps below reflect the amount of data available at each sampling site.

Table 21: Programs contributing data for Secchi Depth

ProgramID	*N_Data*	*YearMin*	*YearMax*
514	2500	1998	2024
69	1750	1997	2022
3000	373	2015	2018
5002	352	2005	2022
4049	252	2005	2023
60	37	1993	2002
115	21	2000	2004

Program names:

60 - Southeast Area Monitoring and Assessment Program (SEAMAP) - Gulf of Mexico Fall & Summer Shrimp/Groundfish Survey[4]
69 - Fisheries-Independent Monitoring (FIM) Program[10]
115 - Environmental Monitoring Assessment Program[6]
514 - Florida LAKEWATCH Program[1]
3000 - Florida Keys Water Watch[14]

4049 - The South Florida Fisheries Habitat Assessment Program (FHAP)[15]
5002 - Florida STORET / WIN[2]

Total Nitrogen - Discrete Water Quality

Total Nitrogen Calculation:

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

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

Additional Information:

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

Seasonal Kendall-Tau Trend Analysis

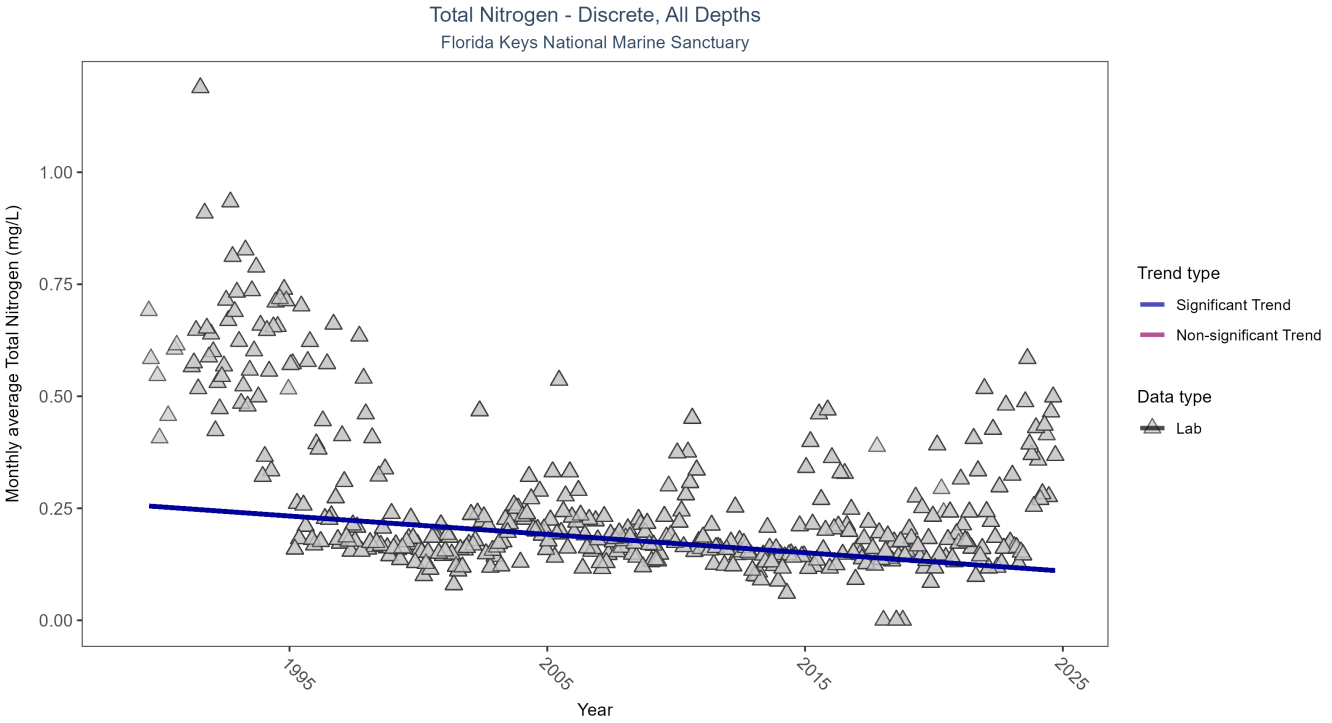

Figure 17: Seasonal Kendall-Tau Results for Total Nitrogen - Discrete

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

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	34563	36	0.1459	TRUE	-0.2655	0	-0.0041	0.2573	5.5799	0.8999	-1

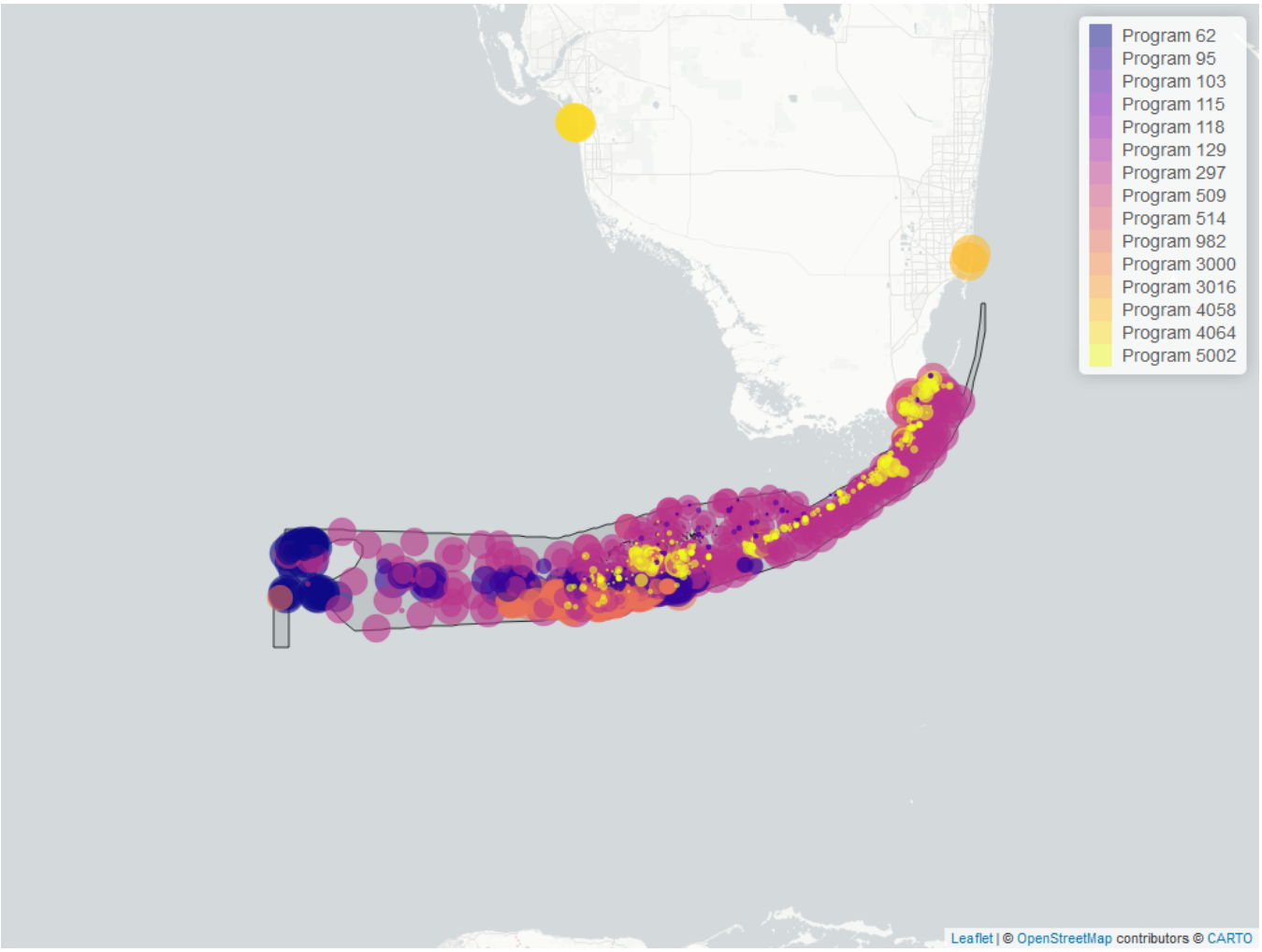

Figure 18: Map showing location of Discrete sampling sites for Total Nitrogen. The bubble size on the maps below reflect the amount of data available at each sampling site.

Table 23: Programs contributing data for Total Nitrogen

ProgramID	*N_Data*	*YearMin*	*YearMax*
297	26153	1995	2023
5002	4790	1998	2024
514	2907	1998	2024
509	1424	1989	2008
103	149	2000	2006
115	28	2000	2004

Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[5]
115 - Environmental Monitoring Assessment Program[6]
297 - Florida Keys National Marine Sanctuary Water Quality Monitoring Project[8]
509 - SERC Water Quality Monitoring Network[9]
514 - Florida LAKEWATCH Program[1]
5002 - Florida STORET / WIN[2]

Total Phosphorus - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

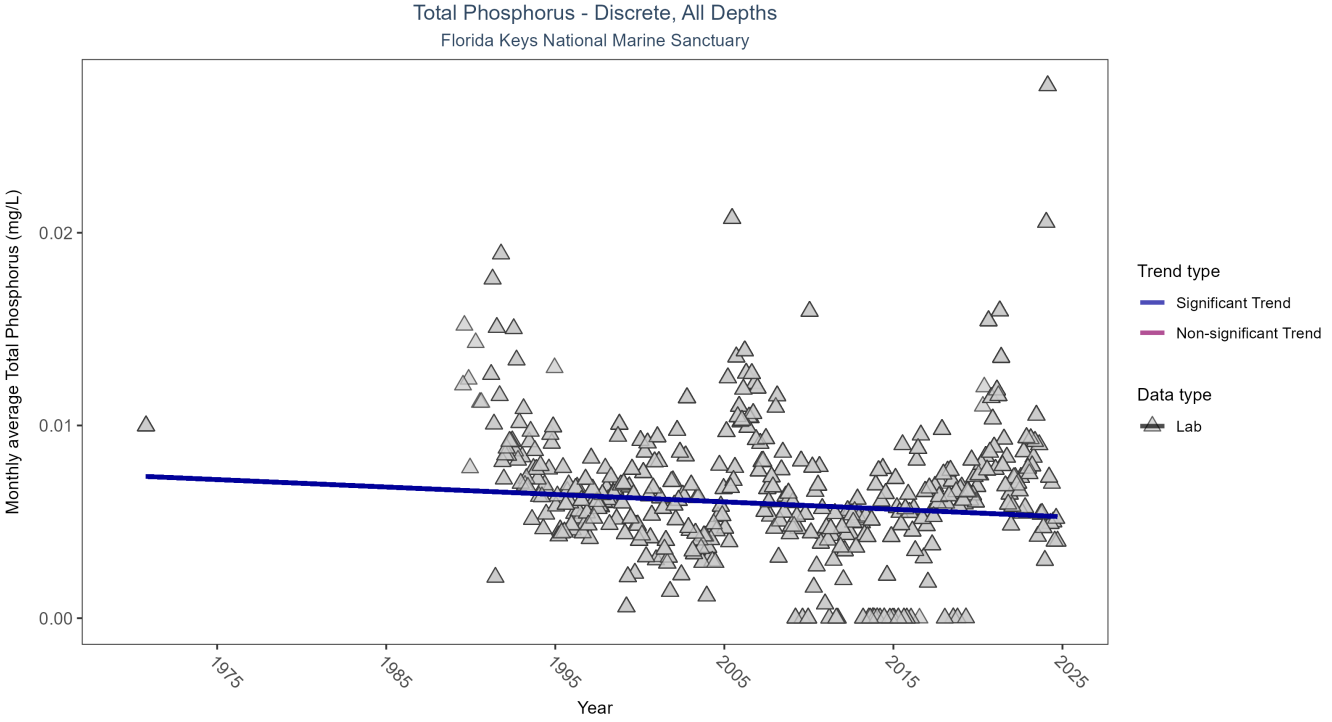

Figure 19: Seasonal Kendall-Tau Results for Total Phosphorus - Discrete

Table 24: Seasonal Kendall-Tau Trend Analysis for Total Phosphorus

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	32274	37	0.0059	TRUE	-0.0894	0.0104	0	0.0074	12.3506	0.3379	-1

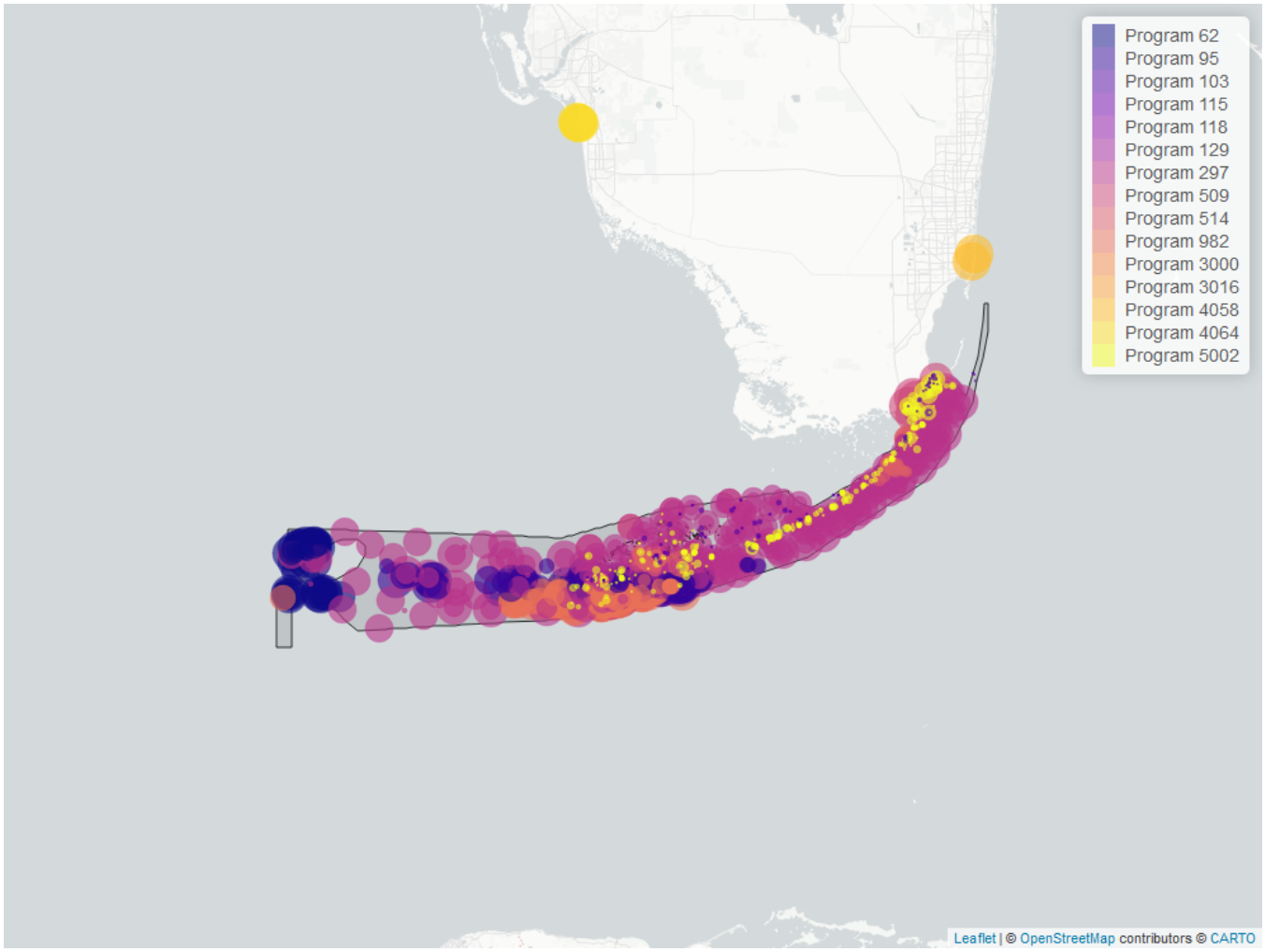

Figure 20: Map showing location of Discrete sampling sites for Total Phosphorus. The bubble size on the maps below reflect the amount of data available at each sampling site.

