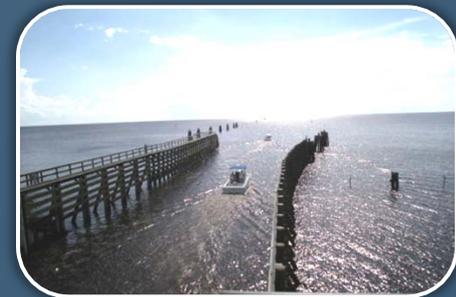


Adaptive Protocols for Lake Okeechobee Operations

Alternative Solutions for Improving Performance of the Caloosahatchee Estuary

*Water Resources Advisory Commission
August 2, 2012*

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Susan Gray, Ph.D.*



Strategies Analyzed Since Summer 2011

- 1. LORS-2008 flexibility (to improve storage capability)**
 - Reduced discharge during stage recessions
 - Relax peak stage constraint
 - Additional minor modifications

- 2. Adaptive Protocol modifications (to improve Caloosahatchee Estuary [CE] salinity)**
 - Relax Tributary Hydrologic Condition
 - Allow releases in Water Shortage Management Band
 - Additional minor modifications

- 3. Lake Okeechobee Service Area water shortage management (increase cutbacks and cutback sooner)**

- 4. Water Supply Augmentation (WSA)**

- 5. Refined Water Supply Augmentation**

Descriptions of Alternatives

EWSA6: Combined/optimized features of (EWS) and (WSA)

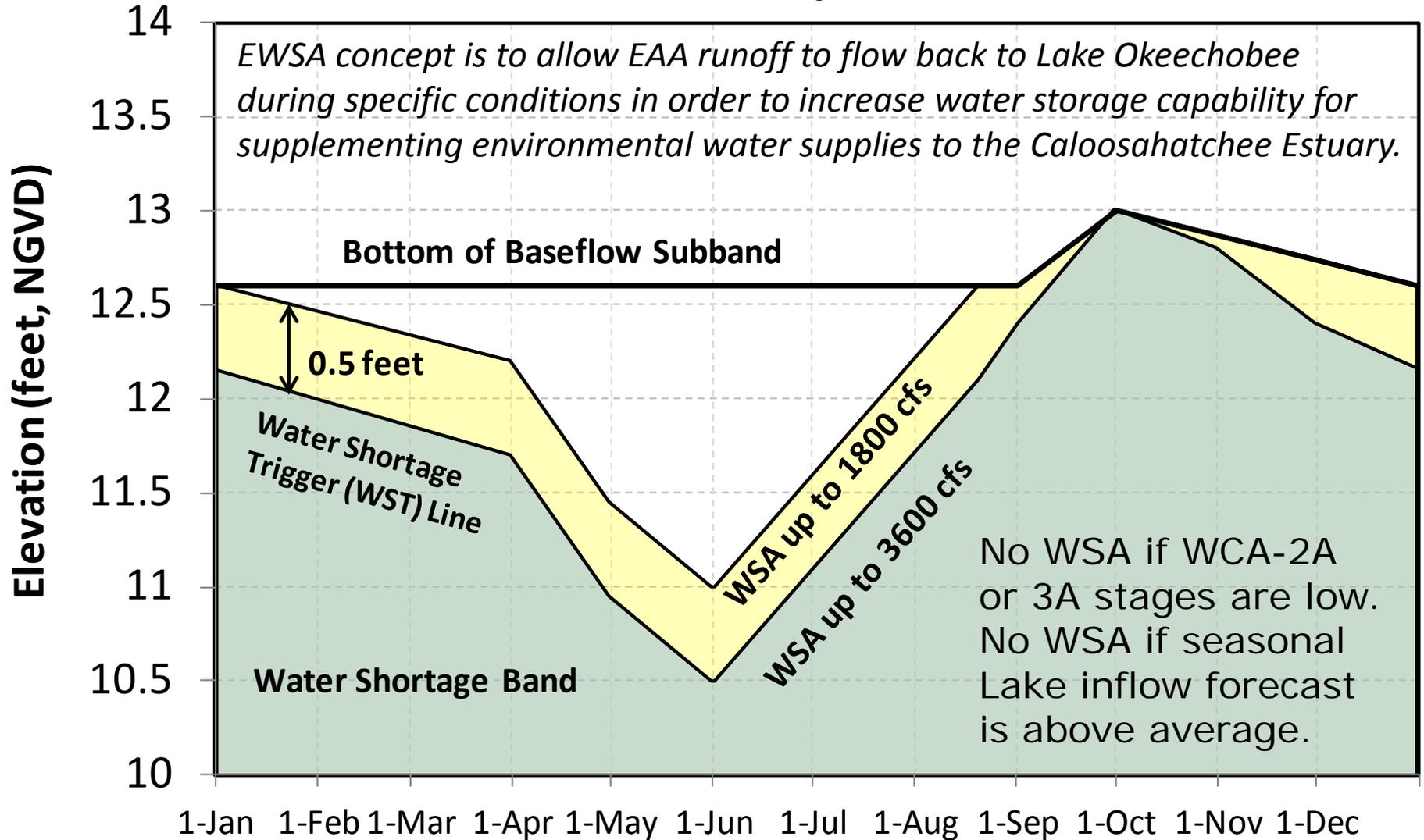
WSA: water supply augmentation (WSA) up to 1800 cfs when LOK stage falls within 0.5' above WST, 3600 cfs when stage falls below Water Shortage Trigger (WST). No WSA when Water Conservation Area (WCA)-3A stage is below floor or if seasonal Lake inflow forecast is above average.

EWS: environmental water supply (EWS) up to 300 cfs in Beneficial Use and Water Shortage bands w/no cutbacks. No Tributary Hydrologic Condition (THC) constraint, and no Lake stage low-chance constraints; LORS-08 baseflow=450cfs.

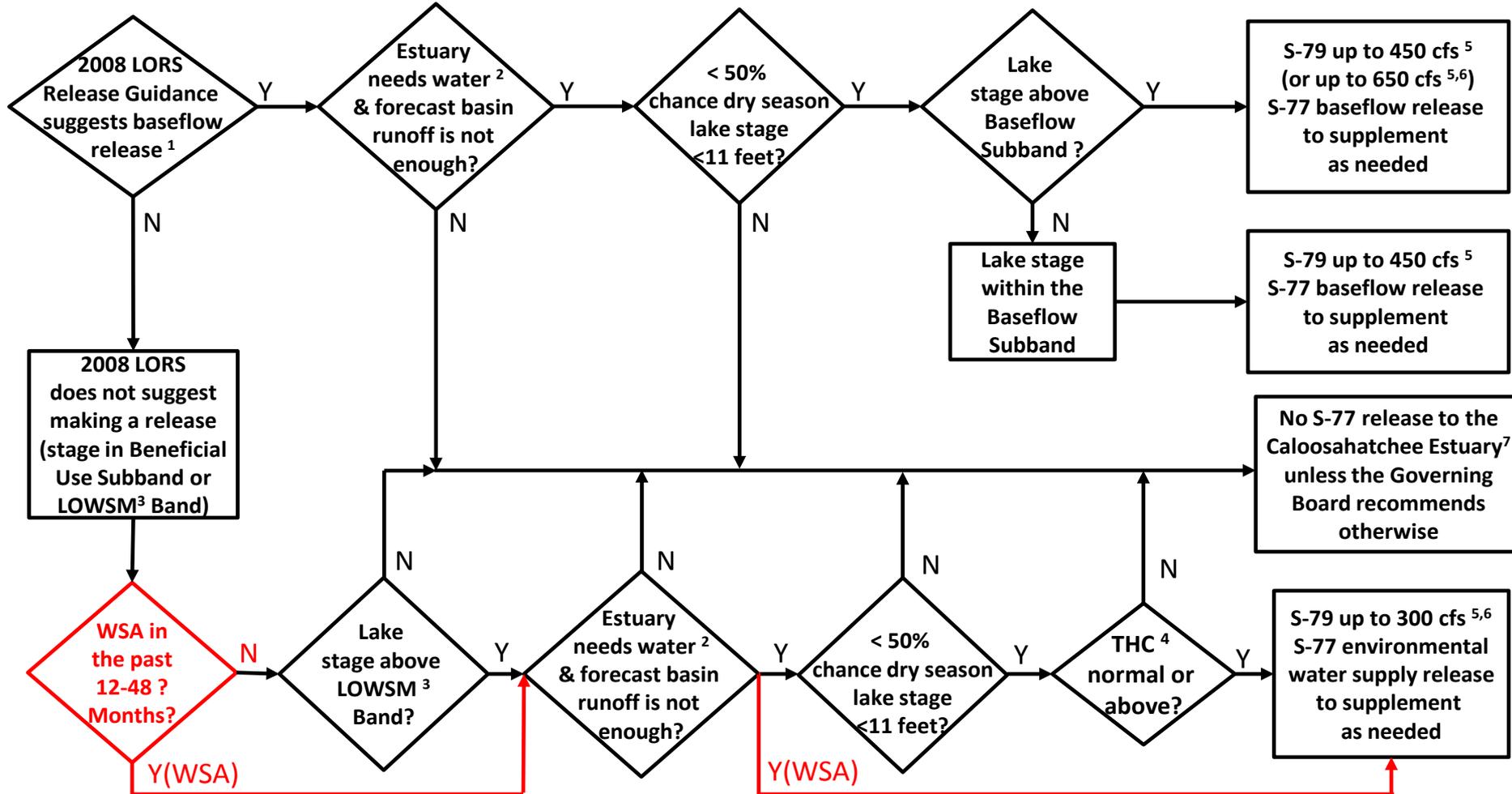
EWSA8: Same assumptions as EWSA6, but with WSA further restricted based on WCA stage limits (3AN < 11', 2A-17 < 11.1', and 3A-28 < 7.5'), and 300 cfs EWS in Lake Okeechobee Water Shortage Management subject to phase 1-4 cutbacks .

