# MONITORING IMPERVIOUS SURFACE EXTENT IN COASTAL NEW HAMPSHIRE – 1990 to 2005

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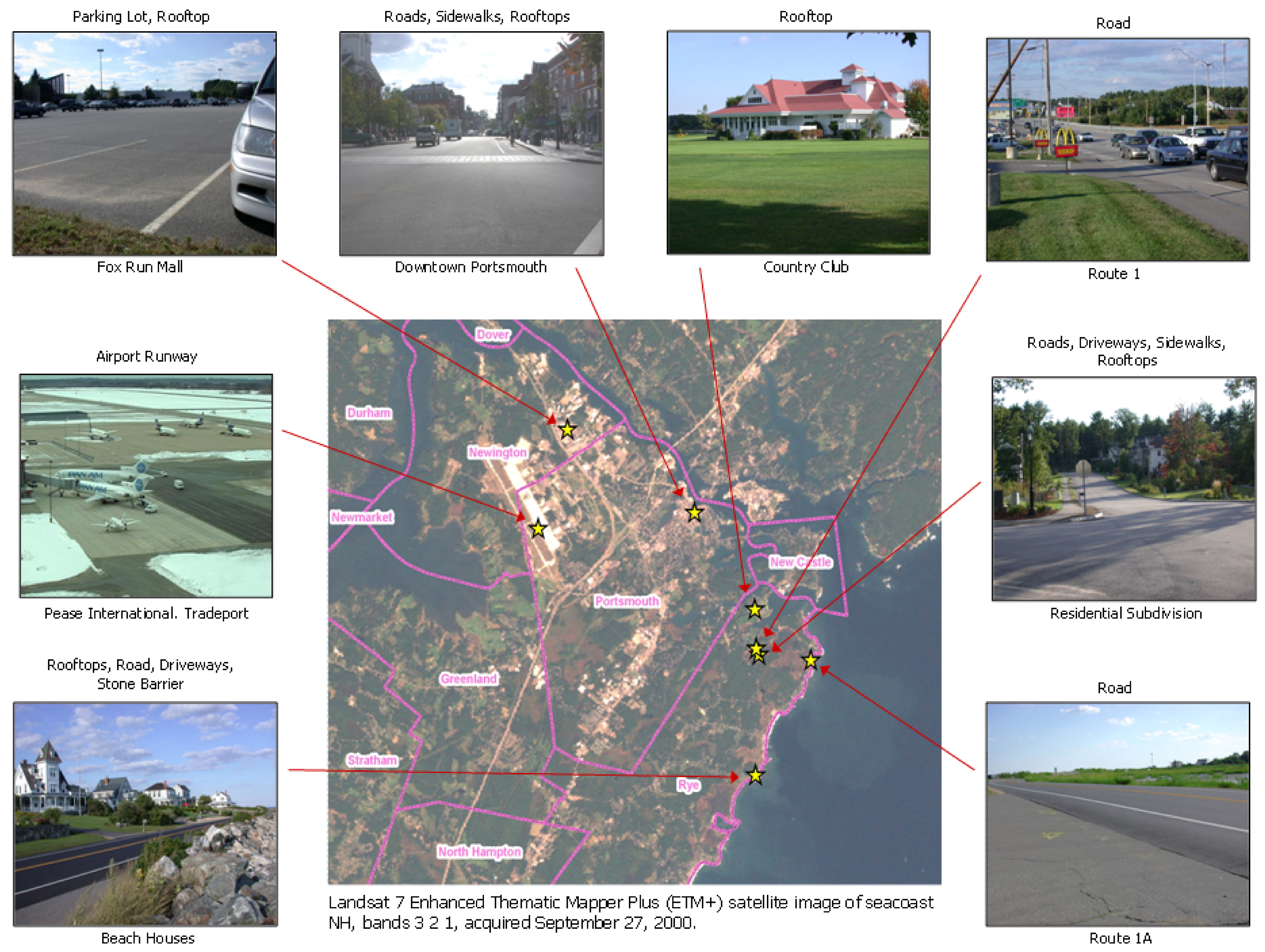
## Project Overview

Future population growth and the corresponding increase in development in the coastal zone of NH are widely recognized as major threats to the integrity of coastal systems and their watersheds. The potential impacts associated with the expansion of developed land, and specifically with increasing amounts of impervious surfaces, may include significant changes in water quantity, degradation in water quality, and habitat loss. Because impervious surfaces effectively seal the ground surface, water is repelled and is prevented from infiltrating soils. Instead, stormwater runoff flows directly into our surface waters, depositing metals, excess nutrients, organics, and other pollutants into the receiving bodies. In addition to these environmental impacts, increasing levels of imperviousness can dramatically alter our landscapes, as forested and other natural settings are converted to urban/suburban uses.

