Changes in Waterfowl and Wetland Abundance in the Chenier Plain of Texas 1970s-1990s

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ABSTRACT

Trends in numbers of ten species of ducks were analyzed using data from 1976 to 1991 Midwinter Aerial Inventories for seven Texas Chenier Plain transects. Transects were also used as a sampling framework for wetland studies; black and white 1:20,000 aerial photos taken during 1964-66 and 1989-90 were analyzed to estimate changes in numbers and areas of wetlands by type. Ten species of ducks selectively ($P < 0.10$) used Zone A (coastal areas). Numbers of gadwalls (*Anas strepera*), mallards (*A. platyrhynchos*), mottled ducks (*A. fulvigula*), pintails (*A. acuta*), wigeons (*A. americana*), and total ducks declined ($P < 0.10$) during 1976-91. By 1991, numbers of total ducks had declined by 89% from peak populations in the late 1970s. Area of wetlands declined 16% (42,000 ha) between 1964-66 and 1989-90. Major losses occurred in Estuarine Intertidal Emergent (17,000 ha) and Palustrine Emergent Farmed (rice) (50,000 ha) wetlands. Many of these losses were by conversion to open water Palustrine Unconsolidated Bottom (8,000 ha), Lacustrine Limnetic (2,400 ha), and/or diked/impounded/excavated (19,000 ha) wetlands. Losses and degradations appeared primarily in coastal Zone A, and appeared highly associated with declining duck numbers. Management efforts should emphasize halting soil subsidence and saltwater intrusion; and the restoration, enhancement, and/or acquisition of Estuarine and Palustrine Emergent wetlands in Zone A.

KEYWORDS: ducks, Gulf Coast

The Monitoring, Evaluation, and Research Team (MERT) of the Gulf Coast Joint Venture (GCJV) of the North American Waterfowl Management Plan (NAWMP) identified as a priority the need to evaluate losses of various kinds of wetlands in Louisiana and Texas since the early 1970s (MERT meetings, 19 July 1990). This information would aid the MERT in setting habitat objectives for the GCJV by identifying wetland types most seriously impacted since the NAWMP baseline period of the early 1970s.

Wetland losses in the Chenier Plain of Louisiana and Texas were documented from 1952 to 1974 by Gosselink et al., (1979). Over the 22-year period, there was a net loss of nearly 44,000 ha of vegetated wetlands in the Chenier Plain of both

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states, with nearly 68% of the loss to open water. Losses and changes in wetlands in Texas have not been quantified since the early 1970s.

The objectives of this study were to (1) estimate losses and changes in various types of wetlands in the Chenier Plain of Texas since the early 1970s; (2) evaluate changes in relative abundance, species composition, and distributions of waterfowl in the Chenier Plain of Texas since the mid 1970s; (3) relate changes in waterfowl distribution to changes in wetlands within and among zones in the Chenier Plain of Texas; and (4) to develop draft priorities for wetland habitat conservation in the Chenier Plain of Texas.

STUDY AREA

The 2.6-million-ha Chenier Plain Initiative area extends 60-100 km inland from the Gulf of Mexico between Vermillion Bay in Louisiana and Galveston Bay in Texas (Chenier Plain Initiative Team 1990). The Chenier Plain Initiative area in Texas includes all of Chambers, Jefferson, Liberty, and Orange counties; encompassing Texas portions of the Chenier Plain Coastal Ecosystem (Gosselink et al., 1979) plus considerable areas of more interior agricultural lands.

The Chenier Plain Initiative area of Texas (hereafter referred to as Texas Initiative area) has a warm, humid climate with mean annual precipitation of 112 cm near Galveston Bay to about 125 cm near the Louisiana border (Chenier Plain Initiative Team, 1979). Soils are the product of sedimentation from rivers and the Gulf. Beach ridges parallel to the coast (cheniers) were formed by Gulf water currents. From the coast inland, a typical cross section currently contains beaches, cheniers, extensive estuarine to fresh water wetlands, and uplands. Interior upland sites in Texas are dominated by rice fields, while both coastal marsh and interior uplands are commonly used for cattle grazing.

