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Developing 1990, 2000, and 2005 Impervious Surface Estimates for Southern York County, Maine

David G. Justice
University of New Hampshire - Main Campus, david.justice@unh.edu

Fay A. Rubin
University of New Hampshire - Main Campus, Fay.Rubin@unh.edu

DEVELOPING 1990, 2000, AND 2005 IMPERVIOUS SURFACE ESTIMATES FOR SOUTHERN YORK COUNTY, MAINE

A Final Report to

The Piscataqua Region Estuaries Partnership

Submitted by

David Justice and Fay Rubin
Complex Systems Research Center
Institute for the Study of Earth, Oceans and Space
Morse Hall
University of New Hampshire, Durham, NH 03824

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PISCATAQUA REGION Estuaries Partnership

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Executive Summary

Estimates of impervious surface acreage in 1990, 2000, and 2005 were generated for an 11-town region in York County, Maine, covered by the Piscataqua Region Estuaries Partnership (PREP). The project extended previous work done in New Hampshire, relying on comparable satellite-based data sources and image processing methodologies. As a result, standardized impervious surface estimates are now available for the entirety of the PREP region.

The impervious surface estimates were derived by applying both traditional and subpixel classification techniques to 30-meter Landsat 5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper Plus (ETM+) satellite image data. The classifications indicated that 3.3% (9,098 acres) of the study area was impervious in 1990, with increases to 5.3 % (14,646 acres) in 2000 and 6.3% (17,394 acres) in 2005. At the subwatershed level, the Portsmouth Harbor subwatershed recorded the highest percentage of impervious surface acreage in 1990, 2000, and 2005 with 7.8% coverage (1,283 acres), 12.3% coverage (2,009 acres), and 14.5% coverage (2,380 acres) respectively.

The regional accuracy assessment indicated an overall accuracy of 97.0% for the 1990 data, 93.0% for the 2000 data, and 92.0% for the 2005 data. These results reflect the overall presence/absence of impervious surfaces within the randomly selected assessment pixels.

The three data sets have been archived in the GRANIT GIS clearinghouse, thereby making them available to the coastal resource community as well as the general public. The data are appropriate for watershed and subwatershed level characterizations. Users are discouraged from accessing them to support larger scale mapping and applications.

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Introduction

In 2009, the New Hampshire Estuaries Project (NHEP) expanded its sphere of inquiry to include those portions of Maine that influence the Piscataqua River drainage. The NHEP was renamed the Piscataqua Region Estuaries Partnership (PREP) to reflect this expanded coverage area. To facilitate regional environmental planning and stewardship in the larger PREP area, it was necessary to expand the project datasets to include the newly added areas in southern Maine. This study focused on the expansion of one key data series - multitemporal impervious surface estimates.

The current project complements two previous efforts conducted for the PREP to map impervious surfaces in the Piscataqua River drainage basin in New Hampshire. The preceding endeavors mapped impervious surfaces (buildings, pavement, etc.) based on 30-meter Landsat Thematic Mapper (TM) data sets using both traditional and sub-pixel image classification techniques (Justice and Rubin (2006), and Justice and Rubin (2003)). The current study utilized comparable satellite imagery, and applied consistent techniques to the Maine portion of the PREP area to generate standardized impervious surface estimates for the entire geography.

Project Goals and Objectives

The primary objective of this study was to utilize Landsat Thematic Mapper (TM) imagery to map impervious surfaces within an 11-town area of southernYork County, Maine. Impervious surfaces were defined as surfaces through which water cannot penetrate, and included roadways, parking lots, rooftops, paved driveways, and any other paved surfaces identified. The goal was to develop data for three points in time – 1990, 2000, and 2005 – in order to quantify the extent of coverage and to provide indications of rates of change. The specific objectives of the study were to:

- Utilize subpixel processing techniques as applied to TM imagery to develop a baseline impervious surface estimate for 1990
- Utilize subpixel processing techniques as applied to TM imagery to develop estimates of impervious surfaces in 2000 and 2005
- Calculate the change in impervious surface acreage over the ten and five-year periods
- Report the results at the subwatershed and town levels
- Convert the data for each year to a GRID format, with corresponding attribute tables reporting the degree of imperviousness for each cell (in ranges of 10%)
- Develop appropriate metadata, or data documentation
- Make the spatial data and metadata available through the GRANIT GIS clearinghouse

Finally, the larger objective of the study was to provide a data resource for land use boards, conservation commissions, and other local decision-makers to use in assessing potential environmental impacts of increasing levels of impervious surfaces in parts of coastal Maine and New Hampshire.

Methods

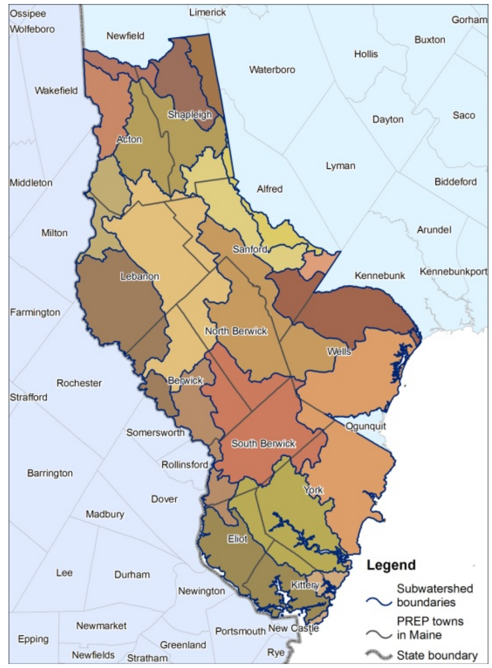
The mapping utilized moderate resolution, 30-meter TM imagery to generate estimates of impervious surface acreage for three years: 1990, 2000, and 2005. The 1990 scene was acquired September 8 (via the Landsat 5 platform), while the 2000 image was acquired September 27 (Landsat 7), and the 2005 data was from October 3 (Landsat 5). Each scene was from path 12, row 30 of the Worldwide Reference System-2 (WRS-2).

a. Traditional Classification

The impervious surface mapping began by using ERDAS Imagine (version 9.2) to conduct a traditional unsupervised classification on the each georeferenced data set (1990, 2000, and 2005) in order to generate an initial delineation of the developed/undeveloped land features. Past mapping efforts indicated that the subpixel technique may omit certain types of impervious features, due in part to the variety of specific surface types that constitute impervious surfaces. The generalized mapping was conducted to anticipate some of these "gaps". It also provided a reference data set to supplement the visual interpretation of the subsequent subpixel classifications. The resulting classifications produced 50 clusters which were identified and coded as either impervious or not impervious.

