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

24 September 2004

Carole Milliman Maddox
SFWMD
8894 Belvedere Road
West Palm Beach, FL 33411

Re: South Florida Coastal Water Quality Monitoring Network - Quarterly Report (C-15397)

Dear Ms. Maddox:

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.

Project Background

This report includes water quality data collected monthly during the annual period of record (POR) April – June 2004 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, so we now have 5 years of data available. But 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. 7-28). 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.

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

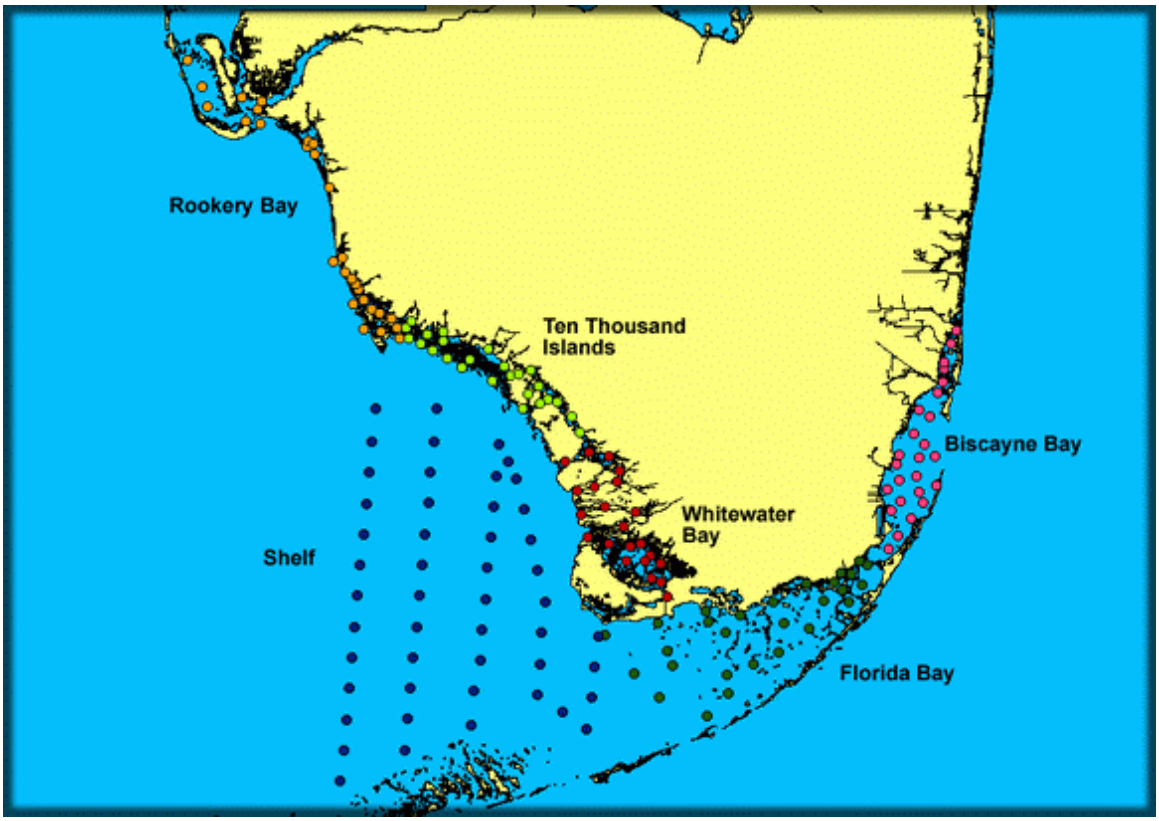

Figure 1: All fixed water quality stations funded by this SFWMD project.

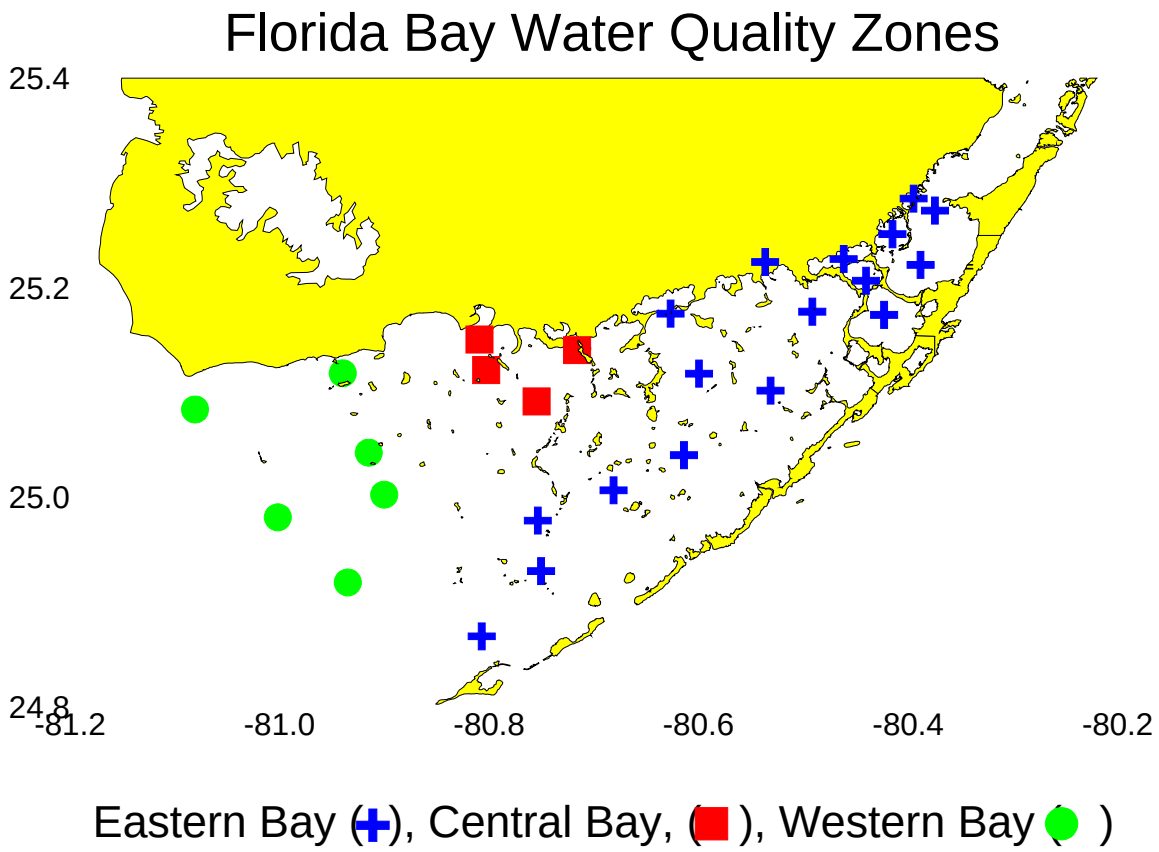

Figure 2. Florida Bay zones.

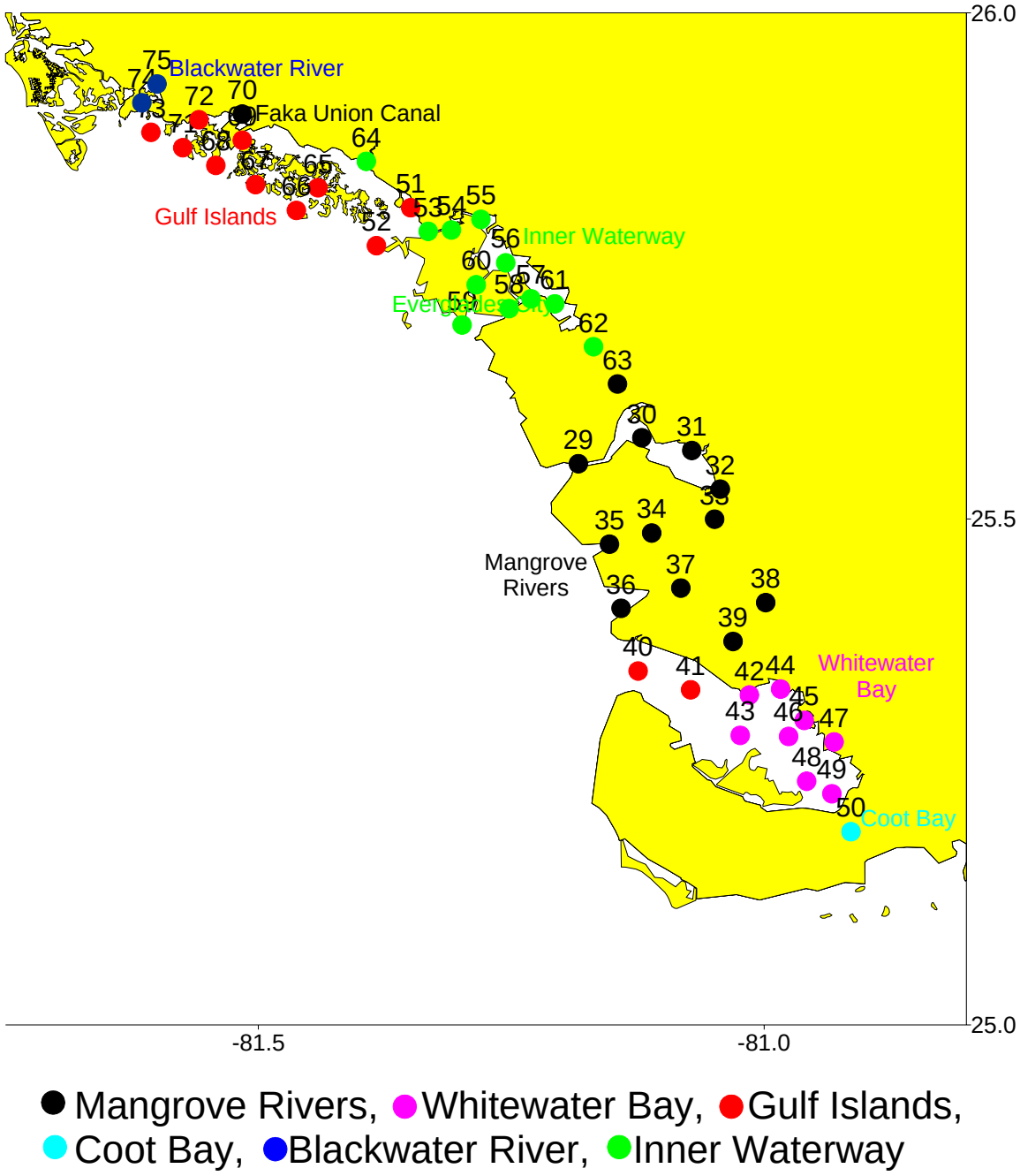

Figure 3. WWB-TTI water quality zones.

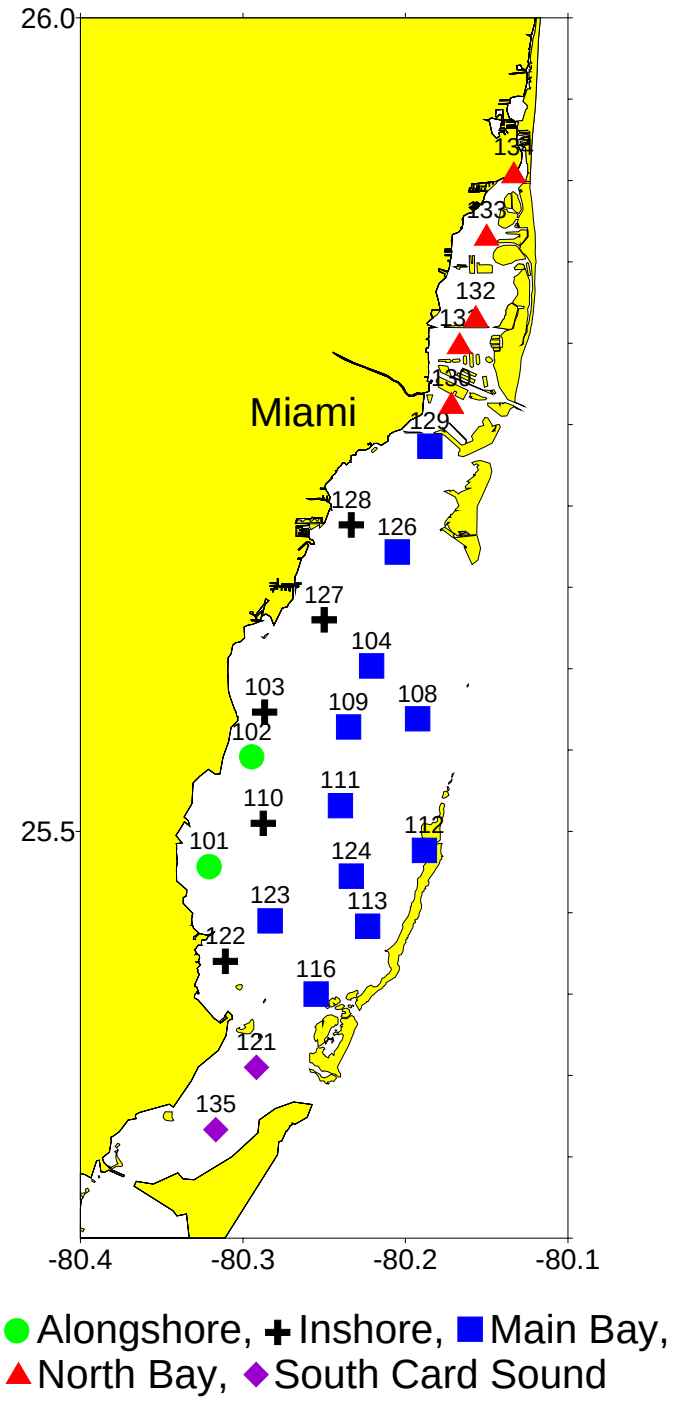

Figure 4. Biscayne Bay water quality zones.

