4.0 GENERAL CHARACTERISTICS OF THE WATER REGIME

The South Florida Everglades water regime characterized in this study consists of over 1,200 km of canals and over 7,600 km^2 of marsh extending from Lake Okeechobee in the north to the Florida Bay in the south and from the edge of the urban area on the east into the central portion of BCNP (Figure 1.1) on the west. The general patterns in precipitation, water depth, and in situ parameters (conductivity, temperature, turbidity, DO, pH) measured during the study period are described in this section.

4.1 Precipitation

Precipitation records for nine stations within and bordering the South Florida Everglades ecosystem (Figure 4.1) were analyzed to determine the relation of the 5-year (1992 to 1996) study period to the period of record. The periods of record varied from 66 years for the northern Belle Glade station to 27 years at the S-8 station (Table 4.1). Annual precipitation comparisons and monthly comparisons were made for the baseline period and the period of record (Table 4.1, Figures 4.2 through 4.10). There was considerable spatial variability in precipitation among stations with annual precipitation estimates for the 5-year baseline ranging from 111 cm/yr (43.7 in/yr) at S-39 to 164 cm/yr (64.8 in/yr) at S-6. This spatial variability was expected because of the convective storms occurring during the wet season. The long-term norms ranged from 119 to 142 cm/yr (46.9 to 56.1 in/yr). In general, 1994 was a wet year throughout most of South Florida with annual precipitation averaging about 127% of the norm and ranging from 87% of the norm at the Royal Palm station to 153% of the norm at the S-5A station (Table 4.1). The other years were generally within 10% to 15% of the long-term norm (Table 4.1). For most stations, the period from November 1994 through October 1995 was considerably above the long-term monthly norms (Figures 4.2 through 4.10). The first canal sampling cycle (i.e., cycle 0) occurred during a relatively normal wet season (September) in 1993. However, the remainder of the canal sampling cycles (i.e., May and September 1994, May 1995) occurred during periods of above normal seasonal precipitation. The marsh sampling cycles were also initiated in periods of above average precipitation (April and September 1995). May and September 1996 sampling

Table 4.1 Precipitation summaries for the 9 stations used to establish the long-term norm and baseline precipitation conditions.

STATIONS									
	S5A	**BELLE GLADE**	**DEVILS GARDEN**	**S6**	**S39**	**S8**	**S9**	**TAMIAMI TRAIL**	**ROYAL PALM**
LONG TERM AVERAGE PRECIPITATION (cm)									
	142.5	137.3	132.2	140.8	126.7	131.4	119.1	120.6	127.5
NUMBER OF YEARS									
	38	66	58	36	32	27	35	56	47
ACTUAL PRECIPITATION (cm)									
1992	151.1	146.8	141.0	109.9	M	133.6	122.3	88.6	121.3
1993	128.0	133.3	140.9	91.7	99.4	141.9	108.4	146.0	114.1
1994	217.5	195.5	144.3	193.0	114.2	167.9	181.0	171.1	111.6
1995	144.8	146.9	163.5	137.6	138.6	140.5	137.3	112.9	141.6
1996	159.8	129.8	119.0	126.6	91.6	126.6	103.8	127.4	96.8
PERCENT OF LONG TERM AVERAGE PRECIPITATION									
1992	106%	107%	107%	78%	M	102%	103%	73%	95%
1993	90%	97%	107%	65%	78%	108%	91%	121%	89%
1994	153%	142%	109%	137%	90%	128%	152%	142%	87%
1995	102%	107%	124%	98%	109%	107%	115%	94%	111%
1996	112%	95%	90%	90%	72%	96%	87%	106%	76%
5 YEAR AVERAGE PRECIPITATION (cm)									
	160.2	150.5	141.8	164.7	110.9	142.1	130.6	129.2	117.1
PERCENT OF 5 YEAR AVERAGE PRECIPITATION									
1992	94%	98%	99%	67%	M	94%	94%	69%	104%
1993	80%	89%	99%	56%	90%	100%	83%	113%	97%
1994	136%	130%	102%	117%	103%	118%	139%	132%	95%
1995	90%	98%	115%	84%	125%	99%	105%	87%	121%
1996	100%	86%	84%	77%	83%	89%	79%	99%	83%

M = missing data

seasons had above average precipitation, but the precipitation quantities were not as extreme as in 1995.

Because the S12D flow is strongly influenced by water management decisions, the total Shark Slough flow (S12ABCD+S333) provided a better frame of reference (Walker personal communication). It should be noted that all 3 years were wet and 1995 was extremely wet. The Shark Slough flow was 4 times the average flow experienced in water years 1979 through 1998 and 1.6 times the maximum flow.

4.2 Canals

4.2.1 Discharge

Discharge through the S-5A, S-6, S-7, S-8, and S-12 structures (Figure 2.1) are shown in Figure 4.11. Discharge through these five structures varied by year (Table 4.2). The South Florida canals and structures are a highly managed water system and drainage through this system is not similar to drainage from a natural watershed. Managing for a more natural, historical flow regime is one of the major Everglades restoration goals.

Table 4.2 Average annual flow (cms) through selected structures (Water years ending September 30). (Walker personal communication)

Water Year	Structures				
	S5A	**S6**	**S7**	**S8**	**S12ABCD + S333**
1979–1993	9.1	6.4	8.8	11.4	24.5
1994	13.4	13.8	9.8	11.0	33.5
1995	16.2	23.9	18.0	25.0	97.5
1996	11.5	12.7	9.7	14.0	58.0

4.2.2 Water Depth

Water depths in the canals generally increased from the north to the south, with the greatest median depth of 4.6 m (15 feet) in the ENP (Table 4.3, Figure 4.12). Median depths in the WCA were about 4 m (13 feet), during both the wet and the dry seasons. Median depths in the EAA canals varied about 0.8 m (4 feet) from 3.2 m (10.5 feet) in the wet season to 2.0 m (6.5 feet) in the dry season. Water depth also varied seasonally in the ENP from about 4.6 m (15 feet) in the wet season to 3.9 m (12.75 feet) in the dry season. Depths in the BCNP canals were similar during the wet and dry seasons.

Table 4.3 Median values for selected canal constituents.

Area	**Season**	**Depth (m)**		**Surface Temp. (°C)**		**Bottom Temp. (°C)**		**Cond. (μmhos)**		**Surface DO (mg/L)**		**Bottom DO (mg/L)**		**Turb. (NTU)**		**pH (su)**	
		n	**Median (CI)***	***n***	**Median (CI)**	***n***	**Median (CI)**	***n***	**Median (CI)**	***n***	**Median (CI)**	***n***	**Median (CI)**	***n***	**Median (CI)**	***n***	**Median (CI)**
EAA	Wet	38	3.2 (±0.7)	38	27.7 (±0.3)	37	27.3 (±0.4)	38	1015.0 (±254)	38	1.8 (±0.4)	37	1.3 (±0.4)	38	2.0 (±0.5)	38	7.19 (±0.05)
	Dry	33	2.0 (±0.6)	33	29.8 (±0.5)	33	28.5 (±0.3)	33	646.0 (±84.7)	33	6.4 (±0.7)	33	4.8 (±1.2)	33	6.5 (±2.5)	33	7.63 (±0.11)
WCA	Wet	30	4.0 (±0.5)	30	27.9 (±0.4)	30	27.3 (±0.4)	30	736.5 (±77.3)	30	2.1 (±0.8)	30	0.9 (±0.4)	30	1.3 (±0.5)	30	7.32 (±0.05)
	Dry	38	4.0 (±0.3)	38	29.3 (±0.5)	38	27.5 (±0.9)	38	739.0 (±73.8)	38	3.7 (±0.9)	38	0.3 (±0.3)	38	2.1 (±0.6)	38	7.40 (±0.08)
ENP	Wet	15	4.6 (±0.4)	15	27.4 (±0.9)	15	27.1 (±1.0)	15	567.0 (±39.4)	15	3.0 (±0.7)	15	2.0 (±0.5)	15	0.7 (±0.4)	15	7.32 (±0.90)
	Dry	14	3.9 (±0.5)	14	29.2 (±0.7)	14	26.1 (±1.0)	14	578.5 (±38.0)	14	5.3 (±1.1)	14	1.6 (±1.1)	14	1.4 (±0.3)	14	7.44 (±0.10)
BCNP	Wet	16	2.1 (±0.8)	16	28.7 (±0.4)	16	28.1 (±0.9)	16	292.0 (±54.1)	16	3.1 (±1.4)	16	2.0 (±1.1)	16	0.4 (±0.2)	16	7.36 (±0.19)
	Dry	15	1.9 (±0.8)	15	28.9 (±0.8)	15	27.9 (±0.9)	15	334.0 (±66.1)	15	2.9 (±1.5)	15	0.8 (±0.5)	15	1.2 (±1.7)	15	7.23 (±0.19)

$$* \quad CI = 95\% \ confidence \ on \ median = 1.58 \ \frac{(75\% - 25\%)}{\sqrt{n}} \ \text{(SPSS 1996)}$$

4.2.3 Temperature

Median surface temperatures ranged between 27° and 30° C in canals during both wet and dry seasons (Table 4.3, Figure 4.13). Median surface temperatures were about 1° C warmer during the dry season (i.e., April, May) than during the wet season (i.e., September). Median bottom temperatures in the canals were lower than surface temperatures ranging from approximately 26" and 28.5" C during the wet and dry seasons (Table 4.3, Figure 4.14). The canals did exhibit thermal stratification during the dry season, particularly in WCA and ENP canals, with as much as a 3° C difference between the surface and the bottom temperatures. At these temperatures (i.e., 27° to 30° C), a 3° C difference in temperature represents a strong density stratification. Because of the nonlinear relationship between density and temperature, a 3° C difference in temperature from 27° to 30° C is equivalent to the density difference between 4° C and 18° C in a strongly stratified, temperate northern lake (Hutchinson 1957).

4.2.4 Conductivity

Conductivity values decreased from north to south, reflecting the increased dilution of the discharge from the EAA by precipitation (Table 4.3, Figures 4.15). Conductivity was significantly higher ($P< 0.05$) in the EAA compared to other management areas during the wet season because of the greater discharge from the EAA during the wet season (Table 4.3, Figure 4.16). Conductivity values in the other management areas, (WCA, ENP, BCNP) were similar regardless of season, with slightly higher conductivity values during the dry season. For areas outside the EAA, evapoconcentration likely contributes to higher conductivity during the dry season with dilution contributing to lower conductivity during the wet season.

4.2.5 Dissolved Oxygen

About 65% of the canal miles had hypoxic bottom waters (i.e., DO concentrations 2.0 mg/L) while 89% of the canal miles had bottom DO concentrations less than 5 mg/L. The DO water quality standard in Class III Florida waters is 5 mg/L. Saturated DO concentrations range from 8 mg/L to 7.6 mg/L based on water temperatures of 27° to 30° C, respectively. With the exception of the EAA, median bottom DO concentrations were lower during the dry season than during the wet season (Table 4.3, Figure 4.17). Median surface DO ranged from 1.8 mg/L (23% saturation) to 6.4 mg/L (84% saturation) in the EAA canals during the wet and dry cycles, respectively (Table 4.3, Figure 4.18). Median surface DO outside of the EAA ranged from 2.1 mg/L (27% saturation) to 5.3 mg/L (69% saturation) in WCAs, ENP, and BCNP. With the exception of BCNP, surface DO typically was higher in the canals during the dry season than the wet season (Table 4.3). Weak thermal stratification in the canals outside the EAA during the dry season likely contributed to decreased bottom DO. In the EAA canals, median DO concentrations were over 3 times higher during the dry season, than the wet season. There was little thermal stratification of the EAA canals, and with shallower depths than the canals in other areas during the dry season, bottom DO in the EAA canals during the dry season was nearly at the water quality standard of 5 mg/L. During the dry season, median surface DO in the EAA met the water quality standard of 5 mg/L (Table 4.3). Wet season loadings to the EAA canals also might have contributed to lower DO concentrations. During both wet and dry seasons, median surface DO in WCAs and BCNP did not meet the water quality standard for Class III waters. Median surface DO in the ENP satisfied the water quality standard during the dry season but not during the wet season.

4.2.6 Turbidity

Turbidity values were more variable and highest in the EAA canals with median values of about 4 Nephelometric Turbidity Unit (NTU) then decreased downstream (Table 4.3, Figure 4.19 and 4.20). Median values with 95% confidence interval plotted from the upstream to downstream direction show this spatial trend (Figure 4.19). Dry season turbidity values in all management areas were 2 to 3 times higher than during the wet season.

4.2.7 pH

The median pH values in the canals were circumneutral regardless of the season and exhibited little seasonal variation (Table 4.3, Figure 4.21). Canal values throughout the network had median pH values around 7.3 su. These circumneutral pH values in the canals are likely a result of surface water contact with the limestone strata in the canals.

4.3 Marsh

4.3.1 Water Depth

Exceedance frequency analyses were conducted for 3 stations in the marsh: 3A-NE in the northern portion of WCA3; 3A-28 in the southern portion of WCA3; and P-33 in Shark River Slough in ENP (Figure 4.22). The 3A-NE site is considered to have shallower water depths and have a greater frequency of drying compared to predrainage conditions while water depths are deeper at the 3A-28 site where water pools behind the levee compared to predrainage conditions. Water depths in Shark River Slough are variable compared to predrainage conditions, but this site typically is wet. These conditions are reflected in the exceedance frequency curves (Figure 4.23). The periods of record for 3A-NE, 3A-28, and P-33 are 27, 41, and 35 years, respectively. The 3A-NE site is dry about 50% of the time while the 3A-28 and P-33 sites are dry only about 15 and 5% of the time, respectively. The 1995 sampling year was exceptionally wet with less than a 1% probability of observing greater water depths at stations 3A-NE and 3A-28 during the wet season (September 1995). During 1996, water depth exceedances ranged from about a 40% probability of observing greater water depths at 3A-NE to about a 50% probability of observing greater water depths at 3A-28 and P-33. Marsh sampling during the 2-year baseline period, therefore, occurred during an above average precipitation and water depth period.

Water depths varied with time and space in the marsh. Water depths were deepest in the eastern portion of WCA3 roughly following the L67 canal from the Miami Canal to Tamiami Trail (Table 4.4, Figure 4.24), regardless of season. In general, WCA2 was inundated during both the wet and dry sampling seasons in 1995 and 1996. The western portion of WCA3 and the southern portion of ENP were dry during the 1995 and 1996 dry seasons. As previously stated, 1995 was an above average precipitation year with maximum depths of 1.8 m (6 feet) in the eastern portion of WCA3. Almost all of the study area had water depths of at least 0.3 m (1 foot) (Figure 4.24) during the wet season in 1995. During the wet season in 1996, the western edge of the study area and the southern area in ENP had water depths less than 0.3 m (1 foot). The dry season in 1995 also was wetter than usual, with the water depths similar to those observed during the wet season in 1996 (Figure 4.24).

Hydroperiod can be inferred from the change in water depths between the wet and dry seasons. The long hydroperiod areas are located in the eastern portion of WCA2 and WCA3, paralleling the L67 canal in WCA3, and extending down Shark River Slough in ENP (Figure 4.24). These areas did not dry between the wet and dry seasons and contained water continuously throughout the study period. During the 1996 dry season, water depths in Shark River Slough in ENP did decrease to less than 0.3 m (1 foot), but the slough did not become dry.

The maximum water depths throughout the marsh reached only to 0.6 m (2 feet) during this May 1996 dry season. During both wet season sampling events the entire system was covered with surface water. In April 1995 and May 1996 (i.e., dry season sampling events) 16% and 29%, respectively, of the marsh was dry and exposed.

Table 4.4 Median values for selected constituents in marsh.

