Boundary Map Report
Habitat Management Plan of Corpus Christi Bay

Outlining an Ecosystem-based Management Plan for the Corpus Christi Bay

Jorge Brenner, Ph.D., Post-doctoral Associate
Paul A. Montagna, Ph.D., Principal Investigator
Thomas Nance, Undergraduate Research Assistant
Terry Palmer, M.S., Research Assistant

Harte Research Institute for Gulf of Mexico Studies
Texas A&M University - Corpus Christi
6300 Ocean Drive, Unit 5869
Corpus Christi, Texas 78412-5869

Phone: 361-825-2040
Email: paul.montagna@tamucc.edu

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CBBEP	Coastal Bend Bays & Estuaries Program
CR	County Road
DOJ	Department of Justice
EBM	Ecosystem-based Management
e.g.	For example (latin *exempli gratia*)
EPA	Environmental Protection Agency
GIS	Geographic Information System
ha	Hectares
HMP	Habitat Management Plan
HUC	Hydrological Unit Code
i.e.	That is (latin *id est*)
IH	Interstate Highway
MANERR	Mission –Aransas National Estuarine Research Reserve
NRA	Nueces River Authority
TCEQ	Texas Commission on Environmental Quality
TGLO	Texas General Land Office
TNRIS	Texas Natural Resources Information System
US	United States of America
USDA	United States Department of Agriculture
USGS	United States Geological Survey

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Introduction

The Habitat Management Plan (HMP) for the Corpus Christi Bay area of the Coastal Bend Bays & Estuaries Program (CBBEP) consists of a comprehensive needs assessment of ecological and socioeconomic benefits. After conducting preliminary meetings and organizing a stakeholder workshop, the next step was to identify the boundary of the planning area, and that is the subject of the current report.

Selecting an area where planning efforts will be performed has been previously identified in the scientific literature as a key process that will affect the products and outcomes of conservation projects (Leslie 2005 and references within). The project's boundary will determine the scale of the conservation elements that will be captured in the plan and the actions that will be proposed. This step of the planning process will establish the spatial framework at which conservation strategies will be implemented.

A basic assumption behind the concept of ecosystem-based management (EBM) is that management strategies should be designed and implemented at meaningful scales for natural features and processes. Thereafter, two of the datasets that had the most influence in shaping the boundary map were ecoregions and hydrological units.

Ecoregions represent areas of similar ecosystems in the type, quality, and quantity of environmental resources. Ecoregions constitute discrete spatial units that provide a spatial framework for assessment, management, and monitoring in EBM that have been used extensively in conservation planning (Leslie 2005, TNC 2000). Ecoregions have been hierarchically defined using natural characteristics, including geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. Level I is the coarsest level, dividing North America into 15 ecological regions. Level II divides the continent into 52 regions. At level III, the continental United States contains 104 ecoregions. Level IV, is a further refinement of level III ecoregions. At this level Texas was divided into 56 ecoregions (Griffith and Omernik 2009, see Appendix A for a description of Level IV ecoregions included in this study).

Hydrological units consist of hierarchical water management units that have the capacity to represent spatial hydrological variability in the landscape (EPA 2008). These are subdivisions of watersheds nested from largest to smallest areas and are used to organize hydrologic data, assessment, and monitoring. The hydrological unit code (HUC), is a hierarchical, numeric code that uniquely identifies hydrologic units (USGS 2009). The third level of classification (8-digit HUC) subdivides many of the sub-regions in the U.S. into accounting units. The fourth level of classification is the cataloging unit (12-digit HUC). This is the smallest element in the hierarchy of hydrologic units representing part of all of a surface drainage basin, a combination of drainage basins, or a distinct hydrologic feature.

The present report describes the methodological approach, databases used, and the proposed HMP boundary map. The boundary was developed using ecological, hydrological, and preliminary socioeconomic criteria to integrate into the planning area the habitats and ecosystem services they provide (see the Workshop Summary Report in Palmer *et al*. 2009). The boundary provides an area of focus, but is not intended to exclude acres of habitat structures and socio-economic activities outside the boundary. Habitat acres extending beyond the boundary may need to be included in future needs assessment depending on their ecological linkage or economic relevance to the planning area.

Methods

Geospatial framework

On 18 February 2009, a Corpus Christi Bay HMP workshop involving various stakeholders was held at HRI. As part of this workshop, participants were asked to comment on which areas and habitats they thought should be included in the proposed HMP for the Corpus Christi Bay area (Palmer *et al*. 2009). Workshop participants were provided a base map on which they could identify key features to be included in the HMP and/or suggest a boundary for the HMP (Figure 1). The data layers in the base map were from two primary sources: land use and coastal boundaries (labeled "Legend" in Figure 1) from the Texas General Land Office (TGLO 2009), and wetland delineations (labeled "Wetlands" in Figure 1) from a CBBEP status and trends report (Tremblay et al. 2008). The present assessment used a larger geographic area than that provided in the workshop, because it represents an area that potentially influences the Corpus Christi Bay area. This influence area includes the aquatic and terrestrial environments bounding Corpus Christi Bay and Nueces Bay, and the 12 counties of the Texas Coastal Bend that are in the CBBEP management area.

The first step of the geospatial framework comprised development of a geographic information system (GIS) for data analysis and synthesis. The GIS was implemented using ArcGIS 9.3 software from ESRI. The GIS layers used were projected into the UTM (zone 14) coordinate system so that areas and distances from geographic features could be accurately estimated. The geospatial database used to develop the map in the Workshop Summary Report (Figure 2 in Palmer *et al*. 2009), and other layers suggested at the workshop form a baseline for analyses in the current study (Figure 1).

The approach was to assemble relevant spatial layers that were transformed, overlaid, intersected to create thematic maps to better understand spatial patterns, and guide the identification of the boundary. The natural environment, hydrological, and land use/land cover maps were combined in the GIS. Criteria to create the map were defined and compromises were made to fulfill it in order to identify a coherent EBM planning area for the HMP project. Finally, maps were created to represent the boundary of the planning area, and its larger area of influence in the Coastal Bend (Figure 2). The following sections describe each step in greater detail.

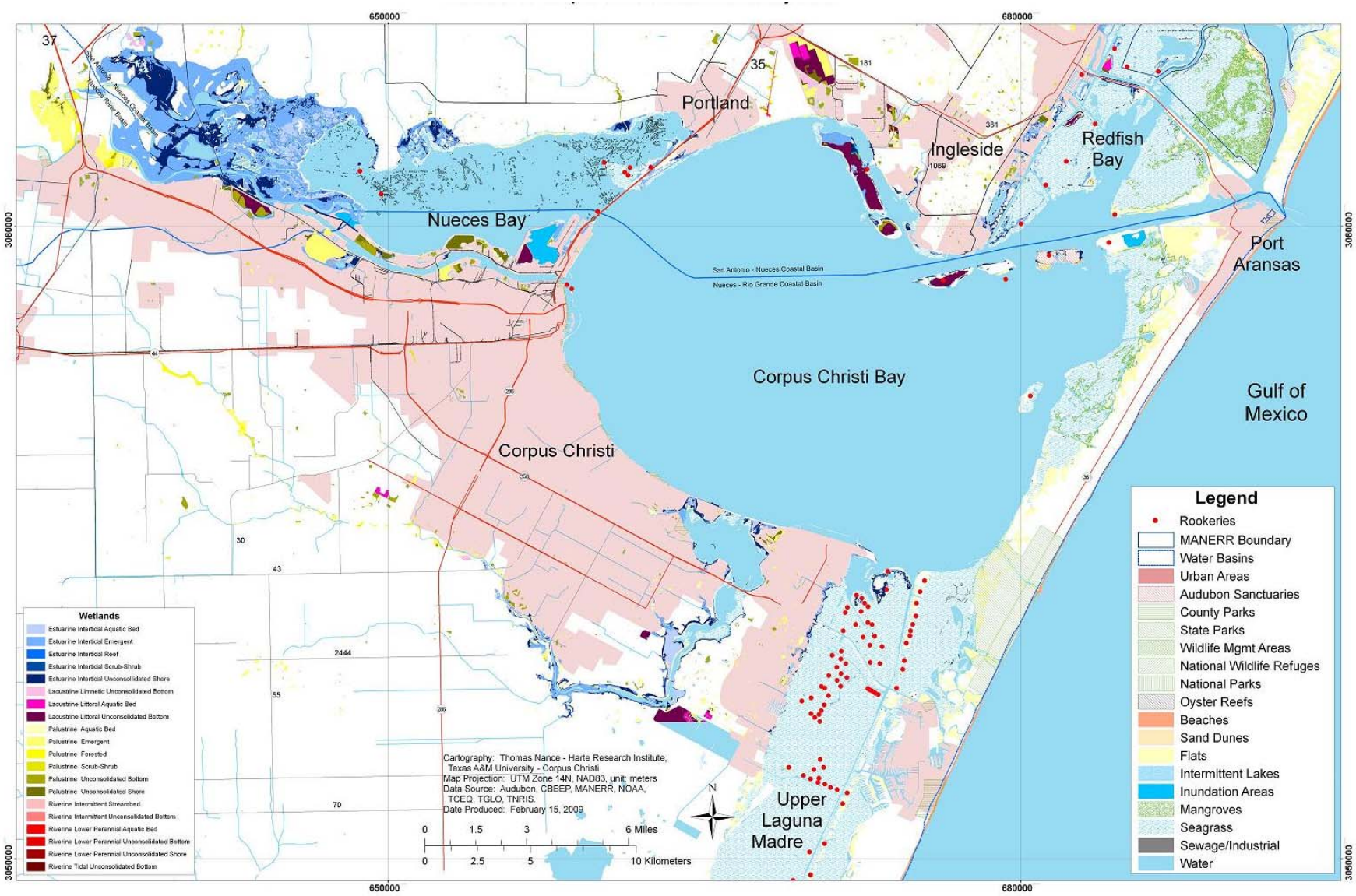

Figure 1. Habitat map that was provided to participants of workshop.