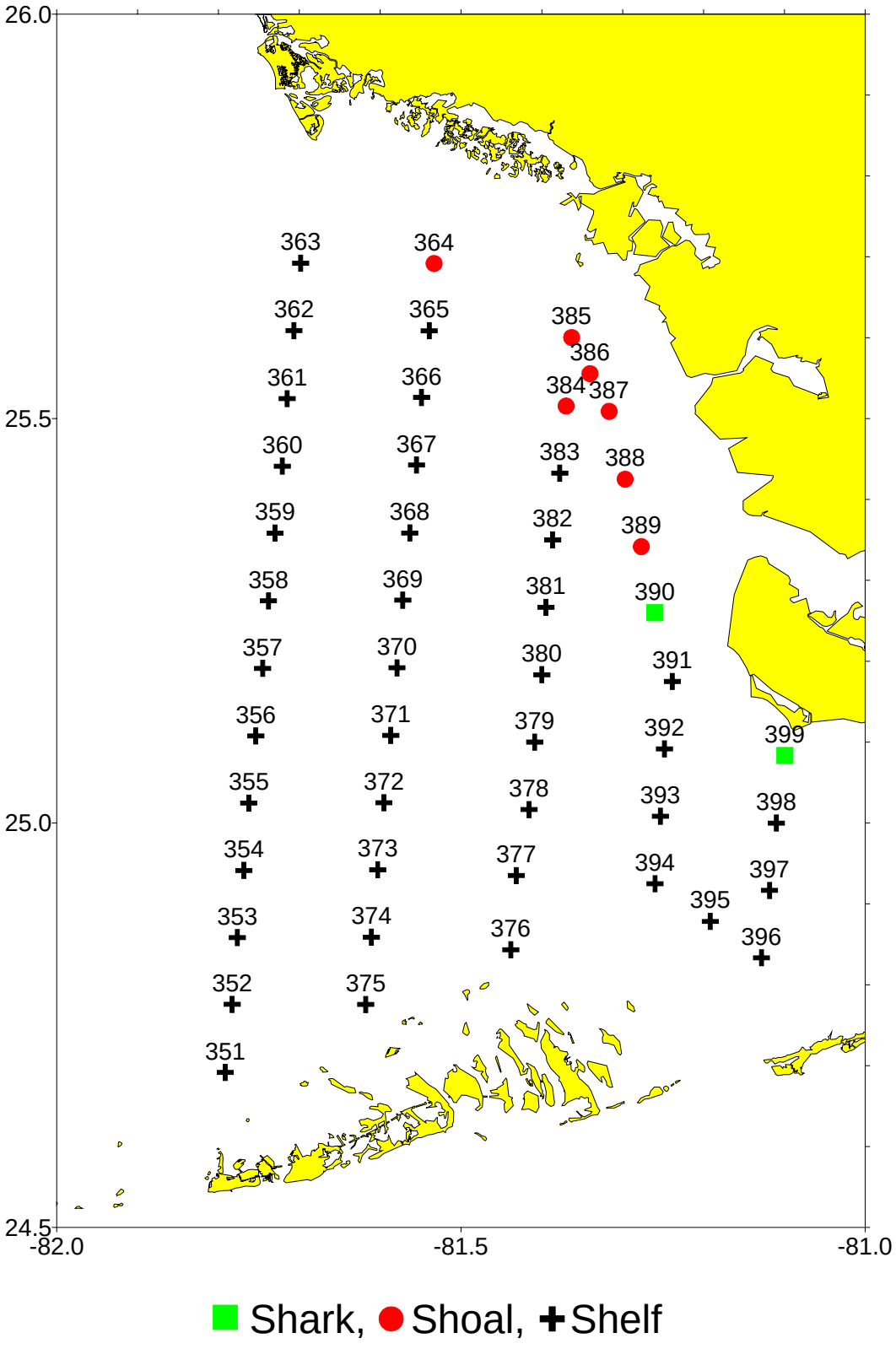

Figure 5. SW Florida Shelf water quality zones.

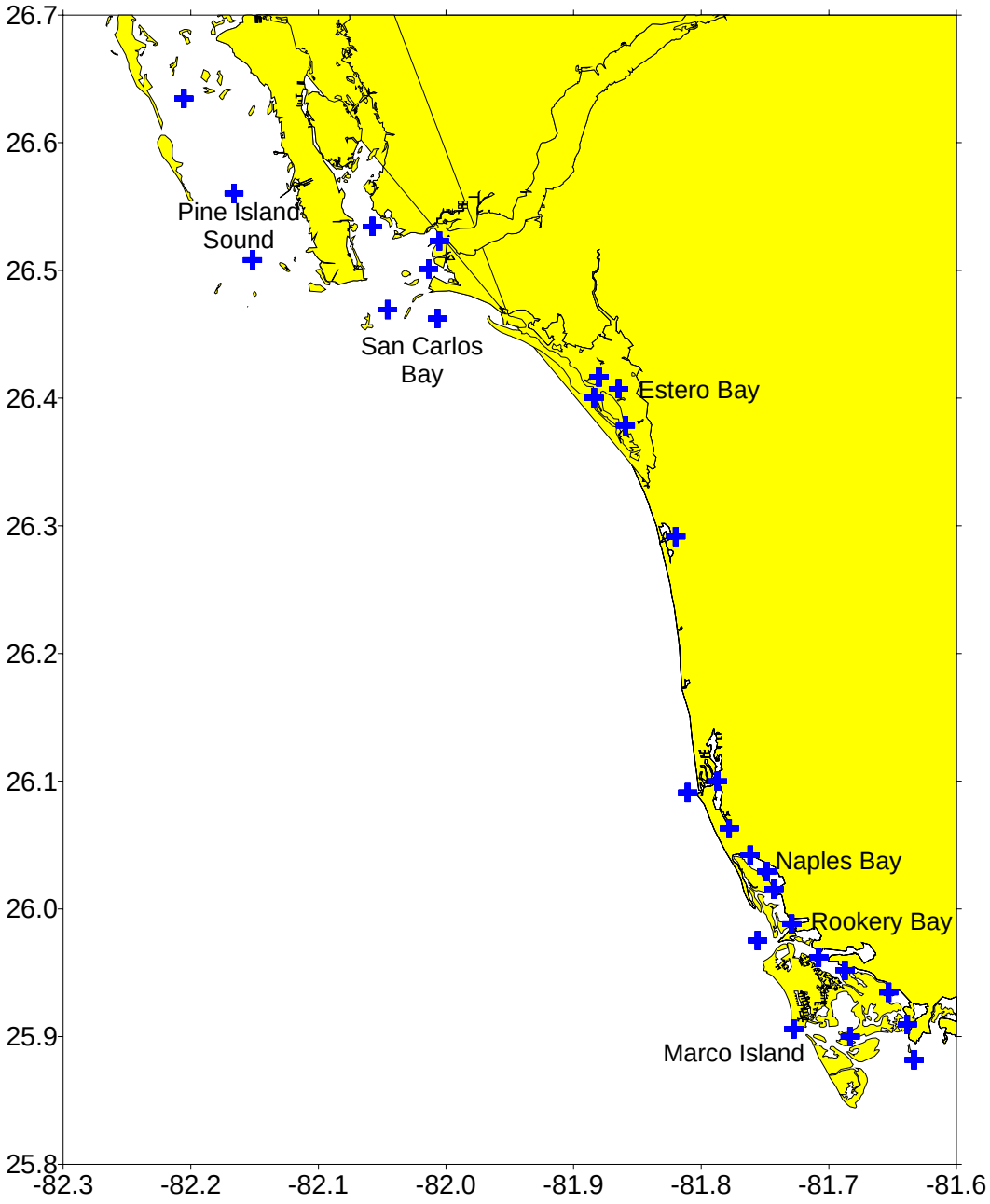

Figure 6. SW estuaries.

Eastern Florida Bay Zone

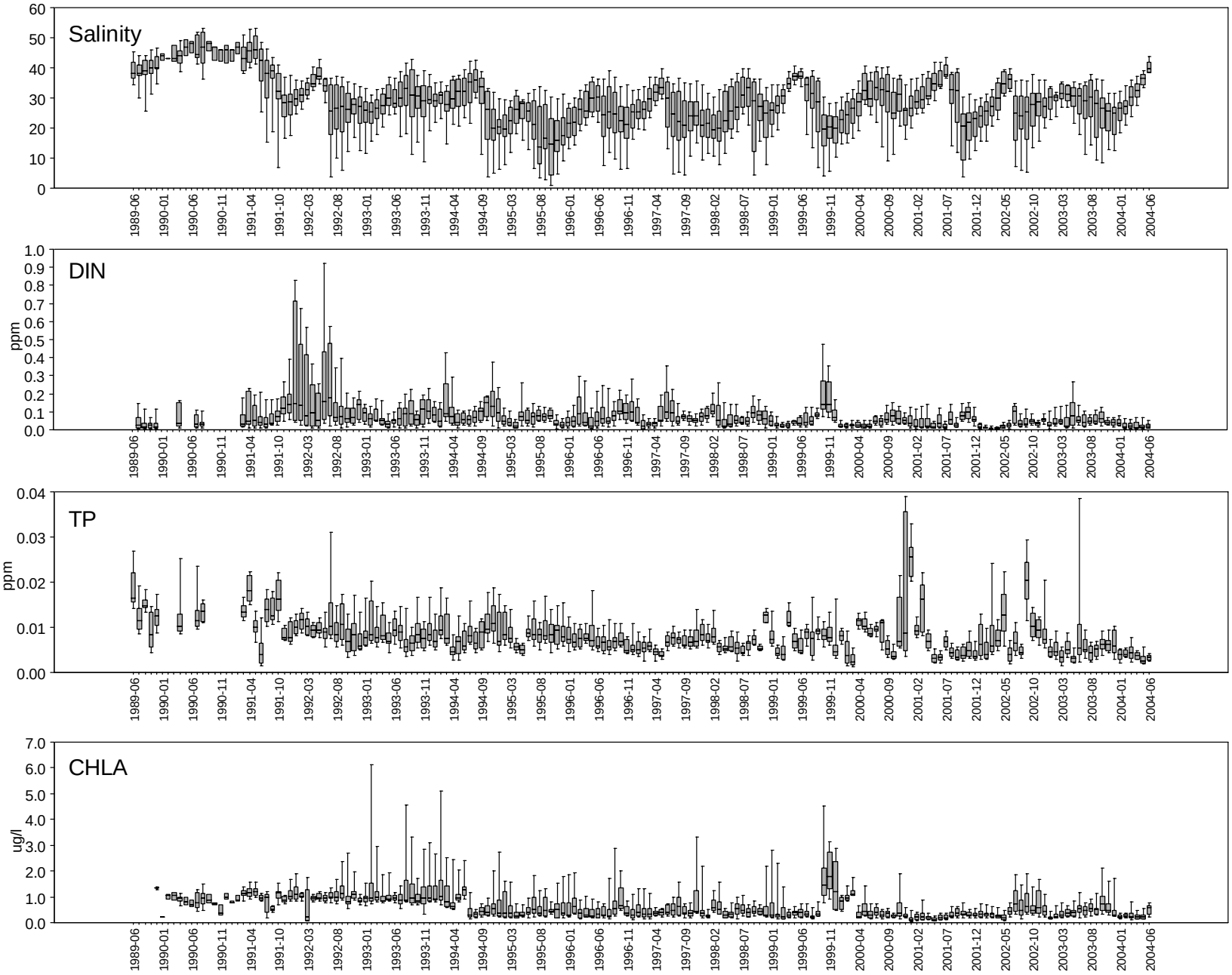

Figure 7. Box-and-whisker plots of water quality in Eastern Florida Bay by survey.

Central Florida Bay Zone

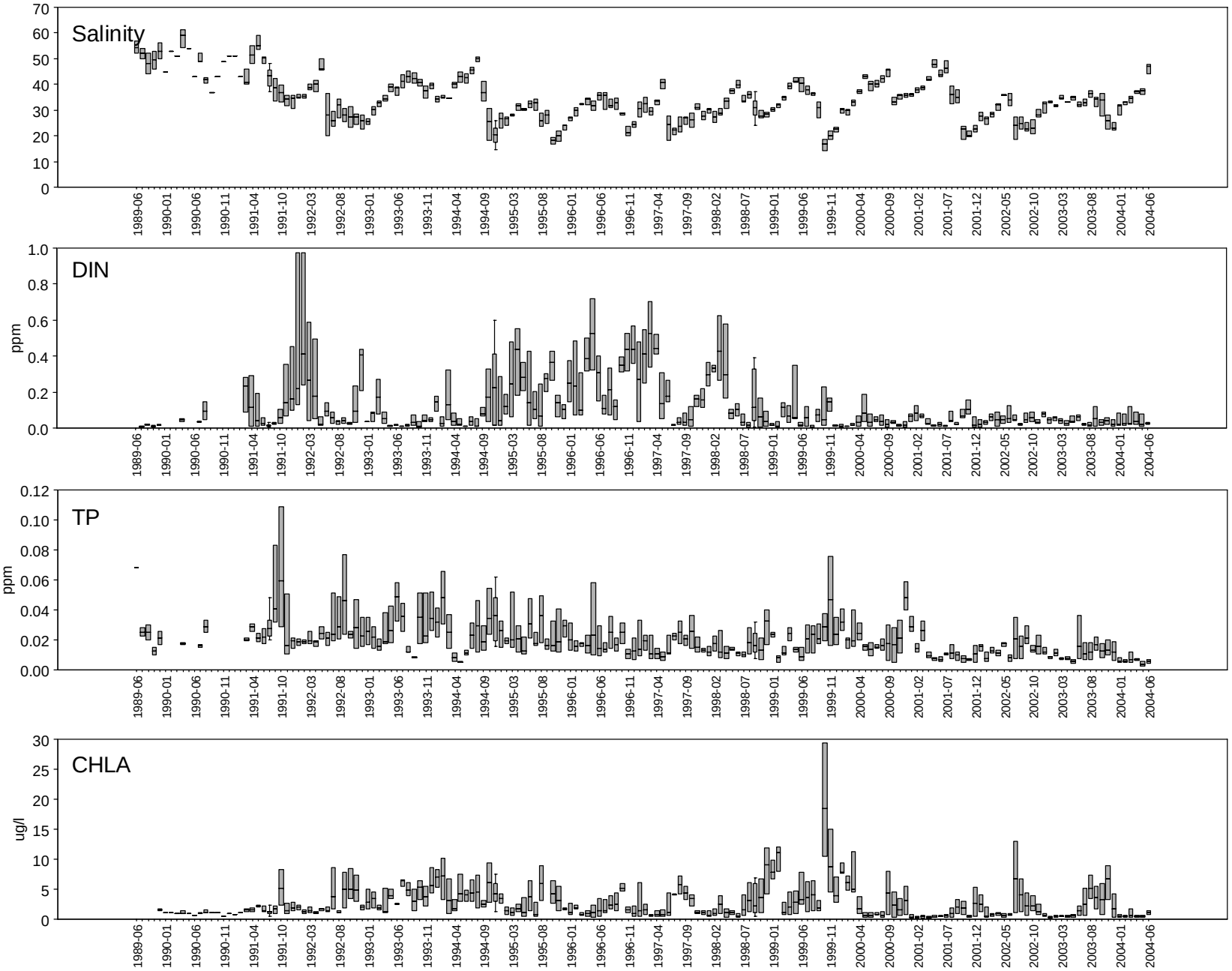

Figure 8. Box-and-whisker plots of water quality in Central Florida Bay by survey.

