Supply Side Management (SSM) for Lake Okeechobee

SFWMM Training

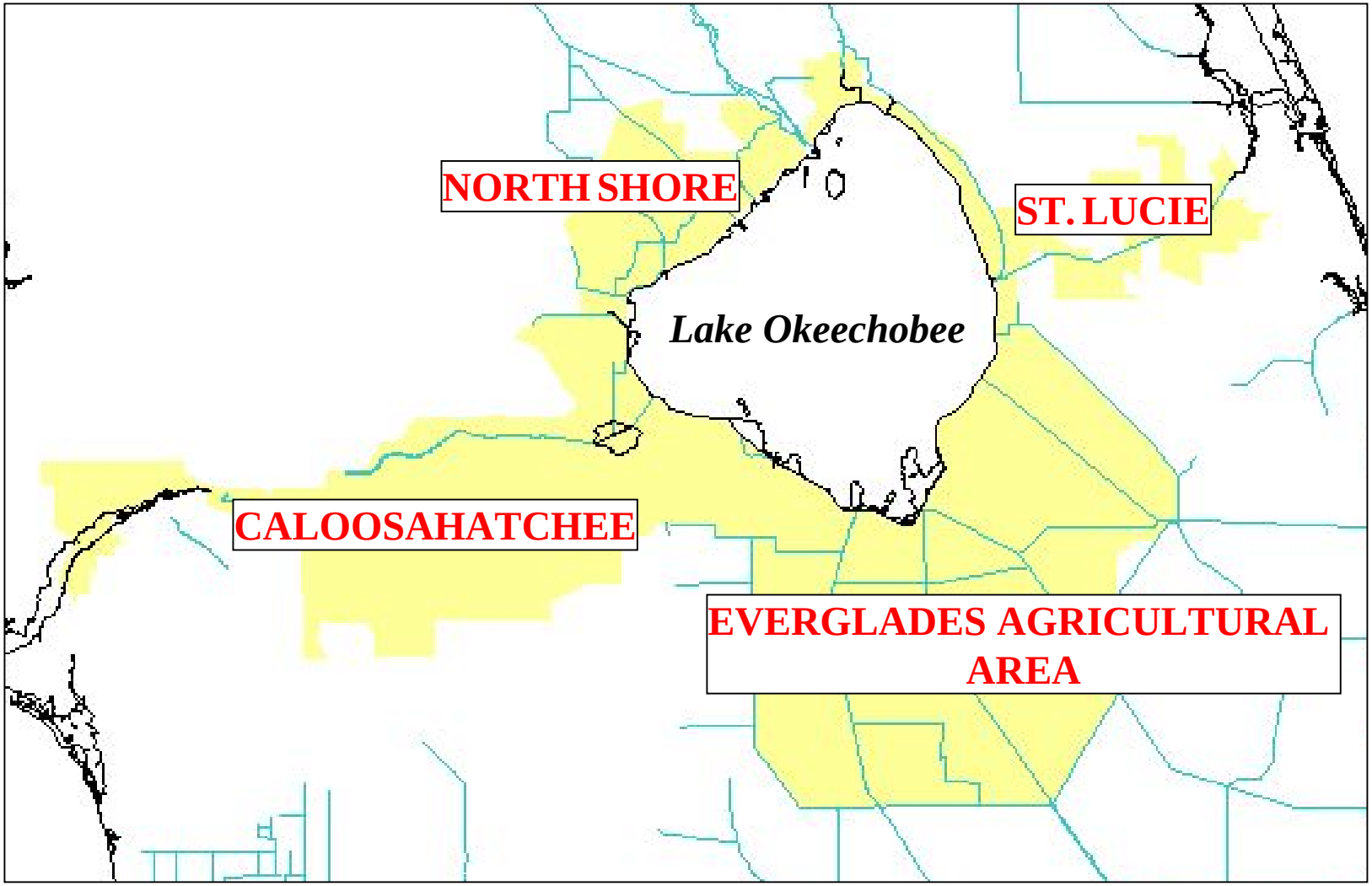
September 4, 2002

Presented by Walter Wilcox, HSM

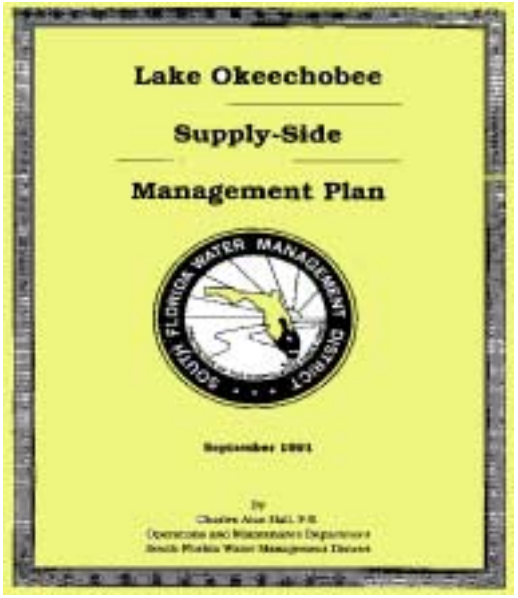
Presentation Outline

- Water Supply Restrictions in LOSA (Supply-Side Management)
- SSM Methodology and Allocation Calculations
- Changing SFWMM Input for SSM
- Reviewing SFWMM and Post Processed Output Related to SSM

