

**Regional Estimates of the Amount of U.S. Agricultural Land
Located in Watersheds with Poor Water Quality**

*By Richard A. Smith, Gregory E. Schwarz
and Richard B. Alexander*

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Table of Contents

	Page
Abstract	6
Introduction	6
Methods	7
Definition of Regions	8
Statistical Estimates	9
Estimates of Agricultural Land Area.....	11
References	15

List of Tables

Table 1. Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where dissolved nitrate concentrations exceed 3.0 milligrams per liter, by hydrologic region, land cover type, and year.

Table 2. Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where total phosphorus concentrations exceed 0.1 milligrams per liter, by hydrologic region, land cover type, and year.

Table 3. Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where fecal coliform bacteria concentrations exceed 200 colonies per 100 milliliters, by hydrologic region, land cover type, and year.

Table 4. Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where suspended sediment concentrations exceed 500 milligrams per liter, by hydrologic region, land cover type, and year.

Table 5. Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where a criterion is exceeded for at least one constituent, by hydrologic region, land cover type, and year.

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Abstract

An estimated 71 percent of U.S. cropland (nearly 300 million acres) is located in watersheds where the concentration of at least one of four common surface water contaminants exceeded generally accepted criteria in 1989. This figure serves as an approximate measure of the efficiencies to be gained by restricting agricultural pollution controls to watersheds with poor water quality.

Introduction

It is widely believed that achievement of national water quality goals will require increased control of nonpoint-source pollution from agricultural land (Adler and others, 1993). One of the more contentious issues related to the design of nonpoint-source pollution controls is whether, in the interest of fairness, controls should be imposed more or less uniformly on all agricultural land of a given type, or whether, in the interest of economic efficiency, controls should be imposed only on agricultural land in areas of poor water quality (Knopman and Smith, 1993). Debate on this issue would be

improved by better information on the efficiencies to be gained by limiting controls to areas of poor water quality. This report presents estimates of the amount of agricultural land in the conterminous United States that is in watersheds where contaminant concentrations in streams exceed generally accepted water-quality criteria (Smith and others, 1993). Estimates are developed separately for four types of agricultural land, seven regions of the Nation, four water contaminants, and for the early and late 1980's.

It should be noted that the extent to which agricultural activity contributes to poor water quality in a given watershed is not at issue in this analysis. Rather, the focus here is on the savings in pollution control costs to be achieved by limiting agricultural controls to areas with poor water quality regardless of the causes.

Study Methods

The water-quality and land-use data used in this analysis are described and illustrated in detail in Smith and others (1993). Watersheds are defined as the 2111 U. S. Geological Survey hydrologic cataloging units in the conterminous United States (Seaber and others, 1987). Water quality conditions for a sample of hydrologic units were determined on the basis of concentrations of dissolved nitrate, total phosphorus, fecal coliform bacteria, and suspended sediment measured at a stream sampling station located near the outflow of each hydrologic unit in the sample. Groundwater quality in the watersheds is not considered in this study.

Water-quality conditions were determined separately for the early and latter 1980's. Conditions for the latter 1980's were based on mean concentrations of contaminants in 1989; conditions for the early 1980's were based on mean concentrations for 1980 in the case of dissolved nitrate, fecal coliform bacteria, and suspended sediment, and for 1982 in the case of total phosphorus. Recent quality assurance data indicate that measurements of total phosphorus for 1980 and 1981 are less reliable than for 1982 (Alexander and others, 1993).

Water quality conditions in the sampled watersheds were classified as either "poor" or "good" on the basis of whether mean contaminant concentrations exceeded generally accepted water quality criteria (see discussion of water quality indicators and criteria in Smith and others, 1993). Contaminant criteria were as follows: dissolved nitrate, 3.0 mg/l; total phosphorus, 0.1 mg/l; fecal coliform bacteria, 200 colonies per 100 ml; suspended sediment, 500 mg/l. Classifications were made separately for the four contaminants as well as jointly for the suite of contaminants. In the latter case, watersheds were classified as having poor water quality if the mean concentration of any contaminant exceeded its criterion.

