A Report on Cortland's Urban Forest

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Cortland Public Tree Highlights	
Trees surveyed	3,149
Number of street trees	2,469
Number of street trees per capita	0.13
Total number of tree species	52
Most common tree species	Norway maple, sugar maple, honey locust, crabapple, and red maple.
% of city covered by canopy	2.3%
% of streets & sidewalks covered by canopy	24.9%
Replacement Value of Public Trees	$15,000,000
Annual Value of Environmental Services	$388,651
Benefit to Cost Ratio for public Trees	10.2: 1$
Estimated Available Tree Spaces	6000

Abstract. A tree survey was conducted and sponsored by the Landscape & Design Commission during the September and October of 2004 and 2005. Data were collected on 2,469 trees in the right-of-way of city streets and 680 trees in municipal parks. The average number of street trees per capita (0.13 trees per person) for Cortland falls well short of national averages (0.37) from 22 cities. Although 52 species were encountered, 43% of these public trees belong to one of six maple species (*Acer*). Ideally, no single tree species should occur in more than 10% of the forest and no genus represented in the forest at more than 20%. Norway (15.8%) and sugar (15.1) maples are two dominate species with an aging demographic distribution and experiencing significant health problems within the Central NY region. Despite additional tree recruitment sponsored by the tree lottery, the city is currently removing nearly as many old trees as are planted on an annual basis. Even though limited city funds are invested in public trees, the city continues to benefit from the environmental services (air quality improvement, storm water mitigation, reduced energy use, property value, and carbon storage) total more than $388,000. The high benefit-to-cost ratio of $10.2 and $15,000,000 replacement value for current public trees demands that city develop a coherent, tenable plan for protecting the long term health of this investment.

Introduction. Interest in urban forests has grown greatly in the last two decades. Several environmental health events have inspired urban forest awareness among arborist and city resource managers. These include the decline of favorite trees such as the American elm that were planted across cities in the Midwest and Northeast, urban sprawl and heat island phenomenon, increases in energy costs for heating and cooling, and the realization that healthy trees provide monetary returns in environmental services. Several organizations (American Forests, National Arbor Day Foundation) have promoted urban forest education to assist communities in planning, planting, and managing their urban forests. Other independent organizations (e.g., Home Depot Foundation) have developed philanthropic sources of funding for building "greener" communities with healthy forests.

Urban arboriculture research has shown that a healthy urban forest has significant social, economic, and ecological services. Green zones in and around business districts has a significant and direct positive impact on attracting consumers and the amount of time consumers spend shopping. Residential property owners directly realize the monetary value of large healthy front yard trees by capturing higher resale values over properties without trees.

The valuable ecological services of a healthy forest provide significant, direct monetary savings for a community. Unfortunately, these services are often taken for granted and their value is not realized until a significant portion of the forest has been removed. Specifically urban trees (1) mitigate the flow of storm water toward wastewater treatment facilities and flood zones, (2) shelter and insulate buildings and residential homes by reducing heating and cooling costs, (3) improve air quality by removing greenhouse gases and filtering particulate pollution, (4) muffle and block automobile, factory, and machinery noise, and (5) improve the aesthetics of a community that creates a sense of well-being by its citizens and visitors.

The year 2007 will likely be recording in United States history as the year of "global warming and environmental awareness." The public has been inundated in documentaries, articles and books in popular press, and a plethora a media reports on global warming. At last, U.S. have finally come to respect that global warming is real and happening at an unbelievable rate. Some climatic models predict that upstate New York will have the climate of Georgia by the year 2050. These models estimate that the number of summer days above 100°F increasing from three in 2007 to 13 for cities such as Buffalo New York. This dramatic environmental shift will result in a significant increase on energy use and cooling costs. A community that plans effectively by improving its urban forest and planting appropriate trees in carefully selected sites will realize large monetary savings in energy costs in the future.

