11-14-2006

South Florida Coastal Water Quality Monitoring Network - 7-9/06 Quarterly Report (C-14397)

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14 November 2006

Patrick Martin
SFWMD
8894 Belvedere Road
West Palm Beach, FL 33411

Re: South Florida Coastal Water Quality Monitoring Network – 7-9/06 Quarterly Report (C-15397)

Dear Mr. Martin:

This letter serves to transmit the South Florida Coastal Water Quality Monitoring Network Quarterly Report as per our SFWMD/SERC Cooperative Agreement #C-15397. This report consists of this letter along with corresponding tables and figures. **Please be advised that this is the final deliverable for C-15397.**

Project Background

This report includes water quality data collected monthly during the annual period of record (POR) July – Sep. 2006 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.

Data Results

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 25th and 75th percentiles (quartiles), and the ends of the whiskers are the 5th and 95th 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 ancillary data and hope to find the cause. Note that 2006 TP and CHLA have been some of the highest levels ever seen in Eastern Florida Bay (Fig. 30).

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

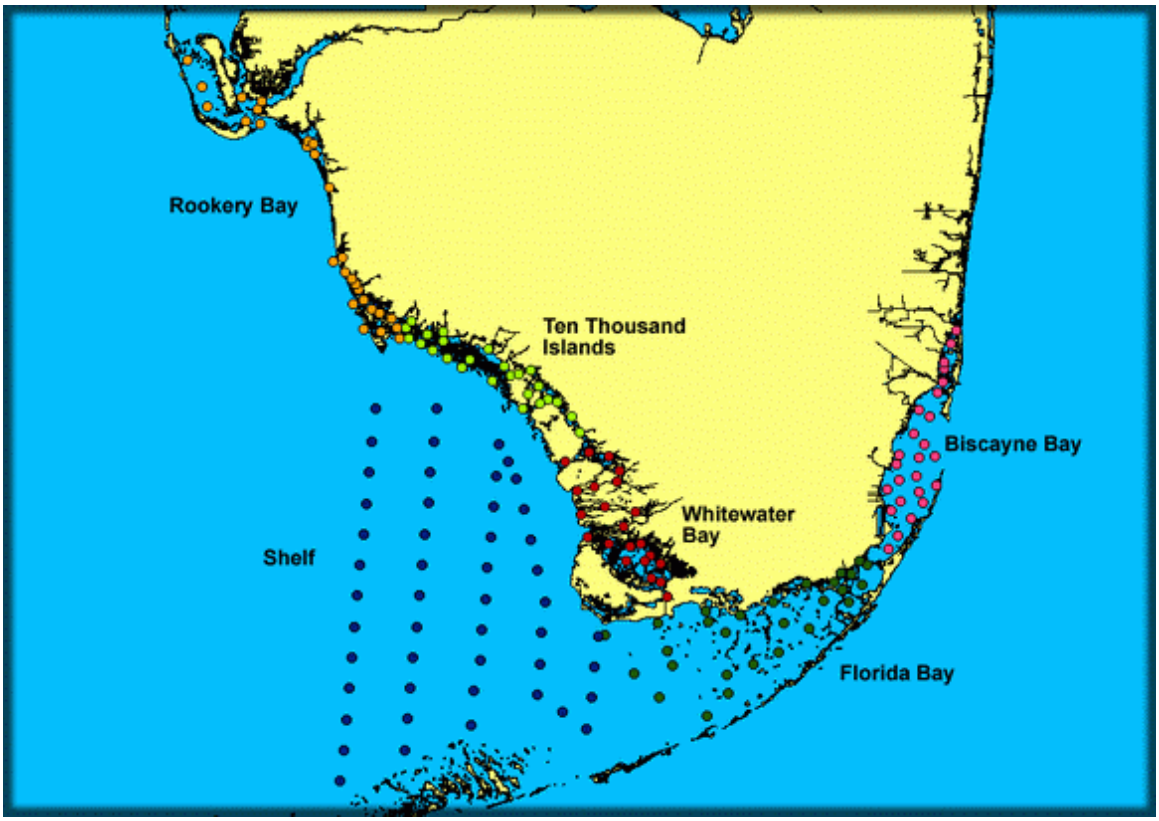

Figure 1: All fixed water quality stations funded by this SFWMD project.

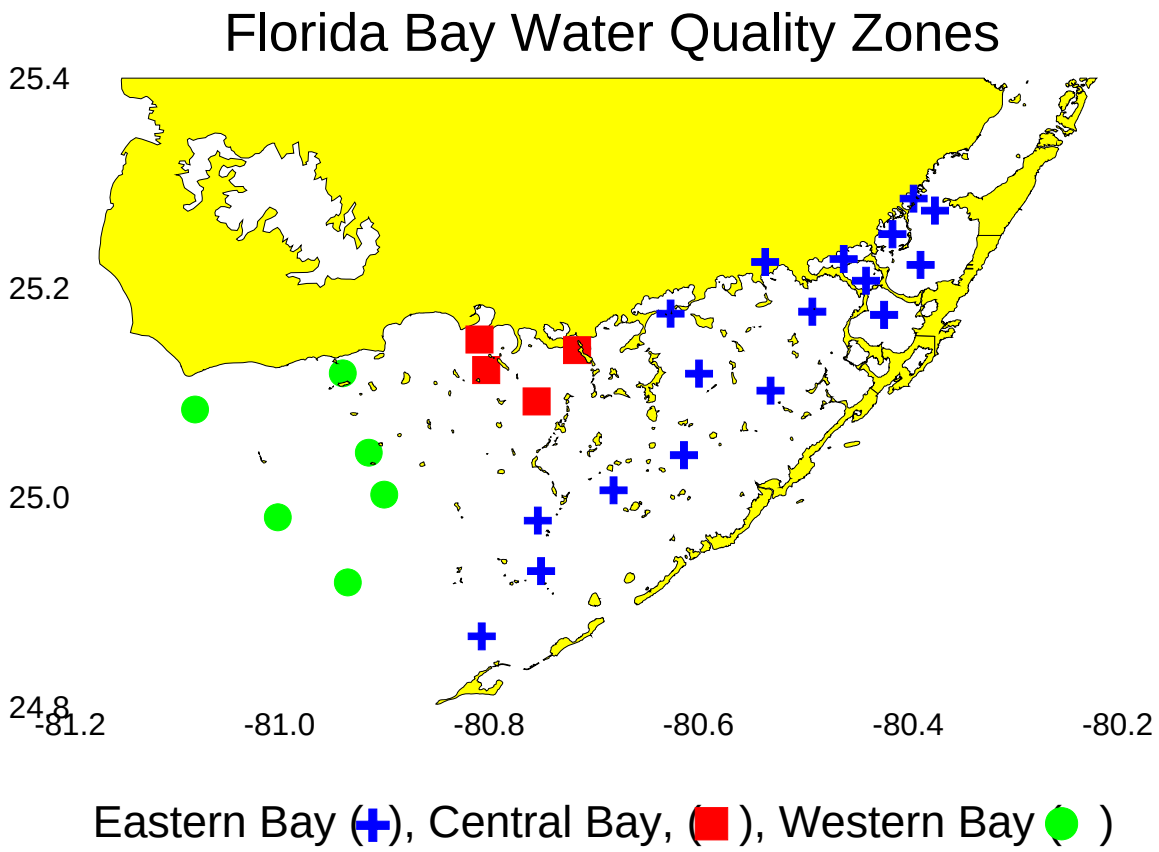

Figure 2. Florida Bay zones.

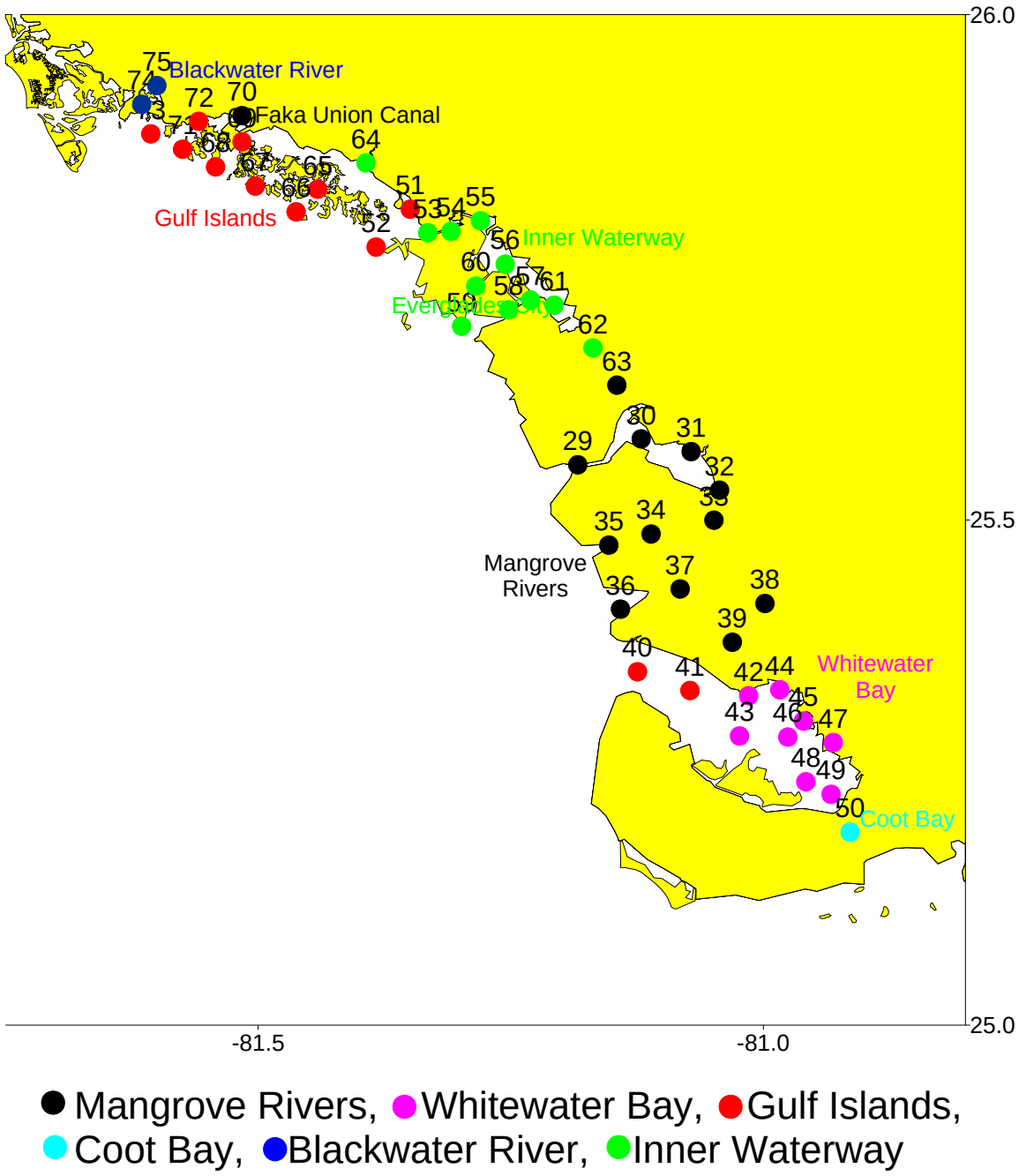

Figure 3. WWB-TTI water quality zones.

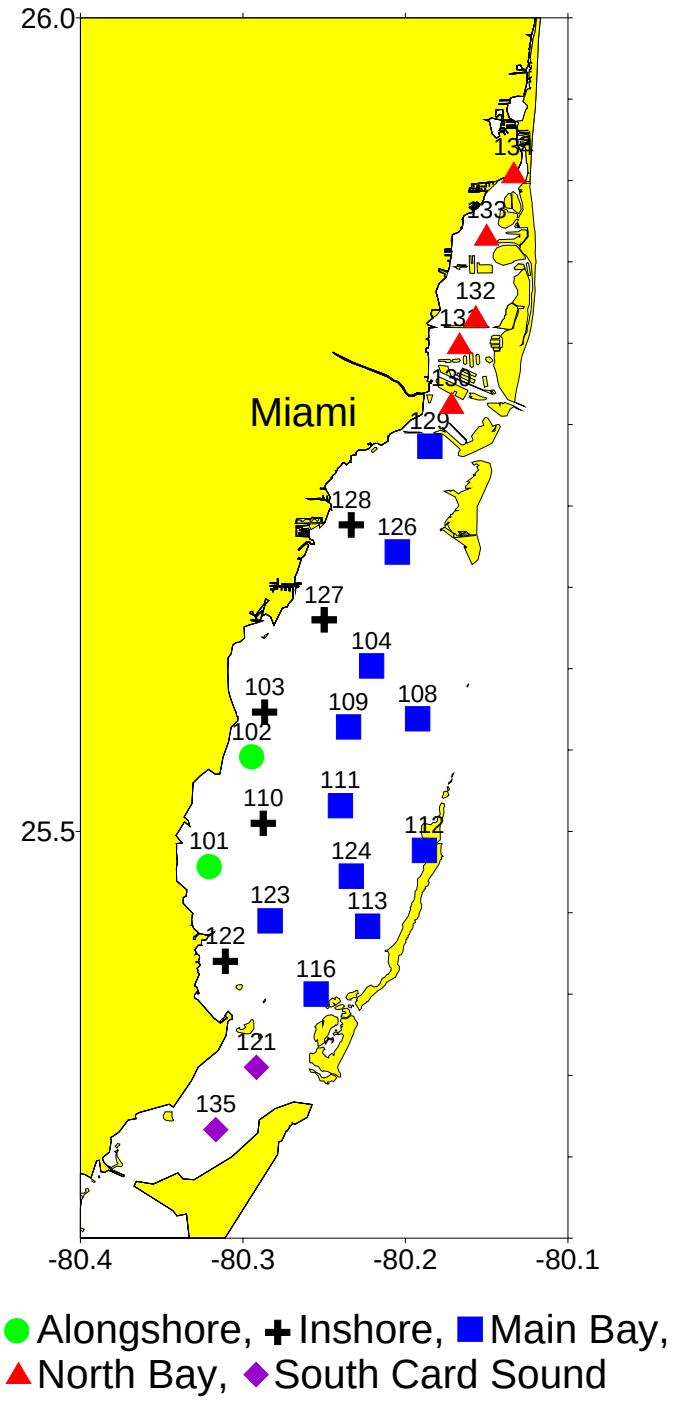

Figure 4. Biscayne Bay water quality zones.

