Biological Monitoring of the Tres Palacios River and Upper Tres Palacios Bay, Texas

Final Report

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Prepared by the Environmental Institute of Houston University of Houston – Clear Lake in cooperation with the National Wildlife Federation

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Project Background

Introduction

The National Wildlife Federation, as a member of a team of NGOs and university partners informally known as the Texas Environmental Flows Initiative (TEFI), is pursuing scientific and technical analyses to set the stage for one or more transactions to help secure freshwater inflows for several Texas bay / estuary systems. One such estuary system under evaluation is the bay / tidal river transition zone of the upper Tres Palacios Bay and Tres Palacios River, a tributary system of the larger Matagorda Bay. For clarity, this transition zone will be referred to herein as the Tres Palacios system.

In order to understand potential benefits of such a transaction in terms of biological and habitat responses, TEFI contracted the Environmental Institute of Houston, University of Houston-Clear Lake (EIH) to complete an initial rapid biological assessment of the Tres Palacios system. This baseline information is needed to determine the potential scope of benefits that the freshwater dedication transaction may provide.

Objectives

The objectives of the rapid biological assessment of the Tres Palacios System include four primary components:

1) <u>Wetland Characterization</u>: Conduct a broad-scale assessment of the Tres Palacios system fringe marshes by characterizing dominant species composition and document hydrologic connectivity to the Tres Palacios River at sixteen representative sites.
2) <u>Bathymetry Characterization</u>: Characterize the Tres Palacios River cross-section bathymetry at five representative sites in the downstream 20km of the River.
3) <u>Aquatic Biologic Sampling</u>: Conduct biologic monitoring of nekton that utilize the Tres Palacios system at five sites in the downstream 17km of the River.
4) <u>Visual Survey, Intertidal Oysters</u>: Conduct a visual survey for inter-tidal oysters in the downstream 8km of the River.

Methods

Study Sites

The study reach included the lower 20km of the Tres Palacios River to its confluence with upper Tres Palacios Bay (Figure 1). Wetland characterization and vegetation assessments were performed at 16 previously determined locations (Figure 2). Bathymetric measurements were taken at cross sections located 1.1km, 5.0km, 9.0km, 13.5km, and 19.0km from the river mouth (Figure 3). Water column profile readings were taken at 0.5km, 4.0km, 8.0km, 11.3km, and 15.5km from the river mouth, corresponding with the nekton sampling locations (Figure 3). Nekton samples were collected via otter trawl and seine net in 5 areas along the reach (Figure 4).

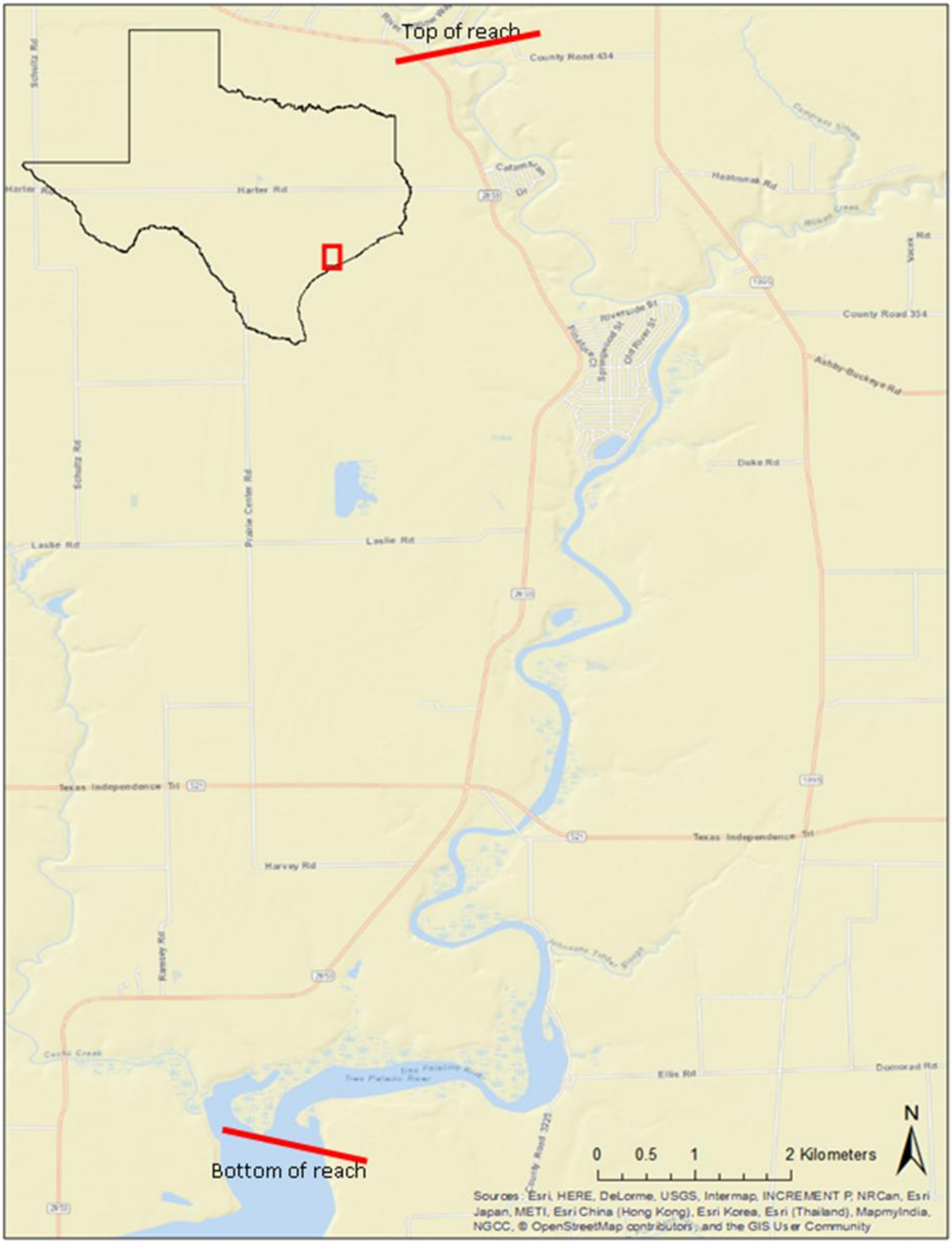

Figure 1 Reach sampled for Tres Palacios rapid biological assessment. Includes the lower 20km of the Tres Palacios River extending to the confluence with Tres Palacios Bay.

