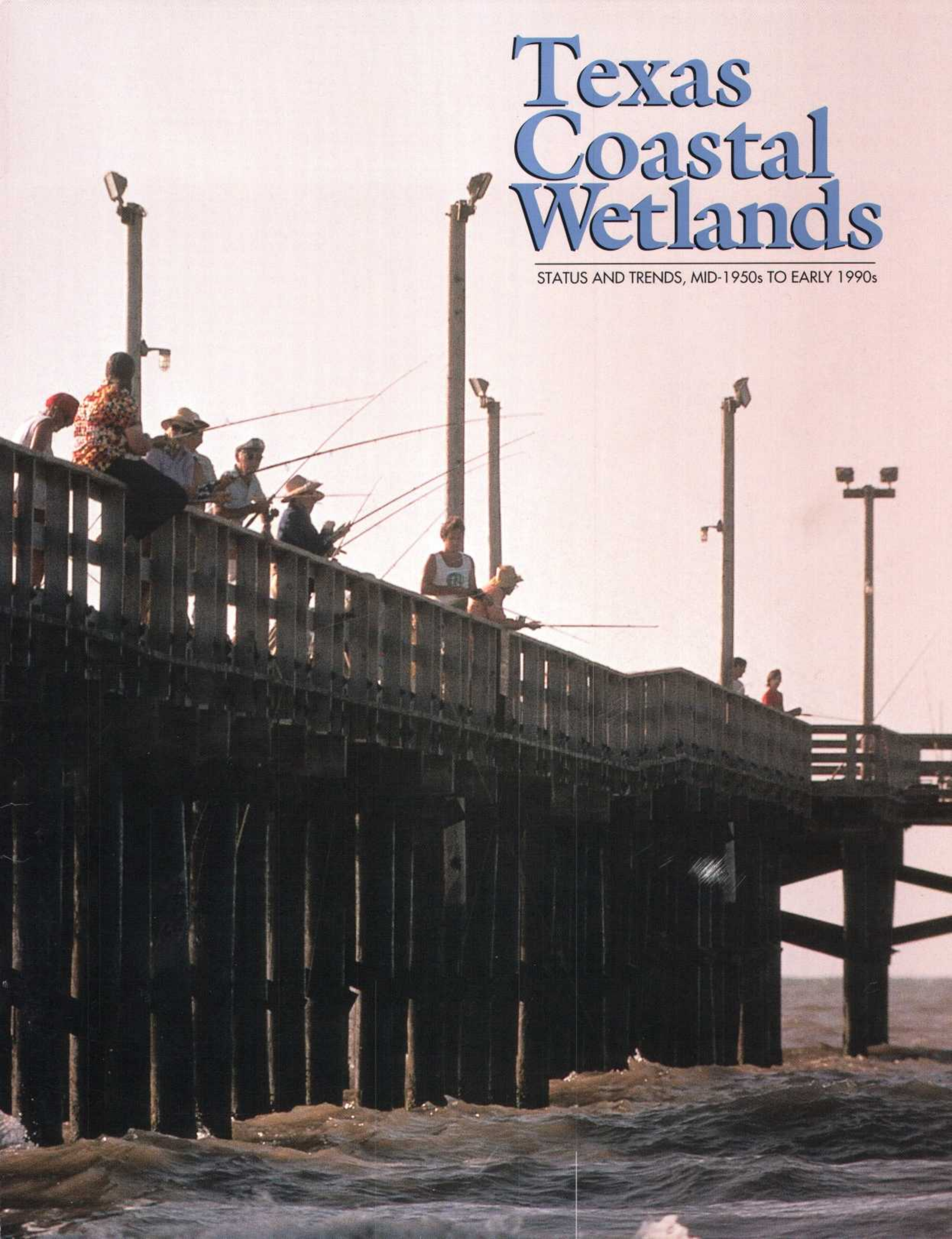
Texas Coastal Wetlands

STATUS AND TRENDS, MID-1950s TO EARLY 1990s



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STATUS AND TRENDS, MID-1950s TO EARLY 1990s

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United States Department of the Interior
Fish and Wildlife Service
Southwestern Region
Albuquerque, New Mexico

Shrimp Harvest
ESTUARINE SYSTEM
TEXAS PARKS & WILDLIFE DEPARTMENT

Cultivated Rice
PALUSTRINE FARMED
TEXAS PARKS & WILDLIFE DEPARTMENT

Cover photo:
Recreational Fishing
ESTUARINE SUBTIDAL
TEXAS PARKS & WILDLIFE DEPARTMENT

English/Metric Conversions

1 acre = 0.4 hectare
1 square mile = 259.1 hectares
1 mile = 1.61 kilometers
1 foot = 0.3 meter

Contents

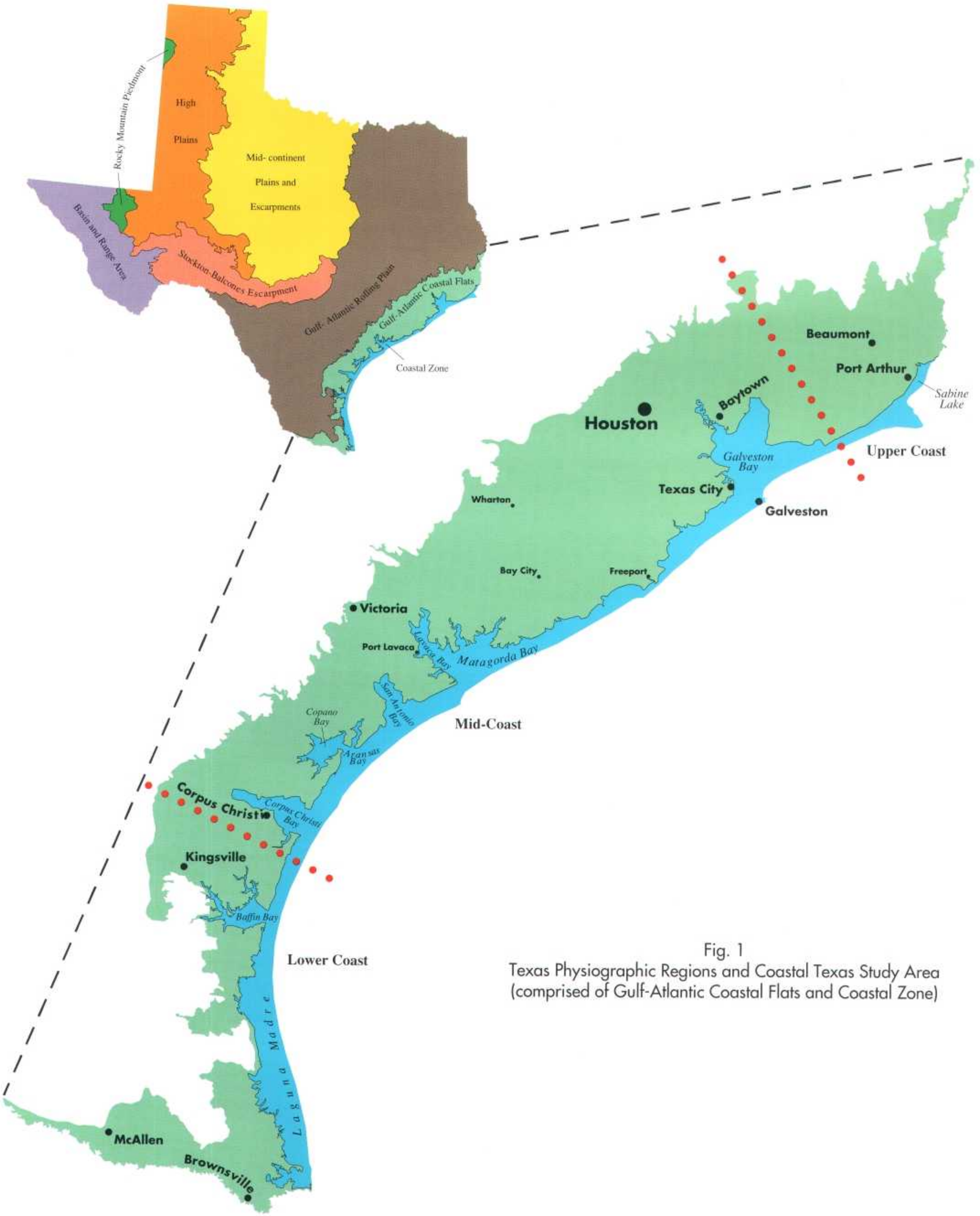


Fig. 1
Texas Physiographic Regions and Coastal Texas Study Area
(comprised of Gulf-Atlantic Coastal Flats and Coastal Zone)

Executive Summary

The U.S. Fish and Wildlife Service prepared this report on the status and trends of coastal Texas wetlands in accordance with the Coastal Wetlands Planning, Protection, and Restoration Act of 1990 (Title III of Public Law 101-646). This report is a product of the Coastal Texas Project completed by the Fish and Wildlife Service in cooperation with the Texas Parks and Wildlife Department and the Texas General Land Office.

This report analyzes data collected for the 12.8 million-acre coastal Texas study area (Fig. 1). The design of the study consisted of a stratified random sample of 754 four-square-mile plots. Aerial photographs from the mid-1950s and early 1990s (mean dates 1955 and 1992) for each of the plots were analyzed to detect changes in wetlands, deepwater habitats, and uplands acreage. Changes were determined to be either natural or human-induced. The total wetlands acreage estimate for 1992 was subtracted from the 1955 total estimate and divided by the 37-year study period to give an estimate for average annual net wetlands loss.

An estimated 4.1 million acres of wetlands existed on the Texas coast in the mid-1950s. By the early 1990s, wetlands had decreased to less than 3.9 million acres including 3.3 million acres of freshwater wetlands and 567,000 acres of saltwater wetlands. About 1.7 million acres (52 percent) of the 3.3 million acres of freshwater wetlands were classified as farmed wetlands. The total net loss of wetlands for the region was approximately 210,600 acres, making the average annual net loss of wetlands about 5,700 acres. The greatest losses were of freshwater emergent and forested wetlands.

Estuarine (saltwater) wetlands decreased by about 9.5 percent, with an estimated net loss of 59,600 acres, making the average annual net loss approximately 1,600 acres. Loss of estuarine emergent wetlands occurred primarily between Freeport in Brazoria County and Port Arthur in Jefferson County. The major cause was faulting and land subsidence, due to withdrawal of underground water and oil and gas, which has resulted in the submergence (drowning) of marshes.

Palustrine (freshwater) wetlands showed a net decline of 151,000 acres (4.3 percent). However, this average figure includes a 96,500-acre net increase in palustrine farmed wetlands.

Palustrine emergent wetlands (fresh marsh, wet prairie, etc.) declined by about 29 percent, with an estimated net loss of 235,100 acres, making the average annual net loss about 6,400 acres. This was the largest acreage change for any wetland category studied. Most of the palustrine emergent loss was to upland agriculture and other upland land uses. Also, there was conversion of palustrine emergents to the palustrine farmed and palustrine scrub-shrub wetland types.

Over 96,000 acres (a 10.9 percent decrease) of forested wetlands (swamps, hardwood bottomlands, etc.) were lost or converted to other wetland types. Most of the losses were to upland agriculture and other upland land uses, with conversions to the palustrine scrub-shrub and palustrine farmed wetland types and to lacustrine deepwater (reservoirs).

Palustrine scrub-shrub wetlands showed a net increase of over 63,000 acres (a 58.7 percent increase). This increase was primarily at the expense of palustrine emergent and palustrine forested wetland types. Invasion of fresh marsh and cut-over forested wetlands by the introduced Chinese Tallow-tree may be responsible for much of the expansion of scrub-shrub wetlands.

Freshwater ponds showed a net gain of 21,700 acres (a 137 percent increase). About half of the increase came from conversion of uplands to farm ponds, stock tanks, and other small impoundments. The other half came from conversion of palustrine emergent, palustrine farmed, and palustrine forested wetlands to ponds. The proliferation of man-made ponds obscured the loss of natural prairie potholes.

The largest land-use category in the region was agriculture (4.7 million acres). Agricultural acreage declined by 618,000 acres even though 98,000 acres of palustrine wetlands were lost to agriculture. Urban land use increased by 529,000 acres, mostly at the expense of agriculture and other upland land uses. There was also loss of palustrine farmed and other palustrine wetlands to urban and rural development. Approximately 245,000 acres of the upland "other" category, much of it originally native hardwood and pine-hardwood forest, were converted to forested plantation (silviculture).

Introduction

The Texas Gulf Coast is one of the most ecologically complex and biologically diverse regions of the state. The region is comprised of three distinct segments — upper, mid, and lower — defined by geomorphologic, climatological, hydrologic, and ecological characteristics. The upper coast, from Sabine Lake west to the estuarine drainage area of Galveston Bay, is characterized by extensive western Louisiana-type marshes grading from salt to brackish to intermediate to fresh, with coastal prairie and humid flatwoods inland.

