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M E M O R A N D U M

TO: John Mitnik, Assistant Executive Director, Executive Office Staff

FROM: SFWMD Staff Environmental Advisory Team

DATE: April 14, 2021

SUBJECT: Weekly Environmental Conditions for Systems Operations

SUMMARY

Weather Conditions and Forecast

A stable air mass with little available moisture should provide for relatively cool mornings, warm daytime temperatures, and dry weather during the next couple of days. Full sunshine, low afternoon relative humidity, and an increasing mid-April sun angle will support high rates of evapotranspiration, more-than-typical for this time of year. Dry conditions should last into Thursday. Model guidance predicts a front arriving over the far northern part of the District Friday morning or afternoon and favors the front stalling north over the Kissimmee Valley. An increase of moisture and the 'lift' of the front are likely to fuel scattered rains Friday morning and afternoon over parts of the Kissimmee Valley, some of which could be moderately heavy. However, a continuation of dry weather around and south of Lake Okeechobee will continue, while westerly low-level winds help daytime maximum temperatures climb to near 90's from the eastern interior through the east coast. By Saturday afternoon, the front is likely to retreat to north Florida, leaving the District under a dry weather pattern with very warm or hot temperatures continuing. The front will again drift southward to over or near the northern part of the District by late Sunday and will stall. This could result in a period of enhanced rains, first over the northwestern half of the District on Sunday and then potentially over a broader area Monday through Wednesday next week. Heaviest rains are predicted over north Florida but could be as far south as the northwestern half of the District. Stalled frontal boundaries have the potential to cause significant District rain events. For the week ending next Tuesday morning, weekly total rainfall is most likely to fall into the below normal category. However, should the early-week cold front next week sag farther south into the District than currently predicted and stall, total rainfall would probably finish close to normal.

Kissimmee

Tuesday morning stages were 56.4 feet NGVD (0.5 feet below schedule) in East Lake Toho, 53.3 feet NGVD (0.6 feet below schedule) in Toho, and 51.4 feet NGVD (0.8 feet above schedule) in Kissimmee-Cypress-Hatchineha (KCH); headwater stages were 46.3 feet NGVD at S-65A and 25.8 feet NGVD at S-65D. Tuesday morning discharges were 880 cfs at S-65, 710 cfs at S-65A, 520 cfs at S-65D and 540 cfs at S-65E. Dissolved oxygen concentration in the Kissimmee River averaged 8.2 mg/L for the week through Sunday. Kissimmee River mean floodplain depth on Sunday was 0.14 feet. Today's recommendation is to recede stage in East Lake Toho and Lake Toho at a rate of approximately -0.17 feet/week to target reaching their low pools on June 1. Allow stage to continue receding in KCH but keep the recession rate below -0.18 feet/week by reducing S-65 discharge as needed. Continue to follow the USACE request to keep S-65A discharge below 800-900 cfs to facilitate construction for the Kissimmee River Restoration Project.

Lake Okeechobee

Lake Okeechobee stage was 14.16 feet NGVD on April 11, 2021, 0.14 feet lower than last week and 0.90 feet lower than a month ago. The Lake is currently in the Low Sub-band. Stage had been above or near the top of the preferred ecological envelope since August 1, 2020 but reentered the envelope

on March 30, 2021. Latest water quality surveys (April 6-7, 2021) found detectable cyanotoxins and *Microcystis* dominant cyanobacteria taxa at six of the nine sites sampled. Chlorophyll *a* results are pending. Recent satellite imagery suggests there is minimal algal bloom activity on the Lake.

Estuaries

Over the past week, total inflow to the St. Lucie Estuary averaged approximately 674 cfs, with 190 cfs coming from Lake Okeechobee. The seven-day average surface salinities decreased at the HR1 and A1A Bridge sites but increased at the US1 Bridge site. Salinity at the US1 Bridge is in the good range (10-26) for adult eastern oysters.

Total inflow to the Caloosahatchee Estuary averaged 1,119 cfs, with approximately 799 cfs coming from the Lake. Seven-day average salinities increased at all sites in the estuary. Salinities are in the good range (0-10) for tape grass at Val I-75 and Ft. Myers. Salinities also are in the good range (10-30) for adult eastern oysters at Cape Coral and Shell Point but on the cusp of the fair range at Sanibel.

Lake stage is in the Low Sub-Band of 2008 LORS. Tributary hydrological conditions are normal. The LORS2008 Release Guidance suggests up to 450 cfs release at S-79 to the Caloosahatchee Estuary and up to 200 cfs release at S-80 to the St. Lucie Estuary.

Stormwater Treatment Areas

Over the past week, approximately 6,000 ac-ft of Lake Okeechobee water was delivered to the FEBs/STAs. The total amount of Lake releases sent to the FEBs/STAs in WY2021 (since May 1, 2020) is approximately 140,600 ac-feet. The total amount of inflows to the STAs in WY2021 is approximately 1,595,000 ac-feet. Most STA cells are near target stage except for EAV cells in STA-5/6, which are drying out. STA-1E Western Flow-way is offline for the Restoration Strategies project to fill and grade Cells 5 and 7, and STA-3/4 Eastern Flow-way is offline for vegetation rehabilitation/drawdown. Operational restrictions are in place in STA-1W Western, Eastern, and Northern Flow-ways, and STA-2 Flow-ways 2 for construction activities. Operational restrictions are in effect in STA-1E Central Flow-way, STA-2 Flow-ways 3 and 4, STA-3/4 Central and Western Flow-ways for vegetation management activities. Operational restrictions are also in effect in STA-5/6 Flow-ways 2 and 3 following the Restoration Strategies project to grade non-effective treatment areas. This week, if 2008 LORS recommends Lake releases to the WCAs and conditions allow, releases will be sent to STA-2 and STA-3/4.

Everglades

Dry conditions continue to dominate the ecological conditions across the Everglades Protection Area with a focus on WCA-2A and WCA-3A North, highlighting the need to maintain moderate recession rates in those basins when possible. Wading birds are feeding in large flocks in Lostman's slough, WCA-2A, and western SRS. The focus of wading bird foraging is likely to shift to WCA-1, -2B and -3A South as these areas continue to dry in the next few weeks. Excessive drying in WCA-2A and WCA-3A North could incur other ecological costs for aquatic wildlife, as well as increased risk of peat oxidation and fire risk. All wading bird nesting numbers continue to build as a productive well-above-average nesting season progresses.

SUPPORTING INFORMATION

KISSIMMEE BASIN

Rainfall

The Upper Kissimmee Basin received 0.68 inches of rainfall in the past week and the Lower Basin received 1.50 inches (SFWMD Daily Rainfall Report 04/12/2021).

Upper Kissimmee

Table 1 lists stage and discharge for several KCL water bodies using data from lake outfall structures. KCL stage hydrographs with respective regulation schedules and rainfall are shown in **Figures 1-3**.

Table 1. Ecological conditions for water bodies in the Kissimmee Chain of Lakes.

Report Date: 4/13/2021

Water Body	Structure	7-day Average Discharge (cfs) ¹	Stage Monitoring Site ²	Lake Stage (feet)	Schedule Type ³	Schedule Stage (feet)	Daily Departure (feet)						
							4/11/21	4/4/21	3/28/21	3/21/21	3/14/21	3/7/21	2/28/21
Lakes Hart and Mary Jane	S-62	22	LKMJ	60.3	R	60.5	-0.2	-0.2	-0.3	-0.4	-0.5	-0.3	-0.2
Lakes Myrtle, Preston, and Joel	S-57	0	S-57	60.5	R	60.6	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1
Alligator Chain	S-60	0	ALLI	63.4	R	63.3	0.1	0.0	0.0	-0.1	-0.1	0.0	0.0
Lake Gentry	S-63	3	LKGT	60.8	R	60.8	0.0	0.0	0.1	0.0	-0.1	0.0	-0.1
East Lake Toho	S-59	109	TOHOE	56.4	R	57.0	-0.6	-0.8	-0.9	-1.0	-1.0	-0.5	-0.3
Lake Toho	S-61	206	TOHOW, S-61	53.3	R	54.0	-0.7	-1.0	-1.0	-1.1	-1.1	-0.8	-0.6
Lakes Kissimmee, Cypress, and Hatchineha	S-65	531	KUB011, LKIS5B	50.9	R	50.7	0.2	0.1	0.2	0.4	0.6	0.8	0.7

¹ Seven-day average of weighted daily means through midnight.

² Names of in-lake monitoring sites and structures used to determine lake stage; if more than one site is listed, an average is reported.

³ A = projected ascension line, R = USACE regulation schedule, S = temporary recession target line, T = temporary schedule, N/A = not applicable or data not available.

DATA ARE PROVISIONAL

Lower Kissimmee

Discharges at lower basin structures are shown in **Table 2**. **Figure 4** compares floodplain inundation depths from one year and one month ago with current inundation depths in the Phase I restored area of the Kissimmee River. **Figure 5** shows dissolved oxygen concentration along with S-65A discharge, water temperature and rainfall. **Figure 6** is the current guide for operation of S-65 and S-65A, called the "Preferred Discharge Plan IS-14-50.0". This is developed collaboratively each year between ecologists and water managers based on prevailing ecological and hydrologic conditions. A preferred discharge plan and the interim regulation schedule (**Figure 7**) will be used until the Headwaters Lakes Revitalization regulation schedule is implemented. **Figure 8** is a map of the Kissimmee Basin showing Central and Southern Florida (C&SF) flood control project structures and color-coded watersheds.

Table 2. Ecological conditions at lower Kissimmee basin structures.**Report Date:** 4/13/2021

Metric	Location	1-Day Average		Average for the Preceding 7-Days ¹							
		4/11/2021	4/11/21	4/4/21	3/28/21	3/21/21	3/14/21	3/7/21	2/28/21	2/21/21	2/14/21
Discharge (cfs)	S-65	479	531	805	736	907	906	903	856	835	880
Discharge (cfs)	S-65A ²	455	492	729	652	837	883	888	897	901	887
Discharge (cfs)	S-65D ²	549	636	755	724	901	926	961	1,012	1,038	946
Headwater Stage (feet NGVD)	S-65D ²	25.76	25.77	25.76	25.83	25.66	25.76	25.80	25.80	25.80	25.87
Discharge (cfs)	S-65E ²	653	635	792	702	879	906	949	1,015	1,049	942
Discharge (cfs)	S-67	0	0	0	0	0	0	0	0	0	0
DO (mg/L) ³	Phases I & II/III river channel	7.8	8.2	7.3	7.2	7.6	9.3	8.9	7.3	7.0	8.7
Mean depth (feet) ⁴	Phase I floodplain	0.14	0.13	0.17	0.22	0.34	0.41	0.46	0.53	0.59	0.41

¹Seven-day average of weighted daily means through Sunday midnight.²S-65A discharge combines S-65A with auxiliary structures; S-65D discharge combines discharge at S-65D, S-65DX1, and S-65DX2; S-65D stage averages stage at S-65D and S-65DX1; S-65E discharge combines S-65E and S-65EX1.³DO is the average for sondes at KRBN, PC62, PC33, PD62R, and PD42R.⁴1-day spatial average from South Florida Water Depth Assessment Tool (SFWDAT).

DATA ARE PROVISIONAL; N/A indicates that data were not available.

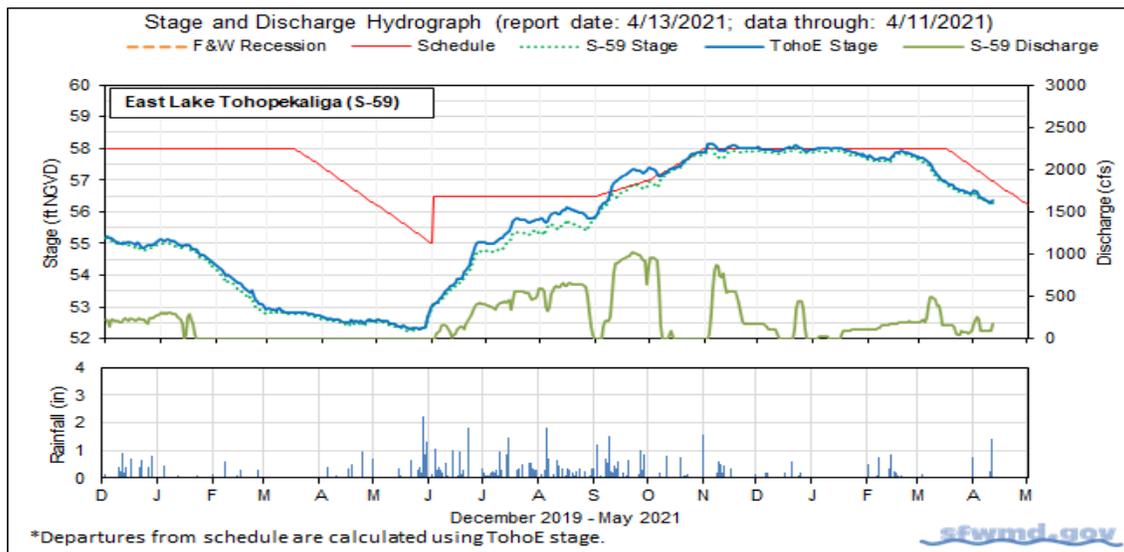


Figure 1. East Lake Toho regulation schedule, stage, discharge and rainfall.

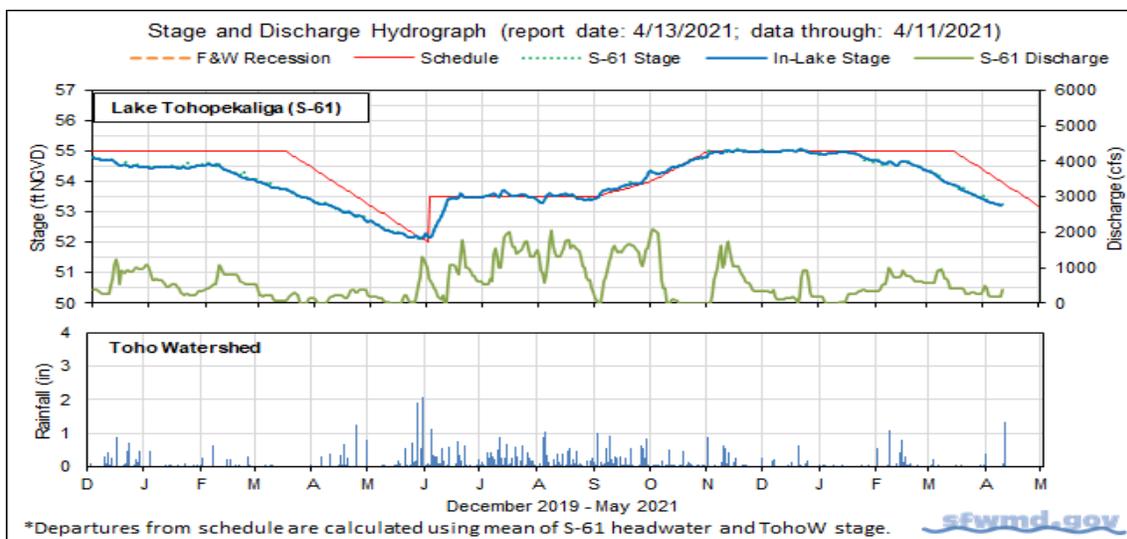


Figure 2. Lake Toho regulation schedule, stage, discharge and rainfall.

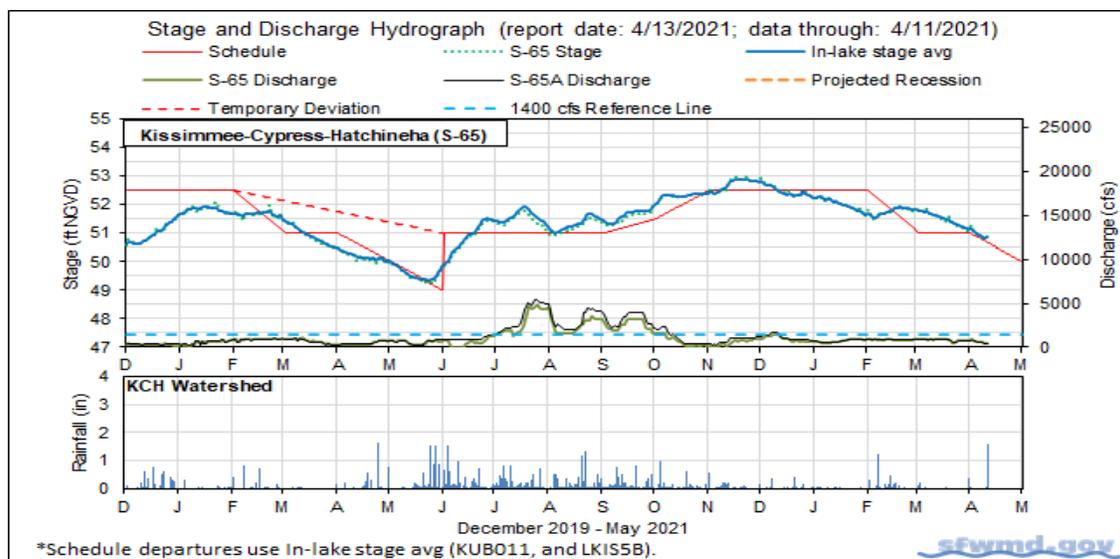


Figure 3. Lakes Kissimmee, Cypress and Hatchineha regulation schedule, stage, discharge and rainfall.