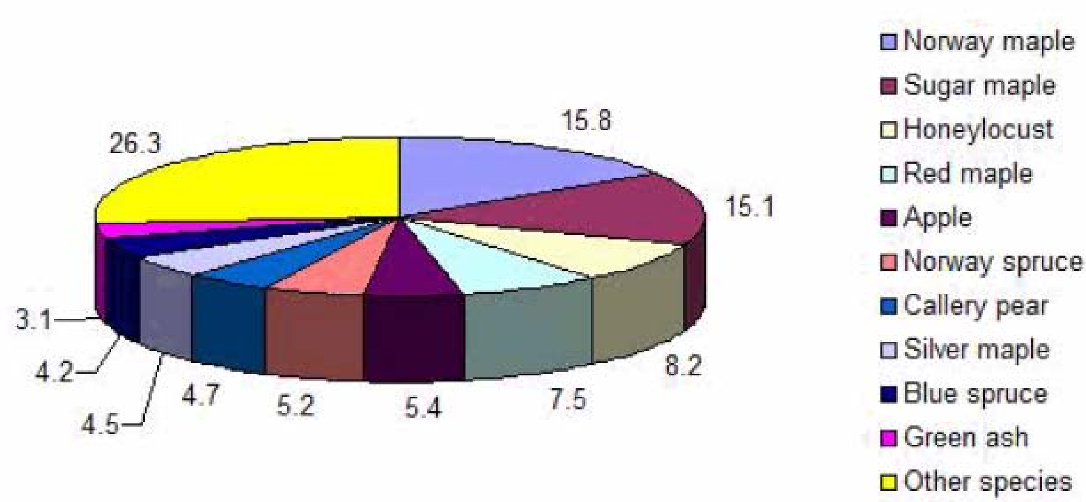
Cortland New York is located in the heart of upstate New York. The temperate deciduous forests native to this region are dominated sugar maple, American beech, yellow birch, and basswood. The forested plot adjacent to Cortland High School is representative of the forest native to upstate New York. A second block of urban forest is composed of non-native scots and red pines that protect the land above and upstream of Cortland's sole source aquifer. In addition, unmanaged urban forest exists along Otter, Dry, and Perplexity creeks that are tributaries to the Tioughnioga river.

The City of 18,740 residents operates on an annual budget of $15,820,245 where less than 0.5% of the budget is allocated toward urban forestry projects. The City allocates $26,000 annually for the removal of problem, hazardous, and dying trees from public spaces. Less than half of that amount ($12,000) is budgeted to plant new trees. The majority of public trees are located in the ROW of city streets (approximately 54 linear miles), three public parks, and the downtown courtyard. The City of Cortland recently adopted a tree ordinance and is planning to declare Cortland a "Tree City U.S.A." (National Arbor Day Foundation).

To assist the City of Cortland in beginning to respect and manage the urban forest, we undertook a two-year survey of the city public trees. The primary goals of the survey were to (1) investigate the coverage of trees in public zones, (2) the species diversity of trees, (3) the incursion of utility wires and sidewalks on public trees, and (4) measure the monetary value of the forest, and (5) estimate the monetary value of ecological services provided by the urban forest. The Cortland Tree survey will provide basic recommendations on planning and maintaining a healthy diverse forest that serves as an invaluable natural resource to the community of Cortland.

Cortland Tree Survey
Results of Significance

Species diversity of public trees. A total of 3,149 public trees from fifty-two species were identified, measured, and examined in 2004 and 2005. Sixty percent of the 2,469 street trees surveyed belong to one of five species. These most common trees are Norway maple (15.2%), sugar maple (15.1%), red maple (7.5%), and honey locust (8.2%). With the inclusion of silver maple, hedge maple, and boxelder, 43% of the street trees belong to the maple genus (*Acer*). City tree lottery plantings since 1988 have improved the diversity with green ash, red oak, Japanese scholar tree, flowering pear, serviceberry, Chinese elm, Japanese lilac, and hedge maple.



The diversity in public parks does not reflect the city street tree diversity. For example, the Beaudry Park parking lot is bordered by many Norway and white spruces. Similarly, the drive through Suggett Park has a large number of Norway spruces. Together 49% of Beaudry trees and 41% of Suggett Park trees are spruces (*Picea*). In addition, 11% and 12% of the trees at Dexter and Suggett Park, respectively, are crabapples (*Malus*).

> No single group of trees should occur more than 20% of the time.
>
> Six species of maples violate this benchmark value by representing 43% of all public trees.
>
> Recommendation: Plant trees from hardy, underrepresented genera.