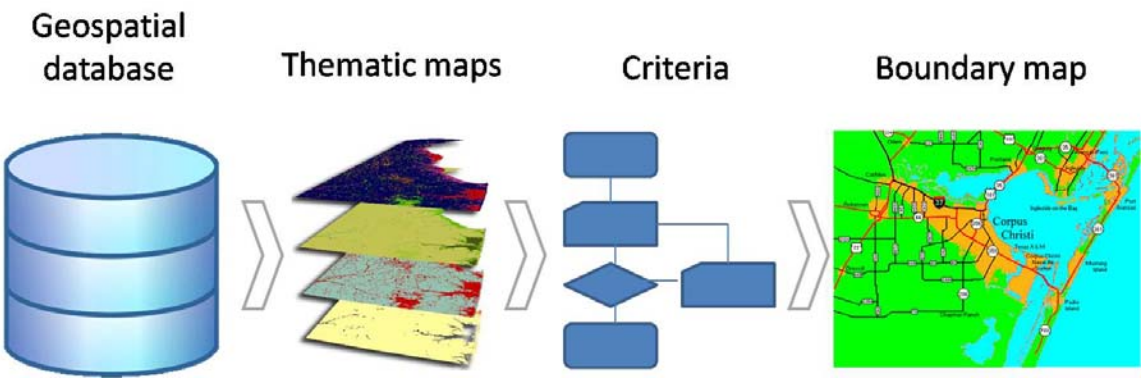

Figure 2. Workflow followed in developing of the boundary map.

Thematic maps

Spatial data layers relevant to the HMP of the Corpus Christi Bay area, and thus to the identification of its planning area, were grouped into themes. Themes included layers from the geospatial database created prior to the workshop and layers that were reported to be relevant in the workshop. Thematic maps were used to increase understanding of spatial patterns and guide the identification of the proposed boundary.

Prior to its inclusion in the maps, each layer was pre-processed in the GIS (i.*e.*, re-projected to UTM-zone14, attributes transformed or recalculated, polygons closed and cleaned). Maps of the natural environment, hydrological system and land use/land covers were created in the GIS. The map's layout was set to the scale that best represent the key features.

The natural environment map is based on ecoregions, which are defined as areas of similar ecological dynamics, as the matrix or baseline for its creation. Ecoregions represent natural units relevant for the analysis and management of habitats. Similarly, hydrological units were used as the baseline for the analysis of water resources. Hydrological units, defined as watershed and sub-units, were included at different hierarchical levels in the analyses. Finally, to assess human use and appropriation of the territory in the terrestrial environment, a land use/land cover map was created. The map included different intensities of development (based on urbanized area, impervious surface and major roads), and cultivated land.

Creating the boundary map

The first step to create the boundary map was to define the conceptual and geographic criteria that will drive its design. Practical criteria on both aspects were selected to develop a simple, but not simplistic, process:

- Conceptual criteria:
  - Based on natural units (*e.g.,* ecoregions).
  - Include as many as possible habitats and their geographic extent that were suggested in the workshop.
  - Be concise but include the upland socio-ecological components of the Corpus Christi Bay system that are relevant for its management (*e.g.,* City of Corpus Christi, surrounding terrestrial habitats).
  - Complement existing managed and conservation areas.

- Geographic criteria:
  - Boundary should be represented as one single polygon.
  - Follow natural limits (*e.g*., river basins, ecoregions).
  - Identify a core boundary for the HMP and its influence area.
  - The possible maximum extent is the 12 county where CBBEP works.

A map showing the boundary that was defined by using the above criteria was created. See Appendix B for a technical description of the steps followed to create the map using ArcGIS 9.3 software. Maps showing the criteria/data used for each segment as annotations, and the influence area of the plan were also created. The extent of the inclusion of habitats and other socio- ecological features suggested at the workshop in the final boundary map was also analyzed.

The final result is a boundary, but the boundary is not intended to be exclusive to the point where contiguous habitats extended beyond the boundary are excluded.

Results

Thematic maps

The following series of maps illustrate the most relevant themes used to assess the socio-ecological features and patterns in the study area. However, other data layers and information not shown in these maps but described below were also used in the creation of the boundary's polygon.

The natural environment map used level IV ecoregions (the largest geographic scale) as the matrix to represent the ecological units that are spatially related to Corpus Christi Bay (Figure 3). Other habitats relevant to the bays were included in the analyses as part of the desirable ecological structure and functions to be explicitly integrated into the plan (*e*.g., oyster reefs, mangroves, sea grasses, bird rookeries). Four ecoregions bound Corpus Christi Bay, the Nueces River Delta, and the selected habitats:

1) Southern Subhumid Gulf Coast Prairies (34b),

2) Floodplains and Low Terraces (34c),

3) Mid-Coast Barrier Islands and Coastal Marshes (34h), and

4) Laguna Madre Barrier Islands and Coastal Marshes (34i) (see Appendix A for a description of these four ecoregions).

All four of these ecoregions are part of the level III Western Gulf Coastal Plains ecoregion (34). This is a coastal plain ecoregion dominated mainly by barrier islands, crops, grasslands, and oil and gas infrastructure (Griffith and Omernik 2009).

