Lake Okeechobee System Operating Manual

Iteration 2 Modeling -
S-77/S-308 Load Estimates

Sanibel-Captiva Conservation Foundation

Conservancy of Southwest Florida

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Iteration 2 - Model runs

Alternative	Description
ECBr [1]	LOSOM Existing Condition Baseline 2019
NA25 [2]	LOSOM No Action 2025 (FWO)
AA	ESLE Framework. Enhances SLE ecology.
BB	SPLC Framework. Improve water supply to pre-LORS08
CC	Pareto Plan D Framework. Enhances CRE ecology and improves water supply
DD	Pareto Plan A Framework. Incremental improvement over LORS.
EE1	Stage Target Operation Framework. Improve water supply performance by reducing flows south.
EE2	Stage Target Operations Framework. Reduce flows to SLE by reducing Zone B release rate.
SR3.5	SFWMD Sensitivity Run for CC (NOT an offical alternative)

[1] Existing Conditions Baseline 2019, revised (replaces LSMECB)

[2] No action Condition 2025 (replaces LSM25B)

SR3.5

- Was included in this evaluation but is **NOT** an official iteration 2 alternative.
- Built from alternative CC
- SFWMD sensitivity run which serves as an example run incorporating policy direction (as informed by the Governing Board) and trade-offs between oper the different systems
- Presented at the July 15th 2021 Governing Board

Methods

- Due to variability in concentration-Discharge relationships and lack of water quality-hydrodynamic model (like ENLM) monthly mean TP and TN concentration data was used.

	Total Phosphorus ($\mu g\ L^{-1}$)		Total Nitrogen ($mg\ L^{-1}$)	
Month	S-77	S-308	S-77	S-308
Jan	79 ± 34 (72)	258 ± 142 (46)	1.43 ± 0.23 (71)	2.27 ± 0.97 (45)
Feb	89 ± 46 (66)	238 ± 149 (43)	1.46 ± 0.35 (67)	2.02 ± 0.75 (43)
Mar	93 ± 33 (66)	229 ± 179 (42)	1.54 ± 0.59 (66)	2.03 ± 1.09 (42)
Apr	117 ± 71 (73)	220 ± 88 (49)	1.55 ± 0.25 (67)	1.95 ± 0.48 (45)
May	112 ± 61 (75)	186 ± 72 (51)	1.69 ± 0.55 (69)	1.79 ± 0.43 (46)
Jun	116 ± 82 (65)	179 ± 86 (42)	1.65 ± 0.42 (65)	1.64 ± 0.60 (39)
Jul	153 ± 103 (72)	210 ± 120 (48)	1.79 ± 0.40 (70)	1.55 ± 0.28 (47)
Aug	158 ± 90 (73)	185 ± 108 (49)	1.81 ± 0.71 (67)	1.57 ± 0.49 (49)
Sep	154 ± 87 (74)	184 ± 95 (51)	1.72 ± 0.47 (71)	1.60 ± 0.48 (51)
Oct	109 ± 99 (73)	177 ± 84 (47)	1.64 ± 0.66 (70)	1.56 ± 0.31 (46)
Nov	81 ± 42 (71)	192 ± 86 (46)	1.47 ± 0.33 (69)	1.87 ± 0.64 (46)
Dec	84 ± 39 (71)	236 ± 129 (47)	1.45 ± 0.24 (69)	2.07 ± 0.76 (47)

Mean ± Std Dev (N)