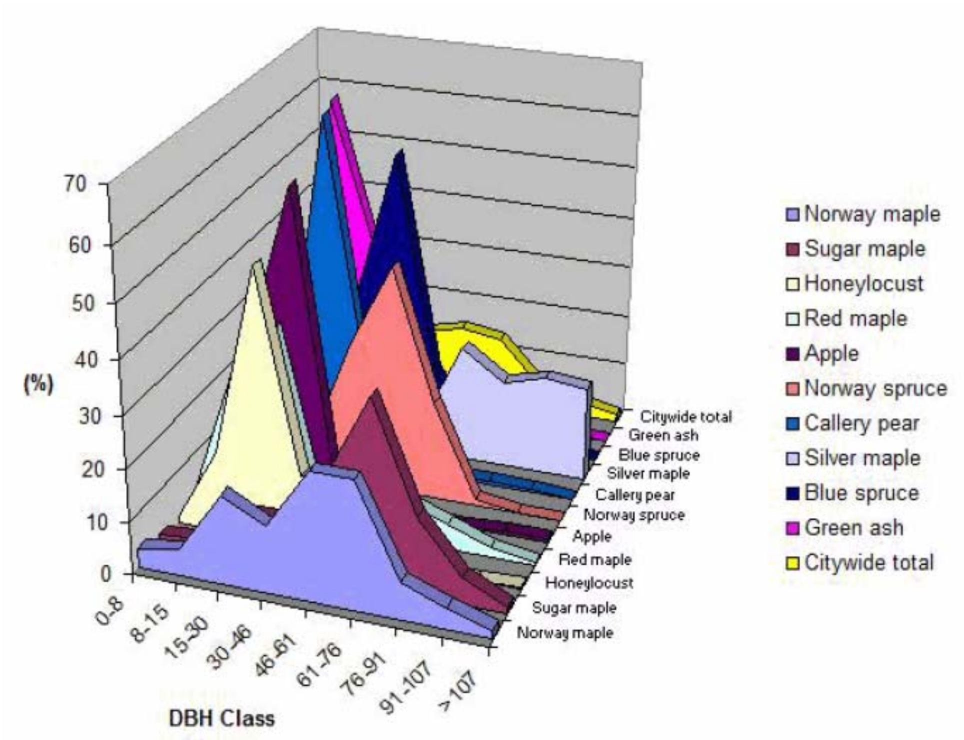
The abundance of maples in our urban forest violates two important rules of healthy tree diversity. First, no single species should represent more than 10% of the total species. Both Norway maple and sugar maple violate this important bench mark. Second, no more than 20% of the total species should represent a single genus. Maples (genus *Acer*) exceed this value by 23%.

Dependence on a few species of trees presents threats to Cortland's urban forest. Disease and pest outbreaks can exert a larger negative effect on an urban forest as the relative abundance of any one species increases. For example, the urban forest of many Midwestern and Northeastern cities was dominated by American elm during the early to middle part of the 20th Century. With the unfortunate introduction of wood infected with Dutch elm disease, many city streets shaded by the graceful arching branches of American elm soon became bare of urban forest.

In general, many cities throughout the Northeastern U.S. and New York State are witnessing a rapid decline in maples. Disease appears to be a major threat with anthracnose, branch canker, tar spot, and afflicting many maples. Cortland maples have experience two major outbreaks of tar spot in the past decade. Many of these problems could be better controlled and mitigated by improving tree diversity.

Tree diversity generally improves the aesthetics and character of city streets when applied appropriately. Cortland should be discouraged from randomly planting different trees without a plan. Planned plantings provide an opportunity for different areas of the city to develop unique character. For example, the row of Norway spruces bordering the Suggett Park drive creates a monolithic corridor to walk through. This use of spruces or any other tree is not effectively a monoculture because relatively few trees are planted together and the species does not exceed 10% throughout the city. Similar arguments could be made for the London plane and green ash trees along Broadway near the intersection with Tompkins or along Cedar Street where 85% of the beautiful towering shade trees are maples.

Forest Demographics. DBH size class information provides the best picture of age-related demographic data for public trees. The most important caveat to using this data is that tree species differ in their growth rates and ultimate size. Thus, a fifty-year old crap apple and a fifty-year old silver maple most definitely differ in size.



Honey locust, red maple, flowering pear (callery pear), and green ash have a size distribution dominated by trees of smaller size classes. This strongly reflects the recent history of planting these species in large numbers throughout the city. Honey locust has been heavily planted along streets and sidewalks of Cortland's downtown district. Similarly, Norway spruces were heavily planted at a more distant point in the past. This is reflected in the peaked size class distribution with 44% of the trees with a DBH between 46 and 61 cm.

Norway and sugar maples have a "normal" size distribution with many trees in the medium size categories and fewer trees in the smallest and largest categories. This pattern is typical of an aging tree population. Silver maple represents the extreme of an aging tree population. Seventy-seven percent of the silver maple population is found in the four largest size categories (>61 cm). Silver maple has not been planted in recent decades in Cortland. As the silver maple population continues to age and ultimately die, its importance in the public forest will diminish.

Several tree species with large maturation sizes were widely planted along Cortland Streets in the 1990s. These species include green ash, northern red oak, and pin oak. All three species dominated the smallest DBH size classes, but will play an important role in the forest structure of shade canopy trees in upcoming decades.

Conflicts with sidewalks and overhead utility wires. The widespread use of overhead utility wires presents an unavoidable challenge to growing a mature urban forest in Cortland. Overall thirty-nine percent of the public trees have potential or current conflict with utility wires. If street trees are considered alone, then 49.6% of the trees have potential or current conflict with utility wires.

