Applied Science and Technology Transfer for Avoided Costs and Protected Forest Values

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Abstract

Applied science and technology transfer in support of healthy forests and rural communities includes more than the training of individuals to use the latest equipment or software products. Success will ultimately be measured not in user adoption statistics but in the degree to which forest practices and public expectations are aligned over the long term. Public expectations are focused on many nonmarket values like clean air, water, and habitat protection. Therefore, those in the business of forest science and technology transfer assume certain responsibilities for providing the best scientific information available in a form that supports the empowerment of interested publics, professionals, and policymakers to achieve the greatest good. First, we must contribute to the development of a common understanding of the present circumstances. Secondly, we must assist with knowledge and tools needed to develop decision-support systems at appropriate scales of temporal and spatial complexity. A successful society must be served by scientific knowledge, understanding, and predictive ability such that informed decisions can be made that evaluate alternatives and tradeoffs.[4] In this paper, we will present a sample of nonmarket valuation methods for forest and forest product attributes as examples of how interdisciplinary applied science and technology is critical both to the valuation process and the decision-support context. The goal is to demonstrate how technology can be used to help analyze the complexities of management choices associated with the sustainable management of multiple values.

Keywords: Forestry technology transfer, applied science, nonmarket values, avoided costs, environmental services, cost/benefit analysis, forest fires, sustainability.

The Importance of Understanding Values Created by Forest Management

Forests provide a number of market and nonmarket values that benefit both consumers and the general public. Market benefits include products and services that can be bought and sold, such as timber and nontimber forest products. These market benefits are determined by public demand and can be relatively easily assessed for comparable value by using existing market price data. Nonmarket benefits include essential environmental services such as clean air and water, carbon sequestration, aesthetics, habitat, biodiversity protection, fire avoidance, and others.

However, pricing nonmarket benefits and services supplied by forests, although very much in public demand, can be problematic owing to their nontraded nature. Nonetheless, nonmarket values can be quite high as evidenced by policies to protect nontraded resources such as air, water, and wildlife habitat. Integrating the benefits of nonmarket values and market values inevitably changes the definition and selection of best management practices.

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[4] Kimmins et al. 2005, Guldin et al. 2005

For example, if the avoided cost of fighting fires were available in the market as an offset to the cost of removing overly dense ladder fuels, more fire-prone forests would be thinned thus reducing fire risk while also contributing to the public understanding and support for such investments (Mason et al. 2006). Providing incentives to produce forest aesthetic and biodiversity attributes that the public values would motivate different management pathways other than short rotations (Lippke et al. 1999). Constructing buildings to the public's high environmental standards would require different product purchases and processing investments; in many cases, wood products would be selected for having higher overall environmental performance (Lippke et al. 2004).

This paper examines several areas where nonmarket values are important and discusses public demand for such benefits and services with the objective of revealing the importance of these values in decisionmaking and the critical integration role for applied science and technology transfer.

What Do Markets Pay For?

It is generally understood that markets facilitate the buying and selling of goods and services at market-established prices. Members of the public are well acquainted with supply and demand. Schumpeter (1954) told us that market signals or "positive" economics explain relative value by establishing price. Market goods from forests include timber and fiber used for building products, paper, cardboard, industrial chemicals, and biofuel for renewable energy products. Nontimber products such as natural foods and flora as well as recreational amenities derived from the forest may also be bought and sold for commercial purposes. In addition to direct production costs, prices established for timber and nontimber products should include all other ancillary costs associated with ownership and management incurred as a result of regulatory compliance, liability risk avoidance, or other factors. For example, modern forest management costs might include insurance to reduce the risk of damage as a result of litigation in courts or additional staffing with relevant expertise to reduce the risk of (perceived or real) negative impacts on surrounding neighbors or the public. Another example might be higher costs associated with alternative, lower impact harvesting practices or forest certification audits. In the market, cost/benefit relationships are dynamic. When factors of production fail to earn marginal profit, the product ceases to be made available. Conversely, if demand (i.e., market price) increases then so does the quantity of products supplied.

What Do Markets Not Pay For?

