Lake Okeechobee System Operating Manual

Iteration 2 Modeling -
Estuary Nutrient Loading Models

Sanibel-Captiva Conservation Foundation

Conservancy of Southwest Florida

July 07, 2021
(Updated: July 16, 2021)

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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

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

Output

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

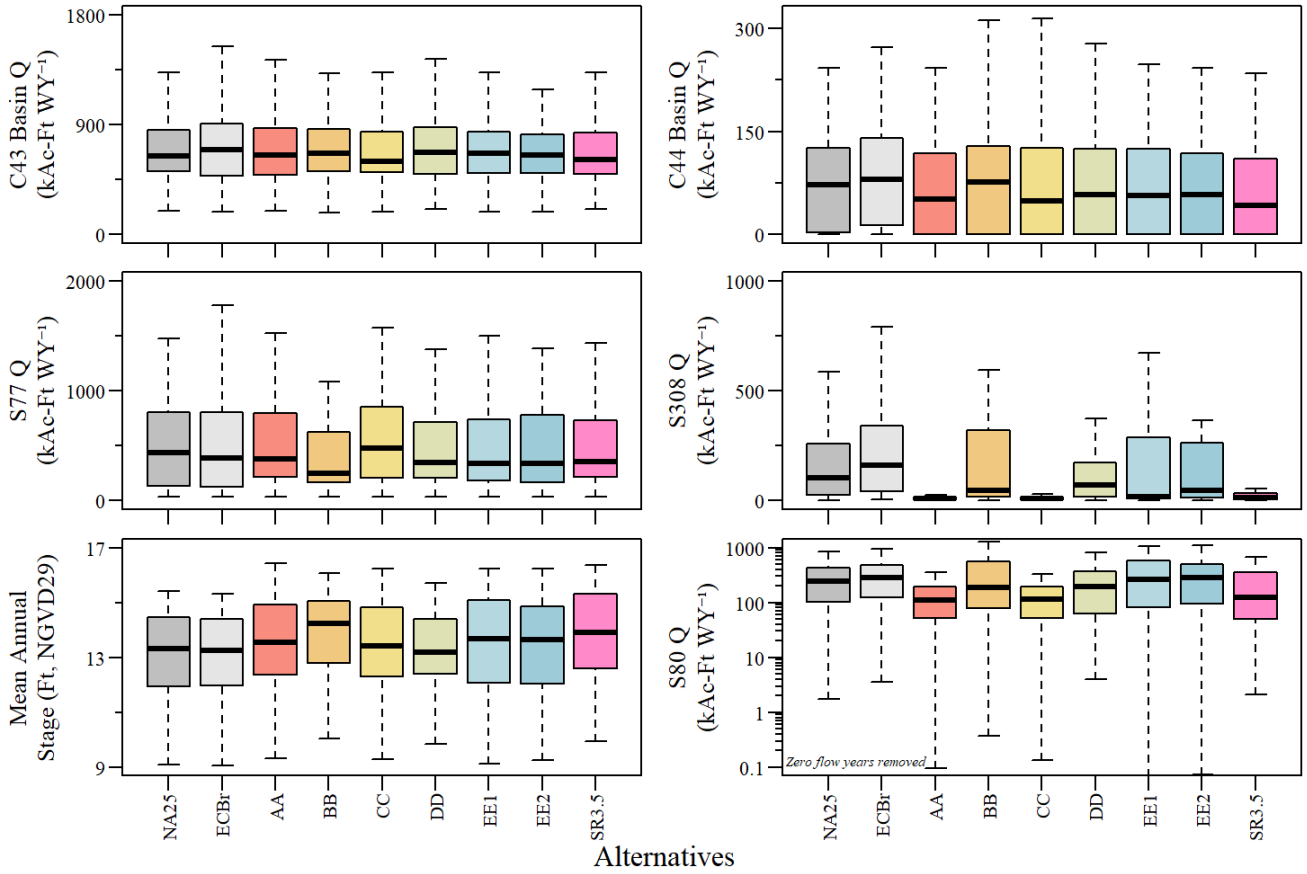
Caloosahatchee River Estuary (S79) Nutrient Load Model Output

Download CRE ENLM results

St Lucie River Estuary (S80) Nutrient Load Model Output

Download SLE ENLM results

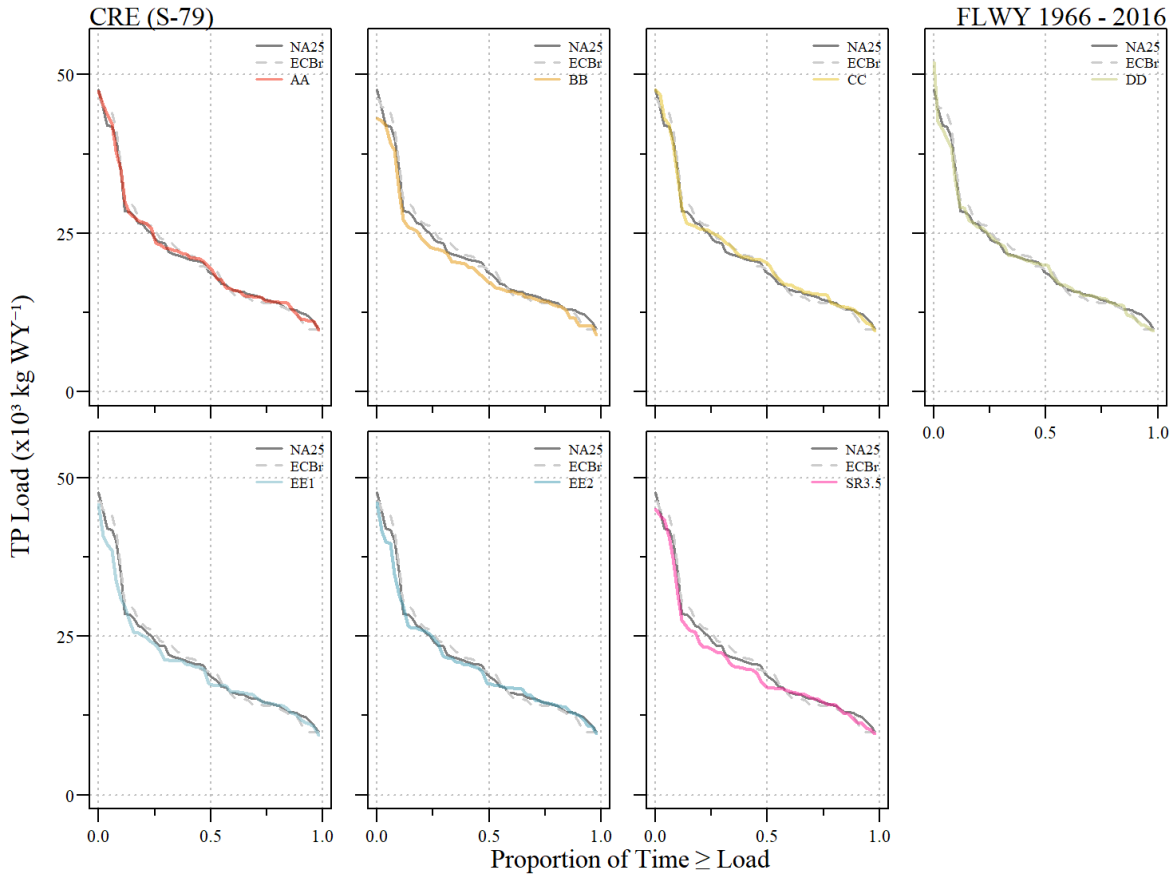
Hydrologic Data



Boxplot of annual total discharge and mean annual lake stage for Florida water years 1966 - 2016 (May 1965 - April 2016).

