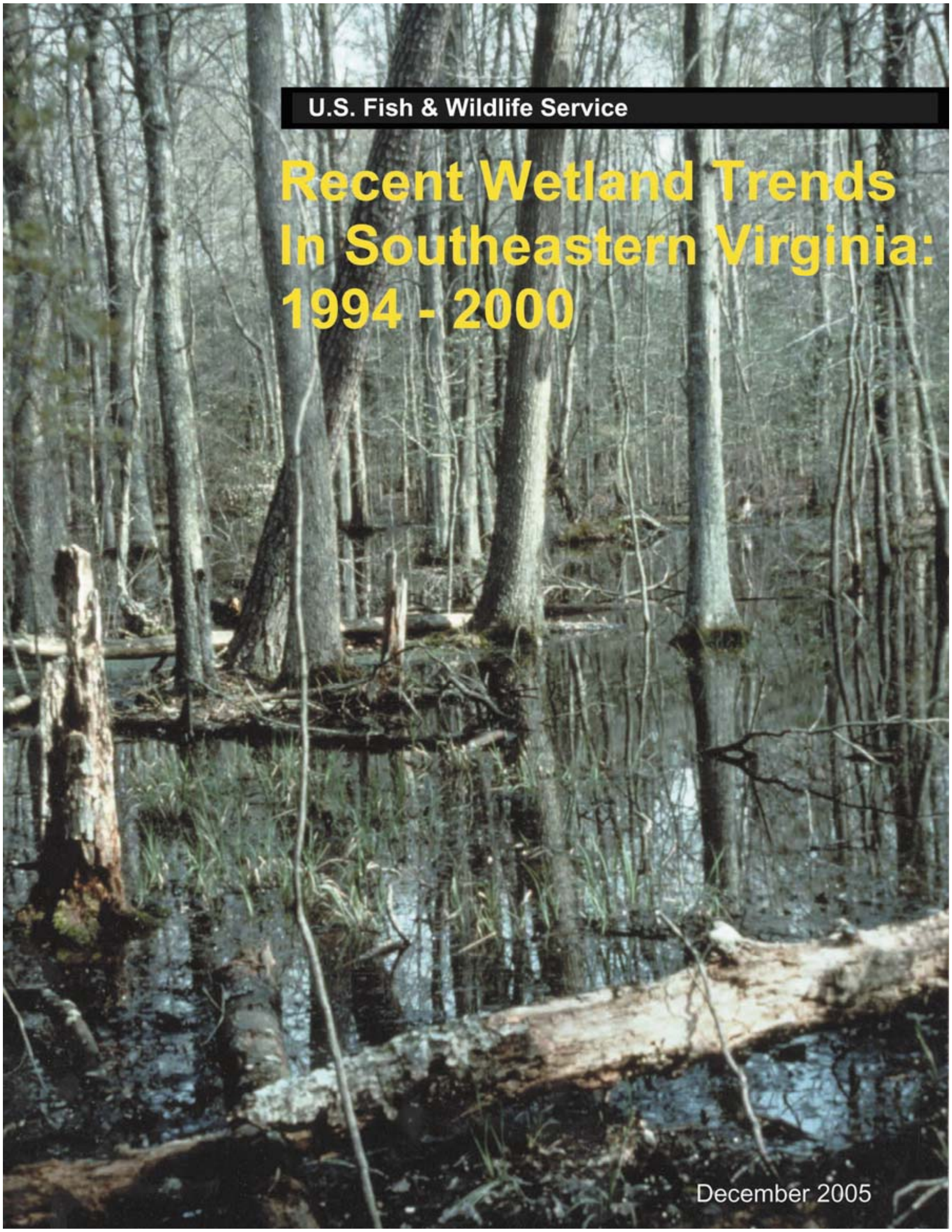
U.S. Fish & Wildlife Service
Recent Wetland Trends
In Southeastern Virginia:
1994 - 2000
December 2005