Forest product prices do not include the value of the numerous public benefits that forests provide such as clean air and water, habitat protection and biodiversity, recreation and aesthetics. Nor do they include the benefits derived from avoiding the high public cost of forest fires associated with fire suppression, fatalities, habitat and facility destruction, and postfire restoration. Forests are often managed to provide opportunities for recreational activities and public enjoyment of forest aesthetics and scenic beauty that (aside from nominal user fees) may not be captured as market prices reflective of intrinsic value (Garber-Yonts et al. 2004, Laband 2003, Pagiola et al. 2004). Life cycle analysis has shown that products made of wood are renewable and are more environmentally-friendly than building products such as steel studs or concrete walls (Lippke et al. 2004); however, the market currently delivers no premium for this environmental contribution, which is also generally not revealed to the public. Such forest "products" are not sold through organized markets, yet there is strong public demand for their environmental attributes. Schumpeter (1954) told us that such deliverables fall into the realm of "welfare" economics, which prescribe rather than explain value. As the complexity and disagreement surrounding forest management (especially on public lands) increases, it is apparent that better agreement on valuation methodologies and cost/benefit relationships that include a broad view of public values could be helpful.

Recognizing Avoided Costs of Fire Suppression as Public Value

Although "welfare" economics may not be explained by market prices, there are nonetheless real costs associated. Suppression of forest fires, for example, can be quite expensive. Added to risk to public resources are forest fire threats to human life, wildlife, and habitat. It has been shown that there is a public willingness to pay (WTP) for fire hazard reduction (Winter and Fried 2001), yet no value for fire hazard reduction has been adopted into the market even though there are readily available cost estimates for at least some of the costs that result from not reducing fire risk. It is estimated that for the period 1999 through 2002, the average cost of firefighting for the Washington State Department of Natural Resources was approximately $2,000 per acre (Washington State DNR 2004). A study of federal forests in Washington and Oregon found the average cost of fire suppression for the Forest Service to be over $1,000 per acre (Mason et al. 2003). The severity and incidence of fighting fires can be reduced by management treatments (Rummer et al. 2002), yet associated avoided costs are not included in cost/benefit analysis of investments in fuel reduction treatments. Better understanding of such relationships could lead to healthier forests and public savings with applied science and technology transfer as the critical agents to produce the required information. The valuation of fire risk reduction is developed here as an example that can be extended to other nonmarket value benefits.

Nonmarket Benefits of Reduced Fire Risk

Removal of small-diameter trees to reduce hazardous fuel conditions is known to be costly. Large trees can be removed for their lumber and other product values as reflected in the market; however, the market value for smaller logs is often less than the harvest and hauling charges. As a tradeoff, failure to remove small-diameter trees results in the retention of fuels that support the transfer of ground fire to crown fire and aggravate negative wildfire impacts to the landscape (Omi and Martinson 2002, Peterson et al. 2005). Unfortunately, the market does not automatically reflect the value of negative environmental consequences that result from crown fires. If the negative impacts that result from crown fires were fully reflected in the market, there would be much higher motivation to avoid them, providing the necessary incentive to remove high fuel loads in spite of the cost.

Land management decisions aimed at reducing the risk of fire can have a high benefit-to-cost ratio, if all market and nonmarket costs and benefits are included. First, the cost of fighting fire could and should be considered a cost of not removing high fuel loads. Mason et al. 2003 developed a parametric approach to assist interested publics and policymakers in quick estimation of relative costs and benefits associated with fuel reduction treatments. A look-up table was developed to estimate the present value of avoided future costs at an assumed discount rate. The independent variable is time-to-fire. With this table, users can estimate costs for a particular event at a predicted time or, by choosing as the temporal target the midpoint of an equal probability distribution, the cumulative cost exposure for a landscape can be approximated where each acre is expected to burn at some time over a designated period.

Mason et al. (2003) demonstrated this methodology for the present value of the public savings associated with fire risk avoidance on federal forests. By using recent experience on firefighting costs of $1,000 per acre and high-hazard forests (those likely to burn within 30 years) and moderate-hazard forests (those likely to burn within 60 years) an estimate of the magnitude of the resulting public liability exposure can be readily developed. The resulting estimated present values of future fire suppression costs are $481 per acre for a high-risk forest (with 15 years as the distribution midpoint) and $231 per acre for a moderate-risk forest (with 30 years as the distribution midpoint). Fuel reduction treatments such as thinning the smaller trees while leaving a basal area of 40 to 60 square feet per acre have been shown to reduce the ladder fuels that trigger crown fires and produce some log revenue (Fiedler et al. 2001). When we add the present value of estimated fire suppression cost avoidance to net return from sale of harvested merchantable logs, we have successfully characterized a combined market (positive economics) and nonmarket (welfare economics) public cost/benefit analysis. Such a framework is essential for integrated evaluation of forest management alternatives.

