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Status and Recent Trends of Wetlands in Five Mid-Atlantic States

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Region III

STATUS AND RECENT TRENDS OF WETLANDS IN FIVE MID-ATLANTIC STATES: DELAWARE, MARYLAND, PENNSYLVANIA, VIRGINIA, AND WEST VIRGINIA

by

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Introduction

National interest in wetlands has steadily increased over the past three decades. Wetlands are now widely recognized as important natural resources, vital to maintaining and improving water quality and reducing flood damage, while providing habitat for many types of plants and animals. Numerous states and the Federal government are regulating, to varying degrees, development activities in many wetlands. Recent public opinion polls show strong public support for wetland protection and even recommend increased protection (Harris 1982).

Recognizing the need for sound biological information to make informed land use decisions on wetlands, the U.S. Fish and Wildlife Service created the National Wetlands Inventory Project (NWI) in 1974. The primary purpose of the NWI Project was to produce a series of detailed wetland maps showing the location, type, and distribution of the Nation's wetlands. To date, wetland maps are available for 45% of the lower 48 states, 12% of Alaska, and all of Hawaii. By 1979, the U.S. Fish and Wildlife Service recognized the need for national statistics on the current status and recent trends in wetlands of the United States and designed a study to generate these statistics. This national wetland trends study was completed in 1983 and technical and popular reports on the study's findings have been published (Frayer, *et al.* 1983 and Tiner 1984). Although the national wetland trends study produced reliable estimates for the Nation, it was not designed to generate reliable statistics for individual states. Additional studies would have to be conducted to provide similar results for individual states.

The U.S. Fish and Wildlife Service, Region 5 and the U.S. Environmental Protection Agency, Region III wanted reliable estimates on the status and trends of wetlands in five states: Delaware, Maryland, Pennsylvania, Virginia, and West Virginia, and developed a joint study to accomplish this objective. This study was designed to identify the status and trends of wetlands in the five states from the mid-1950s to the late 1970s. It represents the first regional intensification of the national wetland trends study. The study also aimed to generate reliable estimates of wetland status and trends in the 64,000-square mile Chesapeake Bay watershed. This technical report presents significant study findings for the five-state region, each state, and the Chesapeake Bay watershed.

Methods

The study involved three basic steps: (1) study design, (2) data collection, and (3) data analysis compilation. Each step is discussed in the following subsections.

Study Design

Statistical sampling techniques are proven methods of making estimates of populations, land cover types, and other variables. The recently completed national wetland trends study used a stratified random sampling technique where four-square mile plots were selected for sampling (Frayer, *et al.* 1983). The same study design was also used in the present regional wetland trends study for obvious reasons, including: (1) it was a proven technique for sampling wetland changes that was immediately available for our use, and (2) existing plot data from the national wetland trends study could be utilized for the present regional study, thereby providing the basis for estimating additional new plots needed to meet our objectives, while avoiding duplication of effort. While the national design served as the model for the present study, adjustments were made to improve sampling efficiency.

The sampling strata for the national wetland trends study were derived from state boundaries, the 35 physical subdivisions described by Hammond (1970), and coastal zone boundaries (marine and estuarine systems and the Great Lakes). Nationally, this amounted to over 150 strata. Looking at our study area, there were five state boundaries, five physical subdivisions, and two coastal zone boundaries (marine and estuarine systems and Lake Erie), comprising a total of 17 strata (Table 1). Based on our knowledge of the distribution of wetlands in the study area, we decided that further stratification was warranted to improve sampling efficiency. After consultation with Dr. Frayer of Michigan Technological University, a new set of strata were developed that isolated areas of known wetland concentration or known intense wetland development pressures (Table 2 and Figure 1). A total of 29 strata were established.

After identifying the sampling strata, the next step would normally be determining the number of samples to be taken within each stratum. In our case, since we wanted to use existing national sample plots, we had to first locate all of these plots and then reconstruct the sampling grids used in the national-study. The national wetland trends study used U.S. Geological Survey state index maps to choose sample plots. A grid of the appropriate size was placed over each state index map and samples were then randomly chosen from the various strata. We automated

Table 1. National strata for the 5-state study area. All strata, except the Coastal Zone and Lake Erie, represent physical subdivisions according to Hammond (1970).

State	Stratum
Delaware	Coastal Zone (Marine and Estuarine Systems)
	Gulf-Atlantic Coastal Flats
	Gulf-Atlantic Rolling Plain
Maryland	Coastal Zone (Marine and Estuarine Systems)
	Gulf-Atlantic Coastal Flats
	Gulf-Atlantic Rolling Plain
	Appalachian Highlands
Pennsylvania	Lake Erie
	Appalachian Highlands
	Middle Western Upland Plain
	Gulf-Atlantic Rolling Plain
	Adirondack–New England Highlands
Virginia	Coastal Zone (Marine and Estuarine Systems)
	Gulf-Atlantic Coastal Flats
	Gulf-Atlantic Rolling Plain
	Appalachian Highlands
West Virginia	Appalachian Highlands

the random selection procedure and therefore needed to reconstruct the national sampling grids. To do this, a program was written in BASIC on a Hewlett-Packard 9845T desktop computer system to find the grid orientation that would come closest to reproducing the locations of the national wetland trends samples. Each state index map was digitized, along with the strata defined in Figure 1 and a grid approximating the national wetland trends study grid. The program would then randomly sample, without replacement, the required number of new plots from each stratum in each state.

To determine the number of samples to take from each stratum, we followed the procedures outlined by Frayer and others (1983). The criterion for the sampling program was to be able to estimate the totals for each major wetland type in each state with a standard error of less than 20 percent of the mean. In order to determine the necessary number of samples in each stratum, we needed: (1) an estimate of the mean area of each wetland type in each stratum and its variance, (2) the area of each state, and (3) the area of each stratum in each state. At first, we estimated the required number of samples from means and variances estimated for strata in the national wetland trends study. After enough new samples were analyzed within the five-state region, we recalculated the required number of samples using estimates derived entirely from samples within the region. The area of each state and the area of each stratum were measured from state index maps using a digitizer. The actual calculations were performed on an Apple II+ microcomputer using two programs, one to set up data files for each stratum and the second to calculate the number of samples needed. Since each wetland type requires a different number of samples to be precisely estimated, we used only the vegetated wetland categories to determine the number of samples required for the entire study. Table 3 shows the number of plots sampled within each stratum and the percent of each stratum sampled. A total of 788 plots were analyzed.

Data Collection

The type and extent of wetlands within each sample plot were determined through aerial photo interpretation techniques. Aerial photographs from the mid-1950s and late 1970s/early 1980s were obtained for each new plot. The approximate study interval was 23 years. Wetlands were classified using the U.S. Fish and Wildlife Service's wetland classification system (Cowardin, *et al.* 1979). Table 4 shows wetland and other categories interpreted for this study. Existing National Wetlands Inventory (NWI) maps were used to record the current wetlands. When these maps were not available, recent high-altitude aerial photography was interpreted. Recent wetlands for each plot were then compared with the 1950s photos to detect changes in wetland boundaries and/or cover types and prepare a wetlands overlay using a Bausch & Lomb stereo zoom transfer scope. When identifying changes, the recent photos were examined to determine the causes of change, either natural or human-induced (i.e., agriculture, urbanization, or other factors). The wetland status and trends data shown on an overlay for each plot were digitized for computer analysis.

Data Analysis

Once samples were photointerpreted and digitized, computer tapes with the results were sent to the U.S. Fish and Wildlife Service's National Ecology Center (formerly the Western Energy and Land Use Team) in Ft. Collins, Colorado. The results were analyzed on the Colorado State University computer using the same program used to analyze the national wetland trends study. However, the program was

modified by Dr. Gregor Auble to incorporate a correction factor for sampling from a finite population without replacement. This factor is insignificant when a small proportion of the population has been sampled, but becomes dominant when the sampling intensity approaches 100 percent, as it did in the Canaan Valley and Meadow River area in West Virginia.

Table 2. Regional sampling strata for the 5-state study area. Most of the strata were derived from Hammond's physical subdivisions (1970), with some smaller areas of interest also identified. More familiar names of the major physiographic regions (Fenneman 1928) are shown in parentheses.

State	Stratum
Delaware	Coastal Water Zone
	Coastal Wetland Zone
	Gulf-Atlantic Coastal Flats (equivalent to Lower Coastal Plain)
	Pothole Region—subset of Coastal Flats stratum
	Gulf-Atlantic Rolling Plain (equivalent to Piedmont)
Maryland	Coastal Water Zone
	Coastal Wetland Zone
	Gulf-Atlantic Coastal Flats (equivalent to Lower Coastal Plain)
	Pothole Region—subset of Coastal Flats stratum
	Gulf-Atlantic Rolling Plain #2—Irregular Plains (equivalent to Upper Coastal Plain)
	Gulf-Atlantic Rolling Plain #1 (equivalent to Piedmont)
	Appalachian Highlands (includes Appalachian Plateau, Valley and Ridge, and Blue Ridge)
Pennsylvania	Lake Erie
	Appalachian Highlands (includes most of Appalachian Plateau, Valley and Ridge, and Blue Ridge)
	Middle Western Upland Plain (part of Appalachian Plateau)
	Poconos #1—subset of Appalachian Highlands
	Poconos #2—subset of Appalachian Highlands
	Other Glaciated Northeast—subset of Appalachian Highlands
	Adirondack-New England Highlands (equivalent to New England Highlands)
	Gulf-Atlantic Rolling Plain (equivalent to Piedmont)
Virginia	Coastal Water Zone
	Coastal Wetland Zone
	Gulf-Atlantic Coastal Flats (equivalent to Lower Coastal Plain)
	Gulf-Atlantic Rolling Plain #2 (equivalent to Upper Coastal Plain)
	Gulf-Atlantic Rolling Plain #1 (equivalent to Piedmont)
	Appalachian Highlands (includes Appalachian Plateau, Valley and Ridge, and Blue Ridge)
West Virginia	Appalachian Highlands (equivalent to Appalachian Plateau and Valley and Ridge)
	Canaan Valley—subset of Appalachian Highlands
	Meadow River Area—subset of Appalachian Highlands

Figure 1. General locations of regional sampling strata.

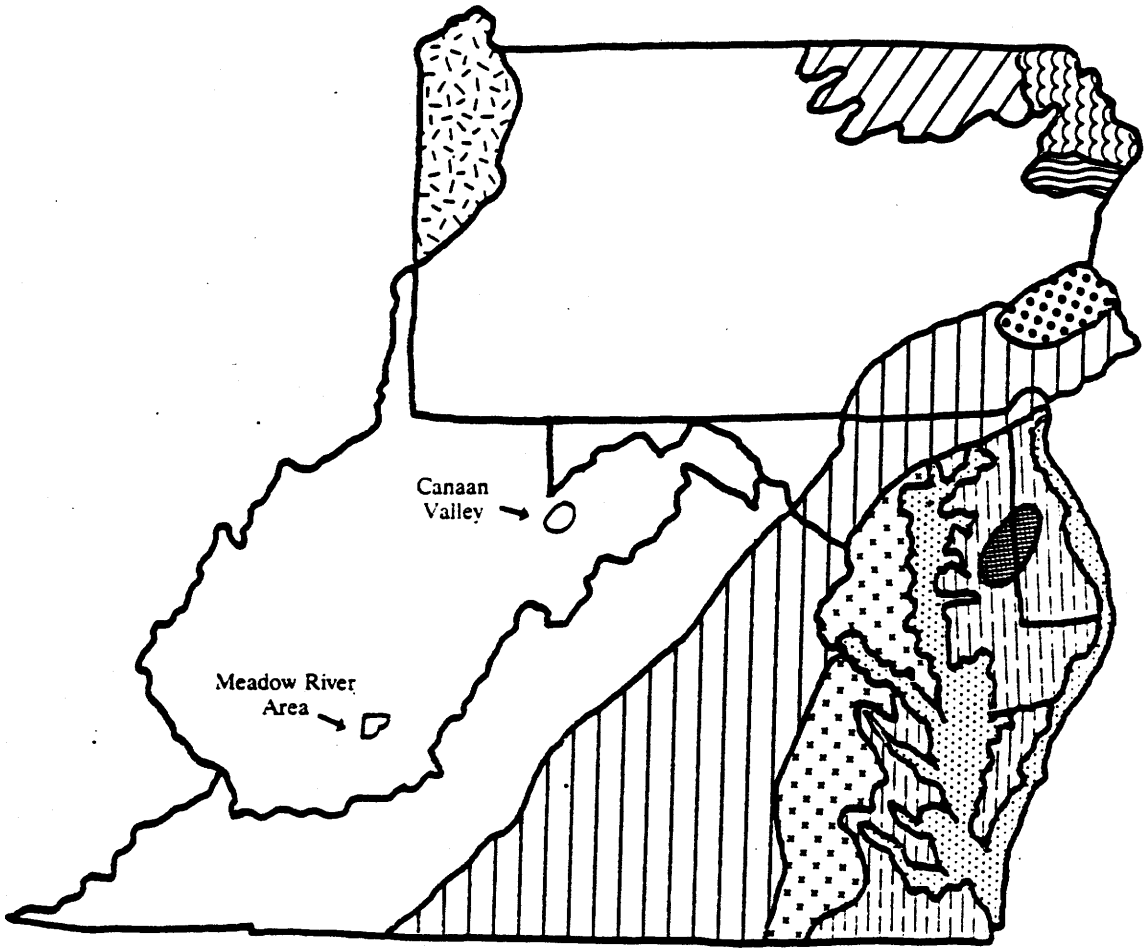

Table 3. Number of plots and percentage of each stratum sampled.