Obvious misclassifications were identified in the results and screen edited to correct the errors. Tidal flats and wetlands, shallow water and scrub-shrub wetlands most often contributed to the problematic situations.

Figure 1. Subwatersheds within the Maine section of the Piscataqua Region Estuaries Partnership



b. Subpixel Processing

The ERDAS Imagine Subpixel analysis tool was then applied to each of the raw data sets (i.e. un-georeferenced) using procedures described in previous reports (Justice and Rubin, (2006), and Justice and Rubin (2003)). We used approximately 24 signatures to produce the 2005 classification, 28 signatures to produce the 2000 data set, and 17 signatures to produce the 1990 classification. In all instances, each signature produced a classification reporting per pixel impervious surface in 10% ranges, and ultimately, these were "merged" to create the final data. The merge of these data sets took the maximum pixel value at each cell location to produce the subsequent provisional layer.

c. Post Processing

The post processing phase of the project was designed to enhance the classification phase by addressing two specific issues – the correction of any remaining, obvious errors in the classification results, and the incorporation (or "burning in") of road centerline data to optimize the mapping of pavement as an impervious surface feature.

The provisional impervious surface classifications included some recurring errors – typically misclassified pixels occurring in open water, wetland and forests. The image analyst could often quickly identify these errors using pattern recognition, past experience and in some cases, ancillary aerial photography used as reference images. Errors were fixed using ESRI ArcScan cleanup tools to remove unwanted pixels from the classification.

For the 2000 data set, the impervious surface estimates from 1990 were incorporated to ensure consistency in mapping over time. Similarly, the 2005 iteration incorporated the 2000 results.

The final post processing step sought to incorporate road pavement width data. (Because of their relatively narrow, linear shape, road features are occasionally omitted in the classification phase.) Road centerlines (public and private) were obtained from the Maine Department of Transportation (May, 2008) and provided the starting point for this task However, the pavement characteristic was only available for the public road data set. Thus, an editing task was required to identify the surface type (paved/unpaved) of private roads. This task included field visits and visual inspections of the various image-based data sources. Ultimately, a default pavement width of 20 ft. was assigned to the subset of private roads found to be paved. In addition, no historical record of roads was available. Consequently, a second editing task was required to subset roads (both public and private) that were present in 1990 and 2000. The editing was accomplished by on-screen visual inspection, comparing the road centerlines with the 1990 and 2000 TM images. Once the editing was complete, the pavement width characteristic was used to "burn" the paved 1990, 2000, and 2005 road centerline data into the appropriate provisional layer to produce the final data sets.

d. Accuracy Assessment

A critical component of the project was the accuracy assessment, which was conducted by selecting a random set of locations and "driving by" those locations to determine the presence/absence of impervious surfaces. While this approach did not yield detailed information on the actual percentage of each pixel's "imperviousness", it provided a basic understanding of the accuracy of the classified data.

Two constraints were applied during the site selection process. First, a road proximity constraint was applied (within 5 pixels or approximately 467 feet of a road) to facilitate the completion of the assessment. Second, each impervious surface feature was "shrunk" by 1 pixel width prior to the selection process to exclude confusion among edge pixels.

A set of 200 assessment sites was randomly selected from the project area – 50 sites in each of four categories:

- coded as impervious in 1990
- coded as impervious in 2000
- coded as impervious 2005
- coded as non-impervious in all three dates (these sites were used as non impervious reference data for each of the three time steps)

An analyst drove by each of the 200 sites, and recorded its impervious status for each time step (1990, 2000, and 2005). Navigation to each site was facilitated by use of a laptop computer operating GPS equipped ESRI ArcMap software.

Impervious status could not be determined at each location based solely on the visual assessment. For example, it was not always evident when a relatively new housing development was constructed. In such cases, the site was marked in the field as undetermined and re-evaluated in the office using appropriate aerial photography.

e. Reporting and Metadata

The results of the impervious surface mapping were tabulated for each year – 1990, 2000, and 2005 – both for the full study area, by subwatershed, and by town. For each image date, acreage totals were calculated for three impervious levels: low, middle, and high. (These levels result from the detection of the impervious surface in 10 percent ranges, typically beginning at the 20-29% range using the subpixel classification technique. However, the post-processing introduction of impervious surface percentages based on pavement widths created impervious percentages lower than the normal 20% minimum value.)

The final reporting step was the development of a full, Federal Geographic Data Committee (FGDC)-compliant metadata record for the three impervious surface data sets. These documents detail the data production and assessment aspects of the project, and are an essential reference for the community utilizing the data.

Results and Discussion

I. Regional Impervious Surface Estimates

The primary results of this project are 1990, 2000, and 2005 impervious surface estimates for the 11 towns in York County, Maine covered by the Piscataqua Region Estuaries Partnership (Figures 3, 4, and 5). Figures 5, 6, and 7 provide somewhat larger-scale illustrations of mapped impervious surface features for a location in the town of York, Maine. These figures show evidence of new housing subdivisions and other development in 2000 and 2005 relative to the 1990 baseline data.

Tables 1, 2, and 3 summarize these results by subwatershed, reporting acreages at 3 levels for each unit. (As previously noted, the subpixel classification reports results by percentage range. To convert the ranges to discrete acreage estimates, the low, mid and high points of each range were selected. All further discussion in this document utilizes the estimate derived from the mid point of the range.) Table 1 reveals that 9,098 acres, or 3.3% of the land surface area in the 19 subwatersheds, were estimated to be impervious in 1990. By the year 2000, Table 2 reports that the acreage had increased to 14,646 acres (5.3%), a marked increase of 5,548 acres. This represents a 2.0% increase in impervious surface coverage over the ten-year period (see Table 4). By 2005, the impervious area was estimated at 17,394 acres, or an additional 1.0% from that of 2000. These numbers show that the rate of increase between 1990 and 2000 was approximately 6.0% per annum while that rate dropped to 3.75% per year between 2000 and 2005.

Associated with the satellite image based mapping are error matrices, used to report the approximate accuracy of the results. Typically, a matrix presents classified data results (e.g. derived from image processing) relative to reference data (e.g. data acquired via field visits or from some other source of known reliability). While the assessments for this project utilized the standard technique, the methodology cannot fully characterize the reliability of our results because the impervious surface pixels were mapped on a percentage basis. The accuracy assessment only evaluated the presence/absence of imperviousness at a given site, not the percentage impervious.

