Water Conservation Area 3 Decompartmentalization & Sheet Flow Enhancement - Part 1

- Existing Conditions -
Hydrology and Water Quality

Technical Publication ERA # 450

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EXECUTIVE SUMMARY

This report documents historical, hydrologic, meteorological and water quality data for Water Conservation Area 3 (WCA-3) and the surrounding area. The data represent existing or baseline conditions prior to implementing the Comprehensive Everglades Restoration Plan (CERP).

WCA-3 is part of the Water Protection Area (WPA) and a remnant of the historical Everglades. It is south of Lake Okeechobee, Water Conservation Area 1 (WCA-1), now managed as the Loxahatchee National Wildlife Refuge (LNWR), the Everglades Agricultural Area and Water Conservation Area 2 (WCA-2). Highly populated, urban areas of Broward and Miami-Dade counties lie to the east of WCA-3. The Big Cypress National Preserve, the Miccosukee Indian Reservation and the Cypress Seminole Indian Reservation share the western boundary. The southern boundary of WCA-3 lies along the northern boundary of Everglades National Park (ENP).

WCA-3 is divided into two impoundments, WCA-3A and WCA-3B, by the L-67A Canal, which runs diagonally from northeast to southwest in the southeastern quadrant of WCA-3. Together, the impoundments cover 921 square miles.

WCA-3A receives water from Lake Okeechobee, WCA-2 and the EAA via the North New River and Miami Canals, from L-28 Interceptor Canal, L-4 cut, and the S140 and S9 pump stations. WCA-3A delivers water to ENP and Miami-Dade County. Water flows across the open portion of the western boundary of WCA-3A, to Big Cypress National Preserve. WCA-3B is a significant recharge area to the Biscayne aquifer and helps control saltwater intrusion in municipal wells in populated areas along the coast. It receives most of its water from rainfall and occasionally from WCA-3A via the Miami and L-67 Canals. Water is discharged from WCA-3B via the Miami Canal although plans are underway to enable discharges to the Northeast Shark River Slough along the northeast boundary of ENP from WCA-3B.

The period of record used for summary hydrologic and meteorological statistics in this report was calendar year 1965 to 2000. In some instances, results are reported by water year (WY). The water year used spans a period from the previous June to May of the year (e.g. WY2000 is the span of time from June 1, 1999 to May 31, 2000). Reference is also made to wet and dry seasons in the report. The wet season used in the analyses starts in June and ends in October. The dry season goes from November to May of the next year. This resulted in 35 wet seasons and 35 dry seasons over the period of record used. Water quality data were based on data from varying periods of record and were abstracted from material presented in the Everglades Consolidated Report, the first of which was submitted to the State Legislature on January 1, 2000.

Seasonal mean rainfall for the 36-year period of record in WCA-3 was about 39 inches (min. = 24.8, max. = 60.1, STD = 7.5) for the wet season and about 18 inches (in, min. = 7.8 in, max. = 30.0 in, STD = 5.5 in) for the dry season. Spatially, there is less rainfall in the northwest corner of WCA-3 and an increasing amount of rainfall towards the southeast in the wet season. In the dry season, the average pattern is for rainfall to increase from west to east. Seasonal mean evapotranspiration (ET) is about 32 in (min. = 29.1 in, max. = 33.8 in, STD = 1.18 in) in the dry season and about 26 in (min. = 24.4 in, max. = 27.6 in, STD = 0.81 in) in the wet season. On average, during the dry season, there is about as much spatial variation in ET as there is in rainfall: there is a range of 1.11 in (max. = 32.06 in, min. = 31.95 in, STD = 0.33 in) for ET, compared to a range of 1.28 in (max. = 18.83 in, min. = 17.56 in, STD = 0.38 in) for rainfall.

The term "stage" refers to water surface level above some datum, in this case the National Geodetic Vertical Datum of 1929 (NGVD). Stage varied cyclically, with a peak in stage typically occurring toward the end of the wet season (October). This characteristic cycle was heavily influenced by system operations, which were designed to supply water to the Lower East Coast (LEC) and ENP. The cycle was also influenced by rainfall and ET. Roughly speaking, the data split into one span of increasing stage during the wet season and another of decreasing stage during the dry season. Spatially, stage contours reflected ground surface elevations through the region: the land surface gently sloped from 10 to 11 feet (ft.) NGVD in the northwest corner of WCA-3A to 5 to 6 ft. NGVD in the southeast corner of WCA-3B. Stage varied from 11.51 ft. NGVD in the northwest corner of WCA-3A to 6.58 ft. NGVD in the southeast corner of WCA-3B during an average dry season and from 11.96 ft. NGVD to 7.15 ft. NGVD during an average wet season. There was no apparent relationship between stage and net rainfall (for the period June 1, 1976, to October 31, 2000). However, there was a moderate correlation between stage and net flow (r = 0.55) for the period June 1, 1980, to October 31, 2000.

Water depth was calculated by subtracting the ground surface elevation from the water surface level. However, soil subsidence may have altered ground surface elevations over time. There is very little information on subsidence in WCA-3, but a decrease in peat thickness from 0 to 1.4 ft. in the vicinity of Tamiami Trail, along the southern boundary of WCA-3B has been reported. Water depth in WCA-3 was typically 1.0 to 2.5 ft., with the shallower waters in the northwestern portion of WCA-3 where higher ground elevations exist. In dry periods, WCA-3 dried out in places—particularly in the northwest corner—as water levels dropped below ground level. Most of WCA-3A was inundated for over 330 days per year, and that more than half of WCA-3B (36,000 acres [ac] of total area of about 69,120 ac) was also inundated for over 330 days per year, with about half of the remaining area being inundated for over 300 days.

Flow into and out of WCA-3 was about one million acre-feet (ac-ft.) per year, but varied by hundreds of thousands of ac-ft. from year to year. Flow volumes vary for each station and reflected water demand and the natural cycle of rainy and dry years.

WCA-3 experienced elevated median inflow concentrations of total phosphorus (TP) in WY2000 (47.5 parts per billion [ppb]), due in part to drought conditions. During WY2001, WCA-3 inflow TP concentrations returned to pre-drought conditions, with a median concentration of 28 ppb. The median outflow TP concentration was at its highest in WY2001 (18 ppb). However in WY2002, the median outflow concentration dropped to 12 ppb. For each year from WY 1996 to WY2002, median outflow TP concentrations were lower than median inflow concentrations.

Approximately 62 metric tons of TP and 1,273,000 ac-ft. of water entered WCA-3 in WY2002. In the same water year, 12.5 metric tons of TP and 907,000 ac-ft. of water were exported from WCA-3. Flows into WCA-3 increased considerably from 2001 to 2002 (from 678,000 to 1,273,000 ac-ft.), while the median TP concentration remained about the same. The increase in flow to WCA-3 resulted in increased TP loading to the area.

Mercury is a persistent, bioaccumulative toxicant and is a contaminant of concern in Florida, It can build up in the food web to levels that are harmful to human and ecosystem health. The dominant proximate source of inorganic mercury to the Everglades is atmospheric deposition. Total inorganic mercury (THg) concentrations in precipitation were substantially higher during the summer months of WY2003, up to about 30 nanograms per liter (ng/L), where the volume-weighted annual concentration was about 14.0 ng/L. The Class III Water Quality Standard for THg in surface water is 12 ng/L.

THg is methylated by sulfate-reducing bacteria. Methylmercury (MeHg) is a highly toxic form of mercury (more so than inorganic Hg), is soluble in water, and is easily absorbed into animal tissue after they ingest food that contains the substance. No surface water quality standard exists for MeHg. An MeHg "hot spot", believed to be the lower edge of a sulfate plume where an optimal environment for MeHg production, exists in the center of WCA-3A. The maximum MeHg concentration observed in calendar year 2002 was 0.36 ng/L.

Bird and fish tissue analyses were used to assess the uptake of mercury into the food chain. Bird tissue samples included eggs and feathers. Concentration of MeHg in eggs is thought to be the best predictor of MeHg risk to avian reproduction. However, to date, a critical egg concentration has not yet been determined for wading birds. While egg THg concentration for Great Egrets has varied since 1999 (appearing to increase slightly in 2001, then decreasing again in 2002), among-year differences were not statistically significant at L67. However, the egg THg concentration observed in 2003 (0.38 micrograms/gram [μg/g]) was lower than levels reported for eggs collected in 1993. THg levels in egret nestling feathers appear to have increased slightly in 2003 compared to 2002, are similar to 2001 but, most importantly, continue to be much lower than 1994 levels and confirm trends observed in egg analyses.

The fish tissue analyses used three kinds of fish: mosquito fish, sunfish, and largemouth bass. Each represents a different level in the food chain or trophic level. Mosquito fish are representative of short-term, localized changes in water quality. Sunfish represent the best measure of potential upper trophic exposure to mercury, because they are the preferred prey item of many fish-eating species in the Everglades. Largemouth bass are an indicator of potential higher order fauna, including human, exposure to mercury.

In 2002, the basin-wide median THg concentration in mosquito fish was 52 ng/g, a 25 percent decrease from 2001. However, THg concentration in mosquito fish has varied geographically and over time since 1999. THg concentration in sunfish in 2002, averaged 194 ng/g. Based on mean concentrations, sunfish at all five sampled sites in 2002 contained THg concentrations exceeding one or both of the proposed predator protection criteria. The mean THg, age-standardized concentration in largemouth bass was 428 ng/g in 2002. The spatial patterns observed in largemouth bass were similar to those for sunfish in 2002.

ACKNOWLEDGEMENTS

The authors would like to thank the Model Information Systems Support Group at the South Florida Water Management District for analyzing rainfall and ET data and producing the summary data that appears in this report for these parameters. Most of the water quality information presented was based on material appearing in the South Florida Environmental Report (formerly the Everglades Consolidated Report). The numerous authors of that report are gratefully acknowledged here. The section on mercury is entirely based on work produced and published by Darren Rumbold (Florida Gulf Coast University) and his colleague, Larry Fink, in the Acceler8 Projects Office at the South Florida Water Management District. The following individuals reviewed this document and provided thoughtful suggestions concerning its format and content: Hedy Marshall, Pam Lehr, Charlie Balmaseda and Cherry James.

ABBREVIATIONS

ac-ft.	Acre-feet (volume)
ANCOVA	ANalysis of COVAriance
BCNP	Big Cypress National Preserve
C-XXX or **CXXX**	Canal number
DBHYDRO	District corporate database for hydrologic, hydraulic and water quality data
DBKEY	Unique 5-digit alphanumeric time series record number in DBHYDRO
ECP	Everglades Construction Project
ECR	Everglades Consolidated Report
ENP	Everglades National Park
EPA	Everglades Protection Area
ET	EvapoTranspiration
FDEP	Florida Department of Environmental Protection
ft.	Feet
ft. NGVD	Feet referenced to the National Geodetic Vertical Datum 1929
G-XXX or **GXXX**	SFWMD structure number
g/m^2-yr	Grams per square meter per year
Hg	Mercury
HSM	Hydrologic Systems Modeling
in	Inches
kg/yr	Kilograms per year
L-XXX	Levee number
LIDAR	Light Detection And Ranging
LNWR	Loxahatchee National Wildlife Refuge
m	Meter
max	Maximum
MDN	Mercury Deposition Network
MeHg	Methyl mercury
min	Minimum
mmol/L	Millimoles per liter
ng/g	Nanograms per gram

ng/L	Nanograms per liter
NGVD	National Geodetic Vertical Datum 1929
NSM	Natural Systems Model
PDSI	Palm Drought Severity Index
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RECOVER	REstoration, COordination and VERification
RGM	Reactive Gaseous Mercury
S-XXX or **SXXX**	Army Corps of Engineers structure
SFER	South Florida Environmental Report (formerly the Everglades Consolidated Report)
SFWMD	South Florida Water Management District (or District)
SFWMM	South Florida Water Management Model
SRB	Sulfate Reducing Bacteria
STA	Storm water Treatment Area
STD	STandard Deviation
Thg	Total mercury
TIN	Triangular Irregular Network
TP	Total Phosphorus
USACE	U. S. Army Corps of Engineers (or the Corps)
USEPA	U. S. Environmental Protection Agency
USFWS	U. S. Fish and Wildlife Service
USGS	U. S. Geological Survey
WCA-1	Water Conservation Area 1
WCA-2	Water Conservation Area 2
WCA-3	Water Conservation Area 3
WCA-3A	Water Conservation Area 3A
WCA-3B	Water Conservation Area 3B
WPA	Water Preserve Areas
WY	Water Year
XCOORD	X-COORDinate
YCOORD	Y-COORDinate

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INTRODUCTION

This report documents historical hydrologic, meteorological and water quality data for Water Conservation Area 3 (WCA-3) and the surrounding area. WCA-3 is part of the Water Protection Area (WPA) and a remnant part of the historical Everglades. It is south of Lake Okeechobee, Water Conservation Area 1 (WCA-1) and currently is managed as the Loxahatchee National Wildlife Refuge (LNWR), the Everglades Agricultural Area (EAA) and Water Conservation Area 2 (WCA-2). Highly populated, urban areas of Broward and Miami-Dade counties lie to the east of WCA-3. The Big Cypress National Preserve (BCNP), the Miccosukee Indian Reservation and the Cypress Seminole Indian Reservation share the western boundary. The southern boundary of WCA-3 lies along the northern boundary of Everglades National Park (ENP). **Figure 1** shows WCA-3 and surrounding areas.

WCA-3 is divided into two impoundments, WCA-3A and WCA-3B by the L-67A Canal that runs diagonally from northeast to southwest in the southeastern quadrant of WCA-3. Together, the impoundments cover 920.9 square miles. WCA-3A receives water from Lake Okeechobee and the EAA via the North New River and Miami Canals, from L-28 Interceptor Canal, L-4 cut, and S140 and S9 stations. Water deliveries are made from WCA-3A to ENP, and Miami-Dade County. Water flows across the open portion of the western boundary of WCA-3A, to Big Cypress National Preserve. WCA-3B is a significant recharge area to the Biscayne aquifer and is important in controlling saltwater intrusion in municipal wells in populated areas to the east, along the coast. It receives most of its water from rainfall and occasionally from WCA-3A via the Miami Canal. Water is discharged from WCA-3B using the Miami Canal although plans are underway to enable discharges to the Northeast Shark River Slough along the northeast boundary of the ENP from WCA-3B (Cooper 1991; Grein, et al., 2003; Hwa 2003; SFWMD 2000; SFWMD Operations 2003; Smelt 2003; STRIVE 1999; USACE 1999).

The sections that follow cover rainfall, potential evapotranspiration (ET), stage and depth, flow and water quality, specifically total phosphorus and mercury. These parameters are associated with the project's performance measures based on the objectives established for the project and published in the Project Management Plan (USACE and SFWMD, 2002). **Figure 2** shows indicator regions identified as part of the development of regional performance measures (RECOVER, 2004). These indicator regions (**Table 1**) are useful for examining changes in the performance measures within landscape features and unique, ecological sub-regions. Several sections in this report refer to these indicator regions.

Table 1. WCA-3 indicator regions.

Number	Name	Number	Name
114	WCA-3A NW Corner	122	WCA-3A Gap
115	WCA-3A North	123	WCA-3A South Central
116	WCA-3A NE	124	WCA-3A South
117	WCA-3A NW	125	WCA-3B North
118	WCA-3A Alley North	126	WCA-3B West
119	WCA-3A East	127	Pennsuco Wetlands
120	WCA-3A West	128	WCA-3B East
121	WCA-3A North Central	190	WCA-3A Sawgrass

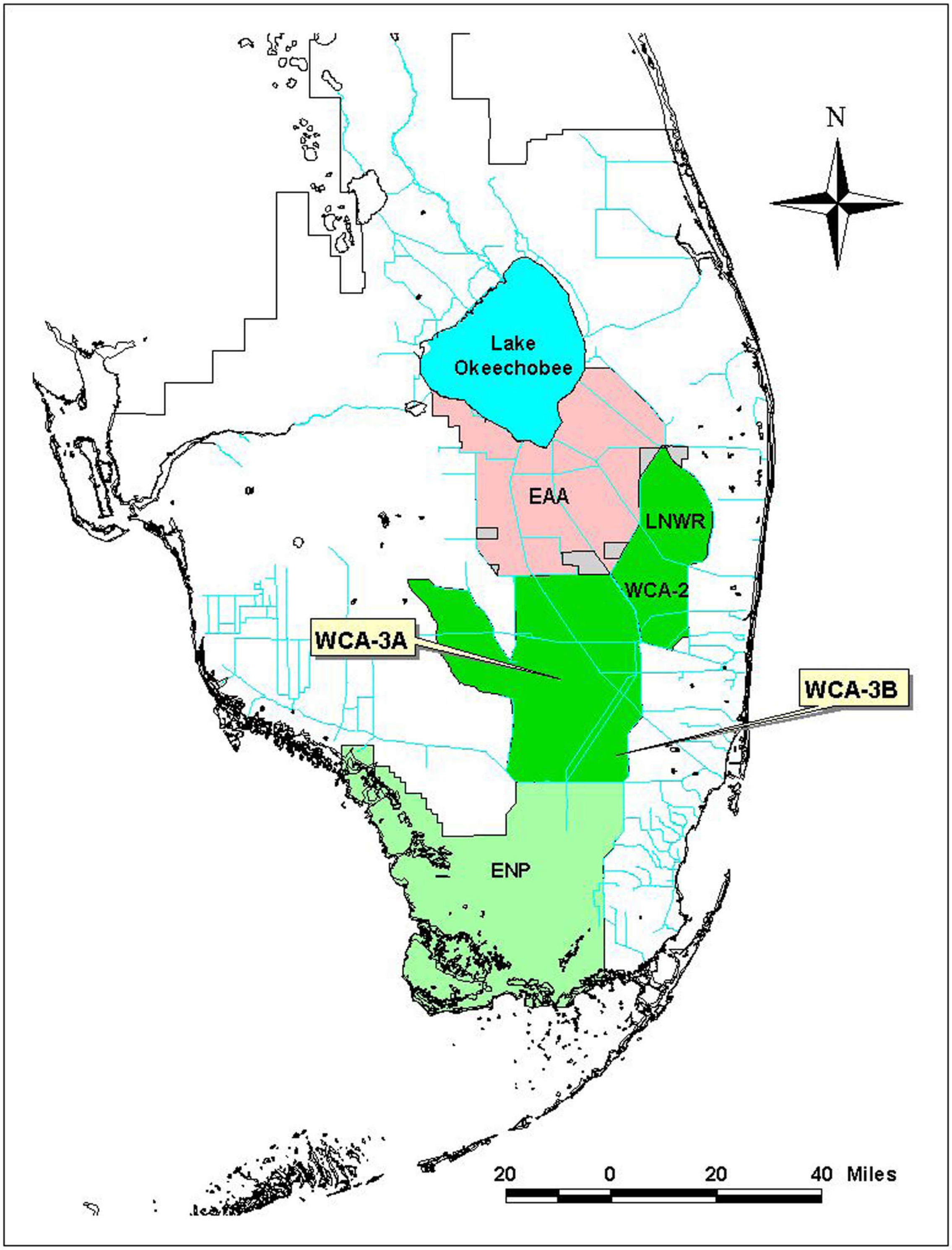

Figure 1. Water Conservation Areas 3A (WCA-3A) and 3B (WCA-3B).

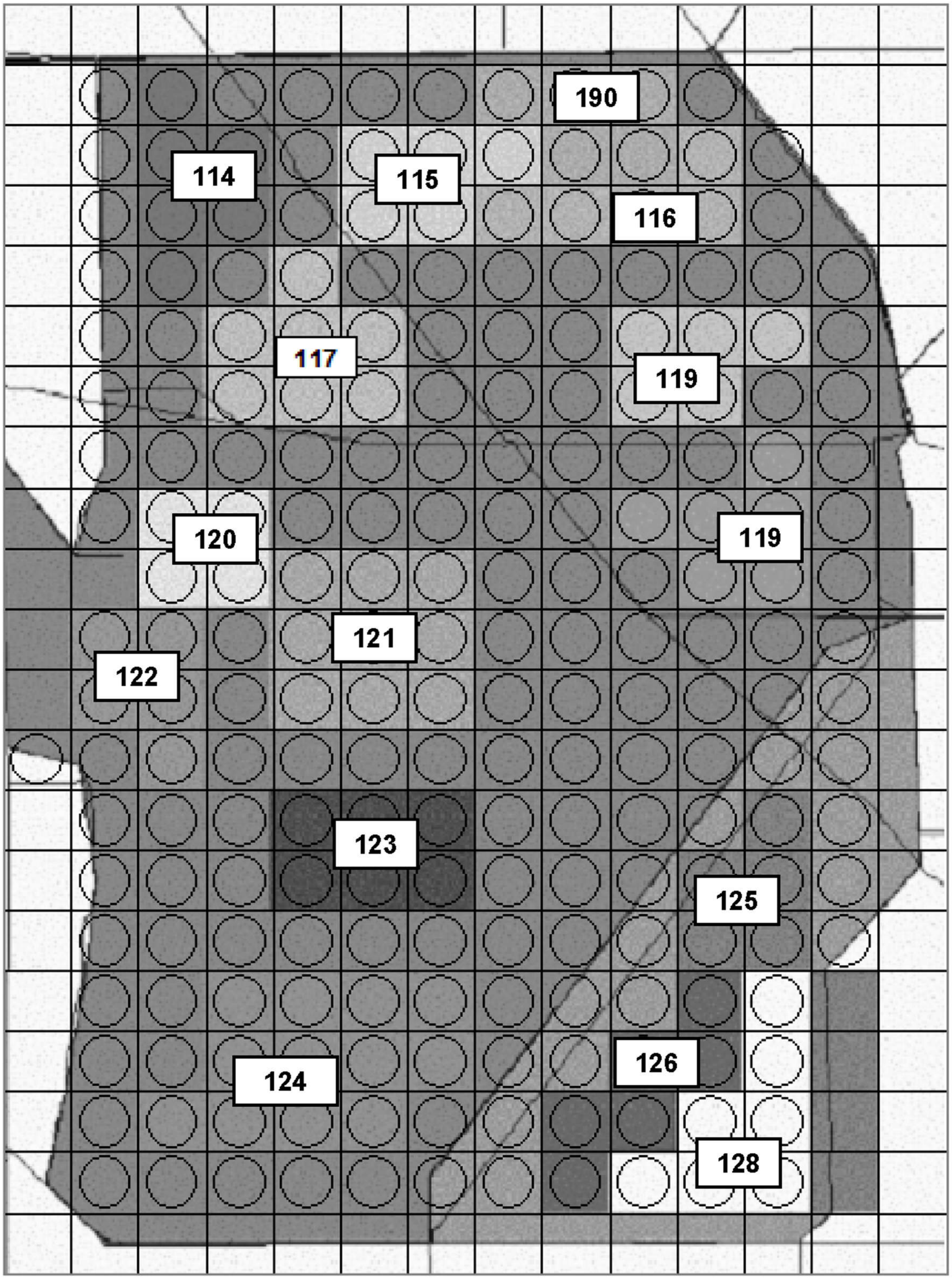

Figure 2. WCA-3, as discretized by the South Florida Water Management Model (SFWMM). Squares are 2 miles across; those that circumscribe circles are part of WCA-3 as defined by the model. Indicator regions are numbered.

The period of record used for summary statistics was calendar year 1965 to 2000. In some instances, results are reported by water year (WY). The water year used in this report spans a period from the previous June to May of the year (Ali and Abtew 1999; e.g. WY 2000 is the span of time from June 1, 1999, to May 31, 2000). Reference is also made to wet and dry seasons in the report due to the meteorology of South Florida. The hydrology and, in some cases, the water quality data show seasonal variation best described by dividing periods into wet and dry seasons. The wet season used in the following analyses starts in June and ends in October. The dry season goes from November to May of the next year. This resulted in 35 wet seasons and 35 dry seasons over the period of record used. The months used for the wet season, dry season, and water year differ from those used in sections of the annual South Florida Environmental Report (SFER), formerly known as the Everglades Consolidated Report (ECR). The definition of the periods used here was based upon the one used by various data sources in order to be consistent with those sources.

HYDROLOGY

Both rainfall and ET input data to the South Florida Water Management Model (SFWMM) are presented[1] in this report. Input data for the SFWMM model were used instead of point values measured at stations because of the ability to represent rainfall and ET over all areas of WCA-3 and to provide consistency with modeling efforts for CERP. This approach also minimized the repetition of work already completed.

The SFWMM model represents the geometry of WCA-3 as a set of discrete, square cells, measuring 2 miles (mi) on each side as shown in **Figure 2**. Values of rainfall for each cell of the SFWMM grid were computed for each day using daily totals extracted from DBHYDRO for each of the rain gages in the vicinity of WCA-3. A quality assurance/quality control (QA/QC) procedure was applied in order to detect suspect values (including high values and zero values), and to reject or keep them over daily, monthly, three-month, and annual periods. For each day, a triangular irregular network (TIN) was constructed, connecting the points corresponding to valid data. One hundred evenly-spaced point values (which form a 10-by-10 grid) of rainfall were interpolated for each cell, using the TIN. These values were averaged in order to produce a rainfall estimate over the 2 mi x 2 mi cell (Cadavid, 2004).

Several specific intervals were selected for spatial analysis of rainfall and ET. These correspond to the seasons in which: 1) extreme rainfall occurs (the minimum rainfall for a dry season or the driest dry season; the maximum rainfall for a wet season or the wettest wet season); and 2) average (median) rainfall occurs (the average wet season or average dry season).

RAINFALL

Figure 3 and **Figure 4** present rainfall on monthly and seasonal bases. The rainfall data follow a general pattern consisting of alternating dry and wet seasons. In the wet season (June through October), rainfall is markedly greater than in the dry season (November through May). The only clear year-to-year pattern in seasonal rainfall (**Figure 4**) is that of alternating high and low values from season to season. It is difficult to discern a pattern other than the obvious difference between wet and dry seasons.

Figure 4 also has a number of features that demonstrate the temporal variability in the rainfall data. The lines representing the mean dry and wet season rainfall amounts for the period of record are shown with lines one standard deviation above and below the means (i.e., lines labeled WM+, WM-, DM+ and DM-). The driest dry season rainfall and the wettest wet season rainfall, as indicated by the highest and lowest Palmer Drought Severity Index (PDSI) are marked. The PDSI combines soil moisture conditions and ET as well as rainfall to indicate the severity of a drought. It is also used to convey relative wetness. The rainfall for the highest and lowest PSDI can be contrasted with the lowest and highest seasonal rainfall, also shown.

Figure 5 through **Figure 10** display wet season and dry season departures from mean rainfall amounts for WCA-3 for each of the indicator regions listed in (integral numbers in small type show the indicator region number). The intent is to show spatial variation across the Water Conservation Area and variation among wet and dry season extremes and median values.

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[1] The rainfall data came from the electronic binary file rain_v2.0_nsm_wmm.bin. The evapotranspiration data come from the electronic binary file ETp_recomputed_tin_wmmgrid.bin.

However, the season that had the greatest rainfall does not correspond to the period when the highest stages were observed in WCA-3. The season with median rainfall also does not correspond to the period of average seasonal stage. This apparent lack of relationship between high rainfall and high stage and low rainfall and low stage is probably due to water management operations. Since the natural system in WCA-3 is most affected by stage levels, the descriptions “wettest wet season”, “driest dry season”, “average wet season” and “average dry season” refer to those seasons associated with high, low and average water levels (stage). Briefly, the wettest wet season is that for which WCA-3 is covered by the greatest amount of water, and the driest dry season is that for which WCA-3 is covered by the least amount of water. The average wet and dry seasons are those for which WCA-3 is covered by an average amount of water.

Figures in Appendix A can be used in conjunction with through **Figure 8** and **Figure 10** through **Figure 13** for ET demonstrates the differences in spatial variation and areal mean values of rainfall if the definition of wettest, driest and median are based on rainfall (or ET) amounts as opposed to stage values.

Seasonal mean rainfall for the 36-year period of record was about 39 inches (in. min. = 24.8 in., max. = 60.1 in., STD = 7.5 in.) for the wet season and about 18 inches (min. = 7.8 in., max. = 30.0 in., STD = 5.5 in.) for the dry season. The difference in median values of rainfall for the wet and dry season also implies a variation over time that appears significant. Rainfall differed from location to location as indicated in **Figure 5** through **Figure 8**, and showed a large range in values. For example, in the wet season of 2000, the range was 19 inches. On average[2], in the wet season there is less rainfall in the northwest corner of WCA-3 and an increasing amount of rainfall towards the southeast (**Figure 6**). In the dry season, the average pattern is for rainfall to increase from west to east. Abtew, Huebner, and Ciuca (2004) estimate that the historical annual average rainfall is 51.4 inches, based upon 30 years of data (1971 to 2000). Several previous publications including Abtew, Huebner, and Sunderland, 2001; Ali and Abtew, 1999; Ali et al., 1999; MacVicar and May, 1981; Sculley, 1986; and Trimble, 1990, also present rainfall summary statistics for WCA-3.

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[2] The general pattern described was determined by first computing the mean of rainfall amounts for each individual rain gage, then ranking the gages according to the size of the mean, and considering the location of each gage. A similar procedure is followed for ET calculations.

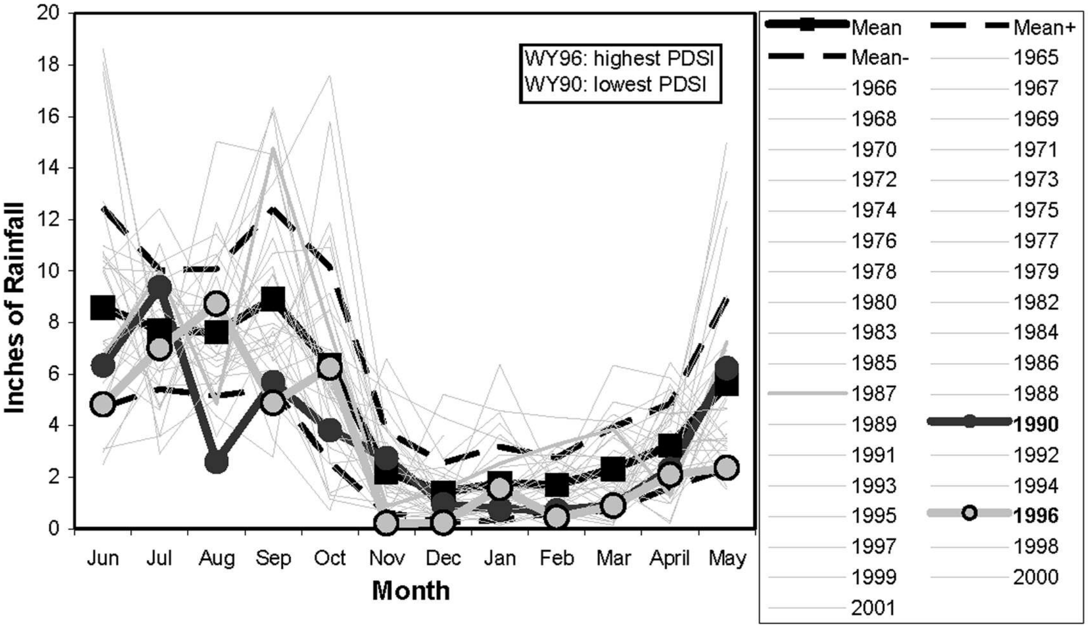
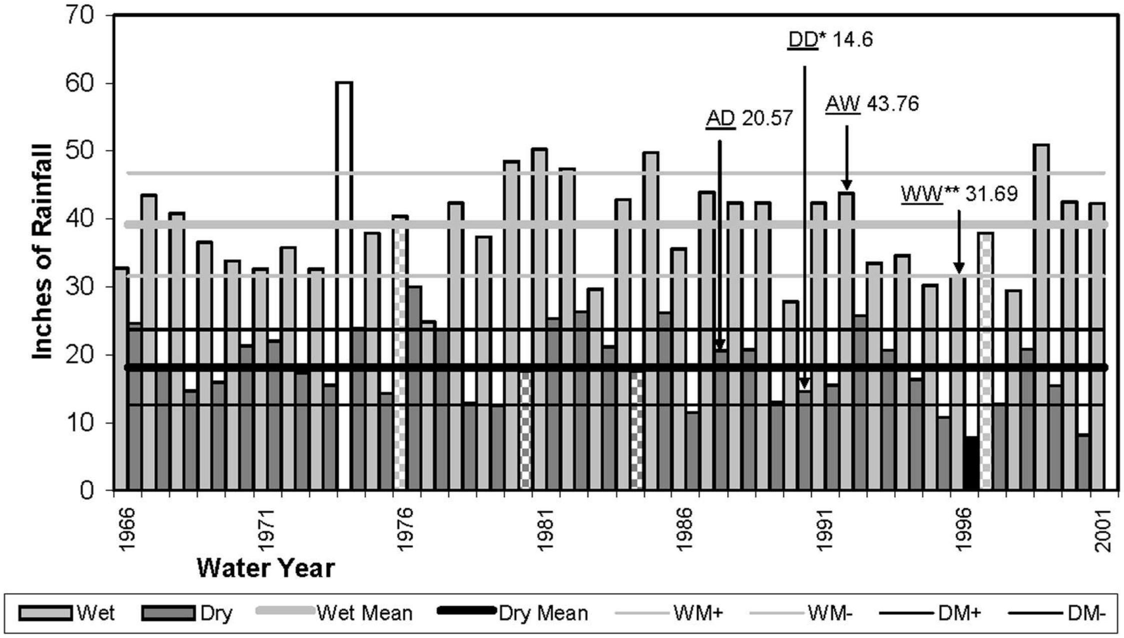


Figure 3. WCA-3 monthly rainfall.



PDSI	Most severe drought
**	Highest PDSI
AD	Average Dry season
AW	Average Wet season
DD	Driest Dry season
WW	Wettest Wet season

Checked patterns indicate median values.

Alternate colors (white and black) indicate extreme low and high evapotranspiration.

Figure 4. WCA-3 seasonal rainfall.

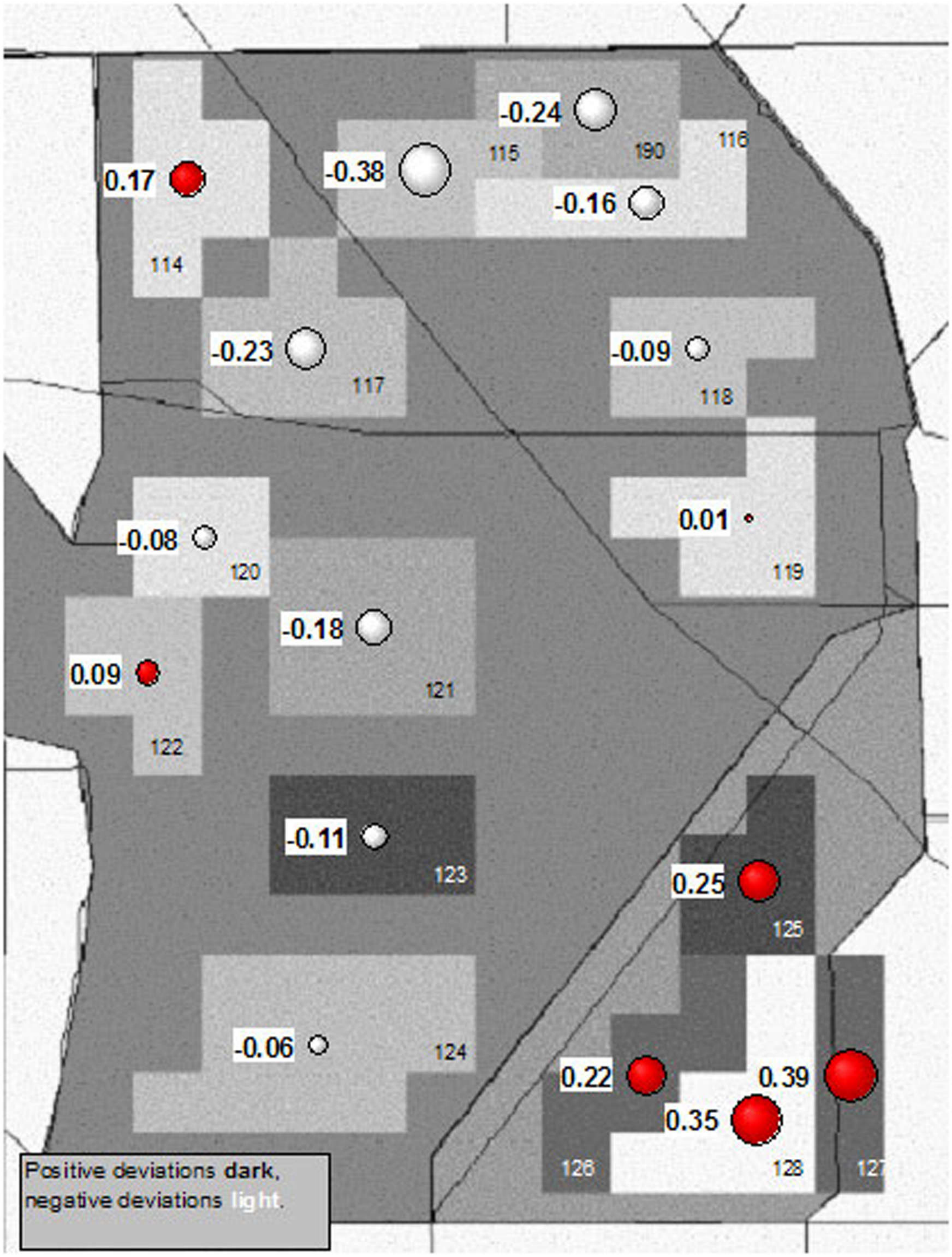


Figure 5. Seasonal rainfall for wet season with high stage (1995; deviation from mean of 31.36 inches).

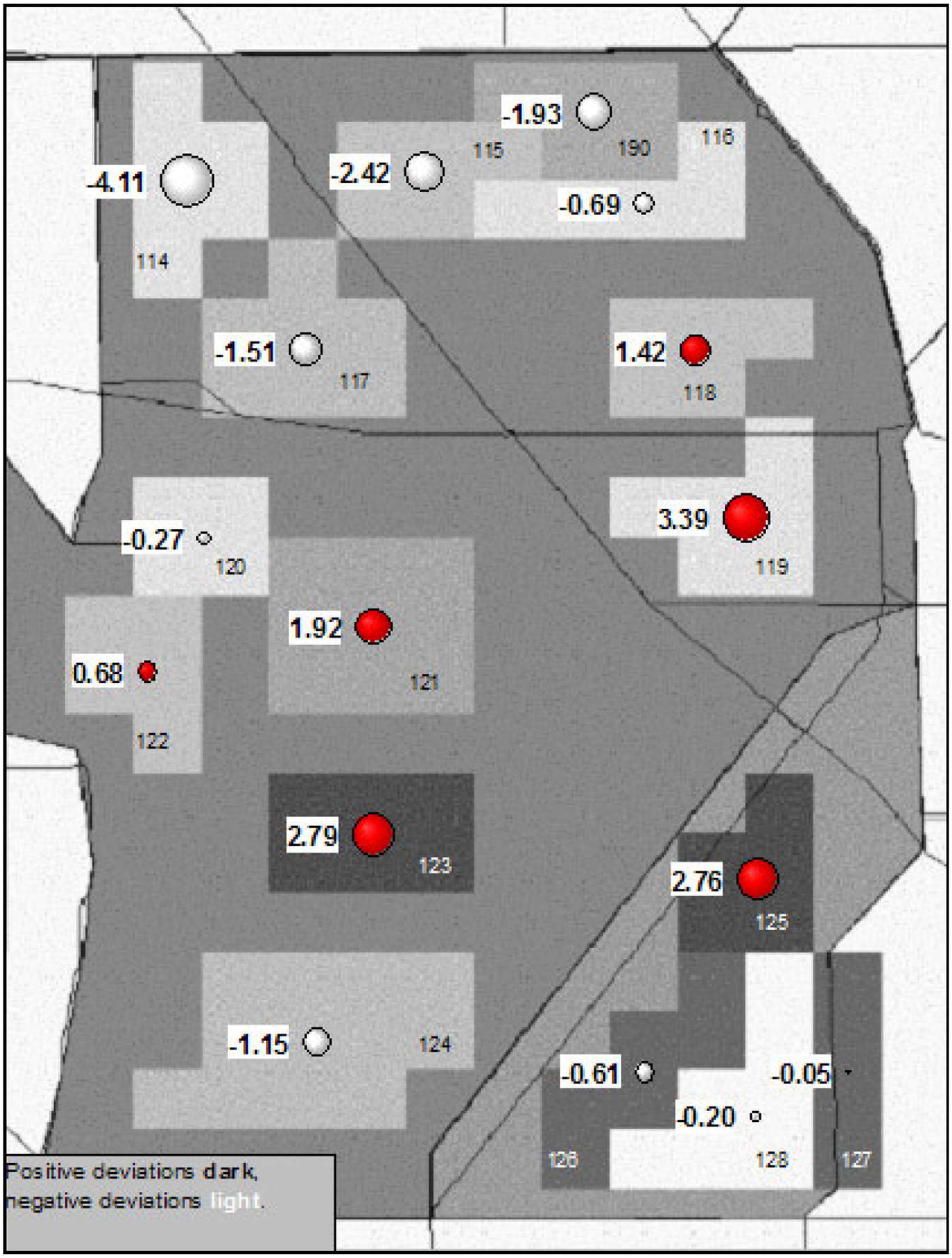


Figure 6. Seasonal rainfall for wet season with average stage (1991; deviation from mean of 43.23 inches).

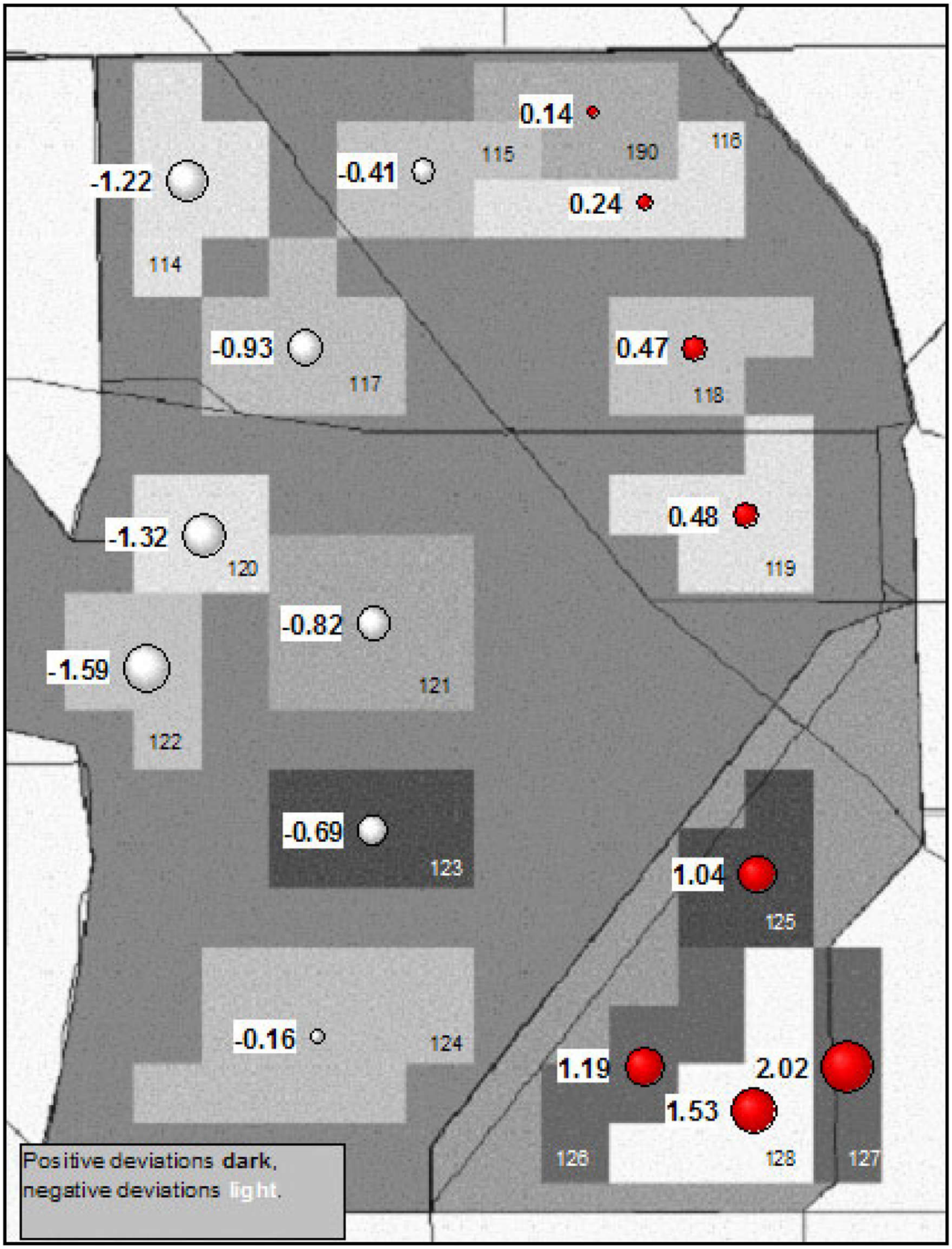


Figure 7. Seasonal rainfall for dry season with low stage (1989; deviation from mean of 14.81 inches).

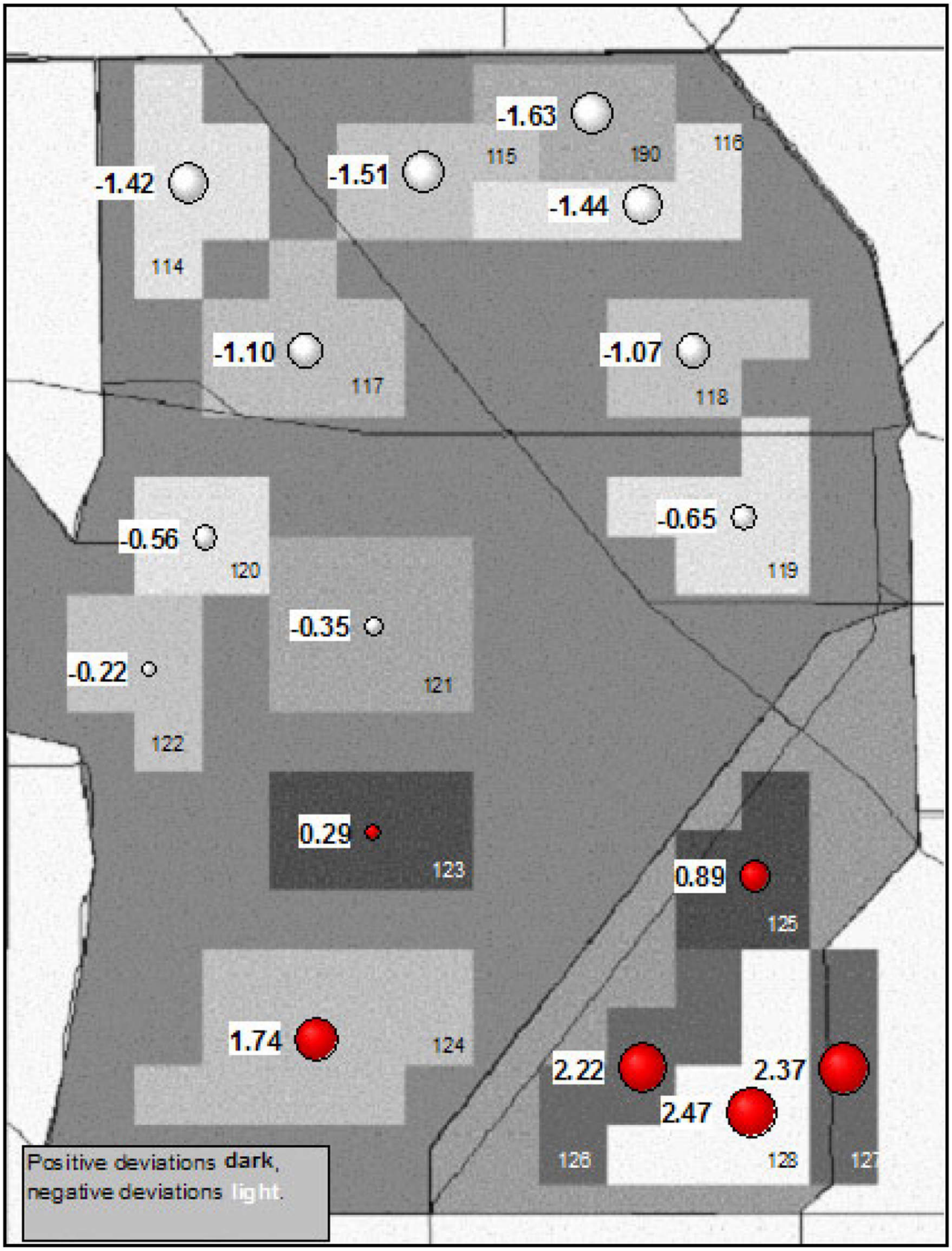


Figure 8. Seasonal rainfall for dry season with average stage (1986; deviation from mean of 20.65 inches).

