Settlement Agreement
January - March 2004 Report

Update, October 1, 2004: In Table 2, the guideline for percent of sampling events greater than 10 ppb was recalculated and updated.

Prepared for the
Technical Oversight Committee

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ARTHUR R. MARSHALL LOXAHATCHEE NATIONAL WILDLIFE REFUGE

The 1991 Settlement Agreement ended the Everglades lawsuit and was entered into by the federal government, the State of Florida and the South Florida Water Management District. The subsequent Consent Decree, as modified in 1995, specified that interim and long-term phosphorus concentration levels for the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) must be met by Feb. 1, 1999, and Dec. 31, 2006, respectively. The concentration levels vary monthly because they are calculated as a function of water stage measured at gauging stations 1-7, 1-8C and 1-9 within the Refuge. The interim and long-term concentration levels are applicable when the average stage is between 15.42 and 17.14 feet (NGVD). If the average stage is less than 15.42 feet (NGVD), the concentration levels are not applicable. If the average stage is more than 17.14 feet (NGVD), 17.14 feet is used for the level calculations. The monthly total phosphorus concentrations are determined from water samples collected at 14 interior marsh stations, LOX 3 through LOX 16 (**Figure 1**). As required in the Consent Decree, the concentrations are converted to a geometric mean, which is compared to the interim and long-term concentration levels.

Average stages in the Refuge were 16.71, 16.71 and 16.46 feet in January, February and March 2004, respectively (**Figure 2, Table 1)**. The geometric means, calculated from total phosphorus concentrations measured in water samples collected in January, February and March were 7.4, 8.2 and 9.0 ppb, respectively. These values were less than the interim and long-term levels for January, February and March.

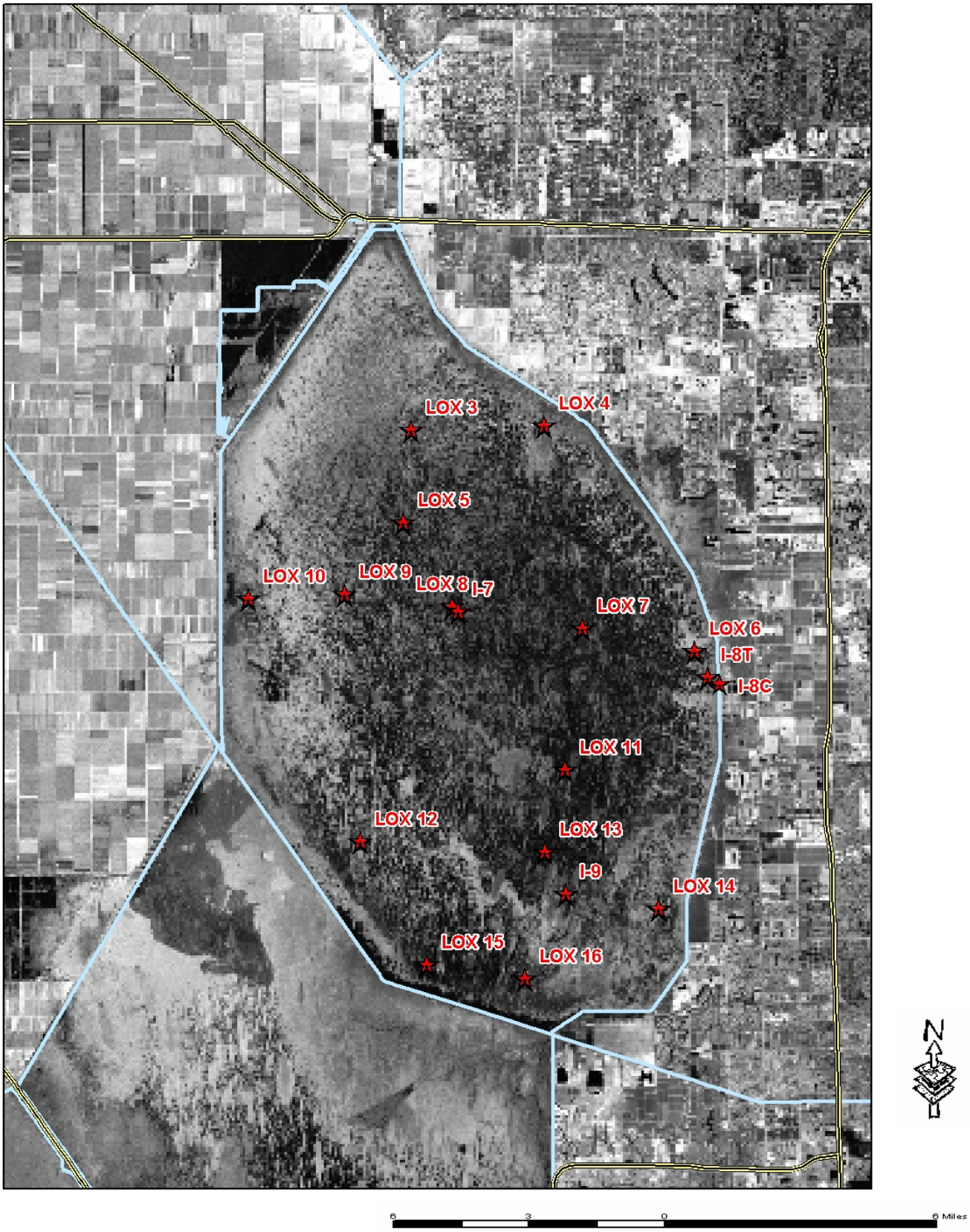

Figure 1. A.R.M. Loxahatchee Refuge Water Quality Sampling and Stage Measurement Sites

