Statewide Summary for Texas

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Background

Seagrass-dominated communities (stands of coastal, saltwater-tolerant, submerged vascular vegetation) support higher biodiversity and production than any other biotic community along the Texas coast. These systems provide nursery areas for estuarine fish and wildlife; direct food sources for various fauna, including fishes, waterfowl, and sea turtles; major contributions of organic matter to coastal systems; key functions in nutrient cycling processes; and a stabilizing agent for coastal sedimentation and erosion control (McRoy and McMillan, 1977). Because of the high quality and limited extent of seagrass beds in Texas in the early 1990s (about 88,877 ha, or 219,612 acres), any impact to this important habitat raises concerns of resource managers, coastal scientists, and conservationists.

Seagrasses are very unevenly distributed along the Texas coast in the following systems: Laguna Madre, Texas Coastal Bend Region, and Galveston Bay (fig. 1). A suite of factors, such as precipitation and freshwater discharge, contributes to a sharply increasing gradient in seagrass coverage from northeast to southwest. Average annual precipitation decreases from 120 cm (47 inches) at Galveston Bay to little more than half that at the south end of Laguna Madre, while average annual pan evaporation increases from 180 cm to 200 cm (71 to 79 inches) over the same span of coastline. Relatively large river systems discharge into embayments of the upper Texas coast compared to the middle Texas coast, while the only continuous freshwater inflow into Laguna Madre is agricultural drainage and municipal discharges to Arroyo Colorado, an abandoned distributary of the Rio Grande. The Rio Grande itself discharges directly to the Gulf of Mexico 5 km (3 mi) south of Laguna Madre and has recently gained notoriety because of lack of freshwater inflows reaching the gulf. The consequence of greater precipitation and freshwater inflow to the upper Texas coast is that its bays are subject to greater freshening and receive heavier sediment and nutrient loadings than do the estuaries farther to the south, resulting in higher turbidity and smaller areas of near-marine salinities suitable for seagrass growth. The other essential ingredient for seagrass meadow development is shallow, protected water, most commonly provided by the lagoonal extensions away from the main stem of the bays, behind barrier islands and peninsulas. Thus, Laguna Madre is doubly advantageous as an environment supporting seagrass as it features both limited inflow and a higher proportion of protected shallow water than any other Texas bay, and seagrasses abound accordingly.

Over the past 30 yr or so, there has been a growing recognition of factors affecting seagrass productivity, species distribution, and susceptibility to human disturbance. The population of Texas coastal counties increased 75% between 1970 and 2000, from 2.9 million to 5.2 million, and is projected to increase another 45% by 2030, to 7.5 million (Skrabanek and others, 1985; Texas Water Development Board, 2001). The population is distributed very unevenly, with the upper coast accounting for 81% of the total in 2000, mostly around Galveston Bay; however, the counties of the lower coast, encompassing lower Laguna Madre, experienced the fastest proportionate growth between 1970 and 2000, increasing 129%. Increased commercial and recreational use of the bays, increased and altered inputs of nutrients and contaminants from the watershed, and associated burgeoning coastal populations are stressing coastal natural resources like seagrasses.

Table 1 shows trend analysis of seagrass beds indicating severe loss of grassbeds in several areas (Galveston Bay (Pulich and White, 1991) and lower Laguna Madre (Onuf,1994)) and minor loss as well as fluctuations in others (Redfish Bay (Pulich and others, 1997) and San Antonio Bay (Pulich, 1991)). In recent years, seagrasses have received attention as environmental indicators of estuarine water quality and ecosystem health because of their sensitivity to nutrient enrichment and incipient eutrophication (Dennison and others, 1993; Neckles, 1994; National Oceanic and Atmospheric Administration, Office of Ocean Resources Conservation Assessment, 1995). Various studies have documented significant impacts at regional scales from dredging (Pulich and White, 1991; Onuf, 1994), boating traffic (Sargent and others, 1995; Dunton and Schonberg, 2002), nutrient loading (Orth and Moore, 1983; Cambridge and McComb, 1984; Pulich and White, 1991; Short and Burdick, 1996; Tomasko and others, 1996), subsidence processes (Pulich and White, 1991), and altered freshwater inflow cycles (Eleuterius, 1987; Quammen and Onuf, 1993; Pulich and others, 1997).

