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EXECUTIVE SUMMARY

The Coastal Bend Bays & Estuaries Program, Inc. (CBBEP) initiated the Regional Coastal Assessment Program (RCAP) in 2000 to meet the stated goals of the *Implementation Strategy for the Coastal Bend Bays Plan*. The *Bays Plan* called for a comprehensive monitoring and assessment program in which maintaining and/or enhancing the quality of water and sediment within the Coastal Bend is a stated primary goal in protecting the natural resources of our region.

The first Center for Coastal Studies (CCS) RCAP report documented monitoring program development and encompassed the initial two years (2000 and 2001) of quarterly baseline monitoring. While a few concerns existed (nutrient concentrations and Chlorophyll *a* at several locations and metal concentrations in sediment at one location), the majority of parameters monitored showed good water and sediment quality conditions existed within the CBBEP region.

The formation of cooperative partnerships, coupled with RCAP 2000 and RCAP 2001 data analysis, lead to a program restructuring for the third RCAP sampling event. RCAP 2002 called for sampling during the summer index period. Sampling within the summer index period represented a "worse case scenario", in which water quality conditions might be stressful and thereby limiting to biota. This event would coincide with the USEPA Environmental Monitoring and Assessment Program (EMAP) - National Coastal Assessment (NCA) effort led in Texas by the Texas Parks & Wildlife Department (TPWD).

RCAP 2002 sampled 50 locations within the CBBEP region for the same parameters as the NCA under an approved Quality Assurance Project Plan. This cooperative effort allowed TPWD and EPA to increase the original 50 locations designated in the NCA sampling program for the State of Texas to 100 sampling locations. This assured better coverage of the extended Texas coastline and yielded a stronger dataset for assessing coastal conditions on a local and regional level. Parameters measured included standard routine field data parameters, routine conventional water chemistry, microbiological, inorganic and organic sediment and fish tissue analysis for contaminants, sediment toxicity, and benthic infaunal organisms.

Data analysis utilized various standard parametric and non-parametric tests dependent on meeting test assumptions of the particular analysis required. Additional data evaluation utilized in this report derives from comparisons or evaluations to applicable Texas Commission on Environmental Quality (TCEQ) water and sediment quality criteria, or if no criteria existed, then to TCEQ Surface Water Quality Monitoring based screening levels. Further comparison and evaluation of RCAP 2002 data used EPA National Coastal Condition Report II (NCCR II) guidelines. Use of this evaluation technique was to provide continuity between locally collected data and the ongoing NCA program for assessing coastal waters and to see if the broad based EPA regional approach is applicable in all estuarine systems. As expected, because of different ways that state and federal entities make assessments, the two primary methods (TCEQ and EPA) used for evaluating water and sediment quality within the CBBEP region produced distinctly different assessments.

WATER MONITORING

Field Data

Field data collected was representative of our region, with values recorded during RCAP 2002 typical for the summer index period. The one dramatic change observed from previous summer sampling events (RCAP 2000 and 2001) was that of salinity concentrations. Typically, this region suffers from a lack of freshwater inflows and this remains a critical factor for sustaining the health of the estuarine systems within the CBBEP region. However, flooding events within the Nueces watershed prior to sampling dramatically altered the salinity regime; producing beneficial but dramatic short-term shifts in salinity that could be stressful to aquatic organisms.

Dissolved oxygen remains the most essential water quality parameter utilized by both TCEQ and EPA in assessments of aquatic life use and the health of a water body. While some surface dissolved oxygen concentrations fell in the "biologically stressful" range of >2.0 mg/L but <5.0 mg/L overall conditions indicated that surface dissolved oxygen quality in the CBBEP region is very good.

Routine Conventional Water Chemistry

In the absence of established nutrient criteria, state and federal monitoring entities employ screening levels based on different methodologies. Based on TCEQ screening levels and EPA NCCR II guidance the interpretation of conditions within the region differed dramatically.

According to TCEQ screening levels, while some nutrient values exceeded screening levels, based on this one time sampling event these elevated levels warrant little concern. However, elevated Total Phosphorus levels seen in Nueces Bay during RCAP 2002, which may be a direct result of increased inflows from flooding prior to sampling, were also elevated in all RCAP 2000 sampling events and may warrant investigating upstream point and non-point discharge conditions. Elevated chlorophyll *a* concentrations observed during RCAP 2002 may relate to natural phytoplankton responses to increased nutrient inflows from flooding events; coupled with the optimal conditions of high temperatures and increased light levels common during the south Texas summer. However, more than a one-time sampling event would be required to make a definitive assessment. If elevated concentrations continue to persist in future RCAP events, or in assessment of regional TCEQ Surface Water Quality Monitoring data, then long-term elevated levels of chlorophyll *a* may be an indicator of possible eutrophication.

Using EPA NCCR II guidance, which looks at surface Dissolved Inorganic Nitrogen (DIN) and Dissolved Inorganic Phosphorus (DIP), provided a more critical assessment of the region. DIN concentrations were all <0.1 mg/L and thereby received a good rating. However, a majority of the DIP concentrations fell in the fair (>0.01 mg/L and <0.05 mg/L) to poor (>0.05 mg/L) category. Based on EPA guidance the majority of chlorophyll *a* concentrations within the region ranked as fair (5.0 µg/L to 20 µg/L). While the upper end of the EPA range is higher than the TCEQ screening level (>20.0 µg/L versus >11.50 µ/L) the lower end of the fair category may be too low based on historical concentrations observed for this region. For

RCAP 2002, of the 39 sites receiving a fair rating, 17 of the sites had chlorophyll *a* concentrations of <9.0 µg/L with five sites <6.0 µg/L.

Overall, the combined modified EPA Water Quality Index ranked 15 sites as good, 34 sites as fair, and one site as poor, with a combination of DIP and chlorophyll *a* concentrations the justification for a fair ranking. EPA guidelines for NCCR II developed criteria for DIP and DIN as possible estimators of eutrophication. However, the utility of DIN as an estimator of possible eutrophication within our region remains questionable, as all DIN concentrations were <0.1 mg/L and did not correspond with high chlorophyll *a* concentrations. Regarding DIP comparisons, no clear association with high levels of chlorophyll *a* existed. Of the 13 sites rated as having poor DIP concentrations (>0.05 mg/L), five had low (good) concentrations of chlorophyll *a*, seven had moderate (fair) concentrations, and only one had poor (high) chlorophyll *a* concentrations. Additional data assessment of CBBEP and Texas coastal waters is clearly necessary and additional data may provide concentration ranges more applicable within our estuaries.

Microbiological Indicators

Currently, all coastal water body segments in Texas are undergoing assessment by the TCEQ TMDL group for bacteria impairments related to the Oyster Water Use (Fecal Coliform criteria). The continuation of bacteria sampling in RCAP 2002 provided data using the new criterion, enterococci, in the assessment of the Contact Recreation Use (CRU) for water within the CBBEP region. Analysis of RCAP 2002 data clearly indicted that the two high concentrations observed resulted from inflows received during the flooding event prior to sampling. For the remaining sites sampled during RCAP 2002, all enterococci concentrations were typically <10 CFU/100ml. Based on the current CRU criteria of 104 CFU/100ml, water quality regarding enterococci concentrations is considered good.

SEDIMENT MONITORING

Sediment Characteristics and Inorganic/Organic Contaminants

As seen with water quality monitoring, in the absence of established sediment criteria, TCEQ screening levels and EPA NCCR II guidance produced different assessments for the region. Data analysis showed that while one case of elevated TOC levels existed within St. Charles Bay, EPA would consider most sites as good according to NCCR II guidance. Percentage of Silt-Clay conformed to expected values for sites sampled, although within some TCEQ Segments there was considerable, but expected, variability.

Concerning sediment metal and organic contaminants, according to TCEQ screening levels, very little concern exists. Only one location, off the town of Bayside in Copano Bay exceeded both the Probable Effects Level and 85th percentile requirements for Total DDT and Total PCB. In addition, this was the only site considered as having poor sediment quality based on the EPA NCCR II guidance. However, multiple incidences of Threshold Effects Level exceedances at several other sites may indicate the beginning of an increasing contaminant trend at those locations.

As a fundamental part of the EPA Sediment Quality Index (TOC, Sediment Contaminants, and Sediment Toxicity), the expression of toxic effects in sediment accounted for 18 of the 20 sites listed as having poor sediment quality during RCAP 2002. The amphipod toxicity test produced conflicting results, with no straightforward cause-effect relationship appearing to exist as none of the sites sampled had co-occurring toxicity and elevated sediment contaminants. As a result, the lack of co-occurring sediment contamination and toxicity raises questions with the amphipod testing method currently used by EPA in the NCCR. It also remains possible that unmeasured chemicals, other confounding factors (e.g. elevated ammonia concentrations), and/or habitat preference of the test organism may have influenced sediment toxicity results.

For the Sediment Contaminant Distribution (SCD), use of the Sediment Quality Guideline Quotient (SQGQ), whereby cumulative effects of multiple contaminants were addressed, provided an alternate method of investigating potential contaminant impacts. This process coupled with Factor analysis, which aided in identifying patterns of environmental contamination, produced 16 sites with moderate contaminant levels (relative to all other RCAP 2002 sites sampled) and only one site with high contaminant levels exceeding established screening levels. Contaminants of interest for the 50 sites sampled were pesticides in the Mission-Aransas estuary, metals within the Nueces Estuary, particularly Arsenic, Chromium, Copper, Nickel, Lead and Zinc. Aforementioned metals along with some PCBs were also found to be in greater concentrations within the Baffin Bay complex.

The benthic community assessment provided a way to link the sediment quality to the biotic environment. Similarity analysis based on community composition and structure resulted in the classification of four benthic community assemblages. Of the four benthic assemblages defined, the Mid-Depth, Mesohaline, Muddy-Sand assemblage grouped together sites consisting of characteristics indicative of a stressed benthic community. The locations of the sites suggests the stress might have been brought upon by natural occurring events, such as the major flooding seen one month prior to RCAP 2002 sampling. However, sites within the assemblage exhibiting the greatest evidence of benthic stress and low EPA Benthic Condition Index scores also contained moderate SCD rankings that should not be ignored. The Shallow-Depth, Euhaline, Sand assemblage grouped together 15 sites, primarily in the Upper Laguna Madre, and consisted of characteristics typically not associated with degraded sediment. However, the EPA's Benthic Condition Index characterized many of the sites as fair or poor. Although this index may be applicable in the other RCAP 2002 assemblages, the authors of this report feel that the index misrepresents this type of benthic community, and requires further refinement.

As an evolving process, understanding the complex sediment interactions within the CBBEP region will require more data collection and continued refinement of the methods and indices. Based on TCEQ guidelines, sediment within the area ranks as good, with only one site meeting exceedance requirements. Using EPA NCCR II guidelines ranked 20 of the 50 sites as having degraded sediments and 10 of the 50 sites as having degraded benthic communities. However, based on questionable sediment toxicity results the EPA rankings may not be justified and further analysis is necessary to provide a more accurate classification of potentially degraded and healthy habitats.

TISSUE MONITORING

Due to the approach EPA NCA uses in the collection of data for the NCCR II report makes RCAP 2002 tissue contaminant data difficult to assess in Texas, as existing standards and methods are not comparable (e.g. whole-body versus edible tissue). EPA is modifying the program to begin analyzing for edible tissue in upcoming RCAP events.

According to TCEQ/Texas Department of State Health Services and EPA guidelines, the concentration of metals in whole-body tissue was lower than all applicable screening levels. All sites had small concentrations of aluminum, chromium, iron, and mercury. A limited amount of nickel and lead followed by zinc, tin, and silver occurred at some locations with many sites having concentration values that were non-detectable. In the case of arsenic, concentrations were all non-detectable except at six sites. Detectable concentrations of PCBs occurred in whole-body tissue at eight locations within the RCAP 2002 sampling area, DDT occurred at three sites, and Total Chlorinated Pesticides other than DDT registered in whole-body tissue samples at four sampling sites. All detected concentrations were far below any applicable screening level. No detectable concentrations of PAHs occurred in any of the sites sampled.

Although not applicable, the results of whole-body tissue analysis were compared to the screening levels normally used for edible tissue as a basis for determining the extent of possible contamination and bioaccumulation in tissue. Based on this analysis we rank the region as very good as most contaminants were non-detectable or well below any applicable screening level. In addition, no specimens showed evidence of lesions or tumors during the external gross pathology examination performed on-board TPWD vessels during RCAP 2002 sampling. Future events and reevaluation of sampling and analysis protocols may produce results that are comparable to existing state guidelines and /or federal guidelines.

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ACKNOWLEDGEMENTS

The authors graciously acknowledge the support of the Coastal Bend Bays & Estuaries Program, Inc., and all the federal, state, and local institutions listed in Chapter 1.2, including their staff, for their participation in this project. In addition, we wish also to thank the individual laboratories that provided analytical assistance. Without their hard work and active support, this project would not have been possible.

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1.0 INTRODUCTION

1.1 RCAP Background and Objectives

The Coastal Bend Bays & Estuaries Program, Inc. (CBBEP) initiated the Regional Coastal Assessment Program (RCAP) in 2000 to meet the stated goals of the *Implementation Strategy for the Coastal Bend Bays Plan* (CBBEP 1998). The *Bays Plan* called for a comprehensive monitoring and assessment program in which maintaining and/or enhancing water and sediment quality is a stated primary goal in protecting the natural resources of our region. A comprehensive understanding provides the tools required for protecting, preserving, and enhancing the unique estuarine and marine resources of our area, and the continued development and implementation of a sound regional water and sediment quality monitoring program is essential for collection, analysis, and dissemination of the highest quality data.

The first Center for Coastal Studies (CCS) RCAP report documented monitoring program development and encompassed the initial two years (2000 and 2001) of quarterly baseline-monitoring that significantly expanded on historical monitoring efforts within the region (Nicolau and Nuñez 2004). In addition, the report provided an overview of the statewide monitoring program protocols, conducted by the Texas Commission on Environmental Quality (TCEQ), and provided a summary of assessment methods used to evaluate conditions in defined Texas water bodies, or Segments, to established standards and screening criteria.

Primary RCAP objectives established and implemented an intensive baseline-monitoring program that yielded accurate and reliable data for initial characterization and assessment of the water and sediment quality within the CBBEP area. While a few concerns existed (nutrient concentrations and Chlorophyll *a* at several locations and metal concentrations in sediment at one location), the majority of parameters monitored during RCAP 2000 and 2001 showed good water and sediment quality conditions existed within the CBBEP region.

A comprehensive RCAP allows the CBBEP and communities within the program area, to interact with local, state, and federal entities in the larger goal of protecting and preserving the entire Gulf Coast environment. These interactions, established and built first at the local level, develop highly effective communication lines that provide for data collection, analysis and improved information transfer that ultimately fosters partnerships specifically designed to provide the means for effective coastal monitoring.

An example of this cooperation was the relationship developed between CCS, Texas Parks & Wildlife Department (TPWD), and the EPA Office of Research and Development (ORD) Environmental Monitoring and Assessment Program (EMAP) - National Coastal Assessment (NCA). Discussions between agencies revealed overlaps in RCAP and NCA sampling programs at four stations in the Upper Laguna Madre scheduled for sampling in August 2001. Adaptive management strategies allowed the CCS to assist with TPWD's responsibilities as the lead agency in Texas for NCA sampling. Integration of the sampling programs yielded data collected by the same quality assured methods that were directly comparable, easily transferable, and significantly more detailed in scope than each program originally intended. By sharing resources, and reducing costs through collaboration, TPWD was able to sample four additional stations in the coastal waters of the State for the NCA 2001 sampling event.

As a five-year effort, led by National Health and Environmental Effects Research Laboratory's Gulf Ecology Division in Gulf Breeze, FL, NCA will evaluate the assessment methods developed to advance the science of ecosystem condition monitoring. NCA will survey the condition of the Nation's coastal resources (estuaries and offshore waters) by creating an integrated, comprehensive coastal monitoring program among states to assess coastal ecological condition.

The strategy for NCA focuses on a strategic partnership with all 24 coastal states and Puerto Rico. Using a probabilistic design and a common set of survey indicators, each state will conduct the survey at a minimum of 50 stations, and assess the condition of their coastal resources, independently; these estimates can then be aggregated to assess conditions at the EPA Regional, biogeographical, and National levels. The first year's effort (NCA 2000) involved monitoring estuarine systems in 20 coastal states and Puerto Rico. In 2001, monitoring continued in most states including Alaska and Hawaii (USEPA 2001).

The purpose of NCA is three fold: (1) to utilize the knowledge and expertise of state agencies and local scientists in implementing NCA to uniformly assess the coastal resources of the Nation, (2) to assist the 24 coastal states and Puerto Rico in the implementation of state-wide coastal monitoring strategies, and (3) to help the states define ambient conditions for coastal waters and support the development of biocriteria in the states. Under the first year of this five-year program, the U.S. coastal states worked with EPA EMAP in implementing field and laboratory efforts to meet the first objective. This involved planning of the survey, field collection, laboratory analysis, and information management. Ultimately, the States will be involved in the analysis of collected data to answer the following two questions:

1. What is the condition of the ecological resources in my state?
2. What stressors are associated with degradation of ecological resources in my state?

Aggregation of the data will allow the same questions to apply at regional and national levels (USEPA 2001).

The formation of cooperative partnerships, along with data obtained during the first two years of the CBBEP RCAP, lead to a restructuring of the program in 2002. With baseline monitoring concluded, CCS researchers proposed to conduct one major sampling event in the summer index period (mid July through mid September for Texas) that would coincide with, and complement, the EMAP NCA effort. Sampling within the summer index period represents a "worse case scenario", in which water quality conditions may be stressful and thereby limiting to biota. Designed to provide scientifically sound water and sediment quality data, EMAP NCA provides essential spatial and temporal components in the monitoring of coastal waters and helps to determine resource conditions, provides information to aid in evaluation of environmental policies, and helps identify emerging environmental problems before they become widespread.

As initial RCAP (2000 and 2001) sampling took place at EPA EMAP randomly generated stations, it made logical sense to continue the association and partnership development with TPWD and EPA for RCAP 2002. The continued utilization of the EMAP probability-based

sampling design maintains continuity and compatibility with past and future monitoring assessments in determining the status and trends in water and sediment quality and the ecological health of our estuaries.

Through the dedication and foresight of the CBBEP, RCAP 2002 sampled 50 locations within the region, at the same time, and for the same parameters (plus additional parameters of local concern) as the NCA. This cooperative effort allowed TPWD and EPA to sample the original 50 NCA stations in the remaining waters of the state, thereby increasing the NCA sampling program in the State of Texas to 100 sampling locations. These 50 extra stations will assure better coverage of the extended coastline of Texas and yield a stronger dataset for assessing coastal conditions on a local and regional level.

The goal of the CBBEP in establishing the RCAP is to protect, preserve, and enhance the natural resources of our coastal environment by providing descriptive and quantitative data and developing diagnostic procedures to characterize the physical, chemical, and biological dynamics of our coastal environment. A comprehensive RCAP addressing these goals and objectives has the unique ability to interact with most, if not all, of the other Action Plans as described in the *Bays Plan* in an overall adaptive management structure. Therefore, the continued objectives of this project are to build upon the current RCAP while at the same time interfacing with the broader NCA that assesses all coastal waters of the United States.

1.2 Regional Coastal Assessment Program Participants and Contractors

RCAP 2002 involved partnership efforts of the federal, state, local agencies, and stakeholder groups listed in Table 1.1. These groups were instrumental in providing funding, in-kind services, and/or expertise. CBBEP and CCS are grateful for their support. Table 1.2 lists participating RCAP 2002 contractors and primary personnel.

Table 1.1. Regional Coastal Assessment Program 2002 participants.

Institution
• **Coastal Bend Bays & Estuaries Program**
• **Texas Commission on Environmental Quality (TCEQ)**
• **Texas Parks and Wildlife Department**
◦ Coastal Ecology
◦ Coastal Fisheries
• **U.S. Environmental Protection Agency (USEPA)**
◦ Region 6 – Dallas, Texas
◦ National Health and Environmental Effects Research Laboratory - Gulf Ecology Division

Table 1.2. Regional Coastal Assessment Program 2002 contractors.

	Contractor/Institution	Primary Personnel
Principal Contractor	Center for Coastal Studies (CCS)	Mr. Brien A. Nicolau Mr. Alex X. Nuñez Ms. Erin M. Albert
Water Chemistry Nutrients Chlorophyll *a*	University of Texas Marine Science Institute (UTMSI)	Dr. Tracy Villareal
Sediment/Tissue Trace Element Chemistry Organic Chemistry	Texas Parks and Wildlife Department Environmental Contaminants Laboratory (TPWD – ECL)	Dr. David Klein Mr. Gary Steinmetz Ms. Pamela Hamlett
Sediment/Water Chemistry Grain Size Total Organic Carbon Total Suspended Solids	FUGRO South, Inc (FSI)	Mr. Steve DeGregorio
Sediment Toxicity Testing	HESS, Inc.	Mr. Neal Huebotter
Microbiological	Texas A&M University-Corpus Christi (TAMUCC)	Dr. Joanna Mott

1.3 References

CBBEP. 1998. Implementation Strategy for the Coastal Bend Bays Plan. CBBEP-2. 179 pp.

Nicolau, B. A. and Alex X. Nuñez. 2004. Coastal Bend Bays & Estuaries Program, Regional Coastal Assessment Program (RCAP): RCAP 2000 and RCAP 2001 Annual Report. Center for Coastal Studies, Texas A&M University-Corpus Christi. TAMUCC-CC-0406-CCS. 246 pp.

USEPA. 2001. Environmental Monitoring and Assessment Program (EMAP): National Coastal Assessment Quality Assurance Project Plan 2001-2004. USEPA, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002.

2.0 METHODS

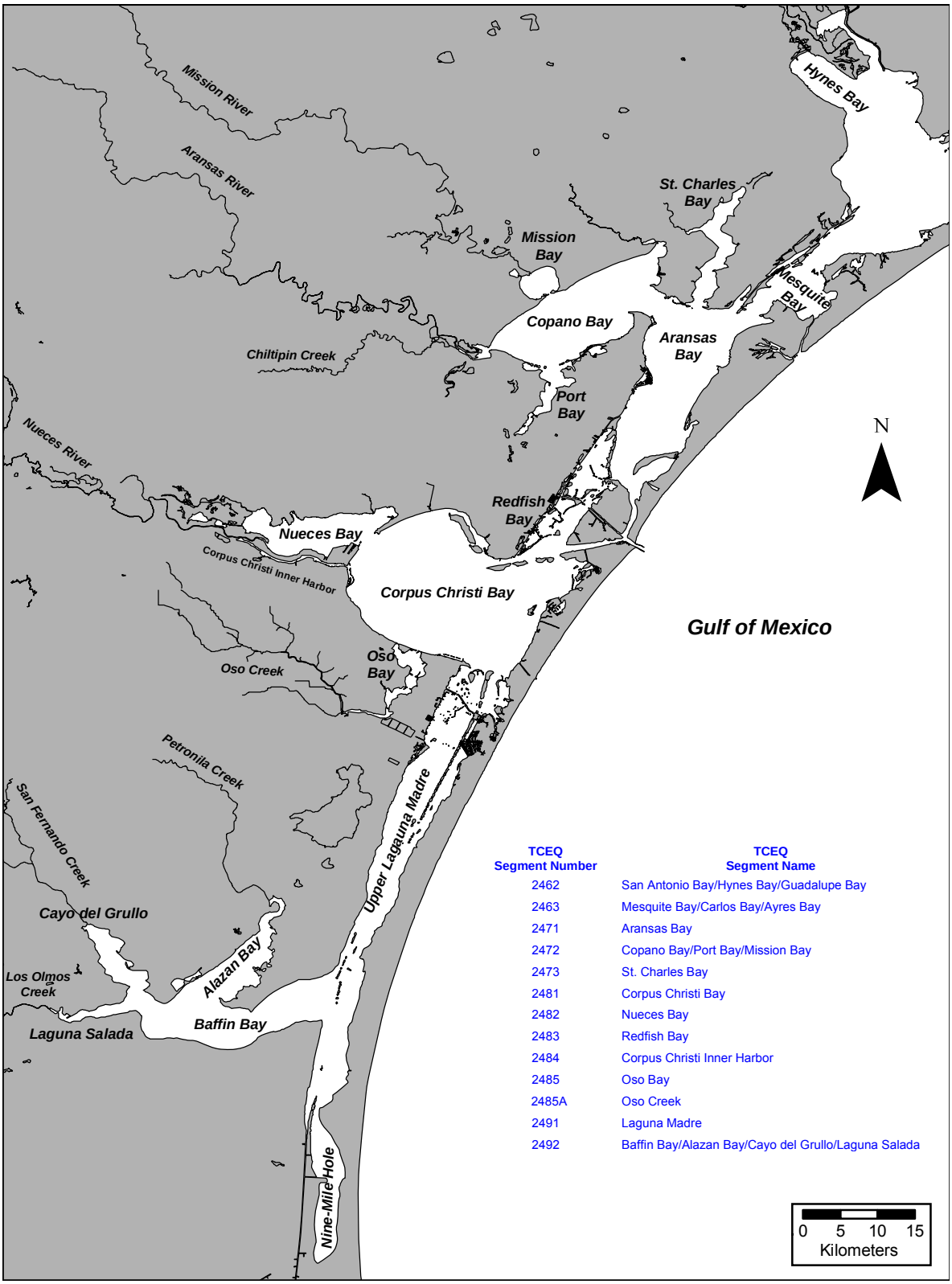
2.1 Sampling Process Design

RCAP development originally consisted of a three-phase process based on providing data that would characterize water and sediment quality conditions in the CBBEP region and begin to identify significant long-term trends that would also support the TCEQ Surface Water Quality Monitoring (SWQM) program and Total Maximum Daily Load (TMDL) process. Input from local, state, and federal representatives, facilitated stakeholder workgroup consensus regarding appropriate and effective sampling and analytical protocols for monitoring the region. As part of the initial process, coordination with TCEQ ensured a comprehensive monitoring strategy that determined effective methods of identifying water and sediment quality concerns for the CBBEP area. This included the Upper Laguna Madre and Baffin Bay; an area determined to be deficient in recent data collection. With attaining achievable water and sediment quality objectives as the goal, development of the work plan attempted to balance objectives with available resources.

Baseline quarterly monitoring for RCAP 2000 consisted of 120 (30 per quarter) randomly selected sites sampled in the northern and central portions of the CBBEP area (Fig 2.1). In addition, sampling occurred at 10 targeted fixed TCEQ sites each quarter, and 8 fixed sites in Oso Creek and Oso Bay for two quarters; bringing the total number of sites sampled to 176 for RCAP 2000. During RCAP 2001, sampling took place in the Upper Laguna Madre and Baffin Bay complex at 31 randomly selected sites per quarter for a total number of 124 sites sampled (Nicolau and Nuñez 2004).

As previously mentioned, RCAP 2002 sampling in the CBBEP region consisted of 50 sites (Fig. 2.2) selected using the EPA-EMAP sampling design in which each sampling site becomes a statistically valid probability-based sample (Stevens 1997; Stevens and Olsen 1999). Selection of sites by the EPA-NCA team involved placement of multiple hexagonal grids, of predetermined size, over the study areas with sites then selected by a systematic random approach. The uniform spatial coverage provided by a grid ensured sampling of parameters was proportional to geographical location.

RCAP 2002 sampling design comprised 50 sites located within 11 of the 13 TCEQ defined Segments previously sampled within the CBBEP region. The following Segments contained sites selected for sampling: San Antonio Bay/Hynes Bay/Guadalupe Bay (Segment 2462), Mesquite Bay/Carlos Bay/Ayers Bay (Segment 2463), Aransas Bay (Segment 2471), Copano Bay/Mission Bay/Port Bay (Segment 2472), St. Charles Bay (Segment 2473), Corpus Christi Bay (Segment 2481), Nueces Bay (Segment 2482), Redfish Bay (Segment 2483), Oso Bay (Segment 2485), Laguna Madre (Segment 2491), and Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada (Segment 2492) (Fig. 2.1). As opposed to RCAP 2000 and RCAP 2001 the random sampling design did not generate any sites to be sampled in either the Corpus Christi Inner Harbor (Segment 2484), or Oso Creek (Segment 2485A-TCEQ unclassified Tidal Stream segment).



TCEQ Segment Number	TCEQ Segment Name
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay
2463	Mesquite Bay/Carlos Bay/Ayres Bay
2471	Aransas Bay
2472	Copano Bay/Port Bay/Mission Bay
2473	St. Charles Bay
2481	Corpus Christi Bay
2482	Nueces Bay
2483	Redfish Bay
2484	Corpus Christi Inner Harbor
2485	Oso Bay
2485A	Oso Creek
2491	Laguna Madre
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada

Fig. 2.1. Map depicting CBBEP RCAP sampling area with listing of TCEQ Segment Numbers and Segment Names.

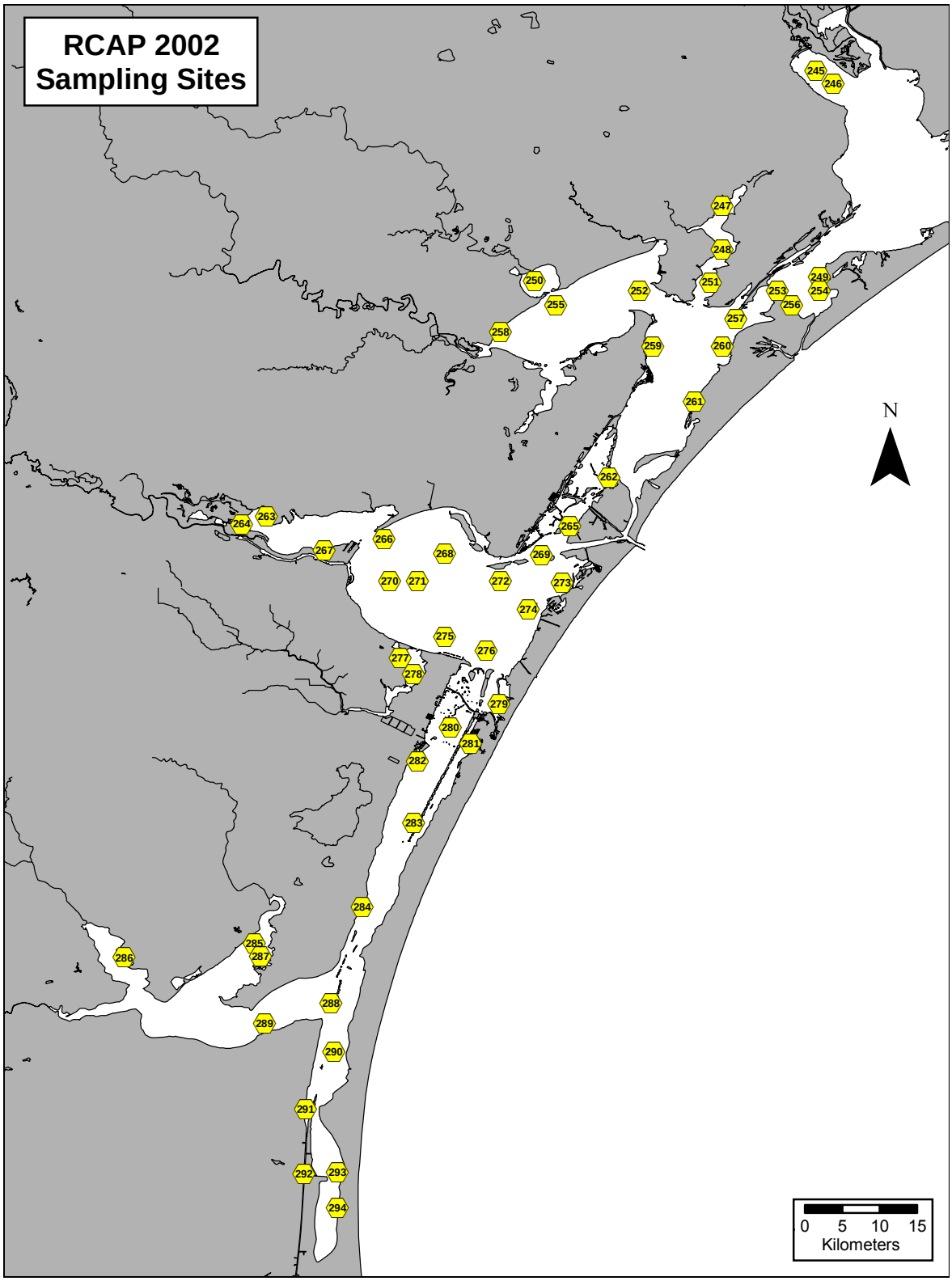


Fig. 2.2. Distribution of RCAP 2002 sampling sites (50) with corresponding CCS Station ID number. See Table 6.1.1 for corresponding TCEQ Station ID numbers and other pertinent information.

2.2 Parameters Sampled

Table 2.1 lists all parameters measured for RCAP 2002. Parameters measured but not presented within the scope of this report are available upon request to the CBBEP and CCS Project Managers.

Table 2.1. Parameters collected for RCAP 2002.

FIELD PARAMETERS (Water)	Units	Lab
Conductivity	µS/cm	CCS
Depth Sample Collected	Meters	CCS
Dissolved Oxygen	mg/L	CCS
Dissolved Oxygen	% Saturation	CCS
Habitat Type	Description	CCS
Marine Debris	Description	CCS
PAR – Terrestrial	µmol s^{-1} m^{-2}	CCS
PAR – Flat Cosine	µmol s^{-1} m^{-2}	CCS
PAR –- Spherical	µmol s^{-1} m^{-2}	CCS
pH	su	CCS
Salinity	PSU	CCS
Seagrass Type (Species)	Scientific name	CCS
Seagrass Percent Cover	%	CCS
Secchi Depth	Meters	CCS
Tide Stage	DNR Tide Gauge	CCS
Total Depth	Meters	CCS
Turbidity	Visual assessment	CCS
Turbidity	NTU	CCS
Water Color	Visual assessment	CCS
Water Odor	Olfactory assessment	CCS
Water Surface	Visual assessment	CCS
Water Temperature	°C	CCS
FIELD PARAMETERS (Weather)	**Units**	**Lab**
Air Temperature	°C	CCS
Barometric Pressure	mm/Hg	CCS
Cloud Cover	%	CCS
Dew Point	°C	CCS
Heat Index	°C	CCS
Present Weather	Visual assessment	CCS
Rainfall (Days since last)	Days	CCS
Rainfall (Inches past 1 day)	Inches	CCS
Rainfall (Inches past 7 days)	Inches	CCS
Relative Humidity	%	CCS
Wind Chill	°C	CCS
Wind Direction	Compass Direction	CCS
Wind Speed	MPH	CCS

Table 2.1. (continued).

ROUTINE CONVENTIONAL CHEMISTRY (Water)	Units	Lab
Ammonia	mg/L	UTMSI
Nitrate	mg/L	UTMSI
Nitrite	mg/L	UTMSI
Nitrate/Nitrite	mg/L	UTMSI
Orthophosphate	mg/L	UTMSI
Total Phosphorus	mg/L	UTMSI
Total Suspended Solids (TSS)	mg/L	FSI
Chlorophyll *a*	µg/L	UTMSI
MICROBIOLOGICAL (Water)	**Units**	**Lab**
Enterococci (IDEXX 51, IDEXX 97, and EPA Method 1600)	CFU/100ml	TAMUCC
SEDIMENT QUALITY PARAMETERS	**Units**	**Lab**
SGS Clay (<0.0039 mm)	% dry wt.	FSI
SGS Silt (0.0039 to 0.0625 mm)	% dry wt.	FSI
SGS Sand (0.0625 to 2.0 mm)	% dry wt.	FSI
SGS Gravel + shell hash (>2.0 mm)	% dry wt.	FSI
Total Organic Carbon (TOC)	mg/kg (% dry wt)	FSI
INORGANICS – SEDIMENT and TISSUE TRACE METALS	**Units**	**Lab**
Aluminum (Al)	mg/kg (dry and wet wt.)	TPWD ECL
Antimony (Sb) (Sediment only)	mg/kg (dry wt.)	TPWD ECL
Arsenic (As)	mg/kg (dry and wet wt.)	TPWD ECL
Cadmium (Cd)	mg/kg (dry and wet wt.)	TPWD ECL
Chromium (Cr)	mg/kg (dry and wet wt.)	TPWD ECL
Copper (Cu)	mg/kg (dry and wet wt.)	TPWD ECL
Iron (Fe)	mg/kg (dry and wet wt.)	TPWD ECL
Lead (Pb)	mg/kg (dry and wet wt.)	TPWD ECL
Manganese (Mn) (Sediment only)	mg/kg (dry wt.)	TPWD ECL
Mercury (Hg)	mg/kg (dry and wet wt.)	TPWD ECL
Nickel (Ni)	mg/kg (dry and wet wt.)	TPWD ECL
Selenium (Se)	mg/kg (dry and wet wt.)	TPWD ECL
Silver (Ag)	mg/kg (dry and wet wt.)	TPWD ECL
Tin (Sn)	mg/kg (dry and wet wt.)	TPWD ECL
Zinc (Zn)	mg/kg (dry and wet wt.)	TPWD ECL

Table 2.1. (continued).

ORGANICS – SEDIMENT AND TISSUE PAHs	Units	Lab
1-Methylnaphthalene	ng/g (dry and wet wt.)	TPWD ECL
1-Methylphenanthrene	ng/g (dry and wet wt.)	TPWD ECL
2,3,5-Trimethylnaphthalene	ng/g (dry and wet wt.)	TPWD ECL
2,6-Dimethylnaphthalene	ng/g (dry and wet wt.)	TPWD ECL
2-Methylnaphthalene	ng/g (dry and wet wt.)	TPWD ECL
Acenaphthene	ng/g (dry and wet wt.)	TPWD ECL
Acenaphthylene	ng/g (dry and wet wt.)	TPWD ECL
Anthracene	ng/g (dry and wet wt.)	TPWD ECL
Benzo(a)anthracene	ng/g (dry and wet wt.)	TPWD ECL
Benzo(a)pyrene	ng/g (dry and wet wt.)	TPWD ECL
Benzo(b)fluoranthene	ng/g (dry and wet wt.)	TPWD ECL
Benzo(g,h,i)perylene	ng/g (dry and wet wt.)	TPWD ECL
Benzo(k)fluoranthene	ng/g (dry and wet wt.)	TPWD ECL
Biphenyl	ng/g (dry and wet wt.)	TPWD ECL
Chrysene	ng/g (dry and wet wt.)	TPWD ECL
Dibenz(a,h)anthracene	ng/g (dry and wet wt.)	TPWD ECL
Dibenzothiophene	ng/g (dry and wet wt.)	TPWD ECL
Fluoranthene	ng/g (dry and wet wt.)	TPWD ECL
Fluorene	ng/g (dry and wet wt.)	TPWD ECL
Indeno(1,2,3-cd)pyrene	ng/g (dry and wet wt.)	TPWD ECL
Naphthalene	ng/g (dry and wet wt.)	TPWD ECL
Phenanthrene	ng/g (dry and wet wt.)	TPWD ECL
Pyrene	ng/g (dry and wet wt.)	TPWD ECL
ORGANICS – SEDIMENT AND TISSUE PCB CONGENERS		
PCB Nos. 8, 18, 28, 44, 52, 66, 77, 101,105, 118, 126, 128, 138, 153, 170, 180, 187, 195, 206, 209	ng/g (dry and wet wt.)	TPWD ECL
ORGANICS – SEDIMENT AND TISSUE DDTs		
2,4'-DDD	ng/g (dry and wet wt.)	TPWD ECL
4,4'-DDD	ng/g (dry and wet wt.)	TPWD ECL
2,4'-DDE	ng/g (dry and wet wt.)	TPWD ECL
4,4'-DDE	ng/g (dry and wet wt.)	TPWD ECL
2,4'-DDT	ng/g (dry and wet wt.)	TPWD ECL
4,4'-DDT	ng/g (dry and wet wt.)	TPWD ECL

Table 2.1. (continued).

ORGANICS – SEDIMENT AND TISSUE CHLORINATED PESTICIDES		
Aldrin	ng/g (dry and wet wt.)	TPWD ECL
Alpha-Chlordane	ng/g (dry and wet wt.)	TPWD ECL
Dieldrin	ng/g (dry and wet wt.)	TPWD ECL
Endosulfan I	ng/g (dry and wet wt.)	TPWD ECL
Endosulfan sulfate	ng/g (dry and wet wt.)	TPWD ECL
Endrin	ng/g (dry and wet wt.)	TPWD ECL
Heptachlor	ng/g (dry and wet wt.)	TPWD ECL
Heptachlor epoxide	ng/g (dry and wet wt.)	TPWD ECL
Hexachlorobenzene	ng/g (dry and wet wt.)	TPWD ECL
Lindane (gamma-BHC)	ng/g (dry and wet wt.)	TPWD ECL
Mirex	ng/g (dry and wet wt.)	TPWD ECL
Toxaphene	ng/g (dry and wet wt.)	TPWD ECL
Trans-Nonachlor	ng/g (dry and wet wt.)	TPWD ECL
SEDIMENT TOXICITY		
Sediment Toxicity – (Amphipod; *Ampelisca abdita*)	% Survival	HESS
BENTHIC SPECIES COMPOSITION		
Sorting	Number of vials	CCS
Counting	Integer	CCS
Biomass	mg (dry wt.)	CCS
Taxonomy	Classification	CCS
FISH COMMUNITY COMPOSITION *		
Counting	Integer	TPWD CF
Taxonomy	Classification	TPWD CF
Gross Pathology	Various	TPWD CF

Notes:

* RCAP is providing additional funding for the tissue analysis and will eventually receive the community data from this sampling activity; however, the CCS RCAP Field Team does not do the actual trawl sampling. This is an integral aspect of the NCA and the TPWD-Coastal Fisheries branch has conducted the sampling in Texas since August 2000. The information provided in this table is for documentation purposes only since the CBBEP will receive the data collected.

2.3 Sampling Methods

The RCAP 2000 and 2001 annual report (Nicolau and Nuñez 2004) previously described sampling methods employed by CCS personnel during baseline monitoring. These methods along with any changes and/or additions appear again in this report to document modifications associated with the revised RCAP monitoring design. In general, RCAP follows methods consistent with the *USEPA National Coastal Assessment–Coastal 2001-2004 Quality Assurance Project Plan* and the *TCEQ Surface Water Quality Monitoring Procedures Manual (1999).*

Unique conditions differentiate EMAP Provinces or geographic regions (e.g., climate, depth, bottom type, tidal influence, biota, etc.), therefore, on occasions; it is necessary to modify standard EMAP field procedures to meet the needs particular to a region or sub region. Such modifications generally gain approval as long as the altered procedures meet the general guidelines of established protocol and adhere to the spirit of the Quality Assurance/Quality Control (QA/QC) established for EMAP so that the resultant data remain comparable to that collected by standard procedures.

During RCAP 2002, a 3 to 4-person primary CCS field crew conducted sampling from a shallow draft bay skiff. Utilizing this craft facilitated sampling in areas often encountered on a daily basis in which water depth typically averaged <1 meter, a common occurrence throughout the Coastal Bend. Field activities performed at each site required approximately 1 to 2 hours per site; therefore, a team sampled 4 to 6 stations in a normal day. Of course, this was subject to factors such as weather, seas, travel distance, and holding times for microbiological samples; with some microbiological samples actually passed to waiting shore personnel for direct transport to the lab so that the field crews could continue sampling.

At each sampling site, CCS field crews uniformly collected a core set of data and samples according to defined methods and protocols. Core field data and samples included those specifically detailed in the applicable QAPPs and listed previously in Table 2.1. CCS field crews had the option of gathering additional environmental information for other researchers or agencies, as long as those activities did not take precedence over core activities. Samples collected from the field arrived back at the CCS facilities the afternoon of sampling to be properly stored, or immediately shipped, to the appropriate laboratories for analysis. Applicable QAPPs list sample handling and storage guidelines.

Additional aspects outlined in the following sections reflect specific requirements for RCAP sampling parameters and/or provide additional clarification. Field crews adhered to these methods as closely as possible during the course of this program.

2.3.1. Field Sampling Procedures

RCAP procedures for field collection of environmental samples and data follow methods developed by TCEQ SWQM program and EMAP-Estuaries over long-term experience with large-scale, regional monitoring projects (e.g., EPA National Coastal Assessment, EMAP-E Province Monitoring, the Mid-Atlantic Integrated Assessment, and the Western Pilot Coastal Monitoring).

Full documentation of RCAP procedures utilized exists in the following approved QAPPs, state, and federal documents:

1. *Quality Assurance Project Plan for the Coastal Bend Bays Project – Surface Water Quality Monitoring and Assessment, 2000.*
2. *Quality Assurance Project Plan for the Coastal Bend Bays Project – Surface Water Quality Monitoring and Assessment, Amendment 2 – Sediment Collection, 2000.*
3. *Quality Assurance Project Plan for the Coastal Bend Bays Project – Phase III, Surface Water and Sediment Quality Monitoring and Assessment, Upper Laguna Madre and Baffin Bay, 2001.*
4. *Quality Assurance Project Plan for the Coastal Bend Bays & Estuaries Program, Regional Coastal Assessment Program (RCAP), 2002.*
5. *TCEQ Surface Water Quality Monitoring Procedures Manual. 1999.*
6. *USEPA National Coastal Assessment-Coastal 2001-2004 Quality Assurance Project Plan – 2001.*

2.3.2. Site Location

EPA provided CCS field crews with randomly selected RCAP sampling locations as coordinates of latitude/longitude in degrees-minutes, expressed to the nearest 0.01 minute (i.e., 00° 00.00'). CCS crews used GPS to locate the site. The acceptable tolerance goal was that the sampling station be within 0.02 nautical miles (nm), or ±120-ft, of the given coordinates. This reflects the accuracy expected from a properly functioning GPS unit of the caliber used for the study. Verification of GPS's performance occurred on a daily basis.

CCS field crews strictly adhered to station positioning guidelines, unless substantiated reasons prevented sampling within that defined area. Because EMAPs probabilistic sampling design is unbiased, potentially, some of the generated sites fell in locations not always conducive to sampling (e.g., shallow conditions, inaccessible due to oyster reefs, shallow conditions over protected seagrass beds, etc.). Prior planning by CCS personnel helped resolve potential problems before the actual sampling day, with substitute stations selected from a list of alternative randomly generated sampling sites.

To ascertain spatial distribution of sites required plotting coordinates of random locations on NOAA nautical charts, or other acceptable charts, to reconnoiter on paper obvious problem situations (e.g., water depth, hazards to navigation, etc.). If suspect sites appeared in this exercise, CCS field crews conducted a field reconnaissance to determine actual site conditions. If an intended site location presented an obvious problem, then depending on the situation, the CCS Project Manager, in consultation with the EPA, elected to relocate the site within an acceptable range of the original location. The CCS Project Manager and EPA made decisions on this level (i.e., significant changes to the sampling design), not the CCS field crews.

Field teams, however, had a limited degree of onsite flexibility to relocate sampling sites when confronted with unexpected obstacles or impediments associated with locating within

the ±0.02 nm guideline (e.g., shallow conditions, danger, or risk, to crew from ship traffic, man-made obstructions, etc.). CCS field crews then moved the station to the nearest location from the intended site amenable to conduct sampling; making every effort to relocate to an area that appeared similar in character to that of the intended site.

When necessary to relocate the site >0.02 nm the reason for the shift became part of the documented field record. Document records for any site relocation, >0.05 nm (300 ft), required review before data collected from the station would be acceptable for inclusion in the study database. At times, crews might experience trouble in obtaining a "good grab" when collecting sediment due to the nature of the bottom at the established site. In these situations, even after collecting the water quality samples and data, it was permissible to move around within a 120-ft radius to locate more favorable sediment conditions without having to resample the water quality indicators.

2.3.3. Water Column Measurements

The first activities conducted upon arriving onsite involved water sampling and water column measurements; as these data and samples strictly required collection before disturbing bottom sediments. If upon arrival at the station, CCS field crews ascertained that sediments had been disturbed (e.g. shallow depth or other disturbance creating turbid conditions) then field crews allowed adequate time so that the disturbance dissipated before sample collection began.

Instantaneous water column profiles and visual assessments performed at each site by CCS field crews measured basic water quality parameters and ambient conditions (Table 2.1) utilizing hand-held multiparameter water quality probes (e.g., YSI Sondes). Water column profiling followed EPA protocols. Instantaneous surface measurements occurred 0.5 m below the surface and near-bottom condition measurements took place at 0.5 m off the bottom. To obtain undisturbed bottom readings required ascertaining bottom depth, pulling up the probe approximately 0.5 m, and then allowing 2-3 minutes for disturbed conditions to settle before taking the near-bottom measurements.

At least one measurement of light attenuation (Photosynthetically Active Radiation or PAR) occurred, with secchi depth also measured at each station. Measurements of light penetration, taken by hand-held light meters, occurred at discrete depth intervals in a manner similar to that for profiling water quality parameters. The underwater sensors are hand lowered slowly. At each discrete interval, the deck reading and underwater readings recorded. If light measurements become negative before reaching bottom, the measurement terminates at that depth. Secchi depth determination used a standard 20-cm diameter black and white secchi disc lowered to the depth at which it no longer discernable; and then slowly retrieved until it just reappears; depth is marked and recorded as secchi depth (rounded to nearest 0.1 m).

2.3.4. Routine Conventional Water Chemistry

Due to different methods used by EPA (samples field filtered from 3 depths) and TCEQ (typically one whole water unfiltered sample collected at near-surface) in the NCA and SWQM programs, respectively, required CCS field crews to collect two individual sets of samples where methods differed. This ensured that data collected would be comparable to

historical TCEQ data used in the assessment of Texas coastal waters and to EPA-NCA data from TPWD/EPA Texas sites and other states.

CCS field crews collected water samples for the determination of dissolved and total nutrients (see Table 2.1), chlorophyll *a*, and total suspended solids by using a Van Doren sampler. Depending on depth at the sampling station, water sample collection followed EPA-NCA protocols (TCEQ samples only collected at near-surface) as follows:

Shallow sites (<2 m) - sample at 0.5 m (near-surface) and 0.5 m off-bottom[1];

Standard site (>2m) - sample at 0.5 m (near-surface), mid-depth, and 0.5 m off-bottom[1];

[1]Unless the depth is so shallow that near-surface and near-bottom overlap; then sample mid-depth, only.

For EPA-NCA samples, an approximate 3 L sub-sample is drawn into a clean, wide-mouth Nalgene container from each applicable water depth at the site. This provides enough water for the remainder of the sample processing which essentially is filtration; with the filtrate becoming the dissolved nutrient sample and the filters retained for chlorophyll *a* analysis. Total Suspended Solids (TSS) and total nutrient samples required unfiltered water collection. TCEQ sample collection took place by directly immersing the inverted sample container beneath the water surface to the appropriate depth, quickly turning the bottle upright, and filling the container at that depth.

2.3.4.1. Chlorophyll *a*

At each site, a new sampling pack consisting of a disposable, graduated 60 ml polypropylene syringe, fitted with a polypropylene filtering assembly, filtered the site water from applicable water depths, through a 25 mm GF/F filter. If conditions allowed (low suspended solids load) then field crews filtered 100 ml of site water for each chlorophyll sample. If another filter was required then field crews carefully detached the filter assembly, replaced the filter, and continued with the filtration until the desired volume was processed. Field crews used tweezers to carefully remove the filter from its holder and fold once upon the pigment side, and then placed it onto a pre-labeled aluminum sheet, wrapped and folded the sheet, and then placed the contents into a pre-labeled, disposable whirl-pak bag. CCS field crews recorded the volume of water filtered on all sample containers, and the field form, and then placed the whirl-pak bag into a small instant-freeze chamber (small ice chest with several pounds of dry ice). Samples remained frozen until time of analysis.

2.3.4.2. Dissolved and Total Nutrients

For dissolved nutrients, CCS field crews collected approximately 40 ml of filtrate from the above chlorophyll filtration into a pre-labeled, clean 125 ml Nalgene screw-capped bottle, which was also stored in the dry ice freezing chamber. Before placing sample in the freezer, they recorded the approximate salinity (±2 ppt) on the container, a convenience for the analyst who performs the nutrient analysis. Depending on the analytical instrumentation used, matrix matching of solutions (e.g., standards or wash solutions) may be necessary for certain analytes. The nutrient samples remained frozen until time on analysis. For TCEQ total

nutrient samples, crews collected 1000 ml of unfiltered seawater at the surface only. Placement of samples on ice and temperature maintenance at 4°C ± 2° ensured sample integrity until delivery to the laboratories for analysis.

2.3.4.3. Total Suspended Solids (TSS)

After chlorophyll *a* and nutrient sample collection, CCS field crews vigorously shook the remaining water in the 3 L sub-sample to re-suspend the particles and collected 1 L into a pre-labeled Nalgene container. TCEQ sample collection took place by directly immersing the inverted sample container beneath the water surface to the appropriate depth, quickly turning the bottle upright, and filling the container at that depth. The samples were held on wet ice in the field and stored at 4ºC to await laboratory determinations.

2.3.5. Composited Surficial Sediment

At each site, CCS field crews utilized an Ekman dredge sampler (22.86 cm x 22.86 cm), to obtain multiple grabs; collecting the surficial sediment layer (top 2-3 cm) by spatula or scoop. The sample was then composited to provide sediment for the analyses of trace metal and organic contaminants, total organic carbon (TOC), sediment grain size, and sediment toxicity. The number of grabs required to yield an adequate volume of composited sediment depended on the surface area obtained by the particular grab. Sediment sampling followed established TCEQ and EPA protocols (TCEQ 1999; EPA 2001)

CCS field crews combined the surficial sediment from the individual grabs in a clean, high-grade stainless steel or Teflon vessel. To protect the sample from contamination between grabs, CCS field crews covered the sample bucket with a lid and placed the sample on ice. Stirring action blended in each addition of sediment to the composite, with the final mixture stirred consistently to ensure a homogenous sample before taking required sub-samples.

2.3.5.1. Organic chemical contaminants

The collection of composited sediment for organic contaminants analysis required placing approximately 500 cc into a clean, pre-labeled, glass wide-mouth, I-Chem jar with jars filled to approximately 75% of capacity to allow for expansion during freezing. The sample was held on wet ice aboard and upon transfer to shore storage was frozen, unless it was scheduled for extraction within 7 days; in that case, the sample was held at 4ºC to await processing.

2.3.5.2. Inorganic chemical contaminants

The collection of composited sediment for inorganic contaminants analysis required placing approximately 125 cc into a clean, pre-labeled, wide-mouth Nalgene bottle with bottles filled to approximately 75% of capacity to allow for expansion during freezing. The sample was held on wet ice while aboard and upon transfer to shore storage was frozen, unless it was scheduled for digestion within 7 days; in that case, the sample was held at 4ºC to await processing.

2.3.5.3. Total Organic Carbon (TOC)

The collection of composited sediment for TOC analysis required placing approximately 250 cc of composited sediment into a small, clean, pre-labeled amber glass jar with jars filled to approximately 75% of capacity to allow for expansion during freezing. The sample was held on wet ice aboard and upon transfer to shore storage was frozen, unless it was scheduled for extraction within 7 days; in that case, the sample was held at 4ºC to await processing.

2.3.5.4. Sediment Grain Size

The collection of composited sediment for Sediment Grain Size analysis required placing approximately 500 cc of composited sediment into a clean, pre-labeled, wide-mouth polypropylene jar. The sample was held on wet ice aboard and upon transfer to shore storage, the sample was held at 4ºC to await laboratory processing.

2.3.5.5. Toxicity testing

The collection of composited sediment for toxicity analysis required placing approximately 4000 cc into a clean, pre-labeled, wide- mouth Nalgene jar. The sample was held on wet ice aboard and upon transfer to shore storage was held at 4ºC to await further processing and initiation of testing.

2.3.6. Benthic Infaunal Community

Biological sampling procedures and methods had prior approval by TCEQ and EPA. CCS field crews sampling benthic biota in this region have historically utilized these methods to provide characterizations and quantify benthic habitat. Sampling protocols and CCS benthic laboratory Quality Assurance/Quality Control procedures are adapted from the Environmental Monitoring and Assessment Program (EMAP): Laboratory Methods Manual-Estuaries, Volume 1: Biological and Physical Analyses (1995) and are maintained and available upon request from the CCS Project Manager.

The method employed by CCS field crews for benthic macroinvertebrate infauna sampling involved using a PVC cylindrical (10.16 cm diameter) push corer to sample benthic infauna to a depth of 10 cm in the sediment. Multiple extensions extended the corer to reach bottom sediments in deeper waters. A minimum of five (5) replicate samples (81.1 cm^2) taken at each station yielded a total area of 405.4 cm^2 sampled. Each sample was then placed in a 0.5 mm mesh biobag and field washed by gently homogenizing the sample by hand. Following this procedure, sediment sample storage on ice occurred to preserve samples for transport to CCS facilities before sample placement in a 10% formalin and seawater mixture.

All benthic samples required a minimum of one (1) week for fixation. Sample transfer to 45% isopropyl alcohol took place approximately seven days later. Laboratory analysis consisted of washing samples through nested sieves (minimum mesh size = 0.5 mm), with organisms sorted, counted, and identified to the lowest possible taxon. Biomass determination required drying all specimens, for a minimum of two days, at 90°C in a standard drying oven before weighing to the nearest 0.0001 g.

2.3.7. Habitat Evaluation

Several observations took place in the field to document certain attributes or conditions of the site to help characterize overall ecological site health. Observations made by CCS field crews included the occurrence of submerged aquatic vegetation (SAV), the occurrence of macro algae beds/mats, the presence of marine debris (litter), and if there was obvious evidence of disruptive anthropogenic activities (e.g., dredging or prop scouring or scarring), these observations, and a brief description, became part of the permanent field record.