★ Station Location

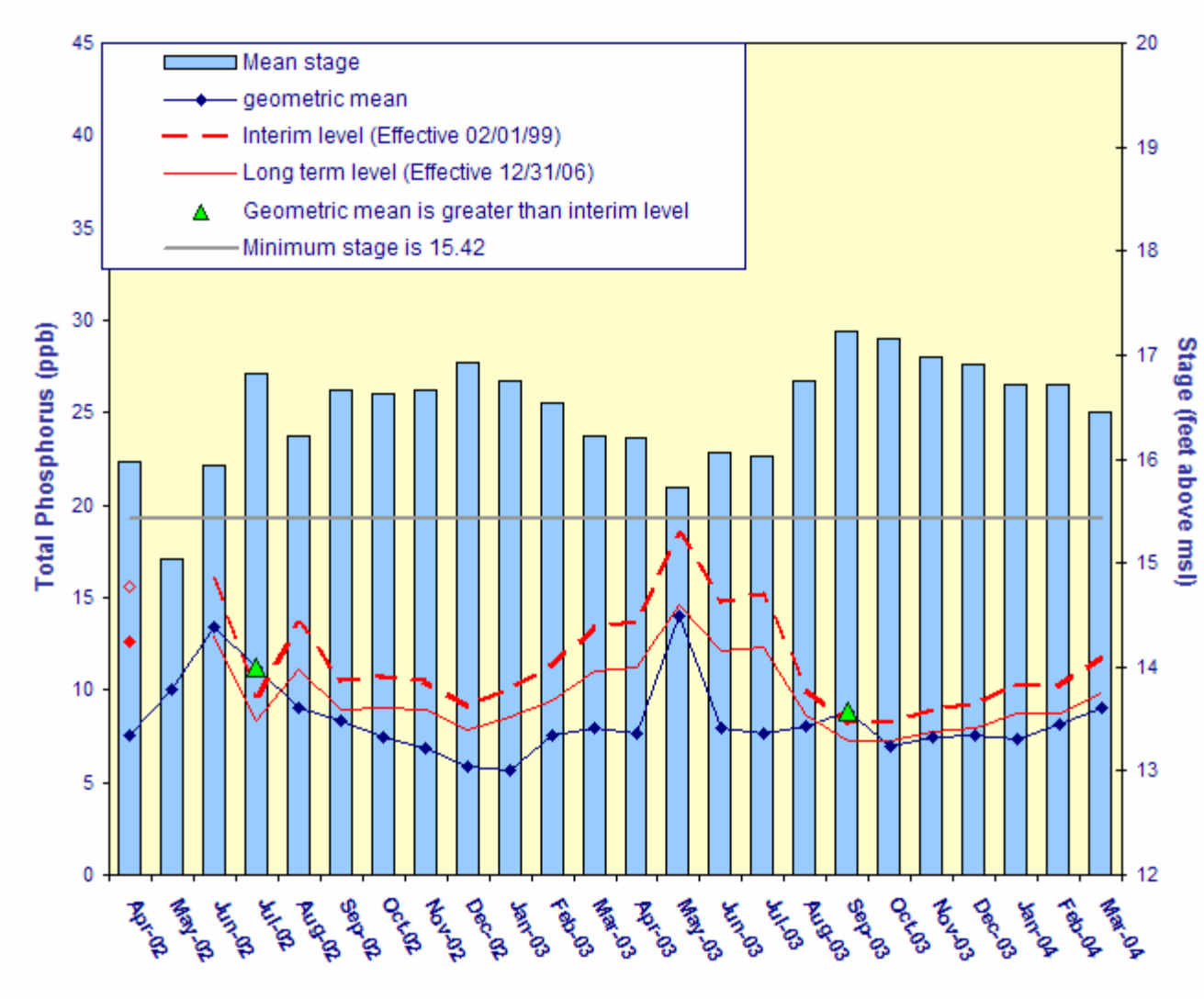

Figure 2. Monthly total phosphorus geometric mean concentrations for the A.R.M. Loxahatchee National Wildlife Refuge compared to the interim and long-term levels. Interim and long-term levels are not applicable if the average stage is less than 15.42 ft. The calculated levels are adjusted for fluctuations in stage.

Table 1. Loxahatchee National Wildlife Refuge Total Phosphorus Compliance Tracking.

Month - Year	Geometric Mean Concentration (ppb)	Interim Level (ppb) Effective 2/1/99	Long Term Level (ppb) Effective 12/31/06	Average Stage (ft,NGVD)	Number of TP Samples	Number of Stage Measure-ments
Apr-2002	7.5	15.6	12.7	15.98	11	3
May-2002	10.0	N/A	N/A	15.04	3	3
Jun-2002	13.4	16.0	12.9	15.94	10	3
Jul-2002	11.2	9.7	8.3	16.82	14	3
Aug-2002	9.0	13.5	11.1	16.22	12	3
Sep-2002	8.3	10.6	8.9	16.66	11	3
Oct-2002	7.5	10.7	9.0	16.64	12	3
Nov-2002	6.9	10.5	8.9	16.66	12	3
Dec-2002	5.9	9.2	7.9	16.93	14	3
Jan-2003	5.7	10.0	8.5	16.76	13	3
Feb-2003	7.5	11.3	9.5	16.54	11	3
Mar-2003	8.0	13.4	11.1	16.23	9	3
Apr-2003	7.6	13.7	11.2	16.20	12	3
May-2003	14.0	18.3	14.6	15.72	7	3
Jun-2003	7.9	14.8	12.1	16.06	11	3
Jul-2003	7.7	15.2	12.3	16.02	9	3
Aug-2003	8.0	10.1	8.6	16.74	14	3
Sep-2003	8.8	8.3	7.2	17.23	13	3
Oct-2003	7.0	8.3	7.2	17.15	14	3
Nov-2003	7.5	8.9	7.7	16.98	11	3
Dec-2003	7.6	9.3	8.0	16.91	14	3
Jan-2004	7.4	10.3	8.7	16.71	14	3
Feb-2004	8.2	10.3	8.7	16.71	14	3
Mar-2004	9.0	11.8	9.8	16.46	14	3

Notes:

(1) Average Stage is calculated using stage elevations at stations 1-7, 1-8C, and 1-9 on the sampling date.

