Moving Forward – Reducing the Destructive Lake Discharges to the St. Lucie River and Estuary

Gary Goforth

January 2014

For 90 years, the coastal communities have ***sacrificed*** their health, economy, and environment in order to protect the health, safety and welfare of residents around Lake Okeechobee.

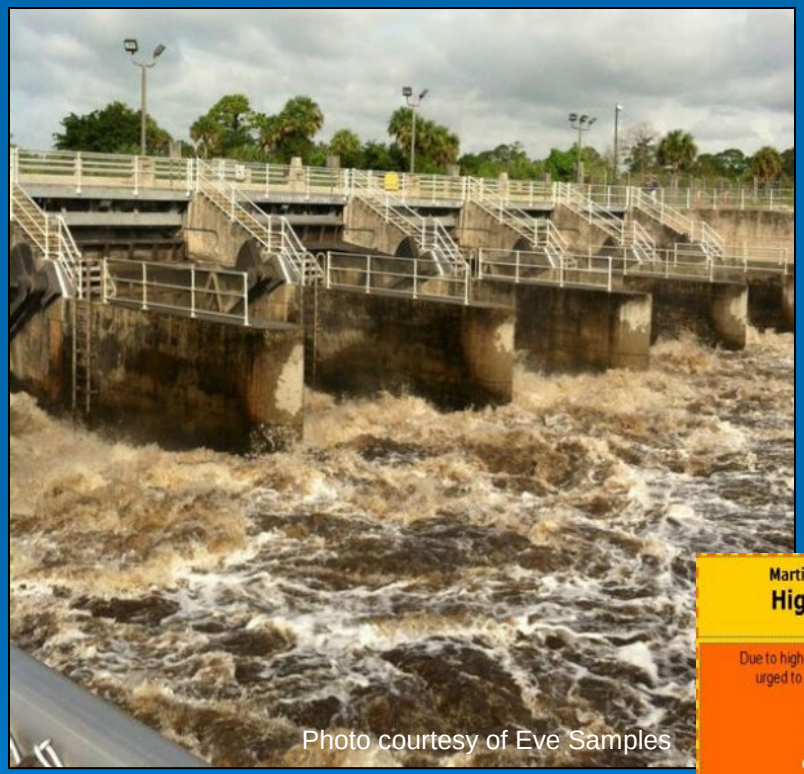
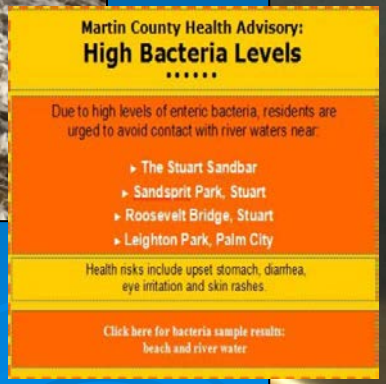


Photo courtesy of Eve Samples



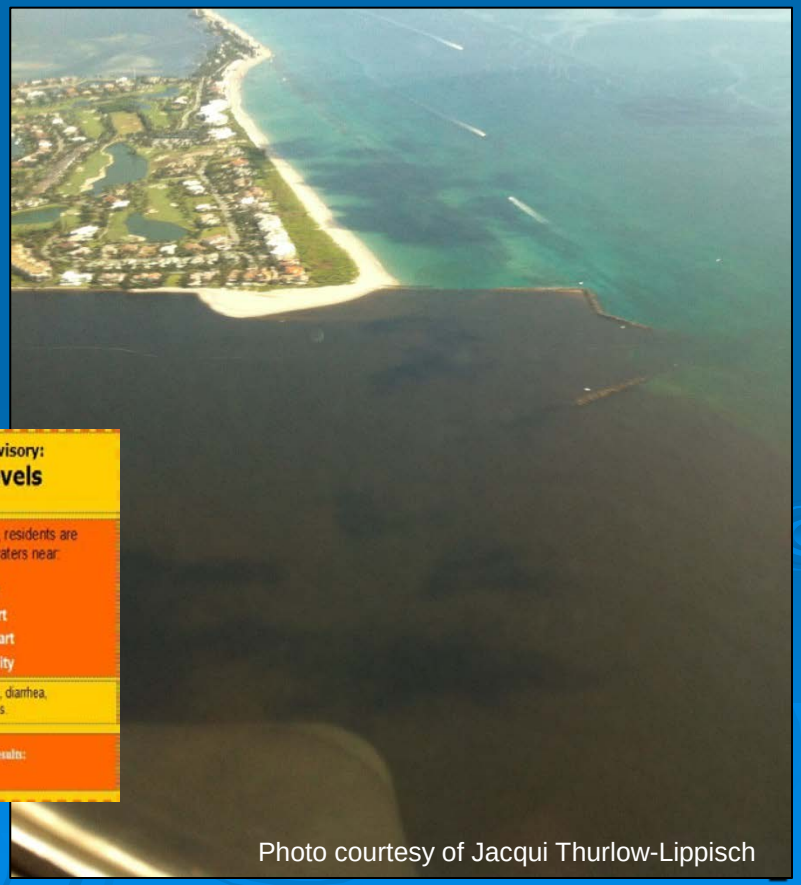


Photo courtesy of Jacqui Thurlow-Lippisch

Why did this happen in 2013?

- Public health advisories
- Massive algae blooms
- Oyster mortality
- Loss of sea grasses
- Record manatee deaths
- Recreation impacts
- Job impacts
- Education impacts
- Tourism impacts
- Real estate impacts

… The Lost Summer

Answers to Why? are complex

Don't know all the reasons, but they include

Continued pollution in areas discharging to Lake Okeechobee

- Existing pollution reduction levels are not being achieved
- A century of development - channelized stormwater into the lake

Lake Okeechobee management – a magnificent endangered ecosystem

- A century of nitrogen and phosphorus pollution
- Operating schedule ("LORS") doesn't adequately balance impacts to estuaries
- Herbert Hoover Dike – restricts expansion during wet periods; breach risk → LORS2008

St. Lucie and Caloosahatchee rivers/estuaries, Lake Worth Lagoon

- Draining the Lake to estuaries has been a state policy for over 100 years
- Estuaries and reefs are "owned" by the state – not protected by private property rights
- Where's the accountability for impacts of Lake discharges? No permits?

South of Lake Okeechobee

- Conveyance and treatment infrastructure to Everglades not yet completed ("3rd outlet")
- Public lands are not being fully utilized - STAs, WMAs and WCAs
  - Where's the accountability for not sending maximum releases south?
- Flow restrictions at boundary to Everglades National Park

Can’t cover it all in one sitting

So we’ll focus on suggestions for moving forward that

… can be initiated in the relative near-term,

… don’t require Congressional authorization or funding,

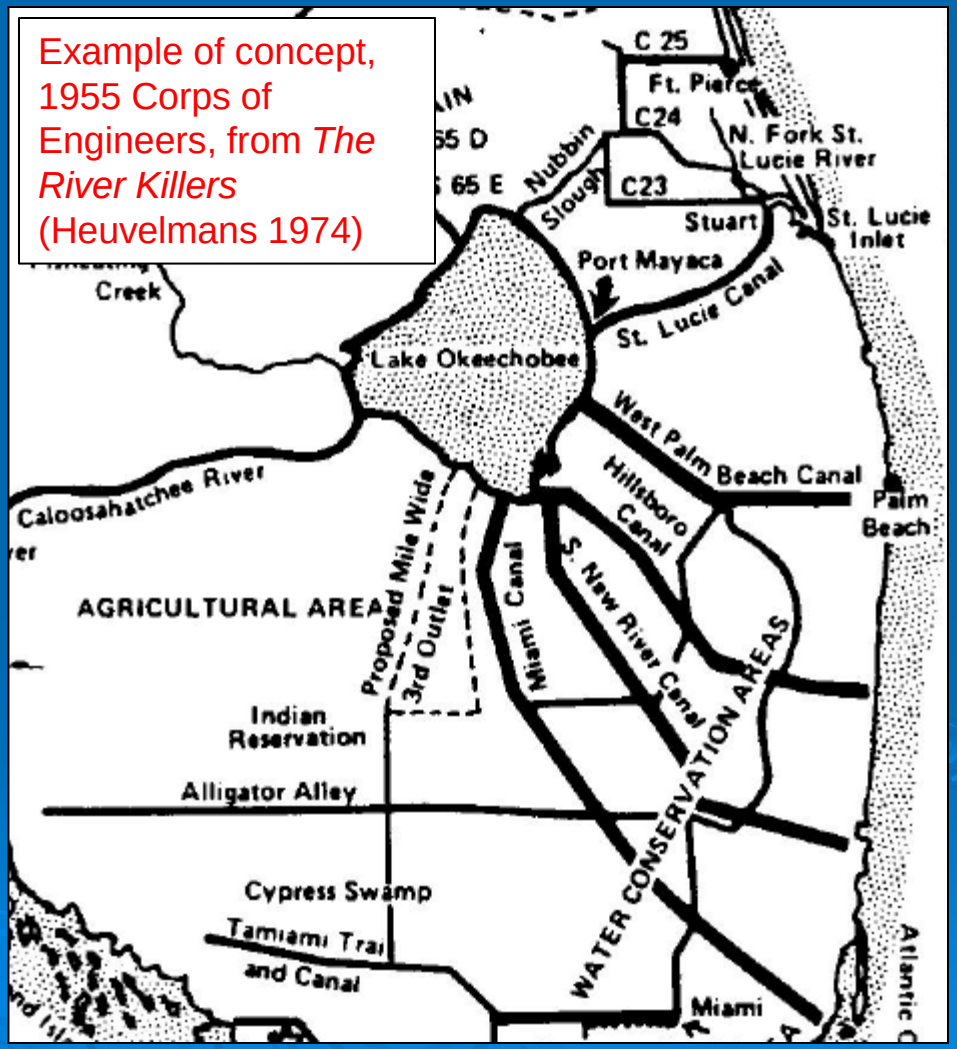
… don’t require large construction projects

… do require operational and policy changes

Did I mention ..

The <u>only</u> long-term solution is to complete facilities to treat Lake Okeechobee releases and convey them to the Everglades.

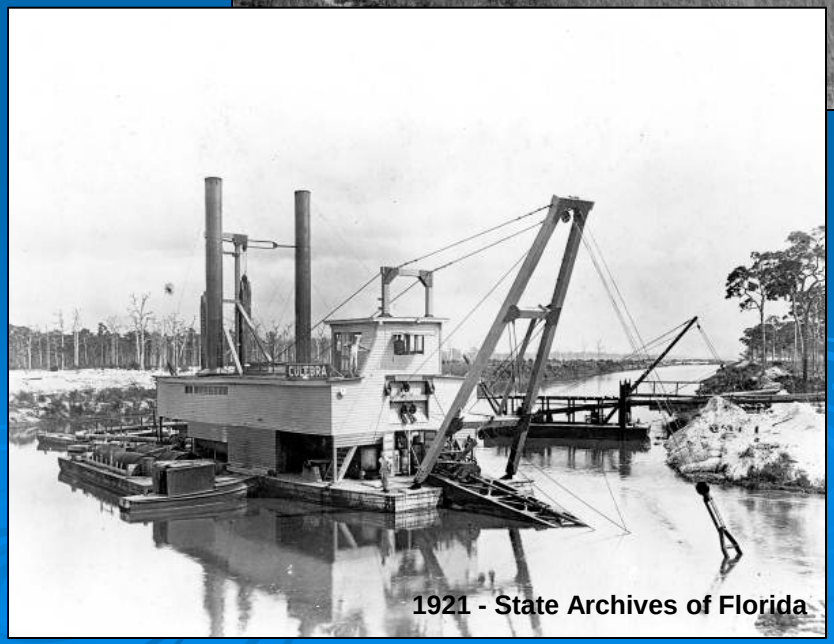
… but you know that.



Brief History: St. Lucie Canal

- Concept of a canal extending from Lake Okeechobee to the Atlantic was formalized in 1913 report commissioned by State of Florida … before Martin County was established.
  - Drain Lake Okeechobee to allow for development of Everglades
  - Provide cross-state canal for navigation and commerce
- Constructed between 1916 and 1924 by Everglades Drainage District
- Enlarged by Corps of Engineers in 1938 and again in 1949 (C-44)

1921 - State Archives of Florida



1921 - State Archives of Florida

Port Mayaca Lock and Spillway

- Originally constructed in 1925 by Everglades Drainage District (Lock No. 1).
  - Navigation lock
  - Spillway for releasing Lake water to canal
  - Bulkhead still visible along south bank of canal

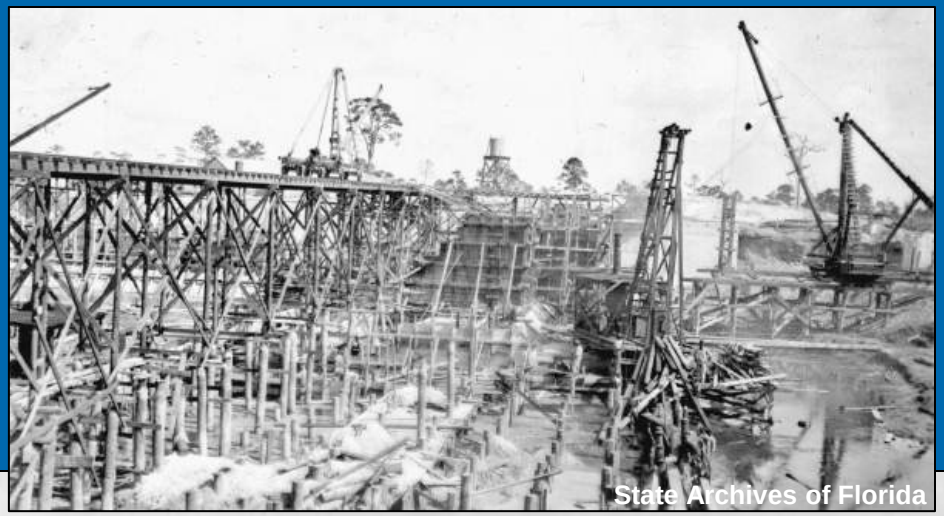
- Replaced in 1978 by Corps of Engineers
  - Referred to as S-308
  - Maximum discharge 8,150 cfs
  - Controls Lake releases to canal and local runoff to Lake