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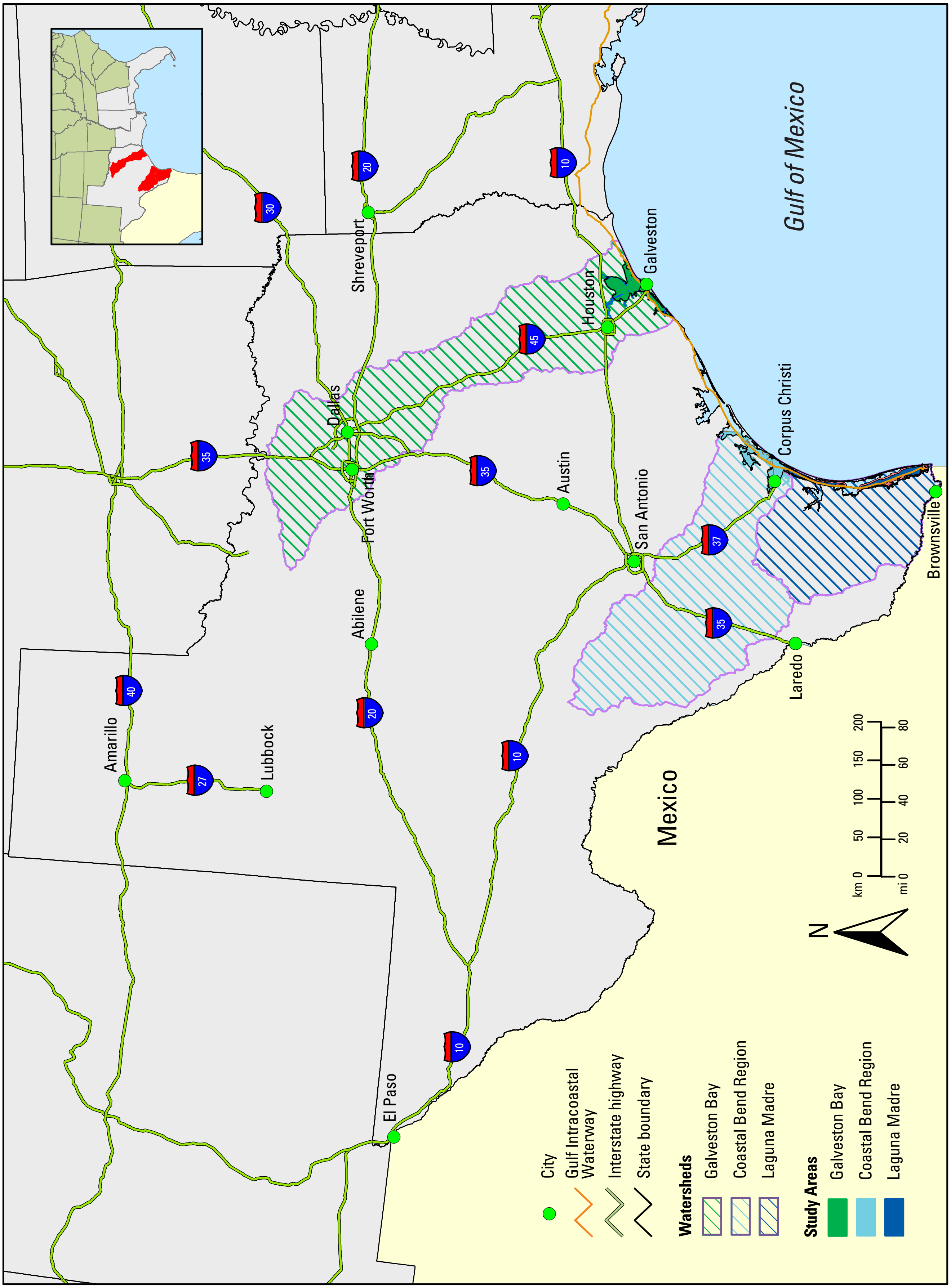

Figure 1. Watershed for the State of Texas.