Area	**Season**	**Depth (m)**		**Temp. (°C)**		**Cond. (μmhos/cm)**		**DO (mg/L)**		**Turb. (NTU)**		**pH (su)**	
		n	**Median (CI)***	***n***	**Median (CI)**	***n***	**Median (CI)**	***n***	**Median (CI)**	***n***	**Median (CI)**	***n***	**Median (CI)**
LNWR	Wet	21	0.518 (±0.06)	21	29.4 (±0.7)	21	69.0 (±76.4)	21	5.9 (±1.1)	21	1.6 (±0.6)	21	6.54 (±0.03)
	Dry	20	0.29 (±0.07)	20	26.7 (±1.0)	20	161.5 (±56.3)	20	3.0 (±0.88)	20	10.3 (±5.0)	20	6.26 (±0.19)
WCA2	Wet	22	0.73 (±0.23)	22	29.4 (±1.1)	22	684 (±112)	22	3.5 (±0.7)	22	0.8 (±0.3)	22	7.125 (±0.13)
	Dry	20	0.305 (±0.12)	19	26.6 (±1.3)	19	935 (±108)	19	4.5 (±0.8)	19	1.2 (±1.3)	19	7.37 (±0.13)
WCA3	Wet	90	0.762 (±0.06)	89	29.9 (±0.6)	90	416 (±40.8)	90	4.5 (±0.5)	90	0.7 (±0.1)	90	7.29 (±0.06)
	Dry	91	0.396 (±0.06)	84	25.7 (±0.5)	84	576.5 (±43.3)	84	3.6 (±0.5)	84	1.9 (±0.7)	84	7.29 (±0.06)
ENP	Wet	75	0.396 (±0.06)	75	30.5 (±0.6)	75	350 (±29.4)	74	7.3 (±0.8)	75	0.7 (±0.1)	75	7.63 (±0.08)
	Dry	78	0.152 (±0.05)	56	26.3 (±0.9)	56	578.5 (±38.6)	56	5.9 (±1.0)	57	2.4 (±1.3)	56	7.425 (±0.12)
BCNP	Wet	24	0.198 (±0.10)	24	29.1 (±1.2)	24	228.5 (±30.5)	24	5.6 (±1.8)	24	1.0 (±0.2)	24	7.345 (±0.17)
	Dry	26	0.3 (±0.04)	13	27.3 (±2.0)	13	375 (±45.6)	13	5.4 (±1.7)	14	2.8 (±2.4)	13	7.61 (±0.15)

$$* \quad CI = 95\% \ confidence \ on \ median = 1.58 \frac{(75\% - 25\%)}{\sqrt{n}} \ (\text{SPSS } 1996)$$

4.3.2 Conductivity and General Flow Paths

Water conductivity is useful for understanding the source of the water and its flow path. Precipitation in the Everglades region has a very low ionic content, with the specific conductivity of volume-weighted annual precipitation as low as 12 μmhos/cm. The flow patterns across the marsh are illustrated by the water conductivity isolines (Figure 4.25). Very low conductivity was observed in the interior of LNWR and the western portions of WCA3A and BCNP indicating that these portions of the system are largely rainfall-driven. High conductivity water is transported downstream by canals draining the EAA and can be used to indicate surface water flow patterns across the marsh system (Figure 4.25, Table 4.4). There is a progressive decrease in conductivity from WCA2 through WCA3 to ENP regardless of the season (Table 4.4). Conductivity in WCA2B is also high, but consistent with the surrounding area. WCA2B is generally considered to be a rain-driven system. Water typically flows from the EAA through canals on the eastern side of the Everglades ecosystem through WCA2 and the eastern part of WCA3 into ENP and Florida Bay. This general flow path is observed during the wet season and the dry season (Figure 4.25, Table 4.4.). Marsh conductivity is higher during the dry season (Figure 4.25, Table 4.4), while canal conductivity within the EAA peaks during the wet season (Table 4.3). The dry season marsh patterns indicate significant ($P< 0.05$) increases in conductivity due to diminished dilution by precipitation, the drying of large areas of the marsh and resulting evapoconcentration, and the greater influence of canal water as the marsh flow pattern becomes restricted to the central flowway. The observed gradient is consistent with that reported throughout the system by Mattraw et al. (1987) and McPherson et al. (1976), and reported in canals near ENP by Flora and Rosendahl (1982b). Waller (1982) documented changes in ionic content and conductivity observed in ENP from 1959 to 1997 due to water management and canal water influence. The origin of the higher ionic content of EAA discharge water may be due to the influence of highly mineralized groundwater (Miller 1988), leaking of highly weatherable materials from oxidizing soils, and agricultural amendments.

4.3.3 Temperature

Water temperatures in the marsh were significantly warmer ($P < 0.05$) during the summer wet season than during the winter dry season (Table 4.4, Figure 4.26). Average summer water temperatures were about 3° to 4° C warmer than the winter water temperatures throughout the marsh. In general, there was an inverse relationship between water depth and water temperature with the shallower areas having warmer water temperatures and the deeper areas having cooler water temperatures, particularly during the dry season in both 1995 and 1996. Because almost all biological and chemical rates are temperature dependent, high reaction and metabolic rates would be expected throughout the year with the highest rates during the wet summer months.

4.3.4 Dissolved Oxygen

DO concentrations were usually greater than 2 mg/L throughout the South Florida Everglades ecosystem with median DO concentrations ranging from 3 mg/L (38% saturation) in LNWR during the dry season to over 7 mg/L (96% saturation) in ENP during the wet season (Table 4.4, Figure 4.27). About 10% of the total area of the marsh was hypoxic, (i.e., DO <2 mg/L) while over 45% of the marsh had DO concentrations less than 5 mg/L. The hypoxic areas were not as extensive during the 1995 above normal precipitation year compared with the 1996 year.

Previous investigators have found that DO in ENP wet prairies and slough communities exhibits a strong diel cycle, with concentration at a particular location ranging from around 0 mg/L in early morning to 12 mg/L in late afternoon. (McCormick et al. 1997). In contrast, oxygen levels at nutrient rich locations within WCA2A have been shown to often be undetectable and rarely exceed 2 mg/L. Excessive nutrient enrichment is also associated with reduced periphyton productivity, changed water column community metabolism toward heterotrophy, and protracted periods of oxygen depletion (Belanger et al. 1989, McCormick et al. 1997). McCormick et al. (1997) noted that although wetland plant and animal species are well adapted to the natural diel cycle of anoxia that often characterizes pristine marsh ecosystems, it is improbable that many native Everglades fish species are tolerant of prolonged oxygen depletion (e.g., less than 2 mg/L) in the water column. There are some fish species that are surface gulpers of oxygen (air), which could give them a competitive advantage over fish species less tolerant to low DO.

4.3.5 Turbidity

Turbidity and water depth were generally inversely related (Table 4.4). As water depth increased, turbidity decreased. The 1995 dry season water depths were greater than the 1996 water depths, and correspondingly, turbidity values in the 1995 dry season were significantly less than in the 1996 dry season ($P < 0.05$). Turbidity was noticeably lower throughout the Everglades ecosystem during the wet seasons compared to dry season median values (Figure 4.28). Turbidity was typically low, throughout the marsh, with the exception of LNWR during the dry season (Table 4.4). The reason for this elevated turbidity is unknown.

Some of the elevated turbidity at the shallow water sites might have occurred because of the very shallow water depths. There might have been disturbance from sampling very shallow waters, where the sampler intake was very close to the bottom and disturbed very fine particle size sediment. Deeper water sites had turbidity values less than 1 NTU.

4.3.6 pH

The pH of the Everglades marsh system is circumneutral with median values ranging from 6.3 to 7.6 su. LNWR was slightly acidic with a median pH value of 6.5 while the remainder of the marsh was slightly alkaline with median pH values between 7.1 and 7.6 (Table 4.4, Figure 4.29). Acidic conditions in LNWR result from the thickness of the peat soil in this subarea, which isolates lower pH rain water from the underlying limestone bedrock (Newman et al. 1997, Richardson et al. 1990).

4.4 Synthesis

Canal and marsh sampling both occurred during a period when precipitation and water depth were above normal. The last marsh sampling cycle (September 1996) occurred during a period approaching average seasonal precipitation. Water depths during the sampling period were significantly higher than normal. Most of the marsh was flooded, even during the first dry season sampling cycle (April 1995). Recurrence intervals for flooding at selected marsh sites indicated that higher water levels would be expected at these sites less than 20% of the time.

Specific conductivity patterns provide an indication of the contribution of the EAA to the downstream system in both the canal and the marsh and also provides an indication of the flow path of water from north to south through the marsh. The change in specific conductivity values indicates the importance of precipitation not only in the water balance, but also in constituent loading to the South Florida Everglades ecosystems. Water temperatures that are consistently greater than 25^{o}C in both the canal and the marsh indicate that because reaction rates are temperature dependent, biogeochemcial reaction rates in the warm tropical Florida systems might be expected to be relatively rapid in temperate systems. Temperature and DO profiles also indicate the canal bottom waters stratify and become anoxic. DO concentrations typically are low in both the marsh and canal, in part, because of higher temperatures and therefore, lower saturation of DO in water. Almost 90% of the canal miles had DO concentrations less than the Class III Florida water quality standard of 5 mg/L during the sampling period while less than 50% of the marsh area had DO concentrations that were less than the water quality standard. Turbidity was typically low in both canal and marsh samples. Both the canal and the marsh systems had circumneutral pH, although the LNWR had lower pH values, consistent with a bog ecosystem.

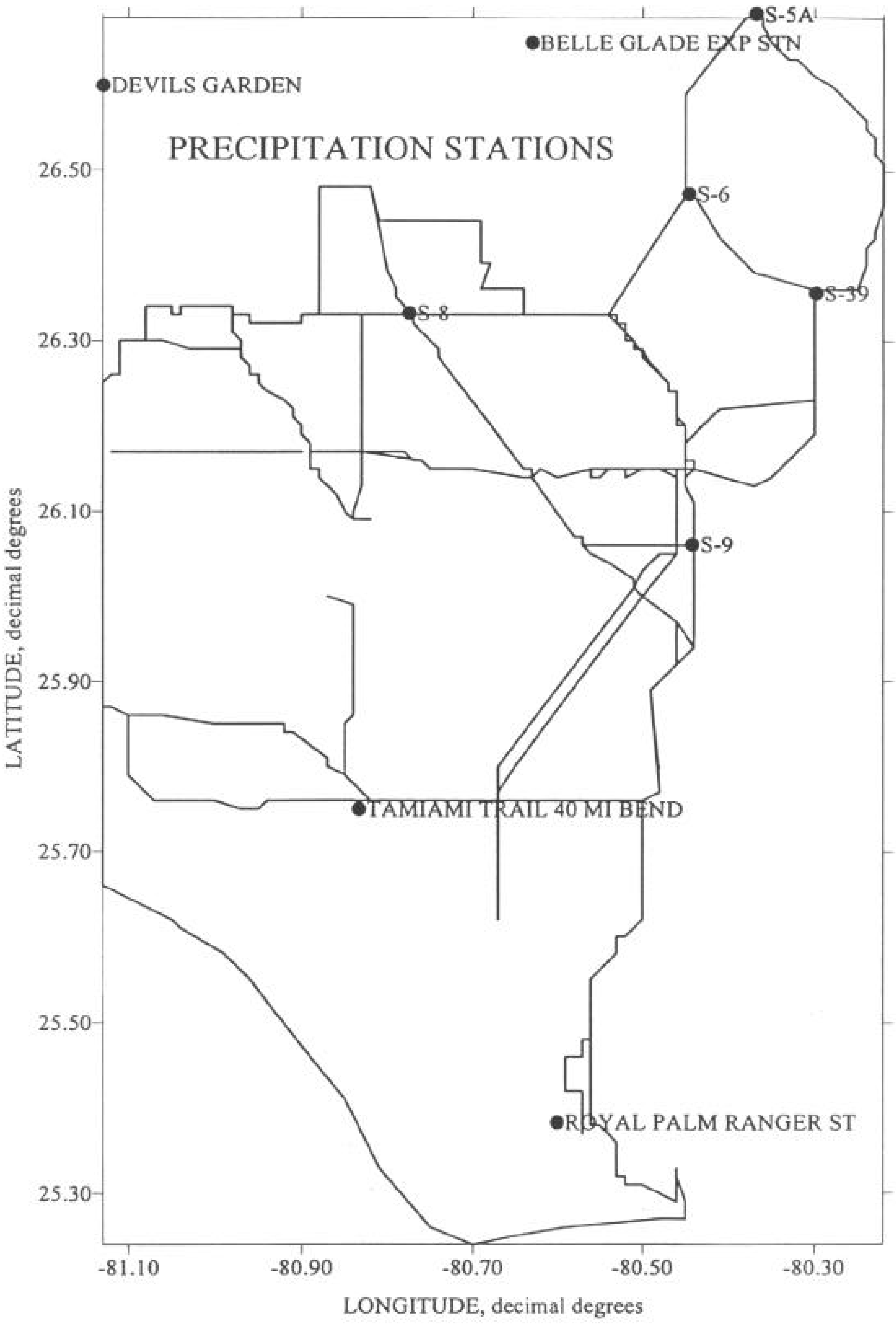

Figure 4.1 Location of precipitation stations from which period of record data were collected to establish long-term norm and baseline period precipitation conditions.

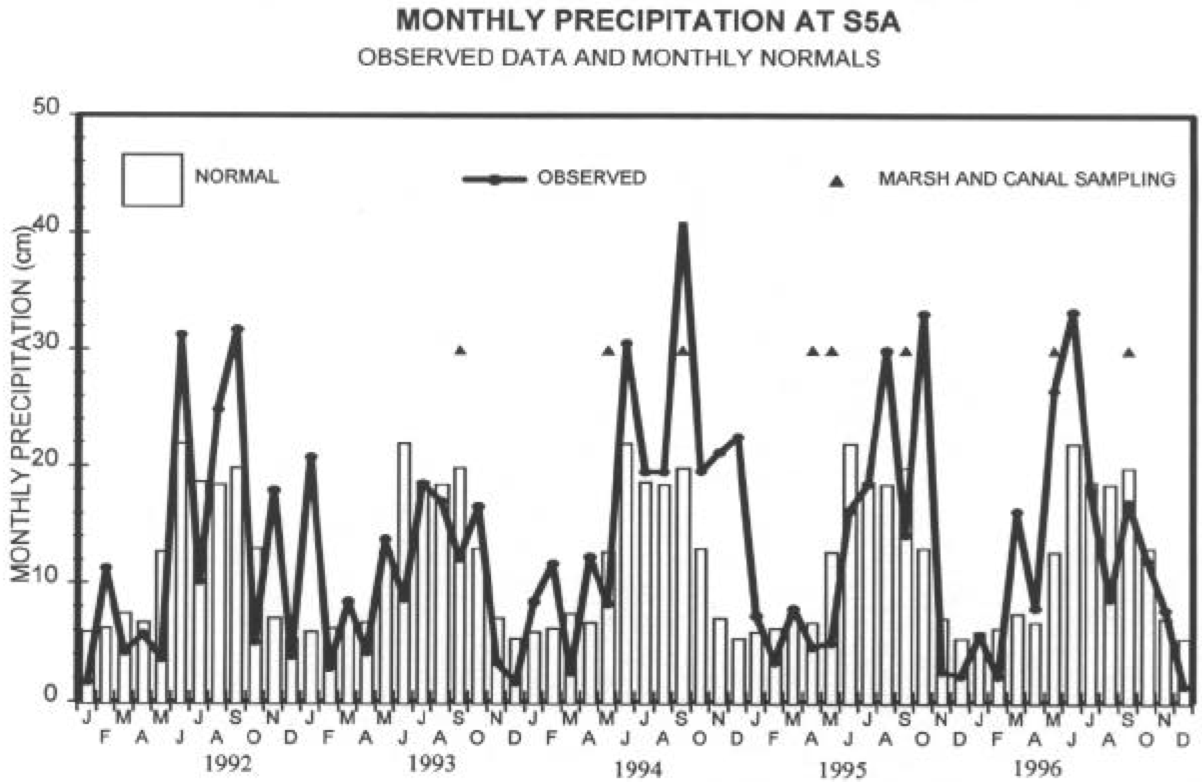

Figure 4.2 Comparison of monthly precipitation during the 5-year study period to normal monthly precipitation over the period of record at precipitation Station S5A, with marsh and canal sampling periods indicated.