Recent Wetland Trends in Southeastern Virginia: 1994-2000

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INTRODUCTION

The U.S. Fish and Wildlife Service (Service) has been actively mapping wetlands since the mid-1970s through its National Wetlands Inventory Program (NWI). The NWI Program has produced wetland maps for approximately 90 percent of the coterminous United States (i.e., lower 48 states). In addition to the mapping, the NWI has conducted wetland trends studies nationally and in specific geographic areas. Prior NWI studies have documented wetland trends for Virginia for two time periods: 1) 1950s–1970s and 2) 1982-1989 (Tiner and Finn 1986, Tiner et al. 1994). Both studies identified southeastern Virginia as a major area of wetland alteration with 80 percent of the state's loss of palustrine wetlands occurring here from the 1950s to the 1970s and nearly 5000 acres converted to upland between 1982 and 1989 (Tiner and Foulis 1994). Consequently, this area may actually have experienced the heaviest recent wetland losses in the Service's Northeast Region (which includes 13 states from Maine through Virginia) in the past 25 years since most Northeast states had some form of wetland protection for freshwater wetlands prior to the 1990s. Southeastern Virginia and other areas on the Coastal Plain are places with a high wetland to upland ratio that increases the likelihood for wetland impacts with increasing population growth.

In the fall of 2001, the NWI received Service funding to update the wetlands inventory in this area through the NWI's national strategic mapping initiative. This mapping effort produced information on current status of wetlands that could be used to assess recent changes.

In 2004, the Region's NWI Program received funding to conduct a wetland trends analysis for a portion of southeastern Virginia. The purpose of this report is to present the findings of that study.

Study Area

The study area is located in southeastern Virginia (Figure 1). It is represented by a 22-quad area encompassing parts of four counties (Gloucester, Isle of Wight, James City, and York) and eight independent cities (Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, and Virginia Beach) (Table 1). Three of the cities are listed among the Nation's 100 fastest growing cities (Virginia Beach #47, Chesapeake #56, and Norfolk #77; http://www.citymayors.com). The total "land" area (upland plus wetlands) amounts to 811 square miles, while waters account for an additional 470 square miles. The study area includes 22-1:24,000 NWI maps: Benns Church, Bowers Hill, Cape Henry, Deep Creek, Fentress, Hampton, Kempsville, Lake Drummond NW, Little Creek, Mulberry Island, Newport News North, Newport News South, Norfolk North, Norfolk South, North Bay, North Virginia Beach, Pleasant Ridge, Poquoson East, Poquoson West, Princess Anne, Virginia Beach, and Yorktown.

Figure 1. Location of the 811-square mile study area in Virginia.

