



Florida Department of Environmental Protection

Nutrient TMDL Development for Sanibel Slough in the Charlotte Harbor Basin:

**Sanibel Slough West (WBID 2092F1) and
Sanibel Slough East (WBID 2092F2)**

February 17, 2017





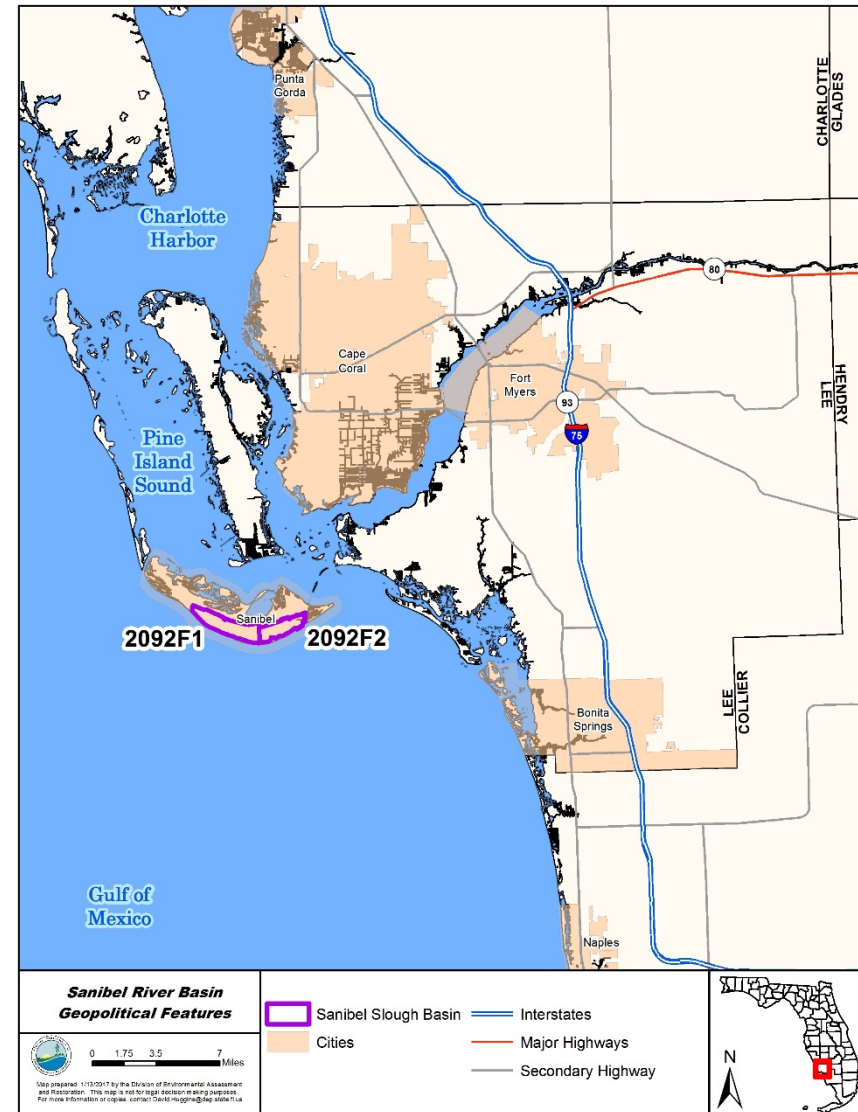
Information

- Florida DEP Draft TMDL Reports Available at:
http://www.dep.state.fl.us/water/tmdl/draft_tmdl.htm#Group2
- Supporting Documentation Available by Request



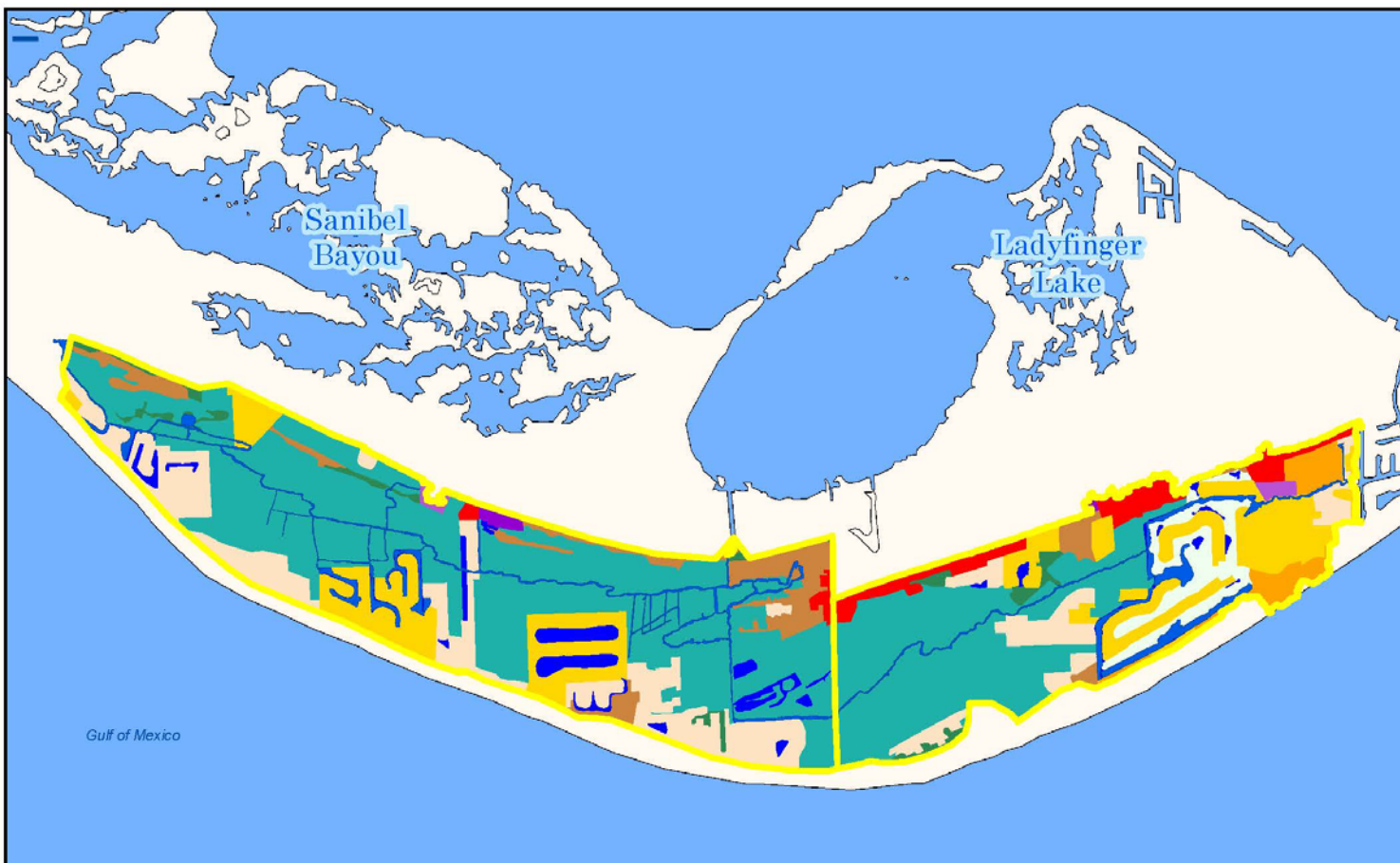
Watershed Location

- Sanibel Slough (aka Sanibel River) is on Sanibel Island in Lee County, Florida.
- Located in the Charlotte Harbor Basin, which is in Group 2 of the statewide five-year basin rotation plan.
- The population of the City of Sanibel was 6,469 (2010 U.S. Census)
 - Population Density \approx 400 / Sq. Mi.





Sanibel Slough Land Use



Sanibel Slough 2008-09 Land Use		
1100 Low-Density Residential	1700 Institutional	5000 Water
1200 Medium-Density Residential	1800 Recreational	6000 Wetlands
1300 High-Density Residential	3000 Rangeland	8000 Communication and Transportation
1400 Commercial	4000 Forest/Rural Open	Sanibel Slough
		Sanibel Slough Basin

0 0.2 0.4 0.8 Miles

Hendry
Collier
Lee
Collier

Map prepared 7/29/2016 by the Division of Environmental Assessment and Restoration. This map is not for legal decision making purposes. For more information or copies, contact David Huggins@dep.state.fl.us



Sanibel Slough Characteristics





Sanibel Slough Control Structures





Waterbody Assessments

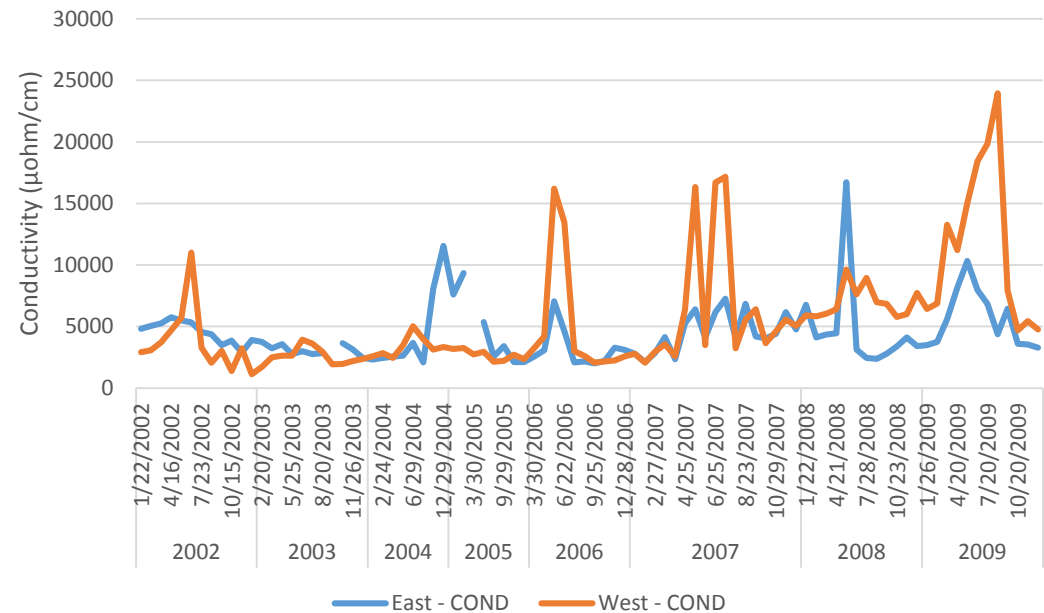
- Cycle 1 Verified Period (January 1996 to June 2003):
 - Classified as lake
 - Impaired for nutrients based on elevated annual average Trophic State Index (TSI)
 - Color ≥ 40 PCU; TSI ≤ 60
 - TSI exceeding threshold in 1996 & 1999–2002
- Cycle 2 Verified Period (January 2001 to June 2008):
 - Classified as stream
 - Impaired for Nutrients (chlorophyll *a*)
 - CHLA ≤ 20 $\mu\text{g/L}$
 - Exceeded in 2007
- Cycle 3 Verified Period (January 2007 to June 2014):
 - Classified as estuary
 - Impaired for Nutrients (chlorophyll *a*)
 - Chl*a* ≤ 11 $\mu\text{g/L}$
 - Exceeded every year