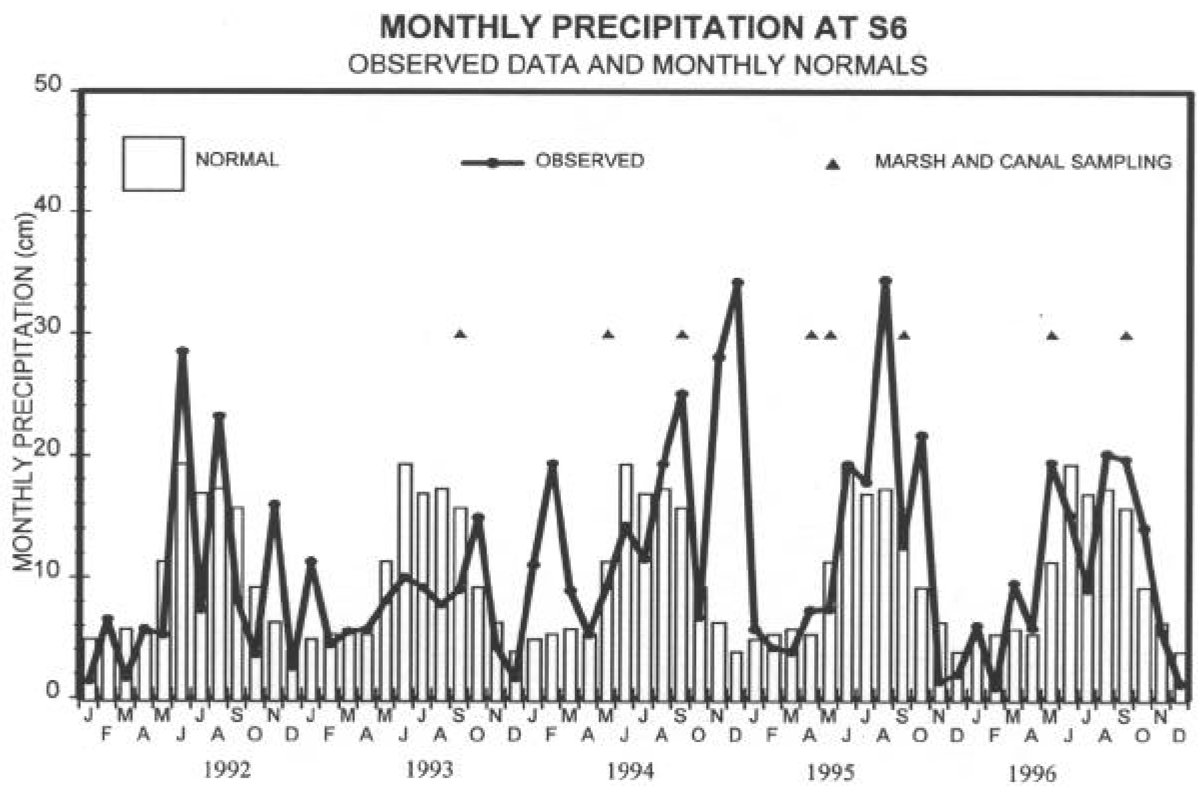

Figure 4.3 Comparison of monthly precipitation during the 5-year study period to normal monthly precipitation over the period of record at precipitation Station S6, with marsh and canal sampling periods indicated.

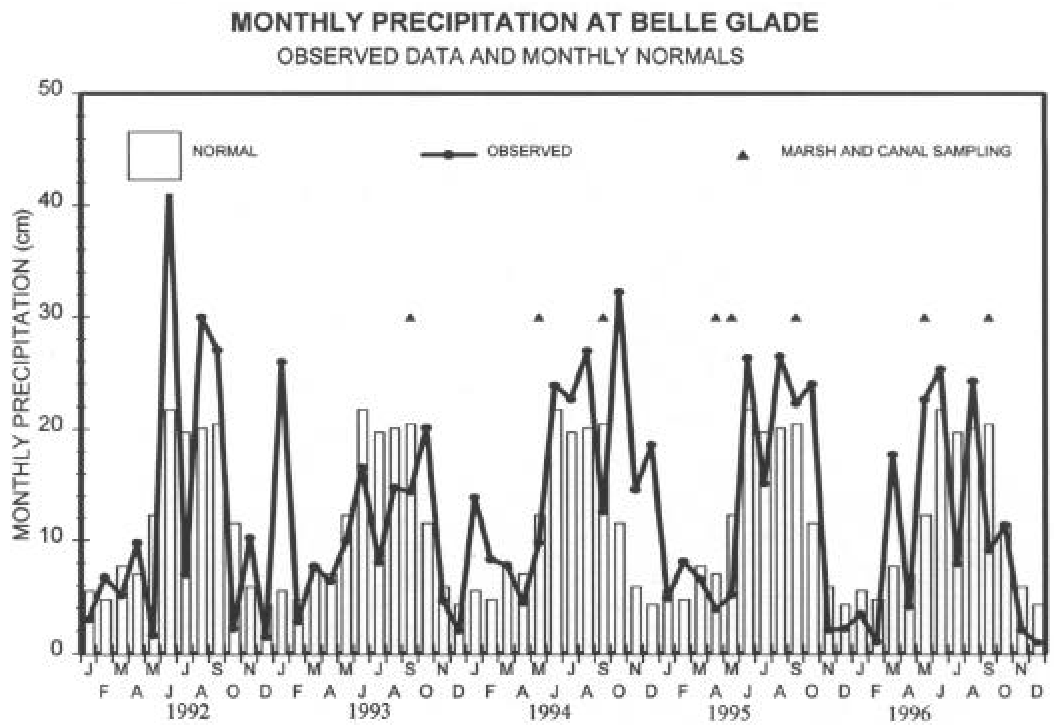

Figure 4.4 Comparison of monthly precipitation during the 5-year study period to normal monthly precipitation over the period of record at Belle Glade precipitation station with marsh and canal sampling periods indicated.

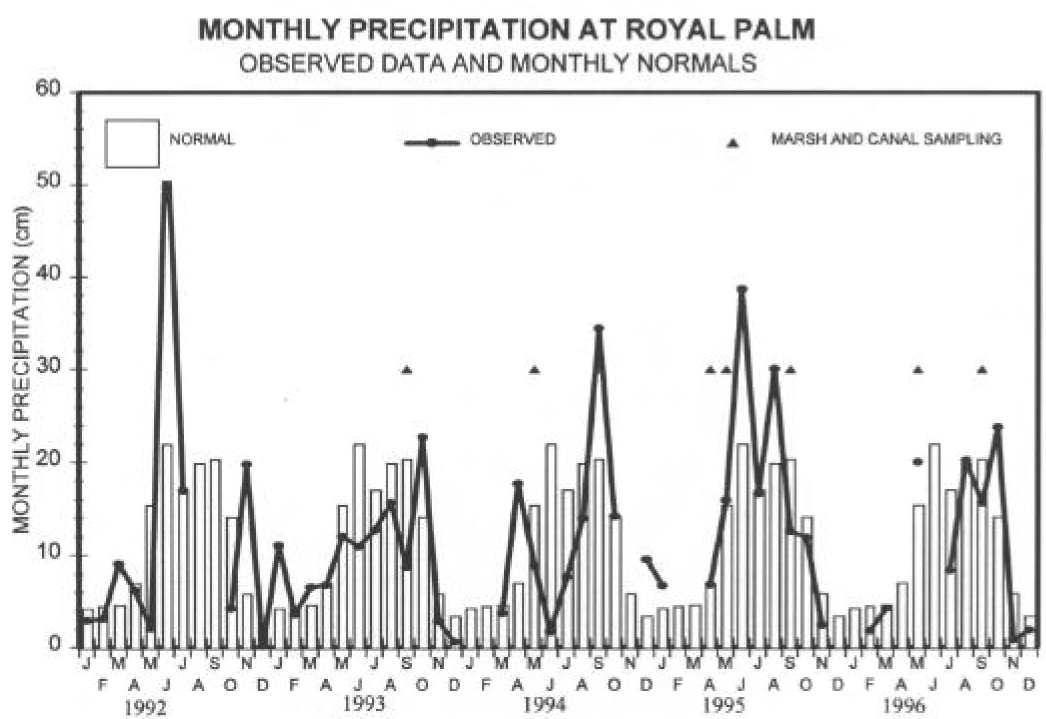

Figure 4.5 Comparison of monthly precipitation during the 5-year study period to normal monthly precipitation over the period of record at Royal Palm precipitation station, with marsh and canal sampling periods indicated.

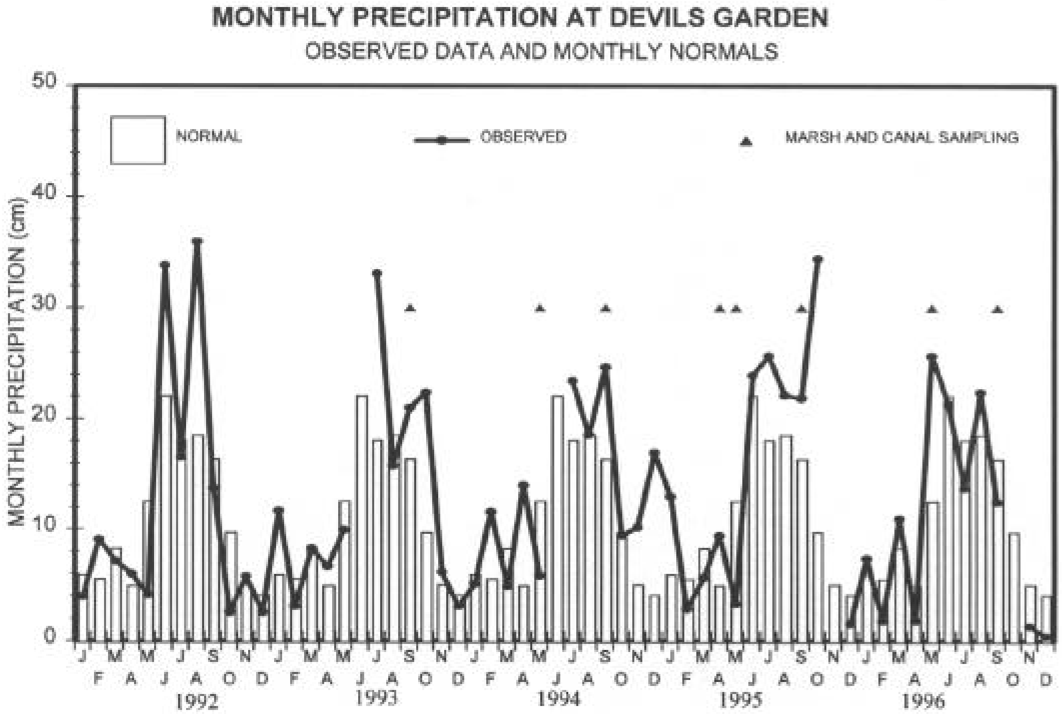

Figure 4.6 Comparison of monthly precipitation during the 5-year study period to normal monthly precipitation over the period of record at Devil's Garden precipitation station, with marsh and canal sampling periods indicated.

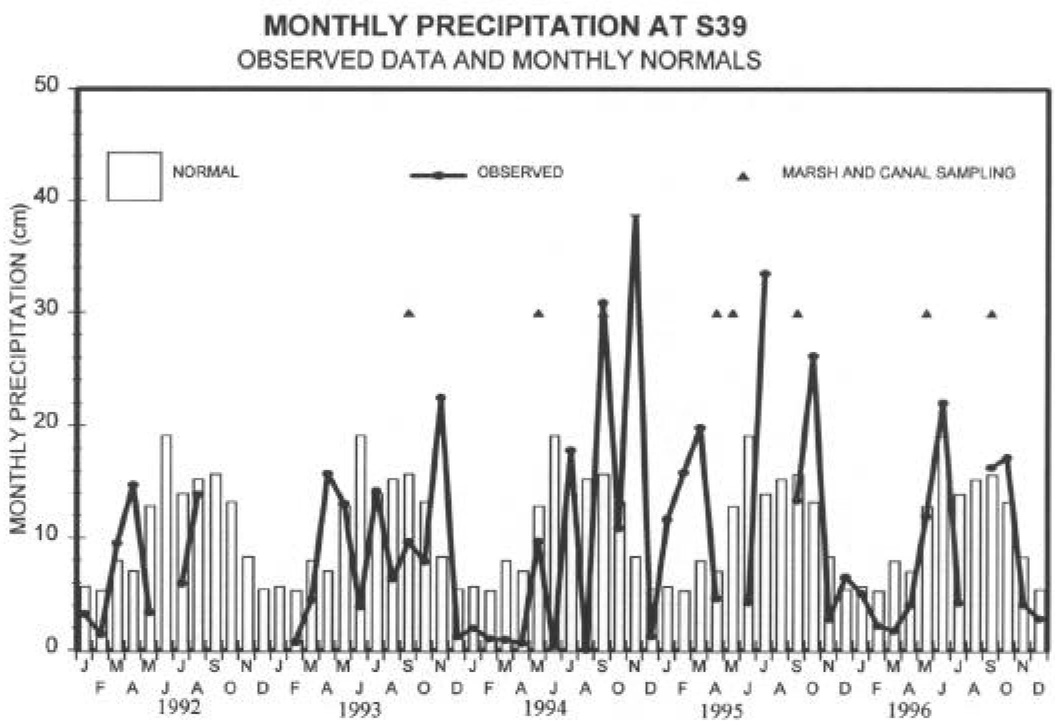

Figure 4.7 Comparison of monthly precipitation during the 5-year study period to normal monthly precipitation over the period of record at precipitation Station S39, with marsh and canal sampling periods indicated.

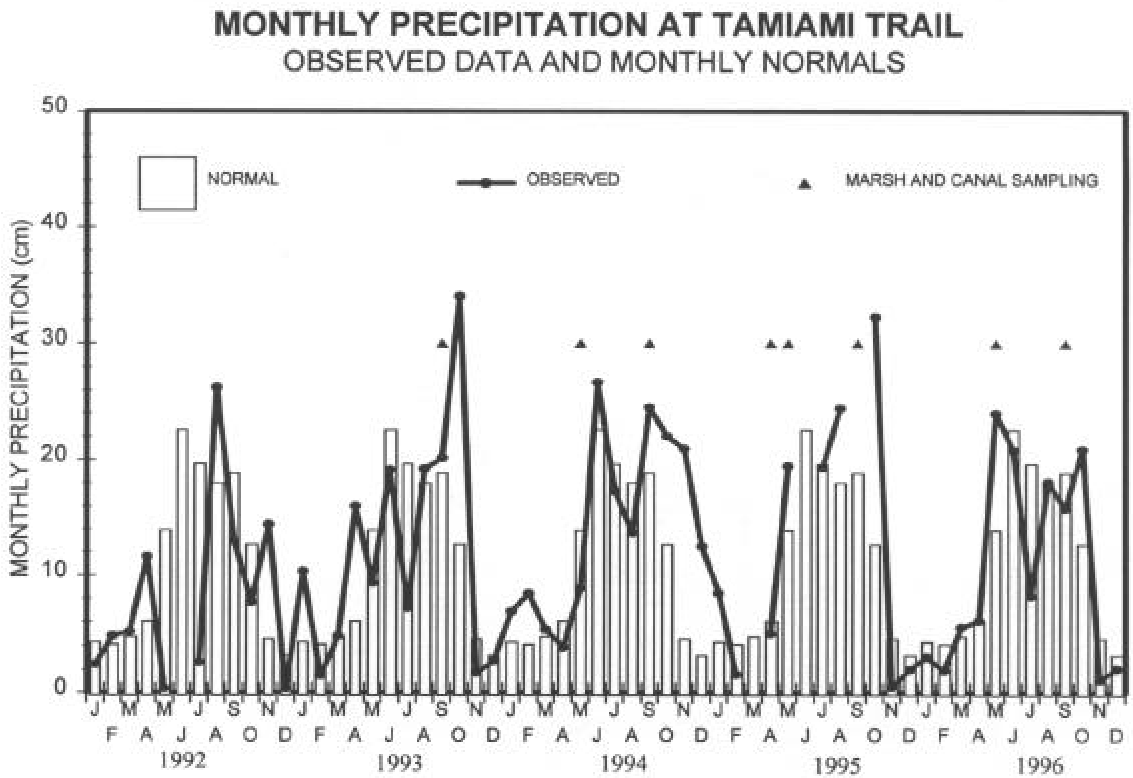

Figure 4.8 Comparison of monthly precipitation during the 5-year study period to normal monthly precipitation over the period of record at Tamiami Trail precipitation station, with marsh and canal sampling periods indicated.