State	Stratum	# Plots	% of Stratum Sampled
Delaware	Rolling Plain	9	39.8
	Coastal Flats	50	10.4
	Pothole Region	8	18.3
	Coastal Wetland Zone	21	18.7
	Coastal Water Zone	9	7.7
Maryland	Appalachian Highlands	20	4.6
	Rolling Plain #1	18	2.6
	Rolling Plain #2	16	2.7
	Coastal Flats	50	3.8
	Pothole Region	9	31.8
	Coastal Wetland Zone	72	8.3
	Coastal Water Zone	28	7.9
Pennsylvania	Middle Western Upland Plain	34	4.4
	Appalachian Highlands	28	0.3
	Poconos #1	17	6.8
	Poconos #2	21	5.3
	Other Glaciated Northeast	10	1.2
	Adirondack-New England Highlands	4	2.1
	Rolling Plain	26	2.4
	Lake Erie	6	3.3
Virginia	Appalachian Highlands	27	0.6
	Rolling Plain #1	24	0.6
	Rolling Plain #2	18	1.7
	Coastal Flats	30	2.8
	Coastal Wetland Zone	66	11.1
	Coastal Water Zone	23	6.4
West Virginia	Appalachian Highlands	66	1.0
	Canaan Valley	55	99.3*
	Meadow River Area	23	97.2*

*Essentially complete inventories of wetland status and trends in these areas.

Table 4. Study categories, including wetlands, deepwater habitats, and other lands. *Note:* In analyzing the data, several individual categories were combined into more generalized aggregated categories.

Individual Categories	Aggregated Categories
Marine Intertidal Wetland (Beach)	
Estuarine Subtidal Water (Deepwater Habitat)	
Estuarine Intertidal Emergent Wetland	Estuarine Vegetated Wetland
Estuarine Intertidal Scrub-Shrub Wetland	
Estuarine Intertidal Unconsolidated Shore	Estuarine Nonvegetated Wetland
Other Estuarine Intertidal Nonvegetated Wetland	
Palustrine Forested Wetland	Palustrine Vegetated Wetland
Palustrine Scrub-Shrub Wetland	
Palustrine Emergent Wetland	
Palustrine Unconsolidated Shore	Palustrine Nonvegetated Wetland
Palustrine Open Water (Pond)	
Other Palustrine Nonvegetated Wetland	
Lacustrine Open Water (Lake/Reservoir—Deepwater Habitat)	
Agricultural Land	
Urban Land	
Other Land (e.g., forests and other development)	

Results

The findings of this regional wetland trends analysis study are presented in Tables 5 through 20. Tables 5 and 6 show the results for the five-state region, while Chesapeake Bay watershed results are presented in Tables 7 and 8. Findings for individual states are given in Tables 9 through 18. Two tables are presented for the region, the Chesapeake Bay watershed, and each state—one showing results for all study categories and the other including results for aggregated categories, such as estuarine vegetated wetland, estuarine nonvegetated wetland, palustrine vegetated wetland and palustrine nonvegetated wetland. The more significant findings are discussed in the following subsections, after a brief discussion of interpretation of results.

Interpretation of Results

Estimated totals and their corresponding standard errors were calculated for major wetland types and other study categories for the mid-1950s and the late 1970s and for recent changes in each category. Tables 5 through 18 present these estimates for the region, the Chesapeake Bay watershed, and the five states. For each estimate, the standard error is expressed as a percentage of the estimated total (%SE). The standard error gives an indication of the reliability of the estimated number. In general, when the standard error is 25 percent or less of the estimated number, the estimate is considered reliable. The lower the %SE, the higher the reliability of the estimate and vice versa. If the %SE is 50 or more, one cannot even be 95 percent confident that the true value is not zero. In some cases, such as lakes and reservoirs (lacustrine open water), a high %SE may indicate that the underlying distribution violates the assumption of a normality (i.e., normal distribution).

The study interval was intended to extend from the mid-1950s to the late 1970s/early 1980s. The mean photo dates for the region were 1956 and 1979, for an interval of 23 years. The mean photo dates and study interval for each state varied according to available photography as follows:

(1) Delaware—1955 and 1981 = 26-year interval;
(2) Maryland—1955 and 1978 = 23-year interval;
(3) Pennsylvania—1956 and 1979 = 23-year interval;
(4) Virginia—1956 and 1977 = 21-year interval; and
(5) West Virginia—1957 and 1980 = 23-year interval.

The results for the region should, therefore, be interpreted based on a 23-year interval, whereas state results should be interpreted for the appropriate time period indicated above.

As previously mentioned, estimated totals for the mid-1950s and the late 1970s and corresponding changes during the study interval are presented in tabular form (Tables 5 through 18). The 1950s estimates (original classification) are given in the rows, whereas the late 1970s estimates (current classification) are indicated by the columns for each category. Net changes during the study period are given in the last row. Standard errors (expressed as a percentage of the estimate) are shown for each estimate.

Regional Results (Tables 5 and 6)

Wetland Status

The five-state region had an estimated 7.1 million acres (± 5.9% SE) of wetlands and deepwater habitats in the late 1970s, excluding marine waters. At this time, wetlands accounted for 2.3 million acres (± 6.8% SE) which represents an area about one-third the size of Maryland, or nearly twice the size of Delaware. Of this wetland total, roughly 80 percent (or 1,829 thousand acres ± 8.1% SE) was represented by palustrine wetlands, including freshwater marshes, swamps, bogs, and ponds. Major types of palustrine wetlands were forested wetlands (1,242 thousand acres or 67% of the region's freshwater wetlands and 54% of the region's total wetland resource), scrub-shrub wetlands (246 thousand acres or 13% of the region's freshwater wetlands), emergent wetlands (181 thousand acres or 10% of the region's freshwater wetlands), and ponds (157 thousand acres or 9% of the region's freshwater wetlands). The remaining 20 percent of the region's wetlands (or 469 thousand acres ± 9.4% SE) were estuarine wetlands, such as salt and brackish marshes and tidal flats. Major estuarine wetland types were emergent wetlands (305 thousand acres or 65% of the region's estuarine wetlands and 13% of the region's total wetland resource), unconsolidated shores (147 thousand acres or 31% of the region's estuarine wetlands), and scrub-shrub wetlands (4.4 thousand acres). Overall, about three percent of the region's land surface area was represented by wetland.

Wetlands are not evenly distributed across the region. Nearly half of the region's wetlands (1,045 thousand acres ± 11.5% SE) were located in Virginia. Pennsylvania and Maryland had 22 percent (498 thousand acres ± 16.4% SE) and 19 percent (438 thousand acres ± 10.3% SE) of the region's wetlands, respectively. The rest of the region's wetlands were found in Delaware (216 thousand acres ± 10.3% SE or nine percent of the regional wetlands) and West Virginia (102 thousand acres ± 20.5% SE or four percent of the region's wetlands). It was interesting to find that about 60 percent of the region's wetlands were located near the coast in association with the Coastal Plain and the Coastal Zone. The Lower Coastal Plain (Coastal Flats stratum) had about 28 percent of the region's wetlands, while about 11 percent occurred in the Upper Coastal Plain (subset of the Rolling Plain stratum) and an additional 20 percent were estuarine wetlands of the Coastal Zone.

Recent Wetland Trends

Between the mid-1950s and late 1970s, the region experienced net losses in its most important wetland types (estuarine and palustrine vegetated wetlands) and substantial net gains in ponds and larger water bodies (lakes and reservoirs). Palustrine vegetated wetlands suffered the greatest net losses, amounting to 132.6 thousand acres or about seven percent of those present in the mid-1950s. This acreage loss equates to an area three times the size of Washington, D.C. or about one-tenth the size of Delaware. The average annual net loss of this type was 5.8 thousand acres. Forested wetlands and emergent wetlands were the most vulnerable wetland types. While these two types equally accounted for all of the net human-induced losses of palustrine vegetated wetlands, the emergent wetlands were hardest hit, with a statistically significant reduction of about 27 percent since the mid-50s. Agriculture and other factors (mostly related to agriculture and chiefly channelization) were equally responsible for about two-thirds of the total gross human-induced losses of palustrine vegetated wetlands. Changes from one wetland type to another type were also observed. In general, there were large net losses of palustrine emergent wetlands to both scrub-shrub wetlands (about 26 thousand acres) and forested wetlands (about 9 thousand acres). To compute these net changes, for example, from emergent wetland to scrub-shrub wetland, one must subtract the gain in emergent wetland from scrub-shrub wetland in the 1970s (12 thousand acres) from the loss of emergent wetland to scrub-shrub wetland (38 thousand acres) as shown in Table 5. Thus, a net loss of 26 thousand acres of emergent wetland to scrub-shrub wetland took place between 1956 and 1979. While scrub-shrub wetlands experienced net increases from emergent wetlands, they had a net loss of about 11 thousand acres to forested wetlands. The Gulf-Atlantic Coastal Flats area (i.e., Lower Coastal Plain) was the principal area of wetland change, accounting for roughly 72

Table 5. Wetland status and trend estimates for the five-state region (1956–1979) by individual type. Estimates are in acres and the standard error (expressed as a percentage of the estimate) is given in parentheses.

CURRENT

ORIGINAL CLASSIFICATION	Marine Intertidal Wetland (Beach)	Estuarine Subtidal Water (Deepwater Habitat)	Estuarine Intertidal Emergent Wetland	Estuarine Intertidal Scrub-Shrub Wetland	Estuarine Intertidal Unconsolidated Shore	Other Estuarine Intertidal Nonvegetated Wetland	Palustrine Forested Wetland	Palustrine Scrub-Shrub Wetland
Marine Intertidal	1,670 (44.9)							
Estuarine Subtidal	121 (92.6)	3,216,008 (1.5)	1,737 (29.4)		4,113 (30.5)			15 (*)
Estuarine Intertidal Emergent	50 (76.0)	9,343 (49.7)	298,901 (9.5)	463 (38.2)	1,590 (38.1)	80 (96.3)	145 (50.3)	175 (41.1)
Estuarine Intertidal Scrub-Shrub		144 (68.8)	1,823 (65.7)	3,882 (28.4)	47 (68.1)		43 (93.0)	
Estuarine Intertidal Unconsolidated Shore		3,260 (36.6)	1,616 (33.1)	27 (55.6)	140,638 (21.2)	2,491 (78.7)	6 (*)	25 (72.0)
Other Estuarine Intertidal Nonvegetated		137 (67.2)	73 (67.1)		15 (*)	10,184 (42.3)		
Palustrine Forested		18 (72.2)	347 (55.6)	40 (95.0)	12 (*)		1,124,523 (10.1)	61,338 (28.2)
Palustrine Scrub-Shrub		63 (66.7)	91 (90.1)				72,479 (12.4)	134,063 (33.9)
Palustrine Emergent		49 (98.0)			26 (96.4)		25,390 (22.3)	38,246 (12.9)
Palustrine Unconsolidated Shore								
Palustrine Open Water							9 (77.8)	896 (74.8)
Other Palustrine Nonvegetated								
Lacustrine							50 (98.0)	342 (97.7)
Agriculture							1,830 (56.6)	1,332 (35.5)
Urban		147 (75.5)	5 (*)	5 (*)			202 (72.8)	1,681 (50.1)
Other	331 (93.4)	352 (40.1)	105 (35.2)	9 (*)	192 (39.1)		17,278 (44.9)	8,152 (24.3)
Total Current Surface Area	2,172 (44.5)	3,229,521 (1.4)	304,698 (9.4)	4,426 (26.5)	146,635 (20.4)	12,755 (42.0)	1,241,955 (9.6)	246,265 (20.8)
Recent Change	+123 (*)	+6,799 (70.5)	−16,371 (34.1)	−2,644 (55.2)	−2,348 (97.7)	+2,228 (91.7)	−69,588 (49.7)	+2,591 (*)