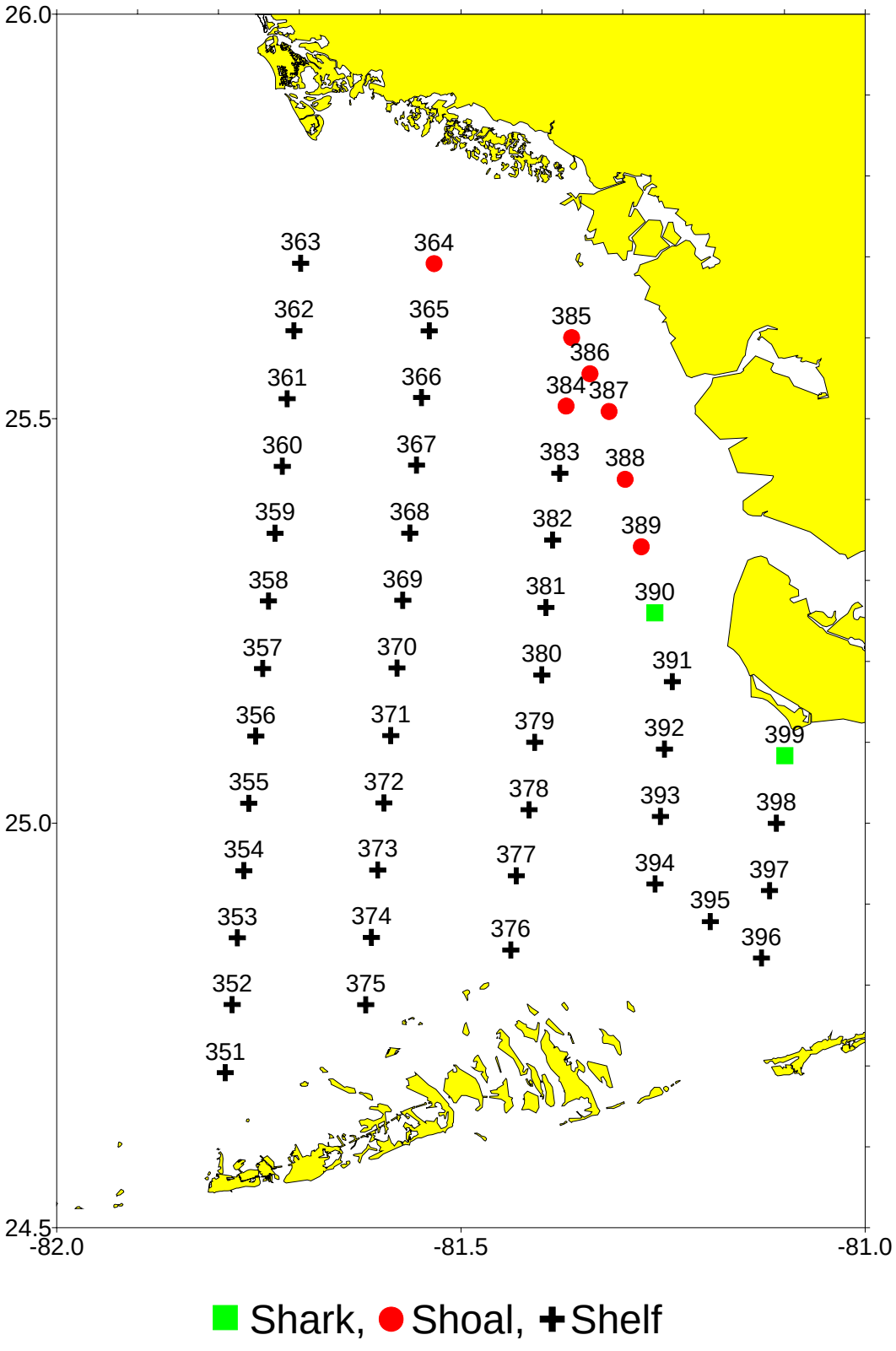

Figure 5. SW Florida Shelf water quality zones.

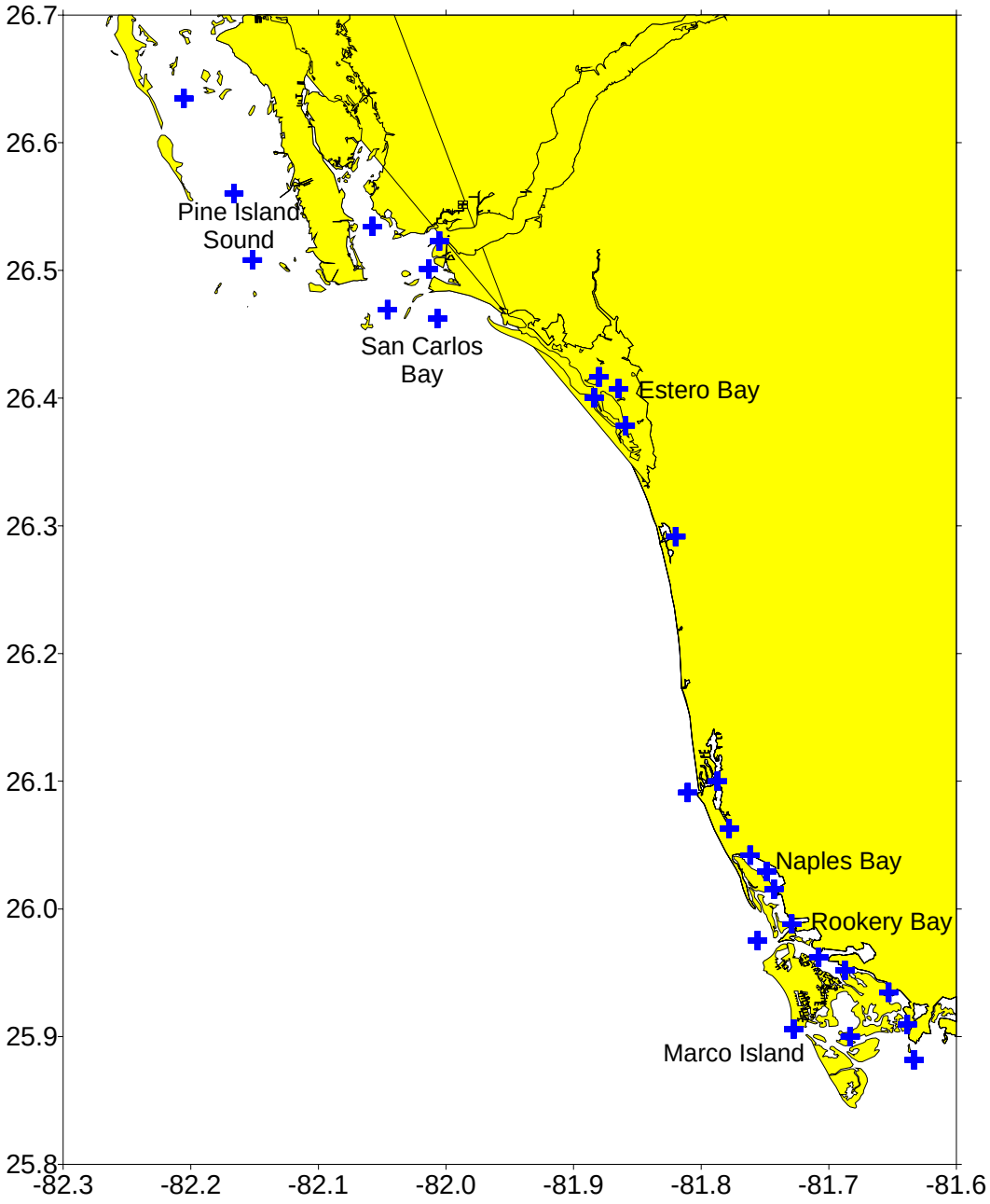

Figure 6. SW estuaries.

Eastern Florida Bay Zone

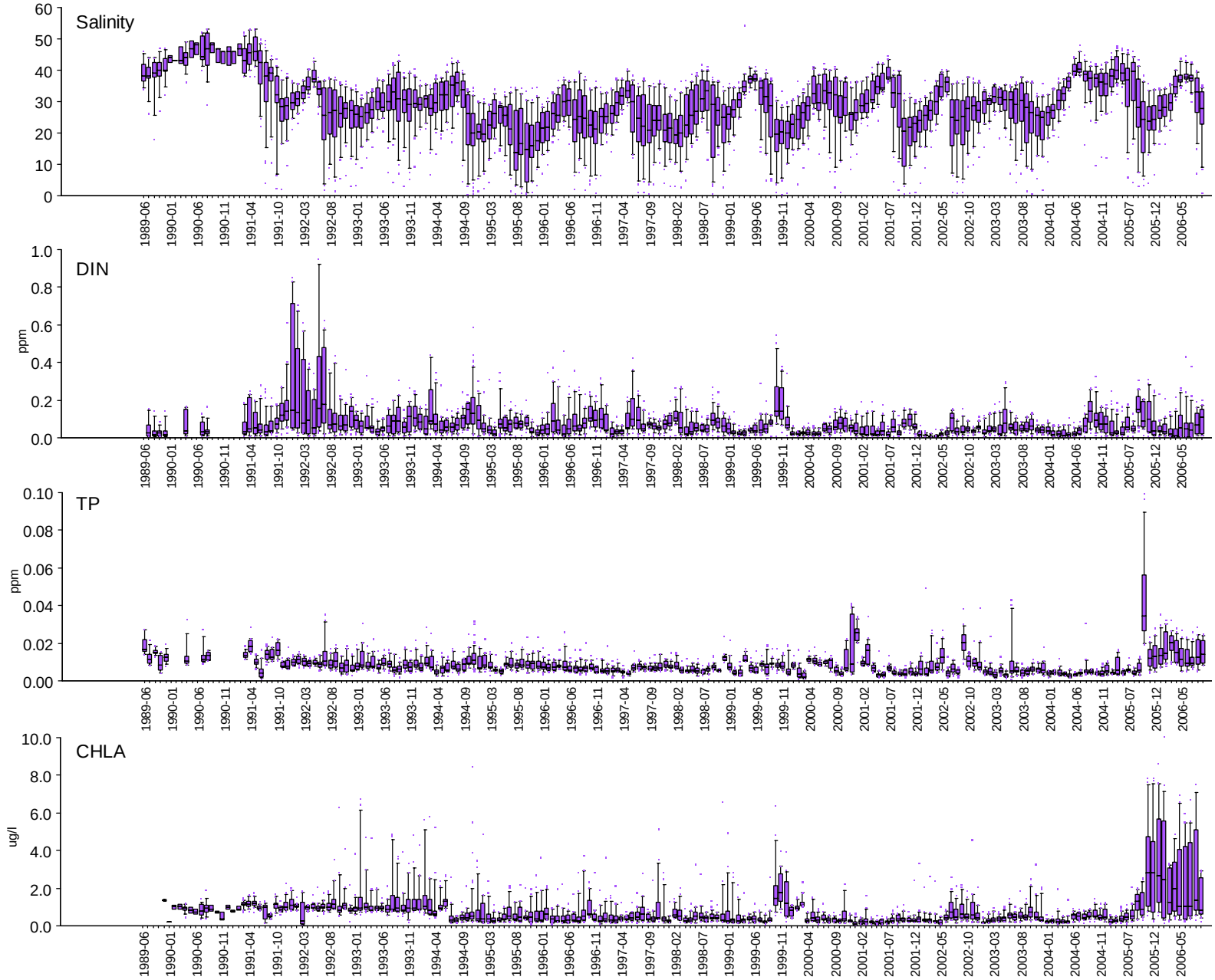

Figure 7. Box-and-whisker plots of water quality in Eastern Florida Bay by survey.

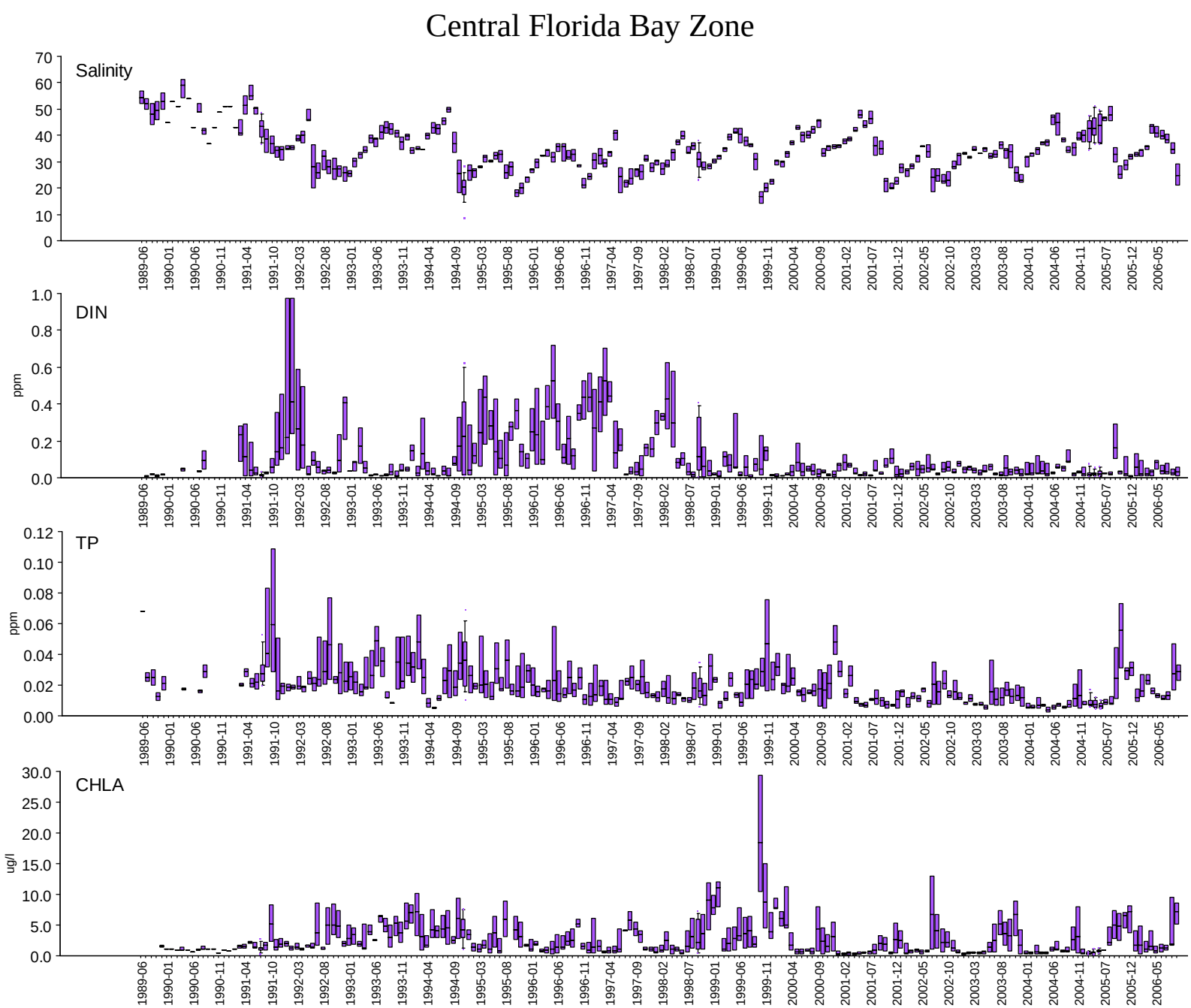

Figure 8. Box-and-whisker plots of water quality in Central Florida Bay by survey.