Statewide Status and Trends Data

In the early 1990s, Galveston and Matagorda Bays on the upper Texas coast had 1,706 ha (4,215 acres) of seagrass meadows total, covering about 1% of bay bottom. The San Antonio, Aransas-Copano, and Corpus Christi Bay systems of the middle Texas coast had an order of magnitude greater of seagrass cover totaling 15,454 ha (38,186 acres) and 12% of bay bottom. Upper and lower Laguna Madre and Baffin Bay of the lower Texas coast supported greater than four times that amount (71,717 ha, or 177,210 acres) of seagrass meadow, covering 50% of bay bottom. In Laguna Madre proper, seagrasses truly define the ecosystem and carpet 65% of the bottom. Status and trends of these three most-investigated Texas coastal areas are presented in vignettes in this report. Summaries of these areas illustrating the range of problems affecting seagrasses coastwide are presented below. Seagrasses in areas not directly covered in the vignettes (i.e., Matagorda/Tres Palacios Bays and San Antonio/Espiritu Santo Bays) appear to be stable or possibly decreasing (i.e., San Antonio Bay system), although mapping data for these systems are rather sparse and rudimentary (Pulich, 1999). Meadows in these latter bay systems totaled 5,855 ha (14,468 acres), approximately 6.6% of the State total (see table 1).

Galveston Bay System

In the Galveston Bay system on the upper Texas coast, practically all seagrass beds disappeared from the main parts of Galveston Bay in the late 1970s. As of 1998, only about 210 ha (518 acres) of mostly shoal grass (*Halodule wrightii*) with some star grass (*Halophila engelmannii*) and 0.6 ha (1.6 acres) of turtle grass (*Thalassia testudinum*) remained in the secondary bay region of Christmas and Drum Bays (Pulich, 2001). Although 1956 is our earliest documented reference point, it is interesting to note that seagrasses were actually more abundant in the Galveston Bay system (even in East Bay and mid-Galveston Bay) during the early part of the 20th century based on anecdotal information. Turtle grass formerly occurred in West Bay, where total seagrass acreage (predominantly shoal grass) decreased from 570 ha (1,408 acres) in 1956, to 200 ha (494 acres) in 1965, to 50 ha (123 acres) in 1975, and finally to 0 in 1982 (Pulich and White, 1991). In the Galveston Bay system, the complete disappearance of shoal grass and turtle grass from the main bay system has been attributed to direct effects of dredge-and-fill operations, adjacent shoreline development, and land subsidence, along with episodic climatic events (i.e., hurricanes, freshwater inflow pulses). Indirect effects are suspected to involve nutrient/pollutant loading and spills or discharges from shoreline developments. With the reintroduction and recolonization of shoal grass and star grass in mid-West Bay near Galveston Island State Park in 1998, it appears that conditions have become favorable once again for restoration of seagrasses to the lower Galveston Bay system (Ikenson, 2001).

Texas Coastal Bend Region

For the Texas Coastal Bend (i.e., Corpus Christi) region, status of seagrass distribution indicates that this area has the third most extensive coverage of seagrasses (12.5%) on the Texas coast, exceeded only by the upper (28.5%) and lower (50.5%) Laguna Madre. Some historical information is available from the University of Texas Bureau of Economic Geology (UT-BEG) reports of Brown and others (1976) and White and others (1983) on submerged grassbed changes between the 1950s and 1979. Complete baywide status and trend analysis performed in 1994 provided a historical perspective for seagrass changes in the Texas Coastal Bend over the last 40 yr and confirms probable causes of trends (Pulich and others, 1997). The Coastal Bend Bays and Estuaries Program (CBBEP) commissioned this study as part of the data synthesis program for developing its Comprehensive Conservation and Management Plan (Coastal Bend Bays and Estuaries Program, 1998).