Definition of Regions

For purposes of statistical analysis, the conterminous United States was divided into five regions on the basis of aggregations of the regional drainage basins described in Smith and others (1993) [see

Figure 44, p 129). The correspondence between the regions used in the two analyses is as follows:

<u>This Analysis</u>	<u>Smith and others, 1993</u>
North Atlantic	North Atlantic
South Atlantic/Gulf	South Atlantic/Gulf + Lower Mississippi
Upper Midwest	Upper Mississippi + Ohio/Tennessee + Great Lakes
Great Plains	Souris/Red/Rainy + Missouri + Arkansas/White/Red + Texas Gulf/Rio Grande
Far West	Pacific Northwest + California + Great Basin + Colorado

In addition to the five regions defined above, two aggregated regions, termed "East" and "West", were formed as follows:

East = North Atlantic + South Atlantic/Gulf + Upper Midwest

West = Great Plains + Far West

Statistical Estimates

The proportion of agricultural land in a given region that is contained in watersheds with poor water quality was estimated as:

$$P_p = \frac{\sum_{i=1}^n a_i q_i}{\sum_{i=1}^n a_i} \quad (1)$$

where a_i is the area of agricultural land in sampled watershed i ; q_i is a binary water-quality index for sampled watershed i , equal to 1 if water quality in the watershed was classified as poor and equal to 0 if water quality was good; and P_p is the estimated proportion of agricultural land in all watersheds in the region (sampled and unsampled) with poor water quality. According to Cochran (1977), proportional estimates based on equation 1 are generally slightly biased but have substantially less error than alternative unbiased estimators.

The area of agricultural land in a given region that is contained in all watersheds with poor water quality was then estimated as:

$$A_p = P_p A , \quad (2)$$

where A is the total area of agricultural land in the region, and A_p is the estimated agricultural land area in watersheds with poor water quality.

The variance of A_p , denoted $V(A_p)$, was estimated using an approximation by Cochran (1977):

$$V(A_p) = \frac{N(N-n)}{n} \left(\frac{\sum_{i=1}^n (q_i - P_p)^2 a_i^2}{n-1} \right) \quad (3)$$

where n is the number of sampled watersheds in the region, and N is the total number of watersheds. Estimates of the variance of A_p were used to develop 90% confidence intervals for the acreage estimates presented below assuming that errors in A_p are normally distributed. Confidence intervals were expressed as the percent error in A_p , calculated as follows:

$$\text{percent error} = 1.645 \frac{\sqrt{V(A_p)}}{A_p} 100. \quad (4)$$

It should be noted that confidence intervals do not account for error in the classification of sampled watersheds resulting from error in the estimation of mean contaminant concentrations.

Estimates of Agricultural Land in Watersheds With Poor Water Quality

Estimates of P_p and A_p for dissolved nitrate, total phosphorus, fecal coliform bacteria, and suspended sediment are summarized in Tables 1-4. Results for the combined analysis, in which watersheds were classified as having poor water quality if concentrations of any of the contaminants exceeded criteria, are presented in Table 5.

The results presented in table 1 indicate that a relatively small proportion of the agricultural land in the United States is in watersheds where dissolved nitrate concentrations exceeded 3.0 mg/l in 1989. An estimated 7% of total cropland (30.6 million acres)

and 3% of pastureland (3.8 million acres) fall in this category. A somewhat higher percentage of the Nation's corn producing cropland (11% or 12.4 million acres) is located in high-nitrate watersheds, however, reflecting the fact that nitrogen fertilizer application rates are generally higher in corn producing areas than elsewhere. A related result seen in table 1 is the still higher proportion (21%) of total cropland in the Upper Midwest, (the Cornbelt) that occurs in watersheds with high dissolved nitrate concentrations. The estimated 26 million acres of Upper Midwest cropland in this category represents most of the total 30 million acres of high-nitrate cropland in the Nation.

Table 2 indicates that much larger amounts of agricultural land are located in watersheds exceeding the total phosphorus criterion of 0.1 mg/l than are located in high-nitrate watersheds. The estimated 266 million acres (63%) of total cropland in this category in 1989 is the largest among the four contaminants. About half of this total (132 million acres) is located in the Great Plains region.

The results of this analysis for most contaminants and regions reflect a consistent pattern of decreasing numbers of watersheds with poor water quality between the early and late 1980's. This trend is particularly evident in the results for fecal coliform bacteria (table 3). The area of total cropland contained in watersheds exceeding the fecal coliform bacteria criterion declined from about 269 to 191 million acres between 1980 and 1989. Declines were steepest in the Great Plains and Far West.