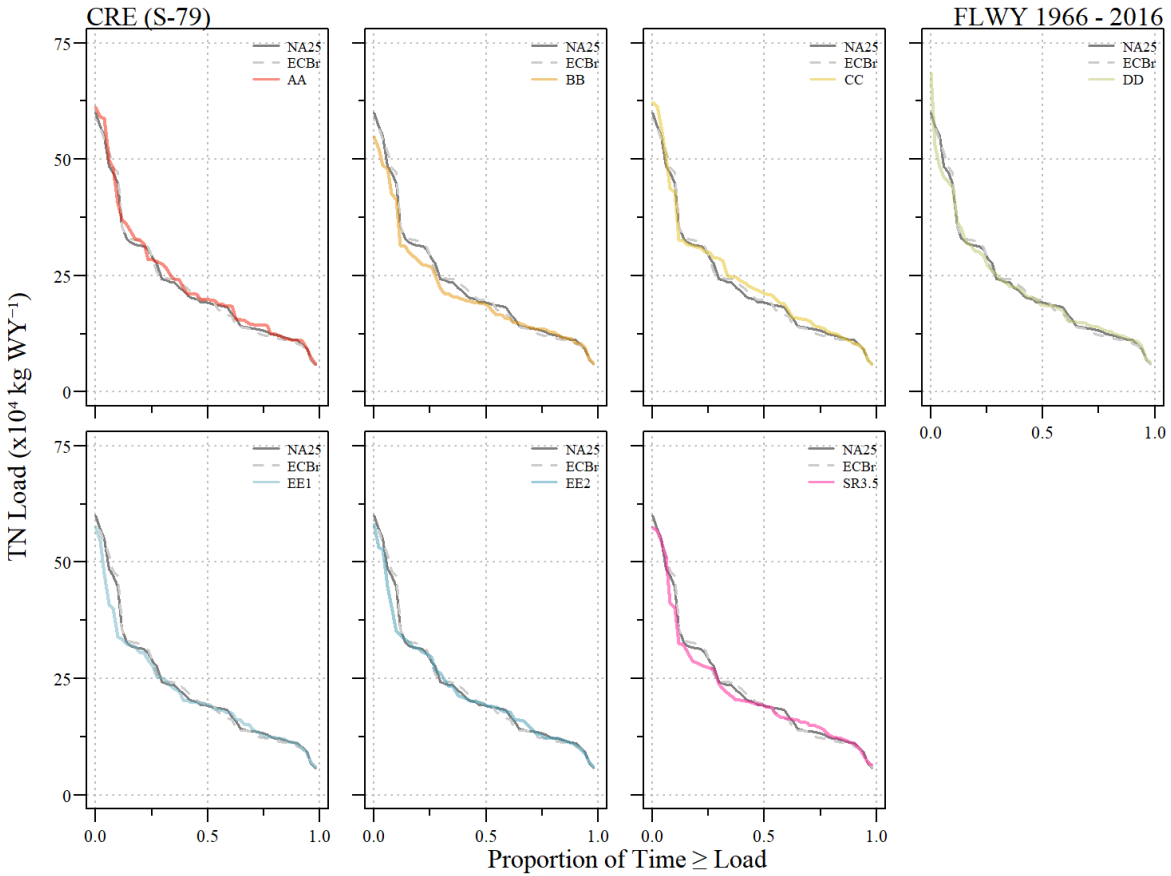
Caloosahatchee River Estuary

Total Phosphorus Load Duration Curve



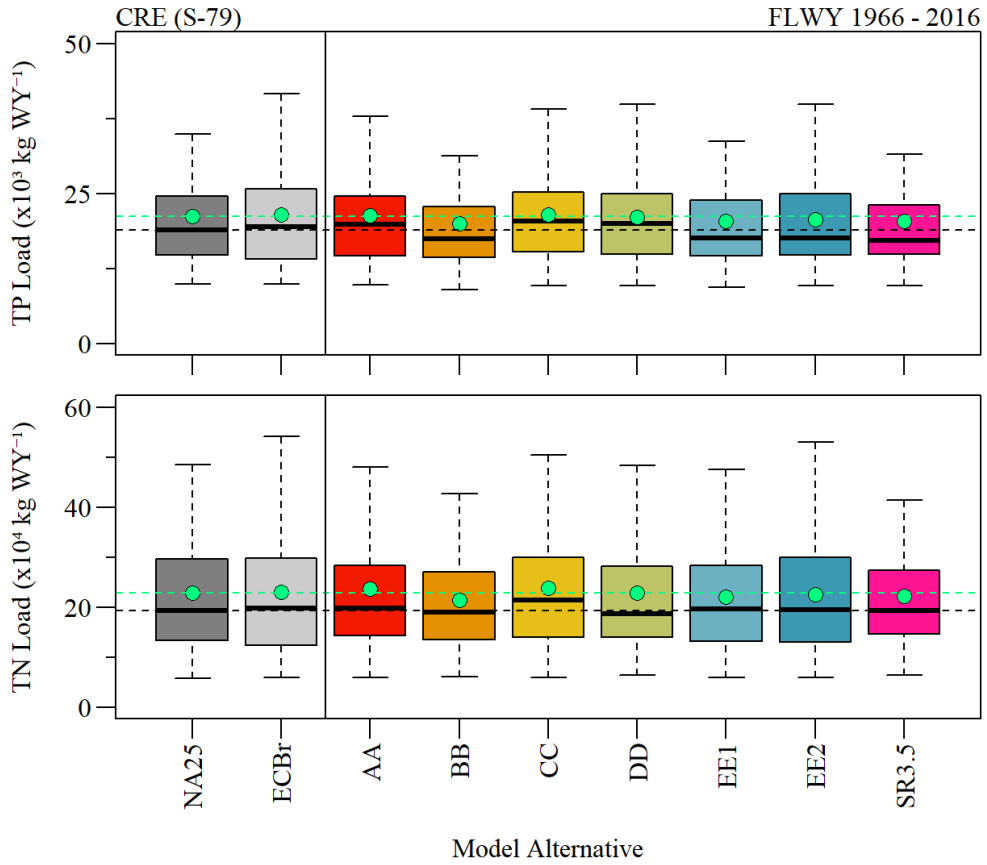
Cumulative distribution/load duration curve comparison of S-79 TP loads for each alternative relative to FWO (NA25) and ECB (ECBr).