Our 450,000-ha study area included the more coastal 85% of the Texas Initiative area (Fig. 1). Coastal Zone A (229,000 ha) contains most of the Texas parts of the Chenier Plain Coastal Ecosystem dominated by coastal marsh, while inland Zone B (221,000 ha) is dominated by more upland agricultural lands.

METHODS

Waterfowl Data

Midwinter aerial transect surveys have been conducted annually in the Chenier Plain Initiative area of Texas (Fig. 1) since 1976. We computerized waterfowl estimates for Zones A and B of the Texas Chenier Plain as reported by Haskins (1991). Estimates of numbers of 10 species of ducks, and the sum of these numbers (total ducks), were available for each zone (Texas Chenier Plain Zones A and B) and each year except 1979. The 10 duck species included in these survey results were canvasback (*Aythya valisineria*), gadwall, green-winged teal (*Anas crecca*), common mallard, mottled duck, northern pintail, redhead (*Aythya americana*), lesser scaup (*Aythya affinis*), northern shoveler (*Anas clypeata*), and American wigeon.

Midwinter inventories were conducted in early to mid-January each year by flying transects at a standardized altitude and speed in a fixed-wing aircraft (Haskins, 1991), and recording numbers of ducks observed within 200 m (220 yards) on either side of the aircraft. These raw numbers were then expanded to reflect numbers of ducks in each zone by multiplying the raw numbers by a factor representing the ratio of the area in each zone to the area surveyed in each zone. The expansion multiplier was 31.66 for Zone A, and 47.52 for Zone B.

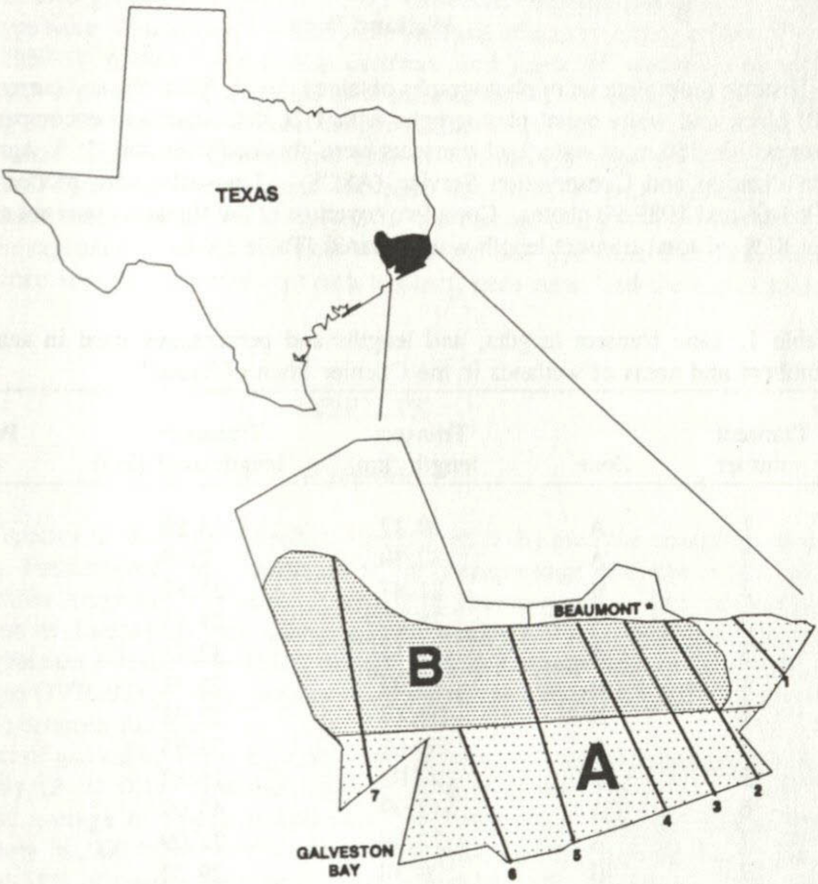

Fig. 1. January waterfowl survey transects and zones in the Chenier Plain of Texas.