State Archives of Florida


From Osborn, 2012, Courtesy Engebretsen family

St. Lucie Lock and Spillway

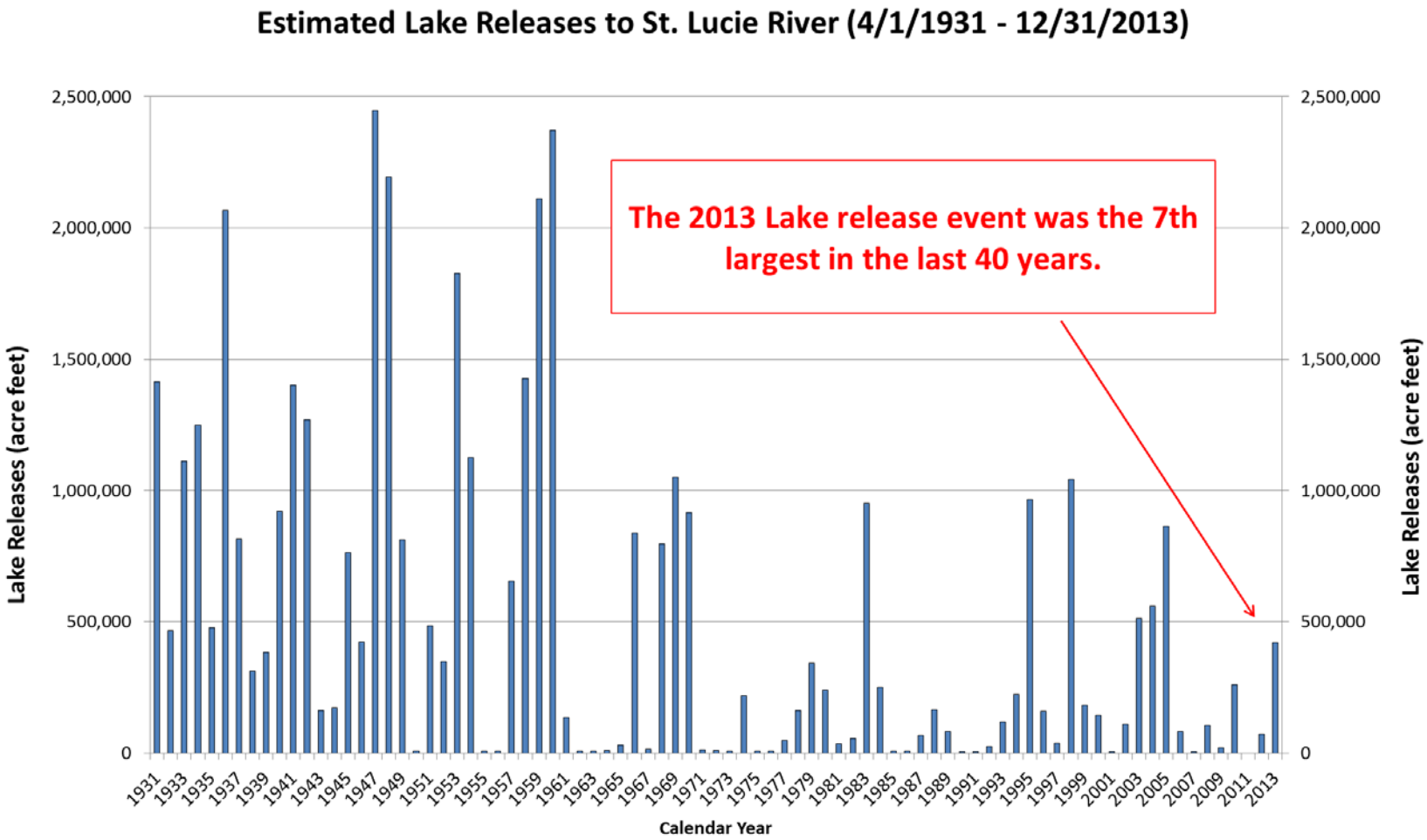
- Originally constructed in 1925 by Everglades Drainage District (Lock No. 2).
  - Navigation lock
  - Spillway for releasing basin runoff and Lake water to River
- Replaced in 1941 by Corps of Engineers
  - Referred to as S-80


State Archives of Florida


State Archives of Florida


Photo courtesy of Stuart News

The first recorded discharge from Lake Okeechobee to the St. Lucie River was on June 13, 1923.



Notes: 1. Data sources for Lake releases: Lake releases to C-44 Canal flows estimated by USGS for 4/1/1931 to 9/30/1952; Lake releases to C-44 Canal flows estimated by SFWMD for 1/1/1965 to 2013;S-80 flows estimated by SFWMD for 10/1/1952 to 2013.

2. Prior to January 1, 1965 concurrent flow estimates were not available for Lake releases to the C-44 Canal and flow at S-80, so approximations of Lake releases to the St. Lucie River were necessary:

1931-1952: Assumed annual Lake release to River was approximately equal to (S-308 flow x 0.918)

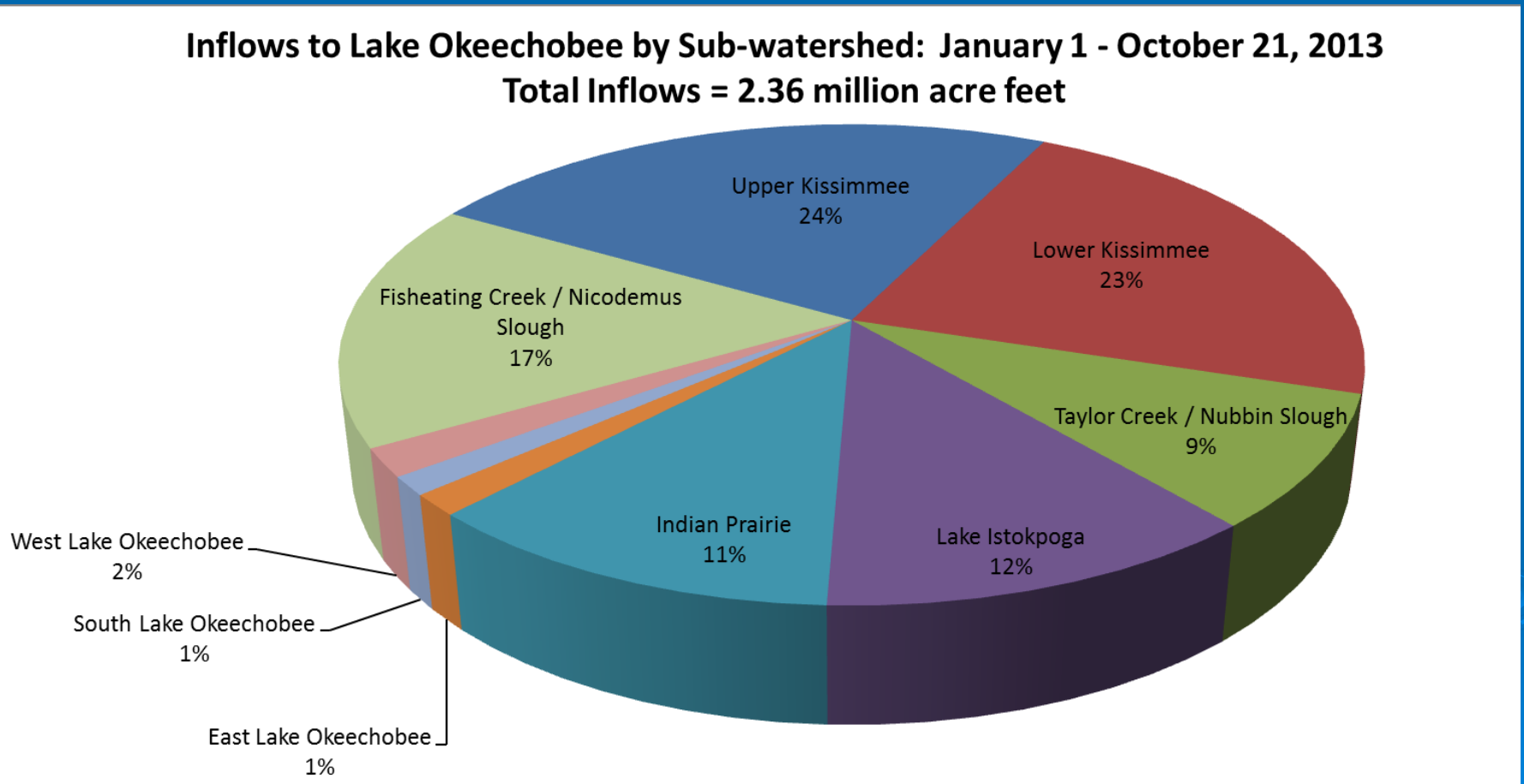
1953-1964: Assumed annual Lake release to River was approximately equal to (S-80 flow x 0.767)

