



FLORIDA INTERNATIONAL UNIVERSITY  
*Miami's public research university*

**Southeast Environmental Research Center**

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12 May 2008

Michael Wright  
SFWMD  
Water Quality Analysis Division  
1480 Skees Road  
West Palm Beach, Florida 33411-2642

Re: South Florida Coastal Water Quality Monitoring Network Apr. – Jun. 2007 Quarterly Report for SFWMD Contract #4600000352

Dear Mr. Wright:

This letter serves to transmit the **REVISED** South Florida Coastal Water Quality Monitoring Network Quarterly Report as per SFWMD Contract #4600000352. This report consists of this letter along with corresponding tables and figures.

### **1. Activities Performed**

This report includes water quality data collected monthly during the annual period of record (POR) Apr. – Jun. 2007 from 28 stations in Florida Bay, 22 stations in Whitewater Bay, 25 stations in Ten Thousand Islands, 25 stations in Biscayne Bay, and 28 stations in Cape Romano-Rookery Bay-Pine Island Sound. A total of 49 stations were also collected on the SW Florida Shelf on a quarterly basis. Figure 1 shows the location of the fixed sampling stations.

Water quality parameters monitored at each station include the dissolved nutrients nitrate + nitrite ( $\text{NO}_x$ ), nitrite ( $\text{NO}_2$ ), nitrate ( $\text{NO}_3$ ), ammonium ( $\text{NH}_4$ ), inorganic nitrogen (DIN), and soluble reactive phosphorus (SRP). Silicate ( $\text{Si}(\text{OH})_4$ ) was analyzed at all stations on a quarterly basis in conjunction with SW Shelf sampling. Total concentrations of nitrogen (TN), organic nitrogen (TON), phosphorus (TP), and organic carbon (TOC) were also measured. All concentrations for each of these parameters are reported as parts per million (ppm) except where noted.

Phytoplankton biomass was measured using chlorophyll *a* ( $\mu\text{g l}^{-1}$ ). Field parameters measured at both surface and bottom of the water column include salinity, dissolved oxygen (DO;  $\text{mg l}^{-1}$ ), and temperature ( $^{\circ}\text{C}$ ). Turbidity (NTU) of the surface water was also measured.

### **2. Problems Encountered**

The following QA report describes any problems in field collection and chemical analysis for this reporting period.

### **3. Attest to Validity of Data**

The Nutrient Analysis Core Lab of the Southeast Environmental Research Center, FIU is focused mainly on water quality nutrients (nitrogen and phosphorus), which are important influences to South Florida's ecosystem. In support of interpreting the nutrient data, the Lab also measures other water quality and physiochemical parameters such as salinity, temperature, turbidity and chlorophyll. The Lab attests to have collected accurate, high quality, and reproducible/verifiable data, which can only be obtained through strict internal and external QA assurance practices. The Nutrient Analysis Core Lab of SERC, FIU views data reliability and validity as critically important in the planning and assessment of its performance. As such, the Lab makes every effort to constantly improve the completeness and reliability of its performance. As a university research facility, SERC is committed to obtaining the most accurate measurements as well as obtaining the lowest possible method detection limits for these nutrients. The QAP plan has been prepared in accordance with the Florida Department of Environmental Protection (FDEP) guidelines and SERC lab is NELAC Certified for non-potable water-General Chemistry under State Lab ID E76930.

### **4. Water Quality Conditions**

A previous spatial analysis of data from Florida Bay resulted in the delineation of 3 groups of stations which have robust similarities in water quality (Fig. 2). We have argued that these spatially contiguous groups of stations are the result of similar loading and processing of materials, hence we call them 'zones of similar influence'. The Eastern Bay zone (FBE) acts most like a 'conventional' estuary in that it has a quasi-longitudinal salinity gradient caused by the mixing of freshwater runoff with seawater. In contrast, the Central Bay (FBC) is a hydrographically isolated area with low and infrequent terrestrial freshwater input, a long water residence time, and high evaporative potential. The Western Bay zone (FBW) is the most influenced by the Gulf of Mexico tides and is also isolated from direct overland freshwater sources. Station #7 - Highway Creek did not cluster out with any of the Florida Bay stations and was considered separately.

Using the same statistical approach as above, the TTI-WWB complex was partitioned into 6 distinct zones of similar water quality (Fig. 3). The first cluster was composed of 13 stations in and around the Shark, Harney, Broad, and Lostmans Rivers and is called the Mangrove River (MR) group. This cluster also included a sampling station just off the Faka Union Canal. The second cluster was made up of the 8 stations enclosed within Whitewater Bay proper (WWB). Twelve stations situated mostly in and around the coastal islands of TTI-WWB formed the Gulf Island group (GI). The water quality characteristics at the Coot Bay site were sufficiently different so as to be a cluster of its own. The next cluster contained the northernmost 2 stations in the Blackwater River estuary (BLK). Finally, the Inland Wilderness Waterway zone (IWW) included 11 stations distributed throughout the inside passage as well as the Chatham River and the station off Everglades City.

Biscayne Bay was partitioned into 6 distinct ZSI using the above statistical analysis. The first cluster was composed of 2 stations closest to the shore in the south Bay (Fig. 4); they were called the Alongshore group (AS). These are stations most influenced by the Goulds, Military and Mowry Canals. The second cluster was made up of the 5 stations farther from the coast called Inshore (IS). Thirteen stations situated mostly in the bay proper were called the main Bay (MAIN) group. The next cluster contained 3 stations situated in areas of great tidal exchange (ocean channel, not shown). Two stations in Card Sound grouped together SCARD. For purposes of this report, the stations added to the area north of the Rickenbacker Causeway are defined, a priori, as a distinct cluster, North Bay (NBAY).

The above statistical analysis objectively classified the 49 Shelf sampling sites into 3 zones having similar water quality (Fig. 5). The first cluster was composed of only 2 stations which were closest to the shore off Cape Sable; they were called the SHARK group, after the Shark River, the main source of freshwater to the region. The second cluster was made up of the 7 more northerly stations nearest the coast and called SHOAL. The remaining stations were called the SHELF group.

Sampling in the Rookery Bay area began Jan. 1999. Because of the very heterogeneous nature of the area, we will continue to use generally accepted geomorphological characteristics to group the stations (Fig. 6). These groupings are Cocohatchee River (COCO), Estero Bay (EST), Cape Romano-Marco Island (MARC), Naples Bay (NPL), Pine Island Sound (PIS), Rookery Bay (RB), and San Carlos Bay (SCB).

Data are also reported as box-and-whiskers plots (Figs. 7-29). The center horizontal line in the box is the median of the data, the top and bottom of the box are the 25<sup>th</sup> and 75<sup>th</sup> percentiles (quartiles), and the ends of the whiskers are the 5<sup>th</sup> and 95<sup>th</sup> percentiles.

Summary statistics of all water quality parameters by ecosystem are shown in Table 1. The median was chosen because it is a more accurate measure of central tendency in non-normally distributed water quality data. The range is expressed as the minimum (Min.) and maximum (Max.) values for the POR, and *n* is the number of data points used in the analysis.

The cyanobacterial bloom in Eastern Florida Bay declined during this period (Fig.7). However, DIN and TP remained elevated relative to historical record. We will continue to analyze this and other data in conjunction with other agency scientists in an effort to provide an explanation.

#### **Other Required Files**

The following files are included on the quarterly report CD.

- 5. QA Report**
- 6. QA Data**
- 7. Chain Of Custody Scans**
- 8. Field Equipment Calibrations**
- 9. Field Equipment Maintenance**
- 10. ADaPT EDD**

If you have any questions about the content of this report, please do not hesitate to contact me at 305-348-4076 or boyerj@fiu.edu.

Sincerely,



Joseph N. Boyer, Ph.D.  
Associate Director and Scientist



Henry O. Briceño, Ph.D.  
Assistant Scientist

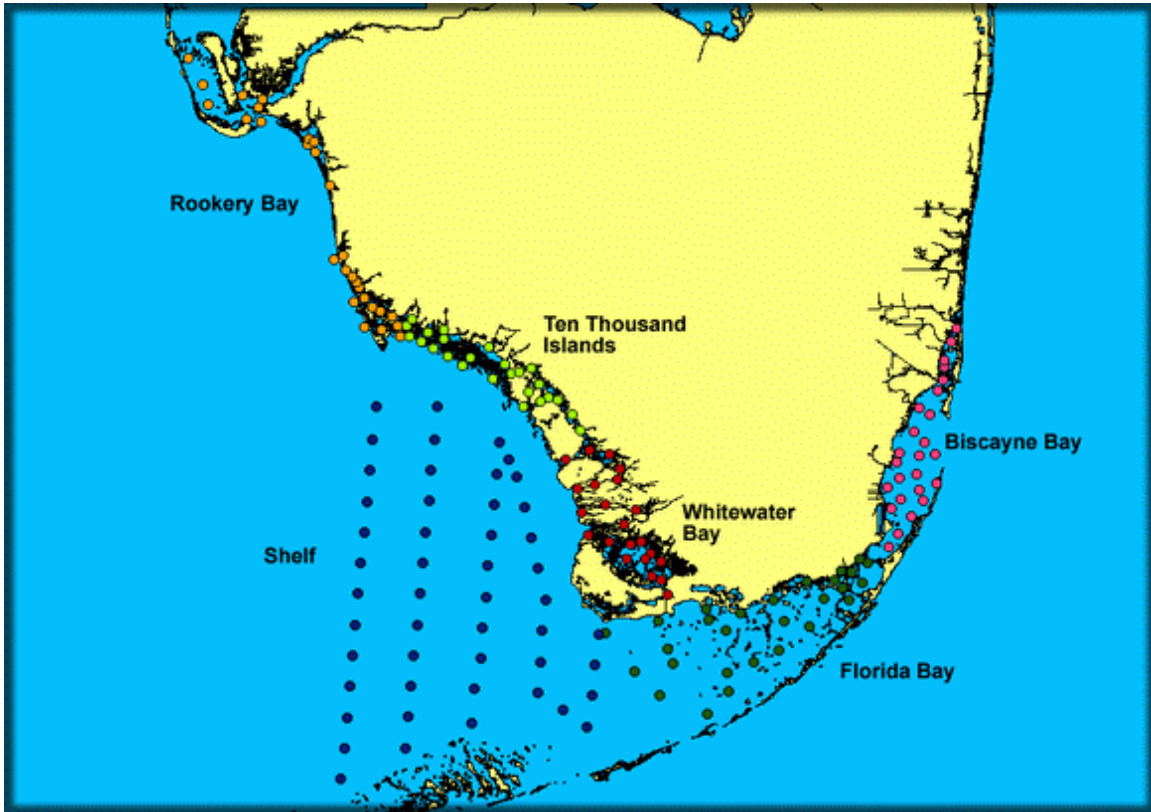
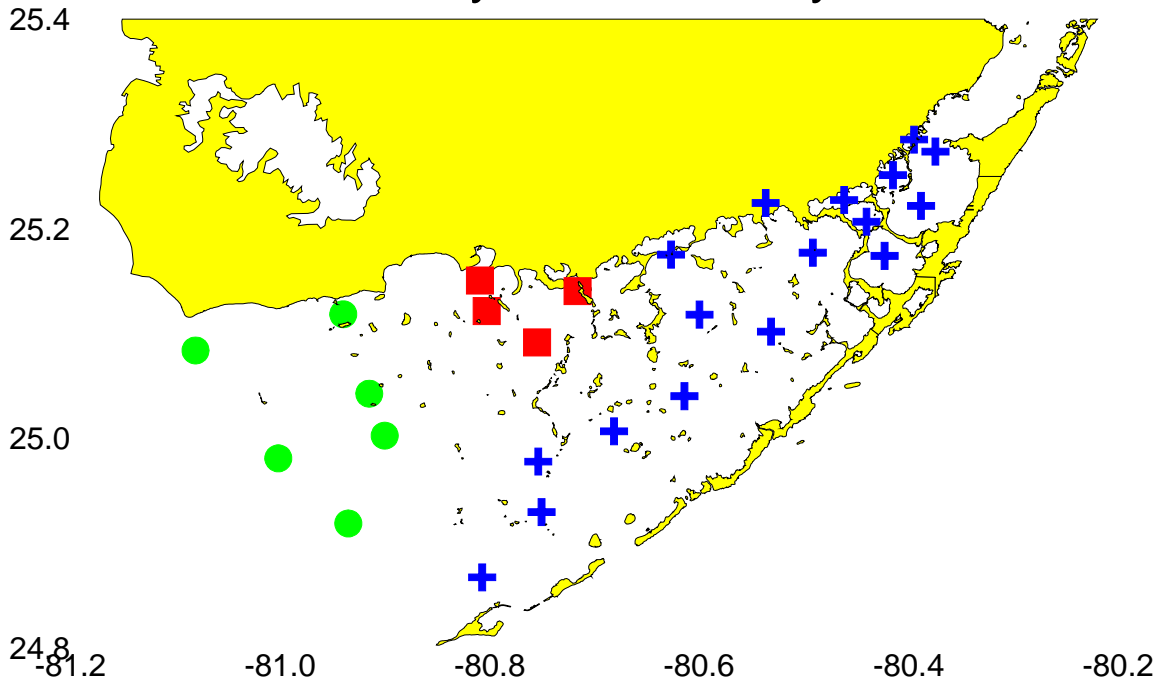


Figure 1: All fixed water quality stations funded by this SFWMD project.

# Florida Bay Water Quality Zones



Eastern Bay (+), Central Bay, (■), Western Bay (●)

Figure 2. Florida Bay zones.

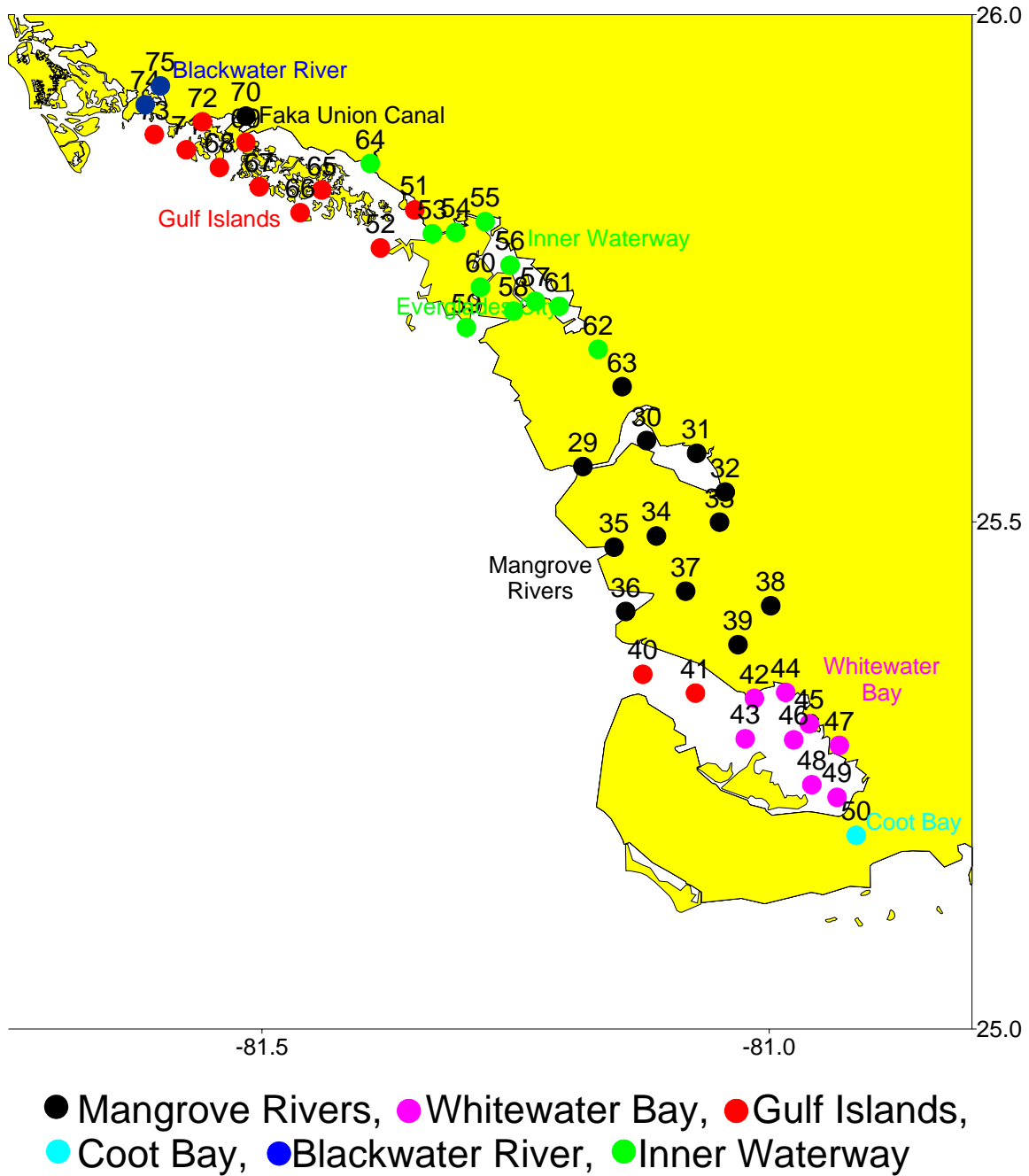


Figure 3. WWB-TTI water quality zones.