Estuary Classification



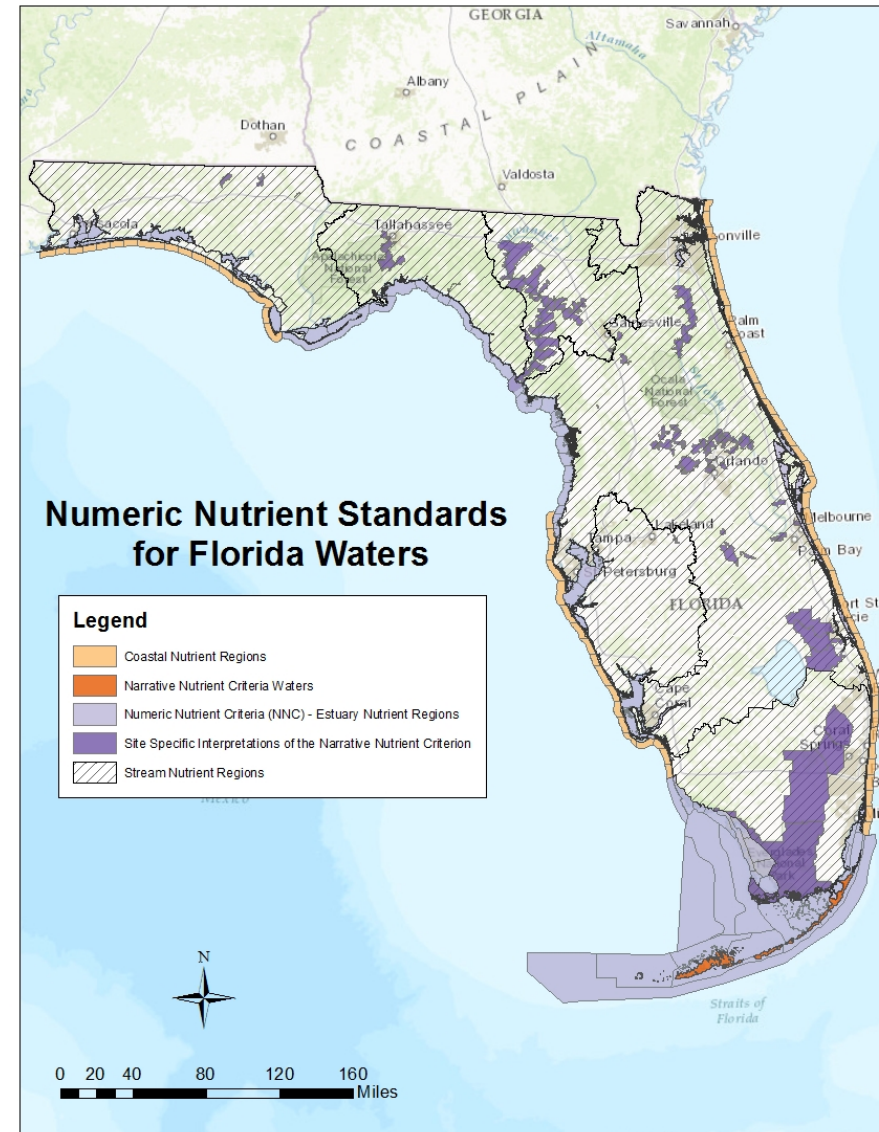
Sanibel Slough East and West Conductivity (2002 - 2009)





State Adopted Estuary Criteria

- Florida incrementally adopted NNC for most estuaries and other marine waters during the period from 2011 to 2014.
- During the derivation of NNC for predominately marine waters, DEP subdivided estuaries into homogeneous segments or Estuary Nutrient Regions (ENRs).
 - Estuary-specific NNC apply in these ENRs.
 - NNC do not apply to:
 - wetlands
 - tidal tributaries
 - non-ENR estuaries
 - those not expressly provided by name or delineated in the maps of the Florida ENRs incorporated by reference in 62-302.532





Non-ENR Estuary Criteria

- Sanibel Slough East and Sanibel Slough West are classified as non-ENR estuaries and therefore are subject to the narrative nutrient criterion.
- Narrative nutrient criterion states that:
 - **Nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna** (Chapter 62-302.531(1) F.A.C.).
- For non-ENR estuaries, a chlorophyll *a* (Chl_a) target of 11 µg/L, expressed as annual geometric mean not to be exceeded more than once in any consecutive three-year period, is used to assess nutrient response.
 - The 11 µg/L Chl_a target represents the level below which a nutrient related imbalance in flora or fauna is not expected to occur (62-303.353(2), F.A.C.).



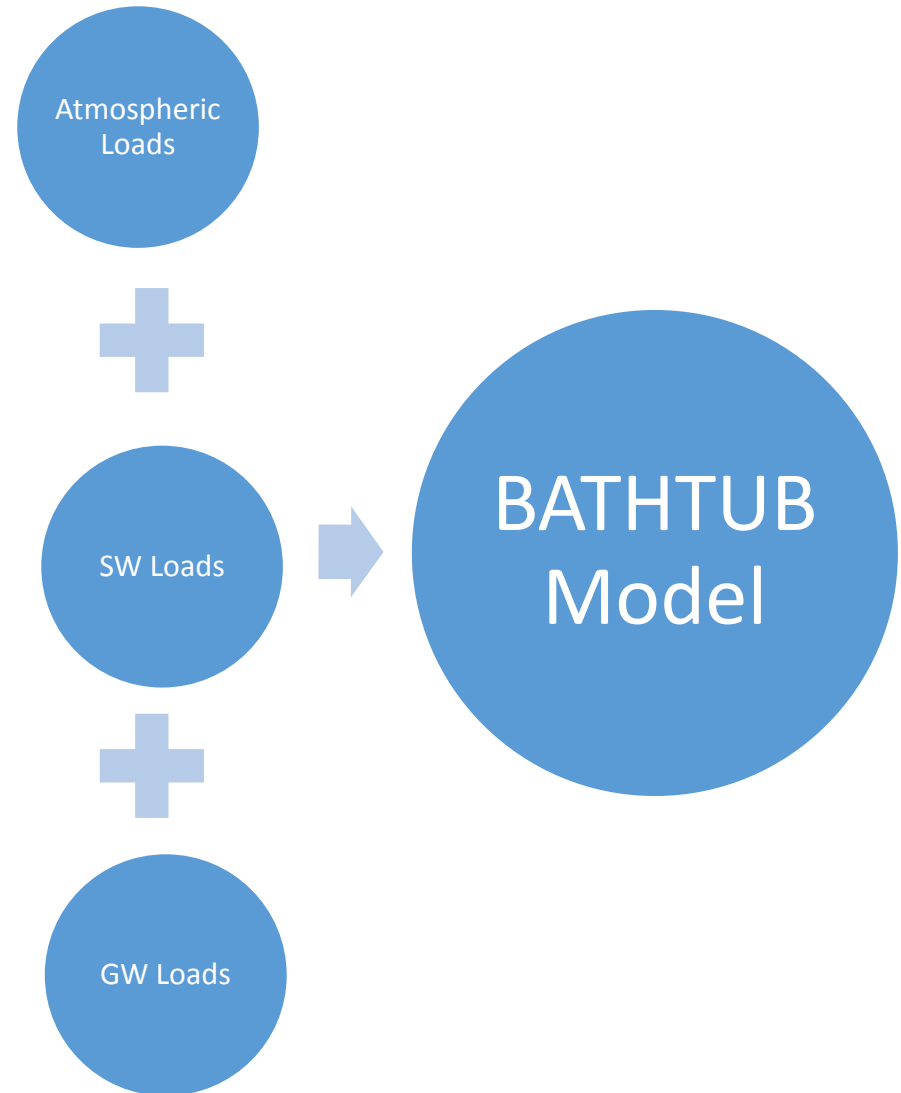
TMDL Development

- Applied Chl a target of 11 $\mu\text{g}/\text{L}$ as restoration target.
- A calibrated model-based prediction was used to estimate the nutrient loads (TN and TP) necessary to achieve the target Chl a concentration of 11 $\mu\text{g}/\text{L}$.
 - The model period used was 2007 through 2013.
 - Observed Chl a , TN and TP measurements were calculated using City of Sanibel and DEP sampling results.
- Expressed TMDLs as nutrient load targets and percent reduction in existing nutrient levels needed to achieve the target.