May 8 – October 21, 2013

The Lost Summer

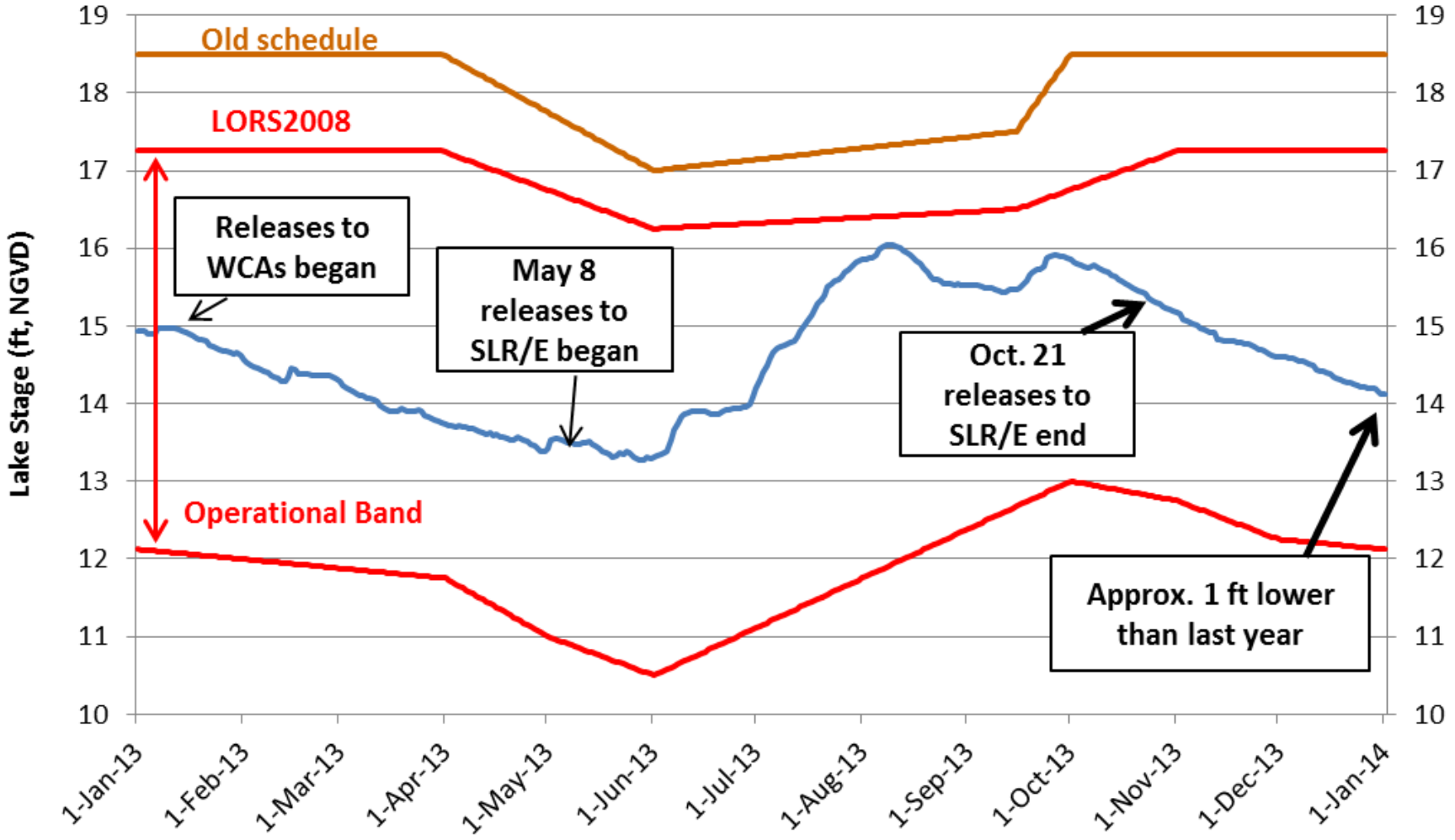
2013 Inflows to Lake Okeechobee

Leading up to, and during, releases to estuaries: 769 billion gallons

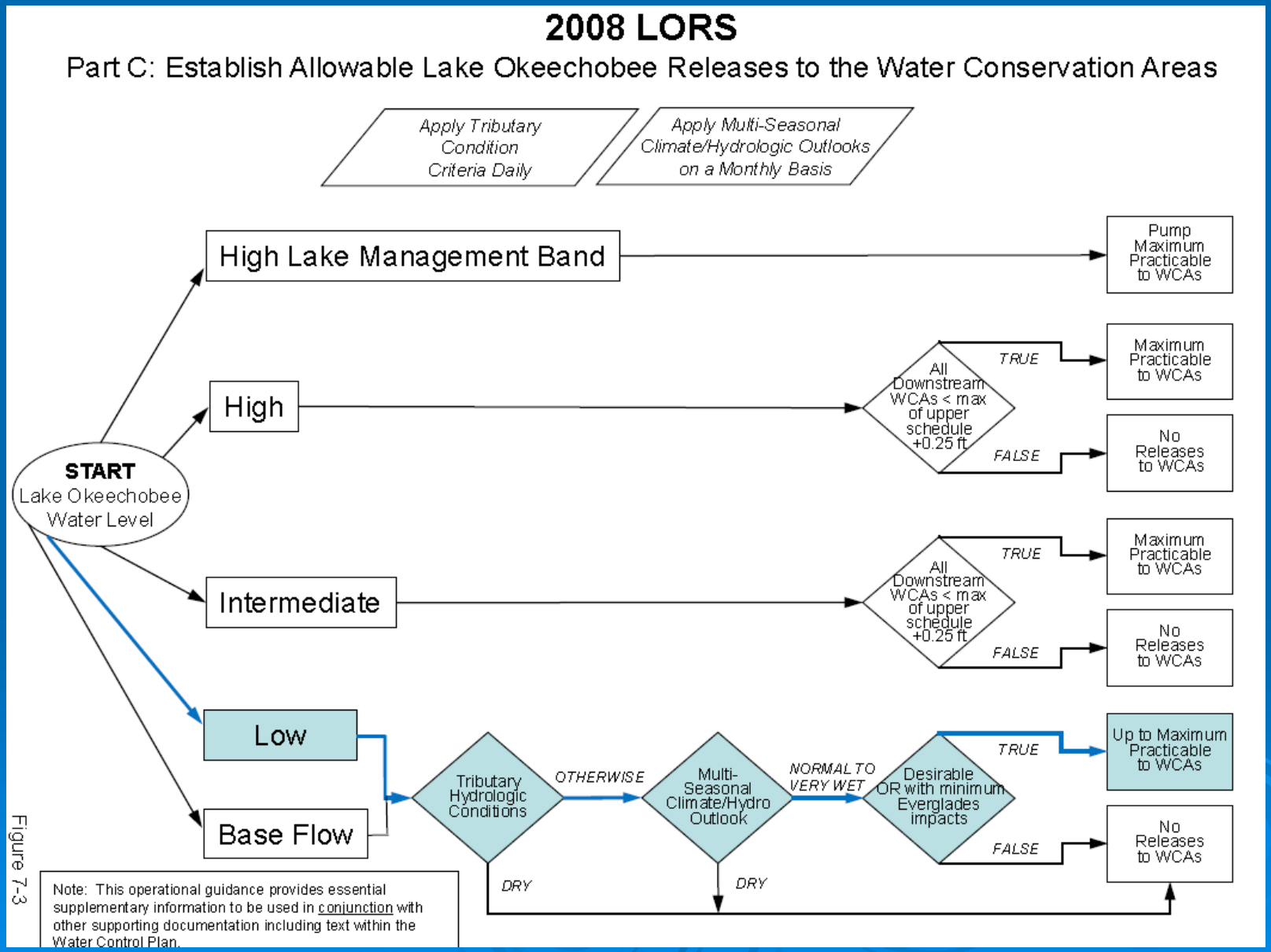


Note: South Lake Okeechobee includes EAA and Ch. 298 Districts. East Lake Okeechobee includes C-44 Basin and L-8 Basin. West Lake Okeechobee includes S-4 / Industrial Canal basin and East Caloosahatchee basin.

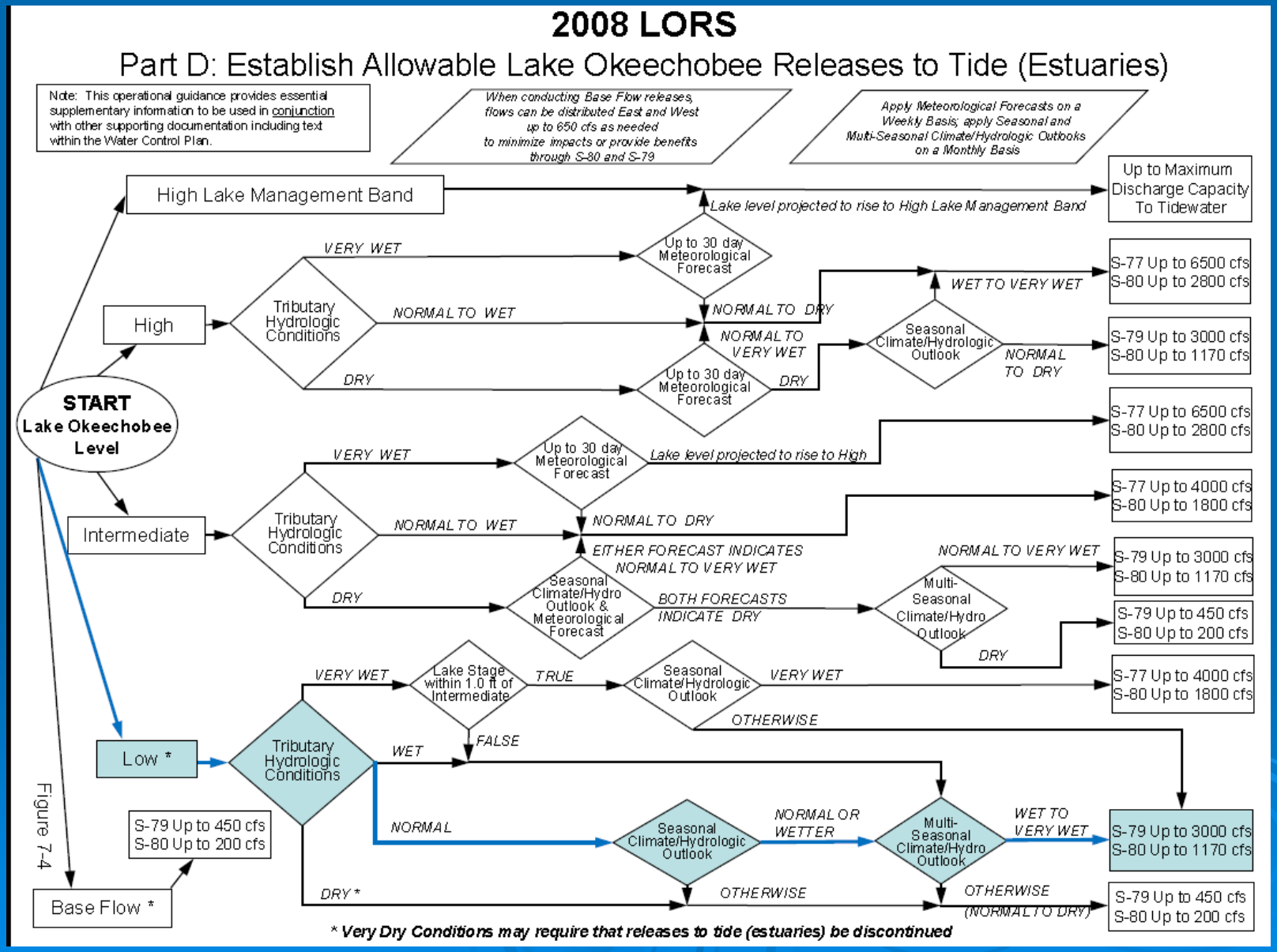
Lake Okeechobee Water Levels - 2013



LORS guidance when releases to SLRE began



LORS guidance when releases to SLRE began



The Lost Summer – Where did the water go?

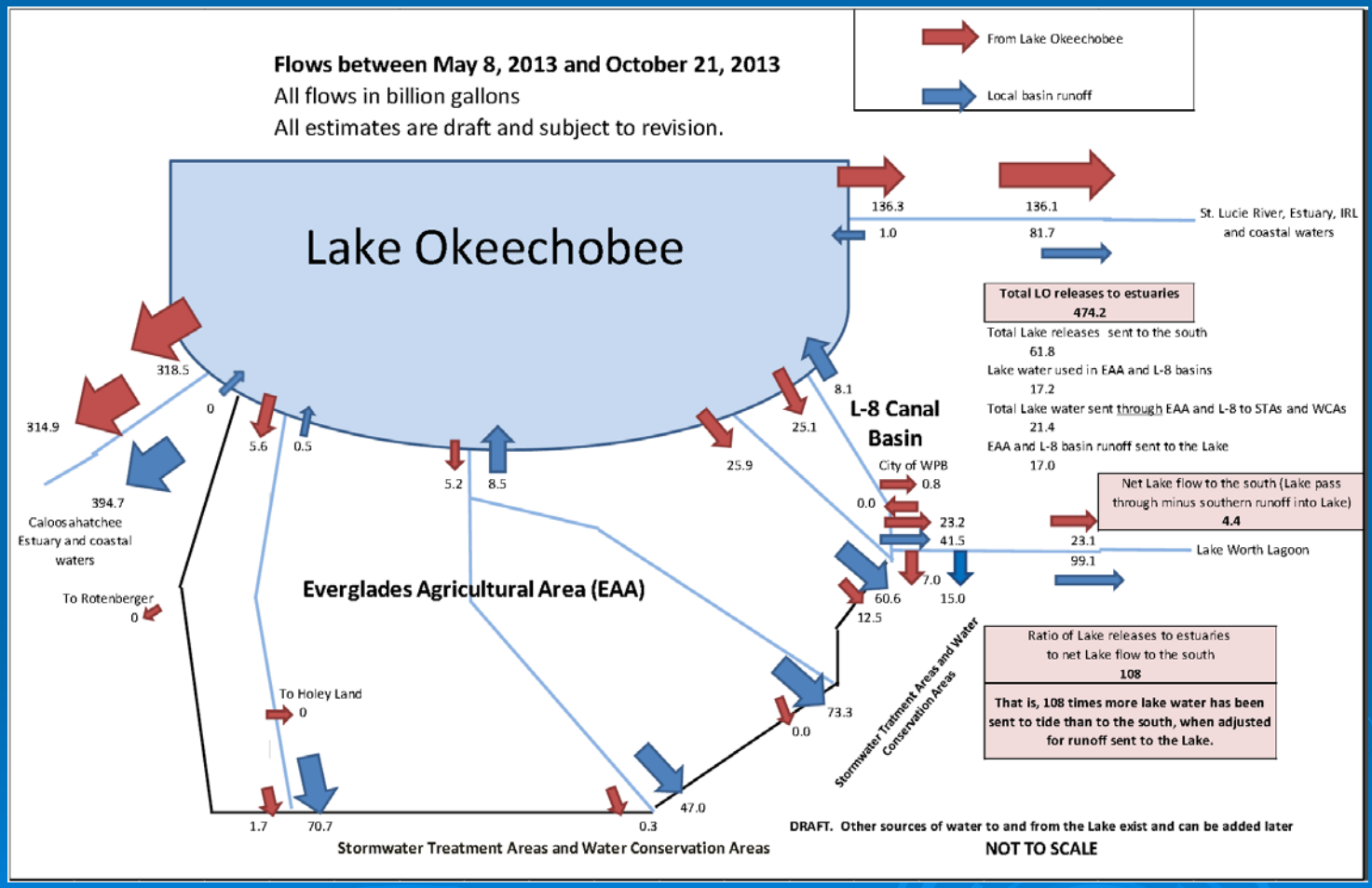
Total releases: 517 billion gallons

To estuaries (incl. Lake Worth Lagoon): 474 billion gallons (92%)

To STAs/WCAs: 21 billion gallons (4%)

Other, e.g., water supply: 21 billion gallons (4%)

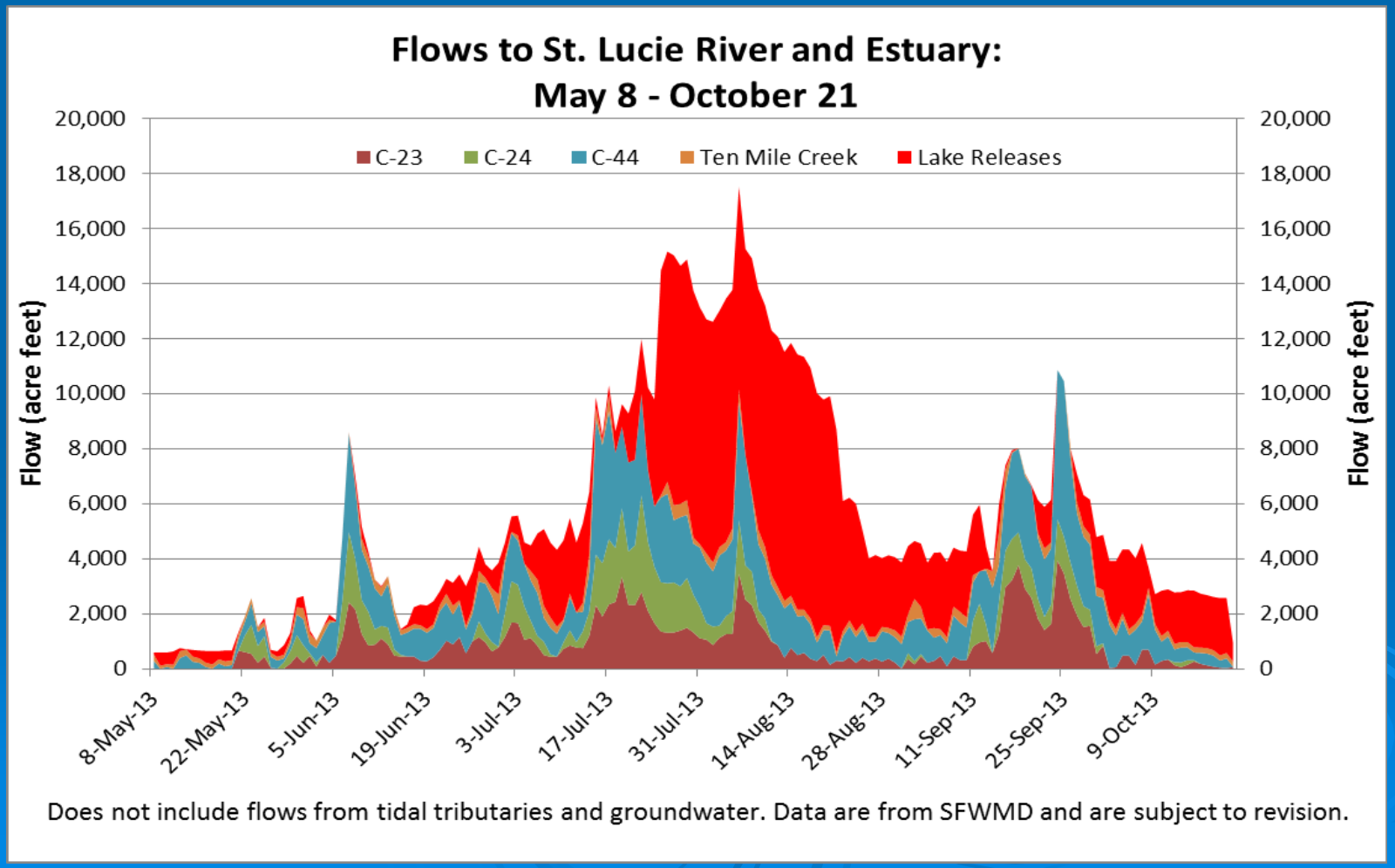
Note: 17 billion gallons of southern stormwater went back to Lake!