2.3.8. Fish Trawls

This is an integral aspect of EMAP-NCA and the TPWD-Coastal Fisheries (TPWD-CF) branch has conducted the NCA sampling in Texas since August 2000. While CCS will not be doing this sampling, the data will eventually become a part of the RCAP data record. The information provided below is for documentation purposes.

Using standard agency protocols, TPWD-Coastal Fisheries conducts fish trawls, where possible, at each site to collect fish and shellfish for community structure and abundance estimates; target species for contaminant analyses, and specimens for histopathological examination. Additional trawls supplemented the sample, if needed, to obtain enough target species for contaminant analyses. Trawling should be the last field activity that the crew performs while onsite because of their disturbance to conditions at the site.

2.3.8.1. Community Structure

TPWD-CF personnel sorted and identified to genus species all fish and invertebrates from a successful trawl (fulltime on bottom with no hangs or other interruptions). The first nineteen individuals per species required measuring to the nearest centimeter (fork length when tail forked, otherwise overall length - snout to tip of caudal). TPWD-CF personnel recorded lengths on a field form, made a total count for each species, and returned fish to the estuary if not retained for histopathology or chemistry.

2.3.8.2. Gross Pathology

All fish were field screened for external gross pathologies while being measured and counted for the community structure evaluation. A brief examination of each fish documented any obvious external conditions such as lesions, lumps, tumors, and fin erosion. In addition, an examination of the gills took place for discoloration or erosion. Any fish exhibiting a pathological condition required saving for further laboratory histopathological evaluation. Field personnel on the Fish Data form recorded a generic description of the observed condition, and then tagged the specimen before immediately preserving in Dietrich's solution to await shipment to the laboratory.

Each fish preserved had its body cavity opened to expose internal tissues to the fixative. Stainless steel surgical scissors were used to open the body starting at the anal pore and cutting anteriorly through the body wall, taking care not to cause undue damage to the internal organs; the cut continued through the thoracic region and over to the gill slits. The body cavity was then be spread apart (popped open) by hand to further ensure the fixative flooded the internal organs. An appropriate container (e.g., a 1-2 gallon plastic bucket), with enough

Dietrich's to completely cover the specimen, served as storage for each tagged fish, with multiple samples held in a common container provided fish were appropriately tagged.

2.3.8.3. Tissue Contaminant Analyses

Several species designated as target samples for analyses of chemical contaminants in whole-body tissue were: Spot (*Leiostomus xanthurus*), Atlantic Croaker (*Micropogonias undulatus*), Catfish (*Arius felis*, *Bagre marinus*, *Ictalurus punctatus*, *Ictalurus furcatus*), Brown Shrimp (*Farfantepenaeus aztecus*), White Shrimp (*Litopenaeus setiferus*), and Pink Shrimp (*Farfantepenaeus duorarum*). In the Laguna Madre, the following species were acceptable surrogates: Pinfish (*Lagodon rhomboides*), Pigfish (*Orthopristis chrysoptera*), and Toadfish (*Opsanus beta*). Five to ten individuals of a species comprised a composited sample at sites where target species collection was sufficient. After measurement and recording on the sampling form as chemistry fish, TPWD-CF personnel rinsed the fish with site water and individually wrapped the fish with heavy-duty aluminum foil before placing samples together in a plastic, Ziploc bag, labeled with Station ID and a Species ID Code (e.g., the first four letters of both the genus and species). Sample placement on wet ice in the field maintained samples until the samples were transferred to shore and frozen to await laboratory analysis.

2.3.9. Microbiological

To compare the EPA Method 1600 (membrane filter) with the newly approved IDEXX (chromogenic substrate, or enzyme specific) method used by TCEQ for microbiological analysis required the collection of two surface water samples from each station, utilizing polypropylene screw cap, 500-1000 ml sterile plastic bottles. Collection involved directly immersing the inverted sample container beneath the water surface to the appropriate depth, quickly turning the bottle upright, and filling the container at that depth; leaving ample air space for shaking, in accordance with Section 9000 Standard Methods for the Examination of Water and Wastewater, 20th ed., 1998 (APHA 1998). The samples were held on wet ice in the field at 4ºC. Depending on holding times (six hours), sample delivery involved passing the samples to waiting shore personnel for direct transport to the lab, or involved delivery by the field crews within the appropriate holding times for applicable analysis.

2.4 Analytical Laboratories and Methods

Analytical procedures for RCAP ranged from straightforward determinations such as percent gravel/silt/sand/clay to comprehensive analyses of trace metal and organic contaminants in complex environmental matrices. Laboratory Directors/Scientists/Managers were responsible for overseeing laboratory sample analyses, and data processing duties related to the parameters as defined in, and according to guidelines included in, the QAPPs.

Analyses were in accordance with the most recently published edition of *Standard Methods for the Examination of Water and Wastewater*, the TCEQ *Surface Water Quality Monitoring Procedures Manual 1999*, alternate TCEQ approved methods, or EPA approved methods. Many procedures (e.g. Sediment Toxicity) for various analyses derive from those developed for the EMAP-Estuaries Program, which documents specific analytical processes details (USEPA 1995). Additional information is contained in Section B4 of the National Coastal Assessment Program QAPP (USEPA 2001).

The Laboratory Director/Manager/Scientist of all contract laboratories and the CCS Project Manager retain copies of all documentation, raw data, and calibration data that are applicable. The CCS Project Manager retains custody of all project records for perpetuity except laboratory calibration and equipment maintenance records, which will remain with the laboratories. Copies of laboratory SOPs are available for review by CBBEP, TCEQ, and EPA. All laboratory SOPs were consistent with EPA requirements as specified in the method.

2.5 Quality Assurance

RCAP monitoring took place under an approved Quality Assurance Project Plan (QAPP). The purpose of the QAPP, which includes sample sites and a sampling plan, is to provide a clear delineation of the CCS QA/QC policy, management structure, and policies used to implement the extensive QA/QC requirements necessary to document reliability, quality, precision, accuracy, completeness, and validity of the data. All participants used Standard Operating Procedures and maintained QA/QC records. QA/QC documentation accompanied all data report submissions. The Laboratory Manager of all contract laboratories and the CCS Project Manager retain copies of all documentation, raw data, and calibration data that is applicable.

QAPP review by the CBBEP, TCEQ, and EPA ensured that data generated for the purposes described above were scientifically valid and legally defensible. This process ensured that data collected, analyzed, and submitted to the statewide database would guarantee reliability and therefore use of the data in possible TMDL development, permit decisions, water quality assessments, and other programs would be deemed appropriate. The individual QAPPs for the all RCAP events are available from CCS upon request.

2.6 Data Analyses

Data analysis utilized various standard parametric and non-parametric tests dependent on meeting test assumptions of the particular analysis required. Additional data evaluation utilized in this report derives from comparisons or evaluations to applicable TCEQ water and sediment quality criteria identifying *Primary Concerns*, or if no criteria exist, then to TCEQ SWQM based screening levels that identify *Secondary Concerns* (e.g. Tidal Water Criteria for Toxic Substance in Water vs. Nutrients and Chlorophyll *a* Screening Levels). Further comparison and evaluation of RCAP 2002 data used EPA National Coastal Condition Report II (NCCR II) guidelines (USEPA 2004). Use of this evaluation technique was to provide continuity between locally collected data and the ongoing NCA program for assessing coastal waters and to see if the broad based EPA regional approach is applicable in all estuarine systems. More details concerning these approaches, and the particular methods utilized, are available within the individual chapters of this document.

2.7 References

American Public Health Association. 1998. Standard methods for the examination of water and wastewater, 20th ed. American Public Health Association, Washington, D.C.

Center for Coastal Studies. 2000. Quality Assurance Project Plan for the Coastal Bend Bays Project – Surface Water Quality Monitoring and Assessment. 71 pp.

Center for Coastal Studies. 2000. Quality Assurance Project Plan for the Coastal Bend Bays Project– Surface Water Quality Monitoring and Assessment, Amendment 2– Sediment Collection. 21 pp.

Center for Coastal Studies. 2001. Quality Assurance Project Plan for the Coastal Bend Bays Project–Phase III, Surface Water and Sediment Quality Monitoring and Assessment, Upper Laguna Madre and Baffin Bay. 76 pp.

Center for Coastal Studies. 2002. Quality Assurance Project Plan for the Coastal Bend Bays & Estuaries Program, Regional Coastal Assessment Program – 2002. 63 pp.

Stevens, D.L., Jr. 1997. Variable density grid-based sampling designs for continuous spatial populations. *Environmetrics*, 8, 167-95.

Stevens, D.L., Jr. and Olsen, A.R. 1999. Spatially restricted surveys over time for aquatic resources. *Journal of Agricultural, Biological, and Environmental Statistics,* 4, 415-28.

TCEQ. 1999. Surface Water Quality Procedures Manual. GI-253. Austin, Texas.

USEPA. 1995. Environmental Monitoring and Assessment Program (EMAP): Laboratory Methods Manual-Estuaries, Volume 1: Biological and Physical Analyses. U.S. Environmental Protection Agency, Office of Research and Development, Narragansett, RI. EPA/620/R-95/ 008.

USEPA. 2001. Environmental Monitoring and Assessment Program (EMAP): National Coastal Assessment Quality Assurance Project Plan 2001-2004. USEPA, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002.

USEPA. 2004. National Coastal Condition Report II. EPA/620/R-03/002. Office of Research and Development and Office of Water, Washington D. C. 285 pp.

3.0 WATER MONITORING RESULTS

3.1 Introduction

Coastal regions are extremely productive systems and conversely highly vulnerable to human impacts (Mann 2000). As significant components of coastal watersheds, estuaries are vital natural and economic resources, with coastal economies often dependent on having pristine estuarine conditions. Typically, estuaries serve as nursery grounds for two-thirds of the nation's commercial fish and shellfish and provide recreational activities such as boating, swimming, fishing, windsurfing, and support one of the fastest growing global ecotourism businesses; bird watching. Currently 53% of the nation's population lives along the coastal margin of the contiguous United States. As population expansion continues, increased demands on our natural resources can have deleterious effects on an estuary and directly affect the livelihood of the people living and working in coastal areas (USEPA 2004).

Many factors affect estuarine system health (i.e., reduced freshwater inflow, habitat modification/destruction, climate change) but the fundamental health of an estuarine system depends on the type and quantity of pollutants that may be entering the water column. Some of those substances such as heavy metals, excessive nutrients, and disease causing microorganisms, or pathogens, (viruses, bacteria, and parasites) can adversely affect estuarine systems. Excessive nutrients may result in accelerated eutrophication and produce undesirable effects (Rabalais 1992; Bricker et al. 1999; CENR 2003) and elevated concentrations of priority pollutants in the water column, sediments, and tissues of aquatic animals may affect diverse groups of species either through direct exposure or indirectly through the food chain, and eventually be harmful to humans.

Bricker et al. (1999), in the *National Estuarine Eutrophication Assessment* conducted by NOAA, stated that the ability to predict definitive trends for all estuaries remains hampered by scarce trend data and large gaps in data and information. Recommendations by all groups involved with this assessment called for comprehensive monitoring, interpretation, modeling, and research for maximum effectiveness in assembling an adaptive management framework that would aid in protecting our watershed and estuarine systems (Bricker et al. 1999; CENR 2003). Therefore, sampling and analysis of water quality parameters remains a primary focus of the RCAP program in assessing status and trends within the CBBEP area.

3.2 Sampling Design and Data Evaluation

Water quality sampling for RCAP 2002 took place from August 5th through August 29th 2002 at 50 randomly selected stations throughout the CBBEP region as described in Chapter 2.0. Table 6.1.1 in the *Data Tables* chapter and Fig. 2.2 provide station information and location. A complete list of parameters measured during the RCAP 2002 sampling event is found in Table 2.1.

The *Data Tables* in Chapter 6.0 provide individual concentration values for near-surface and near-bottom Field Parameters measured (Table 6.2.1 and 6.2.2), with summary statistics by TCEQ segments (Table 6.3.1 through 6.3.8). In the case of near-bottom measurements the total number of sites with data is 30, as water depth at 20 sites was too shallow (e.g. surface and bottom depths are equal) to obtain multiple measurements.

For Routine Conventional Water Chemistry, the *Data Tables* in Chapter 6.0 present individual parameter concentrations (Tables 6.4.1 through 6.4.6) according to each sampling method (TCEQ near-surface and EPA multiple depths), with summary statistics by TCEQ segments (Table 6.5.1 through 6.5.6). Individual microbiological concentrations are in Table 6.6.1. While information exists for multiple parameters at additional depths, presently TCEQ and EPA only use surface data for assessment. Additional data provided in the *Data Tables* serves only as a reference.

If a criterion, screening level, or concentration range existed, then data evaluation followed two different approaches; 1) the TCEQ regulatory approach and 2) according to guidelines utilized in the EPA NCCR II (USEPA 2004). Where no criteria or screening level exists, data presentation considers how the parameter compares between segments or applies to water quality within the CBBEP region in general.

3.2.1. TCEQ Criteria and Screening Levels

TCEQ uses many physical, chemical, and biological characteristics in assessing support of designated uses and criteria of a water body, or Segment. Primarily, comparison of individual parameter values to either numerical criteria or screening levels determines the number of values exceeded. Based on number of exceedances, the assessment classifies a segment as either being in full support, partial support, or not supportive of the official designated use. Similar exceedances of numerical screening levels identify segments with no concerns or concerns for impairment. As defined in the *Texas Surface Water Quality Standards* (TSWQS) the identification of *Primary Concerns*" relates directly to criteria adopted in the TSWQS that protect the designated use of a water body. *Secondary Concerns* are parameters for which there are no existing standards adopted but that have elevated concentrations exceeding screening levels.

Results appear in the *Texas Water Quality Inventory and 303(d) List*, as required by Sections 305(*b*) and 303(*d*) of the federal Clean Water Act on a periodic basis. Section 305(*b*) requires states to report the extent to which water bodies attain designated water quality standards while Section 303(*d*) of the act requires states to identify water bodies for which effluent limitations are not stringent enough to implement water quality standards. Therefore, the 303(*d*) list contains Segments with *Primary Concerns* and while water bodies with *Secondary Concerns* appear on the 305(*b*) report, they are not included on the 303(*d*) list. Typically, areas exhibiting *Secondary Concerns* will receive more frequent and possible additional parameter monitoring (TCEQ 2003).

To establish whether *Primary Concerns* exist, and if a segment supports the Aquatic Life Use, TCEQ assesses dissolved oxygen (DO) and toxic substances in water criteria, among others. Contact Recreation Use assessment utilizes the Enterococci criterion as an indicator of concern and support for bacterial pathogens in Tidal Waters. TCEQ uses methodologies for assessing *Secondary Concerns* for nutrients and chlorophyll *a* in water, as no water quality criteria exists on a national or state level. However, EPA, state regulatory agencies, and a multitude of researchers are working to address this situation to better protect and restore the waters of the country (EPA 2003). Individual criteria and screening levels for the various parameters sampled for RCAP 2002 appear in the following applicable sections.

3.2.2. EPA NCCR II Guidelines

Evaluation of RCAP 2002 water quality data used a subset of the EPA NCCR II guidelines for assessing individual sites (Table 3.1). Use of this evaluation approach was to begin to provide continuity between locally collected data and the ongoing NCA program for assessing coastal waters and to see if the broad based EPA regional approach is applicable in all estuarine systems. We evaluated the RCAP region using four of the five parameters comprising the overall EPA Water Quality Index (DO, DIN, DIP, Chlorophyll *a*), as questions of applicability of the fifth parameter, the Water Clarity criteria, still exist for this region.

Table 3.1. EPA NCA guidelines for assessing Dissolved Oxygen, Dissolved Inorganic Nitrogen, Dissolved Inorganic Phosphorus, Chlorophyll *a*, and the modified Water Quality Index by site (USEPA 2004).

Rating		**Dissolved Oxygen (DO)**
Good		DO concentration >5.0 mg/L.
Fair		DO concentration between 2.0 mg/L and 5.0 mg/L.
Poor		DO concentration <2.0 mg/L.
Rating		**Dissolved Inorganic Nitrogen (DIN)**
Good		DIN concentration <0.1 mg/L.
Fair		DIN concentration between 0.1 mg/L and 0.5 mg/L.
Poor		DIN concentration >0.5 mg/L.
Rating		**Dissolved Inorganic Phosphorus (DIP)**
Good		DIP concentration <0.01 mg/L.
Fair		DIP concentration between 0.01 mg/L and 0.05 mg/L.
Poor		DIP concentration >0.05 mg/L.
Rating		**Chlorophyll *a***
Good		Chlorophyll *a* concentration <5.0 µg/L.
Fair		Chlorophyll *a* concentration between 5.0 µg/L and 20 µg/L.
Poor		Chlorophyll *a* concentration >20.0 µg/L.
Rating		**Water Quality Index (WQI)**
Good		A maximum of one indicator is rated fair, and no indicators are poor.
Fair		One of the indicators is rated poor, or two or more indicators are rated fair.
Poor		Two or more of the four indicators are rated poor.

3.3 Results and Discussion

3.3.1. Field Data

A complete list of instantaneous core field parameters, along with summary statistics, appears in Chapter 6-*Data Tables* 6.2.1 and 6.2.2 and 6.3.1 through 6.3.8, respectively. For many parameters no established state or federal criteria exists. They however serve as initial descriptors of a water body, or segment, and aid as indicators when making determinations of whether unusual or stressful conditions exist. As standard protocol in most monitoring programs, collection of multi-year datasets may allow for future status and trends analysis and be useful in ascertaining changing conditions within the CBBEP region.

3.3.1.1. Precipitation and Gauged Inflows

Precipitation, as recorded at Corpus Christi International Airport (CRP), totaled 25.70 cm yr from January 1st through August 31st 2002 (NOAA 2002). The most significant event occurred in July 2002 prior to RCAP 2002 sampling in August. While CRP recorded only 8.9 cm yr of rainfall, widespread flooding resulted from a slow moving tropical wave that produced enough rainfall in the upper Nueces River watershed to raise combined system reservoir levels from 46.2% to 100% in the first eleven days of July. This resulted in the pass-through of approximately 1,060,159 ac-ft of water from Lake Corpus Christi to the Nueces River (Fig. 3.1). Subsequent downstream flooding of the Nueces River resulted in total submergence of the Nueces Delta and directly affected the receiving waters of the Nueces estuary. While not as dramatic, increased inflows also occurred in the Mission and Aransas River watersheds, resulting in lowered salinities within portions of the Mission-Aransas estuary.

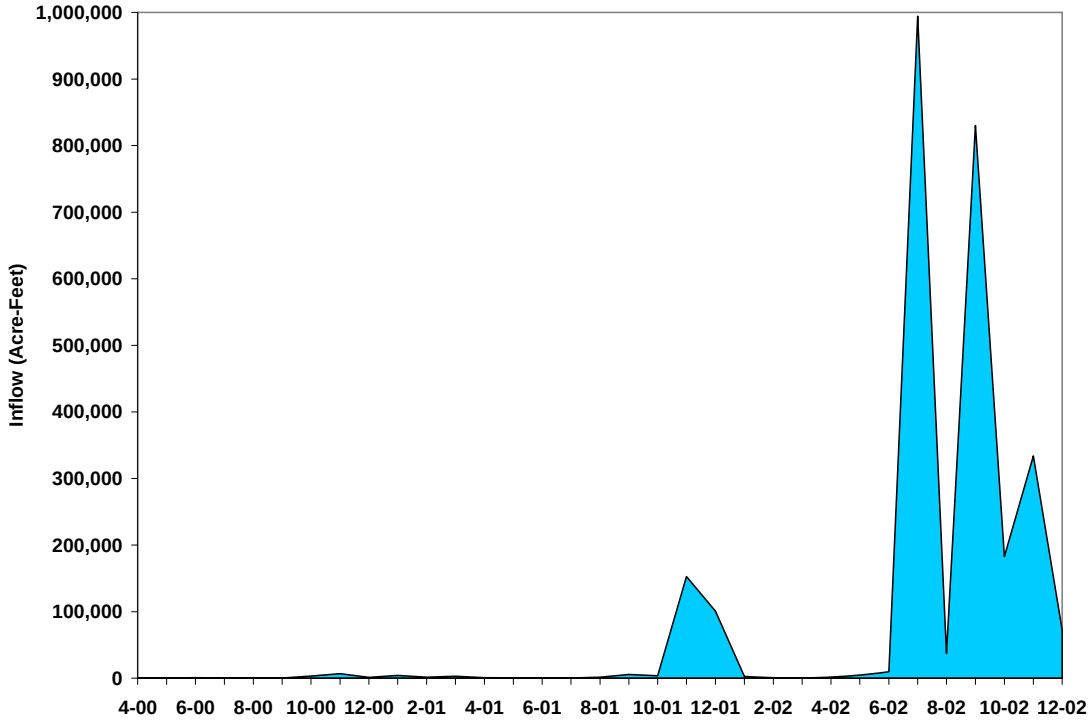


Fig. 3.1. Total monthly inflow (acre-feet) on the Nueces River recorded at the Saltwater Diversion Dam in Calallen, Texas (USGS Gauge No. 08211500).

3.3.1.2. Total Depth

Total Depth ranged from 0.30 m in the Upper Laguna Madre (Segment 2491) to 4.78 m in Corpus Christi Bay (Segment 2481). Mean Total Depth was greatest in Corpus Christi Bay at 3.35 m and shallowest in Oso Bay (Segment 2485) at 0.67 m (Table 6.2.1). Mean Total Depth in all other Segments ranged from 1.18 m to 1.83 m except Redfish Bay (Segment 2483 - only one station sampled) which had a Total Depth of 2.77 m. (Table 6.3.8). Water depths were representative of all water bodies sampled but mean Total Depth of stations sampled in Corpus Christi Bay was lower in RCAP 2002 than RCAP 2000 because no stations fell within the Corpus Christi Ship Channel (Nicolau and Nuñez 2004).

3.3.1.3. Water Temperature

Collection of water temperature data relates to how this parameter may affect other water quality indicators, such as dissolved oxygen. For all 50 RCAP 2002 sampling sites water temperature ranged from 28.19°C to 32.23°C (Tables 6.2.1 and 6.2.2). Comparison of all sites ($n = 30$) where multiple-depth sampling occurred showed no significant differences ($p = 0.62$) between surface and bottom water temperatures. Within Segments, mean surface water temperature ranged from 29.54°C in Redfish Bay (Segment 2483) to 31.05°C in Aransas Bay (Segment 2471), respectively (Table 6.3.7). Mean bottom water temperature ranged from 29.51°C in Nueces Bay (Segment 2482) to 30.94°C in Aransas Bay (Table 6.3.7). Mean difference between surface and bottom measurements was <0.2°C during RCAP 2002. Recorded temperatures were consistent with those seen during RCAP 2000 and RCAP 2001 summer sampling events (Nicolau and Nuñez 2004) and are typical of the summer months; with the local fauna well adapted to the conditions observed.

3.3.1.4. pH

Typically many sampling programs discount pH as an important indicator of water quality, and of the possible stressful conditions that changes in pH can exert within estuarine environments. As pH scales are logarithmic, significant stress may result from small changes in pH values. Extremely low or high pH values are often indicative of possible pollutants to the water body (Van Dolah et al. 2004). Typically, the pH of estuarine and coastal waters ranges from 7.5 to 8.5 with occasional deviations above 9.0 or below 7.0.

pH values for RCAP 2002 ranged from 7.86 at Site 253 in Mesquite Bay (Segment 2463) to a high of 8.93 at Site 294 located in the Nine-Mile Hole area of the Upper Laguna Madre (Tables 6.2.1 and 6.2.2). Significant statistical differences ($p = 0.04$) existed between surface and bottom pH at sites ($n = 30$) where multiple-depth sampling occurred. Mean surface pH ranged from 8.17 in Aransas Bay (Segment 2471) to 8.51 in Oso Bay (Segment 2485) (Table 6.3.5). Mean bottom pH ranged from 8.11 in Corpus Christi Bay (Segment 2481) to 8.51 in Oso Bay (Table 6.3.5). The mean difference between surface and bottom pH was <0.2°C, with many segments exhibiting no mean difference between depths. Mean surface pH values tended to be higher than values recorded in RCAP 2000 or 2001 summer sampling events.

3.3.1.5. Secchi Depth

While TCEQ does not use secchi depth data as a visual way to measure eutrophication in estuarine systems, it still provides a historically used visual method to ascertain some relative measure of water clarity. Bay systems, or water body segments, within the CBBEP region are

typically turbid and Secchi Depth measurements for RCAP 2002 tended to validate readings recorded in earlier RCAP sampling events.

Secchi Depth ranged between 0.20 m in Hynes Bay (Segment 2462) to 2.0 m in the Copano/Port/Mission Bay complex (Segment 2472) (Table 6.2.1). Mean Secchi Depth for all segments averaged <1.00 m with Hynes Bay, Mesquite Bay, Baffin Bay Complex (Segment 2492), and Nueces Bay being the most turbid; mean Secchi Depth readings typically <0.50 m (Table 6.3.8). As seen in earlier RCAP events many readings (90.0%) in the shallower waters of the Upper Laguna Madre were listed as > then the depth at station and reflected the secchi disk sitting on the bottom; signifying that water clarity may be considerably better than the low Secchi Depth numbers alone reveal.

3.3.1.6. Turbidity

Turbidity also serves as a measurement of water clarity, as turbidity provides a measure of the amount of suspended particles from natural erosion, organic decay, and algae in the water. While no criteria or screening levels exist in Texas, increasingly sophisticated and accurate probes are becoming more common on hand-held multiparameter water quality probes (e.g., YSI Sondes) for the determination of turbidity, thereby removing the visual subjectivity of the person recording Secchi Depth. The addition of reliable data may aid TCEQ in the establishment of applicable screening levels for the naturally turbid bay systems of Texas.

Turbidity values during RCAP 2002 ranged from 1.80 NTU in the Upper Laguna Madre (Segment 2491) to 70.70 NTU in Hynes Bay (Segment 2462) (Table 6.2.1). Comparison of all sites (n = 30) where multiple-depth sampling occurred showed statistically significant differences (p = <0.02) between surface and bottom turbidities. Mean surface turbidity ranged from 7.58 NTU in the Upper Laguna Madre to 64.75 NTU in Hynes Bay while mean bottom turbidity ranged from 7.57 in the Upper Laguna Madre to 64.60 NTU in Hynes Bay (Table 6.3.6). The mean difference between surface and bottom turbidity was greatest in Corpus Christi Bay at 12.01 NTU (Tables 6.2.1 and 6.2.2 and 6.3.6).

3.3.1.7. Salinity

Nicolau and Nuñez (2004) stated aspects of the CBBEP regional salinity regime in earlier RCAP reports. In summary, salinity concentrations typically are quite high due to natural conditions, reduced freshwater inflows, and the hypersaline Upper Laguna Madre. Often used as a measure of habitat stress, due to the influence of salinity on species distribution and diversity, careful interpretation of salinity values is often necessary. Many species in the region are clearly adapted to stressful conditions of hypersaline waters; adjusting to wide salinity fluctuations that occur when significant amounts of freshwater flows into the system.

RCAP 2002 sampling recorded the impact of significant amounts of freshwater inflow to the system. Substantial inflow amounts recorded in July 2002 (see section 3.2.1.1 and Fig. 1), one month prior to sampling, resulted in dramatic changes in salinity regimes throughout most of the region. The greatest reduction (-84.8%) observed in mean salinity concentrations occurred in Nueces Bay, followed by St. Charles Bay (Segment 2473) and the Copano/Port/Mission Bay complex (Segment 2472) (Table 3.2). Mean concentration actually increased in the Upper Laguna Madre, once again demonstrating the variability in regional freshwater inflows, with location being as important as volume.

Table 3.2. Mean surface salinity concentrations recorded for the same Segments during RCAP 2000 and RCAP 2001 summer sampling events versus summer RCAP 2002, with changes in PSU and percent reduction in mean concentrations observed.

Segment	Segment Name	2000/2001* Mean PSU	2002 Mean PSU	PSU Change	% Change
2471	Aransas Bay	37.40	18.82	-18.58	-49.7%
2472	Copano Bay/Port Bay/Mission Bay	29.30	10.83	-18.47	-63.0%
2473	St. Charles Bay	37.28	12.11	-25.17	-67.5%
2481	Corpus Christi Bay	39.51	21.15	-18.36	-46.5%
2482	Nueces Bay	37.96	5.76	-32.20	-84.8%
2483	Redfish Bay	37.43	24.57	-12.86	-34.4%
2485	Oso Bay	37.67	30.60	-7.07	-18.8%
2491	Laguna Madre (Upper)	42.30	46.78	4.48	10.6%
2492	Baffin Bay/Alazan Bay/ Cayo del Grullo/Laguna Salada	53.61	48.67	-4.94	-9.2%

*Segments 2471 through 2485 sampled Summer 2000 and Segments 2491 and 2492 sampled summer 2001

Salinity values for RCAP 2002 ranged from 0.36 PSU at Site 245 in Hynes Bay to 55.10 PSU at Site 294 located in the Nine-Mile Hole area of the Laguna Madre (Figs. 3.2 and 3.3; Tables 6.2.1 and 6.2.2). Comparison of all sites (n = 30) where multiple-depth sampling occurred showed no significant differences ($p = 0.58$) between surface and bottom salinities. Mean surface salinity within Segments ranged from 0.55 PSU in Hynes Bay to 48.67 PSU in the Baffin Bay complex (Table 6.3.2). Mean bottom salinity ranged from 0.55 PSU in Hynes Bay to 48.68 PSU in the Baffin Bay complex (Table 6.3.2). The mean difference between surface and bottom salinity was <1.00 PSU for most Segments, except Corpus Christi Bay where the mean difference was 4.93 PSU (Tables 6.2.1 and 6.2.2 and 6.3.2).

Data evaluation of readings taken in Corpus Christi Bay, along with CCS field crew observations, confirmed that the volume of freshwater inflow created a substantial stratification in the water column. Typically, surface values ranged from 2.42 PSU to 11.29 PSU less than bottom values, with increases in salinity beginning at mid-depth in the water column. Mean differences would have been substantially higher except that several sites occurred in shallow waters of Corpus Christi Bay where full mixing of the water column occurred. Statistical differences existed ($p = <0.01$) between surface and bottom salinities for Corpus Christi Bay sites sampled.

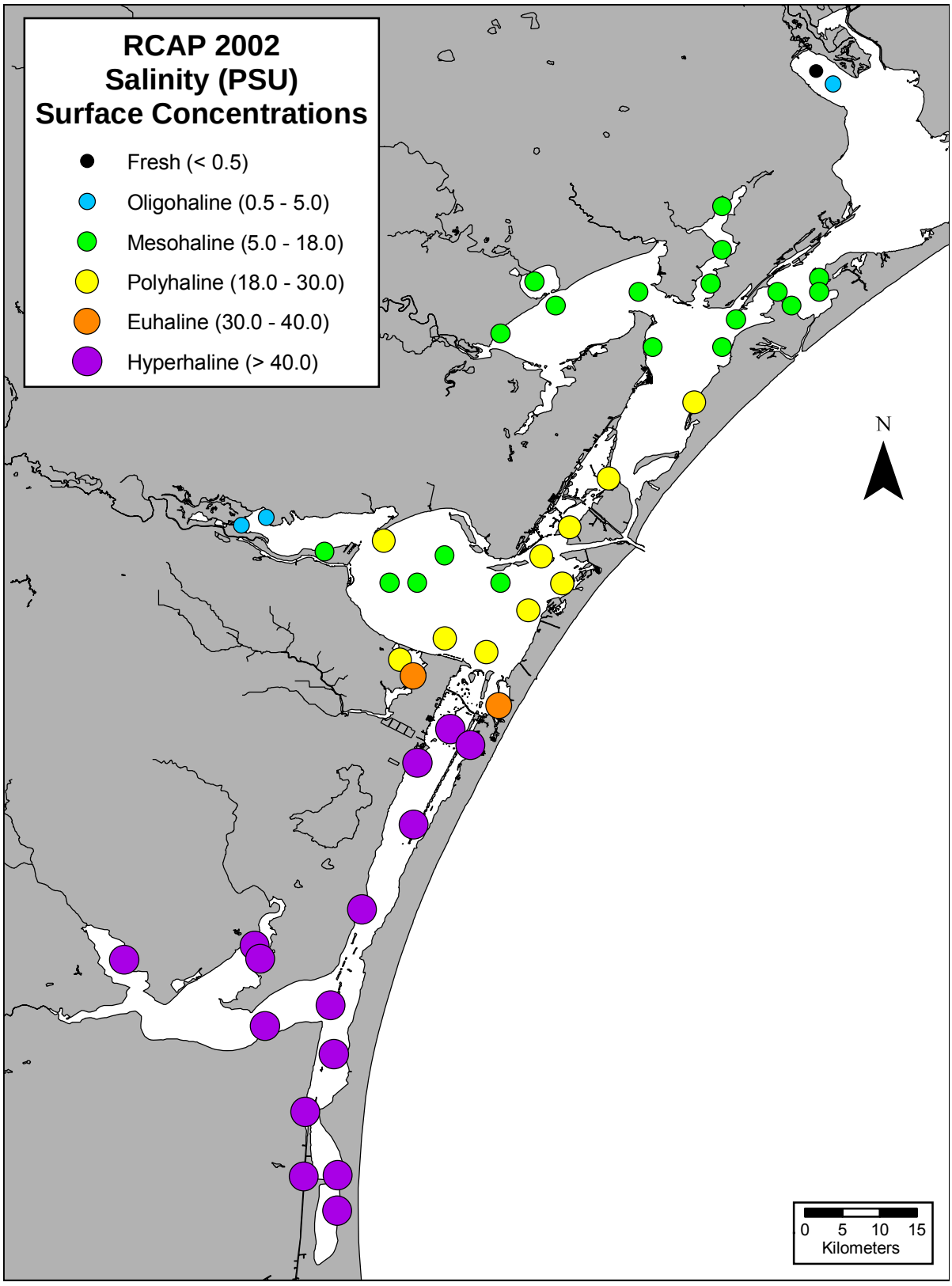


Fig. 3.2. Surface salinity concentrations (PSU) at RCAP 2002 sampling sites.

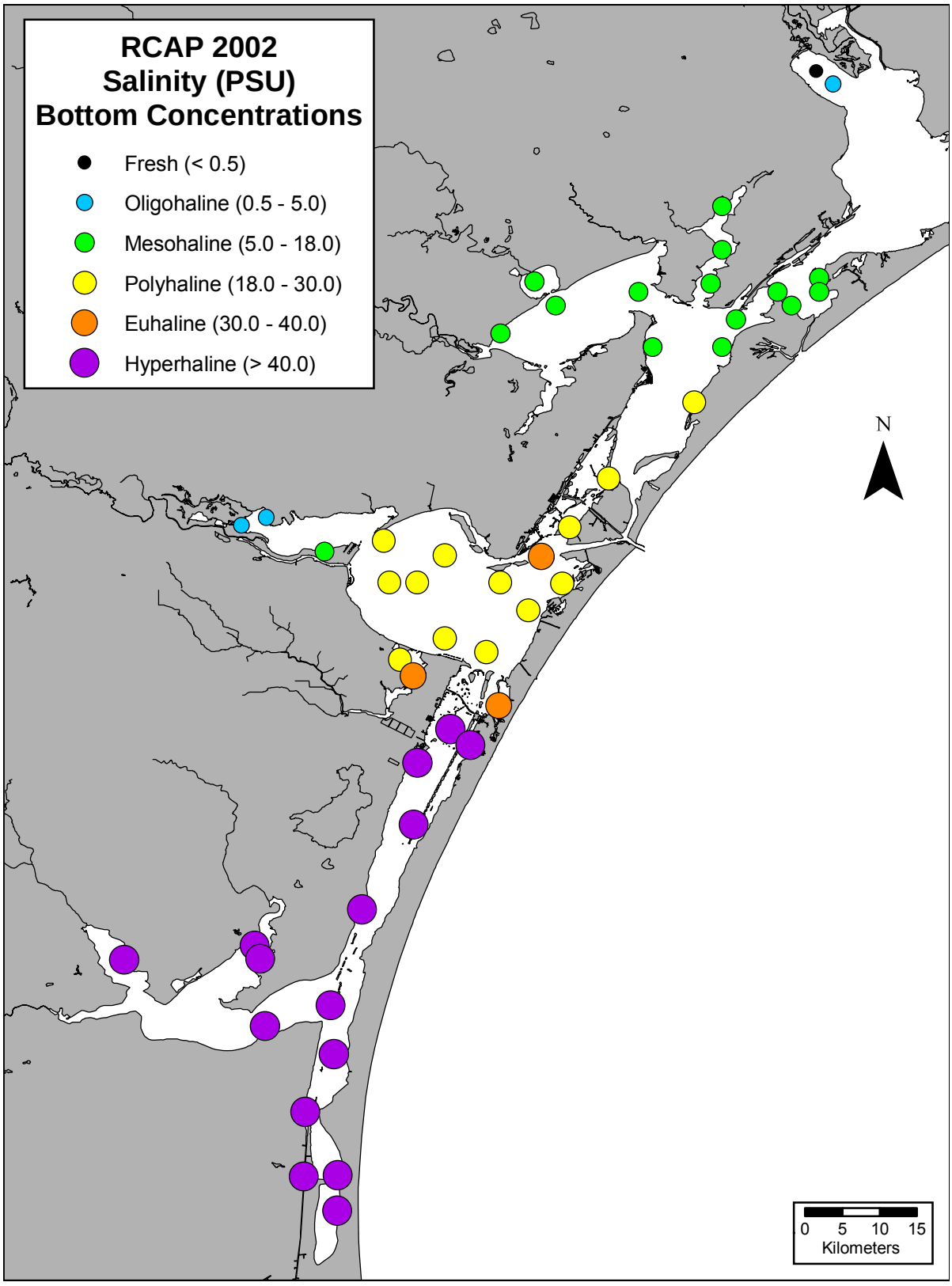


Fig. 3.3. Bottom salinity concentrations (PSU) at RCAP 2002 sampling sites.

3.3.1.8. Dissolved Oxygen

Based on RCAP 2002 sites sampled, surface Dissolved Oxygen (DO) quality evaluated as very good throughout the CBBEP region. DO represents the primary water quality parameter TCEQ utilizes in assessing aquatic life use and health of a water body, and TCEQ classifies tidally-influenced segments with an Aquatic Life Use (ALU) based on physical, chemical, and biological characteristics. Segment classifications are *exceptional, high,* or *intermediate use,* with criteria based on meeting 24-hour surface (0.30 m below) average concentrations of 5.0, 4.0, and 3.0 mg/L, respectively. In addition, absolute minimum criteria to protect the range of ALUs in tidal waters are 1.0 mg/L less for all categories (TCEQ 2003). All segments monitored for RCAP 2002 carry a 24-hour surface DO criterion of 5.0 mg/L for *exceptional* habitat, except the Baffin Bay complex; classified as *high* habitat with a 4.0 mg/L criterion.

However, one fundamental drawback exists; while TCEQ routinely measures DO (grab sample) throughout the water column on a quarterly basis, assessments are made only on 24-hour surface DO measurements, which in many cases may incorrectly interpret actual DO conditions and resultant aquatic health. Persistent low DO throughout the water column can affect numerous estuarine aquatic species and have varying detrimental effects (USEPA 2001). Most regulatory monitoring programs typically discount the effect of low DO concentrations over the bottom sediments and the subsequent consequence to benthic community health. While mobile organisms can evade low oxygen conditions, immobile benthic organisms tend to die. Extreme die-offs can result in dramatic alterations to the entire aquatic community through changes in species richness, density, and diversity. Depletion of bottom water DO may also change chemical cycling in bottom waters and/or sediments and potentially lead to conditions harmful to a wide host of aquatic organisms.

RCAP 2002 instantaneous grab sampling (throughout the water column) took place during the most critical part of the summer index period, when expected DO levels routinely are low, and does not warrant using the 24-hour criterion to evaluate segment conditions. However, DO sampling to meet compliance routinely targets segments where low instantaneous DO concentrations indicate partial or nonsupport of the designated ALU. In this case, continued RCAP DO data serves as a valuable tool for the CBBEP and TCEQ to assess if conditions perhaps warrant further monitoring due to restrictive conditions at surface and bottom depths.

During RCAP 2002, no recorded instances of surface hypoxia (<2.0 mg/L) occurred at all sites sampled (Fig. 3.4; Tables 6.2.1 and 6.3.3). While a small amount (5 sites) of surface DO concentrations fell in the "biologically stressful" range of >2.0 mg/L but <5.0 mg/L, these were stations sampled in the early morning and concentrations tended to be >4.5 mg/L at those stations. Regarding segment criterion, 3 sites, or 6.0%, of the sites sampled failed to meet their respective criteria (Site 253 in Mesquite Bay and Sites 280 and 290 in the Upper Laguna Madre).

However, when evaluating bottom DO concentrations for RCAP 2002 one instance of hypoxia (1.54 mg/L) occurred at Site 270 in Corpus Christi Bay (Fig. 3.5; Tables 6.2.2 and 6.3.3). In addition, five other sites in Corpus Christi Bay fell in the range of >2.0 mg/L but <5.0 mg/L with DO concentrations ranging from 2.41 mg/L to 4.41 mg/L (Fig 3.5; Table 6.2.2). If criteria applied, this represents 54.5 % of the stations sampled in the segment would not meet the DO standard. Low DO concentrations likely resulted from salinity stratification

in the water column observed throughout Corpus Christi Bay, as DO concentrations fell dramatically at the mid-depth point that salinity levels began to increase.

DO surface concentrations for RCAP 2002 ranged from 2.96 mg/L at Site 253 in Mesquite Bay to 11.82 mg/L at Site 283 located in the Upper Laguna Madre (Figs. 3.4; Tables 6.2.2 and 6.3.3). Comparison of all sites (n = 30) where multiple-depth sampling occurred showed significant differences (p = <0.01) between surface and bottom DO concentrations.

Mean surface DO ranged from 5.14 mg/L in Mesquite Bay to 8.94 mg/L in Oso Bay (Table 6.3.3). Mean bottom salinity ranged from 4.47 mg/L in Corpus Christi Bay to 8.94 mg/L in Oso Bay (Table 6.3.3). Typically, the mean difference between surface and bottom DO concentrations was <0.50 mg/L for most Segments, except Corpus Christi Bay where the mean difference was 2.32 mg/L (Tables 6.2.1 and 6.2.2 and 6.3.3). Bottom DO values in Corpus Christi Bay ranged from 0.03 to 6.24 mg/L less than surface values, with decreases in DO beginning at mid-depth in the water column. Mean differences would have been substantially greater except that several sites occurred in shallow waters of Corpus Christi Bay where full mixing of the water column occurred and DO levels were higher.

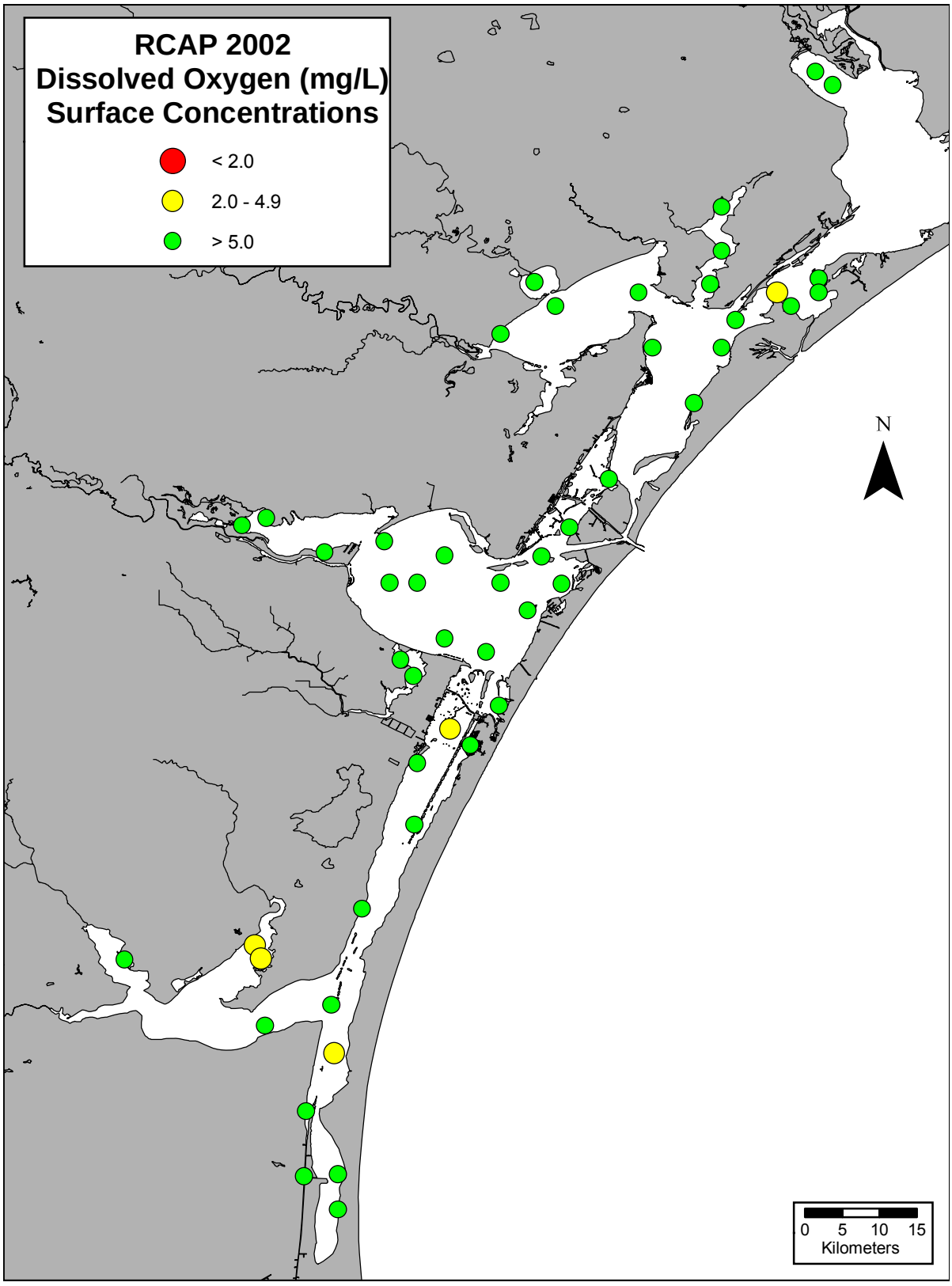


Fig. 3.4. Surface dissolved oxygen concentrations (mg/L) at RCAP 2002 sampling sites.

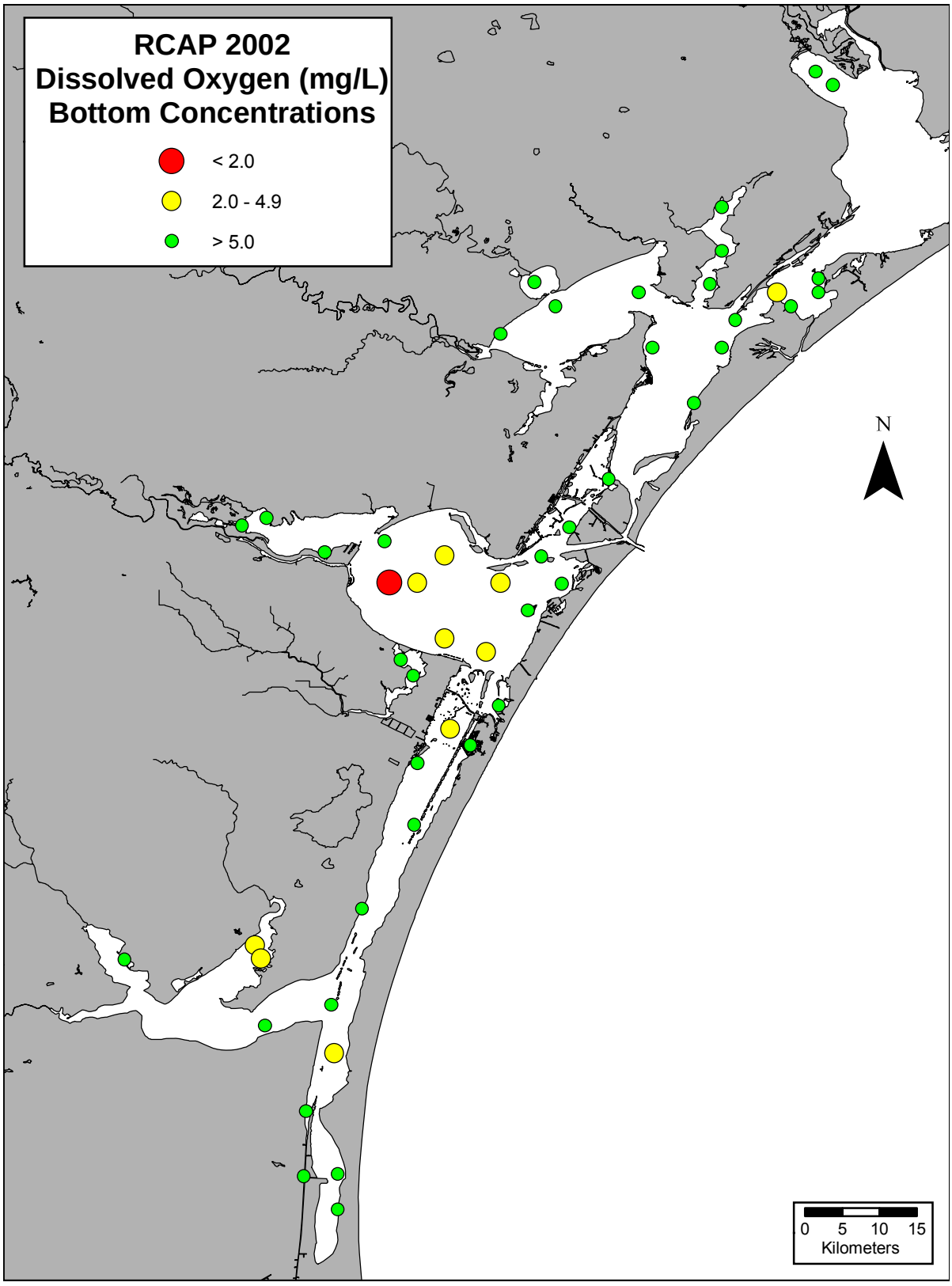


Fig. 3.5. Bottom dissolved oxygen concentrations (mg/L) at RCAP 2002 sampling sites.

3.3.2. TCEQ Routine Conventional Water Chemistry

The presence of excessive nutrient concentrations is a major concern in some estuarine waters. Persistent high nutrient levels may result in eutrophication and produce undesirable effects, such as increased incidents of algal blooms, which may produce low dissolved oxygen levels and harmful biotic conditions (Bricker et al. 1999; CENR 2003). In the absence of established criteria, TCEQ utilizes screening levels for nutrients (ammonia, nitrate + nitrite, orthophosphate, total phosphorus), and chlorophyll *a*. These screening levels aid in identifying aquatic life use concerns within a segment based on percent exceedance derived from long-term SWQM data. Screening Level Estuary 2002 (SLE 2002) concentrations apply to all sites sampled in RCAP 2002.

3.3.2.1. Nitrogen

A primary limiting nutrient in estuarine systems, nitrogen levels control rates of primary production, with high input levels often producing significant increases in phytoplankton and macrophyte production. Some limits suggested for avoiding algal blooms and for maintaining designated aquatic life uses in estuaries range between 0.1 mg/L for maximum diversity, to 1.00 mg/L for moderate diversity (NOAA/EPA 1988; AWWA 1990; Rabalais 1992; Bricker et al. 1999).

Applying the applicable TCEQ screening level for ammonia of 0.10 mg/L, showed relatively low near-surface ammonia concentrations recorded during RCAP 2002. Concentrations at all 50 sites ranged from <0.001 mg/L to 0.473 mg/L; with a mean of 0.021 mg/L (Fig. 3.6; Tables 6.4.1 and 6.5.1). Table 3.3 indicates the number of sampling site exceedances during RCAP 2002 and shows only one exceedance for ammonia in the Baffin Bay complex (Segment 2492). The only high concentration for RCAP 2002 occurred at Site 289 and resulted in mean ammonia concentrations exceeding the screening level for the segment. Mean concentrations in other segments sampled were typically <0.01 mg/L (Table 6.5.1).

Nitrate + Nitrite evaluations in the first RCAP (2000 and 2001) report were difficult to conduct due to conflicting laboratory results (Nicolau and Nuñez 2004) for RCAP 2000 data. Multiple questions arose to the usefulness and validity of the laboratory data, as many results were simply reported as <0.25 mg/L. While below the SLE 2002 limit of 0.26 mg/L, which satisfied assessment from a regulatory perspective, it failed to provide actual values, which would have been more practical in understanding concentration gradients within the CBBEP region. In addition to this shortcoming, it was felt that most of the extremely elevated concentrations reported might not be valid for various described reasons (Nicolau and Nuñez 2004). No such difficulties existed in RCAP 2001 as all values were <0.05 mg/L and similar to TCEQ historical data.

Applying TCEQ screening levels for nitrate + nitrite data evaluation proved more successful for RCAP 2002. Individual surface concentrations at all 50 sites ranged from <0.001 mg/L to a high of 0.202 mg/L at Site 245 in Hynes Bay (Segment 2462); with a mean of 0.007 mg/L and no recorded exceedances (Fig.3.7; Table 3.3; Tables 6.4.4 and 6.5.4). Mean concentrations of nitrate + nitrite were highest in Hynes Bay, which may relate to inflows received from the San Antonio and Guadalupe Rivers. All other segments reported mean nitrate + nitrite concentrations of <0.01 mg/L (Table 6.5.4).

Table 3.3. Total number of sampling sites (n) and the number of applicable TCEQ screening level exceedances seen for nutrients and chlorophyll *a* within each TCEQ Segment sampled for RCAP 2002.

Segment Number	Segment Name	n	Ammonia	Nitrate + Nitrite	Ortho P	Total P	Ch *a*
2462	San Antonio/Hynes/Guadalupe Bay	2	-	-	-	-	2
2463	Mesquite/Carlos/Ayers Bay	4	-	-	-	-	-
2471	Aransas Bay	5	-	-	-	-	-
2472	Copano/Port/Mission Bays	4	-	-	-	-	-
2473	St. Charles Bay	3	-	-	-	-	1
2481	Corpus Christi Bay	11	-	-	-	-	5
2482	Nueces Bay	3	-	-	-	1	2
2483	Redfish Bay	1	-	-	-	-	-
2485	Oso Bay	2	-	-	-	-	1
2491	Laguna Madre	10	-	-	-	-	2
2492	Baffin Bay/Alazan Bay/ Cayo del Grullo/Laguna Salada	5	1	-	-	-	1

3.3.2.2. Phosphorus

Total phosphorous measures the various forms of phosphorus (particulate and dissolved) found in water. Particulate phosphorus is bound to mineral and organic sediment while dissolved phosphorus exists in the water solution. Particulate phosphorus availability to plants and algae varies from 10% to 90% of total phosphorus inputs where as the dissolved portion is 100% bioavailable. Combined, the bioavailable portion of particulate and dissolved phosphorus represents the phosphorus that promotes surface water eutrophication (NRCS 1994). Recommended levels of phosphorus to avoid algal blooms are 0.01 mg/L to 0.10 mg/L or a 10:1 N:P ratio (NOAA 1998; Bricker et al. 1999).

Total Phosphorus (TP) surface concentrations ranged from 0.002 mg/L to 0.246 mg/L, with an overall mean of 0.058 mg/L. Mean concentrations for all segments were <0.070 mg/L, except in Nueces Bay (Segment 2482), which had a mean value of 0.185 mg/L (Fig. 3.8; Tables 6.4.5 and 6.5.5). TP exceeded the established TCEQ screening level of 0.22 mg/L in Nueces Bay at one location (Table 3.3). No other segments recorded exceedances. While higher TP concentrations may be a direct result of increased inflows received into the system the month prior to sampling, past sampling during RCAP 2000 (a dry period) also showed higher concentrations of TP in Nueces Bay; producing a 41.6% exceedance of the screening level over four quarters of sampling.

For RCAP 2002 sampling, 90% of sites sampled recorded values that were <0.10 mg/L. The 10% of sites above 0.10 mg/L were located in Nueces Bay (all 3 sites) and Corpus Christi Bay (2 sites). Mean TP concentrations for all sites averaged were generally lower during RCAP 2002 than during the summer sampling event for RCAP 2000.

Ortho-Phosphate (OP), or dissolved phosphate, concentrations ranged from <0.001 mg/L to 0.137 mg/L, with an overall mean of 0.031 mg/L. Mean concentrations for all segments were typically <0.054 mg/L, except in Nueces Bay (Segment 2482), which had a mean value of 0.103 mg/L (Fig. 3.9; Tables 6.4.5 and 6.5.5). OP did not exceed the established TCEQ screening level of 0.16 mg/L at any station sampled (Table 3.3).

3.3.2.3. Chlorophyll *a*

Chlorophyll *a* concentrations serve as an indicator of phytoplankton biomass in estuarine waters and are a commonly used measure of water quality within many monitoring programs. Due to the rapid response of phytoplankton to increases in nutrient levels, high chlorophyll *a* concentrations may be indicative of poor water quality. However, short-term elevated levels do not necessarily indicate poor water quality as much as the persistence of elevated levels over the long-term. Long-term elevated levels of chlorophyll *a* may reflect increased nutrients, with increasing trends being a strong indicator of eutrophication (Bricker et al. 1999; CENR 2003).