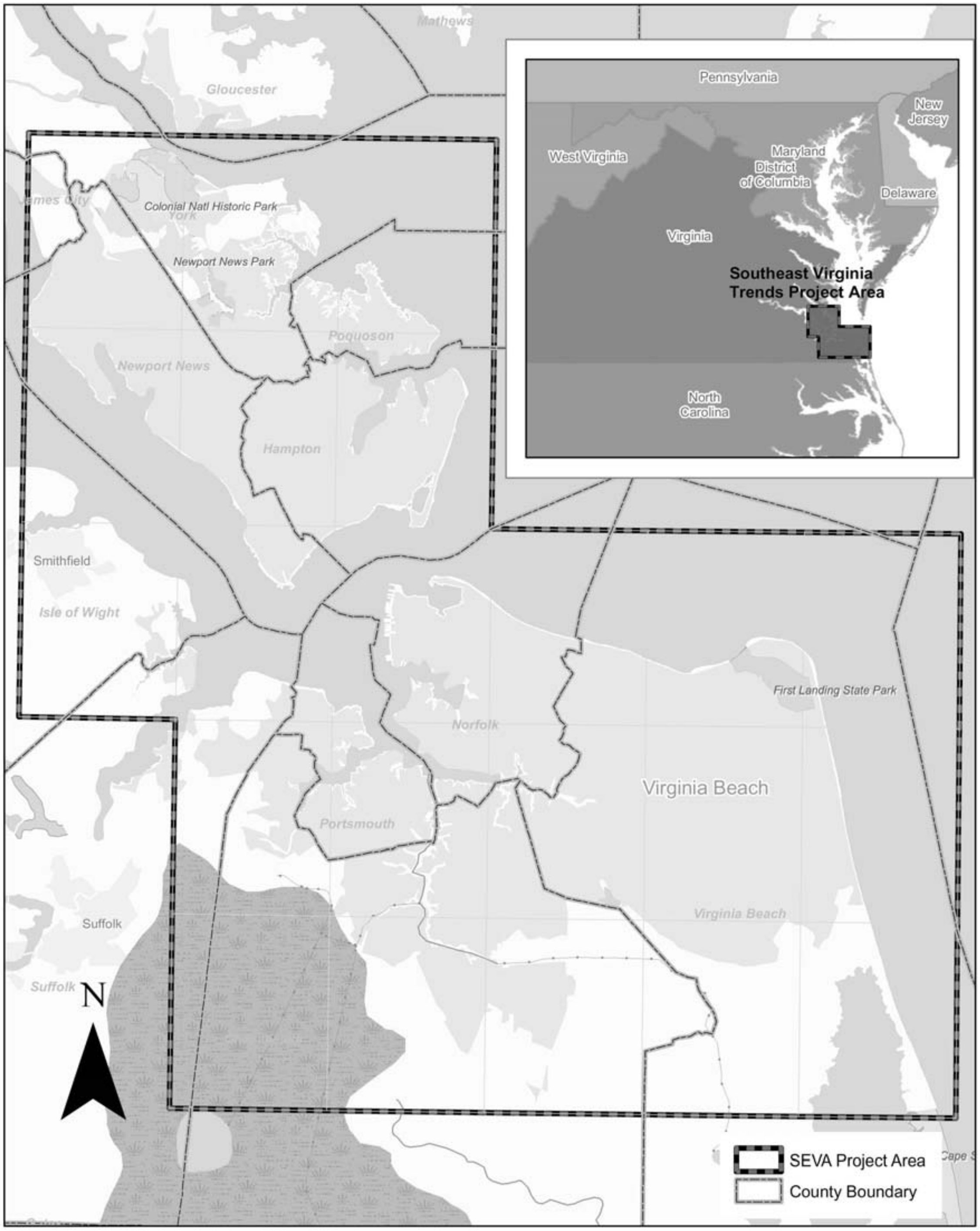

Table 1. Percentage of county or independent city located within the study area.

County or Independent City	Percent within Study Area
Chesapeake	70
Gloucester	2
Hampton	67
Isle of Wight	22
James City	5
Newport News	97
Norfolk	93
Poquoson	59
Portsmouth	100
Suffolk	15
Virginia Beach	76
York	49

METHODS

Wetland trends analysis involves examination of two dates of aerial photographs covering the same area. Such examination identifies areas of change due to numerous factors. Changes can be attributed to two basic causes: natural processes and human activities. Natural processes include succession from one plant community to another, beaver activity, fire, and sea level rise. Some changes in plant communities are brought about by human actions such as timber harvest, partial drainage, and pollution (e.g., water quality degradation). Other human-induced changes largely result in losses of wetlands due to filling, dredging/excavation, impoundment, stream channelization, and drainage.

The existing NWI data that was derived from 1980s 1:58,000 color infrared photography served as the foundation for this update. From 2000-2001, the NWI Program updated wetland geospatial data for southeastern Virginia using two sources of aerial photography: 1994-1:40,000 color infrared photographs and 2000-1:40,000 black and white (panchromatic) photographs. The photography was acquired by the U.S. Geological Survey's National Aerial Photography Program. With this imagery, the minimum mapping unit for wetland inventory purposes is about 1 acre, recognizing the inherent limitations of photointerpretation for mapping wetlands (Tiner 1990). Such targets are for general guidance as in practice, many conspicuous, smaller wetlands are often mapped. For example, a recent Virginia Institute of Marine Sciences study found that more than one third of the 1,200 vegetated wetlands examined in the coastal plain were less than one acre in size (David L. Davis, pers. comm. 2005). Small ponds may be the most common wetland type frequently mapped below the target mapping unit. Wetlands were added, deleted, or their boundaries were reconfigured to represent more contemporary conditions. Wetlands were classified according to the Service's official wetland classification system (Cowardin et al. 1979) which has been adopted by the Federal Geographic Data Committee as the national wetland classification standard for reporting wetland trends statistics. Table 2 lists some of the more common wetland types in the study area.

