Both sets of data indicate major losses, which is a trend supported by other studies (Pulich and White, 1991). The most significant losses were in West Bay and along the margins of west Galveston Bay (fig. 28). Pulich and White (1991) concluded that losses along the margins of west Galveston Bay (League City and Bacliff quads) were related to Hurricane Carla and subsidence. This area was affected by a hurricane surge of 4.3 m (14.2 ft) and intense wave and current action generated by strong onshore winds. Increasing nearshore water depths as a result of subsidence placed a stress on submerged vegetation before Hurricane Carla and inhibited its recovery after the storm (Pulich and White, 1991). In West Bay, the apparent complete loss of submerged vegetation is thought to be due primarily to human activities including industrial, residential and commercial development, wastewater discharges, chemical spills, and increased turbidity from boat traffic and dredging activities (Pulich and White, 1991).

CONCLUSIONS

Wetland Status (1989)

- Wetlands and aquatic habitats in the Galveston Bay system are dominated by an estuarine system that encompasses approximately 507,500 acres and represents 89 percent of the wetland and deep-water habitats. The palustrine system is second at 6 percent (34,100 acres), followed by the lacustrine (4 percent), riverine (0.5 percent), and marine (0.4 percent, excluding open water).

- Vegetated wetlands (marshes, scrub-shrub, and forested wetlands) have a total area of about 138,600 acres, 94 percent (130,400 acres) of which consists of marshes (estuarine and palustrine emergent wetlands).

- Salt and brackish marshes (estuarine intertidal emergent wetlands) constitute 83 percent (108,200 acres) of the marsh system; fresh or inland marshes (palustrine emergent wetlands) make up the remaining 17 percent (22,200 acres).

- Forested (5,650 acres) and scrub-shrub (2,560 acres) wetlands have a total area of about 8,200 acres, representing approximately 6 percent of all vegetated wetland habitats.

- Submerged vascular vegetation (estuarine subtidal aquatic bed) has a total area of about 700 acres, the largest area (386 acres) occurring in Christmas Bay.

- Approximately 17,800 acres of sand and mud flats and bay beaches (estuarine intertidal unconsolidated shores) were mapped on late 1980's photographs. This acreage is higher than normal because of extremely low tides during the 1989 photographic mission, which exposed shallow areas that are usually submerged.

Wetland Trends

- The trend in vegetated wetlands is one of net loss as revealed by acreages of 171,000 in the 1950's, 146,000 in 1979, and 138,600 in 1989. The rate of loss, however, declined over time from about 1,000 acres per year between 1953 and 1979, to about 700 acres per year between 1979 and 1989. The rate of loss for the period 1979 to 1989 would be lower (less than 500 acres/yr) if inaccuracies in wetland interpretation on the 1979 photographs are taken into account.

- Marshes (emergent wetlands) experienced the most extensive wetland losses. Net losses in these habitats exceeded 35,000 acres, or about 21 percent of the 1950's resource. The

actual loss when adjusted for photointerpretation problems is somewhat lower, probably below 19 percent. Although the net loss in emergent wetlands (marshes) from the 1950's to 1989 encompassed about 35,000 acres, the gross "loss," exclusive of offsetting gains in other areas, was considerably larger—approximately 88,500 acres.

Causes of Trends

Marshes (Emergent Wetlands)

- Conversion of emergent wetlands to open water and flats from the 1950's to 1989 exceeded 26,400 acres, accounting for about 30 percent of the total gross loss in marshes in the Galveston Bay system. There is evidence that humanly induced subsidence and associated relative sea-level rise are the major factors contributing to this type of loss. Subsidence along active surface faults also contributed to replacement of marshes by water and flat in some areas.

- Major losses in interior, or fresh, marshes occurred as large areas of palustrine emergent wetlands were transformed to uplands. The magnitude of this change is approximately 35,800 acres from the 1950's to 1989, and accounts for about 40 percent of the total gross loss in palustrine and estuarine emergent wetlands. The change from emergent wetlands in the 1950's to upland rangeland in 1989 encompassed 25,400 acres. Conversion of wetlands to urban upland areas amounted to 5,700 acres, and to cropland and pastureland, 3,600 acres. It appears that some changes of wetlands to uplands are related to natural conditions, such as annual (and seasonal) changes in moisture levels, which affected photointerpretation, but a substantial amount of the change appears to be due to draining of wetlands, a common practice, especially from the 1950's to 1970's. Approximately 33 percent of the gross loss in emergent wetlands is attributed to their replacement by upland rangeland and cropland.

Scrub-Shrub and Forested Wetlands

- The general trend in scrub/shrub wetlands for the 1950's to 1989 period was one of net loss. Scrub-shrub wetlands declined by approximately 850 acres, or about 25 percent of the 1950's resource. The net loss in scrub-shrub wetlands was countered by a net gain in forested wetlands, which increased by approximately 3,600 acres—1.8 times the 1950's forested wetland area. Much of this gain in forested wetlands was due to (a) taller growth of shrubs and trees in areas previously mapped as scrub-shrub wetlands, and (b) photointerpretation inconsistencies. Locally, losses in forested wetlands were due to alterations in hydrology.

Estuarine Submerged Vegetation (Aquatic Beds)

- An extensive net loss occurred in submerged vascular vegetation. This habitat decreased from about 2,500 acres in the 1950's to approximately 700 acres in 1989, reflecting a decline of 1,800 acres, or more than 70 percent of the 1950's habitat. The loss of submerged vegetation is even greater, 86 percent of the mid-1950's resource, using the area of 5,000 acres reported by Fisher and others (1972) for submerged vegetation in 1956. Loss of submerged vegetation has been attributed to subsidence and Hurricane Carla in parts of Galveston Bay, and to human activities including development, wastewater discharges, chemical spills, boat traffic, and dredging activities in West Bay (Pulich and White, 1991).

Local Gains in Wetlands

- Losses in emergent wetlands in some areas were partly offset by gains in emergent wetlands in other areas. Conversion of uplands to emergent wetlands, in part due to subsidence, accounted for an increase of about 21,000 acres. Additional increases in emergent wetlands resulted from the spread of emergent vegetation over areas previously mapped as intertidal flats.

- Although newly established wetlands provide some measure of areal offset to net wetland loss, there is not necessarily a corresponding offset in terms of functional value. Some researchers suggest that several years of development may be necessary for newly formed marshes to reach overall functional equivalency to older marshes (Minello and Zimmerman, 1992). It is possible that they may never become totally equivalent.

- The declining rate of loss of wetlands over the more recent period (1979–1989), coupled with local gains in wetland habitats in some areas, provide a cautionary measure of hope that planning and proper management of wetlands can help mitigate the trend toward net loss of these valuable resources in the Galveston Bay system.

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