APPENDIX B: SWQMIS HISTORICAL WATER QUALITY DATA ANALYSIS

A full set of reported water quality data collected in the study area was developed in the summer of 2014 by TIAER. Dataset compilation began with a data request to TCEQ's SWQMIS. The request sought all water quality data in the Brownsville-Resaca watershed within segments 2491, 2491A, 2493, 2494, 2494A, and 2494B. Over 8,600 records were returned from 150 stations covering 1969 - 2014. An initial assessment of the data revealed 112 stations that were not located in the Brownsville-Resaca watershed and these were culled. Additional stations were culled if they were represented by only a few records from a single year. Among the 572 water quality parameters, hundreds were culled because they were irrelevant to the analyses contained in this report (e.g., pesticides and sediment metals) or appeared in fewer than 10 records. All records were scanned for demonstrably spurious data, e.g., a turbidity value of -229.8 that was removed from the dataset. Following the removal of unnecessary stations and parameters, some parameters were integrated after unit conversion. For example, water temperature in degrees Fahrenheit was converted to degrees centigrade and integrated with values directly reported in degrees centigrade. Other parameters were merged that were deemed equivalent for the purposes of this report (e.g., fecal coliform evaluated using three different lab methods). Consolidating parameters produced a dataset with higher numbers of samples for each parameter and reduced the total number of parameters used in analyses, an important benefit given the complexities of the dataset.

The final working dataset contains 5,464 records from 29 stations covering 49 water quality parameters for the Brownsville-Resaca watershed. The full period of record in the working dataset is 1969–2014. Historical data (pre-2000) was retained primarily to provide context for investigations of water quality data availability over time, however, this report is principally focused only on recent trends and the period of record (POR) will henceforth refer to the years 2000-2014. Since the full dataset contains profile data—samples collected at various depths on the same date—and pertinent criteria and screening levels refer to surface samples (~ 0.3 m), it was necessary to create a dataset that included only surface samples. Thus, the set of groomed surface data from 2000 – 2014, contains 1397 records from 29 stations. This report is chiefly concerned with the data availability and basic statistics of water quality parameters pertaining to bacteria, dissolved oxygen, and nutrients. Hereafter, these will be collectively referred to as the "key parameters" and they are described in Table 4-##. Other water quality parameters were retained for reference but are not analyzed in this report. It must be noted that it is common practice to use the parameter nitrite plus nitrate nitrogen to represent nitrate. Although some of the nitrate data described in this report is attributable strictly to nitrate nitrogen, the majority of nitrate data is actually the combined parameter of nitrite plus nitrate nitrogen.

Table 4-1. Key water quality parameters given priority in this report according to data availability across time and space and relevance to primary water quality concerns in the Brownsville-Resaca watershed.

Water Quality Parameter	Abbreviation Used in Report	Criteria and Screening Levels	
Enterococcus (saline and tidal freshwaters)	Entero	35 MPN/100mL	Criterion
Fecal Coliform (oyster waters)	Fcoli	14 MPN/100mL	Criterion
Dissolved Oxygen (Grab)[a]	DO	5.0 mg/L (Single Sample)	Screening Level

		4.0 mg/L (Minimum)	
Total Ammonia as Nitrogen	NH3	0.10 mg/L	Screening Level
Total Nitrate as Nitrogen	NO23[b]	0.17 mg/L	Screening Level
Dissolved Orthophosphate Phosphorus	OPO4	0.19 mg/L	Screening Level
Total Phosphorus	TP	0.21 mg/L	Screening Level
Chlorophyll-a	CHLA	11.6 µg/L	Screening Level

[a] Segment 2494A has screening levels of 4.0 and 3.0 mg/L for single sample and minimum, respectively.

[b] Due to the low number of samples of simply nitrate (NO_3), the parameter nitrite plus nitrate nitrogen (NO_2+NO_3) will be used as a surrogate.

Only 8 of the total 29 SWQM stations retained for potential analysis contained a sufficient number of samples for key parameters since 2000 and were set aside for full data analysis. These will hereafter be referred to as "primary" stations and they are described below in Table 4-# and their locations are visually presented in Figure 4-#.

Table 4-2. Location descriptions for the 29 SWQM stations in the Brownsville-Resaca watershed that contain key water quality parameters since 2000. The eight primary stations with robust data analyzed in this report are highlighted.

AU	TCEQ AU Description	SWQM Station	TCEQ Station Description	Lat	Long
2491_02	**Area adjacent to the Arroyo-Colorado confluence**	13447[a]	LAGUNA MADRE INTERSECTION OF INTRACOASTAL CANAL AND ARROYO COLORADO	26.36667	-97.31667
2491_03	**Lower portion of bay** *south of the Arroyo-Colorado confluence*	13446	LAGUNA MADRE INTRACOASTAL CANAL AT MARKER 129 EAST OF PORT ISABEL	26.08333	-97.2
		14844	LAGUNA MADRE AT ICWW CHANNEL MARKER 49	26.26222	-97.28389
		14845	LAGUNA MADRE AT ICWW CHANNEL MARKER 109	26.14945	-97.23612
		14861	LAGUNA MADRE 300 YDS NW OF THE YACHT CLUB TURNING BASIN ENTRANCE	26.0825	-97.22916
		14862	LAGUNA MADRE 300 YDS NE OF ENTRANCE TO YACHT CLUB TURNING BASIN	26.08028	-97.21445
		14863	PORT ISABEL SIDE CHANNEL AT SH 100	26.07333	-97.21445
		14868	LAGUNA MADRE 200 YDS OFF SOUTH PADRE ISLAND 2 MI NORTH OF THE CAUSEWAY	26.1	-97.17028
		14869	LAGUNA MADRE 200 YDS OFF LAGUNA HEIGHTS SHORELINE	26.08417	-97.28056
		14870	LAGUNA MADRE 200 YDS OFF LAGUNA VISTA SHORELINE	26.1	-97.28056
		14876	LAGUNA MADRE AT THE MIDDLE OF THE SOUTH PADRE ISLAND CAUSEWAY	26.08056	-97.19583
		14878	LAGUNA MADRE AT ENTRANCE TO SEA RANCH MARINA CHANNEL	26.07556	-97.16944
		14879	LAGUNA MADRE 0.25 MI SOUTH OF COASTGUARD BOAT DOCKS	26.06945	-97.16306
		17100	LAGUNA MADRE 400M WEST OF ANDY BOWIE PARK	26.13764	-97.17811
		17975	LAGUNA MADRE IN BRAZOS SANTIAGO PASS 200 M SOUTH AND 325 M WEST OF SOUTHEASTERN TIP OF SOUTH PADRE ISLAND TDH STATION SOU20	26.06639	-97.15861
		14877[b]	LAGUNA MADRE NEAR RANGE MARKER	26.03194	-97.18889

AU	TCEQ AU Description	SWQM Station	TCEQ Station Description	Lat	Long
2493_01	**South Bay** *(entire segment)*	13459	LAGUNA MADRE SOUTH BAY PASS APPROXIMATELY 0.1 KM WEST OF CLARK ISLAND	26.05	-97.18333
		14855	SOUTH BAY 100 YDS NW OF BRAZOS ISLAND	26.03861	-97.17416
		14856	SOUTH BAY	26.01833	-97.18
		14857[c]	SOUTH BAY	26.02222	-97.2
		14858	SOUTH BAY	26.01806	-97.19361
		14865	SOUTH BAY MIDDLE OF BAY	26.02639	-97.18584
		14880	SOUTH BAY 1.3 KM SW OF BAY MOUTH	26.04056	-97.18889
		17101	SOUTH BAY 1.9MI EAST OF DEL MAR BEACH	26.01997	-97.17322
2494_01	**Brownsville Ship Channel** *From the Laguna Madre confluence upstream to the Port of Brownsville*	13460	BROWNSVILLE SHIP CHANNEL NEAR SHIP CM 35/BLACK BUOY	26.01472	-97.2575
		14871	BROWNSVILLE SHIP CHANNEL MID CHANNEL 595 M EAST OF SH 48 AT FOUST RD	25.95556	-97.385
		14875	BROWNSVILLE SHIP CHANNEL MID CHANNEL AT ENTRANCE TO SAN MARTIN LAKE	25.99644	-97.29263
		17102	BROWNSVILLE SHIP CHANNEL 4.2MI WEST OF THE MOUTH AT CM 38	26.02558	-97.23903
2494A_01	**Port Isabel Fishing Harbor** (unclassified water body) *From the Laguna Madre confluence to 0.4 km (.25 mi) south of SH 100 in Port Isabel*	13285	PORT ISABEL FISHING HARBOR APPROXIMATELY 60 M DOWNSTREAM OF SH 100 BRIDGE	26.07291	-97.21384

[a] This station is located at the extreme north end of the study area and likely is more representative of the Arroyo-Colorado watershed than the AUs of interest.

[b] Station 14877, although used in the 2012 integrated report for 2491_03, is located more south in the South Bay than Station 13549, the principal sampling site in South Bay.

[c] Not used in Assessment but included in analyses because of relatively robust dataset.

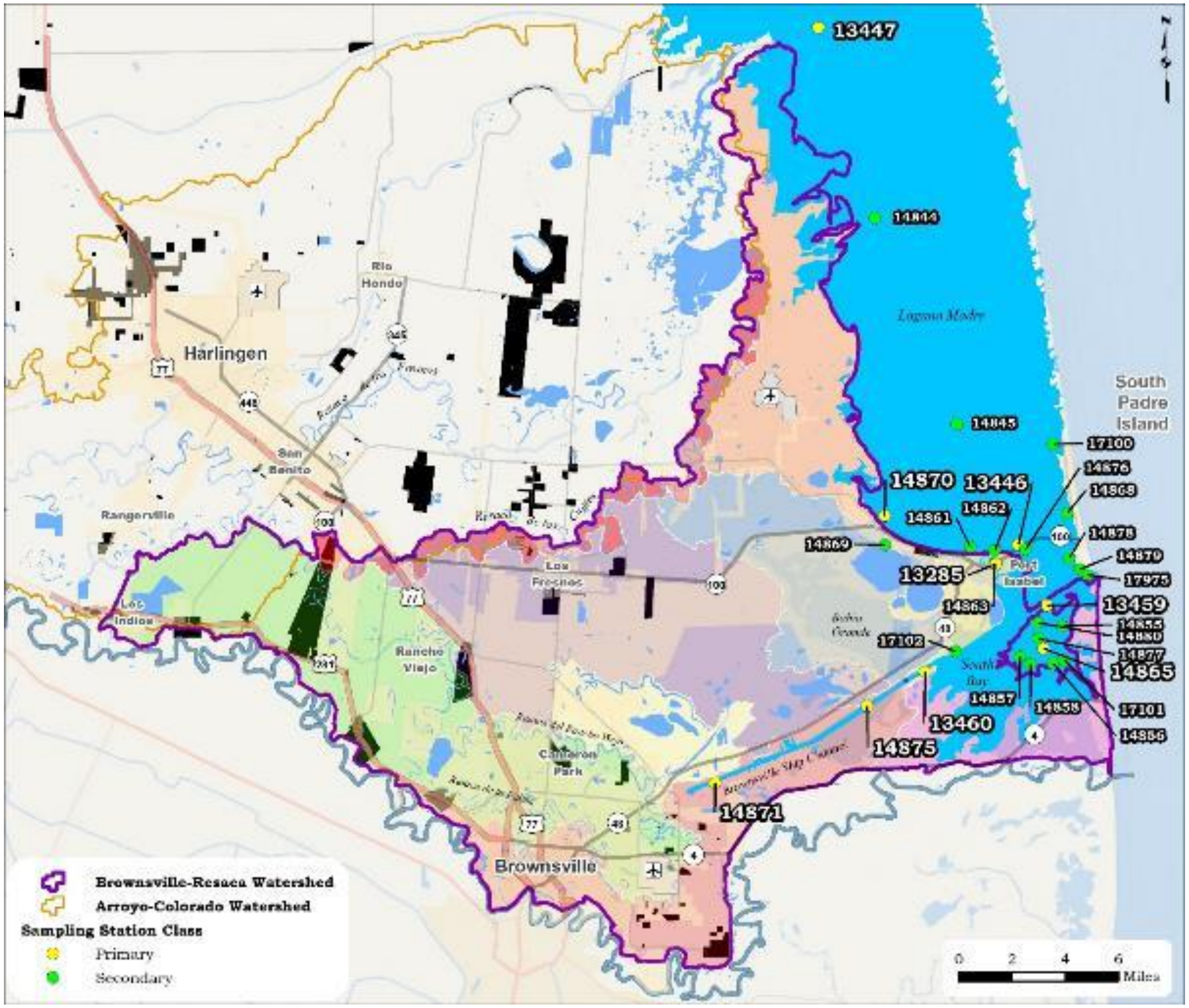


Figure 4-1. SWQM stations in the Brownsville-Resaca watershed that contain key water quality parameters since 2000. Primary stations—those with robust datasets given particular attention in this report—are distinguished from secondary by yellow markers and large font.

1.1 Data Gaps

Table 4-#. Sampling effort "heat map" showing number samples across year and location that contain key parameters. Higher numbers = darker shading; shading is relative to data within a row except for the vertical total column.

