Quantifying Public Benefits

on Private Forestland

in Massachusetts

by the Massachusetts Forest Stewardship Program's

Task Force on Reforming Forest Taxation

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PREFACE

A task force of the state's Forest Stewardship Committee* met for a year to discuss the problem of private forest taxation as a disincentive to forest conservation, and the lack of forest policies that encourage private forest landowners to steward their land. This group agreed that it would be useful to document, to the extent possible, the many ways that the Massachusetts public benefits from undeveloped private forestland, both managed and unmanaged. From this understanding it is our hope that a reformed forest tax policy may be crafted that recognizes the large contribution of these private forestlands to the entire citizenry of the state.

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EXECUTIVE SUMMARY

Reformed forest property taxes and other financial incentives can better conserve, for the long term, the currently unrecognized but essential public benefits that derive from private forestland. Quantification of public goods and services that flow from privately owned forests shows that, when these lands are not developed, they provide a substantial benefit to society. Because 78 percent of the state's 3.1 million acres of forest is privately held, the ways in which the more than 200,000 landowners are motivated to treat their land has

significant implications for the greater public good. If society's goal is to develop policies that recognize and support the crucial role our forests play in sustaining its future, property tax laws and other forestland policies must better reflect economic and non-economic benefits below, and give private forest landowners incentives to steward their land rather than degrade or convert it to non-forest uses.

We selected eight public benefits that come from the forest—a list that embraces most of the ways that forests are important to people. But from an economist's point-of-view, difficulties arise. Some of these benefits are useable, renewable products such as wood or clean water; others are economic impacts such as tourism dollars that derive from landscape character or wildlife-centered recreation spending. Others still, are unquantifiable, such as biological diversity or social meaning. Another difficulty we confronted with the paucity of data is that some values exist in the form of stocks (total value per acre) and others in flows (dollar value per acre, per year). In short, these two types of measure further complicate the possibility of neatly summing what dollar values were available.

Of necessity, we used several approaches to valuing forest-based services and products. Sometimes reasonable economic data exist; sometimes the cost of an alternative solution might be presented with reasonable extrapolations made. In the absence of data, we describe ways of approaching the valuation problem with the hope that better numbers may be available in the future. Other values simply defy economic quantification so we reference studies that discuss these values. In all cases we focused on attaching values to the *public* benefits on *privately* owned forestlands.

1. **Water Quality** - Clean water is arguably our most important forest product. Given that two-thirds of the state are covered by forests and, of these, 78 percent are privately owned, the decisions of these landowners to conserve or convert their land will greatly influence the quality of the public drinking water supply. Actual payments for forestland purchases and assessed values suggest per acre values of $2,396 and $1,744, respectively. These are not annualized, nor are they attributable to actual water-pollution avoidance values. Figures for the cost avoided by filtering clean water from a healthy forest ecosystem vs. a degraded landscape, were they available, might better capture the water quality benefit of forests. A study summarizing the cost avoidance provided by natural systems throughout the world report an annual per acre value of $222.

2. **Climate Moderation & Air Quality** - Forests play a critical role in the global carbon equation. According to regional sources, the average acre of forest provides between $42 and $105 of carbon value in the standing trees, with an annual increase worth between $0.70 and $1.75 per acre. The last full inventory of the state's forests shows that conversion from forest to other land uses has averaged about 6,538 acres per year. This conversion results in four types of loss in the carbon equation: 1) carbon stored in standing trees transforms from sink to source, 2) most of the ongoing annual carbon fixation is eliminated, 3) the new land use is almost certain to function as a new source of atmospheric carbon, and 4) most of the large carbon reservoir in forest soils will be released to the atmosphere under a different land use.

Polluted air is filtered through the extensive and complex surface area of forest ecosystems; thus trees play a key role in improving the human-degraded air quality of modern times. Studies from the Midwest quantify air pollution removal costs avoided in the range of $1-$10 million (in suburban to urban areas, respectively) though extrapolation of these

figures to our state would be questionable.

3. **Biological Diversity** - Massachusetts is naturally diverse in plant and animal life, with a total of 2,040 native species, not including invertebrates. Roughly 90 percent of these use our extensive native forest ecosystems for part or all of their life cycle needs. A patchwork of mostly small, private forest ownerships result in a mix of forest size-classes across a variety of sites. State-listed rare species number 424 and are found in a variety of natural communities, with about one quarter of these occurring in forested settings. Seventy-four percent of known rare species occurrences are on private lands, though experts don't have the data to say how many of these are private forestlands. This estimate points to the important role private landowners must play in protecting biological diversity. Because we are incapable of predicting the consequences of losing a species, and because we cannot predict the future value of some as-yet-undiscovered human use of a forest organism, the public benefit of biologically diverse forests is unquantifiable.

4. **Landscape Character** - Private forestlands cover roughly half of the Massachusetts landscape. In this sense they are valuable to society for enhancing the quality of life; they buffer the visual severity of development and urban sprawl, and they muffle sounds of traffic and human activity. Trees are central to society's notion of scenic beauty and numerous studies show that people prefer landscapes with trees. Tourism industry data provide the only readily available means to quantify landscape character. With 27.8 percent of state visits identified as being related to reasons dependent on forests or scenery, 78 percent of the total traveler expenditures in these categories was attributed to private forestlands. On a per acre basis, that contribution is $1001. Forested landscape character can also positively impact property values. One can hypothesize a tax base erosion and subsequent loss in quality of life and ability to attract desirable revenue sources if this forested landscape were to be converted to other uses.

