Lake Okeechobee System Operating Manual

Iteration 1 Modeling -
Estuary Nutrient Loading Models

Sanibel-Captiva Conservation Foundation

Conservancy of Southwest Florida

DRAFT - April 05, 2021

Iteration 1 - Model runs

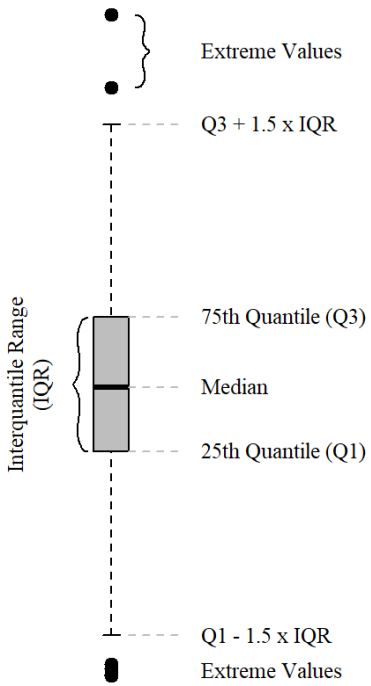
Alternative	Category	P Index	Model Index
LCMECB	LOSOM Existing Condition Baseline 2019	---	---
LCM25B	LOSOM No Action 2025 (FWO)	---	---
ABNE	Algal Bloom Risk for Northern Estuaries	6329	1C-1_8086
ECRE	Ecology - Caloosahatchee Estuary	7023	2C_2193
ELOK	Ecology - Lake Okeechobee	601	LORS08flex_2827
ESFL	Ecology - South Florida	18729 (mode 2)	4BC-2_6132
ESLE	Ecology - St. Lucie Estuary	22448	4C-1_3307
WAS	Water Supply	15122	4BC-1_5423
REC	Recreation	20814	4C-1_687
NAV	Navigation	15617	4BC-1_7802
WRDC [1] [a]	Alternative to address WRDA2020 requirements for Caloosahatchee	---	---
WRDS [2]	Alternative to address WRDA2020 requirements for St Luice	---	---
SPAS	Stakeholder Plan - Audubon	---	---
SPEF	Stakeholder Plan - Everglades Foundation	---	---
SPLC	Stakeholder Plan - Lakeside Communities	---	---

[1] Prohibiting high volume releases S77,S78,S79; [a] Does not satisfy Dam Saftey criteria.

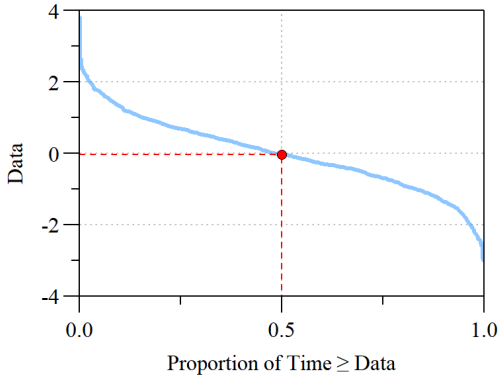
[2] Prohibiting high volume releases S308,S80

Quick 101

- How to read box-and-whisker plots or boxplots



- Duration curves are based on cumulative distribution functions.



- *Example:* What is the data value 50% (or 0.5) of the time?
  - Follow the red dashed lines and you get a value of -0.04.

More reading on empirical CDF at this link.

The Models

Caloosahatchee River Estuary (S-79) - Model Presentation - FDEP (2021a)

$$TPLoad_{S79} = 127156 + 0.20Q_{C43Basin} + 0.08Q_{S77} - 7689MeanLakeStage$$

$$TNLoad_{S79} = 27561 + 1.53Q_{C43Basin} + 1.58Q_{S77} + 20813MeanLakeStage$$

- Model as .RData file

St Lucie River Estuary (S-80) - Model Presentation - FDEP (2021b)

$$ln(TPLoad_{S80}) = -2.49 - (2.85x10^{-7} \times Q_{C44Basin}) - (5.29x10^{-8} \times Q_{S308}) + (1.22 \times ln(Q_{S80})) - (0.13 \times MeanStage)$$

$$ln(TNLoad_{S80}) = 1.76 \times 10^{-2} + (6.60 \times 10^{-8} Q_{C44Basin}) + (1.99 \times 10^{-7} Q_{S308}) + (1.06 \times 10^{-2} ln(Q_{S80})) - (1.70x10^{-2} MeanStage)$$

- Model as .RData file

Metadata

Alt[1]	WY	Q.S77	Q.S79	Q.C43	mean.stg	TPLoad.kg.fit	TPLoad.kg.95LCI	TPLoad.kg.95UCI	TNLoad.kg.fit	TNLoad.kg.95LCI	TNLoad.kg.95UCI
ABNE	1966	401169	1223672	822503	13.26	219960	187353	252567	2199080	1982352	2415807
ABNE	1967	898245	1721681	823435	15.48	244794	215331	274257	3032165	2836335	3227994
ABNE	1968	393250	981757	588507	12.47	179506	151962	207049	1811290	1628218	1994362