Water Body	AU	Station	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	TOTAL
Mid-Laguna Madre	2491_02	13447	11	10	12	19	34	23	7	7	6	2	6	5	4	2	148
		14844	4	2	3	4	7	2	0	0	0	0	0	0	0	0	22
		14845	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
		14870	5	3	3	8	15	10	6	5	7	2	5	5	3	2	79
		14869	5	3	3	4	7	2	0	0	0	0	0	0	0	0	24
		14861	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
		14862	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
		14863	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
Lower Laguna Madre	2491_03	13446	8	7	6	15	26	18	9	6	7	3	5	5	4	3	122
		14876	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
		17100	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
		14868	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
		14878	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
		14879	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
		17975	0	0	3	4	6	2	0	0	0	0	0	0	0	0	15
		14877	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
		14858	5	2	3	4	6	2	0	0	0	0	0	0	0	0	22
		14865	10	5	6	10	18	10	8	6	4	2	5	5	4	3	96
		14856	6	2	3	4	6	2	0	0	0	0	0	0	0	0	23
South Bay	2493_01	17101	5	2	3	4	6	2	0	0	0	0	0	0	0	0	22
		14855	5	2	3	4	5	2	0	0	0	0	0	0	0	0	21
		14880	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
		13459	8	7	6	6	8	6	8	6	5	1	5	5	4	2	77
		14871	0	0	0	2	8	8	7	5	7	2	6	5	2	2	54
Ship Channel	2494_01	14875	8	7	6	7	8	6	9	5	7	2	6	5	2	3	81
		13460	13	10	9	10	13	8	9	6	7	3	6	5	2	2	103
		17102	5	3	3	4	6	2	0	0	0	0	0	0	0	0	23
Port Isabel Harbor	2494A_01	13285	6	4	4	7	7	8	6	6	7	1	5	5	4	4	74
		TOTAL	159	102	109	160	252	135	69	52	57	18	49	45	29	23	*1259*

Table 4-#. *Enterococci* sample "heat map" showing number of Entero samples across year and location. Higher numbers = darker shading; shading is relative to data within a row except for the vertical total column that compares number of Entero samples across AUs.

Water Body	AU	Station	2001	2002	2003	2004	2005	2006	2007	2008	TOTAL
Mid-Laguna Madre	2491_02	13447	1	5	3	3	5	3	3	2	25
Lower Laguna Madre	2491_03	14870	0	0	2	4	4	2	3	3	18
		13446	2	3	2	3	3	4	3	3	23
South Bay	2493_01	14865	0	0	0	2	3	3	3	1	12
		13459	2	3	1	4	3	3	3	2	21
Ship Channel	2494_01	14871	0	0	0	4	4	3	3	3	17
		14875	2	3	2	4	3	4	3	3	24
		13460	2	3	1	3	3	4	3	3	22
Port Isabel Harbor	2494A_01	13285	1	2	3	4	4	2	2	3	21
		TOTAL	10	19	14	31	32	28	26	23	***183***

1.2 Data Analysis Methodology

Datasets after 2005 for key parameters—bacteria, DO, and nutrients—are generally not robust in the Brownsville-Resaca watershed. Limits on dataset size translated to considerable restrictions on trends analysis. With small sample sizes it is particularly unwise to assign much meaning to the trajectory of a water quality parameter if the POR is short (1-3 years). In the case of Enterococci samples, none have been reported to SWQMIS since 2008 undermining any confidence in what trend analysis reveals about current bacteria trends in the watershed. Trend results within seasons are even more dubious because the sample sizes are significantly smaller.

In this report, trends were statistically analyzed for a station only when at least 10 samples were available for the POR. Trends within warm (May–October) and cool (November–April) seasons were also examined only where $n \geq 10$. It should be noted that according to TCEQ guidance (TCEQ, 2012), statistical trend analyses require 20–60 samples collected over 5–20 years. Some of datasets contained herein fall short of these requirements. Nevertheless, trends were evaluated using the limited data available and caveats regarding sample sizes and temporal representativeness are provided in the text as appropriate. The test used to determine the significance of trends over time was Spearman rank-order correlation and it was conducted with the SAS procedure PROC CORR (SAS 9.3, Cary, North Carolina, 2011). Tabular results are presented for each AU but only discussed in depth for cases where the number of continuous sampling years and statistical significance render the results relatively trustworthy to convey the actual trajectory of the parameters. Scatter plots of key parameter data are also provided for each AU. Where applicable, reference lines for *E. coli* criterion and screening levels are applied to the graphs to aid quick visual assessment of when, and in what proportion, sample concentrations were higher than their respective criterion or screening level.

1.3 Overview of Water Quality

1.3.1 Basic Statistics on Bacteria, DO, and Nutrients

Key water quality parameters selected for deeper analysis include bacteria (Entero and Fcoli), DO grab samples, and the screening nutrients NH3, NO3 (represented by NO23), OPO4, TP, and CHLA. Basic descriptive statistics for these parameters show considerable variation in the number of samples between AUs and parameters (Table 4-#)

Table 4-#. Basic descriptive statistics for key water quality parameters in the Brownsville-Resaca watershed, 2000 - 2014. Statistics were calculated for data across all stations with relevant data.

Water Body	AU	POR	Statistic	Entero MPN/100mL	Fcoli MPN/100mL	DO mg/L	NH3 mg/L	NO23 mg/L	OP mg/L	TP mg/L	CHLA µg/L
LLM	2491_02	Jan '00 - Feb '14	***n***	17	22	36	39	39	34	37	37
			Min	1	1	1.5	0.02	0.02	0.01	0.06	4
			Max	2419	540	14.1	0.22	4.09	0.60	0.37	88
			Mean	353	50	8.0	0.07	0.50	0.10	0.15	17
			Median	20	4	8.0	0.05	0.17	0.02	0.13	11
			SD	784	120	2.3	0.05	0.76	0.14	0.07	17
LLM	2491_03	Jan '00 - Aug '13	***n***	26	165	60	54	52	40	47	52
			Min	1	1	1.2	0.02	0.02	0.01	0.02	0
			Max	2419	1600	10.3	0.11	0.31	0.15	0.11	7
			Mean	136	13	7.1	0.04	0.03	0.02	0.05	2
			Median	13	2	7.8	0.05	0.02	0.02	0.06	2
			SD	474	124	2.2	0.02	0.04	0.02	0.02	2
SB	2493_01	Jan '00 - Aug '13	***n***	20	81	49	43	39	26	33	38
			Min	5	1	4.4	0.05	0.02	0.02	0.02	1
			Max	2419	11	14.2	0.14	1.25	0.75	0.11	9
			Mean	158	2	7.9	0.05	0.07	0.06	0.05	3
			Median	34	2	8.1	0.05	0.02	0.02	0.06	2
			SD	533	1	1.8	0.02	0.20	0.15	0.02	2
SC	2494_01	Jan '00 - Feb '14	***n***	41	42	88	58	55	39	45	50
			Min	1	1	1.2	0.05	0.02	0.02	0.02	2
			Max	1733	36	11.9	0.52	2.50	1.50	1.30	252
			Mean	111	4	7.7	0.06	0.10	0.08	0.10	11
			Median	28	2	7.8	0.05	0.02	0.02	0.06	5
			SD	290	6	1.9	0.06	0.35	0.25	0.19	35

Water Body	AU	POR	Statistic	Entero MPN/100mL	Fcoli MPN/100mL	DO mg/L	NH3 mg/L	NO23 mg/L	OP mg/L	TP mg/L	CHLA µg/L
PI	2494A_01	Mar '00 - Nov '13	***n***	14	7	24	25	24	15	20	21
			Min	5	1	2.1	0.05	0.02	0.02	0.03	2
			Max	2419	227	8.9	0.15	0.18	0.15	0.09	20
			Mean	212	55	6.6	0.06	0.03	0.03	0.05	4
			Median	38	25	6.9	0.05	0.02	0.02	0.06	4
			SD	636	79	1.7	0.02	0.04	0.04	0.01	4

1.3.2 Bacteria

Fecal indicator bacteria are organisms that in high concentrations indicate to the probable presence of fecal pollution. Fecal coliform is an FIB used in oyster waters while *Enterococcus* is the FIB used in tidal and/or saline inland waterbodies. Samples of fecal coliform were collected from the Brownsville Ship Channel from 2000 – 2005 and *Enterococcus* was sampled from 2001 – 2007. Changes in lab qualification requirements in YEAR left the Brownsville region without a qualified lab for processing bacteria samples, thus explaining the absence of FIB data after 2007. As of 2014, the primary contact recreation criterion for *Enterococci* is a geomean of 35 MPN/100mL (33 for high saline inland freshwater where conductivity ≥ 10,000 µmhos/cm; the Brownsville Ship Channel is 35 MPN/100mL). In oyster waters, the criterion for fecal coliform is a median value of 14 MPN/100mL. Sample values of *Enterococci* commonly exceeded the criterion in all AUs from 2001 – 2007.

The *Enterococci* data in SWQMIS shows eight sample concentrations above the criterion of 35 MPN/100mL between 2000 – 2007, five of them at Station 14871 at the western end of the Ship Channel (Figure 4-#). This dataset is not identical to that used in the 2014 Assessment which had a period of record from December 2005 – November 2012, nor did the 2014 Assessment necessarily use all of the samples included in SWQMIS in that time frame. Fecal coliform concentrations only exceeded the criterion of 14 MPN/100mL on two occasions between 2003 – 2008, both at Station 14875.

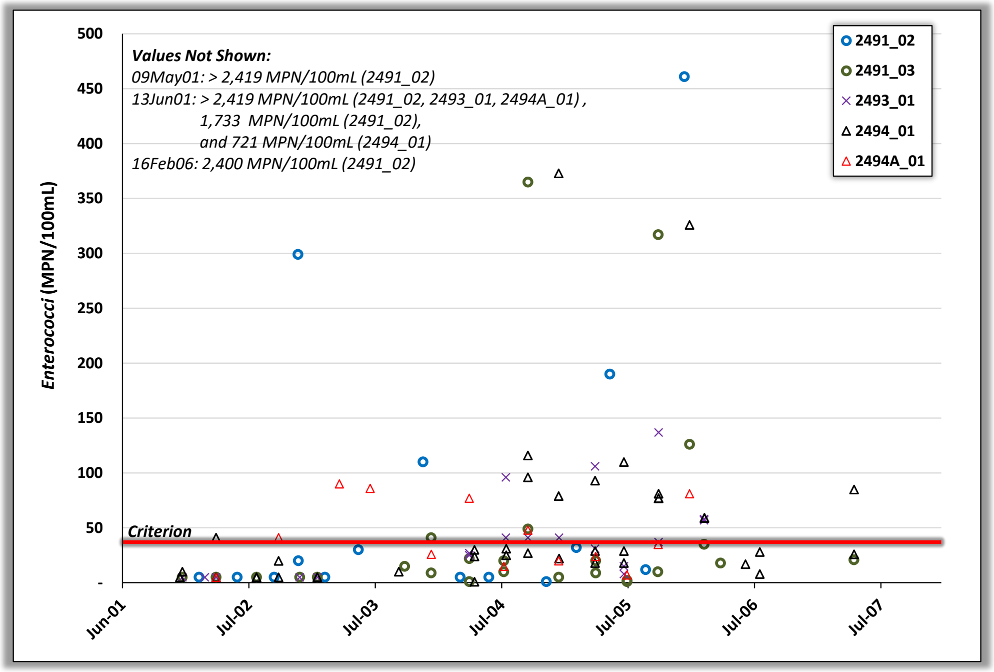


Figure 4-#. ***Enterococci*** **concentrations (MPN/100mL), 2001 - 2007.**

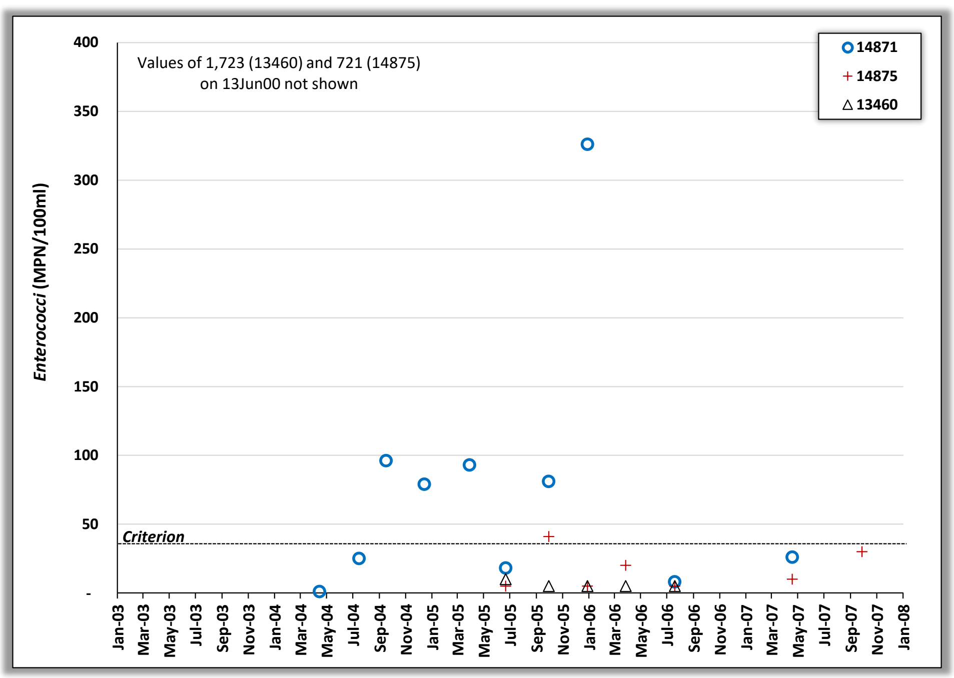


Figure 4-#. ***Enterococci*** **concentrations (MPN/100mL), 2000 - 2015 from the three primary stations in the Brownsville Ship Channel: 14871, 14875, and 13460.**