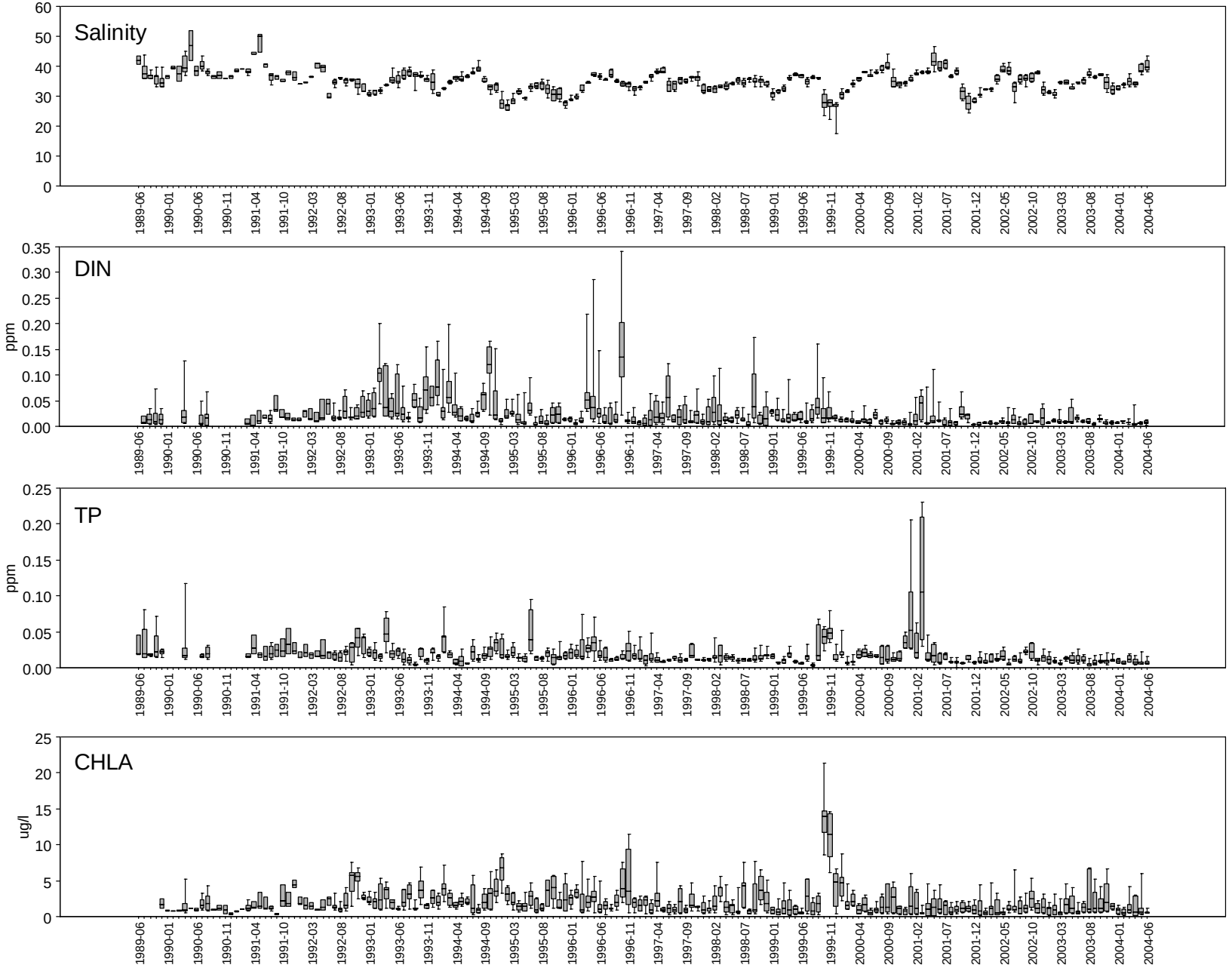

Figure 9. Box-and-whisker plots of water quality in Western Florida Bay by survey.

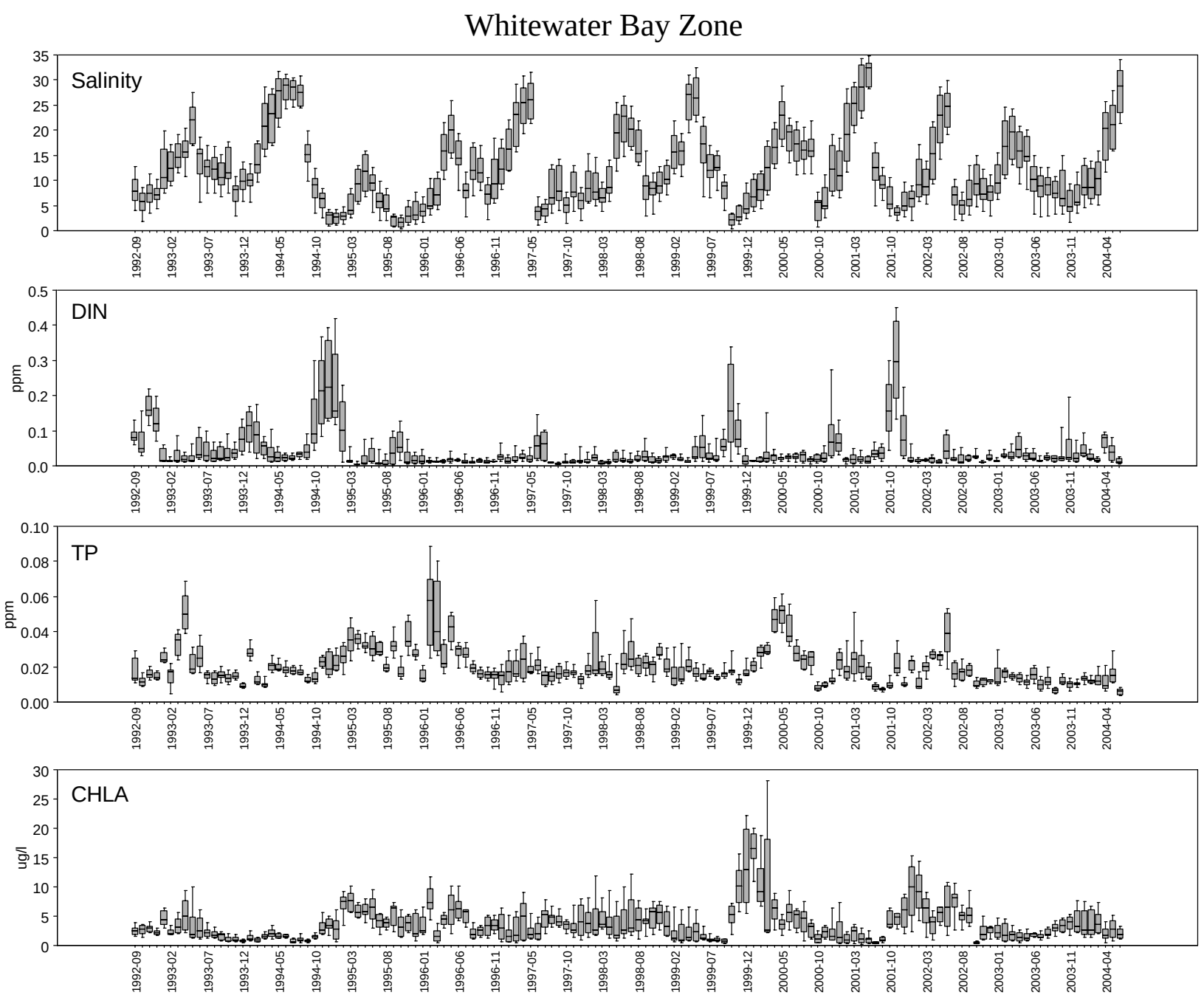

Figure 10. Box-and-whisker plots of water quality in WWB-TTI by survey.

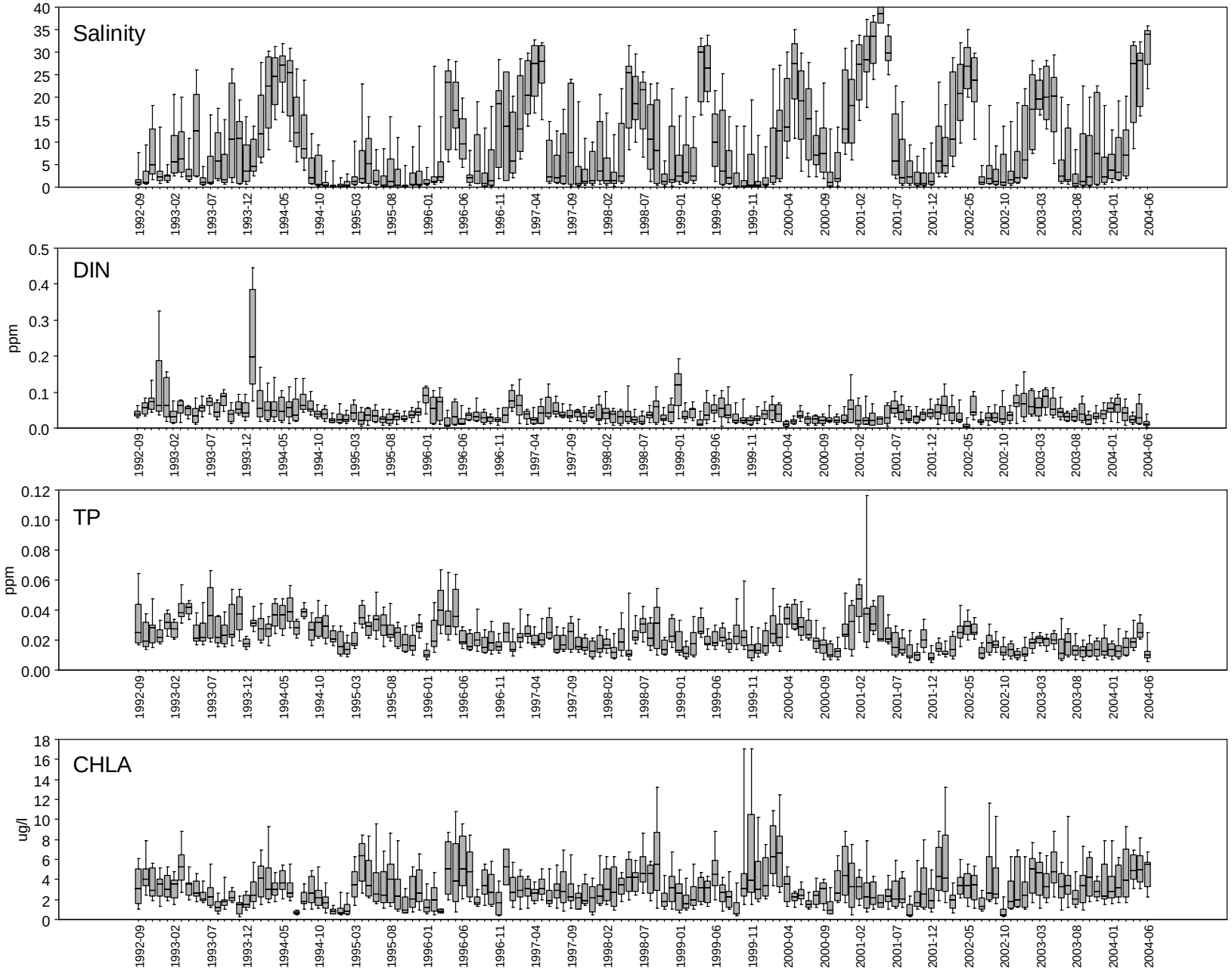

Figure 11. Box-and-whisker plots of water quality in WWB-TTI by survey.