POTENTIAL EVAPOTRANSPIRATION

Values of ET were computed for each SFWMM model cell using point values of ET applied to a TIN similar to the way cellular rainfall values were computed. Point values of ET were calculated using a method that estimates potential ET from solar radiation and air temperature.

Figure 9 shows monthly variation in ET for the period of record for this study. In general, ET begins to decline from a high at the end of the dry season or beginning of wet season, reaching a minimum in December, and then increases again. The only clear year-to-year pattern in seasonal ET (**Figure 10**) is that of alternating high and low values from season to season. It is difficult to discern a pattern in seasonal ET (**Figure 10**), other than the obvious difference between wet and dry seasons.

Seasonal mean ET is about 32 in. (min. = 29.1 in., max. = 33.8 in., STD = 1.18 in.) in. the dry season and about 26 in. (min. = 24.4 in., max. = 27.6 in., STD = 0.81 in.) in the wet season. On average, during the dry season, there is about as much spatial variation in ET as there is in rainfall: there is a range of 1.11 in. (max. = 32.06 in., min. = 31.95 in., STD = 0.33 in.) for ET, compared to a range of 1.28 in. (max. = 18.83 in., min. = 17.56 in., STD = 0.38 in.) for rainfall. During the wet season, there is more variation in rainfall than in ET: there is a range of 0.6 in. (max. = 26.0 in., min. = 25.4 in., STD = 0.20 in.) for ET, compared to a range of 2.67 in. (max. = 40.54 in., min. = 37.87 in., STD = 0.96 in.) for ET. The general spatial pattern for ET is that ET increases towards the southwest. However, note the variability in spatial patterns for specific years and seasons, as represented by the **Figure 11** through **Figure 13**. Abtew et al., (2003) estimate annual average potential ET of 52 to 54 in., based upon previous literature and distinct lysimeter studies conducted over a period of about 60 years, from 1940 (Abtew et al., 2003) to 1999 (Mao, 2002, cited by Abtew et al., 2003), in various geographic areas of the South Florida Water Management District (SFWMD or the District).

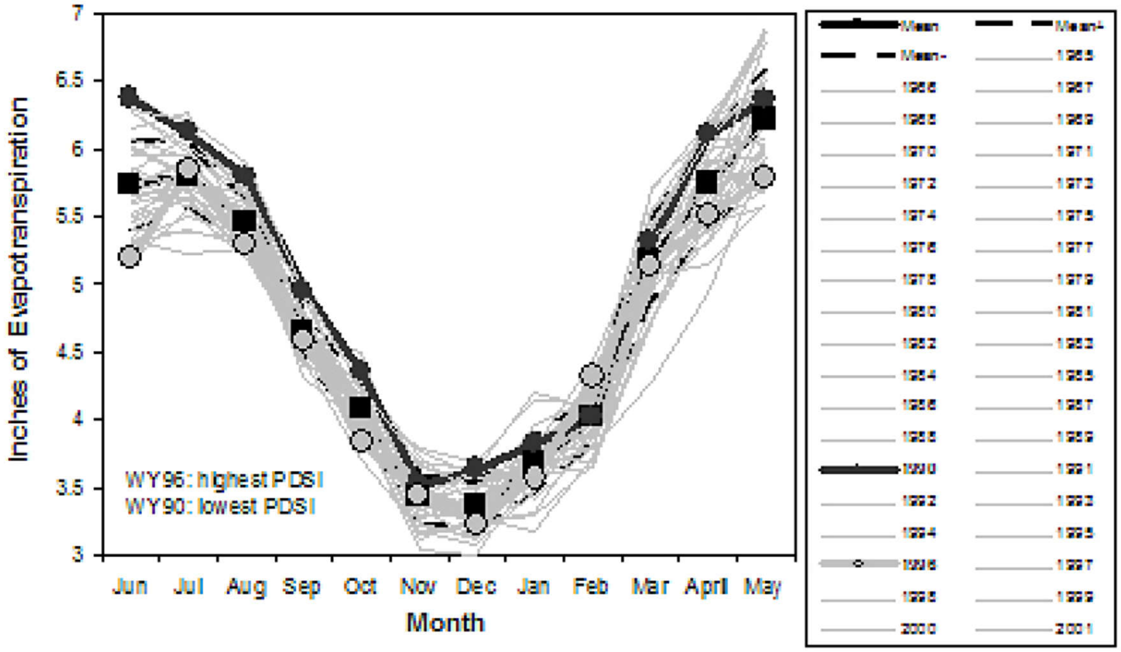
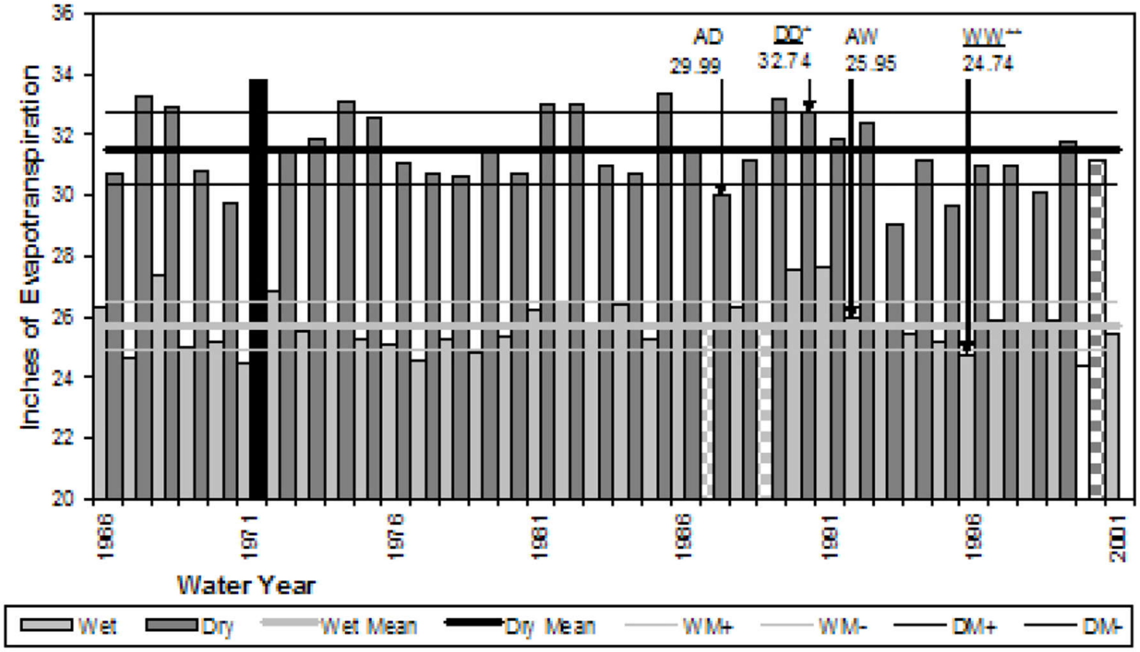


Figure 9. WCA-3 monthly ET.



PDSI	Most severe drought
**	Highest PDSI
AD	Average Dry season
AW	Average Wet season
DD	Driest Dry season
WW	Wettest Wet season

Checked patterns indicate median values.

Alternate colors (white and black) indicate extreme low and high evapotranspiration.

Figure 10. WCA-3 seasonal ET.

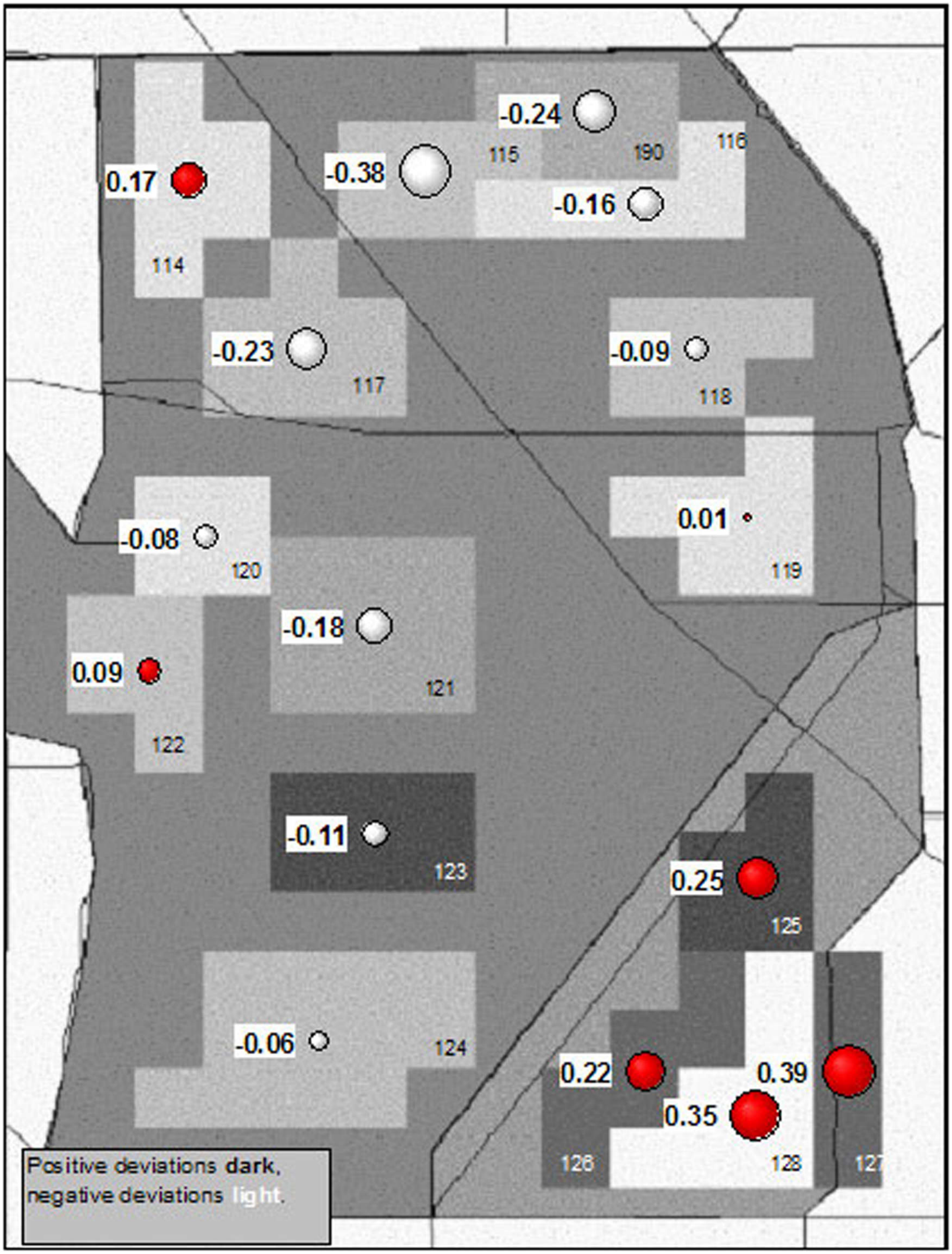


Figure 11. Seasonal ET for wet season with high stage (1995; deviation from mean 24.75 inches).

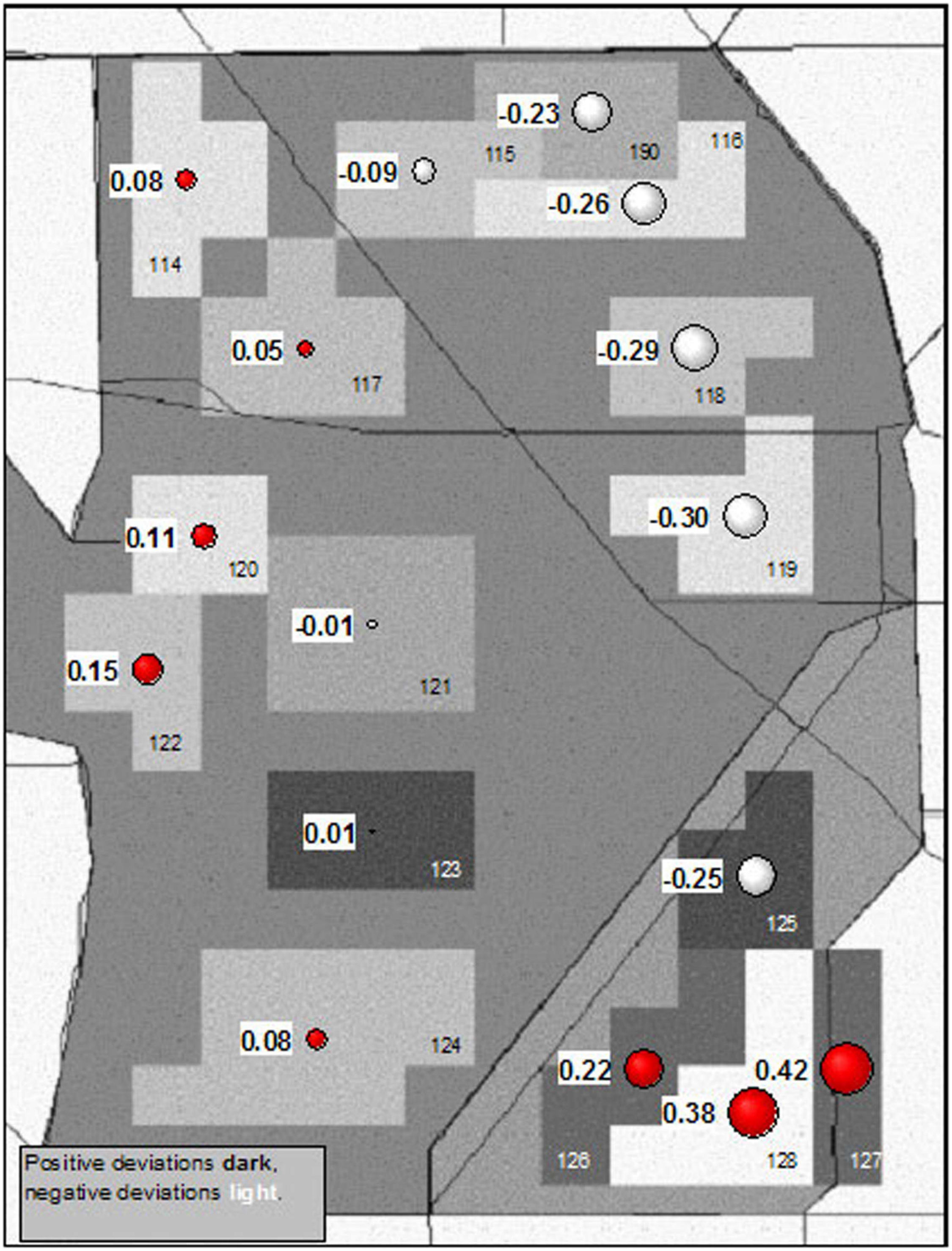


Figure 12. Seasonal ET for wet season with average stage (1991; deviation from mean of 26.03 inches).

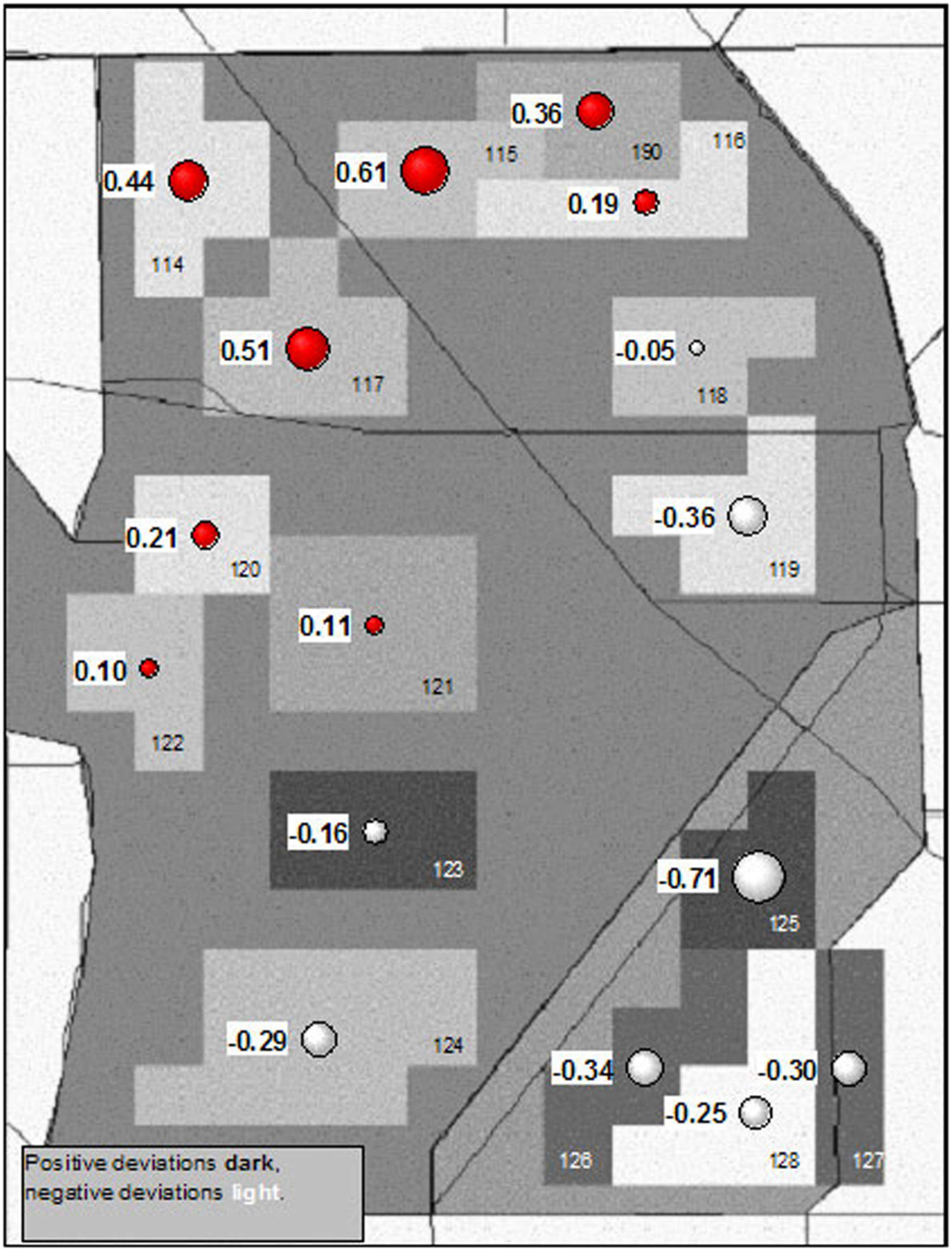


Figure 13. Seasonal ET for dry season with low stage (1999; deviation from mean of 31.30 inches).

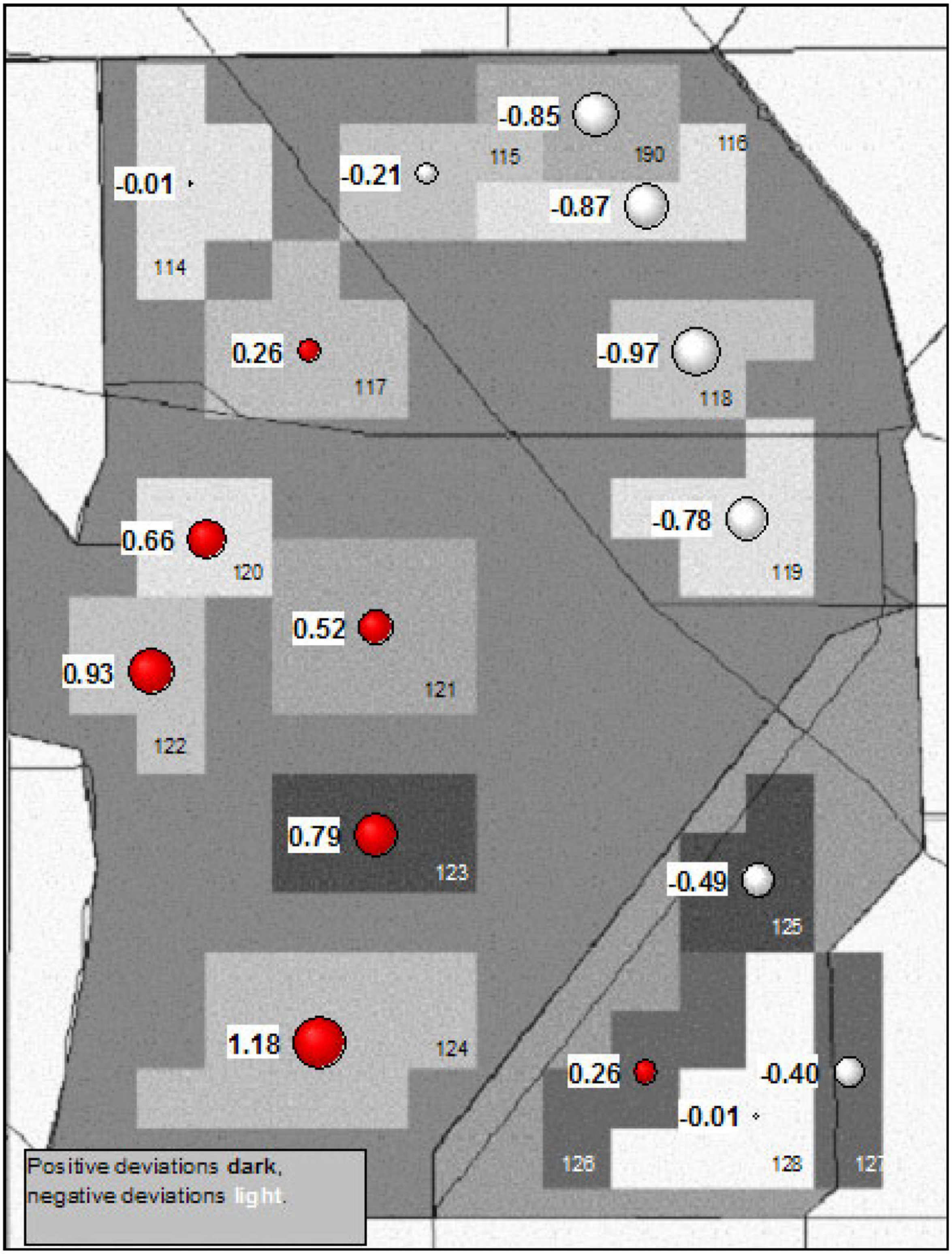


Figure 14. Seasonal ET for dry season with median stage (1989; deviation from mean of 32.69 inches).

STAGE

Average and extreme stage conditions are presented in this section. The term stage refers to water surface level above some datum, in this case the National Geodetic Vertical Datum of 1929 (NGVD). Overall, stage decreases from northwest to southeast, which is the general direction of water flow. The stage analysis was conducted using two periods per year, corresponding to the wet and dry seasons of rainfall. Stage is cyclical, with a dominant frequency of one cycle per year; a peak in stage typically occurs toward the end of the wet season (October). This characteristic cycle is heavily influenced by operations which are designed to supply water to the Lower East Coast (LEC) and ENP. The cycle is also influenced by natural phenomena (chiefly rainfall). Roughly speaking, analyzing data on a seasonal basis splits the data into one span of increasing stage and another of decreasing stage.

Data sources for the mean daily flows were the Hydrologic Systems Modeling (HSM) data set (SFWMD, 2003b) and DBHYDRO (SFWMD, 2003a). The HSM data set is one that has been developed expressly for the purposes of modeling and has been subjected to a QA/QC process. DBHYDRO is the District's corporate database for environmental data and includes the HSM data set. Time series data for a single parameter such as flow at a station is referenced by a single DBKEY. Appropriate DBKEYs for each station were determined by first checking the HSM data set. When data were not available there, DBKEYs were selected from other data in DBHYDRO. Each of the interior stations, in all but one case, has only one DBKEY. Two DBKEYs were found for G69_H; one covers the period up to September 19, 1995, and the other begins on the same day and continues. There are no preferred DBKEYs of mean daily stage within WCA-3. See Appendix B for details on which DBKEYS were selected for each station.

Based on a query of the DBHYDRO database, there are 33 locations in WCA-3 where stage (or water surface elevation) is recorded. This number was based on a bounding box {25°45'00" N ≤ lat ≤ 26°22'00" N ∩ 80°52'30" ≤ long ≤ 80°22'30" W} determined by examination of the maps by Grein, Householder, and Hohner (2003). The station descriptions and XCOORD and YCOORD values retrieved were reviewed in order to determine whether the structures are located within WCA-3, and, if so, whether they are in the marsh or in one of its canals. Mean daily stage is available for 31 stations—24 were in WCA-3A and 7 were in WCA-3B. Data were not available for all stations at all times; these gaps in data resulted in sparse coverage, especially for WCA-3B. Mean daily stage records were analyzed and summarized by calculating average stage for each season, for each water year, and by examining contour plots representing select periods: "wettest wet," "average wet," "average dry," and "driest dry" seasons.

Maps of the stage structures are presented in **Figure 15 and Figure 16.** The station structures are listed in **Table B-1, Appendix B.** There were locations not listed at which stage information was available, though not as mean daily values and/or not during the period of record examined (1965 to 2000). Also, there were several stations for which it is difficult to determine whether they were located within WCA-3 or adjacent to it; G-618_B, L28-1, S12_H, C4.L30, and L29 are therefore not included in the map. The period of record for each station shown is presented in **Table 2** Most of the records begin in 1978 or later.

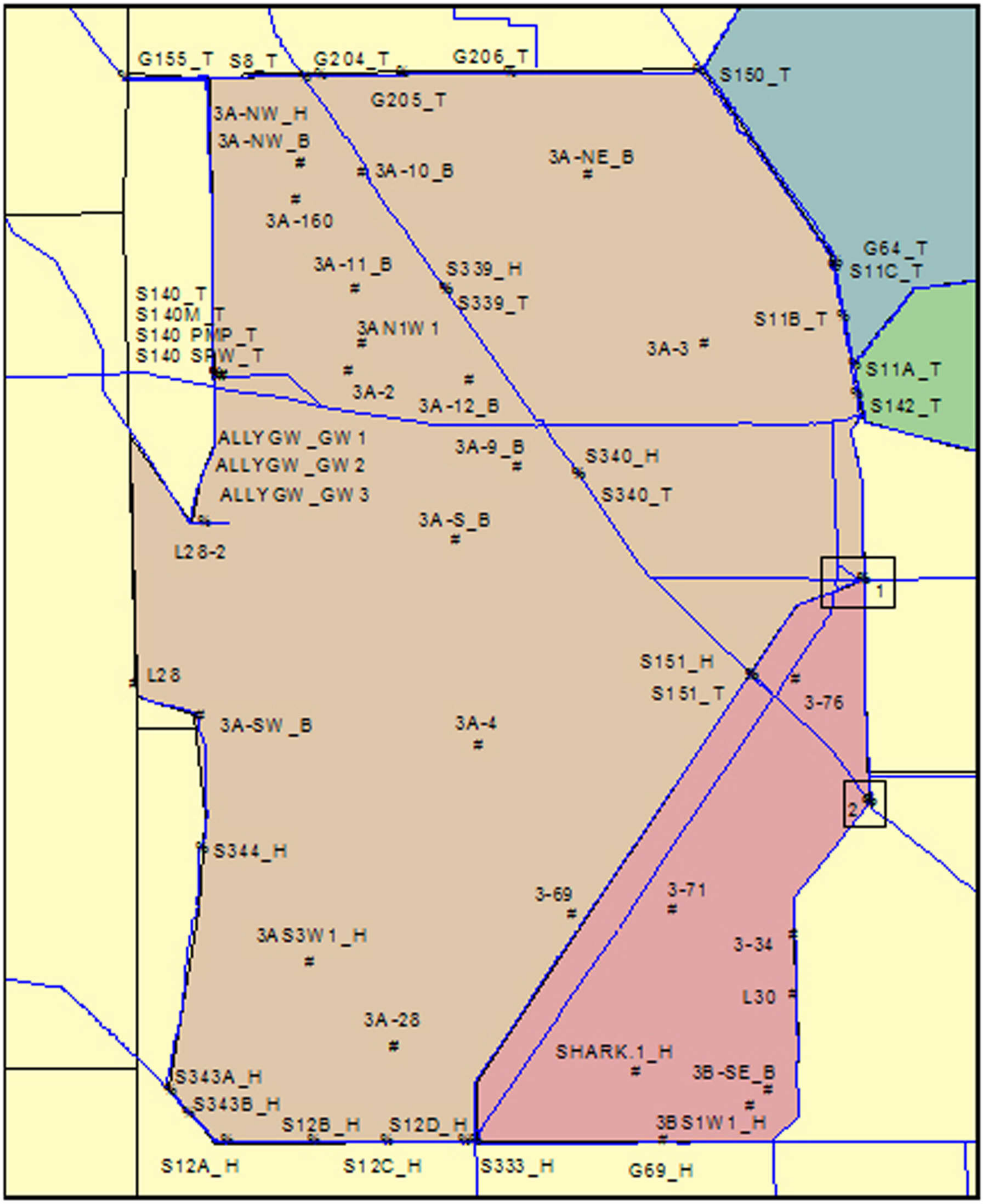


Figure 15. Round dots mark stage stations within the marsh in WCA-3, while square dots mark stage stations within the canals.

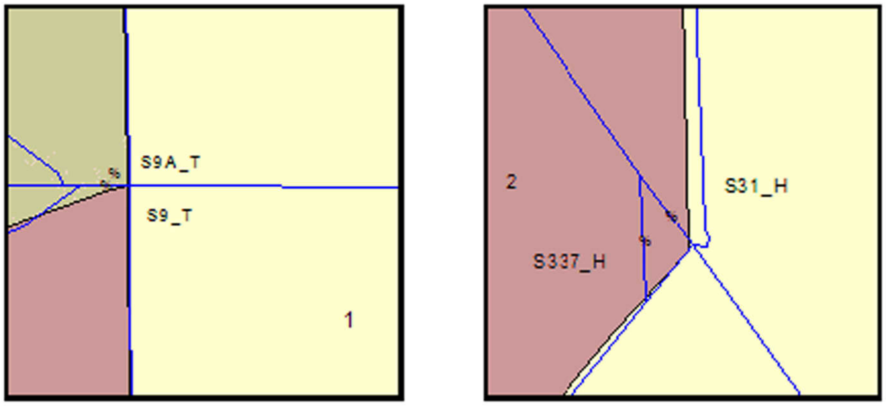


Figure 16. Insets of Figure 15.

Mean daily stage records were analyzed and summarized. **Figure 17** through **Figure 20** are contour plots that correspond to actual water years that are representative of extreme and average conditions for both wet and dry seasons (i.e., plots are shown for the "wettest wet," "average wet," "average dry," and "driest dry" seasons). The two seasonal mean stages (one for wet, one for dry) for the years in which the greatest number of stations experienced extreme seasonal mean stage were selected to represent extreme stage conditions. In order to represent average conditions for each season, the difference between the seasonal stage[3] and the mean seasonal stage was calculated for each year and station, and the seasonal stage corresponding to the least average deviation[4] was selected. Surfer 8.0 software was used to generate a regular grid by point kriging using a linear variogram model; all data points were used to determine values at grid points. Contour lines are generated by interpolation between grid points.

Generally, the stage contours reflect the flow of water through the region: flow is generally from the northwest corner towards the southeast corner; the land surface gently slopes in this direction. Note that the stage contours are based upon sparse data points. While this is less than ideal, all available data were used in the selection of representative years and in the generation of the contours.

During the preparation of this document, the question was asked whether stage was more dependent upon net flow (inflow – outflow) or net rainfall (rainfall – ET). The available data were used to examine possible relationships between stage and net flow, and between stage and net rainfall. There is no apparent relationship between stage and net rainfall for the period June 1, 1976, to October 31, 2000. Correlation between stage and net flow for the period June 1, 1980, to October 31, 2000 is weak (r^2, the coefficient of determination, is approximately 0.3).

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[3] Seasonal stage is the mean of daily stage values for a single season.

[4] The total number of stations in the data set divided total deviation for a single year, for all stations.

Also, during the preparation of this document, the question was asked whether the accuracy of the stage records is affected once the stage falls below ground level. Not all records show daily mean stages below ground level. **Table 3** shows stations that do have daily mean values below ground level, along with the number and percentage of such values. Each gage is capable of measuring stage within a certain range (this range is documented in DBHYDRO[5]); if the instrument records a value that is below (or above) this range, a technician will decide whether the recorded value is correct, and will mark the value with a "Code" in the database if the value is not representative of the true stage (Scirrotto, 2003). During the period analyzed herein, there is only one station (3BSE_B) for which daily mean stage falls below the minimum stage listed in **Table 3**; the Codes reported for the corresponding low values are either blank (27 values) or were designated as "estimated" (Code = E; 26 values) or "not appropriate for regional scale modeling" Code = Z; 1 value).

---

[5] Example: Access DBHYDRO through a web browser; from the DBHYDRO main menu, click "Surface Water and Meteorological Data," then mark the check box next to "Station." Next, enter 3-62 in the "Station" text box and click "Submit." Click on the 3-62 hyperlink in the Station column; then click the Info hyperlink beside the title of "Structure Info" on the next page. When the Info hyperlink page loads, the "Min. Stage" and "Max. Stage" will be shown under "Stage Station Information."

Table 2. Period of Record for Stage Structures.[1]

```
Water Year         1977    1979    1981    1983    1985    1987    1989    1991    1993    1995    1997    1999    2001
               1976    1978    1980    1982    1984    1986    1988    1990    1992    1994    1996    1998    2000
Season         DDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDD
Station
3A-160         XXXXXXXXXXXXXXXXXXXX
3A-10_B                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3A-12_B                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3A-2_G                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3A-28_G                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3A-3_G                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3A-4_G                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3A-NE_B                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3A-NW_B                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
SHARK.1_H              XXXXXXXXXXXX      XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
L28                        XXXXXXXX
G69_H                          XXXXXX              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3A-11_B                            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3A-9_B                                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3A-S_B                                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3A-SW_B                                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3B-SE_B                                        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3-62                                                                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3-63                                                                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3-64                                                                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3-65                                                                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3-69                                                                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3-71                                                                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3-76                                                                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3-34                                                                                   XXXXXXXXXXXXXXXXXXXX
3AS3W1_H                                                                                                               XXXXXX
3BS1W1_H                                                                                                           XXXXXX
Water Year       1977    1979    1981    1983    1985    1987    1989    1991    1993    1995    1997    1999    2001
               76    1978    1980    1982    1984    1986    1988    1990    1992    1994    1996    1998    2000
```

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[1] The beginning and ending seasons of each period of record maybe partially populated.

D Dry

W Wet

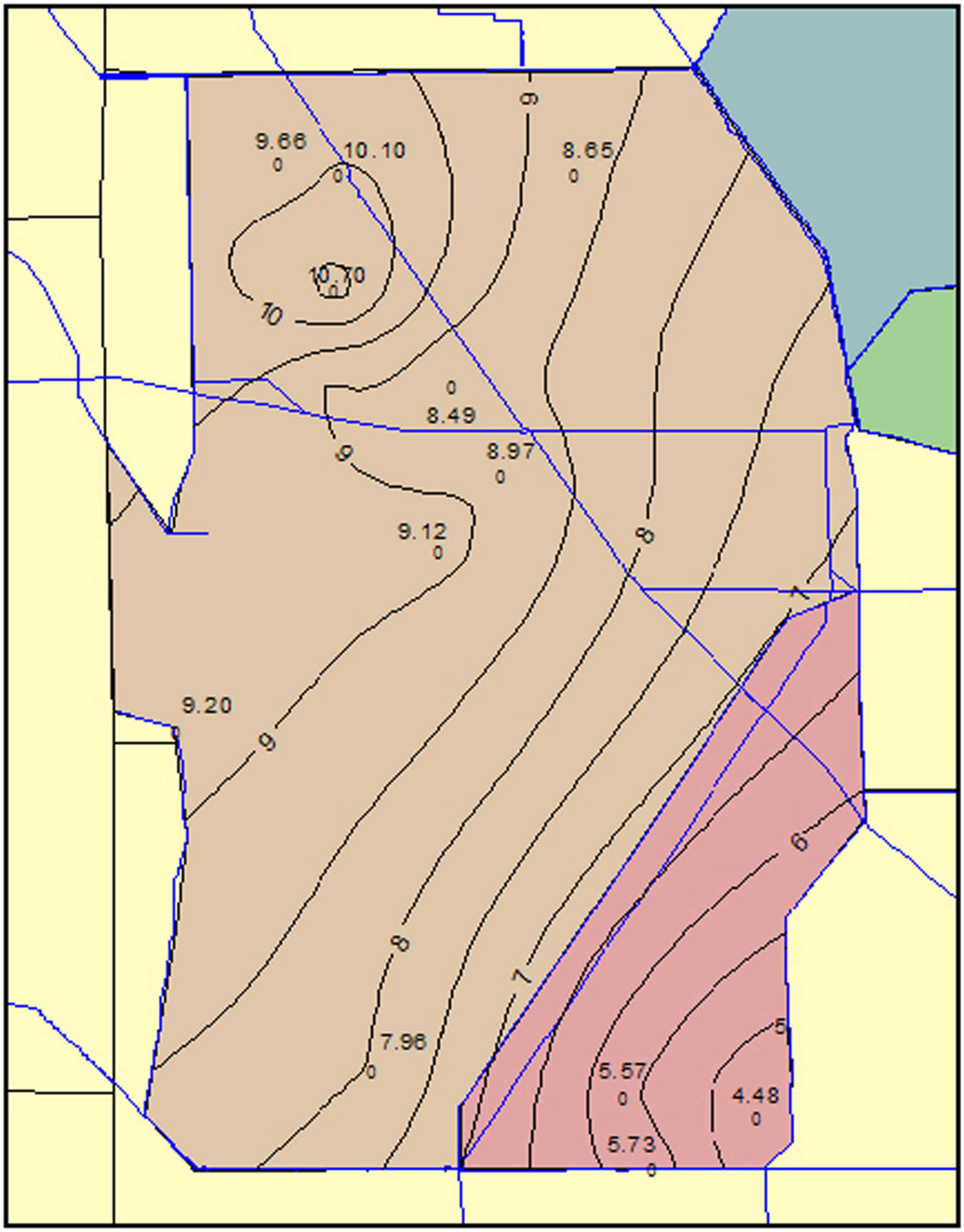


Figure 17. Contours of mean water surface (stage) for the driest dry season, Nov. 1, 1989, to May 31, 1990 (contour interval: 0.5 feet).

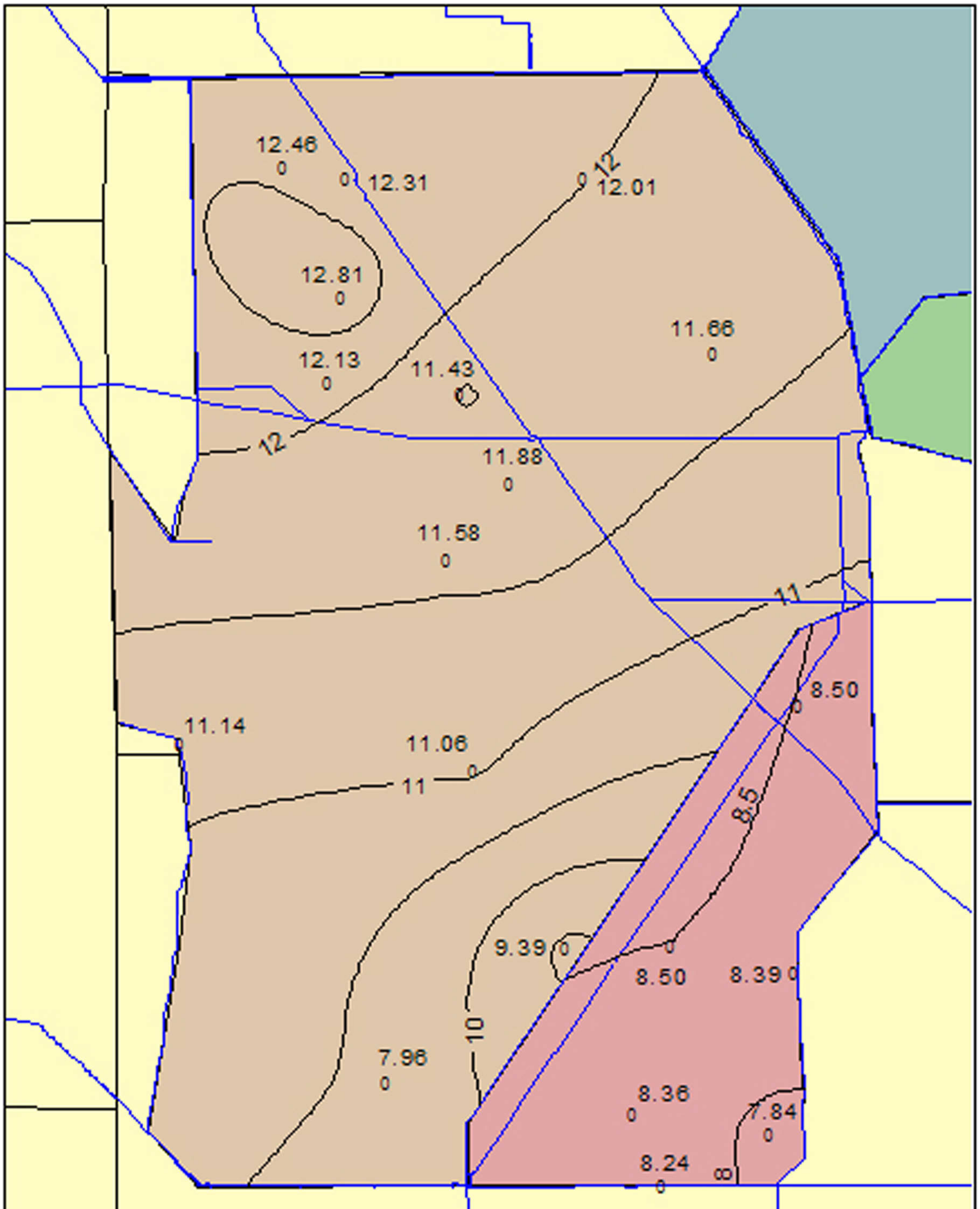


Figure 18. Contours of mean water surface (stage) for the wettest wet season, June 1 to Oct 31, 1995 (contour interval: 0.5 feet).

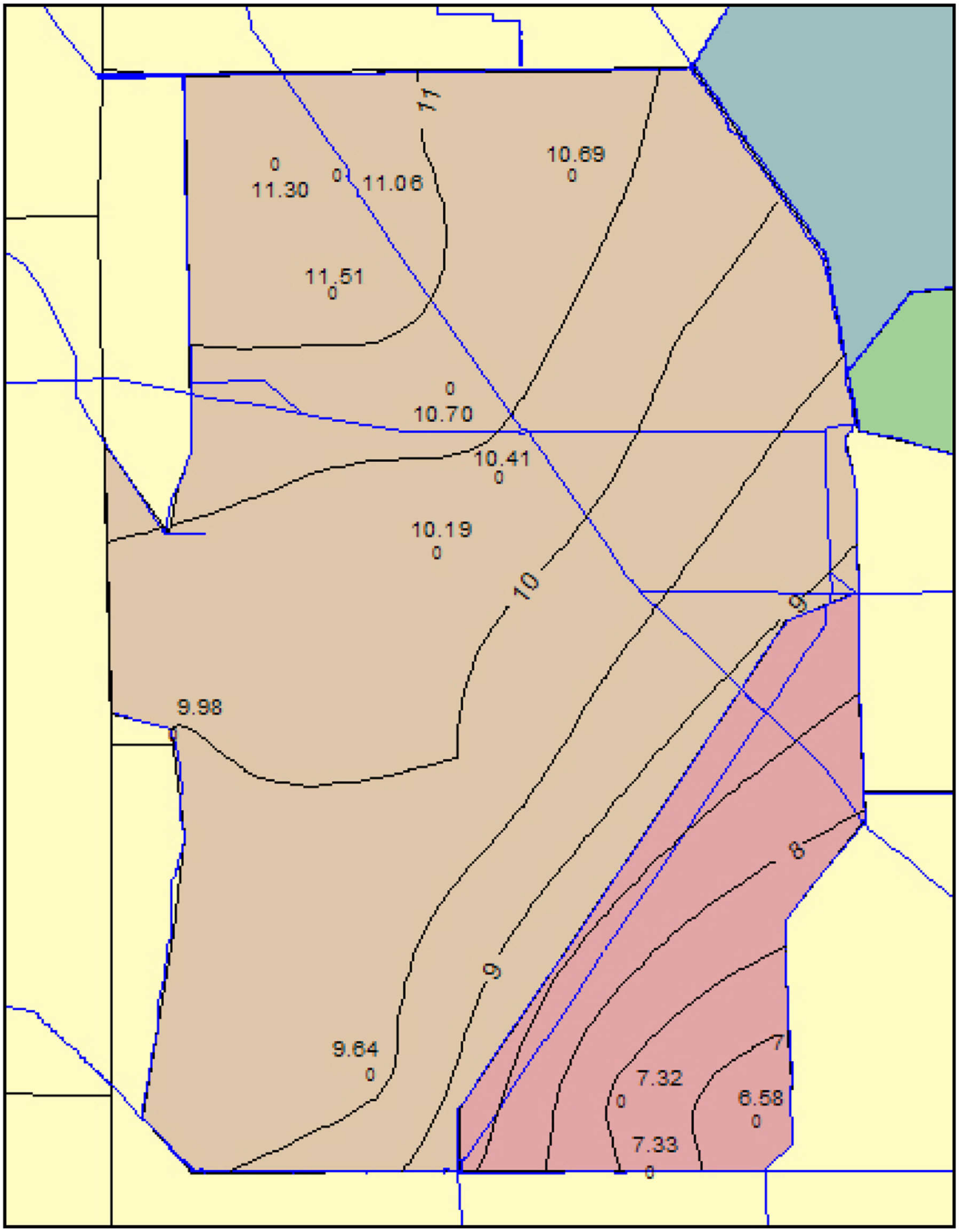


Figure 19. Contours of mean water surface (stage) for an average dry season, Nov. 1, 1986, to May 31, 1987 (contour interval: 0.5 feet).

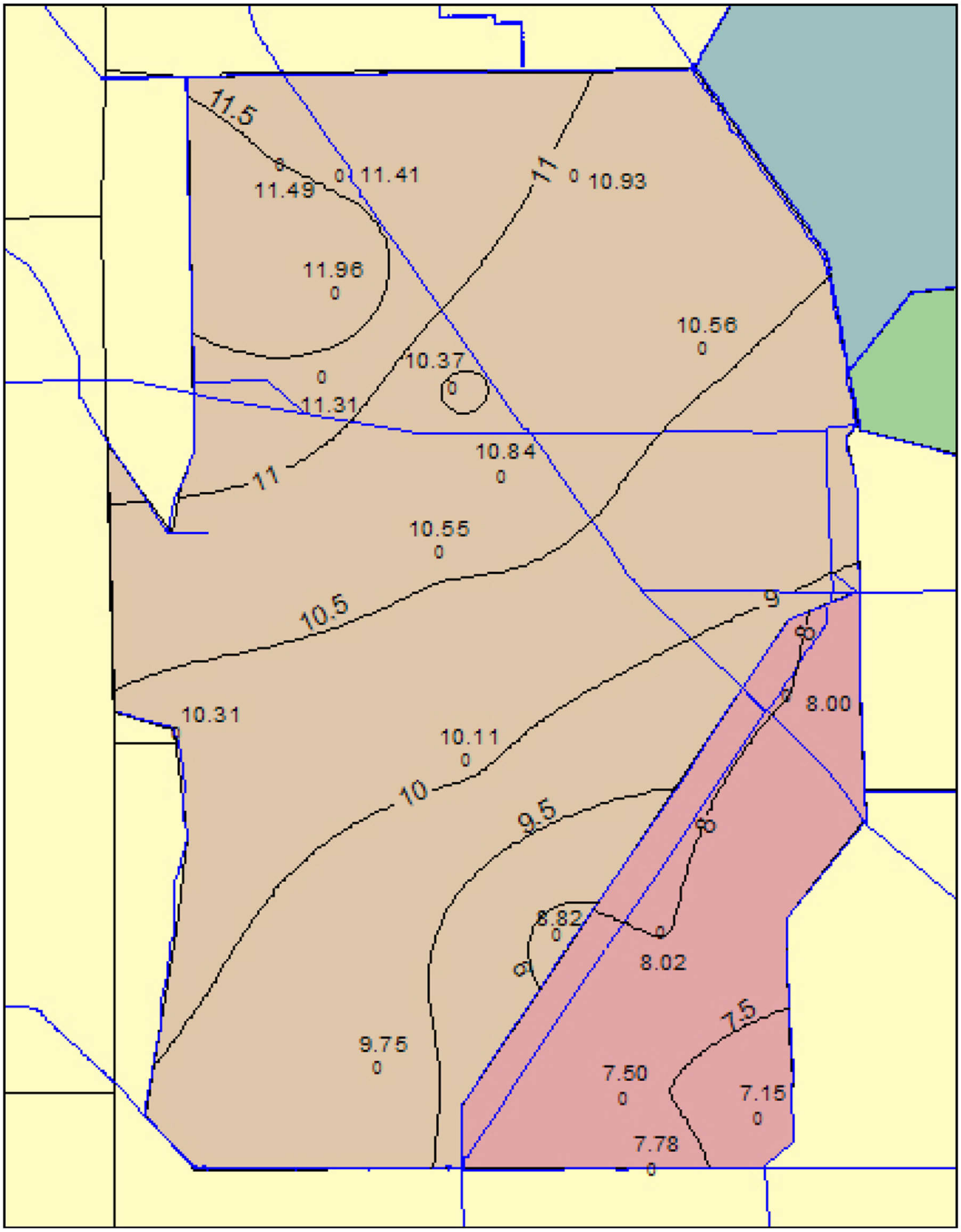


Figure 20. Contours of mean water surface (stage) for an average wet season, June 1 to Oct 31, 1991 (contour interval: 0.5 feet).