The mid- and lower coasts are both characterized by barrier islands and peninsulas and extensive bays or lagoons. The mid-coast, Galveston Bay to Corpus Christi Bay, consists of large bay and estuary systems supplied with freshwater inflow by rivers, with extensive coastal prairies inland. The lower coast consists of the upper and lower Laguna Madre, which are frequently hypersaline due to lack of freshwater inflow (no rivers and low rainfall) and restricted Gulf inlets. The lower coast has extensive wind-tidal flats adjacent to the Laguna Madre backed by semiarid rangeland inland and intensive irrigated agriculture in the lower Rio Grande Valley.

More than one-third of the state's population and about 70 percent of its industrial base, commerce, and jobs are located within 100 miles of the coastline (Texas General Land Office 1995). About 4.5 million people live in the 18 counties adjacent to the Gulf. More than half of the nation's chemical and petroleum production is located on the Texas coast, and the state leads the nation in marine commerce with 10 deep-draft ports and over 420 miles of the Gulf Intracoastal Waterway.

Every coastal county supports intensive agriculture or grazing. Texas coastal waters support major commercial and recreational fishing industries. Numerous recreational opportunities are afforded by the beaches, bays, marshes, prairies, and other fish and wildlife habitats of the Texas coast. These resources have contributed to making tourism the third largest industry in Texas, after oil and gas production and agriculture (Texas Parks and Wildlife Dept. and Texas Dept. of Commerce, no date).

The total economic impact on the Texas coastal region of wetland-based recreation and wetland-dependent commercial fisheries is substantial. In 1993, the dock-side value of shellfish (brown, pink, and white shrimp; blue crab; and eastern oyster) and finfish (black drum, flounder, sheepshead, and snapper) landed commercially from the Galveston Bay system was about $11.6 million (Robinson et al. 1994). The total economic impact at the wholesale level from Galveston Bay alone was estimated at $35 million. The total economic impact of commercial fishing at the wholesale level coastwide is over $400 million annually, providing jobs for about 30,000 coastal residents.

There were about 850,000 saltwater sport fishers in Texas during 1991 (Texas Parks & Wildlife Dept. 1993). Direct expenditures by these anglers totaled about $380 million and supported about 11,000 jobs in Texas (U.S. Fish & Wildlife Service 1993). The total annual economic value of recreational fishing to users of Galveston Bay living in the Houston-Galveston area was estimated to be $75-150 million, with the total annual value of the bay for all recreational uses (7 million user-days per year) in the range of $115-200 million (Whittington et al. 1994).

In 1990-1994, 30-40,000 coastal waterfowl hunters pursued waterfowl populations that averaged about 1 million geese and 1.5 million ducks (Texas Parks & Wildlife Dept. unpubl. data). In 1991, the economic impact of waterfowl hunting and nonconsumptive waterfowl use in Texas was about $96 million and $240 million, respectively (Teisl and Southwick 1995). A substantial portion of this activity took place on the coast. In the spring of 1992, about 6,000 birdwatchers, an important segment of the rapidly expanding nature tourism industry, poured into tiny High Island in eastern Galveston County (Eubanks et al. 1993). The total economic impact was estimated to be $4-6 million over a 2-month period.

Although these estimates of wetlands-related economic impacts were generated by mainstream economists, most classic market economists have not yet fully recognized the concept that ecological and economic concerns are not only related but inseparable. From an economic point of view, market forces are grossly underestimating the true economic value of existing coastal wetlands to society (Whittington et al. 1994). Table 1 lists some known wetlands goods and services, many of which provide undetermined monetary values. These ecological and cultural values are important to the people of Texas and our Nation.

To conserve and manage Texas coastal wetlands resources, it is necessary to understand the dynamics of the processes, both natural and human-induced, that are affecting them. This report presents data that estimate the extent (status) of Texas coastal wetlands in the early 1990s and the changes in areal extent (trends) that have taken place since the mid-1950s. These data may indicate the impact of existing policies and programs intended to conserve the state's valuable coastal wetlands resources, and identify which wetland habitats are experiencing change.

Table 1. Some valuable goods and services produced by coastal Texas wetlands; environmental quality functions and socioeconomic values (after Tiner 1984 and Hefner et al. 1994).

ENVIRONMENTAL QUALITY FUNCTIONS	SOCIOECONOMIC VALUES
Water Quality Maintenance	**Products**
— Sediment Trapping & Stabilization	— Finfish & Shellfish
— Chemical & Toxicant Trapping	— Forage & Hay
— Nutrient Absorption & Cycling	— Timber
Hydrologic Functions	— Food Products
— Groundwater Recharge/Discharge	— Fur and Other Wildlife Products
— Saltwater Intrusion Prevention	— Aquaculture/Mariculture
— Flow Stabilization	**Recreation & Nature Tourism**
Primary Production/Energy Transfer	— Fishing & Crabbing
Ecosystem Stabilization	— Hunting & Trapping
Biological Diversity	— Nonconsumptive Fish & Wildlife Uses
Biogeochemical Cycling	— Boating & Swimming
Fish & Wildlife Habitat	— Camping & Picnicking
— Invertebrates	— Hiking, Trail Walking/Jogging
— Fish & Shellfish	— Visual Aesthetics & Photography
— Reptiles & Amphibians	**Water Supply**
— Waterfowl, Wading Birds, Shorebirds & Other Birds	**Wastewater Treatment**
— Furbearers & Other Mammals	**Flood Control**
— Endangered & Threatened Species	**Erosion Control**
	Storm Buffering
	Education & Scientific Research
	Cultural/Archaeological

Survey Methods

Statistical sampling procedures for this study were developed and first used by Frayer et al. (1983). Other national (Dahl and Johnson 1991) and regional (Frayer et al. 1989, Frayer and Hefner 1991, Hefner et al. 1994) wetlands status and trends studies have also used the survey procedures.

The coastal Texas status and trends study consisted of 754 plots. Each plot was 4 square miles (2,560 acres). Plots were randomly distributed within the Gulf-Atlantic Coastal Flats subdivision (10,400,556 acres; 613 plots) of Hammond (1970) plus a Coastal Zone stratum (2,417,589 acres; 141 plots) added to incorporate estuarine and marine wetlands that extend beyond the continuous land mass (Fig 2). The Coastal Zone, as described here, is not synonymous with any state or federal jurisdictional coastal zone definitions. The total number of sample plots used was derived to provide a statistically robust estimate of coastal wetlands within this study area. The study area encompassed approximately 20,028 square miles (12,818,145 acres).

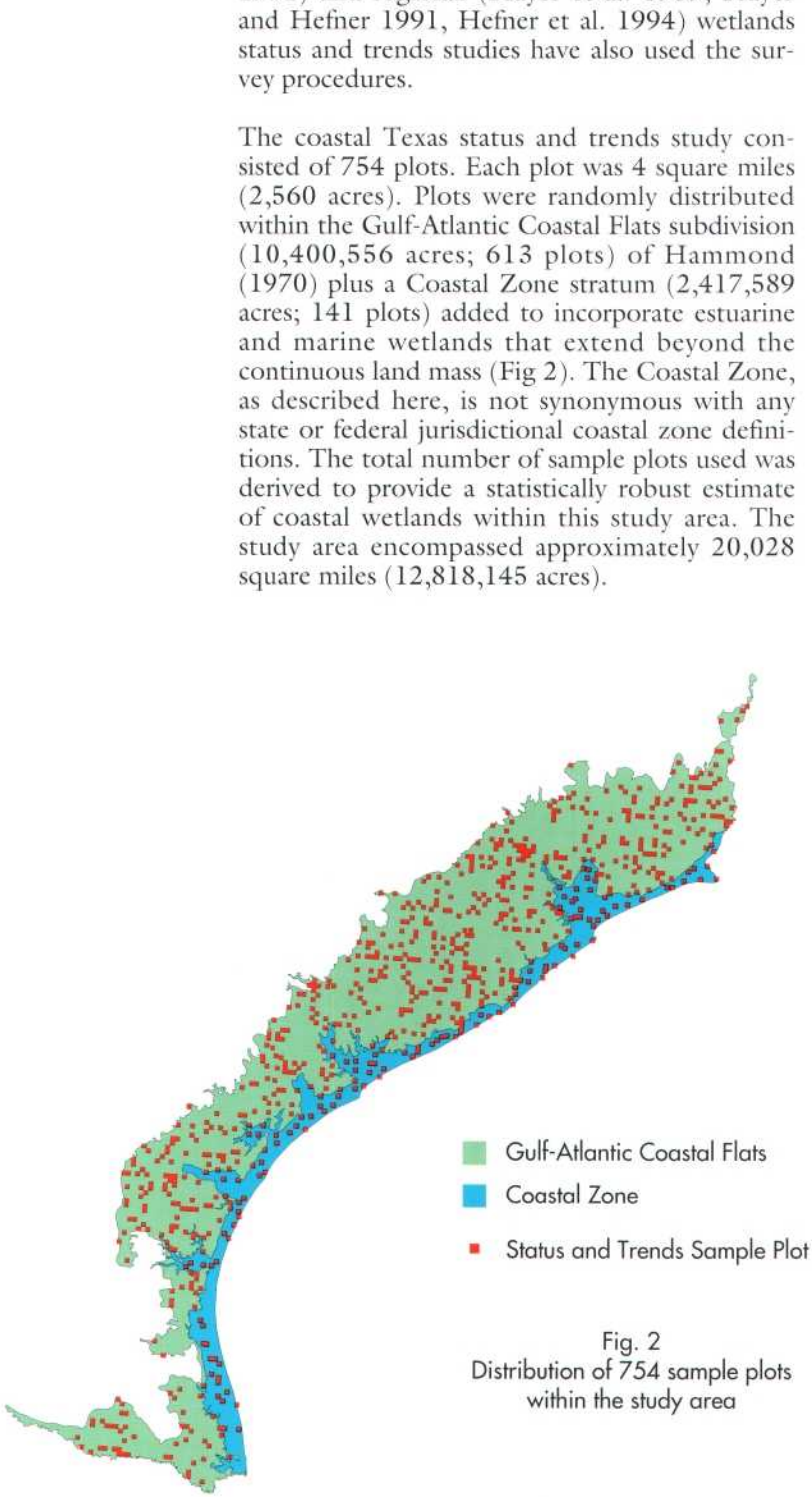


Fig. 2
Distribution of 754 sample plots within the study area

Two sets of aerial photographs were analyzed for each sample plot. The mean years of the aerial photos were 1955 and 1992. This 37-year interval was used to estimate average annual wetland acreage changes. The 1950s photos were black and white and ranged in scale from 1:20,000 to 1:36,000. The 1990s photos were color infrared at 1:40,000 or 1:62,500 scales. Aerial photos were stereoscopically interpreted and cover types delineated using procedures developed by the National Wetlands Inventory (U.S. Fish and Wildlife Service 1990a,b). Wetlands, deepwater habitats, and uplands identified on the photos were assigned to one of 20 categories listed in Table 2 and described in Appendix A. All changes in category acreages were classified as either natural (e.g., natural succession of scrub-shrub to forested wetland) or human-induced (e.g., loss of wetlands to agricultural or urban use). Upland areas were assigned to 1 of 5 general land-use categories: agriculture, urban, forested plantation, rural development, and "other." Field verification of features on the aerial photos was done for approximately 10 percent of the sample plots.

Habitat-category delineations on the interpreted aerial photos were transferred to mylar overlays on 1:24,000-scale U.S. Geological Survey topographic maps. Digital measurements of the various categories were made and acreages recorded. For this study, wetlands 3 acres and larger composed the target population. Changes in area of all categories from 1955 to 1992 for each sample plot were determined. Estimates of acreage changes were developed from the sample plot data using accepted statistical procedures developed by the U.S. Fish and Wildlife Service and Colorado State University. This study, like previous Fish and Wildlife Service status and trends studies, measured wetlands acreages and made no assessment of wetlands functional quality other than changes in areal extent.

Table 2. Wetland, deepwater, and upland habitat categories used in this study. (Detailed descriptions in Appendix A)

Saltwater Habitats*	Common Description
Marine Subtidal**	Permanent open water of Gulf
Marine Intertidal Shore	Gulf beaches, bars, and flats
Estuarine Subtidal**	Permanent open water of bays
Estuarine Intertidal Emergent	Salt, brackish, intermediate marsh
Estuarine Intertidal Scrub-Shrub	Baccharis, Black Mangrove, other shrubs
Estuarine Intertidal Unconsolidated Shore	Unvegetated bay beaches, bars, and flats

Freshwater Habitats*	Common Description
Palustrine Forested	Swamps, hardwood bottomlands, etc.
Palustrine Scrub-Shrub	Shrub-sapling wetlands
Palustrine Emergent	Fresh marshes, wet prairie, etc.
Palustrine Farmed	Cultivated rice fields, some natural wetlands
Palustrine Unconsolidated Shore	Unvegetated pond beaches, bars, and flats
Palustrine Unconsolidated Bottom	Permanent open water of ponds
Palustrine Aquatic Beds	Floating or submerged vegetation
Riverine**	Open water of rivers, streams, canals
Lacustrine**	Lakes and reservoirs

Upland Land Use	Common Description
Agriculture***	Cropland, pasture, managed rangeland
Urban***	Cities, towns, other densely built-up areas
Forested Plantation	Planted or intensively managed forests
Rural Development	Nonurban built-up areas and infrastructure
Other Uplands***	Nonpatterned native forest, brush, and grassland; barren land

* *Adapted from Cowardin et al. (1979)*

** *Deepwater Habitats*

*** *Adapted from Anderson et al. (1976)*

Results & Discussion

Acreage estimates for 1955 and 1992, and changes over the 37-year period, were developed for wetlands, deepwater habitats, and upland categories within the coastal Texas study area (Table 3). The complex dynamics of these conversions were derived from Data Tables 1 and 2 in Appendix B.