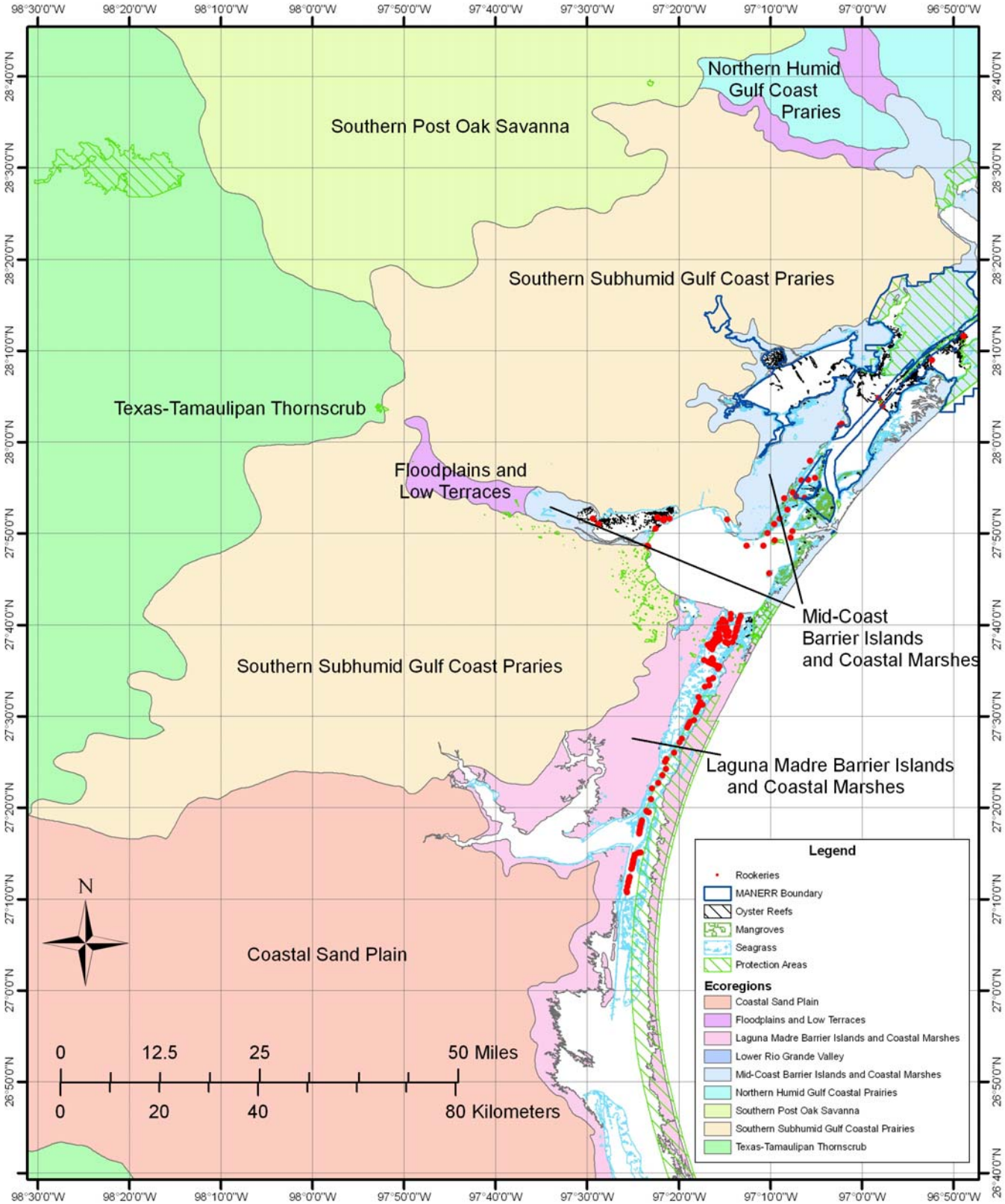

Figure 3. Natural environment of the Coastal Bend.

The hydrological map used the hydrological units at the 8-digit HUC level as the matrix to represent the hydrological variability of the study area in a spatial manner (Figure 4). These hydrological units constitute real water monitoring and management units used in Texas (EPA 2008). This characteristic provides the advantage of integrating key environmental properties and the governance dimension to any planning and conservation effort. Other hydrological layers were used in the analyses, such as 12-digit HUCs (Figure 5), major and minor streams, reservoirs, wetlands and bay limits (as defined by the HUCs). Four 8-digit HUCs immediately bound Corpus Christi Bay and the Nueces River Delta:

1) Aransas Bay (12100405),
2) North Corpus Christi Bay (12110201),
3) Lower Nueces (12110111), and
4) South Corpus Christi Bay (12110202).

The four HUCs were defined according to the river basins as defined by the Texas Commission on Environmental Quality (TCEQ). These four HUCs overlap with:

1) Nueces River basin (21),
2) San Antonio-Nueces coastal basin (20), and
3) Nueces-Rio Grande coastal basin (22)

Appendix C illustrates the streams that drain in the study area by river basin.

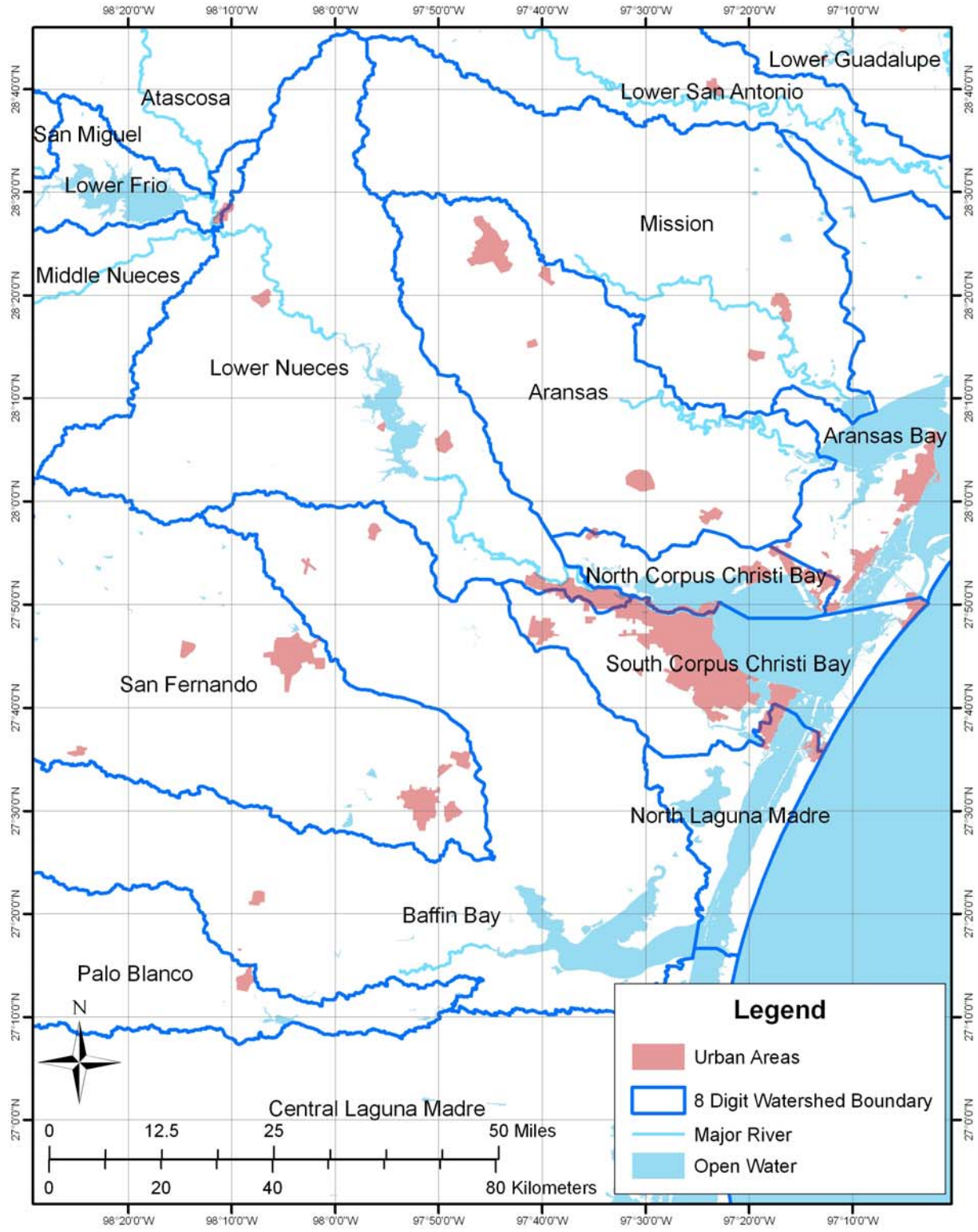

Figure 4. Hydrological units (8-digit HUCs) of the Coastal Bend.