Note: EWSA6 and EWSA8 were tuned to provide most benefits to the Caloosahatchee Estuary. Other solutions can be developed which have a different balance of the benefits of WSA.

Lake Okeechobee Water Supply Augmentation Zones for EWSA8



ONE POSSIBLE MODIFICATION TO THE Flowchart to Guide Recommendations for Lake Okeechobee Releases to the Caloosahatchee Estuary for 2008 LORS Baseflow & for Environmental Water Supply



¹The 2008 LORS Release Guidance (Part D) can suggest baseflow releases in the Intermediate, Low, or Baseflow Subbands.

²Estuary “needs” water when the 30-day moving average salinity at I-75 bridge is projected to exceed 5 practical salinity units (psu) within 2 weeks.

³LOWSM = Lake Okeechobee Water Shortage Management.

⁴Tributary Hydrologic Condition (THC) is based on classification of Lake Okeechobee Net Inflow and Palmer Index.

⁵Can release less than the “up to” limit if lower release is sufficient to reach or sustain desired estuary salinity; cfs = cubic feet per second.

⁶After reviewing conditions in Water Conservation Areas (WCAs), Stormwater Treatment Areas (STAs), ENP, St. Lucie Estuary and Lake Okeechobee.

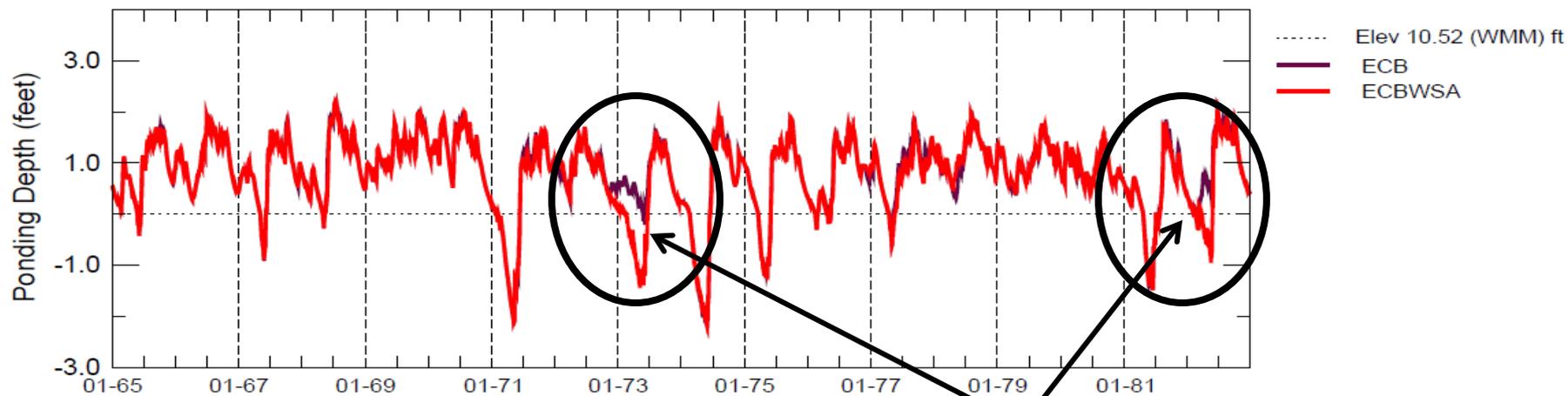
⁷Should this condition be reached, the Governing Board will be briefed at their next regularly scheduled meeting.

Example EWSA6 problem area in WCA-3A

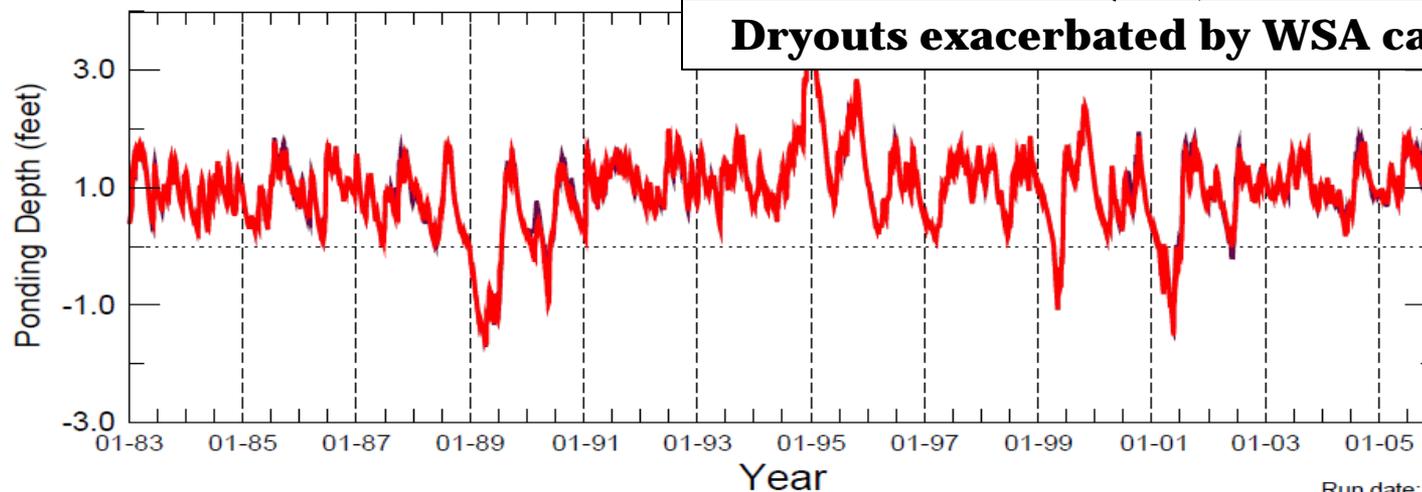
Operating constraints added for EWSA8 to restrict WSA when water depth is less than 0.5 feet.