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

CLASSIFICATION

Palustrine Emergent Wetland	Palustrine Unconsolidated Shore	Palustrine Open Water (Pond)	Other Palustrine Nonvegetated Wetland	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
							379 (68.9)	2,049 (43.5)
					2 (*)	615 (46.7)	111 (43.2)	3,222,722 (1.5)
170 (82.9)	7 (*)	1,350 (38.1)		243 (93.4)	546 (58.3)	7,361 (32.5)	645 (32.6)	321,069 (9.3)
		109 (98.2)			106 (76.4)	711 (67.7)	205 (71.2)	7,070 (31.2)
					476 (65.5)	99 (54.5)	345 (64.9)	148,983 (20.1)
						118 (94.9)		10,527 (41.6)
16,291 (19.2)	316 (59.5)	9,585 (14.8)	60 (98.3)	9,431 (69.5)	36,774 (39.0)	5,832 (19.5)	46,976 (36.3)	1,311,543 (9.6)
12,077 (29.7)	7 (*)	7,023 (32.2)	40 (97.5)	4,732 (49.2)	3,069 (21.6)	4,553 (35.6)	5,477 (24.7)	243,674 (21.9)
128,800 (18.6)	7 (*)	13,560 (25.4)	98 (72.4)	4,381 (64.1)	21,088 (18.0)	5,536 (34.8)	9,388 (26.5)	246,571 (11.4)
	1,834 (96.6)	572 (71.0)				175 (61.1)		2,581 (70.8)
1,913 (34.8)	13 (84.6)	51,795 (14.5)		110 (80.9)	382 (27.7)	285 (36.1)	1,939 (24.7)	57,342 (13.7)
			20 (*)					20 (*)
1,251 (74.7)	45 (97.8)	29 (96.6)		954,038 (26.9)		1,477 (89.3)	322 (91.9)	957,554 (26.9)
8,382 (37.9)	12 (66.7)	34,427 (11.0)	20 (*)	3,097 (87.9)			68 (98.5)	49,168 (12.5)
2,821 (38.9)	79 (94.9)	4,926 (35.0)	29 (96.6)	8,430 (90.0)			29 (*)	18,354 (43.7)
9,269 (27.7)	180 (43.9)	33,839 (17.6)	15 (93.3)	549,888 (56.1)	27 (96.3)	145 (77.2)	75,229,410 (0.6)	75,849,192 (0.4)
180,974 (14.7)	2,500 (71.5)	157,215 (9.6)	282 (53.2)	1,534,350 (25.7)	62,470 (24.0)	26,907 (17.9)	75,295,294 (0.6)	82,448,419 (0)
−65,597 (17.7)	−81 (*)	+99,873 (9.6)	+262 (53.4)	+576,796 (54.5)	+13,302 (*)	+8,553 (*)	−553,898 (55.7)	

Table 6. Wetland status and trend estimates for the five-state region (1956–1979). Estimates are in acres and the standard error (expressed as a percent of the estimate) is shown in parentheses. *Note:* Wetland types are aggregated within system as vegetated or nonvegetated.

ORIGINAL CLASSIFICATION	CURRENT: Marine Intertidal Wetland (Beach)	Estuarine Subtidal Water (Deepwater Habitat)	Estuarine Intertidal Vegetated Wetland	Estuarine Intertidal Nonvegetated Wetland	Palustrine Vegetated Wetland
Marine Intertidal	1,670 (44.9)				
Estuarine Subtidal	121 (92.6)	3,216,008 (1.5)	1,737 (29.4)	4,113 (30.5)	15 (*)
Estuarine Intertidal Vegetated	50 (76.0)	9,486 (49.1)	305,068 (9.4)	1,717 (35.8)	533 (34.7)
Estuarine Intertidal Nonvegetated		3,397 (35.1)	1,716 (32.9)	153,329 (20.0)	32 (75.0)
Palustrine Vegetated		130 (56.2)	478 (44.4)	40 (72.5)	1,613,206 (8.9)
Palustrine Nonvegetated					2,818 (32.7)
Lacustrine					1,643 (61.5)
Agriculture					11,544 (30.3)
Urban		147 (75.5)	11 (63.6)		4,703 (33.6)
Other	331 (93.4)	352 (40.1)	115 (33.0)	192 (39.1)	34,700 (26.8)
Total Current Surface Area	2,172 (44.5)	3,229,520 (1.4)	309,125 (9.3)	159,391 (19.3)	1,669,194 (8.7)
Recent Change	+123 (*)	+6,798 (70.5)	−19,014 (30.3)	−121 (*)	−132,591 (20.6)

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

CLASSIFICATION

Palustrine Nonvegetated Wetland	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
				379 (68.9)	**2,049** (43.5)
		2 (*)	**615** (46.7)	**111** (43.2)	**3,222,722** (1.5)
1,466 (39.9)	**243** (93.4)	**653** (34.6)	**8,073** (34.2)	**850** (31.1)	**328,139** (9.2)
		476 (65.5)	**217** (74.7)	**345** (64.9)	**159,512** (19.3)
30,696 (19.7)	**18,543** (57.5)	**60,931** (24.6)	**15,920** (22.4)	**61,841** (28.1)	**1,801,785** (8.4)
54,235 (14.9)	**110** (80.9)	**382** (27.7)	**461** (33.4)	**1,939** (24.7)	**59,945** (14.0)
74 (70.3)	**954,038** (26.9)		**1,477** (89.3)	**322** (91.9)	**957,554** (26.9)
34,459 (11.0)	**3,097** (87.9)			**68** (98.5)	**49,168** (12.5)
5,034 (34.6)	**8,430** (90.0)			**29** (*)	**18,354** (43.7)
34,033 (17.5)	**549,888** (56.1)	**27** (96.3)	**145** (77.2)	**75,229,410** (0.6)	**75,849,193** (0.4)
159,997 (9.6)	**1,534,349** (25.7)	**62,471** (24.0)	**26,908** (17.9)	**75,295,294** (0.6)	**82,448,421** (0)
+100,052 (9.6)	**+576,795** (54.5)	**+13,303** (*)	**+8,554** (*)	**−553,899** (55.7)	

percent of the region's net loss (96 thousand acres ± 22.3% SE) of palustrine vegetated wetland.

A significant net loss of 19 thousand acres or about six percent of the region's estuarine vegetated wetlands occurred during the study period. The annual net loss of estuarine vegetated wetlands averaged 827 acres. Slightly more than 85 percent of these losses affected estuarine emergent wetlands, amounting to a five percent net loss in these wetlands during the study period. Urbanization and conversion of estuarine vegetated wetlands to open water, largely through dredging projects, saltwater impoundment construction, and rising sea level, accounted for over three-quarters of the gross losses of these wetlands. Maryland had the greatest estimated losses of this wetland type.

In stark contrast to vegetated wetland losses, pond (palustrine open water) acreage significantly increased by 100 thousand acres from the mid-50s, for a 174 percent gain. The construction of ponds in farmland and forests was largely responsible for this increase. Slightly less than one-third of the net gains in ponds came from freshwater wetlands, mainly emergent wetlands, forested wetlands, and scrub-shrub wetlands. Pennsylvania and Virginia had the biggest increases in pond acreage.

Chesapeake Bay Watershed Results
(Tables 7 and 8)

Wetland Status

An estimated 4.5 million acres of wetlands and deepwater habitats were present in the Chesapeake Bay watershed in the late 1970s. Wetlands alone accounted for 1.2 million acres. Nearly three percent of the watershed was represented by wetland. Palustrine wetlands were the most abundant, occupying about one million acres, while estuarine wetlands made up the remainder. Palustrine forested wetlands were the most common type (658 thousand acres), representing about 55 percent of the watershed's wetlands. Palustrine scrub-shrub wetlands (152 thousand acres) were next in abundance followed closely by estuarine emergent wetlands (132 thousand acres) and palustrine emergent wetlands (104 thousand acres).

Recent Wetland Trends

Recent trends of major proportion in the watershed's wetlands were net losses in estuarine vegetated wetlands and palustrine vegetated wetlands and a tremendous net gain of 172 percent in freshwater ponds. A net loss of about nine percent of the Chesapeake Bay's estuarine vegetated wetlands occurred since the mid-1950s, with most of the loss involving emergent wetlands. Major human-induced causes of these estuarine losses were dredging, saltwater impoundment construction, and urbanization (e.g., filling for housing and industrial facilities). Creation of freshwater impoundments (i.e., conversion to palustrine nonvegetated wetlands) was another important factor. Palustrine vegetated wetlands declined by about six percent or 55 thousand acres during the study period. Agriculture and other factors, mainly channelization related to farming, were responsible for nearly 60 percent of the gross losses in palustrine vegetated wetlands. Pond, lake, and reservoir construction combined for about 30 percent of the losses.

State Results

DELAWARE (Tables 9 and 10)

Wetland Status

In 1981, Delaware had an estimated 216 thousand acres (± 10.3% SE) of wetlands and 275 thousand acres (± 2.6% SE) of deepwater habitats. Wetlands covered about 17 percent of the state's land area. Palustrine (freshwater) wetlands were most abundant, totaling about 148 thousand acres (± 13.9% SE). They represented about 68 percent of the state's wetlands. Palustrine forested wetland was the most common and widespread type, representing 90 percent of the state's freshwater wetlands and about 62 percent of the state's total wetland resource. Estuarine (salt and brackish) wetlands made up slightly less than one third of the state's wetlands (or about 67 thousand acres ± 13.5% SE). The dominant estuarine type was emergent wetland which accounted for about 93 percent of the estuarine wetlands.

Since the Coastal Plain region (including the Coastal Flats and Pothole strata) covers nearly all of Delaware (actually 94 percent of the state), it was not surprising to find 98 percent of the state's inland vegetated wetlands there. The remaining two percent was found in the Rolling Plain or Piedmont region of northern Delaware.

Recent Wetland Trends

Delaware recently experienced a significant net loss of nearly 42 thousand acres of vegetated wetlands and a significant net gain of about two thousand acres

of nonvegetated wetlands, mostly ponds. Annual losses of vegetated wetlands averaged about 1.6 thousand acres.

A startling 21 percent (or 38 thousand acres ± 13.3% SE) of the state's palustrine vegetated wetlands were lost since the mid-1950s. Average annual losses of these wetlands amounted to almost 1.5 thousand acres. Most of the losses involved forested wetlands which declined by about 17 percent or roughly 28 thousand acres. Scrub-shrub wetlands dropped by seven thousand acres or nearly 55 percent. Agriculture and other factors (mostly channelization related to agriculture) were responsible for about 82 percent of the gross losses of palustrine vegetated wetlands, with channelization projects having the greatest adverse impacts. Urban development caused 12 percent of the losses, whereas impoundment construction for ponds, lakes, and reservoirs caused about five percent of the losses of these freshwater wetlands.

Losses of estuarine wetlands were not as extensive as the palustrine vegetated wetland losses. About six percent (or nearly four thousand acres) of the state's estuarine vegetated wetlands (mainly emergent wetlands) were lost since the mid-50s. Roughly 64 percent of the gross losses were attributed to urban development (filling of tidal marshes for homes, commercial and industrial facilities, and highways), while a combination of dredging projects (many related to housing developments), saltwater impoundments, and rising sea level caused about 20 percent of the losses. Six percent of the losses were the result of conversion to freshwater impoundments.

Pond (palustrine open water) acreage increased dramatically by nearly two thousand acres or 400 percent. Slightly more than half of these new open water bodies came from vegetated wetlands, mostly forested wetlands. Much of the remaining new pond acreage came from upland forests.