Table 3. Stations with stage records indicating water surfaces below ground level. Record interval is March 10, 1976, to December 31, 2000.

Station Description	Ground Level (ft. NGVD[1])	Minimum on Record (ft. NGVD)	Minimum Stage (ft. NGVD)	DBKEY	Count (Number)	Below Ground Level	Below Ground Level
3-62	9.2	8.09	8	16536	3390	26	0.8%
3-63	8.8	7.28	7.2	16532	3396	46	1.4%
3-64	8.9	8.25	8	16537	3428	41	1.2%
3-71	6.3	6.22	6.2	P1082	3454	4	0.1%
3A-10_B	10.7	9.71	8.88	P1071	7336	1719	23.4%
3A-12_B	9.1	8.19	7	P1098	7824	374	4.8%
3A-160	10.5	7.16	6.9	02157	1686	386	22.9%
3A-2	9.2	7.31	5	P1073	8241	579	7.0%
3A-28	7.2	5.82	5	P1074	8391	165	2.0%
3A-3	9.0	5.80	5	P1075	8401	1568	18.7%
3A-4	8.6	6.74	5	P1076	8401	789	9.4%
3A-9_B	9.2	8.30	8.29	P1077	6969	657	9.4%
3A-NE_B	9.6	6.30	5.27	P1078	7856	1108	14.1%
3A-NW_Bor 3A-NW_H	10.6	8.48	8.31	P1079	8131	1469	18.1%
3A-S_B	9.13	8.16	7.6	P1080	6871	579	8.4%
3A-SW_B	8.83	7.64	6	P1081	6641	264	4.0%
3B-SE_B	5.8	3.67	3.85	P1084	6029	1001	16.6%
G69_H	6.4	3.973	3.69	05422	4202	641	15.3%

[1] NGVD – National Geodetic Vertical Datum

GROUND SURFACE

For reference, the ground surface elevation at each station is presented in **Figure 21**. The sources for these spot elevations are two distinct data sets, "USGS LIDAR in WCA3A North" (EarthData; approx. 100 m resolution), which covers the portion of WCA-3 north of I-75, and "USGS High-Accuracy Elevation Data Collection" (Desmond; approx. 400 m resolution), which covers the remaining portion of WCA-3. Note that the accuracy of these elevation data are ± 0.5 ft. The source data were interpolated onto a 200 x 200 m grid by the Interpolation Extension of ArcView (ESRI 2000). Values of elevation for each cell of the grid were calculated using an inverse-distance-weighted technique, where the nearest four data points are averaged, weighted by the inverse of the square of the distance from the cell to the points. Note that the elevation source data are more recent than the periods represented by the water surface contours, and that soil subsidence may have altered ground surface in the interim. There is very little information on subsidence in WCA-3, but the approximate magnitude is presented by Sklar et al., (2002). They report a decrease in peat thickness from 0 to 1.4 feet in the vicinity of Tamiami Trail, along the southern boundary of WCA-3B (range 37 to 40). Ground surface elevation is 10 to 11 feet. in the northwest corner of WCA-3, and 5 to 6 feet in the southeast corner.

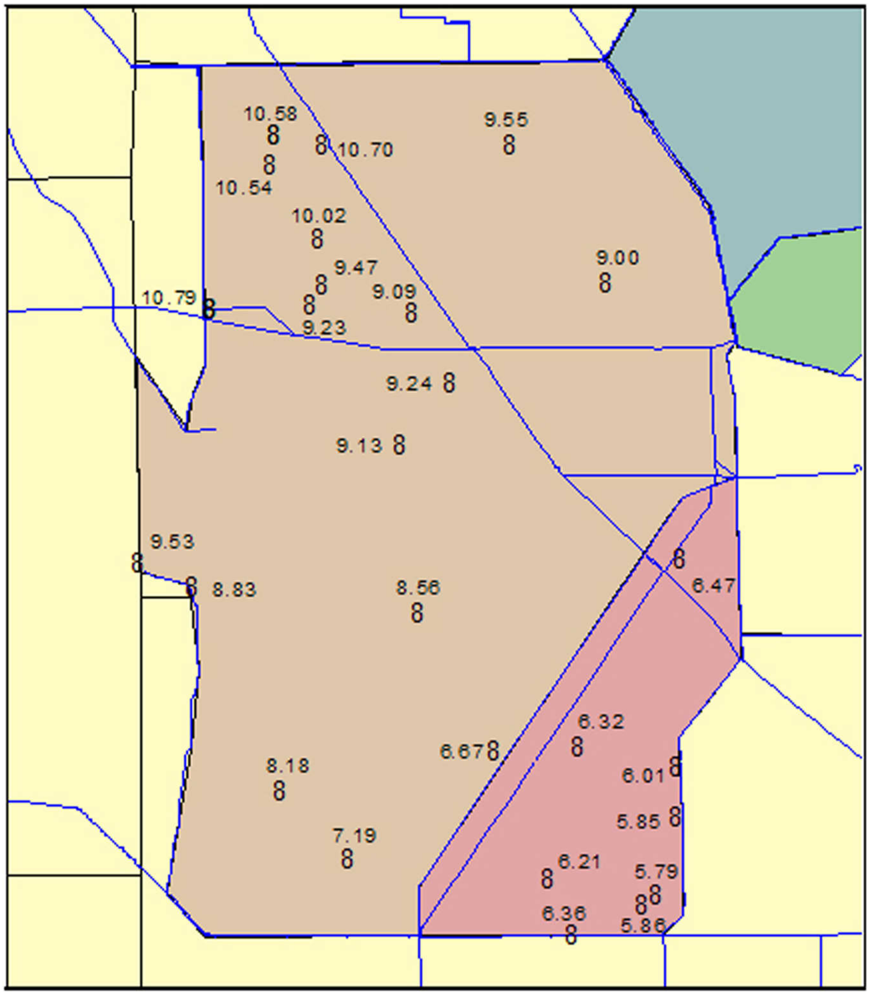


Figure 21. Ground surface elevation (ft. NGVD) at stage stations in WCA-3 (Sources: EarthData, 1999 and Desmond, 1998-2002).

PONDING

Water depth is presented in **Figure 22** through **Figure 25**. It is calculated by subtracting the ground surface elevation from the water surface level. Note that in dry periods (see **Figure 22** and **Figure 24**) WCA-3 dries out in places—particularly in the northwest corner—as water levels drop below ground level. Water depth is typically between one to two and a half feet, with the shallower waters in the northwestern portion of WCA-3, where higher ground elevations exist.

HYDROPERIOD AND HYDROPATTERN

Hydroperiod is the number of days that there is water above the ground surface in wetland areas. Hydropattern refers to the spatial distribution of the hydroperiod. Hydroperiod and hydropattern information presented here was generated using data from the SFWMM for the base year, 2000, and the Natural System Model (NSM). The NSM results represent pre-drainage conditions in the Everglades. Both the SFWMM and the NSM are based on a discretized domain using grid cells that are 2 miles by 2 miles.

A map of hydroperiod is presented for calendar years 1991, a typical "average" year, and 1995, a typical "wet" year, in **Figure 26a** and **Figure 26b**. These figures show that most of the cells in WCA-3 were inundated for 330 days or more in these years (In 1991, the portion of WCA-3B along its eastern boundary tended to have a shorter hydroperiod.). These years were wetter than average with respect to hydroperiod. During years of average hydroperiod from 1965-2000, the northwest corner of WCA-3 and in the central region of WCA-3, south of Alligator Alley and west of the Miami Canal, tended to be drier, being inundated 300 to 330 days per year. Other portions of WCA-3 were inundated for over 330 days per year (CERP).

Figure 27 and **Figure 28** show hydroperiod distributions for WCA-3A and WCA-3B. The figures contrast base year (2000) hydroperiods shown in red with hypdroperiods estimated by the NSM shown in black. These plots demonstrate that for the period 1965-2000, most of WCA-3A is inundated for over 330 days per year, and that over half of WCA-3B (36,000 ac of total area of about 69,120 ac) is also inundated for over 330 days per year. About half of the remaining area is inundated for over 300 days (CERP).

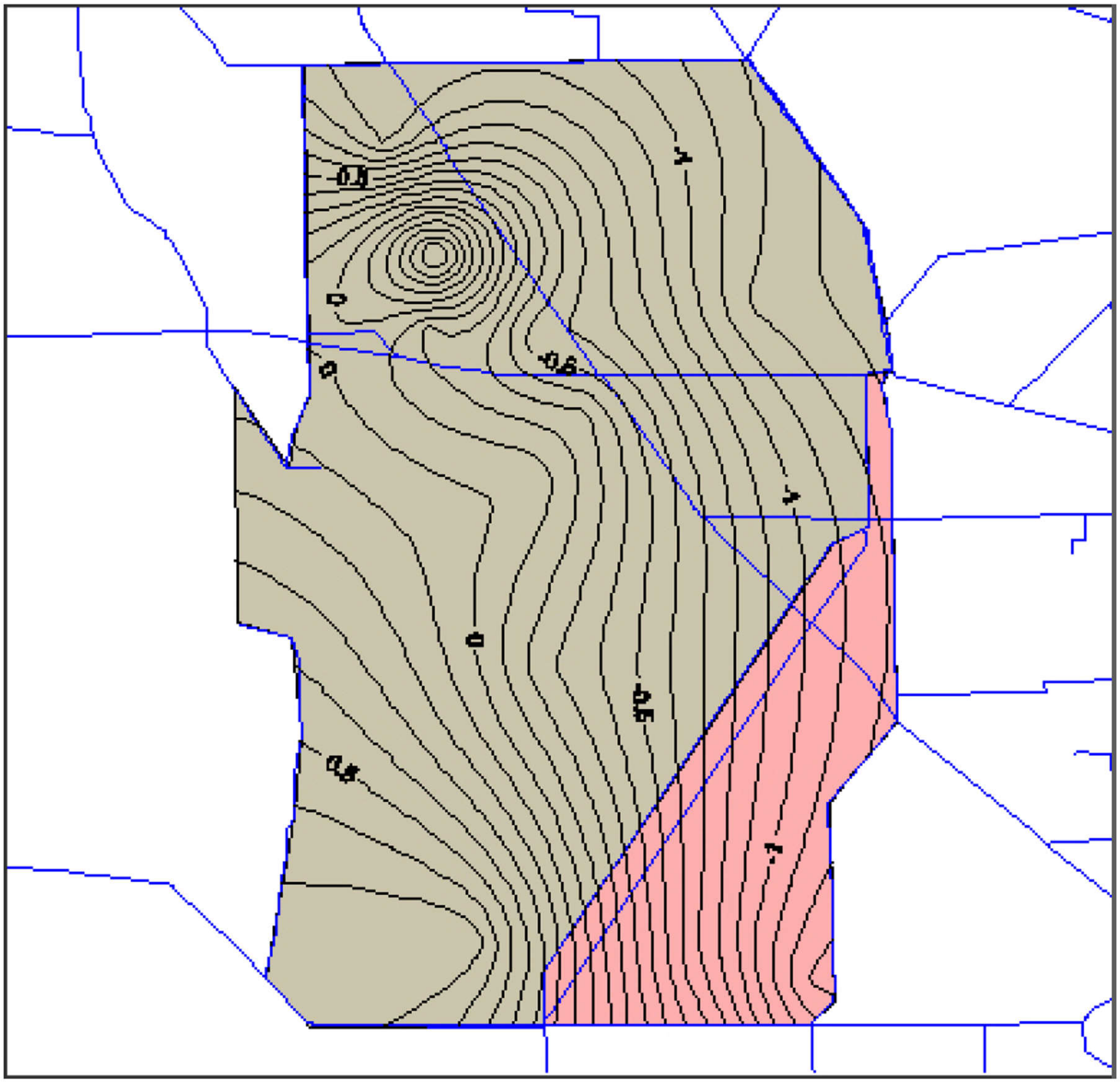


Figure 22. Contours of depth for the driest dry season, November 1, 1989, to May 31, 1990 (contour interval: 0.5 feet).

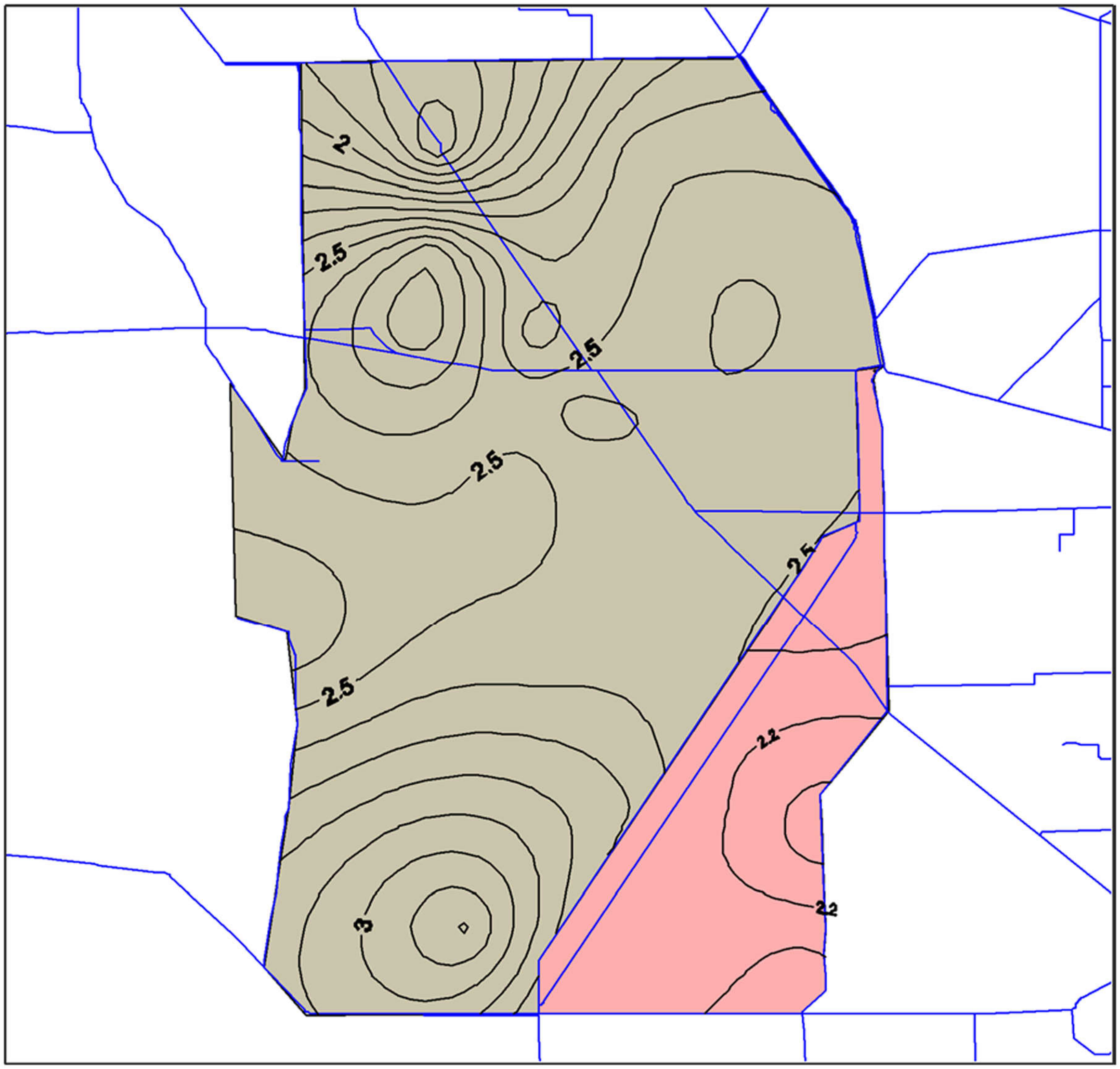


Figure 23. Contours of depth mean water surface (stage) for the wettest wet season, June 1 to October 31, 1995 (contour interval is 0.5 feet).

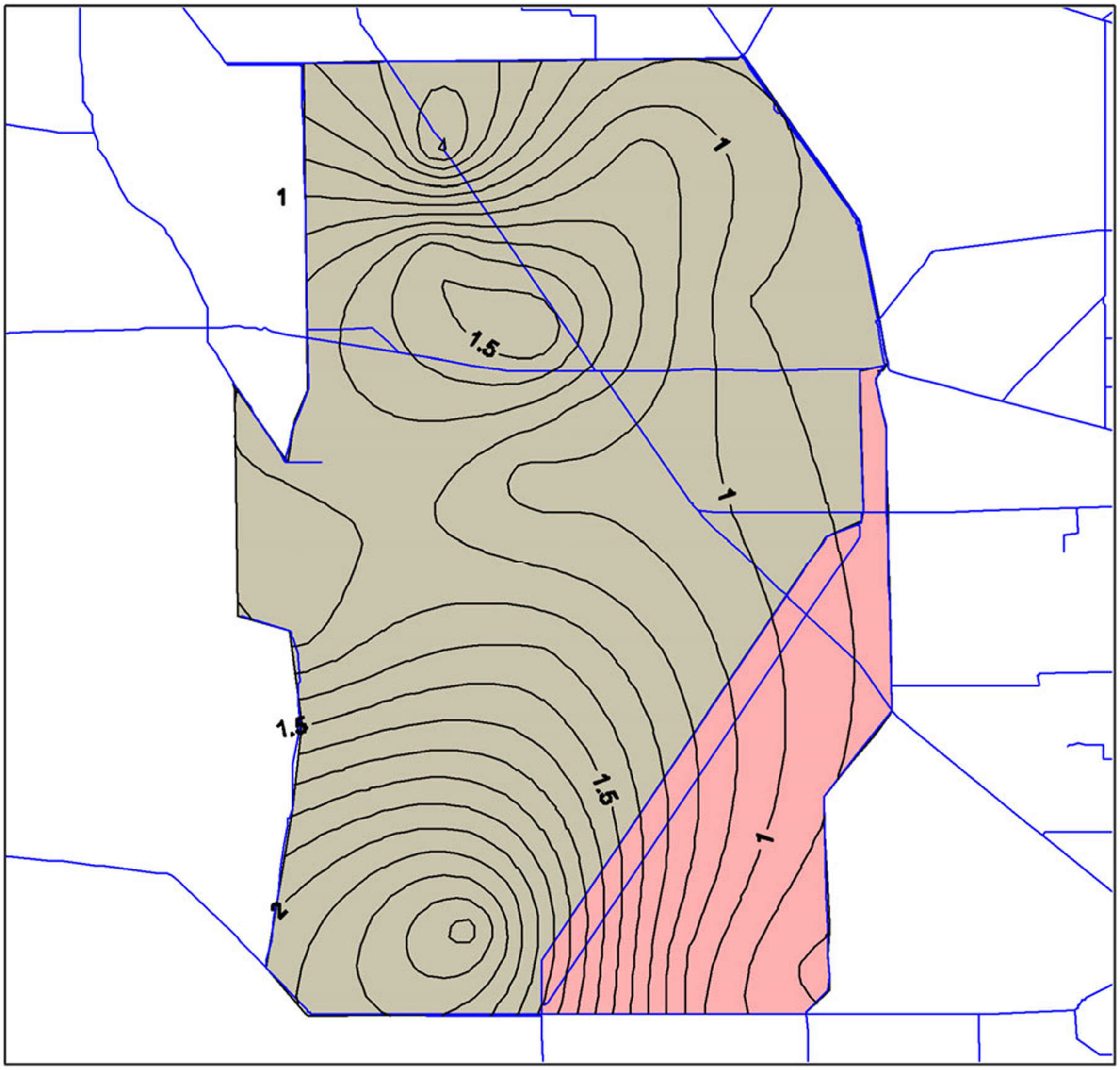


Figure 24. Contours of depth for average dry season, November 1, 1986, to May 31, 1987 (contour interval: 0.5 feet).

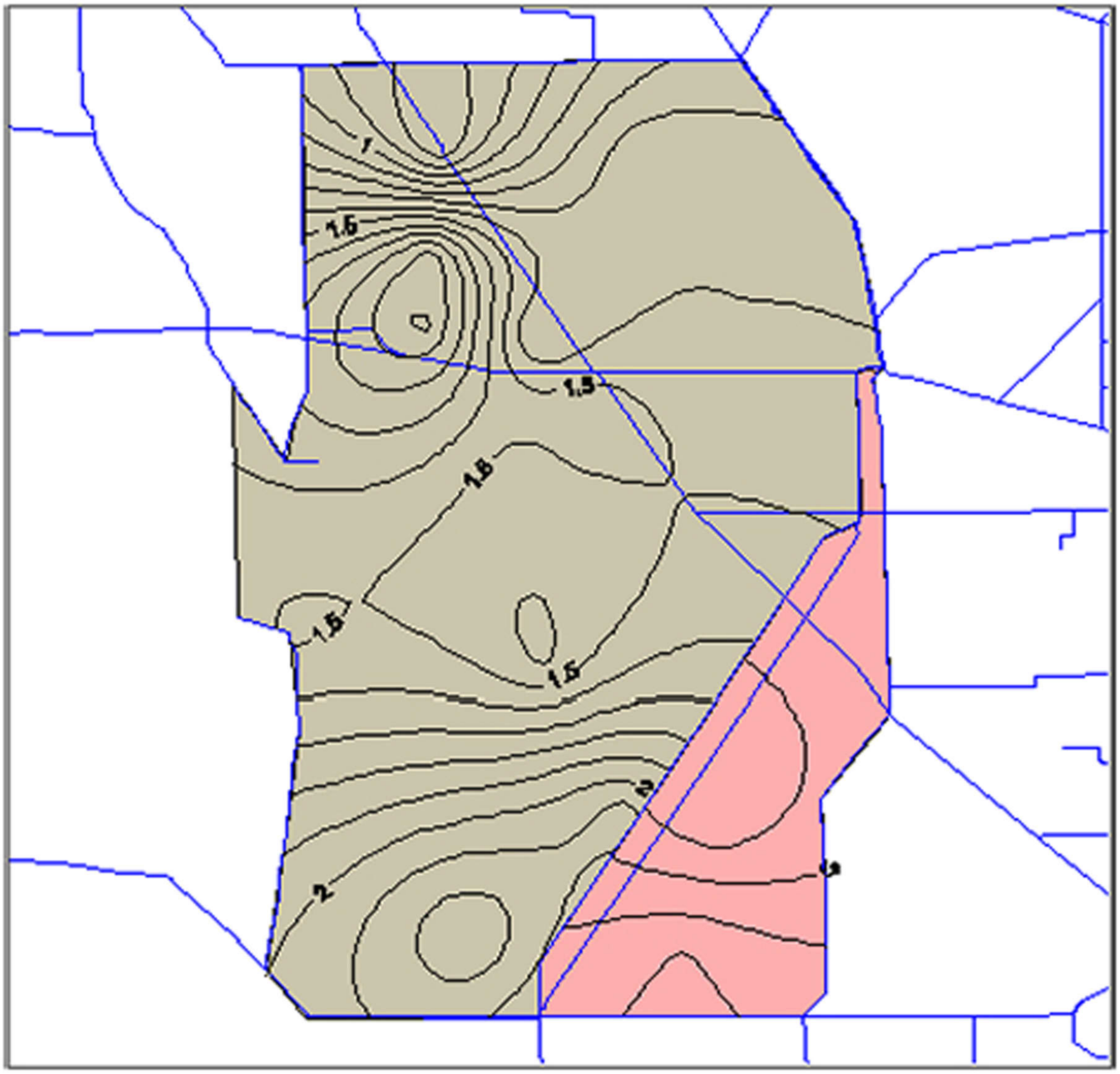
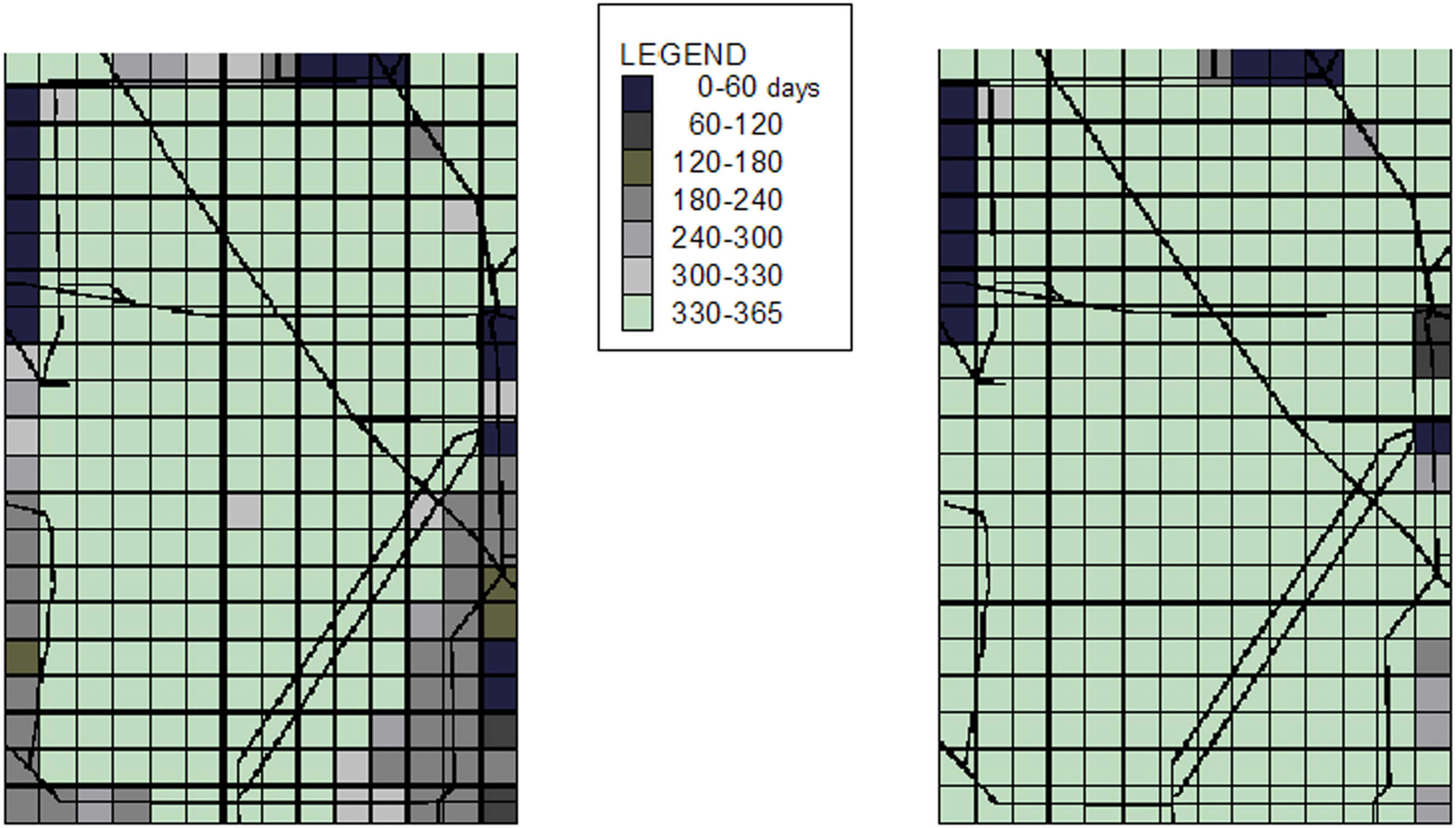


Figure 25. Contours of depth average wet season, June 1 to October 31, 1991 (contour interval is 0.5 feet).



(a)

(b)

Figure 26. (**a**) Hydroperiod distribution—mean number of days of inundation for calendar year 1991, representative of an average year (CERP); (**b**) Hydroperiod distribution—mean number of days of inundation for calendar year 1995, representative of an average wet year (CERP).

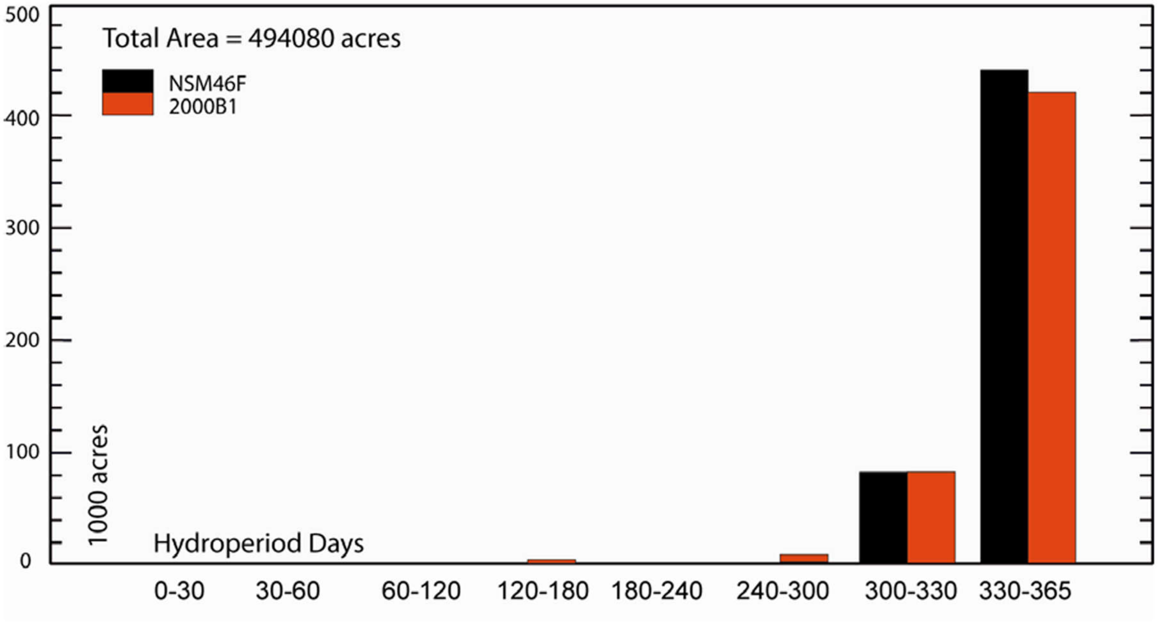


Figure 27. Mean hydroperiod distribution for the 1965-2000 period for WCA-3A (Source: CERP; "For Planning Purposes Only/Run date: 09/16/03 00:03:57/SFWMM v5.0/Filename wca3a_HpDistrib.fig").

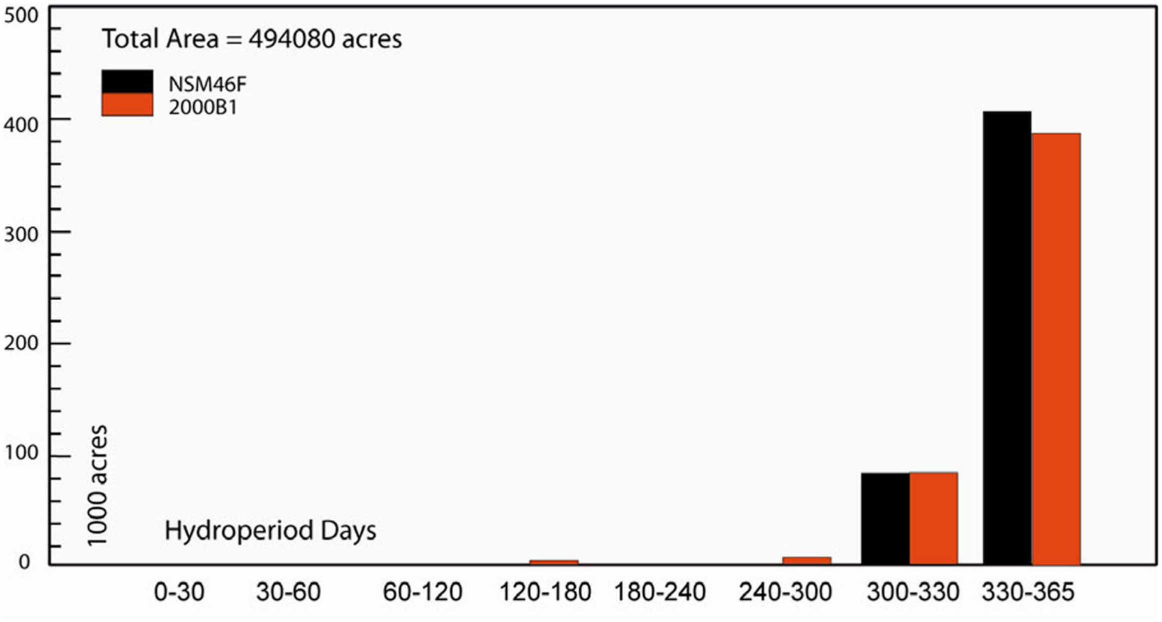


Figure 28. Mean hydroperiod distribution for the 1965-2000 period for WCA-3B (Source: CERP; "For Planning Purposes Only/Run date: 09/16/03 00:04:57/SFWMM v5.0/Filename wca3b_HpDistrib.fig").

SURFACE FLOW

Thirty-one structures control flow into and out of WCA-3; there are also flow structures and canals which control the flow of water within WCA-3. WCA-3 is connected to WCA-2, the EAA, Big Cypress National Preserve (BCNP), ENP and the LEC. The flow structures within or on the boundaries of WCA-3 were determined through a query of the DBHYDRO database, using two bounding boxes which together covered the region. The bounding box {25°45'00" N ≤ lat ≤ 26°22'00" N ∩ 80°52'30" ≤ long ≤ 80°22'30" W} U {26°15'00" N ≤ lat ≤ 26°22'00" N ∩ 81°07'30" W ≤ long ≤ 80°52'30" W} was determined through an examination of maps (Grein, Householder, and Hohner, 2003; SFWMD, 2000, 2003c, d, e). The Structure Books (SFWMD Operations, 2003), Restudy (USACE, 1999), surface water management atlas (Cooper, 1991), other publications (STRIVE, 1999; Microsoft, 2003), and individuals (Smelt, 2003 and Hwa, 2003), were then consulted in order to determine whether the structures located are actually connected directly to WCA-3, and, if so, how they are connected.

Figure 29, **Figure 30** and **Table 4** show a map and a list of the structures. Note that although Structures G64, G70, S355A, and S355B are connected to WCA-3, there are no flow records available for these structures.

Mean daily flow records were analyzed and summarized. The period of record for each structure is presented in **Table 4**. Records for most flow structures begin during or after 1978. A few datasets have missing data within the period of record (i.e. for G69, S344, and S343-Total). Note that for the present analysis, fractions of seasons at either end of a dataset are typically eliminated; the remaining data were used as the period of record.

Flow into and out of WCA-3 is about one million ac-ft. per year, but can vary by hundreds of thousands of ac-ft. from year to year. Flow volumes vary for each station (SFWMD 2003a and b), and may reflect water demand and the natural cycle of rainy and dry years. Flow at specific stations may also be affected by operational policies. For example, flow through the S8 structure, on the northern boundary of WCA-3, has averaged about 173 thousand ac-ft. each wet season, and 110 thousand ac-ft. in the dry season (for the years 1965 to 2000). In some years, these flows are less than 50 thousand or greater than 400 thousand ac-ft. Flow through S12D has ranged from less than 1000 ac-ft. in a single dry season (1983/1984) to over 500 thousand ac-ft. in dry season of 1994/1995 (SFWMD 2003a and b).

Others (e.g. those listed in **Table 5**) have previously reported flow summaries for WCA-3 and for flow entering ENP. **Table 5** shows annual total inflows for WCA-3 and annual total flows to ENP from WCA-3.

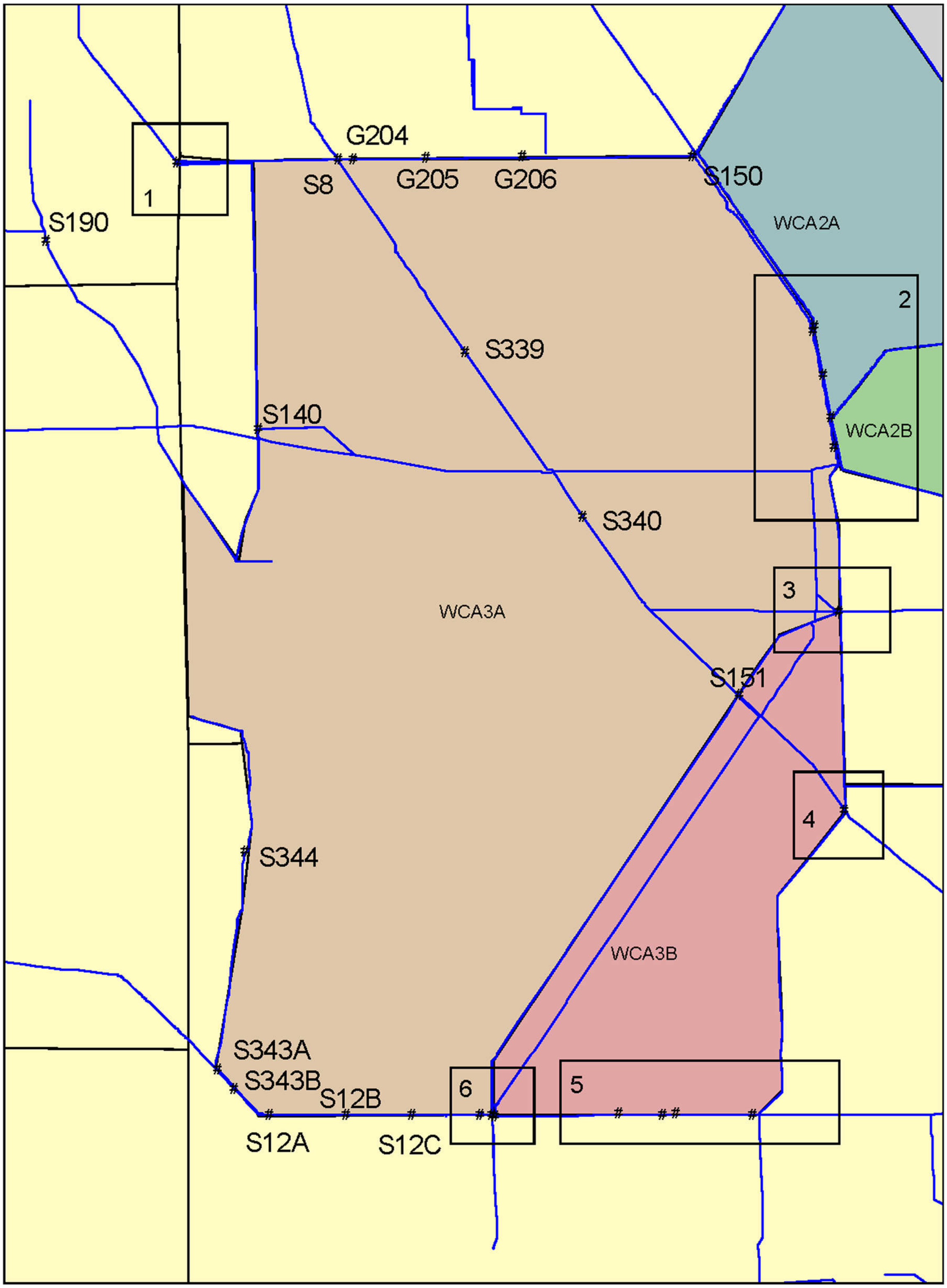


Figure 29. WCA-3 flow structures.

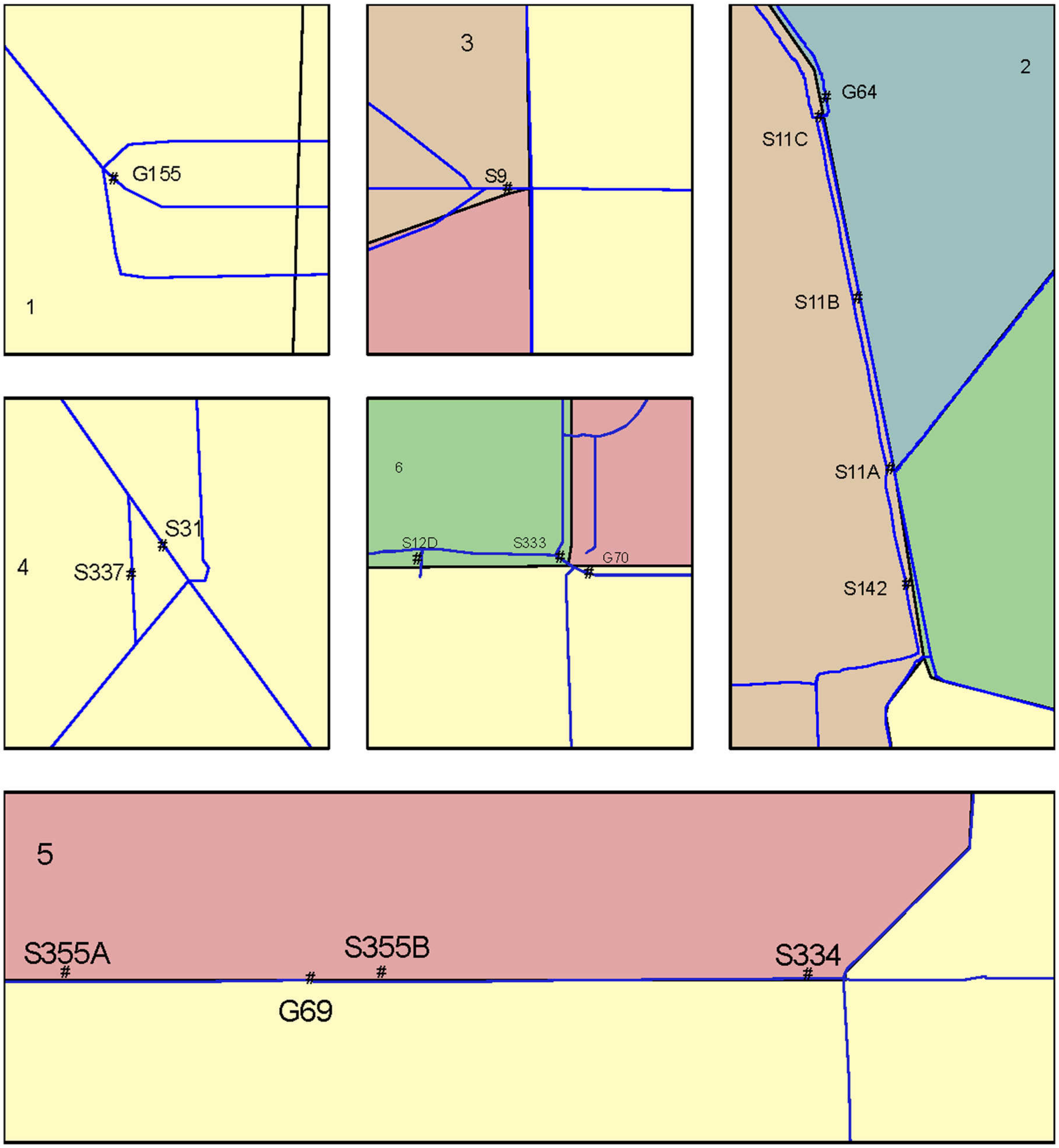


Figure 30. Insets of Figure 32 - WCA-3 flow structures.

Table 4. Period of record for WCA-3 flow structures.

```
   Water Year 1966    1970    1978    1980    1982    1984    1986    1988    1990    1992    1994    1996    1998    2000    2002
                  ....    ....    1979    1981    1983    1985    1987    1989    1991    1993    1995    1997    1999    2001    2003
       Season WWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDDWWDD
Station
S8            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S190                    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
G155                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S140                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S150                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S9                                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S11_T                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S11A                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S11B                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S11C                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S151                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S12A                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S12B                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S12C                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S12D                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S333                                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S31                                       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S337                                      XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S339                                        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S340                                        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S344                                                            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S343_T                                                                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
G204                                                                                        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
G205                                                                                        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
G206                                                                                        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S343A                                                                                                     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
S343B                                                                                                     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Water Year    1966    1970    1978    1980    1982    1984    1986    1988    1990    1992    1994    1996    1998    2000    2002
                  ....    ....    1979    1981    1983    1985    1987    1989    1991    1993    1995    1997    1999    2001    2003
```

D Dry season

W Wet season

Table 5. Total flows from WCA3 into ENP and total flows into ENP (Water Year begins May 1 and ends the following April 30).

Water Year	Flow to ENP from WCA-3 (thousand ac-ft.)	Reference	Stations Included
1990-1999	1077	Bechtel et al., 2000	S12's, S333, S343's
2002	855	Goforth et al., 2003	S12's, S333, S343's
Water Year	**Flow into WCA-3 (thousand ac-ft.)**	**Reference**	**Stations Included**
1970-1998	1109	Sklar et al., 2000	S11A, S11B, S11C, G155, S140, S190, S9, S8, G204, G205, G206, S150
1970-2001	1128	Sklar et al., 2002b	
1998	1345	Sklar et al., 2000	S11A, S11B, S11C, G155, S140, S190, S9, S8, G204, G205, G206, S150
2001	678	Sklar et al., 2002b	
2002	1233	Weaver et al., 2003	
2002	1273	Goforth et al., 2003	S140, S190, G88, G155, S8, S150, G204, G205, G206, G404, S11A, S11B, S11C, G123, S9

Seasonal flows for stations S8 and S12D (on average, the largest inflow is through S8 and the largest outflow is through S12D) are presented in **Figure 31** and **Figure 32**. Note that the scales of both axes vary due to differences in flows and in period of record. The standard deviation of the mean daily flow is given as an indication of the variability of the mean daily flows. This is preferred to the standard deviation of the seasonal flows, since there are values missing in some records. See Appendix C for details on how these figures were produced, and for plots of seasonal flow through other structures.

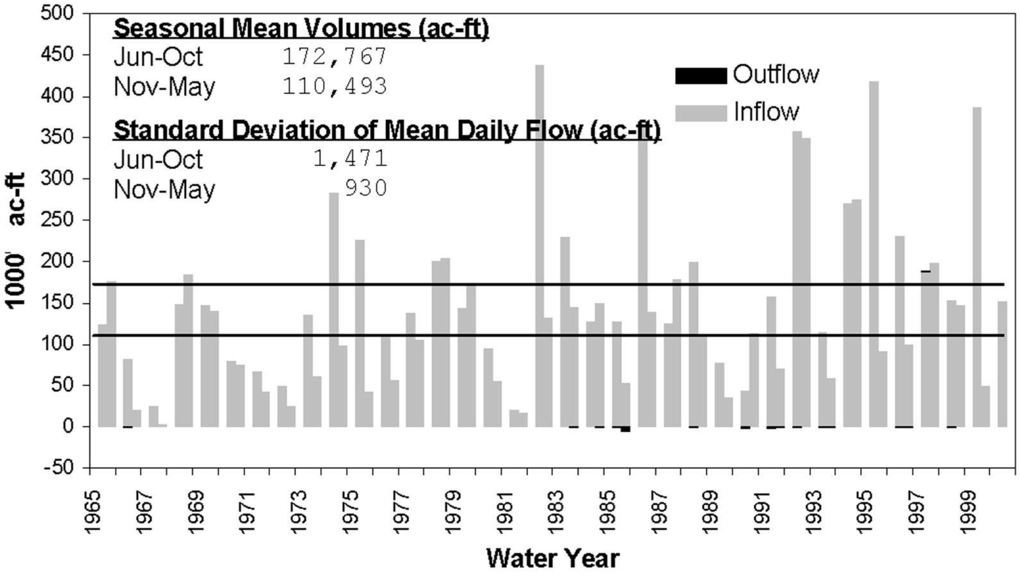


Figure 31. Seasonal flow for S8.

