EXECUTIVE SUMMARY

INTRODUCTION

There are many ways of valuing open spaces. Among the two dominant schools of thought, traditional economy generally recognizes fewer natural services than ecological economics and thus the latter provides a more complete value of a parcel of open space. The purpose of this project was to compare the value of the land from both sides of this conflict. A key finding of this research was that open spaces are typically undervalued. A more holistic value derived from the ecological economic perspective would make a better case for conservation.

Through a case study of the West Tatnuck neighborhood of Worcester, Massachusetts this project examined the two valuation approaches. The study area is a peri-urban neighborhood with a mixture of forested open spaces and residential blocks with tree lined streets. For this project, West Tatnuck will be defined by the area between MA-Route 122, the Worcester city limit, and all parcels on the east side of Tory Fort Lane. While much of the open space is protected a good portion is zoned for development.

BACKGROUND

Ecological services are the goods and services provided by an ecosystem to help sustain human life. Of the many possible ecological services, only a few were examined. The traditional or economic viewpoint focuses on services have market value and include raw materials, food production, recreational and cultural values. The ecological economics view is much broader. Services valued by ecological economics are categorized (in Table 1) into soil based and regulatory; soil based services include erosion control, soil formation and nutrient cycling while air filtration, micro climate regulation, noise reduction, overland flow mitigation and waste treatment are part of the regulatory services.

Table 1: Service Classification

Regulatory	*Soil Based*	*Economic*
Air Filtration	Erosion Control	Aesthetics
Climate Regulation	Nutrient Cycling	Food Production
Noise Reduction	Soil Formation	Raw Materials
OLF Mitigation		Recreation
Waste Treatment		

There are several types of value that can be prescribed to ecological services. The value from the perspective of the government cost was assessed, but some values, such as microclimate regulation, were more beneficial to the individual land owner. In both cases, indirect economic valuation methods such as avoided cost, replacement cost and hedonic pricing, as outlined by de Groot, Wilson, and Boumans (2002), were used. Avoided cost is the amount the city doesn't

have to spend because the natural system takes care of it whereas replacement cost is more specific to the installation and maintenance cost involved in setting up gray infrastructure to replace the work of the green infrastructure. Hedonic pricing is based on the effect open spaces have on the real estate value and consequently the revenue generated from property taxes of the surrounding houses. Another method of valuing ecosystem services is "willingness to pay" which is defined by Bockstael, Freeman, Kopp, Portney, and Smith (2000) as "how much individuals would be willing to give up in other things to obtain this outcome" (p. 1387). This can be accomplished by doing surveys in the specific area and is best saved for specific services such as recreation where the other methods are insufficient. Because of the varying unit time of the individual services, the worth of the land was examined over a period of thirty years. The aforementioned information represents the theory behind this project. Next, the practical application of this information will be investigated

FINDINGS: CONVENTIONAL ECONOMIC VALUE

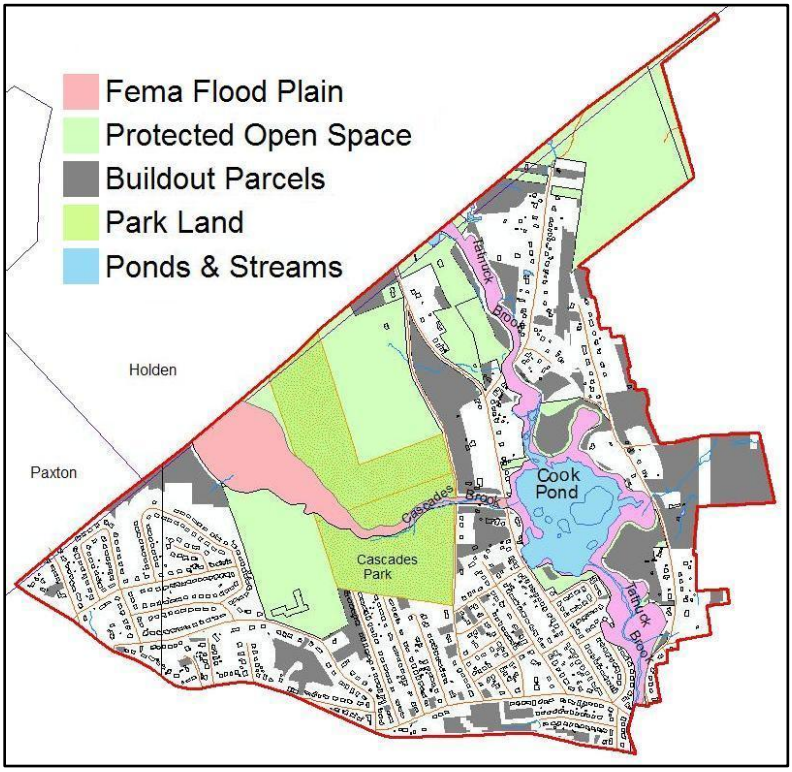
Two economic values were explored in this project. The "current" economic value is the typical value of open spaces derived from the traditional viewpoint of considering only those services that benefit the individual. The "maximum" economic value is calculated from the tax revenue generated from full development. The first finding of the project concluded that the potential revenue from the region is *greater* than currently valued services.