Table 25: Programs contributing data for Total Phosphorus

ProgramID	*N_Data*	*YearMin*	*YearMax*
297	26170	1995	2023
514	2914	1998	2024
5002	2113	2005	2024
509	1425	1989	2008
103	182	1970	2021
115	28	2000	2004

Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[5]
115 - Environmental Monitoring Assessment Program[6]
297 - Florida Keys National Marine Sanctuary Water Quality Monitoring Project[8]
509 - SERC Water Quality Monitoring Network[9]
514 - Florida LAKEWATCH Program[1]
5002 - Florida STORET / WIN[2]

Total Suspended Solids - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

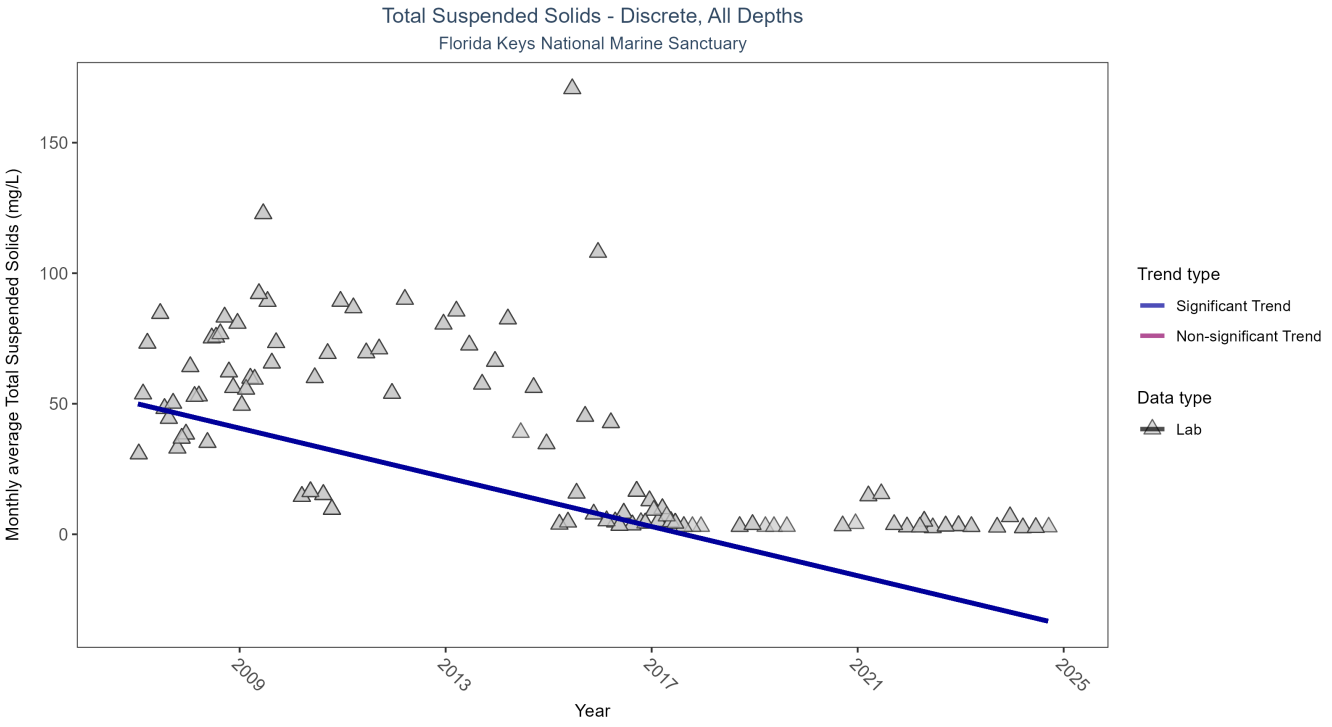

Figure 21: Seasonal Kendall-Tau Results for Total Suspended Solids - Discrete

Table 26: Seasonal Kendall-Tau Trend Analysis for Total Suspended Solids

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	536	18	12	TRUE	-0.5976	0	-4.7089	50.053	14.9584	0.1844	-2

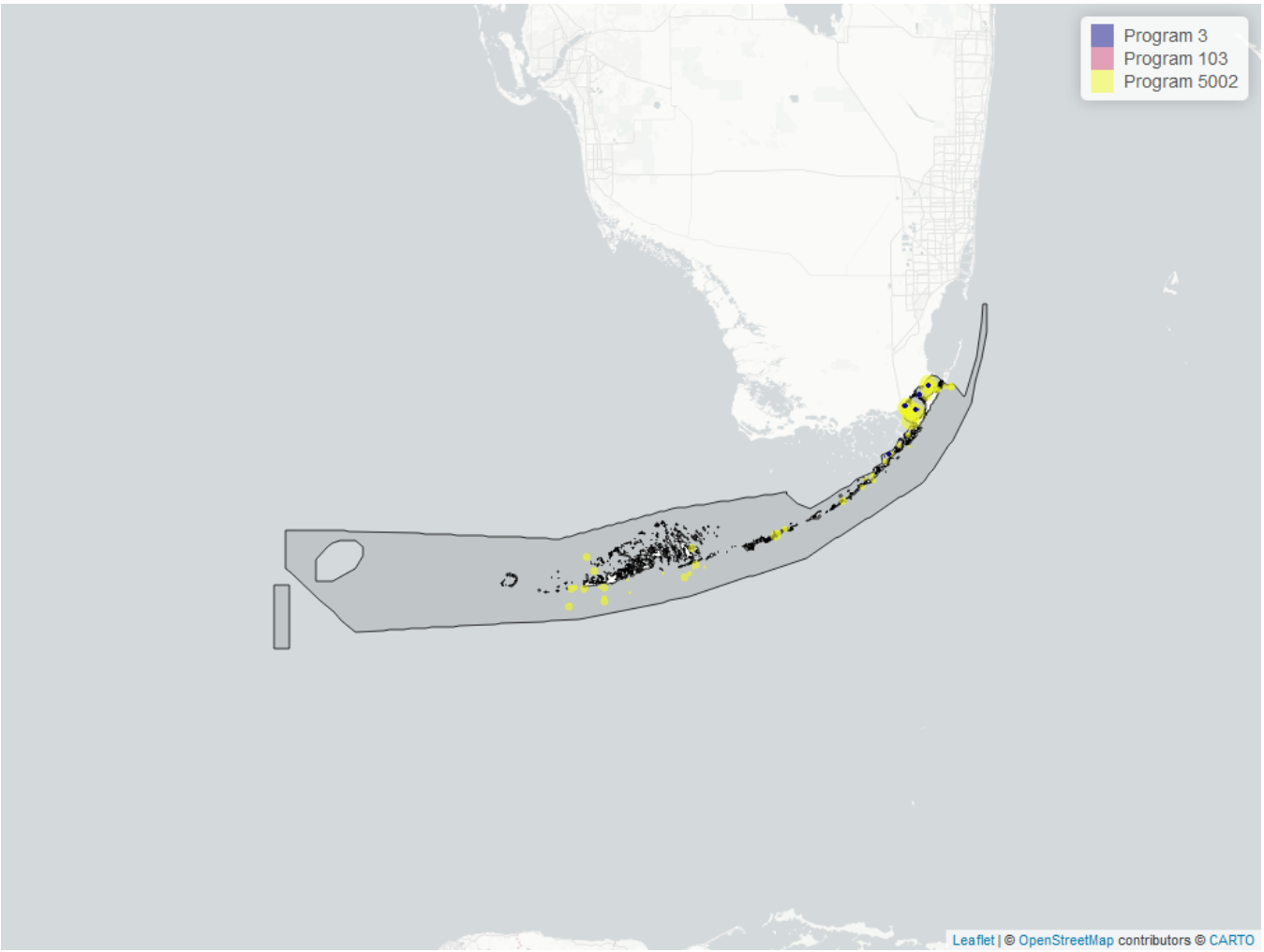

Figure 22: Map showing location of Discrete sampling sites for Total Suspended Solids. The bubble size on the maps below reflect the amount of data available at each sampling site.

Table 27: Programs contributing data for Total Suspended Solids

ProgramID	*N_Data*	*YearMin*	*YearMax*
5002	548	2007	2024
3	342	2001	2012
103	1	2020	2020

Program names:

3 - Atlantic Oceanographic and Meteorological Laboratory (AOML) South Florida Program Synoptic Shipboard Surveys[3]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[5]
5002 - Florida STORET / WIN[2]

Turbidity - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

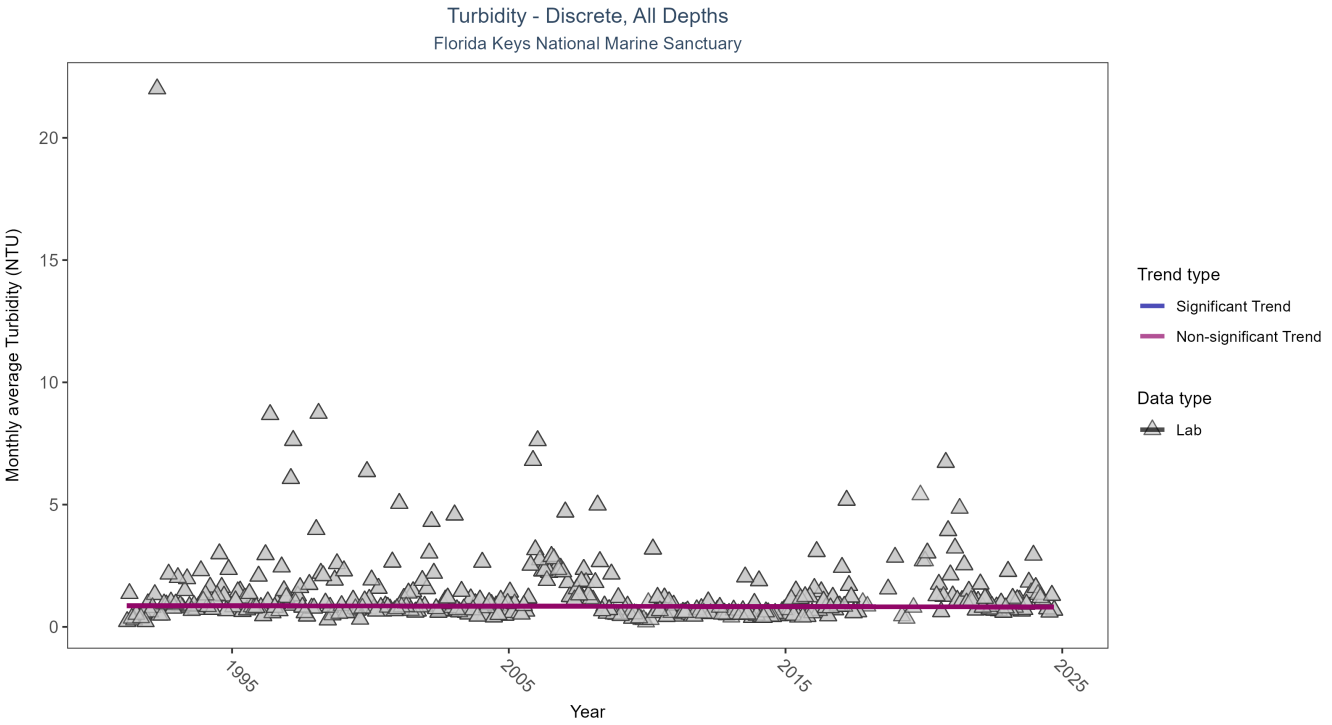

Figure 23: Seasonal Kendall-Tau Results for Turbidity - Discrete

Table 28: Seasonal Kendall-Tau Trend Analysis for Turbidity

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	3521	34	0.7	TRUE	-0.0224	0.5464	-0.0017	0.8692	3.2909	0.9863	0

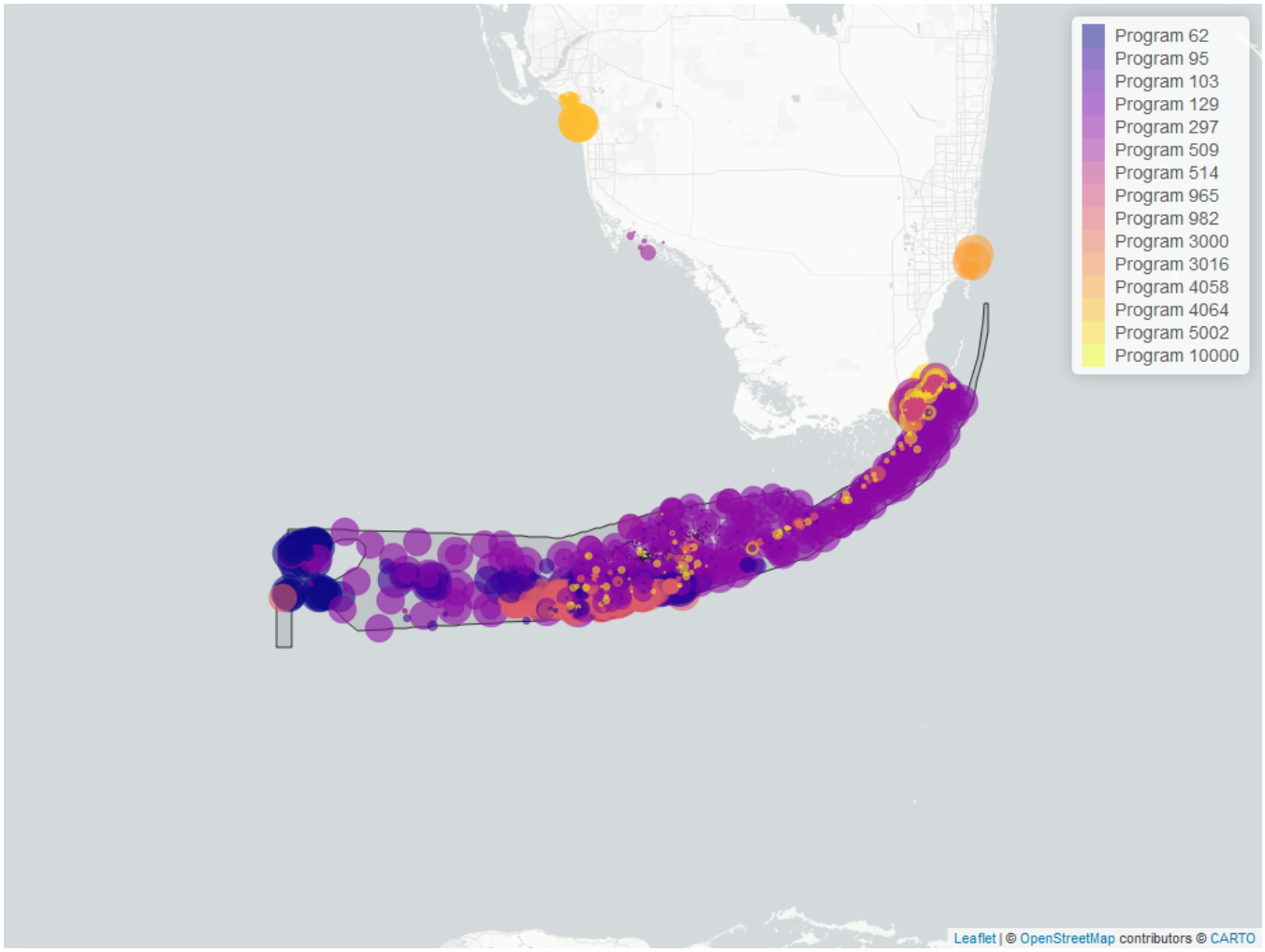

Figure 24: Map showing location of Discrete sampling sites for Turbidity. The bubble size on the maps below reflect the amount of data available at each sampling site.