MARYLAND (Tables 11 and 12)

Wetland Status

In 1978, Maryland possessed an estimated 438 thousand acres (± 10.3% SE) of wetlands, which occupied about six percent of the state's land area. In addition, about 1.6 million acres (± 1.4% SE) of deepwater habitats existed. About 58 percent of the state's wetlands were palustrine vegetated wetlands, while roughly 25 percent were estuarine vegetated wetlands and about 12 percent were estuarine nonvegetated wetlands. Freshwater ponds (palustrine open water) comprised four percent of the state's wetlands. Palustrine forested wetlands were most abundant, covering an estimated 220 thousand acres and representing half of the state's wetland resource. Estuarine emergent wetlands with nearly 110 thousand acres were second-ranked in abundance.

Almost 80 percent (200 thousand acres ± 20.0% SE) of the state's palustrine vegetated wetlands occurred on the Lower Coastal Plain (Coastal Flats and Pothole strata), while about 11 percent (28 thousand acres ± 30.6% SE) was in the Upper Coastal Plain (Rolling Plain—Irregular Plains stratum). Eight percent (21 thousand acres ± 24.3% SE) of these wetlands were located in the Piedmont (Rolling Plain—area 1 stratum) and only two percent (6 thousand acres ± 40.3% SE) of these palustrine vegetated wetlands were found in the Appalachian Highlands of western Maryland.

Recent Wetland Trends

Maryland's vegetated wetlands declined substantially since the mid-50s, whereas vast acreages of freshwater ponds were created. About eight percent of the estuarine vegetated wetlands (largely emergent wetlands) and almost six percent of the palustrine vegetated wetlands (mostly emergent types) were lost. Annual net losses of these two types averaged about 450 acres and 650 acres, respectively. About two-thirds of the estuarine vegetated wetland losses were due to conversion of tidal marshes to coastal deepwater habitats. This resulted from a combination of both natural and human-induced factors such as coastal submergence due to rising sea level, dredging projects, and creation of saltwater impoundments. Of the other factors causing losses of estuarine wetlands, urbanization and freshwater impoundment construction were important, combining for about 76 percent of the losses directly attributed to human impacts.

Roughly 15 thousand acres of palustrine vegetated wetlands were lost. Most of this loss impacted freshwater emergent wetlands. Agriculture and other factors (mostly channelization related to agriculture) were equally responsible for about two-thirds of the palustrine vegetated wetland losses. Pond construction in these wetlands was also a significant factor, accounting for nearly 30 percent of the losses. By contrast, urban development caused only 8 percent of the losses. The Lower Coastal Plain region (Coastal Flats and Pothole strata) was by far, the most heavily impacted area of the state: about 91 percent (13.7 thousand acres ± 18.5% SE) of the state's palustrine vegetated wetland losses occurred here.

Table 7. Wetland status and trend estimates for the Chesapeake Bay Watershed (1956–1979) by individual type. Estimates are in acres and the standard error (expressed as a percentage of the estimate) is given in parentheses.

CURRENT

ORIGINAL CLASSIFICATION	Estuarine Subtidal Water (Deepwater Habitat)	Estuarine Intertidal Emergent Wetland	Estuarine Intertidal Scrub-Shrub Wetland	Estuarine Intertidal Unconsolidated Shore	Other Estuarine Intertidal Nonvegetated Wetland	Palustrine Forested Wetland	Palustrine Scrub-Shrub Wetland	Palustrine Emergent Wetland
Estuarine Subtidal	**2,744,303** (1.2)	**796** (28.1)		**2,280** (34.6)			**16** (93.8)	
Estuarine Intertidal Emergent	**7,402** (64.7)	**129,413** (13.4)	**213** (55.4)	**876** (41.4)	**83** (96.4)	**53** (64.2)	**62** (46.8)	**23** (56.5)
Estuarine Intertidal Scrub-Shrub	**35** (54.3)	**1,112** (83.7)	**2,323** (35.1)	**48** (72.7)		**35** (94.3)		
Estuarine Intertidal Unconsolidated Shore	**1,371** (36.3)	**402** (55.5)	**13** (92.3)	**69,078** (25.2)	**2,591** (78.7)	**6** (*)	**19** (94.7)	
Other Estuarine Intertidal Nonvegetated	**56** (94.6)	**29** (93.1)		**16** (93.8)	**9,391** (44.6)			
Palustrine Forested	**13** (92.3)	**67** (56.7)	**33** (93.9)	**13** (92.3)		**604,451** (15.0)	**19,284** (28.6)	**6,587** (26.4)
Palustrine Scrub-Shrub	**39** (94.9)					**32,361** (16.7)	**102,859** (51.3)	**8,667** (45.9)
Palustrine Emergent	**51** (98.0)			**29** (96.6)		**15,582** (27.7)	**23,278** (20.3)	**76,799** (25.1)
Palustrine Unconsolidated Shore								
Palustrine Open Water							**865** (89.4)	**1,360** (47.4)
Other Palustrine Nonvegetated								
Lacustrine								**879** (97.7)
Agriculture						**1,636** (69.5)	**743** (43.9)	**5,346** (33.5)
Urban	**10** (90.0)					**37** (70.3)	**687** (59.5)	**660** (57.1)
Other	**195** (54.9)	**73** (45.2)		**98** (43.9)		**3,544** (35.3)	**4,188** (39.7)	**3,213** (34.1)
Total Current Surface Area	**2,753,475** (1.1)	**131,892** (13.2)	**2,582** (33.6)	**72,434** (24.2)	**12,065** (44.2)	**657,705** (14.0)	**152,001** (37.3)	**103,534** (20.6)
Recent Change	**+5,725** (85.2)	**−11,253** (46.7)	**−1,330** (78.6)	**−1,394** (*)	**+2,476** (85.5)	**−4,070** (*)	**−5,986** (*)	**−44,530** (19.8)

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

CLASSIFICATION

Palustrine Unconsolidated Shore	Palustrine Open Water (Pond)	Other Palustrine Nonvegetated Wetland	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
				2 (*)	289 (39.8)	64 (65.6)	2,747,750 (1.2)
6 (83.3)	1,485 (43.0)			445 (47.0)	2,815 (66.6)	269 (50.9)	143,145 (13.7)
	163 (98.8)			91 (72.5)	32 (84.4)	77 (*)	3,912 (42.4)
				199 (81.9)	89 (51.7)	60 (63.3)	73,828 (24.0)
					97 (92.8)		9,589 (44.2)
163 (96.3)	5,096 (20.8)	66 (98.5)	750 (58.0)	6,660 (37.9)	2,404 (39.4)	16,188 (25.9)	661,775 (13.8)
6 (83.3)	4,824 (51.8)	44 (97.7)	2,195 (91.6)	1,840 (30.6)	2,743 (63.6)	2,409 (31.5)	157,987 (38.7)
7 (*)	9,062 (39.2)	37 (97.3)	399 (82.5)	13,734 (21.8)	4,713 (49.2)	4,373 (27.3)	148,064 (15.5)
30 (76.7)	423 (99.3)						453 (92.9)
	29,822 (26.0)		94 (98.9)	237 (34.2)	67 (67.2)	738 (44.0)	33,183 (24.3)
		22 (*)					22 (*)
	29 (96.6)		207,060 (82.7)		1,343 (97.7)	19 (*)	209,330 (81.8)
	22,638 (14.7)	22 (*)	3,292 (98.9)			82 (98.8)	33,759 (15.9)
	1,853 (46.6)		722 (97.6)				3,969 (36.8)
	14,875 (22.5)	29 (96.6)	311,843 (89.3)		106 (99.1)	39,078,540 (0.9)	39,416,704 (0.5)
212 (75.0)	90,270 (16.4)	220 (60.2)	526,355 (62.1)	23,208 (17.4)	14,698 (31.3)	39,102,819 (0.9)	43,643,470 (0)
−241 (*)	+57,087 (13.8)	+198 (59.3)	+317,025 (87.9)	−10,551 (63.4)	+10,729 (44.7)	−313,885 (88.5)	

Table 8. Wetland status and trend estimates for the Chesapeake Bay Watershed (1956–1979). Estimates are in acres and the standard error (expressed as a percent of the estimate) is shown in parentheses. *Note:* Wetland types are aggregated within system as vegetated or nonvegetated.

ORIGINAL CLASSIFICATION	CURRENT: Estuarine Subtidal Water (Deepwater Habitat)	Estuarine Intertidal Vegetated Wetland	Estuarine Intertidal Nonvegetated Wetland	Palustrine Vegetated Wetland	Palustrine Nonvegetated Wetland
Estuarine Subtidal	2,744,303 (1.2)	796 (28.1)	2,280 (34.6)	16 (93.8)	
Estuarine Intertidal Vegetated	7,437 (64.4)	133,060 (13.2)	1,003 (37.6)	174 (32.2)	1,654 (46.1)
Estuarine Intertidal Nonvegetated	1,427 (35.1)	443 (51.7)	81,077 (23.2)	26 (92.3)	
Palustrine Vegetated	103 (68.9)	100 (49.0)	42 (73.8)	889,869 (13.5)	19,305 (33.9)
Palustrine Nonvegetated				2,225 (43.2)	30,296 (25.6)
Lacustrine				879 (97.7)	29 (96.6)
Agriculture				7,725 (28.7)	22,660 (14.7)
Urban	10 (90.0)			1,385 (46.8)	1,853 (46.6)
Other	195 (54.9)	73 (45.2)	98 (43.9)	10,945 (25.6)	14,904 (22.4)
Total Current Surface Area	2,753,475 (1.1)	134,472 (13.1)	84,500 (22.4)	913,244 (13.3)	90,701 (16.3)
Recent Change	+5,725 (85.2)	−12,585 (41.5)	+1,082 (87.8)	−54,591 (17.3)	+57,044 (13.7)

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

CLASSIFICATION

Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
	2 (*)	289 (39.8)	64 (65.6)	2,747,750 (1.2)
	536 (41.0)	2,847 (65.9)	346 (48.6)	147,057 (13.5)
	199 (81.9)	186 (70.4)	60 (63.3)	83,418 (22.7)
3,345 (71.3)	22,241 (18.1)	9,861 (39.9)	22,969 (19.6)	967,835 (12.8)
94 (98.9)	237 (34.2)	67 (67.2)	738 (44.0)	33,657 (24.0)
207,060 (82.7)		1,343 (97.7)	19 (*)	209,330 (81.8)
3,292 (98.9)			82 (98.8)	33,759 (15.9)
722 (97.6)				3,970 (36.8)
311,843 (89.3)		106 (99.1)	39,078,540 (0.9)	39,416,704 (0.5)
526,356 (62.1)	23,215 (17.4)	14,699 (31.3)	39,102,818 (0.9)	43,643,480 (0)
+317,026 (87.9)	−10,544 (63.4)	−10,729 (44.7)	−313,886 (88.5)	

Table 9. Wetland status and trend estimates for Delaware (1956–1979) by individual type. Estimates are in acres and the standard error (expressed as a percentage of the estimate) is given in parentheses.

