Forestland Parcelization in the New York City Watershed

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ABSTRACT

New York City's (NYC) water supply system is the largest unfiltered surface storage and supply system in the country. Forests cover 89 percent of the Catskill/Delaware systems, with 75 percent of the forest area owned by non-industrial private forestland (NIPF) owners. The results describe the degree of parcelization on private forestlands in four of the five counties within the Catskill/Delaware systems of the NYC Watershed between 1984 and 2000. Parcelization on NIPF in the eastern half of the Catskill/Delaware systems is occurring at a rate exceeding the national average. The average parcel size is 14 acres, 10 acres below the current national average for NIPF, and already below the projected national NIPF average parcel size of 17 acres for 2010. Changes in land use and development on private lands threaten the quality of the NYC water supply.

Keywords: watershed, water quality, parcelization, ownership fragmentation, working landscape, forest management

Throughout most of the 20th century, New York City (NYC) residents have benefited from some of the purest drinking water in the nation. As we enter the 21st century, changes in land use and development threaten the quality of the City's water supply (NYC Department of Environmental Protection [DEP] 2002). On the surface, NYC Watershed's (Figure 1) working forested landscape appears to be stable, if not thriving. Aerial images offer views of large forested expanses, sometimes stretching for miles. However, there is a serious, often unnoticed, threat lurking under the forest canopy – forestland parcelization.

Parcelization describes changes in ownership patterns when larger tracts are divided into smaller parcels. Parcelization is arguably the strongest driver of forest fragmentation as well as a precursor to urban development (Zipperer and Birch 1993, Sampson and DeCoster 2000, Thorne and Sundquist 2001). When parcelization and development occur simultaneously, managers are faced with the added challenges of nutrient loading from septic systems, lawn fertilizers, animal wastes, and road salts, with transport accelerated through an increase in the amount of impermeable surfaces (Heisig 2000, EPA 2001, Endreny et al. 2002, Hassett et al. 2003). As 100-acre woodlots are subdivided into ten 10-acre ownerships, a common occurrence in the NYC Watershed, the potential for development increases, posing serious implications for soil and water conservation (Dennis 1992; USDA Forest Service 1995, Drzyaga and Brown 1998). A case in point: the Chesapeake Bay Watershed, the nation's largest estuary and one of the most productive ecosystems in the world, is losing approximately 100 acres of private forestland per day to suburban development. The effects of this high rate of parcelization on the working forested landscape pose serious challenges to watershed managers (Cooksey 2000).

Worldwide, large cities and rural communities are striving to balance economic development and long-term prosperity with environmental quality and protection. The NYC Watershed is a high-profile example of a working forested landscape seeking to meet this balance. This paper documents the phenomenon of parcelization on forested rural private lands within a four-county area of the Catskill/Delaware systems of the NYC Watershed. Although anecdotal evidence suggests that parcelization is occurring, there is no empirical evidence at the watershed scale. The results describe the degree of parcelization on non-industrial private forestlands (NIPF) in four of the five counties within the Catskill/Delaware systems of the Watershed between 1984 and 2000. Subsequently, we discuss the threat to water quality and offer recommendations on addressing this land management issue.

The NYC Watershed. New York City's water supply system is the largest unfiltered surface storage and supply system in the country. The entire system supplies drinking water to nine million people in the greater NYC area, plus another one million tourists and commuters who visit NYC throughout the year. The Catskill/Delaware systems west of the Hudson River comprise nearly 1,625 square miles and supply approximately 90 percent of NYC's water. The older and suburbanized 375-square mile Croton system, 40 miles north of Manhattan, supplies about 10 percent of NYC's water, although it may supply up to 20–25 percent during certain drought conditions. Forests cover approximately 90 percent of the Catskill/Delaware systems and 57 percent of the Croton system (Heisig 2000, EPA 2001, Anderson et al. 2001). An estimated 75 percent of the forest area within the Catskill/Delaware systems is controlled by NIPF owners (Watershed Forestry Task Force 1996, NYC DEP 2002).