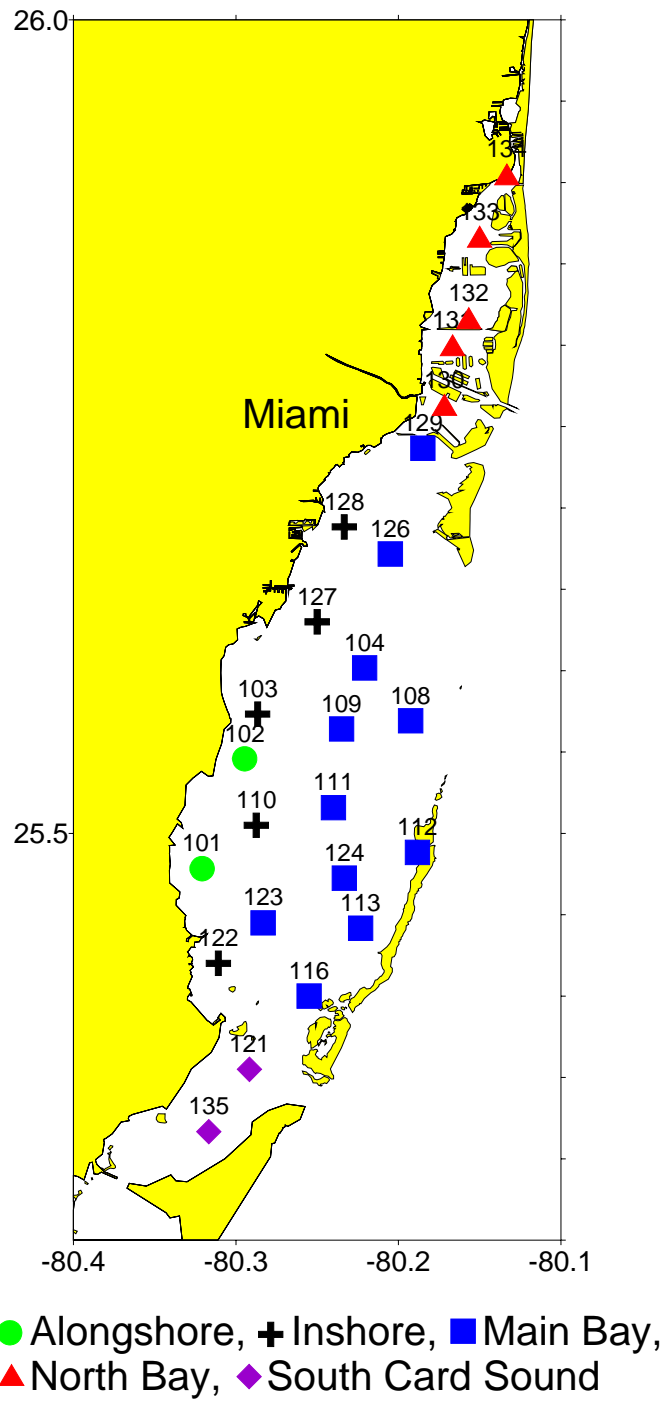


Figure 4. Biscayne Bay water quality zones.

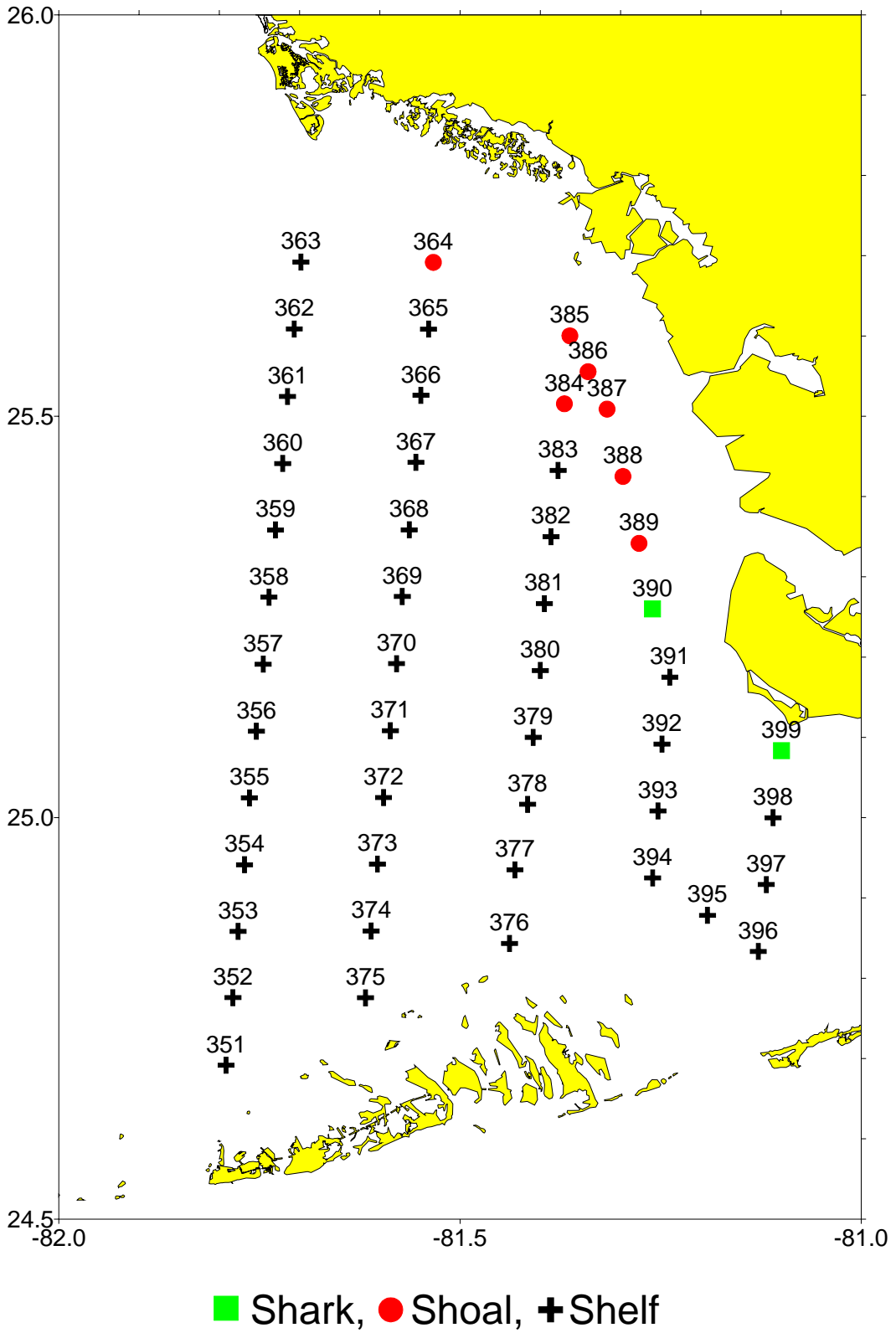


Figure 5. SW Florida Shelf water quality zones.



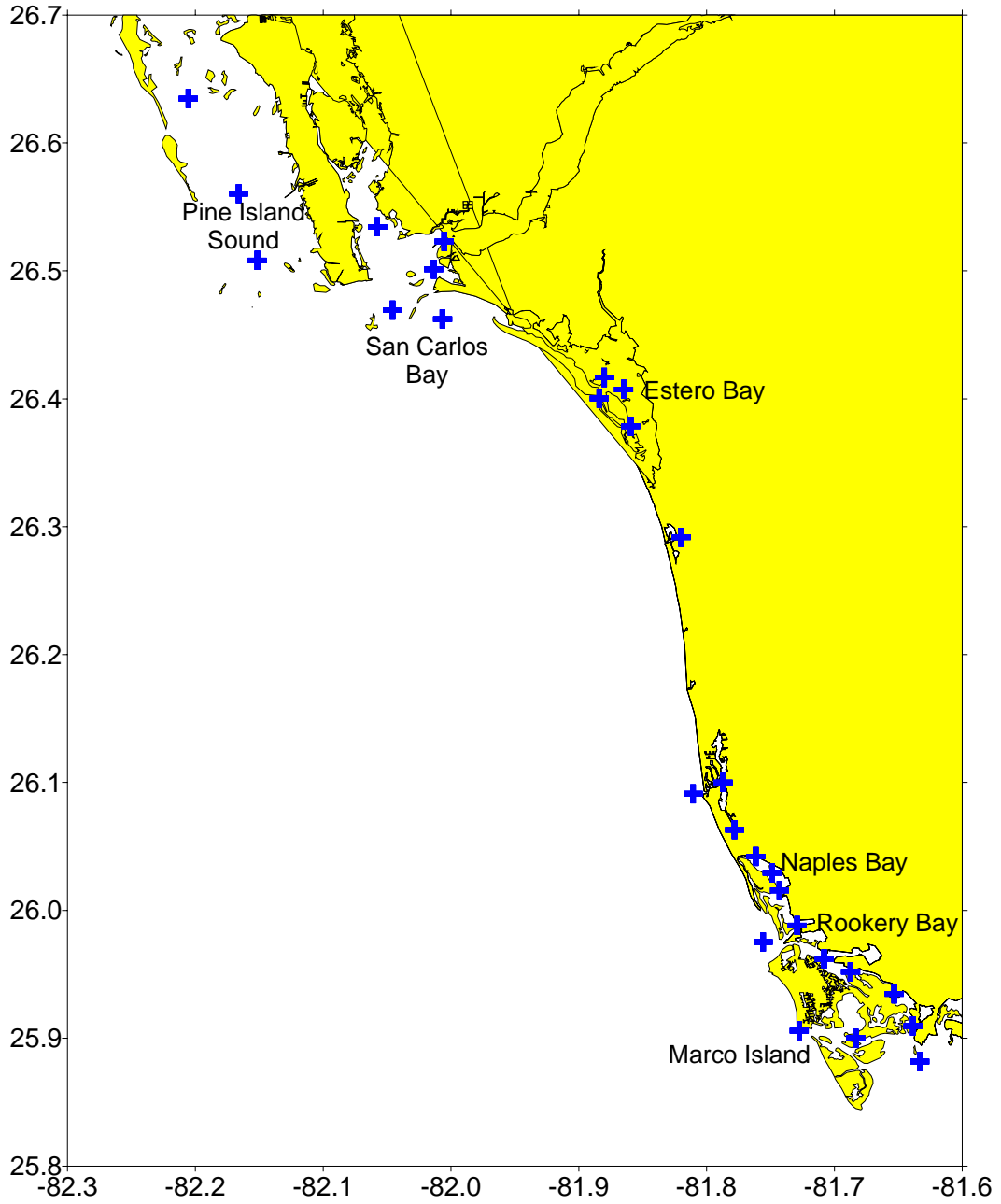


Figure 6. SW estuaries.

# Eastern Florida Bay Zone

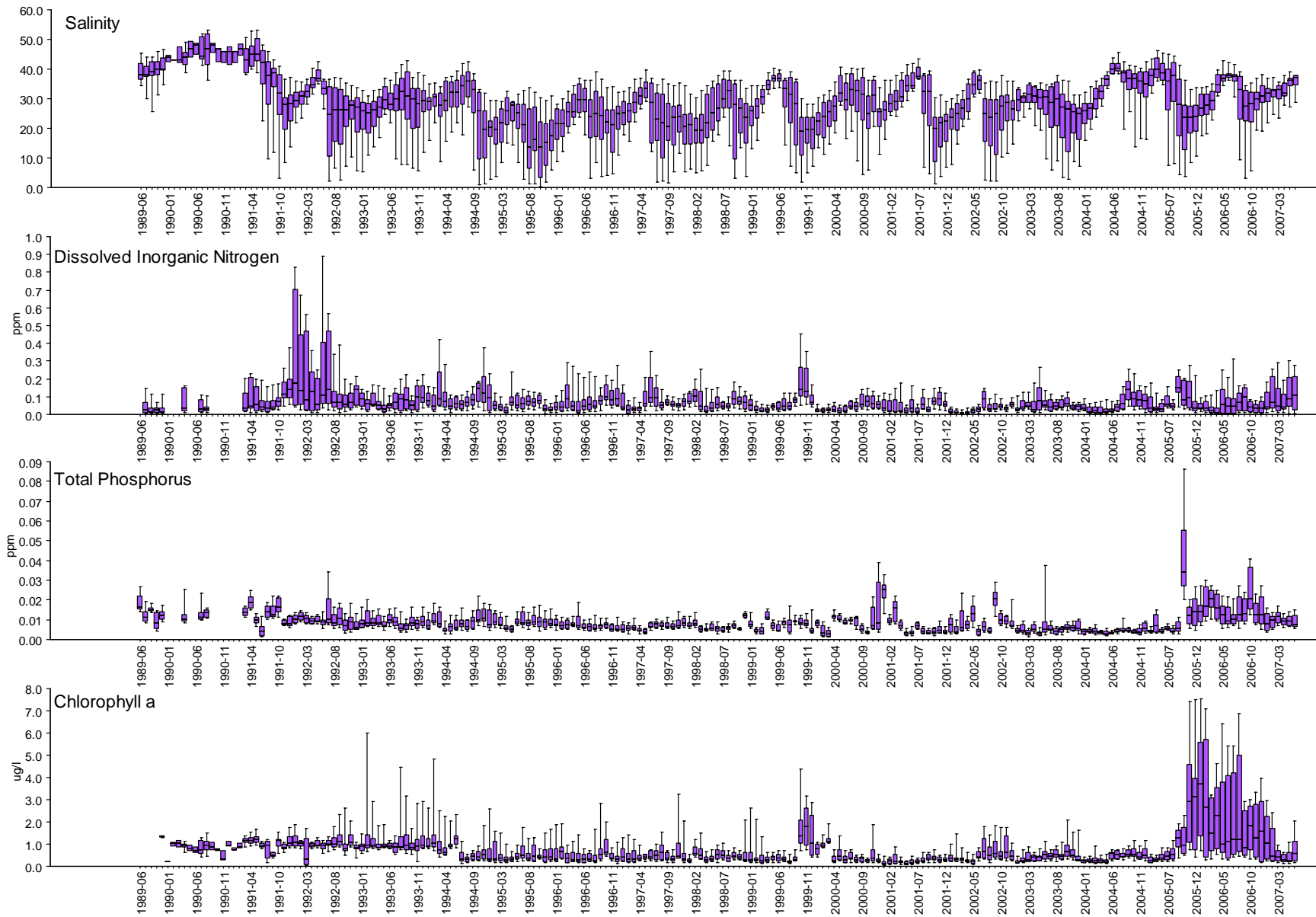


Figure 7. Box-and-whisker plots of water quality in Eastern Florida Bay by survey.