5. **Recreation** - Forests offer the setting for popular recreational activities such as walking, hiking, skiing, hunting, wildlife observation, and nature contemplation. Of 2,522 miles of trails reported in a regional study, 23 percent occurred on private lands. Wildlife-centered recreation is chiefly a forest-based activity, with more than 90 percent of our native plant and animal species using the forest. With 78 percent of the forest privately owned, the integrity of native wildlife populations is directly tied to this sector. Although private lands are commonly used by the public, only data for hunting use were available; 67 percent of time spent in that activity was on private land in the study year of 1996. Total in-state expenditures for all wildlife-centered recreation in 1996 was $1 billion; even if only a conservative fraction of these revenues--for example, 30 to 50 percent--came from activities actually occurring on private forestlands, the income to the state's economy would be hundreds of millions of dollars.

6. **Forest Products** - Our forests have historically provided, and continue to provide, important raw materials for human consumption. Lumber, pallets, firewood, maple syrup and Christmas trees generate significant economic activity and enhance tourism by keeping open space productive. Income from these products also helps landowners offset property taxes and other carrying costs of undeveloped forestland. Two different estimates of the average annual cut--83 and 121 million board feet--lead to a range of $232 to $338 million generated within the wood products sector, when a value-added multiplier is used. An economic multiplier of 2.5 points to a range of $580 to $845 when those dollars circulate beyond this sector, through the state's economy. Maple products and Christmas trees generate an additional $13 million in the wood products sector. Current harvest levels are

estimated to be less than 20 percent of the potential sustainable harvest rate, so the public benefit of wood production could be significantly greater in the future.

7. **Social Meaning** - An unspoken and unquantifiable benefit of forests and trees is documented in a series of studies that shows the importance of trees in peoples' lives. Satisfaction with neighborhood and numerous health benefits are strongly affected by forests and trees. Trees figure heavily in folklore, myth, religion and literature, another important cultural value. An expert on this topic asserts that it is not the distant wilderness park that figures so heavily in these studies, but rather the trees and forests in the day-to-day lives of people that matter. Although in Massachusetts these trees and forests are mostly privately owned, they create a backdrop that figures prominently in the lives of all citizens.

8. **A Global Environmental Ethic** - In the 1990s, the annual wood consumption for Massachusetts was about 1.7 billion board feet. For the same years, wood harvested from our forests was about 6 percent of this total consumption. Further, the potential sustainable harvest rate of Massachusetts forests is estimated at about 41percent of current consumption. Very little of our wood is supplied locally, in spite of abundant forests with commercially desirable species, relatively resilient ecosystems and a strong safety net of environmental regulations to protect the public interest in our forests. Citizens have the potential to improve global environmental quality by matching a much larger proportion of their wood consumption with ecologically sustainable production in Massachusetts. As this potential expands, private forest landowners will play a critical role.

Our forests provide vital goods and services to all citizens of the Commonwealth, and a great portion of these values comes from private lands. Research and discussion point to a very significant contribution of dollars each year from privately owned forest activities that generate a quantifiable public benefit. When less tangible or infinitely valuable forest benefits are considered, their worth is vastly greater. As it would be impossible for the state to buy all of these lands or their development rights, a cost-effective approach would be to craft rewards and incentives to make it highly desirable to keep land in forest, rather than convert it to other uses. We therefore propose that public policies be crafted that acknowledge the Commonwealth's reliance on private forestlands and their stewards. Conceptual changes to existing tax policies would initially reward private landowners for not developing their forestland, and incrementally increase that reward as forest landowners increase the extent to which they protect and enhance public benefits on their land.

PURPOSE

In broad terms, this paper seeks to stimulate a fresh look at creating public policies that promote a thriving and diverse forest across the state. More particularly, this paper makes a case for property tax reform on private forestland in Massachusetts. By attempting to quantify public goods and services that flow from privately owned forests, it will show that when these lands remain undeveloped, they provide an unrecognized and uncompensated benefit to society. Paradoxically, private forest landowners are often financially penalized with taxes that can mean the difference between keeping and selling the forest. And because 78 percent of the state's 3.1 million acres of forest is privately held, how these more than 200,000 landowners are motivated to treat their land has significant implications for the greater public good. It is around this ownership sector that this discussion revolves.

Public benefits such as clean water and air, wildlife habitat, landscape character and more are possible and abundant because private forestlands remain undeveloped. The historic notion that private property ownership is an absolute right to do anything has evolved to incorporate society's stake in these private lands. In fact, public interests on private lands are so important that the U.S. Congress, the state of Massachusetts and even local municipalities have passed a strong set of laws to ensure that some aspects of these interests remain intact. At the federal level we have the Endangered Species and Clean Water Acts; at the state level, the Wetlands Protection, Forest Cutting Practices and Rivers Protection Acts, and the Slash Law. While these laws go some distance in protecting public interests on private lands, they do not explicitly encourage forest landowners to refrain from selling to the highest bidder, which often leads to development.

Perhaps because forests have been so plentiful in our lifetime--and steadily on the rise since the middle of the 19th century--we are in danger of taking their health and abundance for granted. Current population trends show that people are moving from cities to rural areas, converting the forest to buildings, roads and pavement. *Losing Ground* (Steel, 1999), a Massachusetts Audubon Society publication, puts the current rate of statewide open space loss at 16,000 acres per year. With the state's landscape so heavily forested, a large portion of those lost acres would be forest. Preliminary results from a recent U.S. Forest Service inventory (USDA-Forest Service, 1998) put the statewide loss of forested acres at 6,538 per year. In Worcester County--the front of western expansion--the annual loss of forested acres was 5,076. While efforts to conserve these lands must continue through outright purchase of title-in-fee or development rights, much of these lands will remain in private hands. Because of the high cost of legally protecting all important conservation lands and the uncertainty of landowners' willingness to sell, at the same time this important work proceeds, we must also look carefully at other tools available to encourage private forest *conservation* and discourage forest *conversion*.