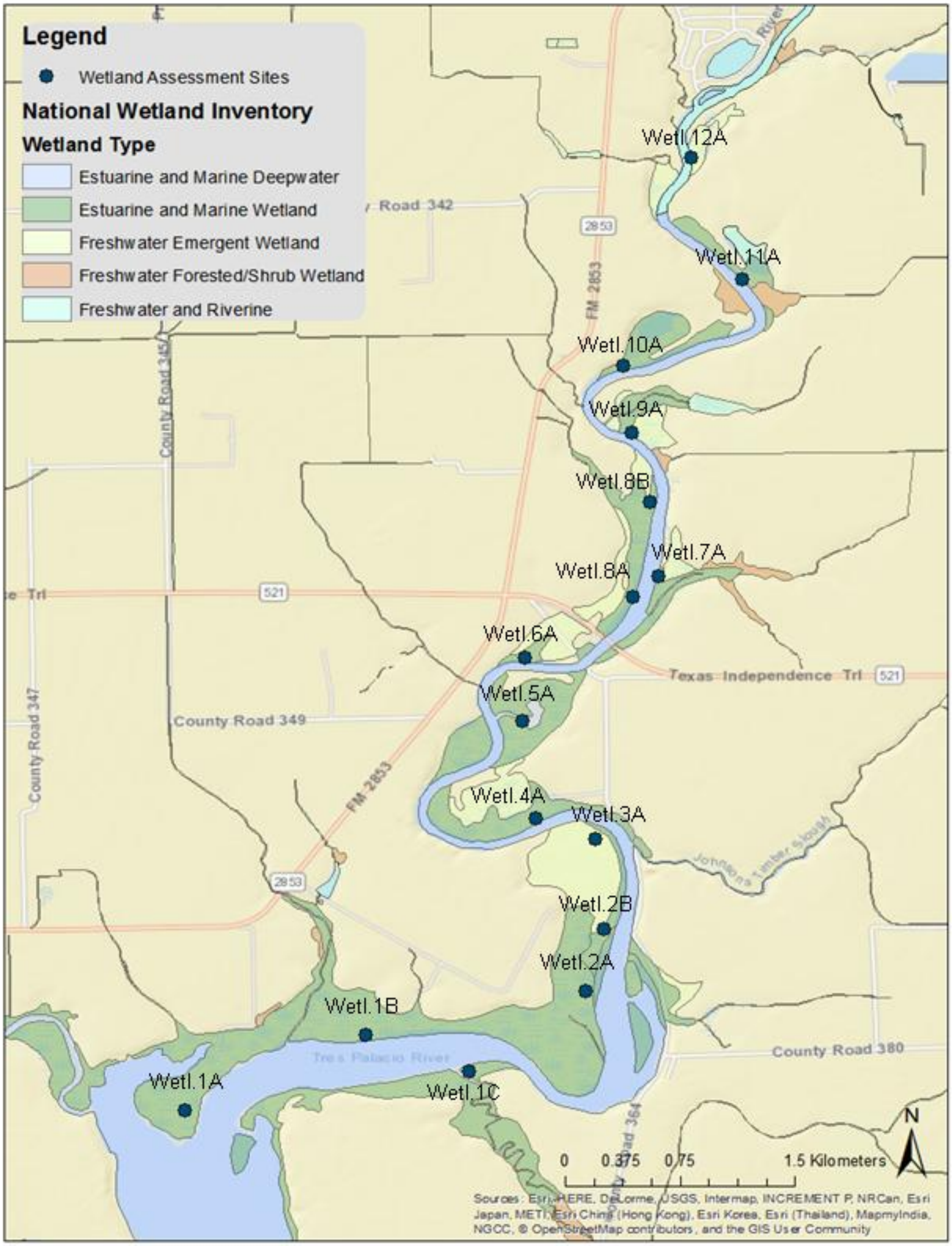

Figure 2 Location of wetland vegetation study sites and National Wetland Inventory wetland classifications.

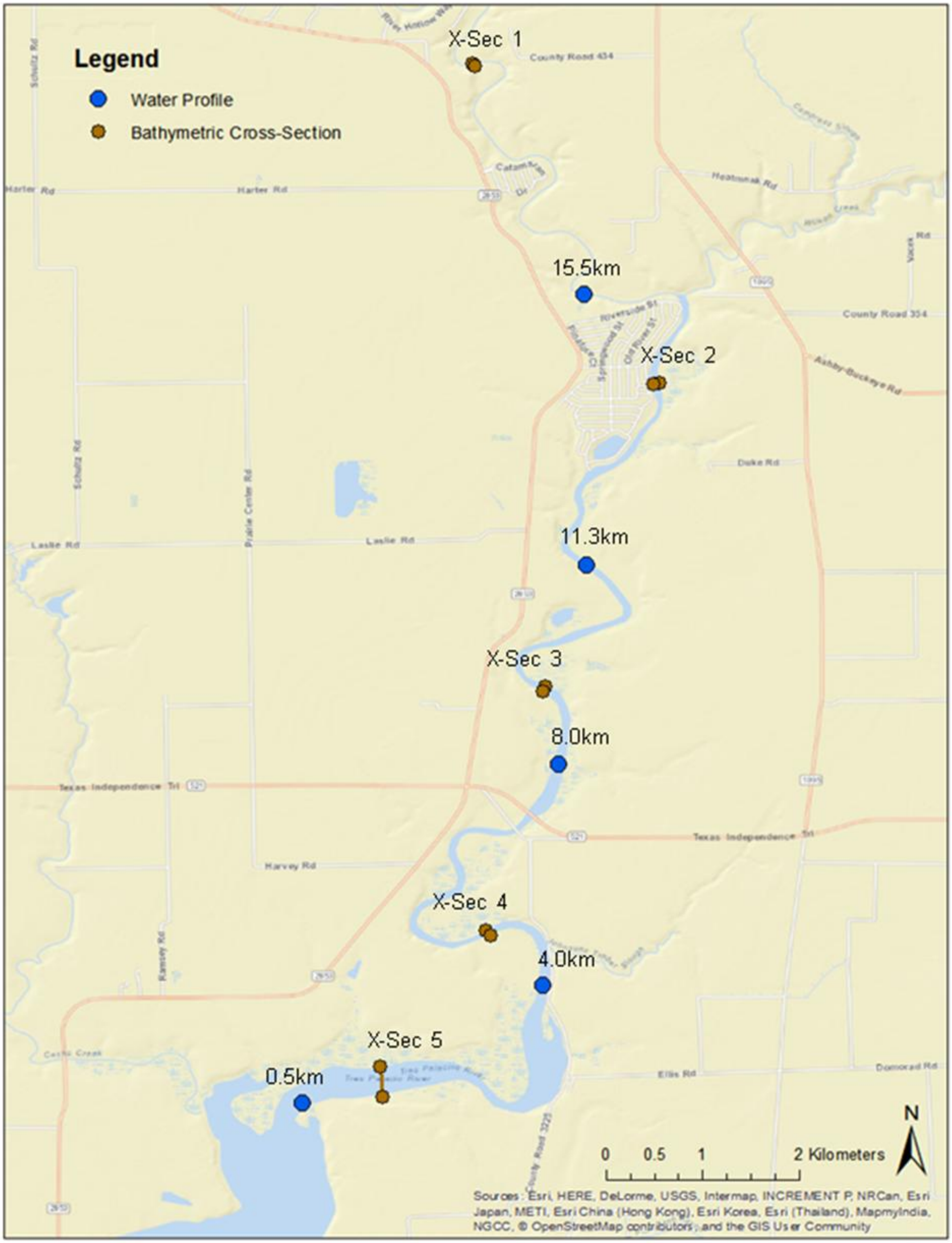

Figure 3 Location of water column profile and bathymetric cross-sections.