Many of the impacts associated with impervious surfaces have been well documented by studies in other areas of the country. However, due to a lack of available data, comprehensive studies in coastal New Hampshire had not been undertaken prior to our mapping project of 2002. The goal of that initial project, funded by the NH Estuaries Project, was to provide an accurate, current description of the extent of impervious surface coverage in a 48-town area within the coastal region of NH. In addition, we sought to develop an estimate of change in the amount of "imperviousness" over the ten-year period between 1990 and 2000. A subsequent effort, completed in the spring of 2006, mapped impervious surfaces based on data acquired in October of 2005. This mapping has provided us with impervious surface estimates covering the period from 1990 through 2005.

The figure to the right illustrates a variety of impervious surface types found within the study area. They include asphalt, concrete, stone, and other impenetrable materials.

Impervious Surfaces Examples




Landsat 7 Enhanced Thematic Mapper Plus (ETM+) satellite image of seacoast NH, bands 3 2 1, acquired September 27, 2000.

## Methods

The regional mapping utilized 30-meter resolution satellite imagery to generate an estimate of impervious surface acreage for three years: 1990, 2000 and 2005. The following source images were used:

- Landsat 5 TM – path 12, row 30, acquired September 9, 1990
- Landsat 7 Enhanced TM Plus – path 12, row 30, acquired September 27, 2000
- Landsat 5 TM – path 12, row 30, acquired October 3, 2005

Together, these images provided the data necessary to generate both the current view of the study area and the historical perspective for the change analysis.

Data processing began using traditional classification techniques (supervised for the years 1990 and 2000; unsupervised for the year 2005) to map urban features in the region for each year. Next, the ERDAS Imagine® Subpixel Analysis tool was applied to refine the mapping