The current system of *ad valorem* property taxation ignores the private guardianship of public forest benefits. In *Forested Landscapes in Perspective* (National Research Council, 1998) the authors assert "the ad valorem property-tax policy produces many of the largest negative effects on stability and sustainability of private non-industrial forestlands." The Northern Forest Lands Council report (1994), addressing the problem of rising land values and development threats in northern New England, found the *ad valorem* property tax to be a barrier to long-term forest conservation for multiple benefits. Further, numerous cost of community services studies show that undeveloped forests generate more tax revenues than costs in community services (Commonwealth Research Group, Inc., 1995). Yet the out-dated *ad valorem* property tax, which bases assessment on "full and fair market value"--usually the developable value of the property--remains the basis for taxation of forestlands. The state's current use program allows for differential assessment for wood production for landowners willing to commit to growing timber, but this law only addresses one of the many alternatives to undeveloped forest use. Landowners holding only about 10 percent of the eligible acres participate in this program. Many people own forests for reasons other than timber production, and find that the program does not meet their needs. Yet, for the purposes of existing state tax policies, forestland is either a dormant building lot or it is growing wood products. Why not develop a tax policy that values the other crucial ecosystem services forests provide, along with sustainable wood production.

A logical antidote to the burdensome costs of retaining forestland is to create income from that land. But in Massachusetts, the opportunities for cash income to forest landowners are

limited. Growing Christmas trees, producing maple products and cross-country ski development are all labor intensive and return little income beyond compensation to the owner for the required management (Mason, pers. com.) This leaves timber management as the principle revenue-generating activity.

The average acre in Massachusetts grows timber at the rate of 158 board feet year (Dickson and McAfee, 1988). Worth roughly $140 per thousand board feet (Boyce, pers. com.), this translates to a periodic income of about $22 per acre per year. Better growing sites and intensive management can substantially increase this amount. However, good sites are limited and sustainable management usually requires an investment in pre-commercial activities and other costs in order to reap value in the distant future.

Using $500 per acre as a reasonable estimate for the average assessed value of forestland across the state (Mason and Kittredge, pers. com.), and a property tax rate of $20 per thousand dollars of value, the owner will pay $10 each year for an acre of forest. When the private, less tangible benefits of ownership—recreation, wildlife enjoyment, privacy—are not affordable or not worth the cost to the individual landowner, the forest is vulnerable to development. In an even more extreme scenario, if that forestland has developable frontage, the same acre could be worth as much as $30,000, with the temptation to sell heightened. Ironically, this theoretical $30,000 asset is taxed annually on the *possibility* that it could be sold at that price. For a $30,000 asset in the form of stocks or mutual funds, taxes are only paid on the annual interest income, not on the assessed value of the total asset. Only at the time of "development" or sale of these securities is the total value taxed.

If society's goal is to develop policies that recognize and support the crucial role our forests play in sustaining its future, property tax laws and other forestland policies must better reflect the economic and non-economic benefits compiled below. Private forest landowners must have incentives to steward their land rather than degrade or convert it to non-forest uses.

METHODS

In this section of the paper we seek to attach economic value to public benefits on private forestlands. In order to conserve our forests, policies designed to further this goal must directly address the large number of private forest landowners in Massachusetts who make the choice either to conserve or convert their forest to other uses. Forestland taxation is an important financial issue for landowners, and existing property taxation inadequately accounts for the real costs and benefits of forestland to the owner and to society. We aim to show that there is public value in private forests—much more than is given credit for--and to provide a basis for launching the dialogue around the question of how to ascribe that value, and what actions to take in order to preserve and sustain that value.

In recent years there has been a growing desire to assign economic values to environmental externalities, so that natural resource-based decisions can be more realistically compared in our market-driven society. Because this is a young trend and the science imperfect, solid data for all forest values, goods and services are scarce, at best. However, we have sought to gather the best available information and to lay the groundwork for a more complete economic picture of public benefits from private forestland.

We selected eight public benefits that come from the forest: water quality, climate moderation and air quality, biological diversity, landscape character, recreation, forest

products, social meaning and a global environmental ethic. From a lay perspective this may be a reasonable list that embraces most of the ways that forests are important to people, but from an economist's point-of-view, difficulties arise. Some of these benefits are useable, renewable products such as wood or clean water; others are economic impacts such as tourism dollars that derive from landscape character or wildlife-centered recreation spending. Others still, are unquantifiable, such as biological diversity or social meaning. How can these values be packaged into a tidy sum? Another difficulty we confronted with the paucity of data is that some values exist in the form of stocks (total value per acre) and others in flows (dollar value per acre, per year). For example, the total standing timber inventory on an acre would be the stock, and the annual growth increment would be the flow. In short, these two types of measure further complicate the possibility of neatly summing what dollar values were available.

Of necessity, we used several approaches to valuing forest-based services and products. Where reasonable economic data exist (e.g. for the wood industry), an economic impact analysis was possible. When those data were not available, the cost of an alternative solution might be presented with reasonable extrapolations made (e.g. costs avoided running clean vs. dirty water through a water filtration plant). In the absence of solid data, we describe ways of approaching the valuation problem with the hope that better numbers may be available in the future (e.g. landscape character). Other values simply defy economic quantification so we reference studies that discuss these values (e.g. biological diversity, social meaning of forests).

Because private forestlands and public benefits are the subject of this paper, we attempted to tease out this subset of values from those of the entire Massachusetts forest. As data were often lacking for various public uses of private lands, the best we could do was multiply the total forest value by the 78 percent that is privately held.

