Spring 2007

Sustainability of New Hampshire's sawmill industry and its forest resource base

Difei Zhang
University of New Hampshire, Durham

SUSTAINABILITY OF NEW HAMPSHIRE'S SAWMILL INDUSTRY AND ITS FOREST RESOURCE BASE

BY

DIFEI ZHANG

Master of Science, University of New Hampshire, 2001

DISSERTATION

Submitted to the University of New Hampshire
In Partial Fulfillment of
the Requirements for the Degree of

Doctor of Philosophy
In
Natural Resources and Environmental Studies

May, 2007

This dissertation has been examined and approved.

Dissertation Director, Dr. Theodore Howard,
Professor of Forestry Economics

Dr. Richard England, Professor of
Economics and Natural Resources

Dr. John Halstead, Professor of
Resource Economics and Natural Resources

Dr. Mark Ducey, Associate Professor of Natural Resources

Dr. Andrew Cooper, Research Assistant Professor of
Natural Resources and Earth, Oceans, and Space

March 8, 2007

Date

ACKNOWLEDGEMENTS

First of all, the committee members, Dr. Richard England, Dr. John Halstead, Dr. Mark Ducey and Dr. Andrew Cooper and especially dissertation advisor Dr. Theodore Howard, are graciously acknowledged for the advice and expertise which have so improved this dissertation and its author.

Without the committee's guidance, my dissertation research would not be a success. I want to thank Dr. Howard, who is not only my PhD advisor, but also a life mentor who lights my academic research path with his resourceful library of knowledge and wit. He is a stunning inspiration during the course of my research and has been a role model for me with his talents and ability in research and teaching excellence. I enjoyed being his graduate assistant in teaching Forestry Economics (NR643) and conducting many research projects. His multilingual ability encouraged me to continue polishing my foreign language skills in Japanese, French and Italian. Thanks to his support; I completed French National Advanced Language Examination Certificate during my exchange study in France. Thanks to the funding from the Canadian Embassy and the N.H Agriculture Experimental Station, we launched our bioregional study beginning with our first forest industry survey in French conducted in Chaudière-Appalaches, Québec. As director of international education, he is also an amazing diplomat who gave me the opportunity to work directly with Ambassador George Bruno and the U.S. government for peace programs with Russia, Latvia, Kazakhstan and Belarus. I want to thank Professor Richard England, a genius economist. I was addicted to his lectures and analytical reasoning in macroeconomics, economic growth and sustainable development theories and environmental economics. He provides me with a live dictionary of excellent teaching methods and various applications of economic theories. He also led me to dive deeply into advanced research in Economics and Natural Resources. I want to thank Professor John Halstead, the chair of Resource Economics. He guided me to the intersection of Economics and Natural Resources with vivid lectures and right-to-the point analysis. I read many of his publications. His thesis inspired my research ideas in logit modeling and contingency analysis for the visibility study in White Mountain. Since then, he continued to be a great resource throughout my dissertation work. I want to thank Professor Mark Ducey who taught me various sampling techniques, statistical modeling and biometric analysis methods in forestry. I want to thank Professor Andrew Cooper for his sharp ideas and expertise in statistical modeling. His PhD dissertation gave me a great example of application of economic theory to the natural resource field. I also want to thank Professor Douglas Morris, my master degree mentor who taught me linear programming, land economics and various quantitative and qualitative analysis skills in research and teaching. I also want to thank Professor Paul Johnson for teaching me solid modeling skills in quantitative ecology and Professor Alberto Manalo for teaching me SAS programming in advanced econometrics. It was also a great experience to be his teaching assistant in statistics. Microeconomics has always been my favorite field and Professor Thorsten Schmidt's Microeconomics II elevated me to an advanced level in microeconomic analysis to tackle current economic problems and issues. He brightened me with advanced game theory from the beautiful mind of John Nash.

I am very thankful to the departments of Natural Resources, Resource Economics, and Economics, for giving me the opportunity to work as a research and teaching assistant and as an instructor starting in 2004 fall, which developed my abilities in many ways and made this work possible. I wish to thank all the professors in these departments for equipping me with solid research and teaching skills in this interrelated field combining natural resources and economics. Especially I want to thank the Department of Economics and the Whittemore School of Business and Economics for offering me a position to be an instructor for two sections of ECON 402 Principles of Microeconomics, which prepared me to be a future faculty member, and complete my cognate in teaching. Economics chair Prof. Evangelos Simos taught me lots of methods in improving my teaching skills. I also want to thank Complex Systems and Climate Change Center in the Institute of Earth, Oceans and Space for giving me the opportunity to work as GAIM director assistant and one of the three editors for GAIM summer 2004 publication. I want to specially thank GAIM director, research Professor Dork Sahagian who inspired me with his productivity in research and scholarly diligence. I also want to thank Professor Claire-Lise Malarte-Feldman, Professor Nadine Berenguier, Professor Cooper in the French Department and Professor Marie Dravasa in the Italian Department who polished my language skills, leading me to win a UNH foreign language award and PDP U.C. Berkley, National French Honorary Society Award.

Special thanks are given to the New Hampshire Agriculture Experimental Station for providing sufficient funds to conduct this research. I also want to address thanks to the sawmill industry operators and professionals in the New Hampshire Forest Service, New Hampshire Department of Resource Economics and Development and University of New Hampshire Cooperative Extension, who supplied important information for this study; their cooperation is greatly appreciated.

Thanks are also due to my dear friends and colleagues during my study at UNH. They are my cheerleaders who never let me down and showed me for so many years that they care. I also want to thank my old buddy, UNH residential scholar, American Space Science Historian and Flying Tiger's author Daniel Ford. He taught me how to fly his 06hotel cub and I had fun being his Japanese and Chinese translator for his books and co-authored his new publication in the Flying Tiger series.

I would lastly want to address special thanks to my devoted parents, Yuexian and Shaohua Zhang who made me believe "there is a will, there is a way". They taught me how to swim in the ocean of endless knowledge with curiosity of learning as the tool and encouraged me to climb all the way to the top of this ivory tower with a brave heart. I also want to dedicate my work to my grandma Fangyin Hou. She is the first person telling me the richness of a person is knowledge. She shaped my character, gave me strength and energy in continuing coloring thousands of empty pages of my life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

SUSTAINABILITY OF NEW HAMPSHIRE'S SAWMILL INDUSTRY AND ITS FOREST RESOURCE BASE

By

Difei Zhang

University of New Hampshire, May, 2007

Sustaining our forests is vital for a healthy ecosystem and for the future of forest industry. To sustain the regional sawmill industry as well as the associated forest resource base, the key is to track the consumption and inventory of eastern white pine (Pinus Strobus L.), the most dominant commercial species in New Hampshire. This research profiled the sawmill industry in New Hampshire and Vermont in terms of production, consumption, labor characteristics and regulating economic and policy issues. We examined the sustainability of the industry and its resource base; with a specific focus on the white pine sawmill industry and the dynamics of its supporting forest resource in New Hampshire by developing a wood supply model. We modeled spatially explicit demand by mills based on procurement data incorporating market forces and simulated inventory, harvest and stumpage prices, for a fifty-year projection period. This is the first approximation of a transparent spread-sheet based timber supply model tracking mill consumption and its forest base inventory at both state and county levels. It tested nine scenarios and corresponding sensitivities to parameter changes. It provided impact assessments of future land use change and other market dynamics on future wood supply for the sawmill industry. Model results suggest that the most sustainable scenario will be the optimistic case with low-end initial mill consumption and the least sustainable scenario will be the pessimistic case with high-end initial mill consumption. Except for the base and the optimistic cases with low-end initial mill consumption, model results forecast general trends of increasing stumpage prices and decreasing inventory, stocking and harvest levels over a 50-year period for eastern white pine in New Hampshire. Policies to absorb the adverse impacts for sustaining a long-term healthy forest industry and its forest resource base are needed. Future works can expand the model fully to more species and integrate a more detailed evaluation at the landscape level of the forest resource base.

Key words: forest sustainability, sawmill industry, wood supply.

INTRODUCTION

Sustainable forests are critical for a healthy ecosystem and for the future of the forest products industry. That industry, as an important engine for driving a healthy regional forest economy, depends on sufficient wood supply from the forest. Without the industry, there may not be enough economic returns to forest landowners and there will not be a healthy forest economy to sustain local communities. Without a healthy forest, the industry would be a castle in the clouds, struggling to survive for lack of wood. This interdependence between the forest products industry and its forest resource base draws attention to establishing a framework for sustaining the industry, communities and the forest itself.

The forest industry is one of New Hampshire's most important economic sectors. New Hampshire's forests are not only a significant source of income for forest landowners but also an important source of employment opportunities in rural communities. According to North East State Foresters Association (NEFA) March 2001 Report, "The direct contribution of forest-based manufacturing and forest-related tourism and recreation to the New Hampshire economy is over $2 billion. In 1998, the total sales of stumpage earned by New Hampshire landowners were $37 million. Sales of these products to sawmills are estimated at $132 million annually. The forest-based manufacturing economy provides employment for almost 9,400 people and generates payrolls of $290 million".

New Hampshire is the second most forested state in the United States with 4.83 million acres of forest land, owned by 25,000 landowners. The timber resource covers 84 percent of the state's total land area, and 93 percent (4.5 million acres) is classified as timberland. New Hampshire's timber inventory has a growing stock volume of 9,415 million cubic feet. Sawtimber stands cover 52 percent of timberland in New Hampshire, mostly owned by private landowners. Forest cover in New Hampshire is comprised largely of twelve common trees species which account for 95 percent of the total volume. Eastern white pine, an important millwork and furniture species, leads all species in volume (USDA Forest Service 2005).

Eastern white pine (Pinus strobus L.) is the least resinous of all pines and has remarkable durability as demonstrated by numerous houses built of eastern white pine in New England more than two hundred years ago which still stand today. Moreover, the ease of transplanting and the rapid growth of eastern white pine make it ideal for landscape and windscreen applications. In addition to being an important lumber species, it is also widely used for Christmas trees. New Hampshire sawmills have a heavy dependence on eastern white pine. In 2003, New Hampshire mills processed 261 million board feet (MMBF) of sawlogs. Softwood species accounted for 219 MMBF, 84 percent of total production, among which 162 MMBF were white pine (2004 New Hampshire Primary Wood Processor Report).

White pine continues to be the most preferred and dominant commercial species, accounting for about 62 percent of all sawtimber production in New Hampshire. This raises compelling concerns about the sustainability of the white pine timber supply. Sustaining white pine from New Hampshire's forest becomes the key to sustaining the state's and region's sawmill industry as well as the associated forest resource base. Due to the importance of this species, we focused our wood supply study (Chapter 4) on white pine timber supply and sawmills.

The health of the sawmill industry is crucial for providing timber income, which contributes to successful management of the forest landscape. While timber supply availability, species composition, land use change and policy change can influence the decision making of sawmill operators, the important questions are how much timberland will be available in the future and how much wood we will be able to harvest to sustain the sawmill industry. It is important to track industry consumption of wood from forests to develop long-term effective forest management plans and policies.

Given various economic forces such as regional and global competition, land use change and pressure for higher financial returns, there is a need to better understand the sawmill industry and its dependence on regional resource bases. The main objectives of this research are to profile the region's sawmill industry and to examine the sustainability of that industry and its resource base, with a specific focus on the white pine sawmill industry and the dynamics of its supporting forest resource.

These research goals will be met by three interrelated studies: detailed examinations of the New Hampshire and Vermont sawmill industries and a New Hampshire wood supply study. The sawmill industry studies will provide profiles of economic and social aspects of New Hampshire and Vermont sawmills, based on survey data. The statistical analysis of the survey will help decision-makers and stakeholders better understand interconnections and regional linkages of the industry to its forest resource base. The wood supply study will build on important findings of the sawmill surveys. Additional data on inventory, growth, utilization, and land use change prepared by the USDA Forest Service, state forestry agencies and private organizations will also be utilized to model wood supply.

Most models available for inventory projection and supply analyses are limited to projecting aggregate softwood and hardwood components. By contrast, this wood supply study will focus on the most important New Hampshire species, eastern white pine, seeking to quantify the rate of white pine timber harvest and growth on New Hampshire forest lands, to identify and quantify the factors affecting long-term wood supply for the state's sawmill industry and to project the inventory and price changes at both the state and county level over a 50-year study period.

The wood supply study will address the future sufficiency of log supply at the county level, accounting for the geographical distribution of sawmills and the spatial nature of inventory and wood flows. We will look at the inventory dynamics as functions of biology, economics, public and private policies, and landowner objectives. The supply study will help decision-makers develop plans based on the future availability of New Hampshire timber. This study will also help track forest health in terms of inventory and stocking dynamics, and major shifts in forest composition associated with changes in harvest levels and stumpage prices.

The plan of this dissertation is to provide a review of the literature supporting this research and to prepare three interrelated papers for submission to journals, followed by concluding remarks. The detailed research objectives are:

- To profile the sawmill industry in New Hampshire and Vermont in terms of production, consumption, labor characteristics and regulating economic and policy issues.
- To conduct a wood supply analysis for eastern white pine in New Hampshire that simulates inventory, harvest and stumpage prices for a fifty-year projection period.

The research conducted to accomplish these objectives is presented as chapters. The second and third chapters of this dissertation are presented as: A Profile of the New Hampshire Sawmill Industry and A Profile of the Vermont Sawmill Industry, divided into sections addressing survey and analytical methods and results. The fourth chapter is presented as Wood Supply Study. Its methodology section develops a wood supply model for New Hampshire's white pine lumber industry. Results for the base, pessimistic and optimistic scenarios are presented in terms of changes in timber harvest, inventory, stocking, and stumpage prices. Conclusions about the sustainability of the industry and the forest resource are developed.

Concerns about the sustainability of the forest and the industry exist but what is "sustainable"? Chapter 1 provides a discussion of the general concept of sustainability and how it relates to forestry as well as the specific concerns of this research.

CHAPTER I.

SUSTAINABILITY AND FORESTRY

Introduction to Sustainability

While we want to examine the sustainability of the sawmill industry and its forest resource base, it is important to define and understand the concept of sustainability and how it relates to this research on forest industry. To understand the complex issues underlying the sustainability of New Hampshire forests requires us to look in more detail at the progress made in sustainability in general. Therefore, the purpose of this chapter is to provide a literature review regarding sustainability and how it applies to forestry, the associated forest industry and dependent communities. Here I synthesize the philosophical approaches to sustainability principally from an economic and ecological perspective.

A central challenge for our century is to accelerate progress in a transition toward sustainability, improving our collective capacity to meet human needs while preserving and restoring the earth's essential life-support systems. Promoting such a transition in an increasingly interconnected world will clearly require advances on a number of fronts: political, ecological, economic and social, to bridge global, regional and local scales.

After more than one century of hegemony of a representation of economics as separate from nature, it was in the early 70's that the conception of an environmentally detached economics began to be challenged by another vision, according to which exponential and unlimited growth is impossible in a world of finite resources. In this renewal process, “sustainability” or “sustainable development” began to appear in economists’ vocabulary at the beginning of the 80’s. However, “sustainability”, by its complexity, became the object of debates in such distinct fields as economics, ecology, sociology and philosophy.

For ecologists “sustainability” connotes preservation of the status and function of ecological systems; for economists, it implies the maintenance and improvement of human living standards. Tietenberg (2001) suggests that neither non-human elements of the global ecological system have less moral claims to the sustained environment as inter-generational fairness nor ecosystems offer resilience against unexpected changes and preserve future options. By way of contrast, he discusses that the economic view focuses on the maintenance and improvement of human being living standards. Human capital needs to be emphasized in the context of tradeoffs between present and future generation. All resources, natural endowments, physical capital, and human knowledge contribute to well-being. Ecosystem destruction addresses compensatory investments for future generations by mean of advances in technology (Tietenberg, 2001).

The World Commission on Environment and Development (1987) defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. The concept of sustainability captures changing public ideologies about the cooperation and coexistence of humans with their environment, the imbrications of the economic and ecological spheres and long-term generational equity.

Approaches to Sustainability

Different interpretations of sustainability are the source of diverse approaches for solving sustainable problems. They reflect strong intellectual competition. Among these diverse approaches, we can identify two groups: a "biocentric" or "ecocentric" vision, and an "anthropocentric" vision of human-nature relations.

According to the biocentric vision, the need for nature preservation constitutes a conservationist objective, not only to satisfy the well-being of present but also of future generations. It is notably the vision of environmental defenders, who emphasize that "man has no more rights to nature than any other species on earth" (Abdelmalki & Mundler, 1997). Ethical considerations extend to nature as a whole and are forward-looking. In this vision, relations between economics and nature are perceived through ecological criteria.

By way of contract, people who adhere to "anthropocentrism", even with important differences in their approaches, defend the idea that if nature needs to be preserved, it is essentially because nature is necessary for the well-being of humans (Channel, 1996). The major idea of sustainable development is to reintroduce the environment into the economic analysis as a production factor. Starting from this conception of the role of nature, some authors propose to differentiate "nature" as the biosphere, being made up of earth and life, especially the "natural environment", as part of the natural place which interacts directly with humans (Channel, 1996). In this interaction between the economic system and the natural place, man takes natural resources from nature, the primary source of materials and energy. Man also disposes materials into nature that are going to be more or less recycled by the natural place, which can be regarded as a service provided by nature. The ecological goods and services are fluxes derived from the existing stock of natural capital. Maintaining the sustainability of these fluxes over time is one of the necessary conditions to sustainable development whichever theoretical approach is undertaken.

Two basic approaches, weak sustainability and strong sustainability and the contradictions between them create difficulties in economic analysis when we must decide what actions are sustainable. The following discussion presents the foundations of each of these anthropocentric approaches, as well as sustainability rules derived from them. The ultimate goal is to analyze the possibility of their application for the evaluation of sustainability of the New Hampshire's sawmill industry and its forest resource base.

Weak Sustainability and the Notion of an Optimal Norm

The first approach of sustainability, weak sustainability is from the neo-classical economics point of view. Here, nature-human relations are analyzed through the prism of the economic sphere putting forth the notion of economic efficiency and the regulatory role of the market. This approach extends conventional economic analysis to new environmental problems.

Nature as an Individual Utility Source and as a Production Factor, Guided by Economic Optimization

Two types of works using this approach to solve environmental problems have relatively independent developments: those belonging to "environmental economics", are rather interested in the loss of well-being or utility caused by environmental problems, and the ones belonging to "natural resource economics" are interested in the scarcity of resources considered as production factors necessary for economic growth.

- Environmental economics emanates from the fact that we are confronted by an environmental problem when well-being, loss or utility, other loss provoked to individuals by phenomena like pollution or resource overexploitation is not turned into monetary compensation. Environmental problems are then the result of suboptimal resources allocation, which derives from the fact that most of environmental goods and services are free and that they are not the object of exclusive property rights allowing a mercantile transaction. These out-of-market phenomena do not have price signals to be integrated into economic computations of agents who are hurt by them or benefit from them, and they are theorized as externalities. The aim of neoclassic theory is not then to release a set of allocation rules (optimal ones if possible) of resources and natural services on a pricing system market. We face the problem of internalizing externalities to determine the optimum, pollution level for example. The optimum can be reached when the marginal cost of 'exhaust' reduction equals the marginal cost of damages caused by this pollution. Implicitly, from a purely neoclassical point of view, the economically optimum level of pollution coincides with the ecological optimum. The environmental norm in this approach is derived from an economic optimization process.
- Natural resource economics sees nature as a production factor, a set of "assets" or "natural capital" able to produce goods and services as well as other economic

assets. The principles of capital theory can then be applied to natural capital. This has two major consequences:

On one hand, economics has the task of managing nature in an optimal way through time, whether renewable resources are involved or not. Different models are proposed for the application of Hotelling's rule in microeconomic analysis (Varian, 1992), giving a determinant role to prices and markets as socially optimal regulating mechanisms. Thus an optimal price of a natural resource is associated with an optimal harvesting rate of this resource. However the optimal harvesting rate of a renewable resource does not prevent exceeding the biological threshold of sustainability.

On the other hand, this consideration of capital (natural capital being convertible to any other form of capital) allows the integration of natural resources into growth production models. There would be sustainable growth if and only if the increase in well-being of present generations does not reduce the well being of future generations (Solow, 1974). Hartwick's rule (Hartwick,1977), a follow-up of Hotelling's rule based on Solow (1974); establishes that rents issued from the exploitation of a natural resource must be invested in reproducible assets capable of substituting for natural resource inputs in the production function. Investment in physical capital and other forms of reproducible capital must equal the economic depreciation of the resource and increases in other forms of capital to offset losses in natural capital, to sustain consumption in a simple economy based on a nonrenewable natural resource. This is given by Hotelling's rule: the product of the quantity of resource extracted and the marginal rent price minus marginal cost. Hartwick's paper (1993) addresses accounting for the environment, which casts light on forestry economics in terms of future green accounting related to the problems of deforestation. In 1996, Hartwick, in an article coauthored with Vincent (Vincent et al., 1996) pointed out that this consumption is sustainable only if net investment - the sum of the values of changes in all forms of capital net investment (Dixit et al., 1980) is nonnegative. In these conditions, the ultimate sustainability criteria according to equity objectives for intra and intergenerational equity (Solow, 1974), resides in the constant maintenance of a balance between revenue generation and consumption, or alternatively of a global capital stock.

However, this criterion demands adhering to a strong hypothesis regarding technical progress allowing the maintaining of productivity of the resource base, and regarding sustainability (and commensurability in monetary units) between different capital elements. Substitution can play a role between capital categories (manufactured, natural and human). Inside each category, we can replace some natural resources by others, and even spatially between stocks of a same capital type in different locations (Abdelmalki and Mundler, 1997). The substitution will be valid as well from a utility function point of view. Environmental degradation can be compensated by a supplemental consumption level of man-made goods. While in a production function point of view, substitution elasticity between technical capital and natural capital is constant.

Such a perspective considers ecological constraints on the economy as not being absolute. The pricing system and technical progress must consider resource degradation and allow the economic growth in a limited physical universe (Beckerman, 1972).

In the neo-classical approach of environmental economics, the choice of environmental constraints is not necessary; these are co-determined by diverse market mechanisms, which determine the economic optimum, and the ecological norm. No purely ecological sustainability criteria are really integrated into the neo-classical analysis of sustainable development.

Limits of this Approach

- Firstly, we can signal the normative character of this approach to choose the best economic solution. The welfare economics originated from internalization theory brings forth the most diverse situations, such as the example of a Pareto Efficiency (Varian, 1992). The perfect market is established as a human behavior finalization tool. Thus, this finalization introduces a reducing analysis of real phenomena by bringing them to a totally arbitrary universal norm (Naredo, 1996). We thus abandon the positive way consisting of understanding, explaining and forecasting based on "real world" observations; in favor of a normative way of researching an "optimal solution" in a perfect market, external norm to concrete markets (Passet, 1979). This optimal solution has the benefit of dealing with uncertainties linked to the lack of information on what is real, which is particularly true regarding environmental problems.
- The determination of a norm, issued from an economic optimization process seems to constitute an imaginary solution, which would be hard to apply in the case of the New Hampshire forests, the focus of our work. First of all, we have the ecosystem component, on which supply and demand can be difficult to quantify. We would measure the number of trees per hectares, but trees take decades to grow, which means that the system's state of conservation is very highly correlated with past management behavior. How can we then overcome

this temporal differential between supply and demand to reach an optimum? How can we express this demand?

- Secondly, the neo-classical approach of sustainability takes the case of natural resources reproduction and the case of reduction of pollution levels separately. In the first case, we take into account the productive capacities of resources, and in a second case, we're interested in assimilation and recycling services. This approach neglects the multi-dimensional character of the resources, which not only presents productive capacities, but also constitutes life support mechanisms and biodiversity mechanisms, and provides aesthetic services.
- Finally, the strong sustainability hypothesis between different forms of capital, drives people to consider, except for certain irreplaceable and unique resources, the exhaustion of natural resources as "an event among others and not a catastrophe"(Solow, 1974). It is this endless substitutability of factors and products which free the economic system from the physical context surrounding it (Naredo, 1996). With this frame of mind "we forget that nature doesn't behave with the logic of an economic entity" (Passet, 1979). We indeed neglect that the biosphere has its own reactions: synergy effects, boundary effects, amplification effects and irreversibility effect, which explain that an apparently minor environmental perturbation can have catastrophic natural consequences (Perrings, 1995).

The limits presented here-above are going to lead us to look at what is proposed by other approaches to defining sustainability rules. These so-called "strong sustainability" approaches impose strong ecological constraints to economic development. Nevertheless, these approaches retain features of neo-classical economics.

Defenders of Strong Sustainability and of Environmental Objectives: from a Maximal Conservation Norm to a Minimal one

Opposing the neo-classical view of sustainability which is judged to be too "minimizing", are other views, all of which have considered the multidimensionality of natural capital. The principal consequences of this conception of natural capital are the doubts about the importance of technical change, as well as the natural capital-technical capital sustainability hypothesis (Mill (1871), and Marshall (1890)). However, this common natural capital view does not avoid the development of different interpretations, each one proposing its own norms or sustainability objectives.

Diverse Views of Strong Sustainability

Among the different interpretations of "strong" sustainability, we can distinguish three fundamentally different ones, based on the importance of ecological constraints: the conservationist view, the School of London view, and the ecological-economic view.

The "Conservationist" View

These analyses present natural capital as a binding constraint on economic growth, to such a point that growth will eventually stop. This view of nature, which relies on theories of thermodynamics, in particular the second or entropy law, introduces into economic analysis, the concept of irreversibility (Faucheux et al, 1995). Irreversibility considers limiting human action on the physical world rather than its infinite expansion as in the neoclassical view. The essential thesis of these conservationists is that we are in a world where this capital is not man-made and natural capital is the factor that limits economic development in the long run. Faucheux et al. (1995) defined that sustainable development as the maximum development which can be reached without reducing the balance of natural capital in the region or country on which the resource is based. It is a view in terms of joint goods and economic services leading to production as well as the maintaining of environmental amenities. The sustainability rule induced by this sustainable development definition is to maintain constant capital of natural stock over time. It relies on subjecting the economy to absolute ecological constraints, keeping nature intact. It is the maximal conservation level which we aim to reach. This view is also called very strong sustainability for this reason.

Contrary to the neoclassical view dealing with natural resources and pollution separately, the rule of constant natural capital stock conservation requires that environmental goods be seen as multidimensional. They provide pollution assimilation services as well as inputs for production.

Without a strong hypothesis regarding technical progress, the conservationist sustainability rule implies zero or negative economic and demographical growth rates (Meadows et al, 1977). This has been the object of numerous critiques which argue that with such a view, intra-generational concerns will be abandoned in favor of inter-generational concerns. Stopping growth in a developing world risks increasing inequalities. International institutions will have to paradoxically use instruments similar to traditional market tools (transferable pollution permits for example) (Faucheux et al, 1995). From ideological, psychological and institutional obstacles to putting such a development model in place, it is rather to transform this sustainability rule institutionally by the reduction of pressure on the environment per economic unit (Daly 1991). The existing difficulties in measuring this environmental pressure and the importance of heterogeneity of necessary information indicate the use of a unique aggregated indicator to solve environmental problems.