The NWI database was first updated using the 1994 imagery creating a 1994 wetland geospatial database using ArcGIS 8.3 (Environmental Systems Research Institute, Inc., ESRI). Next, the 2000 photography was used to bring the data closer to current-day conditions. A copy of the original 1994 data was retained while these data were brought up-to-date by interpreting the 2000 imagery.

To conduct the trends analysis, changes between the 1994 mapped wetlands and the 2000 dataset were highlighted by the union geo-processing function of ArcGIS 8.3. A trends data layer was created through this process. Photointerpreters then re-examined the aerial photos using a digital transfer scope (DTS) to document the cause of the changes. Land use and land cover classifications follow Anderson et al. (1976) (Table 3). The minimum area of change detected was approximately 0.5 acre. It must be recognized that some wetlands, especially evergreen forested types and drier-end wetlands (e.g., seasonally saturated) are difficult to identify through photointerpretation (Tiner 1990) and that the changes recorded involve wetlands that were mapped by the NWI Program. The findings therefore are probably a conservative estimate of actual changes.

Table 2. Generalized classification of common wetland types in the study area following Cowardin et al. (1979).

Common Name	**Cowardin et al. Type**	**NWI Code**
Salt marsh	Estuarine Intertidal Emergent Wetland	E2EM__
Salt shrub swamp	Estuarine Intertidal Scrub-Shrub Wetland	E2SS___
Saltwater tidal flat	Estuarine Intertidal Unconsolidated Shore	E2US___
Freshwater tidal flat	Riverine Tidal Unconsolidated Shore	R1US___
Freshwater marsh	Palustrine Emergent Wetland	PEM___
Wet meadow	Palustrine Emergent Wetland	PEM___
Deciduous shrub swamp	Palustrine Scrub-Shrub Wetland, Broad-Leaved Deciduous	PSS1___
Evergreen shrub swamp	Palustrine Scrub-Shrub Wetland, Needle-Leaved Evergreen	PSS4___
Deciduous wooded swamp	Palustrine Forested Wetland, Broad-Leaved Deciduous	PFO1___
Evergreen wooded swamp	Palustrine Forested Wetland, Needle-Leaved Evergreen	PFO4___
Farmed wetland	Palustrine farmed	Pf
Pond	Palustrine Unconsolidated Bottom	PUB___
Pond (dry)	Palustrine Unconsolidated Shore	PUS___

Table 3. Land use/cover classifications used for this project (adapted from Anderson et al. 1976). Note: Transitional land is land undergoing alteration with intended use unknown.

Land Use/Cover Type	**Code**
Residential Development	110
Commercial Development	120
Industrial Development	130
Transportation/Utilities	140
Airport	144
Golf Course	191
Agriculture (Crops/Pasture)	210
Mixed Fields/Shrub Thickets	330
Deciduous Forest	410
Evergreen Forest	420
Mixed Forest	430
Gravel Pit	753
Transitional Land	760

RESULTS

Year 2000 Wetland and Deepwater Habitat Status

In 2000, wetlands occupied nearly 157,000 acres, representing 30 percent of the land area within the southeastern Virginia study area. Palustrine wetlands made up 77 percent of the wetlands (120,981 acres) with estuarine wetlands comprising the bulk of the remaining acreage (32,975 acres). Fourteen percent of the palustrine wetlands are freshwater tidal wetlands. Overall, forested wetlands predominated, representing 65 percent of the area's wetlands (102,485 acres including 378 acres of estuarine forests). Estuarine emergent wetlands were second-ranked in extent, accounting for 17 percent (26,143 acres), followed by palustrine scrub-shrub wetlands (7,811 acres; 5%), palustrine emergent wetlands (6,525 acres; 4%), estuarine unconsolidated shore (5,730 acres; 4%), and ponds (palustrine unconsolidated bottoms and shores, 4,424 acres; 3%).

