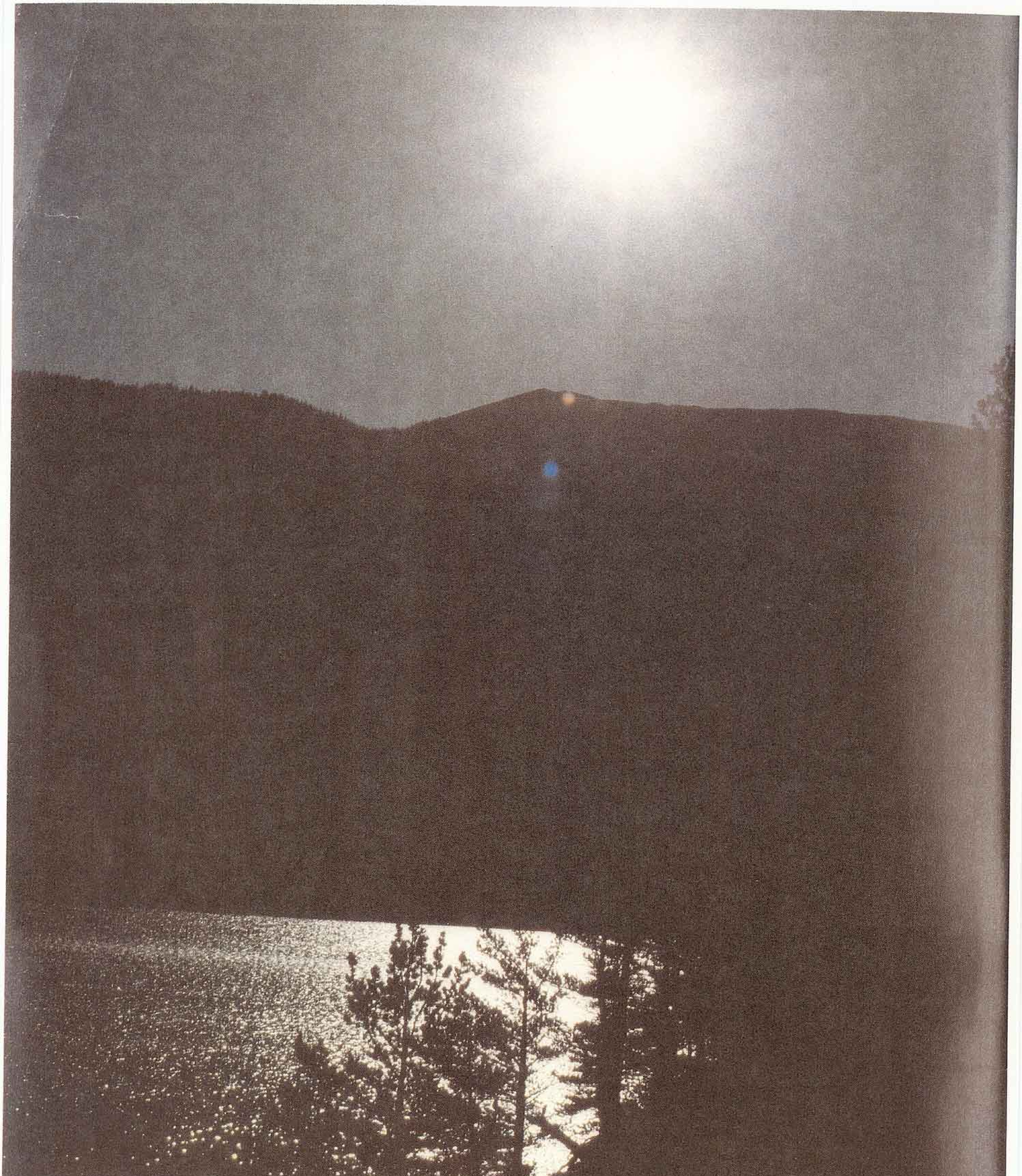
STATUS AND TRENDS OF

WETLANDS AND DEEPWATER HABITATS

IN THE CONTERMINOUS UNITED STATES, 1950's TO 1970's



STATUS AND TRENDS OF WETLANDS AND DEEPWATER HABITATS IN THE CONTERMINOUS UNITED STATES, 1950's TO 1970's

April 1983

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cover: Lake Drummond, Virginia (Lacustrine)

left: Chambers Lake, Colorado (Lacustrine)

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HIGHLIGHTS

Total acreage of wetlands and deepwater habitats in the 48 conterminous United States in the 1950's was 179.5 million acres. In the 1970's it was 171.9 million acres, a net loss of 7.6 million acres. Average annual net loss for the 20-year period was 380 thousand acres.

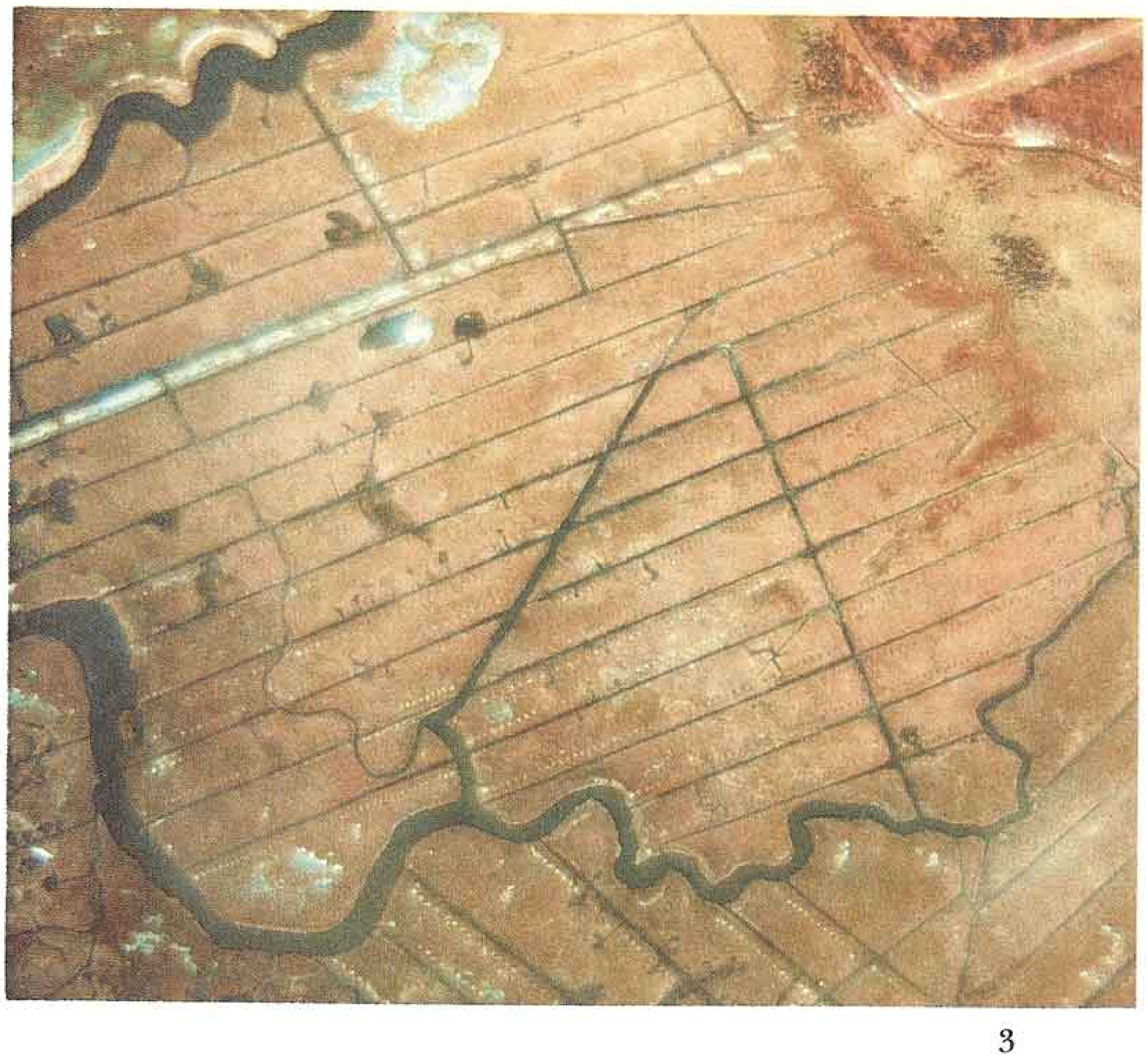
There were important gains in deepwater habitats. There were 71.3 million acres of deepwater habitats in the 1950's and 72.9 million acres in the 1970's, a net increase of 1.6 million acres. Average annual net gain was 78 thousand acres. Lacustrine deepwater habitats (lakes) had a net national gain of 1.4 million acres, most of which came from nonagricultural and nonurban areas due to the construction of lakes and reservoirs. Estuarine subtidal deepwater habitats (bay bottoms) increased by 200 thousand acres.

There were 108.1 million acres of wetlands in the 1950's and 99.0 million acres in the 1970's, a net loss of over nine million acres. Average annual net loss was 458 thousand acres. Average annual net loss of palustrine wetlands (inland wetlands) was 439 thousand acres, and the remaining loss was from estuarine wetlands (coastal wetlands).

Increases in palustrine wetlands occurred in palustrine open water areas (ponds). There were 2.3 million acres of palustrine open water wetlands in the 1950's. This increased to 4.4 million acres in the 1970's, an average annual net gain of over 100 thousand acres.

left: Chesapeake Bay (Estuarine Subtidal)
right: Infrared photograph showing mosquito ditching in New Jersey

Major losses in palustrine wetlands occurred in palustrine vegetated wetlands. There were 99.8 million acres of palustrine vegetated wetlands in the 1950's and 88.8 million acres in the 1970's, an average annual net loss of 553 thousand acres. Losses from palustrine forested wetlands (swamps) accounted for 300 thousand acres of average annual net loss, while palustrine emergent wetlands (marshes and wet meadows) accounted for an average annual net loss of 234 thousand acres.



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left: Coastal Florida (Estuarine Intertidal Forested and Scrub/Shrub)

CHAPTER ONE
INTRODUCTION

The United States Fish and Wildlife Service has major responsibility for the protection and proper management of migratory and endangered fish and wildlife and their habitat. In 1974 the U.S. Fish and Wildlife Service directed its Office of Biological Services to design and conduct an inventory of the nation's wetlands. The mandate was to develop and disseminate a technically sound, comprehensive data base concerning the characteristics and extent of the nation's wetlands. The purpose of this data base is to foster wise use of wetlands by providing the information needed to make sound decisions. To accomplish this, principles and methods pertaining to all aspects of wetland inventory were assimilated and developed by the newly formed National Wetlands Inventory Project.

By 1979, it was clear that two very different kinds of information were needed. First, national statistics on the current status and trends of wetlands were needed in order to provide information for development or alteration of federal programs and policies. Secondly, detailed wetland maps for geographic areas of critical concern were needed for site-specific decisions. Included are such areas as coastlines, the Great Lakes and prairie potholes regions, and floodplains of major rivers.

In order to obtain national statistics, the U.S. Fish and Wildlife Service instituted a study in 1979 called "Statistical Analysis of Wetland Gains and Losses Over the Past 20 years in the Conterminous United States." The National Wetlands Inventory Project, assisted by an interagency group of statisticians from the Fish and Wildlife Service, Forest Service, Soil Conservation Service and the Corps of Engineers, developed and awarded a competitive procurement to construct a statistical design for a national survey which can be intensified to obtain reliable estimates for areas such as individual states. Data acquisition and generation were done by the National Wetlands Inventory Project.

This study documents natural and man-induced wetland and deepwater habitat gains and losses in the 48 conterminous United States between the mid-1950's and mid-1970's. It does not reveal gains or losses prior to the mid-1950's or after the mid-1970's. While it provides estimates of the abundance of the nation's wetlands and deepwater habitats, it does not provide information on their quality. This report presents significant findings at the national level.

FLYWAYS OF THE UNITED STATES

left: Seney National Wildlife Refuge, Michigan (Lacustrine)

CHAPTER TWO

CLASSIFICATION OF WETLANDS AND DEEPWATER HABITATS

National estimates of status and trends were needed for several kinds of wetlands and deepwater habitats. The classification and categories used are described by Cowardin, **et al.** (1979). Groupings of categories were made to accommodate 1) the special interests of the study and 2) the detail to which available aerial photography could be interpreted.