Table 29: Programs contributing data for Turbidity

ProgramID	*N_Data*	*YearMin*	*YearMax*
297	26741	1995	2023
5002	2136	1994	2024
509	1404	1991	2008
965	1157	2005	2011
3000	370	2015	2018
103	117	2005	2021

Program names:

103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[5]
297 - Florida Keys National Marine Sanctuary Water Quality Monitoring Project[8]
509 - SERC Water Quality Monitoring Network[9]
965 - South Florida Seagrass Fish and Invertebrate Assessment Network[18]
3000 - Florida Keys Water Watch[14]
5002 - Florida STORET / WIN[2]

Water Temperature - Discrete Water Quality

Seasonal Kendall-Tau Trend Analysis

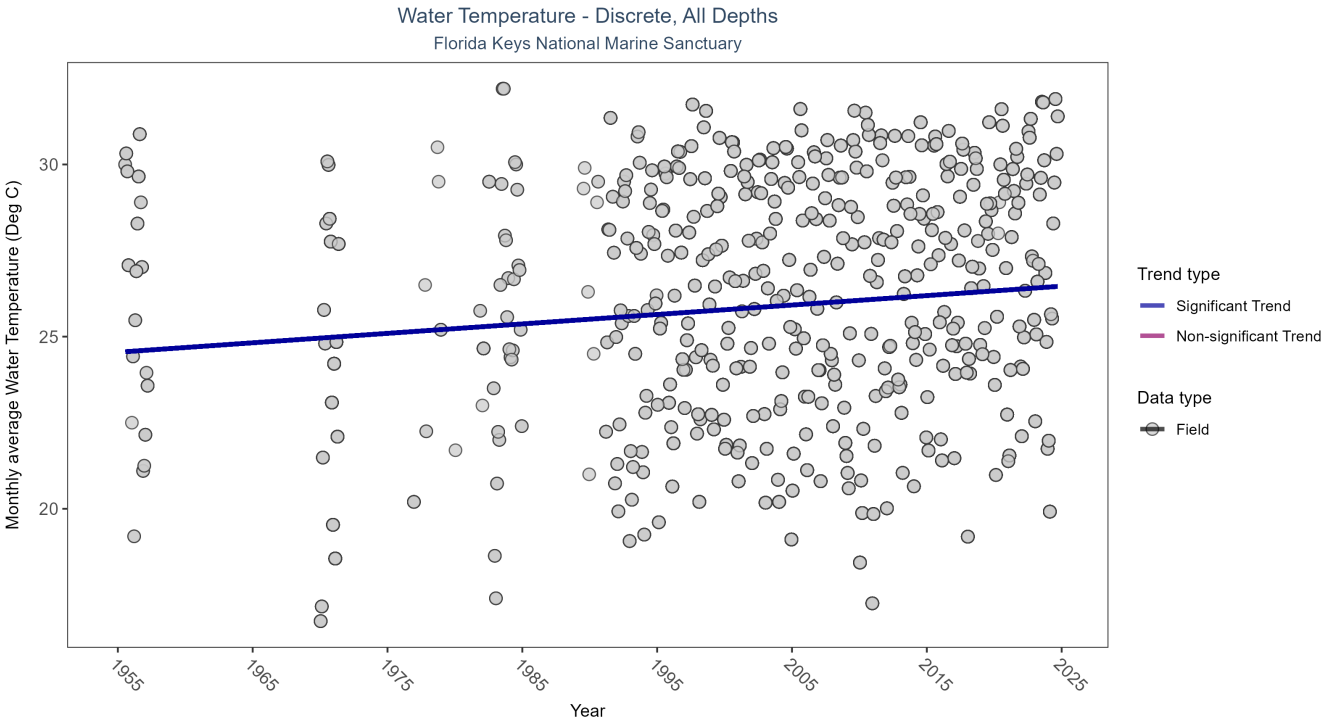

Figure 25: Seasonal Kendall-Tau Results for Water Temperature - Discrete

Table 30: Seasonal Kendall-Tau Trend Analysis for Water Temperature

RelativeDepth	N-Data	N-Years	Median	Independent	tau	p	SennSlope	SennIntercept	ChiSquared	pChiSquared	Trend
All	51933	49	27.1796	TRUE	0.2233	0	0.0274	24.5463	13.7272	0.2485	1

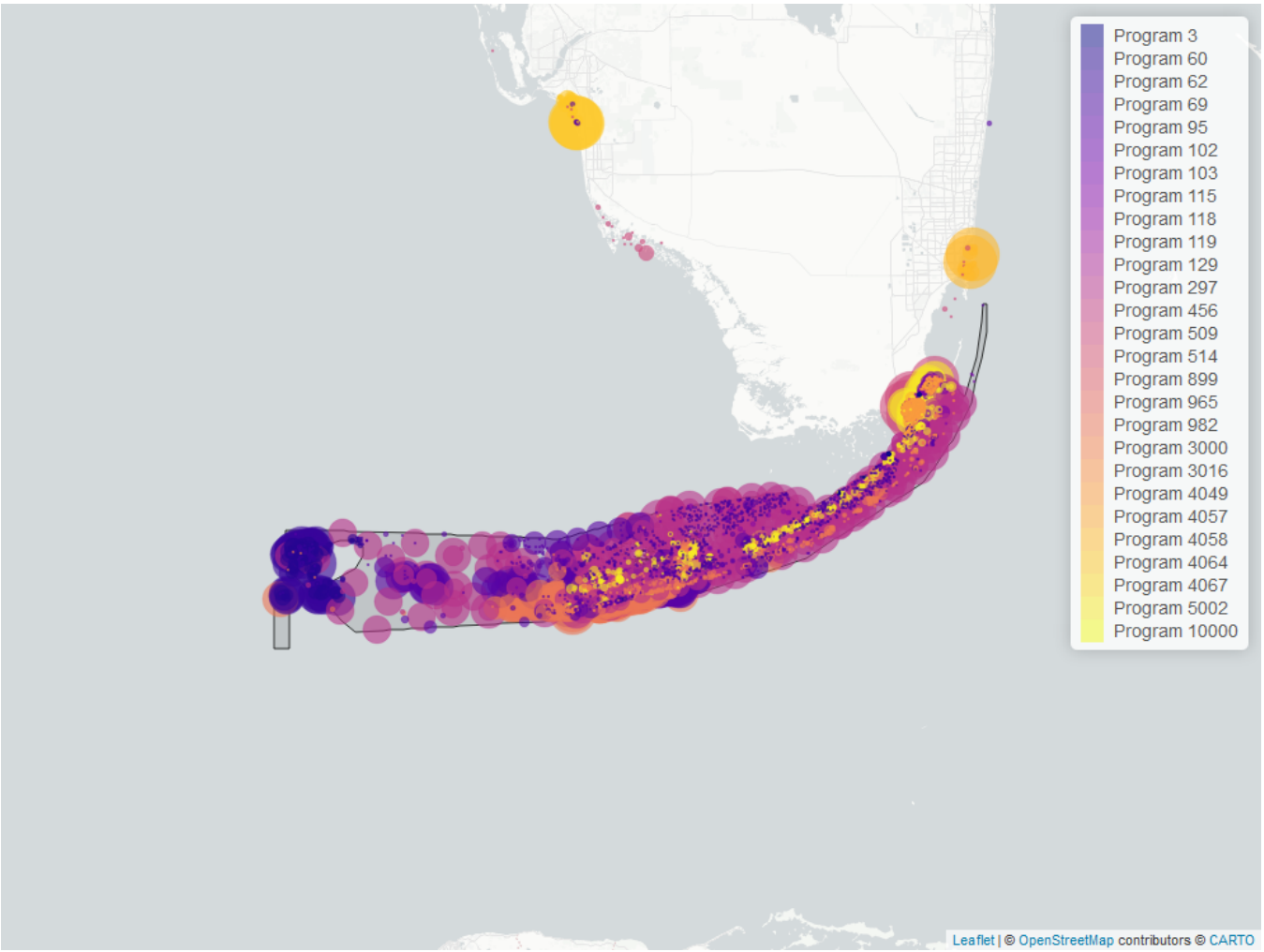

Figure 26: Map showing location of Discrete sampling sites for Water Temperature. The bubble size on the maps below reflect the amount of data available at each sampling site.

Table 31: Programs contributing data for Water Temperature

ProgramID	*N_Data*	*YearMin*	*YearMax*
297	31803	1995	2023
5002	5715	2003	2024
509	2591	1989	2008
965	2317	2005	2011
95	1957	1955	2018
69	1776	1997	2022
60	1582	1993	2016
4049	1168	2005	2023
982	1129	2014	2023
103	875	1970	2021
3	403	1998	2012
3000	374	2015	2018
115	89	2000	2004
899	85	2014	2015
4057	59	2015	2018
102	43	1996	2000

Program names:

3 - Atlantic Oceanographic and Meteorological Laboratory (AOML) South Florida Program Synoptic Shipboard Surveys[3]
60 - Southeast Area Monitoring and Assessment Program (SEAMAP) - Gulf of Mexico Fall & Summer Shrimp/Groundfish Survey[4]
69 - Fisheries-Independent Monitoring (FIM) Program[10]
95 - Harmful Algal Bloom Marine Observation Network[11]
102 - National Status and Trends Mussel Watch[12]
103 - EPA STOrage and RETrieval Data Warehouse (STORET)/WQX[5]
115 - Environmental Monitoring Assessment Program[6]
297 - Florida Keys National Marine Sanctuary Water Quality Monitoring Project[8]
509 - SERC Water Quality Monitoring Network[9]
899 - USGS Coral Reef Ecosystem Studies (CREST) Project[13]
965 - South Florida Seagrass Fish and Invertebrate Assessment Network[18]
982 - Florida Keys Bleach Watch[19]
3000 - Florida Keys Water Watch[14]
4049 - The South Florida Fisheries Habitat Assessment Program (FHAP)[15]
4057 - Biscayne Bay Water Watch[16]
5002 - Florida STORET / WIN[2]

Water Quality - Continuous

The following files were used in the continuous analysis:

- *Combined_WQ_WC_NUT_cont_Dissolved_Oxygen_SE-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_cont_Dissolved_Oxygen_Saturation_SE-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_cont_pH_SE-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_cont_Salinity_SE-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_cont_Turbidity_SE-2024-Dec-08.txt*
- *Combined_WQ_WC_NUT_cont_Water_Temperature_SE-2024-Dec-08.txt*

Continuous monitoring locations in Florida Keys National Marine Sanctuary

Table 32: Florida Keys Aquatic Preserves Continuous Water Quality Monitoring (10004)

ProgramLocationID	*Years of Data*	*Use in Analysis*	*Parameters*
FKCB	1	FALSE	DO , DOS , pH , Sal , Turb , TempW
FKLK	1	FALSE	DO , DOS , pH , Sal , Turb , TempW

Table 33: Atlantic Oceanographic and Meteorological Laboratory (AOML) South Florida Program Moored Instrument Array (2)

ProgramLocationID	*Years of Data*	*Use in Analysis*	*Parameters*
1B	6	TRUE	Sal , TempW

Table 34: National Water Information System (7)

ProgramLocationID	*Years of Data*	*Use in Analysis*	*Parameters*
245323080410100	3	FALSE	Sal , TempW
245622080364200	3	FALSE	Sal , TempW

Table 35: National Data Buoy Center (5)

ProgramLocationID	*Years of Data*	*Use in Analysis*	*Parameters*
KYWF1	20	TRUE	TempW
LONF1	28	TRUE	TempW
MLRF1	33	TRUE	TempW
SANF1	15	TRUE	TempW
SMKF1	21	TRUE	TempW

Table 36: Florida Keys National Marine Sanctuary Seagrass Monitoring Project (296)

ProgramLocationID	*Years of Data*	*Use in Analysis*	*Parameters*
214	18	TRUE	TempW
215	16	TRUE	TempW
216	17	TRUE	TempW
220	17	TRUE	TempW
223	18	TRUE	TempW
225	18	TRUE	TempW
227	17	TRUE	TempW
235	18	TRUE	TempW
237	18	TRUE	TempW
239	17	TRUE	TempW
241	18	TRUE	TempW
243	18	TRUE	TempW
248	18	TRUE	TempW
255	18	TRUE	TempW
260	18	TRUE	TempW
267	18	TRUE	TempW
269	18	TRUE	TempW
271	18	TRUE	TempW
273	18	TRUE	TempW
276	18	TRUE	TempW
284	18	TRUE	TempW
285	18	TRUE	TempW
287	18	TRUE	TempW
291	18	TRUE	TempW
294	18	TRUE	TempW
296	18	TRUE	TempW
305	18	TRUE	TempW
307	18	TRUE	TempW
309	18	TRUE	TempW
314	18	TRUE	TempW
500	8	TRUE	TempW
501	7	TRUE	TempW
502	4	FALSE	TempW
503	1	FALSE	TempW
504	1	FALSE	TempW
506	8	TRUE	TempW
507	8	TRUE	TempW
508	8	TRUE	TempW
509	8	TRUE	TempW
SB	19	TRUE	TempW

Table 37: Water Temperature on Coral Reefs in the Florida Keys (986)

ProgramLocationID	*Years of Data*	*Use in Analysis*	*Parameters*
10	3	FALSE	TempW
11	20	TRUE	TempW
12	15	TRUE	TempW
14	21	TRUE	TempW
15	17	TRUE	TempW
18	7	TRUE	TempW
21	7	TRUE	TempW
22	14	TRUE	TempW
23	11	TRUE	TempW
24	13	TRUE	TempW
25	13	TRUE	TempW
26	14	TRUE	TempW
30	11	TRUE	TempW
32	20	TRUE	TempW
33	7	TRUE	TempW
34	21	TRUE	TempW
35	17	TRUE	TempW
36	16	TRUE	TempW
37	7	TRUE	TempW
38	21	TRUE	TempW
39	5	TRUE	TempW
40	21	TRUE	TempW
50	10	TRUE	TempW
51	20	TRUE	TempW
52	15	TRUE	TempW
53	15	TRUE	TempW
54	11	TRUE	TempW
55	21	TRUE	TempW
56	17	TRUE	TempW
57	15	TRUE	TempW
58	9	TRUE	TempW
59	21	TRUE	TempW
60	14	TRUE	TempW
61	7	TRUE	TempW
70	10	TRUE	TempW
72	15	TRUE	TempW
73	15	TRUE	TempW
74	11	TRUE	TempW
75	13	TRUE	TempW
76	14	TRUE	TempW
77	15	TRUE	TempW
78	9	TRUE	TempW
79	16	TRUE	TempW
80	14	TRUE	TempW
81	7	TRUE	TempW
83	17	TRUE	TempW

Table 38: USGS Coral Reef Ecosystem Studies (CREST) Project (899)

ProgramLocationID	*Years of Data*	*Use in Analysis*	*Parameters*
Crocker	10	TRUE	TempW
Molasses	5	TRUE	TempW
Sombrero	14	TRUE	TempW

Table 39: Continuous Bottom Temperature Measurements along the Florida Reef Tract (989)

ProgramLocationID	*Years of Data*	*Use in Analysis*	*Parameters*
FKNMS_200YR_HD	12	TRUE	TempW
FKNMS_7MILE_BR	20	TRUE	TempW
FKNMS_9FT_SHOAL	21	TRUE	TempW
FKNMS_ALLIGATOR	21	TRUE	TempW
FKNMS_BHONDA_BR	22	TRUE	TempW
FKNMS_BOCA_GRND	23	TRUE	TempW
FKNMS_BULLARD	18	TRUE	TempW
FKNMS_CARD_SND	6	TRUE	TempW
FKNMS_CARYSFORT	17	TRUE	TempW
FKNMS_DIEGO_TER	5	TRUE	TempW
FKNMS_ELPIS	8	TRUE	TempW
FKNMS_GRECIAN	21	TRUE	TempW
FKNMS_HARBORKEY	6	TRUE	TempW
FKNMS_HEN&CHIX	23	TRUE	TempW
FKNMS_KW_CHANL	22	TRUE	TempW
FKNMS_LONG_KEY	21	TRUE	TempW
FKNMS_LOOE_BACK	23	TRUE	TempW
FKNMS_LOOE_BUOY5	11	TRUE	TempW
FKNMS_LOOE_ISELIN	16	TRUE	TempW
FKNMS_MAITLAND	4	FALSE	TempW
FKNMS_MOLASSES	13	TRUE	TempW
FKNMS_NEWGROUND	15	TRUE	TempW
FKNMS_PILLAR	11	TRUE	TempW
FKNMS_SAND_KEY	21	TRUE	TempW
FKNMS_SMITH_SHL	15	TRUE	TempW
FKNMS_SNAKE_CRK	19	TRUE	TempW
FKNMS_SOMBRERO	15	TRUE	TempW
FKNMS_SPRIGGER	15	TRUE	TempW
FKNMS_TENN_REEF	17	TRUE	TempW
FKNMS_WELLWOOD	8	TRUE	TempW
FKNMS_WS_BUOY16	3	FALSE	TempW
FKNMS_WS_JACKYL	9	TRUE	TempW
FKNMS_W_SAMBO	6	TRUE	TempW

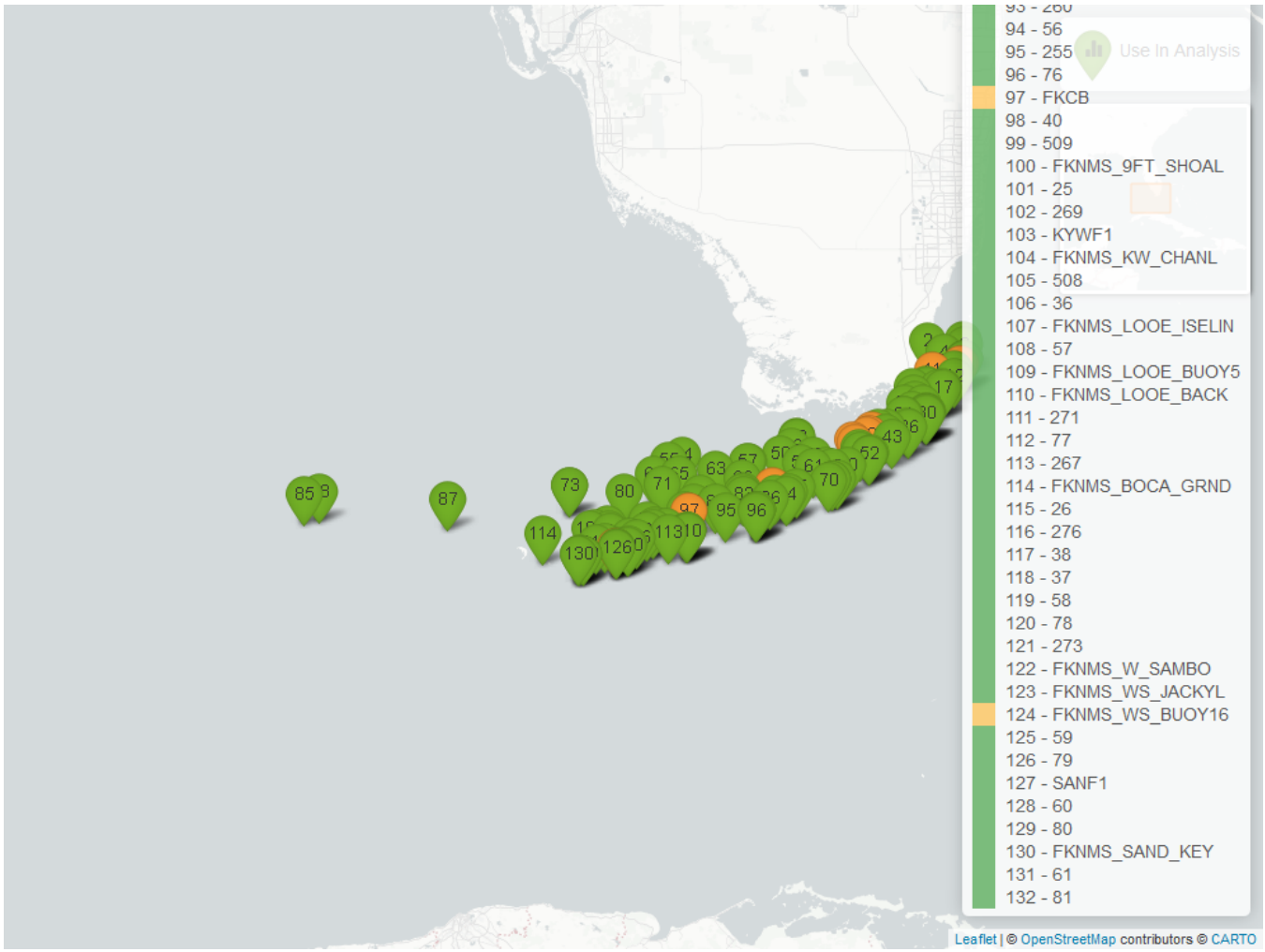

Figure 27: Map showing Continuous Water Quality Monitoring sampling locations within the boundaries of Florida Keys National Marine Sanctuary. Sites marked as *Use In Analysis* are featured in this report.