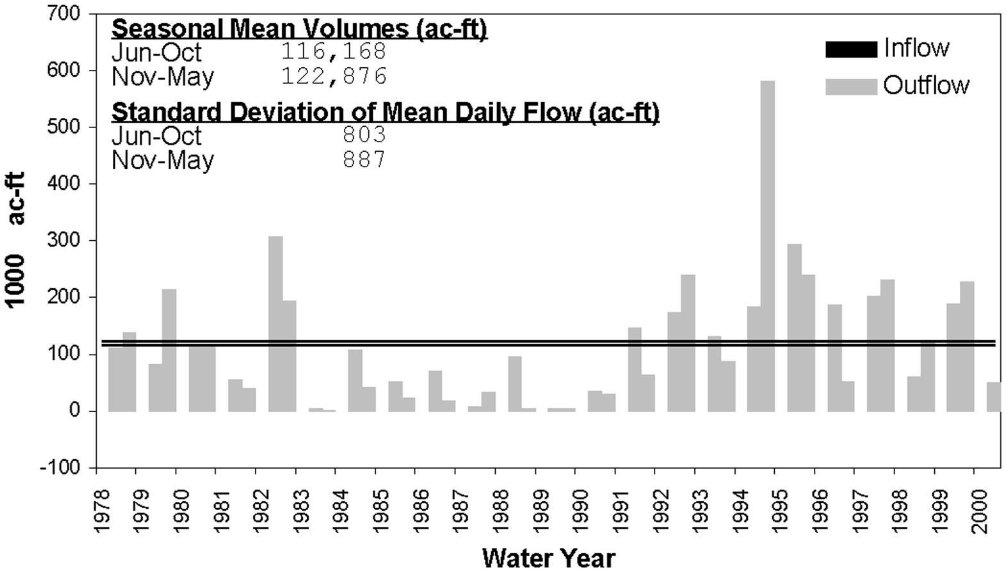


Figure 32. Seasonal flow for S12D.

WATER QUALITY

TOTAL PHOSPHORUS

Locations within WCA-3 and along its boundary at which TP is monitored are presented in **Figure 33** and **Figure 34**. Samples for TP analysis were collected at 128 monitoring stations throughout WCA-3. Most of the stations (about 90 percent) were located in WCA-3A. Only a few of these stations had data extending back to 1978.

The data presented herein cover several distinct time periods (during which it is expected that the range in TP concentrations will differ). These periods are: (1) the Base Period (WY 1980 to WY 1989); (2) the Pre-BMP (Best Management Practices) Period (WY 1980 to WY 1991); and (3) the BMP period (beginning in WY 1992) (Sievers et al, 2003). While the Lake Okeechobee Surface Water Improvement and Management Act BMPs and Everglades Rule BMPs both begin in WY 1992, only a partial implementation of the Everglades Rule BMPs was in effect until WY 1996, when it was fully implemented. Numerous policies in effect during these periods were responsible, to a certain extent, for the variations in TP loads. The types of policies include pumping schedules, tax structure and recycling of runoff from farms.

Concentration

Table 6 summarizes TP concentrations with median, mean (geometric or arithmetic), and maximum values for inflow, outflow, and interior marsh stations, while **Table 7** presents summary statistics for individual stations.[6] Note that the Everglades Forever Act (EFA) specifies that geometric means be used for the TP criterion measurement methodology (Weaver et al, 2003 p. 2A-30). The geometric mean replaced the arithmetic mean used in Everglades Consolidated Reports prior to 2003.

Under current Florida Statutes, the phosphorus concentration criterion in Everglades Protection Area (EPA) will be 10 ppb in the EPA. The statutes recognize “that the Long-Term Plan[7] contains an initial phase and a 10-year second phase” (373.4592.2.d), and prescribes, “The Long-Term Plan shall be implemented for an initial 13-year phase (2003-2016)” (373.4592.2.e; Florida Senate 2003).

---

[6] Note that due to the reclassification of several monitoring sites, the addition of new monitoring sites, and a change in the method used to deal with values reported as less than the MDL (i.e., half the MDL replacement), summary statistics for TP presented in Table 1 are given in duplicate for 2001. For example, the 2002 ECR reported a median concentration of 26 µg/L for WCA-3 inflows during WY01, whereas the 2003 ECR reports a median concentration of 28 µg/L (adapted from Weaver et al 2003 p. 30 P 1; re Table 2A-5).

[7] The Long Term Plan includes the achievement of the geometric mean 10 ppb criterion.

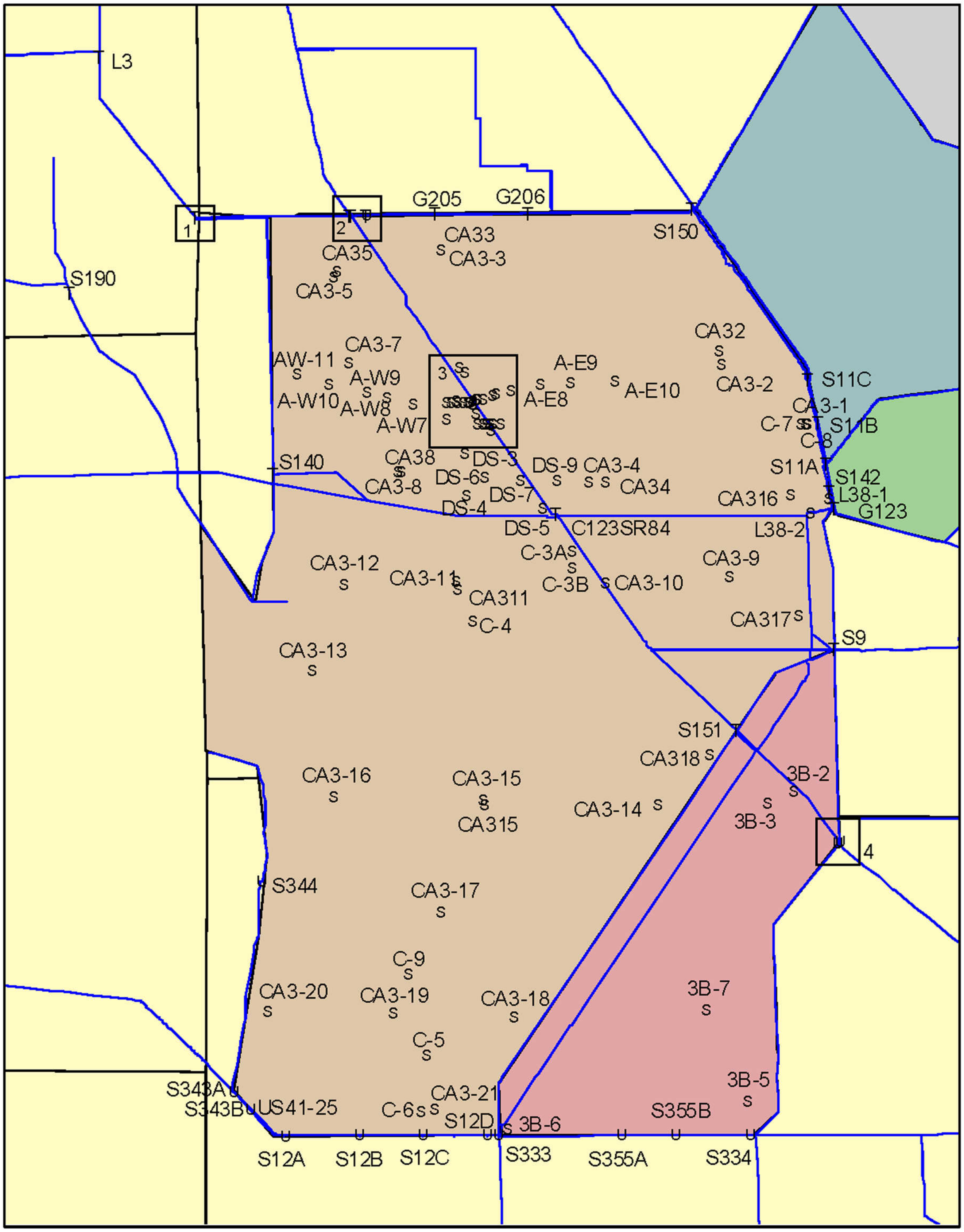


Figure 33. Monitoring stations for total phosphorus. Triangles (inflow), squares (outflow) and circles represent inflow, outflow (interior stations), and interior stations, respectively.

Note: FDEP (2003) Table 3 classifies C123SR84 and S151 as inflow stations.

Not Pictured: 3AE0, 3AW0, 3AE05, 3AE10, 3AE15, 3AE20, 3AE40, 3ANMESO, 3ASMESO, 3AW05, 3AW10, 3AW15, 3AW20, 3AW30, 3AW40).

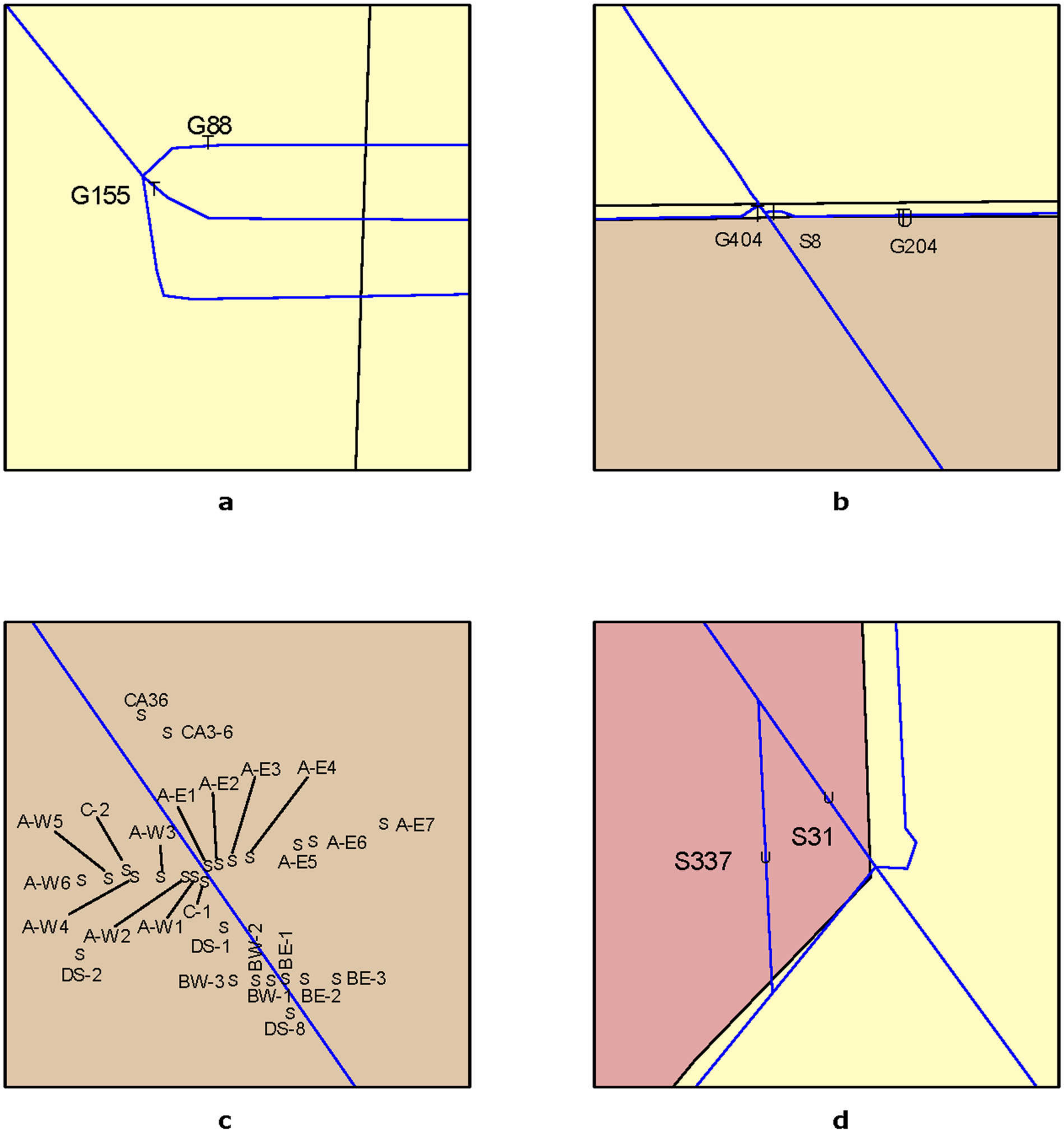


Figure 34. Insets of Figure 36: **a**: Inset 1; **b**: Inset 2, **c**: Inset 3, **d**: Inset 4. Stations for monitoring total phosphorus. Triangles, squares and circles represent inflow, outflow, and interior stations respectively.

Table 6. Annual summary statistics by class: Geometric and flow-weighted mean TP concentration of the interior marsh.

Water Year	Marsh Concentration		Median Concentration			Maximum Inflow Concentration	Maximum Outflow Concentration	Maximum Marsh Concentration
	Arithmetic Mean	Geometric Mean	Marsh	Inflow	Outflow			
1978-1998[1]	20		10	41	10	933	593	38
1999[1]	19		8	39	11	263	217	92
2000[2]	16.9		11	47.5	12	347	171	103
2001[2]	20.1		11	26	18	289	90	136
2001[3]		8.6	8	28	18	1286	145	150
2002[4]		8.8	8	26	12	408	132	310
2003[4]		8.0	7	29	11	213	53	120

[1] Weaver et al., 2001

[2] Weaver et al., 2002

[3] Weaver et al., 2003

[4] Payne and Weaver, 2004

Table 7. Annual summary TP statistics for individual inflow stations.

Station	Water Year	Flow-Weighted Mean Concentration (ppb)	25th Percentile (mg/L)	Median (mg/L)	75th Percentile (mg/L)
G123	2000	17[1]	0.013[2]	0.017[2]	0.022[2]
	2001	13[1, 2]			
	2002	16[1, 2]			
G204	2002	18[1]			
G404	2002	44[1]			
S8	2002	60[11]			
S9	1999	19			
	2000	25[1], 26[2]	0.012[2]	0.014[2]	00.017[2]
	2001	23[1, 2]			
S9	2002	20[1], 19[2]			
S11A	2000	84[1]	0.009[2]	0.012[2]	0.164[2]
	2001	25[1]			
	2002	10[1]			
S11B	2002	10[1]			
S11C	2002	29[1]			
S140	1999	52			
	2000	67[1, 3]			
	2001	144[1], 113[2]			
	2002	48[1], 47[2]			
S142	2000	19[1]	0.011[2]	0.0195[2]	0.032[2]
	2001	22[1]			
S150	2002	37[1]			
S151	2000	25[1]			
	2001	35[1]			
S190	1999	73			
	2000	111[1, 2]			
	2001	177[1], 156[2]			
	2002	88[1], 90[2]			
S339_S/C123 SR84	2000	45[1]	0.017[2]	0.037[2]	0.064[2]
	2001	100[1]			
S340_S/C123 SR84	2000	42[1]	0.017[2]	0.037[2]	0.064[2]
	2001	91[1]			
L3 (G88+G155) (from C139)	2002	123[1]			
G204+G10	2002	72[1]			

Station	Water Year	Flow-Weighted Mean Concentration (ppb)	25th Percentile (mg/L)	Median (mg/L)	75th Percentile (mg/L)
S8	2002	112[1]			
S12A	2002	10[1]			
S12B	2002	7[1]			
S12C	2002	7[1]			
S12D	2000	10[2]	0.008[2]	0.012[2]	0.014[2]
	2001	14[1]			
	2002	10[1]			
S31	2000	12.7[1]	0.009[2]	0.012[2]	0.016[2]
	2001	38[1]			
	2002	14[1]			
S150	2002	21[1]			
S197	2000	9.7[1]	0.006[2]	0.0075[2]	0.01[2]
	2001	12[1]			
S333	2000	10[1]	0.008[2]	0.011[2]	0.016[2]
	2001	21[1]			
	2002	15[1]			
S334	2000	9.4[1]			
	2001	18[1]			
S337	2002	24[1]			
S343A	2002	11[1]			
S343B	2002	11[1]			
S344	2000	15.6[1]			
	2001	(No positive flow)[1]			
	2002	12[1]			

1999 Data: Bearzotti et al, Table 11-3

2000 Data: [1] Trost et al, Appendix 11-1a, Table A11-1a.2

[2] Trost et al, Table A11-1b.3

[3] Trost et al, Table 11-1

2001 Data: [1] Meiers et al, Appendix 8B-1a, Table 2

[2] Meiers et al, Appendix 8B-1, Table 4 (May 1, 2000 – April 30, 2001) & Meiers et al, Table 8B-1

2002 Data: [1] Goforth, Piccone, et al, Table 8A-7

[2] McGinnes et al, Table 8B-1

Interior Marsh Concentration

Using values from Weaver, et. al (2003, Appendix 2A, Table 3), WY 2000 exhibited the highest average geometric mean TP concentration (24.3 ppb) for the marsh sites in WCA-3 since full BMP implementation. During WY 2000, geometric mean TP concentrations at individual marsh monitoring stations ranged from 4.1 at station 3ASMESO to 130 ppb at station 3AE05. In contrast, geometric mean TP concentrations ranged from <4 to 21.1 ppb for WY 1999 with an overall average of 7.6 ppb. Prior to WY2000, less than 10 sites were monitored annually for TP compared to 20 or more stations that were monitored since then (FDEP 2003).

Interior marsh geometric mean TP concentrations ranged from <4 ppb to 61 ppb in WY 2002 (FDEP 2003).

Interior marsh geometric mean concentrations of TP at all 8 continuously monitored stations showed increases in WY 2000 and WY 2001, and declines again in WY 2002. For example at station CA35, the geometric mean concentration in WY 1999 was 6.8 ppb, while in WY 2000 and WY 2001 the geometric means were 16.9 and 15.6 ppb, respectively. By WY 2002, the marsh geometric mean concentration had declined to 9.4 ppb (FDEP 2003). For a listing of annual summary statistics (geometric mean concentration, 25th percentile, median, and 75th percentile) for individual interior marsh stations, see Appendix D (which is a copy of Table 3 in FDEP 2003).

The spatial distribution of TP concentrations in WCA-3 for WY97 (the year in which the mean annual concentration is the median of 7 mean annual concentrations calculated for WY 1996 to WY 2002) is presented in **Figure 35**. "A decreasing north-to-south gradient [is generally apparent for WCA-3. This gradient is] indicative of settling, adsorptive (both adsorptive and absorptive), assimilative (biological), and other biogeochemical processes [that occur] in the marsh" (Weaver et al, 2003 2A-30 P 2). This north-to-south gradient has been observed during previous reporting periods (through WY 2002). Higher concentrations in the north are related to canal discharges composed primarily of agricultural runoff originating in the EAA. (Weaver et al, 2003, p. 2A-30 P 2, which references Bechtel et al, 1999 and 2000; Weaver et al, 2001a and b).

Inflow and Outflow Concentration

WCA-3 experienced elevated median inflow concentrations of TP in WY 2000 (47.5 ppb), due in part to drought conditions. During WY 2001, WCA-3 inflow TP concentrations returned to pre-drought conditions, with a median concentration of 28 ppb (**Table** 7).

The median outflow TP concentration was at its highest in WY 2001 (18 ppb). However, in WY 2002, the median outflow concentration dropped to 12 ppb. For each year from WY 1996 to WY 2002, median outflow TP concentrations were lower than median inflow concentration.

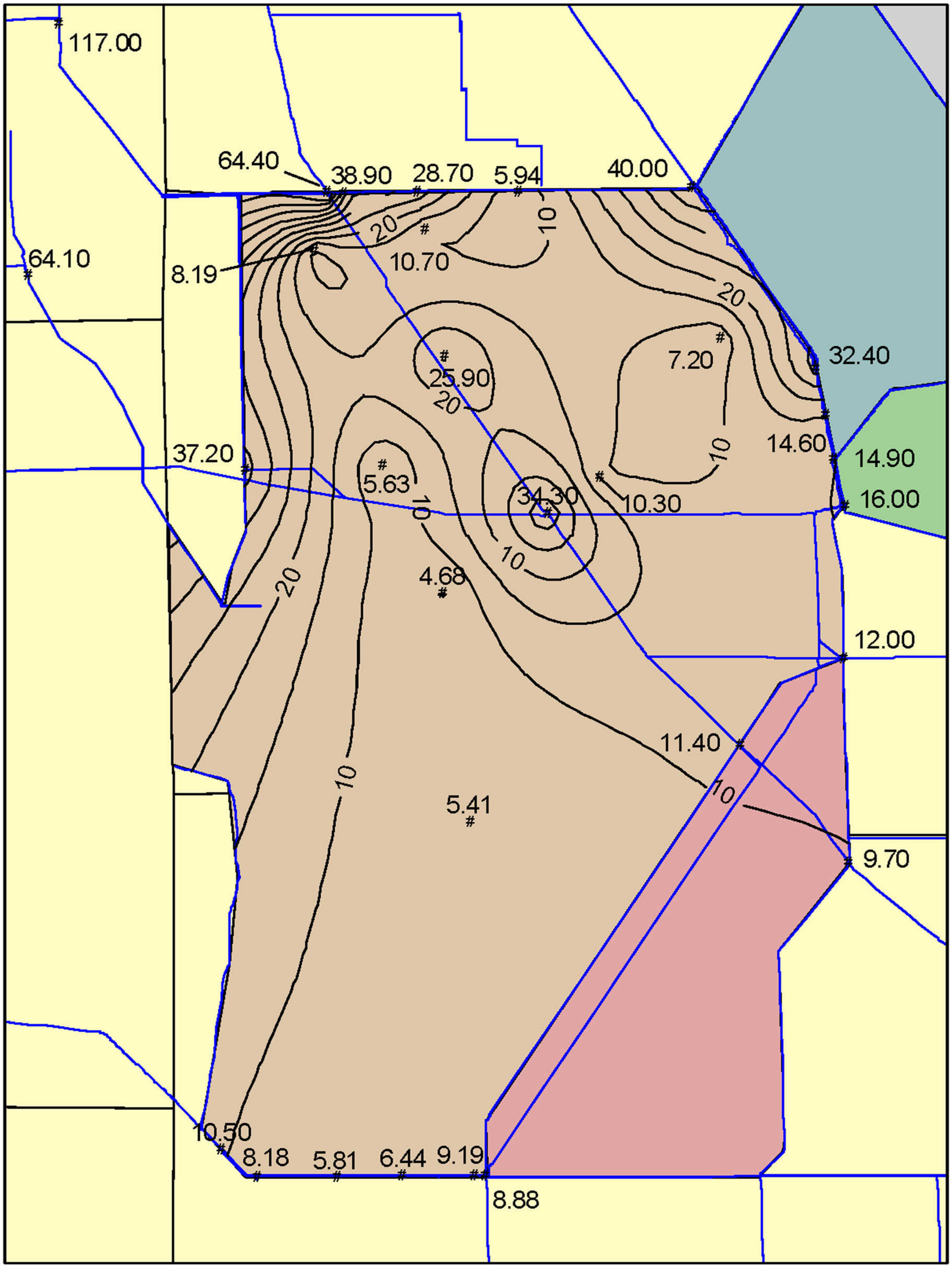


Figure 35. Contours of WY 1997 TP geometric mean concentrations. Contour interval: 5 ppb. Point values are indicated by decimal numbers.

Loading

Approximately 62 metric tons of TP and 1273 thousand ac-ft. of water entered WCA-3 in WY2002 (Goforth et al, 2003b). In the same water year, 12.5 metric tons of TP and 907 thousand ac-ft. of water were exported from WCA-3. Flows into WCA-3 increased considerably from 2001 to 2002 (from 678 to 1273 thousand ac-ft.; Sklar et al, 2002 and Goforth et al, 2003b) while median TP concentration remained about the same. The increase in flow to WCA-3 resulted in increased TP loading to the area.

Flows into WCA-3 increased considerably from 2001 to 2002 (**Table 5** in the flow section) and, with median P concentration remaining about the same (**Table 6**), P inflow loads to WCA-3 appear to have increased as well. **Table 8** and **Table 9** show loads for individual stations.

Table 8. Annual TP loadings for inflow stations.

Station	Water Year	Loading (metric tons)
G123	2002	1.057
G155	1990-1999	27.9
G204	2002	0.001
G205	2002	0
G206	2002	0
G404	2002	6.146
L3 (G88+G155)	2002	12.020
S8	1990-1999	46.3
	1990	23.8
	1991	27.7
	1992	33.4
	1993	101.4
	1994	24.3
	1995	79.4
	1996	69.2
	1997	39.1
	1998	25
	1999	39.6
	2002	10.015

Station	Water Year	Loading (metric tons)
S9	1990-1999	4.1
	2002	6.918 (6.716)
S11A	1990-1999	3.7
	2002	1.171
S11B	1990-1999	5
	2002	1.434
S11C	1990-1999	8.8
S140	1990-1999	5.6
	2002	6.460
S142	1990-1999	1.2
S150	1990-1999	8.4
	1990	36.2
	1991	12.3
	1992	11.3
	1993	5
	1994	1.7
	1995	1.9
	1996	4.5
	1997	4.5
	1998	1.8
	1999	4.9
	2002	0.977
S190	1990-1999	11.5
	2002	9.270 (9.314)

1990-1999 Data:	Bechtel et al., 2000, Table 4-1 (lumped)
1990-1999 Data:	Bechtel et al., 2000, Table 4-16 (individual years)
2002 Data:	Goforth, Piccone, et al., Table 8A-7, (McGinnes et al., Table 8B-1)

Table 9. Annual TP loadings for outflow stations.

Station (Stations flowing to ENP are underlined)	Water Year	Loading (metric tons)
G204+G10	2002	0
S8	2002	0.579
S12A	1990-1999	1.2
	2002	0.698
S12B	1990-1999	1
	2002	0.969
S12C	1990-1999	2.3
	2002	1.656
S12D	1990-1999	3.5
	2002	2.660
S14	2002	0
S31	2002	0.449
S150	2002	0.001
S333	1990-1999	2.6
	2002	4.685
S337	2002	0.364
S343A+B	1990-1999	1.3
S343A	2002	0.159
S343B	2002	0.182
S344	2002	0.141

1990-1999 Data: Bechtel et al., 2000, Table 4-1 (lumped)

1990-1999 Data: Bechtel et al., 2000, Table 4-16 (individual years)

2002 Data: Goforth, Piccone, et al., Table 8A-7, (McGinnes et al., Table 8B-1)

Groundwater Loads and Dry Deposition

Other sources of TP to WCA-3 include dry deposition and groundwater flow (which could also provide a mechanism for TP to be imported to and exported from WCA-3). Neither of these quantities has been estimated for WCA-3. However, it is estimated that for STA-1W, Cell 2, groundwater outflow of TP averaged[8] 1590 kg/yr or 0.374 g/m^2-yr, and dry deposition is approximately 155 kg/yr or 0.0364 g/m^2-yr (Goforth, 2003a and Bennett, 2003[9]).

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[8] Note that the other cells' groundwater TP outflow was much less than 1590 kg/yr.

[9] Bennett, 2003 reports the area of STA1W Cell 2 to be 45,799,020 ft2, or about 4,254,000 m2.

MERCURY

Introduction

Mercury[10] is a contaminant of concern in Florida as well as in most states of the United States and in other parts of the world. Mercury is a persistent, bioaccumulative toxicant and, as such, can build up in the food web to levels that are harmful to human and ecosystem health. WCA-3B, WCA-3A center section, and the Tamiami Canal are currently identified on Florida's 303(d) list as water body segments impaired due to mercury (based on Fish Consumption Advisory; USEPA June 11, 2003); the list also includes C-111, Snake Creek Canal West, L-28 interceptor, WCA-2A east sector, S7, S8, WCA-1 center sector, Hillsboro Canal, North New River Canal, S3, Everglades National Park, and the Shark Slough).

Human health concerns have been addressed through consumption advisories on fish and a ban on the sale of alligator meat, however, ecological concerns remain. Elevated concentrations of mercury have been found in fish and wildlife inhabiting WCA-3A (Sundlof et al, 1994 and Beyer et al, 1997). Moreover, wading birds feeding in WCA-3A were found to be at risk of chronic toxic effects in a probabilistic ecological risk assessment (Rumbold, 2000). Although population-level effects have not been demonstrated in any Everglades populations studied over the last decade, there is sufficient inferential evidence of negative effects to the individual to warrant concern, at least at the level of reasonable maximum exposure (Spalding et al, 1994; Sundlof et al, 1994; Beyer et al, 1997; Frederick et al, 1997; Bouton et al, 1999; Heinz, in prep). Further, the lack of unambiguous epidemiological evidence of population-level effects may reflect the inability of the study methods used to date to detect more subtle effects in the field (i.e., behavioral teratology; Nocera & Taylor, 1998).

The District tracks two mercury parameters: total mercury (THg) and methylmercury (MeHg). The Class III Water Quality Standard for mercury is based on THg. The dominant proximate source of inorganic mercury to the Everglades is atmospheric deposition. However, the complication lies in the relationship between influx of inorganic mercury and the amount that is methylated post deposition by sulfate-reducing bacteria. MeHg is a highly toxic form of mercury (more so than inorganic Hg), is soluble in water, and is easily absorbed into animal tissue, after ingestion of food containing the substance. The major sources of inorganic mercury are certain commercial and industrial practices and processes, where mercury is released into the atmosphere. MeHg is formed from inorganic mercury by certain bacteria in the absence of oxygen and in the presence of sulfide ion. Methylation is of fundamental concern because MeHg is the more toxic and bioaccumulative form that can build up in the food chain to levels harmful to humans and other fish-eating animals.

The District has 21 routine mercury monitoring sites for WCA-3. Samples are taken from surface water (at L28, L28A, S12D, S140, S141, S151, S32, S334, and S9), rainfall (at Andytown), bird eggs and feathers (at L67, JW1, and Cypress City), and fish (at CA315, CA33, CA35, CA3F1, CA3F2, L38F1, and L5F1). In addition, other State and Federal agencies (e.g., Florida Fish Wildlife Conservation Commission, USGS, and EPA) have mercury monitoring or research sites in the WCA. Water quality monitoring stations for mercury, in WCA-3, are presented in **Figure 36.**

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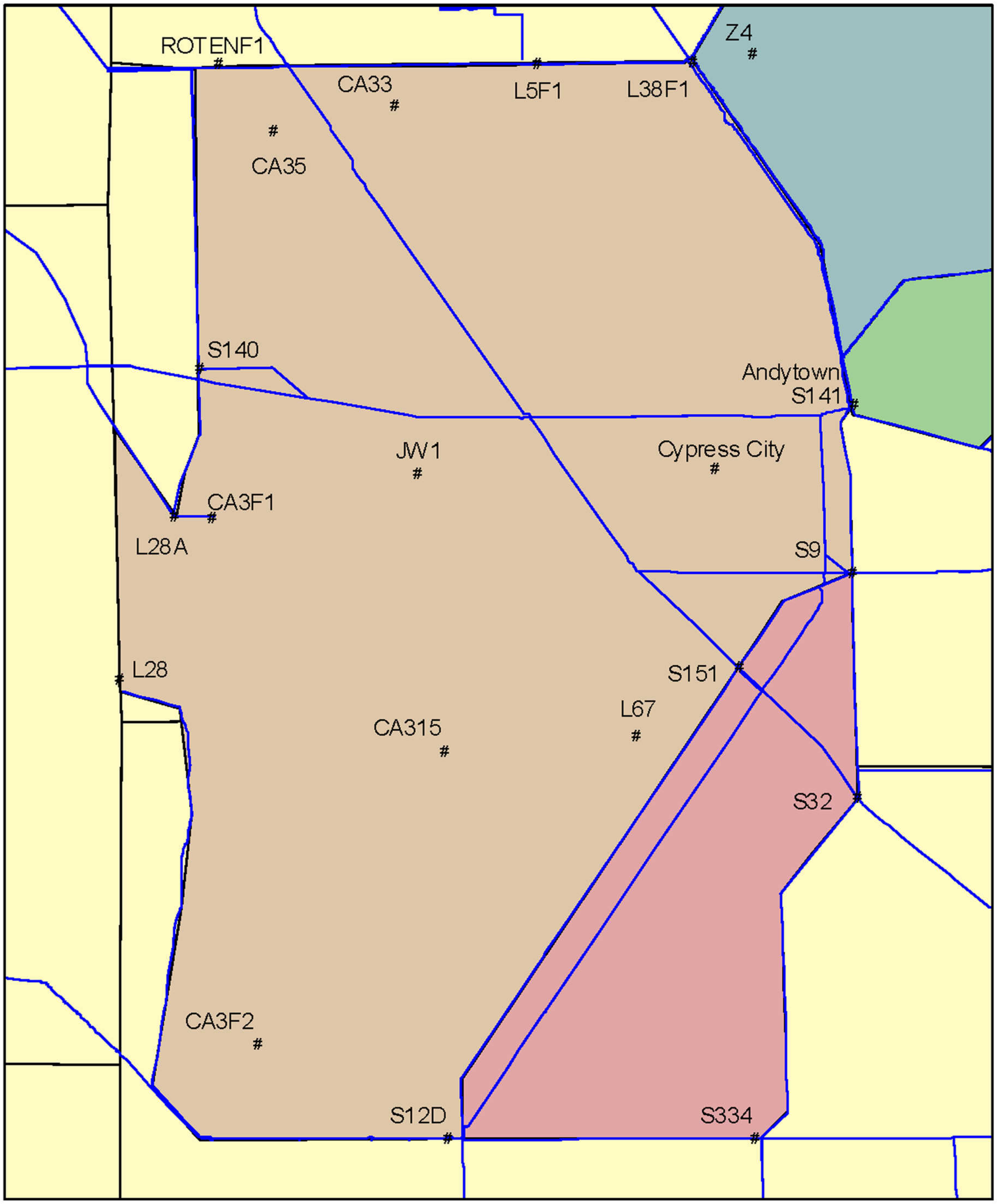
[10] Bennett, 2003 reports the area of STA1W Cell 2 to be 45,799,020 ft2, or about 4,254,000 m2.


ROTENF1
Z4
CA33
L5F1
L38F1
CA35
S140
Andytown
S141
JW1
Cypress City
CA3F1
L28A
S9
L28
S151
L67
CA315
S32
CA3F2
S12D
S334

Mercury and Sulfur

One of the most complex determining factors in the microbial methylation process is the relationship between the sulfur and mercury cycles. Sulfate-reducing bacteria (SRB), which methylate Hg to the more bioaccumulative MeHg, are stimulated by sulfate up to a point. However, the reduced form of sulfur, sulfide, has long been known to also inhibit Hg methylation above a certain threshold concentration (Compeau & Bartha, 1984). "Too little sulfate and the sulfate bacteria do not go into action; too much sulfate, and the bacteria produce excess sulfide, which inhibits Hg methylation" (C. Gilmour, Academy of Natural Sciences Estuarine Research Center, as cited in Renner, 2001). Bates et al (2002) hypothesize that it is in the center of WCA-3A, at the downgrade edge of the sulfate plume, where the stimulating effects of sulfate and the inhibitory effects of sulfide achieve the optimal balance for MeHg production. Areas of the northern Everglades having high sulfate concentrations in the surface water (WCA-2A) have lower overall MeHg concentrations compared with the optimal area in the center of WCA-3A (Gilmour et al, 1998), probably due to the inhibitory effects of porewater sulfide levels up to 0.38 millimoles per liter (mmol/L, Orem et al, 1997). Pristine sites with sulfate concentrations at background levels in surface water (0.005 mmol/L or less) tend to exhibit relatively low MeHg concentrations (Stober et al, 1998; Gilmour et al, 1998), probably due to limitation of sulfate reduction (and MeHg production) by sulfate availability.

An area or region where the microbially mediated speciation of sulfur produces a sulfide-to-sulfate ratio that is just right for maximum Hg methylation has been termed a "Goldilocks" region (W.H. Orem; USGS, as cited in Renner, 2001). Concerns have been raised that CERP-related changes in flows, including the simple act of backfilling of a canal to increase sheetflow, has the potential to shift sulfate loading to certain areas and, thereby, shift and possibly increase the areal extent of "Goldilocks" regions. Hydroperiod can add to this complexity by influencing the sulfur cycle and, at least temporarily, create "Goldilocks" regions even in areas typically under the inhibitory effects of porewater sulfide.

Krabbenhoft and Fink (2001) report increased concentrations of MeHg in Everglades' interior marshes following drydown and reflooding. Because inorganic mercury concentrations in pore water and the overlying water column did not increase substantially over average levels, but sulfate increased more than 10-fold in locations of highest MeHg increase, the authors concluded that sulfate release (as a result of sediment oxidation) and SRB stimulation was the most likely explanation for the observed pulse of excess MeHg production.

Atmospheric Mercury

"Collectively, the results reported [by Rumbold, 2004] for wet deposition of THg in comparison with monitoring of surface water at non-ECP structures… show that the major source of mercury to the Everglades is from the air. This is consistent with previous assessments by both the FDEP [Atkeson, 2002] and the USEPA [1998]. Dry deposition, which may exceed wet deposition by a factor of 2 (Keeler and Lindberg, 2001), likely adds significantly to the overall atmospheric input" (Rumbold, 2004, p. 10).

Aqueous Mercury

RAINFALL

"Samples of bulk rainfall were collected weekly under the protocols of the National Atmospheric Deposition Program's Mercury Deposition Network (MDN) at the… Andytown substation (**Figure 37**). For more information on MDN and to retrieve raw data, see [the MDN internet site at] http://nadp.sws.uiuc.edu/mdn" (Rumbold, 2004, p. 9).

"Atmospheric deposition of THg to South Florida was highly variable both temporally and spatially [**Figure 38** and **Table 9Error! Reference source not found.**]. As shown in [Figure 38], THg concentrations in precipitation were substantially higher during the summer months [of water year 2002/2003—May 2002 to April 2003—up to about 30 ng/L, where the volume-weighted annual concentration is about 14.0 ng/L, based on preliminary data],… possibly due to seasonal, tall, convective thunderstorms that can scavenge particulate Hg and water soluble reactive gaseous Hg (RGM) from the middle and upper troposphere. This is consistent with observations of Guentzel (1997) during the Florida Atmospheric Mercury Study. Because both THg concentration and rainfall volumes increase during the summer, the latter by a factor of 2 to 3, THg wet deposition increases five-to-eight fold during the wet season [**Figure 38**].… Concentrations… increased in 2002," compared to the previous year (Rumbold, 2004, p. 9-10).

"Concentrations of THg in rainfall collected during the reporting year were similar to levels reported for the period-of-record [that extends back to 1998]. As observed previously, rainfall volumes and [THg] concentration increased in late summer/early fall; consequently, atmospheric wet deposition of THg also increased during these months" (Rumbold 2004, p.1). "Wet deposition, which is a function of both concentration and rainfall… declined" from 2001 to 2002 (Rumbold, 2004, p. 10 and Table. 3).

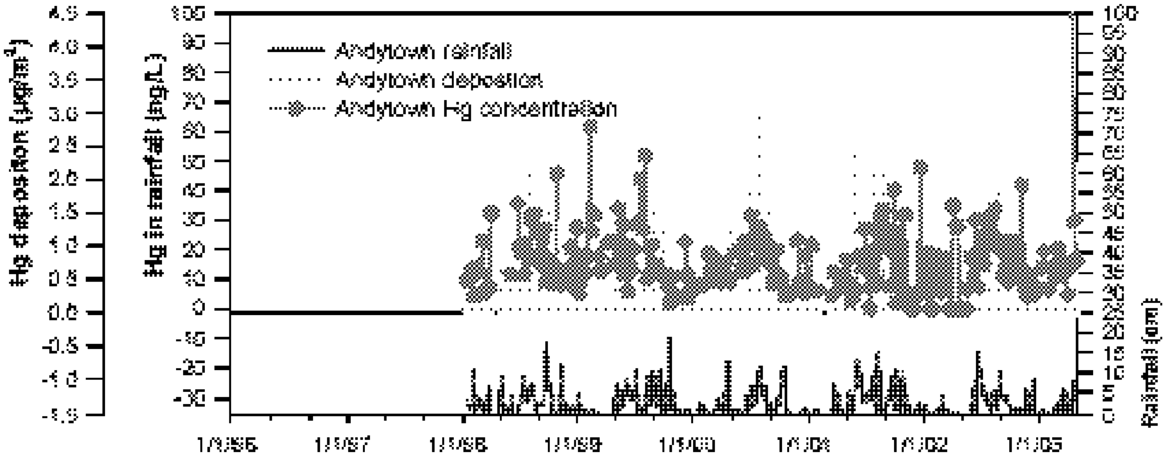


Figure 37. Time series of rainfall, rainfall Hg concentrations, and Hg rainfall deposition at MDN sites at the ENR Project, Andytown, and ENP Baird Research Center.

Note: 2002 rainfall and deposition data for ENR should be considered preliminary and subject to change (from Rumbold, 2004, p. 22., Figure 5).

`Table 10. THg concentration data (ng/L) for volume-weighted bulk rainfall from the Andytown site of the Mercury Deposition Network - reporting year ending April 30, 2003 (from Rumbold, 2004, p. 22).

Note: Annual point estimates are based on the calendar year.

Week Ending	ng/L	Summary Statistics	
		Year	Volume-wt. Concentration (ng/L)
5/7/2002	0	1997*	NA
5/21/2002	7	1998*	13.8
6/4/2002	11	1999*	12.3
6/18/2002	7.8	2000*	15.8
7/2/2002	17.4	2001*	13.2
7/16/2002	19.8	2002†	14
7/30/2002	28.7	Year	Deposition Annual (µg/m2)
8/13/2002	28.3	1997*	NA
8/27/2002	20.3	1998*	20.1
9/10/2002	16.5	1999*	17.5
9/24/2002	12.5	2000*	18.1
10/8/2002	17.8	2001*	21.1
10/22/2002	16.5	2002†	17.9
11/5/2002	19.6		
11/19/2002	6.4		
12/3/2002	5.9		
12/17/2002	4.6		
12/31/2002	0		
1/14/2003	16.8		
1/28/2003	6.4		
2/12/2003	0		
2/25/2003	11		
3/11/2003	18.4		
3/25/2003	13.7		
4/8/2003	4.6		
4/22/2003	29.7		

[*] Adapted from NADP/MDN Program Office Report by C. Sweet, http://nadp.sws.uiuc.edu/mdn/maps/

[†] Preliminary data; final data set may use seasonal averages to estimate annual concentration and deposition where Quality Rating of a given value is C.

SURFACE WATER

Figure 41 and **Figure 43** provide summaries of THg and MeHg for surface water stations. Note that the Florida Class III Water Quality Standard for THg is 12 ng THg/L, and that, "currently, Florida has no Water Quality Standard (WQS) for MeHg" (Rumbold, 2004, p. 10). Also, whether S141 or S32 represent conditions in WCA-3 depends upon whether water from WCA-3 was flowing in the canals along its eastern boundary.

"The maximum MeHg concentration observed during the reporting year at a non-ECP structure was 0.36 ng/L and occurred at L28 during the third quarter of 2002 [**Table 11Error! Reference source not found.**, **Figure 43**]… [Over the EPA as a whole], concentrations of MeHg observed during the reporting year [May 2002 to April 2003] were similar to 2001 and much reduced compared to the spikes observed in the third and fourth quarters of 2000" (Rumbold, 2004, p. 10).

Seasonal average concentrations of both MeHg and THg were highest during the 3rd quarter, at the height of the wet season [**Table 11Error! Reference source not found.**]. "Concentrations of THg were generally similar to… cumulative averages [**Table 11Error! Reference source not found.**] (Note, concentrations are not volume-weighted)" (Rumbold, 2004, p. 10).

Annual concentrations (mean of first through fourth quarters) of THg for individual stations are less than cumulative averages for two stations (by 2 percent for S140, and 22 percent for S32). Two stations have annual concentrations that are slightly greater than cumulative averages (2 percent and 7 percent). Annual concentrations are greater than cumulative averages for the remaining stations (12, 13, 27, and 36 percent; see **Table 11**).

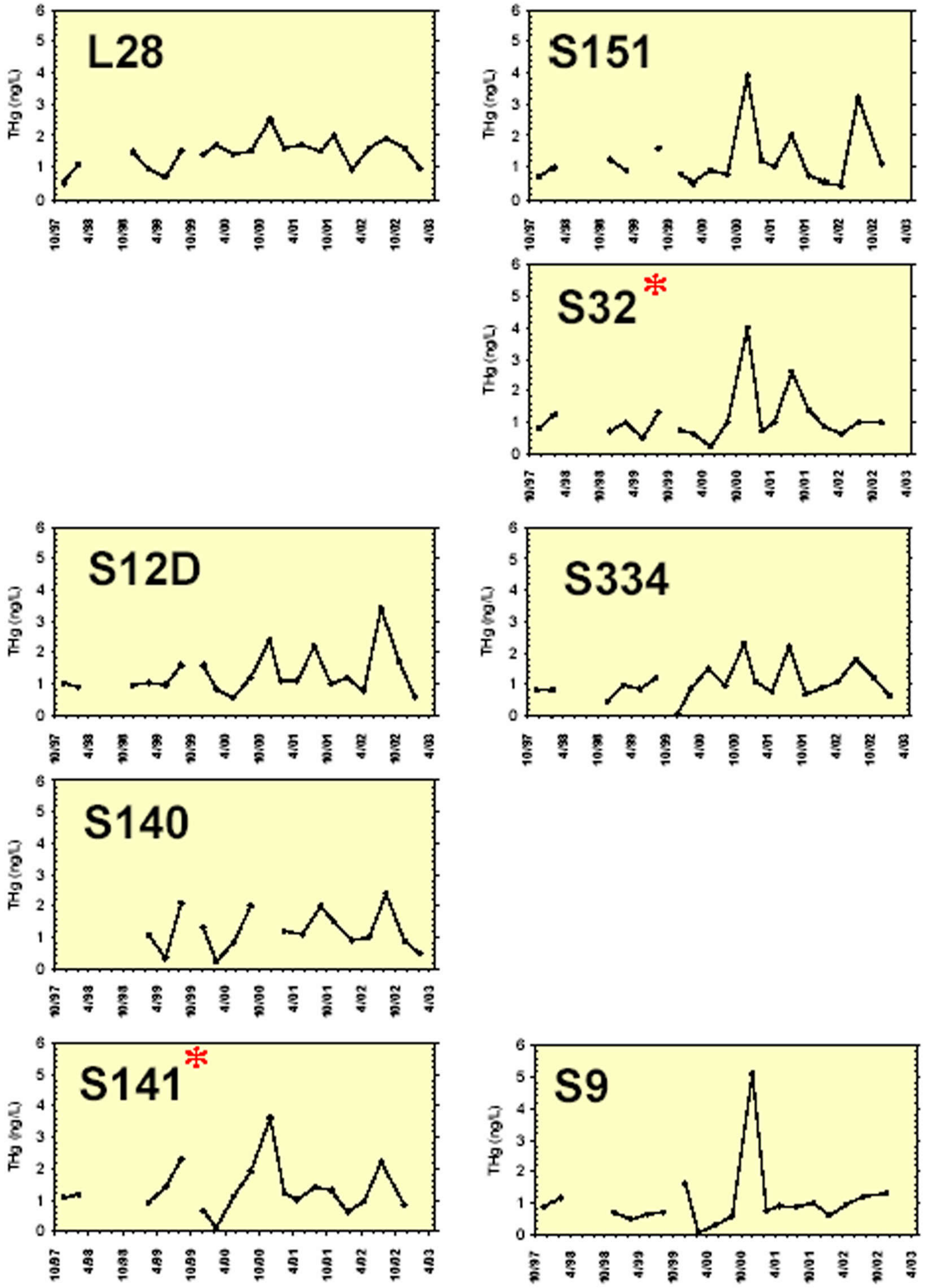


Figure 38. Concentrations of THg in unfiltered surface waters at ten (10) non-ECP structures for period-of-record (part copied from Rumbold, 2004, p. 23, Figure 6).

* S32 and S141 may not always represent conditions of WCA-3.

Note the break in the y-axis (THg concentration) in graph S5A (where is S5A?).