Approximately 22 times more water sent to the estuaries than to the STAs/WCAs

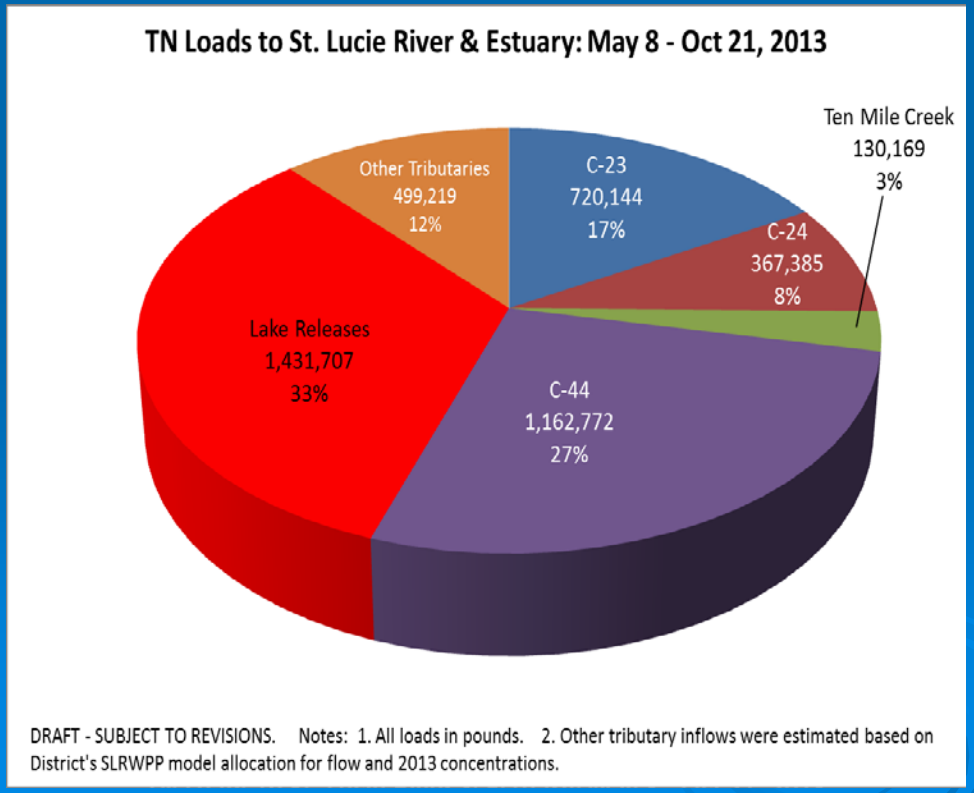
The Lost Summer – St. Lucie Estuary Inflows

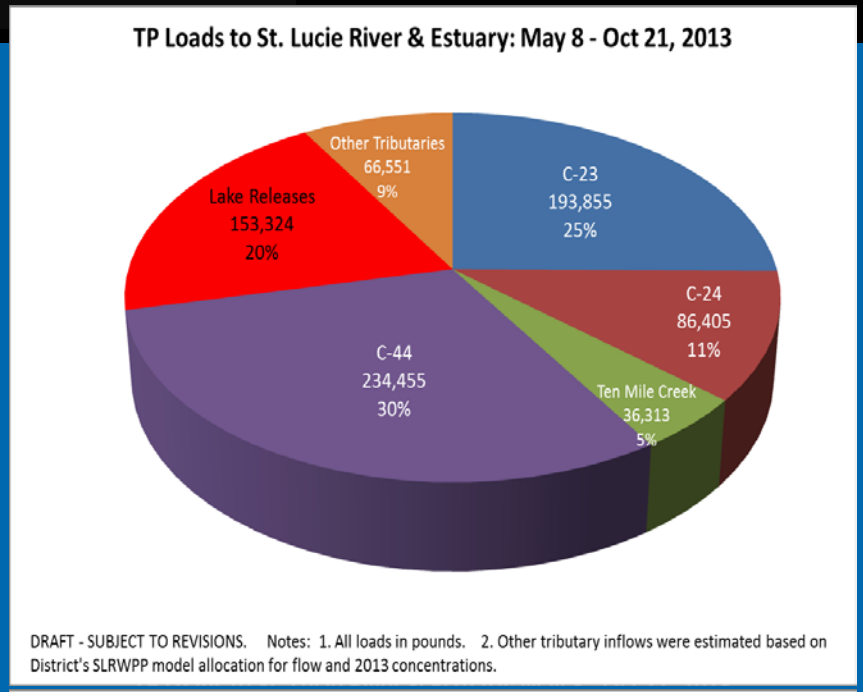
More than 417,700 acre feet (136 billion gallons) of Lake water sent to the St. Lucie River and Estuary – ~40 percent of total surface flows to estuary.
S-308 max flow of 4,680 cfs on 8/15/13; S-80 max flow of 5,869 cfs on 8/6/13

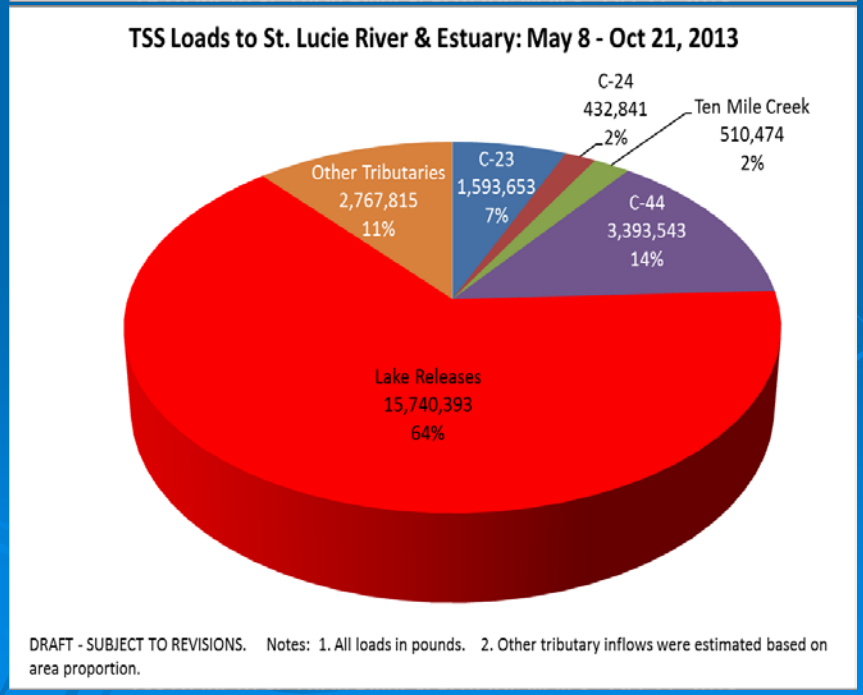


Lost Summer - Nutrient Loads to St. Lucie Estuary

Not “freshwater” - Lake contributed almost 6 times the Total Maximum Daily Load established for nitrogen and phosphorus







Moving forward –

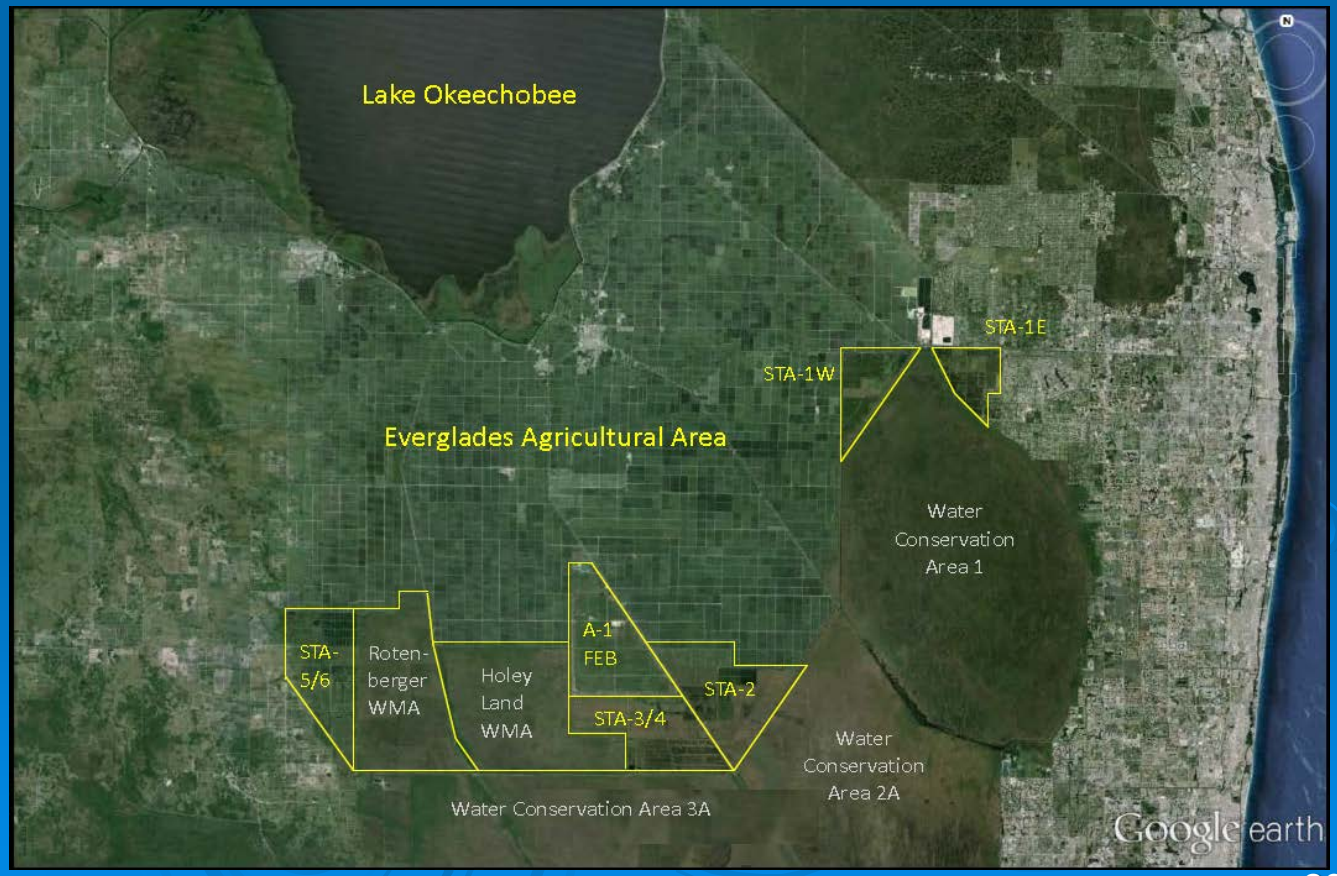
What to do the next time

releases threaten

Send more water south – slow and steady

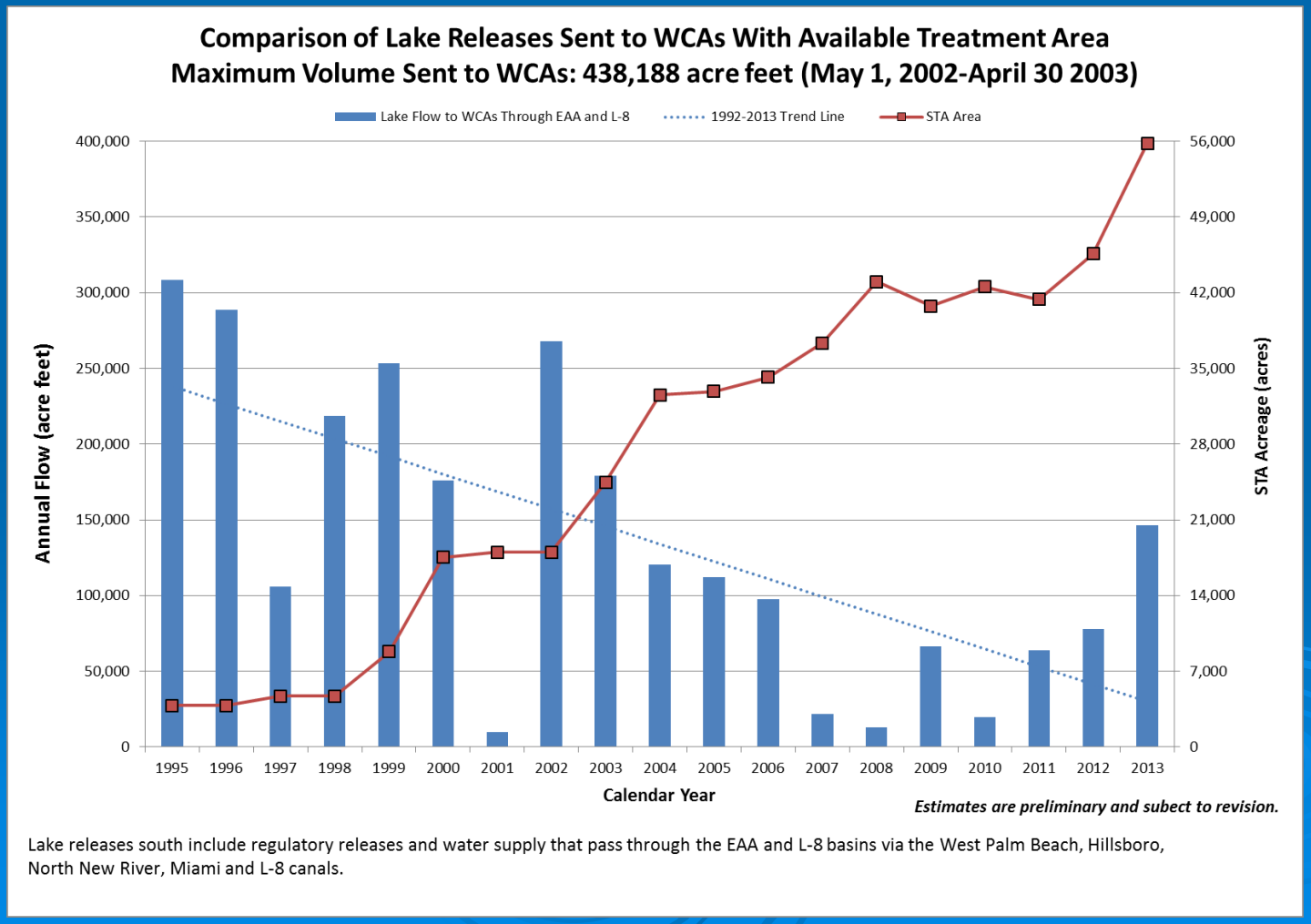
Stormwater Treatment Areas (57,000 acres)
Wildlife Management Areas (62,000 acres)
Water Conservation Areas (849,000 acres)

Sense of scale - if the entire 2013 Lake releases to St. Lucie Estuary were uniformly spread out over these areas - the result would be less than a 1 inch per month increase in depth (hypothetical – can't physically spread water uniformly)



Sufficient publically-owned conveyance and treatment capacity exists today to send more lake water to the WCAs

Lake releases to the WCAs have ***decreased dramatically*** despite more than $1 billion of public investment to, in part, send more Lake water south.