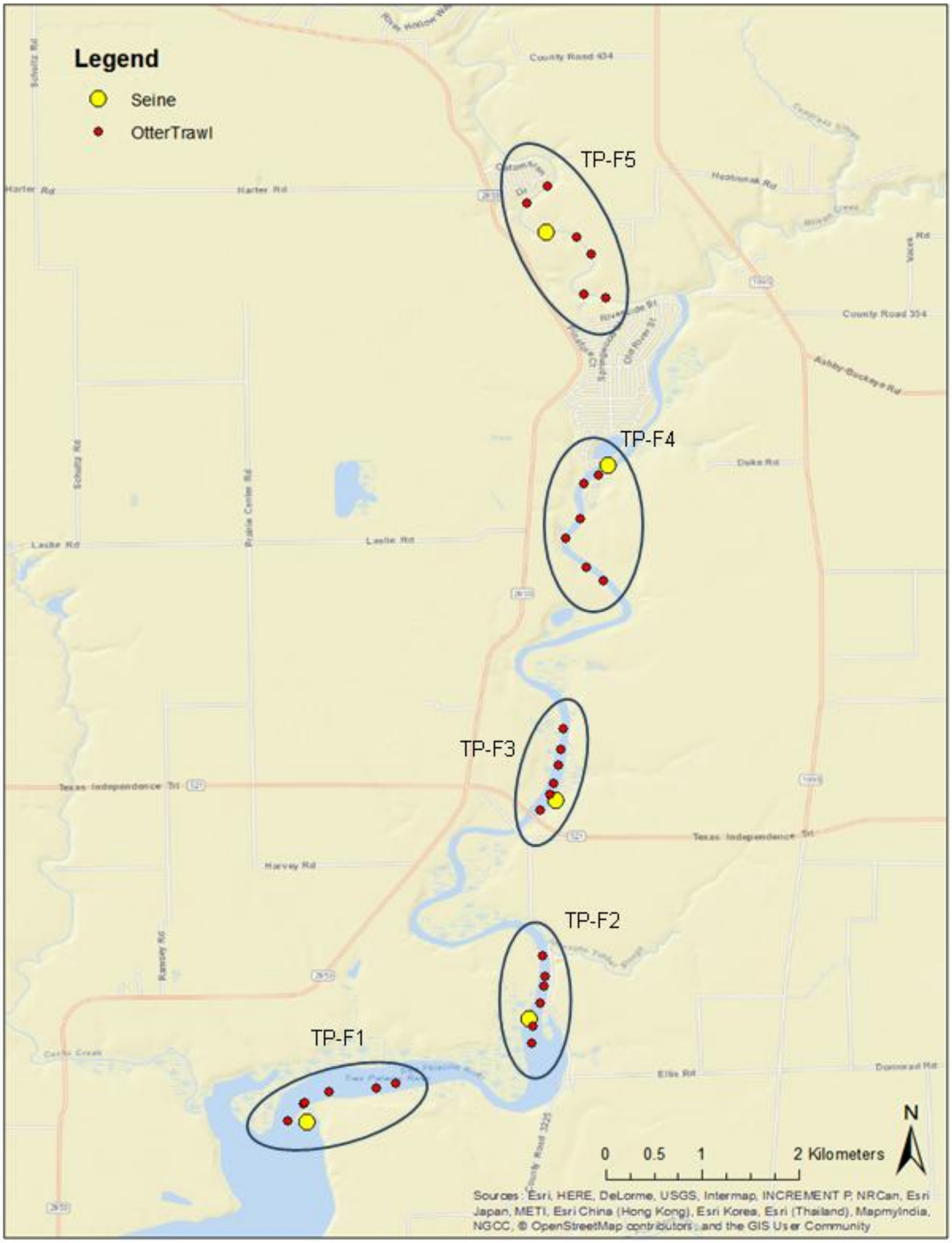

Figure 4 Location of nekton sampling via otter trawl (red dots; each dot represents start and stop locations of replicates) and seine (yellow dots).

Sampling Methods

Wetland Characterization

Broad scale wetland vegetation characterization was conducted at 16 previously determined locations. Dominant vegetation species present within the visible area surrounding the designated sites were identified and enumerated as percent cover at each of the wetland sites. Observed hydrologic connectivity or evidence of hydrologic connectivity were recorded and photographed. National Wetland Inventory aerial coverage of sampled wetlands were mapped and compared to wetland classifications observed in the field. Photographs at each site were taken in the cardinal directions and are provided in Appendix 1. All plant nomenclature was verified with the United States Department of Agriculture PLANTS Database.

Bathymetry Characterization

Bathymetric measurements were taken at cross sections located 1.1km, 5.0km, 9.0km, 13.5km, and 19.0km from the river mouth (Figure 3). Total wetted width of the river was determined from the left bank using a laser range finder (Scout DX 1000 ARC; Bushnell, Overland Park, KS). Width was then divided by 6 to determine distance between depth readings. Depth at the left bank was recorded then readings were taken at the calculated distances across the width of the river until the right bank was reached. A stadia rod was used to determine depths at the banks while a handheld sounding probe was used to determine depths across the transect (Hondex SM-5 Portable Water Depth Sounder; Davis Instruments, Vernon Hills, IL). GPS coordinates were recorded at each bank. Bathymetric data was entered into Excel and plotted along equal axes for visualization of real-time conditions.

Aquatic Biologic Sampling

Shoreline and demersal nekton were collected using a combination of methods (seine and otter trawl). Nekton includes mobile finfish and invertebrates such as shrimp, crabs and squid. Demersal nekton were collected mid-channel at all biologic sites with an otter trawl (3.1 m wide, 38.2mm stretch mesh, 6.1mm net fitted within cod end) deployed for 2-minutes with three replicate tows per site. Trawls were performed counter to stream flow (facing upriver) at an average speed of 2.5 knots and equipped with a 30m tow line. In instances where snags prevented the full trawling allotment, catch was released and the trawl was redeployed upstream of the hazard location. Shoreline nekton collections were conducted using a straight seine (15’ x 4’) with ¼” bar mesh. Three replicate seine hauls, approximately 10 meters each, were made parallel to the marsh edge at each sampling site.

All specimens were identified to the lowest possible taxonomic level and enumerated. Additionally, up to five representatives from each species and replicate were measured for standard length (mm). Any specimen unidentifiable in the field was anesthetized in MS-222, preserved in 10% formalin and brought back to the lab for later identification and enumeration.