The "School of London" (SOL) View

The second strong sustainability view is the one advocated by the School of London (SOL), of which D.W. Pearce is one of the main proponents. Contrary to the conservationist's view, this view questions the hypothesis of limits between different capital forms (Pearce et al., 1990), and proposes a sustainability rule as the maintaining of a minimum natural capital stock, or "critical natural capital", disregarding the total natural capital stock. The SOL view lies between the weak and strong sustainability hypothesis. Natural capital is not considered as homogeneous and its diversity can be hierarchical functions of the sustainability level between different capital types. It is easier to substitute gas to petroleum (substitution inside natural capital K_n) or capital (technical) to mineral resources (manufactured capital or producible K_m by K_n), rather than substitute technical capital to the ozone layer. We can call "critical natural capital" the components of natural capital which, compared to the ozone layer, are linked to the "survivability" functions of stability and permanence of biochemical cycles, upon which humanity depends, and for which no manufactured capital substitutes exist, or even natural substitutes (Pearce and Turner, 1990).

Thus the substitutability hypothesis applies solely to natural capital components which are not critical in the renewal of life support systems. Degradation is reversible on a small scale (Barbier and Markandya, 1990). The sustainable development model of Barbier and Markandya (1990) is inspired by neoclassical works. It meets "cost efficiency" analysis proposed by Baumol and Oates (1988) in the vision of accounting for pollution, considering that it can also be applicable to other natural resources. It first determines physical environmental norms and then minimizes economic cost.

The sustainability objective is then expressed through three ecological constraint categories or resource utilization boundaries which have to be linked to a utility function of which the actualized value must be maximized. These constraints are as follows (Stoffaës, 1993):

- Limit the interjection of waste into natural environment to the level which can be assimilated ecologically.
- Exploit renewable resources according to a regime assuring resource reproduction.
- Exploit non-renewable resources at a rate that resource reserves would be balanced by the combined 'use' of technical progress regarding extraction efficiency and the use of these resources, and technological substitutions by renewable resources.

Respecting these ecological constraints requires the conservation of a minimal stock of critical natural capital. Problems arise when it comes to measuring this minimal capital stock. Their physical measure is problematic because critical capital is heterogeneous (ozone, water, biodiversity), and because it is difficult to aggregate physical quantities in terms of different units (Pearce and Turner, 1990). For this reason, the School of London adherents favor a monetary evaluation, while recognizing the limits of this procedure. They propose the "total economic value" concept which is made up of not only the "use value" and "option value" – already considered in the weak sustainability view, but also the "existence value", which refers to the intrinsic value of some asset, normally natural and environmental assets. Its utility derives from its existence for simply being there, instead of from the direct use of the resource. The SOL sustainability rules take the following form (Pearce and Turner, 1990):

- Total economic consumption of natural capital stocks cannot exceed certain limits.
- Economic value of natural capital stocks must remain constant.
- The value of revenue stream (fluxes) must remain constant (the stream of revenue being the product of price by quantity used).

These new rules result in contradictory reasoning. On one hand, they refute the neoclassic view which uses monetary evaluation to determine cost curves (social and private) necessary for optimization. It consists of fixing an environmental objective in physical terms, outside of market mechanisms; and using the cheapest means to reach it. On the other hand, difficulties arise in making explicit environmental objectives in physical terms. School of London proposed a monetary evaluation to evaluate the environmental norm considering ecological constraints when optimizing their objective-function. We thus retain individual preference, under environmental constraints to determine the most efficient means to reach them, which brings this close to the weak sustainability view (Pearce & Turner, 1990 and Pearce, 1993). The neoclassic view concerns the monetary evaluation and the pursuit of a timeless optimum.

The "Ecological Economic" View or "Co-Evolutionist" View

The ecological-economic view or co-evolutionist view of sustainability synthesizes the standard economic view and the two strong sustainability views presented above; indicating that they are in some terms complementary rather than competitive. This view refuses to use sustainability norms in monetary terms, as any form of optimization, and suggests that natural capital evolves and cannot be considered as fixed or constant, even though it is the source of heavy constraints for economic growth from the first two laws of thermodynamics.

This view is not inspired by entropic thermodynamics, but by a new branch of thermodynamics specific to living systems, Prigogine non-equilibrium thermodynamics (Costanza et al, 1991). This new branch, relying on Darwin's theory of evolution, insists on the instability of life regarding the physical world, the multi-dimensionality, the growing complexity, and the preservation of the biosphere. In the long run, a healthy economy can only exist in symbiosis with a healthy ecology. The two are so interdependent that isolating them for academic purpose has led to distortions and poor management (Constanza, 1991).

This evolutionist influence is understood through the "co-evolution" concept developed by Norgaard (1988). It is extended to interact between two evolving systems: the socio-economic one and the ecological one. "Co-evolution" appears when a change happens in one part of these two systems, which triggers multiple changes in reaction mechanisms. Because of the "co-evolution" of economic, social and ecological systems, we can represent it as intertwined spheres. The changing of the economic sphere on the surrounding ecological sphere is not without effects on itself. Beyond a certain level of disturbances, ecological systems react in a more or less violent way. The ecological system can stand that the economic one transgresses its laws, as long as the fundamental equilibrium conditions are not broken.

The connections between the economy and its environment are spatial and temporal. It is, for example, possible that the components of a conjoined system not be linked on a given temporal or spatial scale, but linked on different temporal or spatial scale (Perrings, 1995). It follows that the connection structure between the economic system and its environment has an important effect on speed and impact of economic changes on the environment.

We are going to focus on the dynamics of the ecological and economic system, and its interactions. This is going to lead us to abandon the idea of only one equilibrium point for economy as in nature, and of the stability of this equilibrium, to reach the idea of the existence of multiple unstable equilibria. More than to identify these equilibrium points, we are interested in the capacity of a stable or unstable system to absorb human or natural shocks while in remaining stable, which is defined as the "resilience" of the system (Holling, 1973). The ecological dynamic system is only foreseeable if the system conserves its resilience. It boils down to determining the natural capital levels which allow a certain degree of resilience. Beyond these 'boundary levels', the risk of a natural "catastrophe" becomes uncontrollable (Parings, 1995). This economy-environment link analysis is going to introduce a change of a viewpoint regarding the action of men on the biosphere. In fact, it appears that human in their producing activities are not only energy and primary materials users bound by entropy, but they can invent and build, at the origin of information. This does not mean that we are not considering the irreversibility idea, but this irreversibility is perceived to be a creation. From this, we need to consider absolute ecological constraints imposed by the first two laws of thermodynamics, but these constraints, far from being constant, modify functions of co-evolution.

In this perspective, the environment is not only the constraint for economic growth, but also the source of opportunities and openings, driving to innovate; such as new economic organization firms, new technologies, or new types of needs. The development is defined as a creative and destructive process, in which the collapse of whole sectors of the economy appear as the condition and consequence of emergence of new structures.

The ecological-economic view does not share the stationary state idea of Daly (1991), because it considers that with technical progress, the law of entropy can be counter-balanced by a better use of clean energies such as solar energy. It also does not share neo-classic theory's "backstop technology" view, according to which one should not worry about environmental constraints because with technical progress one will be able to find other inexhaustible energy sources. The ecological-economic sustainability defenders take into account uncertainty linked to this new technological discovery, as well as the transitional phase which can lead to irreversible changes in the ecological system.

As far as critical natural capital is concerned, "ecological economics" authors propose to use natural capital under set limits rather than maintaining total natural capital stock constant. Contrary to the School of London, they propose the definition of minimal safeguard norms, or conservationist ones for the critical natural capital. They are half way between the technological optimism of neo-classical view, and the pessimistic view of stationary view. From this, they use the tools, evaluations, models and concepts of neo-classical economics and these of ecology of thermodynamics complementarily.

Unlike the neoclassic and the School of London view, supporters of "co-evolutionist" view of sustainability consider that natural constraints and minimal conservation norms cannot be measured monetarily, but be seen as physical or biological terms. They propose the unit of energy as a means to aggregate physical measures by using physical measures. We take into account the ecological temporality, by which we resolve the environmental evaluation relying on preferential revelation of temporality between life duration of human societies and that of individuals. Nevertheless, this approach does not completely reject the neoclassical view. We accept substitutability between artificial and natural capital only when productive and economic functions of natural capital are in play. The neoclassical 'print' is manifested by the importance given in this view to the economic dimension in sustainability definition: we're not only worried about irreversibility and uncertainties appearing in the economic direction to the environment, but also of the ones in the environmental direction to economy.

Sustainability is then going to be defined not only through a minimal conservation norm defined in physical terms, but also through economic indicators such as the reliable sustainability rule. Disregarding optimization thoughts, this is not only because of the existence of "strong uncertainty" and the "co-evolution" of economic and ecological systems, but also because in this domain objective functions are multiple. Ecological objectives must also be integrated with economic and social objectives. Moreover, this view asks the role of institutions in modifying the actual development model towards a more sustainable one. This constitutes particularly in the field of environmental research (Kapp 1950, Bromley 1985, Klaassen Opschoor 1991, Van der Straiten & Opschoor 1992), which also share the ecological-economic view in terms of "co-evolution" and "minimal conservation norms' definition. We're not only interested in pertinence and spatial articulation of institutions and public sectors to manage the environment, but also the importance of "institutional dissonances" often observable in this institutional, formal environment, and the informal institutions existing in the actions between individuals and nature (Bromley, 1985).

Applications of Forest Sustainability to This Research

Forest economy is a subset within a natural environment. For the economy to function, it needs certain goods and services. These commodities can be found in the natural environment. Inputs for production are extracted from the natural settings. The forest plays a key role in various aspects of production, such as the economic implications of forests for production and consumption purposes.

What is the priority for the current generation when looking forward to future generation concerns for our forest? Forest sustainability can be viewed as a means to ensure the long-term health of forest ecosystems for the benefit of the local and global environments while enabling present and future generations to meet their material and social needs. As forest sustainability is defined here as long-term forest health, we can perceive forest health as the condition of a forest ecosystem that sustains the ecosystem's complexity while providing for the needs of the people and the community. Sustainable forest management is then based on considering social, economic and environmental values when planning and implementing forest management activities and providing people with employment, recreational opportunities as well as a healthy forest in the long-run.

As defining sustainability is a perplexing issue, Gale and Cordray (1994) described nine perspectives of forest sustainability ranging from a dominant product perspective to a deep ecology philosophy. These "nine answers to what to sustain" were perspectives labeled as dominant product sustainability, dependent social system sustainability, human benefit sustainability, global niche preservation, global product sustainability, ecosystem identity sustainability, self-sufficient sustainability, ecosystem insurance and ecosystem benefit sustainability. Dominant product sustainability sustains economic efficiency. Dependent social system sustainability is oriented toward a specific human social system that depends on an ecosystem and its products but it focuses heavily on the development of the local community while disregarding the international flow of natural resources. Human benefit sustainability is the opposite side of the "dominant product sustainability". It maintains the flow of diverse human benefits that result from intensive resource management. It emphasizes a greater range of resource products and contributions to the larger society rather than to targeted resources – dependent social systems. However, it may result in economic and ecological inefficiency. Global niche preservation sustains some specific local ecosystems judged as integral toward the goal of sustaining the entire earth. Global product sustainability emphasizes the flow of unique or increasingly valuable natural resource commodities produced by local ecosystems for the international market. Ecosystem identity sustainability is oriented toward a general land use of ecosystem type rather than specific ecosystem characteristics. Self-sufficient sustainability supports long-term natural resource integrity as seen in relatively balanced, self-sustaining ecosystems. Ecosystem insurance sustains ecosystem diversity and insures against ecological disaster and diversity loss. This sustainability has the general need for reserved area versus questions of future needs and tech-optimism. Ecosystem benefit sustainability targets natural ecosystem as free of human management or exploitation as possible. It sustains undisturbed ecosystem and respect rights inherent in natural ecosystems, but it may be only an ideal because the introduction of species by humans and the extinction of others by human alteration of ecosystems make it unlikely that any ecosystem can be considered fully restored. Out of these nine perspectives for forest sustainability, global product sustainability, dependent social system sustainability, human benefit sustainability, and ecosystem identity sustainability are applicable especially for this research. Primary and value-added wood products locally produced by New Hampshire sawmill industry entering northern New England and Canadian market competition tie to the application of global product sustainability approach in the sawmill survey analysis. Various social and economic indicators used in sawmill profile study, especially community and business environment perspectives examined in both New Hampshire and Vermont Sawmill Surveys tie to the dependent social system sustainability and human benefit sustainability. Ecological factors examined in the wood supply study tie to the ecosystem identity sustainability approach, such as the impact of changing utilization rate and species composition of New Hampshire forest and changing landscape to the future condition of forest inventory and harvest level to sustain regional consumption of sawmills.

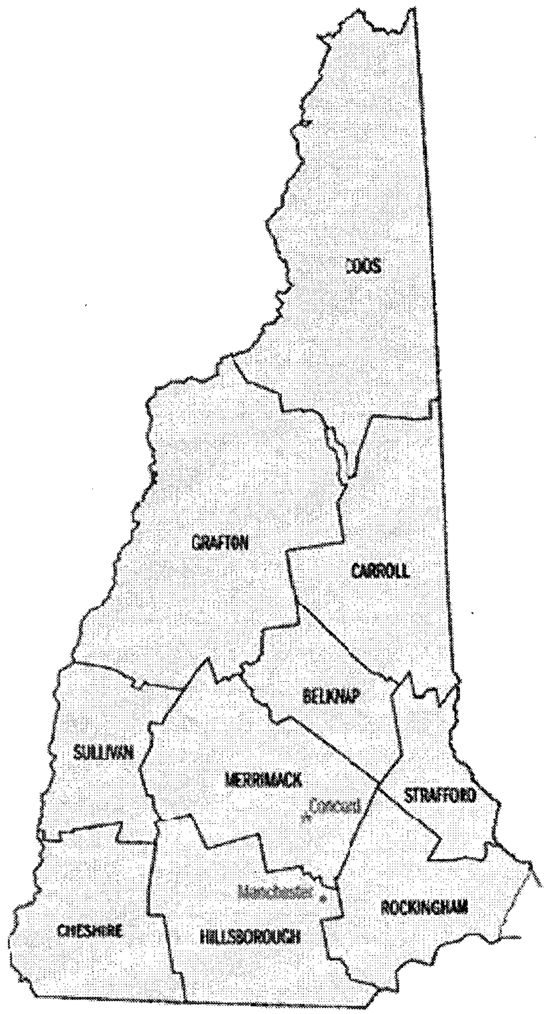
To conclude, these views of sustainability, notwithstanding their agreement regarding the definition of absolute economic growth constraints, remain quite heterogeneous regarding the definition of sustainability. We went from "a maximal conservation norm" with the conservationist view to a minimalist one with the last two

(SOL, co-evolution). We went from a deterministic irreversibility concept yielding the fixation of unmovable ecological constraints to one of creative irreversibility in the co-evolutionist view, the environmental constraints being able to evolve. We finally went from a SOL view where ecological constraints are monetarily evaluated, to a physical unit's evaluation.

Aware of the debates about sustainability we have outlined before, we will employ for our analysis a perspective close to the "ecological-economic" sustainability or the "co-evolutionist" perspective. It will ask the definition of boundaries, measured in non-monetary terms, which can evolve and have to connect to economic indicators. We can rely on a representation of ecosystem-proper dynamics while taking into account the existence of boundaries before studying their relationship with societies. The "ecological-economic" sustainability will be embedded in the New Hampshire and Vermont Sawmill Industry Study and the Wood Supply Study. For example, this sustainability approach links to our wood supply study to concern about conserving a minimal stock of New Hampshire's critical natural capital eastern white pine, in terms of sustaining the relationship between its consumption by New Hampshire's sawmill industry and the inventory level of New Hampshire timbershed over a 50 years time horizon.

CHAPTER II

A PROFILE OF THE NEW-HAMPSHIRE SAWMILL INDUSTRY[1]



---

[1] Difei Zhang and Theodore Howard, 2007. Submitted to the Northern Journal of Applied Forestry. Scientific Contribution No.xxxx of the New Hampshire Agricultural Experiment Station

Abstract

This survey of New Hampshire sawmills profiles the industry in terms of capital investment trends, market conditions of log supply and final products, domestic and international competition, work force characteristics and business environment. We surveyed sawmill operators' perceptions regarding social and economic issues and their concerns about log availability, log procurement sources and cost of logs. Mill operators answered questions about their connections to communities and their willingness to participate in forest products certification programs. Return statistic analysis indicates that mill employees are mostly local and similarly, the log sources for these mills are also mostly local. About 52% of the small mills procure their logs within 20 miles while about 45% of the medium mills' log source is within 20 miles to 49 miles. New Hampshire mills make extensive use of eastern white pine. The products are mostly used locally, with 36% remaining in the county, 31% going elsewhere in NH, and 26% going elsewhere in New England. Many mill operators claimed involvement with the local community. About 61% of mills do not consider certification of sources, but medium mills used many more certified logs than the small mills. Very few mills track the chain of custody of the log sources. More than half of the mills reported that no modernization has been conducted or planned, due to lack of investment. Both small and medium mills agree that Canadian sawmills have an advantage due to lower production costs, lower stumpage prices, and lower wood transportation costs. The mills realized the threat of Canadian mills imposed on the success of their mills. Medium mills were more emphatic that the stumpage price advantage for the Canadians was a factor in their success, and that the transportation costs were also a significant factor. This study can help reinforce

the role of the bioregional forest-based economy by defining the relationship between forests, bioregional communities and forest industries.

Introduction

The forest industry is one of New Hampshire's most important economic sectors. New Hampshire's forests are not only a significant source of income for forest landowners, but also an important source of employment opportunities in rural communities. According to the North East State Foresters Association (NEFA) March 2001 Report,

> "The direct contribution of forest-based manufacturing and forest-related tourism and recreation to the New Hampshire economy is over $2 billion. In 1998, the total sales of stumpage earned by New Hampshire landowners were $37 million. Sales of these products to sawmills are estimated at $132 million annually. Forest-based manufacturing economy provides employment for almost 9,400 people and generates payrolls of $290 million".

New Hampshire is the second most forested state in the United States with 4.83 million acres of forest land, owned by 25,000 landowners. The timber resource covers 84 percent of the state's total land area, and 93 percent (4.5 million acres) is classified as timberland. New Hampshire's timber inventory has a growing stock volume of 9,415 million cubic feet. Sawtimber stands cover 52 percent of timberland in New Hampshire, mostly owned by private landowners. Forest cover in New Hampshire is comprised largely of twelve common trees species which account for 95 percent of the total volume. Eastern white pine (Pinus strobus L.), an important millwork and furniture species, leads all species in volume (USDA Forest Service 2005). New Hampshire sawmills depend heavily on eastern white pine. In 2003, New Hampshire mills processed 261 million board feet (MMBF) of sawlogs. Softwood species accounted for 219 MMBF, 84 percent of total production, among which 162 MMBF were white pine (2004 New Hampshire Primary Wood Processor Report).

Given the importance of the forest industry in New Hampshire, this research provides an in-depth examination of the sawmill industry to better understand the New Hampshire sawmill industry as it relates to the state and region, including neighboring Canada. To accomplish the goal, we conducted a survey of the industry to develop a profile of that industry and to identify industry concerns. The survey included questions about mill operations, capital investments, log supply, markets, certification, trade, community connections and the business environment. As part of a larger regional project, this study contributes to better understanding of forest product issues in Northern New England and Southern Québec, Canada.

Previous Work

Many survey-based studies have examined the forest industry, ranging from primary processing to secondary wood manufacturing and marketing as well as to assessments of timber products and production. Example of surveys of primary processing industry conducted in East, Northwest and Great Lake regions of the U.S are summarized here.

Haugen and Weatherspoon (2003) surveyed 319 primary processing mills in Michigan in 1998. Their survey results covered important wood procurement and forest management information such as species composition, the industry's size, use of roundwood, and generation and disposition of residues. The survey also reports changes and trends in Michigan's primary wood-using industry in timber output and use, noting shifts in species composition and products. Smith et al. (2000) conducted a mail survey of Pennsylvania's hardwood sawmill industry examining firm size, species used, log source and grades, processing technology and value-added features. Harris et al's (2003) survey analyzed the development of wood procurement on non-industrial private forest lands. Hill (2000) conducted a sawmill survey of Alaska primary processing industry, examining mill capacity, employment, log production and consumption, which connected to earlier work linking Alaska forests and communities through value-added forest products. Bailes and Nielsen (1997) conducted a study in Oregon examining aspects of management and accounting in the forest product industry's capital budgeting practices, project evaluation, risk analysis methods and post-audit procedures.

There have been also surveys conducted to assess secondary processing and marketing. Wilson et al. (2001), Mangun and Phelps (2000) and Volskey et al. (1997) provide examples of surveys of secondary wood manufacturing industries. Examples of marketing surveys include Minnesota Department of Natural Resources (2003) detailed marketing survey of decorative spruce top production and Shook and Eastin's (2001) work on the use of deck materials in the residential construction industry. Finally, the US Forest Service provides periodic state level assessments of Timber Products Output and Production. There are no previous studies of New Hampshire mills that address the breadth of issues contained in our survey. However, Straussfogel (2003) and Cummings (2003) represent our initial investigations into northern New England's and Southern Québec's industry and serve as the basis for the survey of New Hampshire's sawmill industry.

Straussfogel et al. (2003) point out that the northern forest ecosystem transcends the political boundary and that communities on both sides of the U.S.-Canada border depend on the same forest. They specifically analyzed the trans-border interactions in the sawmill industry of Chaudière-Appalaches, Québec, and found that the larger the mills were, the more likely they depend on a trans-border wood flow from Maine. Cummings (2004) continued exploring the trans-border forest economy and community impacts by examining the Maine sawmill industry from a bioregional perspective as a means of understanding regional sustainability. She also assessed the usefulness of measures of forest industry dependence to the social and economic dimensions of the forest certification process.

To complete the larger picture of bioregional sustainability of the northeastern forest region, this research will expand previous work in Québec and Maine to include New Hampshire. There are significant wood flows from New Hampshire forests supplying their own mills as well as to mills in adjacent counties in Vermont, Massachusetts and Maine and to southern Québec. This research can help strengthen our understanding of the forest economy and the bioregional connections within Northern New England linking its sawmill industry to its forest resource base.

Methods

Survey Process

During spring of 2004, we conducted a mail survey of New Hampshire's sawmill industry following Dillman's (1978) total design protocol for mail and telephone surveys. We consulted experts in the industry and other professionals for their opinions and advice about the survey design and tested the questionnaire with them. The survey was a nine-page booklet (Appendix C) with a sawmill photograph and an explanatory introduction letter at the front and a set of twenty-two questions that took about twenty minutes to complete. The mailing addresses were obtained through the New Hampshire Directory of Sawmills and Lumber Wholesalers (2004) published by the University of New Hampshire-Cooperative Extension. All of the surveys were addressed to mill proprietors, although the survey also asked the function of the person who actually filled out the questionnaire.

Survey Content

The survey focused on economic and social factors affecting mill operations as well as connections between the mills and the communities in which they were located. We designed the survey questionnaires to gather sawmill operators' input on the following six general areas:

- Part 1 of the survey (questions 1 through 9) focused on location, history, structure and organization, and work force characteristics of the mill.
- Part 2 (questions 10 through 14), examined mill operators' assessments of the importance of operational factors including: labor issues, cost of capital and capital availability, log supply and log cost, and the nature and structure of the end-product markets. Responses to log supply and cost, as well as mill production questions were requested in ranges to protect proprietary information.
- Part 3 (question 15) focused on the impact of certification on mill's operations and the importance of chain of custody tracking of products. By

determining the levels of mill participation and interest in the forest products certification process, we assess whether the process holds potential to advance sustainability objectives within the state.

- Part 4 (questions 16 and 17) identified mill interactions with its community and the importance of the mill to the social and economic well-being of its community, of New Hampshire or adjacent state and Canadian communities adjacent to the borders of these states.
- Part 5 (question 18) focused on the operator's perception on the importance of international wood competition, exchange rates, current tariff and general trade agreements to the success of the mill. Respondents were asked to indicate their level of agreement with each statement about Canadian sawmills' comparative advantages in production costs, stumpage prices and transportation costs and their perception of whether Canadian mills posed a threat to the success of US mills in the northeast.
- Part 6 (questions 19 and 20) asked respondents to rank business climate factors, industry assistance factors, and government entities according to their importance to the success of their mill.

Finally, question 21 was an open-ended question for respondents to write in any additional comments or address other concerns.

Analytical Methods

We hypothesize that mill size influences responses to survey questions. In their survey analysis of Chaudière-Appalaches, Straussfogel et al. (2003) divided mills into three size categories based on annual production: small (<10,000 cubic meters, m^3), medium (10,000-100,000 m^3), and large (>100,000 m^3). Cummings (2003) employed the board foot equivalents of the Chaudière-Appalaches size categories using a conversion factor of 0.423775 m^3 per thousand board feet (MBF). Maine mills were then classified as small (<5 MMBF (million board feet)), medium (5-25 MMBF) and large (>25 MMBF). To be consistent with these earlier work, we categorized sawmills in New Hampshire into two mill size categories: small (<5 MMBF) and medium (>5 MMBF) based on survey data of annual production. Because there are only three large mills (>25 MMBF) in New Hampshire, the large and medium mills (5-25 MMBF) will be classified into one size class, Medium (>5 MMBF). The analyses of questions 1 to 17 provide quantitative and qualitative information about New Hampshire's sawmills using statistical methods such as weighted average, average rank, student's t-test and Chi-square analysis.

For questions ranking the importance of several factors to the mill's business success, we generate an average rank for each factor of importance rated by mill size. We used the T-test analysis on average ranking questions to compare the means of two samples, the actual difference between two means in relation to the variation in the data expressed as the standard deviation of the difference between the means (Hamilton, 1990). By comparing calculated t-values with tabulated values for higher levels of significance, we get the probability of our conclusion being correct, which allow us to make statements with a degree of precision. The t-tests, and the analysis of variance are to analyze continuous measurement data. When we wish to record how many individuals fall into a particular category, these enumeration data are discontinuous and must be treated differently from continuous data. In this case, we used Chi-square analysis to test whether or not response patterns to questions 16 a-c and questions 18 b-f are dependent on mill size, to reject or accept the null hypothesis that row and column variables are independent of each other in the population by contingency tables comprised of (r) rows and (c) columns.

However, since the Chi-square distribution is the sampling distribution of the chi-square test statistic, only if the sample size is large, we have to combine categories of responses. Agresti and Finlay (1997) suggested a rough guideline for this requirement, that the expected frequency should exceed 5 in each cell otherwise the Chi-square distribution may poorly approximate the actual distribution of the Chi-square statistic. Zar (1999) suggested that appropriate criterion was the average expected cell frequency, which was defined as $n/(r*c)$, where n was the sample size and r and c were the number of rows and columns. If the average expected cell frequency was at least 6.0 at the probability level, $\alpha = 0.05$, or at least 10.0 at the 0.01 level, then Chi-Square tests worked well. To meet Zar's criterion for testing at the 0.05 significance level, the responses of each sub-question in question 16 and 18 are collapsed into a 2 by 3 contingency table. There are two mill sizes and three response categories created by combining the six response options: the first two response categories were combined into one high-level of importance or agreement category, the middle two responses into one moderate-level category, and the last two responses into one low-level category. Specific Chi-square test results are included in Appendix A New Hampshire Sawmill Survey Chi-square Analysis Tables. Detailed calculations and explanations of t-test results on average ranking survey question 10 and question 11 are included in Appendix A New Hampshire Sawmill Survey T-test Tables.