There are many other nonmarket values associated with the reduction of fire risk important to forest owners and to society at large (Pfilf et al. 2002). For example, there is a financial value of avoiding facility losses and human fatalities. Communities value a lower fire risk and reduced smoke. Habitats for threatened and endangered species that are valued by many publics may be lost to wildfires. Fires reduce the carbon stored in the forest and the opportunity to produce long-lasting pools of carbon stored in products. Fires consume biomass that might otherwise be used for energy conversion and green energy credits. Regeneration after fires can be problematic and costs are high. Postfire rehabilitation may be needed to avoid serious erosion, water contamination from excessive sediment, and invasion of exotic species. If there are harmful impacts from thinning treatments they can be incorporated as well.

Where future costs (losses) can be identified for these and other values, then cumulative present-value liability estimates can be approximated and the relative costs and benefits of management alternatives better understood. Mason et al. (2003) created an accounting ledger for cost/benefit analysis of fuels reduction investments per acre on federal forests to demonstrate how avoided costs and nonmarket values might be better considered as real returns on management investments. Although management costs of $580 per acre are charged for fuel reductions and no net market returns are credited from log sales, the magnitude of protected values and avoided costs they estimated was large, $1,402 over the investment cost of thinning on high-risk stands and $606 net on moderate-risk stands. An alternative way to view the investment is as a payback time to breakeven chart (fig. 1). Considering only the avoided firefighting cost, it takes about 10 years to break even with the initial investment in fire risk reduction, but as other avoided costs (or values) are included, the payback is much quicker.

However, under current market mechanisms (that exclude nonmarket values), forest owners/managers may not adequately benefit from forestry investments to avoid costs as they absorb all the market costs while the nonmarket values flow to other stakeholders. The effective result is a disincentive for sustainable forest management based in an irreconcilable tension between what the public pays versus what the public desires.

Other Examples of Nonmarket Tradeoffs

Although WTP studies may overestimate actual consumer behavior, experimental choice surveys, a specialized form of Contingent Valuation Analysis (CVA), provide a means of allowing survey respondents to choose the best among many different treatments, thereby demonstrating a means of ranking different environmental attributes (Green and Srinivasan 1990). For example, a mail survey conducted in Washington state asked rural and urban families to select the best of different forest management alternatives that altered forest attributes. Respondents selected from different tradeoffs of biodiversity and habitat, aesthetics, rural jobs, cost, and a brand label for the treatments (Xu et al. 2003). The result showed a substantial WTP for biodiversity/habitat and aesthetics restoration, as well as a willingness to accept a level of cost and job losses to achieve these benefits. A WTP of more than $100 per year per family for aesthetics and habitat restoration was not uncommon with the amount sensitive to the location of the family (urban/rural) and their income.