Gulf Islands Zone

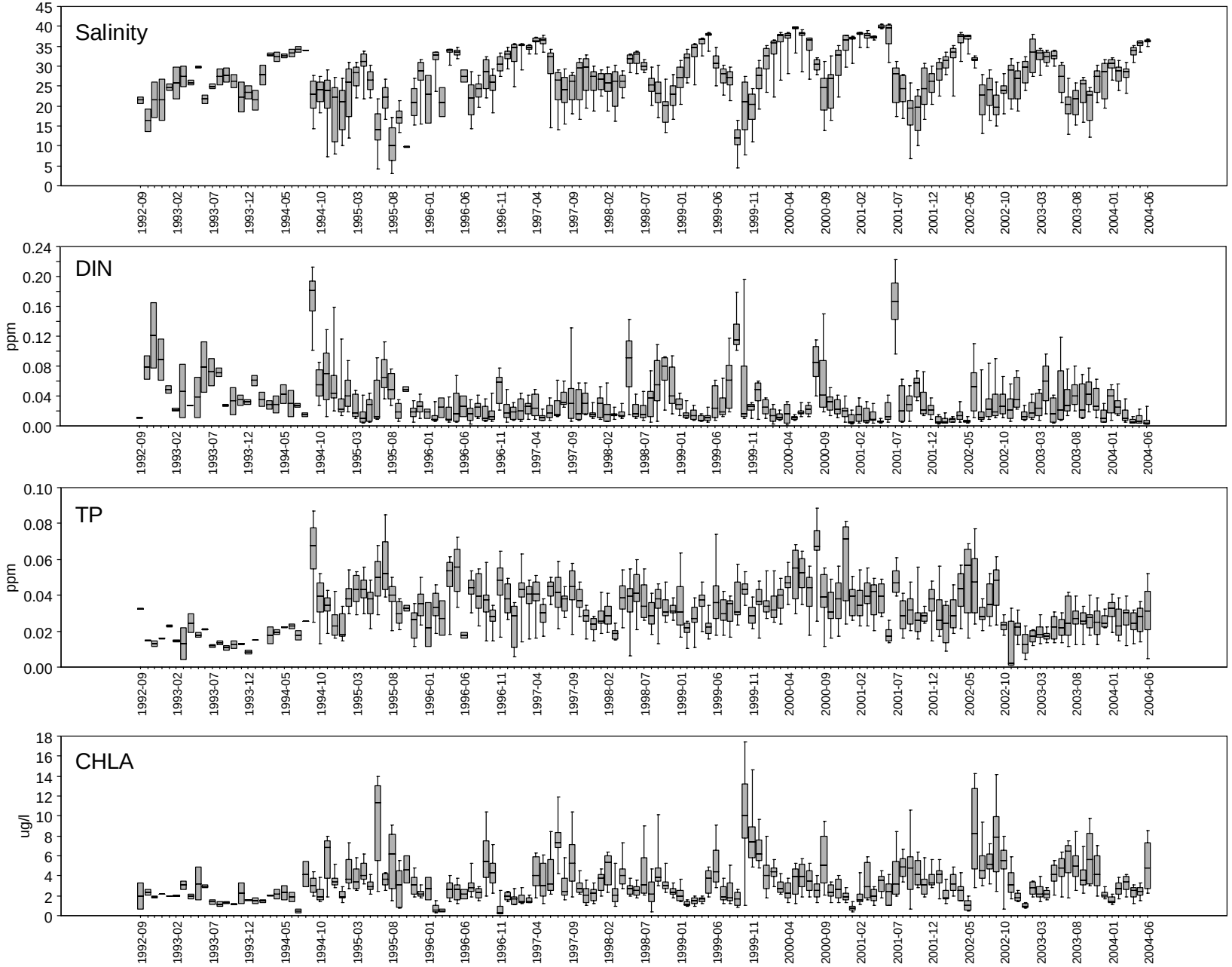

Figure 12. Box-and-whisker plots of water quality in WWB-TTI by survey.

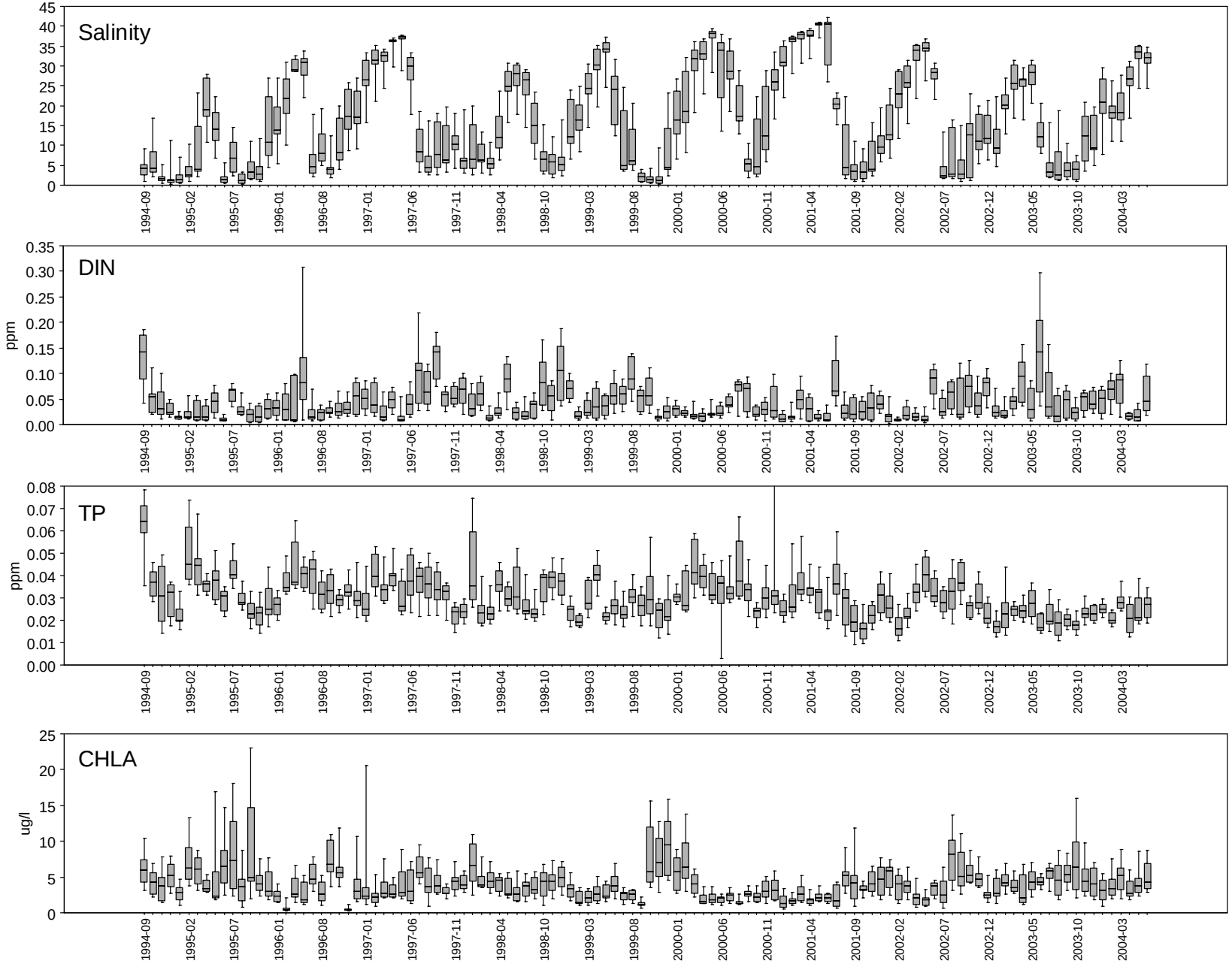

Figure 13. Box-and-whisker plots of water quality in WWB-TTI by survey.

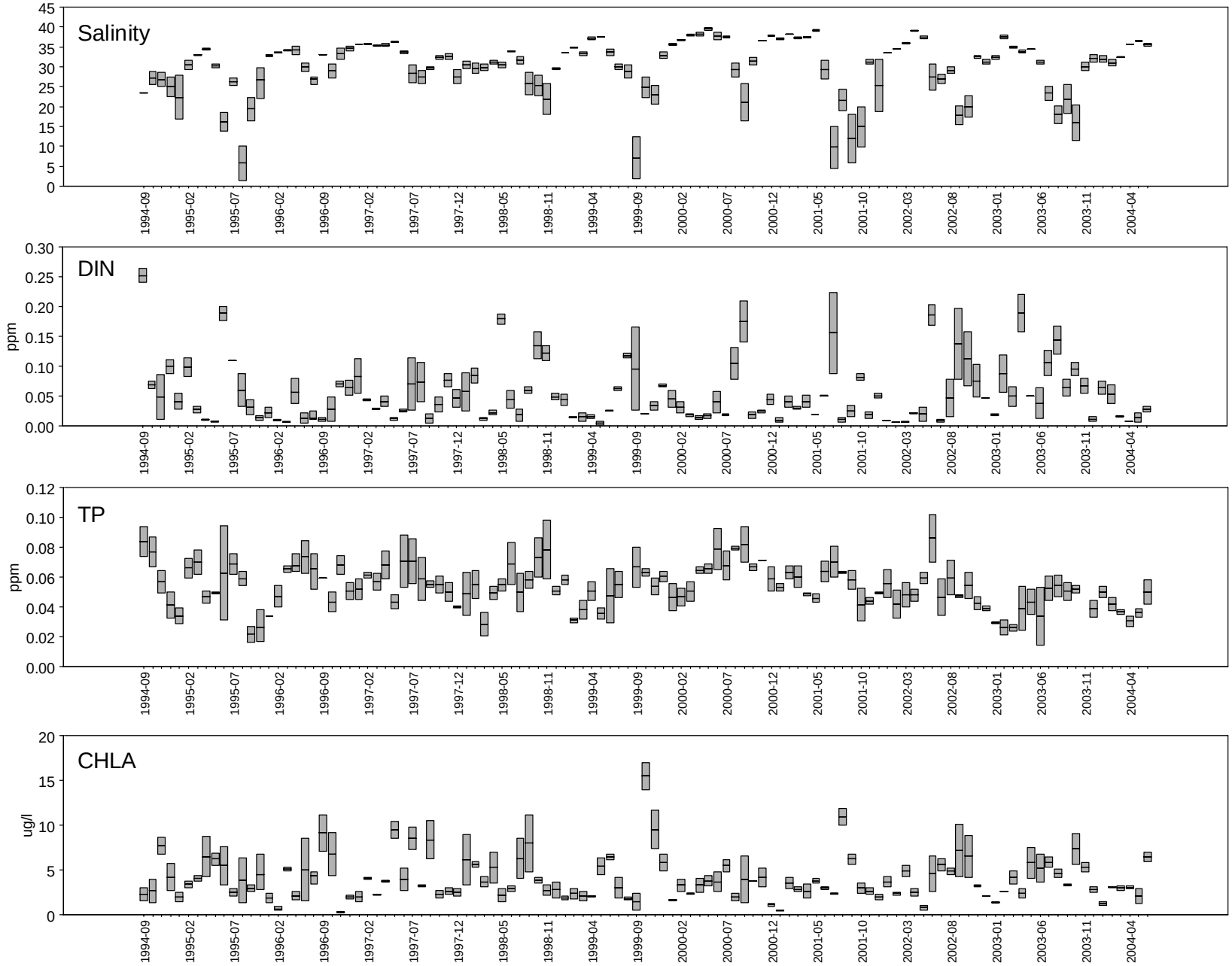

Figure 14. Box-and-whisker plots of water quality in WWB-TTI by survey.

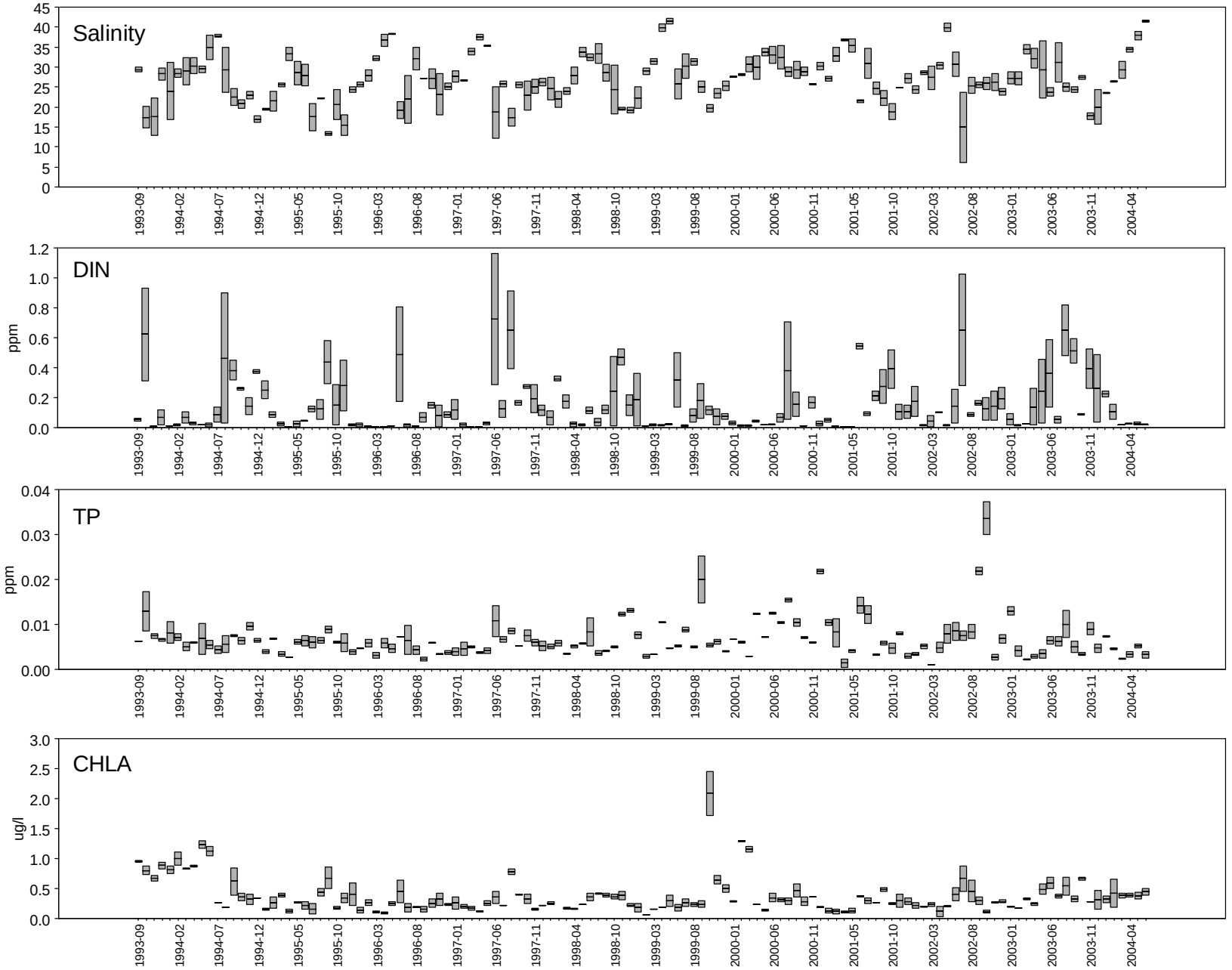

Figure 15. Box-and-whisker plots of water quality in Biscayne Bay by survey.