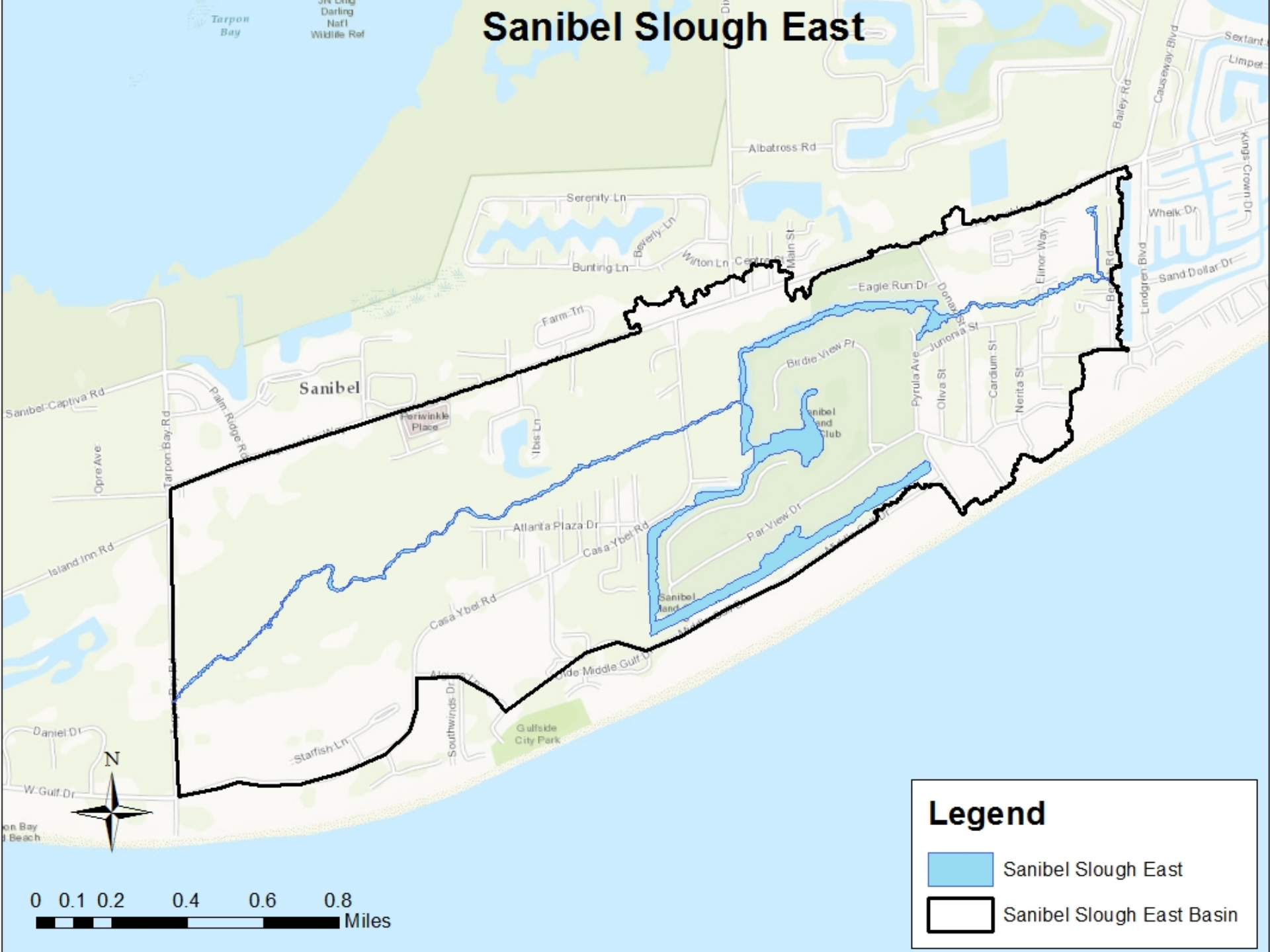


Modeling Approach

- City of Sanibel and Sanibel-Captiva Conservation Foundation did extensive studies and calculated:
 - Atmospheric loads
 - Island specific runoff coefficients and EMC
 - Groundwater loading
- Runoff coefficients and EMCs were used in a spreadsheet model for watershed loadings
- All loads feed into BATHTUB model



Sanibel Slough East



Legend

-  Sanibel Slough East
-  Sanibel Slough East Basin



Sanibel Slough East Nutrient Annual Geometric Means

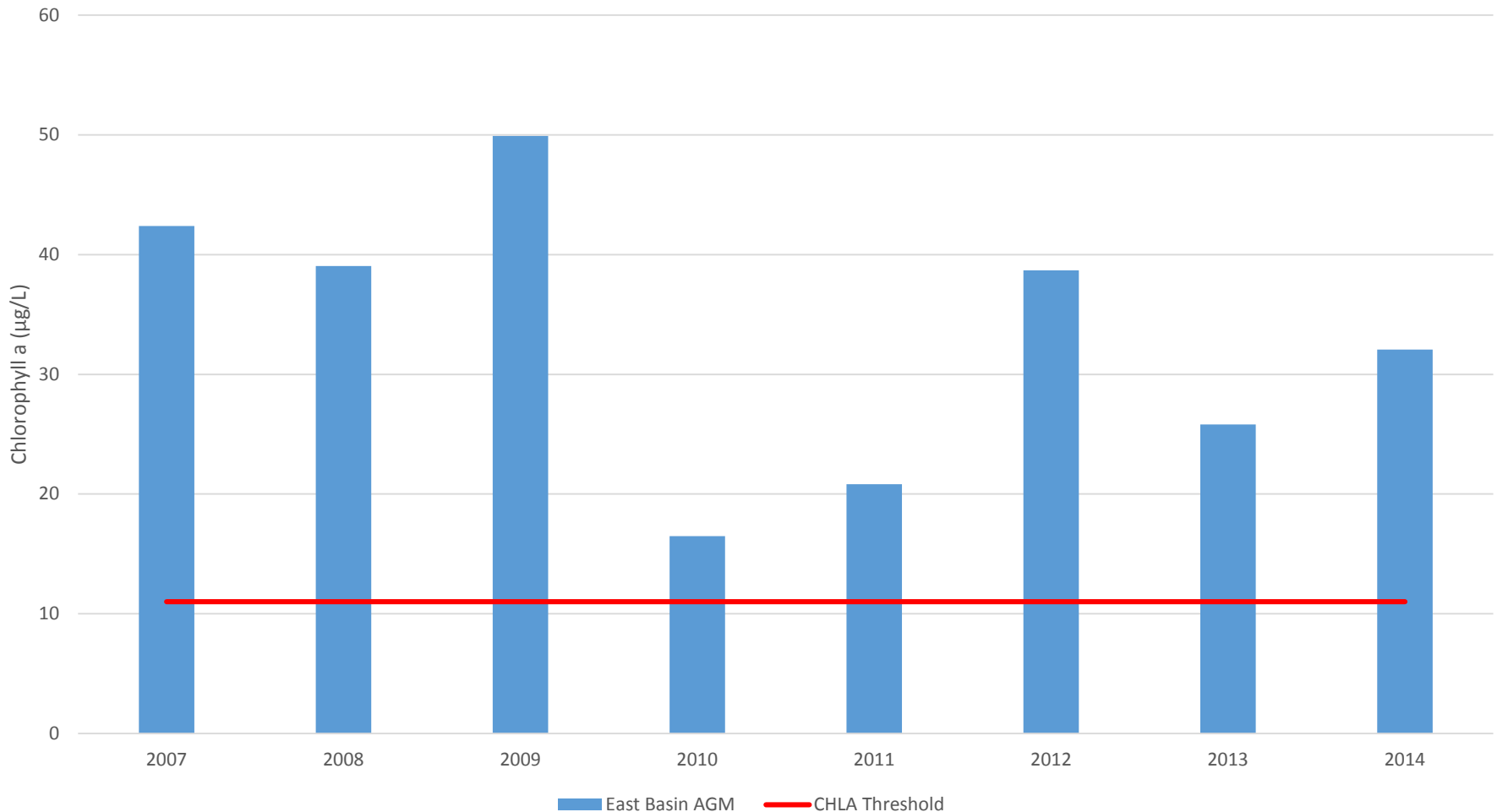
Year	Sanibel Slough East Chla ($\mu\text{g/L}$)
2007	42
2008	39
2009	50
2010	16
2011	21
2012	39
2013	26

Note: Values shown shaded are greater than the narrative nutrient threshold for non-ENR estuaries. Rule 62-302.531 states that the threshold for Chla shall not be exceeded more than once in any consecutive three year period.