Dissolved Oxygen - All Stations Combined

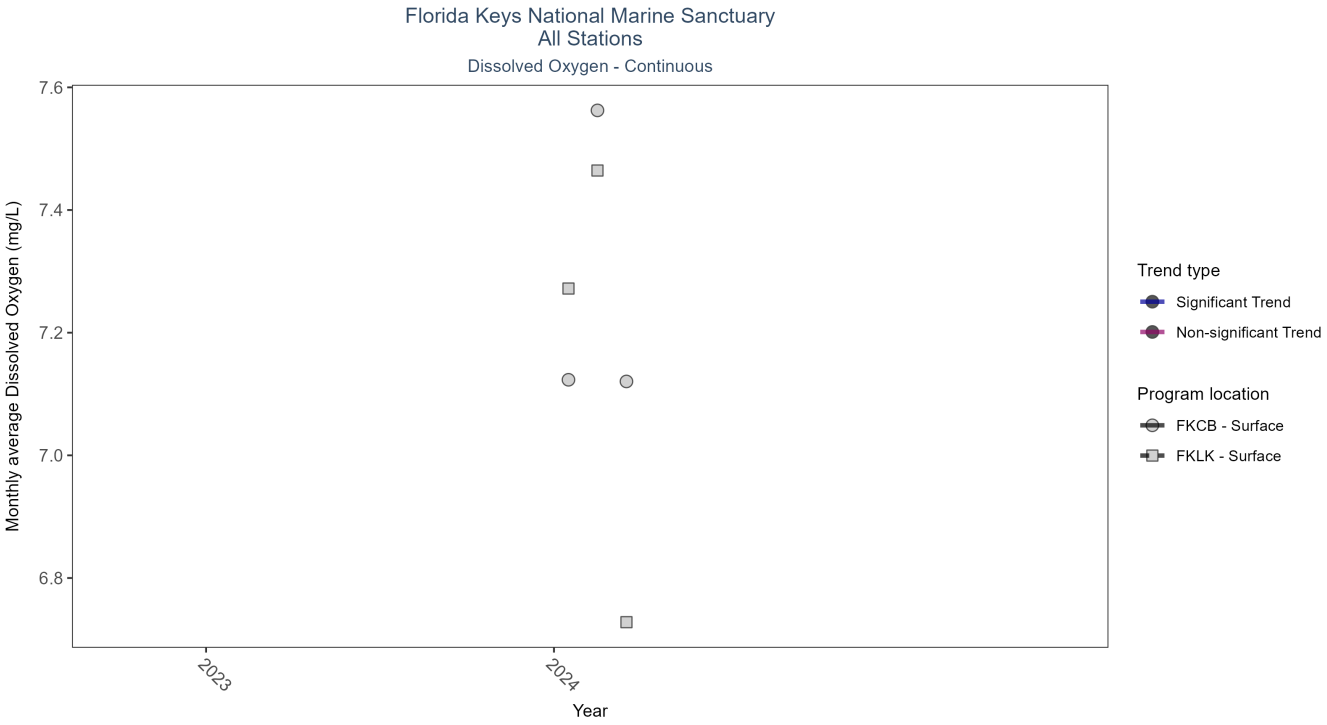

Figure 28: Figure for Dissolved Oxygen - Continuous - All stations combined

Table 40: Seasonal Kendall-Tau Results for All Stations - Dissolved Oxygen

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
FKCB	6522	1	2024 - 2024	7.2	-	-	-	-
FKLK	6712	1	2024 - 2024	6.9	-	-	-	-

Dissolved Oxygen Saturation - All Stations Combined

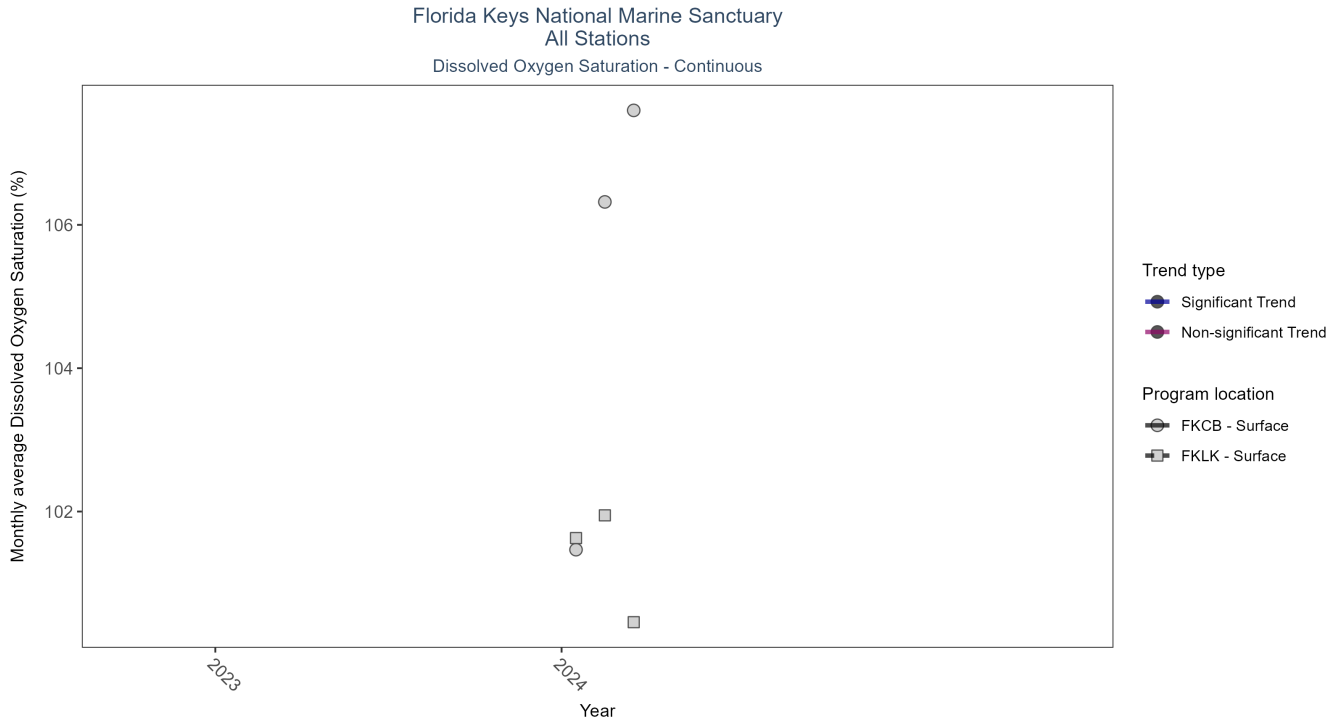

Figure 29: Figure for Dissolved Oxygen Saturation - Continuous - All stations combined

Table 41: Seasonal Kendall-Tau Results for All Stations - Dissolved Oxygen Saturation

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
FKCB	6523	1	2024 - 2024	103.5	-	-	-	-
FKLK	6712	1	2024 - 2024	95.4	-	-	-	-

pH - All Stations Combined

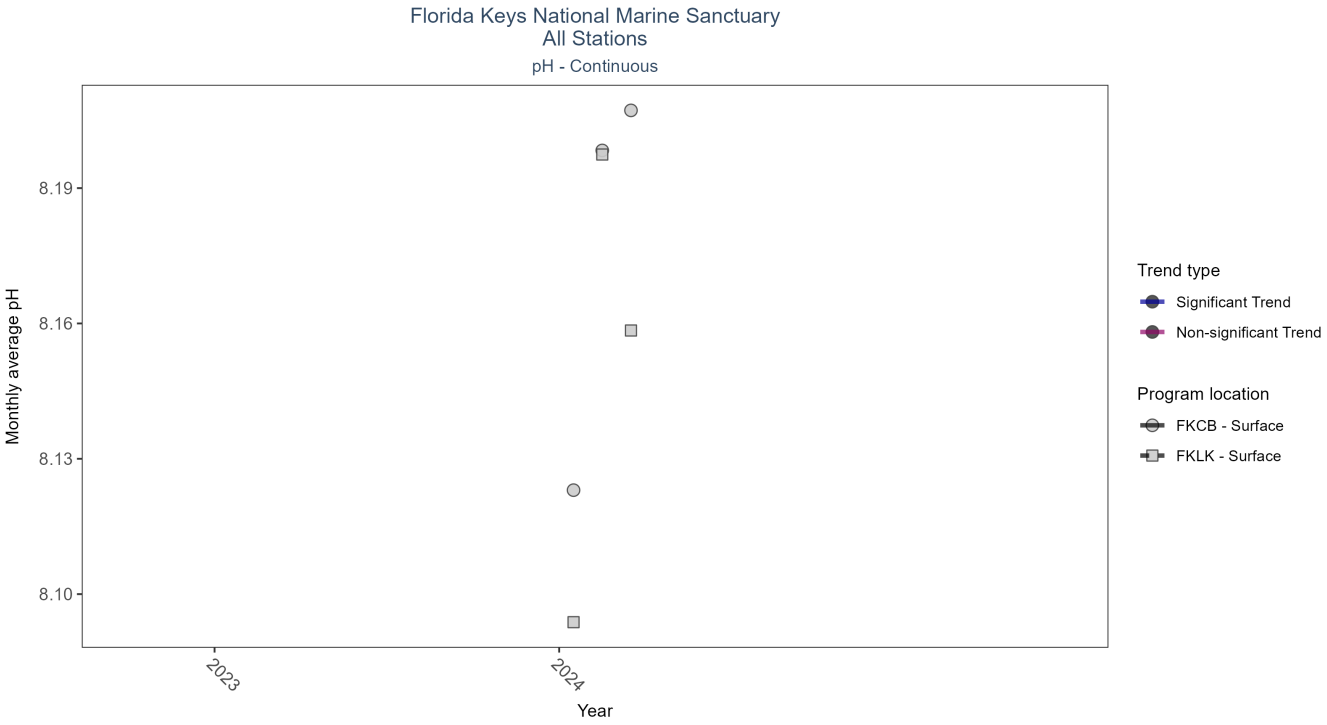

Figure 30: Figure for pH - Continuous - All stations combined

Table 42: Seasonal Kendall-Tau Results for All Stations - pH

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
FKLK	6712	1	2024 - 2024	8.1	-	-	-	-
FKCB	6523	1	2024 - 2024	8.2	-	-	-	-

Salinity - All Stations Combined

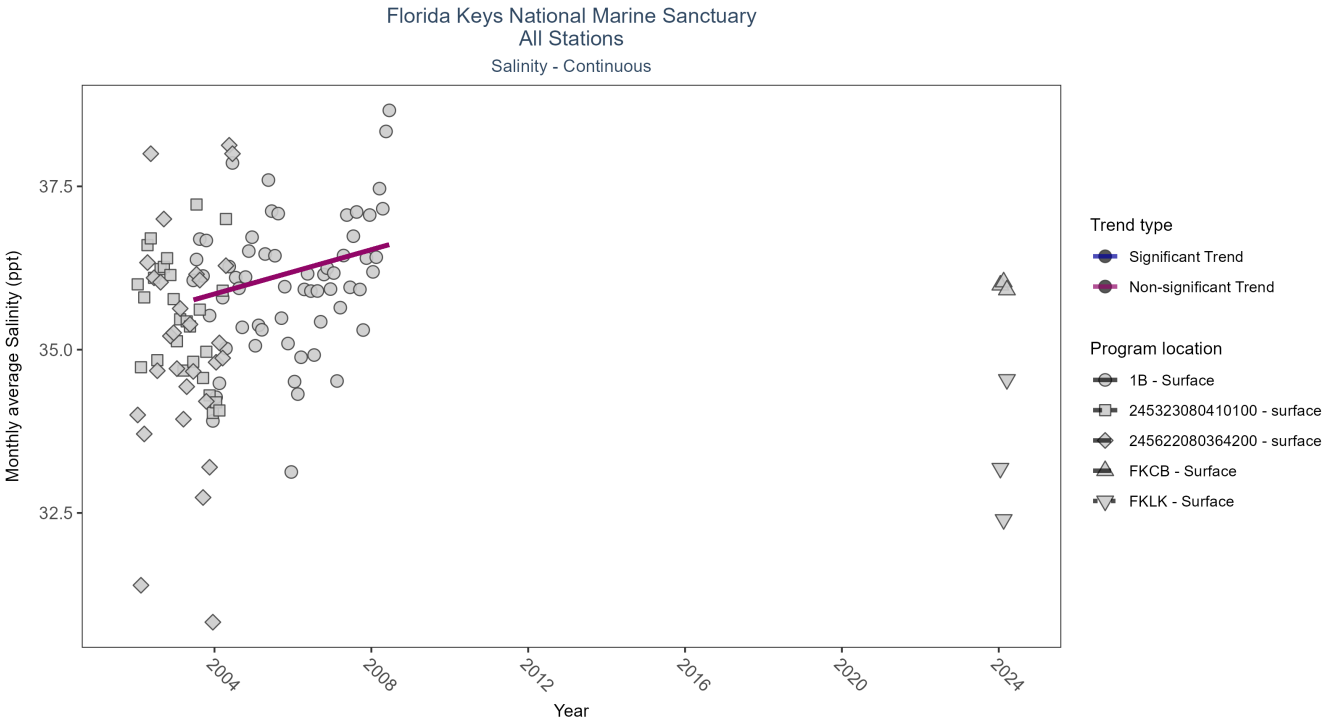

Figure 31: Figure for Salinity - Continuous - All stations combined

Table 43: Seasonal Kendall-Tau Results for All Stations - Salinity

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
1B	86204	6	2003 - 2008	36.07	0.24	35.68	0.17	0.0543
245622080364200	764	3	2002 - 2004	35.00	-	-	-	-
245323080410100	746	3	2002 - 2004	35.00	-	-	-	-
FKLK	6712	1	2024 - 2024	33.60	-	-	-	-
FKCB	6518	1	2024 - 2024	35.90	-	-	-	-