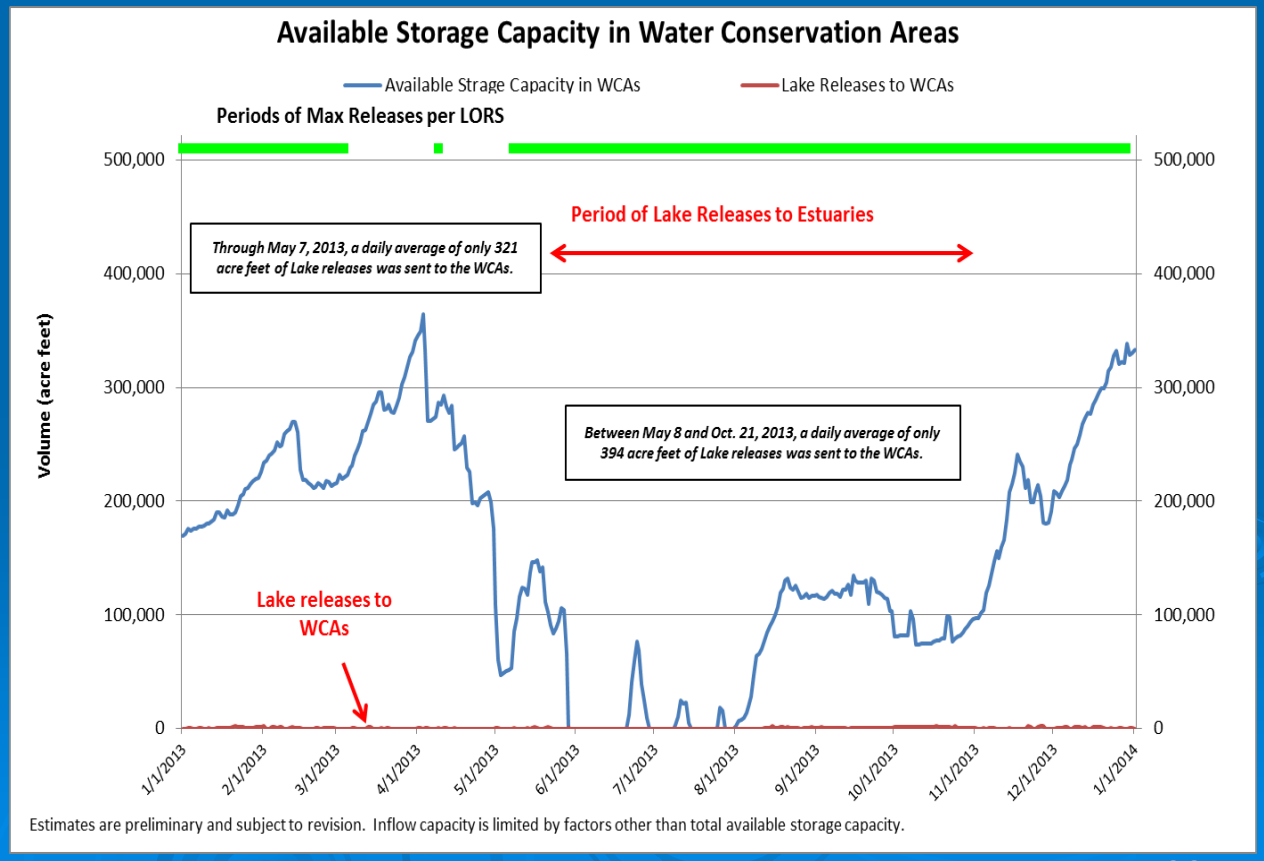
Lake releases south include regulatory releases and water supply that pass through the EAA and L-8 basins via the West Palm Beach, Hillsboro, North New River, Miami and L-8 canals.

Available Capacity Exists in WCAs

Despite significant available storage capacity in the WCAs and the direction to send "up to maximum practicable releases to the WCAs", regulatory releases to the WCAs were not maximized; appears to be no accountability for not sending regulatory releases to the WCAs.

Suggestions:

1. ***Send a minimum of 250,000 acre feet to WCAs before any regulatory releases to the estuaries***
2. ***Establish non-discretionary minimum release targets to the WCAs (subject to levee heights)***
3. ***Remove all policy restrictions to sending regulatory releases to the WCAs***



Stormwater Treatment Areas

5 large water treatment areas utilizing wetland plants and natural processes to remove nutrients from water entering the Everglades; constructed within the EAA and adjacent basins.

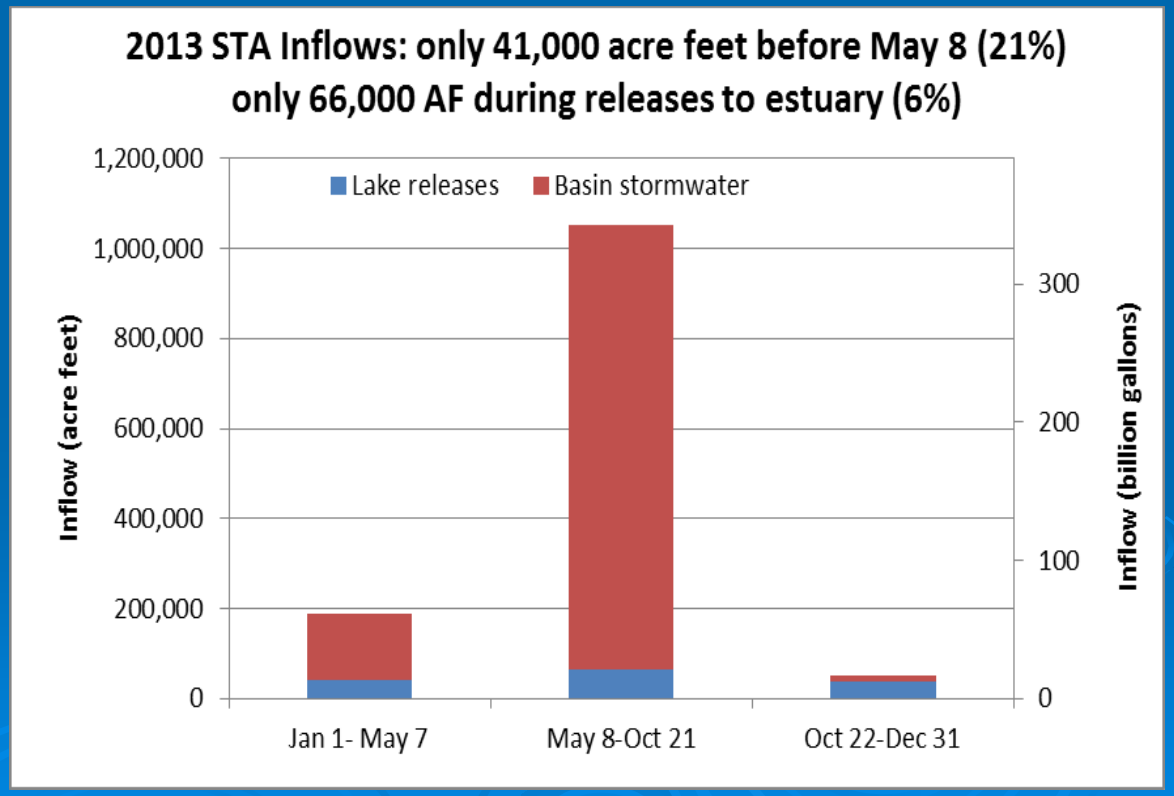
More Fully Utilize the STAs

State legislation authorized public funding of STAs to treat a 28% increase in flows to the Everglades. The original 40,000 acres were designed to treat an average of 250,000 acre feet per year (81.5 billion) – more during wet years. Now there are more than 56,000 acres of STAs, so even more capacity exists.

Lake releases to STAs have averaged about 65,000 acre feet per year.

Fear of sending Lake water to STAs stems from a 2002-03 event – overloaded STA-1W with 6 ft per month; water quality performance dropped, but recovered in 18 months.

2013 flows to STAs were restricted in approx. 20,000 acres due to ground nesting birds, construction, and "resting" treatment vegetation.



More Fully Utilize the STAs

Suggestions:

1. ***Slow and steady flow of Lake water south – River of Grass***
2. ***Send 0.5 – 3 cm per day to STAs (0.5 – 3 ft per month)***

   Target of 87,000 acre feet/month

   Under ideal conditions 435,000 AF over a 5-month period

   Actual capacity will vary depending on various factors (rainfall, STA and WCA water levels, etc.) and while short-term impacts to STAs/WCAs may occur, public health safety and welfare justify these.
3. ***Maintain minimum of 0.5 ft water depth and obtain Special Purpose Permits to avoid restrictions due to ground nesting birds***
4. ***Return all STA cells to full operation during regulatory releases to estuaries***

More fully utilize Wildlife Management Areas

Publicly-funded infrastructure exists to re-establish slow continuous flow-through conditions

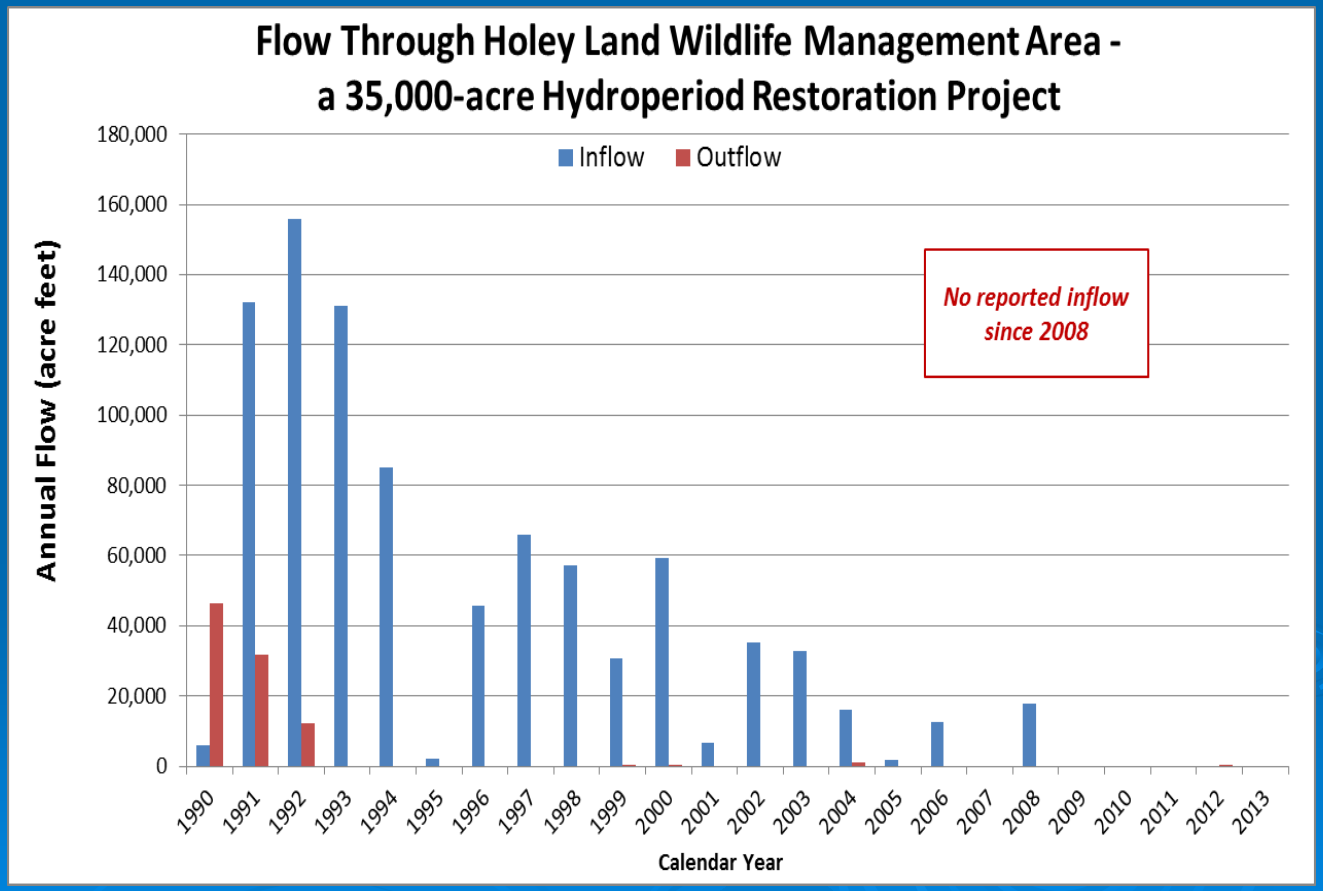
Suggestion:

<u>Slow and steady</u> flow of Lake water south

Send 0.5 cm per day to Holey Land and Rotenberger WMAs

Target 31,000 AF/month

Under ideal conditions, 155,000 acre feet over a 5-month period



When Regulatory Releases to Estuaries are Unavoidable

Until the long-term solution is in place, estuaries will get destructive releases.