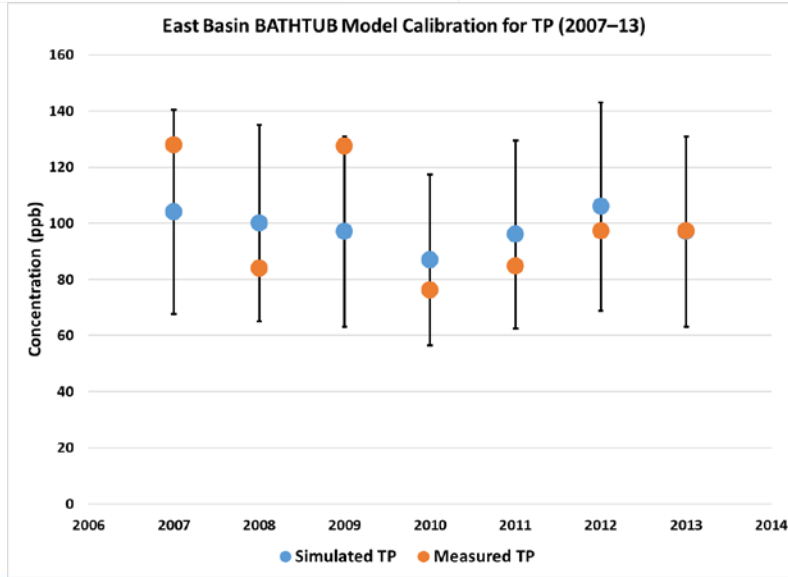
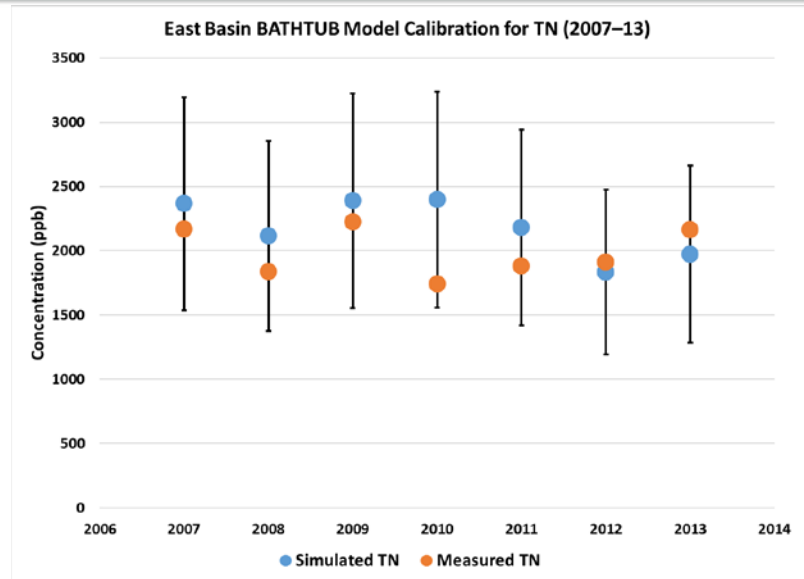
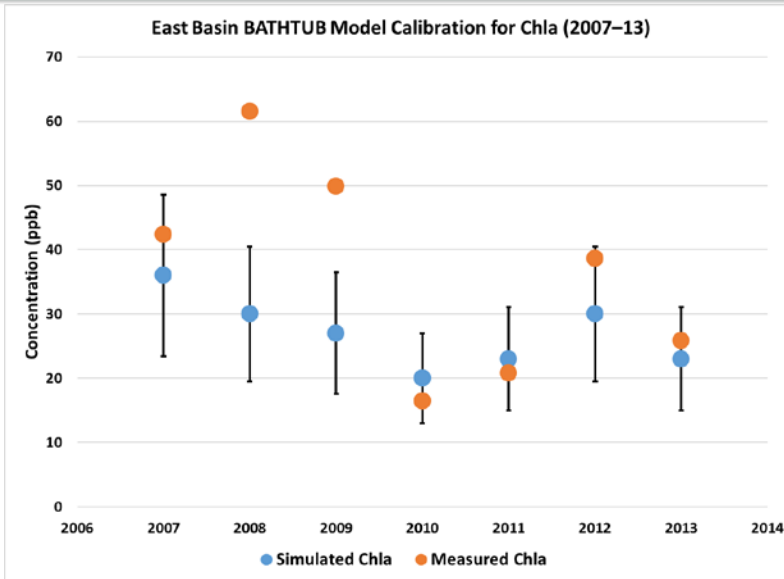
Sanibel Slough Chla Annual Geometric Means

Sanibel Slough East Chla Annual Geometric Means and Criterion





Sanibel Slough East Calibration

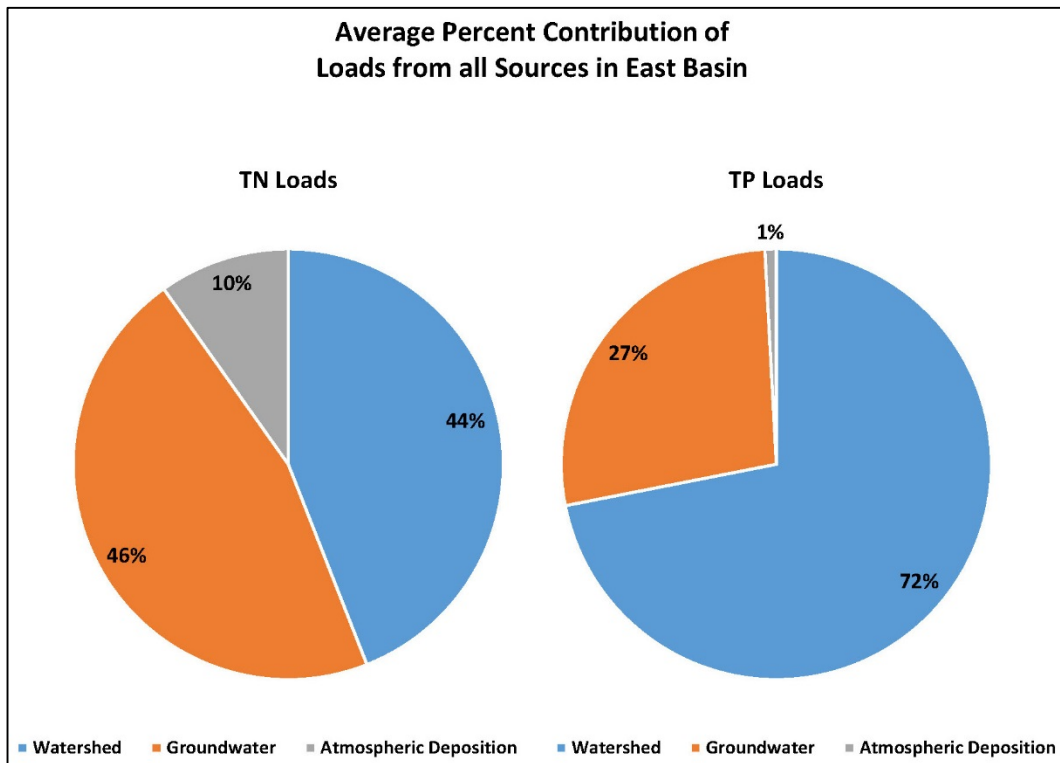




East Simulated Existing Condition

- Simulated annual loads from stormwater, groundwater and atmospheric deposition.

Year	East Basin TN Loads (kg/yr)	East Basin TP Loads (kg/yr)
2007	1,570	313
2008	2,271	447
2009	2,121	384
2010	2,336	413
2011	2,351	445
2012	2,371	544
2013	2,258	467



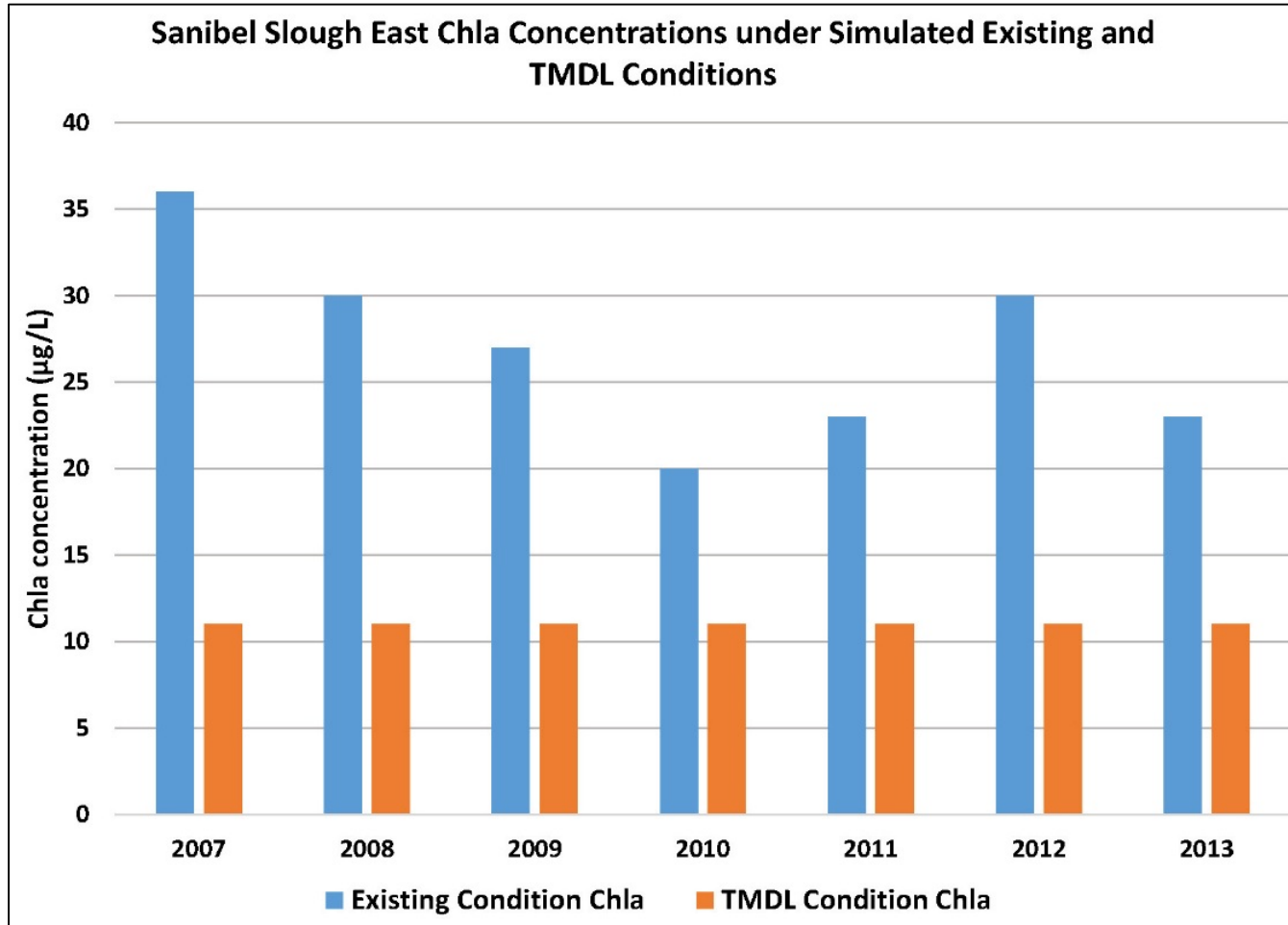


Achieving Target Condition

- In order to achieve the 11 $\mu\text{g}/\text{L}$ Chl a target every year, the TN and TP loads that achieve the Chl a target were simulated using the BATHTUB model.
 - The anthropogenic loads were incrementally decreased from the existing land use conditions (Existing Condition) until the estuary Chl a geometric mean concentration of 11 $\mu\text{g}/\text{L}$ was achieved every year (TMDL Condition).