Elevated chlorophyll *a* concentrations may indicate concerns based on RCAP 2002 data analysis. When compared to the 11.50 µg/L TCEQ screening level, individual concentrations produced percent exceedances ranging from 20% to 100% in seven of eleven segments sampled (Table 3.3). Chlorophyll *a* concentrations ranged from <0.22 µg/L to 45.42 µg/L; with an overall mean concentration for all 50 sites of 9.24 µg/L (Fig. 3.10; Tables 6.4.6 and 6.5.6). The high value recorded at Site 245 in Hynes Bay (Segment 2462) exceeded the screening level by fourfold and produced a mean segment concentration of 32.04 µg/L. Screening level exceedances of mean segment concentrations also occurred in Nueces Bay (Segment 2482) and Oso Bay (Segment 2485) (Table 6.5.6).

However, elevated chlorophyll *a* concentrations may be short-term and may correspond with possible increased nutrient inputs from the extreme flooding event recorded one month prior to sampling. During all RCAP 2000 sampling events, elevated chlorophyll *a* concentrations occurred in known areas of historical concern; the Corpus Christi Inner Harbor (Segment 2484), which was not sampled during RCAP 2002, and Oso Bay (Segment 2485). Concentrations were generally <6.0 µg/L at all other sites sampled. During RCAP 2001, the majority of elevated concentrations occurred primarily in the Baffin Bay complex (Segment 2492) during the Summer and Fall 2001 sampling events, with the Fall 2001 event coinciding with increased inflows to the system (Nicolau and Nuñez 2004).

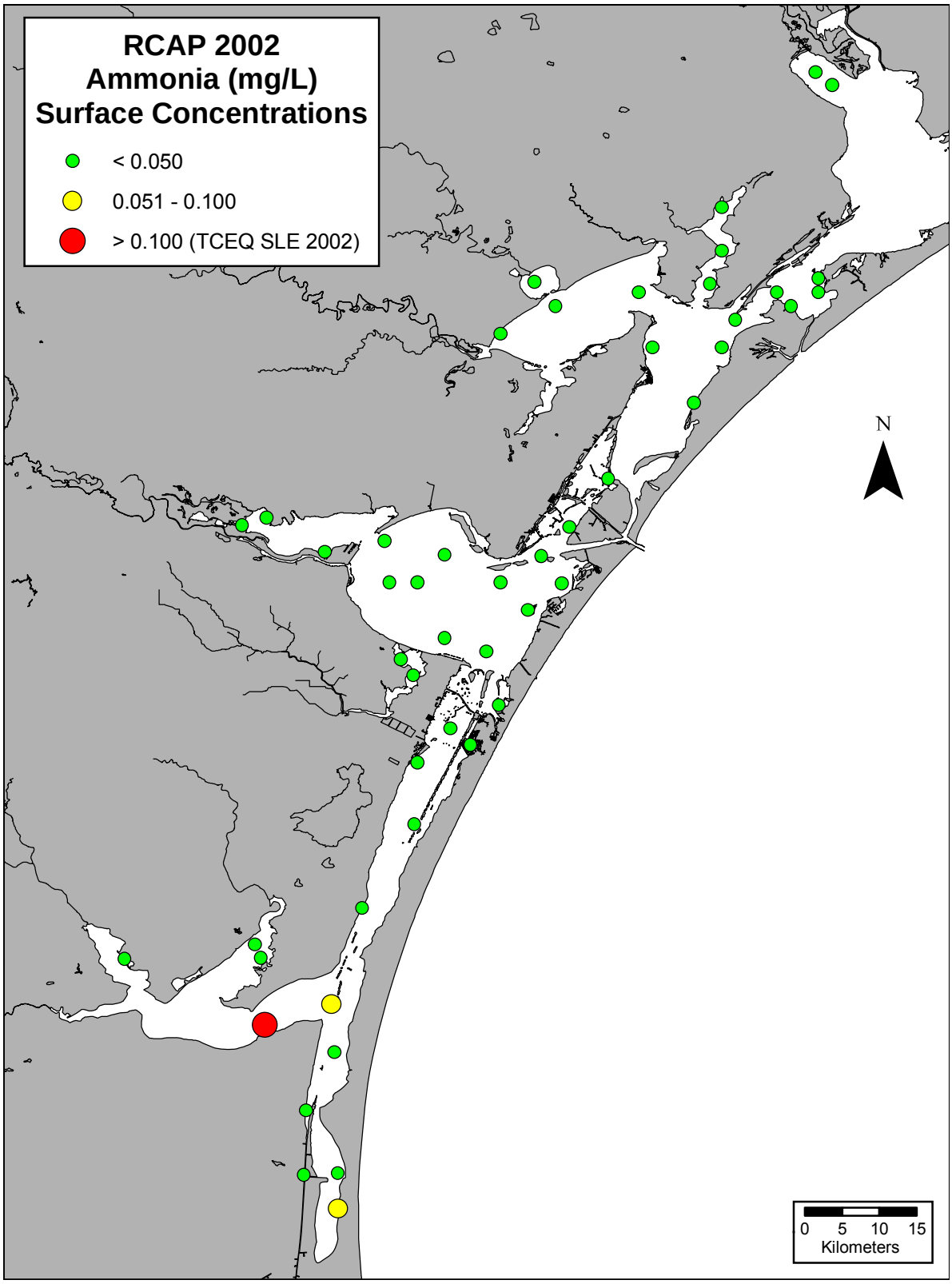


Fig. 3.6. Ammonia surface concentrations (mg/L) at RCAP 2002 sampling sites as evaluated according to TCEQ Screening Level Estuary 2002 (SLE 2002) guidelines.

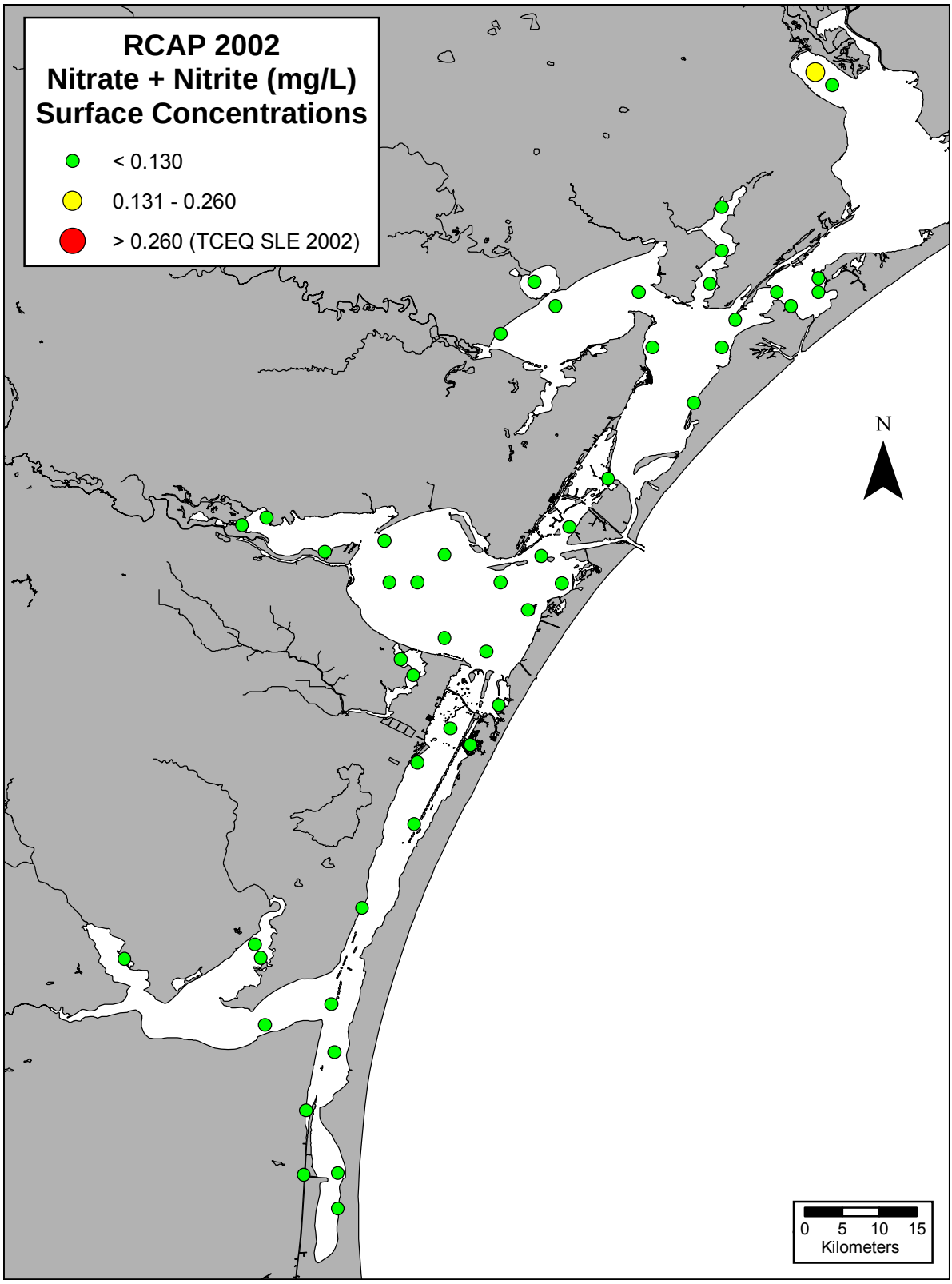


Fig. 3.7. Nitrate + Nitrite surface concentrations (mg/L) at RCAP 2002 sampling sites evaluated according to TCEQ Screening Level Estuary 2002 (SLE 2002) guidelines.

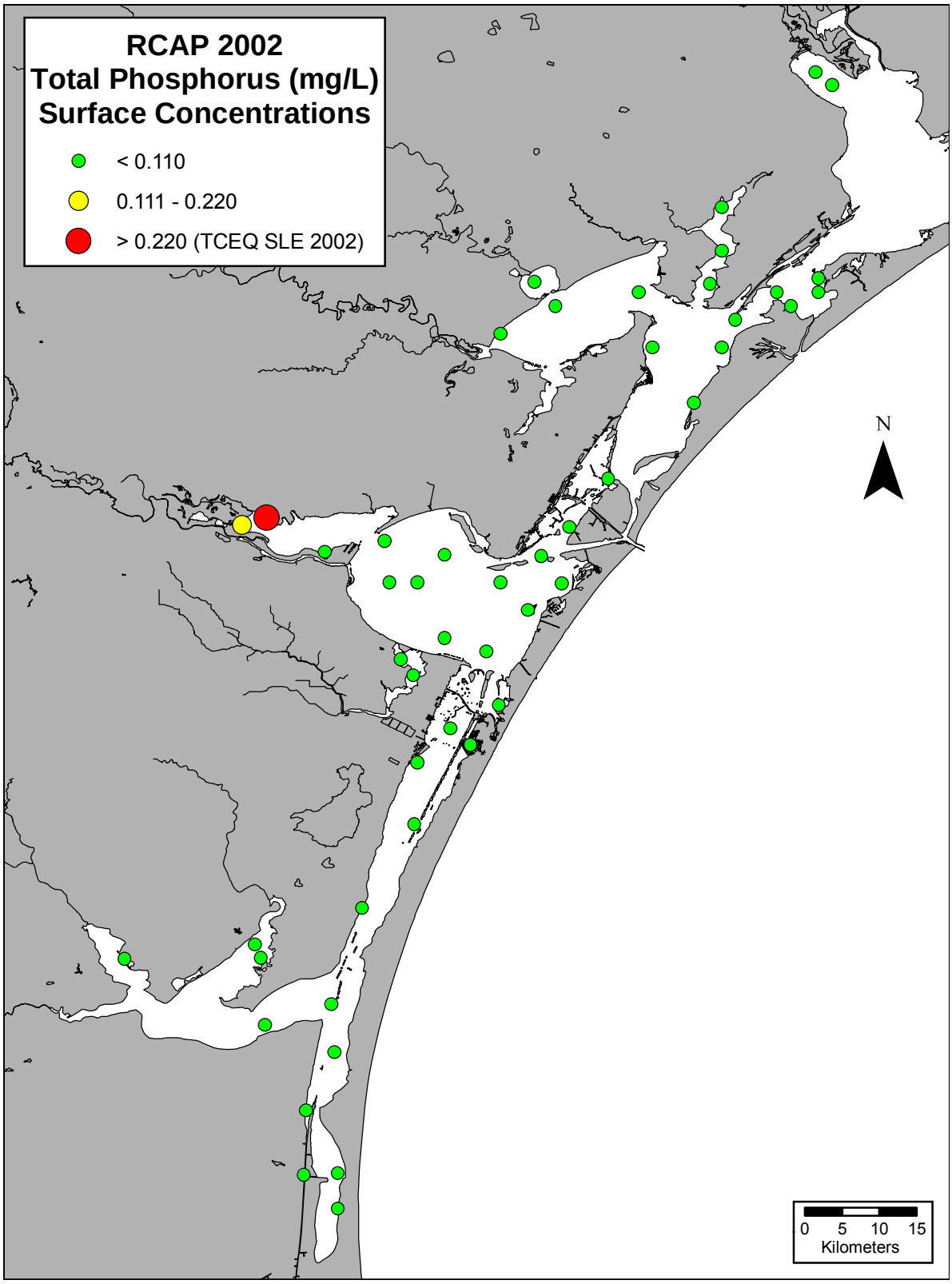


Fig. 3.8. Total Phosphorus surface concentrations (mg/L) at RCAP 2002 sampling sites evaluated according to TCEQ Screening Level Estuary 2002 (SLE 2002) guidelines.

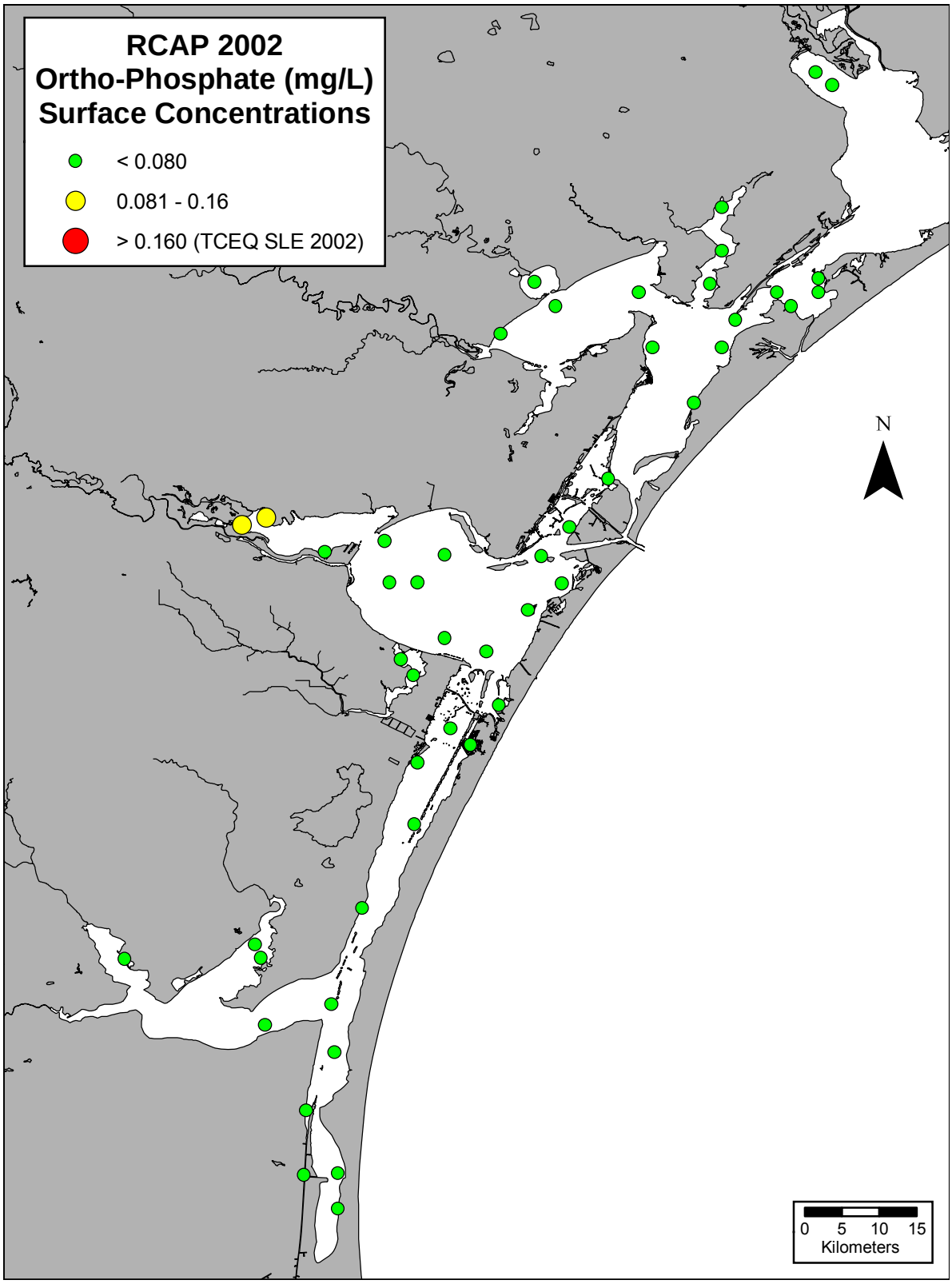


Fig. 3.9. Orthophosphate surface concentrations (mg/L) at RCAP 2002 sampling sites evaluated according to TCEQ Screening Level Estuary 2002 (SLE 2002) guidelines.

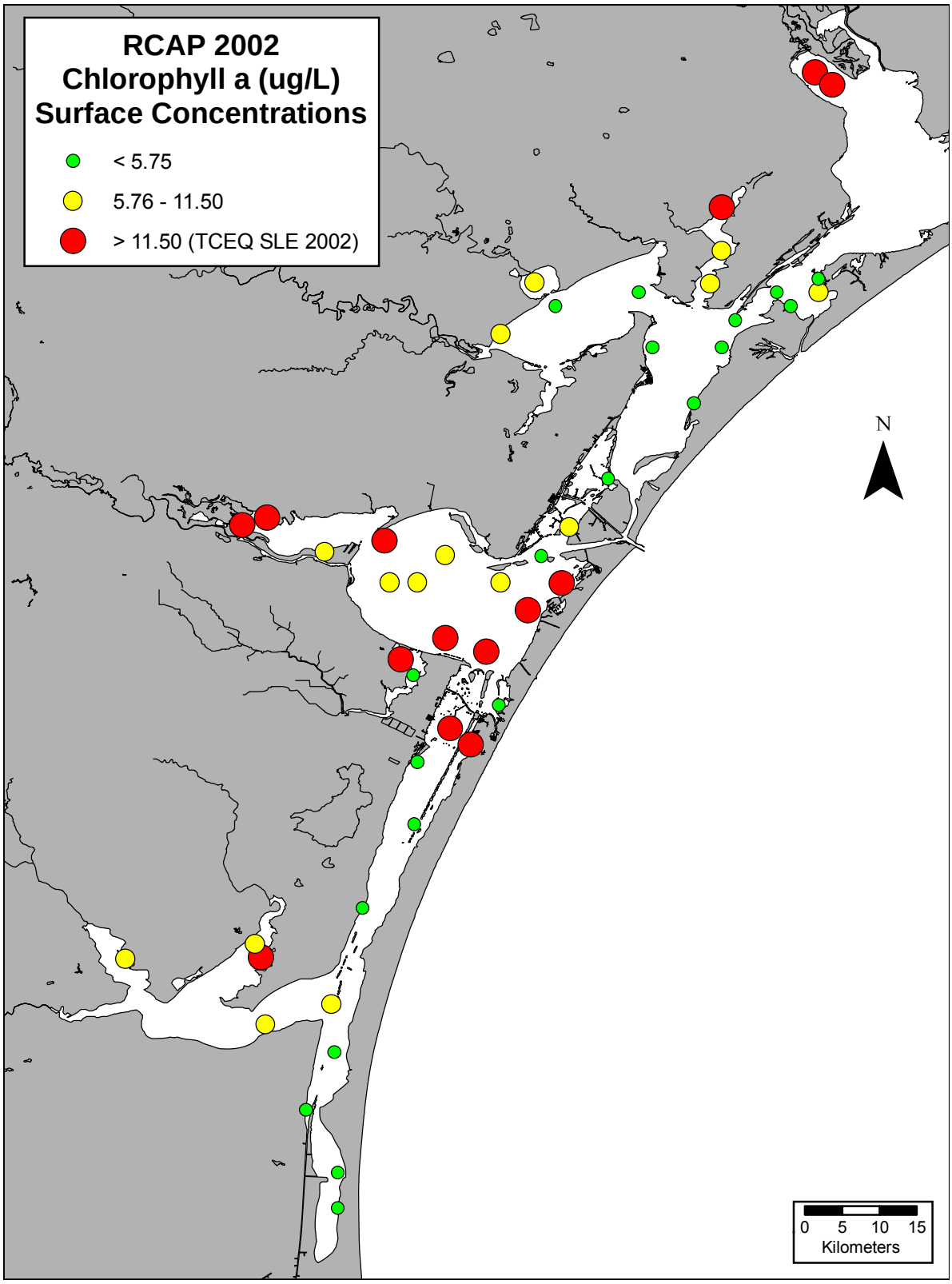


Fig. 3.10. Chlorophyll *a* surface concentrations (µg/L) at RCAP 2002 sampling sites evaluated according to TCEQ Screening Level Estuary 2002 (SLE 2002) guidelines.

3.3.3. EPA NCCR II Water Quality Index

According to EPA, the Water Quality Index (WQI) utilized in the NCCR II report only intends to characterize acutely degraded water quality conditions (USEPA 2004). It does not identify sites that may experience infrequent hypoxic events or nutrient enrichment on a consistent basis. Therefore, EPA states, "a rating of poor for the WQI means that the site is likely to have consistently poor condition during the monitoring period. If the designation is fair or good, the site did not experience poor condition on the date sampled, but could be characterized by poor condition for short time periods". In addition, to assess WQI variability at a specific site will require increased or supplemental sampling (USEPA 2004).

3.3.3.1. Dissolved Oxygen

While a limited number of TCEQ defined segments (Baffin Bay complex - Segment 2492) carry a <5.0 mg/L dissolved oxygen criterion, EPA and TCEQ generally evaluate surface DO along the same guidelines. As seen in Section 3.3.1.8, surface DO concentrations within the RCAP 2002 area rank as good with no recorded instances of hypoxia and only a few stations recording DO concentrations of <5.0 mg/L (Fig. 3.4; Tables 6.2.1 and 6.3.3). Based on EPA NCCR II guidelines listed in Table 3.1, DO was good at 95% and fair at 5% of the sites sampled during RCAP 2002 (Table 3.4).

3.3.3.2. Dissolved Inorganic Nitrogen

EPA NCCR II guidelines (Table 3.1) evaluate surface Dissolved Inorganic Nitrogen (DIN) based on the combined concentrations of ammonia, nitrate, and nitrite samples collected and filtered in the field. EPA considers DIN as one of the estuarine eutrophication indicators. However, reference concentrations used in evaluation of Gulf Coast and East Coast sites (Table 3.1) are lower than NOAA concentrations reported in Bricker et al. (1999) because EPA believes that summer does not represent the period when nutrient values would reach a maximum in these regions.

Based on these guidelines, RCAP 2002 sampling shows that 49 sites achieved a rating of good (Table 3.4; Fig. 3.11). Site 272 in Corpus Christi Bay (Segment 2481) had missing data, but based on all other samples it is our opinion that this site would also have ranked as good. DIN concentrations ranged from 0.002 mg/L to 0.281 mg/L, with a mean of 0.025 mg/L for all sites sampled.

3.3.3.3. Dissolved Inorganic Phosphorus

EPA NCCR II guidelines (Table 3.1) evaluate surface Dissolved Inorganic Phosphorus at considerably lower concentrations then TCEQ screening levels (>0.16 mg/L). Along with DIN, EPA also considers DIP as an estimator of eutrophication and gives the same reasoning for reference concentrations being lower than reported in Bricker et al. (1999).

Based on these guidelines, 16 sites achieved a rating of good, 20 sites ranked as fair, and 13 sites ranked as poor (Table 3.4; Fig. 3.12). Site 272 in Corpus Christi Bay (Segment 2481) had missing data. Based on samples from sites nearby it is our opinion this site would most likely have ranked as fair. DIP concentrations ranged from <0.001 mg/L to 0.137 mg/L, with an overall mean of 0.031 mg/L. Sites ranked as poor occurred in areas that typically received the majority of freshwater inflows prior to sampling (Fig. 3.12 and see Figs. 3.1 and Fig. 3.2).

Therefore, elevated DIP concentrations recorded during RCAP 2002 may be indicative of short-term nutrient inputs from freshwater inflow events and not reflective of long-term eutrophication within the system.

3.3.3.4. Chlorophyll *a*

In the absence of established criteria, TCEQ uses the screening level of >11.50 µg/L to indicate areas of *Secondary Concerns* for elevated chlorophyll *a* concentrations. Based on this screening level for RCAP 2002 sampling, *Secondary Concerns* may be justified. However, these elevated concentrations may also be indicative of short-term influences from the freshwater inflow event that occurred prior to sampling (see Section 3.3.2.3).

EPA NCCR II guidelines (Table 3.1) evaluate surface chlorophyll *a* concentrations based on recommendations proposed in Bricker et al. (1999), with the poor, or concerned, range being >20.0 µg/L. Based on these guidelines, 16 sites achieved a rating of good, 30 sites ranked as fair, and 3 sites ranked as poor (Table 3.4; Fig. 3.13). Site 292 in the Upper Laguna Madre (Segment 2491) had missing data. Based on samples from sites nearby it is our opinion this site would most likely have ranked as good. Surface chlorophyll *a* concentrations ranged from <0.22 µg/L to 45.42 µg/L, with an overall mean concentration for all sites of 9.24 µg/L (Tables 6.4.6 and 6.5.6). As might be expected, sites ranked as poor occurred in areas that received increased freshwater inflows (Nueces Bay and Hynes Bay) and/or were located adjacent to wastewater treatment plants (Oso Bay) (Fig. 3.13 and see Figs. 3.1 and Fig. 3.2).

Table 3.4. Results of individual parameter and combined EPA Water Quality Index by site for RCAP 2002 as defined by guidelines in Table 3.1. (DO= Dissolved Oxygen, DIN= Dissolved Inorganic Nitrogen, DIP= Dissolved Inorganic Phosphorus, Ch *a* = Chlorophyll *a*, WQI= Water Quality Index, and ND = No Data).

Segment *	Site	DO	DIN	DIP	Ch *a*	EPA WQI
2462	245					
2462	246					
2463	249					
2463	253					
2463	254					
2463	256					
2471	257					
2471	259					
2471	260					
2471	261					
2471	262					
2472	250					
2472	252					
2472	255					
2472	258					
2473	247					
2473	248					
2473	251					
2481	266					
2481	268					
2481	269					
2481	270					
2481	271					
2481	272		ND	ND		
2481	273					
2481	274					
2481	275					
2481	276					
2481	279					
2482	263					
2482	264					
2482	267					
2483	265					
2485	277					
2485	278					
2491	280					
2491	281					
2491	282					
2491	283					
2491	284					
2491	290					
2491	291					
2491	292				ND	
2491	293					
2491	294					
2492	285					
2492	286					
2492	287					
2492	288					
2492	289					

* 2462 (San Antonio Bay/Hynes Bay/Guadalupe Bay), 2463 (Mesquite Bay/Carlos Bay/Ayers Bay), 2471 (Aransas Bay), 2472 (Copano Bay/Port Bay/Mission Bay), 2473 (St. Charles Bay), 2481 (Corpus Christi Bay), 2482 (Nueces Bay), 2483 (Redfish Bay), 2485 (Oso Bay), 2491 (Laguna Madre), 2492 (Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada).

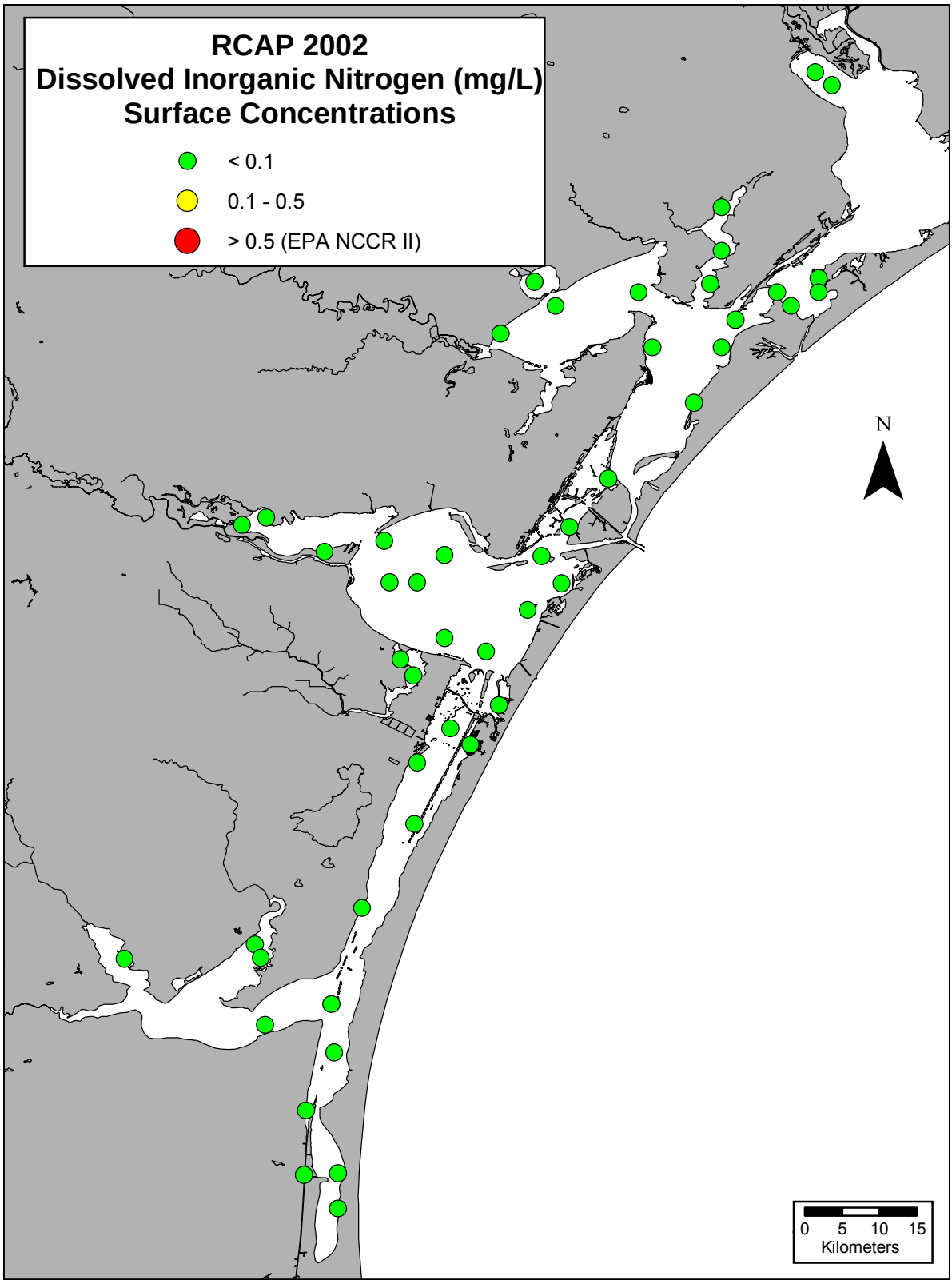


Fig. 3.11. Dissolved Inorganic Nitrogen surface concentrations (mg/L) at RCAP 2002 sampling sites evaluated according to EPA NCCR II guidelines.

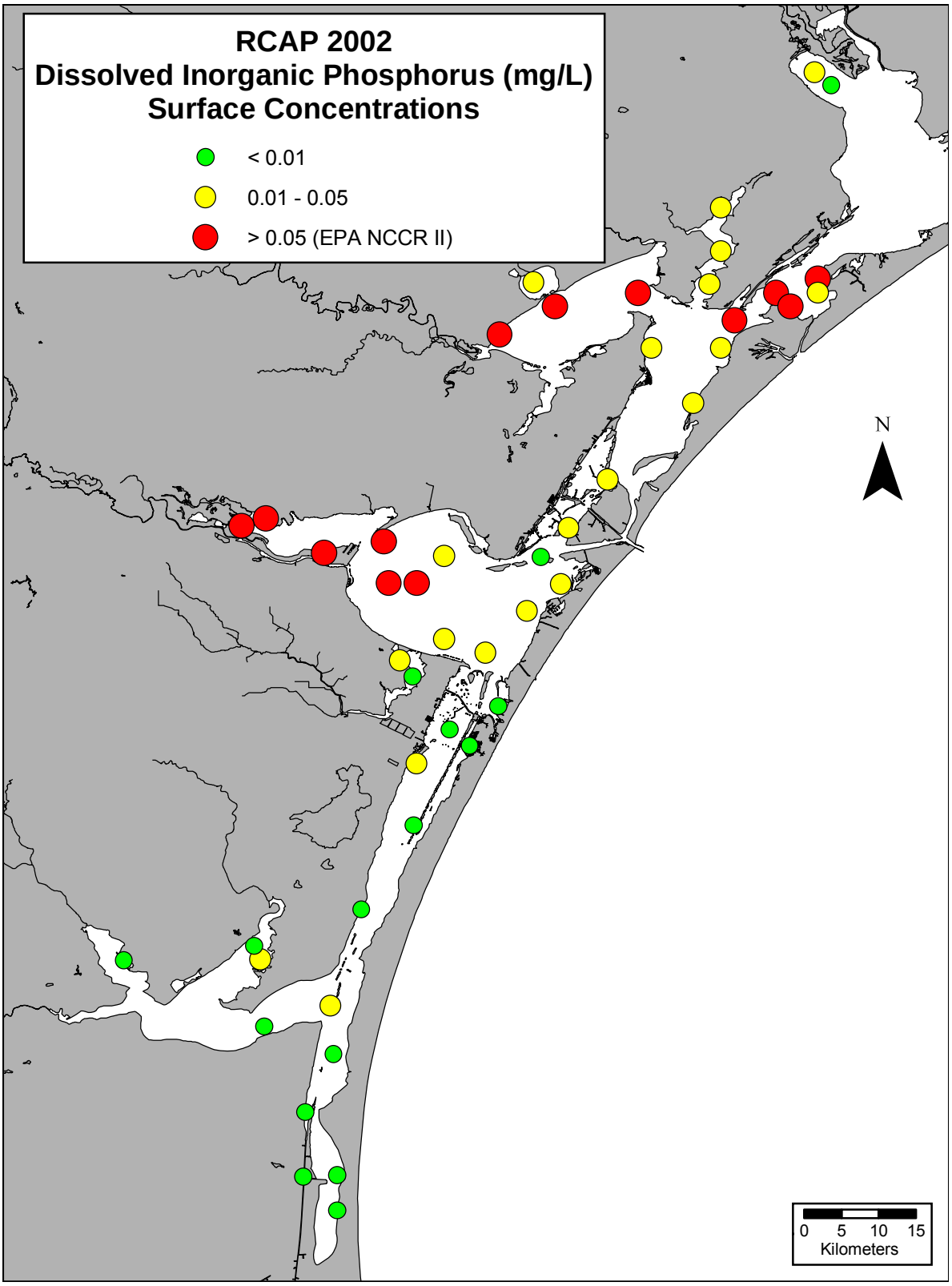


Fig. 3.12. Dissolved Inorganic Phosphorus surface concentrations (mg/L) at RCAP 2002 sampling sites evaluated according to EPA NCCR II guidelines.

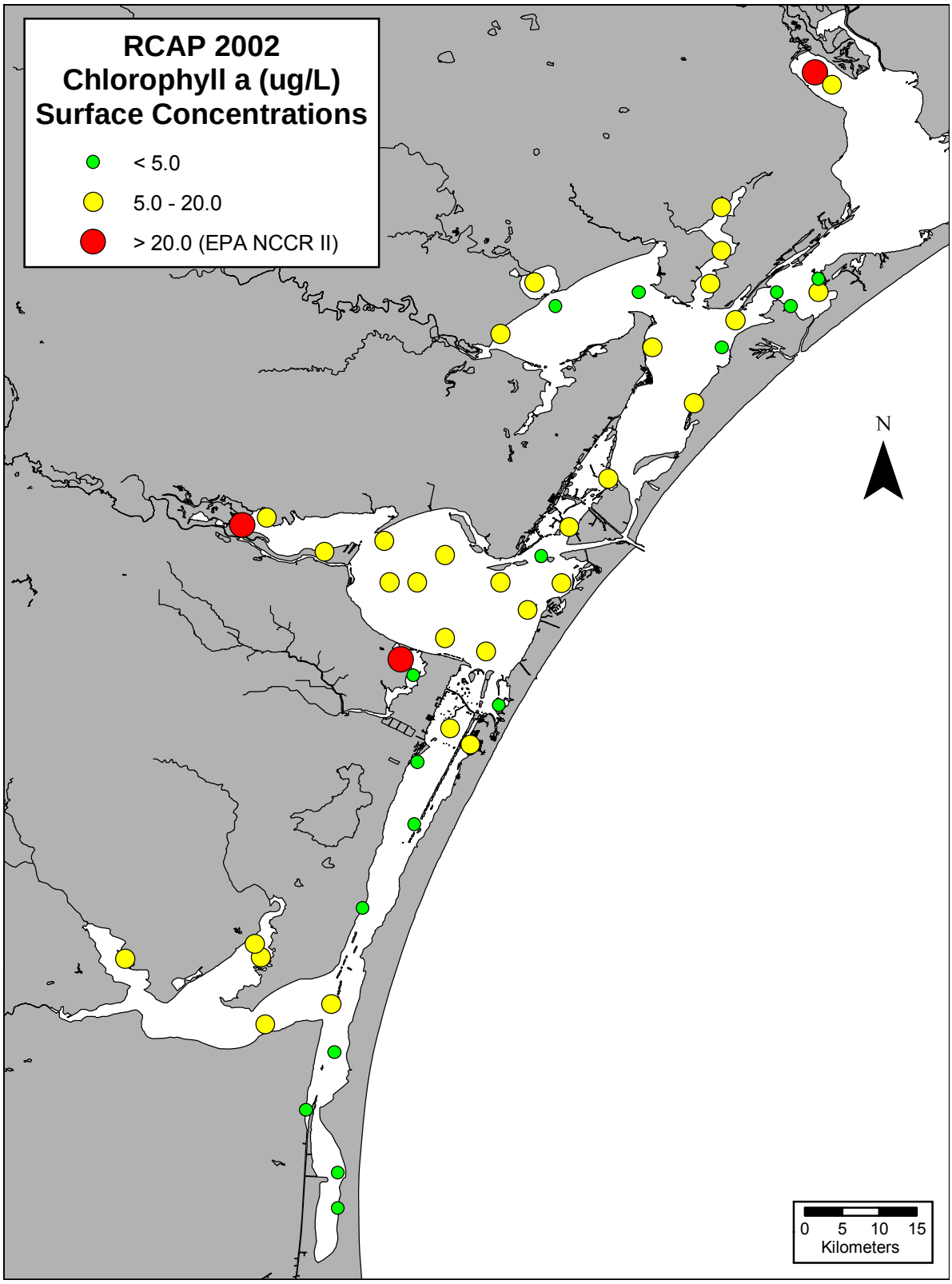


Fig. 3.13. Chlorophyll *a* surface concentrations (µg/L) at RCAP 2002 sampling sites evaluated according to EPA NCCR II guidelines.

3.3.4. Microbiological Indicators

Disease causing microorganisms, or pathogens, can adversely affect estuarine systems. Densities considered unsafe often result in closure or restrictions of shellfish harvesting areas, produce fish kills, and can have adverse effects on human health. Public concern exists as the transmittal of microbial pathogens to humans may occur during recreational use involving primary contact (i.e., wading, swimming, fishing, etc) with water (Heilman 2000; USEPA 2002). High pathogen concentrations may result from such possible sources as polluted stormwater runoff, wastewater overflows, boating wastes, and malfunctioning septic systems that carry microorganisms from fecal material into the environment.

TCEQ analyzes concentrations of three organisms to determine support of the Contact Recreation Use (CRU): fecal coliform and *Escherichia coli* in freshwater, and enterococci in marine or tidal water. Existence of these naturally occurring organisms in high numbers within the water column indicates contamination by fecal matter originating from warm-blooded animals, including humans. TCEQ guidance stresses that full support of the CRU does not necessarily guarantee that freshwater or tidal waters are completely free of disease causing organisms (TCEQ 2003). In addition, the national EPA Beachwatch Program monitors enterococci concentrations to determine beach closures based on elevated bacterial concentrations.

Support of the TCEQ CRU utilizes a 10-sample minimum per individual station. For routinely monitored bacteria data, the long-term geometric average for enterococci is 35-colony forming units/100 ml (CFU/100ml) in tidal water. An enterococci criterion of 104 CFU/100ml also applies to individual samples. The CRU is not supported if the geometric average of samples collected exceeds the mean criterion of if the criteria for individual samples are exceeded >25% of the time. As RCAP 2002 sampling occurred only one time and at random locations, determination of CRU support is not applicable. However, data collected serves as a tool for CBBEP and TCEQ to assess conditions over a broad area.

For comparative purposes, RCAP 2002 sampling utilized the newly approved TCEQ IDEXX method (SWQM monitoring) and the established EPA Method 1600 (EPA Beachwatch Program) for the determination of enterococci concentrations. TCEQ adopted the IDEXX method for simplicity and ease of use by field personnel, as opposed to the more labor-intensive EPA 1600 laboratory filtration method. Some concerns exist as to the possibility of the IDEXX method under or over reporting actual bacterial concentrations present. In attempt to provide comparisons, we used the IDEXX 51 method that provides accuracy of 1 to 200 CFU/100 ml, or when concentrations are low; the IDEXX 97 method that provides accuracy of 1 to 2149 CFU/100 ml, or when concentrations are high; and the EPA Method 1600 that theoretically provides accuracy at all concentration levels.

Results revealed very little differences, as enterococci concentrations were relatively low at 48 of the 50 sites sampled (Fig. 3.14; Table 6.6.1). For many sites, when IDEXX methods reported concentrations of <10 CFU/100 ml the EPA Method 1600 reported <1 CFU/100 ml. From a TCEQ regulatory aspect, the IDEXX values represent adequate concentration determinations. While there was minimal variability between methods it was hard to discern method effectiveness as no values fell near the criteria number of 104 CFU/ 100 ml, the point at which an under or over reported value would be more critical. Additional sampling, when

expected concentrations are in this critical range, would be required to determine method efficacy.

Applying TCEQ criteria to evaluate RCAP 2002 results identified only two of fifty sites (Nueces Bay -Segment 2482 and Corpus Christi Bay -Segment 2481) where enterococci concentrations exceeded the individual 104 CFU/100 ml criteria. For the two sites recording values >104 CFU/100 ml, the three methods agreed as to the elevated concentrations, but values differed between methods (Table 6.6.1). Site 264 in Nueces Bay (Segment 2482) had extremely elevated values. Concentrations ranged from 1184 CFU/100 ml for IDEXX 51, to 1576 CFU/100 ml for IDEXX 97, to >1560 CFU/100 ml for Method 1600. At these levels, the method accuracy becomes a moot point as the exceedance of the criteria is extreme and without question. These extremely high numbers were most likely due to the excessive inflows from the upstream watershed that began in July 2002 and were still ongoing during sampling. The same situation occurred in Corpus Christi Bay (Segment 2481) at Site 266, although at reduced levels (Fig. 3.14; Table 6.6.1). Other areas recording slightly elevated concentrations typically were near freshwater inflows (Fig 3.14).

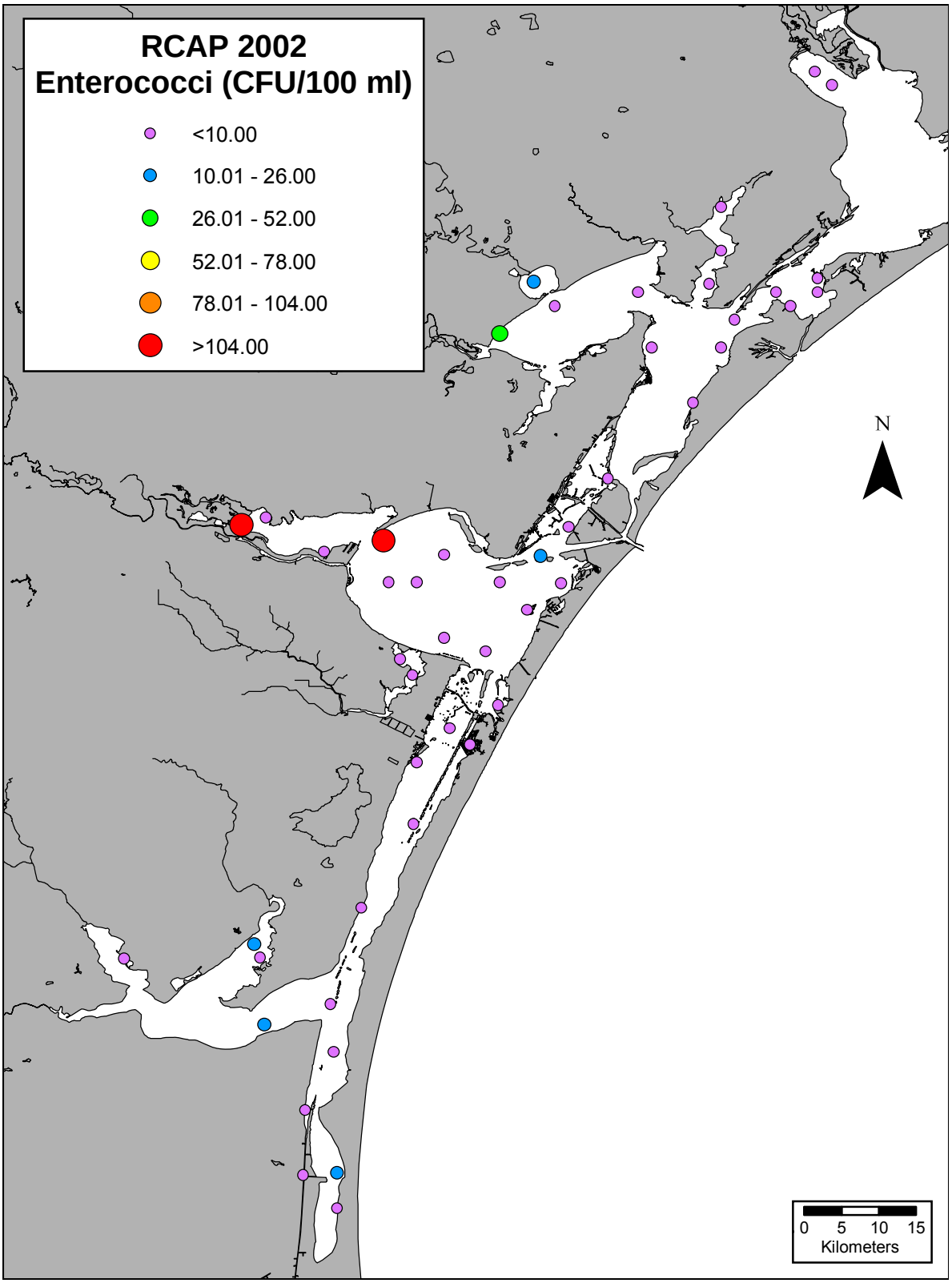


Fig. 3.14. Enterococci concentrations (CFU/100 ml), using IDEXX 97 well test, at RCAP 2002 sampling sites.

3.4 Summary

The initial attempt at providing data for comparisons on a local, regional, and national level began with the RCAP 2002 assessment. As expected, because of different ways that state and federal entities make assessments, the two primary methods (TCEQ and EPA) used for evaluating water quality within the CBBEP region produced distinctly different assessments. As the first truly comparable RCAP event, rather than judging estuarine conditions based on one critical index period sampling event, this should be treated as an evolving process in which a clearer understanding develops with each event. From the collection and assimilation of additional data, indicators will be developed and revised to give us a better picture as to what may represent healthy or degraded conditions or habitat within our region.

Field data collected was representative of our region, with values recorded during RCAP 2002 typical for the summer index period. The one dramatic change observed from previous summer sampling events (RCAP 2000 and 2001) was that of salinity concentrations. Typically, this region suffers from a lack of freshwater inflows and this remains a critical factor for sustaining the health of the estuarine systems within the CBBEP region. However, the flooding event within the Nueces watershed in July 2002 dramatically altered the salinity regime and produced characteristic estuarine salinity gradient patterns throughout most of the RCAP 2002 sampling area except for the Upper Laguna Madre (see Table 3.2; Fig. 3.2). Clearly, freshwater inflows are important, but dramatic short-term shifts in salinity can also be stressful to aquatic organisms (Montagna et al. 2002).

Dissolved oxygen continues to represent one of the most essential water quality parameters utilized by both TCEQ and EPA in assessments of aquatic life use and the health of a water body. While some surface dissolved oxygen concentrations fell in the "biologically stressful" range of >2.0 mg/L but <5.0 mg/L overall conditions indicated that based on one-time grab sampling, overall surface dissolved oxygen quality for the CBBEP region can be considered very good (see Figs. 3.4). The drawback of measuring only surface DO to interpret conditions and resultant aquatic health were evident when evaluating bottom DO concentrations (see Fig. 3.5). The low DO concentrations observed throughout Corpus Christi Bay, caused by salinity stratification in the water column resulting from the increased amount of freshwater inflows, produced one instance of hypoxia and caused DO concentrations to be <5.0 mg/L at an additional five other sampling sites within the bay (see Fig. 3.5). Future events will continue to monitor bottom DO concentrations to provide a complete picture of the system.

In the absence of established nutrient criteria, state and federal monitoring entities employ screening levels based on different methodologies. According to TCEQ screening levels, while some values exceeded screening levels for ammonia, nitrate + nitrite, Total Phosphorus, and Ortho or Dissolved Inorganic Phosphorus (see Figs. 3.6 through 3.9); based on this one time sampling event these elevated levels warrant little concern. However, elevated Total Phosphorus levels seen in Nueces Bay during RCAP 2002, which may be a direct result of increased inflows prior to sampling, were also elevated in all RCAP 2000 sampling events. Perhaps this data provides a basis for investigating upstream point and non-point discharge conditions. Regarding chlorophyll *a* concentrations, possible *Secondary Concerns* may exist based on TCEQ screening levels (see Fig. 10). Elevated concentrations may relate to natural phytoplankton responses to increased nutrients from flooding events prior to sampling, coupled with the optimal conditions of high temperatures and increased light levels during the

south Texas summer, which often produce high concentrations of chlorophyll *a* (Monbet 1992). However, more than a one-time sampling event would be required to make a definitive assessment. If elevated concentrations continue to persist in future RCAP events, or in assessment of regional TCEQ SWQM data, then long-term elevated levels of chlorophyll *a*, may be an indicator of possible eutrophication.

Using EPA NCCR II guidance, which looks at surface Dissolved Inorganic Nitrogen (DIN) and Dissolved Inorganic Phosphorus (DIP), provided a more critical assessment of the region. DIN concentrations were all <0.10 mg/L and thereby received a good rating. However, a majority of the DIP concentrations fell in the fair (>0.01 mg/L and <0.05 mg/L) to poor (>0.05 mg/L) category (see Fig. 3.12). EPA guidance concerning DIP concentrations is more restrictive than TCEQ methodologies used to establish criteria ranges. While the point may be debatable, as to which concentration range to use, EPA is attempting to use a range for all Gulf Coast states so that conditions are comparable throughout the region. Based on EPA NCCR II guidance the majority of chlorophyll *a* concentrations within the region ranked as fair (see Fig. 3.13). While the upper end of the EPA range is higher than the TCEQ screening level (>20.0 µg/L versus 11.50 µ/L) the lower end of the fair category may be too low based on historical concentrations observed for this region. For RCAP 2002, of the 39 sites receiving a fair rating (5.0 µg /L to 20 µg /L), 17 of the sites had chlorophyll *a* concentrations of <9.0 µg/L with five sites <6.0 µg/L (Table 6.4.6).

Overall, the combined EPA Water Quality Index (not including the Water Clarity Index) ranked 15 sites as good, 34 sites as fair, and one site as poor, with a combination of DIP and chlorophyll *a* concentrations the justification for a fair ranking (Table 3.4). EPA guidelines for NCCR II developed criteria for DIP and DIN as possible estimators of eutrophication. However, the utility of DIN as an estimator of possible eutrophication within our region is questionable, as all concentrations were <0.10 mg/L and did not correspond with high chlorophyll *a* concentrations (Table 3.4). Regarding DIP comparisons, no clear association with high levels of chlorophyll *a* existed. Of the 13 sites rated as having poor DIP concentrations (>0.05 mg/L), five had low (good) concentrations of chlorophyll *a*, seven had moderate (fair) concentrations, and only one had poor (high) chlorophyll *a* concentrations (Table 3.4). Van Dolah et al. (2004) also questioned the effectiveness of DIN and DIP as indicators of high phytoplankton concentrations indicative of possible eutrophication for South Carolina sites monitored during the summers of 2001 and 2002 for the NCA program. Additional data assessment of CBBEP and Texas coastal waters is clearly necessary and additional data may provide concentration ranges more applicable within our estuaries.

Currently, all coastal water body segments in Texas are undergoing assessment by the TCEQ TMDL group for bacteria impairments related to the Oyster Water Use (Fecal Coliform criteria). The continuation of bacteria sampling in RCAP 2002 is to provide data using the new criterion, enterococci, in the assessment of the Contact Recreation Use (CRU) for water within the CBBEP region. At present, only Oso Creek (Segment 2485A) and Oso Bay (Segment 2485) show impairment for the CRU use. Analysis of RCAP 2002 data clearly indicted that the two high concentrations observed resulted from the inflows received during the flooding event prior to sampling. For the remaining sites sampled during RCAP 2002, all enterococci concentrations were typically <10 CFU/100ml. Based on the current CRU criteria of 104 CFU/100ml, water quality regarding enterococci concentrations is considered very good throughout the CBBEP region.

3.5 References

American Water Works Association (AWWA). 1990. Water Quality and Treatment: A Handbook of Community Water Supplies. 4th ed. McGraw-Hill.

Bricker, S.B., C.G. Clement, D.E. Pirhalla, S.P. Orlando and D.R.G. Farrow. 1999. National Estuarine Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries. National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects Office and the National Centers for Coastal Ocean Science. Silver Spring, Maryland. 71 pp.

CENR. 2003. An Assessment of Coastal Hypoxia and Eutrophication in U.S. Water. National Science and Technology Council Committee on Environmental and Natural Resources, Washington D. C. 74 pp.

Clarke, K.R. and R.M. Warwick. 2001. Change in marine communities: an approach to statistical analysis and interpretation, 2nd edition. PRIMER-E Ltd., Plymouth, UK.

Heilman, S., J.B. Mott, and B.A. Nicolau. 2000. Fecal Coliforms, Enterococci, *E. coli*, and Total Coliforms as Indicators of Water Quality in Oso Bay, Corpus Christi, Texas. Texas A&M University-Corpus Christi, Center for Coastal Studies Technical Report No. TAMUCC-0001-CCS. 67 pp.

Mann, K.H. 2000. Ecology of Coastal Waters: with implications for Management. Blackwell Science Ltd., London, England. 406 p.

Monbet, Y. 1992. Control of phytoplankton biomass in estuaries: A comparative analysis of microtidal and macrotidal estuaries. *Estuaries* 15(4), 563-571.

Montagna, P.A., R.D. Kalke, and C. Ritter. 2002. Effect of Restored Freshwater Inflow on Macrofauna and Meiofauna in Upper Rincon Bayou, Texas, USA. *Estuaries* 25(6B): 1436-1447.

National Oceanic and Atmospheric Administration and Environmental Protection Agency. 1988. Strategic Assessment of Near Coastal Waters, Chapter 3, Susceptibility and Concentration Status of Northeast Estuaries to Nutrient Discharges. NOAA: Washington, D.C.

National Oceanic and Atmospheric Administration. 2002. Local climatological data at Corpus Christi International Airport - annual summary with comparative data. U.S. Department of Commerce. Ashville, NC.

NRCS. 1994. The phosphorus index: A phosphorus assessment tool. Technical Note 1901. www.nrcs.usda.gov/technical/ECS/nutrient/pindex.html

Nicolau, B. A. and Alex X. Nuñez. 2004. Coastal Bend Bays & Estuaries Program, Regional Coastal Assessment Program (RCAP): RCAP 2000 and RCAP 2001 Annual Report. Center for Coastal Studies, Texas A&M University-Corpus Christi. TAMUCC-CC-0406-CCS. 246 pp.

Rabalais, N.N. 1992. An updates summary of status and trends in indicators of nutrient enrichment in the Gulf of México. Report to the Gulf of México Program, Nutrient Enrichment Subcommittee. Publication No. EPA/800-R-92-004, U.S. Environmental Protection Agency, Office of Water, Gulf of México Program, Stennis Space Center, Mississippi, 421 pp.

Sanger, D.M., M.D. Arendt, Y. Chen, E.L. Wenner, A.F. Holland, D. Edwards and J. Caffrey. 2002. A Synthesis of Water Quality Data: National Estuarine Research Reserve System-wide Monitoring Program (1995-2000). National Estuarine Research Reserve Technical Report Series 2002: 3. South Carolina Department of Natural Resources, Marine Resources Division Contribution No. 500. 135 pp.

TCEQ. 2003. Guidance for assessing Texas surface and finished drinking water quality data, 2004. 87 pp.

USEPA. 2001. National Coastal Condition Report. EPA-620-R-01-005. 204 pp.

USEPA. 2002. Draft Implementation Guidance for Ambient Water Quality Criteria for Bacteria. EPA-823-B-02-003. Office of Water. Washington, D.C. 101 pp.