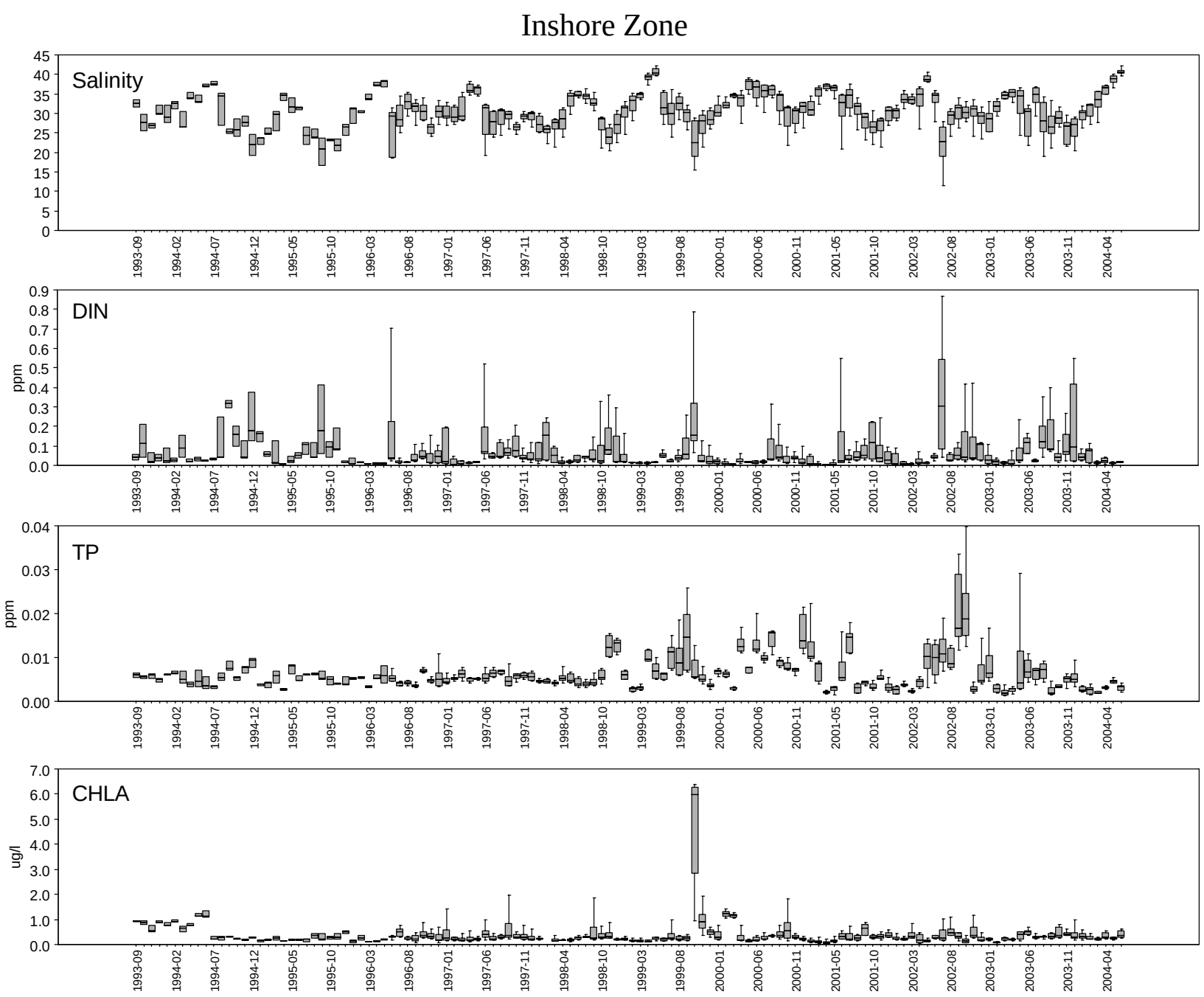

Figure 16. Box-and-whisker plots of water quality in Biscayne Bay by survey.

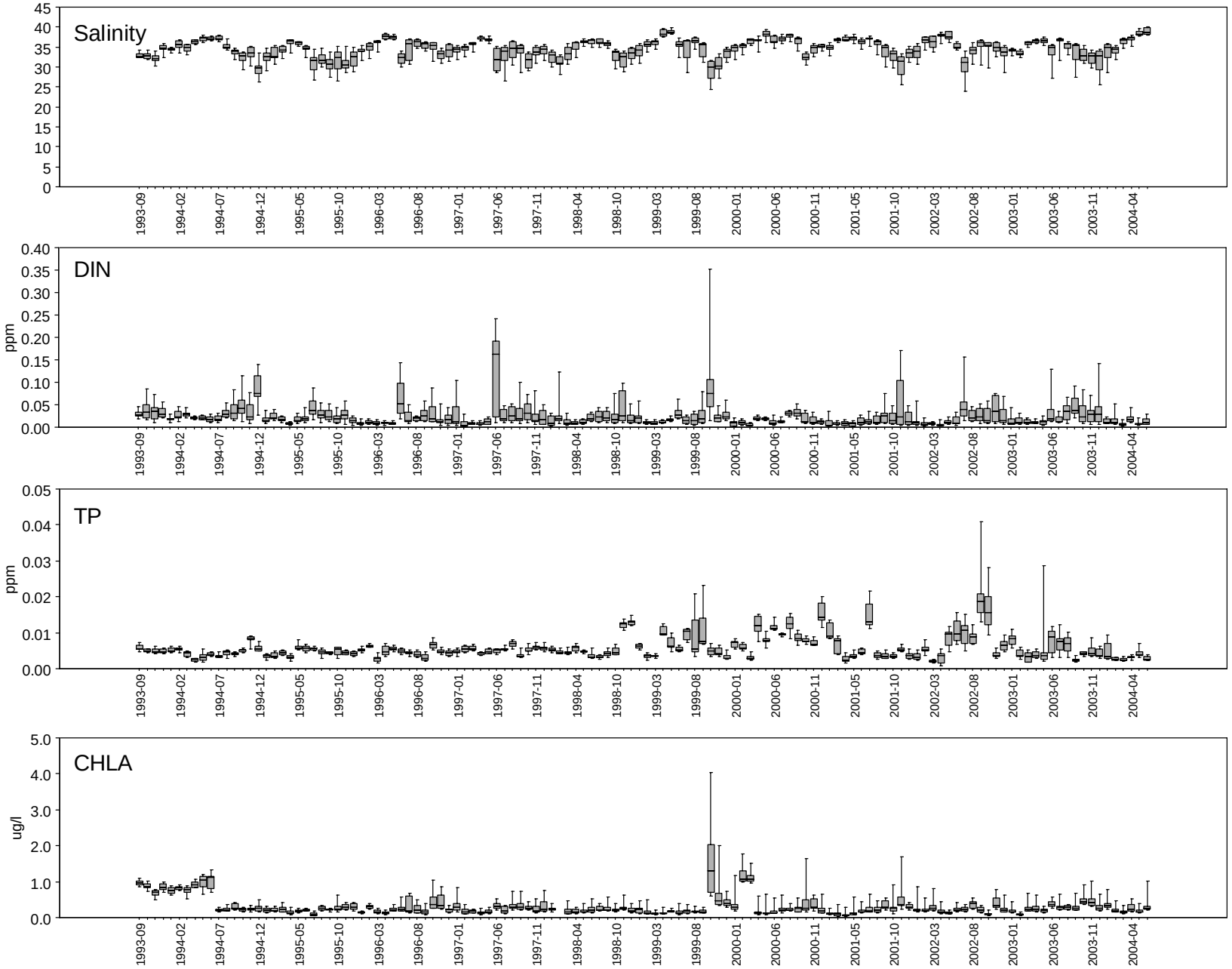

Figure 17. Box-and-whisker plots of water quality in Biscayne Bay by survey.

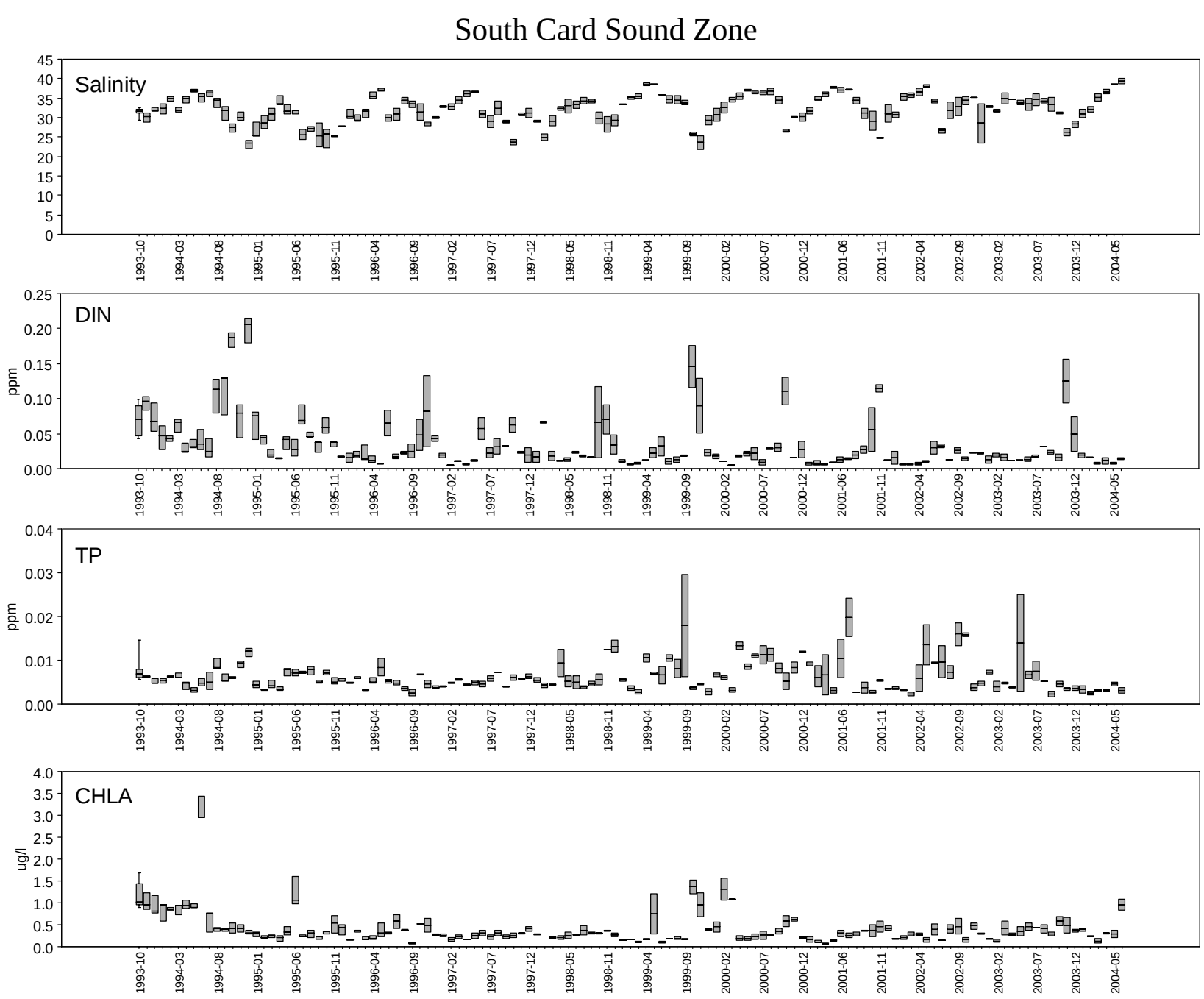

Figure 18. Box-and-whisker plots of water quality in Biscayne Bay by survey.

North Bay Zone

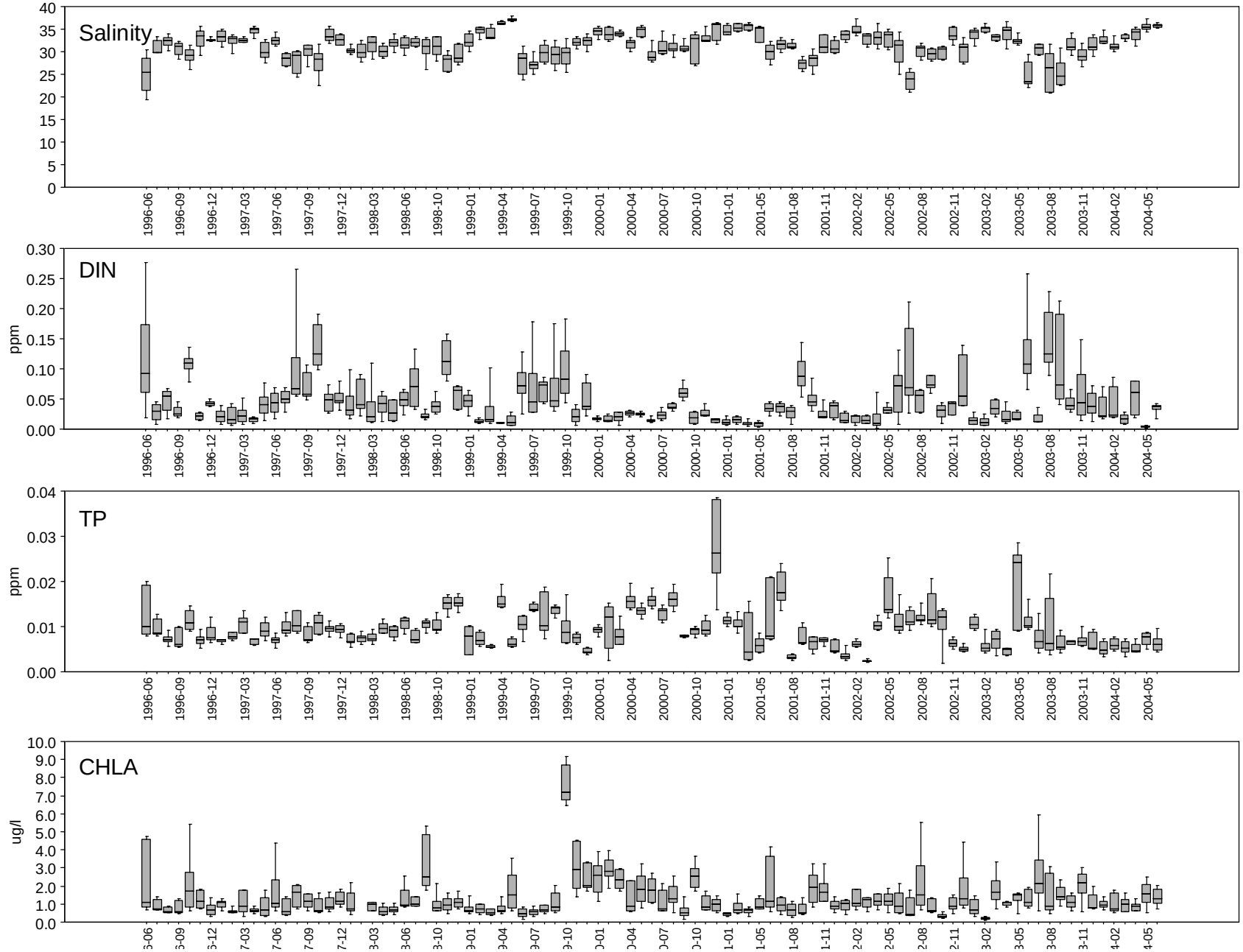

Figure 19. Box-and-whisker plots of water quality in Biscayne Bay by survey.