Table 2: Net Tax Revenue

Taxes from CMPRC Lots	$	22,524,210.00
Schooling for CMRPC Lots	$	(7,274,397.00)
Taxes from Group Projection	$	68,170,620.00
Schooling for Group Projection Lots	$	(33,787,660.00)
Cost of New School in District	$	(17,850,000.00)
Net Tax Revenue	$	31,782,773.00

The current economic value (Table 2) of the study area, which is mixed between development and open space, is less than the value derived if the area was to be fully developed. The Central Massachusetts Regional Planning Commission (CMRPC) estimates that 339 additional units could be built in West Tatnuck if needed. The locations of these plots are shown in gray in Figure 1. Protected open space makes up a significant portion of the study area which was not included in the CMRPC data set. An estimate for the number of new units in the protected area was calculated by using the zoned RS-7 minimum lot size of 7,000 square feet and the total square footage not falling in the FEMA flood plain. The revenue generated from the additional 1365 units, in terms of property tax over a period of thirty years, was assessed using Worcester's current tax rate of 1.21% and the average house value of $183,000. The city would also have to spend the money generated in infrastructure costs the largest of which would be education costs for 573 new children that would include building at least one new school. Without accounting for other gray infrastructure costs, the net amount gained from maximum build out was calculated to be $31,782,773

Figure 1: Build-Out Map



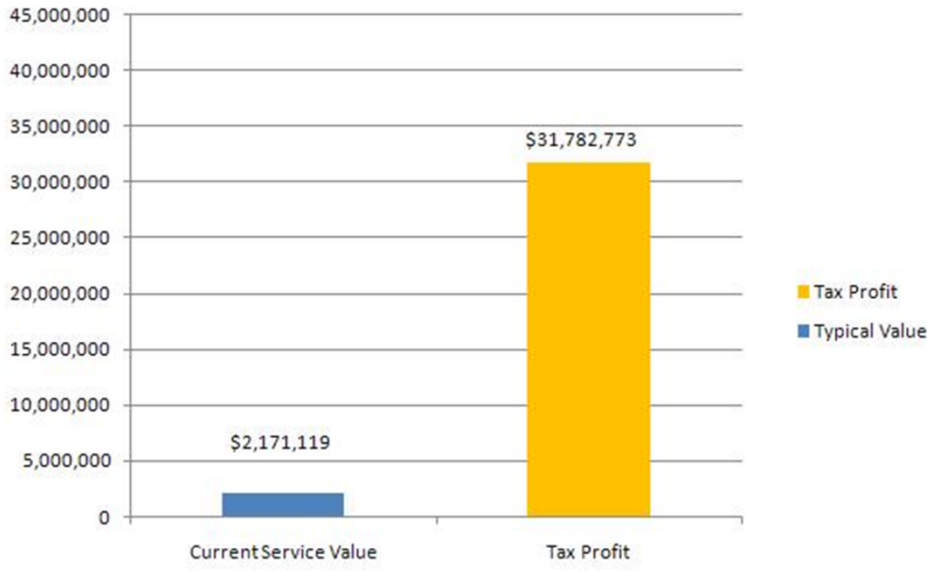
The current economic value of the area comes from four services. The value of homes that are located in or abut natural open spaces would be greater than houses in less aesthetically pleasing areas. The houses in West Tatnuck were considered to be 22% more valuable because of their proximity to the Cascades, Cook's Pond, Tatnuck Brook, and other forested areas. There are 100 such houses in the area which would generate a total of $1,461,750. Through a regiment of sustainable harvesting the timber in West Tatnuck could realistically be cut three times in thirty years. A combined 104.5 acres of the region has sustainability practices in place. By extrapolating this into West Tatnuck, the 314 harvestable acres could yield $379,129.20. The total number of passive recreation (fishing, hiking, and biking) visits per year to West Tatnuck is approximately 2,500 according to the Greater Worcester Land Trust. According to National Park Service, U.S. Forest Services, and Illinois Parks and Recreation Department, the average willingness to pay for these activities is $4 per person which places the recreational value at $300,000. The sap production in West Tatnuck is provided by approximately 504 sugar maples of adequate size in the area which would produce $30,240 of raw sap.

- Cultural Value: $ 1,461,750
- Raw Materials: $ 379,129
- Recreation: $ 300,000
- Food Production: $ 30,240
  Total: $2,171,119

The total value of these services is $2,171,119. This is less than the gross amount gained from property taxes, $31,782,773 and implies that development is the better option for the city of

Worcester (Figure 2). The services mentioned above are the maximum value land use planning would assess for the open space. However, this value is incomplete because it fails to account for all the ecological services offered by the open spaces of West Tatnuck. These services combined with the four mentioned above provide a more comprehensive value to the open spaces.

Figure 2: Conventional Economic Valuation



Findings: Ecological Economic Value

The full value of the open spaces of West Tatnuck is derived from the combination of typical value and two other categories of services—soil based and regulatory. If the typical value, which was previously calculated to be $2.17 million and the full value were closer together, then the additional categories services could be considered negligible and the economic valuation could be assumed as correct. In the particular case of West Tatnuck there is a large difference between the two pointing to the conclusion that the open space is typically undervalued.