Kissimmee River Phase I Restoration Area Water Depth Maps

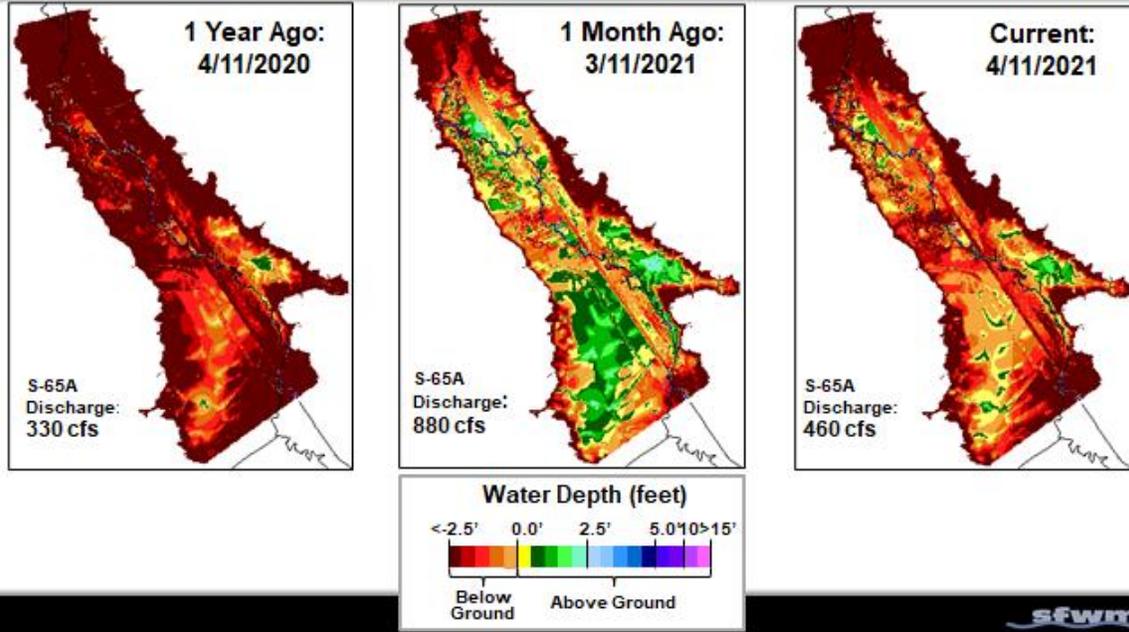
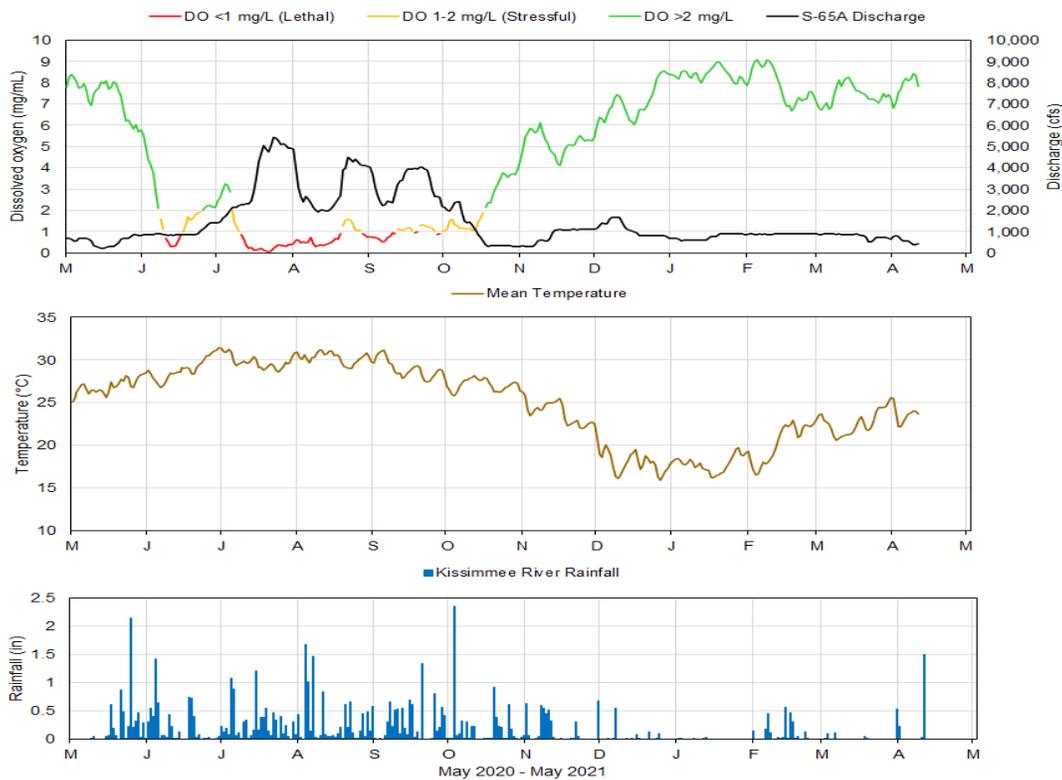


Figure 4. Phase I area floodplain water depths (from left to right) one year ago, one month ago and current. Color-coding has been modified to accommodate greater water depths; these maps are not directly comparable to Kissimmee Basin WDAT maps published prior to January 16, 2012.



Dissolved oxygen (DO) and temperature are mean daily values averaged for PC62, KRBN, PC33, PD62R and PD42R with an average of 3 stations reporting this week. Rainfall values are daily totals for Kissimmee River (Pool BCD) AHED watershed.
Report Date: 4/13/2021; data are through: 4/11/2021

Figure 5. Restored Kissimmee river channel mean daily dissolved oxygen concentration (mg/L), S-65A discharge (cfs), temperature (°C) and rainfall (inches)

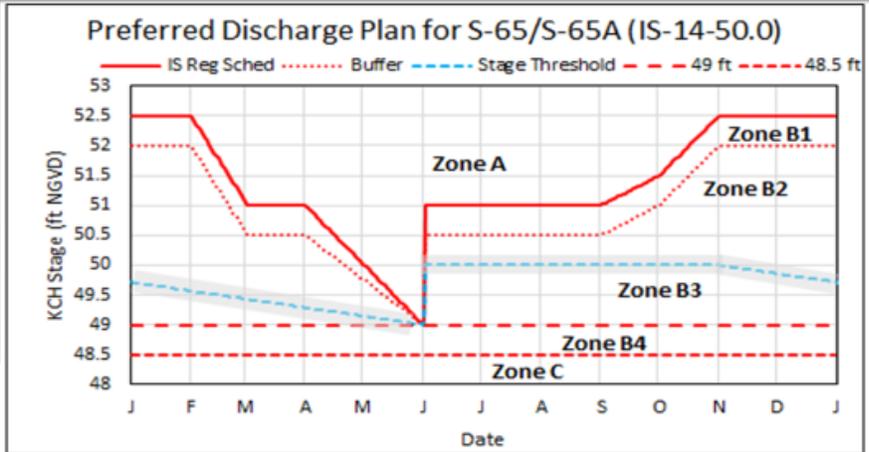
Stage and Discharge Guidance for 2019-2020.		
Zone	KCH Stage (ft NGVD)	S-65/S-65A Discharge*
A	Above regulation schedule line.	Flood control releases as needed with no limits on the rate of discharge change.
B1	In flood control buffer zone (0.5 ft below the schedule line).	Adjust S-65 discharge so that S-65A discharge is between 1400 cfs at the buffer zone line and 3000 cfs at the schedule line.
B2	Between the Flood Control Buffer and the 50.0 ft line.	Adjust S-65 discharge to maintain at least 1400 cfs at S-65A. Use ± 0.2 ft buffer (gray band) above and below the 50.0 ft line to decide when to begin ramping up to 1400 cfs or down to 300 cfs; do not continue reducing discharge if stage rises back to or above the threshold stage line.
B3	Between the 50.0 ft line and 49 ft.	Adjust S-65 discharge to maintain at least 300 cfs at S-65A.
B4	Between 48.5 ft to 49 ft.	Adjust S-65 discharge to maintain S-65A discharge between 0 cfs at 48.5 ft and 300 cfs at 49 ft.
C	Below 48.5 ft.	0 cfs.

*Changes in discharge should not exceed limits in inset table below.

Discharge Rate of Change Limits for S65/S65A (revised 7/13/18).		
Q (cfs)	Maximum rate of increase (cfs/day)	Maximum rate of decrease (cfs/day)
0-300	50	-50
301-650	75	-75
651-1400	150	-150
1401-3000	300	-600
>3000	1000	-2000

Revised 5/16/2019

2019-2020 Discharge Plan S-65/S65A



- Other Considerations
- When possible, limit lake ascension rate in the Jun 1 - Aug 15 window to 0.5 ft per 14 days in Lakes Kissimmee, Cypress, Hatchineha (S-65), East Toho (S-59) and Toho (S-61).
 - If outlook is for extreme dry conditions meet with KB staff to discuss modifications to this plan.

Figure 6. The 2019-2020 Discharge Plan for S-65/S-65A.

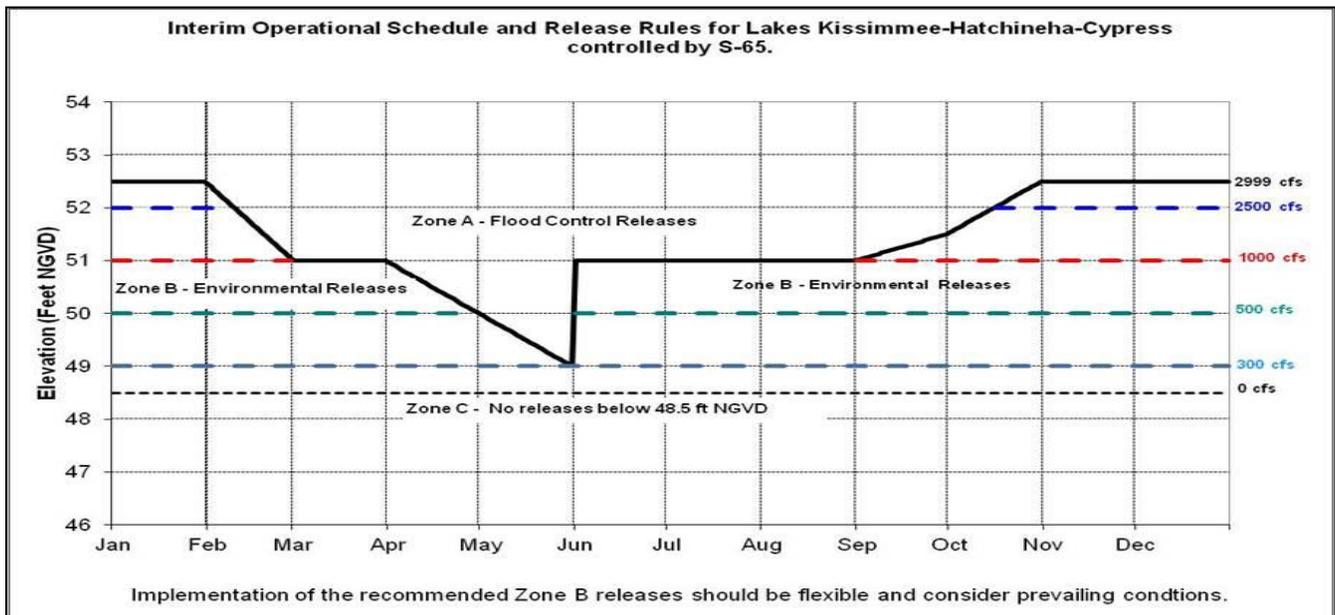


Figure 7. Interim operations schedule for S-65 (solid black line).

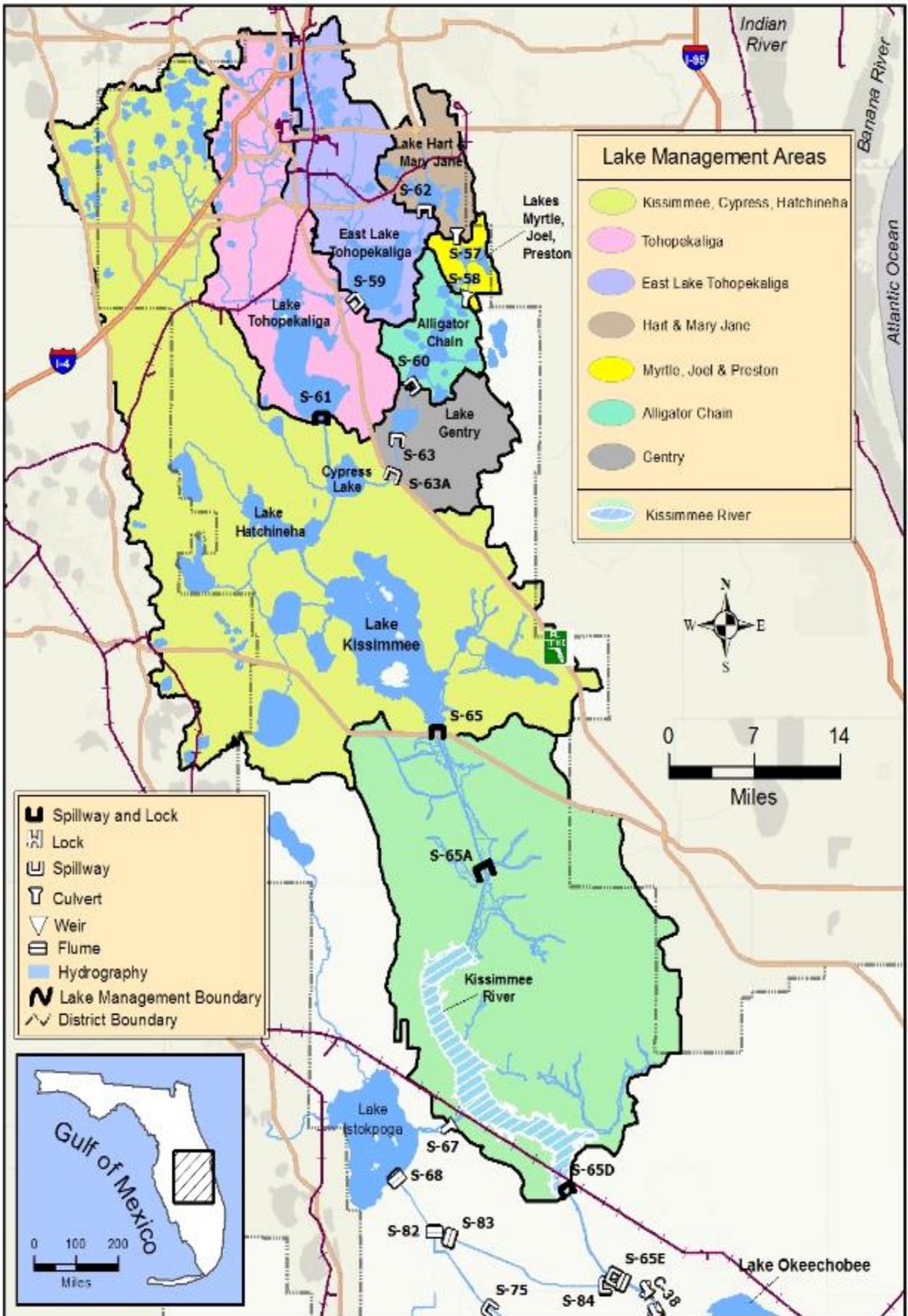


Figure 8. The Kissimmee Basin.

LAKE OKEECHOBEE

Lake Okeechobee stage was 14.16 feet NGVD on April 11, 2021, 0.90 feet lower than a month ago, and 2.67 feet higher than one year ago (**Figure 1**). Lake stages rose into the lower portion of the preferred ecological envelope on June 2, 2020 (**Figure 2**) and had been above the envelope since August 1, 2020. Lake stage reentered the envelope on March 30, 2021, and is still in the Low sub-band. Lake stage reached a low of 10.99 feet on May 17 and a high of 16.45 feet on November 12 (post Tropical Storm Eta), a difference of 5.5 feet (**Figure 3**). Lake stage declined slowly from mid-November through mid-February, but recession rates have been high over the past several weeks. At the end of this week, stage began increasing from the weekend rain event. According to NEXRAD, 1.36 inches of rain fell directly on the Lake; most northern regions received between 1.5 and 3 inches of rain, while less than 1.5 inches fell in most southcentral portions. The district-wide average was 1.5 inches (**Figure 4**).

Average daily inflows (excluding rainfall) decreased from the previous week, declining from 826 cubic feet per second (cfs) to 677 cfs. Outflows (excluding evapotranspiration) also decreased, going from 3,429 cfs to 3,203 cfs. Over 94% of the inflows came from the Kissimmee River (635 cfs through S-65E and S-65EX1). Releases to the west via S-77 decreased from 1,524 cfs the prior week to 1,089 cfs, and releases east via S-308 dropped from 279 cfs to 183 cfs. Releases south through the S-350 structures increased, going from 1,287 cfs to 1,589 cfs. Average inflows and outflows through water control structures surrounding the Lake for the previous two weeks are shown in **Table 1**. The resultant Lake elevation change in inches due to each structure's flow for the past week is also shown in **Table 1**. **Figure 5** shows the combined average daily cfs for inflows and outflows for the Lake over the past eight weeks. These data are provisional and are subject to change.

Water quality sampling is now operating from the non-bloom season schedule (November–April), occurring once monthly at 32 stations for chlorophyll *a*, and at nine stations for taxonomic identification and toxin analyses. Most of the April sampling occurred on the 6th and 7th (**Figure 6**). Six of the samples from the nine algal ID stations had detectable levels of cyanotoxins (but well below 8 µg/L) and the algal community was dominated by the cyanobacteria *Microcystis*. Chlorophyll *a* results are pending. The most recent satellite image (April 10, 2021) from the NOAA cyanobacteria monitoring product derived from EUMETSAT's Sentinel 3 OLCI sensor data showed continued low bloom potential on the Lake (**Figure 7**).

Table 1. Average daily inflows and outflows for the most recent two weeks and approximate depth equivalents on Lake Okeechobee for various structures.

INFLOWS	Previous week Avg Daily CFS	Avg Daily Flow cfs	Equivalent Depth Week Total (in)	OUTFLOWS	Previous week Avg Daily CFS	Avg Daily Flow cfs	Equivalent Depth Week Total (in)
S-65E & S-65EX1	792	635	0.3	S-77	1524	1089	0.4
S-71 & S-72	0	2	0.0	S-308	279	183	0.1
S-84 & S-84X	0	0	0.0	S-351	570	740	0.3
Fisheating Creek	13	22	0.0	S-352	557	618	0.3
S-154	0	0	0.0	S-354	160	231	0.1
S-191	14	0	0.0	L-8 Outflow	338	342	0.1
S-133 P	0	11	0.0	ET	2669	2940	1.2
S-127 P	0	0	0.0	Total	6097	6143	2.5
S-129 P	0	0	0.0				
S-131 P	0	7	0.0				
S-135 P	0	0	0.0				
S-2 P	7	0	0.0				
S-3 P	0	0	0.0				
S-4 P	0	0	0.0				
L-8 Backflow							
Rainfall	1861	3644	1.5				
Total	2687	4321	1.8				

Provisional Data

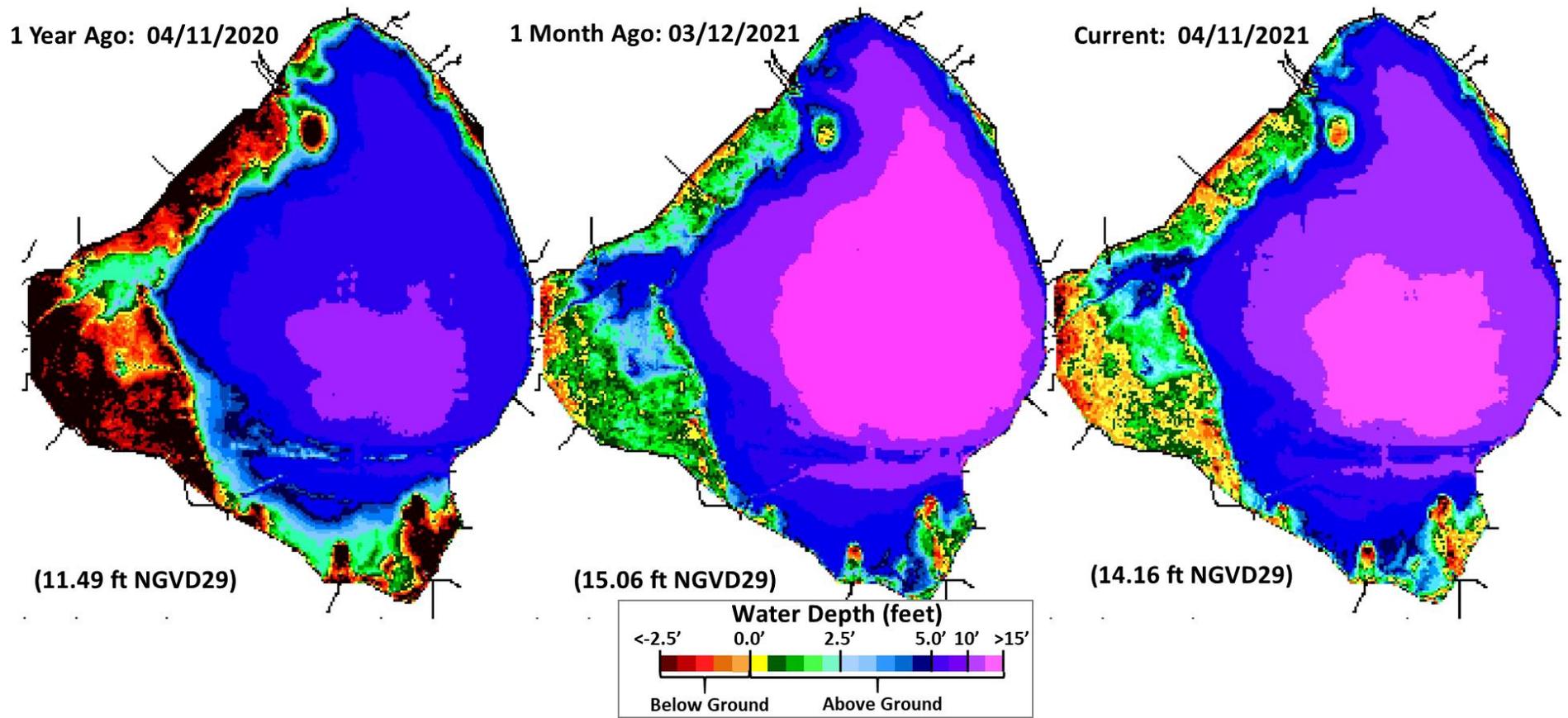


Figure 1. Water depth estimates on Lake Okeechobee based on the South Florida Water Depth Assessment Tool.