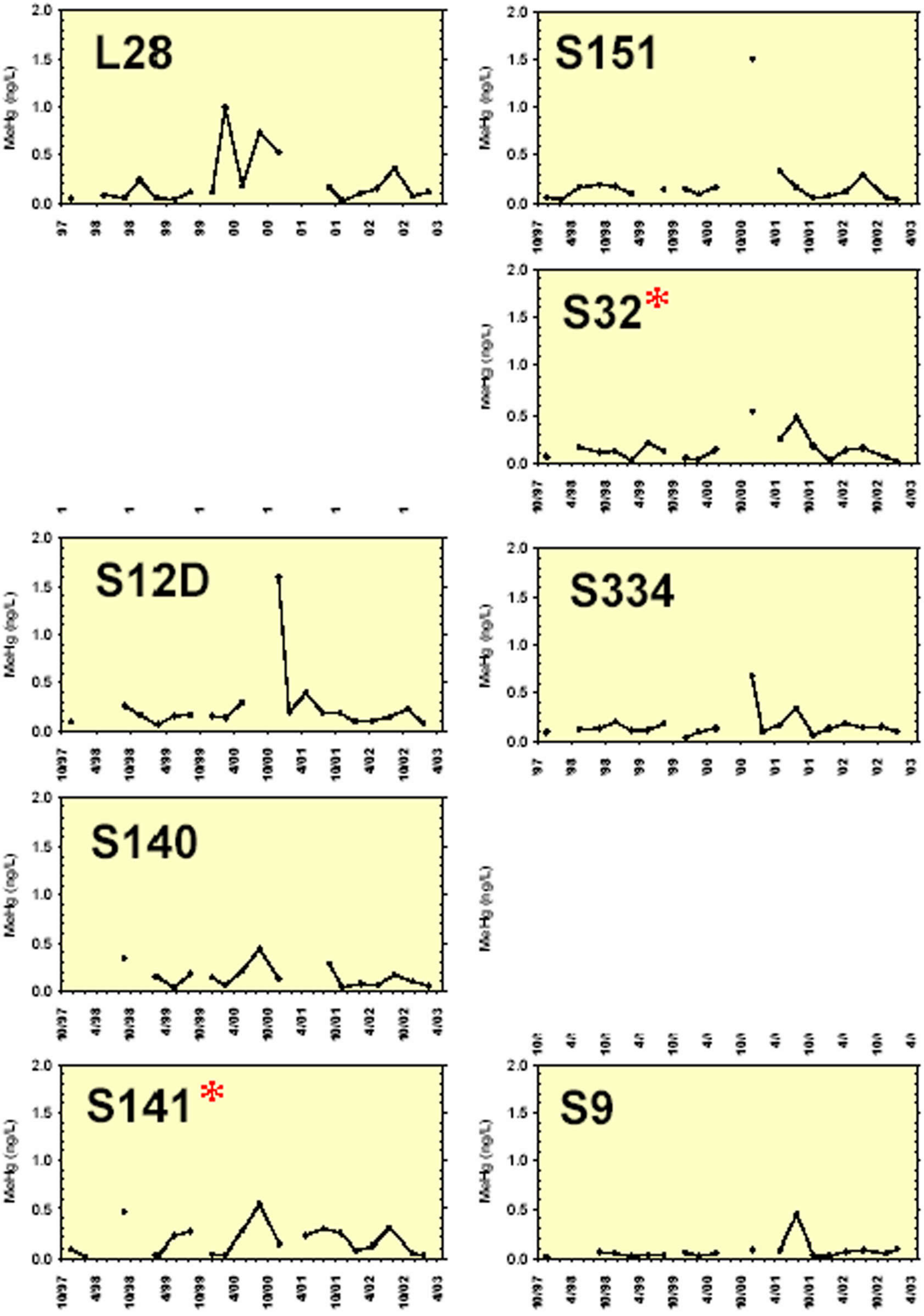


Figure 39. Concentrations of MeHg in unfiltered surface waters at 10 non-ECP structures for period of record (part copied from Rumbold, 2004, p. 24, Figure 6).

Note that S32 and S141 may not always represent conditions of WCA-3.

Table 11. Concentrations of THg and MeHg in non-ECP structure surface waters (units, ng/L) in May 1, 2002 through April 30, 2003.

Note: Due to shifts in scheduling within the quarter, sampling may have occurred outside the water year (Rumbold, 2004, p. 32).

Structure	Quarter	THg (ng/L)	Remark**	WQS*	MeHg (ng/L)	Remark**	% MeHg
L28	2nd Quarter	1.6		<WQS	0.15		9%
	3rd Quarter	1.9		<WQS	0.36		19%
	4th Quarter	1.6		<WQS	0.072	I	5%
	1st Quarter	0.96	A	<WQS	0.11		11%
	Average† Last 4 Quarters	1.52			0.173		11%
	Cumulative Average†	1.42			0.219		15%
S12D	2nd Quarter	0.76		<WQS	0.096		13%
	3rd Quarter	3.4		<WQS	0.14		4%
	4th Quarter	1.7		<WQS	0.22		13%
	1st Quarter	0.57		<WQS	0.076	I	13%
	Average Last 4 Quarters	1.61			0.133		11%
	Cumulative Average	1.18			0.216		24%
S140	2nd Quarter	1		<WQS	0.06	I	6%
	3rd Quarter	2.4		<WQS	0.17		7%
	4th Quarter	0.89		<WQS	0.098		11%
	1st Quarter	0.48		<WQS	0.052	I	11%
	Average Last 4 Quarters	1.19			0.095		9%
	Cumulative average	1.21			0.153		13%
S141	2nd Quarter	0.94		<WQS	0.12		13%
	3rd Quarter	2.2		<WQS	0.30		14%
	4th Quarter	0.84		<WQS	0.05	I	6%
	1st Quarter	0.68	V	<WQS	0.039	I	
	Average Last 4 Quarters	1.33			0.127		11%
	Cumulative Average	1.31			0.183		14%
S151	2nd Quarter	0.46		<WQS	0.12		26%
	3rd Quarter	3.2	A	<WQS	0.29		9%
	4th Quarter	1.1		<WQS	0.06	I	5%
	1st Quarter	0.47	A, V	<WQS	0.035	I	
	Average Last 4 Quarters	1.59			0.126		14%
	Cumulative Average	1.25			0.205		15%
S32	2nd Quarter	0.64	A	<WQS	0.14		22%
	3rd Quarter	0.99		<WQS	0.16		16%
	4th Quarter	0.98		<WQS	0.061	I	6%
	1st Quarter	0.55	V	<WQS	0.022	U	
	Average Last 4 Quarters	0.87			0.096		15%
	Cumulative Average	1.12			0.155		18%

Structure	Quarter	THg (ng/L)	Remark**	WQS*	MeHg (ng/L)	Remark**	% MeHg
S334	2nd Quarter	1.1		<WQS	0.18		16%
	3rd Quarter	1.8		<WQS	0.14		8%
	4th Quarter	1.2		<WQS	0.15		13%
	1st Quarter	0.64		<WQS	0.098		15%
	Average Last 4 Quarters	1.19			0.142		13%
	Cumulative Average	1.05			0.162		17%
S9	2nd Quarter	0.94		<WQS	0.071	I	8%
	3rd Quarter	1.2		<WQS	0.091		8%
	4th Quarter	1.3		<WQS	0.056	I	4%
	1st Quarter	0.23	I,V	<WQS	0.1		
	Average Last 4 Quarters	1.15			0.08		6%
	Cumulative Average	1.03			0.078		13%
	Ann. Average† 02-2	1.19	±0.7(10)		0.1	±0.1 (10)	12%
	Ann. Average 02-3	2.21	±1.1 (10)		0.19	±0.1 (10)	10%
	Ann. Average 02-4	3.41	±7.1 (10)		0.1	±0.1 (10)	7%
	Ann. Average 03-1	0.86	±0.6 (6)		0.07	±0.0 (10)	13%
	Cumulative Average† Q1	0.98	±0.5 (55)		0.1	±0.1 (47)	14%
	Cumulative Average Q2	1	±0.5 (39)		0.14	±0.1 (40)	18%
	Cumulative Average Q3	1.77	±0.8 (40)		0.28	±0.2 (45)	17%
	Cumulative Average Q4	1.9	±3.1 (58)		0.18	±0.3 (59)	14%

* Class III Water Quality Standard of 12 ng THg/L

** For qualifier definitions, see FDEP rule 62-160: "A"—averaged value; "U"—undetected, value is the MDL; "I"—below PQL; "J"—estimated value, the reported value failed to meet established QC criteria; “J3”—estimated value, poor precision, “V”—analyte detected in both the sample and the associated method blank. Flagged values were not used in calculating averages.

† Averages were not volume-weighted.

Value in parenthesis, i.e., (**n**), is number of unqualified values used to calculate mean ±1SD.

Mercury Present in Animal Tissue

"Based on U.S. Fish and Wildlife Service (USFWS) and U.S. Environmental Protection Agency (USEPA) guidance values, Everglades populations [generally, not restricted to WCA-3 populations] of piscivorous avian and mammalian wildlife continue to be at risk from adverse effects due to mercury exposure" (Rumbold, 2004, p. 2).

BIRDS

The District collected great egret eggs and nestling feathers to monitor mercury levels in fish-eating wading birds—among the most highly exposed organisms (to mercury) in the Everglades, because of the MeHg bioaccumulation in top predator fish, which they consumed (Rumbold, 2004, p. 5). "The District's monitoring program focused on two [great] egret colonies, designated JW1 and L67, that are located in WCA-3A. These two colonies consistently showed the highest THg concentrations during background studies" (Rumbold, 2004 p. 14; citing Frederick et al, 1997; FTN Associates, 1999; Sepulveda et al, 1999). However, because JW1 colony was inactive in 2002 and 2003, collections were made at the Cypress City colony, which is also located in WCA-3A.

Concentration of MeHg in eggs "is thought to be the best predictor of MeHg risk to avian reproduction (Wolfe et al, 1998)... To date, a critical egg concentration has not yet been determined for wading birds [although benchmark studies have been conducted by Bouton et al, 1999 and Spalding et al, 2000].... Establishing a benchmark for critical feather THg concentration has also been difficult because of observed or suspected interspecies differences in mercury sensitivity, particularly between piscivores and non-piscivores and between freshwater birds and seabirds. This is further complicated because, unlike MeHg in eggs, MeHg bonded to keratin and sequestered in feathers no longer represents a risk to the bird. Feather THg concentration is used only as an indicator of MeHg level and... risk in targeted organs" (Rumbold, 2004, p. 16). "It is unlikely that levels of THg in egret nestling feathers in 2003 would have exceeded the lowest observed adverse effect benchmark established by Spalding et al, (2000)," 19 µg/g (Rumbold, 2004, p. 16).

Frederick and Hylton (2004) conducted a study of MeHg in bird feathers. Their specimens covered a time period of about one hundred years, the older specimens coming from museum pieces. They do not distinguish WCA-3 from the rest of the Everglades in their report (however, they did collect data on location that was at least as specific as the county in which the specimen was found). Their results are summarized in **Table 12Error! Reference source not found.** and in **Figure 44**. Note the differences across species, and the differences between time periods.

Table 12. Concentration (ppm) of MeHg in bird feathers (after Frederick and Hylton, Table 4).

Species	Mean	Standard Deviation	Median	n
Pre-1980s				
Anhinga	1.86	2.72	0.87	21
Great Egret	2.77	3.64	1.5	7
White Ibis	1.04	0.77	0.86	33
Great Blue Herons	3.34	3.34	2.35	12

Species	Mean	Standard Deviation	Median	n
Post-1990				
Anhinga	10.03	9.11	6.5	7
Great Egret	19.84	12.45	18	37
White Ibis	7.47	4.58	7.1	98
Great Blue Herons	21.03	15.98	19	49

Figure 40. Comparison of mean mercury values pre-1980 (diamonds) with mean mercury concentrations of feathers post-1990 (squares). Standard deviations are shown as vertical bars (source Frederick and Hylton, 2004).

Great Egret

Eggs

"District staff have… collected egret eggs to support an ecological risk assessment of MeHg (Rumbold, 2000) and to better assess spatial and temporal trends in wading bird exposure (for details, refer to Rumbold et al, 2001)…. Mean THg concentration was 0.37 µg/g (± 0.21; fresh weight) in eggs at L67, and 0.38 (± 0.24) in eggs at Cypress City colony…" (**Figure 45**) "This between-colony difference was not significant[11]. While egg THg concentration has varied since 1999 (appearing to increase slightly in 2001, then decreasing again 2002), among year differences were not statistically significant at L67[12], however, egg-THg concentration observed in 2003 (0.38 µg/g) continue to be lower than levels reported for eggs collected in 1993[13]" (Rumbold, 2004, p. 15-16).

"In 2003, conditions were not optimal for wading bird nesting in central and southern WCA-3A. The JW1 and L67 colonies were first visited on February 19, 2003; L67 was found to be active and ten eggs[14] were collected for THg determination… In contrast, JW1 was again found to be inactive… Accordingly, an alternate colony, designated 'Cypress City' [26°7'26.882" N Latitude, 80°30'17.023" W Longitude], located several miles east of JW1, was visited on March 6 and found to be active; ten eggs were collected. Chicks were also present in several nests at Cypress City during the first sampling event. When the Cypress City colony was revisited for feather collection on April 1, nests were found to have been abandoned with many dead chicks remaining; several live chicks were located and sampled for feathers… In addition, six dead chicks were salvaged for… feather samples" (Rumbold, 2004, p. 14-15).

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[11] df= 1, 18; F = 0.01; p = 0.9

[12] df= 4, 45; F = 1.5; p = 0.22

[13] Great egret eggs collected within WCA3A in 1993 by USGS contained on average 0.46 µg/g; n = 43; D = Day, USGS, pers. comm.

[14] i.e., one egg each from 10 nests

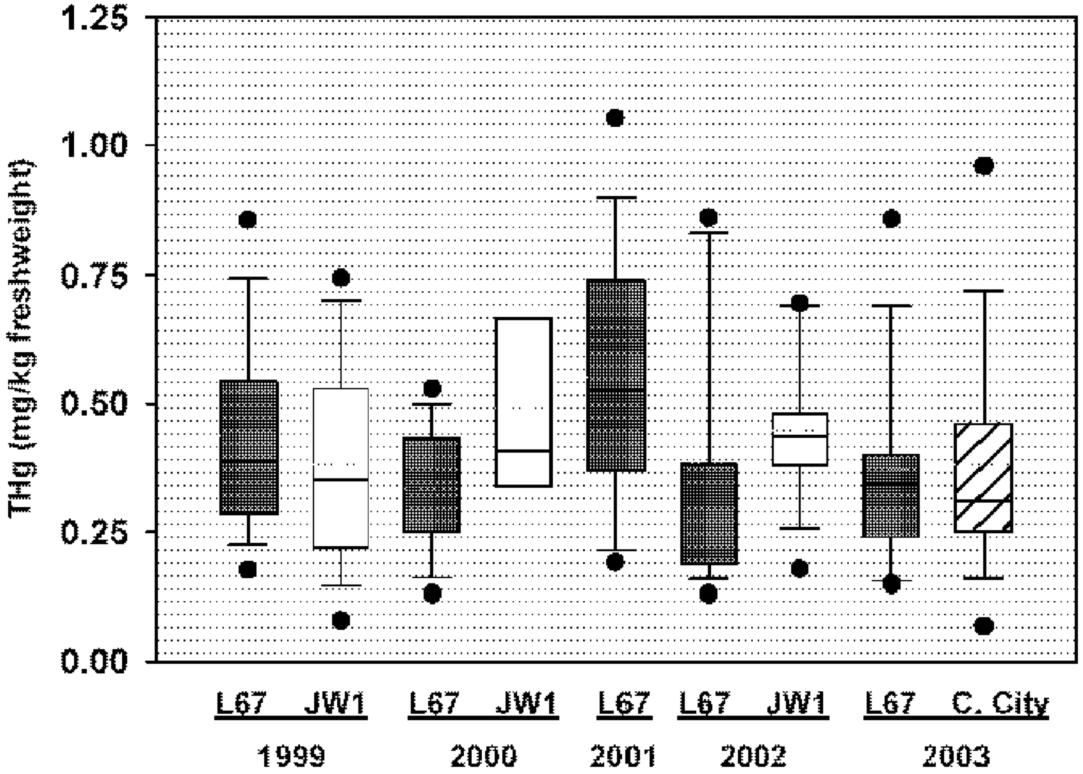

Figure 41. Boxplots of THg concentration in great egret eggs collected from colonies within WCA-3A.

Note: Eggs were collected at Cypress City colony in 2003 due to inactivity at JW1 colony. Outliers that lie outside the 10th and 90th percentile are shown as filled circles (source Rumbold, 2004, Figure 11).

Feathers

"THg concentrations in great egret nestling feathers ranged from 2.6 µg/g to 9.8 µg/g, with an overall mean concentration (two colonies pooled) of 5.5 ±1.8 µg/g. Given the ages of nestlings sampled, THg levels in [great] egret [nestling feathers] appear to have increased slightly in 2003 compared to 2002, are similar to 2001 levels but, most importantly, continue to be much lower than 1994 levels." (Rumbold, 2004, p. 2).

In order "to evaluate temporal trends, results from the District's program to monitor mercury bioaccumulation in wading birds are compared to results from similar collections made by Frederick et al (1997; later published by Sepulveda et al, 1999) in 1994 and 1995. In accordance with USACE permit 199404532, Condition 8b.2, these results were found to be representative of background mercury concentrations in Everglades wading birds (FTN Associates, 1999). The study by Frederick et al (1997) involved monitoring THg in feathers of great egret (Ardea albus) nestlings at various Everglades colonies. The District's monitoring program focuses on two egret colonies designated JW1 and L67 that are located in WCA-3A. These two colonies consistently showed the highest THg concentrations during background studies (Frederick et al, 1997; FTN Associates, 1999; Sepulveda et al, 1999)" (Rumbold, 2004, p. 14).

"Caution must be used when interpreting these [egret nestling feather concentrations] because THg is often dependent on the duration of exposure and, thus, the age of the bird. Regression and standardization of feather Hg concentration in 2003 (two colonies pooled) based on bill length (i.e., age surrogate) was not statistically significant[15]. Attempts to standardize feather THg for 1999 through 2001 at the L67 colony were also not statistically significant (… note, regressions were significant at JW1). This lack of significant regressions (i.e., concentration does not show a statistically significant increase with age) has been interpreted as an indication that exposure at L67 had been reduced to a level such that growth dilution overwhelmed daily intake. Nevertheless, temporal trends can be assessed qualitatively. On average, nestlings sampled in 2003 were 13 days old[16], which is the same age as birds sampled in 2002, three days younger than chicks sampled in 1994, and only two days younger than chicks sampled in 2001. Given these ages, THg levels in egret nestlings appear to have increased slightly in 2003 compared to 2002 [Table 12], are similar to 2001 but, most importantly, continue to be much lower than 1994 levels. An interpretation that mercury exposure to egrets was reduced compared to 1994 and even 2001 was strengthened by the results of egret egg collections" (Rumbold, 2004, p. 15).

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[15] df= 1, 16; F = 0.16; P = 0.7

Note: Regression was also attempted on Cypress City alone and was also non-significant.

[16] i.e., based on an average bill length of 4.4 cm and relationship developed by P. Frederick.

Figure 42. Standardized least square mean of THg (µg/g dw) for a chick with a 7.1 cm bill (arithmetic mean concentration ±1SD, n) in growing scapular feathers collected annually from great egret nestlings (2 to 3 weeks old) at the JW1 and L67 colonies.

Colony	1994 *†	1995 *	1999	2000	2001	2002	2003
JW1	21.12 ± 6.1	14.51 ±3.31	7.18 ±1.14	6.9 ±1.3	Failed to initiate nesting.	Colony abandoned.	Failed to initiate nesting.
	(25.0 ±7.9, 9)	(NA, 8)	(4.0 ±2.2, 13)	(3.4 ±1.9, 10)			
L67	16.29 ± 4.53	15.51 ±6.16	NC	NC	NC	NC	NC
	(NA, 27)	(15.9 ±6.16, 14)	(3.6 ±1.5, 20)	(3.2 ±1.4, 10)	(7.0 ±3, 13)	(2.1 ±0.5, 6)	(5.1 ±2, 3)
Cypress City							NC
							(5.6 ±2, 15)

* Data from Frederick et al (1997).

† Concentrations standardized to a bill length of 5.6 cm.

NC Not calculated where slope of regression was not significant ($p > 0.05$).

Estimated mean age of sampled nestling, based on bill length, was 16 days in 1994, 24 days in 1995, 15 days in 1999, 16 days in 2000, 15 days in 2001 and 13 days in 2002 and 2003.

FISH

“Levels of mercury in fish tissues can… be put into perspective and evaluated with respect to mercury risk to wildlife. The USFWS has proposed a predator protection criterion of 100 ng/g THg in prey species (Eisler, 1987). More recently, in its Mercury Study Report to Congress, the USEPA proposed 77 ng/g and 346 ng/g for trophic level (TL) 3 and 4 fish, respectively, for the protection of piscivorous avian and mammalian wildlife (USEPA, 1997)” (Rumbold, 2004, p. 14).

Note that differences in basin-wide point estimates of THg in fish may arise because they may simply reflect the difference in geographic distribution of samples collected in given year. Also, note that age, size and species related differences in diet combine to complicate evaluating the significance of differences among Hg levels in fish tissue (Rumbold, 2004, p. 11-12).

Fish samples were collected in 2002. “Where fish could not be collected after a good-faith effort, collection sites defaulted to nearby canals where fish were more plentiful and the same source water was being sampled” (Rumbold, 2004, p. 11). MeHg is typically about 80 percent of the THg in fish—the District measures THg, which is less costly than measuring MeHg.

“In 2002, mosquito fish (considered to be at TL 2 to 3, depending on age; Loftus et al, 1998) at [only one] of the… sites had [a] THg [concentration] exceeding either the USFWS or USEPA criterion (i.e., [20] percent of the monitored sites, [**Table 13**]). Based on mean concentrations, sunfish, which are at TL 3 (L. gulosus at TL 4; Loftus et al, 1998), at [all five] sites… contained THg concentrations exceeding one or both of the predator protection criteria in 2002 ... This finding is significant because, as is noted above, sunfishes represent the preferred prey item of many fish-eating species in the Everglades. Consequently, sunfish represent the best measure of potential upper trophic-level exposure to THg. After adjusting arithmetic mean THg concentrations in largemouth bass fillets (Table [6]) to whole-body concentrations[17], bass at [3] of the [4] sites… also exceeded the guidance value for TL 4 fish; [note, however, that] largemouth bass are considered to be at TL 5 (Loftus et al, 1998). Based on these guidance values it appears that Everglades' populations of piscivorous avian and mammalian wildlife continue to be at risk of adverse effects from mercury exposure” (Rumbold, 2004, p. 14).

Mosquito Fish

Mosquito fish represent short-term, localized changes in water quality because of their small range, short lifespan, and wide occurrence in the Everglades (Rumbold, 2004, p. 4).

“THg concentrations in mosquito fish collected from [interior] marsh sites in 2002 ranged from [42] ng/g at [CA3F2] to [133] ng/g at [CA35alt2] [**Table 13**]” (Rumbold, 2004, p. 11). “The 2002 basin-wide median concentration was [52] ng/g... which represents a [25]-percent decrease from the 2001 basin-wide median concentration (note, when annual arithmetic means were compared, a [12]-percent decrease was observed from 2001 to 2002...). In 2002..., [four out of five] sites… showed a decline (negative between-year change) in THg in mosquito fish... Mosquito fish at most sites exhibited a dramatic increase in 1999 following a drydown and reflooding, decreasing substantially in 2000 but [increasing again] in 2001 [**Figure 43**]” (Rumbold 2004, p. 11). While CA3F2 had the highest concentration in 2002, CA315 had the highest in the previous year.

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[17] Whole-body THg concentration = 0.69 x fillet THg; Lange et al, 1998.

Table 13. Concentration of total mercury (THg) in mosquito fish composites (units ng/g wet weight) collected in 2002 from downstream sites. Value represents a mean of 3 analyses (source Rumbold, 2004 p. 34).

Location	THg (ng/g)	Between-Year Change (%)	Cumulative Average
CA33 Alt (L5F1)	52	33%	80
CA35alt2	133	-4%	116
Non-ECP North (CA3F1; end of L-28)	43	-24%	73
CA315	75	-53%	138
Non ECP South (CA3F2)	42	-10%	65

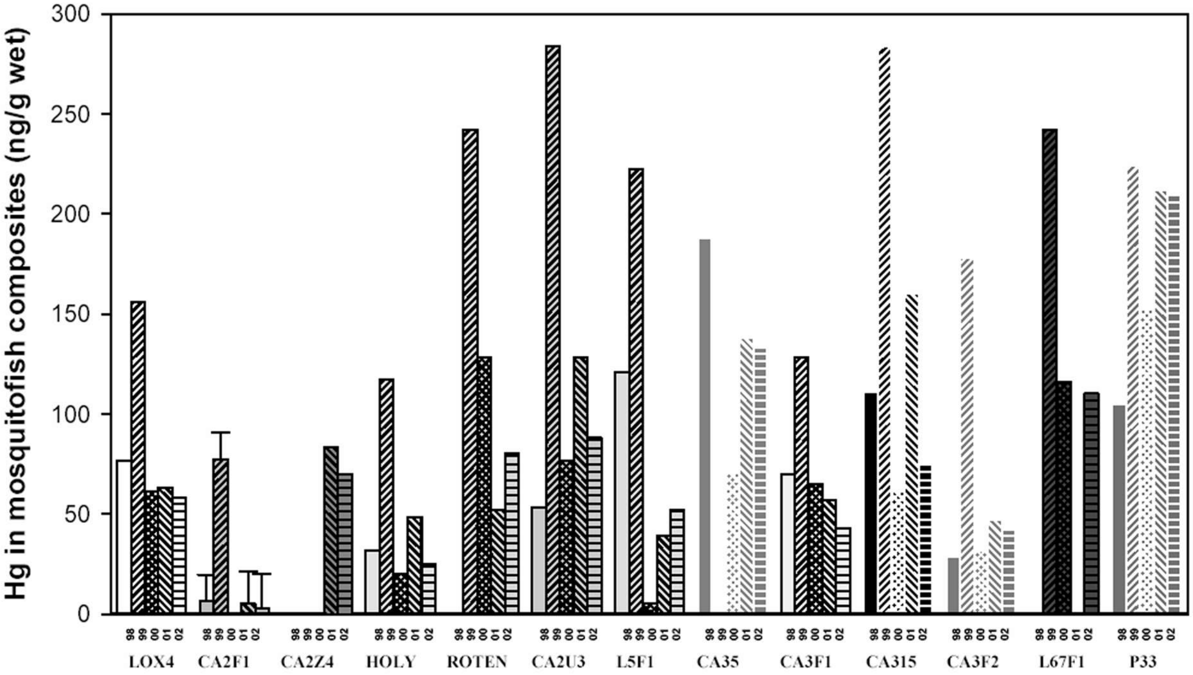


Figure 43. Mercury concentrations in mosquito fish (Gambusia sp.) **collected at** ECP and non-ECP sites for period of record (source Rumbold, 2004 p. 25). Not all sites were sampled in all years.

1) Sunfish

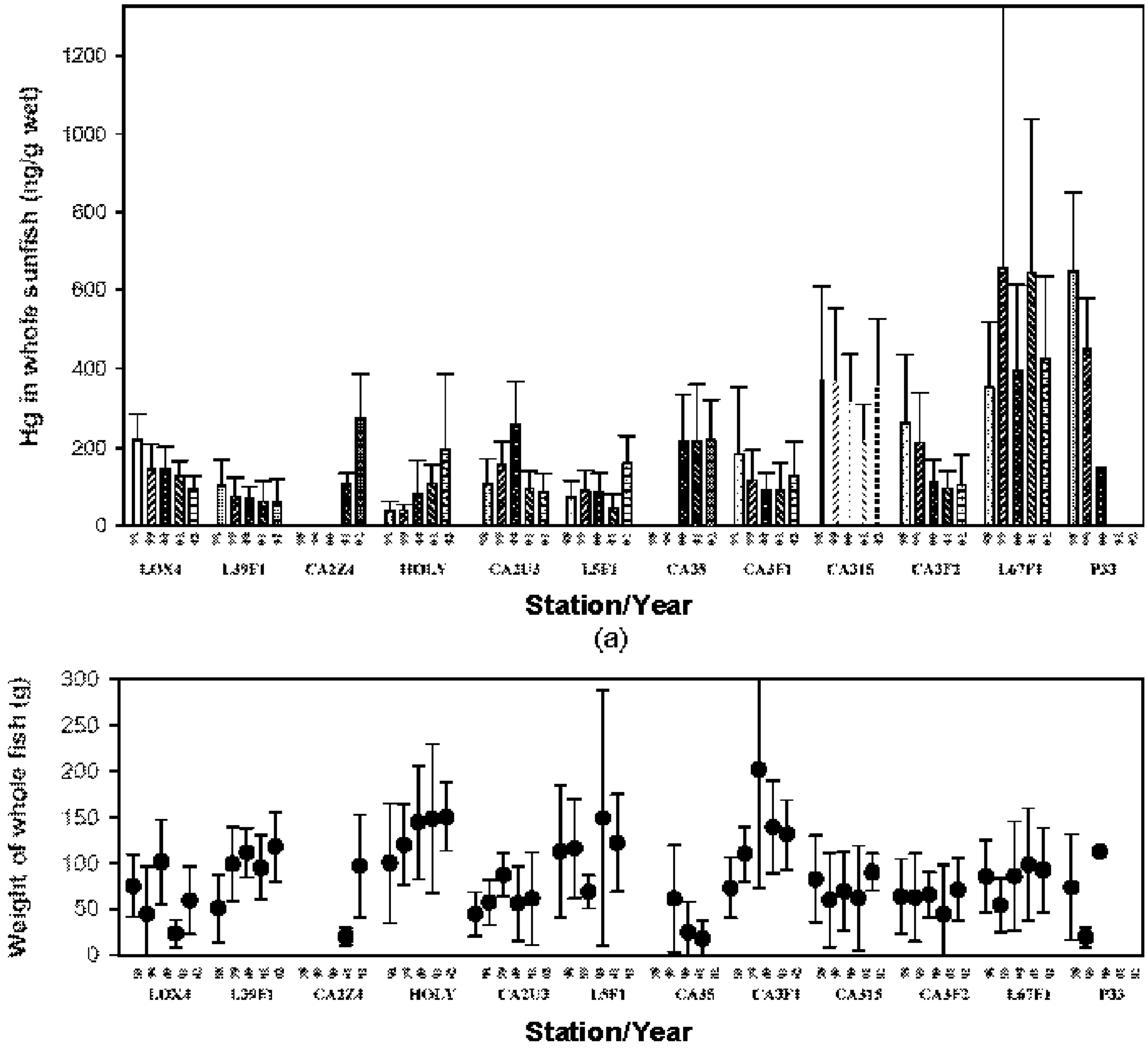
Sunfish were selected "because of their widespread occurrence, and because they are a preferred prey for a number of fish-eating Everglades species. [They are] an indicator of mercury exposure to wading birds and other fish-eating wildlife" (Rumbold, 2004, p. 4).

"Sunfish were not aged; consequently, age normalization was not available. Instead, arithmetic means were reported… the distribution of the different species of lepomis (L. gulosus warmouth; L. punctatus, spotted sunfish; L. macrochirus, bluegill; L. microlophus, redear sunfish) collected during electroshocking was also considered to be a potential confounding influence on THg concentrations prior to each comparison" (Rumbold, 2004, p. 9).

"THg concentration in sunfish collected from [interior] marsh sites in 2002 [n = 99] averaged [194] ng/g… (**Table 14**).… However, as described below, exercise caution when interpreting these basin-wide concentrations" (Rumbold, 2004, p. 11). For a given site, the between-year percent change in Hg levels from 2001 to 2002 ranged from a 2-percent increase at WCA-3A 5 Alt. 2 site (**Table 14**, **Figure 44**) to a 256-percent increase at L5F1 (Rumbold, 2004, p. 11).

Table 14. Mean concentration (± 1SD; ng/g wet weight) of total mercury (THg) in Sunfish (Lepomis spp.) collected in 2002 from interior marshes within the EPA downstream of the STAs (Rumbold, 2004, p. 35).

Target Location	Sampling Location	Mean THg (ng/g)	(±1SD, n)	Between-Year Change (%)	Mean for Fish Collected (1998-2002)
WCA-3A 3	L5F1	160	(±69, 19)	256%	90
WCA-3A 5	Alt. 2 site	220	(±98, 20)	2%	218
Non-ECP North	CA3F1	128	(± 88, 20)	45%	121
WCA-3A 15	CA315	357	(±170, 20)	60%	328
Non-ECP South	CA3F2	105	(±78, 20)	11%	157
Average		194		75%	



(a)

(b)

Figure 44. THg concentration (a) and weights (b) of whole sunfish (Lepomis spp.) collected at ECP and non-ECP sites for period of record (copied from Rumbold, 2004, p. 26).

The following four paragraphs (taken from Rumbold, 2004, p. 12) do not apply directly to WCA-3, but to the EPA generally (**Table 15**). They are provided so that some of the difficulties in assessing Hg levels in sunfish may be exposed.

- "Warmouth at [site] WCA3A15... contained much higher Hg levels than spotted sunfish (as well as the other two species). The difference was statistically significant."[18]
- Attempts to use analysis of covariance (ANCOVA) to evaluate patterns of mercury concentrations in sunfish... using weight as a covariate were often inappropriate because weight/concentration relationships were inconsistent (i.e., slopes were either not significant or were not parallel each year). The lack of a strong concentration/size relationship likely resulted from interspecies

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[18] df =3, H = 32.6, $p < 0.001$; Dunn's po'st hoc test $p < 0.05$

differences... in growth and bioaccumulation factors, which are likely a function of diet.

- Species was a significant factor in tissue mercury concentration in sunfish caught in 2002.[19] THg was less concentrated in L. microlophus (redear, median 68 ng/g) than each of the other three species[20] (see **Table 15**). When pooled across sites, the difference between bluegill and spotted sunfish was also statistically significant (P< 0.05); other paired comparisons were not significant. Note that some of these interspecies differences can vary over time and space.
- As in past reports, among-year differences in tissue Hg and sunfish weights were assessed at each location... with qualitative consideration given to possible influences from among-year differences in collected species.... Redear sunfish were caught in greater proportion in 1998 (78 percent redear) and 1999 (85 percent redear) compared to later years (about 50 percent redear and 50 percent bluegill); this may explain lower average mercury levels in those earlier years. Sunfish at L5F1 also contained greater concentrations of mercury in 2002 compared to each of the four previous years.[21] However, neither species caught nor fish size appeared to account for the difference in mercury (with the possible exception of fish caught in 2000, which were almost half the size of the 2002 fish).

Table 15. Median THg concentration in distinct sunfish species collected over entire EPA.

Species	Median THg Concentration (ng/g)
Redear (*L. Microlophus*)	68
Spotted Sunfish (*L. Punctatus*)	280
Warmouth (*L. Gulosus*)	215
Bluegill (*L. Macrochirus*)	170

Largemouth Bass

"Largemouth bass were selected both as an indicator of potential human exposure to mercury and because this species has been monitored at several Everglades sites since 1989" (Rumbold, 2004, p. 5). "Mercury levels in largemouth bass at… CA3-15 (WCA-3A 15), [have been] monitored by the FWC prior to initiation of the ECP, [beginning in] 1993" (Rumbold, 2004, p. 11).

"A total of [81] largemouth bass were collected at [4] of the [5] sites in 2002 (**Table 16**). The average tissue-Hg concentration in these bass was [432]… ng/g"[22] (Rumbold, 2004, p. 13). "The

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[19] Kruskal-Wallis ANOVA on Ranks, df = 3, H=57.7, $p < 0.001$

[20] Dunn's method, $P < 0.05$

[21] df = 4, 93; F = 13.3; $p < 0.001$; post-hoc Tukey test

[22] Over the entire EPA, median age of bass was 1.8 yrs in 2002, 2.8 yrs in 2001, 2.8 yrs old in 2000, 2.8 yrs old in 1999, 2.9 yrs old in 1998. These age differences may be the source of some variation in mercury concentration.

grand mean[23] of site-specific age-standardized concentrations (expected in a three-year-old bass, EHg3) was [428] ng/g in 2002 (based on the [4] sites where it was appropriate to calculate an EHg3)" (Rumbold, 2004 p. 2).

There were "spatial patterns in tissue-Hg concentrations similar to those observed in sunfish (**Figure 45**)… For instance, as observed over the past four years, highest tissue-Hg concentrations in both sunfish and bass occurred at L67F1 in 2002. In 2002, bass at L67F1 had significantly greater concentrations of mercury than fish from… the well-known methylmercury 'hot spot,' WCA3A15" (Rumbold, 2004, p. 13).

"Tissue-Hg concentration did not differ among years at L67F1,[24] [nor] at WCA3A15.[25] It is important to note that although the FWC also report slight increases in EHg3 at [some] sites in 2002, fillet-THg concentrations remain well below levels observed during the early 1990s (T. Lange, FWC, pers. comm.)" (Rumbold, 2004 p. 14).

Table 16. Standardized (EHg3) and arithmetic mean concentrations of total mercury (THg) in largemouth bass fillets (ng/g wet weight) collected in 2002 from ECP and non-ECP interior marsh sites.

Target Location	Sampling Location	EHg3 ± 95th CI ng/g Wet	(Mean ±1SD, n)	Between-Year Change (%)	Consumption Advisory Exceeded*	Cumulative Mean for EHg3
CA3-3	L5F1	400 ±70	(368 ±141, 20)	NA	No	415
CA3-5	CA3-5	NC (2)	(NA, 0)	NA	NA	NA
Non-ECP North	CA3F1	570 ±50	(481 ±194, 19)	41%	Yes	450
CA3-15	CA3-15	1,030 ±96	(649 ±394, 22)	NA	Yes	1,022
Non-ECP South	CA3F2	430 ±80	(212 ±105, 20)	NA	No	430

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[23] The grand mean is calculated by taking the mean of each individual population, then taking the mean of those means.

[24] df = 3, 73; F = 0.81, p = 0.49

[25] i.e., sufficient bass were collected only in years 1999 and 2002; df = 1, 40; F = 0.23, p = 0.64

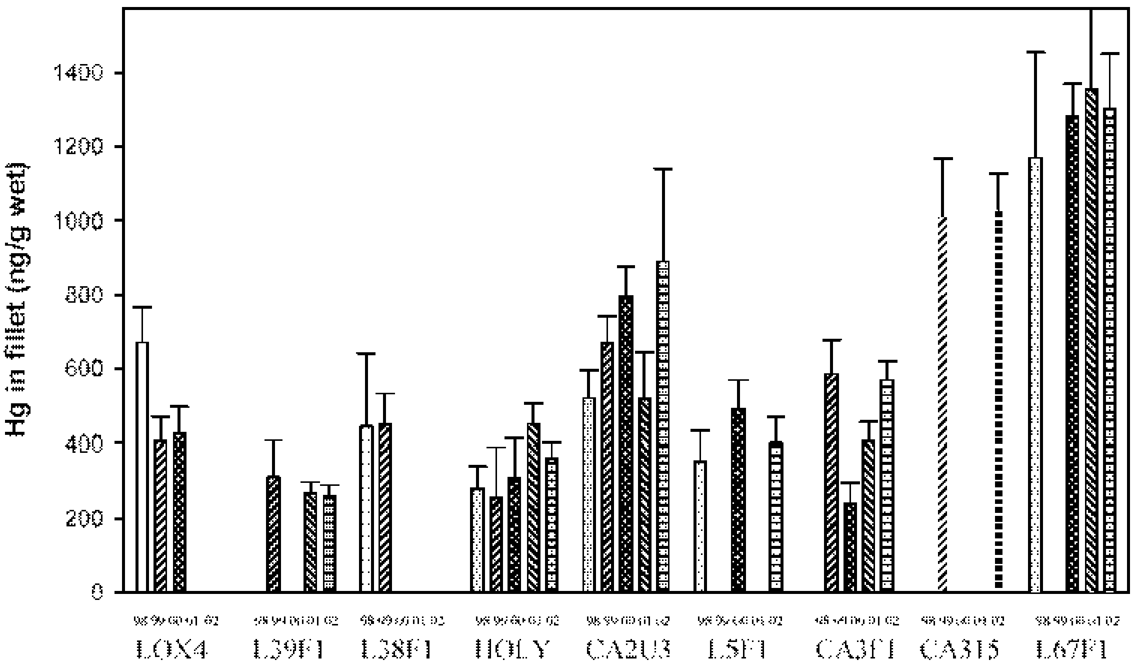

Figure 45. Standardized age (3) expected mercury concentration (EHg3) in largemouth bass (Micropterus salmoides) collected at ECP and non-ECP sites for period of record (copied from Rumbold, 2004, Figure 10) EHg3 was not calculated (NC) where regressions were not significant or if age distribution was narrow.

Additional Information

"The monitoring and reporting program… is described in detail in the Mercury Monitoring and Reporting Plan for the Everglades Construction Project, the Central and Southern Florida Project, and the Everglades Protection Area, which the District submitted to the FDEP, the USEPA, and the USACE in compliance with the (permit) requirements ... The details of the procedures to be used in ensuring the quality of and accountability for the data generated in this monitoring program are set forth in the District's Quality Assurance Project Plan (QAPP) for the Mercury Monitoring and Reporting Program, which was approved on issuance of the permit by the FDEP. The FDEP approved QAPP revisions on June 7, 1999" (Rumbold, 2004).

"Levels of THg and MeHg in various… media… collected prior to the operation of the first STA define the baseline condition from which to evaluate the mercury-related changes, if any, brought about by STA operation. The pre-ECP mercury baseline conditions are defined in the Everglades Mercury Background Report, which summarized all the relevant mercury studies conducted in the Everglades through July 1997, during the construction of but prior to the operation of the first STA. Originally prepared for submittal in February 1998, it has now been revised to include the most recent data released by the USEPA and the U.S. Geological Survey (USGS) and was submitted in February 1999 (FTN Associates, 1999)" (Rumbold, 2004).

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APPENDIX A: RAINFALL AND ET MAPS BASED ON STAGE VALUES

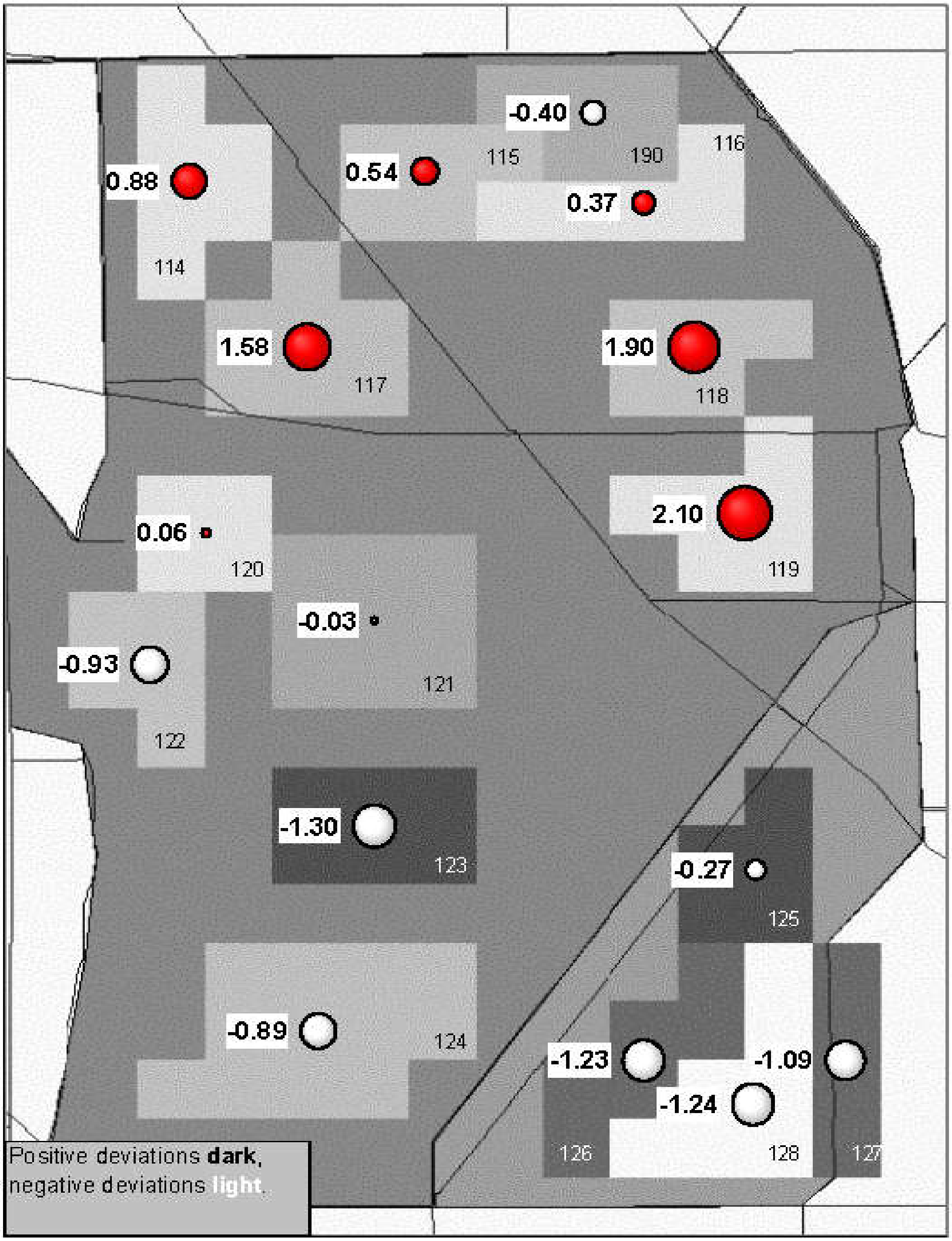

Figure A-1. Seasonal rainfall for wet season with highest rainfall (1973; deviation from mean of 59.86 inches).

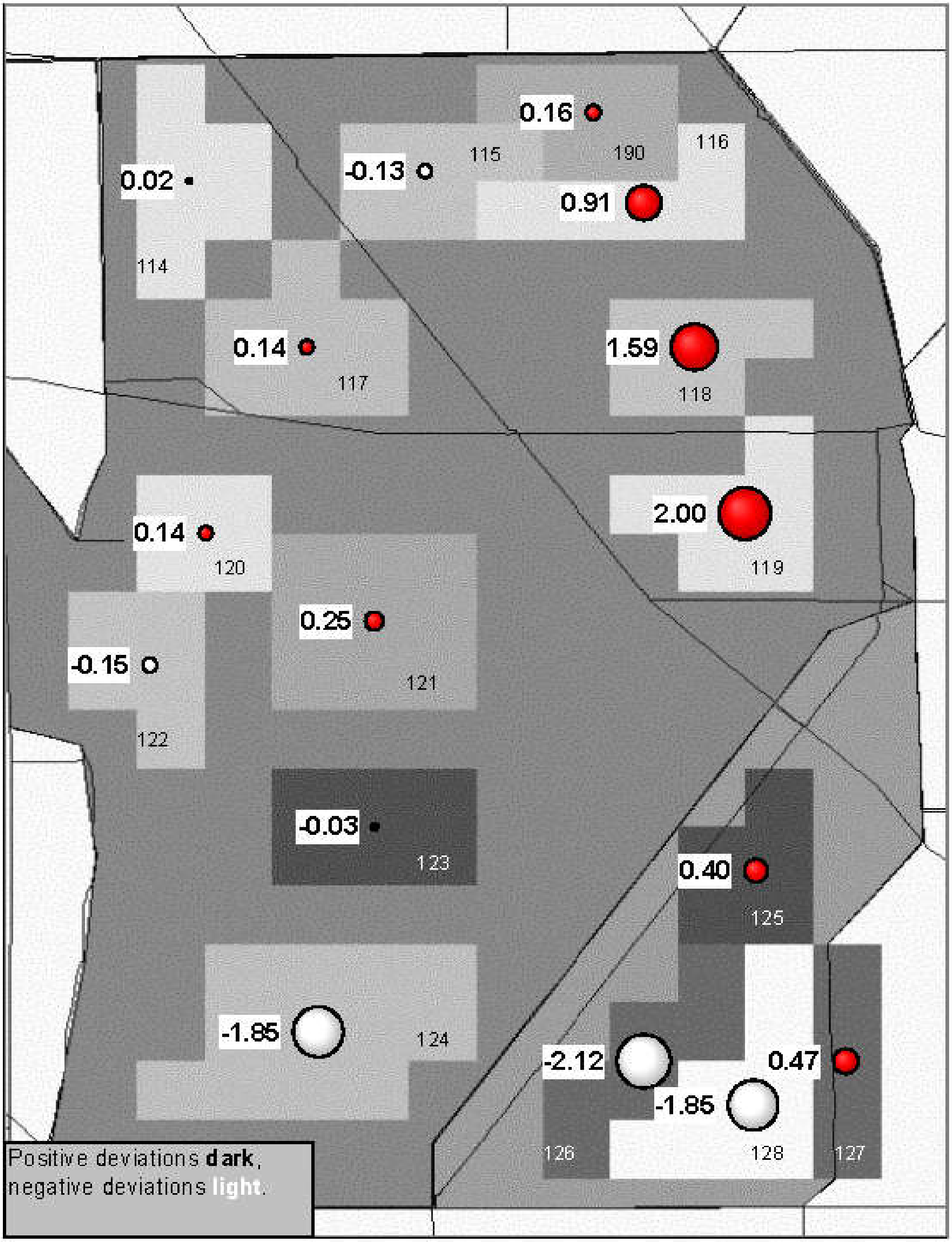

Figure A-2. Seasonal rainfall for wet season with median rainfall (1975; deviation from mean of 40.26 inches).