Suggestions:

1. ***Declare emergency – notify permit holders and regulatory agencies of need for emergency operations***

2. ***Alert county health departments when algae is observed in Lake releases***

3. ***Implement additional measures to reduce inflows to the Lake***

   2013: more than 17 billion gallons of southern stormwater added to Lake during releases to estuary

4. ***Terminate releases when Lake level is at or below 16 ft***

5. ***Prepare environmental and economic impact analysis***

Other suggestions

1. ***Conduct an updated risk assessment of Herbert Hoover Dike***
2. ***Revise Lake's regulation schedule – balance impacts to estuaries <u>at the same priority</u> as impacts to other regions***
3. ***Add projects to State's BMAP and District's Protection Plan to treat Lake regulatory releases***
4. ***Expedite actions to achieve Lake Okeechobee TMDL***
    1. ***Document effectiveness of source controls***
    2. ***Ensure Dispersed Water Management Projects are cost effective at reducing pollution loading, or re-direct funding to regional water quality projects***
5. ***<u>Begin conceptual design of long-term solution – "3rd outlet" to Everglades</u>***

Summary of near-term suggestions

1. When LORS directs "up to maximum releases to WCAs", fully utilize public lands south of Lake Okeechobee
   a. Slow continuous releases to the STAs, WMAs and WCAs
   b. Before regulatory releases to estuaries: minimum of 250,000 AF
   c. Non-discretionary levels until releases terminated
2. When regulatory releases to estuary are unavoidable:
   a. Declare emergency
   b. Alert county health departments when algae is observed in Lake releases
   c. Implement additional measures to reduce inflows to the Lake
   d. Terminate releases when Lake level is at or below 16 ft
   e. Conduct environmental and economic impact analysis
3. Revise Lake's regulation schedule with updated risk assessment and impacts to estuary evaluated at same priority as other regions
4. Take cost effective actions to achieve Lake and estuaries' TMDLs
5. Begin conceptual design of long-term solution – "3rd outlet" to Everglades

Thanks to all who have contributed to raising and sustaining public awareness during the Lost Summer

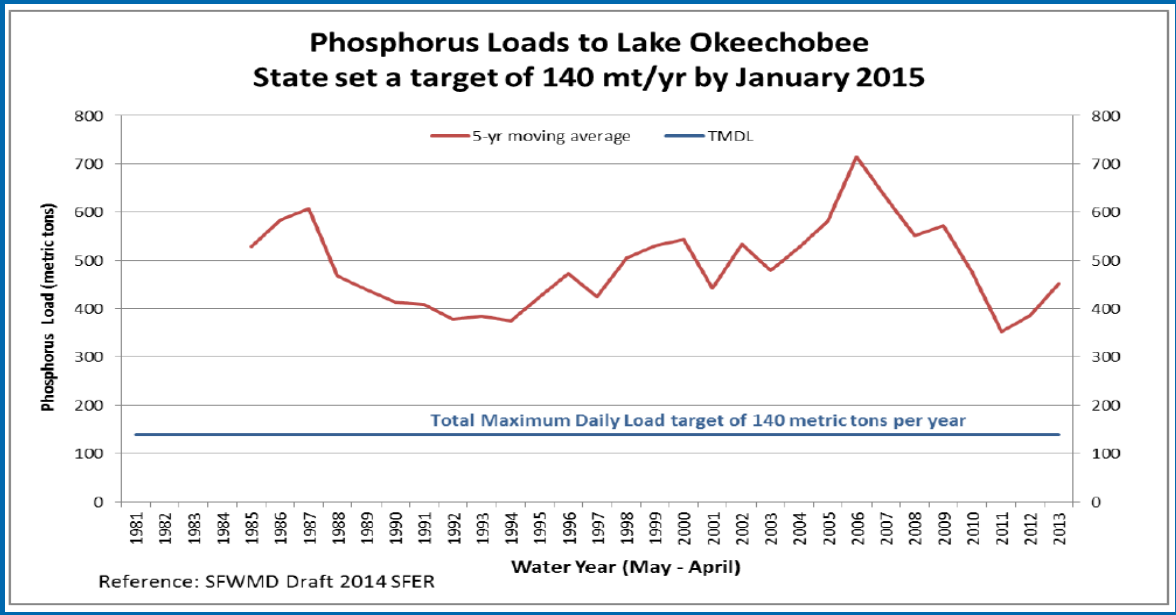
The future for South Florida, as for all once-beautiful and despoiled areas of our country, ***lies in aroused and informed public opinion and citizen action****. If more and more of us continue forcefully and untiringly to demand a* ***balanced*** *development of land, of salt and fresh water, of people and wilderness, farms, cities, appropriate industries, wildlife and recreation such as the region can intelligently be expected to support,* ***we can still bring back much usefulness and beauty to a changed and re-created earth****.*

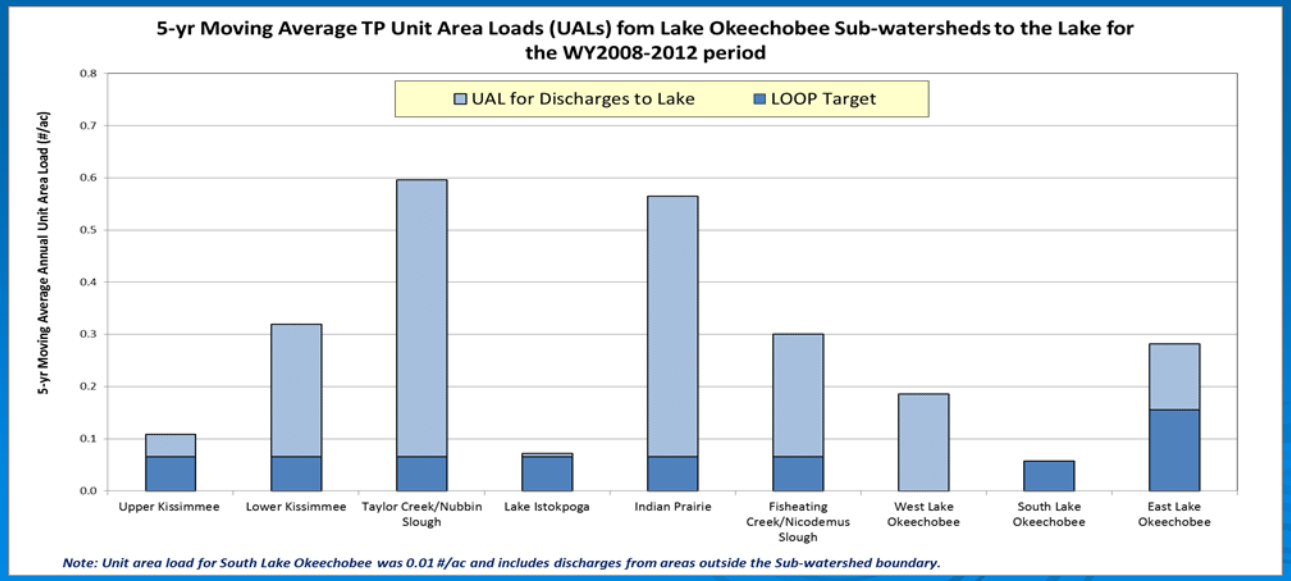
Marjory Stoneman Douglas, The Everglades: River of Grass, 1947

Questions or comments?

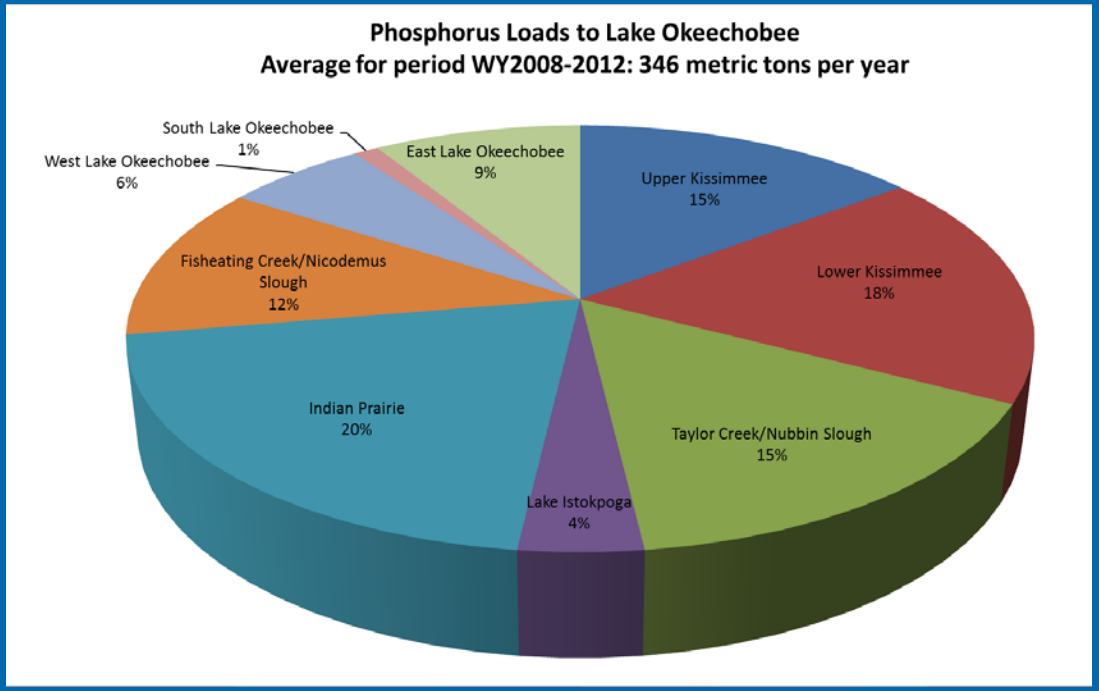
Photo courtesy of Jacqui Thurlow-Lippisch