USEPA. 2004. National Coastal Condition Report II. EPA/620/R-03/002. Office of Research and Development and Office of Water, Washington D. C. 285 pp.

USGS. 1995. The Strategy for Improving Water-Quality Monitoring in the United States. Final Report of the Intergovernmental Task Force on Monitoring Water Quality. Interagency Advisory Committee on Water Data and Water Information Coordination Program. Open-File Report 95-742. Washington, D.C.

Van Dolah, R.F., P.C. Jutte, G.H.M. Riekerk, M.V. Levisen, S. Crowe, A.J. Lewitus, D.E. Chestnut, W. McDermott, D. Bearden, and M.H. Fulton. 2004. The Condition of South Carolina's Estuarine and Coastal Habitats During 2001-2002: Technical Report. Charleston, S.C.: South Carolina Marine Resources Division. Technical Report No. 100. 67 pp.

4.0 SEDIMENT MONITORING

4.1 Introduction

Environmental concerns exist in many estuaries regarding the contamination of sediments with toxic chemicals (USEPA 2004). While natural processes may provide low-level environmental inputs of certain trace metals, the discharge of a wide variety of metal and organic substances from anthropogenic activities affects the estuarine environment. Inputs often come from point and non-point sources such as agriculture, automobiles and boats, wastewater treatment plants, urban runoff, and numerous industrial activities (USEPA 2004).

When contaminants enter estuarine systems, they bind to suspended particulates in the water column then settle out, or sink, to the underlying sediments. Sediments consisting of fine grains (Silt-Clay) or enriched with organic matter (Total Organic Carbon or TOC) may influence the degree of contamination. A primary concern also exists in the possible re-suspension and transport of sediment contaminants across wide areas (Kennish 1992; GBEP 2002; USEPA 2004; SFEI 2004). As sediments also provide biological habitat, potential effects may result when benthic (organisms living in or on the bottom) deposit-feeding organisms ingest sediment particles. While not all sediment contaminants are biologically available, some may yield potentially harmful effects through bioaccumulation and possible biomagnification through the food web to the extent that humans are affected (Kennish 1992).

Therefore, regulatory agencies and informed citizens, consider contaminated sediments as a primary indicator of poor estuarine conditions. Researchers, resource managers, and regulatory officials utilize a multitude of methodologies for assessing coastal sediments, which often yield differing results. Sediment and biological monitoring is important for assessing long-term status and trends. The need for accurate, reliable, and substantial amounts of data, analyzed using multiple evaluation techniques, is necessary to make informed decisions to protect and enhance the estuarine environment of the CBBEP region.

4.2 Sampling Design and Data Evaluation

Sediment sampling for RCAP 2002 took place from August 5th through August 29th 2002 at 50 randomly selected stations throughout the CBBEP region as described in Chapter 2.0. Table 6.1.1 in the *Data Tables* chapter and Fig. 2.2 provide station information and location.

RCAP 2002 sediment contaminant analysis consisted of 15 trace metals, 20 Polychlorinated Biphenyls (PCBs), 6 DDT metabolites and 13 chlorinated pesticides other than DDT, and 23 Polycyclic Aromatic Hydrocarbons (PAHs) (Table 2.1). The *Data Tables* in Chapter 6.0 provide actual concentration values for each contaminant recorded at an individual site location (Metals-Table 6.7.1; PCB–Table 6.9.1; DDT-Table 6.9.2; Chlorinated Pesticides–Table 6.9.3; PAHs–Table 6.9.4) and summary descriptive results for metals in sediments for each TCEQ Segment (Table 6.8.1).

Data analysis and evaluation of sediment contaminants utilized all, or a subset, of contaminants and employed three different methods: 1) the TCEQ Sediment Quality Screening Level regulatory approach, 2) according to guidelines utilized in the EPA NCCR II (USEPA 2004), and 3) the Sediment Contaminant Distribution approach utilizing the Sediment Quality Guideline Quotient method with Factor Analysis.

4.2.1. TCEQ Sediment Quality Screening Levels

Currently, regulatory criteria do not exist for the majority of sediment contaminants. However, TCEQ does employ sediment-screening levels to assess *Secondary Concerns*; previously defined as parameters for which no adopted standard exists but exhibit elevated concentrations exceeding these screening levels.

Screening levels established by TCEQ utilize long-term data based on the 85th percentiles of all TCEQ SWQM data and the Probable Effects Level (PEL) guidelines developed by NOAA through its National Status and Trends Program. TCEQ revises the sediment 85th percentiles on an annual basis while NOAA sediment guidelines derive from a multitude of nationwide datasets of sediment contamination and corresponding biological effects compiled by Long et al. (1995). A *Secondary Concern* is identified by TCEQ if both the 85th percentiles and PEL should be exceeded greater than 25% of the time based on the number of exceedances for a given sample size (TCEQ 2003).

Depending on the effects level used, a wide range of interpretations is possible using these guidelines. Not considered regulatory criteria or standards, these screening levels and guidelines serve as a non-regulatory interpretive aid for sediment chemical data. Based on comparable datasets, but calculated differently (Long et al. 1995; MacDonald et al. 1996), the classification of these levels and their corresponding increasing effect thresholds employs the following terminology:

Threshold Effects Level	TEL	*Rare* adverse effects observed
Effects Range Low	ERL	Effects begin to occur in sensitive species
Probable Effects Level	PEL	*Frequent* adverse effects observed
Effects Range-Median	ERM	Median concentration of the compiled toxic data

4.2.2. EPA NCCR II Sediment Quality Index

Evaluation of RCAP 2002 sediment data used the EPA NCCR II guidelines for assessing individual sites (Table 4.1). Utilization of this evaluation technique was to provide continuity between locally collected data and the ongoing NCA program for assessing coastal waters, and to see if the broad based EPA regional approach is applicable in local estuarine systems. The EPA Sediment Quality Index (SQI) utilizes a combined approach (Sediment TOC, Sediment Contaminants, and Sediment Toxicity) to assess sediment conditions, with sediment toxicity from organic matter enrichment assessed by measuring TOC and Sediment Contaminants assessed in relation to ERL and ERM values as previously defined in Section 4.2.1 and listed in Table 4.2.

Sediment toxicity analysis followed EPA procedures for ten-day solid phase tests conducted with the amphipod, *Ampelisca abdita*, with test organisms collected from Dillon Beach, California (USEPA 1995). Analysis of sediment toxicity results involved one-tailed paired T-tests performed between sediment duplicates, and between control and reference sediment data from each test series, utilizing TOXSTAT 3.3 (Gulley et al. 1991). Toxicity results with duplicate samples did not differ significantly from each other (p=0.05). Therefore, removal of the duplicate results from the dataset occurred prior to further analyses. Significant

differences occurred between some of the controls and replicates and, therefore, this data remained in the dataset as separate results for further analyses.

Data from each sediment toxicity test, analyzed for normality and homogeneity of variances, used SAS/LAB® Software (SAS 1992). The datasets from samples analyzed for toxicity on September 6th and 13th, 2002 did not meet the homogeneity of variances assumption and were, therefore, square root transformed prior to further analyses. No transformation took place on the remaining datasets. Statistical comparisons among treatments used ANOVA and Dunnett's one-tailed t-test (which controls the experimentwise error rate) performed with SAS (SAS 1989). Dunnett's comparisons occurred separately towards the performance control (Dillon Beach, California) and reference (Christmas Bay, Galveston Island, Texas) samples. Differences from both control and reference samples required analysis at $\alpha = 0.05$ and 0.01, and a minimum significant difference (MSD) from the control of 15% supplied an additional criterion (Thursby et al. 1997).

A Spearman correlation analysis was done between amphipod survival data and concentrations of all measured chemicals, Total Organic Carbon (TOC) and sediment grain size distribution. PCB data for the correlation analysis required reduction to Total PCBs and all concentrations below detection limits equaled zero for the correlation analysis. Application of a Bonferroni adjustment for analysis of significance of correlations used the following formula: $p/\sqrt{\#}$ variables, where $p = 0.05$ or 0.01 and # variables = 51. Correlations with a Bonferroni adjusted $p \leq 0.007$ or 0.0014 were significant at 5 and 1% levels, respectively.

Table 4.1. EPA NCA guidelines for assessing Sediment TOC (% dry weight), Sediment Toxicity, and Sediment Contaminants for determining the Sediment Quality Index (SQI), by site (USEPA 2004).

Rating		TOC (% dry weight) Guidelines
Good (Low)		TOC concentration <2.0%.
Fair (Moderate)		TOC concentration between 2.0% and 5.0%.
Poor (High)		TOC concentration >5.0%.
Rating		**Sediment Toxicity Guidelines**
Good		The amphipod survival rate is greater than or equal to 80%.
Poor		The amphipod survival rate is less than 80%.
Rating		**Sediment Contaminant Guidelines**
Good		No ERM concentrations are exceeded, and less than five ERL concentrations are exceeded.
Fair		Five or more ERL concentrations are exceeded.
Poor		An ERM concentration is exceeded for one or more contaminants.
Rating		**Sediment Quality Index (SQI) Guidelines**
Good		None of the individual components are poor, and sediment contaminants indicator is good.
Fair		No measures are poor, and the sediment contaminants indicator is fair.
Poor		One or more of the of the component indicators is poor.

Table 4.2. List of metal concentrations in parts per million (ppm) and organic contaminant concentrations in parts per billion (ppb) along with corresponding ERL and ERM, values used in the NCCR II analysis and the PEL values used in SQGQ analysis.

Metals (ppm)	ERL	ERM	PEL
Arsenic	8.2	70.0	41.60
Cadmium	1.2	9.6	4.21
Chromium	81.0	370.0	160.40
Copper	34.0	270.0	108.20
Lead	46.7	218.0	112.18
Mercury	0.15	0.71	0.70
Nickel	20.9	51.6	42.4
Silver	1.0	3.7	1.77
Zinc	150	410.0	271.00
Organics (ppb)			
Acenaphthene	16.0	500.0	88.90
Acenapthylene	44.0	640.0	127.87
Anthracene	85.3	1,100.0	245.00
Flourene	19.0	540.0	144.35
2-Methyl naphthalene	70.0	670.0	201.00
Napthalene	160.0	2,100.0	390.64
Phenanthrene	240.0	1,500.0	543.53
Benz(a)anthracene	261.0	1,600.0	692.53
Benzo(a)pyrene	430.0	1,600.0	763.22
Chrysene	384.0	2,800.0	845.98
Dibenzo(a,h)anthracene	63.4	260.0	1,34.61
Fluoranthene	600.0	5,100.0	1,493.54
Pyrene	665.0	2,600.0	1,397.60
Low molecular weight PAH*	552.0	3,160.0	1,442.00
High molecular weight PAH**	1,700.0	9,600.0	6,676.14
Total PAH	4,020.0	44,800.0	16,770.40
4,4'-DDE	2.2	27.0	374.00
Total DDT	1.6	46.1	51.70
Total PCBs	22.7	180.0	188.79

*Low Molecular weight: acenaphthene, acenapthylene, anthracene, flourene, naphthalene, phenanthrene

**High Molecular weight: benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, pyrene

4.2.3. Sediment Contaminant Distribution

RCAP 2002 sediment contaminant characterization utilized both Sediment Quality Guideline Quotient (SQGQ) and factor analysis in order to determine the Sediment Contaminant Distribution (SCD) for the region. The purpose of this method is to identify the distribution patterns of the sediment contaminant and associated loadings within the CBBEP.

The SQGQ approach is a method increasingly utilized to quantify potentially harmful mixtures of contaminants present in varying concentrations (Hyland et al. 1999). The purpose of this method is to identify sites that may not have multiple contaminant exceedances, but could cumulatively have concentrations that may negatively affect the biota of the system. This approach follows methods described in Long et al. (2003) and incorporates multiple RCAP 2002 contaminants also used in EPA NCCR II sediment assessments (Table 4.2). Calculating the SQGQ for each individual site involved first obtaining the ratio for each contaminant variable by dividing the variable concentration by its respective PEL (Texas screening value), then summing up the individual quotients and dividing by the total number of contaminant variables to arrive at a final collective quotient.

Factor analysis, using Varimax rotation, aided in identifying patterns of environmental contamination. This is a data reduction technique, which consolidates and transforms data sharing similar characteristics into a new variable. The newly generated data matrix contains the variables, which are orthogonal (i.e. non-correlating or covarying) and ordered in decreasing variance (Long et al. 2003). Varimax rotation maximizes the variance of the squared loadings of a factor (column) on all the variables (rows) in a factor matrix. This has the effect of differentiating the original variables by extracted factor by minimizing the number of variables that have high loadings on any one given factor. A Varimax solution yields results that make it as easy as possible to identify each variable with a single factor.

4.2.4. Benthic Community

Benthic analysis included common measures of community composition such as richness, density, biomass, and diversity. In addition, benthic community evaluation utilized the EPA Benthic Condition Index (EPA-BCI) for Gulf of Mexico Estuaries (Engle and Summers 1999) according to the guidelines in Table 4.3. Development of the index aids in assessing the health of the macrobenthic community. The purpose of the index is to reflect conditions of both water and sediment quality and serves as an independent variable used for the assessment of estuarine condition by EPA in NCCR II. If calculated correctly, a poor benthic condition should often co-occur with poor sediment or water quality (USEPA 2004). Community characterizations also included mean community measures for TCEQ designated segments and benthic community assemblages.

Table 4.3. EPA NCA guidelines for determining the Benthic Index (Gulf Coast), by site (USEPA 2004).

Rating		Benthic Index (Gulf Coast) Guidelines
Good		Benthic Index score is >5.0
Fair		Benthic Index score is between 3.0 and 5.0
Poor		Benthic Index score is <3.0

Identification of benthic community assemblages utilized the PRIMER v5.0 (Plymouth Routines in Multivariate Ecological Research) software program developed by Clark and Warwick (2001). Community characterization begins with the Bray-Curtis Similarity Matrix, which replaces the original data with pairwise similarity coefficients that reflect aspects of similarity (species composition and densities) in a community. Delineation of Benthic Assemblages and Species Groups from this matrix incorporated hierarchical clustering and the ordination technique referred to as Non-metric Multidimensional Scaling (MDS). The two techniques are compared in order to cross check for adequacy and mutual consistency of both representations. Cluster analysis aims to find the "natural groupings" of sites by describing the patterns of occurrences of each species across a given set of samples with a dendrogram constructed for graphic illustration of the clustering. MDS constructs a configuration of the samples in an attempt to satisfy all the conditions imposed by the rank similarity matrix (Clark and Warwick, 2001).

The BIOENV procedure identified factors distinguishing Benthic Assemblages from each other. This program selects the environmental variables that best explain community patterns, by maximizing the rank correlation between biological (Bray-Curtis Similarity Matrix) and physiochemical (Euclidean Similarity Matrix) similarity matrices (Clarke and Warwick 2001). The SIMPER procedure identified the top contributing species for both the TCEQ Segments and the Benthic Assemblages. This procedure indicates which species are responsible for the observed clustering pattern (Benthic Assemblage), or the differences between sets of samples defined *a priori* (TCEQ Segments) (Clarke and Warwick 2001).

4.3 Results and Discussion

4.3.1. Sediment Characteristics

Total Organic Carbon (TOC) provides a relative measure of organic matter contained in sediments and is one of three components (TOC, Sediment Contaminants, and Sediment Toxicity) the EPA uses in the assessment of estuarine sediment quality for the National Coastal Condition Reports (USEPA 2004). Typically, elevated TOC percentages are associated with sediments high in Slit-Clay content. During RCAP 2002, Spearman's correlation coefficient identified a slight positive correlation between TOC and Silt-Clay content ($r= 0.486$, $p <0.001$), with the Silt-Clay content of moderately enriched sites typically ranging from 70.6% to 98.8%.

St. Charles Bay (Segment 2473) had the highest mean TOC enrichment value of 6.64%. However, the extremely elevated TOC percentage of 17.9% occurring at Site 251 skews this mean percentage, as the other two sites in this segment yielded low enrichment values (<2.0%) (Fig. 4.1; Fig. 4.2; Table 6.7.1; Table 6.8.1). Lowest individual TOC values of <0.1% occurred at Site 250 in Mission Bay (Segment 2472) and Site 256 in Mesquite Bay (Segment 2463). However, the lowest mean TOC enrichment per segment value of 0.38% occurred in Oso Bay (Segment 2485) (Table 6.7.1; Table 6.8.1).

The Upper Laguna Madre (Segment 2491) was the only segment characterized as moderately enriched, with a mean TOC concentration of 2.02% (Table 6.8.1). Within this segment, four of the ten sites characterized as moderately enriched were located in seagrass beds (Table 4.4). Explanations of elevated TOC for this segment may be due to the high primary productivity and detrital retention time associated with this habitat. While some segments

showed signs of moderate enrichment, most segments had low TOC enrichment (Table 4.4; Table 6.8.1). Overall, the mean TOC concentration for all 50 RCAP 2002 sites sampled was 1.71% with only one site rated as being in poor condition (Site 251 in Segment 2473). Based on this fact we feel that the CBBEP region rates as good concerning TOC enrichment.

The percentage of mud (Silt-Clay) within sediments is also an important aspect in the assessments of estuarine condition. Typically, as sediment grain size decreases, the risk of contamination increases due to the strong affinity metals have to adsorb to Silt-Clay particles. Sediment grain size is also a contributing factor effecting the distribution of marine benthic organisms. Individual Silt-Clay proportions ranged from 4.2% to 98.8%. As expected with a randomized sampling design, considerable variability occurred in most segments (Fig. 4.3; Fig. 4.4; Table 6.7.1). Segment 2462 had the highest percentage of sites with mud content (>75% Silt-Clay), Segment 2473 the highest muddy sand content (50% - 75% Silt-Clay), and Segment 2483 had the highest sandy mud content (25% - 50% Silt-Clay) (Table 4.4). The Upper Laguna Madre (Segment 2491) contained the lowest Silt-Clay content (<25%) of all segments. Mean Silt-Clay proportions for segments ranged from 18.9% to 81.9% with highest and lowest mean values recorded in Segment 2462 and Segment 2491, respectively (Table 6.8.1).

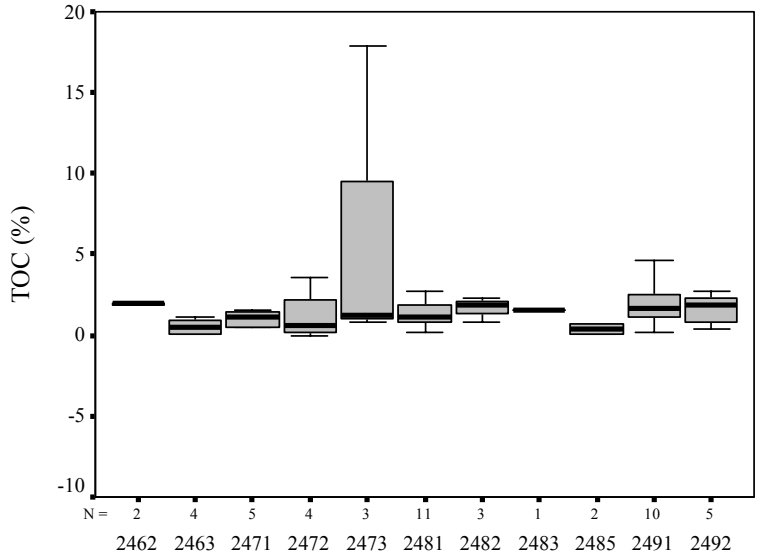


Fig. 4.1. Box and whisker plots of TOC (%) for TCEQ segments during RCAP 2002. Boxes are interquartile ranges; horizontal lines within boxes are medians; whisker endpoints are high and low extremes.

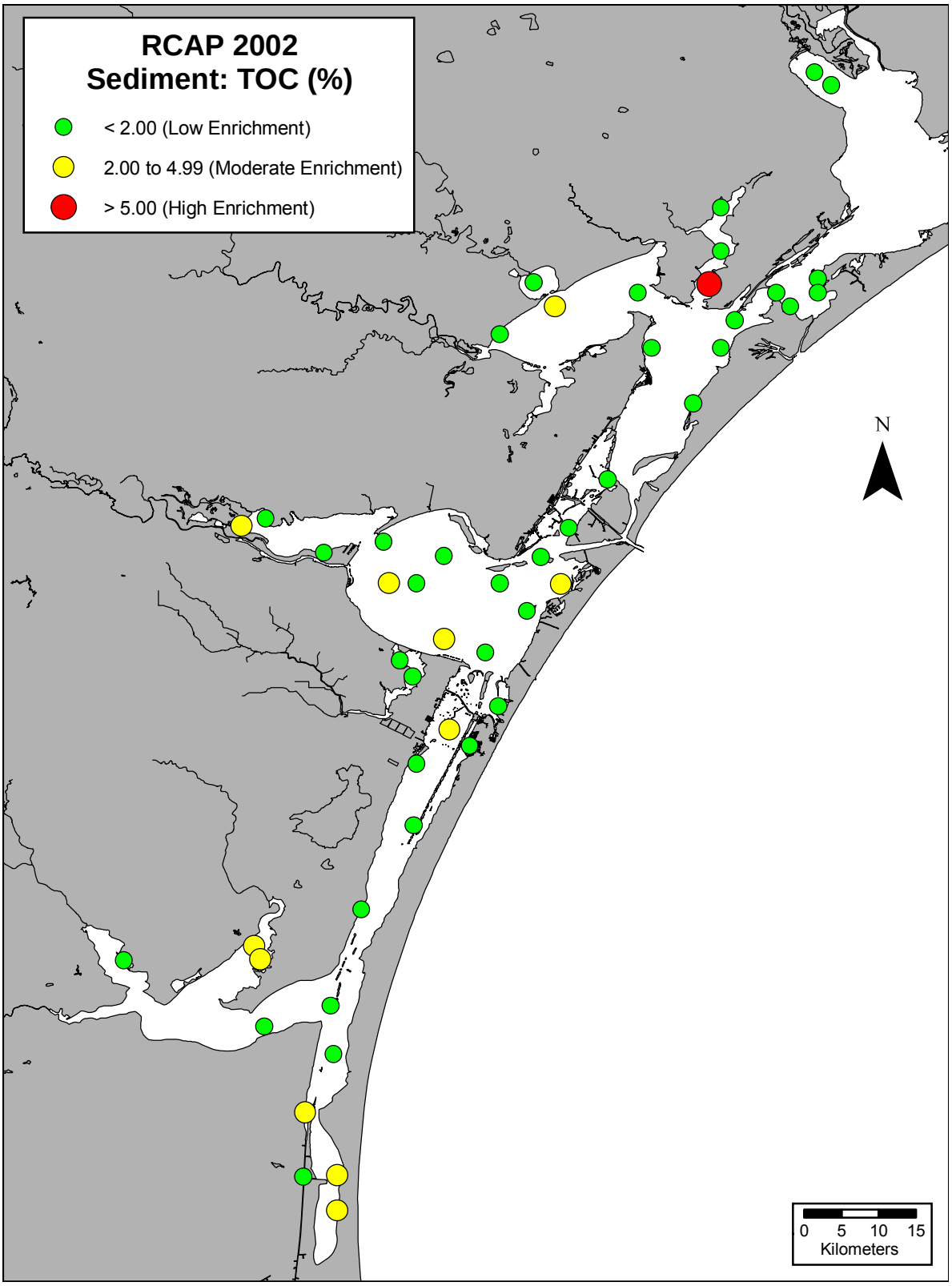


Fig. 4.2. Total Organic Carbon sediment concentrations (% dry weight) for RCAP 2002 sampling sites.

Table 4.4. Sediment characteristics distribution listing total number of sampling sites within TCEQ designated Segments and number of sites associated with % TOC and % Silt-Clay categories.

Segment	Segment Name	n	% TOC			% Silt-Clay			
			<2% (Low)	2% - 5% (Mod)	>5% (High)	<25% (Sand)	25% – 50% (Sand-Mud)	50% – 75% (Mud-Sand)	>75% (Mud)
2462	San Antonio/Hynes/ Guadalupe Bay	2	2	-	-	-	-	-	2
2463	Mesquite/Carlos/Ayers Bay	4	4	-	-	-	3	1	-
2471	Aransas Bay	5	5	-	-	2	2	-	1
2472	Copano Bay/Port Bay/ Mission Bay	4	3	1	-	1	-	-	3
2473	St. Charles Bay	3	2	-	1	-	-	3	-
2481	Corpus Christi Bay	11	8	3	-	3	1	1	6
2482	Nueces Bay	3	2	1	-	-	1	-	2
2483	Redfish Bay	1	1	-	-	-	1	-	-
2485	Oso Bay	2	2	-	-	1	-	1	-
2491	Laguna Madre	10	6	4	-	6	4	-	-
2492	Baffin Bay/Alazan Bay/ Cayo del Grullo/Laguna Salada	5	3	2	-	2	-	-	3

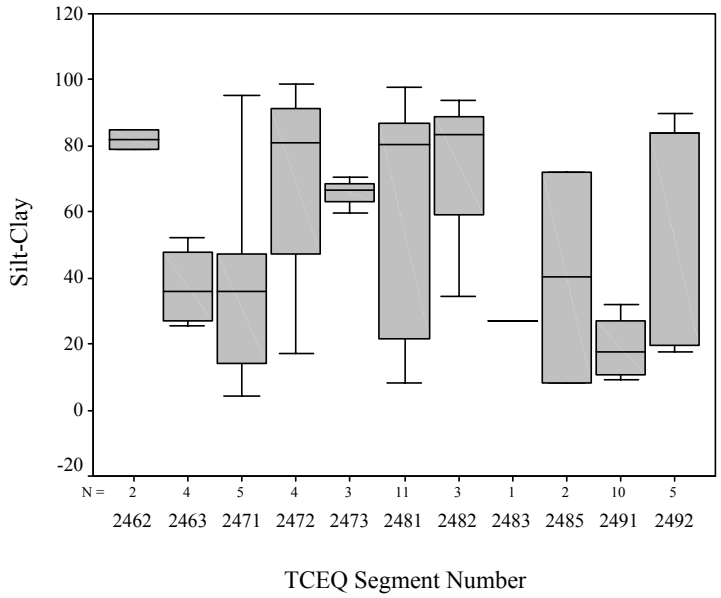


Fig. 4.3. Box and whisker plots of Silt-Clay (%) for TCEQ segments during RCAP 2002. Boxes are interquartile ranges; horizontal lines within boxes are medians; whisker endpoints are high and low extremes.

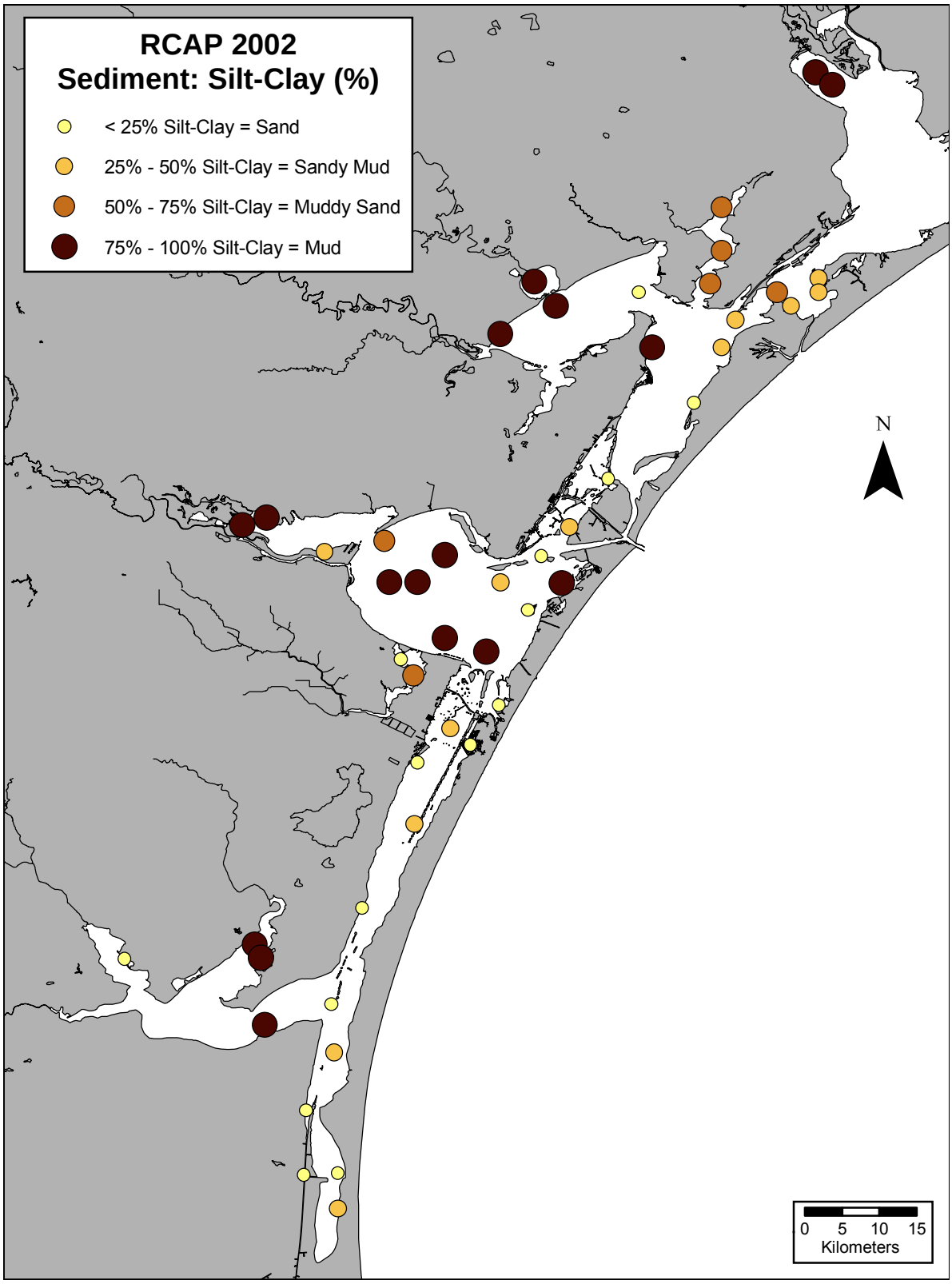


Fig. 4.4. Silt-Clay sediment concentrations (%) for RCAP 2002 sampling sites.

4.3.2. TCEQ Sediment Quality Screening Levels

As previously stated, TCEQ procedures for identifying *Secondary Concerns* only require exceedances of the 85th percentile and PEL screening levels. Table 4.5 lists RCAP 2002 sites whose contaminant concentrations exceeded the 85th percentile and PEL levels, along with sites above the Threshold Effects Levels (TEL). While concentrations above TEL values do not factor in identifying *Secondary Concerns*, they do provide TCEQ with a baseline reference indicating that concentrations may be increasing.

TCEQ requires a minimum of 10 samples within a Segment in order to apply the 25% temporal exceedance of the screening level necessary to justify a *Secondary Concern*. While not applicable to a one-time sampling event, based on data analysis no Segment had *Secondary Concerns*. However, on an individual site basis, Site 258 may be a potential site for future concern. Located in Copano Bay (Segment 2472), near the City of Bayside and the mouth of the Aransas River, this site had three contaminant concentrations (4,4'-DDD, Total DDT and Total PCB) above PEL and 85th percentile values. In addition, the pesticide Mirex also exceeded the 85th percentile value. Site 269 in Corpus Christi Bay (Segment 2481), also exceeded the TEL and PEL for the pesticide Lindane. With the exception of those two sites, no other sites had concentrations above respective PEL values. However, cadmium, chromium, copper, lead, mercury, and zinc had concentrations above TCEQ 85th percentile screening levels, with seven sites located in Corpus Christi Bay (Segment 2481), followed by three in Nueces Bay (Segment 2482), two each in the Copano Bay complex (Segment 2472) and Baffin Bay complex (Segment 2492), and one site in Aransas Bay (Segment 2471).

Table 4.5. RCAP 2002 sampling sites with sediment contaminants above respective screening levels. Shaded = values above TCEQ screening levels.

	Contaminant	Screening Level	Site (s)
Metals	Cadmium	TEL and 85th Percentile	263, 264, 267, 275
	Chromium	85th Percentile	250, 255, 259, 270, 271, 273, 275, 276, 285, 289
	Copper	TEL and 85th Percentile	276
	Lead	TEL and 85th Percentile	255, 259, 263, 264, 266, 268, 270, 271, 273, 275, 276, 289
	Mercury	TEL	263, 271
	Zinc	85th Percentile	266, 275
Organics	4,4'-DDT	TEL	249, 254
	4,4'-DDD	TEL	254, 256, 257, 260, 277
	4,4'-DDD	TEL and PEL	258
	4,4'-DDE	TEL	257, 258
	Total DDT	TEL	254, 256, 257, 260, 277
	Total DDT	TEL, PEL, and 85th Percentile	258
	Total PCB	TEL	257, 285, 289
	Total PCB	TEL, PEL, and 85th Percentile	258
	Mirex	85th Percentile	258
	Dibenz(a,h)anthracene	TEL	258, 262
	Lindane gamma BHC	TEL and PEL	269
	Acenaphthylene	TEL	280

4.3.3. EPA NCCR II Sediment Quality Index

Following EPA NCCR II sediment quality assessment guidelines (Table 4.1), 20 sites had poor sediment quality during the RCAP 2002 study (Fig. 4.5; Table 4.6). Site 251 was poor due to high TOC and Site 258 had high Sediment Contamination based on ERM exceedances for Total DDT and Total PCBs. The number of sites characterized with poor sediment quality due to expression of toxic effects was 18 (Fig 4.5). Seven of the 18 sites exhibiting toxic effects were located in the Laguna Madre (Segment 2491), with six sites located in seagrass beds.

Control and reference survival ranged from 90% to 98%, and 79% to 88%, respectively. Amphipod survival at 18 sites was significantly lower than in the performance control and met the MSD criterion (Thursby et al. 1997), but only five of those sites also exhibited significant effects relative to the reference sediment (Table 6.10.1). Please note that EPA criteria for toxic determination only applies if significantly different from control and not reference sediment. Sites 285 and 286 in the Baffin Bay complex (Segment 2492) also exhibited amphipod survival significantly below the control, but did not meet the MSD criterion. The strongest effects (63% survival) occurred at Site 279 in extreme southern Corpus Christ Bay (Segment 2481) and Site 290 in the Upper Laguna Madre (Segment 2491) just south of Baffin Bay (Fig. 4.5; Table 6.10.1).

Some sites exhibiting toxic effects had concentrations of a few contaminants, e.g., DDTs, PCBs, acenaphthylene, dibenz(a,h)anthracene, cadmium, lead and mercury above the Effects Range-Low (ERL) and/or the threshold effect level (TEL) (Long et al. 1995; MacDonald et al. 1996; NOAA 1999). Concentrations above TEL and/or ERL, but below respective PEL or ERM (Effects Range-Median) represent a range at which adverse effects are possible but only expected to occur occasionally. None of the sites exhibiting toxic effects had ERM or PEL exceedances, in which effects are expected to occur frequently. The only ERM and/or PEL exceedances occurred for 4,4'-DDD, total DDT and total PCBs at Site 258, which did not exhibit expressions of toxicity.

Significant positive Spearman rank correlations existed between amphipod survival and Silt-Clay content (Table 6.10.2). Several metals also positively correlated with Silt-Clay, as well as with amphipod survival. The co-occurrence of fine-grained sediments and metals would have been responsible for the high correlation with survival. Despite the positive correlation between fine grain size and survival, sand and gravel content alone do not explain the significant mortality in some of the samples. Several sites with high levels of sand and/or gravel also exhibited high amphipod survival, e.g., Sites 266 and 274, which contained 13.7% gravel and 89.5% sand, respectively, and exhibited 91% survival.

The pH of the overlying water in all tests, measured on days 0 through 10, ranged from 7.4 to 8.3. The unionized ammonia (NH_3 - as ammonia N) levels reached at day 10 in the reference samples were some of the highest measured in the experiments, ranging from 63 to 84 μg/L (Table 6.10.2). The only samples in which ammonia reached levels higher than the reference on day 10 were from Sites 261, 279 and 291, with concentrations of 180, 109 and 79 μg/L, respectively. Amphipod mortality was not different from the respective reference in any of these samples. Kohn et al. (1994) found a 96-h LC50 of 830 μg NH3/L for *Ampelisca abdita* in aqueous phase tests. Therefore, ammonia is unlikely to be responsible for the toxic effects

observed in Sites 261, 279 and 291. However, the potential for ammonia as a contributing factor in producing toxic effects cannot be ruled out. Overall, toxicity tests performed with sediments from RCAP 2002 did not discern any straightforward cause-effect relationships. Concentrations of some contaminants, grain size distribution and confounding factors (e.g., ammonia), may have contributed to adverse effects in one or more samples.

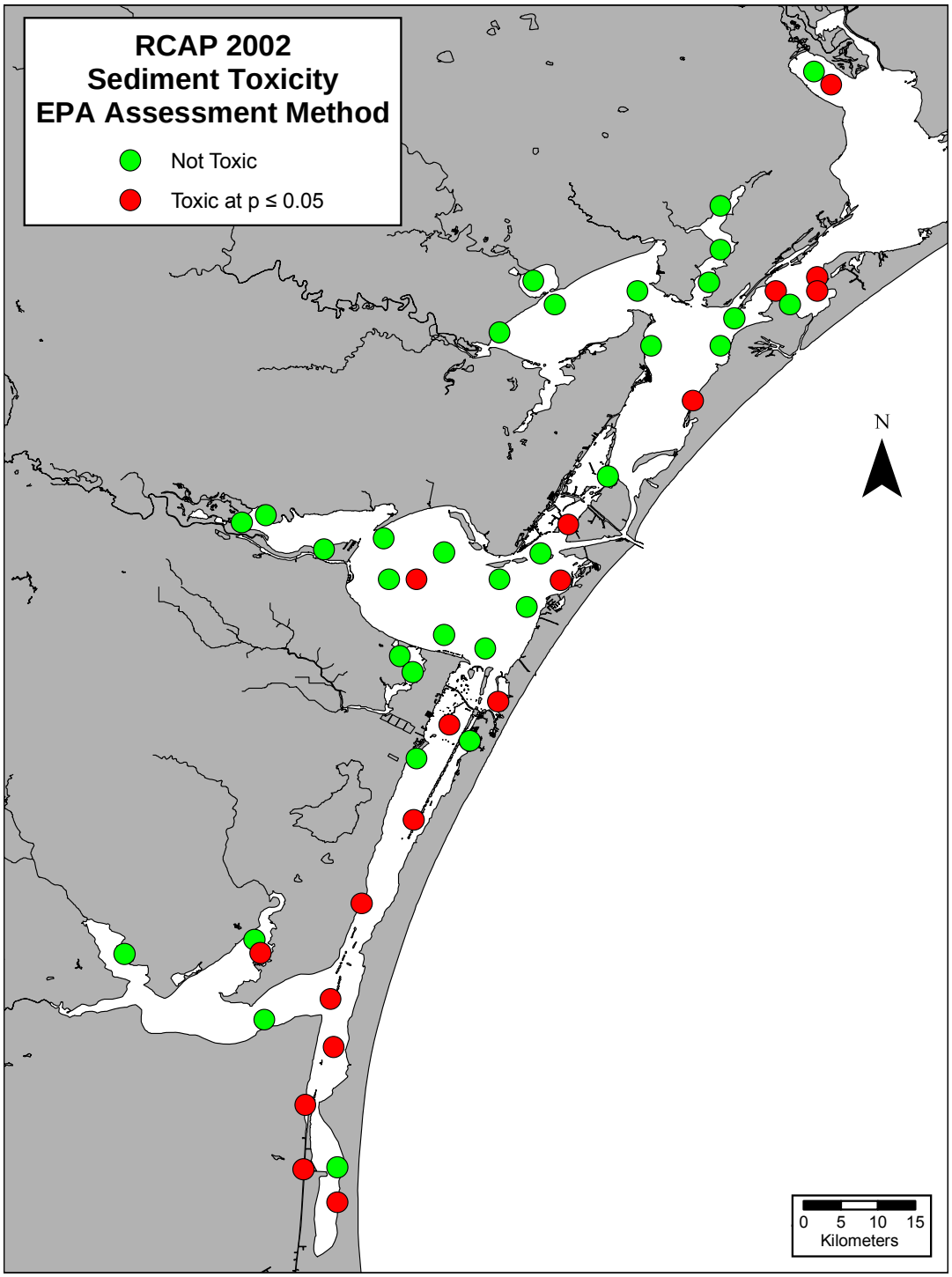


Fig. 4.5. RCAP 2002 sampling sites exhibiting toxic effects based on EPA assessment methods.

Table 4.6. Results of individual parameter and combined EPA Sediment Quality Index (SQI) by site for RCAP 2002, as defined by guidelines in Table 4.1. (TOC= Total Organic Carbon).

Segment	Site	TOC	Sediment Toxicity	Sediment Contaminant	EPA SQI
2462	245				
2462	246				
2463	249				
2463	253				
2463	254				
2463	256				
2471	257				
2471	259				
2471	260				
2471	261				
2471	262				
2472	250				
2472	252				
2472	255				
2472	258				
2473	247				
2473	248				
2473	251				
2481	266				
2481	268				
2481	269				
2481	270				
2481	271				
2481	272				
2481	273				
2481	274				
2481	275				
2481	276				
2481	279				
2482	263				
2482	264				
2482	267				
2483	265				
2485	277				
2485	278				
2491	280				
2491	281				
2491	282				
2491	283				
2491	284				
2491	290				
2491	291				
2491	292				
2491	293				
2491	294				
2492	285				
2492	286				
2492	287				
2492	288				
2492	289				

* 2462 (San Antonio Bay/Hynes Bay/Guadalupe Bay), 2463 (Mesquite Bay/Carlos Bay/Ayers Bay), 2471 (Aransas Bay), 2472 (Copano Bay/Port Bay/Mission Bay), 2473 (St. Charles Bay), 2481 (Corpus Christi Bay), 2482 (Nueces Bay), 2483 (Redfish Bay), 2485 (Oso Bay), 2491 (Laguna Madre), 2492 (Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada).

4.3.4. Sediment Contaminant Distribution

SQGQ analysis incorporated a subset of contaminants analyzed for RCAP 2002. The subset consisted of the 28 contaminants (see Table 4.2) used in the EPA NCCR II for the sediment contaminant assessment (see guidelines in Table 4.1) (EPA 2004). As previously stated, calculating the SQGQ sites involved first obtaining the ratio for each of the 28 contaminants at a site by dividing the variable concentration by its respective PEL value, then summing up the individual quotients and dividing by 28 to arrive at a final collective quotient for that site.

For RCAP 2002, individual SQGQ site values ranged from 0.002 to 0.177 with a mean of 0.037. The highest individual quotient value occurred at Site 258 in Copano Bay (Segment 2472) and the lowest at Site 284 in the Upper Laguna Madre (Segment 2491). Overall, higher individual SQGQ values occurred at sites located in Corpus Christi Bay (Segment 2481). Other sites with high individual SQGQ values included Sites 285 and 289 in Baffin Bay (Segment 2492), Sites 263 and 264 in Nueces Bay (Segment 2482), and Sites 257 and 259 in Aransas Bay (Segment 2471).

Mean SQGQ values within TCEQ segments ranged from 0.016 and 0.073, with the highest mean segment SQGQ values occurring in Copano Bay (Segment 2472), Nueces Bay (Segment 2482) and Corpus Christi Bay (Segment 2481), respectively (Table 4.7). Box-plots in Fig. 4.6 indicates the wide variability seen within some segments and clearly shows the effect of the high SQGQ value calculated for Site 258 in Copano Bay (Segment 2472). The Baffin Bay complex is also right-skewed resulting from high SQGQ values at Sites 289 and 285. Low extremes in Corpus Christ Bay (Segment 2481) are a result of low SQGQ values at Sites 269, 272, 274, and 279 (Fig. 4.6). Segments with lower mean SQGQ values were Oso Bay (Segment 2485), St. Charles Bay (Segment 2473), and the Upper Laguna Madre (Segment 2491), respectively.

Table 4.7. Mean SQGQ values for TCEQ designated segments during the RCAP 2002.

Segment	Segment Name	n	Min	Max	Mean
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.027	0.031	0.029
2463	Mesquite Bay/Carlos Bay/ Ayers Bay	4	0.024	0.040	0.030
2471	Aransas Bay	5	0.005	0.052	0.033
2472	Copano Bay/Port Bay/Mission Bay	4	0.014	0.177	0.073
2473	St. Charles Bay	3	0.024	0.033	0.028
2481	Corpus Christi Bay	11	0.008	0.076	0.048
2482	Nueces Bay	3	0.045	0.068	0.057
2483	Redfish Bay	1	-	-	0.035
2485	Oso Bay	2	0.021	0.036	0.028
2491	Laguna Madre	10	0.002	0.037	0.016
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.012	0.071	0.038

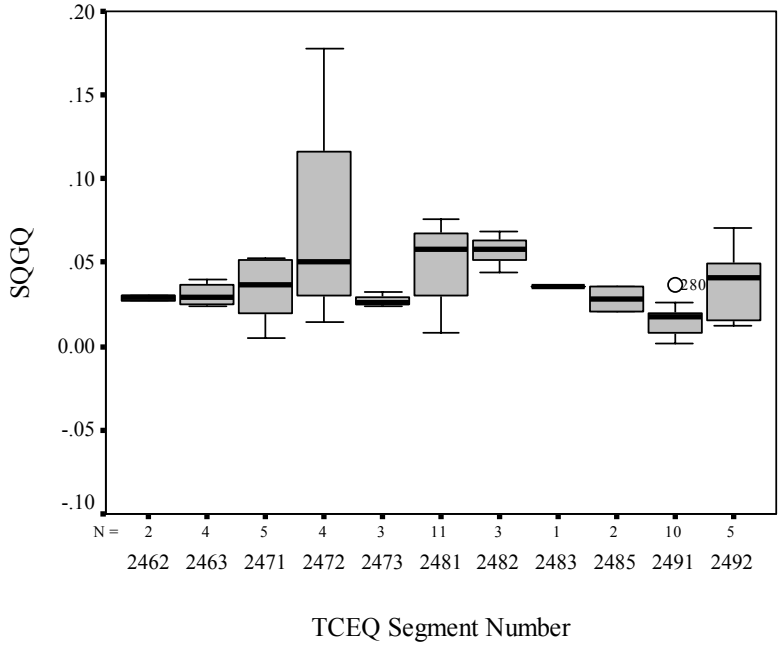


Fig. 4.6. Box and whisker plots of SQGQ values for TCEQ segments during RCAP 2002. Boxes are interquartile ranges; horizontal lines within boxes are medians; whisker endpoints are high and low extremes.

Factor analysis identified the variables primarily contributing to sediment loadings. Prior to analysis, 23 PAHs, 20 PCB's, 6 DDT metabolites and 13 Chlorinated Pesticides were reduced to four variables consisting of Total PAHs, Total PCB's, Total DDT's, and Total Chlorinated Pesticides. These variables, along with nine of the 15 metals (see Table 4.2), and the abiotic factors TOC, Sand, Silt-Clay, Salinity, and Dissolved Oxygen (DO) were combined into one data matrix.

Characterization of the sediment through ordination resulted in three PC axes that accounted for 81.5% of the cumulative variation. The first axis (Contaminant PC1) represented 39.8% of the variation with Arsenic, Chromium, Copper, Nickel, Lead, Zinc, Silt-Clay and Sand accounting for much of the variation. Positive PC1 factor values exhibiting increased metal concentrations and higher percentages of Silt-Clay, while negative values represented high sand content. The second PC axis (Contaminant PC2) represented 29.1% of the variation. Positive factor scores had higher loadings of Total PAHs. The third PC axis (Contaminant PC3) represented 12.6% of the variation. Positive factor scores had higher loadings of Total DDT and Total Chlorinated Pesticides. Sites with PC factor scores >0.80 typically had two or more concentrations above respective TEL values.

Sites located in Quadrant I (Fig. 4.7) had increases in concentrations of PC1 metals and Silt-Clay content. Quadrant II also contained sites characterized with increased Silt-Clay content and PC1 metals, with the addition of Total PAH concentrations. Quadrant III had increased Sand content and low contaminant concentrations, while Quadrant IV had high sand content and increased Total PAH concentrations.

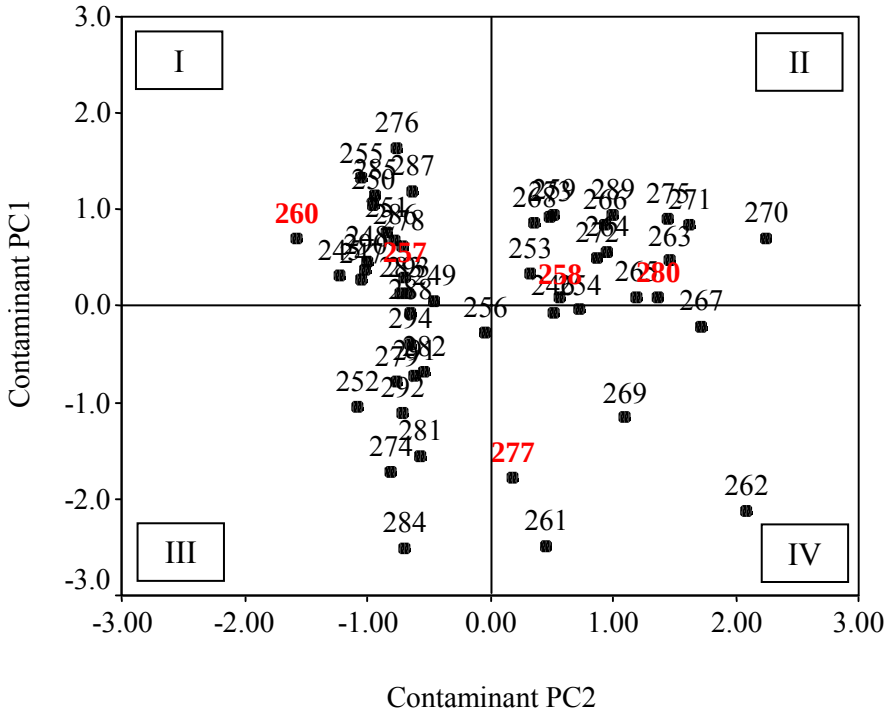


Fig. 4.7. Factor-loading scores for RCAP 2002 based on physical-chemical and contaminant variables. Sites found on the third PC axis are designated in bold red.

The sites with high PC1 scores were greatest in Corpus Christi Bay and Baffin Bay (Fig. 4.7). Sites 250 and 255 in Copano Bay (Segment 2472), Site 259 in Aransas Bay (Segment 2471), Sites 266, 268, 271, 273, 275, and 276 in Corpus Christi Bay (Segment 2481), and Sites 285 and 289 in Baffin Bay (Segment 2492) had high Contaminant PC1 scores and contained at least one metal concentration above respective TCEQ screening values (i.e. 85th percentiles).

Although concentrations of Total PAHs were low, factor analysis identified this variable as the second PC possibly due to the linear trend of increasing Total PAHs observed. Sites with high PC2 scores were greatest in the Nueces Estuary (Fig. 4.7) with Total PAHs detected in 82.4% of the sites sampled. Sites with high PC2 scores included Sites 263, 264, and 267 in Nueces Bay (Segment 2482), Site 265 in Redfish Bay (Segment 2483), and Sites 266, 269, 270, 271, 272 and 275 in Corpus Christi Bay (Segment 2481). In addition, high PC2 scores occurred at Site 262 in Aransas Bay (Segment 2471), Site 280 in the Upper Laguna Madre (Segment 2491) and Site 289 in Baffin Bay (Segment 2492).

The third PC axis consisted of sites (Fig. 4.7) with increased Chlorinated Pesticides and DDT. Typically, higher concentrations occurred in the Mission-Aransas Estuary. These included sites 257 in Mesquite Bay (Segment 2463), 258 in Copano Bay (Segment 2472), and 260 in Aransas Bay (segment 2471). Other sites include 277 in Oso Bay (Segment 2485) and 280 in Laguna Madre (Segment 2491).

RCAP 2002 Sediment Contaminant Distribution (SCD) ranking utilized both SQGQ and factor analysis. Initially, the upper and lower bound of the 95% Confidence Interval (CI) was used to group the SQGQ values into three categories. As a result, SQGQ breaks occurred at 0.029 for the lower bound CI and 0.045 for the upper bound CI. However, due to the relatively low contaminant concentrations seen at most RCAP 2002 sites, those sites with contaminants above the 85th percentile were not observed until SQGQ values were above the Upper Bound CI. This resulted in characterizing sites with SQGQ values above the Upper Bound CI as "Moderately" contaminated and sites below the Upper Bound CI as exhibiting "Low" contamination.

Moderately contaminated sites were located in five of eleven TCEQ segments with the CBBEP region (Fig 4.8). Site 258 was the only extreme outlier identified; and was thereby characterized with "High" sediment contamination. Additionally results from Factor analysis in Table 4.8 aided in determining what components were potentially responsible for elevated SQGQs (i.e. metals, PAH's, pesticides, etc.).

Table 4.8. Sites within TCEQ designated segments identified through factor analysis as having higher contamination relative to RCAP 2002 sampling sites.

Segment	Bay	Site	PC1 (Metals)	PC2 (Total PAH)	PC3 (Pesticides)
2472	Copano Bay/ Port Bay/ Mission Bay	250	*		
		255	*		
		258			*
2471	Aransas Bay	257			*
		259	*		
2482	Nueces Bay	263	*	*	
		264	*	*	
		267		*	
2481	Corpus Christi Bay	266	*	*	
		268	*		
		270		*	
		271	*	*	
		273	*		
		275	*	*	
		276	*		
2492	Baffin Bay/ Alazan Bay/	285	*		
	Cayo del Grullo/ Laguna Salada	289	*	*	

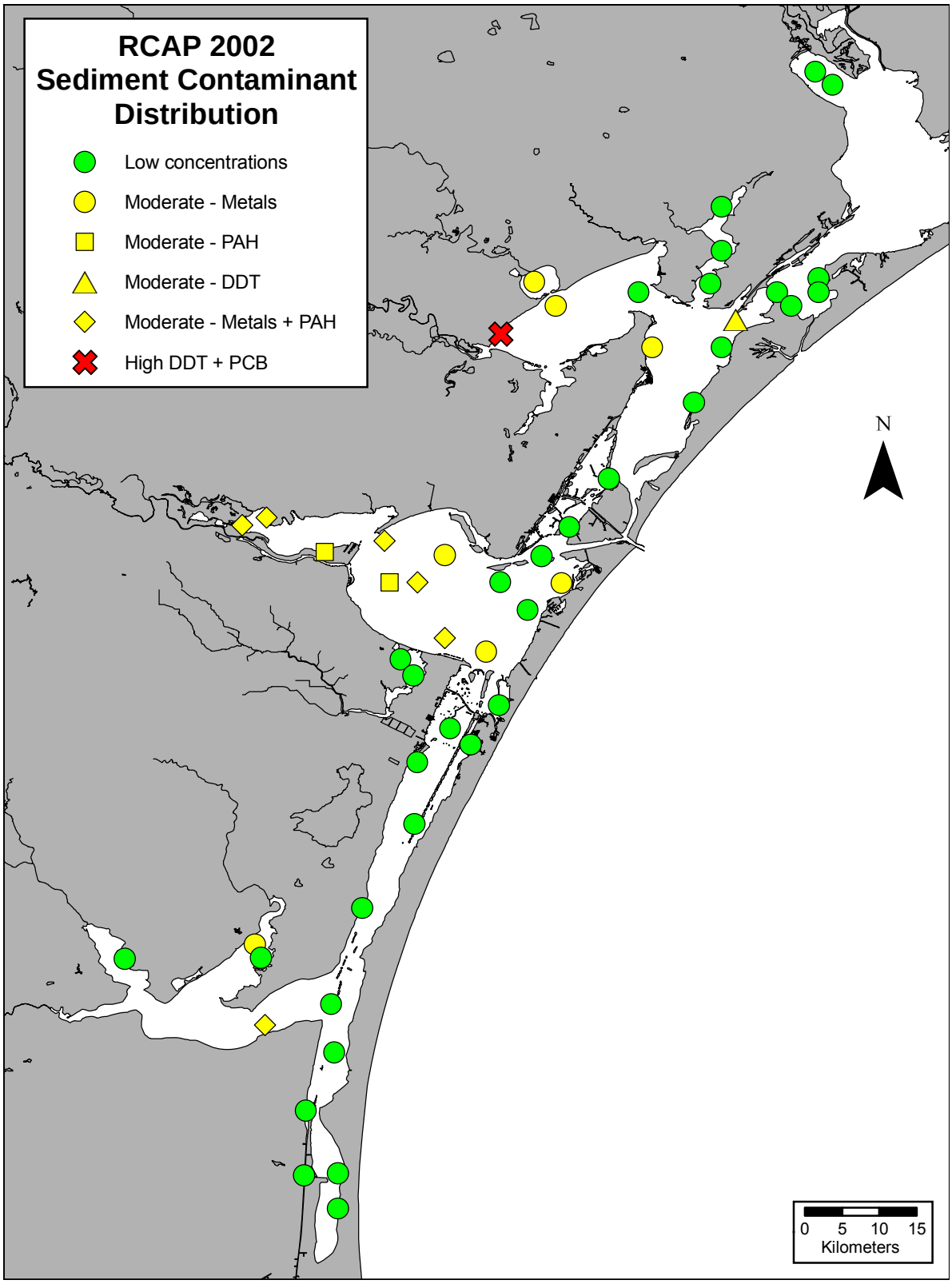


Fig. 4.8. Sediment contaminant distribution for RCAP 2002 sampling sites derived by SQGQ and Factor analysis. Metals consisted of Arsenic, Chromium, Copper, Nickel, Lead, and Zinc.