Lake Okeechobee Stage vs Updated Ecological Envelope

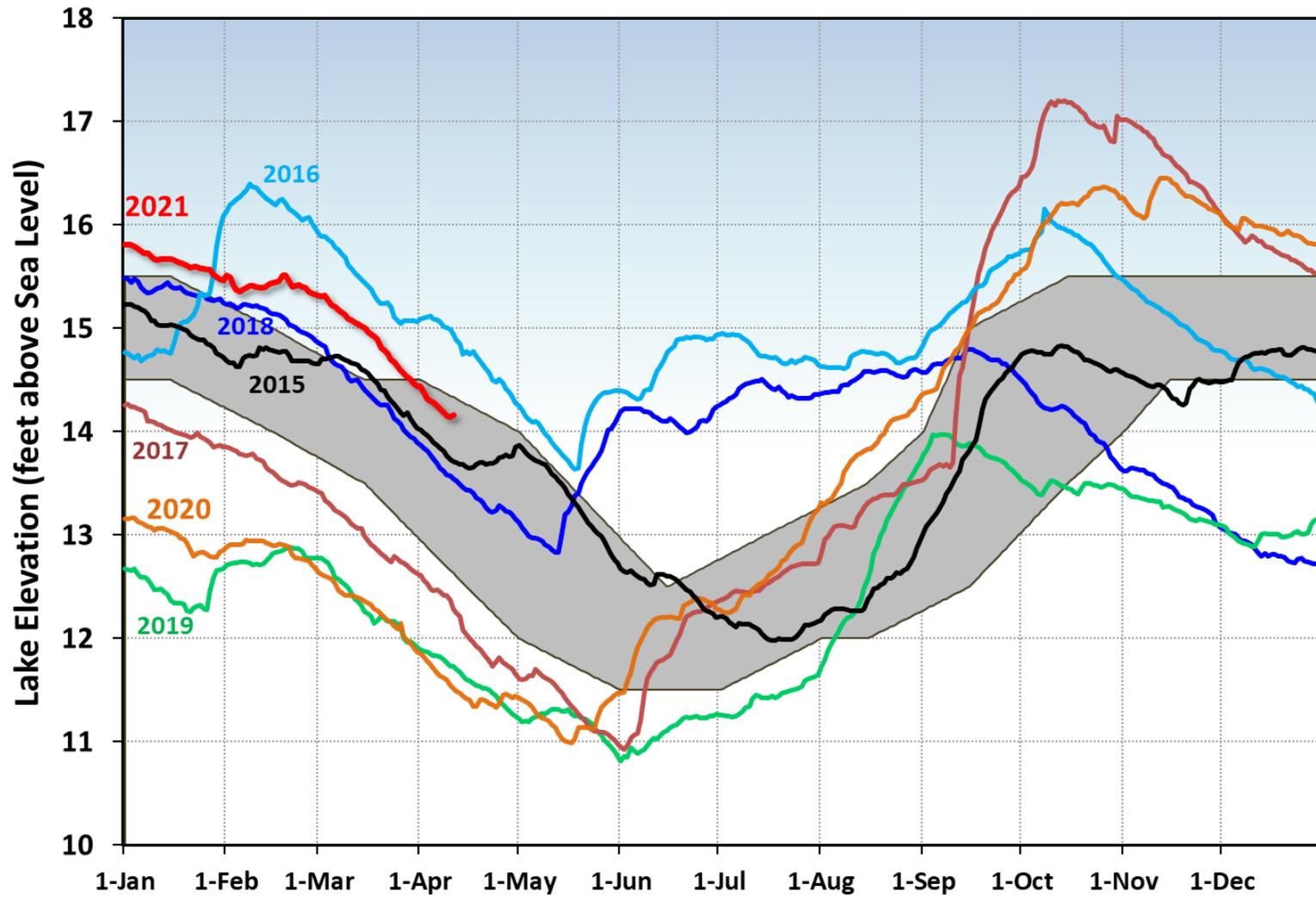


Figure 2. Select annual stage hydrographs for Lake Okeechobee in comparison to the updated Ecological Envelope.

Lake Okeechobee Water Level History and Projected Stages

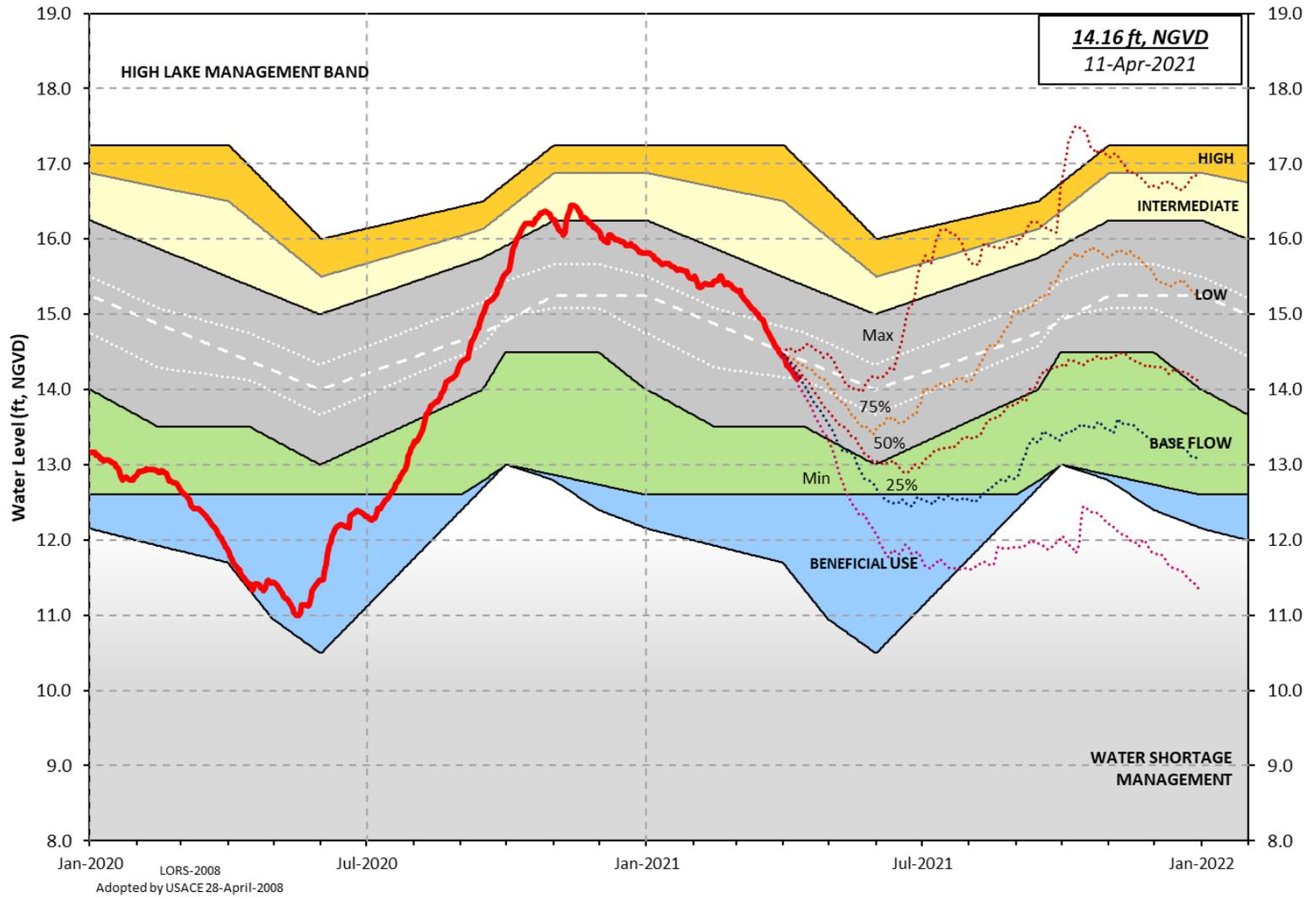


Figure 3. Recent Lake Okeechobee stages and releases, with projected stages based on a dynamic position analysis.

SFWM D PROVISIONAL RAINDAR 7-DAY BASIN RAINFALL ESTIMATES

FROM: 0400 EST, 04/05/2021 THROUGH: 0400 EST, 04/12/2021

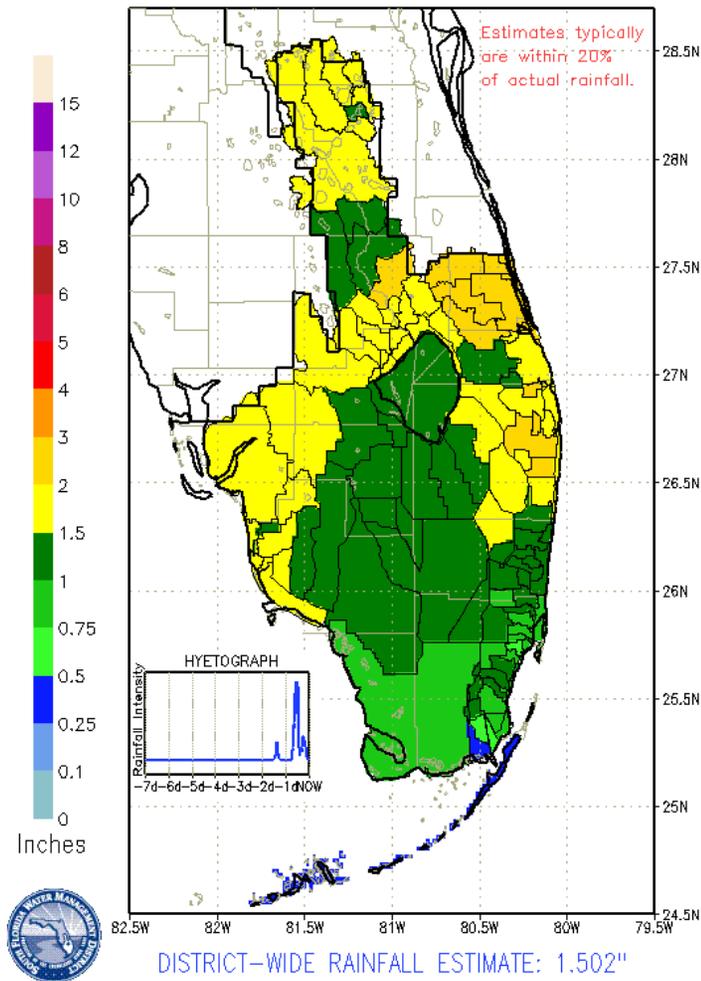


Figure 4. 7-Day rainfall estimates by RAINDAR.

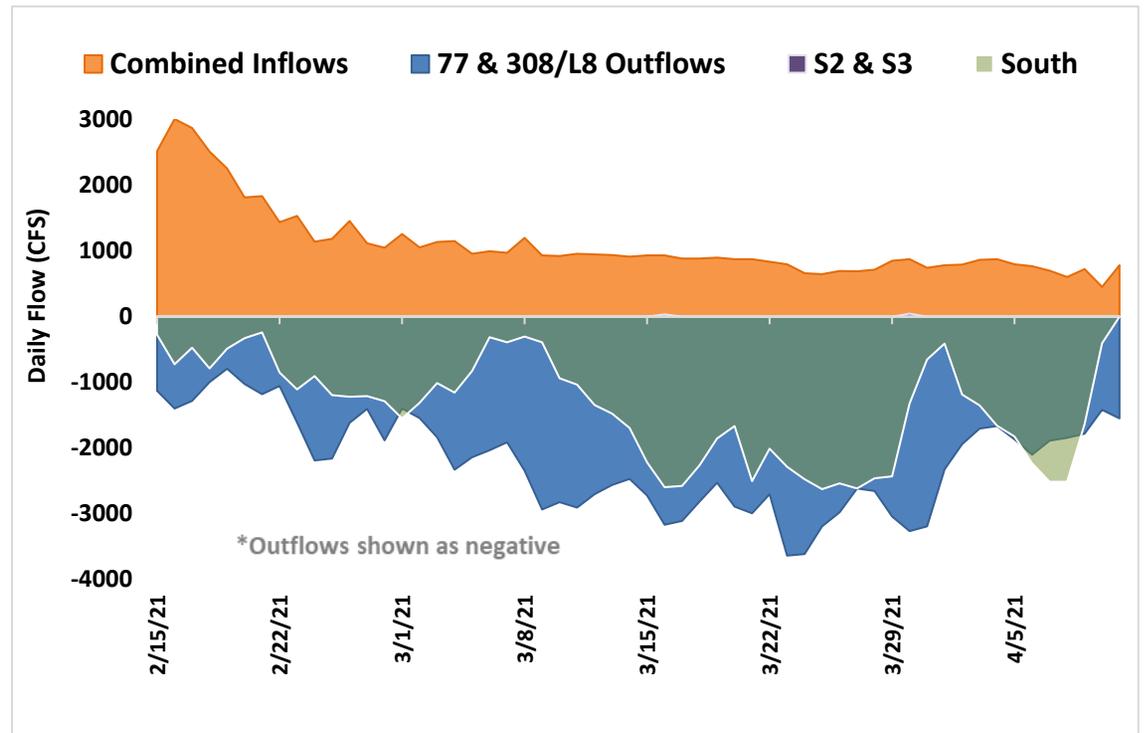


Figure 5. Major inflows (orange) and outflows (blue) of Lake Okeechobee, including the S-350 structures designated as South (green). The L-8 Canal flows through Culvert 10A are included as outflows when positive, and as inflows when backflowing into the Lake. All inflows and outflows are shown as positive and negative, respectively, for visual purposes. Outflows through the S-77 and S-308 structures are shown based on their downstream gauges to account for lock openings for navigation.

Collection Date: April 6-7, 2021

Station	CHL α (ug/L)	TOXIN (ug/L)	TAXA
FEBIN			
FEBOUT			
KISSR0.0	P	0.4	<i>Microcys</i>
L005	P	0.8	<i>Microcys</i>
LZ2	P	0.5	<i>Microcys</i>
KBARSE	P	BDL	NS
RITTAE2	P	BDL	mixed
PELBAY3	P		
POLE3S	P		
LZ25A	P		
PALMOUT	P	1.1	<i>Microcys</i>
PALMOUT1	P		
PALMOUT2	P		
PALMOUT3	P		
POLESOUT	P	0.6	<i>Microcys</i>
POLESOUT1	P		
POLESOUT2	P		
POLESOUT3	P		
EASTSHORE	P		
NES135	P		
NES191	P		

Station	CHL α (ug/L)	TOXIN (ug/L)	TAXA
L001	P		
L004	P		
L006	P		
L007	P		
L008	P		
LZ30	P	1.1	<i>Microcys</i>
LZ40	P		
CLV10A	P	BDL	mixed
NCENTER	P		

sampled 4/5

S308C	P	0.3	mixed
S77	P	0.5	<i>Microcys</i>

- SFWMD considers >40 $\mu\text{g/L}$ Chlorophyll a (Chl a) an algal bloom
- BDL – Below Detectable Limit of **0.25** $\mu\text{g/L}$
- ND – No Dominant taxa
- P – Pending
- NS – Not Sampled
- Bold – crew observed possible BGA
- Chlorophyll a analyzed by SFWMD
- Toxin and Taxa analyzed by FDEP

Cylindro = *Cylindrospermopsis*
Planktol = *Planktolyngbya*
Dolicho = *Dolichospermum*

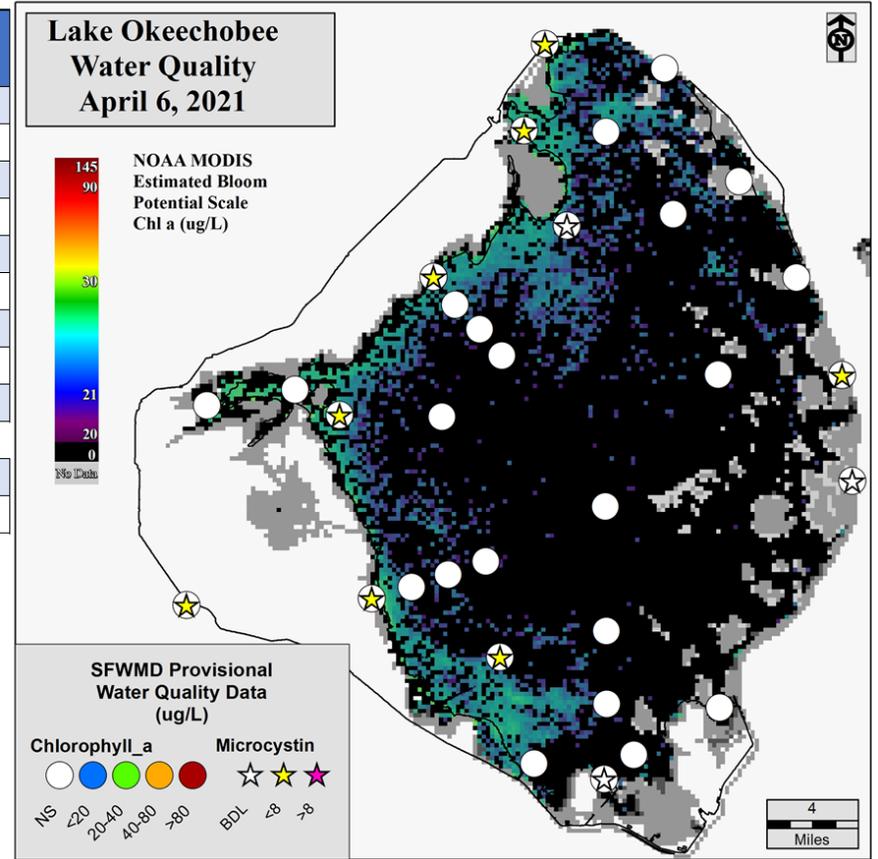


Figure 6. Provisional results from the expanded monitoring sampling trips April 6-7, 2021.