# Central Florida Bay Zone

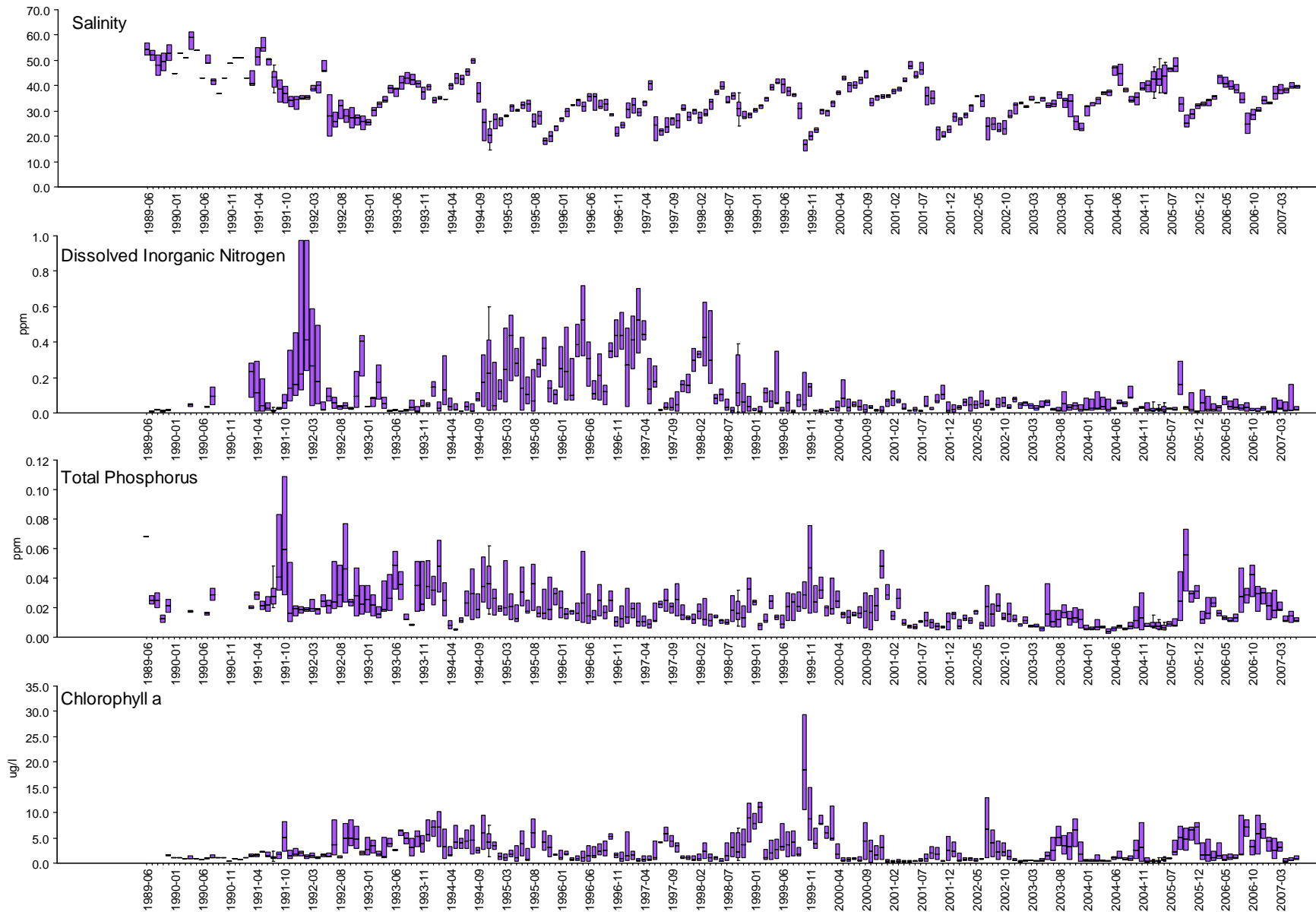


Figure 8. Box-and-whisker plots of water quality in Central Florida Bay by survey.

# Western Florida Bay Zone

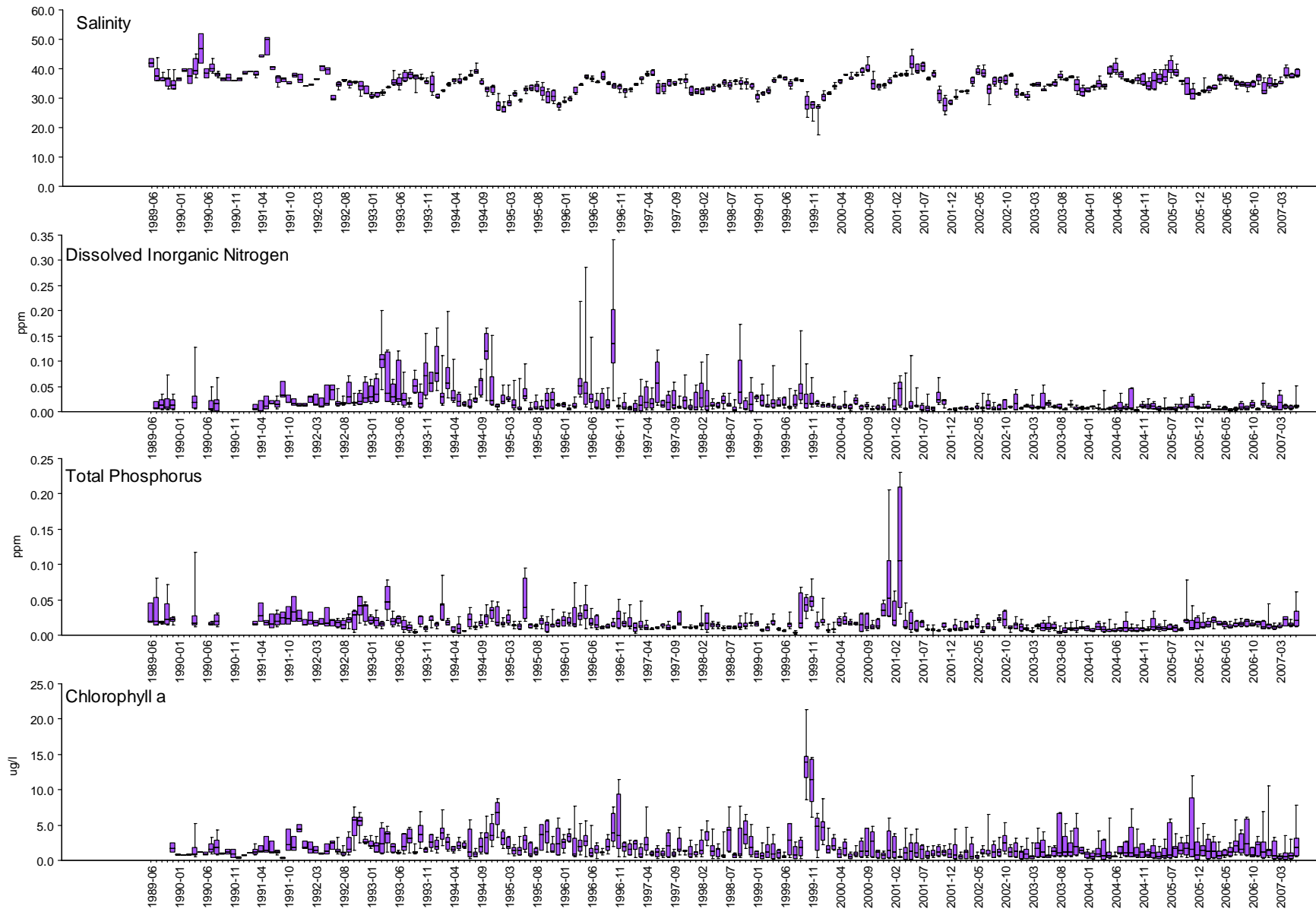


Figure 9. Box-and-whisker plots of water quality in Western Florida Bay by survey.

# Whitewater Bay Zone

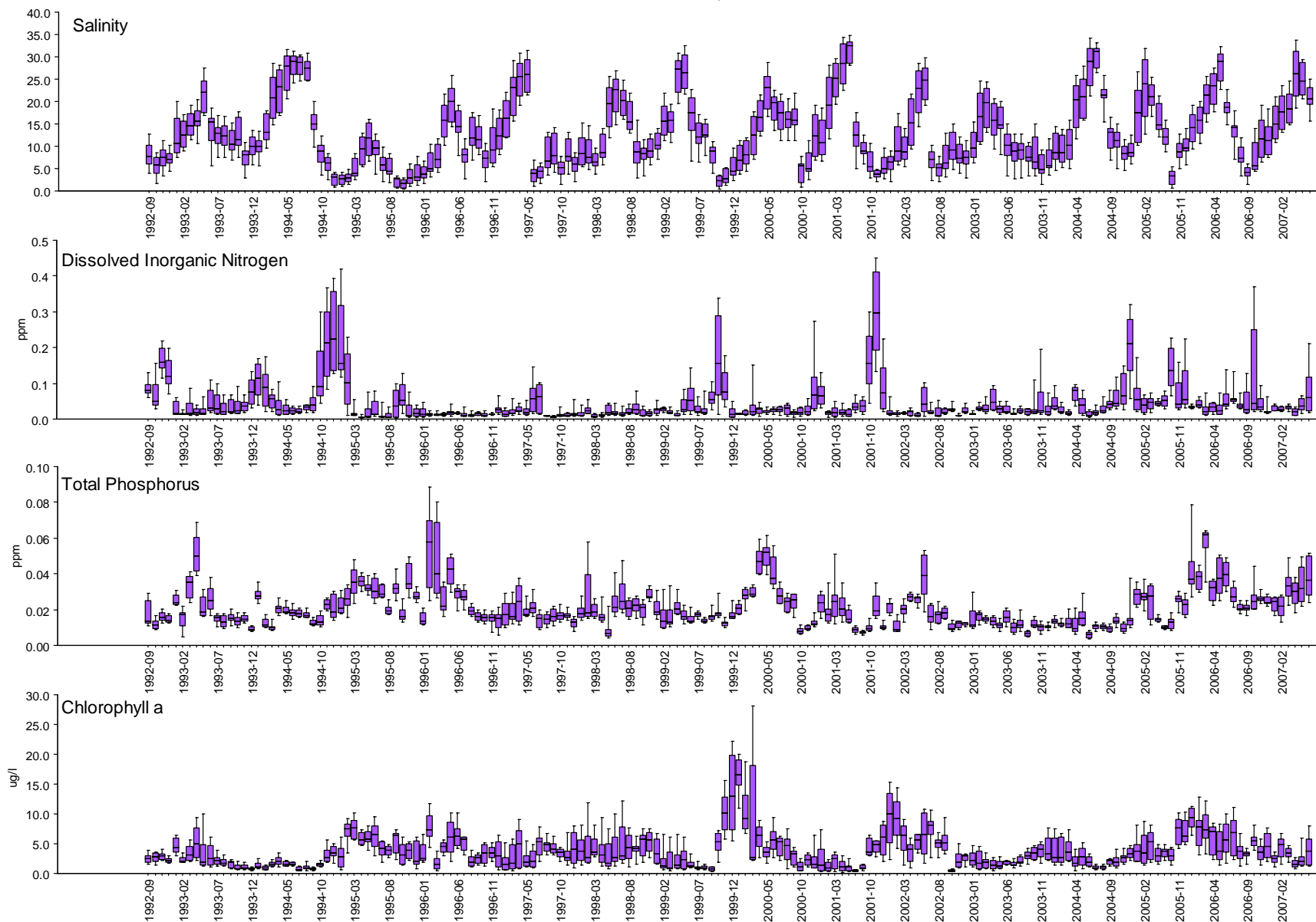


Figure 10. Box-and-whisker plots of water quality in WWB-TTI by survey.

# Mangrove Rivers Zone

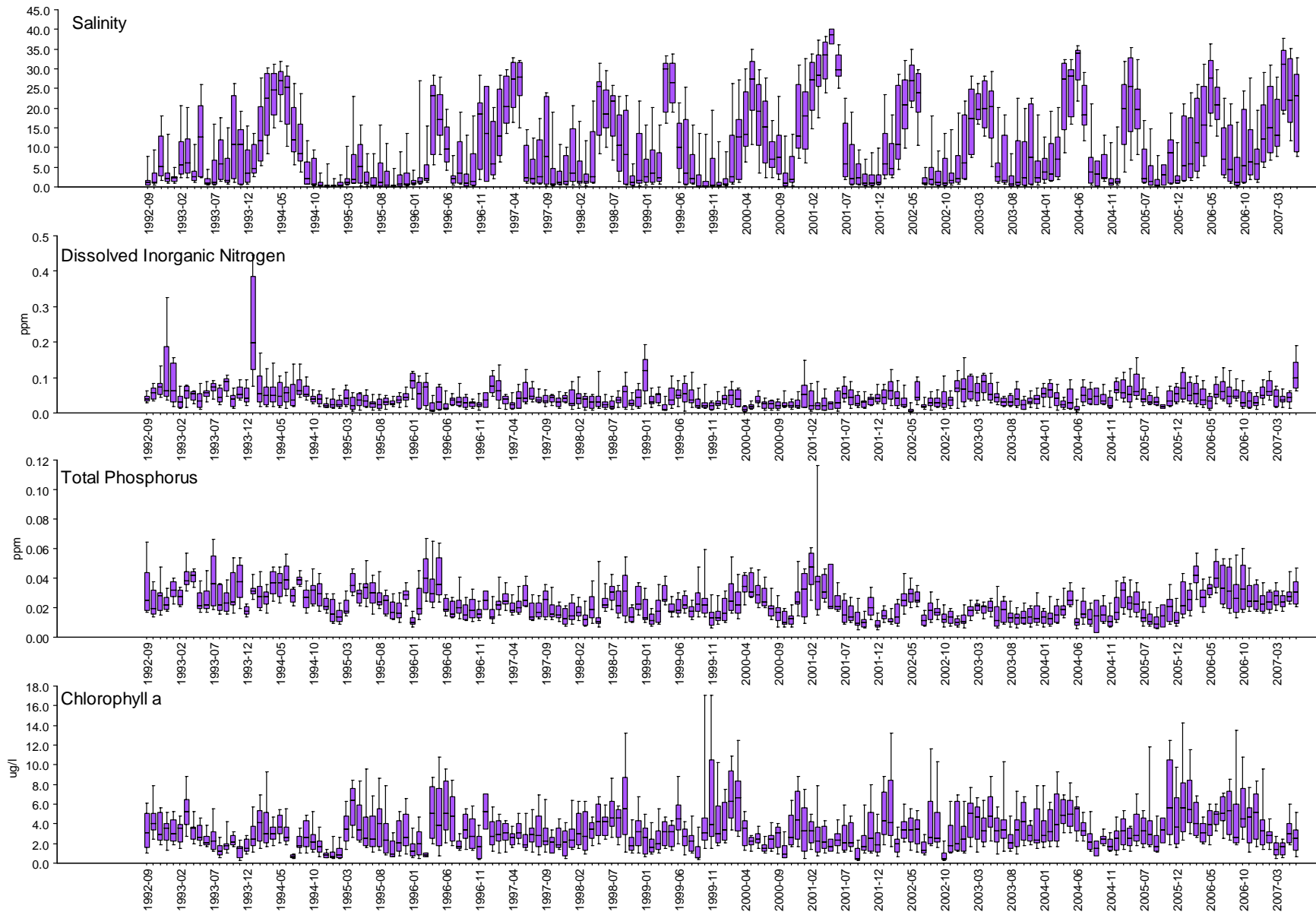


Figure 11. Box-and-whisker plots of water quality in WWB-TTI by survey.