Statistical analyses were conducted using the Statistical Analysis System (SAS Institute, 1985). Average proportions of ducks (by species) occurring in Zones A versus B were compared with Z tests to document waterfowl distribution. Estimated numbers of each species and total duck numbers were subjected to simple linear regression analyses (PROC REG of SAS) to delineate significant trends among years (1976-91) for each zone and zones combined. This approach was conservative because of the highly variable estimates of duck numbers that can occur due to variable weather conditions at the time of January surveys, and did not allow particularly low estimates in any one year to bias analyses. For species with significant ($P < 0.10$) trends, average annual rate of change in numbers (regression slope) and percent ($\bar{x}$ number change/year divided by $\bar{x}$ number observed across all years) were calculated; the overall percentage change (of lowest number/highest number X 100) was also calculated.

Wetland Data

Historic (complete set of photographs obtained during 1964-66) and current (1989-90) black and white aerial photographs with 1:20,000 scale and encompassing the area within 250 m of waterfowl transects were obtained from the U. S. Agricultural Stabilization and Conservation Service (ASCS). Transects were plotted on both 1964-66 and 1989-90 photos. Complete coverage of the transects was not available, but 81% of total transect length was acquired (Table 1).

Table 1. Line transect lengths, and lengths and percentages used in analyses of numbers and areas of wetlands in the Chenier Plain of Texas[†].

Transect number	Zone	Transect length (km)	Transect length used (km)	Percent used
1	A	29.87	15.85	53
2	A	32.30	7.19	22
2	B	21.87	21.87	100
3	A	25.71	21.93	85
3	A	32.11	32.11	100
4	A	28.08	25.71	92
4	B	31.13	29.63	95
5	A	39.60	28.95	73
5	B	27.02	16.32	60
6	A	43.99	43.99	100
7	A	22.09	22.09	100
7	B	29.30	29.30	100
Total or average		363.07	294.94	81

[†]Only those parts of transects for which both 1964-66 and 1989-90 aerial photos were available could be used.

Transect lines were flown in a Cessna 182 fixed-wing aircraft (equipped with a Loran Navigation System) at 305 m (1000 feet) above ground level at 100 km hr^{-1} during 26-29 May 1992. All wetlands within 250 m of transect lines were identified on 1989-90 photos, and classified according to Cowardin et al. (1979) with as much detail as possible. Subsequent analyses comparing wetland images on 1989-90 photos allowed delineation of wetlands on 1964-66 photos using the same level of detail in classification. In identifying wetlands on both 1989-90 and 1964-66 photos, only areas showing water or hydrophytic vegetation were considered wetlands; dry wetland basins were not considered wetlands because we could not identify them. Fortunately, conditions at the time of our 1992 aerial surveys, and at the times of all aerial photography, were relatively wet.

Numbers and area of wetlands by type were quantified from surveyed portions of both 1964-66 and 1989-90 photos using an electronic digitizer capable of recording 0.1 ha wetlands given the 1:20,000 scale. Observed numbers and areas of each wetland type were summarized for each zone segment of each transect on both 1964-66 and 1989-90 photos. Observed numbers and areas of wetlands in each zone/transect segment were analyzed in a manner similar to waterfowl data, but accounting for both reduced transect length (Table 1) and the ratio of sampled to available area. Expanded 1964-66 and 1989-90 estimates of numbers and area of each wetland type were summarized for each zone area of each transect, each transect, each zone, and the entire study area. Percentage changes from 1964-66 to 1989-90 in expanded numbers and areas of each wetland type were then calculated for each zone area of each transect, each transect, each zone, and the entire study area.

RESULTS

Waterfowl

All ten species of ducks selectively (Z-tests, $P < 0.01$) used the coastal Zone A (Table 2). Furthermore, the distribution of ducks (percentage of ducks in Zone A) did not differ (regression F-tests, $P > 0.10$) among years. The percentage composition of ducks (e.g., percentage of total ducks that were mallards) did not differ (regression F-tests, $P > 0.10$) among years in the study area or either zone. The average (1976-91) percentage composition of ducks also did not differ (Z-tests, $P > 0.10$) between the zones.