Status and Distribution

An estimated 4,105,343 acres of coastal Texas wetlands existed in 1955 (Fig. 3a). About 84.6 percent of the total was freshwater palustrine (3,474,330 acres) (Fig. 4a), 15.3 percent was saltwater estuarine (626,188 acres) (Fig. 5a), and 0.1 percent was marine intertidal (Fig. 3a). There were 1,664,698 acres of deepwater habitats consisting of rivers (59,303 acres), reservoirs (67,544 acres), and estuarine subtidal bays (1,537,851 acres);(Fig. 6a) in 1955. In 1992, an estimated 3,894,753 acres of wetlands existed. About 85.3 percent of the total was palustrine, 14.5 percent was estuarine, and 0.1 percent was marine (Fig. 3b). There were 1,757,595 acres of deepwater rivers (60,159 acres), reservoirs (147,363 acres), and estuarine bays (1,550,073 acres) in 1992.

Areas of wetlands concentration did not change significantly between 1955 and 1992. Wetlands distribution is shown in Fig. 7a and Fig. 7b. Areas of greatest wetlands concentration appeared to be in Jefferson, Liberty, and Chambers Counties (Fig. 7b). Substantial acreage also existed in Orange, Brazoria, Fort Bend, Wharton, Matagorda, Jackson, Calhoun, and Kenedy Counties.

Estuarine wetlands

Texas estuarine wetlands totaled about 566,570 acres in 1992 — about 10 percent of all estuarine wetlands of the conterminous U.S. About 62.8 percent (355,632 acres) was emergent, 36.3 percent (205,972 acres) was intertidal unvegetated (unconsolidated shore) mud or sand flats and bars, and less than 1 percent (4,966 acres) was estuarine shrubs (Fig. 5b). There were also 1,550,073 acres of estuarine subtidal open water bays, classified as deepwater habitats, in 1992 (Fig. 6b). Estuarine wetlands were most common in the areas around Sabine Lake, Galveston Bay, Matagorda Bay, San Antonio Bay, Aransas Bay, and the Laguna Madre (Fig. 8). Estuarine emergent wetlands were concentrated along the upper and mid-coast (Sabine Lake to Aransas Bay), while estuarine unvegetated flats were concentrated along the lower Laguna Madre (Figs. 9 and 10). Estuarine shrubs were most abundant in three areas: Galveston Island, the Sea Drift area in Calhoun County, and the southern end of South Padre Island (Fig. 11).

Palustrine wetlands

There was a total of 3,323,282 acres of palustrine wetlands in the study area in 1992 (Fig. 4b). About 52.4 percent (1,741,981 acres) was farmed wetlands. This acreage was dominated by rice growing operations, but also included some natural wetlands that are farmed when dry enough. Forested wetlands made up 23.8 percent (789,808 acres) of the total. Emergents made up 17.2 percent (571,867 acres) of the total, and scrub-shrub wetlands and ponds made up 5.2 percent (171,295 acres) and 1.1 percent (37,621 acres), respectively. Other palustrine wetlands (unvegetated shore and aquatic beds) made up only about 0.3 percent of the total. Palustrine wetlands were most common in Jefferson, Chambers, Liberty, Orange, Hardin, Brazoria, Wharton, Jackson, Matagorda, and Calhoun Counties (Fig. 12). Palustrine emergents were most prevalent in Jefferson, Chambers, Brazoria, Calhoun, Refugio, Aransas, Kleberg, Kenedy, and Cameron Counties (Fig. 13). Palustrine forested wetlands were found mostly on the northern half of the coastal plain (Fig. 14). Newton, Jasper, Orange, Hardin, Liberty, Harris, and Brazoria Counties had significant forested wetland acreage; Jefferson, Chambers, and Matagorda Counties supported some acreage. Palustrine scrub-shrub occurred mostly in the upper coast counties of Newton, Jasper, Orange, Hardin, Liberty, and Harris, although some concentrations of shrub wetlands were found in Jefferson, Victoria, and Cameron Counties (Fig. 15).

Regional Trends

Overall, coastal Texas wetlands sustained an estimated net loss of 210,590 acres from 1955 to 1992 (Table 3). This was an average annual net loss of about 5,700 acres of wetlands. This compares with 259,000 acres average annual net loss observed for the other 10 states of the southeastern U.S. (Hefner et al. 1994). Deepwater habitats gained an estimated 96,203 net acres. Upland categories had an estimated net gain of 114,387 acres.

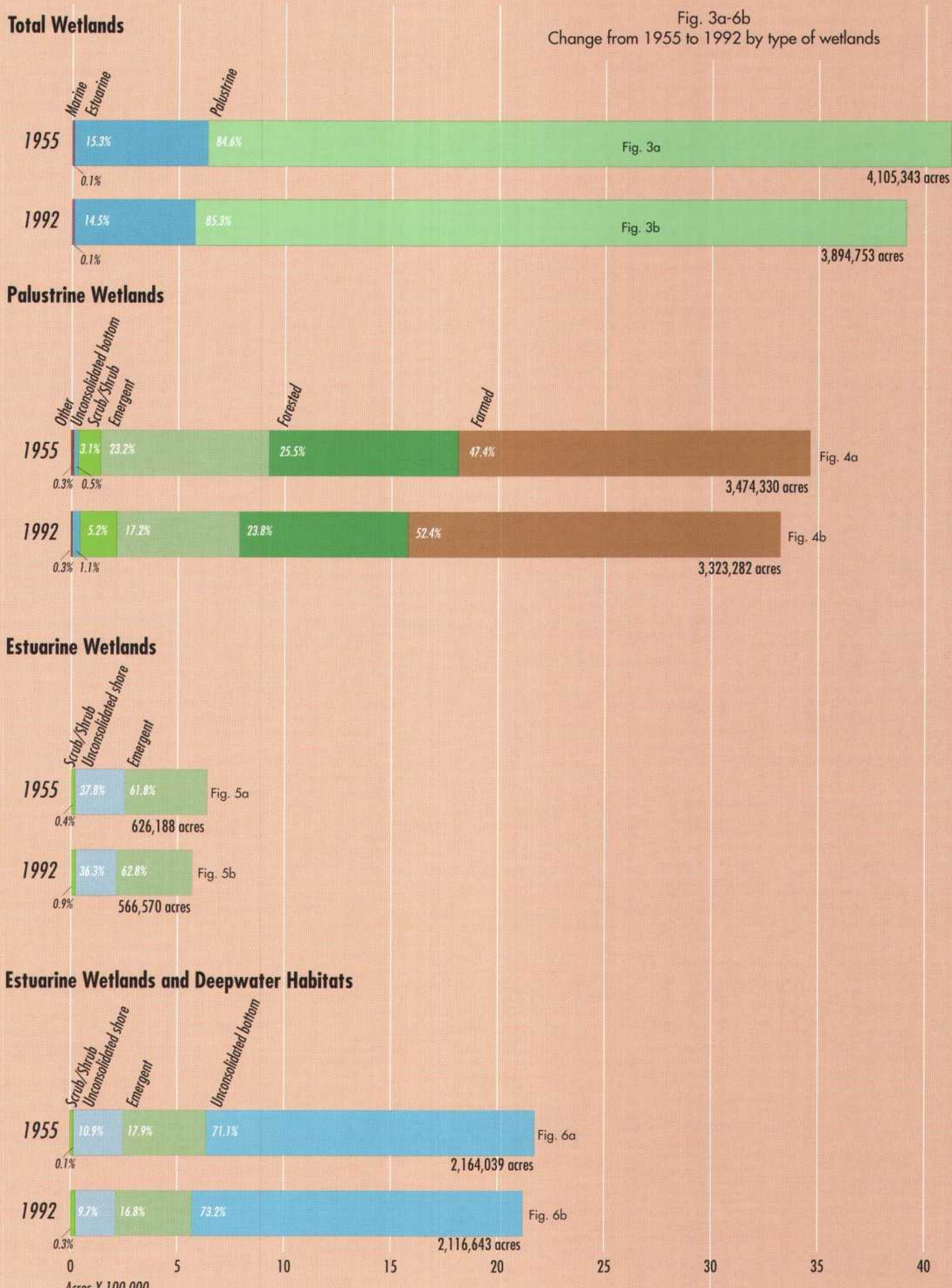


Fig. 3a-6b
Change from 1955 to 1992 by type of wetlands

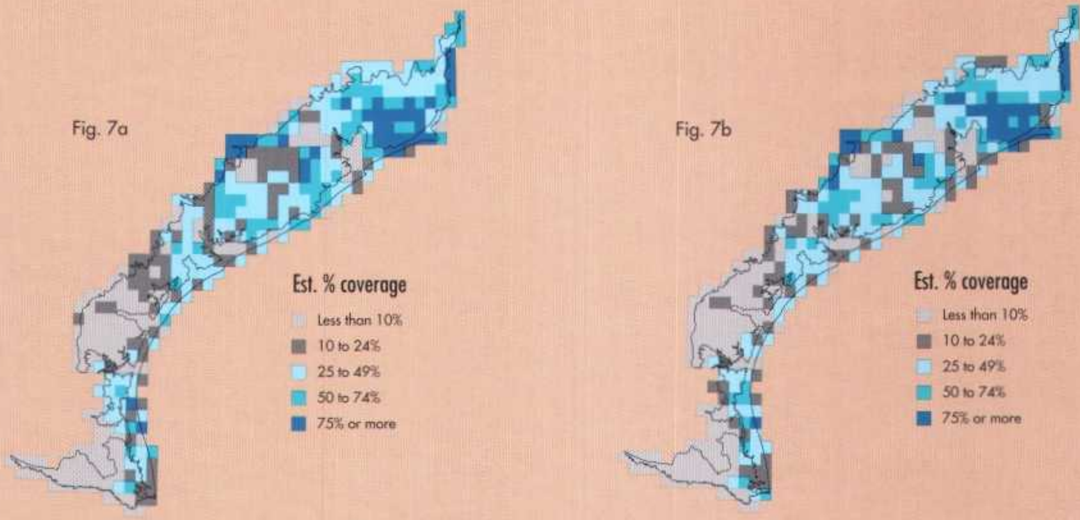
Table 3. Coastal Texas wetland, deepwater habitat, and upland trends (acres) — 1955 to 1992. Standard error, in percent, shown below acreage estimates; percentage of total acreage for each category included for comparison.

CLASS	1955		1992		NET CHANGE Acres	%
WETLANDS						
Marine Intertidal	4,825 22	0.1%	4,901 20	0.1 %	+76 817	+0.02%
Estuarine Emergent	387,211 12	9.4%	355,632 11	9.1%	-31,579 47	-8.2%
Estuarine Scrub-shrub	2,563 38	0.1%	4,966 30	0.1 %	+2,403 40	+93.8%
Estuarine Unvegetated Shore	236,414 15	5.8%	205,972 17	5.3%	-30,442 57	-12.9%
Palustrine Forested	886,285 8	21.6%	789,808 7	20.3%	-96,477 24	-10.9%
Palustrine Scrub-shrub	107,951 9	2.6%	171,295 9	4.4%	+63,344 23	+58.7%
Palustrine Emergent	806,996 6	19.7%	571,867 7	14.7%	-235,129 10	-29.0%
Palustrine Unvegetated Shore	11 ,285 21	0.3%	8,937 21	0.2%	-2,348 59	-20.8%
Palustrine Ponds	15,872 8	0.4%	37,621 5	1.0%	+21,749 8	+137.0%
Palustrine Aquatic Beds	449 29	0.01%	1,773 19	0.1 %	+ 1,324 25	+ 294.9%
Palustrine Farmed	1,645,492 6	40.1%	1,741,981 6	44.7%	+96,489 42	+5.9%
TOTAL	4,105,343 3	100%	3,894,753 3	100%	-210,590 21	-5.1%
DEEPWATER						
Marine Subtidal	3,535 68	0.2%	6,841 27	0.4%	+3,306 74	+93.5%
Estuarine Subtidal	1,537,851 4	92.2%	1,550,073 4	87.8%	+12,222 140	+0.8%
Riverine	59,303 9	3.6%	60,159 8	3.4%	+856 203	+ 1.4%
Lacustrine	67,544 23	4.0%	147,363 15	8.4%	+79,819 21	+118.0%
TOTAL	1,668,233 4	100%	1,764,436 4	100%	+96,203 25	+ 5.8%
UPLANDS						
Agriculture	5,315,561 3	75.4%	4,697,248 3	65.6%	-618,313 11	-11.6%
Urban	329,790 16	4.7%	858,490 10	12.0%	+528,700 11	+160.0%
Other	1,178,802 6	16.7 %	788,186 6	11.0%	-390,616 14	-33.0%
Forested Plantation	82,302 23	1.2%	404,284 12	5.7%	+321,982 13	+391.0%
Rural Development	138,114 10	2.0%	410,748 6	5.7%	+272,634 10	+197.0%
TOTAL	7,044,569 2	100%	7,158,956 2	100%	+114,387 33	+1.6%

Figures 7a-b

Distribution of all coastal Texas wetlands in 1955 (a) and 1992 (b)

Note: the "pixels" shown on these graphics represent USGS 7.5 minute quadrangles



Estuarine wetlands

Overall, estuarine intertidal wetlands sustained a net loss of about 59,618 acres (a 9.5 percent decrease); an average annual net loss of about 1,600 acres over the 37 years. Figure 16 summarizes the dynamics of net acreage changes for estuarine wetlands and deepwater habitats.