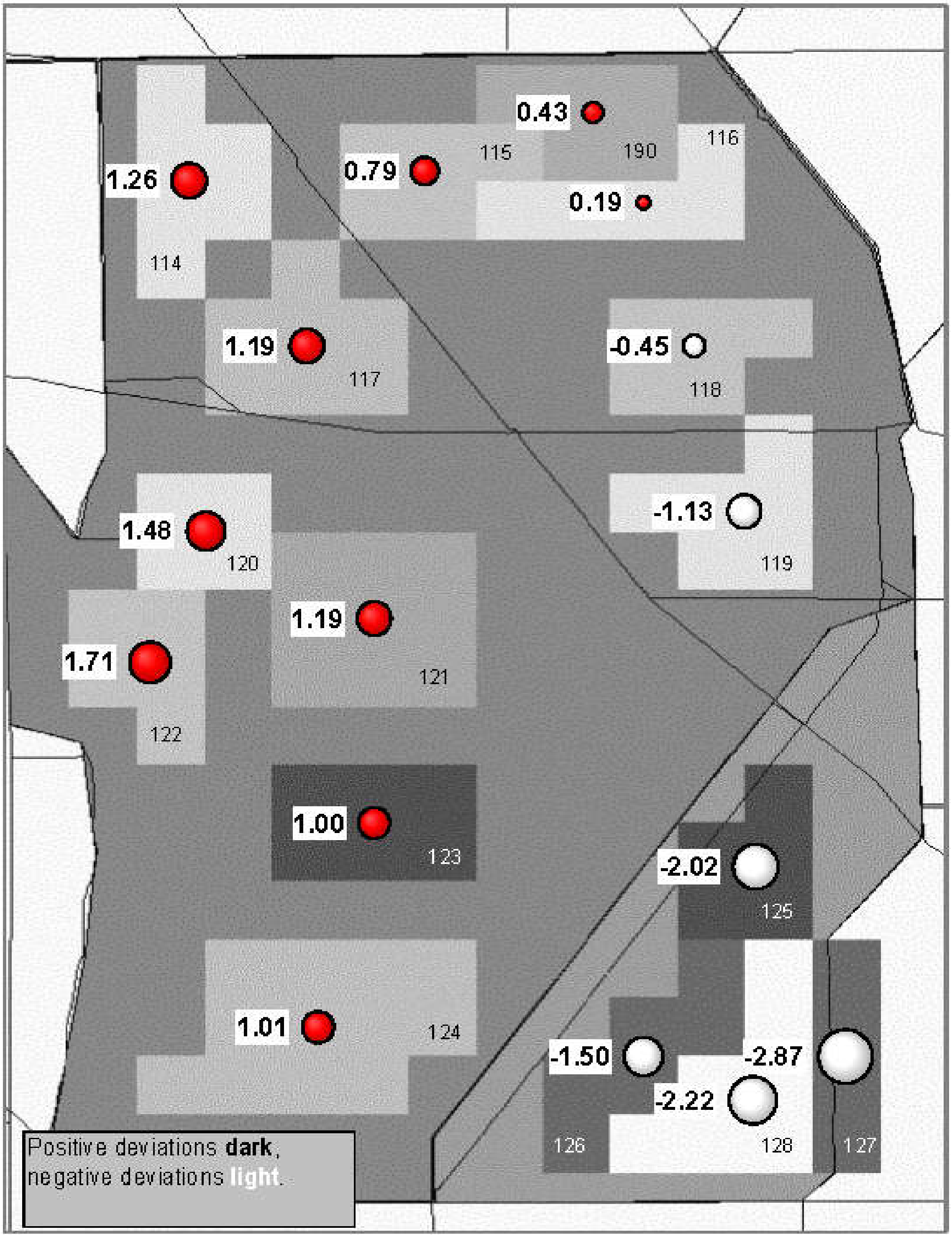

Figure A-3. Seasonal rainfall for wet season with median rainfall (1996; deviation from mean of 37.10 inches).

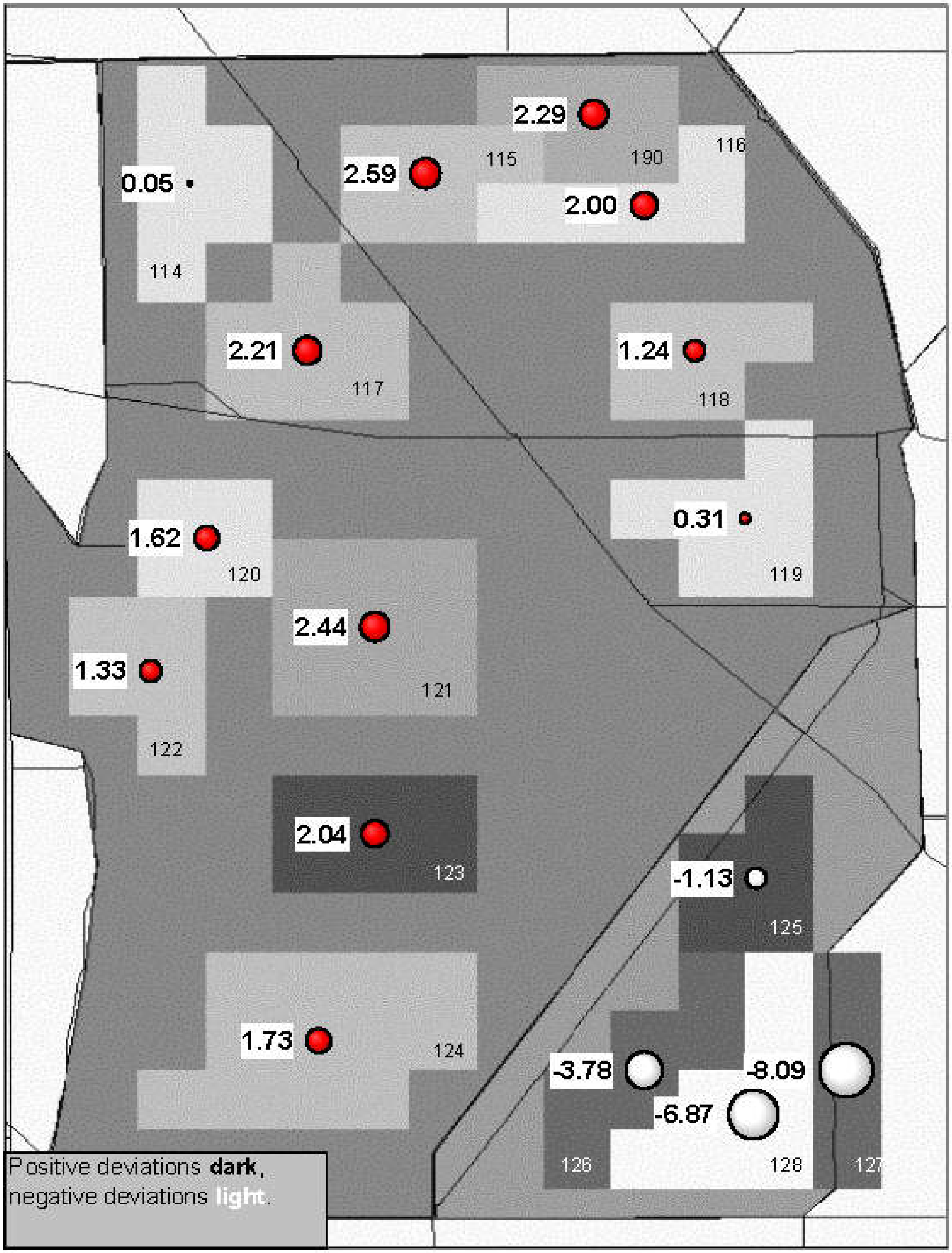

Figure A-4. Seasonal rainfall for dry season with minimal rainfall (1995; deviation from mean of 7.47 inches).

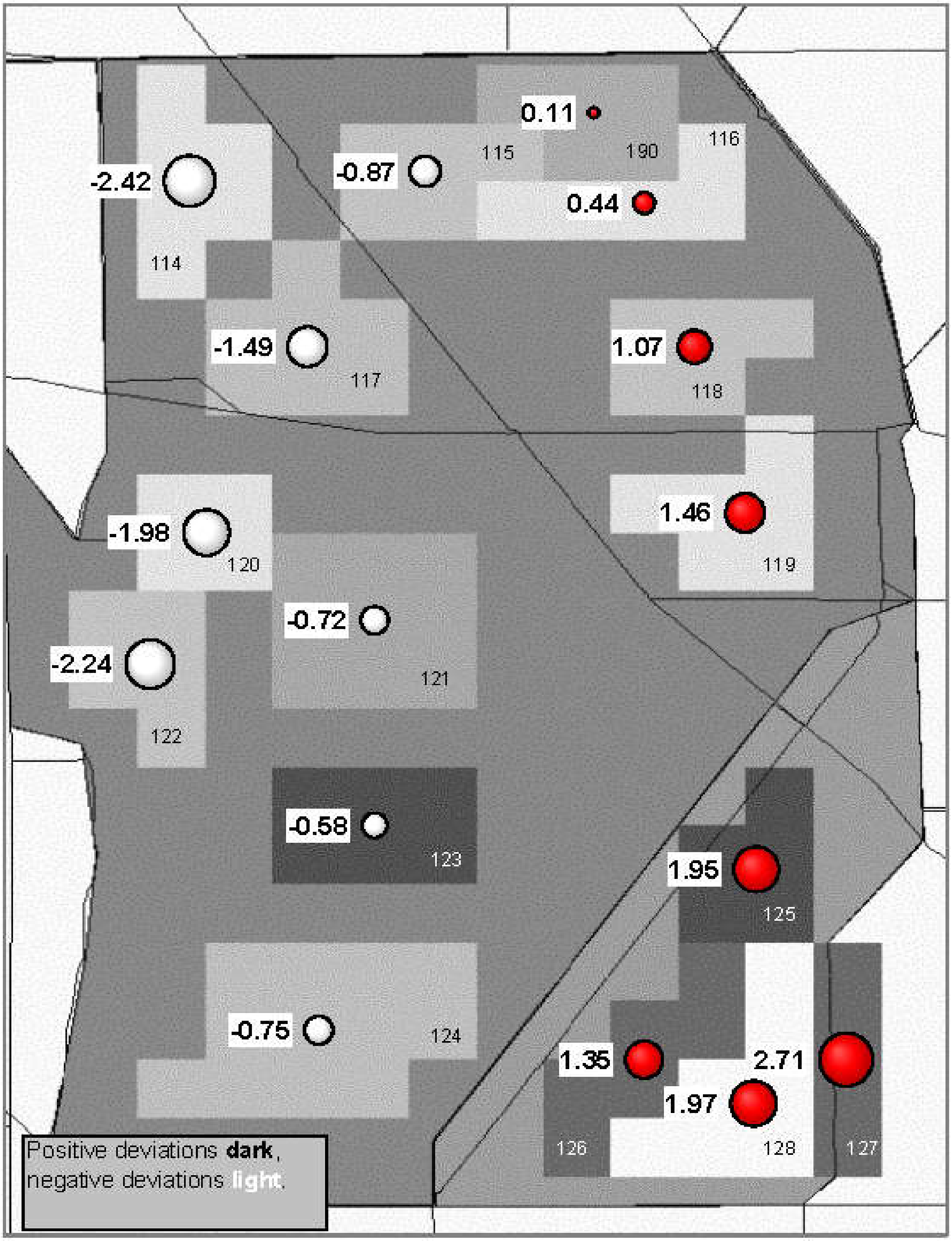

Figure A-5. Seasonal rainfall for dry season with median rainfall (1979; deviation from mean of 17.86 inches).

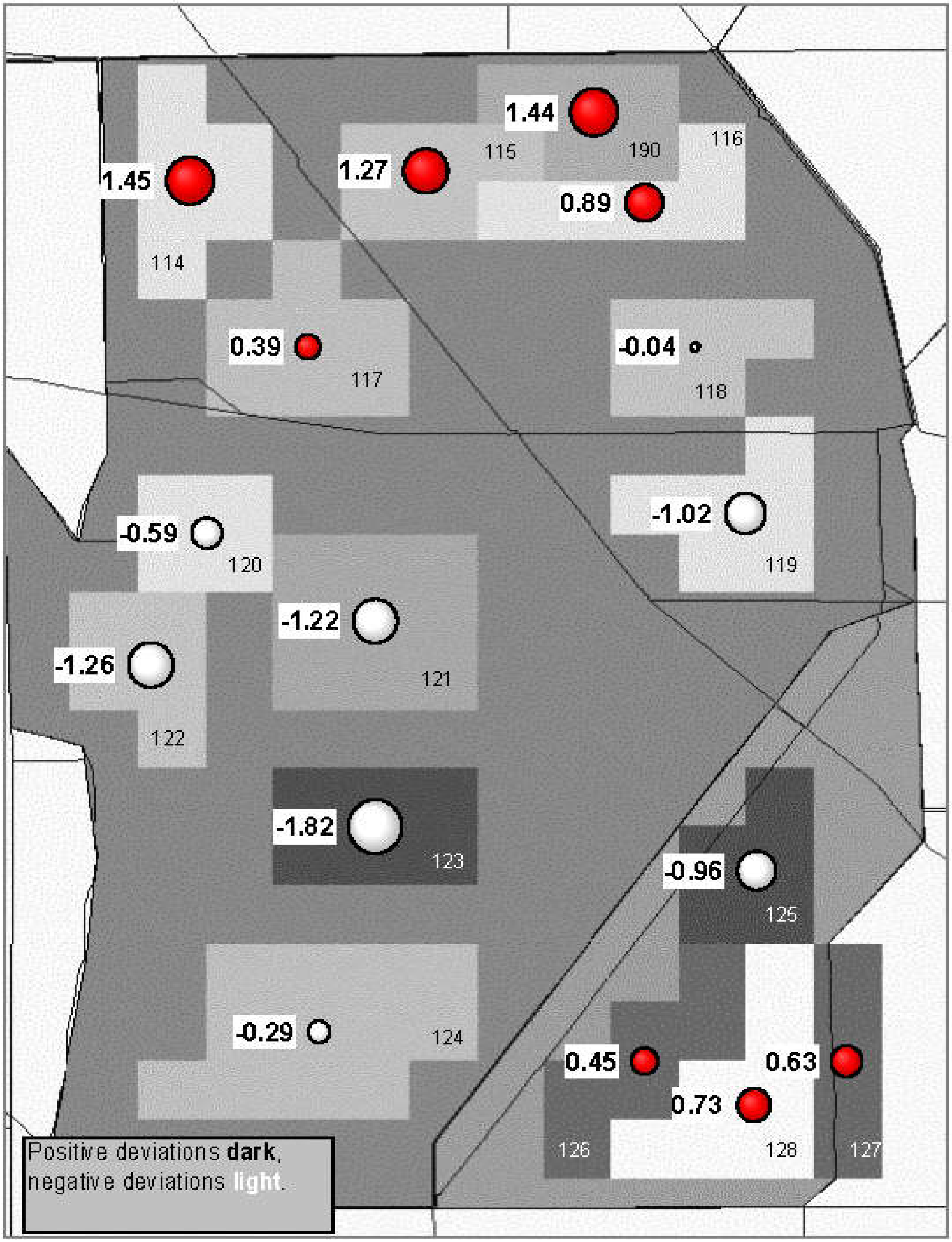

Figure A-6. Seasonal mean rainfall for dry season with median rainfall (1983; deviation from mean of 18.05 inches).

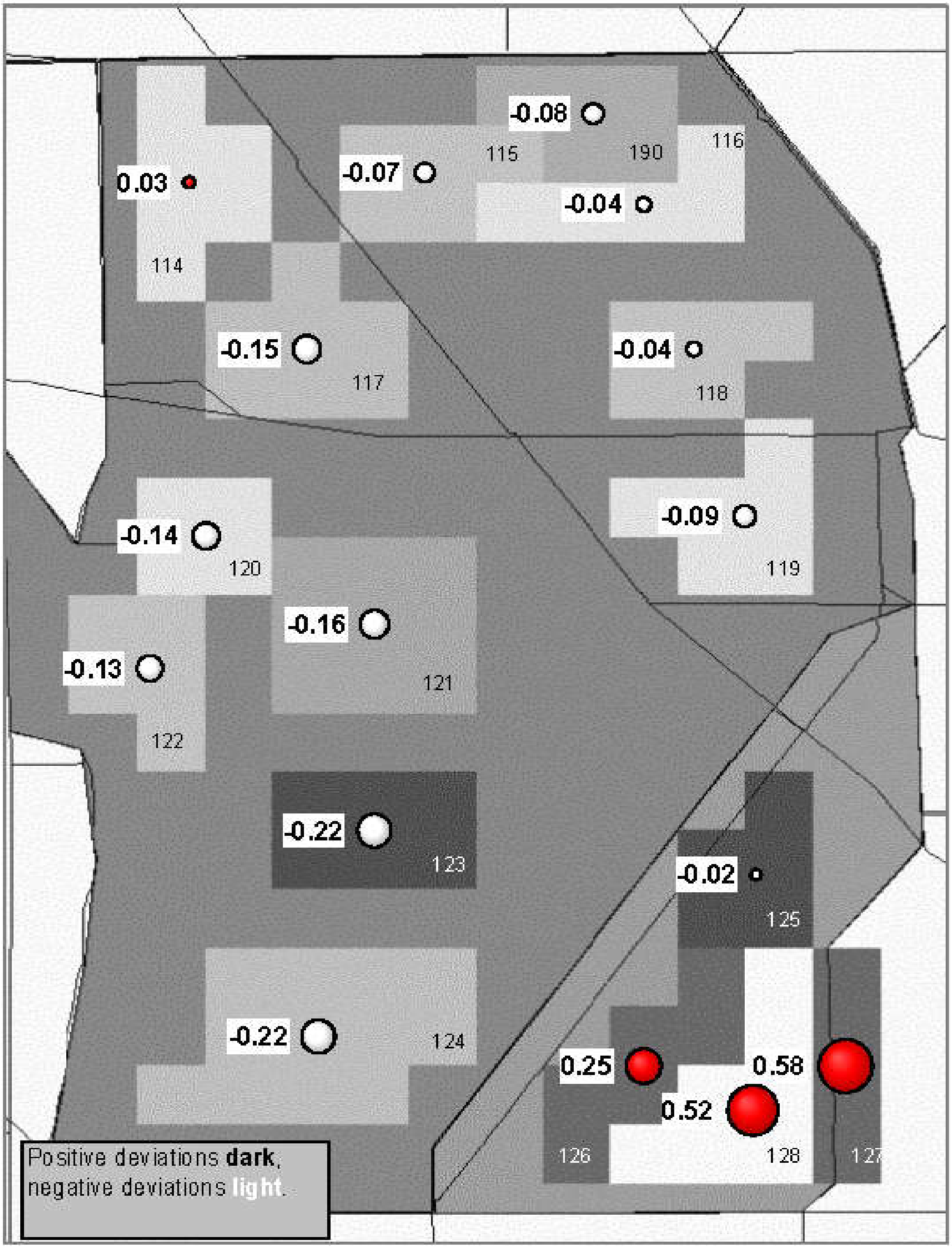

Figure A-7. Evapotranspiration for wet season with minimal ET (1999; deviation from mean of 24.42 inches).

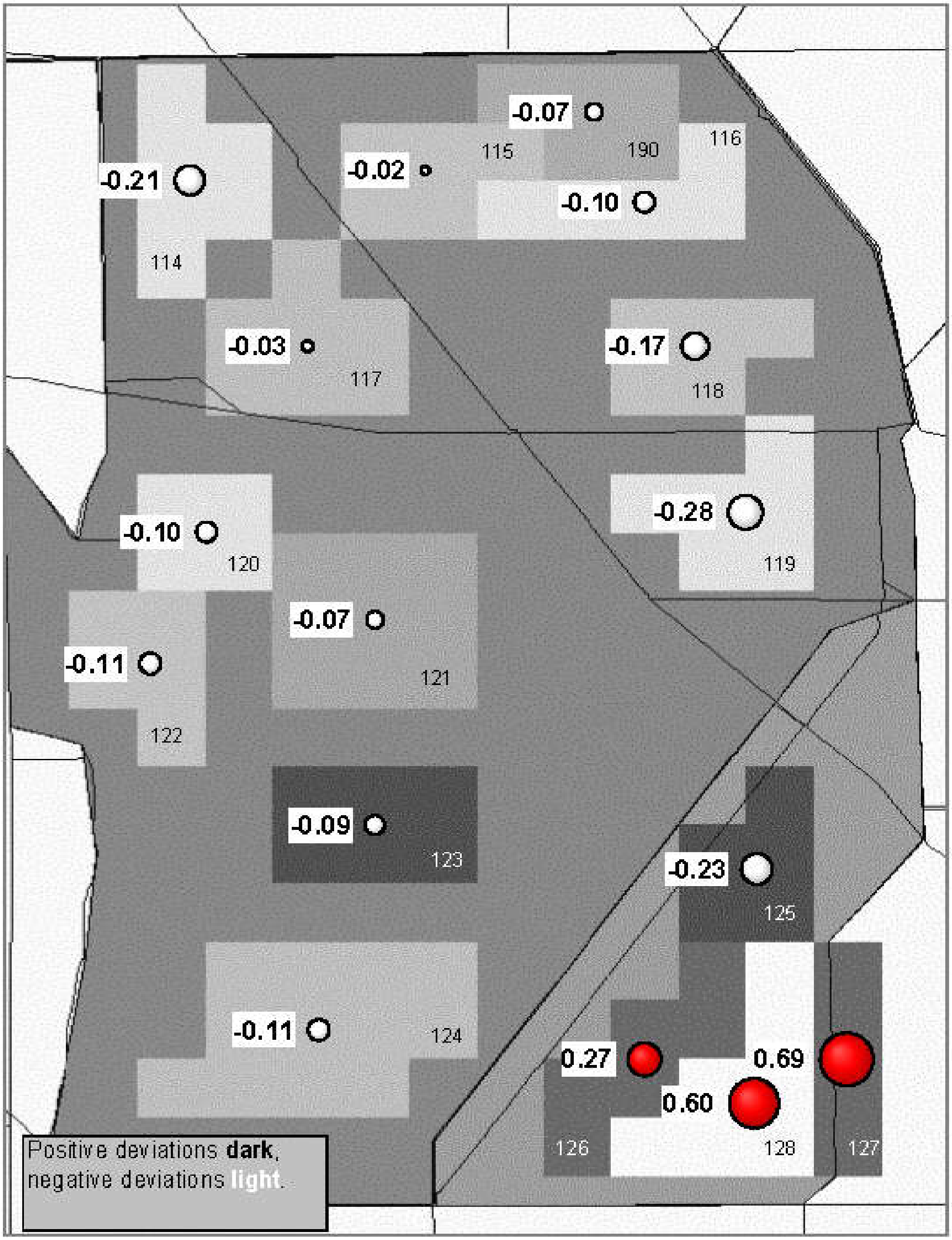

Figure A-8. Seasonal evapotranspiration for wet season with median ET (1986; deviation from mean 25.83 inches).

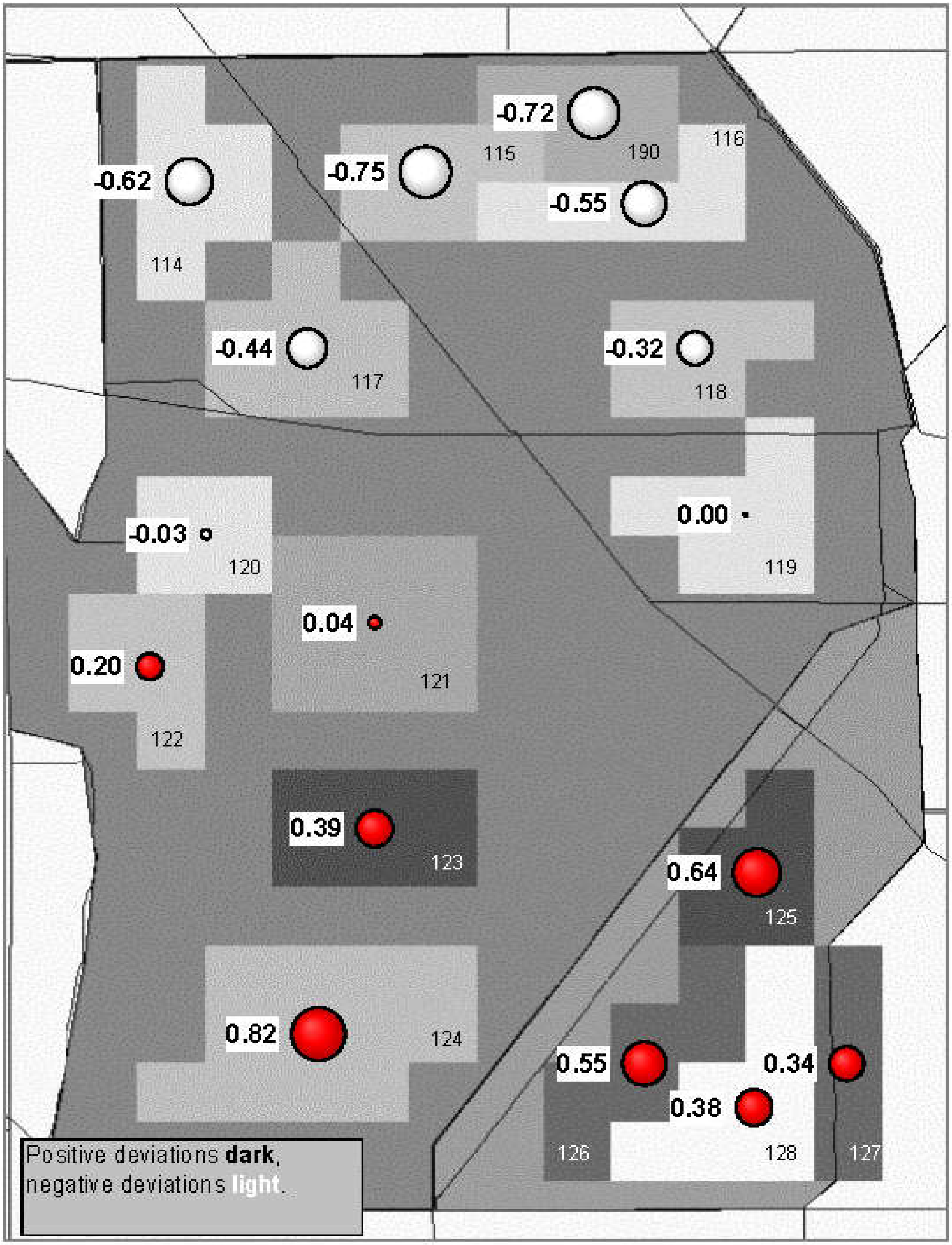

Figure A-9. Seasonal evapotranspiration for wet season with median ET (1988; deviation from mean 25.70 inches).

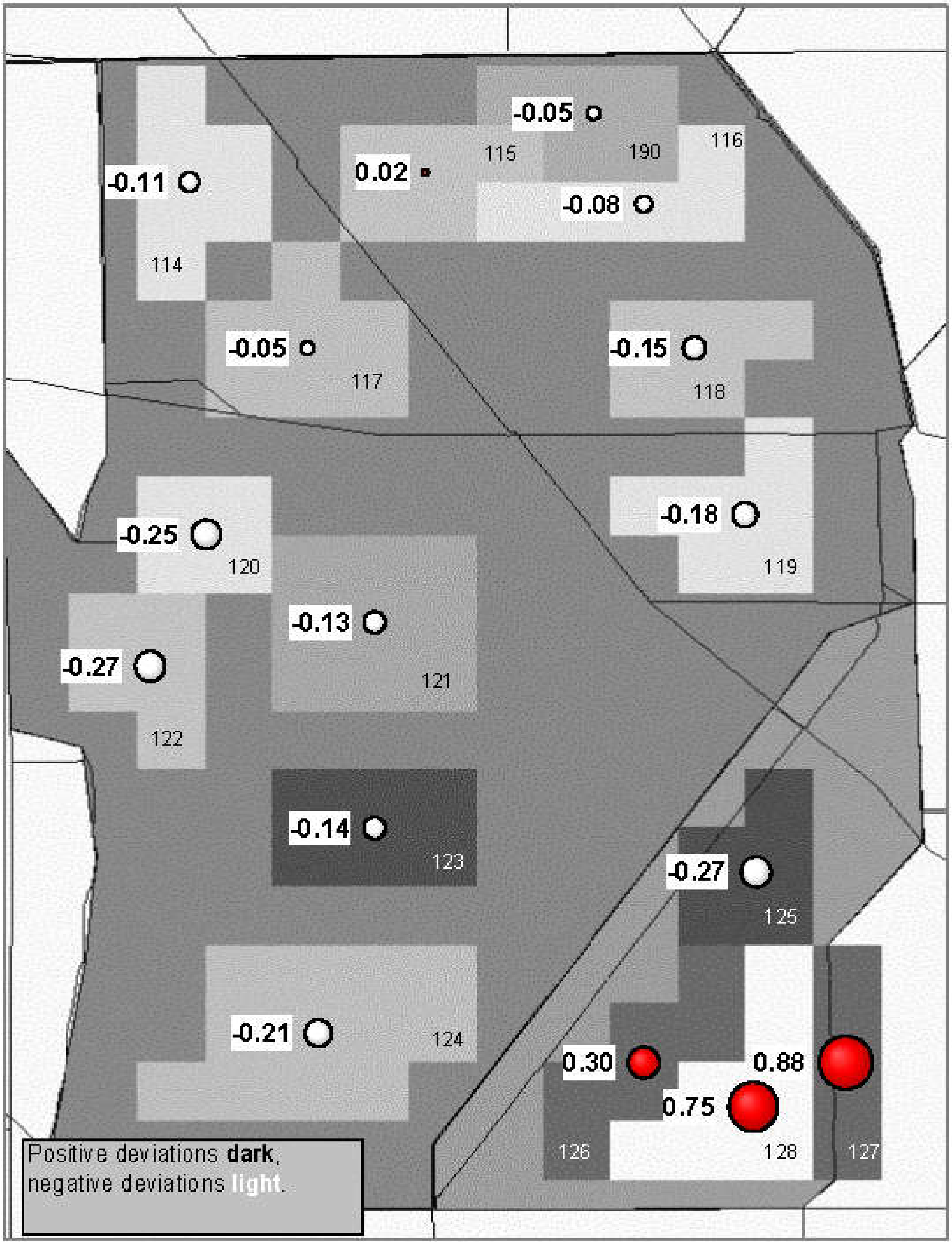

Figure A-10. Seasonal evapotranspiration for dry season with maximum ET (1970; deviation from mean of 33.64 inches).

APPENDIX B: DATASET DESCRIPTIONS FOR FLOW AND STAGE DATA

Table B-1. Stage Stations and DBKEYs.

Station	DBKEY	Station	DBKEY
3-34	P1083	3AN1W1	OH538[1]
3-62	16536	3A-NE_B	P1078
3-63	16532	3A-NW_B	P1079
3-64	16537	3A-NW_H	-[2]
3-65	16538	3A-S_B	P1080
3-69	P1037	3AS3W1_H	M6883
3-71	P1082	3A-SW_B	P1081
3-76	P1069	3BS1W1_H	M6889
3A-10_B	P1071	3B-SE_B	P1084
3A-11_B	P1072	ALLYGW_GW1	P6836[3]
3A-12_B	P1098	ALLYGW_GW2	P6834[3]
3A-160	02157	ALLYGW_GW3	P6842[3]
3A-2_G	P1073	G69_H	(MULTI)
3A-28_G	P1074	L28	P0809
3A-3_G	P1075	L30	-
3A-4_G	P1076	SHARK.1_H	P0900
3A-9_B	P1077		

Underlined stations are also represented in ELM (ELM Developers)

Highlighted DBKEYs were retrieved from the HSM databse; Non-highlighted DBKEYs were retrieved from DBHydro.

[1] Data for OH538 begin on 18-Jul-2002, outside the period of consideration.

[2] 3A-NW_H will not be considered here, since the only DBKEY available is 07602, which is a daily water reading.

[3] Data for P6836, P6834, and P6842 begin on 01-Nov-2001, outside of the period of consideration. DBKEYs OB338, OB339, and OB340 also belong to ALLYGW_GW1, ALLYGW_GW2, and ALLYGW_GW3, respectively; but since they apparently do not contain surface water data (Data Values ≈ 40.0), they are not used here.

[4] Two DBKEYs were found for G69_H: 05422 and 16513.

Table B-2. Flow Structures and DBKEYs.

Inflow Structures		**Outflow Structures**	
Site	**DBKEY**	**Site**	**DBKEY**
G155	P1039[1]	G69	(MULTI)[5]
G204	P1042[1]	G70	(NONE)[2]
G205	P1043[1]	S12A	P0796
G206	P1044	S12B	P0950
G64	06948[2]	S12C	P0951
S11A	15258[3]	S12D	P0952
S11B	15259[3]	S142	K5494
S11C	15260[3]	S31	P0991
S140	P0956	S333	P0997
S150	P0961	S337	P1001
S190	P0974	S343A	(MULTI)[5]
S8	P1024	S343B	(MULTI)[5]
S9	P1026	S344	P1007
S11 (Total)	P1067[4]	S355A	MQ895[2]
Internal Flow Structures		S355B	MQ896[2]
Site	**DBKEY**	S343 (Total)	P1006[4]
S339	P1003		
S340	P1005		
S151	P0962		

[1] The Site field is empty in the header of DBKEYS P1042, P1043, and P1044; the Station value is given in its place.

[2] No flow records are available for G64, G70, S355A, and S355B. Flow is assumed to be zero during WY 1989 to 1999.

[3] The records of DBKEYS 15258, 15259, and 15260 do not contain enough data to report here.

[4] DBKEYs P1067 and P1006 correspond to *groups* of structures.

[5] Multiple DBKEYs are available for G69, S343A, and S343B: (06762, 16512, 16526, KE943, K5480), (06902, 16193), and (06905, 16196), respectively.

APPENDIX C: DETAILS ON PLOTS OF FLOW DATA

Seasonal mean volumes, presented in graphical format in Chapter [X] (indicated by the dark horizontal lines) and in this appendix are computed by taking the mean of the net flows for each season. Seasonal mean volumes corresponding to records with missing values are calculated by dividing the sum of all the mean daily flow values for the season (e.g. the sum of values for June to October 2000, June to October 1999, etc.) then dividing by the total number of days for which a value of flow is available; the resulting quotient is then multiplied by the number of days in the period of record, for that season; alternatively:

$$\mathrm{SMV} = \mathrm{N/M}\ \Sigma_{i=1,M}\ \mathrm{MDF}_i \qquad (1)$$

Where SMV is the seasonal mean volume, MDF_i is the mean daily flow for day i, M is the number of MDFs available, and N is the total number of days in the period of record, for the given season (note that the dry season of a particular year has either 212 or 213 days, because of leap year). For example, the SMV for a wet season (153 days) where the mean daily flow is 50 cfs for the first 60 days, then zero for 80 days, then missing for the remainder of the season, would be 153/140 * [(50 + 50 + 50 + … + 50) + (0 + 0 + 0 + … + 0)] = 153/140 * [60*50 + 80*0] ≈ 3279 cfs-days ≈ 6502 ac-ft.

SEASONAL FLOW THROUGH WCA-3 STRUCTURES

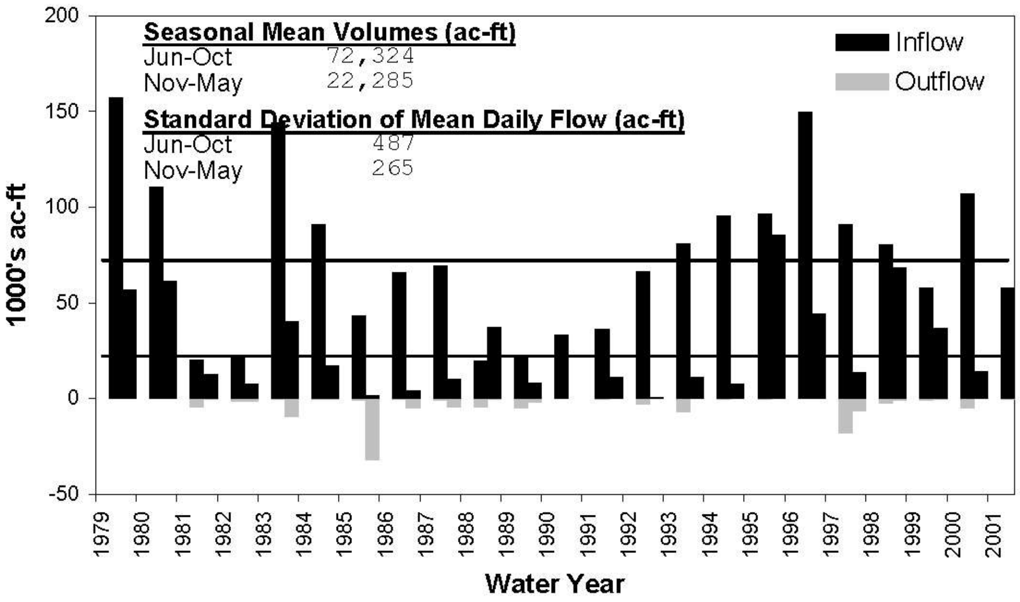

Figure C-1. Seasonal flow for G155.

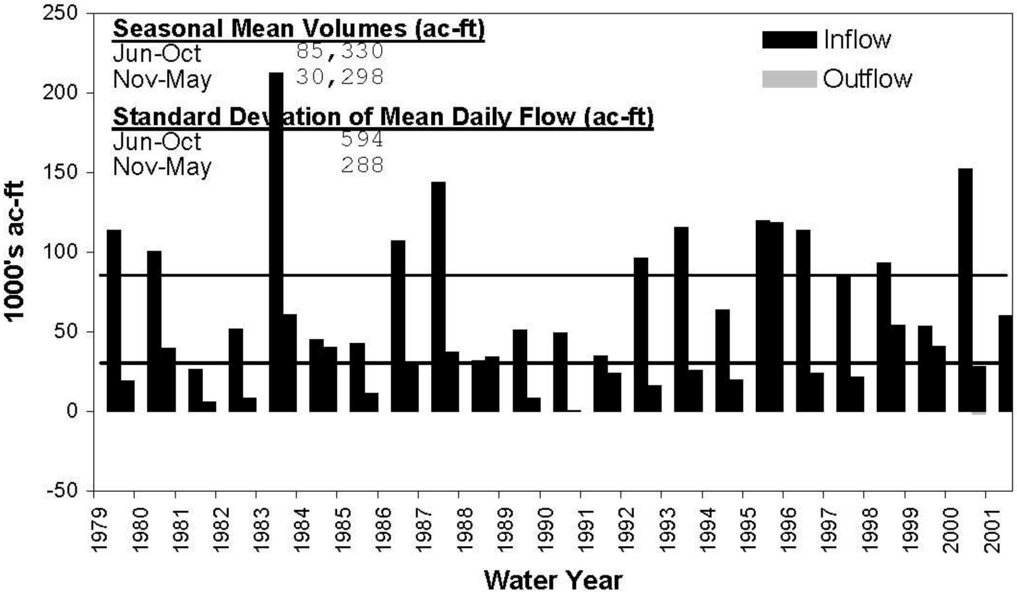

Figure C-2. Seasonal flow for S140.

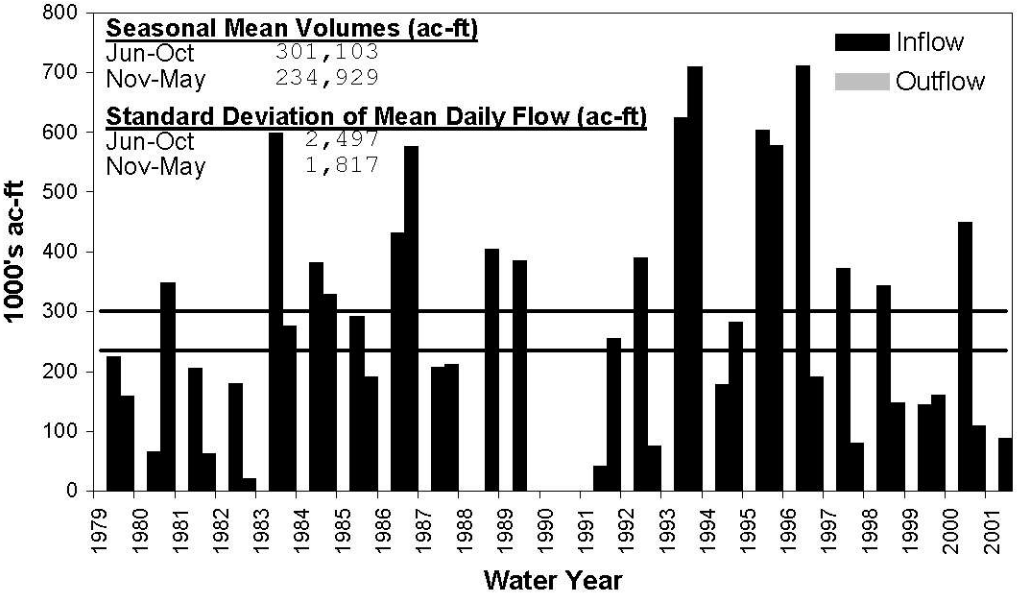

Figure C-3. Total seasonal flow for S11A, S11B and S11C.

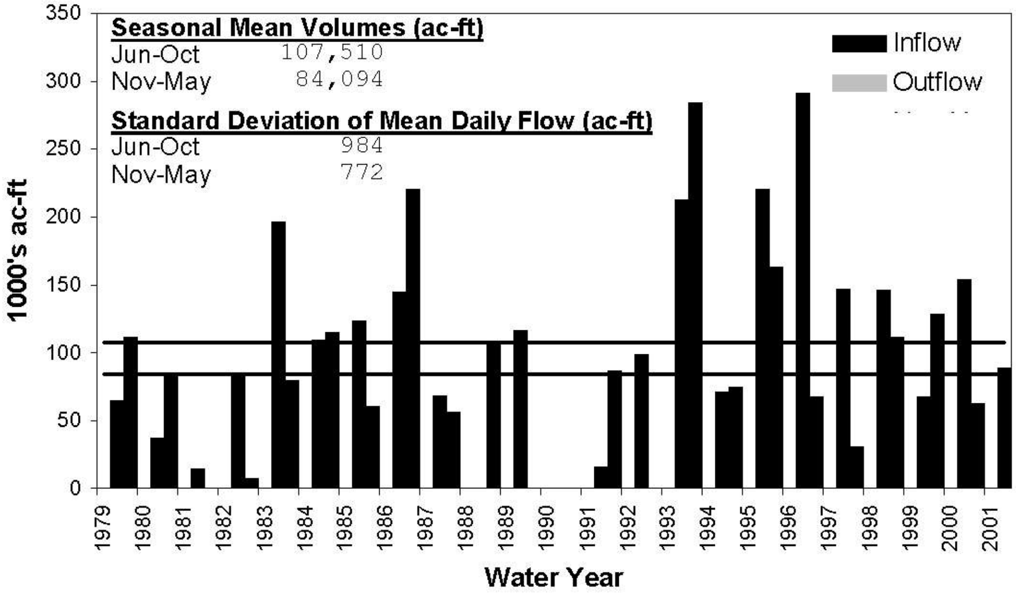

Figure C-4. Seasonal flow for S11A.

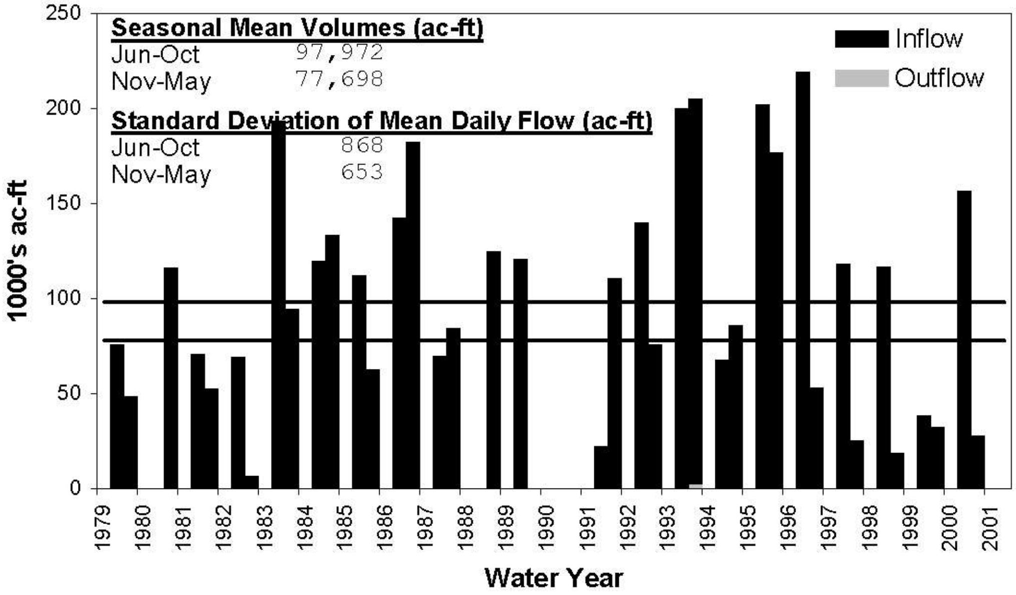

Figure C-5. Seasonal flow for S11B.

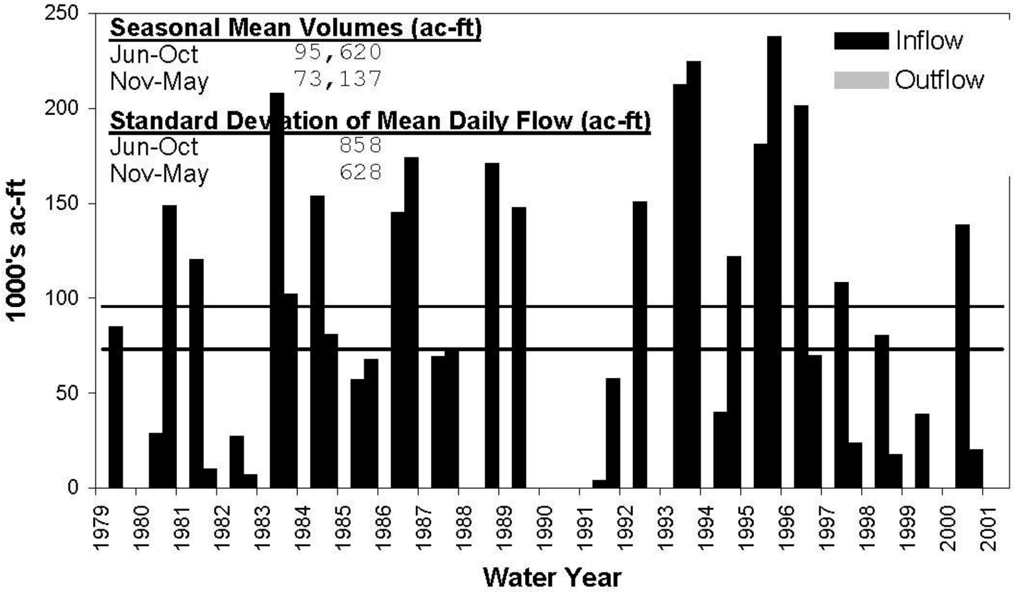

Figure C-6. Seasonal flow for S11C.

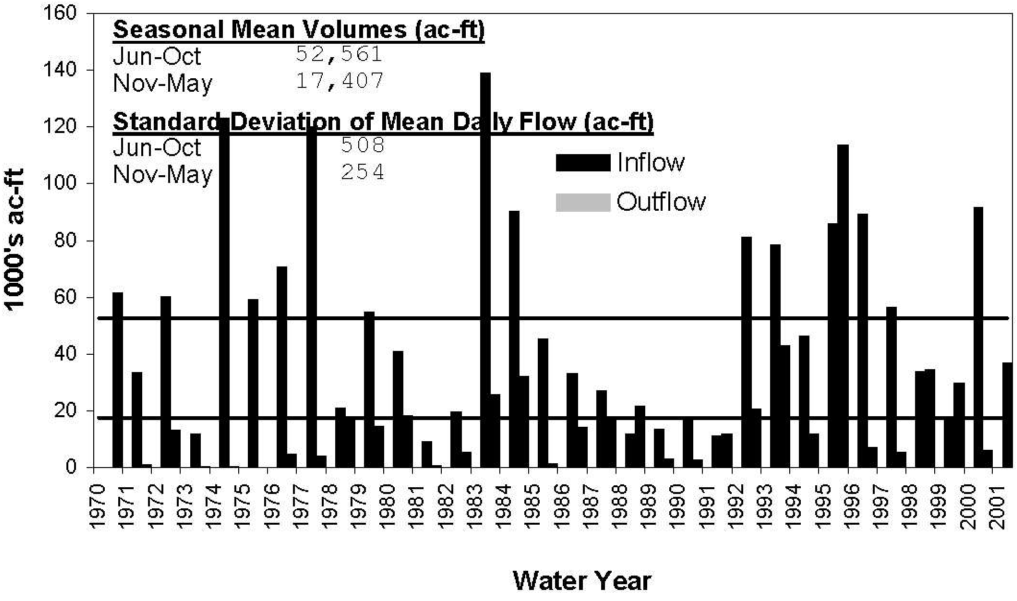

Figure C-7. Seasonal flow for S190.