PUBLIC BENEFITS

1. Water Quality

It can be argued that clean water is our most important forest product, a resource essential to all life--human and non-human alike. Whether water comes from a large or small reservoir, or a public or private well, the hydro-geologic conditions of this region dictate that forests play a critical role in providing clean drinking water. These ecosystems protect water quality and influence water production (water yield). When forest cover is maintained, deep organic layers develop, as do soils full of macropores with storage and holding capacity; these characteristics enable water to stay longer in the ground. This increased retention time lowers sediment and nutrient pollution before water ultimately enters a nearby tributary. Forest ecosystems generally reduce water yield compared to land in either grassland, or under various levels of agricultural, residential, commercial, industrial development; but none of these land types retain and filter water as forests can, with high quality water the result.

Given that two-thirds of the state is covered by forests, and of these, 78 percent are privately owned (2.4 million acres), it is safe to say that these landowners' decisions to conserve or convert their forests will greatly influence the quality of the public drinking water supply. Although difficult to measure this benefit, here are three approaches to the

task.

Studiies by the Metropolitan District Commission (MDC) provide the only known state-specific data (Kyker-Snowman, pers. com.) on the value of the forest in protecting drinking water supply. Although publicly owned, the Quabbin and Wachusett reservoirs, which supply drinking water to 2.6 million inhabitants in metro-Boston (40 percent of the state's total population), are ecologically representative of privately owned forests in much of the state. Based on actual payments for land purchases, the total value of MDC's watershed holdings as of 1997 was $225,224,700 for 94,000 acres, or an average value per acre of $2,396. MA Dept. of Revenue figures for fiscal year 1999 show the assessed value of these same acres as $163,954,930, which yields a per acre value of $1,744. The problem with the above figures is that they are not actual water-pollution avoidance values, but derive from an alternative land use (usually development); they represent the market cost to purchase these lands and keep them undeveloped.

With water filtration plants a near-term inevitability for even the cleanest of Massachusetts water supplies, the cost-avoidance calculation is no longer "with" and "without" a filtration plant. However, experts (Barten, pers. com.) assert that it is far cheaper to filter clean water than dirty water; capital, construction, and annual operating costs will all be lower. Both the reliability and performance of the plant are enhanced by moving cleaner water through it. The costs avoided by filtering clean water that originates from an intact forest ecosystem, versus dirty water from a developed and degraded landscape, are more to the point.

For comparison purposes, a recent article in *Nature* (Costanza et al., 1997) attempts to put a dollar per hectare figure on cost avoidance provided by natural systems throughout the world. Forests in general are calculated to provide $2 for water regulation, $3 for water supply, $96 for erosion control, $361 for nutrient cycling, and $87 for water treatment, per hectare, for a total of $549 per hectare, or $222 per acre. Unlike the other values discussed above, this is an annual value per acre.

2. Climate Moderation & Air Quality

The influence of forests on climate is very important and well recognized. The climatic benefits of trees and forests are complex and occur at several scales—from very local to global. Individual trees provide shade and reduce the effects of wind. In residential and urban situations, trees can moderate the heat island effect, thereby lowering the amount of fossil fuel burned and subsequent heating and cooling costs. Significant changes in the total amount of forest over a large land area can influence general weather patterns.

At the largest scale, forests are critical in the global carbon equation. Although controversy continues as to whether "global warming" is occurring, it is indisputable that the concentration of atmospheric carbon dioxide has risen steeply during the last several decades as the combustion of petroleum has increased. Efforts to reverse the buildup of atmospheric carbon dioxide involve reducing "sources" of carbon dioxide and finding ways to increase long-term storage, or sequestration, of carbon in "sinks."

Functioning both as "source" and "sink," the role that forests play in carbon sequestration is complex; the soil and smaller plants are involved, too. Trees remove carbon dioxide from the air and store carbon in the form of wood and other tissues (sink). When trees respire or decompose, the stored carbon is returned to the atmosphere (source). Since nearly half the dry weight of wood is carbon, forests sequester enormous total amounts. Forests that are

growing and accumulating wood are net carbon sinks. Young stands accumulate carbon at a high rate; older stands contain more stored carbon than younger stands, but accumulate additional amounts at a lower rate. When trees are harvested, some of the stored carbon is returned to the atmosphere in the form of limbs, leaves and roots. Other portions converted to long-lasting products continue to store carbon well into the future. The bottom line is that continued forestland use produces a net carbon benefit, compared to residential, industrial, and commercial development.

The international marketplace is now in the process of determining the value of carbon, as an emissions trading system takes shape. Several utilities have undertaken carbon forestry projects, most often in tropical forests. The "cost" or "value" of carbon in these projects has ranged from about $1 to $20 per ton, with most falling in the $2 to $5 per ton range (Thompson, pers. com.). Current Massachusetts forest inventory data indicate that an average forested acre contains about 21 tons of tree carbon, with an average annual increase of 0.35 tons per year (USDA-Forest Service, 1998). Using the range of $2 to $5 per ton of carbon, an average acre of forest provides between $42 and $105 of "carbon value" in the standing trees, with an annual increase worth between $0.70 and $1.75 per acre. On a statewide basis, the carbon value alone of the Massachusetts forest is between $130 and $325 million with an annual increase of between $2.2 and $5.4 million. This is exclusive of the significant carbon value provided by trees on land that is not considered "forest." Again, 78 percent of this value can be attributed to the privately owned forests across the state.