Estuarine intertidal emergents decreased from 387,211 acres in 1955 to 355,632 acres in 1992. The net loss of 31,579 acres (an 8.2 percent decrease) resulted primarily from loss or conversion to: estuarine subtidal bays (19,931 acres); palustrine emergents (9,238 acres); lacustrine reservoirs (7,023 acres); and, upland categories other than agriculture (6,291 acres).

The loss of estuarine marsh to open subtidal bay occurred primarily between Freeport and Port Arthur and was associated with the submergence (drowning) and erosion of wetlands probably due to faulting and land subsidence resulting from the withdrawal of underground water and oil and gas as described by White and Tremblay (1995).

Estuarine intertidal unconsolidated (unvegetated) shore decreased from 236,414 acres in 1955 to 205,972 acres in 1992. This net loss of 30,442 acres (a 12.9 percent decrease) resulted primarily from loss or conversion to: upland "other" (15,805 acres); estuarine emergents (14,376 acres); rural development (4,079 acres); and, palustrine emergents (3,686 acres).

Loss of estuarine intertidal wetlands to upland "other" and conversion to palustrine emergents resulted partly from the construction of dredge spoil compartments along the Gulf Intracoastal Waterway and other ship channels, and also from construction of roads, levees, etc. that altered original tidal hydrologic characteristics.

Estuarine intertidal scrub-shrub increased from 2,563 acres in 1955 to 4,966 acres in 1992. This net gain of 2,403 acres (a 93.8 percent increase) resulted primarily from conversion of estuarine emergents (2,226 acres) to estuarine scrub-shrub.

Palustrine wetlands

Overall, palustrine wetlands decreased by 151,048 acres (a 4.3 percent loss) from 3,474,330 acres in 1955 to 3,323,282 acres in 1992. Figure 17 summarizes the dynamics of net acreage changes for palustrine wetlands.

Palustrine emergents decreased from 806,996 acres in 1955 to 571,867 acres in 1992. This net loss of 235,129 acres (a 29 percent decrease) resulted primarily from loss or conversion to: agriculture (67,745 acres); the other upland categories

(37,183 acres), especially urban and rural development; palustrine farmed (62,830 acres); palustrine scrub-shrub (42,198 acres); palustrine forested (13,072 acres); ponds (5,171 acres); and, lacustrine reservoirs (20,470 acres).

Palustrine emergents sustained an average annual net loss of 6,355 acres. This was the largest acreage change for any wetland category studied (Fig. 18). On the upper and mid-coast, part of the conversion of emergents to scrub-shrub resulted from invasion by the introduced Chinese Tallow-tree (White et al. 1993). The 20,470-acre loss of emergents to lacustrine was due to reservoir construction.

The 67,745-acre loss of emergents to agriculture occurred despite the 618,313-acre net loss for the agriculture category. The loss of palustrine wetlands to agriculture was widespread along the coast and was greatest in Chambers, Harris, Brazoria, Fort Bend, Wharton, Matagorda, and Refugio Counties (Fig. 19).

Palustrine forested wetlands decreased from 886,285 acres in 1955 to 789,808 acres in 1992. This net loss of 96,477 acres (a 10.9 percent decrease) resulted primarily from loss or conversion to: palustrine scrub-shrub (29,573 acres); palustrine farmed (12,252 acres); ponds (2,910 acres); agriculture (26,818 acres); forested plantation (14,232 acres); rural development (13,112 acres); urban (9,563 acres); and, lacustrine reservoirs (15,436 acres). Loss of forested wetlands to forested plantation was confined to the upper coast, with Newton, Hardin, and Jefferson Counties showing the greatest losses (Fig. 20).

Palustrine scrub-shrub wetlands increased from 107,951 acres in 1955 to 171,295 acres in 1992. This net gain of 63,344 acres (a 58.7 percent increase) resulted primarily from conversion of: palustrine emergents (42,197 acres); palustrine forested (29,573 acres); and, palustrine farmed (2,138 acres) to scrub-shrub wetlands.

Palustrine unconsolidated bottom, mostly man-made ponds, increased from 15,872 acres in 1955 to 37,621 acres in 1992. This net gain of 21,749 acres (a 137 percent increase) consisted primarily of gain from or conversion of: agriculture (7,759 acres); upland "other" (2,337 acres); palustrine emergents (5,171 acres); palustrine farmed (2,985 acres); and, palustrine forested (2,910 acres) to ponds. A loss of natural prairie potholes was masked by the proliferation of man-made stock tanks and other ponds.

Palustrine farmed wetlands increased from 1,645,492 acres in 1955 to 1,741,981 acres in 1992. This net gain of 96,489 acres (a 5.9 per-

Fig. 8
Estuarine wetland distribution in 1992

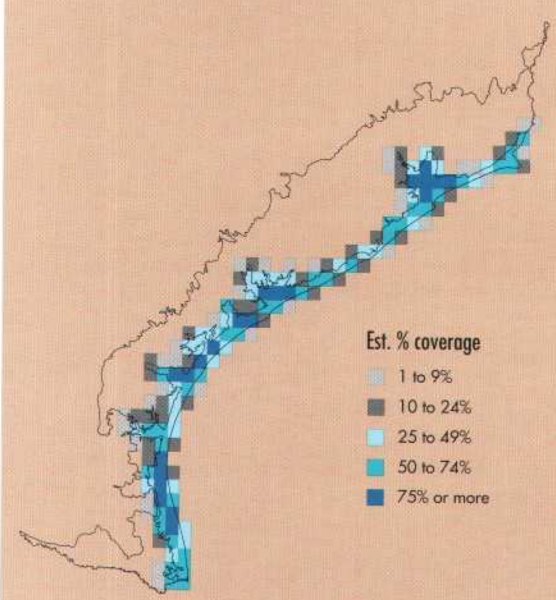
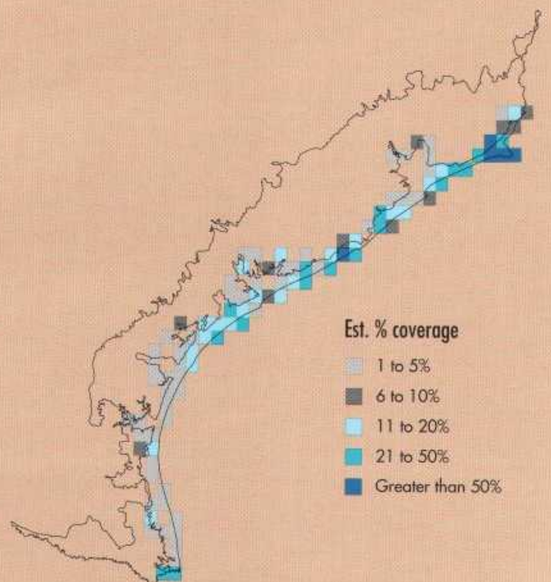


Fig. 9
Estuarine emergent wetland distribution in 1992



cent increase) consisted primarily of gain from or conversion of: agriculture (140,865 acres); palustrine emergents (62,830 acres); and, palustrine forested (12,252 acres) to farmed wetlands.

Most of the palustrine farmed wetlands acreage is in some type of rice production rotation, primarily in Wharton, Colorado, Brazoria, Matagorda, Jackson, Jefferson, Chambers, Liberty, and Fort Bend counties. Texas ranks fourth among all states in rice production, with an average annual value in the early 1990s of about $150 million (Texas Agricultural Statistics Service 1994).

There were losses of palustrine wetlands, particularly palustrine farmed (96,500 acres) and palustrine emergents (29,100 acres), to urban and rural development. Loss to urban land use was greatest in the Houston and Beaumont-Port Arthur areas (Fig. 21). Loss to rural development was greatest in Orange, Jefferson, Chambers, Galveston, Harris, Brazoria, and Nueces Counties (Fig. 22).

Deepwater habitats

Overall, deepwater habitats increased by 96,203 acres (a 5.8 percent gain), from 1,668,233 acres in 1955 to 1,764,436 acres in 1992.

Estuarine subtidal unconsolidated bottom, i.e., open water of bays and lagoons, increased from 1,537,851 acres in 1955 to 1,550,073 acres in 1992 (Fig. 16). This net gain of 12,222 acres (a 0.8 percent increase) resulted primarily from conversion of: estuarine emergents (19,931 acres); upland "other" (3,875 acres); and, agriculture (2,461 acres) to subtidal bays. These conversions resulted from the submergence and erosion of tidal marshes and bay shorelines mostly along the upper and mid-coast.

Lacustrine acreage increased from 67,544 acres in 1955 to 147,363 acres in 1992. This net gain of 79,819 acres (a 118 percent increase) resulted primarily from conversion of: palustrine emergents (20,470 acres); palustrine forested (15,436 acres); palustrine farmed (11,110 acres); upland "other" (11,791 acres); agriculture (6,409 acres); and, estuarine intertidal wetlands (8,100 acres), mostly emergents, to lacustrine. The expansion of the lacustrine category resulted from reservoir construction.

Marine subtidal habitats, i.e., open Gulf water, were included in this study only insofar as they relate to losses or gains of the other measured habitat categories. For example, the erosion of Gulf beaches would create a loss of marine intertidal shore to marine subtidal; or, the accretion

Fig. 10
Estuarine unvegetated wetland distribution in 1992

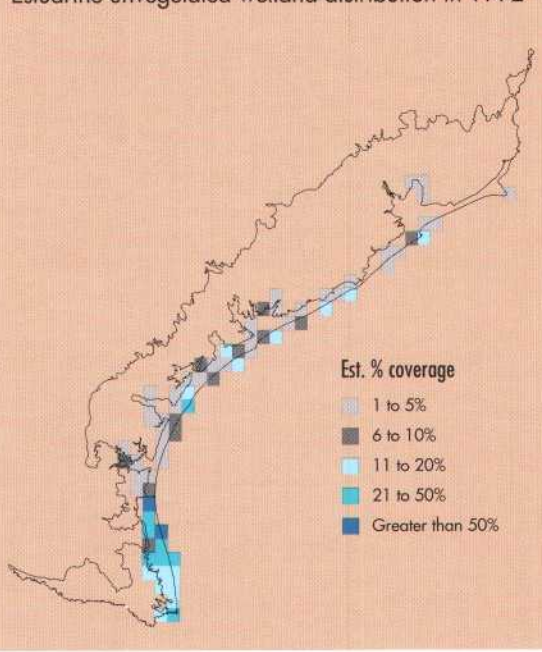
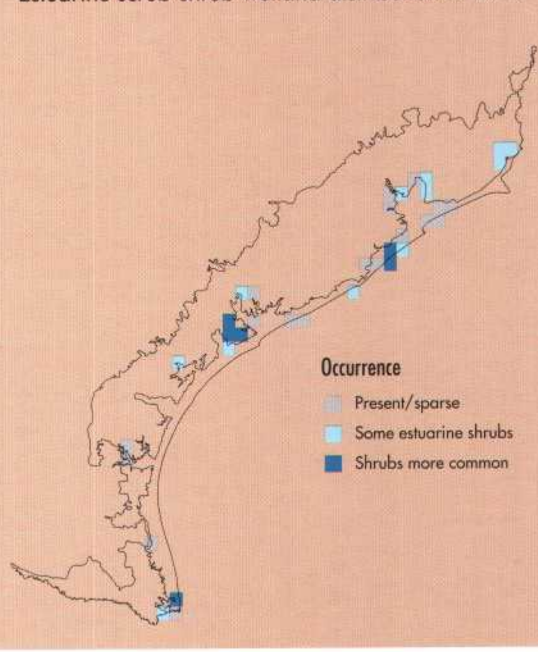


Fig. 11
Estuarine scrub-shrub wetland distribution in 1992



of sand on a barrier island beach would create a loss of marine subtidal to marine intertidal. In that regard, marine subtidal acreage increased from 3,535 in 1955 to 6,841 in 1992. This net gain of 3,306 acres (a 93.5 percent increase) resulted primarily from conversion of: marine intertidal beaches (2,044 acres); and upland "other" (1,627 acres) to marine subtidal.

