FIU
FLORIDA INTERNATIONAL UNIVERSITY
Miami's public research university

Southeast Environmental Research Center
OE-148 Florida International University, Miami, FL 33199
305-348-3095, 305-348-4096 fax, http://serc.fiu.edu

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 Jan. – Mar. 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) Jan. – Mar. 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 (NO_x), nitrite (NO_2), nitrate (NO_3), ammonium (NH_4), inorganic nitrogen (DIN), and soluble reactive phosphorus (SRP). Silicate ($Si(OH)_4$) 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.

Biological parameters monitored included chlorophyll *a* ($\mu g\ l^{-1}$) and alkaline phosphatase activity (APA; $\mu M\ hr^{-1}$). Field parameters measured at both surface and bottom of the water column include salinity, dissolved oxygen (DO; $mg\ l^{-1}$), and temperature (^oC). 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^{th} and 75^{th} percentiles (quartiles), and the ends of the whiskers are the 5^{th} and 95^{th} 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 continued through this period (Fig.7). We are not sure as to the cause of the bloom but it was widespread affecting Card Sound, Barnes Sound, Manatee Bay, Blackwater Sound, Little Blackwater Sound, and most of Eastern Florida Bay. We will continue to analyze this and other data in conjunction with other agency scientists in an effort to provide an explanation. Note that 2006 TP and CHLA have been some of the highest levels ever seen in Eastern Florida Bay. Also note the increasing trend in TP seen in Biscayne Bay for the last year (Fig 16-18).

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

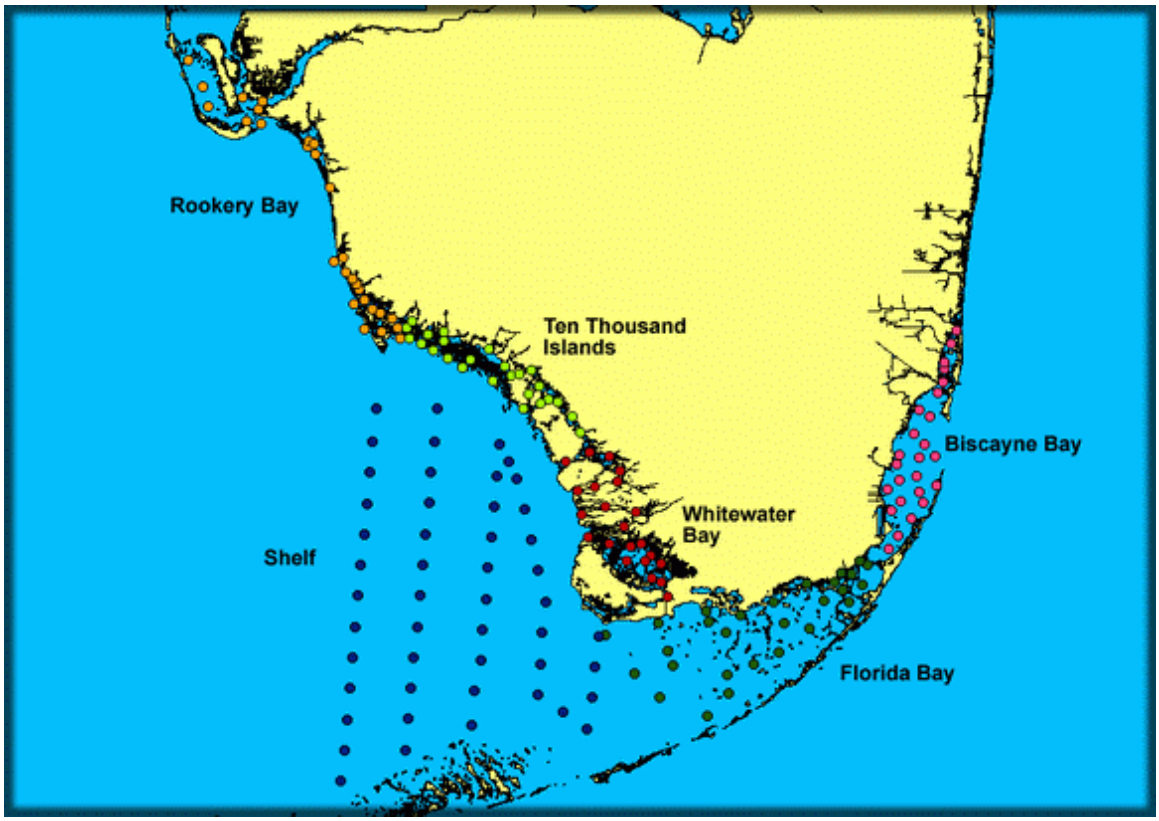

Figure 1: All fixed water quality stations funded by this SFWMD project.

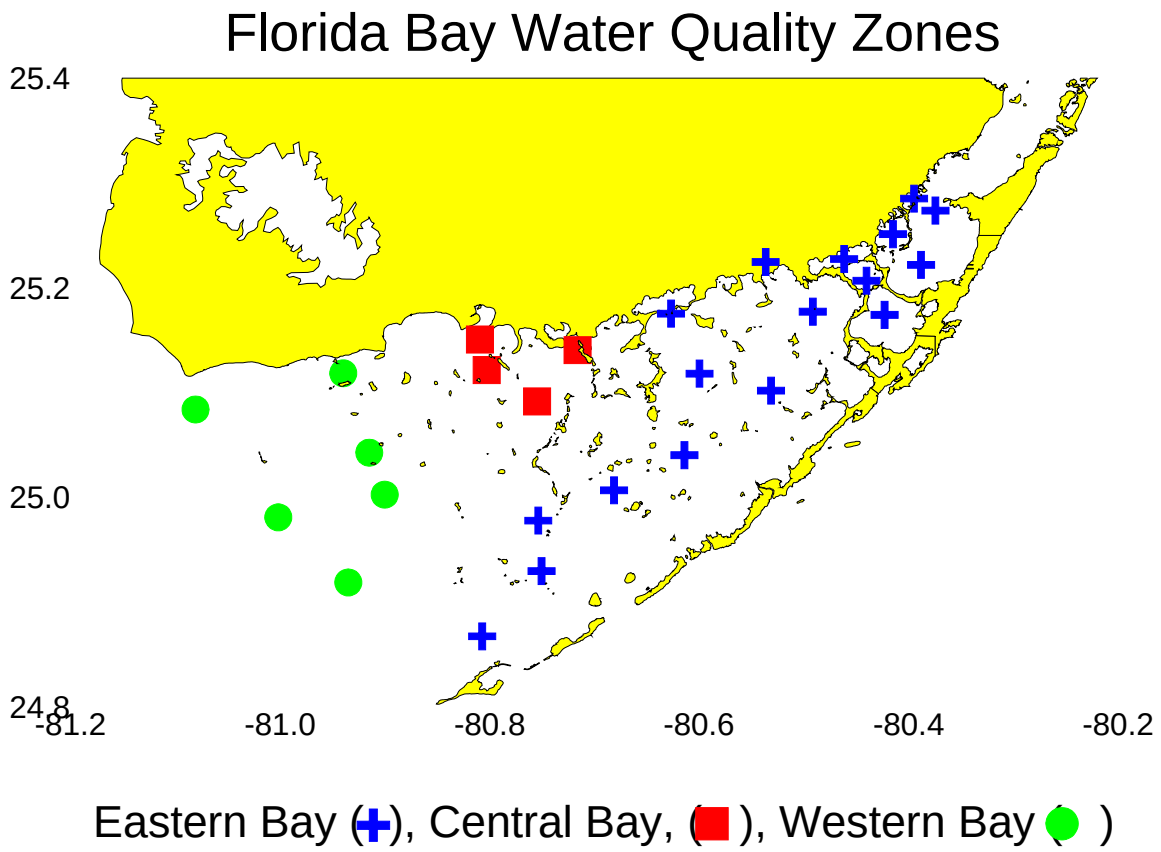

Figure 2. Florida Bay zones.

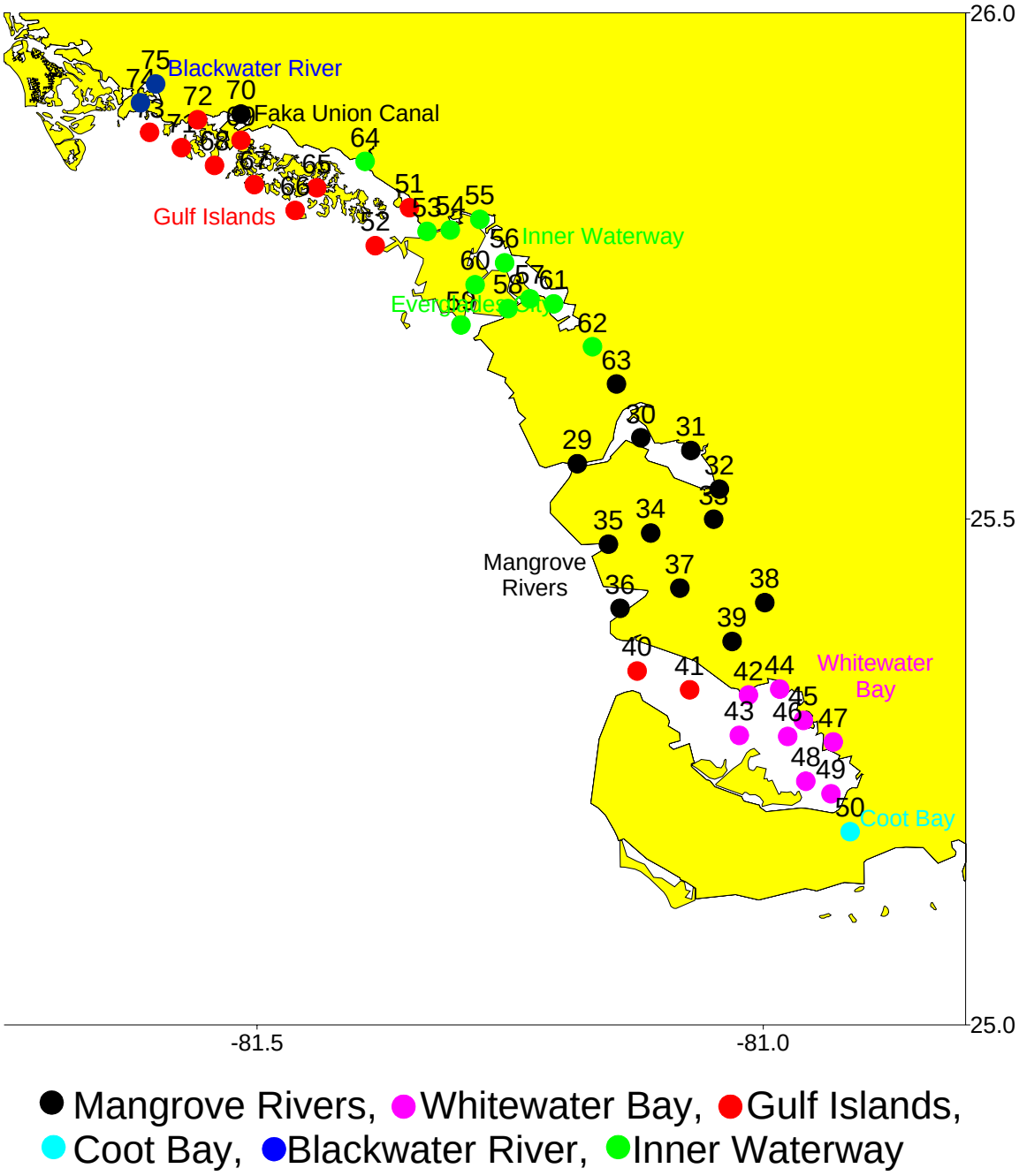

Figure 3. WWB-TTI water quality zones.

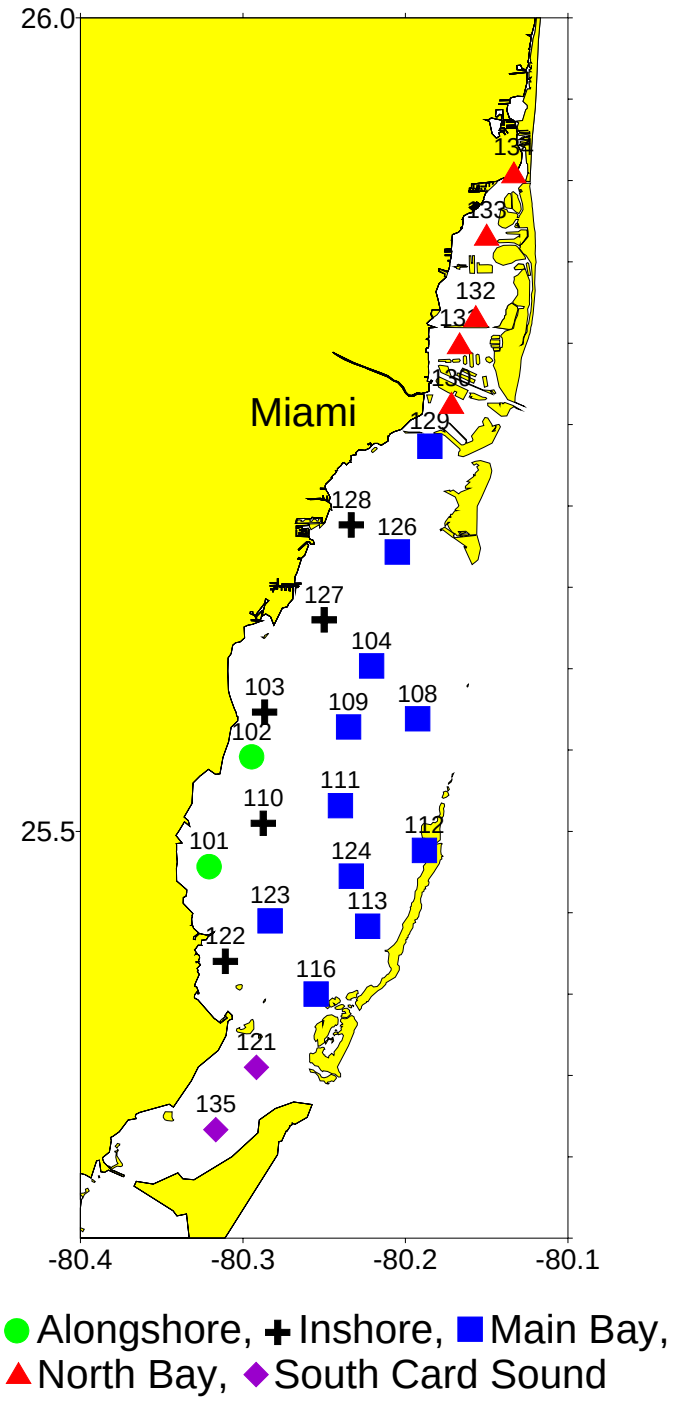

Figure 4. Biscayne Bay water quality zones.