Total Nitrogen Load Duration Curve



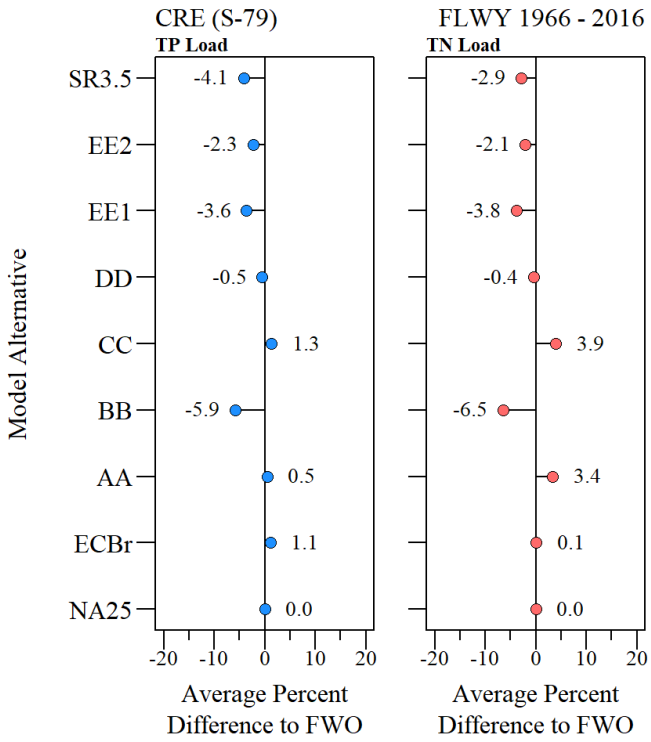
Cumulative distribution/load duration curve comparison of S-79 TN loads for each alternative relative to FWO (NA25) and ECB (ECBr).

S-79 Load



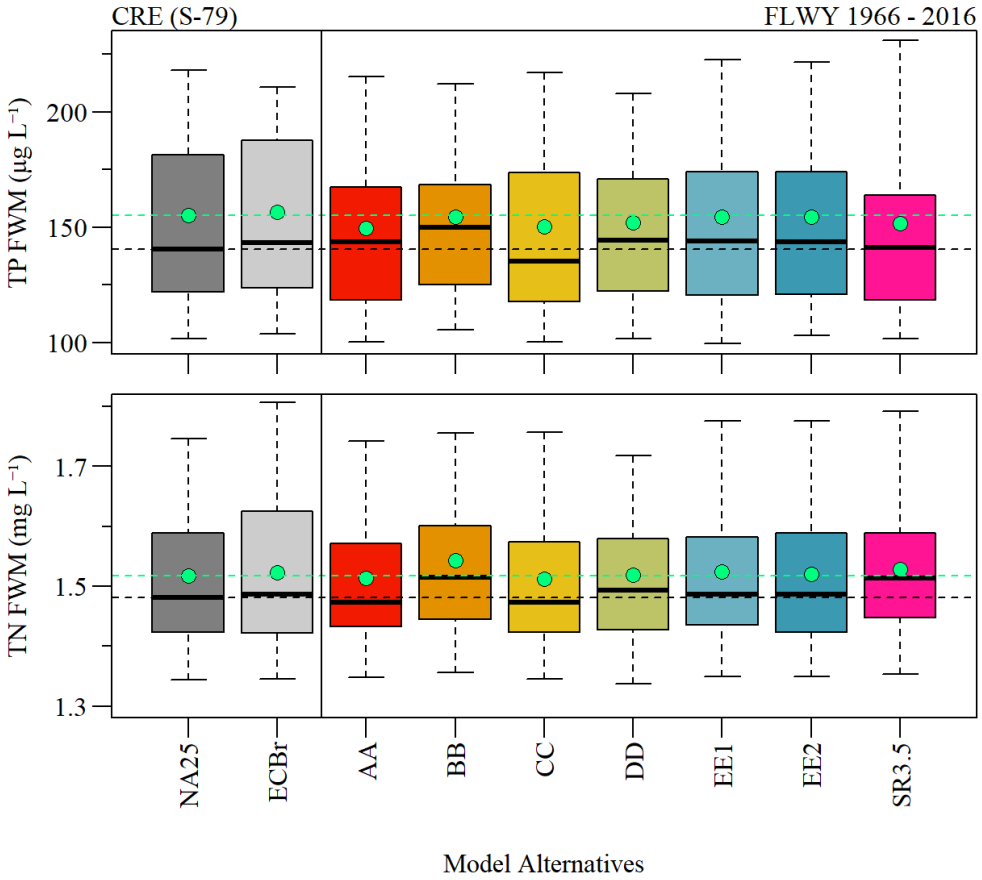
Boxplot representing annual TP (top) and TN (bottom) loads during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

S-79 Load Summary



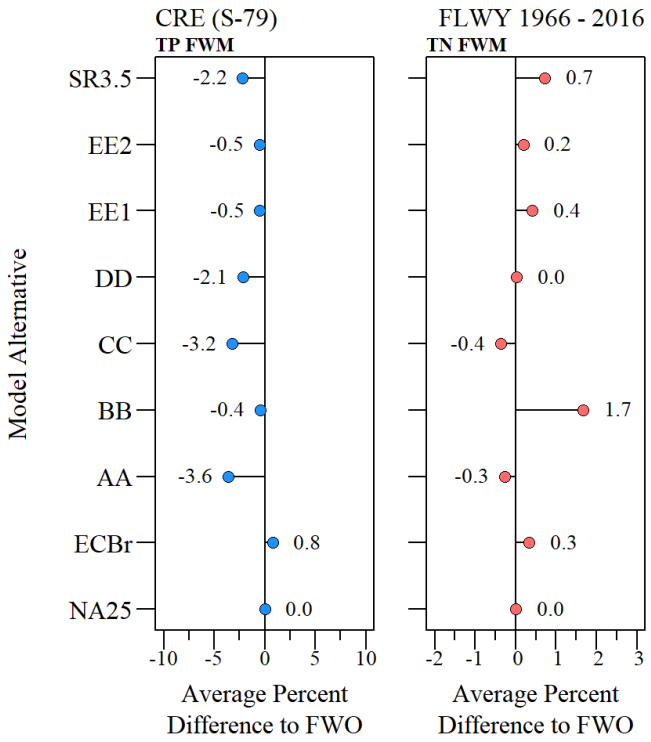
Percent difference of average load relative to the FWO (NA25) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

S-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 (NA25) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

CRE Nutrient Load/FWM MCDA

- Equal weight for TP and TN loads and FWM Concentrations

Alt	Mean TP Load (kg WY^{-1}) [1]	Mean TN Load (kg WY^{-1}) [1]	MCDA Score [2]	Rank [3]
NA25	212106	2292785	0.294	5
ECBr	214379	2294090	0.228	6
AA	213083	2370227	0.076	7
BB	199689	2144604	1.000	1
CC	214786	2382016	0.000	8
DD	211071	2284075	0.344	4
EE1	204478	2205691	0.718	2
EE2	207240	2245683	0.543	3
SR3.5	203348	2226177	---	---

[1]Period of Simulation mean.

