Lake Okeechobee System Operating Manual

Iteration 2 Modeling -
Evaluation Technical workshop

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.

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

[2] No action Condition 2025 (replaces LSM25B)

Refinements (from Modeling Subteam)

- Improved eastern RSMBN domain (Grassy Waters and ITID)
- Refine C-44 basin and reservoir modeling to maintain reservoir benefits to C-44 basin
- Updated water supply for STOF Brighton Reservation

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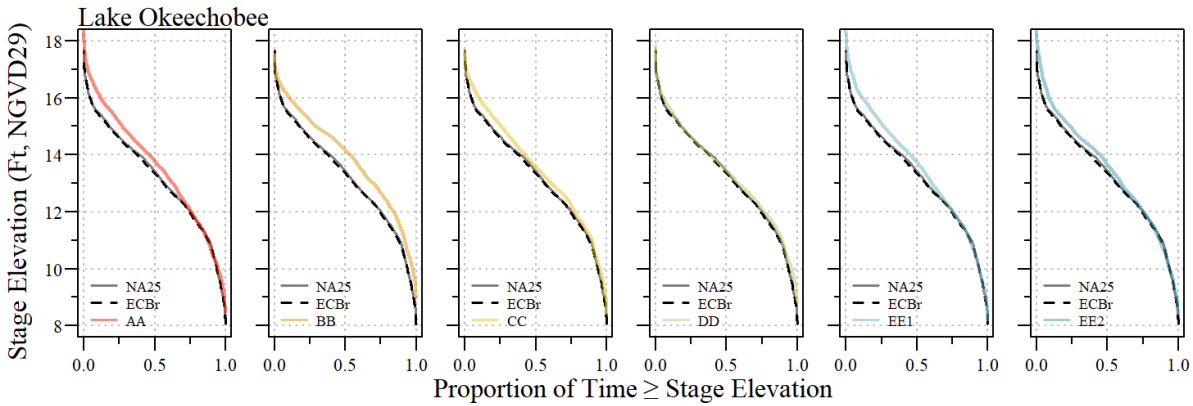
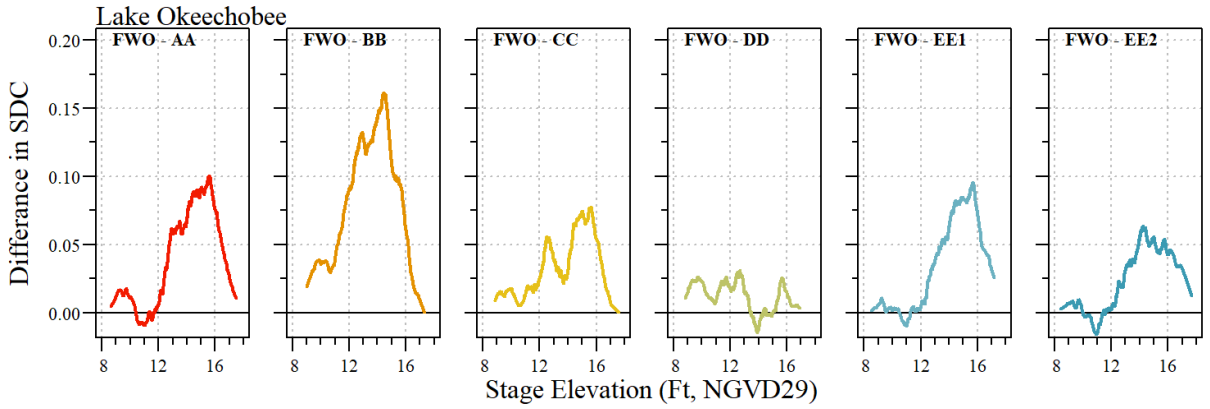
Lake Stage Duration Curves

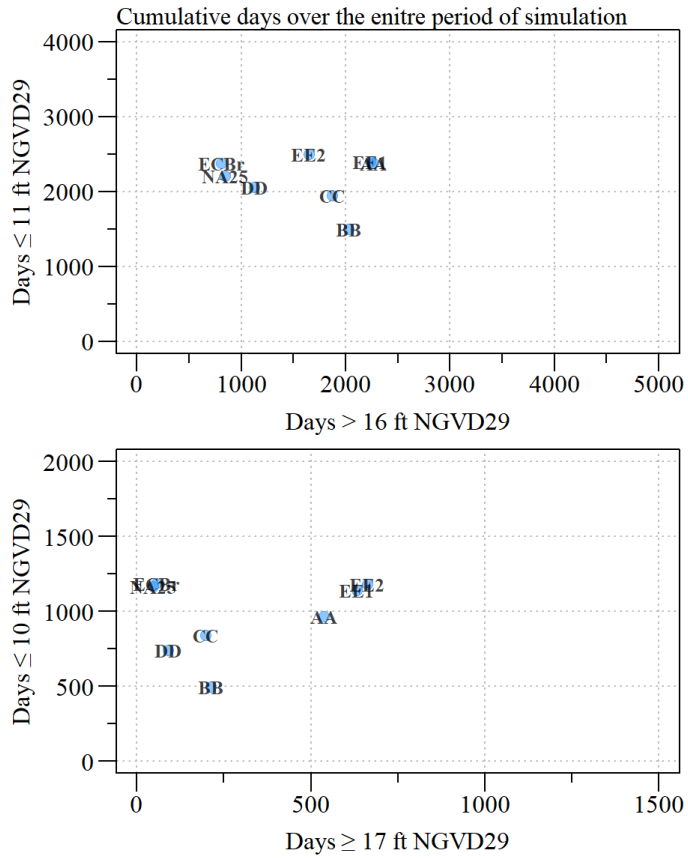


Stage duration curves for the entire period of simulation (Jan 1, 1965 - Dec 31, 2016) for each alternative compared to FWO (NA25) and ECB (ECBr).



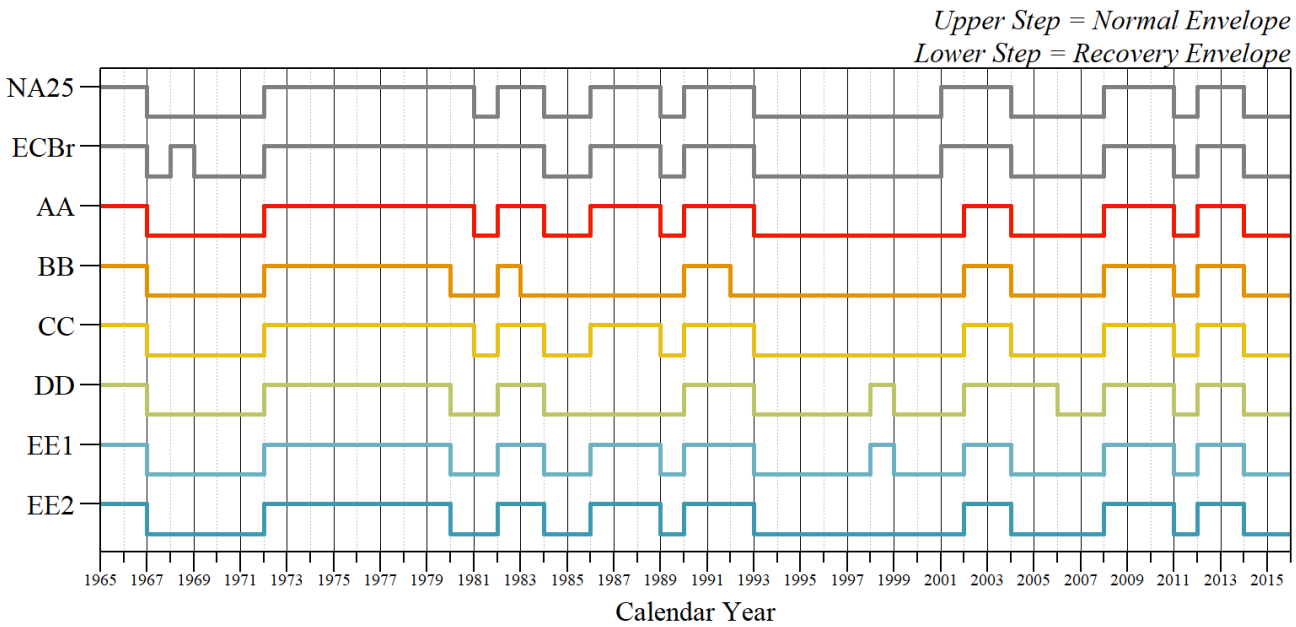
Difference in stage duration curves (SDC) for the entire period of simulation (Jan 1, 1965 - Dec 31, 2016) for each alternative compared to FWO (NA25).