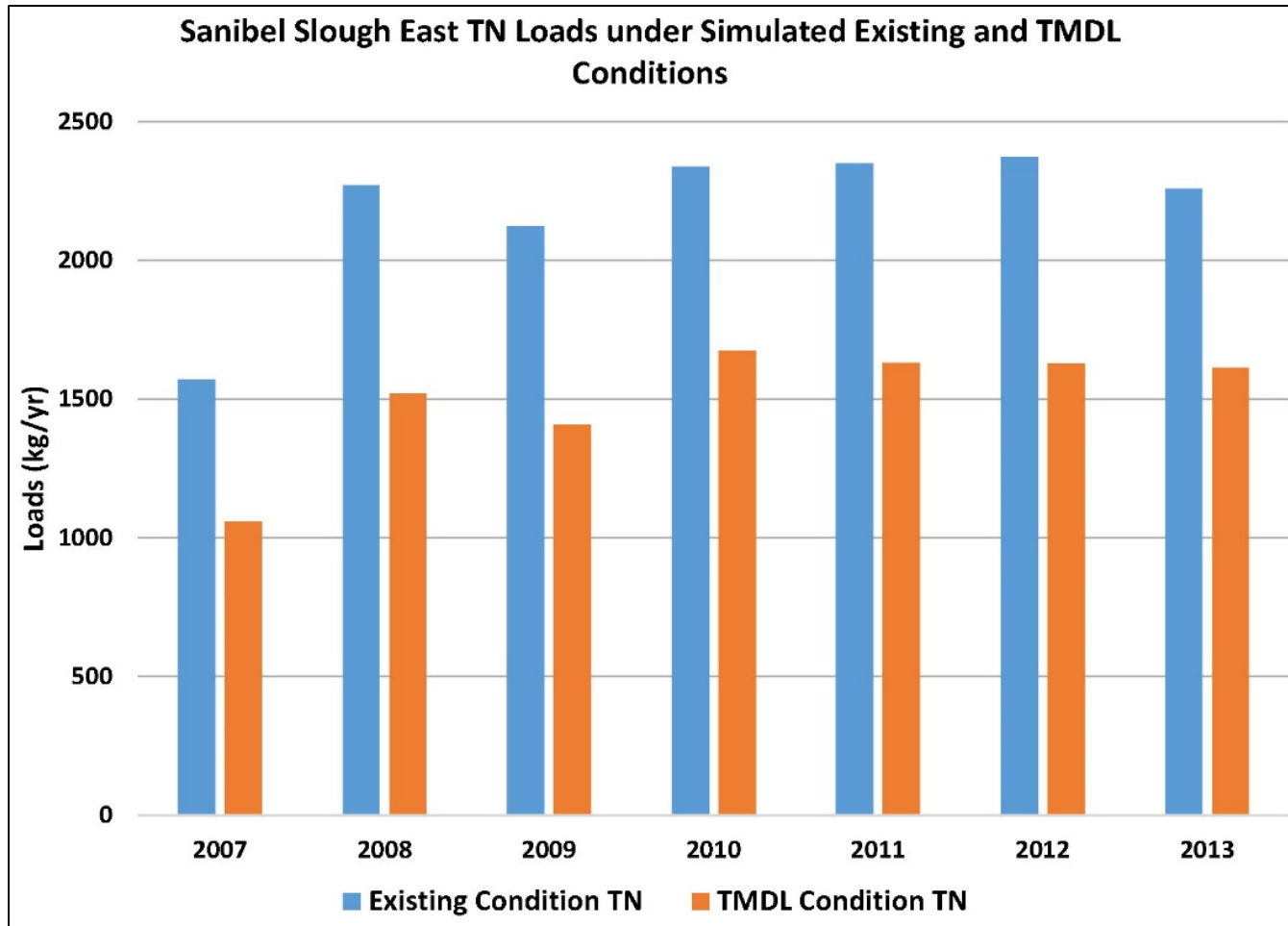


Sanibel Slough East Chla Scenarios



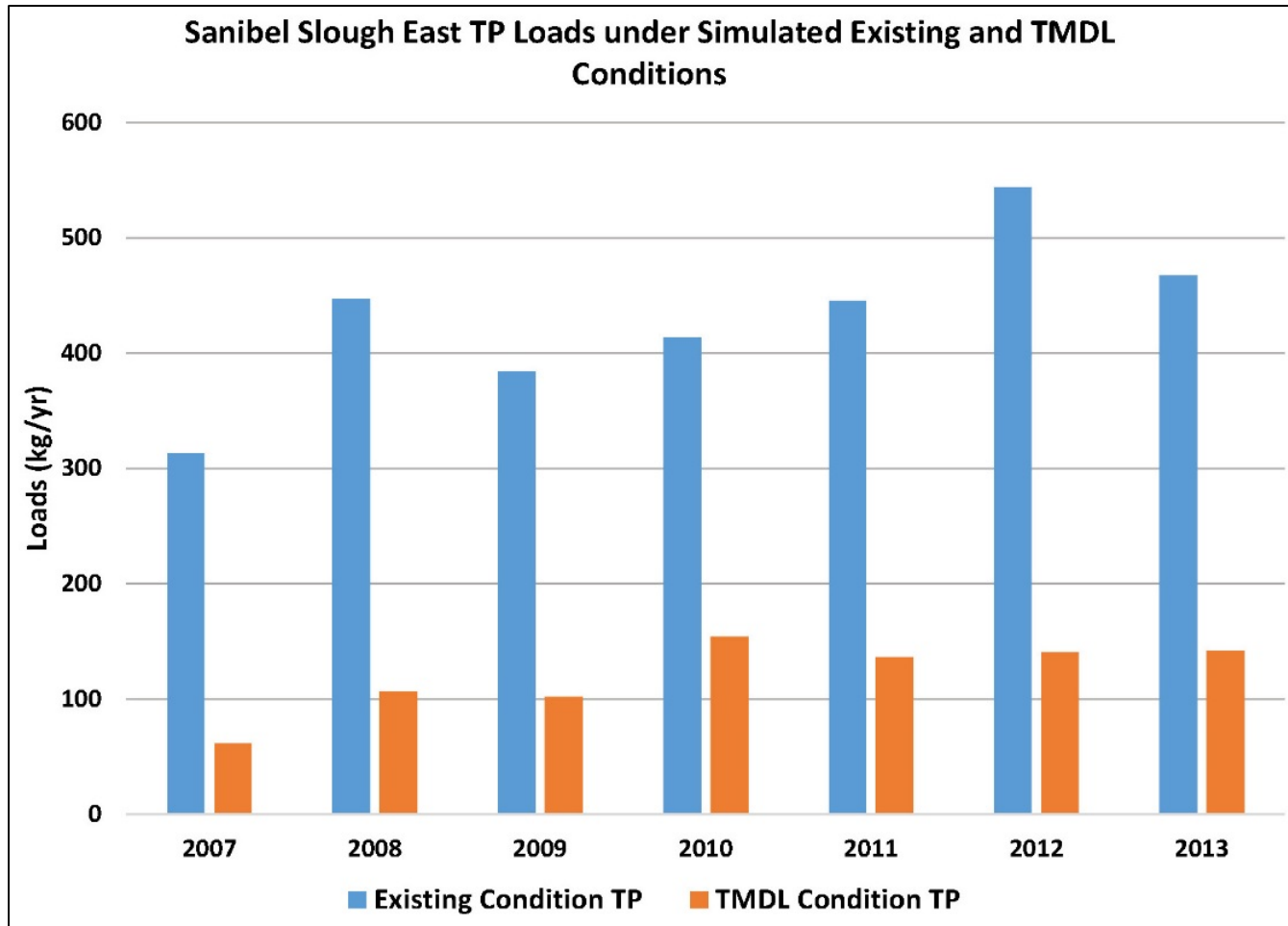


Sanibel Slough East TN Scenarios





Sanibel Slough East TP Scenarios





East Target Load Selection

A lagged 3-year rolling average was applied to the distribution of yearly nutrient loads, and the maximum of the resulting 3-year averages was chosen as the target TN and TP loads

Year	TMDL Condition TN Loads (kg/yr)	Lagging 3-Year Rolling Average TN Loads (kg/yr)	TMDL Condition TP Loads (kg/yr)	Lagging 3-Year Rolling Average TP Loads (kg/yr)
2007	1,058		61	
2008	1,519		107	
2009	1,407	1,328	101	90
2010	1,676	1,543	154	121
2011	1,630	1,571	136	131
2012	1,627	1,644	140	143
2013	1,612	1,623	141	139



East Percent Reductions

Condition	East Basin TN Loads (kg/yr)	East Basin TP Loads (kg/yr)
Maximum Existing Load	2,371	544
Target Load	1,644	143
% Reduction	31 %	74 %

The equation used to calculate the percent reduction is as follows:

$$\frac{[\text{maximum existing load} - \text{target load}]}{\text{maximum existing load}} \times 100$$