48-Town Project Area:
759,313 acres

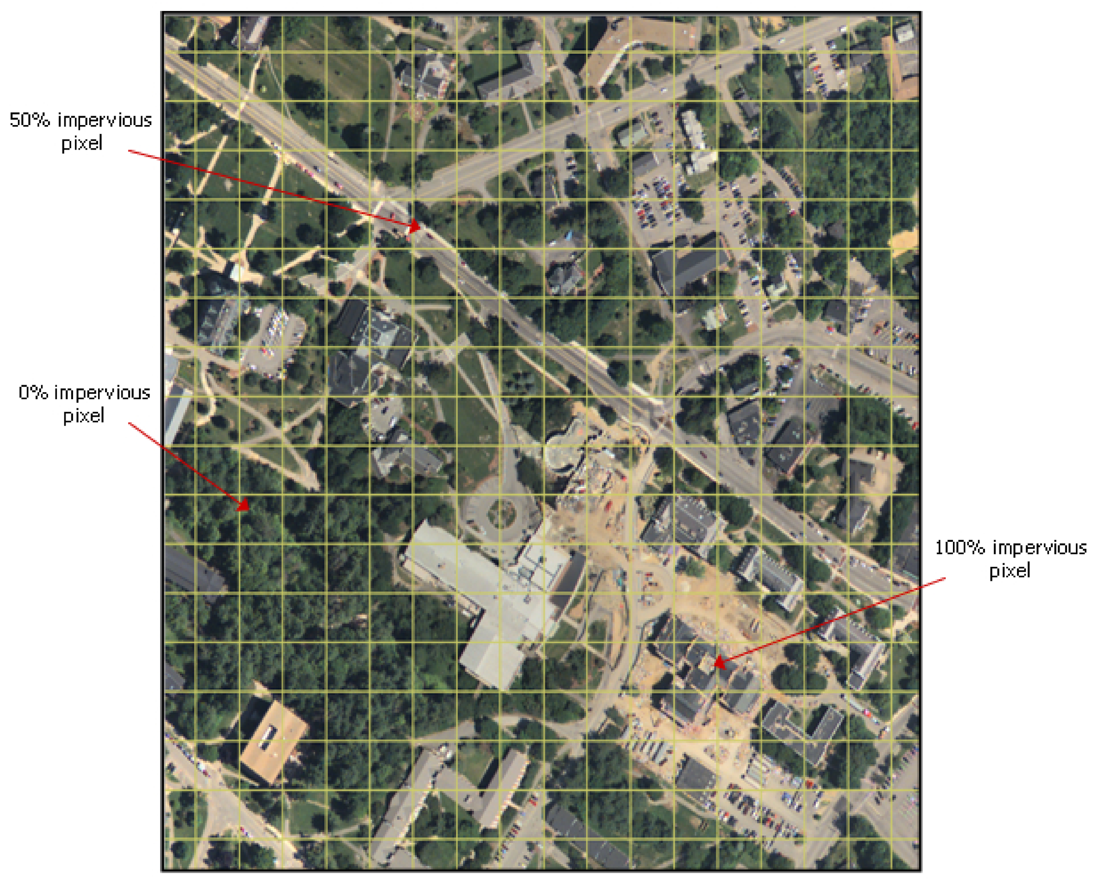

by estimating the "proportion of imperviousness" in each urban grid cell (or "pixel"). This methodology, more fully described at www.erdas.com, is capable of detecting specific materials of interest (MOI ) that occur within each pixel. In this case, the MOI comprised impervious surfaces.

The subpixel classification technique yielded a data set in which each pixel was described as having a percentage of imperviousness ranging from 20% to 100%, reported in increments of 10%. Additional processing, incorporating road centerline data, allowed for the inclusion of the lower, 0.1-19% range.

The figure to the right illustrates the range of imperviousness that may occur on the landscape within the data cells. Here, the yellow fishnet cells each represent an area equal to that of a 30-meter Landsat TM pixel. These simulated pixels are overlaid on a high resolution aerial image (covering part of the University of New Hampshire campus). The reader may observe the continuum of imperviousness (ranging from 0 to 100%) that occurs within the cells.

The mapping phase of the project was followed by a ground assessment, which allowed us to report the approximate accuracy of the results.