Results

New Hampshire Return Statistics

Of the 74 year-round mills surveyed, 49 mills responded. Forty-six mills of these completed most of the questions in the survey and three indicated that their mills were closed, yielding a survey response rate of 65%. The survey process was divided into three rounds. The first round of mailing obtained 32 responses, among which were included the three closed mills (41% response rate). A second round of mailing after a reminder postcard to the mills which had not yet responded to the survey obtained 14 more surveys, increasing the response rate to 61%. The third round of telephone prompting resulted in 3 more completed surveys, increasing the overall response rate to 65%. According to the New Hampshire Directory of Sawmills, among the remaining 71 yearly-round operating sawmills, 46 are small sawmills (annual production less than 5 MMBF) and 25 are medium sawmills (annual production greater than 5 MMBF).

Table 2-1: Response rates by size class

Mill size	Total Number	Percent of Total	Number responding	Percent of mills responding	Percent Distribution of Respondents
Small	46	65%	35	76%	76%
Medium	25	35%	11	44%	24%

While we obtained a good overall response (65%), a greater portion of small sawmills (76%) responded than did medium mills (44%) (Table 2-1). Thus our responses are somewhat biased toward small mills (76% versus 24%). Only two of the three large New Hampshire mills responded, further justifying our decision to merge three mill classes into the two small and medium classes. Most respondents completed the entire survey questionnaires while a small number of respondents answered questions selectively. Hence, response rates vary for each question (Table A-50). All statistical tables are in Appendix A as New Hampshire Sawmill Survey Return Statistics Table A-39 to Table A-50, and are followed by Chi-square analysis tables (Table A-51 to Table A-62).

Mill Characteristics

The oldest New Hampshire small-sized mill was established in 1800, the newest was established in 1996, with an average establishment date of 1948 (Table A-39). For medium-sized mills, the oldest was established in 1935, the newest was established in 1994, with an average establishment year of 1966. Most mills (48%) had a closely-held corporation business organization; the second-preferred business organization was the proprietorship, followed by the partnership, then equally across publicly-traded company and other types (Table A-39). Most small mills are family-owned business. Of the 35 responding small mills, 32 were family-owned business (Table A-39). Among the ten responding medium-sized mills, six were family-owned business. Nearly all mills reported to be US-owned; only one declared to be Canadian-owned (Table A-39).

Operations

In total, among 45 responses, the number of softwood dimension, white pine lumber and hardwood mills was 17, 16, and 16 respectively. Among 35 responding small mills, 14 were softwood dimension mills, 13 were white pine lumber mills, 15 were hardwood lumber mills and 10 were categorized as other types (Table A-40). Among 10 responding medium sized mills, there were 3 softwood dimension mills, 3 white pine lumber mills and 1 hardwood mill. Two mills were categorized as other types. Overall, most New Hampshire mills are softwood and white pine lumber mills. All mills provided either a single figure or a range of their approximate annual total production. Small mills' annual total production averaged 2 MMBF and medium mills' annual total production averaged 14 MMBF (Table A-40). The average for all mills was about 5 MMBF.

Work Force

Among responding small mills, the most common (19 of 33 responses) work force size was 1 to 5 people while eleven mills indicated 6 to 25 and three indicated 26-50 employees (Table A-41). A majority of medium mills employ 26 to 50 people (6 of 11 responses) and 5 medium mills employ 6 to 25 people. No mill indicated employing more than 50 people. More than 75% of all mills employed 25 or fewer workers.

In response to the question regarding average work force age, the most common response for small mills was that employees were from 41 to 50 years of age (11 out of 32 mills) (Table A-41). The second most common response was 31 to 40 years of age (9 of 32 mills). Average work force age for the medium mills was somewhat younger, with 6 of 11 mills indicating 31 to 40 years of age. No New Hampshire mills indicated that they had employees under the age of 20. Only the small mills employed people over the age of 50, with 9 of 32 selecting this response. This result may be due to the family-owned nature of these businesses.

According to survey respondents, sawmill work force in New Hampshire is very experienced. The most common length of employment for both small and medium mills was 6 to 10 years, with 34% of small mills' and 48% of medium mills' employees having been employed for this long (Table A-41). Small mills were more skewed to longer employment time than medium mills, suggesting that family-operated small mills were more likely to retain employees, or were older businesses. Small mills indicated 19% of employees had been with the mill for more than 20 years, while only 6% of medium mills employees had been there for that long. Medium mills also had more first-year employees, with 9% of their workers employed less than one year compared to only 5% of small mills employees being employed for their first year.

For both small and medium mills, most employees lived within 10 miles of the mill (67% of small mills' employees, and 41% of medium mills' employees) (Table A-41). Small mills employees were more likely to live close to the mill, with only 8% living from 20 to 29 miles while 21% of medium mill employees lived within this distance. Very few employees lived more than 40 miles from their place of employment.

Among 38 responding mills, 11 reported that their new hires did not have any prior lumber mill experience; 13 reported that approximately 1-25% of their new employees have prior experience; 8 reported that 26-50% of their new employees have prior experience and only 6 small mills reported that more than 50% of their new employees have prior lumber mill experience (Table A-41). None of the responding medium mills had over 50% of their new hires with prior lumber mill experience. Medium mills seem to have more flexibility than small mills in hiring inexperienced workers and are more likely to provide training programs on-the-job or by means of structured job-specific training within the company.

Although all responding mills provided training programs, medium mills offer their new employees more training programs than small mills (Table A-41). All 10 responding medium mills offered various training programs, including on-the-job training, structured in-house safety and job-specific training, as well as external training involving the Northeast Lumber Manufactures Association's (NELMA) lumber grading school and even college-level courses. Because respondents could indicate the availability of more than one training program, the total number of responses exceeds the number of responding mills, 16 and 10 respectively. All 29 responding small mills offered on-the-job training. Only 7 of 29 responding small mills had structured training within the company and only 3 small mills offered external training programs. All responding mills stated they only had one shift per day (Table A-41).

We asked respondents to rank factors important to mill success from 1 to 4 in order of importance to the mill with 1 being most important and 4 being least important (survey question 10). These factors were listed as labor issues (costs and availability), capital costs and availability, delivered log costs and end-product markets. Among the 31 responding small mills, the end-product markets response was rated relatively more important than other factors with an average rank of 2.03. The capital cost and availability response was ranked relatively least important among the four factors with an average rank of 3.23 (Table A-41). The average rank for labor issues and delivered log cost were 2.61 and 2.10, respectively. The 11 medium mills indicated that delivered log cost was rated relatively more important than other factors with an average rank of 1.46; labor costs were ranked relatively least important among all the four factors with the average rank of 3.00. The average rank for capital costs and availability and end-product markets for medium mills were 2.82 and 2.46, respectively.

We performed t-tests to compare the differences among means from all responding mills. From t-test results (Table A-63), delivered log cost (1.92) and end-product markets (2.14) are not significantly different in terms of their importance to mill success while these two factors are statistically proved to be more important than labor issues, capital costs and availability. Though mills gave a higher ordinal ranking for labor issues (2.71) than capital costs and availability (3.11), they are not significantly different in term of their importance to mill success.

We also asked respondents to rank the importance of specific labor factors to their mill (survey question 11) and we performed t-tests to compare the means as well. These labor factors were direct labor costs, indirect labor costs (insurance, workers' compensation, etc), availability of skilled labor and turnover of workforce. The 29 responding small mills indicated that indirect labor costs were relatively more important than other factors with an average rank of 1.79 (Table A-41). Turnover of workforce was ranked the least important (3.59). The average ranks for direct labor costs and availability of skilled labor were 2.03 and 2.93, respectively. Medium mills also rated indirect labor costs as most important (1.46) and turnover of workforce was ranked least important (3.46). The average ranks for direct labor costs and availability of skilled labor were 2.28 and 2.46, respectively. Medium and small mills ranked the four labor factors in the same hierarchical order of importance, suggesting similar perceptions of the importance of these labor factors.

From t-test results of survey question 11 (Table A-64), direct labor costs (2.1) and indirect labor costs (1.7) are not significantly different in terms of their importance to their mill. They are equally important to their mill and significantly more important than availability of skilled labor (2.8).Turnover of workforce (3.55) is statistically least important among all labor factors.

Capital Investment

When asked whether they have made capital investment in the form of a major modernization/upgrade project within the past 5 years, small and medium mills responded quite differently. Most small mills had not made such investments while most medium mills had (Table A-42).

Both small and medium mills responded similarly regarding their plans for modernization (Table A-42). Seven of 11 medium mills and 22 of 30 small mills responded that they did not plan any modernization project in the near future. The most frequent reason given for not planning modernization was that no modernization was necessary (13 of 26 mills) (Table A-42).

Log Supply

Medium mills indicated that 64% of their log supply was obtained through their own log buyers (Table A-43). Among small mills, only 14% of log supply was obtained through their own log buyers. Medium mills responded that only 1% of logs were from their own forest lands, while small mills state that 12% of their logs supply was from their own forest lands. Among all mills, about 25% of logs were procured through brokers and long-term wood supply agreements. Small mills depended on stumpage purchase for a larger percentage of their log supply 19% than did medium mills 9%.

The vast majority of mills responded that their log source was from private forests in New Hampshire, with 86% of the total volume of logs coming from this source (Table A-43). The second most common source of logs for small mills was from outside New

Hampshire in the United States (9%), while for medium mills the second most common choice was from private forests within Maine (5%).

Small mills were more likely to procure their logs nearby, with 52% of volume from within 20 miles (Table A-43). The most common distance zone for the medium mills was from 20 to 49 miles, with 45% of log volume received from this distance. The medium mills received 29% of their log volume from within 50 to 99 miles, whereas the small mills received only 12% of their log volume from this zone. The larger scale of operations and more diverse log procurement methods are likely to require log sources further away from the mill. Among all responding mills, 78% of their log supply came from within 50 miles of the mills

Markets – Primary Products

New Hampshire mills produce and sell various types of primary products such as bark, beams and timbers, veneer, green lumber, pulp chips, saw dust, studs and dimension lumber, kiln dried lumber, pallet stock, shavings, shingles and firewood. Some lumber is shipped out-of-state for further processing.

Small mills responding to the survey shipped most of their primary product within their home county, with 36% of the products shipped locally (Table A-44). Only 22% of medium mills' product was shipped within the county, while 32% of medium mills' product was shipped elsewhere in New Hampshire. Small mills' products shipped elsewhere decreased in percentage with distance, while medium mills still shipped 25% of their product to other regions of the U.S., compared to 11% of small mills shipping their product to other regions of the U.S.

While small mills in New Hampshire responded that their products were almost evenly distributed between wholesale and retail markets (48% and 52%, respectively), medium mills were more likely to sell wholesale, with 83% of their products going to the wholesale market (Table A-44). This reflects in part the larger production volumes of the medium mills, which makes it difficult to market all of the products in a retail setting.

Markets – Value-Added Products

Both small and medium mills indicated that they were slightly more likely to have value-added product manufacturing on site than not, with 18 of 32 small mills indicating some value-added manufacturing and 6 of 11 medium mills indicating as such (Table A-45). Small sawmills ship 74% of their value-added products in New Hampshire or to Vermont (38% locally, and 36% elsewhere in New Hampshire or Vermont) (Table A-45). Medium mills ship 68% of their value-added products elsewhere in New England (45%) or to other regions of the U.S. (23%). Very little (<1%) of value-added products are shipped out of the U.S.

Certification

We asked about mill operators' participation in and perceptions of certification programs such as those offered by the Forest Stewardship Council and the American Forest and Paper Association's Sustainable Forestry Initiative. The 24 small mills who answered the question revealed that their average percentage of supply from certified log sources was 17% (Table A-46). Medium mills used more certified logs (31%) than the small mills (17%) but seemed less sure of the certification status of their logs than the small mills, with 54% coming from unknown log certification sources versus 11% of unknown sources for small mills. A majority of New Hampshire mills do not track the chain of custody of the logs, with only 1 of 29 small mills and 1 of 11 medium mills responding that they did so (Table A-46).

Two-thirds of responding small mills currently not marketing certified wood did not plan to market certified wood in the near future (21 of 32) with only 11 of 32 stating they may consider doing so (Table A-46). Both small and medium mills were not presently considering marketing certified wood, with none of the responding small mills and only 2 of 11 medium mills claiming they are considering marketing certified wood.

We asked respondents to identify the reasons why they were not considering marketing certified wood. Because respondents could choose more than one reason, response totals exceed the number of responding mills. The most frequently given reason for not marketing certified wood was that the market is not large enough at this time. Overall, 18 of 32 responded mills selected this reason, small mills in particular selecting this reason (15 of 24 responses) (Table A-46). The second most common response was that the certification process was too expensive with 15 of 32 mills favoring this reason (12 of 24 small mills and 3 of 8 medium mills). The least frequent response was that following the chain of custody was too difficult.

Community

We asked the mill operators' opinion as to their firm's importance to the social and economic well-being of their community, with the response 1 indicating extreme importance and response 6 indicating no importance (Table A-47). No medium mills responded with a 5 or 6, indicating that they thought they were at least somewhat important to the community. Four of eleven medium mills indicated response 1, indicating they thought their mill was important to the community. Small mills, however, did not consider themselves as important, with their responses having a weighted average of 3.61, as compared to a weighted average of 2.18 for medium mills. Six small mills responded that they were not at all important to their local community, but no medium mill made that response. While these results suggest a difference in the pattern of responses, chi-square analysis of the aggregated responses (3 levels of responses rather than 6), (Table 2-2) indicates the response patterns are independent of mill size.

Table 2-2: Question 16(a) - percent distribution of aggregate responses regarding the importance of the sawmill to the community

Scale	Important	Neutral	Not Important
Small Mill	32.3%	35.5%	32.3%
Medium Mill	63.6%	36.4%	0.0%
Total	40.5%	35.7%	23.8%

$\chi 2$= 5.525, not significant at α=0.05 with 2 df

By way of contrast, the Chi-square test statistic of 7.341 (Table A-52) for question 16(b) (significant at a confidence level of 0.05 with 2 degrees of freedom) suggests that the owners' opinion of their mill's importance to the state of New Hampshire does depend on mill size. Most small mill owners felt their mills were unimportant to the state but most medium mill respondents felt their mills were important to the state (Table 2-3). None of the medium mills thought their importance to New Hampshire was in the lowest two categories of importance while 12 of 31 small mills selected the lowest two categories (Table A-47).

Table 2-3: Question 16(b) - percent distribution of aggregate responses regarding the importance of the sawmill to the State of New-Hampshire

Mill Size	Important	Neutral	Not Important
Small Mill	16.1%	45.2%	38.7%
Medium Mill	45.5%	54.5%	0.0%
All	23.8%	47.6%	28.6%

$\chi 2$= 7.341, significant at α=0.05 with 2 df

Less than half of the mill operators surveyed considered their operations to be important to any Canadian community, 28 of 41 selecting the least important responses category and only one selecting the most important response category (Table A-47). Among all 41 responses, 34 were in the lowest two categories of importance. The medium mills responses are more skewed toward the importance to the bordering community, although the smaller sample size (11 responses from medium mills versus 30 responses from small mills) could be partially responsible. The Chi-square test statistic (10.736) indicates that mill size affects the owners' opinion of their mill's influence to adjacent Canadian communities (Table 2-4). Almost all small mills selected "not important responses", while only about half of medium sawmill owners felt their mill was not important to adjacent Canadian community.

Table 2-4: Question 16(c) - percent distribution of aggregate responses regarding the importance of the sawmill to the adjacent canadian community

Mill Size	Important	Neutral	Not Important
Small Size Mill	0.0%	6.7%	93.3%
Medium Size Mill	27.3%	18.2%	54.5%
All	7.1%	9.8%	82.9%

$\chi 2$= 10.736, significant at α=0.05 with 2 df

New Hampshire sawmills engage in a variety of community activities, the most common of which were making donation of money and/or products to the community (Table A-47). A smaller number of mills were active in organizations and very few mill operators had provided an open house or tour for local community members or encouraged employees to be engaged locally or encouraged recreational use of company lands (Table A-47). Very few mills (3 of 36) hold a question and answer session for the community. Four of 10 responding medium mills and 4 of 26 responding small mills claimed to encourage an employee's leadership in the local community. Such participation can generate good publicity and economic relations, and does not have the privacy concerns of an open house or an open question and answer session. Among 36 responding mills, 5 responded that they allow community members to use their lands for recreational purposes, 3 of 26 responding small mills and 2 of 10 responded medium mills.

International Factors

Responses to questions concerning international factors indicated that these are not critical concerns. The average ranks of importance rated among all New Hampshire mills, were 2.28, 2.75, 2.67, and 2.75 respectively for the four international factors (Table A-48) of international competition for wood, exchange rate of US and Canadian dollars, the current tariff on Canadian lumber and general trade agreements (NAFTA, GATT/WTO). International competition for wood was rated as the most important. This is especially true in the medium size mills, whose average rank was 1.91 for that question. The other factors' average ranks indicated that there is less concern about exchange rates, tariffs and general trade agreements among responding mills.

In 2002, US government officials imposed tariffs and duties averaging 29% on most Canadian softwood lumber shipped into the US. We asked respondents about the importance of maintaining current tariff on Canadian lumber to the success of their mill. Responses indicate clearly that this tariff was of larger importance to medium mills than to small mills. Among 11 responding medium mills, 6 chose the most important rank, while only 3 of 32 responding small mills chose the most important rank (Table A-48). Also, 13 of 32 responding small mills chose the least important rank for this issue, while only 2 out of 11 responding medium mills chose the least important rank. The result of the Chi-square test was 7.167 (Table A-54) for question 18b, significant at a confidence level of 0.05 with 2 df. This suggested sawmill owners' perception on the importance of tariff on the Canadian lumber is dependent on mill size. The pattern of response was significantly different between the two mill classes with the medium mills selecting high levels of agreement while most small mills indicated low levels of agreement (Table 2-5).

Table 2-5: Question 18(b) - percent distribution on the importance of maintaining the current tariff on canadian lumber

Mill Size	High Level of Agreement	Medium Level of Agreement	Low Level of Agreement
Small Mill	15.6%	25.0%	59.3%
Medium Mill	54.5%	9.1%	36.4%
All	25.6%	20.9%	53.5%

$\chi 2 = 7.167$, significant at $\alpha=0.05$ with 2 df

We asked a battery of four questions about the competition with Canadian sawmills in general and specifically with Québec mills along the New England border. The latter obtain logs largely from private lands in Québec and northern New England. Most small and medium mill respondents indicated high levels of agreement with the statement that Canadian border mills enjoyed an advantage due to lower production costs (Table 2-6). Chi-square tests showed no significant difference in the pattern of response. Since the result of Chi-square test statistics for aggregate results of question 18(c)-1 is 2.325 (not significant at both the 0.05 and the 0.10 confidence level with 2df) (Table A-55), mill owners' perception is independent of mill size.

Table 2-6: Question 18(c)-1 - percent distribution of mill perception on canadian border mills' advantage in lower production costs

Mill Size	High Level of Agreement	Medium Level of Agreement	Low Level of Agreement
Small Mill	70.4%	18.5%	11.1%
Medium Mill	63.6%	36.4%	0.0%
All	68.4%	23.7%	7.9%

$\chi 2 = 2.325$, not significant at $\alpha=0.05$ with 2 df

The operators' opinions were virtually unchanged when asked about mills throughout Canada (Table A-48). As was the case with the border mill question regarding production cost advantages, the Chi-square analysis result (1.314 for aggregate responses to question 18(c)-2) (Table A-56), indicated that sawmill size did not affect owners' opinion. The majority of the sawmill owners considered that mills throughout Canada have an advantage due to their lower production costs (Table 2-7).

Table 2-7: Question 18(c)-2 - percent distribution of mill perception on mills throughout Canada's advantage in lower production costs

Mill Size	High Level of Agreement	Medium Level of Agreement	Low Level of Agreement
Small Mill	65.4%	23.1%	11.5%
Medium Mill	66.7%	33.3%	0.0%
All	65.7%	25.7%	8.6%

$\chi 2$= 1.314, not significant at α=0.05 with 2 df

We asked mill operators about competition from Canada, in terms of their opinion about the following statement: "Canadian mills do not pose a threat to the success of US mills in the northeast". Most mill operators thought Canadian border mills were a threat, with none responding that they strongly agreed with a statement that border mills are not a threat (Table A-48). Among 38 responses, fourteen mills strongly disagreed with the statement that Canadian border mills are not a threat to US mills. This response was most common for both small mills (9 of 27) and medium mills (5 of 11). It is clear that New Hampshire mill operators are very concerned about competition from Canadian border mills.

The result of the Chi-Square test for question 18(d)-1 (Table A-57) is 1.847, insignificant at a confidence level of 0.05 with 2 df, which indicates that the pattern of responses is not related to mill size. Most sawmill owners consider that Canadian border mills do pose a threat to the success of US mills in the northeast (Table 2-8).

Table 2-8: Question 18(d)-1 - percent distribution on mill agreement level with the statement: "Canadian border mills do not pose a threat to the success of US mills in the Northeast"

Mill Size	High Level of Agreement	Medium Level of Agreement	Low Level of Agreement
Small Mill	14.8%	33.3%	51.9%
Medium Mill	0.0%	36.4%	63.6%
All	10.5%	34.2%	55.3%

$\chi 2 = 1.847$, not significant at $\alpha=0.05$ with 2 df

When we asked if mills throughout Canada are a threat to US mills, responses did not indicate a change of attitude among mill operators regarding mills throughout Canada compared with Canadian border mills (Table A-48). Most sawmill owners consider that mills throughout Canada do pose a threat to the success of US mills in the northeast (Table 2-9). The result of Chi-square test for question 18(d)-2 (Table A-58) suggests that sawmill owners' perceptions are independent of mill size.

Table 2-9: Question 18(d)-2 - percent distribution on mill agreement level with the statement: "Mills throughout Canada do pose a threat to the success of US mills in the Northeast"

Mill Size	High Level of Agreement	Medium Level of Agreement	Low Level of Agreement
Small Mill	7.4%	44.4%	48.1%
Medium Mill	0.0%	40.0%	60.0%
All	5.4%	43.2%	51.4%

$\chi 2 = 0.974$, not significant at $\alpha=0.05$ with 2 df

We asked mill operators their opinion about the following statement: "Canadian mills are at an advantage because they can buy timber at lower stumpage prices". Both small and medium mills' responses to this statement indicate that they did think lower stumpage prices in Canada gave these mills an advantage. Nearly 90% of all mills either agreed or strongly agreed with the statement (Table A-48).

The Chi-square test result 4.496 for question 18(e)-1 (Table A-59) suggests that the sawmill owners' opinions on this question are not influenced by mill size. Over half of the sawmill owners felt that Canadian border mills enjoy the advantage of lower stumpage price (Table 2-10).

Table 2-10: Question 18(e)-1 - percent distribution of mill perception on canadian border mills' advantage in lower stumpage prices

Mill Size	High Level of Agreement	Medium Level of Agreement	Low Level of Agreement
Small Mill	55.6%	29.6%	14.8%
Medium Mill	36.4%	63.6%	0.0%
All	50.0%	39.5%	10.5%

$\chi 2$= 4.496, not significant at α=0.05 with 2 df

There was not a major change in responses to this statement from perceptions of border mills to perceptions regarding mills throughout Canada. Small mills responded mostly (13 of 27) that they agreed with the statement, and this was also the most common response for medium mills (4 of 10) (Table A-48). No mills said that they strongly disagreed with the statement. All mills felt that the alleged lower prices of Canadian stumpage to be an advantage for mills throughout Canada, and medium mills placed slightly more emphasis on the advantage of mills throughout Canada over border mills. Chi-square analysis result 0.798 of the stumpage price question 18(e)-2 (Table A-60) indicates that the response patterns to this question are independent of mill size. Over two-thirds of the sawmill owners in New Hampshire agree with the statement of question 18(e)-2 (Table 2-11). They consider that lower stumpage prices bring mills throughout Canada an advantage to their business.

Table 2-11: Question 18(e)-2 - percent distribution of mill perception on mills throughout Canada's advantage in lower stumpage prices

Mill Size	High Level of Agreement	Medium Level of Agreement	Low Level of Agreement
Small Mill	66.7%	25.9%	7.4%
Medium Mill	70.0%	30.0%	0.0%
All	67.6%	27.0%	5.4%

$\chi 2$= 0.798, not significant at α=0.05 with 2 df

Responses to the question "Canadian border mills are at an advantage because they pay lower wood transportation costs" indicated that operators are less concerned about wood transportation cost differences in Canada than they are about lower stumpage costs or production costs. The most common response was "somewhat agree", with 11 of 37 mills and 13 of 27 small mills (Table A-48). However, for medium mills the most common response was "strongly agree", with 5 of 10 mills giving this response.

The Chi-square test for question 18(f)-1 (Table A-61) suggests that the sawmill owners' answers on this question are independent of mill size. Over half of the respondents agreed that lower wood transportation costs give Canadian border mills a comparative advantage (Table 2-12).

Table 2-12: Question 18(f)-1 - percent distribution of mill perception on Canadian border mills' advantage in lower wood transportation costs

Mill Size	High Level of Agreement	Medium Level of Agreement	Low Level of Agreement
Small Mill	33.3%	51.9%	14.8%
Medium Mill	60.0%	20.0%	20.0%
All	55.6%	43.2%	16.2%

$\chi 2 = 3.113$, not significant at $\alpha=0.05$ with 2 df

The importance of wood transportation costs as a Canadian advantage was viewed a lesser concern for the case of mills throughout Canada. Among 36 responses, 10 indicated "somewhat disagree". However, responses in general were more towards "agree" than towards "disagree", for both small and medium mills (Table A-48). Responses suggest that this statement was more valid for medium mills, with 3 of 9 responses saying "strongly agree", and 3 of 27 small mills also saying "strongly agree". However, Chi-square analysis (Table A-62 for question 18f2) indicated that mill's perceptions of the importance of wood transportation costs were independent of mill size.

Over half of respondents neither agreed nor disagreed on the question's statement (Table 2-13).

Table 2-13: Question 18(f)-2 - percent distribution of mill perception on mills throughout Canada's advantage in lower wood transportation costs

Mill Size	High Level of Agreement	Medium Level of Agreement	Low Level of Agreement
Small Mill	33.3%	59.3%	7.4%
Medium Mill	55.6%	33.3%	11.1%
All	38.9%	52.8%	8.3%

$\chi 2$= 1.828, not significant at α=0.05 with 2 df

Business Environment

We asked mill operators to rank four business climate factors: state regulations, federal regulations, taxes, and public acceptance. A scale of 1 to 4 was used with 1 as the most important and 4 as the least important. Two factors among all mills, state environmental regulations and taxes were seen as most important, with average rank scores of 2.33 (Table A-49). Public acceptance and federal environmental regulations with average rank scores of 2.8 and 2.68, respectively, were less important. The most important factor among medium mills was taxes (2.00). One more interesting result from this question is the difference between federal and state regulations. Small mills considered state regulations as more important than federal ones (2.17 versus 2.67) while medium mills considered state regulations less important than federal ones (2.73 versus 2.64).