[1] only the first two rows of data

Column	Units	Description
Alt		Model Alternative
WY		Florida Water Year (May - April)
Q.S77/Q.S308		Annual Discharge S77/S308 (depending on file)
Q.S79/Q.80	Ac-Ft WY^{-1}	Annual Discharge S79/S80 (depending on file)
Q.C43/Q.C44		Annual Discharge C43/C44 (depending on file)
mean.stg	Ft, NGVD	Annual (WY) average Lake Okeechobee Stage
TPLoad.kg.fit		Predicted TP load
TPLoad.kg.95LCI		Predicted 95% lower CI TP load
TPLoad.kg.95UCI	kg WY^{-1}	Predicted 95% upper CI TP load
TNLoad.kg.fit		Predicted TN load
TNLoad.kg.95LCI		Predicted 95% lower CI TN load
TNLoad.kg.95UCI		Predicted 95% upper CI TN load

TP = Total Phosphorus; TN = Total Nitrogen; WY = Florida Water Year; Ac-Ft = Acre-foot; kg = kilogram; CI = Confidence Interval; NGVD = National Geodetic Vertical Datum

Critical Loads

- The concept of critical loads was proposed as a way to evaluate the modeled loads across alternatives.
  - Janicki (2003)

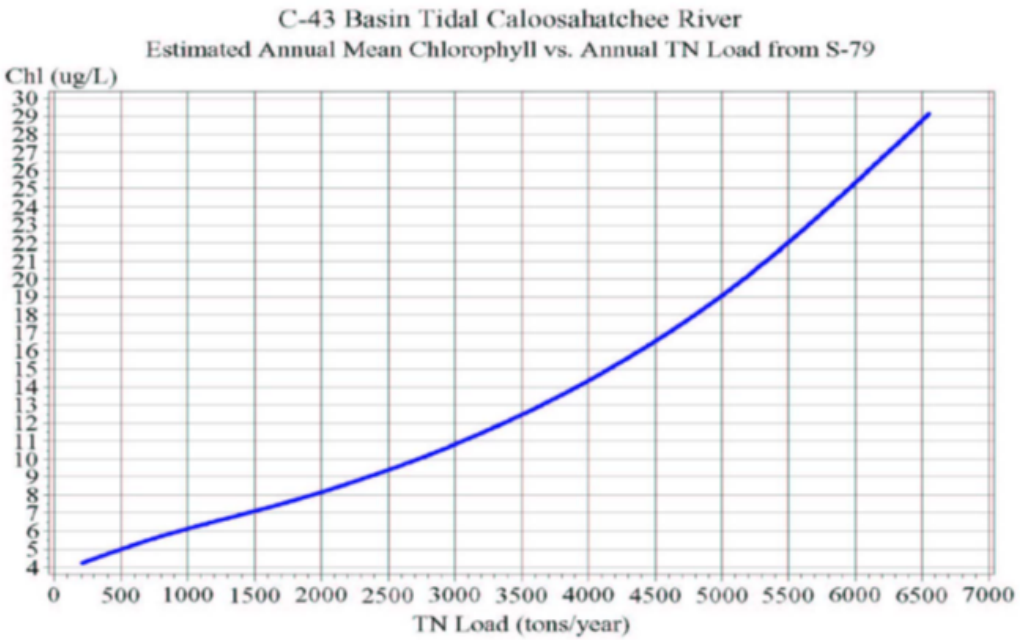
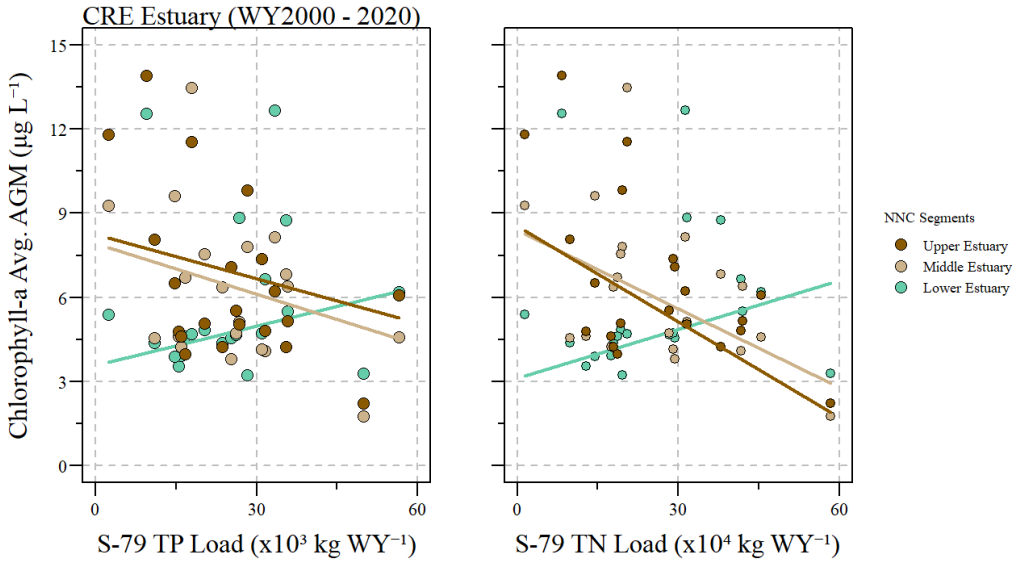


Figure 4-1. The estimated relationship between mean annual chlorophyll-a concentration in the tidal Caloosahatchee River and annual TN load from S-79.

- Janicki Environmental (2003) Development of Critical Loads for the C-43 Basin, Caloosahatchee River. Prepared for: Florida Department of Environmental Protection, Tallahassee, FL.