New York City has faced water supply issues in terms of quality and quantity since

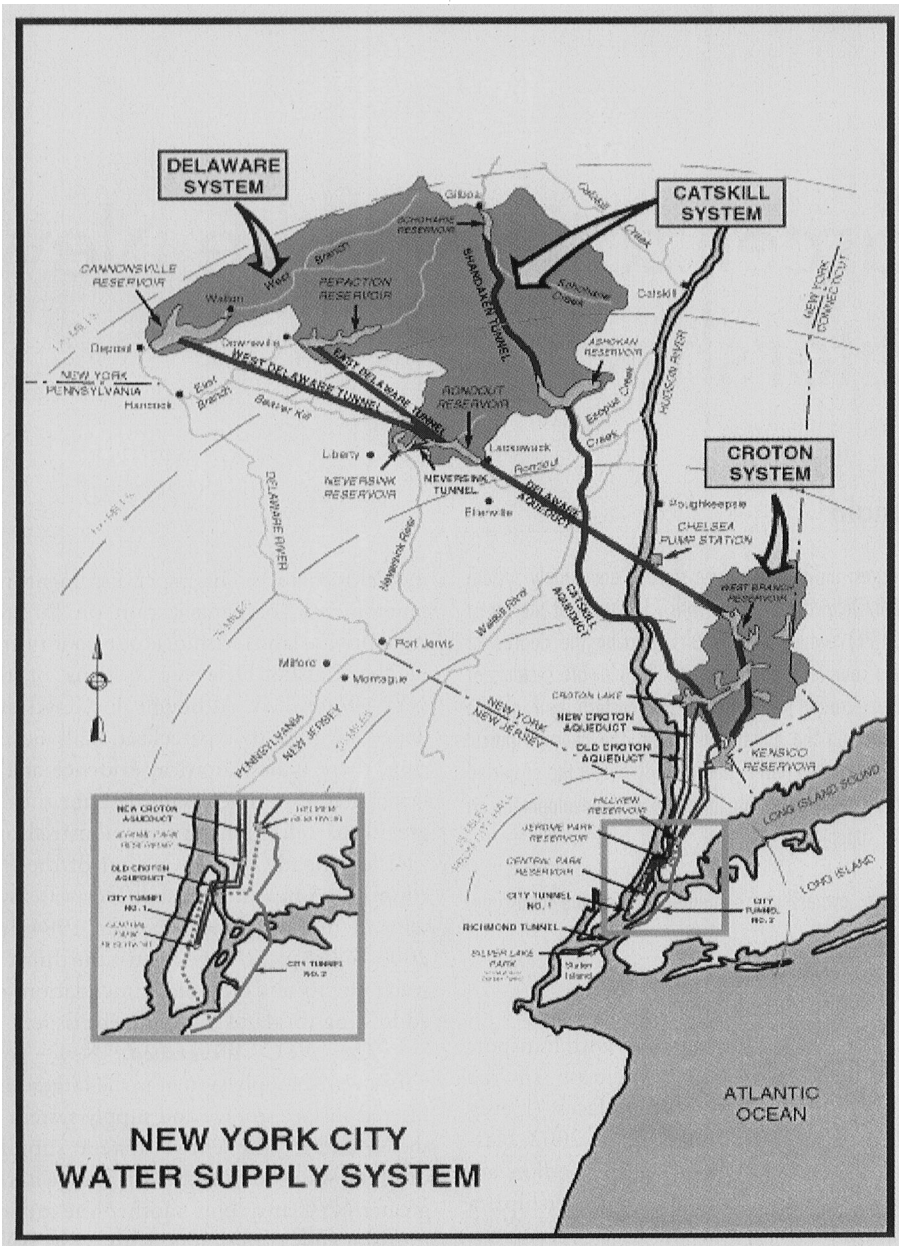

Figure 1. New York City Water Supply System (NYC DEP 2002).

the Dutch settled Manhattan Island in the early 1600s. Today, the overall consumption has leveled off to 1.3 billion gallons per day. NYC-sponsored conservation measures have cut average daily consumption by almost 20 percent since the late 1980s (NYC DEP 2002). Maintaining water quality, on the other hand, remains a growing challenge.