High/Low Stages



Total number of days during the simulation period where (Top) stage elevations were ≤ 11 or > 16 Ft NGVD29 and (Bottom) ≤ 10 or ≥ 17 Ft NGVD29.

Normal/Recovery Envelope



Transition between normal and recovery stage envelopes for each alternative during the entire simulation period.

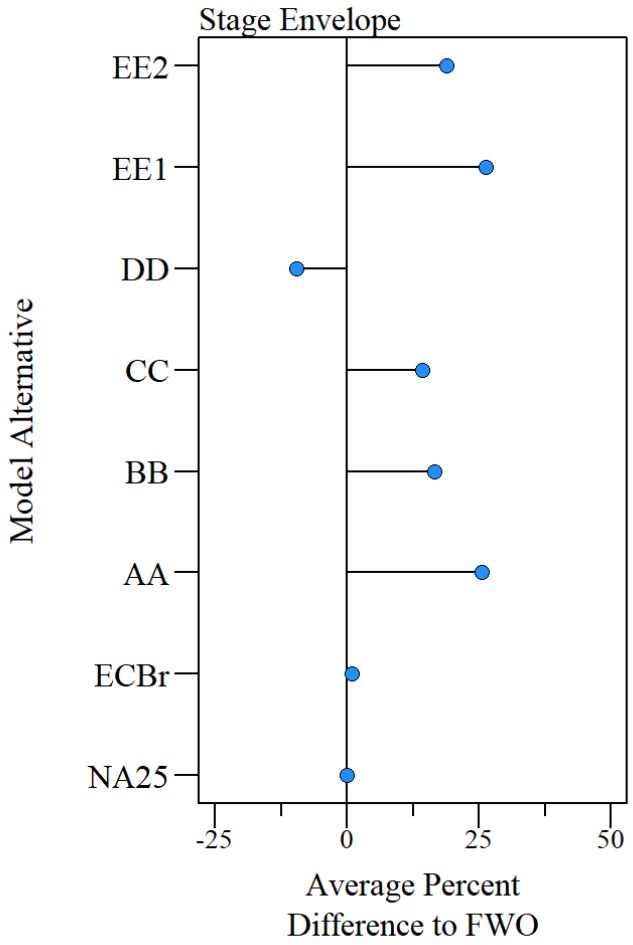
Shift from normal to recovery:

- Stages >17 Ft any time of the year *or*
- Stage in the June1 – July31 window is ≤ 13.0 ft for < 30 days

Shift from recovery to normal:

- Stage ≤16.0 ft from Aug1 – Dec31 *and*
- Stage during May1 - Aug1 falls below 11.5 Ft for 60 or more days *or*
- Stage during Apr15 - Sep15 falls below 12.0 Ft for 90 or more days

Lake Envelope Score Summary

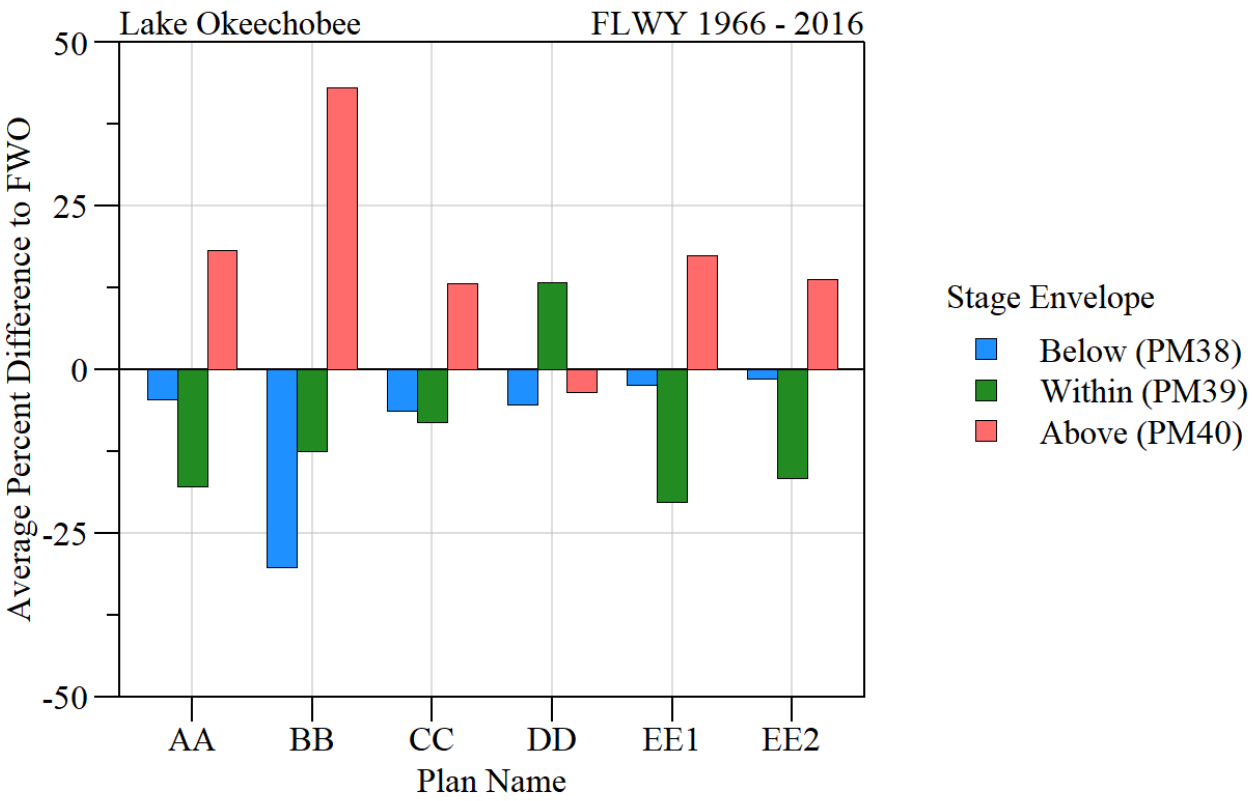


Percent difference of average annual score relative to the FWO (NA25) alternative over the entire simulation period (FLWY 1966-2016).

- On average, stage enevelope score for alt **DD** is 9.6% lower than FWO.
- On average, stage enevelope score for alt **EE1** is 26.4% higher than FWO.

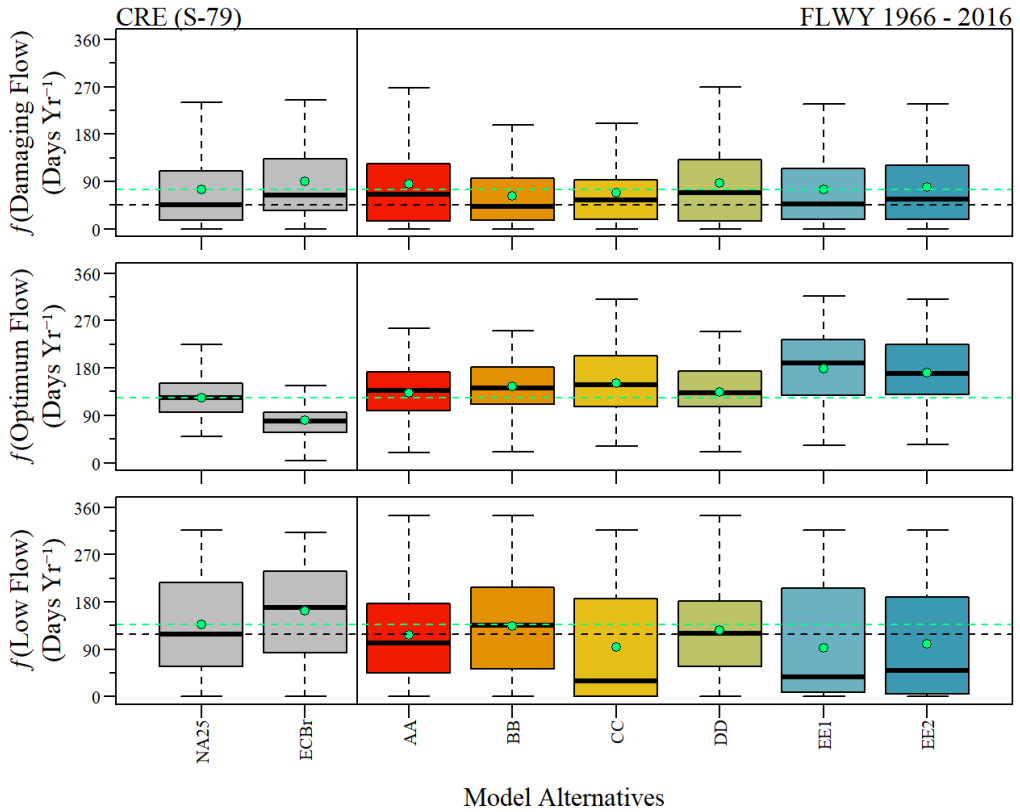
Alternative	Mean Score	% Diff. to FWO
AA	740	25.5
BB	687	16.5
CC	674	14.3
DD	533	-9.6
EE1	745	26.4
EE2	701	18.9

Lake Okeechobee Stage Envelope



Average percent difference of relative to the FWO (NA25) alternative over the entire simulation period (FLWY 1966-2016) comparing percent below, within and above the Lake stage envelope (including transitions between normal and recovery).