Critical Loads

- However, when attempting to verify this relationship for purposes of this evaluation the relationship (based on available data) were not congruent with prior efforts (Janicki 2003) or were not consistent with temporal resolution of the models (Doering et al. 2006).

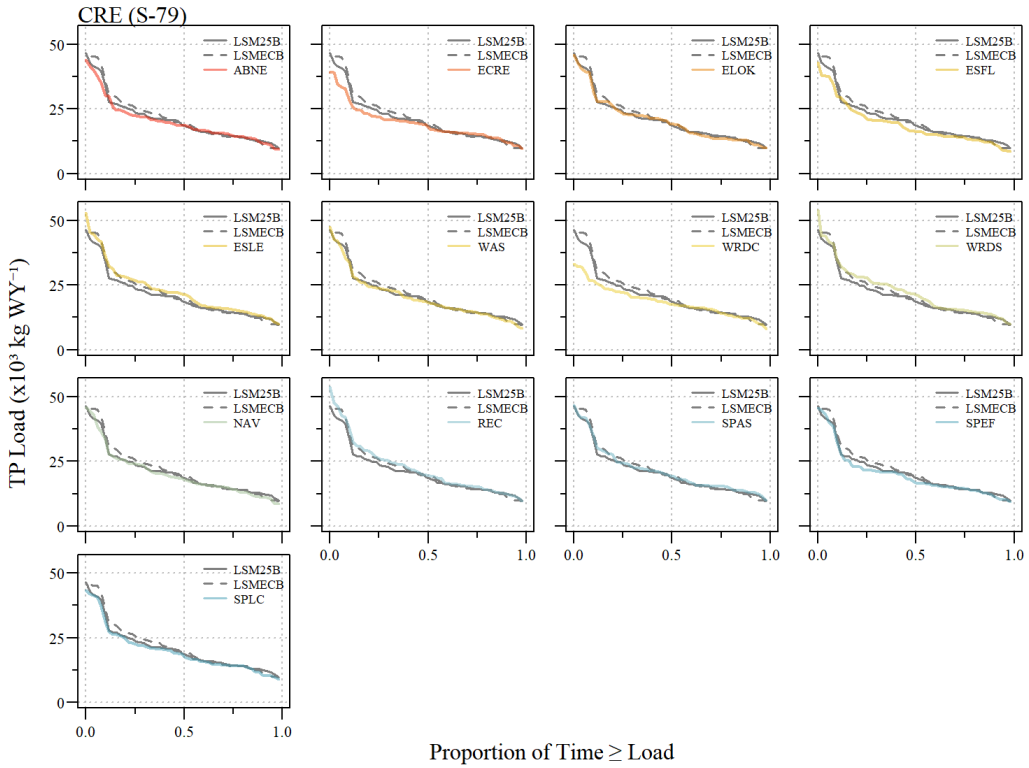


S-79 TP and TN annual loads compared to spatially averaged annual geometric mean Chlorophyll-a concentration for each segment.

- The effects of season, color (CDOM), biology, and hydrodynamics affect the chlorophyll-load relationship across the estuary.

Caloosahatchee River Estuary

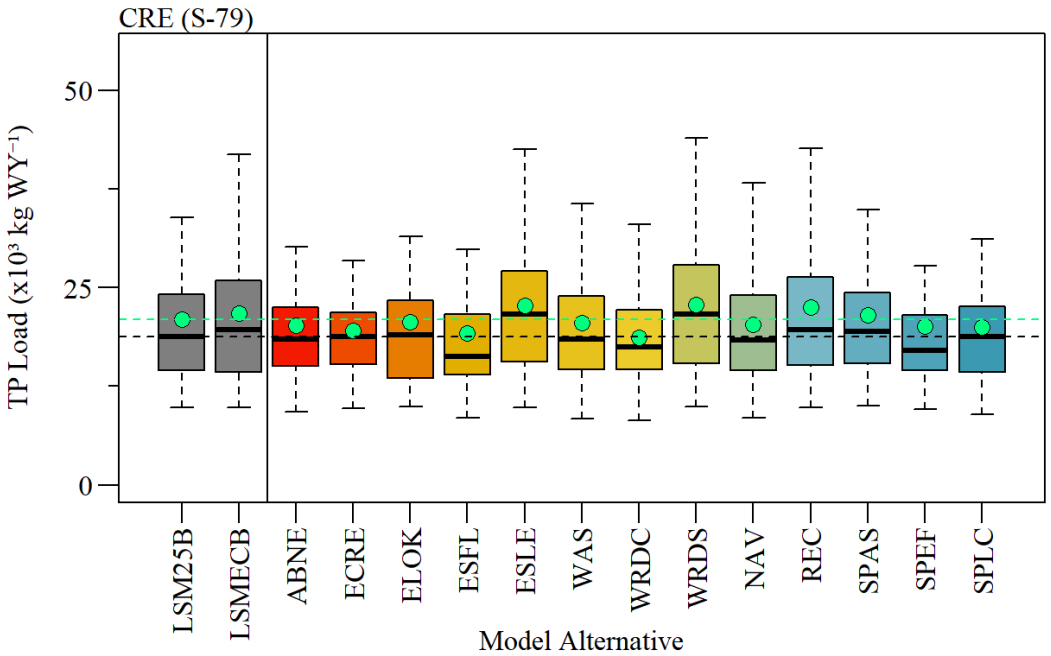
Total Phosphorus Load Duration Curve



Cumulative distribution/load duration curve comparison of S-79 TP loads for each alternative relative to FWO and ECB.