[2]Data Normalized and equally weighted. SR3.5 Not included in MCDA analysis.

[3]When ties are present, the 'first' method was used (permutation with increasing values at each index set).

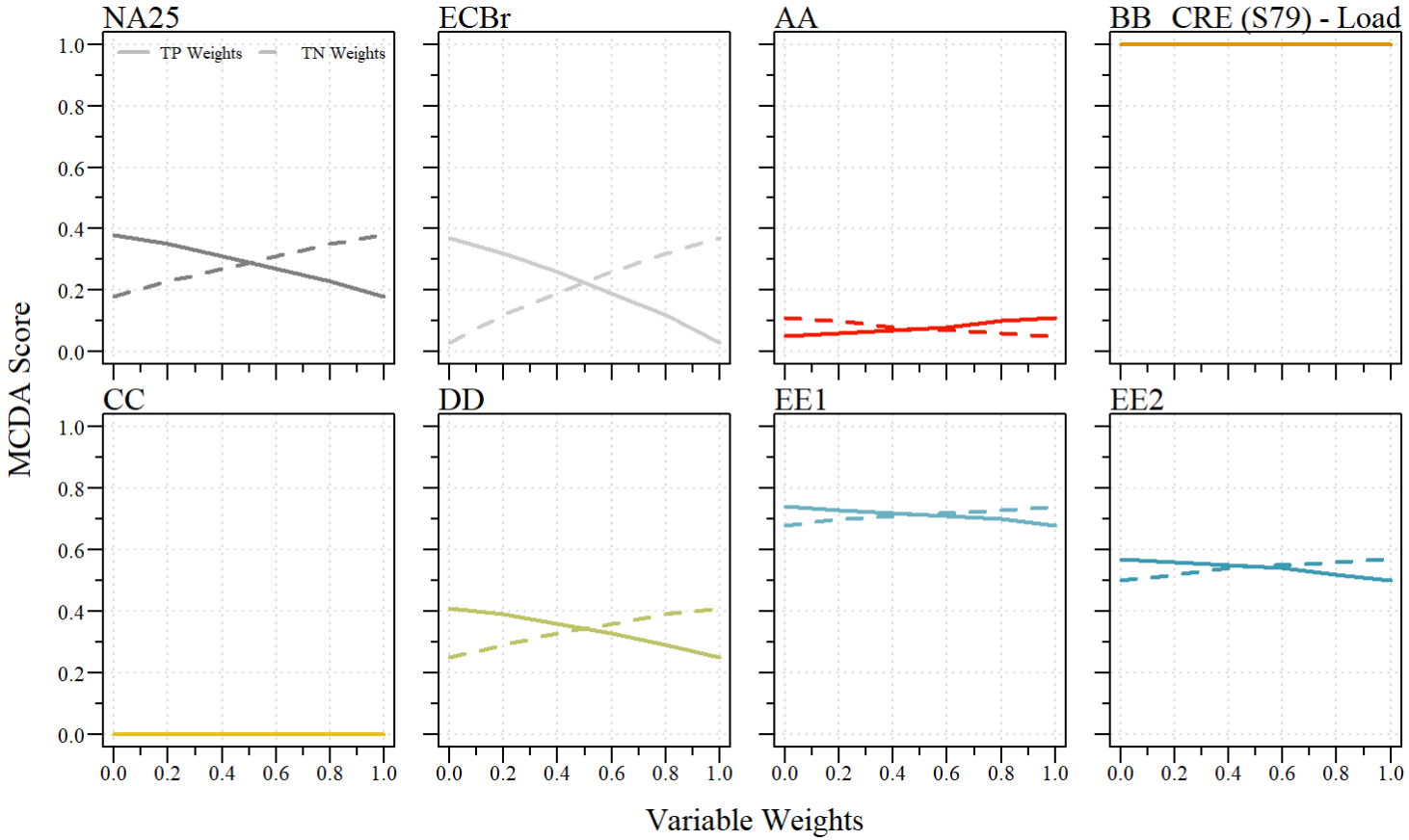
Alt	Mean TP FWM (µg L^{-1}) [1]	Mean TN FWM (mg L^{-1}) [1]	MCDA Score [2]	Rank [3]
NA25	155	1.52	0.335	6
ECBr	156	1.52	0.224	7
AA	150	1.51	1.000	1
BB	154	1.54	0.221	8
CC	150	1.51	1.000	2
DD	152	1.52	0.667	3
EE1	154	1.52	0.445	4
EE2	154	1.52	0.445	5
SR3.5	152	1.53	---	---

[1]Period of Simulation mean.

[2]Data Normalized and equally weighted. SR3.5 Not included in MCDA analysis.