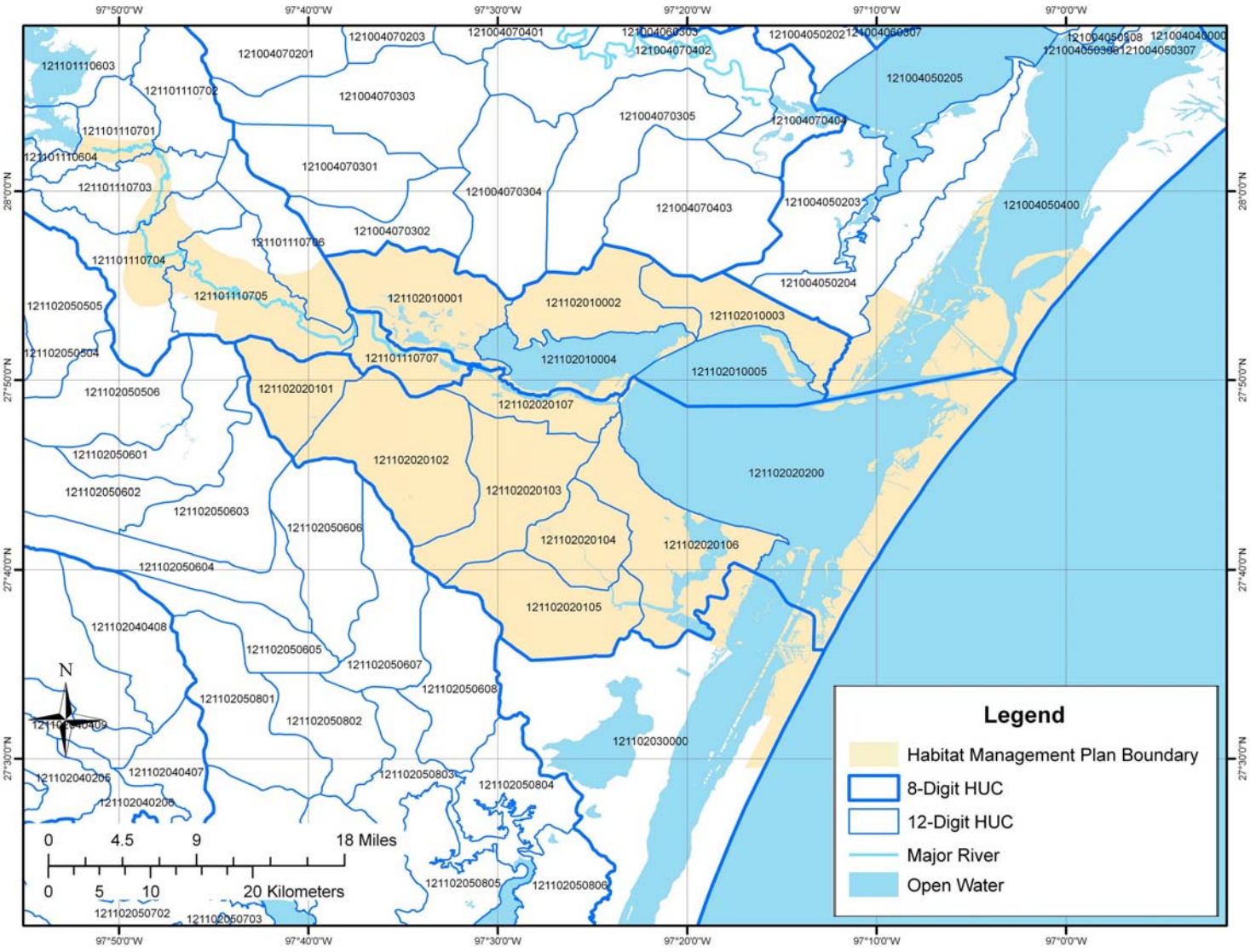

Figure 5. 12-digit Hydrological Unit Codes surrounding Corpus Christi Bay

The socioeconomic dimension was assessed by analyzing the different intensities of built development and land use of the natural space. High-to-low intensity development and cultivated areas developed by the National Oceanic and Atmospheric Administration's Coastal Change Analysis Program were included as the matrix land use/land covers for analysis (Figure 6). However, other layers such as major and minor roads, city limits, population and population density, etc. were also used. Urbanized areas, other impervious land and agricultural were analyzed to make sure we included the essential components of the socio-ecological system of Corpus Christi Bay.

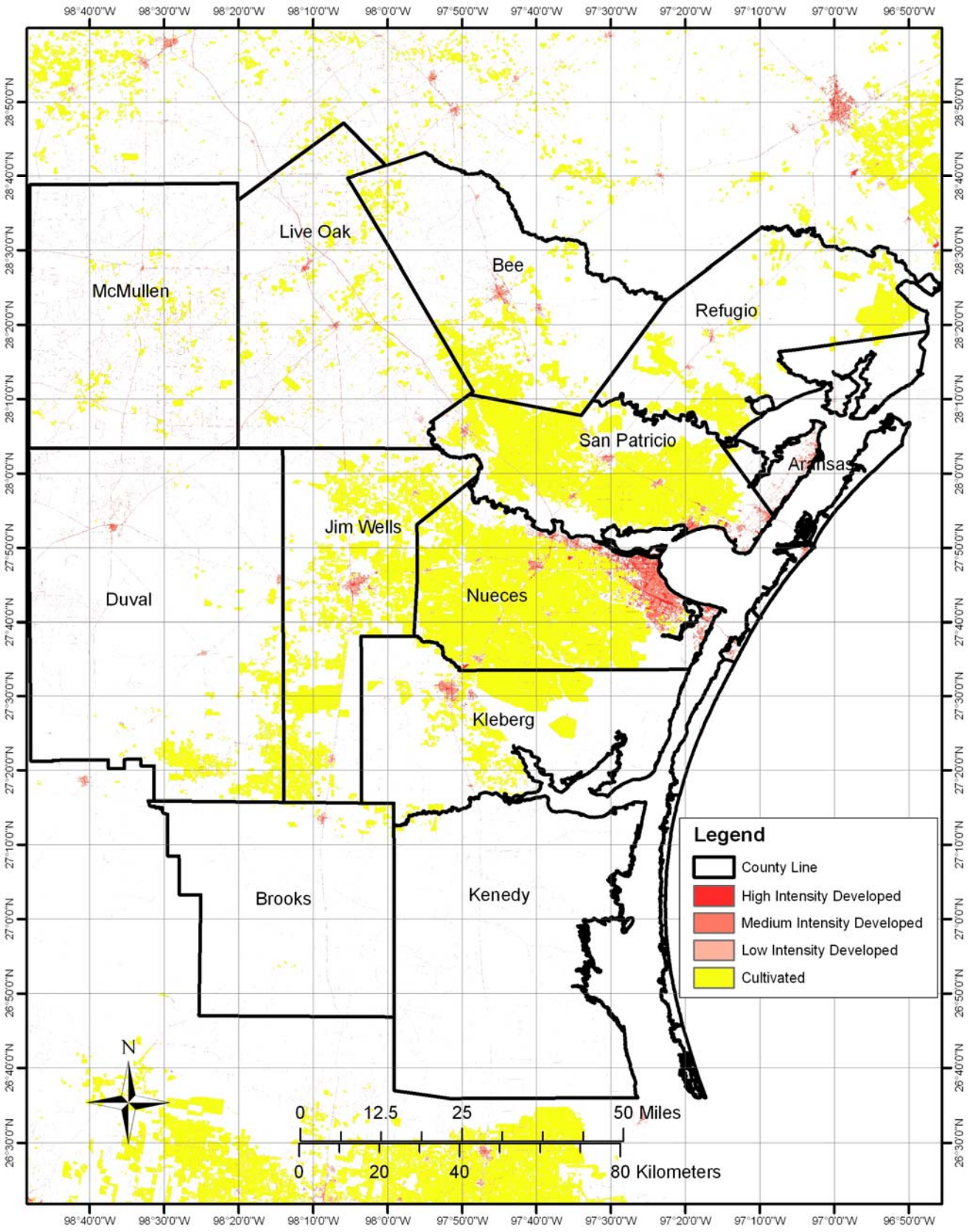

Figure 6. Developed and cultivated lands of the Coastal Bend.

Boundary map

A polygon representing the boundary of the Habitat Management Plan was created using the GIS (Table 1). See Appendix B for a technical description of the steps followed to develop the boundary. The boundary was compiled using elements of the matrix layers from the three themes. See Appendix D for a list of the GIS layers used in the creation of the final map. The final boundary represents a sense of balance of the criteria outlined in the Methods section. The boundary constitutes an area for conservation complementing two major managed areas:

1) The Mission-Aransas National Estuarine Research Reserve to the North.
2) The Padre Island National Seashore to the South.

The boundary (Figure 7) was in general framed by:

- ↑ North: The Southeast boundary of the city of Rockport and shoreline between the cities of Rockport and Ingleside (that partially overlaps the Mission-Aransas National Estuarine Research Reserve (MANERR) boundary) and the North Corpus Christi Bay 8-digit HUC.
- → East: The Texas offshore boundary, defined by "the line of fixed coordinates three marine leagues seaward from the 1865 coast or the 1997 coast, whichever is more landward." (DOJ 1997).
- ← West: The Flood Plains and Low Terraces Ecoregion and the Lower Nueces 8-digit HUC to the base of Wesley Seale Dam.
- ↙ Southwest: The South Corpus Christi Bay 8-digit HUC.
- ↓ South: The Padre Island National Seashore.

Table 1. Characteristics of the polygon representing the Habitat Management Plan boundary.

Characteristic	Dimension	Details
Polygon		
Area	247,362.85 ha (611,247.19 ac)	
Perimeter	337.18 km (209.51 mi)	
Upland area	137,634.08 ha (340,099.85 ac)	Terrestrial
Barrier island area	14,226.74 ha (35,154.89 ac)	Terrestrial
Estuarine area	63,113.75 ha (155,956.84 ac)	Aquatic
Marine area	32,388.28 ha (80,032.86 ac)	
Length of Gulf's shoreline	57.53 km (35.75 mi)	
Maximum length	85.43 km (53.08 mi)	
Maximum width	57.53 km (35.75 mi)	
Max. distance from shoreline to inland	79.80 km (49.58 mi)	
Distance from shoreline to offshore limit	5.47 km (3.40 mi)	
Administrative		
Counties intersected	5	Aransas, Kleberg, Jim Wells, Nueces, San Patricio
Cities intersected	11	Aransas Pass, Corpus Christi, Gregory, Ingleside, Ingleside on-the-Bay, Odem, Port Aransas, Portland, Rockport, Robstown, San Patricio
Cities within the boundary	4	Corpus Christi, Ingleside on-the-Bay, Portland, Port Aransas
Percentage of CBBEP working area	7.94 %	CBBEP 12 CO = 3,111,870.71 ha
Percentage of area of offshore waters in boundary	13.09 %	Offshore area: 32,388.28 ha

Figure 7. Boundary of the Habitat Management Plan of Corpus Christi Bay.