Turbidity - All Stations Combined

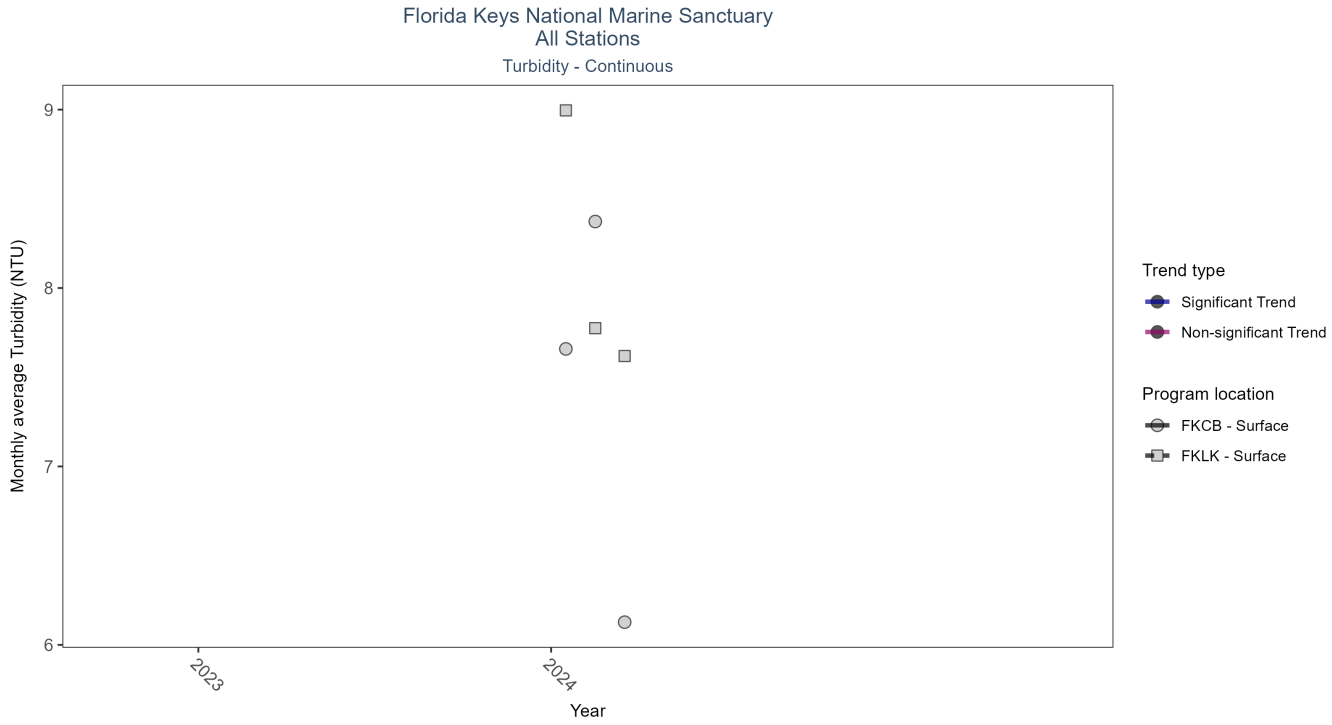

Figure 32: Figure for Turbidity - Continuous - All stations combined

Table 44: Seasonal Kendall-Tau Results for All Stations - Turbidity

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
FKCB	6517	1	2024 - 2024	5	-	-	-	-
FKLK	6712	1	2024 - 2024	6	-	-	-	-

Water Temperature - All Stations Combined by Program

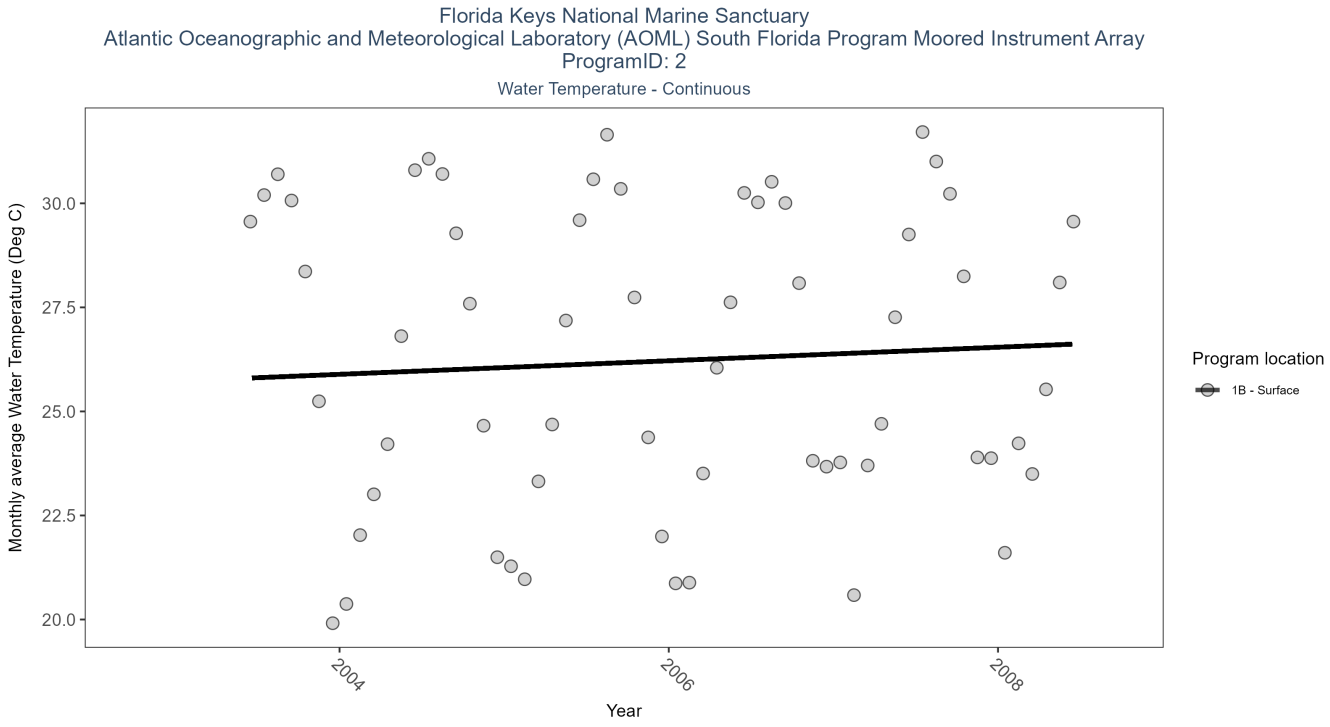

Figure 33: Figure for Water Temperature - Continuous - Program 2

Table 45: Seasonal Kendall-Tau Results for All Stations - Water Temperature

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
1B	86204	6	2003 - 2008	26.38	0.26	25.73	0.16	0.0392

Water Temperature - All Stations Combined by Program

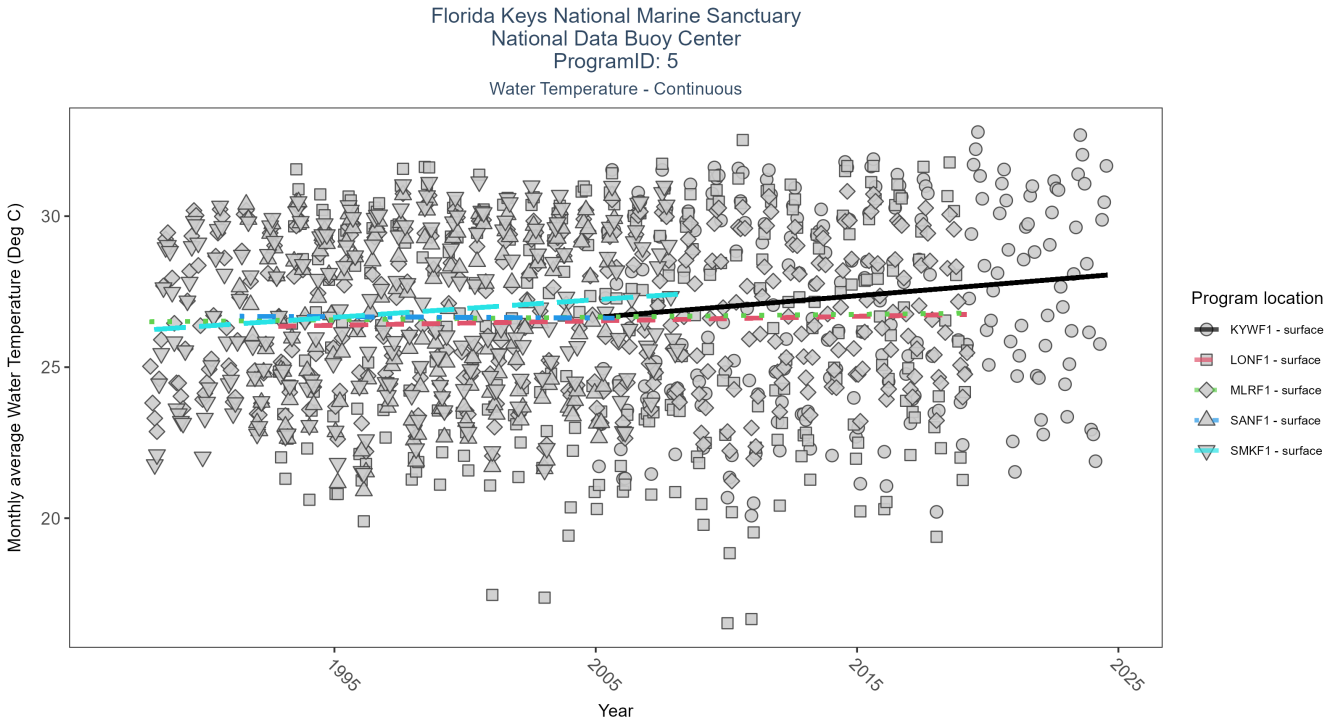

Figure 34: Figure for Water Temperature - Continuous - Program 5

Table 46: Seasonal Kendall-Tau Results for All Stations - Water Temperature

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
KYWF1	1441302	20	2005 - 2024	27.6	0.31	26.65	0.07	0.0000
LONF1	205971	28	1992 - 2019	26.6	0.07	26.34	0.01	0.0825
MLRF1	256798	33	1987 - 2019	26.5	0.10	26.49	0.01	0.0043
SMKF1	154326	21	1988 - 2008	26.8	0.34	26.24	0.06	0.0000
SANF1	117833	15	1991 - 2005	26.7	-0.03	26.69	0.00	0.6199

Water Temperature - All Stations Combined by Program

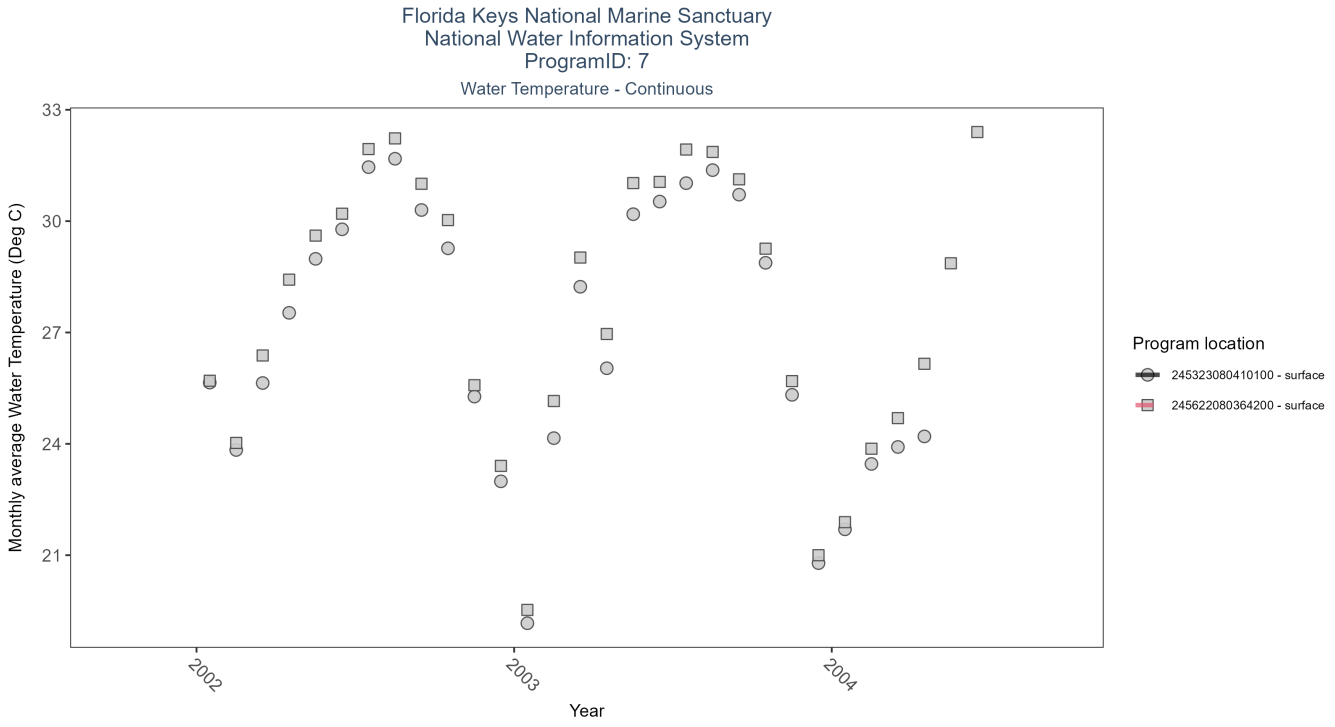

Figure 35: Figure for Water Temperature - Continuous - Program 7

Table 47: Seasonal Kendall-Tau Results for All Stations - Water Temperature

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
245622080364200	853	3	2002 - 2004	28.3	-	-	-	-
245323080410100	791	3	2002 - 2004	27.9	-	-	-	-

Water Temperature - All Stations Combined by Program

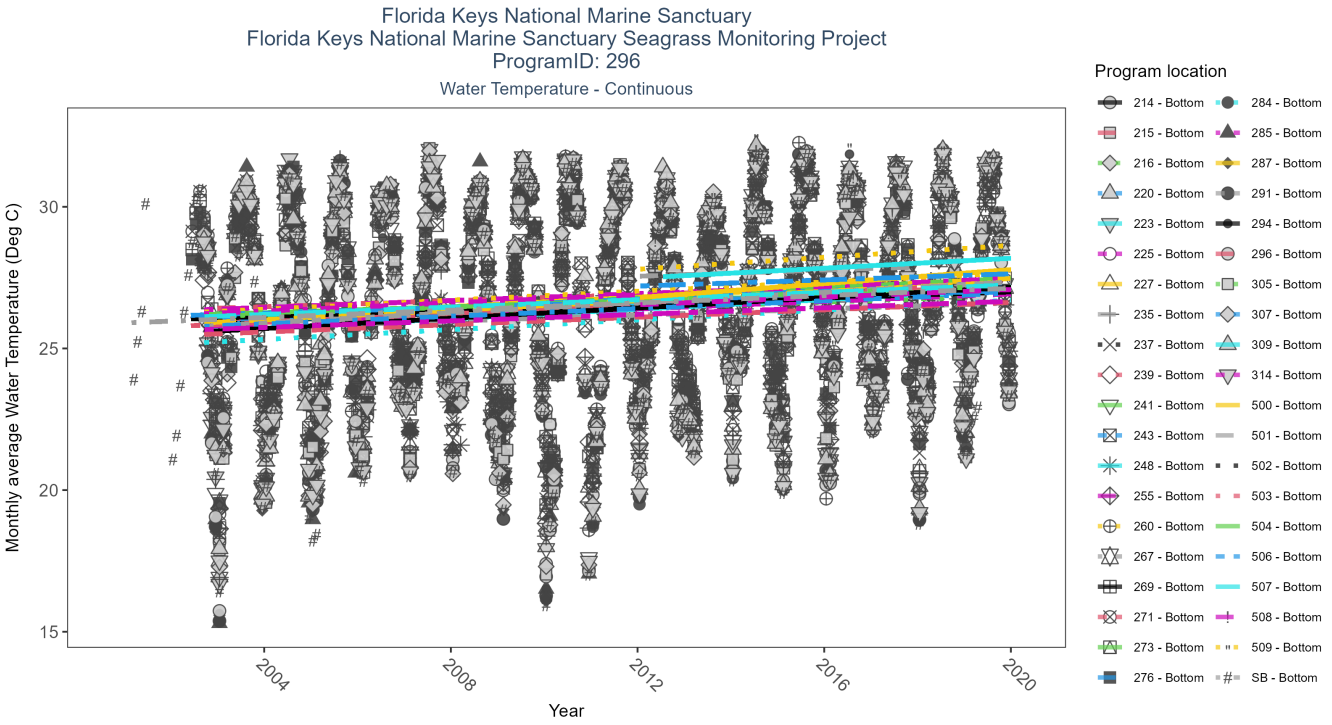

Figure 36: Figure for Water Temperature - Continuous - Program 296

Table 48: Seasonal Kendall-Tau Results for All Stations - Water Temperature

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
508	24021	6	2012 - 2019	26.67	0.33	26.54	0.07	0.2949
237	122250	18	2002 - 2019	26.38	0.31	25.74	0.09	0.0000
284	123977	17	2002 - 2019	26.86	0.28	25.14	0.09	0.0000
287	133008	18	2002 - 2019	26.87	0.29	25.84	0.08	0.0000
267	99735	18	2002 - 2019	26.57	0.24	25.64	0.05	0.0002
291	116240	18	2002 - 2019	26.38	0.26	25.72	0.09	0.0000
309	107410	18	2002 - 2019	27.85	0.27	26.07	0.06	0.0000
260	97832	16	2002 - 2019	27.07	0.28	26.22	0.08	0.0000
273	129817	18	2002 - 2019	27.16	0.24	26.16	0.05	0.0000
SB	145514	19	2001 - 2019	26.34	0.23	25.9	0.06	0.0000
223	133082	18	2002 - 2019	26.89	0.3	25.84	0.08	0.0000
241	127914	18	2002 - 2019	27.26	0.27	25.91	0.09	0.0000
307	110802	17	2002 - 2019	26.74	0.22	25.73	0.07	0.0003
500	69048	8	2012 - 2019	27.33	0.23	26.79	0.12	0.0074
214	136333	18	2002 - 2019	26.52	0.27	25.84	0.07	0.0000
248	111702	18	2002 - 2019	26.79	0.31	25.54	0.08	0.0000
243	121593	18	2002 - 2019	26.62	0.3	26	0.07	0.0000
271	133627	18	2002 - 2019	26.92	0.26	25.77	0.07	0.0000
296	114497	17	2002 - 2019	27.36	0.21	25.45	0.07	0.0002
305	122296	18	2002 - 2019	26.43	0.22	26.07	0.06	0.0001
314	110686	18	2002 - 2019	27.41	0.23	25.63	0.06	0.0002
225	117692	17	2002 - 2019	26.82	0.32	26.32	0.06	0.0000
285	121423	18	2002 - 2019	26.86	0.25	26.17	0.07	0.0000