The uncertainty involved in making many of the acreage estimates in tables 1-5 is high, especially in the case of the results for suspended sediment (Table 4). For example, the 90% confidence interval for the acreage of Western cropland in high suspended-sediment watersheds in 1980 is from 22.0 to 59.6 million acres (that is, 40.8 million acres plus or minus 46%). The comparable figures for Eastern cropland are from zero to 10.7 million acres (that is, 4.5 million acres plus or minus 141%). As indicated by equation 3, the error of acreage estimates is large when the number of sampled watersheds in a region is small compared to the total number of watersheds in the region, and when the estimated percentage of agricultural land exceeding criteria approaches zero.

A key issue involved in designing efficient, targeted regulatory policies for controlling the quality of agricultural runoff is that of defining poor water quality. While each of the contaminants referred to in tables 1-4 is relevant to the overall problem of nonpoint-source pollution, it is not likely that areas of poor water quality would be identified on the basis of the concentration of a single contaminant.

Table 5 presents results for a more comprehensive definition of water quality, in which watersheds were classified as having poor water quality if concentrations of any of the four contaminants exceeded criteria. By this definition, an estimated 297 million acres of cropland (plus or minus about 39 million acres) would be located

in watersheds with poor water quality based on 1989 data. This figure represents 71 percent of total cropland in the conterminous States, and serves as an approximate measure of the efficiencies to be gained by restricting agricultural controls to watersheds with poor water quality as defined by this suite of indicators.

Despite the broader definition of water quality, the results in table 5 suggest that the effect of a targeted regulatory policy on the farm economy would differ greatly from region to region. For example, an estimated 87 percent (109 million acres) of cropland in the Upper Midwest would lie in watersheds with poor water quality compared to only 40 percent (5.7 million acres) in the North Atlantic.

Moreover, regional differences in regulatory effects on certain sectors of the farm economy would be still greater. An estimated 94 percent of corn acreage in the Great Plains region would lie in poor water quality watersheds, compared to only 39 percent in the North Atlantic.

In summary, it appears that there would be significant cost savings to be gained through the targeting of nonpoint-source pollution controls to areas of poor water quality, but the amount of savings will depend greatly on the indicators used to define water quality conditions. Moreover, by design, a targeted regulatory policy would affect regions unevenly, and the results presented here suggest that regional differences in the costs of nonpoint-source pollution regulation could be substantial.

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Table 5. (continued) Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where a criterion is exceeded for at least one constituent, by hydrologic region, land cover type, and year.

1980										1989												
Region	Total Acres (1,000 acres)	Wheat Acreage					Pastureland					Acres in Water-sheds Exceed Criterion (1,000 acres)					Acres in Water-sheds Exceed Criterion (1,000 acres)					Pct. Error
		Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)				
Land cover type by region and year:																						
North Atlantic	1,197	18	12	44	65	773	93	17	12	41	34	409	190									
S. Atlantic/Gulf	8,044	40	14	63	76	6,125	16	29	10	69	87	6,982	12									
Upper Midwest	9,761	49	13	67	81	7,924	16	46	12	67	91	8,902	8									
Great Plains	96,889	71	10	75	81	78,332	32	69	10	58	63	61,439	39									
Far West	17,078	55	10	51	48	8,259	65	52	9	25	34	5,873	91									
East	19,002	107	13	62	78	14,822	12	92	11	63	86	16,293	8									
West	113,967	126	10	64	76	86,591	30	121	9	44	59	67,312	36									
United States	132,969	233	11	63	76	101,413	25	213	10	52	63	83,605	29									
Land cover type by region and year:																						
North Atlantic	7,821	18	12	44	59	4,601	50	17	12	41	51	3,972	64									
S. Atlantic/Gulf	21,995	40	14	63	69	15,262	20	29	10	69	73	16,152	24									
Upper Midwest	39,984	49	13	67	64	25,560	24	46	12	67	73	29,247	20									
Great Plains	55,380	71	10	75	80	44,221	21	69	10	58	69	37,939	28									
Far West	8,071	55	10	51	51	4,113	39	52	9	25	35	2,823	62									
East	69,800	107	13	62	65	45,423	16	92	11	63	71	49,371	15									
West	63,452	126	10	64	76	48,334	19	121	9	44	64	40,762	26									
United States	133,252	233	11	63	70	93,756	13	213	10	52	68	90,133	15									

Table 5. Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where a criterion is exceeded for at least one constituent, by hydrologic region, land cover type, and year.