Numbers of gadwalls, mallards, mottled ducks, pintails, wigeons, and total ducks significantly ($P < 0.10$) declined between 1976 and 1991 (Table 3). Pintails declined an average of nearly 16,000 $year^{-1}$, and total ducks declined an average 7.8% (nearly 30,000 birds $year^{-1}$). Overall, numbers of ducks in the study area declined to 11% of peak populations between 1976 and 1991 (Table 3). Only 1% of peak wigeon, 2% of peak pintail, and 5% of peak mallard numbers were present in 1991.

These declines in duck numbers were almost entirely due to declines in Zone A (Table 3). Gadwalls, mallards, mottled ducks, and wigeon significantly ($P < 0.10$) declined in Zone A, while no declines in duck numbers ($P > 0.10$) were detected in Zone B.

Table 2. Average percentages[†] of ducks in Zone A estimated in the Chenier Plain of Texas in January 1976-91.

Species	% in Zone A	Species	% in Zone A
Canvasback	96.4	Pintail	73.9
Gadwall	95.2	Redhead	99.7
Green-winged teal	84.3	Scaup	98.5
Mallard	86.5	Shoveler	72.4
Mottled duck	81.7	Wigeon	96.7
Total ducks	82.5		

[†]Percentages did not change 1976-91, $P > 0.10$.

Table 3. Significant ($P < 0.10$) simple linear regressions showing declines in numbers of ducks in January in the Chenier Plain of Texas 1976-91[†].

Zones[‡]/Variable	F - value[§]	P	$\bar{x}$ change year^{-1} No.	$\bar{x}$ change year^{-1} %[¶]	Overall % decline[#]
Combined zones					
Gadwall	18.4	0.001	-4,724	-10.2	90
Mallard	15.9	0.002	-1,221	-8.7	95
Mottled duck	29.8	0.001	-666	-7.6	74
Pintail	3.9	0.072	-15,925	-11.3	98
Wigeon	3.7	0.079	-1,263	-14.7	99
Total ducks	5.5	0.036	-29,677	-7.8	89
Zone A					
Gadwall	20.9	0.001	-4,886	-11.1	90
Mallard	18.5	0.001	-1,167	-9.6	95
Mottled duck	40.2	0.001	-699	-9.9	77
Wigeon	3.2	0.099	-1,198	-14.4	99

[†]No data were available for 1979.
[‡]No significant ($P > 0.10$) changes occurred 1976-91 in Zone B.
[§]df = 1, 12 for all tests.
[¶]% = $\bar{x}$ number change/year divided by $\bar{x}$ number observed in all years. This is a rate-of-change estimate and not a percentage of peak population numbers that would eventually reach zero.
[#]Percentage change from peak estimates 1976-91; lowest estimates for all species occurred in 1991.

Wetlands

The number of wetlands in the study area declined 12% between 1964-66 and 1989-90 (Table 4). Area of wetlands declined 16% over the same period, from 269,128 ha to 226,887 ha. Nearly 16,000 ha (24%) of Estuarine wetlands were lost or altered, including 49% of Aquatic Bed and 31% of Emergent Intertidal Estuarine wetlands. Estuarine Subtidal Unconsolidated Bottom wetlands increased 69%. Nearly 20,000 ha (15%) of Palustrine wetlands were lost, including 13% of Aquatic Bed and 18% of Emergent classes. Area of Palustrine Emergent diked/impounded, and Palustrine Unconsolidated Bottom wetlands increased 166% and 754%, respectively. Area of Riverine wetlands changed little overall, although area of excavated Riverine wetlands increased 40%. Area of Lacustrine wetlands increased 37%, from 6,226 ha to 8,498 ha. Area of shallow Lacustrine Littoral wetlands declined 17%, while deeper Lacustrine Limnetic wetlands (particularly diked/impounded areas) increased 45%.

