SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Water Quality of the Biscayne Bay Watershed

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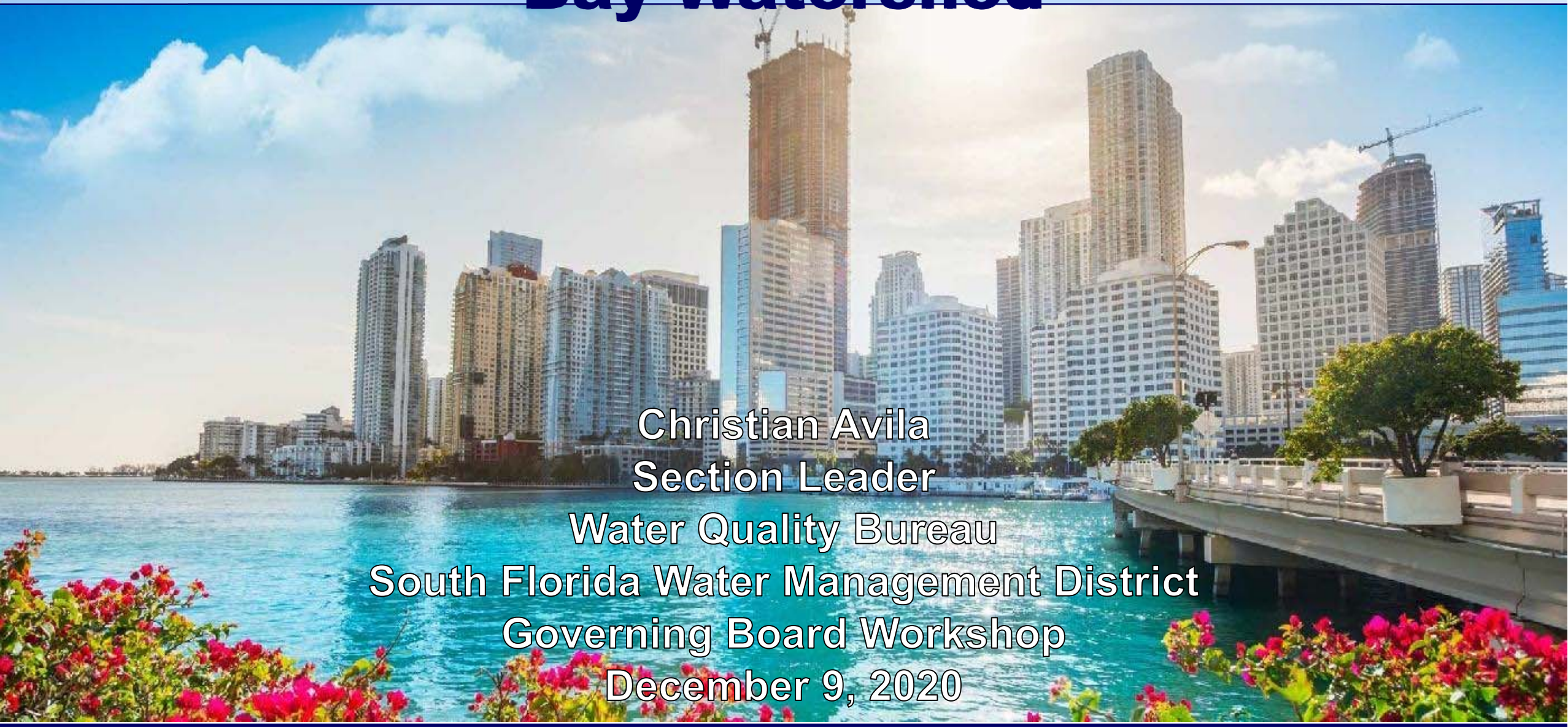

Christian Avila
Section Leader
Water Quality Bureau
South Florida Water Management District

Governing Board Workshop
December 9, 2020

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Presentation Overview

1. Timeline of Legal Framework for Water Quality and Ecological Events

2. Water Quality in the Bay

3. Regional Water Deliveries to the Headwaters of the Biscayne Bay Watershed

Timeline of Legal Framework to Improve Water Quality in Biscayne Bay

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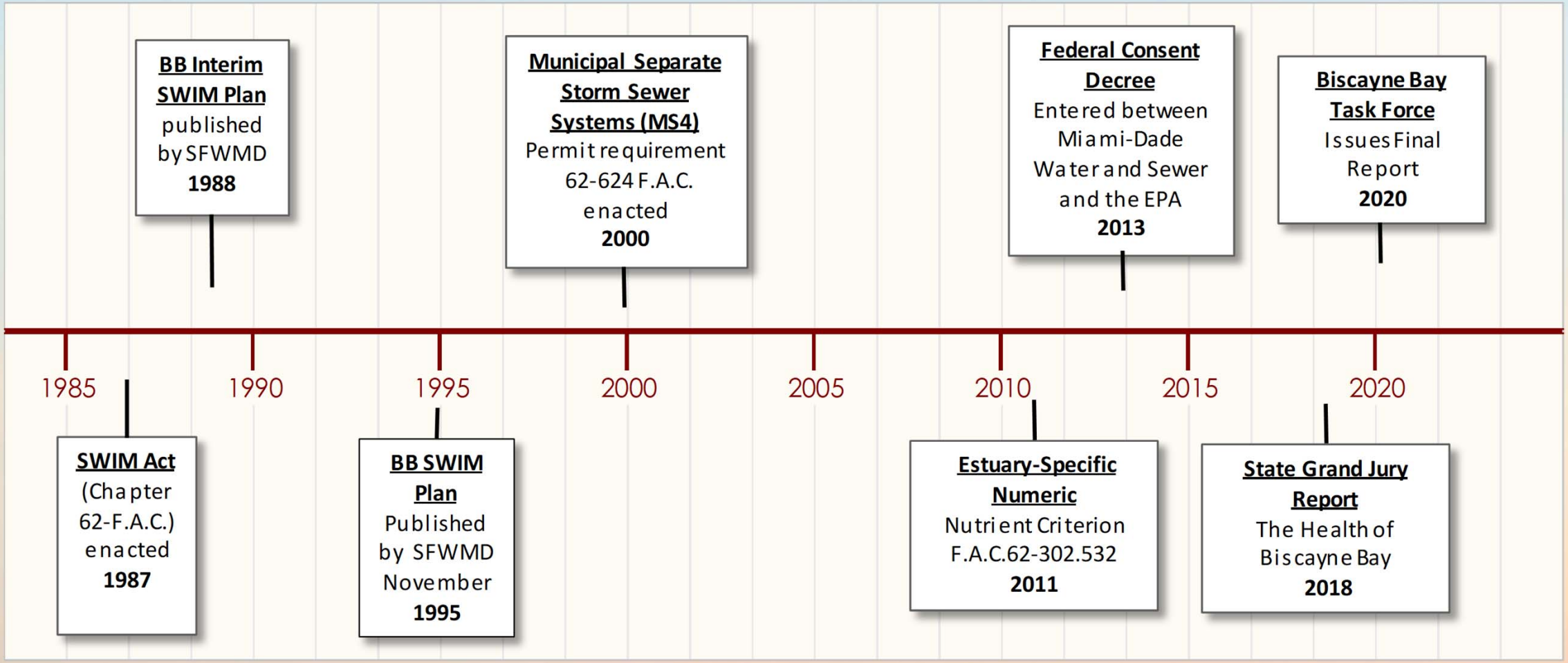

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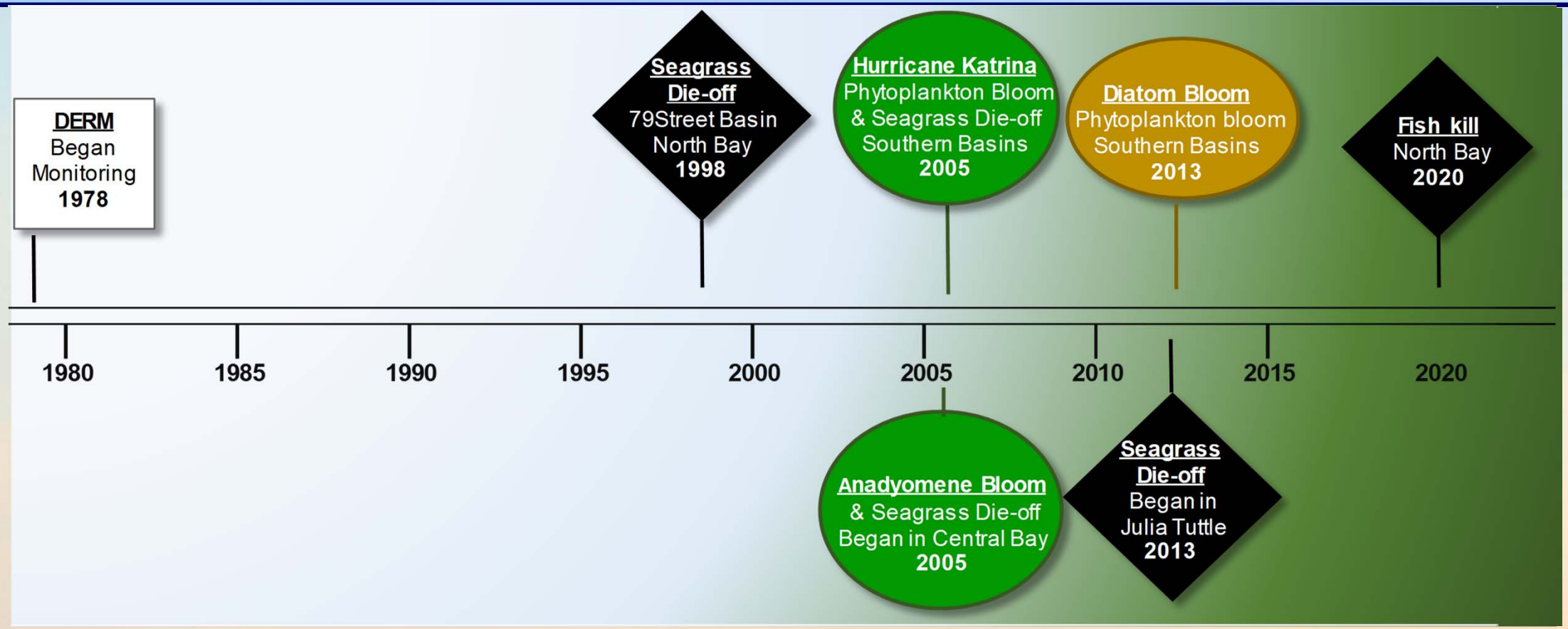
Timeline of Ecological Events in Biscayne Bay



- **Over 40-year time span of monitoring**
- **One seagrass die off event documented prior to 2005 and no algal blooms**
- **Since 2005 - Six major events**

Source: Avila et al. 2017

Timeline of Ecological Events in Biscayne Bay

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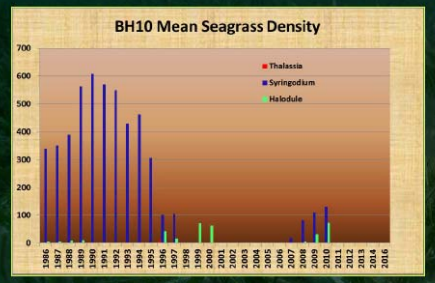
North Bay Seagrass loss event in late 1990's