(2) Highlighted rows indicate months when excursions occurred.

(3) N/A denotes that the concentration values were not applicable because the average stage was less than 15.42 feet.

EVERGLADES NATIONAL PARK

Shark River Slough

The Consent Decree of 1995 specified that interim and long-term total phosphorus concentration limits for discharges into the Everglades National Park (ENP) through Shark River Slough be met by October 1, 2003, and December 31, 2006, respectively. Only the total phosphorus concentrations for the water year ending September 30 are evaluated for compliance with the Consent Decree limits. It was also specified that the total phosphorus concentrations be presented as 12-month moving flow-weighted means. The long-term total phosphorus concentration limit for inflows to Shark River Slough through structures S12A, S12B, S12C, S12D and S333 represents the concentrations delivered during the Outstanding Florida Waters baseline period of March 1, 1978 to March 1, 1979, and is adjusted for variations in flow.

Inflow concentrations of total phosphorus through Shark River Slough are compared to the interim and long-term limits at the end of each water year from 1991 to 2003 (**Figure 3A**). The 12-month moving flow-weighted mean total phosphorus concentration ending September 30, 2003 was 8.9 ppb. Corresponding interim and long-term limits were 9.4 and 7.7 ppb, respectively. For the ten-year period 1994 through 2003, the interim limit applicable to Shark River Slough has been met eighteen times. The limit was exceeded in Water Years 2000 and 2001.

Table 2 presents the moving flow-weighted mean concentrations for each 12-month period beginning in October 2001 as well as the corresponding interim and long-term total phosphorus concentration limits, calculated using the 12-month period flow. For the 12-month periods ending in January, February and March 2004, the flow-weighted mean total phosphorus concentrations were 9.2, 9.1 and 8.9 ppb, respectively. The January, February and March concentrations were less than the interim limits. The long-term limits were exceeded in each of these recent months.

The Consent Decree stipulates that the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed a guideline value based on flow into Shark River Slough for the same 12-month period. For the 12-month periods ending January, February and March 2004, the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb were 46.2, 44.4 and 37.0, respectively. January and February observed percentages were greater than the guidelines (**Table 2**). The individual sampling events and the 12-month moving average are presented in **Figure 3B**.