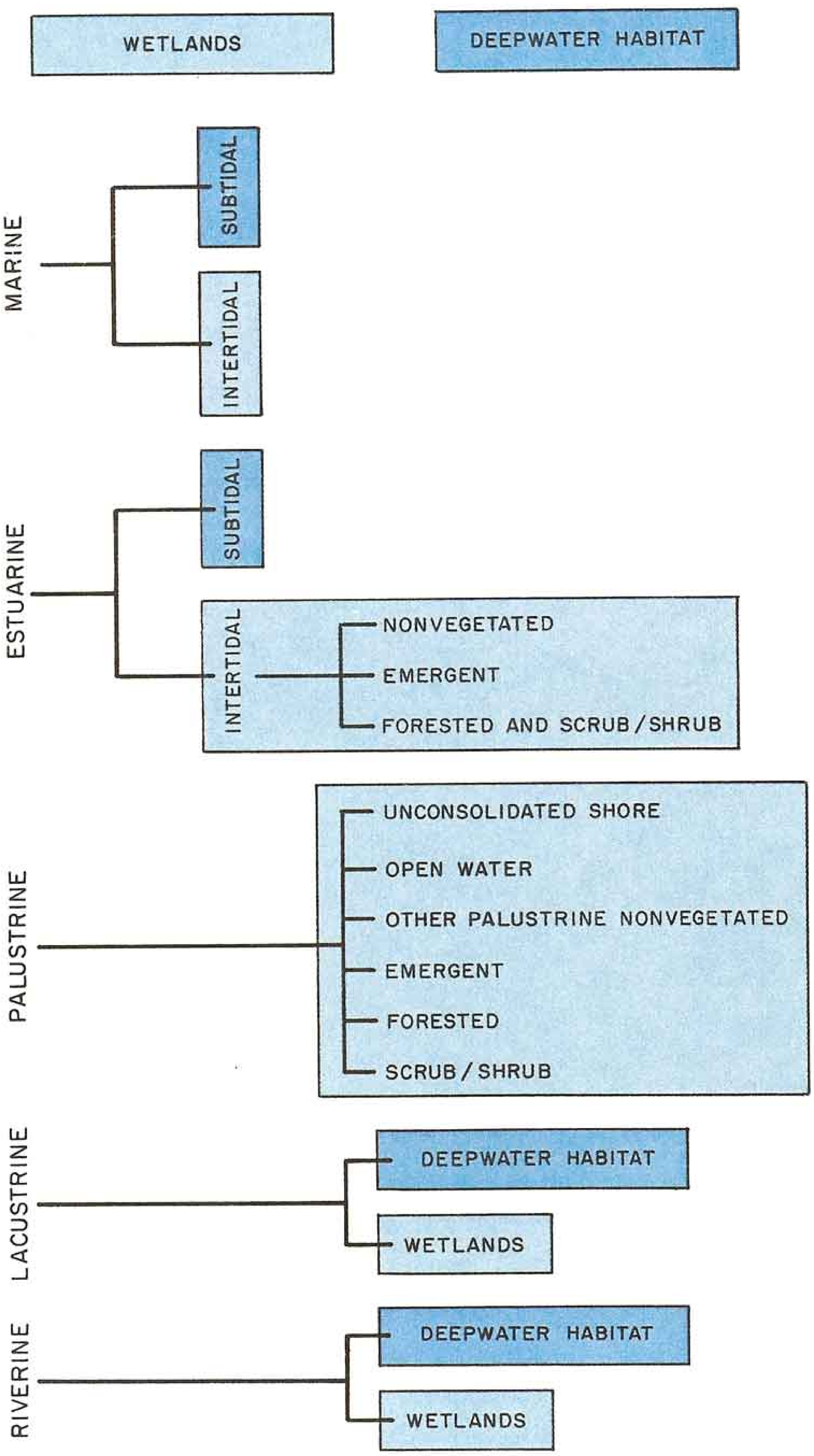
In general terms, wetland is land where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Technically, wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes; 2) the substrate is predominantly undrained hydric 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. Common terms used to describe various wetlands include marshes, swamps, bogs, small ponds, sloughs, potholes, river overflows, mud flats, and wet meadows.

Deepwater habitats are permanently flooded lands lying below the deepwater boundary of wetlands. In saltwater areas, the separation between wetland and deepwater habitat coincides with the elevation of the extreme low water of spring tide. In other areas, the separation occurs at a depth of two meters (6.6 feet) below low water. This is the maximum depth in which emergent plants normally grow.

left: White River, Arkansas (Palustrine Forested)**right:** Savannah Wildlife Refuge, South Carolina (Palustrine Emergent)

Within the classification structure that follows, wetlands and deepwater habitats are grouped according to systems. A system consists of environments of similar hydrological, geomorphological, chemical and biological influence. Each system is further

CLASSIFICATION USED IN THE STUDY



divided by the driving ecological force, such as ebb and flow of tide, and by substrate material and flooding regimes, or on vegetative life form.

The **Marine System** extends from the outer edge of the continental shelf to the high water of spring tides or to the boundary of other systems as defined later. **Marine Subtidal** includes that portion that is continuously submerged. Because of relatively small expected change in this portion, it was not included in this study. **Marine Intertidal** includes areas in which the substrate is exposed and flooded by tides, including the associated splash zone.

The **Estuarine System** consists of deepwater tidal habitats and adjacent tidal wetlands which are usually semi-enclosed by land, but have open, partially obstructed, or sporadic access to the open ocean and in which ocean water is at least occasionally diluted by fresh water runoff from the land. Offshore areas with typically estuarine plants and animals, such as mangroves and oysters,

below: Coastal Oregon (Marine Intertidal)

are also included. **Estuarine Subtidal** is that portion that is continuously submerged (considered deepwater habitat), while **Estuarine Intertidal** is the portion exposed and flooded by tides including the associated splash zone. For the purposes of this study, **Estuarine Intertidal** wetlands are shown by the following groups: **Nonvegetated, Emergent, Forested** and **Scrub/Shrub. Nonvegetated** contains no emergent vegetation but does include vegetation in the form of aquatic beds, while **Emergent** contains primarily those erect, rooted herbaceous plants typically found in wet environments. **Forested** is characterized by the presence of trees, and **Scrub/Shrub** includes areas dominated by shrubs and small or stunted trees.

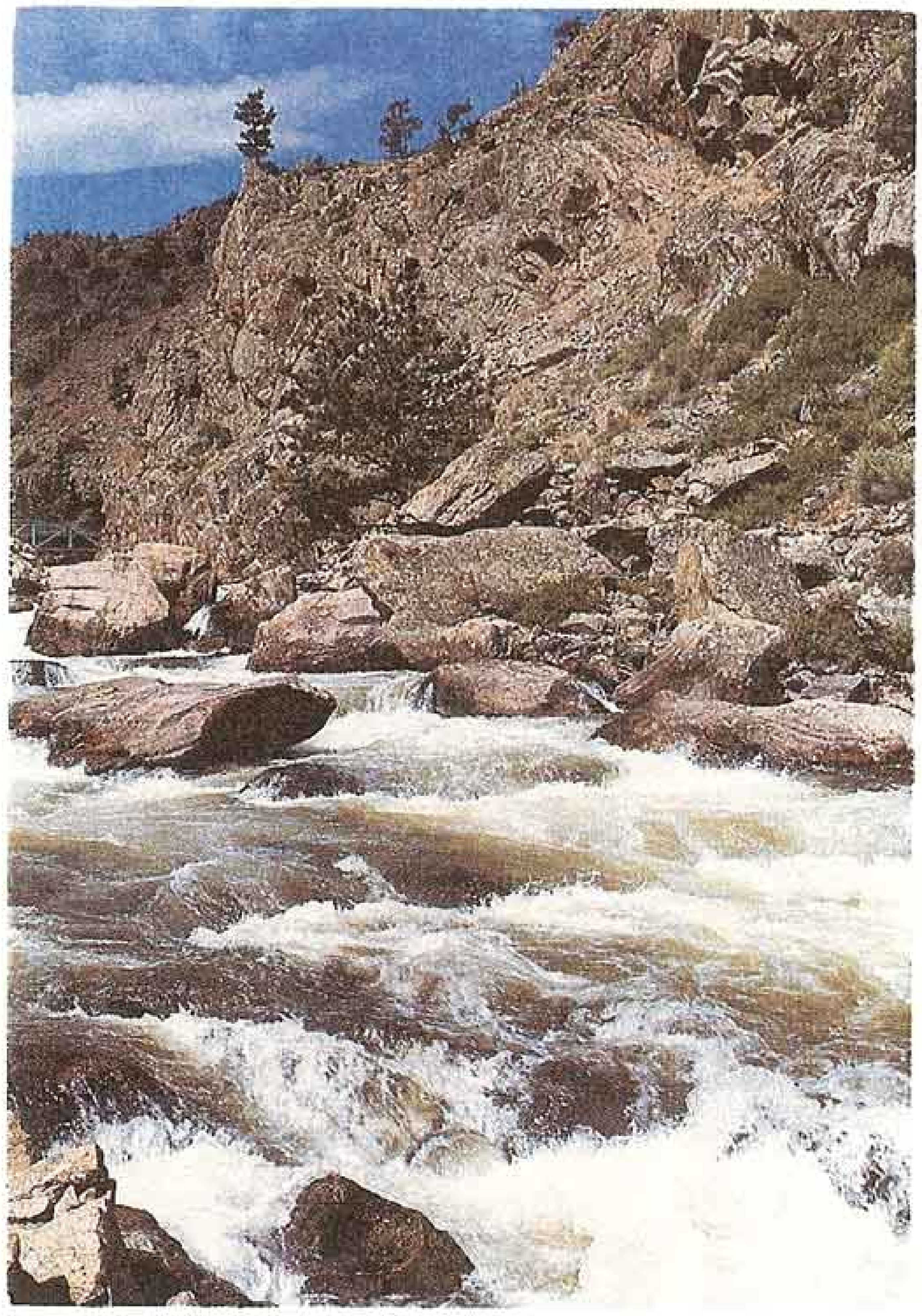
The **Lacustrine System** includes wetlands and deepwater habitats situated in

left: Florida Everglades (Estuarine Intertidal Forested and Scrub/Shrub) **below:** Rabbit Island, Louisiana (Estuarine Intertidal Emergent)

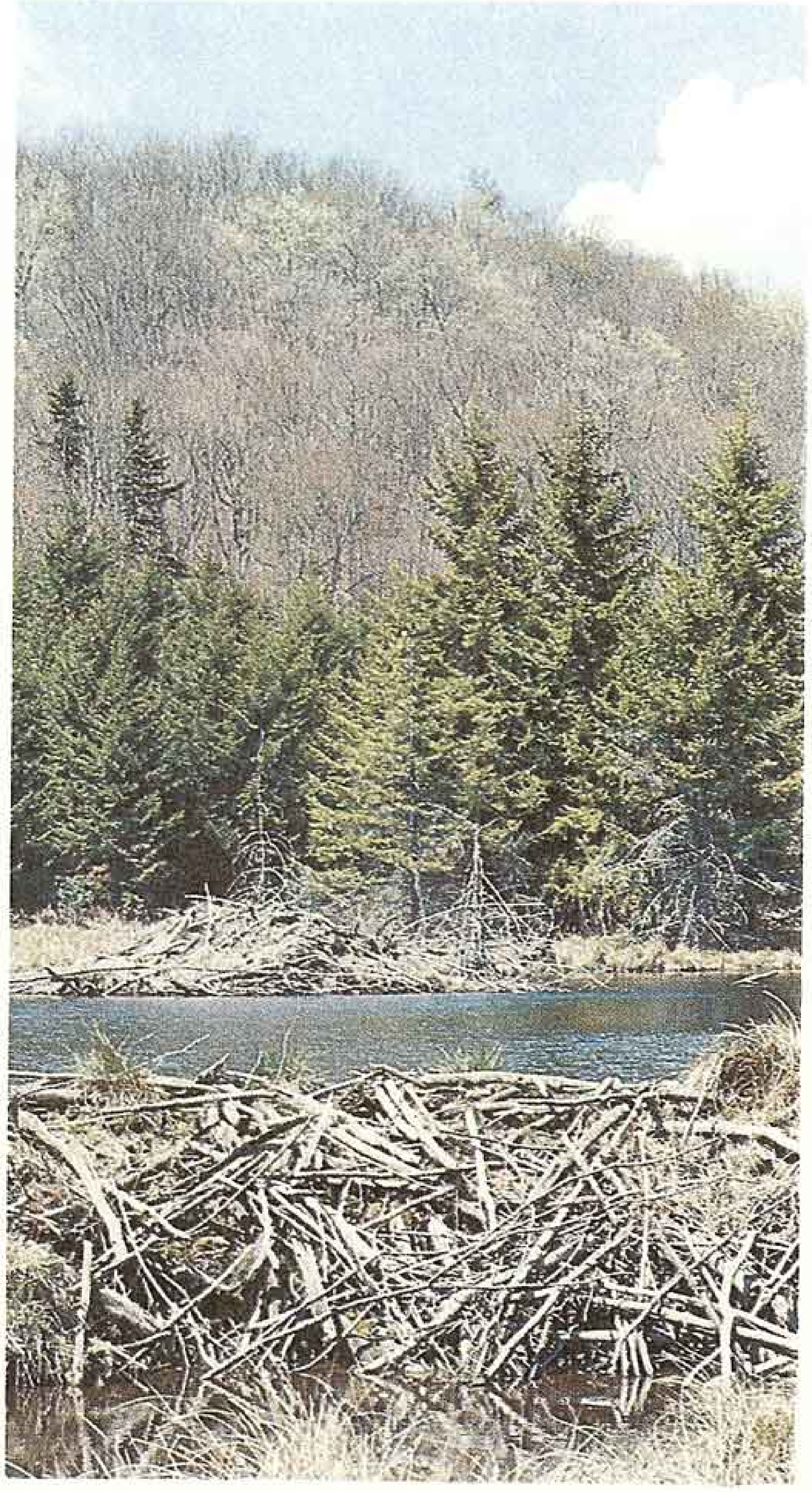
topographic depressions or dammed river channels. Each area must exceed 20 acres or have depths in excess of two meters or have an active wave-formed or bedrock shoreline feature. The **Lacustrine System** consists of open water (considered deepwater habitat) and associated wetlands.