Since the last full inventory of the Massachusetts forest, conversion from forest to other land uses has averaged about 6,538 acres per year (USDA-Forest Service, 1998). Land conversion from forest results in four distinct types of loss in the carbon equation. First, most of the carbon stored in the standing trees is converted from sink to source when the land is converted. Secondly, most of the capacity for ongoing annual net carbon fixation is eliminated. Thirdly, the new land use is almost certain to function as an additional significant source of new atmospheric carbon dioxide. Finally, most of the large reservoir of carbon stored in forest soils will be released to the atmosphere under a different land use.

Polluted air is filtered through the extensive and complex surface area of forest ecosystems. This process helps to alleviate human health problems, damage to vegetation and anthropogenic materials, reduced visibility and acid deposition. Trees intercept particulate pollution from dry or wet deposition and hold it until it falls or washes to the forest floor; in addition, some heavy metals can be absorbed by the leaves, though may cause a drop in photosynthetic capability. Trees absorb gaseous pollutants through their leaves, removing them from the atmosphere. The fact that they also emit natural compounds that can contribute to air pollution means that this is a complex system. However, the net effect is that trees play a key role in improving the human-degraded air quality of modern times.

A pioneering study done in Chicago and its environs (McPerson, Nowak, Rowntree, 1994) documented the effects of urban trees on air quality. Researchers estimated that trees removed hundreds of tons of carbon monoxide, sulfur dioxides, nitrogen dioxide, ozone and particulate matter less than 10 microns and affixed an air pollution removal cost around $1 million and $10 million for Chicago and the Chicago area, respectively. It would be a questionable exercise to extrapolate these numbers to Massachusetts where we have a dramatic east-west geographical gradient that ranges from urban to rural. Until research can be conducted closer to home, it will be difficult to quantify air pollution control costs avoided by our region’s forests.

3. Biological Diversity

As defined by Noss and Cooperrider (1994), biodiversity is "the variety of life and its processes; it includes the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning, yet ever changing and adapting." From a human perspective, biological diversity can be likened to a savings account, providing resilience to the landscape to buffer climate change, human impacts such as introduced species and unforeseen social uses.

Massachusetts is naturally diverse in plant and animal life, with a total of 2,040 native species, not including invertebrates (Barbour and others, 1998); roughly 90 percent of these use our extensive native forest ecosystems for part or all of their life cycle needs (Swain, pers. com.). Woodlands today cover 62 percent of the state, a reflection of the landscape's ability to grow forest, in spite of the predominance of treeless farmland 150 years ago and an ever-growing population. A patchwork of mostly small, private forest ownerships--both managed and unmanaged--result in a mix of young, middle-aged and old forests across a variety of sites. The end result of this mosaic of mostly small ownerships with varying objectives is an uncoordinated, yet seemingly resilient and biologically diverse forest.

State-listed rare species number 424 and are found in a variety of natural communities (Barbour and others, 1998); roughly one quarter of these occur in forested settings (Swain, pers. com.). Seventy-four percent of known rare species occurrences are on private lands (Barbour and others, 1998), though experts don't have the data to say how many of these are private forestlands. However, this estimate points to the important role private landowners must play in protecting biological diversity in this state. In the majority of cases protection means not developing land, though perhaps in some situations sensitive development with these rare species in mind will suffice. Despite centuries of human manipulation and under threat by exotic invasives, our forests nonetheless harbor the rich biological diversity we recognize today.

We may know the names of every tree in the forest, but we don't begin to understand the complex matrix of organisms and relationships that comprise the web of life. We are not capable of predicting the consequences of losing a species; nor can we predict the future importance of some as-yet-undiscovered human use of a forest organism. Therefore, an economic impact analysis is beyond reach and perhaps even trivializes the profound meaning of biological diversity to life on earth; in short, this benefit is unquantifiable. A look at recent forest history points to the commercial importance of hemlock bark for the tanning process and white pine for boxboard--two uses now obsolete. The recent discovery of a cancer-fighting chemical in Pacific yew bark serves as a prominent example of important new forest products. Because we can't read the future, no dollar value can be attached to unknown goods and services. What we can do is adopt an approach that conserves all the native elements of the web of life, common and rare alike. At the same time, public policies that give incentives to protect biological diversity can be created and employed.

4. Landscape Character

Private forestlands cover roughly half of the Massachusetts landscape. In this sense they are valuable to society for enhancing the quality of life: they buffer the visual severity of development and urban sprawl; they muffle sounds of traffic and human activity. Trees are central to society's notion of scenic beauty and numerous studies show that people prefer landscapes with trees. Research has also shown that a 35 to 100 foot swath of trees can reduce noise as much as 50 percent (McDonough, pers. com.). But how can one quantify a tangible public benefit in the spectacular fall foliage that draws tourists from near and far? Or the impression of continuous forest, broken by fields, streams and villages? Certainly without our forest-dominated landscape, tourist and recreation revenues would be lost to Vermont, New York and New Hampshire.

Tourism industry data provide the only readily available means to quantify landscape character. We make the assumption that, to the extent that the scenic landscape attracts visitors, forests must play an important role. The Berkshires could not provide respite and solitude, cool summer air for vacationers, or clear water for recreation without its forests. Nor would the Connecticut River Valley have the same bucolic appeal without its patchwork of farms and working woodlands. The Massachusetts Office of Travel and Tourism reports that in 1997, 27.8 percent of all visitors to the state identified a reason for coming to the Commonwealth as having to do with forests or scenery, a combination of the outdoors (16.6 percent), National/state parks (7.9 percent), or golf/tennis/skiing (3.3 percent) categories (MA Office of Travel & Tourism, 1999).