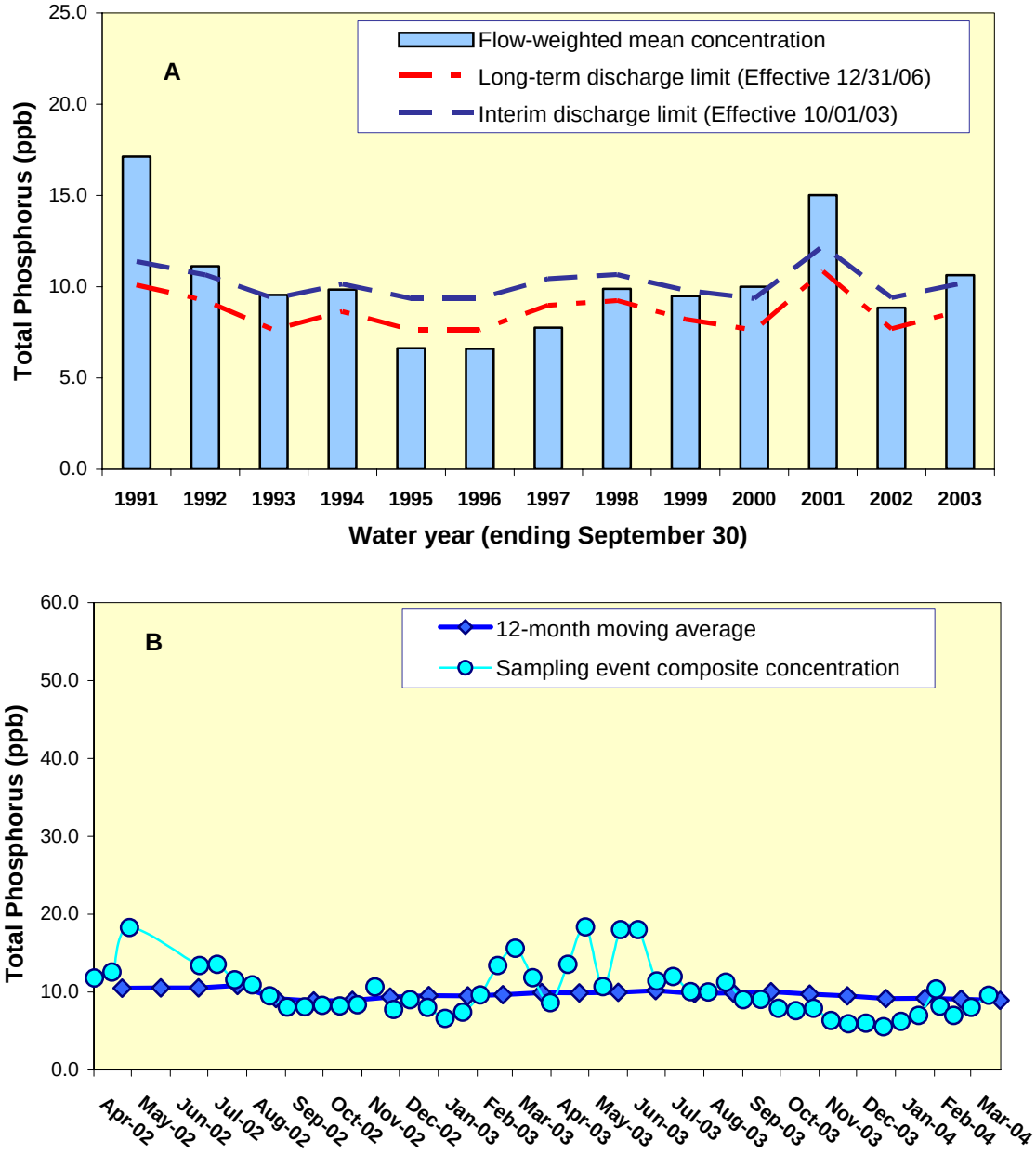

Figure 3. Total phosphorus flow-weighted mean concentrations (fwmc) in inflows to Everglades National Park through Shark River Slough.
A. The 12-month moving average fwmc at the end of each water year compared to the total phosphorus interim and long-term limits.
B. The 12-month moving average fwmc at the end of each month and the composite total phosphorus concentration for each sampling event.

Table 2. Shark River Slough Total Phosphorus Concentration Compliance Tracking.

12-Month Period Ending On	Total Period Flow	Flow Weighted Mean Total Phosphorus	Interim Limit (ppb)	Long Term Limit (ppb)	Percent of Sampling Events Greater than 10 ppb	
			Effective	Effective	(%)	
	(Kac-ft)	(ppb)	10/1/2003	12/31/2006	Guideline	Observed
30-Apr-02	829.9	10.5	10.3	8.8	45.6	40.9
31-May-02	833.5	10.5	10.2	8.7	45.5	43.5
30-Jun-02	839.6	10.5	10.2	8.7	45.3	40.9
31-Jul-02	958.5	10.9	9.7	8.1	42.4	***45.8***
31-Aug-02	1003.2	9.1	9.6	7.9	41.4	39.1
30-Sep-02	1048.1	8.8	9.4	7.7	40.4	30.4
31-Oct-02	999.9	8.9	9.6	7.9	41.5	30.4
30-Nov-02	884.5	9.4	10.0	8.5	44.2	34.8
31-Dec-02	802.2	9.6	10.4	8.9	46.3	33.3
31-Jan-03	831.1	9.5	10.3	8.8	45.6	34.8
28-Feb-03	843.6	9.7	10.2	8.7	45.2	39.1
31-Mar-03	812.1	9.9	10.3	8.9	46.1	***47.8***
30-Apr-03	832.1	9.9	10.2	8.8	45.5	43.5
31-May-03	871.3	10.0	10.1	8.6	44.5	***45.8***
30-Jun-03	901.1	10.2	10.0	8.4	43.8	***50.0***
31-Jul-03	891.3	9.8	10.0	8.5	44.0	***50.0***
31-Aug-03	839.3	9.9	10.2	8.7	45.3	***50.0***
30-Sep-03	850.1	10.0	10.2	8.7	45.1	***50.0***
31-Oct-03	921.8	9.7	9.9	8.3	43.3	***50.0***
30-Nov-03	1001.5	9.5	9.6	7.9	41.4	***46.2***
31-Dec-03	1076.8	9.1	9.4	7.6	40.1	***46.2***
31-Jan-04	1049.0	9.2	9.4	7.7	40.4	***46.2***
29-Feb-04	1033.9	9.1	9.5	7.8	40.7	***44.4***
31-Mar-04	1036.7	8.9	9.4	7.7	40.7	37.0

Notes: ***Bold italicized*** *values exceeded the guideline percentages.*

The daily flows through the individual Shark River Slough structures and S334 from October 2001 through March 2004 are presented in **Figure 4A**. Since mid-November 2002 inflows to Shark River Slough have been through S333 and S12D. Beginning in mid-January 2003 a large proportion of the flow in the L29 Canal was released from the system through S334 due to above-average rainfall. This condition lasted until mid-June 2003.

The relationship between the sum of the daily flows at Shark River Slough structures and corresponding flow-weighted mean total phosphorus concentrations for individual sampling events is presented in **Figure 4B.** Values for Water Years 2001 and 2002 follow the strong inverse relationship between flow and total phosphorus concentration expected for waters entering the Park through Shark River Slough. However, during the un-seasonal rainfall conditions that occurred from February through June 2003, total phosphorus concentrations were greater and more variable, 9 to 18 ppb, than observed previously when flows were less than 500 cfs. From June through September 2003, increasing flows resulted in gradually decreasing total phosphorus concentrations from 18 ppb to 9 ppb. The concentration continued to decrease to 5.5 ppb by the end of December 2003, but shows an increasing trend with the reduced flows experienced during the first quarter of 2004.