Mill operators were also asked to rate the importance of five industry assistance factors, with the same numbering (from 1 to 4), where an average of 2.5 indicates neutrality on the importance of the factor. The financial assistance factor was near neutral for both small (2.46) and medium (2.55) mills (Table A-49). Research and development in production technology was the least important factor for small mills, with an average of 3.00. Market development programs were the most important factor for both small (2.04) and medium (2.27) mills. Technical assistance from state organizations was a little bit less important than neutral, with a 2.81 average response from small mills and a 2.46 average response for medium mills.

We also asked mill operators to rank the importance of various government entities to their business, on a scale of 1 to 5. Local governments were slightly more important to small mills (2.15) than to medium mills (2.73) (Table A-49). New Hampshire government was on average the most important factor for both small (2.12) and medium (1.91) mills. This reflects a strong influence of state politics and lawmaking regarding New Hampshire sawmills of all sizes. The U.S. federal government was slightly less important for small mills (2.54) than for medium mills (2.00). The provincial governments of Quebec and/or New Brunswick were less important for small mills (4.00) than for medium mills (3.82); while Canadian government was the least important factor with average responses from small mills (4.50) and medium mills (4.00). One interesting thing learned from this question is that small mills find the New Hampshire state government affects them more than the federal government, while medium mills see less of a difference between these two government entities.

Discussion

New Hampshire's sawmills are nearly all small and medium sized mills and a majority of them are softwood dimension or white pine lumber mills. Annual total production averaged about 2 MMBF for small mills and 14 MMBF for medium mills. Most mills are organized as proprietorships, closely-held corporations, or as partnerships.

Mill employees are mostly local and, similarly, log sources for these mills are also mostly local, suggesting a dependence on a healthy local forest. Small mills procure 52% of their logs from within 20 miles while medium mills procure 45% of their logs from within 20 miles to 49 miles. New Hampshire mills make extensive use of eastern white pine. Products are mostly used locally, with 36% remaining in the county, 31% going elsewhere in New Hampshire and Vermont, and 26% going elsewhere in New England. Both small and medium mills indicated that they were slightly more likely to have value-added product manufacturing on site. Small mills are more likely to ship their value-added products locally (38%), whereas the medium mills are most likely to ship elsewhere in New England (45%). Indirect labor costs (insurance, employee's medical benefits, and workmen's compensation) are the most important labor issue. There is no surprise due to high costs of these factors in the forest product industry.

Many mill operators claimed involvement with the local community. Though respondents commonly made donations of money or products or participated in non-profit organizations, not many mills were active in organizations and very few mill operators had provided an open house or tour for local community members, encouraged employees to be engaged locally or encouraged recreational use of company lands. However, the low response rate suggests that mill operators have environmental and economic concerns about their land, and perhaps would prefer monetary compensation for the use of their land investment. Medium mills' responses suggested their importance to the local community is greater than that of small mills'. Policies to link the forest industry and the local communities are suggested, such as by providing a common ground for localizing mill forest products in the community.

An interesting result is the difference between the perception of the importance of federal and state regulations. Small mills considered state regulations more important than federal ones while medium mills considered state regulations less important than federal ones. This could be due to more importing and exporting from other states by larger mills, while smaller mills conduct business more locally. Most small mill owners felt their mills were unimportant to the state while medium mills' influence to the state is important. The clearest indicator of this is that none of medium mills thought their importance to the State of New Hampshire was in the lowest two categories of importance while 12 of 31 responses from small mills were in the lowest two categories of importance. This is not surprising considering that larger mills have relatively stronger social and economic impacts on the State of New Hampshire.

Certification, although of growing importance in forest management, is not seen as viable for option for forest products manufacturers due to costs, lack of markets and difficulties associated with chain-of-custody procedures. It is not surprising that 61% of mills do not consider certification of sources, but medium mills used many more certified logs than small mills. Very few mills track the chain-of-custody of log sources and lumber production.

International factors are perceived as somewhat important. New Hampshire mills rated international competition for wood as the most important. Both small and medium mills agree that Canadian sawmills have an advantage due to lower production costs, lower stumpage prices, and lower wood transportation costs. Medium mills were more emphatic that stumpage price advantage for Canadian mills was a factor in their success, and that transportation costs were also important. It was interesting that mills perceived

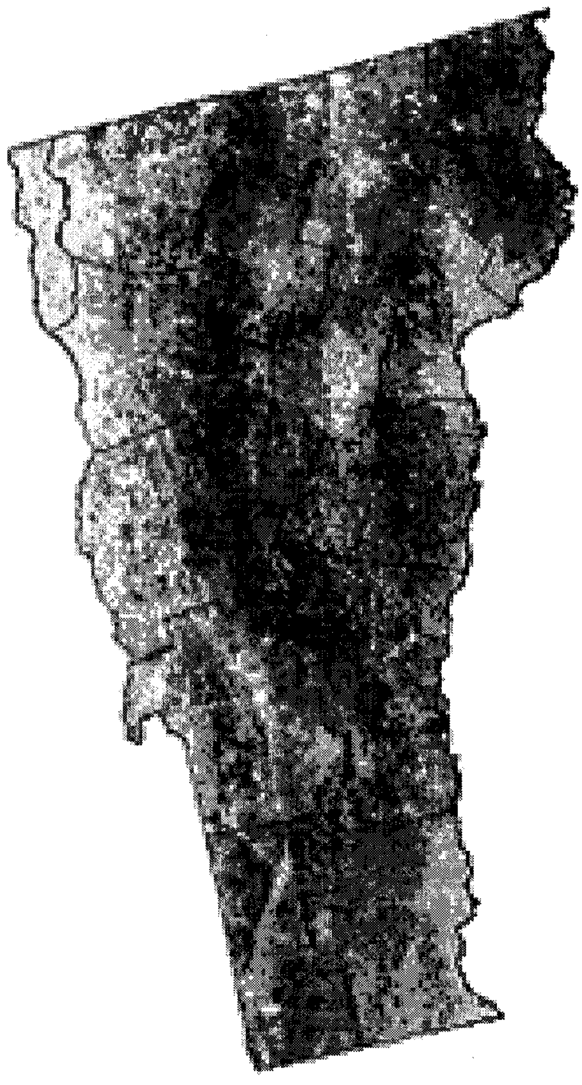
Canadian border mills as having a comparative advantage because of lower stumpage prices because reality is different than perception. Border mills purchase private stumpage in competitive Québec markets or buy logs in New England. They were exempt from the softwood lumber tariff because the U.S. government decided these mills did not enjoy lower stumpage prices allegedly administered for the purchase of Crown timber.

Survey results indicated that there was little difference in the opinions of New Hampshire mill operators as to the competition from neighboring Canadian mills versus mills throughout Canada. The impact of mill size was also not significant on mill operators' opinions, of the comparative advantage of Canadian mills to the success of their mill while the mill operator's perception on the importance of tariff on the Canadian lumber is dependent on mill size. Medium mills agreed more than small mills on the importance of maintaining the current tariff on the Canadian lumber to the success of their mill.

In summary, the New Hampshire sawmill industry is comprised of small business, dependent on local work force and local wood. They are not interested in certification programs and are wary of Canadian competition. The nature of the industry in New Hampshire, with the presence of much national forest land, as well as privately owned forests, and large stocks of softwood and eastern white pine, make it an interesting example of forestry in the context of sustainability. A good analysis of the industry is only possible in the larger context of the bioregion ignoring national, state and county boundaries. Having profiled the New Hampshire sawmill industry, it is important for policy makers to identify the concerns this profile provides to better manage the long-term health of New Hampshire's sawmill industry and its forest resource base.

CHAPTER III

A PROFILE OF THE VERMONT SAWMILL INDUSTRY[2]



---

[2] Difei Zhang and Theodore Howard, 2007. Submitted to the Northern Journal of Applied Forestry. Scientific Contribution No.xxxx of the New Hampshire Agricultural Experiment Station

Abstract

The survey of the Vermont Sawmill Industry examined the sawmill industry in terms of capital investment trends, market conditions of log supply and final product, domestic and international competition, mill work force characteristics and business environment. We surveyed sawmill operators' perceptions regarding social and economic issues, their concerns about log availability, log procurement sources and cost of logs. Mill operators answered questions about different levels of sawmill participation in bioregional community activities and their willingness to participate in forest products certification programs, and response to policies and international trade factors. The results of the study can be useful to both people in the industry and policy makers by providing a profile of Vermont sawmill industry and identifying current concerns and issues affecting the industry.

Return statistics revealed that Vermont's mills were mostly small and medium sized mills, with predominantly local employees, using mostly logs from within 50 miles. Medium mills also used logs from further away than small mills, with 4.25% of logs coming from 100 to 250 miles as opposed to only 2.03% of small mills logs coming from within this distance. Vermont's sawmills and their forest bases are currently operating at a self-sufficient level of log supply in that they have healthy inventory and good growth and drain ratio. Most logs used by Vermont mills (86.89%) were from private forests in Vermont. This was more the case for small mills (88.42%) than for medium mills (79.86%). Medium mills were much more reliant on logs from elsewhere in the United States than small mills. Products of Vermont's mills are used worldwide, but mostly locally in Vermont and New England. About 40% of the product remains in the same

county. Relative to New Hampshire mills, Vermont's mills use less softwood and more hardwood. Most mill operators claimed involvement in local community, but did not feel involved with Canadian communities despite the common border. The industry has not been overly modernized, with about half mills reporting recent investment. More than half of mills do not consider certification of log sources. More than half of mills do not consider certification of log sources, and very few track the chain of custody of the log sources. Both small and medium mills agreed that Canadian mills were a threat to the success of their mill. Mill size does not affect its owner's agreement about the statement that "Canadian sawmills are at an advantage due to lower production costs, lower stumpage price and lower wood transportation costs". Most of sawmill owners valued the advantage of lower stumpage price as insignificant while they valued the advantage of lower production costs and lower wood transportation costs as significant. The smaller nature of the mill industry in this state leads itself to a community-based analysis of sustainability and economic factors, and allows a more complete analysis of the industry's sustainability, as compared with more international markets. The study can help reinforce the role of the bioregional forest-based economy by defining the relationship between forests, bioregional communities and forest industries.

Introduction

The health and sustainability of Vermont's forests and its forest industry are the key factors to the Vermont forest economy, especially to the state's rural communities. It provides substantial timber income to landowners and employment opportunities for over 7,800 people with payrolls of $216 million. Most forest land in Vermont is privately owned and total sales of stumpage earned by Vermont landowners reached $30 million in 2001 (U.S. Bureau of the Economic Census, 2001). North East State Foresters Association (2004) reported that "the Forest-based manufacturing totaled $1 billion and forest-related recreation and tourism expenditures contribute $425 million annually to Vermont's economy. Each 1,000 acres of forestland in Vermont support 1.6 forest-related manufacturing jobs and .52 forest-based recreation and tourism jobs." Seventy-eight percent of Vermont's landscape is forested and covered with large-diameter trees averaging 9.16 inches in diameter at breast height. There are 5.9 million acres in Vermont, among which 4.5 million acres are classified as timberland (USDA Forest Service 2005). The forest cover is comprised mainly of northern hardwood forest type, covering about sixty-six percent of the timberland in Vermont.

The sawmill industry is an important economic sector in Vermont. Although there are no pulp mills in Vermont, about 170,000 cords of harvested pulpwood were exported to neighboring states and Canada (U.S. Bureau of the Economic Census (logging), 2001). Small scale primary processing mills dominate the forest economy. Their major primary processing activities are lumber and related solid wood products. In 2002, Vermont sawmills processed 126.3 million board feet (MMBF) of hardwood and 81.7 million board feet (MMBF) of softwood timber into lumber. More than 86% was processed by only 23 mills. In total, 222.4 million board feet (MMBF) were harvested from Vermont forests, of which 103 MMBF were hardwood and 119.4 MMBF were softwood sawlogs (Census Bureau's Annual Survey of Manufacturers, 2002). According to the USDA Forest Service Forest Inventory and Analysis (FIA) 1997 database, the net growth of trees (total growth of trees plus gains from land coming into forest, minus losses to mortality from insect and disease outbreaks, and disturbances) exceeds removals from harvesting and inventory loss due to land use change. Vermont forest inventory averages over 26 cords per acre and maintains a good growth-to-removal ratio of nearly 2.0.

The purpose of this research is to provide a profile of the Vermont sawmill industry and to identify current forest industry concerns and issues, to thereby better understand the industry as an integral part of the northern New England forest economy. The profile examines mill operators' perceptions of current business climate, production and market factors, the interaction between the sawmill industry and its surrounding communities, the levels of mill participation and interest in forest products certification process and the importance of international issues to mill success.

Previous Work

Several survey-based studies have examined the forest industry, ranging from primary processing to secondary wood manufacturing and marketing as well as to assessments of timber products and production. There have been some surveys of primary processing industry conducted in East, Northwest and Great Lake regions of the U.S. Haugen and Weatherspoon (2003) surveyed 319 primary processing mills in

Michigan in 1998. Their survey results covered important wood procurement and forest management information such as species composition, industry's size, use of roundwood, and generation and disposition of residues. The survey also reports changes and trends in Michigan primary wood-using industry in timber output and use, noting shifts in species composition and products. Smith et al. (2000) conducted a mail survey of Pennsylvania's hardwood sawmill industry examining firm size, species used, log source and grades, processing technology and value-added features. Harris et al. (2003)'s survey analysis measured the development of wood procurement management on non-industrial private forest lands. Hill (2000) conducted a sawmill survey of Alaska primary processing industry, examining mill capacity, employment, log production and consumption, which connected to earlier work linking Alaska forests and communities through value-added forest products. Bailes and Nielsen (1997) conducted a study in Oregon examining aspects of management and accounting in the forest product industry's capital budgeting practices, project evaluation, risk analysis methods and post-audit procedures.

There have been also surveys conducted to assess secondary processing and marketing. Wilson et al. (2001), Mangun and Phelps (2000) and Volskey et al. (1997) provide examples of surveys of secondary wood manufacturing industries. Examples of marketing surveys include Minnesota Department of Natural Resources (2003) detailed marketing survey of decorative spruce top production and Shook and Eastin's (2001) work on the use of deck materials in the residential construction industry. Finally, the US Forest Service provides periodic state level assessments of Timber Products Output and Production. There are no previous studies of Vermont mills that address the breadth of issues contained in our survey. However, Straussfogel (2003) and Cummings (2003) represent our initial investigations into northern New England's and Southern Québec's industry, and serve as the basis for the survey of Vermont's sawmill industry.

Straussfogel et al. (2003) point out that the northern forest ecosystem transcends political boundary and that communities on both sides of the U.S.-Canada border depend on the same forest. They specifically analyzed the trans-border interactions in the sawmill industry of Chaudière-Appalaches, Québec, and found that the larger the mills were, the more likely they depend on a trans-border wood flow from Maine. Cummings (2004) continued exploring trans-border forest economy and community impacts by examining the Maine sawmill industry from a bioregional perspective, as a means of understanding regional sustainability. She also assessed the usefulness of measures of forest industry dependence to the social and economic dimensions of the forest certification process.

To complete the larger picture of bioregional sustainability of the northeastern forest region, this research will expand previous work in Québec and Maine to include Vermont. There are significant wood flows from Vermont forests supplying their own mills as well as to mills in adjacent counties in New Hampshire, Massachusetts and Maine and to southern Québec. This research can help strengthen our understanding of the forest economy and the bioregional connections linking Northern New England linking is sawmill industry to its forest resource base.

Methods

Survey Process

During spring of 2004, we conducted a mail survey of Vermont's sawmill industry following Dillman's (1978) total design protocol for mail and telephone surveys. We consulted experts in the industry and other professionals for their opinions and advice about the survey design and tested the questionnaire with them. The survey was a nine-page booklet (Appendix C) with a sawmill photograph and an explanatory introduction letter at the front and a set of twenty-two questions that took about twenty minutes to complete. The mailing addresses were obtained through the Vermont Division of Forestry. All of the surveys were addressed to mill proprietors, although the survey also asked the function of the person who actually filled out the questionnaire.

Survey Content

The survey focused on economic and social factors affecting mill operations as well as the connections between the mills and the communities in which they were located. We designed the survey questionnaires to gather sawmill operators' input on the following six general areas:

- Part 1 of the survey (questions 1 through 9) focused on location, history, structure and organization, and work force characteristics of the mill.
- Part 2 (questions 10 through 14), examined mill operator's assessment of the importance of operational factors including: labor issues, cost of capital and capital availability, log supply and log cost, and the nature and structure of the end-product markets. Responses to log supply and cost, as well as mill

production questions were requested in ranges to protect proprietary information.

- Part 3 (question 15) focused on the impact of certification on mill's operations and the importance of chain of custody tracking of products. By determining the levels of mill participation and interest in the forest products certification process, we assess whether the process holds potential to advance sustainability objectives within the state.
- Part 4 (questions 16 and 17) identified mill interactions with its community and the importance of the mill to the social and economic well-being of its community, to the state of New Hampshire or Vermont and to Canadian communities adjacent to the borders of these states.
- Part 5 (question 18) focused on the operator's perception on the importance of international wood competition, exchange rates, current tariff and general trade agreements to the success of the mill. Respondents were asked to indicate their level of agreement with each statement about Canadian sawmills' comparative advantages in production costs, stumpage prices and transportation costs and their perception of whether Canadian mills posed a threat to the success of US mills in the northeast.
- Part 6 (questions 19 and 20) asked respondents to rank business climate factors, industry assistance factors, and government entities according to their importance to the success of their mill.

Finally, question 21 was an open-ended question for respondents to write in any additional comments or address other concerns.

Analytical Methods

We hypothesize that mill size influences responses to survey questions. In their survey analysis of Chaudière-Appalaches, Straussfogel et al. (2003) divided mills into three size categories: small (<10,000 cubic meters, m3), medium (10,000-100,000 m3), and large (>100,000 m3). Cummings (2003) employed board foot equivalents of the Chaudière-Appalaches size categories using a conversion factor of 0.423775 m3 per thousand board feet (MBF). Maine mills were then classified as small (<5 million board feet (MMBF)), medium (5-25 MMBF) and large (>25 MMBF).To be consistent with earlier work for Chaudière-Appalaches region (Straussfogel et al., 2003) and Maine (Cummings, 2003), we categorized sawmills in Vermont into two mill size categories: small (<5 MMBF) and medium (>5 MMBF) based on the survey data of mill annual production. According to annual production statistics of Vermont mill, none of the 49 mills who completed this open-ended question could be categorized as large mills. All these mills have a lower annual total production than 25 MMBF. The analyses of questions 1 to 17 provide quantitative and qualitative information about Vermont's sawmills using statistical methods such as weighted average, average rank, t-tests and Chi-square analysis.

For questions ranking the importance of several factors to the mill's business success, we generate an average rank for each factor of importance rated by mill size. We used t-tests on average ranking questions for comparing the means of two samples, the actual difference between two means in relation to the variation in the data expressed as the standard deviation of the difference between the means (Hamilton, 1990). By comparing calculated t-value with tabulated values for higher levels of significance, we get the probability of our conclusion being correct or reasonable, which allow us to make statements with a degree of precision. The t-test and analysis of variance are used to analyze measurement datum of theoretically continuous variables. When we wish to record how many individuals fall into a particular category, these enumeration data are discontinuous and must be treated differently from continuous data. In this case, we used Chi-square analysis to test whether or not response patterns to questions 16 a-c and questions 18 b-f are dependent on mill size, to reject or accept the null hypothesis that row and column variables are independent of each other in the population by contingency tables comprised of rows (r) and columns (c).

However, since the Chi-square distribution is the sampling distribution of the chi-square test statistic only if the sample size is large, we have to combine categories of responses. Agresti and Finlay (1997) suggested a rough guideline for this requirement, that the expected frequency should exceed 5 in each cell otherwise the Chi-square distribution may poorly approximate the actual distribution of the Chi-square statistic. Zar (1999) suggested that appropriate criterion was the average expected cell frequency, which was defined as n/(r*c), where n was the sample size and r and c were the number of rows and columns. If the average expected cell frequency was at least 6.0 at the probability level, $\alpha = 0.05$, or at least 10.0 at the 0.01 level, then Chi-Square tests worked well. To meet Zar's criterion for testing at the 0.05 significance level, the responses of each sub-question in question 16 and 18 are collapsed into a 2 by 3 contingency table. There are two mill sizes and three response categories created by combining the six response options: the first two response categories were combined into one high-level of importance or agreement category, the middle two responses into one moderate-level category, and the last two responses into one low-level category. Specific Chi-square test results are included in Appendix B Vermont Sawmill Survey Chi-square Analysis Tables. Detailed calculations and explanations of t-test results on average ranking question 10 and question 11 are included in Appendix B: Vermont Sawmill Survey T-test Tables.

Results

We sent surveys to 116 year-round operating sawmills in Vermont. Among 61 returned surveys, 6 had invalid addresses and 6 indicated they were closed (Table 3-14). Forty-nine surveys returned appropriate results, yielding a response rate of 47%. Response rates vary for each question by small and medium sized mills (Table B-75). All statistical tables are in Appendix B as Vermont Sawmill Survey Return Statistics Tables Table B-65 to Table B-75 and are followed by Chi-square analysis tables.

Table 3-14: Vermont response rate

Survey sent out	116
Fulfilled survey	49
Sawmill closed	6
Invalid address	6
Response rate	47.12%

Vermont Return Statistics

Mill Characteristics

All responding mills established their mills between 1800 and 2000. The average year of establishment of all small and medium mills is around 1967 (Table B-65). Small mills were established earlier than medium mills (1800 versus 1929). Thirty- six (92%) small mills reported their mills were established from 1800 to 2000. Eight (80%) medium mills established their mills from 1929 to 1987. Most responding mills were proprietorships (20 of 47 mills) (Table B-65). Closely-held corporations were the second most common type, with 13 of 47. Small mills were especially skewed towards these two types of organizations, (27 of 38 mills). Among 38 responding small mills, 5 were partnership while no medium mills were this type. Only one small mill and one medium mill were publicly-traded corporations. Most of the mills were family businesses, 31 of 47 (Table B-65). However, more small mills were family businesses (26 of 38) whereas among medium mills only about half were family businesses (5 of 9). Most mills were U.S. owned (25 of 30) (Table B-65). All five responding medium mills were U.S. owned. Two small mills were Canadian, and three were of other nationalities.

Operations

The types of mills were quite evenly distributed among softwood dimension, white pine lumber, hardwood lumber, and other (Table B-66). Only one medium size mill processed hardwood lumber. Among 45 responded mills, 33 were softwood dimension and white pine lumber mills and 16 of 45 mills are hardwood lumber company.

The average of annual total production of surveyed mills was 4.27 MMBF (Table B-66). The average production for small mill was 1.11 MMBF; while the average for medium mill was 16.6 MMBF. All these mills have a lower annual total production than 25 MMBF and none of the 49 mills who completed this open-ended question could be categorized as large mills, confirming our decision to categorize Vermont sawmills into two mill size classes.

Work Force

Most mills have very few employees, with 1 to 5 employees being the most common (27 of 45 respondents) (Table B-67). The second most common was 6 to 25 employees, with 15 of 45. No small mills reported more than 25 employees, and only three medium mills reported more. Only one medium mill reported more than 75 employees.

The work force age distribution was similar for small and for medium size mills, both in the 31-40 age category (Table B-67). No mills reported having employees less than 20 years of age. Medium mills were more likely to hire workers over the age of 50, with 2 of 7 reporting such employees as compared to 6 of 38 small mills reporting such employees.

Medium mills showed a monotonic increase in the number of employees, with how long they had been employed, with 34.2% of their employees having 20 years or more experience with the mill (Table B-67). Small mills showed evidence of more recent hiring, with 28.6% having only 1 to 5 years on the job. This trend was also visible in the number of new employees (having less than 1 year with the mill) for which the percentage was 11 for small mills and 5.6 for medium mills.

Most mill employees in Vermont lived close to their mills, with 69.3% living within 10 miles, and 21.7% living from 10 to 19 miles from their mills (Table B-67). Medium mills were somewhat more likely to have employees from further away, reporting 14% of employees living from 20 to 29 miles whereas only 5.69% of small mill employees lived this far from work.

Mill operators' answers indicated that newly hired mill workers had generally not had prior experience, with 15 of 38 reporting hiring new employees with no prior experience, and 14 of 38 reporting 1% to 25% of new employees had prior experience (Table B-67).

Mills offered a variety of training programs. Among 33 responding small mills, 30 offered on the job training, 7 offered structured training within the company such as safety training and job specific training, while only 3 offered external training with college level courses or grading schools and three small mills provided no training at all (Table B-67). All seven responding medium mills offered training programs, 7 offering on the job training, 5 offering structured training with company and 4 offering external training. On the job training is the most common type of training used by both small and medium mills, which is consistent with the factor that mills do not have high requirements on prior experience for new employees. All 34 small mills reported they only run one shift (Table B-67). Medium mills (6 of 7) also ran 1 shift. Only one medium mill ran 3 shifts.

We asked respondents to rank factors important to mill success from 1 to 4 in order of importance to the mill; with 1 being most important and 4 being least (survey question 10). These factors were categorized as A: labor issues (costs and availability), B: capital costs and availability, C: delivered log costs, and D: end-product markets. Responding small mills rated delivered log costs as relatively more important than other factors with an average rank of 2.18. Capital costs and availability was ranked relatively least important among all the four factors with the average rank of 2.97 (Table B-67). The average rank for labor issues and end-product market were 2.58 and 2.3 respectively.

Thus, the hierarchical order of factors important to mill success from high to low for small mills is delivered log costs, end- product markets, labor issues, and capital costs and availability.

By comparison, 7 responding medium mills rated end-product markets relatively more important than other factors with the average rank of 1.71; capital costs and availability were ranked relatively least important (3.43). The average rank for labor issues and delivered log costs were 2.57 and 2.29 respectively. Hence, the hierarchical order of factors important to mill success for medium mills is listed as end - product markets, delivered log costs, labor issues, and capital costs and availability.

In addition to examining the ordinal ranks, we performed the t-test analysis to determine if the average ranks in question 10 were significantly different. Observed from t-test results (Table B-88), the importance ranking of these four factors is: C = D = A > B. Unlike the ordinal ranking of the average rank values, the t-test results of all responding Vermont mills suggest that the importance of the end–product markets (2.2) and delivered log costs (2.2) to Vermont sawmills are not significantly different than the importance of labor issues (2.58) even though their numerical average rank values are different. It also suggests that capital costs and availability (3.05) are significantly less important than all other three factors to mill success.

We then asked respondents to rank specific labor factors important to their mill from 1 to 4 in order of their importance to the mill, with 1 being most important and 4 being least important (survey question 11). We performed t-test on this question as well and include the detailed calculation and explanation of t-test results in Table B-89. These labor factors were listed as A: direct labor costs, B: indirect labor costs (insurance, workers' compensation etc), and C: availability of skilled labors and D: turnover of workforce.