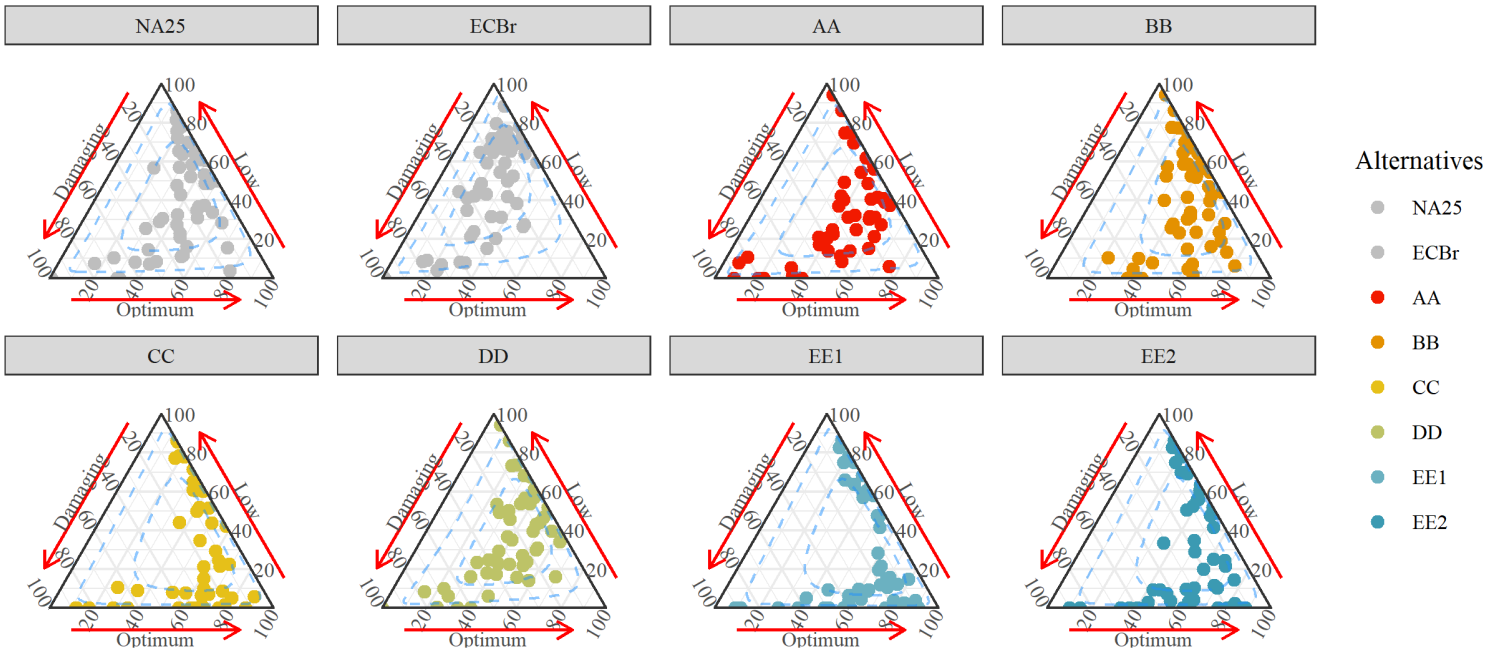
CRE Flow Categories



Boxplot representing the frequency of low (<750 cfs), optimum (2100 - 2600 cfs) and damaging (>2600 cfs) flow events during the simulation period across alternatives. Dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

Frequency of RECOVER Flow catergories (CRE)

FLWY 1966 - 2016



Frequency of optimum, damaging and low flow events for the CRE during the simulation period of record (FLWY 1966 - 2016). Each point represents a seperate water year, 95% and 50% confidence intervals identified by blue dashed lines

- The data is normalized to show variables relative to one another.

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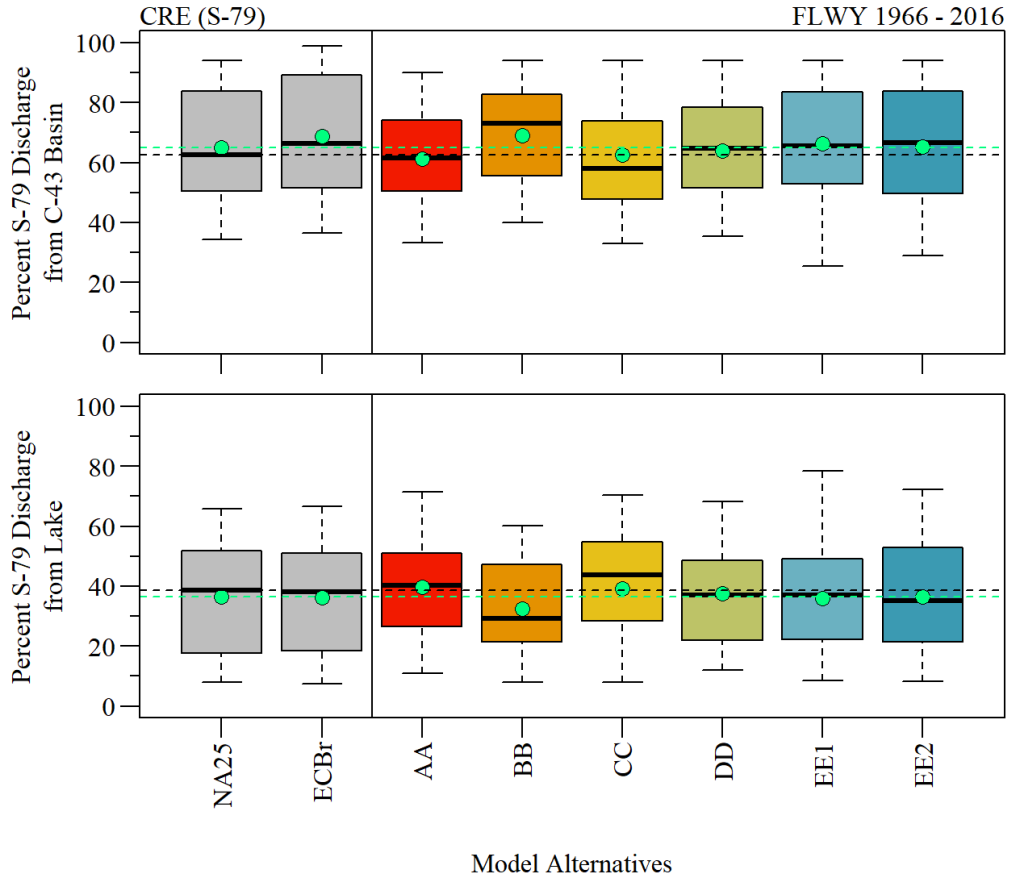
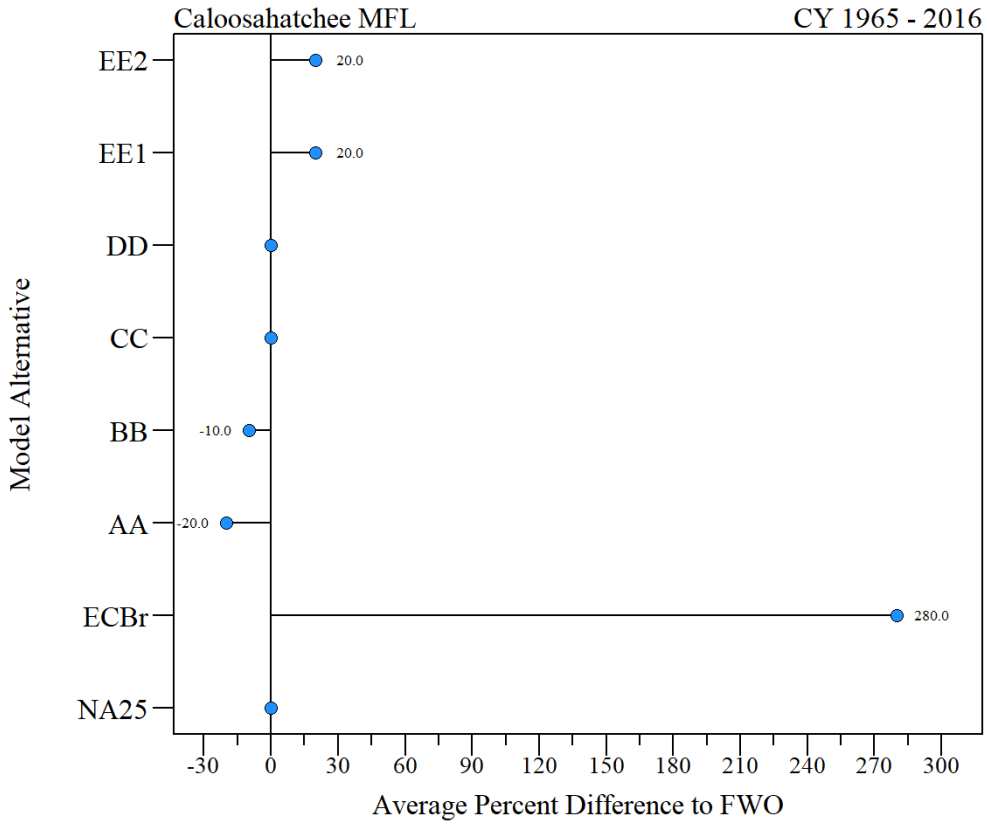
Source of Discharges