Total traveler expenditures for all counties in 1996 was $8,587 million; travel related payroll was $2,075 million; and state and local taxes related to travel were $420 million (MA Office of Travel & Tourism, 1999). Assuming, then, that 27.8 percent of this travel income was influenced by the scenic benefits of the forested landscape, and that 78 percent of the state's forests are privately owned, the following revenues were generated: $1,862 million for traveler expenditures, $450 million for payroll, and $91 million for state and local taxes, for a total contribution of $2,403 million.

Landscape character can also positively impact property values surrounding a key scenic feature--in this case forest landscape. Although no data are available, it is worth considering to what extent affected property values might drop if the forest were destroyed. This hypothetical tax base erosion could affect the community, its quality of life and its ability to attract desirable revenue sources in the future.

Another possible means to document the benefit to landscape character may come from the second home market. Berkshire County, for example, is known both for its heavily forested hillsides as well as its reputation for a second home economy. If one assumed that even half of these homes were purchased because of the pleasing rural ambiance afforded in large part by the forested landscape, the value of these homes plus the ripple effect to the local economy becomes significant. This, though, is a double-edged sword, because the very landscape that draws second home development and the attendant local economic benefits can become degraded by too much of a "good thing."

5. Recreation

Forests offer the setting for a huge variety of recreational activities--whether athletic, adventure-oriented, intellectual or more spiritual in nature. Walking, hiking, skiing,

hunting, wildlife observation, and nature contemplation describe many of the forest-based activities important to Massachusetts residents. In short, forests fill very basic physical and social human needs.

Walking, hiking and skiing usually require trails for moving efficiently through the woods. Massachusetts offers thousands of miles, both on private and public lands. A conservative estimate from one regional study (National Park Service and Appalachian Mountain Club, 1991) reports that of 2,522 miles of Massachusetts trails documented from their survey, 586 miles (23 percent) occur on private lands. Because of the make-up of our landscape, the majority of these trail-miles would cross a forested landscape. About half of the trail-miles crossing these privately owned lands are permanently protected and allow legal access by the public; the other half permit access through informal verbal, handshake or license agreements (Evans, pers. com.).

The three major long distance trails alone--Appalachian, Metacomet-Monadnock and Midstate--provide 298 miles of trails for a variety of uses, with an estimated 40 percent occurring on private land (Evans, pers. com.). Local trail networks also provide shorter, but more frequent recreational experiences for Massachusetts residents. For example, in the town of Amherst, an 80-mile public trail network relies on private land crossings for about 26 (33 percent) of those miles (Westover, pers. com.). Even when trail systems are developed mainly on public lands, access across private forestland can forge key links between parcels, greatly enhancing what might otherwise be shorter trail experiences. If we assume a 50-foot wide aesthetic buffer along 586 miles of trail, it is the equivalent of 3,552 acres used by the public.

Wildlife-centered recreation such as wildlife observation, freshwater fishing and hunting are popular activities in the state, documented most recently in a 1996 survey (U. S. Fish & Wildlife and Dept. of Commerce, 1998). Birding, in particular, accounts for 84 percent of the 834,000 residents and non-residents participating in wildlife observing activities reported in the study; freshwater fishing and hunting accounted for 377,000 and 84,000 participants, respectively.[1] These types of recreation are, to a large extent, forest-based activities because experts at the MA Div. of Fisheries & Wildlife's Natural Heritage Program report that roughly more than 90percent of our native plant and animal species use the forest for some part of their life cycle needs. Fifty-five percent of the state's nesting bird species nest in forested ecosystems (Swain, pers. com.). Freshwater species such as Brook trout and Atlantic salmon are highly dependent on the water quality that is protected by the filtering and erosion control functions discussed in the Water Quality section. Hunted species--of which deer is by far the most common, with fewer numbers of turkey, bear, grouse and woodcock--are principally forest-dwellers. Therefore, the forest is indispensable to the vast majority of species that are the focus of these recreational activities. And because 78 percent of the forest is privately owned, the integrity of our native wildlife populations is integrally tied to the private stewardship of these forest ecosystems.

To enjoy the recreational activities listed above, people use both private and public lands, though little documentation is available to quantify the extent. The survey cited above reports that for hunting, 67 percent of time spent in that activity was on private land that year.[2] Though this same federal report contains no public vs. private land use data for fishing or wildlife-watching, it is safe to assume that private lands, as with hunting, are used to a significant extent for these activities. Although many freshwater ponds may be public waters, access to the same, as well as to rivers and streams, will often be across

private lands.

In the same 1996 survey, data were collected on the contribution to the Massachusetts economy that these recreational activities represent. In-state expenditures (including: food and lodging, transportation, other trip costs, equipment, magazines and books, membership dues, other) for freshwater fishing was $524.6 million; wildlife-watching was $392.7 million; and hunting was $106 million.[3] The grand total of in-state expenditures for all of these activities was $1 billion. Even if only a conservative fraction of these revenues came from activities actually occurring on private forestlands--say 30 to 50 percent--the income to the state's economy would be hundreds of millions of dollars. Looking at deer hunting alone--the only subset activity for which private vs. public land use data exist--the total in-state trip and equipment expenditures associated with big game hunting was $70.5 million for the survey year.[4] Of this, at least 67 percent can be attributed to hunting on private land, or $47.2 million.

If private forestlands were unavailable to the public in the ways described above, residents and visitors would have to go elsewhere for recreation, taking their spending power with them and raising environmental costs from increased travel.

6. Forest Products

Massachusetts forests have historically provided and continue to provide important raw materials for human consumption. Our forests grow many highly valued species (white pine, red oak, sugar maple, white ash, black cherry) whose lumber is sold throughout the world. Other species (hemlock, birch, beech, red maple) usually make lower grade products like pallets, pulpwood or firewood, or supply building materials for landowners' use. Sugar maple and Christmas tree producers generate significant family income and enhance tourism both by opening their operations to the public and for the "open space" value of their properties on the landscape.