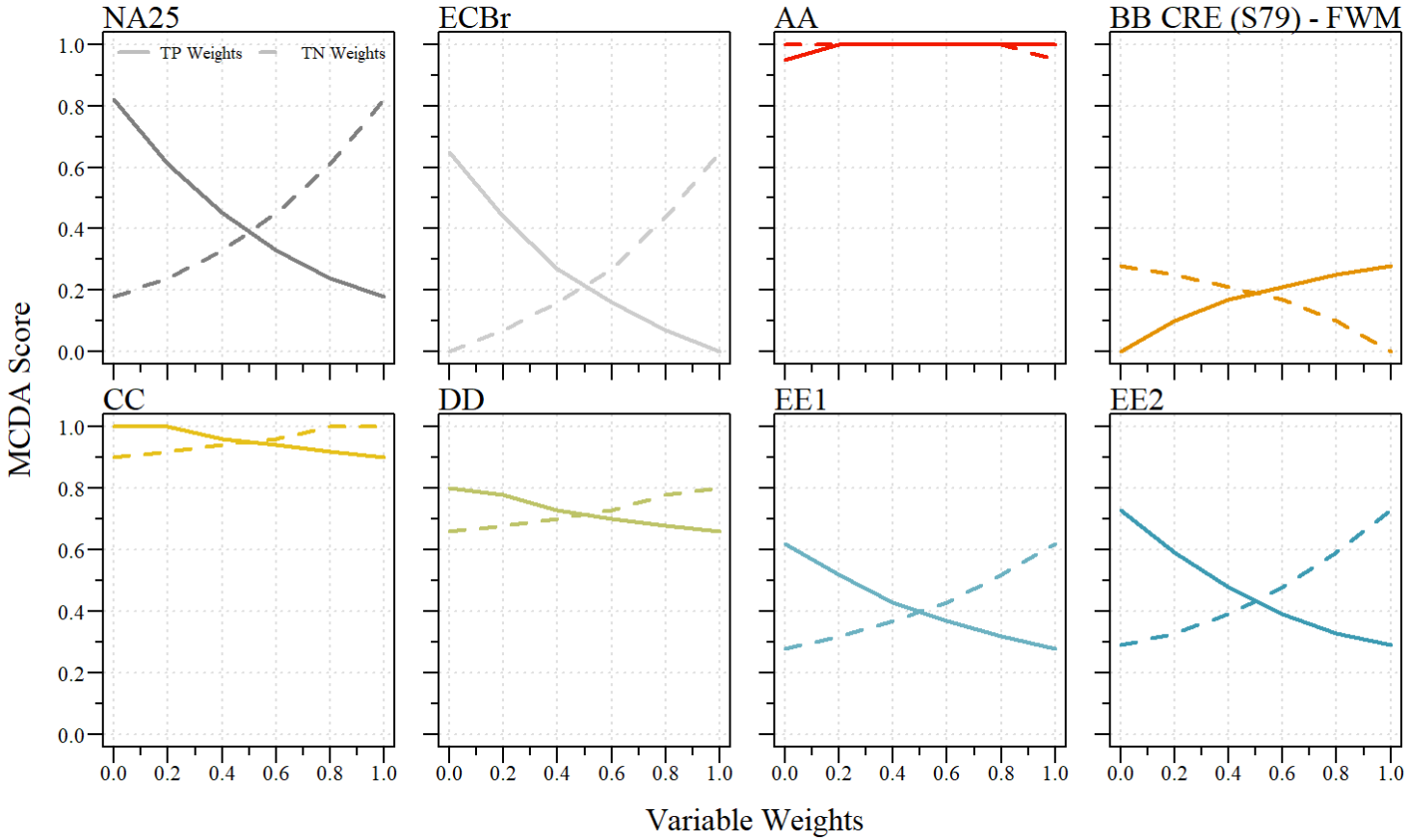
[3]When ties are present, the 'first' method was used (permutation with increasing values at each index set).

CRE Load MCDA Sensitivity



MCDA weighting sensitivity for S79 during the simulated period of record mean TP and TN loads for each alternative.

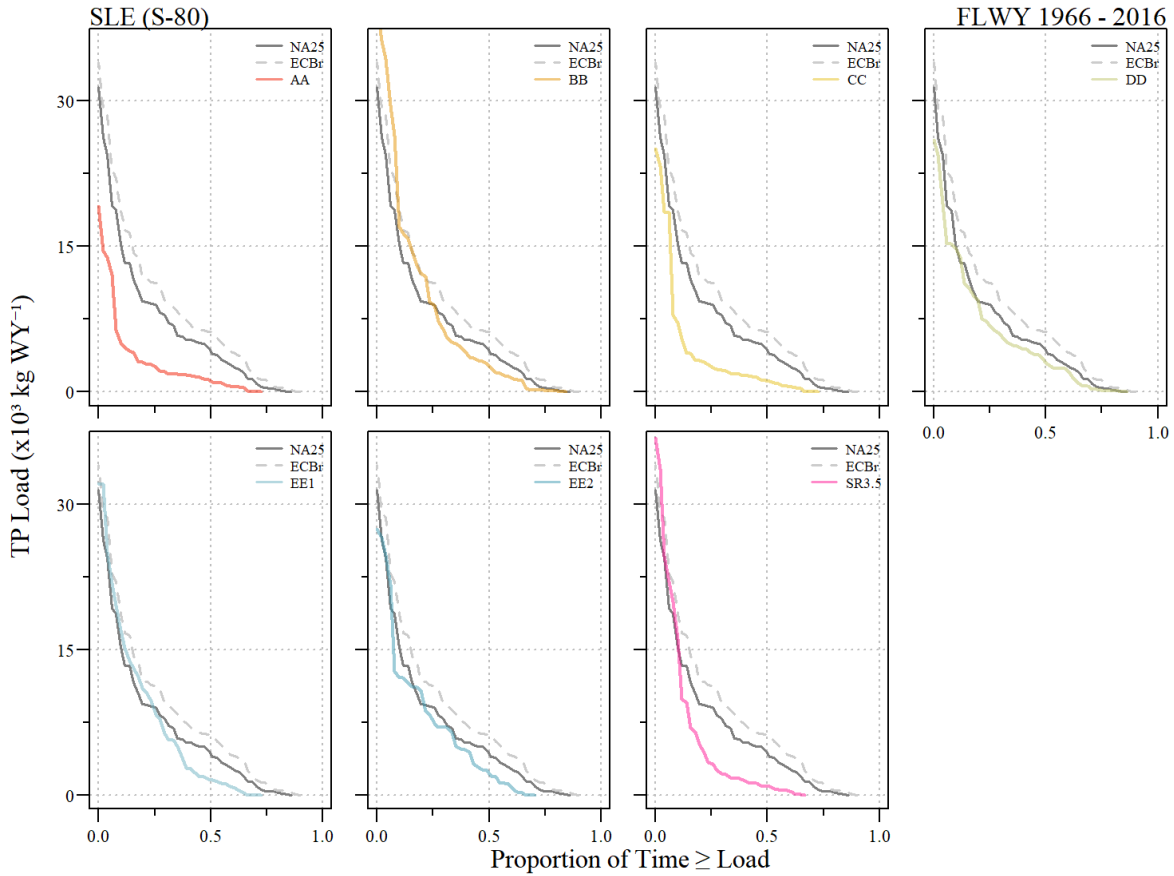
CRE FWM MCDA Sensitivity



MCDA weighting sensitivity for S79 during the simulated period of record mean TP and TN FWM for each alternative.