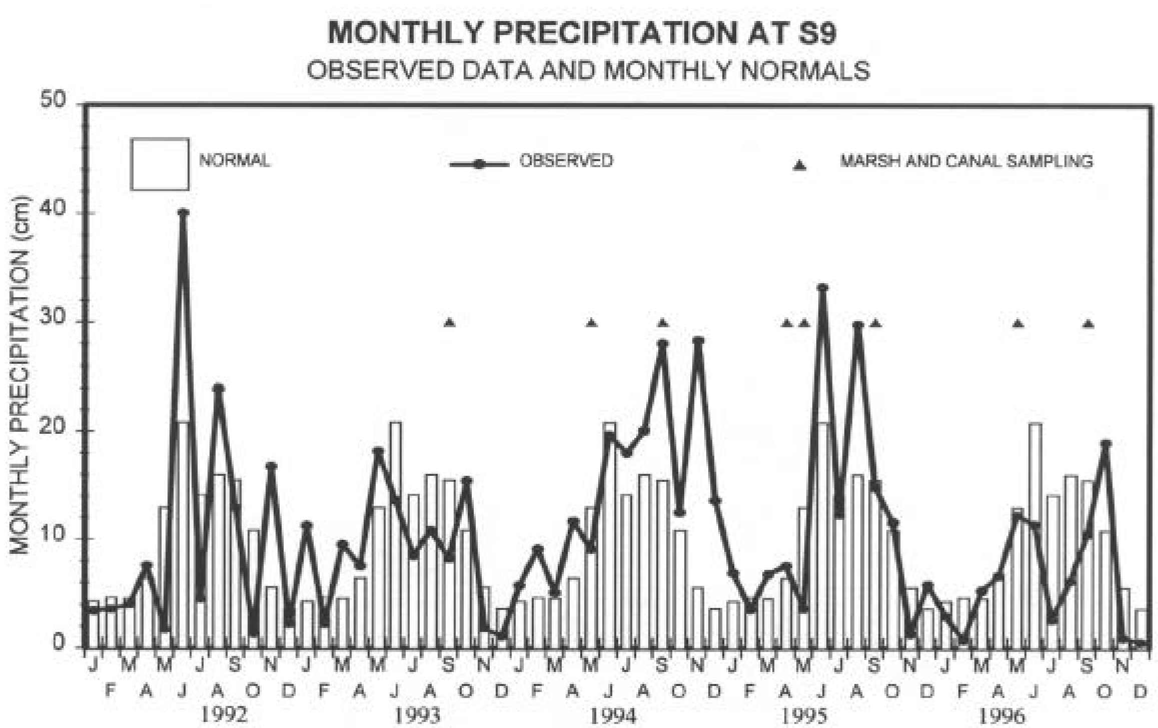

Figure 4.9 Comparison of monthly precipitation during the 5-year study period to normal monthly precipitation over the period of record at precipitation Station S9, with marsh and canal sampling periods indicated.

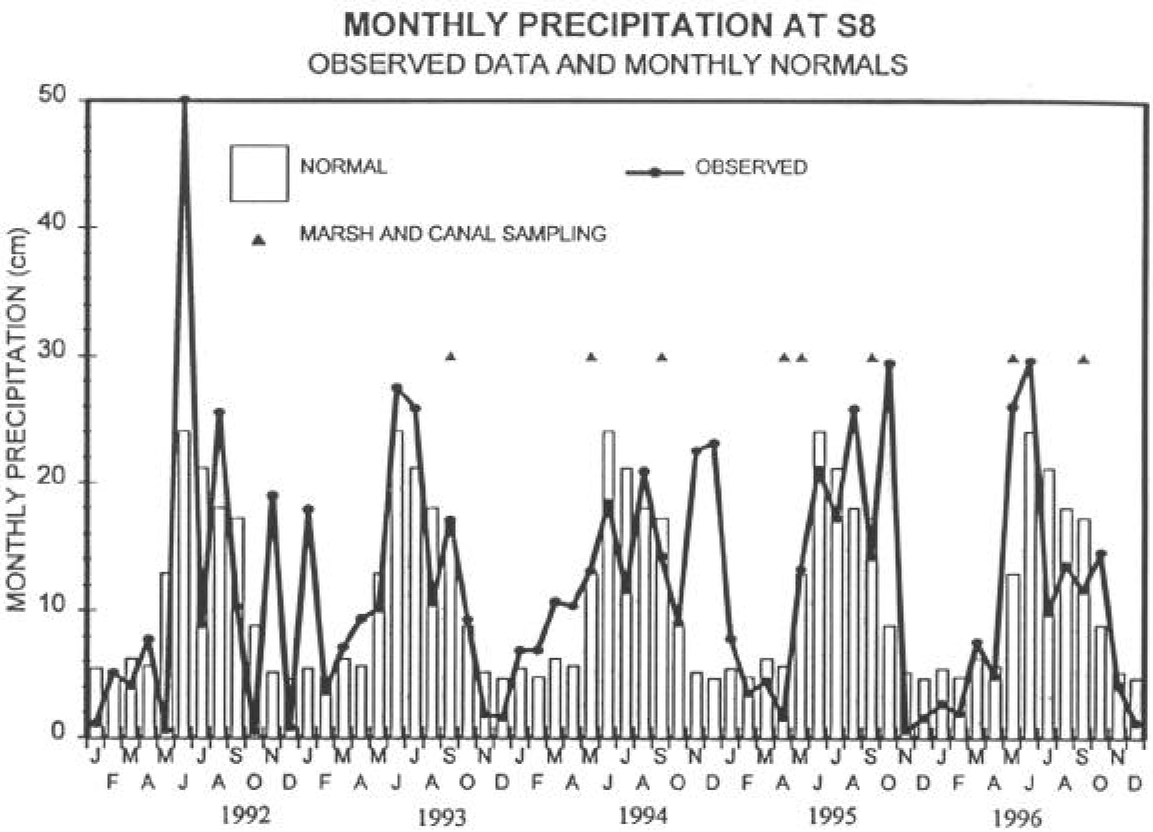

Figure 4.10 Comparison of monthly precipitation during the 5-year study period to normal monthly precipitation over the period of record at precipitation Station S8, with marsh and canal sampling periods indicated.

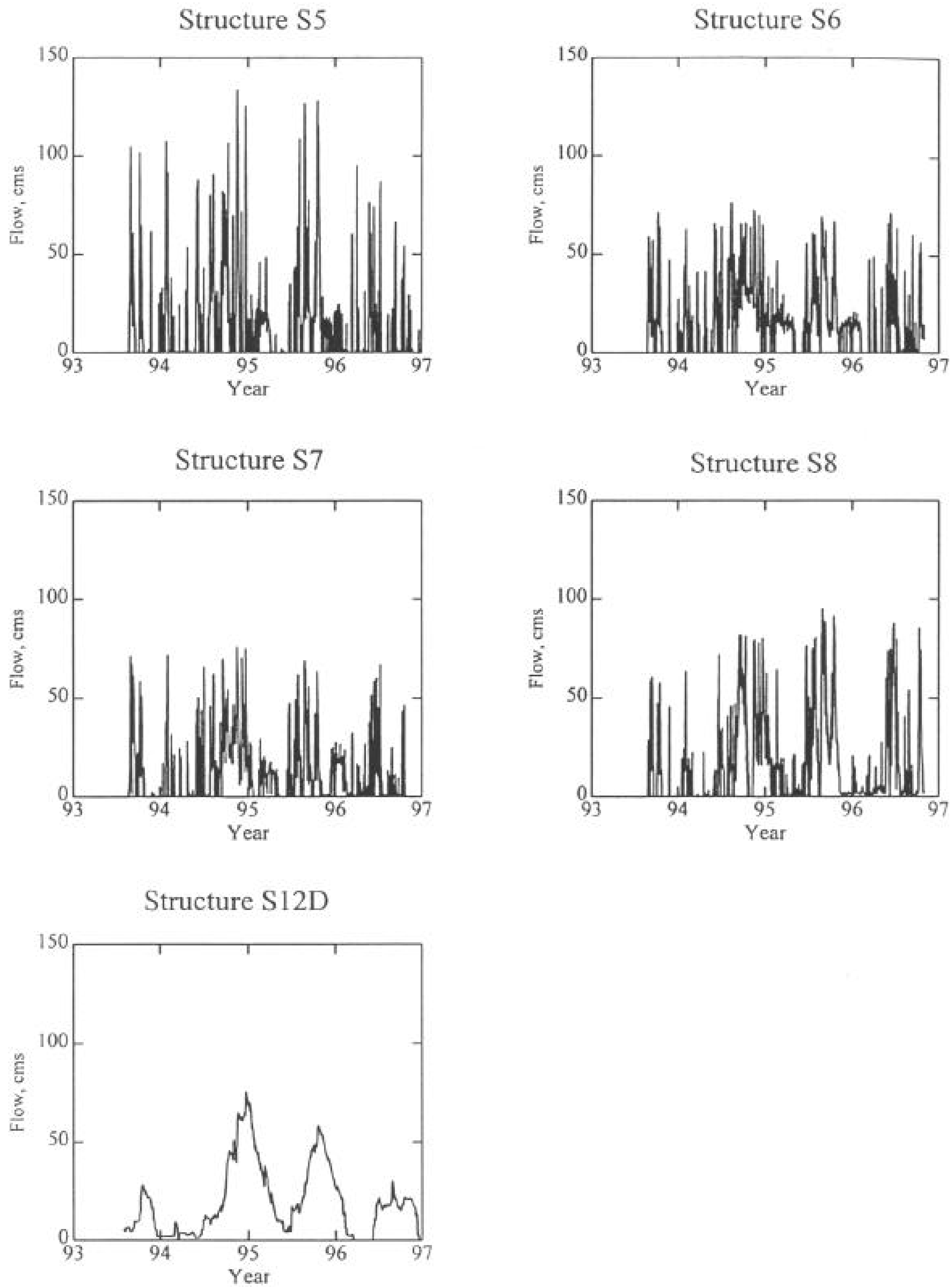

Figure 4.11 Daily discharge through selected SFWMD structures during the study period.

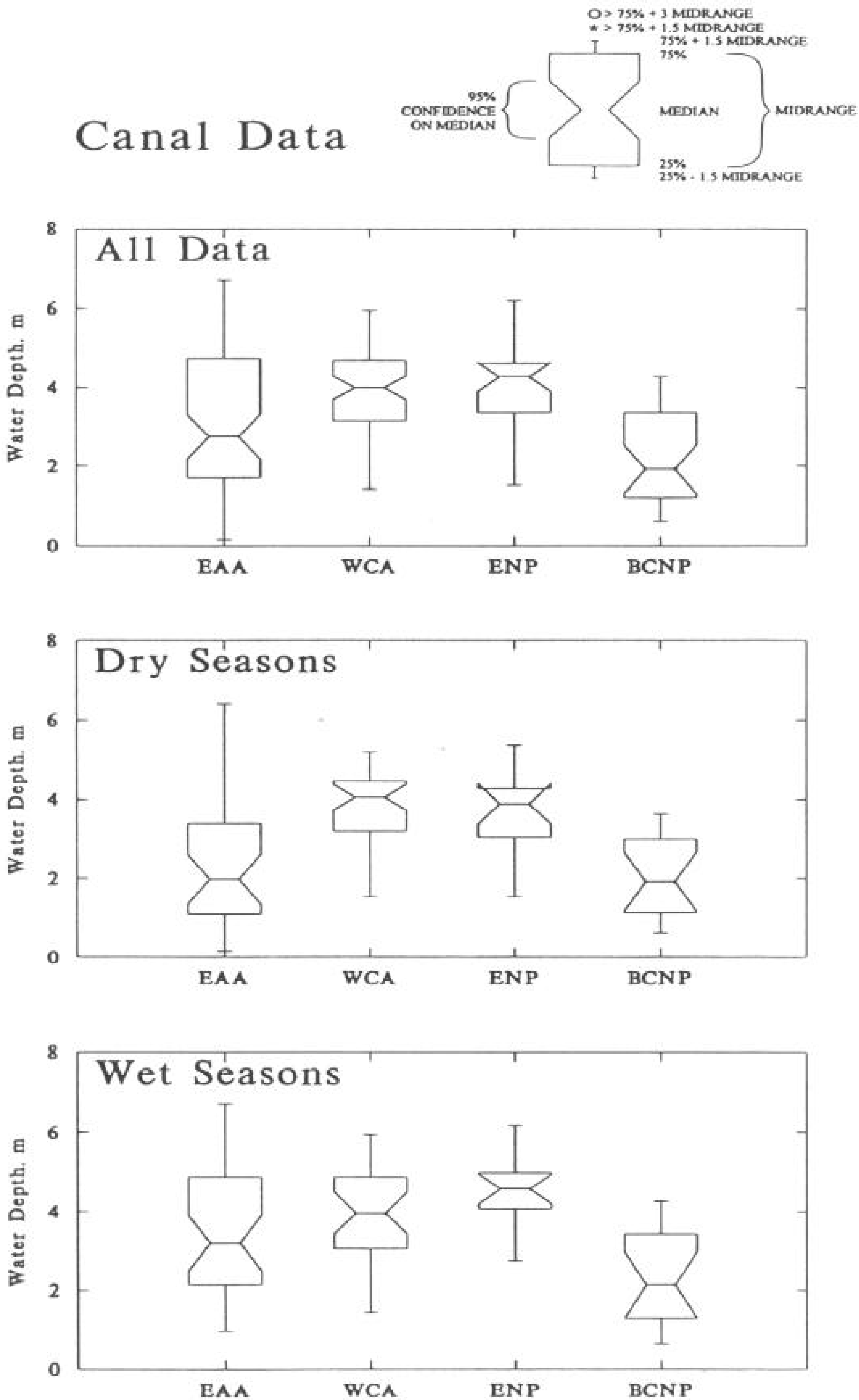

Figure 4.12 Notched box and whisker plots comparing water depths in canals by subareas with all of the sampling data, and data grouped into dry and wet season measurements.

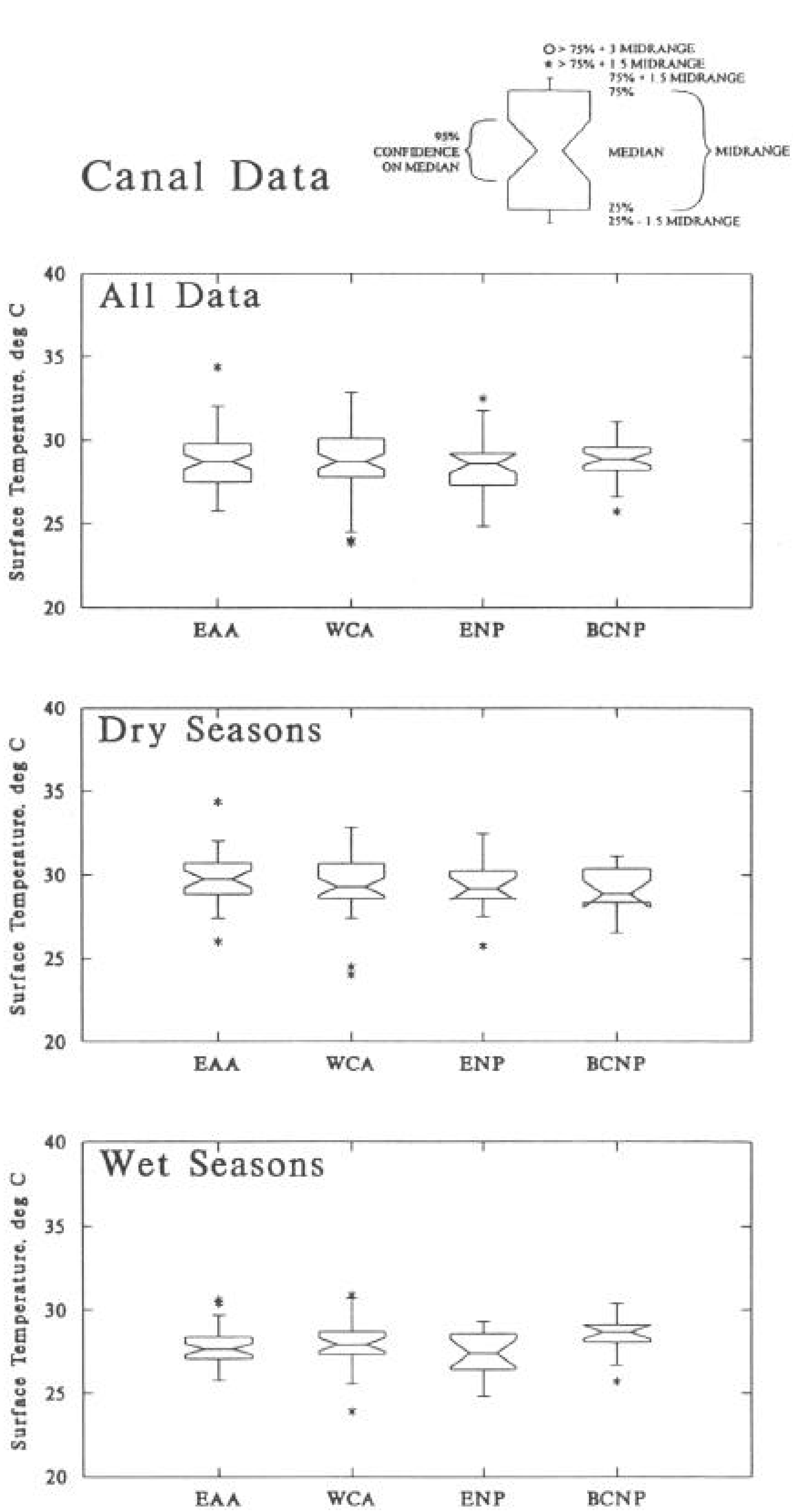

Figure 4.13 Notched box and whisker plots comparing canal surface water temperature in subareas during dry and wet seasons.