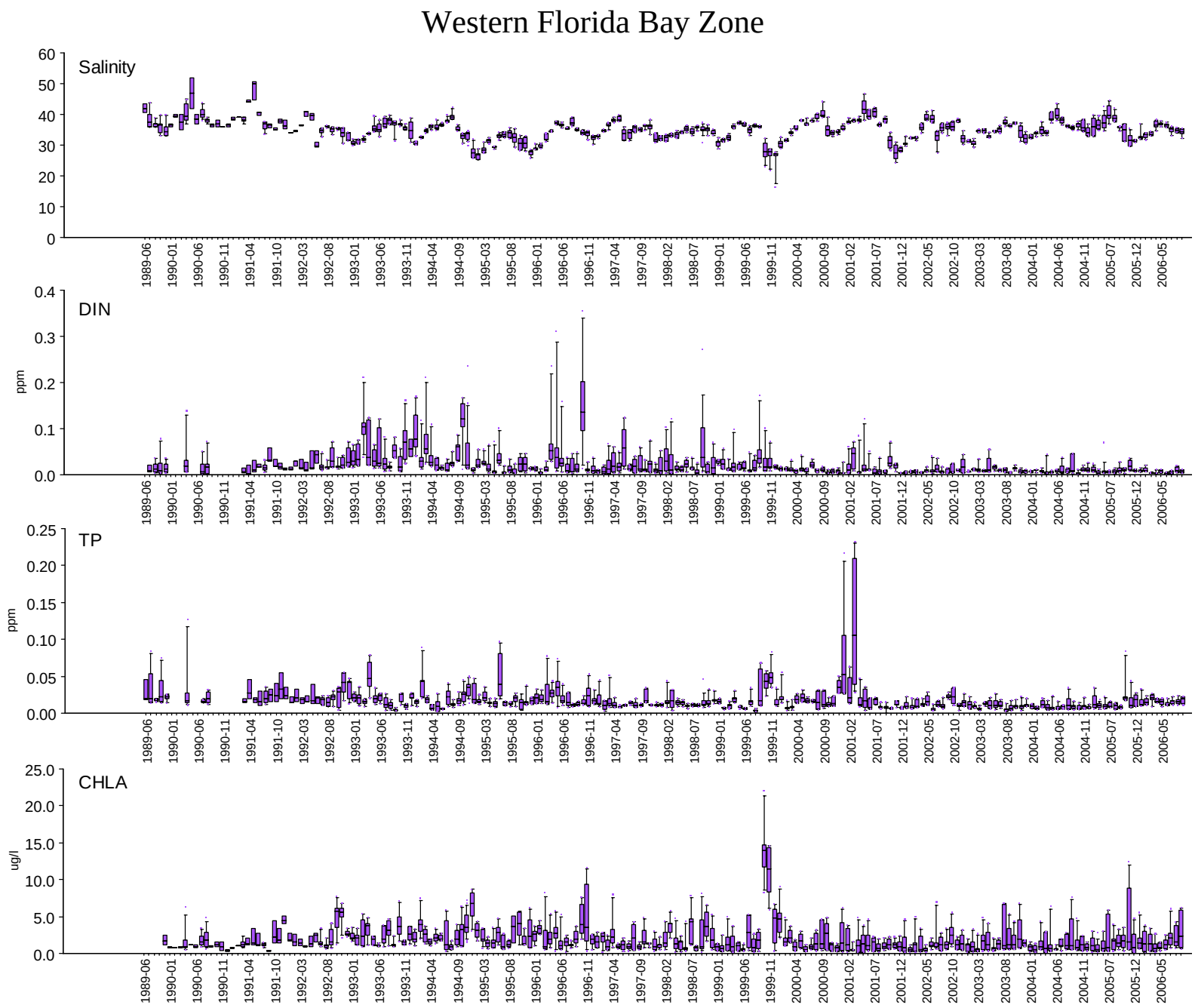

Figure 9. Box-and-whisker plots of water quality in Western Florida Bay by survey.

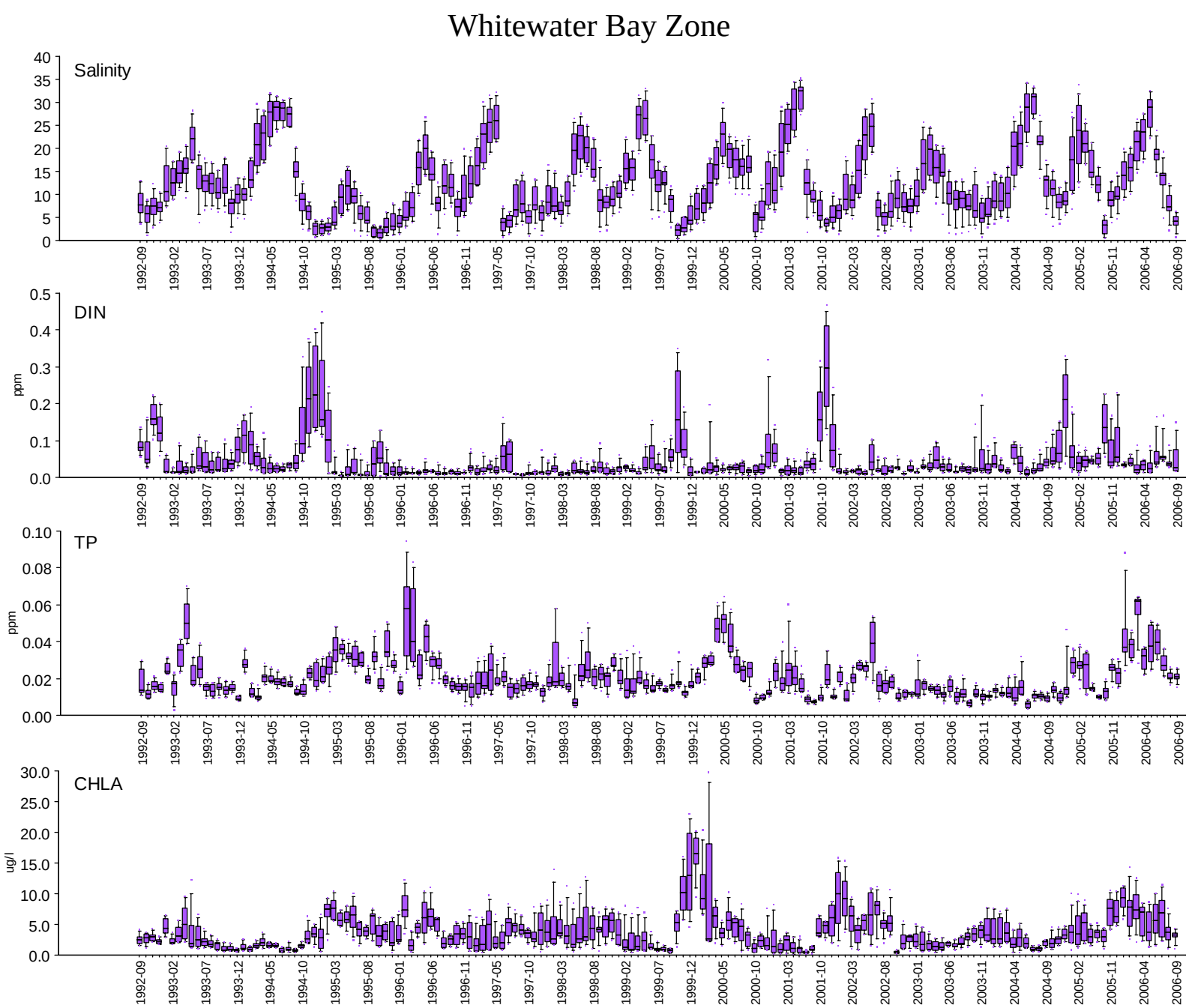

Figure 10. Box-and-whisker plots of water quality in WWB-TTI by survey.

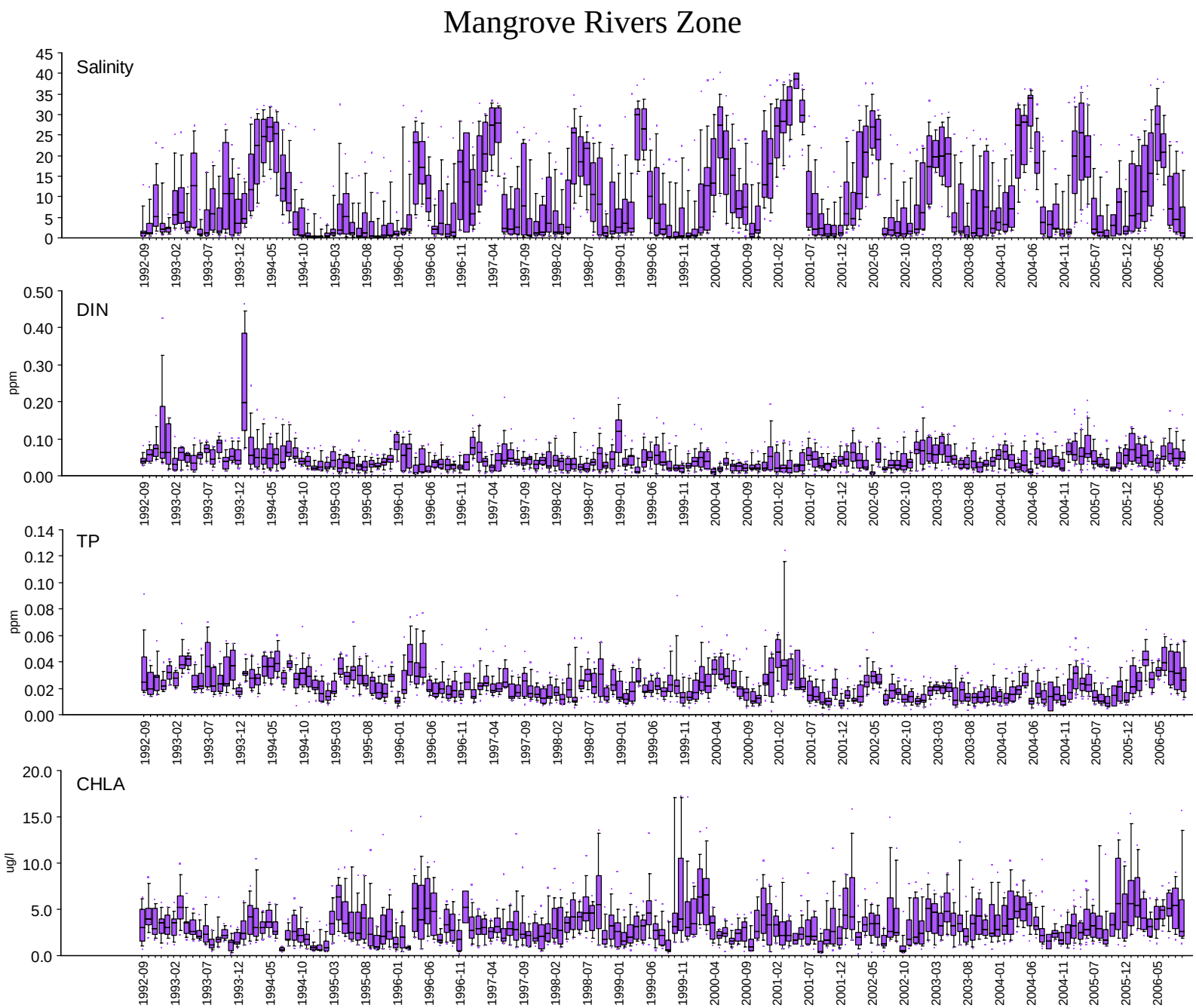

Figure 11. Box-and-whisker plots of water quality in WWB-TTI by survey.

Gulf Islands Zone

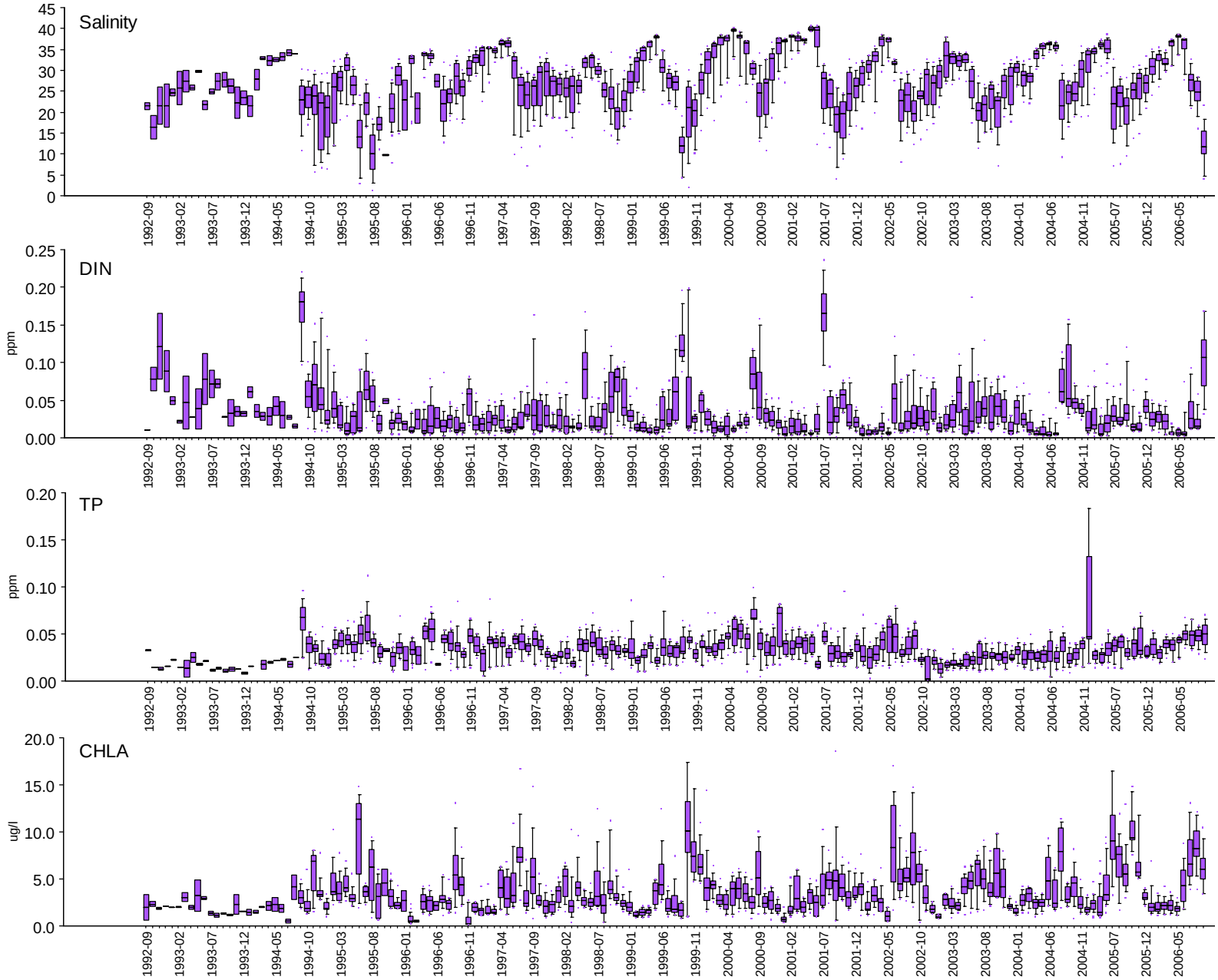

Figure 12. Box-and-whisker plots of water quality in WWB-TTI by survey.