Normalized Hydrographs for North-West End of WCA-3A

(Gage 3A-NW, Cell Row 40 Col 18)



Dryouts exacerbated by WSA can be prevented

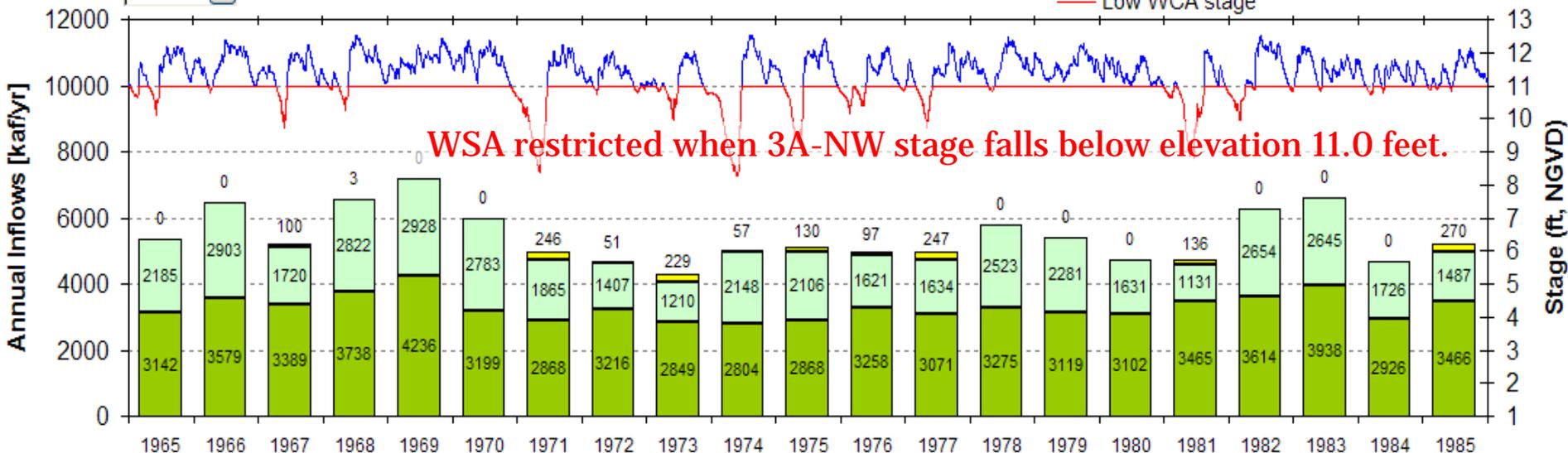


EWSA8 flow comparison & 3A-NW stage constraint

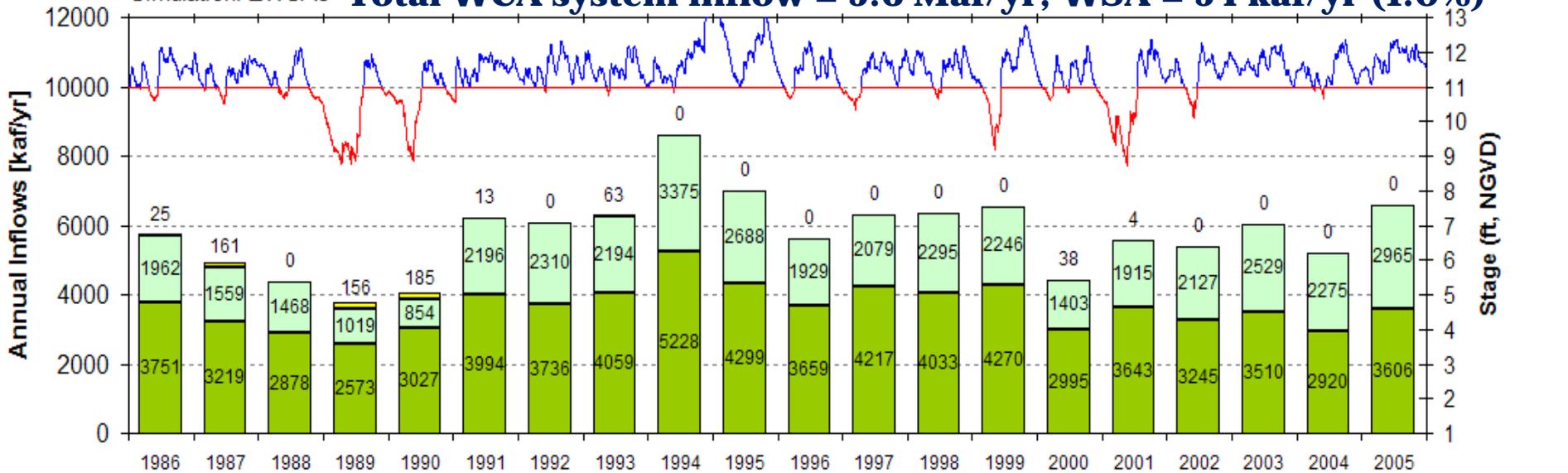
Annual WCA System Inflow Volumes

■ Rainfall
■ WSA
■ Inflows-WSA
— 3A-NW
— Low WCA stage

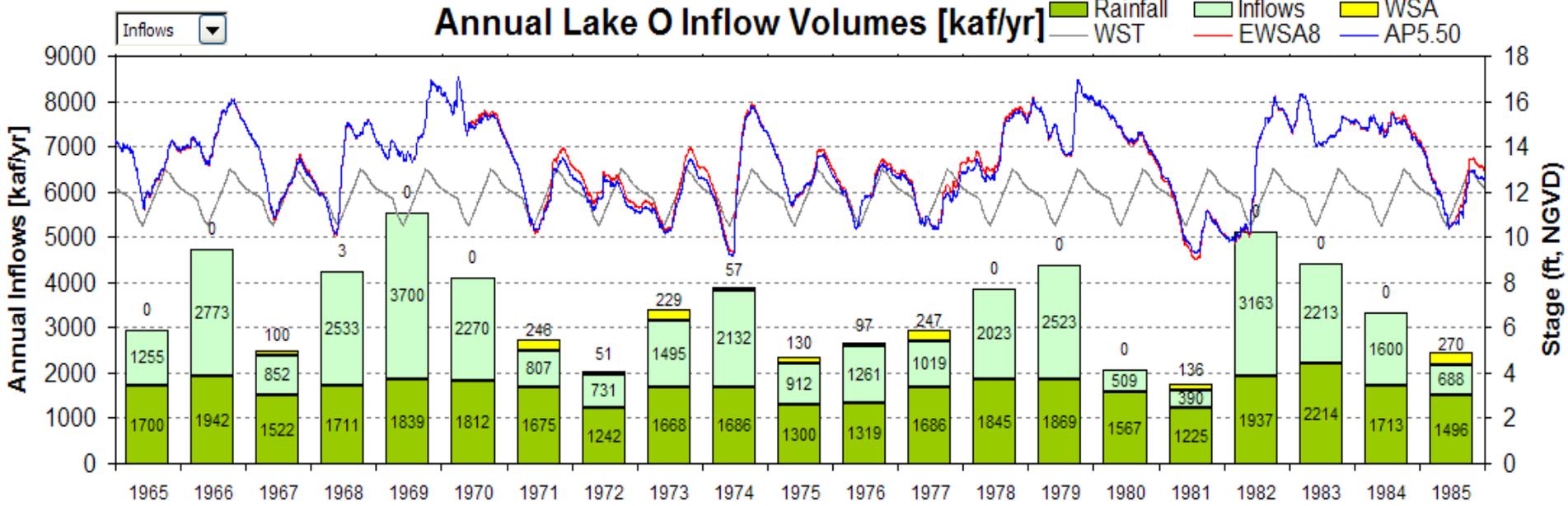
3A-NW



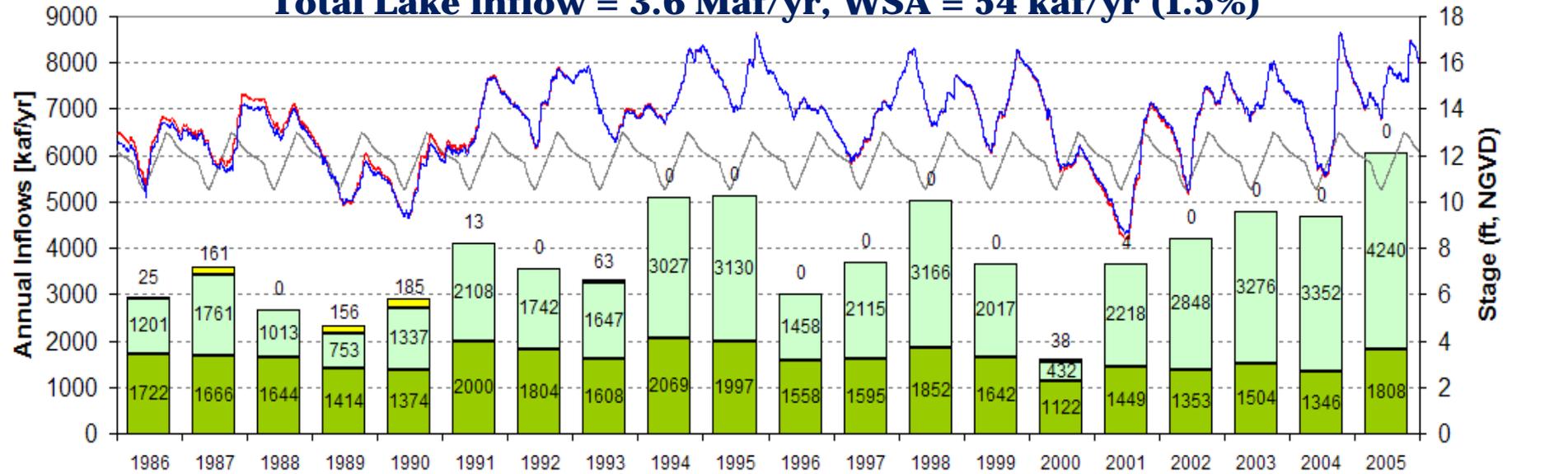
Simulation: EWSA8 **Total WCA system inflow = 5.6 Maf/yr, WSA = 54 kaf/yr (1.0%)**



EWSA8 flow and Lake O stage comparison



Total Lake inflow = 3.6 Maf/yr, WSA = 54 kaf/yr (1.5%)



Descriptions of Alternatives (cont)

AP5.5R: AP5.50 with no Tributary Hydrologic Condition (THC) constraint in the late dry season (April-May)

TA524R: Optimized components of AP5.50 and Lake Okeechobee Regulation Schedule (LORS)-08:

- 100% of LORS-08 up-to discharges in Intermediate & High Subbands. 100% of up-to discharge limits in Low Subband when stages are rising, 60% of up-to limit when stages are receding. Baseflow up to the lower third of the Low Subband.
- no CE environmental water supply releases when Lake stage is in Water Shortage Band.
- no THC constraint in the late dry season (April-May).

Performance Measures used for Analysis

A Performance Measure (PM) is a key summary statistic that represents an important characteristic of a system. PMs are used in modeling analyses to make relative comparisons among alternative plans or what-if scenarios.

1. LOK: Maximum Stage
2. LOK: # of days above elevation 17.25 ft, NGVD*
3. LOK: # of MFL Rule Exceedances*
4. LOSA: # of months of significant water shortage cutbacks*