POR: May 1999 - April 2020

Methods

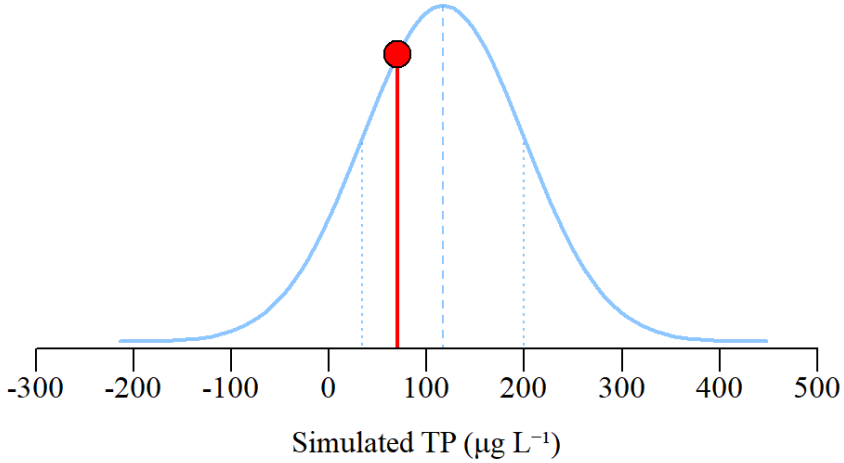
- Monthly TP/TN concentrations were pulled from a normal distribution using monthly mean and sd values for each month within the simulation period of record (1965 - 2016).
- If negative "simulated" values occurred (its possible given a normal distribution), the values was set to the POR mean value.

Example R Code

```
set.seed(123)
mean.val<-0.1168
sd.val<-0.0826

sim.TP<-rnorm(1,
              mean=mean.val,
              sd=sd.val)
sim.TP
```

```
## [1] 0.07050471
```



Example normal distribution with with $sim.TP$ identified.

Methods

Proof of concept

- Comparison of observed and simulated WQ data
  - POR: May 1999 - Apirl 2020
  - Want to ensure long-term mean values are comparable (i.e. POR mean).

		Observed		Simulated	
Site	Parameter	Mean	St. Dev.	Mean	St. Dev.
S77	TP (mg L^{-1})	0.1116	0.0741	0.1175	0.0682
	TN (mg L^{-1})	1.60	0.48	1.61	0.47
S308	TP (mg L^{-1})	0.2071	0.1175	0.2176	0.1079
	TN (mg L^{-1})	1.82	0.68	1.84	0.67

Methods

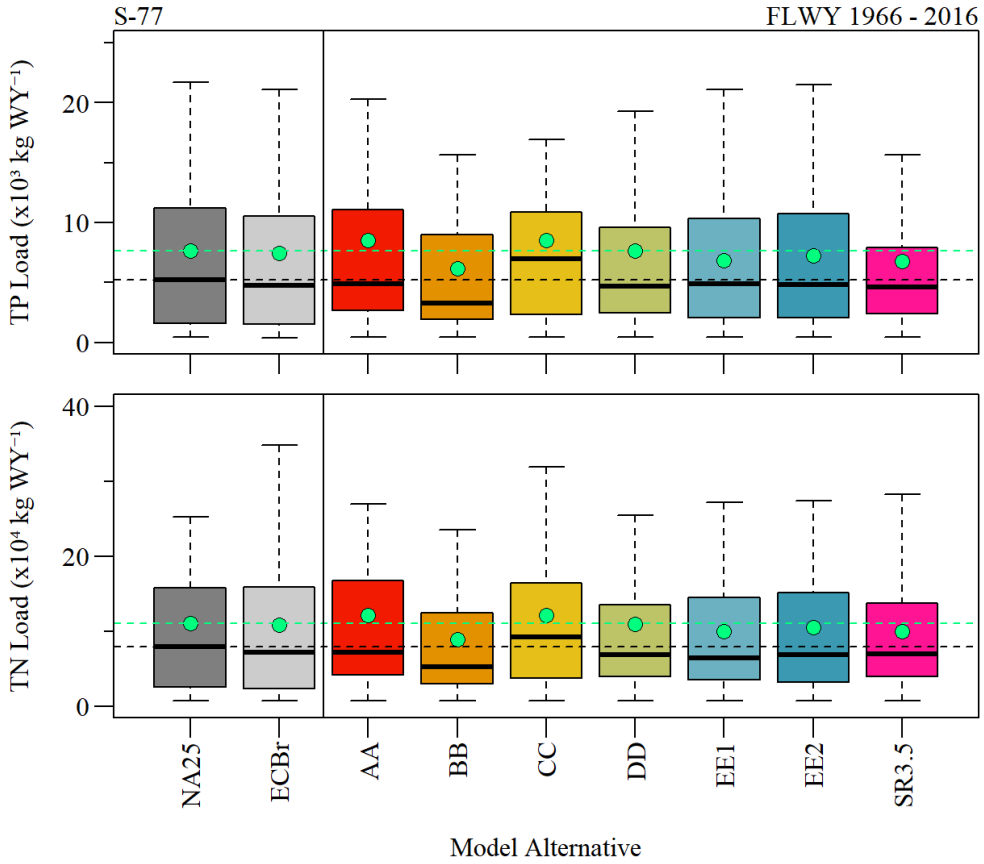
- Simulated TP & TN conc. were paired with daily discharge values for each alternative during the period of simulation.
- Load were estimated by interpolating concentrations daily from simulated data. Daily interpolated water quality concentrations were then multiplied by daily flow and summed for each WY.
- Load and FWM were estimated for S-77, S-308 and S-308 backflow events.