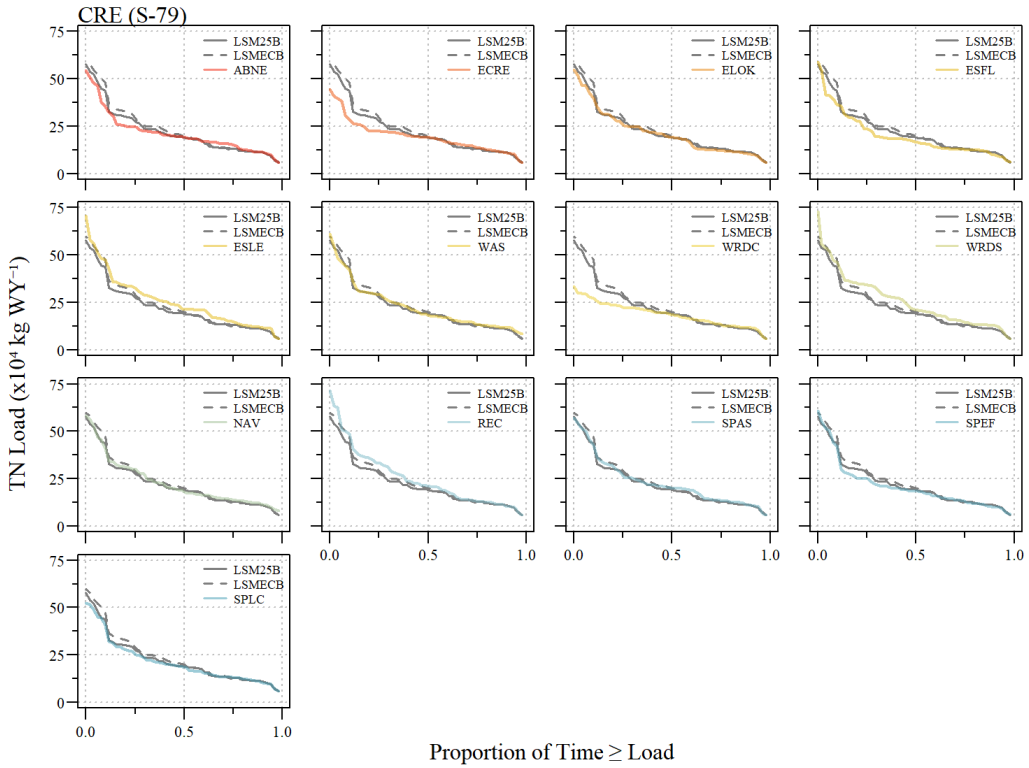
- Relative to FWO - REC, WRDS and ESLE results in generally higher loads

Total Phosphorus Load



Boxplot representing annual TP loads during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

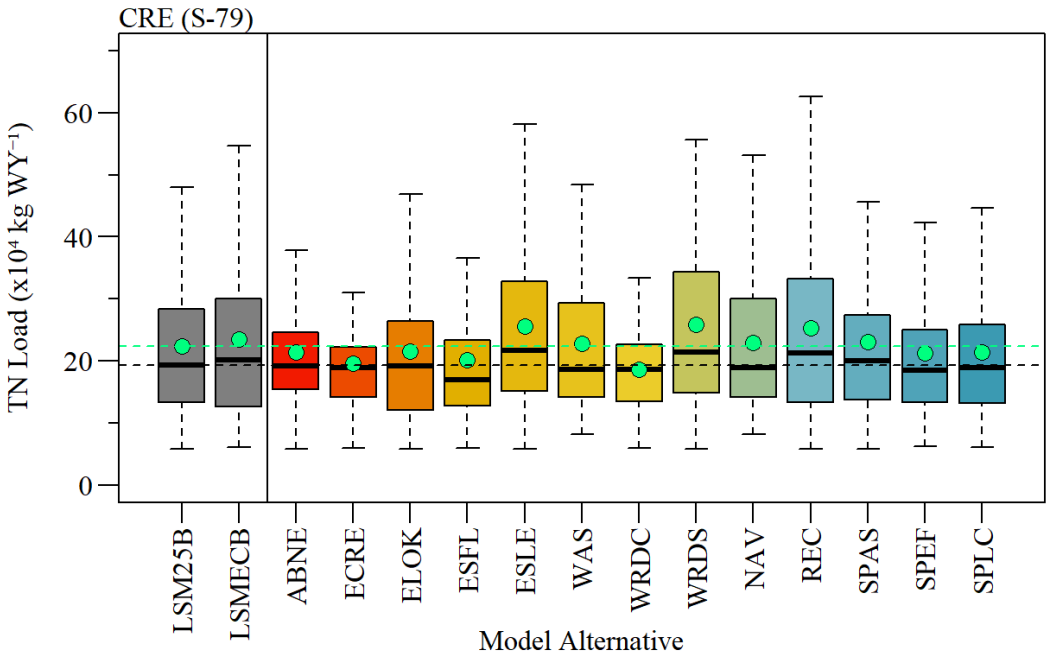
Total Nitrogen Load Duration Curve



Cumulative distribution/load duration curve comparison of S-79 TN loads for each alternative relative to FWO and ECB.