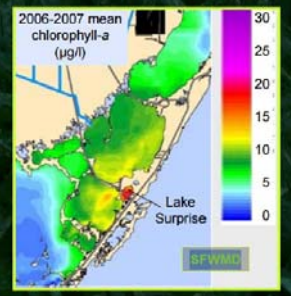


- Density increased steadily 1986 – 1990
- Declined rapidly 1995-1997
- No causal event identified
- Seagrass monitioring in the basin has been limited – therefore the extent of the area lost is unknown
- Sustained recovery has not occurred in the transect area through 2016

1

2005- 2007 Phytoplankton Bloom in the Southern Biscayne Bay Basins

- Series of events contributed to the phytoplankton bloom that lasted 2.5 years
  - Preceded by a two year drought and hypersalinity event with database Period of Record highs in 2004 and 2005
  - Aug 2005 Hurricane Katrina rainfall resulted in a large Total Phosphorus discharge & rapid salinity decreases
  - Oct 2005 Additional disturbances to the region with Hurricane Rita
  - US1 road construction practices likely contributed (Rudnick et al. 2007)



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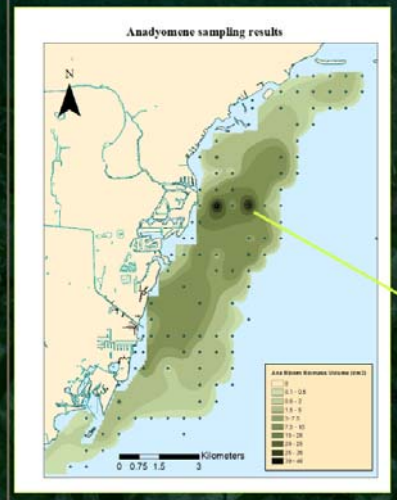
2005-Present macroalgal Bloom in the North Central Inshore Region



- Two species in the genus *Anodyomene*
- Majority of station had >75% cover – however, biomass was noted as variable
- Pattern of greatest biomass just offshore of the two main canals in the region: Snapper Creek and Coral Gables

3

2013 Phytoplankton/Diatom Bloom

- In 2013 Diatom Bloom along inshore and the Southern Bay - Card Sound regions
- SFWMD analysis shows early onset of rainy season, and periods of heavy rains have resulted in high flow from coastal control structures
- Causes of this bloom are uncertain, however, higher flows from coastal structures would have increased nutrient loads

4

2013-Present Developing Seagrass loss event in North Biscayne Bay

Julia Tuttle Basin

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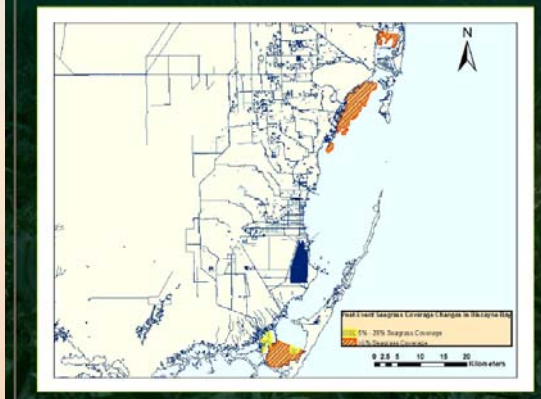
2005 - Present Summary of seagrass loss events



- An estimated total of 56km² of seagrass has been lost
- An 88km² area that has been effected and lost 64% of the seagrass.

Event	Before event	Present	Lost Area	Percent Decrease
Anadyomene Bloom Area	51.2 Km² (2000-2003)	12.1 Km² (2014-2016)	39.1 Km²	76.40%
Julia Tuttle Area	12.0 Km² (2002-2008)	6.6 Km² (2016)	5.4 Km²	45.00%
Barnes Sound/Manatee Bay	24.5 Km² (2005)	12.6 Km² (2014-2016)	11.9 Km²	48.60%
Total	87.7 Km²	31.3 Km²	56.4 Km²	64.31%

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Presenter: Christian Avila

Source: Avila et al. 2017

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Water Quality in the Bay

Estuarine Specific Numeric Nutrient Criteria

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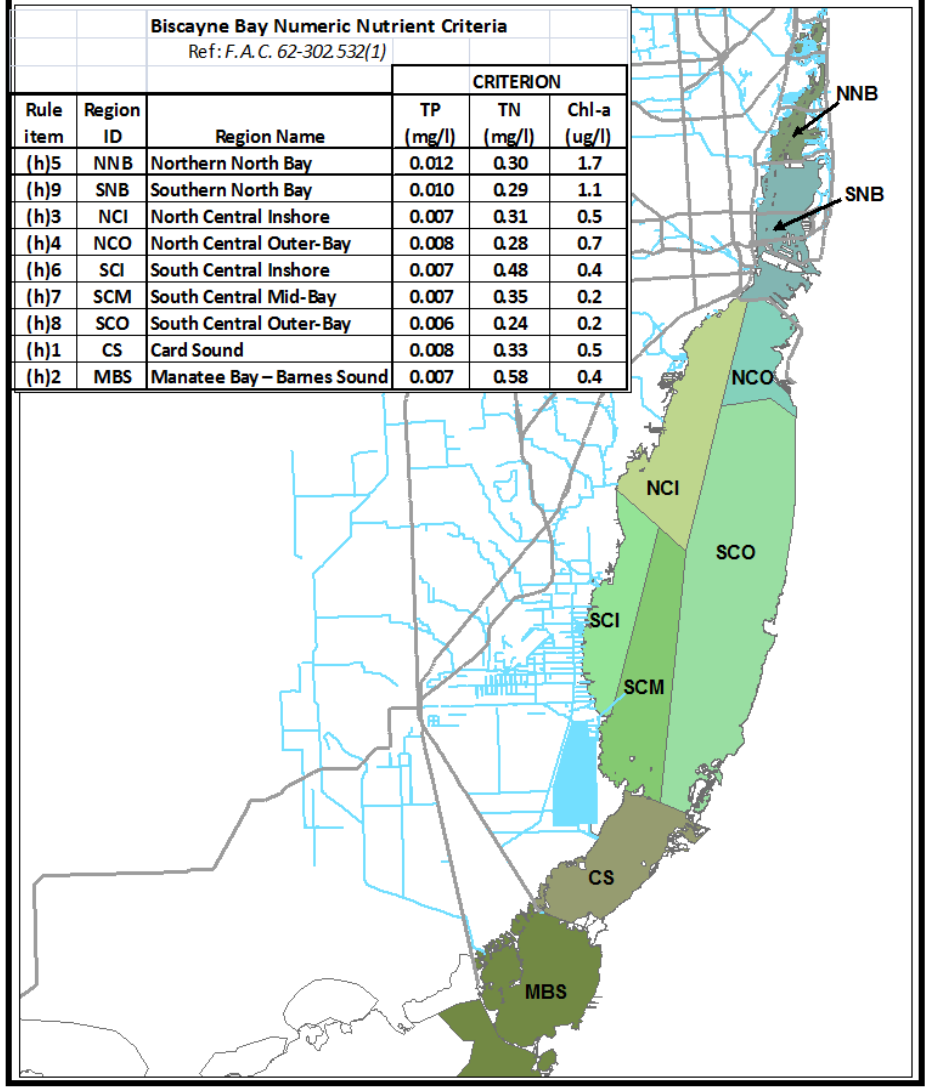
Numeric Nutrient Criterion Regions For Biscayne Bay (Dec., 2012)

Biscayne Bay Numeric Nutrient Criteria
Ref: *F.A.C. 62-302.532(1)*

Rule item	Region ID	Region Name	CRITERION TP (mg/l)	TN (mg/l)	Chl-a (ug/l)
(h)5	NNB	Northern North Bay	0.012	0.30	1.7
(h)9	SNB	Southern North Bay	0.010	0.29	1.1
(h)3	NCI	North Central Inshore	0.007	0.31	0.5
(h)4	NCO	North Central Outer-Bay	0.008	0.28	0.7
(h)6	SCI	South Central Inshore	0.007	0.48	0.4
(h)7	SCM	South Central Mid-Bay	0.007	0.35	0.2
(h)8	SCO	South Central Outer-Bay	0.006	0.24	0.2
(h)1	CS	Card Sound	0.008	0.33	0.5
(h)2	MBS	Manatee Bay – Barnes Sound	0.007	0.58	0.4



Numeric Nutrient Criteria (Ch. 62-302.532, F.A.C.)

- Florida Department of Environmental Protection identified regions based on hydrologic and water quality characteristics
- Numeric interpretations based on "maintaining current conditions" as observed during 1995–2009
- Annual geometric means (AGM) for a region not to exceed limit more than once in three years.

Map: Miami-Dade DERM

2019 MDC MS4 Report: Numeric Nutrient Region Assessment

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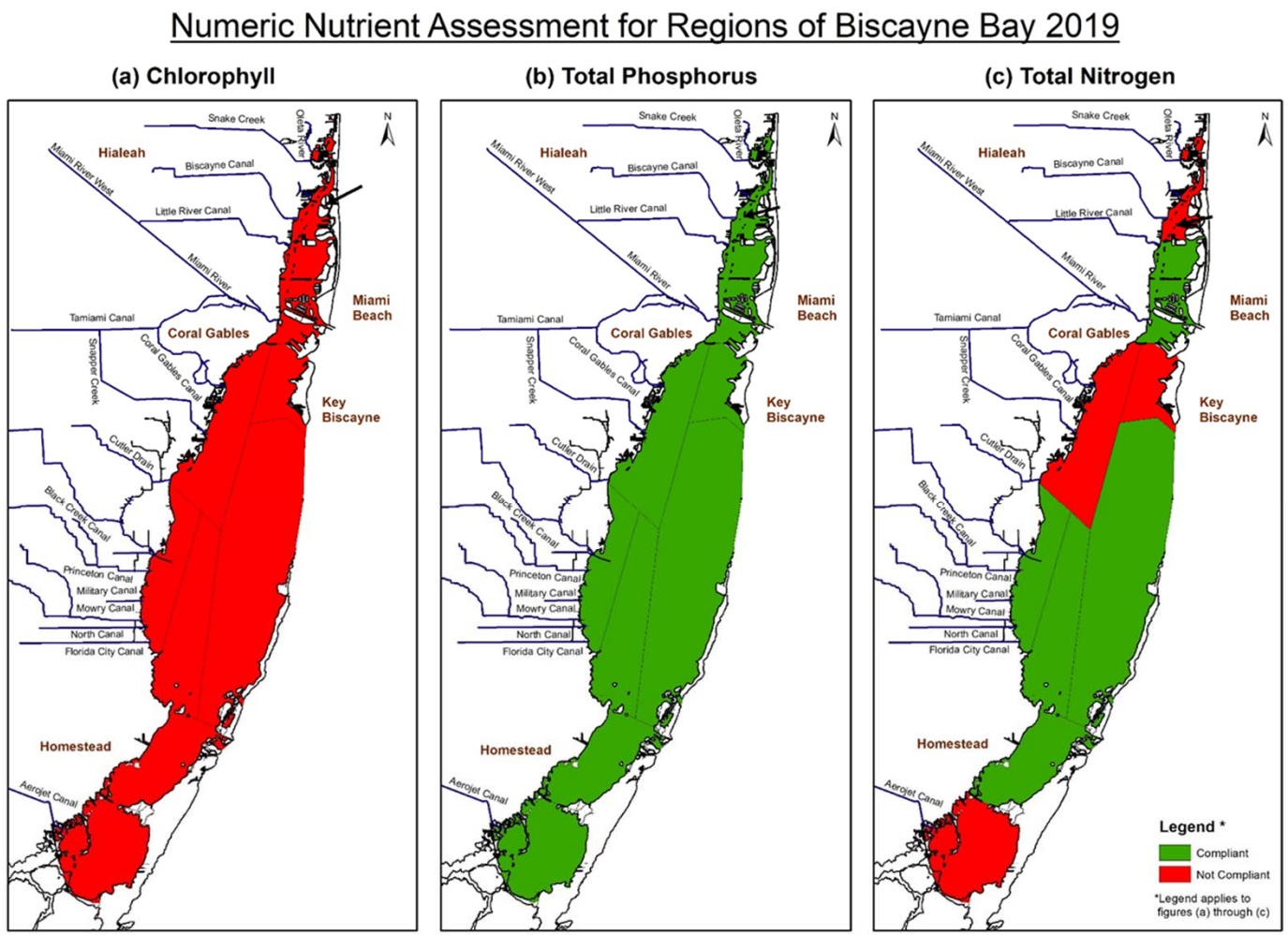

Compliance = Annual Geometric Mean (AGM) does not exceeds criteria more than once in a consecutive three (3) year period.