5. CE: # of months of high salinity (> 10 psu) at Val-I75*
6. CE: # of months of high salinity (> 10 psu) at Ft. Myers
7. SLE: # of months of damaging high discharge > 2000 cfs*
8. CE: # of months of damaging high discharge > 2800 cfs*

*** Same PMs used for development of 2010 Adaptive Protocols**

Performance Summary Table

	PERFORMANCE SUMMARY						
	WSE	LORS08	AP5.50	EWSA6	EWSA8	AP5.5R	TA524R
LOK: Peak stage (ft)	18.51	17.25	17.31	17.28	17.29	17.30	17.30
LOK: Days>17.25'	483	0	11	3	3	10	5
LOK: MFL Exc	4	10	7	5	6	7	7
LOSA: Cutback Mos	26	42	37	33	38	37	38
CE-I75: Mos>10psu	118	79	58	0	2	51	51
CE-FM: Mos>10psu	200	176	163	118	122	162	160
SLE: Mos>2000cfs	72	78	79	78	78	79	77
CE: Mos>2800cfs	95	88	97	97	96	96	90

PERFORMANCE CHANGES RELATIVE TO AP5.50

	AP5.50	EWSA6	EWSA8	AP5.5R	TA524R
LOK: Peak stage (ft)	17.31	-0.03	-0.02	-0.01	-0.01
LOK: Days>17.25'	11	-8	-8	-1	-6
LOK: MFL Exc	7	-2	-1	0	0
LOSA: Cutback Mos	37	-4	1	0	1
CE-I75: Mos>10psu	58	-58	-56	-7	-7
CE-FM: Mos>10psu	163	-45	-41	-1	-3
SLE: Mos>2000cfs	79	-1	-1	0	-2
CE: Mos>2800cfs	97	0	-1	-1	-7

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CE-FM: Mos>10psu	200	176	163	118	122	162	160
SLE: Mos>2000cfs	72	78	79	78	78	79	77
CE: Mos>2800cfs	95	88	97	97	96	96	90
WSA (kaf/yr)	0	0	0	69	54	0	0
EWS to CE (kaf/yr)	0	0	13	58	51	16	17
WCA inflow (kaf/yr)	5585	5585	5585	5516	5531	5585	5585

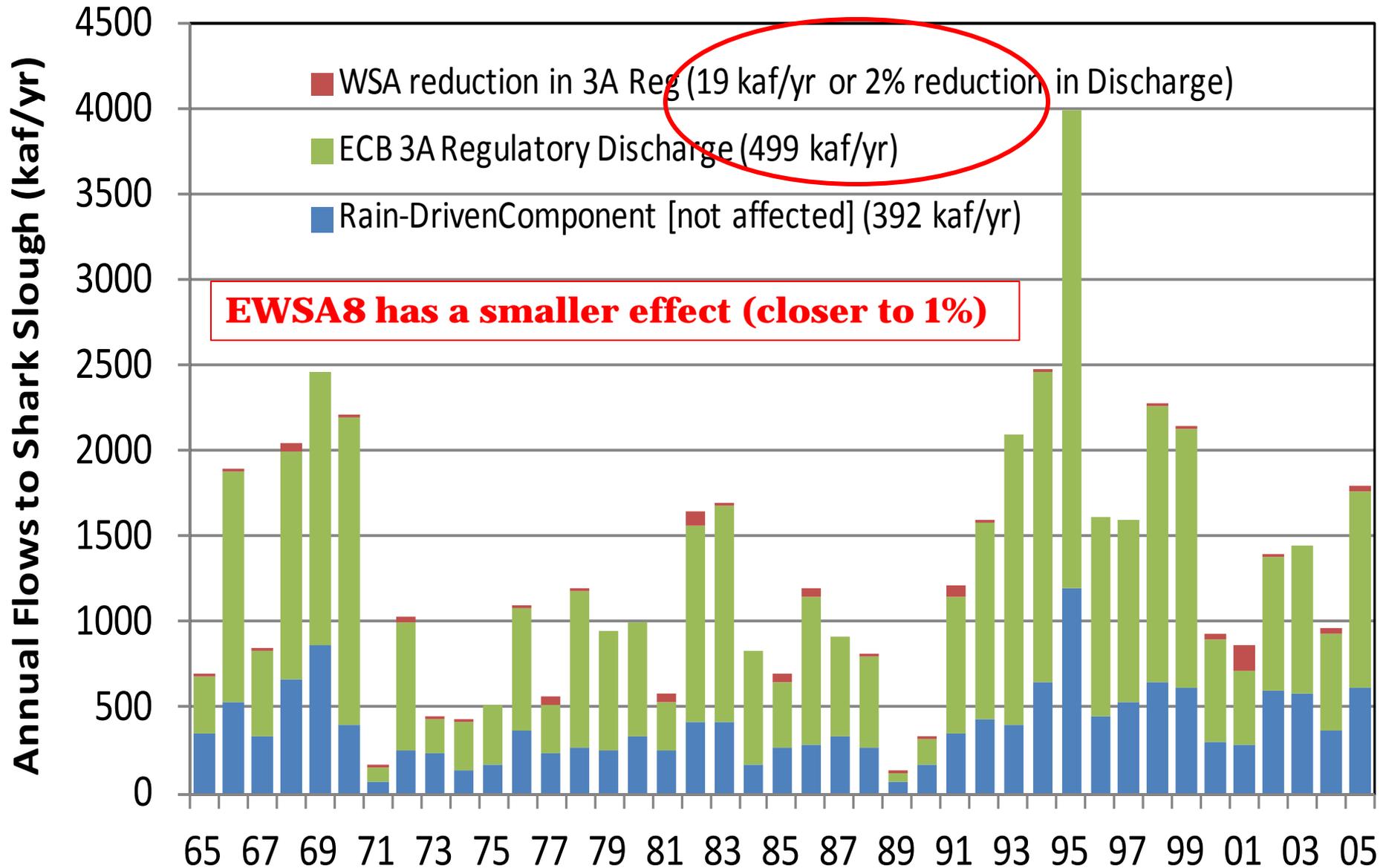
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SLE: Mos>2000cfs	79	-1	-1	0	-2
CE: Mos>2800cfs	97	0	-1	-1	-7
WSA (kaf/yr)	0	69	54	0	0
EWS to CE (kaf/yr)	13	45	38	3	4
WCA inflow (kaf/yr)	5585	-69 (1.2%)	-54 (1.0%)	0	0