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
507	47517	8	2012 - 2019	27.36	0.18	27.48	0.09	0.1213
220	126033	17	2003 - 2019	26.52	0.25	25.94	0.06	0.0000
227	105351	17	2003 - 2019	26.67	0.29	26.06	0.08	0.0000
235	128499	18	2002 - 2019	27.14	0.28	25.77	0.08	0.0000
502	22765	4	2016 - 2019	26.70	-	-	-	-
276	123833	18	2002 - 2019	26.87	0.21	26.15	0.05	0.0002
294	112348	18	2002 - 2019	26.92	0.27	25.52	0.09	0.0000
255	119939	18	2002 - 2019	26.35	0.24	25.73	0.07	0.0000
269	106458	17	2002 - 2019	26.74	0.2	26.02	0.05	0.0010
506	35198	7	2012 - 2019	27.41	0.04	27.2	0.05	0.7350
509	38607	8	2012 - 2019	27.70	0.05	27.79	0.11	0.4739
216	98535	17	2002 - 2018	26.26	0.31	25.86	0.06	0.0000
239	111523	17	2002 - 2018	26.92	0.24	25.96	0.07	0.0001
215	133286	16	2003 - 2018	26.74	0.26	26.42	0.05	0.0000
501	34805	5	2012 - 2018	27.48	0.11	27.55	0.05	0.6481
503	7490	1	2016 - 2016	28.74	-	-	-	-
504	4339	1	2018 - 2018	29.84	-	-	-	-

Water Temperature - All Stations Combined by Program

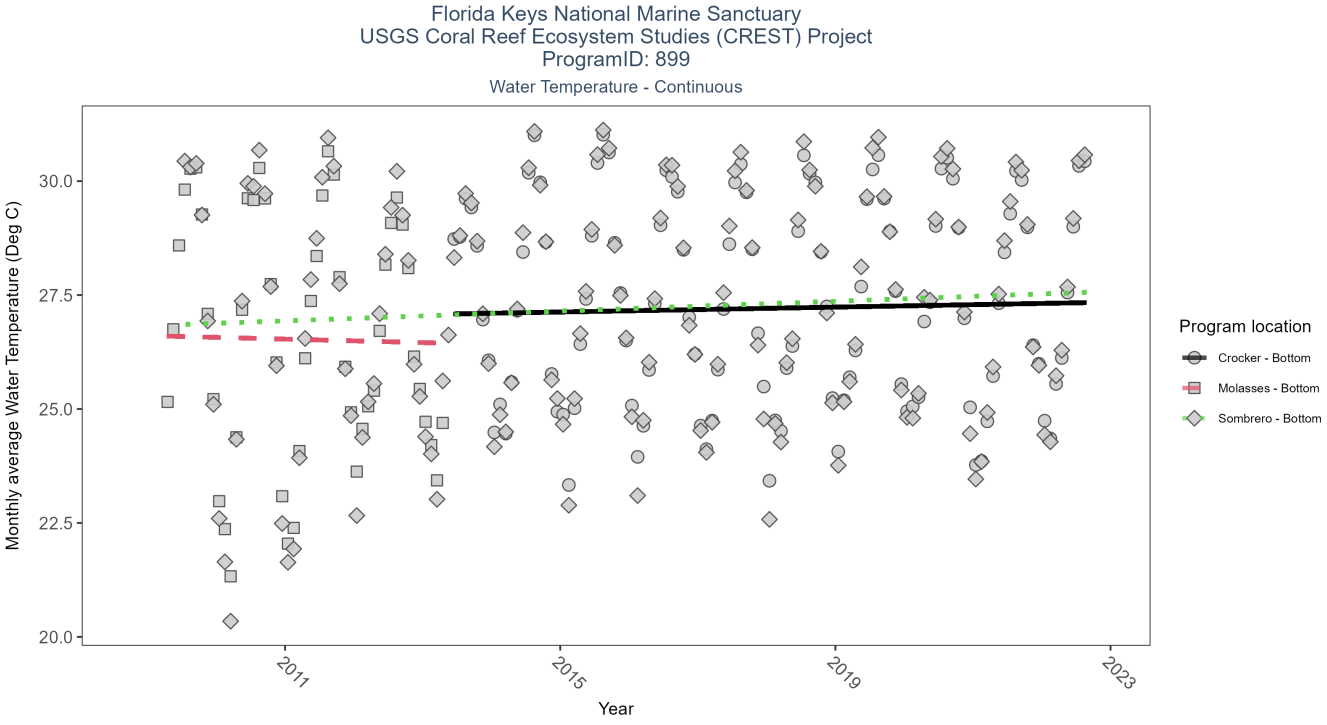

Figure 37: Figure for Water Temperature - Continuous - Program 986

Table 49: Seasonal Kendall-Tau Results for All Stations - Water Temperature

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
51	222780	18	2003 - 2022	26.67	0.31	26.27	0.06	0.0000
56	175648	17	2006 - 2022	26.67	0.14	26.67	0.03	0.0187

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
74	130333	11	2012 - 2022	26.87	0.24	26.64	0.05	0.0005
15	212659	17	2006 - 2022	26.99	0.19	26.4	0.05	0.0006
34	274006	21	2002 - 2022	26.74	0.3	26.19	0.07	0.0000
52	188237	15	2008 - 2022	26.92	0.34	26.63	0.07	0.0000
55	225636	21	2002 - 2022	26.86	0.28	26.79	0.05	0.0000
22	171553	14	2009 - 2022	26.91	0.25	26.43	0.07	0.0000
38	256177	21	2002 - 2022	26.47	0.28	26.15	0.06	0.0000
32	223104	18	2003 - 2022	26.69	0.31	26.09	0.06	0.0000
40	244138	21	2002 - 2022	26.79	0.28	26.27	0.07	0.0000
53	179447	15	2008 - 2022	26.98	0.37	26.53	0.07	0.0000
57	187914	15	2008 - 2022	26.96	0.3	26.66	0.07	0.0000
54	130399	11	2012 - 2022	27.06	0.25	26.77	0.06	0.0002
75	144589	13	2010 - 2022	27.06	0.27	26.71	0.07	0.0001
35	217666	17	2006 - 2022	26.84	0.22	26.41	0.05	0.0000
59	191677	18	2002 - 2022	26.81	0.27	26.85	0.05	0.0000
73	179435	15	2008 - 2022	26.74	0.35	26.49	0.07	0.0000
80	167362	14	2009 - 2022	26.87	0.21	26.92	0.05	0.0005
70	104819	10	2013 - 2022	26.91	0.22	26.73	0.05	0.0044
14	223851	19	2002 - 2022	26.84	0.24	26.31	0.06	0.0000
76	168914	14	2009 - 2022	26.84	0.23	26.82	0.05	0.0002
11	228643	18	2003 - 2022	26.81	0.3	26.1	0.06	0.0000
26	142040	14	2009 - 2022	26.96	0.21	26.97	0.06	0.0024
36	192871	16	2007 - 2022	26.89	0.24	26.52	0.06	0.0001
72	188119	15	2008 - 2022	26.77	0.42	26.42	0.08	0.0000
77	188336	15	2008 - 2022	26.89	0.27	26.57	0.07	0.0000
23	113161	11	2012 - 2022	27.33	0.19	26.83	0.07	0.0111
83	130599	16	2006 - 2022	25.79	0.14	25.79	0.04	0.0106
61	54044	7	2016 - 2022	27.06	0.15	26.58	0.05	0.1513
37	52521	7	2016 - 2022	26.74	0.07	26.3	0.05	0.4651
12	138064	13	2008 - 2022	27.16	0.21	26.39	0.06	0.0020
58	72230	9	2014 - 2022	27.11	0.01	27.23	0.01	0.9631
25	117274	12	2010 - 2022	27.19	0.08	27.07	0.03	0.2669
33	38112	6	2016 - 2022	27.13	0.08	26.23	0.01	0.6585
60	150013	14	2009 - 2022	26.94	0.17	27.07	0.04	0.0094
30	116701	11	2012 - 2022	26.62	0.21	26.3	0.05	0.0055
18	44119	7	2016 - 2022	27.03	0.13	26.59	0.06	0.2890
21	55870	7	2016 - 2022	27.18	0.13	26.51	0.04	0.2228
79	175394	16	2007 - 2022	26.79	0.21	26.56	0.04	0.0006
24	111388	11	2010 - 2022	26.89	0.33	26.12	0.09	0.0000
39	33723	5	2018 - 2022	27.01	-0.09	27.6	-0.08	0.6877
50	103998	10	2013 - 2022	27.01	0.23	26.85	0.05	0.0035
78	87924	9	2014 - 2022	26.98	0.11	26.81	0.03	0.1925
81	53957	7	2016 - 2022	27.03	0.13	26.63	0.05	0.2247
10	18268	3	2020 - 2022	27.72	-	-	-	-

Water Temperature - All Stations Combined by Program

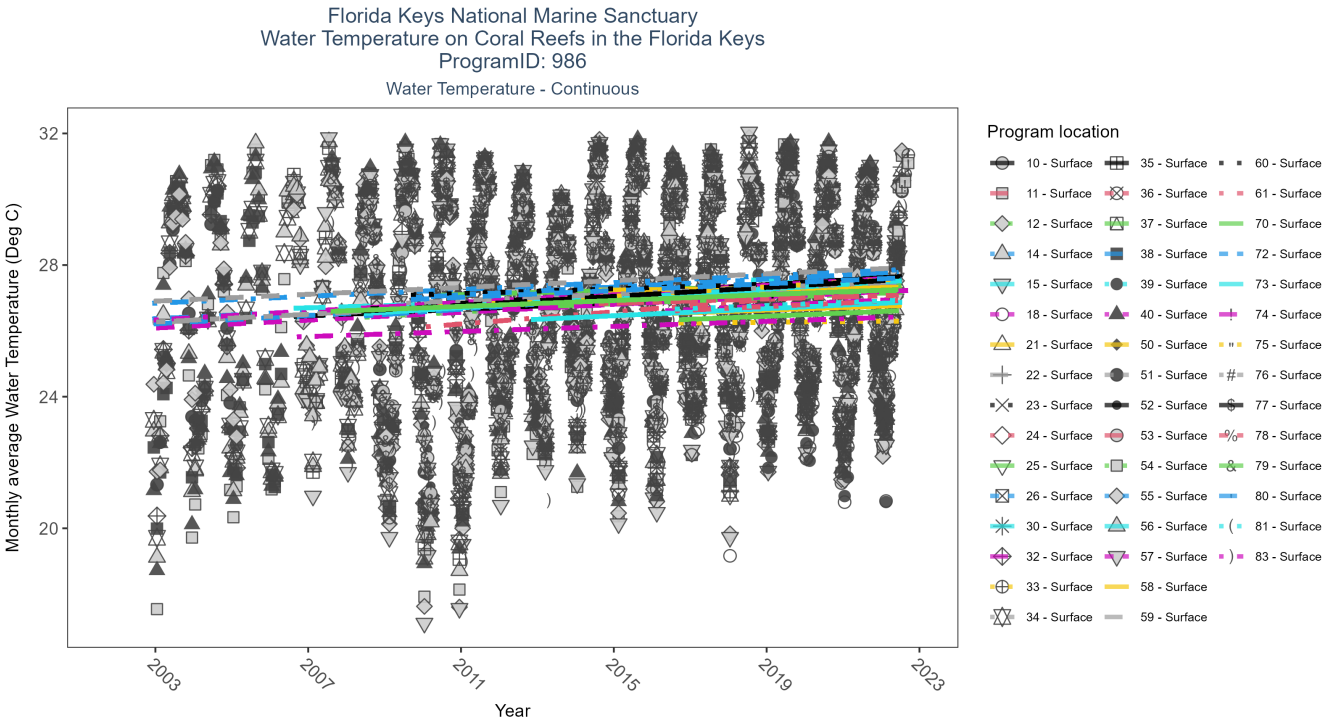

Figure 38: Figure for Water Temperature - Continuous - Program 899

Table 50: Seasonal Kendall-Tau Results for All Stations - Water Temperature

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
Crocker	322670	10	2013 - 2022	27.32	0.15	27.07	0.03	0.0436
Sombrero	459354	14	2009 - 2022	27.16	0.26	26.83	0.05	0.0000
Molasses	140713	5	2009 - 2013	26.72	-0.03	26.61	-0.04	0.9247