Estimates of Imperviousness within 30-Meter Resolution Pixels




1-foot EMERGE data, acquired June 20, 2002

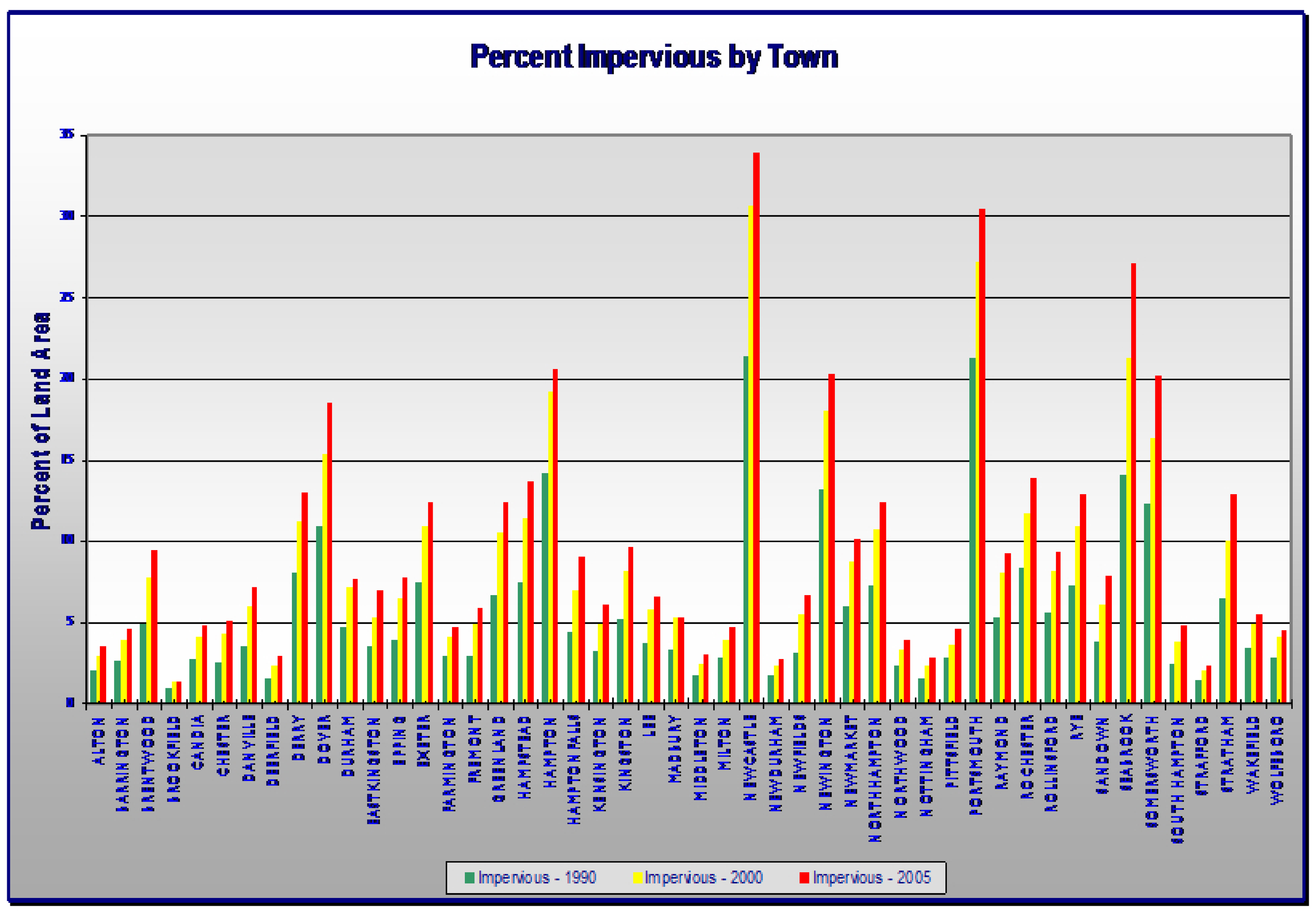
## Results

The study showed that 53,408 acres, or 7.4% of the land surface area in the 48 towns, were estimated to be impervious in 2005. This represents a 1.1% change in total percent impervious over the five-year period (2000 - 2005), or a 3.5% annual increase. Further, it suggests a decline in the rate of change, as the period from 1990 to 2000 exhibited a 4.5% annual increase in impervious surfaces. Over the entire preceding fifteen-year period (1990-2005), the results indicate a 3.1% change in total percent impervious, or a 4.7% annual increase.