NUMERIC NUTRIENT CRITERIA (NNC) of BISCAYNE BAY 2015-2019

NNC Standard: The Annual Geometric Mean (AGM) shall not exceed the criterion more than once in any three-year period (62-302.532 (1) (h) FAC)

List of Estuarine Regions: *Card Sound (CS); Manatee Bay (MBS); North Central Inshore (NCI); North Central Offshore (NCO); North North Bay (NNB); South Central Inshore (SCI); South Central Mid (SCM); South Central Offshore (SCO); South North Bay (SNB)*

AGM for Total Phosphorus Concentrations (mg/l)

Bay Region	CS	MBS	NCI	NCO	NNB	SCI	SCM	SCO	SNB
Criterion	**0.008**	**0.007**	**0.007**	**0.08**	**0.012**	**0.007**	**0.007**	**0.006**	**0.01**
2015	0.004	0.004	0.004	0.005	0.009	0.005	0.004	0.004	0.009
2016	0.002	0.003	0.003	0.003	0.008	0.004	0.002	0.002	0.005
2017	0.002	0.003	0.003	0.003	0.007	0.003	0.002	0.002	0.005
2018	0.003	0.004	0.005	0.003	0.009	0.004	0.003	0.003	0.007
2019	0.004	0.004	0.005	0.004	0.009	0.004	0.004	0.005	0.007

AGM for Total Nitrogen Concentrations (mg/l)

Bay Region	CS	MBS	NCI	NCO	NNB	SCI	SCM	SCO	SNB
Criterion	**0.33**	**0.58**	**0.31**	**0.28**	**0.3**	**0.48**	**0.35**	**0.24**	**0.29**
2015	0.301	**0.709**	**0.35**	**0.286**	0.228	**0.605**	0.276	0.178	0.243
2016	0.287	0.539	**0.317**	0.23	**0.301**	0.39	0.303	0.119	0.188
2017	**0.388**	**0.631**	**0.42**	**0.33**	**0.384**	**0.55**	**0.432**	**0.262**	**0.338**
2018	0.307	0.569	**0.383**	**0.353**	**0.314**	0.476	0.335	0.197	0.283
2019	0.294	**0.607**	0.296	0.238	**0.3**	0.458	0.281	0.14	0.216

AGM for Chlorophyll (ug/l)

Bay Region	CS	MBS	NCI	NCO	NNB	SCI	SCM	SCO	SNB
Criterion	**0.5**	**0.4**	**0.5**	**0.7**	**1.7**	**0.4**	**0.2**	**0.2**	**1.1**
2015	**0.591**	**0.615**	**0.592**	0.67	**2.024**	**0.453**	**0.346**	**0.252**	**1.328**
2016	**0.515**	**0.634**	**0.619**	**0.779**	**2.055**	**0.526**	**0.424**	**0.333**	**1.277**
2017	**0.615**	**0.786**	**0.88**	**0.965**	**2.559**	**0.493**	**0.468**	**0.341**	**1.42**
2018	**0.526**	**0.722**	**0.659**	**0.712**	**1.823**	**0.42**	**0.426**	**0.245**	**1.619**
2019	**0.52**	**0.586**	**0.642**	0.627	1.631	0.355	**0.315**	**0.358**	1.084

Source: Miami-Dade County MS4 Report

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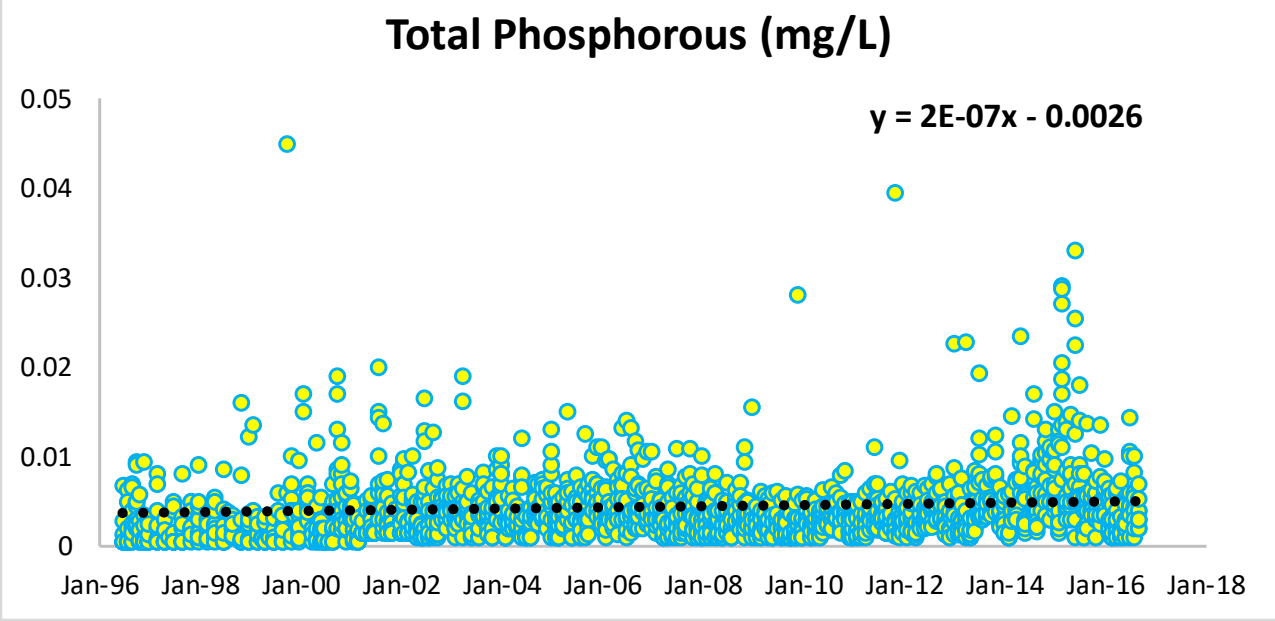