All nekton identification was conducted using taxonomic keys and recorded using common and scientific names from most current nomenclature used by the American Fisheries Society. All sampling techniques were reviewed and approved by the UHCL Institutional Animal Care and Use Committee (IACUC protocol #14.002-S) and are covered under Texas Parks and Wildlife Scientific Collection Permit #SPR-0504-383.

For each nekton sampling site and method, water depth (m) and tide stage (flood, high slack, ebb, low slack) were recorded. Observed water level data from NOAA site 8773259, (Port Lavaca, TX) was recorded for each sample event date/time. Water quality measurements, including temperature (°C), dissolved oxygen (mg/L and %), conductivity (µS/cm), pH, and salinity (ppt) were collected using a YSI ProDSS sonde (YSI, Yellow Springs, OH). Water clarity (m) was also measured at each site with the use of a 120 cm Secchi tube (Forestry Suppliers, Jackson, MS).

Visual Survey, Intertidal Oysters

During wetland, bathymetric, and biologic characterizations, crews visually surveyed for evidence, presence, or remnants of intertidal oysters or oyster reefs within the Tres Palacios River. If any bivalves were observed, a GPS coordinate and time were recorded at the location of the observation.

Results

The lower Tres Palacios River was sampled on December 4-5, 2017 to characterize the wetland community, bathymetric cross-section, nekton community, and the intertidal oyster community. The surveys were performed just prior to a strong cold front that impacted the area the afternoon of December 5th. Tidal amplitude observed during sampling reflected normal conditions. Recent rainfall resulted in some standing water in the wetland areas assessed, but did not appear to significantly impact the water condition in the river. Results from the two-day survey are summarized by task herein.

Wetland Characterization

Sixteen sites were visited for wetland vegetation assessment and thirty-two species of plants were identified between all sites. Site Wetl.12A was moved to the nearest wetland with the same National Wetland Inventory (NWI) classification due to thick vegetation making the original site inaccessible. Species indicative of brackish conditions were observed at all sites, including those areas designated as palustrine wetlands per the NWI (Table 1). The brackish shrub species *Iva frutescens* was observed at every site, and was the most abundant species representing 22% of the total percent cover of the wetlands assessed (Table 2). *Juncus roemerianus* was the second most abundant species observed, but was most abundant at the most downstream three sites (Wetl.1A-C). Some sites, particularly in the middle of the study reach, were overcome with the vine *Vigna luteola* which made navigating the site and identifying the species present very difficult. In general, the lower Tres Palacios riparian wetlands are transitional in species composition with a mix of saline tolerant and intolerant species present along a continuum from the most downstream site, Wetl.1A to the most upstream site surveyed, Wetl.12A (Figure 5).

Signs of hydrologic connectivity were recorded at many of the sites, and no barriers to hydrologic connectivity were observed that would prevent direct connection with the Tres Palacios River during high flows, or in during extremely high tides. Recent rainfall may have created the standing water observed at some sites, while clear and direct connections via tidal creeks were observed at others. Wild hog and cattle tracks were observed at a number of the wetland sites, and large hog wallows were observed at a few sites.

Table 1 Wetland general site assessment parameters.

Site	Latitude	Longitude	% Cover (Veg)	% Cover (Bare)	% Cover (Litter)	% Cover (Open Water)	NWI Wetland Type	Observed Wetland Type	Species Richness
Wetl-1A	28.75881	-96.17467	95	2	0	3	EEM	EEM	8
Wetl-1B	28.76322	-96.16403	99	0.5	0	0.5	EEM	EEM	9
Wetl-1C	28.76112	-96.15791	95	2	0	3	EEM	EEM	9
Wetl-2A	28.76581	-96.15108	90	4	3	3	EEM	ESS	11
Wetl-2B	28.76942	-96.14999	85	5	3	7	EEM	EEM/PSS	11
Wetl-3A	28.77476	-96.15053	90	10	0	0	PEM	EEM	7
Wetl-4A	28.77597	-96.15402	90	2	3	5	EEM	EEM/ESS	5
Wetl-5A	28.78169	-96.15481	90	2	3	5	EEM	EEM/ESS	5
Wetl-6A	28.78539	-96.15462	80	10	0	10	EEM	EEM/ESS/PEM	13
Wetl-7A	28.79016	-96.14682	95	3	2	0	PEM	ESS/PSS	9
Wetl-8A	28.78897	-96.14825	90	0	0	10	EEM	EEM/ESS/PEM	6
Wetl-8B	28.79453	-96.14725	85	15	0	0	EEM	EEM/ESS/PEM	11
Wetl-9A	28.79861	-96.14835	65	30	0	5	EEM	ESS	10
Wetl-10A	28.80253	-96.14885	98	2	0	0	EEM	EEM/ESS/PEM	17
Wetl-11A	28.80760	-96.14189	98	2	0	0	EEM	ESS	8
Wetl-12A	28.81474	-96.14489	98	2	0	0	PEM	ESS/PEM/PSS	11

Table 2 Vegetation percent cover by species. Total cover indicates relative abundance across all species and all sites.