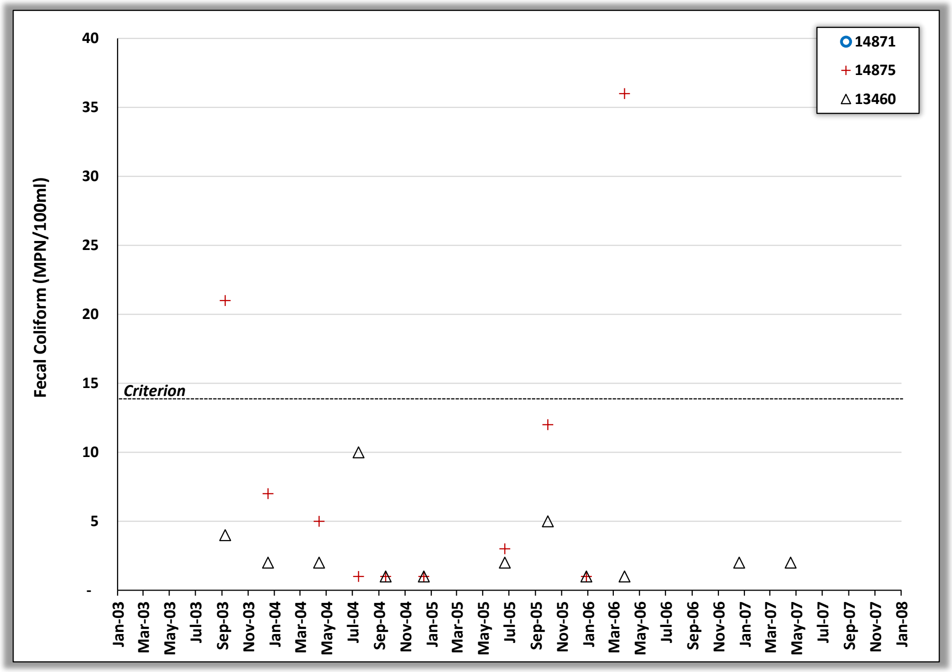
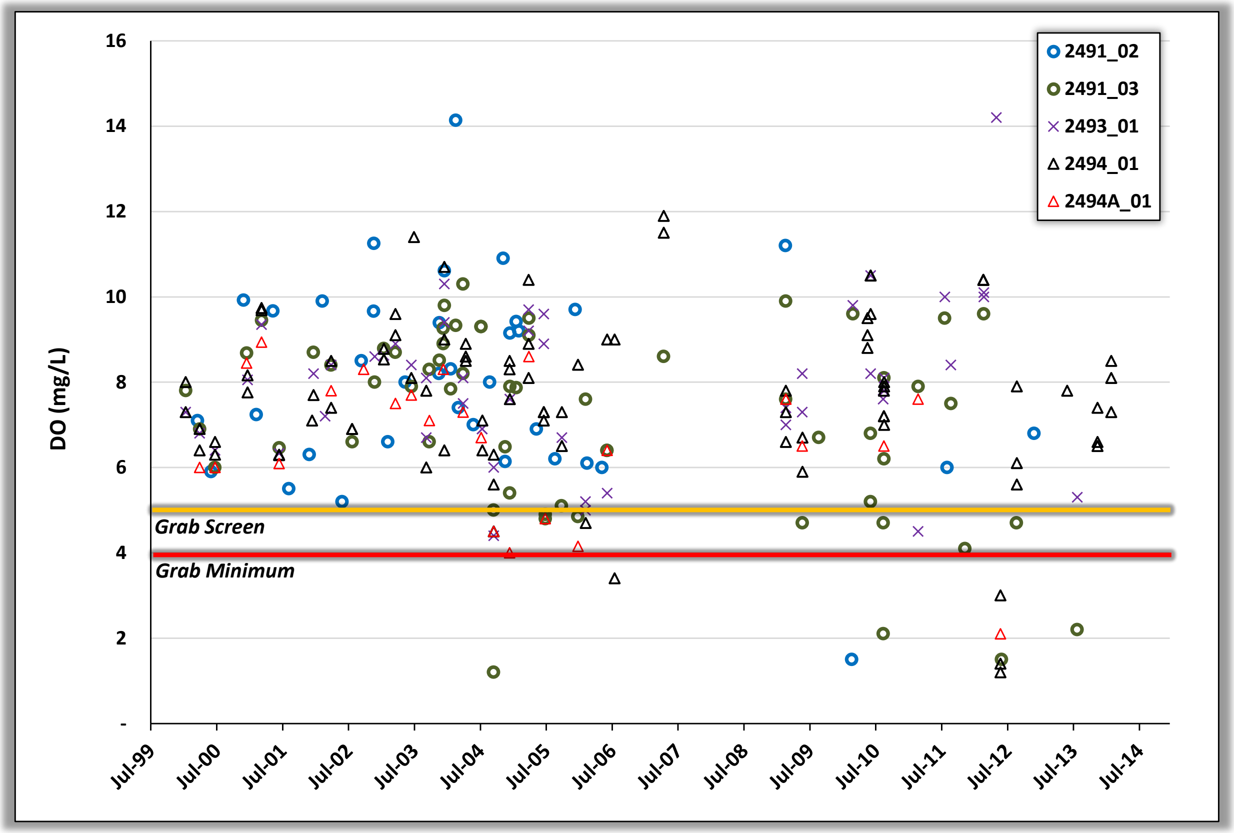


Figure 4-#. Fecal coliform concentrations (MPN/100mL), 2000 - 2015 from the three primary stations in the Brownsville Ship Channel: 14871, 14875, and 13460.

1.3.3 DO

Contrary to many inland freshwater streams, DO in the estuaries around Brownsville is assessed with instantaneous grab samples rather than 24-h means and minimums. In the Brownsville-Resaca watershed the grab sample screening level is 5.0 mg/L and the grab minimum criterion is 4.0 mg/L. Port Isabel Fishing Harbor (2494A_01) is an exception with the screening level and grab minimum set at 4.0 mg/L and 3.0 mg/L, respectively. No AUs examined in this report were listed for DO impairment in the 2014 Assessment but in the 2012 Assessment AUs 2491_02, 2491_03, and 2494_01 were listed for low DO. From 2000 – 2014 DO concentrations below the screen and minimum values were actually rare in most AUs. The southern end of Lower Laguna Madre (2491_03) and the Brownsville Ship Channel (2494_01) accounted for most of the samples with concentrations below 4 mg/L for that period of record.



1.3.4 Diel DO

Diel samples included in the SWQMIS database were collected at Stations 13447 (Laguna Madre near the Arroyo-Colorado confluence) and 13446 (Laguna Madre near Port Isabel) from August 2003 through August 2005 (Figure 4-#). Seasonal patterns were typical with 24-h DO average concentrations above 8 mg/L during cool months (November – March) and dipping as low as 5 mg/L during warm months (April – October). Exceedances below the criteria for DO average and minimum concentrations occurred only in the warm season. All but one of the nine exceedances was recorded at Station 13447.

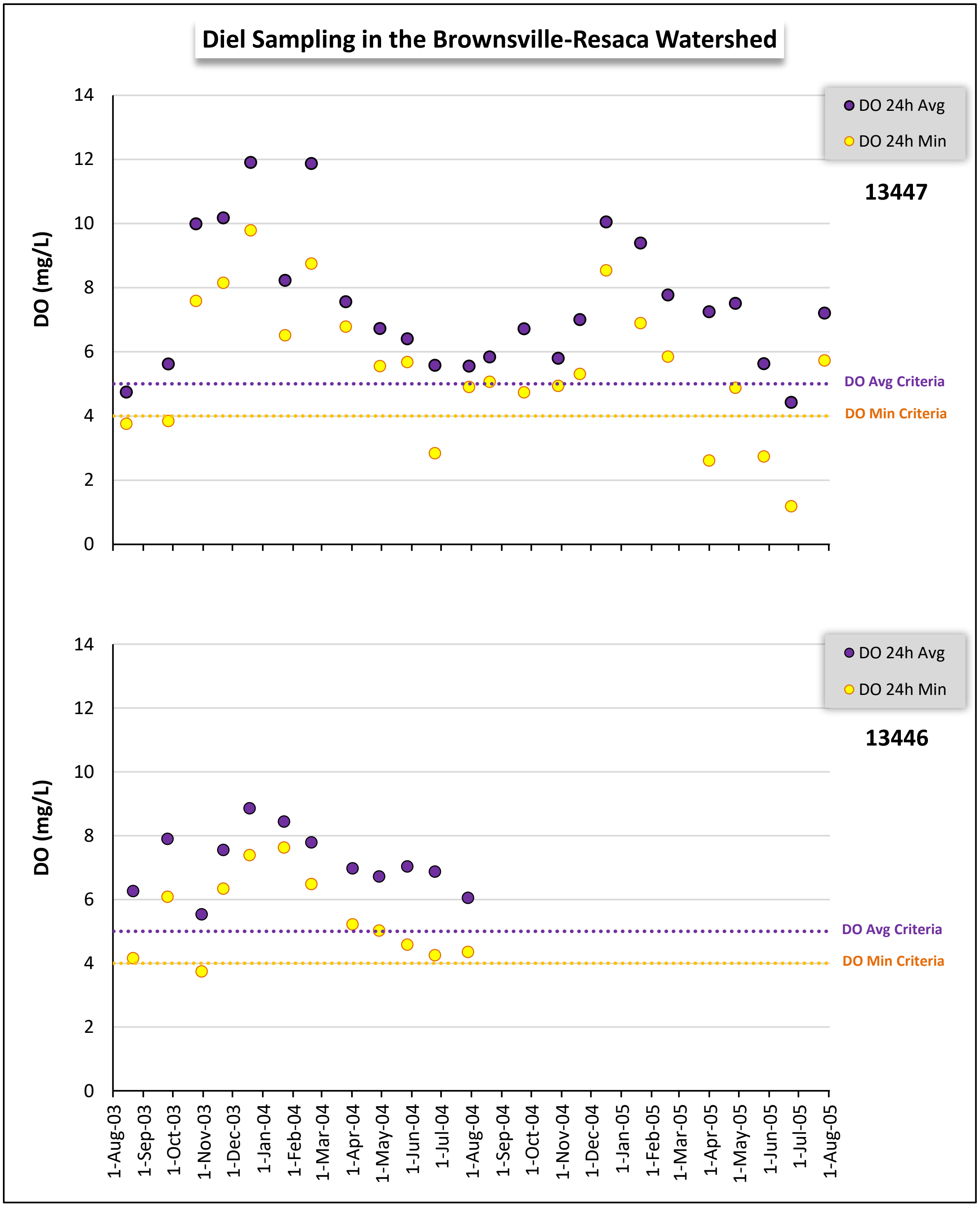


Figure 4-#. Diel DO average and minimum concentrations at Stations 13446 (top) and 13447 (bottom), 2003 – 2005.

1.3.6 Nutrients

Nutrient concentrations in excess of the screening level are not a widespread problem in the Brownsville-Resaca watershed but are relatively common at Station 13447 at the extreme north end of the Lower Laguna Madre at the Arroyo-Colorado River confluence. The following graphs of nutrient samples over time are organized by water body and distinguished by warm (red) and cool (blue) season. Screening levels (see Table 1-2) are not assessment criteria and are provided for reference only.

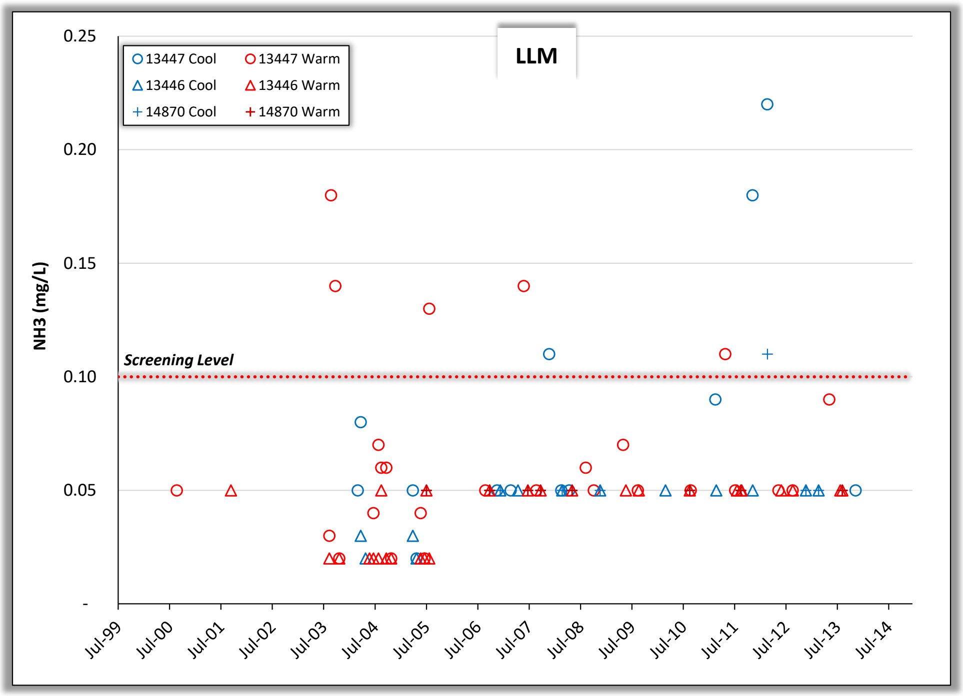


Figure 4-#. NH3 concentrations (mg/L) in Lower Laguna Madre, 2000 – 2013. Screening level of 0.10 mg/L provided for reference.