Upland categories

Overall, upland categories increased by 114,387 acres (a 1.6 percent gain) from 7,044,569 acres in 1955 to 7,158,956 acres in 1992.

Upland agriculture decreased from 5,315,561 acres in 1955 to 4,697,248 acres in 1992. This net loss of 618,313 acres (a 11.6 percent decrease) resulted primarily from loss or conversion to: urban (323,706 acres); rural development (184,633 acres); forested plantation (58,891 acres); palustrine farmed (140,865 acres); ponds (7,759 acres); and, lacustrine reservoirs (6,409 acres).

Agriculture, the largest land-use category, experienced a 618,313-acre net loss even though 98,000 acres of palustrine vegetated wetlands, mostly emergent and forested, were lost to agriculture, as were 12,000 acres of upland "other."

Upland urban increased from 329,790 acres in 1955 to 858,490 acres in 1992. This gain of 528,700 acres (a 160 percent increase) resulted primarily from conversion of: agriculture (323,706 acres); upland "other" (72,271 acres); rural development (64,252 acres); palustrine farmed (36,628 acres); palustrine emergents (15,966 acres); palustrine forested (9,563 acres); and, palustrine scrub-shrub (2,425 acres) to urban.

Upland "other," primarily unmanaged or nonpatterned forest and rangelands, and barren land, decreased from 1,178,802 acres in 1955 to 788,186 acres in 1992. This net loss of 390,616 acres (a 33 percent decrease) resulted primarily from loss or conversion to: forested plantation (244,900 acres); urban (72,271 acres); rural development (53,507 acres); agriculture (11,960

Village Creek, Hardin County
RIVERINE & PALUSTRINE FORESTED
JIM DICK

Fig. 12
Distribution of palustrine wetlands in 1992

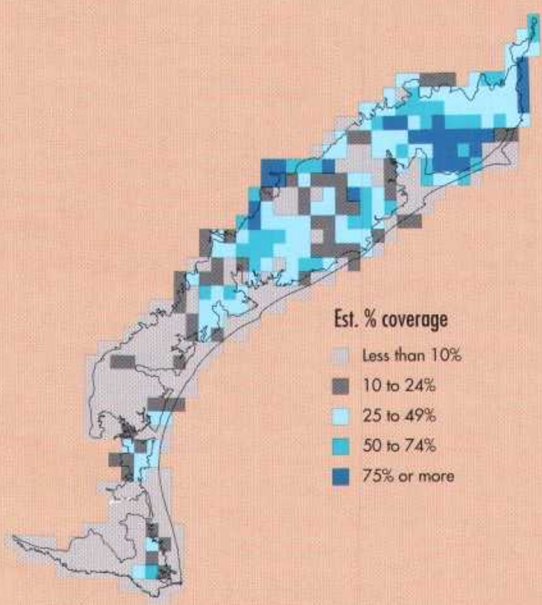


Fig. 13
Distribution of palustrine emergent wetlands in 1992

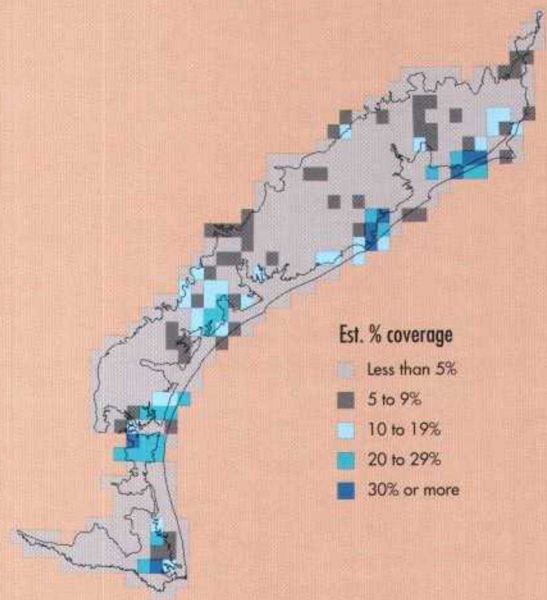


Fig. 14
Distribution of palustrine forested wetlands in 1992

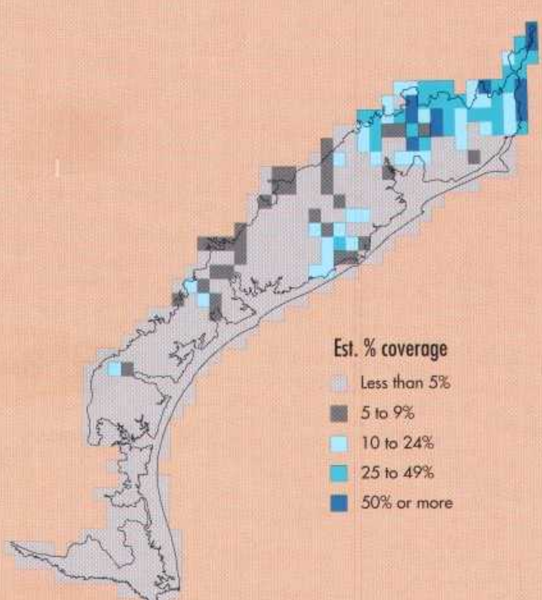
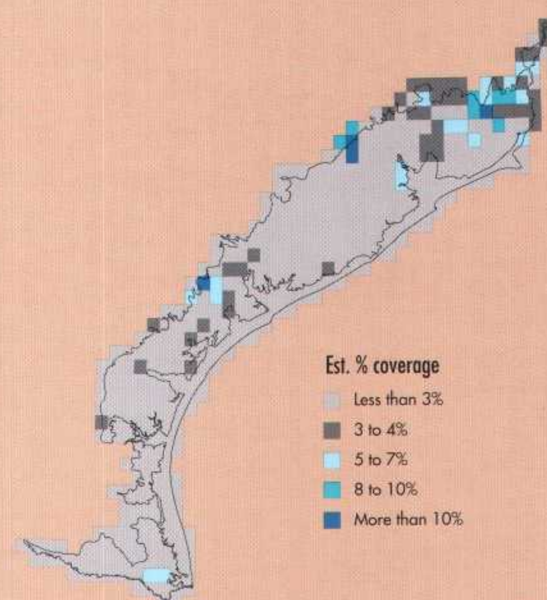


Fig. 15
Distribution of palustrine scrub-shrub wetlands in 1992



acres); palustrine forested (14,570 acres); ponds (2,337 acres); lacustrine reservoirs (11,791 acres); and, estuarine subtidal bays (3,875 acres). Much of the upland "other" acreage that was converted to forested plantation was originally native hardwood and pine-hardwood forest.

Upland forested plantation (silviculture), primarily planted and managed pine plantations, clear cuts, and other intensively managed forest stands, increased from 82,302 acres in 1955 to 404,284 acres in 1992. This net gain of 321,982 acres (a 391 percent increase) resulted primarily from conversion of: upland "other" (244,900 acres); agriculture (58,891 acres); palustrine forested (14,232 acres); palustrine emergents (4,588 acres); and, palustrine farmed (1,774 acres) to forested plantation. Commercial timber operations in southeast Texas have emphasized the growing of Loblolly and nonnative Slash Pine for production of pulp for paper, lumber and plyboard for building, and pressure-treated fenceposts, pilings, landscape timbers, etc. (G. Spencer pers. comm.). There is a growing export market, particularly to Japan, for hardwood chips used in the production of high quality papers.

Upland rural development, i.e., low-intensity, often isolated development outside distinct cities or towns, increased from 138,114 acres in 1955 to 410,748 acres in 1992. This net gain of 272,634 acres (a 197 percent increase) resulted primarily from conversion of: agriculture (184,633 acres); upland "other" (53,507 acres); palustrine farmed (59,838 acres); palustrine forested (13,112 acres); and, palustrine emergents (13,062 acres) to rural development.

Timber Harvest by Barge
RIVERINE & PALUSTRINE FORESTED
TEXAS PARKS & WILDLIFE DEPARTMENT

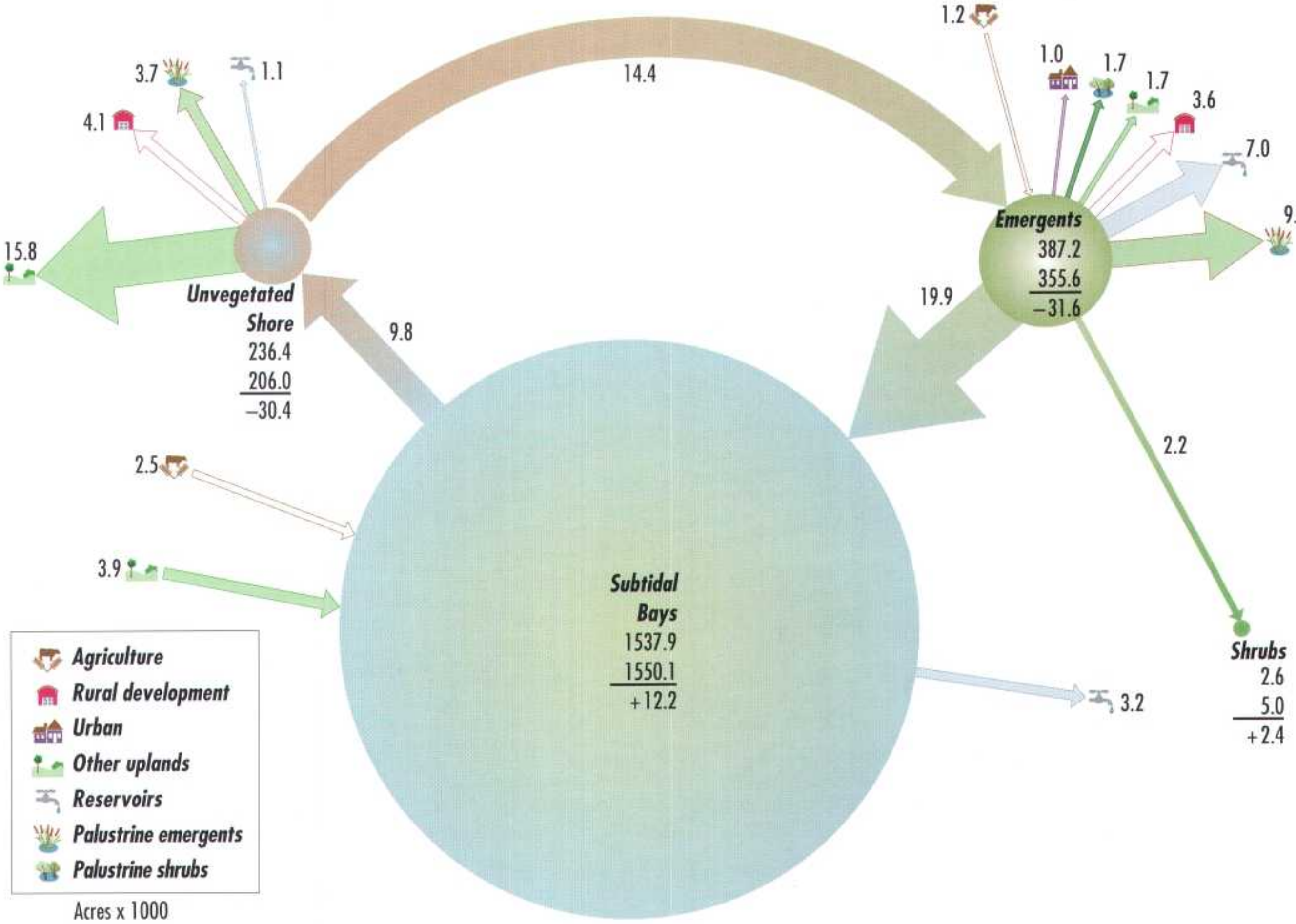


Fig. 16
Net acreage changes for estuarine wetlands and deepwater habitats of coastal Texas
1955 to 1992