Lake Okeechobee Service Area (LOSA)

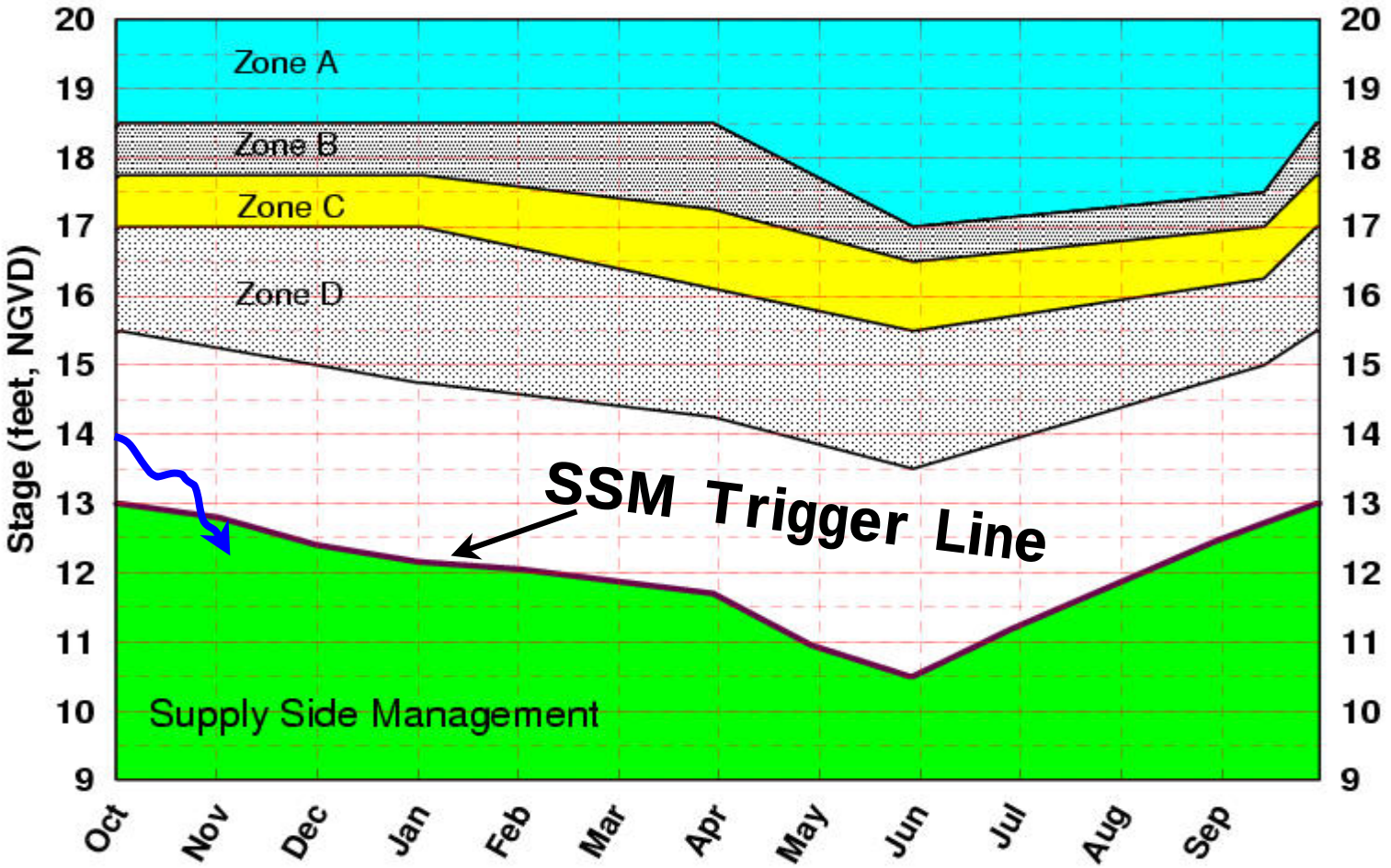


SSM Plan (Hall 1991)



- Part of the SFWMD Water Shortage Plan
- Supply Side Management is “designed to manage supply and demand for water users within the Lake Okeechobee Service Area and the Lower East Coast of Florida” during periods of shortage
- Water shortage cutbacks associated with SSM are imposed on LOSA when Lake Okeechobee stages fall below the SSM Trigger Line.