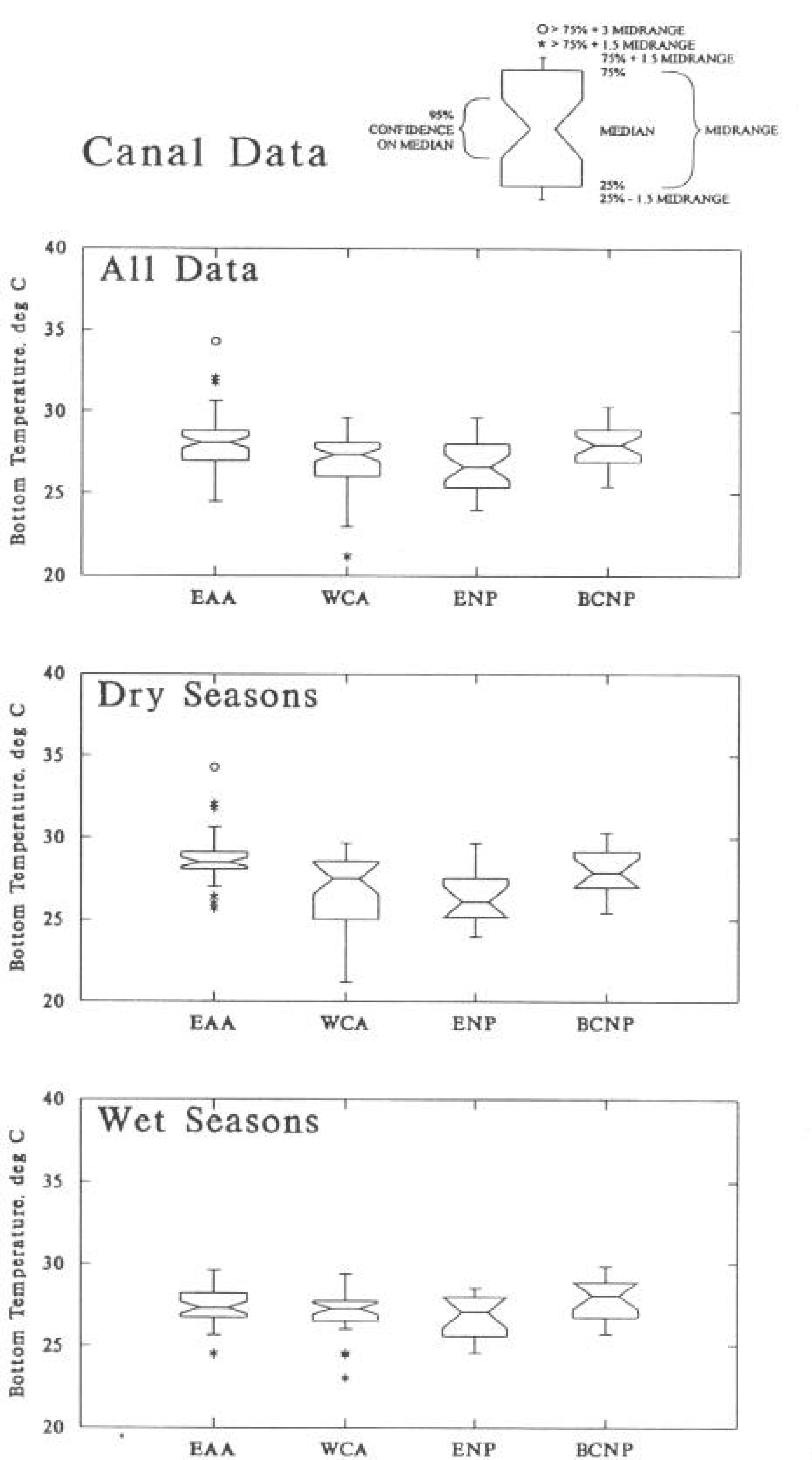

Figure 4.14 Notched box and whisker plots comparing canal bottom water temperature in subareas during dry and wet seasons.

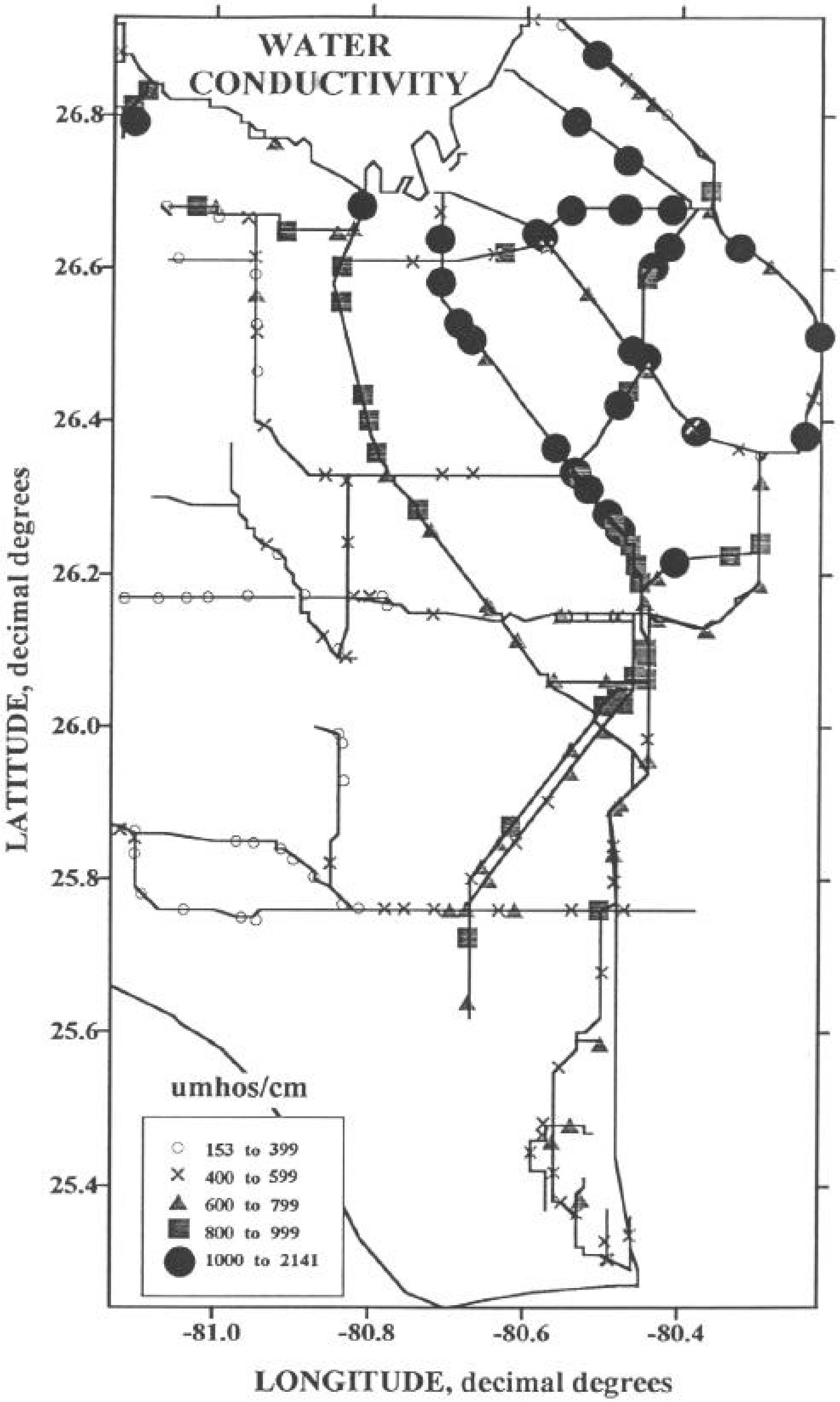

Figure 4.15 Canal conductivity reflects dilution of EAA discharge by precipitation.

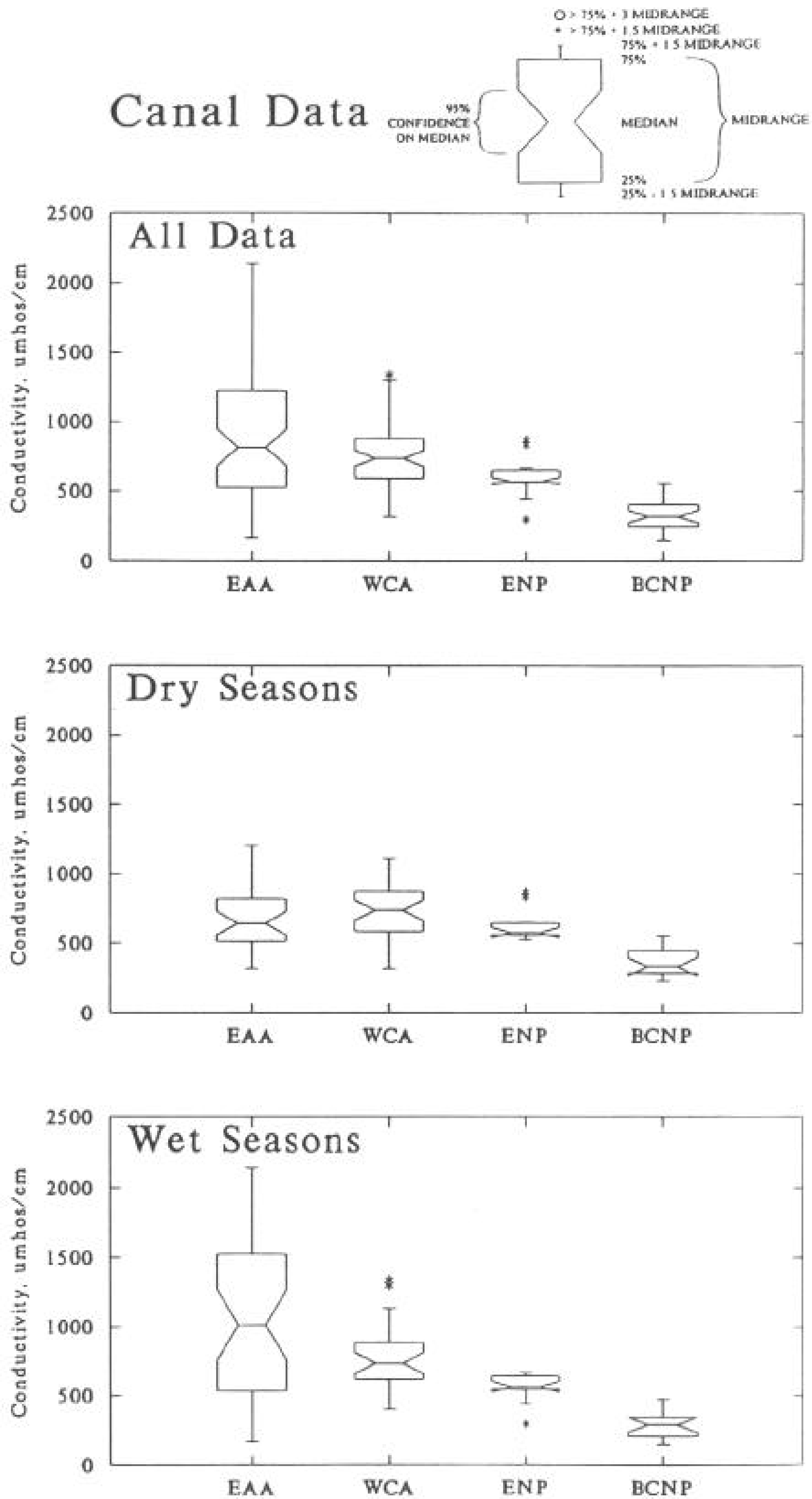

Figure 4.16 Notched box and whisker plots comparing canal conductivity in subareas during dry and wet seasons.

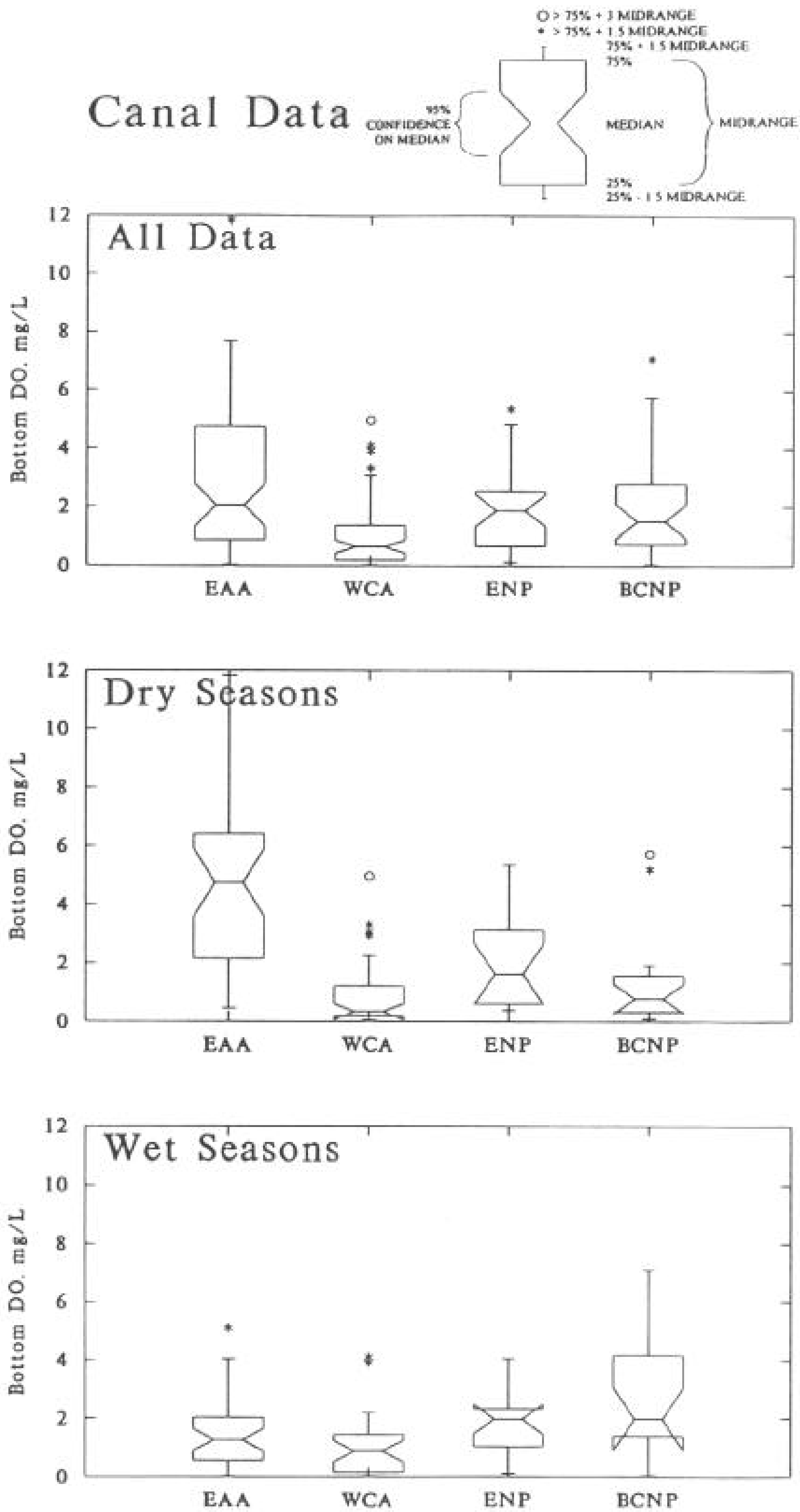

Figure 4.17 Notched box and whisker plots comparing canal bottom DO in subareas during dry and wet seasons.