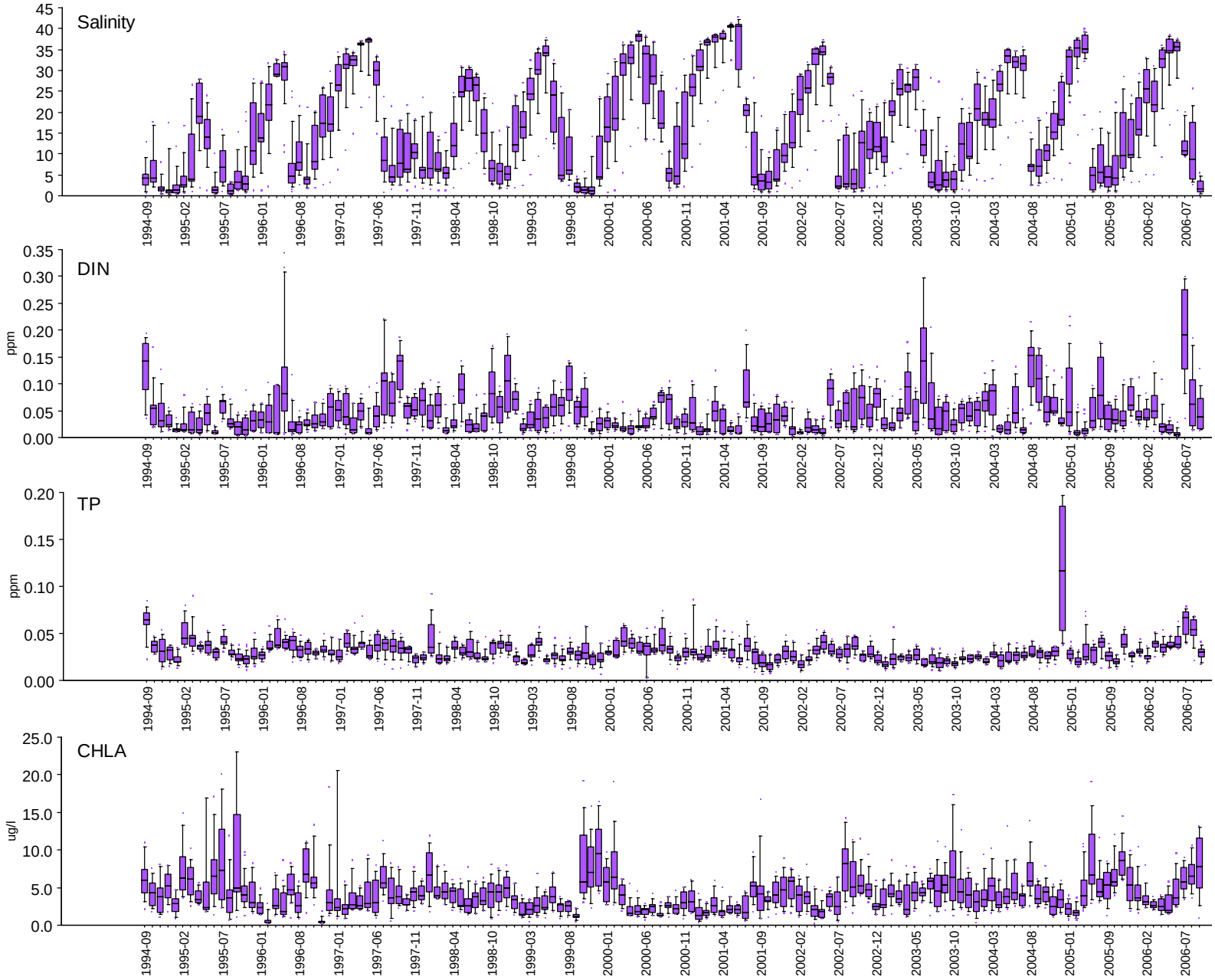

Figure 13. Box-and-whisker plots of water quality in WWB-TTI by survey.

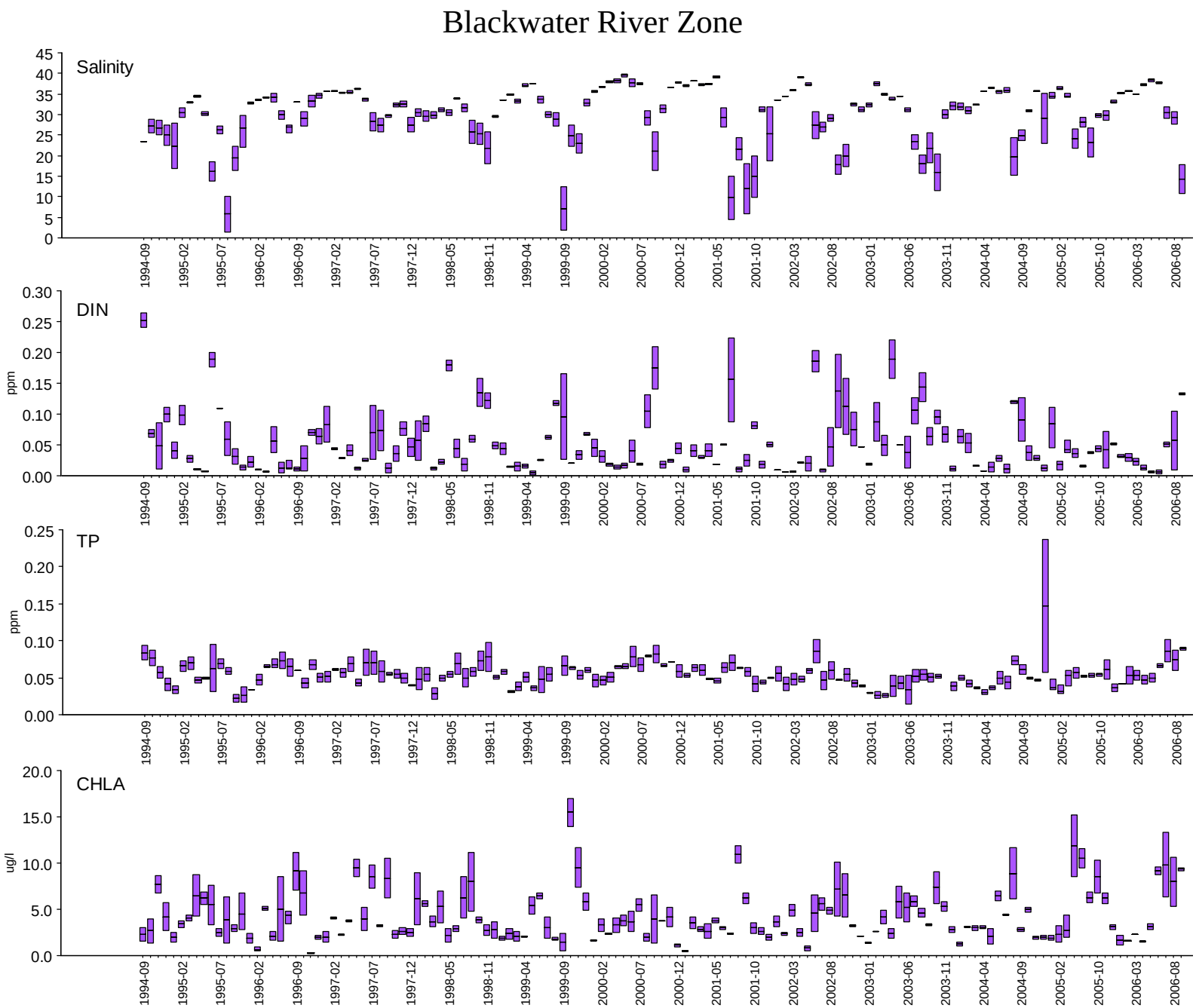

Figure 14. Box-and-whisker plots of water quality in WWB-TTI by survey.

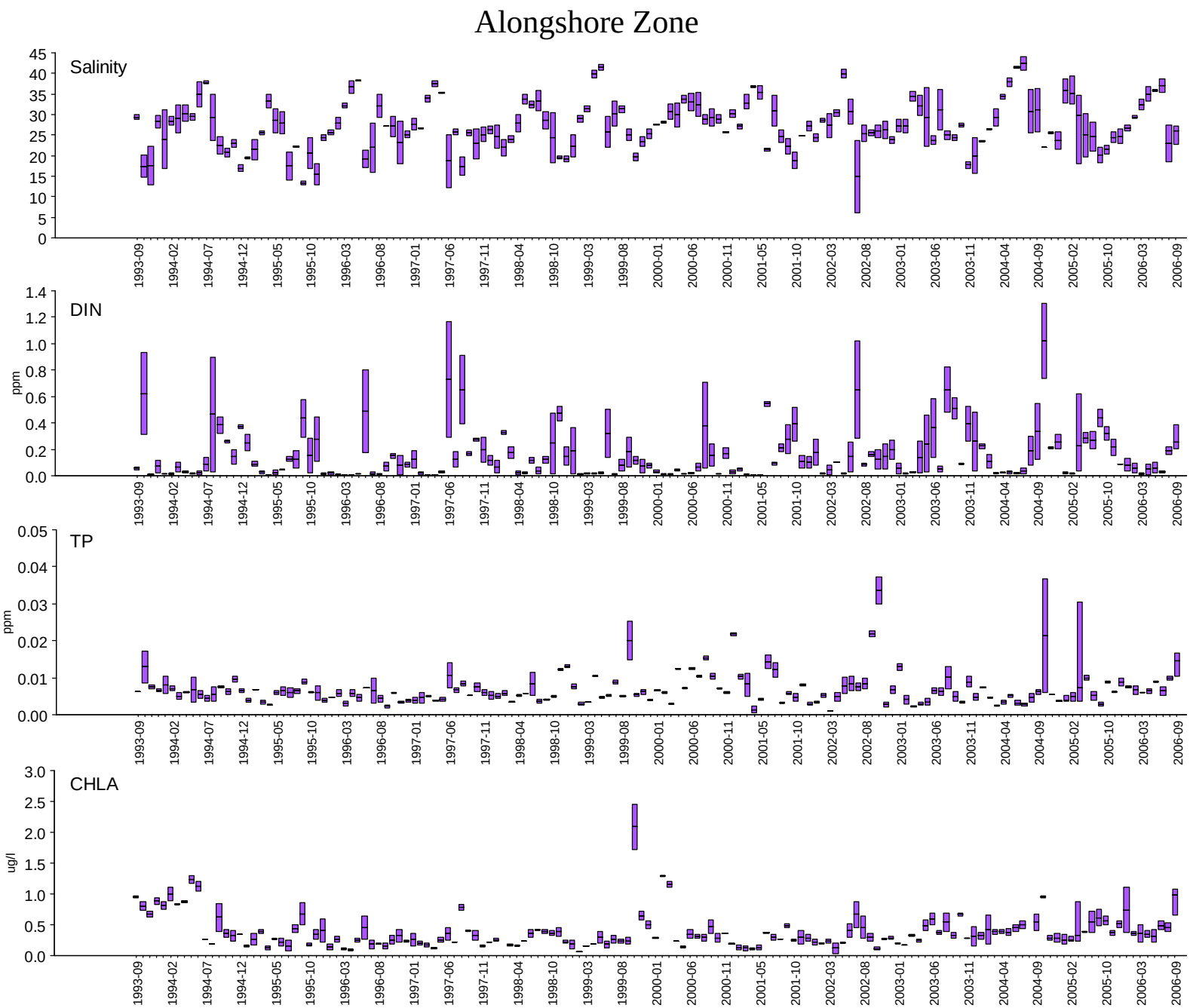

Figure 15. Box-and-whisker plots of water quality in Biscayne Bay by survey.

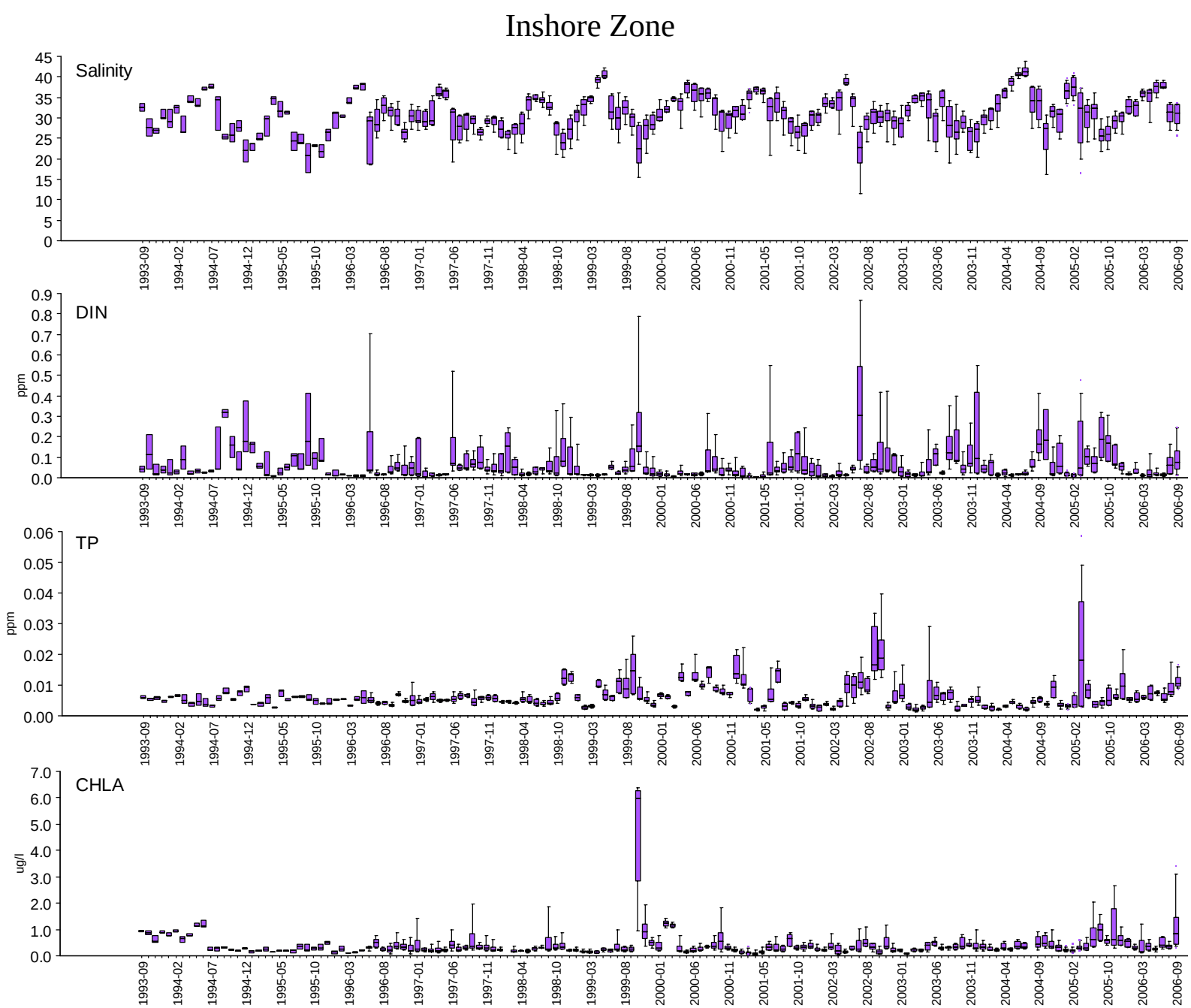

Figure 16. Box-and-whisker plots of water quality in Biscayne Bay by survey.