"Moderately" contaminated sites in the Mission-Aransas estuary primarily consisted of pesticides and metals. Sites typically were near sources of freshwater inflows or in areas where two bays or estuarine systems converged. Copano Bay and Mission Bay (Segment 2472) had three sites characterized as moderately contaminated. Based on factor analysis, SQGQ values at Sites 250 and 255 are likely due to metal concentrations (Table 4.8; Fig 4.8). Cumulatively these sites had high metal concentrations, with both sites exceeding 85th percentile screening values for Chromium and Lead. Site 258 was most associated with PCBs and pesticides with a PEL exceedance for 4,4'-DDD, Total DDT and Total PCB, and a TEL exceedance for 4,4'-DDE. Aransas Bay (Segment 2471) had two sites located in the northern portion of the bay that were characterized as moderately contaminated (Table 4.8; Fig. 4.8). Site 257 was characterized by increased pesticides, with concentrations above respective TEL values for 4,4'-DDE and Total DDT. A TEL exceedance also existed for Total PCBs. Site 259 exhibited elevated metal concentrations with 85th percentile exceedances for Chromium and Lead.

When compared to the other estuaries, the Nueces estuary exhibited higher PAH concentrations (Table 4.8; Fig. 4.7; Fig. 4.8). Factor analysis attributed the moderate contamination to Total PAHs and metals, with the majority of the sites being located in Quadrant II of Fig. 4.7. However, no exceedances of TCEQ screening levels (PEL and 85th percentile) existed. This could be a result of the overall increase of PAH concentrations in the area when compared to other RCAP 2002 sites. Increased PAH concentrations typically consisted of species characterized as High Molecular Weight PAHs, more indicative of historic deposition. Relative to the study, higher metal concentrations consisted of Cadmium, Chromium, and Lead. For Nueces Bay, all sites exhibited moderate contamination levels. Based on TCEQ screening levels, Site 263 had an 85th percentile exceedance for Cadmium and Lead. In addition, Mercury was above its respective TEL value. Site 264 had an 85th percentile exceedance for Cadmium and Lead and Site 267 exceeded the 85th percentile for Cadmium (see Table 4.5).

As with Nueces Bay, no TCEQ screening level exceedances (PEL and 85th percentile) for PAHs occurred in Corpus Christi Bay (Segment 2481). Factor scores associated with the higher SQGQ values detected some PAHs, typically consisting of High Molecular Weight PAHs, and metals as contributing to the moderate contaminant characterization (Table 4.8; Fig. 4.7; Fig. 4.8). Site 266 had 85th percentile exceedances for Lead and Zinc. Site 268 had an 85th percentile exceedance for Lead. Sites 270 and 271 had 85th percentile exceedances for Chromium and Mercury, in addition to an 85th percentile exceedance for Lead at Site 271. Site 273 also had 85th percentile exceedances for Chromium and Lead. Site 275 exceeded the 85th percentile for Chromium and Zinc in addition to concentrations above TEL values for Cadmium and Lead. In addition to the exceeded 85th percentile for Chromium and Lead, Site 276 the concentration for Copper was above the respective TEL (see Table 4.5).

Within the Baffin Bay complex (Segment 2492), Sites 285 and 289 were characterized with moderate contamination (Fig. 4.8). Factor analysis identified metal concentrations as the primary source (Table 4.8). Site 285 surpassed the 85th percentile for Chromium. Site 289 was above the 85th percentile for Lead in addition to higher Total PAHs concentrations relative to other RCAP 2002 sites. Furthermore, Total PCB concentrations were above TEL values at both sites (see Table 4.5).

Increased contaminant deposition observed in Nueces Bay (Segment 2482) and Copano Bay (Segment 2472), and possibly the Baffin Bay complex (Segment 2492) may be a result of increased freshwater inflows and concurrent sediment deposition, which occurred prior to sampling, as previously discussed in Section 3.3. This may also explain increased loadings observed in the northern portion of Aransas Bay, with possible contaminant transport from the San Antonio estuary to Aransas Bay, via the Intra-Coastal Waterway.

In general, sediment contamination throughout the CBBEP area was low. With the exception of Site 258, sites exhibiting any form of sediment contamination were characterized as "moderate". These sites typically had one or more contaminant above the respective 85th percentile or TEL. This suggests that although contamination is not high relative to the PEL, those particular areas may need additional sampling in future RCAP events to monitor whether concentrations are continuing to increase. Breaking the CBBEP region into four estuarine systems, based on a one-time sampling event, contaminants of interest for RCAP 2002 showed no concerns existed for sites sampled in the Guadalupe estuary, pesticides in the Mission-Aransas estuary, metals in the Nueces estuary, and metals along with PAHs for sites sampled in the Baffin Bay complex. Overall, except for Site 258, PCB's were of little concern with the majority of the concentrations at or near minimum detection limits.

4.3.5. Benthic Community

RCAP 2002, benthic analysis identified 173 species totaling 4775 individuals within the sampling area. Additional segments not sampled in previous studies (RCAP 2000 and 2001) included Segments 2462 (San Antonio Bay/Hynes Bay/Guadalupe Bay) and 2463 (Mesquite Bay/Carlos Bay/Ayres Bay) located in the Guadalupe Estuary.

The most abundant group was annelids, comprising 72.2% of all organisms collected. Polychaetes represented 89.6% of annelids collected. No one particular species numerically dominated this group. The second most abundant group was molluscs, which accounted for 12.3% of all organisms collected with collections dominated by the bivalve, *Mulinia lateralis*, which represented 20.4% of all molluscs collected. Arthropods represented 12.0% of all organism collected with the amphipod crustacean, *Microdeutopus* sp., representing 27.0% of all arthropods collected. Collectively these three groups represented 96.4% of all organism collected during RCAP 2002. The remaining 3.6% of organisms collected included representatives from the phyla Chaetognatha, Cnidaria, Echinodermata, Nemertea, Nemata, Sipuncula, and Hemichordata.

Across the region at all 50 RCAP 2002 sites species richness ranged from 1 to 55 (mean = 16) species collected and was negatively correlated with Silt-Clay (-0.555, $p<0.01$). Density ranged from 49 to 13,445 individuals m^{-2} (mean = 2356 individuals m^{-2}), and was positively correlated with salinity (0.318, $p <0.05$) and was negatively correlated with Silt-Clay (-0.424, $p <0.01$). Biomass ranged from 0.01 to 15.63 g m^{-2} (mean = 3.96 g m^{-2}). Table 4.9 list benthic community characteristics by TCEQ Segment. The EPA-BCI resulted in values ranging from –1.07 to 10.49 (mean = 5.27).

Table 4.9. Benthic community characteristics, EPA Benthic Condition Index, and dominant species percent contribution as related to density and distribution, listed by TCEQ Segment. Numbers for community characteristics are ranges with mean values in parentheses. AC =Arthropod Crustacean, AP =Annelid Polychaete, MB =Mollusc Bivalve, and N =Nemertean.

Segment*	Species Richness	Density (m^{-2})	Biomass (g m^{-2})	Species Diversity	EPA Benthic Index	Dominant Species and Percent Contribution (Density and Distribution)	%
2462 (n=2)	4 – 7 (6)	937 – 1100 (1024)	0.88 – 4.62 (2.75)	1.74 – 2.64 (2.19)	3.49 – 4.21 (3.85)	*Capitella capitata* (AP) *Mediomastus* sp. (AP) *Mulinia lateralis* (MB)	91.3
2463 (n=4)	7 – 28 (15)	345 – 13,445 (3842)	0.09 – 11.16 (4.62)	2.50 – 3.13 (2.81)	-1.07 – 7.30 (4.55)	*Mediomastus* sp. (AP) Nemertean (N) *Cossura delta* (AP)	83.4
2471 (n=5)	7 – 55 (23)	197 – 10,090 (2724)	0.11 – 11.18 (4.24)	2.75 – 4.74 (3.63)	5.56 – 9.45 (7.24)	*Glycinde solitaria* (AP) *Capitella capitata* (AP) Cumacean (AC)	64.9
2472 (n=4)	4 – 29 (11)	321 – 1752 (826)	0.09 – 10.45 (2.80)	1.49 – 4.55 (2.44)	2.34 – 10.49 (5.00)	*Mediomastus* sp. (AP) *Capitella capitata* (AP) Nemertean (N)	95.6
2473 (n=3)	3 – 10 (6)	99 – 1406 (584)	0.09 – 0.60 (0.38)	1.50 – 2.27 (1.83)	4.10 – 4.72 (4.42)	*Mediomastus* sp. (AP)	100.0
2481 (n=11)	10 -44 (21)	740 – 6686 (2279)	1.02 – 9.85 (4.27)	2.71 – 4.30 (3.39)	0.52 – 8.08 (6.34)	*Aricidea fragilis* (AP) *Paleanotus heteroseta* (AP) *Branchioasychis americana* (AP)	49.6
2482 (n=3)	1 – 14 (6)	123 – 690 (411)	0.01 – 1.11 (0.51)	0.00 – 3.35 (1.70)	1.82 – 8.21 (5.44)	*Mediomastus* sp. (AP)	100.0
2483 (n=1)	- (30)	- (7006)	- (5.29)	- (3.63)	- (7.28)	*Paraonides cf. lyra* (AP) *Tharyx cf. annulosus* (AP) *Clymenella torquata* (AP)	54.6
2485 (n=2)	11 – 17 (14)	1110 – 5477 (3293)	1.78 – 12.00 (6.89)	2.68 – 2.95 (2.82)	4.55 – 4.57 (4.56)	*Capitella capitata* (AP) *Streblospio benedicti* (AP) *Heteromastus filiformis* (AP)	94.3
2491 (n=10)	2 – 39 (19)	49 – 8314 (3626)	0.11 – 10.51 (4.15)	1.00 – 4.42 (2.98)	2.34 – 7.75 (4.90)	*Syllis gracilis* (AP) *Prionospio heterobranchia* (AP) *Microdeutopus* sp. (AC)	40.1
2492 (n=5)	1 – 30 (10)	74 – 2196 (1110)	0.02 – 15.63 (6.25)	0.00 – 4.42 (1.87)	1.82 – 6.15 (3.67)	*Mulinia lateralis* (MB) *Streblospio benedicti* (AP) *Anomalocardia auberiana* (MB)	91.3

* 2462 (San Antonio Bay/Hynes Bay/Guadalupe Bay), 2463 (Mesquite Bay/Carlos Bay/Ayers Bay), 2471 (Aransas Bay), 2472 (Copano Bay/Port Bay/Mission Bay), 2473 (St. Charles Bay), 2481 (Corpus Christi Bay), 2482 (Nueces Bay), 2483 (Redfish Bay), 2485 (Oso Bay), 2491 (Laguna Madre), 2492 (Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada).

Benthic community assemblage analysis grouped together sites into clusters by constructing a dendrogram using a Bray-Curtis similarity matrix that reflected aspects of similarity (species composition and densities). Groups were super-imposed over an MDS plot to cross-check the adequacy and consistency of both representations (Fig. 4.9).

Both cluster analysis and the MDS plot (Stress = 0.22) revealed that 47 of the 50 sites sampled during RCAP 2002 could be attributed to four assemblages. The three remaining sites, which did not group within any assemblage, were outliers (Site 248 located in St. Charles Bay, Site 284 in the Upper Laguna Madre adjacent to the King Ranch shoreline, and Site 281 in the Upper Laguna Madre located with the Padre Isles subdivision canal system) (Fig. 4.9).

Mean similarities of sites within each assemblage ranged from 14.3% to 23.2%. Univariate analysis of variance (ANOVA) and Kruskwal-Wallis also showed statistically significant among group differences for richness ($F = 21.78$, $p < 0.001$), density ($F = 18.27$, $p < 0.001$), and biomass (Chi-Square = 15.80, $p = 0.001$). Box-plots in Fig. 4.10 show the spread within the assemblages.

The BIOENV analysis indicated the best correlation between abiotic and biotic data was the combination of depth, salinity, and Silt-Clay ($r_w = 0.395$). Although significant, the relatively low correlation suggests that some unmeasured variable is effecting the benthic distribution in addition to the aforementioned variables. Univariate analysis of variance (ANOVA) and Kruskwal-Wallis also showed statistically significant among group differences for total depth (Chi-Square = 32.73, $p < 0.001$), bottom salinity (Chi-Square = 13.93, $p = 0.003$), and Silt-Clay (Chi-Square = 18.00, $p < 0.001$) Box-plots in Fig. 4.11 show the spread within the assemblages.

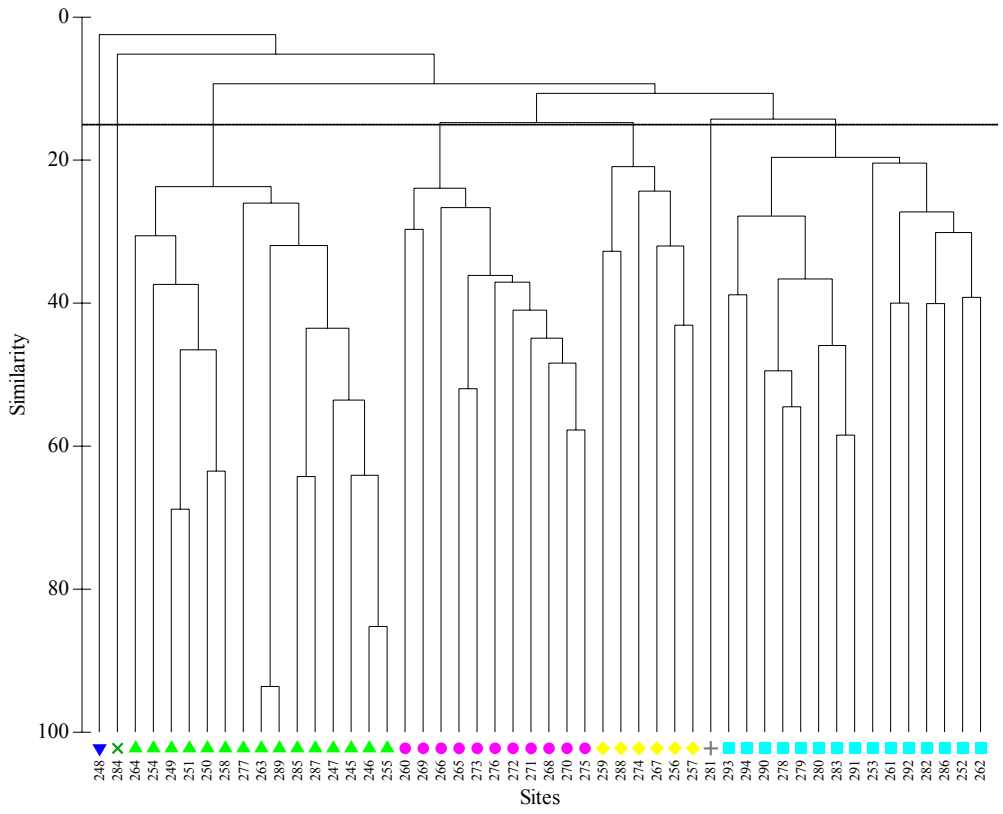
Based on factors that the BIOENV procedure identified as affecting assemblage distribution resulted in the four assemblage classifications, with Fig. 4.12 supplied to provide a geographical distribution of these assemblages:

1. **M**id-Depth **M**esohaline **M**uddy-**S**and Assemblage (**MMMS**),

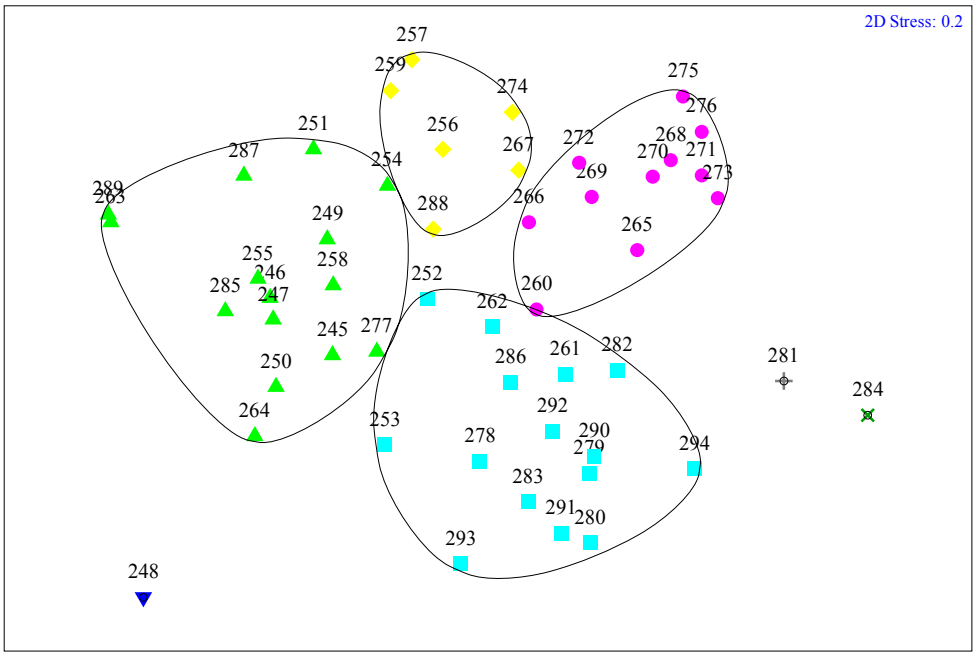
2. **D**eep-Depth **P**olyhaline **M**uddy-**S**and Assemblage (**DPMS**),

3. **S**hallow-Depth **E**uhaline **S**and Assemblage (**SES**),

4. **M**id-Depth **P**olyhaline **S**andy-**M**ud Assemblage (**MPSM**).



a)



b)

Fig. 4.9. Benthic assemblages determined by a) cluster analysis with results super-imposed onto a b) MDS plot to cross check for adequacy and mutual consistency of both representations.

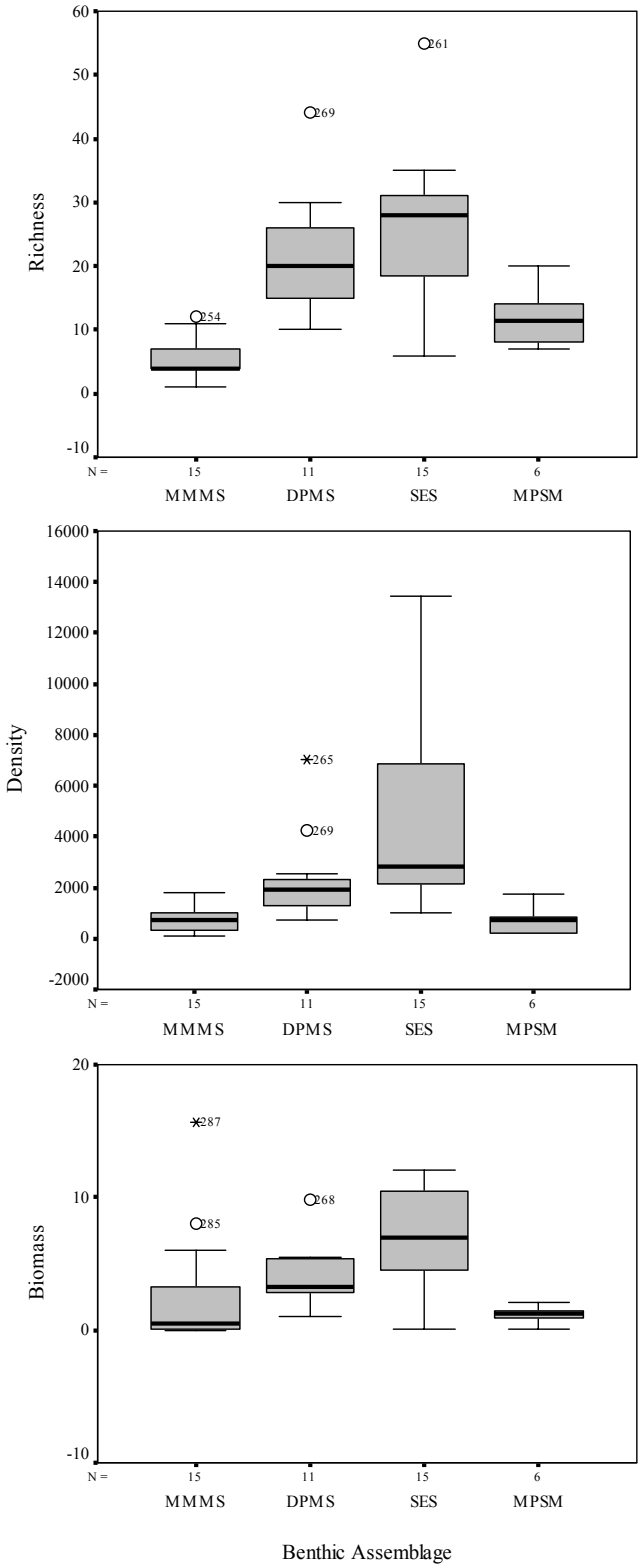


Fig. 4.10. Box and whiskers plots of biotic factors a) Richness, b) Density, and c) Biomass by benthic assemblage. Boxes are interquartile ranges; horizontal lines within boxes are medians; whisker endpoints are high and low extremes.

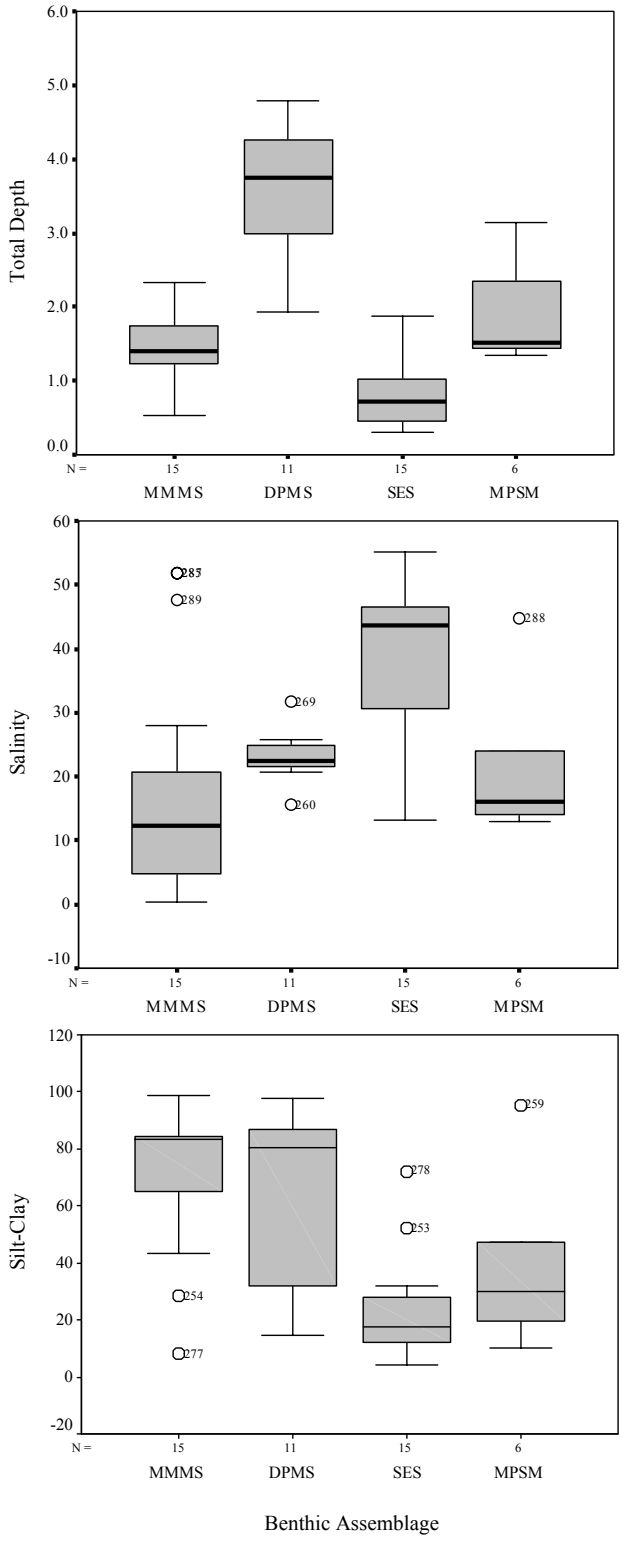


Fig. 4.11. Box and whisker plots of abiotic factors a) Total Depth, b) Salinity, and c) Silt-Clay content by benthic assemblage. Boxes are interquartile ranges; horizontal lines within boxes are medians; whisker endpoints are high and low extremes.

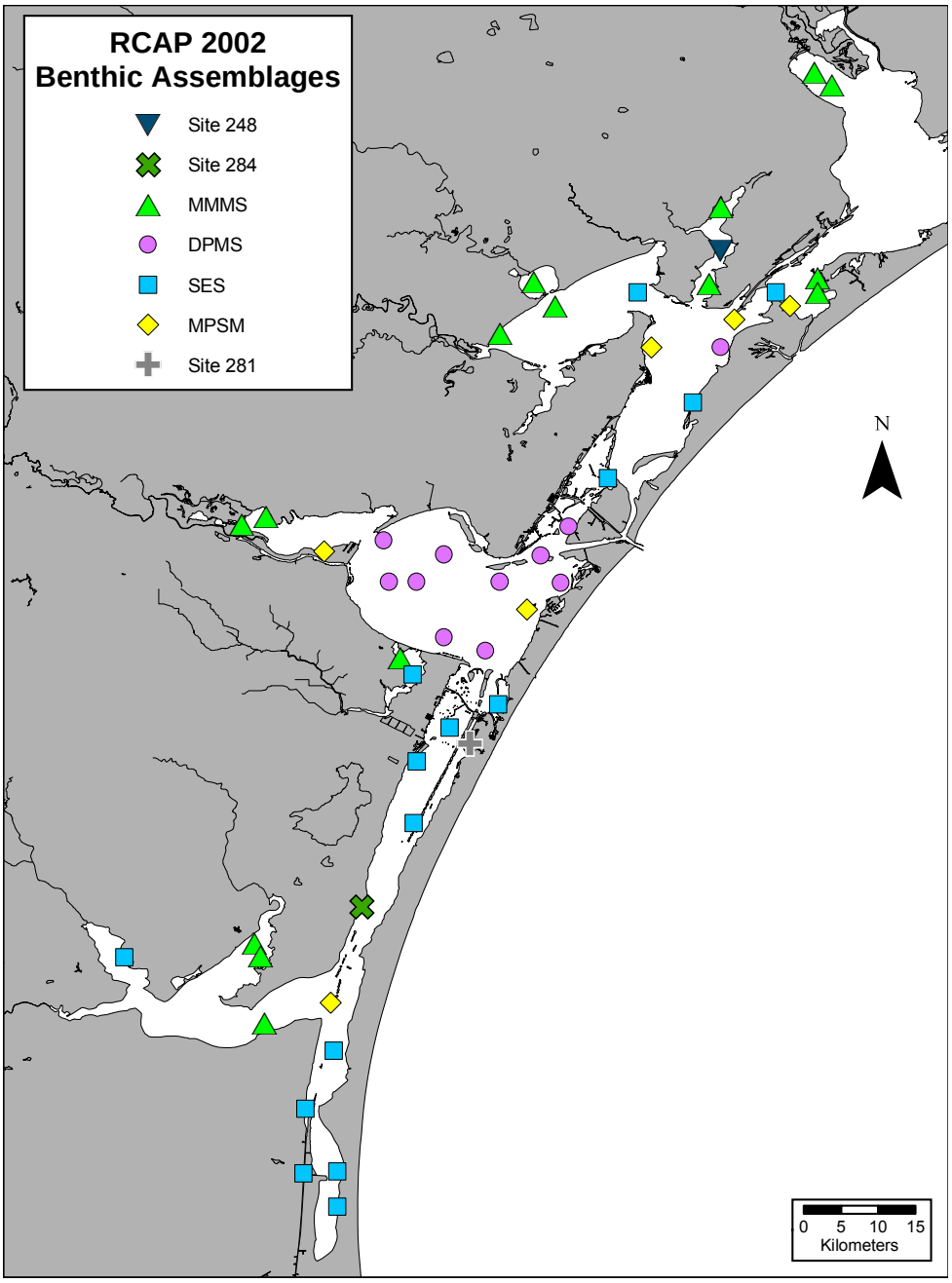
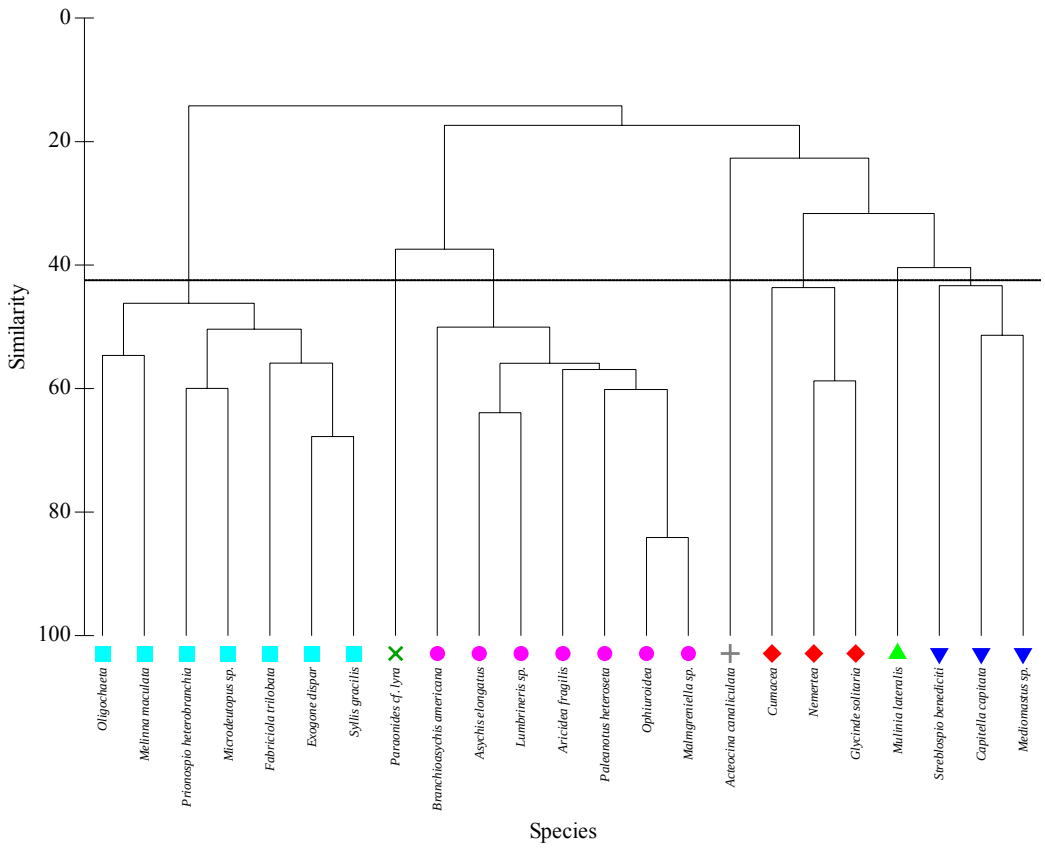
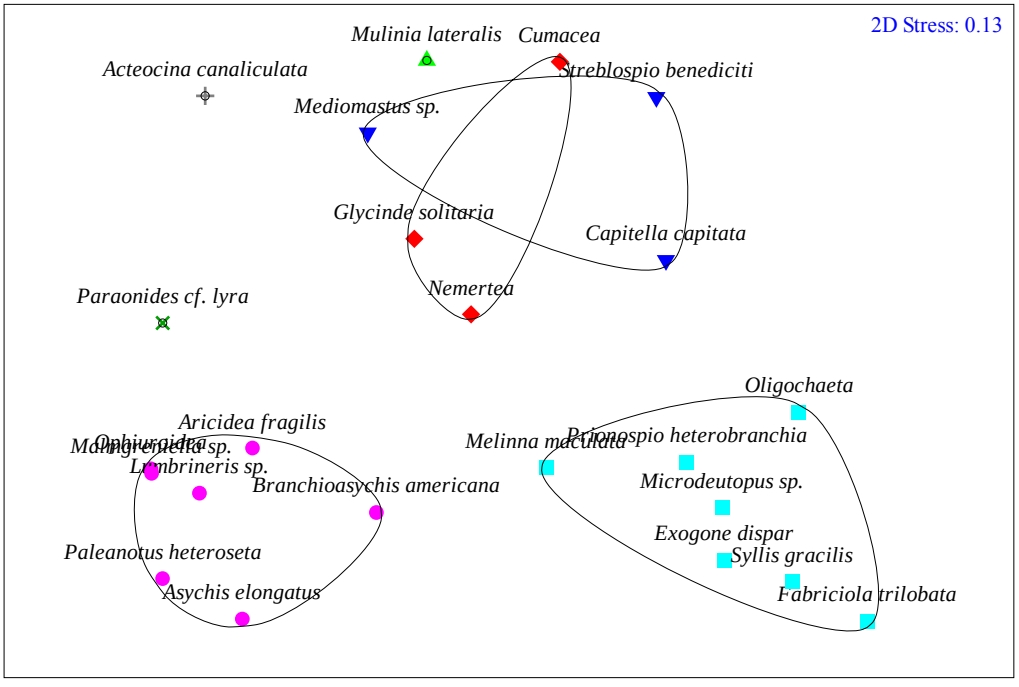


Fig. 4.12. Benthic assemblage distribution for RCAP 2002.

The SIMPER procedure identified the species that contributed the greatest to similarity within the assemblage and dissimilarity between the assemblages. The species contributing to over 70% of inter-group similarity within the benthic assemblages reduced the matrix from 173 species to 23 species. Inverse cluster analysis performed on the reduced species matrix identified species that were more representative of the benthic assemblages. Cluster analysis and the MDS plot (Stress = 0.13) revealed that 20 of the 23 species could be attributed to four species groups, with three outlying species, *Mulinia lateralis*, *Acteocina canaliculata* and *Paraonides* cf. *lyra* (Fig. 4.13). Table 4.10 presents total densities and percent frequency of occurrence within each benthic assemblage, listed by species groups.



a)



b)

Fig. 4.13. Species groups determined by a) cluster analysis with results superimposed onto a b) MDS plot.

Table 4.10. Total density (individuals m^{-2}) of taxa within each benthic assemblage by species group. Numbers in parentheses denote the percentage of occurrence within the benthic assemblage groups. Species contributing to over 70% of inter-group similarity within the benthic assemblages are in bold.

	Benthic Assemblages			
Species	**MMMS** (n=15)	**DPMS** (n=11)	**SES** (n=15)	**MPSM** (n=6)
Species Group 1				
Oligochaeta	98.7 (7)	98.7 (9)	**8585.2 (60)**	24.7 (17)
Melinna maculata	222.0 (7)	246.7 (55)	**1307.5 (73)**	-
Prionospio heterobranchia	-	24.7 (9)	**8017.8 (73)**	74.0 (33)
Microdeutopus sp.	-	-	**3774.5 (80)**	-
Fabriciola trilobata	24.7 (7)	-	**3157.8 (33)**	-
Exogone dispar	-	-	**1628.2 (47)**	-
Syllis gracilis	-	-	**2738.4 (53)**	-
Species Group 2				
Paraonides cf. *lyra*	-	**3034.4 (45)**	24.7 (7)	172.7 (17)
Species Group 3				
Branchioasychis americana	-	**1011.5 (100)**	**1406.2 (33)**	148.0 (50)
Asychis elongatus	-	**1307.5 (64)**	123.4 (7)	-
Lumbrineris sp.	-	**789.4 (73)**	24.7 (7)	24.7 (17)
Aricidea fragilis	-	**2565.7 (91)**	370.0 (20)	567.4 (33)
Paleanotus heteroseta	24.7 (7)	**1751.6 (82)**	-	-
Ophiuroidea	74.0 (7)	**740.1 (73)**	24.7 (7)	24.7 (17)
Malmgreniella sp.	49.3 (7)	**888.1 (64)**	49.3 (7)	-
Species Group 4				
Acteocina canaliculata	-	24.7 (9)	49.3 (7)	**197.4 (83)**
Species Group 5				
Cumacea	98.7 (13)	-	246.7 (27)	**74.0 (50)**
Nemertea	419.4 (40)	567.4 (45)	**986.8 (60)**	24.7 (17)
Glycinde solitaria	148.0 (27)	123.4 (36)	**493.4 (40)**	**296.0 (100)**
Species Group 6				
Mulinia lateralis	2121.6 (47)	98.7 (18)	394.7 (20)	**345.4 (83)**
Species Group 7				
Streblospio benedicti	**1578.9 (73)**	370.0 (27)	2269.6 (20)	24.7 (17)
Capitella capitata	**2368.3 (67)**	98.7 (18)	**4366.6 (73)**	24.7 (17)
Mediomastus sp.	**1847.9 (67)**	468.7 (27)	518.1 (27)	394.7 (33)

MMMS (Mid Depth, Mesohaline, Muddy sand)
DPMS (Deep, Polyhaline, Muddy Sand)
SES (Shallow, Euhaline, Sand)
MPSM (Mid Depth, Polyhaline, Sandy Mud)

Based on weight-of-evidence approach, biotic measures of species richness, density, biomass, and the EPA Benthic Condition Index (EPA-BCI) were combined with SCD rankings (SQGQ values and factor analysis) and sediment toxicity results within the assemblages to assess sediment quality. Sites were characterized as having low species richness, density and biomass if measures fell below the 25th percentile and high if measures were above the 75th percentile relative to the other sites sampled in the study. Sites with low benthic measures, SQGQ values >0.045 and/or exhibiting expression of toxic effects, were reported as potentially stressed sites.

Mid Depth, Mesohaline, Muddy Sand (MMMS)

The MMMS assemblage grouped together 15 sites, typically near sources of freshwater inflows (Fig. 4.12), located in St. Charles Bay (Segment 2473), Copano Bay/Port Bay/Mission Bay (Segment 2472), Oso Bay (Segment 2485), Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada (Segment 2492), Nueces Bay (Segment 2482), and Mesquite Bay/Carlos Bay/Ayres Bay (Segment 2463). Depths ranged from 0.53 m to 2.33 m with a mean of 1.5 m. Due to the broad geographic location of sites, this assemblage had the greatest bottom salinity variability. Concentrations ranged from 0.36 PSU to 51.74 PSU with a mean of 17.60 PSU, classifying this as a mesohaline assemblage. Low Silt-Clay content at Sites 254 and 277 (Fig. 4.11) skewed Silt-Clay content within this assemblage. Silt-Clay ranged from 8.1% to 98.8% with a mean of 71.3%, classifying this as a muddy-sand assemblage.

Mean benthic density was 705 individuals m^{-2} and ranged from 74 individuals m^{-2} to 1826 individuals m^{-2}. Biomass ranged from 0.01 g m^{-2} to 15.63 g m^{-2}. Mean species richness was 6 species collected and ranged from 1 to 12 species collected. Species diversity ranged from 0.00 to 3.13. The EPA-BCI ranged from good to poor, with the majority of the 15 sites characterized as poor. The inverse cluster analysis identified the two ubiquitous groups, Species Group 6 and 7, as the primary species contributing the greatest similarity within the MMMS assemblage (Table 4.10). While theses species occurred within other assemblages, densities and frequencies of occurrence typically were greatest within this assemblage (Table 4.10). Both groups consist of organisms characterized as pollution-tolerant species indicative of environmental stress and organic enrichment. As a result, the MMMS assemblage as a whole, exhibited characteristics of a stressed community.

Sites in the MMMS assemblage were located in areas where salinity shifts are common. Northern sites were located near freshwater inputs, often subjecting these communities to dramatic salinity reductions during significant freshwater inflows. Sites in Baffin Bay were located in areas where evaporation exceeds precipitation, creating a hypersaline environment; both decreases and increase in salinity often result in stressful environments for benthic communities. As a result, the possibility that the bioeffects are partially due to co-varying stressors, other than anthropogenic inputs, deserves consideration (Hyland et al. 2003).

Seven of 15 sites within the MMMS assemblage, characterized with moderate sediment contaminants exhibited characteristics of a stressed benthic community consisting of low richness, densities, and biomass (Table 4.11). The EPA-BCI at these seven sites ranged from good to poor. Site 258, characterized with high sediment contamination, exhibited characteristics of a stressed community with low richness and biomass and poor EPA-BCI rank. Site 285, which characterized with low richness, moderate densities and high biomass,

was dominated by the bivalve *Mulinia lateralis*. The dominance of a single organism is another characteristic of a disturbed community (Hyland et al. 2000; Gray 1981). Carr et al. (1998) identified this bivalve as a pollution tolerant organism in this area.

Four of the 15 sites exhibited toxic effects. The expression of toxic effects at Sites 249 and 254 might be attributed to elevated 4,4'-DDT concentrations. While Site 249 exhibited characteristics of a stressed benthic community (low density and biomass), the EPA-BCI characterized the benthic condition as good. Sediment toxicity analysis showed Site 287 as exhibiting toxic effects and displaying characteristics of a stressed benthic community, as well as poor EPA-BCI ranking. This site had a low Sediment Contaminant Distribution (SCD) rank, but an 85th percentile exceedance for chromium. Site 251, the only site with high TOC concentrations also exhibited characteristics of a stressed community (Table 4.11). Site 246 exhibited toxic effects, but did not display characteristics typical of a stressed benthic community, nor was there evidence of sediment contamination.

Table 4.11. Benthic community characterization in relation to sediment contaminant characteristics within the MMMS assemblage. Bold represents sites characterized with reduced benthic community measures. SAV indicates presence or absence of submerged aquatic vegetation.

Segment*	Site	Richness	Density	Biomass	EPA BCI	Toxic	TOC	SCD	SAV	Silt-Clay
2462	245	Moderate	Moderate	Moderate						Mud
2462	246	Moderate	Moderate	Moderate						Mud
2463	**249**	**Moderate**	**Low**	**Low**						**Sandy Mud**
2463	254	Moderate	Moderate	High						Sandy Mud
2472	**250**	**Low**	**Low**	**Low**						**Mud**
2472	**255**	**Low**	**Low**	**Low**						**Mud**
2472	**258**	**Low**	**Moderate**	**Low**						**Mud**
2473	247	Moderate	Moderate	Low						Muddy Sand
2473	**251**	**Low**	**Low**	**Low**						**Muddy Sand**
2482	**263**	**Low**	**Low**	**Low**						**Mud**
2482	**264**	**Low**	**Low**	**Low**						**Mud**
2485	277	Moderate	Moderate	Moderate						Mud
2492	**285**	**Low**	**Moderate**	**High**						**Mud**
2492	**287**	**Low**	**Moderate**	**High**						**Mud**
2492	**289**	**Low**	**Low**	**Low**						**Mud**

* 2462 (San Antonio Bay/Hynes Bay/Guadalupe Bay), 2463 (Mesquite Bay/Carlos Bay/Ayers Bay), 2472 (Copano Bay/Port Bay/Mission Bay), 2473 (St. Charles Bay), 2482 (Nueces Bay), 2485 (Oso Bay), 2492 (Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada).

Deep Depth, Polyhaline, Muddy Sand (DPMS)

The DPMS assemblage grouped together 11 sites primarily in Corpus Christi Bay (Segment 2481), with one site in Redfish Bay (Segment 2483), and one in Aransas Bay (2471) (Fig. 4.12). Sites were typically deep, ranging from 1.94 m to 4.78 m with a mean of 3.61 m. Salinities ranged from 15.69 PSU to 31.73 PSU with a mean of 23.21 PSU, classifying it as a polyhaline assemblage. Sediments in this assemblage ranged from 14.9% to 97.7% Silt-Clay with a mean of 63.7%, classifying this assemblage as a muddy-sand assemblage.

Mean benthic density was 2344 individuals m^{-2}. Density ranged from 740 individuals m^{-2} to 7006 individuals m^{-2} and biomass ranged from 1.02 g m^{-2} to 9.85 g m^{-2}. Mean species richness was 22 and ranged from 10 to 44 species collected. Species diversity ranged from 2.71 to 4.30. The EPA-BCI characterized all sites as good. Two species groups were associated with the assemblage. Species Group 2 consisted of one small-bodied polychaete, whose distribution within the assemblage was primarily near the pass to the Gulf of Mexico and Species Group 3 consisted of ubiquitous, large-bodied organisms (Table 4.10).

The DPMS assemblage is a relatively stable community with sites primarily located in Corpus Christi Bay. Salinities were polyhaline with minimal variability. Although no evidence of significant benthic impairment exists, a reduction of benthic community measures existed where moderate sediment contamination occurred (Table 4.12). This was greatest at Sites 266, 270, 273, 275, and 276. Sites 275 and 276 were also located in an area of Corpus Christi Bay where reduced richness and densities previously occurred (Nicolau and Nuñez 2004). Sites 265 and 271 exhibited toxic effects without exhibiting any reduction of benthic community characteristics. Contaminant concentrations at Site 265 were either non-detects or well below sediment quality guidelines.

Table 4.12. Benthic community characterization in relation to sediment contaminant characteristics within the DPMS assemblage. Bold represents sites characterized with reduced benthic community measures. SAV indicates presence or absence of submerged aquatic vegetation.

Segment	Sites	Richness	Density	Biomass	EPA-BCI	Toxic	TOC	SCD	SAV	Silt-Clay
2471	260	High	Moderate	Moderate						Sandy Mud
2481	**266**	**Moderate**	**Moderate**	**Moderate**						**Muddy Sand**
2481	268	Moderate	Moderate	High						Mud
2481	269	High	High	Moderate						Sand
2481	**270**	**Moderate**	**Moderate**	**Moderate**						**Mud**
2481	271	Moderate	High	Moderate						Mud
2481	272	High	Moderate	Moderate						Sandy Mud
2481	**273**	**Moderate**	**Moderate**	**Moderate**						**Mud**
2481	**275**	**Moderate**	**Moderate**	**Moderate**						**Mud**
2481	**276**	**Moderate**	**Moderate**	**Moderate**						**Mud**
2483	265	High	High	Moderate						Sandy Mud

* 2471 (Aransas Bay), 2481 (Corpus Christi Bay), 2483 (Redfish Bay),

Shallow Depths, Euhaline, Sand (SES)

The SES assemblage grouped together 15 sites with the majority of sites located in the Upper Laguna Madre (Segment 2491) (Fig. 4.12). Sites in this assemblage were typically shallow, ranging from 0.30 m to 1.88 m, with a mean of 0.83 m. Salinities ranged from 13.22 PSU to 55.10 PSU with a mean of 37.91 PSU, classifying it as a euhaline assemblage. Sediments in this assemblage ranged from 4.2 % to 72.3 % Silt-Clay, with a mean of 23.7%; classifying this assemblage as a sandy-mud assemblage (Fig. 4.11).

Mean benthic density was 4969 individuals m^{-2}. Density ranged from 1011 individuals m^{-2} to 13445 individuals m^{-2} and a biomass ranged from 0.11 g m^{-2} to 12.00 g m^{-2}. Mean species richness was 26 and ranged from 6 to 55 species collected. Species diversity ranged from 1.46 to 4.74. Benthic condition based on the EPA-BCI ranged from poor to good. Three species groups were associated with this assemblage. Species Group 1 consisted of a large number of organisms, including three species found exclusively within this assemblage (Table 4.10). Although not exclusive to this assemblage, Species Groups 5 and 7 had higher densities and frequencies of occurrences within this assemblage (Table 4.10).

The SES assemblage contained the greatest number of sites (nine) characterized as exhibiting toxic effects (Table 4.13). Of those, only two sites (290 and 294) exhibited reductions in community composition. Within the nine sites, only Site 280 had a TEL exceedance for acenaphthylene, with no observations of biological stress. SCD rankings for this assemblage were all low and benthic community characteristics did not reflect a degraded benthic community, as this assemblage exhibited the highest richness, densities and biomass (Fig. 4.10).

The SES assemblage also had the greatest number of top contributing species, in addition to the most diverse species group associated with it (Table 4.10). In addition, 12 sites within the SES assemblage also occurred in the presence of submerged aquatic vegetation, or SAV (Table 4.13). Of these 12 sites, five had a good EPA-BCI score, four were fair, and three classified as poor. Many of the characteristics listed are not typical within an impaired benthic community. For this reason, there is reason to suspect that the EPA Benthic Condition Index may misrepresent this type of benthic community due to the extreme negative weight placed on the occurrence of oligochaetes, the one common factor for most sites classified as fair and poor, and warrants further investigation.

Five sites exhibited reductions of benthic community measures. Site 262 did not exhibit toxic effects nor classified with moderate or high SCD's. However a TEL exceedance for Dibenz(a,h)pyrene was observed. Two sites (293 and 294) described as exhibiting signs of stress were characterized with moderate richness, high densities and low biomass; suggesting the dominance of a few small-bodied organisms. These sites are located in "Nine-Mile or Dead Mans Hole" which is a naturally stressed environment for the benthic community, due to its shallow depth (<0.5), limited circulation, and high salinities.

Table 4.13. Benthic community characterization in relation to sediment contaminant characteristics within the SES assemblage. Bold represents sites characterized with reduced benthic community measures. SAV indicates presence or absence of submerged aquatic vegetation.

Segment	Site	Richness	Density	Biomass	EPA-BCI	Toxic	TOC	SCD	SAV	Silt-Clay
2463	253	High	High	High						Muddy Sand
2471	261	High	High	High					*	Sand
2471	**262**	**Moderate**	**Moderate**	**Moderate**						**Sand**
2472	252	High	High	High						Sand
2481	279	High	High	High					*	Sand
2485	278	Moderate	High	High					*	Muddy Sand
2491	280	High	High	High					*	Sandy Mud
2491	**282**	**Moderate**	**Moderate**	**Moderate**					*****	**Sand**
2491	283	High	High	High					*	Sandy Mud
2491	**290**	**Moderate**	**Moderate**	**Moderate**					*****	**Sandy Mud**
2491	291	High	High	High					*	Sand
2491	292	High	High	Moderate					*	Sand
2491	**293**	**Moderate**	**High**	**Low**					*****	**Sand**
2491	**294**	**Moderate**	**High**	**Low**					*****	**Sandy Mud**
2492	286	High	Moderate	Moderate					*	Sand

* 2463 (Mesquite Bay/Carlos Bay/Ayers Bay), 2471 (Aransas Bay), 2472 (Copano Bay/Port Bay/Mission Bay), 2481 (Corpus Christi Bay), 2485 (Oso Bay), 2491 (Laguna Madre), 2492 (Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada).

Mid Depth, Polyhaline, Sandy Mud (MPSM)

The MPSM assemblage grouped together six sites located throughout the study area (Fig. 4.12). Depths ranged from 1.35 m to 3.14 m with a mean of 1.88 m. Salinities ranged from 12.87 PSU to 44.87 PSU with a mean of 21.33 PSU, classifying it as a polyhaline assemblage. Sediments in this assemblage ranged from 10.1% Silt-Clay to 95.5% with a mean of 38.7%, classifying this assemblage as a sandy-mud assemblage (Fig. 4.11).

Mean benthic density was 736 individuals m^{-2}. Density ranged from 197 individuals m^{-2} to 1726 individuals m^{-2} and a biomass range of 0.11 g m^{-2} to 2.11 g m^{-2}. Mean species richness was 12 and ranged from 7 to 20 species collected. Species diversity ranged from 2.75 to 3.35. The EPA-BCI primarily consisted of sites classified as good. Species Group 4 consisted of one organism *(Acteocina canaliculata)*, which was indicative of this assemblage (Table 4.10). Geographically this assemblage had a greater distribution through out the study area (Figure 4.12). For example, the MMMS assemblage consisted of sites located in secondary bays of the estuaries; DPMS had sites primarily located in Corpus Christi Bay; and SES sites were located primarily in the Laguna Madre. For this reason, the MPSM assemblage consisted of many of the species associated with aforementioned assemblages (Table 4.10).

The MPSM assemblage was primarily located on the bay margins of present day, or geographically historical barrier islands. These sites were typically moderate in richness, densities and biomass. The only sites in this assemblage characterized with moderate contamination showed reductions of densities and/or biomass yet had a good EPA-BCI. Site 259 is located in an area that typically experiences heavy shrimp trawling activity, which often disturbs the bottom sediments that may explain the reduced benthic measures observed. Site 288, characterized as exhibiting toxic effects, but did not have sediment quality guideline exceedances, nor did it exhibit signs of benthic stress (Table 4.14).

Table 4.14. Benthic community characterization in relation to sediment contaminant characteristics within the MPSM assemblage. Bold represents sites characterized with reduced benthic community measures. SAV indicates presence or absence of submerged aquatic vegetation.

Segment	Sites	Richness	Density	Biomass	EPA-BCI	Toxic	TOC	SCD	SAV	Silt-Clay
2463	256	Moderate	Moderate	Moderate						Sandy Mud
2471	**257**	**Moderate**	**Low**	**Moderate**						**Mud**
2471	**259**	**Moderate**	**Low**	**Low**						**Sandy Mud**
2481	274	Moderate	Moderate	Moderate						Sand
2482	267	Moderate	Moderate	Moderate						Sandy Mud
2492	288	Moderate	Moderate	Moderate						Sand

* 2463 (Mesquite Bay/Carlos Bay/Ayers Bay), 2471 (Aransas Bay), 2481 (Corpus Christi Bay), 2482 (Nueces Bay), 2492 (Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada).

The three outlying sites were distinct from the other assemblages due to differing species composition (281), or reduced richness and densities (248 and 284) (Table 4.15). Site 281 was located in the canal system of the Padre Island Subdivision and therefore was a somewhat atypical site when compared with other sampling locations. Site 248 was located in mid-bay of St. Charles Bay and exhibited characteristics of a stressed community. However, no evidence of sediment contamination occurred. Site 284, near the King Ranch shoreline also exhibited characteristics of a stressed community and exhibited toxic effects, but no high contaminant concentrations existed.

Table 4.15. Benthic community characterization in relation to sediment contaminant characteristics for three outlier sites. Bold represents sites characterized with reduced benthic community measures. SAV indicates presence or absence of submerged aquatic vegetation.

Segment	Sites	Richness	Density	Biomass	EPA-BCI	Toxic	TOC	SCD	SAV	Silt-Clay
2473	**248**	**Low**	**Low**	**Low**						**Muddy Sand**
2491	281	Moderate	Moderate	Moderate						Sand
2491	**284**	**Low**	**Low**	**Low**						**Sand**

* 2473 (St. Charles Bay), 2481 (Corpus Christi Bay), 2482 (Nueces Bay), 2491 (Laguna Madre)

Benthic community characterization resulted in the delineation of four assemblages with three outliers. The BIOENV procedure identified salinity, depth and sediment grain-size as the primary natural factors responsible for benthic community distribution. Some patterns of stress occurred within benthic assemblages where either elevated contamination or expressions of toxic effects existed, but not both. Researchers suggest that degraded benthos associated with high contamination or toxicity, but not both conditions, could be due to under-sensitivity of assays; or field and lab bioeffects caused by unmeasured stressors (Carr et. al 1998; Hyland et al. 2000; Balthis et al. 2002; Hyland 2003).

Based on RCAP 2002 data, further sediment quality investigations should occur in areas where MMMS assemblages are located. The MMMS assemblage contains sites located in naturally stressed areas, as reflected in the benthic community. However, sites within the assemblage exhibiting the greatest evidence of benthic stress and low EPA Benthic Condition Index scores also exhibited moderate sediment contamination and/or expressions of sediment toxicity. Other sites within this assemblage not characterized with sediment contamination or toxicity might be affected by unmeasured chemical contaminants, biological interactions, or other unmeasured physical factors such as upwelling of bottom waters due to high winds, bottom water currents and/or storm events (Balthis et al. 2002; Hyland et al. 2003).

Although the observed magnitude of benthic community stress was not as large as in the MMMS assemblage, a reduction of benthic community measures was observed in the DPMS and MPSM assemblages where increased sediment contamination or expression of toxic effects occurred. However, one site (268) in the DPMS assemblage did not show reductions of benthic measures or exhibit toxic effects but was characterized with moderate sediment contamination. This may suggest that possible contaminants may not be biologically available (Hyland et al. 2000; Balthis et al. 2002; Hyland 2003).

The majority of sites, characterized according to EPA methodology with degraded sediment and benthos and/or exhibiting toxic effects, occurred in the SES assemblage. Toxicity may be a result of unmeasured contaminants or low sensitivity of contaminants to infauna (Balthis et al. 2002; Hyland et al. 2003). However, the authors believe that habitat type may influence the toxicity results in this assemblage. Based on RCAP 2002 and historical RCAP data, *Ampelisca abdita* rarely occurred within Upper Laguna Madre benthic samples and was completely absent where seagrass was present, suggesting this habitat may not be conducive to this species.

According to the EPA's Benthic Condition Index, the SES assemblage had four sites characterized as fair and four sites characterized as poor. However, the benthic community within this assemblage consisted of characteristics typically not associated with degraded sediment. Development of the EPA Benthic Condition Index was to be applicable across a wide variety of estuarine environments in the Gulf of Mexico. Such an endeavor resulted in a more generalized, as opposed to precise, index (Engle and Summers 1999). Although this index may be applicable in the other assemblages defined in RCAP 2002, the authors of this report feel that the index misrepresents the SES type of benthic community, and requires further refinement.

4.4 Summary

As seen with water quality monitoring, in the absence of established sediment criteria, state and federal monitoring entities employ screening levels based on different methodologies. Based on TCEQ screening levels and EPA NCCR II guidance the interpretation of conditions within the region produced different assessments. As the first truly comparable RCAP event, this assessment should be treated as an evolving process, from which indicators will hopefully be developed and continually revised in order to develop a better understanding of what may or may not represent healthy or degraded conditions or habitat within the CBBEP region.