The **Riverine System** includes wetlands and deepwater habitats contained within a channel. There was little interest (because of small expected net changes) in the **Riverine System.** It was included in **Other Surface Area.**

The **Palustrine System** includes all nontidal wetlands not included within any of the other four systems. There are no deepwater habitats included. For this study, the **Palustrine** wetlands are shown by the following groups: **Unconsolidated Shore, Open Water, Other Palustrine Nonvegetated, Emergent, Forested** and **Scrub/Shrub. Unconsolidated Shore** includes wetlands generally having unstable substrates with less than 75 percent cover of stones, boulders or bedrock, and little or no vegetation. **Open Water** includes small



above: Cache La Poudre River, Colorado (Riverine) **left:** Apalachicola, Florida (Palustrine Forested) **below:** Eastern Maine (Palustrine Scrub/Shrub)

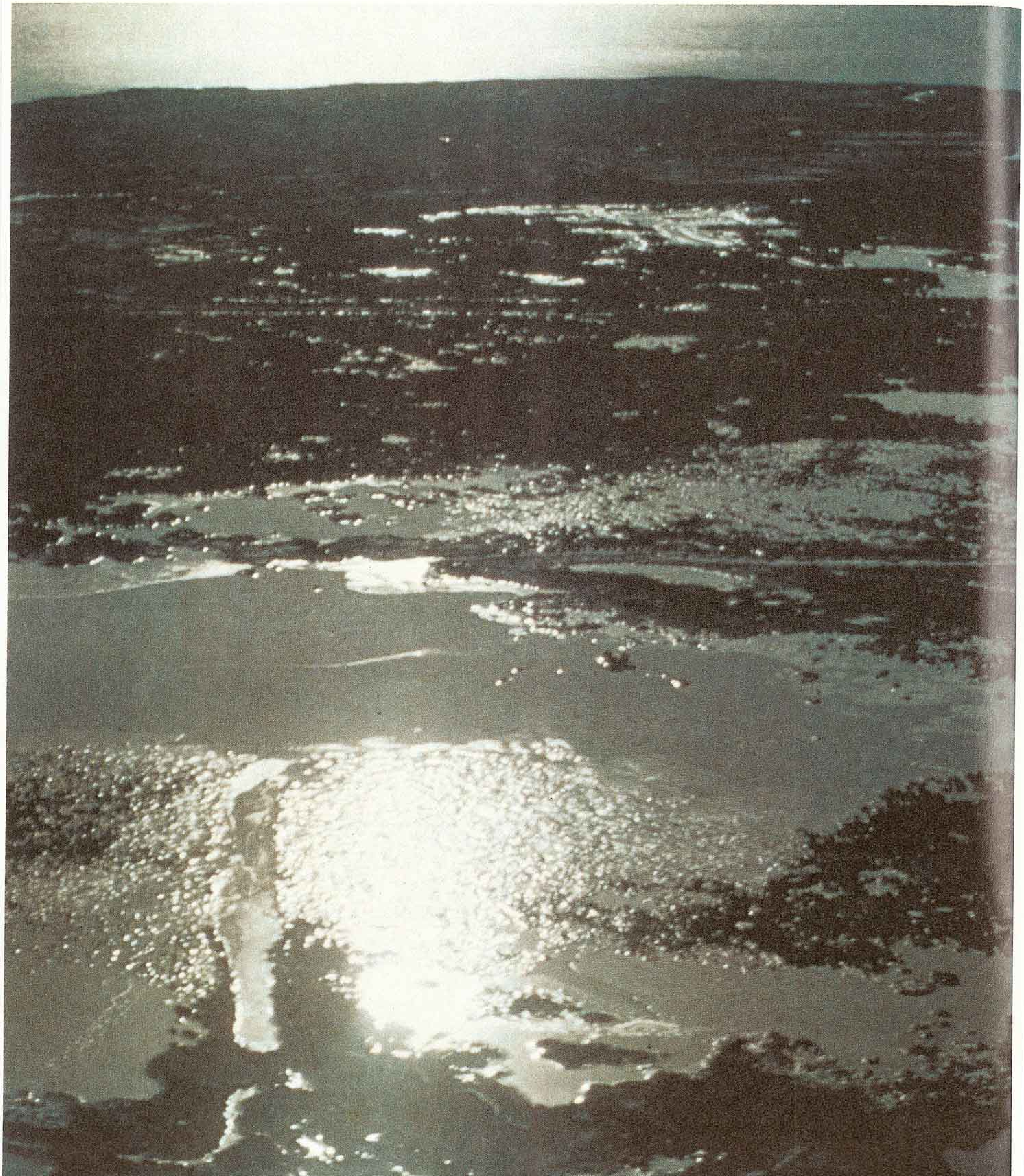


inland open water bodies that are not part of the **Lacustrine System. Other Palustrine Nonvegetated** includes other inland wetlands with little or no vegetation other than aquatic beds, and the remaining terms are defined as they were under the **Estuarine System.**

In addition to **Other Surface Area,** two more categories were used in the study. These are **Urban** and **Agriculture;** and, together with **Other Surface Area** (forests, rangeland, etc., not qualifying as wetland), they account for all other areas not considered wetlands or deepwater habitats.

This is only a brief discussion of the classification used in the study. It is difficult to differentiate the categories further without introducing highly technical terms. For those interested in detailed, exact definitions, the descriptions presented by Cowardin, **et al.** (1979) are available.

left: Highland County, Virginia (Palustrine Open Water) **below:** Southern Virginia (Unconsolidated Shore)



CHAPTER THREE

SURVEY PROCEDURE

The objective of the study was to develop statistical estimates of acreage for categories of wetlands and deepwater habitats for the lower 48 states during the 1950's, the 1970's and the change for the period. A survey was designed to develop national statistics for the 1970's that will, on the average, have a probability of 90 percent that estimated totals are within 10 percent of the true totals, by category.

The sampling design and data compilation procedures were developed to generate flyway and state estimates also. Although these estimates are less reliable, they provide a basis for designing and intensifying flyway or state studies to obtain precise estimates.

A stratified random sample was used with the basic strata being formed by state boundaries and the 35 physical subdivisions described by E.H. Hammond (1970). Additional strata specific to the study are special coastal strata encompassing the Marine Intertidal category and Estuarine System and other strata encompassing the Great Lakes. This resulted in over 200 strata for the study.

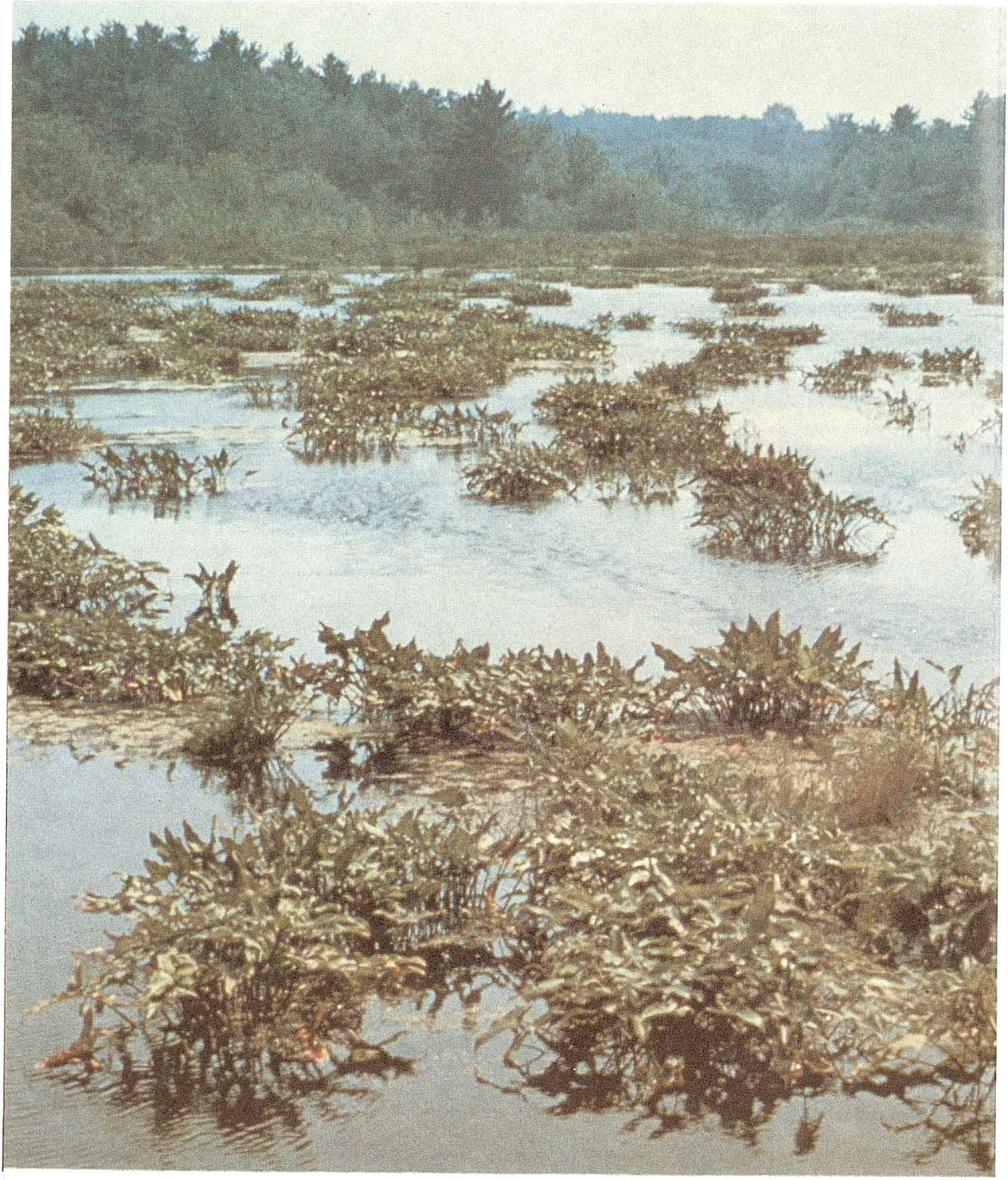
Sample units were allocated to strata in proportion to the expected amount of wetland and deepwater habitat acreage as estimated by earlier work (including Shaw and Fredine, 1956). A total of 3635 sample units were used in the study.

Each sample unit is a four-square mile area, two miles on each side. After the units were selected at random within strata and plotted on U.S. Geological Survey topographic maps, aerial photography was obtained for the 1950's and 1970's. The majority of the 1950's photography was 1:20,000 scale black and white and for the 1970's it was 1:40,000 black and white.

left: Cambridge, Maryland (Estuarine Intertidal Emergent) **right:** Central Massachusetts (Palustrine Emergent)

Scales were adjusted using stereo zoom transfer scopes. The units were photointerpreted in entirety for the 1950's and the changes were photointerpreted on the 1970's photos. All wetland and deepwater habitat changes were marked as to cause, either natural or human induced. The photointerpreted data from each unit were then prepared for computer analysis. Several quality control checks were routinely made to eliminate errors.

Photointerpretation and data compilation were completed in July, 1982.



CHAPTER FOUR
RESULTS

Interpretation of Results

Estimates produced include proportions of area and their standard errors, acreages with standard errors, and coefficients of variation. As mentioned earlier, the major objective of the study was to obtain national statistics but estimates were compiled for flyways, states and even for areas within individual states. Many estimates, especially at the state level, are not considered reliable enough to recommend their use for making decisions. An indication is given of the reliability of each estimated acreage in the tables included in this report. The standard error of each entry expressed as a percentage of the entry (SE%) is given in parentheses. 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 entry the SE%/100 times the entry." For example, if an entry is one million acres and the SE% is 20, then we are 68 percent confident that the true value is between eight hundred thousand and 1.2 million acres. An equivalent statement for 95 percent confidence can be made by adding and subtracting twice the amount to and from the entry.

It is easy to see that a large SE% indicates low reliability, if any, in the estimate. In fact, if the SE% is 50 or greater, we cannot even say that we are 95 percent confident that the true value is not zero.