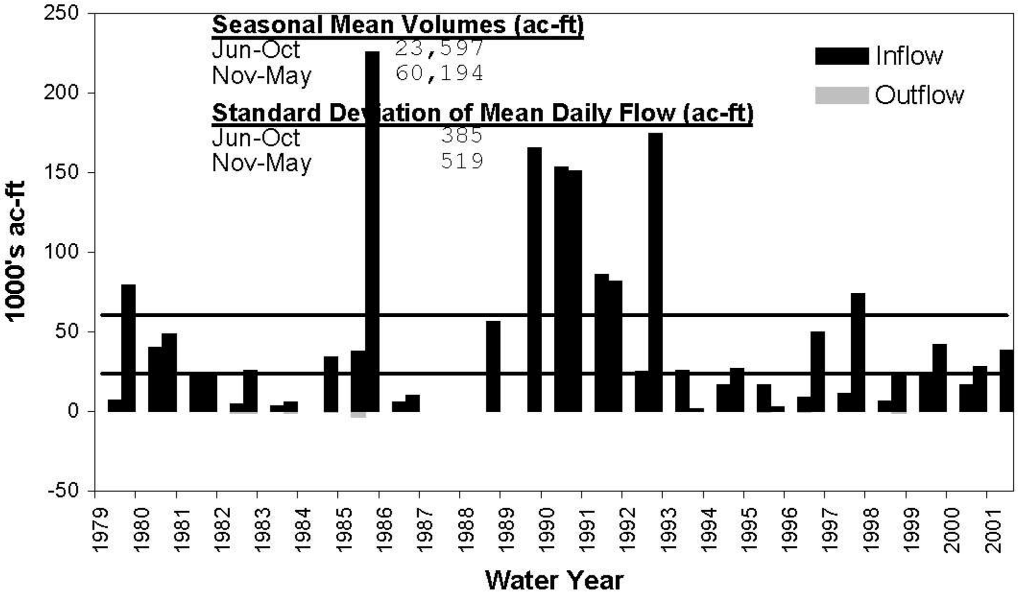

Figure C-8. Seasonal flow for S150.

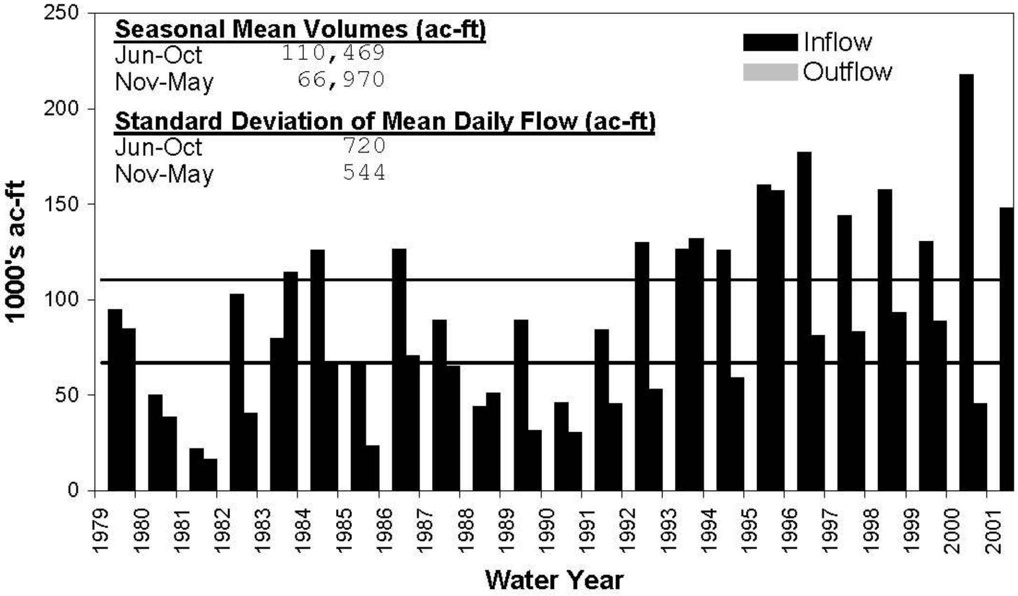

Figure C-9. Seasonal flow for S9.

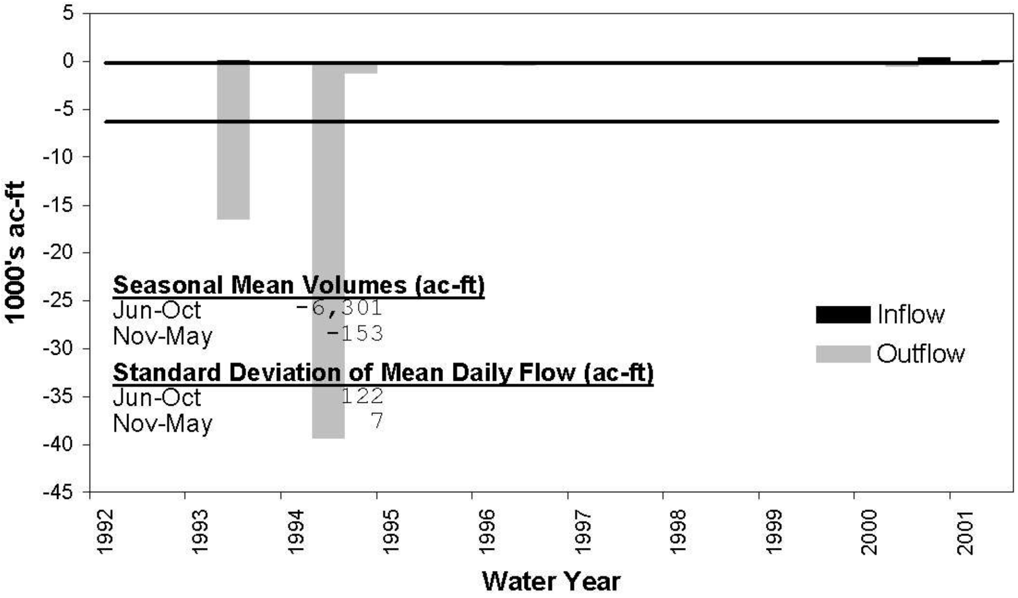

Figure C-10. Seasonal flow for G204.

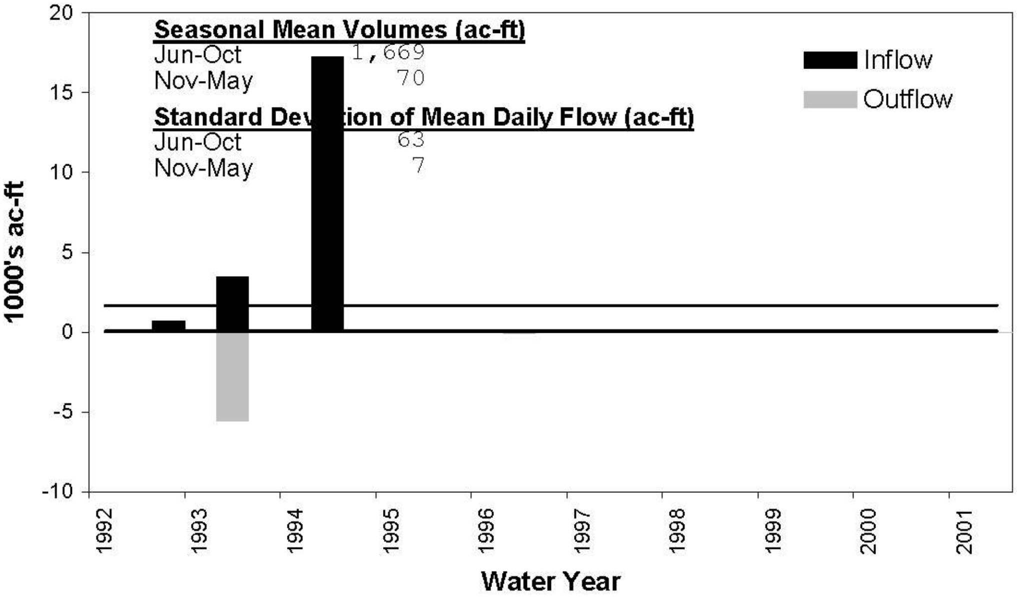

Figure C-11. Seasonal flow for G205.

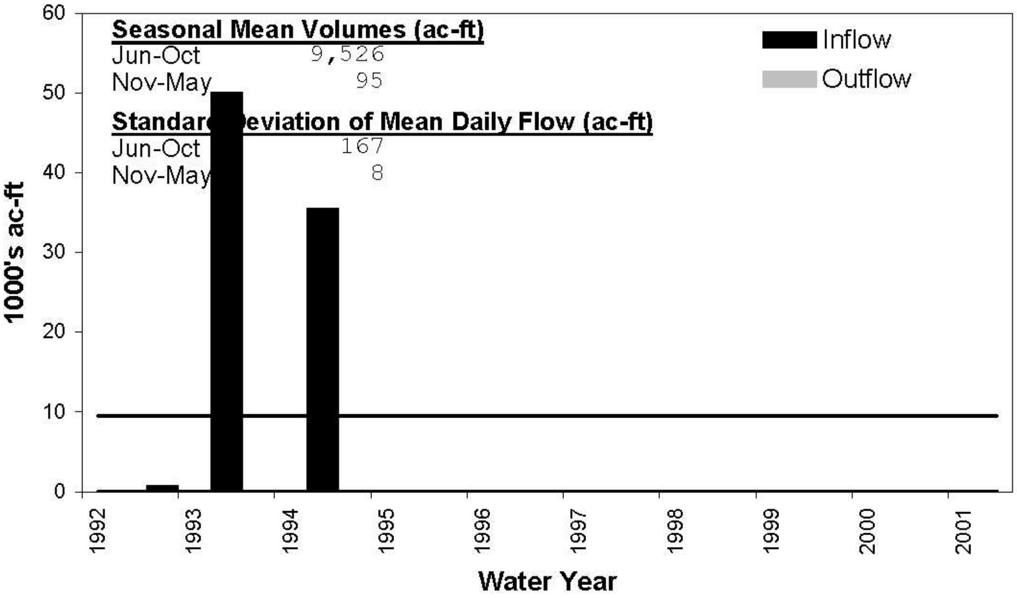

Figure C-12. Seasonal flow for G206.

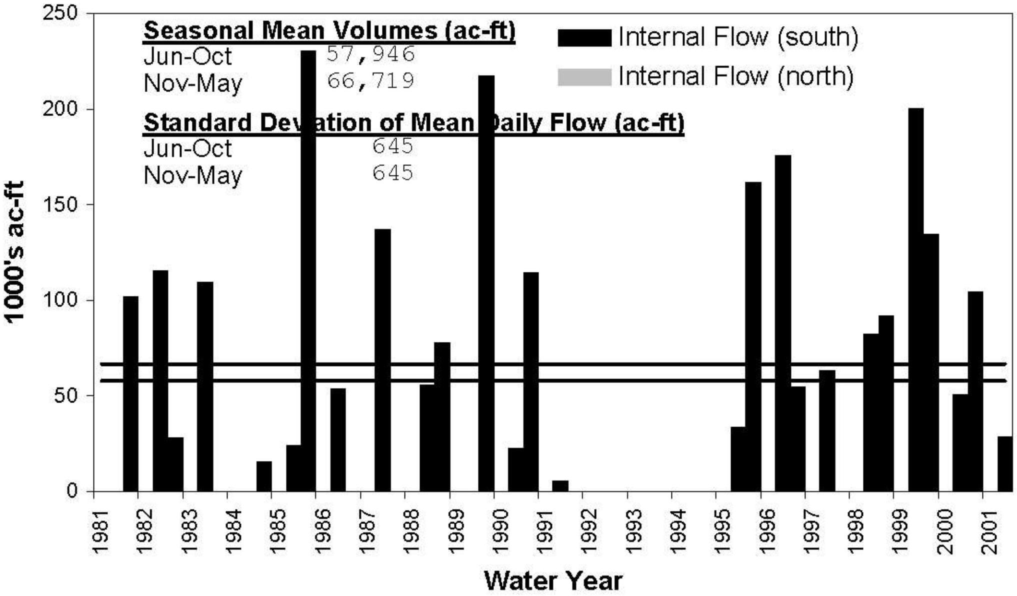

Figure C-13. Seasonal flow for S339.

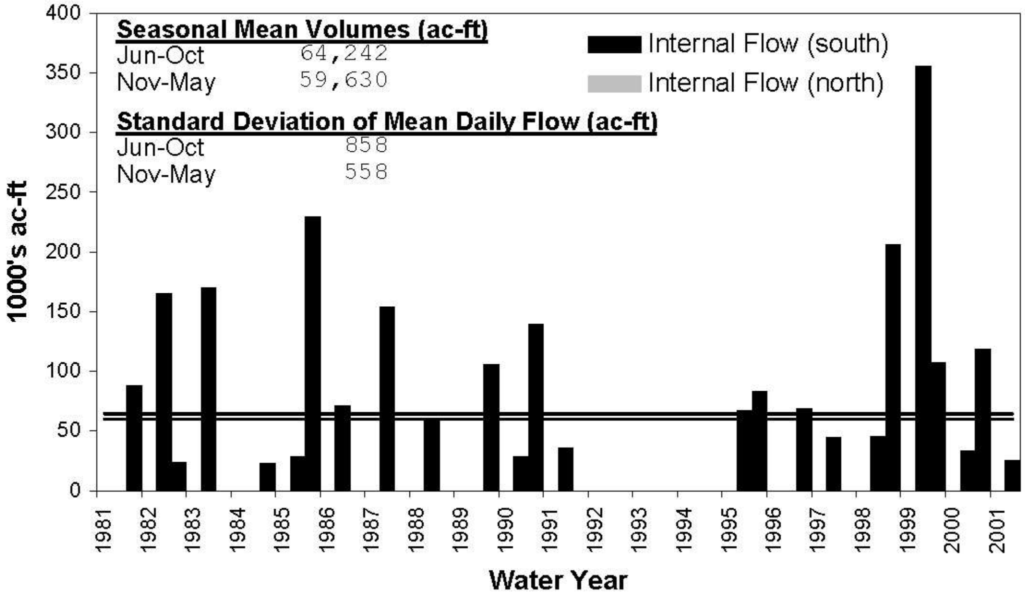

Figure C-14. Seasonal flow for S340.

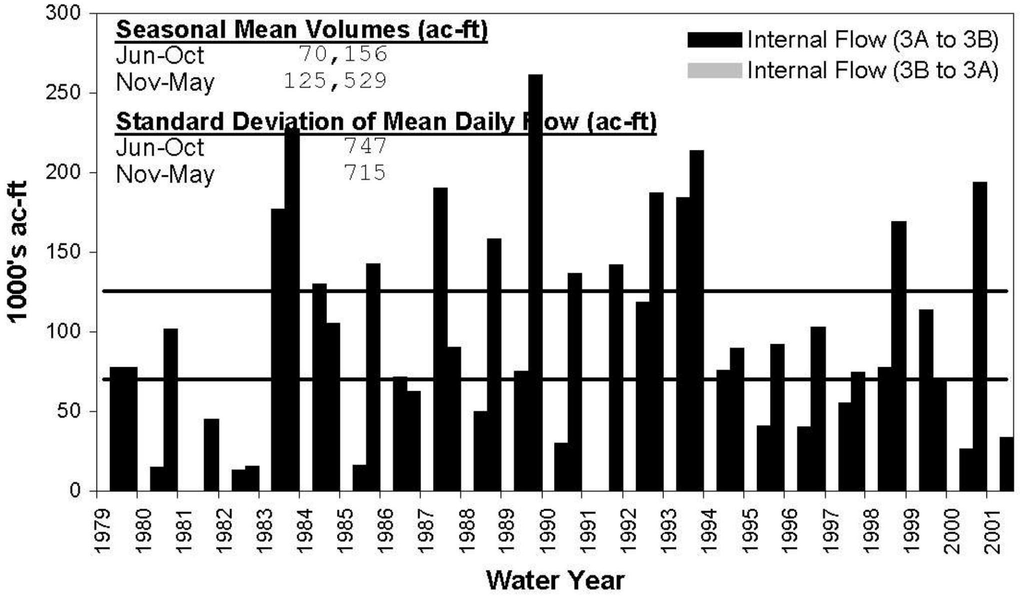

Figure C-15. Seasonal flow for S151.

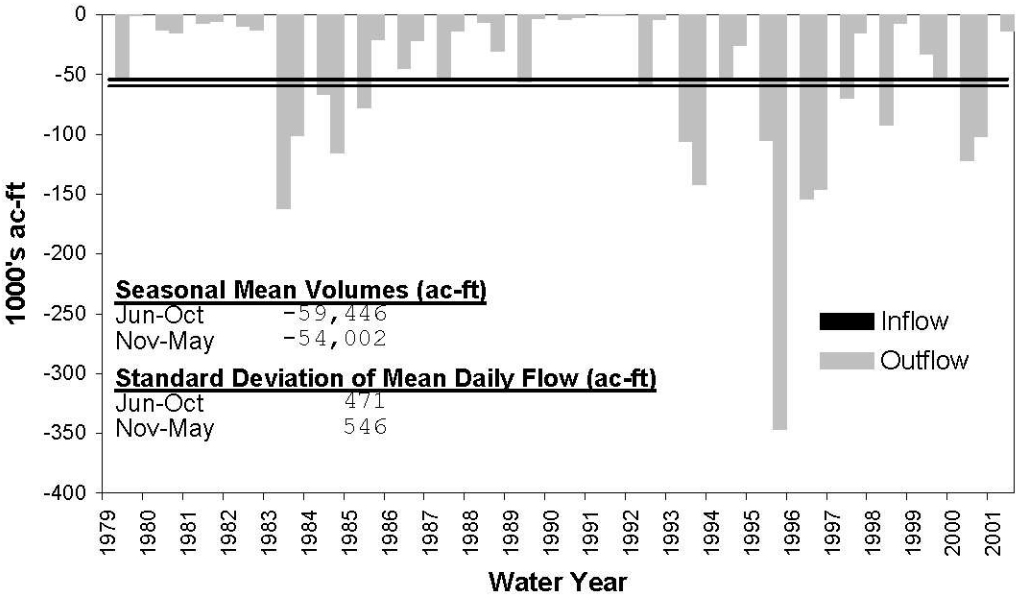

Figure C-16. Seasonal flow for S12A.

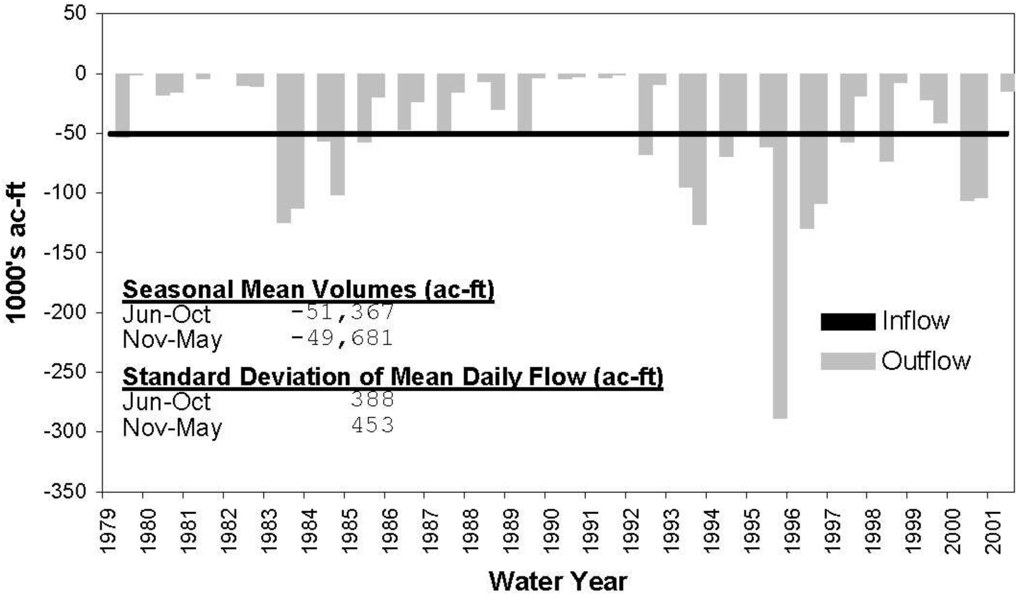

Figure C-17. Seasonal flow for S12B.

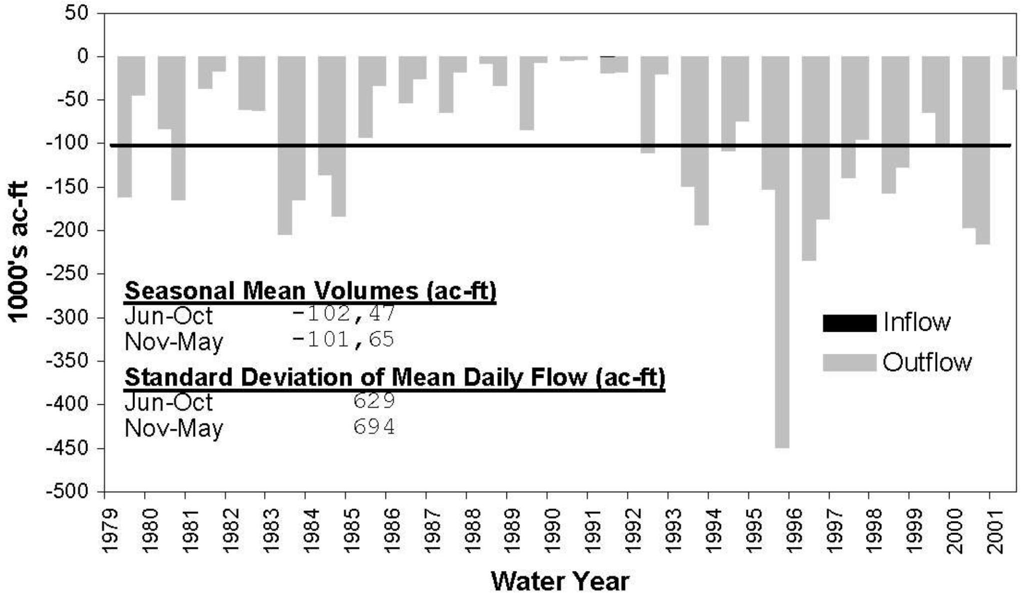

Figure C-18. Seasonal flow for S12C.

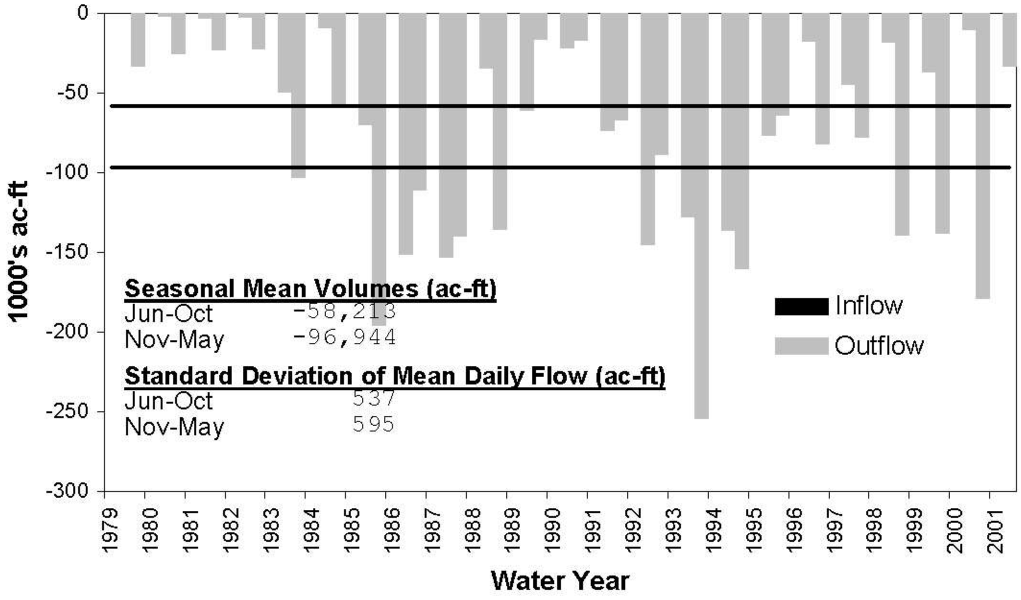

Figure C-19. Seasonal flow for S333.

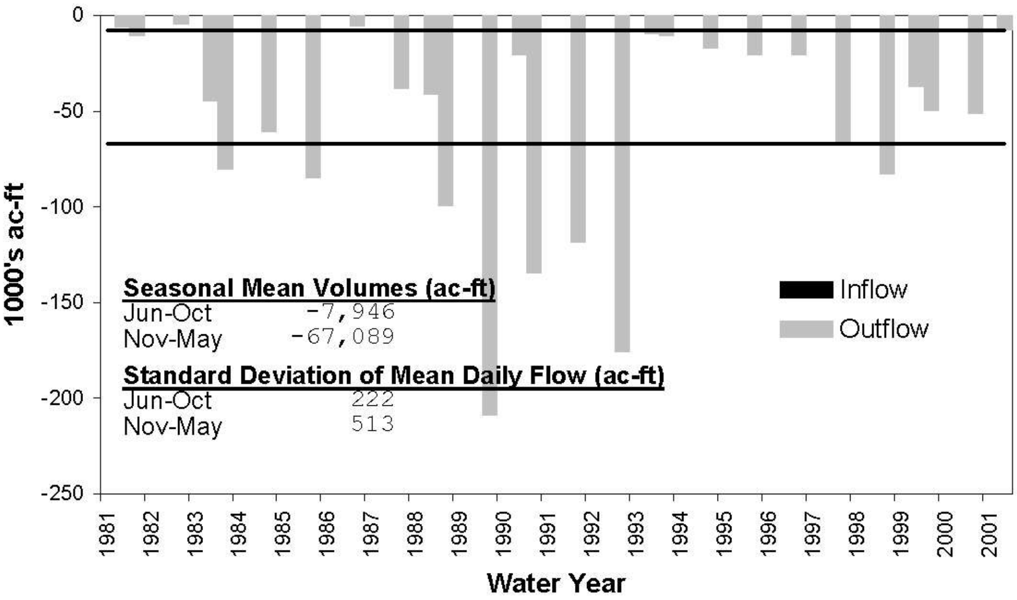

Figure C-20. Seasonal flow for S337.

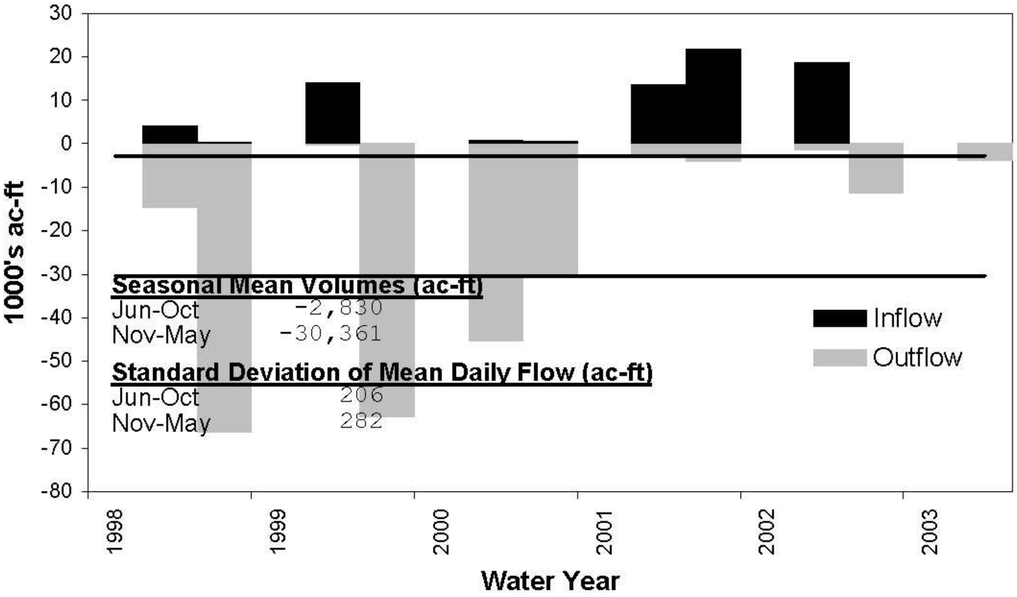

Figure C-21. Seasonal flow for S142.

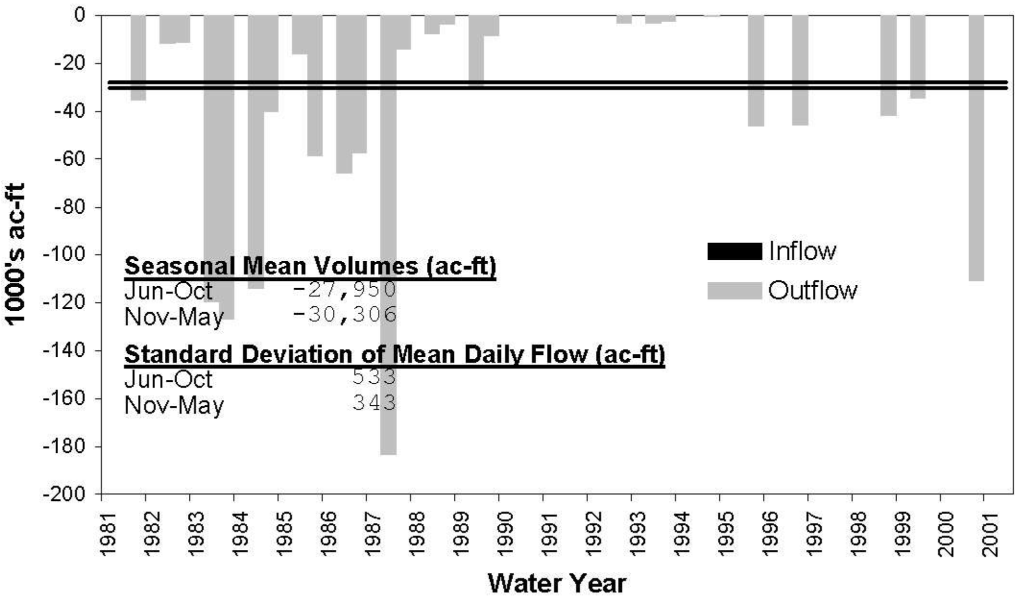

Figure C-22. Seasonal flow for S31.

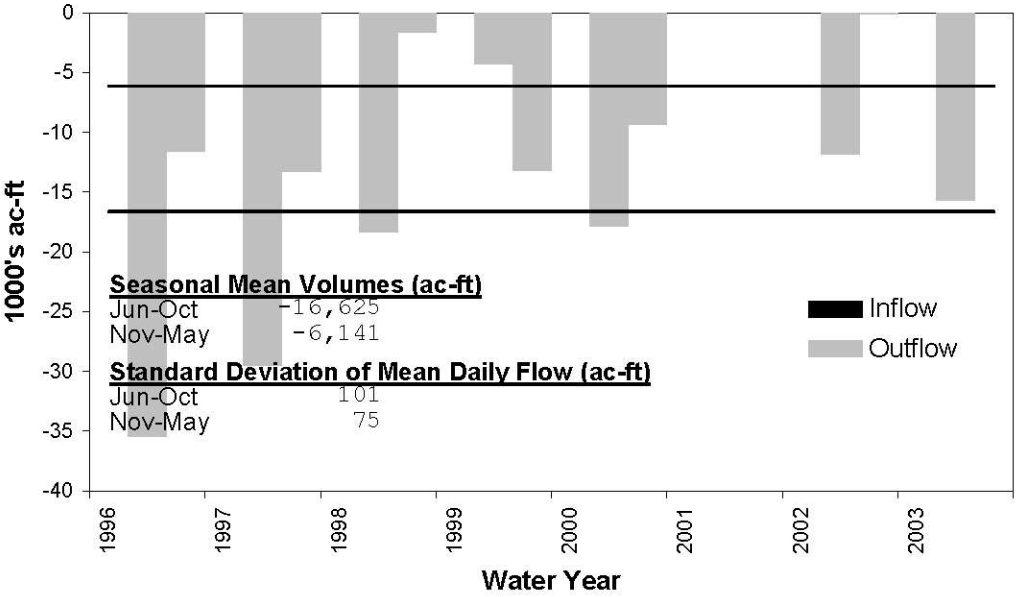

Figure C-23. Seasonal flow for S343A.

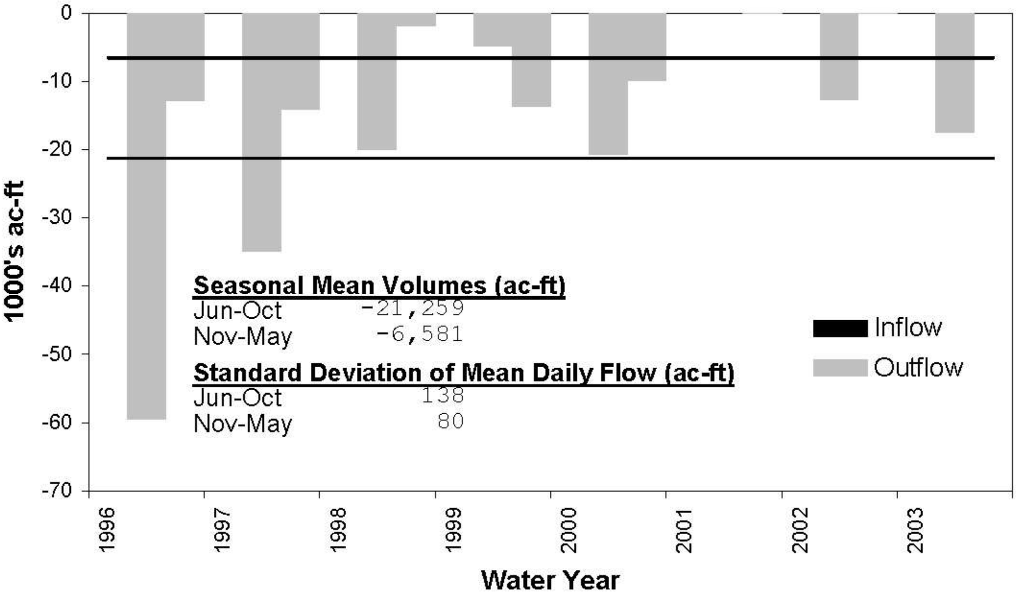

Figure C-24. Seasonal flow for S343B.

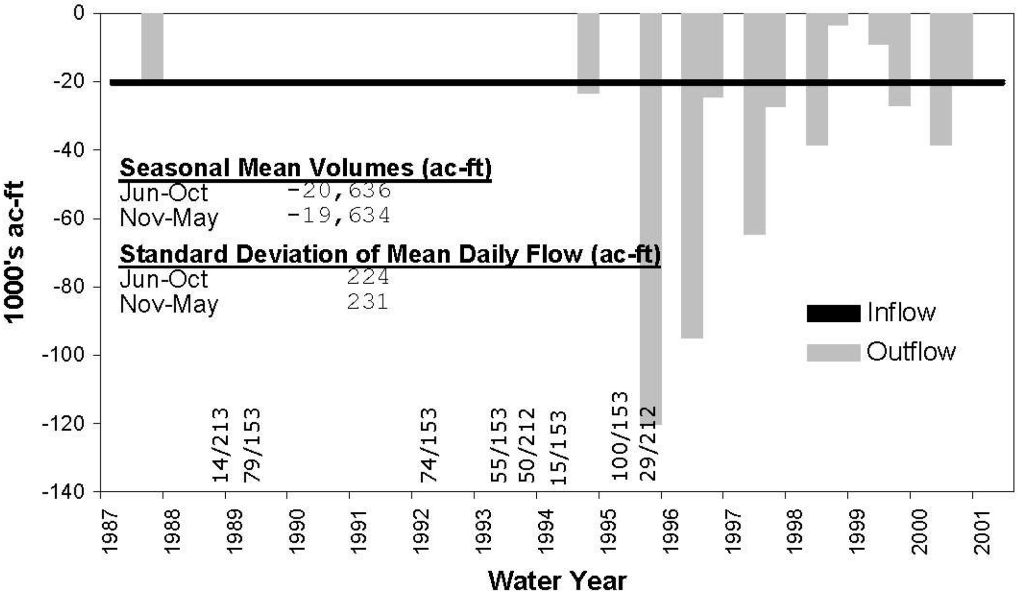

Figure C-25. Total seasonal flow for S343A and S343B.

Note: Text aligned vertically within plotting region denotes the number of missing values for the respective time period (Number missing/Number of days in season).

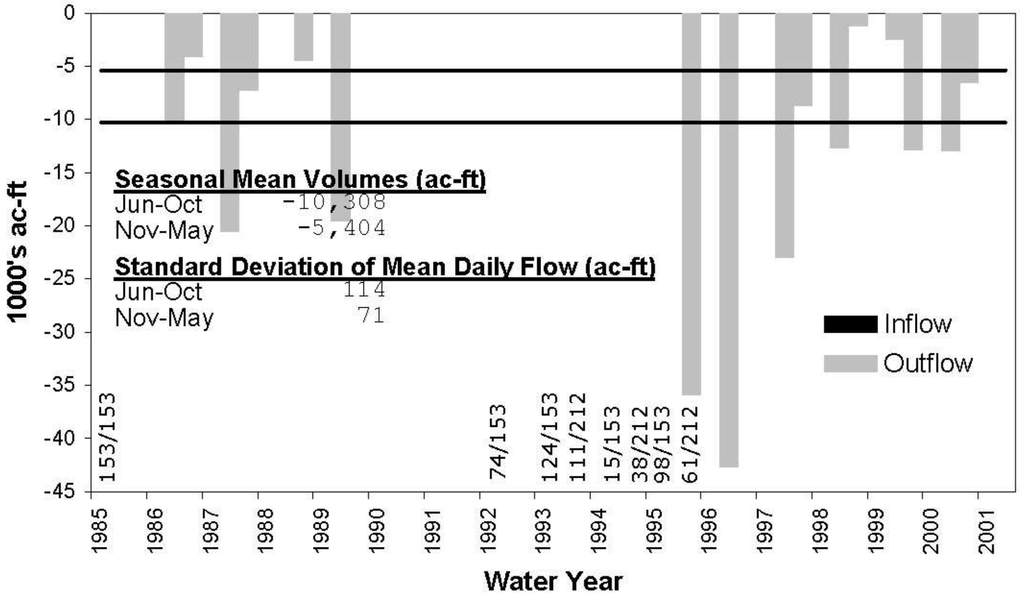

Figure C-26. Seasonal flow for S344.

Note: Text aligned vertically within plotting region denotes the number of missing values for the respective time period (Number missing/Number of days in season).

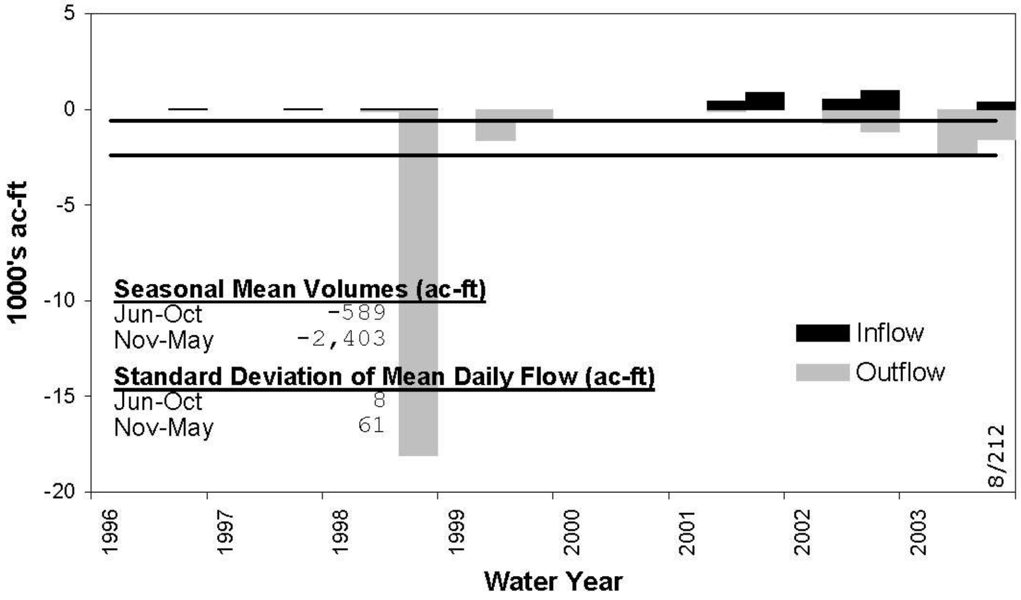

Figure C-27. Seasonal flow for G69.

Note: Text aligned vertically within plotting region denotes the number of missing values for the respective time period (Number missing/Number of days in season).

APPENDIX D: SUMMARY STATISTICS FOR ANNUAL TOTAL PHOSPHORUS CONCENTRATIONS

Table D-1. Annual summary statistics for TP concentration at individual stations (ppb, from Weaver et al., [ECR03, Appendix 2A-3, Table 3]).

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
3AE0	INFLOW	2000	77.1	54		82		110
3AE0	INFLOW	2001	94.9	55	65.5	87.8	138	240
3AE0	INFLOW	2002	57.7	31	49	54	74	100
3AW0	INFLOW	2000	60.2	33		71.5		110
3AW0	INFLOW	2001	65.4	48	50.5	63.5	86	89
3AW0	INFLOW	2002	53.2	29	39	49.5	72	100
C123SR84	INFLOW	1988	59.9	25	30.3	78	93.5	107
C123SR84	INFLOW	1989	45.1	29	30.3	49.5	60.3	77
C123SR84	INFLOW	1990	54.4	29	40	56	66.5	98
C123SR84	INFLOW	1991	38.9	18	26	38	62	112
C123SR84	INFLOW	1992	27.5	9	15	33	50	73
C123SR84	INFLOW	1993	15.6	7	10	17	22	36
C123SR84	INFLOW	1994	29.5	17	17	23	54	104
C123SR84	INFLOW	1995	54.1	16	24	51	90	262
C123SR84	INFLOW	1996	42.5	15	33	46	62	78
C123SR84	INFLOW	1997	34.3	13	18	36	59	90
C123SR84	INFLOW	1998	33.6	17	21	33	53	82.3
C123SR84	INFLOW	1999	47	13	22	56	110	133
C123SR84	INFLOW	2000	31.1	12	15	37	67	103
C123SR84	INFLOW	2001	45.7	13	30	49	70	136
C123SR84	INFLOW	2002	23.7	11	15.5	25	35.5	44
G123	INFLOW	1983	4.31	<4	<4	5	8	8
G123	INFLOW	1985	15.5	11	11	14	24	24
G123	INFLOW	1986	22	8	12	24	41.5	47
G123	INFLOW	1987	15	15		15		15
G123	INFLOW	1988	19.4	10	17.5	21.5	24	24
G123	INFLOW	1989	42	22	22	42	80	80
G123	INFLOW	1990	17	12	12	15	25	34
G123	INFLOW	1991	17.6	9	13.3	16.5	25	31
G123	INFLOW	1992	13.1	8	9	11	18	28
G123	INFLOW	1993	10	10		10		10
G123	INFLOW	1995	12.9	5	8	15	21	21
G123	INFLOW	1996	31	30		31		32
G123	INFLOW	1997	16	6	9.5	18	27.5	30
G123	INFLOW	1998	14.6	4	12	19	22	22
G123	INFLOW	1999	16.2	10	10.5	14	32.5	51
G123	INFLOW	2000	16.2	8	13	17	22	25
G123	INFLOW	2001	11.8	8	10	11	13	22
G123	INFLOW	2002	15.6	9	13	16	18	41
G204	INFLOW	1990	37.7	24	24.5	39	59.5	62

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
G204	INFLOW	1991	30.8	24	26	28	39	46
G204	INFLOW	1992	43.9	15	27.5	37.5	58.5	325
G204	INFLOW	1993	29.4	9	19	29	42	88
G204	INFLOW	1994	46.8	29	29	52	68	68
G204	INFLOW	1995	35.5	15	15.8	40	86.8	95
G204	INFLOW	1996	94.9	33	51	110	182	205
G204	INFLOW	1997	38.9	22	25.8	41.5	57.3	61
G204	INFLOW	1998	43.9	31	31.8	44	62.3	65
G204	INFLOW	1999	48	38	38.8	42	70	79
G204	INFLOW	2000	86.6	26	37.5	94	223	259
G204	INFLOW	2001	40.3	18	22.5	30	124	214
G204	INFLOW	2002	61.5	54		62		70
G205	INFLOW	1990	30.3	18	20.8	31	45	49
G205	INFLOW	1991	20.9	19	19	19	24.5	29
G205	INFLOW	1992	40.4	12	23	34	57.3	394
G205	INFLOW	1993	31.3	10	17	30	68	81
G205	INFLOW	1994	59.1	16	16	68	190	190
G205	INFLOW	1995	22.3	12	13	19.5	47.8	56
G205	INFLOW	1996	23.7	10	11	25.5	55	61
G205	INFLOW	1997	28.7	14	17.8	34	42	43
G205	INFLOW	1998	47.6	32	34.3	46	70.5	77
G205	INFLOW	1999	59.6	34	34.3	54	127	145
G205	INFLOW	2000	57.8	13	20.8	52.5	255	319
G205	INFLOW	2001	38.3	24	24.5	41	59	71
G205	INFLOW	2002	27.5	18	18	25	46	46
G206	INFLOW	1990	37.2	20	20.8	25.5	118	148
G206	INFLOW	1991	19	16	16.5	18	22.5	25
G206	INFLOW	1992	17.2	4	13.3	18	22.8	97
G206	INFLOW	1993	24.4	9	12	16	50	199
G206	INFLOW	1994	8.41	6	6	9	11	11
G206	INFLOW	1995	10.5	6	7.25	12	13.8	14
G206	INFLOW	1996	10.1	4	4.5	8	34.8	43
G206	INFLOW	1997	5.94	<4	<4	8	12.8	13
G206	INFLOW	1998	11.8	8	8.75	12	16	17
G206	INFLOW	1999	9.51	<4	<4	8	50	64
G206	INFLOW	2000	14.4	7	8	13	31.5	37
G206	INFLOW	2001	18.5	12	13.3	18.5	26.8	29
G206	INFLOW	2002	14	8	8	17	20	20
L3	INFLOW	1978	54.1	28	35	48	70	163
L3	INFLOW	1979	49.2	<4	28.8	47.5	127	252
L3	INFLOW	1980	81.5	12	50.3	86.5	143	307
L3	INFLOW	1981	45.8	16	31.5	43	73.5	194
L3	INFLOW	1982	17	17		17		17
L3	INFLOW	1983	176	28	112	200	294	860
L3	INFLOW	1984	297	297		297		297
L3	INFLOW	1985	121	32	38.8	109	481	807
L3	INFLOW	1986	87.9	29	52	83	174	211

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
L3	INFLOW	1987	93.6	24	53	95	158	445
L3	INFLOW	1988	105	21	62	104	184	373
L3	INFLOW	1989	53.4	17	31	41	94	271
L3	INFLOW	1990	56.6	31	39.5	51	69	161
L3	INFLOW	1991	54.8	16	33.3	53.5	109	141
L3	INFLOW	1992	65.3	40	52.5	66	82	97
L3	INFLOW	1993	86.2	38	59	64	144	318
L3	INFLOW	1994	82.2	36	53	76	135	188
L3	INFLOW	1995	133	44	92	124	229	288
L3	INFLOW	1996	80.3	27	41.3	73	155	295
L3	INFLOW	1997	117	27	53	137	221	431
L3	INFLOW	1998	88.2	28.7	58.8	93	130	195
L3	INFLOW	1999	85.9	34.7	46.6	79.2	161	261
L3	INFLOW	2000	107	46.7	67.6	93.8	181	338
L3	INFLOW	2001	107	79.7	85.5	122	124	125
S11A	INFLOW	1978	6	6		6		6
S11A	INFLOW	1979	6.19	<4	<4	4	16	18
S11A	INFLOW	1980	15.4	4	7	16	31	113
S11A	INFLOW	1981	13.1	7	8	14.5	20.3	21
S11A	INFLOW	1982	13.3	7	7.5	15	23.3	24
S11A	INFLOW	1983	12.2	<4	5	14	22	99
S11A	INFLOW	1984	19.9	5	8	27.5	43.5	71
S11A	INFLOW	1985	36.2	<4	20.5	48	65	152
S11A	INFLOW	1986	18.2	<4	11	18	57	87
S11A	INFLOW	1987	30.2	12	15	27.5	63.5	106
S11A	INFLOW	1988	11.3	6	6.5	9.5	26	31
S11A	INFLOW	1989	6.65	<4	<4	6	17.5	27
S11A	INFLOW	1991	18.5	6	12	17	19	192
S11A	INFLOW	1992	14.9	7	8.5	10	34	44
S11A	INFLOW	1993	7.39	4	6.5	7	9	11
S11A	INFLOW	1994	15.3	5		26		47
S11A	INFLOW	1995	10.5	<4	7	11.5	23.3	28
S11A	INFLOW	1996	9.34	<4	6.25	8	13.8	135
S11A	INFLOW	1997	14.9	6	7.75	14	25.5	66
S11A	INFLOW	1998	19.2	5	12.5	19	40.1	48
S11A	INFLOW	1999	19.2	7	8	15	40	74
S11A	INFLOW	2000	18.4	9	11.5	14	18	160
S11A	INFLOW	2001	19.2	8	14.5	18.5	23.5	75
S11A	INFLOW	2002	17.3	7	9	14	36	66
S11B	INFLOW	1978	7.03	<4	<4	8.5	15	17
S11B	INFLOW	1979	15.3	6	10	13	27	43
S11B	INFLOW	1980	14.5	<4	7.25	14.5	25.5	57
S11B	INFLOW	1981	15.2	8	10	13.5	25.3	33
S11B	INFLOW	1982	50.3	23	29	33	90	429
S11B	INFLOW	1983	26.7	9	16	27	47.5	85
S11B	INFLOW	1984	29.9	6	19	36	58.5	71
S11B	INFLOW	1985	63.6	16	46	60	100	285