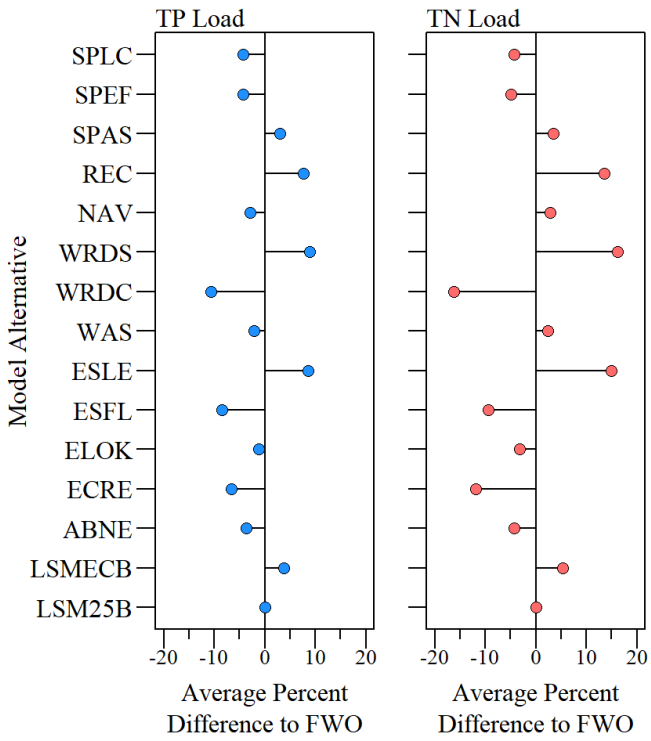
- Relative to FWO - REC, WRDS and ESLE results in generally higher loads

Total Nitrogen Load



Boxplot representing annual TN loads during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

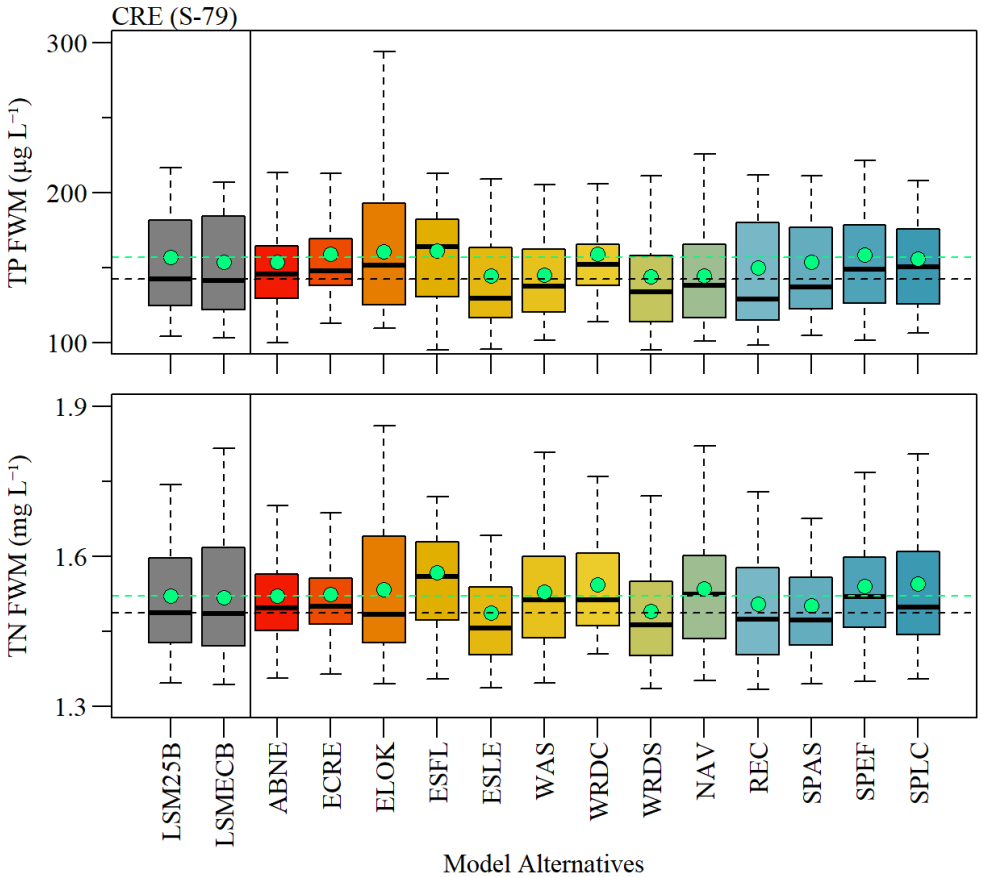
S-79 Load Summary



Percent difference of average load relative to the FWO (LSM25B) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