Effects of EWSA8 on the Everglades

- EWSA8 constraints designed to not allow WSA when WCA stages are low
- Constraints reduce WSA from about 70 kaf/yr (EWSA6) to 54 kaf/yr (EWSA8).
- EWSA8 Statistics for the 41-yr simulation period
 - 86% of time WCA-2A or 3A stages are above regulation levels
 - WCA regulatory discharges to tide are likely (Cape Sable Seaside Sparrow constraints on S-12 operation, WCA-3A regulation schedule to be lowered via the ERTP)
 - WSA triggered in 9 of 41 years, but occurs only 6% of the time
 - During WSA events, WCAs are above regulation stage about 70% of the time
- Minimal effect of EWSA8 on flows to the Everglades

Simulated Flow to Shark Slough (S12+S333)

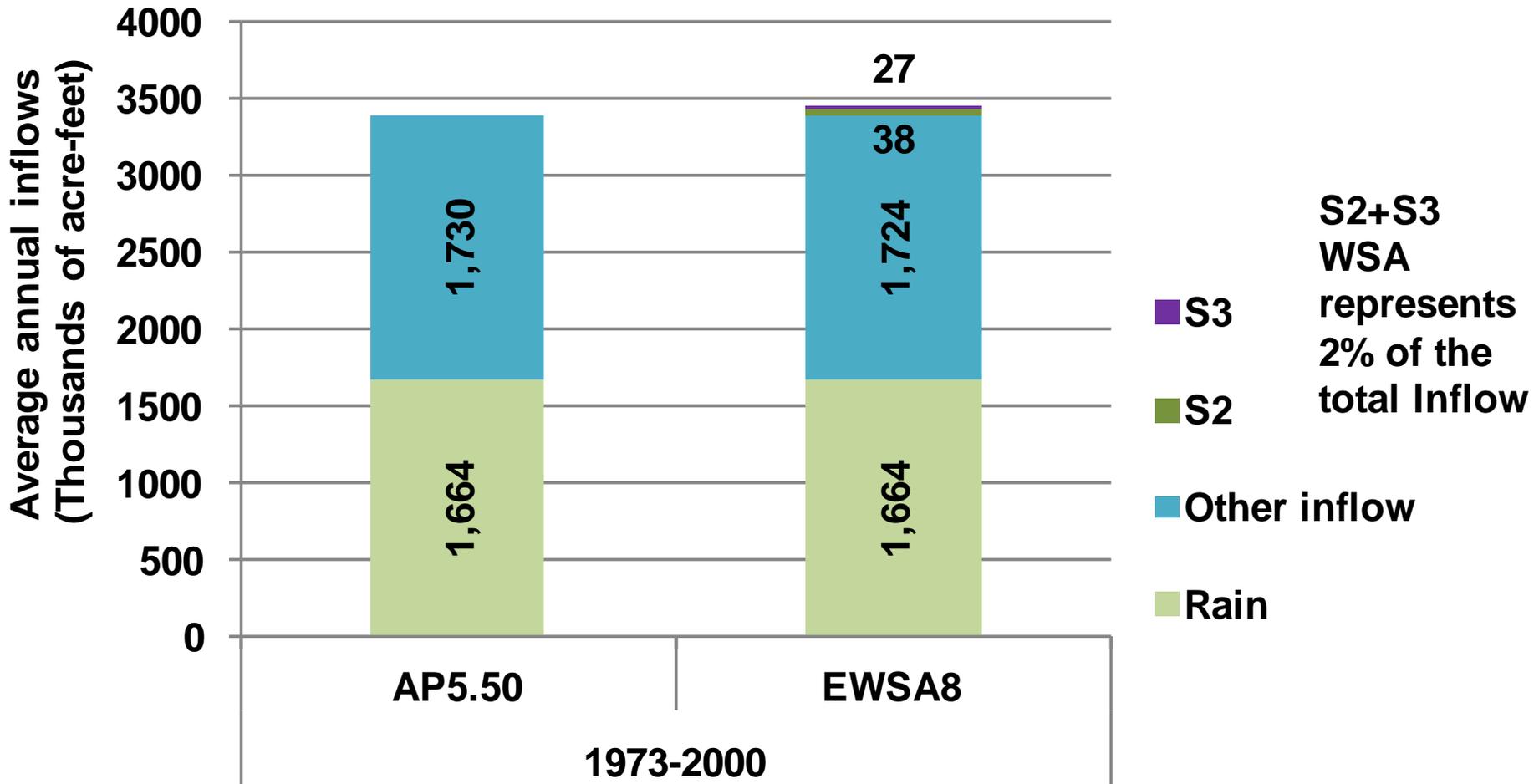


Effects of WSA on Lake Okeechobee & Caloosahatchee Estuary Water Quality

- Analyzed EWSA8 scenario using the Lake Okeechobee Water Quality Model (LOWQM)
 - Close look at TP and TN
- Results show little, if any, adverse impacts from WSA
- Increases Lake inflow load for TP (1.8%) and TN (4.9%)
- However, little to no change in in-lake TN or TP concentrations due to internal processes
- 15-17% increase in loads discharged at S-77 due primarily to increased Lake O release volumes
- Slight decrease in loads discharged at S-308 due to decrease in Lake O release volumes

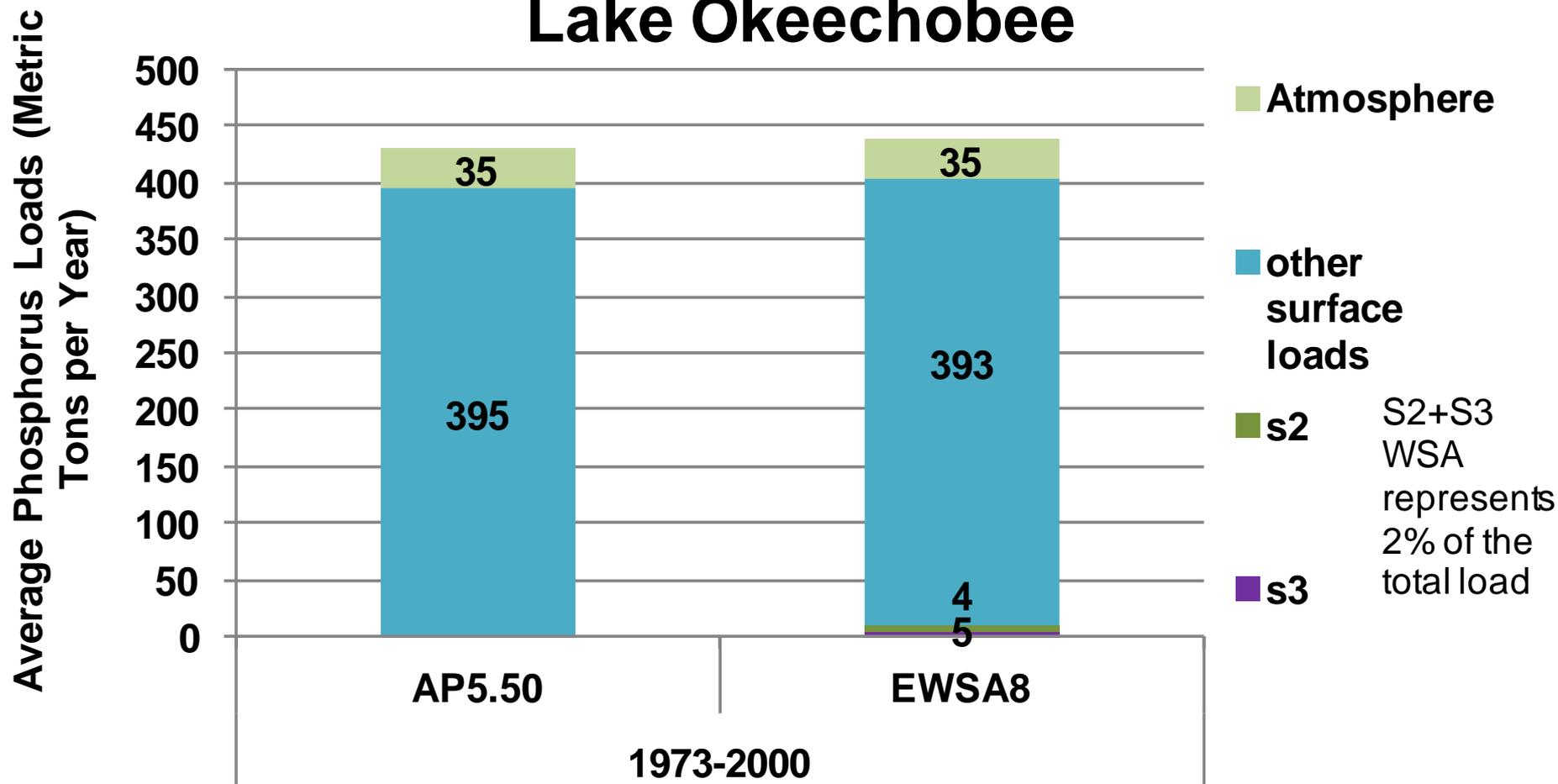
Comparison of Average Annual Simulated Lake Inflows