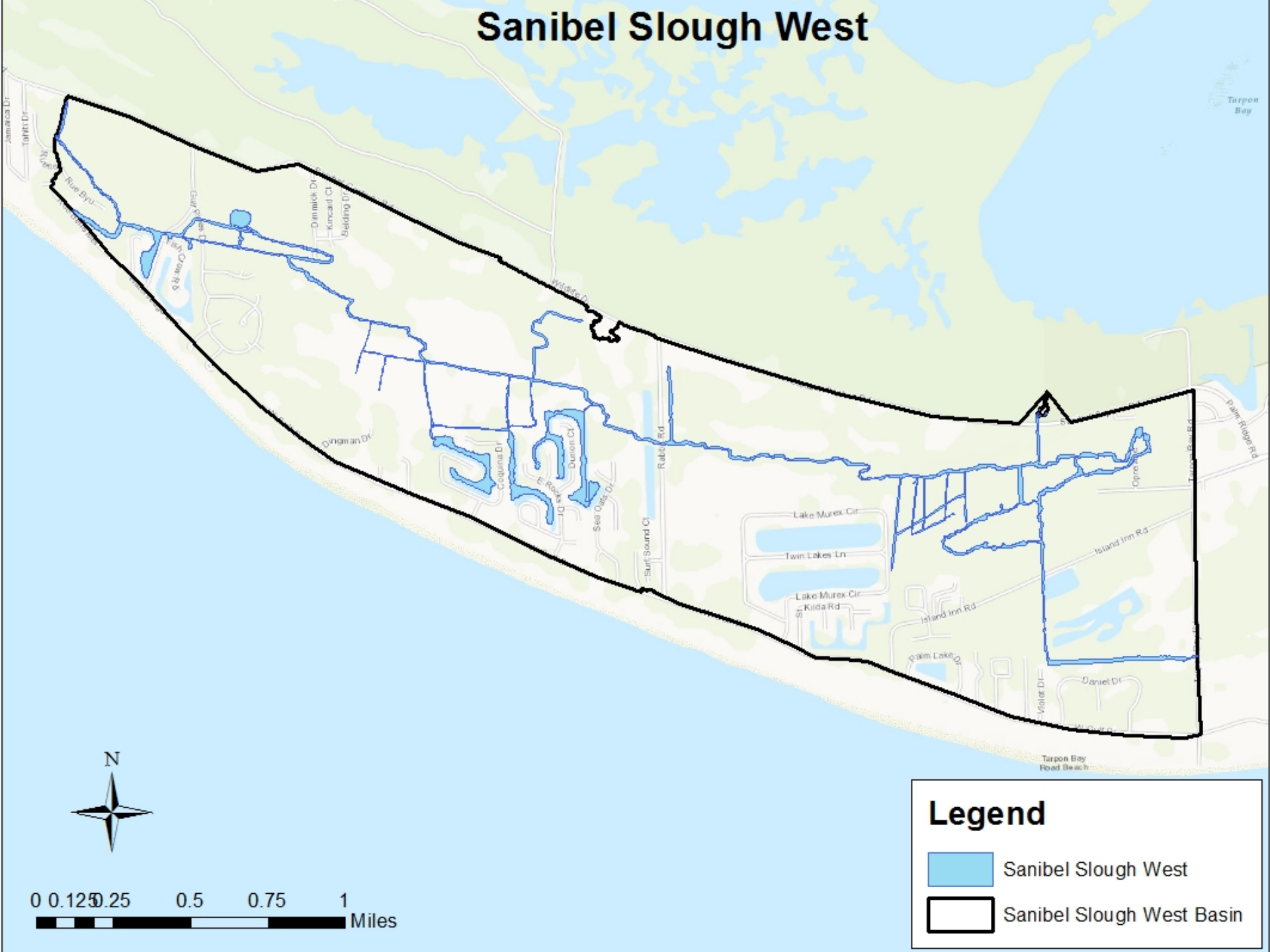


East Site Specific NNC

WBID	AGM Chlorophyll <i>a</i> (µg/L)	Rolling 3-year annual average TN (kg/yr)	Rolling 3-year annual average TP (kg/yr)
2092F2	11	1,644	143



- The nutrient TMDLs presented constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(47)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C.
- These nutrient loads shall be expressed as a rolling 3-year annual average load not to be exceeded.
- The Chla concentration shall be expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period.

Sanibel Slough West



0 0.125 0.25 0.5 0.75 1 Miles

Legend

-  Sanibel Slough West
-  Sanibel Slough West Basin



Sanibel Slough West Chla Annual Geometric Means

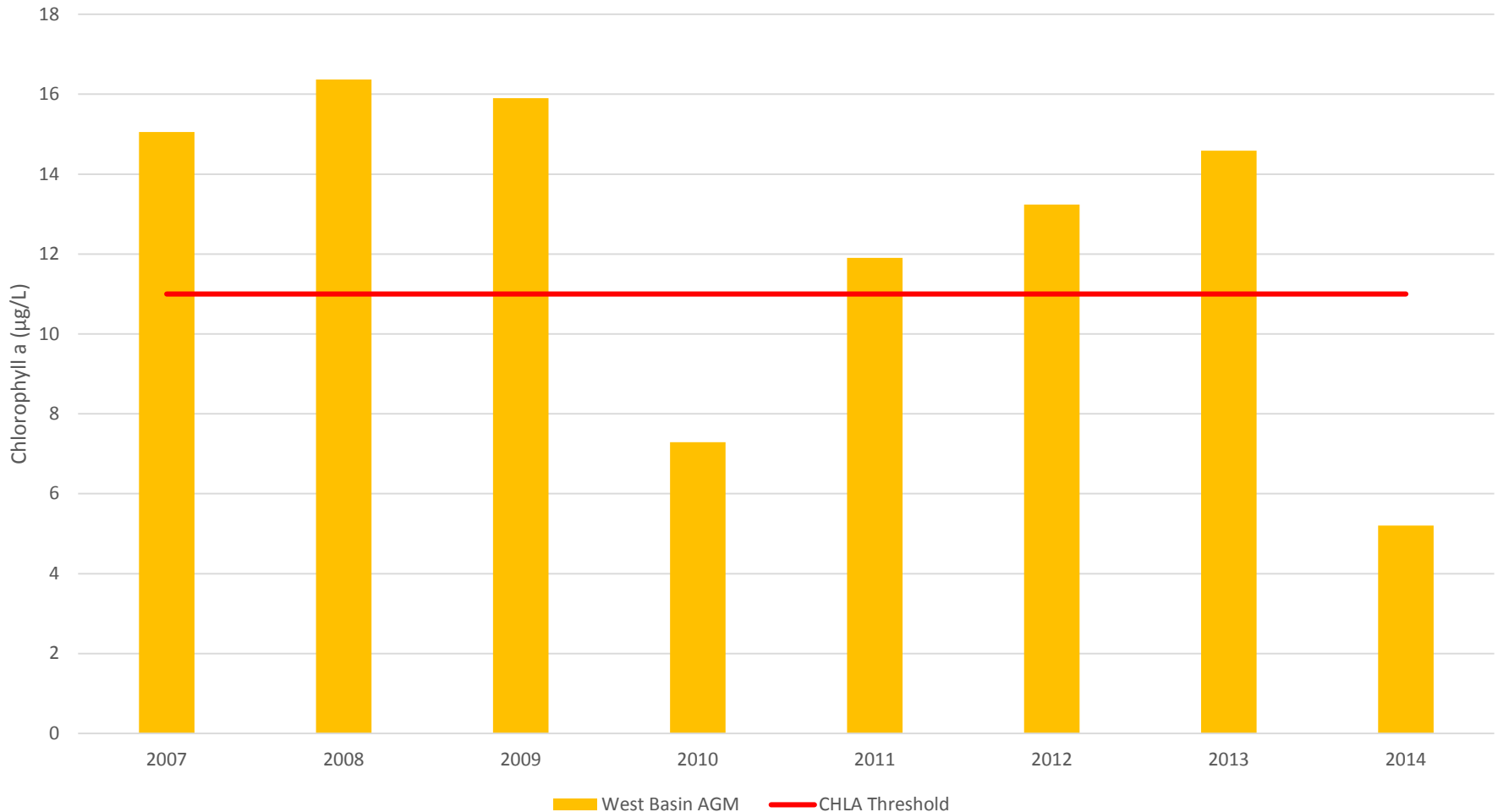
Year	Sanibel Slough West Chla ($\mu\text{g/L}$)
2007	15
2008	16
2009	16
2010	7
2011	12
2012	13
2013	15

Note: Values shown shaded are greater than the narrative nutrient threshold for non-ENR estuaries. Rule 62-302.531 states that the threshold for Chla shall not be exceeded more than once in any consecutive three year period.



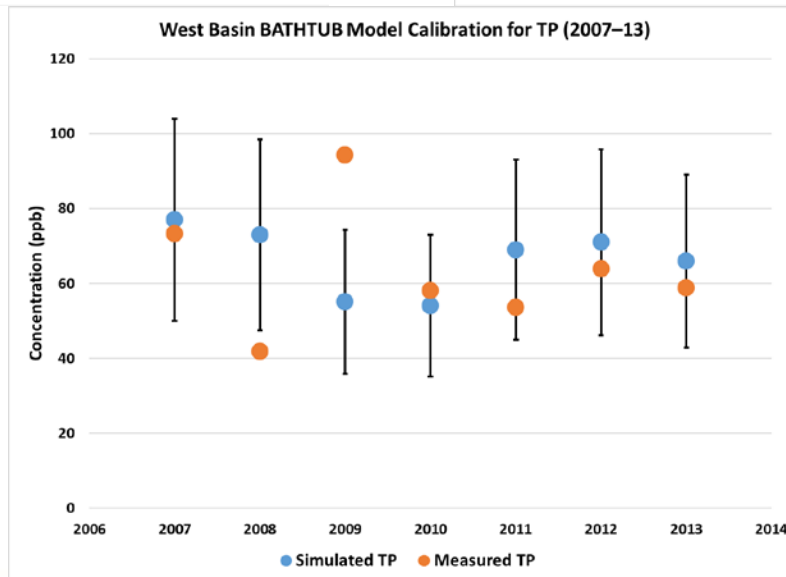
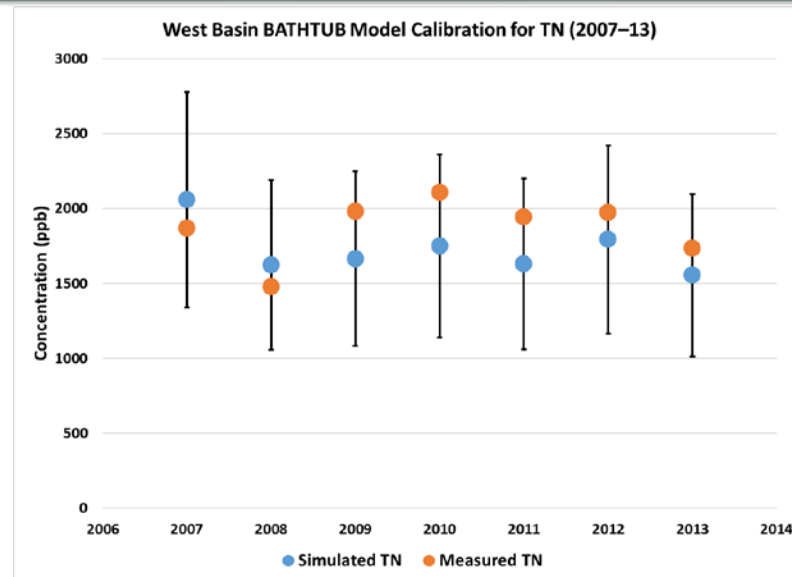
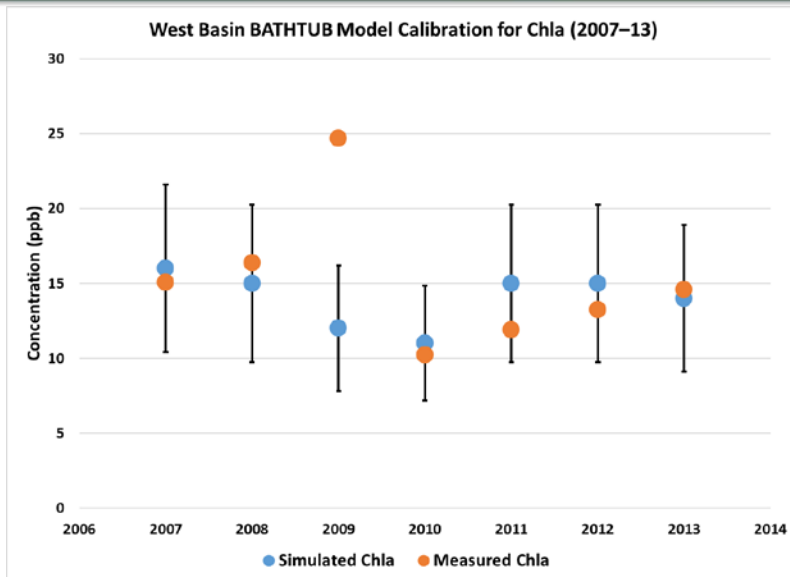
Sanibel Slough Chla Annual Geometric Means