This discussion on reliability is meant to aid in interpretation of the study results. It was expected that only certain estimates would be precise enough to use for national planning. However, it was also anticipated that future intensification of sampling might be carried out to provide reliable results for selected critical areas. For this reason, estimates were made even for areas within individual states. Even though those results are not included in this report, they are available for planning future intensified studies.

left: Eastern Massachusetts (Palustrine Emergent)

The intent was for the period of study to be from the 1950's to the 1970's. The median years of the photography are 1954 and 1974, with over 98 percent of the photo coverage within five years of the median years. The median and mode interval is 20 years, and the average interval is 20.0 years. Thus, the results should be interpreted in terms of a 20-year interval.

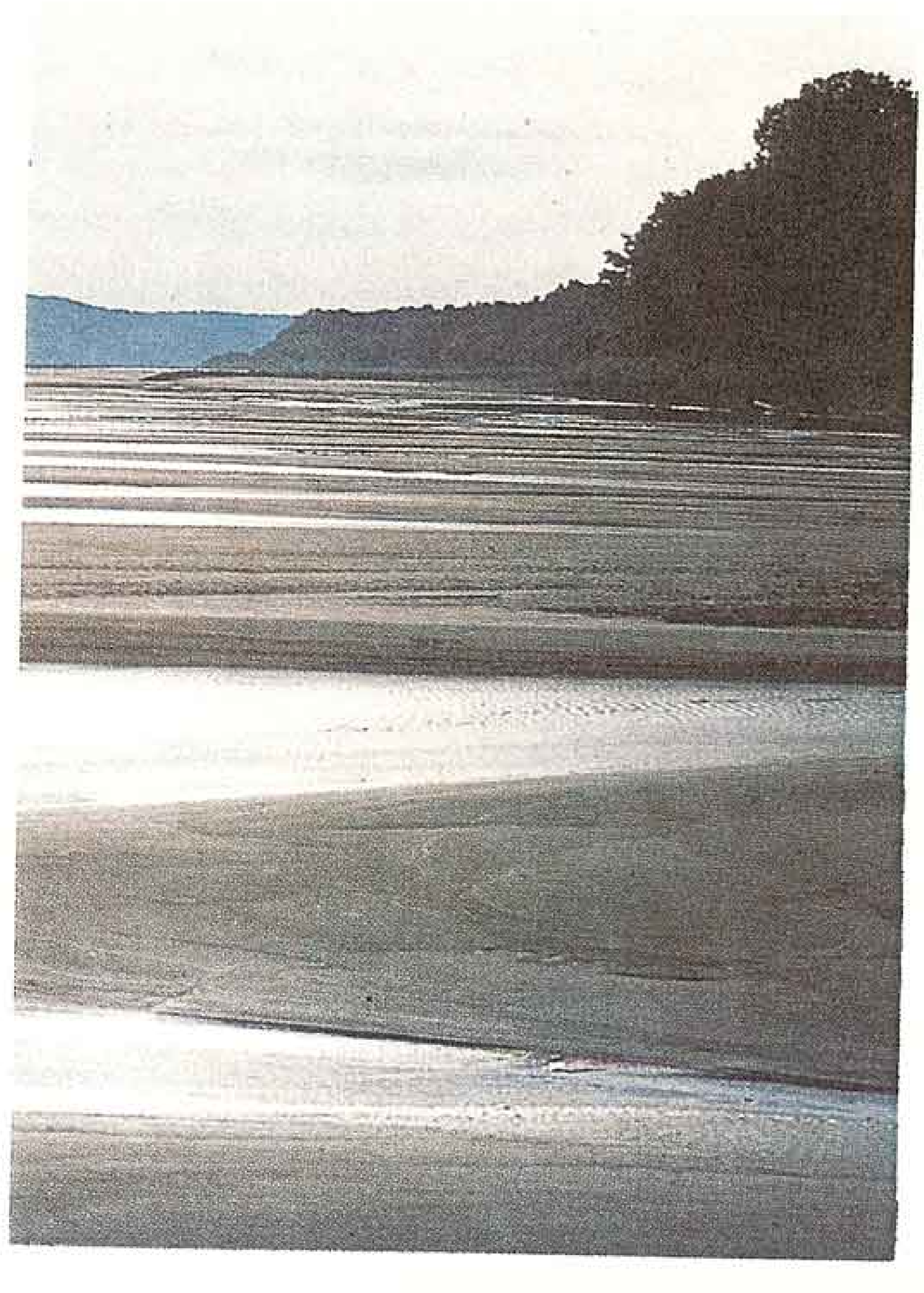
Estimates for the 1950's, 1970's and change during the period were produced for the categories described in Chapter Two. These estimates are given in Table 1. Totals for columns are estimates of total acreage by category for 1974. Row totals (the extreme right column) are estimates of total acreage by category for 1954. Entries are interpreted as in the following examples (all from the ninth row or column of Table 1):

- 46,299.4 thousand acres classified as Palustrine Forested in 1954 was again classified Palustrine Forested in 1974.
- 6,214.5 thousand acres classified as Palustrine Forested in 1954 had changed to Agriculture by 1974.
- 1,929.6 thousand acres classified as Palustrine Scrub/Shrub in 1954 had changed to Palustrine Forested by 1974.
- The estimate of Palustrine Forested area in 1954 is 55,707.4 thousand acres.
- The estimate of Palustrine Forested area in 1974 is 49,713.4 thousand acres.
- The estimate of net change in Palustrine Forested area between 1954 and 1974 is -5,994.0 thousand acres.

Several of the categories in Table 1 were grouped based on physical, chemical and biological similarities and are presented in Table 2. Groupings in Table 2 include the following:

- **Estuarine Intertidal Vegetated** includes Estuarine Intertidal Emergent wetlands and Estuarine Intertidal Forested and Scrub/Shrub wetlands.
- **Estuarine wetlands** includes Estuarine Intertidal Vegetated wetlands and Estuarine Intertidal Nonvegetated wetlands.

left: Atlantic Coast (Estuarine Intertidal Emergent) **below:** Southern Minnesota (Unconsolidated Shore)



above: Wilmington, North Carolina (Palustrine Scrub/Shrub) **right:** Wallops Island, Georgia (Estuarine Intertidal Emergent) **below:** Coastal Florida (Estuarine Intertidal Forested and Scrub/Shrub)

- **Estuarine** (estuarine wetlands and deepwater habitats) includes Estuarine wetlands and Estuarine Subtidal, a deepwater habitat.
- **Palustrine Nonvegetated** includes Palustrine Unconsolidated Shore wetlands, Palustrine Open Water wetlands and Other Palustrine Nonvegetated wetlands.
- **Other Palustrine Vegetated** includes Palustrine Forested wetlands and Palustrine Scrub/Shrub wetlands.
- **Palustrine Vegetated** includes Other Palustrine Vegetated wetlands and Palustrine Emergent wetlands.
- **Palustrine wetlands** includes Palustrine Nonvegetated wetlands and Palustrine Vegetated wetlands.
- **Deepwater habitats** includes Estuarine Subtidal deepwater habitats and Lacustrine deepwater habitats.
- **Estuarine and Palustrine wetlands** includes Estuarine wetlands and Palustrine wetlands.
- **Wetlands and deepwater habitats** includes Marine Intertidal wetlands, Estuarine, Palustrine wetlands and Lacustrine.

Table 1. Area, in thousands of acres, by kind of surface area for the conterminous United States.

CURRENT

ORIGINAL CLASSIFICATION

	MARINE INTERTIDAL	ESTUARINE SUBTIDAL	ESTUARINE INTERTIDAL NON-VEGETATED	ESTUARINE INTERTIDAL EMERGENT	ESTUARINE INTERTIDAL FORESTED & SCRUB/SHRUB	PALUSTRINE UNCONSOLI-DATED SHORE	PALUSTRINE OPEN WATER	O PAL I VE(
MARINE INTERTIDAL	62.1 (15.9)	2.7 (63.0)	1.6 (68.8)	1.5 (46.7)	1.0 (60.0)			
ESTUARINE SUBTIDAL	0.4 (50.0)	14,611.8 (1.6)	64.5 (17.4)	50.8 (35.4)	3.4 (38.2)			
ESTUARINE INTERTIDAL NON-VEGETATED	1.4 (57.1)	58.0 (15.9)	612.6 (11.2)	33.4 (14.1)	9.8 (38.8)			
ESTUARINE INTERTIDAL EMERGENT	3.5 (34.3)	255.0 (10.9)	52.3 (31.2)	3,815.9 (4.4)	31.5 (28.3)			
ESTUARINE INTERTIDAL FORESTED & SCRUB/SHRUB	0.1 (*)	10.8 (26.9)	8.1 (44.4)	10.3 (27.2)	525.7 (15.2)			
PALUSTRINE UNCONSOLI-DATED SHORE						144.4 (27.8)	37.1 (56.9)	
PALUSTRINE OPEN WATER						25.6 (25.0)	1,664.2 (7.4)	
OTHER PALUSTRINE NON-VEGETATED						< 0.1	6.4 (35.9)	
PALUSTRINE FORESTED			7.6 (32.9)			11.6 (38.8)	145.5 (8.2)	
PALUSTRINE SCRUB/SHRUB						5.3 (66.0)	46.6 (21.0)	
PALUSTRINE EMERGENT						171.4 (79.7)	384.9 (10.7)	
LACUSTRINE						2.9 (75.9)	51.5 (63.3)	
OTHER	10.6 (24.5)	23.9 (38.5)	7.3 (41.1)	9.4 (31.9)	1.4 (42.9)	83.8 (39.1)	2,055.4 (13.3)	
TOTAL SURFACE AREA	78.4 (14.0)	14,967.7 (1.5)	746.5 (9.8)	3,922.8 (4.3)	573.0 (14.4)	445.6 (33.2)	4,393.1 (7.7)	
CHANGE, 50's TO 70's	- 4.0 (57.5)	+ 200.2 (14.9)	+ 5.4 (*)	- 353.2 (8.3)	- 19.1 (93.2)	+ 152.0 (5.5)	+ 2,073.2 (2.5)	

* Standard error of estimate is equal to or larger than estimate.

CLASSIFICATION

'HER STRINE ON- ETATED	PALUSTRINE FORESTED	PALUSTRINE SCRUB/SHRUB	PALUSTRINE EMERGENT	LACUSTRINE	AGRICULTURE	URBAN	OTHER	TOTAL SURFACE AREA
					0	0.1 (*)	13.4 (20.1)	82.4 (13.3)
					0.1 (*)	30.3 (27.1)	5.1 (39.2)	14,767.5 (1.5)
	30.2 (31.5)				0.6 (66.7)	20.8 (25.5)	3.7 (29.7)	741.1 (9.9)
					8.6 (46.5)	71.7 (19.8)	10.0 (28.0)	4,276.0 (4.2)
					0.3 (66.7)	34.8 (25.3)	1.2 (41,7)	592.1 (13.6)
0	12.5 (65.6)	13.2 (43.9)	40.1 (44.1)	1.0 (70.0)	10.8 (26.9)	7.6 (59.2)	26.9 (42.8)	293.6 (23.0)
8.2 (30.5)	37.8 (25.7)	46.9 (33.0)	364.7 (13.2)	8.4 (35.7)	112.0 (14.1)	24.3 (15.6)	27.6 (24.6)	2,319.9 (6.5)
60.2 (31.9)	1.0 (60.0)	0.2 (50.0)	11.4 (40.4)	0.1 (*)	2.9 (55.2)	2.8 (71.4)	5.9 (94.9)	90.9 (25.2)
5.9 (33.9)	46,299.4 (3.7)	1,237.0 (10.8)	952.5 (11.4)	223.1 (37.3)	6,214.5 (11.0)	372.9 (9.2)	243.9 (20.7)	55,707.4 (3.7)
2.7 (55.6)	1,929.6 (8.0)	7,367.9 (15.2)	467.7 (23.0)	46.9 (39.0)	952.6 (16.4)	128.0 (17.0)	49.5 (22.6)	10,998.2 (11.0)
15.6 (59.0)	1,002.0 (9.3)	1,394.2 (11.3)	24,493.4 (20.3)	345.5 (20.3)	4,552.8 (13.0)	424.3 (19.7)	323.6 (16.4)	33,112.6 (15.7)
15.3 (88.2)	8.5 (31.8)	12.0 (32.5)	283.5 (19.9)	56,038.9 (12.5)	128.7 (54.5)	18.3 (39.9)	3.1 (64.5)	56,562.7 (12.4)
23.8 (43.7)	419.6 (16.2)	537.5 (37.9)	1,807.3 (11.3)	1,257.7 (41.6)	1,794,642.2 (0.5)			1,800,879.9 (0.5)
131.8 (23.4)	49,713.4 (3.6)	10,611.1 (12.5)	28,441.4 (17.5)	57,923.6 (12.1)	1,808,475.9 (0.5)			1,980,424.3 (0)
+40.9 (39.9)	-5,994.0 (3.7)	-387.1 (56.7)	-4,671.2 (5.2)	+1,360.9 (34.1)	+7,596.0 (7.0)			0 (0)

Table 2. Area, in thousands of acres, by selected combinations of surface area groups for the conterminous United States.