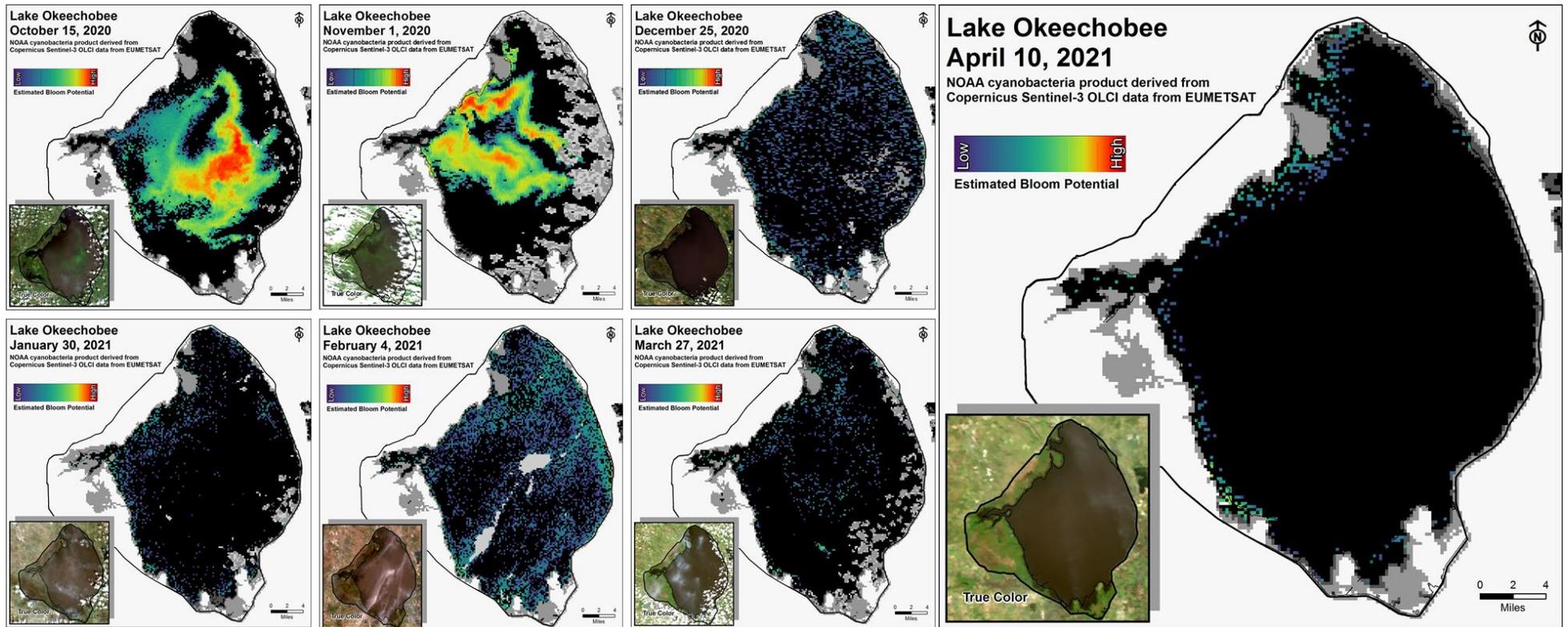


Figure 7. Cyanobacteria bloom potential based on NOAA's harmful algal bloom monitoring system. Gray color indicates cloud cover.

ESTUARIES

St. Lucie Estuary:

Over the past week, total inflow to the St. Lucie Estuary averaged approximately 674 cfs (**Figures 1 and 2**), while the previous 30-day inflow averaged approximately 632 cfs. This past week's provisional averaged inflows from the tidal basin and the structures are shown in **Table 1**.

Table 1. Weekly average inflows (data are provisional). Note: flows for S-97 were estimated using S-48.

Location	Flow (cfs)
S-308	183
S-80	322
S-97 on C-23	3
S-49 on C-24	0
Gordy Road structure on Ten Mile Creek	51
Tidal Basin Inflow	298

Over the past week, surface salinity decreased while bottom salinity increased at the HR1 site. Salinity increased at the US1 Bridge site and decreased at the A1A Bridge site (**Table 2, Figures 3 and 4**). The seven-day moving average of salinity for the water column (an average of the surface and bottom salinity) at the US1 Bridge was 16.8. Salinity conditions in the middle estuary are estimated to be within the good range for adult eastern oysters (**Figure 4**).

Table 2. Seven-day average salinity at three monitoring sites in the St. Lucie Estuary. Current average is in bold face type, previous average in parentheses. The envelope reflects the preferred salinity range for adult eastern oysters (*Crassostrea virginica*) in the middle estuary.

Sampling Site	Surface	Bottom	Envelope
HR1 (North Fork)	12.5 (12.9)	13.5 (13.0)	NA ¹
US1 Bridge	15.6 (14.7)	17.9 (16.0)	10.0-26.0
A1A Bridge	24.1 (25.0)	27.6 (28.3)	NA ¹

Envelope not applicable

Caloosahatchee Estuary:

Over the past week, total inflow to the Caloosahatchee Estuary averaged approximately 1,119 cfs (**Figures 5 and 6**) while the previous 30-day inflow averaged about 1,745 cfs. This past week's provisional averaged inflows from the structures and the tidal basin are shown in **Table 3**.

Table 3. Weekly average inflows (data is provisional).

Location	Flow (cfs)
S-77	1089
S-78	823
S-79	1061
Tidal Basin Inflow	58

Over the past week, salinities increased at all sites throughout the estuary (**Table 4, Figures 7 and 8**). The seven-day average surface salinity values were within the good range (10-30) for adult eastern oysters at Cape Coral and Shell Point, and in the fair range at Sanibel (**Figure 9**). The seven-day average surface salinities (**Table 4**) are in the good range (0-10) for tape grass at Val I-75 and at Ft. Myers.

Table 4. Seven-day average salinity at six monitoring stations in the Caloosahatchee Estuary. Current average is in bold, previous average in parentheses. The envelope at Val I-75 is for the protection of tape grass in the upper estuary and the envelope in the lower estuary reflects the preferred salinity range for adult eastern oysters (*Crassostrea virginica*).

Sampling Site	Surface	Bottom	Envelope
S-79 (Franklin Lock)	0.6 (0.2)	0.7 (0.2)	NA ¹
Val I-75	0.6 (0.2)	1.3 (0.2)	0.0-0.5 ²
Ft. Myers Yacht Basin	2.9 (2.1)	4.0 (2.4)	NA ¹
Cape Coral	13.3 (10.6)	16.0 (12.0)	10.0-30.0
Shell Point	26.9 (24.8)	27.7 (25.6)	10.0-30.0
Sanibel	30.3 (29.5)	31.8 (31.0)	10.0-30.0

¹Envelope not applicable and ²Envelope is based on a 2-week forecast 30-day average

Forecast of surface salinity (**Table 5** and **Figure 10**) at Val I-75 for the next two weeks using the autoregression model (Qiu and Wan, 2013) coupled with a linear reservoir model for the tidal basin predicts daily salinity to be 2.1 or lower at the end of the two week period via pulse release at S-79 ranging from 0 to 1500 cfs and a steady release of 2000 cfs at S-79. Tidal Basin inflows are estimated to be 60 cfs. The 30-day moving average surface salinity at Val I-75 is forecast to be 0.6 or lower (**Table 5**). The current salinity conditions at Val I-75 are within the envelope of salinity (0.0-5.0) for this site (**Table 4**).

Table 5. Predicted salinity at Val I-75 at the end of forecast period.

Scenario	S-79 (cfs)	Tidal Basin Runoff (cfs)	Daily Salinity	30-Day Mean
A	0	60	2.1	0.6
B	450	60	1.1	0.5
C	1000	60	0.4	0.4
D	1500	60	0.3	0.3
E	2000	60	0.3	0.3

Red tide:

The Florida Fish and Wildlife Research Institute reported on April 9, 2021, that *Karenia brevis*, the Florida red tide dinoflagellate, was observed at background to very low concentrations in Lee County and very low to medium concentrations in Collier County. On the east coast, red tide was not observed in samples from St. Lucie, Martin or Palm Beach counties.

Water Management Recommendations

Lake stage is in the Low Sub-Band. Tributary conditions are normal. The LORS2008 release guidance suggests up to 450 cfs release at S-79 to the Caloosahatchee Estuary and up to 200 cfs release at S-80 to the St. Lucie Estuary.

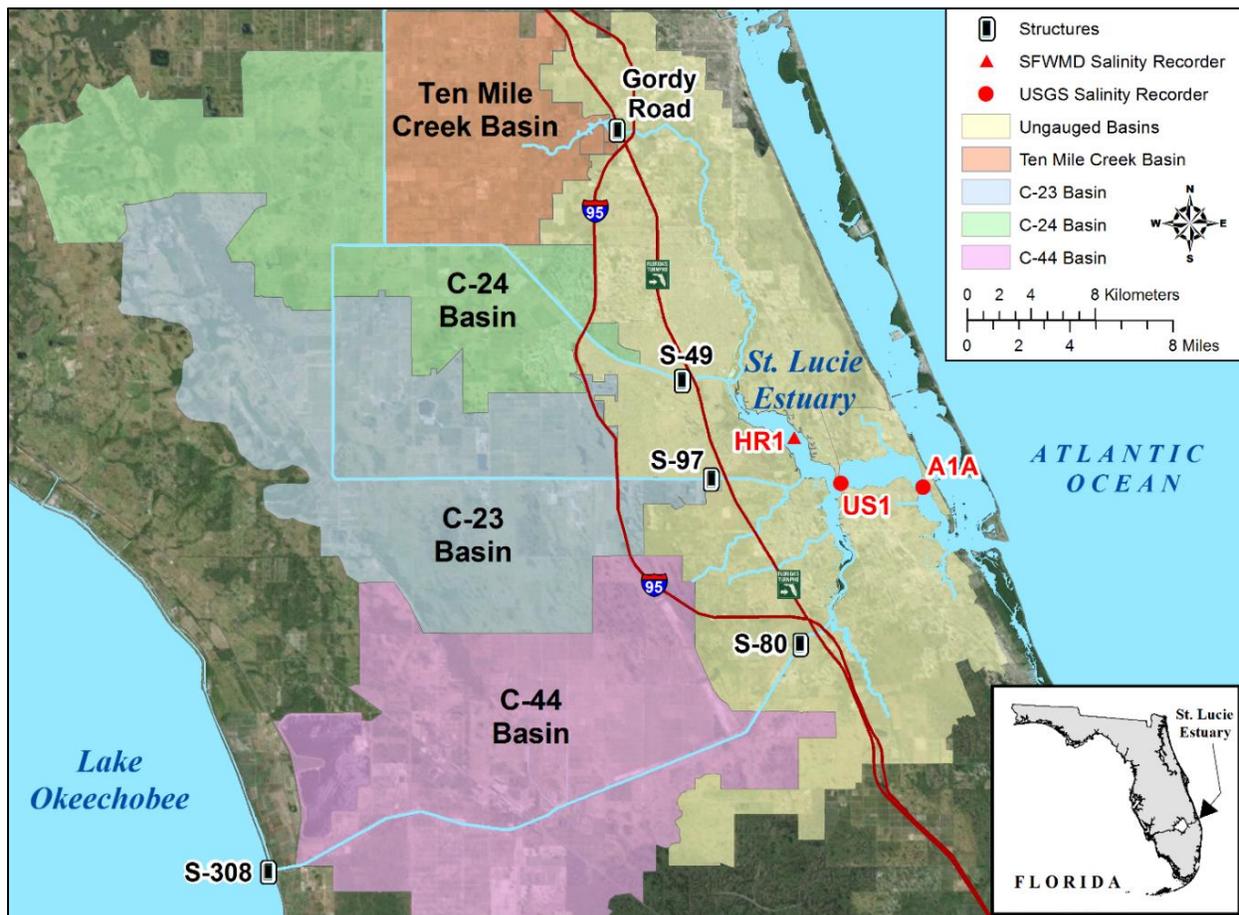


Figure 1. Basins, water control structures, and salinity monitoring for the St. Lucie Estuary.

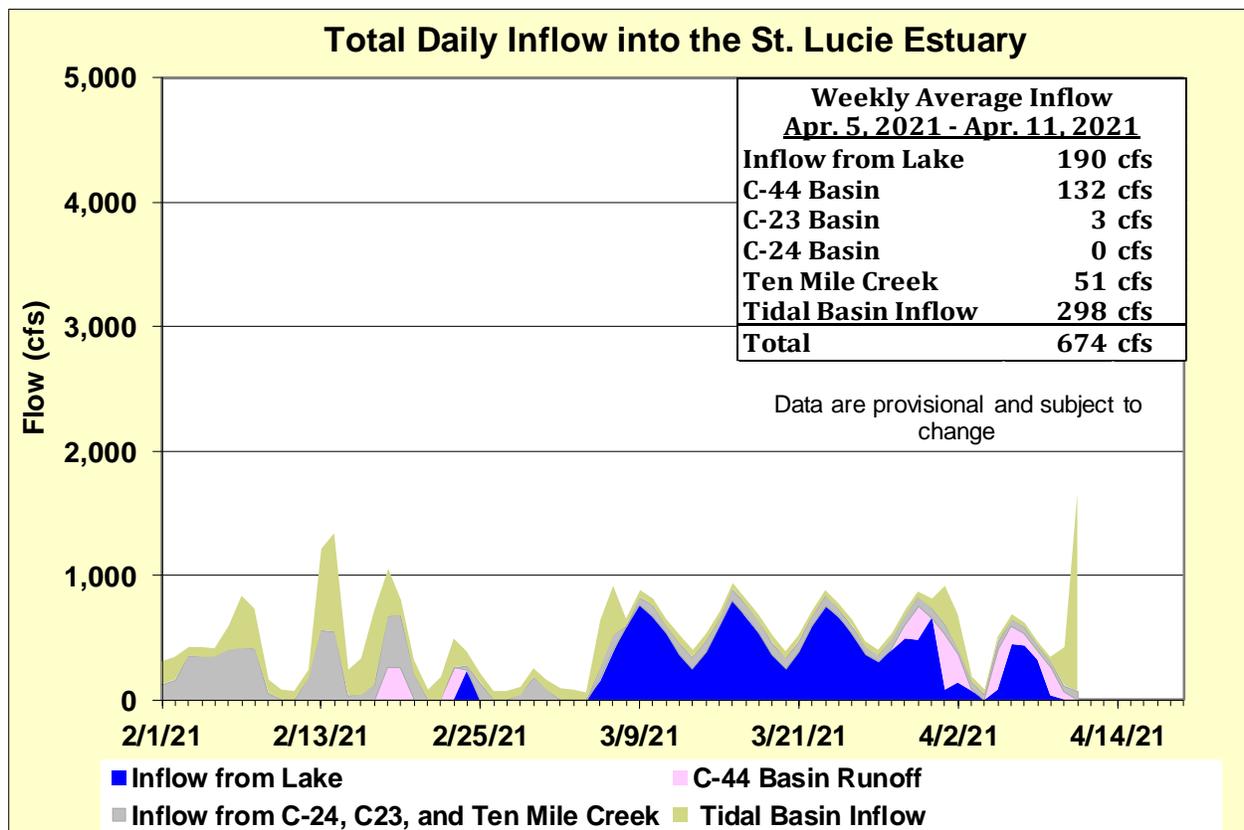


Figure 2. Total daily inflows from Lake Okeechobee and runoff from the C-44, C-23, C-24, Ten Mile Creek, and tidal basin into the St. Lucie Estuary. Note: C-23 Basin inflows were estimated using S-48.

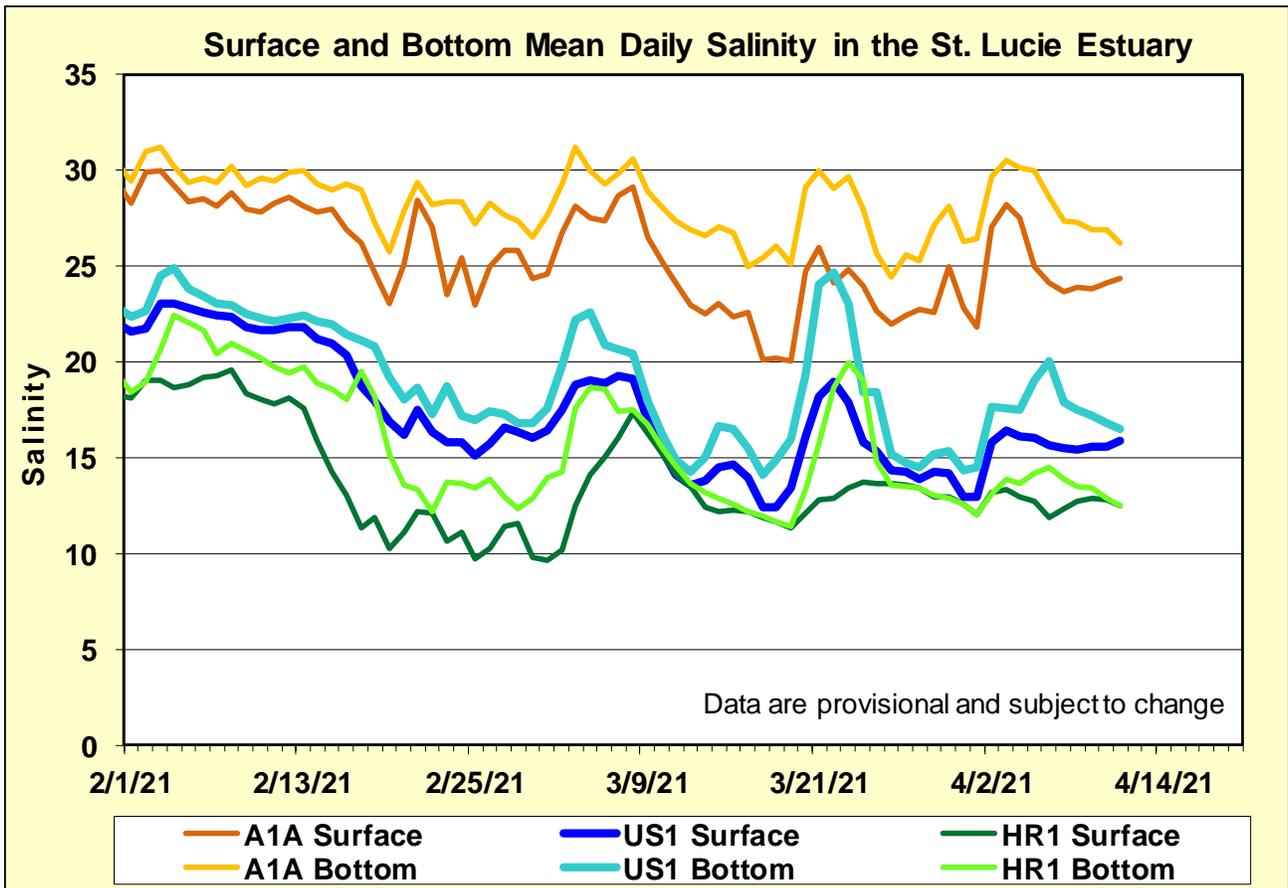


Figure 3. Daily mean salinity at the A1A, US1, and HR1 stations.

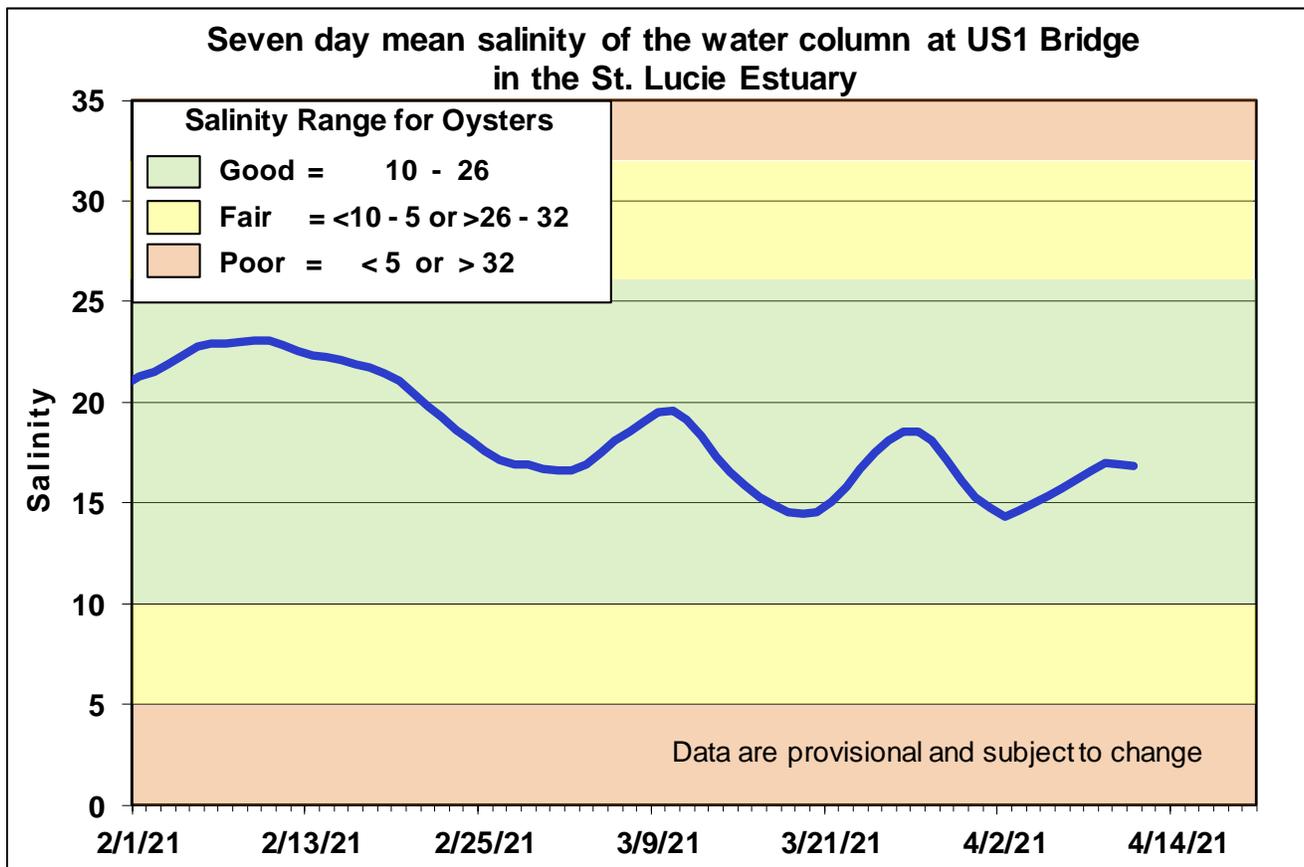


Figure 4. Seven-day mean salinity of the water column at the US1 Bridge.