The following route provides details of each segment of the Habitat Management Plan boundary (Figure 8) (clockwise from the MANERR Boundary at the East):

1. City of Rockport to Texas offshore boundary: From the Southeast corner of the city of Rockport follow the direction to the Texas offshore boundary.

2. The Texas offshore boundary to Padre Island National Seashore: From the coordinates of the North-Eastern boundary of Padre Island National Seashore to the Texas offshore boundary with the same latitude.

3. Padre Island National Seashore to South Corpus Christi Bay 8-digit HUC: From the coordinates of the North-Western boundary of Padre Island National Seashore to the mainland shoreline with the same latitude. Follow the shoreline to the Corpus Christi City limits. Follow the Corpus Christi City limits until they cross the South Corpus Christi Bay 8-digit HUC.

4. South Corpus Christi Bay 8-digit HUC to Wesley Seale Dam: From the intersection of the South Corpus Christi Bay and Lower Nueces 8-digit HUCs follow the Lower Nueces 8-digit HUC West until CR 83. Follow CR 83 until the Flood Plains and Low Terraces Ecoregion. The ecoregion limit was extended to the base of the Wesley Seale Dam.

5. Wesley Seale Dam to North Corpus Christi Bay 8-digit HUC: The North Corpus Christi Bay 8-digit HUC intersects IH 37 at exit 20B. From exit 20B about 45 degrees South from West there is a private road that intersects with the Flood Plains and Low Terraces Ecoregion. The ecoregion limit was extended to the base of the Wesley Seale Dam.

6. North Corpus Christi Bay 8-digit HUC to the city of Rockport: From the intersection of the North Corpus Christi Bay 8-digit HUC and the Aransas Bay 12-digit HUC follow the Aransas Bay 12-digit HUC to the intersection of Wheeler Ave and Ave A in Aransas Pass. From the intersection of Wheeler Ave and Ave A follow Wheeler Ave to the shoreline. From Wheeler Ave and the shoreline, follow the shoreline to the Southeast corner of the city of Rockport.

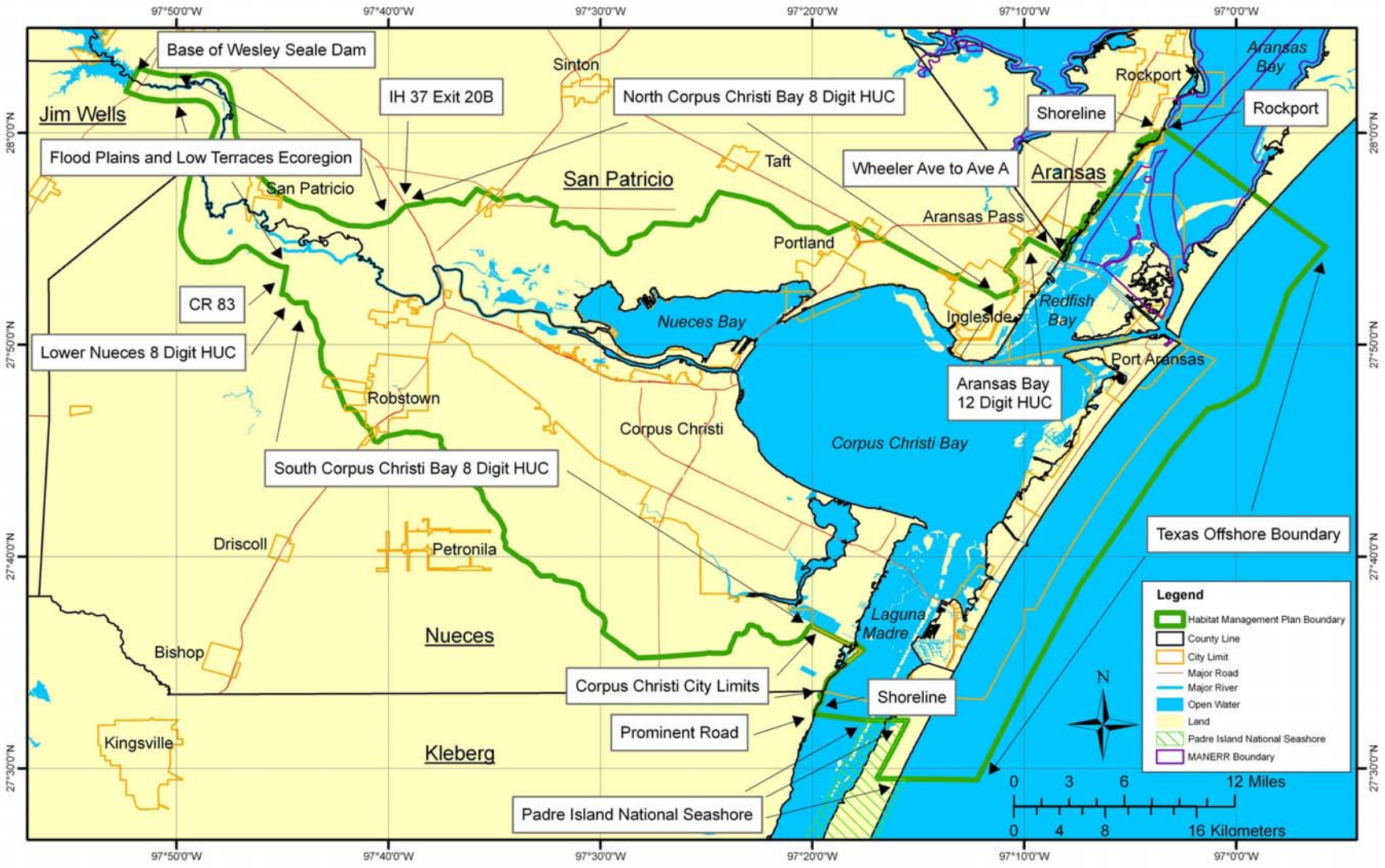

Figure 8. Criteria used in defining each segment of the boundary.

Influence area

If the boundary is to be considered the core area on which strategies, actions and projects will be implemented, it is also relevant to identify the larger area that will influence such projects. An overlay and proximity analysis was performed using the ecoregions and hydrological units to select those units whose pressures, state, and responses will determine that of the core area. The area that influences the boundary was selected to be that all the 8-digit HUCs and Level IV ecoregions that intersect or are contiguous to the boundary (Figure 9). Therefore, this extended area could be also seen as a buffer zone whose management strategies and actions need to be aligned to the core area. The total area of this buffer zone is 1,916,000 ha, of which the core area makes up 12.9 %.

The influence area extends the boundary influence to three 8-digit HUCs, Aransas, Baffin Bay, and North Laguna Madre. Although no new ecoregions influence the area, the Southern Subhumid Gulf Coast Prairies adds considerable area. In general terms, the majority of the influence area constitutes part of the 12 counties where the CBBEP operates.

The influence area will also be considered in future implementation. That is, the boundary here, which is derived from ecosystem-based criteria, does not suggest that adjoining habitats should be ignored.