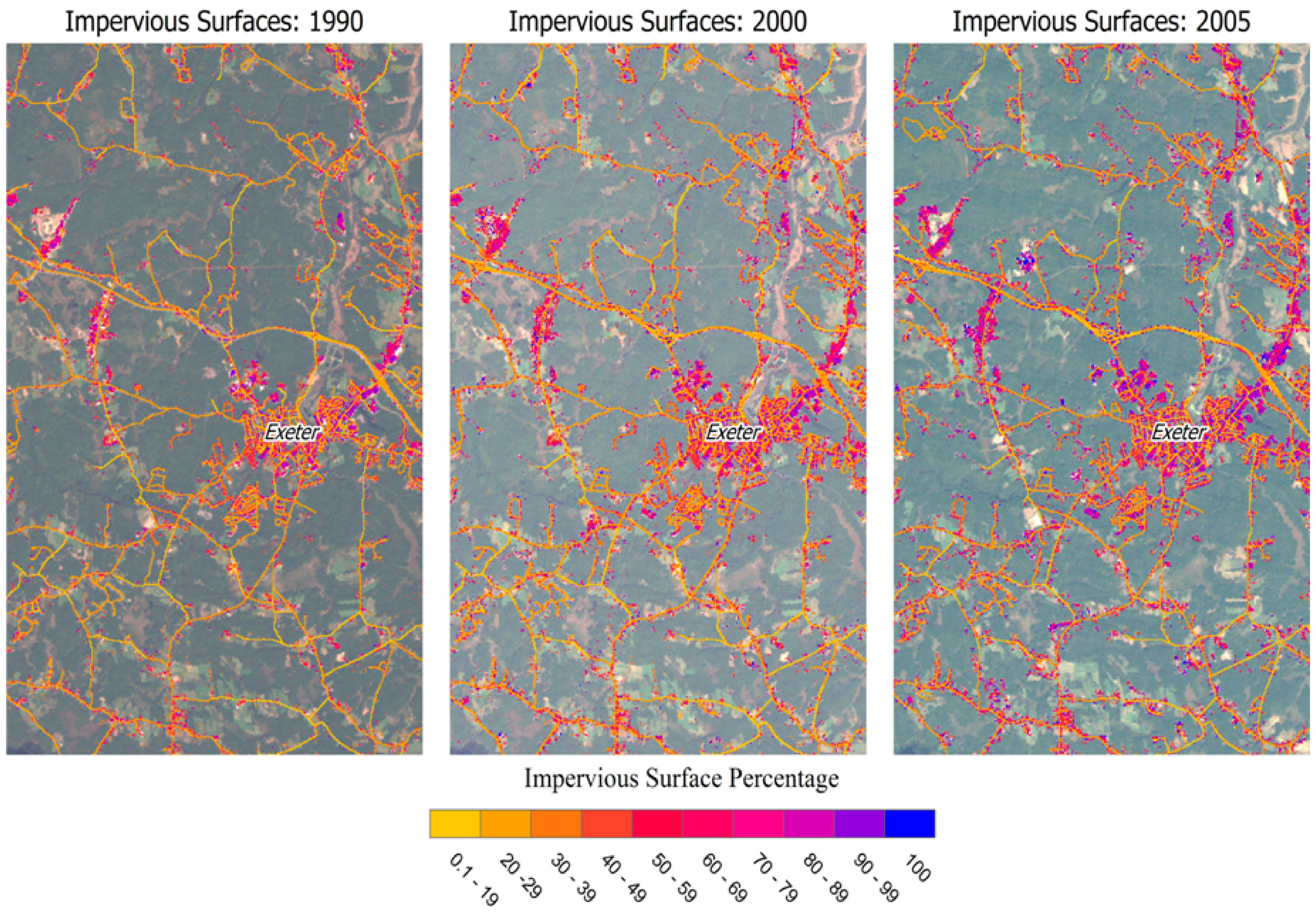
Not surprisingly, the towns/cities with the highest percent impervious estimates in 2005 were the seacoast communities of New Castle (33.9%), Portsmouth (30.5%), and Seabrook (27.1%). Northern and western Strafford County towns displayed the lowest percent impervious estimates for 2005, including Brookfield (1.4%), Strafford (2.3% ), and New Durham and Nottingham (both at 2.8%).

At the subwatershed level, 2005 impervious surface estimates ranged from 0.1% (Branch Brook) to 28.9% (Portsmouth Harbor). Results from 2000 showed a similar pattern, with estimates ranging from a low of 0.0% (Branch Brook and Massabesic Lake) to a high of 25.5% (Portsmouth Harbor). The 5-year increase for Portsmouth Harbor (2000 – 2005) of 3.4% was the largest observed in that period. Other significant increases between 2000 and 2005 included Hampton River (2.8% change), Hampton Harbor (2.5% change), Lower Spickett River (2.2% change), and Taylor River-Squamscott River (2.0% change). Subwatershed estimates in 1990 ranged from 0.0% (Branch Brook and Massabesic Lake) to 19.8% (Portsmouth Harbor). The average impervious surface percentage by subwatershed was 6.98% in 2005, 5.97% in 2000 and 4.11% in 1990.

The accuracy assessment indicated that the data for the 2005 interval were 98.3% correct. This compared favorably with the previous study which achieved accuracies of 93.1% (2000) and 98.6% (1990).




Note on Calculation of Acreages: The midpoint of the percent impervious range for each pixel is used for reporting purposes. For example, the size of a TM pixel is approximately .2 acres. Therefore, a pixel mapped as 30-39% impervious accounts for .07 impervious acres, or .345 x .2.




This study demonstrates that impervious surface acreage within coastal New Hampshire increased between 1990 and 2005. While this result is not surprising, this study provides continuing quantitative estimates of the extent of the change. 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 patterns of impervious surfaces. The techniques are low-cost and repeatable, and may be used in the future to monitor changes in impervious surface coverage in the region.

To access the data:

The impervious surface data for 1990, 2000 and 2005 are available from the GRANIT web site. They are distributed in ASCII grid format. From the GRANIT home page (ww.granit.sr.unh.edu), click on "GRANIT Data", then "Access the Database". Search on the theme keyword: impervious.

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New Hampshire Estuaries Project

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