In 1989, the United States Environmental Protection Agency (EPA) promulgated the Surface Water Treatment Rule pursuant to the Federal Safe Drinking Water Act Amendments of 1986, which stated that all surface drinking water sources, whether reservoirs, streams, lakes, or rivers must undergo filtration unless managers could control human activities within the watershed. This mandate was particularly significant for managers of the NYC water supply; constructing and operating a filtration plant offered logistical and budgetary challenges (cost estimates ran well over $8 billion to build and $300 million to operate annually). Thus, NYC faced a monumental natural resource management decision: either they could construct a costly filtration plant or enact stricter policies to control human activity. NYC opted to direct human activities in the Catskill/Delaware systems west of the Hudson River (NYC DEP 2002).

It is important to note that NYC did not apply for a filtration waiver for the more densely populated and developed Croton system east of the Hudson River due to chronic water quality problems. In fact, NYC DEP recently issued a white paper arguing for the need to filter the Croton water supply. Approximately 80 percent of the Croton is suburbanized, and no longer capable of serving as a working forested landscape compatible with water quality. The development patterns are increasing peak flows of stormwater runoff, leading to erosion and streambank instabilities, and nutrient loading (NYC DEP 2003, Hassett et al. 2003).

The 1997 signing of the NYC Watershed Memorandum of Agreement by NYC, State, and Federal agencies, NYC Watershed communities and environmental groups enabled NYC DEP to receive a long-term waiver regarding the federal requirement of a filtration plant. This landmark agreement culminated years of negotiations between NYC Watershed communities and NYC regarding the city's long-range watershed protection plan for the Catskill/Delaware systems (NYC DEP 2002). To meet the requirements laid out in the agreement, NYC is obligated to protect watershed lands through attempted purchases (both fee simple and conservation easements). In addition, other efforts must be made to aid municipalities and landowners in protecting water from pollution (resulting from failed residential septic systems, municipal salt storage, logging and farming activities) through identification and remediation. This has resulted in septic replacements, construction of municipal salt barns, and cooperation with the Watershed Agricultural Council to encourage Best Management Practices (BMPs) in association with farming and forestry practices (NYC DEP 2002).

The Watershed Forestry Program, one of many partnership programs specifically identified by the MOA, operates under the premise that a well-managed, working forested landscape provides the most beneficial land cover for water quality protection (Watershed Forestry Task Force 1996, EPA 2001). The Program seeks to minimize nonpoint source pollution related to forestry activities by promoting forest management planning and the implementation of BMPs on NIPF, which account for the majority of the forestland in the NYC Watershed.