Region	1980										1989									
	Total Acres (1,000 acres)					Acres in Water-sheds Exceed Criterion (1,000 acres)					Acres in Water-sheds Exceed Criterion (1,000 acres)					Acres in Water-sheds Exceed Criterion (1,000 acres)				
	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (Pct.)	Pct. Error
Land cover type by region and year:																				
Total Cropland																				
North Atlantic	14,112	18	12	44	64	9,087	53	17	12	41	40	5,662	104	16	8	26	79	8	25	13
S. Atlantic/Gulf	48,988	40	14	63	75	36,591	17	29	10	69	80	39,145	16	8	26	79	8	25	13	
Upper Midwest	125,277	49	13	67	84	105,519	9	46	12	67	87	108,803	8	26	79	8	25	13		
Great Plains	195,016	71	10	75	85	164,840	19	69	10	58	67	129,907	26	79	8	26	79	8	25	
Far West	35,276	55	10	51	52	18,442	54	52	9	25	37	13,153	79	8	25	13	79	8	25	
East	188,376	107	13	62	80	151,197	8	92	11	63	82	153,610	8	25	13	79	8	25	13	
West	230,292	126	10	64	80	183,281	18	121	9	44	62	143,061	25	13	79	8	25	13	79	
United States	418,669	233	11	63	80	334,478	11	213	10	52	71	296,671	13	79	8	26	79	8	25	
Land cover type by region and year:																				
Corn Acreage																				
North Atlantic	7,670	18	12	44	71	5,433	49	17	12	41	39	2,955	133	37	11	4	67	12	12	
S. Atlantic/Gulf	5,484	40	14	63	67	3,689	32	29	10	69	71	3,880	37	11	4	67	12	12	12	
Upper Midwest	65,683	49	13	67	85	55,774	10	46	12	67	85	55,567	11	4	67	12	12	12	12	
Great Plains	28,560	71	10	75	97	27,673	2	69	10	58	94	26,738	4	67	12	12	12	12	12	
Far West	3,105	55	10	51	71	2,190	88	52	9	25	74	2,289	67	12	12	12	12	12	12	
East	78,837	107	13	62	82	64,896	9	92	11	63	79	62,402	12	37	11	4	67	12	12	
West	31,665	126	10	64	94	29,862	7	121	9	44	92	29,028	6	37	11	4	67	12	12	
United States	110,501	233	11	63	86	94,759	7	213	10	52	83	91,430	8	37	11	4	67	12	12	

Table 4. (continued) Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where suspended sediment concentrations exceed 500 milligrams per liter, by hydrologic region, land cover type, and year.

1980										1989											
Region	Total Acres (1,000 acres)	Wheat Acreage					Pastureland					Land cover type by region and year:					Land cover type by region and year:				
		Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (1,000 acres)	Pct. Error	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (1,000 acres)	Pct. Error	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (1,000 acres)	Pct. Error	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (1,000 acres)	Pct. Error
Land cover type by region and year:																					
North Atlantic	1,197	27	18	0	0	-	25	17	0	0	-	25	17	0	0	-	25	17	0	0	-
S. Atlantic/Gulf	8,044	49	18	0	0	-	41	15	0	0	-	41	15	0	0	-	41	15	0	0	-
Upper Midwest	9,761	64	16	3	1	166	65	17	0	0	166	65	17	0	0	-	65	17	0	0	-
Great Plains	96,889	107	15	23	16	63	98	14	16	15,974	63	98	14	16	15,252	80	98	14	16	15,252	80
Far West	17,078	67	12	15	11	155	63	11	10	1,819	155	63	11	10	1,441	198	63	11	10	1,441	198
East	19,002	140	17	1	0	166	131	16	0	59	166	131	16	0	0	-	131	16	0	0	-
West	113,967	174	14	20	16	59	161	13	14	17,793	59	161	13	14	16,693	75	161	13	14	16,693	75
United States	132,969	314	15	12	13	59	292	14	8	17,852	59	292	14	8	16,693	75	292	14	8	16,693	75
Land cover type by region and year:																					
North Atlantic	7,821	27	18	0	0	-	25	17	0	0	-	25	17	0	0	-	25	17	0	0	-
S. Atlantic/Gulf	21,995	49	18	0	0	-	41	15	0	0	-	41	15	0	0	-	41	15	0	0	-
Upper Midwest	39,984	64	16	3	3	170	65	17	0	1,005	170	65	17	0	0	-	65	17	0	0	-
Great Plains	55,380	107	15	23	25	56	98	14	16	13,716	56	98	14	16	7,536	71	98	14	16	7,536	71
Far West	8,071	67	12	15	7	83	63	11	10	583	83	63	11	10	529	120	63	11	10	529	120
East	69,800	140	17	1	1	170	131	16	0	1,005	170	131	16	0	0	-	131	16	0	0	-
West	63,452	174	14	20	23	54	161	13	14	14,299	54	161	13	14	8,065	67	161	13	14	8,065	67
United States	133,252	314	15	12	11	52	292	14	8	15,304	52	292	14	8	8,065	67	292	14	8	8,065	67