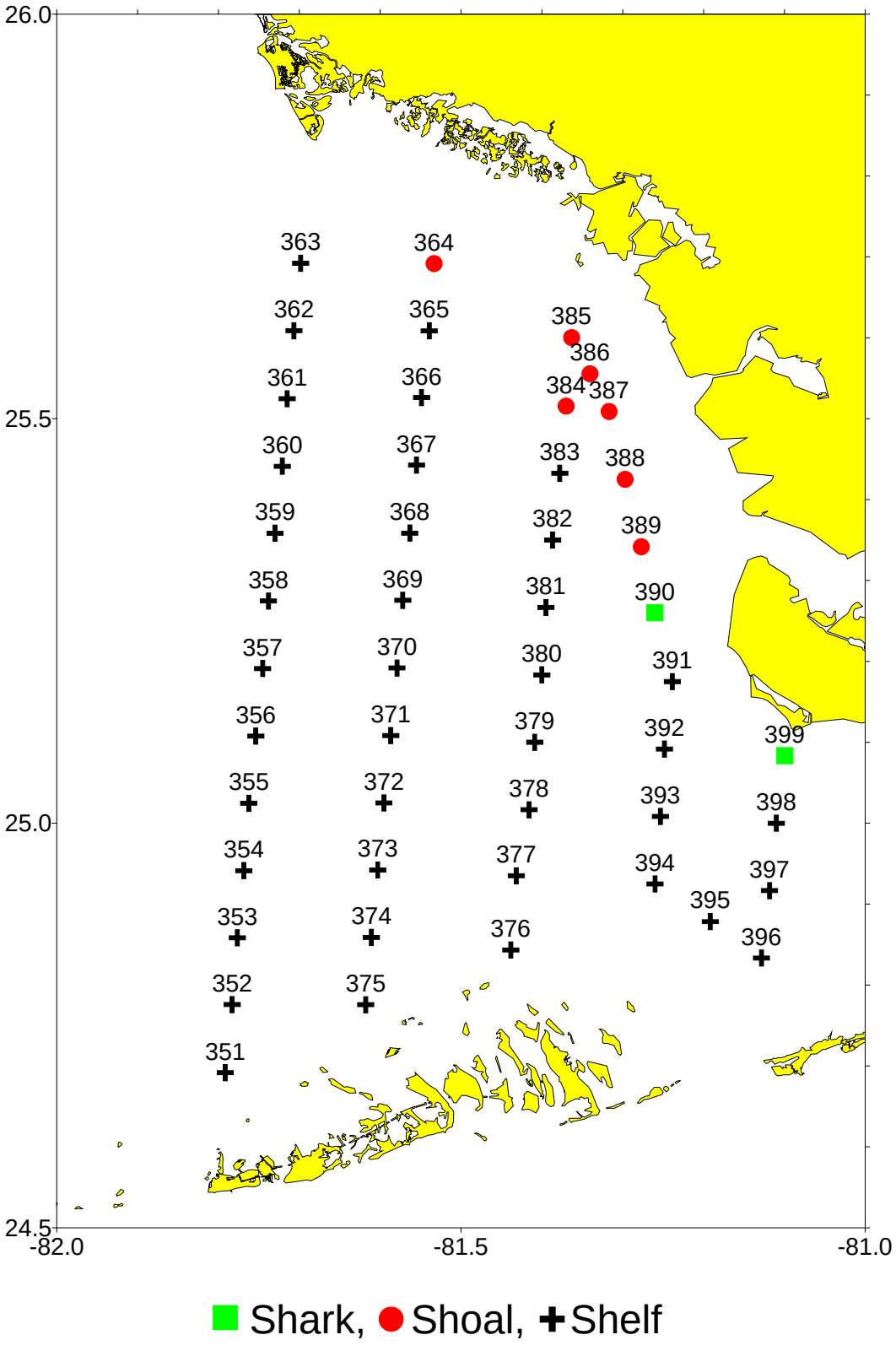

Figure 5. SW Florida Shelf water quality zones.

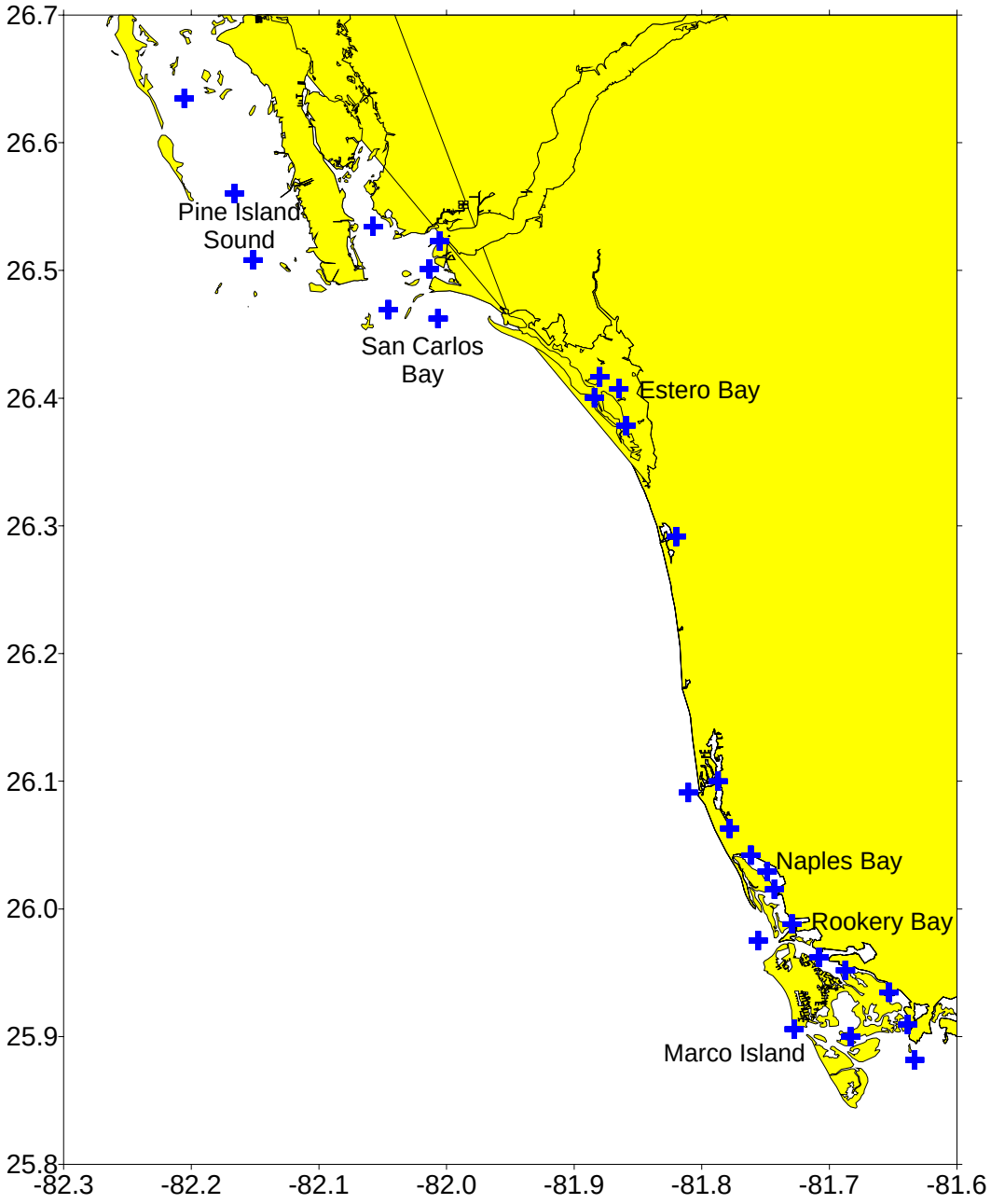

Figure 6. SW estuaries.

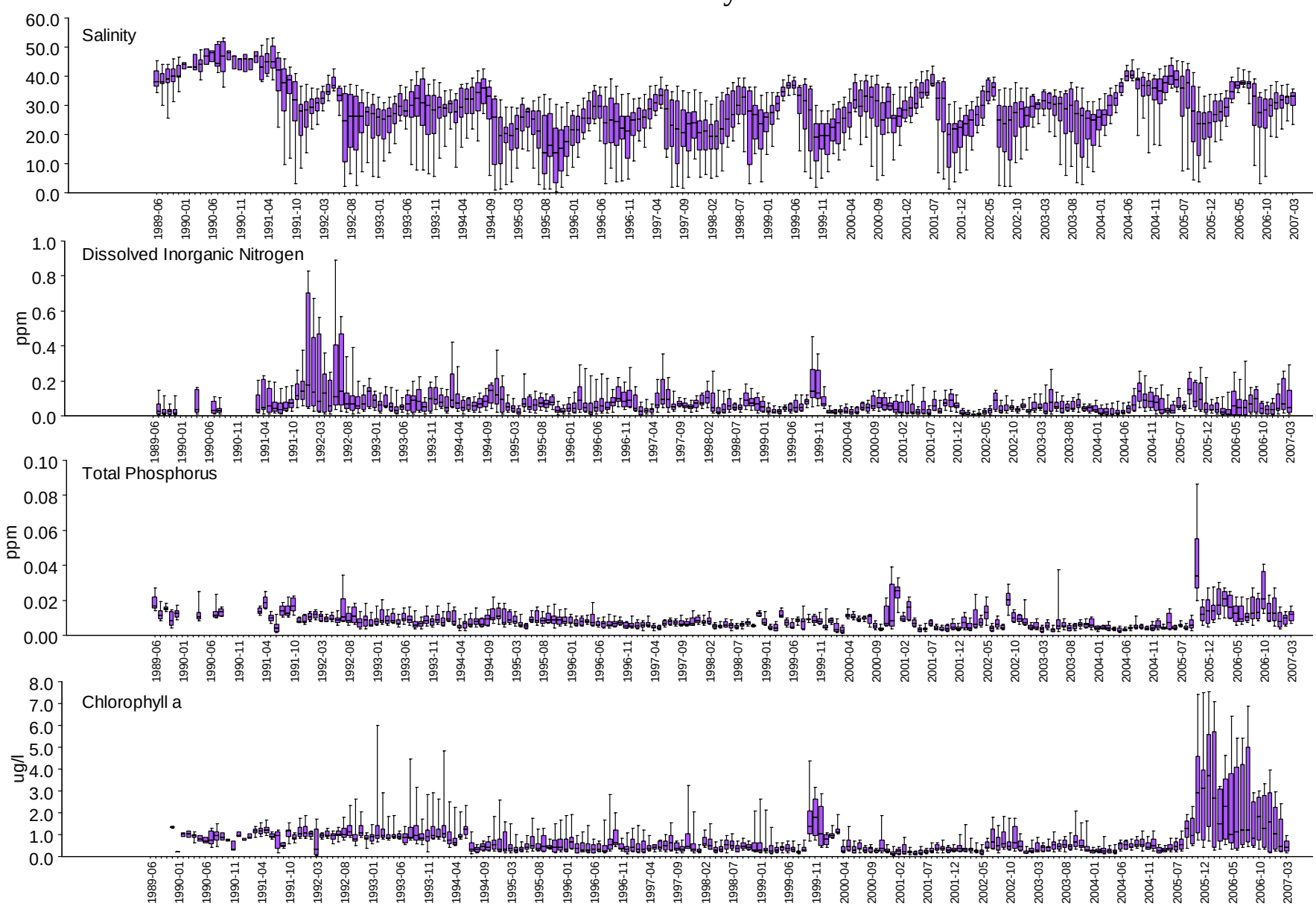

Figure 7. Box-and-whisker plots of water quality in Eastern Florida Bay by survey.

Central Florida Bay Zone

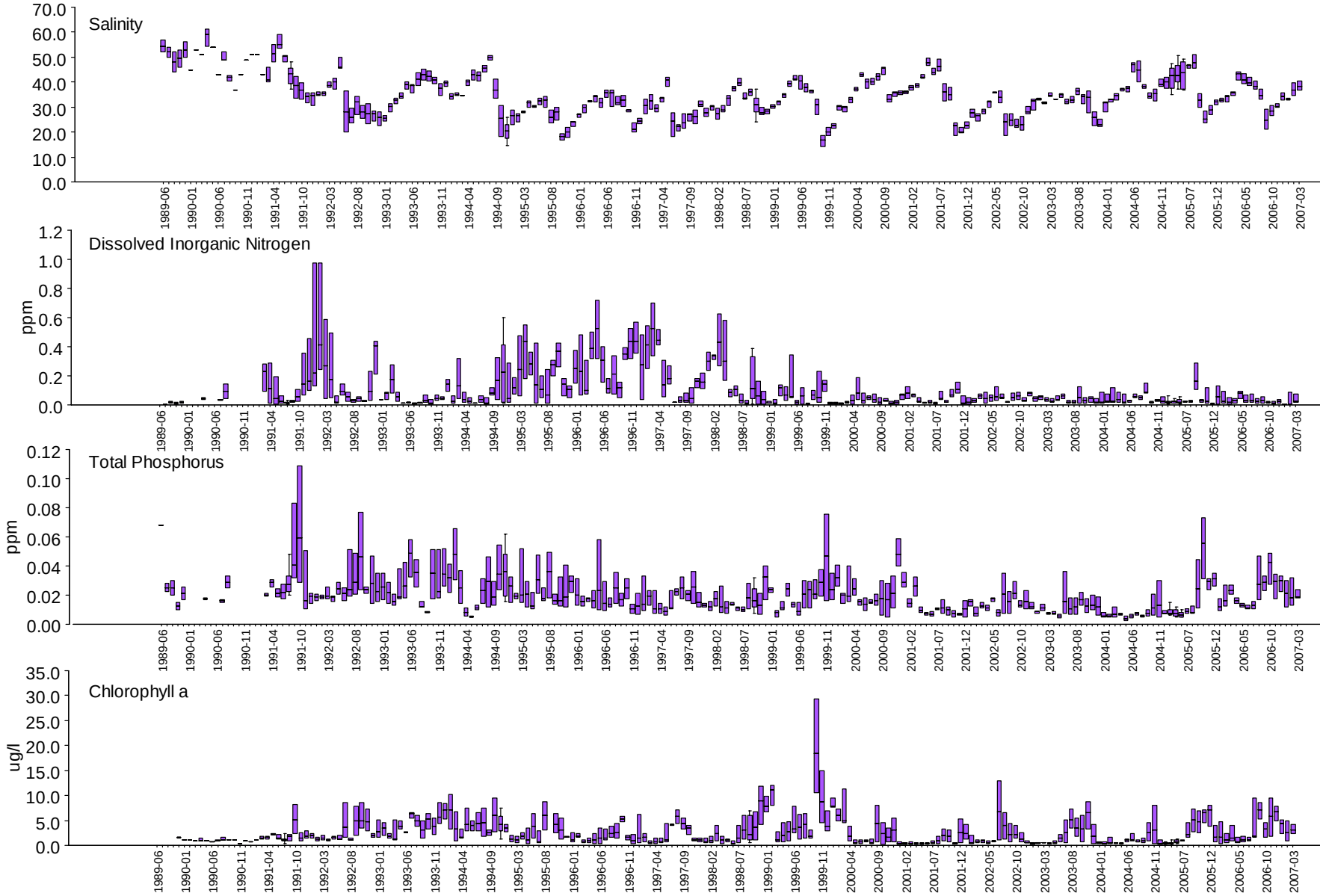

Figure 8. Box-and-whisker plots of water quality in Central Florida Bay by survey.