Responding small mills indicated that indirect labor costs was relatively more important than other factors with the average rank of 1.37 and turnover of workforce was ranked relatively least important among the four factors with an average rank of 3.63 (Table B-67). The average ranks for direct labor costs and availability of skilled labor were 2.37 and 2.7 respectively. Thus, the hierarchical order of importance of labor factors for small mills from highest to lowest is: indirect labor costs, direct labor costs, availability of skilled labor and turnover of workforce. Responding medium mills gave the same order of ranking to labor factors as small mills did: indirect labor costs (1.43); direct labor costs (2.29); availability (2.71); turnover of workforce (3.57).

T-test results in Table B-89 reveal different significance levels of these factors in terms of their importance to the mill. The t-test results suggest that the importance ranking order of these four factors for all responding Vermont mills is: B > (A = C) >D. The importance of direct labor costs (2.35) to Vermont mills is not significantly different than the importance of availability of skilled labor (2.71) though the numerical average rank values of the two factors are different. Turnover of workforce is significantly less important than all other three labor factors while indirect labor cost is statistically proved to be the most important labor factor to Vermont mills.

Capital Investment

Among 35 responding small mills, 16 reported a major modernization/upgrade project undertaken in the mill within the past five years. Most medium mills (6 of 7) reported they had undertaken modernization projects within the past five years (Table B-

68). All respondents completed this open-ended part of the question by filling in the exact year of the most recent project and type of project undertaken such as ring de-barker, sorter, kiln etc. Ten of 35 responding small mills and 3 of 7 medium mills had planned modernization/upgrade projects within the next three years (Table B-68). There are various reasons which possibly explain the unpopularity of mills' future modernization planning such as the expensive cost of future project, high costs of borrowing money and the efficiency of the mill, with no near future necessity for modernization, weak markets for products, and, difficulties of completing the project due to government regulations.

We asked operators to indicate why no capital projects are planned for the next three years. Among 26 responses, most common reason for no future project planned is that no modernization is necessary (Table B-68) since with indication that either the project itself and/or the cost of capital was too expensive.

Log Supply

More mill operators (40.8%) indicated that their primary source was own log buyers than any other sources (Table B-69). The second most common source, for both small and medium mills, was from forest lands owned by the mill (23.24%).The third popular source was from stumpage purchase, 12.43% as the average, 14.7% for small mills and 4.11% for medium mills. Very few mills used brokers; only 2.14% of logs are obtained through brokers (2.58% for small mills; 0.56% for medium mills). No medium sized mills used long-term wood supply agreements; as opposed to 11.06% of logs obtained this way by small mills. Almost all logs used by Vermont mill operators (86.9%) are from private forests in Vermont (Table B-69). This is slightly higher for small mills

(88.4%), who import very little wood from elsewhere in the US (2.0%) as compared with 18.4% of medium mills wood coming from elsewhere in the US.

Not surprisingly, most mills are located close to their log sources, with 49.15% of all logs coming from within 20 miles of the mills, and 35.95% of logs coming from within 20 to 49 miles (Table B-69). Although medium mills were more likely to receive logs from more than 50 miles, the "medium range" source, from 20 to 49 miles, is more common for small mills (40.16%) than for medium mills (19.13%). The more gradual fall off of log source percentage versus distance of medium mills reflects their ability to maintain profitability at greater distance.

Markets – Primary Products

Vermont mills' primary products are more likely to be used within the county (41.71%) than elsewhere, while 25.65% is destined for elsewhere in Vermont, 11.26% destined for elsewhere in New England, 12.57% destined for other regions of the US, and 8.86% destined for markets outside the US (Table B-70). While only 1.89% of wood from medium mills is destined for the international market, 10.76% of small mills' product is bound for markets outside the US. Also surprising is that very little wood from small mills goes to other regions of the US (6.06%), while a good fraction of wood from medium mills (36.44%) is destined for other regions of the US. Vermont mills indicated that 59.7% of their product is sold wholesale (Table B-70).

Markets – Value Added Products

The slightly higher rate of retail sales (45%) by medium size mills is also reflected in the higher rate of value-added manufacturing by these mills. Half of the responding medium mills do value-added manufacturing, whereas only 13 of 36 small mills reported this practice (Table B-71). The destination of value-added merchandise was very different for small and medium sized mills (Table B-71). For small mills, the destination reflected roughly the destination of their other lumber, with the most (47.53%) staying in the county, whereas medium mills reported 69.75% of their product bound for other regions of the US.

Certification

A majority of logs processed at responding mills (63.7%) were not certified (Table B-72). However, medium mills used many more certified logs (40.63%) than small mills did (4.47%). Also, medium mills were much more likely to be aware of the certification status of their logs, with only 2.5% being of unknown status whereas small mills said 29% of the logs were of unknown status. It appears that certification is more important for larger volume of logs used by medium mills.

Very few mills tracked the chain of custody of logs, with only 3 of 41 mills responding that they tracked chain-of-custody (Table B-72). These procedures were considered too costly for both medium and small mills. Most mills surveyed did not want to consider marketing certified wood, with 27 of 42 responding that they did not want to certify (Table B-72).

The most common reason for not marketing certified wood was that the market is not large enough at this time (18 of 29) with small mills in particular selecting this reason 15 of 25 responses (Table B-72). The second most common response for small mills was that the certification process was too expensive (12 of 25 responses). The least chosen response for small mills was that following the chain of custody was too difficult (5 of

25). Medium mills seemed to be indifferent to the reason for not marketing certified wood, with 3 of 4 selecting each choice and 2 of 4 selecting "other".

Community

Vermont mills surveyed generally thought their mills were not very important to the local community, with the most popular response being 4 (13 of 46), where 3.5 is 'neutral' and 6 is 'no importance' (Table B-73). The distribution for small and medium mills was roughly the same; with the exception of more medium mill operators saying they were extremely important to the local community. Three of eight medium mills' operators selected the maximum importance choice, while only 2 of 38 small mills selected this choice. The Chi-square test statistic 1.768 (Table B-76) for question 16(a), which is smaller than the table value of 5.99, is not significant at a confidence level of 0.05 with 2 degrees of freedom. This suggests that sawmills owner's opinion of their mill's importance to the community is not affected by mill size. Most of mill owners considered their influence on the community to be neither important nor unimportant (Table 3-15).

Table 3-15: Question 16(a) - percent distribution of aggregate responses regarding the importance of the sawmill to the community

Mill Size	Important	Neutral	Not Important
Small Mill	26.3%	52.6%	21.1%
Medium Mill	50.0%	37.5%	12.5%
All	30.4%	50.0%	19.6%

$\chi 2$= 1.768, not significant at α=0.05 with 2 df

Most responding Vermont mills considered their mills to be unimportant to the state of Vermont, with the most popular response (12 of 46) being 6 – 'not at all important'. Medium mills selected 'more important' more often, though not a single mill selected the 'most important' option (Table B-73). The Chi-square test statistic (3.584) of question 16(b) (Table B-77), not significant at a confidence level of 0.05 with 2 df, indicates that mill owners' opinion of their mill importance to the state of Vermont is independent of mill size. Only a minority of responding mill owners rated their influence over state of Vermont as important (Table 3-16). Over 90% of surveyed mill owners thought their influence to the state of Vermont is not important.

Table 3-16: Question 16(b) - percent distribution of aggregate responses regarding the importance of the sawmill to the State of Vermont

Mill Size	Important	Neutral	Not Important
Small Mill	5.3%	44.7%	50.0%
Medium Mill	25.0%	25.0%	50.0%
All	8.7%	41.3%	50.0%

$\chi 2 = 3.584$, not significant at $\alpha=0.05$ with 2 df

Vermont mills generally considered themselves not of any importance to Canadian border communities, with 32 of 45 selecting option 6 – 'not at all important' (Table B-73). Surprisingly, the medium mills were more likely to select this option, 7 of 8, as opposed to 25 of 37 for the small mills. Small mills generally considered themselves to be more important to Canada than the medium mills.

Not significant at a confidence level of 0.05 with 2 df, the Chi-square test statistic (0.069) for question 16(c) (Table B-78) suggests that mill size does not influence mill owners' opinion of their sawmills' importance to adjacent Canadian communities. Table 3-17 below shows that none of responding small size mill owners and medium size mill owners thought their influence on adjacent Canadian communities was important. The majority (84.4%) of surveyed mill owners rated scale 5 or 6 in this question, suggesting that they evaluated their influence on adjacent Canadian communities to be fairly small.

Table 3-17: Question 16(c) - percent distribution of aggregate responses regarding the importance of the sawmill to the adjacent canadian community

Mill Size	Important	Neutral	Not Important
Small Mill	0.0%	16.2%	83.8%
Medium Mill	0.0%	12.5%	87.5%
All	0.0%	15.6%	84.4%

$\chi 2$= 0.069, not significant at α=0.05 with 2 df

Vermont mills engaged in many community activities. Most small and medium mills have given a monetary and/or products charitable donation (Table B-73). Neither medium mills nor small mills were more likely to have donated products than money. Only 7 of 38 responding mills had provided an open house or tour for local community members. Very few mills held a question and answer session about the mill in the community. Medium mills are more likely to encourage employees to take leadership roles within the community than small mills. Only 5 of 38 responding mills invited community members on to their company's land for recreational purposes.

International Factors

We asked respondents to rank listed international factors in order of importance to the mill with 1 as most important and 4 as least. We used average rank method to analyze the result. For all mills, the average ranks were 1.44, 2.48, 2.92, and 3.04, respectively for international competition for wood, exchange rate of U.S. and Canadian dollars, the current tariff on Canadian lumber and general trade agreements (NAFTA, GATT/WTO) respectively (Table B-74). Small mills value the importance of current tariff on Canadian lumber more than the importance of general trade agreements to their mill. In contrast, medium mills weigh the importance of current tariff on Canadian lumber, less than the importance of general trade agreements to their mill. Both third and fourth factors' average ranks indicated that there is less concern on tariff and general trade agreements.

Particularly, we asked mill operators to rate the importance of the tariff on Canadian lumber to their mill on a scale of 1 to 6. This tariff was instituted spring 2002, averaging 29% on some Canadian lumber shipped to the US. The most common response for small mills was 6: "not at all important". The average rank for small mills was 4.8 (Table B-74). However, the tariff was more important to medium mills, with an average rank of 3.7. The Chi-square test statistic for question 18(b) 7.029 (Table B-79), significant at a confidence level of 0.05 with 2 df, suggests that sawmill owners' perception of tariff is dependent on mill size. Medium sawmill owners agreed more than small mills on the importance of maintaining the current tariff on Canadian lumber to the success of their mill.74.3% of small sawmills perceive the importance of maintaining the current tariff on some Canadian lumber, as not very important while only 28.6% of medium mills agreed on this unimportance. 42.9% of responding medium sawmill owners thought the tariff is neither important nor unimportant to their success (Table 3-18).

Table 3-18: Question 18(b) - percent distribution on the importance of maintaining the current tariff on the canadian lumber

Mill Size	Important	Neutral	Not Important
Small Mill	17.1%	8.6%	74.3%
Medium Mill	28.6%	42.9%	28.6%
All	19.0%	14.3%	66.7%

$\chi2$= 7.029, significant at α=0.05 with 2 df

We asked mill operators' opinions about the statement regarding the advantage of cheaper production costs in border mills in Canada. Seen from Table B-74 1 stands for strongly agree, 2 stands for agree, 3 stands for somewhat agree, 4 stands for somewhat disagree, 5 stands disagree and 6 stands for strongly disagree. Among 31 responding small mills, 14 strongly agree, and 14 agree with the statement of Canadian border mills having an advantage because of lower production cost (Table B-74). Only one small mill somewhat disagrees and one small mill strongly disagrees with this statement. All 6 responding medium mills chose "strongly agree" and "somewhat agree". To various degrees both small and medium Vermont mills agree that Canadian border mills have advantage because of lower production cost. The Chi-Square test statistic 3.879 for question 18(c)-1 (Table B-80), suggests that mill owners' response to this question is independent of mill size. Most sawmill owners (68.4%) in Vermont agreed with the statement of question 18(c)-1 (Table 3-19). They perceived that Canadian border mills had an advantage due to lower production costs.

Table 3-19: Question 18(c)-1 - percent distribution of mill perception on canadian border mills' advantage in lower production costs

Mill Size	High-level of Agreement	Medium-Level of Agreement	Low-Level of Agreement
Small Mill	90.3%	6.5%	3.2%
Medium Mill	66.7%	33.3%	0.0%
All	86.5%	10.8%	2.7%

$\chi 2 = 3.879$, not significant at $\alpha=0.05$ with 2 df

We asked mill operators to comment on mills throughout Canada rather than just bordering mills. Most Vermont mills agree with the statement that "mills throughout Canada have an advantage because they have lower production costs" , with 24 of 26 mills selecting the 1, 2 and 3 "agree" responses and only 2 small mills choosing the 4 and 6 "disagree" responses (Table B-74). These responses are consistent with those regarding border mills. Chi-square test statistic 4.094 for question 18(c)-2 (Table B-81) indicates that responses are independent of mill size. The majority of responding sawmill owners (69.7%) in Vermont agreed with the statement of question 18(c)-2 that mills throughout Canada have an advantage because of their lower production costs (Table 3-20).

Table 3-20: Question 18(c)-2 - percent distribution of mill perception on mills throughout Canada's advantage in lower production costs

Mill Size	High-Level of Agreement	Medium-Level of Agreement	Low-Level of Agreement
Small Mill	76.9%	19.2%	3.9%
Medium Mill	42.9%	57.1%	0.0%
All	69.7%	27.3%	3.0%

$\chi2= 4.094$, not significant at $\alpha=0.05$ with 2 df

We asked mill operators their opinion about the following statement: "Canadian border mills do not pose a threat to the success of US mills in the Northeast". Consistent with responses regarding lower production costs, both small and medium Vermont mills disagree with this question's statement. Among 32 responding small mills, 25 disagree and all 6 responding medium mills disagree (Table B-74). Hence, from Vermont mill operators' view, Canadian border mills do pose a threat to the success of US mills in the northeast. Chi-square test statistic 3.288 for question 18(d)-1 (Table B-82), suggests that mill owners' response pattern is independent of mill size. 68.4% of sawmill owners in Vermont disagreed with the statement of question 18(d)-1 (Table 3-21).

Table 3-21: Question 18(d)-1 - percent distribution on mill agreement level with the statement: "Canadian border mills do not pose a threat to the success of US mills in the Northeast"

Mill Size	High-Level of Agreement	Medium-Level of Agreement	Low-Level of Agreement
Small Mill	12.5%	25.0%	62.5%
Medium Mill	0.0%	0.0%	100.0%
All	10.5%	21.1%	68.4%

$\chi2= 3.288$, not significant at $\alpha=0.05$ with 2 df

Responses to this question regarding the threat to US mills by mills throughout Canada are consistent with the question regarding Canadian border mills. All 7 responding medium mills disagree and 23 of 28 small mills also disagree with the statement that mills throughout Canada are not a threat to US mills (Table B-74). From questions 18(d)-1 and 18(d)-2, Vermont mill operators agreed that Canadian mills posed a threat to the success of US mills in the northeast. The Chi-square test statistic 0.963 for question 18(d)-2 (Table B-83) indicates that sawmill owners' response to this question is independent of mill size. About 60% of the sawmill owners in Vermont disagreed with the statement of question 18(d)-2 (Table 3-22). They considered that mills throughout Canada do pose a threat to the success of US mills in the northeast. Only 8.6% of sawmill owners agreed on Canadian mills do not pose a threat to the success of US mills in the northeast in regards to mills throughout Canada.

Table 3-22: Question 18(d)-2 - percent distribution on mill agreement level with the statement: "Mills throughout Canada do pose a threat to the success of US mills in the Northeast"

Mill Size	High-Level of Agreement	Medium-Level of Agreement	Low-Level of Agreement
Small Mill	10.7%	32.1%	57.1%
Medium Mill	0.0%	28.6%	71.4%
All	8.6%	31.4%	60.0%

$\chi 2 = 0.963$, not significant at $\alpha=0.05$ with 2 df

We asked mill operators their opinion about the following statement: "Canadian border mills are at an advantage because they can buy timber at lower stumpage prices". Most of small mills agreed with this statement, with 19 of 30 small mill operators selecting the 1, 2, 3 "agree" responses, only 4 small mills choosing "disagree", and 1 small mill choosing "strongly disagree". Half of responding medium mill operators agreed while other 3 of 6 responses were more skewed towards "somewhat disagree" (Table B-74). The small sample size of medium mills' responses to this question may result in statistical bias. However we can see that medium mills are less likely to agree with the statement than small mills. Above all, Vermont mills agreed that Canadian border mills are at an advantage because they can buy timber at lower stumpage price. The Chi-square test statistic for question 18(e)-1 is 0.027 (Table B-84) suggesting that mill size does not have significant influence on sawmill owners' responses to this question. Focusing on the overall perception (Table 3-23), 16.7% of sawmill owners in Vermont disagreed with the statement of question 18(e)-1. Most consider that lower stumpage prices bring Canadian border mills the advantage to their business in regards to border mills.

Table 3-23: Question 18(e)-1 - percent distribution of mill perception on canadian border mills' advantage in lower stumpage prices

Mill Size	High-Level of Agreement	Medium-Level of Agreement	Low-Level of Agreement
Small Size Mill	46.7%	36.7%	16.7%
Medium Size Mill	50.0%	33.3%	16.7%
All	47.2%	36.1%	16.7%

$\chi 2 = 0.027$, not significant at $\alpha = 0.05$ with 2 df

We asked the perceptions of mill operators about the same statement regarding mills throughout Canada, as opposed to just border mills. All 10 responding medium mills and 23 of 27 responding small mills, agreed with the statement (Table B-74). From mill operators' perceptions in both questions 18(e)-1 and 18(e)-2, either mills throughout Canada or border mills are at an advantage because of lower stumpage prices, while respondents agreed more with the statement regarding mills throughout Canada than with the one regarding border Canadian mills. Chi-square test statistic (1.292) for question 18(e)-2 (Table B-85) indicates that sawmill owners' response to this question is independent of mill size. About 54.3% of sawmill owners in Vermont agreed with the statement of question 18(e)-2 (Table 3-24). They considered that the lower stumpage prices bring mills throughout Canada an advantage to their business. Only about 14.3% of sawmill owners disagree with that statement.

Table 3-24: Question 18(e)-2 - percent distribution of mill perception on mills throughout Canada's advantage in lower stumpage prices

Mill Size	High-Level of Agreement	Medium-Level of Agreement	Low-Level of Agreement
Small Mill	50.0%	35.7%	14.3%
Medium Mill	71.4%	14.3%	14.3%
All	54.3%	31.4%	14.3%

$\chi 2$= 1.292, not significant at α=0.05 with 2 df

We asked the mills' operators opinion about the following statement: "Canadian border mills are at an advantage because they pay lower wood transportation costs". This is another perspective of the comparative advantage between the U.S. mills in the northeast and Canadian border mills. Most small and medium Vermont mills agreed that Canadian mills are at an advantage, because of lower wood transportation costs, with 18 of 27 small mills and 8 of 10 medium mills who agreed with the statement (Table B-74). The Chi-square test statistic 0.923 for question 18(f)-1 (Table B-86), indicates that mill owners' response to this question is independent of mill size. From Table 3-49, 47.2% of sawmill owners in Vermont neither strongly agreed nor strongly disagreed with the statement of question 18(f)-1 (Table 3-25). Nevertheless, 33% of sawmill owners agree strongly on this advantage.

Table 3-25: Question 18(f)-1 - percent distribution of mill perception on Canadian border mills' advantage in lower wood transportation costs

Mill Size	High-Level of Agreement	Medium-Level of Agreement	Low-Level of Agreement
Small Mill	30.0%	50.0%	20.0%
Medium Mill	50.0%	33.3%	16.7%
All	33.3%	47.2%	19.4%

$\chi 2$= 0.923, not significant at α=0.05 with 2 df

Seventeen of 27 small mills and 6 of 9 medium mills responded that they agreed with the statement that "mills throughout Canada are at an advantage because they pay lower wood transportation costs." This is consistent with the response to question 18(f)-1

(Table 3-25). Thus, from both Vermont small and medium mills' view, either border Canadian mills or mills throughout Canada are at an advantage because of their lower wood transportation cost. They agreed a little bit more with the statement on the advantage of transportation costs regarding Canadian border mills than the one regarding mills throughout Canada. The Chi-square test statistic 0.274 for question 18(f)-2 (Table B-87), suggests that sawmill owners' responses to this question are independent of mill size. From Table 3-26, 48.5% of sawmill owners in Vermont neither agreed nor disagreed with the statement of question 18(f)-1 whereas 30% of sawmill owners strongly agreed on the advantage of lower transportation costs that mills throughout Canada are perceived to have.

Table 3-26: Question 18(f)-2 - percent distribution of mill perception on mills throughout Canada's advantage in lower wood transportation costs

Mill Size	High-Level of Agreement	Medium-Level of Agreement	Low-Level of Agreement
Small Mill	28.6%	50.0%	21.4%
Medium Mill	40.0%	40.0%	20.0%
All	30.3%	48.5%	21.2%

$\chi 2 = 0.274$, not significant at $\alpha=0.05$ with 2 df

Business Environment

We ask respondents to rank business factors that affect mills (state regulations, federal regulations, taxes, and public acceptance) from 1 to 4 in order of importance to the mill with 1 as most important and 4 as least important. Mills surveyed, both small and medium, ranked state environmental regulations as the most important factor, with an average rating of 1.71 (Table B-75). The least important factor for all responded mills was the public acceptance of the industry, with an average rank of 3.21. There was very little difference in this question between the small and medium mills.

There was more difference between the responses of the small and medium mills, regarding the importance of industry assistance factors. The most important factor for small mills, with an average rank of 2.12, was market development programs, while the most important factor for medium mills was research and development in production technology, with an average rank of 2.00 (Table B-75). The least important industry assistance factor for small mills was technical assistance from state organizations, with an average rank of 2.84, while the least important factor for medium mills was financial assistance with an average rank of 3.50. This suggests that medium mills are less dependent on such assistance, perhaps due to their larger operating budgets.

Responding mills of both small and medium size chose the state government as the most important government entity affecting their business, with an average rank of 1.66 (Table B-75). Both small and medium mills thought that the Canadian government was the least important factor, with an average rank of 4.56. The local government was far more important for small mills with an average rank of 1.96; whereas medium mills gave local government a far less important rank of 3.40. This suggests that larger mills are less affected by decisions of town or county governments. The U.S. government was ranked as neither important nor unimportant, with an average rank of 2.47 among all responses.

Discussion

Most Vermont mills are small to medium-sized, with predominantly local employees using logs mostly from within 50 miles. Medium mills were more heavily reliant than small mills on logs from within 25 miles, with 58% of log sources coming from within this distance. However, medium mills also used logs from further away than small mills, with 4% of logs coming from 100 to 250 miles as opposed to only 2% of small mills logs coming from within this distance. Most logs used by Vermont mills (87%) were from private forests in Vermont. This was more the case for small mills (88%) than for medium mills (80%). Almost no logs from Maine are used by Vermont mills, with only 1.5% of logs used by medium mills and none by small mills. Medium mills were much more reliant on logs from elsewhere in the United States than small mills, with 18% of medium mills' logs originating from these locations as compared with only 2% of small mills' logs.

Products of Vermont's mills are used worldwide, but mostly locally in Vermont and New England. About 40% of the products remain in the same county. Relative to New Hampshire mills, Vermont's mills use more hardwood than softwood. Most mill operators claimed involvement in the local community, but did not feel connected to Canadian communities despite the common border. Mill operators are not very interested in inviting community members to use their company lands for recreational activities. Some monetary compensation for the use of their land investment may motivate mills while the compensation generates relatively a very small proportion of total mill income and profit.

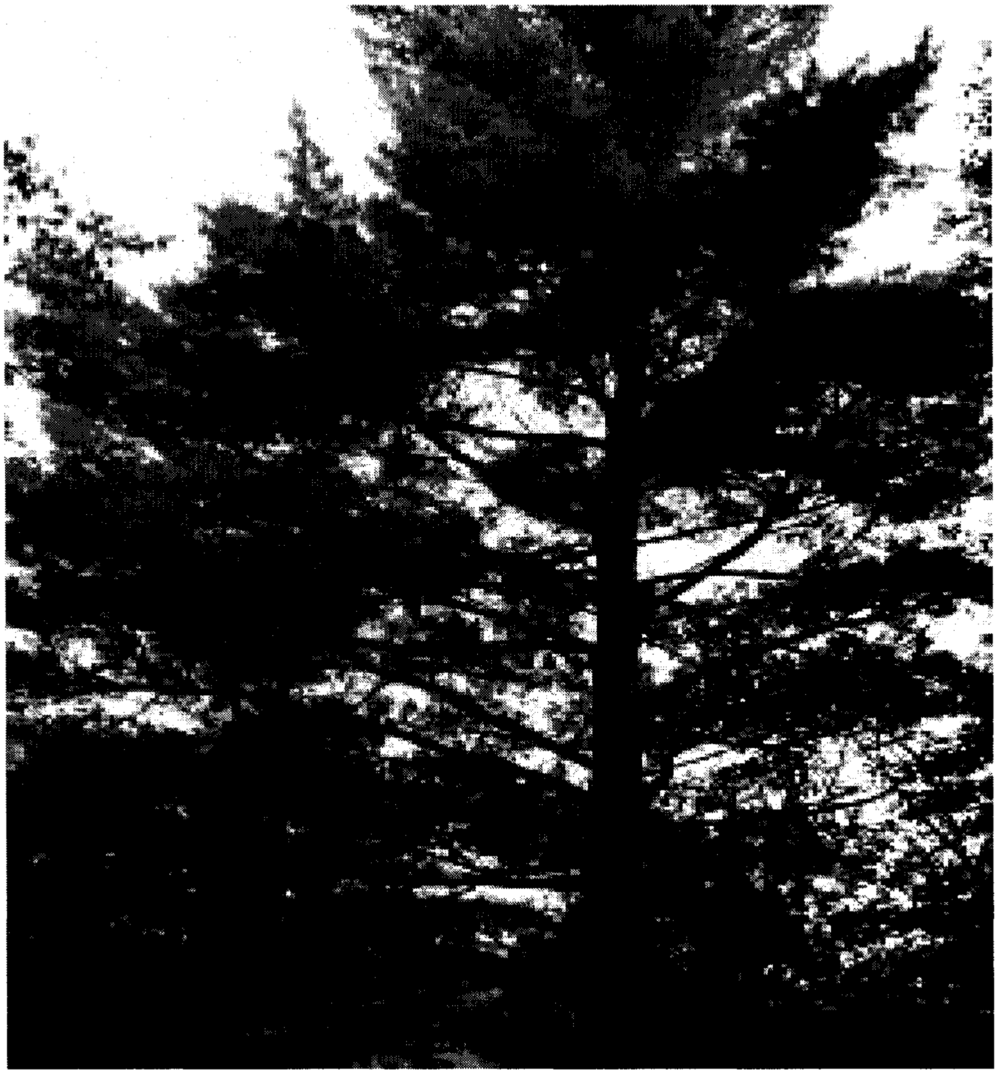
The industry has not been overly modernized, with only about half mills reporting recent investment. More than half of the mills (64%) do not consider certification of log sources, and very few track the chain-of-custody of the log sources. Medium mills used many more certified logs (41%) than small mills (4.5%) and they were much more likely to be aware of the certification status of their logs than small mills, with only 2.5% being of unknown sources versus 29% unknown for small mills. It appears that certification is more important for larger volume of logs used by medium mills. The most common reason for not marketing certified wood was that the market is not large enough at this time. The second most common response for small mills was that the certification process was too expensive and the least common response for the small mills was that tracking the chain-of-custody was too difficult.