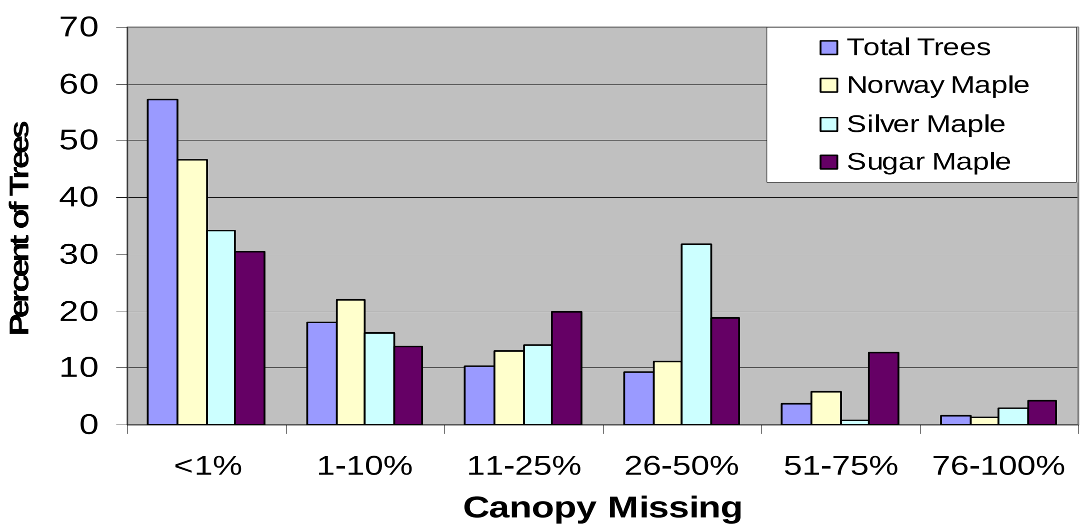
Utility wire and public tree conflicts pose several important problems for the city. First, there is the potential utility disruption when trees fall or limbs break on top of wires. Second, trees growing in the proximity of utility wires require routine pruning maintenance to prevent service disruption. Third, the required preventative pruning practices distorts the natural growth form of trees and reduces their functional and aesthetic value. These concerns warrant that tree planting be planned careful to minimize maintenance costs, prevent utility disruption, and maintain a healthy urban forest.

Street trees have been implicated in cracking, eroding, and elevating sidewalk surfaces. Our study shows that while this can be tree, it is a minority of trees responsible for disturbing sidewalks. Only 4.3% of the public street trees were associated with moderate elevation (1 inch or more) of sidewalk surfaces. Of the 108 trees associated with sidewalk problems 93 were caused by mature Norway, silver, and sugar maples.

Canopy Cover and Condition. For liability issues, participants on the tree survey were not trained on how to assess tree health and condition. Participants did measure the percentage of the canopy missing from trees. While this circumvents the issues on tree health, percent canopy missing provides important data on tree vigor and function. Mature trees with large intact canopies provide better environmental services, grow more, and absorb more carbon dioxide than trees with missing canopies. Furthermore, there are generally fewer wounds from routine pruning. Wounds may provide a gateway for microbial infections and force the tree to allocate resources to the healing process.

An intact canopy is a healthy canopy. Overall, 75% of public trees have less than 10% of their canopy intact. In contrast, three of the most abundant maples have significantly more of their canopy missing. Three factors account for this pattern. First, these three species represent the largest and oldest segment of our urban forest (see section on Forest Demographics). In general, high quality trees should have more than 70% of the canopy intact. This canopy benchmark is met by only 69%, 50%, and 44% of the public Norway, sugar, and silver maples, respectively. Second, these trees are most likely to receive utility wire preventative pruning. This action will over time prevent the tree from acquiring a normal form and appear to have

Percent Canopy missing for all public trees and three species of maple in Cortland.



significant portions of the canopy missing. Nevertheless, these data argue that the largest component of the public tree forest is in a significant decline.

Recruitment and removal. Cortland invests less than 0.5% annually ($38,000) of the total city budget on operations associated with maintenance of public trees. Two-thirds of the public tree budget is allocated to tree and stump removal ($26,000) and the remaining $12,000 for tree planting through the tree lottery system. The large disparity between budget allocation to removal and planting may be justified in that old, large trees are more expensive to remove than planting small trees.

Tree recruitment via the tree lottery program barely matches the removal rate. Between the years 2000 and 2005, the city planted 32 more trees than were removed. Even with tree survival of 91%, the number of trees surviving exceeded the number removed by only eleven at the end of these six years.

	2000	2001	2002	2003	2004	2005	Total
Trees Planted (remaining)	40 (32)	44 (39)	36 (31)	46 (43)	43 (43)	37 (37)	246(225)
Trees Removed	32	41	36	25	46	34	214
Net Change (remaining-removed)	0	-2	-5	+18	-3	+3	+11

Species diversity has increased by five species between 2000 and 2005. The new public tree species include serviceberry, Chinese elm, Japanese lilac, Japanese scholar tree, and hedge maple. In addition, red oaks and pin oaks were planted in 2000. Prior to that year, the majority of public oaks were located at Suggett Park. We are encouraged that the lottery system works to improve tree species diversity and offer a variety of growth patterns to accommodate the diversity of planting sites.

