HISTORICAL DATA REVIEW
ON
TRES PALACIOS CREEK TIDAL

Performed as part of the Tidal Stream Use Assessment
under TCEQ Contract No. 582-2-48657 (TPWD Contract No. 108287)

Cindy Contreras
Resource Protection Division
Texas Parks and Wildlife Department
Austin, Texas

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Introduction

This historical data review was performed as part of an assessment of aquatic life use attainability for three tidally-influenced streams in Texas. The work was performed by Texas Parks and Wildlife Department (TPWD) under contract with the Texas Commission on Environmental Quality (TCEQ). Funding for the contract is from the United States Environmental Protection Agency (USEPA). Under the contract, TPWD Resource Protection Division staff, led by the Water Quality and Coastal Studies Programs, will collect data on five tidal streams. These data will be used to determine the appropriate aquatic life use of three tidal streams, Cow Bayou Tidal, Garcitas Creek Tidal and Tres Palacios Creek Tidal.

Tidal streams serve as nursery grounds for many types of fish and shellfish, including important commercial and sport species. As tidal streams become healthier, the health of Texas bays and estuaries, and the Gulf of Mexico, will also improve.

Numerous tidal streams are included on the state's list of impaired waters. Inclusion on the list of impaired waters initiates the Total Maximum Daily Load (TMDL) process. As a first step in the TMDL process, it is necessary to assess the water body, and determine if the impairment is genuine, and if so, whether or not it is caused by pollutants. It is difficult to do this for tidal streams, because there is no generally accepted methodology for performing the assessment. The TCEQ and TPWD have jointly recognized the need for developing a methodology for assessing the health of tidal streams. The data collected as part of this project will ultimately be analyzed to make recommendations regarding aquatic life uses in use attainability analysis (UAA) reports for Cow Bayou Tidal, Garcitas Creek Tidal and Tres Palacios Creek Tidal.

The Tidal Streams Use Attainability Assessment project will be conducted through FY2006. In 2003 and 2004 TPWD staff will collect data about flow, physico-chemical parameters, fish, shellfish, benthic invertebrates, sediment, habitat, and water chemistry for Cow Bayou Tidal, Garcitas Creek Tidal, Tres Palacios Creek Tidal and two reference streams. In FY2005, TPWD staff will analyze data and prepare a methodology to assess the ecosystem health of Cow Bayou Tidal, Garcitas Creek Tidal, Tres Palacios Creek Tidal. In FY2006, staff will prepare aquatic life use attainability assessment reports.

Site Description

Tres Palacios Creek originates in Wharton County and flows about 55 miles to Tres Palacios Bay in Matagorda County. The tidal portion of the stream, Segment 1501, is defined as extending upward from the bay about twelve miles, to one mile upstream of the confluence with Wilson Creek.

There is one permitted wastewater discharge in Segment 1501, Markham Municipal Utility District (Figure 1a). There is also a registered aquaculture facility, Ekstrom Enterprises, which discharges a significant volume of wastewater into Segment 1502, upstream of Tres Palacios Creek Tidal.

Water Quality Standards

Water quality standards include designated uses for a water body, specific numerical criteria for certain water quality parameters, and narrative criteria. The Texas Surface Water Quality Standards (TSWQS) are set by the TCEQ and approved by the USEPA. The TCEQ has established aquatic life uses and associated criteria for all waters of the state. The numeric criterion for dissolved oxygen is a surrogate or indirect measure of whether the aquatic life use is being maintained. Adequate dissolved oxygen is necessary for a healthy aquatic community. Most aquatic organisms become stressed if oxygen levels below about 2 mg/l persist for very long.

The designated uses for Tres Palacios Creek Tidal, Segment 1501, are contact recreation and exceptional aquatic life use (Texas Natural Resource Conservation Commission 2000b: 30 TAC §307.10(1)). The dissolved oxygen criteria for a tidal water body with an exceptional aquatic life use are: daily average 5 mg/l, and daily minimum 4 mg/l (30 TAC §307.7(b)(3)(A)(i)). The daily average is evaluated as a minimum average across 24 hours. Since most data collected at fixed monitoring stations are instantaneous measurements, direct comparison to the 24-hour criteria is not possible. For Tres Palacios Creek Tidal, 5.0 mg/l is used as the single measurement screening level to evaluate whether the high aquatic life use is being met (TNRCC, 1999). The dissolved oxygen criteria only apply in the "mixed surface layer," which in tidally-influenced water bodies is defined as "the portion of the water column from the surface to the depth at which the specific conductance is 6,000 umhos/cm greater than the specific conductance at the surface" (TNRCC, 1999). However, the TSWQS at 30 TAC 307.9(c)(3)(C) also specify that a composite sample from the mixed surface layer be used to determine standards attainment when stratification is caused by temperature (density stratification).

Review of Previous Studies

There are no previous studies published by TCEQ on Tres Palacios Creek Tidal. The Lower Colorado River Authority (LCRA), in conjunction with the Clean Rivers Program, has maintained a routine monitoring site on Segment 1501, collecting water quality measurements as well as dissolved metals in water data. During 1998, metals samples were collected using a peristaltic pump with c-flex tubing and in-line disposable 0.45 micron filters. The samples were analyzed for dissolved aluminum, arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. Dissolved metals, except for mercury, were analyzed using USEPA analytical method 200.8. Mercury was analyzed using USEPA method 7470.A (LCRA 2002). Results of the dissolved metals in water samples are summarized in Table 1 and water quality measurements in Table 2.

Table 1. Metals Results for Dissolved Metals in Water Sampling August 1998 (single samples).

Site	Segment	Constituent					
		Mercury (ug/L)	Aluminum (ug/L)	Arsenic (ug/L)	Selenium (ug/L)	Silver (ug/L)	Barium (ug/L)
Tres Palacios at FM 521	1501	< 0.2	7.5	6.3	95.6	< 1.0	192.0
		Cadmium (ug/L)	Chromium (ug/L)	Copper (ug/L)	Lead (ug/L)	Nickel (ug/L)	Zinc (ug/L)
Tres Palacios at FM 521	1501	< 1.0	19.3	20.2	< 1.0	26.0	< 4.0

On the recommendation of the Clean Rivers Program Steering Committee, a special study was initiated in 1999 to investigate the source of elevated bacterial counts on the Tres Palacios River (Segments 1501 and 1502). This study (Bass and Reinmund, 1999) found that bacterial counts were elevated throughout the river during and approximately one week after rain events strong enough to produce runoff into the river, and nutrient concentrations during dry weather monitoring conditions appeared to be tied to populated areas. In Segment 1501, these elevated nutrient levels could be attributed to housing subdivisions using onsite sewage facilities (LCRA 2002). Two of the ten stations monitored during the study were located in Segment 1501. One-third of the dissolved oxygen measurements made at those two stations were below 5.0 mg/l, the state criterion. The authors found that more violations of the criterion occur in the upper end of Segment 1501.

West Carancahua Creek, the reference stream for Tres Palacios Creek, was sampled by TPWD River Studies in 1988 by seine and backpack electrofisher (Linam et al 2002). Twelve fish species were identified from the sample (Appendix A at the end of this document). The same year TCEQ and TPWD sampled the benthic community in West Carancahua Creek using a Surber sampler. Thirty-four taxa of benthic invertebrates were identified (Bayer et al 1992). The list of taxa is attached in Appendix B.

Table 2. Summary of Water Quality Results for Tres Palacios River, Station 12515, for 1996 to 2000.

Segment	Year	Constituent										
		Temperature (^{0}C)	Dissolved Oxygen (mg/L)	pH (S.U.)	Ammonia (mg/L)	Nitrate+ Nitrite (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphorus (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	E. coli (cfu/dL)	Chlorophyll (µg/L)
1501	1996	21.45	6.73	7.58	0.135	0.626	0.291	0.132	1524.0	207.7	78	3.4
	1997	20.82	6.74	7.48	0.125	1.539	0.400	0.091	255.8	34.0	101	9.0
	1998	23.82	5.63	7.14	0.204	1.475	0.238	0.075	1057.0	407.7	67	5.1
	1999	23.16	6.78	7.58	0.063	1.158	0.220	0.128	4090.1	561.5	48	10.0
	2000	20.33	6.66	7.80	0.205	0.688	0.450	0.173	2368.0	337.9	48	5.1
	Mean	22.01	6.52	7.46	0.148	1.096	0.305	0.119	1770.9	292.6	38	6.6
	Benchmark	35.00	5.00	6.5 - 9.0	0.580	1.830	0.710	0.550	-	-	126	19.2
	Violation Rate %	0.00	23.10	0.00	0.00	9.10	5.60	0.00	0.00	0.00	22.0	25.0

Review of Water Quality Data

Water quality data from the Surface Water Quality Monitoring (SWQM) portion of the TCEQ Regulatory Activities and Compliance System (TRACS) database was reviewed for the period of record. The focus was on dissolved oxygen measurements, since low oxygen is the reason this water body was suspected to be impaired. The data used in the assessment to list Tres Palacios Creek Tidal as impaired for dissolved oxygen was also reviewed separately.