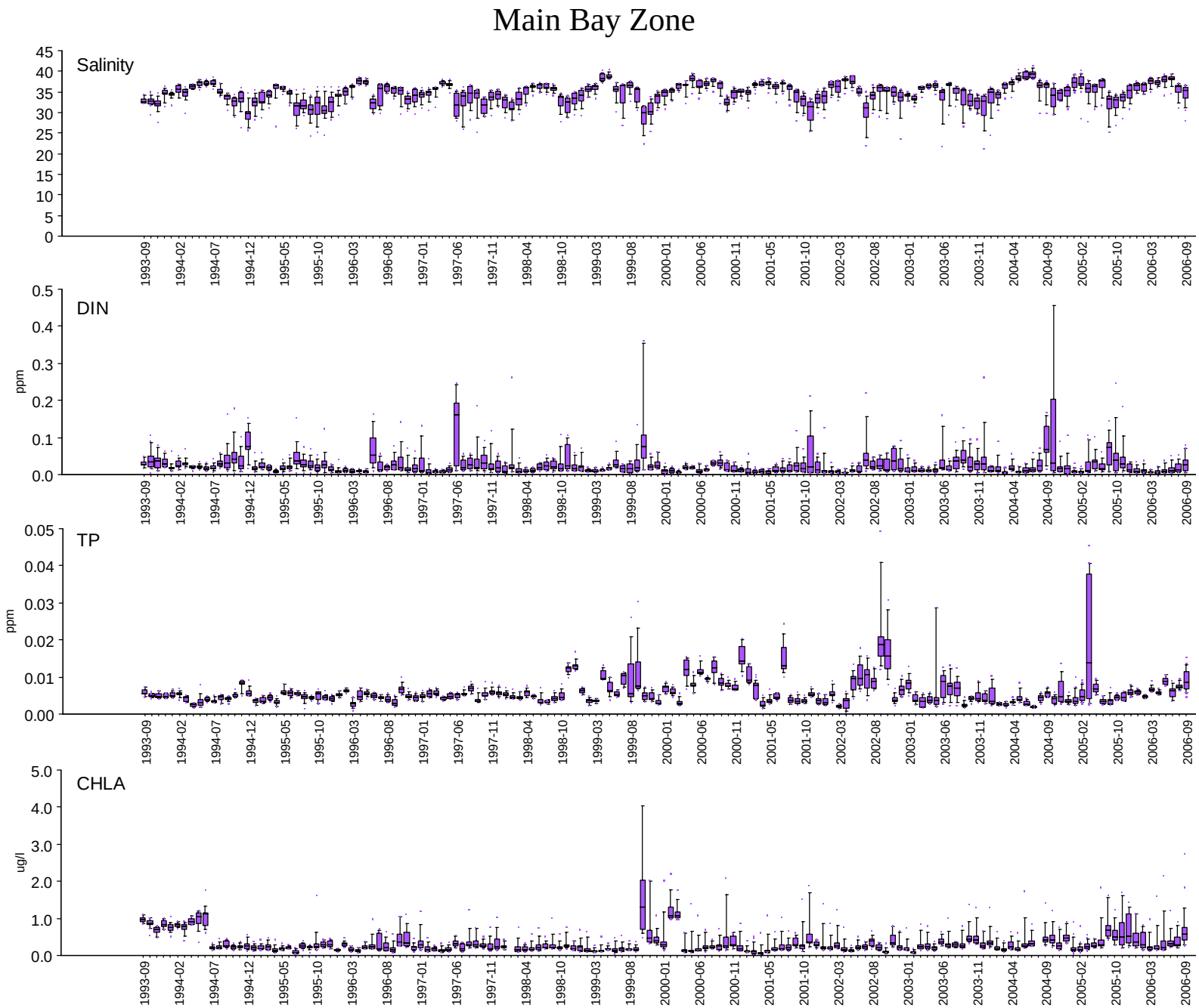

Figure 17. Box-and-whisker plots of water quality in Biscayne Bay by survey.

South Card Sound Zone

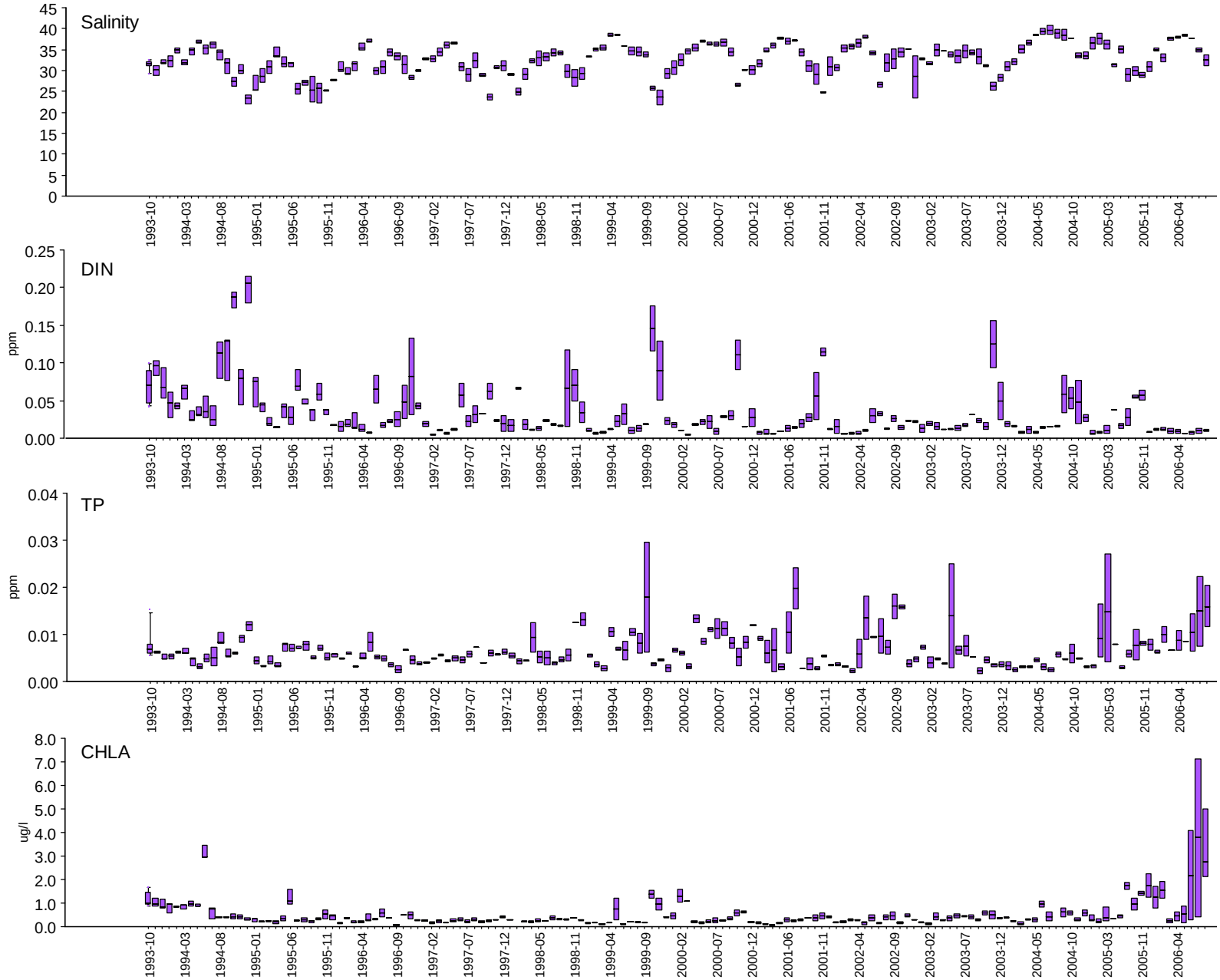

Figure 18. Box-and-whisker plots of water quality in Biscayne Bay by survey.

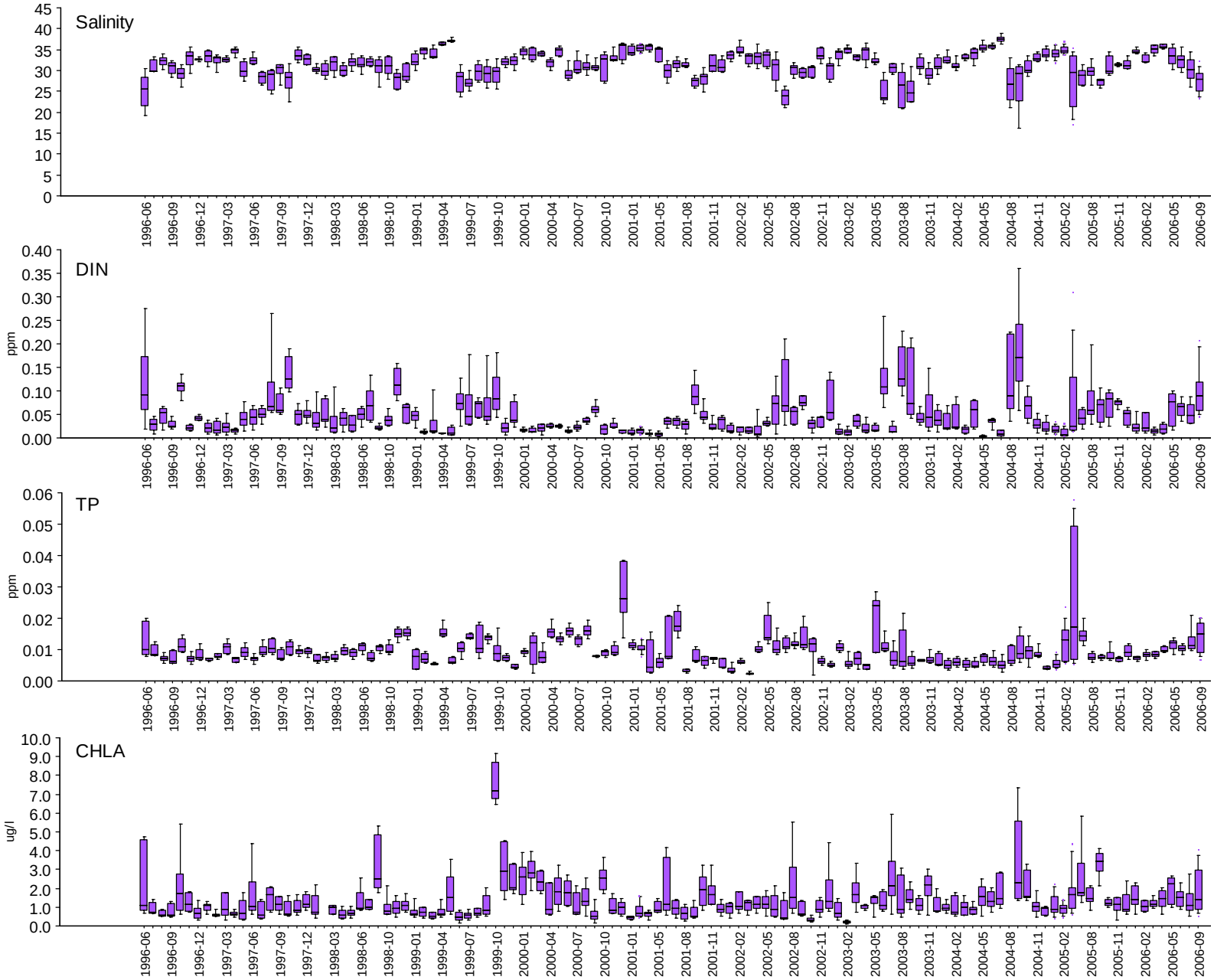

Figure 19. Box-and-whisker plots of water quality in Biscayne Bay by survey.