Existing Tree Type	Large	Medium	Small
Deciduous	58.4	12.3	15.3
Conifers	13.1	0.9	0.0
Total	71.5	22.2	15.3
Trees Planted between 2000 and 2005			
Deciduous	24.0	41.9	34.1

A forest of large tree species has a greater positive impact on the community than a forest of small trees.

If tree lottery purchases are used to predict the future forest, then the Cortland urban forest will experience a shift from large tree species to a forest dominated by medium and small trees. Planting smaller trees will reduce utility wire conflicts, but small trees will also reduce the environmental services the forest provides. Large trees store more carbon, provide a greater reduction in energy use, intercept more storm water, and increase property more than small trees.

Cortland averages 0.13 street trees per capita. This is significantly lower than the national average for 22 U.S. cities of 0.37 reported by McPherson and Rowntree (1989). Whereas the national average is one street tree for every three citizens, Cortland falls behind with only one tree for every seven citizens. Even with all public trees included, the Cortland average is only 0.16 public trees per capita.

There are 6000 available tree spaces in public areas along Cortland streets. More than 50% are suitable for medium to large growing trees.

Public Tree Spaces. The tree survey did not record all potential and occupied tree spaces in the city. We did, however, record public tree spaces for several streets (Atkins, Ellwood, Floral, Forest, Groton, Hamlin, Lincoln, Madison, Maple, and Woodruff) as noted within the boundaries on the Google Earth (see next page). Public tree spaces are defined as all occupied and potential spaces for trees in public areas. Tree spaces were identified according to guidelines stipulated in the City Tree Ordinance. For example, tree spaces are a minimum of 25 feet from street corners and fire hydrants as well as 10 feet from driveways. One potential caveat with this method is that trees currently in violation of the Tree Ordinance were included as an occupied tree space. Underground utilities were not considered in this analysis.

The following criteria were used to identify plant spaces as suitable for small, medium, and large trees. Small plant spaces can accommodate trees with a mature height of 20 feet or less (e.g., crabapple). Medium plant spaces can accommodate trees with a mature height between 20 and 40 feet (e.g., small leaf linden, green ash). Large plant spaces provide space for trees with a mature height greater than 40 feet. Plant spaces were also evaluated for utility wires and an appropriate tree size was chosen to minimize interaction with utilities.

	Occupied	Potential	**Total**
Small	10	198	**208 (46%)**
Medium-Large	9	49	**58 (13%)**
Large	114	73	**187 (41%)**
Total	**133 (29%)**	**320 (71%)**	**453**

More than 70% of the total planting spaces are vacant in this section of Cortland. Of the 453 plant spaces, 54% are suitable for medium to large trees. Many of the occupied planting spaces contain large tree species and more than 85% were identified as silver, Norway, or sugar maples. Thirty-eight percent of the potential plant spaces are suitable for medium to large trees.

The linear street distance evaluated in this sample was 2.9 miles or 5.5% of the total linear street distance for Cortland. If we assume that this is a representative sample of the city, then we estimate that there are nearly 6000 potential tree spaces in the city with more than 3000 capable of accommodating medium to large trees.

Environmental Services. Public trees provide important services that result in monetary savings to the City and its citizens. ***Energy*** *savings.* Trees contributed to significant energy savings by providing shade during the summer and a wind-buffer in the winter. These services can be translated into electricity (air conditioning) use in the summer and natural gas combustion (heating) in the winter. ***Air quality improvement.*** Trees improve city air quality predominantly by two methods. First, trees filter and absorb many atmospheric pollutants (ozone, nitrous oxides, sulfur oxides, and particulate matter). Second, because trees reduce energy required by buildings, they also reduce pollution emissions from power plants that burn fossil fuels are carbon based energy sources. ***Storm water mitigation***. Trees have enormous capacity to slow the movement of water and take-up water from the soil. In periods of heavy rain, trees intercept and retain storm water runoff and decrease the need for additional retention ponds to mitigate runoff into the municipal wastewater. ***Aesthetic value***. The intrinsic beauty of public trees has a tangible monetary value by increasing property value in the city.

> Cortland public trees store 9191 tons of carbon valued at $61,000.
> Each year Cortland public trees remove another 333 tons of CO_2.
> Trees reduce summer and winter energy use and avoid the release of 356 tons of CO_2 from power plants.