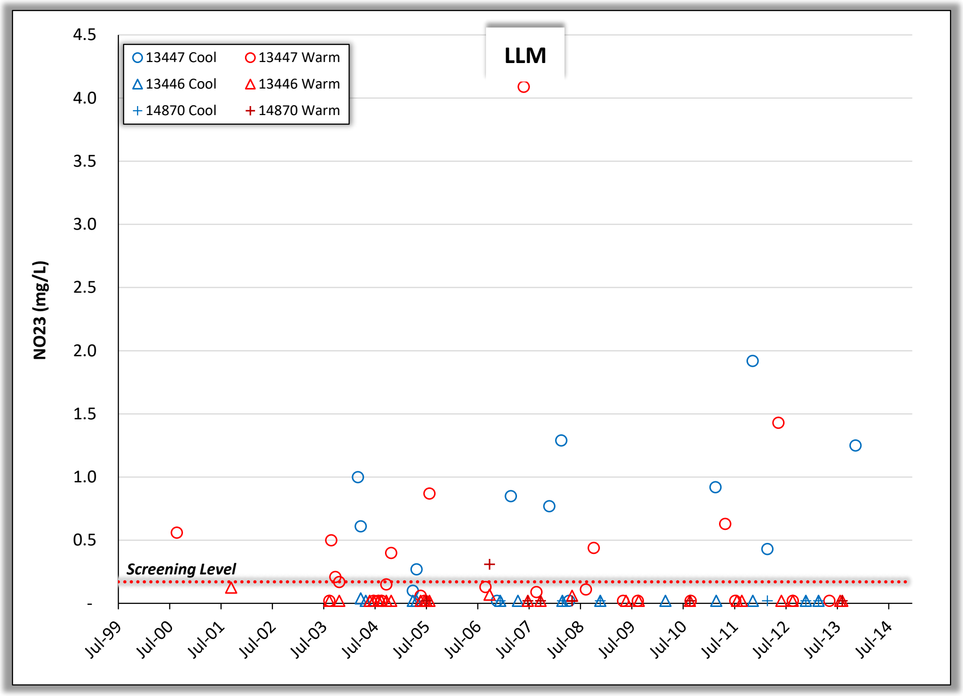


Figure 4-#. NO23 concentrations (mg/L) in Lower Laguna Madre, 2000 – 2013. Screening level of 0.17 mg/L provided for reference.

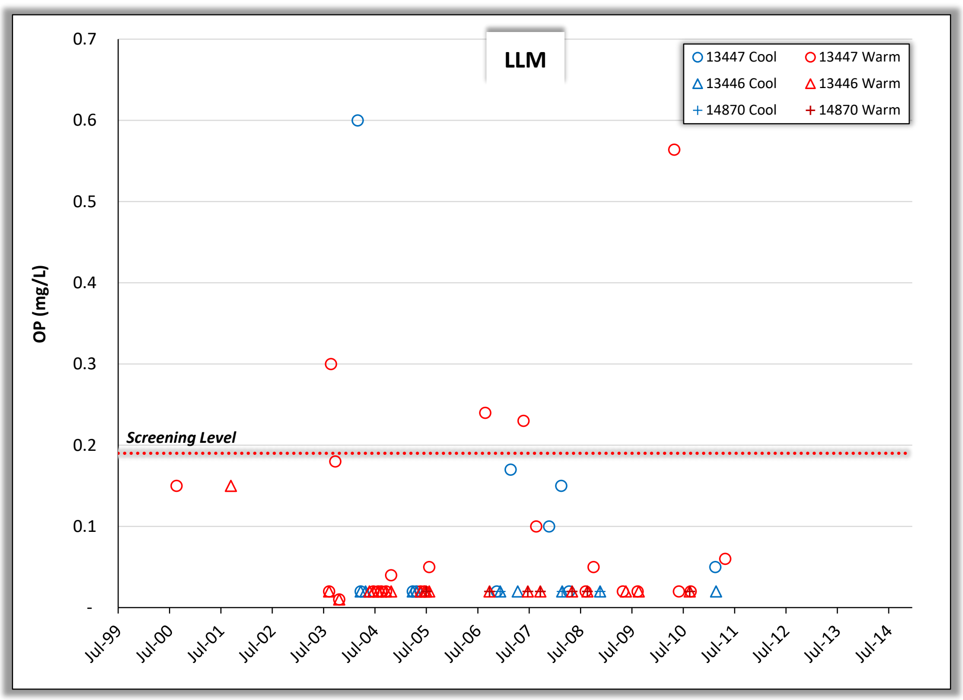


Figure 4-#. OP concentrations (mg/L) in Lower Laguna Madre, 2000 – 2013. Screening level of 0.19 mg/L provided for reference.

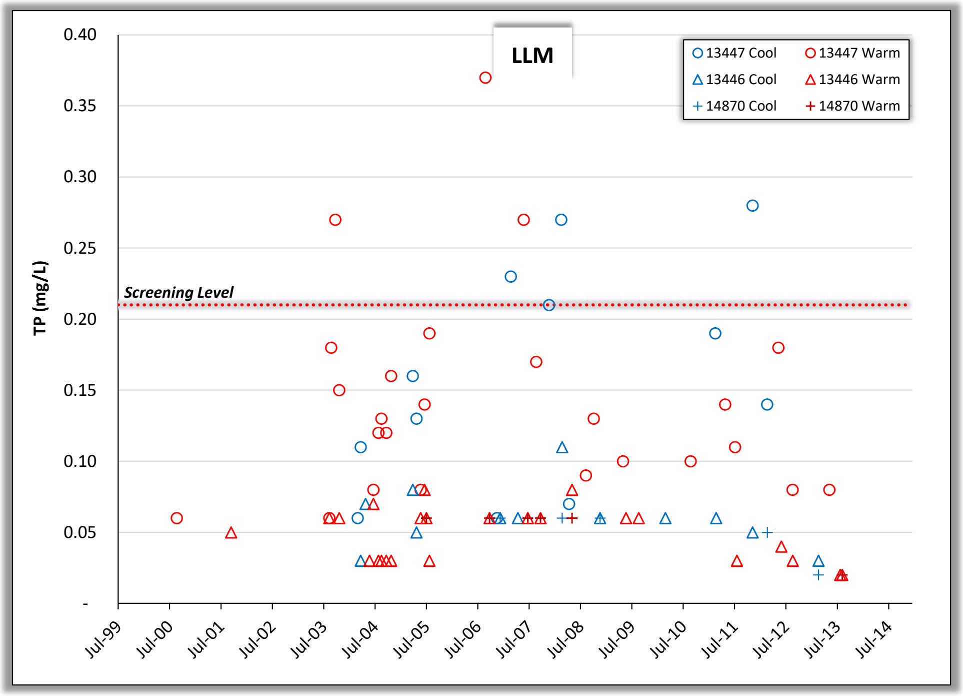


Figure 4-#. TP concentrations (mg/L) in Lower Laguna Madre, 2000 – 2013. Screening level of 0.21 mg/L provided for reference.

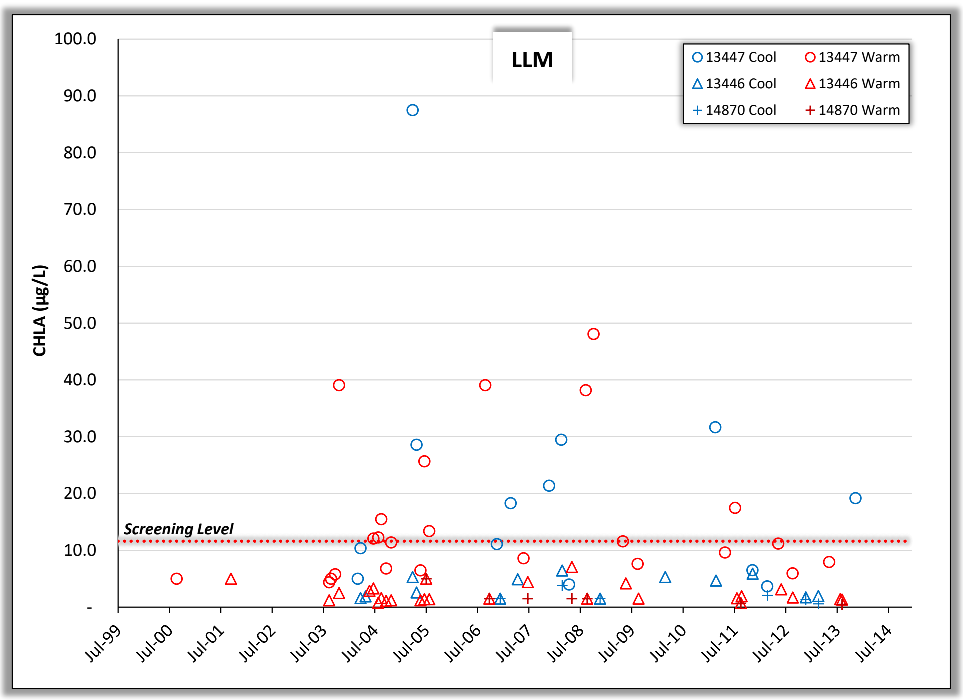


Figure 4-#. CHLA concentrations (µg/L) in Lower Laguna Madre, 2000 – 2013. Screening level of 11.6 µg/L provided for reference.

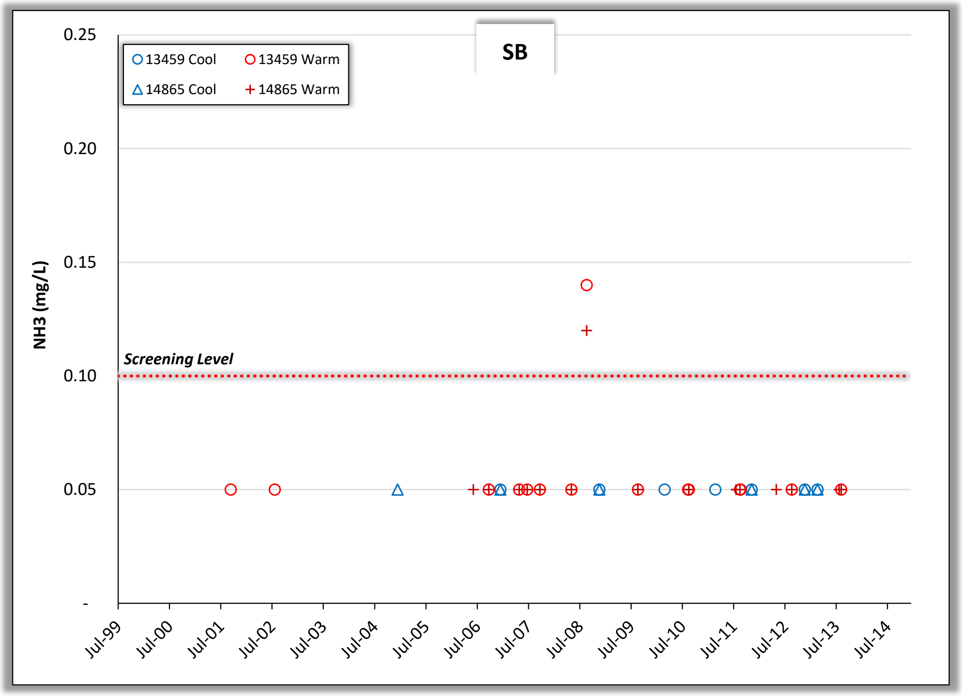


Figure 4-#. NH3 concentrations (mg/L) in South Bay, 2000 – 2013. Screening level of 0.10 mg/L provided for reference.

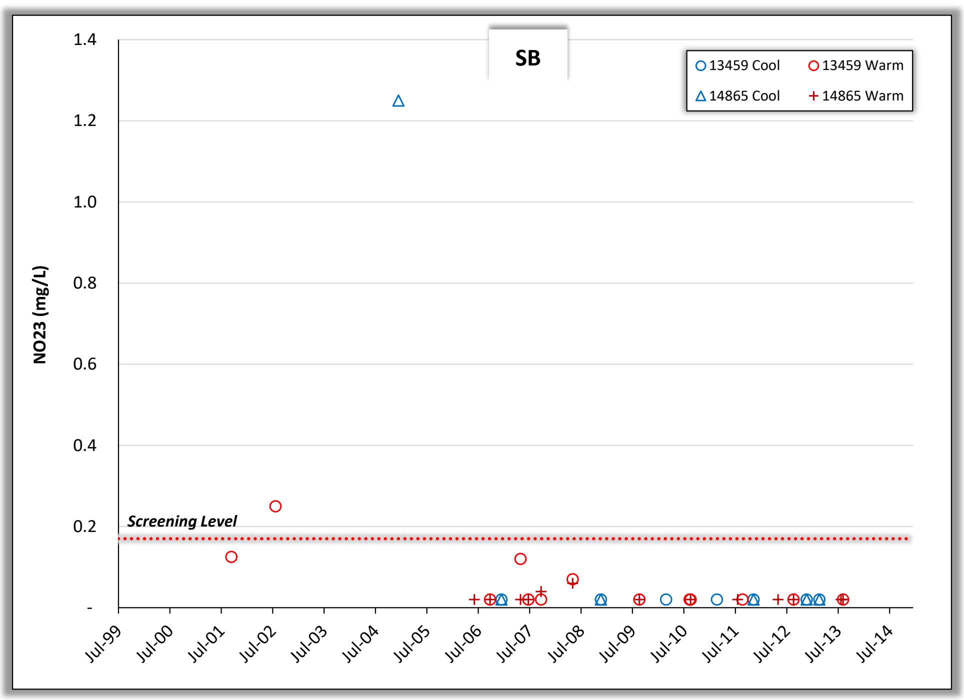


Figure 4-#. NO23 concentrations (mg/L) in South Bay, 2000 – 2013. Screening level of 0.17 mg/L provided for reference.