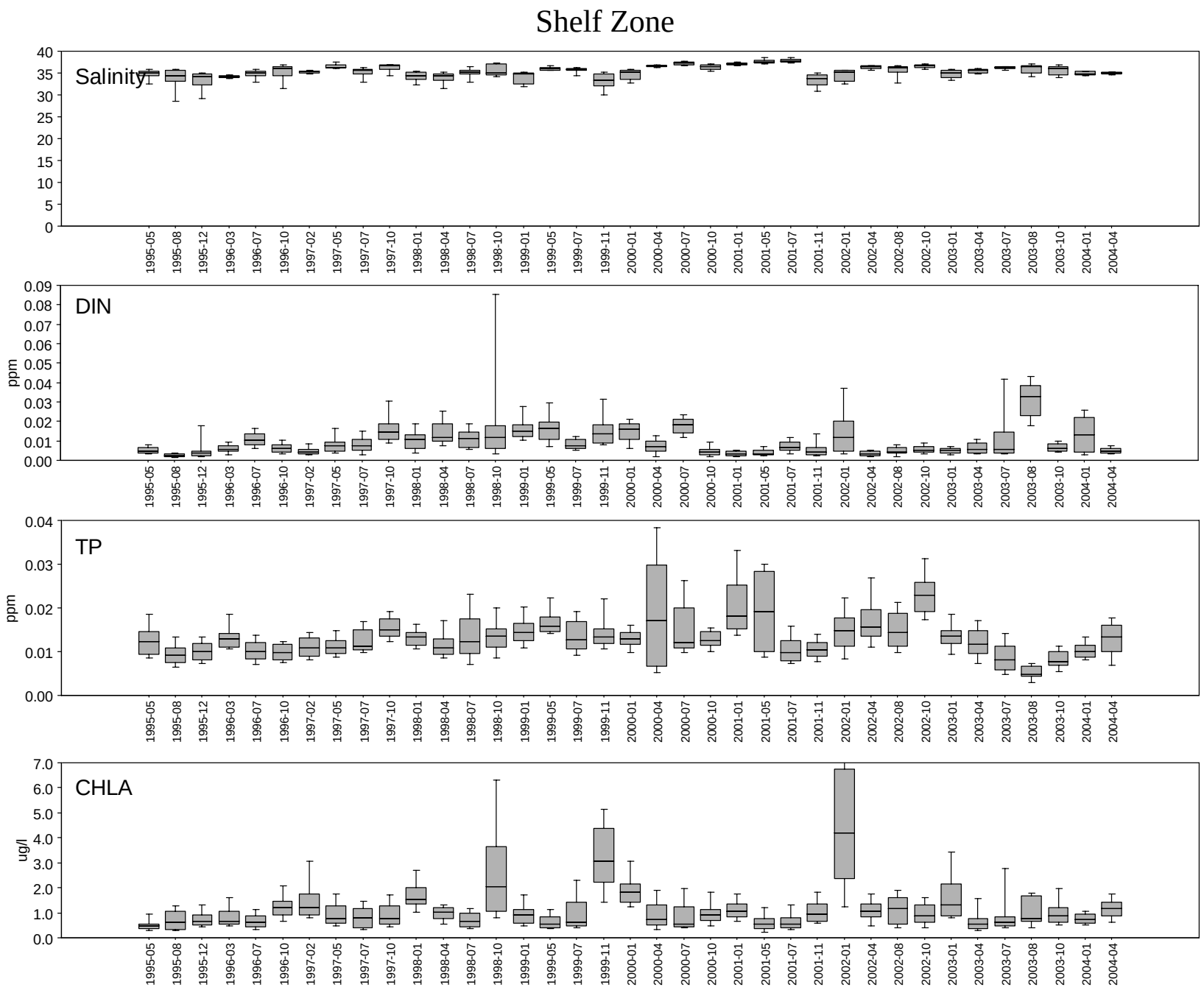

Figure 20. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

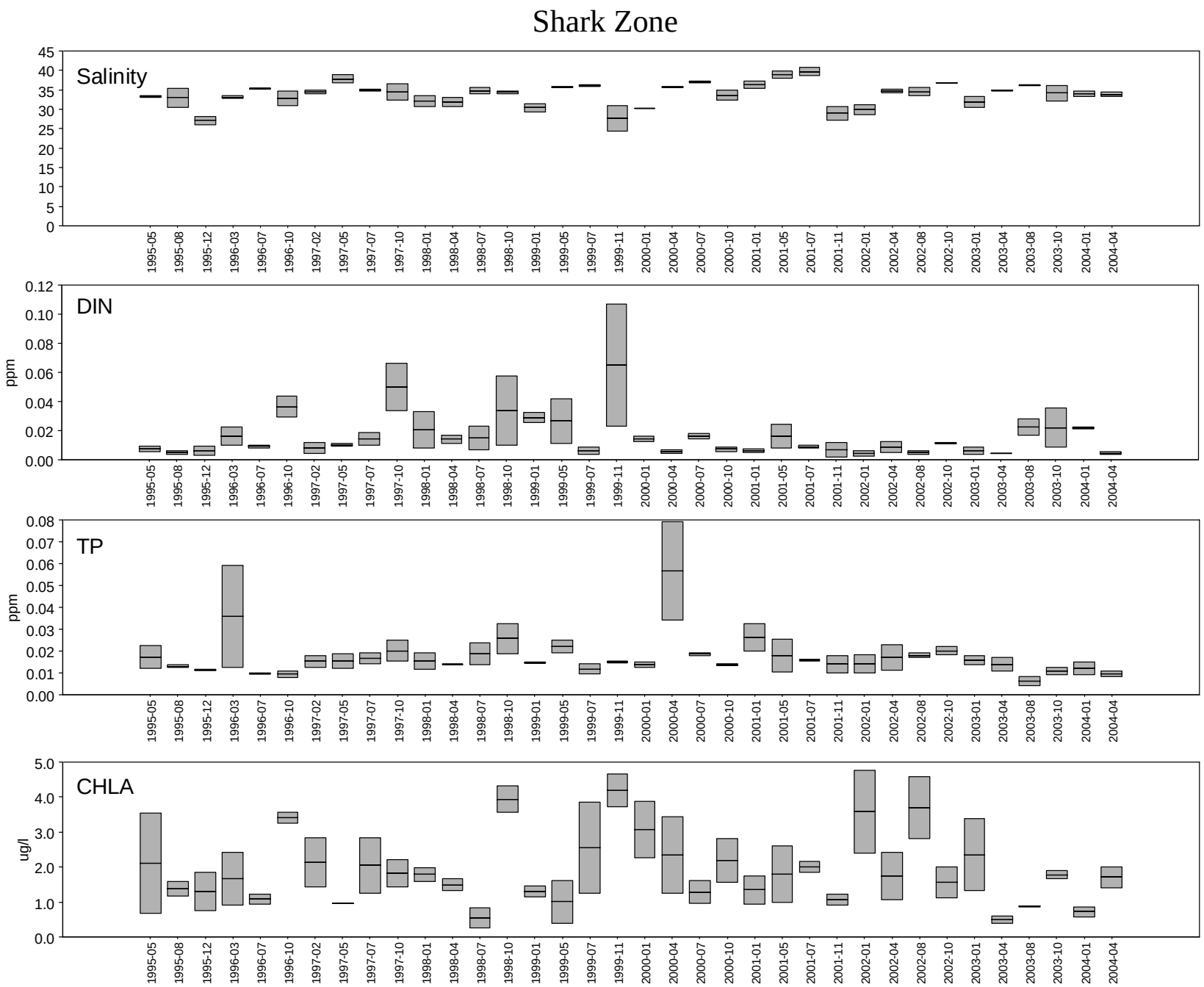

Figure 21. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

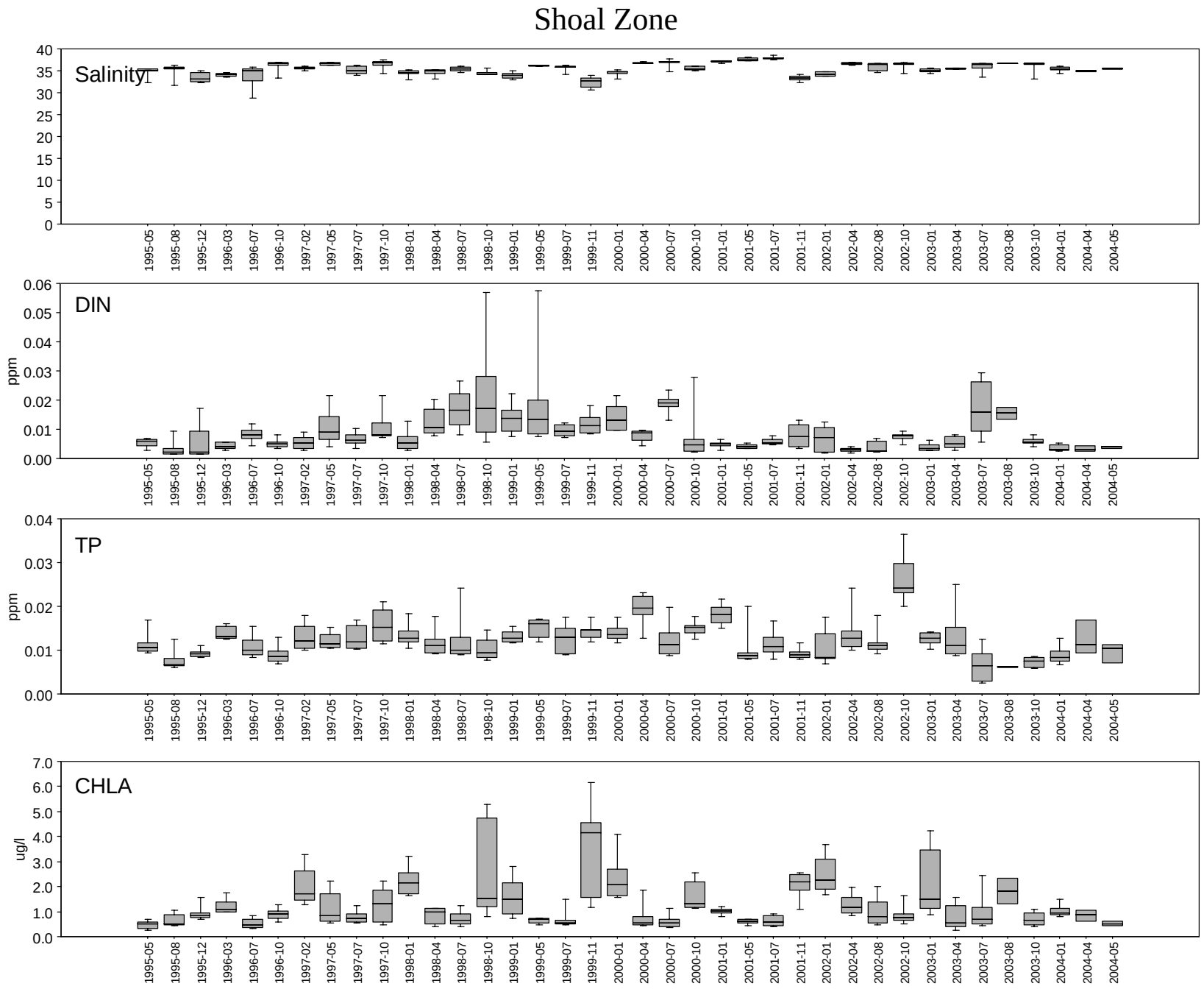

Figure 22. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

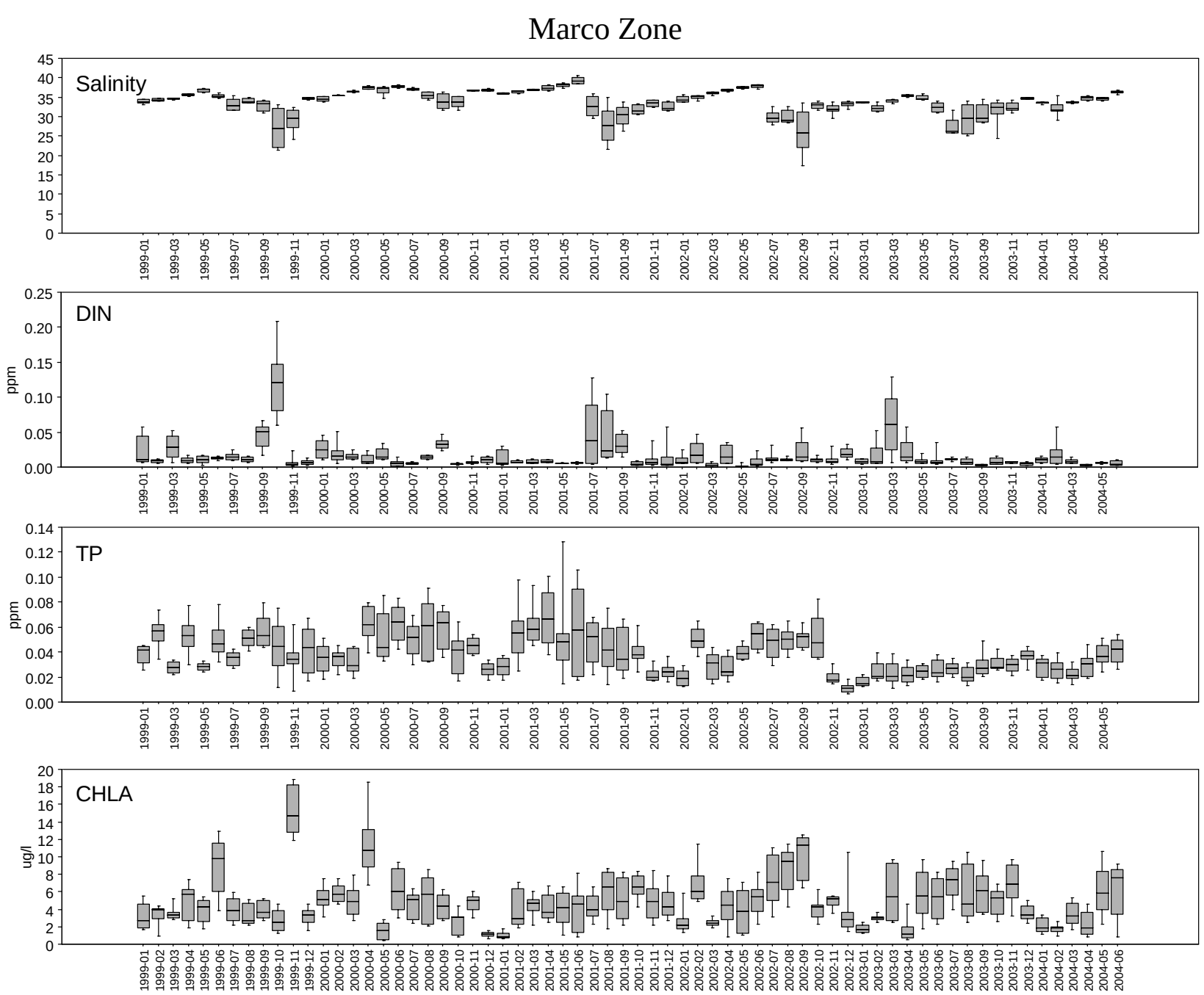

Figure 23. Box-and-whisker plots of water quality in RB-PIS by survey.