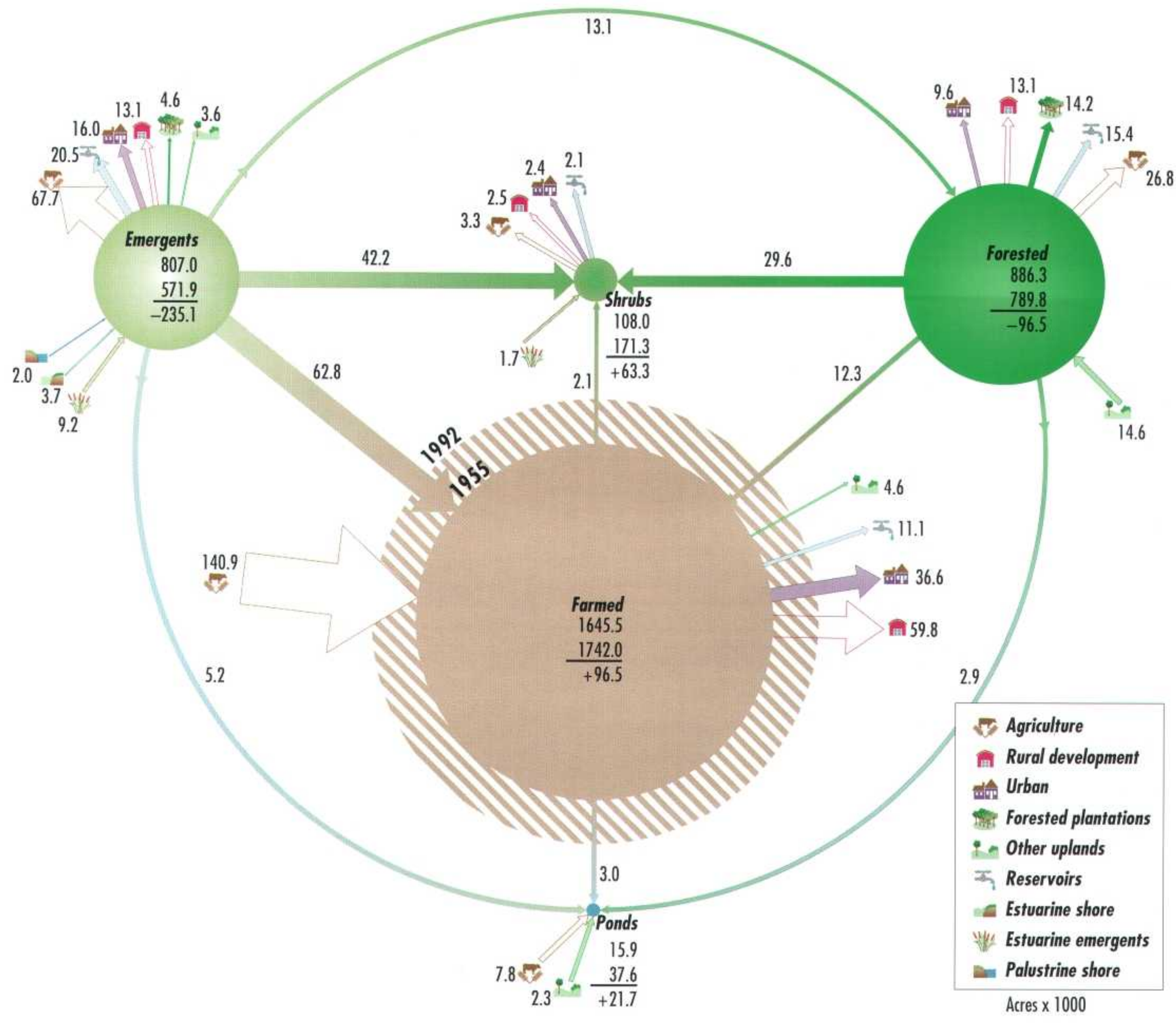
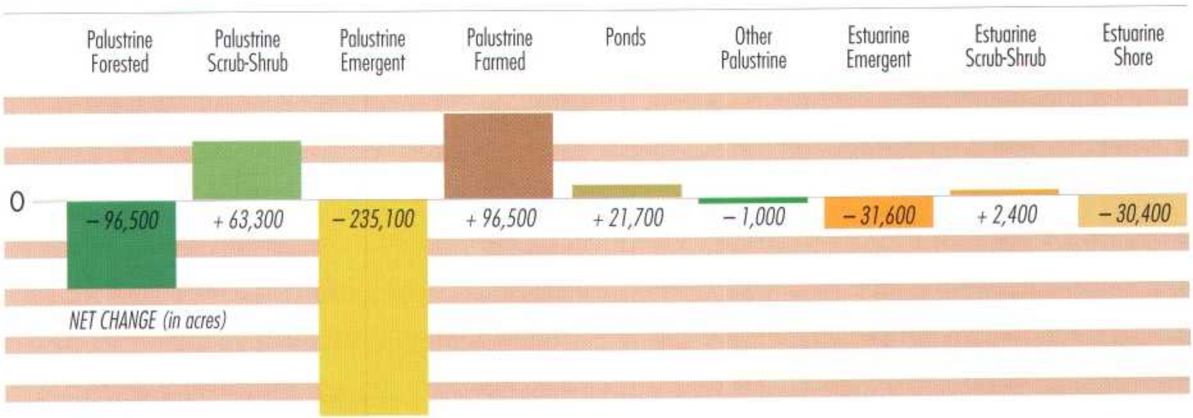


Fig. 17
Net acreage changes for palustrine wetlands of coastal Texas
1955 to 1992

Figure 18

Changes in coastal Texas wetland acreages, 1955 – 1992



Bird Watching, Mid-coast

ESTUARINE SCRUB/SHRUB

TEXAS PARKS & WILDLIFE DEPARTMENT

Fig. 19
Loss of coastal Texas wetlands to agriculture
1955 to 1992

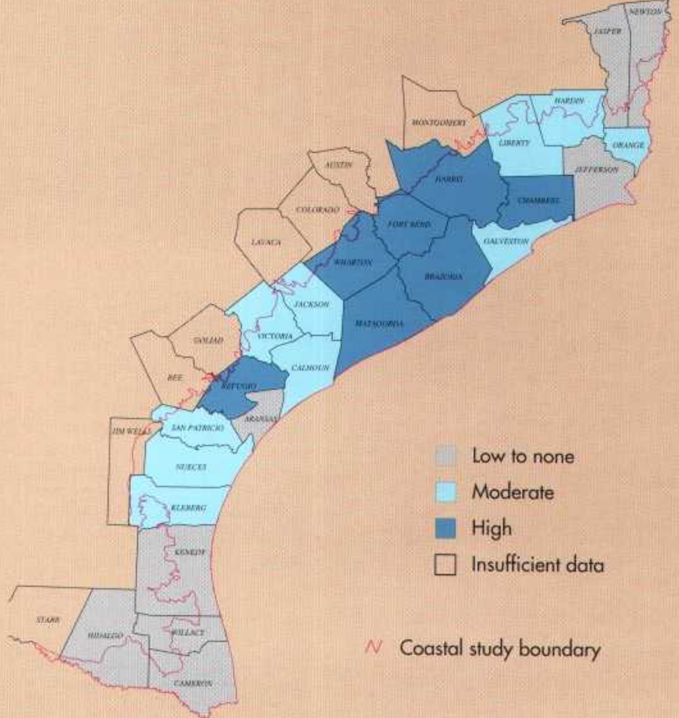


Fig. 20
Loss of coastal Texas wetlands to silviculture
1955 to 1992

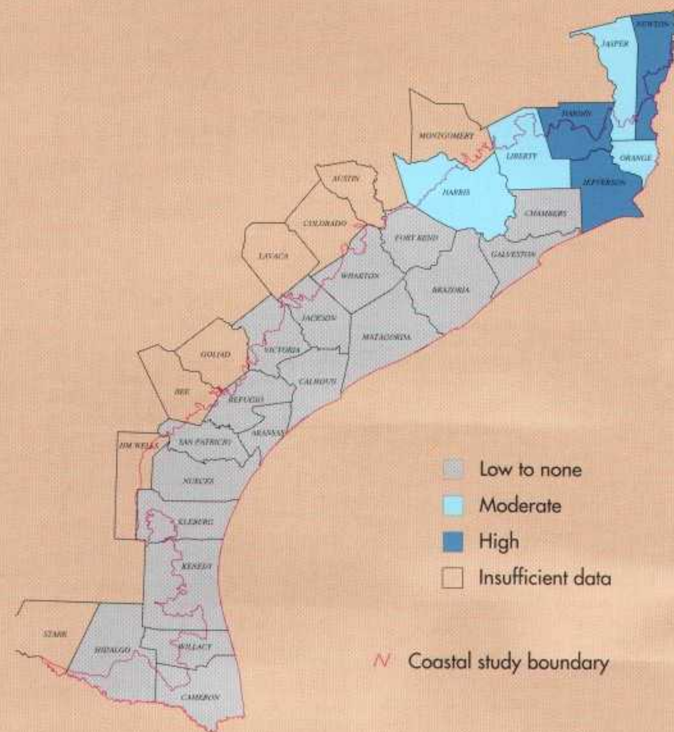


Fig. 21
Loss of coastal Texas wetlands to urban
1955 to 1992

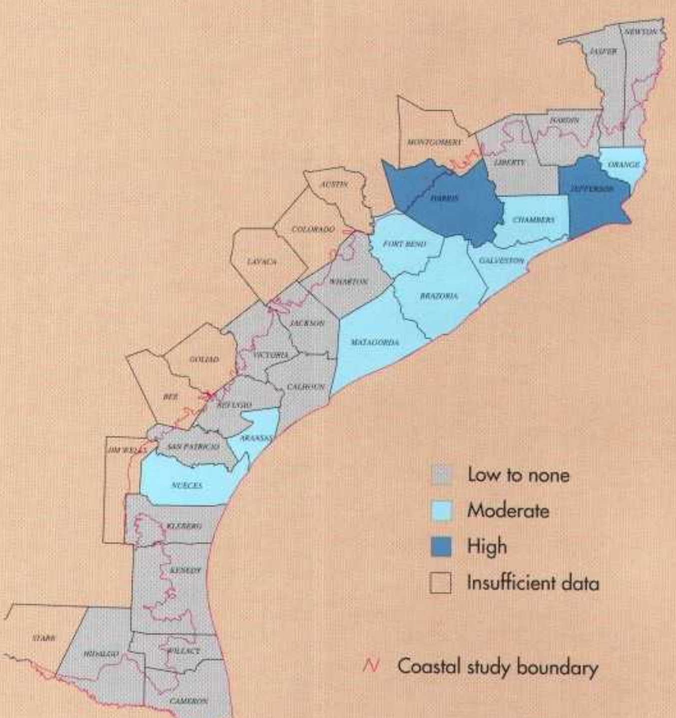
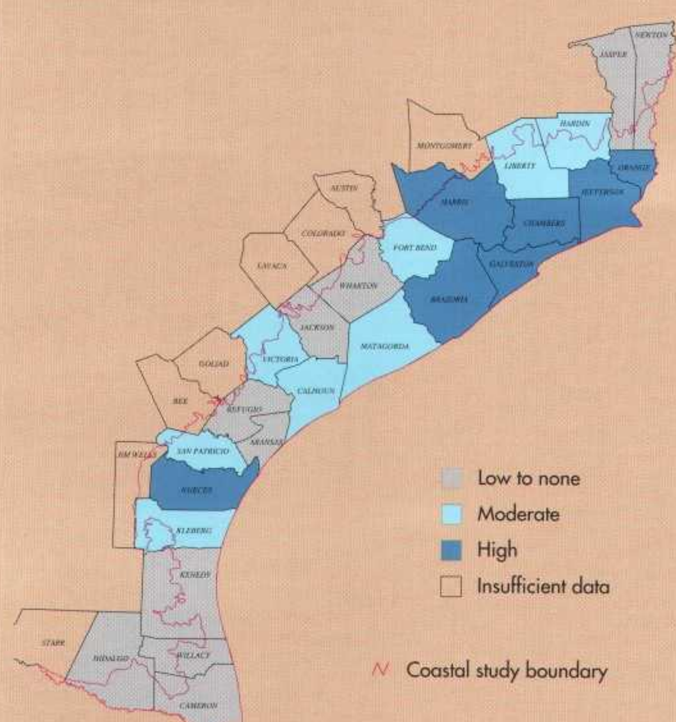


Fig. 22
Loss of coastal Texas wetlands to rural development
1955 to 1992



Conclusions

We examined the status of coastal Texas wetlands at two points in time — the mid-1950s and the early 1990s. The average annual net loss of all vegetated wetlands for that period was 5,400 acres. However, federal and state legislation such as the 1948 "Clean Water Act" as amended, the 1969 National Environmental Policy Act, the 1985 and 1990 "Farm Bills," the 1986 Emergency Wetlands Resources Act, the 1989 North American Wetlands Conservation Act, the 1981 Texas Waterfowl Stamp Act, the 1991 Texas Coastal Coordination Act, and others, have had a positive influence on wetlands conservation and management in Texas. For example, in the Galveston Bay area, the average rate of loss of vegetated wetlands decreased from about 1,000 acres per year from 1953–1979 to about 500 acres per year from 1979–1989 (White et al. 1993).