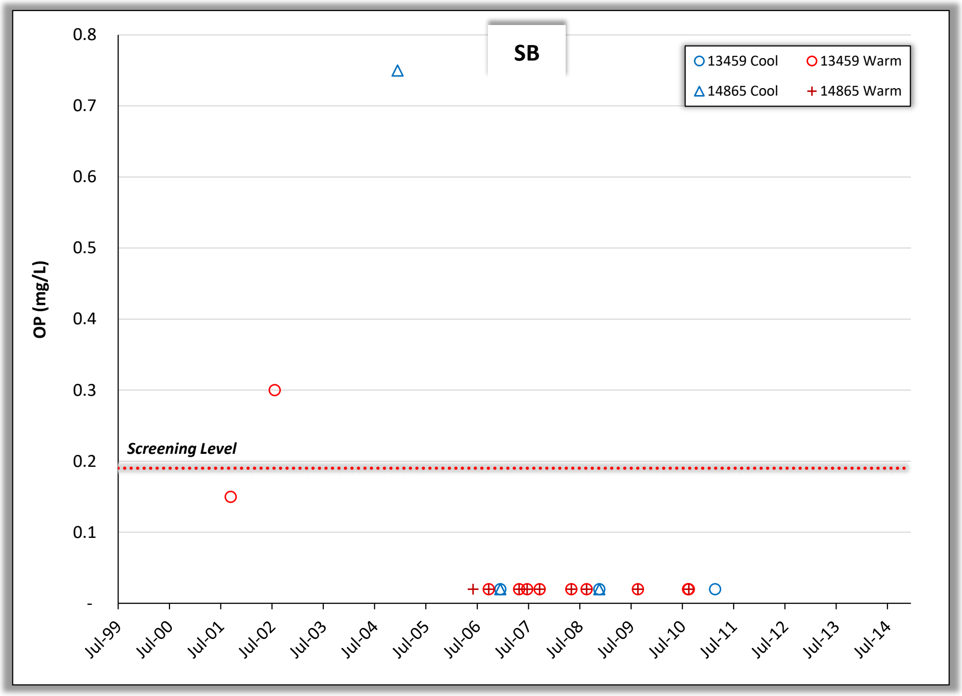


Figure 4-#. OP concentrations (mg/L) in South Bay, 2000 – 2013. Screening level of 0.19 mg/L provided for reference.

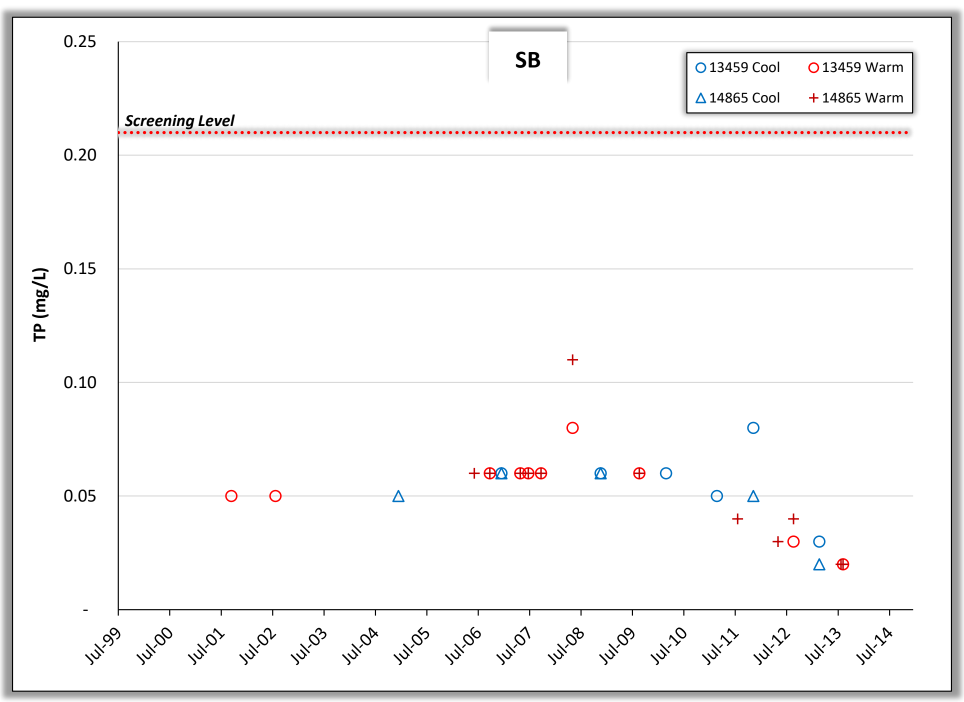


Figure 4-#. TP concentrations (mg/L) in South Bay, 2000 – 2013. Screening level of 0.21 mg/L provided for reference.

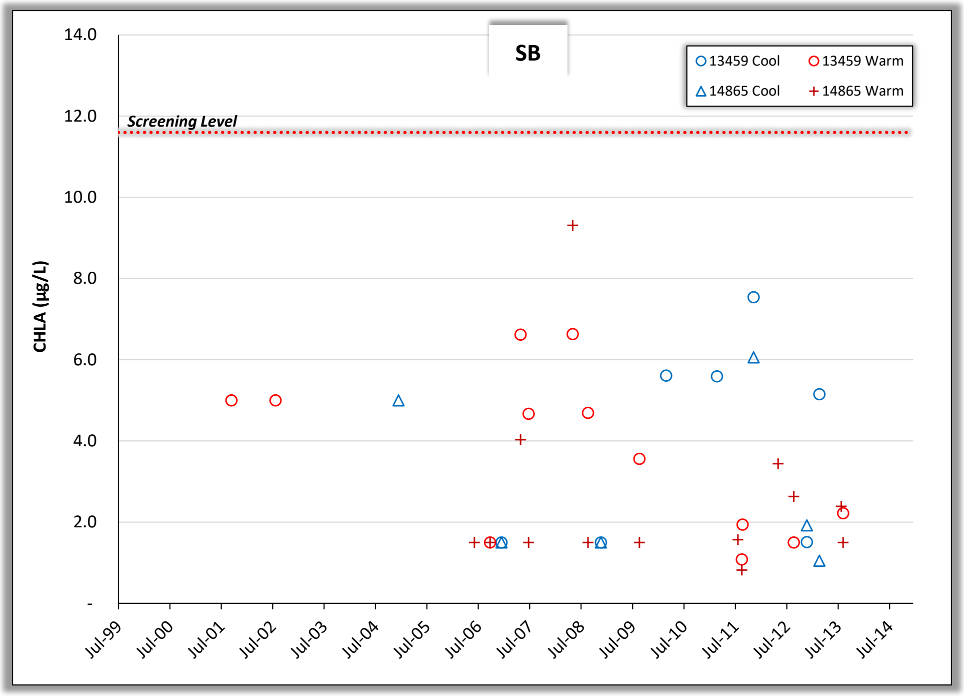


Figure 4-#. CHLA concentrations (µg/L) in South Bay, 2000 – 2013. Screening level of 11.6 µg/L provided for reference.

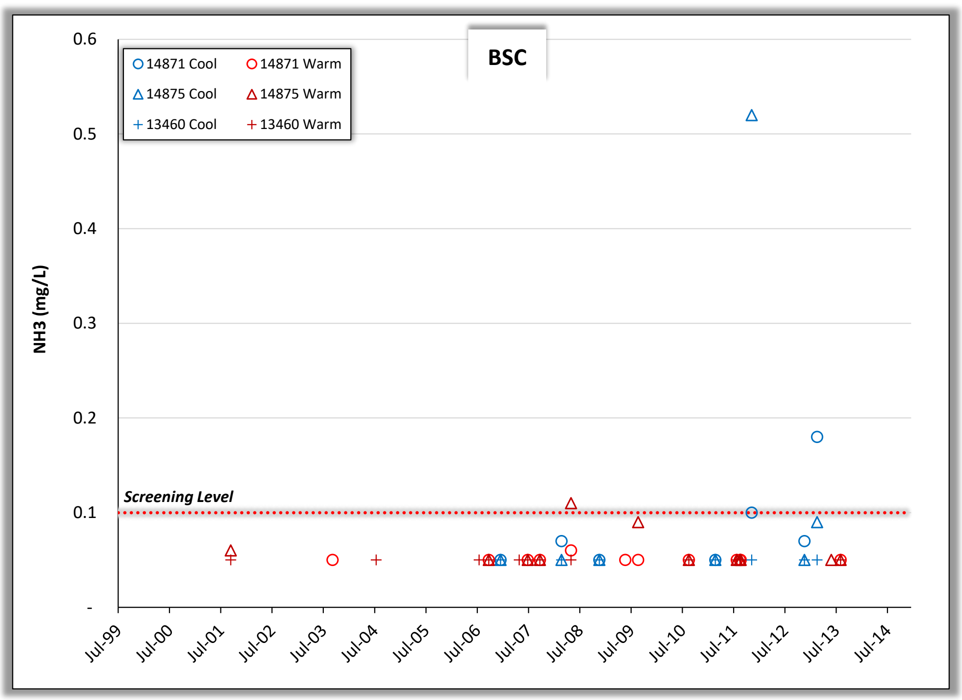


Figure 4-#. NH3 concentrations (mg/L) in Brownsville Ship Channel, 2000 – 2013. Screening level of 0.10 mg/L provided for reference.

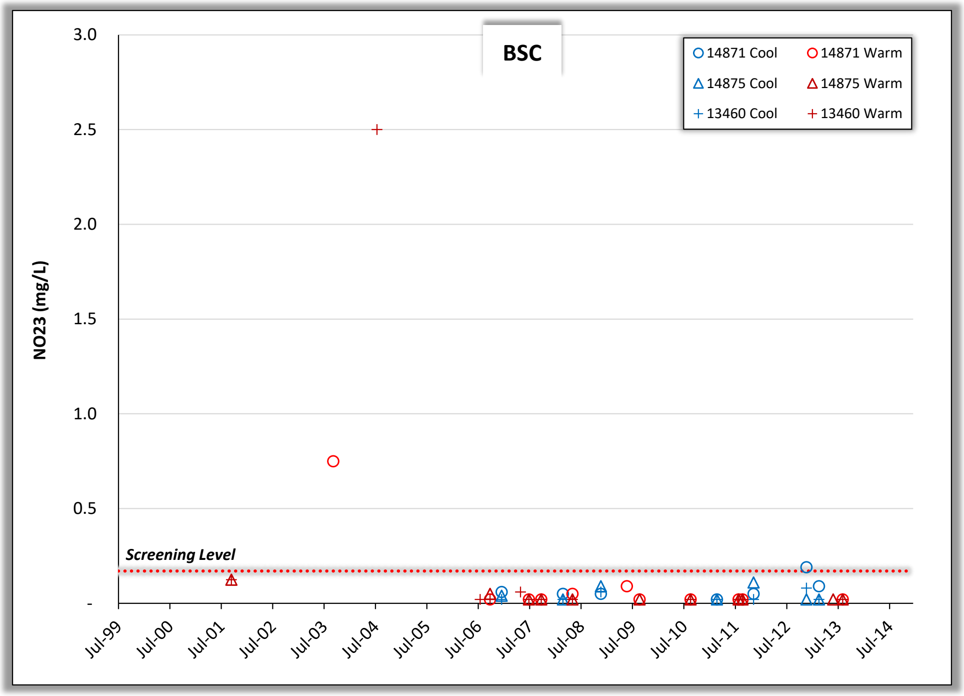


Figure 4-#. NO23 concentrations (mg/L) in Brownsville Ship Channel, 2000 – 2013. Screening level of 0.17 mg/L provided for reference.

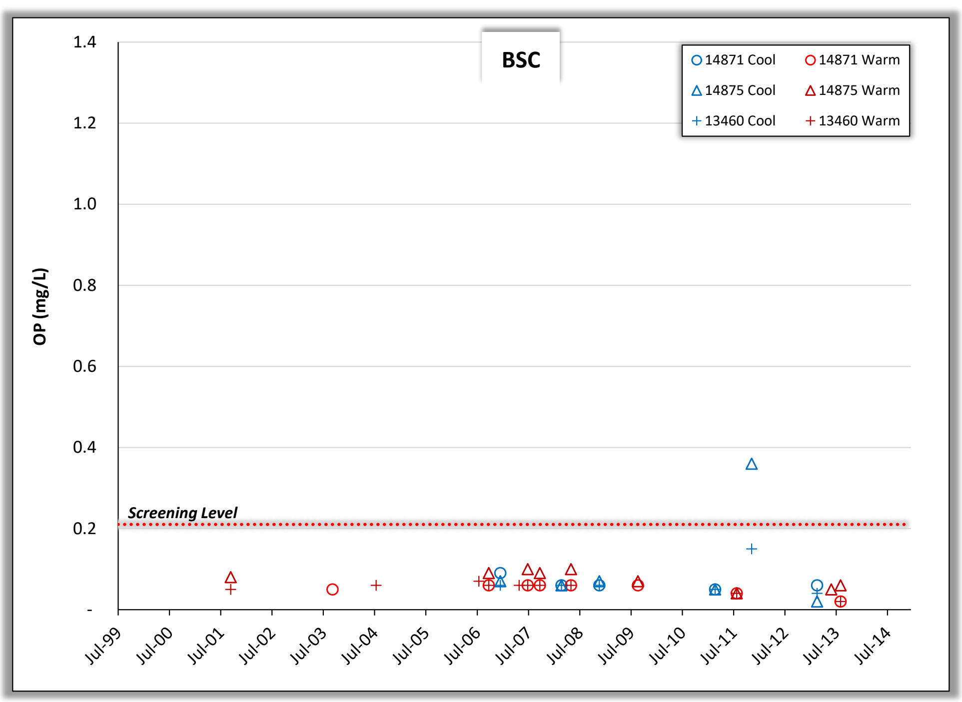


Figure 4-#. OP concentrations (mg/L) in Brownsville Ship Channel, 2000 – 2013. Screening level of 0.19 mg/L provided for reference.