With this caveat, error matrices are presented in Tables 5, 6, and 7. The tables show that satisfactory overall accuracies were achieved for the three time steps with the 1990 data 97.0% correct, the 2000 data 93.0% correct, and the 2005 data 92.0% correct. By constraining our accuracy assessment selection technique, the site selections were probably biased in favor of those areas that are most easily mapped (e.g. large parking lots, buildings, and residential subdivisions rather than single houses and isolated features). Nevertheless, the assessments provide a general estimate of the data reliability.

Figure 2. Regional mapping of impervious surfaces, 1990. Impervious surface features are shown in red and are displayed on the 12-digit watershed boundaries.

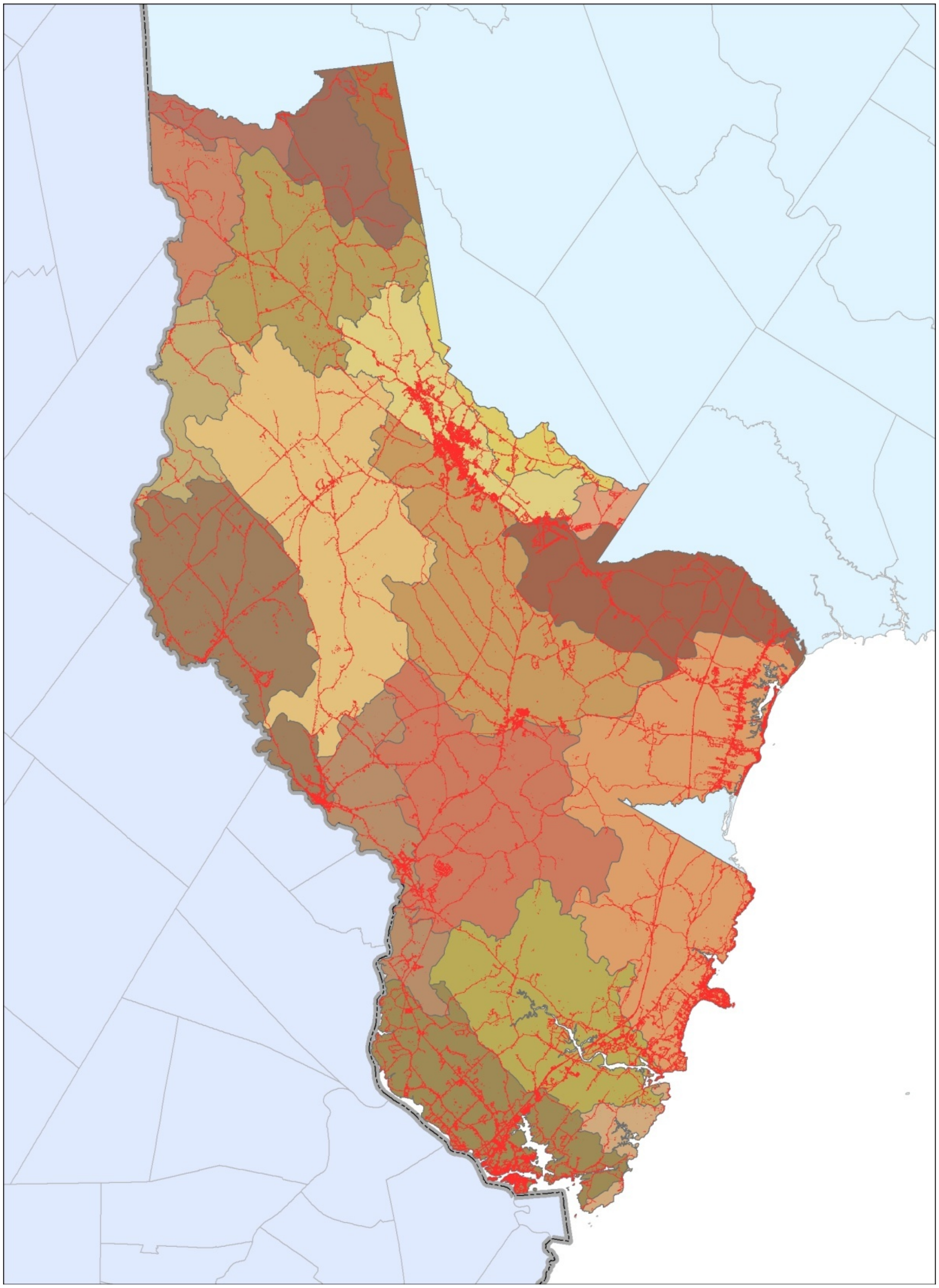


Figure 3. Regional mapping of impervious surfaces, 2000. Impervious surface features are shown in red, and are displayed on the 12-digit watershed units.