Western Florida Bay Zone

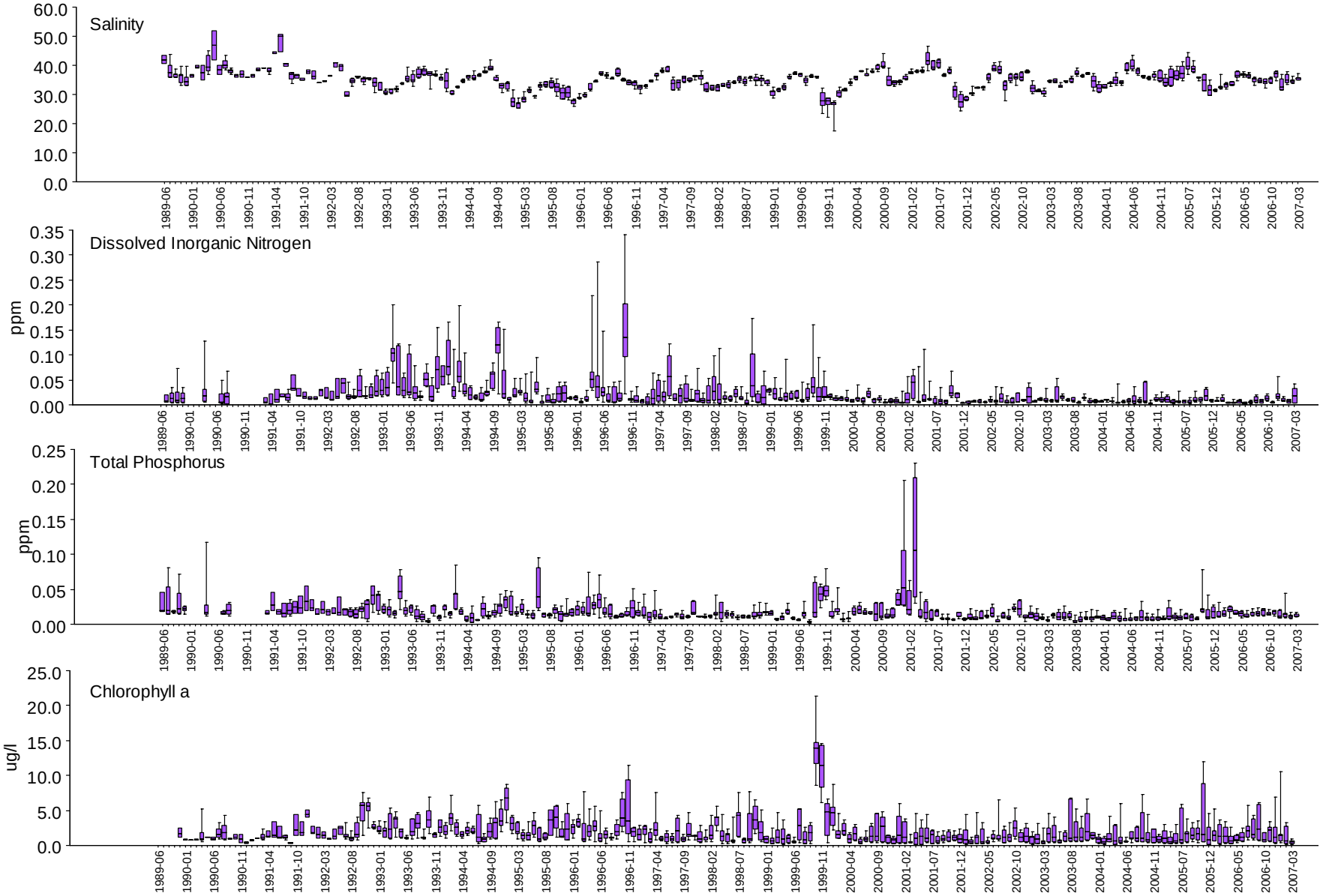

Figure 9. Box-and-whisker plots of water quality in Western Florida Bay by survey.

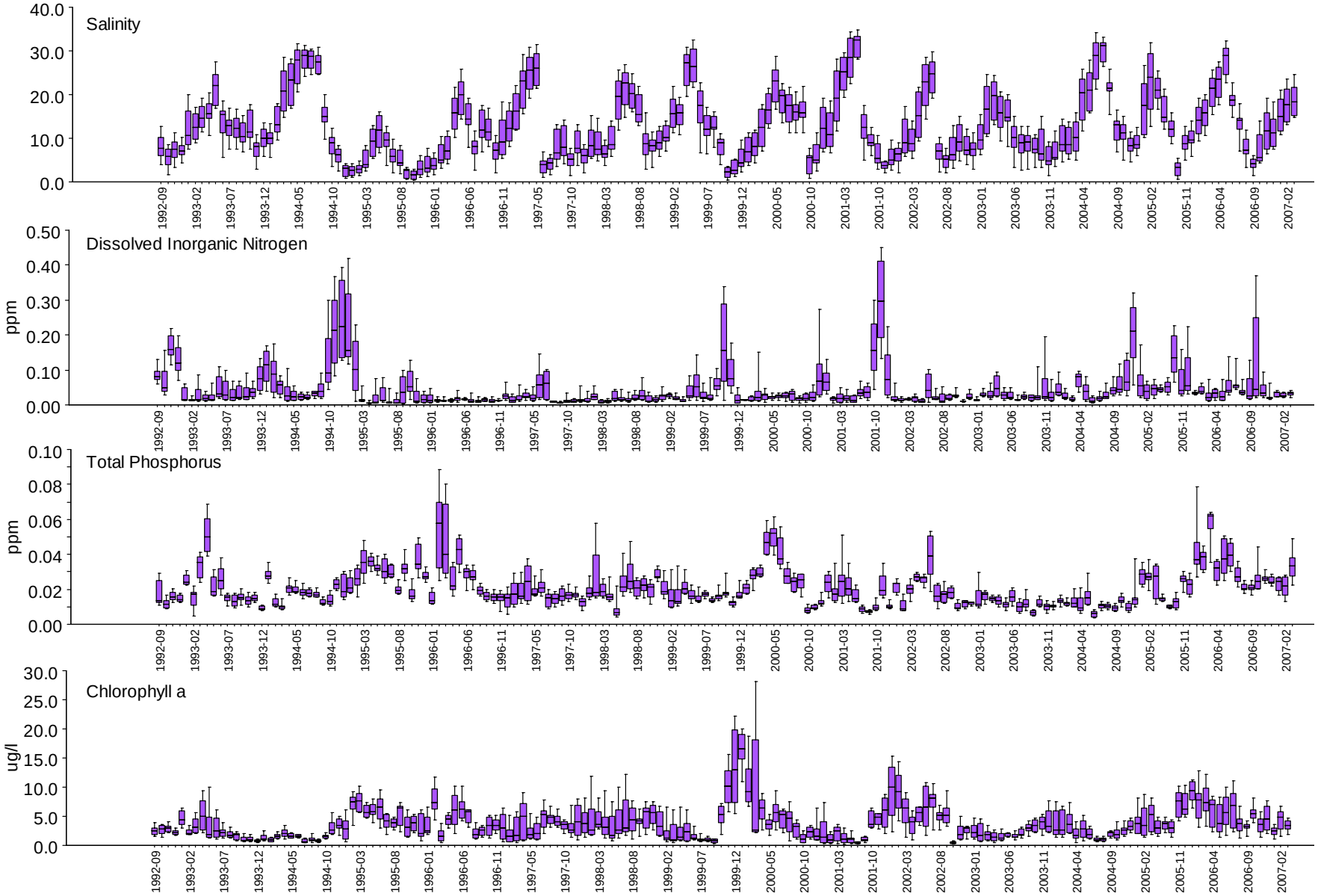

Figure 10. Box-and-whisker plots of water quality in WWB-TTI by survey.

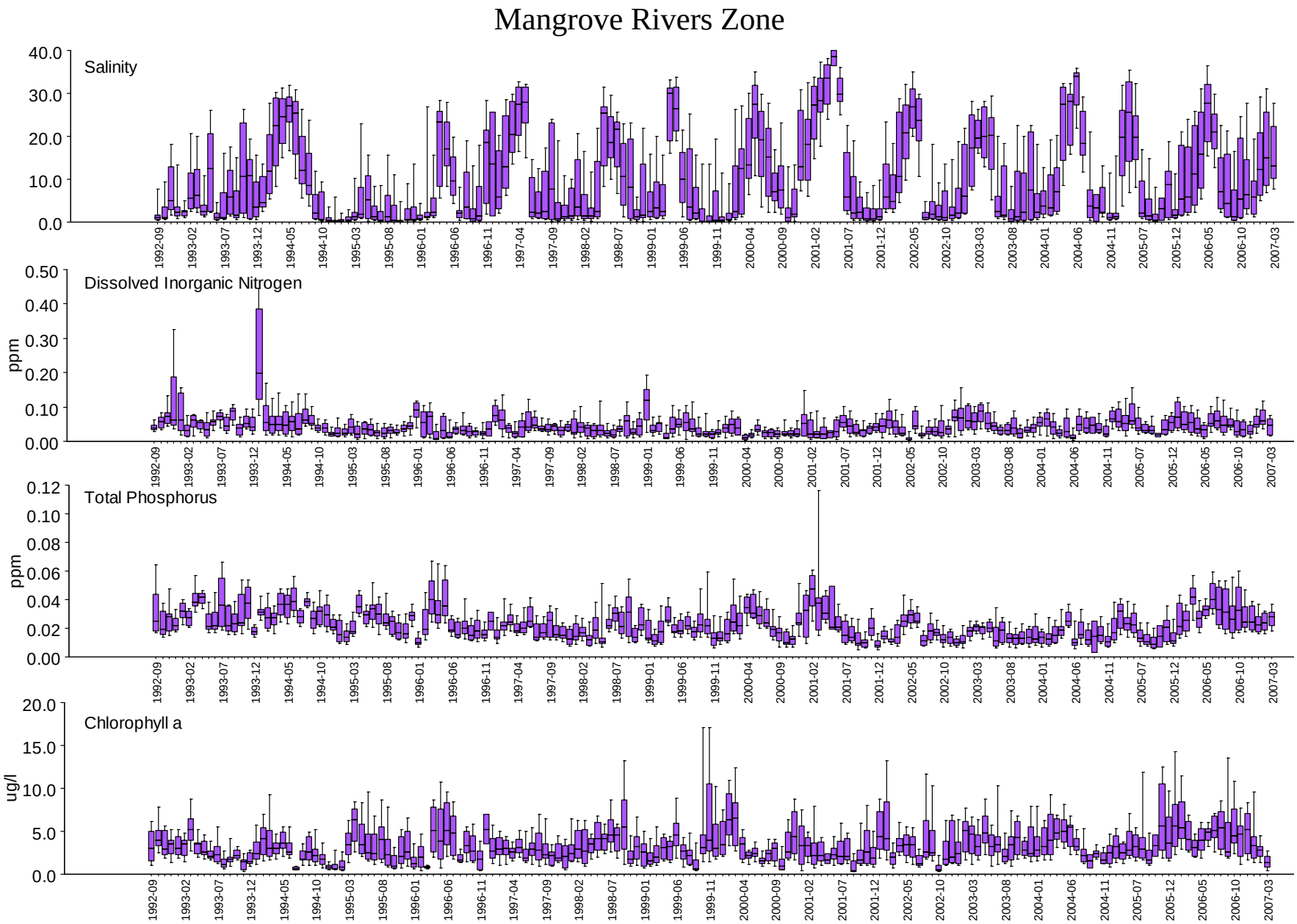

Figure 11. Box-and-whisker plots of water quality in WWB-TTI by survey.

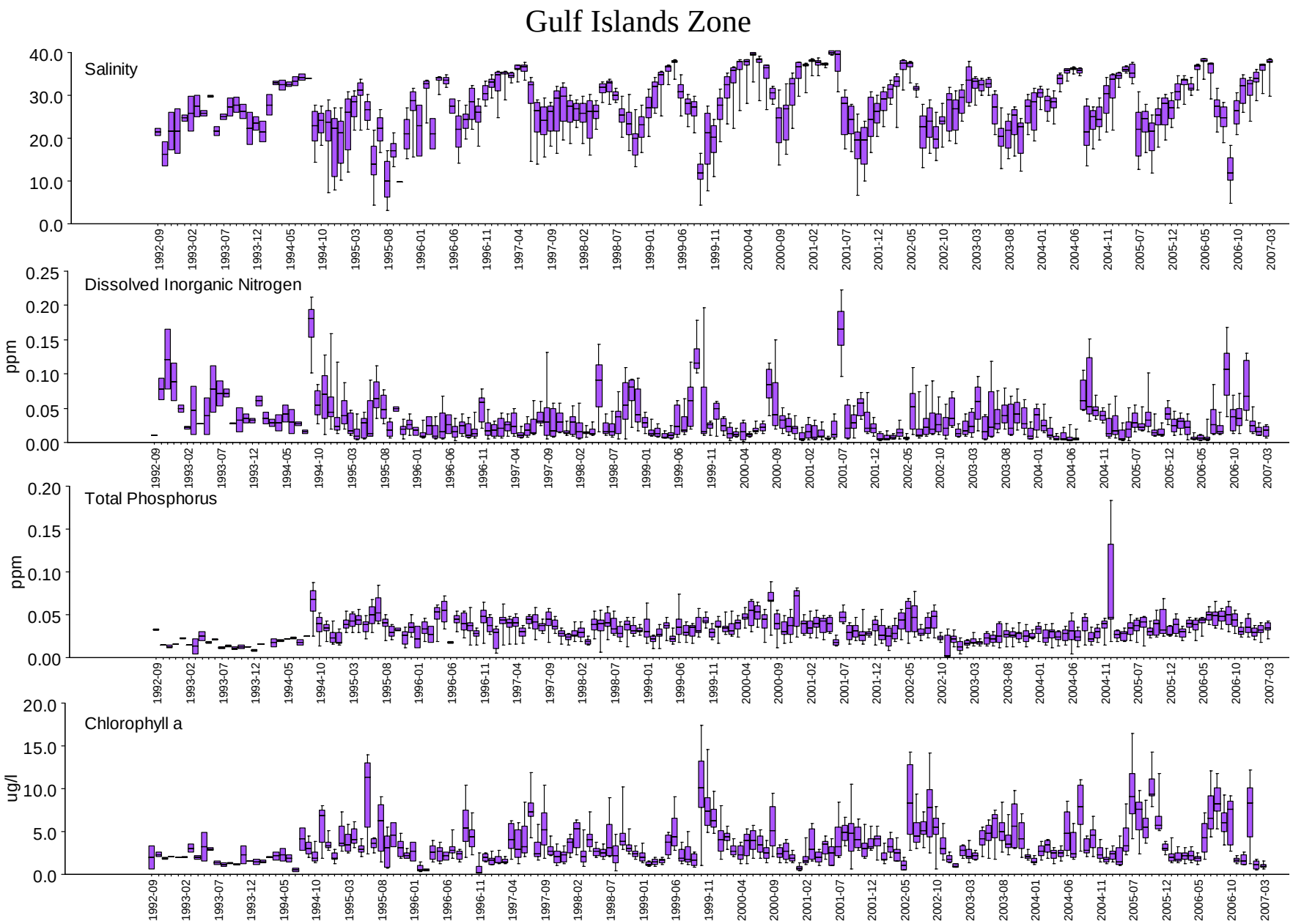

Figure 12. Box-and-whisker plots of water quality in WWB-TTI by survey.