CURRENT

ORIGINAL CLASSIFICATION

	Marine Intertidal Wetland (Beach)	Estuarine Subtidal Water (Deepwater Habitat)	Estuarine Intertidal Emergent Wetland	Estuarine Intertidal Scrub-Shrub Wetland	Estuarine Intertidal Unconsolidated Shore	Palustrine Forested Wetland	Palustrine Scrub-Shrub Wetland	Palustrine Emergent Wetland
Marine Intertidal	1,054 (57.9)							
Estuarine Subtidal		271,243 (2.5)	150 (48.0)		428 (77.8)			
Estuarine Intertidal Emergent		914 (29.8)	61,366 (14.9)	215 (54.4)	147 (70.1)	91 (71.4)	47 (93.6)	
Estuarine Intertidal Scrub-Shrub		7 (85.7)	418 (75.1)	604 (64.7)				
Estuarine Intertidal Unconsolidated Shore		233 (78.1)	272 (61.4)	10 (90.0)	3,404 (52.1)		7 (85.7)	
Palustrine Forested		5 (*)	280 (67.5)			123,187 (14.3)	2,010 (33.7)	2,296 (53.4)
Palustrine Scrub-Shrub		26 (84.6)	88 (93.2)			6,910 (33.0)	2,815 (23.4)	243 (60.1)
Palustrine Emergent						1,879 (32.9)	490 (36.9)	2,495 (25.3)
Palustrine Unconsolidated Shore								
Palustrine Open Water						3 (66.7)		74 (68.9)
Other Palustrine Nonvegetated								
Lacustrine								
Agriculture						363 (47.4)		148 (41.2)
Urban		135 (82.2)	5 (*)	5 (*)		3 (66.7)	13 (53.8)	226 (88.1)
Other	327 (94.5)	66 (81.8)	16 (62.5)			856 (51.3)	450 (54.7)	423 (57.4)
Total Current Surface Area	1,381 (61.3)	272,629 (2.6)	62,595 (14.6)	834 (53.1)	3,979 (44.2)	133,292 (15.0)	5,832 (18.9)	5,905 (26.0)
Recent Change	+327 (94.5)	+512 (62.9)	−3,366 (44.7)	−514 (80.5)	+53 (*)	−28,272 (18.1)	−7,041 (35.3)	−2,603 (64.6)

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

CLASSIFICATION

Palustrine Unconsolidated Shore	Palustrine Open Water (Pond)	Other Palustrine Nonvegetated Wetland	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
							1.054 (57.9)
					296 (88.9)		272.117 (2.6)
	40 (77.5)		243 (93.4)	46 (69.6)	2,807 (43.6)	45 (84.4)	65.961 (13.4)
					191 (76.4)	128 (95.3)	1,348 (43.3)
							3.926 (44.5)
7 (71.4)	711 (27.1)		596 (74.0)	8,570 (27.5)	3,468 (26.6)	20,434 (22.3)	161.564 (12.3)
	96 (51.0)		76 (59.2)	791 (39.4)	612 (55.6)	1,216 (48.4)	12.873 (19.8)
	183 (29.5)		415 (53.7)	2,012 (29.2)	662 (52.1)	372 (53.8)	8.508 (16.5)
20 (65.0)	25 (76.0)				59 (94.9)		104 (73.8)
2 (*)	367 (24.8)			4 (75.0)	7 (71.4)	39 (64.1)	496 (24.1)
							0
			894 (61.2)				894 (61.2)
7 (*)	290 (29.0)						808 (28.0)
79 (94.9)	240 (75.0)						706 (66.2)
72 (52.8)	534 (31.1)	15 (*)	344 (95.1)	27 (96.3)		1.002.777 (2.2)	1.005.907 (2.2)
187 (44.4)	2,486 (16.4)	15 (*)	2,568 (36.7)	11,450 (21.7)	8,102 (24.7)	1,025,011 (2.1)	1,536,266 (0)
+83 (47.0)	+1,990 (18.5)	+15 (*)	+1,674 (38.9)	+10,642 (23.4)	+7,396 (27.7)	+19,104 (25.1)	

Table 10. Wetland status and trend estimates for Delaware (1955–1981). Estimates are in acres and the standard error (expressed as a percent of the estimate) is shown in parentheses. *Note:* Wetland types are aggregated within system as vegetated or nonvegetated.

ORIGINAL CLASSIFICATION	CURRENT: Marine Intertidal Wetland (Beach)	Estuarine Subtidal Water (Deepwater Habitat)	Estuarine Intertidal Vegetated Wetland	Estuarine Intertidal Nonvegetated Wetland	Palustrine Vegetated Wetland
Marine Intertidal	1,054 (57.9)				
Estuarine Subtidal		271,243 (2.5)	150 (48.0)	428 (77.8)	
Estuarine Intertidal Vegetated		921 (30.0)	62,604 (14.6)	147 (70.1)	137 (67.2)
Estuarine Intertidal Nonvegetated		233 (78.1)	281 (59.4)	3,404 (52.1)	7 (85.7)
Palustrine Vegetated		32 (81.3)	368 (55.7)		142,324 (14.3)
Palustrine Nonvegetated					76 (67.1)
Lacustrine					
Agriculture					510 (41.2)
Urban		135 (82.2)	11 (63.6)		241 (83.0)
Other	327 (94.5)	66 (81.8)	16 (62.5)		1,728 (43.2)
Total Current Surface Area	1,381 (61.4)	272,630 (2.6)	63,430 (14.5)	3,979 (44.2)	145,023 (14.1)
Recent Change	+327 (94.5)	+513 (62.8)	−3,878 (41.0)	+54 (*)	−37,922 (13.3)

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

CLASSIFICATION

Palustrine Nonvegetated Wetland	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
					1,054 (57.9)
			296 (88.9)		**272,117** (2.6)
40 (77.5)	**243** (93.4)	**46** (69.6)	**2,998** (44.0)	**172** (76.7)	**67,308** (13.2)
					3,925 (44.5)
997 (22.4)	**1,087** (48.4)	**11,373** (21.8)	**4,742** (25.8)	**22,022** (22.0)	**182,945** (12.0)
414 (22.7)		**4** (75.0)	**66** (84.8)	**39** (64.1)	**599** (24.7)
	894 (61.2)				**894** (61.2)
298 (29.5)					**808** (28.0)
318 (79.9)					**705** (66.2)
621 (30.0)	**344** (95.1)	**27** (96.3)		**1,002,777** (2.2)	**1,005,906** (1.4)
2,688 (17.0)	**2,568** (36.7)	**11,450** (21.7)	**8,102** (24.7)	**1,025,010** (2.1)	**1,536,261** (0)
+2,089 (18.2)	**+1,674** (38.9)	**+10,642** (23.4)	**+7,397** (27.7)	**+19,104** (25.1)	

Table 11. Wetland status and trend estimates for Maryland (1955–1978) by individual type. Estimates are in acres and the standard error (expressed as a percentage of the estimate) is given in parentheses. *Note:* The marine intertidal area of Maryland was too small to statistically sample, so no marine estimates are given.

CURRENT

ORIGINAL CLASSIFICATION	Estuarine Subtidal Water (Deepwater Habitat)	Estuarine Intertidal Emergent Wetland	Estuarine Intertidal Scrub-Shrub Wetland	Estuarine Intertidal Unconsolidated Shore	Other Estuarine Intertidal Nonvegetated Wetland	Palustrine Forested Wetland	Palustrine Scrub-Shrub Wetland
Estuarine Subtidal	1,554,027 (1.3)	500 (37.6)		1,721 (42.7)			15 (*)
Estuarine Intertidal Emergent	7,237 (63.7)	107,715 (15.9)	99 (77.8)	789 (44.5)	80 (96.3)	42 (78.6)	65 (44.6)
Estuarine Intertidal Scrub-Shrub	28 (64.3)	139 (41.7)	1,335 (31.6)	28 (96.4)			
Estuarine Intertidal Unconsolidated Shore	934 (45.8)	339 (63.1)	12 (*)	42,818 (21.0)	2,479 (79.1)	6 (*)	19 (89.5)
Other Estuarine Intertidal Nonvegetated	68 (94.1)			15 (*)	6,722 (53.4)		
Palustrine Forested	12 (*)	48 (66.7)		12 (*)		204,429 (19.1)	3,028 (36.4)
Palustrine Scrub-Shrub	37 (97.3)	3 (*)		0		10,184 (20.3)	5,833 (19.0)
Palustrine Emergent	49 (98.0)			28 (96.4)		3,341 (17.6)	3,498 (27.4)
Palustrine Unconsolidated Shore							
Palustrine Open Water						7 (*)	7 (*)
Other Palustrine Nonvegetated							
Lacustrine						50 (98.0)	342 (97.7)
Agriculture						437 (39.1)	367 (67.6)
Urban						13 (*)	171 (64.3)
Other	151 (66.2)	56 (48.2)		49 (55.1)		1,423 (45.5)	114 (49.1)
Total Current Surface Area	1,562,543 (1.2)	108,800 (15.8)	1,446 (30.8)	45,460 (20.2)	9,281 (51.6)	219,932 (18.3)	13,459 (18.0)
Recent Change	+5,983 (78.3)	−9,845 (47.4)	−183 (74.3)	−1,426 (*)	+2,476 (82.2)	+2,004 (*)	−5,557 (55.5)

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

CLASSIFICATION

Palustrine Emergent Wetland	Palustrine Unconsolidated Shore	Palustrine Open Water (Pond)	Other Palustrine Nonvegetated Wetland	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
						245 (42.9)	52 (73.1)	1,556,560 (1.3)
19 (63.2)		965 (42.9)			432 (46.8)	1,093 (42.7)	109 (52.3)	118,645 (16.3)
					19 (94.7)	3 (*)	77 (*)	1,629 (27.7)
					191 (81.7)	37 (62.2)	51 (68.6)	46,886 (20.2)
								6,805 (52.8)
1,214 (25.3)	87 (69.0)	2,761 (25.2)	60 (98.3)	22 (81.8)	1,949 (34.6)	264 (48.1)	4,042 (37.0)	217,928 (18.2)
516 (30.4)		818 (31.3)	40 (97.5)	34 (97.1)	560 (42.3)	586 (39.1)	405 (35.6)	19,016 (13.4)
17,036 (41.1)	7 (*)	1,850 (21.1)	34 (97.1)	7 (*)	4,095 (23.6)	857 (47.7)	2,380 (59.6)	33,182 (24.8)
	40 (60.0)	27 (96.3)						67 (52.2)
47 (61.7)		3,602 (16.6)			73 (45.2)	92 (51.1)	35 (62.9)	3,863 (15.8)
			20 (*)					20 (*)
879 (97.7)		29 (96.6)		14,932 (61.6)		1,343 (97.7)	322 (91.9)	17,897 (57.5)
1,361 (27.0)		6,304 (15.9)	20 (*)	2,894 (93.8)			68 (98.5)	11,451 (27.5)
230 (52.2)		283 (34.6)		684 (97.5)			29 (*)	1,410 (49.7)
384 (35.7)	63 (84.1)	1,374 (27.9)		4,091 (73.6)		145 (77.2)	6,187,289 (0.7)	6,195,139 (0.7)
21,686 (32.2)	197 (59.9)	18,013 (9.8)	174 (68.4)	22,664 (47.6)	7,319 (17.6)	4,665 (31.9)	6,194,859 (0.7)	8,230,498 (0)
−11,496 (22.7)	+130 (83.8)	+14,150 (11.4)	+154 (68.2)	+4,767 (*)	−4,132 (80.7)	+3,255 (49.9)	−280 (*)	

Table 12. Wetland status and trend estimates for Maryland (1955–1978). Estimates are in acres and the standard error (expressed as a percentage of the estimate) is shown in parentheses. *Note:* Wetland types are aggregated within system as vegetated or nonvegetated; also the marine intertidal area of Maryland was too small to statistically sample, so no marine estimates are given.

ORIGINAL CLASSIFICATION	CURRENT: Estuarine Subtidal Water (Deepwater Habitat)	Estuarine Intertidal Vegetated Wetland	Estuarine Intertidal Nonvegetated Wetland	Palustrine Vegetated Wetland
Estuarine Subtidal	1,554,027 (1.3)	500 (37.6)	1,721 (42.7)	15 (*)
Estuarine Intertidal Vegetated	7,265 (63.5)	109,288 (15.8)	897 (40.7)	126 (35.7)
Estuarine Intertidal Nonvegetated	1,002 (42.8)	352 (61.6)	52,034 (21.0)	25 (92.0)
Palustrine Vegetated	99 (68.7)	52 (61.5)	40 (72.5)	249,080 (16.6)
Palustrine Nonvegetated				60 (50.0)
Lacustrine				1,272 (73.9)
Agriculture				2,165 (26.0)
Urban				414 (39.6)
Other	151 (66.2)	56 (48.2)	49 (55.1)	1,921 (35.6)
Total Current Surface Area	1,562,544 (1.2)	110,248 (15.7)	54,741 (20.4)	255,078 (16.2)
Recent Change	+5,984 (78.3)	−10,025 (46.5)	+1,049 (82.4)	−15,050 (19.9)

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

CLASSIFICATION

Palustrine Nonvegetated Wetland	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
			245 (42.9)	52 (73.1)	1,556,560 (1.3)
965 (42.9)		450 (45.1)	1,096 (42.6)	186 (60.8)	120,273 (16.1)
		191 (81.7)	37 (62.2)	51 (68.6)	53,692 (20.7)
5,657 (15.4)	62 (59.7)	6,604 (18.9)	1,707 (31.5)	6,827 (30.9)	270,128 (15.6)
3,689 (16.4)		73 (45.2)	92 (56.5)	35 (62.9)	3,949 (15.6)
29 (96.6)	14,932 (61.6)		1,343 (97.7)	322 (91.9)	17,898 (57.5)
6,324 (15.8)	2,894 (93.8)			68 (98.5)	11,451 (27.5)
283 (34.6)	684 (97.5)			29 (*)	1,410 (49.7)
1,437 (28.5)	4,091 (73.6)		145 (77.2)	6,187,289 (0.7)	6,195,139 (0.7)
18,384 (9.9)	22,663 (47.7)	7,318 (17.6)	4,665 (31.9)	6,194,859 (0.7)	8,230,500 (0)
+14,435 (11.4)	+4,765 (*)	−4,133 (80.7)	+3,255 (49.9)	−280 (*)	

As elsewhere across the five-state region, pond acreage in Maryland greatly increased, by 366 percent or over 14 thousand acres. About 45 percent of the new ponds were created from vegetated wetlands, with palustrine forested wetlands and emergent wetlands being most affected. Another 45 percent of the ponds came from farmland, with most of the remainder coming from upland forests.