Simulated Lake Okeechobee Inflows



Comparison of Average Annual Simulated Phosphorus Loads

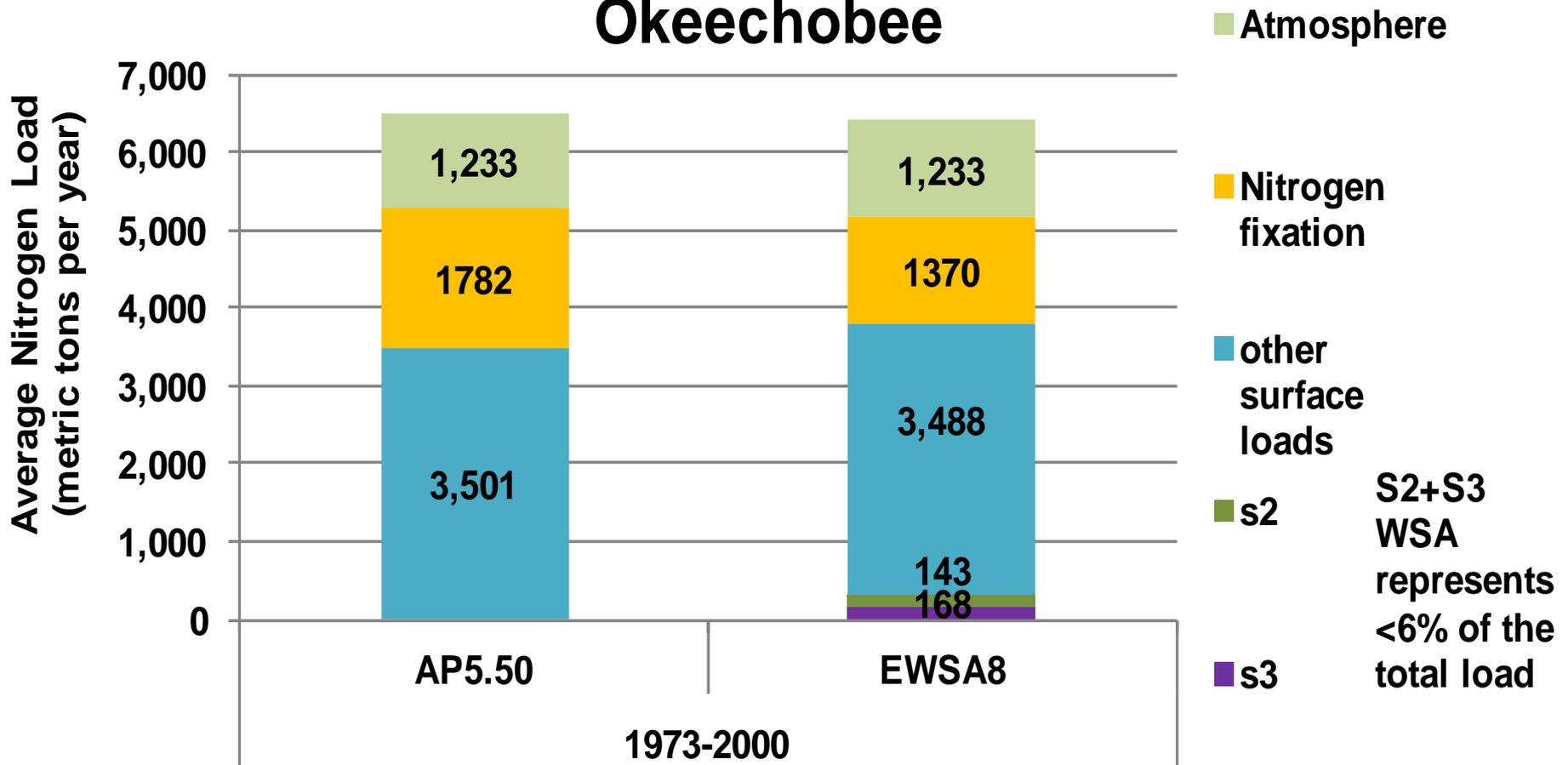
Simulated Phosphorus Inflow Loads to Lake Okeechobee



LOWQM simulation period 1973 - 2000

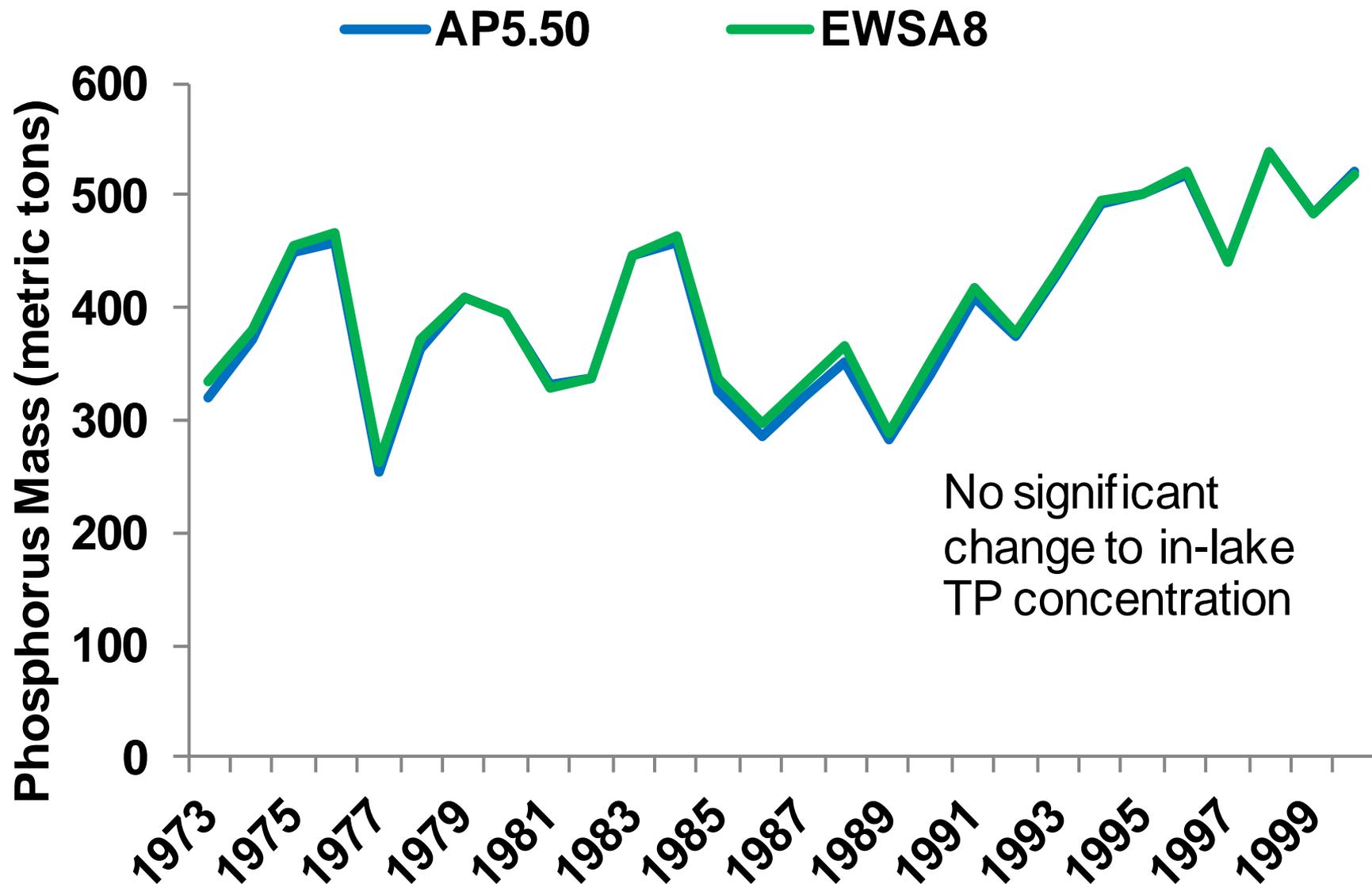
Comparison of Average Annual Simulated Nitrogen Loads