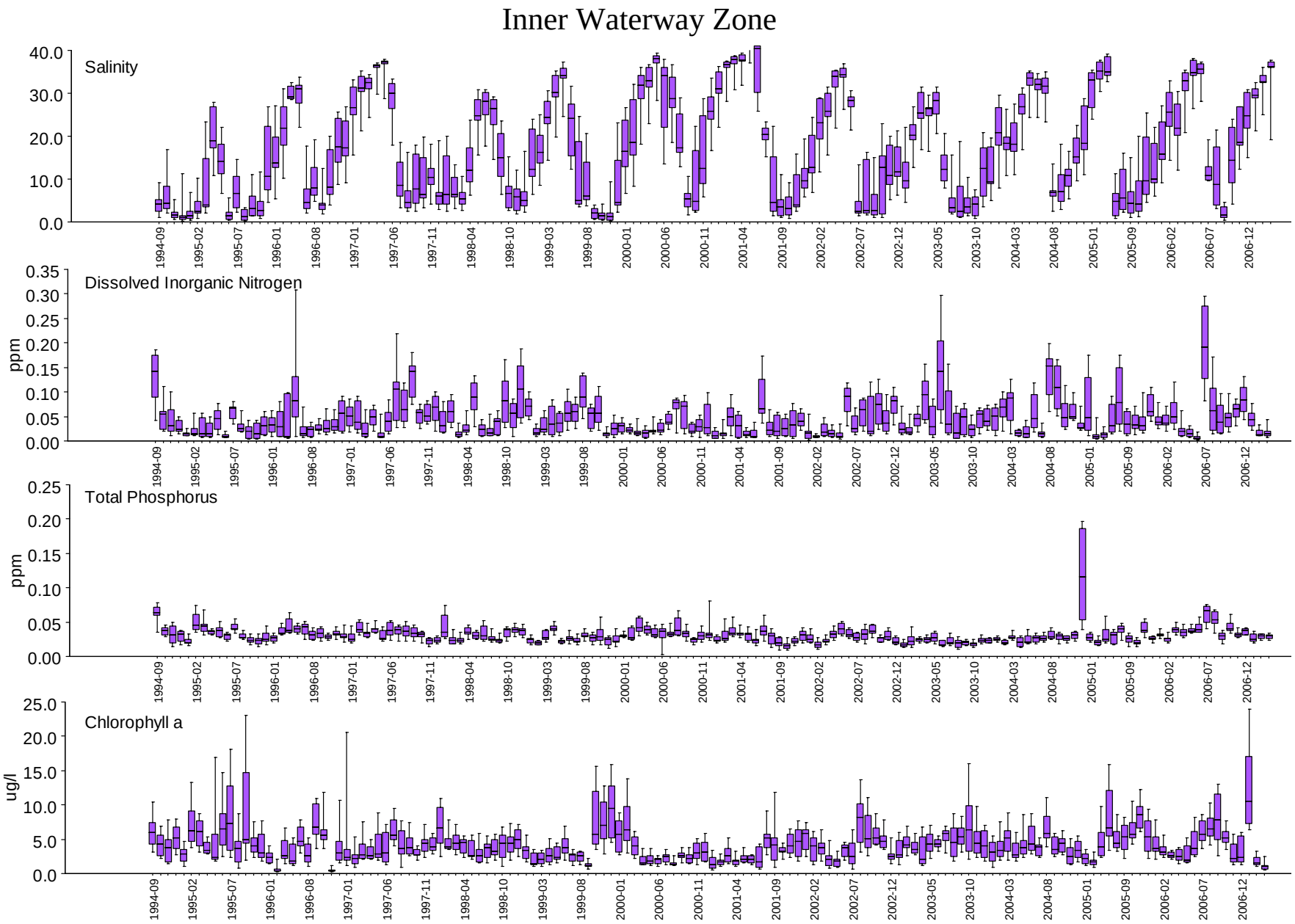

Figure 13. Box-and-whisker plots of water quality in WWB-TTI by survey.

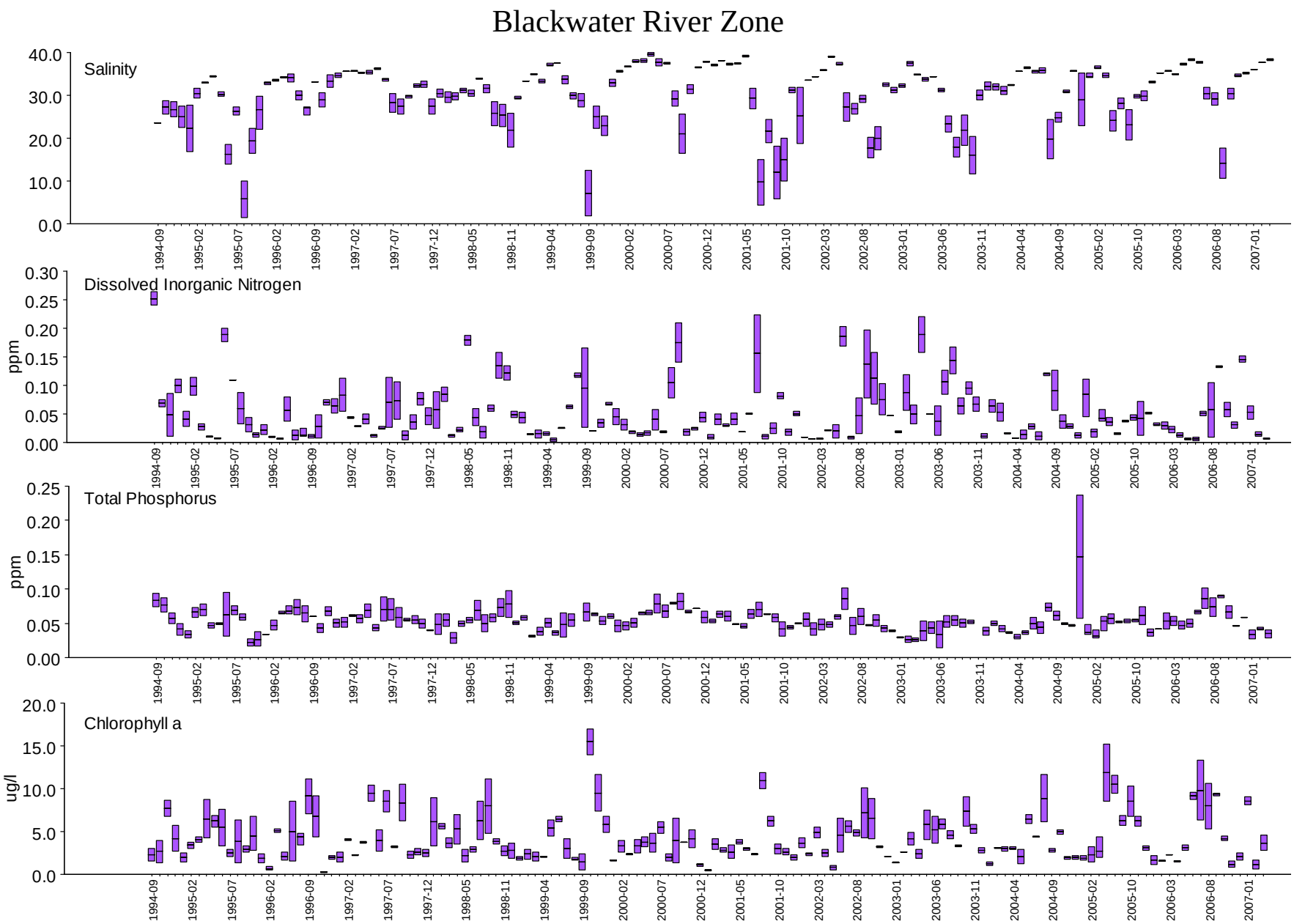

Figure 14. Box-and-whisker plots of water quality in WWB-TTI by survey.

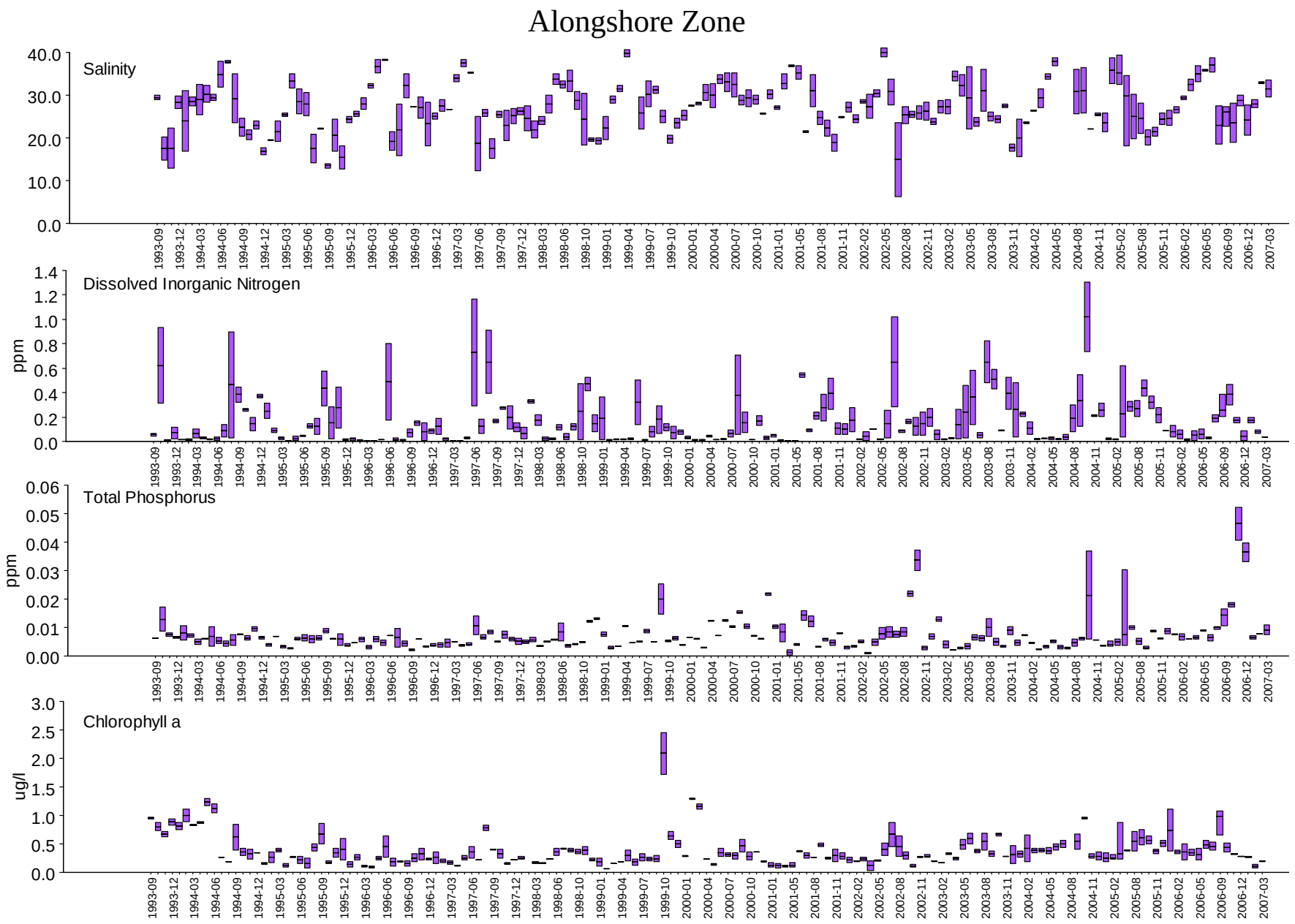

Figure 15. Box-and-whisker plots of water quality in Biscayne Bay by survey.

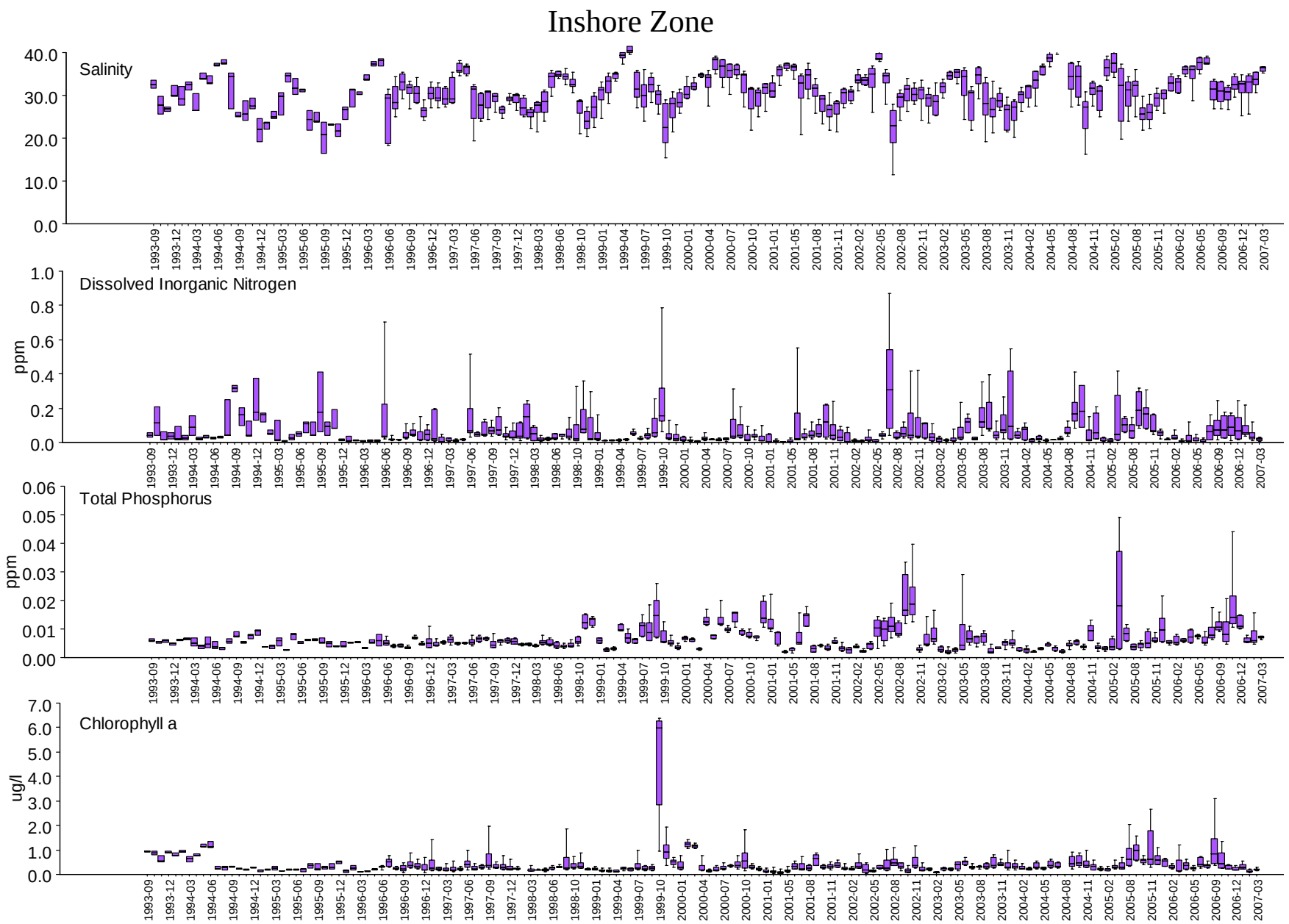

Figure 16. Box-and-whisker plots of water quality in Biscayne Bay by survey.