CURRENT

ORIGINAL CLASSIFICATION	MARINE INTERTIDAL	ESTUARINE SUBTIDAL	ESTUARINE INTERTIDAL NON-VEGETATED	ESTUARINE INTERTIDAL VEGETATED	ESTUARINE WETLANDS	ESTUARINE	PALUSTRINE NON-VEGETATED	PALUSTRINE EMERGENT	OTHER PALUSTRINE VEGETATED
MARINE INTERTIDAL	62.1 (15.9)	2.7 (63.0)	1.6 (68.8)	2.5 (36.0)	4.1 (39.0)	6.8 (33.8)			
ESTUARINE SUBTIDAL	0.4 (50.0)	14,611.8 (1.6)	64.5 (17.4)	54.2 (33.2)	118.7 (18.0)	14,730.5 (1.5)			
ESTUARINE INTERTIDAL NON-VEGETATED	1.4 (57.1)	58.0 (15.9)	612.6 (11.2)	43.2 (14.1)	655.8 (10.7)	713.8 (10.1)			
ESTUARINE INTERTIDAL VEGETATED	3.6 (33.3)	265.8 (10.5)	60.4 (27.6)	4,383.4 (4.2)	4,443.8 (4.2)	4,709.6 (4.1)			
ESTUARINE WETLANDS	5.0 (34.0)	323.8 (9.2)	673.0 (10.7)	4,426.6 (4.2)	5,099.6 (3.9)	5,423.4 (3.8)			
ESTUARINE	5.4 (33.3)	14,935.6 (1.5)	737.5 (9.9)	4,480.8 (4.2)	5,218.3 (3.8)	20,153.9 (0.7)			
PALUSTRINE NON-VEGETATED							1,946.1 (7.1)	416.2 (13.2)	111.6 (20.5)
PALUSTRINE EMERGENT							571.9 (25.1)	24,493.4 (20.3)	2,396.2 (8.5)
OTHER PALUSTRINE VEGETATED							217.6 (8.2)	1,420.2 (11.7)	56,833.9 (3.8)
PALUSTRINE VEGETATED							789.5 (18.4)	25,913.6 (19.2)	59,230.1 (3.8)
PALUSTRINE WETLANDS							2,735.6 (7.5)	26,329.8 (18.9)	59,341.7 (3.8)
LACUSTRINE							69.7 (50.8)	283.5 (19.9)	20.5 (23.9)
DEEPWATER HABITATS									
ESTUARINE & PALUSTRINE WETLANDS									
WETLANDS & DEEPWATER HABITATS									
OTHER	10.6 (24.5)	23.9 (38.5)	7.3 (41.1)	10.8 (28.7)	18.1 (25.4)	42.0 (25.0)	2,163.0 (12.8)	1,807.3 (11.3)	957.1 (22.6)
TOTAL SURFACE AREA	78.4 (14.0)	14,967.7 (1.5)	746.5 (9.8)	4,495.8 (4.2)	5,242.3 (3.8)	20,210.0 (0.7)	4,970.5 (7.5)	28,441.4 (17.5)	60,324.5 (3.8)
CHANGE, 50's TO 70's	-4.0 (57.5)	+200.2 (14.9)	+5.4 (*)	-372.3 (8.4)	-366.9 (8.9)	-166.7 (13.0)	+2,266.1 (2.4)	-4,671.2 (5.2)	-6,381.1 (4.1)

* Standard error of estimate is equal to or larger than estimate.

CLASSIFICATION

ALUSTRINE EGETATED	PALUSTRINE WETLANDS	LACUSTRINE	DEEPWATER HABITATS	ESTUARINE & PALUSTRINE WETLANDS	WETLANDS & DEEPWATER HABITATS	AGRICULTURE	URBAN	OTHER	TOTAL SURFACE AREA
						0	0.1 (*)	13.4 (20.1)	82.4 (13.3)
						0.1 (*)	30.3 (27.1)	5.1 (39.2)	14,767.5 (1.5)
						0.6 (66.7)	20.8 (25.5)	3.7 (29.7)	741.1 (9.9)
						8.9 (44.9)	106.5 (16.4)	11.2 (25.9)	4,868.1 (4.0)
						9.5 (42.1)	127.3 (14.8)	14.9 (21.5)	5,609.2 (3.7)
						9.6 (41.7)	157.6 (16.0)	20.0 (21.0)	20,376.7 (0.7)
527.8 (12.2)	2,473.9 (6.7)	9.5 (32.6)				125.7 (13.1)	34.7 (20.2)	60.4 (23.3)	2,704.4 (6.4)
26,889.6 (18.8)	27,461.5 (18.4)	345.5 (20.3)				4,552.8 (13.0)	424.3 (19.7)	323.6 (16.4)	33,112.6 (15.7)
58,254.1 (3.8)	58,471.7 (3.8)	270.0 (32.1)				7,167.1 (10.1)	500.9 (8.8)	293.4 (18.7)	66,705.6 (3.7)
85,143.7 (7.4)	85,933.2 (7.3)	615.5 (19.0)				11,719.9 (8.2)	925.2 (11.6)	617.0 (12.9)	99,818.2 (6.5)
85,671.5 (7.3)	88,407.1 (7.1)	625.0 (18.8)				11,845.6 (8.2)	959.9 (11.3)	677.4 (12.2)	102,522.6 (6.3)
304.0 (18.7)	373.7 (20.3)	56,038.9 (12.5)				128.7 (54.5)	18.3 (39.9)	3.1 (64.5)	56,562.7 (12.4)
			70,651.0 (9.9)	493.3 (16.0)	71,144.7 (9.8)	128.8 (54.4)	48.6 (22.6)	8.2 (34.1)	71,330.2 (9.8)
			956.1 (12.7)	93,535.9 (6.7)	94,497.2 (6.7)	11,855.1 (8.2)	1,087.2 (10.1)	692.3 (11.9)	108,131.8 (6.0)
			71,609.7 (9.8)	94,033.2 (6.7)	165,710.7 (0.6)	11,983.9 (8.1)	1,135.9 (9.8)	713.9 (11.6)	179,544.4 (5.3)
2,764.4 (11.6)	4,927.4 (9.9)	1,257.7 (41.6)	1,281.6 (40.8)	4,945.5 (9.9)	6,237.7 (11.6)	1,794,642.2 (0.5)			1,800,879.9 (0.5)
88,765.9 (7.1)	93,736.4 (6.8)	57,923.6 (12.1)	72,891.3 (9.6)	98,978.7 (6.4)	171,948.4 (5.5)	1,808,475.9 (0.5)			1,980,424.3 (0)
-11,052.3 (2.5)	-8,786.2 (3.2)	+1,360.9 (34.1)	+1,561.1 (29.8)	-9,153.1 (3.1)	-7,596.0 (7.0)	+7,596.0 (7.0)			0 (0)

Significant Trends in the Estuarine System

Changes in Estuarine Subtidal Deepwater Habitats (bay bottoms)

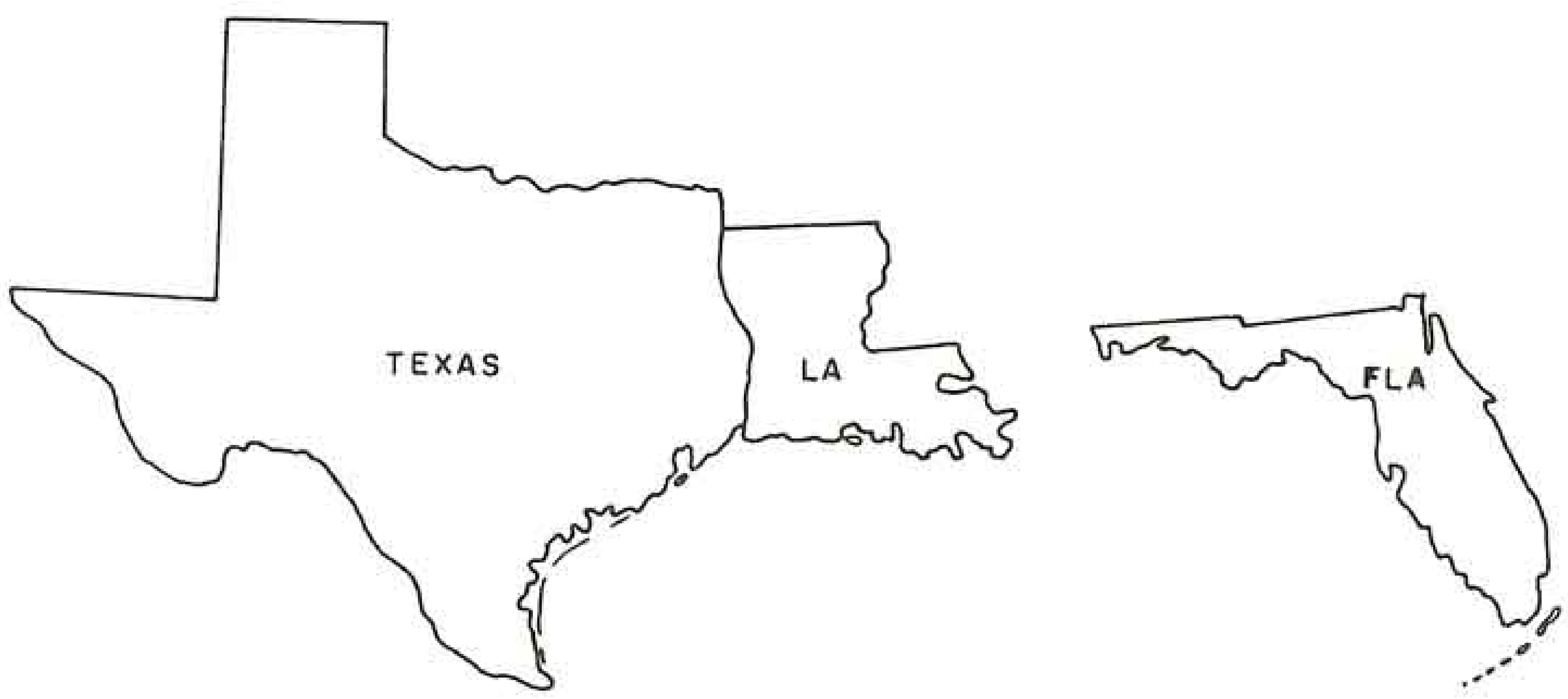
The overall net change in Estuarine Subtidal deepwater habitats resulted in a gain of 200 thousand acres.

Some changes occurred between Estuarine Subtidal deepwater habitats and Estuarine Nonvegetated wetlands; however, the net change was small.

Change with Estuarine Vegetated wetlands resulted in a net gain of 212 thousand acres, where 204 thousand acres shifted from Estuarine Intertidal Emergent wetlands (coastal salt marshes) to bay bottoms. The vast majority of this net change occurred in Louisiana (183 thousand acres) with most of the remainder (15 thousand acres) in Florida.

There was a loss of 30 thousand acres from Estuarine Subtidal deepwater habitats to urban development. Over half of this was in the Atlantic Flyway with Florida having almost 11 thousand acres of loss. Louisiana, in the Mississippi Flyway, contributed 10 thousand acres of loss.

Some gain in Estuarine Subtidal deepwater habitats came from areas that originally were land other than urban or agriculture. The net gain was 18 thousand acres, of which 13 thousand acres are in Florida. Some additional gain came from Estuarine Intertidal Forested and Scrub/Shrub wetlands. This net gain was seven thousand acres, all of which occurred in Florida.



Changes in Estuarine Nonvegetated Wetlands

The net change in Estuarine Nonvegetated wetlands was small. The only change of significance was a loss of 21 thousand acres to urban development. Texas, in the Central Flyway, accounted for almost 10 thousand acres of loss and Florida over nine thousand acres.