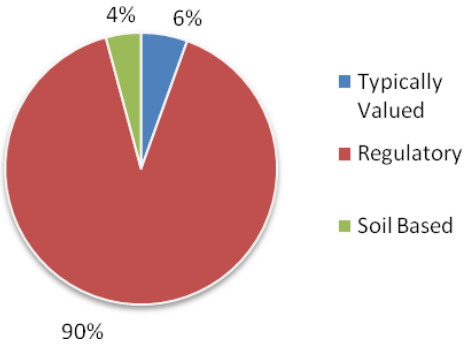
Regulatory services were valued at $35,409,363. The real estate value of houses under the flight paths decreases by 0.5% per decibel of ambient noise over 55dB (Nelson, 2003). The homes in the area have reduced noise pollution because of the forested areas. Without this vegetation absorbing the sound, the area would be afflicted with the ambient noise of 60 dB (Kneeland Airport Master Plan Update, 2005) and suffer from a reduction of 2.5% in real estate value which translates to a loss of $21,632,604 of tax revenue for the city of Worcester. The air filtration calculator from CITYgreen requires the model of a city. The city of Worcester was not included in this and thus the model of the city of Providence was used instead. The total value of air filtration was $2,008,659. Climate regulation was valued by measuring the amount the average resident of West Tatnuck saves in energy costs. According to a study by MIT, the average house saves about 20-25% if it is surrounded by trees such that it provides shade in the summer and blocks the cold air in the winter. A conservative estimate of 15% was used for the homes of West Tatnuck since an ideal situation is not applicable to all the houses. According to

Energy Star (2005), the average home spends $1,900 on energy costs per year. The total worth of Micro-Climate regulation in the region was found to be $6,412,500. The waste treatment provided by the natural resources of the region especially the Cascades, is helpful mostly because of the water it affects in Cook Pond and Coe's Reservoir. The most immediate effect of polluted water in Coe's Reservoir would be the lack of clean water to swim in. The replacement cost involved in installing a public swimming pool was measured to determine the total value for this service. Reviewing many estimates for both of the costs and comparing it to the value given by the department, the value of this service was determined to be $1.5 million initial cost and $53,520 per year which makes the thirty year total $3,105,600.

Soil based services were valued at $1,647,196.56. Soil is formed by decomposing organic matter into compost. The City of Worcester has a residential leaf collection program. A City Official estimates that the program collects approximately 75,000 to 100,000 pounds of leaves, which translates to 10,000 to 15,000 tons of compost per year. Assuming that the city has a uniform distribution of street tree cover (West Tatnuck constitutes 2.73%) and using estimates that compost cost $26 per ton (http://www.epa.gov/compost/basic.htm), this service will produce $7,103 per year and $213,090 over thirty. The naturally occurring cycle of nutrients through an ecosystem could be manually replaced by annual application of fertilizer. West Tatnuck, specifically, is rich in nitrogen and phosphorus; the chosen fertilizer must contain these elements. To re-nutrition an acre of land for these components would cost $65 to $90 (Fristoe & Gothard, 1998). There are 314 acres of land that would need to be fertilizer and over thirty years would cost $612,865.50. Erosion control is the cost to replace erosion resistant surfaces when development occurs. In order to determine this cost, the maximum number of new homes was determined from the build-out data from CMRPC. Only 5,000 sq ft of the 7,000 sq ft lot would require sodding. Using sod estimates from numerous sources (Lyons; Smith) a total sod cost of $2,422.54 per new home was assigned making the total value $821,241.06.

Figure 3: Individual Values and Category Comparison

Ecological Service	Value ($/30 years)
Food Production	30,240
Raw Materials	379,129
Recreation	300,000
Cultural	1,461,750
Category Total	**2,171,119**
Noise Reduction	21,632,580
Air Filtration	2,008,650
Climate Regulation	6,412,500
Overland Flow Mitigation	2,250,000
Waste Management	3,105,600
Category Total	**35,409,330**
Soil Formation	213,090
Nutrient Cycling	612,900
Erosion Control	821,241
Category Total	**1,647,231**
Total	**39,227,680**



Discussion

Through a comparison of the calculated values (Figure 3) some inferences can be made. The traditional economic valuation a parcel of land would be considered profitable to develop if the potential tax yield from the region is greater than the typically economically valued factors. In the case of West Tatnuck, the maximum economic value of $31,782,773, if completely developed, would be much greater than the yield from timber, food products, recreation, and aesthetic value totaling $2,171,119. Because of this, development in the neighborhood would seem financially sound. However, in the more comprehensive valuation technique that this project proposed, the question of development gained another facet. Under this method, the value of all the ecological services of West Tatnuck (including those services traditionally accounted for in the economy) should be compared to the maximum economic value. In this case the open undeveloped space, valued at $39,227,678 outweighs the maximum economic value of $31,782,773 from development.

Figure 3: Value Comparison