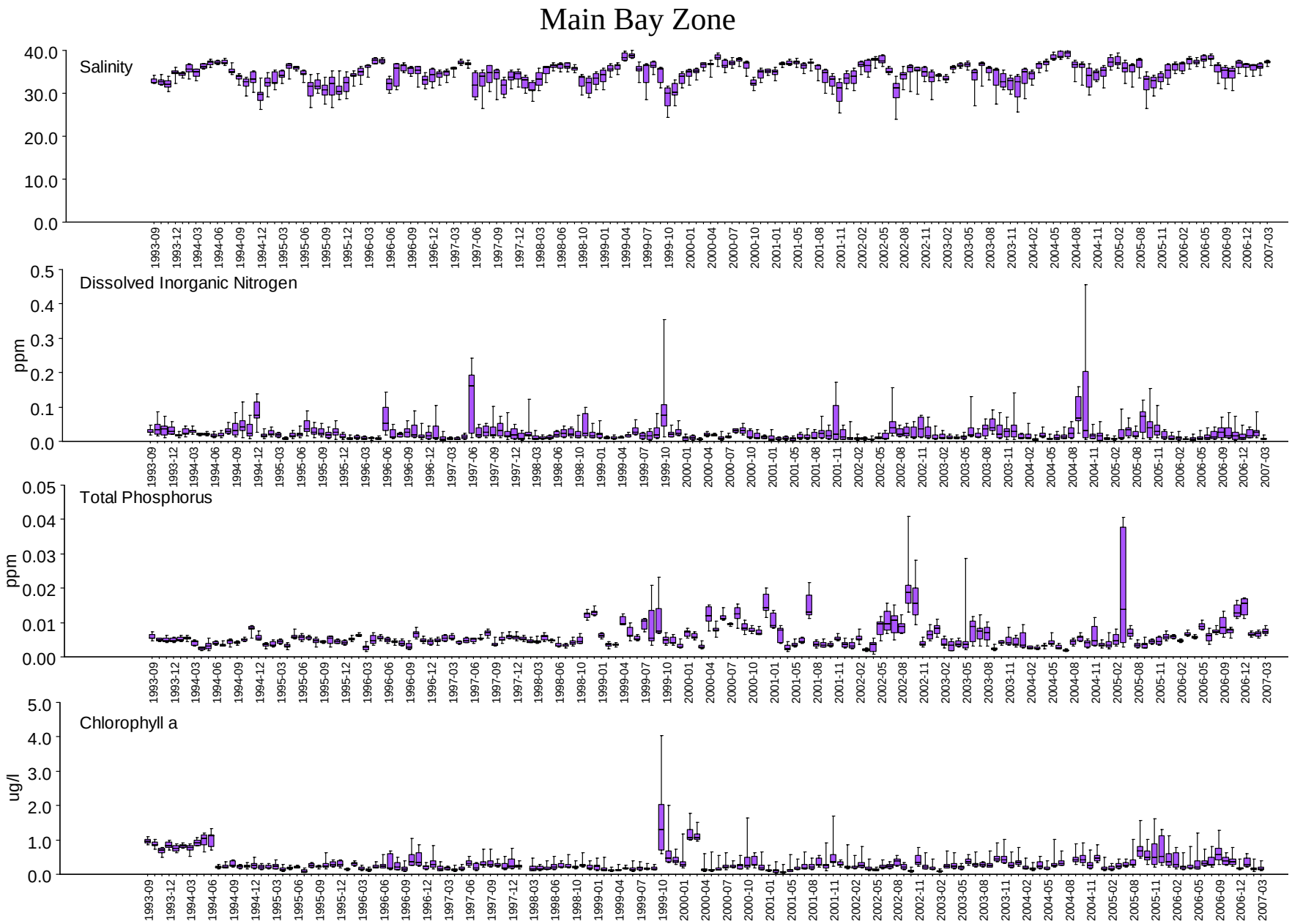

Figure 17. Box-and-whisker plots of water quality in Biscayne Bay by survey.

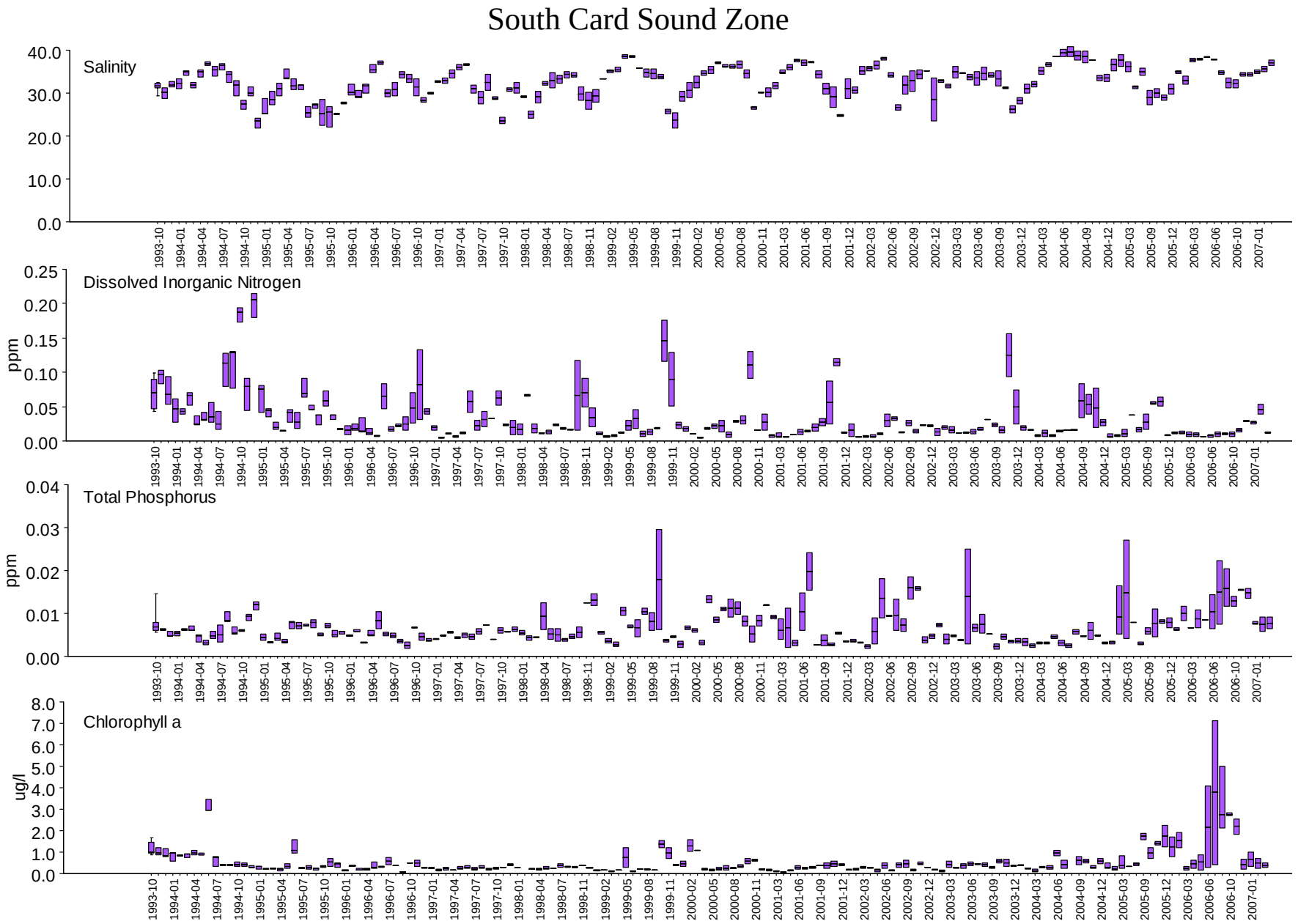

Figure 18. Box-and-whisker plots of water quality in Biscayne Bay by survey.

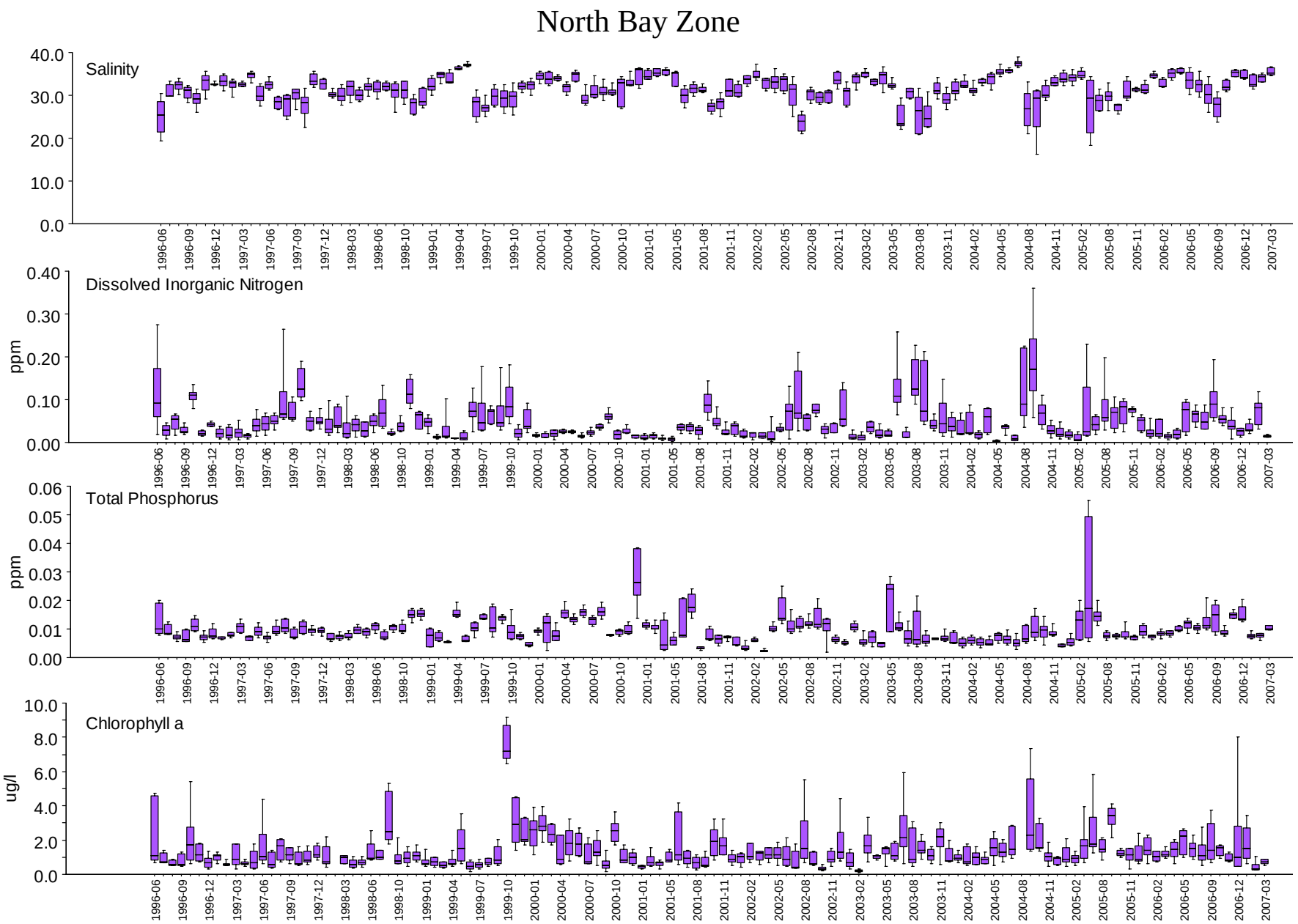

Figure 19. Box-and-whisker plots of water quality in Biscayne Bay by survey.