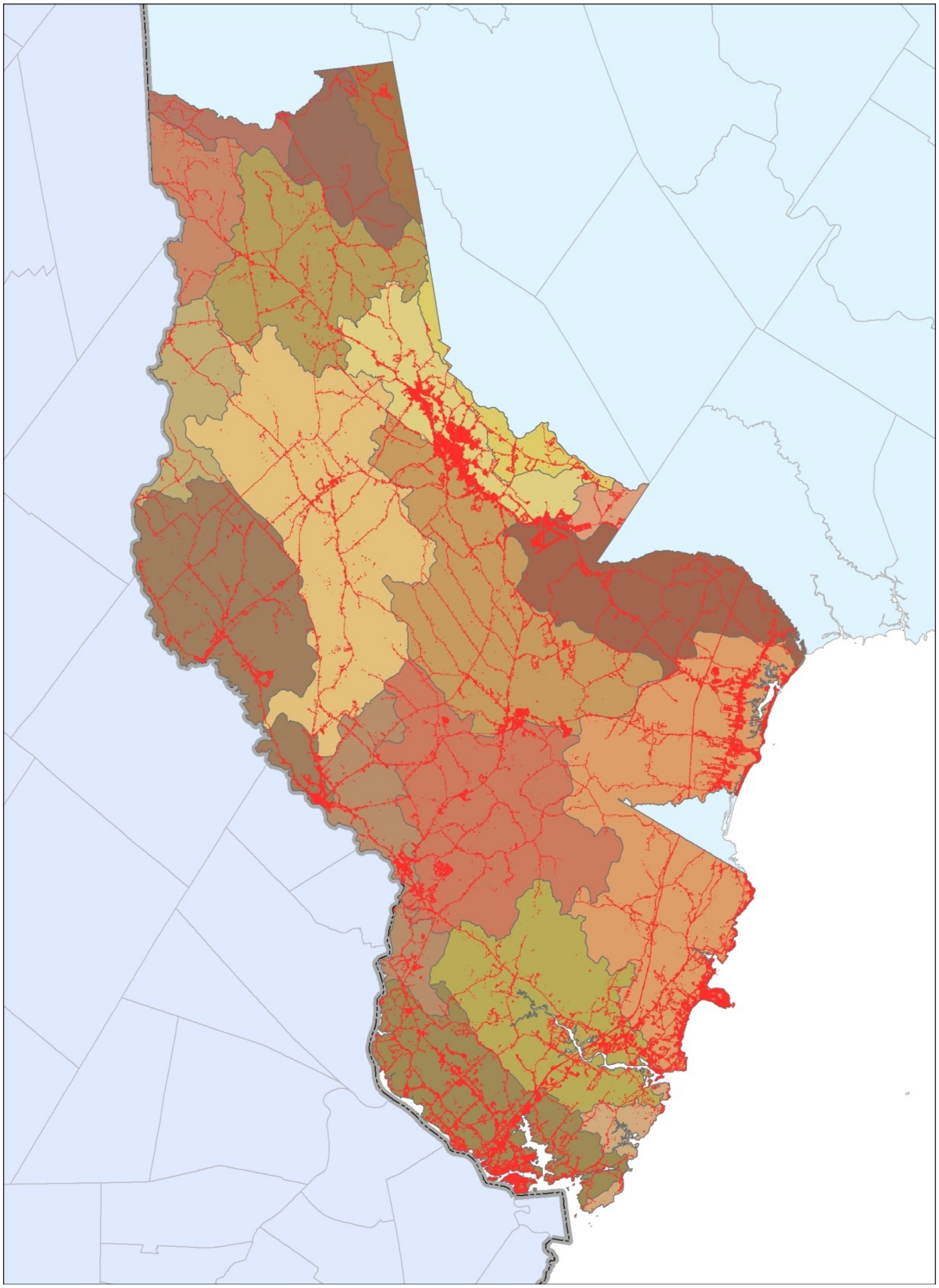


Figure 4. Regional mapping of impervious surfaces, 2005. Impervious surfaces are shown in red and displayed on the 12-digit watershed units.

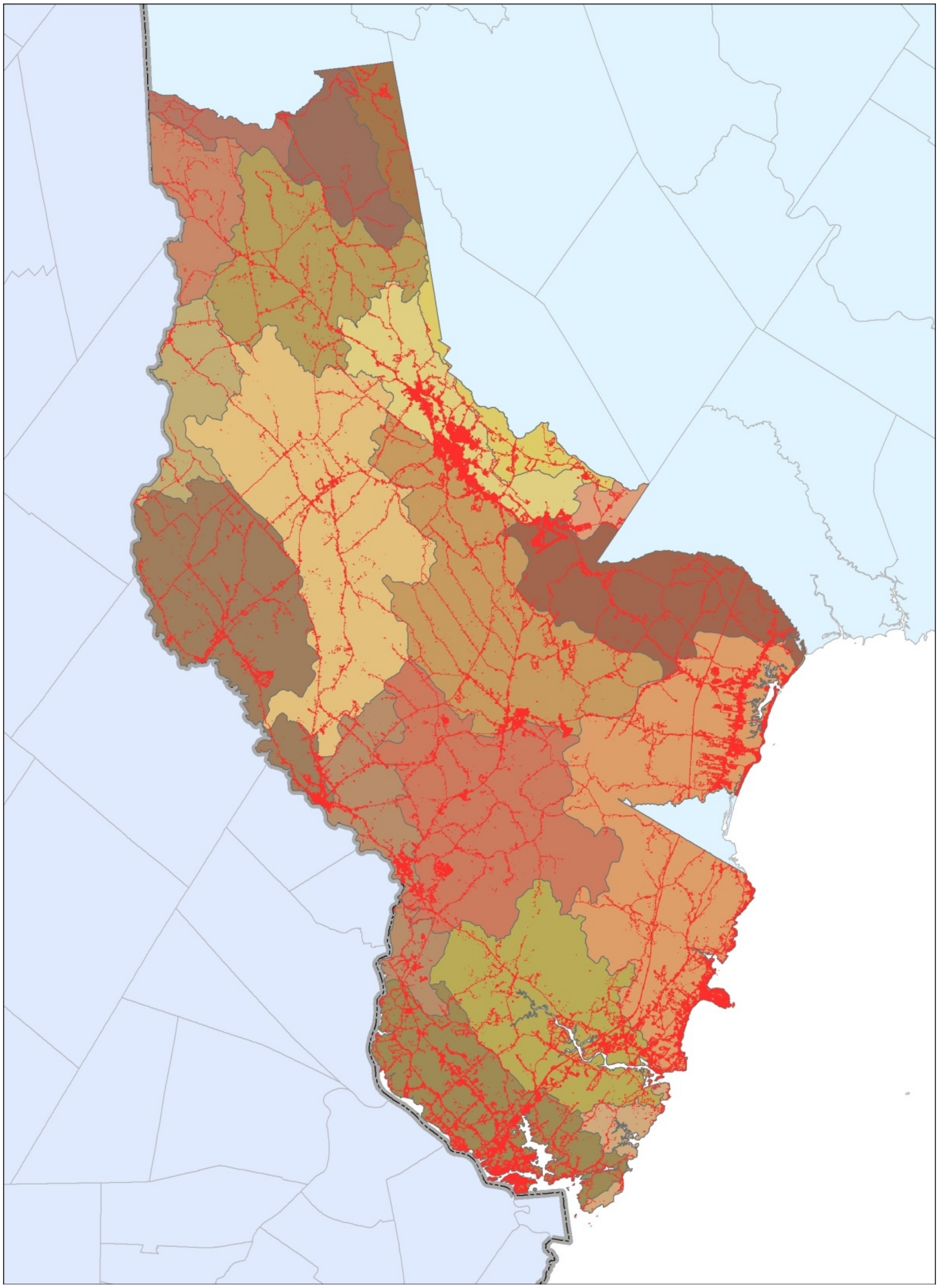


Figure 5. Regional mapping of impervious surfaces, 1990, for the York, ME vicinity.