Table 4. Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where suspended sediment concentrations exceed 500 milligrams per liter, by hydrologic region, land cover type, and year.

1980															1989														
Region	Total Acres (1,000 acres)	Land cover type by region and year:					Land cover type by region and year:					Land cover type by region and year:					Land cover type by region and year:												
		Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (1,000 acres)	Pct. Error	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (1,000 acres)	Pct. Error	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (1,000 acres)	Pct. Error										
Land cover type by region and year:																				Total Cropland									
North Atlantic	14,112	27	18	0	0	0	-	25	17	0	0	0	-	25	17	0	0	0	-										
S. Atlantic/Gulf	48,988	49	18	0	0	0	-	41	15	0	0	0	-	41	15	0	0	0	-										
Upper Midwest	125,277	64	16	3	4	4,454	141	65	17	0	0	0	-	65	17	0	0	0	-										
Great Plains	195,016	107	15	23	18	36,071	49	98	14	16	15	29,051	61	98	14	16	15	29,051	61										
Far West	35,276	67	12	15	13	4,723	124	63	11	10	7	2,616	174	63	11	10	7	2,616	174										
East	188,376	140	17	1	2	4,454	141	131	16	0	0	0	-	131	16	0	0	0	-										
West	230,292	174	14	20	18	40,794	46	161	13	14	14	31,668	57	161	13	14	14	31,668	57										
United States	418,669	314	15	12	11	45,248	43	292	14	8	8	31,668	57	292	14	8	8	31,668	57										
Land cover type by region and year:																				Corn Acreage									
North Atlantic	7,670	27	18	0	0	0	-	25	17	0	0	0	-	25	17	0	0	0	-										
S. Atlantic/Gulf	5,484	49	18	0	0	0	-	41	15	0	0	0	-	41	15	0	0	0	-										
Upper Midwest	65,683	64	16	3	4	2,692	137	65	17	0	0	0	-	65	17	0	0	0	-										
Great Plains	28,560	107	15	23	26	7,425	53	98	14	16	21	6,139	71	98	14	16	21	6,139	71										
Far West	3,105	67	12	15	10	296	219	63	11	10	5	163	246	63	11	10	5	163	246										
East	78,837	140	17	1	3	2,692	137	131	16	0	0	0	-	131	16	0	0	0	-										
West	31,665	174	14	20	24	7,721	51	161	13	14	20	6,302	70	161	13	14	20	6,302	70										
United States	110,501	314	15	12	9	10,413	52	292	14	8	6	6,302	70	292	14	8	6	6,302	70										

Table 3. (continued) Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where fecal coliform bacteria concentrations exceed 200 colonies per 100 milliliter, by hydrologic region, land cover type, and year.