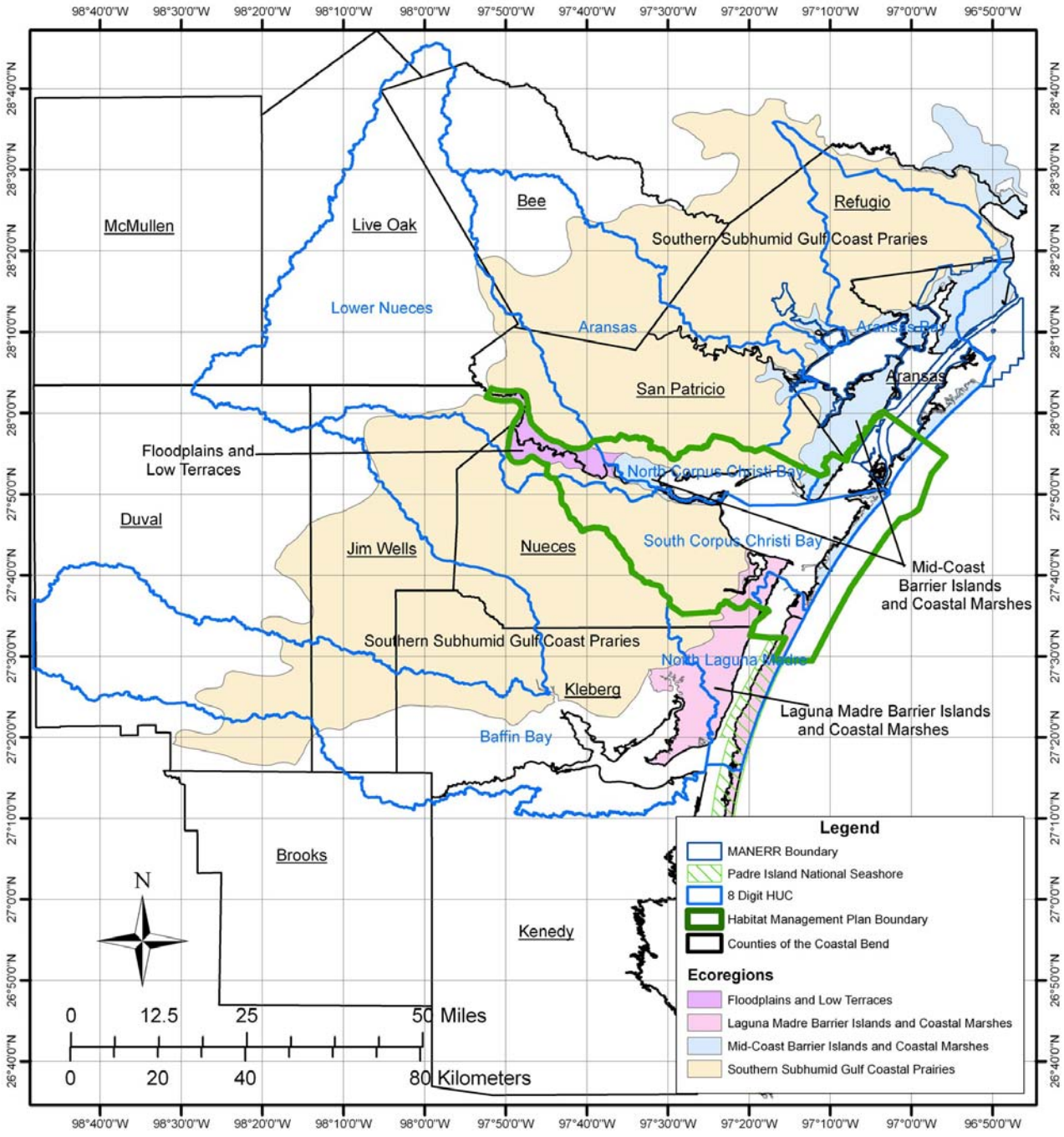

Figure 9. Boundary's area of influence.

Implementation of suggestions from workshop participants

Relevant habitats in the Coastal Bend, and to this study, were recommended for inclusion in the HMP at the workshop conducted on February 18, 2009 at the Harte Research Institute (Table 7 in Palmer *et al*. 2009). The extent that habitats and their specific locations described in the Workshop Summary Report (Palmer *et al*. 2009) have been included into the current boundary (Figure 7) were quantified and are presented in Table 2. Specific locations were classified based on its percent spatial inclusion: all (100%), most (<100%), half (50%), some (<50%), and none (0%). The analysis was conducted to the West in the area between the MANERR and the Padre Island National Seashore. Most of the locations suggested at the workshop were included inside the boundary.

Based on the criteria used in the definition of the boundary and outlined in the methods section, half of the rookeries and the majority of seagrass in Upper Laguna Madre were not included in the boundary. Parts of the city limits of Ingleside and Aransas Pass were omitted from the proposed HMP boundary because they were outside the North Corpus Christi Bay HUC. The North Corpus Christi Bay HUC was essentially the northern boundary for the proposed Corpus Christi HMP study area. Live Oak Peninsula was left out of the plan completely. The areas omitted from the Corpus Christi Bay HMP can be included in the drainage areas and aquatic habitats of future Habitat Management Plans of Nueces River uplands, Aransas Bay, Copano Bay, and/or Upper Laguna Madre and Baffin Bay.

Table 2. Proportion of specific locations reported at the HMP workshop that are in the HMP boundary. Classification: All: 100 %, Most: <100 %, Half: 50 %, Some: <50 %, and None: 0 %. *Count = number of groups who suggested that location (max = 7).

General & specific location	Count*	Included
Oso Creek Watershed	**7**	
Riparian Habitat		All
Botanical Gardens		All
Intersection with Road 286		All
Upper Laguna Madre	**7**	
Mollie Bettie Conservation Habitat Community		All
Rookery Islands		Half
Seagrass Area		Some
Western Urban Shore		All
Blue Hole (Channel)		All
Laguna Madre Field Station		All
Tidal Flat by Padre Island		All
Nueces Delta / Rincon Bayou	**6**	
Delta Mouth		All
Riparian Bottomland and Palmetto		All
Nueces Bay	**6**	
Oyster Reefs		All
Area North of North Nueces Bay Causeway		All
North Side of Bay		All
Rookery Islands		All
Gum Hollow		All
Redfish Bay	**6**	
Just North of Ship Channel		All
Mangroves		All
Intracoastal Easement		Half
Tidal Inlets	**6**	
Packery Channel		All
Aransas Pass (channel)		All
Fish Pass Jetties		All
Port Aransas Jetties		All
Packery Channel Jetties		All
Temporary Tidal Inlets / Washover Channels		All
Corpus Christi Bay	**6**	
Backside of Mustang Island / Marsh		All
Hypoxic Zone		All
Spoil Islands Along Ship Channel		All
Portland Shoreline		All
NAS Ingleside		All

General & specific location	Count*	Included
Open Bay Bottom		All
Shamrock Island		All
Port of Corpus Christi		All
Ship Channel		All
Oso Bay	**5**	
Along Ennis Joslin St		All
At Intersection with West Rodd Field Rd		All
Mud Flats		All
Areas Close to Inlets to Corpus Christi Bay		All
Mustang Island	**5**	
Dunes		All
Barrier Island Uplands / Prairies		All
Freshwater Wetlands		All
Beach		All
Port Aransas		All
Mustang Island State Park		All
Ingleside	**4**	
Live Oak / Coastal Prairie / Freshwater Ponds		Half
Industrial Area / Port		All
Kinny Bayou		All
Padre Island	**4**	
Scrub / Shrub and Packery Channel Park		All
Oak Mottes		All
Barrier Island Uplands / Prairies		All
Freshwater Wetlands		All
Dunes		All
Channelized Housing		All
Padre Island National Seashore		None
Willow Habitat Behind Padre Island National Seashore		All
Corpus Christi Urban Area	**4**	
Port of Corpus Christi		All
Shoreline Dr		All
Hans Suter Park		All
Flour Bluff		All
Gulf of Mexico	**1**	
To 10 mi Offshore		All
Agricultural Land Surrounding Corpus Christi	**1**	Some
San Jose Island	**1**	Some

Final remarks

The boundary of the Corpus Christi Bay HMP was conceived to determine the areal extent for future protection and restoration projects by the CBBEP of relevant socio-ecological systems. The boundary was designed to follow management relevant socio-ecological units in the study area that complemented existing managed areas in the Coastal Bend. The resulting boundary accomplished both criteria. Therefore, it represents the core planning area for representative habitats that were reported at the workshop. Furthermore, its influence area also corresponds basically to the working area of the CBBEP. This characteristic will provide the opportunity to the CBBEP to guide the future of the core planning area by ensuring that conservation and sustainable development projects are conducted in this buffer area (Figure 8). Major biophysical features that included within the HMP boundary include the Nueces River Delta, Corpus Christi, Nueces, Oso and Redfish Bays, in addition to parts of the Upper Laguna Madre. The cities of Corpus Christi, Robstown, Aransas Pass, and Port Aransas are entirely included within the boundary. The cities of Robstown, Portland, Ingleside and Rockport were partially included in the plan. Mustang Island and the Texas State owned waters in the Gulf of Mexico were also included in the Corpus Christi Bay HMP. The boundary of the HMP represents the spatial framework at an appropriate scale for the design and implementation of EBM projects.

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Appendix A: Ecoregions.

Summary of Level IV ecoregions included in this study from Griffith and Omernik 2009. Ecoregions have been hierarchically arranged by Level III ecoregion. Some relevant habitat and management issues in the description have been underlined.

34. Western Gulf Coastal Plains

This is an ecoregion with flat topography and potential natural vegetation, mainly grassland. Inland from this region the plains are older, more irregular, and have mostly forest or savanna-type vegetation. A high percentage of the land is cropland, compared to bordering ecological regions. Main crops are rice, grain sorghum, cotton, and soybeans. In recent decades, urban and industrial land uses have expanded greatly together with oil and gas production is common.

- **34b. Southern Subhumid Gulf Coastal Prairies**

  "This ecoregion is drier than Northern Humid Gulf Coastal Prairies ecoregion (34a) to the north, not only receiving less annual precipitation, but also typically experiencing summer drought. Annual precipitation ranges from 26 inches in the southwest to 37 inches in the northeast, with May and September peaks. Soils are hyperthermic compared to thermic in most of Ecoregion 34a. Little bluestem, yellow Indiangrass, and tall dropseed were once dominant grasses. Eragrostoid grasses, including the genera Bouteloua, Buchloe, Eragrostis, Hilaria, and Setaria increase in importance in Ecoregion 34b compared to 34a. Invasive species such as honey mesquite and huisache are a concern. Within the region, there are some differences from the higher Lissie Formation to the lower Beaumont Formation, both of Pleistocene age. The Lissie Formation has lighter colored soils, mostly Alfisols with sandy clay loam surface texture, while darker, clayey Vertisols are more typical of the Beaumont Formation. Almost all of the coastal prairies have been converted to other land uses: cropland, pasture, or urban and industrial."