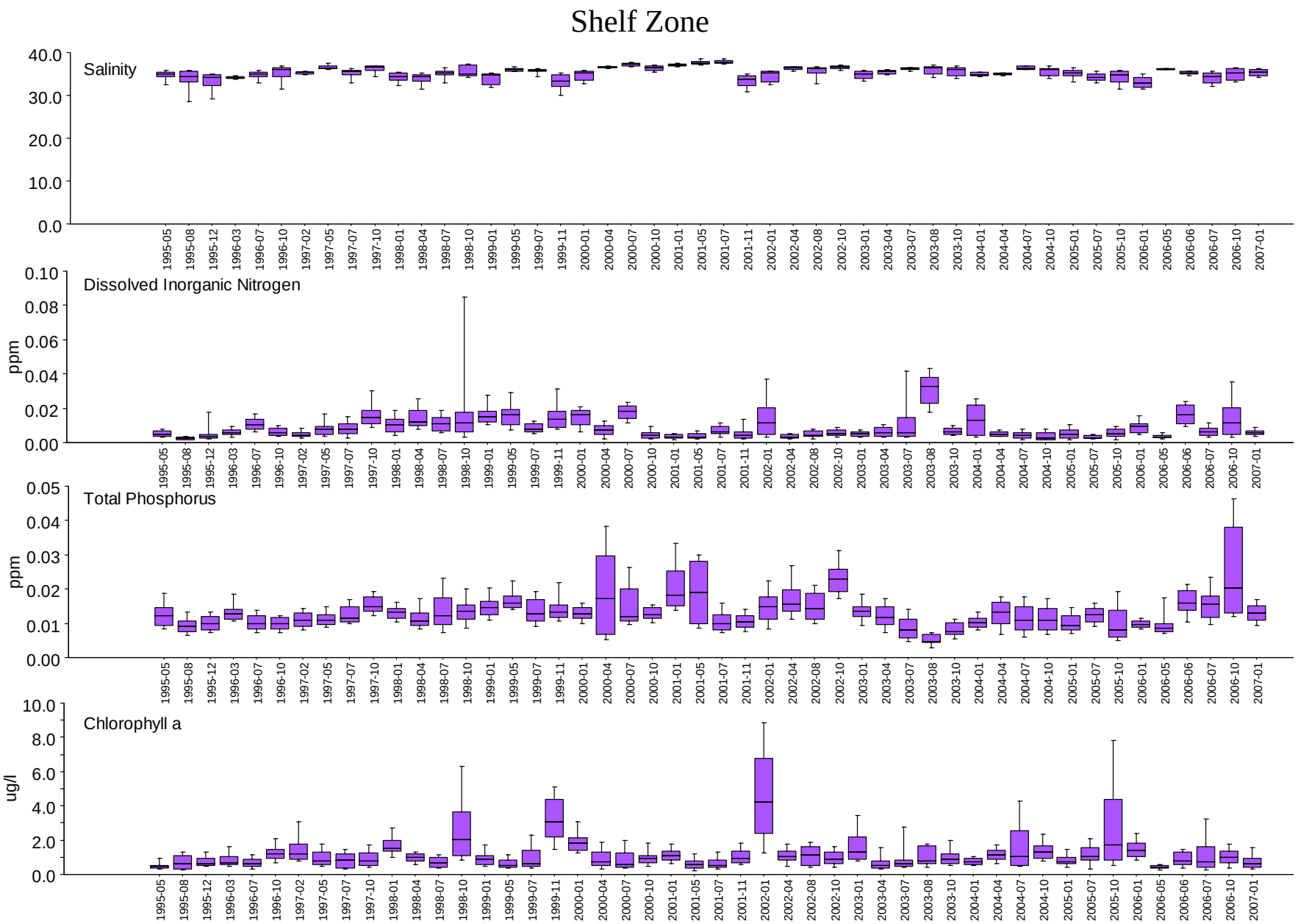

Figure 20. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

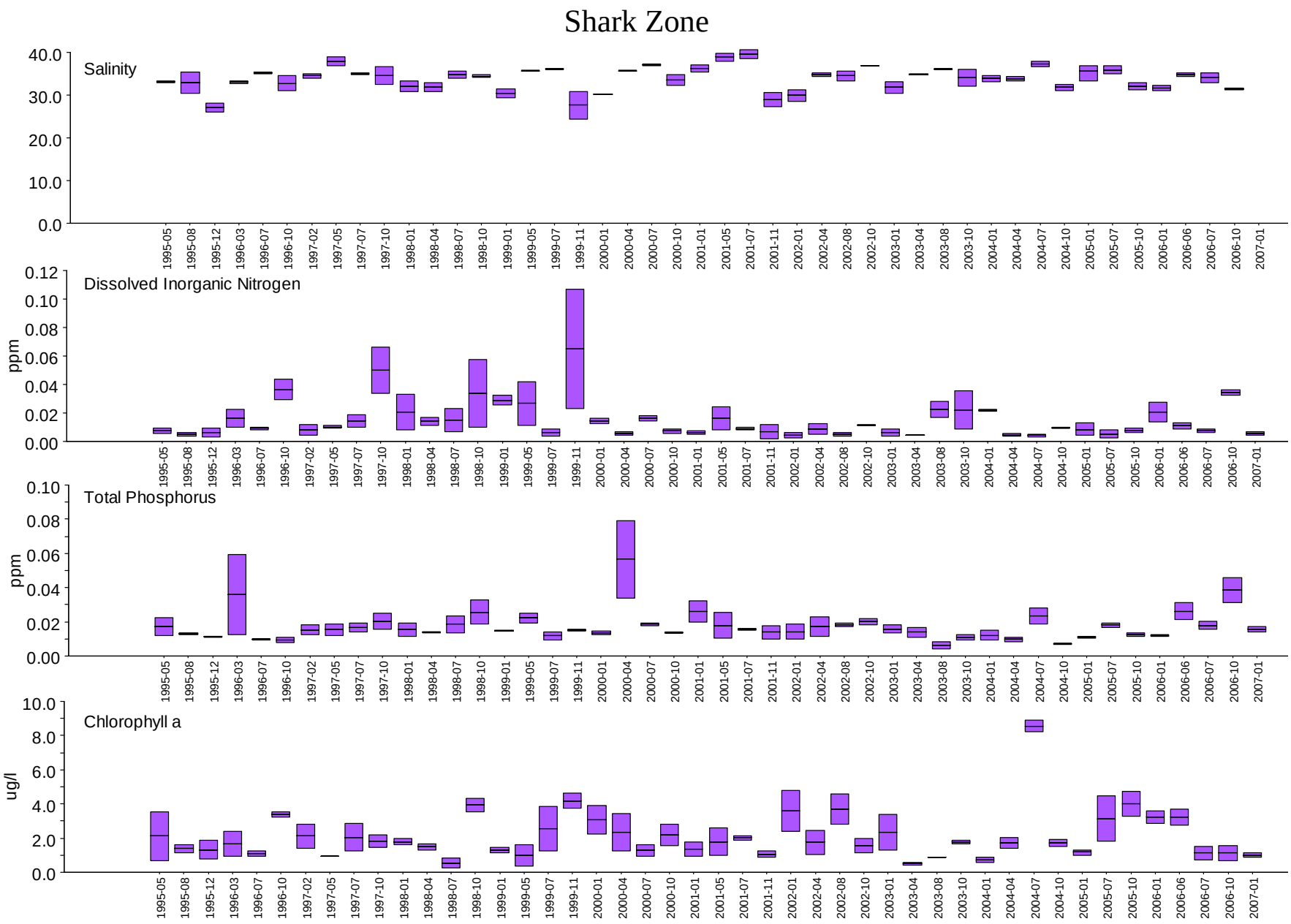

Figure 21. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

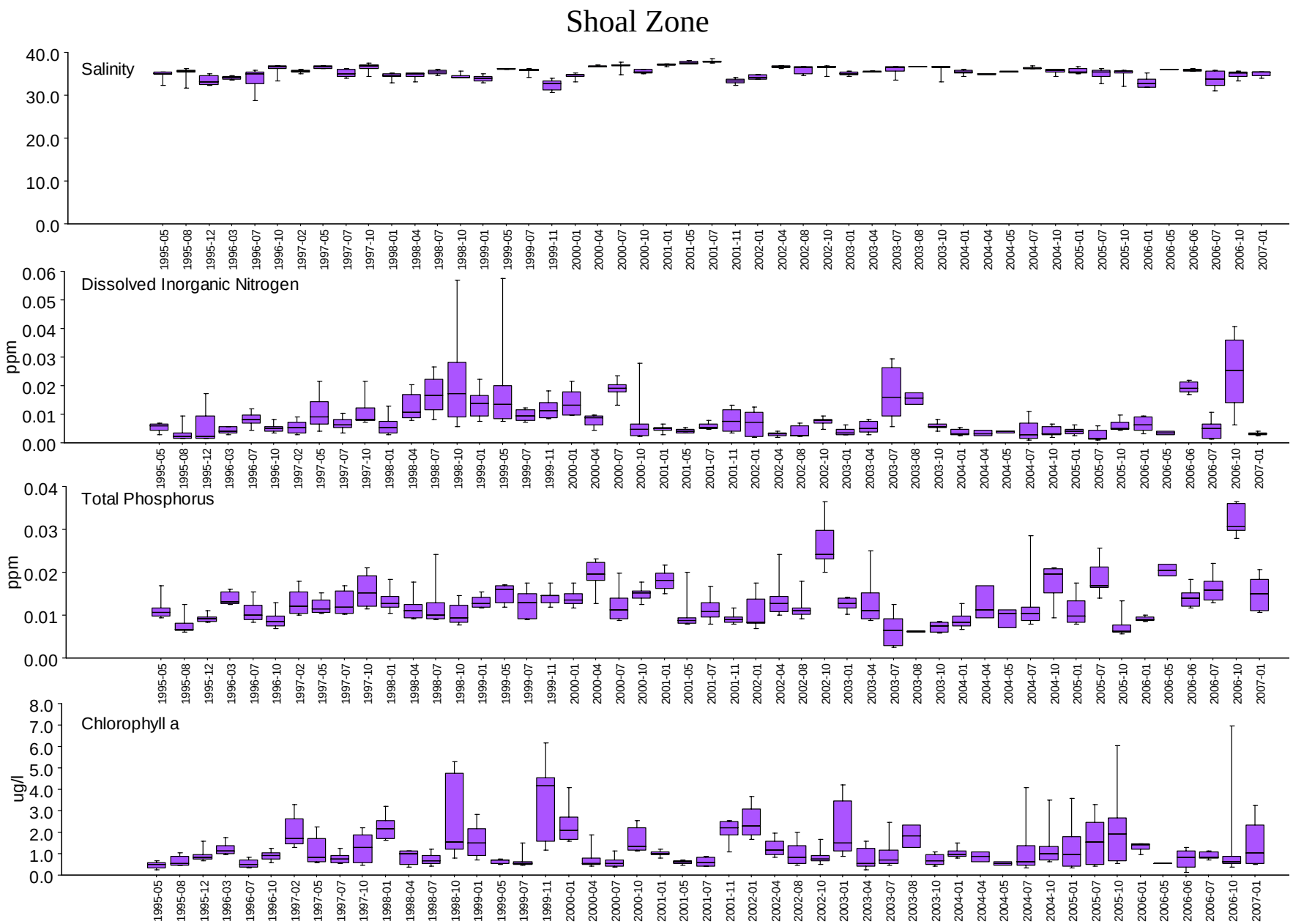

Figure 22. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

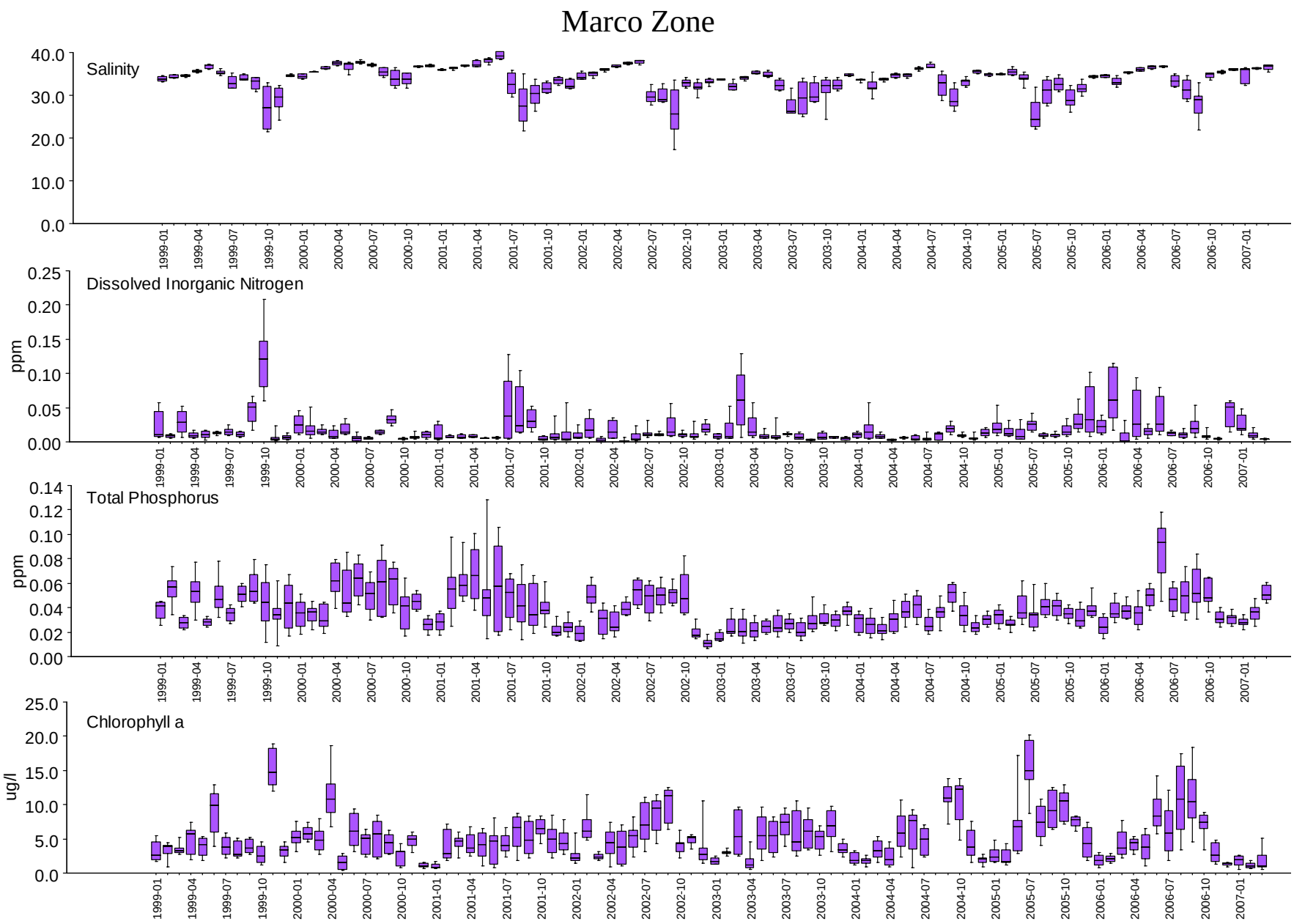

Figure 23. Box-and-whisker plots of water quality in RB-PIS by survey.