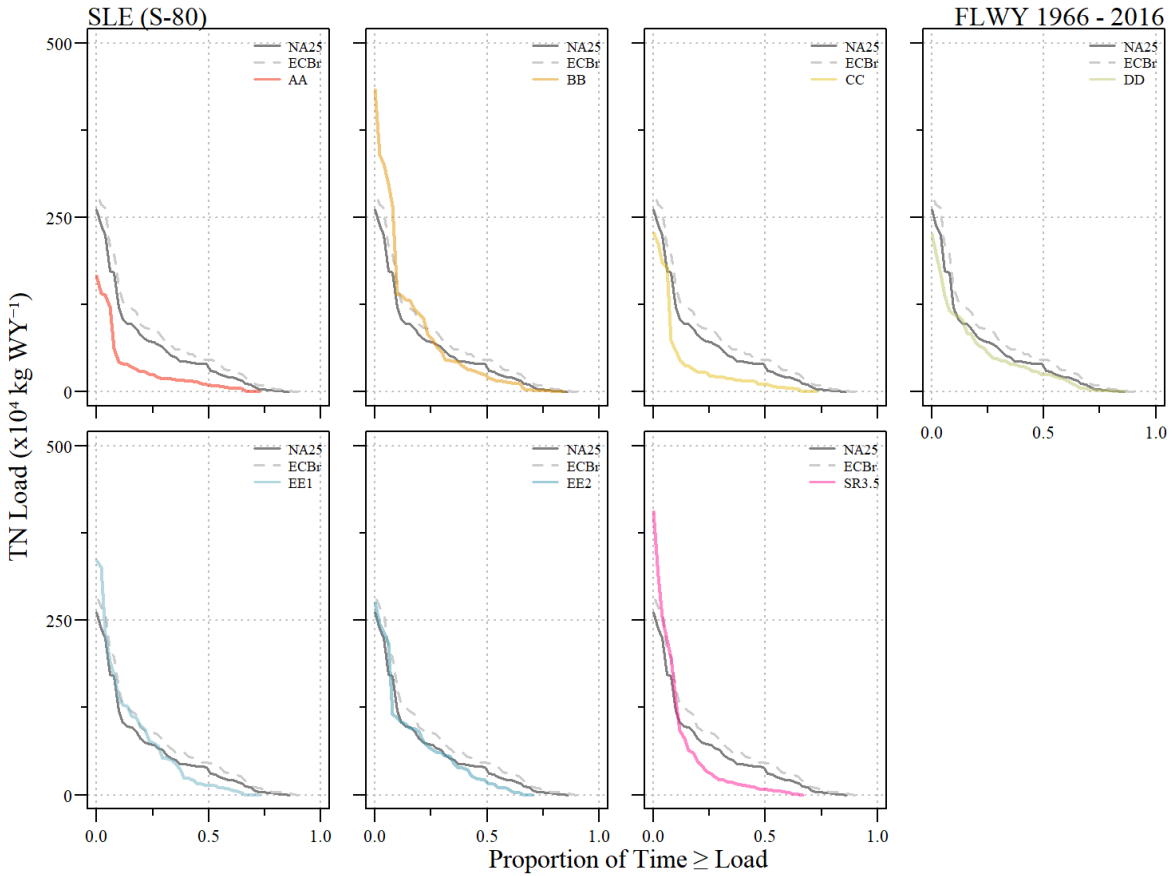
St Lucie River Estuary

Total Phosphorus Load Duration Curve



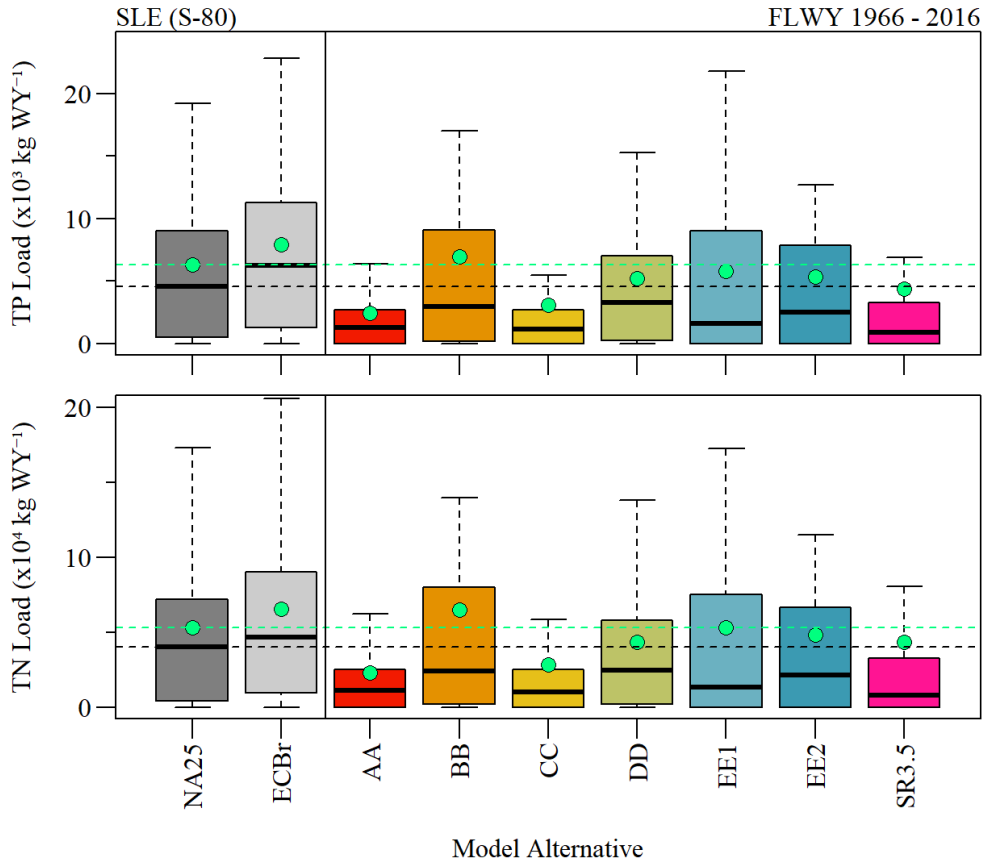
Cumulative distribution/load duration curve comparison of S-80 TP loads for each alternative relative to FWO and ECB.

Total Nitrogen Load Duration Curve



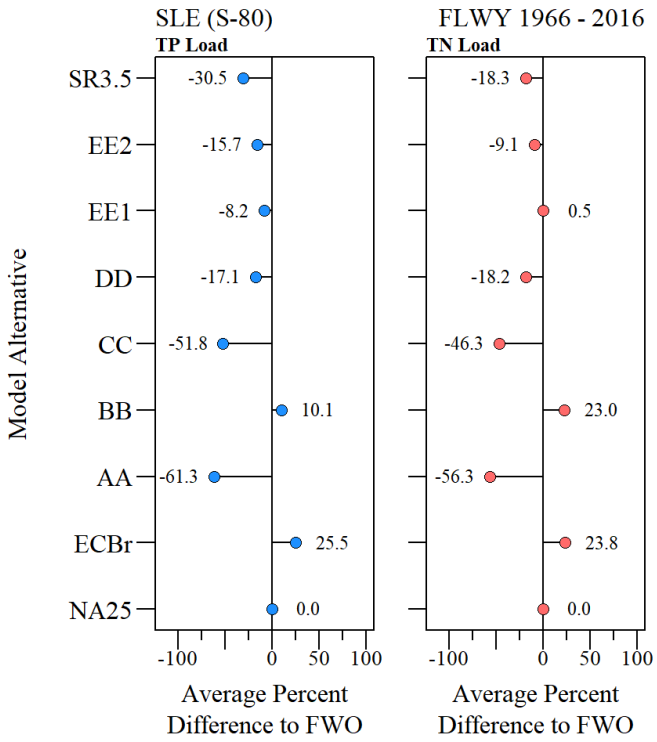
Cumulative distribution/load duration curve comparison of S-80 TN loads for each alternative relative to FWO (NA25) and ECB (ECBr).