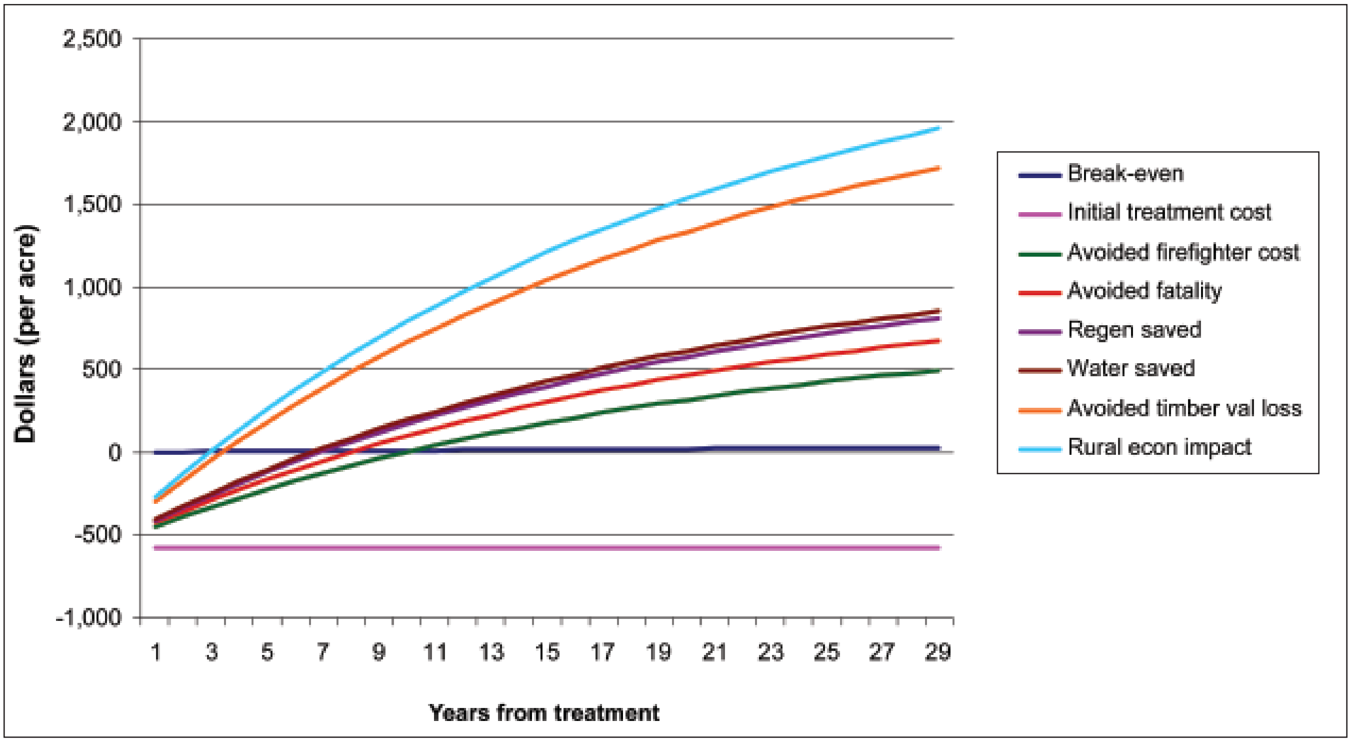

Figure 1—Buildup of nonmarket values from thinning treatment to reduce fire risk.

Another example is a recent study that used results from life cycle assessments (Lippke et al. 2004) and a choice-based, stated preference approach and basic consumer demand theory, to analyze household preferences for reductions in environmental emissions from building products (Robbins and Perez-Garcia 2005). By means of a national mail survey, respondents were asked to assess a set of goods with different levels of emissions and price attributes; they were then asked to choose their most preferred alternative. Four price levels, four environmental levels (including a baseline no-change scenario) for four environmental attributes (greenhouse gas emissions, solid wastes, clean water, and air particulates) were included in each of the 15 choice sets. The results of this survey suggest that consumers are sensitive to differences in the amounts and favor building materials with lower greenhouse gas emissions and other environmental burdens over those resulting in higher burdens.

These types of experimental choice studies can help demonstrate specific public preferences and values in order to improve targeted educational and training programs. Management can be geared to provide or improve values such as those described above (aesthetics, biodiversity, or reduced greenhouse gas emissions); marketing can be directed to improve public information so consumers have a better understanding of the true costs of their purchasing decisions.

Technology Development and Transfer

Integrated approaches to modern forest management require the support of software products with the capability to test treatment alternatives and project results forward in time with growth and yield models. Interested members of the lay public as well as forestry professionals and policymakers must be informed of present conditions and future possibilities such that choices for action are not confusing and subject to distrust. Effectiveness will depend on egalitarian availability and transparency of forest modeling technologies. Both formal and informal delivery partnerships are evolving.

For example, the USDA Forest Service has spent years developing and refining the Forest Vegetation Simulator (FVS) as a publicly available growth-and-yield model with variants for most areas in North America (Dixon 2003). The Fire and Fuels Extension (FFE) has also been developed by the USDA Forest Service for use with FVS to assess risk, behavior, and impact of fire in forest ecosystems (Reinhardt and Crookston 2003).

On a parallel track, has been development of the user-friendly Landscape Management System (LMS) at the University of Washington (McCarter 2001). Because these systems project tree list responses, they are especially important tools for quantifying forest structure attributes important to many environmental values, such as habitat suitability, fire, and aesthetics. The Rural Technology Initiative (RTI) at the University of Washington and Washington State University provides workshops and training sessions to help the public learn how to use forestry software products such as FVS, FFE, and LMS.