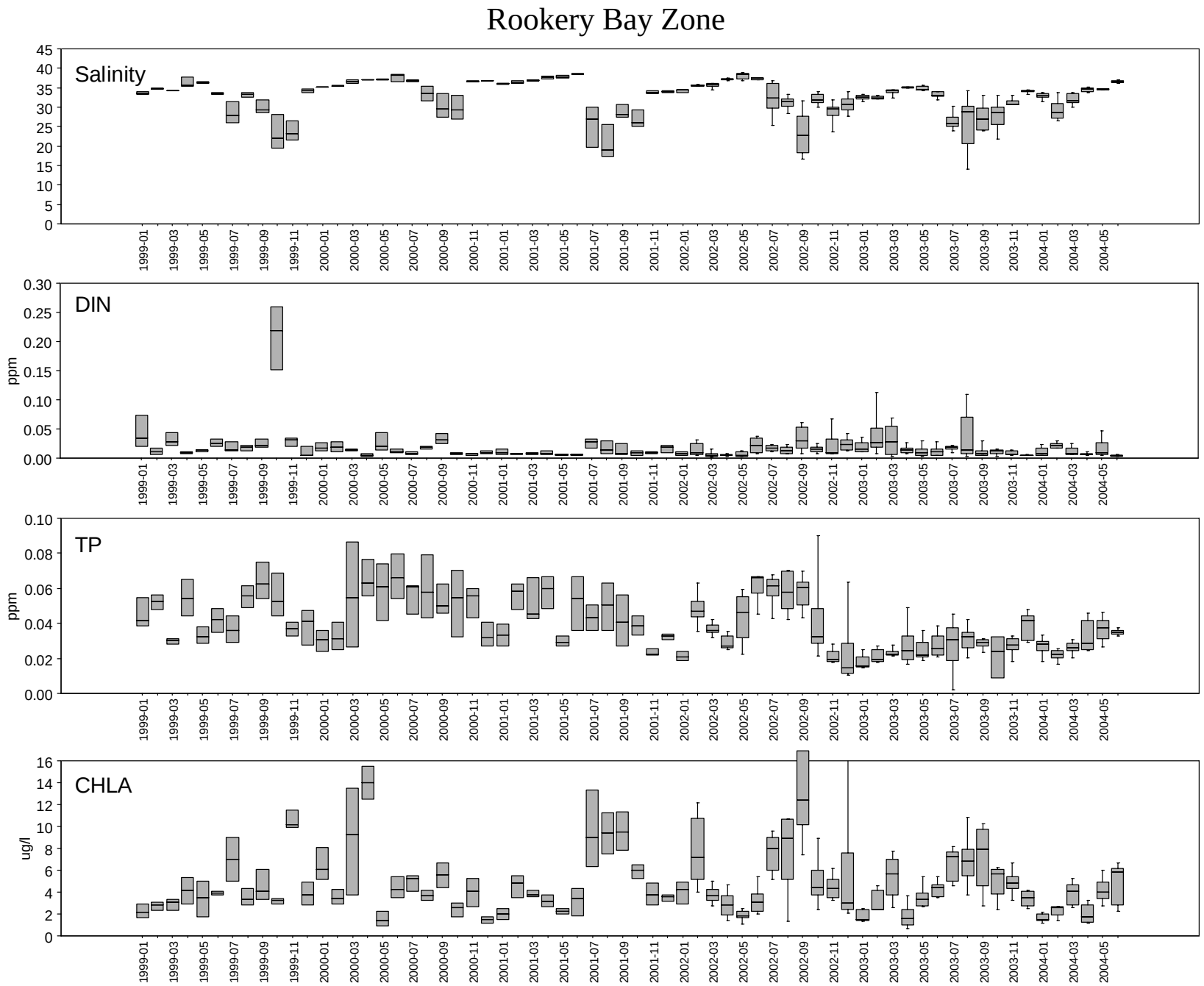

Figure 24. Box-and-whisker plots of water quality in RB-PIS by survey.

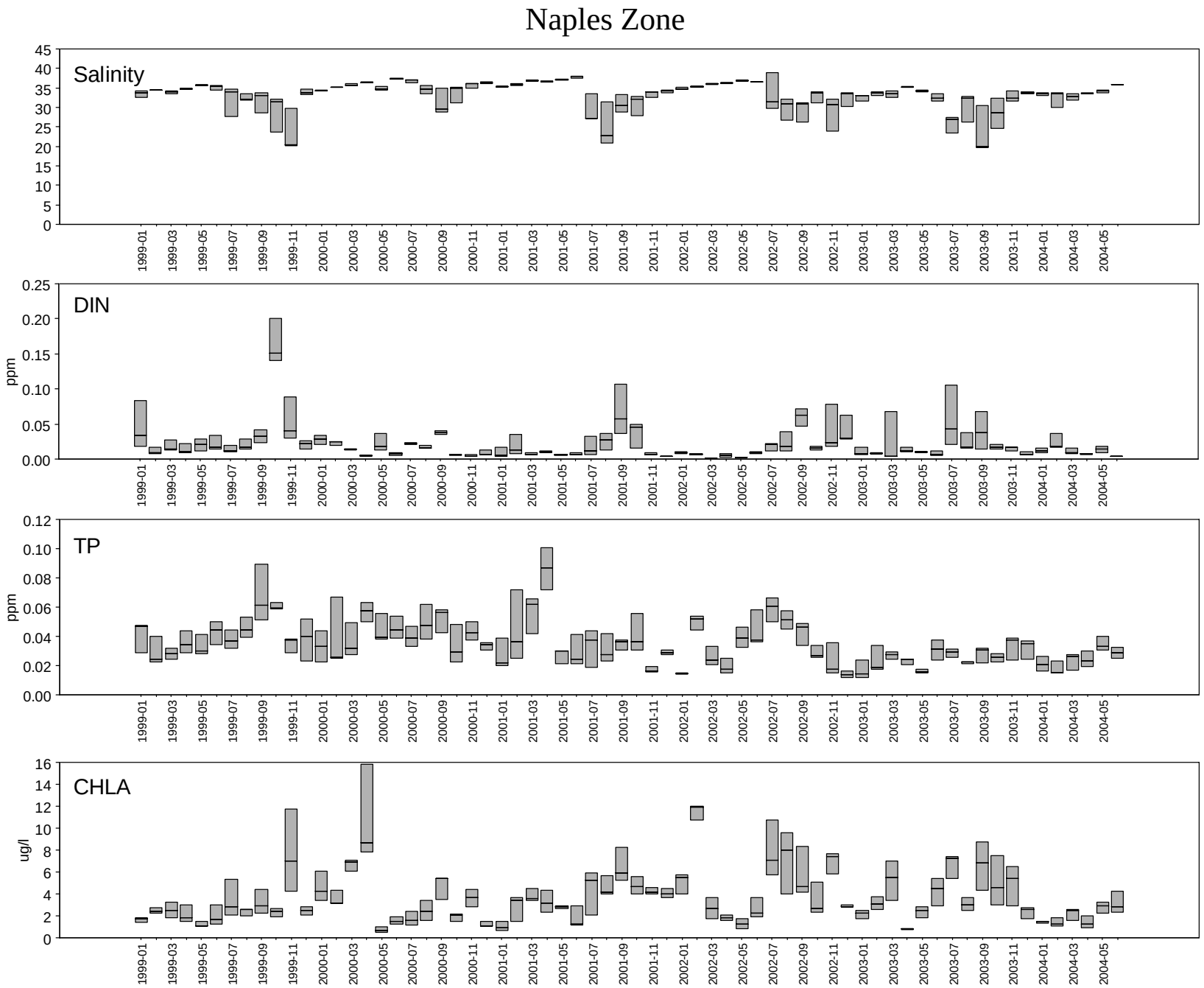

Figure 25. Box-and-whisker plots of water quality in RB-PIS by survey.

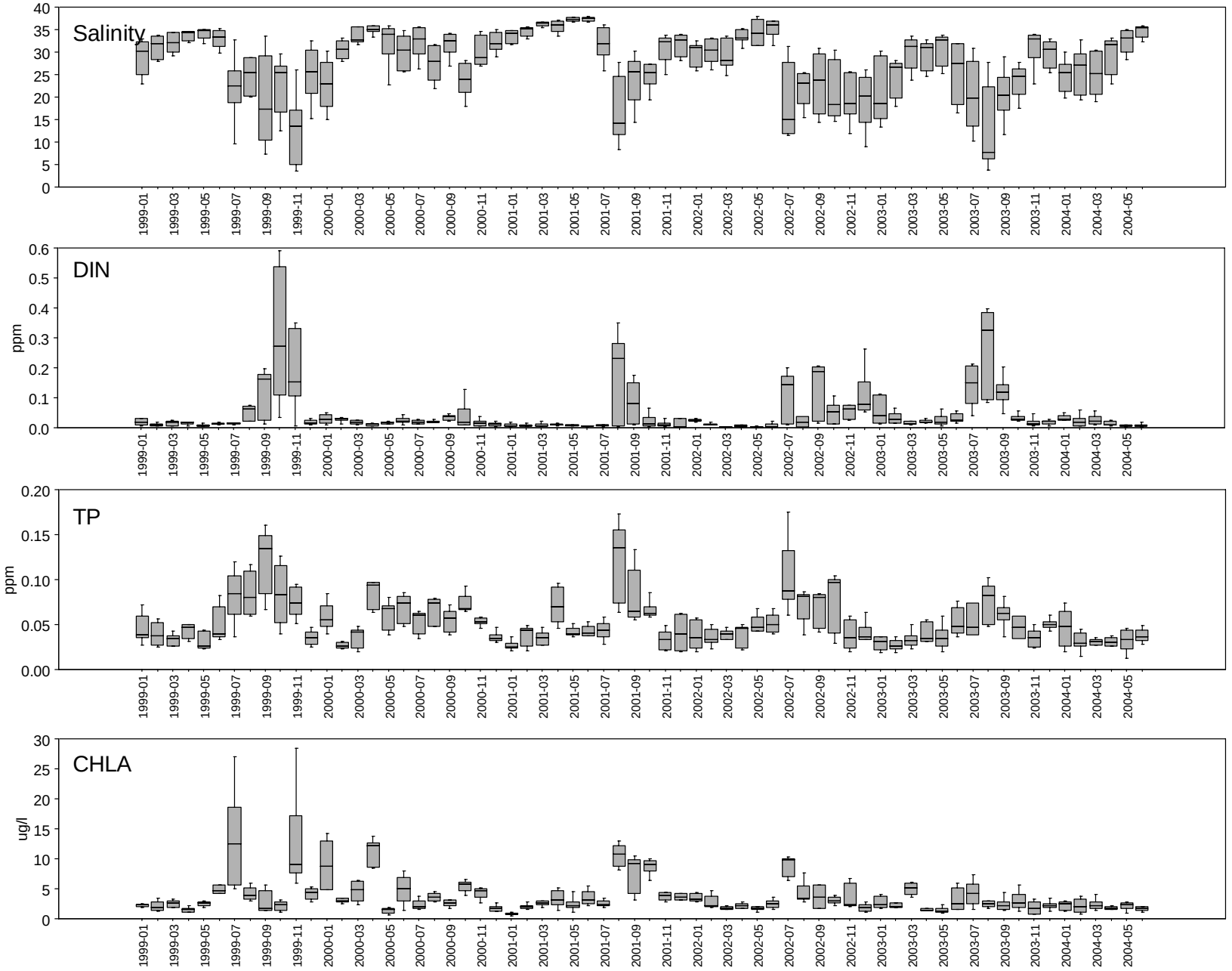

Figure 26. Box-and-whisker plots of water quality in RB-PIS by survey.