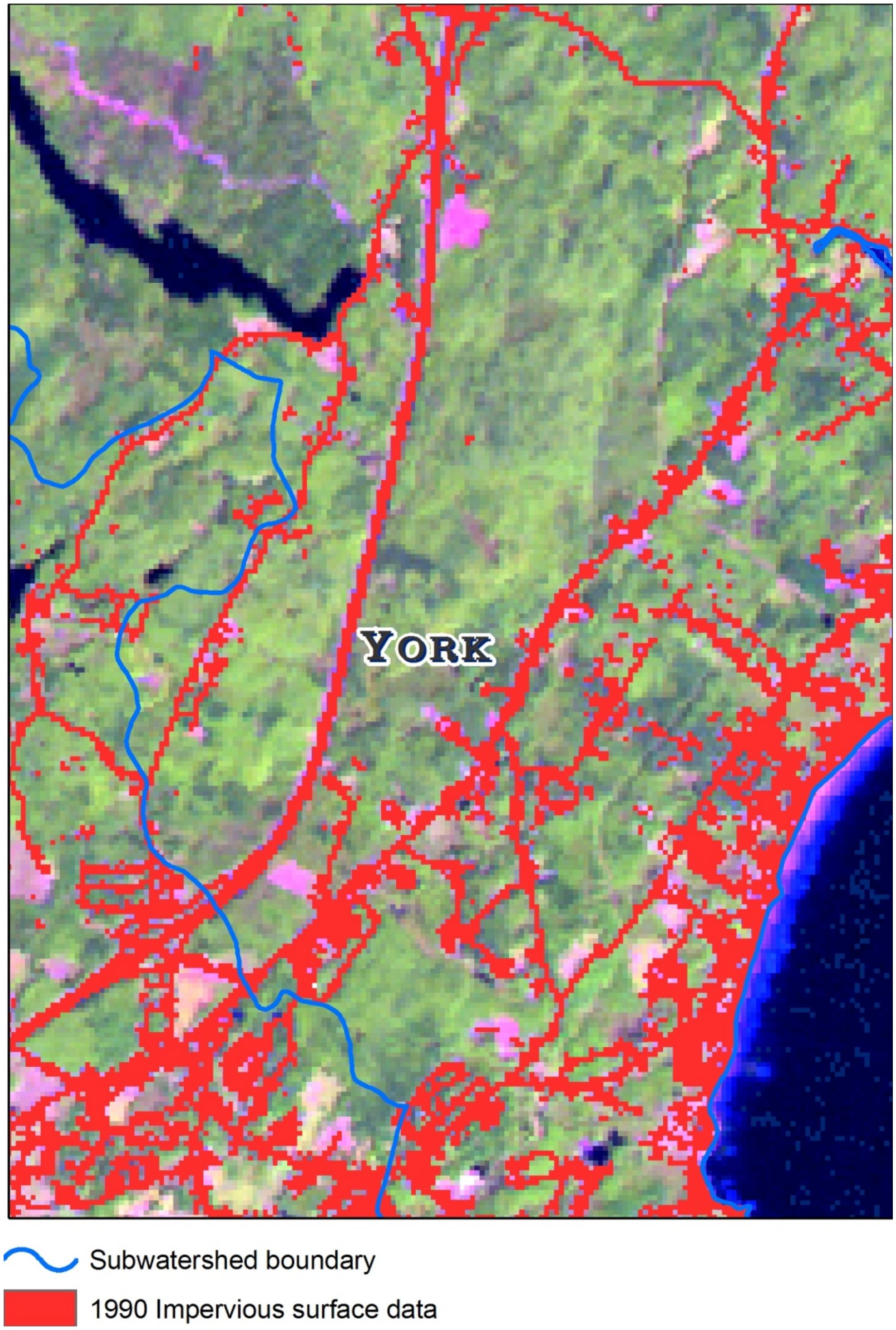


Figure 6. Regional mapping of impervious surfaces, 2000 for the York, ME vicinity.