Simulated Nitrogen Inflow Loads to Lake Okeechobee

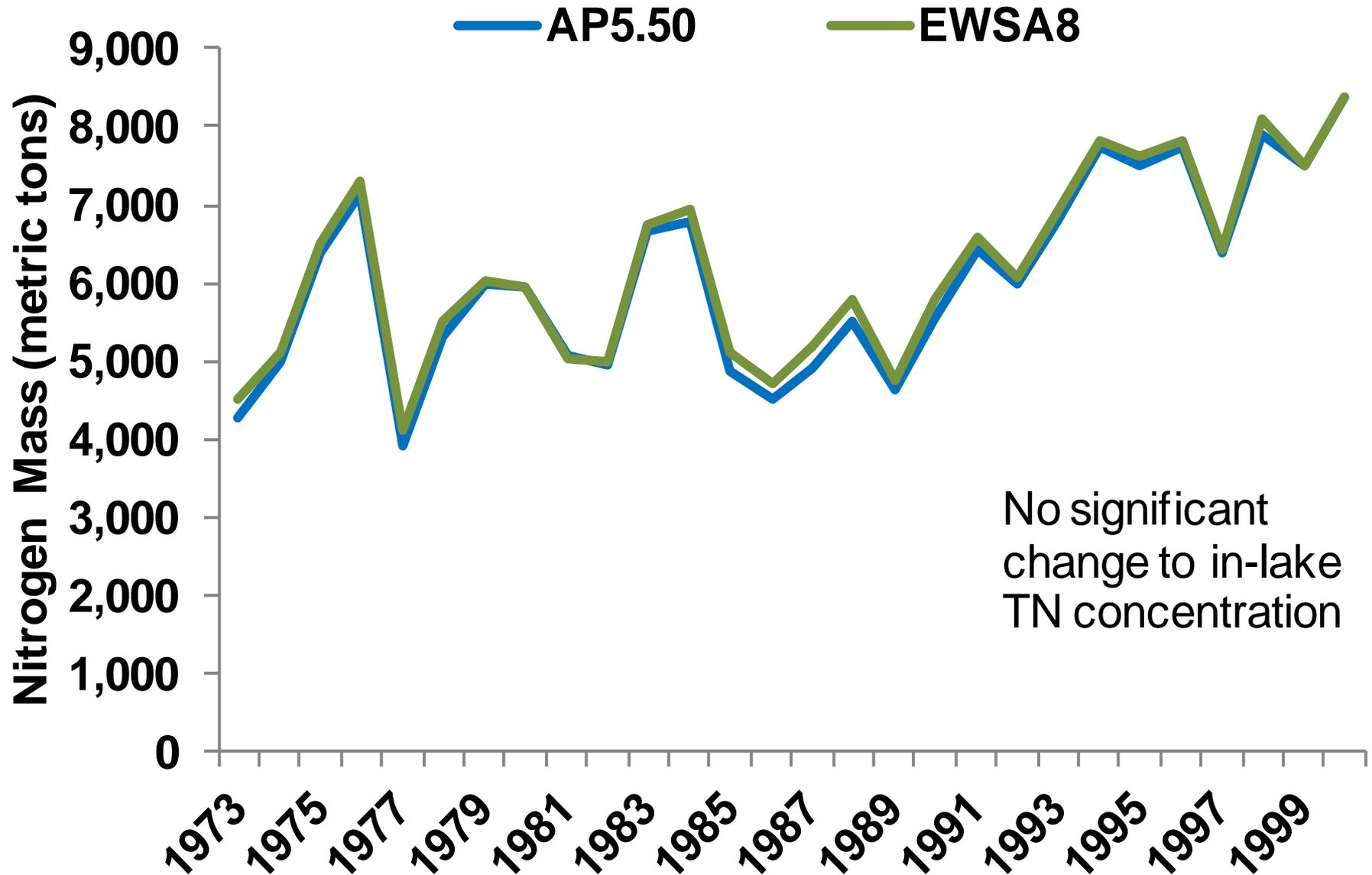


LOWQM simulation period 1973 - 2000

Simulated In-Lake TP Mass

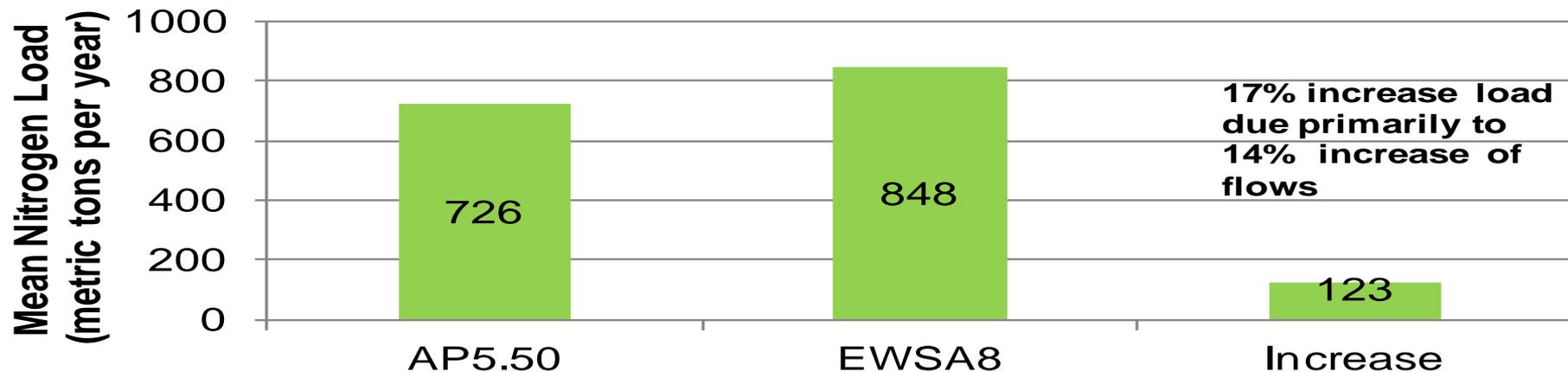


Simulated In-Lake TN Mass

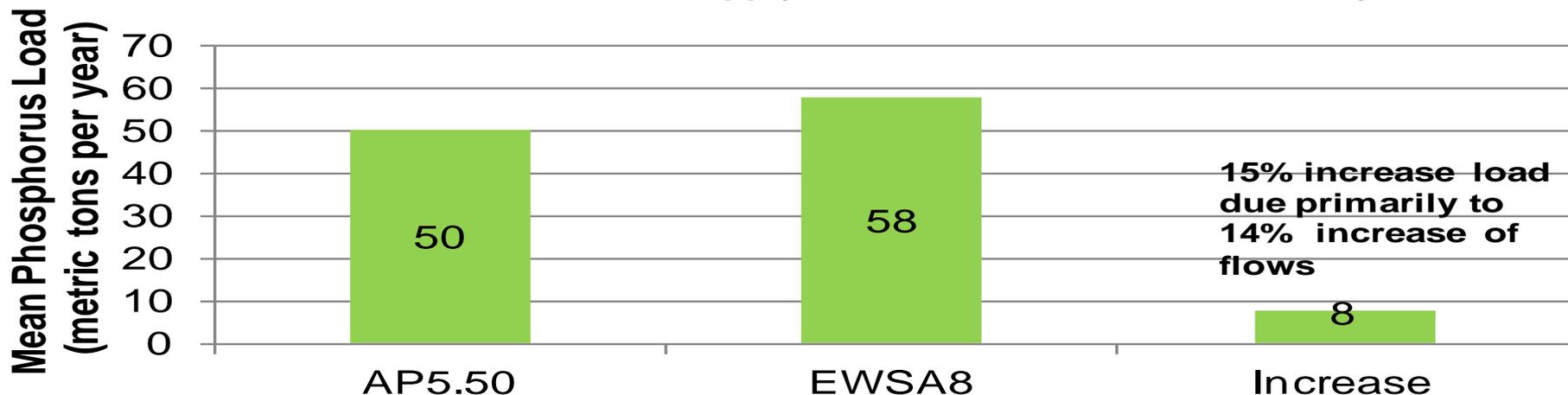


Nitrogen and Phosphorus Loads Discharged from Lake O via S-77 to the Caloosahatchee Estuary

Simulated S77 nitrogen load Discharged for Lake Stage Regulation and Environmental Water Supply to the Caloosahatchee Estuary

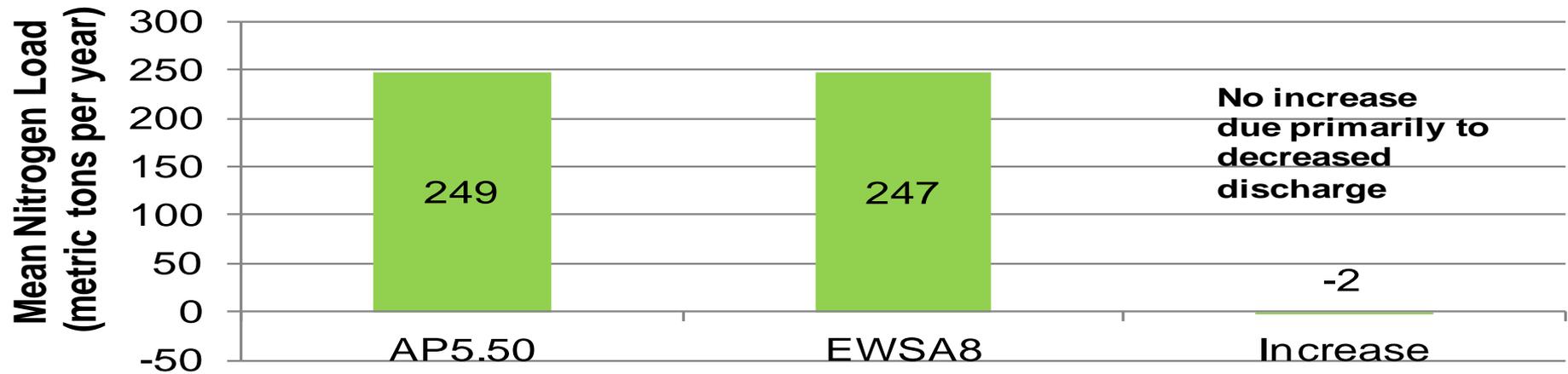


Simulated S77 phosphorus load discharged for Lake Stage Regulation and Environmental Water Supply to the Caloosahatchee Estuary

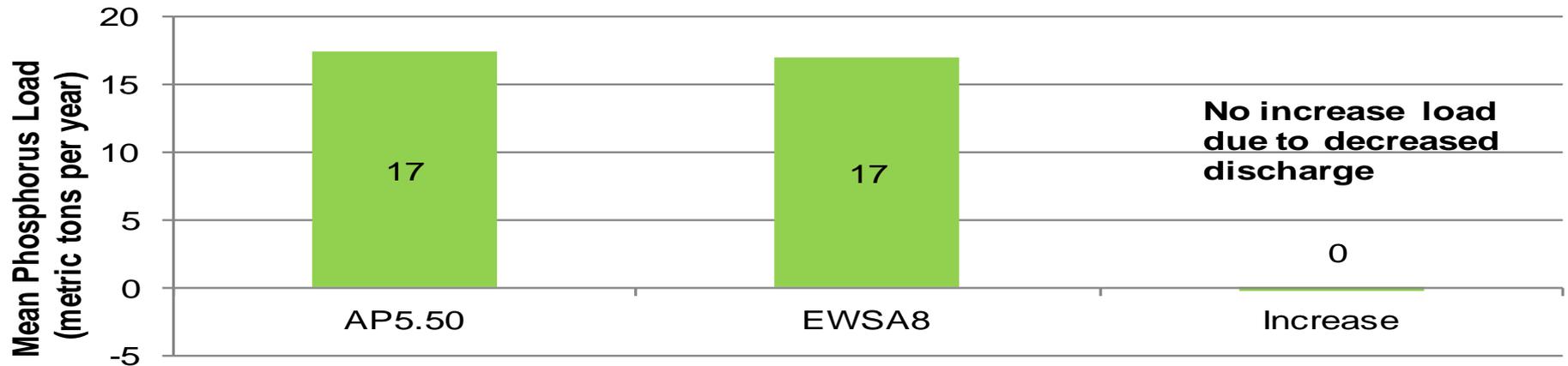