Estuarine wetlands totaled nearly 33,000 acres, with slightly brackish (oligohaline) wetlands accounting for 17 percent of the acreage. Seventy-nine percent of the estuarine wetland acreage was emergent wetland with the majority being irregularly flooded. Only 720 acres of regularly flooded emergent wetlands were inventoried, while 2,630 acres (10.1%) were assigned "unknown" water regime. The "unknown" regime indicates transitional intertidal marsh between regularly flooded or irregularly flooded marsh and likely represents high marsh evolving into low marsh due to sea-level rise. Nearly 90 percent of the estuarine unconsolidated shore (tidal flat) was either regularly flooded or irregularly exposed, with the remainder being irregularly flooded.

The study area had nearly 227,000 acres of deepwater habitats excluding marine waters (Atlantic Ocean) on the NWI maps. Estuarine waters dominated this coastal region with 220,872 acres inventoried. Fresh waterbodies included 4,275 acres of lacustrine waters (reservoirs and large impoundments) and 1,429 acres of riverine waters. Over 4,400 acres of freshwater ponds were also inventoried but they are included in the wetland totals since they are considered a type of wetland according to the Cowardin et al. classification system.

Table 4. Acreage summary for wetlands in the study area for 2000. Note: Types include mixed classes where designated class predominated.

NWI Wetland Type	Acreage
Estuarine Wetlands	
Emergent	26,142.8 (5,519.5 = oligohaline)
Forested	377.5 (129.1 = oligohaline)
Rocky Shore	3.4
Scrub-Shrub	720.5 (76.6 = oligohaline)
Unconsolidated Shore	5730.4 (8.7 = oligohaline)
Subtotal Estuarine	*32,974.6 (5,733.9 = oligohaline)*
Lacustrine Wetlands	
Vegetated	37.7
Nonvegetated	2180.9
Subtotal Lacustrine	*2218.6*
Marine Wetlands	371.4
Palustrine Wetlands	
Aquatic Bed	25.9
Emergent, non-Phragmites	6486.3 (646.9 = tidal)
Emergent, Phragmites	38.4 (3.8 = tidal)
Farmed	87.9
Forested, Broad-leaved Deciduous	83,958.4 (10,063.0 = tidal)
Forested, Bald Cypress	1590.9 (71.0 = tidal)
Forested, Broad-leaved Evergreen	2.3
Forested, Needle-leaved Evergreen	16,440.0 (4,081.6 = tidal)
Forested, Dead	116.0
Scrub-Shrub, Deciduous	4539.4 (536.6 = tidal)
Scrub-Shrub, Broad-leaved Evergreen	2059.4 (1,567.9 = tidal)
Scrub-Shrub, Needle-leaved Evergreen	1212.4 (403.5 = tidal)
Unconsolidated Bottom	4273.9
Unconsolidated Shore	150.1 (0.2 = tidal)
Subtotal Palustrine	*120,981.3 (17,374.5 = tidal)*
GRAND TOTAL	156,545.9

Wetland Trends

From 1994 to 2000, the study area experienced a net loss of nearly 2,100 acres of wetlands (Table 5). This amounts to a 1.3 percent decline in just six years. Vegetated wetlands declined by 2,545 acres while nonvegetated wetlands (mainly ponds) increased by about 450 acres. The types that changed the most were forested wetlands with a net loss of 3,306 acres, palustrine emergent wetlands with a net gain of 930 acres, and ponds (palustrine unconsolidated bottoms and shores) with a net gain of nearly 500 acres. Estuarine wetlands declined by 101 acres.