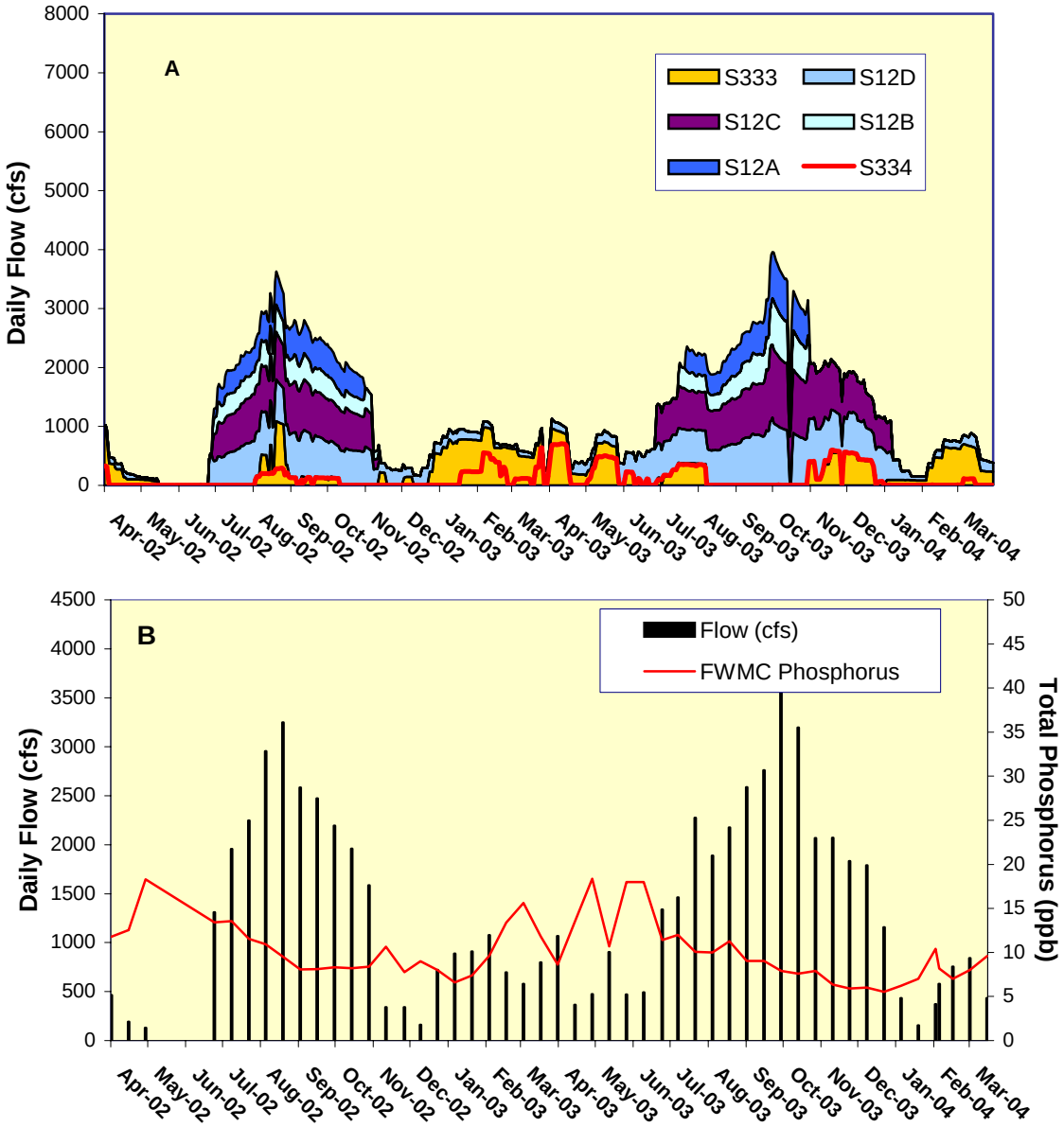

Figure 4. **A**. Daily flows into Shark River Slough (through S12 structures and S333) and flow through S334. **B**. The relationship between daily flow at Shark River Slough structures and the corresponding flow-weighted mean total phosphorus concentrations for individual sampling events.

Taylor Slough and the Coastal Basins

Under the Consent Decree, a single total phosphorus long-term limit of 11 ppb, to be met by December 31, 2006, was set for the two points of inflow to Taylor Slough (S332 and S175) and the inflow point to the Coastal Basins (S18C). The 11 ppb limit applies to the water year ending September 30.

C-111 Project Structures and Detention Areas

Beginning in August 1999, structure S332D, a new pump station constructed by the U.S. Army Corps of Engineers (USACE), began operation. The structure is adjacent to spillway S174 and pumps water from the L31N canal into the L31W canal. The S332D and S174 structures became the new inflow compliance monitoring sites for Taylor Slough on October 1, 1999, replacing S332 and S175.

The USACE completed construction of the remaining C-111 project structures and detention areas along the eastern boundary of the ENP in June 2002. The project was authorized by the USACE in 1995 to restore more natural hydrologic conditions in Taylor Slough and to maintain flood protection to the east of the L31N and C-111 canals. Project facilities consist of pump stations S332B, S332C and S332D, Detention Cells 1 through 5, a Connector Cell between cells 2 and 3, a Flow Way Cell originating at Berm 3 of Cell 5, and four emergency overflow structures (**Figure 5**). The Flow Way Cell is the only location where surface water routinely discharges to the ENP from this project.

The construction of these facilities was accelerated to respond to U.S. Fish and Wildlife requirements to give immediate relief to water conditions that threaten the Cape Sable Seaside Sparrow, an endangered species. The USACE signed a Record of Decision on July 2, 2002 that authorizes the implementation of an Interim Operational Plan (IOP) to govern the operation of the new facilities. Since July 31, 2002, the USACE has been operating the project under Emergency Orders issued by the Florida Department of Environmental Protection (FDEP).

The USACE and the South Florida Water Management District (District) will monitor the implementation of the IOP under the terms and conditions of the C-111 Project Cooperation Agreement executed in 1995. The USACE has implemented a monitoring plan approved by FDEP that assesses the hydrologic, environmental, and surface and ground water quality changes that may occur as a result of the IOP.