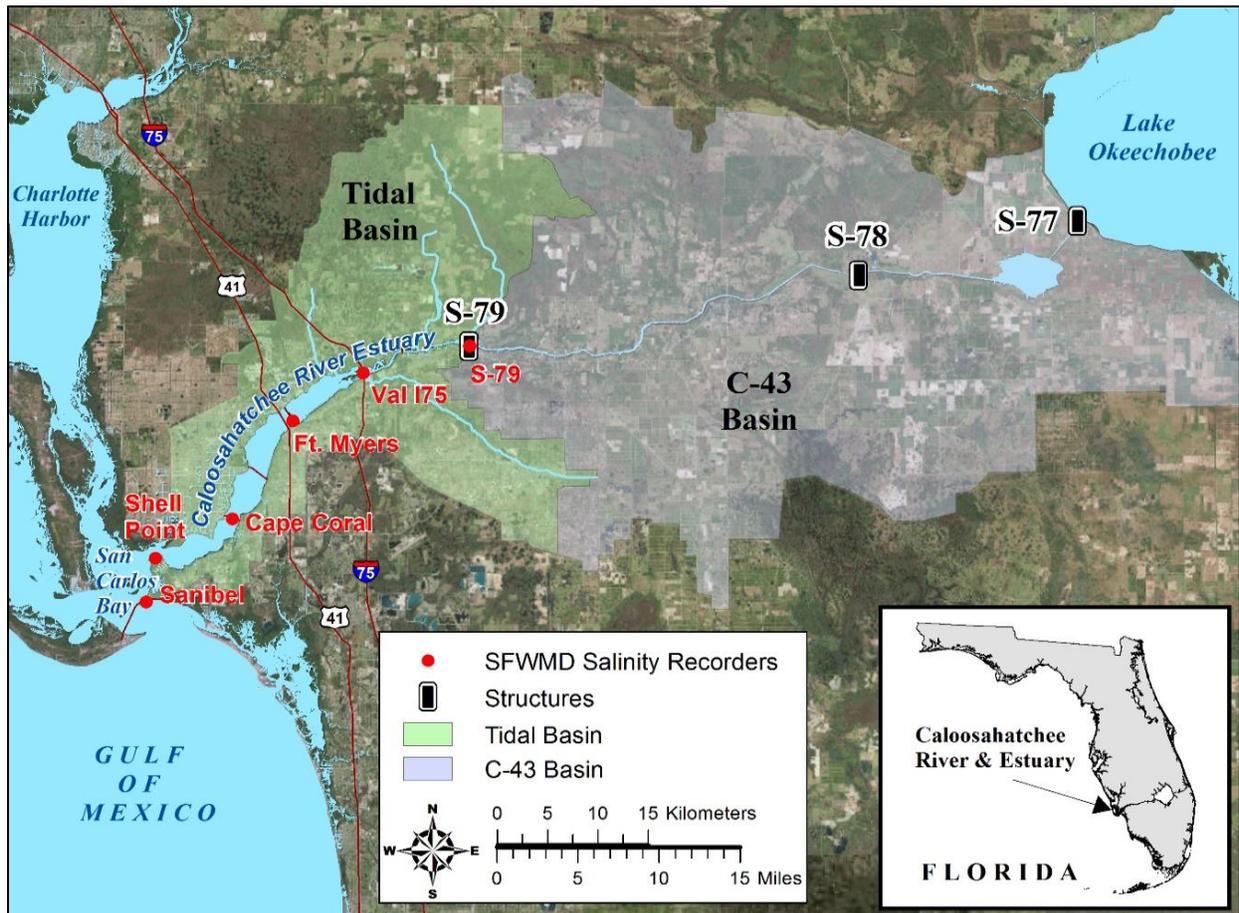


Figure 5. Basins, water control structures, and salinity monitoring for the Caloosahatchee Estuary.

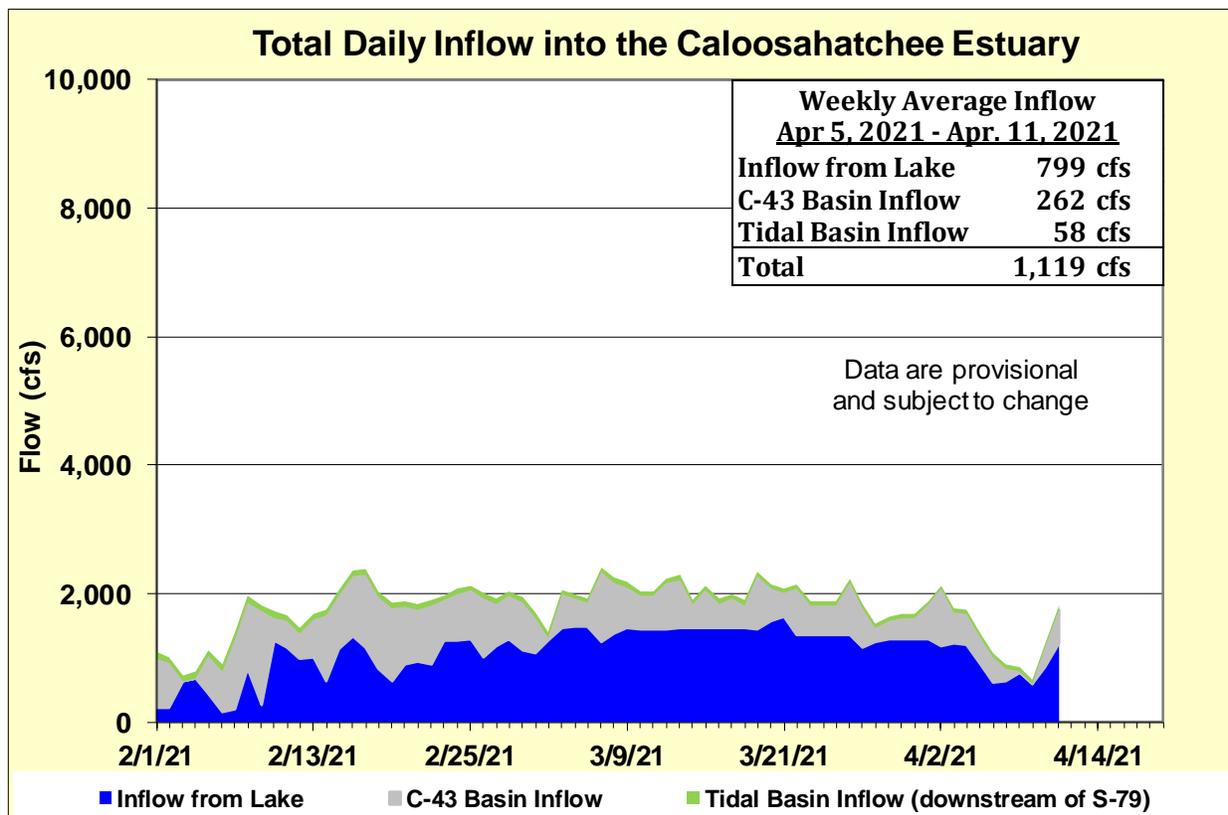


Figure 6. Total daily inflows from Lake Okeechobee, runoff from the C-43 basin and tributaries in the tidal basin into the Caloosahatchee River Estuary.

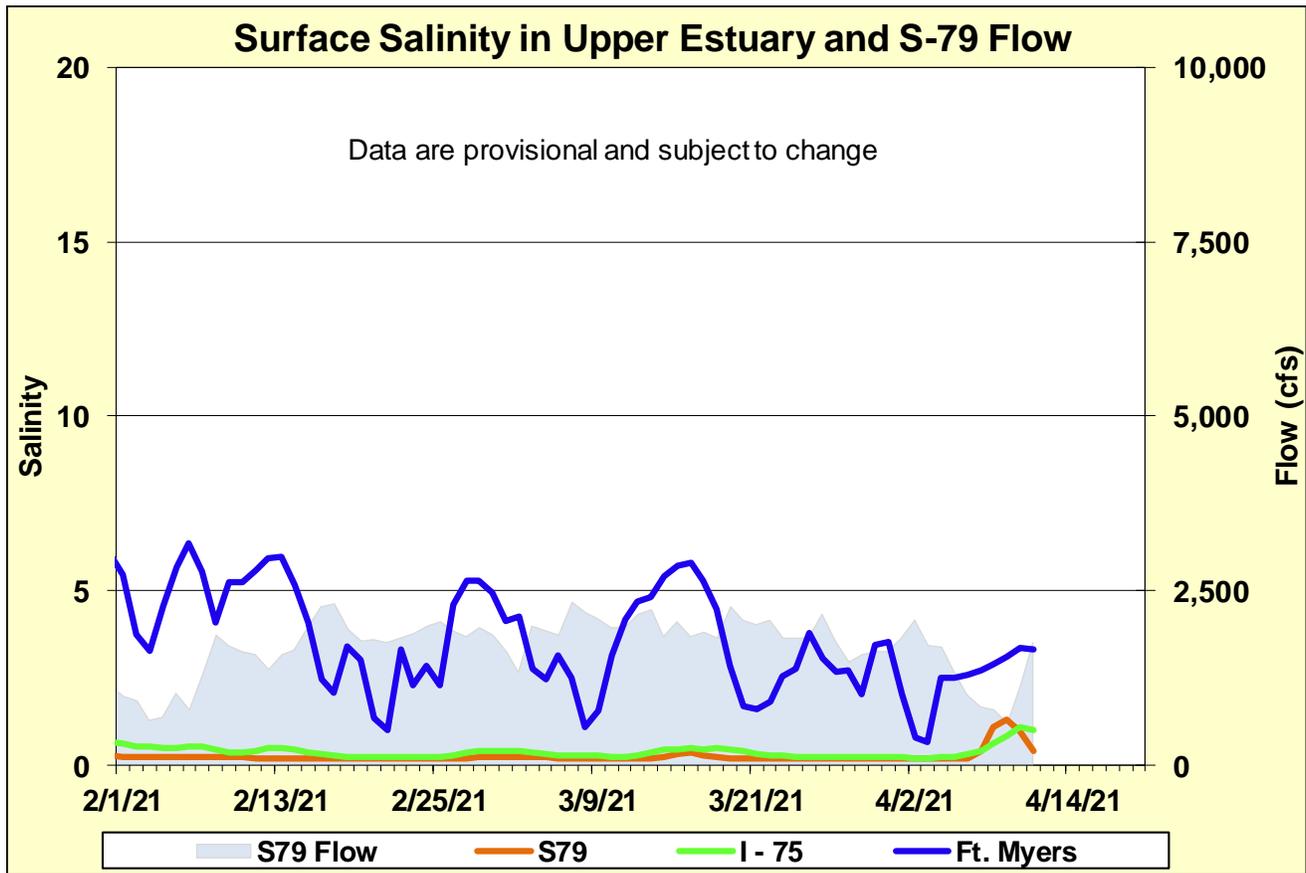


Figure 7. Daily mean flows at S-79 and salinity at upper estuary monitoring stations.

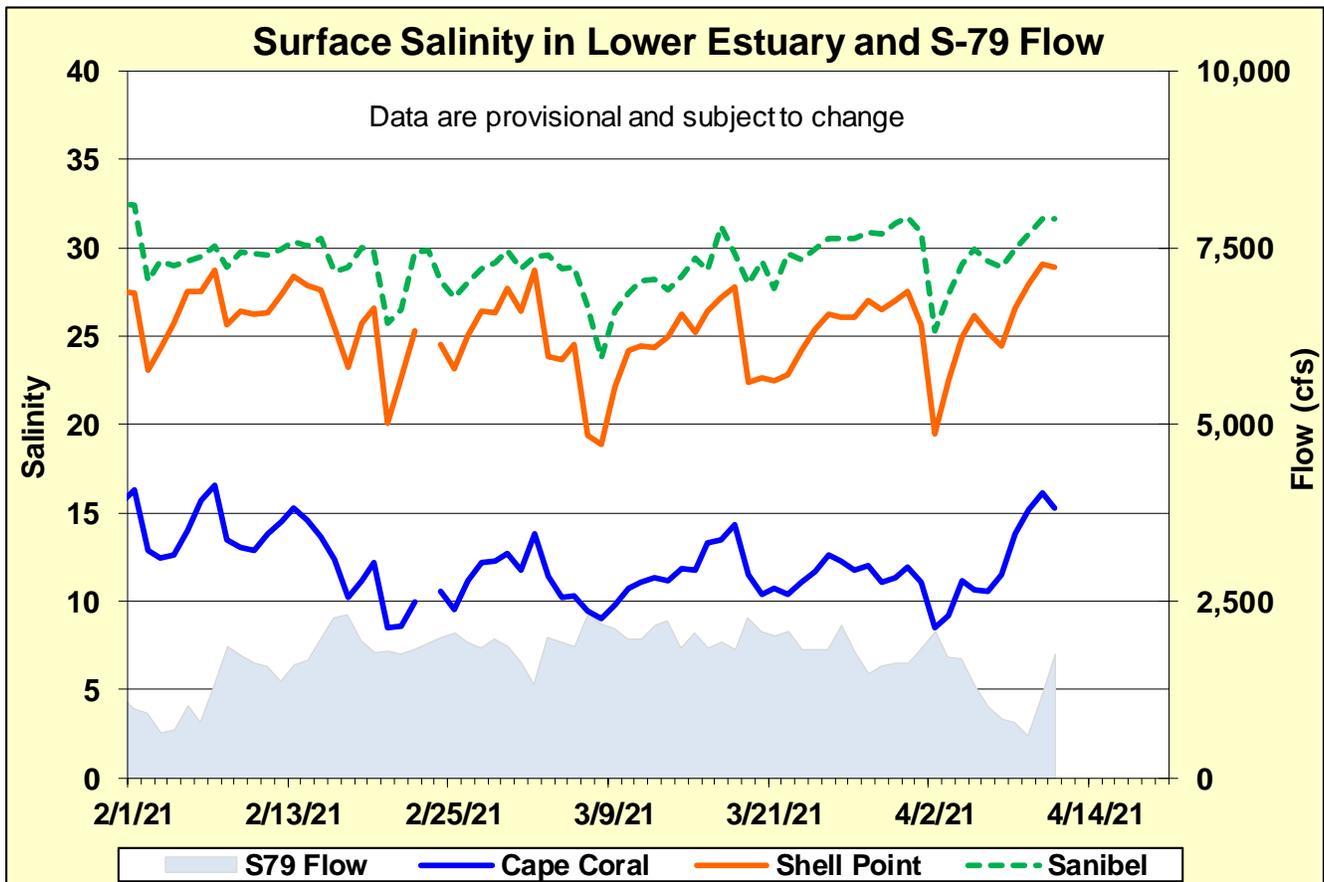


Figure 8. Daily mean flows at S-79 and salinity at lower estuary stations.

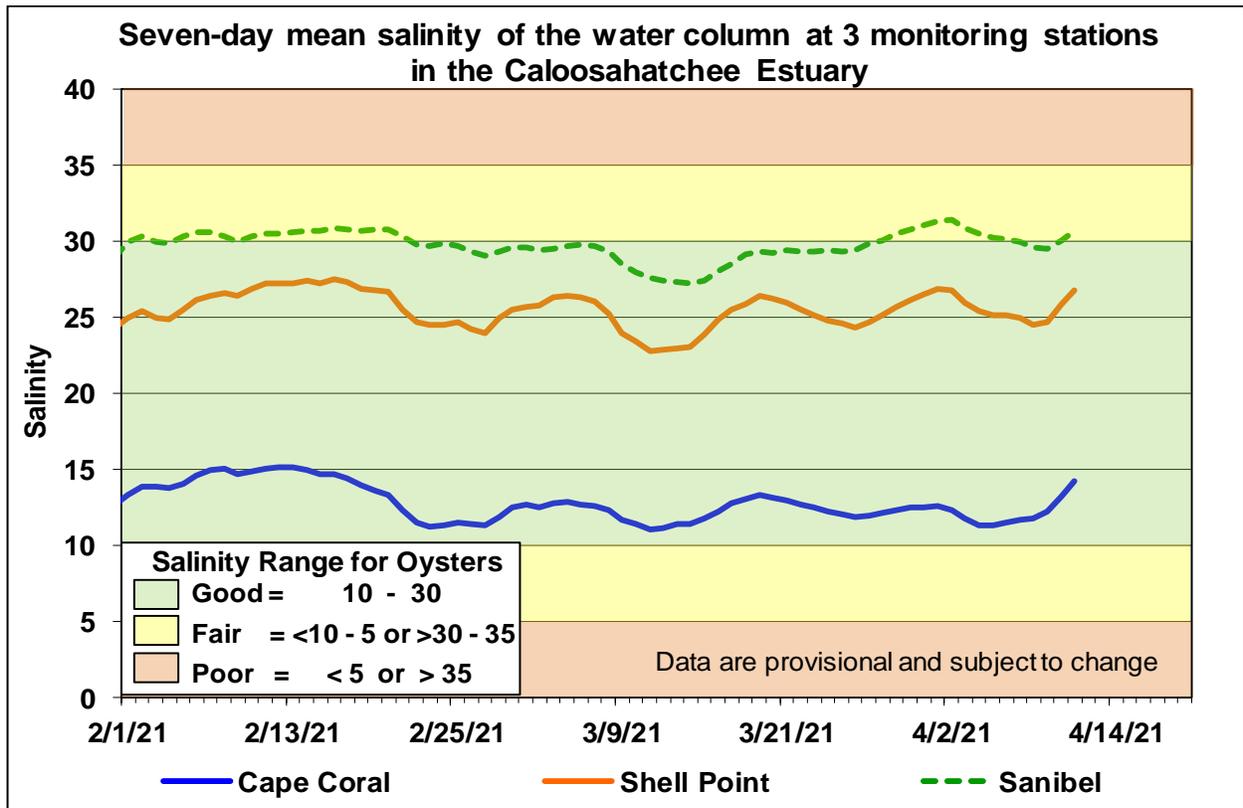


Figure 9. Seven-day mean salinity at Cape Coral, Shell Point, and Sanibel monitoring stations.