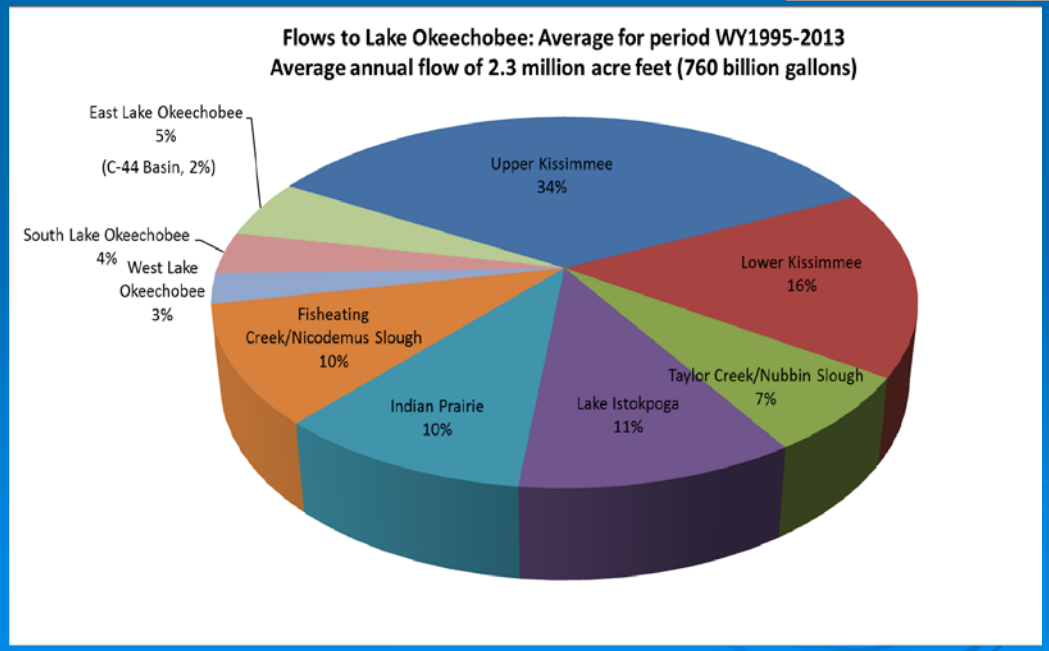
Continued Pollution of Lake Okeechobee



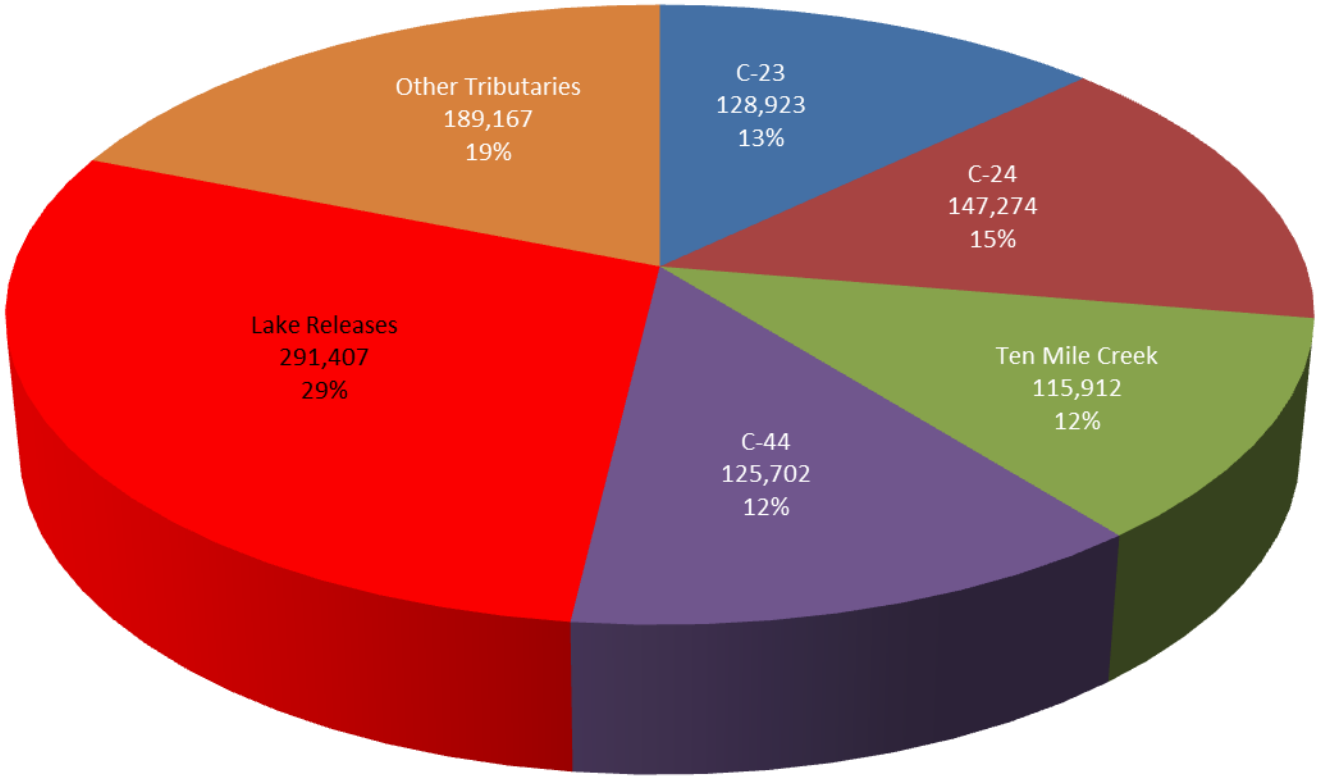


Flows and Phosphorus Loads to Lake Okeechobee





Historical Flows to St. Lucie Estuary

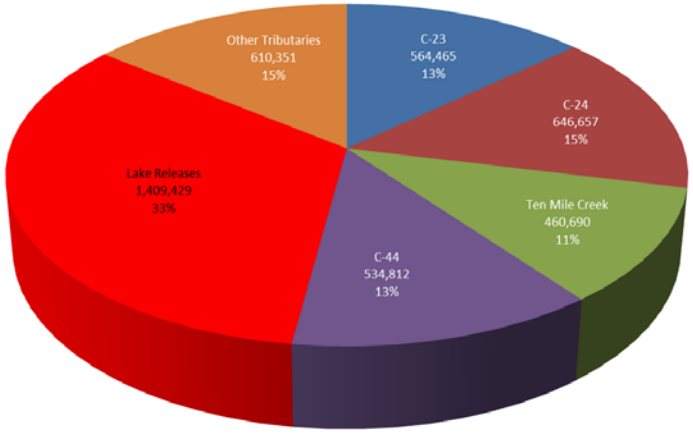


DRAFT - SUBJECT TO REVISIONS. Notes: 1. Missing flows for C-23 Basin are estimated from C-24 flows prior to 1996. 2. Missing flows for Ten Mile Creek are estimated from C-24 flows prior to 2000.

3. Flows for other tributary inflows estimated based on SLRWPP model allocation.

Historical Loads to St. Lucie Estuary

Nitrogen Loads to St. Lucie River & Estuary: 1995-2013
Average annual loads in pounds



DRAFT - SUBJECT TO REVISIONS. Notes: 1. Missing flows for C-23 Basin are estimated from C-24 flows prior to 1996. 2. Missing flows for Ten Mile Creek are estimated from C-24 flows prior to 2000.
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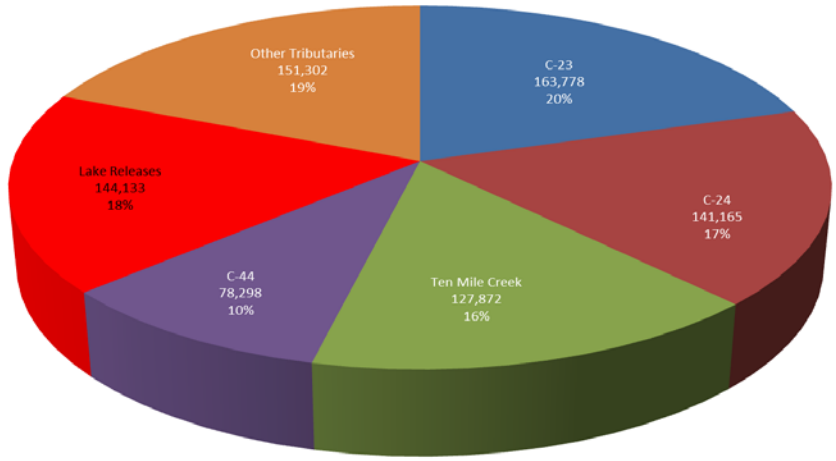
Phosphorus Loads to St. Lucie River & Estuary: 1995-2013
Average annual loads in pounds



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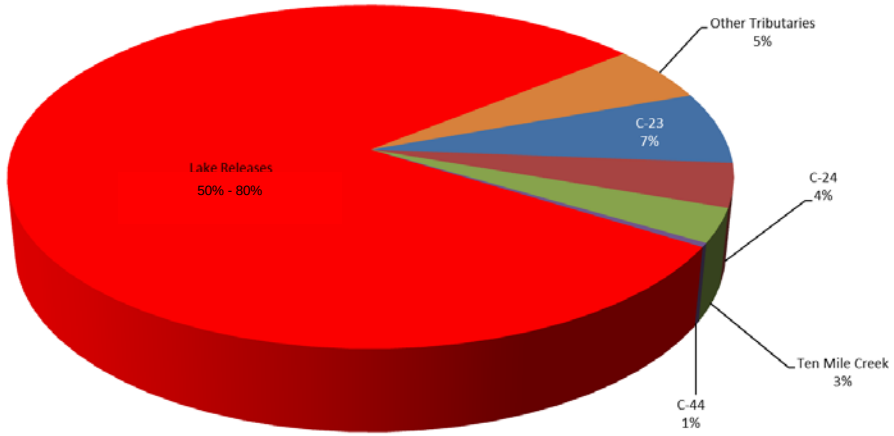
3. Flows for other tributary inflows estimated based on SLRWPP model allocation.

Suspended Solids Loads to St. Lucie River & Estuary: 1995-2013
High uncertainty on estimates of average annual sediment loads



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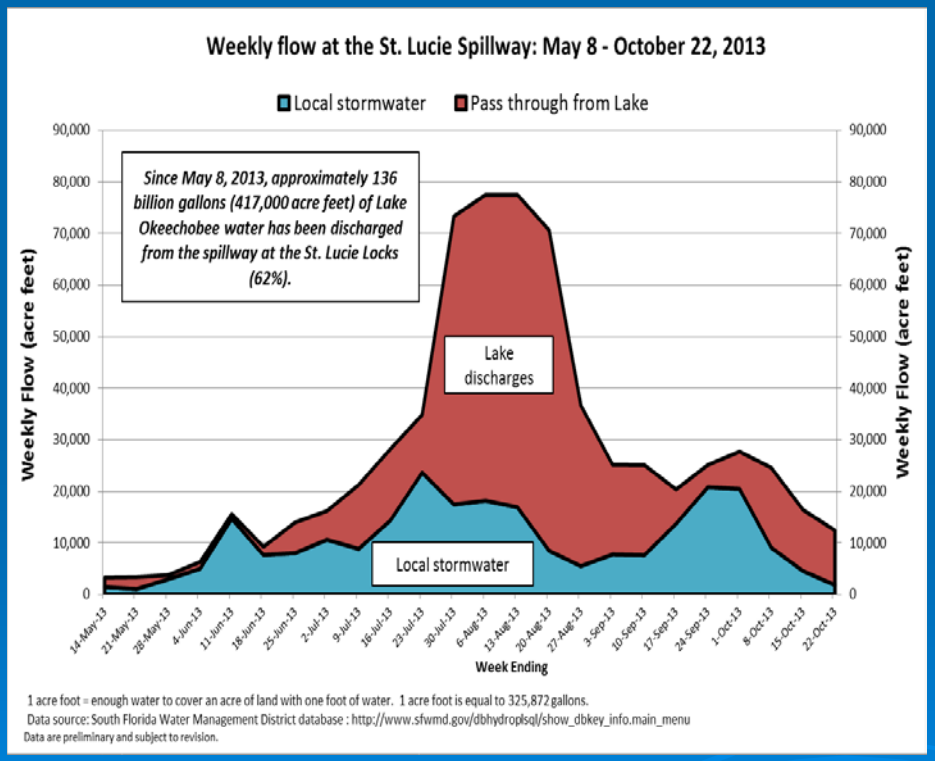
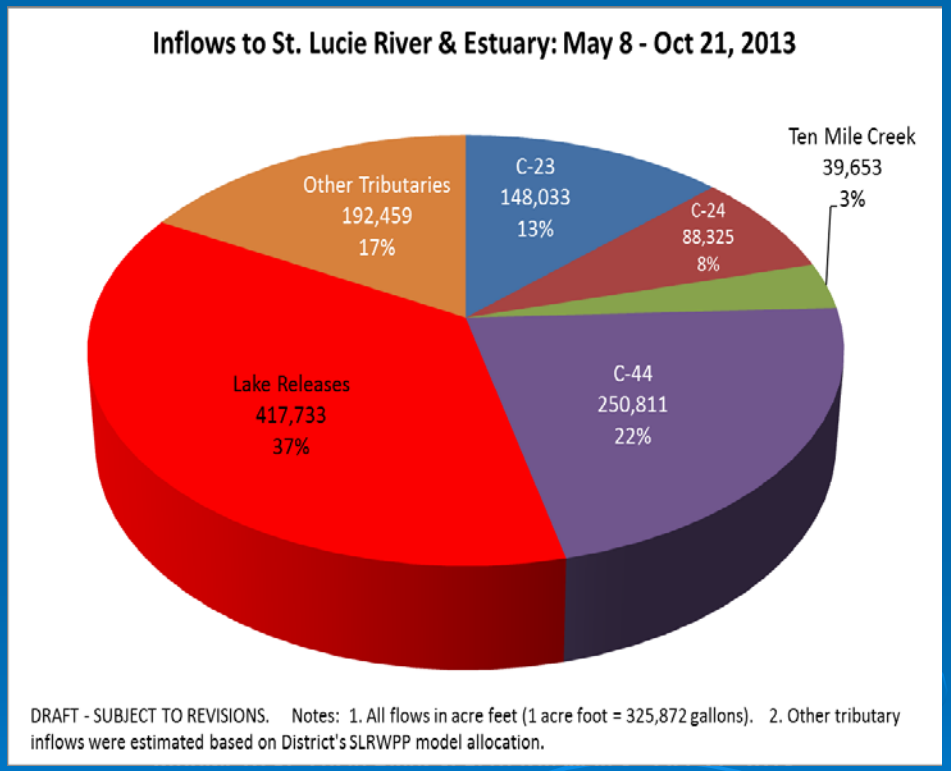
3. Flows for other tributary inflows estimated based on SLRWPP model allocation.

2013 - The Lost Summer

More than 417,000 acre feet (136 billion gallons) of Lake water sent to the estuary – 37 percent of total surface flows.