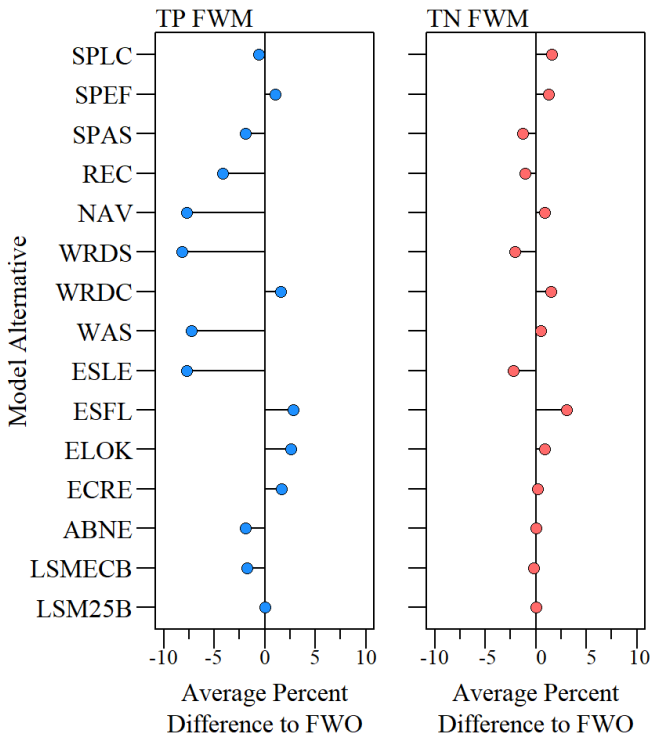
- ABNE, ECRE, ESFL and *WRDC* provide load benefit (negative % difference).
- ESLE, WRDC, and REC provide load impact (positive % difference).
- Remaining alternatives result in minor changes (±) to loading.

S-79 FWM Concentration



Boxplot representing annual TP (top) and TN (bottom) flow-weighted mean concentration during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

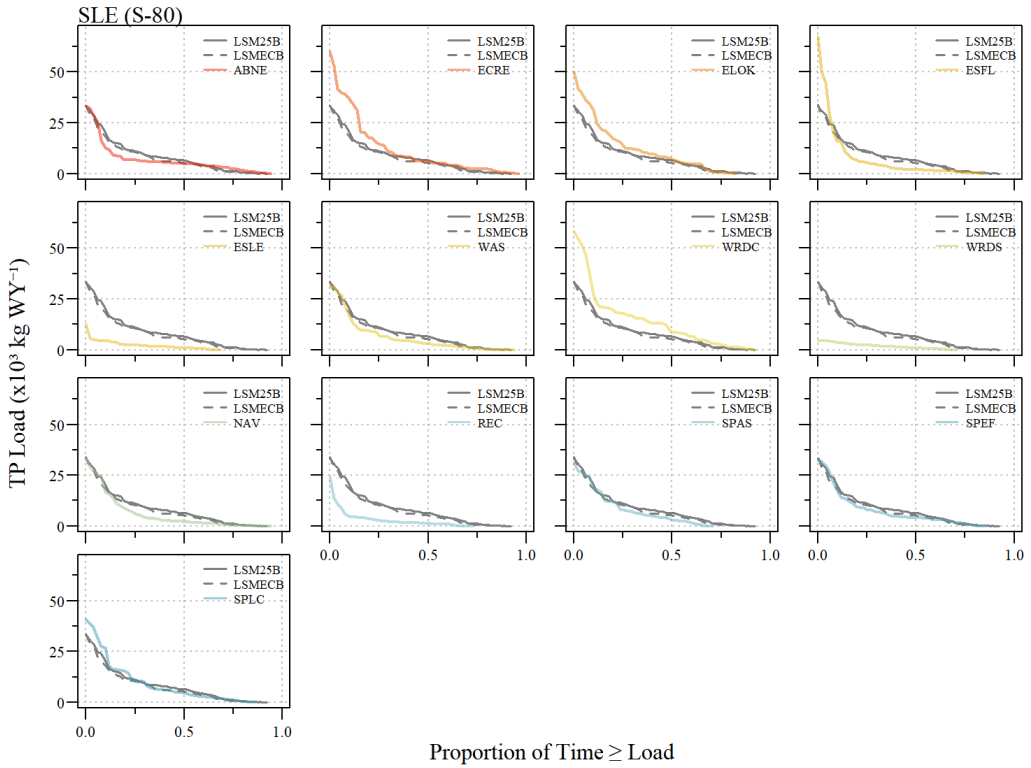
S-79 FWM Summary



Percent difference of average flow-weighted mean relative to the FWO (LSM25B) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