Sanibel Slough West Chla Annual Geometric Means





Sanibel Slough West Calibration

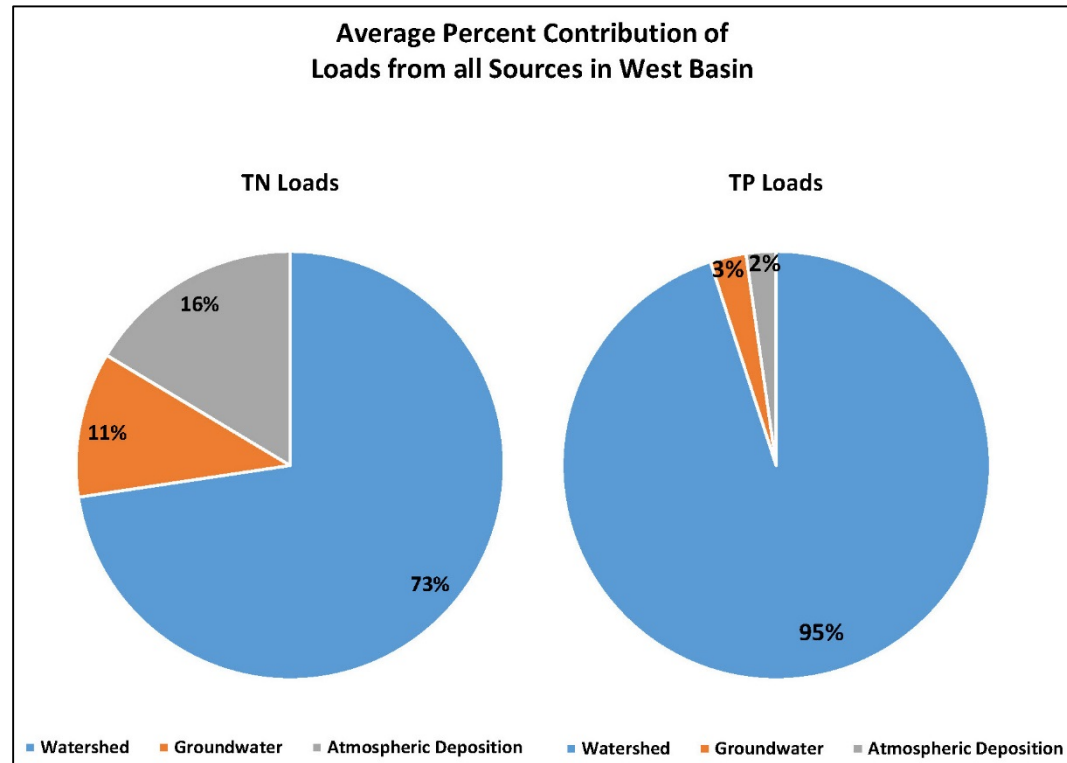




West Simulated Existing Condition

- Simulated annual loads from stormwater, groundwater and atmospheric deposition.

Year	West Basin TN Loads (kg/yr)	West Basin TP Loads (kg/yr)
2007	785	158
2008	1,109	222
2009	983	199
2010	1,033	191
2011	1,112	217
2012	938	190
2013	1,172	242



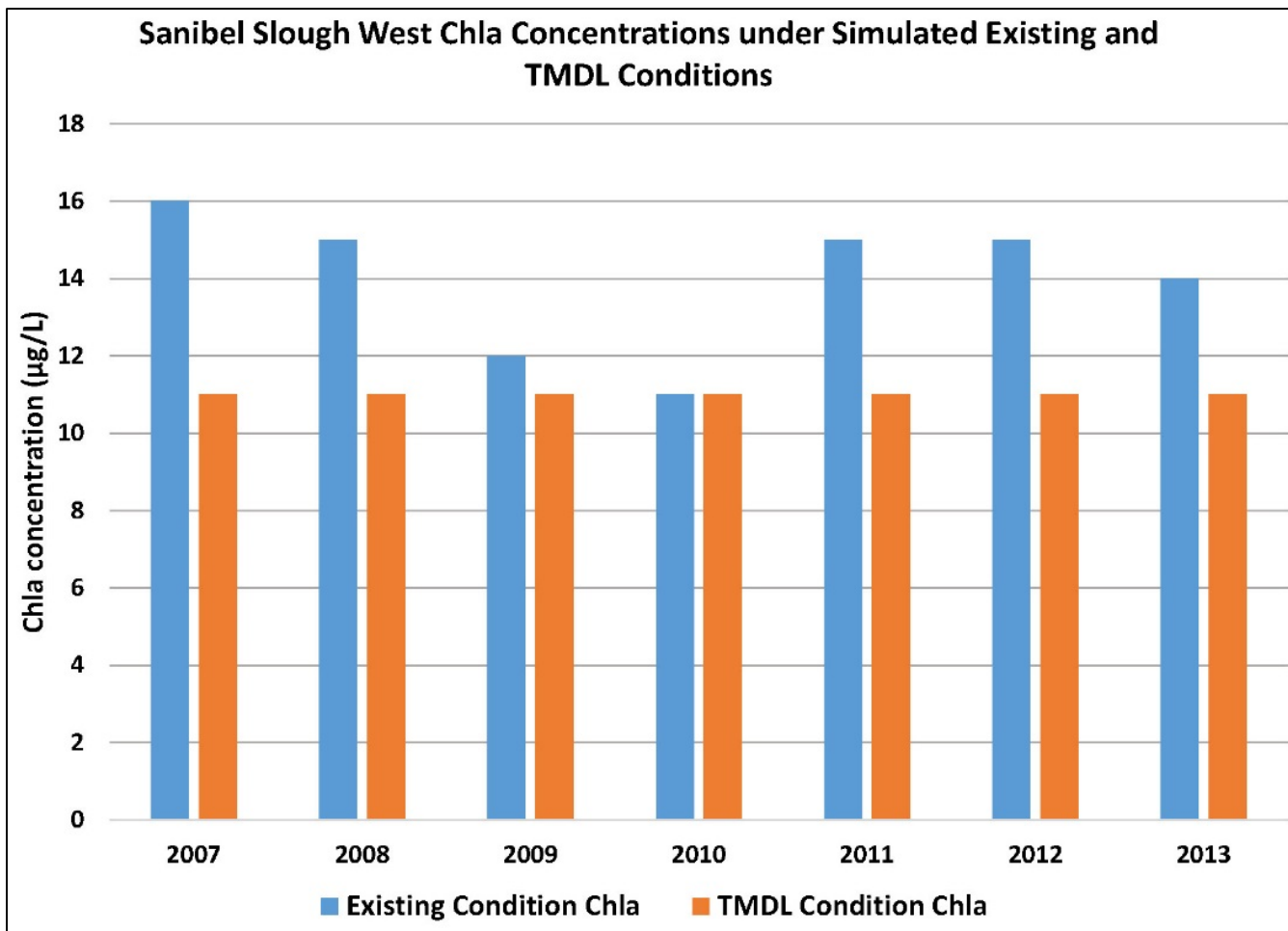


Achieving Target Condition

- In order to achieve the 11 $\mu\text{g}/\text{L}$ Chl a target every year, the TN and TP loads that achieve the Chl a target were simulated using the BATHTUB model.
 - The anthropogenic loads were incrementally decreased from the existing land use conditions (Existing Condition) until the estuary Chl a geometric mean concentration of 11 $\mu\text{g}/\text{L}$ was achieved every year (TMDL Condition).