1980										1989									
Region	Total Acres (1,000 acres)	Acres in					Acres in					Acres in							
		Sampled Water- sheds (No.)	Sampled Water- sheds (Pct.)	Water- sheds Exceed Criterion (Pct.)	Water- sheds Exceed Criterion (Pct.)	Water- sheds Exceed Criterion (1,000 acres)	Pct. Error	Sampled Water- sheds (No.)	Sampled Water- sheds (Pct.)	Water- sheds Exceed Criterion (Pct.)	Water- sheds Exceed Criterion (1,000 acres)	Pct. Error							
Land cover type by region and year:																			
Wheat Acreage																			
North Atlantic	1,197	24	16	38	707	86	23	16	43	35	417	146							
S. Atlantic/Gulf	8,044	46	16	43	5,540	27	35	13	51	85	6,831	16							
Upper Midwest	9,761	59	15	64	8,048	13	56	14	55	78	7,601	18							
Great Plains	96,889	112	16	61	46,253	33	109	15	32	26	25,099	43							
Far West	17,078	63	11	32	4,432	113	61	11	11	13	2,182	164							
East	19,002	129	16	52	14,295	13	114	14	52	78	14,850	12							
West	113,967	175	14	50	50,684	32	170	13	25	24	27,280	42							
United States	132,969	304	14	51	64,979	25	284	14	36	32	42,130	27							
Land cover type by region and year:																			
Pastureland																			
North Atlantic	7,821	24	16	38	4,315	41	23	16	43	51	4,014	47							
S. Atlantic/Gulf	21,995	46	16	43	12,405	28	35	13	51	56	12,265	36							
Upper Midwest	39,984	59	15	64	25,425	22	56	14	55	62	24,971	24							
Great Plains	55,380	112	16	61	32,432	28	109	15	32	35	19,141	46							
Far West	8,071	63	11	32	2,791	55	61	11	11	13	1,071	106							
East	69,800	129	16	52	42,146	16	114	14	52	59	41,250	18							
West	63,452	175	14	50	35,223	26	170	13	25	32	20,212	44							
United States	133,252	304	14	51	77,368	15	284	14	36	46	61,462	19							

Table 3. Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where fecal coliform bacteria concentrations exceed 200 colonies per 100 milliliter, by hydrologic region, land cover type, and year.

Region	1980										1989									
	Land cover type by region and year:					Acres in					Acres in					Acres in				
	Total Acres (1,000 acres)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (1,000 acres)	Pct. Error	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (1,000 acres)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (1,000 acres)	Pct. Error	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (1,000 acres)	Pct. Error
Land cover type by region and year:																				
Total Cropland																				
North Atlantic	14,112	24	16	38	57	8,053	23	16	43	5,708	23	16	43	5,708	81	23	16	43	5,708	81
S. Atlantic/Gulf	48,988	46	16	43	61	30,068	35	13	51	33,693	35	13	51	33,693	27	35	13	51	33,693	27
Upper Midwest	125,277	59	15	64	82	102,547	56	14	55	75,038	56	14	55	75,038	22	56	14	55	75,038	22
Great Plains	195,016	112	16	61	60	117,722	109	15	32	70,750	109	15	32	70,750	34	109	15	32	70,750	34
Far West	35,276	63	11	32	29	10,315	61	11	11	5,501	61	11	11	5,501	134	61	11	11	5,501	134
East	188,376	129	16	52	75	140,667	114	14	52	114,440	114	14	52	114,440	17	114	14	52	114,440	17
West	230,292	175	14	50	56	128,037	170	13	25	76,251	170	13	25	76,251	33	170	13	25	76,251	33
United States	418,669	304	14	51	64	268,704	284	14	36	190,691	284	14	36	190,691	17	284	14	36	190,691	17
Land cover type by region and year:																				
Corn Acreage																				
North Atlantic	7,670	24	16	38	65	4,971	23	16	43	3,037	23	16	43	3,037	100	23	16	43	3,037	100
S. Atlantic/Gulf	5,484	46	16	43	39	2,146	35	13	51	1,961	35	13	51	1,961	65	35	13	51	1,961	65
Upper Midwest	65,683	59	15	64	81	53,457	56	14	55	37,059	56	14	55	37,059	26	56	14	55	37,059	26
Great Plains	28,560	112	16	61	81	23,214	109	15	32	17,409	109	15	32	17,409	44	109	15	32	17,409	44
Far West	3,105	63	11	32	51	1,571	61	11	11	741	61	11	11	741	234	61	11	11	741	234
East	78,837	129	16	52	77	60,574	114	14	52	42,057	114	14	52	42,057	24	114	14	52	42,057	24
West	31,665	175	14	50	78	24,786	170	13	25	18,150	170	13	25	18,150	43	170	13	25	18,150	43
United States	110,501	304	14	51	77	85,360	284	14	36	60,207	284	14	36	60,207	21	284	14	36	60,207	21

Table 2. (continued) Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where total phosphorus concentrations exceed 0.1 milligrams per liter, by hydrologic region, land cover type, and year.