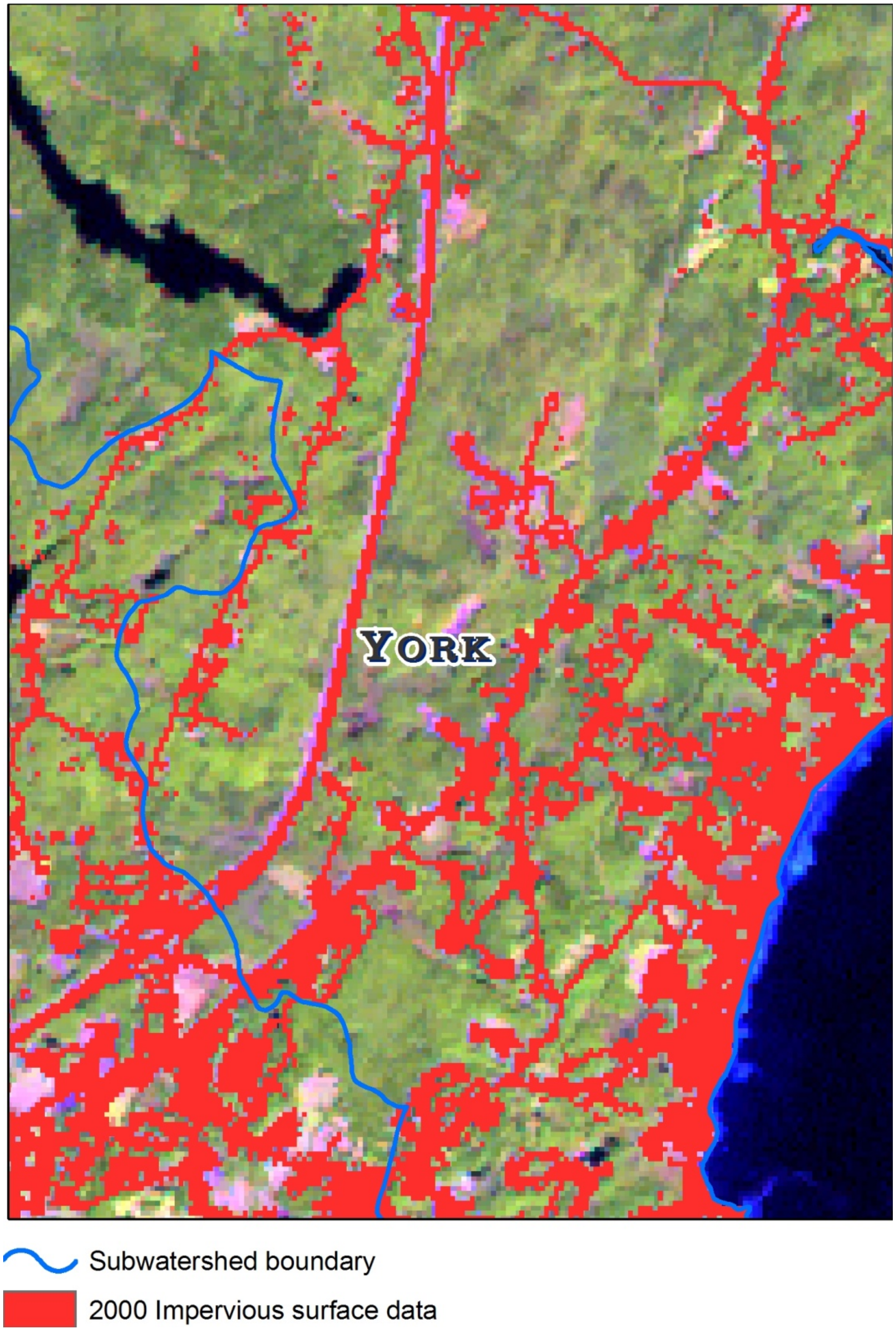


Figure 7. Regional mapping of impervious surfaces, 2005, for the York, ME vicinity.

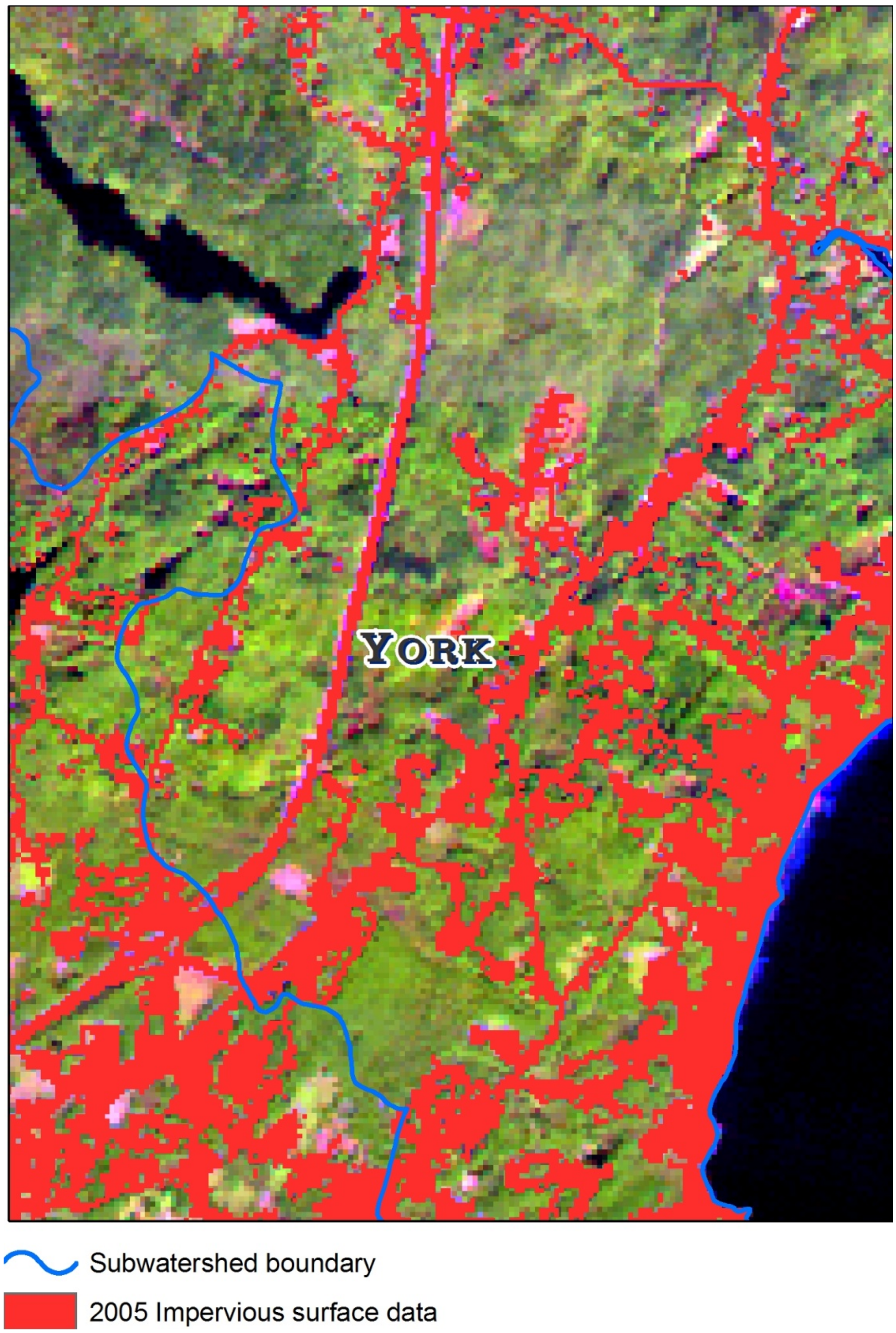


Table 1. Impervious Surface Acreage and Total Acreage by Subwatershed, 1990

12-Digit HUC Subwatershed Name	Impervious Acreage - 1990						Total Acres			
	Low Range	% Land Area	Mid Range	% Land Area	High Range	% Land Area	Mapped Area	Surface Water[1]	Land Area[1]	Total Sub-watershed
Coastal Drainages-Brave Boat Harbor	44	1.7	57	2.3	63	2.5	2,639	125	2,513	2,639
Coastal Drainages-Kennebunk R. to York R.	1,600	4.4	1,938	5.3	2,112	5.8	37,306	656	36,651	40,067
Estes Lake	93	2.3	123	3.1	137	3.4	4,214	182	4,031	19,118
Great Works River (1) at North Berwick	772	2.7	952	3.4	1,045	3.7	28,601	398	28,203	28,601
Great Works River (2) at mouth	403	1.5	538	2.0	598	2.2	26,870	264	26,607	26,870
Headwaters-Great East Lake	76	1.2	99	1.5	111	1.7	7,671	1,245	6,426	17,733
Henderson Brook	66	1.7	88	2.3	97	2.5	4,037	182	3,855	13,033
Little Ossipee River at Henderson Brook	66	0.8	89	1.1	99	1.2	8,047	81	7,966	20,827
Little River	334	1.0	472	1.4	528	1.5	35,006	163	34,844	35,006
Little River at Wells	384	2.3	480	2.8	526	3.1	17,169	93	17,077	20,065
Lower Salmon Falls River	296	2.8	374	3.6	412	3.9	10,752	291	10,461	13,810
Middle Salmon Falls River	420	1.9	552	2.5	609	2.7	22,686	412	22,275	38,464
Milton Pond	58	0.8	91	1.3	103	1.5	7,533	525	7,009	15,173
Mousam Lake at Emery Mills	258	1.5	333	2.0	370	2.2	18,886	2,052	16,834	18,897
Mousam River (1) at Estes Lake	752	6.4	888	7.5	962	8.2	12,177	384	11,792	12,212
Mousam River (2)	49	2.6	67	3.6	74	4.0	1,904	35	1,870	12,093
Portsmouth Harbor	1,032	6.3	1,283	7.8	1,404	8.6	19,243	2,866	16,377	31,097
Shapleigh Pond	30	1.1	39	1.4	44	1.6	2,998	241	2,756	14,095
York River	499	2.5	635	3.1	702	3.5	21,305	1,120	20,185	21,305
Total	7,232	2.6	9,098	3.3	9,996	3.6	289,045	11,315	277,731	401,106