Nevertheless, our results indicate that vegetated wetlands, particularly freshwater emergent and forested wetlands, are resources that need additional conservation efforts. The acreage losses within the upland agriculture and upland "other" categories also give cause for concern. The upland "other" category consists mostly of nonpatterned native forests, grasslands, and brush lands. As these habitats, as well as agricultural lands, undergo urban, rural, and silvicultural development, pressure to make up losses of farm and range lands at the expense of wetlands may intensify.

In 1992, palustrine farmed wetlands comprised 52 percent of all palustrine wetlands and 45 percent of total wetlands for coastal Texas. The predominance of this wetland type commands attention from coastal resource managers; and also indicates great potential for the conservation of wildlife and other resources.

The Gulf Coast Joint Venture of the North American Waterfowl Management Plan and the Texas Wetlands Conservation Plan (Texas Parks and Wildlife Dept. 1997) have led the way in Texas regarding private lands incentive programs for wetlands conservation and management. The role of private landowners in wetlands conservation is crucial, and efforts to provide incentives and assistance must be redoubled. The great potential of coastal Texas for wetlands restoration on upland agricultural lands is, as yet, largely unrealized.

Mid-coast Salt Marsh
ESTUARINE INTERTIDAL EMERGENT
ROSE SULLIVAN

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Habitat Categories

Wetland and deepwater habitat categories used in this report were adapted from Cowardin et al. (1979). In general terms, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal assemblages living in the soil and on its surface. Wetlands are lands transitional between terrestrial and aquatic ecosystems where the water table usually is at or near the surface or the land is covered by shallow water. The classification system requires that wetlands have one or more of the following attributes: 1) at least periodically, the land supports predominantly hydrophytes (water-loving plants); 2) the substrate is predominantly undrained hydric (water-logged) soil; and, 3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

Deepwater habitats consist of certain permanently flooded lands. The separation between wetland and deepwater habitat in tidal areas coincides with the elevation of the extreme low water of spring tide. In other areas, the separation is at a depth of 2 meters (6.6 feet) below low water. This is the maximum depth in which emergent plants normally grow.

Within the classification hierarchy, wetlands and deepwater habitats are grouped according to five major systems: Marine, Estuarine, Palustrine, Riverine, and Lacustrine. Systems consist of environments of similar hydrologic, geomorphological, chemical, and biological characteristics. Each system is further divided by the predominant ecological influence, such as the ebb and flow of the tide, and by substrate material and flooding regimes, or by vegetative life form. Groupings of habitat categories were made to accommodate the special interests of the study and the detail to which aerial photography could be interpreted.

An overview of the Cowardin et al. classification system and general descriptions of category types can be found in Dahl and Johnson (1991). The following descriptions are specific examples of the most common coastal Texas wetland habitats included within the study categories.

Marine Wetlands

The marine intertidal unconsolidated shore category includes beaches, bars, and flats alternately exposed and flooded by tidal action, including the splash zone, of the open Gulf of Mexico.

Galveston Island Salt Marsh
ESTUARINE INTERTIDAL EMERGENT
JIM DICK

Estuarine Wetlands

The estuarine intertidal emergent category includes coastal marshes which are flooded periodically by tidal waters with salinity of at least 0.5 parts per thousand. The three types of estuarine marshes that occur along the Gulf of Mexico are commonly called salt marsh, brackish marsh, and intermediate marsh. These types can be separated based on salinity, as reflected by the dominant plant assemblages. Some common plants of the estuarine marshes include Smooth Cordgrass (*Spartina alterniflora*), Saltwort (*Batis maritima*), Seashore Saltgrass (*Distichlis spicata*), and Seashore Dropseed (*Sporobolus virginicus*) in salt marshes; Black Needlerush (*Juncus roemerianus*), Marshhay Cordgrass (*Spartina patens*), and Olney's Bulrush (*Scirpus americanus*) in brackish marshes; and California Bulrush (*Scirpus californicus*), Southern Cattail (*Typha domingensis*), and Seashore Paspalum (*Paspalum vaginatum*) in intermediate marshes.

The estuarine intertidal scrub-shrub category describes wetlands dominated by woody vegetation and periodically flooded by tidal waters with salinity of at least 0.5 parts per thousand. On the Texas coast, this category includes wetlands dominated by the evergreen shrubs Eastern Baccharis (*Baccharis halimifolia*), Marshelder (*Iva frutescens*), and on the mid- and lower coast, Black Mangrove (*Avicennia germinans*). Sea Oxeye (*Borrichia frutescens*), although a shrub, does not appear as such on aerial photos probably because it often occurs in low, dense stands of unbranched plants.

The estuarine intertidal unconsolidated shore category includes wetlands with less than 30 percent areal coverage by vegetation and periodically flooded by tidal waters with salinity of at least 0.5 parts per thousand. This category includes sandbars, mudflats, and other nonvegetated or sparsely vegetated habitats called saltflats. Saltflats are hypersaline environments that generally occur near the interface of salt marsh and upland habitats. Sparse vegetation of saltflats may include glassworts (*Salicornia* spp.), Saltwort, and Shoregrass (*Monanthochloe littoralis*). Wetlands consisting mostly of sand flats dominated by algal beds or blue-green algal mats and periodically flooded by astronomic or wind tides were also included in this category. These habitats occur extensively on the lower Texas coast along the Laguna Madre.

This study did not include estuarine subtidal aquatic beds (seagrasses) or oyster reefs because these habitats cannot always be accurately delineated on color infrared aerial photos.

Palustrine Wetlands

The palustrine forested category includes all freshwater (less than 0.5 parts per thousand ocean-derived salinity) wetlands dominated by woody vegetation greater than 6 meters (20 feet) in height. Floodplain wetlands called hardwood bottomlands are the predominant habitat of this category. Water regimes range from brief periodic flooding to near permanent inundation. For example, assemblages dominated by oaks such as Overcup Oak (*Quercus lyrata*), Water Oak (*Q. nigra*), and Willow Oak (*Q. phellos*) along with Green Ash (*Fraxinus pennsylvanica*), Sweetgum (*Liquidambar styraciflua*), and Black Willow (*Salix nigra*) are subject to seasonal flooding. Old river channels and oxbows may support swamps vegetated predominantly by Bald Cypress (*Taxodium distichum*) and Water-Tupelo (*Nyssa aquatica*) and may be flooded almost continuously. Forested wetlands with intermediate degrees of flooding are an extensive component of the hardwood bottomland spectrum. Some common trees of the intermediate zones include elms (*Ulmus* spp.), Red Maple (*Acer rubrum*), Water Hickory (*Carya aquatica*), and Hackberry/Sugar-Berry (*Celtis* spp.). In addition to hardwood bottomlands, interfluvial forested wetlands such as wet pine flatwoods

Cypress Swamp, Orange County
PALUSTRINE FORESTED
TEXAS PARKS & WILDLIFE DEPT.

dominated by Loblolly Pine (*Pinus taeda*) cover large acreages on the upper Texas coast.

The palustrine scrub-shrub category includes all freshwater wetlands dominated by woody vegetation less than 20 feet in height. These habitats include formerly forested wetlands experiencing regrowth or invasion by species such as Green Ash or the introduced Chinese Tallow-tree (*Sapium sebiferum*). This category includes shrub-dominated floodplain depressions, beaver ponds, gravel pits, river point-bars, and backwaters of ponds and reservoirs vegetated by species such as Swamp Privet (*Forestiera acuminata*), Brook-side Alder (*Alnus serrulata*), Black Willow, ash (*Fraxinus caroliniana, F. pennsylvanica*), Buttonbush (*Cephalanthus* spp.), and Planer-tree (*Planera aquatica*). Chinese Tallow-tree is rapidly invading palustrine emergent wetlands, including rice fields, on the upper and mid-coast. Rattlebush (*Sesbania* spp.) and Saltcedar (*Tamarix ramosissima*) are common in depressions and along drainages throughout the coastal plain.

The palustrine emergent category includes all freshwater wetlands dominated by rooted herbaceous (nonwoody) plants. Most habitats in this category are freshwater marshes dominated by plants such as cattails (*Typha* spp.), spikerushes (*Eleocharis* spp.), smartweeds (*Polygonum* spp.), arrowheads (*Sagittaria* spp.), etc. Also included are wet prairies and meadows vegetated by species such as Gulf Cordgrass (*Spartina spartinae*), sedges (*Carex* spp.), Bushy Bluestem (*Andropogon glomeratus*), Switchgrass (*Panicum virgatum*), Seacoast Bluestem (*Schizachyrium scoparium var. littoralis*), Giant Bristle Grass (*Setaria magna*), and other grasses.

The palustrine farmed category consists primarily of actively farmed rice (*Oryza sativa*) fields, but also includes some natural wetlands which are farmed when dry enough.

The palustrine aquatic bed category includes shallow freshwater wetlands dominated by floating or submerged vegetation. Typical species are floating vascular plants such as duckweed (*Lemna* spp.), and Common Water-Hyacinth (*Eichhornia crassipes*); and rooted vascular plants such as water-lilies (*Nymphaea* spp.), pondweeds (*Potamogeton* spp.), and Hydrilla (*Hydrilla verticillata*).

Two palustrine nonvegetated (less than 30 percent areal coverage by vegetation) categories were evaluated. These are palustrine unconsolidated bottom, which includes all ponds and other permanently flooded open freshwater bodies less than 20 acres in size; and palustrine unconsolidated shore, which includes periodically flooded freshwater beaches, bars, and flats, as well as palustrine wetlands temporarily devoid of vegetation.

Redhead Pond, Corpus Christi
PALUSTRINE UNCONSOLIDATED BOTTOM
BRIAN BENEDICT

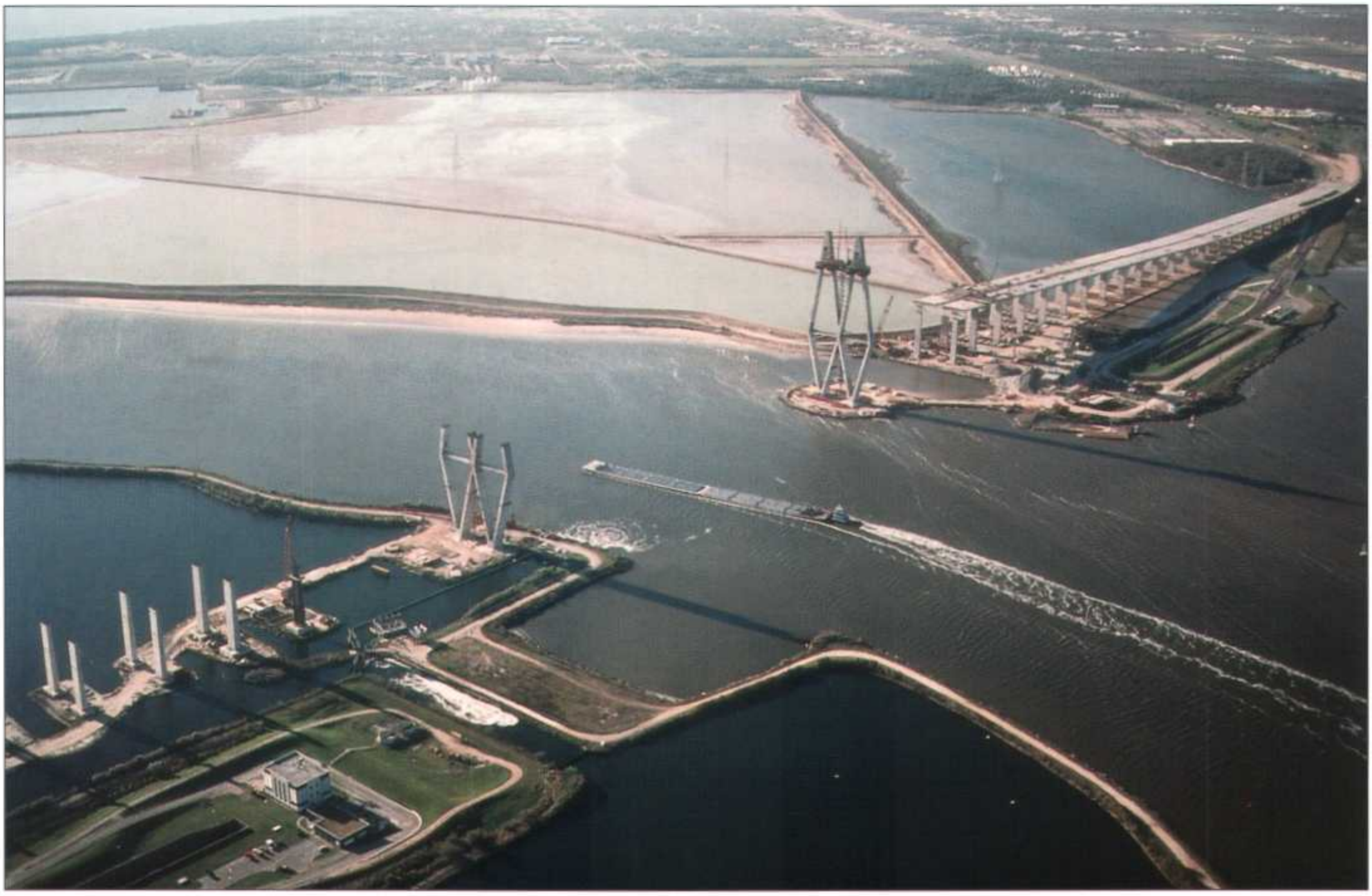
Deepwater Habitats

Several deepwater habitat categories were included as they are the aquatic end of the continuum for which wetlands function as transitional zones. These categories are: marine subtidal, where the substrate is permanently submerged by the open Gulf of Mexico; estuarine subtidal, which includes the permanently submerged areas of bays, lagoons, and lakes where ocean-derived salinity exceeds 0.5 parts per thousand, where there is at least partial obstruction (barrier islands or peninsulas) from the open Gulf of Mexico, and there is occasional dilution by freshwater runoff from the land; riverine, which includes all flooded unvegetated freshwater habitats found within a channel; and lacustrine, which includes all flooded unvegetated freshwater areas of lakes and reservoirs larger than 20 acres.