The monitoring plan treats the detention areas as a single project with five cells, three inflows and a single outflow to ENP. Only Emergency Overflows EO2 and EO4 would discharge into ENP if utilized. Overflows have periodically occurred at EO2 between September 2001 and September 2003. **There were no overflows during the period from October 2003 through March 2004.** Discharges from Emergency Overflows EO1 and EO3 would flow onto District property and eventually into the L31N Canal. The majority of the water pumped into the detention cells, as well as rainfall, is expected to seep into the Biscayne Aquifer directly below the project site and provide a hydrologic “curtain” to reduce ground water seepage in an easterly direction from ENP. Until FDEP issues an operating permit to the District and approves the District’s monitoring plan, the District will continue to report data from S332D and S174 to determine compliance with the Consent Decree requirements as described in the following section.

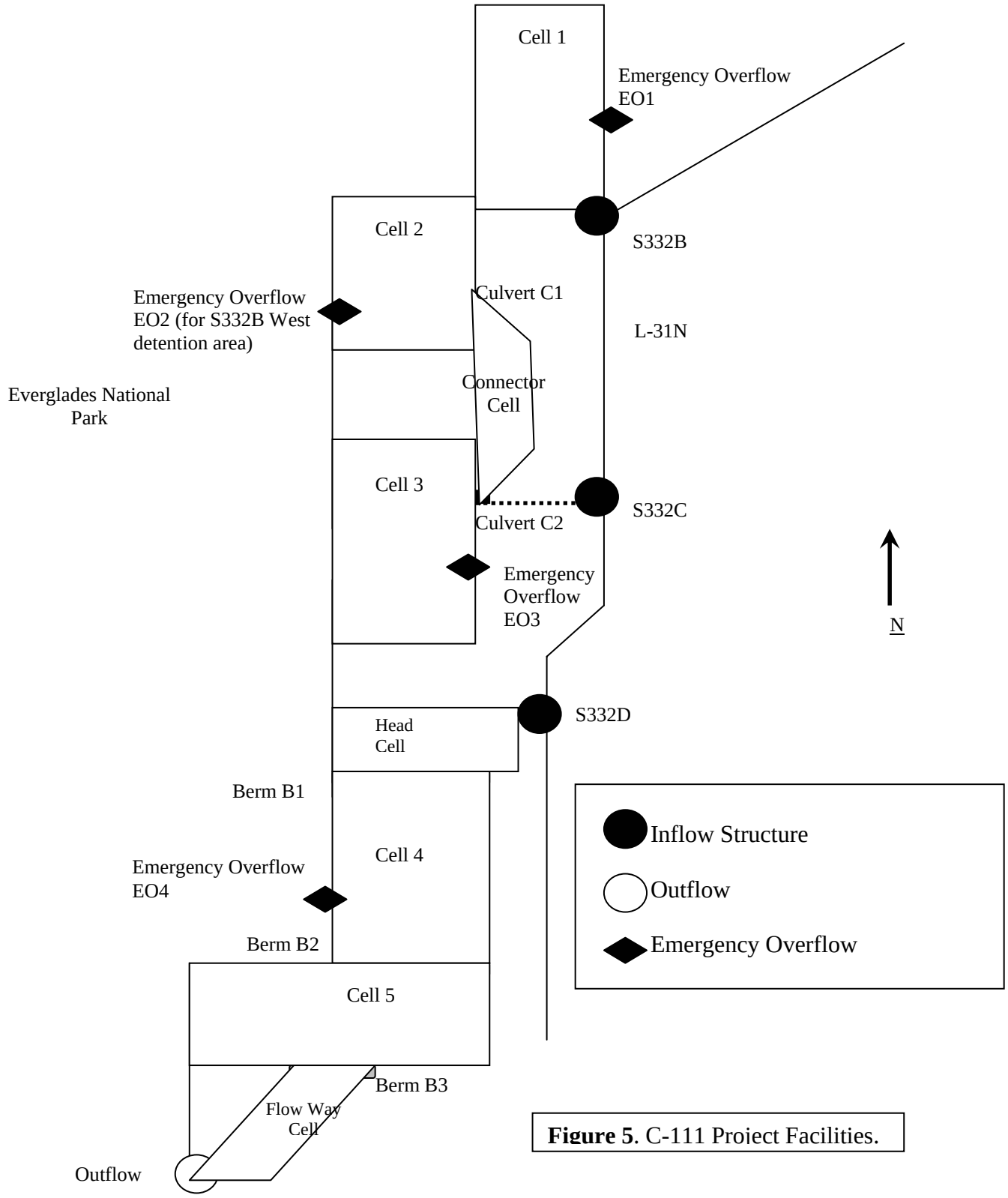

Figure 5. C-111 Proiect Facilities.

Compliance with Consent Decree

Inflow concentrations of total phosphorus to the Everglades National Park through Taylor Slough and the Coastal Basins are compared to the 11 ppb limit at the end of each water year using data from both the old (S175, S332, S18C) and new (S174, S332D, S18C) combinations of structures (**Figure 6A**). The bars in **Figure 6A** represent the flow-weighted mean total phosphorus concentrations from S332, S175 and S18C for water years 1989 through 2002. The diamond point values for water years 1999 through 2002 represent the new combination of structures. **Figure 6B** presents the 12-month moving average and individual sampling event flow-weighted mean total phosphorus concentrations at the S174, S332D and S18C structures.

Total phosphorus and flow data from both sets of structures presented in prior editions of this report through December 2001 (April 2002 report) showed that, beginning October 2000, the 12-month moving total flow for S332D, S174 and S18C was consistently greater than flow at S332, S175 and S18C. There was also a shift in flow-weighted mean total phosphorus concentration data whereby S332D, S174 and S18C concentrations became equal to and then consistently lower than the concentrations at S332, S175 and S18C. These changes reflected the switch made from S332 to S332D for water delivery to Taylor Slough between July 3 and July 5, 2000. Consequently, as of the July 2002 report, only S332D, S174 and S18C data are presented for monthly tracking of data in **Figure 6B**.