Causes of Wetland Changes

Changes for each major wetland type are outlined in Table 6. Over 2,400 wetland acres were converted to upland and about 85 acres to estuarine deepwater habitat. Nearly 1,100 acres of new palustrine emergent wetlands became established between 1994 and 2000, largely at the expense of forested wetlands. This gain and the associated "loss" of forested wetlands were due to timber harvest practices which also undoubtedly accounted for the 10-acre gain in palustrine scrub-shrub wetland (Table 6). When forested wetlands are cutover, a cycle of changing plant communities begins. The initial vegetative re-growth is typically herbaceous species and seedlings of woody plants. This phase is often succeeded by a mixed community of shrubs and emergents, then later a "shrub" community of true shrubs and tree saplings, and finally after more than 25 years, trees (i.e., woody plants ≥20 feet tall) predominate, re-establishing the forested wetland. Consequently, much of the "loss" of forested wetland as well as the "gain" in emergent wetlands as detected by this and other wetland trend studies in forested regions often reflects a temporary vegetation change following timber harvest, although the change may last for more than 20 years. Such changes are treated as changes in type and not as conversions to upland; they have no effect on the overall net change in wetland acreage.

Actual losses of wetland to upland and deepwater habitat totaled 2,508 acres, while changes from one wetland type to another accounted for 1,220 acres of changes (Table 6). Only one acre of deepwater habitat was converted to upland, whereas 2,422 acres of wetlands were developed. Most of the wetland losses to upland involved residential development (1,580 acres or 65.2% of overall loss; Table 7) and affected forested wetlands (2,124 acres or 87.7% of the loss). Loss to "transitional land" (lands under active development for unknown purpose) was responsible for 19 percent of the converted wetlands (468 acres). With all the residential development going on in this area it is likely that much of this lost acreage may be home sites today. Commercial development was the third-ranked cause of wetland conversion to upland (6.8%, 165 acres). Industrial development was next-ranked, accounting for nearly four percent of the conversions to upland (92 acres). Transportation/utilities and golf course construction in wetlands were each responsible for two percent of the losses to upland (49 and 48 acres, respectively). Airport construction (20 acres, 0.8%) and sand and gravel pit operations (1 acre, 0.1%) make up the remainder of the wetland losses to upland.

Conversion of forested wetlands to upland amounted to more than 2,100 acres, with 71 percent of this loss attributed to residential development. Transitional land was the second-leading cause of forested wetland loss to upland, accounting for 16 percent (or 343 acres) of this loss. Commercial development was the next-ranked cause of these forested losses, comprising nearly six percent of the total loss (119 acres). Timber harvest of forested wetlands affected over 1,000 acres (Table 6).

Eighty-three percent of the losses of estuarine wetlands were largely attributed to conversion to open water (85 acres) (Table 6). This change was likely due to submergence of wetlands by rising sea level since the excavated modifier ("x") indicative of dredging was not applied to the deepwater habitat. Only 15 acres of estuarine wetlands (emergent) were converted to upland with nearly all of this being in a transitional state (i.e., land use was not detectable) (Table 7).

Deepwater Habitat Trends

All deepwater habitats experienced net increases in acreage between 1994 and 2000. Lacustrine water acreage rose by 146 acres, estuarine waters by 79 acres, and riverine waters by 8 acres. The gain in lacustrine and riverine waters came from upland, whereas the gains in estuarine waters came from tidal flats (estuarine unconsolidated shores, 46 acres) and salt marshes (estuarine emergent wetlands, 34 acres and estuarine scrub-shrub wetlands, 4 acres) (Table 6). These changes are likely due to submergence of wetlands by rising sea level since the excavated modifier ("x") indicative of dredging was not applied to the deepwater habitat. A small amount of estuarine waters was converted to upland (1 acre) and ponds (4 acres).

Table 5. Comparison of wetland acreages 1994-2000 for the study area. Note: Types include mixed classes where designated class predominated.