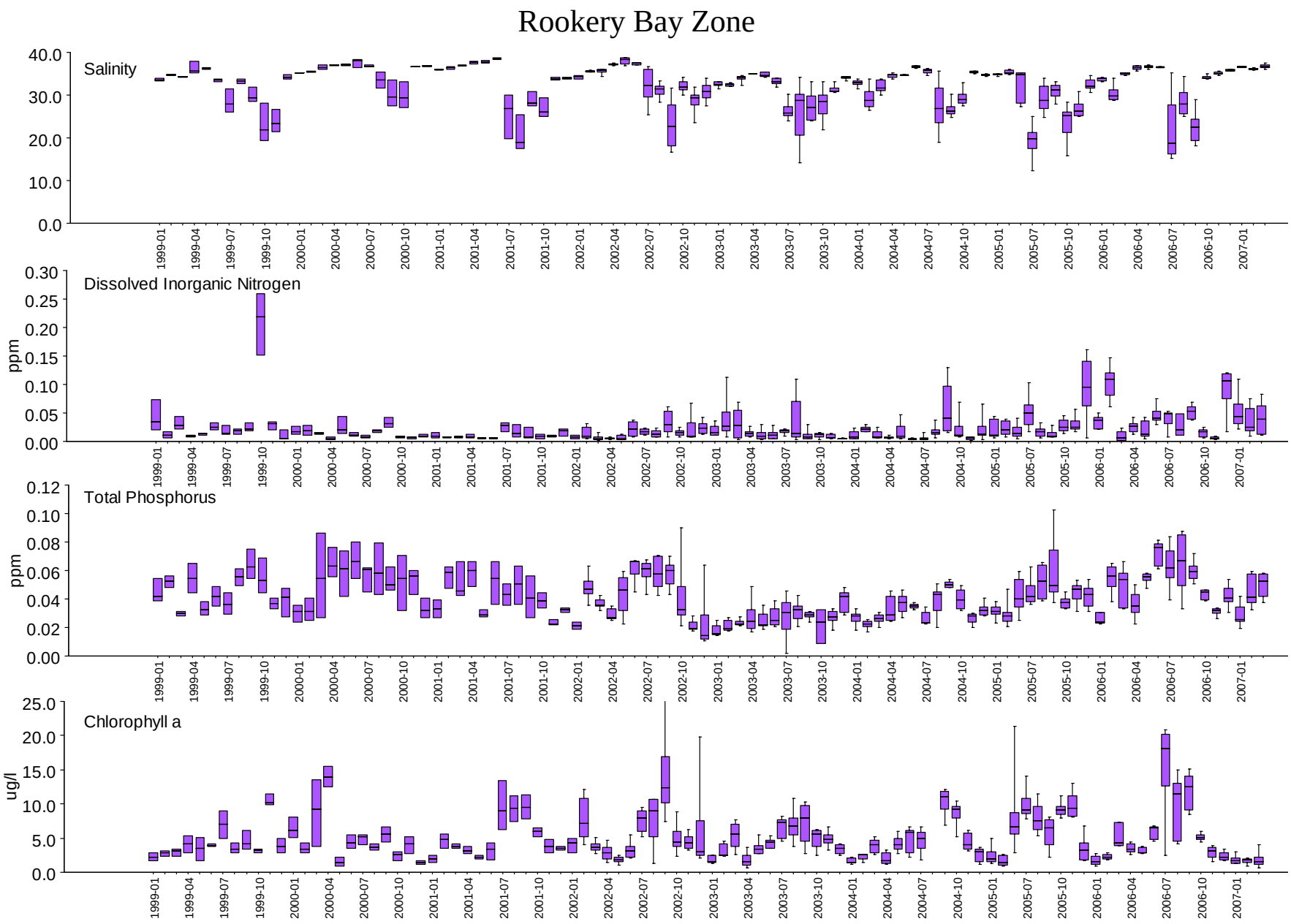

Figure 24. Box-and-whisker plots of water quality in RB-PIS by survey.

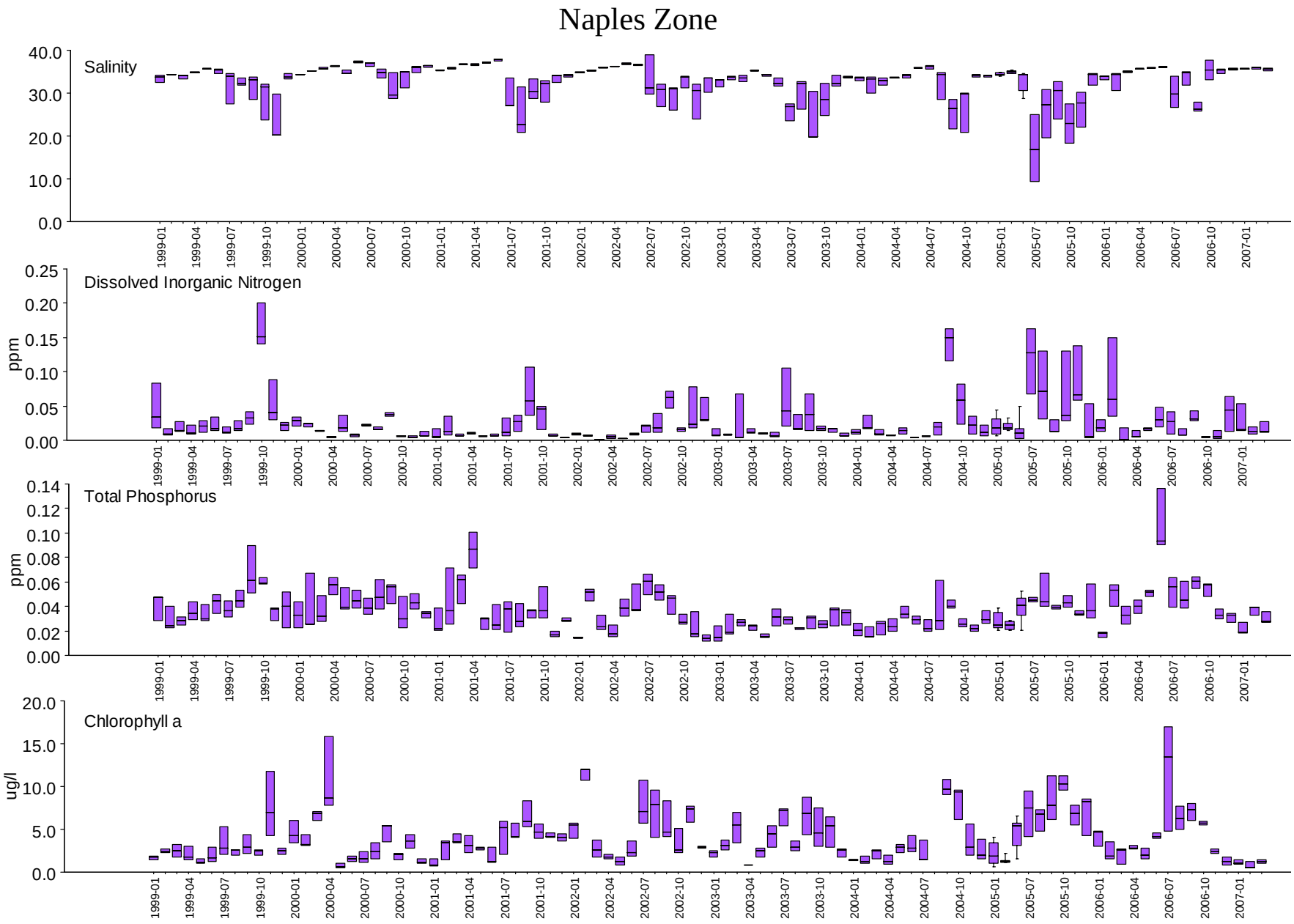

Figure 25. Box-and-whisker plots of water quality in RB-PIS by survey.

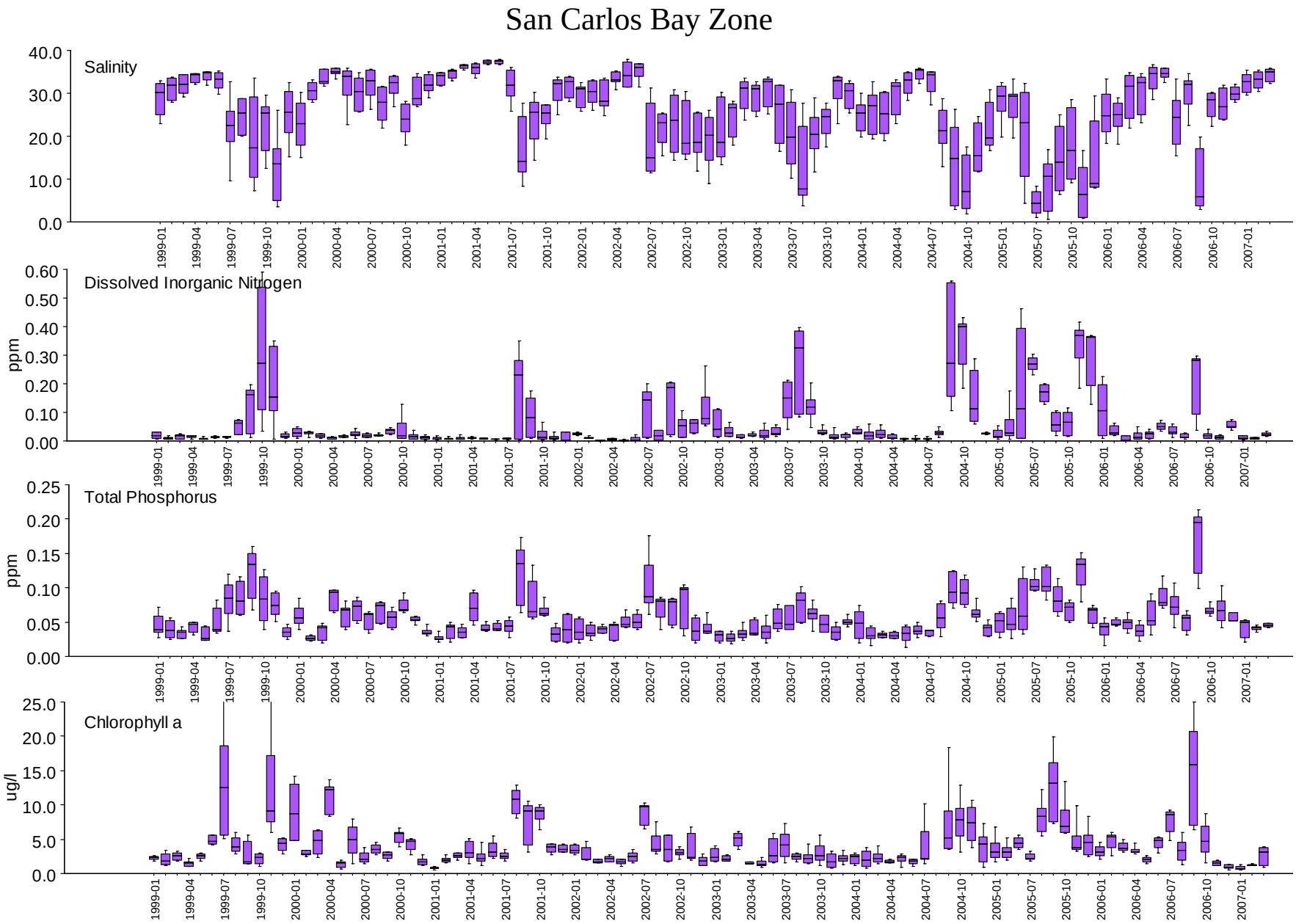

Figure 26. Box-and-whisker plots of water quality in RB-PIS by survey.

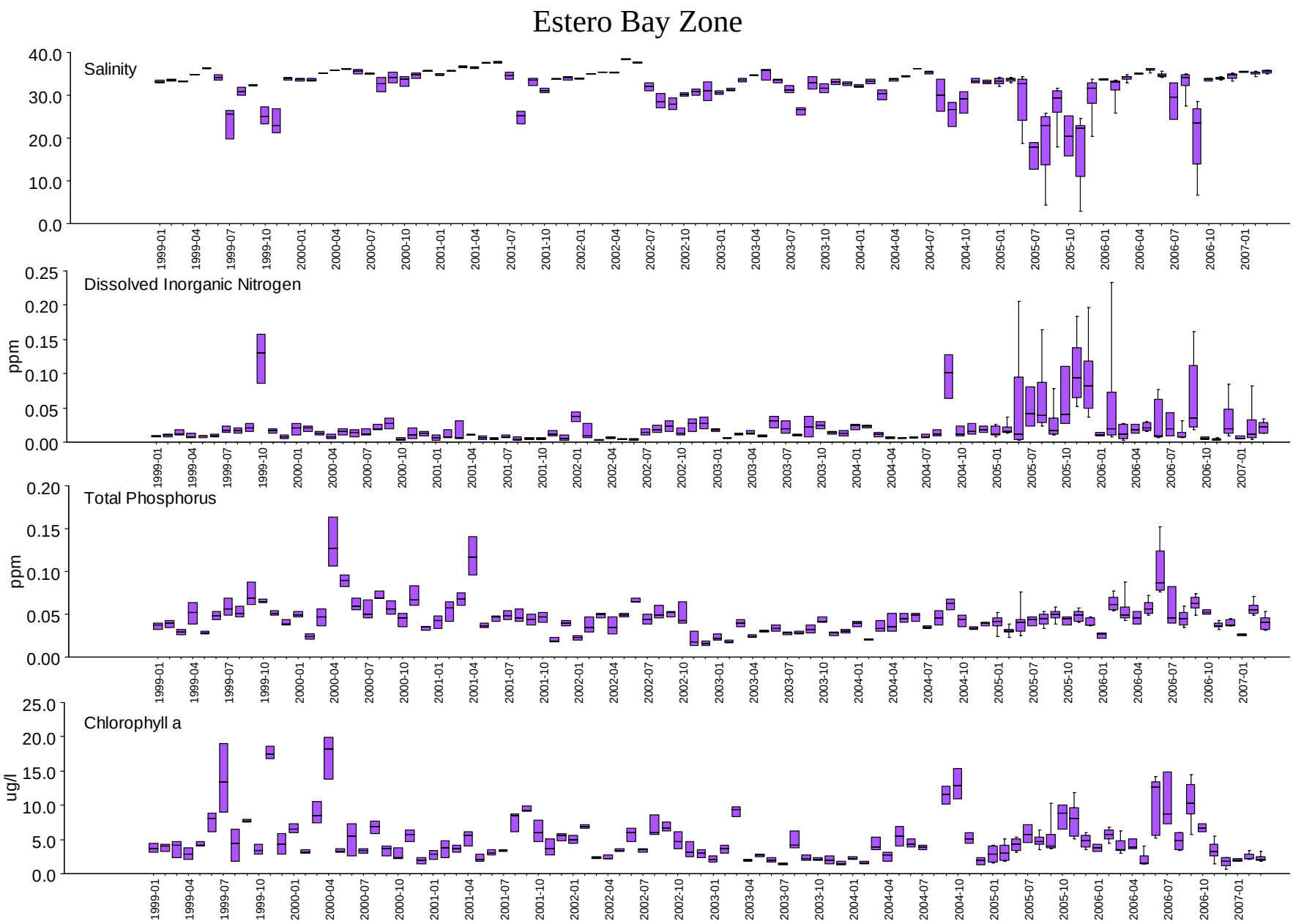

Figure 27. Box-and-whisker plots of water quality in RB-PIS by survey.