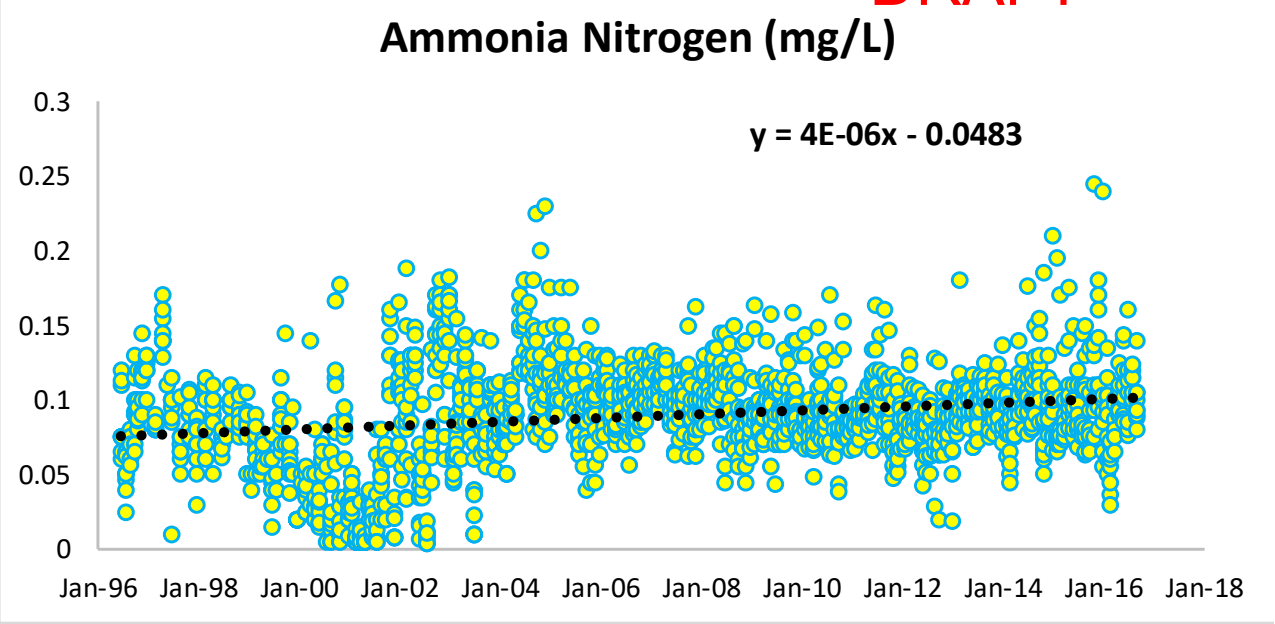

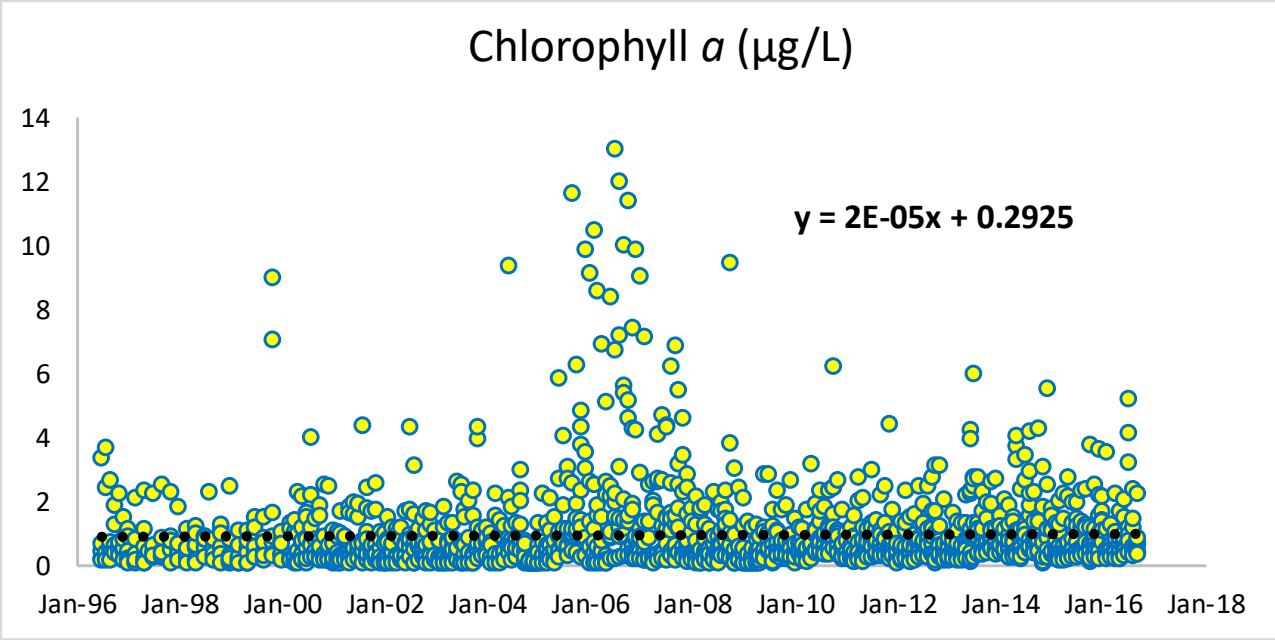

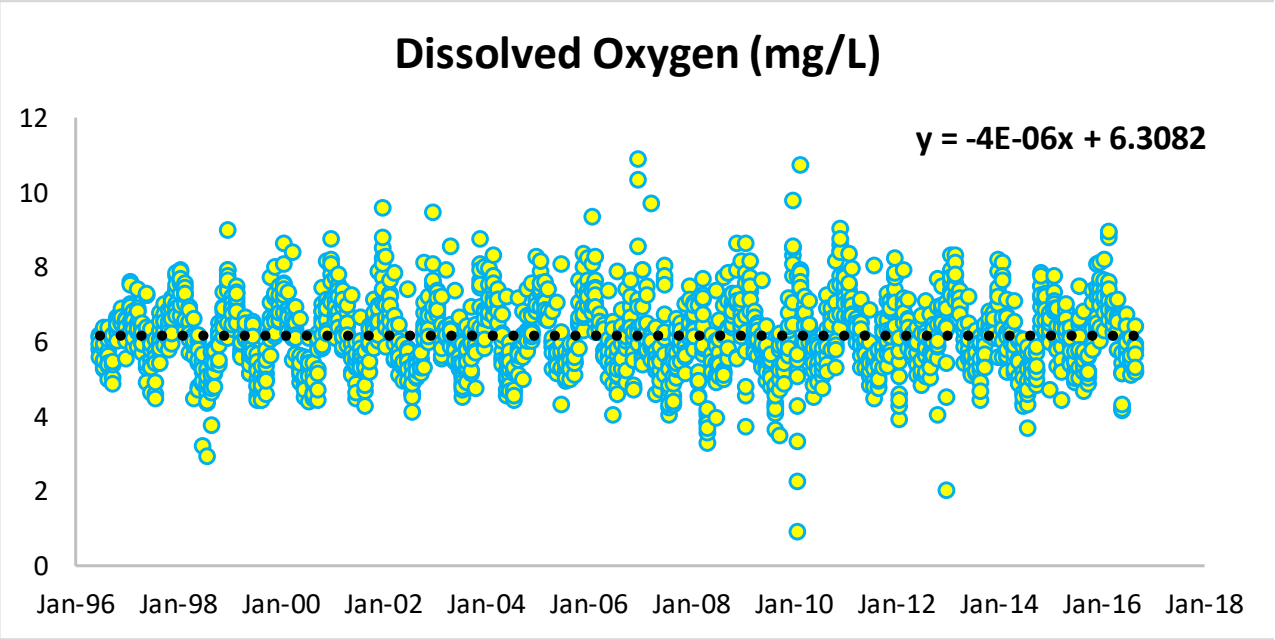

Source: Henry Briceño presentation to the BBTF October 2019

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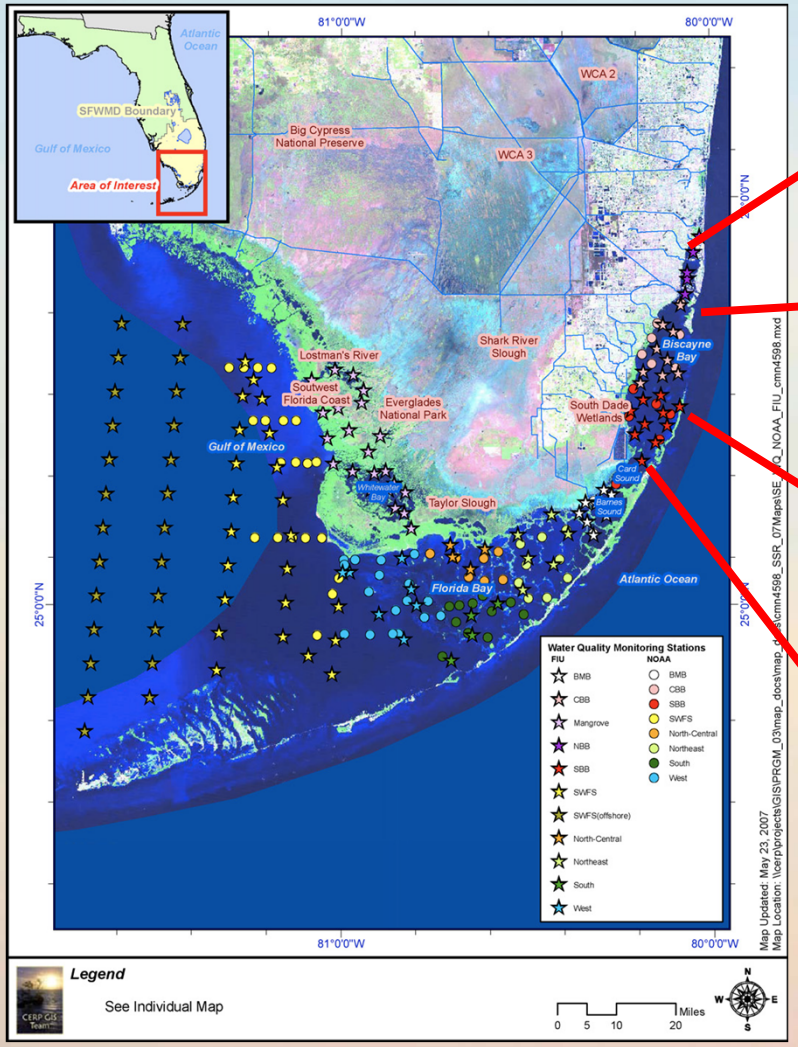
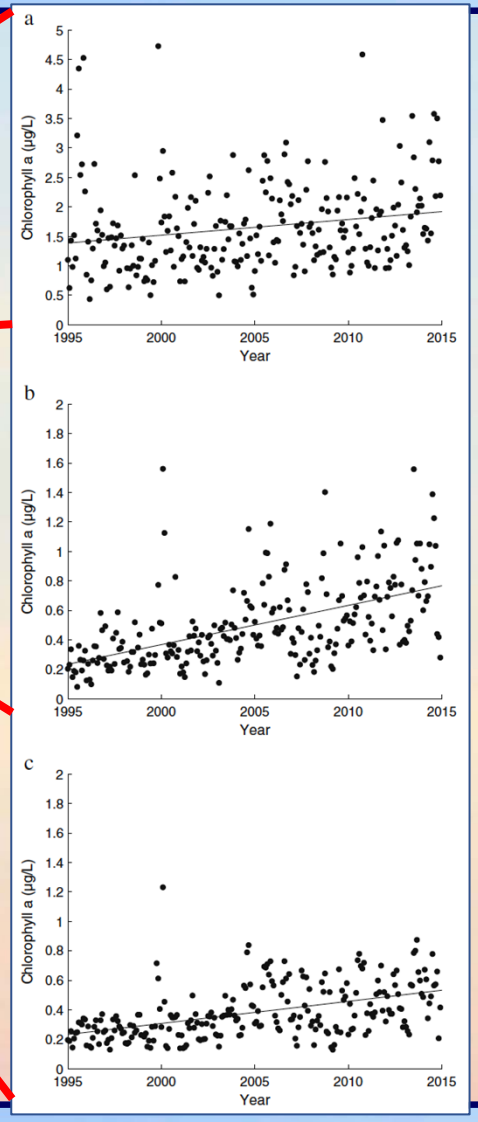
NOAA Biscayne Bay Water Quality Trends





- Chlorophyll a concentrations from 1996-2015
- Trending higher in all regions of the Bay
- Millette et al. 2019