2000 303(d) Listing of Tres Palacios Creek Tidal

Tres Palacios Creek Tidal was listed in 2000 for partial support of the aquatic life use. The procedures for evaluating surface water data to determine whether uses and criteria were being met is described in "2000 Guidance for Screening and Assessing Texas Surface and Finished Water Quality Data." Under this guidance, dissolved oxygen data from the five-year period of record (1994-1999) was compared to the criterion, to determine whether the aquatic life use was being met. Two types of data could be used to assess use support – instantaneous or routinely collected data and 24-hour or intensively collected data. With instantaneous data, at least nine values were required to evaluate whether the criterion was being met, with use being fully, partially, or not met based on the percentage of measurements not meeting the instantaneous screening level (5.0 mg/l in the case of Tres Palacios Creek Tidal). With 24-hour data, at least five sets of measurements were required to evaluate whether the criterion was being met. Use attainment was evaluated based on the percentages of means and minimum values from those data sets which met the average and minimum criteria established under the TSWQS.

For the 2000 assessment, 18 dissolved oxygen measurements were evaluated; all were taken at Station 12515, Tres Palacios Creek Tidal at FM 521 east of Palacios (Figure 1b). All were instantaneous measures of dissolved oxygen. Table 3 summarizes the results of the assessment.

Table 3. Summary of Dissolved Oxygen Data and Violations of Criteria Assessed for the 2000 Water Quality Inventory and 303(d) List.

Station ID	Mean D.O. (mg/l)	N	No. Violations	(%)
12515	6.7	18	4	22.2

The four violations prompting the listing were measurements of 4.75 mg/l (taken in September 1993), 2.60 (June 1994), 3.07 (September 1994), and 3.7 (June 1997). All were taken during hot months of the year (water temperatures ranging from 26.7 to 29.3 degrees C). It may be possible that a larger sample size will show that low dissolved oxygen is not characteristic of Tres Palacios Creek Tidal.

Summary of SWQM TRACS Historical Data

A raw data report of all SWQM data on Tres Palacios Creek Tidal (Segment 1501) was obtained for the period of record ending with June 21, 2002. Over the period of record, water quality data has been collected at only one station, Station 12515.

Mixed Surface Layer D.O. Measurements

Since dissolved oxygen (D.O.) is the parameter of most concern for this study, an analysis was made of instantaneous D.O. measured at 0.3 meters or less from the surface (to approximate the mixed surface layer). Data collected between 5:00 and 9:00 a.m., which approximates the critical early morning period, was removed from the analysis. The mean D.O. for the remaining 131 measurements was 7.52 mg/l, and values ranged from 2.57 to 16.3 mg/l.

Critical Early Morning

The data set contained only four measurements collected from 5:00 to 9:00 a.m., ranging from 2.33 to 6.76 mg/l.

Vertical Profiles

Summarizing vertical profile data is problematic since data were collected at different depths each sampling trip, depending on the maximum depth at the sampling location that day. Most of the profile data showed a relatively well-mixed water column with little stratification due to salinity (Figures 2, 3, and 4). Dissolved oxygen was maintained at a good level (near or above the water quality standard). One profile (Figure 5) exhibited density stratification. Specific conductivity and dissolved oxygen displayed an inverse relationship, with dissolved oxygen levels dropping by almost half in a vertical span of less than 2 meters.

Trends Over Time

Data from the mixed surface layer (measured at 0.3 meters or less from the surface) and collected anytime other than the critical early morning period (5:00 – 9:00 a.m.) were examined for Station 12515 (Figure 6). Overall D.O. levels looked good. It was difficult to determine whether a trend existed over time, but the graph of the mean D.O. values appeared to oscillate over about a six-year cycle.

Twenty-four Hour Data

The data set included two 24-hour measurements of dissolved oxygen and other conventional parameters. Table 3 depicts the results of two twenty-four hour measurements made at Station 12515. The measurements indicate a good average oxygen level, although the minima and maxima imply a fairly strong diel swing in oxygen, which is probably due to instream photosynthesis.

Table 3. Summary of 24-hour measurements made on Tres Palacios Creek Tidal, Station 12515, at 0.61 meters.

Date	Mean D.O. (mg/l)	Min. D.O. (mg/l)	Max. D.O. (mg/l)
7/8/1998	6.9	2.2	11.5
7/9/1998	6.2	2.2	9.4

Effects of Nutrients, Suspended Solids, and TOC on Dissolved Oxygen

TRACS data were requested for sampling events where nutrients (ammonia, nitrate, phosphate), total suspended solids (TSS) and total organic carbon (TOC) were measured along with dissolved oxygen. A significant number of observations were available for Station 12515. Each water quality parameter was charted versus dissolved oxygen. A Pearson correlation was run for each pair of variables, with the assumption that dissolved oxygen was the dependent variable.

Dissolved oxygen appeared to decline as TSS increased, but the relationship was not signficant at $p<0.05$ (Figure 7, Table 4). There was no significant relationship of dissolved oxygen to TOC (Figure 8) or ammonia (Figure 9). The only significant correlation was a negative one between dissolved oxygen and phosphate (Figure 10). There was no significant relationship between nitrate and dissolved oxygen (Figure 11).

Table 4. Pearson correlations.

	TSS	TOC	NH4	PO4	NO3
Correlation coefficient (r)	- 0.057	-0.238	0.011	-0.379*	0.082
Sample size	66	47	76	58	61

r : used to quantify the strength of the association between the variables. While positive r values indicate both increase together, negative r values indicate a negative relationship

*: p values < 0.05, hence one variable can be used to predict the other variable.

Figure 1a. Tres Palacios Creek Tidal permitted wastewater discharges.