The most significant changes in numbers and areas of wetlands occurred in Zone A (Tacha et al., 1992:tables 5,6). In Zone A, declines in area of valuable Estuarine Intertidal, Palustrine, and Lacustrine Littoral wetlands, and increases in generally poorer quality diked/impounded and Unconsolidated Bottom wetlands, follow changes for the entire study area. Flooded rice fields declined in both zones, but a nearly 50% decline occurred in Zone A.

Table 4. Numbers and areas of wetlands in the Chenier Plain of Texas 1964-66 and 1989-90 (wetland classification from Cowardin et al., 1979).

System / Subsystem / Class / Subclass	Numbers† 1964-66	Numbers† 1989-90	Numbers† % change	Area (ha) 1964-66	Area (ha) 1989-90	Area (ha) % change
Estuarine	2,908	3,656	+26	67,989	51,916	−24
Intertidal	2,207	2,650	+21	66,089	48,708	−26
Aquatic bed	312	234	−25	1,320	668	−49
Emergent	791	1,061	+34	55,991	38,854	−31
Uncon. shore	1,104	1,355	+23	8,777	9,186	+5
Diked/impnd	30	30	0	639	590	−8
Subtidal	701	1,006	+44	1,901	3,207	+69
Uncon. bottom	701	1,006	+44	1,901	3,207	+69
Excavated	481	686	+43	1,326	2,987	+25
Lacustrine	483	507	+5	6,226	8,498	+37
Limnetic	368	392	+7	5,362	7,781	+45
Aquatic bed	115	170	+48	2,591	3,191	+23
Diked/impnd	0	55	+++	0	1,041	+++
Uncon. bottom	253	222	−12	2,771	4,590	+66
Diked/impnd	35	127	+263	194	4,252	+2,092
Littoral	115	115	0	863	717	−17
Aquatic bed	115	115	0	863	717	−17
Palustrine	16,257	13,072	−20	188,370	159,928	−15
Aquatic bed	416	746	+79	888	777	−13
Diked/impnd	30	25	−17	22	5	−77
Emergent	13,665	9,946	−27	178,663	146,670	−18
Diked/impnd	502	1,773	+235	12,425	33,022	+166
Farmed rice	10,955	7,116	−35	144,615	99,326	−31
Forested	522	411	−21	7,658	2,554	−67
Uncon. bottom	1,654	1,968	+19	1,162	9,927	+754
Diked/impnd	90	96	+07	57	1,345	+2,260
Excavated	278	511	+84	122	223	+83
Riverine	3,005	2,784	−7	6,543	6,545	+1
Lower perennial	3,005	2,784	−7	6,543	6,545	+1
Uncon. bottom	3,005	2,784	−7	6,543	6,545	+1
Excavated	1,491	2,010	+35	2,781	3,882	+40
Total	22,653	20,019	−12	269,128	226,887	−16

†Numbers of estuarine and riverine wetlands may be inflated due to sampling approach.

DISCUSSION AND CONCLUSIONS

Waterfowl

The circa 90% declines in numbers of each species (except mottled ducks with a 74% decline) in the Texas Chenier Plain area far exceeds the more modest declines observed in continental, Central Flyway, Texas statewide or Texas Gulf coastal duck populations (Haskins, 1991; Caithamer et al., 1992). Given that the magnitude of these large declines cannot be attributed to continental, flyway, statewide, or Texas coastal duck population changes, the Texas Chenier Plain waterfowl habitat base has almost certainly declined in quantity and/or quality since 1976.

The Chenier Plain Initiative Team (1990:table 16) listed population baseline (averages of 1984-88 Midwinter Inventories) and objectives for ducks in the Texas Initiative area. Duck populations are currently (1990-92) averaging only about 6% of population objectives. Furthermore, current populations on average are only 20% of the baseline populations. Clearly, massive effort will be required just to stabilize duck population declines, let alone meet Texas Initiative area objectives.