[1]Acreages reported within mapped area

Table 2. Impervious Surface Acreage and Total Acreage by Subwatershed, 2000

12-Digit HUC Subwatershed Name	Impervious Acreage - 2000						Total Acres			
	Low Range	% Land Area	Mid Range	% Land Area	High Range	% Land Area	Mapped Area	Surface Water[1]	Land Area[1]	Total Sub-watershed
Coastal Drainages-Brave Boat Harbor	95	3.8	112	4.5	121	4.8	2,639	125	2,513	2,639
Coastal Drainages-Kennebunk R. to York R.	2,672	7.3	3,073	8.4	3,298	9.0	37,306	656	36,651	40,067
Estes Lake	172	4.3	206	5.1	224	5.6	4,214	182	4,031	19,118
Great Works River (1) at North Berwick	1,284	4.6	1,496	5.3	1,615	5.7	28,601	398	28,203	28,601
Great Works River (2) at mouth	782	2.9	946	3.6	1,028	3.9	26,870	264	26,607	26,870
Headwaters-Great East Lake	136	2.1	164	2.6	180	2.8	7,671	1,245	6,426	17,733
Henderson Brook	113	2.9	138	3.6	149	3.9	4,037	182	3,855	13,033
Little Ossipee River at Henderson Brook	108	1.4	133	1.7	145	1.8	8,047	81	7,966	20,827
Little River	634	1.8	793	2.3	866	2.5	35,006	163	34,844	35,006
Little River at Wells	672	3.9	785	4.6	845	4.9	17,169	93	17,077	20,065
Lower Salmon Falls River	527	5.0	623	6.0	673	6.4	10,752	291	10,461	13,810
Middle Salmon Falls River	780	3.5	936	4.2	1,010	4.5	22,686	412	22,275	38,464
Milton Pond	111	1.6	148	2.1	162	2.3	7,533	525	7,009	15,173
Mousam Lake at Emery Mills	463	2.8	554	3.3	601	3.6	18,886	2,052	16,834	18,897
Mousam River (1) at Estes Lake	1,141	9.7	1,296	11.0	1,387	11.8	12,177	384	11,792	12,212
Mousam River (2)	87	4.7	107	5.7	117	6.2	1,904	35	1,870	12,093
Portsmouth Harbor	1,716	10.5	2,009	12.3	2,164	13.2	19,243	2,866	16,377	31,097
Shapleigh Pond	43	1.6	53	1.9	58	2.1	2,998	241	2,756	14,095
York River	906	4.5	1,073	5.3	1,162	5.8	21,305	1,120	20,185	21,305
Total	12,443	4.5	14,646	5.3	15,806	5.7	289,045	11,315	277,731	401,106

[1]Acreages reported within mapped area

Table 3. Impervious Surface Acreage and Total Acreage by Subwatershed, 2005

12-Digit HUC Subwatershed Name	Impervious Acreage - 2005						Total Acres			
	Low Range	% Land Area	Mid Range	% Land Area	High Range	% Land Area	Mapped Area	Surface Water[1]	Land Area[1]	Total Sub-watershed
Coastal Drainages-Brave Boat Harbor	116	4.6	135	5.4	145	5.8	2,639	125	2,513	2,639
Coastal Drainages-Kennebunk R. to York R.	3,260	8.9	3,697	10.1	3,952	10.8	37,306	656	36,651	40,067
Estes Lake	209	5.2	246	6.1	265	6.6	4,214	182	4,031	19,118
Great Works River (1) at North Berwick	1,529	5.4	1,758	6.2	1,889	6.7	28,601	398	28,203	28,601
Great Works River (2) at mouth	978	3.7	1,157	4.3	1,250	4.7	26,870	264	26,607	26,870
Headwaters-Great East Lake	158	2.5	188	2.9	205	3.2	7,671	1,245	6,426	17,733
Henderson Brook	132	3.4	158	4.1	170	4.4	4,037	182	3,855	13,033
Little Ossipee River at Henderson Brook	126	1.6	152	1.9	165	2.1	8,047	81	7,966	20,827
Little River	810	2.3	983	2.8	1,066	3.1	35,006	163	34,844	35,006
Little River at Wells	793	4.6	915	5.4	982	5.7	17,169	93	17,077	20,065
Lower Salmon Falls River	664	6.3	768	7.3	825	7.9	10,752	291	10,461	13,810
Middle Salmon Falls River	981	4.4	1,150	5.2	1,236	5.5	22,686	412	22,275	38,464
Milton Pond	142	2.0	182	2.6	198	2.8	7,533	525	7,009	15,173
Mousam Lake at Emery Mills	544	3.2	640	3.8	692	4.1	18,886	2,052	16,834	18,897
Mousam River (1) at Estes Lake	1,253	10.6	1,413	12.0	1,510	12.8	12,177	384	11,792	12,212
Mousam River (2)	103	5.5	124	6.6	134	7.2	1,904	35	1,870	12,093
Portsmouth Harbor	2,065	12.6	2,380	14.5	2,553	15.6	19,243	2,866	16,377	31,097
Shapleigh Pond	48	1.7	58	2.1	64	2.3	2,998	241	2,756	14,095
York River	1,109	5.5	1,289	6.4	1,389	6.9	21,305	1,120	20,185	21,305
Total	15,020	5.4	17,394	6.3	18,690	6.7	289,045	11,315	277,731	401,106