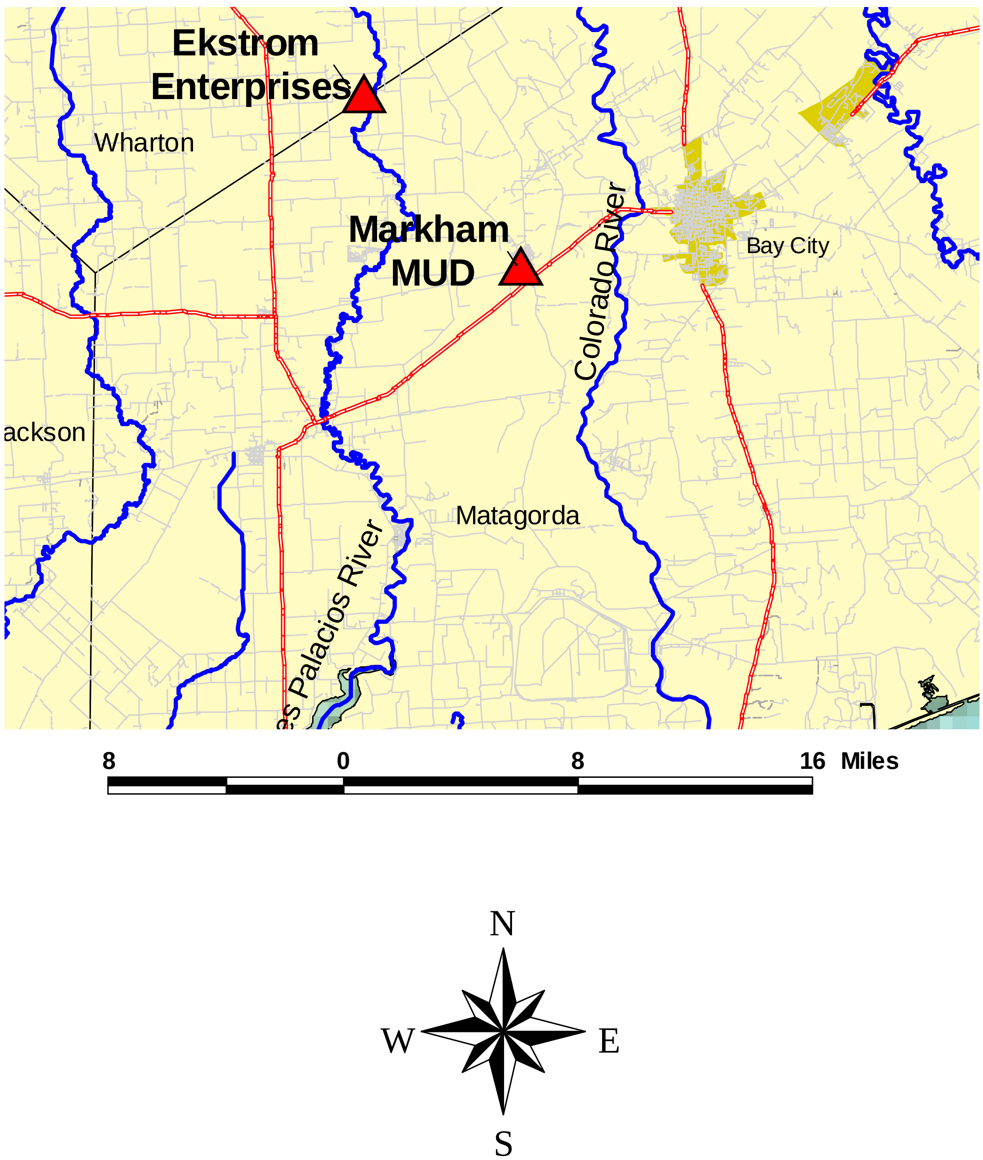


Figure 1b. Map of Tres Palacios Creek Tidal showing TCEQ station locations.

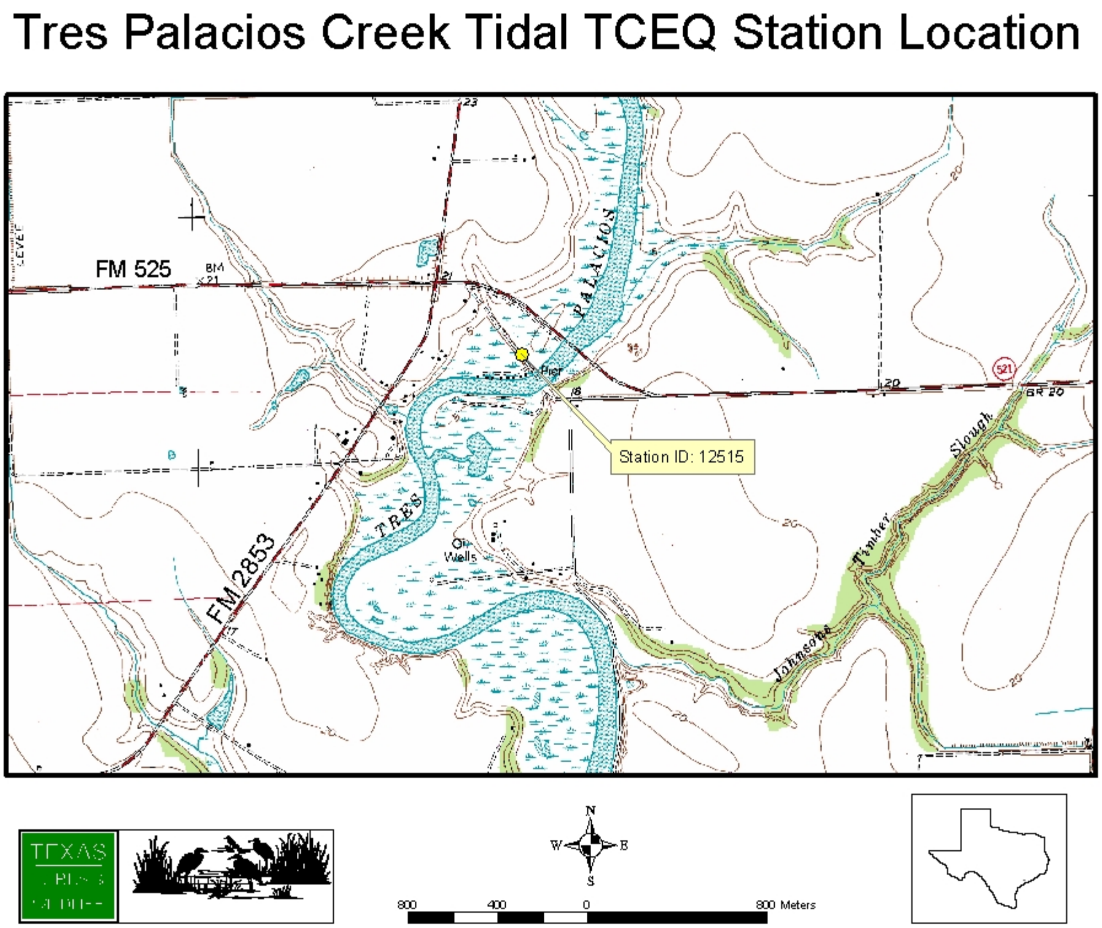


Figure 2. Tres Palacios Station 12515: Dissolved oxygen and conductivity on 10/17/73 at 4:40 p.m.

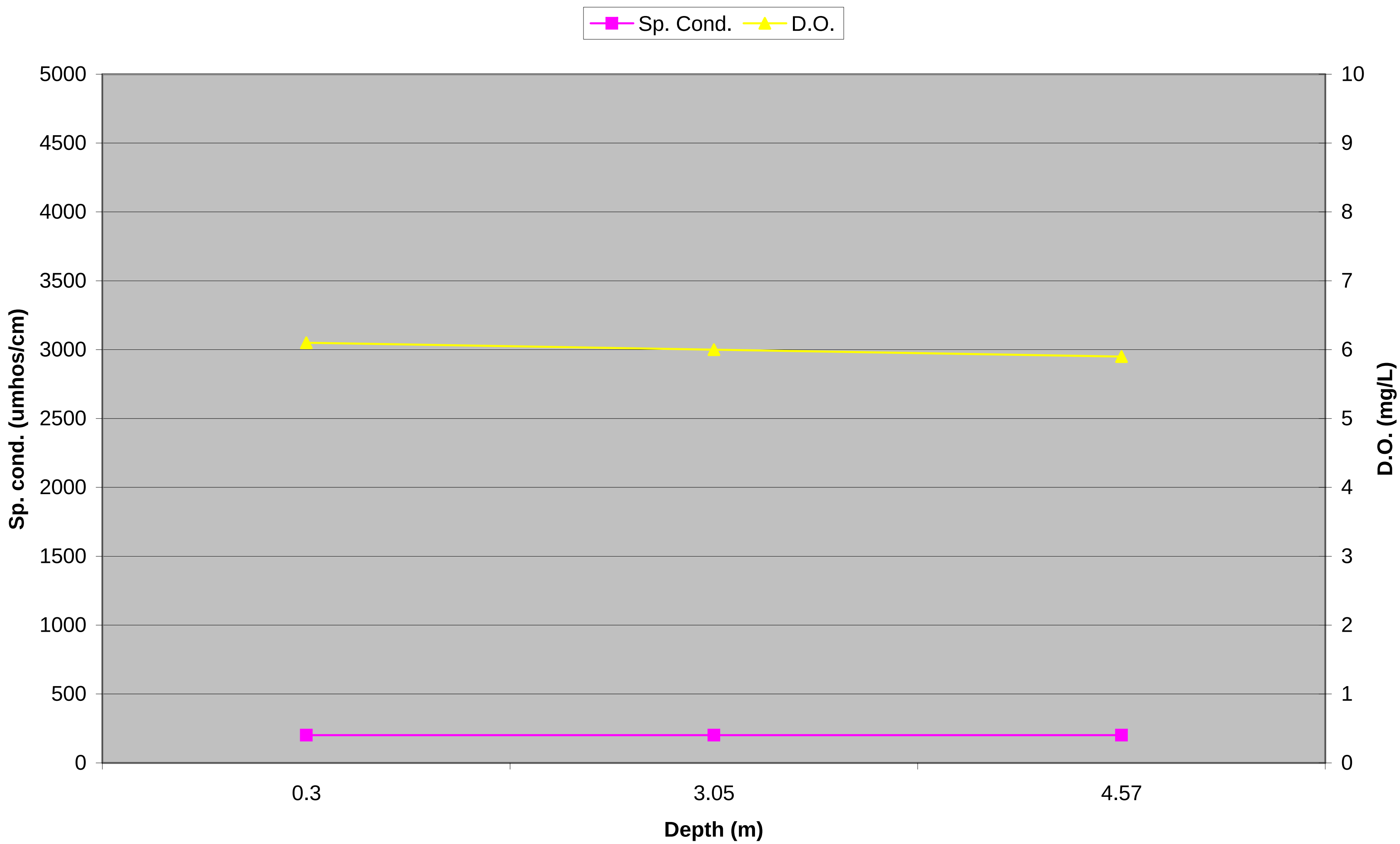


Figure 3. Tres Palacios Station 12515: Dissolved oxygen and conductivity on 9/12/85 at 10:04 a.m.