Short Name	Species	Wetl. Ind.	Sal. Tol.	Wetl-1A	Wetl-1B	Wetl-1C	Wetl-2A	Wetl-2B	Wetl-3A	Wetl-4A	Wetl-5A	Wetl-6A	Wetl-7A	Wetl-8A	Wetl-8B	Wetl-9A	Wetl-10A	Wetl-11A	Wetl-12A	Total Cover
IVFR	*Iva frutescens*	FACW	H	3	1	2	10	33	5	30	40	20	1	5	35	60	15	72	20	22.0
JURO	*Juncus roemerianus*	OBL	H	90	92	91	-	-	-	15	-	10	-	1	5	-	15	-	-	19.9
VILU	*Vigna luteola*	FACW	M	-	-	1	4.5	5	-	50	45	10	50	-	-	-	-	10	1	11.0
SPSP	*Spartina spartinae*	OBL	H	-	-	-	-	3	80	-	-	-	-	-	30	5	-	-	-	7.4
DISP	*Distichlis spicata*	OBL	H	1	0.5	1	30	42	-	3	3	1	-	-	10	10	5	-	-	6.7
TYDO	*Typha domingensis*	OBL	M	-	-	-	-	1	-	-	-	-	5	85	-	-	-	-	-	5.7
BAHA	*Baccharis halimifolia*	FAC	H	1	1	-	20	-	3	2	-	-	30	5	1.5	5	-	5	10	5.2
BAMO	*Bacopa monnieri*	OBL	M	-	-	-	-	-	-	-	-	40	-	-	1	1	35	-	-	4.8
PHAU	*Phragmites australis*	FACW	H	-	-	-	0.5	-	-	-	-	-	-	3	-	-	-	-	50	3.3
SCCA	*Schoenoplectus californicus*	OBL	L	-	-	-	-	-	-	-	-	2.5	5	-	-	10	6	5	5	2.1
SPPA	*Spartina patens*	FACW	H	-	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	1.9
CYEN	*Cyperus entrerianus*	FACW	L	-	-	-	-	-	-	-	-	0.5	-	-	15	2	1	-	-	1.2
SYTE	*Symphyotrichum tenuifolium*	OBL	M	2	-	-	1	5	-	-	-	5	-	-	-	1	3	-	1	1.1
IPSA	*Ipomoea sagittata*	FACW	M	1	0.5	0.5	1	1	-	-	10	1	-	-	0.5	-	0.5	-	1	1.1
BORO	*Bolboschoenus robustus*	OBL	H	1	1	2	1	5	-	-	2	-	-	-	0.5	-	1	-	-	0.8
ALPH	*Alternanthera philoxeroides*	OBL	L	-	-	0.5	1	1	-	-	-	3	1	1	-	-	0.5	2	3	0.8
BOFR	*Borrichia frutescens*	OBL	H	-	2	1	-	-	5	-	-	-	-	-	-	-	1	-	-	0.6
HYOC	*Hymenocallis occidentalis*	OBL	L	-	-	-	-	-	-	-	-	-	1	-	-	-	5	2	-	0.5
POHY	*Polygonum hydropiperoides*	OBL	L	-	-	-	-	-	-	-	-	1	-	-	-	5	2	-	-	0.5
SAGR	*Sagittaria graminea*	OBL	L	-	-	-	-	-	-	-	-	5	-	-	1	-	1	-	-	0.4
HYUM	*Hydrocotyle umbellata*	OBL	L	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	1	0.4
MIKS	*Mikania scandens*	FACW	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	0.4
SAMI	*Sabal minor*	FACW	N	-	-	-	-	-	-	-	-	-	2	-	-	-	3	1	-	0.4
CUIN	*Cuscuta indecora*	None*	M	-	-	-	1	2	-	-	-	1	-	-	0.5	1	-	-	-	0.3
LYCA	*Lycium carolinianum*	FACW	M	1	1	1	-	2	-	-	-	-	-	-	-	-	-	-	-	0.3
NEAR	*Nekemias arborea*	FAC	L	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	0.3
PASP	*Paspalum* sp.	None**	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0.3
MOLI	*Monanthochloe littoralis*	OBL	H	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	0.2
SAVI	*Salicornia virginica*	OBL	H	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	0.2
COCA	*Conyza canadensis*	None*	N	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	0.1
SEPA	*Seteria parviflora*	FACW	M	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	0.1
SPAL	*Spartina alterniflora*	OBL	H	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1
	Species Richness (S)	32		8	9	9	11	11	7	5	5	13	9	6	11	10	17	8	11	

*No wetland type available.

**Unable to determine wetland indicator type without specific epithet.

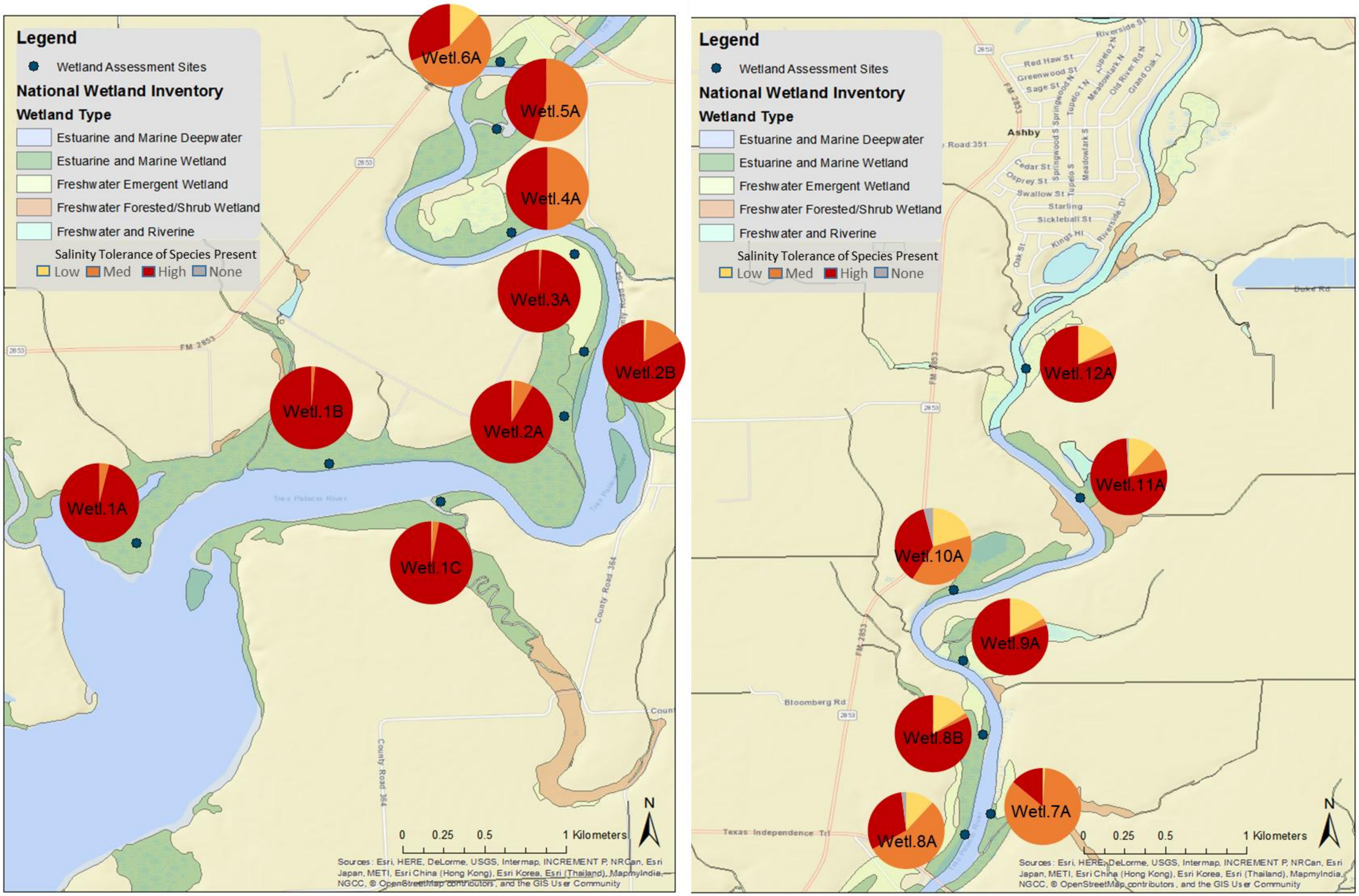

Figure 5. Percent composition of salt tolerance of species present at each wetland site. Red = high salinity tolerance, orange = medium salinity tolerance, yellow = low salinity tolerance, and gray = No salinity tolerance information

Bathymetry Characterization

Cross section bathymetry was measured at five pre-determined sites along the Tres Palacios. The channel of the Tres Palacios was consistently narrower and deeper at the upper end of the study area, and wider and shallower at the mouth of the river (Figure 6).