SSM Trigger Line



SSM Methodology

In essence, SSM attempts to answer two questions in the event of water shortage caused by low Lake Okeechobee stages:

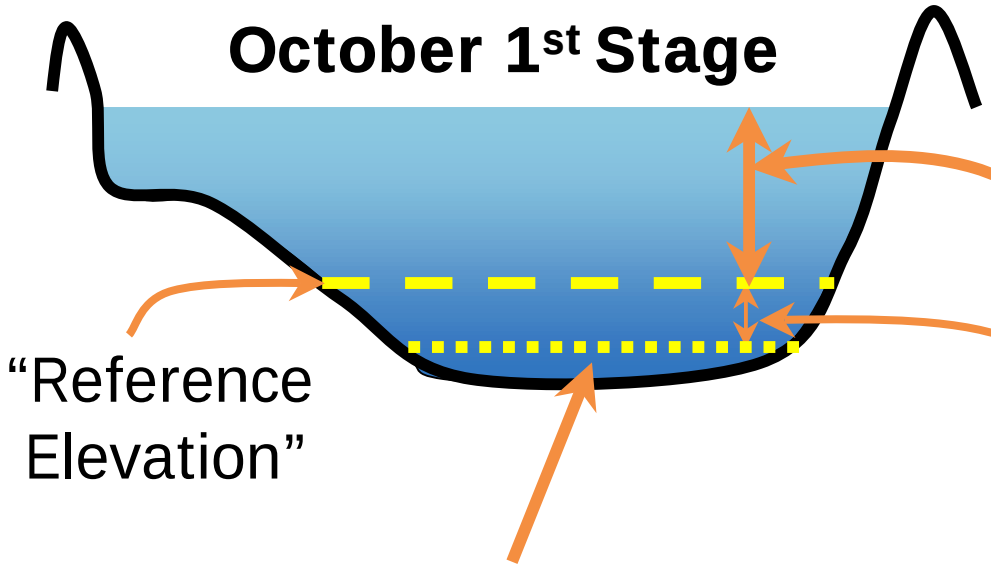
1. How much water is available in Lake Okeechobee for use by LOSA between now and the end of the dry season? (Volumetric Quantity)
2. How much of this available water should be used for the current period and how much should be retained for later use in the dry season? (Temporal Distribution of above Quantity)

SSM does not specifically calculate the demands of non-LOSA water users, but it does keep them in mind.

SSM Methodology (cont.)

- SSM 1991 (A. Hall) states that “the amount of water available for use… is a function of the anticipated rainfall, lake evaporation and water needs for the remainder of the dry season in relation to the amount currently in storage.”
- Available (and allocable) storage is dependent on the “Reference Elevation” or “Target Stage” which is used to determine the Lake level above which water can be used for the purpose of supplying LOSA agricultural water supply. (Volumetric Quantity)
- “Allocation factors” (fraction of current demand to remaining demand) are used to distribute allocable storage in time throughout the dry season. (Temporal Distribution)

SSM Reference Elevation



"Reference Elevation"

Water level below which gravity outflow is limited (~ 10 feet;~7 feet with forward pumps)

Water available for Lake Service Area (after meeting evaporation losses)