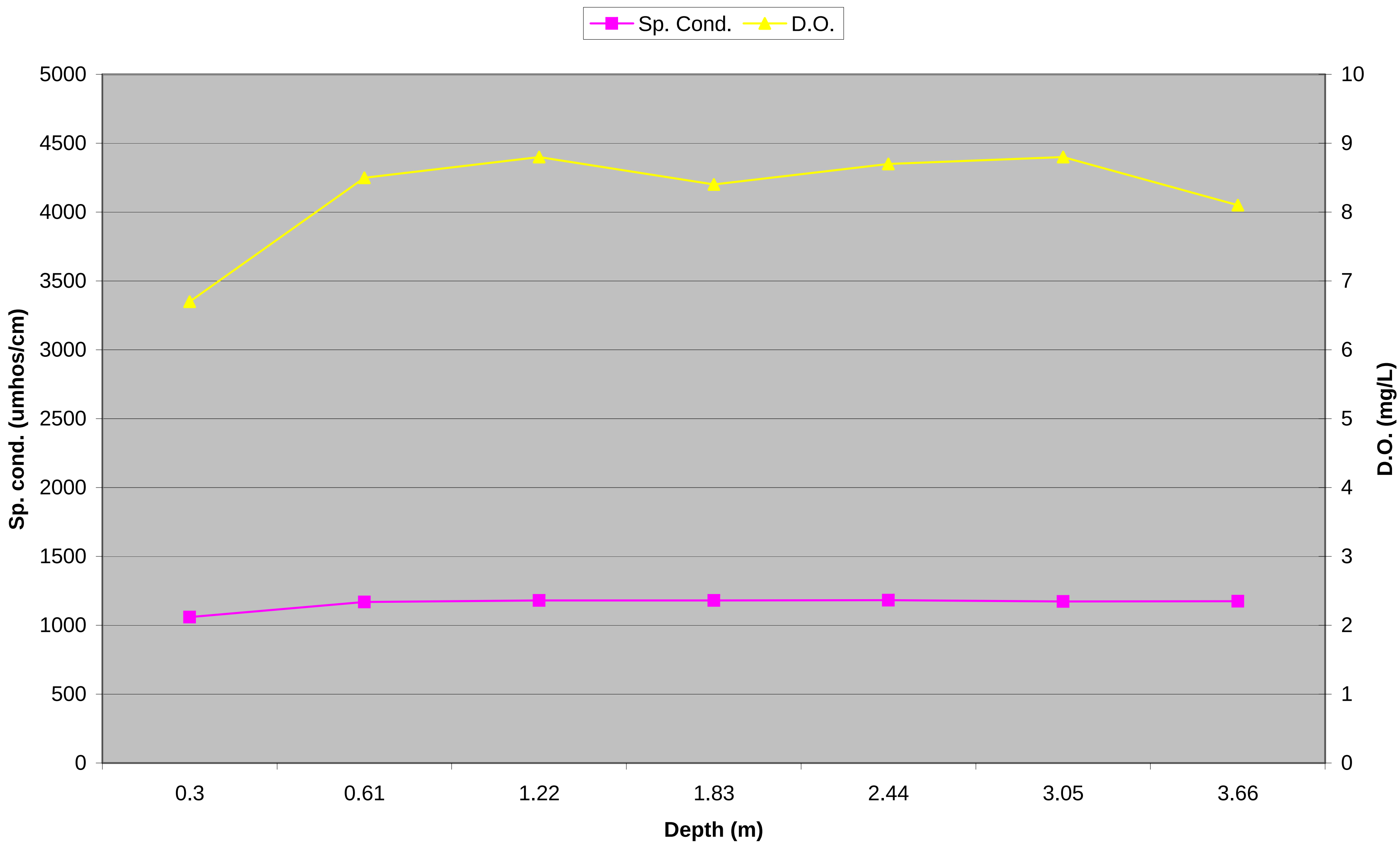


Figure 4. Tres Palacios Station 12515: Dissolved oxygen and conductivity on 7/22/91 at 12:47 p.m.

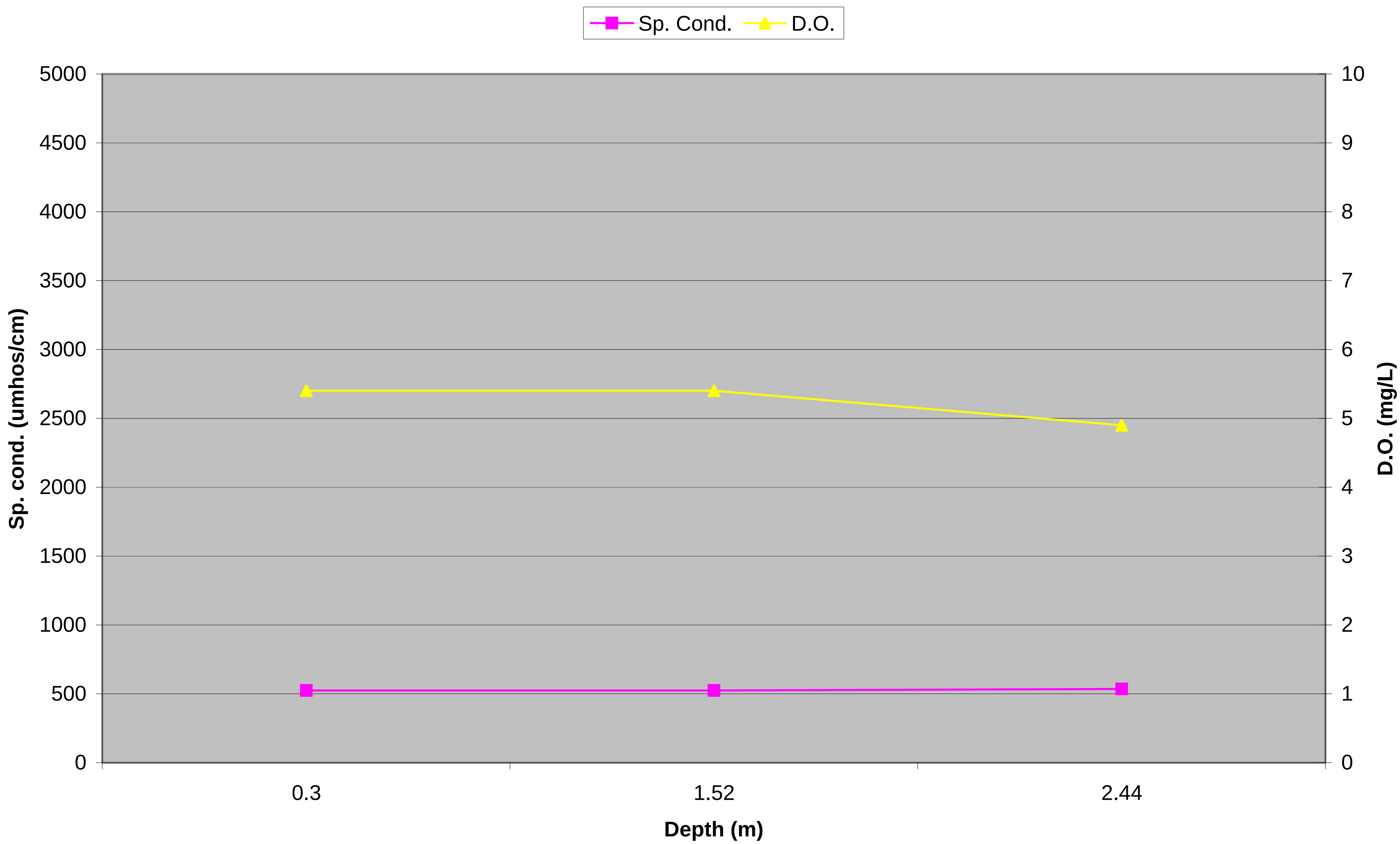


Figure 5. Tres Palacios Station 12515: Dissolved oxygen and conductivity at 9/22/87 at 1:15 p.m.