PENNSYLVANIA (Tables 13 and 14)

Wetland Status

In 1979, nearly one-half million acres (498 thousand acres ± 16.4% SE) of wetlands existed in Pennsylvania, including about 431 thousand acres of vegetated wetlands and 67 thousand acres of nonvegetated wetlands (mostly ponds). In addition, about 685 thousand acres of deepwater habitats (lakes and reservoirs) were present. Wetlands occupied about two percent of the state's land surface. Almost 45 percent (or 221 thousand acres) of the state's wetlands were palustrine forested wetlands, while scrub-shrub wetlands were next in abundance (28 percent or 139 thousand acres). Emergent wetlands were only a third as abundant as the forested wetlands and only half as common as the scrub-shrub wetlands, with 70 thousand acres (or 14 percent of the state's wetlands). The remaining freshwater wetlands were made up largely by ponds.

The state's palustrine vegetated wetlands were largely concentrated in the northeastern and northwestern corners of the state that represented only 17 percent of the state's land area. These two areas were represented by four sampling strata: Poconos #1, Poconos #2, and Other Glaciated Northeast for the northeastern corner and Middle Western Upland Plain for the northwestern corner. Over a quarter of the state's vegetated wetlands (112 thousand acres ± 13.1% SE) were in the northeastern area and about one-fifth (89 thousand acres ± 19.6% SE) occurred in the northwestern corner of the state. Thus, nearly half of the state's vegetated wetlands were concentrated in these two areas.

Recent Wetland Trends

Between 1956 and 1979, Pennsylvania had a net loss of about 28 thousand acres, or six percent of its vegetated wetlands. Meanwhile, its pond acreage increased by about 130 percent (or roughly 37 thousand acres). Tremendous losses in emergent wetlands took place, with a net loss of nearly 42.5 thousand acres which represented a 38 percent loss of this type. Over 1.8 thousand acres of this type were lost annually on the average. These emergent wetland losses were mostly (64 percent) attributed to changes to other vegetated wetland types (i.e., forested and shrub wetlands), while direct human-induced changes to other land and water types were mostly the result of channelization, pond construction and urban development. Net losses of 16.6 thousand acres of emergent wetlands to scrub-shrub wetlands and 8.5 thousand acres of emergent wetlands to forested wetlands were estimated. These losses of emergent wetlands, in fact, contributed to estimated small net gains (but not statistically significant) in the two other vegetated types. Actual conversion of palustrine vegetated wetlands to ponds, lakes, and reservoirs (mostly ponds) accounted for about 45 percent of the losses. Conversion to farmland, urban development, and other lands (largely due to channelization/drainage projects) were responsible for 17 percent, 14 percent and 23 percent of the losses of vegetated wetlands, respectively.

Slightly more than one-third (9.7 thousand acres ± 29.7% SE) of the palustrine vegetated wetland losses took place in northeastern Pennsylvania. The heaviest loss (5.3 thousand acres ± 26.5% SE) was observed in the northern Poconos area (Poconos #2 stratum), which lost about 15 percent of its vegetated wetlands. The northwestern part of the state also lost substantially, recently losing about five percent (4.6 thousand acres ± 37.2% SE) of its vegetated wetlands.

Statewide, pond acreage increased by 37 thousand acres due to alteration of vegetated wetlands and conversion of other land types. Forty-two percent of the new pond acreage came from wetlands (mostly from emergent wetlands), while 30 percent came from other land (mainly upland forests) and 23 percent from farmland.

VIRGINIA (Tables 15 and 16)

Wetland Status

In the late 1970s, Virginia had slightly more than one million acres (1.045 thousand acres ± 11.5% SE) of wetlands and 2.2 million acres (± 16.7% SE) of deepwater habitats, excluding marine waters. Wetlands represented about four percent of the state's land surface area. Palustrine vegetated wetlands predominated, representing 72 percent of the state's wetlands, while estuarine vegetated wetlands and estuarine nonvegetated wetlands made up 13 percent and ten percent, respectively. The remainder of wetlands were mostly freshwater ponds. Palustrine forested wetlands were the most abundant type, covering about 626 thousand acres and alone accounting

for about 60 percent of the state's wetlands. Estuarine emergent wetlands were next in abundance, with an estimated 133 thousand acres.

Most of Virginia's wetlands were found in the Lower Coastal Plain area. About 36 percent (290 thousand acres ± 27.2% SE) of the state's freshwater wetlands were found in this area (Coastal Flats stratum), while all of its estuarine wetlands (236 thousand acres ± 16.6% SE) were also in the Lower Coastal Plain area (the Coastal Zone stratum). The Upper Coastal Plain (Rolling Plain—area 2 stratum) had about 22 percent of the state's wetlands (229 thousand acres ± 22.8% SE). In all, about 72 percent of the Virginia's wetlands existed in the Coastal Plain area, including the Coastal Zone. The majority of the remaining wetlands (227 thousand acres ± 26.9% SE or about 22 percent of the state's wetlands) were found in the Piedmont area (Rolling Plain—area 1 stratum). The rest of the state's wetlands were located in the Appalachian Highlands region of western Virginia.

Recent Wetland Trends

Virginia recently lost an estimated net total of nearly 57 thousand acres of palustrine vegetated wetlands, while it experienced a net gain of about 35 thousand acres of palustrine nonvegetated wetlands. This latter gain resulted largely from pond construction and less so from beaver impoundments which in combination increased pond acreage by over 170 percent since the mid-50s. Most of these new ponds were created from upland areas, mainly from farmland and forests.

About seven percent (or a net of 57 thousand acres) of the state's palustrine vegetated wetland acreage was recently lost. Most of these losses involved forested wetlands. Major causes of the palustrine vegetated wetland loss included agricultural conversion (45 percent), other factors such as channelization (largely related to agriculture) and forestry (27 percent), and pond, lake, and reservoir construction (25 percent). Urban development was responsible for only three percent of these losses. Roughly 80 percent (45.7 thousand acres ± 45.4% SE) of the state's losses of palustrine vegetated wetlands occurred in the Lower Coastal Plain region.

Coastal wetlands were adversely affected to a lesser degree, with an estimated net loss of about six thousand acres (± 48.6% SE). This loss represented about three percent of the estuarine wetlands present in the mid-50s. Most of the estimated losses involved estuarine emergent wetlands. Urban development was the primary cause of loss of estuarine vegetated wetlands, accounting for about 54 percent of the t gross loss or 62 percent of the gross direct huma induced losses. Conversion of estuarine emergen wetlands to open water by saltwater impoundment construction, dredging projects, and the natural rise in sea level caused almost one-fifth of the gross losses.

It is interesting to note that lakes and reservoirs in Virginia increased by an estimated 520 thousand acres, or almost 200 percent, although the statistics were not significant. The lack of significance for this huge increase is almost certainly due to the violation of normality in the distribution of lakes and reservoirs in the sample plots. The design of this study simply makes it unsuitable for estimating change in lacustrine deepwater habitats.

WEST VIRGINIA (Tables 17 and 18)

Wetland Status

West Virginia had an estimated 102 thousand acres (± 20.5% SE) of palustrine wetlands in 1980. This acreage amounted to about 0.7 percent of the state's land area. Forested wetlands prevailed, accounting for slightly more than 40 percent of the state's wetlands or about 42 thousand acres. Scrub-shrub wetlands and emergent wetlands comprised 23 percent and 20 percent of the wetlands, respectively, while ponds made up the remaining balance.

Two areas of the state were intensively sampled at essentially 100 percent: (1) Canaan Valley and (2) Meadow River area. The Canaan Valley had an estimated nine thousand acres (± 1.7% SE) of palustrine vegetated wetlands and 206 acres (± 1.9% SE) of ponds. About 77 percent of the vegetated wetlands were scrub-shrub wetlands (seven thousand acres ± 1.7% SE), while forested wetlands and emergent wetlands were equally abundant with about one thousand acres of each (± 2.5% SE and ± 3.4% SE, respectively). Vegetated wetlands occupied 5.3 thousand acres (± 1.8% SE) in the Meadow River area, while only 24 acres (± 4.2% SE) of ponds were observed. In contrast to the Canaan Valley, most of the Meadow River area's wetlands were forested wetlands (2.4 thousand acres ± 2.5% SE) and emergent wetlands (1.9 thousand acres ± 2.1% SE), with only one thousand acres (± 3.1% SE) of scrub-shrub wetlands present. Overall, wetlands in the Canaan Valley and Meadow River area represented about 14 percent of the state's wetlands.

Table 13. Wetland status and trend estimates for Pennsylvania (1956–1979) by individual type. Estimates are in acres and the standard error (expressed as a percentage of the estimate) is given in parentheses. *Note:* The estuarine zone of Pennsylvania was too small to statistically sample, so no estuarine estimates are given.

ORIGINAL CLASSIFICATION	CURRENT: Palustrine Forested Wetland	Palustrine Scrub-Shrub Wetland	Palustrine Emergent Wetland	Palustrine Unconsolidated Shore	Palustrine Open Water (Pond)
Palustrine Forested	**170,817** (12.7)	**23,486** (43.9)	**5,625** (36.4)	**178** (97.2)	**2,996** (33.1)
Palustrine Scrub-Shrub	**30,966** (16.1)	**85,942** (52.1)	**8,070** (42.9)		**4,859** (45.6)
Palustrine Emergent	**14,171** (36.7)	**24,715** (17.8)	**48,916** (18.5)		**9,285** (35.4)
Palustrine Unconsolidated Shore				**1,774** (99.8)	
Palustrine Open Water		**726** (91.6)	**1,666** (39.6)	**11** (90.9)	**24,519** (27.8)
Other Palustrine Nonvegetated					
Lacustrine					
Agriculture	**1,029** (97.8)	**192** (58.3)	**971** (37.7)	**5** (*)	**9,273** (17.4)
Urban	**175** (83.4)	**361** (62.0)	**1,361** (61.2)		**2,098** (60.9)
Other	**4,265** (66.7)	**3,850** (35.4)	**3,692** (56.9)		**12,163** (32.8)
Total Current Surface Area	**221,423** (12.5)	**139,272** (34.7)	**70,301** (17.0)	**1,968** (90.4)	**65,193** (19.2)
Recent Change	**+12,474** (*)	**+2,135** (*)	**−42,365** (20.4)	**+194** (89.2)	**+37,010** (18.7)

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

CLASSIFICATION

Other Palustrine Nonvegetated Wetland	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
	1,131 (54.2)	164 (45.7)	1,413 (39.8)	3,139 (31.7)	208,949 (12.3)
	1,523 (58.7)	851 (43.8)	2,608 (58.4)	2,318 (46.7)	137,137 (37.8)
64 (98.4)	857 (47.7)	7,018 (30.8)	2,458 (62.2)	5,182 (36.8)	112,666 (13.6)
					1,774 (99.8)
	23 (95.7)	42 (59.5)	95 (78.9)	1,101 (35.1)	28,183 (25.3)
	670,434 (22.2)				670,434 (22.2)
	202 (97.0)				11,672 (16.7)
29 (96.6)	7,746 (97.6)				11,770 (65.4)
	2,904 (63.4)			28,204,780 (0.6)	28,231,654 (0.6)
93 (97.8)	684,820 (21.8)	8,075 (27.8)	6,574 (46.4)	28,216,520 (0.6)	29,414,239 (0)
+93 (97.8)	+14,386 (64.8)	−3,597 (86.5)	−5,196 (*)	−15,134 (46.9)	

Table 14. Wetland status and trend estimates for Pennsylvania (1956–1979). Estimates are in acres and the standard error (expressed as a percent of the estimate) is shown in parentheses.
Note: Wetland types are aggregated within system as vegetated or nonvegetated; also the estuarine zone of Pennsylvania was too small to statistically sample, so no estuarine estimates are given.