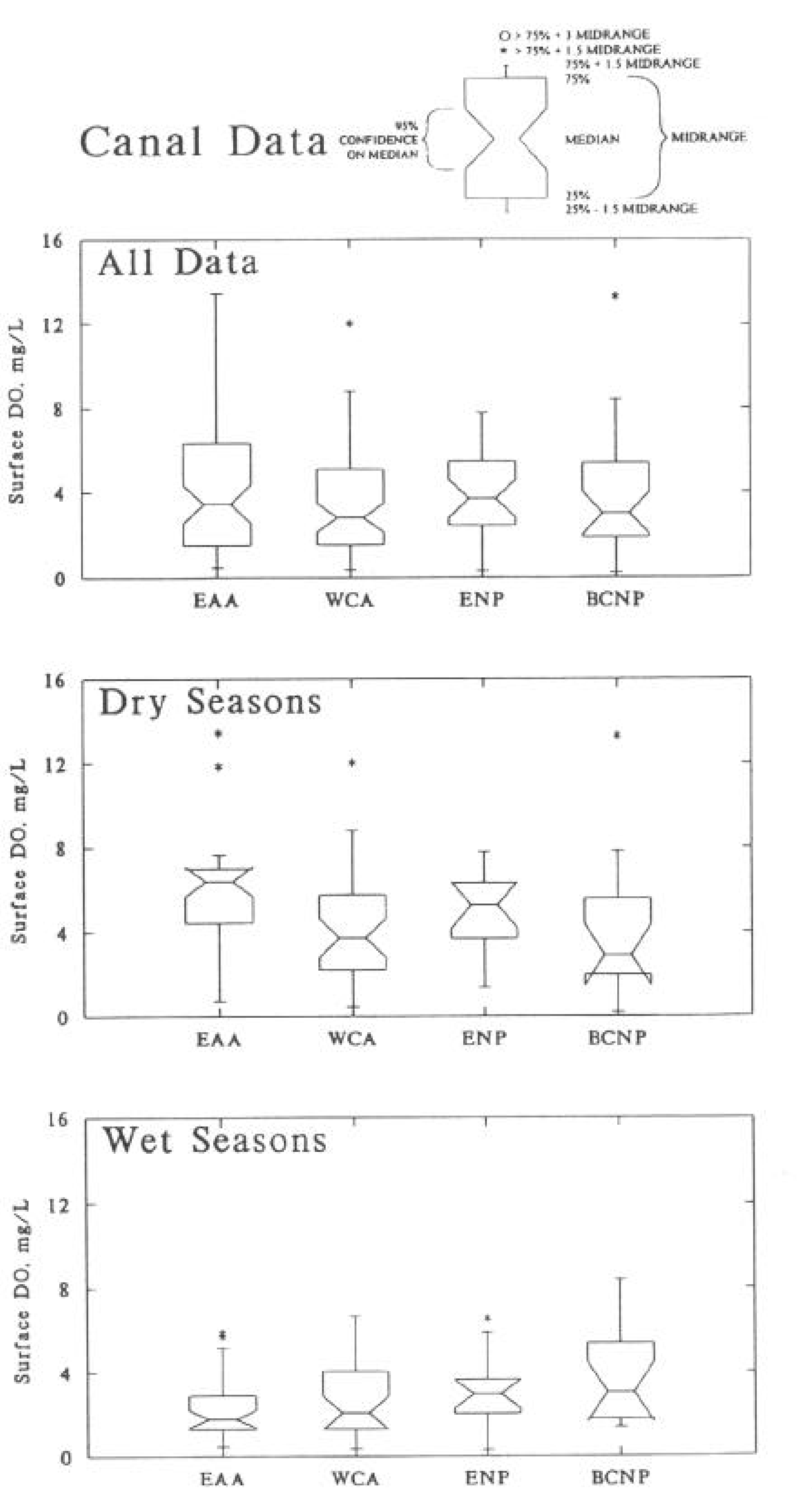

Figure 4.18 Notched box and whisker plots comparing canal surface DO in subareas during dry and wet seasons.

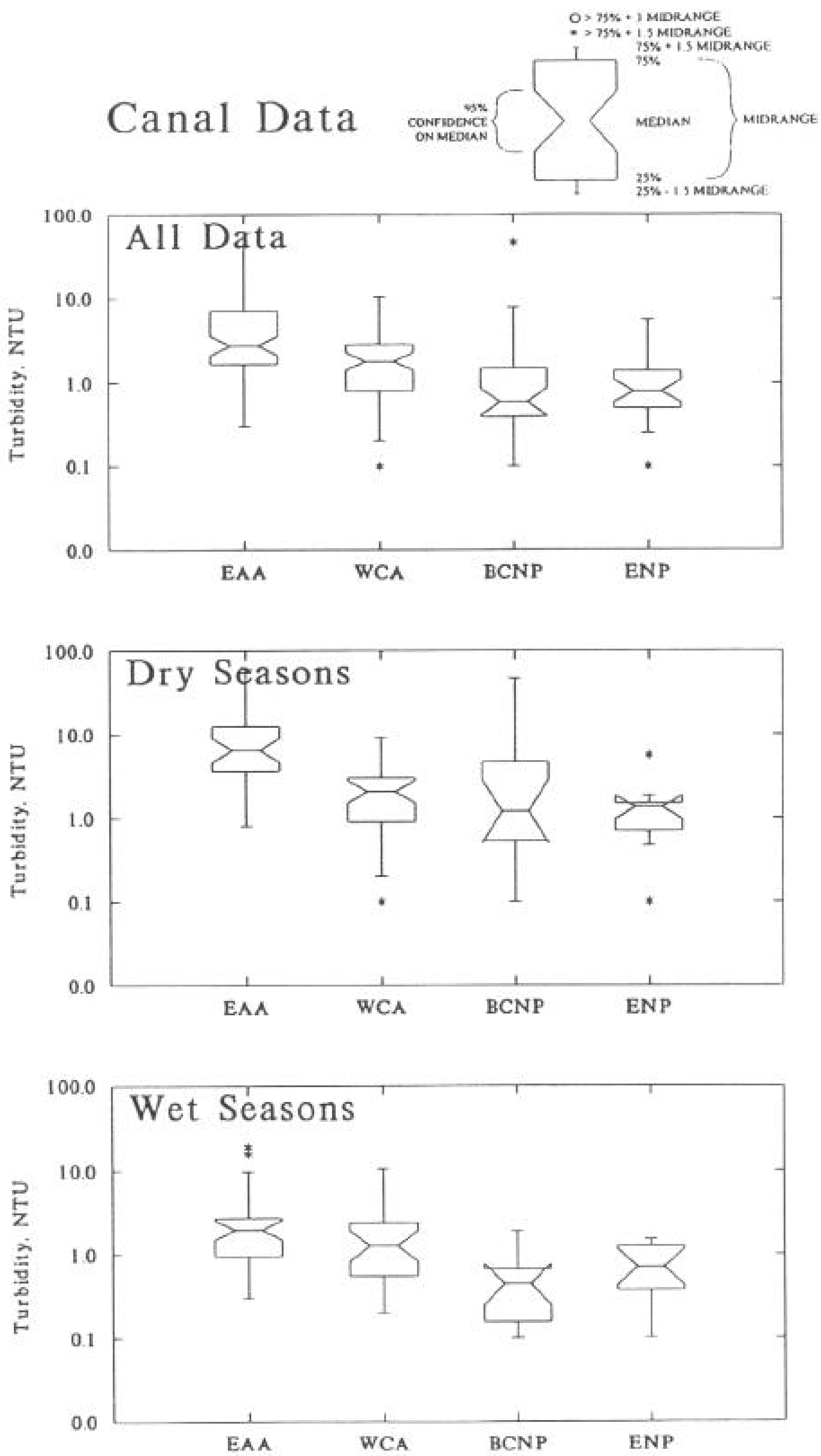

Figure 4.19 Notched box and whisker plots comparing canal turbidity in subareas during dry and wet seasons.

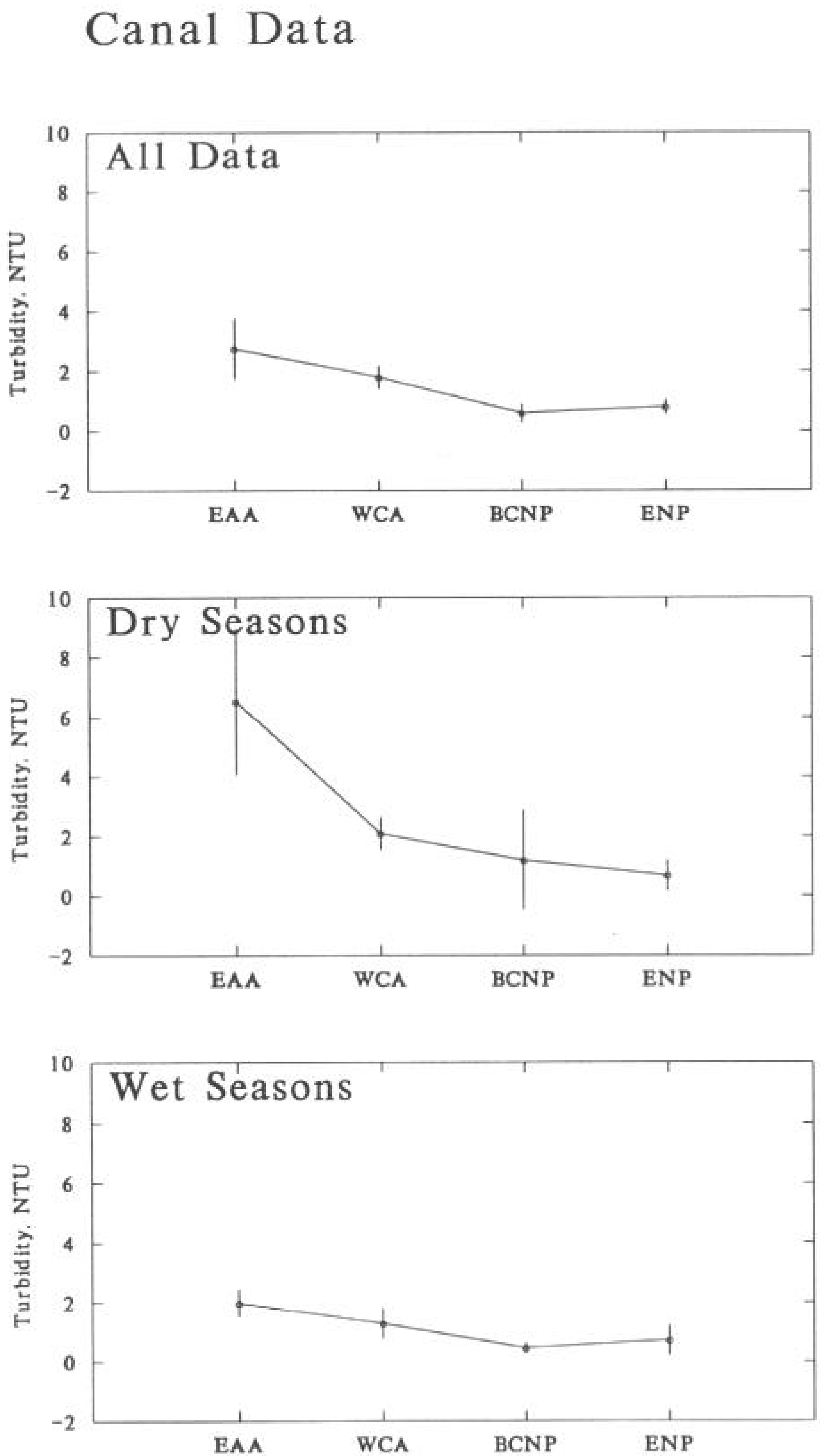

Figure 4.20 Plots of the medians of the canal turbidity measurements for each of the subareas with a vertical line indicating the 95% confidence interval about each median.

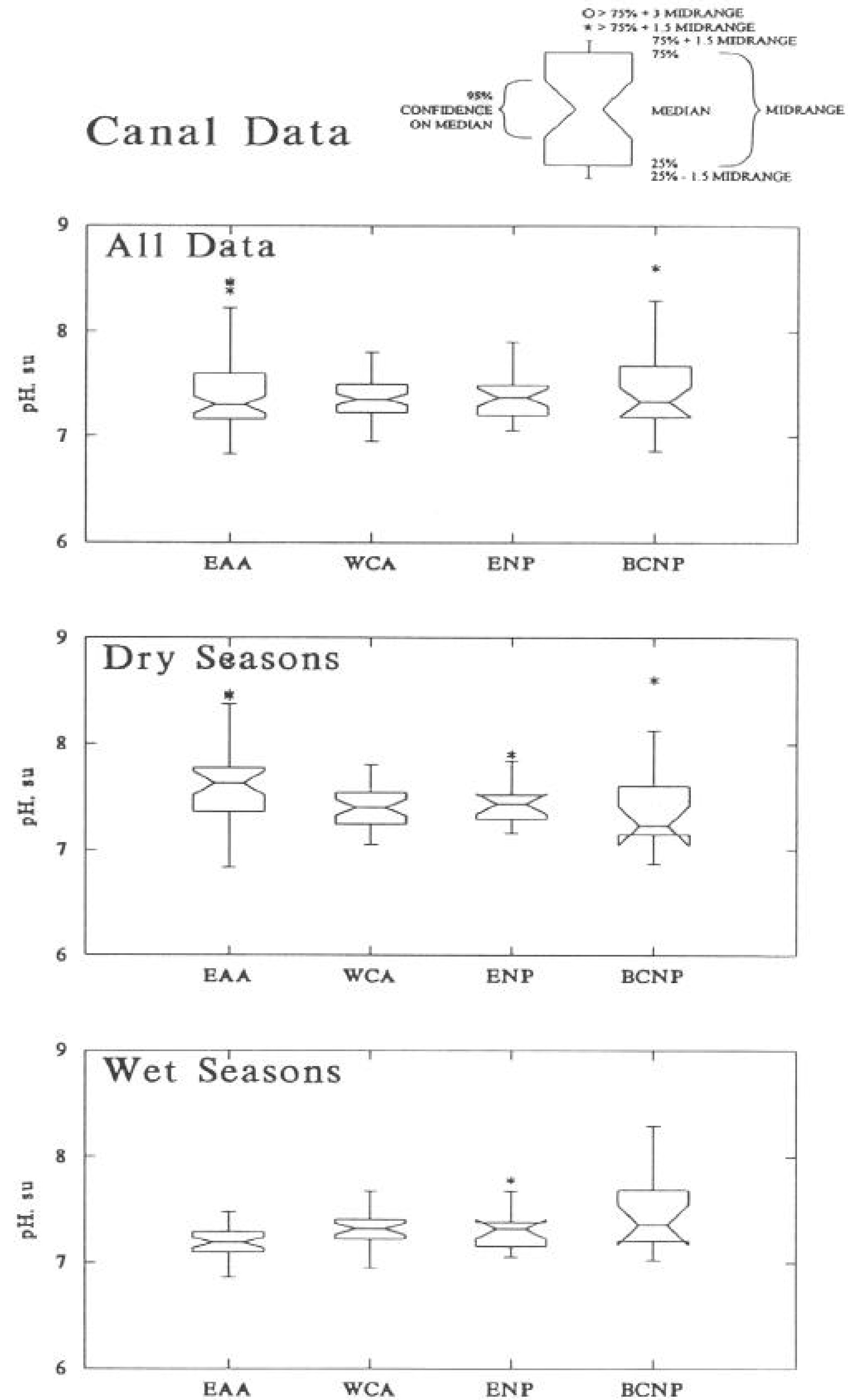

Figure 4.21 Notched box and whisker plots comparing canal pH measurements in subareas during dry and wet seasons.