BBTF = Biscayne Bay Task Force

Source: Christopher Kelble BBTF January 2020

FIU Spatial Relationship Between Seagrass Losses and Blooms

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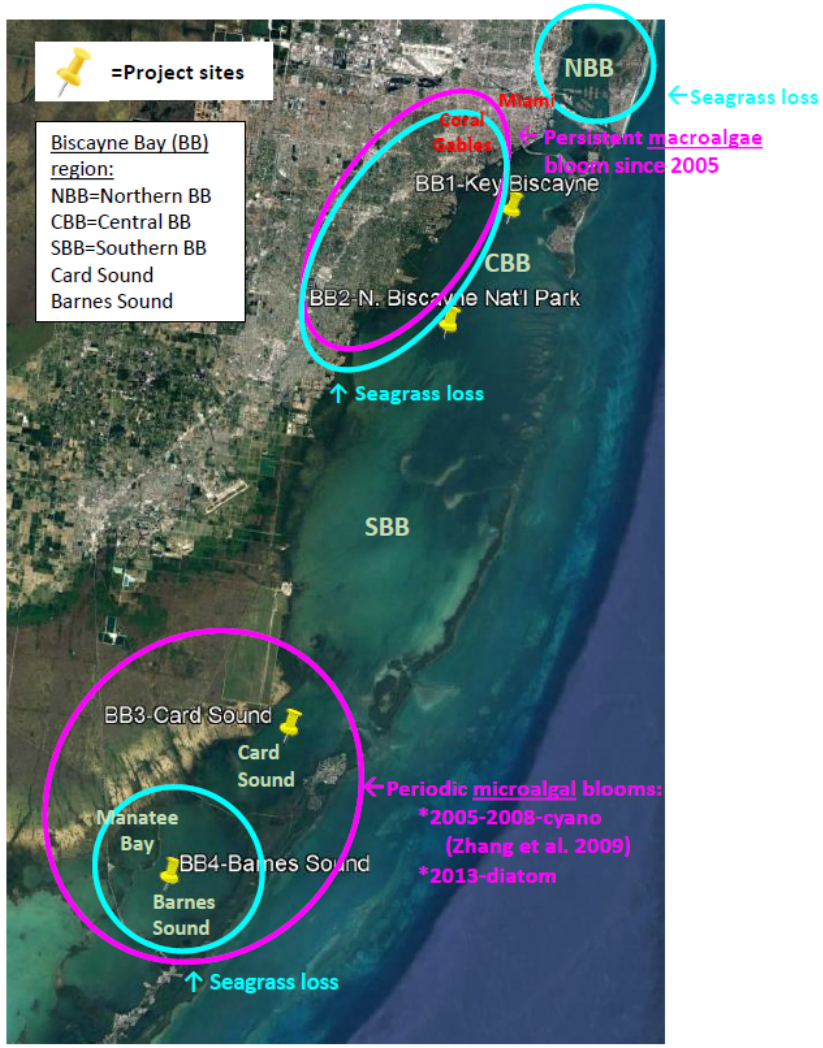
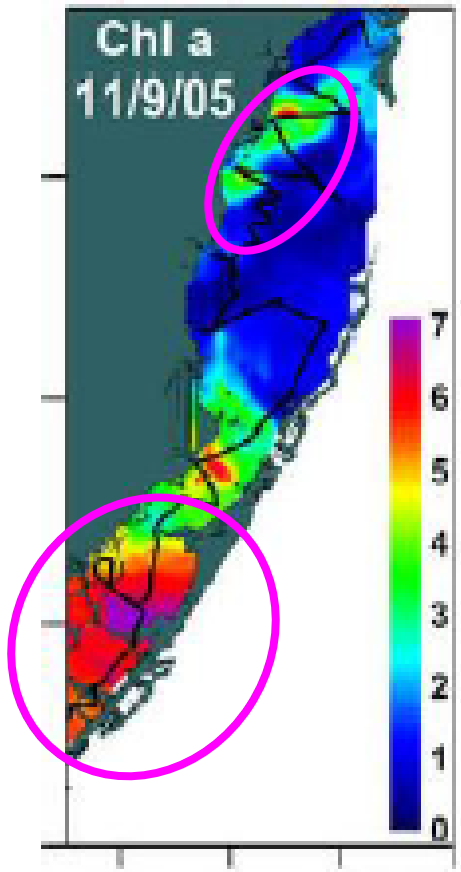
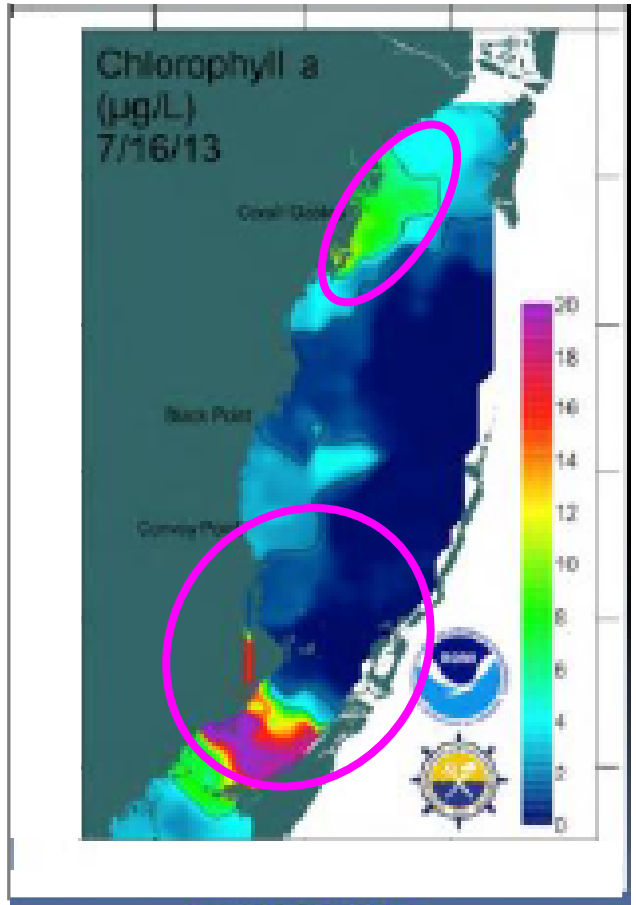


'05-'08 cyano bloom



Source: Zhang et al. (2009)

'13 diatom bloom



Source: NOAA

Source: FIU Henry Briceño presentation to the BBTF October 2019

NOAA Biscayne Bay Spatial Water Quality Patterns and Trends

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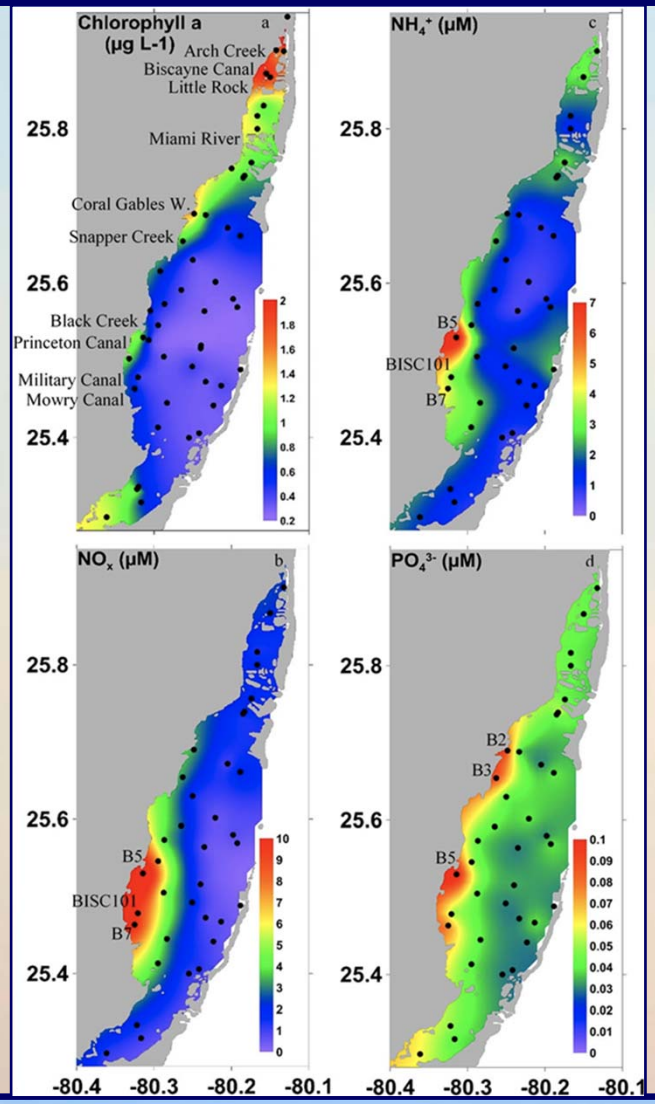
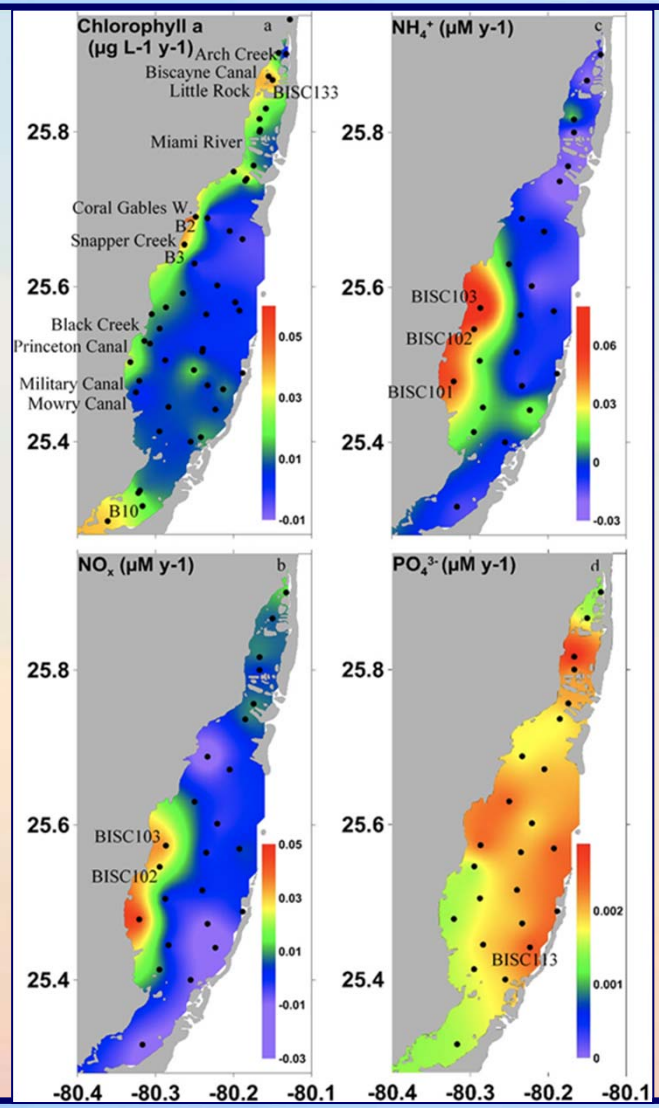


Spatial Concentrations

- Mean concentrations from 1996-2015
- Patterns of nutrients discharged from canals are related to patterns of land use in the watershed
- Credit: Millette et al. 2019



Spatial Trends

- Rate of change: Annual increases from 1996-2015
- Highest in the north and in the nearshore

Unit Conversions

NO_x and NH_4:
1 µM = 0.014 mg N/L
PO_4:
1 µM = 31 µg P/L

Source: Christopher Kelble BBTF January 2020

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Regional Water Deliveries to the Headwaters of the Biscayne Bay Watershed

Miami Canal Regional Water Deliveries Nutrient Temporal Trends

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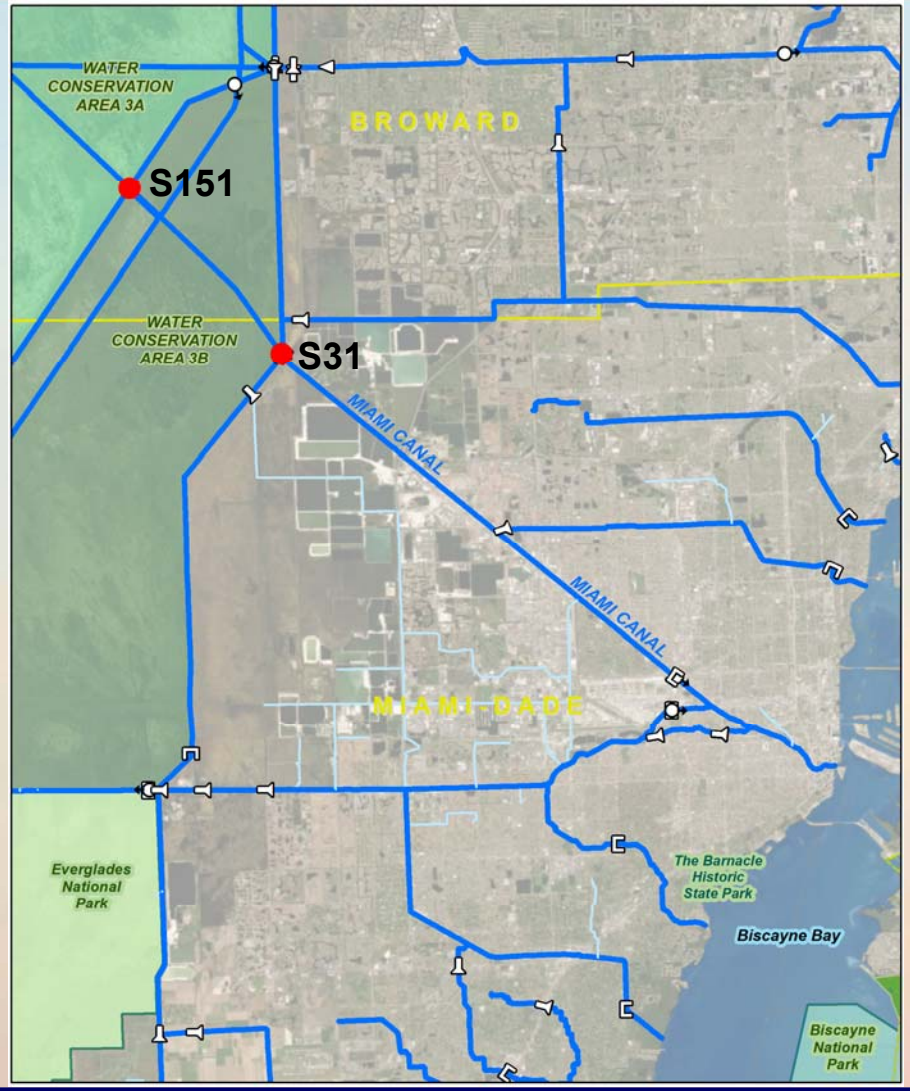