From the analysis of international factor, mill operators' agreements with the statements indicated their different perceptions about comparative advantages in international trade and competition in terms of production cost, stumpage cost and wood transportation cost. Most Vermont mills feel that the Canadian mills (either border Canadian mills or mills throughout Canada) pose a threat to the success of mills in the U.S. northeast. While forest is continuous from northern New England to Canada as a whole bioregion encompassing both U.S. mills and Canadian mills across country border, it is necessary for decision-makers of U.S. mills to realize the importance of improving or using their comparative advantage regarding international trade competition in the sawmill business, such as participating with the state in road construction for lowering wood transportation costs, investing more on research and development on production technology or expanding business to some region with cheaper labor costs, to decrease their production costs.

Both small and medium mills agreed that Canadian mills were a threat to their mill success. From Chi-square analysis of aggregate responses, mill response patterns are independent of mill size, which does not affect mill owners' agreement on the statement that Canadian sawmills are at an advantage due to lower production costs, lower stumpage price and lower wood transportation costs. They feel that Canadian mills are at an advantage because of lower stumpage prices, while respondents agreed more with the statement regarding mills throughout Canada than with the one regarding border Canadian mills. Only a minority of sawmill owners (17%) in Vermont disagree that lower stumpage prices bring Canadian border mills an advantage to their business regarding border mills. In fact, Canadian border mills do not have lower stumpage prices than U.S. mills in New England. Canadian border mills purchase private stumpage in competitive markets or buy logs in New England. They were exempt from the softwood lumber tariff because the U.S. government decided these mills did not enjoy the lower stumpage prices allegedly administered for the purchase of Crown timber. Most the sawmill owners viewed the advantage of lower stumpage price as insignificant, while they viewed the advantage of lower production costs and lower wood transportation costs as significant. While Vermont has extensive wood flow with adjacent states, its active and diversified sawmill industry provide good markets for Vermont's wood and important employment opportunities to the many rural communities in Vermont. The smaller nature of the sawmill industry in this state leads itself to a community-based analysis of sustainability and economic factors, and allows a more complete analysis of the industry's sustainability, compared with regional and international markets.

CHAPTER IV

WOOD SUPPLY STUDY[3]



[3] Difei Zhang and Theodore Howard, 2007. Submitted to the Forest Products Journal. Scientific Contribution No.xxxx of the New Hampshire Agricultural Experiment Station

Abstract

The importance of eastern white pine supplies to the New Hampshire sawmill industry deserves close monitoring. This wood supply study is to examine the condition of New Hampshire forest inventory, specifically the eastern white pine future supply condition of New Hampshire's forests in terms of inventory and harvest in response to sawmill industry demand. The paper modeled eastern white pine dynamics and projected timber supply over a 50-year time horizon. It addresses the biological factors shaping the forest as well as the economic factors. It provides an integrated analysis of demand, supply, inventory, and stumpage prices all as one package, with model formulas built into a transparent spread-sheet based timber supply model to test nine scenarios and corresponding sensitivity to parameter changes. The model analysis features nine base, pessimistic and optimistic scenarios with base, low-end and high-end initial mill consumptions at both the aggregate state level and the specific county level. It provides impact assessments of future land use change and other market dynamics on future wood supply for the sawmill industry. Model results suggest that the best case scenario will be the optimistic case with low-end initial mill consumption data and the worst case scenario will be the pessimistic case with high-end initial mill consumption data. In the best case with parameter values moving in directions favorable to sustainability, sawlog stumpage prices decline by 0.26% annually and harvest levels increase by 0.12% annually. Inventory increases by 0.36% annually and stocking rises by 0.43% annually. In contrast, the worst case results reflect adverse economic and ecological impacts on the sawmill industry and future possibility of unsustainable forest resource base. Except the base case and the optimistic case with low-end initial mill consumption, model results forecast the

general increasing trend of stumpage prices and the decreasing trend of inventory, stocking and harvest levels over a 50-year projection period for eastern white pine in New Hampshire timbershed. Policies to absorb the adverse impacts for sustaining a long-term healthy forest industry and its forest resource base are suggested. Future works on the species expansion of the model and the integration of a more detailed evaluation at the landscape level of New Hampshire's vanishing forest are suggested. Sawmill industry will be possibly more regional and international to some extent, ignoring the county, state and border boundaries as a result of combinations of cooperation such as shared ownership, supply agreements and long-term joint ventures.

Introduction

This study will examine the relationship between the inventory of eastern white pine (Pinus strobus, L.) in New Hampshire and the sawmill industry's consumption of that species to better understand the relationship between a healthy forest and a healthy industry.

According to the New Hampshire Primary Wood Processor Report (Dec.2004), the state's sawmills' production was over 260 MMBF (million board feet) of sawtimber in 2003. New Hampshire mills processed 162 MMBF of eastern white pine, of which 134 MMBF was obtained from New Hampshire's forest. However, this report neither informs us about the specific amount of eastern white pine harvested from New Hampshire for processing in adjacent states and Québec, nor about the geographic distribution of wood sources within the state itself. Our study modeled spatially explicit demand for eastern white pine by mills at both state and county levels based on procurement data incorporating market conditions to project the levels of the pine inventory and industry consumption for the coming decades.

The main objectives are:

- To examine if the supply of eastern white pine from New Hampshire's forest is sustainable for a projection period of 50 years.
- To examine how stumpage prices and inventory are affected by changes in demand and land use as well as other parameters.
- To address the following questions:

- How does wood consumption of sawmill industries in our defined timbershed affect the potential capacity of New Hampshire forest inventory?
- What is the inventory supply capability to the sawmill industry over a 50-year horizon?
- How will we sustain inventory and harvest levels in the face of changing land use, such as the impacts of conversion of timberland to private and public non-timber uses on the sustainable development of sawmill industries?

Previous Work

Promoting the transition toward forest sustainability clearly requires advances in assessments of future wood supply in ways that bridge global, national, regional and local scales. Since the 1980s, many studies have been done at these scales to assess future wood supply and forest sustainability.

At the global level, Tromborg et al. (2000) examined the global timber market in terms of changes in economic growth, timber supply, and technological trends. Bentley et al. (1997, 1998) studied how potential consumers of forest products would be affected by the impact of mandated lower ozone levels and other stricter air pollution standards. At the national level, Haynes et al. (1995), Mills (1990, 1992) and Mills et al. (2003) employed an aggregate timberland assessment system (ATLAS) model to project changes in forest growth rates associated with changing temperatures and rainfall for a national assessment on the impacts of climate change.

Adams and Haynes (1980) developed the aggregate timberland assessment system (ATLAS) model for analyzing the softwood timber market. ATLAS incorporated assumptions about timber management, harvesting, forest growth and yield, changes in land use and forest cover to project future inventories. ATLAS evolved into the Timber Assessment Market Model (TAMM) (Adams and Haynes 1996), a national - scale model which examined how harvest scenarios affect inventory levels. TAMM was later utilized for the Forest and Rangeland Renewable Resources Planning Act (RPA) timber assessments (Haynes 2002). It tracked inventories, associated growth parameters and alternative timber management options, to analyze the timber situation in the United States from 1952 to 2050 (Adams and Haynes 1980, 1996).

Several models have been developed to examine regional wood supply issues. In the Pacific Northwest, Deal and White (2005) suggest that the region's wood supply would primarily come from private land, and that sustainable wood production would be largely determined by future markets, harvest potential, land use changes, and sustainable forestry practices. They indicate that regional changes in sawmilling capacity and uncertain market conditions would affect wood flow and production throughout the Pacific Northwest. Abt et al. (2000) used a sub-regional timber supply (SRTS) model to assess southern forest resource issues. The SRTS model was linked to the regional ATLAS model used by Mills and Kincaid (1992) and by Turner and Caldwell (2001). The purpose of linking ATLAS and SRTS was to assess the implication of market adjustments to timber supply projections.

For the Atlantic Northeast region, the Irland Group (1999) developed a working estimate of the regional wood flow balance and plan for tracking future wood flows in New York, Vermont, New Hampshire and Maine. Data were aggregated to the softwood and hardwood level for primary wood production, interstate wood movements, and international trade flows. The North East State Foresters Association (NEFA) commissioned a wood flow report (2001), which summarized state data that estimated the harvesting, processing, exporting, and importing of primary wood products for the NEFA states. The Vermont and Maine information was derived from mill data systematically collected by state governments, while the New York and New Hampshire information was derived from several data sources. Building on that report, Turner and Caldwell (2001) developed the NEFA-ATLAS model to examine inventory and harvests in the four states. Over a range of economic and land use change assumptions, they also included analysis of ecological factors based on habitat type. The results indicated that total inventory would experience a net increase and that the current harvest could be sustained over a 50-year time horizon. Sendak et al. (2003) used the integrated ATLAS-SRTS framework to extend the 2001 NEFA-ATLAS study and to analyze impacts on timber harvest, inventory, and price under various market conditions. Five scenarios were examined through the integrated SRTS model to project long-run effects on growing stock and price. Growth was forecasted to be in a balance with harvest on a regional basis over their 50-year projection period.

At the state level, Abt (1986) combined national models' assessments of regional economies with state-specific information on industries and resources to model state forest economies. ATLAS also has been used for specific state-level timber studies in both even-aged timber conditions of western Washington (Adams et al. 1992) and uneven-aged forests in Maine (Gadzik et al. 1998). Gadzik et al. (1998) assessed Maine's future timber supply using ATLAS to aid in the development of sustainability standards and other policy needs. They found that the current rate of growth in Maine's forests could not be sustained at current harvest level.

Luppold et al. (2003) determined that Pennsylvania sawmills varied in size and design as a function of species composition, resource grade and value. They found that timber value, timber volume, grade and diameter of logs consumed, and the size of sawmills and levels of sawmill computerized optimization were higher and larger in the northwest than in the southeast of Pennsylvania due to differences in resource value.

Facing a concern about the decline in Maine softwood growing stock, Luppold et al. (2004) examined Maine forest changes in species composition and evaluated the relative impacts of harvesting versus growth and mortality. They analyzed the impact of market and biological forces on forest composition using relationship coefficients for harvest, growth, and mortality based on relative values. Further research was needed for developing the dynamic relationship of demand and supply in forest simulation models to incorporate the impact of markets on species composition and structure.

Considering the relationship between the sawmill industry to its forest resource base, the mill log procurement impact on the interstate and international wood trade flows in a certain bioregion is an essential component to examine. While wood flows to and from Canada and between US states are especially crucial to individual northeastern mills and the entire region, it is necessary in my research to study mill procurement impact on bilateral and interstate wood flows. White and Carver (2004) studied timber mill procurement influence effects on interstate sawlog exportation using a location-driven and a production-driven procurement influence scenario. They explained how the location of mills was a partial explanation of the increase in sawlog exports under differential market power based on mill size characteristics. They suggested that Illinois experienced little procurement pressure from high production mills operating within the state but was under procurement pressure from high production timber mills operating in neighboring states.

In addition to the TAMM, ATLAS and SRTS models, statistical approaches such as logit models have been employed to estimate regional inventories. Teeter and Zhou (1998) developed a multinomial logit model to estimate sets of product proportion functions to distribute plot volumes by product class for each forest type and size class. This model distributes the volume on each FIA survey plot to product classes and simulates the changes in product distribution over time.

Based on previous wood supply studies, this research develops a timber supply model specific to both state-level and county-level to study the sustainability of the sawmill industry of New Hampshire and the resource base upon which it depends. Different from previous works, this research models spatially explicit demand for eastern white pine by mills based on procurement data; focuses on the most critical resource (eastern white pine) for the state's forest industry rather than aggregated by species type (softwood, hardwood); and incorporates market forces affecting eastern white pine, extending the work of Sendak et al (2003). In addition, we employ widely familiar spreadsheet-based software to increase the transparency of the model for decision-makers.

Methods

The wood supply study developed a wood supply simulation model built in Excel spreadsheets, to encompass the sawmill industry's market structure, the spatial nature of harvests, inventory dynamics, the change of landscape, and sawlog composition to project the New Hampshire white pine harvest, prices and inventory for a projection period of 50 years in ten 5-year intervals. We measured the quantity of white pine demanded from New Hampshire forest as a basis for determining the initial harvest volume. We focused on white pine procurement at the county level indicating geographical distributions of white pine mills and the wood flow across state boundaries and Québec using GIS. We examined how the wood requirements of regional sawmills affects the supply capacity of New Hampshire forests, what happens if the inventory decreases in terms of land use change, and how it affects the sawmill industry.

Most previous research on log supply and regional inventory studies of the northern forest has not explicitly treated sawmill-level and county-level dimensions. We used primary data from sawmill surveys to model the location-driven and production-driven influences of white pine mill procurement within New Hampshire and the surrounding region using GIS mapping technology to display the geographical distribution of white pine mills and white pine flow interactions specific to each county level. From each white pine mill's production and its procurement sources in the defined timbershed, we calculated the quantity of white pine demanded from each New Hampshire county timberland to meet all regional mills' requirements including the export to Québec as well. We then compared the quantity demanded from timberland in each New Hampshire county: the white pine demand, with what each county's inventory can supply: the white pine supply. We used the total white pine demanded from New Hampshire forest by the defined bioregion as the initial stage harvest amount, together with the U.S.D.A. Forest Service Forest Inventory and Analysis (FIA) latest available county-level database, to establish initial conditions for projections of change in eastern white pine inventory over a 50-year horizon. By projection models with the land use change used in the calculation of inventory from period to period, the variation in standing volume of white pine can predict the supply capability of eastern white pine inventory in New Hampshire over time. The analysis will add land-use change at the county level; incorporating the loss, or gain of forest land acres by ecological and geographical zones.

The wood supply study can provide sawmill industries, policy makers, and landowners with strategies to enhance the balance in eastern white pine market, to enhance the self-regenerating capacity of New Hampshire forest, and the economic viability of wood growing; to enhance sawmill industry competitiveness in wood production systems, in meeting regional white pine demands. The inventory supply side database will be compiled by developing each county's white pine growing stock database, net growth and land use change database using FIA data. If white pine growth exceeds harvest and mortality, the change in inventory will increase over time. The wood supply study would use projection models built into excel spreadsheets, to encompass the sawmill industry's market structure, the spatial nature of harvests, inventory dynamics, the change of landscape, and sawlog composition. Data sources include primary data from our sawmill surveys, and secondary data at the county and state level for New Hampshire, from the U.S.D.A Forest Service Forest Inventory and Analysis (FIA) latest available database of simple random samples of 20% of plots sampled from 862 plots in New Hampshire.

Study Area

The primary concerns are the eastern white pine (EWP) resource in New Hampshire and the state's forest industry which depends on that resource for 83% (134/162) of its wood supply. Therefore, the study region is New Hampshire but we recognize that nearly 20% of pine processed in New Hampshire comes from outside the state. Similarly, we estimate that 43 MMBF of EWP (based on average mill consumption data Table 4-80) is harvested from New Hampshire forests but processed in other states or Québec.

This bioregion is a wood supply source and demand sink. As a wood supply source, it includes all timberlands in New Hampshire which supply wood to the state's own mills, mills in adjacent states and Canadian border mills. As a wood demand sink, it includes sawmills in New Hampshire and adjacent counties in Vermont, Massachusetts, Maine and Quebec, which demand wood from New Hampshire timberlands. Thus, the demand side study region is larger than New Hampshire. The study region is displayed using GIS mapping to show the distribution of sawmills that produce white pine lumber (Figure 4-1).The number of mills located in each town is indicated by the numbers 1, 2…4, where 1 means there is 1 white pine mill in the town and 2 means there are 2 white pine mills in the same town. If there are two mills in very close proximity, but in different towns, these two mills are marked separately as 1 and 1.

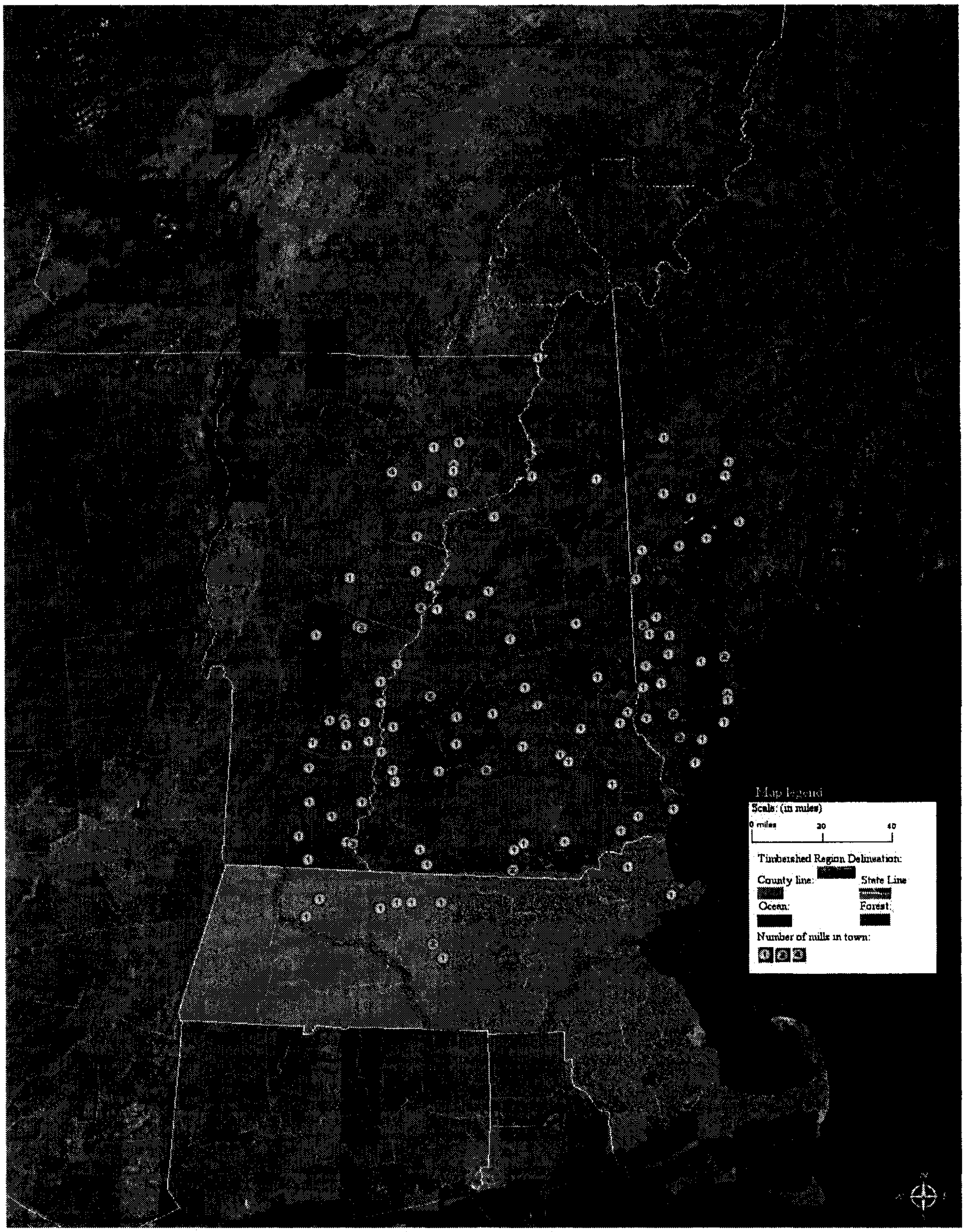


Figure 4-1: Regional map of eastern white pine wood supply timbershed

As wood moves across county, state and national boundaries, our study region includes not only the ten New Hampshire counties, but also the eleven counties adjacent to New Hampshire (NH) in Vermont (VT), Massachusetts (MA) and Maine (ME) and three municipal regional councils (Municipalités regionales de comté, or MRC) in Québec, which draw upon New Hampshire's pine resource for a portion of their wood furnish. We extended the study region to these adjacent counties because survey data indicated that nearly all New Hampshire white pine logs are processed within the state or these adjacent counties.

For the demand side of the study region, there are 55 New Hampshire white pine sawmills in ten New Hampshire counties, and 91 sawmills in the 11 adjacent counties of Vermont, Maine and Massachusetts. These adjacent counties are Essex, Caledonia, Orange, Windsor, Windham in Vermont (45 mills); York and Oxford in Maine (35 mills) and Middlesex, Essex, Franklin and Worcester in Massachusetts (11 mills). Though there are no white pine mills in Middlesex, we included this county in our study region to account for wood flows from New Hampshire. The three adjacent MRCs (municipalités regionales de comté) in l'Estrie (or les Cantons- de- l'Est) Québec region are included as proxies for all southern Québec mills using New Hampshire white pine. Although we have good data on the total volume of New Hampshire white pine entering Québec, transportation practices for imported logs make it impractical to identify all Québec mills receiving these logs. Therefore, we include the three adjacent MRCs as proxies for all of southern Québec. These three MRCs are Coaticook, Sherbrooks, Le Granit. This study region for the demand side is highlighted in the regional map (Figure 4-1) in red along the county boundary, instead of existing state or country boundaries.

Wood Supply Model

Based on previous work in timber supply models, in particular Sendak et al. (2003)'s timber supply projection model for northern New England and New York, we developed a wood supply model with additions of spatial realism in sawmill demand and experimental approaches to the impacts of land use change. Sendak et al. (2003) pointed out that "a market in SRTS is a collection of ATLAS harvest units deemed to be in competition" and he defines "markets" as harvest-unit groupings by habitat type across states, across regions, or across both regions and habitats. Unlike Sendak et al. (2003) and other studies which aggregated timber by species type, we focused our attention on the most important species in New Hampshire, eastern white pine. We defined our market as New Hampshire and its adjacent county harvest units which are in competition for EWP across the New Hampshire timbershed. Components of the model are a market module that determines price and quantity harvested in each county for each period and an inventory module that tracks inventory changes due to harvest, growth, and land use change by county for each period.

Market Model

We develop the market model at the county level to project changes in white pine inventory, harvest and prices in New Hampshire over a 50-year time horizon. For county i in time period t, the following core equations form our model.

$$Q^{S}_{(i,t)} = V_{(i,t)} * P_t^{\beta} * I^{\gamma}_{(i,t)} \quad (1)$$
$$Q_t^D = Z_t * P_t^{\alpha} \quad (2)$$
$$Q_t^D = \sum_i Q^{S}_{(i,t)} \quad (3)$$

- α : price elasticity of demand parameter
- β: price elasticity of supply parameter
- γ : inventory elasticity of supply parameter
- $Q^S_{(i,t)}$ is the quantity of eastern white pine supplied from county i in time period t.
- P_t is the stumpage price for eastern white pine in time period t.
- $I_{(i,t)}$ is the quantity of eastern white pine inventory in county i in time period t.
- $V_{(i,t)}$ is the shifter of supply for county i in time period t.
- Q^D_t is the total quantity of eastern white pine demanded in New Hampshire in time period t.
- Z_t is the demand shifter for demand

In equation 1, the supply function includes variable P_t, the sawlog stumpage price, variable I $_{(I,t)}$, the sawlog inventory, and variable Q_t, the quantity of sawlog supply. V_{it} is a supply shifter for county i at the period t, which we calculated for each county i but hold constant for the study period so it does not vary with time; P_t stands for the sawlog price at time period t, which is conditional at first period inventory used in the model. $Q^S_{i,t}$ stands for quantity of supply, namely harvests in county i in time period t, which can be determined by P_t such that the sum of harvests over all harvest units in New Hampshire counties equals the quantity demand of white pine by regional mills that draws wood from New Hampshire. In equation 2, the demand function includes variable $P_{t,}$ the sawlog price and variable $Q^D{}_{t,}$ the quantity of sawlog demand. Z_t is a demand shifter, which we assume to be a constant for each harvest unit county i in time period t. Equation 3 denotes the equilibrium condition between sawlog demand and sawlog supply.

We divided our projection period of 50 years into ten 5-year intervals. We calculated the sawlog price, P_t at each period t, as well as the sawlog demand volume $Q^D{}_{,t}$ and the sawlog supply volume $Q^S{}_i$ for each county i in New Hampshire at time period t.

Since specific values for price elasticity of demand a, price elasticity of supply b, inventory elasticity r are neither available at the county, state, sub-regional level nor at ecological habitat level. Adams and Haynes (1996) defined elasticities at a broad regional level and estimated the inventory elasticity of supply to be 1 for the northeast region. Sendak et al., (2003) assumed inventory elasticity of supply to be 1, price elasticity of demand to be -0.5 to reflect inelastic timber demand, price elasticity of supply to be 0.31 for softwood-dominated vegetation types, and 0.26 for hardwood-dominated vegetation types. Based on these previous researches, we assume elasticity parameters as α = -0.5, β = 0.33 and γ = 1.0 as initial values. We use 0.33 for the white pine price elasticity of supply based on Sendak's assumption about softwood-dominated vegetation types, for which white pine is the predominate species in New Hampshire. Results vary dependent on different assumptions for these values and later we changed the values of price and inventory elasticity from the base case to be both low (for optimistic case) and high (for pessimistic case) to different conditions such as land use change and growth rate change.

We assume the variable Z_t and V_i remain constant throughout the 10 periods, which means $Z_t == Z_0$ and $V_i == V_{i0}$. To calculate the values for Z_t and V_{it}, we obtained the white pine inventory $I_{(i,0)}$ in each New Hampshire county from FIA database and the actual white pine sawlog consumption (harvest volume) $Hi,_0$ from our recent sawmill surveys. We used the average stumpage price as P_0 to start the first run of the model. Based on information from the New Hampshire Department of Revenue Administration, we use $145 per MBF ($797.5 per thousand cubic feet (MCF)) as the initial average stumpage price of white pine sawlogs P_0. Under the assumption of market equilibrium, white pine sawlog quantity supply equals quantity demand, and the following equations are valid at period 0:

$$Q^S_{(i,0)} = H_{(i,0)}$$

$$Q^D_0 = \sum_i H_{(i,0)}$$

Then we transform our supply and demand equations to calculate the value for Z_0 and $V_{(i,0)}$ as follows:

$$V_{(i,0)} = \frac{Q^S_{(i,0)}}{P_0^\beta * I^\gamma_{(i,0)}}$$

$$Z_0 = \frac{Q^D_0}{P_0^\alpha}$$

The value for $Q^S_{(i,0)} = Q^D_0$, P^β_0, and $I^\gamma_{(i,0)}$ are known from the initial year market equilibrium and the survey data.

At every period t, we need white pine inventory after the development of the previous period $(t\text{-}1)$ to calculate the sawlog price.