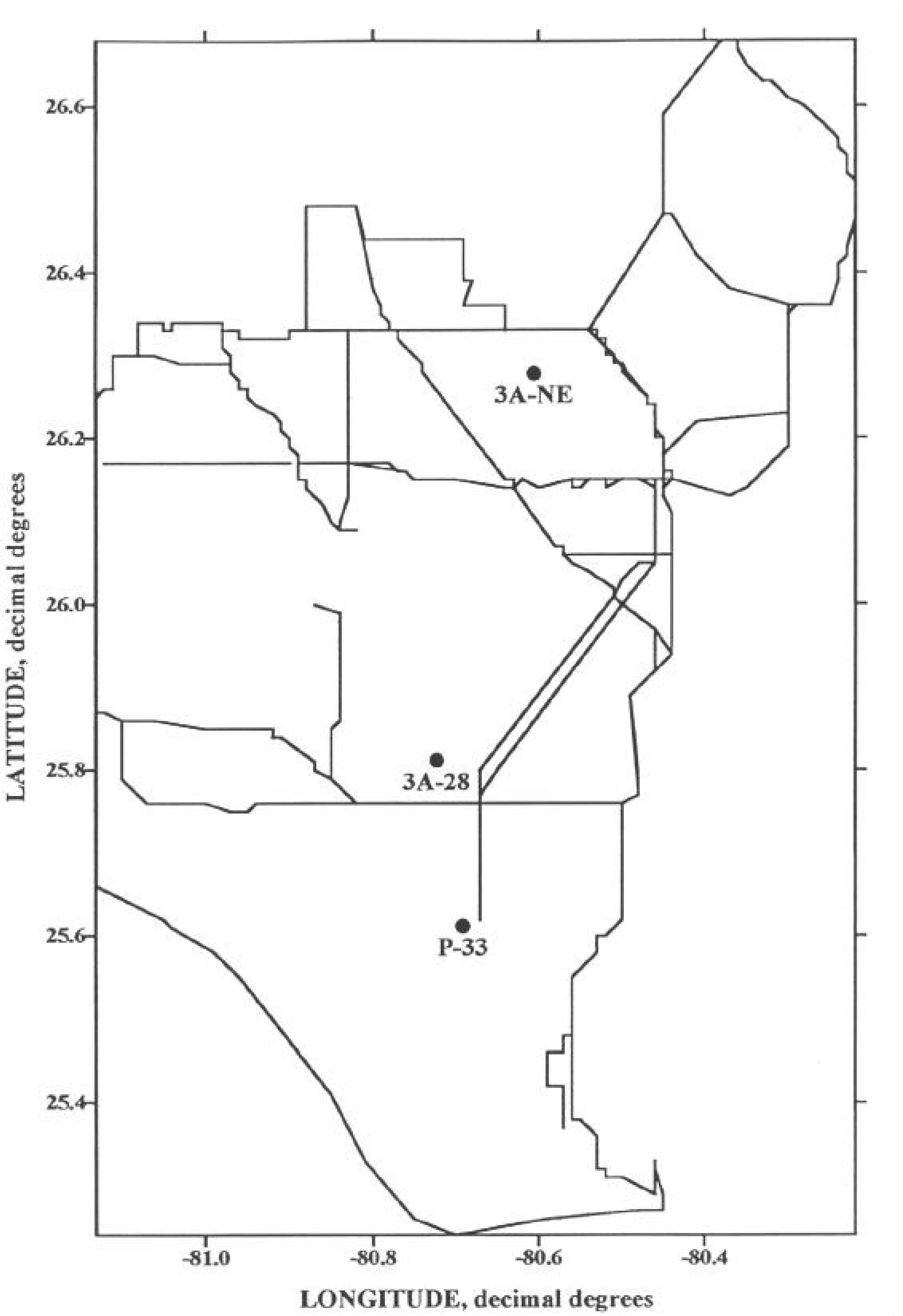

Figure 4.22 Locations of SFWMD water depth gaging stations used for exceedance frequency analysis.

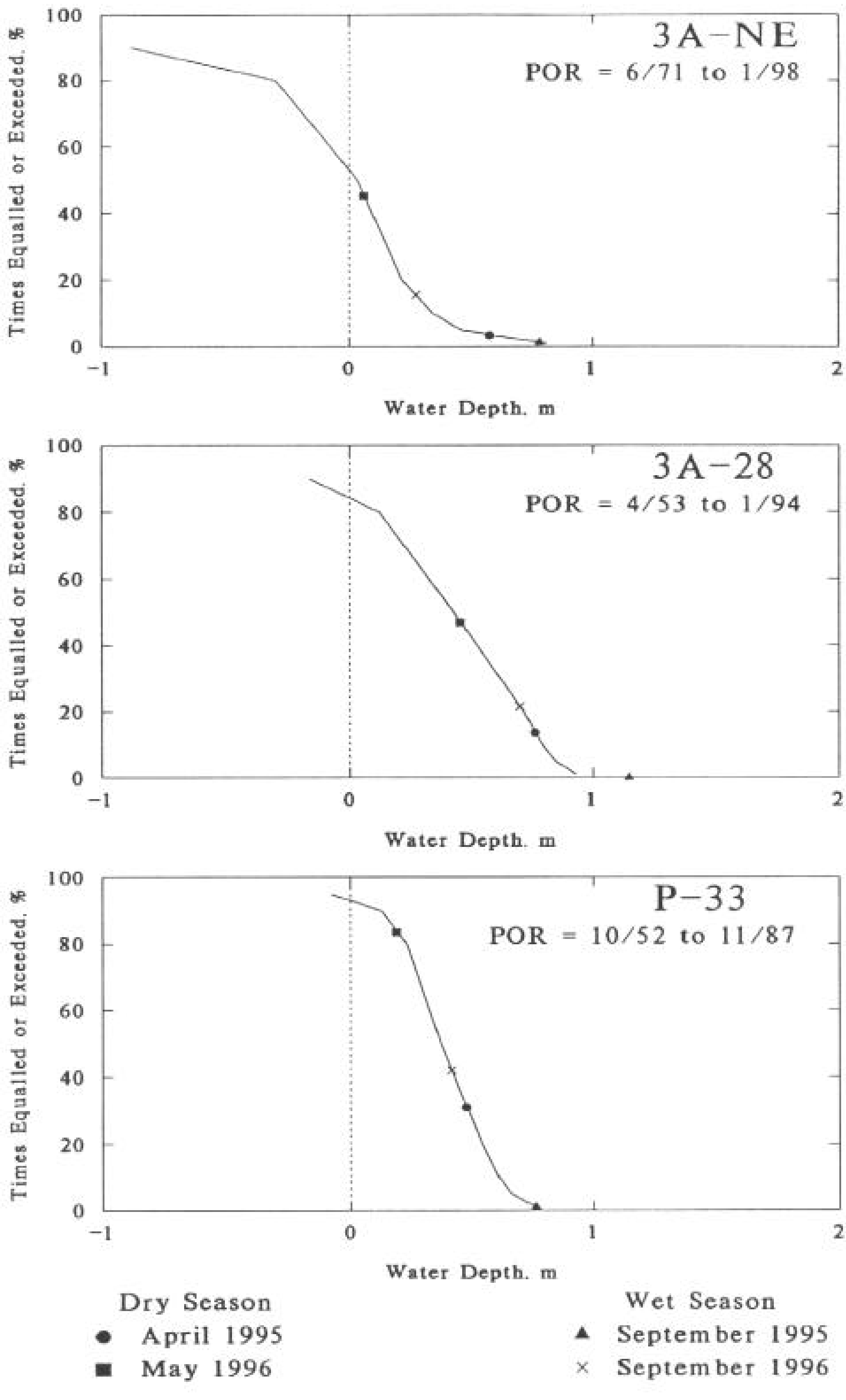

Figure 4.23 Exceedance frequency curves for SFWMD gaging stations with water depths measured during each of the sampling cycles at nearby marsh sampling sites. Frequency curves are based on daily period of record (POR) noted.

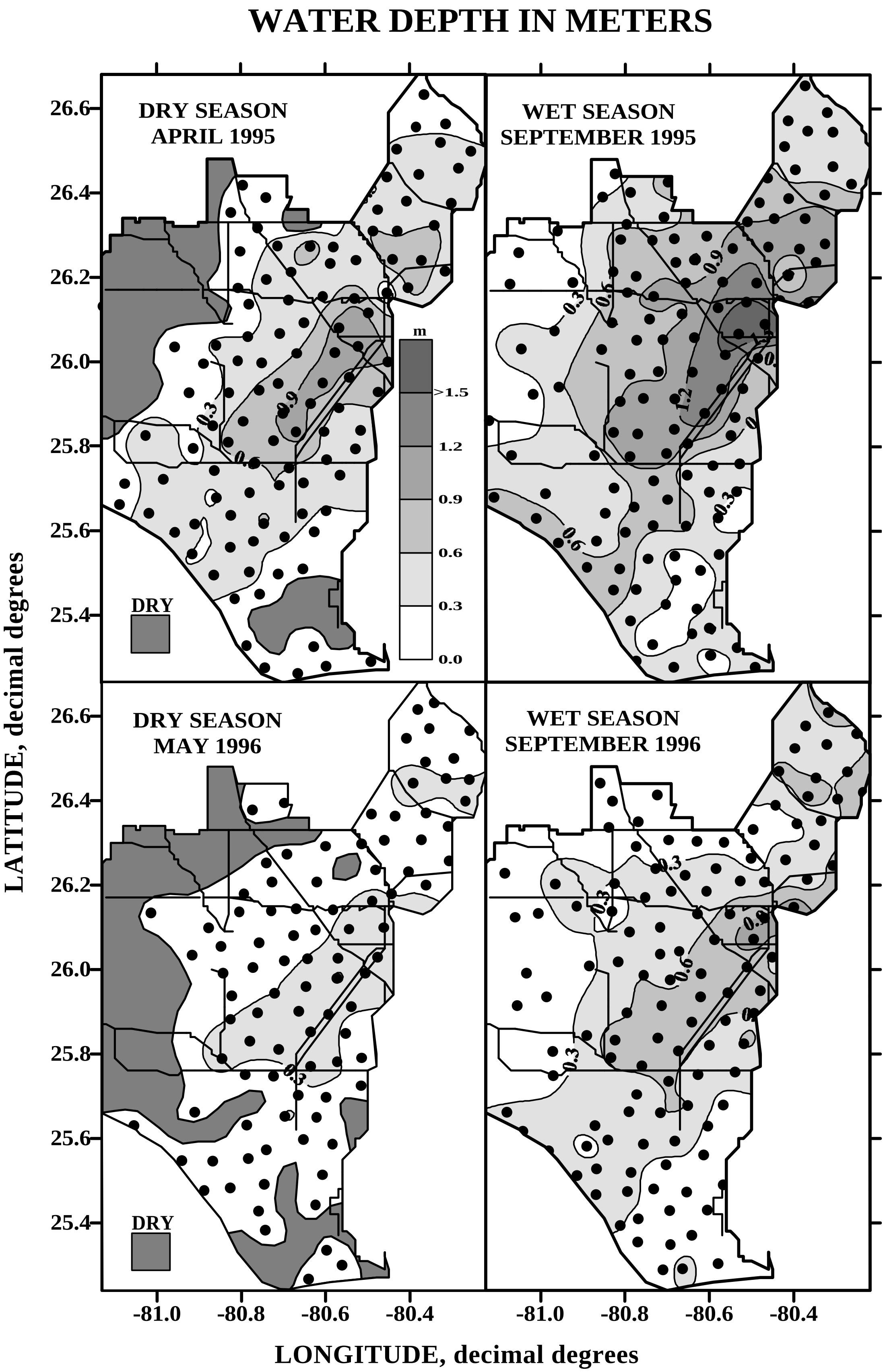

Figure 4.24 Kriged surface showing water depths in marsh during each sampling cycle.

CONDUCTIVITY IN WATER

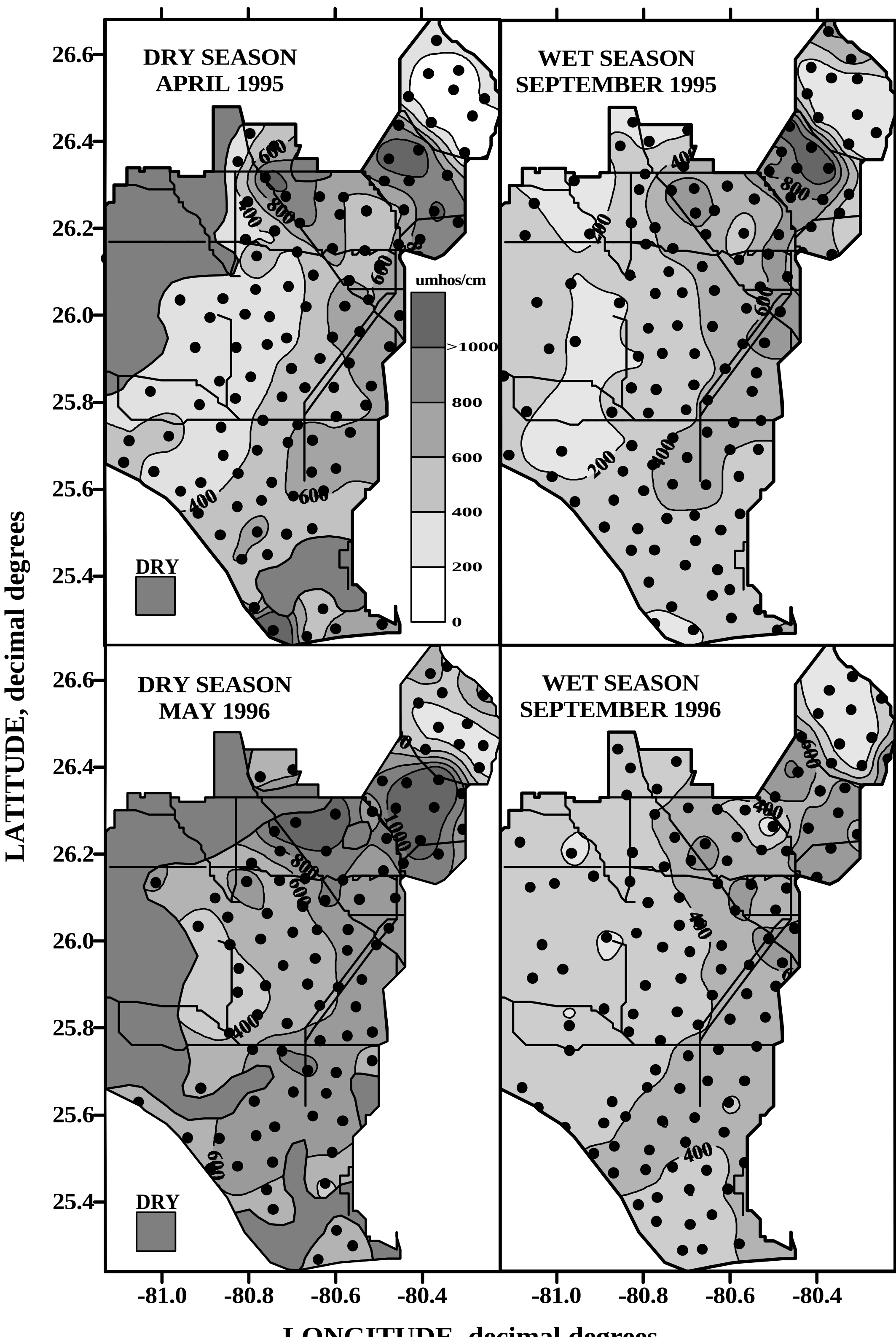

Figure 4.25 Kriged surface showing marsh water conductivity illustrates flow patterns during each of the sampling cycles.