When these public domain software products are brought together and made available through public training programs such as those described above, the resulting technology and applied science transfer empowers local participation in fuel reduction planning. For people concerned about forests but not inclined to use software, process empowerment also occurs when scientific findings are made available and linked to transparent and replicable methodologies including visual displays and templates.

Conclusions

The challenge of developing long-term strategies to reduce wildfire risks across tens of millions of acres of inland West forest, to enhance the public's understanding of the existing tradeoffs between biodiversity protection while eliminating jobs, and to improve consumer product information, is daunting. The body of information to be considered is huge, and the planning process may be formidable. Infrastructure is limited, funding is scarce, costs high, and conflicts rampant (USDA Forest Service 2002). Strategies to help professionals, publics, and policymakers gain better understanding of the present circumstances and the future possibilities of adjustment would be helpful. New technology applications are providing the definition of variables needed to estimate many nonmarket values and the benefits that can be gained by including them in management decisions. It is important to understand the value of these benefits and to integrate them with the other needs of consumers and forest managers. Ignoring these values because they may be more difficult to quantify, results in poor management practices and unintended consequences.

As an example, for Washington state alone, we could expect that close to $1 billion in potential firefighting costs could be avoided with implementation of publicly supported proactive fuel reduction treatments (Washington State DNR 2004). There are additional nonmarket benefits associated with targeted forest biomass removals like green energy, protecting habitat, aesthetics, and reduced smoke. In terms of aesthetics and biodiversity, the analysis indicates that public valuation of forests could be increased by $1 to $2 billion per year by motivating more alternative management practices (Lippke et al. 1999). This net benefit includes the value for increasing biodiversity and aesthetics less the value lost from lower employment and higher costs accumulated across all residents of the state as measured in the survey described above.

The Nation's investment in just residential construction is $750 billion per year (USDI Bureau of Economic Analysis 2006); integrating consumer demand for green building products can lead to a significant change in the distribution of market share if accompanied by changes in perceived public value. Decisions to build and buy houses that do not consider environmental burdens misdirect purchases to products that are fossil fuel intensive instead of using renewable resources for buildings and green energy. As a result, even as the movement to curb carbon emissions gains momentum, such emissions will, in fact, continue to increase. Purchasing standards could better reflect recent scientific findings by using labels to identify products with lighter environmental burdens. This would enable nonmarket values to be internalized into consumer decisions.

Applied science and technology transfer toward building a better understanding of value tradeoffs will help the public, policymakers, and forestry professionals develop a common understanding of management options. Without such assistance, the complexity of disparate valuation systems against a backdrop of broad landscapes and extended timeframes will leave us arguing about what is out there today rather than developing a vision for how we could manage forests tomorrow.

Metric Equivalents

1 acre = 0.405 hectares

Literature Cited

Dixon, G.E. 2003. Essential FVS: a user's guide to the Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Forest Management Service Center. 193 p. http://www.fs.fed.us/fmsc/fvs/. (16 April).

Fiedler, C.; Keegan C., III; Woodall, C. 2001. A strategic assessment of fire hazard in Montana. Joint Fire Sciences Program Report. Missoula, MT: University of Montana. http://jfsp.nifc.gov/documents/NMreport.pdf. (16 April 2006).

Garber-Yonts, B.; Kerkvliet, J.; Johnson, R. 2004. Public values for biodiversity conservation policies in the Oregon Coast Range. Forest Science. 50(5): 589–602.

Green, P.; Srinivasan, V. 1990. Conjoint analysis in marketing: new developments with implications for research and practice. Journal of Marketing. 54(4): 3–19.

Guldin, R.; Parrotta, J.; Hellström, E. 2005. Working effectively at the interface of forest science and forest policy; guidance for scientists and research organizations. IUFRO Occasional Paper No. 17. Vienna: International Union of Forest Research Organizations. 29 p.

Kimmins, J.; Welham, C.; Seely, B.; Meitner, M.; Rempel, R.; Sullivan, T. 2005. Science in forestry: Why does it sometimes disappoint or even fail us? The Forestry Chronicle. 81(5): 723–734.

Laband, D. 2003. Regulating biodiversity: tragedy in the political commons. Reprinted. In: Easton, T.; Goldfarb, T., eds. Taking sides: clashing views on controversial environmental issues. 10th ed. Guilford, CT: McGraw-Hill. 400 p.