The 12-month flow-weighted mean concentrations for January, February and March 2004 were 5.1, 5.0 and 5.0 ppb, respectively, for the combined flow through S174, S332D and S18C (**Table 3**). The Consent Decree stipulates that the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed a fixed guideline of 53.1 percent. The percentage of flow-weighted mean total phosphorus concentrations greater than 10 ppb for the combined flow through S174, S332D and S18C was 0.0, 0.0 and 0.0 for the periods ending January, February and March 2004.

The daily flows into Everglades National Park through S332D, S174 and S18C are presented in **Figure 7A**. **Figure 7B** shows the relationship between the daily inflows and the corresponding flow-weighted mean total phosphorus concentrations for each sampling event. As the data indicate, there is no observable linear relationship between daily mean flow and flow-weighted mean total phosphorus concentrations at these structures.

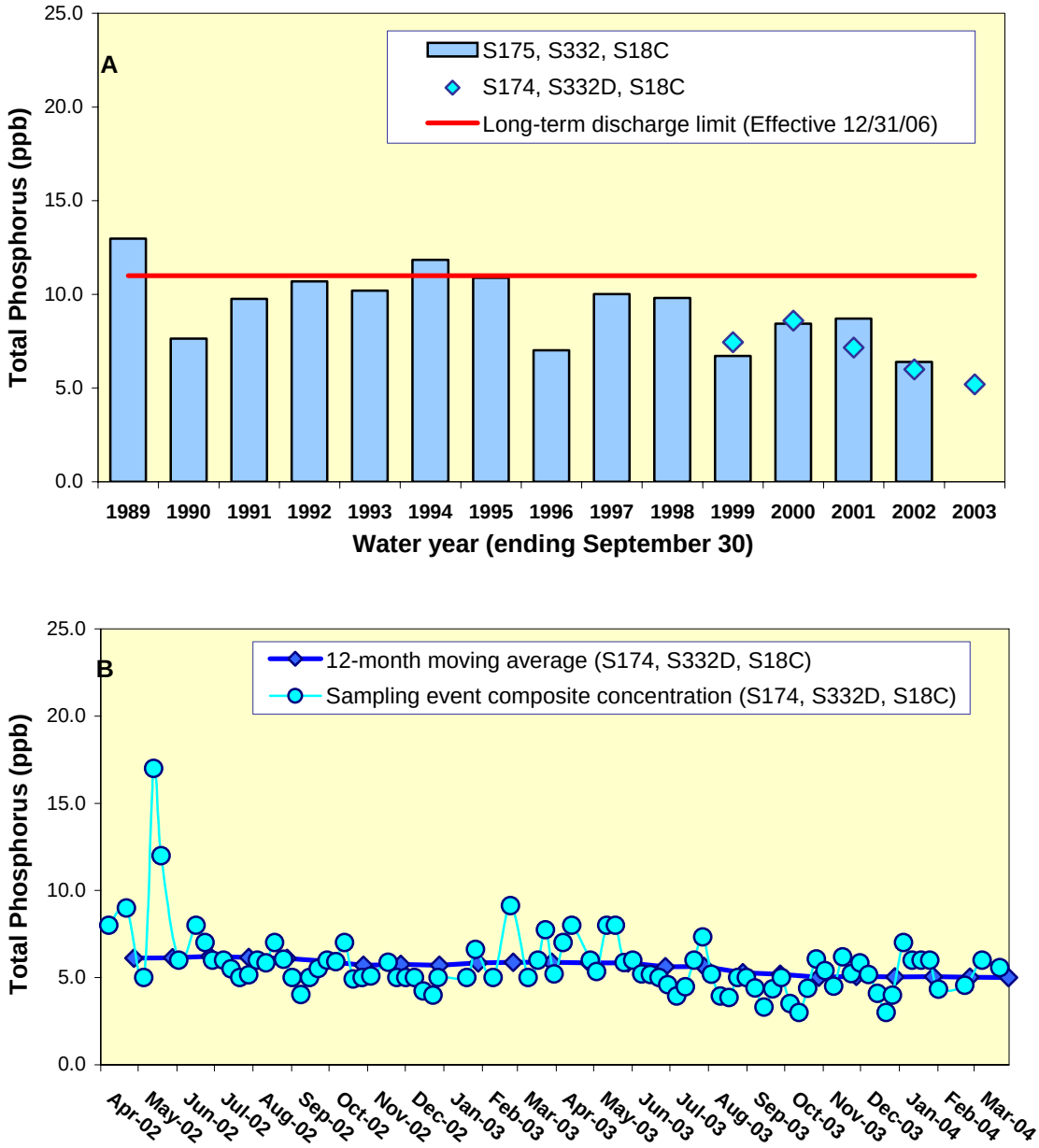

Figure 6. Total phosphorus flow-weighted mean concentrations (fwmc) in inflows to Everglades National Park through Taylor Slough and the Coastal Basins. **A.** The 12-month moving average fwmc at the end of each water year compared to the 11 ppb long-term total phosphorus limit. **B**. The 12-month moving average fwmc at the end of each month and the composite total phosphorus concentration for each sampling event.

Table 3. Taylor Slough and the Coastal Basins Total Phosphorus Concentration Compliance Tracking.