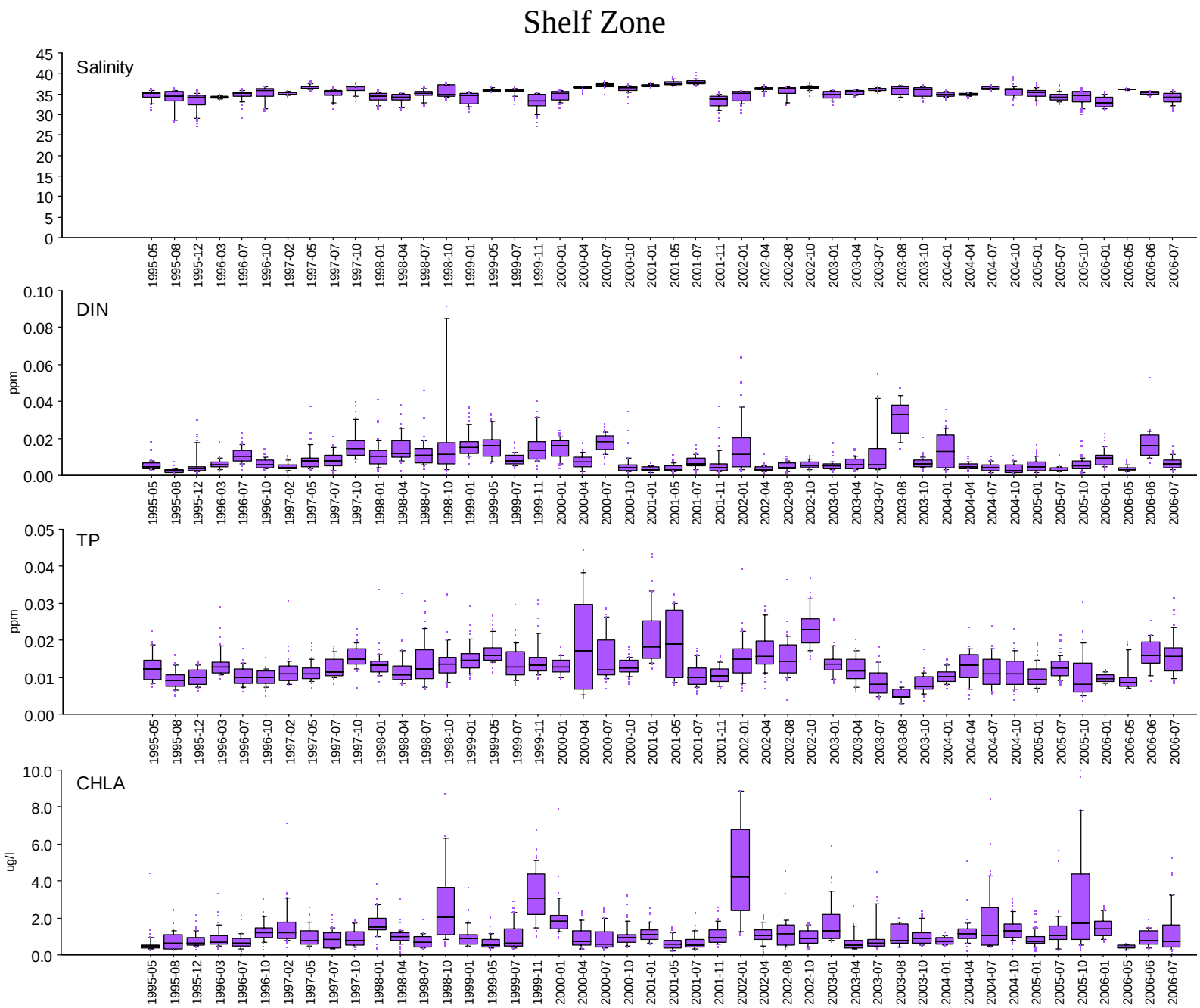

Figure 20. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

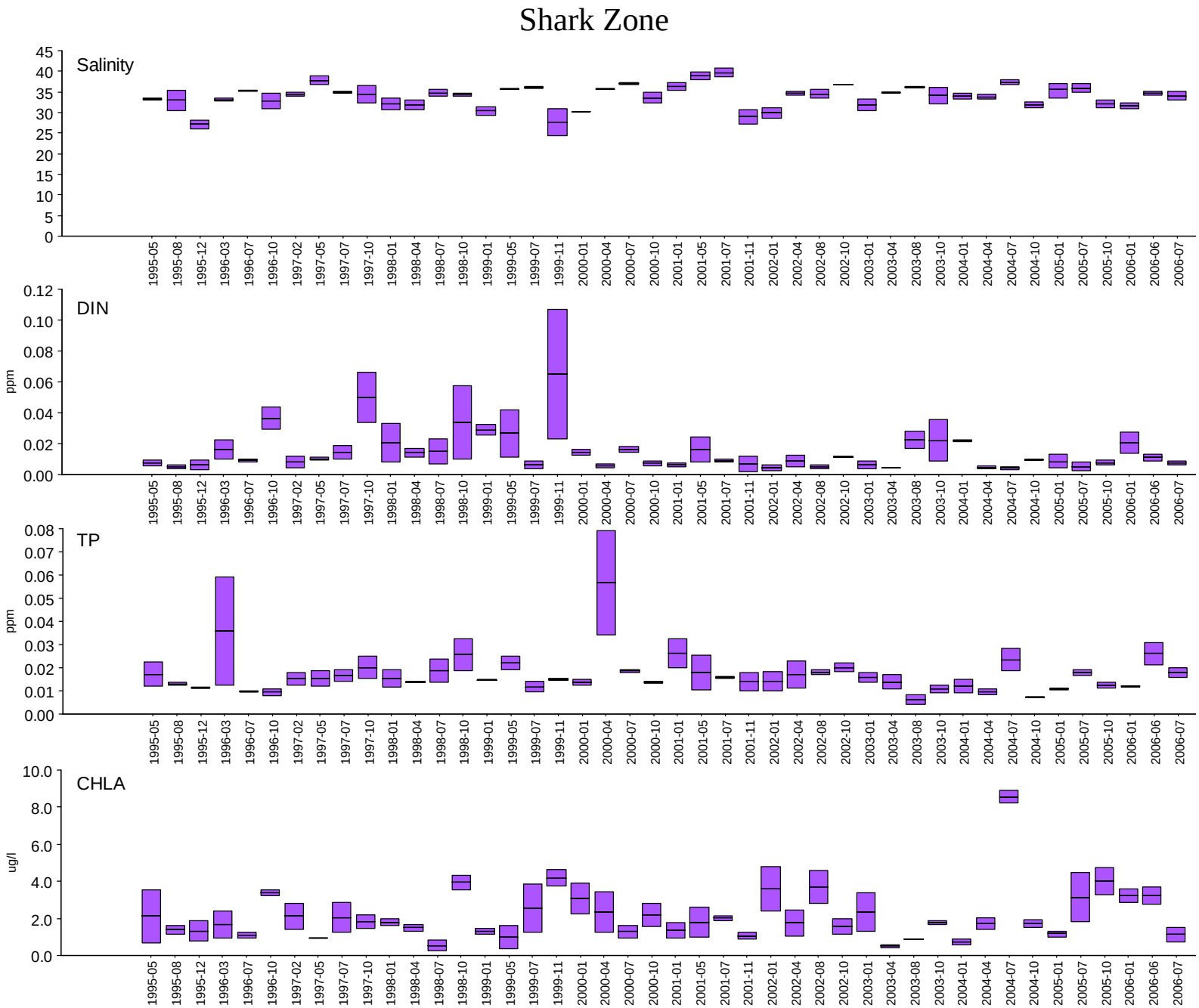

Figure 21. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

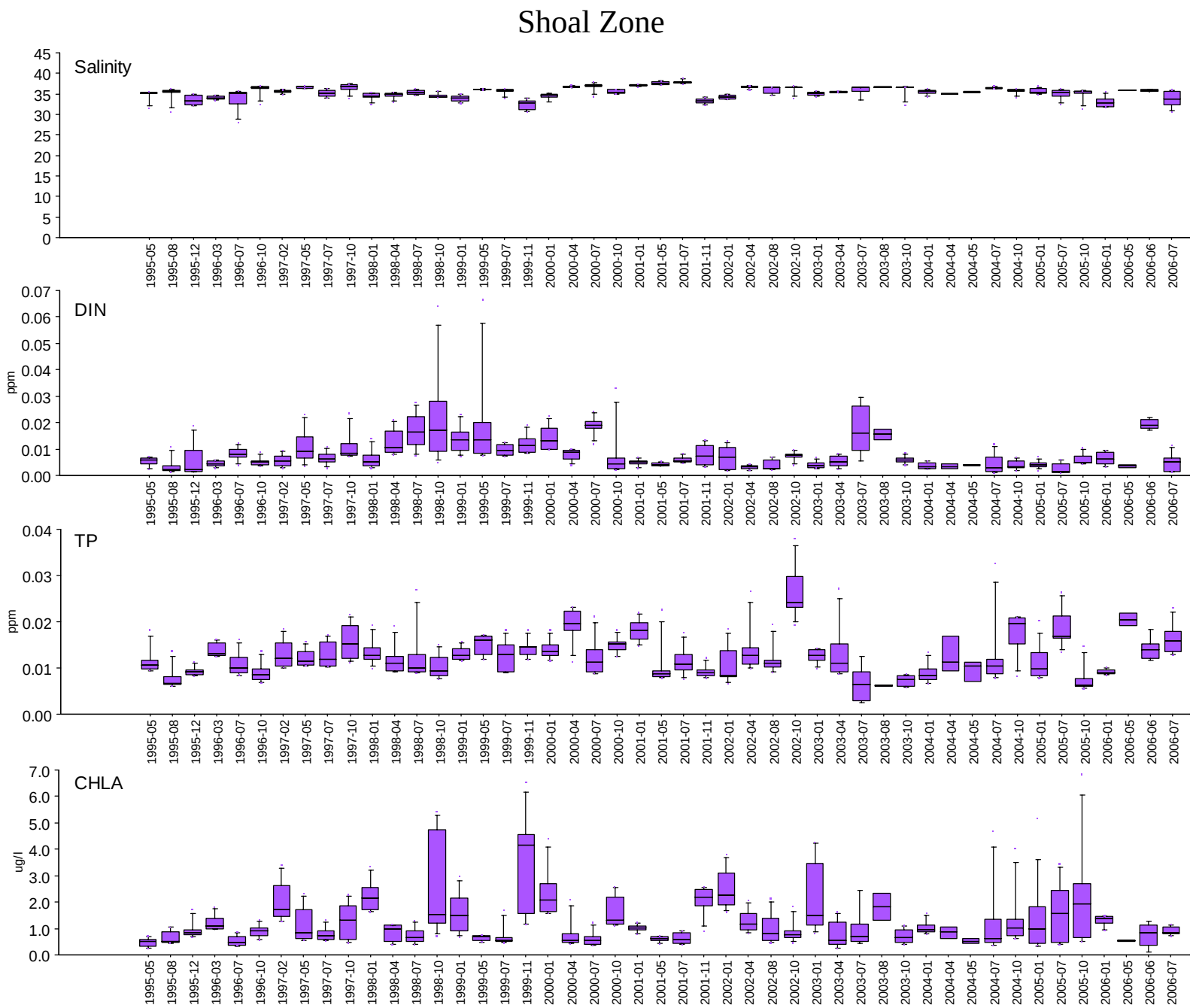

Figure 22. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

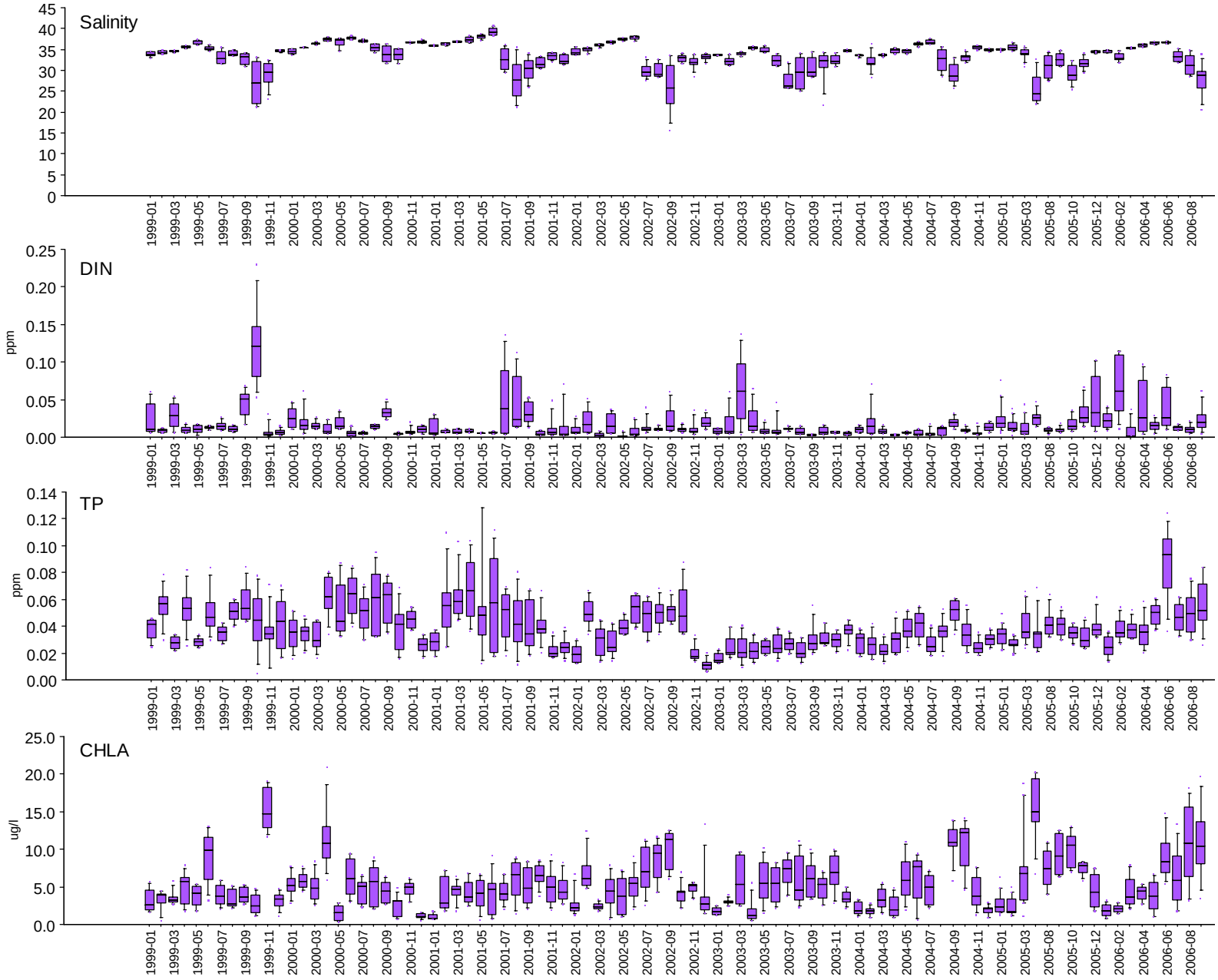

Figure 23. Box-and-whisker plots of water quality in RB-PIS by survey.

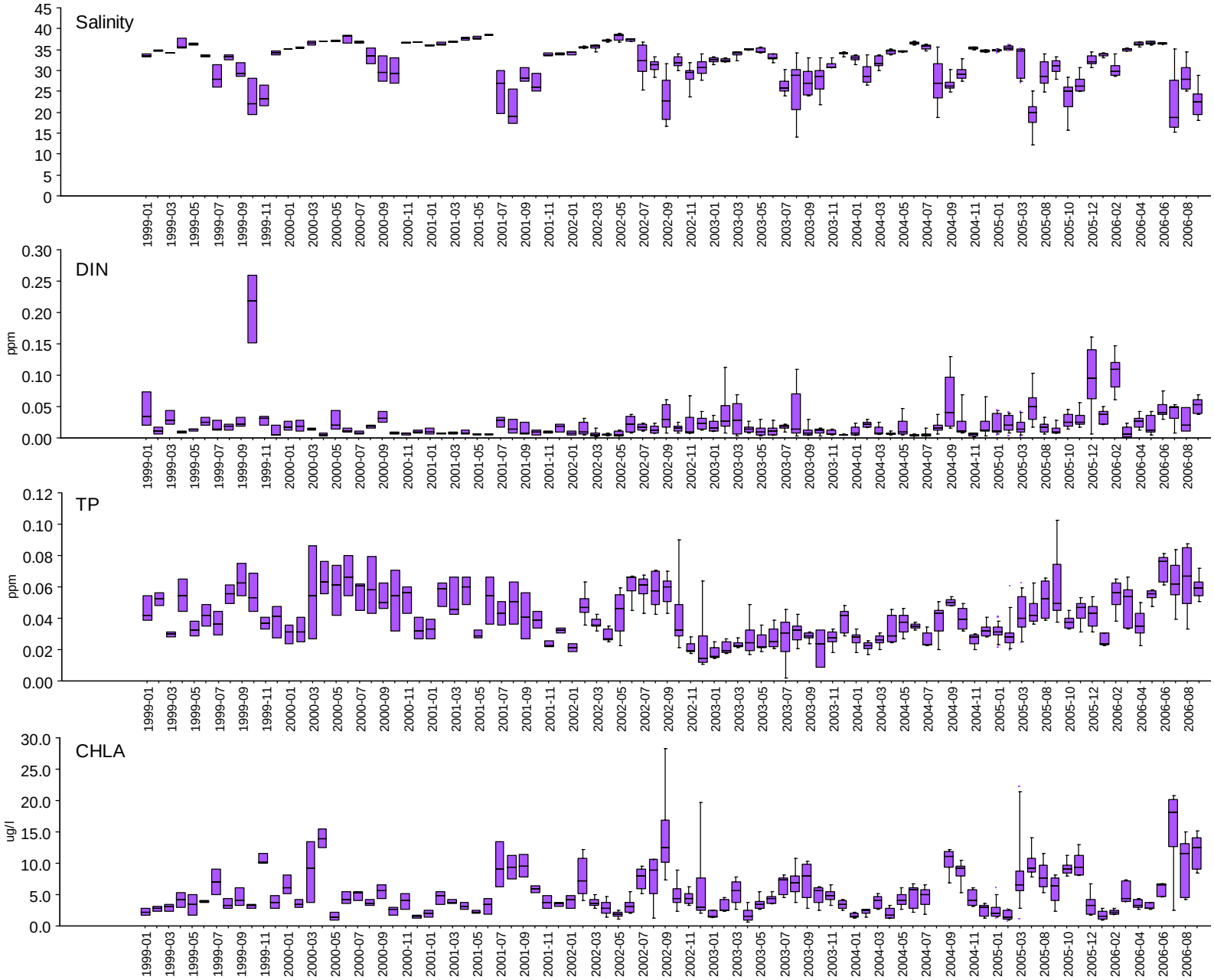

Figure 24. Box-and-whisker plots of water quality in RB-PIS by survey.