ORIGINAL CLASSIFICATION	CURRENT CLASSIFICATION: Palustrine Vegetated Wetland	Palustrine Nonvegetated Wetland	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
Palustrine Vegetated	412,708 (17.2)	17,382 (33.5)	3,511 (41.6)	8,033 (28.0)	6,478 (47.1)	10,639 (24.1)	458,751 (16.5)
Palustrine Nonvegetated	2,392 (38.3)	26,304 (28.3)	23 (95.7)	42 (59.5)	95 (78.9)	1,101 (35.1)	29,957 (25.8)
Lacustrine			670,434 (22.2)				670,434 (22.2)
Agriculture	2,192 (49.0)	9,278 (17.4)	202 (97.0)				11,672 (16.7)
Urban	1,897 (50.2)	2,127 (60.8)	7,746 (97.6)				11,770 (65.4)
Other	11,807 (42.1)	12,163 (32.8)	2,904 (63.4)			28,204,780 (0.6)	28,231,654 (0.6)
Total Current Surface Area	430,996 (16.8)	67,254 (19.1)	684,820 (21.8)	8,075 (27.8)	6,573 (46.4)	28,216,520 (0.6)	29,414,238 (0)
Recent Change	−27,755 (31.6)	+37,297 (18.6)	+14,386 (64.8)	−3,597 (86.5)	−5,197 (*)	−15,134 (46.9)	

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

Recent Wetland Trends

Statewide, a slight net gain (not statistically significant) in palustrine vegetated wetlands and a tremendous gain in pond acreage were estimated. The 227 percent gain in ponds is a reliable estimate, whereas the six percent gain in vegetated wetlands is not reliable. Beaver activity in the state may be largely responsible for the estimated net increase in vegetated wetland at the expense of upland forest. Losses of vegetated wetlands were mainly related to other factors such as channelization, and to pond, lake, and reservoir construction. Palustrine emergent wetland was the most vulnerable type, with a significant net loss of about 22 percent in this type since the mid-50s. Most of this loss was, however, due to plant community succession to either scrub-shrub wetland or forested wetland. About 21 percent of the emergent wetland acreage present in the mid-50s became scrub-shrub wetland by 1980.

The Canaan Valley lost a net total of 1.1 thousand acres (± 2.2% SE) or 53 percent of its emergent wetlands, but had net increases in scrub-shrub wetland (844 acres ± 3.4% SE or 14 percent gain) and forested wetlands (37 acres ± 37.8% SE or three percent gain). Pond acreage increased by about 117 percent from 95 acres (± 2.1% SE) to 206 acres (± 1.9% SE). Most of the losses of the emergent wetlands were the result of succession to scrub-shrub wetlands (net loss of 896 acres). Human-induced gross losses of vegetated wetlands in the Valley accounted for nearly 500 acres, with other factors such as channelization accounting for 42 percent of these losses (197 acres ± 2.5% SE) and impoundment construction causing 35 percent of these losses (a total of 166 acres, or 87 acres ± 5.7% SE to lakes and reservoirs plus 79 acres ± 3.8% SE to ponds). Urban development caused about 14 percent (66 acres ± 3.0% SE) of the remaining losses, while agricultural conversion of wetland accounted for only nine percent (45 acres ± 6.7% SE). The large gain in pond acreage came mainly from vegetated wetlands, especially emergent and scrub-shrub wetlands. Beaver activity was probably the major reason for these changes.

The Meadow River area experienced a net loss of 320 acres (± 5.9% SE) or roughly six percent of its vegetated wetlands, while it had a slight increase in pond acreage from 15 acres (± 6.7% SE) to 24 acres (± 4.2% SE). Most (79 percent) of the losses of vegetated wetland were due to conversion to farmland, which affected 252 acres (± 5.6% SE). Emergent wetlands suffered the greatest losses (219 acres ± 6.4% SE) from agriculture. Other factors such as channelization involved 143 acres (± 4.9% SE) of vegetated wetlands, while urban development impacted only 27 acres (± 14.8% SE), mostly scrub-shrub wetlands (19 acres ± 15.8% SE). Most of the new pond acreage came from emergent wetlands (7 acres ± 0.0% SE).

DISCUSSION

The five-state region comprises about four percent of the land surface area of the conterminous United States, and in the late 1970s, it possessed about 2.3 percent of the wetlands in the lower 48 states. It had about nine percent of the estuarine wetlands, 2.5 percent of the palustrine forested wetlands, 2.3 percent of the palustrine scrub-shrub wetlands, 0.6 percent of the palustrine emergent wetlands, and 3.6 percent of the ponds in the conterminous United States.

Regional losses of vegetated wetlands accounted for about 1.3 percent of the national (conterminous U.S.) losses reported by Frayer and others (1983). About five percent of the national losses of estuarine vegetated wetlands and about 1.2 percent of the national losses of palustrine vegetated wetlands occurred in the five-state region. The region's loss of palustrine emergent wetlands was higher than the national loss: 27 percent versus 14 percent. At both the national and regional levels, urban development was responsible about 84 percent of the losses of estuarine vegetated wetlands due to the three major human-induced factors (i.e., agriculture, urban and other development). Urban losses of palustrine vegetated wetlands were less substantial causing about seven percent of the national losses and 12 percent of the regional losses attributed to the three major types of development. Agriculture and pond construction were responsible for 80 percent and five percent of the total recent palustrine vegetated wetland losses in the Nation, respectively, while agriculture, other factors (mostly channelization related to farming), and pond construction combined for 81 percent of the regional loss in these wetlands. Reservoir and lake construction had a greater adverse wetland impact regionally, accounting for ten percent of the total palustrine vegetated wetland loss versus four percent of the national loss of these wetlands.

Comparisons between the wetland estimates produced by the present study and estimates or actual acreage measurements reported in other studies provide some interesting results. Existing data on wetland acreage for Delaware, West Virginia, and Maryland (estuarine wetlands) were available from other

Table 15. Wetland status and trend estimates for the Virginia region (1956–1977) by individual type. Estimates are in acres and the standard error (expressed as a percentage of the estimate) is given in parentheses.

CURRENT

ORIGINAL CLASSIFICATION

	Marine Intertidal Wetland (Beach)	Estuarine Subtidal Water (Deepwater Habitat)	Estuarine Intertidal Emergent Wetland	Estuarine Intertidal Scrub-Shrub Wetland	Estuarine Intertidal Unconsolidated Shore	Other Estuarine Intertidal Nonvegetated Wetland	Palustrine Forested Wetland
Marine Intertidal	616 (70.6)						
Estuarine Subtidal	121 (92.6)	1,390,739 (3.1)	1,088 (43.1)		1,964 (48.9)		
Estuarine Intertidal Emergent	50 (76.0)	1,192 (39.8)	129,819 (16.0)	149 (72.5)	654 (73.9)		12 (58.3)
Estuarine Intertidal Scrub-Shrub		109 (89.0)	1,265 (91.2)	1,943 (48.3)	19 (94.7)		43 (93.0)
Estuarine Intertidal Unconsolidated Shore		2,092 (52.5)	1,005 (45.9)	5 (80.0)	94,417 (30.0)	12 (91.7)	
Other Estuarine Intertidal Nonvegetated		69 (95.7)	73 (67.1)			3,462 (68.8)	
Palustrine Forested			19 (94.7)	40 (95.0)			592,953 (17.4)
Palustrine Scrub-Shrub							20,399 (32.1)
Palustrine Emergent							3,758 (33.0)
Palustrine Unconsolidated Shore							
Palustrine Open Water							
Lacustrine							
Agriculture							
Urban		12 (91.7)					
Other	5 (*)	135 (63.0)	33 (69.7)	9 (*)	142 (49.3)		8,639 (81.1)
Total Current Surface Area	792 (58.5)	1,394,348 (3.0)	133,302 (15.8)	2,146 (46.3)	97,196 (29.3)	3,474 (68.8)	625,804 (16.9)
Recent Change	−203 (*)	+302 (*)	−3,165 (84.7)	−1,947 (71.5)	−975 (88.1)	−248 (62.1)	−61,352 (48.8)

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

CLASSIFICATION

Palustrine Scrub-Shrub Wetland	Palustrine Emergent Wetland	Palustrine Unconsolidated Shore	Palustrine Open Water (Pond)	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
							379 (68.9)	995 (65.2)
					2 (*)	73 (60.3)	59 (50.8)	1,394,046 (3.0)
64 (75.0)	152 (92.1)	7 (*)	346 (88.2)		69 (62.3)	3,462 (57.7)	491 (40.3)	136,467 (15.5)
			109 (98.2)		88 (89.8)	517 (88.8)		4,093 (50.8)
					284 (95.1)	62 (77.4)	294 (75.5)	98,171 (29.0)
						118 (94.9)		3,722 (67.5)
31,574 (43.8)	6,802 (29.2)	43 (*)	2,820 (24.2)	7,673 (84.8)	25,874 (54.6)	666 (51.4)	18,692 (87.4)	687,156 (16.8)
26,823 (26.1)	2,342 (34.4)	7 (*)	910 (36.9)	3,039 (70.8)	854 (44.6)	692 (52.9)	1,215 (47.3)	56,281 (20.5)
4,139 (32.5)	43,971 (42.8)		1,877 (49.6)	3,083 (89.8)	7,625 (37.9)	1,221 (80.8)	671 (51.0)	66,345 (29.5)
			521 (77.7)			117 (77.8)		638 (68.7)
128 (57.0)	125 (51.2)		18,840 (15.6)	87 (98.9)	188 (42.6)	39 (79.5)	383 (58.7)	19,790 (15.2)
	371 (99.2)	45 (97.8)		267,342 (78.2)		134 (98.5)		267,892 (78.1)
293 (72.7)	5,514 (56.7)		14,623 (21.6)					20,430 (23.3)
703 (49.7)	910 (73.8)		1,978 (55.5)					3,603 (56.2)
225 (64.9)	2,804 (44.0)	45 (97.8)	13,111 (28.4)	506,360 (60.6)			24,333,650 (1.5)	24,865,158 (1.0)
63,949 (25.6)	62,991 (32.5)	147 (51.7)	55,135 (13.7)	787,584 (46.0)	34,984 (41.5)	7,101 (39.0)	24,355,834 (1.5)	27,624,787 (0)
+7,668 (*)	−3,354 (*)	−491 (91.0)	+35,345 (16.7)	+519,692 (60.1)	+14,554 (*)	+3,498 (95.3)	−509,324 (60.2)	

Table 16. Wetland status and trend estimates for Virginia (1956–1977). Estimates are in acres and the standard error (expressed as a percentage of the estimate) is shown in parentheses.
Note: Wetland types are aggregated within system as vegetated or nonvegetated.