Assumptions

- No annual (or seasonal) trend in TP or TN concentrations during the period of simulation.

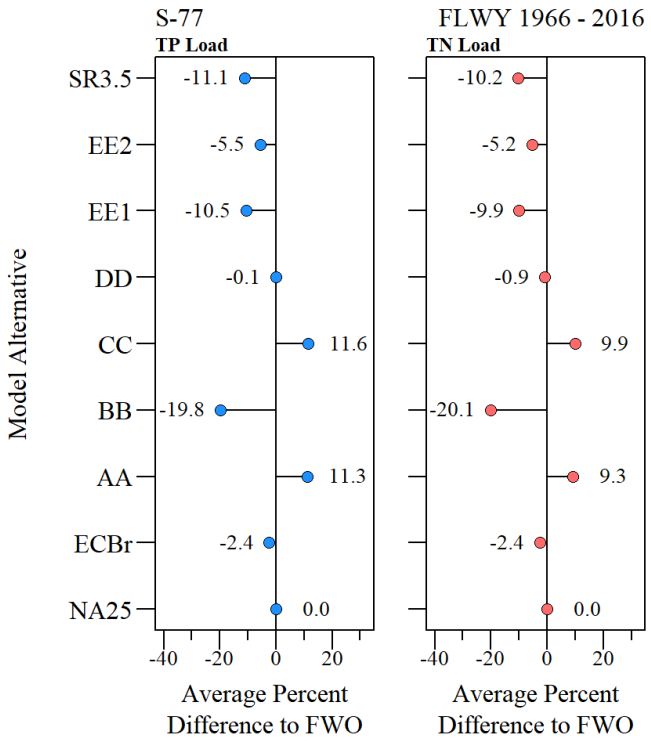
- Monthly data come from a normal distribution.