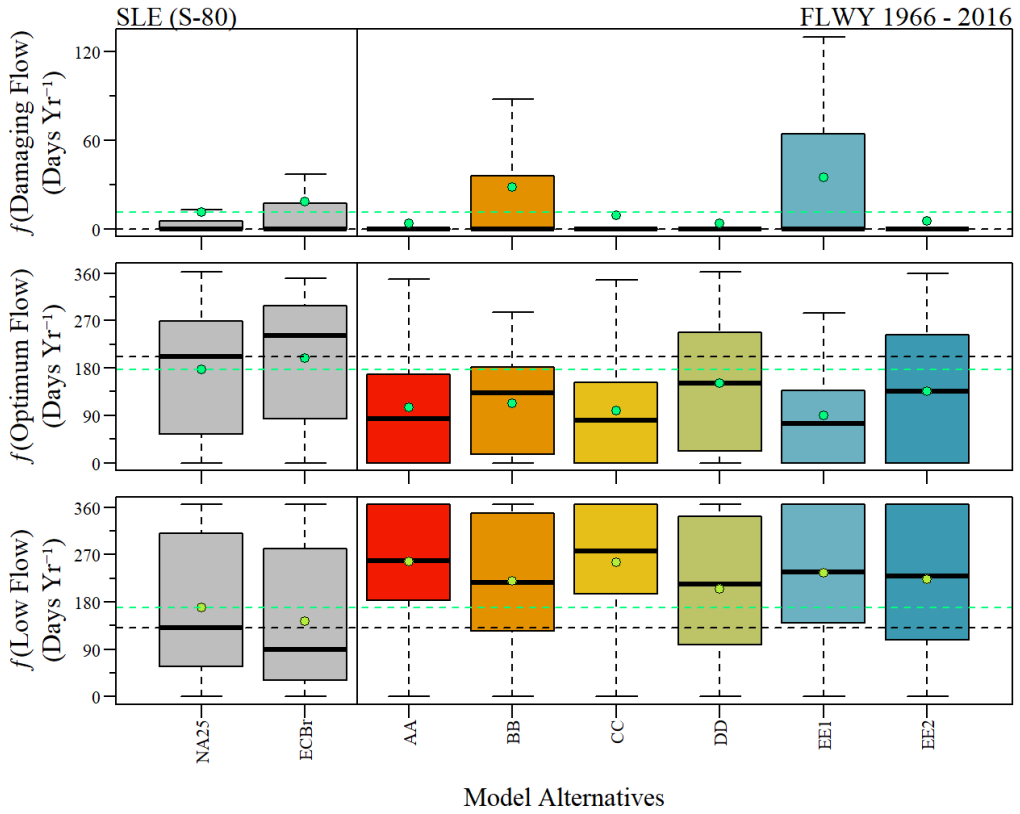
Boxplot representing the percent of S-79 discharges originating from the C-43 Basin (top) and Lake Okeechobee (bottom). Dashed line represents the FWO median and green point in boxplot indicates period of simulation mean.

Caloosahatchee MFL

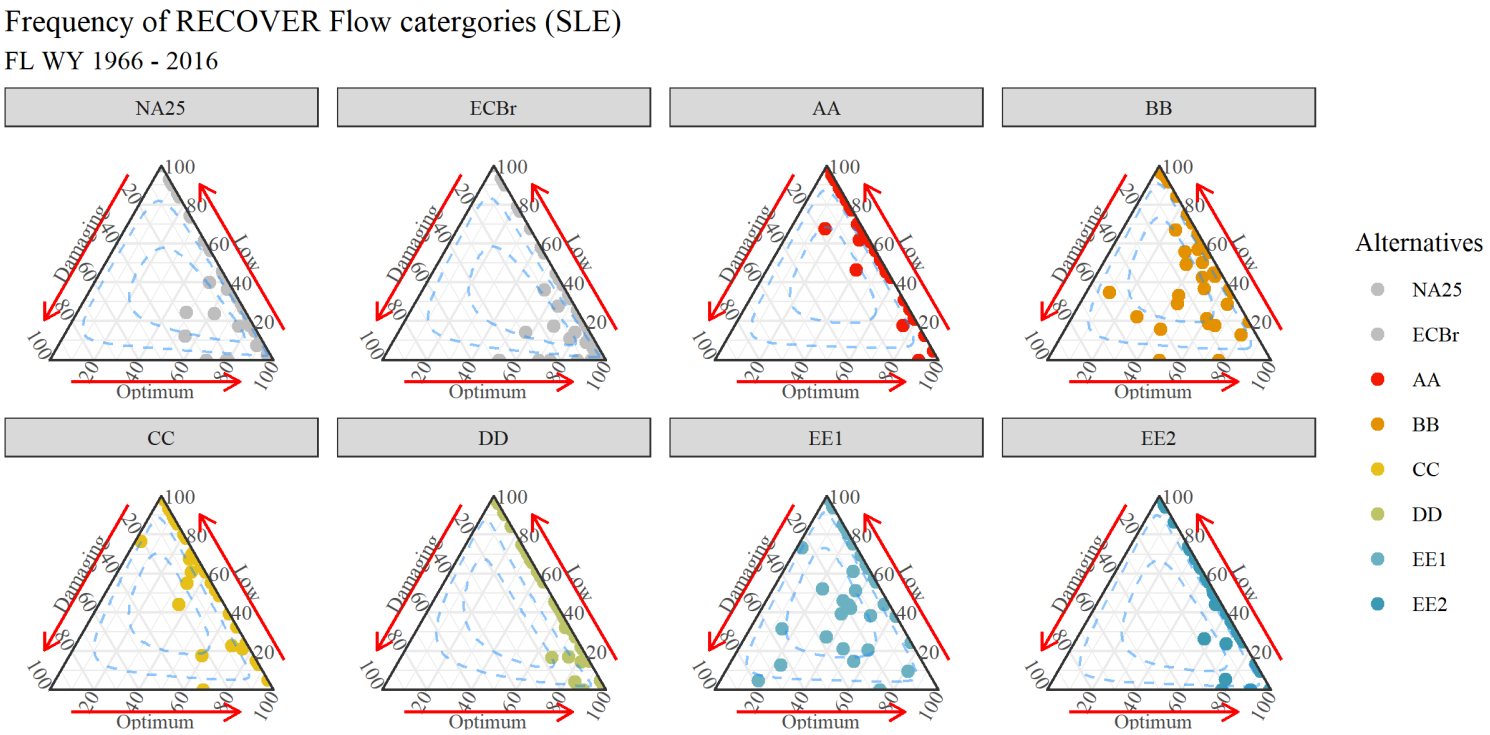


Average percent difference of MFL exceedances compared to FWO (NA25) during the simulation period of record (Jan 1, 1965 - Dec 31, 2016).