Changes in Estuarine Vegetated Wetlands

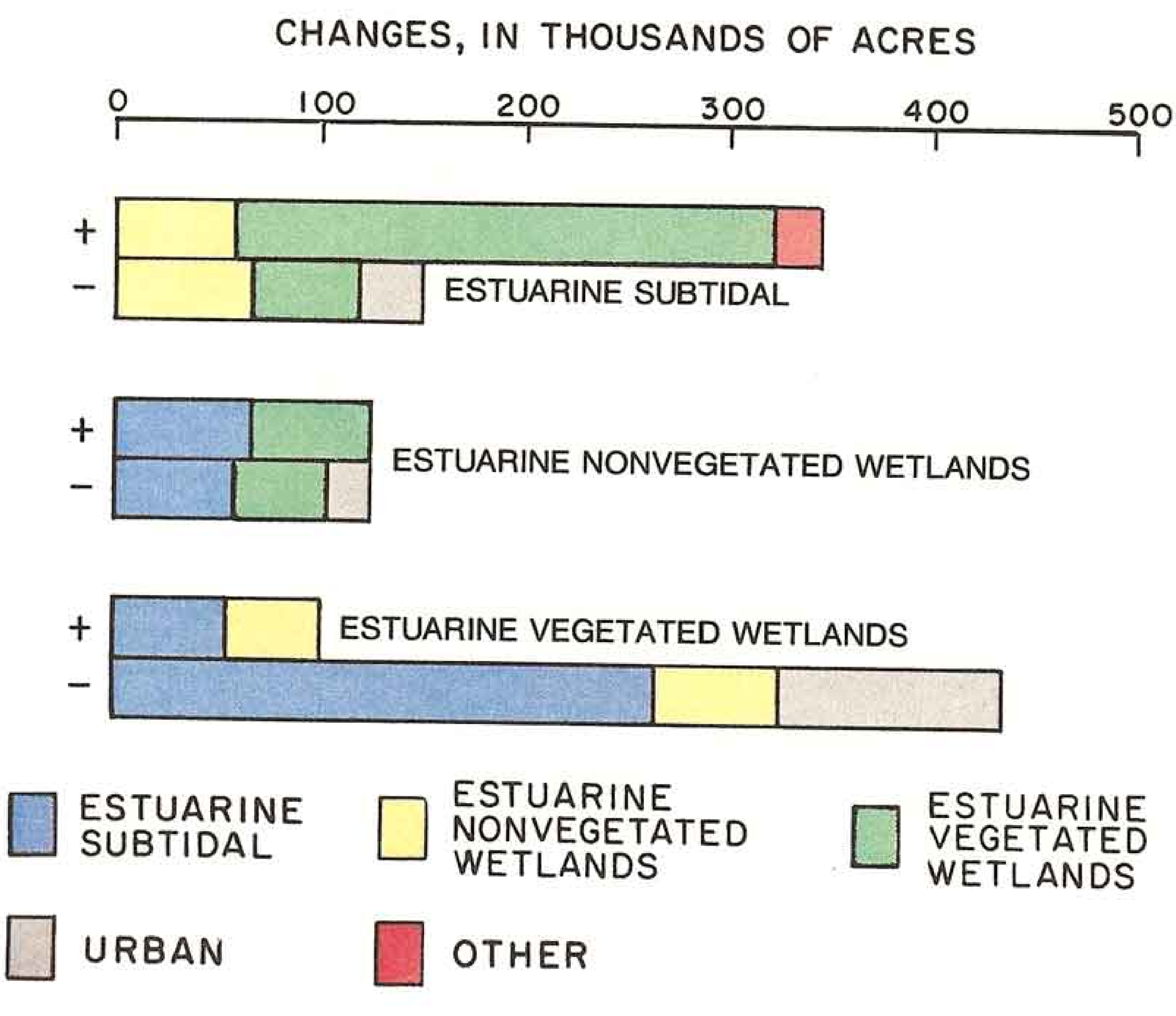
The change in Estuarine Vegetated wetlands resulted in a net loss of 372 thousand acres. Most of this loss (353 thousand acres) was in Estuarine Intertidal Emergent wetlands where 204 thousand acres of the loss was to Estuarine Subtidal deepwater habitats as described earlier.

Most of the 168 (372-204) thousand acres of remaining loss was to urban development which accounted for over 106 thousand acres (the size of a square area almost 13 miles on each side). Two-thirds of this loss was from Estuarine Intertidal Emergent wetlands with the remainder from Estuarine Intertidal Forested and Scrub/Shrub wetlands. The majority of this change of 106 thousand acres occurred in the

Atlantic Flyway with Florida accounting for 43 thousand acres. Louisiana, in the Mississippi Flyway, lost 34 thousand acres.

Some Estuarine Intertidal Emergent wetlands changed to Estuarine Intertidal Forested and Scrub/Shrub wetlands. The net change was 21 thousand acres of which 18 thousand acres are in Florida. Some additional Estuarine Intertidal Emergent wetland changes were due to shifts to Estuarine Nonvegetated wetlands. The net change was 19 thousand acres.

left: Wachapreague, Virginia (Estuarine Intertidal Unconsolidated Shore)



Significant Trends in the Palustrine and Lacustrine Systems

Changes in Palustrine Nonvegetated Wetlands

The overall net change in Palustrine Nonvegetated wetlands was a gain of 2.3 million acres.

Changes occurred between Palustrine Nonvegetated wetlands and Palustrine Vegetated wetlands. These changes balanced out for the most part.

A significant net gain came from agricultural land. Over 200 thousand acres were gained, mainly in Palustrine Open Water wetlands, due to construction of farm ponds. The vast majority of gains were in the Central and Mississippi flyways.

A large net gain, mainly in Palustrine Open Water wetlands, came from lands not originally classified as agriculture or urban. Over 1.7 million acres were gained, mostly due to construction of ponds. Half of these areas were in the Central Flyway.

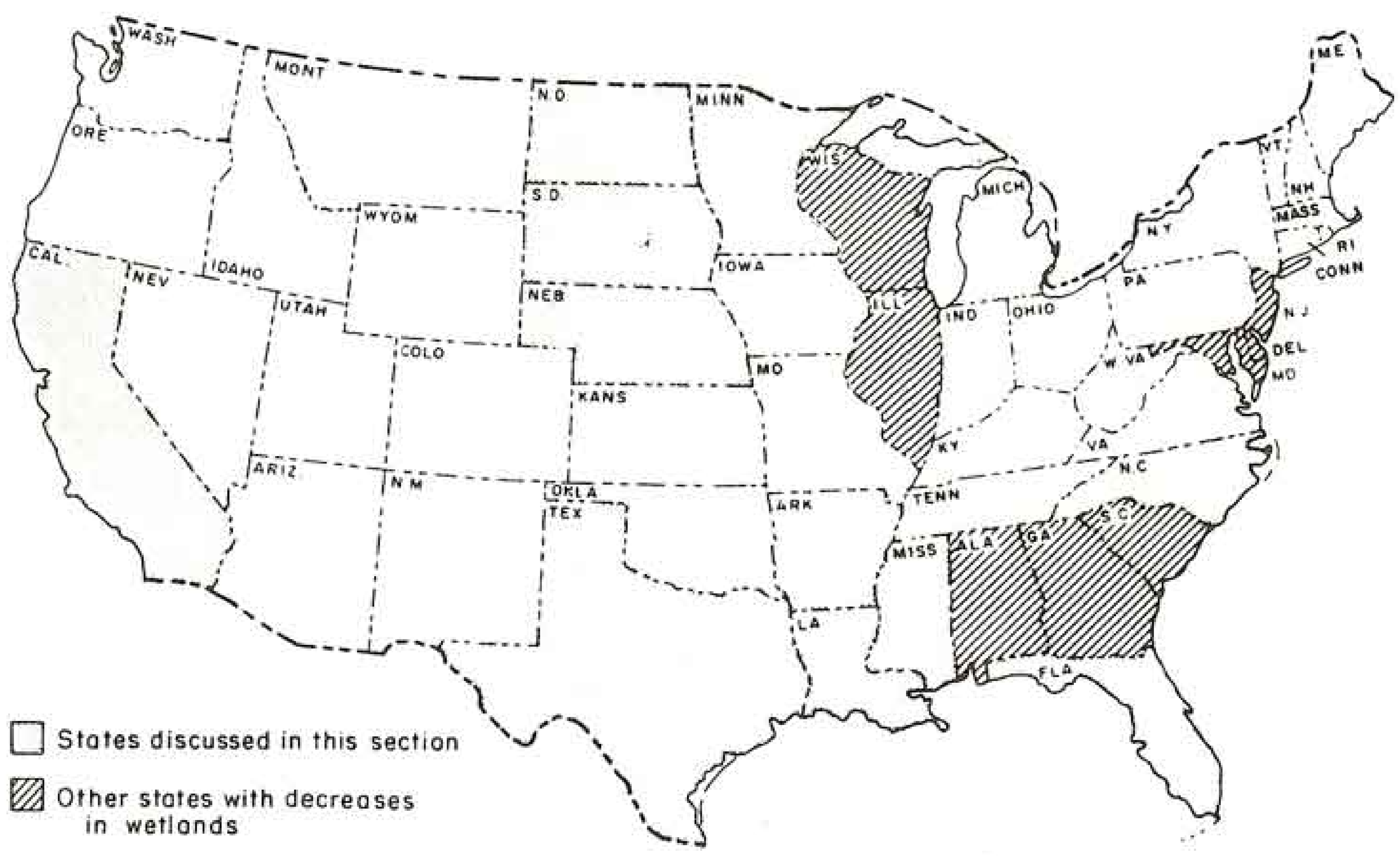
Another net gain in Palustrine Open Water wetlands came from Palustrine Forested wetlands — 108 thousand acres.

Changes in Palustrine Vegetated Wetlands

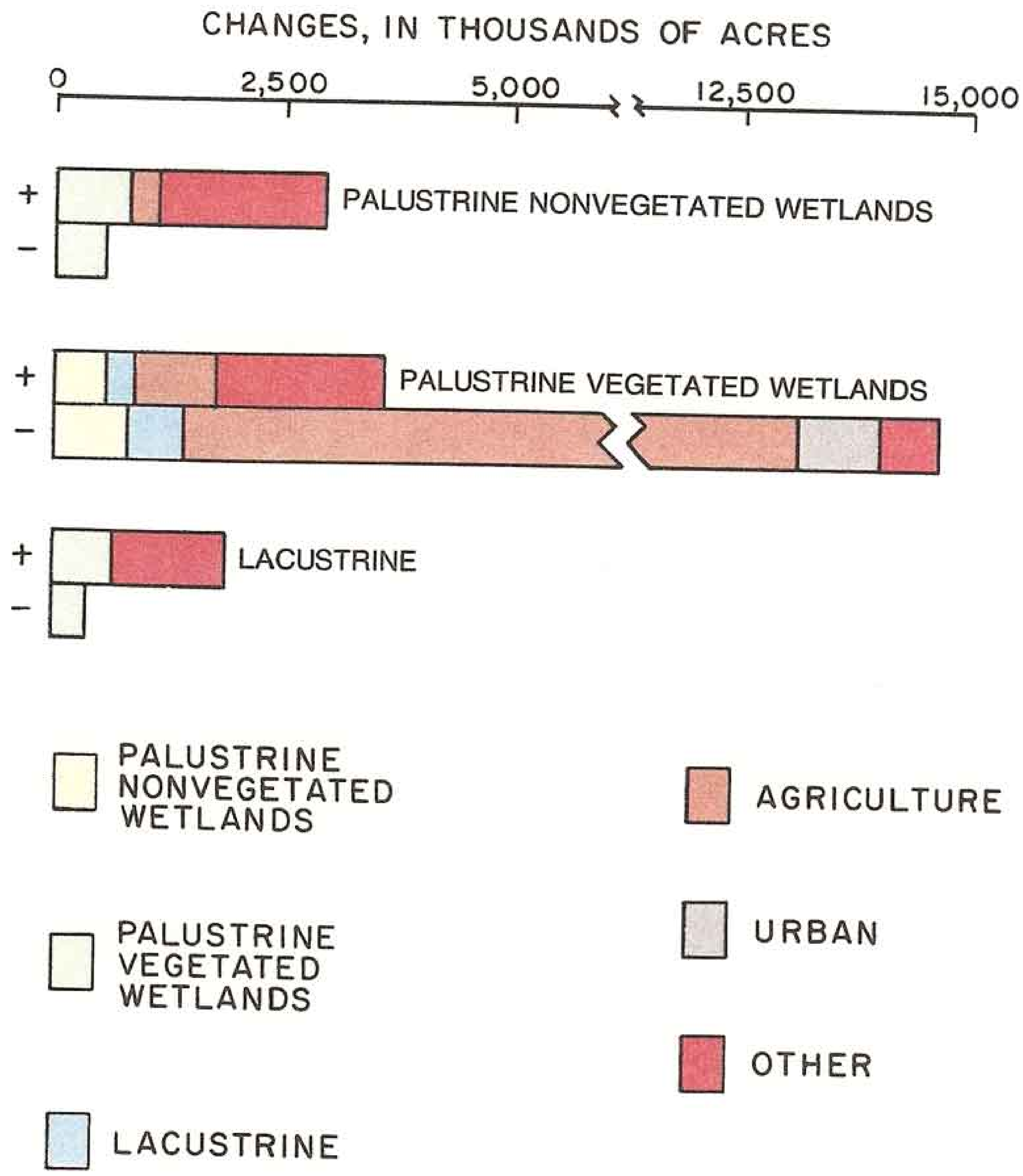
The net change in Palustrine Vegetated wetlands was a loss of 11 million acres. Nearly all the loss was due to agriculture. The overall net loss consists of six million acres of Palustrine Forested wetlands, 4.7 million acres of Palustrine Emergent wetlands, and the remainder from Palustrine Scrub/Shrub wetlands.