The white pine inventory of period t is calculated using the following equation:

$$I_{(i,t)} = I_{(i,t-1)} - \frac{Q^S_{(i,t-1)}}{u} + (G_i * (1-L_i) - L_i) * I_{(i,t-1)} \text{ (Step 1)}$$

In the above equation, we introduce parameters L_i, G_i and u. L_i represents the land use change for county i. G_i represents the net white pine growth rate (growth-mortality) at county i. Sawlog growth rate is calculated based on softwood growth data from 2003 FIA data. These two factors together with the harvest volume effectively determine the inventory of white pine carried over from the previous period. u represents the sawlog utilization rate. We don't use the $Q^S_{(i,t)}$ directly but use $Q^S_{(i,t)}/u$ to make the subsequent year's inventory calculation. Inventory is comprised of sawlog and lower grade materials. We assume a constant proportion of sawlogs (u =0.75) so that the total harvest that reduces inventory $Q^S_{(i,t)}/u$ is larger than the sawtimber harvest itself.

Once we obtain the value for the inventory of period t, we can calculate the sawlog equilibrium price at this period by using the equation transformed from the original core equations as follows:

$$P_t = \left(\frac{\sum_i V_{(i,t)} * I^{\gamma}_{(i,t)}}{Z_t} \right)^{-\frac{\beta}{\alpha}} \text{ (Step 2)}$$

The calculated P_t is substituted into equations 1 and 2 to determine the supply volume and demand volume for the period t.

For each subsequent period, from the projected inventory harvest and price we calculate rate of change by county and state, as appropriate, for the 50-year projected period.

Initializing the Model

To initialize the model, we used the FIA inventory data for eastern white pine in thousands of cubic feet (MCF), survey based estimate of mill consumption, a state-wide average equilibrium stumpage and estimate of land use.

Given *Qs*, price and inventory for each county in the initial period, we calculated V_{it} for each county. Knowing V_{it} and the inventory, we varied price to determine the supply schedule for each county. Summing across each county yields the total New Hampshire supply for each period. Simply using the same volumes, we can calculate Z_{it} for our initial year given the initial equilibrium price. County level demand schedules can then be calculated by varying price and summed to generate total demand and, in conjunction with supply, solved for the market equilibrium for one year. With the new equilibrium price, we can allocate the market harvest quantities in each county.

In the base case, we shift the demand schedule by 1% annually. On a new graph, we can map the supply and demand schedules and determine total quantity demanded and the regional equilibrium price. That price can then be fed back through the county supply schedules to figure out how much is cut from each county. The sum of the county harvests should equal the total harvest determined in the graph. In the next period, we update the inventory and derive the county supply schedules with an increase in demand (shift) of 1%. The change in demand shifts the demand curves, but for price and quantity are determined by supply and demand, timber harvests may actually decline. The model is set up to handle any change in demand with no change or even a decrease. In this study, we assumed a uniform annual change in demand. We excise the model projection into ten periods at the both state and county level through the base, pessimistic, optimistic scenarios by varying the elasticity parameters for demand, supply and inventory and the change in land use and growth rate, with a constant 75% of utilization rate. The wood supply study appendix includes the model results of inventory, harvest and stumpage price change over the projection period specifically at each New Hampshire county level.

The general interactions in the white pine supply model can also be depicted by the following diagram 4-2. The next period's inventory equals the sum of the current period inventory, and net growth on remaining land, minus the sum of the current period harvest volume and current net growth inventory on lost land. The derived demand for New Hampshire EWP stumpage by regional mills impacts the harvest levels and the stumpage market price which affect the white pine inventory directly.

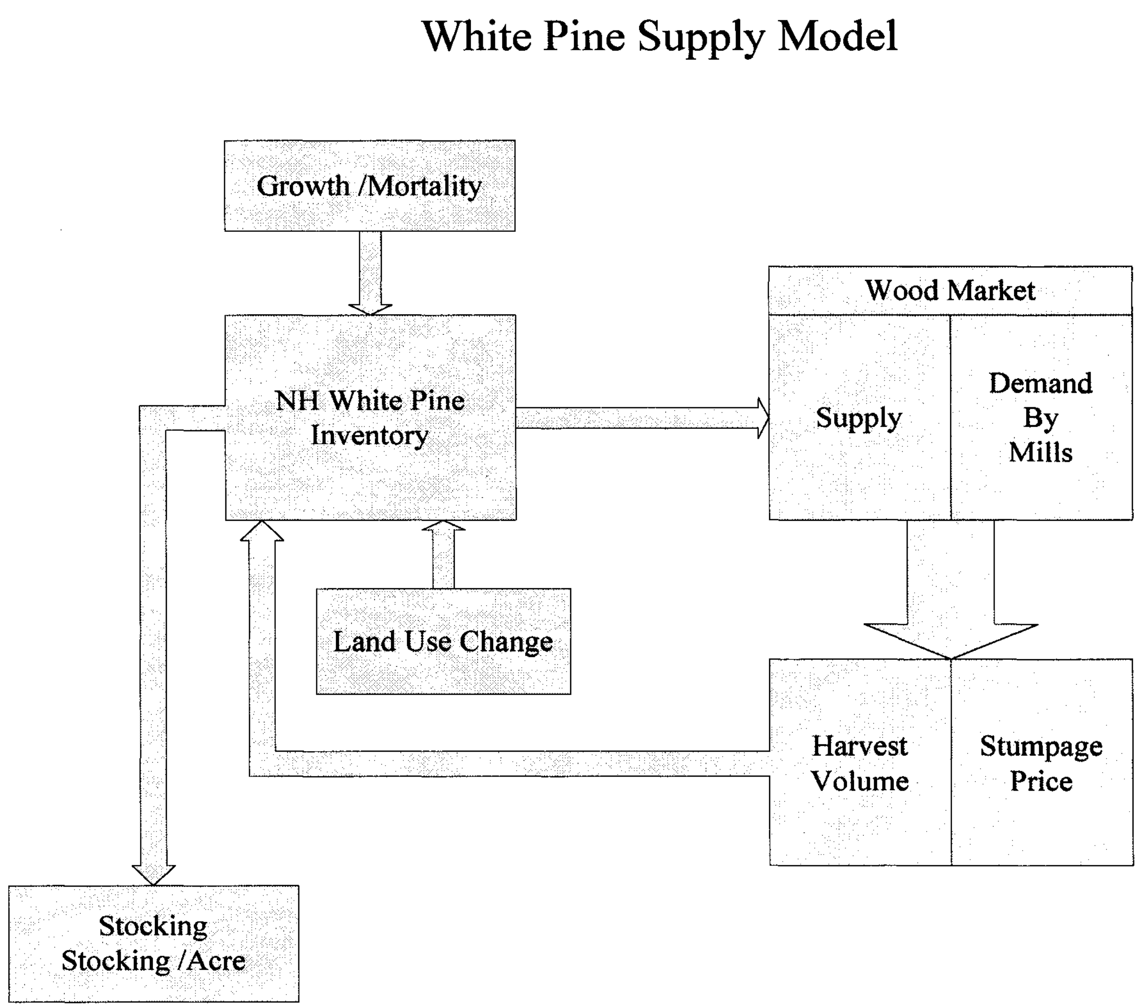


Figure 4-2: White pine supply model

Determining Initial Quantities Demanded

We used primary and secondary survey data to identify white pine mills and how much white pine they use. White pine log consumption data by these mills were used as initial mill consumption for demand in the model. The primary wood supply study data were obtained from our previous surveys conducted in white pine mills in New Hampshire and Vermont. For the rest of the wood supply study primary data, we surveyed the rest of the non-respondents of New Hampshire and Vermont sawmill mail surveys by telephone to obtain the data for annual total production for the white pine mills, and their log supply source distribution. We also surveyed by telephone the 11 white pine sawmills listed in the Massachusetts Directory of Sawmills in 2003 from the Massachusetts Department of Conservation and Recreation (2003). We surveyed by telephone 35 white pine sawmills in the Maine counties of York and Oxford, listed in the primary processor mill list (Year-Round Sawmills) from Maine Forest Service (2004).

In a survey of New Hampshire and Vermont sawmill industry (Zhang and Howard, 2007), we obtained information about total annual production as well as the percentages of log procured from five zones from 0 to19 miles, 20 to 49 miles, 50 to 99 miles, 100 to 249 miles, and over 250 miles from the mills. Similar information was obtained by telephone surveys of white pine mills in adjacent states. We focused on studying the white pine log demand from New Hampshire forest land specific to each county in the study. It included the county's own demand, and the demand for counties adjacent to where the mill was located. Based on primary data regarding wood procurement, we allocated the quantities consumed to the county of origin. The quantity of white pine demanded by a mill consists of the quantities demanded from its own county and adjacent counties. The quantity supplied from a county's forest is apportioned to mills within that county, to mills in other New Hampshire counties, to mills in other state counties adjacent to New Hampshire and to mills in southern Québec.

Because some of the data on the quantities demanded by mills were given in ranges, we calculated low, average, and high estimates of annual wood consumption. Our average estimate of the consumption of New Hampshire white pine by New Hampshire sawmills (132.94 MMBF, Table 4-28) is close to the New Hampshire Primary Wood

Processor Report (2004)'s estimate of 134 MMBF. These estimates of low, average and high mill consumption were used to establish the initial equilibrium condition and the values of Z_t and V_{it} in the market model.

Mill Demand from New Hampshire Timbershed

Within 71 still operating NH sawmills, there are 55 white pine sawmills. They are located in 10 counties of New Hampshire (Table 4-27):

Table 4-27: Number of year-round operating white pine sawmills in New-Hampshire

County	Mills
Belknap	5
Carroll	3
Cheshire	4
Coos	2
Grafton	8
Hillsborough	4
Merrimack	11
Rockingham	8
Strafford	2
Sullivan	8
Total	55

Estimates of low, average, and high quantities demanded range from all states are shown in Table 4-28.

Table 4-28: Total eastern white pine log supply from New-Hampshire timberland

Mill Consumption (MMBF)	High-end	Low-end	Average
Total Demand from NH	207.78	142.41	175.09
Total Own Demand	161.63	104.25	132.94
Total VT demand	7.85	5.61	6.73
Total ME demand	19.00	13.25	16.13
Total MA demand	5.12	5.12	5.12
Total Québec Demand	14.17	14.17	14.17

Because we did not have mill-specific data from Québec, we estimated the volume of New Hampshire whit pine exported to Québec. This was done by combining information on the total softwood log imports from New Hampshire by Québec (64.43 MMBF), Québec Ministry of Natural Resources; personal communication) with Hidenfelter's (2000, p26) estimate that 22% of softwood log exported from New Hampshire to Québec was white pine, to obtain an estimate of 14.17 MMBF (Table 4-28). We allocated the Québec imports from each county in New Hampshire in proportion to each county's share of the state's white pine inventory (FIA database).

Determining Spatial Distribution of Supply

Based on mill requirements and survey data, we determined the spatial distribution of supply using GIS. The initial-period mill consumption is allocated according to distance from the mill. Assuming the sawmill processed L MMBF of logs every year, we defined $A_{20}\%$ log source, as given by the survey result, was in the distance range of 1 to19 miles from the mills, $A_{50}\%$ log was in the distance range of 20 to 49 miles, $A_{100}\%$ log was in the distance range of 50 to 100 miles. $B_{NH}\%$ represents that logs are from New Hampshire, $B_{VT}\%$ represents that logs are from Vermont, $B_{ME}\%$ represents that logs are from Maine, and $B_{MA}\%$ represents that logs are from Massachusetts. In our survey results, nearly all the log sources were within 100 miles of the mill.

We located each mill by its latitude and longitude and drew a circle with a radius of 20 miles, centered around the mill on the map to count the number of counties intersecting the circle, N_{20}. If the circle intersected with N_{20} counties, including the mill's own county, of which there were N_{20NH} New Hampshire counties, N_{20VT} Vermont counties, N_{20ME} Maine counties and N_{20MA} Massachusetts counties, we set the percentage of log source within county as $\boxed{A_{20} * B_{NH} / N_{20NH}}$ and the percentage for each adjacent New Hampshire county as $\boxed{A_{20} * B_{NH} / N_{20NH}}$ too. The percentage of log source from each adjacent Vermont county would be $\boxed{A_{20} * B_{VT} / N_{20VT}}$. $\boxed{A_{20} * B_{ME} / N_{20ME}}$ and $\boxed{A_{20} * B_{MA} / N_{20MA}}$ would be assigned respectively for each intersected adjacent Maine and Massachusetts counties (if any).

In the second phase, we drew a circle with a radius of 50 miles, centered on the mill. We counted the number of counties (N_{50}) that intersected the circle and assign the $B\%$ to every intersected county the same as the procedure in the first phase. We defined and calculated: $\boxed{A_{50} * B_{NH} / N_{50NH}}$ for each adjacent New Hampshire county, $\boxed{A_{50} * B_{VT} / N_{50VT}}$ for each adjacent Vermont county, $\boxed{A_{50} * B_{ME} / N_{50ME}}$ for each adjacent Maine county and $\boxed{A_{50} * B_{MA} / N_{50MA}}$ for each Massachusetts county. Likewise, in the third phase, we drew a circle with a radius of 100 miles using the mill as the center, the result would be $\boxed{A_{100} * B_{NH} / N_{100NH}}$ for each adjacent New Hampshire county, $\boxed{A_{100} * B_{VT} / N_{100VT}}$ for each adjacent Vermont county, $\boxed{A_{100} * B_{ME} / N_{100ME}}$ for each adjacent Maine county and $\boxed{A_{100} * B_{MA} / N_{100MA}}$ for each Massachusetts county. We added up the percentages assigned to each adjacent county through the three phases, and got the percentage distribution across the mill's own county, its adjacent New Hampshire, Maine and Vermont counties. By multiplying the percentage with the mill's white pine annual production, we obtained all the corresponding volume distribution of log sources.

For New Hampshire and Vermont, the wood supply study data are available from our New Hampshire and Vermont sawmills surveys; and for Maine, Massachusetts and Québec, the data are from our recent telephone surveys of white pine mills in the defined study region. Then, we applied the same method used on the New-Hampshire and Vermont county data. We used the log source percentage and volume distribution across the mill's own county and the adjacent New Hampshire counties to calculate the volume demanded by white pine mills in Vermont, Maine and Massachusetts adjacent with New Hampshire counties. After processing the data as described above for each county, we obtained the total volume demanded from each county adjacent to New Hampshire by summing up the volume of log demand of each sawmill within that county. Specific to each county, by adding volume demands from all the adjacent New Hampshire, Vermont, Maine, Massachusetts counties and Québec, the total volume of demand from outside of each New Hampshire county was determined. Adding the own demand within that of each other county, we obtained the total volume demand of white pine from each county's timber land in New Hampshire. By this calculation, the data for white pine flow from New Hampshire to Vermont, Massachusetts, Maine, and Québec can be obtained and mapped by GIS for every mill in each county of New Hampshire. The demand-side data at the county-level (Table 4-29 and Table D-99) are ready to use for the initial condition of harvest for the projection models.

Table 4-29: EWP mill demand from NH timbershed by county in MMBF, with high-end, low-end and average mill consumptions

County Demand	High End	Low End	Average
Belknap			
Total Demand	20.29639	14.89183	17.59411
Carroll			
Total Demand	19.34396	13.52034	16.43215
Cheshire			
Total Demand	18.28037	13.03824	15.65931
Coos			
Total Demand	12.40176	8.486479	10.44412
Grafton			
Total Demand	21.90852	13.66185	17.78519
Hillsborough			
Total Demand	22.83419	17.32095	20.07757
Merrimack			
Total Demand	43.3097	27.77594	35.54282
Rockingham			
Total Demand	22.34407	15.10311	18.72359
Strafford			
Total Demand	13.39276	8.997639	11.1952
Total Demand	13.66636	9.612078	11.63922
Total Demand from NH	207.7781	142.4085	175.0933
Total Own Demand	161.63	104.25	132.94
Total VT demand (from NH)	7.85	5.61	6.73
Total ME demand (from NH)	19	13.25	16.125
Total MA demand (from NH)	5.12	5.12	5.12
Total Québec Demand (from NH)	14.17	14.17	14.17

Table 4-29 shows the total wood demanded from each New Hampshire county, from the largest supplier (Merrimack) to the smallest (Strafford). The detached analysis of county wood flows summarized in Table D-99, is located in the Wood Supply Study Appendix D. These detailed wood supply data for New Hampshire ten counties are used to set up the initial EWP supply condition for timber supply projections at the specific county level in our wood supply model.

Elasticities

Own Price Supply Elasticity

Own price supply elasticity is generally seen as inelastic in stumpage markets. Sendak et al. (2003) used the value 0.31 for own price supply elasticity. We employ 0.33 as base and varied the value to 0.38 and 0.28 for the pessimistic and optimistic cases, respectively.

Inventory Elasticity

Inventory elasticity reflects change in quantity supplied due to a change in inventory. Declines in inventory are expected to have similar impacts on quantity supplied. We employ Sendak et al.'s (2003) value of 1.00 in our base case. Unlike them, we experimented with other values reflecting alternative assumptions about the impacts of land use change. We used 1.05 for inventory elasticity in the pessimistic case and we used 0.95 in the optimistic case. Forest land use is declining in New Hampshire and the loss of forest represents a permanent reduction in inventory. However, one hypothesis is that the impact of that loss on short-term timber supply is dampened because the associated land clearing provides a one-time flush of timber to the market. In the optimistic case, we represent that dampening effect by reducing the inventory elasticity from Sendak et al.'s 1.00 to 0.95. In the pessimistic case, we have an opposing hypothesis. Because land use changes in New Hampshire are leading to increased forest fragmentation, remaining forests are less operable due to diseconomies associated with small lot sizes as well as constraints imposed by adjacent non-forest land uses. To simulate these effects, we increased the inventory elasticity to 1.05.

Own Price Demand Elasticity

Own price demand elasticity is generally seen as inelastic in stumpage markets. For our base case, we used -0.5 for own price demand elasticity as did Sendak et al. (2003). We used -0.55 for the pessimistic case, and -0.45 for the optimistic case.

Assumptions

Demand changes are set exogenous to the model. Mills are assumed to remain in business or at least the relative spatial pattern of stumpage production and consumption does not change (local mergers may occur). Equilibrium stumpage prices apply on a state-wide basis.

Inventory Module

Inventory Data

From the FIA database, we extracted county-level data for inventory, standing volume of growing stock, size class, and percentage of white pine inventory in one county versus the total volume in New Hampshire, annual growth, mortality, and annual harvest. The inventory data act as inputs in the supply equation for the initial inventory condition. Changes in inventory over time are tracked for sustainability.

Growth Information

Utilization Factor

The utilization factor represents the eastern white pine sawlog utilization percentage versus all pine products. This number is based on average utilization rate from the FIA database. While changes in product grade proportion, in the standing inventory would change utilization rate, we employed the same utilization rate (0.75) for the entire projection period for base, pessimistic, and optimistic cases.

Growth Rate

Growth rates are estimated using FIA data on net volume of growing stock on timberland by county and major species group in cubic feet and the average net annual growth of growing stock by county and major species group in cubic feet (Table 4-30).

For example, to calculate annual growth rate of Belknap softwood:

Annual Growth Rate = (2836896.5) / (200750629.8 - 2836896.5) = 1.43%

Five Year Growth Rate = $(1.43\% + 1)^5 - 1 = 7.38\%$

Thus, we obtained annual growth rates for softwood for the ten New Hampshire counties (Table 4-30).

Table 4-30: Softwood growth rates by New-Hampshire county

NH Counties	Net Volume of Softwood growing stock (CF)	Average Net Annual Growth of Softwood Growing Stock (CF)	Annual Growth Rate	Five Year Growth Rate
Belknap	200,750,629.8	2,836,896.5	1.43%	7.38%
Carroll	420,313,981.3	8,718,960.6	2.12%	11.05%
Cheshire	338,491,890.7	7,297,825.6	2.20%	11.51%
Coos	620,170,695.0	10,390,813.0	1.70%	8.82%
Grafton	631,613,683.5	14,501,730.2	2.35%	12.32%
Hillsborough	455,295,679.5	9,621,050.6	2.16%	11.27%
Merrimack	459,817,158.7	9,748,662.5	2.17%	11.31%
Rockingham	284,561,968.5	5,032,035.2	1.80%	9.33%
Strafford	140,884,152.9	2,929,552.9	2.12%	11.08%
Sullivan	247,172,472.8	6,980,838.5	2.91%	15.40%

Since there are no data provided specifically for eastern white pine growth rate and we cannot separate white pine from softwood, we use calculated softwood growth rate for each county as the white pine growth rate for each county. As eastern white pine is a faster growing softwood species in New Hampshire with higher volume/acre growth than hemlock, spruce-fir and cedar, using the softwood growth rate as the white pine growth rate give us conservative estimates of that rate.

Land Use Change

As one parameter in the model, land use change plays a significant role in the change of model results in inventory and stocking, the equilibrium of harvest and the stumpage price in the ten 5-year periods over the model projection. Based on Society for the Protection of New Hampshire Forests (2001) data, we project forest land use change for each county over the 50 year projection period (Table 4-31).Land use change data are derived from Report of the New Hampshire Forest Land Base Study (Figure 4-3). Total area of timberland of each New Hampshire county is derived from FIA database. Forest land decline is based on statistical analysis of population projections and existing percent of forest cover in 1993.

Table 4-31: Land use change

50-year projected % decline in forest land area for New Hampshire counties			
County	Average 50-year % Decline	Low End 50-year % Decline	High End 50-year % Decline
Belknap	6.22%	3.69%	8.75%
Carroll	6.53%	4.11%	8.95%
Cheshire	3.41%	0.52%	6.32%
Coos	0.67%	0.00%	1.34%
Grafton	2.48%	0.35%	3.04%
Hillsborough	17.65%	11.85%	23.45%
Merrimack	6.64%	3.72%	9.57%
Rockingham	27.85%	19.23%	36.49%
Strafford	10.19%	5.83%	14.57%
Sullivan	2.97%	0.34%	5.60%
Average	8.46%	4.96%	11.81%

Land use change affects the amount of timberland available. The conversion, fragmentation, and parcelization of forests in each county cause the decline of forest land over a range. Each colored area is within a range with a high-end decline and a low-end decline for the projection period of 1993-2020. For example, Strafford county has six towns labeled pink (500-1000 acres), five yellow (0-500 acres), and two red (1000-2000 acres).The average annual decline in Strafford is then calculated as (6*750 + 5*250 + 2*1500) / 27 = 324 (acres per year). The percentage decline for 50 years for all counties is shown in Table 4-80. The total forested area of New Hampshire is from this data predicted to decline from 4,640,007 acres to 4,352,507 acres. The forest land in Rockingham, Hillsborough and Strafford declines significantly faster than in other New Hampshire counties over 50 years. There are big variations in the projected percentage decline among these ten counties. Forest land in Coos is projected to decline only 0.67% over 50 years while Rockingham declines 27.85% on average.

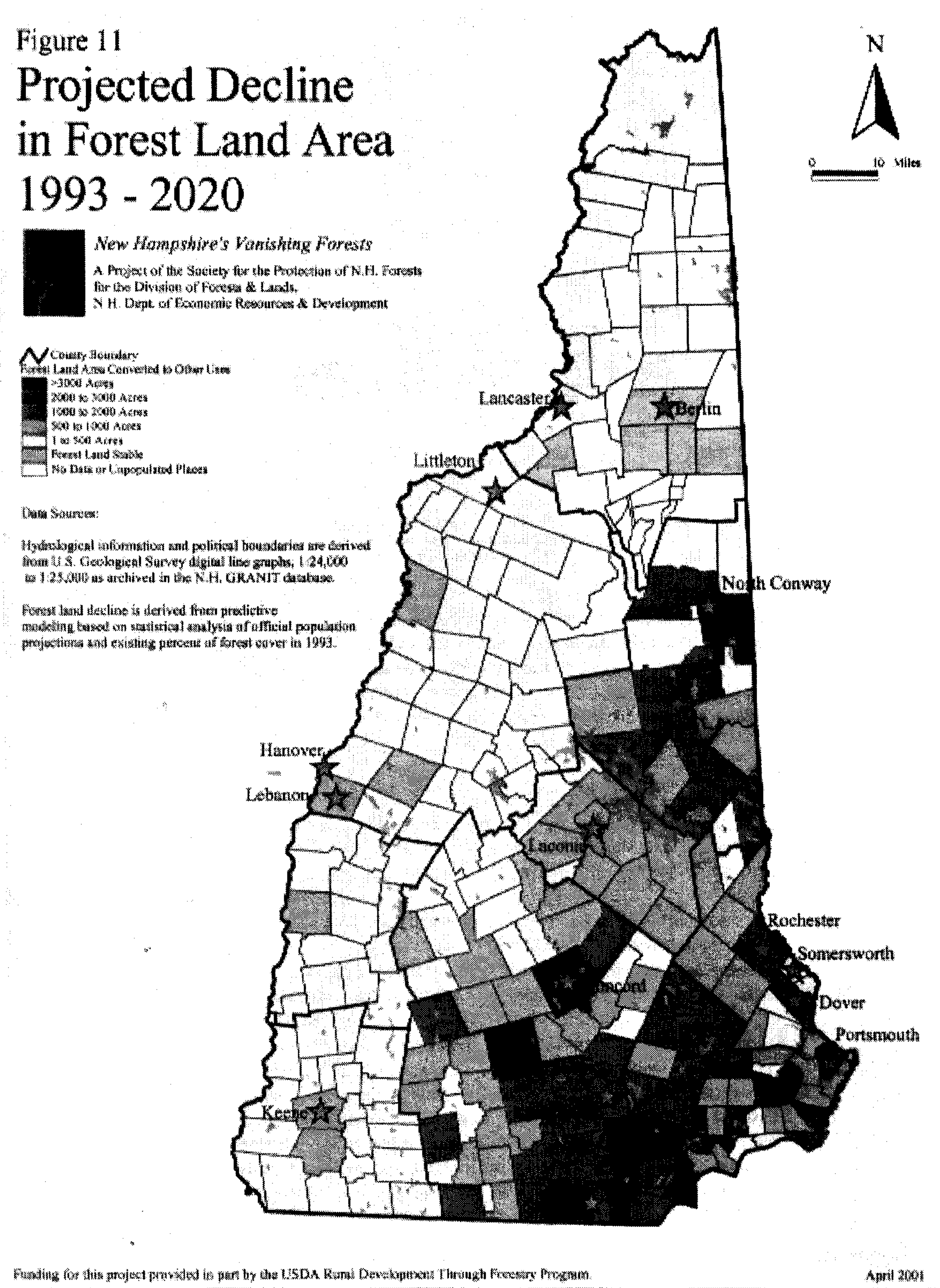


Figure 4-3: Land use change

Source of Figure 4-3:.Projected decline in forest land area 1993-2020 by county (acres)
Figure 11
New Hampshire's vanishing forests: Conversion, fragmentation, and parcelization of forests in the Granite State
Report of the New Hampshire Forest Land Base Study.
Society for the Protection of New Hampshire Forests, April,2001
Total area of timberland of each NH county source: FIA database mapmaker version 1.0
http://ncrs2.fs.fed.us/4801/fiadb/temp2/j916023411.htm

Scenario Descriptions

We used nine scenarios to project changes in inventory and stocking, harvest and stumpage prices and to test sensitivity to the parameter changes over 50 years. These nine scenarios are categorized by base, pessimistic and optimistic cases with combinations of average, low-end and high-end initial mill consumptions (Table 4-32). They are examined at the state and county levels. Each case is labeled as a combination of parameter assumption conditions (pessimistic, base and optimistic / and initial mill consumption estimate of low, average and high). For example, case BH represents the combination of base level parameter value and high initial estimate of mill consumption.