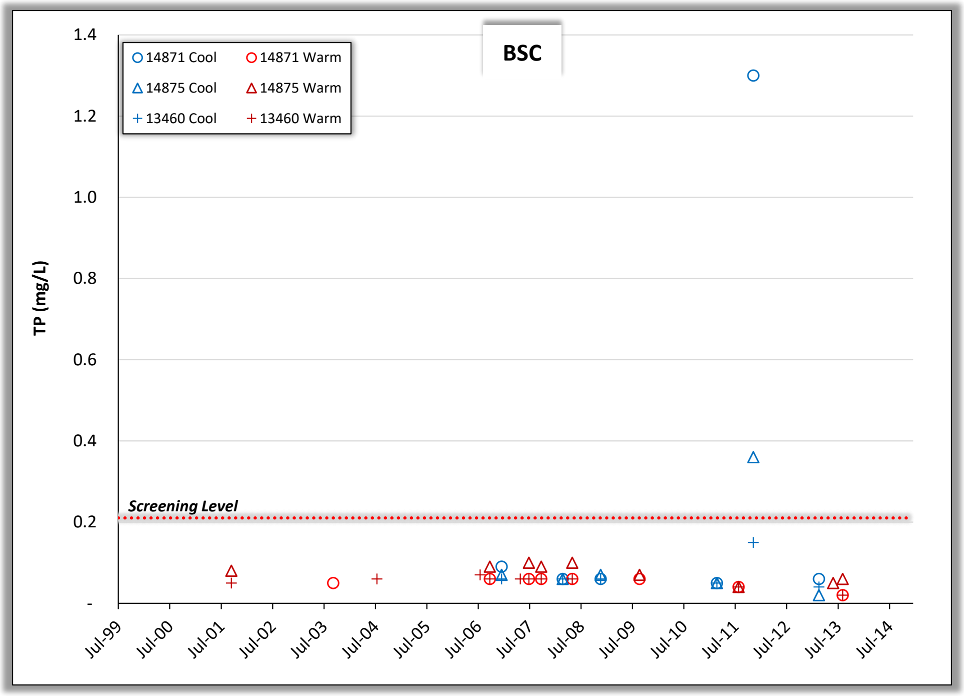


Figure 4-#. TP concentrations (mg/L) in Brownsville Ship Channel, 2000 – 2013. Screening level of 0.21 mg/L provided for reference.

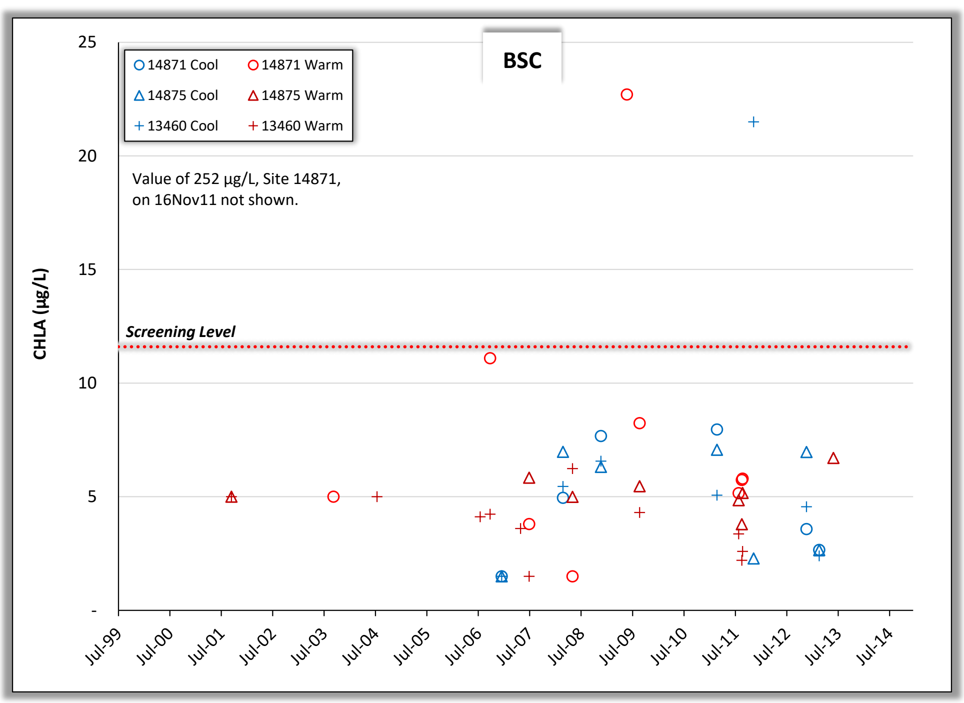


Figure 4-#. CHLA concentrations (µg/L) in Brownsville Ship Channel, 2000 – 2013. Screening level of 11.6 µg/L provided for reference.

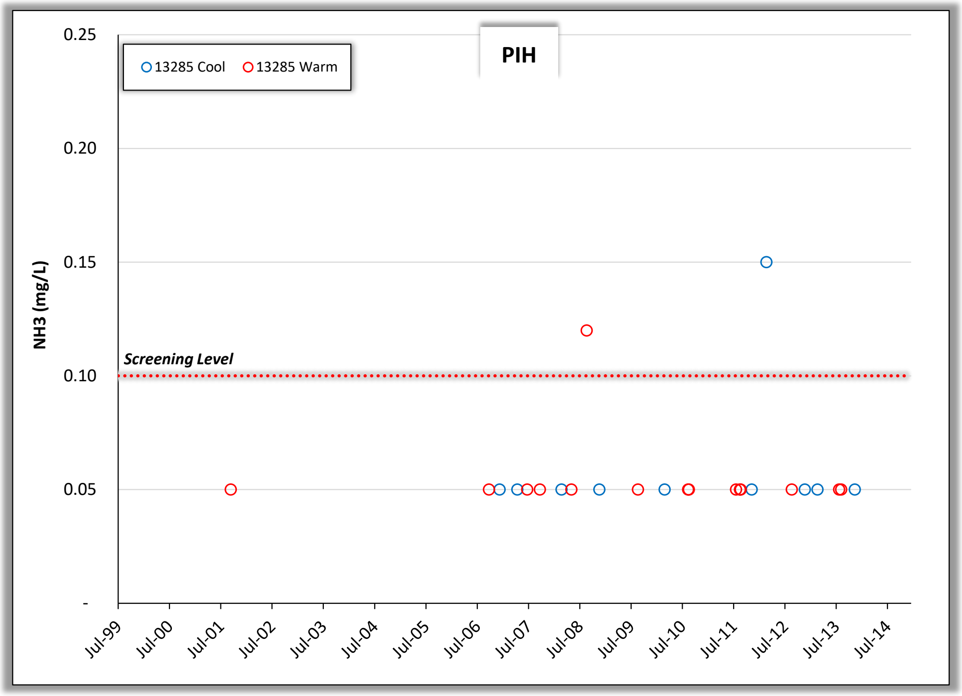


Figure 4-#. NH3 concentrations (mg/L) in Port Isabel Fishing Harbor, 2000 – 2013. Screening level of 0.10 mg/L provided for reference.

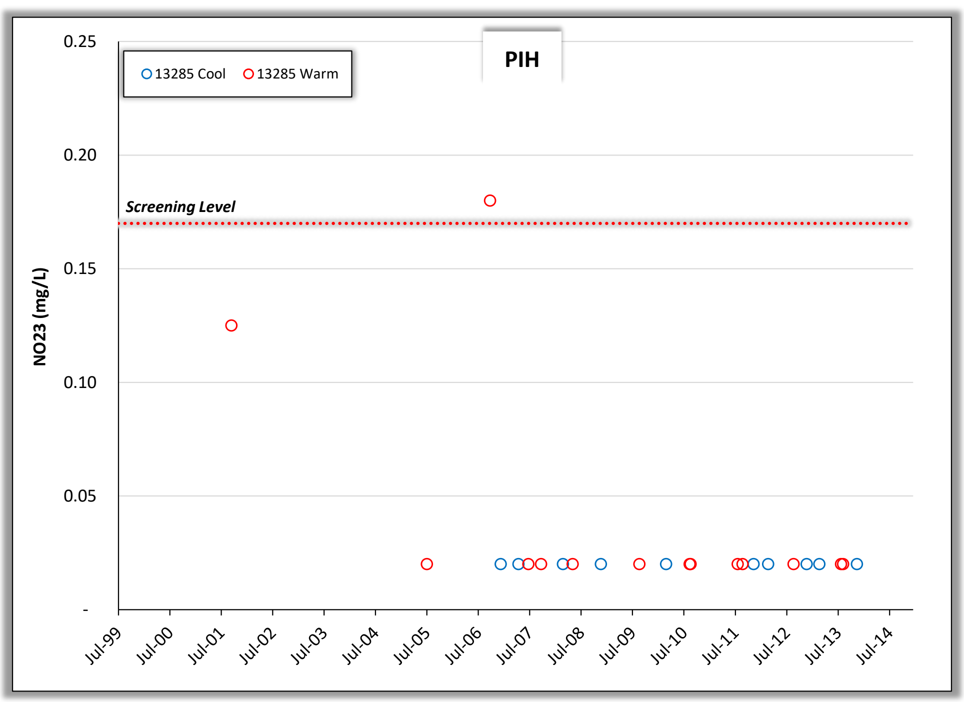


Figure 4-#. NO23 concentrations (mg/L) in Port Isabel Fishing Harbor, 2000 – 2013. Screening level of 0.17 mg/L provided for reference.

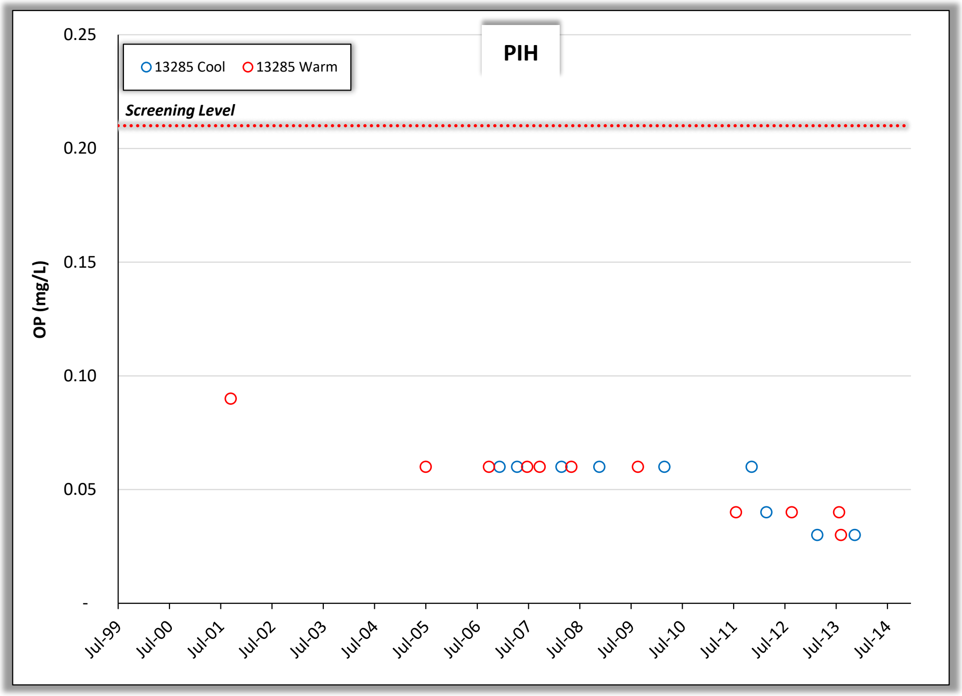


Figure 4-#. OP concentrations (mg/L) in Port Isabel Fishing Harbor, 2000 – 2013. Screening level of 0.19 mg/L provided for reference.

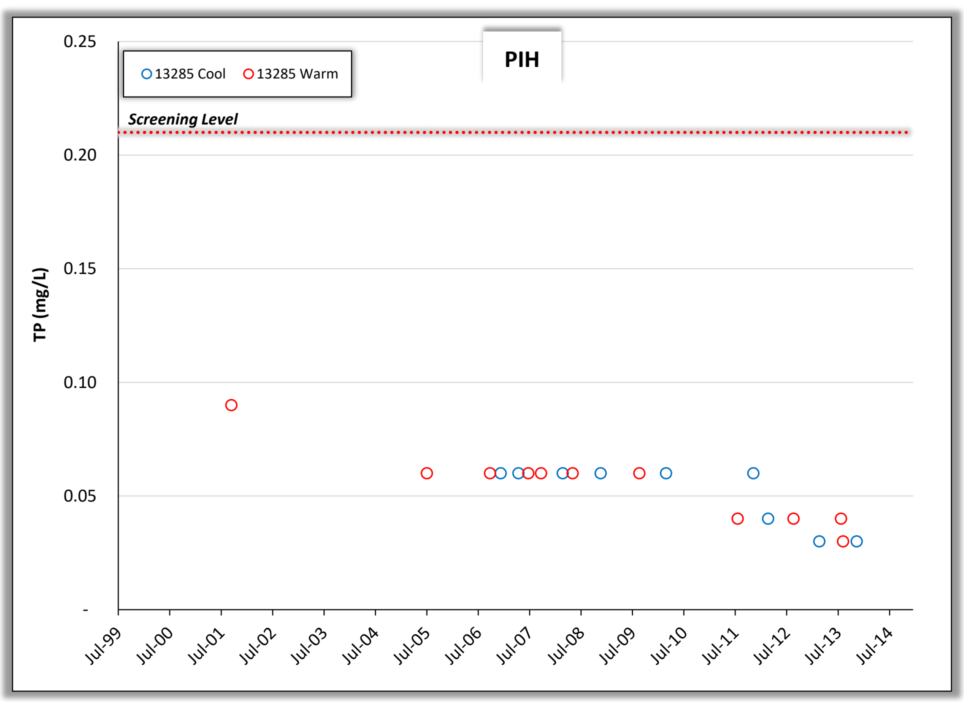


Figure 4-#. TP concentrations (mg/L) in Port Isabel Fishing Harbor, 2000 – 2013. Screening level of 0.21 mg/L provided for reference.