[1]Acreages reported within mapped area

Table 4. Change in Impervious Surface Acreage by Subwatershed, 1990 - 2005

12-Digit HUC Subwatershed Name	Imp. Acres, 1990 (mid point)	% Imp., 1990	Imp. Acres, 2000 (mid point)	% Imp., 2000	Imp. Acres, 2005 (mid point)	% Imp., 2005	Change in % Imp. 1990 - 2005	Change in % Imp. 2000 - 2005
Coastal Drainages-Brave Boat Harbor	57	2.3	112	4.5	135	5.4	3.1	0.9
Coastal Drainages-Kennebunk R. to York R.	1,938	5.3	3,073	8.4	3,697	10.1	4.8	1.7
Estes Lake	123	3.1	206	5.1	246	6.1	3.0	1.0
Great Works River (1) at North Berwick	952	3.4	1,496	5.3	1,758	6.2	2.9	0.9
Great Works River (2) at mouth	538	2.0	946	3.6	1,157	4.3	2.3	0.8
Headwaters-Great East Lake	99	1.5	164	2.6	188	2.9	1.4	0.4
Henderson Brook	88	2.3	138	3.6	158	4.1	1.8	0.5
Little Ossipee River at Henderson Brook	89	1.1	133	1.7	152	1.9	0.8	0.2
Little River	472	1.4	793	2.3	983	2.8	1.5	0.5
Little River at Wells	480	2.8	785	4.6	915	5.4	2.5	0.8
Lower Salmon Falls River	374	3.6	623	6.0	768	7.3	3.8	1.4
Middle Salmon Falls River	552	2.5	936	4.2	1,150	5.2	2.7	1.0
Milton Pond	91	1.3	148	2.1	182	2.6	1.3	0.5
Mousam Lake at Emery Mills	333	2.0	554	3.3	640	3.8	1.8	0.5
Mousam River (1) at Estes Lake	888	7.5	1,296	11.0	1,413	12.0	4.5	1.0
Mousam River (2)	67	3.6	107	5.7	124	6.6	3.1	0.9
Portsmouth Harbor	1,283	7.8	2,009	12.3	2,380	14.5	6.7	2.3
Shapleigh Pond	39	1.4	53	1.9	58	2.1	0.7	0.2
York River	635	3.1	1,073	5.3	1,289	6.4	3.2	1.1
Total	9,098	3.3	14,646	5.3	17,394	6.3	3.0	1.0

Table 5. Impervious Surface Acreage and Total Acreage by Town, 1990, 2000, and 2005

Town		Mapped Area (acres)[1]			Impervious Surface (acres)			% Imp. Land Area		
Name	FIPS	Total	Water	Land	1990[2]	2000[2]	2005[2]	1990	2000	2005
Acton	31010	26,408	2,146	24,262	374	597	693	1.5	2.5	2.9
Berwick	31040	24,227	225	24,002	617	1,053	1,308	2.6	4.4	5.4
Eliot	31090	13,650	1,041	12,609	522	937	1,158	4.1	7.4	9.2
Kittery	31130	48,199	36,824	11,375	917	1,345	1,574	8.1	11.8	13.8
Lebanon	31140	35,633	600	35,033	627	1,065	1,304	1.8	3.0	3.7
North Berwick	31190	24,423	129	24,293	526	848	1,018	2.2	3.5	4.2
Sanford	31230	31,205	621	30,584	1,780	2,745	3,068	5.8	9.0	10.0
Shapleigh	31240	26,361	1,665	24,696	383	616	711	1.6	2.5	2.9
South Berwick	31250	20,891	330	20,561	482	795	965	2.3	3.9	4.7
Wells	31270	46,857	10,427	36,430	1,377	2,188	2,703	3.8	6.0	7.4
York	31280	84,348	49,428	34,919	1,503	2,471	2,907	4.3	7.1	8.3
Total		382,203	103,437	278,765	9,108	14,659	17,409	3.3	5.3	6.2

[1]Acreages based on 1:24,000-scale town boundary and surface water data, both retrieved in December, 2008 from the Maine GIS Data Catalog (http://megis.maine.gov/catalog). The total area of the coastal towns includes significant water acreage (as legal town bounds extend into the Atlantic Ocean).
[2]Minor differences in total impervious acreage estimates (e.g. < 20 acres) reported at the town vs. subwatershed levels result from discrepancies in coastline delineations between the two data sets.

Table 6. Accuracy Assessment Error Matrix, 1990

REFERENCE DATA (columns) / CLASSIFIED DATA (rows)

1990 Data	Impervious	Non Impervious	Total	User's Accuracy
Impervious	49	1	50	98.0%
Non Impervious	2	48	50	96.0%
Total	51.0	49.0	100	
Producers Accuracy	96.1%	98.0%		
Overall Accuracy				97.0%

Table 7. Accuracy Assessment Error Matrix, 2000

REFERENCE DATA (columns) / CLASSIFIED DATA (rows)

2000 Data	Impervious	Non Impervious	Total	User's Accuracy
Impervious	46	4	50	92.0%
Non Impervious	3	47	50	94.0%
Total	49	51	100	
Producers Accuracy	93.9%	92.2%		
Overall Accuracy				93.0%

Table 8. Accuracy Assessment Error Matrix, 2005

CLASSIFIED DATA / 2005 Data	REFERENCE DATA: Impervious	Non Impervious	Total	User's Accuracy
Impervious	46	4	50	92.0%
Non Impervious	4	46	50	92.0%
Total	50	50	100	
Producers Accuracy	92.0%	92.0%		
Overall Accuracy				92.0%

Conclusions

This study demonstrated that impervious surface acreage within 11 southern towns of York County, Maine has continually increased between 1990 and 2005 (Table 4). While the results are not surprising, this study quantifies and documents the extent of the increase, and provides a comparable extension to the previously mapped data for the New Hampshire segment of the Piscataqua Region Estuaries Partnership. The accuracy assessment indicates that the data are accurate and reliable – where mapped, impervious surfaces typically did occur.

In general, TM-based subpixel classifications provide a useful means of characterizing regional estimates of impervious surface acreages. The techniques described herein are low-cost and repeatable, and may be used in the future to monitor changes in impervious surface acreage in the region.

Recommendations

Given the rapid population growth in southern Maine and coastal New Hampshire, the researchers recommend that the impervious assessment be repeated on a 3-5 year cycle. The results achieved using TM-based imagery, processed using the subpixel techniques described herein, suggest that this methodology is appropriate for future applications where regional acreage estimates are required.

That being said, as new sources of large scale and inexpensive imagery become available on a regular basis, including 1-meter resolution aerial photography from the National Agriculture Imagery Program, we recommend that new classification technologies (e.g. object based image analysis/segmentation) be explored that take advantage of these resources.

References

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