- **34c. Floodplains and Low Terraces**

  "Covering primarily the Holocene floodplain and low terrace deposits, this ecoregion has a different bottomland forest than the floodplains of Ecoregion 35, especially to the southwest. Bottomland forests of pecan, water oak, southern live oak, and elm, are typical, with some baldcypress on larger streams. The Brazos and Colorado River floodplains are a broad expanse of alluvial sediments, while floodplains to the south are more narrow. Soils include Vertisols, Mollisols, and Entisols. Large portions of

floodplain forest have been removed and land cover is now a mix of forest, cropland, and pasture."

- **34h. The Mid-Coast Barrier Islands and Coastal Marshes**

"This ecoregion is subhumid compared to the humid climate of Ecoregion 34g to the northeast and to the semiarid climate of Ecoregion 34i to the south. Annual precipitation within Ecoregion 34h increases to the northeast, ranging from 34 to 46 inches. The region encompasses primarily Holocene deposits with saline, brackish, and freshwater marshes, barrier islands with minor washover fans, and tidal flat sands and clays. In the inland section from Matagorda Bay to Corpus Christi Bay, Pleistocene barrier island deposits occur. Typical soils on the coastal marshes are Entisols, with a minor extent of Histosols. Mollisols occur on tidal flats and coastal marshes, and Entisols form in sandy barrier islands and dunes. Smooth cordgrass, marshhay cordgrass, and gulf saltgrass dominate in more saline zones. Other native vegetation is mainly grassland composed of seacoast bluestem, sea-oats, common reed, gulfdune paspalum, and soilbind morning-glory. Some areas have clumps of sweetbay, redbay, and dwarf southern live oak trees. In the Coastal Bend area, the barrier islands support extensive foredunes and back-island dune fields. Scarps can characterize bay margins due to beach erosion. Salt marsh and wind-tidal flats are mostly confined to the back side of the barrier islands with fresh or brackish marshes associated with river-mouth delta areas. Marshhay cordgrass becomes less important to the south in this region. Black mangrove begins to appear from Port O'Connor south. This area of the coast has all three commercially important species of shrimp as well as important oyster and blue crab fisheries. Convergence of longshore currents from north and south occurs south of the Corpus Christi area near Padre Island National Seashore. Corpus Christi Bay serves as the ecozone or boundary between two distinct estuarine ecosystems. Copano and Mesquite bays to the north are low to moderate-salinity bays and attract whooping cranes and other birdlife. To the south in 34i, hypersaline Laguna Madre forms a unique ecosystem and supports greater expanses of seagrasses."

- **34i. The Laguna Madre Barrier Islands and Coastal Marshes**

"This ecoregion is distinguished by its hypersaline lagoon system, vast seagrass meadows, wide tidal mud flats, large overwintering redhead duck population, numerous protected species, great fishery productivity, and a narrow barrier island with a number of washover fans. The lower coastal zone in Texas has a more semi-arid climate and has less precipitation (27-29 inches) compared to 34g and 34h. There is extreme variability in annual rainfall, and evapotranspiration is generally two to three times greater than precipitation. As no rivers drain into the Texas Laguna Madre, the lagoon

water can be hypersaline. Combined with the Laguna Madre of Tamaulipas, it is the largest hypersaline system in the world. The shallow depth, clear water, and warm climate of this lagoon are conducive to seagrass production. Nearly 80% of all seagrass beds in Texas are now found in the Laguna Madre. The food web of the Laguna Madre is predominantly based on this submerged aquatic vegetation (seagrass and algae), rather than free-floating phytoplankton. Because of the hypersalinity, oysters are not commercially harvested to a large extent, although the region does contain the only strain of high-salinity adapted oysters in North America. The blue crab harvest is also smaller than the other two coastal regions to the north. Pink shrimp make up an important part of the commercial harvest while white shrimp are more abundant to the north in 34g. The historically highly productive commercial fisheries have now given way to an important sport fishery for species such as red drum, black drum, and spotted sea trout. Marshes are less extensive on the southern coast. A few stands of black mangrove tidal shrub occur in this region."

Source: http://www.eoearth.org/article/Ecoregions_of_Texas_(EPA)

Appendix B: Technical steps followed in the creation of the boundary.

To digitally create the Habitat Management Plan boundary in ArcMap 9.3 (ESRI) a layer was created from the North and South Corpus Christi Bay 8-digit HUCs by selecting the North and South Corpus Christi Bay 8-digit HUCs layer in the GIS. Once the layer has been selected create a new layer from selected features. The previous steps were repeated to create a layer from the Flood Plains and Low Terrace ecoregion and Mid-Coast Barrier Islands and Coastal Marshes ecoregion in the Nueces River Delta.

A polygon was digitized from the southeast corner of the city of Rockport along the shoreline to to Wheeler Ave to Ave A to the North Corpus Christi Bay 8-digit HUC along the Aransas Bay 12-digit HUC. From there the polygon was digitized to the first intersection of the South Corpus Christi Bay 8-digit HUC and the Corpus Christi City Limits near Flour Bluff. That same polygon continued along the Corpus Christi City Limits toward the Laguna Madre and when the Corpus Christi City Limits cross the Laguna Madre the polygon was continued down the shoreline to a prominent road almost horizontal to the Padre Island National Seashore Northwestern corner. The polygon was digitized from there to the Padre Island National Seashore Northwestern corner, followed the Padre Island National Seashore boundary until at the shoreline of the Northeastern boundary of the Padre Island National Seashore. From that coordinate the polygon was digitized to the point of the Texas offshore boundary with the same latitude, followed the Texas offshore boundary until intersecting a line extended out of the city of Rockport, and followed that line making sure to include any area inside the boundary that wasn't covered by the previous polygons.

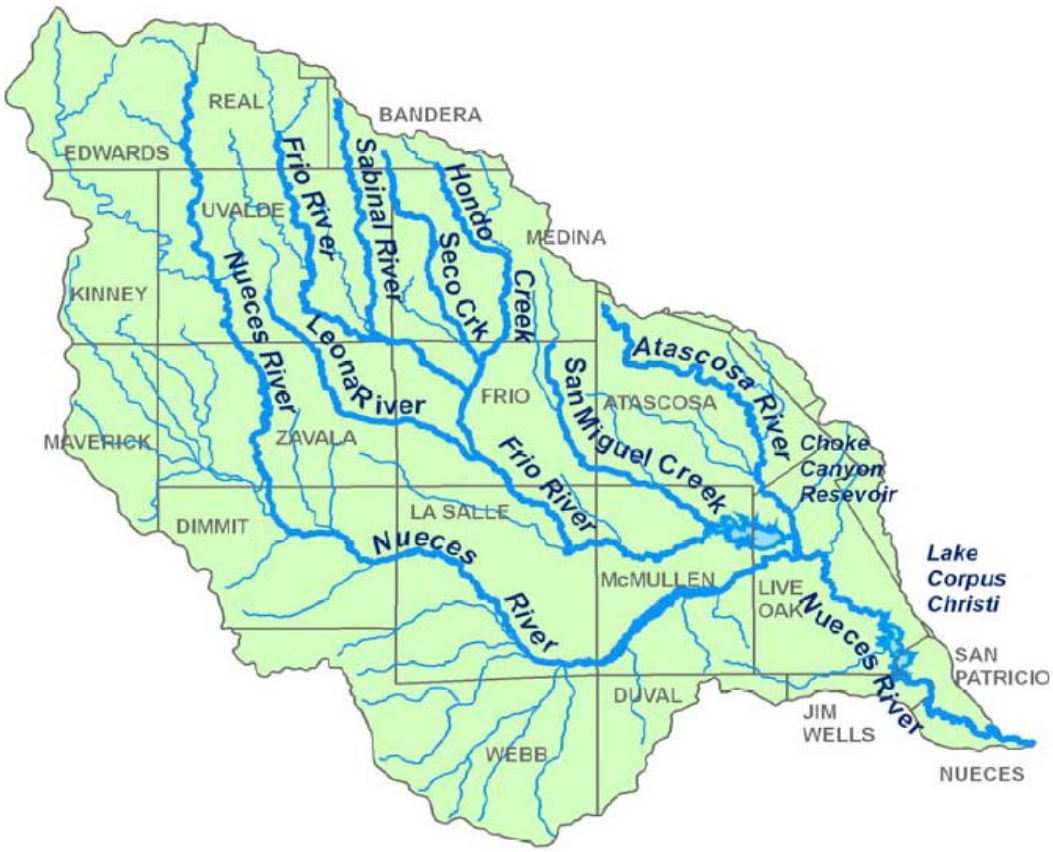
The TCEQ Bays layer was used as the Texas Boundary, but fixed Texas offshore boundary should be used. A polygon was created from the intersection of the South Corpus Christi Bay 8-digit HUC and the Lower Nueces 8-digit HUC to CR 83 to the Flood Plains and Low Terraces ecoregion and included the rest of the area until the South Corpus Christi Bay 8-digit HUC and the ecoregions intersect. Create a polygon from the intersection of the North Corpus Christi Bay 8-digit HUC and IH 37 exit 20b to the intersection of the private road about 45 degrees South of West and the Flood Plains and Low Terraces ecoregion to the intersection of the Flood Plains and Low Terraces ecoregion and the North Corpus Christi Bay 8-digit HUC. Finally, all of the polygons created were merged to compile the final Habitat Management Plan boundary.