Mississippi Flyway losses were dominant in terms of size; in that flyway, a net loss of

below: Prairie potholes, North Dakota (Palustrine Open Water)



NOTE: States not indicated may have important losses not detected by the national survey.



above: Okefenokee Swamp (Palustrine Aquatic Bed and Forested)

4.5 million acres occurred in Palustrine Forested wetlands. The vast majority is along the lower Mississippi River in Louisiana, Mississippi and Arkansas. The next largest loss in the Mississippi Flyway was in Minnesota. Dominant losers of Palustrine Forested wetlands in the Atlantic Flyway are Florida and North Carolina. Large losses in the Central Flyway occurred in South Dakota, North Dakota, Nebraska and Texas. The largest loss in the Pacific Flyway was in California.

In general, the states along the lower Mississippi River lost acreage from Palustrine Forested wetlands, while losses in most other states were predominantly from Palustrine Emergent wetlands.

Net losses to urban development consisted of 367 thousand acres from Palustrine Forested wetlands, 396 thousand acres from Palustrine Emergent wetlands, and 124 thousand acres from Palustrine Scrub/Shrub wetlands. This total, larger than the size of Rhode Island, is concentrated in the Atlantic and Mississippi flyways. The largest loss in the Atlantic Flyway occurred in Florida. Large losses in the Mississippi Flyway took place in Louisiana, Michigan and Minnesota.

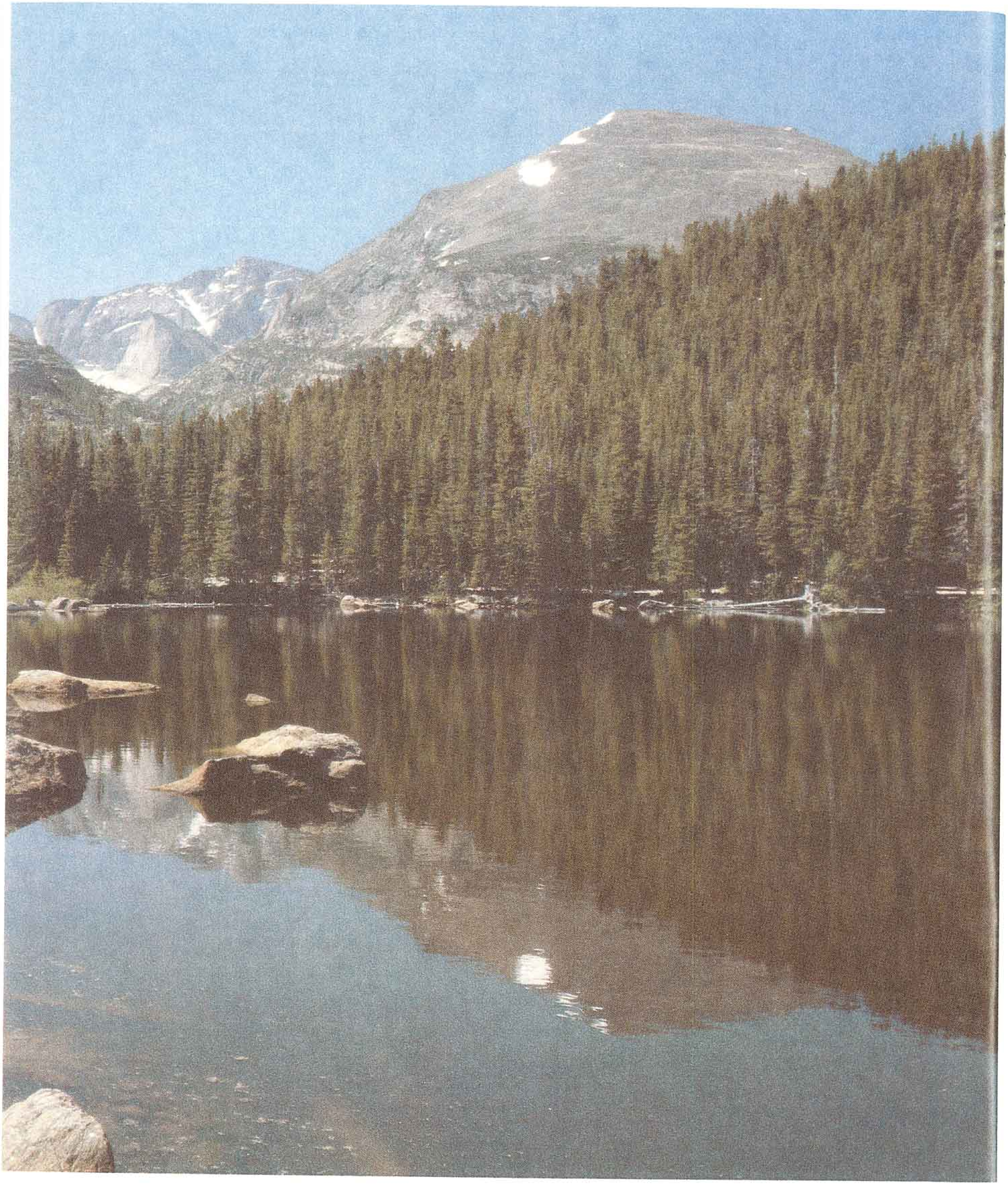
There was a net change of 927 thousand acres of Palustrine Emergent wetlands to Palustrine Scrub/Shrub wetlands and a net change of 693 thousand acres of Palustrine Scrub/Shrub wetlands to Palustrine Forested wetlands.

Net change of Palustrine Emergent wetlands to Palustrine Unconsolidated Shore wetlands occurred on 131 thousand acres, of which 124 thousand acres are in the Central Flyway.

Changes in Lacustrine Deepwater Habitats

The net change in Lacustrine deepwater habitats was a gain of 1.4 million acres.

Most of the gain is the result of construction of lakes and reservoirs on 1.2 million acres of land not considered wetlands, deepwater habitats, urban or agricultural land in the 1950's.



CHAPTER FIVE

IN CONCLUSION

The results reported are based on a designed study of the wetlands and deepwater habitats of the lower 48 states. The results of this report document major net losses of wetlands and provide insights to where these net losses are taking place. The design involved careful measurement of a sample of the nation's surface area. In general, results are meaningful only at the national level or for broad areas. Some of the results, however, have adequate reliability to be useful at flyway and state levels. Intensification of the samples for selected areas in future studies can provide useful results for those areas.

Some findings are very clear and involve large acreages. Huge decreases in wetlands occurred in the lower Mississippi River states of Louisiana, Mississippi and Arkansas. The next largest loss in the Mississippi Flyway was in Minnesota, with losses also occurring in Michigan, Wisconsin, Illinois and Alabama. Dominant losers of wetlands in the Atlantic Flyway are Florida and North Carolina with losses also in Georgia, South Carolina, Maryland, New Jersey and Delaware. Large losses in the Central Flyway occurred in South Dakota, North Dakota, Nebraska and Texas. The largest loss in the Pacific Flyway was in California.

Other changes are also clear, but involve lesser acreages. Importance of change, however, is not necessarily reflected by area alone. Some of the smaller wetlands and deepwater habitats — particularly along the coastline of the United States — are extremely important habitats for plant and animal life.

Very significant increases occurred in large and small open water areas. These newly created habitats were mostly constructed on land not originally classified as agriculture or urban. The importance of these new habitats to fish and wildlife populations is yet to be fully determined.

The vast majority of the loss of Estuarine Intertidal Emergent wetlands occurred in Louisiana. This resulted from a shift to Estuarine Subtidal deepwater habitats. The remaining loss of Estuarine Intertidal Emergent wetlands was to urban development, mostly in Florida and Louisiana.

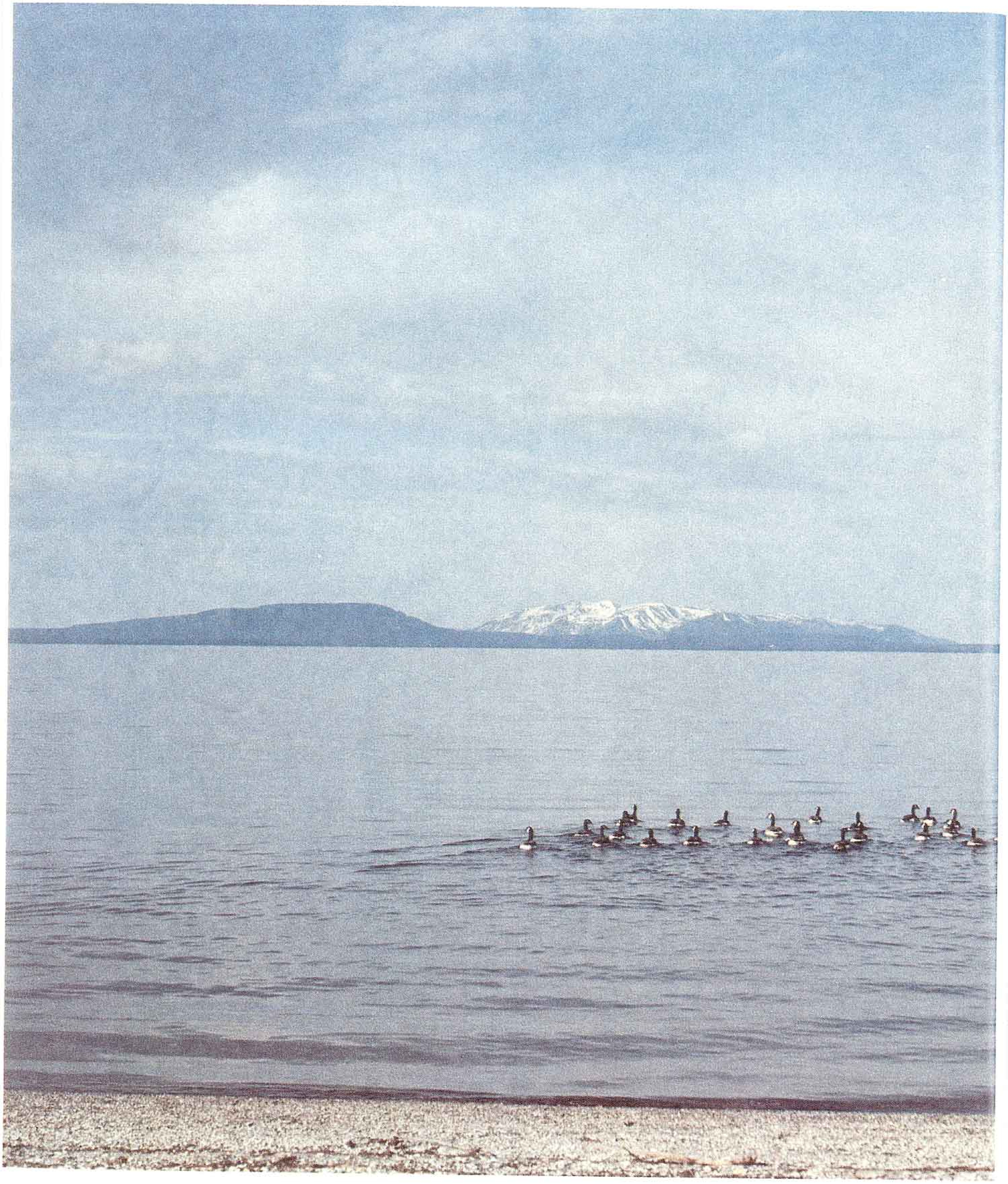
Nearly all the loss of Estuarine Intertidal Forested and Scrub/Shrub wetlands occurred in Florida to urban development.

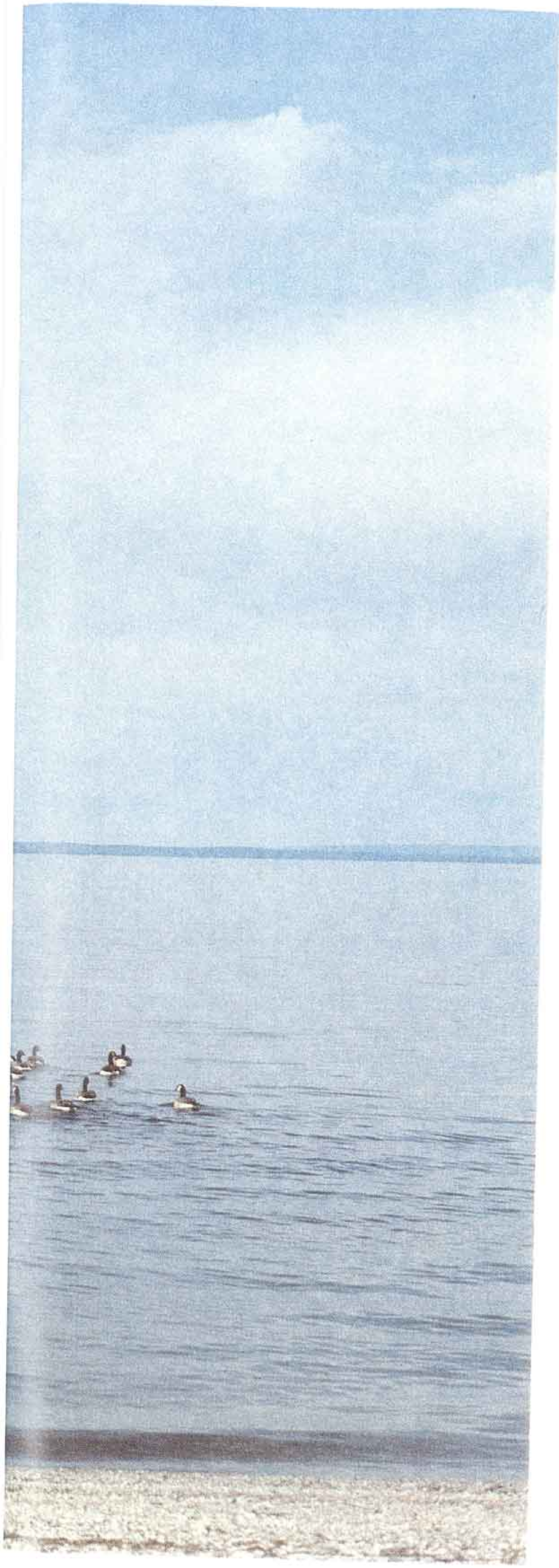
The net loss in Palustrine Vegetated wetlands was 11 million acres; 14 times the size of Rhode Island; twice the size of New Jersey; as large as the combined states of Massachusetts, Connecticut and Rhode Island. Nearly all the net loss was due to agriculture.