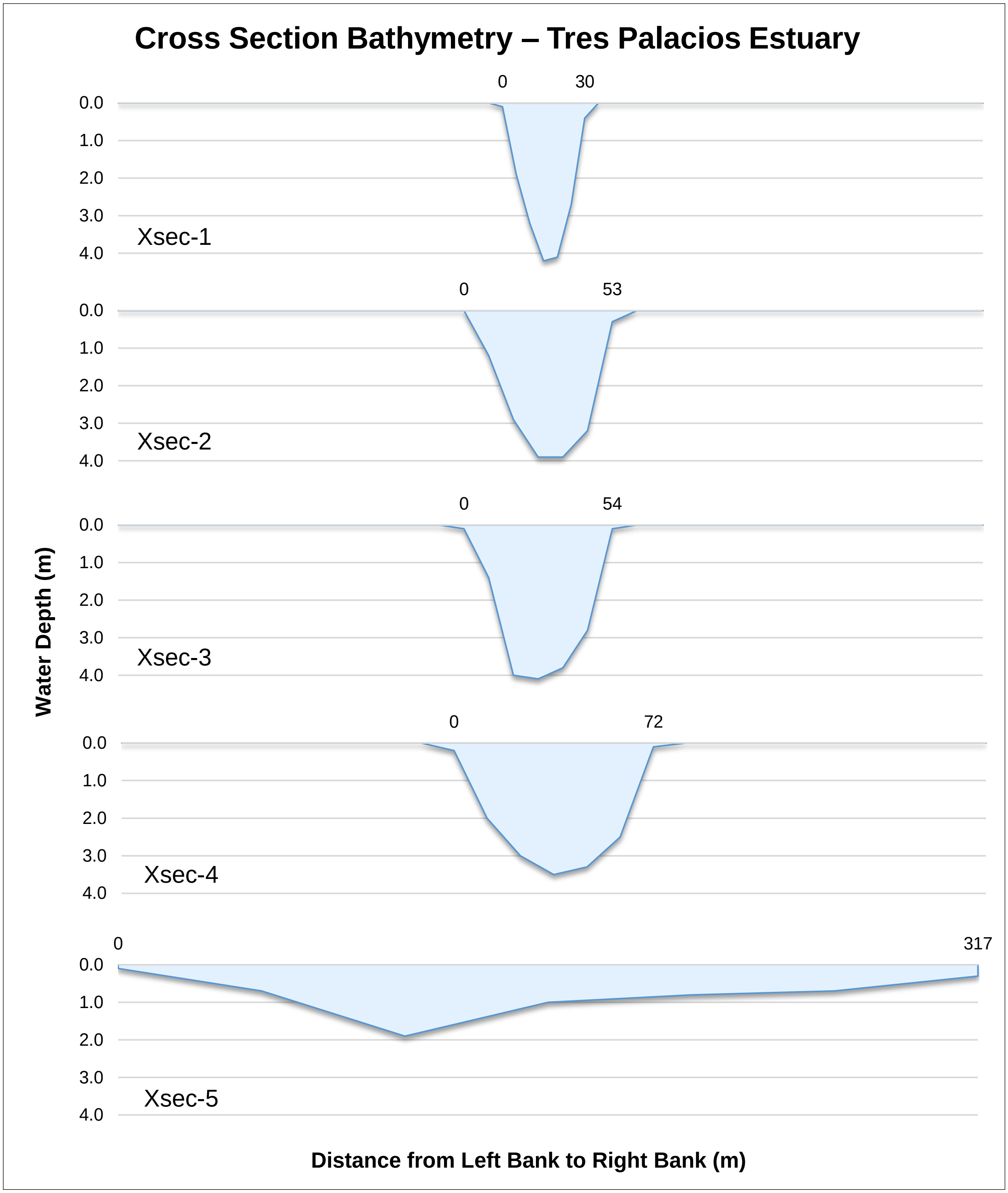

Figure 6 Bathymetric cross sections from five locations along the Tres Palacios River. Xsec-1 represents top of reach; Xsec-5 represents bottom of reach at confluence with Tres Palacios Bay.

Aquatic Biologic Sampling

A total of 9,939 individuals from 32 species of nekton were collected at the five aquatic biologic sites via otter trawl and seine. The most abundant species across both gear types and sites was the Bay Anchovy (*Anchoa mitchilli*) with a relative abundance of 69.83% for otter trawl and 48.58% for seine (Table 3). The Bay Anchovy, White Shrimp (*Litopenaeus setiferus),* and the daggerblade grass shrimp *(Palaemonetes pugio)* were the only three species captured with the seine gear type that occurred at all five aquatic biologic sites (Table 4). White shrimp and Black Drum (*Pogonias cromis*) were the only species captured with the otter trawl gear type at all five sites (Table 4). Black Drum catches were primarily composed of high numbers of juvenile individuals. Additionally, Saltmarsh Topminnow (*Fundulus jenkinsi)* was captured at the two most upstream sites during this survey. The results of water quality profiles measured at nekton collection sites are reported in Figure 7.

Table 3 Nekton average length (mm), total count (N), relative abundance and species richness (S) by sample method.

Species	Avg length (mm) (*n*)	Total Count (*N*)	Relative Abundance
Otter Trawl			
Anchoa mitchilli	27.8 (55)	958	69.83
Ictalurus furcatus	208.7 (37)	135	9.84
Litopenaeus setiferus	56.8 (48)	112	8.16
Pogonias cromis	141.4 (31)	67	4.88
Micropogonias undulatus	64.9 (20)	29	2.11
Cynoscion arenarius	119.3 (18)	18	1.31
Arius felis	116.6 (17)	17	1.24
Mugil cephalus	143.6 (6)	7	0.51
Stellifer lanceolatus	89.3 (7)	7	0.51
Brevoortia patronus	90.6 (5)	5	0.36
Bairdiella chrysoura	141.6 (3)	3	0.22
Dorosoma petenense	55.0 (3)	3	0.22
Bagre marinus	104.5 (2)	2	0.15
Palaemonetes pugio	22.5 (2)	2	0.15
Sciaenops ocellatus	21.5 (2)	2	0.15
Callinectes sapidus	32.0 (1)	1	0.07
Cynoscion nebulosus	306.0 (1)	1	0.07
Dorosoma cepedianum	153.0 (1)	1	0.07
Leiostomus xanthurus	112.0 (1)	1	0.07
Lepisosteus oculatus	571.0 (1)	1	0.07
Total *N*		1,372	
S		20	
Seine			
Anchoa mitchilli	23.3 (55)	4,163	48.58
Brevoortia patronus	20.7 (39)	1,732	20.22
Gambusia affinis	22.6 (25)	1,243	14.51
Litopenaeus setiferus	33.4 (64)	590	6.89
Palaemonetes pugio	26.2 (39)	523	6.10
Callinectes sapidus	21.7 (34)	92	1.07
Farfantepenaeus aztecus	33.4 (25)	59	0.69
Mugil cephalus	22.6 (11)	56	0.65
Trinectes maculatus	19.6 (13)	44	0.51
Menidia beryllina	40.5 (17)	32	0.37
Poecilia latipinna	24.1 (11)	18	0.21
Fundulus grandis	25.1 (5)	5	0.06
Fundulus jenkinsi	35.9 (4)	4	0.05
Adinia xenica	19.9 (1)	1	0.01
Archosargus probatocephalus	27.6 (1)	1	0.01
Fundulus pulvereus	34.7 (1)	1	0.01
Lepomis cyanellus	48.0 (1)	1	0.01
Lucania parva	15.4 (1)	1	0.01
Stellifer lanceolatus	18.3 (1)	1	0.01
Total *N*		8,567	
S		19	
Total *N* via All Methods		9,939	
Overall S		32	