S-77 Load



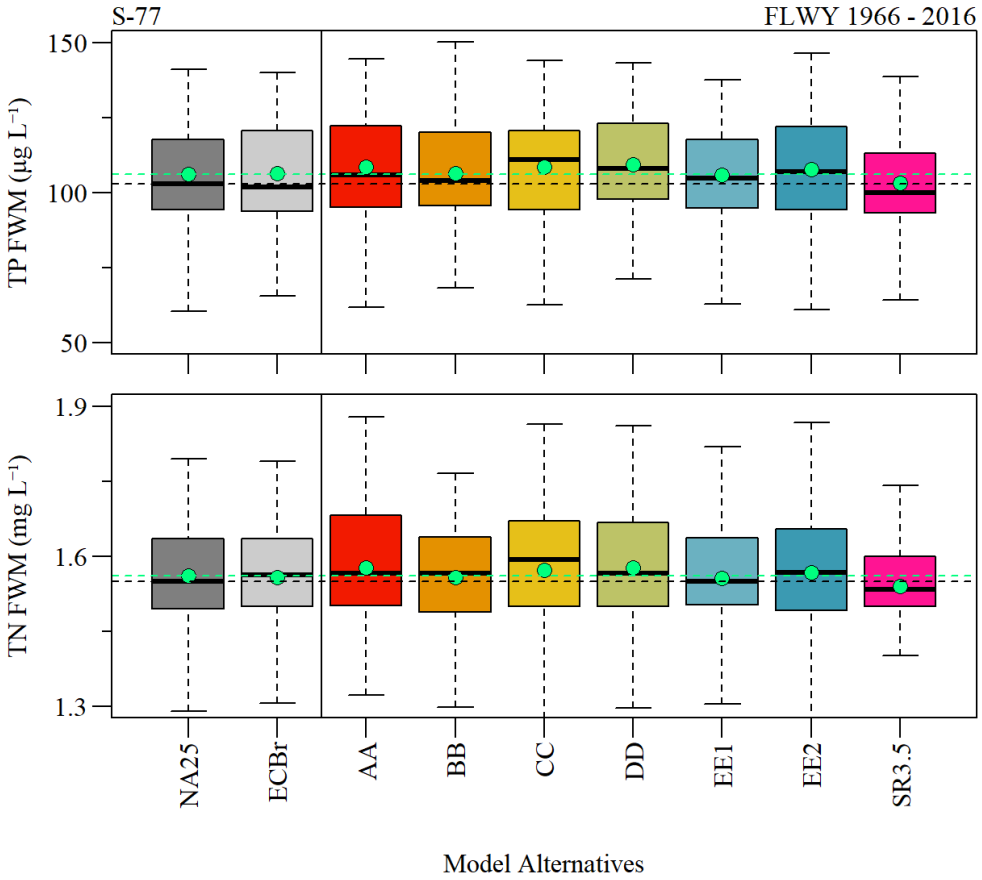
Boxplot representing annual TP (top) and TN (bottom) loads during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

S-77 Load Summary



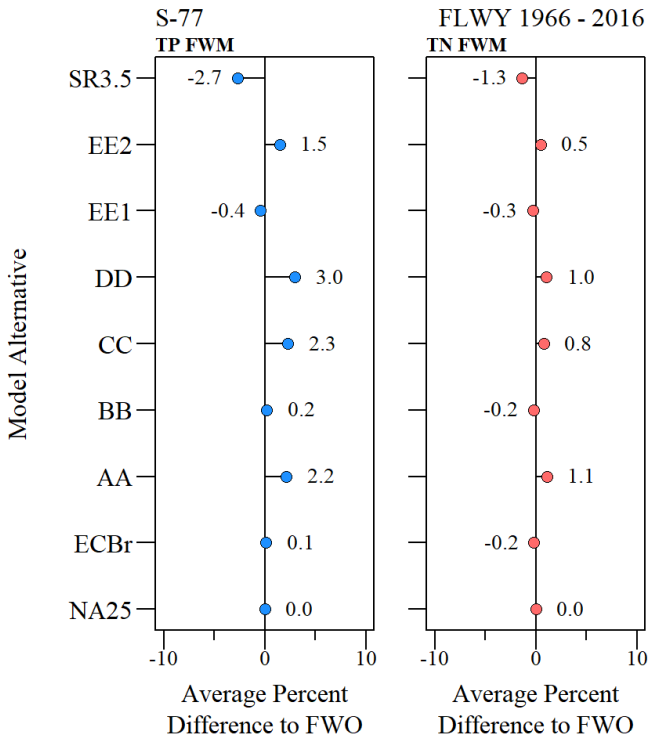
Percent difference of average load relative to the FWO (NA25) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