Appendix C: River basins.

Summary of Texas river basins with HUCs included in this study. Summaries from the Nueces River Authority have been included (NRA 2007).

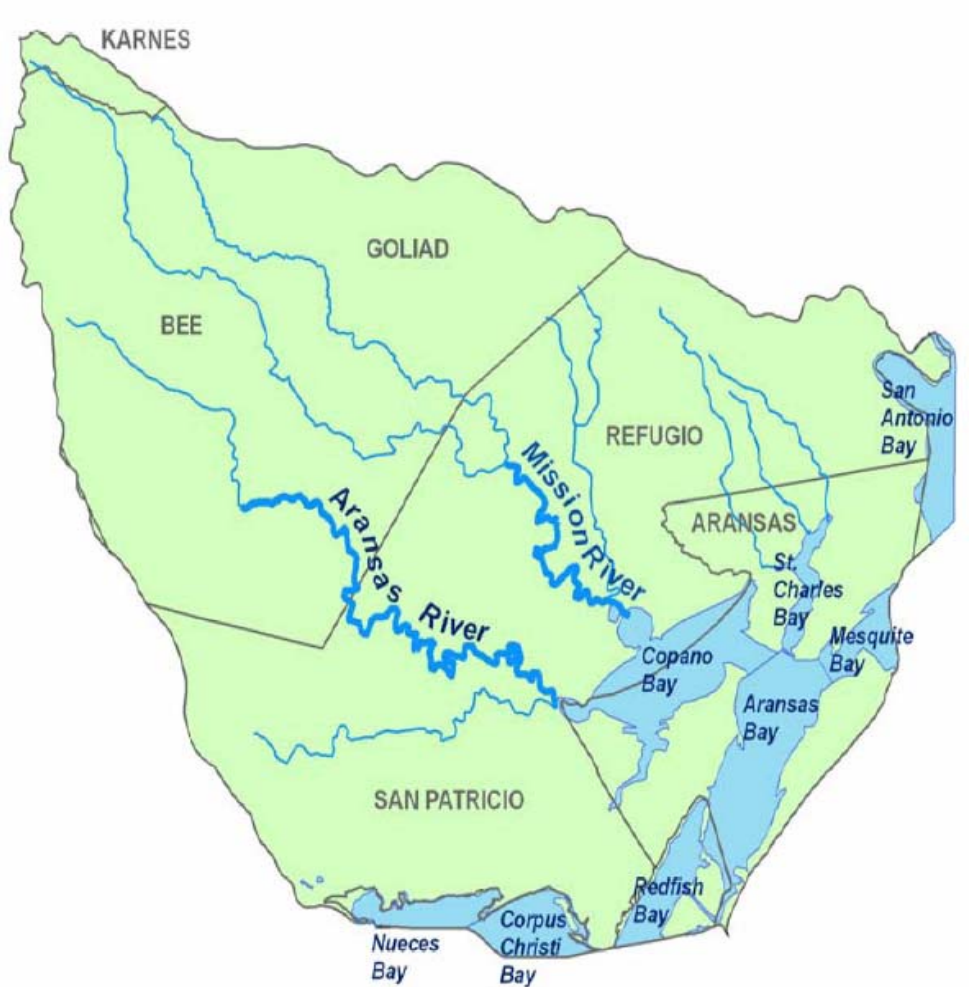
- **Nueces River Basin (TCEQ # 21)**

  "This river basin covers approximately 17,000 square miles, encompassing all or part of 23 counties in South-Central Texas. Other rivers within the basin include the Frio, Leona, Sabinal, and Atascosa Rivers. The basin is bordered by the Colorado, Guadalupe, and San Antonio River Basins to the north, the San Antonio – Nueces Coastal Basin to the southeast, the Nueces – Rio Grande Coastal Basin to the south, and the Rio Grande River basin to the south and southwest. Throughout the basin, the rivers are used for water supply and recreational purposes. The basin is home to numerous state-operated recreational areas including: Choke Canyon State SP on the south side of Choke Canyon Reservoir near Three Rivers, Lake Corpus Christi SP on the southeast bank of Lake Corpus Christi near Mathis, Garner SP north of Concan, Tips State Recreational Area on the Frio River in Three Rivers, Lipantitlan SHP near Sandia, Lost Maples SNA north of Vanderpool, and Hill Country SNA north of Hondo. There are 15 stream and two lake segments in the basin. TMDLs are being or have been conducted on four of the stream segments. Water quality monitoring for FY 2007 includes 34 sites with at least one site on every segment. All of the segments will be discussed in detail in the following sections."



- **The San Antonio – Nueces Coastal Basin (TCEQ # 20)**

  "This basin is approximately 3,100 square miles, covering all or part of 7 counties. The basin is bordered by the San Antonio River Basin to the north, the Lavaca-Guadalupe Coastal Basin to the northeast, bays, estuaries, and the Gulf of Mexico to the east, the Nueces-Rio Grande Coastal Basin to the south, and the Nueces River Basin to the northwest. Being a coastal area, the basin is naturally host to several state-operated recreational areas. These include Goose Island SP near Rockport, Copano Bay State Fishing Pier along State Highway 35 north of Fulton, Fulton Mansion SHP in Fulton, and the Aransas National Wildlife Refuge in Aransas County."



- **The Nueces – Rio Grande Coastal Basin (TCEQ # 22)**

  "This basin covers approximately 10,400 square miles, encompassing all or part of 12 counties in South Texas. The basin is bordered by the Nueces River Basin and the San Antonio – Nueces Coastal Basin to the north, bays, estuaries, and the Gulf of Mexico to the east, and the Rio Grande River Basin to the south and southwest. The inland area of the basin is dominated by large ranches, including the King Ranch. State-operated recreational areas are primarily along the coast and include Mustang Island SP, Port Isabelle Light House SHP in Port Isabel, and the Padre Island National Seashore."

Source: http://www.nueces-ra.org/CP/CRP/pdfs/BHLR_2007.pdf

Appendix D: Spatial layers used in creating the boundary map.

Layer	Attribute(s) used	Year*	Name & source	Retrieved from
County Line	Name	1990	County boundaries – TGLO	http://www.glo.state.tx.us/gisdata/gisdata.html
City Limit	Name	2002	City limits – TGLO	http://www.glo.state.tx.us/gisdata/gisdata.html
Major & Minor Road	Name: Interstate, U.S., State Highways	2004	Transportation – TNRIS	http://www.tnris.state.tx.us/datadownload/download.jsp
Major Stream	Type: Major River	1997	Hydrography – TGLO	http://www.glo.state.tx.us/gisdata/gisdata.html
Open Water	Type: Lake, Bay, River	2000	Hydrography – TGLO	http://www.glo.state.tx.us/gisdata/gisdata.html
Bays	SEG_NAME	2004	Bays - TCEQ	http://www.tceq.state.tx.us/implementation/water/tmdl/atlas.html
Ecoregions	Level4_nam	2004	Ecoregions of Texas - EPA	http://www.tpwd.state.tx.us/landwater/land/maps/gis/data_downloads/shp/ecoreg04.zip
8-digit HUCs	HUC	1994	Hydrological Units of the US - USGS	http://water.usgs.gov/GIS/huc.html
12-digit HUCs	HUC_12	2008	12 Digit Watershed Boundary - USDA	http://datagateway.nrcs.usda.gov/
Padre Island National Seashore	Parkname	2001	National Parks – TGLO	http://www.glo.state.tx.us/gisdata/gisdata.html
Mission-Aransas NERR	Boundary	2006	MANERR Boundary - MANERR	Obtained from Dr. Kiersten Madden – Stewardship Coordinator, MANERR

Notes: * Year refers to year of content was developed if available, or date of publication of dataset.