LEC Urban Area and others

SSM Trigger Line and Reference Elevation

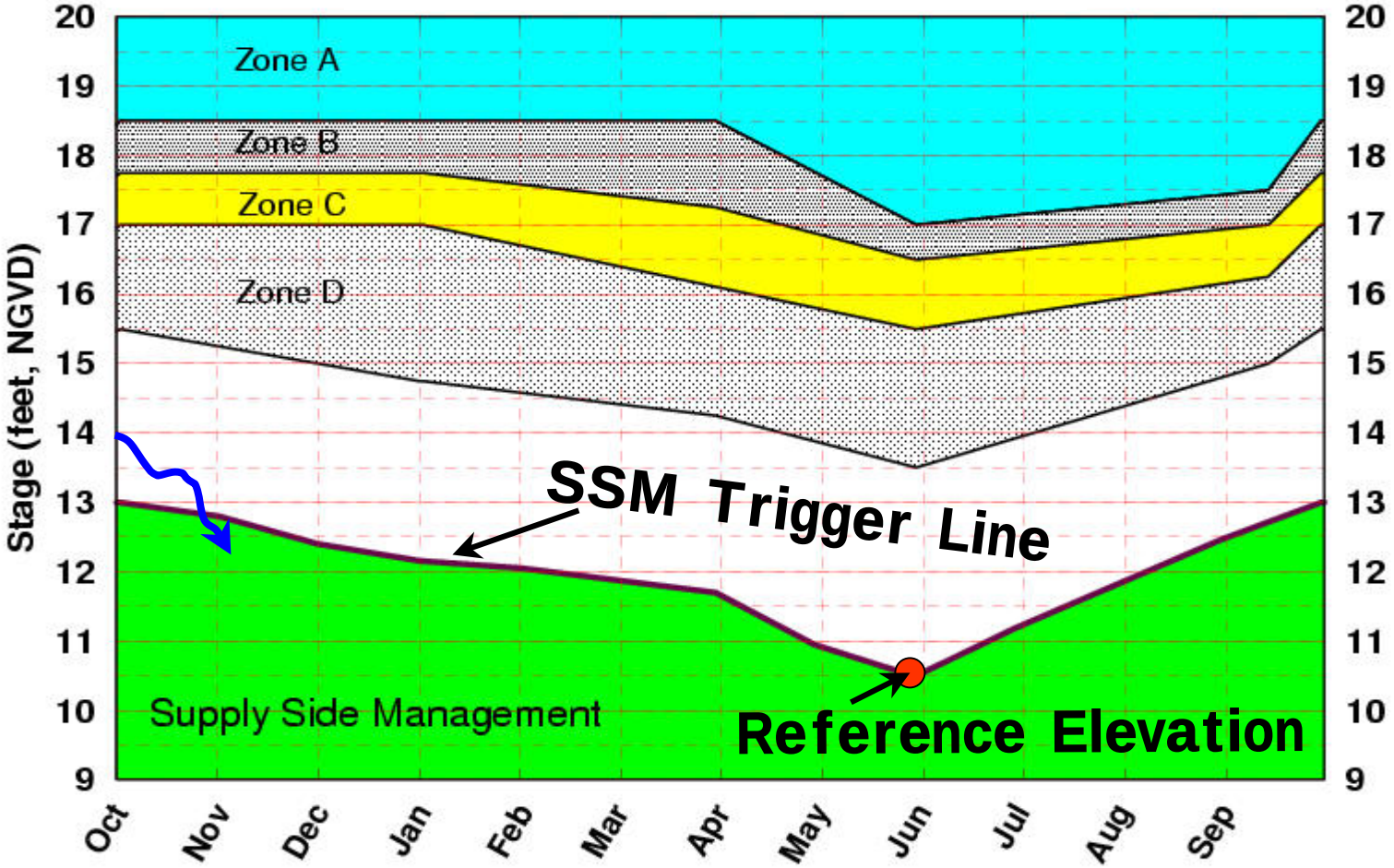


Table 3.2.2 Normal Dry Season Lake ET and Rainfall, and EAA Water Use Incorporated in the Supply-Side Management Module of the South Florida Water Management Model *

Month	LOK_ET (ac-ft)	LOK_RF (ac-ft)	EAA_WU (ac-ft)
OCT	126,720	89,472	52,402
NOV	118,203	66,917	68,135
DEC	96,999	76,702	73,548
JAN	104,599	88,589	53,115
FEB	119,551	105,900	54,751
MAR	171,687	120,991	84,581
APR	207,259	97,898	143,108
MAY	236,151	232,277	133,711

***Taken From Lake Okeechobee SSM Plan (Hall 1991)**

Table 3.2.3 Normal Cumulative Dry Season Lake ET and Rainfall, and EAA Water Use Incorporated in the Supply-Side Management Module of the South Florida Water Management Model

Month	LOK_ET (acre-ft)	LOK_RF (acre-ft)	EAA_WU (acre-ft)
OCT	1,181,169	878,746	663,351
NOV	1,054,449	789,274	610,949
DEC	936,246	722,357	542,814
JAN	839,247	645,655	469,266
FEB	734,648	557,066	416,151
MAR	615,097	451,166	361,400
APR	443,410	330,175	276,819
MAY	236,151	232,277	133,711

note: LOK area = 466,000 acres (~728 sq. miles); LOSA = 855,731 acres
source: Lake Okeechobee Supply-Side Management Plan (Hall, 1991)

C. COMPUTATION PROCEDURES *

1. DRY SEASON

The computation procedure at its highest level is for a dry season allocation amount which is presented as an available percentage of normal demand. The computation is:

ASSUME:

October 1st Water Level is 13.00' NGVD
June 1st Target Level is 11.00'NGVD

APPLY STORAGE VOLUMES:

Storage @13.00 = 3,108,000 Acre-feet
Storage @11.00 = 2,366,000 Acre-feet

AVAILABLE SUPPLY:

3,108,000 AF minus 2,366,000 AF = 742,000 AF

LESS REDUCTIONS OF EVAPORATION:

Rainfall minus Evaporation = -302,423 AF

WATER ALLOCABLE:

742,000 AF - 302,423 AF = 439,577 AF

PERCENT OF NORMAL USE:

439,577 AF / 663,351 AF = 66%

As can be seen in this case, the amount of water in storage which can be allocated to meet total dry season demands would be 439,577 acre-feet or about 66% of the normal requirements. The most simplistic perspective would indicate a need for a 33% water use cutback in order to equitably meet user demands. As can be seen above, the computation procedure is extremely simple, logical and straightforward. This has the advantage of being easily understood by all users when presented in this format.