Table 4 Nekton counts by sample method and site. Values represent number of specimen collected for all three replicates at each site. Total catch (N) and species richness per site are presented as summary data below each sample type.

Species	TP1	TP2	TP3	TP4	TP5	Total
Seine						
Adinia xenica	1	-	-	-	-	1
Anchoa mitchilli	3	19	3,863	260	18	4,163
Archosargus probatocephalus	-	-	-	1	-	1
Brevoortia patronus	-	4	67	1,656	5	1,732
Callinectes sapidus	64	5	-	19	4	92
Farfantepenaeus aztecus	8	3	44	4	-	59
Fundulus grandis	2	3	-	-	-	5
Fundulus jenkinsi	-	-	-	1	3	4
Fundulus pulvereus	-	-	-	1	-	1
Gambusia affinis	-	-	-	1,093	150	1,243
Lepomis cyanellus	-	-	-	-	1	1
Litopenaeus setiferus	62	13	365	129	21	590
Lucania parva	-	-	-	1	-	1
Menidia beryllina	-	4	28	-	-	32
Mugil cephalus	6	1	-	49	-	56
Palaemonetes pugio	303	40	6	171	3	523
Poecilia latipinna	-	-	-	16	2	18
Stellifer lanceolatus	-	-	1	-	-	1
Trinectes maculatus	-	-	-	40	4	44
Total (N)	449	92	4,374	3,441	211	8,567
S	8	9	7	14	10	19
Otter Trawl						
Anchoa mitchilli	267	237	436	-	18	958
Arius felis	6	6	5	-	-	17
Bagre marinus	2	-	-	-	-	2
Bairdiella chrysoura	3	-	-	-	-	3
Brevoortia patronus	-	1	-	4	-	5
Callinectes sapidus	-	-	-	1	-	1
Cynoscion arenarius	8	3	6	1	-	18
Cynoscion nebulosus	-	-	1	-	-	1
Dorosoma cepedianum	1	-	-	-	-	1
Dorosoma petenense	-	-	-	-	3	3
Ictalurus furcatus	-	-	47	70	18	135
Leiostomus xanthurus	1	-	-	-	-	1
Lepisosteus oculatus	-	-	-	1	-	1
Litopenaeus setiferus	41	34	21	4	12	112
Micropogonias undulatus	4	3	22	-	-	29
Mugil cephalus	1	6	-	-	-	7
Palaemonetes pugio	2	-	-	-	-	2
Pogonias cromis	1	10	37	16	3	67
Sciaenops ocellatus	-	1	-	-	1	2
Stellifer lanceolatus	5	2	-	-	-	7
Total (N)	342	303	575	97	55	1,372
S	13	10	8	7	6	20
Total *N* via All Methods	791	395	4,949	3,538	266	9,939
Overall S	17	15	13	18	14	32

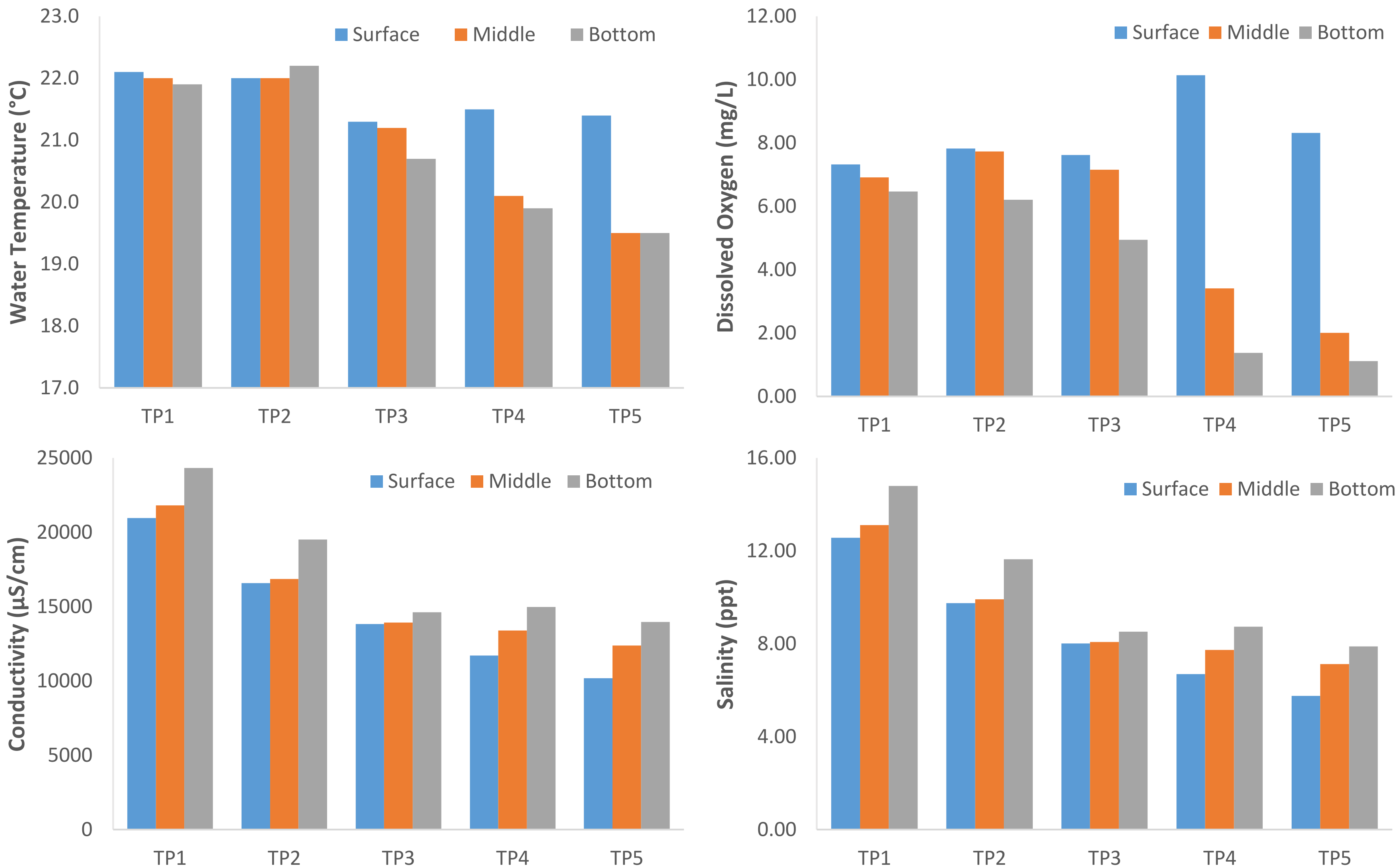

Figure 7 Water quality profiles by parameter for the five aquatic biologic sites sampled on the Lower Tres Palacios.