Results from this study suggested that different coastal processes have contributed to seagrass trends at localized sites. In the entire Corpus Christi/Redfish/Nueces Bays system, total seagrass bed acreage appeared to be fairly stable over a 40-yr timeframe, despite dynamic cycles and localized changes in seagrass bed distribution. Comparisons of 1958, 1975, and 1994 inventories for the Redfish Bay/Harbor Island complex revealed an increase of 819 ha (2,023 acres) between 1958 and 1975, but a decrease of 488 ha (1,205 acres) between 1975 and 1994, for a net increase of 330 ha (815 acres) in total area for this system between 1958 and 1994 (see table 1). Evidence of bed fragmentation or deterioration is reflected in the progressive increase in patchy grassbeds, while continuous beds apparently underwent conversion to patchy morphology; however, large increases in grassbeds (1,838 ha, or 4,540 acres, between 1958 and 1975; 519 ha, or 1,282 acres, between 1975 and 1994) occurred along Mustang Island over the same period.

Landscape analysis revealed “hot spots” of seagrass impact and loss in parts of the estuary. The Redfish Bay and Harbor Island systems may be at a stage where seagrass decline is escalating. Both progressive fragmentation of beds and seagrass loss have been noted. Although not definitive, accumulations of wrack, drift macroalgae, and epiphytes observed in Redfish Bay suggest possible water quality problems. Increase of shoreline development along the north Redfish Bay region may be contributing excess nutrients to this area. In addition, widespread physical damage to shallow water grassbeds was observed in the entire Redfish Bay/Harbor Island complex from motorboat propeller scarring (Dunton and Schonberg, 2002) and navigation channel impacts.

Table 1. Summary of total seagrass changes for Texas bay systems over four decades.

[Seagrass values are in hectares with acres in parentheses]

Bay systems	[1]Late 1950s or mid-1960s	[2]Mid-1970s	[3]1987 or early 1990s	[4]1998
		Galveston Bay system		
Galveston/ Christmas Bays	590[a]	134[a]	113[b]	210[c]
	(1,457)	(331)	(279)	(519)
		Midcoast region		
Matagorda Bay system			1,099[b]	
			(2,716)	
San Antonio Bay system		5,000[d]	4,305[d]	
		(12,350)	(10,638)	
		Coastal Bend region		
Aransas/Copano Bays			2,871[e]	
			(7,094)	
Redfish Bay and Harbor Island	5,380[e]	6,200[e]	5,710[e]	
	(13,293)	(15,320)	(14,109)	
Corpus Christi Bay system			2,568[e]	
			(6,346)	
		Laguna Madre system		
Upper Laguna Madre	12,321[f]	20,255[g]	22,903[h]	22,443[i]
	(30,445)	(50,050)	(56,593)	(55,456)
Lower Laguna Madre	59,153[f]	46,558[g]	46,624[h]	46,174[i]
	(146,166)	(115,044)	(115,207)	(114,095)
Baffin Bay			2,200[j]	
			(5,436)	

[1] Data for Galveston/Christmas Bays, Redfish Bay, and Harbor Island based on 1956/58 Tobin photography. Data for upper and lower Laguna Madre based on field surveys during mid-1960s.

[2] Data for Galveston/Christmas and Redfish Bay/Harbor Island based on 1975 (National Aeronautics and Space Administration Johnson Space Center (NASA-JSC) photography; San Antonio Bay based on 1974 NASA-JSC photography. Data for upper and lower Laguna Madre based on 1974–75 field surveys.

[3] Data for Christmas, Matagorda, and San Antonio Bay systems from 1987 NASA-Ames Research Center photography. Data for Aransas/Copano, Redfish, and Corpus Christi Bay systems based on 1994 TPWD photography. Data for upper and lower Laguna Madre based on 1988 field surveys. Data for Baffin Bay based on 1992 U.S. Fish and Wildlife Service National Wetlands Inventory photography.