SLE Flow Categories

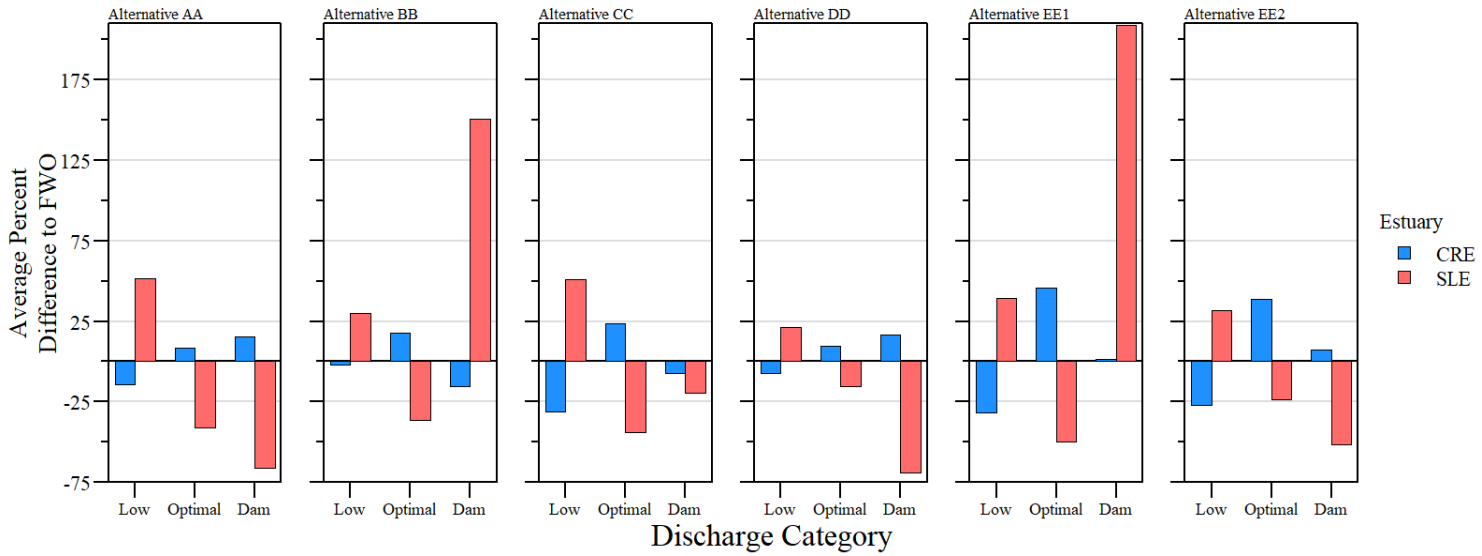


Boxplot representing the frequency of low (<150 cfs), optimum (1400 - 1700 cfs) and damaging (>1700 cfs) flow events during the simulation period across alternatives. Dashed line represents the FWO median and green point in boxplot indicates period of simulation mean.



Frequency of optimum, damaging and low flow events for the SLE during the simulation period of record (FLWY 1966 - 2016). Each point represents a seperate water year, 95% and 50% confidence intervals identified by blue dashed lines

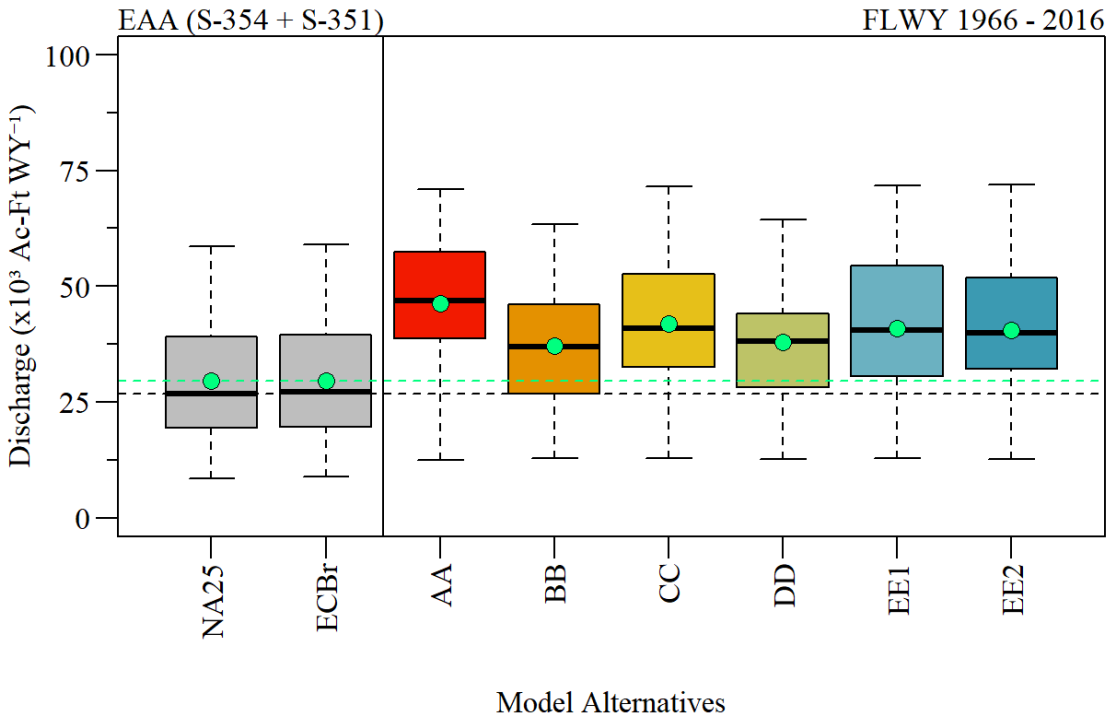
FWO Discharge Comparison



Average percent difference from FWO (NA25) for low, optimal and damaging discharges for Caloosahatchee River Estuary and St Lucie Estuary (CRE and SLE, respectively).

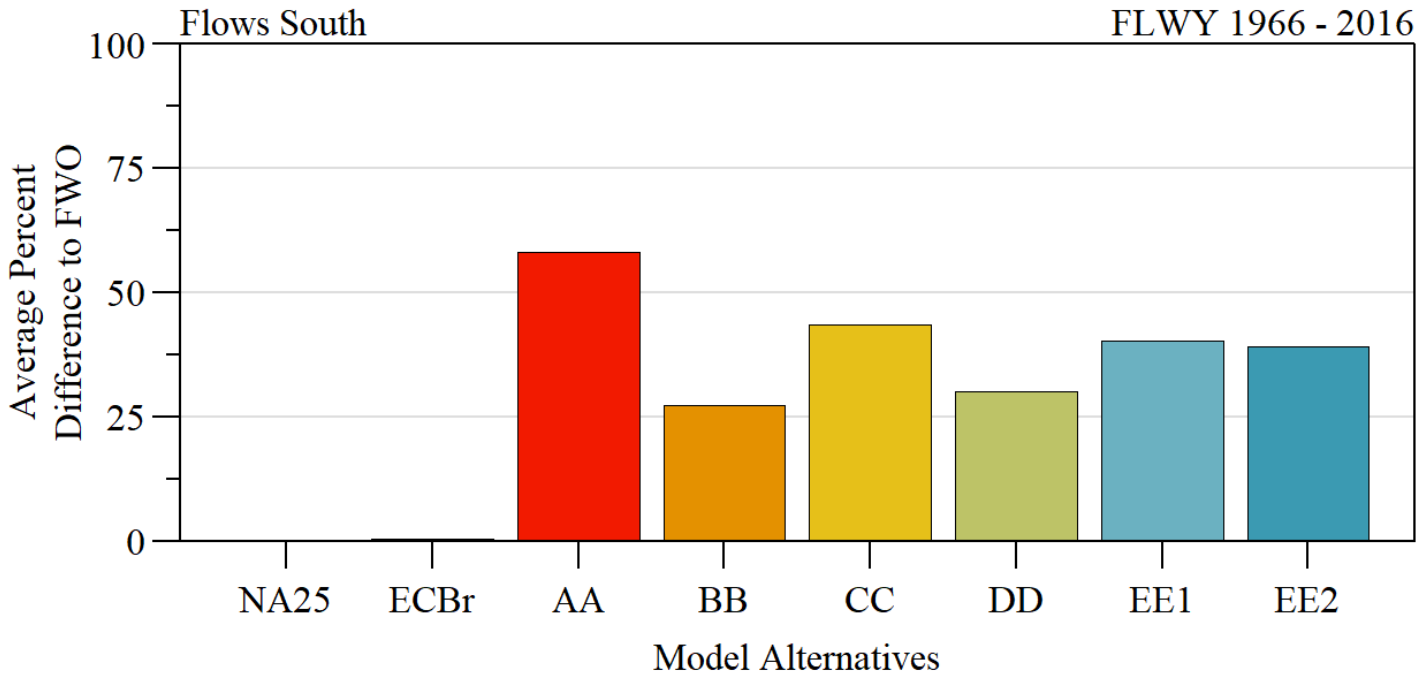
- Compared annual average number of events over the FLWY 1966 - 2016 simulation period

EAA (S-354 + S-351)



Boxplot representing the annual discharge volume from Lake Okeechobee to the EAA via S-354 and S-351 during the simulation period across alternatives. Dashed line represents the FWO median and green point in boxplot indicates period of simulation mean.