Cortland City public trees provide more than $388,510 in ANNUAL environmental services. More than 80% of the savings is provided in tangible forms of energy savings and improved property value. A significant energy savings also improves the air quality and reduces greenhouse gas emissions as less natural gas and coal are required for energy production. Property value is significantly improved in Cortland by public trees. Dollar value is realized by improved resale value and city tax collection on more valuable property. In addition, 20% of the annual environmental services is provide through air quality improvement, storm water control, and carbon sequestration. On average, each public tree provides $123 in free annual services to Cortland.

Benefits	Total ($)
Energy	159,189
CO2	4,137
Air Quality	29,043
Stormwater	42,984
Aesthetic/Other	153,157
Total Benefits	388,510

Home resale value and large trees. The positive effect of green spaces and urban trees on home resale values is well known among real estate appraisers. A study focused on Athens

Georgia (Anderson and Cordell 1988) estimated that a single, large front yard tree placed in the front yard of a single family home adds approximately 0.88% in resale value. In 2005, the average single family home resale value for Cortland was $89,500. Thus, a large front yard tree would add approximately $787 in resale value. When summed across all single family residential areas in a city, large trees can add substantial property value and increase tax revenues for the city. Property value increases disproportionately based on property use. For example, large trees will improve single-family residential property value more than multi-family residential, commercial or industrial property.

Undervalued benefits to urban forests. Unlike pollution reduction, storm water mitigation, carbon sequestration, and increases property value, many human social and health benefits can not be estimated as easily by allometric equations based on tree size. Street trees in the proximity to business improve curb appeal and often harshness of buildings and roadways. Consumers are more likely to shop in areas associated with green zones, forests, and planned landscaping (Wolf, 1999). Large trees and urban forest are known to improve social interactions, reduce crime and violence, and increase social benevolence (Sullivan and Kuo, 1996)., reduced UV exposure (Tretheway and Manthe, 1999). Plant foliage provides an effective barrier to mechanical noise penetration. Anyone who has hiked along a wooded trail knows that noise rapidly diminishes over short distances from roadways. Furthermore, plant foliage absorbs stress-inducing high frequency noise more readily than low frequency noise (Miller, 1997). Trees and natural vegetation in an urban setting provide a free hands-on educational classroom for public schools. An urban forest provides opportunities to coexist with deer, birds, squirrels, soils, and other biological forms. Interactions with nature and wildlife provide life-long benefits to children who are able in interact directly with nature (Luv, 200X). In short, healthy urban forests have benefits that extend far beyond the monetary and cost benefit analysis important to city managers.

Meeting Tree Canopy Goals. American Forest (www.americanforests.org) has conducted national, regional, and city surveys of urban forests across North America in the past two decades. These surveys have shown that urban areas quickly outgrow the capacity of environmental services performed by the urban forest. In fact, American Forests estimates that urban footprints have increased by 20% at the same time that tree cover in urban forests has decreased by 30%. This trend has dire consequences on the environmental health and vigor of urban ecosystems.

In order to sustain healthy urban ecosystems, American Forest has developed the following tree cover goals for urban forests east of the Mississippi River.

Average Tree Canopy in residential and business districts	40%
Business Districts	15%
Suburban Residential Cover	50%
Urban Residential Cover	25%

American Forests estimates that approximately 90% of the urban forest falls on private land and that 10% of the forest is public zones.

Although the Cortland Tree Survey did not estimate total canopy cover in the city, these benchmarks can provide guidance in understanding where Cortland falls with respect to these goals. For example, 25% of the street and sidewalk area is covered by tree canopy which falls below the average goal of 40% across all city zones. Thus, in order to meet this goal, Cortland would need to increase its current forest size by 30% (1000 trees of various sizes and species).

While meeting the American Forest goal appears unobtainable in the near future, more tenable short term goals can be established. For example, if the city planted 100 trees of a large fast growing tree each year for ten years (total of 1000 trees), then the cities tree canopy will increase by 3.65 acres (3.8% of total street and sidewalk area). This estimate assumes modest canopy diameter growth 0.5 feet per year. A 10-year old tree will be expected to have a canopy 15 feet wide and total area of 353 square feet. Red maples (*Acer rubrum*) planted in 1996 through the lottery exhibit similar growth characteristics when measured in 2005. After 20 years, these 1000 trees would cover 15.4 additional acres (16.5% of street and sidewalk area) and the city would surpass the 40% goal set by American Forest. Planting trees that are slower growing or smaller in stature would produce less favorable results.

Conclusions & Recommendations. The Cortland urban forest is facing troubling times. The forest is dominated by large deteriorating maples that are being removed at a rate equal to recruitment by smaller trees. This situation increases the likelihood of rapid deforestation following the introduction of genus specific pathogens. In addition, as the forest demographics shifts towards smaller, low growing trees, the citizens will realize smaller monetary benefits from the urban forest. Energy consumption, atmospheric pollutants, and storm water runoff will increase. Furthermore, the rate of property value increase will decline relative to areas with a mature, well-maintained urban forest.