12-Month Period Ending On	Total Period Flow	Flow Weighted Mean Total Phosphorus	Limit (Effective 12/31/06)	Percent of Sampling Events Greater than 10 ppb	
			(ppb)	(%)	
	(Kac-ft)	(ppb)	Long Term	Guideline	Observed
30-Apr-02	331.1	6.1	11.0	53.1	0.0
31-May-02	336.4	6.1	11.0	53.1	5.0
30-Jun-02	364.3	6.2	11.0	53.1	4.9
31-Jul-02	392.1	6.1	11.0	53.1	4.7
31-Aug-02	388.3	6.1	11.0	53.1	4.7
30-Sep-02	371.8	6.0	11.0	53.1	4.7
31-Oct-02	316.0	5.7	11.0	53.1	4.5
30-Nov-02	271.6	5.8	11.0	53.1	4.8
31-Dec-02	249.8	5.7	11.0	53.1	4.7
31-Jan-03	234.2	5.8	11.0	53.1	5.0
28-Feb-03	229.9	5.9	11.0	53.1	5.0
31-Mar-03	230.5	5.9	11.0	53.1	4.9
30-Apr-03	231.5	5.8	11.0	53.1	4.8
31-May-03	244.2	5.8	11.0	53.1	0.0
30-Jun-03	249.8	5.6	11.0	53.1	0.0
31-Jul-03	209.0	5.6	11.0	53.1	0.0
31-Aug-03	216.1	5.3	11.0	53.1	0.0
30-Sep-03	221.9	5.2	11.0	53.1	0.0
31-Oct-03	233.8	5.0	11.0	53.1	0.0
30-Nov-03	276.6	5.1	11.0	53.1	0.0
31-Dec-03	293.9	5.0	11.0	53.1	0.0
31-Jan-04	295.9	5.1	11.0	53.1	0.0
29-Feb-04	301.4	5.0	11.0	53.1	0.0
31-Mar-04	297.9	5.0	11.0	53.1	0.0

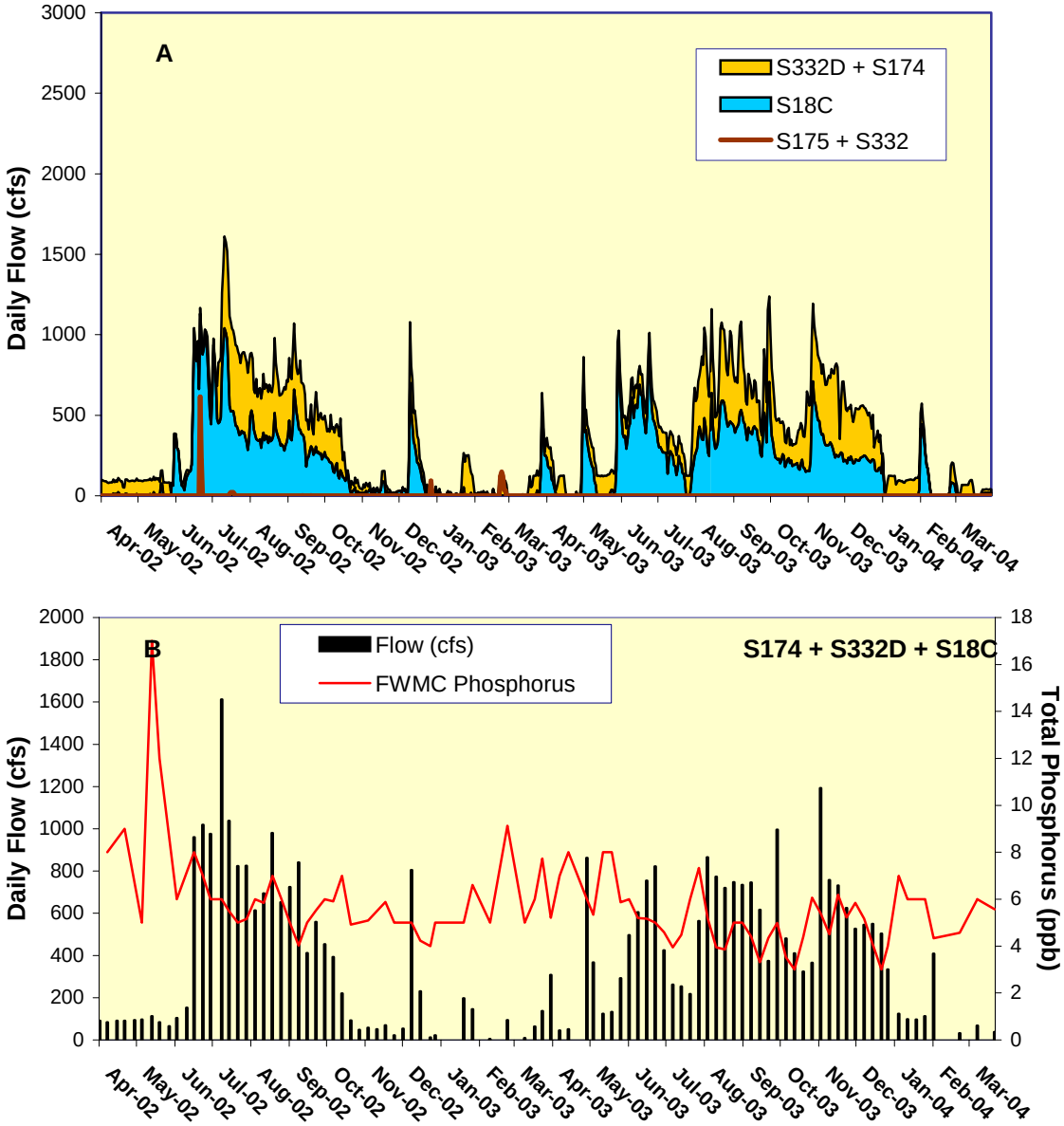

Figure 7. **A.** Daily flows into Everglades National Park through Taylor Slough and S18C. **B**. The relationship between daily flows at Taylor Slough structures and S18C and the corresponding flow-weighted mean total phosphorus concentrations for individual sampling events.