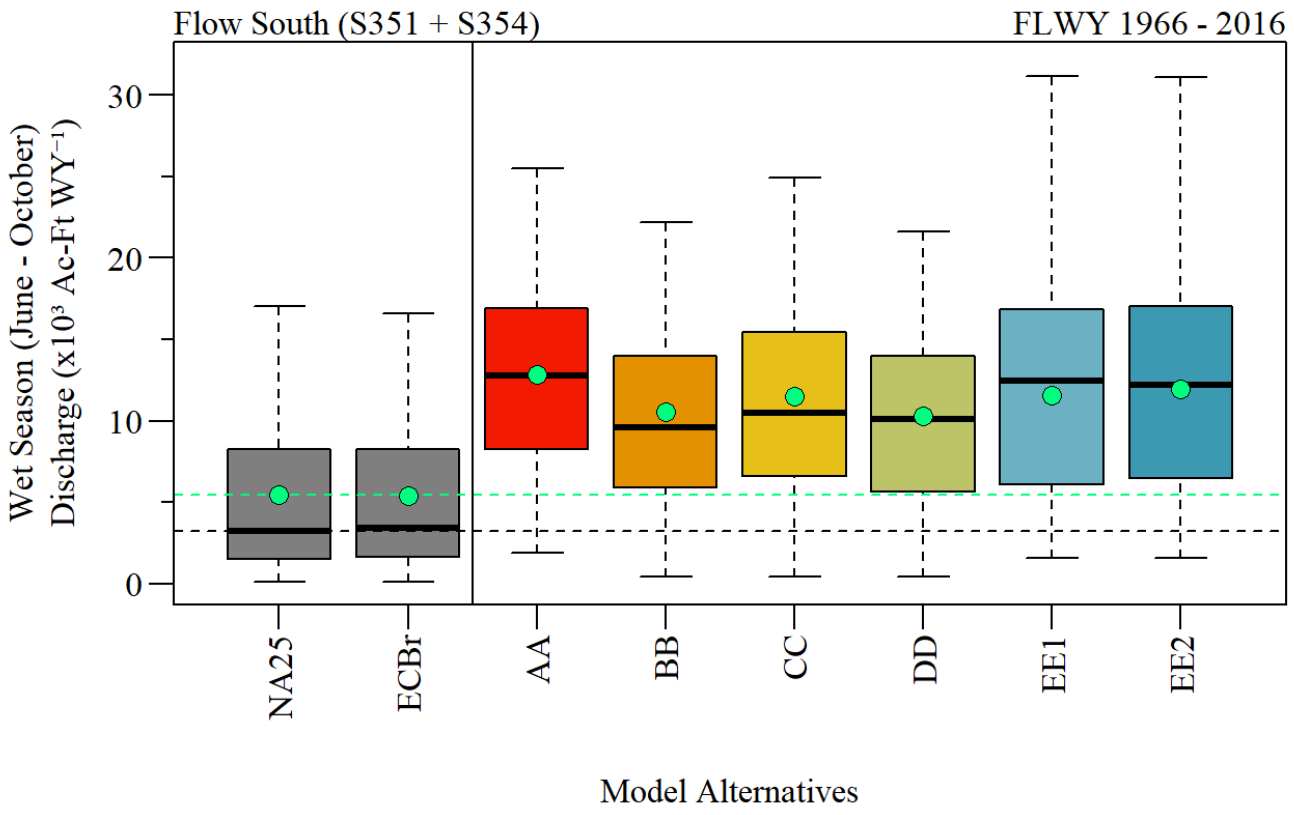
FWO Discharge Comparison



Percent Difference from FWO (NA25) for total discharges south (S-351 and S-354).

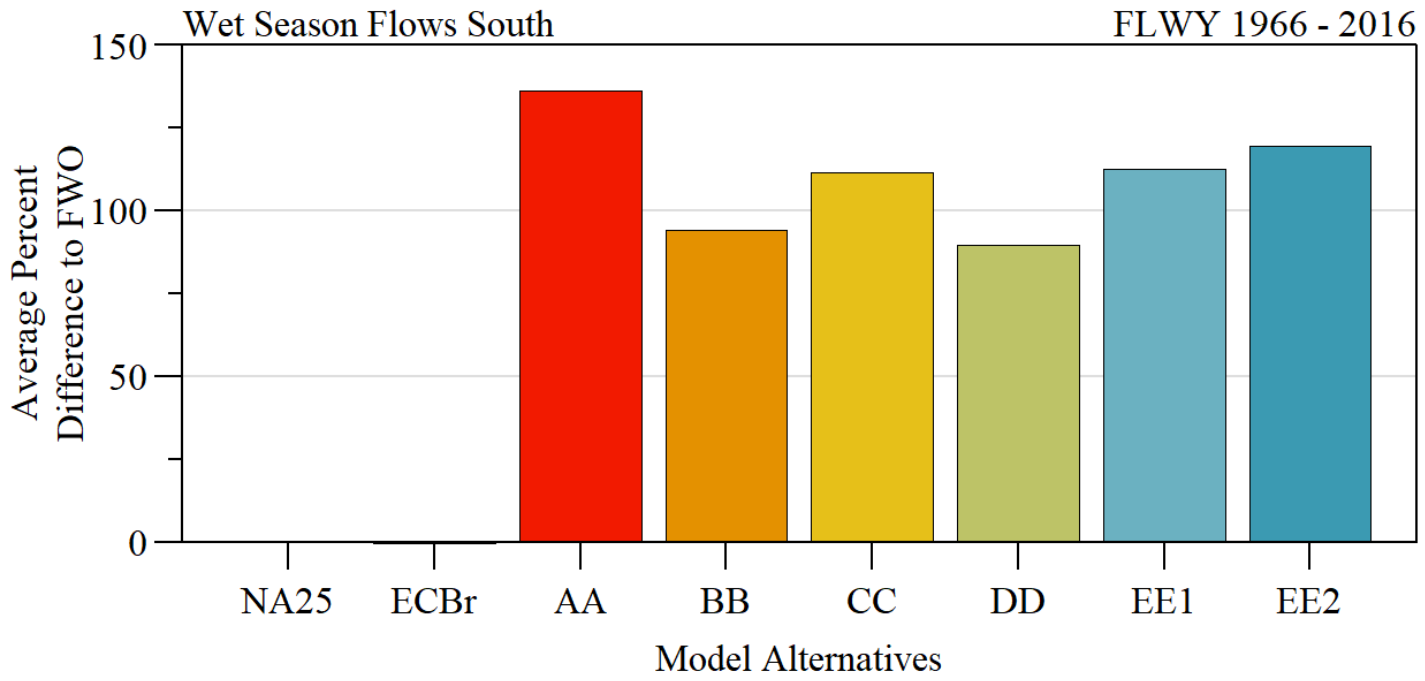
- Compared annual average number of events over the FLWY 1966 - 2016 simulation period

EAA (S-354 + S-351) Wet Season



Wet Season (June - October) discharge to the EAA via S-354 and S-351 during the simulation period across alternatives. Dashed line represents the FWO median and green point in boxplot indicates period of simulation mean.

FWO Discharge Comparison



Average percent difference from FWO (NA25) for wet season discharges south (S-351 and S-354) during the simulation period of record.