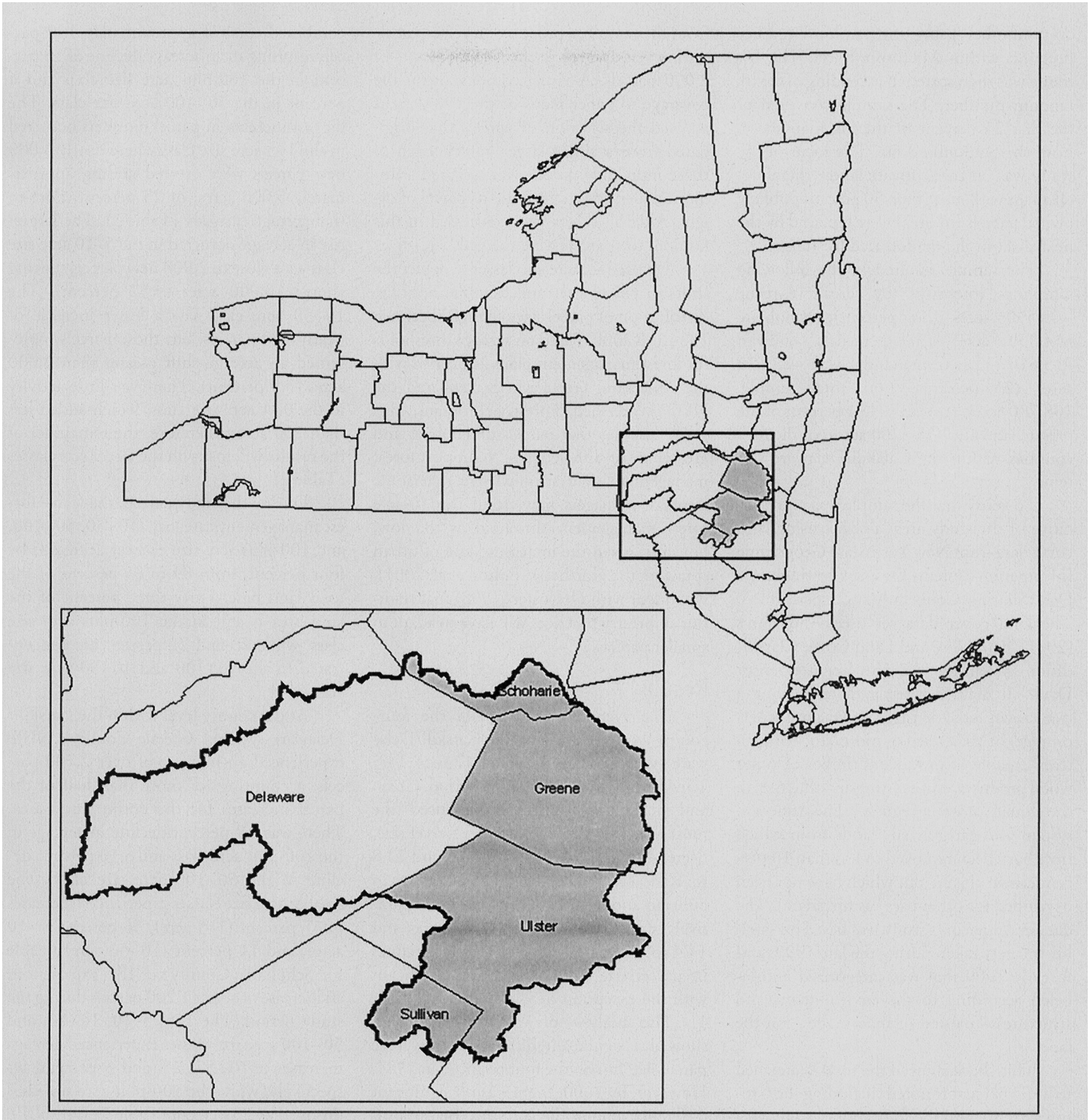

Figure 2. Catskill/Delaware systems of NYC Watershed with four-county study area shaded.

As forestland parcelization leads to increasing numbers of NIPF owners on smaller parcels, maintaining a working forested landscape while preserving water quality is becoming increasingly more difficult. Increased parcelization could lead to widespread development, leading to the "Crotonization" of the Catskill/Delaware systems.

Methods

The area comprising the Catskill/Delaware systems of the NYC watershed falls within the boundaries of five counties. The study focused on those portions of Greene, Schoharie, Sullivan, and Ulster counties within the Catskill/Delaware systems, discarding Delaware County due to insufficient data. The total area of the four-county study area was calculated at 602,300 acres (Figure 2), of which private land was estimated at 355,200 acres.

To enable reasonable conclusions on parcelization at the county level, a stratified sampling strategy was chosen. A list frame of tax map sheet numbers was compiled for each county. Each sheet was assigned a ran-

dom number using the random number function within Microsoft Excel. The list frame was then sorted in ascending order by random number. The sample consisted of the first 25 percent of the tax map sheets from the randomized list. The focus of the study was on rural private lands; therefore, tax maps with more than 50 percent publicly owned parcels (by area) were replaced by the next sheet in the randomized list frame.