CURRENT

ORIGINAL CLASSIFICATION	Marine Intertidal Wetland (Beach)	Estuarine Subtidal Water (Deepwater Habitat)	Estuarine Intertidal Vegetated Wetland	Estuarine Intertidal Nonvegetated Wetland	Palustrine Vegetated Wetland
Marine Intertidal	616 (70.6)				
Estuarine Subtidal	121 (92.6)	1,390,739 (3.1)	1,088 (43.1)	1,964 (48.9)	
Estuarine Intertidal Vegetated	50 (76.0)	1,301 (43.4)	133,177 (15.7)	673 (71.9)	270 (57.0)
Estuarine Intertidal Nonvegetated		2,161 (50.9)	1,083 (45.6)	97,891 (29.1)	
Palustrine Vegetated			59 (71.2)		732,759 (15.6)
Palustrine Nonvegetated					254 (37.8)
Lacustrine					371 (99.2)
Agriculture					5,806 (56.0)
Urban		12 (91.7)			1,613 (71.0)
Other	5 (*)	135 (63.0)	43 (55.8)	142 (49.3)	11,668 (60.5)
Total Current Surface Area	792 (58.5)	1,394,348 (3.0)	135,450 (15.6)	100,670 (28.4)	752,741 (15.2)
Recent Change	−203 (*)	+302 (*)	−5,107 (58.3)	−1,223 (71.4)	−57,038 (43.7)

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

CLASSIFICATION

Palustrine Nonvegetated Wetland	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
				379 (68.9)	**995** (65.2)
		2 (*)	**73** (60.3)	**59** (50.8)	**1,394,046** (3.0)
461 (89.4)		**156** (59.0)	**3,978** (59.7)	**491** (40.3)	**140,557** (15.2)
		284 (95.1)	**180** (88.9)	**294** (75.5)	**101,893** (28.1)
5,657 (22.4)	**13,795** (76.4)	**34,353** (42.3)	**2,578** (47.9)	**20,578** (79.3)	**809,779** (14.8)
19,361 (15.2)	**87** (98.9)	**188** (42.6)	**155** (67.7)	**383** (58.7)	**20,428** (14.7)
45 (97.8)	**267,342** (78.2)		**134** (98.5)		**267,892** (78.1)
14,623 (21.6)					**20,429** (23.3)
1,978 (55.5)					**3,603** (56.2)
13,155 (28.3)	**506,360** (60.6)			**24,333,650** (1.5)	**24,865,158** (9.7)
55,280 (13.7)	**787,584** (46.0)	**34,983** (41.5)	**7,098** (39.0)	**24,355,834** (1.5)	**27,624,780** (0)
+34,852 (16.6)	**+519,692** (60.1)	**+14,554** (*)	**+3,495** (95.3)	**−509,324** (60.2)	

Table 17. Wetland status and trend estimates for West Virginia (1957–1980) by individual type. Estimates are in acres and the standard error (expressed as a percentage of the estimate) is given in parentheses.

CURRENT CLASSIFICATION

ORIGINAL CLASSIFICATION

	Palustrine Forested Wetland	Palustrine Scrub-Shrub Wetland	Palustrine Emergent Wetland	Palustrine Open Water (Pond)	Lacustrine Open Water (Lake/ Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
Palustrine Forested	**33,139** (29.3)	**1,241** (26.6)	**354** (63.3)	**298** (64.4)	**9** (11.1)	**218** (65.1)	**22** (9.1)	**670** (62.5)	**35,951** (27.7)
Palustrine Scrub-Shrub	**4,020** (45.9)	**12,649** (17.3)	**906** (40.9)	**340** (55.3)	**59** (6.8)	**13** (7.7)	**55** (5.5)	**323** (53.3)	**18,365** (18.3)
Palustrine Emergent	**2,242** (74.3)	**5,404** (28.9)	**16,382** (57.8)	**365** (36.2)	**20** (5.0)	**338** (16.6)	**338** (94.7)	**783** (78.5)	**25,872** (38.8)
Palustrine Open Water		**35** (71.4)	**1** (0)	**4,466** (22.7)		**75** (73.3)	**52** (67.3)	**381** (43.8)	**5,010** (20.8)
Lacustrine					**437** (4.8)				**437** (4.8)
Agriculture	**1** (0)	**480** (67.3)	**389** (47.8)	**3,936** (23.1)					**4,806** (22.3)
Urban	**10** (20.0)	**434** (90.8)	**94** (78.7)	**328** (90.2)					**866** (65.8)
Other	**2,095** (73.0)	**3,514** (40.2)	**1,966** (39.5)	**6,658** (35.3)	**36,189** (92.1)			**15,500,960** (0.2)	**15,551,382** (0.1)
Total Current Surface Area	**41,507** (31.1)	**23,757** (17.0)	**20,092** (47.5)	**16,391** (18.5)	**36,714** (90.8)	**644** (24.7)	**467** (68.7)	**15,503,117** (0.2)	**15,642,689** (0)
Recent Change	**+5,556** (74.1)	**+5,392** (53.5)	**−5,780** (34.0)	**+11,381** (23.2)	**+36,277** (91.9)	**−4,162** (24.6)	**−399** (*)	**−48,265** (69.3)	

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

Table 18. Wetland status and trend estimates for West Virginia (1957–1980). Estimates are in acres and the standard error (expressed as a percent of the estimate) is shown in parentheses. *Note:* Wetland types are aggregated within system as vegetated or nonvegetated.

CURRENT CLASSIFICATION

ORIGINAL CLASSIFICATION	Palustrine Vegetated Wetland	Palustrine Nonvegetated Wetland	Lacustrine Open Water (Lake/Reservoir–Deepwater Habitat)	Agricultural Land	Urban Land	Other Land (e.g., forests and other development)	Total Original Surface Area
Palustrine Vegetated	76,336 (22.7)	1,002 (36.1)	87 (5.7)	569 (26.7)	415 (77.1)	1,775 (42.5)	80,184 (21.9)
Palustrine Nonvegetated	36 (69.4)	4,466 (22.7)		75 (73.3)	52 (67.3)	381 (43.8)	5,010 (20.8)
Lacustrine			437 (4.8)				437 (4.8)
Agriculture	870 (42.2)	3,936 (23.1)					4,806 (22.3)
Urban	538 (87.0)	328 (90.2)					866 (65.8)
Other	7,576 (44.1)	6,658 (35.3)	36,189 (92.1)			15,500,960 (0.2)	15,551,383 (0.1)
Total Current Surface Area	85,356 (22.8)	16,390 (18.5)	36,713 (90.8)	644 (24.7)	467 (68.9)	15,503,116 (0.2)	15,642,686 (0)
Recent Change	+5,172 (66.4)	+11,380 (23.2)	+36,276 (91.9)	−4,162 (24.6)	−399 (*)	−48,267 (69.3)	

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

reports prior to initiating this study. Data for Delaware and West Virginia were actual measurements based on wetland mapping surveys conducted by the U.S. Fish and Wildlife Service (Tiner 1985) and the West Virginia Department of Natural Resources (Evans, *et al.* 1982), respectively. The Delaware inventory methodology was consistent with our study, while the West Virginia methodology was different. In contrast to these sources, the Maryland data for coastal wetlands were estimates derived by grid sampling techniques (McCormick and Somes 1982).

Our estimate of Delaware's total wetland acreage (Tables 9 and 10) was within three percent of the National Wetlands Inventory total based on detailed mapping (Tiner 1985). When individual types were compared, the differences were, of course, greater. In general, our more reliable estimates proved to be good estimates. For example, we estimated 145 thousand acres (± 14.1% SE) of palustrine vegetated wetlands, while NWI reported 128 thousand acres, for a difference of about 17 thousand acres or 13 percent of the value based on detailed statewide mapping. For estuarine vegetated wetlands, we estimated 63.4 thousand acres (± 14.5% SE) and that estimate is within 20 percent of the NWI total of 79 thousand acres. The greatest difference occurred in the estuarine nonvegetated wetland category where our estimate was 63 percent less than the NWI acreage, but our estimate was not a reliable one, since the standard error was high (44.2% of the estimate). Overall, our results were in reasonable agreement with the actual numbers based on detailed NWI mapping.

When compared with the West Virginia data (Evans, *et al.* 1982), differences were anticipated principally due to sampling methods (e.g., classification system and inventory techniques). It was, therefore, not surprising to see our estimate of West Virginia's wetlands (Tables 17 and 18) 47 percent higher than the state's figure. If the floodplain community riparian type was added to the state's wetlands total, the difference was reduced to 36 percent. Comparisons with our estimates for the Canaan Valley and Meadow River area, which were essentially complete wetland inventories, also showed quite different results. We identified 9,042 acres of palustrine vegetated wetland for the Canaan Valley, while the state survey reported only 6,995 acres, for a difference of about two thousand acres. Thus, our estimate of palustrine vegetated wetland was about 30 percent higher. For the Meadow River area, our wetland estimate was 46 percent higher than the state's number: 5,315 acres versus 3,631 acres. Again, these differences were not surprising, since the NWI mapping technique is more comprehensive than the state's inventory method.

Our estimate of Maryland's estuarine wetlands (Table 12) was within two percent of McCormick and Somes' estimate: 164,988 acres versus 168,483 acres. The breakdown of these totals was, however, quite different, with our estimate of vegetated wetlands being 33 percent lower than theirs and our estimate of nonvegetated wetlands being about 18 times higher than theirs. These differences may be related to methodology, since our estimated totals were nearly the same.

The above comparisons do show that while differences exist, there are good correlations with existing sources at various levels, especially with NWI data which employed similar inventory techniques. Where differences do exist, they may be largely attributed to differences in methodology, such as wetland definition and classification or inventory technique (e.g., mapping detail).

Conclusions

An estimated 2.3 million acres of wetlands and 4.8 million acres of deepwater habitats (excluding marine waters) existed in the five-state region in the late 1970s. Regionwide, wetlands covered an area nearly twice the size of Delaware. About 46 percent (or roughly one million acres) of the region's wetlands were in Virginia. Pennsylvania was next in wetland abundance with nearly one-half million acres or about 22 percent of the region's wetlands, closely followed by Maryland with 438 thousand acres or about 19 percent. Delaware had about 216 thousand acres of wetland or about nine percent, while West Virginia had only about 102 thousand acres or about four percent of the region's wetlands.

Recent wetland losses were greatest in the Lower Coastal Plain region (Coastal Flats and Pothole strata) where nearly 75 percent (96 thousand acres ± 22.3% SE) of the region's net losses in palustrine vegetated wetlands occurred. Regionwide, about 133 thousand acres of palustrine vegetated wetlands were recently lost. This acreage loss represents an area three times the size of Washington, D.C. or about one-tenth the size of Delaware. Agriculture and other factors (mostly related to channelization) were equally responsible for about two-thirds of the gross human-induced losses of these wetlands. The region experienced a net loss of about seven percent of its inland vegetated wetlands. Virginia and Delaware had the heaviest losses of these wetlands. Estuarine

wetlands, especially emergent wetlands which decreased regionwide by nearly six percent since the mid-50s, also declined substantially, with a net loss of about 19 thousand acres. Urban development and conversion of vegetated wetlands to open water by dredging projects, saltwater impoundment construction, and sea level rise caused nearly 85 percent of the gross losses of these wetlands. Maryland experienced the greatest losses of estuarine wetlands.

While significant losses of vegetated wetlands took place, pond acreage increased dramatically in the region, going from 57 thousand acres in the mid-50s to 157 thousand acres in the late 1970s for a 175 percent gain. Most of the new ponds came at the expense of farmland or upland forests, but nearly a third of the new acreage was constructed in freshwater wetlands. Pennsylvania and Virginia had the biggest gains in pond acreage.

We can easily see that huge gains in freshwater ponds and substantial losses of vegetated wetlands have recently taken place in the region. The importance of the gain in pond acreage to fish and wildlife species has not been assessed and is still subject to much discussion. By contrast, the losses of vegetated wetlands (e.g., emergent, scrub-shrub, and forested wetlands) represent known losses of valuable fish and wildlife habitats and losses of the many other environmental quality and socio-economic values provided free-of-charge to society by wetlands. Moreover, the significance of the vegetated wetland losses is not simply reflected by the acreage lost alone, since prior to the mid-1950s, many wetlands had already been destroyed, making the remaining wetlands more important and future losses more serious. While this report documents recent trends in the extent of wetlands, it does not address changes in the quality of the remaining wetlands. Today, wetlands are subjected to a multitude of perturbations that reduce their quality. Water pollution from urban, agricultural, and industrial sources, increased sedimentation and erosion related to changing land uses, channelization and ditching projects, reduced freshwater inflows, ground-water withdrawals, and various forms of urban encroachment are among many factors adversely impacting the quality of wetlands.

This report represents the first regional intensification of the national wetland status and trends study. As such, it has provided the most up-to-date information on the status and trends of wetlands in the five-state region, the Chesapeake Bay watershed, and each individual state. These results will prove invaluable to regulatory agencies, natural resource managers and planners, environmental organizations, and the general public in making future land use decisions and in addressing the region's major wetland problems. This type of study provides, in large part, a comprehensive overview of the cumulative recent impacts of agriculture, urban development, impoundment construction, and other factors on wetlands and will be useful in evaluating current policies affecting wetlands. In the future, these results can be updated as needed to reassess the status of wetlands. Similar studies should be conducted where information of recent wetland changes and the current status of wetlands is needed.

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