Visual Survey, Intertidal Oysters

During wetland, bathymetric, and biologic characterizations, intertidal oysters or oyster reefs were not observed by field crews. Though other bivalves were anecdotally observed throughout the sampling reach, only one was found alive (Asiatic Clam, *Corbicula fluminea*, at TP5) and one other was found as a recently deceased, whole shell (Ribbed Mussel at Wetl.1A) (Table 5). The tidal amplitude during this sampling event was moderate which resulted in no exposed sediment along the banks of the Tres Palacios, which is non-ideal conditions for a visual intertidal oyster assessment.

Table 5 Other bivalves observed during oyster and oyster reef visual surveys.

Common Name	Scientific Name	Latitude	Longitude	Observation
Atlantic Rangia	*Rangia cuneata*	28.7676	-96.15004	Half shell observed while seining at TP2
Quahog	*Mercenaria* sp.	28.7657	-96.15046	Half shell observed while traveling to Wetl-2A
Ribbed mussel	*Geukensia* sp.	28.7588	-96.17467	Dead full shell observed while assessing Wetl-1A
Coquina clam	*Donax* sp.	28.7578	-96.17064	Dead half shell observed while seining at TP1
Corbicula clam	*Corbicula fluminea*	28.8347	-96.14395	Live clam trawled up during TP5 replicate 2

Conclusions

Vegetative, bathymetric, and biologic surveys performed by EIH over a two-day sampling period generally indicate that the lower Tres Palacios river system is functioning as a connected estuarine system. The wetland plant community along the lower Tres Palacios can be best described as transitional. Extensive hydrologic connectivity provides direct connection throughout the lower Tres Palacios river system during high flows, flood conditions, or extremely high tides. Bathymetric cross-sections were typical of natural riverine-estuarine connectivity with narrower, deeper channels in the upper reaches, and wider, shallower characteristics near the confluence with Tres Palacios Bay. The nekton community was composed of a wide range of halo-tolerant species and life stages collected. Presence of juvenile Black Drum occurring in relatively high abundance may suggest that the lower Tres Palacios River is an important nursery area for the species. Additionally, presence of Saltmarsh Topminnow (*F. jenkinsi*), which is currently under consideration for listing as a federally threatened or endangered species, may indicate that the more upstream region of the lower Tres Palacios river system is critical habitat for this species. Water quality parameters followed general trends expected for a transitional riverine-estuarine system. The water quality parameters in the downstream regions of the estuary were more vertically homogenous in comparison to the upper regions of the river-estuary which were more stratified. Though no intertidal oyster reefs were observed during this study, conditions were not ideal for detection of reefs (increased water levels, turbidity, and flow) and more sampling may be required to determine extent of oyster reef presence or absence in the lower estuary. To determine full functionality and connectivity of the lower Tres Palacios River system, additional sampling is recommended to better characterize the temporal shifts in community structures residing in this dynamic tidal river.

Appendix A: Vegetation Plot Site Photographs

Wetland 1A (Wetl-1A)

(Bottom of reach)

View of Wetl-1A facing north.

View of Wetl-1A facing west.

View of Wetl-1A facing east.

View of Wetl-1A facing south.

Wetland 1B (Wetl-1B)

View of Wetl-1B facing north.

View of Wetl-1B facing west.

View of Wetl-1B facing east.

View of Wetl-1B facing south.

Wetland 1C (Wetl-1C)

View of Wetl-1C facing north.

View of Wetl-1C facing west.

View of Wetl-1C facing east.

View of Wetl-1C facing south.

Wetland 2A (Wetl-2A)

View of Wetl-2A facing north.

View of Wetl-2A facing west.

View of Wetl-2A facing east.

View of Wetl-2A facing south.

Wetland 2B (Wetl-2B)

View of Wetl-2B facing north.

View of Wetl-2B facing west.

View of Wetl-2B facing east.

View of Wetl-2B facing south.

Wetland 3A (Wetl-3A)

View of Wetl-3A facing north.

View of Wetl-3A facing west.

View of Wetl-3A facing east.

View of Wetl-3A facing south.

Wetland 4A (Wetl-4A)

View of Wetl-4A facing north.

View of Wetl-4A facing west.

View of Wetl-4A facing east.

View of Wetl-4A facing south.

Wetland 5A (Wetl-5A)

View of Wetl-5A facing north.

View of Wetl-5A facing west.

View of Wetl-5A facing east.

View of Wetl-5A facing south.

Wetland 6A (Wetl-6A)

View of Wetl-6A facing north.

View of Wetl-6A facing west.

View of Wetl-6A facing east.

View of Wetl-6A facing south.

Wetland 7A (Wetl-7A)

View of Wetl-7A facing north.

View of Wetl-7A facing west.

View of Wetl-7A facing east.

View of Wetl-7A facing south.

Wetland 8A (Wetl-8A)

View of Wetl-8A facing north.

View of Wetl-8A facing west.

View of Wetl-8A facing east.

View of Wetl-8A facing south.

Wetland 9A (Wetl-9A)

View of Wetl-9A facing north.

View of Wetl-9A facing west.

View of Wetl-9A facing east.

View of Wetl-9A facing south.

Wetland 10A (Wetl-10A)

View of Wetl-10A facing north.

View of Wetl-10A facing west.

View of Wetl-10A facing east.

View of Wetl-10A facing south.

Wetland 11A (Wetl-11A)

View of Wetl-11A facing north.

View of Wetl-11A facing west.

View of Wetl-11A facing east.

View of Wetl-11A facing south.

Wetland 12A (Wetl-12A)

View of Wetl-12A facing north.

View of Wetl-12A facing west.

View of Wetl-12A facing east.

View of Wetl-12A facing south.

Abbreviation Index

EEM	Estuarine Emergent Wetland
ESS	Estuarine Scrub Shrub Wetland
FAC	Facultative (low salinity tolerance)
FACW	Facultative Wetland (medium salinity tolerance)
OBL	Obligate (high salinity tolerance)
PEM	Palustrine Emergent Wetland
PSS	Palustrine Scrub Shrub Wetland