Data analysis showed that while one case of elevated TOC levels existed within St. Charles Bay (Segment 2473), EPA would consider most sites as good according to NCCR II guidance (see Table 4.1; Fig. 4.1; Fig. 4.2; Table 4.4). Percentage of Silt-Clay conformed to expected values for sites sampled, although within some TCEQ Segments there was considerable variability (see Table 4.4; Fig. 4.3; Fig. 4.4).

Concerning sediment metal and organic contaminants, according to TCEQ screening levels, very little in the way of *Secondary Concerns* exists. Only one location, Site 258, located off the town of Bayside in Copano Bay (Segment 2472) (see Fig. 2.2) exceeded both the PEL and 85th percentile requirements for Total DDT and Total PCB (see Table 4.5). In addition, this was the only site considered as having poor sediment quality based on the EPA NCCR II guidance. However, multiple incidences of TEL exceedances at other sites may indicate the beginning of an increasing contaminant trend at those locations.

As a fundamental part of the EPA Sediment Quality Index (TOC, Sediment Contaminants, and Sediment Toxicity), the expression of toxic effects in sediment accounted for 18 of the 20 sites listed as having poor sediment quality during RCAP 2002. The amphipod toxicity test produced the most conflicting results, with no straightforward cause-effect relationship appearing to exist as none of the sites sampled had co-occurring toxicity and elevated sediment contaminants. As a result, the lack of co-occurring sediment contamination and toxicity raises questions with this analytical testing method. As suggested, unmeasured chemicals, other confounding factors (e.g. elevated ammonia concentrations), and/or habitat preference of the test organism may have influenced sediment toxicity results.

For the Sediment Contaminant Distribution (SCD), use of the Sediment Quality Guideline Quotient (SQGQ) provided an alternate method of investigating potential contaminant impacts. This process is gaining widespread use among researchers and resource managers, by which cumulative effects of multiple contaminants is addressed, as opposed to a single sediment screening level assessment. This process coupled with Factor analysis, to aid in identifying patterns of environmental contamination, produced 16 sites with moderate contaminant levels (relative to all other RCAP 2002 sites sampled) and only one site with high contaminant levels exceeding established screening levels (Fig. 4.8). Contaminants of interest for the 50 sites sampled were pesticides in the Mission-Aransas estuary and metals within the Nueces Estuary, particularly Arsenic, Chromium, Copper, Nickel, Lead and Zinc. Aforementioned metals along with some PCBs were also found to be in greater concentrations within the Baffin Bay complex.

The benthic community assessment provided a way to link the sediment quality to the biotic environment. Similarity analysis based on community composition and structure resulted in the classification of four benthic community assemblages. Of the four benthic assemblages defined, the MMMS assemblage grouped together sites consisting of characteristics indicative of a stressed benthic community. The locations of the sites suggests the stress might have been brought upon by natural occurring events, such as the major flooding seen one month prior to RCAP 2002 sampling. However, sites within the assemblage exhibiting the greatest evidence of benthic stress and low EPA Benthic Condition Index scores also contained moderate SCD rankings that should not be ignored. The SES benthic assemblage consisted of characteristics typically not associated with degraded sediment. However, the EPA's Benthic Condition Index characterized many of the sites as fair or poor. Although this index may be applicable in the other RCAP 2002 assemblages, the authors of this report feel that the index misrepresents the SES type of benthic community, and requires further refinement.

As an evolving process, understanding the complex sediment interactions within the CBBEP region will require more data collection and continued refinement of the methods and indices. Based on TCEQ guidelines, sediment within the area ranks as good, with only one site meeting the exceedance requirements for *Secondary Concerns*. Using EPA NCCR II guidelines would rank 20 of the 50 sites as having degraded sediments and 10 of the 50 sites as having degraded benthic communities. However, based on questionable sediment toxicity results the EPA rankings may not be justified and further analysis is necessary to provide a more accurate classification of potentially degraded and healthy habitats.

4.5 References

Balthis, W.L., J. L. Hyland, G. I. Scott, M. H. Fulton, D. W. Bearden and M.D. Greene. 2002. Sediment quality of the Neuse River, North Carolina: an integrated assessment of sediment contamination, toxicity, and condition of benthic fauna. *Journal of Aquatic Ecosystem Stress and Recovery*. 9: 213-225.

Clarke, K.R. and R.M. Warwick. 2001. Change in marine communities: an approach to statistical analysis and interpretation, 2nd edition. PRIMER-E Ltd., Plymouth, UK.

Carr, R. S., P. A. Montagna, and M. C. Kennicutt. 1998. Sediment quality assessment of storm water outfalls and other sites of concern in the Corpus Christi Bay National Estuary Program study area. CCBNEP-32. Texas Natural Resource Conservation Commission, Austin, Texas.

Engle, V. D. and J. K. Summers. 1999. Refinement, validation, and application of a benthic condition index for northern Gulf of México estuaries. *Estuaries* 22(3A): 624-635.

GBEP 2002. Galveston Bay Estuary Program. The State of the Bay: A characterization of the Galveston Bay Ecosystem, Second Edition. GBEP T-7 and TCEQ AS-186/02. 162 pp.

Gray, J. S. 1981. The Ecology of Marine Sediments: An Introduction to the Structure and Function of Benthic Communities. Cambridge University Press, Cambridge: 185p.

Gulley, D. D., A. M. Boelter and HL Bergman. 1991. TOXSTAT 3.3. Fish Physiology and Toxicology Laboratory Department of Zoology and Physiology, University of Wyoming, Laramie, Wyoming, USA.

Hyland, J. L., R. F. Van Dolah, T.R. Snoot. 1999. Predicting stress in benthic communities of southeastern U.S. estuaries in relation to chemical contamination of sediments. *Environmental Toxicology and Chemistry***.** 18: 2557-2564.

Hyland, J. L., W. L. Balthis, C.T. Hackney, and M. Posey. 2000. Sediment quality of North Carolina estuaries: an integrative assessment of sediment contamination, toxicity, and condition of benthic fauna. *Journal of Aquatic Ecosystem Stress and Recovery*. 8: 107-124.

Hyland, J. L., W. L. Balthis, V. D. Engle, E. R. Long, J. F. Paul, J. K. Summers, and R. F. Van Dolah. 2003. Incidence of stress in Benthic communities along the U.S. Atlantic and Gulf of Mexico Coasts within different ranges of sediment contamination from chemical mixtures. *Environmental Monitoring and Assessment* 81: 149-161.

Kennish, M. J. 1992. Ecology of Estuaries: Anthropogenic Effects. CRC Press, Boca Raton, Fl. 494 pp.

Kohn, N P, J Q Word and D K Niyogi. 1994. Acute toxicity of ammonia to four species of marine amphipod. *Marine Environmental Research*. 38: 1-15.

Long, E. R., D. D. MacDonald, S. L. Smith, and F. D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management*. 19: 81-97.

Long, E. R., R. S. Carr, P.A. Montagna. 2003. Porewater Toxicity Tests: Value as a Component of Sediment Quality Triad Assessments, pp.163-198. *In* Carr, R. S. and M Nipper (eds.). Porewater Toxicity Testing: Biological, Chemical, and Ecological Considerations. Pensacola FL, USA: Society of Environmental Toxicology and Chemistry (SETAC). 346 pp.

MacDonald, D D , R S Carr, F D Calder, E R Long and C G Ingersoll. 1996. Development and evaluation of sediment quality guidelines for Florida coastal waters. *Ecotoxicology*. 5: 253-278.

Nicolau, B. A. and A. X. Nuñez. 2004. Coastal Bend Bays & Estuaries Program Regional Coastal Assessment Program (RCAP) RCAP 2000 and 2001 Annual Report. TAMU-CC-0406-CCS.

Reish, D J and P J Oshida. 1987. Manual of methods in aquatic environmental research. Part 10. Short-term static bioassays. Food and Agriculture Organization of the United Nations, Rome, FAO Fisheries Technical Paper No 247.

SAS Institute Inc. 1989. SAS/STAT® user's guide, Version 6, Fourth Edition, Volume 2. Cary, NC: SAS Institute Inc., 846 p.

SAS Institute Inc. 1992. SAS/LAB® software: User's guide, Version 6, First Edition, Cary, NC: SAS Institute Inc., 291 p.

SFEI 2004. San Francisco Estuary Institute. Regional Monitoring Program Annual Monitoring Results 2002 (http://www.sfei.org/rmp/2002/2002_Annual_Results.htm).

TCEQ. 2003. Guidance for assessing Texas surface and finished drinking water quality data, 2004. 87 pp.

Thursby, GB, J Heltshe and KJ Scott. 1997. Revised approach to toxicity test acceptability criteria using a statistical performance assessment. *Environmental Toxicology and Chemistry*. 16: 1322-1329.

USEPA. 1995. Environmental Monitoring and Assessment Program (EMAP): Laboratory methods manual – Estuaries, Vol. 1: Biological and Physical Analyses. United States Environmental Protection Agency, Office of Research and Development, Narragansett, RI, EPA/620/R-95/008.

USEPA. 2004. National Coastal Condition Report II. EPA/620/R-03/002. Office of Research and Development and Office of Water, Washington D. C. 285 pp.

5.0 TISSUE MONITORING

5.1 Introduction

According to EPA, pathways that contaminants may enter into marine organisms involve direct uptake from contaminated waters and/or sediments or consumption of already contaminated organisms (USEPA 2004). Once an organism acquires theses contaminants, the tendency to remain in the animal tissues or increase through subsequent contamination can be significant. This same bioaccumulation pattern can also happen when humans eat contaminated tissue thereby effecting human health. Contaminants of concern consist of Mercury (methyl-mercury), chromium, PAHs, PCBs, and DDT and other pesticides.

5.2 Sampling Design and Data Evaluation

Tissue sampling (whole-body) for RCAP 2002 took place from August 5th through August 29th 2002 at 41 (nine sites not sampled due to shallow water or no specimens collected) randomly selected stations throughout the CBBEP region as described in Chapter 2.0. Table 6.1.1 in the *Data Tables* chapter and Fig. 2.2 provide station information and location. A complete list of parameters measured during the RCAP 2002 sampling event is in Table 2.1.

The *Data Tables* in Chapter 6.0 provide individual concentration values for tissue metals and tissue organic parameters measured (Table 6.11.1 and 6.12.1 through 6.12.4). Tissue analysis involved processed whole-body tissue rather than fillets to provide a better idea of possible bioaccumulation. If a screening level or concentration range existed, then data evaluation followed two different approaches; 1) the TCEQ regulatory approach and 2) according to guidelines utilized in the EPA NCCR II (USEPA 2004).

5.2.1. TCEQ Criteria and Screening Levels

Currently, regulatory criteria do not exist for the majority of tissue contaminants. However, TCEQ does employ screening levels developed from human health criteria in the TSWQS for lead and 31 organic substances to assess the concentration of toxicants in edible fish tissue. Screening levels for an additional six metals include arsenic (inorganic arsenic screen is based on 20% of total arsenic value), cadmium, chromium, copper, mercury, and selenium which come from Texas Department of State Health Services (DSHS) screening levels used to issue consumption advisories. Screening levels aid in identifying *Secondary Concerns* for those parameters for which no adopted standard exists that exhibit elevated concentrations greater than 25% of the time based on the number of exceedances for a given sample size (TCEQ 2003). TCEQ and DSHS do not screen or issue advisories based on whole-body fish tissue. Results presented serve as a point of reference for comparison of possible tissue contamination within the CBBEP region.

5.2.2. EPA NCCR II Guidelines

Evaluation of RCAP 2002 tissue contaminant data used the EPA NCCR II guidelines for assessing individual sites as listed in Table 5.1 and based on the risk guidelines for recreational fishers provided in Table 5.2. EPA recognizes that these assessments do not often involve widely consumed fish species of market length. However, if the fish contaminant data exceeds the risk-based concentrations ranges in Table 5.2 for consumption of four 8-ounce meals per month for any contaminant then the site is assessed as impaired for human use

(USEPA 2004). Furthermore, no guidance exists to asses the ecological risk of whole-body contaminants but EPA Advisory Guidance often serves as a basis for estimating consumption advisories even when data are based on whole-fish or organ-specific body burdens. Use of this evaluation approach in the RCAP is to provide continuity between locally collected data and the ongoing NCA program for assessing coastal waters.

Table 5.1. EPA NCA guidelines for assessing fish tissue contaminants, by site (USEPA 2004).

Rating		Fish Tissue Contaminant Guidelines
Good		The index score falls below the range of the guidance criteria for a risk-based consumption associated with four 8-ounce meals per month.
Fair		The index score falls within the range of the guidance criteria for a risk-based consumption associated with four 8-ounce meals per month
Poor		The index score exceeds the maximum value of the range of the guidance criteria for a risk-based consumption associated with four 8-ounce meals per month

Table 5.2. EPA NCA risk guidelines for recreational fishers. Multiple screening values are for noncancer health endpoints, respectively (USEPA 2004).

Metals	Screening Value (ppm)	Concentration Range (ppm) (noncancer)
Arsenic (Inorganic)[a]	1.2	3.5 – 7.0
Cadmium	4.0	0.35 – 0.70
Mercury	0.4	0.12 – 0.23
Selenium	20.0	5.9 – 12.0
Organics	**Screening Value (ppb)**	**Concentration Range (ppb) (noncancer)**
Chlordane	2000	590 - 1200
DDT (Total)	2000	59 - 120
Dieldrin	200	59 - 120
Endosulfan	24000	7000 - 14000
Endrin	1200	350 - 700
Heptachlor epoxide	52	15 - 31
Hexachlorobenzene	3200	940 - 1900
Lindane	1200	350 - 700
Mirex	800	230 - 470
Toxaphene	100	290 - 590
PAH (Total)	5.47	-
PCB (Total)	80	23 - 47

[a] EPA estimates inorganic arsenic at 2% of total arsenic.

5.3 Results and Discussion

Due to the approach EPA NCA uses in the collection of data for the NCCR II report makes RCAP 2002 tissue contaminant data difficult to assess in Texas, as existing standards and methods are not comparable (e.g. whole-body versus edible tissue). EPA is modifying the program to begin analyzing for edible tissue in upcoming RCAP events.

According to TCEQ/DSHS and EPA guidelines, the concentration of metals in whole-body tissue was lower than all applicable screening levels (Table 6.11.1). All sites had small concentrations of aluminum, chromium, iron, and mercury. A limited amount of nickel and lead followed by zinc, tin, and silver occurred at some locations with many sites having concentration values that were non-detectable. In the case of arsenic, concentrations were all non-detectable except at six sites.

Concentrations of PCBs occurred in whole-body tissue at eight locations within the RCAP 2002 sampling area (6.12.1). All concentrations were far below any screening level. One sample with detectable PCB occurred in Mesquite Bay (Segment 2463), Copano Bay (Segment 2472), St. Charles Bay (Segment 2473), Corpus Christi Bay (Segment 2481), and Nueces Bay (Segment 2482). Three sites had detectable PCB concentrations in the Upper Laguna Madre (Segment 2491). The highest concentration occurred in Nueces Bay but as stated was well below the screening level.

Detectable concentrations of DDT occurred at three sites. Two located in Mesquite Bay (Segment 2463) and one site in the Upper Laguna Madre (Segment 2491) that had the highest recorded value (Table 6.12.2). As seen with PCB the highest value was well below the screening level. Total Chlorinated Pesticides other than DDT registered in whole-body tissue samples at four sampling sites and comprised of alpha-chlordane, t-nonachlor, and toxaphene (Table 6.12.3). One site in Hynes Bay (Segment 2462) recorded concentrations of all three parameters while one site in Aransas Bay (Segment 2471) and Copano Bay (Segment 2472) recorded concentrations of alpha-chlordane and t-nonachlor. One site in Corpus Christi Bay (Segment 2481) had a small amount of t-nonachlor present in whole-body tissue analyzed. No detectable concentrations of PAHs occurred in any of the 41 sites sampled (Table 6.12.4).

5.4 Summary

Although not applicable, for this discussion the results of whole-body tissue analysis were compared to the screening levels normally used for edible tissue as a basis for determining the extent of possible contamination and bioaccumulation in tissue. Based on this analysis we rank the region as very good as most contaminants were non-detectable or well below any applicable screening level (Fig. 5.1). In addition, no specimens showed evidence of lesions or tumors during the external gross pathology examination performed on-board TPWD vessels during RCAP 2002 sampling. Future events and reevaluation of sampling and analysis protocols may produce results that are comparable to existing state guidelines and /or federal guidelines.

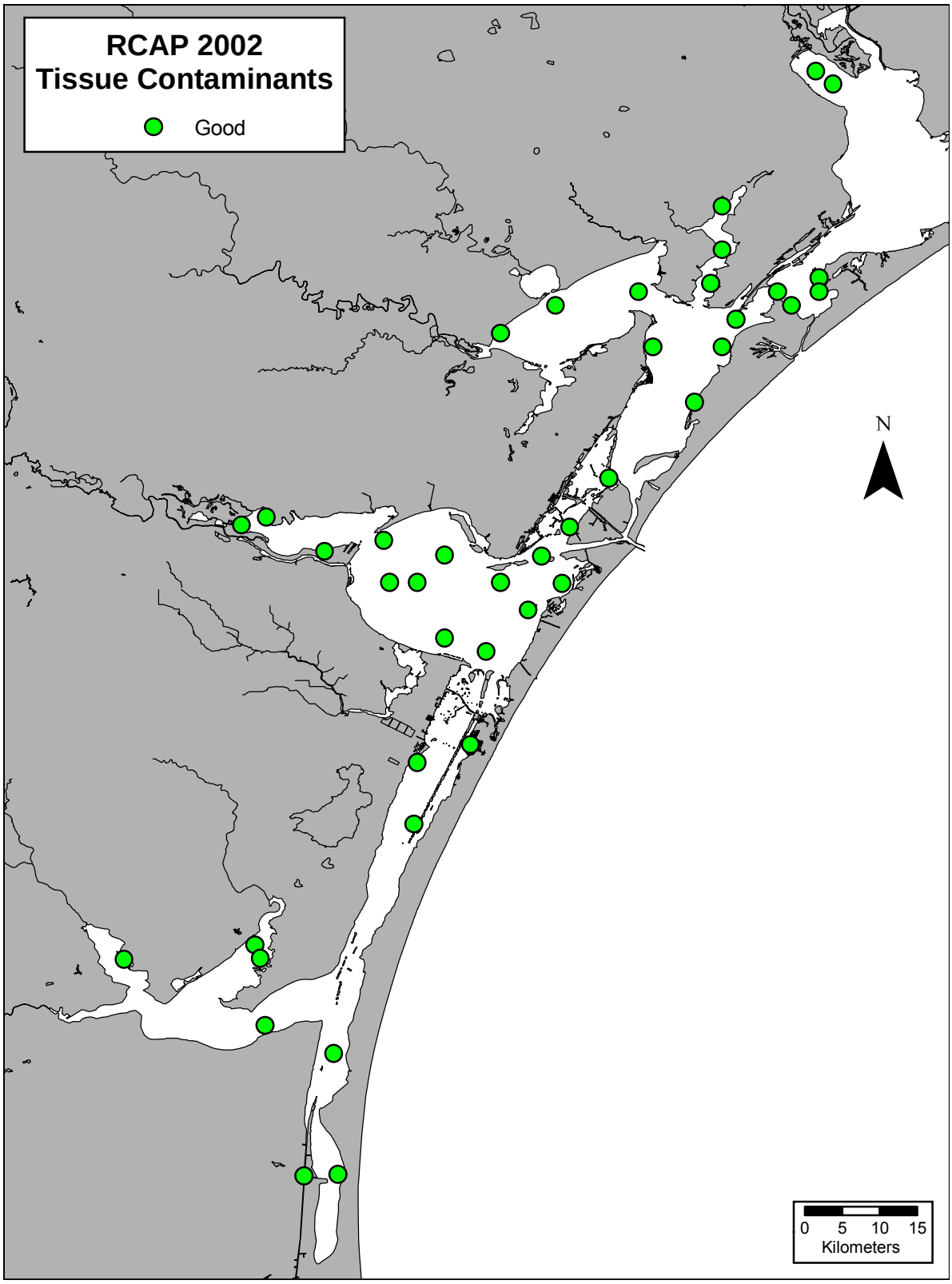


Fig. 5.1. Results of tissue contaminant (metals, PCBs, DDT and other chlorinated pesticides, and PAHs) evaluation at 41 RCAP 2002 sampling sites.

5.5 References

TCEQ. 2003. Guidance for assessing Texas surface and finished drinking water quality data, 2004. 87 pp.

USEPA. 2004. National Coastal Condition Report II. EPA/620/R-03/002. Office of Research and Development and Office of Water, Washington D. C. 285 pp.

6.0 DATA TABLES

6.1 Sampling Site Information

Table 6.1.1. RCAP 2002 site (50) information, sample type, and sampling date. **Sample Types:** FD = Field Data, RC = Routine Conventional Water Chemistry, M = Microbiological, TMSED = Trace Metals-Sediment, SEDORG = Sediment Organics, SEDTOX = Sediment Toxicology, TISORG = Tissue Organics, TMTIS = Trace Metals-Tissue, BEN = Benthic Cores.

Segment Number	Segment Name	CCS ID	TCEQ ID	Sample Type	Sampling Date	Latitude (dd)	Longitude (dd)	Depth (m)
2462	San Antonio/Hynes/Guadalupe Bay	245	18216	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/28/2002	28.40710	96.82887	1.24
		246	18217	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/28/2002	28.39167	96.80833	1.52
2463	Mesquite/Carlo/Ayres Bay	249	18220	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/05/2002	28.15833	96.82500	1.31
		253	18224	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/05/2002	28.14167	96.87500	0.46
		254	18225	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/05/2002	28.14167	96.82500	1.50
		256	18227	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/05/2002	28.12500	96.85833	1.43
2471	Aransas Bay	257	18228	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/05/2002	28.10833	96.92500	1.46
		259	18230	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/06/2002	28.07500	97.02500	3.14
		260	18231	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/05/2002	28.07500	96.94167	1.94
		261	18232	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/26/2002	28.00833	96.97500	1.14
		262	18233	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/26/2002	27.91725	97.07797	1.16
2472	Copano/Port/Mission Bay	250	18221	FD, RC, M, TMSED, SEDORG, SEDTOX, BEN	08/06/2002	28.15413	97.16719	1.17
		252	18223	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/06/2002	28.14167	97.04167	1.88
		255	18226	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/06/2002	28.12500	97.14167	2.33
		258	18229	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/06/2002	28.09167	97.20833	1.95
2473	St. Charles Bay	247	18218	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/26/2002	28.24420	96.94162	1.40
		248	18219	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/26/2002	28.19167	96.94167	1.59
		251	18222	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/26/2002	28.15185	96.95539	1.55
2481	Corpus Christi Bay	266	18237	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/12/2002	27.84223	97.34806	3.21
		268	18239	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/07/2002	27.82500	97.27500	4.25
		269	18240	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/07/2002	27.82372	97.15886	2.68
		270	18241	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/07/2002	27.79167	97.34167	3.75
		271	18242	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/07/2002	27.79167	97.30833	4.25
		272	18243	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/07/2002	27.79167	97.20833	3.95
		273	18244	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/14/2002	27.79052	97.13410	3.67
		274	18245	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/14/2002	27.75833	97.17500	1.35
		275	18246	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/14/2002	27.72500	97.27500	4.78
		276	18247	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/07/2002	27.70833	97.22500	4.50
		279	18250	FD, RC, M, TMSED, SEDORG, SEDTOX, BEN	08/20/2002	27.64392	97.21022	0.42

Table 6.1.1. (continued).

Segment Number	Segment Name	CCS ID	TCEQ ID	Sample Type	Sampling Date	Latitude (dd)	Longitude (dd)	Depth (m)
2482	Nueces Bay	263	18234	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/12/2002	27.87025	97.48974	1.38
		264	18235	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/12/2002	27.86080	97.51947	2.10
		267	18238	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/12/2002	27.82873	97.41988	1.57
2483	Redfish Bay	265	18236	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/14/2002	27.85833	97.12500	2.77
2485	Oso Bay	277	18248	FD, RC, M, TMSED, SEDORG, SEDTOX, BEN	08/20/2002	27.69924	97.32864	0.53
		278	18249	FD, RC, M, TMSED, SEDORG, SEDTOX, BEN	08/20/2002	27.67960	97.31287	0.80
2491	Laguna Madre	280	18251	FD, RC, M, TMSED, SEDORG, SEDTOX, BEN	08/20/2002	27.61555	97.26837	0.86
		281	18252	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/27/2002	27.59617	97.24392	0.50
		282	18253	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/20/2002	27.57500	97.30833	1.72
		283	18254	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/27/2002	27.50051	97.31216	0.71
		284	18255	FD, RC, M, TMSED, SEDORG, SEDTOX, BEN	08/27/2002	27.39919	97.37450	0.68
		290	18261	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/19/2002	27.22500	97.40833	0.92
		291	18262	FD, RC, M, TMSED, SEDORG, SEDTOX, BEN	08/27/2002	27.15528	97.44253	0.45
		292	18263	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/27/2002	27.07731	97.44461	0.30
		293	18264	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/27/2002	27.07939	97.40402	0.52
		294	18265	FD, RC, M, TMSED, SEDORG, SEDTOX, BEN	08/27/2002	27.03683	97.40428	0.42
2492	Baffin/Alazan	285	18256	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/29/2002	27.35534	97.50393	1.23
	Cayo del Grullo/Laguna Salada	286	18257	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/29/2002	27.33814	97.66069	0.67
		287	18258	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/29/2002	27.33938	97.49671	1.21
		288	18259	FD, RC, M, TMSED, SEDORG, SEDTOX, BEN	08/19/2002	27.28295	97.41216	2.35
		289	18260	FD, RC, M, TMSED, SEDORG, SEDTOX, TISORG, TMTIS, BEN	08/19/2002	27.25833	97.49167	2.25

6.2 Field Parameters – Individual Concentrations (Near-Surface and Near-Bottom Grab Samples)

Table 6.2.1. Near-surface Field Parameter concentrations recorded 0.50 m below surface at RCAP 2002 sampling sites. Shaded = value below TCEQ 24-Hour DO average criteria. Not applicable to grab samples but provides a reference. All Segments have a 5.0 mg/L DO criteria except Segment 2492 where criterion is 4.0 mg/L.

Segment	Segment Name	CCS ID	TCEQ ID	Cond. (µmhos)	DO (mg/L)	DO Sat. (%)	pH (su)	Salinity (psu)	Secchi Depth (m)	Total Depth (m)	Turbidity (NTU)	Water Temp (°C)
2462	San Antonio/Hynes/Guadalupe Bay	245	18216	747	6.73	88.80	8.14	0.36	0.25	1.24	70.70	29.63
		246	18217	1495	6.68	88.50	8.53	0.74	0.20	1.52	58.80	29.84
2463	Mesquite/Carlos/Ayres Bay	249	18220	22005	6.04	86.10	8.31	13.15	0.50	1.31	12.98	29.87
		253	18224	22660	2.96	42.10	7.86	13.58	> 0.46	0.46	9.35	29.62
		254	18225	22490	5.73	82.50	8.23	13.42	0.20	1.50	54.70	30.37
		256	18227	21589	5.82	82.90	8.34	12.87	0.40	1.43	10.75	30.20
2471	Aransas Bay	257	18228	21372	6.28	90.60	8.16	12.69	0.40	1.46	19.81	30.74
		259	18230	24626	7.11	104.80	8.24	14.84	1.00	3.14	5.03	31.55
		260	18231	25920	6.53	95.90	7.97	15.71	0.70	1.94	9.49	31.02
		261	18232	36120	7.54	115.30	8.17	22.64	> 1.14	1.14	14.70	31.30
		262	18233	44084	5.82	90.80	8.29	28.21	0.90	1.16	7.60	30.63
2472	Copano/Port/Mission Bay	250	18221	11962	6.24	84.20	8.18	6.79	0.25	1.17	20.02	28.96
		252	18223	21288	6.59	94.60	8.11	12.67	0.90	1.88	5.51	30.69
		255	18226	20143	6.54	92.50	8.18	11.96	2.00	2.33	16.46	29.97
		258	18229	20073	6.72	96.40	8.28	11.88	2.00	1.95	14.16	30.93
2473	St. Charles Bay	247	18218	16873	6.96	97.50	8.45	9.84	0.50	1.40	16.30	30.11
		248	18219	21945	5.95	84.30	8.21	13.11	0.60	1.59	11.80	29.74
		251	18222	22381	6.51	93.10	8.15	13.39	0.50	1.55	20.80	30.23
2481	Corpus Christi Bay	266	18237	31403	6.20	91.00	8.28	19.43	0.60	3.21	12.90	29.86
		268	18239	25668	6.94	100.60	8.41	15.55	1.10	4.25	2.51	30.36
		269	18240	44812	6.11	95.20	8.09	28.82	1.40	2.68	4.05	30.26
		270	18241	20872	7.78	112.40	8.48	12.40	1.00	3.75	2.30	31.14
		271	18242	23506	7.14	103.40	8.43	14.11	1.25	4.25	2.58	30.30
		272	18243	29243	6.79	99.50	8.40	17.96	1.25	3.95	2.02	30.20
		273	18244	34993	6.05	89.60	8.27	21.91	0.60	3.67	16.00	29.48
		274	18245	37943	6.12	90.90	8.14	23.98	0.50	1.35	20.30	29.10
		275	18246	34057	5.93	87.60	8.25	21.26	0.60	4.78	17.50	29.62
		276	18247	29801	7.68	114.60	8.36	18.31	1.10	4.50	2.65	31.09
		279	18250	58414	7.93	126.10	8.23	38.92	> 0.42	0.42	6.60	29.09
2482	Nueces Bay	263	18234	4463	6.68	88.10	8.50	2.36	0.25	1.38	30.40	29.00
		264	18235	4681	6.18	82.20	8.36	2.48	0.40	2.10	26.60	29.98
		267	18238	20898	6.91	97.70	8.33	12.43	0.35	1.57	7.80	29.82

Table 6.2.1. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	Cond. (µmhos)	DO (mg/L)	DO Sat. (%)	pH (su)	Salinity (psu)	Secchi Depth (m)	Total Depth (m)	Turbidity (NTU)	Water Temp (°C)
2483	Redfish Bay	265	18236	38800	5.86	88.10	8.18	24.57	0.60	2.77	14.00	29.54
2485	Oso Bay	277	18248	43724	7.38	113.80	8.48	28.06	0.40	0.53	37.50	29.65
		278	18249	50749	10.49	168.40	8.54	33.13	> 0.80	0.80	4.00	30.52
2491	Laguna Madre	280	18251	67097	4.63	76.90	8.46	45.56	> 0.86	0.86	1.80	28.41
		281	18252	68962	6.29	110.10	8.46	46.90	> 0.50	0.50	7.90	31.24
		282	18253	70394	5.38	91.70	8.51	48.10	1.30	1.72	4.30	29.22
		283	18254	70981	11.82	212.20	8.54	48.43	> 0.71	0.71	18.30	32.23
		284	18255	72301	5.75	102.70	8.04	49.48	> 0.68	0.68	6.20	31.95
		290	18261	66793	4.54	74.80	8.21	45.33	> 0.92	0.92	6.40	28.19
		291	18262	64756	8.54	145.30	8.51	43.65	> 0.45	0.45	6.20	30.88
		292	18263	62128	5.32	87.60	8.38	41.69	> 0.30	0.30	15.30	29.35
		293	18264	64548	8.16	133.50	8.66	43.60	> 0.52	0.52	6.50	28.95
		294	18265	79127	5.24	91.40	8.93	55.10	> 0.42	0.42	2.90	28.19
2492	Baffin Bay/Alazan Bay/	285	18256	75015	4.96	87.40	8.11	51.74	0.30	1.23	39.30	29.78
	Cayo del Grullo/Laguna Salada	286	18257	69584	5.13	87.70	8.27	47.45	> 0.67	0.67	12.10	29.66
		287	18258	74996	4.76	83.50	8.15	51.72	0.30	1.21	37.20	29.78
		288	18259	66196	6.28	105.10	8.22	44.83	0.60	2.35	14.60	29.24
		289	18260	69757	5.85	99.80	8.15	47.60	0.35	2.25	30.50	29.40

Table 6.2.2. Near-bottom Field Parameter concentrations recorded 0.50 m off-bottom at RCAP 2002 sampling sites. At sites where water depth is shallow, the near-surface and near-bottom values are the same. Shaded = value below TCEQ 24-Hour DO average criteria which is not applicable to grab or bottom samples but provides a reference. All Segments have a 5.0 mg/L DO criteria except Segment 2492 where the criterion is 4.0 mg/L.

Segment	Segment Name	CCS ID	TCEQ ID	Cond. (µmhos)	DO (mg/L)	DO Sat. (%)	pH (su)	Salinity (psu)	Total Depth (m)	Turbidity (NTU)	Water Temp (°C)
2462	San Antonio/Hynes/Guadalupe Bay	245	18216	747	6.73	88.80	8.14	0.36	1.24	70.70	29.63
		246	18217	1495	6.61	87.50	8.53	0.74	1.52	58.80	29.84
2463	Mesquite/Carlos/Ayres Bay	249	18220	21995	5.95	84.70	8.31	13.14	1.31	12.98	29.93
		253	18224	22660	2.96	42.10	7.86	13.58	0.46	9.35	29.62
		254	18225	22425	5.68	81.40	8.23	13.41	1.50	54.70	30.45
		256	18227	21590	5.80	82.60	8.35	12.87	1.43	10.75	30.21
2471	Aransas Bay	257	18228	24206	6.18	89.20	8.14	14.13	1.46	19.81	30.70
		259	18230	28505	5.38	79.90	8.13	17.43	3.14	5.03	31.22
		260	18231	25789	6.50	95.10	7.98	15.69	1.94	9.49	30.85
		261	18232	36120	7.54	115.30	8.17	22.64	1.14	14.70	31.30
		262	18233	44084	5.82	90.80	8.29	28.21	1.16	7.60	30.63
2472	Copano/Port/Mission Bay	250	18221	11962	6.24	84.20	8.18	6.79	1.17	20.02	28.96
		252	18223	22125	6.46	92.50	8.08	13.22	1.88	5.51	30.42
		255	18226	20522	6.28	89.20	8.16	12.20	2.33	16.46	30.19
		258	18229	20081	6.72	96.30	8.30	11.88	1.95	14.16	30.92
2473	St. Charles Bay	247	18218	17444	6.50	91.20	8.40	10.23	1.40	16.30	30.12
		248	18219	21946	5.90	83.50	8.21	13.13	1.59	11.80	29.72
		251	18222	22361	6.42	91.70	8.16	13.38	1.55	20.80	30.25
2481	Corpus Christi Bay	266	18237	34927	5.73	86.10	8.22	21.85	3.21	12.90	30.28
		268	18239	39049	3.31	51.20	8.07	24.74	4.25	2.51	30.18
		269	18240	48825	6.50	97.20	8.13	31.73	2.68	4.05	30.22
		270	18241	37547	1.54	22.90	7.87	23.69	3.75	2.30	30.13
		271	18242	39770	2.49	37.90	8.00	25.24	4.25	2.58	30.14
		272	18243	40425	4.41	68.10	8.16	25.69	3.95	2.02	30.37
		273	18244	35713	5.57	82.80	8.22	22.49	3.67	16.00	29.59
		274	18245	37945	6.09	90.60	8.14	23.98	1.35	20.30	29.10
		275	18246	37252	3.16	45.00	8.07	23.71	4.78	17.50	29.87
		276	18247	39192	2.41	43.90	8.12	24.80	4.50	2.65	30.13
		279	18250	58414	7.93	126.10	8.23	38.92	0.42	6.60	29.09
2482	Nueces Bay	263	18234	4474	6.57	86.80	8.48	2.37	1.38	30.40	28.98
		264	18235	5150	5.41	71.20	8.28	2.76	2.10	26.60	28.92
		267	18238	24392	6.34	91.80	8.26	14.72	1.57	7.80	30.33

Table 6.2.2. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	Cond. (µmhos)	DO (mg/L)	DO Sat. (%)	pH (su)	Salinity (psu)	Total Depth (m)	Turbidity (NTU)	Water Temp (°C)
2483	Redfish Bay	265	18236	39191	5.85	88.20	8.23	24.87	2.77	14.00	29.55
2485	Oso Bay	277	18248	43724	7.38	113.80	8.48	28.06	0.53	37.50	29.65
		278	18249	50749	10.49	168.40	8.54	33.13	0.80	4.00	30.52
2491	Laguna Madre	280	18251	67097	4.63	76.90	8.46	45.56	0.86	1.80	28.41
		281	18252	68962	6.29	110.10	8.46	46.90	0.50	7.90	31.24
		282	18253	70403	5.35	91.10	8.51	48.11	1.72	4.30	29.23
		283	18254	70981	11.82	212.20	8.54	48.43	0.71	18.30	32.23
		284	18255	72301	5.75	102.70	8.04	49.48	0.68	6.20	31.95
		290	18261	66793	4.54	74.80	8.21	45.33	0.92	6.40	28.19
		291	18262	64756	8.54	145.30	8.51	43.65	0.45	6.20	30.88
		292	18263	62128	5.32	87.60	8.38	41.69	0.30	15.30	29.35
		293	18264	64548	8.16	133.50	8.66	43.60	0.52	6.50	28.95
		294	18265	79127	5.24	91.40	8.93	55.10	0.42	2.90	28.19
2492	Baffin Bay/Alazan Bay/	285	18256	75015	4.96	87.40	8.11	51.74	1.23	39.30	29.78
	Cayo del Grullo/Laguna Salada	286	18257	69584	5.13	87.70	8.27	47.45	0.67	12.10	29.66
		287	18258	74996	4.76	83.50	8.15	51.72	1.21	37.20	29.78
		288	18259	66232	6.20	103.70	8.22	44.87	2.35	14.60	29.24
		289	18260	69791	5.74	97.60	8.15	47.62	2.25	30.50	29.39

6.3 Field Parameters – Summary Statistics (Near-Surface and Near-Bottom grab samples)

Table 6.3.1. Conductivity (µmhos) near-surface and near-bottom summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. At sites where water depth is shallow, the near-surface and near-bottom values are the same. **Bold** = highest recorded mean concentration.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Conductivity	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	747	1495	1121
(µmhos)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	21589	22660	22186
	2471	Aransas Bay	5	21372	44084	30424
	2472	Copano Bay/Port Bay/Mission Bay	4	11962	21288	18367
Near-Surface	2473	St. Charles Bay	3	16873	22381	20400
(0.50 m below)	2481	Corpus Christi Bay	11	20872	58414	33701
	2482	Nueces Bay	3	4463	20898	10014
	2483	Redfish Bay	1	38800	38800	38800
	2485	Oso Bay	2	43724	50749	47237
	2491	Laguna Madre	10	62128	79127	68709
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	66196	75015	**71110**
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Conductivity	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	747	1495	1121
(µmhos)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	21590	22660	22168
	2471	Aransas Bay	5	24206	44084	31741
	2472	Copano Bay/Port Bay/Mission Bay	4	11962	22125	18673
Near-Bottom	2473	St. Charles Bay	3	17444	22361	20584
(0.50 above)	2481	Corpus Christi Bay	11	34927	58414	40824
	2482	Nueces Bay	3	4474	24392	11339
	2483	Redfish Bay	1	39191	39191	39191
	2485	Oso Bay	2	43724	50749	47237
	2491	Laguna Madre	10	62128	79127	68710
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	66232	75015	**71124**

Table 6.3.2. Salinity (PSU) near-surface and near-bottom summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. At sites where water depth is shallow, the near-surface and near-bottom values are the same. **Bold** = highest recorded mean concentration.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Salinity	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.36	0.74	0.55
(PSU)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	12.87	13.58	13.26
	2471	Aransas Bay	5	12.69	28.21	18.82
	2472	Copano Bay/Port Bay/Mission Bay	4	6.79	12.67	10.83
Near-Surface	2473	St. Charles Bay	3	9.84	13.39	12.11
(0.50 m below)	2481	Corpus Christi Bay	11	12.40	38.92	21.15
	2482	Nueces Bay	3	2.36	12.43	5.76
	2483	Redfish Bay	1	24.57	24.57	24.57
	2485	Oso Bay	2	28.06	33.13	30.60
	2491	Laguna Madre	10	41.69	55.10	46.78
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	44.83	51.74	**48.67**
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Salinity	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.36	0.74	0.55
(PSU)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	12.87	13.58	13.25
	2471	Aransas Bay	5	14.13	28.21	19.62
	2472	Copano Bay/Port Bay/Mission Bay	4	6.79	13.22	11.02
Near-Bottom	2473	St. Charles Bay	3	10.23	13.38	12.25
(0.50 above)	2481	Corpus Christi Bay	11	21.85	38.92	26.08
	2482	Nueces Bay	3	2.37	14.72	6.62
	2483	Redfish Bay	1	24.87	24.87	24.87
	2485	Oso Bay	2	28.06	33.13	30.60
	2491	Laguna Madre	10	41.69	55.10	46.79
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	44.87	51.74	**48.68**

Table 6.3.3. Dissolved Oxygen (mg/L) near-surface and near-bottom summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. At sites where water depth is shallow, the near-surface and near-bottom values are the same. **Bold** = highest recorded mean concentration. Shaded = value below TCEQ 24-Hour DO average criteria. Value is not applicable to grab or bottom samples but provides a reference. All Segments have a 5.0 mg/L DO criteria except Segment 2492 where criterion is 4.0 mg/L).

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Dissolved Oxygen	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	6.68	6.73	6.71
(mg/L)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	2.96	6.04	5.14
	2471	Aransas Bay	5	5.82	7.54	6.66
	2472	Copano Bay/Port Bay/Mission Bay	4	6.24	6.72	6.52
Near-Surface	2473	St. Charles Bay	3	5.95	6.96	6.47
(0.50 m below)	2481	Corpus Christi Bay	11	5.93	7.93	6.79
	2482	Nueces Bay	3	6.18	6.91	6.59
	2483	Redfish Bay	1	5.86	5.86	5.86
	2485	Oso Bay	2	7.38	10.49	**8.94**
	2491	Laguna Madre	10	4.54	11.82	6.57
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	4.76	6.28	5.40
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Dissolved Oxygen	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	6.61	6.73	6.67
(mg/L)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	2.96	5.95	5.10
	2471	Aransas Bay	5	5.38	7.54	6.28
	2472	Copano Bay/Port Bay/Mission Bay	4	6.24	6.72	6.43
Near-Bottom	2473	St. Charles Bay	3	5.90	6.50	6.27
(0.50 above)	2481	Corpus Christi Bay	11	1.54	7.93	4.47
	2482	Nueces Bay	3	5.41	6.57	6.11
	2483	Redfish Bay	1	5.85	5.85	5.85
	2485	Oso Bay	2	7.38	10.49	**8.94**
	2491	Laguna Madre	10	4.54	11.82	6.56
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	4.76	6.20	5.36

Table 6.3.4. Dissolved Oxygen (% saturation) near-surface and near-bottom summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. At sites where water depth is shallow, the near-surface and near-bottom values are the same. **Bold** = highest recorded mean concentration.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Dissolved Oxygen	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	88.50	88.80	88.65
(% Saturation)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	42.10	86.10	73.40
	2471	Aransas Bay	5	90.60	115.30	99.48
	2472	Copano Bay/Port Bay/Mission Bay	4	84.20	96.40	91.93
Near-Surface	2473	St. Charles Bay	3	84.30	97.50	91.63
(0.50 m below)	2481	Corpus Christi Bay	11	87.60	126.10	100.99
	2482	Nueces Bay	3	82.20	97.70	89.33
	2483	Redfish Bay	1	88.10	88.10	88.10
	2485	Oso Bay	2	113.80	168.40	**141.10**
	2491	Laguna Madre	10	74.80	212.20	112.62
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	83.50	105.10	92.70
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Dissolved Oxygen	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	87.50	88.80	88.15
(% Saturation)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	42.10	84.70	72.70
	2471	Aransas Bay	5	79.90	115.30	94.06
	2472	Copano Bay/Port Bay/Mission Bay	4	84.20	96.30	90.55
Near-Bottom	2473	St. Charles Bay	3	83.50	91.70	88.80
(0.50 above)	2481	Corpus Christi Bay	11	22.90	126.10	68.35
	2482	Nueces Bay	3	71.20	91.80	83.27
	2483	Redfish Bay	1	88.20	88.20	88.20
	2485	Oso Bay	2	113.80	168.40	**141.10**
	2491	Laguna Madre	10	74.80	212.20	112.56
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	83.50	103.70	91.98

Table 6.3.5. pH (su) near-surface and near-bottom summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. At sites where water depth is shallow, the near-surface and near-bottom values are the same. **Bold** = highest recorded mean concentration.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
pH	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	8.14	8.53	8.34
(su)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	7.86	8.34	8.19
	2471	Aransas Bay	5	7.97	8.29	8.17
	2472	Copano Bay/Port Bay/Mission Bay	4	8.11	8.28	8.19
Near-Surface	2473	St. Charles Bay	3	8.15	8.45	8.27
(0.50 m below)	2481	Corpus Christi Bay	11	8.09	8.48	8.30
	2482	Nueces Bay	3	8.33	8.50	8.40
	2483	Redfish Bay	1	8.18	8.18	8.18
	2485	Oso Bay	2	8.48	8.54	**8.51**
	2491	Laguna Madre	10	8.04	8.93	8.47
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	8.11	8.27	8.18
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
pH	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	8.14	8.53	8.34
(su)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	7.86	8.35	8.19
	2471	Aransas Bay	5	7.98	8.29	8.14
	2472	Copano Bay/Port Bay/Mission Bay	4	8.08	8.30	8.18
Near-Bottom	2473	St. Charles Bay	3	8.16	8.40	8.26
(0.50 m above)	2481	Corpus Christi Bay	11	7.87	8.23	8.11
	2482	Nueces Bay	3	8.26	8.48	8.34
	2483	Redfish Bay	1	8.23	8.23	8.23
	2485	Oso Bay	2	8.48	8.54	8.51
	2491	Laguna Madre	10	8.04	8.93	8.47
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	8.11	8.27	8.18

Table 6.3.6. Turbidity (NTU) near-surface and near-bottom summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. At sites where water depth is shallow, the near-surface and near-bottom values are the same. **Bold** = highest recorded mean concentration.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Turbidity	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	58.80	70.70	**64.75**
(NTU)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	9.35	54.70	21.95
	2471	Aransas Bay	5	5.03	19.81	11.33
	2472	Copano Bay/Port Bay/Mission Bay	4	5.51	20.02	14.04
Near-Surface	2473	St. Charles Bay	3	11.80	20.80	16.30
(0.50 m below)	2481	Corpus Christi Bay	11	2.02	20.30	8.13
	2482	Nueces Bay	3	7.80	30.40	21.60
	2483	Redfish Bay	1	14.00	14.00	14.00
	2485	Oso Bay	2	4.00	37.50	20.75
	2491	Laguna Madre	10	1.80	18.30	7.58
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	12.10	39.30	26.74
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Turbidity	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	58.50	70.70	**64.60**
(NTU)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	9.35	53.03	21.41
	2471	Aransas Bay	5	7.60	18.41	13.68
	2472	Copano Bay/Port Bay/Mission Bay	4	8.30	31.43	19.18
Near-Bottom	2473	St. Charles Bay	3	12.20	30.10	21.47
(0.50 m above)	2481	Corpus Christi Bay	11	5.03	74.76	20.14
	2482	Nueces Bay	3	8.50	36.80	25.57
	2483	Redfish Bay	1	15.63	15.63	15.63
	2485	Oso Bay	2	4.00	37.50	20.75
	2491	Laguna Madre	10	1.80	18.30	7.57
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	12.10	39.30	28.36

Table 6.3.7. Water Temperature (°C) near-surface and near-bottom summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. At sites where water depth is shallow, the near-surface and near-bottom values are the same. **Bold** = highest recorded mean concentration.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Water Temperature	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	29.63	29.84	29.74
(°C)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	29.62	30.37	30.02
	2471	Aransas Bay	5	30.63	31.55	**31.05**
	2472	Copano Bay/Port Bay/Mission Bay	4	28.96	30.93	30.14
Near-Surface	2473	St. Charles Bay	3	29.74	30.23	30.03
(0.50 m below)	2481	Corpus Christi Bay	11	29.09	31.14	30.05
	2482	Nueces Bay	3	29.00	29.98	29.60
	2483	Redfish Bay	1	29.54	29.54	29.54
	2485	Oso Bay	2	29.65	30.52	30.09
	2491	Laguna Madre	10	28.19	32.23	29.86
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	29.24	29.78	29.57
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Water Temperature	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	29.63	29.84	29.74
(°C)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	29.62	30.45	30.05
	2471	Aransas Bay	5	30.63	31.30	**30.94**
	2472	Copano Bay/Port Bay/Mission Bay	4	28.96	30.92	30.12
Near-Bottom	2473	St. Charles Bay	3	29.72	30.25	30.03
(0.50 m above)	2481	Corpus Christi Bay	11	29.09	30.37	29.92
	2482	Nueces Bay	3	28.92	30.33	29.41
	2483	Redfish Bay	1	29.55	29.55	29.55
	2485	Oso Bay	2	29.65	30.52	30.09
	2491	Laguna Madre	10	28.19	32.23	29.86
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	29.24	29.78	29.57

Table 6.3.8. Secchi Depth (m) and Total Depth (m) summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. **Bold** = highest recorded mean concentration.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Secchi Depth	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.20	0.25	0.23
(m)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.20	0.50	0.39
	2471	Aransas Bay	5	0.40	>1.14	0.83
	2472	Copano Bay/Port Bay/Mission Bay	4	0.25	2.00	0.91
	2473	St. Charles Bay	3	0.50	0.60	0.53
	2481	Corpus Christi Bay	11	>0.42	1.40	0.89
	2482	Nueces Bay	3	0.25	0.70	0.45
	2483	Redfish Bay	1	0.60	0.60	0.60
	2485	Oso Bay	2	0.40	>0.80	0.60
	2491	Laguna Madre	10	>0.30	1.30	0.67
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.30	>0.67	0.44
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Total Depth	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	1.24	1.52	1.38
(m)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.46	1.50	1.18
	2471	Aransas Bay	5	1.14	3.14	1.77
	2472	Copano Bay/Port Bay/Mission Bay	4	1.17	2.33	1.83
	2473	St. Charles Bay	3	1.40	1.59	1.51
	2481	Corpus Christi Bay	11	0.42	4.78	3.35
	2482	Nueces Bay	3	1.38	2.10	1.68
	2483	Redfish Bay	1	2.77	2.77	2.77
	2485	Oso Bay	2	0.53	0.80	0.67
	2491	Laguna Madre	10	0.30	1.72	0.71
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.67	2.35	1.54

6.4 Routine Conventional Water Chemistry – Individual Concentrations (mg/L or ppm, chlorophyll *a* µg/L or ppb)

Table 6.4.1. Ammonia concentrations (mg/L or ppm) at RCAP 2002 sampling sites. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). Shaded value exceeded TCEQ Screening Level Estuary (SLE) indicated in parentheses below parameter and is only applicable to SNU samples. Other exceedances provided for reference. * = did not meet QA/QC and no value (-) indicates sample not collected due to depth requirements.

Segment	Segment Name	CCS ID	TCEQ ID	Ammonia SNU (SLE 0.10)	Ammonia SN	Ammonia MN	Ammonia BN
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	0.020	0.009	-	0.037
		246	18217	0.011	0.021	-	0.030
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	0.035	0.058	-	0.054
		253	18224	0.048	0.045	-	-
		254	18225	0.009	0.007	-	0.027
		256	18227	0.019	0.032	-	0.015
2471	Aransas Bay	257	18228	0.007	0.007	-	0.002
		259	18230	0.006	0.007	-	0.013
		260	18231	0.016	0.032	-	0.020
		261	18232	<0.001	0.011	-	0.025
		262	18233	<0.001	0.011	-	0.022
2472	Copano Bay/Port Bay/Mission Bay	250	18221	0.010	0.021	-	0.021
		252	18223	0.009	0.024	-	0.002
		255	18226	0.014	0.010	0.002	0.026
		258	18229	0.005	0.021	-	0.001
2473	St. Charles Bay	247	18218	0.009	0.011	-	0.013
		248	18219	0.005	0.006	-	0.027
		251	18222	0.011	0.010	-	0.042
2481	Corpus Christi Bay	266	18237	0.010	0.020	0.002	0.002
		268	18239	0.005	0.020	0.002	0.075
		269	18240	0.008	0.004	0.020	0.005
		270	18241	0.006	0.006	0.051	0.110
		271	18242	0.006	0.021	0.002	0.094
		272	18243	0.006	*	0.003	0.057
		273	18244	0.007	0.019	0.002	<0.001
		274	18245	0.007	0.006	-	<0.001
		275	18246	0.007	0.036	0.001	0.025
		276	18247	0.008	0.006	0.002	<0.001
		279	18250	0.014	0.027	-	-

Table 6.4.1. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	Ammonia SNU (SLE 0.10)	Ammonia SN	Ammonia MN	Ammonia BN
2482	Nueces Bay	263	18234	0.011	0.008	-	0.004
		264	18235	0.012	0.022	0.004	0.027
		267	18238	0.005	0.006	-	0.017
2483	Redfish Bay	265	18236	0.001	0.009	0.001	0.001
2485	Oso Bay	277	18248	0.010	0.008	-	-
		278	18249	0.016	0.011	-	-
2491	Laguna Madre	280	18251	0.001	0.007	-	-
		281	18252	0.003	0.005	-	-
		282	18253	0.003	<0.001	-	0.004
		283	18254	<0.001	0.003	-	-
		284	18255	0.003	0.006	-	-
		290	18261	0.027	0.005	-	-
		291	18262	0.009	0.014	-	-
		292	18263	0.006	0.006	-	-
		293	18264	0.002	0.002	-	-
		294	18265	0.058	0.017	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	0.001	0.012	-	0.006
		286	18257	0.003	0.014	-	-
		287	18258	0.008	0.002	-	0.041
		288	18259	0.063	0.023	0.006	0.031
		289	18260	0.473	0.009	0.048	0.087

Table 6.4.2. Nitrate concentrations (mg/L or ppm) at RCAP 2002 sampling sites. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). * = did not meet QA/QC and no value (-) indicates sample not collected due to depth requirements.

Segment	Segment Name	CCS ID	TCEQ ID	Nitrate SNU	Nitrate SN	Nitrate MN	Nitrate BN
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	0.190	0.245	-	0.334
		246	18217	0.001	0.009	-	0.006
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	0.004	0.016	-	0.008
		253	18224	0.006	0.011	-	-
		254	18225	0.001	0.006	-	0.002
		256	18227	0.006	0.007	-	<0.001
2471	Aransas Bay	257	18228	0.002	0.005	-	0.002
		259	18230	0.001	0.004	-	0.003
		260	18231	0.002	0.007	-	0.003
		261	18232	0.001	0.001	-	0.002
		262	18233	0.002	0.001	-	0.002
2472	Copano Bay/Port Bay/Mission Bay	250	18221	<0.001	0.015	-	0.002
		252	18223	0.004	0.009	-	0.002
		255	18226	0.001	0.003	0.001	0.003
		258	18229	0.002	0.007	-	<0.001
2473	St. Charles Bay	247	18218	0.003	<0.001	-	0.002
		248	18219	0.002	0.001	-	0.003
		251	18222	0.001	0.003	-	0.005
2481	Corpus Christi Bay	266	18237	<0.001	0.006	0.002	0.001
		268	18239	0.001	0.006	0.001	0.001
		269	18240	0.002	0.005	0.002	0.001
		270	18241	0.001	0.003	0.002	0.006
		271	18242	0.001	0.006	0.001	0.011
		272	18243	0.001	*	0.002	0.004
		273	18244	0.001	0.005	0.002	<0.001
		274	18245	0.001	0.002	-	0.001
		275	18246	0.001	0.004	0.001	0.002
		276	18247	0.001	0.004	0.001	<0.001
		279	18250	0.001	0.001	-	-
2482	Nueces Bay	263	18234	0.001	0.001	-	<0.001
		264	18235	0.002	0.007	0.001	0.013
		267	18238	0.001	0.003	-	0.016

Table 6.4.2. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	Nitrate SNU	Nitrate SN	Nitrate MN	Nitrate BN
2483	Redfish Bay	265	18236	0.001	0.004	0.001	0.001
2485	Oso Bay	277	18248	0.001	0.002	-	-
		278	18249	0.003	0.001	-	-
2491	Laguna Madre	280	18251	0.001	0.001	-	-
		281	18252	0.001	0.001	-	-
		282	18253	0.002	0.003	-	0.001
		283	18254	0.001	<0.001	-	-
		284	18255	0.002	<0.001	-	-
		290	18261	0.003	0.001	-	-
		291	18262	0.003	<0.001	-	-
		292	18263	0.004	<0.001	-	-
		293	18264	0.004	0.001	-	-
		294	18265	0.004	0.001	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	0.001	<0.001	-	<0.001
		286	18257	0.002	<0.001	-	-
		287	18258	0.002	0.003	-	0.003
		288	18259	0.002	0.004	0.001	0.001
		289	18260	0.002	0.003	0.001	0.001

Table 6.4.3. Nitrite concentrations (mg/L or ppm) at RCAP 2002 sampling sites. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). * = did not meet QA/QC and no value (-) indicates sample not collected due to depth requirements.