In 1996, NYS DEC conducted a street tree survey in Cortland. Their survey resulted in a brief three-page report with four page appendix of supporting graphs. Their survey was smaller in scope and examined six linear miles of city streets and a total of 422 tree spaces. They found that the forest was dominated by sugar, silver, Norway, and red maple which totaled more than 40% of the urban forest. Forty-two percent of the trees examined were interfering with overhead utility wires. These results are concordant with the results presented in the current study.

The NYS DEC determined, however, that 67% of the tree spaces were occupied by trees. This result does contrast with the current study where we found 71% of the available tree spaces vacant within a sampling area. Differences in study design and coverage, fast tree removal rates and slow replanting likely account for these differences. The NYS DEC further noted that City trees were lacking medium size diameters. They concluded that “there will be a period of time when the number of trees in larger size classes will be low.” The DEC recommended acceleration in the planting rate and better matching of tree growth patterns to reduce interference with overhead utility wires.

Specific Recommendations

Educate City Officials and leadership on the economic value of a health urban forest. If Cortland's urban forest is to survive and be resurrected, then the city's elected officials, finance manager, and department directors must take an active role in planning, maintaining, investing, and showing interest in the urban forest. We are at a critical point in city history with respect to global warming and health of the urban forest. Small investments in trees and education today will pay large dividends in environmental services and property value in the future.

Place a temporary ban on planting any tree species totaling more than 10% of the forest or any genus at 20% or more. The fact that more than 40% of the trees are maples (boxelder, silver maple, Norway maple, hedge maple, sugar maple, and red maple) creates a hazardous situation for the health of the urban forest. In addition, the city should closely monitor future planting of honey locust (8.2%) and spruces in public parks.

Greatly accelerate planting of trees. The city should increase planting rate to exceed tree removal by a factor of two. Thus, in a year where 45 mature trees are removed, the city should plant 90 trees in appropriate locations. This strategy is desperately needed to prevent further degradation of the urban forest and allow forest recovery to occur.

Plant large. Urban forestry models demonstrate that planting large growing trees results in a higher rate of return for environmental services than planting small trees. In addition, small trees generally have shorter life spans and require more maintenance. Consider banning small tree plantings from spaces capable of supporting large trees.

Investigate alternative sources of trees. Balled and bur-lapped trees are expensive, heavy, and require substantial root pruning prior to transplanting. The city should investigate planting container grown trees, bare root trees, and those produced by RPM technology (www.rpmecosystems.com). These alternatives are less expensive and may offer trees that grow at faster rates.

Permit community forest character to build. Recently, a landscape and design member proposed replanting the City Courtyard with disease resistant elms. Appropriate plantings of elms would provide gracefully arching branch structure, a tall canopy with a large airy under story. This would create a unique character to the public grounds. Similarly, new plantings along city streets should be planned carefully to allow streets to exhibit character. As long as no species is planting at 10% of the total forest, then small scale monoculture should be allowed.

Tax credits for tree planting. Landowners should be encouraged to plant appropriate trees in public spaces bordering their property. This will reduce the city burden for planting and allow landowners flexibility in choosing the tree species.

Identify all available tree spaces and develop a strategic plan for replacement. Analysis of available tree spaces will permit the city to focus on planting large growing species first. This will provide the city with the greatest return on investment over the shortest period of time.

Increase grant writing efforts. The city should consider applying for tree funds from the NYS DEC, the U.S. Environmental Protection Agency, and regional private agencies that support community development. In addition, the city should develop grass root efforts to provide incentives to local companies, agencies, and individuals to invest in Cortland's urban forest.

Noteworthy Trees in Cortland

Eugene "Charlie" Moon sits on the massive roots of the City's largest tree on Alvena

Biggest Public Tree. The largest public tree in Cortland is a Silver Maple located at 34 Alvena. This tree has a DBH of 176 cm, a height of 60 feet with a canopy spread of 35 feet. The tree is in great health and has more than 90% of its canopy intact.

Most Unusual Public Tree. The most unusual tree is a Weeping Beech (*Fagus* sylvatica 'Pendula') located at 57 Greenbush. Weeping Beech is not an ideal street tree because its growth form can be obstructive to street traffic and line of driveways and corners. This particular individual has not outgrown its site. Weeping Beech has an unusual corkscrew form of branching and when the canopy is full of leaves it has a graceful cascading form.

Nicest Specimen. The mature European Horse Chestnut (*Aesculus hippocastanum*) at 6 Chestnut Street is the most handsome public tree in the city. It has a full canopy reaching 75 feet in height and blossoms profusely in early June.

European Horsechestnut on Chestnut Street.