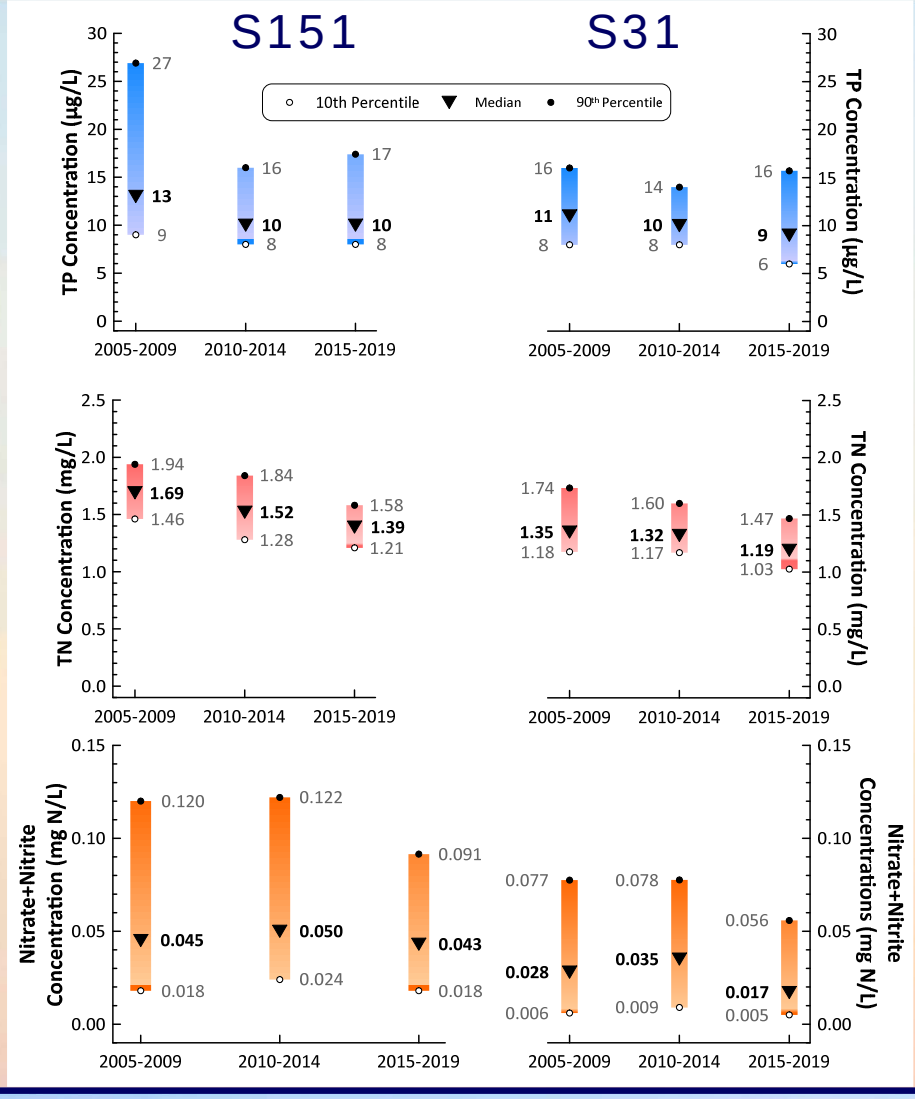

L-31N Regional Water Deliveries Total Phosphorus Spatial and Temporal Trends

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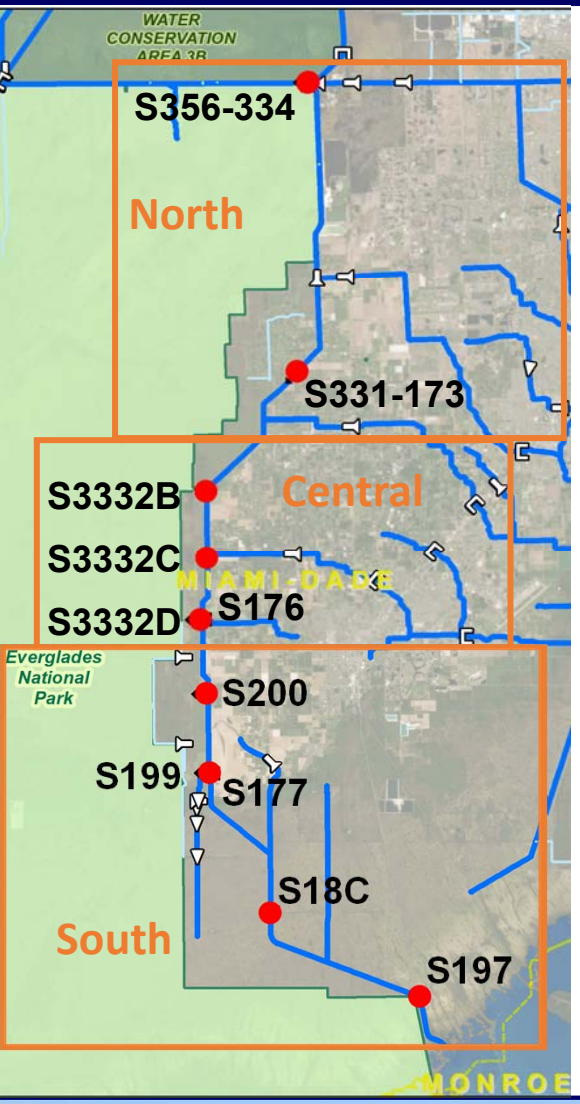
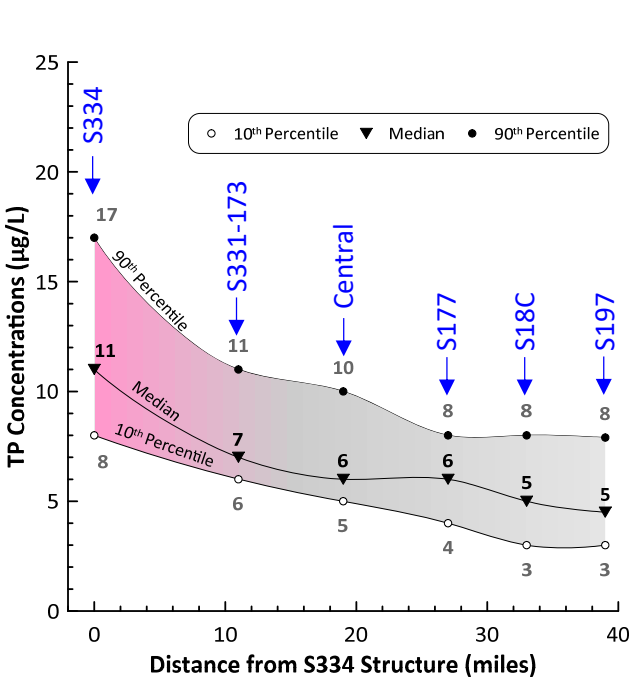
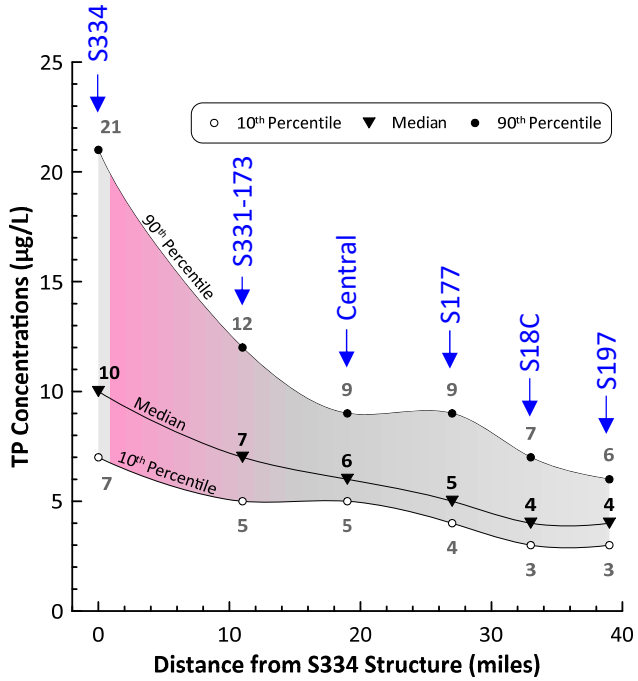