Wetlands

Wetland losses from 1964-66 through 1989-90 in the Texas Initiative area (42,000 ha destroyed) were primarily in Zone A. The largest losses of habitat were Estuarine Intertidal Emergent (17,000 ha) and Palustrine Emergent Farmed (50,000 ha of primarily rice fields) wetlands. Not all of these wetlands were destroyed, but rather many were converted to Palustrine Unconsolidated Bottom (8,000 ha), Lacustrine Limnetic (2,400 ha), and/or were diked/impounded or excavated (19,000 ha). These 1964-66 through 1989-90 losses and conversions are consistent with overlapping similar estimates made for the entire Chenier Plain during 1952-74 by Gosselink et al. (1979). Unfortunately, direct comparisons are not possible due to differences in classification methods, and the fact that Gosselink et al. (1979) did not separately summarize Texas losses.

Losses of Estuarine and Palustrine Emergent wetlands were probably due to subsidence, saltwater intrusion, and continuing disruption of freshwater inflows described in detail by Gosselink et al. (1979). Conversion of these emergent wetlands to open water (all unconsolidated bottom and Lacustrine Limnetic, and most diked, impounded, or excavated wetlands) was probably primarily the result of subsidence and saltwater intrusion in Estuarine areas, and construction of levees and canals in Palustrine areas (Gosselink et al., 1979; Craig et al., 1980). Large-scale pumping of groundwater for use in agriculture and industry, and dredging of large navigation channels, is responsible for much of the subsidence and saltwater intrusion (Chenier Plain Initiative Team, 1990). These degradations are exacerbated by reductions in freshwater inflows caused by interior levees, ditches, pipelines, roads, and canals.

Wetland/Waterfowl Associations

Estuarine and Palustrine Emergent (particularly when salinities are < 5 g L^{-1}) wetlands are generally high quality waterfowl habitat (Palmisano, 1973; Chabreck, 1979; Gosselink et al., 1979; Stutzenbaker and Weller, 1989). Palustrine Emergent

Farmed (rice field) wetlands are particularly valuable (Hobaugh et al., 1989). Losses and conversion of these to less productive open water habitats (Gosselink, 1984; Armstrong, 1987) undoubtedly has had a negative impact on duck numbers in the Texas Initiative area (Gosselink et al., 1979; Briggs and Everett, 1983). Although open-water wetlands are not necessarily less productive or valuable to ducks than emergent wetlands (see Stutzenbaker and Weller, 1983), many of the converted wetlands in this study have greater water depth, and higher salinities, turbidity, or disturbance that render them far less valuable to ducks (Gosselink et al., 1979; Stutzenbaker and Weller, 1989).

Substantial losses and degradation of wetlands have probably directly influenced the decline in duck use of the Texas Initiative area. However, we do not believe the dramatic declines in duck use can be entirely explained by the changes in wetland habitats we have documented. Perhaps declining duck use in the Texas Initiative area is aggravated by less tangible degradation of the entire coastal marsh ecosystem, or by widespread pollution, disturbance, or other less obvious habitat changes. A comprehensive, in-depth field study focused on details of duck habitat, population, and behavioral ecology will be needed to fully understand the precipitous declines in duck use of the Texas Chenier Plain area.

MANAGEMENT IMPLICATIONS

This study documented dramatic declines in duck use, and losses and degradation of wetlands, associated with coastal Zone A of the Texas Chenier Plain area. Wetland management efforts should clearly focus on Zone A. Within Zone A, we specifically recommend (in descending order of priority):

1. Organized state and federal interagency efforts to combat soil subsidence and salt water intrusion via control of dredging, filling, ditching, and draining of wetlands and their water sources. Aggressive enforcement and more restrictive interpretation of regulations associated with Section 404 of the Clean Water Act, and swampbuster provisions of the Food Security Act, may be necessary to have a meaningful effect.
2. Restoration, enhancement, and/or acquisition of Estuarine and Palustrine Emergent wetlands, with emphasis of marsh productivity in general, and early successional seed-bearing annual (moist soil) plants in particular. Priority for ducks should be given to wetlands capable of maintaining < 5 g L^{-1} salinities (fresh and intermediate marshes). Restoration of historic duck use may require addition of as much as 50,000 ha of these high-quality wetlands.

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