Lippke, B.; Bare, B.; Xu, W.; Moffett, J.; Turner, B. 1999. The joint production of timber and environmental values: demonstration for the westside of Washington state. In: Yoshimoto, A.; Yukutake, K., eds. Global concerns for forest resource utilization: sustainable use and management. The Netherlands: Kluwer Academic Publishers: 295–309.

Lippke, B.; Wilson, J.; Perez-Garcia, J.; Bowyer, J.; Meil, J. 2004. CORRIM: life-cycle environmental performance of renewable building materials. Forest Products Journal. 54(6): 8–20.

Mason, L.; Ceder, K.; Rogers, H.; Bloxton, T.; Comnick, J.; Lippke, B.; McCarter, J.; Zobrist, K. 2003. Investigation of alternative strategies for design, layout and administration of fuel removal projects. Seattle, WA: Rural Technology Initiative, College of Forest Resources, University of Washington. 78 p.

Mason, L.; Lippke, B.; Zobrist, K.; Bloxton, T.; Ceder, K.; Comnick, J.; McCarter, J.; Rogers, H. 2006. Investments in fuel removals to avoid forest fires result in substantial benefits. Journal of Forestry. 104(1): 27–31.

McCarter, J. 2001. Landscape management system (LMS): background, methods, and computer tools for integrating forest inventory, GIS, growth and yield, visualization and analysis for sustaining multiple forest objectives. Seattle, WA: University of Washington. 101 p. Ph.D. dissertation. http://lms.cfr.washington.edu/.

Omi, P.; Martinson, E. 2002. Effect of fuels treatment on wildfire severity. Joint Fire Sciences Program Report. http://jfsp.nifc.gov/JFSP_Products_3.htm. (16 April 2006).

Pagiola, S.; von Ritter, K.; Bishop, J. 2004. Assessing the economic value of conservation. Environment Department Paper No. 101. Washington, DC: The World Bank.

Peterson, D.; Johnson, M.; Agee, J.; Jain, T.; McKenzie, D.; Reinhardt, E. 2005. Forest structure and fire hazard in dry forests of the Western United States. Gen. Tech. Rep. PNW-GTR-628. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 30 p. http://www.treesearch.fs.fed.us/pubs/8572. (16 April 2006).

Pfilf, R.; Marker, J.; Averill, R. 2002. Forest health and fire: an overview and evaluation. Chantilly, VA: National Association of Forest Service Retirees. http://www.fsx.org/NAFSRforesthealth.pdf. (16 April 2006).

Reinhardt, E.; Crookston, N., tech. eds. 2003. The Fire and Fuels Extension to the Forest Vegetation Simulator. Gen. Tech. Rep. RMRS-GTR-116. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 209 p. http://forest.moscowfsl.wsu.edu/gems/RMRS-GTR-116.pdf. (16 April 2006).

Robbins, A.; Perez-Garcia, J. 2005. Consumer willingness to pay for renewable building materials: an experimental choice analysis and survey. Seattle, WA: Center for International Trade in Forest Products, College of Forest Resources, University of Washington. 65 p.

Rummer, R.; Prestmon, J.; May, D.; Sheppard, W. 2002. A strategic assessment of forest biomass and fuel reduction treatments in Western States. U.S. Department of Agriculture, Forest Service. 21 p. http://www.fs.fed.us/research/pdf/Western_final.pdf. (16 April 2006).

Schumpeter, J. 1954. History of economic analysis. Schumpete, E.B., ed. New York: Oxford University Press. 1260 p.

U.S. Department of Agriculture, Forest Service. 2002. The process predicament: how statutory, regulatory, and administrative factors affect national forest management. Washington, DC. 40 p. http://www.fs.fed.us/projects/documents/Process-Predicament.pdf. (16 April 2006).

U.S. Department of Commerce, Bureau of Economic Analysis. 2006. Gross domestic product statistics. http://www.bea.gov/bea/dn/home/gdp.htm. (16 April).

Winter, G.; Fried, J. 2001. Estimating contingent values for protection from wildland fire using a two-stage decision framework. Forest Science. 47(3): 349–360.

Washington State Department of Natural Resources [DNR]. 2004. A desirable forest health program for Washington's forests. Forest Health Strategy Working Group Report. Olympia, WA. 63 p.

Xu, W.; Lippke, B.; Perez-Garcia, J. 2003. Valuing biodiversity, aesthetics and job losses associated with ecosystem management using stated preferences. Forest Science. 49(2): 247–257.