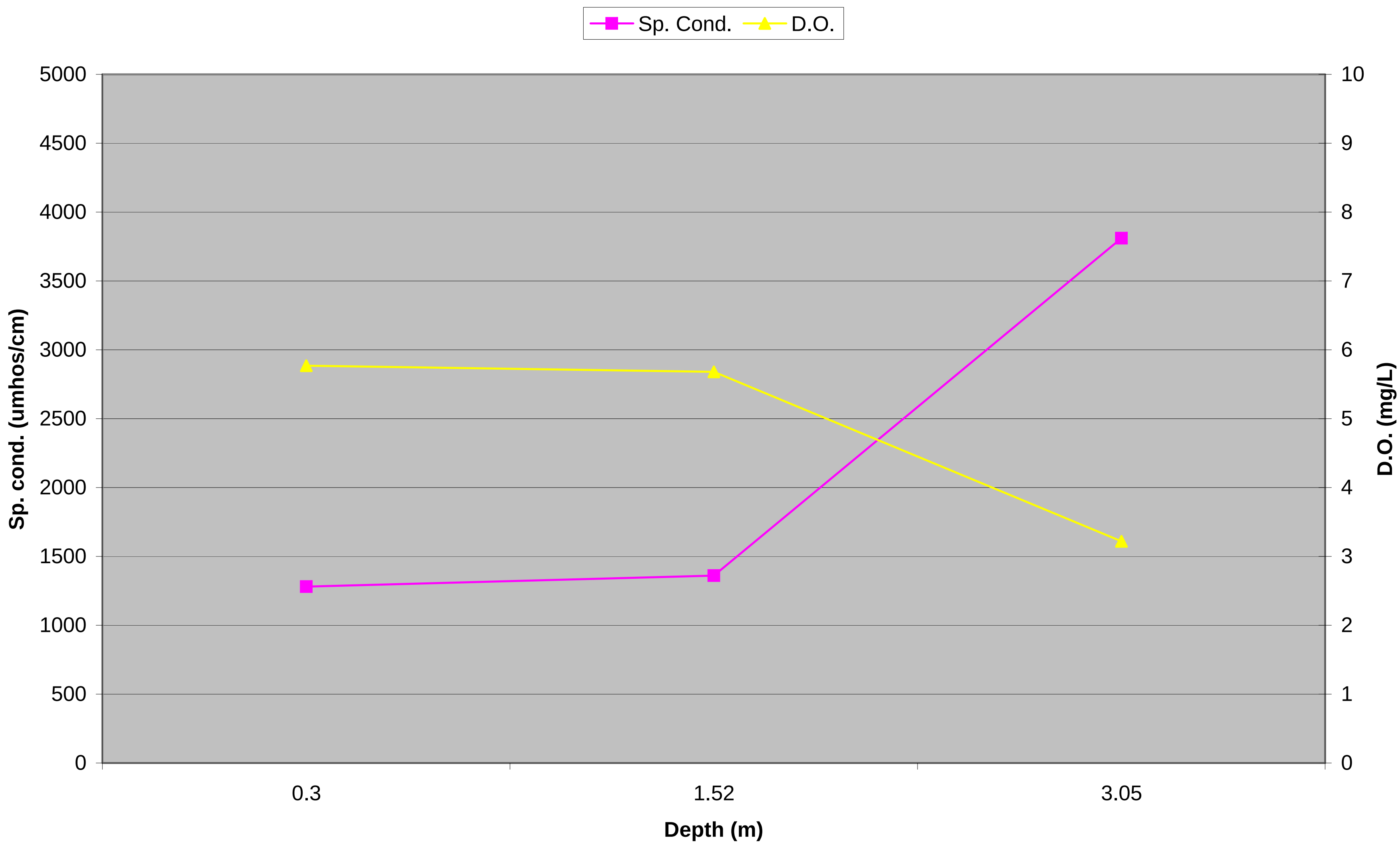


Figure 6. Mean Dissolved Oxygen at Tres Palacios Station 12515 (+/- Std. Dev.)
N = 131