NWI Wetland Type	1994 Acreage	2000 Acreage	Net Acreage Change (% Change)
Estuarine Wetlands			
Emergent	26,193.8	26,142.8	-51.0 (0.2)
Forested	377.5	377.5	0 (0)
Rocky Shore	3.4	3.4	0 (0)
Scrub-Shrub	724.6	720.5	-4.1 (0.6)
Unconsolidated Shore	5776.7	5730.4	-46.3 (0.8)
Subtotal Estuarine	*33,076.0*	*32,974.6*	*-101.4 (0.3)*
Lacustrine Wetlands			
Vegetated	37.7	37.7	0 (0)
Nonvegetated	2,180.9	2,180.9	0 (0)
Subtotal Lacustrine	*2,218.6*	*2,218.6*	0 (0)
Marine Wetlands	371.4	371.4	0 (0)
Palustrine Wetlands			
Aquatic Bed	25.9	25.9	0 (0)
Emergent	5,594.4	6,524.7	+930.3 (16.6)
Farmed	89.7	87.9	-1.8 (2.0)
Forested	105,413.5	102,107.6	-3,305.9 (3.1)
Scrub-Shrub	7,927.3	7,811.2	-116.1 (1.5)
Subtotal P-vegetated	*119,050.8*	*116,557.3*	*-2,493.5 (2.1)*
Unconsolidated Bottom	3,811.2	4,273.9	+462.7 (12.1)
Unconsolidated Shore	113.8	150.1	+36.3 (31.9)
Subtotal P-nonvegetated	*3,925.0*	*4,424.0*	*+499.0 (12.7)*
Subtotal Palustrine	*122,975.8*	*120,981.3*	*-1,994.5 (1.6)*
GRAND TOTAL	**158,641.8**	**156,545.9**	**-2,095.9 (1.3)**

Table 6. Changes in wetland types in southeastern Virginia (1994-2000).

	2000 Type								
	Upland	**Deepwater Habitat**	**Nonvegetated Wetland**			**Vegetated Wetland**			**Total Change**
1994 Type[1]		**E1UB**	**PUS**	**PUB**	**E2EM**	**PEM**	**PSS**	**PFO**	
E2EM	15.0	34.1	--	0.2	--	1.7	--	--	-51.0
E2SS	--	4.1	--	--	--	--	--	--	-4.1
E2US	--	46.3	--	--	--	--	--	--	-46.3
PEM (tidal)	25.4	--	--	0.8	--	--	--	--	-26.2
PEM (nontidal)	126.0	--	--	--	--	--	10.1*	--	-136.1
PSS (tidal)	3.8	--	--	3.2	--	0.4	--	--	-7.4
PSS (nontidal)	100.4	--	--	--	--	15.7	--	2.7	-118.8
PFO (tidal)	56.1	--	--	3.6	20.5	--	--	--	-80.2
PFO1 (nontidal)	1,634.5	--	7.7	57.5	9.3	773.6*	--	--	-2,482.6
PFO4 (nontidal)	433.0	--	6.2	8.6	--	298.0*	--	--	-745.8
PUB	19.1	--	--	--	--	--	--	--	-19.1
PUS	8.2	--	--	--	--	--	--	--	-8.2
Pf	1.8	--	--	--	--	--	--	--	-1.8
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Total Change	2,423.3	84.5	13.9	73.9	29.8	1,089.4	10.1	2.7	3,727.6

*Likely vegetation change following timber harvest.

[1] See Table 2 for wetland type names for these codes.

Table 7. Causes of wetland and deepwater habitat conversion to upland (1994-2000).