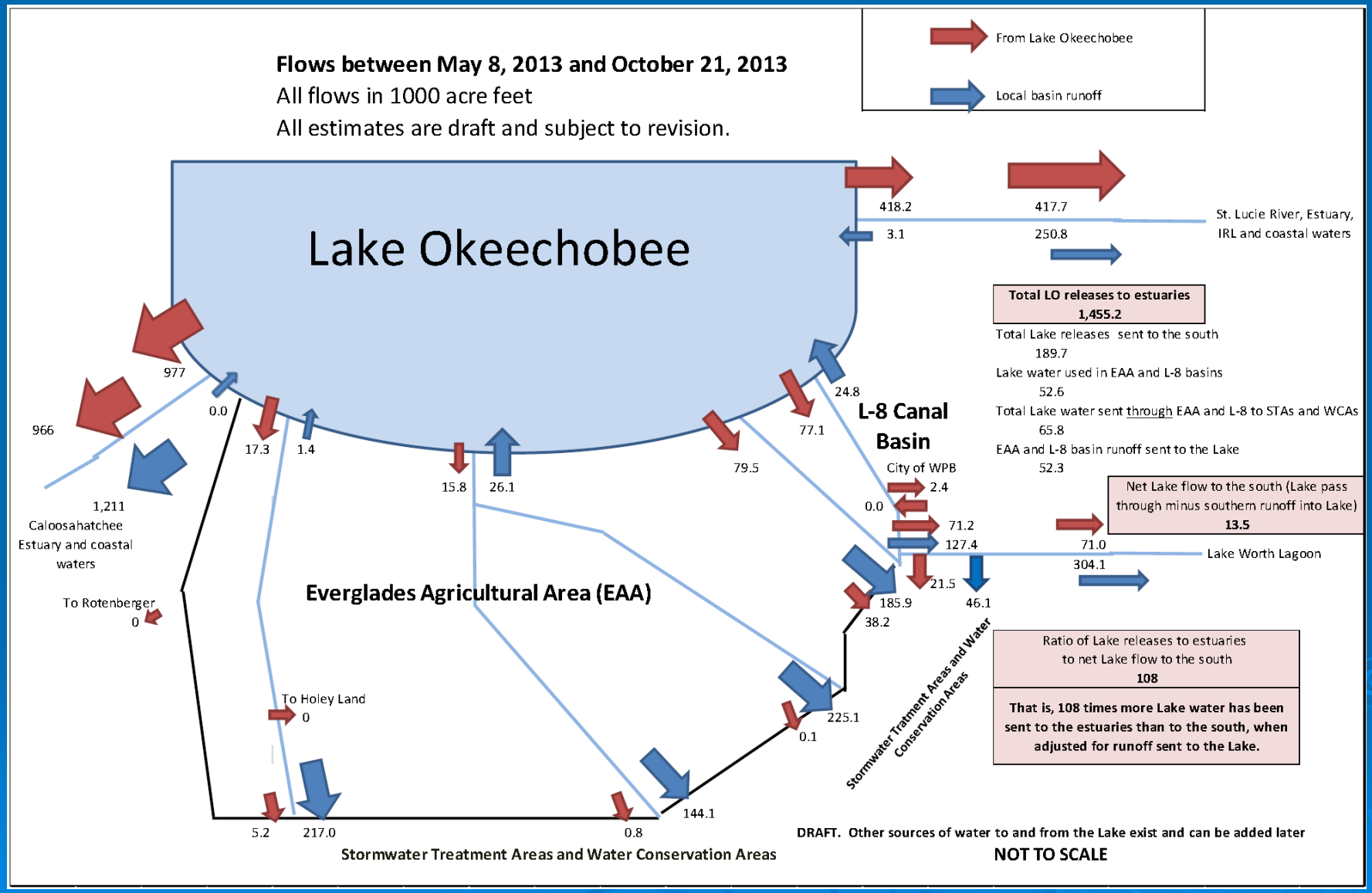

From Lake Okeechobee
Local basin runoff
Flows between May 8, 2013 and October 21, 2013
All flows in 1000 acre feet
All estimates are draft and subject to revision.
Lake Okeechobee
418.2
3.1
417.7
250.8
St. Lucie River, Estuary, IRL and coastal waters
Total LO releases to estuaries
1,455.2
Total Lake releases sent to the south
189.7
Lake water used in EAA and L-8 basins
52.6
Total Lake water sent through EAA and L-8 to STAs and WCAs
65.8
EAA and L-8 basin runoff sent to the Lake
52.3
977
966
0.0
17.3
1.4
15.8
26.1
79.5
77.1
24.8
L-8 Canal Basin
City of WPB
2.4
0.0
71.2
127.4
21.5
46.1
185.9
38.2
225.1
0.1
144.1
0.8
5.2
217.0
1,211
Caloosahatchee Estuary and coastal waters
To Rotenberger
0
To Holey Land
0
Everglades Agricultural Area (EAA)
Net Lake flow to the south (Lake pass through minus southern runoff into Lake)
13.5
71.0
304.1
Lake Worth Lagoon
Ratio of Lake releases to estuaries to net Lake flow to the south
108
That is, 108 times more Lake water has been sent to the estuaries than to the south, when adjusted for runoff sent to the Lake.
Stormwater Tratment Areas and Water Conservation Areas
DRAFT. Other sources of water to and from the Lake exist and can be added later
NOT TO SCALE
Stormwater Treatment Areas and Water Conservation Areas

Table 1. Summary of 2013 Lake Releases to Estuaries and WCAs (excludes Lake releases for water supply to adjacent basins).

Source	Jan 1- May 7	May 8-Oct 21	Oct 22-Dec 31	Total 2013
Lake Release to STA/WCAs	41,334	65,800	39,375	146,509
Basin Runoff to STA/WCAs	148,370	1,002,127	12,374	1,162,871
Total to STAs/WCAs	189,704	1,067,927	51,749	1,309,380
Lake as % of Total	22%	6%	76%	11%
Lake Release to St. Lucie R/E	1,450	417,733	768	419,951
Basin Runoff to St. Lucie R/E	41,283	719,281	30,438	791,002
Total to St. Lucie R/E	42,733	1,137,015	31,206	1,210,953
Lake as % of Total	3%	37%	2%	35%
Lake Release to Caloos. R/E	65,957	966,463	23,808	1,056,228
Basin Runoff to Caloos. R/E	66,301	1,762,350	45,587	1,874,237
Total to Caloos. R/E	132,257	2,728,813	69,395	2,930,465
Lake as % of Total	50%	35%	34%	36%
Lake Release to LW Lagoon	5,058	71,030	24,877	100,966
Basin Runoff to LW Lagoon	19,502	304,100	7,442	331,045
Total to LW Lagoon	24,560	375,130	32,320	432,010
Lake as % of Total	21%	19%	77%	23%
Total Lake Releases	113,799	1,521,027	88,828	1,723,653

Notes:

1. Estimates are preliminary and subject to revision; all flows in acre feet.
2. Basin Runoff to STAs/WCAs include only those basins that discharge to the STAs.
3. Basin Runoff to St. Lucie River/Estuary includes runoff from C-23, C-24, C-25 and C-44
4. Basin Runoff to Caloosahatchee River/Estuary includes runoff from S-78 and S-79 basins only.
5. Basin Runoff to Lake Worth Lagoon includes only runoff from C-51 Basin.

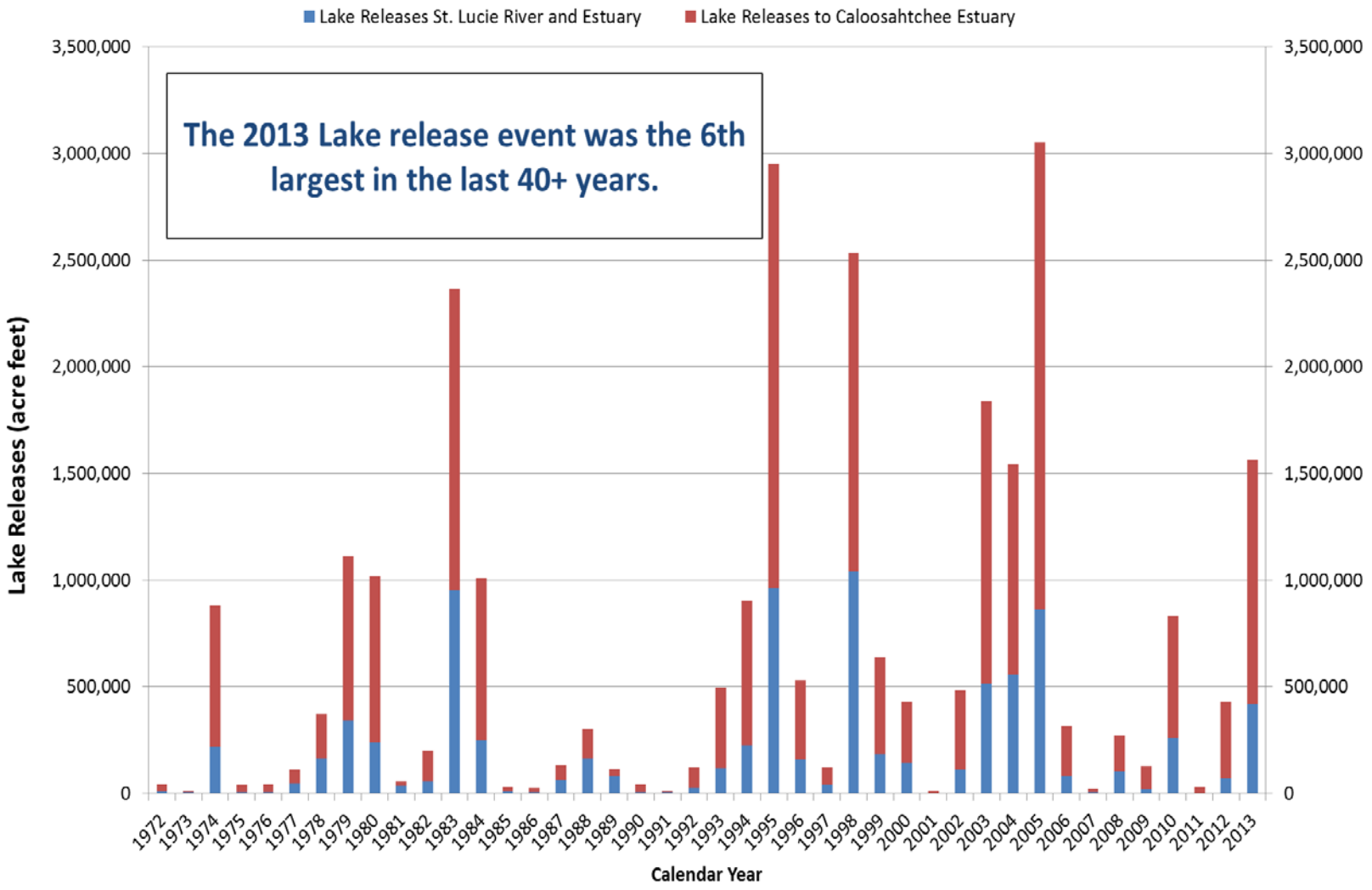
Summary of 2013 Lake Releases to Estuaries and WCAs (excludes Lake releases for water supply to adjacent basins). (billion gallons)

Source	Jan 1- May 7	May 8-Oct 21	Oct 22-Dec 31	Total 2013
Lake Release to STA/WCAs	13.5	21.4	12.8	47.7
Basin Runoff to STA/WCAs	48.3	326.6	4.0	378.9
Total to STAs/WCAs	61.8	348.0	16.9	426.7
Lake as % of Total	22%	6%	76%	11%
Lake Release to St. Lucie R/E	0.5	136.1	0.3	136.9
Basin Runoff to St. Lucie R/E	13.5	234.4	9.9	257.8
Total to St. Lucie R/E	13.9	370.5	10.2	394.6
Lake as % of Total	3%	37%	2%	35%
Lake Release to Caloos. R/E	21.5	314.9	7.8	344.2
Basin Runoff to Caloos. R/E	21.6	574.3	14.9	610.8
Total to Caloos. R/E	43.1	889.2	22.6	955.0
Lake as % of Total	50%	35%	34%	36%
Lake Release to LW Lagoon	1.6	23.1	8.1	32.9
Basin Runoff to LW Lagoon	6.4	99.1	2.4	107.9
Total to LW Lagoon	8.0	122.2	10.5	140.8
Lake as % of Total	21%	19%	77%	23%
Total Lake Releases	37.1	495.7	28.9	561.7

Notes:

1. Estimates are preliminary and subject to revision; all flows in billion gallons.
2. Basin Runoff to STAs/WCAs include only those basins that discharge to the STAs.
3. Basin Runoff to St. Lucie River/Estuary includes runoff from C-23, C-24, C-25 and C-44
4. Basin Runoff to Caloosahatchee River/Estuary includes runoff from S-78 and S-79 basins only.
5. Basin Runoff to Lake Worth Lagoon includes only runoff from C-51 Basin.

Estimated Lake Releases to the Estuaries



Note: Lake releases include regulatory releases, water supply releases and releases for salinity adjustment.

Historical (WY1995-2013) structure maximum discharges from the Lake

- South/southeast
  - S-351: 2,050 cfs (1,406 in 2013)
  - S-352: 1,300 cfs (1,104 in 2013)
  - S-354: 1,860 cfs (1,448 cfs in 2013)
  - LC10-A: 622 cfs (562 cfs in 2013)
  - **Combined: 5,832 cfs (3,703 cfs in 2013)**
- East/West
  - Caloosahatchee River – once a natural meandering river
    - S-77 – 8,967 cfs (7,151 cfs in 2013) 8,967 cfs POR max (1965 – present)
    - S-79 – 21,338 cfs in 2103
    - In general receives about twice the Lake releases than St. Lucie Canal
  - St. Lucie Canal – man-made
    - S-308 – 7,695 cfs (4,680 cfs in 2013) 8,150 cfs POR max (1978-present)
    - S-80 – 5,869 cfs in 2013
  - Combined: 16,662
  - **Ratio of E/W to S = 2.9 to 1**

STA	Period	Lake Releases AF	Stormwater Flows AF	Total to WCAs AF	STA Area acres	Hydraulic Load from Lake cm per day
STA-1E	Jan 1- May 7	6,344	4,718	11,062	5,000	0.30
	May 8-Oct 21	21,476	83,315	104,791		0.78
	Oct 22-Dec 31	4,828	102	4,931		0.41
	Total 2013	32,649	88,135	120,783		0.55
STA-1W	Jan 1- May 7	1,179	25,791	26,971	6,500	0.04
	May 8-Oct 21	38,217	154,563	192,780		1.07
	Oct 22-Dec 31	8,466	3,572	12,038		0.56
	Total 2013	47,862	183,926	231,789		0.61
STA-2	Jan 1- May 7	9,352	51,809	61,160	15,500	0.14
	May 8-Oct 21	395	288,434	288,829		0.00
	Oct 22-Dec 31	8,420	13,941	22,361		0.23
	Total 2013	18,167	354,184	372,350		0.10
STA-3/4	Jan 1- May 7	24,358	60,229	84,587	16,300	0.36
	May 8-Oct 21	5,712	362,266	367,978		0.06
	Oct 22-Dec 31	17,657	-5,903	11,755		0.47
	Total 2013	47,728	416,592	464,320		0.24
STA-5/6	Jan 1- May 7	0	5,805	5,805	13,700	0.00
	May 8-Oct 21	0	96,144	96,144		0.00
	Oct 22-Dec 31	0	662	662		0.00
	Total 2013	0	102,612	102,612		0.00
Total	Jan 1- May 7	41,233	148,352	189,585	57,000	0.17
	May 8-Oct 21	65,800	984,723	1,050,523		0.21
	Oct 22-Dec 31	39,372	12,374	51,746		0.30
	Total 2013	146,405	1,145,448	1,291,854		0.21
Portion of STA Inflows	Jan 1- May 7	22%	78%			
	May 8-Oct 21	6%	94%			
	Oct 22-Dec 31	76%	24%			
	Total 2013	11%	89%			
Diverted directly to WCAs	Jan 1- May 7	90	20	110		
	May 8-Oct 21	0	17,394	17,394		
	Oct 22-Dec 31	3	0	3		
	Total 2013	93	17,413	17,506		
Total Lake to STAs and WCAs	Jan 1- May 7	41,323	148,371	189,695		
	May 8-Oct 21	65,800	1,002,116	1,067,916		
	Oct 22-Dec 31	39,374	12,375	51,749		
	Total 2013	146,498	1,162,862	1,309,360		

Notes:

1. "Stormwater Flows" is total STA outflow to WCAs minus Lake inflows to STAs; assumed all Lake flows pass through STAs
2. Negative value appears for STA-3/4 during Oct. 22-Dec. 31 because not all Lake flows left the STA during this period
3. Some STA-3/4 and STA-5/6 outflow was sent to Rotenberger WMA instead of the WCAs.