# Gulf Islands Zone

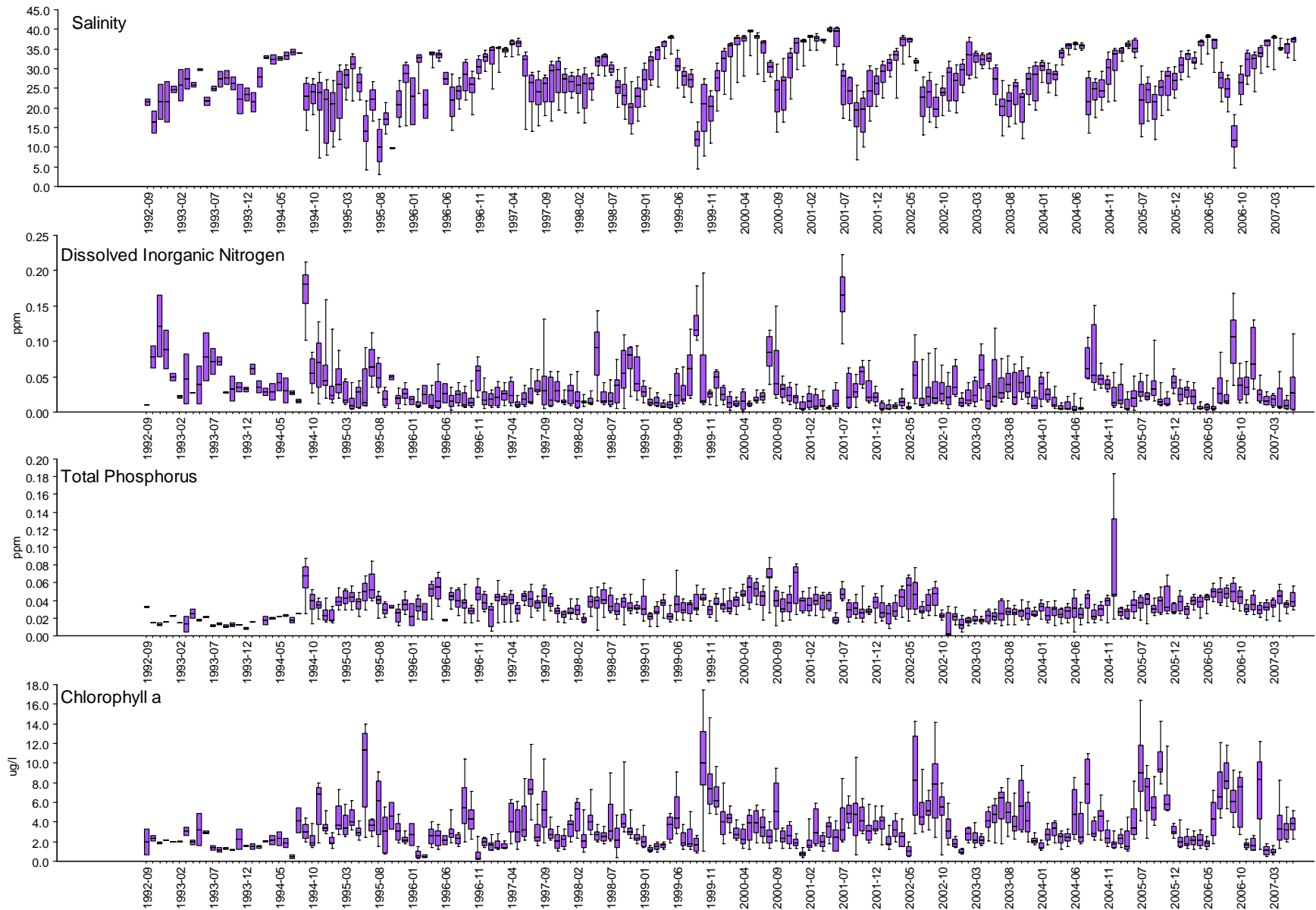


Figure 12. Box-and-whisker plots of water quality in WWB-TTI by survey.

# Inner Waterway Zone

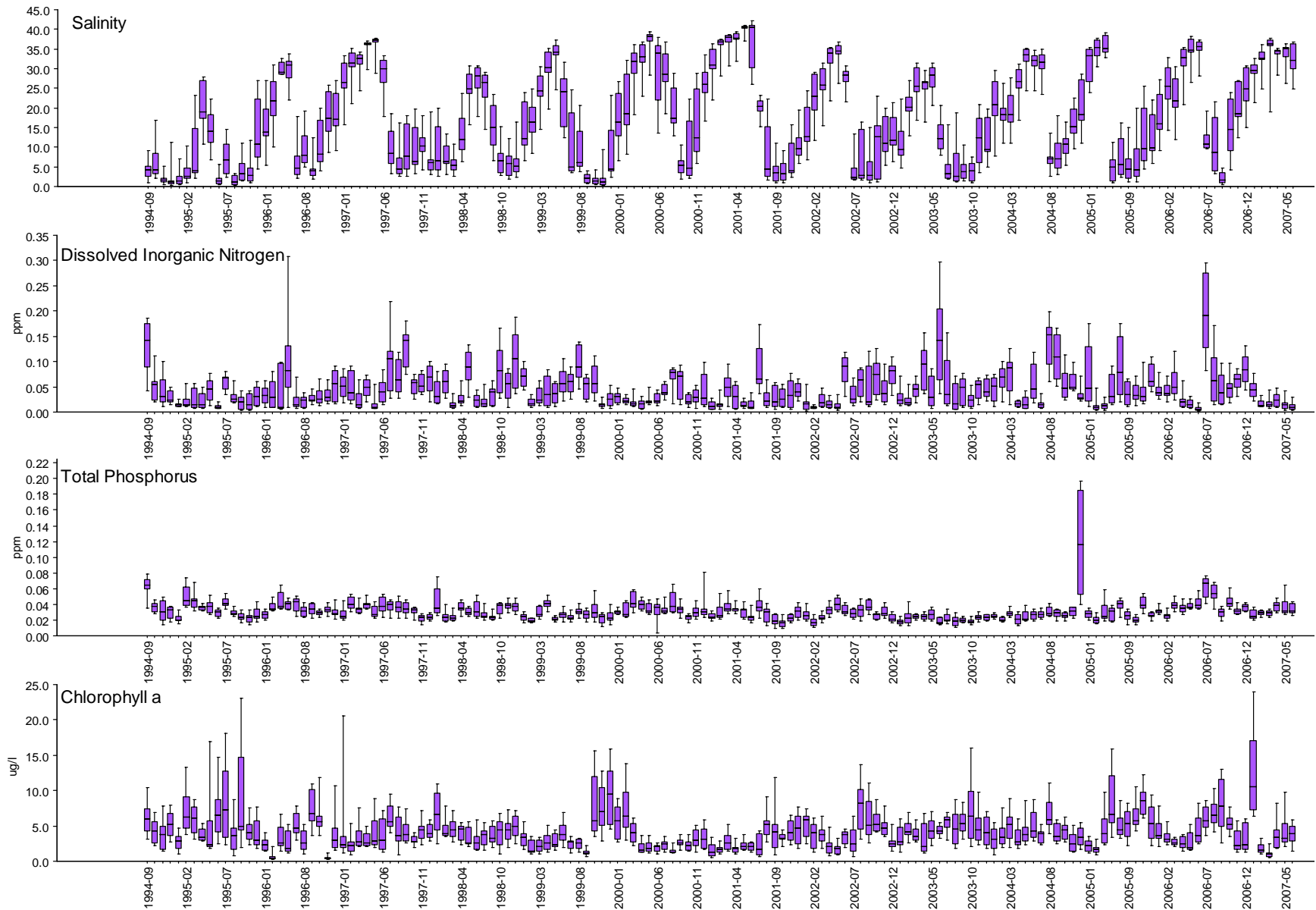


Figure 13. Box-and-whisker plots of water quality in WWB-TTI by survey.



# Blackwater River Zone

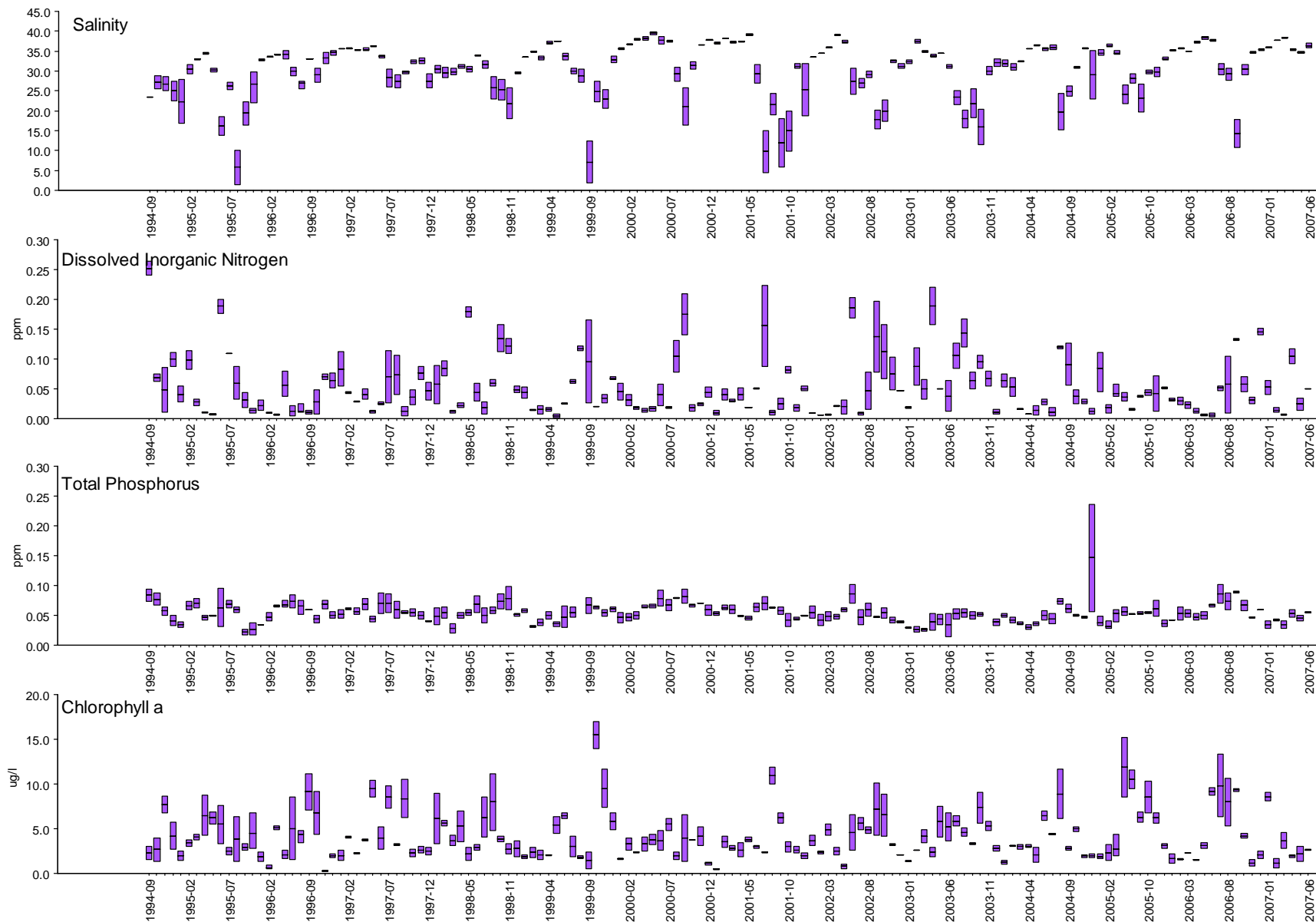


Figure 14. Box-and-whisker plots of water quality in WWB-TTI by survey.

# Alongshore Zone

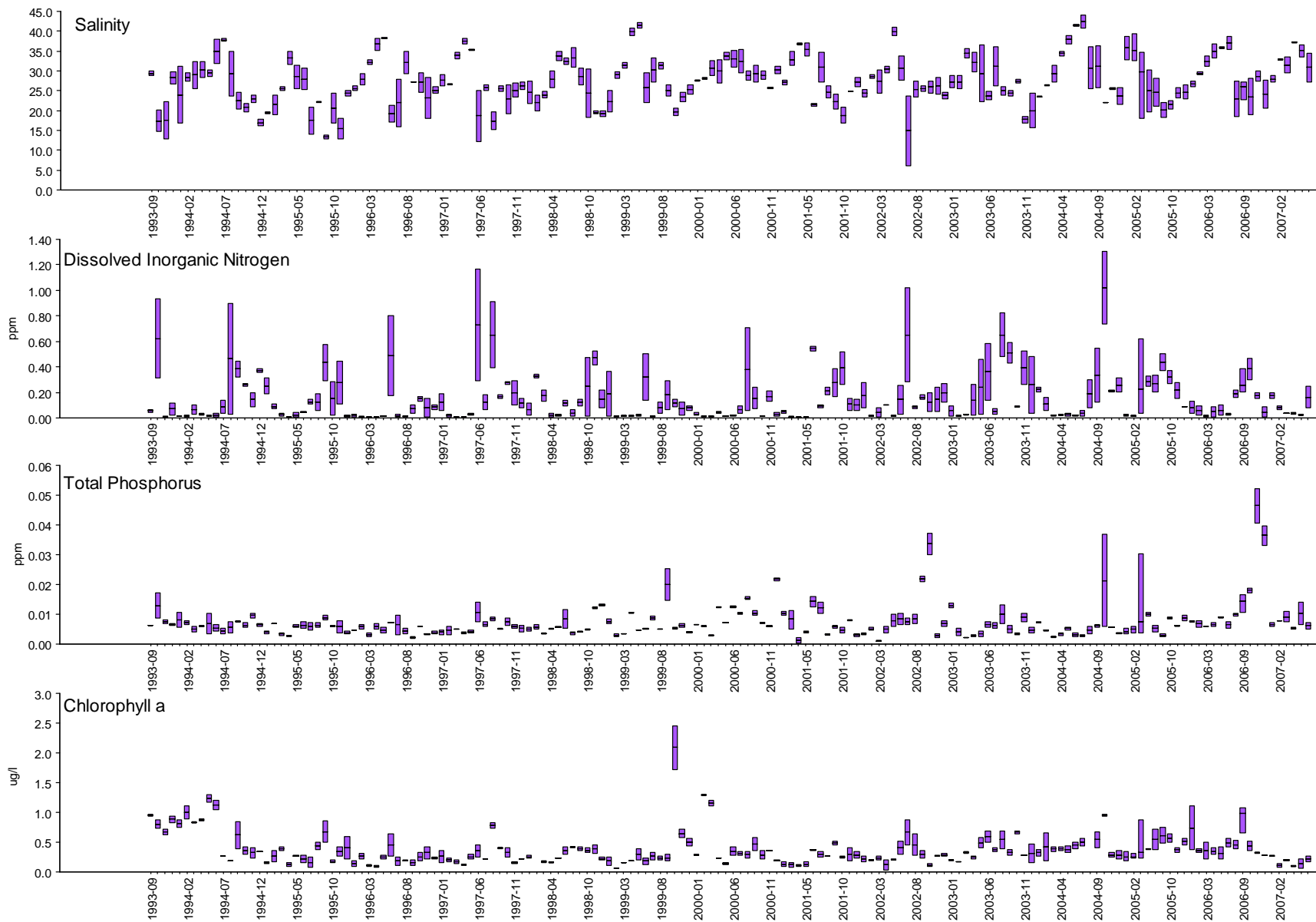


Figure 15. Box-and-whisker plots of water quality in Biscayne Bay by survey.