S-77 FWM



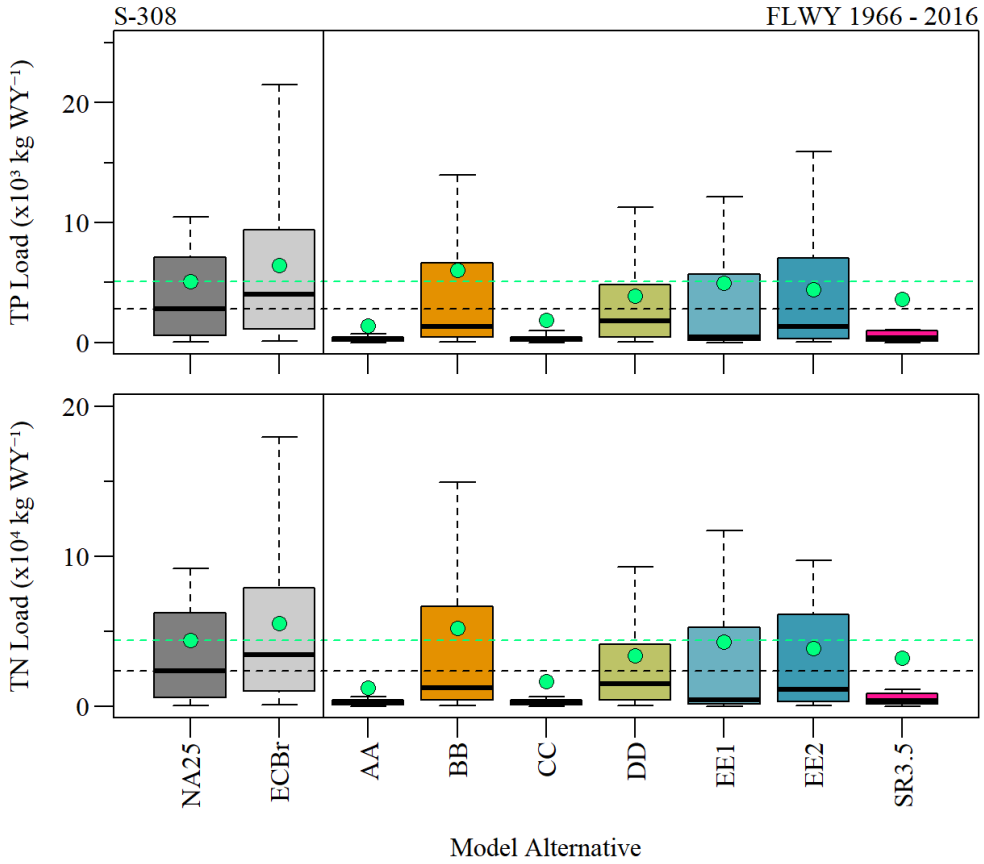
Boxplot representing annual TP (top) and TN (bottom) flow-weighted mean concentration during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

S-77 FWM Summary



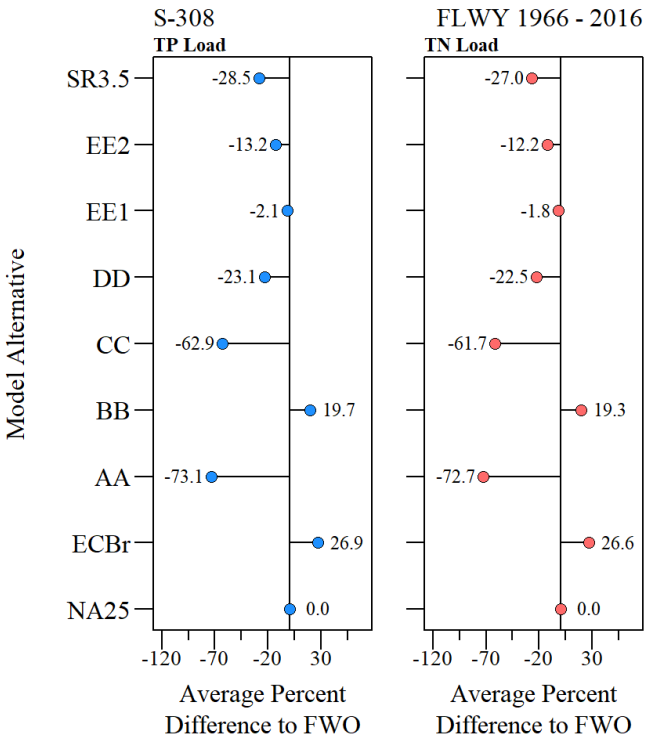
Percent difference of average load relative to the FWO (NA25) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