Water Temperature - All Stations Combined by Program

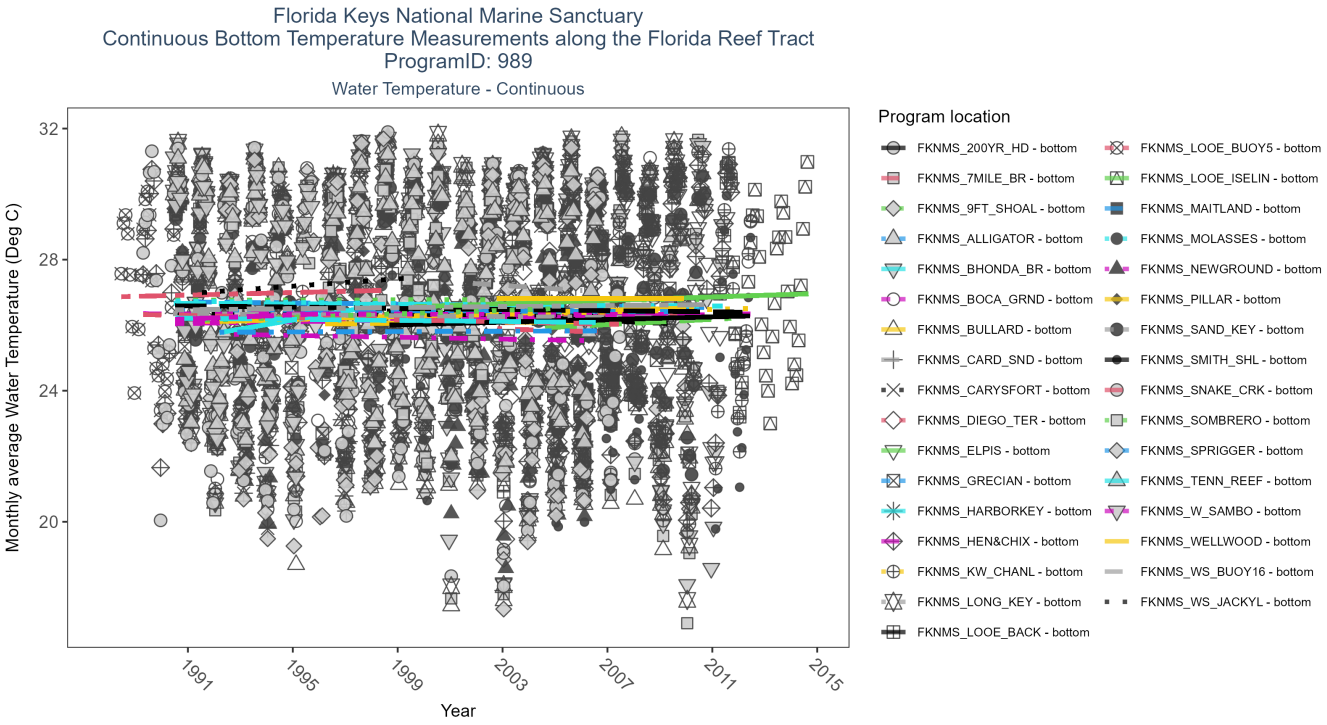

Figure 39: Figure for Water Temperature - Continuous - Program 989

Table 51: Seasonal Kendall-Tau Results for All Stations - Water Temperature

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
FKNMS_HEN&CHIX	72285	21	1989 - 2011	26.50	-0.01	26.35	0	0.8763
FKNMS_MOLASSES	36146	13	1990 - 2002	26.70	-0.05	26.74	-0.01	0.4806
FKNMS_LOOE_ISELIN	194367	13	1999 - 2014	26.88	0.13	26.55	0.03	0.0801
FKNMS_LONG_KEY	69656	19	1990 - 2010	26.64	-0.03	26.35	-0.01	0.5769
FKNMS_BULLARD	66230	18	1992 - 2009	26.31	0.12	26.11	0.02	0.0313
FKNMS_BHONDA_BR	77111	22	1990 - 2011	26.60	-0.02	26.67	0	0.6571
FKNMS_200YR_HD	44601	12	1998 - 2009	26.10	-0.1	26.45	-0.04	0.1720
FKNMS_SNAKE_CRK	56777	19	1989 - 2007	26.16	-0.06	26.33	-0.02	0.2771
FKNMS_SOMBRERO	48974	13	1991 - 2005	26.50	0.13	26.14	0.03	0.0508
FKNMS_TENN_REEF	63260	16	1990 - 2006	26.70	-0.06	26.22	-0.01	0.2738
FKNMS_SMITH_SHL	94527	10	1998 - 2012	25.45	0.13	25.99	0.02	0.1933
FKNMS_9FT_SHOAL	80299	21	1990 - 2010	26.50	0	26.76	0	0.9917
FKNMS_SPRIGGER	41834	13	1992 - 2006	26.10	0.02	25.78	0	0.8553
FKNMS_WS_BUOY16	8123	3	2003 - 2005	25.99	-	-	-	-
FKNMS_WELLWOOD	30427	8	2002 - 2009	26.43	0	26.82	0	1.0000
FKNMS_NEWGROUND	35329	12	1992 - 2006	25.49	-0.05	25.73	-0.01	0.5207
FKNMS_PILLAR	40805	11	1996 - 2006	26.24	0.02	26.04	0.01	0.9363
FKNMS_KW_CHANL	123578	18	1991 - 2012	26.27	0.1	26.11	0.02	0.0805
FKNMS_GRECIAN	51723	18	1990 - 2010	26.65	-0.03	26.48	0	0.6634
FKNMS_ALLIGATOR	65144	19	1990 - 2010	26.55	-0.06	26.72	-0.01	0.2339
FKNMS_SAND_KEY	59287	18	1990 - 2010	26.70	0.05	26.46	0.01	0.3230
FKNMS_CARYSFORT	55001	16	1990 - 2006	26.40	-0.03	26.38	0	0.6354
FKNMS_7MILE_BR	73055	19	1991 - 2010	26.66	0.05	26.22	0.01	0.3549

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
FKNMS_CARD_SND	18249	6	2001 - 2006	26.52	-0.05	27.32	-0.05	0.7909
FKNMS_BOCA_GRND	73434	17	1990 - 2012	26.14	0.08	26.04	0.01	0.1662
FKNMS_DIEGO_TER	16693	5	2002 - 2006	25.58	-0.05	25.91	-0.03	0.8407
FKNMS_LOOE_BACK	84984	18	1990 - 2012	26.80	-0.06	26.6	-0.01	0.4216
FKNMS_LOOE_BUOY5	35252	10	1988 - 1998	26.90	0.05	26.86	0.02	0.3627
FKNMS_HARBORKEY	15407	5	1992 - 1997	26.50	0.14	25.74	0.14	0.3261
FKNMS_WS_JACKYL	29557	9	1991 - 1999	26.40	0.17	26.96	0.06	0.0860
FKNMS_W_SAMBO	18786	6	1990 - 1995	26.90	0.09	26.16	0.03	0.5597
FKNMS_ELPIS	31035	8	2004 - 2011	26.35	0.06	25.9	0.04	0.5313
FKNMS_MAITLAND	12421	4	2004 - 2007	26.07	-	-	-	-

Water Temperature - All Stations Combined by Program

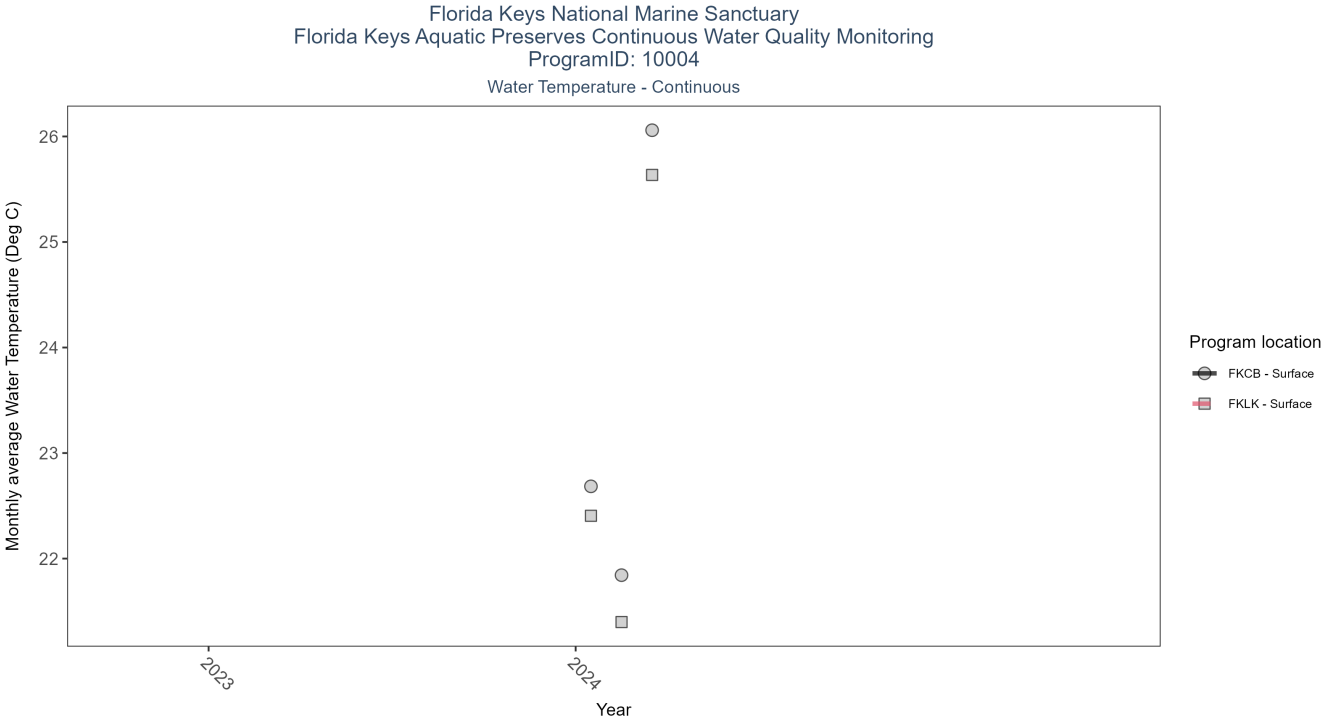

Figure 40: Figure for Water Temperature - Continuous - Program 10004

Table 52: Seasonal Kendall-Tau Results for All Stations - Water Temperature

Station	N_Data	N_Years	Period of Record	Median	tau	SennIntercept	SennSlope	p
FKLK	6712	1	2024 - 2024	23.2	-	-	-	-
FKCB	6523	1	2024 - 2024	23.7	-	-	-	-

Submerged Aquatic Vegetation

The data file used is: **All_SAV_Parameters-2024-Dec-08.txt**

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

Parameters

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

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

Species

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

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

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

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

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

Notes

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

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

- Biscayne Bay Aquatic Preserve
- Florida Keys National Marine Sanctuary

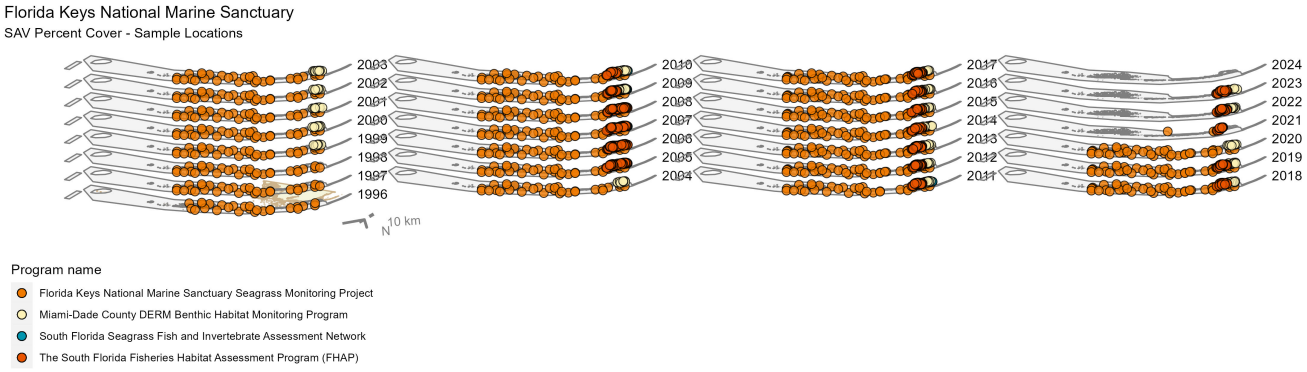

Figure 41: Maps showing the temporal scope of SAV sampling sites within the boundaries of *Florida Keys National Marine Sanctuary* by Program name.

Sampling locations by Program:

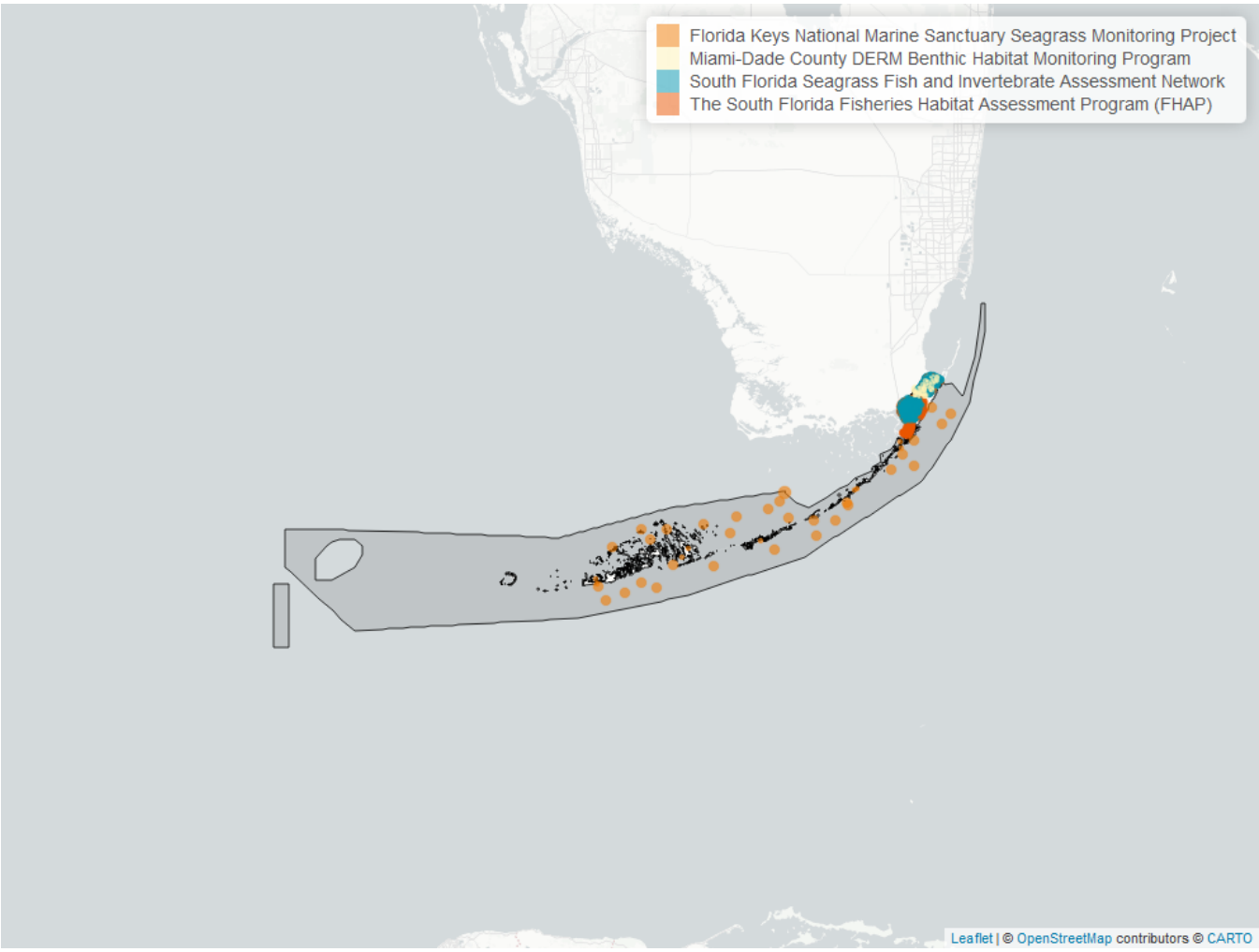

Figure 42: Map showing SAV sampling sites within the boundaries of *Florida Keys National Marine Sanctuary*. The point size reflects the number of samples at a given sampling site.

Table 53: Florida Keys National Marine Sanctuary Seagrass Monitoring Project - Program 296

N-Data	*YearMin*	*YearMax*	*method*	*Sample Locations*
4200	1996	2021	Braun Blanquet	40

Table 54: South Florida Seagrass Fish and Invertebrate Assessment Network - Program 965

N-Data	*YearMin*	*YearMax*	*method*	*Sample Locations*
65538	2005	2011	Braun Blanquet	87

Table 55: Miami-Dade County DERM Benthic Habitat Monitoring Program - Program 4018

N-Data	*YearMin*	*YearMax*	*method*	*Sample Locations*
3925	1999	2023	Braun Blanquet	115
279	1999	2007	Percent Cover	67

Table 56: The South Florida Fisheries Habitat Assessment Program (FHAP) - Program 4049

N-Data	*YearMin*	*YearMax*	*method*	*Sample Locations*
104563	2005	2024	Braun Blanquet	1267

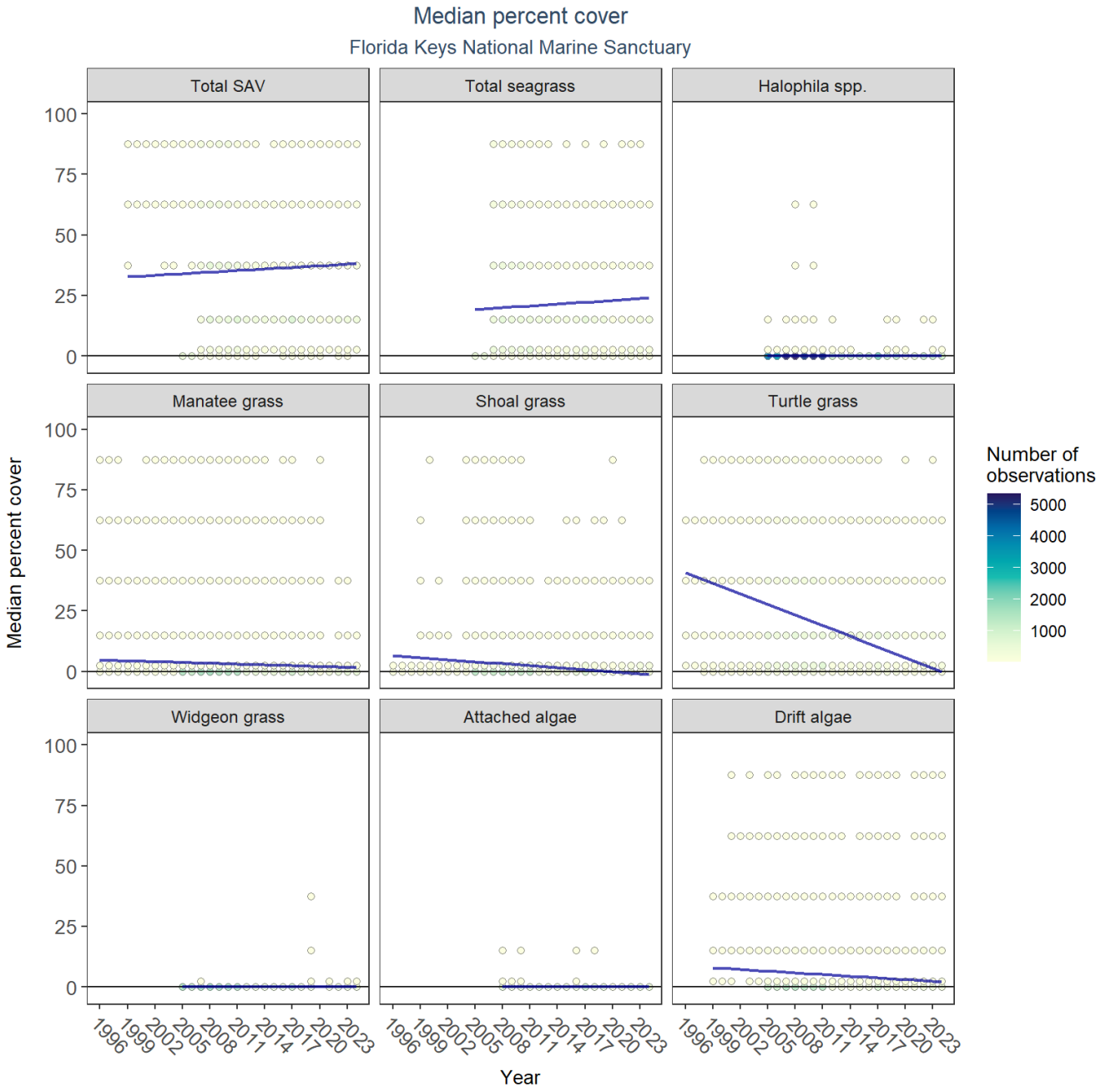

Figure 43: Trends in median percent cover for various seagrass species in Florida Keys National Marine Sanctuary