# Inshore Zone

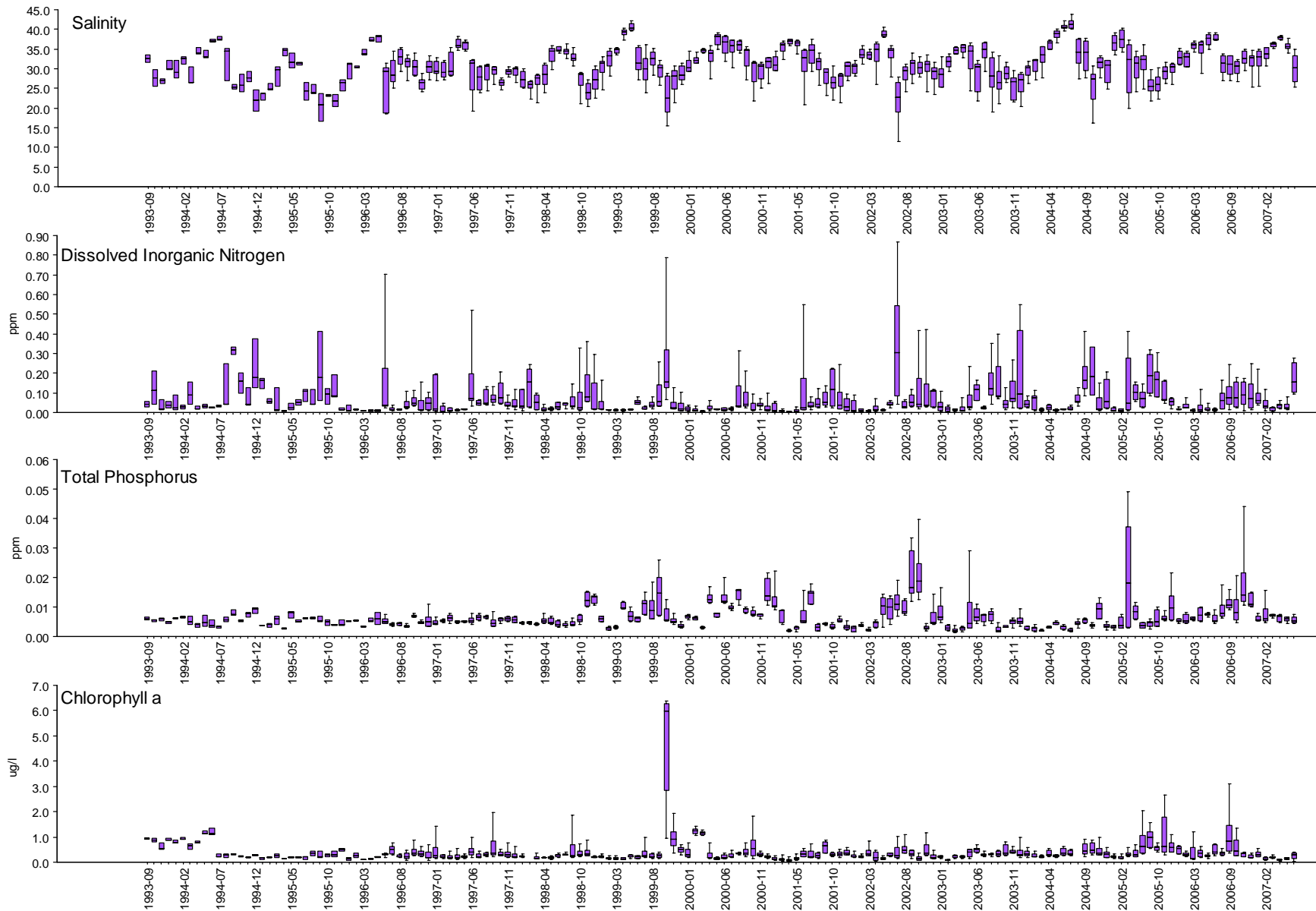


Figure 16. Box-and-whisker plots of water quality in Biscayne Bay by survey.

# Main Bay Zone

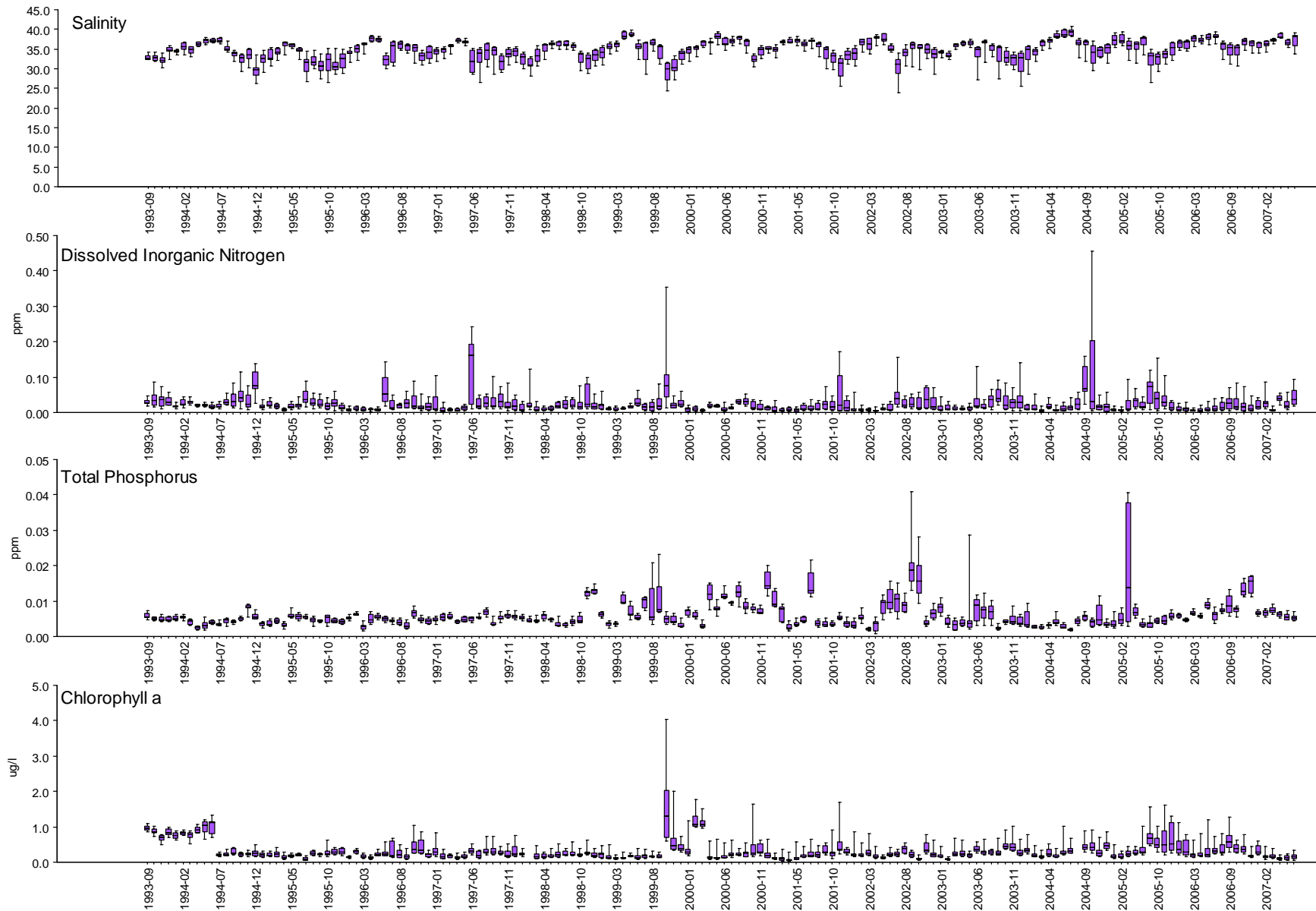


Figure 17. Box-and-whisker plots of water quality in Biscayne Bay by survey.

# South Card Sound Zone

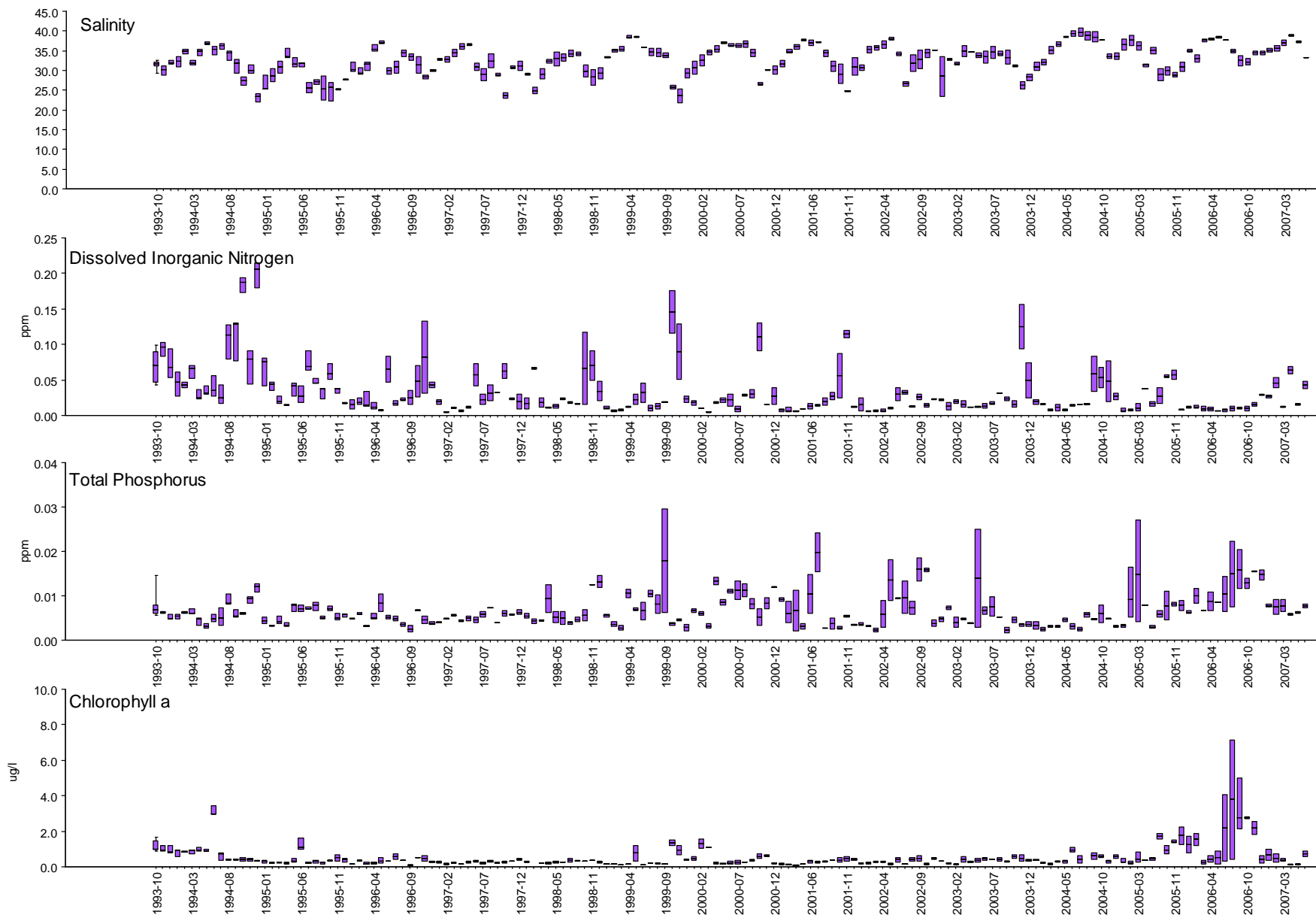


Figure 18. Box-and-whisker plots of water quality in Biscayne Bay by survey.

# North Bay Zone

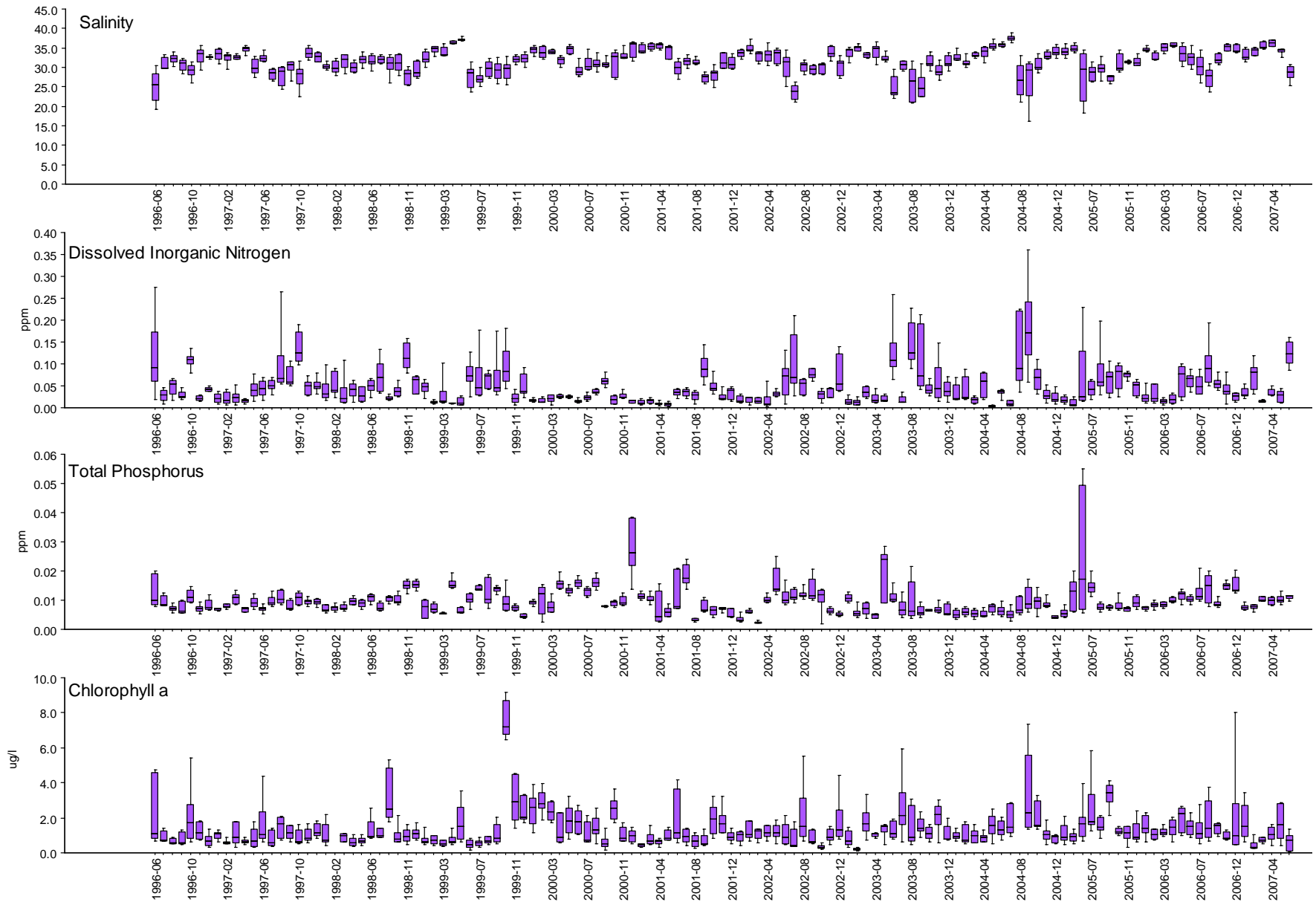


Figure 19. Box-and-whisker plots of water quality in Biscayne Bay by survey.