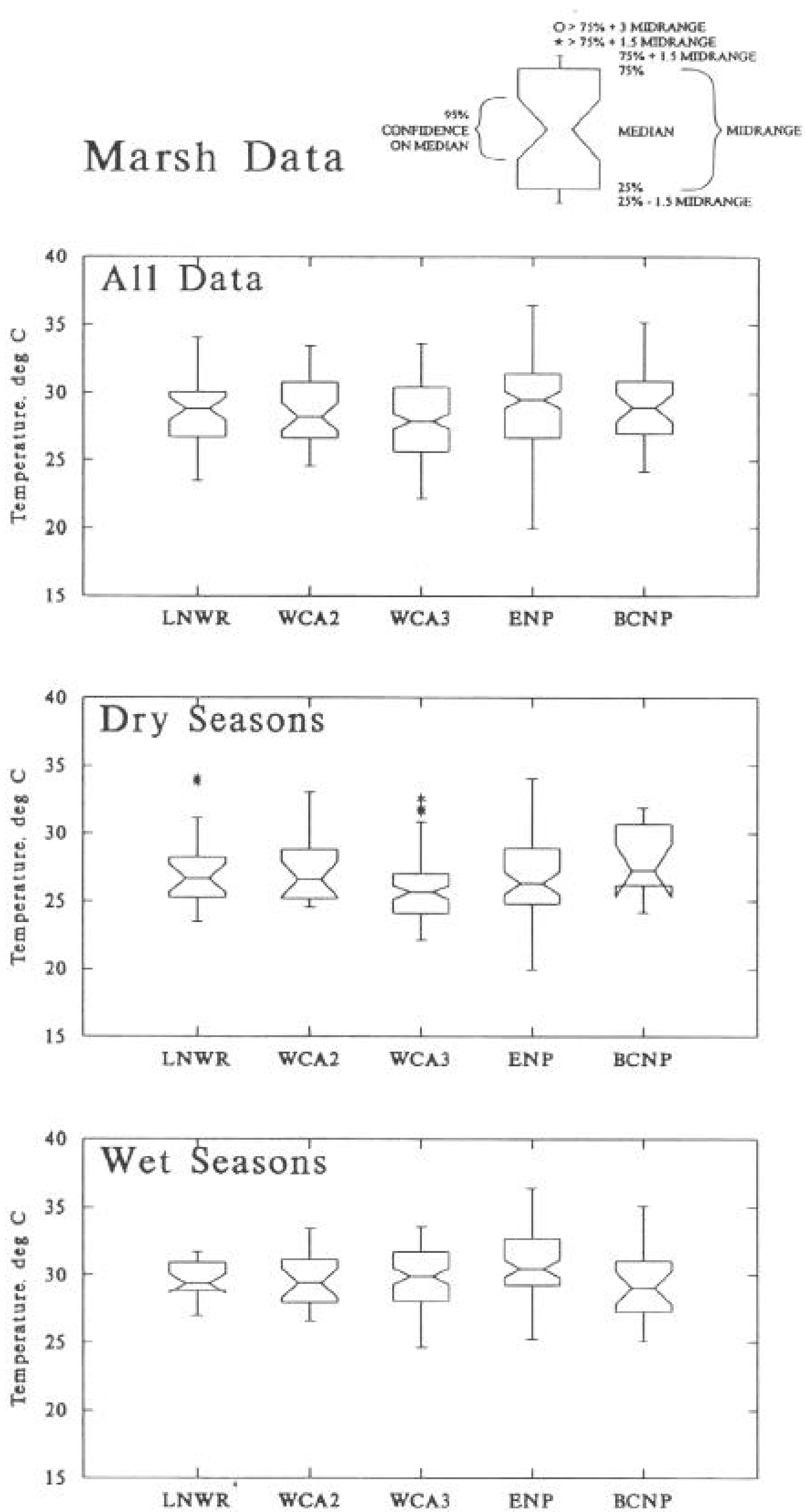

Figure 4.26 Notched box and whisker plots comparing marsh water temperature in subareas during dry and wet seasons.

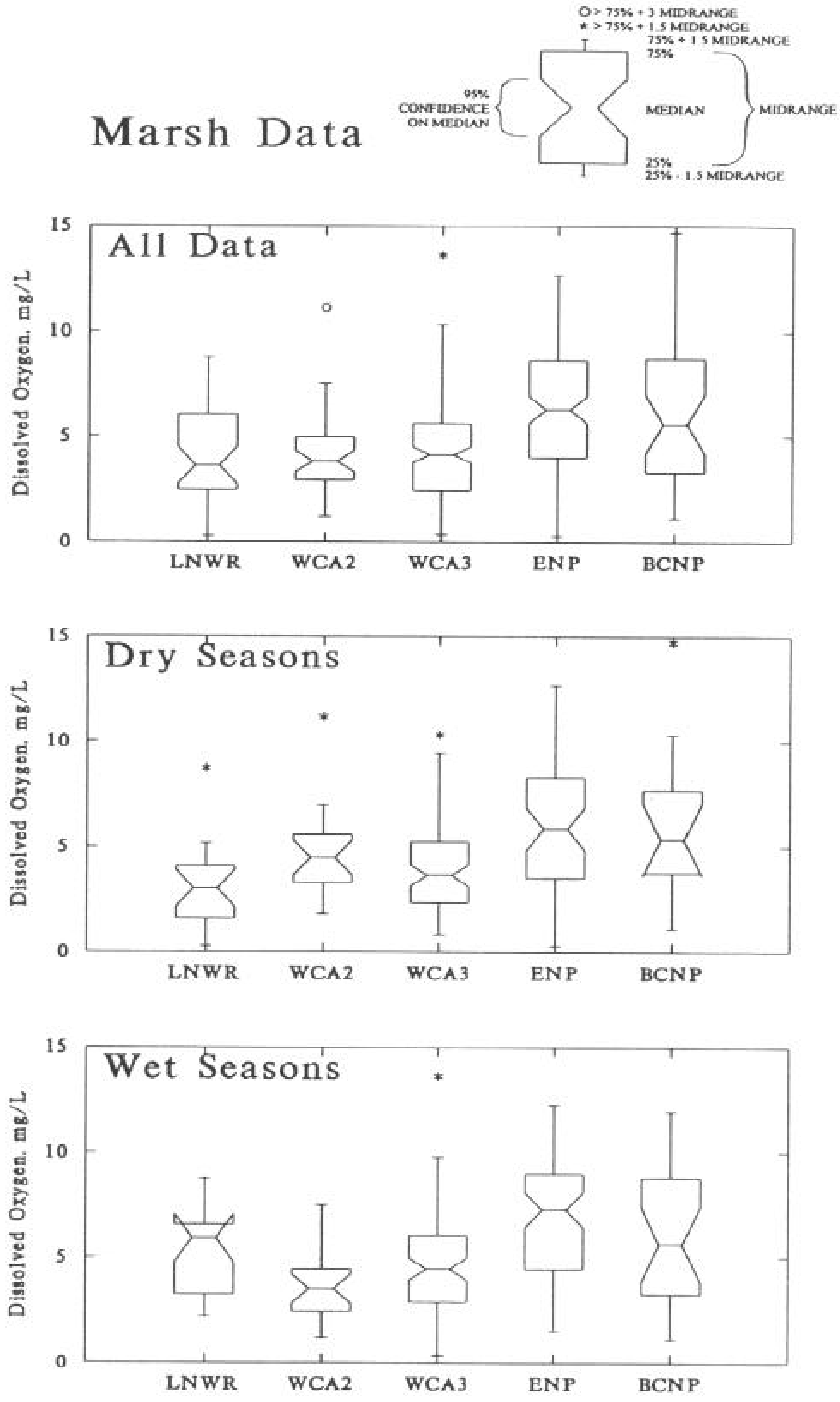

Figure 4.27 Notched box and whisker plots comparing marsh DO in subareas during dry and wet seasons.

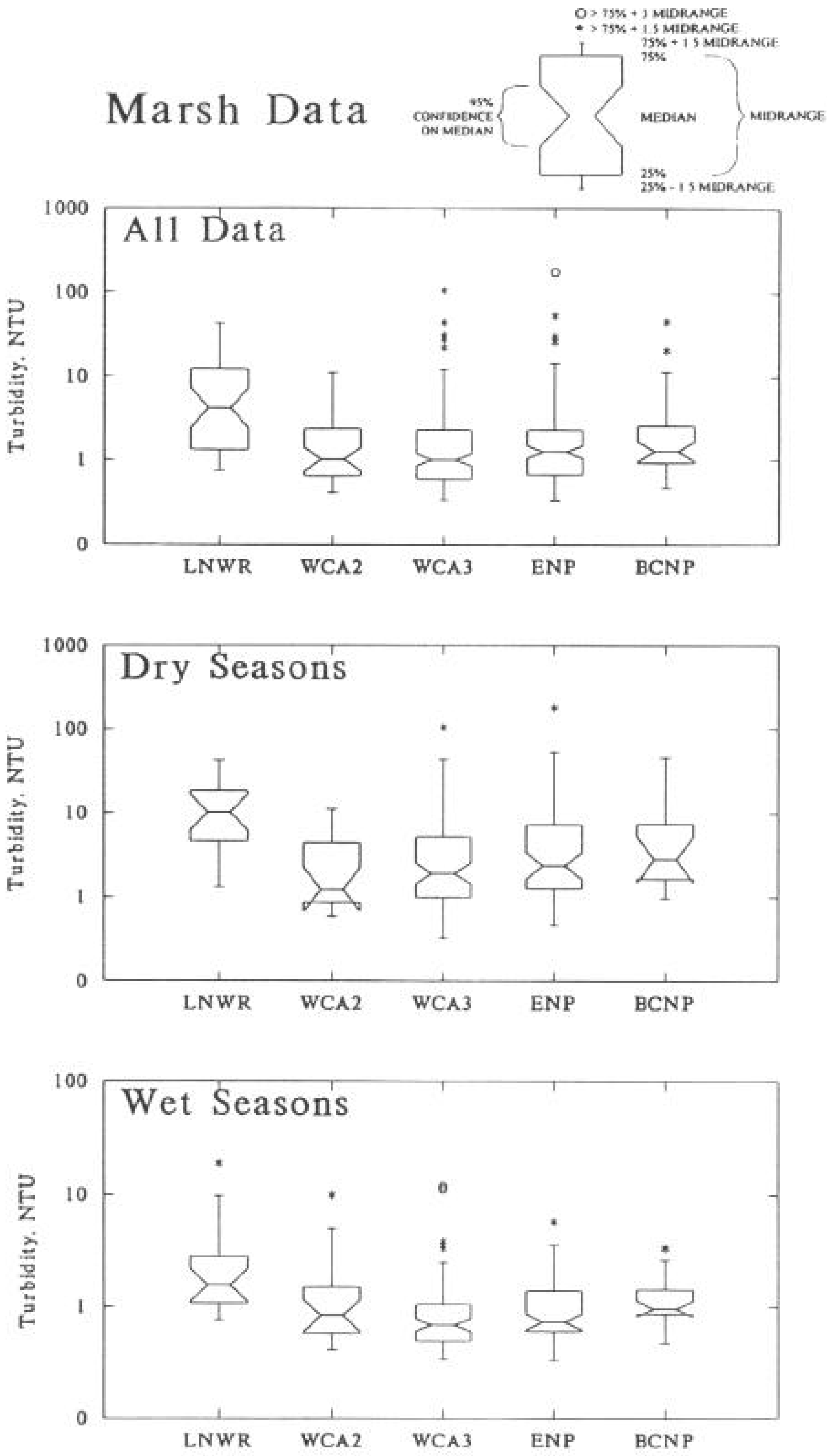

Figure 4.28 Notched box and whisker plots comparing marsh turbidity in subareas during dry and wet seasons.

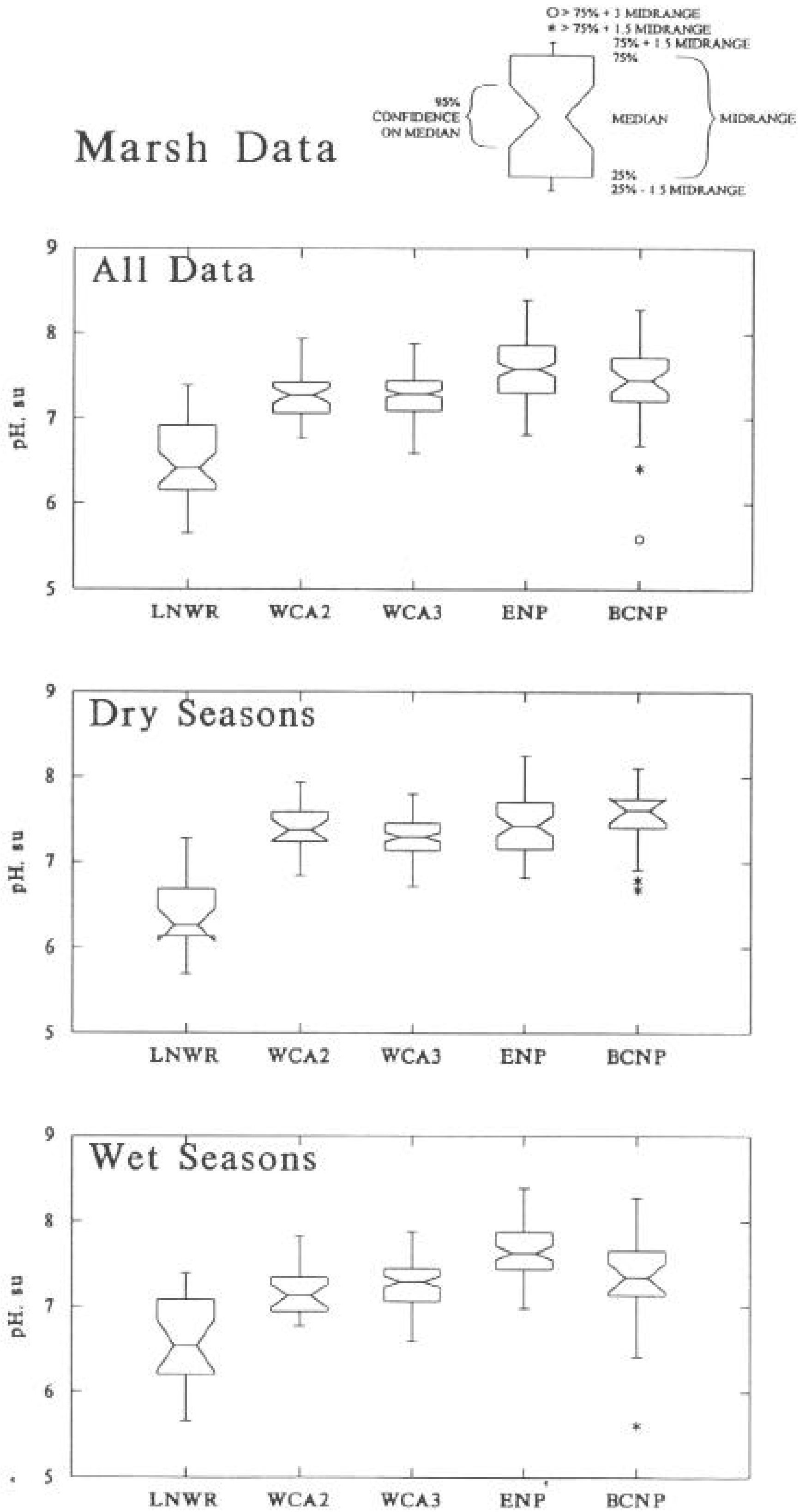

Figure 4.29 Notched box and whisker plots comparing marsh pH in subareas during dry and wet seasons.