[4] Data for Christmas Bay from 1998 Galveston Bay National Estuary Program photography. Data for upper and lower Laguna Madre from 1998 field surveys.

[a] From Pulich and White (1991).

[b] From Adair and others (1994).

[c] From Pulich (2001).

[d] From Pulich (1991).

[e] From Pulich and others (1997).

[f] Areas computed for this review from McMahan (1965–67). See Laguna Madre vignette.

[g] Areas computed for this review from Merkord (1978). See Laguna Madre vignette.

[h] Areas computed for this review from Quammen and Onuf (1993). See Laguna Madre vignette.

[i] Areas computed for this review. See Laguna Madre vignette.

[j] Areas computed for this review by Texas Parks and Wildlife Department, Coastal Studies Program, Austin, Tex. (unpub. data).

Laguna Madre System

Along the lower coast in the Laguna Madre, two largely independent dynamics have led to fundamental change in the seagrass community over the last 30 yr. First, hydrological alteration brought about by construction of the Gulf Intracoastal Waterway (GIWW) has resulted in moderation of the hypersaline conditions that set the Laguna Madre ecosystem apart from all others along the U.S. coastline. Salinity levels dropped from highs exceeding 100 ppt before construction of the GIWW to the low 50s ppt (after GIWW construction) in the upper Laguna Madre and from the mid-60s ppt to 50 ppt or less in the lower Laguna Madre. A successional process has ensued in lower Laguna Madre, with the euhaline (intolerant of salinity extremes) species manatee grass (*Syringodium filiforme*) increasing from 6,100 ha (15,073 acres) to 12,900 ha (31,875 acres) and turtle grass expanding in coverage from 440 ha (1,080 acres) to 11,100 ha (27,428 acres) between the mid-1960s and 1998 at the expense of shoal grass, a colonizing species that is also more tolerant of high salinities. In upper Laguna Madre, where hypersalinity had been even more extreme, cover of shoal grass increased from 12,300 ha (30,393 acres) to 22,900 ha (56,585 acres) for the first 20 yr of record; however, in the last 10 yr, manatee grass has begun to displace shoal grass. While manatee grass was not dominant anywhere in the upper laguna before 1988, it had become dominant over 1,450 ha (3,582 acres) by 1998.

Factors affecting the transmission of light to the bottom are the second set of forcing functions driving change to the Laguna Madre ecosystem. In lower Laguna Madre, increased light attenuation attributable to maintenance dredging practices for the GIWW is implicated in the loss of more than 10,000 ha (25,000 acres) of shoal grass meadow in deep areas. In upper Laguna Madre, an algal bloom of unprecedented persistence, the Texas brown tide, also reduced underwater light to the extent that 1,200 ha (2,965 acres) of seagrasses were lost, mostly shoal grass. One disturbing aspect of this perturbation is that recovery has not occurred in the 5 yr since the continuous bloom conditions.

The net result of these changes between the first whole system distributional survey in the mid-1960s and the most recent survey in 1998 (table 1) is an overall reduction in seagrass cover of 4%, a decrease of 36% in cover of shoal grass, and very large proportionate increases in the other species. The continuing loss of shoal grass is a special concern because it is almost the sole food of wintering redhead ducks (*Aythya americana*), and the Laguna Madre system of Texas and Tamaulipas serves as the wintering ground for more than 75% of the world population of redheads.

Causes of Change

Natural Process Changes

Natural processes include mostly climatic effects from drought, hurricanes, or freshwater inflows. Climatic events such as droughts, hurricanes, and periods of higher than normal rainfall can influence bay water levels and turbidities, which in turn affect the distribution of seagrass. The most extreme drought in recorded history, which occurred in Texas in the 1950s and climaxed in 1956 (Riggio and others, 1987), produced lower than average sea levels along the entire Texas coast. Following the 1950s drought was a period of abnormally high rainfall that was punctuated by aftermath rains associated with Hurricanes Beulah (1967) and Fern (1971). The period from 1968 to 1975 was much wetter than normal in south-central Texas. Bay and gulf water levels rose at an accelerated rate coastwide from the 1960s to 1975, as exemplified by tide gages at Galveston, Rockport, and Port Isabel, Tex., as well as in Louisiana, Mississippi, Alabama, and Florida (Swanson and Thurlow, 1973; Ramsey and Penland, 1989)