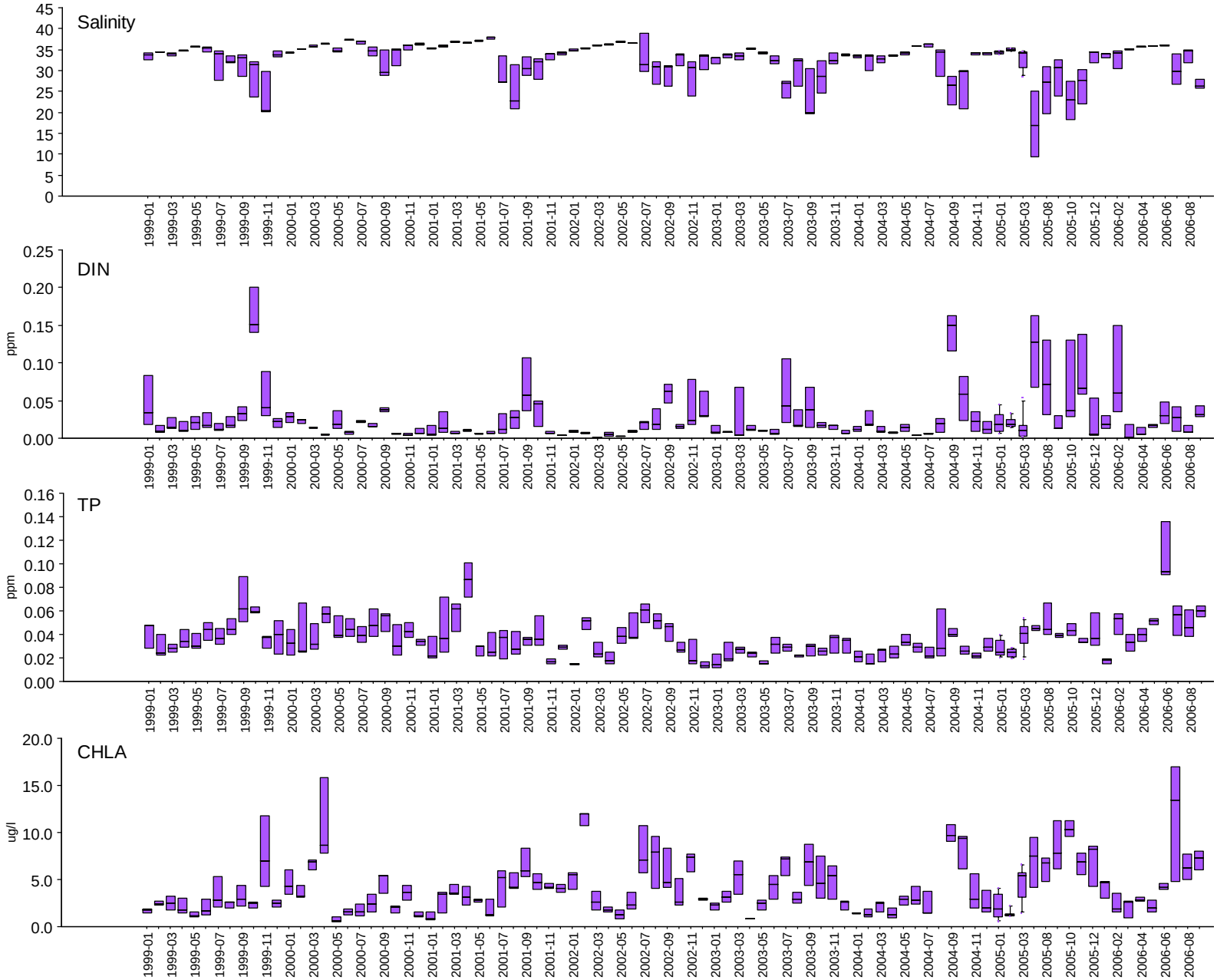

Figure 25. Box-and-whisker plots of water quality in RB-PIS by survey.

San Carlos Bay Zone

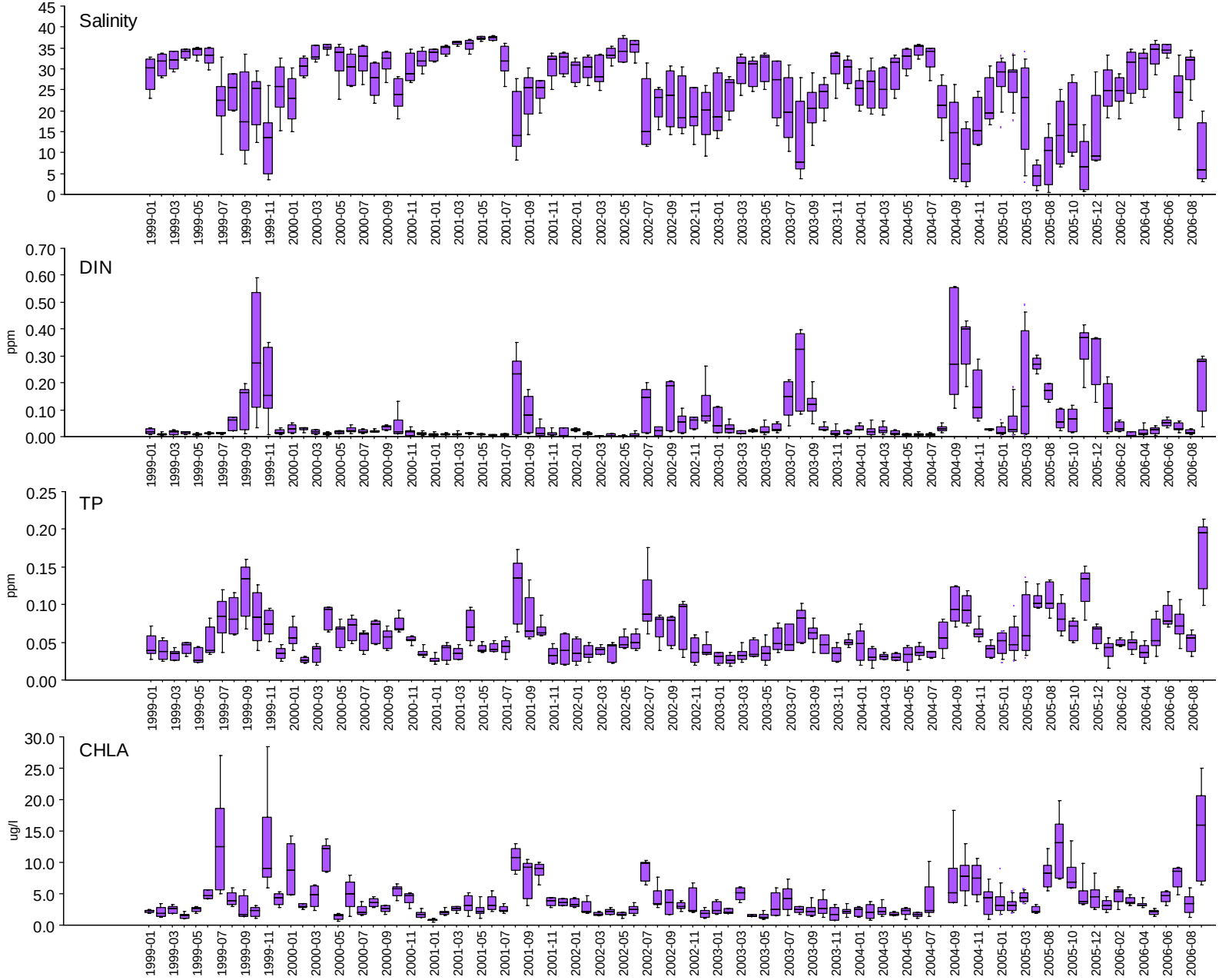

Figure 26. Box-and-whisker plots of water quality in RB-PIS by survey.

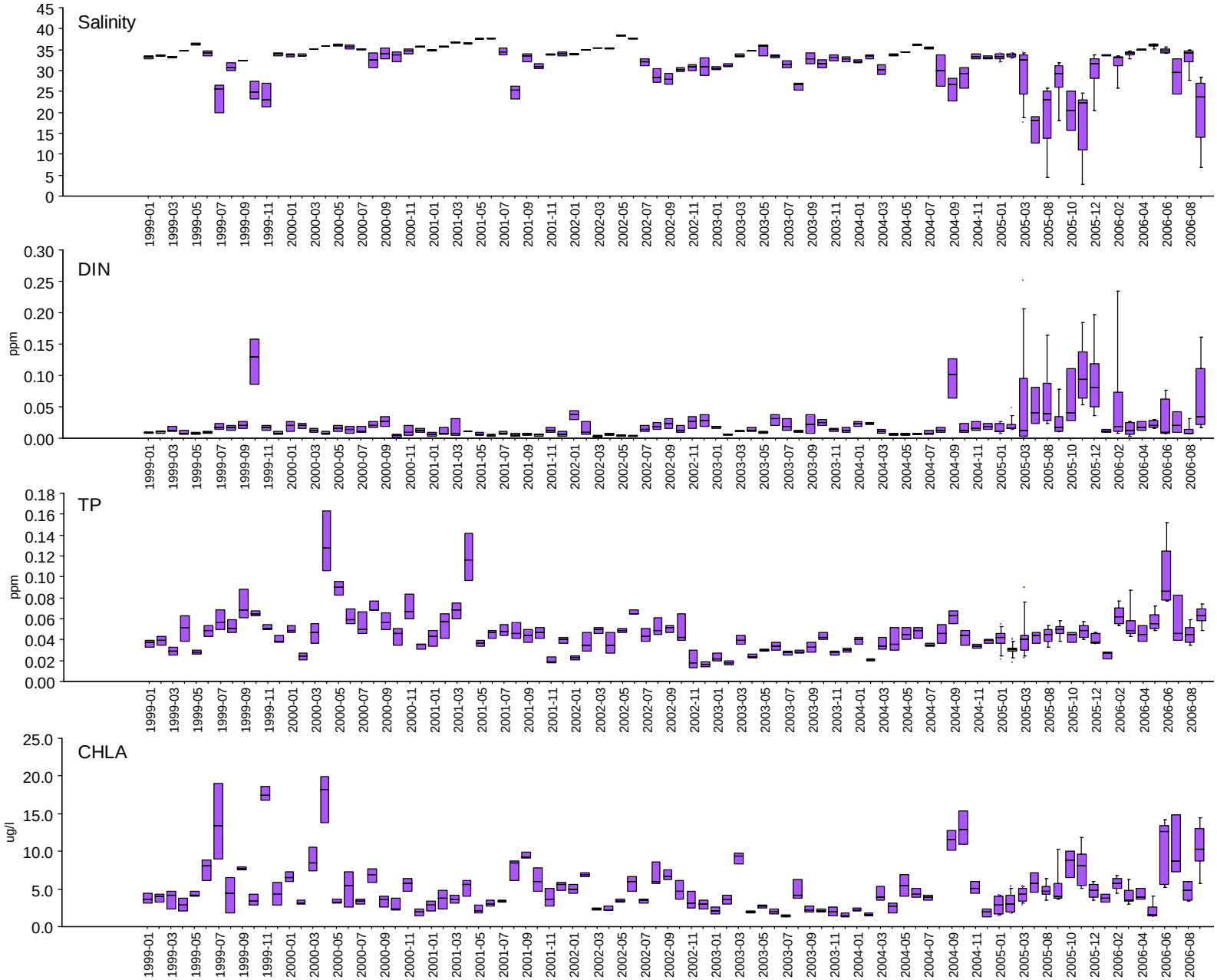

Figure 27. Box-and-whisker plots of water quality in RB-PIS by survey.

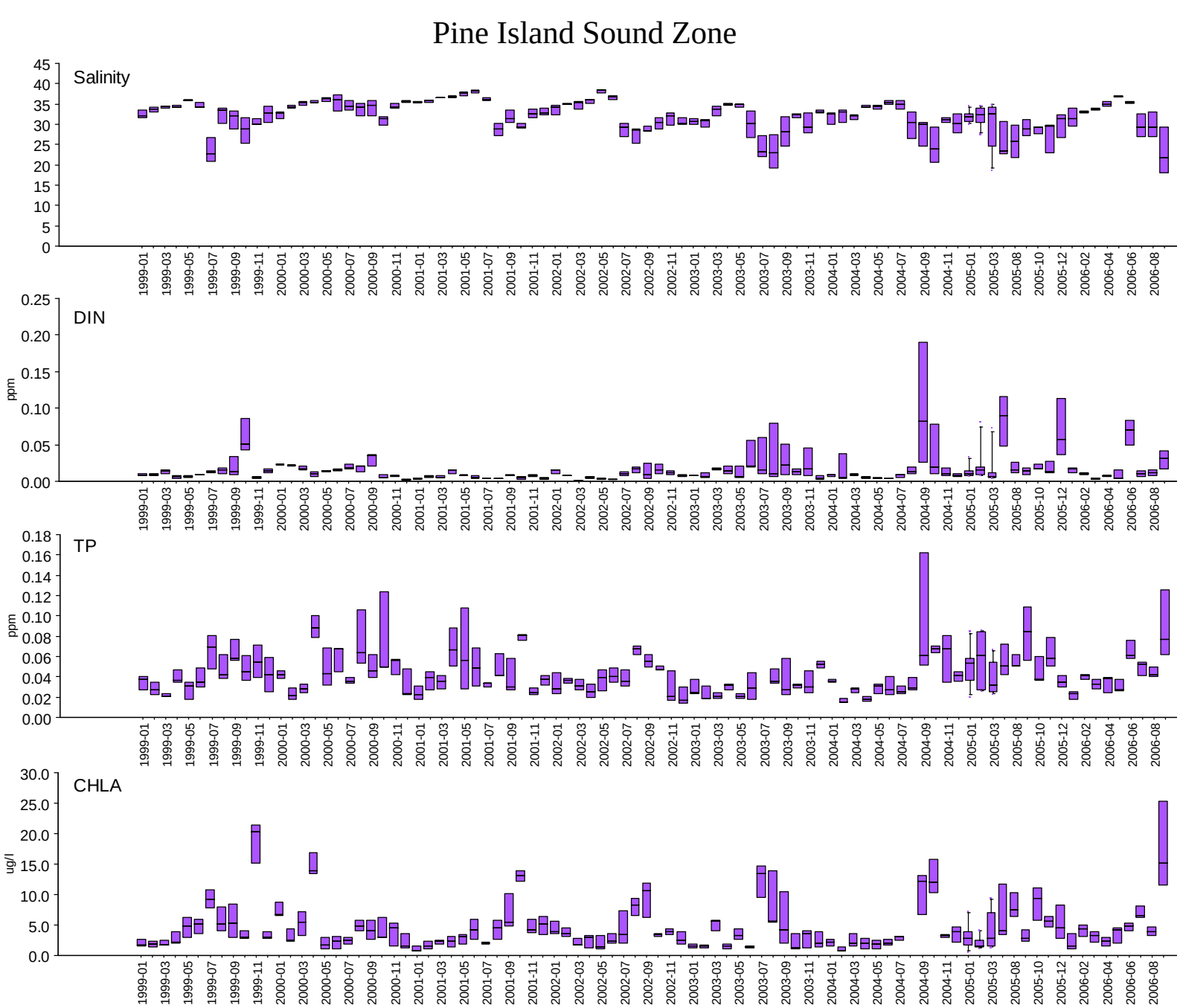

Figure 28. Box-and-whisker plots of water quality in RB-PIS by survey.