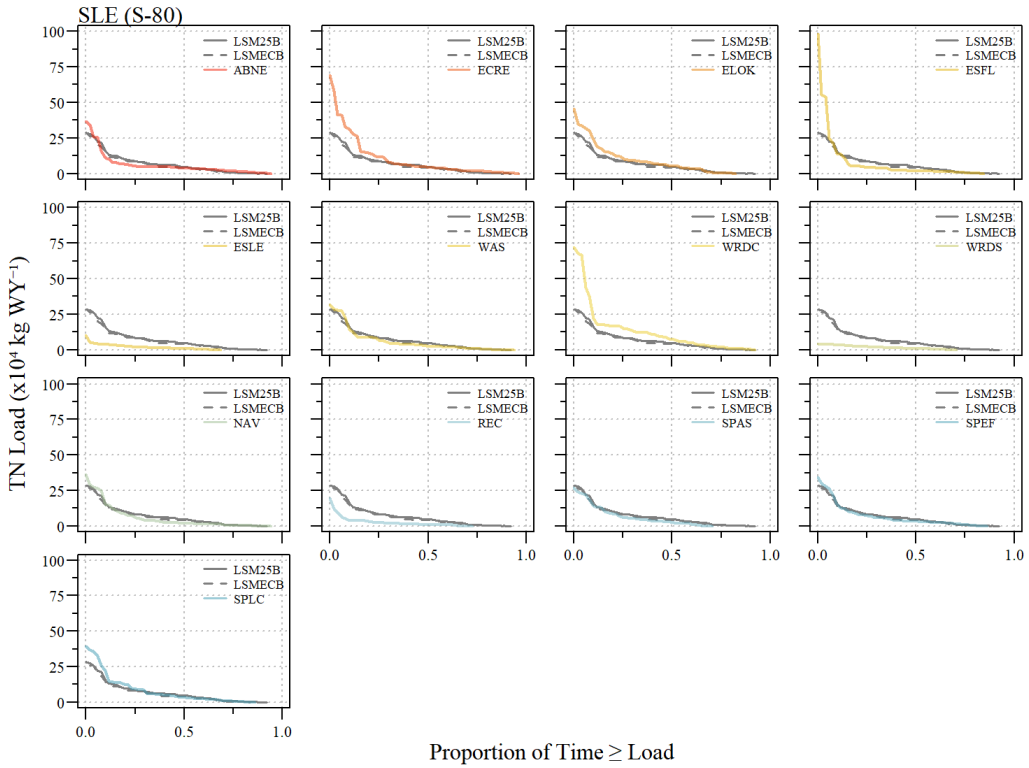
St Lucie River Estuary

Total Phosphorus Load Duration Curve



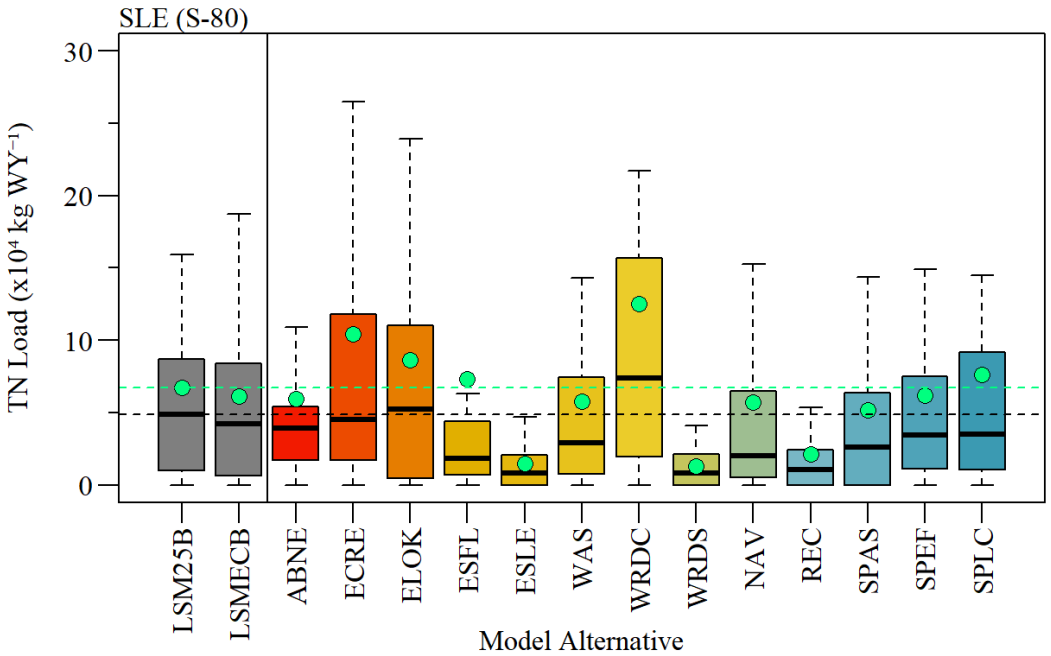
Cumulative distribution/load duration curve comparison of S-80 TP loads for each alternative relative to FWO and ECB.

Total Nitrogen Load Duration Curve



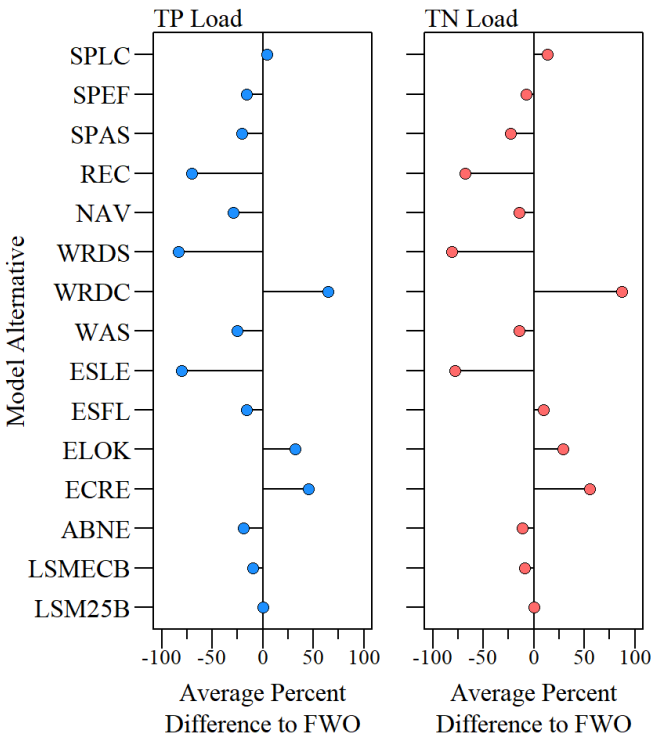
Cumulative distribution/load duration curve comparison of S-80 TN loads for each alternative relative to FWO and ECB.