Human-induced Changes

Human-induced effects include (1) nutrient loading causing water-quality degradation and light attenuation from phytoplankton blooms, epiphyte growth, or macroalgae accumulation; (2) suspended sediments from dredging or boat traffic; and (3) direct physical disturbances, including dredged material deposition, removal by channelization and waterfront construction, boat propeller scarring, and effects of ship traffic. Based on recent events in the CBBEP study area and site-specific studies by Pulich (1985), Quammen and Onuf (1993), Dunton (1994, 1996), Onuf (1994), Pulich and others (1997), and Dunton and Schonberg (2002), seagrass distributions and trends are suspected of changing under the influence of natural estuarine conditions (e.g., freshwater inflow alterations and phytoplankton blooms) or contemporary human disturbances including dredging, channelization, and propeller scarring.

Some of the relative rise in sea level along the Texas gulf coast (including at Rockport) is attributed to subsidence associated with the pumping of ground water, or oil and gas, as opposed to eustatic sea-level rise (Ramsey and Penland, 1989). Average annual water levels recorded at the Rockport gage rose approximately 20 cm (8 inches) between 1964 and 1975 (Swanson and Thurlow, 1973). As the land surface subsided, seagrasses became more deeply submerged, leading to loss of plants in deeper waters. In the Galveston Bay system, the complete disappearance of shoal grass and turtle grass from the main bay system has been attributed to a combination of direct effects of dredge-and-fill operations, adjacent shoreline development, and land subsidence, along with episodic climatic events (i.e., hurricanes, freshwater inflow pulses) (Pulich and White, 1991). Indirect effects are suspected to involve nutrient/pollutant loading and spills or discharges from shoreline developments. The increases in seagrass cover occurring primarily on the bay side of Mustang Island in the Texas Coastal Bend region are probably a response to continuous submergence of wind-tidal flats because of subsidence and eustatic sea-level rise (Pulich and others, 1997).

Gaps in Data Coverage

Bay Systems Lacking Inventories

The middle Texas coast bay systems—including East Matagorda Bay, Matagorda Bay/Tres Palacios Bay, and San Antonio Bay/Espiritu Santo Bay—require more concerted, regular surveys and mapping coverage to ascertain seagrass dynamics. Only sketchy, rudimentary mapping data are currently available for these systems (Pulich, 1991; Adair and others, 1994).

Data Limitations and Future Needs

Some of the seagrass coverage values presented in this report (table 1) are not consistent with those of earlier sources, such as Pulich (1999). The compilation of seagrass coverage estimates presented in table 1 is based on reanalysis and digitization of maps from a variety of sources as cited in the table. In the process of preparing the old maps for digitization, some errors were found and corrected. Therefore, the coverage values can differ from those presented in earlier references and represent improvements on the earlier calculations.

Mapping data provide a reference baseline for comparing inventory results. It is critical to continue status and trends monitoring at the 1:24,000 scale to detect large changes in seagrass distributions caused by natural or human-induced environmental stresses. Mapping at 2–3 yr intervals represents the best strategy for routine monitoring of such seagrass landscape dynamics. Fragmentation patterns within grassbeds may be correlated with incipient stages of stress response (Robbins and Bell, 1994). Landscape patterns may indicate problems from the observed changes in bed morphology, before complete loss of seagrass occurs.

Poor availability of good color photography and reliable field data limits historical seagrass trend analysis in Texas to only about the last 25–30 yr. This perspective is important since long-term cycles may require more time to detect; however, because seagrass plants in Texas bays are mostly perennial species (star grass and wigeon grass being the exceptions), the population dynamics of established grassbeds are very stable compared to annual plants which must reestablish from seeds every year. Consequently, seagrass distributions can be reliably detected from clear, large-scale historical photography. Using such techniques, seagrass trends have been reasonably documented in the Galveston Bay, Texas Coastal Bend, and the Laguna Madre systems since the 1970s.