The sample resulted in the following sampling intensity (by area): Greene –49,590 acres (36 percent); Schoharie –14,830 acres (31 percent); Sullivan –15,610 (32 percent); and Ulster –28,670 acres (23 percent). Our total sample, 108,700 acres, represented 31 percent of the private land area (355,200 acres) of the four counties within the Catskill/Delaware systems.

To verify that the sample was representative of the study area, a check using land cover data from New York State Geographic Information Systems Online Clearinghouse Data Sharing Cooperative was performed. The land cover data set used Anderson's (2001) "Land Use and Land Cover Classification System for Use with Remote Sensor Data." It defined forestlands as "having a tree-crown aerial density (crown closure percentage) of 10 percent or more, stocked with trees capable of producing timber or other wood products, and exerting an influence on the climate or water regime." The Anderson system also categorized "lands from which trees have been removed to less than 10 percent crown closure but which have not been developed for other uses" as forestland. The data in Anderson's study was based on satellite imagery taken during the late 1990s and in early 2000 that was categorized and labeled according to the environments and structures – natural or man-made – on the land.

This check showed the total Watershed to be 75 percent forested (including the Croton system), and the four-county study area within the Catskill/Delaware systems to be 92 percent forested. Using the same database, we determined our sample to be 90 percent forested and thus representative of the population. Given the low percentage of non-forested land in the sample, we chose not to compare the degree of parcelization between forested and non-forested lands (NYS GIS 2001). Given that 90 percent of our sampled was forested, we present our results in the context of NIPF.

To extract the parcel size information from the sample, a process of reverse-parcelization was applied to the GIS coverages of 2,000 parcels. A visual comparison of the coverage to paper maps of the 1984 status allowed the selection of parcels that originated from a single larger parcel. Each of those individual parcels was assigned a numerical identifier to indicate its parcel of origin. After all sheets were addressed in this fashion, the parcels were merged.

We used six acreage classes to depict the shifts in parcel sizes and examine how the distribution of parcel sizes changed between 1984 and 2000. Based on acreage thresholds for forest management plans associated with the American Tree Farm System and the NYC Watershed Forestry Program, this study assumes that parcels of 10 acres and greater are of sufficient size to support forest management. We acknowledge that some resource managers may deem the 10-acre forest management threshold as too low; however, given the increasing rate of urban sprawl in the Northeast (Fulton et al. 2001), we concur with DeCoster (1998) that traditional forestry practices will have to adapt to smaller parcels.

Results

The average parcel size of the four-county study area within the Catskill/Delaware systems decreased from 17.6 to 14.5 acres during the 16-year study period. Green and Schoharie counties experienced the most dramatic drops in average parcel size, decreasing from 20.8 to 16.0 acres and 23.8 to 16.3 acres, respectively. The changes in Sullivan and Ulster counties were comparatively subtle, from 13.5 to 12.1 acres and 14.4 to 13.1 acres, respectively. All declines in parcel size were statistically significant with the exception of Ulster county (Table 1). The analysis of variance (ANOVA) showed a significant difference in average parcel size among the four counties in 1984. However, by 2000, there was no significant difference among the counties. Before proceeding further, it is important to remind the reader that the four-county study area, including our sample, are approximately 90 percent forest cover, thus providing the basis for presenting our results in the context of NIPF.

The 355,200-acre study region experienced an increase of over 5,200 parcels between 1984 and 2000, representing an acreage shift of approximately 25,000 acres to the lower acreage size classes (Table 2). The 50–100 and 100-plus acre size classes, lost a combined total of approximately 130 parcels resulting in an acreage decline of 10 percent in the 100-plus acre size class and 4 percent in the 50–100 acre size class. The biggest increase in parcel numbers occurred in the 1–5 acre size class where nearly 3,000 new parcels were created adding approximately 5,000 acres, or 25 percent more to that acreage category (Table 2). The largest rise in acreage occurred in the 5–10 acre size class with close to 2,000 new parcels shifting almost 10,000 acres (+52 percent). The 10–50 acre class saw a lesser increase of nearly 500 parcels, but those parcels represented an acreage shift greater than 6,000 acres (+9 percent). There was little activity in the 0–1 acre size class, which added less than 200 acres; therefore, the remainder of the results will focus on the larger size classes (Table 2).