1982											1989										
Region	Total Acres (1,000 acres)	Wheat Acreage					Pastureland					Wheat Acreage					Pastureland				
		Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion		Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion		Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion						
					(1,000 acres)	Pct. Error				(1,000 acres)	Pct. Error				(1,000 acres)	Pct. Error	(1,000 acres)	Pct. Error			
Land cover type by region and year:																					
North Atlantic	1,197	31	21	23	12	149	29	20	21	14	172	29	20	21	14	172	180				
S. Atlantic/Gulf	8,044	67	24	54	59	4,779	56	20	52	74	5,990	56	20	52	74	5,990	19				
Upper Midwest	9,761	77	20	52	74	7,190	78	20	46	71	6,882	78	20	46	71	6,882	21				
Great Plains	96,889	153	21	69	80	77,427	134	19	52	58	56,462	134	19	52	58	56,462	22				
Far West	17,078	77	14	42	28	4,784	70	12	16	20	3,345	70	12	16	20	3,345	125				
East	19,002	175	22	47	64	12,118	163	20	44	69	13,044	163	20	44	69	13,044	15				
West	113,967	230	18	60	72	82,212	204	16	40	52	59,807	204	16	40	52	59,807	22				
United States	132,969	405	19	55	71	94,329	367	17	41	55	72,851	367	17	41	55	72,851	18				
Land cover type by region and year:																					
North Atlantic	7,821	31	21	23	13	995	29	20	21	20	1,546	29	20	21	20	1,546	69				
S. Atlantic/Gulf	21,995	67	24	54	55	12,196	56	20	52	46	10,078	56	20	52	46	10,078	41				
Upper Midwest	39,984	77	20	52	55	21,989	78	20	46	52	20,888	78	20	46	52	20,888	30				
Great Plains	55,380	153	21	69	70	38,758	134	19	52	62	34,438	134	19	52	62	34,438	24				
Far West	8,071	77	14	42	45	3,668	70	12	16	17	1,350	70	12	16	17	1,350	88				
East	69,800	175	22	47	50	35,180	163	20	44	47	32,512	163	20	44	47	32,512	23				
West	63,452	230	18	60	67	42,427	204	16	40	56	35,787	204	16	40	56	35,787	23				
United States	133,252	405	19	55	58	77,607	367	17	41	51	68,299	367	17	41	51	68,299	16				

Table 2. Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where total phosphorus concentrations exceed 0.1 milligrams per liter, by hydrologic region, land cover type, and year.

1982										1989									
Region	Total Acres (1,000 acres)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion			Pct. Error	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion			Pct. Error				
					(1,000 acres)	(Pct.)	(1,000 acres)					(Pct.)	(1,000 acres)	(Pct.)					
Land cover type by region and year:																			
North Atlantic	14,112	31	21	23	15	2,151	92	29	20	21	14	1,993	96						
S. Atlantic/Gulf	48,988	67	24	54	61	29,862	23	56	20	52	64	31,562	24						
Upper Midwest	125,277	77	20	52	75	94,090	14	78	20	46	74	92,447	15						
Great Plains	195,016	153	21	69	84	163,036	10	134	19	52	68	132,203	15						
Far West	35,276	77	14	42	33	11,797	62	70	12	16	21	7,570	98						
East	188,376	175	22	47	67	126,103	12	163	20	44	67	126,002	12						
West	230,292	230	18	60	76	174,833	10	204	16	40	61	139,773	15						
United States	418,669	405	19	55	72	300,936	8	367	17	41	63	265,775	10						
Land cover type by region and year:																			
North Atlantic	7,670	31	21	23	7	560	119	29	20	21	12	918	117						
S. Atlantic/Gulf	5,484	67	24	54	59	3,251	28	56	20	52	72	3,926	24						
Upper Midwest	65,683	77	20	52	71	46,605	17	78	20	46	70	46,257	17						
Great Plains	28,560	153	21	69	97	27,616	2	134	19	52	95	27,197	4						
Far West	3,105	77	14	42	47	1,451	114	70	12	16	41	1,282	147						
East	78,837	175	22	47	64	50,416	16	163	20	44	65	51,101	15						
West	31,665	230	18	60	92	29,066	6	204	16	40	90	28,480	7						
United States	110,501	405	19	55	72	79,483	10	367	17	41	72	79,580	10						

Table 1. (continued) Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where dissolved nitrate concentrations exceed 3.0 milligrams per liter, by hydrologic region, land cover type, and year.