S-308 Load



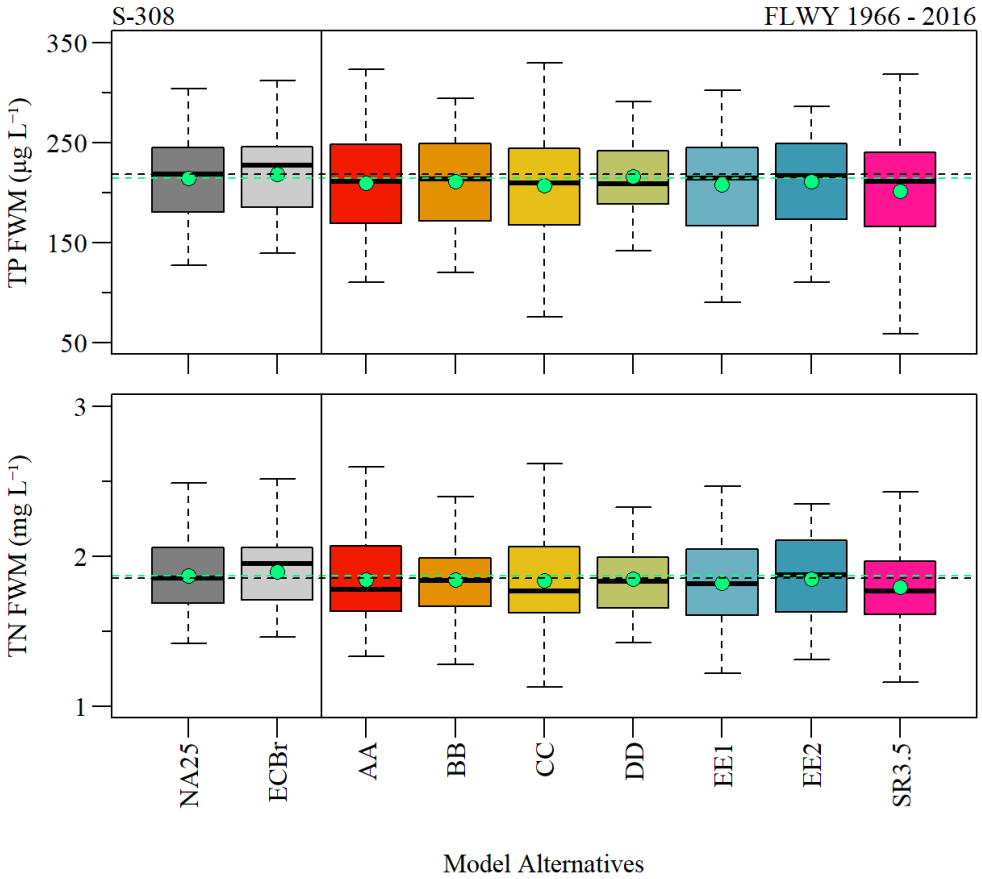
Boxplot representing annual TP (top) and TN (bottom) loads during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

S-308 Load Summary



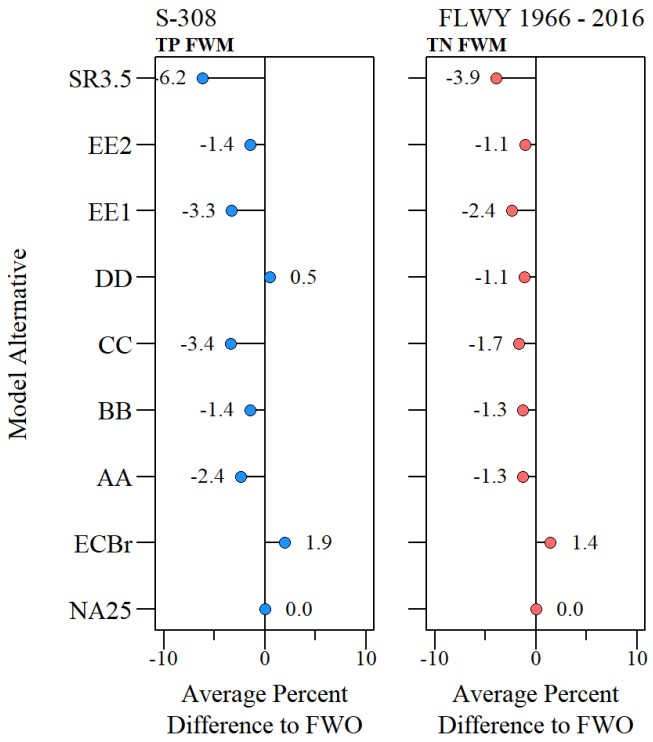
Percent difference of average load relative to the FWO (NA25) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