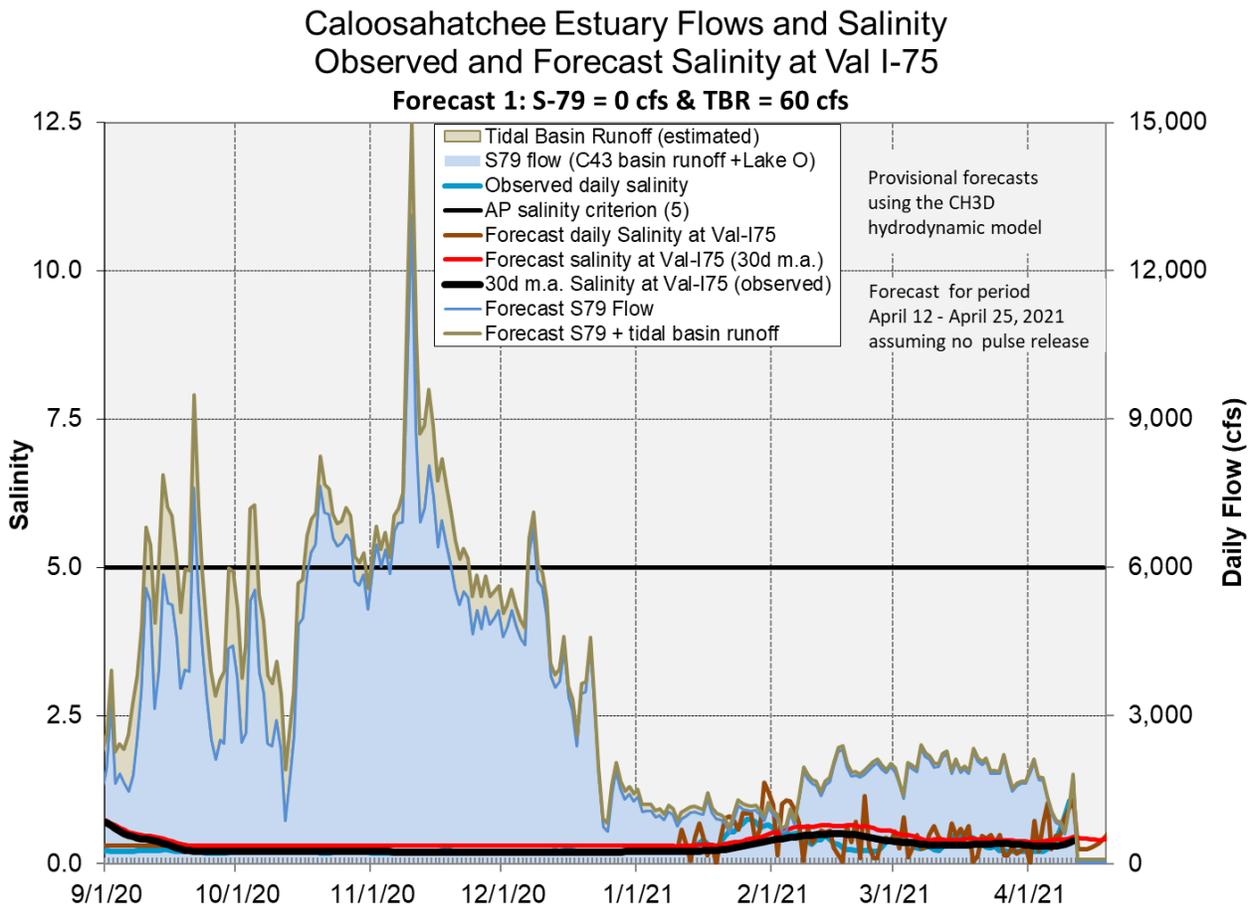


Figure 10. Forecasted Val I-75 surface salinity assuming no pulse release at S-79.

STORMWATER TREATMENT AREAS

Over the past week, approximately 6,000 ac-ft of Lake Okeechobee water was delivered to the FEBs/STAs. The total amount of Lake releases sent to the FEBs/STAs in WY2021 (since May 1, 2020) is approximately 140,600 ac-feet. The total amount of inflows to the STAs in WY2021 is approximately 1,595,000 ac-feet. This week, if 2008 LORS recommends Lake releases to the WCAs and conditions allow, releases will be sent to STA-2 and STA-3/4. For definitions on STA operational language see glossary following figures.

STA-1E: STA-1E Western Flow-way is offline for the Restoration Strategies project to fill and grade Cells 5 and 7. Operational restrictions are in place in STA-1E Central Flow-way for vegetation management activities. Online treatment cells are at or near target stage, vegetation in these cells is highly stressed and the 365-day phosphorus loading rates (PLR) for these flow-ways are extremely high (**Figure 1**).

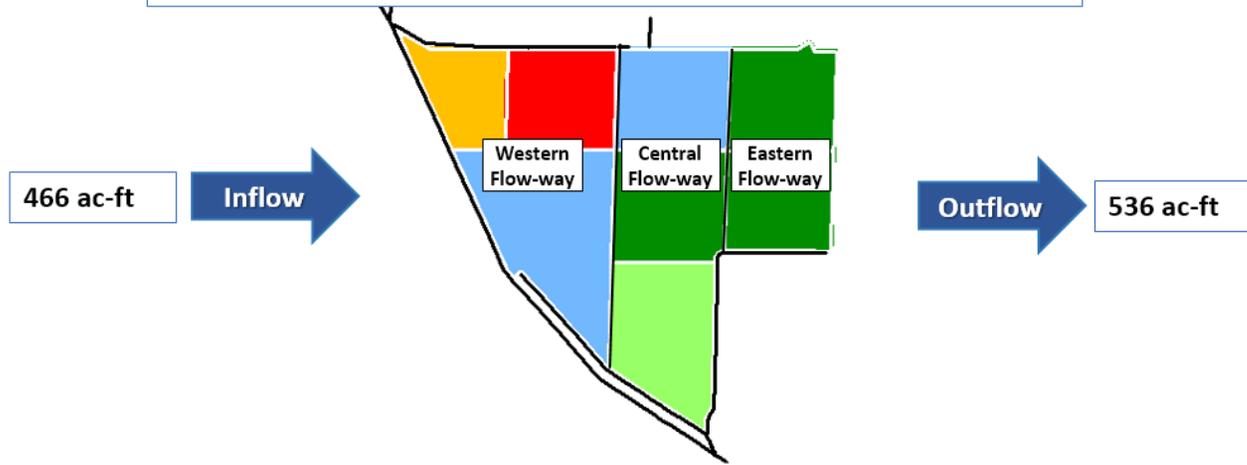
STA-1W: Operational restrictions are in place in STA-1W Western, Eastern, and Northern Flow-ways due to construction activities. All treatment cells are at or below target stage. Vegetation in all flow-ways is highly stressed and the 365-day PLRs for all flow-ways are high to very high (**Figure 2**).

STA-2: Operational restrictions are in place in STA-2 Flow-ways 3 and 4 for vegetation management activities and in Flow-way 2 for construction activities. Treatment cells are near target stage. Vegetation in Flow-way 1 is healthy, in Flow-ways 2 and 3 is stressed, and in Flow-ways 4 and 5 is highly stressed. The 365-day PLRs for all flow-ways are about 1.0 g/m²/year except Flow-way 2 which is very high (**Figure 3**).

STA-3/4: STA-3/4 Eastern Flow-way is offline for vegetation rehabilitation/drawdown. Operational restrictions are in place in STA-3/4 Central and Western Flow-ways for vegetation management activities. Online treatment cells are at or near target stage. Vegetation in the Eastern and Central Flow-ways is highly stressed and in the Western Flow-way is stressed. The 365-day PLRs for all flow-ways are below 1.0 g/m²/year (**Figure 4**).

STA-5/6: Operational restrictions are in place in STA-5/6 Flow-ways 2 and 3 following the Restoration Strategies project to grade non-effective treatment areas. Some treatment cells are at or near target stage while several cells are starting to dry out. The 365-day PLRs for most flow-ways are near 1.0 g/m²/year. All treatment cells have highly stressed vegetation conditions except Flow-ways 7 and 8 which are healthy (**Figures 5 and 6**).

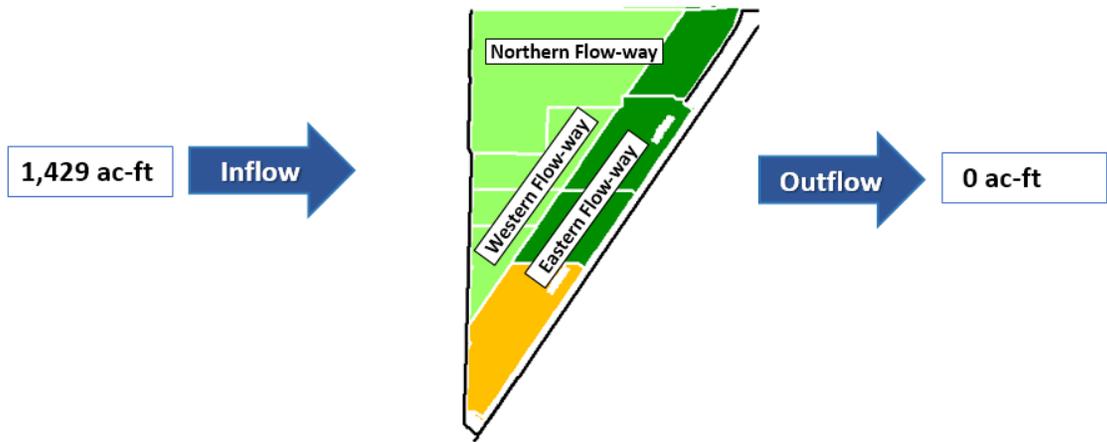
STA-1E Weekly Status Report – 4/5/2021 through 4/11/2021



STA-1E Flow-Way Status				As of 4/11/2021		STA-1E Flow & Phosphorus Concentration				
Flow-Way	Vegetation Status Healthy ----- Stressed	365-day P Loading Rate (below 1.0 g P / m ² /yr is optimal)	Online / Offline / Restrictions	Stage Based: Relative to Target Stage (TS)			7-day	28-day	365-day	
Eastern	← →		Online	Deep Water Level (> 2.8' above TS)	High Water Level (1.5' – 2.8' above TS)	Total Inflow, ac-ft	466	3,409	316,933	
Central	← →		Vegetation Rehab	0.2' – 1.5' above TS	Target Stage (TS +/- 0.2')	--Lake Inflow, ac-ft	466	N/A	24,500	
Western	Offline, construction activities starting 11/01/2019			Low Water Level (<0.2' below TS)	Depth / Area Based: Percent of Area Dry		Total Outflow, ac-ft	536	2,332	278,595
				0-25% Dry	50-75% Dry	Inflow Conc., ppb	129	133	137	
				25-50% Dry	75-100% Dry	Outflow Conc., ppb	29	39	37	
						Includes Preliminary Data				

Figure 1. STA-1E Weekly Status Report

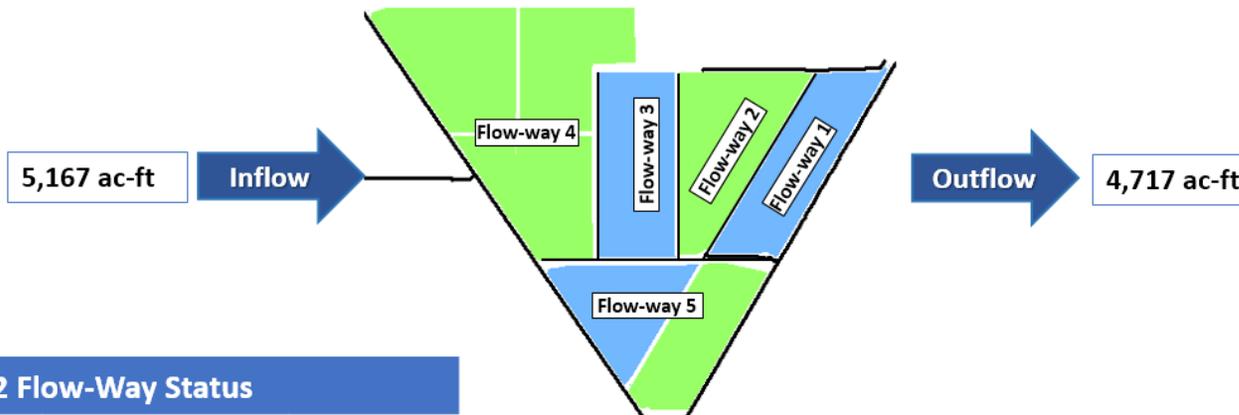
STA-1W Weekly Status Report – 4/5/2021 through 4/11/2021



STA-1W Flow-Way Status				As of 4/11/2021		STA-1W Flow & Phosphorus Concentration			
Flow-Way	Vegetation Status Healthy --- Stressed	365-day P Loading Rate (below 1.0 g P /m ² /yr is optimal)	Online / Offline / Restrictions	Stage Based: Relative to Target Stage (TS)		7-day	28-day	365-day	
				<ul style="list-style-type: none"> Deep Water Level (> 2.8' above TS) High Water Level (1.5' – 2.8' above TS) 0.2' – 1.5' above TS Target Stage (TS +/- 0.2') Low Water Level (<0.2' below TS) 					
				Depth / Area Based: Percent of Area Dry					
				 0-25% Dry	 50-75% Dry				
				 25-50% Dry	 75-100% Dry				
Northern			Construction						
Western			Construction						
Eastern			Construction						
Total Inflow, ac-ft						1,429	1,429	193,361	
--Lake Inflow, ac-ft						1,200	N/A	8,400	
Total Outflow, ac-ft						0	0	216,680	
Inflow Conc., ppb						136	136	252	
Outflow Conc., ppb						N/A	N/A	38	
Includes Preliminary Data									

Figure 2. STA-1W Weekly Status Report

STA-2 Weekly Status Report – 4/5/2021 through 4/11/2021



STA-2 Flow-Way Status

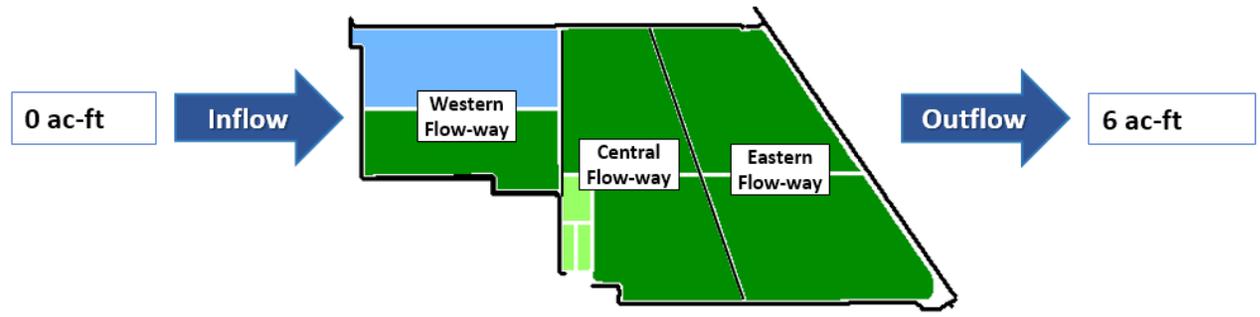
Flow-Way	Vegetation Status Healthy ----- Stressed	365-day P Loading Rate (below 1.0 g P /m ² /yr. is optimal)	Online / Offline / Restrictions
1			Online
2			Construction
3			Vegetation Rehab
4			Vegetation Rehab
5			Online

As of 4/11/2021	
Stage Based: Relative to Target Stage (TS)	
	Deep Water Level (> 2.8' above TS)
	High Water Level (1.5' – 2.8' above TS)
	0.2' – 1.5' above TS
	Target Stage (TS +/- 0.2')
	Low Water Level (<0.2' below TS)
Depth / Area Based: Percent of Area Dry	
	0-25% Dry
	25-50% Dry
	50-75% Dry
	75-100% Dry

STA-2 Flow & Phosphorus Concentration			
	7-day	28-day	365-day
Total Inflow, ac-ft	5,167	23,969	421,380
--Lake Inflow, ac-ft	4,000	N/A	63,700
Total Outflow, ac-ft	4,717	20,754	485,132
Inflow Conc., ppb	71	66	102
Outflow Conc., ppb	14	16	21
Includes Preliminary Data			

Figure 3. STA-2 Weekly Status Report

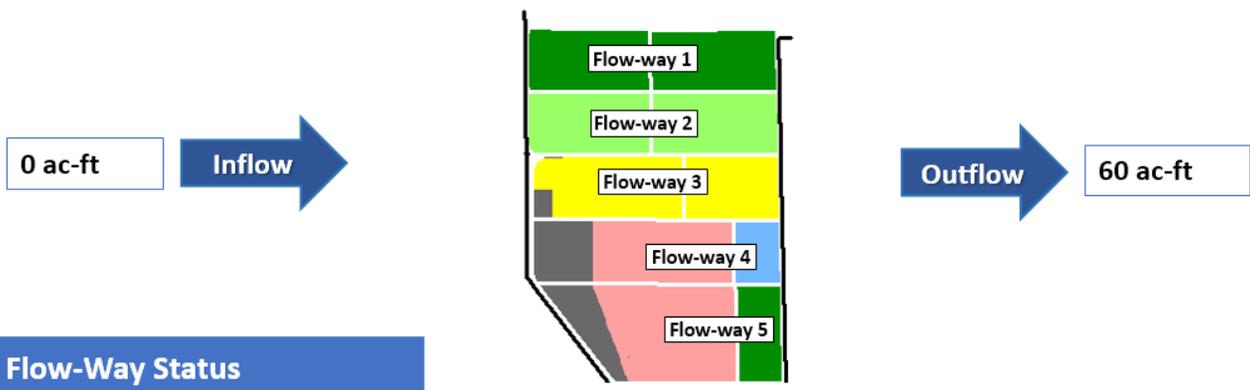
STA-3/4 Weekly Status Report – 4/5/2021 through 4/11/2021



STA-3/4 Flow-Way Status				As of 4/11/2021		STA-3/4 Flow & Phosphorus Concentration			
Flow-Way	Vegetation Status Healthy ----- Stressed ←-----→	365-day P Loading Rate (below 1.0 g P / m ² /yr. is optimal)	Online / Offline / Restrictions	Stage Based: Relative to Target Stage (TS)			7-day	28-day	365-day
Eastern	Offline, vegetation management drawdown as of 3/1/2021			<ul style="list-style-type: none"> Deep Water Level (> 2.8' above TS) High Water Level (1.5' – 2.8' above TS) 0.2' – 1.5' above TS Target Stage (TS +/- 0.2') Low Water Level (<0.2' below TS) 	Total Inflow, ac-ft	0	30	561,732	
Central	←-----→		Vegetation Rehab	Depth / Area Based: Percent of Area Dry		--Lake Inflow, ac-ft	0	N/A	42,200
Western	←-----→		Vegetation Rehab	<ul style="list-style-type: none"> <li style="width: 50%;">0-25% Dry <li style="width: 50%;">50-75% Dry <li style="width: 50%;">25-50% Dry <li style="width: 50%;">75-100% Dry 	Total Outflow, ac-ft	6	15	544,592	
					Inflow Conc., ppb	N/A	32	58	
					Outflow Conc., ppb	8	8	12	
Includes Preliminary Data									

Figure 4. STA-3/4 Weekly Status Report

STA-5/6 Weekly Status Report – 4/5/2021 through 4/11/2021



STA-5/6 Flow-Way Status

Flow-Way	Vegetation Status Healthy ----- Stressed	365-day P Loading Rate (below 1.0 g P /m ² /yr. is optimal)	Online / Offline / Restrictions
1	← →		Online
2	← →	N/A	Post-construction
3	← →	N/A	Post-construction
4	← →		Online
5	← →		Online

As of 4/11/2021

Stage Based: Relative to Target Stage (TS)	
	Deep Water Level (> 2.8' above TS)
	High Water Level (1.5' – 2.8' above TS)
	0.2' – 1.5' above TS
	Target Stage (TS +/- 0.2')
	Low Water Level (<0.2' below TS)