Results also indicate that resource managers must examine seagrass responses cautiously and on a case-by-case basis to identify environmental stressors causing changes. Net quantitative change in area for an entire bay seldom gives an accurate clue as to causes of seagrass changes. Rather, spatial location of changes as determined by geographic information system (GIS) analysis is necessary to infer relationships to environmental factors (Robbins, 1997). Generic stressors (e.g., water quality degradation, water level changes, and climatic conditions) may be suspected when effects are produced over wide bay areas; however, stressors such as mechanical or physical impacts often produce localized, site-specific effects. Monitoring programs for seagrasses must take into account the localized mechanisms by which stress responses are propagated.

Species composition of grassbeds is another key parameter for monitoring incipient stress effects. Replacement of a colonizing species, such as shoal grass, with a climax species, such as turtle grass, may represent normal succession in a grassbed over time. The opposite direction of succession, from turtle grass to shoal grass, is more likely to indicate some disturbance or stress to the grassbed. As a stage in the grassbed fragmentation process, this response could be expected to occur prior to complete loss of seagrass. Monitoring of such species succession patterns requires more detailed ground surveys coupled with remote sensing analysis.

In order to increase the resolution of site-specific data, remote sensing data should be collected at a 1:10,000 or larger scale. High-resolution photography should be interpreted by using groundtruthing data based on differential Global Positioning System parameter or techniques, which have a precision of +/- 1 m resolution. While this resolution of monitoring cannot be supported coastwide, target sites would be amenable to assessment at these finer scales of resolution. Landscape dynamic studies would provide a measure of variability over very small ground distances, yielding information on patch coalescence and spreading rates, or denudation rates of fragmenting grassbeds.

Overview of Seagrass Restoration Efforts

Seagrass Conservation Plan and Resource Management Needs

Texas Parks and Wildlife Department (TPWD), U.S. Fish and Wildlife Service (USFWS), and the U.S. Geological Survey (USGS) National Wetlands Research Center (NWRC) have conducted and coordinated monitoring and ecological assessment of seagrass along the entire Texas coast. Over the past 20 yr, special studies for Galveston Bay National Estuary Program (Pulich and White, 1991), Coastal Waterfowl/ Fisheries Habitat Assessment (Quammen and Onuf, 1993; Adair and others, 1994), Coastal Natural Resources Inventories, and Coastal Bend National Estuary Program (Pulich and others, 1997; Dunton and Schonberg, 2002) have documented status and trends of most Texas seagrass beds and their sensitivity to disturbance from environmental factors. In recent years, results compiled from these studies on seagrass distribution trends, environmental factors (such as sea-level changes, water-quality conditions, and adjacent watershed land use), and physical disturbance features (e.g., dredged-material disposal, navigation channels, and motorboat propeller scarring) have led to serious concerns for Texas seagrass conservation and resource management.

The TPWD has been spearheading a statewide program that aims to coordinate research, monitoring, and management activities focused specifically on Texas seagrass habitat. Other collaborators in this process are the Texas General Land Office (TGLO), Texas Commission on Environmental Quality (TCEQ), and the two State Estuary Programs, one in the Galveston Bay area and the other in the Corpus Christi Bay area. During fall 1996, TPWD organized and cosponsored the “Texas Seagrass Symposium” to prepare for developing the comprehensive *Seagrass Conservation Plan for Texas* (SCPT) dealing with strategies and recommendations for protecting coastal seagrass habitat. Some 100 persons attended the planning symposium to identify issues relevant to producing a plan for Texas. These efforts culminated in the writing and publication of the SCPT in early 1999 (Pulich, 1999).