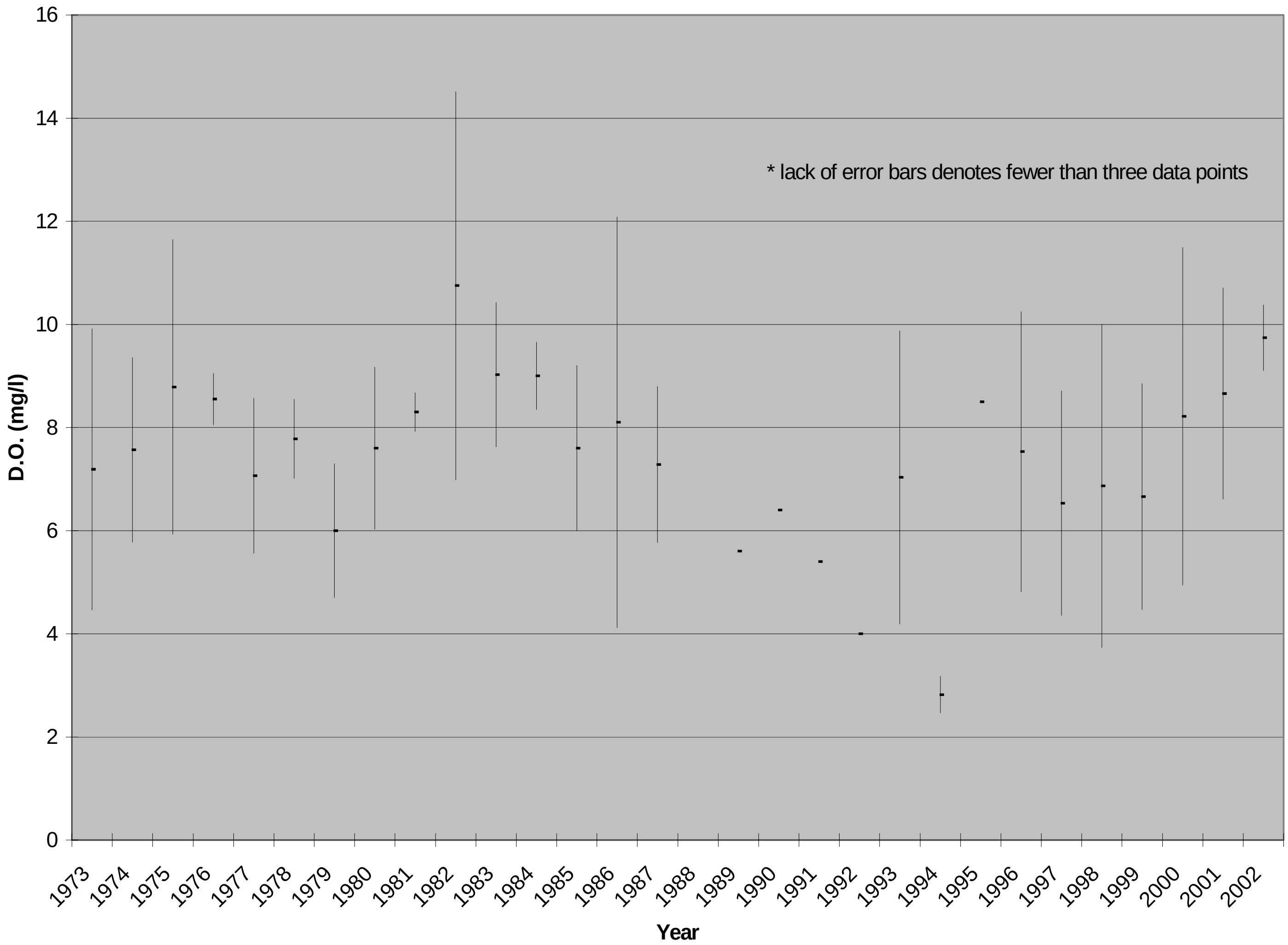


Figure 7. TSS vs. DO at Tres Palacios Station 12515

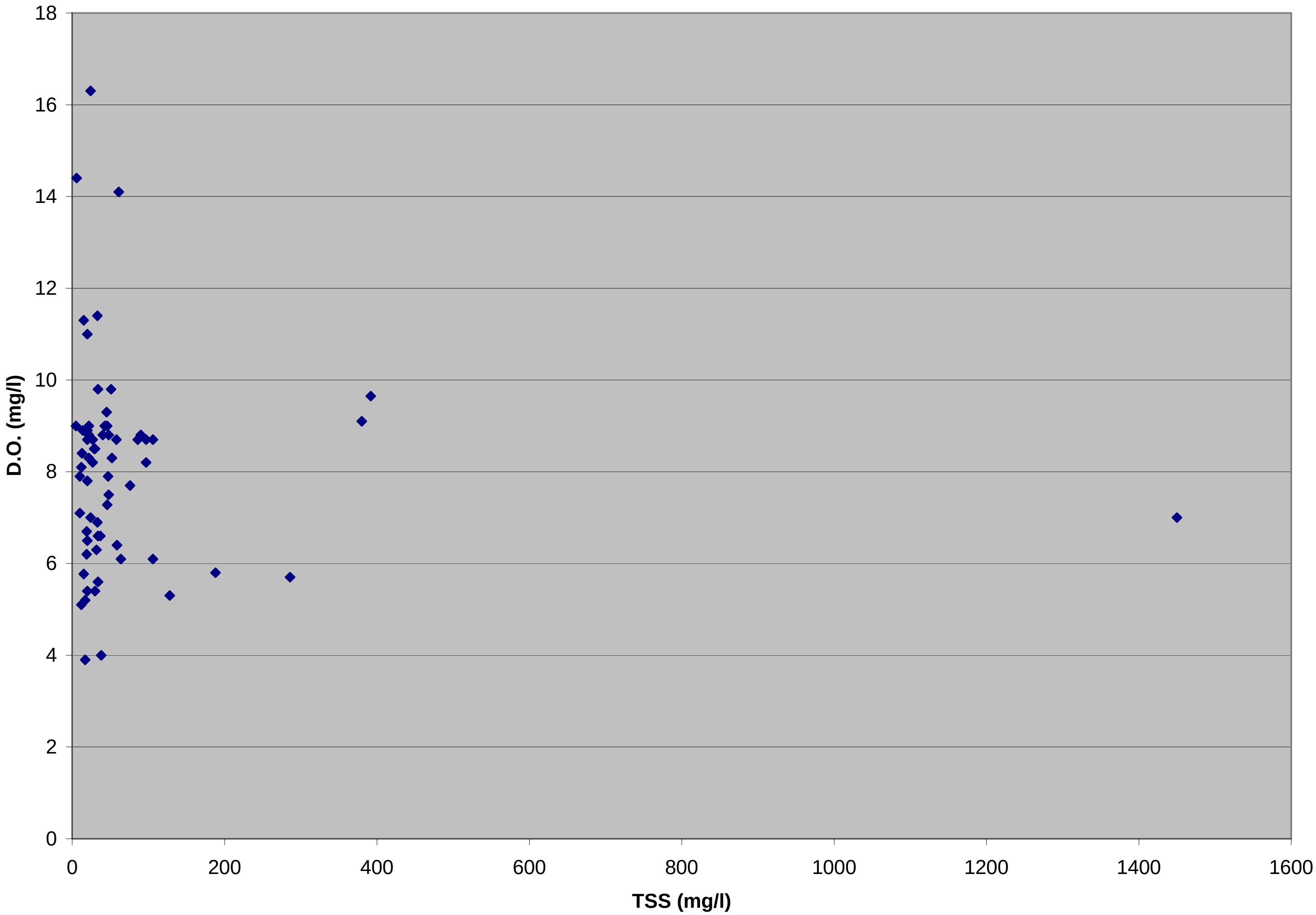


Figure 8. TOC vs. DO for Tres Palacios Tidal Station12515

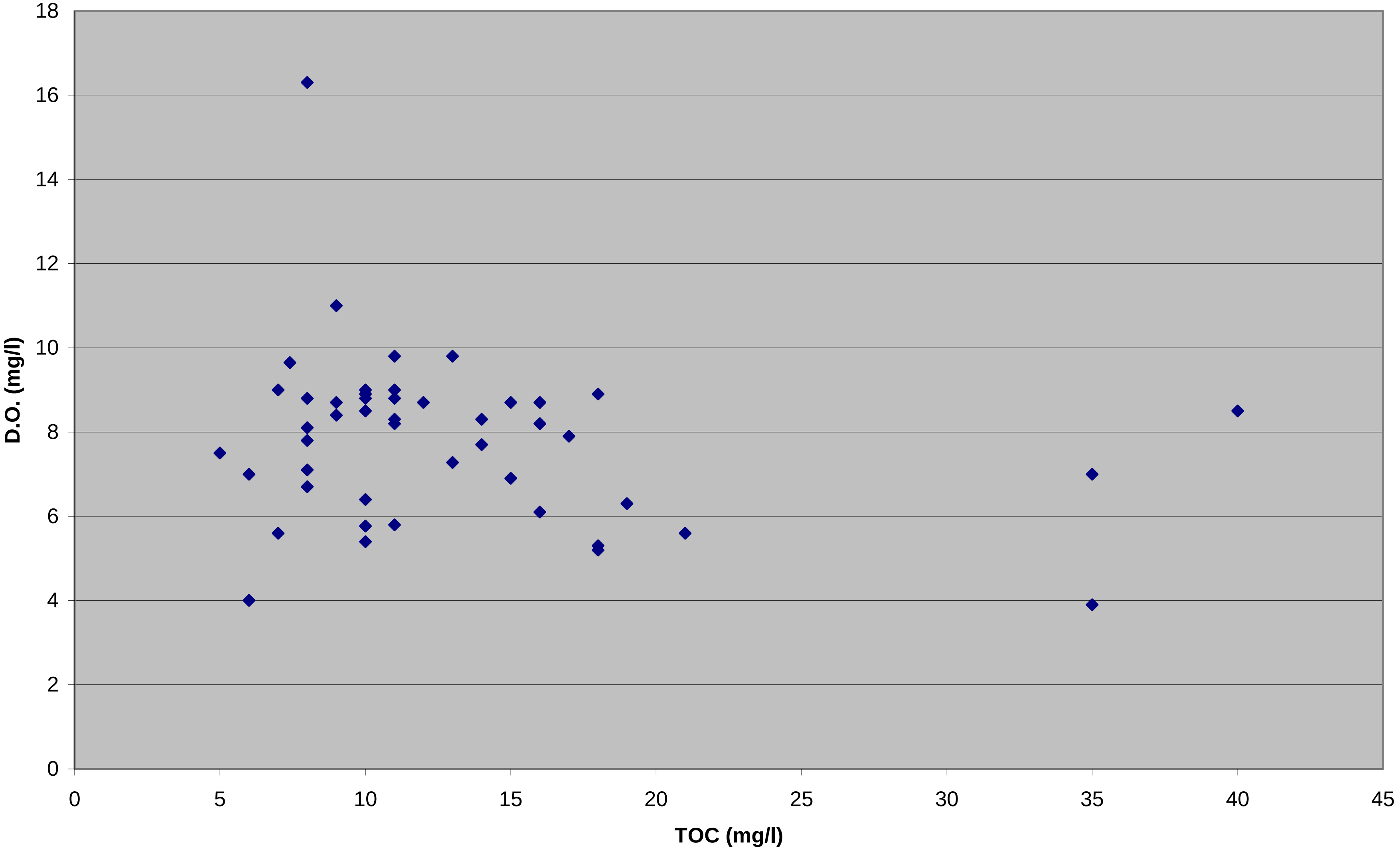