## Shelf Zone

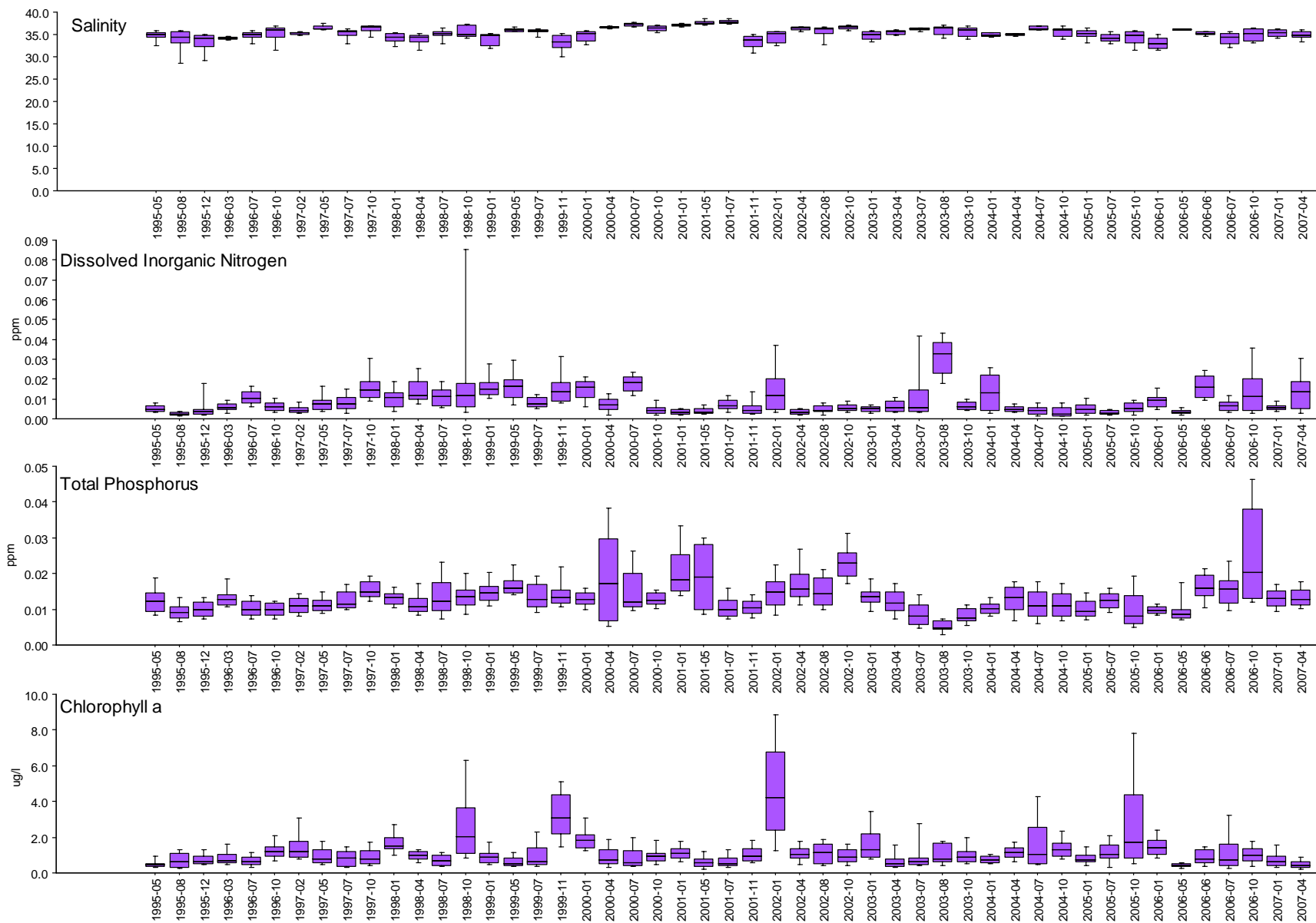


Figure 20. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

# Shark Zone

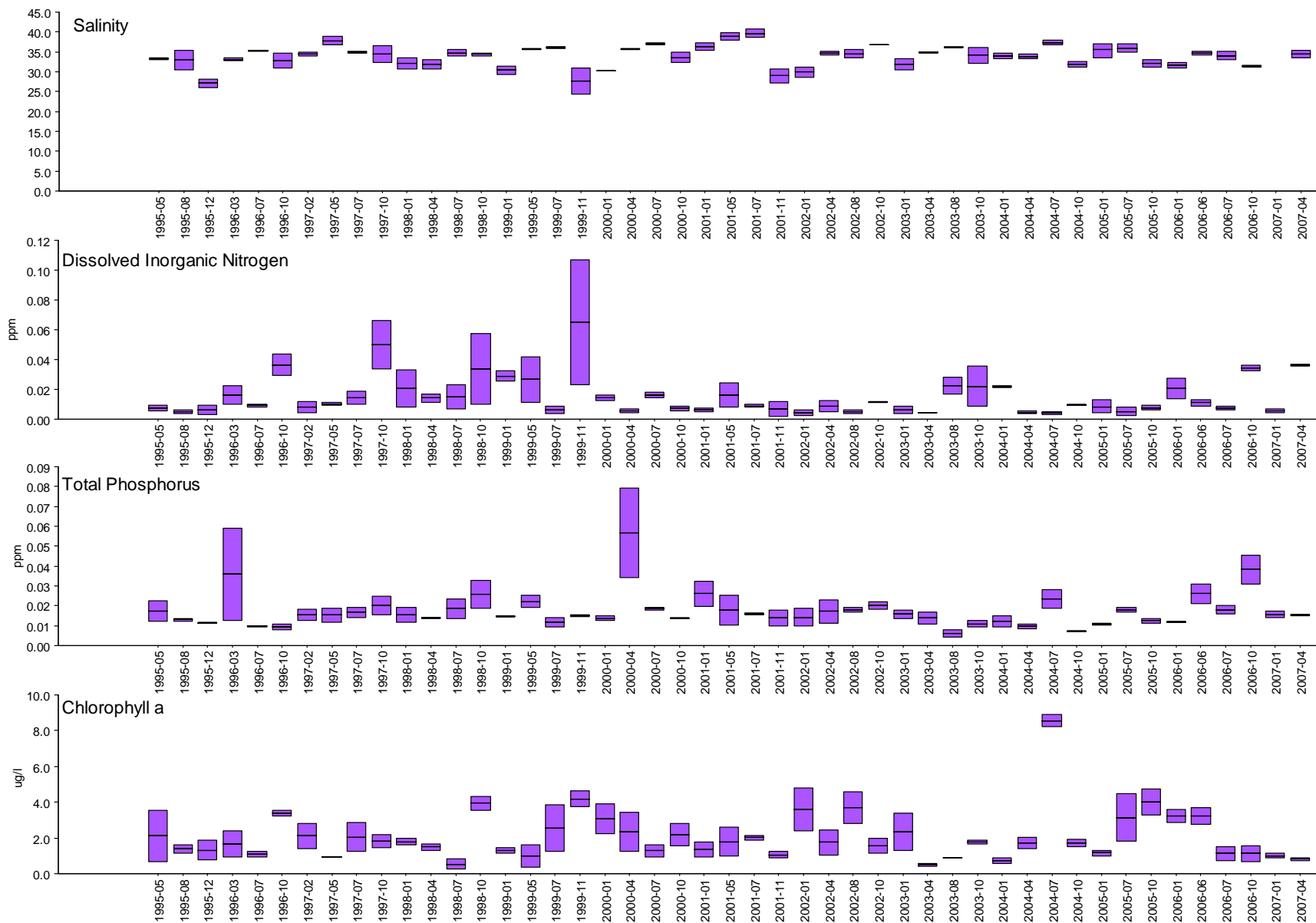


Figure 21. Box-and-whisker plots of water quality in SW Florida Shelf by survey.



## Shoal Zone

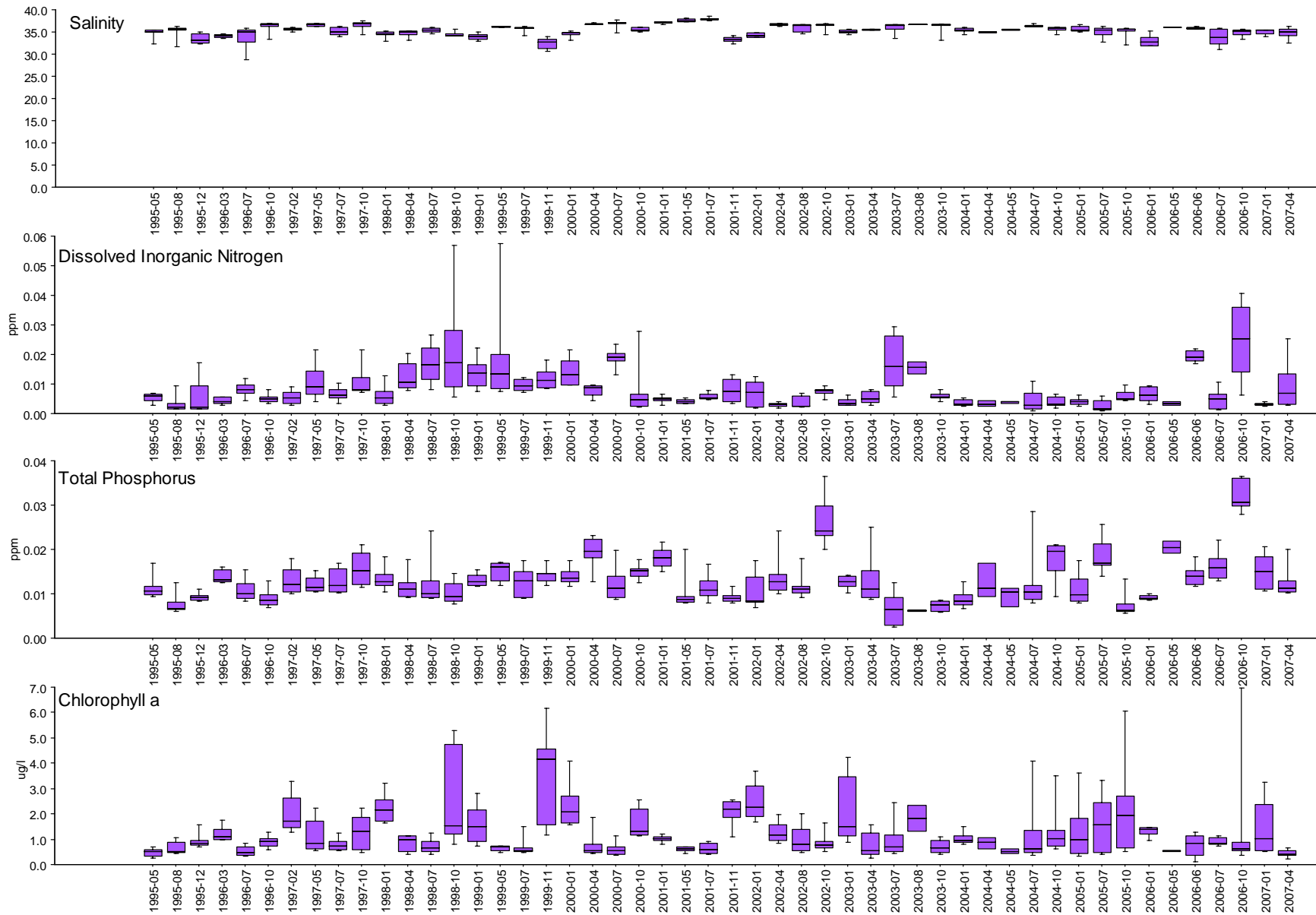


Figure 22. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

# Marco Zone

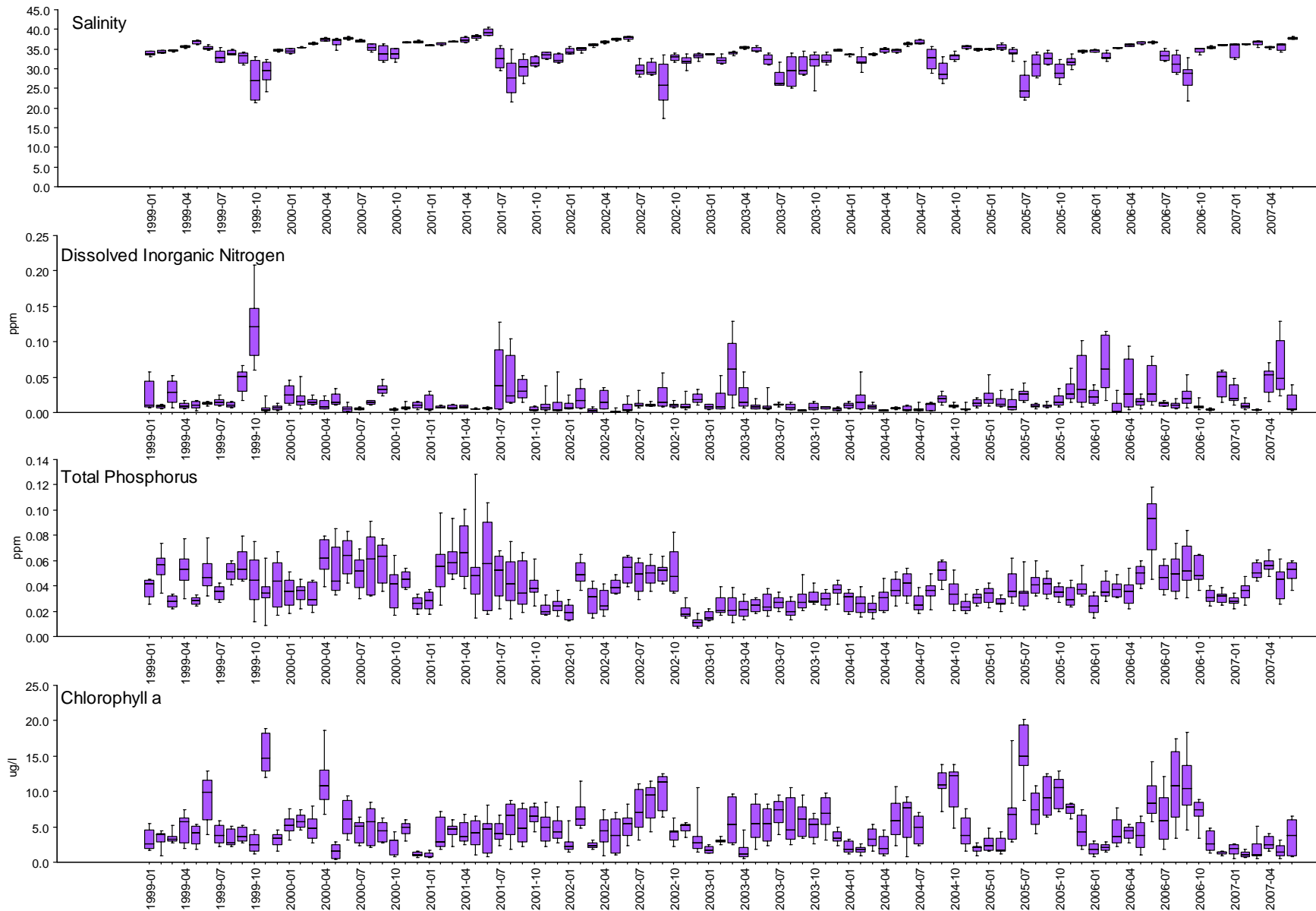


Figure 23. Box-and-whisker plots of water quality in RB-PIS by survey.