***Taken From Lake Okeechobee SSM Plan (Hall 1991)**

Table 3 - Normal Monthly Allocation Factors*

MONTH	NORMAL USE (AF)	REMAINING USE (AF)	USE AS PERCENT OF REMAINING (%)	ALLOCATION FACTOR
OCTOBER	52,402	663,351	7.9%	0.079
NOVEMBER	68,135	610,949	11.1%	0.111
DECEMBER	73,548	542,814	13.5%	0.135
JANUARY	53,115	469,266	11.3%	0.113
FEBRUARY	54,751	416,151	13.2%	0.132
MARCH	84,581	361,400	23.4%	0.234
APRIL	143,108	276,819	51.7%	0.517
MAY	133,711	133,711	100.0%	1.000

***Taken From Lake Okeechobee SSM Plan (Hall 1991)**

SSM Methodology - Allocation Borrowing

- Attempts to meet agricultural demand beyond what would normally be allocated using the SSM calculation procedure.
- Occurs during the first half (4 months) of the dry season if above normal usage exists.
- Allocation for the current period may be increased by borrowing up to 1/3 of the projected future allocation for the corresponding period during the second half of the dry season (four months in the future).
- When “future” period is reached, calculated allocation will be reduced by the borrowed volume.

SSM in the SFWMM

- Supply-Side Management Module is document in SFWMM Primer, Chapter 3.2, page 78 (P. Trimble, L. Brion, R.Santee, 1993)
- Calculations associated with SSM (including borrowing) and using input RF, ET and demand data are performed in on a weekly basis. A percent cutback for LOSA is calculated from this information.
- For a daily time step, the delivery to the lake service area is calculated by applying the cutback percentage to the actual demand.
- Calculated allocation can be superceded by imposing a maximum allowable cutback percentage.
- LOSA deliveries are still subject to conveyance constraints, etc.

Generic SSM Calculations in SFWMM

- Equation A: (Volumetric Quantity)

  Allocable Volume$_i$ = LOK Storage (current) -
  LOK Storage (at reference elevation) +
  RF (to end of Dry Season) -
  ET (to end of Dry Season)

- Equation B: (Temporal Distribution)

  Allocation$_i$ = Allocable Volume$_i$ * Allocation Factor$_i$

- Equation C: (Percent Cutback)

  Cutback %$_i$ = (1 - Allocation$_i$ / Estimated Demand$_i$)

- Equation D: (Actual Delivery Subject to Conveyance)

  Delivery$_k$ = (1 - Cutback %$_i$ **) *** Actual Demand$_k$

(for week *i* and day *k)*

Table 5 - Normal Weekly Allocation Factors 1990/91 *

JANUARY	2	14	11,994	0.024896
	9	15	11,994	0.025532
	16	16	11,994	0.026201
	23	17	11,994	0.026906
	30	18	13,446	0.030998
FEBRUARY	6	19	13,688	0.032565
	13	20	13,688	0.033661
	20	21	13,688	0.034834
	27	22	18,326	0.048320
MARCH	6	23	19,099	0.052915
	13	24	19,099	0.055872
	20	25	19,099	0.059178
	27	26	25,224	0.083075
APRIL	3	27	33,392	0.119937
	10	28	33,392	0.136282
	17	29	33,392	0.157785
	24	30	32,935	0.184782
MAY	1	31	30,193	0.207794
	8	32	30,193	0.262298
	15	33	30,193	0.355561
	22	34	30,193	0.551736
	29	35	24,530	1.000000
TOTAL			674,184	

***Taken From Lake Okeechobee SSM Plan (Hall 1991)**

* To illustrate the inputs and outputs which are generated each week during the dry season, the week of January 9, 1991 has been selected as an example. On that date the stage of Lake Okeechobee was 12.22' NGVD:

ASSUME:

January 9th Water Level is 12.22' NGVD
June 1st Target Level is 11.00' NGVD

APPLY STORAGE VOLUMES:

Storage @12.22 = 2,806,920 Acre-feet
Storage @11.00 = 2,366,000 Acre-feet

AVAILABLE SUPPLY:

2,806,920 AF minus 2,366,000 AF = 440,920 AF

LESS REDUCTIONS OF EVAPORATION:

Rainfall minus Evaporation = -189,069 AF

WATER ALLOCABLE:

440,920 AF - 189,069 AF = 251,851 AF for dry season
251,851 AF times 0.025532 = 6,430 AF for week No. 15

PERCENT OF NORMAL USE:

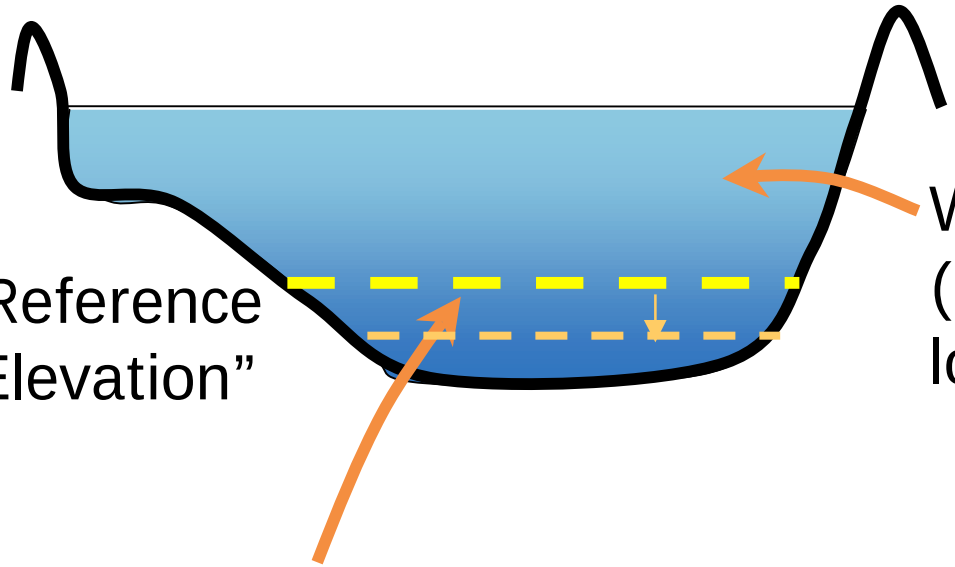
6,430 AF / 11,994 AF = 54%

***Taken From Lake Okeechobee SSM Plan (Hall 1991)**

SSM in the SFWMM (cont.)

- Borrowing and “credit” calculations done on a monthly basis.
- Both dry season and wet season SSM can be implemented.
- Additional flexibility of imposing earlier cutbacks in “drought watch” and “drought warning” zones is provided.
- When releases are made from Lake Okeechobee for purposes other than LOSA agricultural water supply, the reference elevation is lowered so that the allocable volume for LOSA is not reduced by other users.

Adjustment to Reference Elevation - *Downward*



"Reference Elevation"

Water available for LOSA (excluding net evaporation losses)

Releases made for LEC, Tribal lands (Brighton & Big Cypress), STAs, etc.

Changing SFWMM Input Related to SSM

lec_def

```
...
BEGCOMM -----------------------------------------------------------
  Definition parameters for LOK
ENDCOMM -----------------------------------------------------------
 15.26                                  !initial stage,ft NGVD - FORMAT(F6.2)
  NO   NO   MTH  YES  NO   NO   NO  0.30      !options to have Caloosahatchee Estuary demands
(YES or NO); option to have ST. Lucie Estuary Demands(YES or NO); frequency of estuarine
accounting(MTH:monthly or DLY:daily); option to have flows from proposed Caloos/St Lucie
reservoir to basin a priority unconditionally over meeting estuarine demands(YES or NO);
option to route excess LOK water to Caloos reservoir(YES or NO); option to route excess
LOK water to St. Lucie reservoir(YES or NO); option to implement flexibility in prioritizing
(based on LOK Stage) RES/ASR and LOK in meeting demands in Caloos/StLucie basins(YES or NO);
fraction of Caloos runoff back to LOK - FORMAT (7(2X,A3),F6.1)
  YES   10.50  0.33  0  1  0                !use supply side management scheme(YES or NO);
LOK target level for May 31 (end of dry season) for ssm; Minimum fraction of LOSA demands met
during SSM ;  option to cutback Big Cypress seminole demands due to SSM (1-yes,0-no); option
to cutback Istapoga basin demands due to SSM(1-yes,0-no); option to cutback Breighton seminole
demands due to SSM (1-yes,0-no): FORMAT(2x,A3,2x,2F6.1,3I3)
  1.00  1.00                             !fraction of LOSA demands met in drought watch
zone ; fraction of LOSA demands met in drought warning zone
  1   9  30 13.00 13.00                    !number of reference stages for wet season;
month,day,reference stage1,reference stage2(cutbacks > 67%) for each reference date during
wet season
...
```

lok_wca_oper_sched.dat

```
...
BEGCOMM-------------------------------
     Drought Watch Line(Not Considered an additional Zone)
ENDCOMM-------------------------------
  10  1  1  3 31  4 30  5 31  6  1  9 30  10  1  10 31  11 30  12 31
     14.15 13.70 12.95 12.50 12.50 15.00  15.00  14.80  14.40  14.16
BEGCOMM-------------------------------
     Drought Warning Line (Not Considered an additional Zone)
ENDCOMM-------------------------------
  10  1  1  3 31  4 30  5 31  6  1  9 30  10  1  10 31  11 30  12 31
     13.15 12.70 11.95 11.50 11.50 14.00  14.00  13.80  13.40  13.16
BEGCOMM-----------------------------
     Supply Side Management Line (Not Considered an additional Zone)
ENDCOMM-----------------------------
  10  1  1  3 31  4 30  5 30  5 31  9 30  10  1  10 31  11 30  12 31
     12.15 11.70 10.95 10.50 10.50 13.00  13.00  12.80  12.40  12.16
BEGCOMM-----------------------------
     Min Lok Allowed for Additional Credit for SSM (Not Considered an additional Zone)
ENDCOMM-----------------------------
  10  1  1  3 31  4 30  5 30  5 31  9 30  10  1  10 31  11 30  12 31
     12.15 11.70 10.95 10.50 10.50 13.00  13.00  12.80  12.40  12.16
BEGCOMM--------------------
...
```

lok_wca_oper_sched.dat (cont.)

```
...
BEGCOMM--------------------
  ESTIMATED WATER USE AND RAIN AND ET FOR LOKSA FOR SSM
ENDCOMM--------------------
  469266.  469266.  645925.  839247.
  416151.  416151.  557066.  734648.
  361400.  361400.  451166.  615097.
  276819.  276819.  330175.  443410.
  133711.  133711.  232277.  236151.
  853143.  853143. 2281987. 2079595.
  669269.  669269. 2031151. 1839637.
  678795.  678795. 1691544. 1605192.
  670257.  670257. 1290655. 1379995.
  663351.  663351.  879016. 1181169.
  610949.  610949.  789544. 1054449.
  542814.  542814.  722627.  936246.
...
```