Segment	Segment Name	CCS ID	TCEQ ID	Nitrite SNU	Nitrite SN	Nitrite MN	Nitrite BN
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	0.012	0.027	-	0.019
		246	18217	0.002	<0.001	-	0.001
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	0.002	0.009	-	0.004
		253	18224	0.003	0.007	-	-
		254	18225	0.001	0.002	-	0.002
		256	18227	0.002	0.002	-	0.002
2471	Aransas Bay	257	18228	0.001	0.005	-	0.002
		259	18230	<0.001	0.001	-	<0.001
		260	18231	0.001	0.004	-	0.002
		261	18232	<0.001	0.001	-	<0.001
		262	18233	0.000	0.001	-	<0.001
2472	Copano Bay/Port Bay/Mission Bay	250	18221	0.002	0.001	-	0.001
		252	18223	0.001	0.003	-	0.001
		255	18226	0.001	0.002	0.001	0.001
		258	18229	<0.001	<0.001	-	0.001
2473	St. Charles Bay	247	18218	0.002	0.002	-	0.001
		248	18219	<0.001	0.002	-	0.001
		251	18222	0.002	0.002	-	0.002
2481	Corpus Christi Bay	266	18237	0.002	<0.001	<0.001	<0.001
		268	18239	0.001	<0.001	0.001	0.005
		269	18240	<0.001	<0.001	0.001	<0.001
		270	18241	0.001	0.002	0.006	0.021
		271	18242	0.001	<0.001	0.001	0.013
		272	18243	0.001	*	<0.001	0.003
		273	18244	0.001	0.001	<0.001	<0.001
		274	18245	0.001	0.001	-	<0.001
		275	18246	0.001	<0.001	0.001	0.001
		276	18247	0.001	0.001	0.001	<0.001
		279	18250	<0.001	0.001	-	-
2482	Nueces Bay	263	18234	0.001	0.004	-	0.002
		264	18235	<0.001	<0.001	0.002	0.002
		267	18238	0.001	0.002	-	0.013

Table 6.4.3. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	Nitrite SNU	Nitrite SN	Nitrite MN	Nitrite BN
2483	Redfish Bay	265	18236	0.001	<0.001	0.001	<0.001
2485	Oso Bay	277	18248	0.002	0.001	-	-
		278	18249	0.002	0.001	-	-
2491	Laguna Madre	280	18251	<0.001	<0.001	-	-
		281	18252	0.001	<0.001	-	-
		282	18253	<0.001	0.001	-	<0.001
		283	18254	<0.001	<0.001	-	-
		284	18255	<0.001	<0.001	-	-
		290	18261	0.002	<0.001	-	-
		291	18262	0.002	0.001	-	-
		292	18263	0.001	<0.001	-	-
		293	18264	0.001	<0.001	-	-
		294	18265	<0.001	<0.001	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	<0.001	<0.001	-	<0.001
		286	18257	<0.001	<0.001	-	-
		287	18258	<0.001	0.002	-	0.002
		288	18259	0.005	0.004	0.003	0.003
		289	18260	0.007	<0.001	0.002	0.004

Table 6.4.4. Nitrate + Nitrite concentrations (mg/L or ppm) at RCAP 2002 sampling sites. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). Shaded value exceeded TCEQ Screening Level Estuary (SLE) indicated in parentheses below parameter and is only applicable to SNU samples. Other exceedances provided for reference. * = did not meet QA/QC and no value (-) indicates sample not collected due to depth requirements.

Segment	Segment Name	CCS ID	TCEQ ID	N + N SNU (SLE 0.26)	N + N SN	N + N MN	N + N BN
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	0.202	0.272	-	0.353
		246	18217	0.003	0.009	-	0.007
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	0.006	0.025	-	0.012
		253	18224	0.009	0.018	-	-
		254	18225	0.002	0.008	-	0.004
		256	18227	0.008	0.008	-	0.002
2471	Aransas Bay	257	18228	0.003	0.010	-	0.004
		259	18230	0.002	0.005	-	0.003
		260	18231	0.003	0.011	-	0.005
		261	18232	0.001	0.002	-	0.002
		262	18233	0.002	0.002	-	0.002
2472	Copano Bay/Port Bay/Mission Bay	250	18221	0.002	0.016	-	0.003
		252	18223	0.004	0.012	-	0.003
		255	18226	0.002	0.005	0.002	0.004
		258	18229	0.002	0.007	-	0.001
2473	St. Charles Bay	247	18218	0.005	0.002	-	0.003
		248	18219	0.002	0.003	-	0.004
		251	18222	0.004	0.005	-	0.008
2481	Corpus Christi Bay	266	18237	0.002	0.006	0.003	0.001
		268	18239	0.002	0.006	0.002	0.007
		269	18240	0.002	0.005	0.003	0.001
		270	18241	0.003	0.005	0.007	0.027
		271	18242	0.002	0.007	0.002	0.024
		272	18243	0.002	*	0.002	0.007
		273	18244	0.002	0.006	0.003	0.000
		274	18245	0.002	0.003	-	0.001
		275	18246	0.002	0.004	0.002	0.002
		276	18247	0.003	0.004	0.002	0.001
		279	18250	0.002	0.001	-	-
2482	Nueces Bay	263	18234	0.002	0.005	-	0.002
		264	18235	0.002	0.007	0.004	0.015
		267	18238	0.002	0.005	-	0.029

Table 6.4.4. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	N + N SNU (SLE 0.26)	N + N SN	N + N MN	N + N BN
2483	Redfish Bay	265	18236	0.002	0.004	0.002	0.001
2485	Oso Bay	277	18248	0.003	0.004	-	-
		278	18249	0.005	0.002	-	-
2491	Laguna Madre	280	18251	0.001	0.001	-	-
		281	18252	0.002	0.001	-	-
		282	18253	0.002	0.005	-	0.001
		283	18254	0.001	0.000	-	-
		284	18255	0.002	0.001	-	-
		290	18261	0.005	0.001	-	-
		291	18262	0.005	0.001	-	-
		292	18263	0.005	0.001	-	-
		293	18264	0.005	0.001	-	-
		294	18265	0.004	0.001	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	0.002	0.001	-	0.001
		286	18257	0.002	0.001	-	-
		287	18258	0.002	0.005	-	0.005
		288	18259	0.007	0.008	0.004	0.004
		289	18260	0.009	0.003	0.004	0.004

Table 6.4.5. Total Phosphorus (TP) and Ortho-phosphorus (OP) concentrations (mg/L or ppm) at RCAP 2002 sampling sites. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). Shaded value exceeded TCEQ Screening Level Estuary (SLE) indicated in parentheses below parameter and is only applicable to SNU and SN samples. ** = no data and no value (-) indicates sample not collected due to depth requirements.

Segment	Segment Name	CCS ID	TCEQ ID	TP SNU (SLE 0.22)	OP SN (SLE 0.16	OP MN	OP BN
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	<0.060	<0.040	-	<0.040
		246	18217	<0.060	<0.040	-	<0.040
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	<0.060	0.059	-	0.060
		253	18224	0.078	0.059	-	-
		254	18225	0.099	0.044	-	0.041
		256	18227	<0.060	0.054	-	0.051
2471	Aransas Bay	257	18228	0.073	0.052	-	0.049
		259	18230	<0.060	<0.040	-	<0.040
		260	18231	<0.060	0.045	-	0.046
		261	18232	<0.060	<0.040	-	<0.040
		262	18233	<0.060	<0.040	-	<0.040
2472	Copano Bay/Port Bay/Mission Bay	250	18221	0.067	0.043	-	0.041
		252	18223	0.060	0.050	-	0.050
		255	18226	<0.060	0.055	<0.040	0.047
		258	18229	0.093	0.051	-	0.056
2473	St. Charles Bay	247	18218	0.071	<0.040	-	<0.040
		248	18219	<0.060	<0.040	-	<0.040
		251	18222	<0.060	<0.040	-	<0.040
2481	Corpus Christi Bay	266	18237	0.077	0.055	<0.040	<0.040
		268	18239	<0.060	0.049	<0.040	0.043
		269	18240	<0.060	<0.040	<0.040	<0.040
		270	18241	0.072	0.051	0.046	0.053
		271	18242	0.076	0.050	<0.040	0.040
		272	18243	0.077	**	<0.040	<0.040
		273	18244	0.102	<0.040	<0.040	<0.040
		274	18245	0.101	0.044	-	0.042
		275	18246	0.091	<0.040	<0.040	<0.040
		276	18247	0.080	<0.040	<0.040	<0.040
		279	18250	<0.060	<0.040	-	-
2482	Nueces Bay	263	18234	0.246	0.137	-	0.132
		264	18235	0.204	0.104	0.086	0.130
		267	18238	0.106	0.067	-	0.054

Table 6.4.5. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	TP SNU (SLE 0.22)	OP SN (SLE 0.16)	OP MN	OP BN
2483	Redfish Bay	265	18236	<0.060	<0.040	<0.040	<0.040
2485	Oso Bay	277	18248	0.084	<0.040	-	-
		278	18249	<0.060	<0.040	-	-
2491	Laguna Madre	280	18251	<0.060	<0.040	-	-
		281	18252	0.071	<0.040	-	-
		282	18253	<0.060	<0.040	-	<0.040
		283	18254	<0.060	<0.040	-	-
		284	18255	<0.060	<0.040	-	-
		290	18261	<0.060	<0.040	-	-
		291	18262	<0.060	<0.040	-	-
		292	18263	<0.060	<0.040	-	-
		293	18264	<0.060	<0.040	-	-
		294	18265	<0.060	<0.040	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna	285	18256	0.076	<0.040	-	<0.040
		286	18257	<0.060	<0.040	-	-
		287	18258	0.080	<0.040	-	<0.040
		288	18259	<0.060	<0.040	<0.040	<0.040
		289	18260	0.060	<0.040	<0.040	<0.040

Table 6.4.6. Chlorophyll *a* (Ch *a*) and Total Suspended Solid (TSS) concentrations (µg/L or ppb and mg/L or ppm) at RCAP 2002 sampling sites. TCEQ and EPA Method (SCL = Surface Ch *a* Field Filtered, MCL = Mid-Depth Ch *a* Field Filtered, BCL = Bottom Ch *a* Field Filtered), SS = Surface sample, MS = Mid-depth sample, and BS = Bottom sample. Shaded value exceeded TCEQ Screening Level Estuary (SLE) indicated in parentheses below parameter and is applicable only to SCL samples. ** = no data and no value (-) indicates sample not collected due to depth requirements.

Segment	Segment Name	CCS ID	TCEQ ID	Ch *a* SCL (SLE 11.50)	Ch *a* MCL	Ch *a* BCL	TSS SS	TSS MS	TSS BS
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	45.42	-	47.58	50	-	72
		246	18217	18.66	-	-	30	-	38
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	3.06	-	3.42	13	-	19
		253	18224	2.02	-	-	17	-	-
		254	18225	8.29	-	7.61	41	-	62
		256	18227	4.86	-	2.93	40	-	65
2471	Aransas Bay	257	18228	5.47	-	7.10	25	-	25
		259	18230	5.68	6.87	9.88	6	6	34
		260	18231	3.58	-	2.94	11	-	11
		261	18232	5.73	-	10.20	5	-	15
		262	18233	5.68	-	-	21	-	17
2472	Copano Bay/Port Bay/Mission Bay	250	18221	8.59	-	9.27	23	-	24
		252	18223	1.14	-	5.13	5	-	7
		255	18226	4.88	4.99	5.34	19	32	44
		258	18229	6.69	-	6.59	19	-	16
2473	St. Charles Bay	247	18218	15.10	-	15.13	14	-	37
		248	18219	5.95	-	5.62	13	17	-
		251	18222	6.11	-	7.55	18	48	-
2481	Corpus Christi Bay	266	18237	13.80	14.00	12.00	11	11	11
		268	18239	6.96	7.86	6.62	3	3	30
		269	18240	2.55	2.71	1.85	7	7	8
		270	18241	7.78	11.90	5.11	4	7	34
		271	18242	8.56	12.10	4.67	4	7	18
		272	18243	7.50	7.95	6.88	3	3	35
		273	18244	13.10	11.30	12.50	14	12	16
		274	18245	19.50	-	20.00	15	-	17
		275	18246	12.10	14.40	14.40	12	10	12
		276	18247	17.20	13.00	10.70	5	6	7
		279	18250	4.96	-	-	6	-	-
2482	Nueces Bay	263	18234	16.90	-	17.58	22	-	32
		264	18235	22.31	21.30	23.66	20	21	31
		267	18238	8.03	-	7.83	6	-	14

Table 6.4.6. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	Ch *a* SCL (SLE 11.50)	Ch *a* MCL	Ch *a* BCL	TSS SS	TSS MS	TSS BS
2483	Redfish Bay	265	18236	9.08	8.68	9.46	12	11	49
2485	Oso Bay	277	18248	24.53	-	-	53	-	-
		278	18249	3.39	-	-	9	-	-
2491	Laguna Madre	280	18251	15.90	-	-	5	-	-
		281	18252	16.20	-	-	12	-	-
		282	18253	4.57	-	4.71	9	-	25
		283	18254	3.10	-	-	5	-	-
		284	18255	3.35	-	-	3	-	-
		290	18261	4.75	-	-	9	-	-
		291	18262	2.01	-	-	9	-	-
		292	18263	**	-	-	8	-	-
		293	18264	1.20	-	-	4	-	-
		294	18265	0.22	-	-	1	-	-
2492	Baffin Bay/Alazan Bay/	285	18256	10.86	-	13.25	39	-	98
	Cayo del Grullo/Laguna Salada	286	18257	6.74	-	-	17	-	-
		287	18258	12.73	-	14.14	48	-	61
		288	18259	7.60	3.08	9.03	21	22	21
		289	18260	8.25	10.30	11.83	39	36	67

6.5 Routine Conventional Water Chemistry –Summary Statistics

Table 6.5.1. Ammonia (mg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). Shaded = value exceeded TCEQ SLE (Screening Level Estuary). SLE is only applicable to SNU samples. **Bold** = highest recorded mean concentrations.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Ammonia	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.011	0.020	0.016
SNU	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.009	0.048	0.028
TCEQ	2471	Aransas Bay	5	<0.001	0.016	0.006
SLE 2000	2472	Copano Bay/Port Bay/Mission Bay	4	0.005	0.014	0.009
0.10 mg/L	2473	St. Charles Bay	3	0.005	0.011	0.008
	2481	Corpus Christi Bay	11	0.005	0.014	0.008
	2482	Nueces Bay	3	0.005	0.012	0.009
	2483	Redfish Bay	1	0.001	0.001	0.001
	2485	Oso Bay	2	0.010	0.016	0.013
	2491	Laguna Madre	10	<0.001	0.058	0.011
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.001	0.473	**0.110**
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Ammonia	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.009	0.021	0.015
SN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.007	0.058	**0.036**
	2471	Aransas Bay	5	0.007	0.032	0.013
	2472	Copano Bay/Port Bay/Mission Bay	4	0.010	0.024	0.019
	2473	St. Charles Bay	3	0.006	0.011	0.009
	2481	Corpus Christi Bay	10	0.004	0.036	0.016
	2482	Nueces Bay	3	0.006	0.022	0.012
	2483	Redfish Bay	1	0.009	0.009	0.009
	2485	Oso Bay	2	0.008	0.011	0.009
	2491	Laguna Madre	10	<0.001	0.017	0.006
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.002	0.023	0.012

Table 6.5.1 (continued). Ammonia (mg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). **Bold** = highest recorded mean concentrations. No value (-) indicates sample not collected due to depth requirements.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Ammonia	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	-	-	-	-
MN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	-	-	-	-
	2471	Aransas Bay	-	-	-	-
	2472	Copano Bay/Port Bay/Mission Bay	1	0.002	0.002	0.002
	2473	St. Charles Bay	-	-	-	-
	2481	Corpus Christi Bay	9	0.001	0.051	0.009
	2482	Nueces Bay	1	0.004	0.004	0.004
	2483	Redfish Bay	1	0.001	0.001	0.001
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	-	-	-	-
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	2	0.006	0.048	**0.027**
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Ammonia	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.030	0.037	0.033
BN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	3	0.015	0.054	0.032
	2471	Aransas Bay	5	0.002	0.025	0.016
	2472	Copano Bay/Port Bay/Mission Bay	4	0.001	0.026	0.013
	2473	St. Charles Bay	3	0.013	0.042	0.028
	2481	Corpus Christi Bay	10	<0.001	0.110	0.037
	2482	Nueces Bay	3	0.004	0.027	0.016
	2483	Redfish Bay	1	0.001	0.001	0.001
	2491	Laguna Madre	1	0.004	0.004	0.004
	2485	Oso Bay	-	-	-	-
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	4	0.006	0.087	**0.041**

Table 6.5.2. Nitrate (mg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). **Bold** = highest recorded mean concentrations.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Nitrate	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.001	0.190	**0.095**
SNU	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.001	0.006	0.004
	2471	Aransas Bay	5	0.001	0.002	0.002
	2472	Copano Bay/Port Bay/Mission Bay	4	<0.001	0.004	0.002
	2473	St. Charles Bay	3	0.001	0.003	0.002
	2481	Corpus Christi Bay	11	<0.001	0.002	0.001
	2482	Nueces Bay	3	0.001	0.002	0.001
	2483	Redfish Bay	1	0.001	0.001	0.001
	2485	Oso Bay	2	0.001	0.003	0.002
	2491	Laguna Madre	10	0.001	0.004	0.003
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.001	0.002	0.002
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Nitrate	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.009	0.245	**0.127**
SN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.006	0.016	0.010
	2471	Aransas Bay	5	0.001	0.007	0.004
	2472	Copano Bay/Port Bay/Mission Bay	4	0.003	0.015	0.008
	2473	St. Charles Bay	3	<0.001	0.003	0.001
	2481	Corpus Christi Bay	10	0.001	0.006	0.004
	2482	Nueces Bay	3	0.001	0.007	0.004
	2483	Redfish Bay	1	0.004	0.004	0.004
	2485	Oso Bay	2	0.001	0.002	0.002
	2491	Laguna Madre	10	<0.001	0.003	0.001
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	<0.001	0.004	0.002

Table 6.5.2 (continued). Nitrate (mg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). **Bold** = highest recorded mean concentrations. No value (-) indicates sample not collected due to depth requirements.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Nitrate	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	-	-	-	-
MN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	-	-	-	-
	2471	Aransas Bay	-	-	-	-
	2472	Copano Bay/Port Bay/Mission Bay	1	0.001	0.001	0.001
	2473	St. Charles Bay	-	-	-	-
	2481	Corpus Christi Bay	9	0.001	0.002	**0.002**
	2482	Nueces Bay	1	0.001	0.001	0.001
	2483	Redfish Bay	1	0.001	0.001	0.001
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	-	-	-	-
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	2	0.001	0.001	0.001
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Nitrate	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.006	0.334	**0.170**
BN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	3	<0.001	0.008	0.003
	2471	Aransas Bay	5	0.002	0.003	0.002
	2472	Copano Bay/Port Bay/Mission Bay	4	<0.001	0.003	0.002
	2473	St. Charles Bay	3	0.002	0.005	0.004
	2481	Corpus Christi Bay	10	<0.001	0.011	0.003
	2482	Nueces Bay	3	<0.001	0.016	0.010
	2483	Redfish Bay	1	0.001	0.001	0.001
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	1	0.001	0.001	0.001
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	4	<0.001	0.003	0.001

Table 6.5.3. Nitrite (mg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). **Bold** = highest recorded mean concentrations.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Nitrite	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.002	0.012	**0.007**
SNU	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.001	0.003	0.002
	2471	Aransas Bay	5	<0.001	0.001	<0.001
	2472	Copano Bay/Port Bay/Mission Bay	4	<0.001	0.002	0.001
	2473	St. Charles Bay	3	<0.001	0.002	0.001
	2481	Corpus Christi Bay	11	<0.001	0.002	0.001
	2482	Nueces Bay	3	<0.001	0.001	0.001
	2483	Redfish Bay	1	0.001	0.001	0.001
	2485	Oso Bay	2	0.002	0.002	0.002
	2491	Laguna Madre	10	<0.001	0.002	0.001
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	<0.001	0.007	0.003
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Nitrite	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	<0.001	0.027	**0.013**
SN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.002	0.009	0.005
	2471	Aransas Bay	5	0.001	0.005	0.002
	2472	Copano Bay/Port Bay/Mission Bay	4	<0.001	0.003	0.001
	2473	St. Charles Bay	3	0.002	0.002	0.002
	2481	Corpus Christi Bay	10	<0.001	0.002	0.001
	2482	Nueces Bay	3	<0.001	0.004	0.002
	2483	Redfish Bay	1	<0.001	<0.001	<0.001
	2485	Oso Bay	2	0.001	0.001	0.001
	2491	Laguna Madre	10	<0.001	0.001	<0.001
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	<0.001	0.004	0.001

Table 6.5.3 (continued). Nitrite (mg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). **Bold** = highest recorded mean concentrations. No value (-) indicates sample not collected due to depth requirements.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Nitrite	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	-	-	-	-
MN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	-	-	-	-
	2471	Aransas Bay	-	-	-	-
	2472	Copano Bay/Port Bay/Mission Bay	1	0.001	0.001	0.001
	2473	St. Charles Bay	-	-	-	-
	2481	Corpus Christi Bay	9	<0.001	0.006	0.001
	2482	Nueces Bay	1	0.002	0.002	0.002
	2483	Redfish Bay	1	0.001	0.001	0.001
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	-	-	-	-
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	2	0.002	0.003	**0.003**
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Nitrite	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.001	0.019	**0.010**
BN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	3	0.002	0.004	0.002
	2471	Aransas Bay	5	<0.001	0.002	0.001
	2472	Copano Bay/Port Bay/Mission Bay	4	0.001	0.001	0.001
	2473	St. Charles Bay	3	0.001	0.002	0.001
	2481	Corpus Christi Bay	10	<0.001	0.021	0.004
	2482	Nueces Bay	3	0.002	0.013	0.005
	2483	Redfish Bay	1	<0.001	<0.001	<0.001
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	1	<0.001	<0.001	<0.001
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	4	<0.001	0.004	0.002

Table 6.5.4. Nitrate + Nitrite (mg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). Shaded = value exceeded TCEQ SLE (Screening Level Estuary). SLE is only applicable to SNU samples. **Bold** = highest recorded mean concentrations.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Nitrate-Nitrite	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.003	0.202	**0.102**
SNU	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.002	0.009	0.006
TCEQ	2471	Aransas Bay	5	0.001	0.003	0.002
SLE 2000	2472	Copano Bay/Port Bay/Mission Bay	4	0.002	0.004	0.002
0.26 mg/L	2473	St. Charles Bay	3	0.002	0.005	0.003
	2481	Corpus Christi Bay	11	0.002	0.003	0.002
	2482	Nueces Bay	3	0.002	0.002	0.002
	2483	Redfish Bay	1	0.002	0.002	0.002
	2485	Oso Bay	2	0.003	0.005	0.004
	2491	Laguna Madre	10	0.001	0.005	0.003
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.002	0.009	0.004
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Nitrate-Nitrite	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.009	0.272	**0.141**
SN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.008	0.025	0.015
	2471	Aransas Bay	5	0.002	0.011	0.006
	2472	Copano Bay/Port Bay/Mission Bay	4	0.005	0.016	0.010
	2473	St. Charles Bay	3	0.002	0.005	0.003
	2481	Corpus Christi Bay	10	0.001	0.007	0.005
	2482	Nueces Bay	3	0.005	0.007	0.006
	2483	Redfish Bay	1	0.004	0.004	0.004
	2485	Oso Bay	2	0.002	0.004	0.003
	2491	Laguna Madre	10	<0.001	0.005	0.001
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.001	0.008	0.003

Table 6.5.4 (continued). Nitrate + Nitrite (mg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). Shaded = value exceeded TCEQ SLE (Screening Level Estuary). SLE is only applicable to SNU samples. **Bold** = highest recorded mean concentrations. No value (-) indicates sample not collected due to depth requirements.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Nitrate-Nitrite	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	-	-	-	-
MN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	-	-	-	-
	2471	Aransas Bay	-	-	-	-
	2472	Copano Bay/Port Bay/Mission Bay	1	0.002	0.002	0.002
	2473	St. Charles Bay	-	-	-	-
	2481	Corpus Christi Bay	9	0.002	0.007	0.003
	2482	Nueces Bay	1	0.004	0.004	**0.004**
	2483	Redfish Bay	1	0.002	0.002	0.002
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	-	-	-	-
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	2	0.004	0.004	**0.004**
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Nitrate-Nitrite	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.007	0.353	**0.180**
BN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	3	0.002	0.012	0.006
	2471	Aransas Bay	5	0.002	0.005	0.003
	2472	Copano Bay/Port Bay/Mission Bay	4	0.001	0.004	0.003
	2473	St. Charles Bay	3	0.003	0.008	0.005
	2481	Corpus Christi Bay	10	<0.001	0.027	0.007
	2482	Nueces Bay	3	0.002	0.029	0.015
	2483	Redfish Bay	1	0.001	0.001	0.001
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	1	0.001	0.001	0.001
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	4	0.001	0.005	0.003

Table 6.5.5. Total Phosphorus and Ortho-Phosphorus (mg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). Shaded = value exceeded TCEQ SLE (Screening Level Estuary). SLE is only applicable to SNU and SN samples. **Bold** = highest recorded mean concentrations.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Total Phosphorus	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.037	0.047	0.042
SNU	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.043	0.099	0.067
TCEQ	2471	Aransas Bay	5	0.002	0.073	0.039
SLE 2000	2472	Copano Bay/Port Bay/Mission Bay	4	0.057	0.093	0.069
0.22 mg/L	2473	St. Charles Bay	3	0.025	0.071	0.044
	2481	Corpus Christi Bay	11	0.002	0.102	0.067
	2482	Nueces Bay	3	0.106	0.246	**0.185**
	2483	Redfish Bay	1	0.031	0.031	0.031
	2485	Oso Bay	2	0.023	0.084	0.053
	2491	Laguna Madre	10	0.006	0.071	0.023
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.040	0.080	0.059
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Ortho-Phosphorus	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	<0.001	0.023	0.012
SN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.044	0.059	0.054
TCEQ	2471	Aransas Bay	5	0.013	0.052	0.037
SLE 2000	2472	Copano Bay/Port Bay/Mission Bay	4	0.043	0.055	0.050
0.16 mg/L	2473	St. Charles Bay	3	0.019	0.032	0.026
	2481	Corpus Christi Bay	10	0.004	0.055	0.035
	2482	Nueces Bay	3	0.067	0.137	**0.103**
	2483	Redfish Bay	1	0.023	0.023	0.023
	2485	Oso Bay	2	0.008	0.011	0.010
	2491	Laguna Madre	10	0.002	0.022	0.007
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.003	0.023	0.012

Table 6.5.5 (continued). Ortho-Phosphorus (mg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method (SNU = Surface Nutrient Unfiltered in Field), EPA Method (SN = Surface Nutrient Field Filtered, MN = Mid-Depth Nutrient Field Filtered, BN = Bottom Nutrient Field Filtered). Shaded = value exceeded TCEQ SLE (Screening Level Estuary). SLE is only applicable to SNU samples and SN samples. **Bold** = highest recorded mean concentrations. No value (-) indicates sample not collected due to depth requirements.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Ortho-Phosphorus	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	-	-	-	-
MN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	-	-	-	-
	2471	Aransas Bay	-	-	-	-
	2472	Copano Bay/Port Bay/Mission Bay	1	0.039	0.039	0.039
	2473	St. Charles Bay	-	-	-	-
	2481	Corpus Christi Bay	9	0.007	0.046	0.023
	2482	Nueces Bay	1	0.086	0.086	**0.086**
	2483	Redfish Bay	1	0.020	0.020	0.020
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	-	-	-	-
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	2	0.001	0.003	0.002
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Ortho-Phosphorus	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.004	0.004	0.004
BN	2463	Mesquite Bay/Carlos Bay/Ayres Bay	3	0.041	0.060	0.051
	2471	Aransas Bay	5	0.002	0.049	0.030
	2472	Copano Bay/Port Bay/Mission Bay	4	0.041	0.056	0.048
	2473	St. Charles Bay	3	0.005	0.020	0.012
	2481	Corpus Christi Bay	10	0.001	0.053	0.033
	2482	Nueces Bay	3	0.054	0.132	**0.105**
	2483	Redfish Bay	1	0.022	0.022	0.022
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	1	<0.001	<0.001	<0.001
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	4	0.001	0.004	0.003

Table 6.5.6. Chlorophyll *a* (µg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method and EPA Method (SCL = Surface Chlorophyll *a* Field Filtered, MCL = Mid-Depth Chlorophyll *a* Field Filtered, BCL = Bottom Chlorophyll *a* Field Filtered). Shaded = value exceeded TCEQ SLE (Screening Level Estuary). SLE is only applicable to SCL samples. Others provided for reference. **Bold** = highest recorded mean concentrations. No value (-) indicates sample not collected due to depth requirements.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Chlorophyll *a*	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	18.66	45.42	**32.04**
SCL	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	2.02	8.29	4.56
TCEQ	2471	Aransas Bay	5	3.58	5.73	5.23
SLE 2000	2472	Copano Bay/Port Bay/Mission Bay	4	1.14	8.59	5.33
11.50 µg/L	2473	St. Charles Bay	3	5.95	15.10	9.05
	2481	Corpus Christi Bay	11	2.55	19.50	10.36
	2482	Nueces Bay	3	8.03	22.31	15.75
	2483	Redfish Bay	1	9.08	9.08	9.08
	2485	Oso Bay	2	3.39	24.53	13.96
	2491	Laguna Madre	9	0.22	16.20	5.70
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	6.74	12.73	9.24
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Chlorophyll *a*	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	-	-	-	-
MCL	2463	Mesquite Bay/Carlos Bay/Ayres Bay	-	-	-	-
	2471	Aransas Bay	1	6.87	6.87	6.87
	2472	Copano Bay/Port Bay/Mission Bay	1	4.99	4.99	4.99
	2473	St. Charles Bay	-	-	-	-
	2481	Corpus Christi Bay	9	2.71	14.40	10.58
	2482	Nueces Bay	1	21.30	21.30	**21.30**
	2483	Redfish Bay	1	8.68	8.68	8.68
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	-	-	-	-
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	2	3.08	10.30	6.69
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
Chlorophyll *a*	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	1	47.58	47.58	**47.58**
BCL	2463	Mesquite Bay/Carlos Bay/Ayres Bay	3	2.93	7.61	4.65
	2471	Aransas Bay	4	2.94	10.20	7.53
	2472	Copano Bay/Port Bay/Mission Bay	4	5.13	9.27	6.58
	2473	St. Charles Bay	3	5.62	15.13	9.43
	2481	Corpus Christi Bay	10	1.85	20.00	9.47
	2482	Nueces Bay	3	7.83	23.66	16.36
	2483	Redfish Bay	1	9.46	9.46	9.46
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	1	4.71	4.71	4.71
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	4	9.03	14.14	12.06

Table 6.5.6 (continued). Total Suspended Solids, or TSS, (mg/L) summary statistics, listed by TCEQ Segment, for RCAP 2002. TCEQ Method and EPA Method SS = Surface sample, MS = Mid-depth sample, and BS = Bottom sample. No value (-) indicates sample not collected due to depth requirements.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
TSS	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	30.0	50.0	40.0
SS	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	13.0	41.0	27.8
	2471	Aransas Bay	5	5.0	25.0	13.6
	2472	Copano Bay/Port Bay/Mission Bay	4	5.0	23.0	16.5
	2473	St. Charles Bay	3	13.0	18.0	15.0
	2481	Corpus Christi Bay	11	3.0	15.0	7.6
	2482	Nueces Bay	3	6.0	22.0	16.0
	2483	Redfish Bay	1	12.0	12.0	12.0
	2485	Oso Bay	2	9.0	53.0	31.0
	2491	Laguna Madre	9	1.0	12.0	6.5
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	17.0	48.0	32.8
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
TSS	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	-	-	-	-
MS	2463	Mesquite Bay/Carlos Bay/Ayres Bay	-	-	-	-
	2471	Aransas Bay	1	6.0	6.0	6.0
	2472	Copano Bay/Port Bay/Mission Bay	1	32.0	32.0	32.0
	2473	St. Charles Bay	-	-	-	-
	2481	Corpus Christi Bay	9	3.0	12.0	7.3
	2482	Nueces Bay	1	21.0	21.0	21.0
	2483	Redfish Bay	1	11.0	11.0	11.0
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	-	-	-	-
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	2	22.0	36.0	29.0
Parameter	**Segment**	**Segment Name**	**n (sites)**	**Min**	**Max**	**Mean**
TSS	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	38.0	72.0	55.0
BS	2463	Mesquite Bay/Carlos Bay/Ayres Bay	3	19.0	65.0	48.7
	2471	Aransas Bay	5	11.0	34.0	20.4
	2472	Copano Bay/Port Bay/Mission Bay	4	7.0	44.0	22.8
	2473	St. Charles Bay	3	17.0	48.0	34.0
	2481	Corpus Christi Bay	10	7.0	35.0	18.8
	2482	Nueces Bay	3	14.0	32.0	25.7
	2483	Redfish Bay	1	49.0	49.0	49.0
	2485	Oso Bay	-	-	-	-
	2491	Laguna Madre	1	25.0	25.0	25.0
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	4	21.0	98.0	61.8

6.6 Microbiological – Individual Concentrations (CFU/100 ml)

Table 6.6.1. Enterococci concentrations comparing three different methods recorded at RCAP 2002 sampling sites. Shaded value exceeded TCEQ criteria level of 104 CFU/100 ml.

Segment	Segment Name	CCS_ID	TCEQ_ID	IDEXX 51	IDEXX 97	Method 1600
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	<10	<10	9
		246	18217	<10	10	<1
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	<10	<10	<1
		253	18224	<10	<10	<1
		254	18225	<10	<10	3
		256	18227	<10	<10	<1
2471	Aransas Bay	257	18228	<10	<10	<1
		259	18230	<10	<10	<1
		260	18231	<10	<10	<1
		261	18232	<10	<10	<1
		262	18233	<10	<10	<1
2472	Copano Bay/Port Bay/Mission Bay	250	18221	<10	20	1
		252	18223	<10	<10	<1
		255	18226	<10	<10	<1
		258	18229	<10	31	3
2473	St. Charles Bay	247	18218	<10	<10	<1
		248	18219	<10	<10	<1
		251	18222	<10	10	<1
2481	Corpus Christi Bay	266	18237	324	201	280
		268	18239	<10	<10	<1
		269	18240	10	20	5
		270	18241	<10	<10	<1
		271	18242	<10	<10	<1
		272	18243	<10	<10	<1
		273	18244	<10	<10	<1
		274	18245	<10	<10	<1
		275	18246	<10	<10	<1
		276	18247	10	<10	<1
		279	18250	<10	<10	4
2482	Nueces Bay	263	18234	10	10	26
		264	18235	1184	1576	>1560
		267	18238	10	<10	3

Table 6.6.1. (continued).

Segment	Segment Name	CCS_ID	TCEQ_ID	IDEXX 51	IDEXX 97	Method 1600
2483	Redfish Bay	265	18236	<10	<10	<1
2485	Oso Bay	277	18248	<10	10	<1
		278	18249	<10	<10	<1
2491	Laguna Madre	280	18251	<10	<10	1
		281	18252	10	<10	<1
		282	18253	<10	<10	<1
		283	18254	<10	10	<1
		284	18255	<10	<10	<1
		290	18261	10	<10	<1
		291	18262	<10	<10	<1
		292	18263	<10	<10	<1
		293	18264	<10	20	<1
		294	18265	<10	<10	1
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	<10	20	4
		286	18257	<10	10	1
		287	18258	<10	10	1
		288	18259	<10	10	<1
		289	18260	<10	20	<1

6.7 Trace Metals in Sediment and Sediment Characteristics– Individual Concentrations (mg/kg or ppm Dry Weight)

Table 6.7.1. Trace metal (mg/kg or ppm dry weight) and sediment characteristic (%) concentrations for RCAP 2002 sampling sites. Shaded value exceeded TCEQ PEL and 85th percentile screening level. Shaded value exceeded TCEQ 85th percentile only. No value (-) indicates concentration below the reporting limit listed in parentheses below chemical symbol. **Bold** = highest recorded concentration.

Segment	Segment Name	CCS ID	TCEQ ID	Ag (0.05)	Al (1300)	As (1.5)	Cd (0.05)	Cr (4.0)	Cu (5.0)	Fe (500)	Hg (0.01)	Mn (2.0)	Ni (1.0)	Pb (1.0)	Sb (0.2)	Se (0.1)	Sn (0.1)	Zn (2.0)	% TOC	% Silt/Clay	% Sand	% Gravel
2462	San Antonio/Hynes/Guadalupe Bays	245	18216	-	32400	2.9	0.17	27.3	5.6	12600	0.024	282	7.0	13.2	0.4	0.9	0.8	34.8	2.0	78.8	20.9	0.3
		246	18217	-	34700	2.8	0.17	27.4	6.5	13800	0.027	301	7.4	14.1	0.4	0.6	0.9	37.9	1.9	85.1	14.7	0.2
2463	Mesquite/Carlos/Ayres Bays	249	18220	-	25300	2.9	0.33	17.6	6.2	8450	0.022	195	5.6	10.3	0.4	-	0.6	24.3	0.7	43.1	48.0	8.9
		253	18224	-	31800	3.7	0.27	26.1	8.7	12700	0.040	363	9.1	13.3	0.4	0.3	0.8	36.4	1.1	52.1	43.3	4.6
		254	18225	-	29200	3.1	0.35	23.6	8.3	11300	0.029	233	7.6	12.9	0.4	0.1	0.8	32.9	0.2	28.4	71.6	-
		256	18227	-	22200	2.6	-	15.5	5.0	6860	0.022	151	5.2	12.3	-	0.1	1.1	18.0	<0.1	25.5	74.2	0.3
2471	Aransas Bay	257	18228	**0.18**	29800	3.1	0.25	24.5	6.7	11800	0.022	212	7.4	12.1	0.4	0.1	1.0	30.2	1.6	47.2	52.8	-
		259	18230	-	53600	5.9	0.29	40.9	13.5	22800	0.052	472	14.4	23.3	0.6	-	2.5	61.5	1.4	95.5	4.3	0.2
		260	18231	-	30900	3.8	0.35	23.0	8.4	12100	0.019	356	8.6	12.3	0.3	0.1	0.9	32.7	1.1	36.0	28.0	36.0
		261	18232	-	3970	-	-	4.3	-	643	-	20	-	10.7	-	-	-	-	0.5	4.2	63.4	32.4
		262	18233	0.16	12100	-	-	6.3	-	2290	0.011	46	1.4	5.5	-	-	0.2	6.2	0.5	13.9	85.5	0.6
2472	Copano/Port/Mission Bays	250	18221	0.09	47900	5.0	0.48	37.0	13.8	19200	0.032	364	10.9	20.4	0.7	-	1.5	48.9	<0.1	83.7	16.4	-
		252	18223	-	13600	1.5	0.50	7.5	-	2340	0.015	90	1.8	7.4	0.3	-	-	7.7	0.4	16.9	81.4	1.7
		255	18226	0.05	49300	5.2	0.25	**44.0**	13.7	**24600**	0.073	438	13.7	23.2	**0.8**	-	1.6	63.9	3.5	**98.8**	1.2	-
		258	18229	**0.18**	33300	3.3	0.17	28.7	9.7	12800	0.030	257	7.8	14.1	0.7	0.1	1.6	34.3	0.8	77.9	21.9	0.2
2473	St. Charles Bay	247	18218	0.07	29800	2.1	0.07	23.5	6.0	10200	0.016	181	4.9	11.6	0.3	-	0.9	26.7	0.8	59.6	40.1	0.3
		248	18219	-	34800	2.7	0.07	25.5	7.2	11700	0.022	216	5.5	12.7	0.3	-	1.2	31.4	1.2	66.5	33.5	-
		251	18222	-	40600	3.6	0.08	30.6	8.5	16900	0.032	262	8.2	15.4	0.3	-	1.2	46.3	**17.9**	70.6	28.6	0.8
2481	Corpus Christi Bay	266	18237	-	44700	6.0	0.41	32.4	10.8	19100	0.123	316	11.8	26.4	0.6	0.2	1.6	111.0	1.5	68.1	18.2	13.7
		268	18239	0.05	45900	5.4	0.29	33.8	11.9	17800	0.081	357	10.1	23.2	0.6	-	2.2	67.9	0.9	80.5	14.0	5.5
		269	18240	-	15700	1.9	0.42	12.7	-	4380	0.023	137	3.0	8.8	0.3	-	1.0	14.3	0.8	14.9	82.5	2.7
		270	18241	0.11	38300	6.0	0.41	41.5	15.1	23200	0.126	354	11.9	31.0	0.7	-	2.5	100.7	2.3	93.9	5.0	1.1
		271	18242	0.08	50900	6.4	0.31	41.6	12.4	23900	0.132	342	12.6	30.7	0.7	-	**2.7**	102.7	1.3	97.7	1.0	1.2
		272	18243	0.05	37000	4.6	0.19	26.8	10.3	14800	0.073	303	9.0	20.1	0.5	-	2.0	61.4	0.6	28.1	31.2	40.8
		273	18244	-	47400	5.6	0.65	37.7	12.9	20000	0.066	431	12.8	22.2	0.5	0.2	1.5	79.1	2.7	80.8	12.5	6.8
		274	18245	-	1930	0.9	0.37	5.0	-	780	0.012	24	-	3.8	0.3	-	0.5	2.5	0.2	10.1	89.5	0.4
		275	18246	0.06	51400	6.3	**0.88**	43.5	14.8	24500	0.101	435	14.4	**35.8**	0.7	-	1.7	**111.3**	2.1	82.7	16.5	0.8
		276	18247	0.16	**58400**	6.2	0.41	40.7	**27.5**	22200	0.103	**479**	13.9	28.9	0.6	0.8	1.4	90.6	1.2	91.2	8.8	-
		279	18250	0.05	4680	3.3	0.45	7.1	-	3150	0.022	71	2.4	9.1	0.4	-	-	11.4	0.9	8.4	82.3	9.4

Table 6.7.1. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	Ag (0.05)	Al (1300)	As (1.5)	Cd (0.05)	Cr (4.0)	Cu (5.0)	Fe (500)	Hg (0.01)	Mn (2.0)	Ni (1.0)	Pb (1.0)	Sb (0.2)	Se (0.1)	Sn (0.1)	Zn (2.0)	% TOC	% Silt/Clay	% Sand	% Gravel
2482	Nueces Bay	263	18234	0.17	46000	4.7	0.89	34.9	13.4	17700	**0.191**	389	9.8	22.8	0.6	-	1.3	102.5	1.9	93.7	5.7	0.6
		264	18235	-	57000	6.6	0.79	34.8	13.1	24600	0.044	361	13.2	22.3	**0.8**	0.1	1.5	74.5	2.3	83.6	16.2	0.2
		267	18238	**0.18**	19100	2.4	**1.27**	18.5	8.2	6060	0.083	143	3.4	14.3	-	0.1	1.0	61.5	0.8	34.4	62.2	3.4
2483	Redfish Bay	265	18236	-	24800	3.6	0.61	23.0	9.6	10200	0.021	242	7.4	14.1	0.4	0.3	0.6	39.5	1.5	27.2	49.8	23.1
2485	Oso Bay	277	18248	0.09	3290	-	0.45	6.5	-	1540	0.017	35	-	7.7	-	-	0.4	6.3	0.1	8.1	**91.6**	0.3
		278	18249	0.17	26500	3.3	0.59	22.4	7.9	10200	0.028	143	5.5	19.3	**0.8**	0.2	0.6	34.4	0.7	72.3	27.5	0.2
2491	Laguna Madre	280	18251	-	18100	4.0	0.21	16.7	7.1	7100	0.035	104	5.2	14.9	0.6	0.2	0.2	31.0	2.0	26.1	65.0	8.8
		281	18252	0.08	6680	-	-	6.9	-	3260	-	98	-	5.6	-	-	0.2	4.8	0.1	9.1	90.6	0.3
		282	18253	-	12400	3.0	0.53	11.1	-	3160	0.021	79	2.4	9.2	0.3	0.2	-	12.7	1.0	10.9	82.5	6.6
		283	18254	-	16600	3.1	0.14	14.5	5.3	5520	0.018	86	4.2	8.5	0.2	-	0.2	20.9	1.5	26.9	68.0	5.1
		284	18255	-	4510	-	0.07	-	-	990	-	44	-	3.0	0.5	-	-	-	1.3	10.5	79.9	9.6
		290	18261	-	7030	5.0	0.19	13.6	6.6	7380	0.013	121	5.6	11.0	0.4	0.7	0.4	23.2	1.8	32.0	67.6	0.4
		291	18262	-	14600	4.5	0.08	7.2	-	3930	0.013	133	3.1	6.3	0.3	0.2	-	11.6	2.6	17.6	69.1	13.4
		292	18263	-	13500	1.7	-	8.9	-	2640	-	64	1.3	5.7	0.3	0.3	-	5.9	1.2	9.5	87.7	2.8
		293	18264	-	21600	3.4	0.08	12.6	5.2	7440	0.028	160	4.7	9.2	0.5	0.2	0.2	22.0	4.6	18.0	79.7	2.4
		294	18265	0.05	21300	3.3	0.07	11.2	-	6640	0.026	170	4.1	8.9	0.4	0.6	-	19.5	4.2	29.0	70.6	0.4
2492	Baffin Bay/Alazan Bay/	285	18256	0.05	49500	4.0	0.10	37.0	8.5	21100	0.026	372	11.8	17.7	**0.8**	0.8	1.2	61.9	2.3	83.9	15.4	0.8
	Cayo del Grullo/Laguna Salada	286	18257	-	13900	1.9	0.09	13.3	-	4380	0.012	99	2.4	7.5	0.3	-	-	10.9	0.8	17.6	68.5	13.9
		287	18258	-	48000	**6.9**	0.16	36.9	10.1	21000	0.026	374	9.7	16.3	0.5	**1.6**	1.2	60.8	2.8	84.1	13.1	2.8
		288	18259	-	18400	2.3	-	10.6	5.4	5390	0.021	124	3.4	9.1	0.2	-	0.4	16.2	0.4	19.7	73.3	7.0
		289	18260	0.06	46800	6.1	0.25	38.9	17.2	23300	0.091	465	**14.6**	24.0	0.7	0.7	1.0	70.3	1.8	89.7	9.4	0.9

6.8 Trace Metals in Sediment and Sediment Characteristics – Summary Statistics

Table 6.8.1. Total Organic Carbon (%), Sand (%), and Silt/Clay (%) summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. **Bold** = highest recorded mean concentrations.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Total Organic Carbon (%)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	1.90	1.97	1.94
	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.02	1.13	0.51
	2471	Aransas Bay	5	0.51	1.57	1.02
	2472	Copano Bay/Port Bay/Mission Bay	4	0.03	3.52	1.17
	2473	St. Charles Bay	3	0.81	17.90	**6.64**
	2481	Corpus Christi Bay	11	0.20	2.73	1.32
	2482	Nueces Bay	3	0.79	2.27	1.64
	2483	Redfish Bay	1	1.52	1.52	1.52
	2485	Oso Bay	2	0.08	0.67	0.38
	2491	Laguna Madre	10	0.13	4.60	2.02
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.41	2.77	1.63

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Percent Sand	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	14.7	20.9	17.8
(0.0625 - 2.00 mm)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	43.3	74.2	59.3
	2471	Aransas Bay	5	4.3	85.5	46.8
	2472	Copano Bay/Port Bay/Mission Bay	4	1.2	81.4	30.2
	2473	St. Charles Bay	3	28.6	40.1	34.1
	2481	Corpus Christi Bay	11	1.0	89.5	32.9
	2482	Nueces Bay	3	5.7	62.2	28.0
	2483	Redfish Bay	1	49.8	49.8	49.8
	2485	Oso Bay	2	27.5	91.6	59.5
	2491	Laguna Madre	10	65.0	90.6	**76.1**
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	9.4	73.3	35.9

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Percent Silt/Clay	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	78.8	85.1	**81.9**
(< 0.0625 mm)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	25.5	52.1	37.3
	2471	Aransas Bay	5	4.2	95.5	39.3
	2472	Copano Bay/Port Bay/Mission Bay	4	16.9	98.8	69.3
	2473	St. Charles Bay	3	59.6	70.6	65.5
	2481	Corpus Christi Bay	11	8.4	97.7	59.7
	2482	Nueces Bay	3	34.4	93.7	70.6
	2483	Redfish Bay	1	27.2	27.2	27.2
	2485	Oso Bay	2	8.1	72.3	40.2
	2491	Laguna Madre	10	9.1	32.0	18.9
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	17.6	89.7	59.0

Table 6.8.2. Aluminum, Antimony, and Arsenic (mg/kg or ppm) summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. Shaded value exceeded TCEQ PEL and 85th percentile screening level. Shaded value exceeded TCEQ 85th percentile only. **Bold** = highest recorded mean concentrations.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Aluminum (Al)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	32400	34700	33550
PEL (NA)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	22200	31800	27125
85th Percentile (NA)	2471	Aransas Bay	5	3970	53600	26074
	2472	Copano Bay/Port Bay/Mission Bay	4	13600	49300	36025
	2473	St. Charles Bay	3	29800	40600	35067
	2481	Corpus Christi Bay	11	1930	58400	36028
	2482	Nueces Bay	3	19100	57000	**40700**
	2483	Redfish Bay	1	24800	24800	24800
	2485	Oso Bay	2	3290	26500	14895
	2491	Laguna Madre	10	4510	21600	13632
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	13900	49500	35320

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Antimony (Sb)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.40	0.40	0.40
PEL (NA)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.20	0.40	0.30
85th Percentile (NA)	2471	Aransas Bay	5	<0.20	0.60	0.26
	2472	Copano Bay/Port Bay/Mission Bay	4	0.30	0.80	**0.63**
	2473	St. Charles Bay	3	0.30	0.30	0.30
	2481	Corpus Christi Bay	11	0.30	0.70	0.54
	2482	Nueces Bay	3	<0.20	0.80	0.47
	2483	Redfish Bay	1	0.40	0.40	0.40
	2485	Oso Bay	2	<0.20	0.80	0.40
	2491	Laguna Madre	10	<0.20	0.60	0.35
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.20	0.80	0.50

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Arsenic (As)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	2.80	2.90	2.85
PEL = 41.60	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	2.60	3.70	3.08
85th Percentile = 9.61	2471	Aransas Bay	5	<1.50	5.90	2.56
	2472	Copano Bay/Port Bay/Mission Bay	4	1.50	5.20	3.75
	2473	St. Charles Bay	3	2.10	3.60	2.80
	2481	Corpus Christi Bay	11	0.90	6.40	**4.78**
	2482	Nueces Bay	3	2.40	6.60	4.57
	2483	Redfish Bay	1	3.60	3.60	3.60
	2485	Oso Bay	2	<1.50	3.30	1.65
	2491	Laguna Madre	10	<1.50	5.00	2.80
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	1.90	6.90	4.24

Table 6.8.3. Cadmium, Chromium, and Copper(mg/kg or ppm) summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. Shaded value exceeded TCEQ PEL and 85th percentile screening level. Shaded value exceeded TCEQ 85th percentile only. **Bold** = highest recorded mean concentrations.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Cadmium (Cd)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.17	0.17	0.17
PEL = 4.21	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	<0.05	0.35	0.24
85th Percentile = 0.663	2471	Aransas Bay	5	<0.05	0.35	0.18
	2472	Copano Bay/Port Bay/Mission Bay	4	0.17	0.50	0.35
	2473	St. Charles Bay	3	0.07	0.08	0.07
	2481	Corpus Christi Bay	11	0.19	0.88	0.44
	2482	Nueces Bay	3	0.79	1.27	**0.98**
	2483	Redfish Bay	1	0.61	0.61	0.61
	2485	Oso Bay	2	0.45	0.59	0.52
	2491	Laguna Madre	10	<0.05	0.53	0.14
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	<0.05	0.25	0.12

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Chromium (Cr)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	27.30	27.40	27.35
PEL = 160.40	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	15.50	26.10	20.70
85th Percentile = 36.90	2471	Aransas Bay	5	4.30	40.90	19.80
	2472	Copano Bay/Port Bay/Mission Bay	4	7.50	44.00	29.30
	2473	St. Charles Bay	3	23.50	30.60	26.53
	2481	Corpus Christi Bay	11	5.00	43.50	29.35
	2482	Nueces Bay	3	18.50	34.90	**29.40**
	2483	Redfish Bay	1	23.00	23.00	23.00
	2485	Oso Bay	2	6.50	22.40	14.45
	2491	Laguna Madre	10	<4.00	16.70	10.27
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	10.60	38.90	27.34

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Copper (Cu)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	5.60	6.50	6.05
PEL = 108.20	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	5.00	8.70	7.05
85th Percentile = 19.90	2471	Aransas Bay	5	<5.00	13.50	5.72
	2472	Copano Bay/Port Bay/Mission Bay	4	<5.00	13.80	9.30
	2473	St. Charles Bay	3	6.00	8.50	7.23
	2481	Corpus Christi Bay	11	<5.00	27.50	10.52
	2482	Nueces Bay	3	8.20	13.40	**11.57**
	2483	Redfish Bay	1	9.60	9.60	9.60
	2485	Oso Bay	2	<5.00	7.90	3.95
	2491	Laguna Madre	10	<5.00	7.10	2.42
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	<5.00	17.20	8.24

Table 6.8.4. Iron, Lead, and Manganese (mg/kg or ppm) summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. Shaded value exceeded TCEQ PEL and 85th percentile screening level. Shaded value exceeded TCEQ 85th percentile only. **Bold** = highest recorded mean concentrations.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Iron (Fe)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	12600	13800	13200
PEL (NA)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	6860	12700	9828
85th Percentile (NA)	2471	Aransas Bay	5	643	22800	9927
	2472	Copano Bay/Port Bay/Mission Bay	4	2340	24600	14735
	2473	St. Charles Bay	3	10200	16900	12933
	2481	Corpus Christi Bay	11	780	24500	15801
	2482	Nueces Bay	3	6060	24600	**16120**
	2483	Redfish Bay	1	10200	10200	10200
	2485	Oso Bay	2	1540	10200	5870
	2491	Laguna Madre	10	990	7440	4806
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	4380	23300	15034

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Lead (Pb)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	13.20	14.10	13.65
PEL = 112.18	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	10.30	13.30	12.20
85th Percentile = 21.90	2471	Aransas Bay	5	5.50	23.30	12.78
	2472	Copano Bay/Port Bay/Mission Bay	4	7.40	23.20	16.28
	2473	St. Charles Bay	3	11.60	15.40	13.23
	2481	Corpus Christi Bay	11	3.80	35.80	**21.82**
	2482	Nueces Bay	3	14.30	22.80	19.80
	2483	Redfish Bay	1	14.10	14.10	14.10
	2485	Oso Bay	2	7.70	19.30	13.50
	2491	Laguna Madre	10	3.00	14.90	8.23
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	7.50	24.00	14.92

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Manganese (Mn)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	282	301	291
PEL (NA)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	151	363	235
85th Percentile (NA)	2471	Aransas Bay	5	20	472	221
	2472	Copano Bay/Port Bay/Mission Bay	4	90	438	287
	2473	St. Charles Bay	3	181	262	220
	2481	Corpus Christi Bay	11	24	479	295
	2482	Nueces Bay	3	143	389	**297**
	2483	Redfish Bay	1	242	242	242
	2485	Oso Bay	2	35	143	89
	2491	Laguna Madre	10	44	170	106
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	99	465	287

Table 6.8.5. Mercury, Nickel, and Selenium (mg/kg or ppm) summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. Shaded value exceeded TCEQ PEL and 85th percentile screening level. Shaded value exceeded TCEQ 85th percentile only. **Bold** = highest recorded mean concentrations.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Mercury (Hg)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.024	0.027	0.026
PEL = 0.696	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.022	0.040	0.028
85th Percentile = 0.230	2471	Aransas Bay	5	<0.010	0.052	0.021
	2472	Copano Bay/Port Bay/Mission Bay	4	0.015	0.073	0.038
	2473	St. Charles Bay	3	0.016	0.032	0.023
	2481	Corpus Christi Bay	11	0.012	0.132	0.078
	2482	Nueces Bay	3	0.044	0.191	**0.106**
	2483	Redfish Bay	1	0.021	0.021	0.021
	2485	Oso Bay	2	0.017	0.028	0.023
	2491	Laguna Madre	10	<0.010	0.035	0.015
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	0.012	0.091	0.035

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Nickel (Ni)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	7.00	7.40	7.20
PEL = 42.80	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	5.20	9.10	6.88
85th Percentile = 21.40	2471	Aransas Bay	5	<1.00	14.40	6.36
	2472	Copano Bay/Port Bay/Mission Bay	4	1.80	13.70	8.55
	2473	St. Charles Bay	3	4.90	8.20	6.20
	2481	Corpus Christi Bay	11	1.00	14.40	**9.26**
	2482	Nueces Bay	3	3.40	13.20	8.80
	2483	Redfish Bay	1	7.40	7.40	7.40
	2485	Oso Bay	2	<1.00	5.50	2.75
	2491	Laguna Madre	10	<1.00	5.60	3.06
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	2.40	14.60	8.38

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Selenium (Se)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.60	0.90	**0.75**
PEL = NA	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	<0.10	0.30	0.13
85th Percentile = 1.70	2471	Aransas Bay	5	<0.10	0.10	0.04
	2472	Copano Bay/Port Bay/Mission Bay	4	<0.10	0.10	0.03
	2473	St. Charles Bay	3	<0.10	0.10	0.00
	2481	Corpus Christi Bay	11	<0.10	0.80	0.11
	2482	Nueces Bay	3	<0.10	0.10	0.07
	2483	Redfish Bay	1	0.30	0.30	0.30
	2485	Oso Bay	2	<0.10	0.20	0.10
	2491	Laguna Madre	10	<0.10	0.70	0.24
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	<0.10	1.60	0.62

Table 6.8.6. Silver, Tin, and Zinc (mg/kg or ppm) summary statistics, listed by TCEQ Segment, for RCAP 2002 sampling sites. Shaded value exceeded TCEQ PEL and 85th percentile screening level. Shaded value exceeded TCEQ 85th percentile only. **Bold** = highest recorded mean concentrations.