Total Nitrogen Load



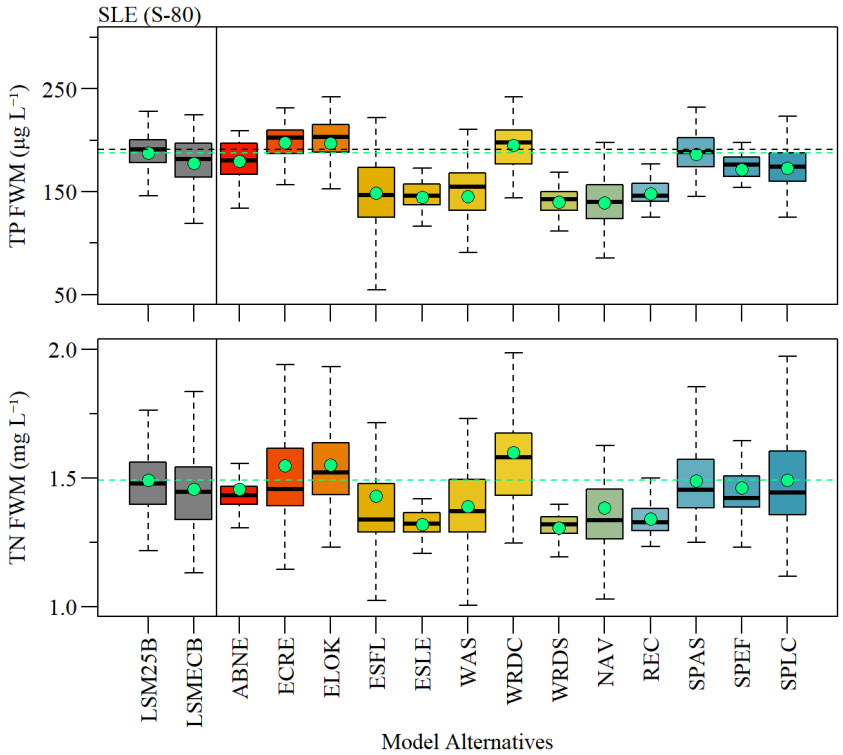
Boxplot representing annual TN loads during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

S-80 Load Summary



Percent difference of average load relative to the FWO (LSM25B) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

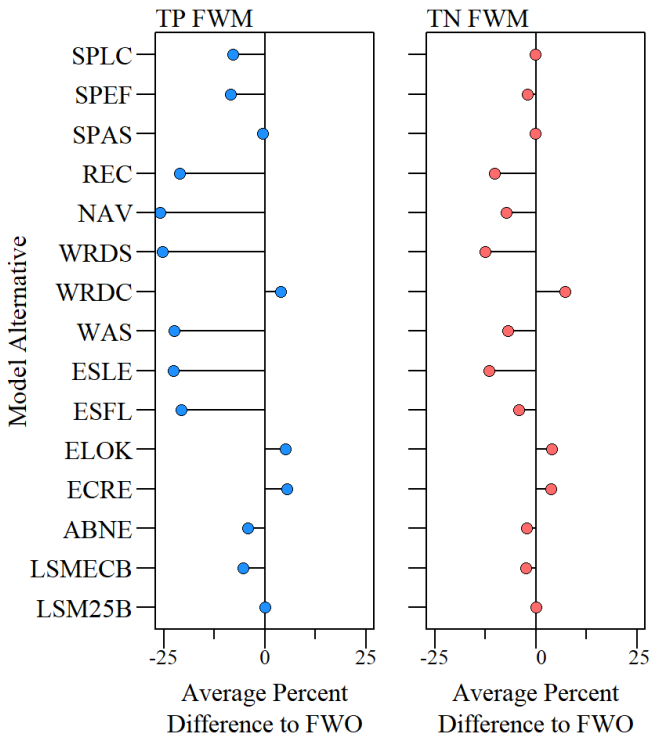
S-80 FWM Concentration



Boxplot representing annual TP (top) and TN (bottom) flow-weighted mean concentration during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

FWMC during years with <80 ac-ft WY^{-1} were excluded. See original presentation - link.

S-80 FWM Summary



Percent difference of average flow-weighted mean relative to the FWO (LSM25B) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

Acknowledgments

South Florida Water Management District (DBHYDRO)

US Army Corps of Engineers (USACE LOSOM)

- Interagency Modeling Center

HTML Slide deck | PDF Slide deck | RMarkdown Source

References

- Doering et al (2006) Chlorophyll-a and its use as an indicator of eutrophication in the Caloosahatchee Estuary, Florida. Florida Scientist 69:51–72
- FDEP (2021a) Lake Okeechobee System Operating Manual (WQ Subteam) DRAFT - Caloosahatchee River Estuary Nutrient Loading Model. Presented January 13, 2021.
- FDEP (2021b) Lake Okeechobee System Operating Manual (WQ Subteam) DRAFT - St Lucie Estuary Nutrient Loading Model. Presented January 13, 2021.
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