SFWMM and Post-Processed Output Related to SSM

LOSA_SSM Post-Processor

Monthly Supply Side Management Results
for the Lake Okeechobee Service Area
Report by Water Years Jun-May
(Volumes in 1000 ac-ft)

Run:
SFWMM v4.4r10 - JUN02 PA BASE LOK 11.90 (NO ESTuary releases).

Note: SSM stands for Supply Side Management
SSMwC.B. stands for Supply Side Management with cutback

...

Year	Mon	# Days SSM	# Days SSMwC.B.	Supplem. Volume	SSM Cutback Volume	% SSM Cutback	Convey. Cutback Volume	% Cutback Convey.	Total Cutback	% Total Cutback
1970	6	0	0	35.63	0.00	0.00	0.91	2.55	0.91	2.55
1970	7	0	0	10.12	0.00	0.00	0.00	0.00	0.00	0.00
1970	8	0	0	5.49	0.00	0.00	0.00	0.00	0.00	0.00
1970	9	20	11	15.81	5.77	36.47	0.00	0.00	5.77	36.47
1970	10	31	0	16.41	0.00	0.00	0.00	0.00	0.00	0.00
1970	11	30	7	64.62	3.63	5.62	0.03	0.04	3.66	5.66
1970	12	31	10	90.69	2.46	2.71	0.03	0.03	2.49	2.74
1971	1	31	11	69.39	7.84	11.30	0.06	0.08	7.90	11.39
1971	2	28	22	50.35	27.67	54.95	0.01	0.02	27.68	54.98
1971	3	31	31	140.30	89.99	64.14	0.05	0.04	90.04	64.18
1971	4	30	30	222.58	148.02	66.50	5.26	2.36	153.28	68.86
1971	5	31	31	217.87	144.71	66.42	14.41	6.62	159.12	73.04

Annual Supply Side Management Results
for the Lake Okeechobee Service Area
Report by Water Years Jun-May
(Volumes in 1000 ac-ft)

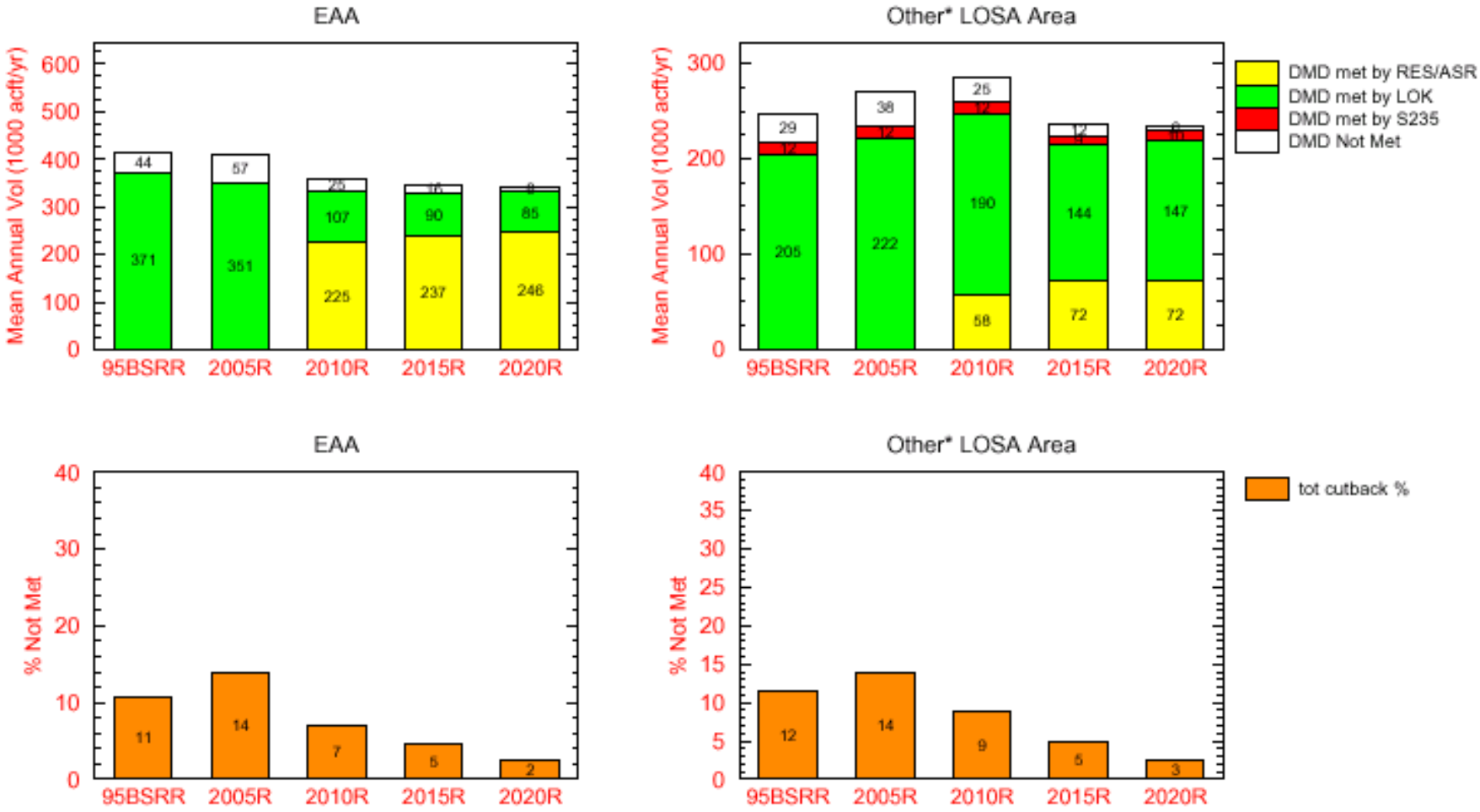
Run:
SFWMM v4.4r10 - JUN02 PA BASE LOK 11.90 (NO ESTuary releases).