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Silver (Ag)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	<0.050	<0.050	<0.050
PEL = 1.77	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	<0.050	<0.050	<0.050
85th Percentile = 0.600	2471	Aransas Bay	5	<0.050	0.180	0.068
	2472	Copano Bay/Port Bay/Mission Bay	4	<0.050	0.180	0.080
	2473	St. Charles Bay	3	<0.050	0.070	0.023
	2481	Corpus Christi Bay	11	<0.050	0.160	0.046
	2482	Nueces Bay	3	<0.050	0.180	0.117
	2483	Redfish Bay	1	<0.050	0.050	<0.050
	2485	Oso Bay	2	0.090	0.170	**0.130**
	2491	Laguna Madre	10	<0.050	0.080	0.013
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	<0.050	0.060	0.022

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Tin (Sn)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	0.80	0.90	0.85
PEL (NA)	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	0.60	1.10	0.83
85th Percentile (NA)	2471	Aransas Bay	5	<0.10	2.50	0.92
	2472	Copano Bay/Port Bay/Mission Bay	4	<0.10	1.60	1.18
	2473	St. Charles Bay	3	0.90	1.20	1.10
	2481	Corpus Christi Bay	11	<0.10	2.70	**1.55**
	2482	Nueces Bay	3	1.00	1.50	1.27
	2483	Redfish Bay	1	0.60	0.60	0.60
	2485	Oso Bay	2	0.40	0.60	0.50
	2491	Laguna Madre	10	<0.10	0.40	0.12
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	<0.10	1.20	0.76

Parameter	Segment	Segment Name	n (sites)	Min	Max	Mean
Zinc (Zn)	2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	2	34.80	37.90	36.35
PEL = 271.0	2463	Mesquite Bay/Carlos Bay/Ayres Bay	4	18.00	36.40	27.90
85th Percentile = 107.0	2471	Aransas Bay	5	<2.00	61.50	26.12
	2472	Copano Bay/Port Bay/Mission Bay	4	7.70	63.90	38.70
	2473	St. Charles Bay	3	26.70	46.30	34.80
	2481	Corpus Christi Bay	11	2.50	111.30	68.45
	2482	Nueces Bay	3	61.50	102.50	**79.50**
	2483	Redfish Bay	1	39.50	39.50	39.50
	2485	Oso Bay	2	6.30	34.40	20.35
	2491	Laguna Madre	10	<2.00	31.00	15.16
	2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	5	10.90	70.30	44.02

6.9 Sediment Organics – Individual Concentrations (ng/g or ppb Dry Weight)

Table 6.9.1. Sediment concentrations (ng/g or ppb) of 18 of 20 PCB congeners (PCB 8 and 18 values were < reporting limit) at RCAP 2002 sampling sites. Shaded value exceeded TCEQ PEL and 85th percentile screening level. Shaded value exceeded TCEQ 85th percentile only. No value (-) indicates concentration below the reporting limit. **Bold** = highest recorded concentration.

Segment	Segment Name	CCS ID	TCEQ ID	28	44	52	66	77	101	105	118	126	128	138	153	170	180	187	195	206	209	Total PCB
2462	San Antonio/Hynes/ Guadalupe Bays	245	18216	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2462		246	18217	-	-	-	-	-	-	-	-	-	-	-	2.20	-	-	-	-	-	-	2.20
2463	Mesquite/Carlos/ Ayres Bays	249	18220	-	-	-	-	-	-	0.86	-	-	-	-	2.25	-	-	0.62	-	-	-	3.72
2463		253	18224	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2463		254	18225	-	-	-	-	-	1.63	-	-	-	-	2.15	1.49	-	-	-	-	-	-	5.27
2463		256	18227	-	-	-	-	-		2.17	-	-	-	-	7.10	0.87	-	-	-	1.04	-	11.18
2471	Aransas Bay	257	18228	-	2.68	2.29	2.61	-	3.94	4.49	3.55	1.70	2.04	4.92	4.53	2.41	3.29	3.41	2.51	3.35	3.21	50.92
2471		259	18230	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2471		260	18231	-	-	-	1.87	-	2.26	2.02	-	-	-	-	6.47	-	-	-	-	-	-	12.62
2471		261	18232	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2471		262	18233	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2472	Copano/Port/Mission Bays	250	18221	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2472		252	18223	-	-	-	1.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.33
2472		255	18226	-	-	-	7.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.30
2472		258	18229	-	**11.28**	**10.61**	**13.43**	**29.08**	**17.19**	**19.38**	**23.66**	**23.23**	**22.14**	**21.00**	24.05	**22.54**	**25.34**	**23.64**	**27.41**	**29.48**	**29.16**	**372.59**
2473	St. Charles Bay	247	18218	-	-	-	-	-	-	-	-	-	-	-	6.32	-	-	-	-	-	-	6.32
2473		248	18219	-	-	-	-	-	-	-	-	-	-	-	6.13	-	-	-	-	-	-	6.13
2473		251	18222	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	-	-	-	-	-	-	1.15	-	-	-	-	3.45	-	-	-	-	-	-	4.60
2481		268	18239	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2481		269	18240	-	-	-	-	-	0.56	2.87	0.45	-	-	0.79	0.50	0.90	0.93	-	0.57	0.80	1.13	9.50
2481		270	18241	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2481		271	18242	-	-	-	-	-	1.75	-	-	-	-	-	-	-	-	-	-	-	1.81	3.56
2481		272	18243	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2481		273	18244	-	-	-	-	-	-	-	-	-	-	-	15.77	-	-	-	-	-	-	15.77
2481		274	18245	-	-	-	-	-	-	-	-	-	-	-	2.69	-	-	-	-	-	-	2.69
2481		275	18246	-	-	-	3.40	-	-	-	-	-	-	-	8.29	-	-	-	-	-	-	11.69
2481		276	18247	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2481		279	18250	-	-	-	-	-	-	-	-	-	-	-	6.24	-	-	-	-	-	-	6.24

Table 6.9.1. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	28	44	52	66	77	101	105	118	126	128	138	153	170	180	187	195	206	209	Total PCB
2482	Nueces Bay	263	18234	-	-	-	1.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.11
2482		264	18235	-	1.32	-	-	-	-	1.70	1.40	-	-	-	4.91	-	-	-	-	-	-	9.32
2482		267	18238	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2483	Redfish Bay	265	18236	-	-	-	-	-	-	-	-	-	-	-	3.76	-	-	-	-	-	-	3.76
2485	Oso Bay	277	18248	-	-	-	-	-	-	-	-	-	-	-	5.70	-	-	-	-	-	-	5.70
2485		278	18249	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2491		280	18251	-	-	-	-	-	-	-	-	-	-	-	1.30	-	-	-	-	-	-	1.30
2491		281	18252	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2491		282	18253	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2491		283	18254	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2491		284	18255	-	-	-	-	-	-	1.49	-	-	-	-	1.84	-	-	-	-	-	-	3.33
2491		290	18261	-	-	-	-	-	-	-	-	-	-	-	2.47	-	-	-	-	-	-	2.47
2491		291	18262	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2491		292	18263	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.00	-	-	-	3.00
2491		293	18264	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2491		294	18265	-	-	-	-	-	-	-	-	-	-	1.68	-	-	-	1.13	-	-	-	2.81
2492	Baffin Bay/Alazan Bay/	285	18256	**32.07**	-	-	-	-	-	-	-	-	-	-	5.46	-	4.57	-	-	-	-	42.10
2492	Cayo del Grullo/ Laguna Salada	286	18257	1.79	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.41
2492		287	18258	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2492		288	18259	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2492		289	18260	-	-	-	-	-	-	13.29	-	-	-	-	**33.91**	19.19	-	-	-	-	-	66.40

Table 6.9.2. Sediment concentrations of DDD, DDE, and DDT (ng/g or ppb) at RCAP 2002 sampling sites. Shaded value exceeded TCEQ PEL and 85th percentile screening level. Shaded value of combined (Total DDD and Total DDE) constituents that exceeded TCEQ 85th percentile only. No value (-) indicates concentration below the reporting limit. **Bold** = highest recorded concentration.

Segment	Segment Name	CCS ID	TCEQ ID	2,4'-DDD	4,4'-DDD	2,4'-DDE	4,4'-DDE	2,4'-DDT	4,4'-DDT	Total DDT (DDD + DDE + DDT)
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	-	-	-	-	-	-
		246	18217	-	-	-	-	-	-	-
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	-	-	-	-	-	1.69	1.69
		253	18224	-	-	-	-	-	-	-
		254	18225	-	1.47	-	-	2.06	**3.32**	6.85
		256	18227	-	1.47	-	-	2.37	-	3.84
2471	Aransas Bay	257	18228	3.92	2.90	2.84	3.04	3.33	-	16.03
		259	18230	-	-	-	-	-	-	-
		260	18231	-	1.60	-	1.11	1.99	-	4.70
		261	18232	-	-	-	-	-	-	-
		262	18233	-	-	-	-	-	-	-
2472	Copano Bay/Port Bay/Mission Bay	250	18221	-	-	-	-	-	-	-
		252	18223	-	-	-	1.44	-	-	1.44
		255	18226	-	-	-	-	-	-	-
		258	18229	**29.08**	**11.14**	**17.05**	**21.08**	**10.27**	-	**88.62**
2473	St. Charles Bay	247	18218	-	-	-	-	-	-	-
		248	18219	-	-	-	-	-	-	-
		251	18222	-	-	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	-	-	-	-	-	-	-
		268	18239	-	-	-	-	-	-	-
		269	18240	-	-	-	-	-	-	-
		270	18241	-	-	-	-	-	-	-
		271	18242	-	-	-	-	-	-	-
		272	18243	-	-	-	-	-	-	-
		273	18244	-	-	-	-	-	-	-
		274	18245	-	-	-	-	-	-	-
		275	18246	-	-	-	-	-	-	-
		276	18247	-	-	-	-	-	-	-
		279	18250	-	-	-	-	-	-	-

Table 6.9.2. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	2,4'-DDD	4,4'-DDD	2,4'-DDE	4,4'-DDE	2,4'-DDT	4,4'-DDT	Total DDT (DDD + DDE + DDT)
2482	Nueces Bay	263	18234	-	-	-	-	-	-	-
		264	18235	-	-	0.76	-	-	-	0.76
		267	18238	-	-	-	-	-	-	-
2483	Redfish Bay	265	18236	-	-	-	-	-	-	-
2485	Oso Bay	277	18248	-	7.55	-	-	3.14	-	10.69
		278	18249	-	-	-	-	-	-	-
2491	Laguna Madre	280	18251	0.60	-	0.89	-	-	-	1.50
		281	18252	-	-	-	-	-	-	-
		282	18253	-	-	-	-	-	-	-
		283	18254	-	-	-	-	-	-	-
		284	18255	-	-	-	-	-	-	-
		290	18261	-	-	3.29	-	-	-	3.29
		291	18262	-	-	-	-	-	-	-
		292	18263	-	-	-	-	-	-	-
		293	18264	-	-	-	-	-	-	-
		294	18265	-	-	-	-	-	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	-	-	-	-	-	-	-
		286	18257	-	-	-	-	-	-	-
		287	18258	-	-	-	-	-	-	-
		288	18259	-	-	-	-	-	-	-
		289	18260	-	-	-	-	-	-	-

Table 6.9.3. Sediment concentrations of Chlorinated Pesticides other than DDT (ng/g or ppb) at RCAP 2002 sampling sites. Shaded value exceeded TCEQ PEL and 85th percentile screening level. Shaded value exceeded TCEQ 85th percentile only. No value (-) indicates concentration below the reporting limit. **Bold** = highest recorded concentration.

Segment	Segment Name	CCS ID	TCEQ ID	aldrin	alpha-chlordane	dieldrin	endosulfan I	endosulfan II	endosulfan sulfate	endrin
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	-	-	-	-	-	-
		246	18217	-	-	-	-	-	-	-
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	-	-	-	-	-	-	-
		253	18224	-	-	-	-	-	-	-
		254	18225	-	-	-	-	-	-	-
		256	18227	-	-	-	-	-	-	-
2471	Aransas Bay	257	18228	-	10.36	-	-	-	-	-
		259	18230	-	-	-	-	-	-	-
		260	18231	-	6.51	-	-	-	-	-
		261	18232	-	-	-	-	-	-	-
		262	18233	-	-	-	-	-	-	-
2472	Copano Bay/Port Bay/Mission Bay	250	18221	-	-	-	-	-	-	-
		252	18223	-	-	-	-	-	-	-
		255	18226	-	-	-	-	-	-	-
		258	18229	-	**94.79**	-	-	-	-	-
2473	St. Charles Bay	247	18218	-	-	-	-	-	-	-
		248	18219	-	-	-	-	-	-	-
		251	18222	-	-	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	-	-	-	-	-	-	-
		268	18239	-	-	-	-	-	-	-
		269	18240	-	0.60	-	-	-	-	-
		270	18241	-	-	-	-	-	-	-
		271	18242	-	0.77	-	-	-	-	-
		272	18243	-	-	-	-	-	-	-
		273	18244	-	-	-	-	-	-	-
		274	18245	-	-	-	-	-	-	-
		275	18246	-	-	-	-	-	-	-
		276	18247	-	-	-	-	-	-	-
		279	18250	-	-	-	-	-	-	-

Table 6.9.3. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	aldrin	alpha-chlordane	dieldrin	endosulfan I	endosulfan II	endosulfan sulfate	endrin
2482	Nueces Bay	263	18234	-	1.84	-	-	-	-	-
		264	18235	-	-	-	-	-	-	-
		267	18238	-	-	-	-	-	-	-
2483	Redfish Bay	265	18236	-	-	-	-	-	-	-
2485	Oso Bay	277	18248	-	-	-	-	-	-	-
		278	18249	-	-	-	-	-	-	-
2491	Laguna Madre	280	18251	-	-	-	-	-	-	-
		281	18252	-	-	-	-	-	-	-
		282	18253	-	-	-	-	-	-	-
		283	18254	-	-	-	-	-	-	-
		284	18255	-	-	-	-	-	-	-
		290	18261	-	-	-	-	-	-	-
		291	18262	-	-	-	-	-	-	-
		292	18263	-	-	-	-	-	-	-
		293	18264	-	-	-	-	-	-	-
		294	18265	-	-	-	-	-	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	-	-	-	-	-	-	-
		286	18257	-	-	-	-	-	-	-
		287	18258	-	-	-	-	-	-	-
		288	18259	-	-	-	-	-	-	-
		289	18260	-	-	-	-	-	-	-

Table 6.9.3. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	heptachlor	heptachlor epoxide	hexachlorobenzene	Lindane	mirex	t-nonachlor	toxaphene	Total Chlorinated Pesticides
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	-	-	-	-	-	-	-
		246	18217	-	-	-	-	-	-	-	-
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	-	-	-	-	-	-	-	-
		253	18224	-	-	-	-	-	-	-	-
		254	18225	-	-	-	-	-	-	-	-
		256	18227	-	-	-	-	-	0.77	-	0.77
2471	Aransas Bay	257	18228	-	-	-	-	-	5.53	-	15.89
		259	18230	-	-	-	-	-	-	-	-
		260	18231	-	-	-	-	-	-	-	6.51
		261	18232	-	-	-	-	-	-	-	-
		262	18233	-	-	-	-	-	-	-	-
2472	Copano Bay/Port Bay/Mission Bay	250	18221	-	-	-	-	-	-	-	-
		252	18223	-	-	-	-	-	1.19	-	1.19
		255	18226	-	-	-	-	-	-	-	-
		258	18229	-	-	-	-	28.69	**20.92**	-	144.40
2473	St. Charles Bay	247	18218	-	-	-	-	-	-	-	-
		248	18219	-	-	-	-	-	-	-	-
		251	18222	-	-	-	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	-	-	-	-	-	1.33	-	1.33
		268	18239	-	-	-	-	-	-	-	-
		269	18240	-	-	2.97	**3.73**	-	0.39	-	7.69
		270	18241	-	-	-	-	-	1.12	-	1.12
		271	18242	-	-	-	-	-	1.26	-	2.03
		272	18243	-	-	-	-	-	-	-	-
		273	18244	-	-	-	-	-	-	-	-
		274	18245	-	-	-	-	-	-	-	-
		275	18246	-	-	-	-	-	-	-	-
		276	18247	-	-	-	-	-	-	-	-
		279	18250	-	-	-	-	-	-	-	-
2482	Nueces Bay	263	18234	-	-	-	-	-	-	-	1.84
		264	18235	-	-	-	-	-	-	-	-
		267	18238	-	-	-	-	-	-	-	-

Table 6.9.3. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	heptachlor	heptachlor epoxide	hexachlorobenzene	Lindane	mirex	t-nonachlor	toxaphene	Total Chlorinated Pesticides
2483	Redfish Bay	265	18236	-	-	-	-	-	-	-	-
2485	Oso Bay	277	18248	-	-	-	-	-	-	**570.48**	**570.48**
		278	18249	-	-	-	-	-	-	-	-
2491	Laguna Madre	280	18251	-	-	-	-	-	0.83	36.00	36.37
		281	18252	-	-	-	-	-	-	-	-
		282	18253	-	-	-	-	-	-	-	-
		283	18254	-	-	-	-	-	0.63	-	0.63
		284	18255	-	-	-	-	-	-	-	-
		290	18261	-	-	-	-	-	-	-	-
		291	18262	-	-	-	-	-	-	-	-
		292	18263	-	-	-	-	-	-	-	-
		293	18264	-	-	-	-	-	-	-	-
		294	18265	-	-	-	-	-	-	-	-
2492	Baffin Bay/Alazan Bay/	285	18256	-	-	-	-	-	-	-	-
	Cayo del Grullo/Laguna Salada	286	18257	-	-	1.54	-	-	-	-	1.54
		287	18258	-	-	-	-	-	-	-	-
		288	18259	-	-	-	-	-	-	-	-
		289	18260	-	-	-	-	-	-	-	-

Table 6.9.4. Sediment concentrations of 23 PAH's (ng/g or ppb) at RCAP 2002 sampling sites. Shaded value exceeded TCEQ PEL and 85th percentile screening level. Shaded value exceeded TCEQ 85th percentile only. No value (-) indicates concentration below reporting limit. **Bold** = highest recorded concentration.

Segment	Segment Name	CCS ID	TCEQ ID	acenaphthene	acenaphthylene	anthracene	benzo(a)anthracene	dibenz(a,h)anthracene	biphenyl	chrysene
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	-	-	-	-	-	-
		246	18217	-	-	-	-	2.13	-	-
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	-	-	-	0.41	-	-	-
		253	18224	-	-	-	-	-	-	-
		254	18225	-	-	-	-	-	-	-
		256	18227	-	-	1.71	-	-	-	-
2471	Aransas Bay	257	18228	-	-	-	-	-	-	-
		259	18230	-	-	-	-	-	-	-
		260	18231	-	-	-	-	-	-	-
		261	18232	-	-	-	-	-	-	-
		262	18233	-	-	-	-	**41.42**	-	-
2472	Copano Bay/Port Bay/Mission Bay	250	18221	-	-	-	-	-	-	-
		252	18223	-	-	-	-	-	-	-
		255	18226	-	-	-	-	-	-	-
		258	18229	-	-	-	3.98	22.67	-	**23.88**
2473	St. Charles Bay	247	18218	-	-	-	-	-	-	-
		248	18219	-	-	-	-	-	-	-
		251	18222	-	-	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	-	-	-	-	-	-	-
		268	18239	-	-	-	-	-	-	-
		269	18240	-	-	1.21	0.80	-	-	0.86
		270	18241	-	-	6.64	**6.46**	-	-	9.18
		271	18242	-	-	4.39	4.14	-	-	2.06
		272	18243	-	-	-	-	-	-	-
		273	18244	-	-	-	-	-	-	-
		274	18245	-	-	-	-	-	-	-
		275	18246	-	-	-	1.73	-	-	2.58
		276	18247	-	-	-	-	-	-	-
		279	18250	-	-	-	-	-	-	-

Table 6.9.4. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	acenaphthene	acenaphthylene	anthracene	benzo(a)anthracene	dibenz(a,h)anthracene	biphenyl	chrysene
2482	Nueces Bay	263	18234	-	-	3.18	3.44	-	-	5.77
		264	18235	-	-	1.17	-	-	-	-
		267	18238	-	-	1.37	1.45	-	-	7.91
2483	Redfish Bay	265	18236	-	-	2.04	2.78	-	-	3.06
2485	Oso Bay	277	18248	-	-	-	-	-	-	-
		278	18249	-	-	-	-	-	-	-
2491	Laguna Madre	280	18251	-	**31.63**	-	-	-	-	-
		281	18252	-	-	-	-	-	-	-
		282	18253	-	-	-	-	-	-	-
		283	18254	-	-	-	-	-	-	-
		284	18255	-	-	-	-	-	-	-
		290	18261	-	-	-	-	-	-	-
		291	18262	-	-	-	-	-	-	-
		292	18263	-	-	-	-	-	-	-
		293	18264	-	-	-	-	-	-	-
		294	18265	-	-	-	-	-	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	-	-	-	-	-	-	-
		286	18257	-	-	-	-	-	-	-
		287	18258	-	-	-	-	-	-	-
		288	18259	-	-	-	-	-	-	-
		289	18260	-	-	**7.56**	-	-	-	-

Table 6.9.4. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	fluoranthene	benzo(b)fluoranthene	benzo(k)fluoranthene	fluorene	naphthalene	1-methylnaphthalene
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	-	-	-	-	-
		246	18217	2.16	-	-	-	-	-
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	0.65	-	-	-	-	-
		253	18224	0.66	-	-	-	-	-
		254	18225	-	-	-	-	**10.85**	-
		256	18227	0.46	-	-	-	-	-
2471	Aransas Bay	257	18228	2.39	-	-	-	-	-
		259	18230	-	-	-	-	-	-
		260	18231	-	-	-	-	-	-
		261	18232	-	-	-	-	2.22	1.95
		262	18233	-	-	-	-	-	-
2472	Copano Bay/Port Bay/Mission Bay	250	18221	-	-	-	-	-	-
		252	18223	-	-	-	-	-	-
		255	18226	-	-	-	-	-	-
		258	18229	**13.35**	**27.03**	**13.94**	-	-	-
2473	St. Charles Bay	247	18218	-	-	-	-	-	-
		248	18219	-	-	-	-	-	-
		251	18222	-	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	3.84	3.77	1.72	-	-	-
		268	18239	-	3.73	1.92	-	-	-
		269	18240	1.01	-	0.45	-	-	-
		270	18241	10.88	6.34	4.91	-	-	3.59
		271	18242	5.92	5.10	2.33	-	-	-
		272	18243	-	-	-	-	-	-
		273	18244	-	-	-	-	-	-
		274	18245	-	-	-	-	-	-
		275	18246	4.54	4.31	2.61	-	4.57	5.07
		276	18247	-	-	6.38	-	-	-
		279	18250	-	-	-	-	-	-
2482	Nueces Bay	263	18234	6.59	10.10	4.42	-	-	-
		264	18235	0.98	-	-	-	-	-
		267	18238	10.69	7.74	0.88	-	-	-
2483	Redfish Bay	265	18236	-	2.58	2.14	-	-	-

Table 6.9.4. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	fluoranthene	benzo(b)fluoranthene	benzo(k)fluoranthene	fluorene	naphthalene	1-methylnaphthalene
2485	Oso Bay	277	18248	-	-	-	-	-	-
		278	18249	-	-	-	-	-	-
2491	Laguna Madre	280	18251	-	-	-	-	-	1.21
		281	18252	-	-	-	-	-	-
		282	18253	-	-	-	-	-	-
		283	18254	-	-	0.44	-	-	-
		284	18255	-	-	-	-	-	-
		290	18261	-	-	-	-	-	-
		291	18262	-	-	-	-	-	-
		292	18263	-	-	-	-	-	-
		293	18264	-	-	-	-	-	-
		294	18265	-	-	-	-	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	-	-	-	-	-	-
		286	18257	-	-	-	-	-	-
		287	18258	-	-	-	-	-	-
		288	18259	-	-	-	-	-	-
		289	18260	-	-	-	-	-	**8.64**

Table 6.9.4. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	2-methylnaphthalene	2,6-dimethylnaphthalene	2,3,5-trimethylnaphthalene	phenanthrene	1-methylphenanthrene
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	-	-	-	-
		246	18217	-	-	-	-	-
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	-	-	-	-	-
		253	18224	-	-	-	-	-
		254	18225	**6.17**	-	-	-	-
		256	18227	-	-	-	-	-
2471	Aransas Bay	257	18228	-	-	-	-	-
		259	18230	-	-	-	-	-
		260	18231	-	-	-	-	-
		261	18232	1.68	-	-	-	-
		262	18233	-	-	-	-	-
2472	Copano Bay/Port Bay/Mission Bay	250	18221	-	-	-	-	-
		252	18223	-	-	-	-	-
		255	18226	-	-	-	-	-
		258	18229	-	-	-	-	-
2473	St. Charles Bay	247	18218	-	-	-	-	-
		248	18219	-	-	-	-	-
		251	18222	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	-	-	-	2.23	-
		268	18239	-	-	-	-	-
		269	18240	-	-	-	1.31	-
		270	18241	2.87	-	-	5.59	-
		271	18242	-	-	-	3.18	-
		272	18243	-	-	-	-	-
		273	18244	-	-	-	-	-
		274	18245	-	-	-	-	-
		275	18246	-	-	-	4.66	-
		276	18247	-	-	-	-	-
		279	18250	-	-	-	-	-
2482	Nueces Bay	263	18234	-	-	-	1.22	-
		264	18235	-	-	-	1.00	-
		267	18238	-	-	-	2.99	-
2483	Redfish Bay	265	18236	-	-	-	2.56	-

Table 6.9.4. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	2-methylnaphthalene	2,6-dimethylnaphthalene	2,3,5-trimethylnaphthalene	phenanthrene	1-methylphenanthrene
2485	Oso Bay	277	18248	-	-	-	-	-
		278	18249	-	-	-	-	-
2491	Laguna Madre	280	18251	-	-	-	-	-
		281	18252	-	-	-	-	-
		282	18253	-	-	-	-	-
		283	18254	-	-	-	-	-
		284	18255	-	-	-	-	-
		290	18261	-	-	-	-	-
		291	18262	-	-	-	-	-
		292	18263	-	-	-	-	-
		293	18264	-	-	-	-	-
		294	18265	-	-	-	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	-	-	-	-	-
		286	18257	-	-	-	-	-
		287	18258	-	-	-	-	-
		288	18259	-	-	-	-	-
		289	18260	-	-	-	**6.98**	-

Table 6.9.4. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	benzo(g,h,i)perylene	pyrene	benzo(a)pyrene	indeno(1,2,3-cd)pyrene	dibenzothiophene	Total PAH
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	-	-	-	-	-
		246	18217	-	1.97	4.54	-	-	10.80
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	-	0.57	-	-	-	1.63
		253	18224	-	0.59	2.48	-	-	3.73
		254	18225	-	-	-	-	-	17.01
		256	18227	-	0.63	2.66	-	-	5.46
2471	Aransas Bay	257	18228	-	2.41	-	-	-	4.80
		259	18230	-	5.29	-	-	-	5.29
		260	18231	-	-	-	-	-	-
		261	18232	-	-	-	-	-	5.85
		262	18233	**36.27**	-	-	-	-	77.69
2472	Copano Bay/Port Bay/Mission Bay	250	18221	-	-	-	-	-	-
		252	18223	-	-	-	-	-	-
		255	18226	-	-	-	-	-	-
		258	18229	18.08	**14.35**	13.17	**33.75**	-	**184.21**
2473	St. Charles Bay	247	18218	-	-	-	-	-	-
		248	18219	-	-	-	-	-	-
		251	18222	-	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	3.18	3.20	3.01	2.09	-	23.02
		268	18239	-	1.41	2.23	-	-	9.28
		269	18240	1.36	1.24	11.12	-	-	19.35
		270	18241	6.49	9.60	8.56	6.14	-	87.23
		271	18242	6.25	5.79	5.84	4.03	-	49.03
		272	18243	4.33	3.32	4.23	3.63	-	15.52
		273	18244	-	6.42	-	-	-	6.42
		274	18245	-	-	-	-	-	-
		275	18246	-	3.84	3.49	2.34	-	39.72
		276	18247	-	-	-	-	-	6.38
		279	18250	-	-	-	-	-	-
2482	Nueces Bay	263	18234	-	8.61	9.86	-	-	53.19
		264	18235	-	1.17	**18.09**	-	-	22.40
		267	18238	-	3.91	0.93	-	-	37.88
2483	Redfish Bay	265	18236	1.94	2.83	2.17	4.53	-	26.61

Table 6.9.4. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	benzo(g,h,i)perylene	pyrene	benzo(a)pyrene	indeno(1,2,3-cd)pyrene	dibenzothiophene	Total PAH
2485	Oso Bay	277	18248	-	-	15.88	-	-	15.88
		278	18249	-	-	-	-	-	-
2491	Laguna Madre	280	18251	-	1.92	-	-	-	34.76
		281	18252	-	-	-	-	-	-
		282	18253	-	-	-	-	-	-
		283	18254	-	-	-	-	-	0.44
		284	18255	-	-	-	-	-	-
		290	18261	-	-	-	-	-	-
		291	18262	-	-	-	-	-	-
		292	18263	-	-	-	-	-	-
		293	18264	-	-	-	-	-	-
		294	18265	-	-	-	-	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	-	-	-	-	-	-
		286	18257	-	-	-	-	-	-
		287	18258	-	-	-	-	-	-
		288	18259	-	-	-	-	-	-
		289	18260	-	-	-	-	-	23.18

6.10 Sediment Toxicity

Table 6.10.1. RCAP 2002 toxicity results and unionized ammonia concentrations in sediment toxicity tests conducted with the amphipod, *Ampelisca abdita*. NM = Not Measured.

Sample ID	Rep Number (Alive Amphipods) 1	2	3	4	5	Mean Number Alive	Mean % Survival	% of Cont.	% of Ref.	Significantly different Cont.	Ref.	Day 10 NH_3
Cont	19	20	19	19	16	18.6	93.0					4.03
Cont	19	19	18	16	18	18.0	90.0					5.05
Cont	20	18	20	19	18	19.0	95.0					5.05
Cont	19	20	20	20	19	19.6	98.0					NM
Ref	17	15	19	17	20	17.6	88.0					63.33
Ref	16	11	18	18	16	15.8	79.0					83.54
Ref	17	19	20	16	19	18.2	91.0					65.54
Ref	18	20	16	18	16	17.6	88.0					NM
245	17	18	15	19	17	17.2	86.0	87.8	97.7			4.03
246	14	18	18	16	16	16.4	82.0	83.7	93.2	**		4.03
247	11	18	14	15	16	14.8	74.0	82.2	93.7			5.05
248	14	16	16	15	17	15.6	78.0	86.7	98.7			5.05
249	16	14	11	13	13	13.4	67.0	72.0	76.1	***	***	6.31
250	17	18	19	17	14	17.0	85.0	91.4	96.6			4.03
251	17	18	15	14	13	15.4	77.0	85.6	97.5			5.05
252	15	13	17	15	19	15.8	79.0	84.9	89.8			5.05
253	15	18	14	17	12	15.2	76.0	81.7	86.4	**		6.31
254	17	14	15	13	15	14.8	74.0	79.6	84.1	**		5.05
255	16	17	18	18	19	17.6	88.0	94.6	100.0			4.03
256	17	13	18	20	16	16.8	84.0	90.3	95.5			5.05
257	15	20	17	16	16	16.8	84.0	90.3	95.5			5.05
258	16	20	12	14	17	15.8	79.0	84.9	89.8			5.05
259	16	18	18	15	18	17.0	85.0	91.4	96.6			5.05
260	18	11	15	14	19	15.4	77.0	82.8	87.5			5.05
261	12	16	15	14	13	14.0	70.0	77.8	88.6	**		179.49
262	14	17	13	17	14	15.0	75.0	83.3	94.9			7.88
263	18	18	19	19	18	18.4	92.0	96.8	101.1			6.31
264	17	18	20	18	18	18.2	91.0	95.8	100.0			5.05
265	16	16	13	12	17	14.8	74.0	77.9	81.3	**	**	7.88
266	17	17	19	19	19	18.2	91.0	95.8	100.0			6.31

Table 6.10.1. (continued).

Sample ID	Rep Number (Alive Amphipods) 1	2	3	4	5	Mean Number Alive	Mean % Survival	% of Cont.	% of Ref.	Significantly different Cont.	Ref.	Day 10 NH_3
267	12	16	18	20	18	16.8	84.0	88.4	92.3			6.31
268	18	19	18	17	17	17.8	89.0	95.7	101.1			5.05
269	15	17	17	18	17	16.8	84.0	90.3	95.5			6.31
270	17	19	16	17	15	16.8	84.0	90.3	95.5			5.05
271	16	15	15	12	14	14.4	72.0	77.4	81.8	***		5.05
272	18	16	16	14	17	16.2	81.0	87.1	92.0			6.31
273	16	13	15	14	20	15.6	78.0	82.1	85.7	**		6.31
274	18	20	15	18	20	18.2	91.0	95.8	100.0			11.58
275	18	17	18	17	18	17.6	88.0	92.6	96.7			9.82
276	15	18	18	15	17	16.6	83.0	89.2	94.3			7.88
277	16	15	15	16	13	15.0	75.0	83.3	94.9			29.32
278	19	15	12	19	9	14.8	74.0	82.2	93.7			12.21
279	15	10	16	12	10	12.6	63.0	70.0	79.7	***		109.19
280	13	11	15	15	12	13.2	66.0	73.3	83.5	***		24.55
281	17	16	14	20	16	16.6	83.0	87.4	91.2			29.73
282	16	17	14	16	16	15.8	79.0	87.8	100.0			22.62
283	14	16	14	17	18	15.8	79.0	83.2	86.8	***		9.50
284	13	14	16	10	16	13.8	69.0	72.6	75.8	***	***	16.20
285	19	13	17	20	16	17.0	85.0	86.7	96.6	*		7.88
286	19	16	18	17	14	16.8	84.0	85.7	95.5	*		6.31
287	15	14	15	16	14	14.8	74.0	75.5	84.1	***	**	5.05
288	15	12	16	14	10	13.4	67.0	74.4	84.8	***		13.52
289	17	17	18	17	10	15.8	79.0	87.8	100.0			47.97
290	12	14	15	8	14	12.6	63.0	70.0	79.7	***		41.38
291	18	13	14	12	18	15.0	75.0	78.9	82.4	***		79.21
292	13	14	17	14	18	15.2	76.0	80.0	83.5	**		27.14
293	16	14	17	17	16	16.0	80.0	84.2	87.9			29.22
294	17	18	12	14	13	14.8	74.0	77.9	81.3	**	**	38.15

* Indicates significant difference at $p \leq 0.05$ but does not meet MSD requirement
** Indicates significant difference at $p \leq 0.05$ and < MSD
*** Indicates significantly different at $p \leq 0.01$ and < MSD

Table 6.10.2. Spearman rank correlation coefficients between concentrations of chemicals in the sediment and amphipod survival, or chemicals and % silt/clay. Shaded = significant correlations at p ≤0.05 and ≤0.01, respectively, with Bonferroni adjustment for multiple comparisons. Negative values indicate an inverse correlation.

Chemical	Toxicity r^2	p	Silt/Clay r^2	p
hexachlorobenzene	0.073	0.6160	-0.198	0.1670
gamma-BHC	0.114	0.4300	-0.153	0.2870
alpha-chlordane	0.114	0.4320	0.164	0.2540
2,4'-DDE	-0.059	0.6850	0.057	0.6950
t-nonachlor	0.116	0.4210	0.046	0.7530
4,4'-DDE	0.052	0.7220	-0.021	0.8840
2,4'-DDD	-0.050	0.7310	0.013	0.9300
4,4'-DDD	-0.017	0.9090	-0.117	0.4200
2,4'-DDT	-0.010	0.9480	-0.115	0.4270
4,4'-DDT	-0.247	0.0840	-0.029	0.8410
Total DDT	-0.157	0.2770	-0.133	0.3580
mirex	0.015	0.9180	0.084	0.5610
Total PCB	0.101	0.4850	0.210	0.1430
naphthalene	-0.078	0.5910	-0.092	0.5270
1-methylnaphthalene	-0.026	-0.8590	0.107	0.4610
2-methylnaphthalene	-0.122	0.4000	-0.039	0.7880
acenaphthylene	-0.223	0.1190	-0.084	0.5610
phenanthrene	0.297	0.0360	0.333	0.0180
anthracene	0.208	0.1480	0.261	0.0670
fluoranthene	0.349	0.0130	0.646	0.0140
pyrene	0.331	0.0190	0.418	0.0025
benzo(a)anthracene	0.101	0.4850	0.260	0.0680
chrysene	0.188	0.1920	0.248	0.0830
benzo(b)fluoranthene	0.292	0.0400	0.351	0.0120
benzo(k)fluoranthene	0.321	0.0230	0.340	0.0160
benzo(a)pyrene	0.356	0.0110	0.224	0.1180
benzo(g,h,i)perylene	0.034	0.8150	0.067	0.6420
dibenz(a,h)anthracene	-0.012	0.9310	0.048	0.7430
indeno(1,2,3-cd)pyrene	0.098	0.4980	0.241	0.0920
toxaphene	-0.225	0.1160	-0.228	0.1110
Al	0.456	0.0009	0.927	<0.0001

Table 6.10.2. (continued).

Chemical	Toxicity r^2	p	Silt/Clay r^2	p
As	0.250	0.0810	0.763	<0.0001
Cd	0.313	0.0270	0.295	0.0370
Cr	0.453	0.0010	0.950	<0.0001
Cu	0.388	0.0054	0.879	<0.0001
Pb	0.392	0.0049	0.868	<0.0001
Ni	0.399	0.0041	0.910	<0.0001
Ag	0.248	0.0830	0.337	0.0170
Zn	0.444	0.0012	0.894	<0.0001
Se	-0.068	0.6380	0.199	0.1660
Hg	0.406	0.0034	0.776	<0.0001
Fe	0.432	0.0017	0.939	<0.0001
Mn	0.448	0.0010	0.906	<0.0001
Sb	0.280	0.0490	0.738	<0.0001
Sn	0.546	<0.0001	0.810	<0.0001
% TOC	0.106	0.4630	0.486	0.0003
% Clay	0.407	0.0034		
% Silt	0.346	0.0140		
% Sand	-0.349	0.0130		
% Gravel	-0.348	0.0130		
% Silt/Clay	0.399	0.0040		

6.11 Trace Metals in Tissue – Individual Concentrations (mg/kg or ppm Wet Weight)

Table 6.11.1. Trace metal concentrations (mg/kg or ppm wet weight) in tissue (whole body) for 41 RCAP 2002 sampling sites. Missing sites (9) reflect no trawls taken due to shallow water or no specimens collected as indicated in Table 6.1.1. Shaded value exceeded applicable TCEQ/TDH Tidal Water screening levels for: As = 3.00 (inorganic arsenic estimated as 20% of total arsenic. Values presented in table represent total arsenic), Cd = 0.50, Cr = 100.00, Cu = 40.00, Hg = 0.70, Pb = 8.33, and Se = 2.0. No value (-) indicates concentration below the reporting limit indicated in parentheses below the chemical symbol. **Bold** = highest recorded concentration.

Segment	Segment Name	CCS ID	TCEQ ID	Ag (0.02)	Al (10.0)	As (2.0)	Cd (0.07)	Cr (0.1)	Cu (1.0)	Fe (25.0)	Hg (0.01)	Ni (0.2)	Pb (0.1)	Se (1.0)	Sn (0.05)	Zn (20.0)
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	66.60	-	-	1.20	1.06	43.30	0.03	0.40	-	-	-	23.50
		246	18217	-	78.30	-	-	1.70	-	47.80	0.02	0.62	-	-	**0.06**	-
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	-	132.00	-	-	0.90	-	51.80	0.01	0.27	-	-	-	-
		253	18224	-	58.60	-	-	0.30	-	44.60	0.01	-	-	-	-	-
		254	18225	-	126.00	-	-	0.80	-	56.40	0.02	0.83	-	-	-	-
		256	18227	-	42.80	-	-	1.90	-	26.10	0.02	0.87	-	-	-	-
2471	Aransas Bay	257	18228	-	79.50	-	-	1.20	-	44.20	0.03	0.43	-	-	-	-
		259	18230	-	120.00	-	-	0.50	-	51.80	0.01	-	-	-	-	-
		260	18231	-	18.00	-	-	1.00	-	11.00	0.04	0.35	-	-	0.05	
		261	18232	-	106.00	-	-	1.70	-	56.70	0.02	0.62	0.11	-	-	-
		262	18233	-	75.60	2.62	-	2.40	-	57.40	0.02	0.66	-	-	-	-
2472	Copano Bay/Port Bay/Mission Bay	252	18223	-	55.50	-	-	1.10	-	27.60	0.02	0.37	-	-	-	-
		255	18226	-	148.00	-	-	1.00	-	60.00	0.01	0.57	-	-	-	-
		258	18229	-	81.80	-	-	2.00	-	42.60	0.02	0.78	-	-	-	-
2473	St. Charles Bay	247	18218	-	107.00	-	-	0.40	-	49.00	0.01	0.81	-	-	-	-
		248	18219	-	124.00	-	-	1.40	-	60.30	0.01	0.49	-	-	-	-
		251	18222	-	163.00	-	-	0.30	-	83.10	0.01	-	0.23	-	-	-
2481	Corpus Christi Bay	266	18237	-	56.60	-	-	0.40	-	35.40	0.05	-	-	-	-	-
		268	18239	-	75.10	-	-	0.80	-	47.60	0.05	0.23	-	-	-	-
		269	18240	-	56.90	-	-	1.50	1.32	36.90	0.04	0.43	0.14	-	-	-
		270	18241	-	53.90	-	-	0.50	-	25.30	0.04	-	-	-	-	-
		271	18242	-	45.50	-	-	0.50	-	27.60	0.03	-	-	-	-	-
		272	18243	-	54.20	-	-	1.30	-	33.20	0.05	0.83	-	-	-	-
		273	18244	-	96.80	-	-	3.00	-	71.50	0.04	0.99	-	-	-	-
		274	18245	-	**172.00**	-	-	1.10	-	89.60	0.02	0.47	0.23	-	-	-
		275	18246	-	53.30	2.12	-	1.10	-	36.50	0.02	0.35	-	-	-	-
		276	18247	-	83.70	-	-	1.10	-	55.60	0.02	0.39	0.24	-	-	-

Table 6.11.1. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	Ag (0.02)	Al (10.0)	As (2.0)	Cd (0.07)	Cr (0.1)	Cu (1.0)	Fe (25.0)	Hg (0.01)	Ni (0.2)	Pb (0.1)	Se (1.0)	Sn (0.05)	Zn (20.0)
2482	Nueces Bay	263	18234	-	65.80	-	-	2.30	-	43.60	**0.09**	0.78	0.10	-	-	-
		264	18235	-	93.50	-	-	2.40	-	65.00	0.08	0.73	0.10	-	-	-
		267	18238	-	24.80	-	-	7.00	-	47.40	0.06	2.26	-	-	-	-
2483	Redfish Bay	265	18236	-	164.00	-	-	0.50	-	94.20	0.02	-	0.20	-	-	-
2491	Laguna Madre	281	18252	-	58.40	-	-	11.70	1.02	90.30	0.02	4.31	-	-	-	-
		282	18253	-	24.40	-	-	17.70	**1.62**	84.00	0.03	6.76	0.13	-	-	-
		283	18254	0.03	117.00	-	-	2.50	1.20	70.80	0.03	0.90	0.19	-	-	-
		290	18261	-	69.70	4.34	-	0.30	1.24	39.00	0.03	-	0.11	-	-	-
		292	18263	-	46.50	-	-	1.90	1.02	37.00	0.05	0.60	0.14	-	-	-
		293	18264	-	104.00	3.89	-		1.22	57.50	0.04	-	**0.43**	-	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	-	50.30	4.28	-	1.00	-	31.00	0.04	0.31	-	-	-	21.00
		286	18257	-	83.00	-	-	2.10	1.20	53.40	0.04	0.70	0.16	-	-	-
		287	18258	**0.04**	38.40	**5.36**	-	**20.30**	1.57	**115.00**	**0.09**	**7.13**	0.19	-	-	**128.00**
		289	18260	-	129.00	-	-	0.60	-	51.30	0.02	-	-	-	-	-

6.12 Tissue Organics – Individual Concentrations (ng/g or ppb Wet Weight)

Table 6.12.1. Tissue concentrations (ng/g or ppb wet weight) of 11 of 20 PCB congeners (PCB's 18, 28, 66, 77, 126, 128, 180, 206, and 209 values were < reporting limit) at 41 RCAP 2002 sampling sites. Missing sites (9) reflect no trawls taken due to shallow water or no specimens collected as indicated in Table 6.1.1. Shaded value exceeded TCEQ screening level. No value (-) indicates concentration below the reporting limit. **Bold** = highest recorded concentration.

Segment	Segment Name	CCS ID	TCEQ ID	8	44	52	101	105	118	138	153	170	187	195	Total PCB
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	-	-	-	-	-	-	-	-	-	-	-
		246	18217	-	-	-	-	-	-	-	-	-	-	-	-
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	-	-	-	-	-	-	-	-	-	-	-	-
		253	18224	-	**1.31**	-	-	-	**3.00**	-	1.61	-	**6.96**	-	12.88
		254	18225	-	-	-	-	-	-	-	-	-	-	-	-
		256	18227	-	-	-	-	-	-	-	-	-	-	-	-
2471	Aransas Bay	257	18228	-	-	-	-	-	-	-	-	-	-	-	-
		259	18230	-	-	-	-	-	-	-	-	-	-	-	-
		260	18231	-	-	-	-	-	-	-	-	-	-	-	-
		261	18232	-	-	-	-	-	-	-	-	-	-	-	-
		262	18233	-	-	-	-	-	-	-	-	-	-	-	-
2472	Copano Bay/Port Bay/Mission Bay	252	18223	-	-	-	-	-	-	-	-	-	-	-	-
		255	18226	-	-	**3.12**	**0.97**	-	-	-	-	-	-	-	4.09
		258	18229	-	-	-	-	-	-	-	-	-	-	-	-
2473	St. Charles Bay	247	18218	-	-	-	-	-	-	-	-	-	-	-	-
		248	18219	**0.23**	-	-	-	-	-	-	-	-	-	-	0.23
		251	18222	-	-	-	-	-	-	-	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	-	-	-	-	-	-	-	-	-	-	-	-
		268	18239	-	-	-	-	-	-	-	-	-	-	-	-
		269	18240	-	-	-	-	-	-	-	-	-	-	-	-
		270	18241	-	-	-	-	-	-	-	-	-	-	-	-
		271	18242	-	-	-	-	-	-	-	-	-	-	-	-
		272	18243	-	-	-	-	-	-	-	-	-	-	-	-
		273	18244	-	-	-	-	-	-	-	-	-	-	-	-
		274	18245	-	-	-	-	-	-	-	-	-	-	-	-
		275	18246	-	-	-	-	**0.38**	-	-	3.32	-	-	-	3.70
		276	18247	-	-	-	-	-	-	-	-	-	-	-	-
2482	Nueces Bay	263	18234	-	-	-	-	-	-	-	-	-	-	-	-
		264	18235	-	-	-	-	-	-	-	-	-	-	-	-
		267	18238	-	-	-	-	-	-	**10.08**	**8.62**	-	-	-	**18.70**

Table 6.12.1. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	8	44	52	101	105	118	138	153	170	187	195	Total PCB
2483	Redfish Bay	265	18236	-	-	-	-	-	-	-	-	-	-	-	-
2491	Laguna Madre	281	18252	-	-	-	-	-	-	-	-	-	-	-	-
		282	18253	-	-	-	-	-	-	-	-	-	-	-	-
		283	18254	-	-	-	-	-	-	-	6.48	-	-	-	6.48
		290	18261	-	-	-	-	-	-	-	-	**1.10**	0.61	**0.79**	2.50
		292	18263	-	-	-	-	-	-	3.63	1.80	-	-	-	5.43
		293	18264	-	-	-	-	-	-	-	-	-	-	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	-	-	-	-	-	-	-	-	-	-	-	-
		286	18257	-	-	-	-	-	-	-	-	-	-	-	-
		287	18258	-	-	-	-	-	-	-	-	-	-	-	-
		289	18260	-	-	-	-	-	-	-	-	-	-	-	-

Table 6.12.2. Tissue concentrations of DDD, DDE, and DDT (ng/g or ppb wet weight) at 41 RCAP 2002 sampling sites. Missing sites (9) reflect no trawls taken due to shallow water or no specimens collected as indicated in Table 6.1.1. Shaded value exceeded TCEQ screening level. No value (-) indicates concentration below the reporting limit. **Bold** = highest recorded concentration.

Segment	Segment Name	CCS ID	TCEQ ID	2,4'-DDD	4,4'-DDD	2,4'-DDE	4,4'-DDE	2,4'-DDT	4,4'-DDT	Total DDT
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	-	-	-	-	-	-
		246	18217	-	-	-	-	-	-	-
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	-	-	-	-	-	-	-
		253	18224	-	**1.60**	-	-	**0.36**	-	1.96
		254	18225	-	-	-	**8.72**	-	-	8.72
		256	18227	-	-	-	-	-	-	-
2471	Aransas Bay	257	18228	-	-	-	-	-	-	-
		259	18230	-	-	-	-	-	-	-
		260	18231	-	-	-	-	-	-	-
		261	18232	-	-	-	-	-	-	-
		262	18233	-	-	-	-	-	-	-
2472	Copano Bay/Port Bay/Mission Bay	252	18223	-	-	-	-	-	-	-
		255	18226	-	-	-	-	-	-	-
		258	18229	-	-	-	-	-	-	-
2473	St. Charles Bay	247	18218	-	-	-	-	-	-	-
		248	18219	-	-	-	-	-	-	-
		251	18222	-	-	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	-	-	-	-	-	-	-
		268	18239	-	-	-	-	-	-	-
		269	18240	-	-	-	-	-	-	-
		270	18241	-	-	-	-	-	-	-
		271	18242	-	-	-	-	-	-	-
		272	18243	-	-	-	-	-	-	-
		273	18244	-	-	-	-	-	-	-
		274	18245	-	-	-	-	-	-	-
		275	18246	-	-	-	-	-	-	-
		276	18247	-	-	-	-	-	-	-
2482	Nueces Bay	263	18234	-	-	-	-	-	-	-
		264	18235	-	-	-	-	-	-	-
		267	18238	-	-	-	-	-	-	-

Table 6.12.2. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	2,4'-DDD	4,4'-DDD	2,4'-DDE	4,4'-DDE	2,4'-DDT	4,4'-DDT	Total DDT
2483	Redfish Bay	265	18236	-	-	-	-	-	-	-
2491	Laguna Madre	281	18252	-	-	-	-	-	-	-
		282	18253	-	-	-	-	-	-	-
		283	18254	-	-	-	-	-	-	-
		290	18261	-	-	-	-	-	-	-
		292	18263	-	-	-	-	-	**10.15**	**10.15**
		293	18264	-	-	-	-	-	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	-	-	-	-	-	-	-
		286	18257	-	-	-	-	-	-	-
		287	18258	-	-	-	-	-	-	-
		289	18260	-	-	-	-	-	-	-

Table 6.12.3. Tissue concentrations of Chlorinated Pesticides (ng/g or ppb wet weight) other than DDT at 41 RCAP 2002 sampling sites. Missing sites (9) reflect no trawls taken due to shallow water or no specimens collected as indicated in Table 6.1.1. Shaded value exceeded screening level. No value (-) indicates concentration below the reporting limit. **Bold** = highest recorded concentration.

Segment	Segment Name	CCS ID	TCEQ ID	aldrin	alpha-chlordane	endosulfan I	endosulfan II	endosulfan sulfate	endrin	dieldrin
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	-	-	-	-	-	-
		246	18217	-	**12.30**	-	-	-	-	-
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	-	-	-	-	-	-	-
		253	18224	-	-	-	-	-	-	-
		254	18225	-	-	-	-	-	-	-
		256	18227	-	-	-	-	-	-	-
2471	Aransas Bay	257	18228	-	1.59	-	-	-	-	-
		259	18230	-	-	-	-	-	-	-
		260	18231	-	-	-	-	-	-	-
		261	18232	-	-	-	-	-	-	-
		262	18233	-	-	-	-	-	-	-
2472	Copano Bay/Port Bay/Mission Bay	252	18223	-	-	-	-	-	-	-
		255	18226	-	1.04	-	-	-	-	-
		258	18229	-	-	-	-	-	-	-
2473	St. Charles Bay	247	18218	-	-	-	-	-	-	-
		248	18219	-	-	-	-	-	-	-
		251	18222	-	-	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	-	-	-	-	-	-	-
		268	18239	-	-	-	-	-	-	-
		269	18240	-	-	-	-	-	-	-
		270	18241	-	-	-	-	-	-	-
		271	18242	-	-	-	-	-	-	-
		272	18243	-	-	-	-	-	-	-
		273	18244	-	-	-	-	-	-	-
		274	18245	-	-	-	-	-	-	-
		275	18246	-	-	-	-	-	-	-
		276	18247	-	-	-	-	-	-	-
2482	Nueces Bay	263	18234	-	-	-	-	-	-	-
		264	18235	-	-	-	-	-	-	-
		267	18238	-	-	-	-	-	-	-
2483	Redfish Bay	265	18236	-	-	-	-	-	-	-

Table 6.12.3. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	aldrin	alpha-chlordane	endosulfan I	endosulfan II	endosulfan sulfate	endrin	dieldrin
2491	Laguna Madre	281	18252	-	-	-	-	-	-	-
		282	18253	-	-	-	-	-	-	-
		283	18254	-	-	-	-	-	-	-
		290	18261	-	-	-	-	-	-	-
		292	18263	-	-	-	-	-	-	-
		293	18264	-	-	-	-	-	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	-	-	-	-	-	-	-
		286	18257	-	-	-	-	-	-	-
		287	18258	-	-	-	-	-	-	-
		289	18260	-	-	-	-	-	-	-

Table 6.12.3. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	heptachlor	heptachlor epoxide	hexachlorobenzene	lindane	mirex	t-nonachlor	toxaphene	Total Chlorinated Pesticides
2462	San Antonio Bay/Hynes Bay/Guadalupe Bay	245	18216	-	-	-	-	-	-	-	-
		246	18217	-	-	-	-	-	**14.85**	**250.42**	**277.57**
2463	Mesquite Bay/Carlos Bay/Ayres Bay	249	18220	-	-	-	-	-	-	-	-
		253	18224	-	-	-	-	-	-	-	-
		254	18225	-	-	-	-	-	-	-	-
		256	18227	-	-	-	-	-	-	-	-
2471	Aransas Bay	257	18228	-	-	-	-	-	1.02	-	2.61
		259	18230	-	-	-	-	-	-	-	-
		260	18231	-	-	-	-	-	-	-	-
		261	18232	-	-	-	-	-	-	-	-
		262	18233	-	-	-	-	-	-	-	-
2472	Copano Bay/Port Bay/Mission Bay	252	18223	-	-	-	-	-	-	-	-
		255	18226	-	-	-	-	-	0.90	-	1.94
		258	18229	-	-	-	-	-	-	-	-
2473	St. Charles Bay	247	18218	-	-	-	-	-	-	-	-
		248	18219	-	-	-	-	-	-	-	-
		251	18222	-	-	-	-	-	-	-	-
2481	Corpus Christi Bay	266	18237	-	-	-	-	-	-	-	-
		268	18239	-	-	-	-	-	-	-	-
		269	18240	-	-	-	-	-	-	-	-
		270	18241	-	-	-	-	-	-	-	-
		271	18242	-	-	-	-	-	-	-	-
		272	18243	-	-	-	-	-	-	-	-
		273	18244	-	-	-	-	-	-	-	-
		274	18245	-	-	-	-	-	0.94	-	0.94
		275	18246	-	-	-	-	-	-	-	-
		276	18247	-	-	-	-	-	-	-	-
2482	Nueces Bay	263	18234	-	-	-	-	-	-	-	-
		264	18235	-	-	-	-	-	-	-	-
		267	18238	-	-	-	-	-	-	-	-
2483	Redfish Bay	265	18236	-	-	-	-	-	-	-	-

Table 6.12.3. (continued).

Segment	Segment Name	CCS ID	TCEQ ID	heptachlor	heptachlor epoxide	hexachlorobenzene	lindane	mirex	t-nonachlor	toxaphene	Total Chlorinated Pesticides
2491	Laguna Madre	281	18252	-	-	-	-	-	-	-	-
		282	18253	-	-	-	-	-	-	-	-
		283	18254	-	-	-	-	-	-	-	-
		290	18261	-	-	-	-	-	-	-	-
		292	18263	-	-	-	-	-	-	-	-
		293	18264	-	-	-	-	-	-	-	-
2492	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada	285	18256	-	-	-	-	-	-	-	-
		286	18257	-	-	-	-	-	-	-	-
		287	18258	-	-	-	-	-	-	-	-
		289	18260	-	-	-	-	-	-	-	-

Table 6.12.4. Tissue concentrations of 23 PAH's (ng/g or ppb wet weight) at 41 RCAP 2002 sampling sites. Missing sites (9) reflect no trawls taken due to shallow water or no specimens collected as indicated in Table 6.1.1. Shaded value exceeded TCEQ screening level. No value (-) indicates concentration below reporting limit. **Bold** = highest recorded concentration.

No detectable concentrations as all values fell below Reporting Limits