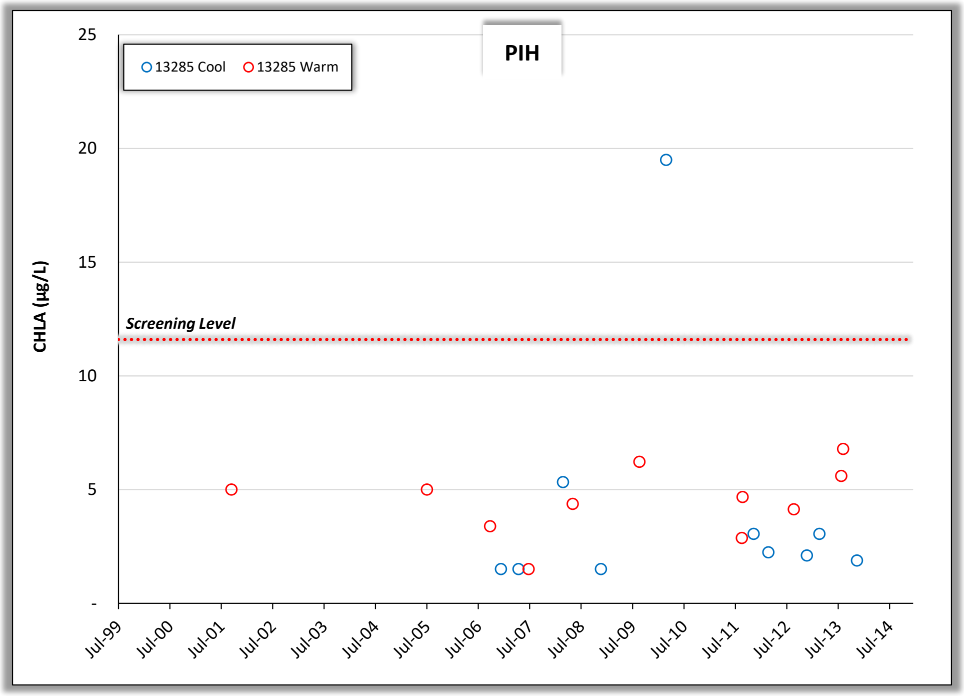


Figure 4-#. CHLA concentrations (µg/L) in Port Isabel Fishing Harbor, 2000 – 2013. Screening level of 11.6 µg/L provided for reference.

1.4 Depth Profile Sampling

Depth profiles can be helpful for understanding the hydrological and chemical dynamics of estuaries and tidally-influenced inland water bodies. In estuaries, heavier salt water tends to sink below lighter freshwater creating a stratified profile. Surface water also typically has higher DO due to wind mixing. If stratification persists for long periods of time, DO deep in the water column can be depleted through metabolic respiration and stark contrasts in DO concentration manifest between the epilimnion and hypolimnion. When strong winds and large freshwater inflows from precipitation events occur they can act as mixing agents that homogenize the chemical profile of stratified water bodies. From 2000 - 2014, depth profiles were collected with some regularity at seven stations in all AUs except 2493_01, the southern end of the Lower Laguna Madre (Figure 4-#).

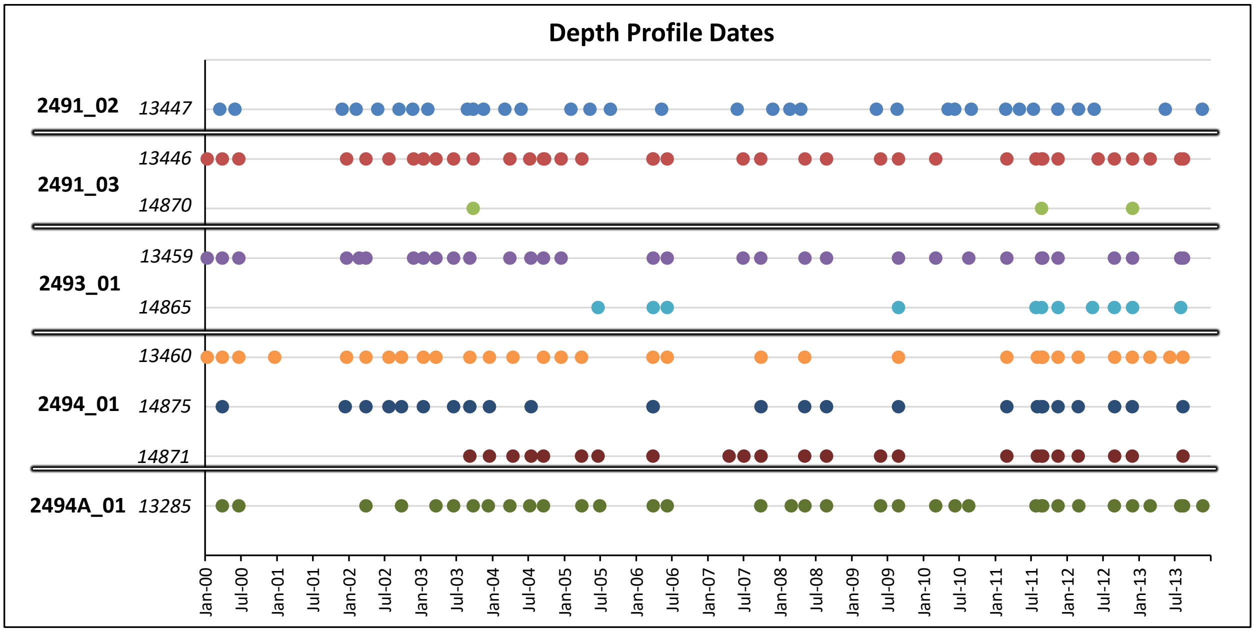


Figure 4-#. Dates of depth profiles by AU and station, 2000 – 2013.

Vertical lines in the following depth profile graphs indicate homogenous salinity and DO concentrations throughout the water column. The stronger the curve, the stronger the contrast in salinity and DO concentrations between the surface and deeper strata. Salinity stratification in the Brownsville Ship Channel is uncommon based on the depth profile data in SWQMIS as the the majority of lines are close to vertical (Figures 4-#, 4-#, and 4-#), illustrating nearly homogenous salinity concentrations throughout the water column. Stratification of DO concentrations is more conspicuous (Figures 4-#, 4-#, and 4-#). The number of sampling dates when changes of 2-3 mg/L of DO occurred between the surface and ≥ 3-m depths were almost as common as days when DO gradually declined 1-3 mg/L from the epilimnion to the hypolimnion. Salinity and DO stratification were both more common at Station 14871, the upper-most sampling location in the Ship Channel where mixing is possibly more dependent on inland storm events than tidal activity relative to Stations 14875 and 13460.

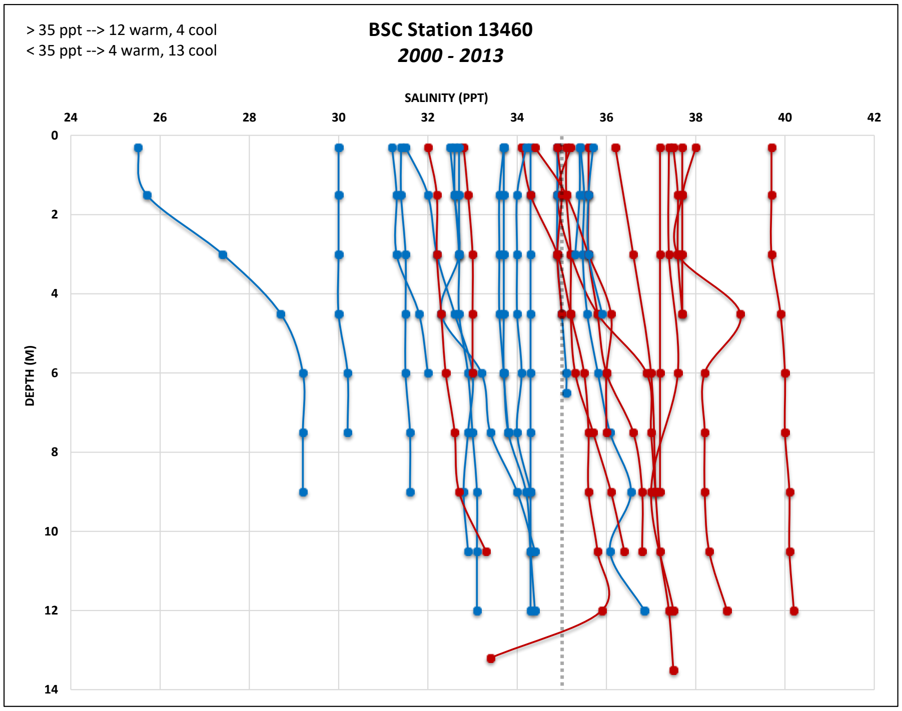


Figure 4-#. Depth profiles of salinity concentrations (ppt) in the Brownsville Ship Channel, Station 13460, 2000 – 2013. Saltwater salinity (35 ppt) denoted with dotted gray line.

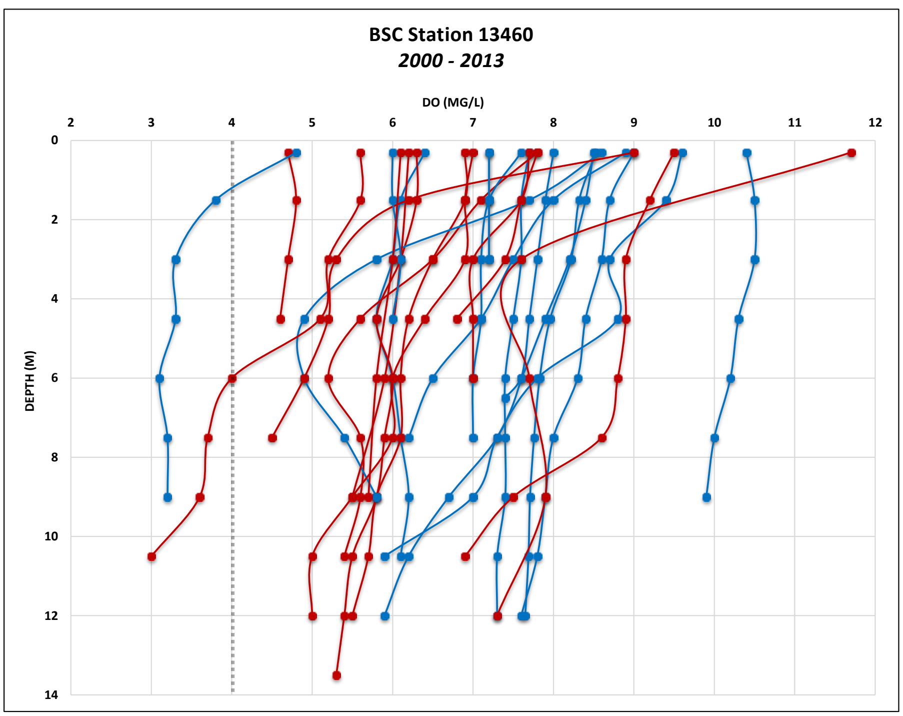


Figure 4-#. Depth profiles of DO concentrations (mg/L) in the Brownsville Ship Channel, Station 13460, 2000 – 2013. DO criterion denoted with dotted gray line.

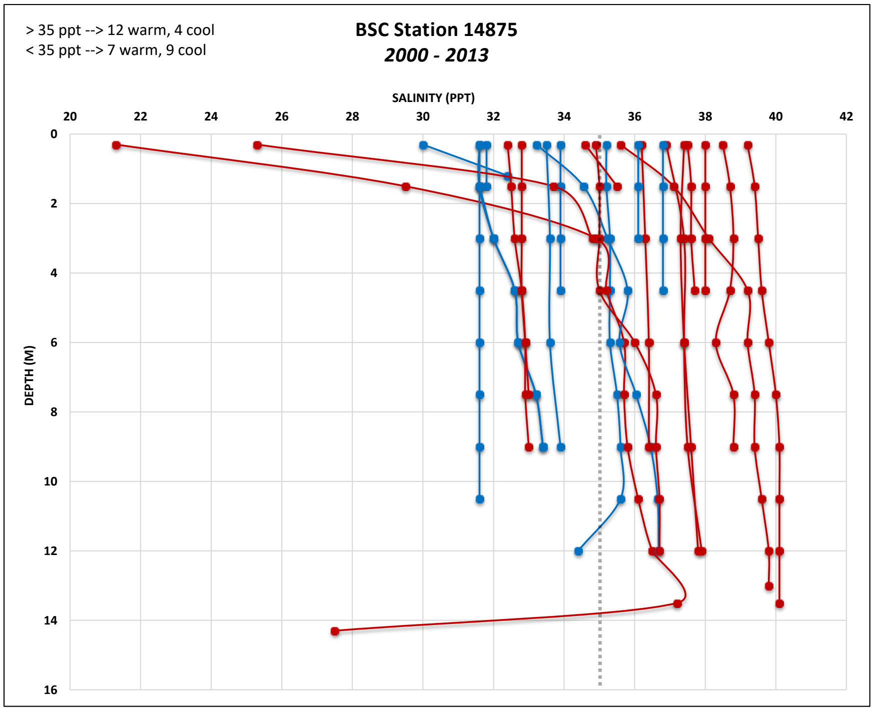


Figure 4-#. Depth profiles of salinity concentrations (ppt) in the Brownsville Ship Channel, Station 14875, 2000 – 2013. Saltwater salinity (35 ppt) denoted with dotted gray line.