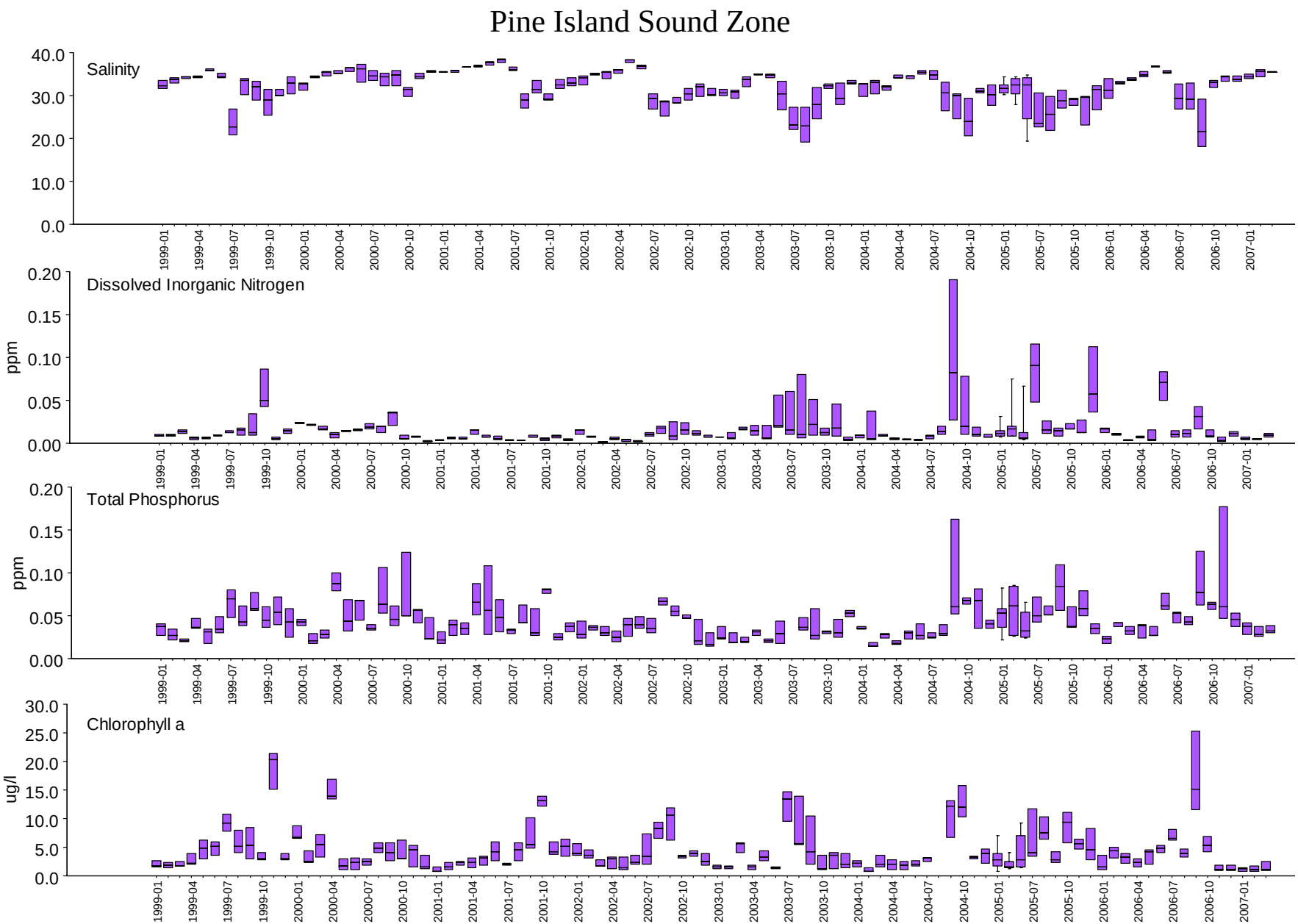

Figure 28. Box-and-whisker plots of water quality in RB-PIS by survey.

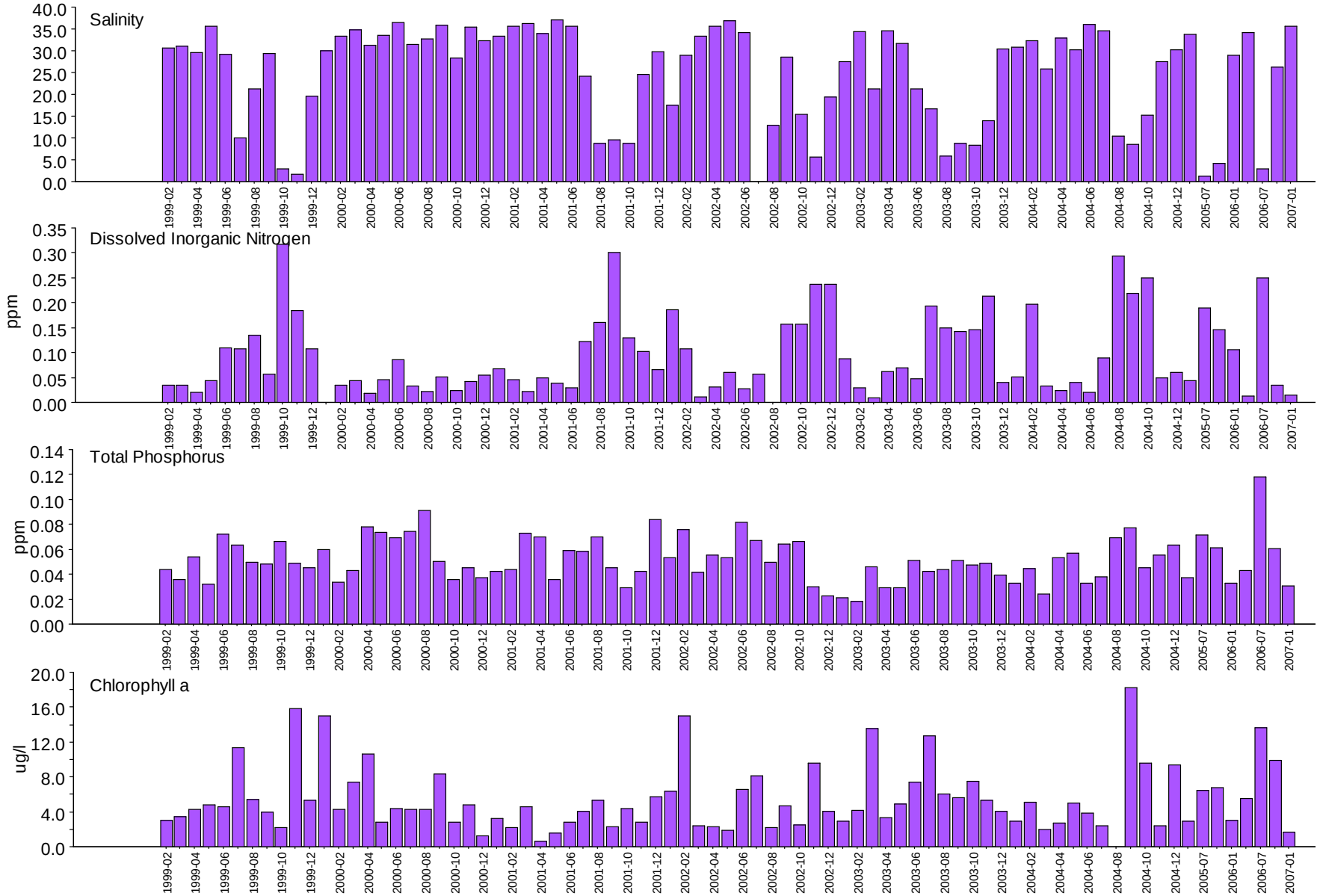

Figure 29. Box-and-whisker plots of water quality in RB-PIS by survey.

Table 1.

Parameter	Zone	Median	Min.	Max.	*n*
Chlorophyll *a*	Biscayne Bay	0.238	0.060	3.460	75
($\mu g\ l^{-1}$)	Florida Bay	0.704	0.100	11.609	84
	Rookery Bay	1.432	0.384	5.655	87
	SW Shelf	0.672	0.084	3.424	49
	Ten Thousand Is.	1.622	0.226	30.073	78
	Whitewater Bay	2.502	0.434	7.381	66
Surface	Biscayne Bay	6.93	5.45	8.66	75
Dissolved	Florida Bay	7.96	6.47	9.88	84
Oxygen	Rookery Bay	7.70	2.50	10.84	81
($mg\ l^{-1}$)	SW Shelf	4.23	3.56	5.40	31
	Ten Thousand Is.	7.83	3.33	10.94	78
	Whitewater Bay	8.00	4.01	12.15	66
Bottom	Biscayne Bay	6.92	5.45	8.78	75
Dissolved	Florida Bay	7.91	6.22	9.43	84
Oxygen	Rookery Bay	7.47	2.50	9.77	81
($mg\ l^{-1}$)	SW Shelf	4.49	4.00	4.96	31
	Ten Thousand Is.	7.30	3.10	10.17	78
	Whitewater Bay	7.67	3.81	10.98	66
NH_4^+	Biscayne Bay	0.0131	0.0017	0.0536	75
(ppm)	Florida Bay	0.0191	0.0018	0.4500	83
	Rookery Bay	0.0084	0.0008	0.0735	87
	SW Shelf	0.0029	0.0011	0.0191	49
	Ten Thousand Is.	0.0128	0.0008	0.0461	78
	Whitewater Bay	0.0217	0.0044	0.0460	66
NO_2^-	Biscayne Bay	0.0016	0.0001	0.0106	75
(ppm)	Florida Bay	0.0015	0.0002	0.0264	83
	Rookery Bay	0.0009	0.0003	0.0056	87
	SW Shelf	0.0007	0.0003	0.0014	49
	Ten Thousand Is.	0.0011	0.0003	0.0069	78
	Whitewater Bay	0.0022	0.0006	0.0065	66

Parameter	Zone	Median	Min.	Max.	*n*
NO_3^- (ppm)	Biscayne Bay	0.0064	0.0005	0.1586	75
	Florida Bay	0.0063	0.0000	0.0880	83
	Rookery Bay	0.0023	0.0002	0.0309	87
	SW Shelf	0.0013	0.0000	0.0036	49
	Ten Thousand Is.	0.0059	0.0002	0.0402	78
	Whitewater Bay	0.0125	0.0020	0.0901	66
pH	Biscayne Bay	8.045	7.915	8.515	75
	Florida Bay	8.125	7.970	8.910	84
	Rookery Bay	7.940	6.985	8.110	81
	SW Shelf	7.565	7.225	7.725	49
	Ten Thousand Is.	7.895	7.435	8.245	78
	Whitewater Bay	7.928	7.315	8.420	66
Surface Salinity	Biscayne Bay	35.52	25.60	37.78	75
	Florida Bay	33.57	17.97	41.10	84
	Rookery Bay	35.65	29.68	37.44	81
	SW Shelf	35.35	33.21	36.80	31
	Ten Thousand Is.	35.95	11.04	38.55	78
	Whitewater Bay	16.19	3.97	31.85	66
Bottom Salinity	Biscayne Bay	35.67	25.55	37.77	75
	Florida Bay	33.62	17.94	41.10	84
	Rookery Bay	35.61	29.90	38.52	81
	SW Shelf	36.03	34.53	36.73	31
	Ten Thousand Is.	35.94	12.28	38.56	78
	Whitewater Bay	16.93	3.98	31.86	66
$Si(OH)_4$ (ppm)	Biscayne Bay	0.0389	0.0005	0.2579	25
	Florida Bay	0.6489	0.0291	6.0260	28
	Rookery Bay	0.5466	0.0845	1.3467	29
	SW Shelf	0.1652	0.0005	1.0047	49
	Ten Thousand Is.	1.7248	0.8489	2.2444	26
	Whitewater Bay	1.6088	0.5672	2.8990	22
Soluble Reactive Phosphorus (ppm)	Biscayne Bay	0.0005	0.0001	0.0076	71
	Florida Bay	0.0008	0.0000	0.0028	83
	Rookery Bay	0.0088	0.0020	0.0386	87
	SW Shelf	0.0012	0.0002	0.0045	49
	Ten Thousand Is.	0.0069	0.0008	0.0272	78
	Whitewater Bay	0.0018	0.0005	0.0135	66

Parameter	Zone	Median	Min.	Max.	*n*
Surface Temperature (^{o}C)	Biscayne Bay	21.82	18.87	24.53	75
	Florida Bay	20.50	16.65	24.27	84
	Rookery Bay	21.65	18.94	24.77	81
	SW Shelf	23.95	23.28	24.49	31
	Ten Thousand Is.	21.13	16.68	25.64	78
	Whitewater Bay	23.25	19.54	25.50	66
Bottom Temperature (^{o}C)	Biscayne Bay	21.83	18.91	24.56	75
	Florida Bay	20.49	16.75	24.27	84
	Rookery Bay	21.56	18.90	24.68	81
	SW Shelf	23.76	23.27	24.59	31
	Ten Thousand Is.	21.13	16.68	25.40	78
	Whitewater Bay	23.09	19.54	24.80	66
Total Nitrogen (ppm)	Biscayne Bay	0.135	0.068	0.413	75
	Florida Bay	0.458	0.100	1.061	84
	Rookery Bay	0.212	0.138	0.313	87
	SW Shelf	0.156	0.067	0.452	49
	Ten Thousand Is.	0.266	0.140	0.904	78
	Whitewater Bay	0.435	0.216	0.756	66
Total Organic Carbon (ppm)	Biscayne Bay	2.029	1.090	4.605	75
	Florida Bay	7.797	1.351	18.565	84
	Rookery Bay	3.008	2.065	6.181	87
	SW Shelf	2.371	1.686	5.361	49
	Ten Thousand Is.	5.055	3.202	14.333	78
	Whitewater Bay	12.186	4.671	20.093	66
Total Organic Nitrogen (ppm)	Biscayne Bay	0.108	0.026	0.292	75
	Florida Bay	0.362	0.052	1.019	83
	Rookery Bay	0.180	0.000	0.306	87
	SW Shelf	0.152	0.060	0.431	49
	Ten Thousand Is.	0.242	0.111	0.857	78
	Whitewater Bay	0.402	0.178	0.732	66
Total Phosphorus (ppm)	Biscayne Bay	0.007	0.005	0.016	75
	Florida Bay	0.011	0.004	0.047	84
	Rookery Bay	0.039	0.018	0.071	87
	SW Shelf	0.013	0.008	0.021	49
	Ten Thousand Is.	0.032	0.018	0.046	78
	Whitewater Bay	0.024	0.011	0.063	66

Parameter	Zone	Median	Min.	Max.	*n*
Turbidity	Biscayne Bay	0.72	0.15	3.93	75
(NTU)	Florida Bay	3.39	0.33	22.30	84
	Rookery Bay	2.29	0.49	13.64	87
	SW Shelf	1.07	0.22	25.95	48
	Ten Thousand Is.	3.29	0.66	15.25	78
	Whitewater Bay	3.73	0.69	15.37	66