Figure 9. Ammonia vs. DO for Tres Palacios Tidal Station12515

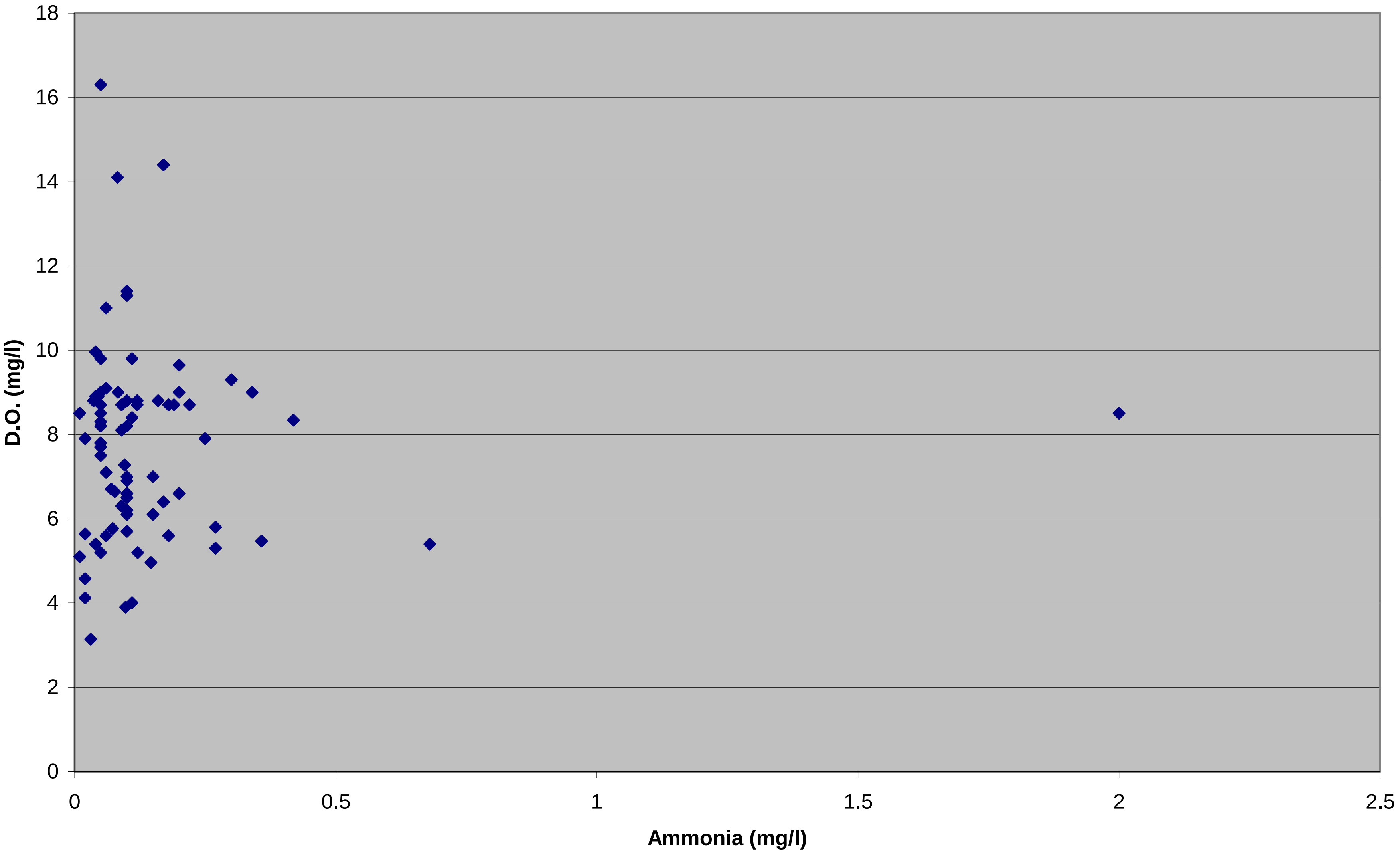


Figure 10. Phosphate vs. DO for Tres Palacios Tidal Station 12515

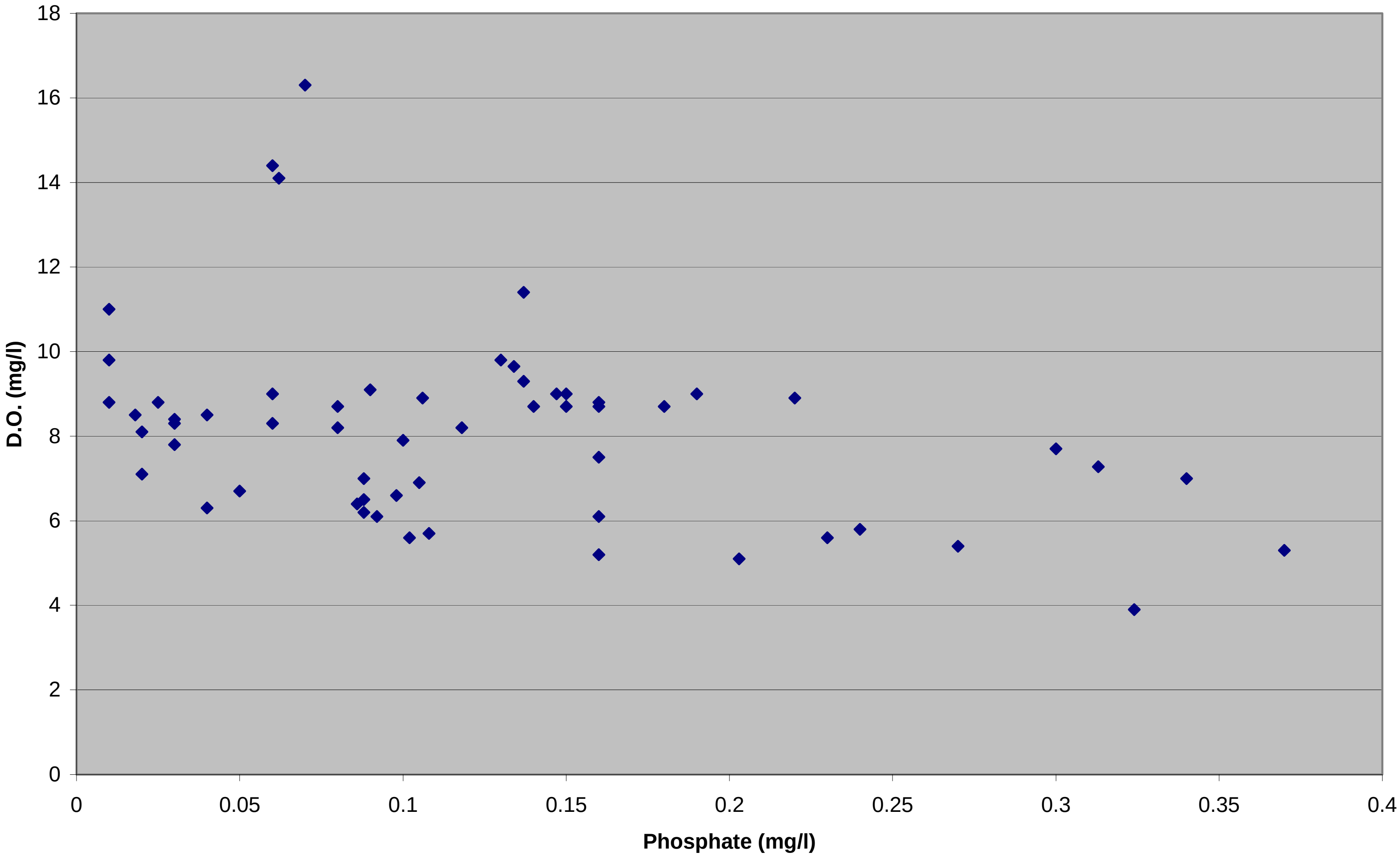
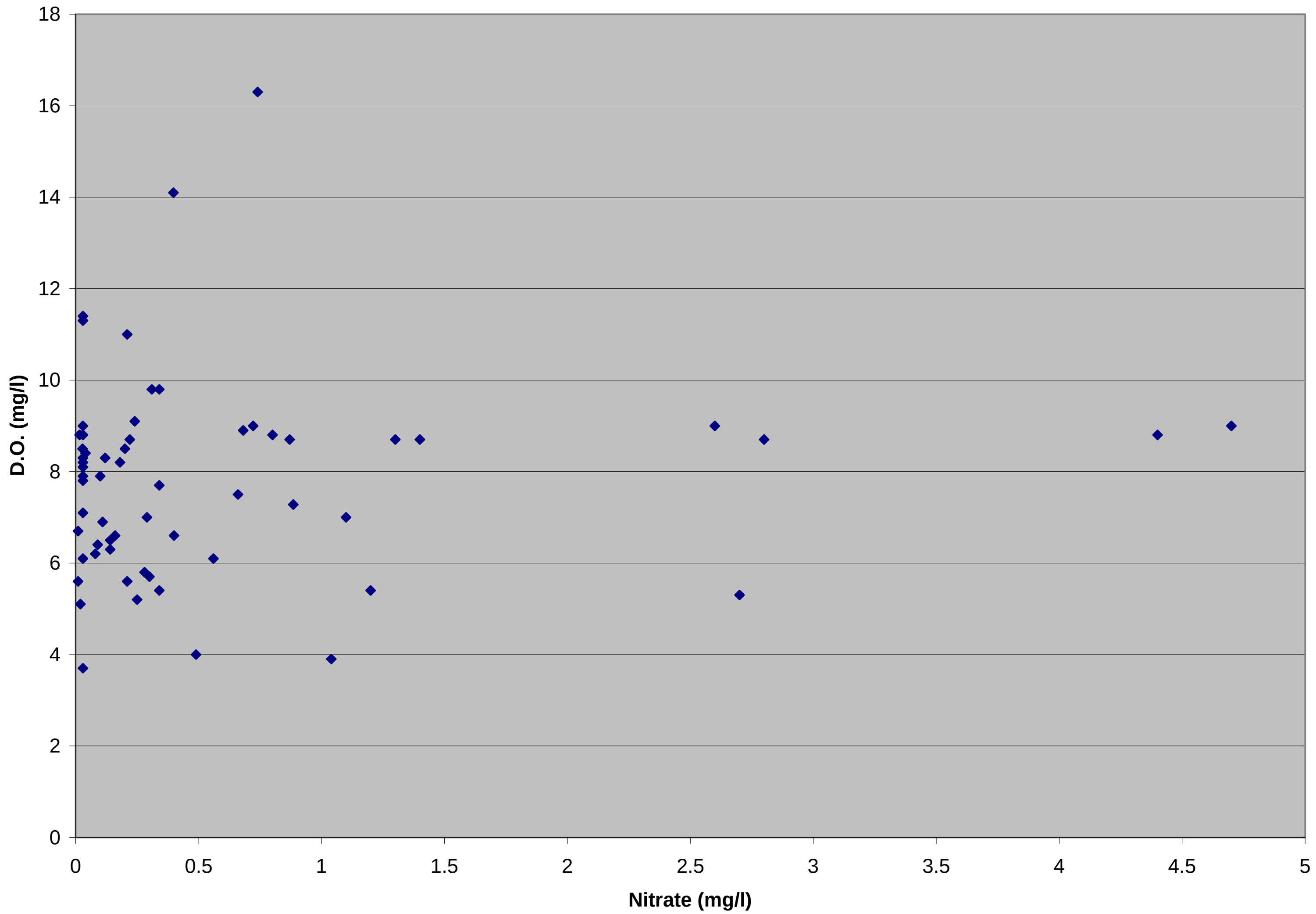