During the study period, the viable forest management category (10–50, 50–100, and 100-plus acre size classes) decreased by four percent, from 89 to 85 percent of the total land base. Forty-three percent of the land area is still in the 100-plus acre size class, while 20 and 22 percent are concentrated in the 50–100 and 10–50 acre size classes.

At the county level within the Catskill/Delaware systems, Greene County's NIPF experienced an increase of over 2,700 parcels, accounting for more than half of the parcel increases for the entire study area. There was a 9 percent decline in acreage in the 100-plus acre class and a 10 percent decline in the 50–100 acre size class. The smaller acre size classes experienced increases of 37 percent (1–5 acre), 56 percent (5–10 acre), and 11 percent (10–50 acre) (Table 3). Schoharie County's NIPF experienced an increase of about 1,200 parcels during the study period. The 1–5, 5–10, 10–50, and 50–100 acre size classes experienced acreage increases of 61, 97, 25, and 3 percent, respectively, while the 100-plus acre size class dropped by 23 percent (Table 3). The NIPF of Sullivan County experienced an increase of about 500 parcels during the study period. The 1–5 and 5–10 acre size classes increased on an acreage basis by 18 and 20 percent, respectively, while the 10–50 and 50–100 acre size classes changed little, 0 percent, and 1 percent, respectively. The 100-plus acre size class declined in acreage by 9 percent (Table 3). Ulster County, location of the majority of the state-owned Catskill Wilderness Preserve, is the only county within the NYC Watershed with

Table 1. Average parcel size of NIPF by county within the study area of the Catskill/Delaware systems between 1,984 and 2,000.

Counties	Greene	Schoharie	Sullivan	Ulster	Study Area Mean
1984	20.8[a]	23.8[a]	13.5[a]	14.4[a]	17.6[a]
2000	16.0[b]	16.3[b]	12.1[b]	13.1[a]	14.5[b]

Note: Means that do not share a superscript letter are significantly different @ 0.05.

more acres in public (150,700 acres) versus private (123,400 acres) ownership. The NIPF added about 800 parcels during the study period, with the majority of the parcels divided evenly between the 1–5 and 5–10 acre size classes. The 100-plus acre size class absorbed almost all the parcel losses. The 1–5 and 5–10 acre size classes increased in acreage by 13 and 36 percent, respectively, while the 10–50 and 50–100 acre size classes increased slightly by 1 and 3 percent, respectively. The 100-plus acre size class declined in acreage by 7 percent (Table 3).

Discussion

Parcelization on NIPF in the eastern half of the Catskill/Delaware systems has exceeded the national average. The average parcel size is 14 acres, 10 acres below the current national average for NIPF, and already below the projected national NIPF average parcel size of 17 acres for 2010 (Birch 1996, Sampson and DeCoster 2000, Butler and Leatherberry 2004). The parcelization activity was greatest in Greene and Schoharie Counties where there were large increases in parcels in the 1–5 and 5–10 acre classes. Sullivan County experienced little variation in average parcel size during the study period. We suspect that the proximity to New York City resulted in much of the available land being parcelized by 1984. The high degree of parcelization is further supported by the low percentage of acreage in the greater-than-100 acres category (28 percent) versus the other three counties which all exceed 41 percent. Similarly, we suspect the reason for the slight change in average parcel size in Ulster County is due to its presence just north of Sullivan County. Also, the high percentage of state-owned land would amplify any effect of location, as the developable land would be parcelized relatively fast in comparison to the other three counties. Recall that Ulster County is 55 percent state owned, whereas Greene, Schoharie, and Sullivan counties, on average, are greater than 75 percent privately owned.