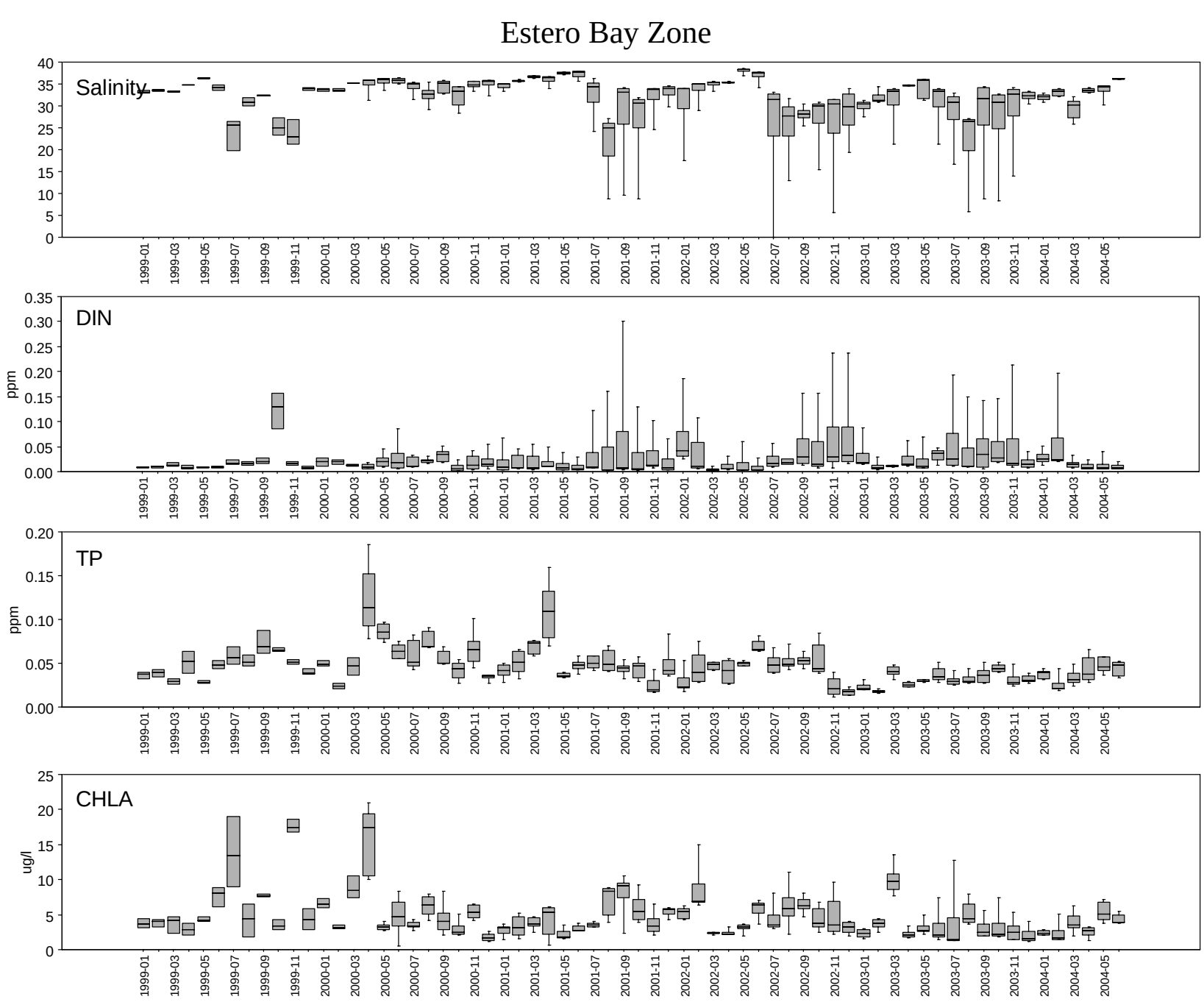

Figure 27. Box-and-whisker plots of water quality in RB-PIS by survey.

Pine Island Sound Zone

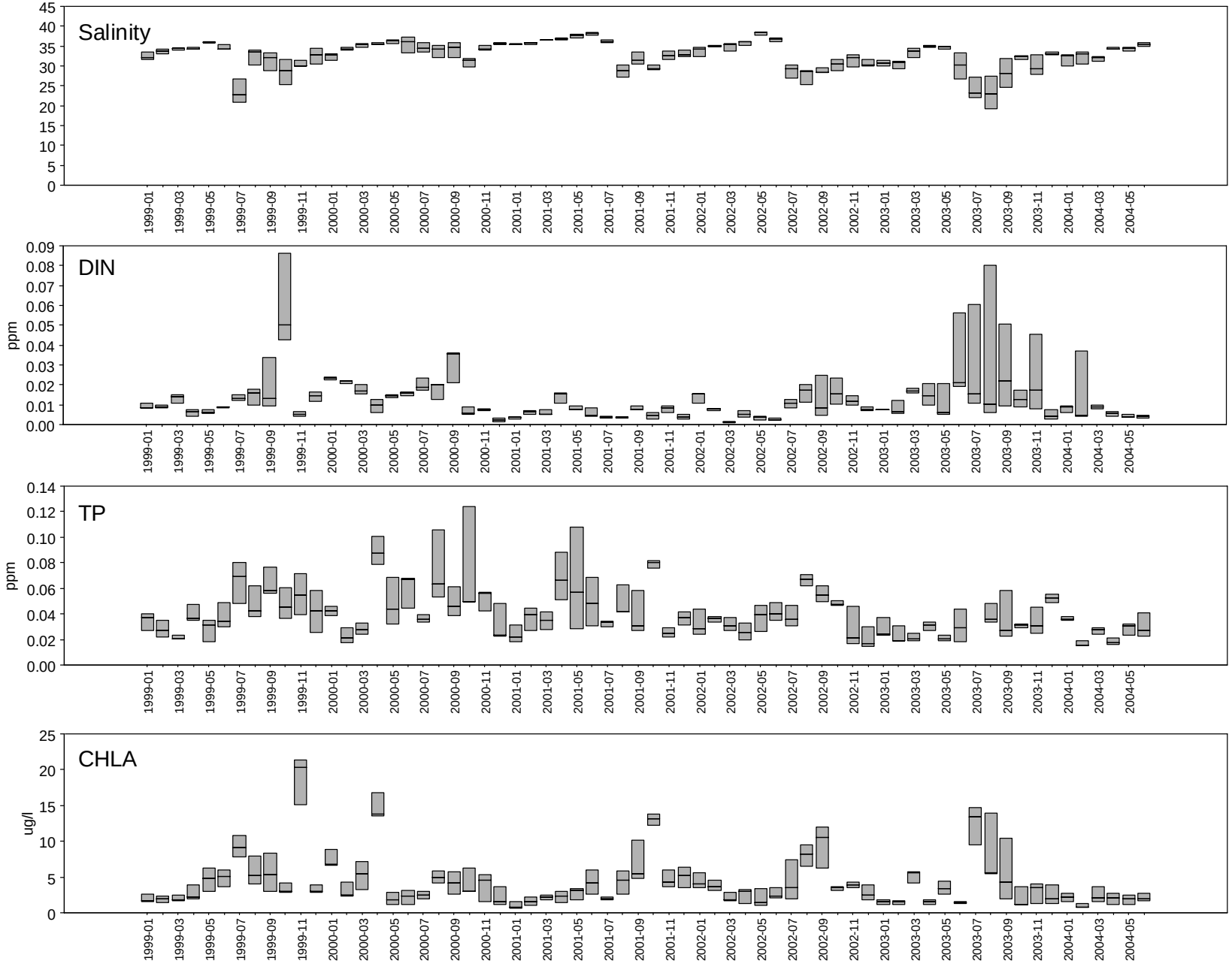

Figure 28. Box-and-whisker plots of water quality in RB-PIS by survey.

Table 1.

Parameter	Zone	Median	Min.	Max.	*n*
Alkaline Phosphatase Activity ($\mu M\ h^{-1}$)	Biscayne Bay	0.138	0.022	0.915	75
	Florida Bay	0.219	0.030	0.791	84
	Rookery Bay	0.041	0.022	0.100	87
	SW Shelf	0.026	0.017	0.071	43
	Ten Thousand Is.	0.051	0.026	1.578	78
	Whitewater Bay	0.358	0.032	3.136	66
Chlorophyll *a* ($\mu g\ l^{-1}$)	Biscayne Bay	0.320	0.123	2.507	75
	Florida Bay	0.399	0.107	6.478	84
	Rookery Bay	2.820	0.613	10.978	87
	SW Shelf	1.121	0.174	5.054	44
	Ten Thousand Is.	3.213	1.016	13.260	78
	Whitewater Bay	3.509	0.427	13.398	66
Surface Dissolved Oxygen ($mg\ l^{-1}$)	Biscayne Bay	5.98	3.99	7.83	75
	Florida Bay	6.42	3.79	8.88	84
	Rookery Bay	5.77	3.74	7.20	87
	SW Shelf	6.93	5.90	9.32	43
	Ten Thousand Is.	5.37	3.37	10.39	78
	Whitewater Bay	5.91	2.85	7.73	66
Bottom Dissolved Oxygen ($mg\ l^{-1}$)	Biscayne Bay	6.12	4.01	8.16	75
	Florida Bay	6.46	3.93	8.93	84
	Rookery Bay	5.78	3.73	7.30	86
	SW Shelf	6.57	4.32	9.32	43
	Ten Thousand Is.	5.20	3.31	9.06	78
	Whitewater Bay	5.85	3.22	8.92	66
NH_4^+ (ppm)	Biscayne Bay	0.010	0.000	0.054	75
	Florida Bay	0.010	0.001	0.229	84
	Rookery Bay	0.003	0.000	0.040	87
	SW Shelf	0.002	0.001	0.008	44
	Ten Thousand Is.	0.006	0.001	0.102	78
	Whitewater Bay	0.007	0.000	0.074	66

Parameter	Zone	Median	Min.	Max.	*n*
NO_2^-	Biscayne Bay	0.001	0.000	0.005	75
(ppm)	Florida Bay	0.001	0.000	0.009	84
	Rookery Bay	0.000	0.000	0.002	87
	SW Shelf	0.000	0.000	0.001	44
	Ten Thousand Is.	0.001	0.000	0.008	78
	Whitewater Bay	0.001	0.000	0.004	66
NO_3^-	Biscayne Bay	0.003	0.000	0.031	75
(ppm)	Florida Bay	0.003	0.000	0.034	84
	Rookery Bay	0.002	0.000	0.011	87
	SW Shelf	0.002	0.000	0.003	44
	Ten Thousand Is.	0.004	0.000	0.034	78
	Whitewater Bay	0.010	0.001	0.060	66
pH	Biscayne Bay	8.110	7.095	8.470	75
	Florida Bay	8.205	7.810	8.715	84
	Rookery Bay	7.940	7.080	8.285	87
	SW Shelf	7.740	7.530	8.045	44
	Ten Thousand Is.	7.883	7.600	8.330	78
	Whitewater Bay	7.980	7.615	8.405	66
Surface	Biscayne Bay	37.80	31.25	42.14	75
Salinity	Florida Bay	37.37	25.77	48.57	84
	Rookery Bay	34.71	22.99	36.96	87
	SW Shelf	34.97	33.27	35.65	43
	Ten Thousand Is.	34.37	7.44	36.86	78
	Whitewater Bay	27.09	5.89	36.32	66
Bottom	Biscayne Bay	37.83	31.40	42.17	75
Salinity	Florida Bay	37.41	25.73	48.64	84
	Rookery Bay	34.79	25.65	37.05	86
	SW Shelf	35.00	33.27	35.67	43
	Ten Thousand Is.	34.56	7.51	37.09	78
	Whitewater Bay	27.58	5.79	36.36	66

Parameter	Zone	Median	Min.	Max.	*n*
$Si(OH)_4$ (ppm)	Biscayne Bay	0.067	0.004	0.637	25
	Florida Bay	0.148	0.008	1.013	28
	Rookery Bay	0.221	0.003	0.713	29
	SW Shelf	0.021	0.003	0.520	44
	Ten Thousand Is.	1.225	0.388	2.015	26
	Whitewater Bay	1.216	0.083	1.946	22
Soluble Reactive Phosphorus (ppm)	Biscayne Bay	0.001	0.000	0.002	75
	Florida Bay	0.001	0.000	0.002	84
	Rookery Bay	0.006	0.001	0.023	87
	SW Shelf	0.001	0.000	0.004	44
	Ten Thousand Is.	0.005	0.001	0.025	78
	Whitewater Bay	0.001	0.000	0.007	66
Surface Temperature (^oC)	Biscayne Bay	29.20	20.74	31.51	75
	Florida Bay	26.94	22.89	31.80	84
	Rookery Bay	26.59	21.33	32.39	87
	SW Shelf	22.96	18.75	26.22	43
	Ten Thousand Is.	28.86	21.38	30.76	78
	Whitewater Bay	27.58	21.52	32.32	66
Bottom Temperature (^oC)	Biscayne Bay	29.12	20.74	31.48	75
	Florida Bay	26.93	22.83	31.87	84
	Rookery Bay	26.45	21.28	31.67	86
	SW Shelf	22.92	21.33	26.20	43
	Ten Thousand Is.	28.62	21.39	30.65	78
	Whitewater Bay	27.48	20.19	32.32	66
Total Nitrogen (ppm)	Biscayne Bay	0.413	0.240	0.760	75
	Florida Bay	0.486	0.244	1.092	84
	Rookery Bay	0.365	0.202	0.904	87
	SW Shelf	0.414	0.299	1.043	44
	Ten Thousand Is.	0.393	0.139	0.996	78
	Whitewater Bay	0.443	0.207	0.992	66

Parameter	Zone	Median	Min.	Max.	*n*
Total Organic Carbon (ppm)	Biscayne Bay	2.603	1.673	5.711	75
	Florida Bay	6.339	1.351	14.047	84
	Rookery Bay	3.074	1.700	6.173	87
	SW Shelf	1.621	1.239	3.486	44
	Ten Thousand Is.	4.925	1.482	17.523	78
	Whitewater Bay	9.095	3.132	20.508	66
Total Organic Nitrogen (ppm)	Biscayne Bay	0.382	0.233	0.742	75
	Florida Bay	0.450	0.237	1.074	84
	Rookery Bay	0.359	0.191	0.897	87
	SW Shelf	0.408	0.295	1.040	44
	Ten Thousand Is.	0.376	0.132	0.968	78
	Whitewater Bay	0.408	0.199	0.968	66
Total Phosphorus (ppm)	Biscayne Bay	0.004	0.002	0.010	75
	Florida Bay	0.004	0.002	0.024	84
	Rookery Bay	0.035	0.012	0.065	87
	SW Shelf	0.012	0.004	0.024	44
	Ten Thousand Is.	0.028	0.012	0.058	78
	Whitewater Bay	0.013	0.003	0.039	66
Turbidity (NTU)	Biscayne Bay	0.69	0.21	1.86	75
	Florida Bay	1.62	0.32	38.05	84
	Rookery Bay	3.06	0.48	12.82	87
	SW Shelf	3.35	0.38	11.22	43
	Ten Thousand Is.	3.99	1.16	15.65	78
	Whitewater Bay	3.00	0.40	9.90	66