1980															1989														
Region	Total Acres (1,000 acres)	Acres in Water-sheds Exceed Criterion (1,000 acres)							Pct. Error	Acres in Water-sheds Exceed Criterion (1,000 acres)							Pct. Error												
		Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (1,000 acres)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)		Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (Pct.)	Water-sheds Exceed Criterion (1,000 acres)																	
Land cover type by region and year: Wheat Acreage																													
North Atlantic	1,197	31	21	0	0	0	0	-	30	21	3	11	3	129	289														
S. Atlantic/Gulf	8,044	53	19	0	0	0	0	-	42	15	0	0	0	0	-														
Upper Midwest	9,761	66	17	18	28	2,718	56	66	17	11	25	2,467	62	195															
Great Plains	96,889	114	16	4	3	2,734	160	107	15	1	1	526	195	200															
Far West	17,078	72	13	8	9	1,467	166	67	12	4	8	1,298	200	61															
East	19,002	150	18	8	14	2,718	56	138	17	6	14	2,596	153	73															
West	113,967	186	14	5	4	4,201	119	174	14	2	2	1,824	153	73															
United States	132,969	336	16	7	5	6,919	76	312	15	4	3	4,420	73	61															
Land cover type by region and year: Pastureland																													
North Atlantic	7,821	31	21	0	0	0	-	30	21	3	4	347	158	-															
S. Atlantic/Gulf	21,995	53	19	0	0	0	-	42	15	0	0	0	-	101															
Upper Midwest	39,984	66	17	18	11	4,593	70	66	17	11	5	1,990	187	148															
Great Plains	55,380	114	16	4	5	2,742	108	107	15	1	2	1,338	187	148															
Far West	8,071	72	13	8	2	188	100	67	12	4	1	114	148	89															
East	69,800	150	18	8	7	4,593	70	138	17	6	3	2,337	89	173															
West	63,452	186	14	5	5	2,930	101	174	14	2	2	1,451	173	86															
United States	133,252	336	16	7	6	7,522	58	312	15	4	3	3,788	86	86															

Table 1. Estimates of the percent and amount of agricultural land in watersheds of the conterminous United States where dissolved nitrate concentrations exceed 3.0 milligrams per liter, by hydrologic region, land cover type, and year.

1980										1989													
Region	Total Acres (1,000 acres)	Total Cropland					Corn Acreage					Pct. Error	Acres in Water-sheds Exceed Criterion (1,000 acres)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (Pct.)	Sampled Water-sheds (No.)	Sampled Water-sheds (Pct.)	Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (Pct.)	Acres in Water-sheds Exceed Criterion (1,000 acres)	Pct. Error
Land cover type by region and year:																							
North Atlantic	14,112	31	21	0	0	-		30	21	3	9	1,334	202										
S. Atlantic/Gulf	48,988	53	19	0	0	-		42	15	0	0	0	-										
Upper Midwest	125,277	66	17	18	34	34		66	17	11	21	25,685	47										
Great Plains	195,016	114	16	4	6	12,221	133		107	15	1	1	980	200									
Far West	35,276	72	13	8	9	3,099	133		67	12	4	7	2,572	168									
East	188,376	150	18	8	22	42,140	34		138	17	6	14	27,019	46									
West	230,292	186	14	5	7	15,320	110		174	14	2	2	3,553	134									
United States	418,669	336	16	7	14	57,460	39		312	15	4	7	30,572	44									
Land cover type by region and year:																							
North Atlantic	7,670	31	21	0	0	0	-		30	21	3	12	923	199									
S. Atlantic/Gulf	5,484	53	19	0	0	0	-		42	15	0	0	0	-									
Upper Midwest	65,683	66	17	18	32	21,239	36		66	17	11	17	11,421	50									
Great Plains	28,560	114	16	4	15	4,306	172		107	15	1	0	10	243									
Far West	3,105	72	13	8	0	4	227		67	12	4	0	3	300									
East	78,837	150	18	8	27	21,239	36		138	17	6	16	12,344	48									
West	31,665	186	14	5	14	4,310	172		174	14	2	0	12	203									
United States	110,501	336	16	7	23	25,549	42		312	15	4	11	12,356	48									