1994 Type	**2000 Upland Land Use**	**Acres**
E1UB	Industrial Development	1.25
TOTAL Deepwater Habitat Loss		**1.25**
E2EM	Residential Development	0.92
	Transitional Land	14.10
	Subtotal	*15.02*
TOTAL Estuarine Wetland Loss		**15.02**
PEM (tidal)	Residential Development	0.36
	Transitional Land	25.00
	Subtotal	*25.36*
PEM (nontidal, A, B, C, E, F)	Residential Development	20.61
	Commercial Development	37.13
	Industrial Development	5.15
	Transportation/Utilities	9.72
	Airport	17.63
	Sand/Gravel Pit	0.44
	Transitional Land	35.31
	Subtotal	*125.99*
Total PEM Loss		**151.35**
Pf (farmed)	Transitional Land	1.76
PFO1 (nontidal, A, B, C, E, F including ¼ mixes)	Residential Development	1,184.23
	Commercial Development	97.69
	Industrial Development	55.44
	Transportation/Utilities	34.33
	Airport	1.84
	Golf Course	46.65
	Transitional Land	214.35
	Subtotal	*1,634.53*

PFO (tidal)	Residential Development	42.82
	Commercial Development	1.20
	Transitional Land	12.07
	Subtotal	*56.09*
PFO4 (nontidal, A, B, C, E, F, including 4/1 mixes)	Residential Development	288.28
	Commercial Development	19.89
	Industrial Development	5.98
	Transportation/Utilities	2.61
	Transitional Land	116.33
	Subtotal	*433.09*
Total PFO Loss		**2,123.71**
PSS (nontidal, A, B, C, E, F, including mixes)	Residential Development	31.86
	Commercial Development	6.64
	Industrial Development	9.76
	Transportation/Utilities	2.51
	Golf Course	1.51
	Transitional Land	48.13
	Subtotal	*100.41*
PSS (tidal)	Residential Development	3.29
	Transitional Land	0.52
	Subtotal	*3.81*
Total PSS Loss		**104.22**
PUB	Residential Development	7.37
	Commercial Development	2.24
	Industrial Development	7.85
	Airport	0.68
	Sand/Gravel Pit	0.97
	Subtotal	*19.11*
PUS	Industrial Development	8.20
Total PUB/US Loss		**27.31**
TOTAL Palustrine Loss		**2,408.35**
TOTAL WETLAND LOSS		**2,423.37**

SUMMARY

Thirty percent of this 811-square mile area in southeastern Virginia is comprised of wetlands. Nearly 157,000 acres of palustrine and estuarine wetlands were inventoried based on 2000 aerial photography. Palustrine forested types accounted for 65 percent of the wetland acreage, while estuarine emergent wetlands made up 17 percent of the wetlands.

From 1994 to 2000, this region experienced a net loss of nearly 2,100 wetland acres. This amounts to a 1.3 percent decline in just six years. More than 3,300 acres of forested wetlands were lost, with over 2,000 acres converted to upland (mostly residential development) and over 1,000 acres transformed to palustrine emergent wetlands by timber harvest. The latter changes are temporary, but will last until forest cover is reestablished. Losses of palustrine forested wetlands amounted to three percent of the 1994 forested wetland acreage. In general, vegetated wetlands were converted to upland with relatively little change in type other than following timber harvest. On the other hand, substantial gains in nonvegetated wetlands (i.e., ponds) were detected with a net gain of nearly 500 acres. This gain represents an almost 13 percent increase from 1994.

Estuarine wetlands were less threatened by development than palustrine wetlands. However, significant acreage of these wetlands (i.e., 85 acres) became estuarine deepwater habitats, presumably due to rising sea level.

It is interesting to note that three major wetland regulatory events took place during the study time period: 1) in 1998, the original "Tulloch Rule" was invalidated, thereby allowing land clearing of wetlands with earth-moving equipment without federal permit (in 2001, such activities again became subject to federal permits through the new "Tulloch Rule"), 2) in 1999, the Corps nationwide permit number 26 expired (it had allowed wetland filling up to 10 acres simply upon notifying the Corps; no individual permit was required), and 3) in 2000, Virginia's General Assembly enabled the Virginia Department of Environmental Quality to regulate nontidal wetlands (Kim Marbain, pers. comm. 2005). We expect that wetland losses will significantly decline with improved wetland protection resulting from the combined effects of the new Tulloch rule, statewide wetland regulation through the Virginia Water Protection Permit Program, and the elimination of nationwide permit number 26.

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