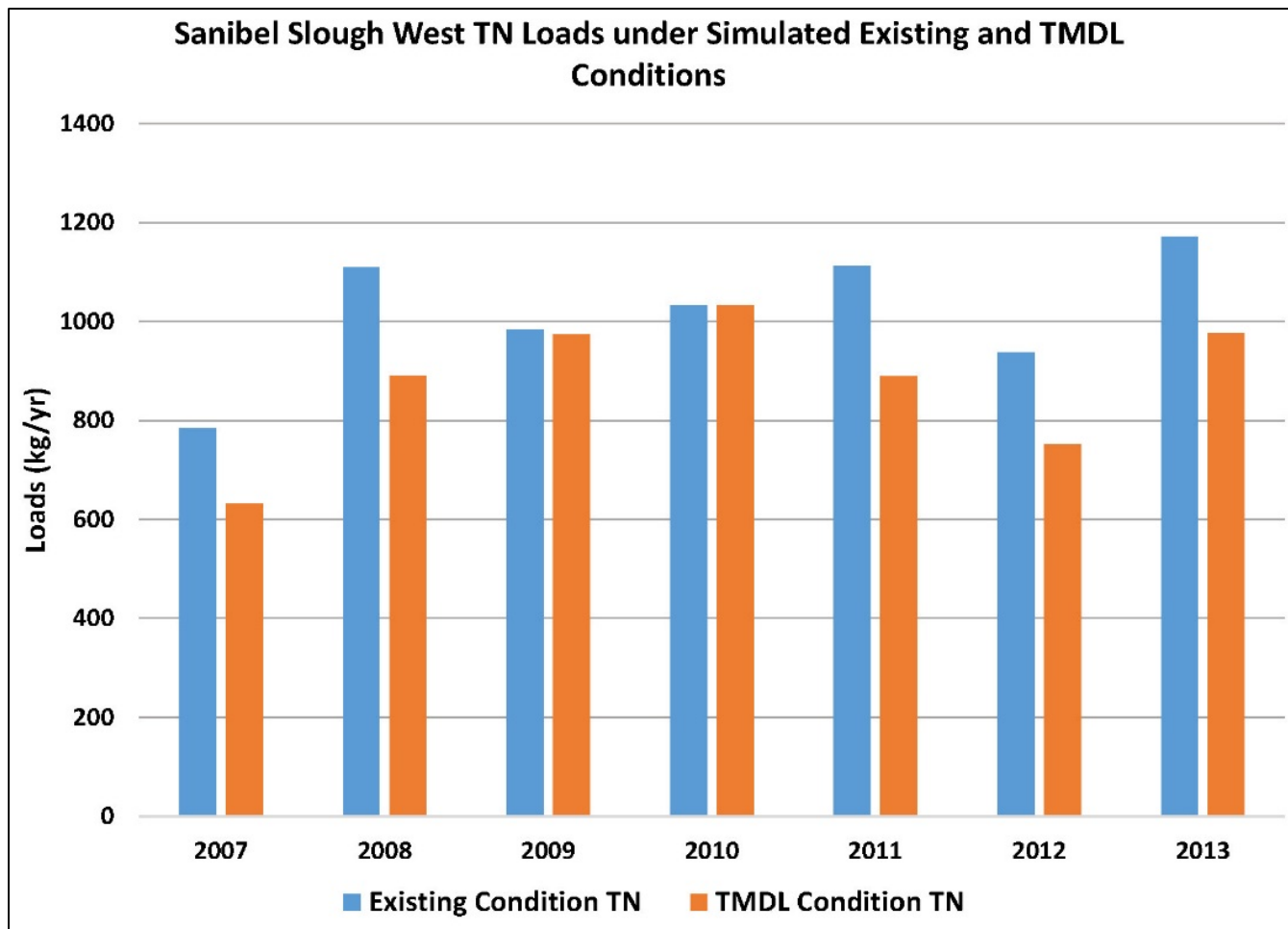


Sanibel Slough West Chla Scenarios



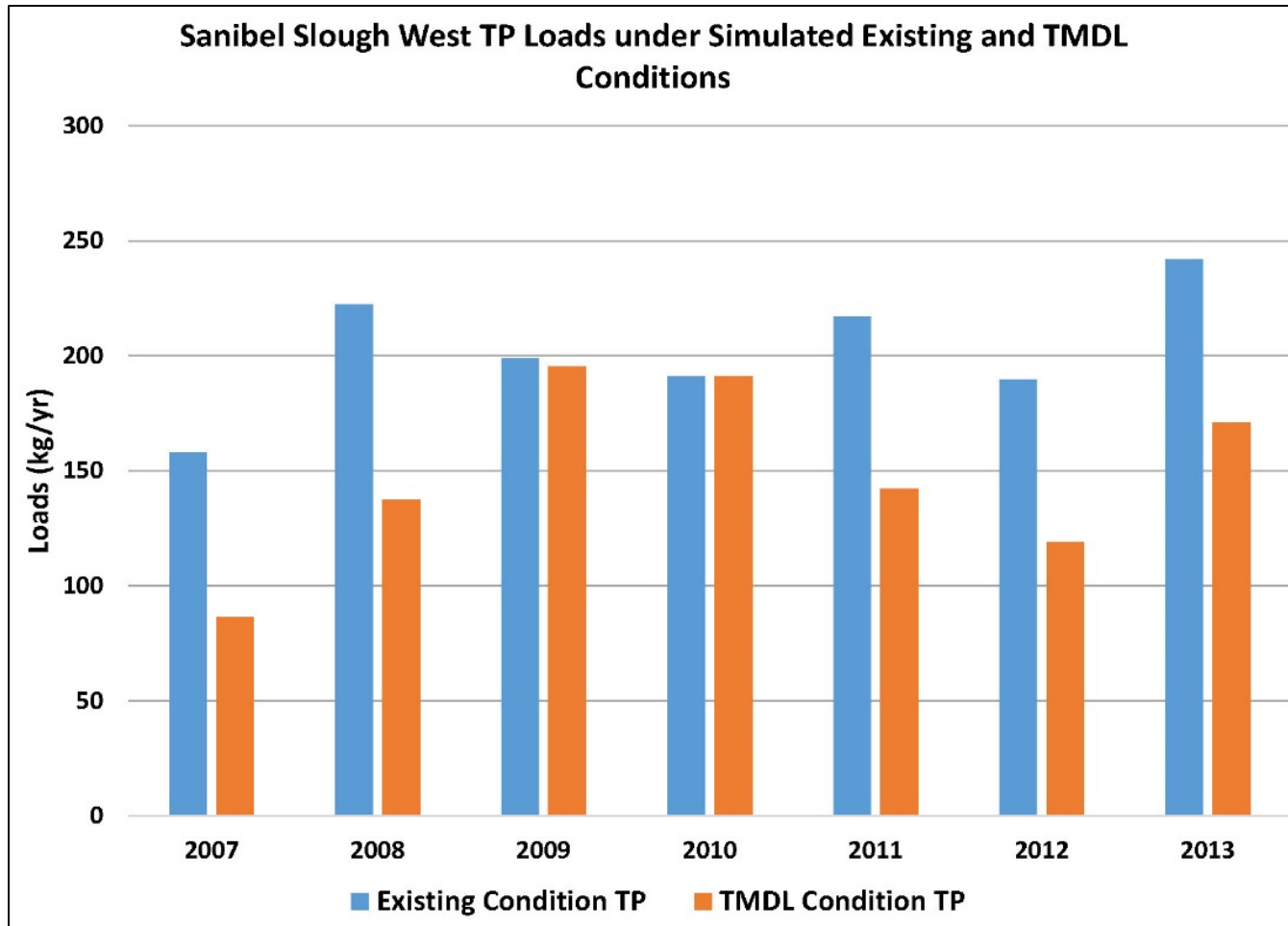


Sanibel Slough West TN Scenarios





Sanibel Slough West TP Scenarios





West Target Load Selection

A lagged 3-year rolling average was applied to the distribution of yearly nutrient loads, and the maximum of the resulting 3-year averages was chosen as the target TN and TP loads

Year	TMDL Condition TN Loads (kg/yr)	Lagging 3-Year Rolling Average TN Loads (kg/yr)	TMDL Condition TP Loads (kg/yr)	Lagging 3-Year Rolling Average TP Loads (kg/yr)
2007	632		87	
2008	891		138	
2009	973	832	195	140
2010	1,033	966	191	175
2011	889	965	142	176
2012	752	891	119	151
2013	976	872	171	144



West Percent Reductions

Condition	West Basin TN Loads (kg/yr)	West Basin TP Loads (kg/yr)
Maximum Existing Load	1,172	242
Target Load	966	176
% Reduction	18 %	27 %

The equation used to calculate the percent reduction is as follows:

$$\frac{[\text{maximum existing load} - \text{target load}]}{\text{maximum existing load}} \times 100$$



West Site Specific NNC

WBID	AGM Chlorophyll <i>a</i> (µg/L)	Rolling 3-year annual average TN (kg/yr)	Rolling 3-year annual average TP (kg/yr)
2092F1	11	966	176

- The nutrient TMDLs presented constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(47)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C.
- These nutrient loads shall be expressed as a rolling 3-year annual average load not to be exceeded.
- The Chla concentration shall be expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period.



Sanibel Slough TMDLs

WATERBODY (WBID)	PARAMETER	TMDL (KG/YR)	WLA WASTEWATER (% REDUCTION)	WLA NPDES STORMWATER (% REDUCTION)	LA (% REDUCTION)	MOS
2092F1	TN	966	N/A	18	18	Implicit
2092F1	TP	176	N/A	27	27	Implicit
2092F2	TN	1,644	N/A	31	31	Implicit
2092F2	TP	143	N/A	74	74	Implicit

Notes:

- 1) The required percent reductions listed in this table represent the reduction from all sources.
- 2) Dividing TMDL (kg/yr) by 365 days yields daily TMDL loads.
- 3) WBID 2092F1 is Sanibel Slough West, and WBID 2092F2 is Sanibel Slough East.



Implementation Considerations

- In addition to addressing reductions in watershed pollutant contributions to impaired waters during the implementation phase, it may also be necessary to consider the impacts of internal sources:
 - sediment nutrient fluxes,
 - presence of nitrogen-fixing cyanobacteria,
 - legacy pollution,
 - high infiltration to groundwater from reuse irrigation water.
- Approaches for addressing these other factors should be included in a comprehensive management plan for the slough.



Sanibel Slough West in SCCF preserve. Taken June 15, 2016.



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