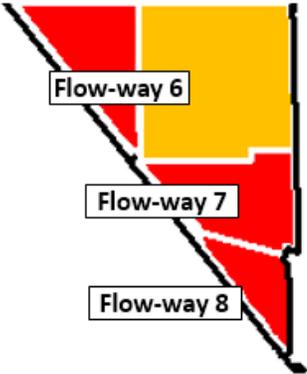
Depth / Area Based: Percent of Area Dry	
	0-25% Dry
	25-50% Dry
	50-75% Dry
	75-100% Dry

STA-5/6 Flow & Phosphorus Concentration

	7-day	28-day	365-day
Total Inflow, ac-ft	0	-13	130,126
--Lake Inflow, ac-ft	N/A	N/A	N/A
Total Outflow, ac-ft	60	75	152,525
Inflow Conc., ppb	N/A	N/A	281
Outflow Conc., ppb	25	29	79
Includes Preliminary Data			

Figure 5. STA-5/6 Weekly Status Report (Flow-ways 1 – 5)

STA-5/6 Weekly Status Report – 4/5/2021 through 4/11/2021



STA-5/6 Flow-Way Status				As of 4/11/2021	
Flow-Way	Vegetation Status Healthy ----- Stressed ←-----→	365-day P Loading Rate (below 1.0 g P /m ² /yr is optimal)	Online / Offline / Restrictions	Stage Based: Relative to Target Stage (TS)	
				<div style="display: flex; flex-direction: column; gap: 5px;"> <div> Deep Water Level (> 2.8' above TS)</div> <div> High Water Level (1.5' – 2.8' above TS)</div> <div> 0.2' – 1.5' above TS</div> <div> Target Stage (TS +/- 0.2')</div> <div> Low Water Level (<0.2' below TS)</div> </div>	Depth / Area Based: Percent of Area Dry
				<div style="display: flex; flex-wrap: wrap; gap: 5px;"> <div> 0-25% Dry</div> <div> 50-75% Dry</div> <div> 25-50% Dry</div> <div> 75-100% Dry</div> </div>	
6	←-----→	 1.0	Online		
7	←-----→	 1.0	Online		
8	←-----→	 1.0	Online		

Figure 6. STA-5/6 Weekly Status Report (Flow-ways 6 – 8)

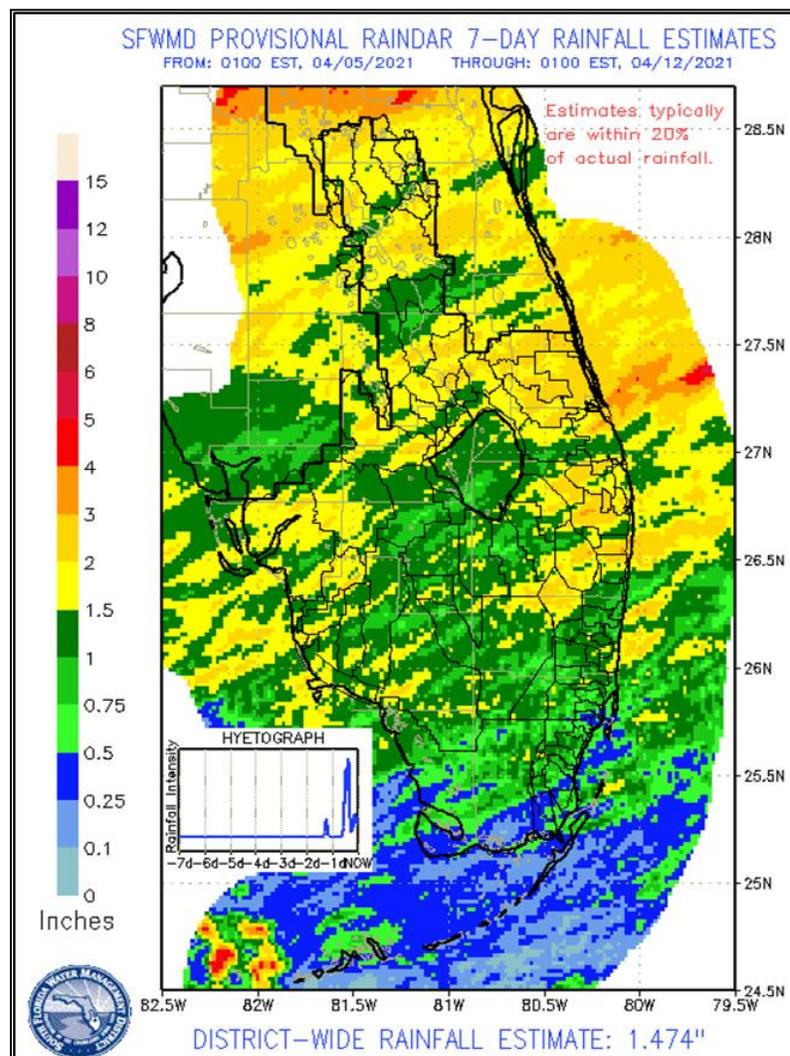
Basic Concepts and Definitions for STA Weekly Status Report

- **Inflow:** Sum of flow volume at all inflow structures to an STA.
- **Lake Inflow:** Portion of the STA total inflow volume that originates from Lake Okeechobee.
- **Outflow:** Sum of flow volume at outflow structures from an STA.
- **Total Phosphorus (TP):** Total mass of phosphorus in all its forms; including particulate, dissolved, etc.
- **Inflow Concentration:** TP concentration is the mass of TP in micrograms per liter of water, $\mu\text{g/L}$ or ppb. Inflow concentration refers to the flow-weighted mean TP from all inflow structures over a period of time.
- **Outflow Concentration:** The flow-weighted mean TP from all outflow structures over a period of time. The outflow concentration represents the reduction of inflow TP achieved by STA treatment of the inflow water.
- **WQBEL:** The STA outflow concentration that is required upon completion of the Restoration Strategies projects by December 2025. The outflow concentration shall not exceed 13 ppb as an annual flow weighted mean in more than 3 out of 5 water years on a rolling basis and shall not exceed 19 ppb as an annual flow weighted in any water year.
- **Flow-Way (FW):** One or more treatment cells connected in series. Cells typically have emergent aquatic vegetation (EAV) in the front portion of the flow-way followed by a mix of EAV and submerged aquatic vegetation (SAV)
- **Vegetation Status:** Healthy means the vegetation condition is good and will allow the STA to perform as designed. Stressed means the vegetation is showing signs of poor health, such as browning or areas of vegetation die-off, or the cell contains undesirable vegetation such as floating exotic vegetation requiring treatment. The TP reduction capability of the STA is affected when the vegetation condition is poor.
- **Phosphorus Loading Rate (PLR):** Mass of inflow TP in grams, divided by total treatment area of STA in square meters, per year. In general, a 365-day value of less than 1.0 is needed for an STA to perform optimally. A PLR of 2.0 is considered very high and a PLR of 3.0 is considered extremely high. The TP reduction capability of the STA is affected when the PLR is high, very high and extremely high.
- **Online:** Online status means the FW can receive and treat inflow.
- **Online with Restriction:** The FW can receive and treat inflow, but the amount of flow or water level may be limited temporarily. For example, a vegetation rehabilitation effort may require reduced flows through an area while the new plants are establishing, or nesting by protected species may require a certain water level not to be exceeded.
- **Offline:** The FW is unable to receive and treat inflow due to repairs, construction, or other prohibitive reasons.
- **Depth:** Difference between the average surface water level in a cell and the average ground elevation in that cell. Target depths, or depths between flow events, are between 1.25 ft to 1.5 ft. As depth approaches or drops below zero, an increasing percentage of the cell is considered dry and STA conditions deteriorate. An increase in depth above target depth is expected with increasing flow. However, as depth increases much above the target depth and is sustained over a period of time, it can be detrimental to vegetation health and overall STA treatment performance.
- **Note:** The data provided in this summary report were developed using a combination of provisional and quality-assured flow and water quality data. In some cases, best professional judgment was used to estimate missing data and revise questionable data. Values provided are not considered final but are appropriate for use in STA operational decision-making.

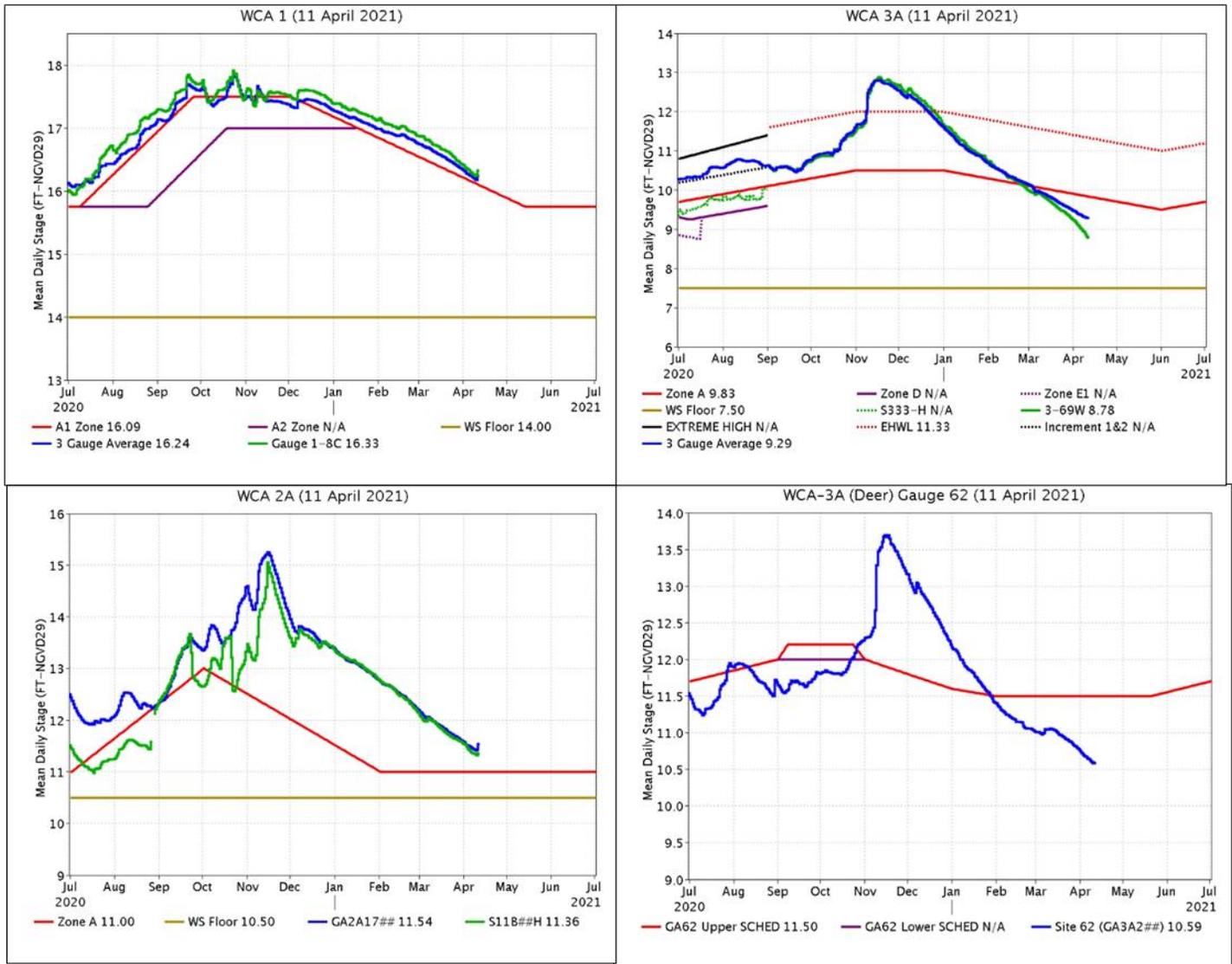
EVERGLADES

Over the past week, the most rain in the last month fell over the Everglades, more in the northernmost basins. At the monitored gauges, stages fell 0.02 feet on average, a slight increase from the week prior. Evaporation was 1.35 inches. The Tamiami Trail Flow Formula (TTFF) - Target Flow from WCA-3A to ENP is 1084 cfs, a reduction of 84 cfs from the previous week.

Everglades Region	Rainfall (Inches)	Stage Change (feet)
WCA-1	1.74	+0.06
WCA-2A	1.94	+0.15
WCA-2B	1.08	-0.10
WCA-3A	1.21	-0.03
WCA-3B	1.00	-0.05
ENP	0.73	-0.09



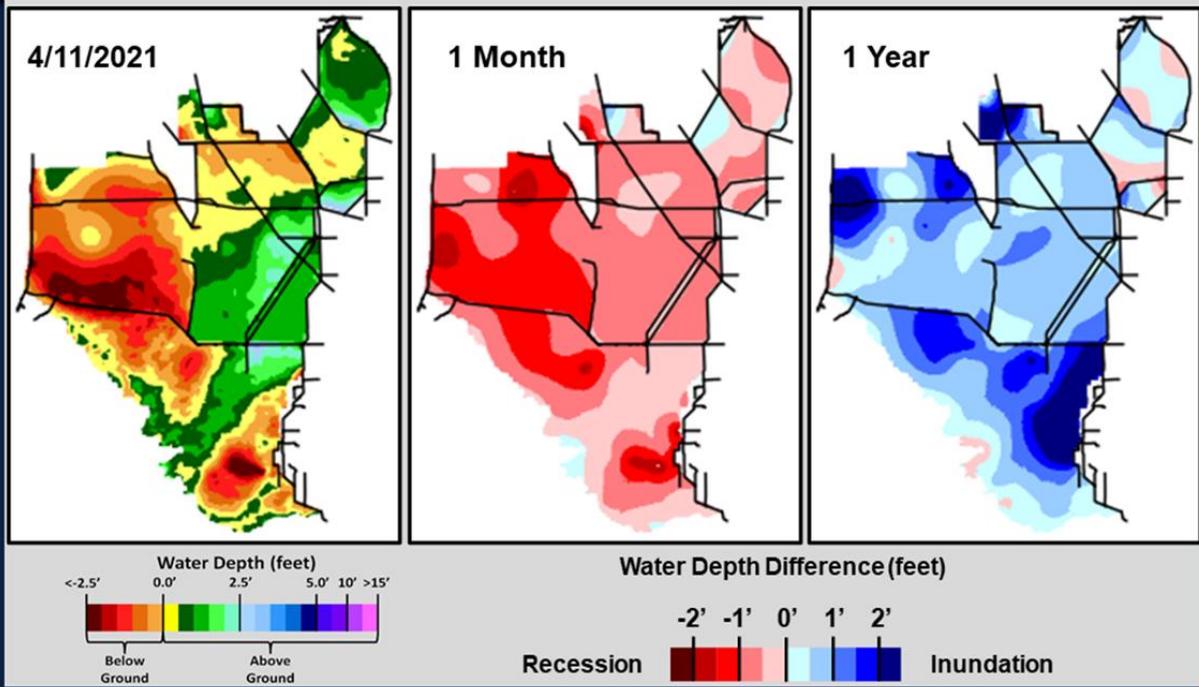
Regulation Schedules: WCA-1: Stage at the 1-8C Gauge continues to follow just above and parallel with schedule, now 0.24 feet above the falling Zone A1 regulation line. WCA-2A: The recession in stage at S11B-HW continues to fall, now 0.36 feet above the stable regulation line. WCA-3A: The Three Gauge Average stages continue to drop steadily below the falling Zone A regulation line and is currently 0.54 feet below. WCA-3A: Stage at gauge 62 (Northwest corner) continues to decline. The average on Sunday was 0.91 feet below the stable Upper Schedule.



The WDAT tool for spatial interpolation of depth monthly snapshots indicate that WCA-3A is drying down in the northeast, areas containing depths potentially at the soil surface or below downstream of S-150 continue to expand. WCA-2A has now drawn down across a majority of that basin. North-South hydrologic connectivity remains established within SRS in ENP as conditions dry down in the western marl prairies and Lostman's and Taylor Sloughs. Southern portions of Big Cypress National Preserve have dried down to up to 2.5 foot below soil surface. Comparing WDAT water levels from present, over the last month stages fell significantly across WCA-3A, WCA-1 and southern WCA-2A. Looking back one year the stage difference patterns are different than one month ago with WCA-3A and northern WCA-2A significantly wetter. Compared to one year ago the eastern boundary of Everglades National Park is significantly wetter than a year ago.



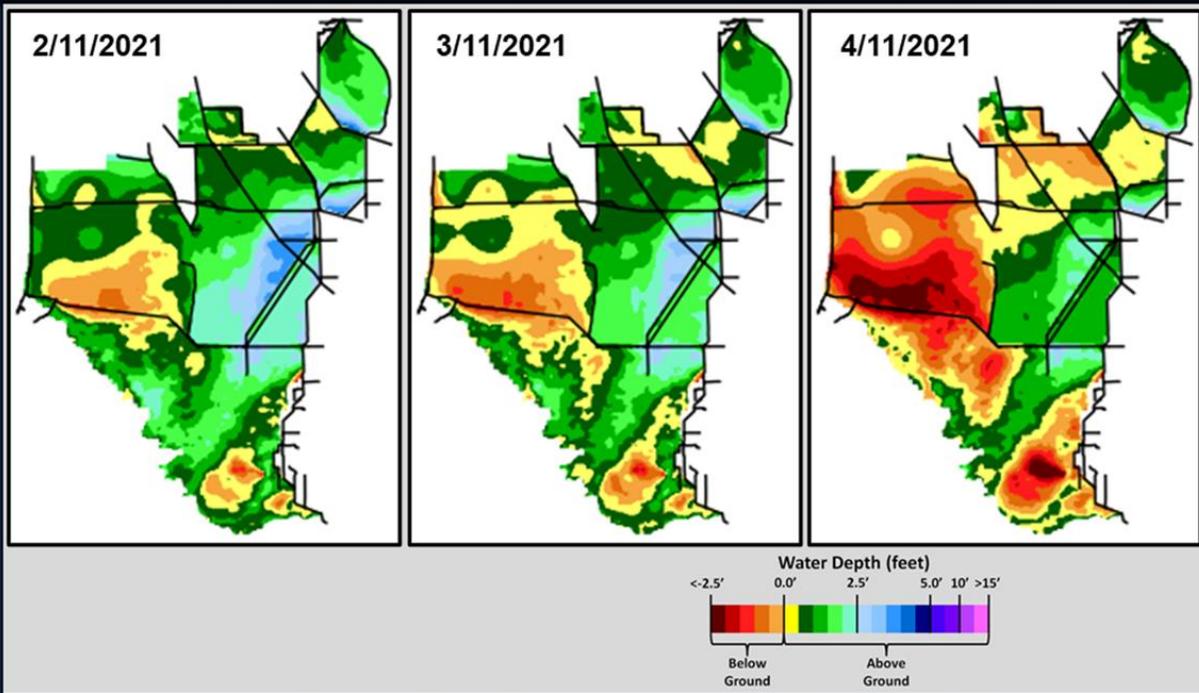
SFWDAT Everglades Difference Maps (Present - Past)



South Florida Water Depth Assessment Tool (SFWDAT)