Note: SSM stands for Supply Side Management
SSMwC.B. stands for Supply Side Management with cutback

Wat_Year	# Days SSM	# Days SSMwC.B.	Supplem. Volume	SSM Cutback Volume	% SSM Cutback	Convey. Cutback Volume	% Cutback Convey.	Total Cutback	% Total Cutback
1966	0	0	407.59	4.20	1.03	26.26	6.44	30.46	7.47
1967	0	0	749.07	0.00	0.00	71.73	9.58	71.73	9.58
1968	0	0	483.90	0.00	0.00	6.57	1.36	6.57	1.36
1969	0	0	292.71	0.00	0.00	0.27	0.09	0.27	0.09
1970	0	0	400.74	0.00	0.00	35.90	8.96	35.90	8.96
1971	263	153	939.26	430.09	45.79	20.75	2.21	450.84	48.00
1972	0	0	397.14	5.34	1.34	10.47	2.64	15.80	3.98
1973	254	149	596.08	156.29	26.22	21.38	3.59	177.67	29.81
1974	28	26	709.88	43.62	6.14	13.13	1.85	56.74	7.99
1975	0	0	578.10	4.60	0.80	5.19	0.90	9.79	1.69
1976	10	4	550.91	0.37	0.07	7.80	1.42	8.18	1.48
1977	0	0	588.48	0.00	0.00	15.92	2.71	15.92	2.71
1978	131	58	442.19	44.50	10.06	1.76	0.40	46.26	10.46
1979	0	0	363.59	0.00	0.00	5.03	1.38	5.03	1.38
1980	84	49	602.41	44.03	7.31	78.73	13.07	122.76	20.38
1981	330	260	1125.42	534.39	47.48	62.21	5.53	596.60	53.01
1982	287	188	749.05	195.78	26.14	26.08	3.48	221.85	29.62
1983	0	0	473.46	0.00	0.00	34.95	7.38	34.95	7.38
1984	11	0	392.12	0.00	0.00	29.48	7.52	29.48	7.52
1985	156	114	887.05	176.91	19.94	90.23	10.17	267.14	30.12
1986	62	21	614.09	7.19	1.17	64.63	10.52	71.82	11.69
1987	0	0	458.42	0.00	0.00	26.67	5.82	26.67	5.82
1988	119	88	668.47	85.75	12.83	35.21	5.27	120.97	18.10
1989	210	115	883.05	181.47	20.55	19.31	2.19	200.78	22.74
1990	175	49	724.73	22.95	3.17	50.49	6.97	73.43	10.13
1991	0	0	509.69	0.00	0.00	19.06	3.74	19.06	3.74
1992	0	0	474.60	0.00	0.00	50.40	10.62	50.40	10.62
1993	0	0	518.21	0.00	0.00	32.12	6.20	32.12	6.20
1994	194	61	658.57	106.16	16.12	27.64	4.20	133.80	20.32
1995	0	0	309.44	0.00	0.00	1.46	0.47	1.46	0.47

Mean Annual EAA/LOSA Supplemental Irrigation: Demands and Demands Not Met

for the 1965 − 1995 Simulation Period



*Other Lake Service SubAreas (S236, S4, L8, C43, C44, and Seminole Indians (Brighton & Big Cypress)).

Run date: 03/14/00 06:04:23
For Planning Purposes Only
SFWMM V3.7
Script used: ssm_4in1.scr
losa_4in1.fig

Thank You!

Questions?