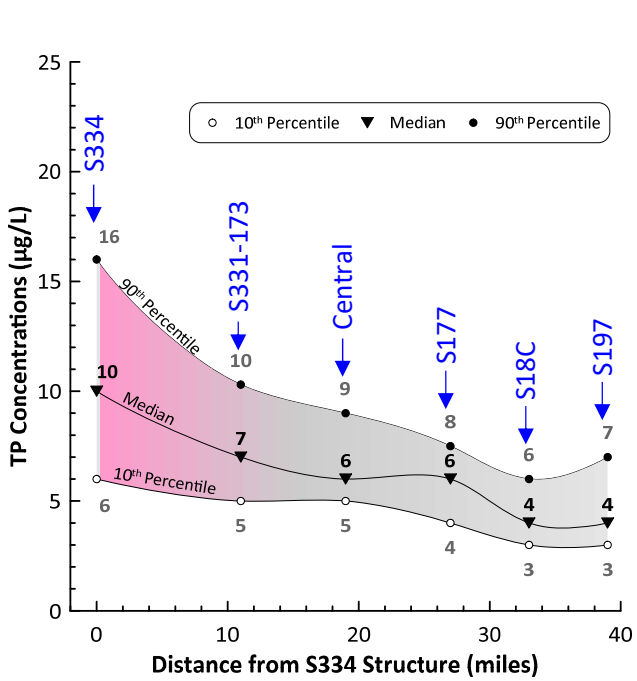
2005 - 2009



2010 - 2014



2015 - 2019



L-31N Regional Water Deliveries Total Nitrogen Spatial and Temporal Trends

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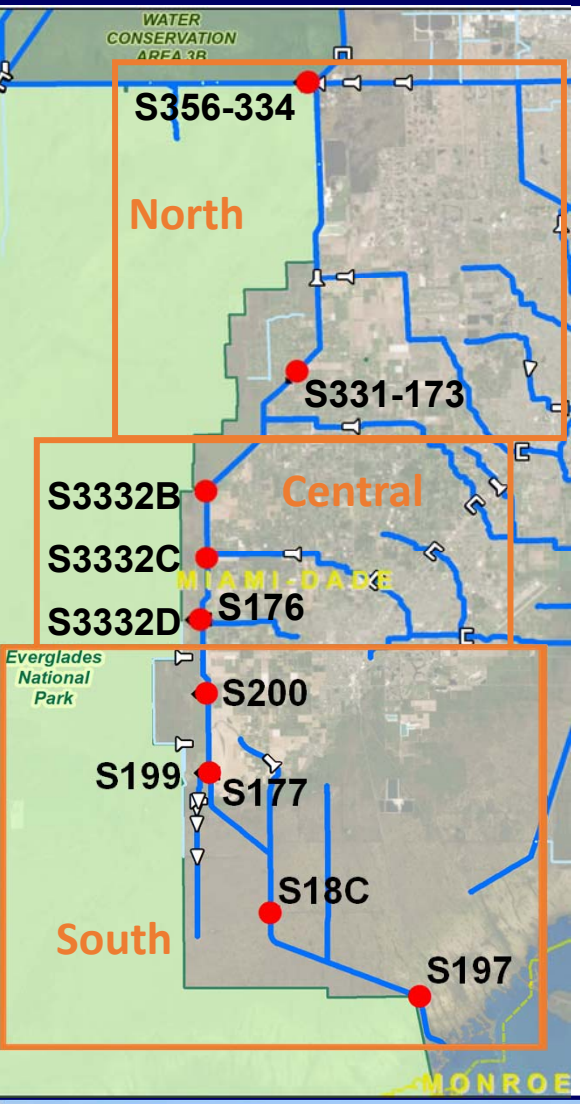
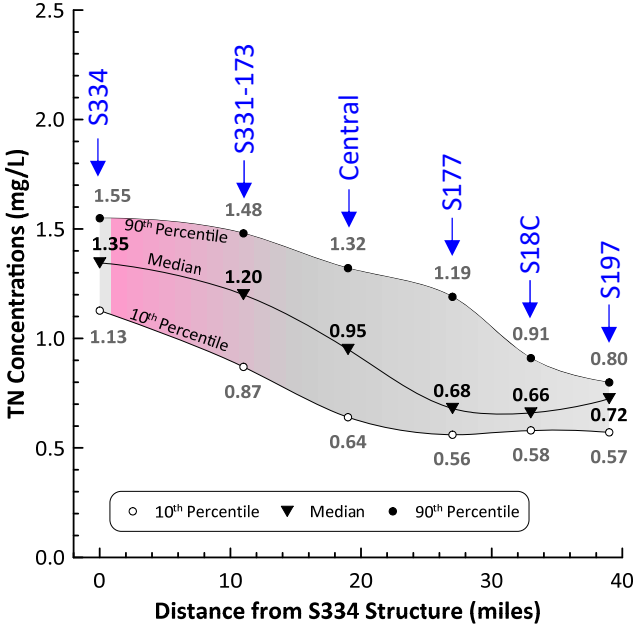
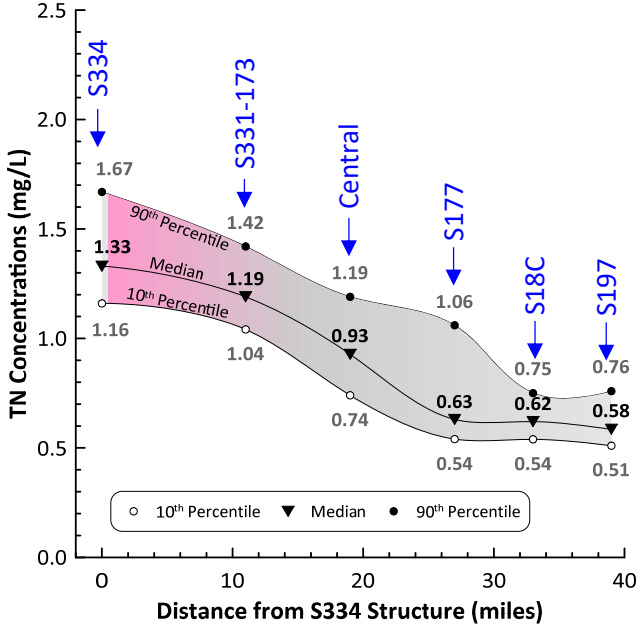


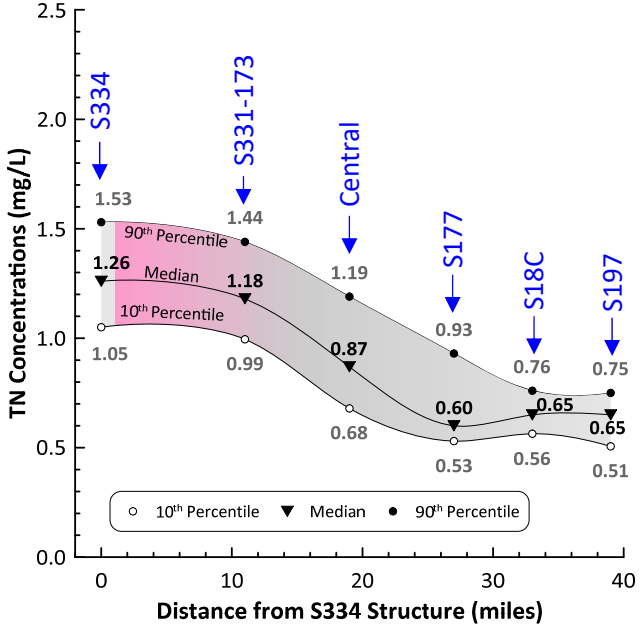
2005 - 2009



2010 - 2014



2015 - 2019



L-31N Regional Water Deliveries Nitrate+Nitrite Spatial and Temporal Trends

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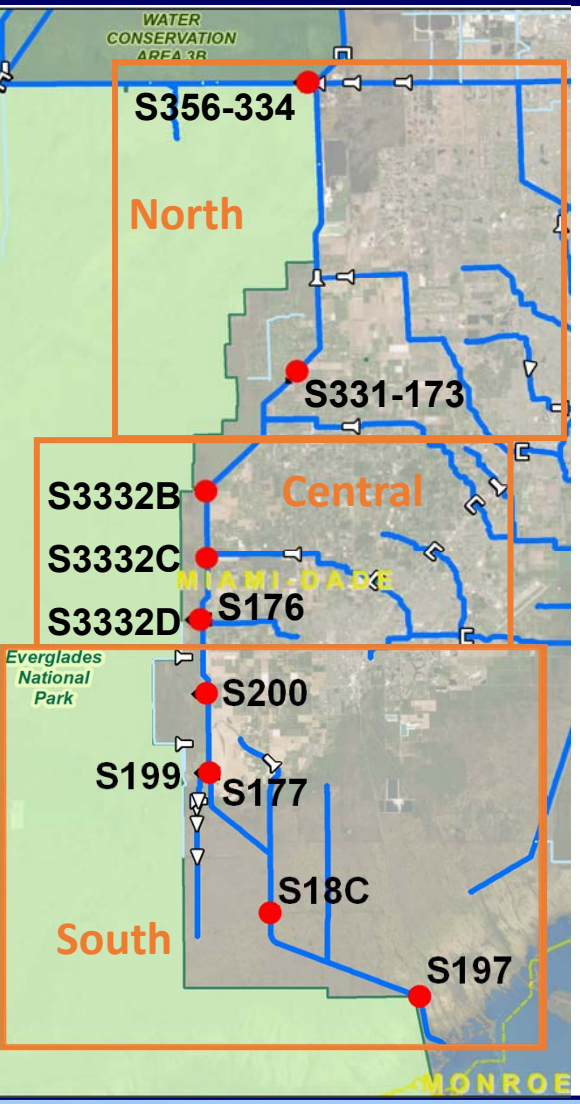