# Rookery Bay Zone

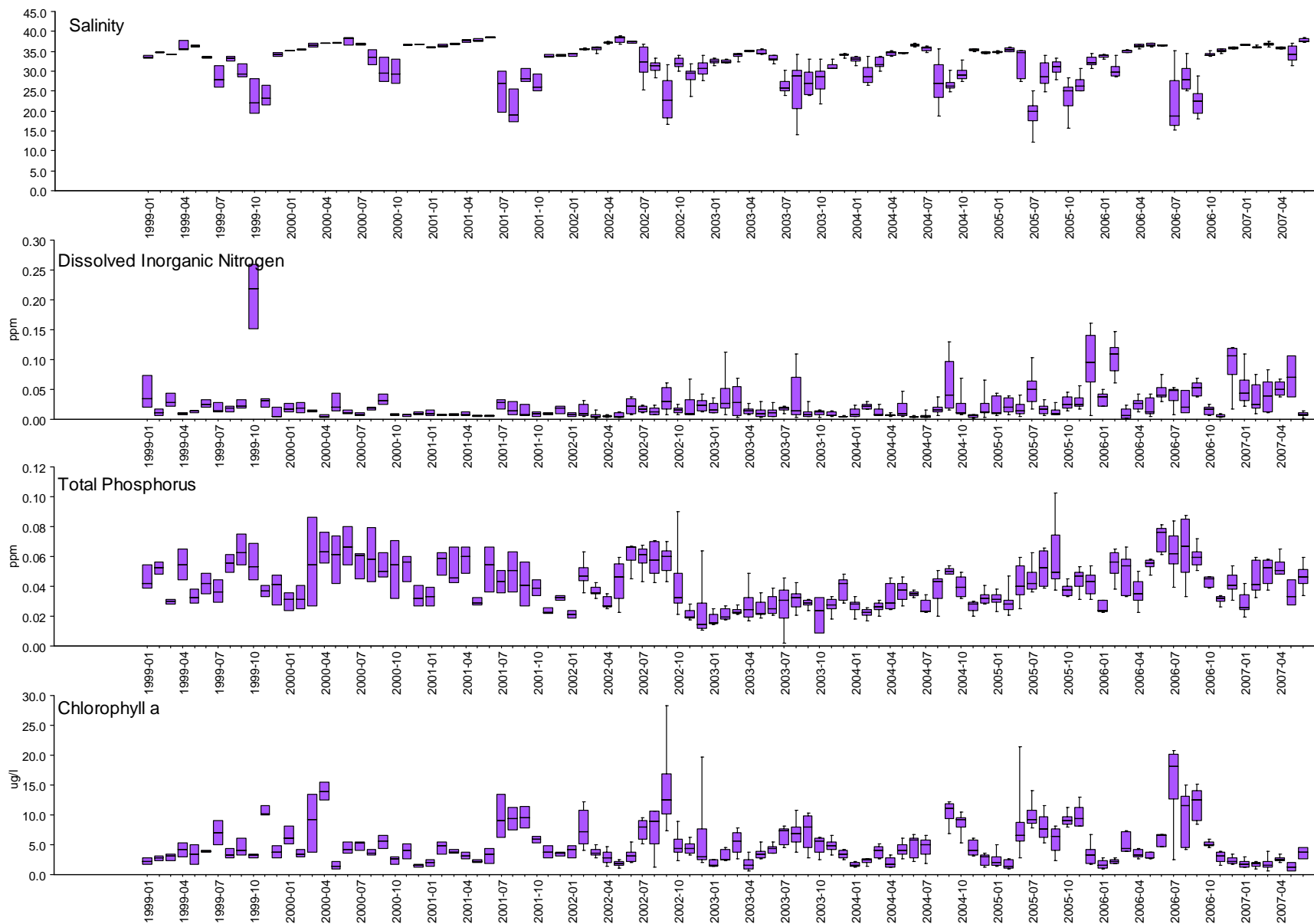


Figure 24. Box-and-whisker plots of water quality in RB-PIS by survey.

# Naples Zone

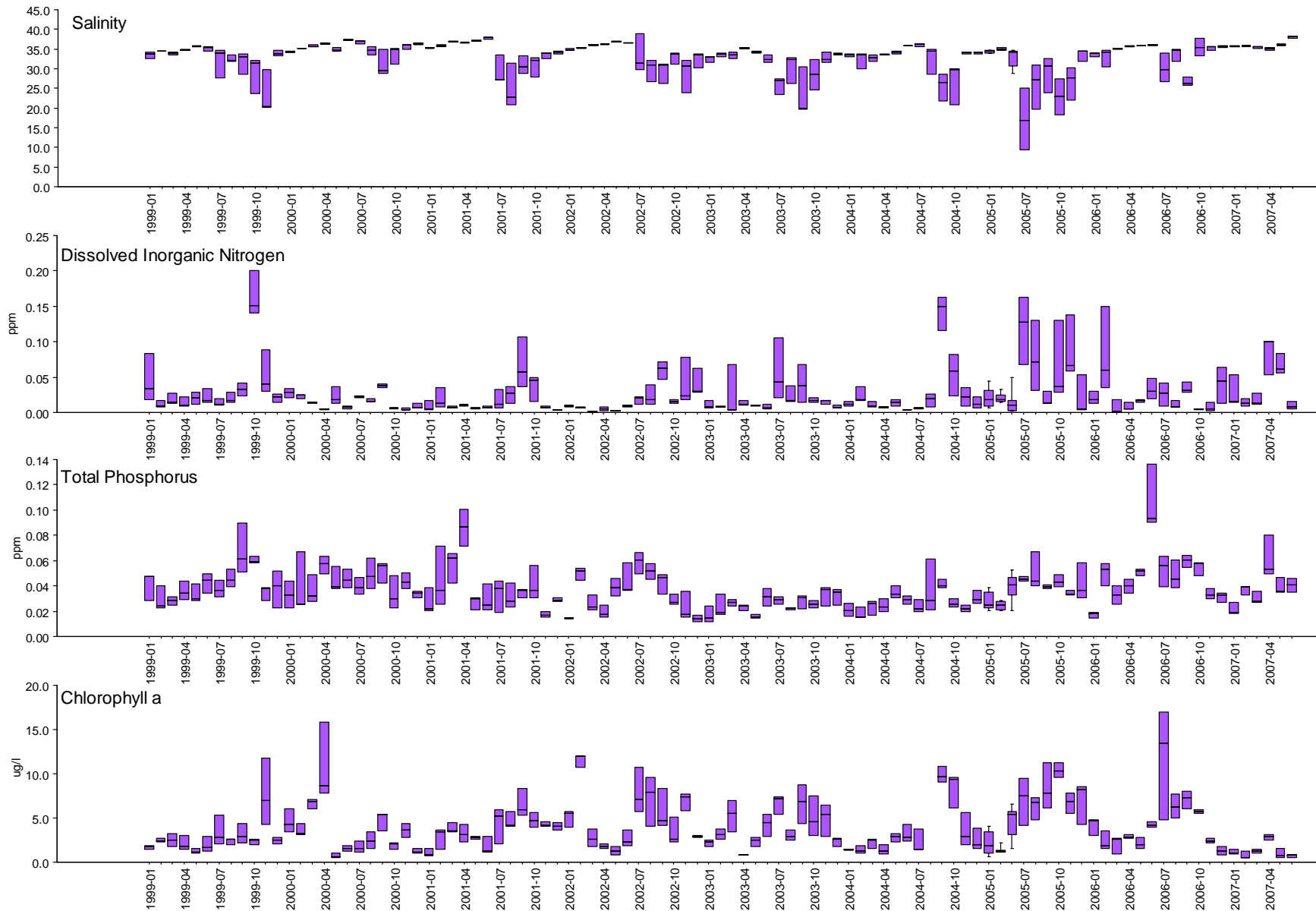


Figure 25. Box-and-whisker plots of water quality in RB-PIS by survey.

# San Carlos Bay Zone

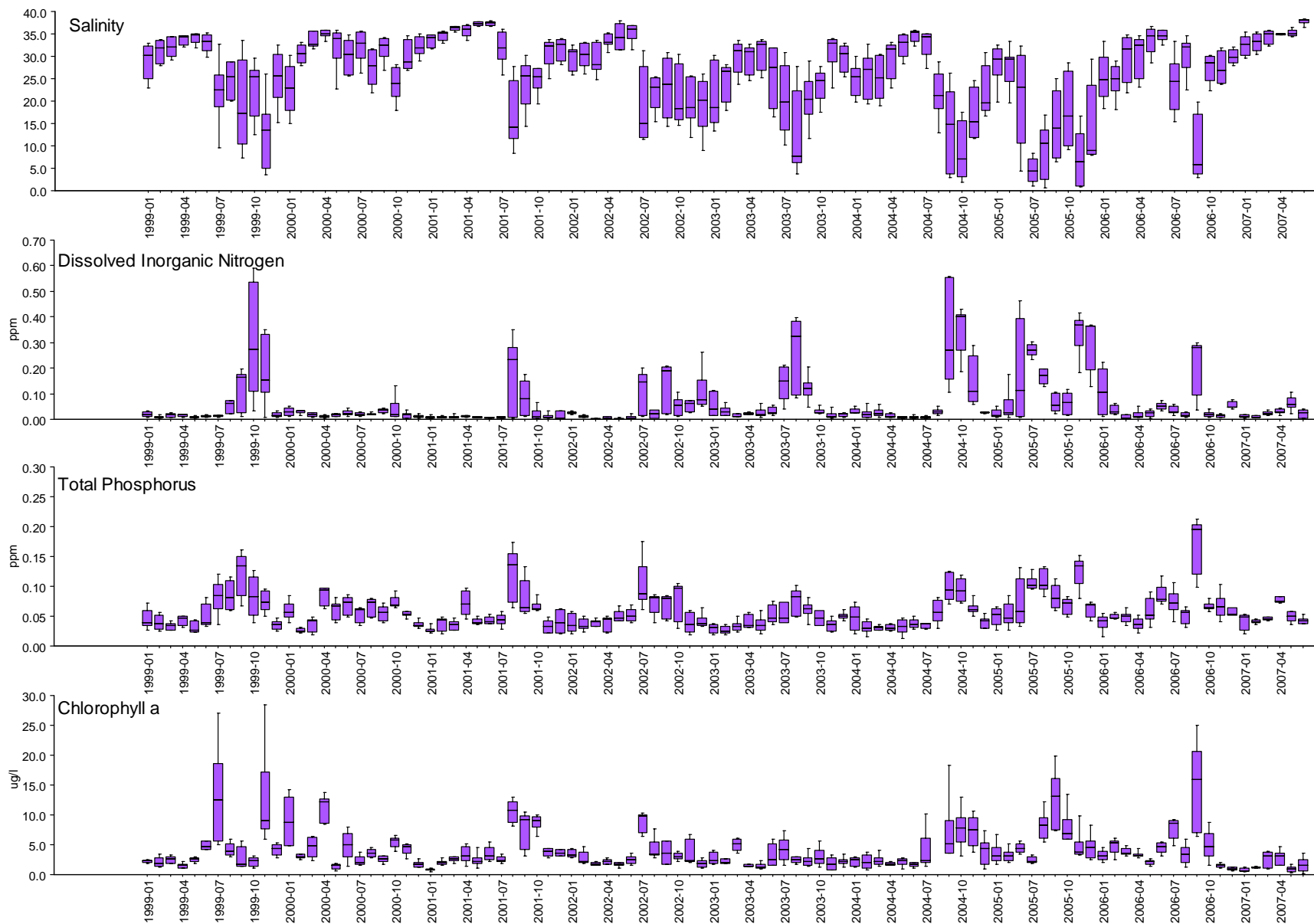


Figure 26. Box-and-whisker plots of water quality in RB-PIS by survey.

# Estero Bay Zone

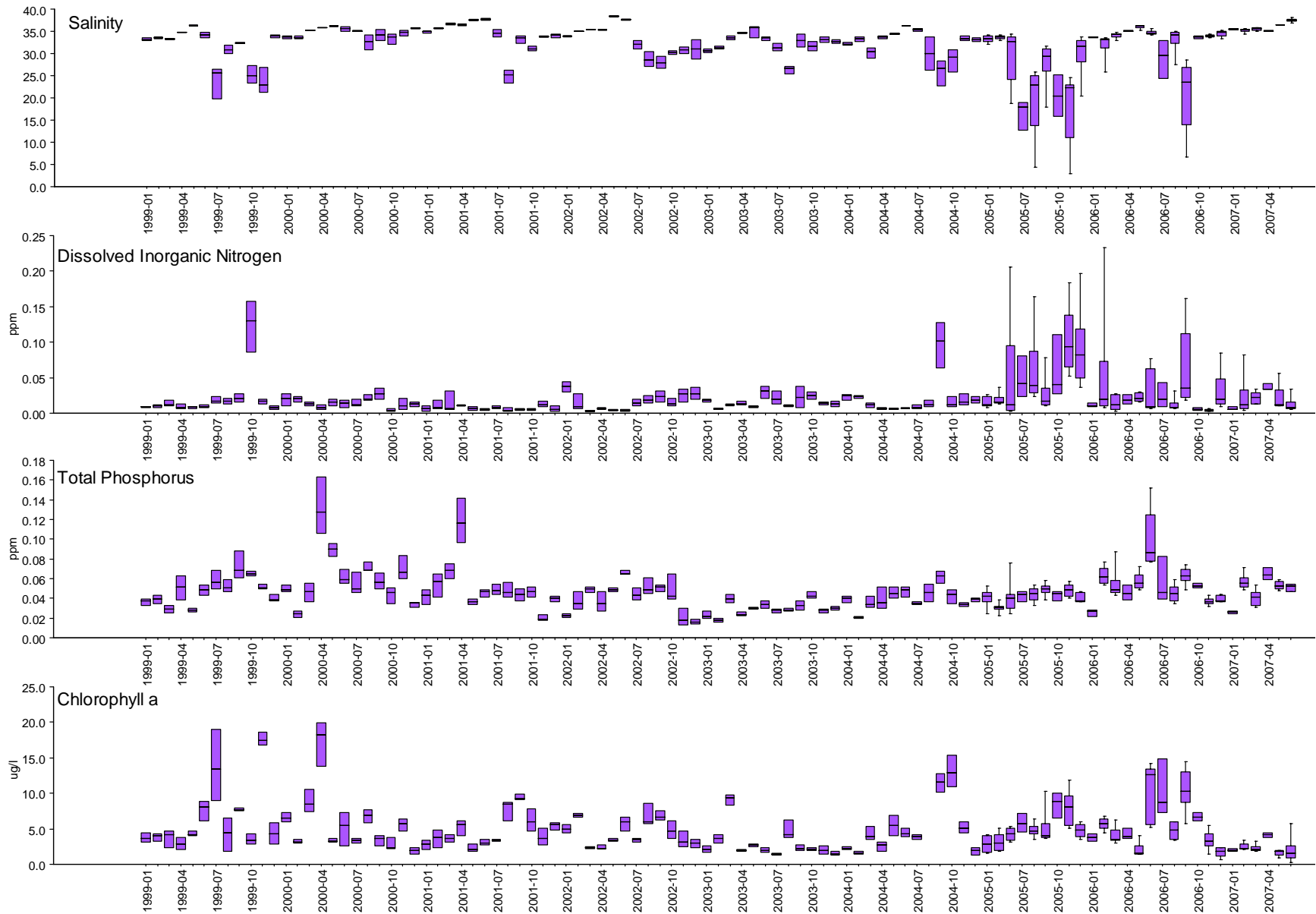


Figure 27. Box-and-whisker plots of water quality in RB-PIS by survey.