Forest production carries both public and private benefits. As the basis of the local wood economy, society benefits through stable jobs for its citizens, state and local tax revenues, and the ripple effect that occurs as earned dollars are spent within the economy. Private benefits accrue when forest products yield an income to the landowner, though often this revenue offsets property taxes and other carrying costs of undeveloped forestland. One might argue that the income is only a private benefit when it exceeds the carrying costs of the land.

Compared to other industries, the chain of production from raw material (stumpage) to finished wood product is longer than for almost any other major commodity. Thus the economic value-added ratio of the finished product to the raw material is high. Two recent efforts to document the economic impacts of the wood industry point to value-added multipliers that might be used for our purposes here. The MDC-Quabbin report on community and economic benefits from forestry (National Wildlife Federation, 1999) uses a value-added ratio of 20:1 within the forest products sector. Further, it states that a dollar generated in the wood products industry circulates 2.5 times before being banked or leaving the state. Effectively, the value-added ratio is then 50:1 when total economic impacts are addressed. A Connecticut wood industry study (Broderick and others, 1997) shows similar results, though arrived at by different methodology. In this case the effective

ratio for total economic impacts is 59:1. In the absence of current Massachusetts wood industry data, we will use high and low ranges to suggest a reasonable range of economic impact values.

For Massachusetts, two reports give the annual wood volume harvested, and when a stumpage value is generated, we have the base number to which the economic multiplier may be applied. A study of cutting plan filings (MA Dept. of Environmental Management, 1999) shows an average annual harvest from recent years of 83 million board feet from 30,682 acres. A recent federal inventory (USDA-Forest Service, 1998) suggests an alternative annual harvest of approximately 121 million board feet. A state expert (Rivers, pers. com.) estimates that less than 10 percent of the above forest products harvesting occurs on public lands. Thus, these two figures can delineate another dimension of the range. Assuming a value of $140 per thousand board feet (Boyce, pers. com.) when the tree is sold at the stump, these two volume estimates generate $11.6 and $16.9 million dollars. Applying the value-added multiplier of 20 to the stumpage revenues generated by the low and high annual harvest figures, we get $232 and $338 million, respectively. The "ripple effect," as these dollars further circulate within the state, would increase the economic impact of 2.5 times (cited above) for a total economic impact range of $580 to $845 million.

When economic impacts are spread over the 2.4 million acres of privately-owned timberland, the value ranges are $96 to $141 per acre for direct impacts within the forest products sector, and $242 to $352 per acre for total economic impact in the economy.

Other forest products contribute another $10 million of direct income from the Christmas trees and greens grown (Wood, pers. com.) and $3 million of direct income from the maple industry and related tourism from operations open to the public (McCrumb, pers. com.). It is unclear whether the same value-added ratios can be applied to these base revenue figures.

Current harvest levels are estimated to be less than 20 percent of the potential sustainable harvest rate (Kittredge, pers. com.), so the public benefit of wood production could be significantly greater in the future. A conservative tripling of the current harvest activity would result in an economic effect within the forest products sector ranging from between $696 and $1,014 million, depending on which initial harvest level is used from above.

7. Social Meaning

An often unspoken, yet very real benefit of trees and forests is its social meaning to people.

Though this benefit defies economic quantification, a large body of literature (McDonough, 1998) documents the range of ways that trees figure heavily in peoples' lives. For instance, peoples' satisfaction with their neighborhood is strongly affected by views of woods and trees and the number of trees near their home. And in fact, large wild lands and parks do not contribute to satisfaction as much as neighborhood trees. Another example is health benefits. Thoreau and Olmsted both wrote about the healing power of nature, and today a number of studies show the restorative effects that derive from access to trees. Reduced post-surgical complications, reduced need for pain killers, lower incidences of health-related stress symptoms like headaches, and lower attentional fatigue associated with the stress of having cancer were all documented in a collection of recent studies as

health benefits of patients who could view trees or walk among them. Cultural values are another aspect of social meaning. Trees figure prominently in folklore, myth, religion and literature--more so than any other plant. Finally, trees and forests are planted or gifted to commemorate special events and people.

McDonough (pers. com.) further reports that it is not the distant wilderness park that figures so heavily in these studies, but rather the trees and forests in the day-to-day lives of people that are so crucial. Trees in yards, the neighbor's woods, the landscape on the way to work give meaning to people. Although in Massachusetts these trees and forests are mostly privately owned, they create a backdrop that figures prominently in the lives of all its citizens.

8. A Global Environmental Ethic

The United States consumes a disproportionately large amount of the world's natural resources, and relies heavily on imported raw materials to support this consumption. For example, comparing western countries alone, U.S per capita consumption of sawn wood in 1997 was 12 times that of eastern European countries and almost three times that of western and central European countries (Berlik, 1999). A global environmental ethic would guide our society to take responsibility for its heavy consumption of the earth's natural resources, by acknowledging its impacts around the globe and by consciously acting to reduce strain on the rest of the earth's ecosystems. What's more, this ethic would recognize that developed nations such as ours are often in a better position to produce natural resources in an environmentally sound way, with access to modern technology and up-to-date regulations already in place.