S-308 FWM



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-308 FWM Summary



Percent difference of average load relative to the FWO (NA25) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

S-77 Summary

Period of simulation annual mean discharge, total phoshphorus and total nitrogen load and flow-weight mean concentrations

Alt	Discharge (kAc-Ft WY^{-1})	TP Load (kg WY^{-1})	TN Load (kg WY^{-1})	TP FWM (µg L^{-1})	TN FWM (mg L^{-1})
NA25	573.5	76413	1106646	106.1	1.56
ECBr	560.5	74579	1079588	106.3	1.56
AA	619.5	85015	1209496	108.4	1.58
BB	461.7	61288	883924	106.4	1.56
CC	623.5	85257	1216571	108.5	1.57
DD	564.6	76327	1096436	109.3	1.58
EE1	517.6	68360	996942	105.7	1.56
EE2	545.0	72228	1048646	107.7	1.57
SR3.5	522.1	67914	993709	103.3	1.54

WY1966 - 2016 (May 1965 - Apirl 2016)

S-308 Summary

Period of simulation annual mean discharge, total phoshphorus and total nitrogen load and flow-weight mean concentrations for S308 and S-308 Backflow.

	S-308 (From Lake to C-44 Canal)					S-308 Back Flow (From C-44 Canal to Lake)		
Alt	Discharge (kAc-Ft WY^{-1})	TP Load (kg WY^{-1})	TN Load (kg WY^{-1})	TP FWM (µg L^{-1})	TN FWM (mg L^{-1})	Discharge (kAc-Ft WY^{-1})	TP Load (kg WY^{-1})	TN Load (kg WY^{-1})
NA25	190.1	50582	437137	214.6	1.87	38.8	9894	84024
ECBr	240.2	64181	553614	218.7	1.89	45.9	11421	96162
AA	54.7	13594	119409	209.5	1.84	46.1	12081	102203
BB	229.1	60533	521628	211.5	1.84	37.0	9315	80083
CC	75.5	18772	167371	207.3	1.84	45.6	11882	101066
DD	149.4	38908	338784	215.6	1.85	42.2	10848	92924
EE1	189.0	49545	429397	207.5	1.82	46.0	11907	100996
EE2	170.4	43907	383700	211.5	1.85	45.6	11809	100014
SR3.5	144.5	36189	319181	201.3	1.79	54.5	14428	121526

WY1966 - 2016 (May 1965 - Apirl 2016)

Summary

	S77	S308
Load	BB lower relative to FWO (lower lake flows)	AA and CC lower relative to FWO (lower lake flows)
	CC higher relative to FWO (higher lake flows)	BB higher relative to FWO (higher lake flows)
FWM	EE1 lower relative to FWO	CC lower relative to FWO
	DD higher relative to FWO	DD higher relative to FWO for TP

SR3.5 not included in this summary table

- Some plans (AA,CC,DD & EEs) increase the flow and load associated with backflow at the S308.
    - of the water discharged through S308, 84% and 60% is returned to the lake as backflow in plan AA and CC, respectively.
- While not included in the summary, SR3.5 does result in reduced loads at S77 and S308 relative to FWO.
- Not evaluated here, backflow from S2, S3 and S4 also contribute to the nutrient and hydrologic load to the Lake. (*Link to summary*)

Acknowledgments

South Florida Water Management District (DBHYDRO)

US Army Corps of Engineers (USACE LOSOM)

- Interagency Modeling Center

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Additional Evaluation with SR3.5

Analysis Script