Principal Component Analysis

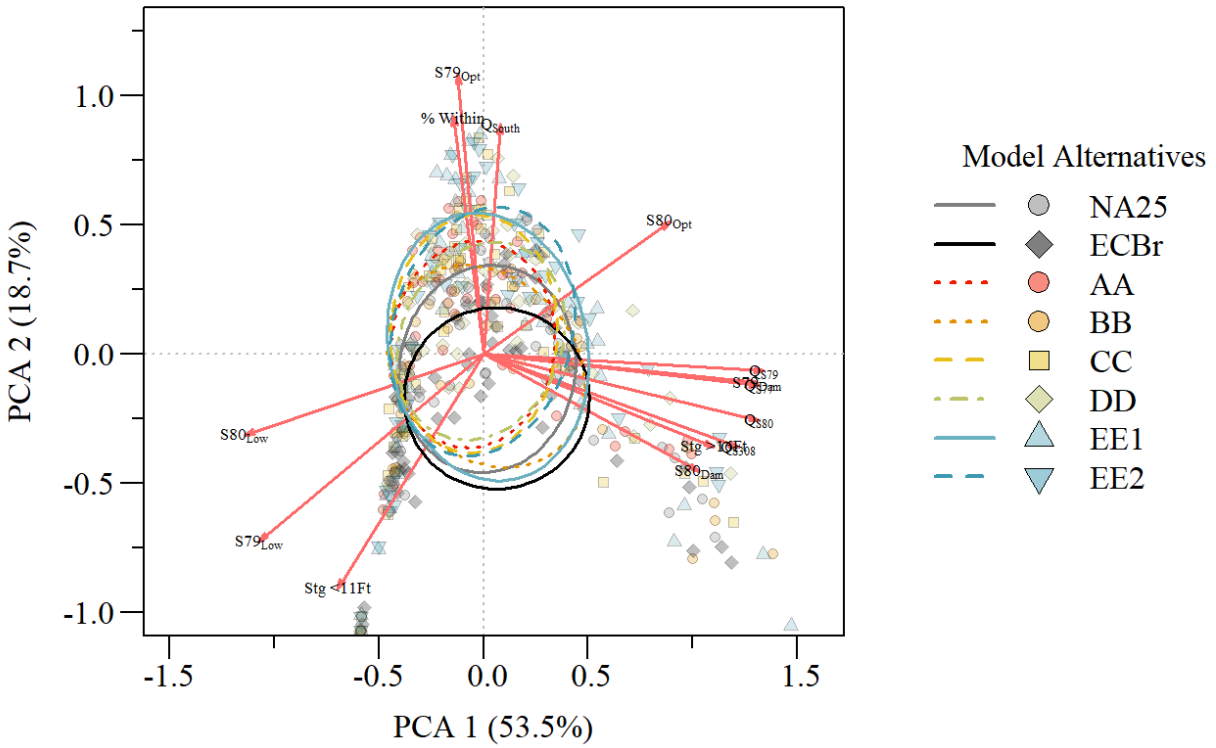
Parameters

- Q_{S79}, Q_{S80}, Q_{S77}, Q_{S308} and Q_{South}: Total annual discharge.
- S79 / S80 $_{Low, Opt, Dam}$: Frequency of low, optimum and damaging events at S79 / S80 (based on 14-day moving average).
- Stg <11Ft: Frequency of daily stage < 11 Ft.
- Stg >16Ft: Frequency of daily stage < 16 Ft.
- % Within: Percentage of time within the Lake stage envelope.

PCA Data Suitability

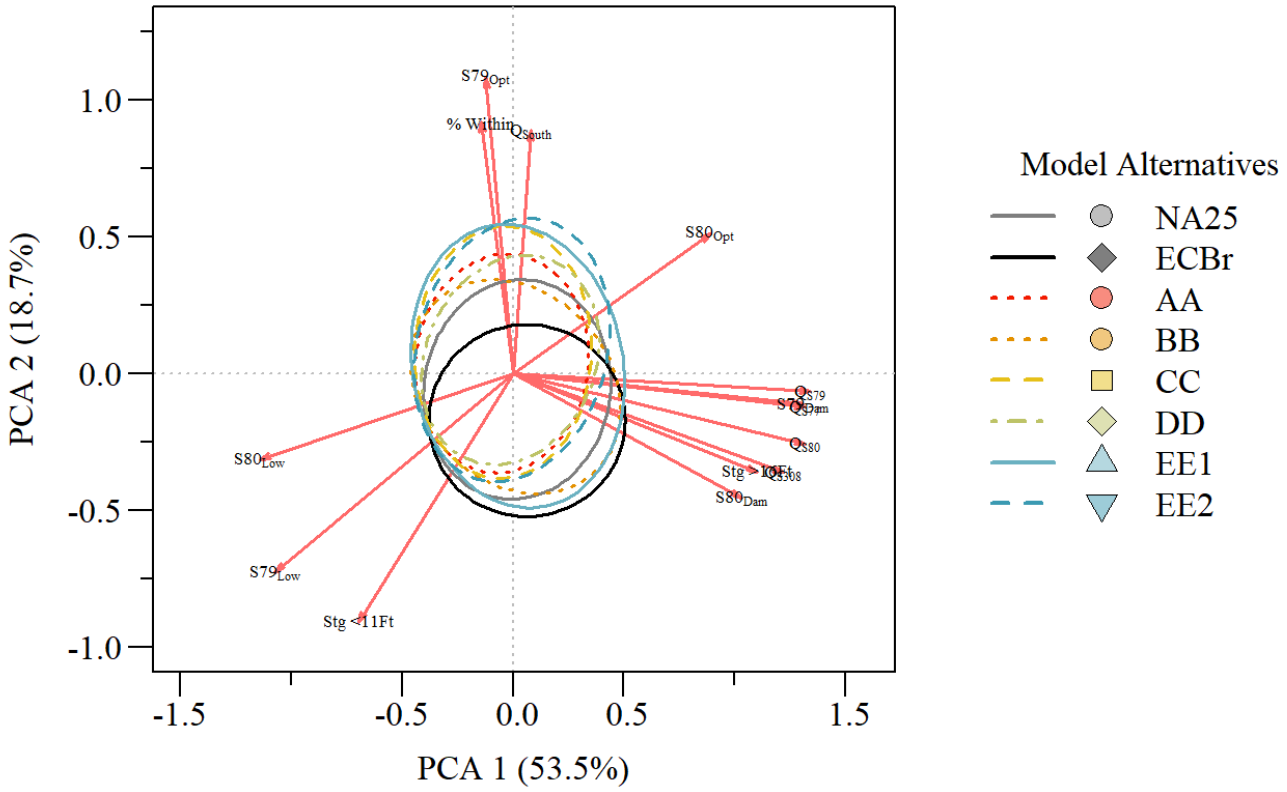
- Kaiser-Meyer-Olkin Statistics (Measure of Sampling Adequacy)
  - KMO-Criterion: 0.79
- Bartlett's Test Of Sphericity
  - $\chi^2 = 10034.6$; DF = 91; $\rho < 0.01$
- PCA Scree Plot

Principal Component Analysis



- Occurrence of optimum flow events, flows south and % within envelope is positively loaded w/ CC and EE plans
- Stg >16 Ft correlated with total discharge and damaging flow events
- Stg <11 Ft correlated with low flow event
- Despite having higher Flows south AA is pulled to the bottom left (driven by higher freq stag <11 Ft).

Principal Component Analysis



- *Removed the individual points to better see the ordination ellipse.*

Summary

Overall, a plan that provides a balanced approach across the system to maintain ecological integrity and function is needed.

- All plans, *except DD*, keep lake stages higher relative to FWO.
    - AA & EEs have the highest number of days in extreme high and low stages.
- CC and EEs provide the greatest number of optimum flow events for CRE.
- AA, CC and EEs provide the greatest number of low flow events for SLE.
    - EE1 has highest frequency of damaging flow events for SLE.
- AA followed by CC and EEs provide the highest discharge volume south (total annual, wet season) and late dry season (*not shown*).
- CC and EE plans are associated with optimal estuary flow events, flow south and % w/in the stage envelope based on principal component analysis.
- **PDT Question**: How much variability could we expect for EE plan(s) due to operational flexibility?