S-80 Load



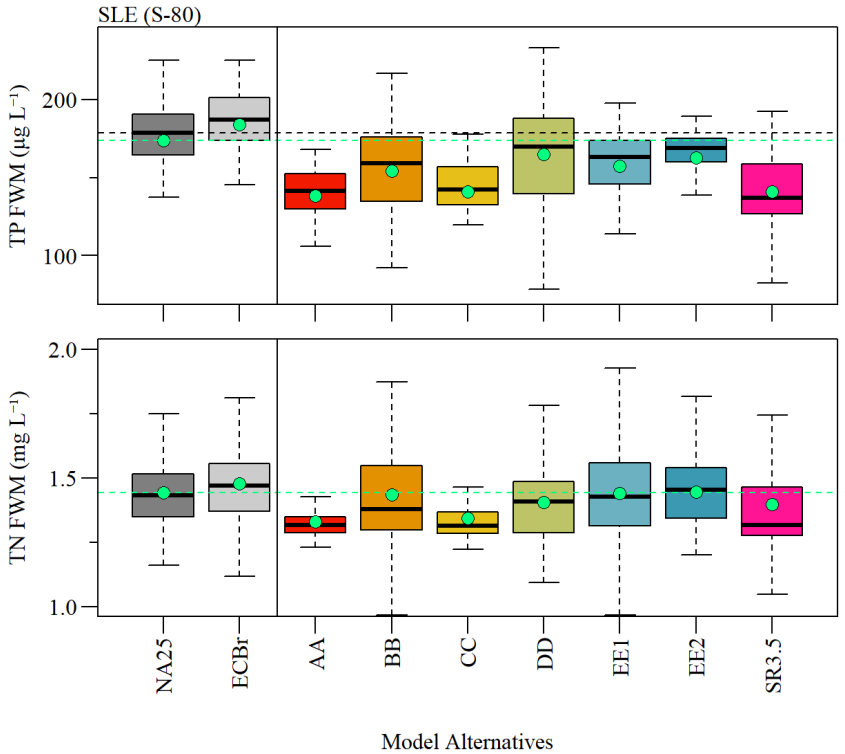
Boxplot representing annual TP (top) and TN (bottom) loads during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

S-80 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.

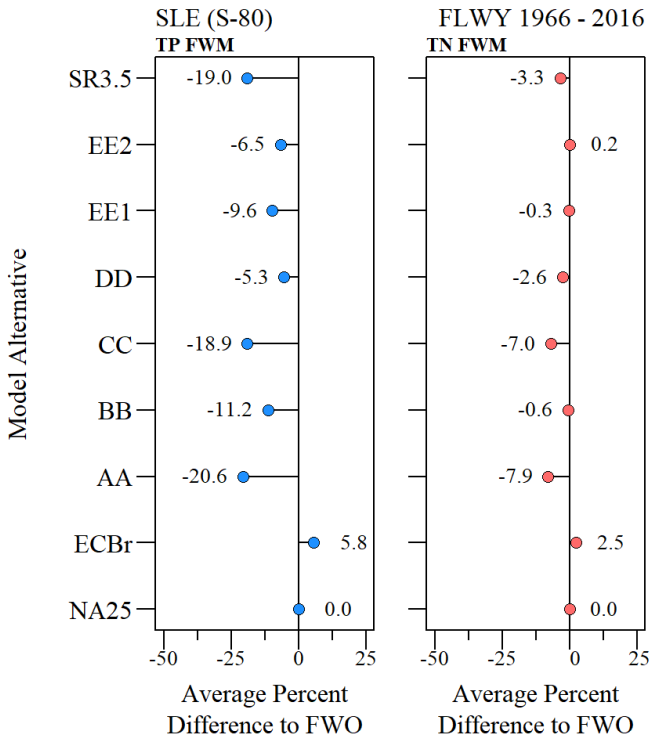
S-80 FWM Concentration



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 (NA25) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

SLE Nutrient Load/FWM MCDA

- Equal weight for TP and TN loads and FWM Concentrations

Alt	Mean TP Load (kg WY^{-1}) [1]	Mean TN Load (kg WY^{-1}) [1]	MCDA Score [2]	Rank [3]
NA25	63173	528214	0.296	6
ECBr	79312	653860	0.000	8
AA	24442	230803	1.000	1
BB	69541	649823	0.097	7
CC	30480	283537	0.883	2
DD	52351	432274	0.507	3
EE1	57977	530651	0.342	5
EE2	53284	480257	0.443	4
SR3.5	43911	431407	---	---

[1]Period of Simulation mean.

[2]Data Normalized and equally weighted. SR3.5 Not included in MCDA analysis.

[3]When ties are present, the 'first' method was used (permutation with increasing values at each index set).

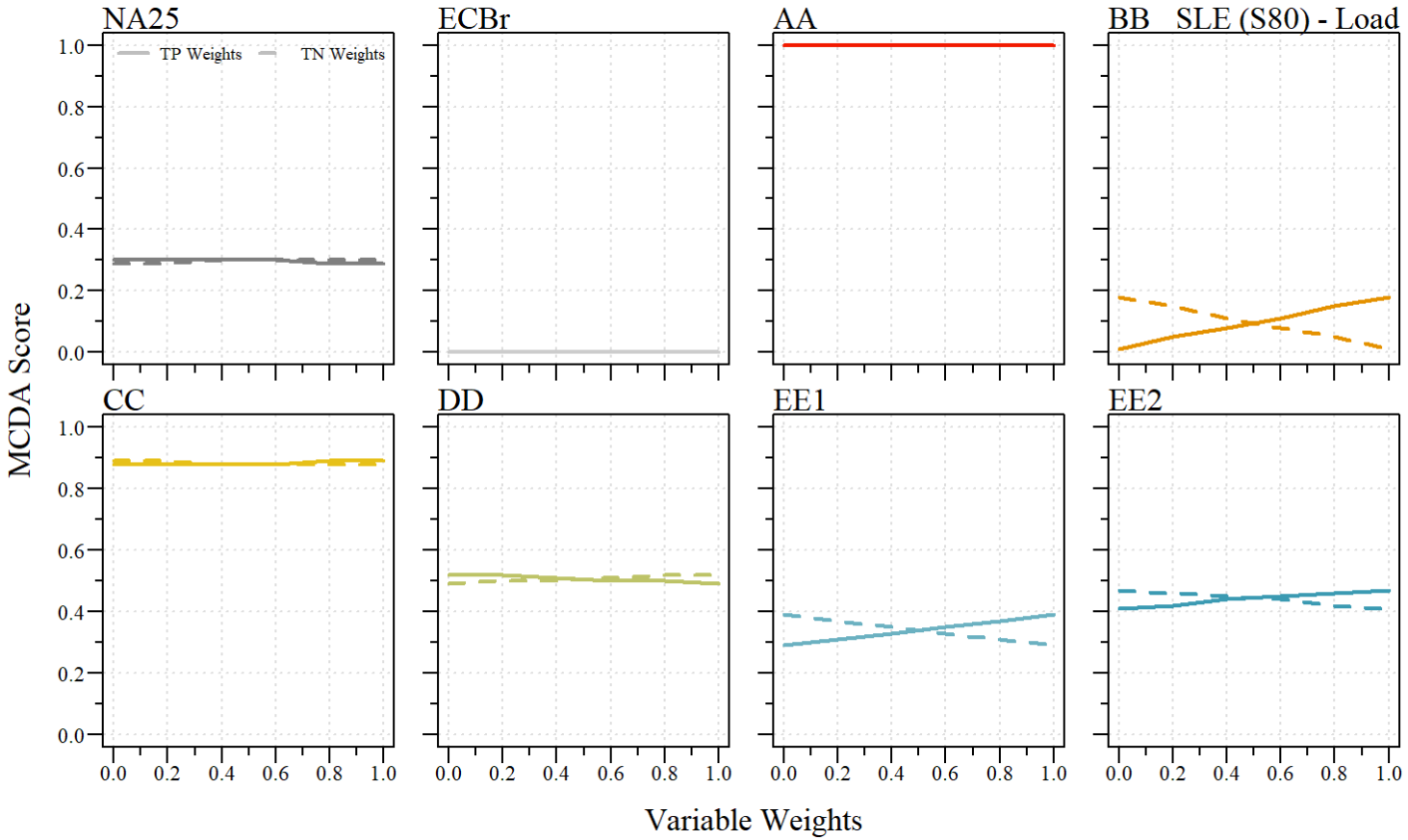
Alt	Mean TP FWM (µg L^{-1}) [1]	Mean TN FWM (mg L^{-1}) [1]	MCDA Score [2]	Rank [3]
NA25	174	1.44	0.232	7
ECBr	184	1.48	0.000	8
AA	138	1.33	1.000	1
BB	154	1.44	0.541	3
CC	141	1.34	0.934	2
DD	165	1.41	0.429	5
EE1	157	1.44	0.495	4
EE2	163	1.45	0.383	6
SR3.5	141	1.40	---	---