In starting this study, we expected a pattern showing the heaviest parcelization to occur with increasing proximity to NYC. The data actually shows the reverse pattern; generally, areas a greater distance from NYC are experiencing greater parcelization effects than those closer. However, this may be due to patterns of parcelization that predate 1984. The analysis of data shows that in 1984 there was a distinct and significant trend from smaller average parcel size to larger from the south to the north of the study area, or as distance from NYC increased. Although that trend was maintained in 2000, enough change had occurred that the difference between the north end and the south end was no longer significant.

One possible explanation for this is that the southern counties are approaching a saturation point, making a greater travel distance from NYC worth trading for increased property size. However, this is a speculative explanation and there is no data to support the idea that the only influence on parcel size is NYC resident property owners. A city to the north, such as Albany, could be exerting influence beyond the area it had prior to 1984. Alternately, economic influences could be playing a larger role in land-use now than in the past. Failing farms, increasing tax burdens, and lack of family heritage or cohesiveness all could be contributing factors.

Single Homes with Big Backyards. Addressing the challenge of increasing NIPF owners with multiple management objectives is an important issue. However, a more serious threat to water quality is the potential for land-use objectives to shift to non-forest uses such as rural residential dwellings. Of particular concern is the steep rise in the 1–5 and 5–10 acre size classes at the expense of the larger parcel sizes. The working forested landscape is gradually shifting from a resource management to a rural residential classification – single home ownerships with big backyards. This trend, which is not unique to the study area, is likely to contribute to the degradation of the water supply. In the Croton system, Heisig (2000) reported increased nutrient loading from septic systems, lawn fertilizers, animal wastes, and road salts in unsewered residential areas, with transport accelerated through an increase in the amount of impermeable surfaces. In contrast, undeveloped forestland exhibited the lowest average baseflow concentrations of all constituents studied (i.e., ammonia, total phosphorous, orthophosphates). Further parcelization and subsequent development in the Catskill/Delaware

Table 2. Change in distribution of NIPF lands in the eastern counties within the Catskill/Delaware systems of the NYC Watershed by parcel size from 1,984 and 2,000

Parcel size class (ac)	1984 # of parcels	1984 Area (ac)	1984 % area	2000 # of parcels	2000 Area (ac)	2000 % area	Percentage change # of parcels	Percentage change Area (ac)	Percentage change % area
<5	15,072	19,891	6%	17,976	24,864	7%	+19%	+25%	+1%
5–10	3,556	18,470	5%	5,536	28,061	8%	+56%	+52%	+3%
10–50	3,744	71,040	20%	4,220	77,434	22%	+13%	+9%	+2%
50–100	1,264	72,816	20%	1,236	69,974	20%	−2%	−4%	0%
>100	1,036	172,983	49%	932	154,867	43%	−10%	−10%	−6%
Totals	24,672	355,200	100%	29,900	355,200	100%			

Table 3. Percent change in acreage distribution by parcel size class of NIPF lands by county in the eastern counties within the Catskill/Delaware systems of the NYC Watershed 1,984 and 2,000.

Parcel size class (ac)	Percentage Change by Area from 1,984 to 2,000			
	Greene	Schoharie	Sullivan	Ulster
<5	+37%	+61%	+18%	+13%
5–10	+56%	+97%	+20%	+36%
10–50	+11%	+25%	0%	+1%
50–100	−10%	+3%	+1%	+3%
>100	−9%	−23%	−9%	−7%

systems will occur on steeper slopes, as most of the valleys in this mountainous region offer fewer opportunities for rural real estate. Development activity on the steep slopes results in rapid water flow across the landscape, increasing the potential for erosion and nitrogen transport into streams (EPA 2001).