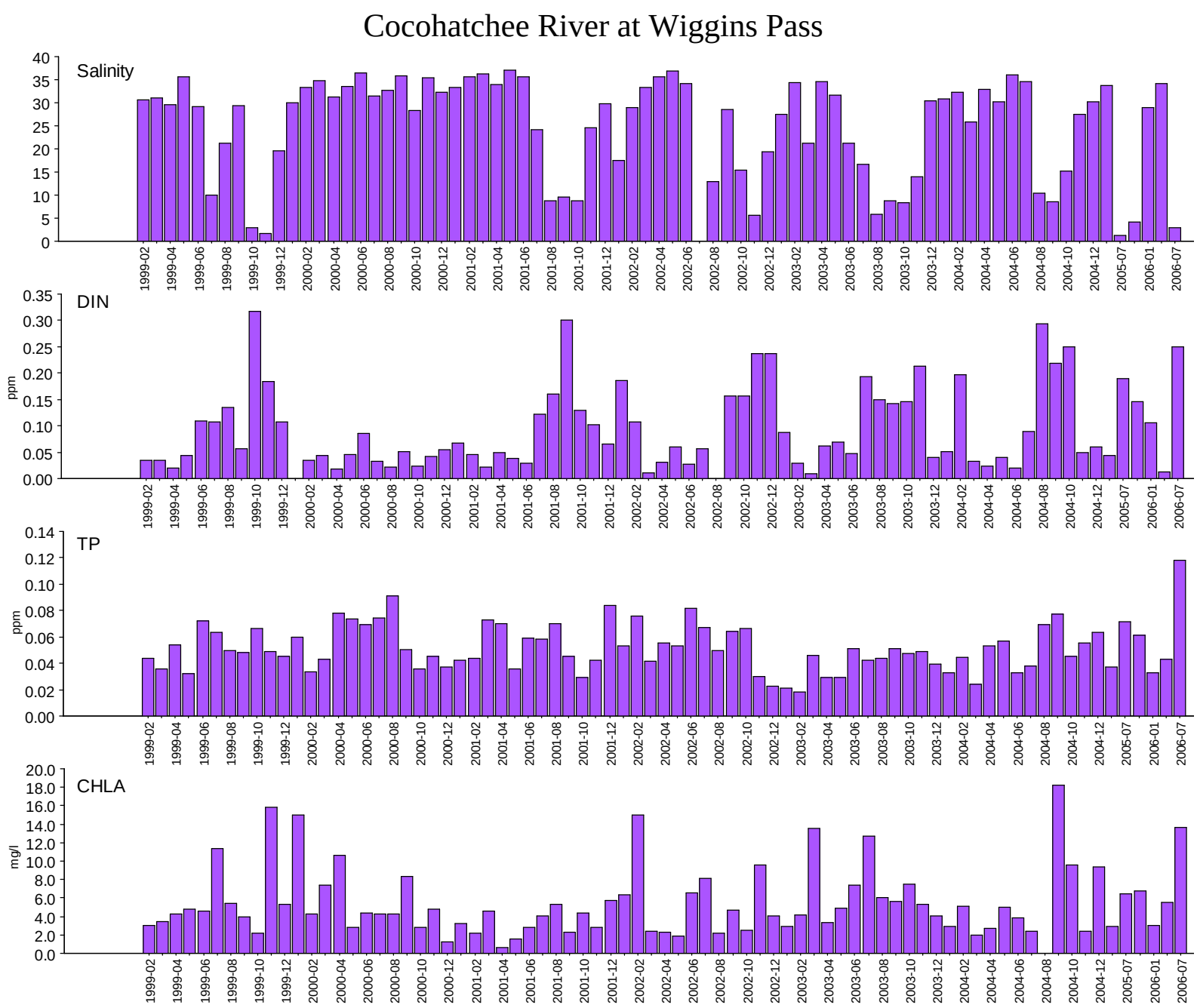

Figure 29. Box-and-whisker plots of water quality in RB-PIS by survey.

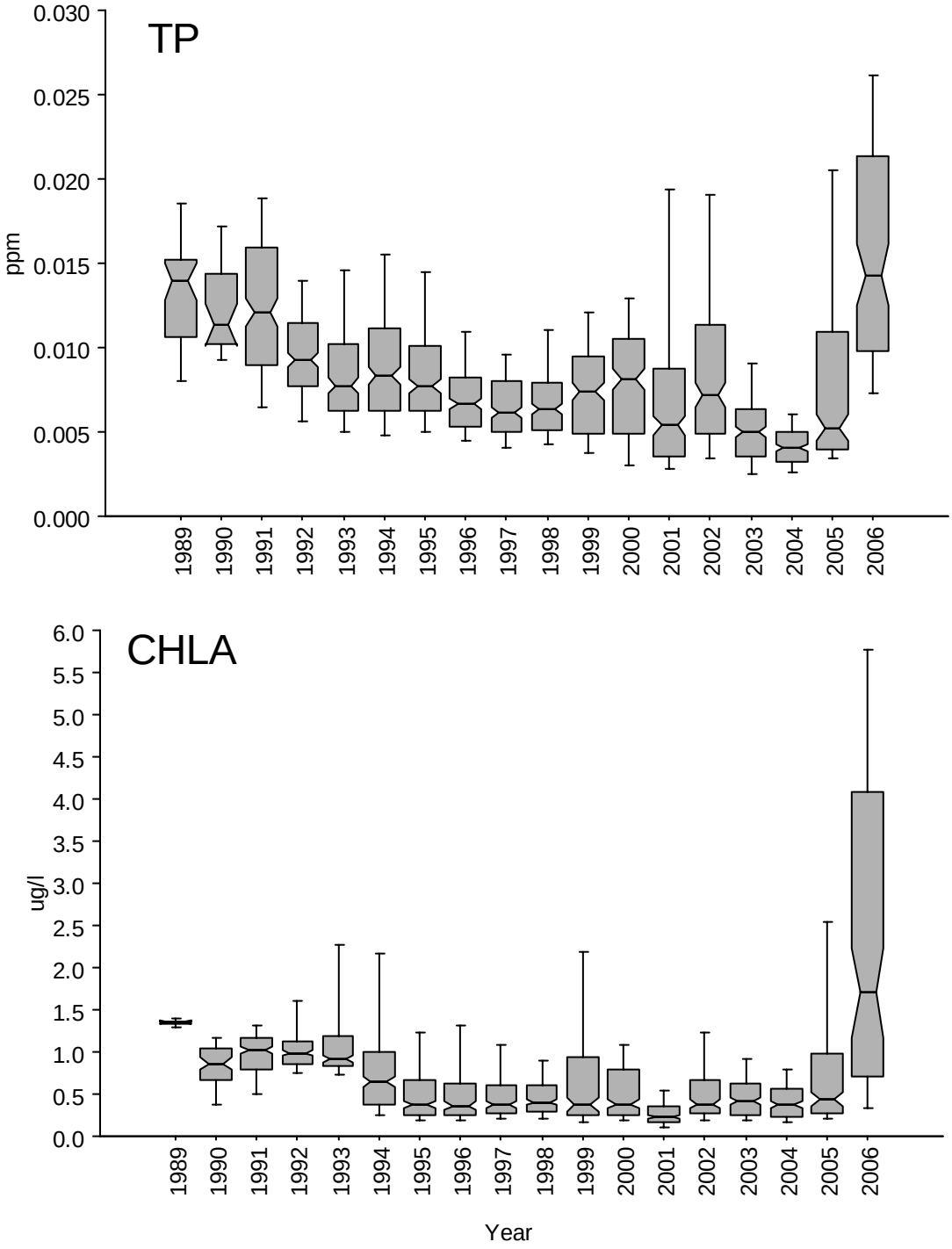

Figure 30. Reversal of TP decline in Eastern Bay in 2006 as related to algal bloom event.

Table 1.

Parameter	Zone	Median	Min.	Max.	*n*
Alkaline Phosphatase Activity ($\mu M\ h^{-1}$)	Biscayne Bay	0.307	0.086	3.378	75
	Florida Bay	0.687	0.056	3.418	84
	Rookery Bay	0.067	0.043	0.179	87
	SW Shelf	0.038	0.015	0.126	49
	Ten Thousand Is.	0.093	0.060	1.113	78
	Whitewater Bay	0.581	0.065	3.680	66
Chlorophyll *a* ($\mu g\ l^{-1}$)	Biscayne Bay	0.690	0.183	7.205	75
	Florida Bay	1.438	0.218	17.207	84
	Rookery Bay	8.657	1.318	28.634	87
	SW Shelf	0.793	0.067	5.259	49
	Ten Thousand Is.	6.640	1.006	13.284	78
	Whitewater Bay	4.707	1.060	15.649	66
Surface Dissolved Oxygen ($mg\ l^{-1}$)	Biscayne Bay	6.33	3.08	8.01	75
	Florida Bay	5.92	3.55	7.82	84
	Rookery Bay	6.37	4.69	10.57	87
	SW Shelf	5.05	3.60	8.66	49
	Ten Thousand Is.	5.60	2.90	9.89	78
	Whitewater Bay	6.09	2.69	9.46	66
Bottom Dissolved Oxygen ($mg\ l^{-1}$)	Biscayne Bay	6.30	3.18	8.67	75
	Florida Bay	5.80	3.55	7.31	84
	Rookery Bay	6.10	3.53	10.77	87
	SW Shelf	5.65	5.05	6.64	49
	Ten Thousand Is.	5.39	2.56	9.80	78
	Whitewater Bay	5.82	1.98	9.62	66
NH_4^+ (ppm)	Biscayne Bay	0.0167	0.0007	0.1091	75
	Florida Bay	0.0205	0.0017	0.3373	84
	Rookery Bay	0.0088	0.0011	0.1262	85
	SW Shelf	0.0039	0.0004	0.0099	49
	Ten Thousand Is.	0.0313	0.0022	0.2654	78
	Whitewater Bay	0.0281	0.0027	0.3063	66

Parameter	Zone	Median	Min.	Max.	*n*
NO_2^- (ppm)	Biscayne Bay	0.0024	0.0002	0.0165	75
	Florida Bay	0.0010	0.0001	0.0174	84
	Rookery Bay	0.0006	0.0000	0.0334	87
	SW Shelf	0.0003	0.0000	0.0018	49
	Ten Thousand Is.	0.0034	0.0003	0.0118	78
	Whitewater Bay	0.0021	0.0005	0.0093	66
NO_3^- (ppm)	Biscayne Bay	0.0137	0.0004	0.4590	75
	Florida Bay	0.0048	0.0002	0.0761	84
	Rookery Bay	0.0109	0.0011	0.1953	87
	SW Shelf	0.0015	0.0002	0.0062	49
	Ten Thousand Is.	0.0161	0.0000	0.1165	78
	Whitewater Bay	0.0138	0.0019	0.0835	66
pH	Biscayne Bay	7.975	7.820	8.275	75
	Florida Bay	8.128	7.750	8.705	84
	Rookery Bay	7.980	7.460	8.380	87
	SW Shelf	7.865	7.685	8.000	49
	Ten Thousand Is.	7.713	7.225	8.075	78
	Whitewater Bay	7.885	7.220	8.420	66
Surface Salinity	Biscayne Bay	33.03	18.48	37.20	75
	Florida Bay	34.28	0.34	42.54	84
	Rookery Bay	28.93	2.94	35.33	87
	SW Shelf	34.28	30.65	36.03	49
	Ten Thousand Is.	12.37	0.34	32.74	78
	Whitewater Bay	7.37	0.27	28.53	66
Bottom Salinity	Biscayne Bay	33.65	20.10	37.19	75
	Florida Bay	34.46	0.37	42.90	84
	Rookery Bay	30.59	2.96	35.37	87
	SW Shelf	35.48	31.31	36.21	49
	Ten Thousand Is.	17.00	0.33	32.78	78
	Whitewater Bay	8.61	0.27	28.77	66
$Si(OH)_4$ (ppm)	Biscayne Bay	0.0750	0.0069	1.5517	25
	Florida Bay	1.2699	0.0072	4.1575	28
	Rookery Bay	0.9799	0.0038	1.9891	29
	SW Shelf	0.0465	0.0002	0.5099	49
	Ten Thousand Is.	2.1041	0.7847	3.4999	26
	Whitewater Bay	1.5003	0.9062	2.6336	22

Parameter	Zone	Median	Min.	Max.	*n*
Soluble Reactive Phosphorus (ppm)	Biscayne Bay	0.0012	0.0002	0.0027	75
	Florida Bay	0.0014	0.0003	0.0040	84
	Rookery Bay	0.0078	0.0010	0.1650	87
	SW Shelf	0.0014	0.0005	0.0033	49
	Ten Thousand Is.	0.0107	0.0000	0.0529	78
	Whitewater Bay	0.0017	0.0004	0.0173	66
Surface Temperature (^{o}C)	Biscayne Bay	29.99	26.94	31.97	75
	Florida Bay	30.11	28.89	32.90	84
	Rookery Bay	30.45	29.17	32.80	87
	SW Shelf	29.39	28.29	30.40	49
	Ten Thousand Is.	29.47	26.24	33.83	78
	Whitewater Bay	29.57	28.41	32.71	66
Bottom Temperature (^{o}C)	Biscayne Bay	29.70	27.28	31.97	75
	Florida Bay	30.06	28.38	33.47	84
	Rookery Bay	30.19	29.21	32.56	87
	SW Shelf	29.88	29.02	30.30	49
	Ten Thousand Is.	29.47	26.25	32.50	78
	Whitewater Bay	29.46	28.47	30.52	66
Total Nitrogen (ppm)	Biscayne Bay	0.208	0.106	0.668	75
	Florida Bay	0.452	0.132	1.423	84
	Rookery Bay	0.219	0.130	0.582	87
	SW Shelf	0.114	0.098	0.317	49
	Ten Thousand Is.	0.279	0.156	0.501	78
	Whitewater Bay	0.336	0.236	0.736	66
Total Organic Carbon (ppm)	Biscayne Bay	3.157	1.424	11.050	75
	Florida Bay	9.367	1.960	23.503	84
	Rookery Bay	5.138	2.470	17.603	87
	SW Shelf	1.859	1.449	4.191	49
	Ten Thousand Is.	10.690	5.135	19.205	78
	Whitewater Bay	13.096	0.300	27.128	66
Total Organic Nitrogen (ppm)	Biscayne Bay	0.147	0.103	0.621	75
	Florida Bay	0.363	0.129	1.402	84
	Rookery Bay	0.195	0.125	0.300	85
	SW Shelf	0.109	0.091	0.305	49
	Ten Thousand Is.	0.199	0.050	0.391	78
	Whitewater Bay	0.282	0.166	0.692	66

Parameter	Zone	Median	Min.	Max.	*n*
Total Phosphorus (ppm)	Biscayne Bay	0.010	0.005	0.025	75
	Florida Bay	0.014	0.005	0.057	84
	Rookery Bay	0.056	0.026	0.213	87
	SW Shelf	0.016	0.008	0.031	49
	Ten Thousand Is.	0.051	0.011	0.102	78
	Whitewater Bay	0.026	0.014	0.080	66
Turbidity (NTU)	Biscayne Bay	0.75	0.08	3.80	75
	Florida Bay	3.08	0.48	15.30	84
	Rookery Bay	3.73	0.86	26.40	87
	SW Shelf	2.49	0.92	16.20	49
	Ten Thousand Is.	6.45	0.25	16.29	78
	Whitewater Bay	2.98	0.74	17.18	66