The plan represents an effort to coordinate and compile information on all the seagrass conservation, management, and research programs in Texas. Seagrass issues were categorized into three topical areas for planning purposes: research, management, and public stewardship. The SCPT reviewed the status of information on these issues and identified gaps in critical programs that should be addressed to slow or reverse losses of seagrass. After a comprehensive list of needs was developed, high-priority recommendations were made for the establishment of an organized, coastwide seagrass monitoring program, an integrated and easily accessible seagrass database, and stakeholder-driven stewardship and restoration projects. The SCPT also recommended development of more effective restoration techniques and applied management programs. Since the TPWD often collaborates on seagrass management problems with State groups (including the TCEQ and TGLO), with Federal resource agencies (including National Marine Fisheries Service (NMFS), U.S. Army Corps of Engineers (USACE), USGS, and USFWS), and with State universities, these groups were considered key to coordinating research and management programs.

Overview of Monitoring, Restoration, and Enhancement Opportunities

Monitoring for Seagrass Ecosystem Health

The SCPT (Pulich, 1999) recommended that a coastwide Texas seagrass monitoring plan be a high priority. In August 2000, the “Texas Seagrass Monitoring Workshop” was held in Corpus Christi to organize a working group of resource managers and scientists who would contribute to the design and development of such a monitoring plan. Approximately 75 people participated in discussions, which resulted in proposals for monitoring goals and objectives, seagrass health indicators, seagrass ecosystem model and sampling design, and a monitoring data management system. The consensus from this meeting was that, in order to detect meaningful changes in seagrass ecosystem health, there was a dual need for regular, organized field surveys and high-resolution landscape monitoring. The group also decided that this monitoring program should be based on a rigorous statistical design that allows assessment of baywide seagrass conditions from stratified random subsamples. From aerial photography and spatial analysis techniques, results from subsamples could be scaled up and extrapolated to larger areas.

In early 2001, the “Seagrass Monitoring Steering Committee” was formed—consisting of TPWD, TCEQ, TGLO, USGS, the University of Texas Marine Science Institute, NMFS, CBBEP, and the U.S. Environmental Protection Agency members—to design a formal seagrass monitoring program. The primary objectives of such a monitoring program are (1) to determine seagrass status and trends coastwide, at suitable scales; (2) to survey environmental and plant criteria and conditions indicative of ecological health of seagrass beds; (3) to compile and store seagrass datasets in an official database allowing users convenient access to seagrass distribution maps and associated, environmental indicator data; and (4) to subsequently apply the seagrass indicator monitoring data to specific management and environmental assessment programs. The first phase will include selection of a seagrass ecosystem and landscape dynamics model on which to base a quantitative sampling design, identification and testing of proposed seagrass health indicators, and establishment of the certified, standardized database for storage and analysis of seagrass monitoring data. A proposed Web-based data distribution network will link standardized, quality-assured spatial datasets at various agencies and scientific institutes. The monitoring program guidance, field and landscape sampling designs, database management system, and other recommendations of the Seagrass Monitoring Steering Committee were recently released for review in a strategic planning document (Pulich and others, 2003).

For management objectives, a habitat landscape analysis perspective was considered extremely important in helping to assess causes of seagrass impacts. This type of analysis requires an effective data management model for integrating plant and environmental indicator data with habitat landscape data. The spatial data generated from monitoring critical areas by using remote sensing and site-specific sampling potentially lend themselves to GIS data models for habitat management applications (Robbins, 1997; Lathrop and others, 2001). Modeling of appropriate spatial data will allow managers to hypothesize about causes from spatial patterns or correlations; these hypotheses can in turn be tested by field-monitoring measurements that are more labor intensive.

The combination of GIS and landscape analysis has power in its ability to show where changes are occurring and the areal extent of changes. This technique has revealed “hot spots” of seagrass disturbance and concentrated loss in parts of the Corpus Christi Bay system (Pulich and others, 1997) and the Laguna Madre (Onuf and others, 2003). Evidence of impact to grassbeds in the entire Redfish Bay/Harbor Island complex from mechanical damage (for example, motorboat propeller scarring), was documented by Dunton and Schonberg (2002). Other studies have shown indications of species succession in progress (Onuf and others, 2003).

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