Nationwide, 80 percent of the new housing construction is taking place beyond the urban fringe on the rural landscape (Heimlich and Anderson 2001). Despite stagnant population growth, the Northeast is adding approximately one person for each new urbanized acre, equaling the rate of land consumption in the faster growing south, and exceeding the west which adds 3.59 persons for each new urbanized acre (Fulton et al. 2001). Population growth increases forestland parcelization (Fulton et al. 2001, Kolankiewicz and Beck 2001), but even minimal or negative population trends can lead to parcelization when people purchase second homes or investment properties in forested regions (Germain and Brazill, in review). Any rise in population will likely result in NIPF ownership change and continued subdivision of forestlands to accommodate new residential and commercial growth. In a study conducted in Virginia, Wear et al. (1999) determined that the probability of forest management approaches zero when forest population densities reach a level of 150 people per square mile. Using Wear's density threshold for forest management, the Croton system, with over 500 people per square mile, far exceeds the population limits to maintain a working forested landscape. At approximately 40 people per square mile, the Catskill/Delaware systems are still within a population density that will support a viable working forested landscape (EPA 2001). This is consistent with our finding that 85 percent of NIPF are still in the viable forest management category (greater than 10 acres).

We feel an effective way to maintain larger forested parcels in the Catskill/Delaware systems, and avoid the widespread development common to the Croton system, is to promote economically viable forest management. Among the important factors that can contribute to this goal is forestry assistance to NIPF owners and equitable property taxes. Written forest management plans have long been viewed as a promising vehicle for building stewardship among NIPF owners. Not only do plans foster sustainable forestry, but they also serve to educate and engage NIPF owners. When NIPF owners better understand their forests and are active in management, they are more apt to become better stewards (Best and Wayburn, 2001). Esseks and Moulton (2000) found that over three-quarters of NIPF owners implement their respective forest management plans, indicating that forestry assistance to NIPF can be a good investment for forestry. Consequently, the effects that written forest management plans have on stewardship make them an important tool for forestry extension in the Catskill/Delaware systems. The NYC Watershed Forestry Program has a strong forest management assistance program, which thus far, has enrolled approximately 415 NIPF owners representing an estimated 75,500 acres of forestland. Munsell and Germain (2004) reported that 21 percent of NIPF owners with greater than 10 acres of forestland within the Catskill/Delaware systems have a written forest management plan. This rate far exceeds the estimated average of six percent for New York State and three percent for the country (Butler and Leatherberry 2004). We strongly recommend that the Watershed Forestry Program continue to build on their success.

Although much progress is being made on forestry assistance to NIPF owners, rising property taxes provide disincentives to long-term forest management, and ultimately contribute to parcelization and development. Quite simply, forested parcels are assessed for their "highest and best use," which in this case is rural residential development, resulting in tax rates of approximately $12–34 per acre per year (Canham 2003). Canham (1992) reported that when tax rates exceed $2 per acre per year in northern hardwoods, forest management is not profitable. Even if Canham's $2 threshold appears low, the $12 minimum for lands growing, at best, 170 board feet per acre annually, does not justify long-term forest management (Canham 2003). Tax abatement programs offer one option (up to 80 percent reduction in assessed value), but New York State's antiquated Forest Tax Law requires 50 acres of contiguous forestland within a single ownership to qualify for the tax incentive program. Currently, this program cannot serve the estimated 18,000 parcels from 10–50 acres within the study region, representing approximately 130,000 acres. An amended Forest Tax Law with a lower acreage threshold could serve as an invaluable tool to promote long-term forest management within the NYC Watershed.

Current parcelization trends will erode at the NYC Watershed's working landscape, an important component of the local economies found within the area. The fact that the area was populated prior to its becoming the source of much of NYC's water requires that efforts be made to accommodate all parties (as negotiated in 1997 MOA with NYC). As parcels continue to subdivide, opportunities to implement long-term forest management will decline, ultimately jeopardizing water quality as well as the livelihood of many residents and the associated rural culture. Unlike deforestation and land conversions in the tropics, the effects of parcelization are not immediate or dramatic. The subtle nature of this phenomenon invites complacency. It is not too late to maintain the Catskill/Delaware systems as a working forested landscape, providing clean water to NYC and income to those who call it home.

Further Research in Progress. This study provides a valuable baseline by which to monitor parcelization in the future. It does not, however, offer empirical evidence to the nature of land use changes resulting

from parcelization. Currently, researchers are using the database from this study to determine what actually occurs to the landscape when parcels are subdivided.

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