Upland Categories

All areas not identified as wetlands or deepwater habitats were placed in five upland categories. The agriculture category consists of cropland, pasture, and managed range. The urban category consists of cities, towns, and other intensively built-up areas. The "other" uplands category was adapted from Anderson et al. (1976). "Other" includes unmanaged or nonpatterned forest land and rangeland, and barren land, as well as lands that have been drained and cleared but not put to identifiable use. The forested plantation category includes planted and managed pine plantations, clear cuts, and other intensively managed forests. The rural development category includes low-density, often isolated development outside distinct cities and towns. Rural infrastructure including major roads, other transportation, power, and communications facilities, mines and quarries, and golf courses and other recreational areas were included.

Houston Ship Channel, San Jacinto River
RIVERINE
TEXAS PARKS & WILDLIFE DEPARTMENT



Data Tables

Estimates produced include acreages with associated standard errors. Some estimates are not considered reliable enough to recommend their use for making decisions. An indication of the statistical reliability of each acreage estimate is given in the summary tables included in this appendix. The standard error of each entry expressed as a percentage of the entry (SE %) is below each acreage estimate. Reliability can be stated generally as: "we are 68 percent confident that the true value is within the interval constructed by adding to and subtracting from the estimate the SE%/100 times the estimate." For example, if an estimate is one million acres and the SE% is 20, then we are 68 percent confident that the true value is between 800,000 and 1,200,000 acres. An equivalent statement for 95 percent confidence can be made by adding and subtracting twice the amount to and from the estimate. Therefore, a large SE% indicates that the estimate has little, if any, reliability. If the SE% is 100 or greater, we can not state that we are 68 percent confident that the true value is not zero.

This discussion of reliability is meant to aid in interpretation of the study results. It was expected that only certain estimates would be precise enough to be meaningful. However, all estimates are included in the summary tables for additivity and ease of comparison.

Estimates for 1955, 1992, and change over that period were produced for the categories described in Appendix A. These estimates are summarized in Table 1 of Appendix B. Table 2 summarizes estimates by selected surface area groups. Totals for columns are estimates of total acreage by category for 1992. Row totals (the column on the extreme right) are estimates of total acreage by category for 1955. Table entries are interpreted as in the following examples (all from the seventh row or column of Table 1):

- •• 447,293 acres classified as palustrine emergent in 1955 were again classified as palustrine emergent in 1992;
- •• 92,562 acres classified as palustrine emergent in 1955 had changed to agriculture by 1992;
- •• 15,523 acres classified as palustrine emergent in 1955 had changed to upland "other" by 1992;
- •• 12,692 acres classified as palustrine scrub-shrub in 1955 had changed to palustrine emergent by 1992;
- •• 70,886 acres classified as palustrine emergent in 1955 had changed to palustrine farmed by 1992;
- •• The estimate of palustrine emergent area in 1955 is 806,996 acres;
- •• The estimate of palustrine emergent area in 1992 is 571,867 acres;
- •• The estimate of net change in palustrine emergent area from 1955 to 1992 is –235,129 acres.

Impounded Farm Pond
PALUSTRINE UNCONSOLIDATED BOTTOM
TEXAS PARKS & WILDLIFE DEPARTMENT

Texas Coastal Wetlands, Mid-1950s to Early 1990s

TABLE 1 Area, in thousands of acres, by surface area classification.

Sampling error, in percent, is given below estimate.

1955 CLASSIFICATIONS		1992 CLASSIFICATIONS: ALL WETLANDS											DEEPWATER HABITATS				UPLANDS					
			ESTUARINE INTERTIDAL			PALUSTRINE																
		MARINE INTERTIDAL	EMERGENT	SCRUB/SHRUB	UNVEGETATED SHORE	FORESTED	SCRUB/SHRUB	EMERGENT	UNVEGETATED SHORE	PONDS	AQUATIC BEDS	FARMED	MARINE SUBTIDAL	ESTUARINE SUBTIDAL	RIVERINE	LACUSTRINE	AGRICULTURE	URBAN	OTHER	FORESTED PLANTATION	RURAL DEVELOPMENT	1955 AREA
	MARINE INTERTIDAL	1.9 33	0.2 64	0	<0.1	0	0	<0.1	0	0	0	0	2.3 31	<0.1	0	0	0	0	0.3 64	0	0	4.8 22
ESTUARINE INTERTIDAL	EMERGENT	0.4 62	303.1 13	2.7 29	11.9 20	0.1 58	1.7 56	12.7 42	0.1 73	0.8 39	<0.1	0.1 53	0.3 76	32.6 27	<0.1	7.0 53	1.2 30	1.0 45	7.9 18	0	3.7 32	387.2 12
	SCRUB/SHRUB	0	0.4 49	1.4 54	<0.1	<0.1	<0.1	0.5 64	0	<0.1	0	<0.1	0	<0.1	0	<0.1	<0.1	0	<0.1	0	<0.1	2.6 38
	UNVEGETATED SHORE	0.3 46	26.2 15	0.3 56	151.4 21	0	0	3.7 46	0.4 52	0.1 39	0	<0.1	0.4 68	2.9 23	0.1 87	1.1 65	0.2 46	0.4 44	18.6 25	0	4.1 47	236.4 15
PALUSTRINE	FORESTED	0	0.1 64	0	<0.1	660.5 8	63.3 14	35.7 14	<0.1	3.5 17	0.3 52	17.7 35	0	<0.1	1.2 33	15.8 37	42.6 16	9.7 35	6.9 17	14.4 26	14.4 19	886.3 8
	SCRUB/SHRUB	0	<0.1	0	<0.1	33.7 11	31.0 15	12.7 19	0.1 72	1.0 19	<0.1	7.3 32	0	<0.1	0.7 63	2.7 25	10.2 17	2.4 28	2.6 35	0.4 31	2.9 27	108.0 9
	EMERGENT	0.2 71	3.4 40	<0.1	<0.1	48.8 11	54.9 14	447.3 9	2.3 32	7.7 10	0.5 32	70.9 17	0.7 77	0.7 31	1.3 29	25.9 27	92.6 10	16.1 17	15.5 19	4.6 34	13.7 16	807.0 6
	UNVEGETATED SHORE	<0.1	<0.1	0	<0.1	0.1 49	0.4 26	4.3 26	3.5 33	0.3 20	0	<0.1	<0.1	<0.1	<0.1	<0.1	1.3 40	0.1 37	0.6 51	<0.1	0.4 48	11.3 21
	PONDS	<0.1	<0.1	0	0	0.6 18	0.2 22	2.6 13	0.3 46	7.6 11	0.3 44	0.5 16	<0.1	<0.1	<0.1	1.0 32	1.0 11	0.7 22	0.3 20	<0.1	0.6 23	15.9 8
	AQUATIC BEDS	0	0	0	0	<0.1	0	<0.1	0	<0.1	0.2 42	<0.1	0	0	0	0	<0.1	<0.1	<0.1	0	<0.1	0.4 29
	FARMED	0	0	<0.1	0	5.4 26	9.4 47	8.1 27	0.2 33	3.4 14	<0.1	1460.6 7	0	<0.1	0.4 38	12.4 65	28.4 28	36.6 29	15.9 29	2.4 56	62.2 20	1645.5 6
DEEPWATER HABITATS	MARINE SUBTIDAL	0.3 83	0.8 87	0	0.5 87	0	0	0	0	0	0	0	1.2 56	0.6 87	0	0	0	0	0.2 87	0	0	3.5 68
	ESTUARINE SUBTIDAL	<0.1	12.7 18	0.2 47	39.0 30	0	0.4 67	0.7 51	<0.1	0.2 44	0	<0.1	<0.1	1477.0 4	<0.1	3.3 58	<0.1	0.9 63	3.1 23	0	0.2 39	1537.9 4
	RIVERINE	0	0	0	0	1.2 33	0.2 54	0.7 42	<0.1	0.2 34	<0.1	0	0	<0.1	52.7 9	0.8 39	0.7 36	0.1 36	2.0 45	<0.1	0.4 40	59.3 9
	LACUSTRINE	0	<0.1	0	0	0.4 36	0.6 47	5.4 28	<0.1	0.4 36	0.1 88	1.3 78	0	0.1 69	0.3 61	56.4 27	1.0 67	<0.1	1.0 41	0	0.4 84	67.5 23
UPLANDS	AGRICULTURE	0.2 61	2.4 30	0.2 55	0.4 29	15.8 20	6.9 18	24.8 12	1.3 28	8.7 8	0.1 45	169.2 12	<0.1	2.5 31	2.0 21	7.4 24	4336.1 3	324.3 13	162.0 10	60.2 23	190.8 8	5315.6 3
	URBAN	0	<0.1	0	0	0.2 67	<0.1	0.1 49	<0.1	<0.1	<0.1	0	0	0.1 69	<0.1	0	0.6 65	325.7 16	2.8 42	<0.1	<0.1	329.8 16
	OTHER	1.5 35	6.2 23	0.1 35	2.7 27	21.5 41	1.8 24	12.0 28	0.4 37	2.7 12	<0.1	11.2 31	1.9 37	7.0 17	1.2 22	12.8 36	174.0 12	75.1 18	542.0 8	246.5 15	58.2 13	1178.8 6
	FORESTED PLANTATION	0	0	0	0	0.2 51	<0.1	<0.1	<0.1	0.1 60	0	0.7 71	0	0	0.1 88	0	1.3 55	0.8 66	1.6 38	75.3 24	2.2 46	82.3 23
	RURAL DEVELOPMENT	<0.1	<0.1	<0.1	<0.1	1.3 37	0.4 52	0.6 30	<0.1	0.7 30	0	2.4 29	0	<0.1	<0.1	0.6 46	6.2 16	64.3 17	4.7 20	0.3 35	56.5 12	138.1 10
	1992 SURFACE AREA	4.9 20	355.6 11	5.0 30	206.0 17	789.8 7	171.3 9	571.9 7	8.9 21	37.6 5	1.8 19	1742.0 6	6.8 27	1550.1 4	60.2 8	147.4 15	4697.2 3	858.5 10	788.2 6	404.3 12	410.7 6	12818.1 0
	CHANGE	<0.1	-31.6 47	2.4 40	-30.4 57	-96.5 24	63.3 23	-235.1 10	-2.3 59	21.7 8	1.3 25	96.5 42	3.3 74	12.2 140	0.9 203	79.8 21	-618.3 11	528.7 11	-390.6 14	322.0 13	272.6 10	0

Texas Coastal Wetlands, Mid-1950s to Early 1990s

TABLE 2 Area, in thousands of acres, by selected surface area groups.

Sampling error, in percent, is given below estimate.

1992 CLASSIFICATIONS

1955 CLASSIFICATIONS	WETLANDS					
	MARINE	ESTUARINE	PALUSTRINE	DEEPWATER	UPLANDS	1955 AREA
MARINE	1.9 33	0.2 67	<0.1	2.4 31	0.3 64	4.8 22
ESTUARINE	0.7 43	497.4 10	20.3 34	70.7 17	37.1 16	626.2 9
PALUSTRINE	0.2 68	3.7 38	3007.7 4	63.1 20	399.7 7	3474.3 3
DEEPWATER	0.3 81	53.1 23	12.2 18	1592.4 4	10.2 17	1668.2 4
UPLANDS	1.8 34	12.2 15	283.1 8	35.8 15	6711.6 2	7044.6 2
1992 AREA	4.9 20	566.6 9	3323.3 4	1764.4 4	7159.0 2	12818.1 0
CHANGE	<0.1	-59.6 37	-151.1 26	96.2 25	114.4 33	0

Duck Hunting
PALUSTRINE EMERGENT
TEXAS PARKS & WILDLIFE DEPARTMENT

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Oyster Harvest
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