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
S11B	INFLOW	1986	40.9	6	22.8	45	75.3	161
S11B	INFLOW	1987	59.7	23	26.8	58	118	264
S11B	INFLOW	1988	24.5	16	17.5	22.5	36.8	45
S11B	INFLOW	1989	44.2	9	28.5	45.5	101	132
S11B	INFLOW	1991	29.5	11	14.5	26	37.8	256
S11B	INFLOW	1992	29.7	7	24	28	53	93
S11B	INFLOW	1993	16	6	9	16.5	23	61
S11B	INFLOW	1994	17.3	13		18		23
S11B	INFLOW	1995	16.5	<4	15	18.5	32.5	37
S11B	INFLOW	1996	15.8	4	7	15	38	95
S11B	INFLOW	1997	14.6	6	8	13.5	22	59
S11B	INFLOW	1998	24.1	6	12.3	21.5	48.3	90
S11B	INFLOW	1999	31.8	8	21	37	56	62
S11B	INFLOW	2000	21.5	10	12.8	17.5	23.3	163
S11B	INFLOW	2001	21.4	11	16.3	18	37.8	40
S11B	INFLOW	2002	16.7	8	9.5	16	27	66
S11C	INFLOW	1978	11.3	9	9.5	12	13	13
S11C	INFLOW	1979	23.1	14	16.3	18.5	38.8	59
S11C	INFLOW	1980	26.4	7	16.3	23.5	40.3	200
S11C	INFLOW	1981	40.3	22	33	40	51	79
S11C	INFLOW	1982	45.4	11	21	43	116	132
S11C	INFLOW	1983	34.8	13	18.5	34	64.5	126
S11C	INFLOW	1984	33.8	14	19	34.5	60.8	96
S11C	INFLOW	1985	70.5	27	39	68.5	118	403
S11C	INFLOW	1986	46.5	11	29	44	79	166
S11C	INFLOW	1987	62.7	20	25.8	68	91.8	240
S11C	INFLOW	1988	45.5	25	28	49	65.8	88
S11C	INFLOW	1989	63.8	28	38.3	58.5	98.5	180
S11C	INFLOW	1990	55.2	22	32.8	55.5	93.5	139
S11C	INFLOW	1991	50.6	9	22	53	83	556
S11C	INFLOW	1992	37.6	16	28.5	35	53.5	97
S11C	INFLOW	1993	35.9	14	25.5	31	49.5	80
S11C	INFLOW	1994	43.2	12	25	34	85	196
S11C	INFLOW	1995	23.5	9	17.3	28	32	43
S11C	INFLOW	1996	27.8	8	15.5	22	53.5	160
S11C	INFLOW	1997	32.4	14	23.5	25	48	125
S11C	INFLOW	1998	37.8	19	25.5	37	50.7	109
S11C	INFLOW	1999	42	15	25	45.5	67.5	91
S11C	INFLOW	2000	44.6	16	28.5	40.5	66.5	199
S11C	INFLOW	2001	28.7	13	17	22.5	55.3	87
S11C	INFLOW	2002	25.7	10	17	23	36	77
S140	INFLOW	1978	30.8	13	21	35	44	99
S140	INFLOW	1979	52.3	22	35.8	41	68.3	224
S140	INFLOW	1980	58.6	11	38.3	56	1040	288
S140	INFLOW	1981	30.9	10	22	27	46.5	119
S140	INFLOW	1982	60.6	16	53.8	61	79	151
S140	INFLOW	1983	95.6	24	47.5	70.5	184	688

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
S140	INFLOW	1984	69.4	27	48	69	87	264
S140	INFLOW	1985	108	43	57.3	87.5	220	542
S140	INFLOW	1986	83.1	44	63.5	80	106	295
S140	INFLOW	1987	75.4	39	54.5	68	90.8	325
S140	INFLOW	1988	53	22	35.8	51.5	74.3	147
S140	INFLOW	1989	45.6	8	23	46	77	356
S140	INFLOW	1990	29.4	11	16.3	31	42.5	108
S140	INFLOW	1991	27.9	9	22	30	33	72
S140	INFLOW	1992	32	15	25	35	43.5	49
S140	INFLOW	1993	26.6	14	18.8	23	40	68
S140	INFLOW	1994	32.7	16	23.3	35	38.8	92
S140	INFLOW	1995	31.1	16	22.8	30	41.5	64
S140	INFLOW	1996	24.3	4	14.5	26	45	70
S140	INFLOW	1997	37.2	18	27	36	48	113
S140	INFLOW	1998	35.3	25	30.5	35	42	53
S140	INFLOW	1999	39.2	15	23	47	68	77
S140	INFLOW	2000	46.2	21	28	42	64	298
S140	INFLOW	2001	39.6	18	24.3	36	50	289
S140	INFLOW	2002	39.5	19	28.8	33	51.1	408
S142	INFLOW	1982	19.7	12	12	12	41.5	44
S142	INFLOW	1983	11.9	5	5.5	16	22.5	25
S142	INFLOW	1985	15.8	10	10	11	36	36
S142	INFLOW	1986	34.2	18	18	37	60	60
S142	INFLOW	1998	21.1	16	17	20	26.8	33
S142	INFLOW	1999	20.7	10	13.5	18	29.5	55
S142	INFLOW	2000	23.8	11	17	19.5	33.5	97
S142	INFLOW	2001	24.8	12	15.5	24	35.3	94
S142	INFLOW	2002	21.9	10	19	20	27	38
S150	INFLOW	1978	31.1	16	17	24	59	125
S150	INFLOW	1979	40.5	8	26.8	49.5	58.8	160
S150	INFLOW	1980	38.9	9	20	37	62	130
S150	INFLOW	1981	45.9	17	21.5	50	70.5	202
S150	INFLOW	1982	77.5	47	52.3	74	126	141
S150	INFLOW	1983	35.1	22	28.3	33.5	48.8	51
S150	INFLOW	1984	65.3	51	56.5	62	79	92
S150	INFLOW	1985	66.3	21	42	72	93	136
S150	INFLOW	1986	64.9	22	34.3	77	109	153
S150	INFLOW	1988	104	95	95	102	116	116
S150	INFLOW	1989	84.7	69	76	88	93	97
S150	INFLOW	1990	80.3	29	59.3	85	117	186
S150	INFLOW	1991	73.6	38	55	65	105	144
S150	INFLOW	1992	42.5	10	24.8	48.5	63.3	158
S150	INFLOW	1993	33.8	21	25.5	30	47	60
S150	INFLOW	1994	29.9	10	15.8	37.5	45.8	75
S150	INFLOW	1995	30.3	11	17.5	25	65	103
S150	INFLOW	1996	47.4	12	26.3	58.5	82.3	96
S150	INFLOW	1997	40	8	28.3	41.5	56	128

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
S150	INFLOW	1998	47.6	12	28	42.5	69	679
S150	INFLOW	1999	40.3	12	27	41.5	64.8	111
S150	INFLOW	2000	48.8	13	31	49.5	75.3	150
S150	INFLOW	2001	31.7	17	19	35.5	49	57
S150	INFLOW	2002	22.1	14	17	21	28.5	41
S151	INFLOW	1978	9.07	5	6	7	14	32
S151	INFLOW	1979	14.2	5	8	12	21.3	63
S151	INFLOW	1980	15	5	9.25	13.5	20.5	86
S151	INFLOW	1981	18.5	8	12	16.5	26.8	62
S151	INFLOW	1982	42.5	22	30	36	69	95
S151	INFLOW	1983	13	7	9	12	16.5	49
S151	INFLOW	1984	16.1	10	12	14	23.5	36
S151	INFLOW	1985	46.9	11	25.5	54	89	171
S151	INFLOW	1986	26.1	7	11.5	24	63	122
S151	INFLOW	1987	18.6	11	14	16	24	94
S151	INFLOW	1988	29.2	14	19.8	27	39	110
S151	INFLOW	1989	37	10	23	39	68.3	87
S151	INFLOW	1990	53.4	9	53	63.5	72.3	118
S151	INFLOW	1991	33.3	10	20	30	59	166
S151	INFLOW	1992	21.4	10	14	18	35	51
S151	INFLOW	1993	14	6	9	12	22.5	52
S151	INFLOW	1994	14.9	9	12.5	14.5	18.8	28
S151	INFLOW	1995	11.2	<4	9	10	14	80
S151	INFLOW	1996	9.36	<4	6.75	10	13.3	30
S151	INFLOW	1997	11.4	7	8.75	10.5	14.3	26
S151	INFLOW	1998	13	8	10	13	15	28
S151	INFLOW	1999	23.5	7	13	20.5	41	146
S151	INFLOW	2000	18.8	8	12	15	30	72
S151	INFLOW	2001	24.7	14	16	22	34	68
S151	INFLOW	2002	16	9	13	14	20	52
S190	INFLOW	1987	34	34		34		34
S190	INFLOW	1988	68.5	33	47	63	100	145
S190	INFLOW	1989	59.1	18	29.5	51	118	213
S190	INFLOW	1990	46.1	17	20.5	41	106	275
S190	INFLOW	1991	27.9	11	18.8	22.5	46.3	134
S190	INFLOW	1992	77.6	31	37.5	79.5	177	210
S190	INFLOW	1993	66.1	28	45	69.5	93	140
S190	INFLOW	1994	54.8	28	34.5	51	83.5	177
S190	INFLOW	1995	77.9	35	47.5	60	116	279
S190	INFLOW	1996	51.4	19	30	44.5	85.5	210
S190	INFLOW	1997	64.1	20	44	55	116	244
S190	INFLOW	1998	67.9	25	49	59	110	177
S190	INFLOW	1999	46.2	19	29.5	43.5	73	139
S190	INFLOW	2000	61.4	34	39.3	50	93	179
S190	INFLOW	2001	38.8	19	27	33	40	254
S190	INFLOW	2002	47.9	23	32.8	42	66.5	186
S8	INFLOW	1978	35.5	19	23	30	62	91

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
S8	INFLOW	1979	43.6	13	31.5	38	52.4	183
S8	INFLOW	1980	34	10	21.8	33	51.6	150
S8	INFLOW	1981	34.6	11	24.5	32.5	48.5	175
S8	INFLOW	1982	37.8	18	20.3	43	64.3	90
S8	INFLOW	1983	176	58	109	153	321	685
S8	INFLOW	1984	134	42	82	155	186	603
S8	INFLOW	1985	121	28	63	113	225	451
S8	INFLOW	1986	122	36	83.8	127	159	428
S8	INFLOW	1987	114	47	59	103	196	933
S8	INFLOW	1988	90.8	37	59	80	150	233
S8	INFLOW	1989	76.2	33	52.3	70.5	130	206
S8	INFLOW	1990	65.8	30	45	57	86	315
S8	INFLOW	1991	76.5	32	46	68	130	418
S8	INFLOW	1992	74.1	28	6100	76	90	191
S8	INFLOW	1993	81.9	13	63.5	94	122	277
S8	INFLOW	1994	61	20	40	59	84	209
S8	INFLOW	1995	84.5	32	54	73.5	135	371
S8	INFLOW	1996	65.9	24	37.3	70	121	169
S8	INFLOW	1997	64.4	28	41.9	65.3	97.5	168
S8	INFLOW	1998	46.3	22	34.5	45.5	61	123
S8	INFLOW	1999	58.2	20	36.3	60	87.1	213
S8	INFLOW	2000	76.8	25	53	79.5	110	307
S8	INFLOW	2001	60.3	25	45.1	56.5	75.8	1286
S8	INFLOW	2002	39.6	17	26	39	47	285
S9	INFLOW	1978	9.18	6	7	11	11	15
S9	INFLOW	1979	10.5	<4	8.5	11	15	31
S9	INFLOW	1980	11.8	5	9	11	13.8	49
S9	INFLOW	1981	11	5	9	11	14	16
S9	INFLOW	1982	14.3	<4	9.5	14	18.5	120
S9	INFLOW	1983	17.2	6	11	13	34	96
S9	INFLOW	1984	17.2	12	14	15	18.8	47
S9	INFLOW	1985	18.3	<4	10	18	32.5	172
S9	INFLOW	1986	16	8	10	14	17	83
S9	INFLOW	1987	18.8	10	13.5	17	25	40
S9	INFLOW	1988	19	11	14.5	18	21	81
S9	INFLOW	1989	14.3	<4	12	15	18	48
S9	INFLOW	1990	25.7	14	16.3	22.5	32	105
S9	INFLOW	1991	14.9	5	11.8	16.5	18.3	41
S9	INFLOW	1992	14.1	8	12	13	18	35
S9	INFLOW	1993	12.7	<4	11.5	13	15	44
S9	INFLOW	1994	11.1	5	9	11	15	19
S9	INFLOW	1995	10.4	<4	8.5	11	16	21
S9	INFLOW	1996	10.6	5	8	10	13	26
S9	INFLOW	1997	12	4	9	14	16.5	37
S9	INFLOW	1998	14	<4	11.9	13.7	17.3	32.5
S9	INFLOW	1999	15.1	10	12.1	14.5	16.4	66
S9	INFLOW	2000	16.3	4	12.8	15.5	18	74

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
S9	INFLOW	2001	16.3	10	13	14	17.5	140
S9	INFLOW	2002	15.7	9	12	14.5	18	73
3AE05	INTERIOR	2000	130	106		133		160
3AE05	INTERIOR	2001	150	150		150		150
3AE05	INTERIOR	2002	56.6	29	47	57.5	75.8	93
3AE10	INTERIOR	2000	73.9	71		74		77
3AE10	INTERIOR	2002	30.1	10	21.3	35	44.5	64
3AE15	INTERIOR	2000	19.7	17	17	18	25	25
3AE15	INTERIOR	2001	70	70		70		70
3AE15	INTERIOR	2002	21.1	13	13	20.5	33.8	39
3AE20	INTERIOR	2000	8.3	6	6.5	8.5	10.5	11
3AE20	INTERIOR	2001	9.17	6.5	7.13	10	11	11
3AE20	INTERIOR	2002	6.36	5	5	5.5	8.75	11
3AE40	INTERIOR	2000	5.47	<4	<4	4.5	25.8	32
3AE40	INTERIOR	2001	8.64	7	7	8	11.5	11.5
3AE40	INTERIOR	2002	4.57	<4	<4	5.25	6.5	8
3ANMESO	INTERIOR	2000	6.07	<4	<4	4.5	26.8	34
3ANMESO	INTERIOR	2001	6.05	<4	<4	5.5	12.4	25.5
3ANMESO	INTERIOR	2002	<4	<4	<4	4	4.25	5
3ASMESO	INTERIOR	2000	4.09	<4	<4	4.5	9.25	10
3ASMESO	INTERIOR	2001	5.68	4	4.75	5.5	7.25	8
3ASMESO	INTERIOR	2002	<4	<4	<4	4.25	5	5
3AW05	INTERIOR	2002	61	40	44.5	56.5	85.5	120
3AW10	INTERIOR	2000	82.5	68		84		100
3AW10	INTERIOR	2002	37.6	17	29.8	42	49.5	60
3AW15	INTERIOR	2000	21.5	12.5		24.8		37
3AW15	INTERIOR	2001	32	32		32		32
3AW15	INTERIOR	2002	23	15	15.8	19.5	35	62
3AW20	INTERIOR	2000	15.1	9	10.5	15.5	22	24
3AW20	INTERIOR	2001	20	20		20		20
3AW20	INTERIOR	2002	14.4	10	12.3	14.5	18	18
3AW30	INTERIOR	2000	6.48	6		6.5		7
3AW40	INTERIOR	2000	6.47	5	5	5	11.8	14
3AW40	INTERIOR	2001	11.4	5	6.25	11	24	28
3AW40	INTERIOR	2002	6.05	<4	4.25	8	8.63	9
3B-2	INTERIOR	1983	7.77	<4	5.5	9.5	12	15
3B-2	INTERIOR	1984	17.5	7	8	12	71.5	126
3B-3	INTERIOR	1983	7.61	4	5	7	12.8	15
3B-3	INTERIOR	1984	5.66	<4	<4	9	9	9
3B-5	INTERIOR	1983	6.18	<4	<4	8	11.5	14
3B-5	INTERIOR	1984	6.03	4	4.5	5	9	10
3B-6	INTERIOR	1983	5.04	<4	<4	6	9	12
3B-6	INTERIOR	1984	6.26	<4	<4	8.5	10.8	11
3B-7	INTERIOR	1983	4.47	<4	<4	<4	12.5	14
3B-7	INTERIOR	1984	<4	<4	<4	4	7.5	8
A-E1	INTERIOR	1984	96	96		96		96
A-E10	INTERIOR	1984	7	7		7		7

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
A-E2	INTERIOR	1984	105	105		105		105
A-E2	INTERIOR	1985	356	290		364		438
A-E2	INTERIOR	1986	12	12		12		12
A-E3	INTERIOR	1984	194	194		194		194
A-E3	INTERIOR	1985	93.9	49		115		180
A-E3	INTERIOR	1986	29	29		29		29
A-E4	INTERIOR	1984	86	86		86		86
A-E4	INTERIOR	1985	163	119		171		223
A-E5	INTERIOR	1984	46	46		46		46
A-E5	INTERIOR	1986	16	16		16		16
A-E6	INTERIOR	1984	20	20		20		20
A-E6	INTERIOR	1985	22	21		22		23
A-E6	INTERIOR	1986	11	11		11		11
A-E7	INTERIOR	1984	22	22		22		22
A-E7	INTERIOR	1985	13.5	13		13.5		14
A-E7	INTERIOR	1986	<4	<4		<4		<4
A-E8	INTERIOR	1984	40	40		40		40
A-E8	INTERIOR	1985	17	17		17		17
A-E8	INTERIOR	1986	10	10		10		10
A-E9	INTERIOR	1984	6	6		6		6
A-E9	INTERIOR	1986	<4	<4		<4		<4
A-W1	INTERIOR	1984	139	139		139		139
A-W1	INTERIOR	1985	196	182		197		212
A-W1	INTERIOR	1986	17	17		17		17
A-W10	INTERIOR	1984	11	11		11		11
AW-11	INTERIOR	1986	11	11		11		11
A-W2	INTERIOR	1984	172	172		172		172
A-W2	INTERIOR	1985	66	66		66		66
A-W2	INTERIOR	1986	12	12		12		12
A-W3	INTERIOR	1984	206	206		206		206
A-W3	INTERIOR	1985	58	57		58		59
A-W3	INTERIOR	1986	12	12		12		12
A-W4	INTERIOR	1984	52	52		52		52
A-W4	INTERIOR	1985	84.6	65		87.5		110
A-W5	INTERIOR	1984	13	13		13		13
A-W5	INTERIOR	1985	88.4	74		89.8		106
A-W5	INTERIOR	1986	12	12		12		12
A-W6	INTERIOR	1984	13	13		13		13
A-W6	INTERIOR	1985	13	10		13.5		17
A-W6	INTERIOR	1986	<4	<4		<4		<4
A-W7	INTERIOR	1984	13	13		13		13
A-W7	INTERIOR	1985	14.4	13		14.5		16
A-W7	INTERIOR	1986	<4	<4		<4		<4
A-W8	INTERIOR	1984	8	8		8		8
A-W8	INTERIOR	1986	5	5		5		5
A-W9	INTERIOR	1984	13	13		13		13
BE-1	INTERIOR	1983	16	16		16		16

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
BE-2	INTERIOR	1983	14	14		14		14
BE-3	INTERIOR	1983	14	14		14		14
BW-1	INTERIOR	1983	51	51		51		51
BW-2	INTERIOR	1983	17	17		17		17
BW-3	INTERIOR	1983	15	15		15		15
C-1	INTERIOR	1979	24.4	6	15.8	25.5	41	87
C-1	INTERIOR	1980	26	26		26		26
C-1	INTERIOR	1983	130	85		142		199
C-1	INTERIOR	1984	144	126		146		165
C-1	INTERIOR	1987	50.5	44		51		58
C-2	INTERIOR	1979	13.2	5	7.5	16	22.3	24
C-2	INTERIOR	1981	8.96	8	8	9	10	10
C-2	INTERIOR	1982	15.1	12		15.5		19
C-2	INTERIOR	1983	9.13	6	7	10	11.5	12
C-2	INTERIOR	1984	8.28	7	7	9	9	9
C-2	INTERIOR	1987	25.7	22		26		30
C-3A	INTERIOR	1979	13.4	<4	6.5	19	27.8	30
C-3A	INTERIOR	1980	11	11		11		11
C-3A	INTERIOR	1981	21	21		21		21
C-3B	INTERIOR	1979	<4	<4	<4	5	8	10
C-3B	INTERIOR	1980	8.51	4	4	7	22	22
C-3B	INTERIOR	1981	9.93	<4	8	9	16.5	52
C-3B	INTERIOR	1982	6.31	4	4.5	6	9.75	11
C-4	INTERIOR	1979	8.21	<4	<4	5	51.5	108
C-4	INTERIOR	1980	6.6	4	4	6	12	12
C-4	INTERIOR	1981	6.55	<4	<4	6	12.5	23
C-4	INTERIOR	1982	6.16	<4	<4	8	11.5	12
C-4	INTERIOR	1983	8.06	5	6	6	14.5	15
C-4	INTERIOR	1984	13.4	5	5	11	15	155
C-4	INTERIOR	1993	9	9		9		9
C-5	INTERIOR	1979	<4	<4	<4	<4	9	15
C-5	INTERIOR	1980	<4	<4	<4	<4	9.5	15
C-6	INTERIOR	1979	<4	<4	<4	4	6.5	9
C-6	INTERIOR	1980	<4	<4	<4	<4	5.5	6
C-6	INTERIOR	1992	21.5	21.5		21.5		21.5
C-6	INTERIOR	1993	8	8		8		8
C-7	INTERIOR	1979	8.7	<4	5.75	10.5	15.3	22
C-7	INTERIOR	1980	30	30		30		30
C-8	INTERIOR	1979	34.1	15	15	47	56	56
C-9	INTERIOR	1979	<4	<4	<4	5	8	9
C-9	INTERIOR	1980	4.64	<4	<4	4	8.5	12
CA3-1	INTERIOR	1979	15.6	9	10.5	13	26	30
CA3-1	INTERIOR	1980	20.6	7	7.75	20	71.3	85
CA3-1	INTERIOR	1981	13.1	10	10	15	15	15
CA3-1	INTERIOR	1983	37	37		37		37
CA3-1	INTERIOR	1984	14	14		14		14
CA3-10	INTERIOR	1979	9.89	<4	4	10	25.5	30

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
CA3-10	INTERIOR	1980	9.3	4	6	9	16.5	22
CA3-10	INTERIOR	1981	17.8	15	15.5	17	21.5	23
CA3-10	INTERIOR	1984	<4	<4		<4		<4
CA311	INTERIOR	1995	6.02	<4	4.75	5.5	8.25	12
CA311	INTERIOR	1996	4.43	<4	<4	5	6	10
CA311	INTERIOR	1997	4.68	<4	4	4	6	20
CA311	INTERIOR	1998	<4	<4	<4	4	5.25	8
CA311	INTERIOR	1999	<4	<4	<4	4	6	9
CA311	INTERIOR	2000	5.86	<4	4	5.5	8	36
CA311	INTERIOR	2001	7.39	5	5.75	7.5	9.25	13
CA311	INTERIOR	2002	5.1	<4	4	5	7	12
CA3-11	INTERIOR	1979	17.4	<4	<4	14	98.5	108
CA3-11	INTERIOR	1980	5.89	<4	<4	8	10	10
CA3-11	INTERIOR	1981	5.24	<4	<4	6.5	8.5	9
CA3-11	INTERIOR	1984	<4	<4		<4		<4
CA3-12	INTERIOR	1979	10.4	5	5.5	9	25	38
CA3-12	INTERIOR	1980	6.84	4	5	6	10.5	13
CA3-12	INTERIOR	1981	11.1	8	8	10.5	16.8	18
CA3-12	INTERIOR	1982	6	6		6		6
CA3-12	INTERIOR	1984	9	9		9		9
CA3-13	INTERIOR	1979	5.33	<4	<4	5	12.5	16
CA3-13	INTERIOR	1980	5.91	4	4.5	5	9	12
CA3-13	INTERIOR	1981	6.78	4	4.5	7	10.3	11
CA3-13	INTERIOR	1982	<4	4		4		4
CA3-13	INTERIOR	1984	<4	<4		<4		<4
CA3-14	INTERIOR	1979	<4	<4	<4	4	8.5	12
CA3-14	INTERIOR	1980	4.54	<4	<4	4	8	10
CA3-14	INTERIOR	1981	6.16	<4	<4	8	11.5	12
CA3-14	INTERIOR	1982	15	15		15		15
CA3-14	INTERIOR	1984	<4	4		4		4
CA315	INTERIOR	1995	6.1	<4	5	6	8	15
CA315	INTERIOR	1996	4.68	<4	<4	5	7.5	10
CA315	INTERIOR	1997	5.41	<4	4	5	7.5	17
CA315	INTERIOR	1998	4.57	<4	4	5	6	8
CA315	INTERIOR	1999	4.4	<4	<4	5	6	12
CA315	INTERIOR	2000	5.83	<4	5	6	8	13
CA315	INTERIOR	2001	8.87	4	6	8	11	90
CA315	INTERIOR	2002	5.38	<4	4	5	7	10
CA3-15	INTERIOR	1979	<4	<4	<4	<4	9.5	11
CA3-15	INTERIOR	1980	4.58	<4	<4	4	8	9
CA3-15	INTERIOR	1981	8.26	<4	<4	8	30	37
CA3-15	INTERIOR	1982	66	66		66		66
CA3-15	INTERIOR	1984	<4	<4		<4		<4
CA316	INTERIOR	2001	8.4	5	6	9	9.75	20
CA316	INTERIOR	2002	8.21	5	6	7.5	11	19
CA3-16	INTERIOR	1979	5	<4	<4	7	15	16
CA3-16	INTERIOR	1980	4.64	<4	<4	6	11	12

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
CA3-16	INTERIOR	1981	5.73	<4	<4	5.5	15	18
CA3-16	INTERIOR	1982	8	8		8		8
CA3-16	INTERIOR	1984	14	14		14		14
CA317	INTERIOR	2001	5.93	<4	5	5	7	13
CA317	INTERIOR	2002	5.49	<4	5	6	7	27
CA3-17	INTERIOR	1979	<4	<4	<4	5	8	9
CA3-17	INTERIOR	1980	<4	<4	<4	4	4	4
CA3-17	INTERIOR	1981	4.16	<4	<4	5	5.75	6
CA3-17	INTERIOR	1982	10	10		10		10
CA3-17	INTERIOR	1984	<4	<4		<4		<4
CA318	INTERIOR	2001	7.19	4	6	7.5	8.25	11
CA318	INTERIOR	2002	6.83	4	5.75	7	8	10
CA3-18	INTERIOR	1979	<4	<4	<4	5	6.5	7
CA3-18	INTERIOR	1980	9.36	<4	4.5	8	30	50
CA3-18	INTERIOR	1981	7.04	5	5.5	7	9.25	10
CA3-18	INTERIOR	1982	11	11		11		11
CA3-18	INTERIOR	1984	<4	4		4		4
CA3-19	INTERIOR	1979	<4	<4	<4	<4	9	13
CA3-19	INTERIOR	1980	<4	<4	<4	<4	10.5	15
CA3-19	INTERIOR	1981	5.73	<4	<4	6.5	13.5	15
CA3-19	INTERIOR	1982	12	12		12		12
CA3-19	INTERIOR	1984	5	5		5		5
CA32	INTERIOR	1995	8.01	4	5.25	9.5	10	20
CA32	INTERIOR	1996	7.59	<4	4.5	7	10.5	94
CA32	INTERIOR	1997	7.2	5	6	8	8.25	9
CA32	INTERIOR	1998	8.31	4	7	8	9	19
CA32	INTERIOR	1999	6.69	4	5	6	8.5	17
CA32	INTERIOR	2000	8.72	4	7	9	11	14
CA32	INTERIOR	2001	8.39	7	7	8	9.5	13
CA32	INTERIOR	2002	7.09	4	6	7	8.5	10
CA3-2	INTERIOR	1979	11.6	8	8.5	11	16.5	20
CA3-2	INTERIOR	1980	10.6	6	7.5	12	14.5	15
CA3-2	INTERIOR	1981	13.7	8	8	17	19	19
CA3-2	INTERIOR	1983	8	8		8		8
CA3-2	INTERIOR	1984	47	47		47		47
CA3-20	INTERIOR	1979	<4	<4	<4	<4	5.5	7
CA3-20	INTERIOR	1980	4.54	<4	<4	4	6.5	8
CA3-20	INTERIOR	1981	9.48	5	5	11	18.5	19
CA3-20	INTERIOR	1982	9	9		9		9
CA3-20	INTERIOR	1984	7	7		7		7
CA3-21	INTERIOR	1979	<4	<4	<4	<4	7	9
CA3-21	INTERIOR	1980	<4	<4	<4	4	5.5	7
CA3-21	INTERIOR	1981	7.91	5	5.5	7	13.8	16
CA3-21	INTERIOR	1982	22	22		22		22
CA3-21	INTERIOR	1984	<4	<4		<4		<4
CA33	INTERIOR	1995	13.9	6	10	13	20	50
CA33	INTERIOR	1996	10.5	5	7.5	9	12.5	62

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
CA33	INTERIOR	1997	10.7	6	8	11	14	21
CA33	INTERIOR	1998	9.63	5	6	10	11.5	36
CA33	INTERIOR	1999	8.74	4	6.75	7.5	10.8	35
CA33	INTERIOR	2000	12.4	8	9	13	16	25
CA33	INTERIOR	2001	12.7	7	9	11	18.5	28
CA33	INTERIOR	2002	10.5	5.5	8	10.5	13.8	22
CA3-3	INTERIOR	1979	37.7	15	22.5	31	97	160
CA3-3	INTERIOR	1980	9.62	9	9	9	11	11
CA3-3	INTERIOR	1981	21	21		21		21
CA3-3	INTERIOR	1983	13	13		13		13
CA3-3	INTERIOR	1984	24	24		24		24
CA34	INTERIOR	1995	8.76	<4	7	8.5	10	43
CA34	INTERIOR	1996	7.43	<4	4.25	7.5	12	36
CA34	INTERIOR	1997	10.3	5	7	8	10	70
CA34	INTERIOR	1998	7.8	5	6	7	9.5	13
CA34	INTERIOR	1999	6.6	<4	5	6	11	16
CA34	INTERIOR	2000	9.73	5	8.25	9.5	11	22
CA34	INTERIOR	2001	9.71	7	8.5	10	11	14
CA34	INTERIOR	2002	9.41	6	7.5	10	12	15
CA3-4	INTERIOR	1979	21.9	7	9	20	59	73
CA3-4	INTERIOR	1980	10.2	9	9.25	10.5	11	11
CA3-4	INTERIOR	1981	42.4	12	12	18	353	353
CA3-4	INTERIOR	1983	23	23		23		23
CA3-4	INTERIOR	1984	9	9		9		9
CA35	INTERIOR	1995	12.7	4	9	10	24	55
CA35	INTERIOR	1996	7.59	4	6	8	10	17
CA35	INTERIOR	1997	8.19	6	7	8	10	11
CA35	INTERIOR	1998	9.13	5	7.25	10	11	14
CA35	INTERIOR	1999	6.79	<4	4.5	7	9.5	14
CA35	INTERIOR	2000	16.9	11	13.5	17	22	29
CA35	INTERIOR	2001	15.6	11	11.5	14	23.5	31
CA35	INTERIOR	2002	9.36	7	8	8.75	11.8	13
CA3-5	INTERIOR	1979	39.1	19	19.5	52	69.5	83
CA3-5	INTERIOR	1980	24.8	12	12	14	91	91
CA3-5	INTERIOR	1981	18.4	13		19.5		26
CA3-5	INTERIOR	1984	13	13		13		13
CA36	INTERIOR	1995	22.1	9	10	23.5	33.3	78
CA36	INTERIOR	1996	23.8	11	13.5	20	35	101
CA36	INTERIOR	1997	25.9	10	18.5	27	37.5	64
CA36	INTERIOR	1998	21.7	10	15	22	27	73
CA36	INTERIOR	1999	21.1	9	11.5	18	33	192
CA36	INTERIOR	2000	39.1	22	26.5	34	62	94
CA36	INTERIOR	2001	52	45		52.5		60
CA36	INTERIOR	2002	42.5	14	24.6	40.5	60	310
CA3-6	INTERIOR	1979	38.5	18	26.5	36	65	87
CA3-6	INTERIOR	1980	14.9	9	10	14.5	23.5	26
CA3-6	INTERIOR	1981	36.3	29	29	35	47	47

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
CA3-6	INTERIOR	1983	24	24		24		24
CA3-6	INTERIOR	1984	177	177		177		177
CA3-7	INTERIOR	1979	20.2	12	13	15	48	79
CA3-7	INTERIOR	1980	14.5	8	8	12	32	32
CA3-7	INTERIOR	1981	55.4	15	15	87	130	130
CA3-7	INTERIOR	1984	7	7		7		7
CA38	INTERIOR	1995	8.71	<4	7	8	10	70
CA38	INTERIOR	1996	6.59	<4	4	6	9	103
CA38	INTERIOR	1997	5.63	<4	4	6	8	16
CA38	INTERIOR	1998	5.47	<4	4	5	6.5	15
CA38	INTERIOR	1999	4.24	<4	<4	4	6.25	8
CA38	INTERIOR	2000	8.08	<4	6.5	8	10	23
CA38	INTERIOR	2001	8.21	6	6.75	8	10.3	14
CA38	INTERIOR	2002	5.49	4	4	5	6	10
CA3-8	INTERIOR	1979	26.9	10	12.5	23	79.5	127
CA3-8	INTERIOR	1980	6.98	<4	<4	8.5	11.8	12
CA3-8	INTERIOR	1981	15.9	9	9.75	16.5	26.3	28
CA3-8	INTERIOR	1984	6	6		6		6
CA3-9	INTERIOR	1979	7.3	<4	4.5	10	16.5	20
CA3-9	INTERIOR	1980	<4	<4	<4	6	7.5	8
CA3-9	INTERIOR	1981	8.12	<4	4	8	19.5	23
CA3-9	INTERIOR	1984	6	6		6		6
DS-1	INTERIOR	1983	77	77		77		77
DS-2	INTERIOR	1983	22	22		22		22
DS-3	INTERIOR	1983	22	22		22		22
DS-4	INTERIOR	1983	9	9		9		9
DS-5	INTERIOR	1983	8	8		8		8
DS-6	INTERIOR	1983	11	11		11		11
DS-7	INTERIOR	1983	13	13		13		13
DS-8	INTERIOR	1983	27	27		27		27
DS-9	INTERIOR	1984	22	22		22		22
L38-1	INTERIOR	1982	54.4	33	36.5	41	95	111
L38-1	INTERIOR	1983	17.8	14	14	17	23.5	28
L38-1	INTERIOR	1985	47.8	33	33	44	75	75
L38-1	INTERIOR	1986	199	199		199		199
L38-2	INTERIOR	1982	58.1	35	42	56	83.5	92
L38-2	INTERIOR	1983	19.4	14	14.5	21	25	28
L38-2	INTERIOR	1985	51.1	37	37	41	88	88
L38-2	INTERIOR	1986	303	303		303		303
S12A	OUTFLOW	1978	9.95	<4	7.5	11	13.5	45
S12A	OUTFLOW	1979	7.75	<4	5	7.5	11	22
S12A	OUTFLOW	1980	8.9	<4	7	8	12.5	20
S12A	OUTFLOW	1981	11	<4	7.5	11	17	29
S12A	OUTFLOW	1982	9.52	4	4.75	7.5	22.8	46
S12A	OUTFLOW	1983	<4	<4	<4	<4	8	16
S12A	OUTFLOW	1984	7.07	<4	5	7	11.5	29
S12A	OUTFLOW	1985	26.9	7	11.8	18.5	92.5	233

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
S12A	OUTFLOW	1986	17.2	<4	7.5	12	38	253
S12A	OUTFLOW	1987	10.3	<4	7.25	10	14.3	33
S12A	OUTFLOW	1988	11	<4	9	12	14.8	22
S12A	OUTFLOW	1989	15.8	5	7.5	13	24.5	100
S12A	OUTFLOW	1990	30.7	10	15.5	37	52	103
S12A	OUTFLOW	1991	20.1	5	14	24	31.5	44
S12A	OUTFLOW	1992	10.4	<4	7.75	10	14.3	58
S12A	OUTFLOW	1993	7.52	<4	5.75	7.5	10.3	33
S12A	OUTFLOW	1994	9.23	<4	8	9	12	50
S12A	OUTFLOW	1995	5.74	<4	4	6	8	39
S12A	OUTFLOW	1996	4.9	<4	<4	5	8	23
S12A	OUTFLOW	1997	8.18	<4	5	8	17	45
S12A	OUTFLOW	1998	8.89	5	8	9	10	19
S12A	OUTFLOW	1999	13.1	5	8	12.5	22.3	60
S12A	OUTFLOW	2000	13.1	7	9	11	21	29
S12A	OUTFLOW	2001	25.2	8	14.5	26	44.5	75
S12A	OUTFLOW	2002	16.8	8	10	12.5	27.3	67
S12B	OUTFLOW	1978	7.84	<4	5.75	8	11.5	22
S12B	OUTFLOW	1979	6.42	<4	4	7	11.3	24
S12B	OUTFLOW	1980	8.19	<4	5	7	14	49
S12B	OUTFLOW	1981	8.28	<4	6	10	13	20
S12B	OUTFLOW	1982	8.28	4	4.75	7.5	15	36
S12B	OUTFLOW	1983	<4	<4	<4	4.5	5.75	13
S12B	OUTFLOW	1984	7.87	<4	5.25	9.5	12	21
S12B	OUTFLOW	1985	25.3	<4	11	17	83.5	593
S12B	OUTFLOW	1986	9.74	<4	4	7.5	15.8	224
S12B	OUTFLOW	1987	10.3	<4	7	9.5	14.5	62
S12B	OUTFLOW	1988	12.4	5	9	11	17	117
S12B	OUTFLOW	1989	13.3	4	7	13	25	47
S12B	OUTFLOW	1990	24.9	6	11	30	48.5	57
S12B	OUTFLOW	1991	17.7	8	11	17	27	37
S12B	OUTFLOW	1992	10.2	<4	7	10	14	484
S12B	OUTFLOW	1993	6.55	<4	5	7	9	34
S12B	OUTFLOW	1994	8.58	<4	7	9	11.5	21
S12B	OUTFLOW	1995	6.48	<4	5	7	8	18
S12B	OUTFLOW	1996	4.65	<4	<4	5	7.5	19
S12B	OUTFLOW	1997	5.81	<4	<4	7	11	44
S12B	OUTFLOW	1998	7.38	4.39	6	7	8.750	13
S12B	OUTFLOW	1999	11	5	7	9.5	17.3	41
S12B	OUTFLOW	2000	11.1	6	8	10	16.5	24
S12B	OUTFLOW	2001	17.6	7	11.5	18	28.5	41
S12B	OUTFLOW	2002	12.4	5	7.75	10.5	19.5	48
S12C	OUTFLOW	1978	7.5	<4	6	8	11	25
S12C	OUTFLOW	1979	5.78	<4	4	6	10.3	21
S12C	OUTFLOW	1980	9.71	<4	6	9	17.5	111
S12C	OUTFLOW	1981	9.55	<4	6.25	9.5	14	142
S12C	OUTFLOW	1982	12.4	4	8.5	11	14	56

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
S12C	OUTFLOW	1983	4.62	<4	<4	5	6	14
S12C	OUTFLOW	1984	11.1	5	8	10	15.5	41
S12C	OUTFLOW	1985	22.2	<4	13	18	51.5	96
S12C	OUTFLOW	1986	8.93	<4	<4	8	16.5	120
S12C	OUTFLOW	1987	13.5	4	8	10	20	127
S12C	OUTFLOW	1988	11.4	6	8	12	14	22
S12C	OUTFLOW	1989	15	<4	8	14	32	97
S12C	OUTFLOW	1990	21.8	7	16.5	25	32.5	48
S12C	OUTFLOW	1991	19.4	6	14.5	20	32	38
S12C	OUTFLOW	1992	11.1	<4	7.75	12	18.8	45
S12C	OUTFLOW	1993	8.39	<4	6	8	9.5	47
S12C	OUTFLOW	1994	8.78	4	7	9	11	31
S12C	OUTFLOW	1995	6.06	<4	5	6	10	16
S12C	OUTFLOW	1996	4.28	<4	<4	4	6	32
S12C	OUTFLOW	1997	6.44	<4	<4	8	12.3	23
S12C	OUTFLOW	1998	7.63	5	6	7	9.75	20
S12C	OUTFLOW	1999	10.2	6	7	10	14.5	27
S12C	OUTFLOW	2000	10.3	4	7	11	16	27
S12C	OUTFLOW	2001	15.9	6	11	16	21	46
S12C	OUTFLOW	2002	11.1	4	7	9.5	18.3	39
S12D	OUTFLOW	1978	11	4	8	11	13	34
S12D	OUTFLOW	1979	7.49	<4	5.5	7	11	28
S12D	OUTFLOW	1980	11.9	4	7.25	9.5	17.5	98
S12D	OUTFLOW	1981	11.6	5	9	10	16	41
S12D	OUTFLOW	1982	16.3	4	9	18	29	41
S12D	OUTFLOW	1983	7.71	<4	5	7	11.3	40
S12D	OUTFLOW	1984	13.3	8	9.5	12	20	23
S12D	OUTFLOW	1985	22.3	<4	14.8	23	46.5	71
S12D	OUTFLOW	1986	13.8	<4	7	11	29.5	94
S12D	OUTFLOW	1987	14.3	6	9	12	19.5	132
S12D	OUTFLOW	1988	11.7	7	9	11	15	25
S12D	OUTFLOW	1989	13.7	4	10	13.5	19.8	31
S12D	OUTFLOW	1990	21.4	8	15	26	32.5	45
S12D	OUTFLOW	1991	21	8	16	19	29.8	59
S12D	OUTFLOW	1992	13.1	4	10	14	18	46
S12D	OUTFLOW	1993	8.95	<4	8	9	11	24
S12D	OUTFLOW	1994	10.2	5	9	10	12	25
S12D	OUTFLOW	1995	7.99	<4	6	8.5	10	23
S12D	OUTFLOW	1996	5.85	<4	4	6	10	40
S12D	OUTFLOW	1997	8.88	<4	7	10	12	21
S12D	OUTFLOW	1998	8.56	5	7	8	10	18
S12D	OUTFLOW	1999	11.2	6	7.5	10	17.5	34
S12D	OUTFLOW	2000	11.3	5	8	12	14	27
S12D	OUTFLOW	2001	15.1	6	11	16	19.5	33
S12D	OUTFLOW	2002	11.6	5	7.75	10.5	20.3	36
S197	OUTFLOW	1998	<4	<4	<4	4	5	5
S197	OUTFLOW	1999	36	36		36		36

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
S197	OUTFLOW	2000	7.47	5	5.75	7.5	10	12
S197	OUTFLOW	2001	8.2	5	6.5	8	10.3	17
S197	OUTFLOW	2002	10	10		10		10
S31	OUTFLOW	1987	19	11	12	17	36.3	42
S31	OUTFLOW	1988	23.2	11	13	23	31	108
S31	OUTFLOW	1989	28.9	18	21.5	27	36.5	63
S31	OUTFLOW	1990	25.8	9	16.5	22	45.8	77
S31	OUTFLOW	1991	15.3	<4	10.5	13.5	22	141
S31	OUTFLOW	1992	23.6	15	15	22	35	49
S31	OUTFLOW	1993	12	4	9	13	14	38
S31	OUTFLOW	1994	9.58	4	8	11	13	16
S31	OUTFLOW	1995	7.06	<4	6	8	9.5	12
S31	OUTFLOW	1996	9.1	<4	7.75	10	11.8	23
S31	OUTFLOW	1997	9.7	<4	6	9	15.5	70
S31	OUTFLOW	1998	12.3	7	10	12.5	14	30
S31	OUTFLOW	1999	17.4	9	10.8	15.5	27	64
S31	OUTFLOW	2000	15	8	9	12	19.5	171
S31	OUTFLOW	2001	18.9	10	11	16	27	90
S31	OUTFLOW	2002	14.3	11	12	13	18	23
S333	OUTFLOW	1979	9.11	<4	6	9	18	33
S333	OUTFLOW	1980	11.5	4	8	10.5	17.8	94
S333	OUTFLOW	1981	14.5	4	11.8	16.5	19.3	23
S333	OUTFLOW	1982	23.5	12	15.8	26.5	33.3	37
S333	OUTFLOW	1983	8	5	6	7.5	10.8	14
S333	OUTFLOW	1984	11.4	10	10.3	11	13.3	14
S333	OUTFLOW	1985	26.5	<4	20	27	47	90
S333	OUTFLOW	1986	19.5	<4	12	17	38	167
S333	OUTFLOW	1987	14.9	7	10.3	13	17	77
S333	OUTFLOW	1988	15	8	11	15	18	30
S333	OUTFLOW	1989	15.6	6	10.5	14	21.5	85
S333	OUTFLOW	1990	21.8	9	15	21	30.5	41
S333	OUTFLOW	1991	19.4	7	15.5	19.5	26.3	50
S333	OUTFLOW	1992	12.2	<4	9	12	18	30
S333	OUTFLOW	1993	10.4	<4	8	10	14	29
S333	OUTFLOW	1994	11.5	6	9	12	14	28
S333	OUTFLOW	1995	9.82	<4	7	9	14	140
S333	OUTFLOW	1996	6.13	<4	4	6	11	49
S333	OUTFLOW	1997	9.19	<4	8	10	14	27
S333	OUTFLOW	1998	9.75	5	7	8.5	13	21
S333	OUTFLOW	1999	11.7	6	7.5	11	16	48
S333	OUTFLOW	2000	11.6	6	8	11	16	25
S333	OUTFLOW	2001	17.2	7	12.5	18	24.5	37
S333	OUTFLOW	2002	12.9	6	8	11	21.5	40
S334	OUTFLOW	1998	10.9	9	9	10	11	24
S334	OUTFLOW	1999	11	8	8	10	14.5	24
S334	OUTFLOW	2000	13.6	8	9.5	14	17	30
S334	OUTFLOW	2001	18.2	6	16.5	18	23	30

Station	Class	WY	Geometric Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum
S334	OUTFLOW	2002	12.6	7	9	10.5	20.8	23
S344	OUTFLOW	1998	11.5	9	9	10	17	17
S344	OUTFLOW	1999	23.9	9	12.3	30.5	41.3	42
S344	OUTFLOW	2000	19.5	9	10.3	16.5	50.5	61
S344	OUTFLOW	2001	38.2	13	13	51	84	84
S344	OUTFLOW	2002	23.3	12	13.8	27.5	36	36
S355A	OUTFLOW	2000	7.98	4	5.5	8.5	11.8	14
S355A	OUTFLOW	2001	20.5	8	9.5	15.5	45.8	145
S355A	OUTFLOW	2002	17.8	6	7.25	11	62	132
S355B	OUTFLOW	2000	10.2	7	8	11	14	15
S355B	OUTFLOW	2001	29.8	11	17.3	24.5	56.5	107
S355B	OUTFLOW	2002	18.1	6	8	13	59	123
US41-25	OUTFLOW	1985	22	<4	11	19	60	201
US41-25	OUTFLOW	1986	11.1	<4	6.75	10	21.3	256
US41-25	OUTFLOW	1987	13.9	4	9	11.5	19.8	144
US41-25	OUTFLOW	1988	15.3	8	9.5	14	23.5	46
US41-25	OUTFLOW	1989	15.5	<4	7	11.5	32.5	92
US41-25	OUTFLOW	1990	19.1	8	11	21	28	40
US41-25	OUTFLOW	1991	15.4	5	9.75	14.5	24.3	46
US41-25	OUTFLOW	1992	12.7	6	9	11	21.8	31
US41-25	OUTFLOW	1993	13.7	<4	8.5	12	17	156
US41-25	OUTFLOW	1994	10.5	7	8	11	12.8	16
US41-25	OUTFLOW	1995	6.87	<4	4	7	10	32
US41-25	OUTFLOW	1996	7.86	<4	4.75	8	15.3	21
US41-25	OUTFLOW	1997	10.5	<4	8	10.5	15.8	38
US41-25	OUTFLOW	1998	8.96	5	7	8.65	11.3	17
US41-25	OUTFLOW	1999	13	6	9	11	19.5	59
US41-25	OUTFLOW	2000	15.4	5	9	13	27	48
US41-25	OUTFLOW	2001	25.8	12	16	24.5	37.3	75
US41-25	OUTFLOW	2002	16.5	7	10	14.5	26	81