# Pine Island Sound Zone

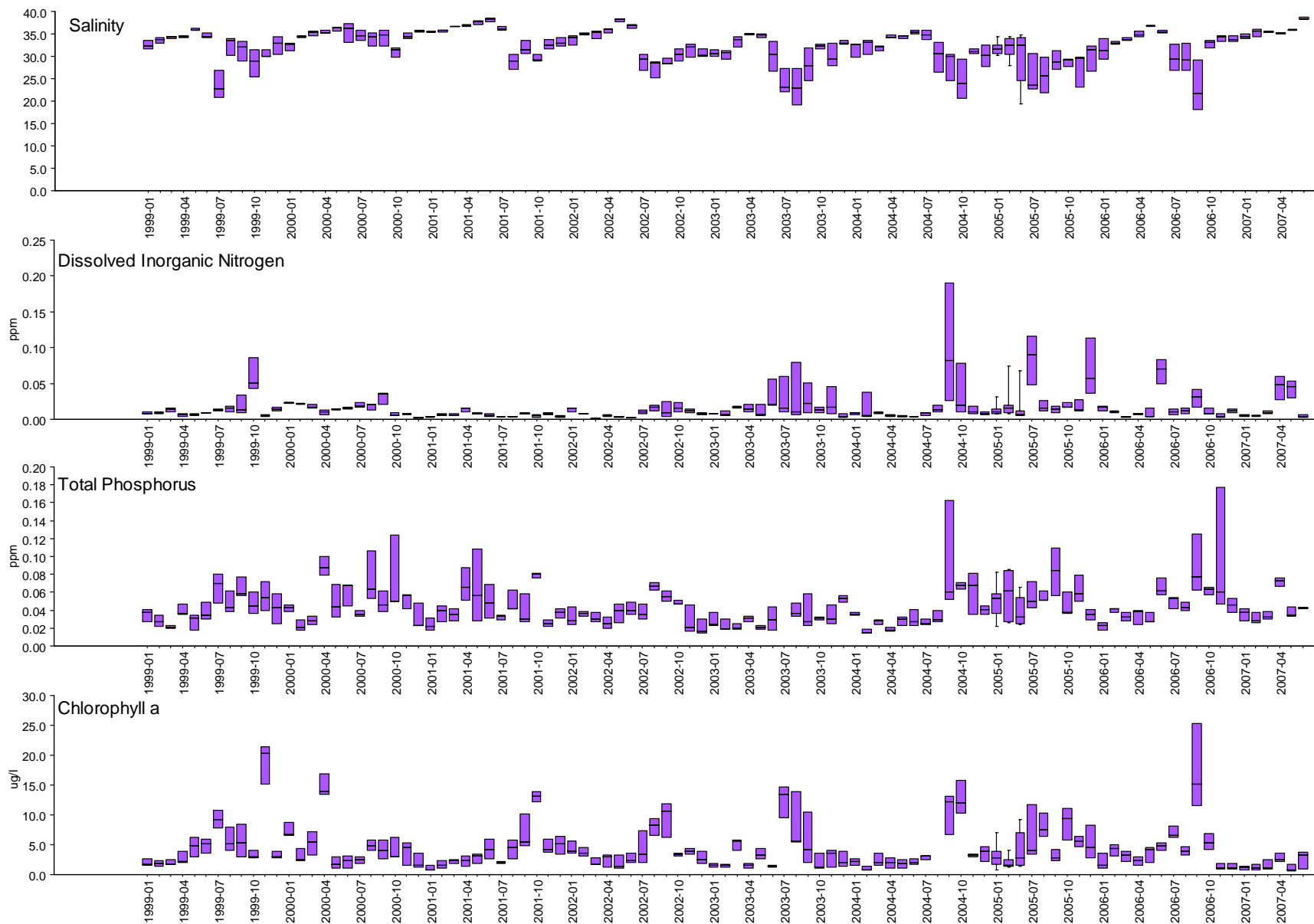


Figure 28. Box-and-whisker plots of water quality in RB-PIS by survey.

# Cocohatchee River at Wiggins Pass

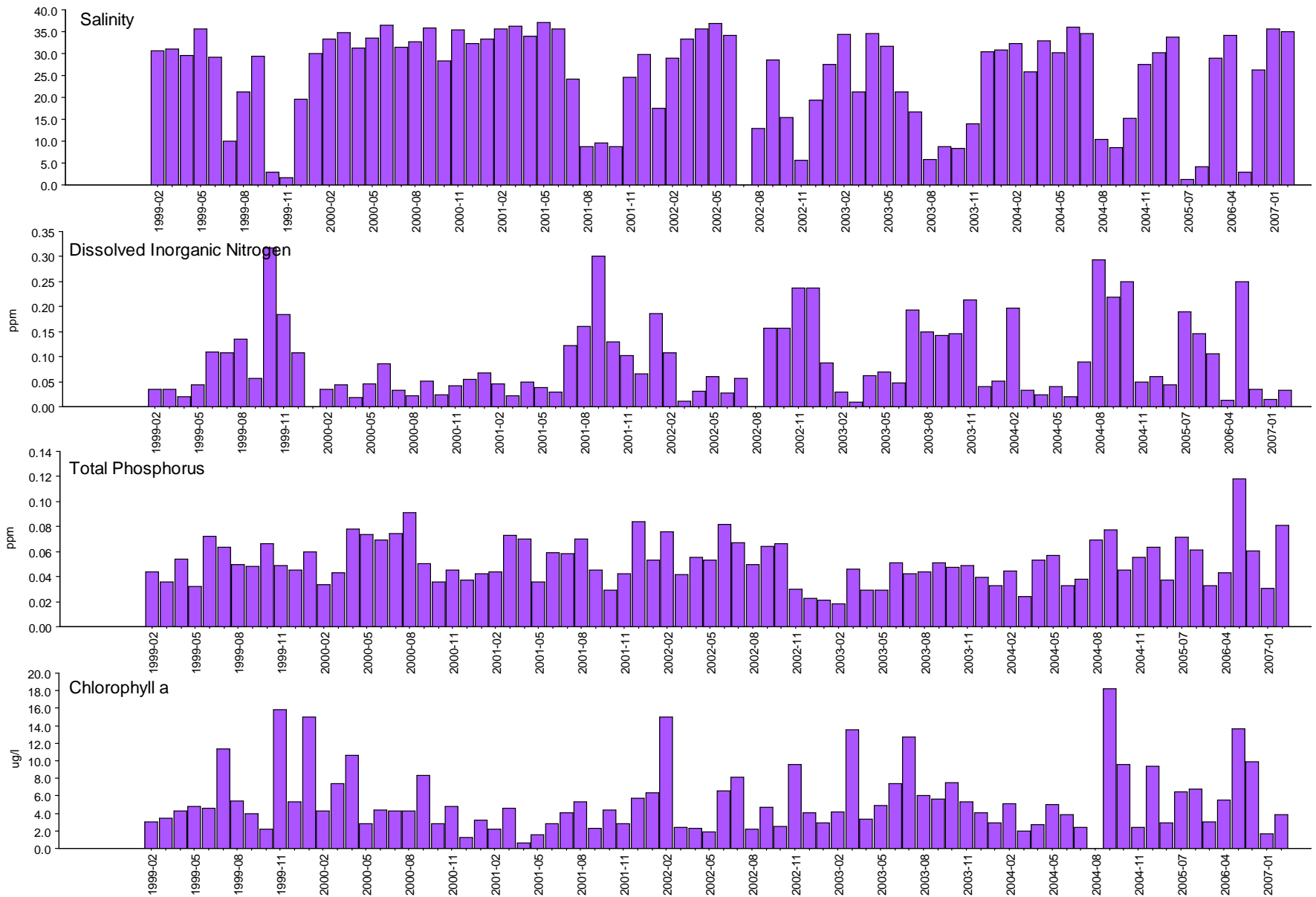


Figure 29. Bar chart of water quality in RB-PIS by survey.



Table 1.

<b>Parameter</b>	<b>Zone</b>	<b>Median</b>	<b>Min.</b>	<b>Max.</b>	<b><i>n</i></b>
Chlorophyll <i>a</i> ( $\mu\text{g l}^{-1}$ )	Biscayne Bay	0.161	0.023	2.891	75
	Florida Bay	0.476	0.108	8.330	84
	Rookery Bay	2.004	0.084	6.564	85
	SW Shelf	0.434	0.025	1.647	49
	Ten Thousand Is.	3.244	1.113	12.480	78
	Whitewater Bay	2.079	0.296	11.797	66
Surface Dissolved Oxygen ( $\text{mg l}^{-1}$ )	Biscayne Bay	6.29	4.85	8.02	75
	Florida Bay	5.24	2.35	9.86	84
	Rookery Bay	6.26	4.71	8.22	87
	SW Shelf	3.96	3.61	4.49	47
	Ten Thousand Is.	6.60	4.17	8.72	78
	Whitewater Bay	6.21	3.43	9.63	66
Bottom Dissolved Oxygen ( $\text{mg l}^{-1}$ )	Biscayne Bay	6.29	4.85	8.02	75
	Florida Bay	5.30	1.80	9.86	84
	Rookery Bay	6.26	4.71	8.22	87
	SW Shelf	4.10	3.73	4.48	47
	Ten Thousand Is.	6.59	3.95	8.67	78
	Whitewater Bay	6.22	3.24	9.65	66
$\text{NH}_4^+$ (ppm)	Biscayne Bay	0.0325	0.0047	0.0877	75
	Florida Bay	0.0281	0.0021	0.3906	83
	Rookery Bay	0.0287	0.0009	0.1360	86
	SW Shelf	0.0106	0.0007	0.0427	49
	Ten Thousand Is.	0.0096	0.0010	0.0700	78
	Whitewater Bay	0.0195	0.0028	0.1546	66
$\text{NO}_2^-$ (ppm)	Biscayne Bay	0.0013	0.0004	0.0112	75
	Florida Bay	0.0015	0.0002	0.0352	84
	Rookery Bay	0.0011	0.0002	0.0052	86
	SW Shelf	0.0007	0.0002	0.0019	49
	Ten Thousand Is.	0.0024	0.0003	0.0067	78
	Whitewater Bay	0.0022	0.0004	0.0207	66

<b>Parameter</b>	<b>Zone</b>	<b>Median</b>	<b>Min.</b>	<b>Max.</b>	<b><i>n</i></b>
NO <sub>3</sub> <sup>-</sup> (ppm)	Biscayne Bay	0.0042	0.0005	0.1852	75
	Florida Bay	0.0036	0.0000	0.1448	84
	Rookery Bay	0.0023	0.0000	0.0237	86
	SW Shelf	0.0016	0.0003	0.0070	49
	Ten Thousand Is.	0.0032	-0.0004	0.0597	78
	Whitewater Bay	0.0135	0.0006	0.1076	66
pH	Biscayne Bay	8.150	7.340	8.490	75
	Florida Bay	8.113	7.750	8.990	84
	Rookery Bay	8.060	7.210	8.320	87
	SW Shelf	7.540	7.060	7.650	49
	Ten Thousand Is.	7.780	7.180	8.185	72
	Whitewater Bay	7.915	7.280	8.445	66
Surface Salinity	Biscayne Bay	36.66	25.28	39.59	75
	Florida Bay	36.99	6.92	42.55	84
	Rookery Bay	36.12	31.30	38.93	87
	SW Shelf	34.92	31.74	36.73	47
	Ten Thousand Is.	35.11	7.78	38.73	78
	Whitewater Bay	24.81	7.42	39.63	66
Bottom Salinity	Biscayne Bay	36.66	25.28	39.59	75
	Florida Bay	36.98	9.86	42.60	84
	Rookery Bay	36.12	31.30	38.49	87
	SW Shelf	36.31	35.14	37.04	47
	Ten Thousand Is.	35.21	13.15	38.79	78
	Whitewater Bay	25.45	7.46	39.54	66
Si(OH) <sub>4</sub> (ppm)	Biscayne Bay	0.0215	0.0014	0.0707	25
	Florida Bay	0.1968	0.0026	3.2434	28
	Rookery Bay	0.3593	0.0541	1.1077	29
	SW Shelf	0.0606	0.0003	1.3949	49
	Ten Thousand Is.	1.7496	0.0002	2.2630	26
	Whitewater Bay	1.2689	0.1246	2.8338	22
Soluble Reactive Phosphorus (ppm)	Biscayne Bay	0.0010	0.0000	0.0042	75
	Florida Bay	0.0010	0.0003	0.0036	84
	Rookery Bay	0.0084	0.0006	0.0256	86
	SW Shelf	0.0010	0.0000	0.0035	49
	Ten Thousand Is.	0.0068	0.0005	0.0343	78
	Whitewater Bay	0.0018	0.0002	0.0137	66

<b>Parameter</b>	<b>Zone</b>	<b>Median</b>	<b>Min.</b>	<b>Max.</b>	<b><i>n</i></b>
Surface Temperature (°C)	Biscayne Bay	25.16	23.58	29.32	75
	Florida Bay	26.91	23.38	29.58	84
	Rookery Bay	26.67	21.47	31.16	87
	SW Shelf	24.09	23.18	31.80	47
	Ten Thousand Is.	26.19	20.11	32.08	78
	Whitewater Bay	25.24	22.61	32.04	66
Bottom Temperature (°C)	Biscayne Bay	25.16	23.59	29.32	75
	Florida Bay	27.01	23.40	29.62	84
	Rookery Bay	26.67	21.47	31.17	87
	SW Shelf	24.10	23.43	31.83	47
	Ten Thousand Is.	26.20	20.10	31.95	78
	Whitewater Bay	25.13	22.65	31.13	66
Total Nitrogen (ppm)	Biscayne Bay	0.180	0.092	0.494	75
	Florida Bay	0.443	0.130	1.247	84
	Rookery Bay	0.213	0.130	0.429	86
	SW Shelf	0.158	0.134	0.229	48
	Ten Thousand Is.	0.232	0.163	0.478	78
	Whitewater Bay	0.357	0.191	0.903	66
Total Organic Carbon (ppm)	Biscayne Bay	2.189	1.373	5.501	75
	Florida Bay	6.791	1.165	17.373	84
	Rookery Bay	3.213	1.718	6.231	86
	SW Shelf	2.053	1.512	3.680	49
	Ten Thousand Is.	5.526	2.928	13.770	78
	Whitewater Bay	11.585	5.443	22.685	66
Total Organic Nitrogen (ppm)	Biscayne Bay	0.123	0.030	0.466	75
	Florida Bay	0.309	0.114	1.236	83
	Rookery Bay	0.141	0.000	0.230	86
	SW Shelf	0.146	0.109	0.212	48
	Ten Thousand Is.	0.210	0.146	0.435	78
	Whitewater Bay	0.302	0.117	0.868	66
Total Phosphorus (ppm)	Biscayne Bay	0.006	0.004	0.014	75
	Florida Bay	0.010	0.005	0.064	78
	Rookery Bay	0.051	0.024	0.089	85
	SW Shelf	0.013	0.009	0.022	49
	Ten Thousand Is.	0.039	0.021	0.075	78
	Whitewater Bay	0.029	0.016	0.073	66

<b>Parameter</b>	<b>Zone</b>	<b>Median</b>	<b>Min.</b>	<b>Max.</b>	<b><i>n</i></b>
Turbidity (NTU)	Biscayne Bay	0.66	0.21	1.48	75
	Florida Bay	2.27	0.56	42.00	84
	Rookery Bay	2.91	1.21	11.20	86
	SW Shelf	1.38	0.21	5.73	48
	Ten Thousand Is.	6.84	1.12	43.20	78
	Whitewater Bay	4.17	0.20	11.59	66