This report does not document the significant reduction of quality of many wetlands. Some of the factors that cause this reduction in quality are: canals and inlets that cause changes in water chemistry due to salt water intrusion, mosquito ditching along the Atlantic coast, polluted runoff from adjacent uplands or polluted inflow from rivers and streams, urban encroachment, and dissection by transportation corridors.

Continual monitoring of land use and changes in land use is needed to provide the basis for wise decisions. This report is the result of one such method of monitoring initiated by the U.S. Fish and Wildlife Service. The results included in this report provide wetland information similar to the forest and range information required by the Forest and Rangeland Renewable Resources Planning Act and to soils information required by the Soil and Water Resource Conservation Act. The results can be updated in the future on the schedule required under those Acts.

left: Rocky Mountain National Park, Colorado (Lacustrine)





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left: Yellowstone Lake (Lacustrine)

AUTHORS

The statisticians who worked on this project are **Dr. W.E. Frayer,** a specialist in natural resource survey design and analysis; **Dr. David C. Bowden,** a specialist in sampling design with emphasis on wildlife applications; and **Dr. Franklin A. Graybill,** a past president of the American Statistical Association and an internationally recognized authority on linear models. **Timothy J. Monahan,** a graduate student, assisted in several phases of the study.

Dr. W.E. Frayer is Professor and Department Head, Department of Forest and Wood Sciences, Colorado State University. Dr. Frayer's expertise is in design and analysis of sample surveys of natural resource populations. He served as the first Chairman of the Inventory Working Group of the Society of American Foresters. In addition, he serves as the Leader of the Successive Forest Inventories Working Group of the International Union of Forestry Research Organizations.

He has been instrumental in organizing national and international conferences on natural resource sampling designs. He has also organized various short courses on sampling, computer use and related quantitative methods.

While working as a research forester at the Northeastern Forest Experiment Station 1962-66, he assisted in developing a data analysis system (FINSYS) for large inventories. The system was subsequently adopted for nationwide use by the U.S. Forest Service. He later completely revised the system for the Forest Service. He modified the system for use in this project.

Timothy J. Monahan is a graduate of the University of Idaho with a B.S. in Forest Resources/Watershed Science. He has worked with the U.S. Fish and Wildlife Service as a biologist conducting instream flow studies for the Upper Colorado River Project. He is currently a graduate research assistant at Colorado State University completing work on a Master of Science degree in Forest Science.

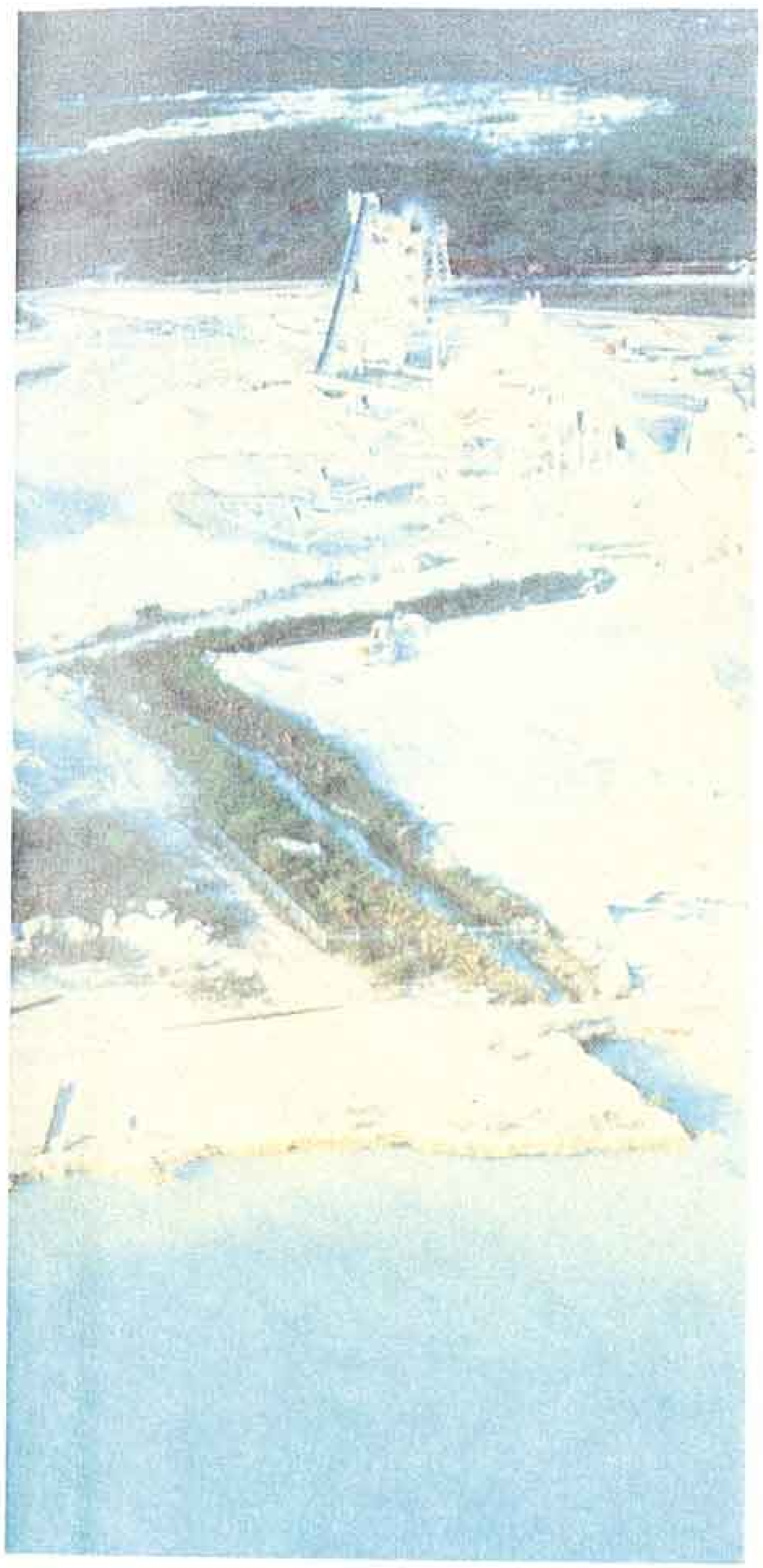
Dr. David C. Bowden is an associate professor of statistics at Colorado State University and a consultant for the Colorado Division of Wildlife. Since 1965, nearly all surveys conducted by the research branch of the Division have either received review comments or received major design input and data analysis supervision from Dr. Bowden. Individual projects have involved winter and spring waterfowl population surveys, direct or indirect census procedures for antelope, deer and elk, questionnaire surveys for statewide harvest of large and small game, creel census surveys of all types and range or vegetation sampling.

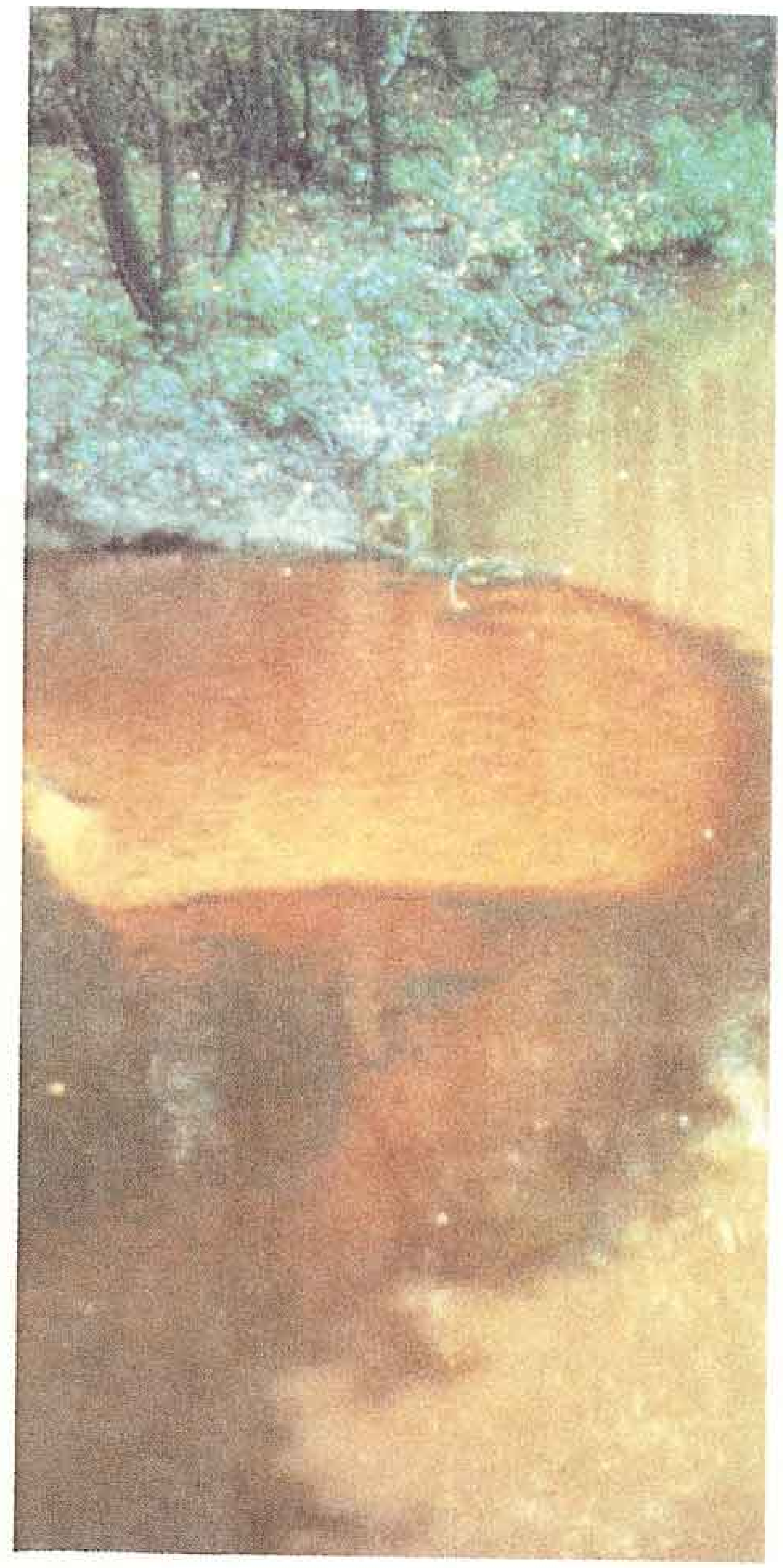
Dr. Bowden was a consultant for many projects for the U.S. Fish and Wildlife Service, Denver Federal Center, particularly to the Bird Damage Control Section. These studies involved determining crop damage and treatment effects in a variety of field situations. In addition, he evaluated the design of the survey, "Indices of Predator Abundance in the Western United States" which was performed for the Predator Ecology and Behavior Project.

One major project of Dr. Bowden's involved the review and evaluation for the U.S. Fish and Wildlife Service of their U.S. and Canada May Waterfowl Breeding Ground Survey. The 1974 report was filed with the Migratory Bird and Habitat Research Station at Laurel, Maryland.

Dr. Franklin A. Graybill is an internationally recognized authority in linear models. He served as president of the American Statistical Association and as editor of *Biometrics.* He has served in official capacities with various professional societies. He is an elected Fellow in the American Statistical Association, the Institute of Mathematical Statistics, and the American Association for the Advancement of Science.

Together with Frayer, Bowden and others, he has conducted research on multilevel (multiphase and multistage) designs for resource inventories.



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