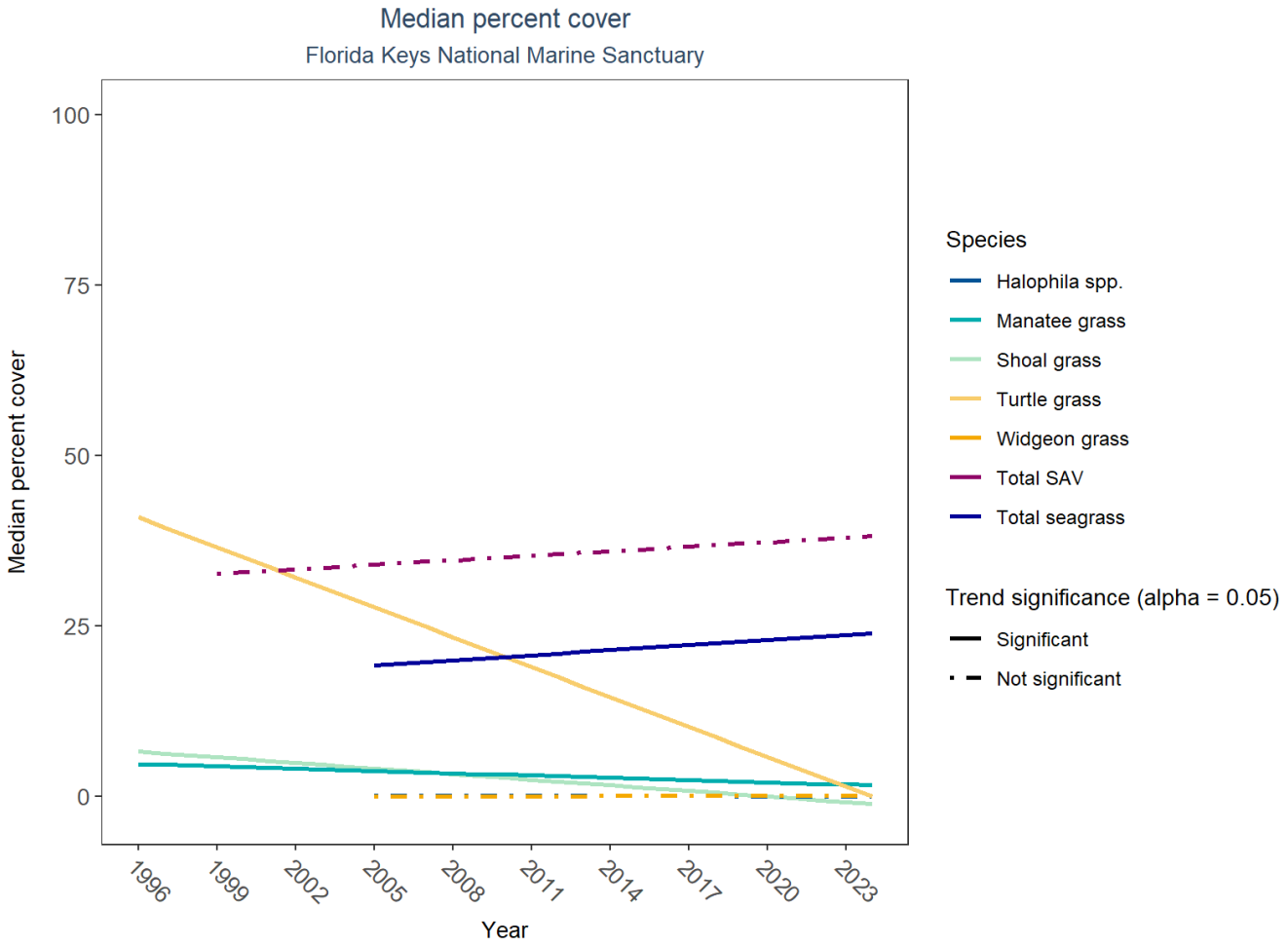

Figure 44: Trends in median percent cover for various seagrass species in Florida Keys National Marine Sanctuary - simplified

Table 57: Percent Cover Trend Analysis for Florida Keys National Marine Sanctuary

CommonName	*Trend Significance (0.05)*	*Period of Record*	*LME-Intercept*	*LME-Slope*	*p*
Attached algae	No significant trend	2008 - 2024	0.0761156	-0.0025431	0.2165288
Drift algae	Significantly decreasing trend	1999 - 2024	9.1453634	-0.2334903	0.0000182
Shoal grass	Significantly decreasing trend	1996 - 2024	7.0786393	-0.2741277	0.0001017
Halophila spp.	No significant trend	2005 - 2024	0.0749748	-0.0023145	0.3291377
Widgeon grass	No significant trend	2005 - 2024	-0.0383110	0.0028175	0.1044228
Manatee grass	Significantly decreasing trend	1996 - 2024	4.9248487	-0.1110175	0.0174462
Turtle grass	Significantly decreasing trend	1996 - 2024	43.8162438	-1.4638940	0.0000000
Total SAV	No significant trend	1999 - 2024	31.5258385	0.2203818	0.1700645
Total seagrass	Significantly increasing trend	2005 - 2024	16.4149528	0.2503528	0.0067936

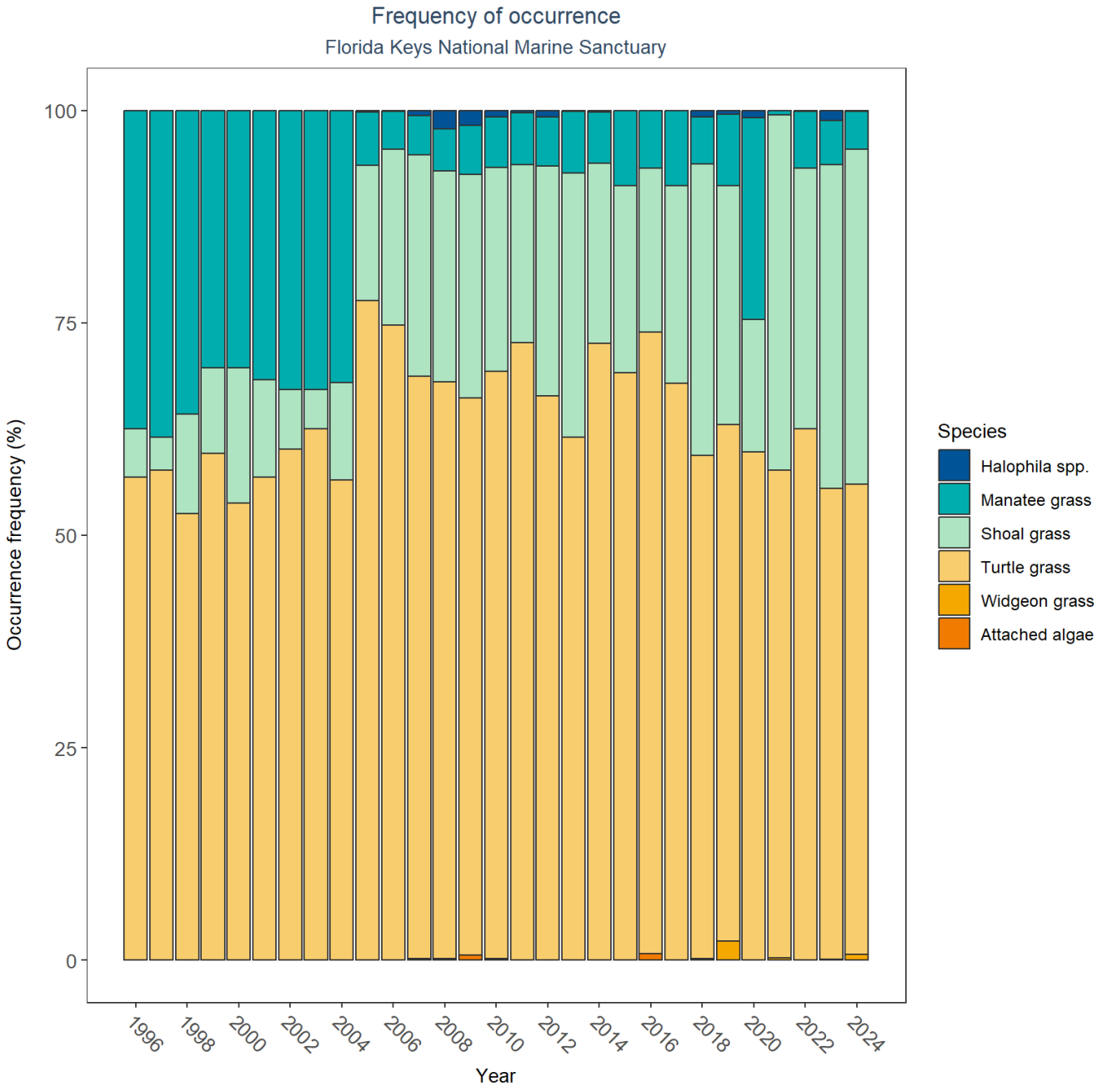

Figure 45: Frequency of occurrence for various seagrass species in Florida Keys National Marine Sanctuary

Coral Reef

The data file used is: **All_CORAL_Parameters-2024-Dec-08.txt**

Percent Cover

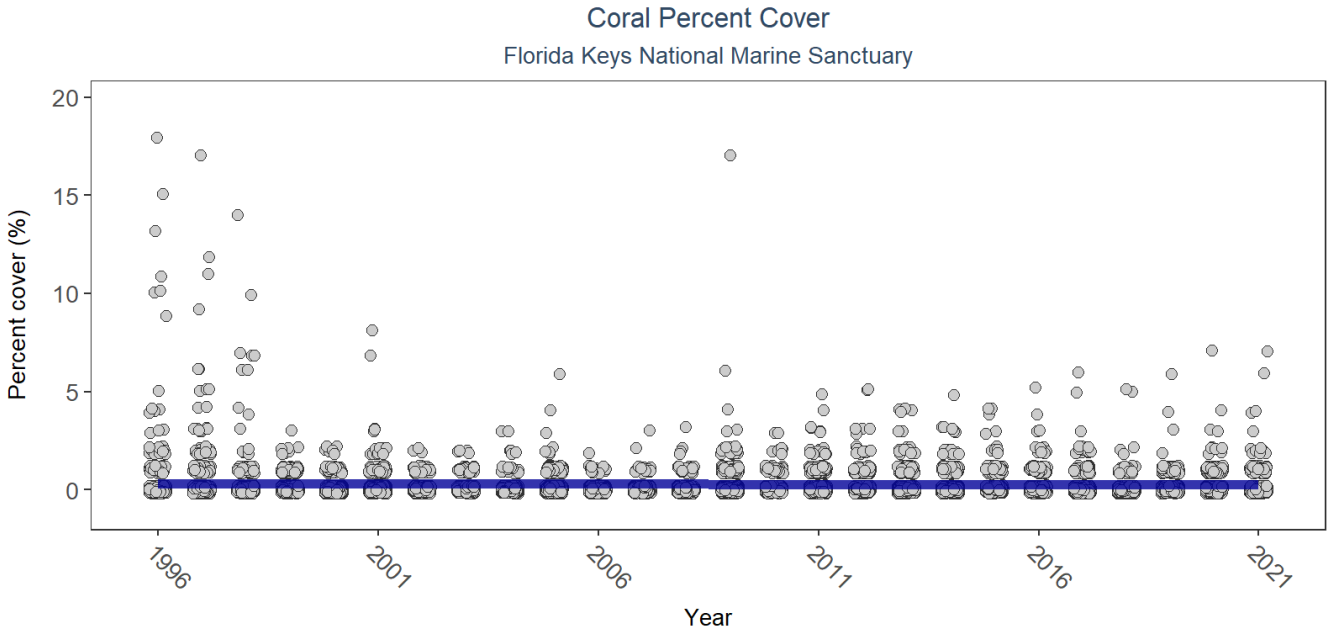

Figure 46: Figure for Coral Percent Cover in Florida Keys National Marine Sanctuary

Table 58: Coral Percent Cover

N-Years	SufficientData	EarliestYear	LatestYear	N-Data	Min	Max	Median	Mean	StDev	LME-Intercept	LME-Slope	LME-p
26	TRUE	1996	2021	8196	0	18	0	0.28	0.83	4.96	0	0.0532

Species Richness

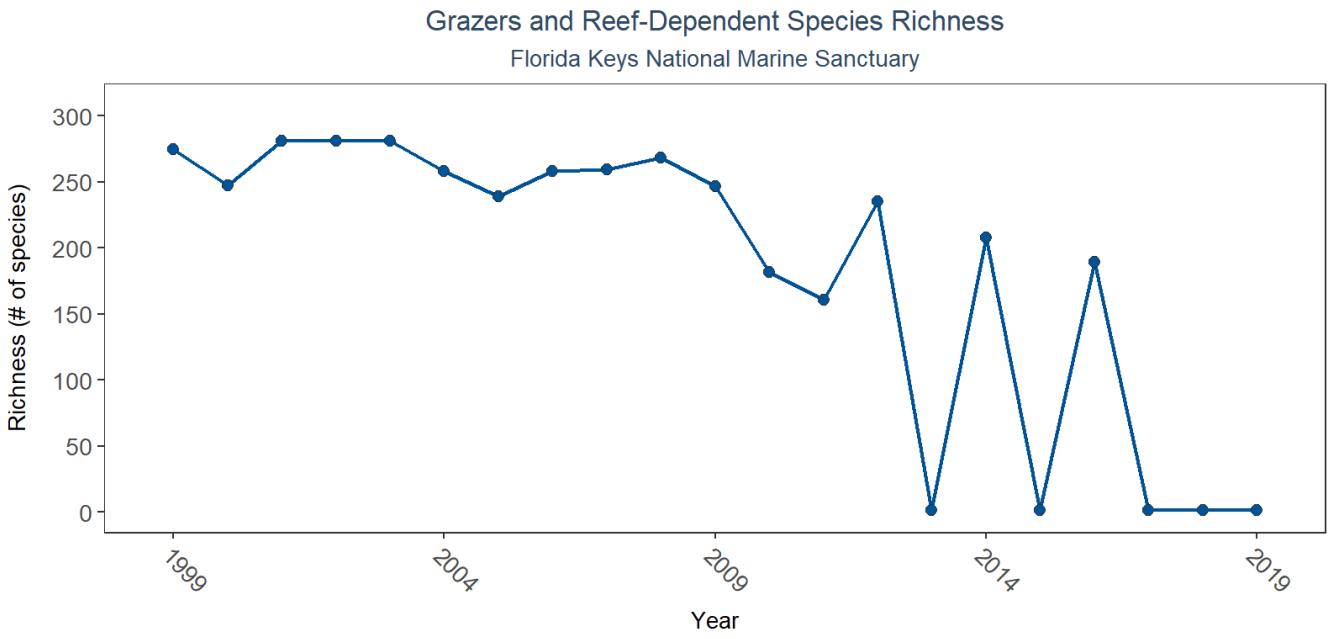

Figure 47: Figure for Coral Species Richness in Florida Keys National Marine Sanctuary

Table 59: Coral Species Richness

N-Years	*EarliestYear*	*LatestYear*	*N-Data*	*Min*	*Max*	*Median*	*Mean*	*StDev*	*Year-MinRichness*	*Year-MaxRichness*
21	1999	2019	11081	1	302	281	220.75	106.06	2019	2001

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