[1]Period of Simulation mean

[2]Data Normalized and equally weighted. SR3.5 Not included in MCDA analysis.

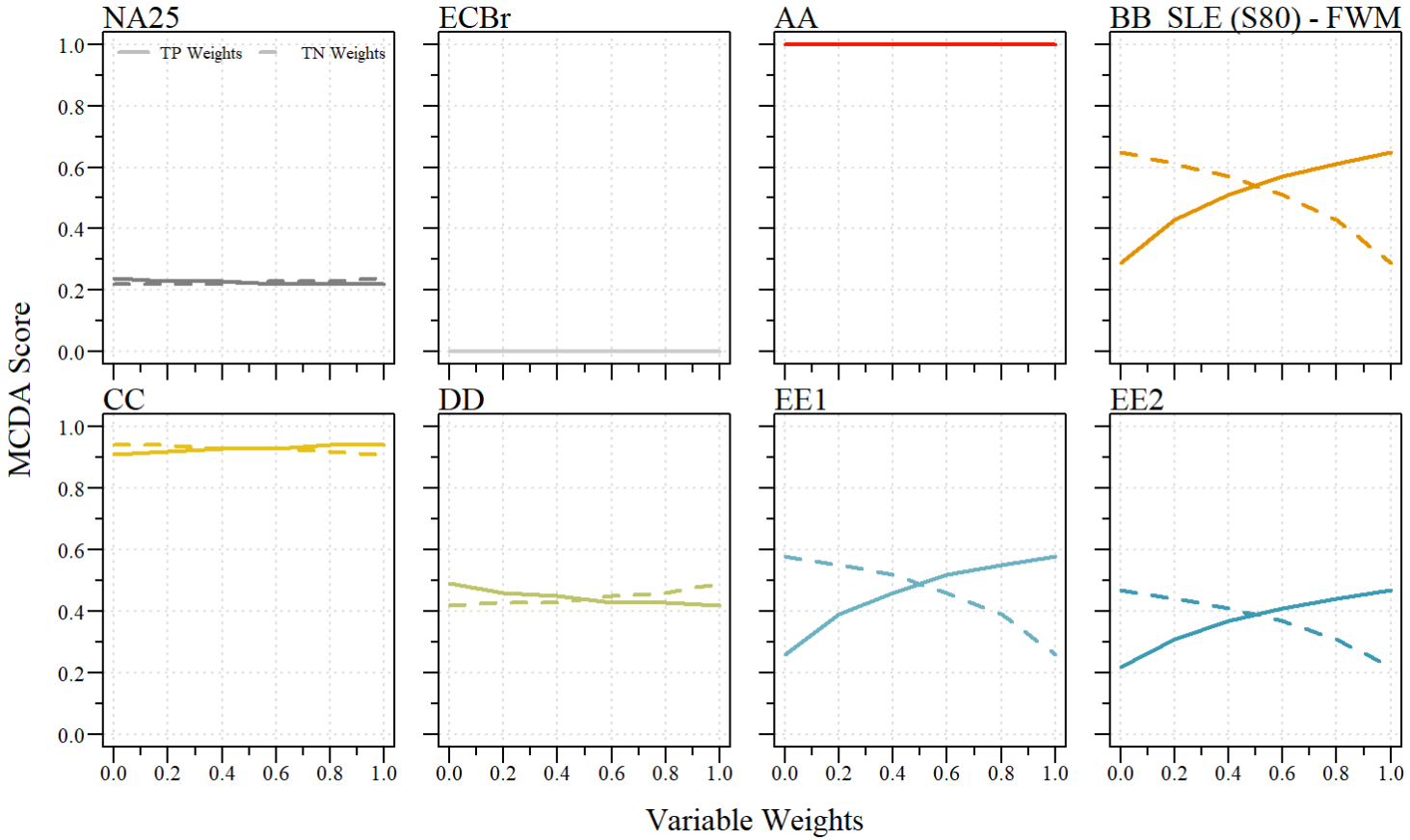
[3]When ties are present, the 'first' method was used (permutation with increasing values at each index set)

SLE Load MCDA Sensitivity



MCDA weighting sensitivity for S80 during the simulated period of record mean TP and TN loads for each alternative.

SLE FWM MCDA Sensitivity



MCDA weighting sensitivity for S80 during the simulated period of record mean TP and TN FWM for each alternative.

Summary

	CRE	SLE
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)
	MCDA Top 3: BB, EE1 and EE2	MCDA Top 3: AA, CC and DD
FWM	BB higher relative to FWO	All plans are lower relative to FWO
	CC & AA lower relative to FWO	AA CC the lowest
	MCDA Top 3: AA & CC (tied), DD	MCDA Top 3: AA, CC and BB

SR3.5 not included in this summary table

Acknowledgments

South Florida Water Management District (DBHYDRO)

US Army Corps of Engineers (USACE LOSOM)

- Interagency Modeling Center

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Analysis Script

SCCF

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