Acknowledgments

South Florida Water Management District (DBHYDRO)

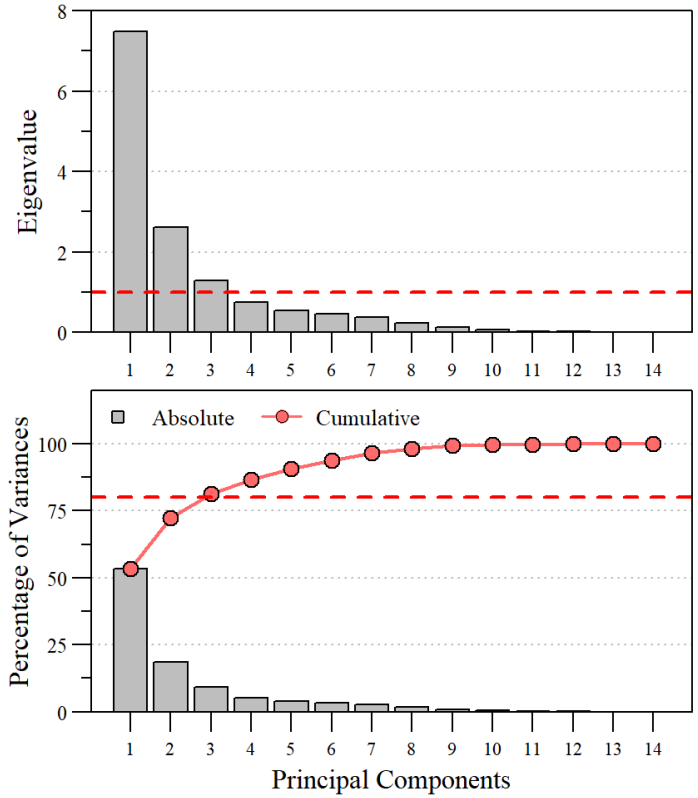
US Army Corps of Engineers (USACE LOSOM)

- Interagency Modeling Center

HTML Slide deck | PDF Slide deck | RMarkdown Source

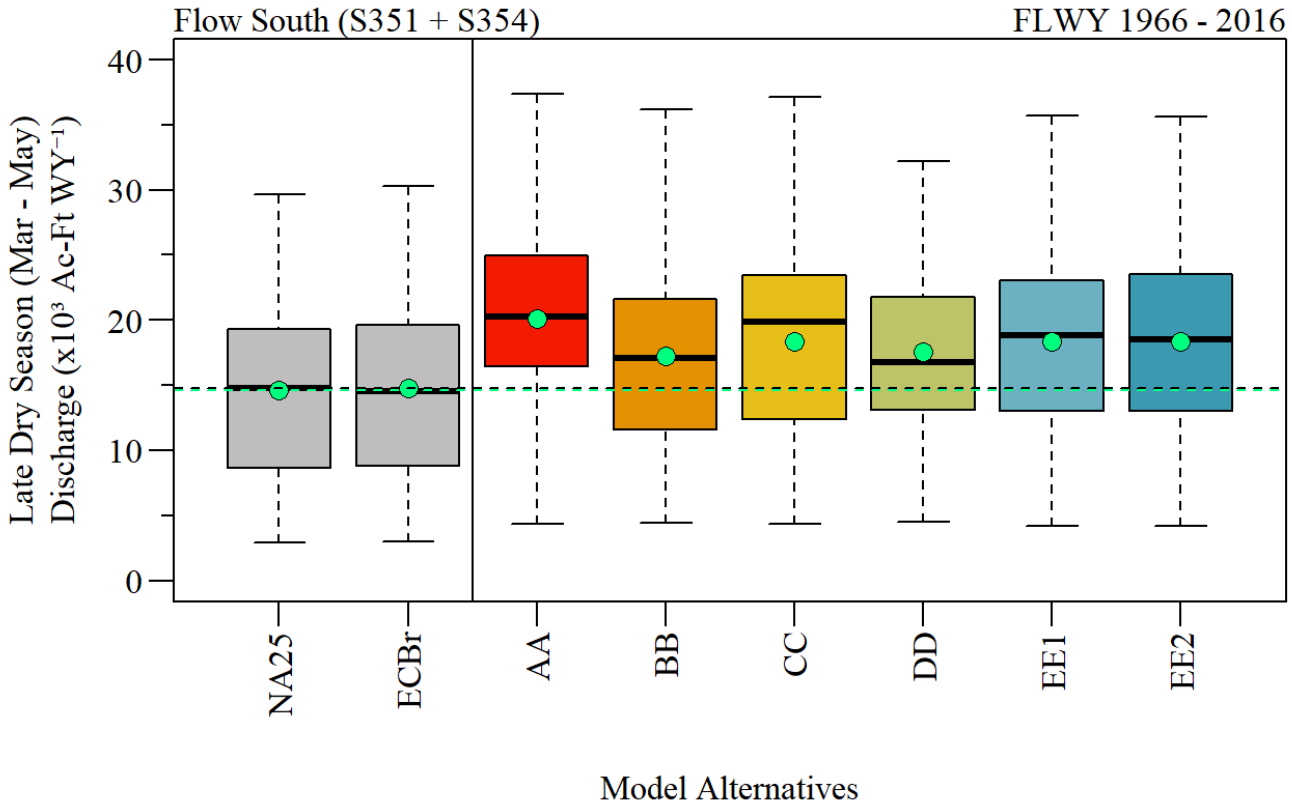
Additional Supplemental Slides

PCA Scree plot



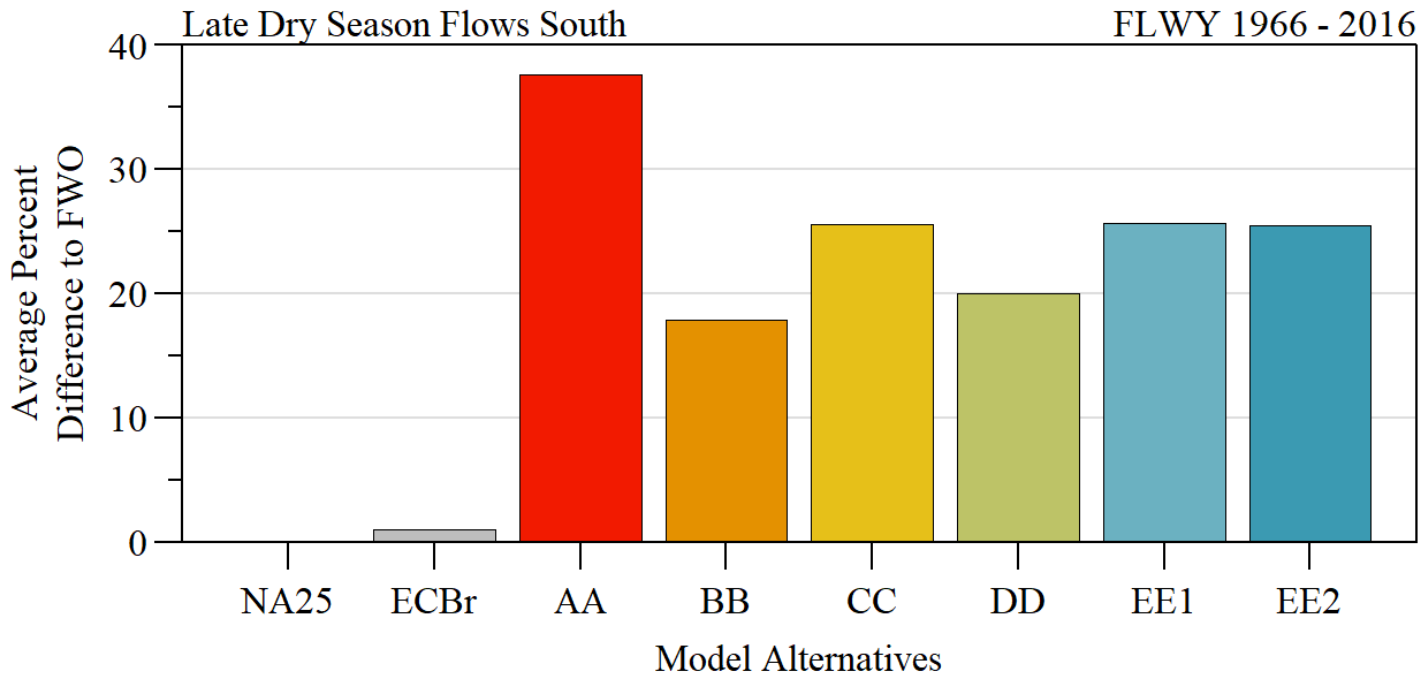
Principal Component Analysis

EAA (S-354 + S-351) Late Dry Season



Late Dry Season (Mar - May) discharge to the EAA via S-354 and S-351 during the simulation period across alternatives. Dashed line represents the FWO median and green point in boxplot indicates period of simulation mean.

FWO Discharge Comparison Late Dry Season



Average percent difference from FWO (NA25) for late dry season (Mar - May) discharges south (S-351 and S-354) during the simulation period of record.

Lake Okeechobee

- Evaluate lake stage consistent with RECOVER - Lake Okeechobee Stage Performance Measure.
  - PM documentation - link
  - R-package - link

Estuaries

- Evaluate estuary discharges consistent with RECOVER thresholds
  - PM documentation - link

Estuary	Optimum	Stress	Damaging
St. Lucie	150 - 1400 cfs	1400 - 1700 cfs	>1700 cfs
Caloosahatchee	750 - 2100 cfs	2100 - 2600 cfs	>2600 cfs

Source: RECOVER Northern Estuaries Performance Measure: Salinity Envelope

- Frequency of low (below optimum), optimum and damaging flow events were evaluated for each water year (May - April) and alternative.

- Principal Component Analysis - compare various metrics across alternatives.