In the context of this paper, we can look at the specific example of wood consumption and production in Massachusetts. A paper on this topic (Berlik, 1999) shows that between 1993 and 1998 about 1.7 billion board feet of wood were used across the state. For the same years, wood harvested from Massachusetts forests was less than 100 million board feet, or about 6 percent of total consumption. Further, the potential sustainable harvest rate of Massachusetts forests is estimated at over 700 million board feet, or about 41 percent of current consumption. This is the projected amount of wood that could be harvested each year from today's forest in an ecologically sustainable way. The bottom line is that very little of the wood consumed in this state is locally grown, in spite of abundant forests with commercially desirable species, relatively resilient ecosystems and a strong safety net of environmental regulations to protect the public interest in our forests. The author argues that

"logging in Massachusetts imposes rather minor ecological and aesthetic effects compared to the other source areas for timber, and the potential exists for the state's conservation-minded people to improve global environmental quality by matching a much larger proportion of their wood consumption with ecologically sustainable production."

Where does our wood come from, if not here? The United States as a whole produces about two-thirds of what it consumes, with domestic production limited largely to the Pacific Northwest and the Southeast. While sustainable forestry practices are gaining wider use in parts of these regions, they are not without ecological concerns. In the Pacific Northwest, geological and climatic conditions result in steep and fragile slopes that are easily eroded, and the unsustainable harvest of unique ancient forest ecosystems has occurred. In the

Southeast, forest ecosystems have been simplified by practices that favor monocultures. The other third comes from Canada, 65 percent of which comes from British Columbia. The environmental cost of shipping west coast Douglas fir and Western red cedar is not limited to poor harvest practices on site, but includes the environmental costs and energy losses in the trucking and material handling functions. Though here in New England, much of our wood comes from Eastern Canada, as well as the more distant regions mentioned, transportation costs and the negative environmental impacts are significant (Damery, pers. com.).

Outside of this country, widespread outrage over tropical deforestation has prompted efforts to reverse that trend. However, a recent study (Sohngen and others, 1999) predicts that for every 50 acres of forest set aside from timber harvesting in North American and Europe, a corresponding loss of 2.5 acres of previously inaccessible forest in Asia, South America, Africa and the former Soviet Union would occur. A global environmental ethic would suggest that harvesting should increase closer to consumers' homes.

To the extent that Massachusetts can meet its consumption levels with ecologically sustainable wood production in the future, private forest landowners will play a key role. For this sustainable wood production, private landowners will reap an economic benefit, but so will a global (public) benefit accrue to unexploited forests around the world. Instead of exporting the impacts of our consumption, we can face them at home and craft policies to ensure sustainable use of our homegrown resources.

CONCLUSIONS

Our forests provide vital goods and services to all citizens of the Commonwealth, and a great portion of these benefits comes from private lands. The research and discussion above point to a very significant contribution of dollars each year from privately owned forest activities that generate a quantifiable public benefit. When less tangible or unquantifiable forest benefits are considered, their worth is vastly greater. Further, this broad-brush assessment scarcely touches on the significant potential economic impacts that could come from a local and sustainable wood economy, a carefully developed eco-tourism industry or increased, sustainable recreation.

We therefore need public policies that acknowledge the Commonwealth's reliance on private forestlands and their stewards. Existing policies are counter-productive when they penalize these landowners by taxing them heavily on an asset that generates relatively low revenues to the individual, yet provides so many public benefits. Under our existing tax situation, a typical acre of forest in our earlier example can generate $22 per acre annually (i.e. on paper only), with the landowner paying out $10 in cash for taxes on that theoretical income each year. The documentation above might suggest that with the substantial public benefit that flows from that forest acre, private landowners should pay little or no forestland property tax. Some might go further to suggest that a credit go to those who are guardians of the public good. The point here is that private forests produce measurable, economic flows in Massachusetts, and contribute to broad social benefits not countable in money; yet, as private revenue-generators for landowners, forests are not big producers.

Based on the documentation of forest benefits in this paper, we propose that the Secretary of Environmental Affairs convene a task force on forestland taxation to develop and adopt

a new incentive mechanism that rewards private forest landowners who protect the public benefits inherent in their land. Although this mechanism(s) might most readily take the form of a reconfigured current use program, other approaches such as a state income tax credit, an exclusion from estate tax treatment or a combination of these and others should be studied as well. Whatever form they take, new policies must be designed with the explicit goal of keeping the private forest landscape thriving and whole. As it would be impossible for the state to buy all of these lands or their development rights, a cost-effective approach would be to craft rewards and incentives to make it highly desirable to keep land in forest, rather than convert it to other uses.

In concept, rewards for forest stewardship would be given incrementally to landowners, according to the degree of public benefit protected. The first level of protection--and the most critical--would be to refrain from development. By simply *not developing*, the possibilities for water and air quality, biological diversity, climate moderation, future wood supply and landscape character are most basically protected. Under current use taxation, for example, *not developing* could be rewarded by a significant reduction in property tax assessment. By managing the forest sustainably, according to a long-term plan, some of these benefits can be enhanced substantially; this could trigger a further reduction in assessment. Allowing public access for recreation could do the same. The most permanent form of protecting public benefits would be the transfer of development rights, so this activity should receive the greatest financial incentive of all.

Further, to ensure that the most critical lands (for any of these benefits) be protected, a parallel system of increased incentives could be activated when lands fall within state or federally designated high priority areas. For example: habitat polygons on the Natural Heritage & Endangered Species Program Atlas and ecologically sensitive communities; Areas of Critical Environmental Concerns; Zones I and II of ground water supply areas and Zones A and B of surface water supply areas; Forest Legacy Areas designated by the Dept. of Environmental Management’s Forest Legacy Task Force; statewide recreational trail systems; and others.

We believe that reforming property taxation for private forest landowners is an important part of the solution to a sustainable future for the forests of Massachusetts. We look forward to supporting this and allied efforts under the broad goal of forest stewardship.

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Personal Communications

As the science behind quantifying private forest benefits is far from perfect, we had to rely on thoughtful conversations with experts in the field to approximate the benefits contained in this paper. These contributors are listed here.

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