One of a Kind. A single Kentucky Coffeetree (*Gymnocladus dioicus*) is located Van Hoesen street at the address of 11 Chestnut. Kentucky Coffeetree is the official state tree of Kentucky. This particular specimen is hidden between two very large Honey Locust trees.

A single Katsura tree (*Cercidiphyllum japonicum*) is located at the end of Bellrose Avenue overlooking the Otter Creek. In Japan, Korea, and China, the Katsura tree produces valuable wood that is used in carvings, veneer, and expensive furniture. This mature tree grows unobstructed by utility wires and homes. It has heart-shaped leaves that resemble those of Redbud (*Cercis canadensis*).

Two handsome purple European Beeches (*Fagus sylvatica* "Atropunicea") are found in public zones of Cortland. One is located on Waterworks property on Broadway Ave. and the second is on Pleasant Street just south of West Court Street.

Former American elm on Peaceful.

Legendary Tree (Deceased). In previewing City streets and organizing blocks for the survey in 2004, I discovered a large (60 ft.), solitary, American Elm (*Ulmus americana*) standing dignified near the corner of Peaceful and River Road (see photo at right). The tree displayed the signature overarching branches and grace of this once legendary tree. Although it was full of leaves and appeared to have the stature of an old strong warrior, I could tell from the brownish fluid oozing from the trunk that the tree's days were short numbered. By summer of 2006, this tree had succumbed to Dutch elm disease like many of its brethren across North America.

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Matthew Germain, Regine Perez, and Sarah Rhodes share a moment with a public tree on Greenbush.

Appendix A. Methods.

The project was undertaken by Dr. Steven B. Broyles and students in Cortland Tree Survey (BIO 329) during the fall of 2004 and 2005. Student participants were taught and tested on the identification of fifty common public trees in central New York. Students were also trained in methods of measuring height (ft), canopy width (ft), diameter at breast height (cm), and percentage of intact canopy on individual trees. Students learned to assess potential building and utility wire conflicts with tree growth, the presence of fire hydrants within 15 feet of trees, and sidewalk damage caused by roadway. Informal training occurred on how to interact with homeowners and Cortland citizens.

The City was divided into block sections by roadways. Two criteria were used to break sections into blocks. First, each block possessed 3-5 miles of linear roadway. Second, blocks were determined by the number of trees believed to be along the streets. Thus, smaller blocks based on linear roadway distance were assigned for areas that had a high number of trees. Student teams of 2-3 individuals were assigned blocks, provided data sheets, diameter tapes, and GPS units. Each team completed their assigned block on two consecutive weekends and on evenings as needed in September and October of 2004 and 2005.

Data was collected on every tree located in planted areas at Dexter, Suggett, and Beaudry Parks as well as the City Courtyard between Church and Greenbush streets. Data were collected on every possible City street tree in the Right-of-Way (ROW). The ROW was assumed to represent 24.75ft of centerline along each city street and 49.5 ft of centerline along state Highways that pass through the city. These highways include routes 11, 13, and 41. The 14.75 ft rule was used along route 222 between Main Street and the western City boundary, and along route 215.

The following data was collected for every Cortland public tree encountered during the survey. Species identification; property number, street name, cardinal location information for multiple trees per site, GPS waypoint, diameter at breast height (cm; hereafter abbreviated DBH), tree height (ft), canopy width (ft), and artificial conflicts on tree growth. Three aspects of artificial conflicts were noted. Teams recorded whether utility wires were (A) above, but not in conflict with trees; (B) in conflict and passed through or touched the tree; and/or (C) within ten lateral feet of the tree canopy. Additionally, each team noted whether a building was conflicting with tree growth and whether sidewalks had buckled from root growth.

Data was entered by hand into Microsoft Excel where it could be managed and checked for errors. Independent team data was collected into one common file and error checked by Steve Broyles during the summers of 2005 and 2006. This included relocating and checking species identification and measurements of individual trees. Accuracy of tree species identification, location information, and measurements exceeding 95%.The majority of mis-identified trees were made between the species for the following species pairs: sugar and Norway maple, Japanese tree lilac and dogwood; and red oak and pin oak.

Special effort was taken to relocate every tree planted by the City lottery between 1998 and 2004. This information is important because it can provide important survival data on recently planted trees. However, we discovered that many of the missing lottery trees had been planted elsewhere on the homeowners' properties outside of the right away.

All public tree data was analyzed using STRATUM (Street Tree Management Tool of Urban Forest Managers). This software package was provided free of charge by i-Tree (www.itreetools.org). STRATUM calculates annual tree benefit data (energy savings, carbon dioxide sequestration, atmospheric pollutant filtration, storm water mitigation, and aesthetic property value) for the public trees. In addition, STRATUM calculates summary statistics that can be used to evaluate the species diversity, demographics, canopy condition, and conflicts between man-made artifacts and tree growth.

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