Nitrogen and Phosphorus Loads Discharged from Lake O via S-308 to the St. Lucie Estuary

Simulated S308 nitrogen load Discharged for Lake Stage Regulation and Environmental Water Supply to the St. Lucie Estuary

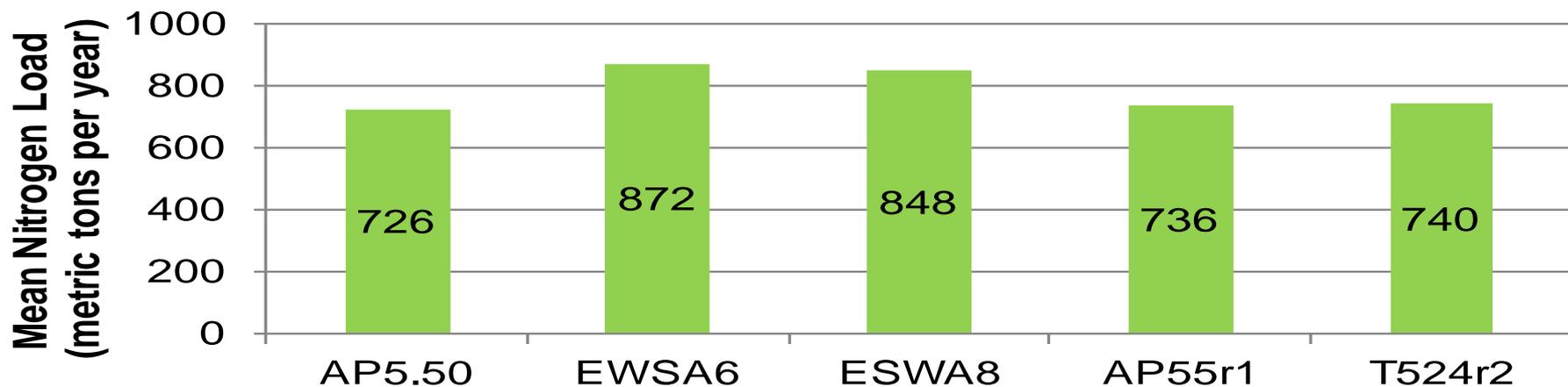


Simulated S308 phosphorus load discharged for Lake Stage Regulation and Environmental Water Supply to the St. Lucie Estuary



Nitrogen and Phosphorus Loads Discharged from Lake O via S-77 to the Caloosahatchee Estuary

Simulated S77 nitrogen load Discharged for Lake Stage Regulation and Environmental Water Supply to the Caloosahatchee Estuary



Simulated S77 phosphorus load discharged for Lake Stage Regulation and Environmental Water Supply to the Caloosahatchee Estuary





Thank You