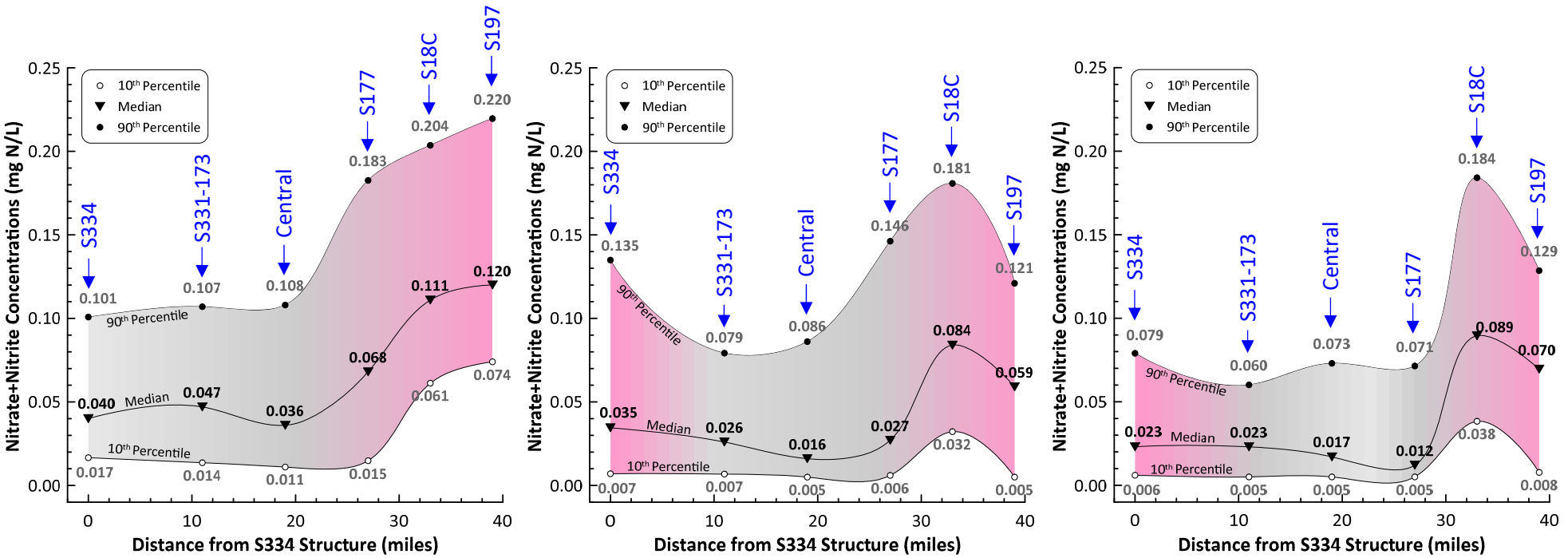

L-31N Regional Water Deliveries Inorganic Nitrogen Spatial Trends

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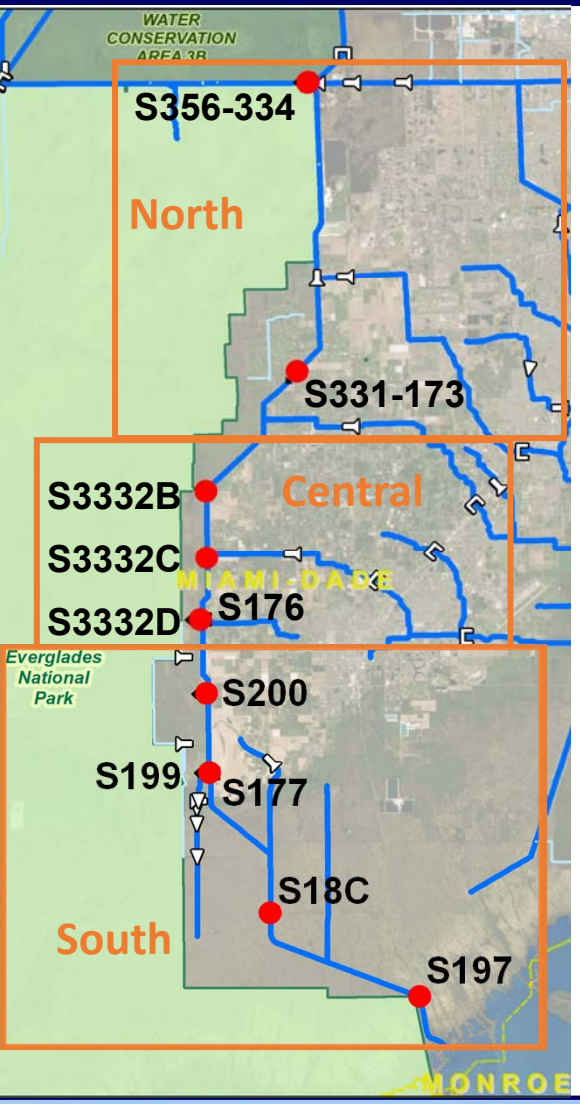
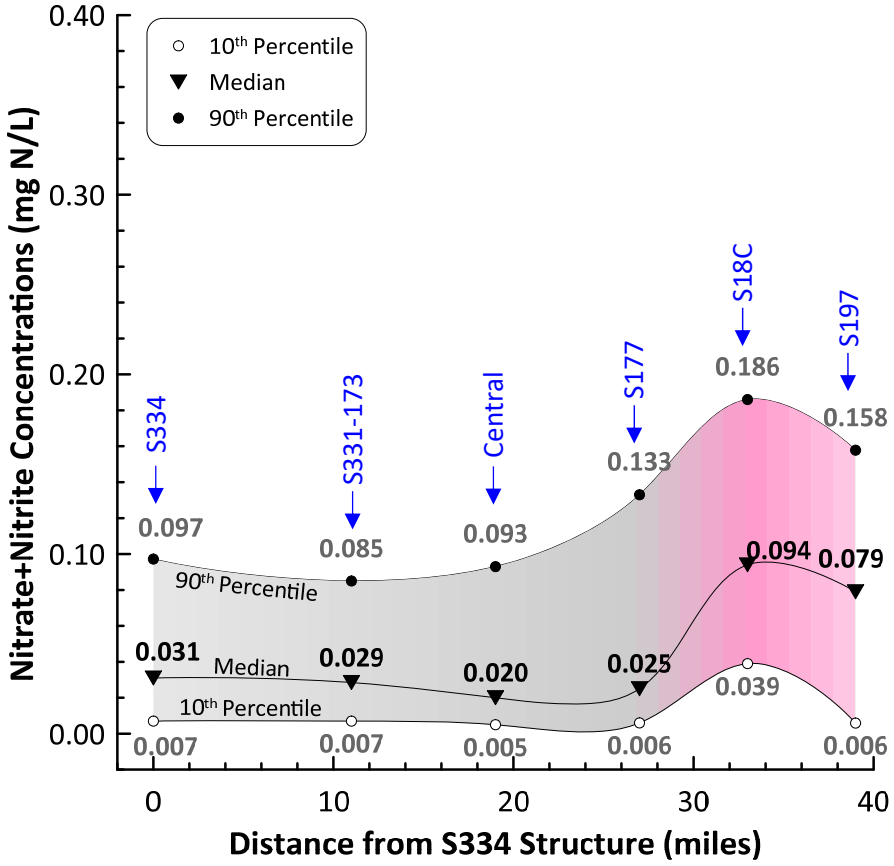
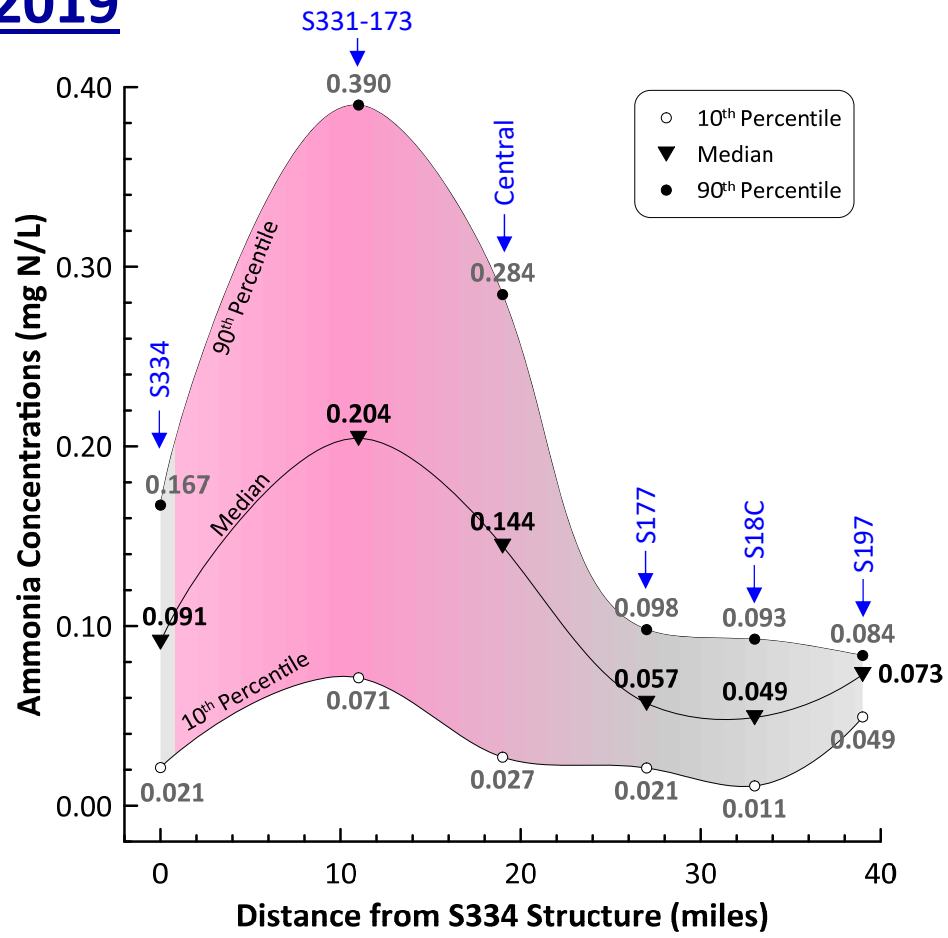


2005 - 2019





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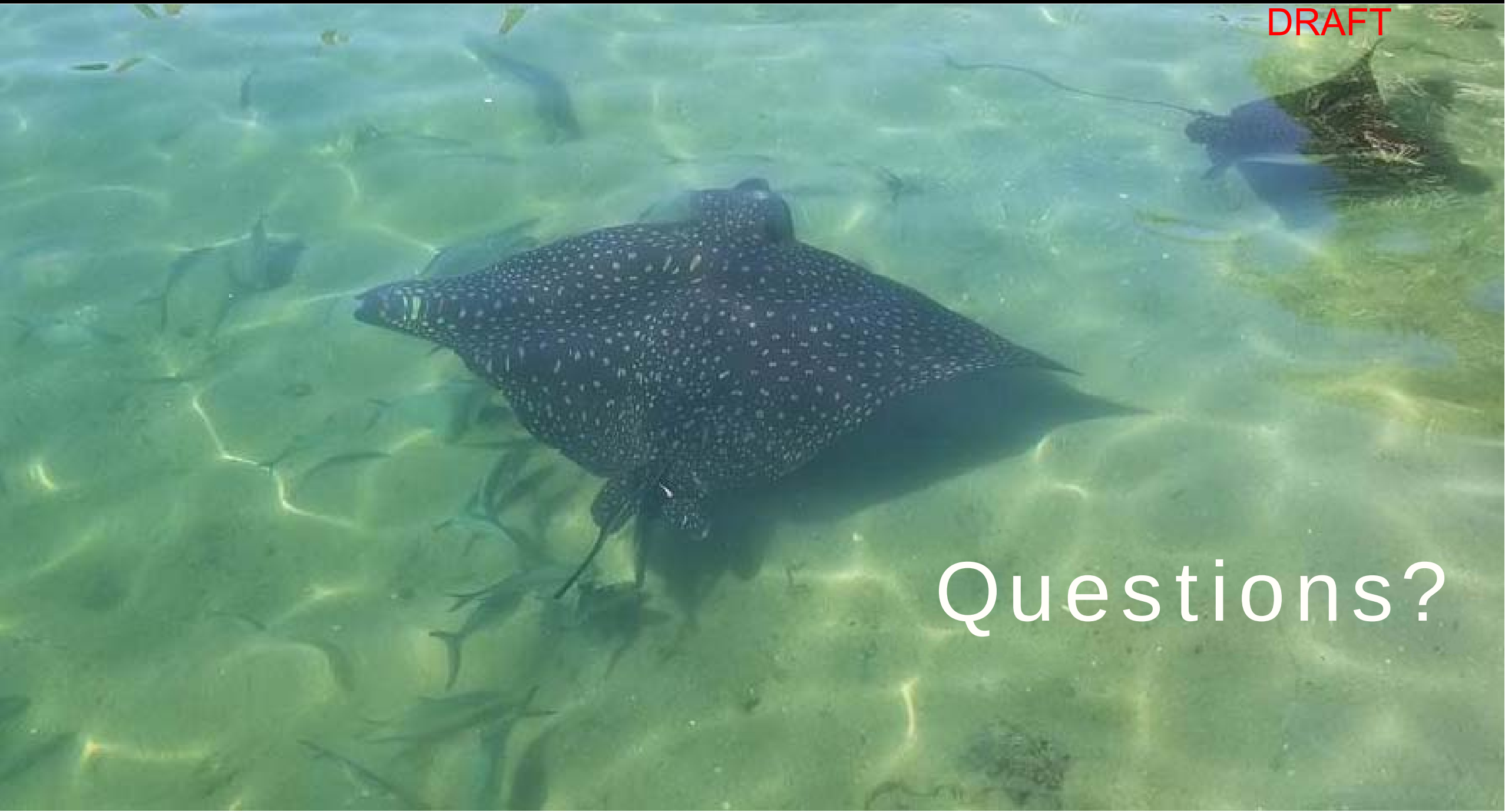
Summary

1. Chlorophyll *a* and Total Nitrogen are not attaining criteria in a number of Bay regions
2. Chlorophyll *a* and nutrients are trending higher throughout the Bay
3. Algal blooms and seagrass losses over the last decade indicate that the Bay is increasingly responsive to increasing nutrient inputs
4. Nutrient inputs over time and acute more frequent storm events are contributing to these effects
5. The types of nitrogen measured in the canals and the Bay may be indicative of the sources associated with different land uses in the watershed
6. Water deliveries to the watershed have contained low nutrient concentrations
7. Reports from the 1995 SWIM to the recent BBTF recommend reducing nutrient inputs to the Bay

DRAFT



Questions?