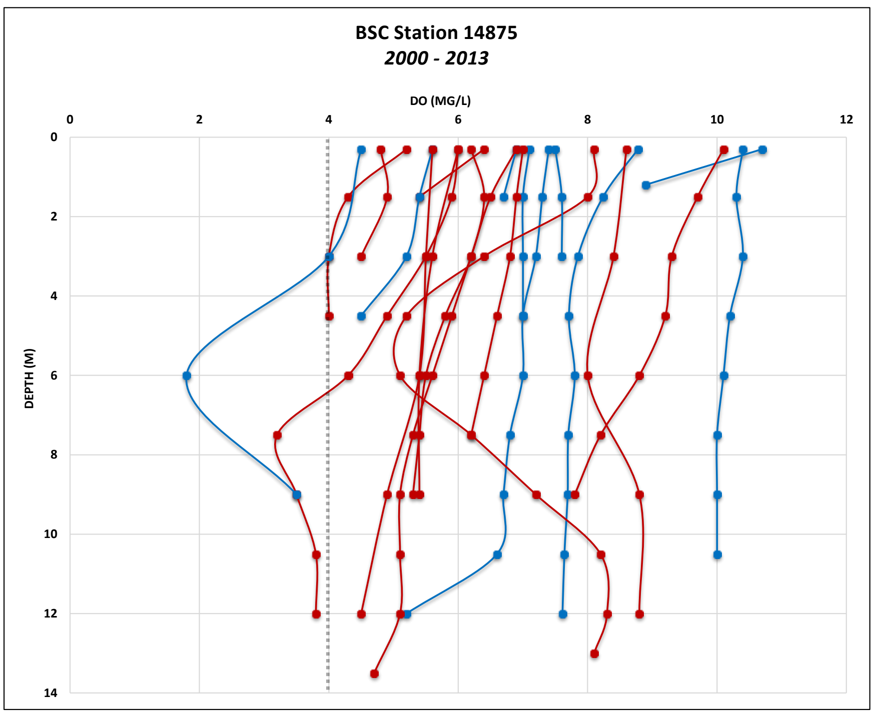


Figure 4-#. Depth profiles of DO concentrations (mg/L) in the Brownsville Ship Channel, Station 14875, 2000 - 2013. DO criterion denoted with dotted gray line.

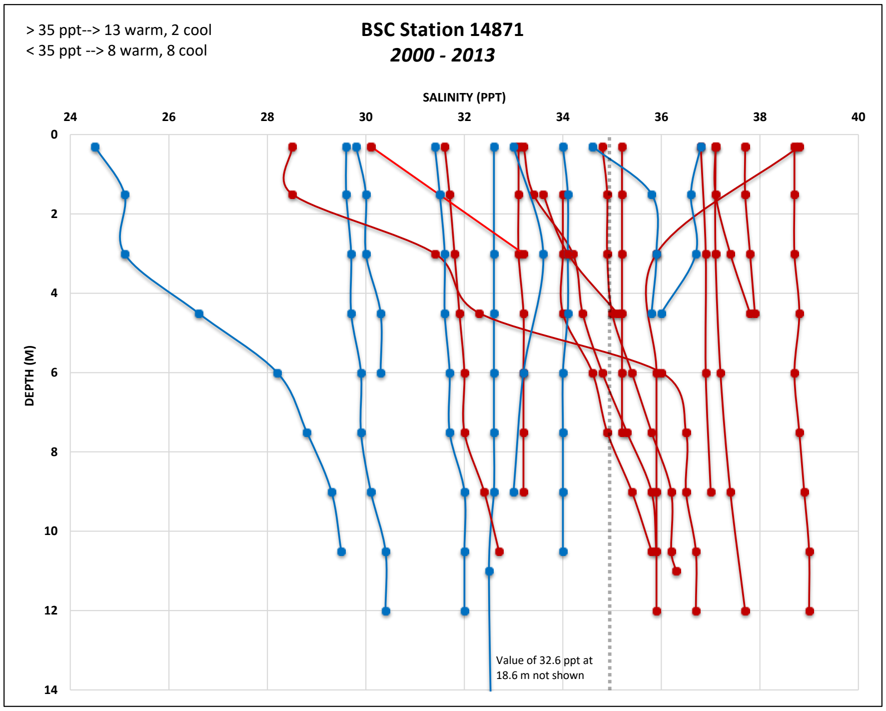


Figure 4-#. Depth profiles of salinity concentrations (ppt) in the Brownsville Ship Channel, Station 14871, 2000 – 2013. Saltwater salinity (35 ppt) denoted with dotted gray line.

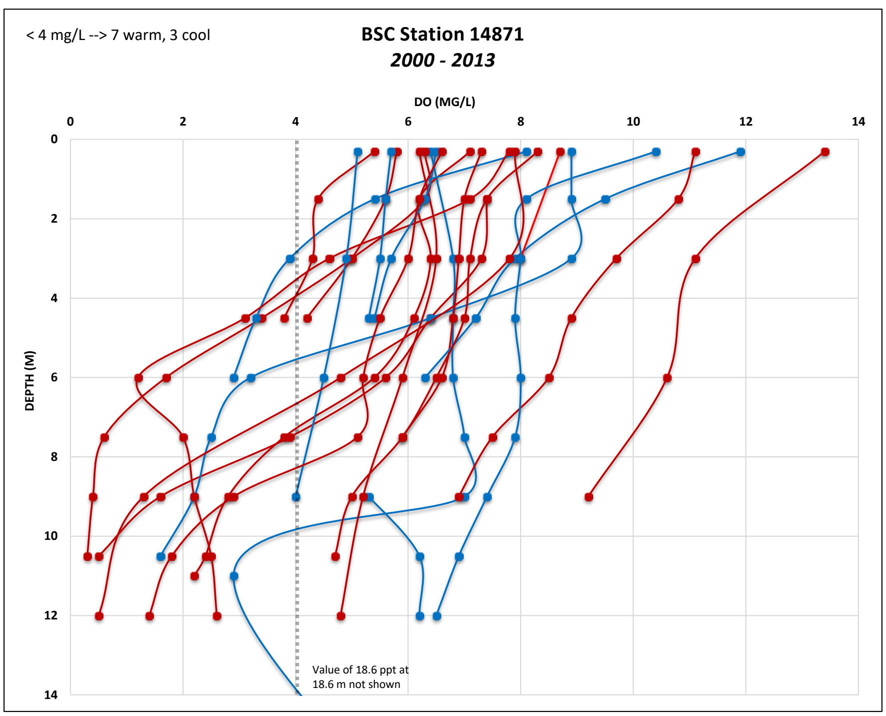


Figure 4-#. Depth profiles of DO concentrations (mg/L) in the Brownsville Ship Channel, Station 14871, 2000 – 2013. DO criterion denoted with dotted gray line.

The depth profile graphs above were plotted according to warm (red) and cool (blue) season where the warm season is considered May – October based on climate data for the region (Figure 2-2). In the Ship Channel, salinity values in excess of 35 ppt, the salinity of seawater, were recorded largely on warm-season sampling dates. Seasonal differences in DO from depth profiles were not as clear. An alternative visual aid for understanding seasonal dynamics is presented in Figures 4-# - 4-#. All profile data was assigned its season and plugged into cumulative percentage graphs. At stations 13460 (Figure 4-#) and 14871 (Figure 4-#) lower salinity values are clearly more common during cool months and DO seasonality is almost undiscernible. The middle station, 14875, shows the highest and lowest salinity readings during warm sampling months (Figure 4-#). As with the other two Ship Channel stations, DO does not demonstrate overt seasonality in depth profile data.

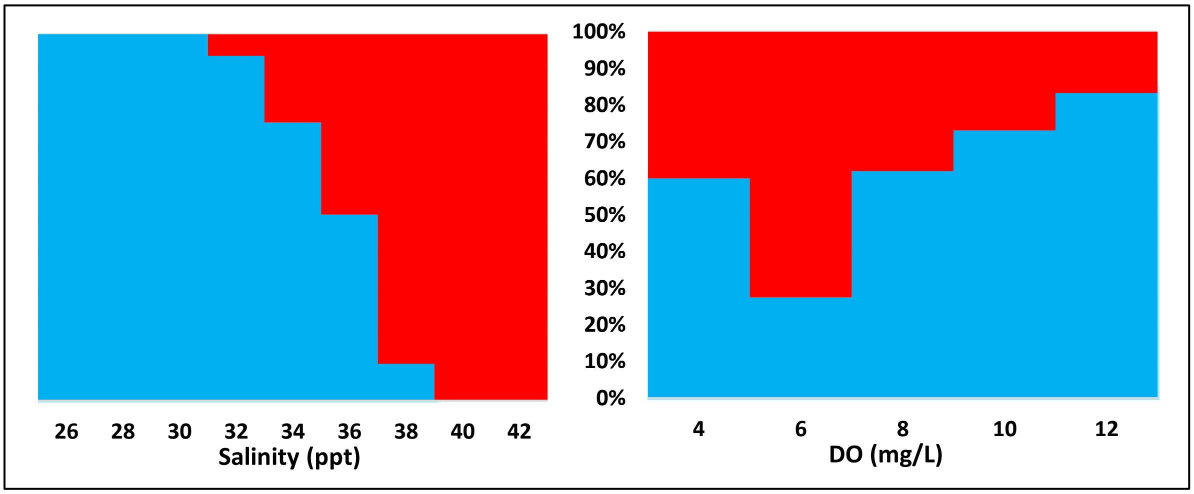


Figure 4-#. Cumulative percentage of DO and salinity by season from all depths in profile samples at Station 13460, 2000 - 2013. Higher salinity concentrations were more common in cool season months (blue) than warm months (red). No pattern is discernable for DO.

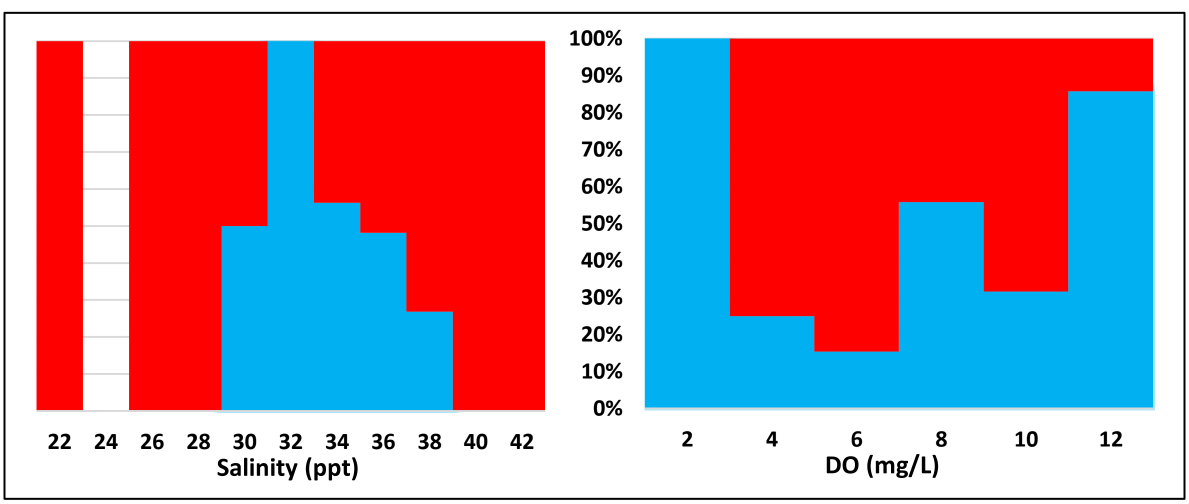


Figure 4-#. Cumulative percentage of DO and salinity by season from all depths in profile samples at Station 14875, 2000 - 2013. Higher salinity concentrations were more common in cool season months (blue) than warm months (red). No pattern is discernable for DO.

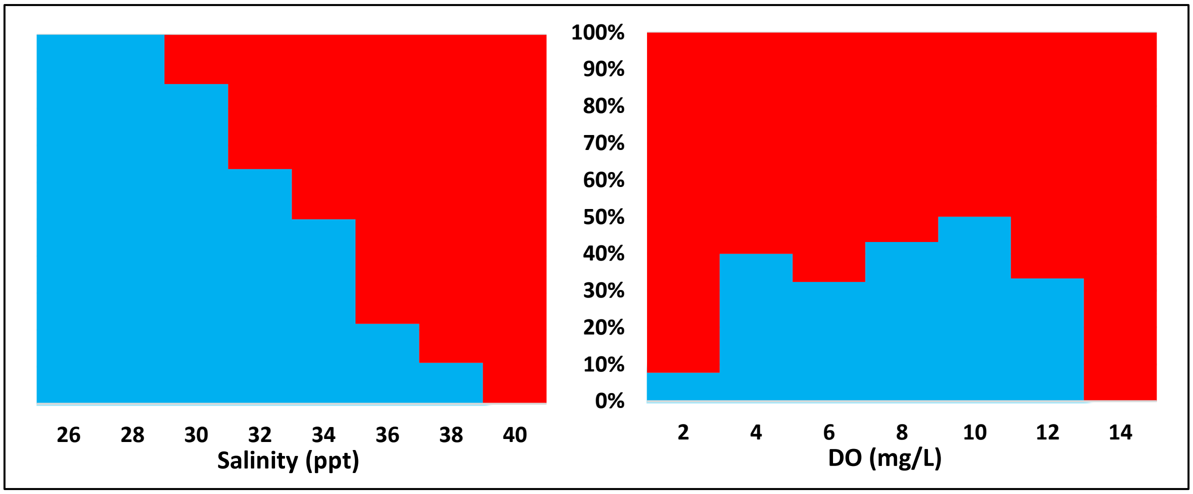


Figure 4-#. Cumulative percentage of DO and salinity by season from all depths in profile samples at Station 14871, 2000 - 2013. Higher salinity concentrations were more common in cool season months (blue) than warm months (red). No pattern is discernable for DO.