SFWDAT Water Depth Monthly Snapshots

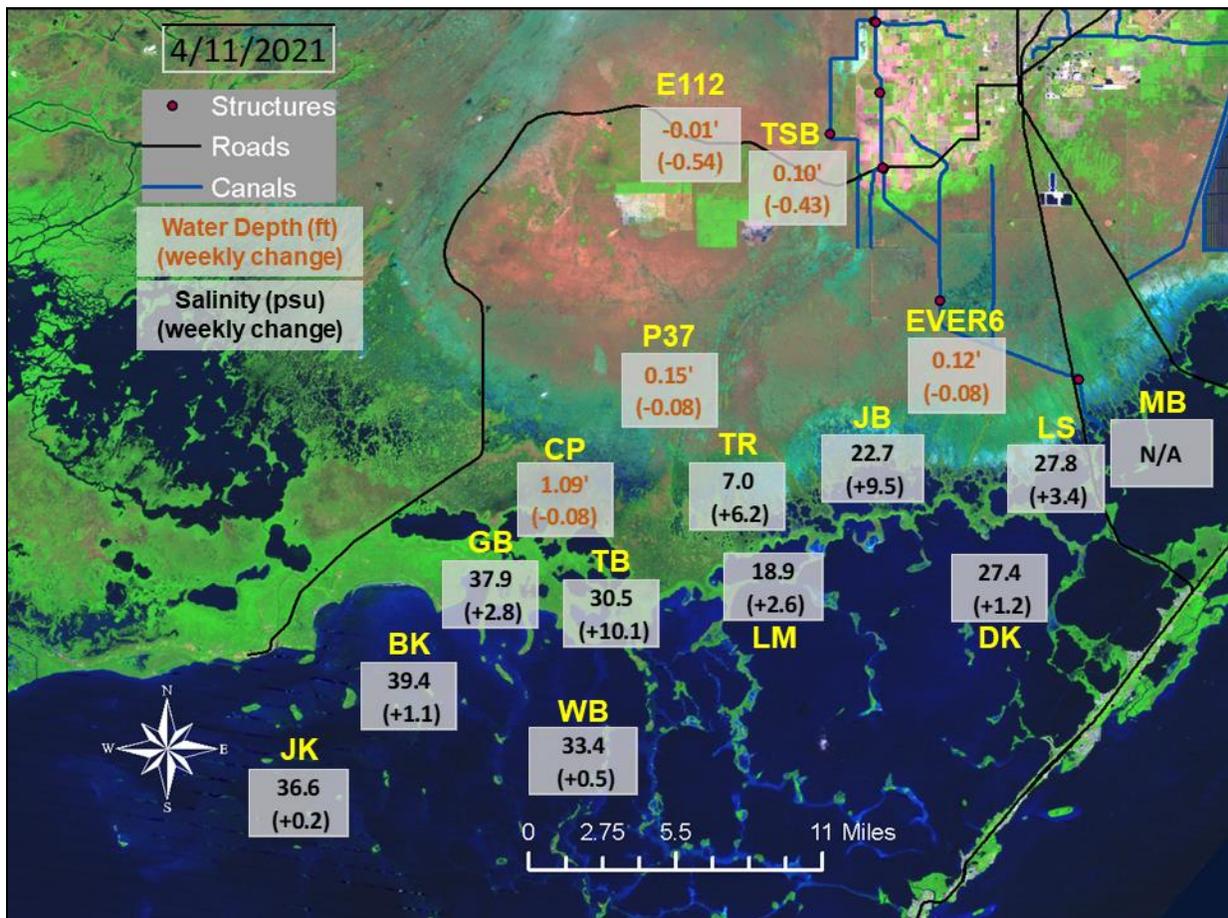


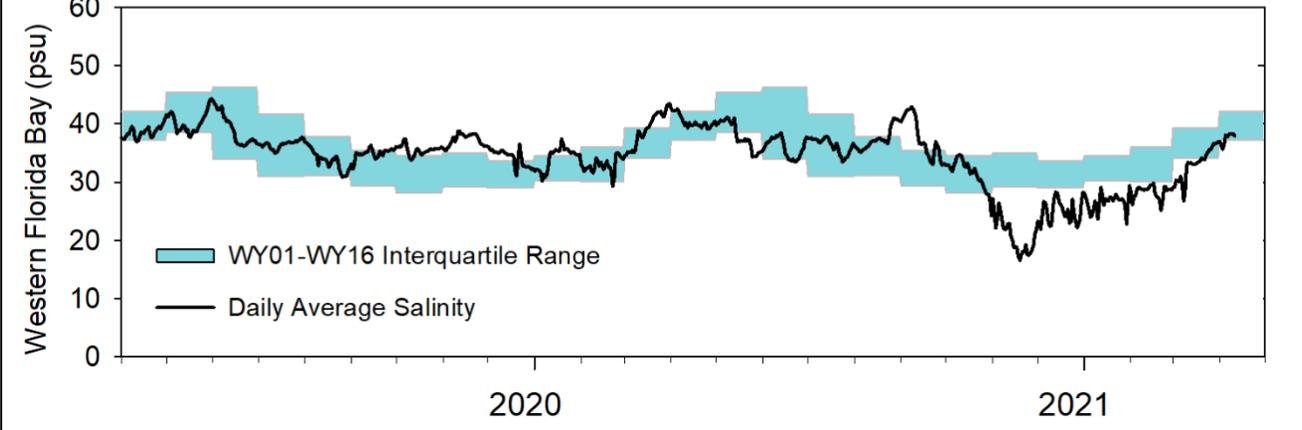
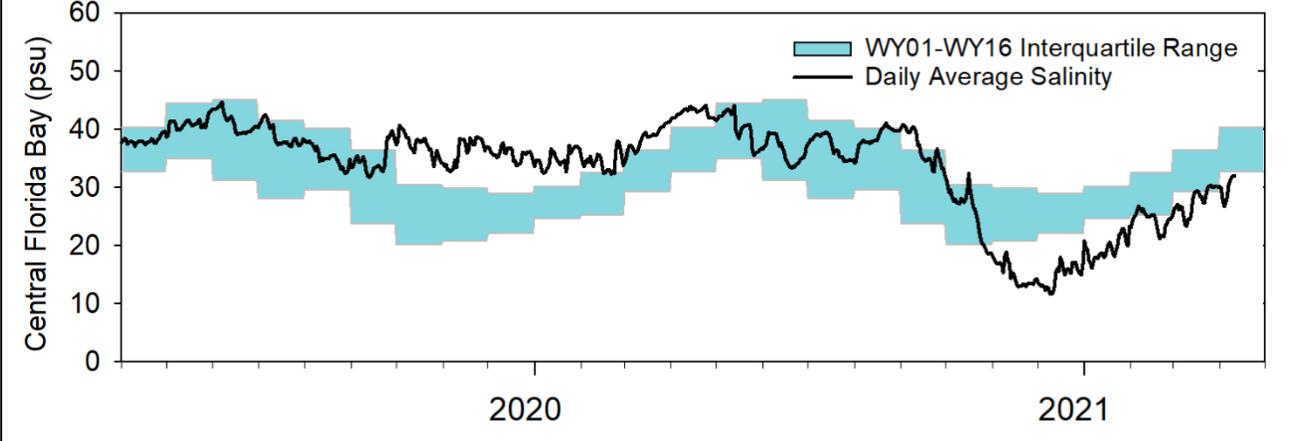
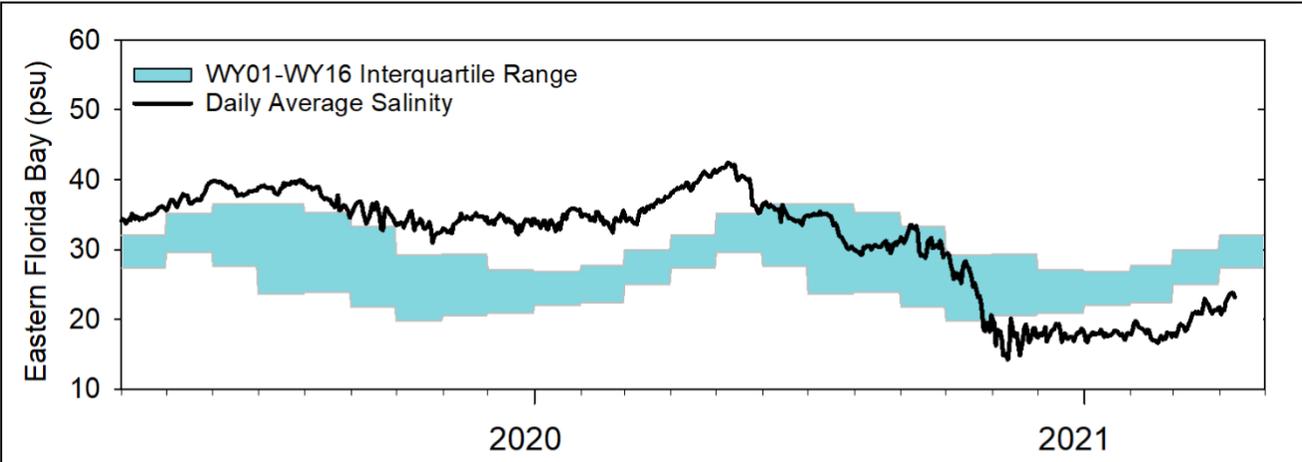
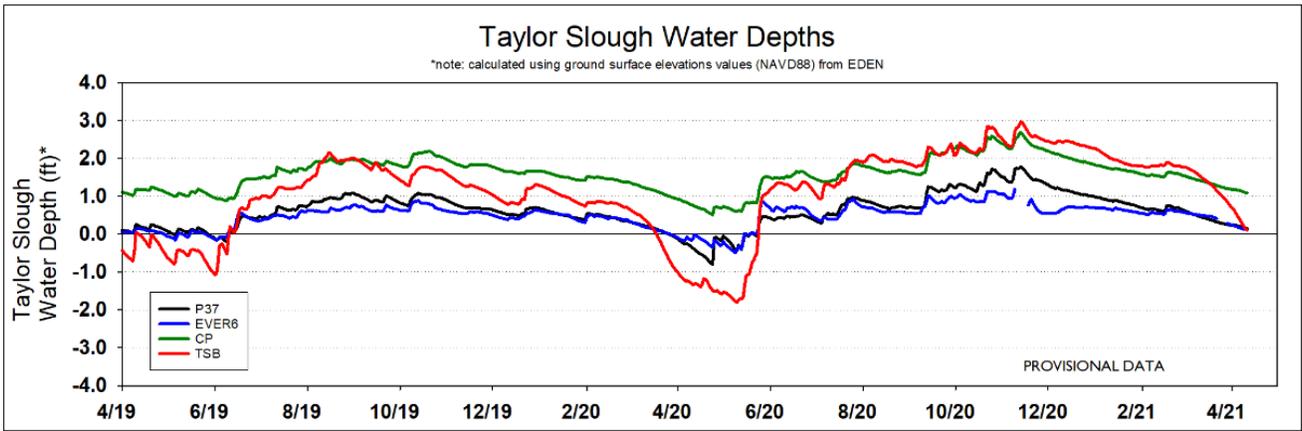
South Florida Water Depth Assessment Tool (SFWDAT)

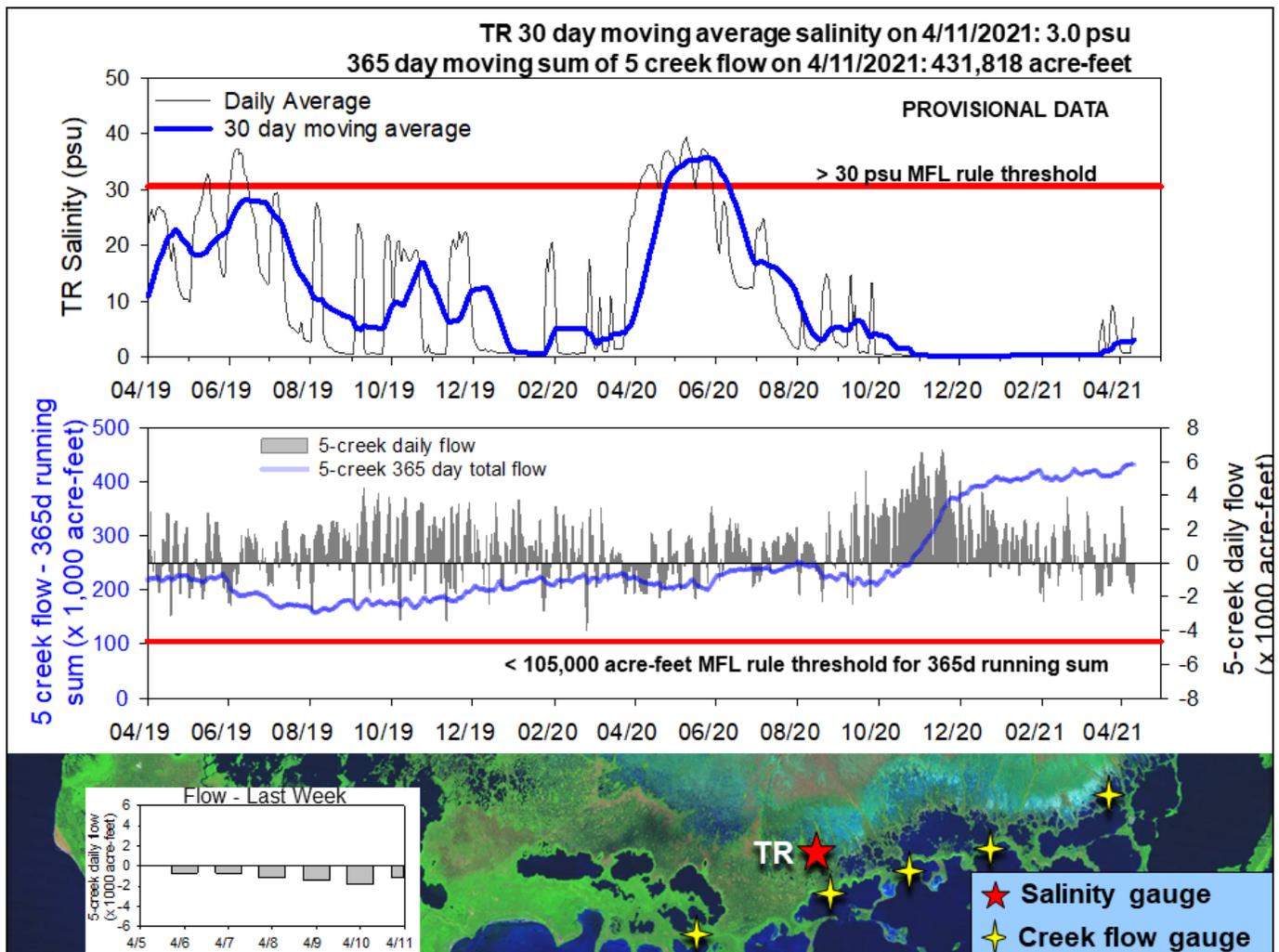
Tree island inundation in WCA-3A, WCA-3B and ENP: 371 Tree Islands of known elevation within WCA-3A, -3B and Everglades National Park's Shark Slough. Current preliminary estimates using WDAT indicate that 4% or 13 of the tree islands are currently inundated (down from 8% the week prior), and all those islands have been inundated for more than 120 days. Inundation for more than 120 days will cause ecological harm to sensitive islands.

Wading bird foraging/nesting: Large numbers of birds continue to forage throughout the Greater Everglades, especially in the drying margins of Lostman's Slough, WCA-2A, Western Shark River Slough near the Loop Trail, and WCA-1. There are few feeding birds in WCA-3A South and numbers have declined considerably in WCA-3A North as the open areas in the north are now too dry for foraging. The continued rapid drying rates and relatively dry conditions in WCAs -2A and -3A North are unlikely to support sustained foraging. The focus of wading bird foraging is likely to shift to WCAs -1, -2B and -3AS as these areas continue to dry over the next few weeks. Wood Stork, White Ibis and Great Egret nests continue to increase in both the WCAs and ENP for a grand total of about 52,000 nests for these three species, which would amount to the third highest nesting effort in the Everglades protection area in recent decades.

Taylor Slough Water Levels: Next to no rain fell over Taylor Slough and Florida Bay this past week until Sunday, when an average of 0.42 inches of rain fell. The impact of the Sunday rain is not yet visible in water levels, so the Slough decreased by 0.24 feet on average over the week (same as last week). Highest recession rates continued to be in the northern parts of the slough as expected for this time of year. Taylor Slough is averaging 5 inches higher than the historical average for this time of year. The pulse of rain on Sunday and Monday caused some of the westward moving structures to briefly activate near northern Taylor Slough.







Florida Bay Salinities: Salinities in Florida Bay averaged a 3.5 increase over the week. Upstream water movements caused salinity increases throughout the Bay, especially at the shoreline. Bay-wide salinity is still 2 lower than the historical average for this time of year, and the nearshore stations average 3 lower than the historical average. The Bay is positioned well to minimize hypersalinity before the rainy season begins. Attention will be on the western Bay this year to see if water quality exacerbates conditions this summer and fall.

Florida Bay MFL: The TR station in the mangrove zone (tracked for the Florida Bay MFL) spiked to salinity 7 due to upstream flows. Thus, the 30-day moving average salinity increased 0.3 to end at 3.0. Weekly flow from the five creeks identified by yellow stars on the map above totaled about -6,800 acre-feet, which essentially returned $\frac{3}{4}$ of last week's positive flows. The 365-day moving sum of flow from the five creeks ended at 431,818 acre-feet this week, which is a 3,000 acre-feet increase from last week. Conditions are still higher than the 95th percentile of historical data (390,830 acre-feet). Creek flows are provisional USGS data.

Water Management Recommendations

Slowing the recession rates in all regions to 0.05 to 0.07 feet per week would have ecological benefit, particularly in central WCA-2A and WCA-3A North. Excessive drying in WCA-2A and WCA-3A North could incur other ecological costs for aquatic wildlife (into next season), as well as increased risk of peat oxidation and fire risk. Distributing flows across the northern perimeter of WCA-3A and into that basin promotes sheet flow and prevents landscape scale peat loss. Inflows that prolong the drying down of northern Taylor Slough have within and downstream ecological benefit.

More specific recommendations appear in the summary table below. The red text represents new or modified information or recommendations.

SFWMD Everglades Ecological Recommendations, April 13th, 2021 (red is new)			
Area	Weekly change	Recommendation	Reasons
WCA-1	Stage increased by 0.06'	Resume a recession when possible. Maintain marsh stage slightly above and parallel to the regulation schedule.	Protect within basin and downstream habitat and wildlife. Maintaining optimal recession rates prepares the habitat for conducive wading bird foraging.
WCA-2A	Stage increased by 0.15'	Moderate the recession rate to near -.05 to -.07 feet per week and maintain marsh stage above the regulation schedule targeting 11.6' NGVD 29.	Protect within basin and downstream habitat and wildlife. Maintaining optimal recession rates prepares the habitat for conducive wading bird foraging.
WCA-2B	Stage decreased by 0.10'	Moderate the recession rate to near -.05 to -.07 feet per week.	Protect (expected) within basin wildlife and downstream habitat and wildlife from flooding stress.
WCA-3A NE	Stage remained unchanged	Maintain the recession rate to near -.05 to -.07 feet per week.	Protect within basin and downstream habitat and wildlife. Optimal recession rates preserves peat soils and extends the time that foraging is optimal on the landscape.
WCA-3A NW	Stage decreased by 0.01'	Maintain the recession rate to near -.05 to -.07 feet per week.	
Central WCA-3A S	Stage decreased by 0.06'	Maintain the recession rate to near -.05 to -.07 feet per week.	Protect within basin and downstream habitat and wildlife. Moderating the recession preserves peat soils and extends the time that foraging is optimal on the landscape.
Southern WCA-3A S	Stage decreased by 0.05'		
WCA-3B	Stage decreased by 0.05'	Maintain the recession rate to near -.05 to -.07 feet per week.	Protect within basin and downstream habitat and wildlife from flooding stress. Tree island ecology is diminished by flooding
ENP-SRS	Stage decreased by 0.09'	Make discharges to the Park according to COP and TTFP protocol while considering upstream and downstream ecological conditions.	Protect within basin and upstream habitat and wildlife from flooding stress.
Taylor Slough	Stage changes ranged from -0.08' to -0.51'	Move water southward as possible.	When available, provide freshwater buffer for downstream conditions.
FB- Salinity	Salinity changes ranged +0.2 to +10.1 psu	Move water southward as possible.	When available, provide freshwater to maintain low salinity buffer and promote water movement.