Figure 11. Nitrate vs. DO for Tres Palacios River Tidal Station 12515



Conclusion

Historical water quality data on Tres Palacios Creek Tidal shows relatively good water quality in terms of dissolved oxygen. Mean dissolved oxygen values collected within the top 0.3 meter of the water column averaged 7.52 mg/l, which is very good. The lowest value which violated the water quality criteria, prompting the listing of the segment as impaired, was 2.60 mg/l. The lowest value recorded during the critical early morning period was 2.33 mg/l. Even these minimum values, while not optimal for aquatic life, are not indicative of severe hypoxic or anoxic conditions.

We did not find any TCEQ-published biological data on Segment 1501. Of the three streams being studied under this project, this is the only one for which no biological data was available.

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APPENDIX A. Fish species collected from West Carancahua Creek in 1988 (data table from Linam et al 2002).

Fish species collected from West Carancahua Creek, Jackson County (9/7/88).

Species	Common Name	Seine (7 hauls)	Backpack Shocker (10.3 min)
Anguilla rostrata	American eel		1
Cyprinella lutrensis	Red shiner	1360	3
Opsopoeodus emiliae	Pugnose minnow	9	1
Pimephales vigilax	Bullhead minnow		1
Ameiurus natalis	Yellow bullhead		1
Ictalurus punctatus	Channel catfish	32	16
Noturus gyrinus	Tadpole madtom	1	
Gambusia affinis	Western mosquitofish	430	2
Lepomis cyanellus	Green sunfish	3	9
Lepomis gulosus	Warmouth		5
Lepomis macrochirus	Bluegill		2
Lepomis megalotis	Longear sunfish		1

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Appendix B. Benthic invertebrate taxa collected in West Carancahua Creek in 1988 (Bayer et al. 1992)

TEXAS WATER COMMISSION ECOREGION INVERTEBRATE DATA

STATION	2400.0330 West Caranchua Creek - Jackson Co. @ Jackson County Rd. 440 (Bonnot Rd.) 5.6 km NE Laward
DATE	09/07/88
ECOREGION	34
SAMPLES	3 sq. ft. Surbers

Code	Genus/species	No.	No./M^2	No./ft^2
90045	*Hydra* sp.	1	4	0.33
90077	*Dugesia tigrina*	1	4	0.33
90501	*Aulodrilus pigueti*	2	7	0.67
90507	*Limnodrilus hoffmeisteri*	11	39	3.67
90510	*Limnodrilus udekemianus*	11	39	3.67
92875	*Physella virgata*	1	4	0.33
93031	*Pisidium casertanum*	29	104	9.67
93040	*Sphaerium transversum*	153	549	51
91101	*Eucypris* sp.	2	7	0.67
92230	*Dubiraphia* sp.	1	4	0.33
92242	*Microcylloepus pusillus*	2	7	0.67
92259	*Stenelmis occidentalis*	290	1041	96.67
92645	*Cladotanytarsus* sp. gr. A	17	61	5.67
92502	*Conchapelopia* sp.	56	201	18.67
90999	*Cricotopus trifascia* gr.	26	93	8.67
92523	*Cryptochironomus fulvus* gr.	13	47	4.33
93294	*Polypedilum convictum*	77	276	25.67
93289	*Polypedilum illinoense*	4	14	1.33
92635	*Polypedilum* nr. *scalaenum* sp. B	17	61	5.67
92538	*Pseudochironomus* sp.	94	337	31.33
92469	*Saetheria* sp.	4	14	1.33
92423	*Tanytarsus glabrescens* gr.	39	140	13
92554	*Tanytarsus* sp.	4	14	1.33
92588	*Thienemanniella* sp.	13	47	4.33
91663	*Baetis ephippiatus*	1	4	0.33
91600	*Caenis* sp.	149	535	49.67
91651	*Fallceon quilleri*	17	61	5.67
91656	*Paracloeodes* sp.	2	7	0.67
91595	*Tricorythodes albilineatus* gr.	255	915	85
91713	*Erpetogomphus* sp.	3	11	1
91732	*Progomphus obscurus*	3	11	1
92292	*Cheumatopsyche* sp.	59	212	19.67
92324	*Hydroptila* sp.	18	65	6
92399	*Oecetis* sp. B	1	4	0.33

90004	Number of Species	34
	Number of Individuals in Sample	1376
90007	Number of Individuals/sq. M	4937
90003	Number of Individuals/sq. ft.	458.67
90000	Diversity	3.64
90002	Redundancy	0.30
	Max. diversity	5.09
	Min. diversity	0.28
90001	Equitability	0.72
90008	EPT Index	8
90009	No. of Functional Feeding Groups	6
90010	Dominant Functional Feeding Group (% of Community)	42.70
90017	Cumulative Abundance of FPOM Feeders (% of Community)	75.42
90020	Grazers (% of Community)	13.76
90025	Gatherers (% of Community)	42.70
90030	Filterers (% of Community)	19.17
90034	Miners (% of Community)	13.55
90035	Shredders (% of Community)	3.36
90036	Predators (% of Community)	7.46
90037	Mean Point Score	3.00
90038	Ohio ICI Index Value	43

2400.0330 09/07/88