Table 4-32: Nine scenarios of the projection model

Case	Low Initial Mill Consumption	Average Initial Mill Consumption	High Initial Mill Consumption
Pessimistic	PL	PA	PH
Base	BL	BA	BH
Optimistic	OL	OA	OH

Along with the analysis, summaries of aggregate state-level results for eastern white pine (EWP) timber supply projections are presented as below in Table 4-33, Table 4-35 and Table 4-37; and summaries of county-level results are presented in Table 4-34, Table 4-36 and Table 4-38. Detailed model results from all nine scenarios are included in Appendix D. Key results from the average case scenario, the optimistic case scenario and the pessimistic case scenario, from a sustainability perspective are presented as Part I of Appendix D and the results of the other six case scenarios are presented as Part II of the WSS appendix. These results could also be used as references for future wood supply studies.

The model determines the outcome of percentage change at the state and county levels for eastern white pine stumpage price, inventory, harvest, and growing stock per unit area annually and over 50 years. The elasticities for demand, supply and inventory were changed by plus 0.05 from the base case to the pessimistic case and by minus 0.05 from the base case to the optimistic case. Market demand is regarded to be exogenous. For the base case we assumed 1% increase in demand; for the pessimistic case, we assumed 1.5% increase in demand and for the optimistic case we assumed the least increase in demand as 0.5% compared to the other two cases. The utilization rate remains the same for the three cases, as we assumed the product recovery rate as 75% will be unchanged for the duration of the model. Growth rate was adjusted by minus 0.002 from the base to the pessimistic case and by plus 0.002 from the base to the optimistic case. Land use change is based on calculations using the range of projected decline in forest land area from 1993 to 2020 provided by Thorne and Sundquist (2001). We used the average calculated land use change for the base case, the maximum land use change values for the pessimistic case and the minimum land use change values for the optimistic case. The pessimistic cases exercise the model with a demand elasticity of -0.5, supply elasticity of 0.33 and inventory elasticity of 1, represent a scenario of high timber demand (higher demand change rate (0.015)) but poor forest sustainable management (lower growth rate (0.0) and higher land use rate (-6.2%)). The optimistic cases exercise the model with demand elasticity of -0.45, supply elasticity of 0.28 and inventory elasticity of 0.95 and represent a scenario of lower timber demand (lower demand change rate (0.005)) and good forest sustainable management (high growth rate (0.004) and lower land use change rate (-3.46%)).

Model Results

Important Model Outputs

We track total and annual rates of change for eastern white pine inventory, harvest volume, stumpage prices and stocking per unit area. Inventory reflects the region's capacity to sustain wood supply. Sawlog harvest levels address future wood supply deficiencies or surpluses. Stumpage price change reflects scarcity and is an important component of lumber production cost. Under the pressure of facing declining forest lands, EWP stocking/unit area has important implications for land use change impacts and the diversity of forest stands, other dimensions of biodiversity, and aesthetics.

Analysis of the Model Results

The state level and county level results are presented for three levels of initial mill consumption, beginning with the high estimate followed by the low estimate and ending with the average estimate.

Table 4-33: State level results for eastern white pine (EWP) timber supply projections (high-end initial mill consumption)

	Base Case		Pessimistic Case		Optimistic Case	
Parameter						
Elasticities						
Demand	-0.5		-0.55		-0.45	
Supply	0.33		0.38		0.28	
Inventory	1		1.05		0.95	
Demand Change	0.01		0.015		0.005	
Utilization	0.75		0.75		0.75	
Growth Rate Adjustment	0.002		0		0.004	
50-year Land Use Change	-6.20%		-8.66%		-3.46%	
Outcome (% Change)	**50 Year**	**Annual**	**50 Year**	**Annual**	**50 Year**	**Annual**
EWP Inventory	-56.57%	-1.65%	-69.90%	-2.37%	-31.57%	-0.76%
EWP Sawlog Harvest	-42.65%	-1.11%	-60.37%	-1.83%	-27.19%	-0.63%
EWP Sawlog Stumpage Price	275.82%	2.68%	276.39%	2.69%	89.63%	1.29%
EWP Stocking/Unit Area	-53.70%	-1.53%	-67.05%	-2.20%	-29.12%	-0.69%

For the high estimate at the state level, inventory for the optimistic case declined 31.57% in 50 years, and 0.76% annually, while the pessimistic case declined almost twice as much (Table 4-33). The base case inventory declined 56.57% in 50 years, and 1.65% annually. The optimistic model predicts smaller changes in inventory, harvest and stumpage price. The predicted sawlog harvest also decreases in all models, the base case decreasing by 42.65% over 50 years and 1.11% annually. In the pessimistic case, the projected sawlog harvest declined by 60.37% over 50 years, more than twice the decline in the optimistic case of 27.19%. The stumpage price increased in all cases, by nearly 275%, in both the base case and the pessimistic case, but only by 89.63% in the optimistic case. The growing stock per unit area decreased in all models, by 53.7% in 50 years for the base case, 67.05% for the pessimistic case, and by only 29.12% for the optimistic case.

Table 4-34: County level results for eastern white pine (EWP) timber supply projections (high-end initial mill consumption)

	Base Case		Pessimistic Case		Optimistic Case	
Outcome (% Change)	**50 Year**	**Annual**	**50 Year**	**Annual**	**50 Year**	**Annual**
Belknap						
EWP Inventory	-91.53%	-4.82%	-94.55%	-5.65%	-83.31%	-3.52%
EWP Sawlog Harvest	-86.90%	-3.98%	-92.21%	-4.98%	-78.16%	-3.00%
EWP Stocking/Unit Area	-90.97%	-4.70%	-94.03%	-5.48%	-82.67%	-3.44%
Carroll						
EWP Inventory	-58.98%	-1.77%	-71.94%	-2.51%	-34.11%	-0.83%
EWP Sawlog Harvest	-36.51%	-0.90%	-56.43%	-1.65%	-19.52%	-0.43%
EWP Stocking/Unit Area	-56.12%	-1.63%	-69.18%	-2.33%	-31.29%	-0.75%
Cheshire						
EWP Inventory	-34.18%	-0.83%	-53.23%	-1.51%	-1.39%	-0.03%
EWP Sawlog Harvest	1.88%	0.04%	-25.49%	-0.59%	18.05%	0.33%
EWP Stocking/Unit Area	-31.85%	-0.76%	-50.07%	-1.38%	-0.88%	-0.02%
Coos						
EWP Inventory	-98.76%	-8.40%	-99.13%	-9.06%	-96.79%	-6.65%
EWP Sawlog Harvest	-98.08%	-7.60%	-98.87%	-8.58%	-95.44%	-5.99%
EWP Stocking/Unit Area	-98.75%	-8.39%	-99.12%	-9.04%	-96.79%	-6.65%
Grafton						
EWP Inventory	-60.51%	-1.84%	-73.13%	-2.59%	-34.32%	-0.84%
EWP Sawlog Harvest	-38.87%	-0.98%	-58.36%	-1.74%	-19.77%	-0.44%
EWP Stocking/Unit Area	-59.50%	-1.79%	-72.28%	-2.53%	-34.10%	-0.83%
Hillsborough						
EWP Inventory	-19.00%	-0.42%	-41.15%	-1.05%	16.36%	0.30%
EWP Sawlog Harvest	25.38%	0.45%	-5.16%	-0.11%	38.14%	0.65%
EWP Stocking/Unit Area	-1.63%	-0.03%	-23.11%	-0.52%	32.00%	0.56%
Merrimack						
EWP Inventory	-71.00%	-2.45%	-80.96%	-3.26%	-49.85%	-1.37%
EWP Sawlog Harvest	-55.10%	-1.59%	-71.00%	-2.45%	-37.90%	-0.95%
EWP Stocking/Unit Area	-68.93%	-2.31%	-78.95%	-3.07%	-47.92%	-1.30%
Rockingham						
EWP Inventory	-74.60%	-2.70%	-83.71%	-3.56%	-55.61%	-1.61%
EWP Sawlog Harvest	-60.68%	-1.85%	-75.39%	-2.76%	-44.70%	-1.18%
EWP Stocking/Unit Area	-64.80%	-2.07%	-74.35%	-2.68%	-45.04%	-1.19%
Strafford						
EWP Inventory	-70.61%	-2.42%	-80.85%	-3.25%	-49.05%	-1.34%
EWP Sawlog Harvest	-54.51%	-1.56%	-70.82%	-2.43%	-36.96%	-0.92%
EWP Stocking/Unit Area	-67.27%	-2.21%	-77.58%	-2.95%	-45.89%	-1.22%
Sullivan						
EWP Inventory	-57.37%	-1.69%	-72.52%	-2.55%	-25.74%	-0.59%
EWP Sawlog Harvest	-34.01%	-0.83%	-57.36%	-1.69%	-9.84%	-0.21%
EWP Stocking/Unit Area	-56.06%	-1.63%	-70.89%	-2.44%	-25.49%	-0.59%

Table 4-34 shows model predictions by county, using high-end initial mill consumption estimates to set for the initial wood supply condition. Only one county, Hillsborough, shows a positive change for EWP inventory in the optimistic case, with a rise in inventory of 16.36% over 50 years. The results for other counties suggest unsustainable harvesting in particular Coos and Belknap. For Coos in particular, the model predicts a change in inventory of -96.79% even with the optimistic case parameters. Belknap, in the optimistic case, shows a decline of 83.31% in eastern white pine inventory. Rockingham, Merrimack, and Strafford were the next three worst counties in terms of sustainability. All three showed base case declines in inventory of over 70% over the next 50 years, while the sawlog harvest also drops by more than 50% for these counties. Sullivan, Grafton, and Carroll counties were next, with inventories in the base case that declined 57.37%, 60.61%, and 58.98%, respectively. Cheshire county was the second best in sustainability, with the optimistic case predicting a 50 year decline in inventory of only 1.39%. Sawlog harvest for Cheshire in the optimistic case is predicted to rise by 18.05% in 50 years. The worst case scenario was the pessimistic case of the high-end initial mill consumption. The ordering of the counties by sustainability, from most to least sustainable is: Hillsborough, Cheshire, Sullivan, Carroll, Grafton, Strafford, Merrimack, Rockingham, Belknap, Coos.

Table 4-35: State-level results for eastern white pine (EWP) timber supply projections (low-end initial mill consumption)

	Base Case		Pessimistic Case		Optimistic Case	
Parameter						
Elasticity						
Demand	-0.5		-0.55		-0.45	
Supply	0.33		0.38		0.28	
Inventory	1		1.05		0.95	
Demand Change	0.01		0.015		0.005	
Utilization	0.75		0.75		0.75	
Growth Rate Adjustment	0.002		0		0.004	
50-year Land Use Change	-6.20%		-8.66%		-3.46%	
Outcome (% Change)	**50 Year**	**Annual**	**50 Year**	**Annual**	**50 Year**	**Annual**
EWP Inventory	-11.39%	-0.24%	-38.52%	-0.97%	19.80%	0.36%
EWP Sawlog Harvest	5.61%	0.11%	-9.66%	-0.20%	6.05%	0.12%
EWP Sawlog Stumpage Price	119.56%	1.59%	275.80%	2.68%	-12.37%	-0.26%
EWP Stocking/Unit Area	-5.53%	-0.11%	-32.69%	-0.79%	24.09%	0.43%

Table 4-35 lists model results at the state level for the low-end initial mill consumption case. The results show much more sustainability for the optimistic case than the results using high-end mill consumption data. The optimistic case inventory and sawlog harvest both increased over the 50-year model period, by 19.80% and 6.05% respectively. Inventory increases at a rate more than three times quicker than sawlog harvest over 50 years. The optimistic case even predicts a decrease in EWP stumpage price of 12.37% over 50 years. The differences between the low-end and high-end initial consumption condition are clear in all categories. The combination of the optimistic case parameters and the low-end initial mill consumption resulted in the most sustainable wood supply level.

Table 4-36: County-level results for eastern white pine (EWP) timber supply projections (low-end initial mill consumption)

	Base Case		Pessimistic Case		Optimistic Case	
Outcome (% Change)	50 Year	Annual	50 Year	Annual	50 Year	Annual
Belknap						
EWP Inventory	-70.77%	-2.43%	-82.47%	-3.42%	-55.97%	-1.63%
EWP Sawlog Harvest	-62.11%	-1.92%	-73.43%	-2.62%	-55.79%	-1.62%
EWP Stocking/Unit Area	-68.83%	-2.30%	-80.79%	-3.25%	-54.28%	-1.55%
Carroll						
EWP Inventory	-12.32%	-0.26%	-39.40%	-1.00%	18.01%	0.33%
EWP Sawlog Harvest	13.66%	0.26%	-2.25%	-0.05%	12.79%	0.24%
EWP Stocking/Unit Area	-6.20%	-0.13%	-33.44%	-0.81%	23.07%	0.42%
Cheshire						
EWP Inventory	15.97%	0.30%	-16.54%	-0.36%	51.61%	0.84%
EWP Sawlog Harvest	50.34%	0.82%	36.79%	0.63%	43.10%	0.72%
EWP Stocking/Unit Area	20.07%	0.37%	-10.90%	-0.23%	52.40%	0.85%
Coos						
EWP Inventory	-85.44%	-3.78%	-92.29%	-5.00%	-75.80%	-2.80%
EWP Sawlog Harvest	-81.13%	-3.28%	-88.78%	-4.28%	-74.97%	-2.73%
EWP Stocking/Unit Area	-85.35%	-3.77%	-92.18%	-4.97%	-75.80%	-2.80%
Grafton						
EWP Inventory	4.64%	0.09%	-26.01%	-0.60%	39.92%	0.67%
EWP Sawlog Harvest	35.65%	0.61%	20.53%	0.37%	32.60%	0.57%
EWP Stocking/Unit Area	7.30%	0.14%	-23.69%	-0.54%	40.41%	0.68%
Hillsborough						
EWP Inventory	18.14%	0.33%	-13.90%	-0.30%	54.28%	0.87%
EWP Sawlog Harvest	53.14%	0.86%	41.33%	0.69%	45.50%	0.75%
EWP Stocking/Unit Area	43.46%	0.72%	12.48%	0.24%	75.02%	1.13%
Merrimack						
EWP Inventory	-18.25%	-0.40%	-44.89%	-1.18%	12.27%	0.23%
EWP Sawlog Harvest	5.98%	0.12%	-11.54%	-0.24%	7.57%	0.15%
EWP Stocking/Unit Area	-12.43%	-0.27%	-39.06%	-0.99%	16.60%	0.31%
Rockingham						
EWP Inventory	-39.73%	-1.01%	-60.86%	-1.86%	-13.47%	-0.29%
EWP Sawlog Harvest	-21.87%	-0.49%	-38.23%	-0.96%	-16.01%	-0.35%
EWP Stocking/Unit Area	-16.47%	-0.36%	-38.36%	-0.96%	7.12%	0.14%
Strafford						
EWP Inventory	-24.36%	-0.56%	-49.97%	-1.38%	5.76%	0.11%
EWP Sawlog Harvest	-1.95%	-0.04%	-20.07%	-0.45%	1.64%	0.03%
EWP Stocking/Unit Area	-15.78%	-0.34%	-41.44%	-1.06%	12.31%	0.23%
Sullivan						
EWP Inventory	4.83%	0.09%	-31.72%	-0.76%	47.25%	0.78%
EWP Sawlog Harvest	35.89%	0.62%	10.79%	0.21%	39.19%	0.66%
EWP Stocking/Unit Area	8.04%	0.15%	-27.67%	-0.65%	47.75%	0.78%

The county predictions for the case of low-end mill initial consumption are shown in Table 4-36. The ordering of the counties by sustainability doesn't change from the outcomes of Table 4-34. However, the initial condition of low-end mill consumption drastically changes the predictions for these counties over the next 50 years. For the best performing county, Hillsborough, the optimistic model predicts an increase in eastern white pine inventory of 54.28% over 50 years. Even in the pessimistic case, Hillsborough's sawlog harvest is predicted to increase by 41.33%. The models are very sensitive to estimates of initial mill consumption.

Table 4-37: State-level results for eastern white pine (EWP) timber supply projections (average initial mill consumption)

	Base Case		Pessimistic Case		Optimistic Case	
Parameters						
Elasticity						
Demand	-0.5		-0.55		-0.45	
Supply	0.33		0.38		0.28	
Inventory	1		1.05		0.95	
Demand Change	0.01		0.015		0.005	
Utilization	0.75		0.75		0.75	
Growth Rate Adjustment	0.002		0		0.004	
50-year Land Use Change	-6.20%		-8.66%		-3.46%	
Outcome (% Change)	**50 Year**	**Annual**	**50 Year**	**Annual**	**50 Year**	**Annual**
EWP Inventory	-36.78%	-0.91%	-57.26%	-1.69%	-8.04%	-0.17%
EWP Sawlog Harvest	-15.45%	-0.33%	-40.35%	-1.03%	-11.04%	-0.23%
EWP Sawlog Stumpage Price	242.50%	2.49%	276.13%	2.68%	25.70%	0.46%
EWP Stocking/Unit Area	-32.60%	-0.79%	-53.21%	-1.51%	-4.74%	-0.10%

Table 4-37 shows the model results at the state level using the average initial mill consumption for an initial condition. The elasticity and demand change parameters are again varied from an optimistic case, a base case, and a pessimistic case, by the same values as in Table 4-33 and Table 4-35. Not surprisingly, the predictions fall between the low-level and high-level initial mill consumption models. Inventory, harvest and stocking change demonstrate a decreasing trend and stumpage prices show an increasing trend in base, pessimistic and optimistic cases with average initial mill consumption. The eastern white pine inventory decreases by 8.04% and stocking decreases by 4.74% over 50 years even in the optimistic case, while the pessimistic case predicts a drop in inventory of 57.26% and a drop in stocking of 53.21%. The stumpage price in the base case still increases greatly in the model, showing an increase of 242.5%, as compared to the optimistic case for which the stumpage price increases by only 25.7% over the 50-year projection period. In the base case, EWP inventory decreases by 36.78% over 50 years, much faster than its harvest decline. Harvest levels drop by 15.45% over 50 years in the base case while in the pessimistic case, harvest levels have a significant decrease of 40.35%.

Table 4-38: County level results for eastern white pine (EWP) timber supply projections (average initial mill consumption)

	Base Case		Pessimistic Case		Optimistic Case	
Outcome (% Change)	**50 Year**	**Annual**	**50 Year**	**Annual**	**50 Year**	**Annual**
Belknap						
EWP Inventory	-83.34%	-3.52%	-90.18%	-4.54%	-71.64%	-2.49%
EWP Sawlog Harvest	-75.00%	-2.73%	-85.54%	-3.79%	-67.80%	-2.24%
EWP Stocking/Unit Area	-82.24%	-3.40%	-89.24%	-4.36%	-70.55%	-2.42%
Carroll						
EWP Inventory	-38.23%	-0.96%	-58.64%	-1.75%	-9.87%	-0.21%
EWP Sawlog Harvest	-7.27%	-0.15%	-34.54%	-0.84%	-3.40%	-0.07%
EWP Stocking/Unit Area	-33.92%	-0.83%	-54.58%	-1.57%	-6.01%	-0.12%
Cheshire						
EWP Inventory	-10.84%	-0.23%	-37.47%	-0.93%	24.11%	0.43%
EWP Sawlog Harvest	33.85%	0.58%	1.05%	0.02%	30.90%	0.54%
EWP Stocking/Unit Area	-7.69%	-0.16%	-33.25%	-0.81%	24.75%	0.44%
Coos						
EWP Inventory	-95.01%	-5.82%	-97.34%	-7.00%	-89.88%	-4.48%
EWP Sawlog Harvest	-92.50%	-5.05%	-96.33%	-6.40%	-87.90%	-4.14%
EWP Stocking/Unit Area	-94.97%	-5.81%	-97.31%	-6.97%	-89.88%	-4.48%
Grafton						
EWP Inventory	-32.99%	-0.80%	-54.98%	-1.58%	-1.17%	-0.02%
EWP Sawlog Harvest	0.59%	0.01%	-28.43%	-0.67%	5.43%	0.11%
EWP Stocking/Unit Area	-31.29%	-0.75%	-53.57%	-1.52%	-0.83%	-0.02%
Hillsborough						
EWP Inventory	-0.97%	-0.02%	-28.91%	-0.68%	35.21%	0.61%
EWP Sawlog Harvest	48.66%	0.80%	15.61%	0.29%	42.00%	0.70%
EWP Stocking/Unit Area	20.26%	0.37%	-7.13%	-0.15%	53.39%	0.86%
Merrimack						
EWP Inventory	-49.06%	-1.34%	-67.30%	-2.21%	-22.41%	-0.51%
EWP Sawlog Harvest	-23.53%	-0.54%	-48.84%	-1.33%	-16.22%	-0.35%
EWP Stocking/Unit Area	-45.44%	-1.20%	-63.84%	-2.01%	-19.42%	-0.43%
Rockingham						
EWP Inventory	-59.48%	-1.79%	-74.62%	-2.70%	-36.38%	-0.90%
EWP Sawlog Harvest	-39.17%	-0.99%	-60.79%	-1.86%	-30.62%	-0.73%
EWP Stocking/Unit Area	-43.83%	-1.15%	-60.03%	-1.82%	-21.24%	-0.48%
Strafford						
EWP Inventory	-50.95%	-1.41%	-68.85%	-2.31%	-24.40%	-0.56%
EWP Sawlog Harvest	-26.36%	-0.61%	-51.38%	-1.43%	-18.26%	-0.40%
EWP Stocking/Unit Area	-45.38%	-1.20%	-63.53%	-2.00%	-19.71%	-0.44%
Sullivan						
EWP Inventory	-30.63%	-0.73%	-56.51%	-1.65%	7.45%	0.14%
EWP Sawlog Harvest	4.13%	0.08%	-30.98%	-0.74%	14.14%	0.26%
EWP Stocking/Unit Area	-28.51%	-0.67%	-53.93%	-1.54%	7.81%	0.15%

Table 4-38 shows the county-wide timber supply projections by the different models when average initial mill-consumption data are used. The order of the counties by sustainability remains the same, although each one goes down in sustainability compared to the low-end initial mill consumption case. The difference between the pessimistic and optimistic case is very clear here, for example in Hillsborough the eastern white pine inventory is predicted to increase by 35.21% over the projection period in the optimistic model, whereas the pessimistic scenario suggests that the inventory will decrease by 28.91%. In the pessimistic case, the sawlog harvest in Hillsborough increased by 15.61%. According to FIA annual growth rate in each county, the relatively faster annual growth rates in Cheshire and Hillsborough counties (Table 4-31) is one factor resulting in the slower decline in inventory in these counties.

Conclusion

Table 4-33, Table 4-35 and Table 4-37 show model results at the state level with high-end, low-end and the average initial mill consumptions. With high-end initial mill consumption, the EWP inventory has the largest decrease for all cases, with only 43.53% (base), 30.10% (pessimistic) and 68.43% (optimistic) of the original white pine levels of inventory remaining after 50 years. With low-end initial mill consumption, the EWP inventory has the lowest decrease of all three cases, which are 88.31% remaining for base case, 61.48% remaining for pessimistic case and 119.80% (an increase in inventory) for the optimistic case. The differences between high-end consumption EWP inventory change and low-end consumption EWP change are very significant, which are 45.18% for the base case, 31.38% for the pessimistic case and 51.37% for the optimistic case. While the high-end mill consumption is only 18% greater than the low-end mill consumption, the difference on the initial consumption data results in almost 100% difference in the predicted EWP inventory change. The same phenomenon is also observed on EWP sawlog harvest, sawlog stumpage price and stocking. Therefore, the model is found to be very sensitive to initial mill consumption data. The accuracy of initial mill consumption will be very important if a precise projection of EWP inventory is expected. The initial mill consumption estimate affects the initial equilibria on data and determines the level upon which increases in demand are comprehended. Given the importance of these data for our model, or any market - based wood supply model, it will be important that an accurate system for collecting wood consumption data be developed and implemented.

Although there are differences between the projections under different initial mill consumptions, all three state-level outcomes accordingly demonstrate the same pattern in which the elasticity (demand, supply and inventory), demand change, utilization, growth rate and land use change parameters affect the projection over 50 years. The model projects that the EWP inventory will have far greater loss within 50 years in the pessimistic case than in the optimistic case. In the pessimistic cases, we also observed greater decrease in the EWP sawlog harvest and greater EWP sawlog price increase over 50 years. EWP stocking per unit area sustains a bigger loss in the pessimistic case than in the optimistic case.

By comparison of the aggregate results at the state level, the best case scenario will be the optimistic case with low-end initial mill consumption data in which harvest is in balance with growth over 50 years. The worst case scenario will be the pessimistic case with high-end initial mill consumption data. In the best case with parameter values moving in directions favorable to sustainability, sawlog stumpage prices decline by nearly 12% over 50 years and by 0.26% annually. The harvest of eastern white pine sawlogs barely increases by 0.12% annually and slightly by 6.05% over the projection period. Regional stocking per unit area rises by 24.09% in 50 years and increases steadily by 0.43% annually. There is a significant increase in eastern white pine inventory by nearly 20% over the projection period and by 0.36% annually. This suggests in the best case scenario, market demand and supply and inventory are less elastic and demand growth is relatively slower while the biological growth is more rapid. There is a 3.46%

loss in forest land use over the 50 year projection period which results in less timberland for the actual inventory so that inventory increases more slowly than the stocking per unit area.

In the worst case with parameter values moving in directions harmful to sustainability, eastern white pine inventory declined 2.37% annually and correspondingly regional stocking declined 2.2% annually. Sawlog stumpage price rose 2.69% annually and timber harvest drop by 1.83% annually and by 60.37% in 50 years. This highlights the more elastic demand, supply and inventory with faster demand growth and slower biological growth in this case.

The average case scenario will be the base case with average initial mill consumption data. State level results for timber supply projection (Table 4-37) indicates that eastern white pine inventory declines by 36.78% and stocking per unit area decreases by 32.6% over the 50-year projection period. The annualized rates of inventory and stocking decline are by only 0.91% and 0.79% respectively. Sawlog harvest declines by 15.45% in 50 years and by 0.33% annually while sawlog stumpage price rises by 242.5% over 50 years and by 2.49% annually. This reflects a more neutral value in net biological growth, demand growth and land use change, and more modest changes in harvests and stumpage prices. The inventory declines more than the stocking per unit because the timberland area declines 6.2% over 50 years.

In fifty years, eastern white pine inventory declines and stumpage price rises except in the optimistic case with low-end initial mill consumption. The best case scenario concludes possible sufficiency of eastern white pine supply to sustain the sawmill industry in the defined New Hampshire timbershed. The eastern white pine inventory and the mill consumption reaches on a relative sustainable basis in which the wood is grown, harvested and produced in an environmentally-sensitive manner to stimulate local economic development. There are noticeable spatial differences regarding the sufficiency of white pine supply and the influence of spatial arrangement of mills on wood flow by comparison of the county level data in Table 4-34, Table 4-36 and Table 4-38. More road construction for the easement of wood transportation with the increase in harvest levels may cause some negative environmental impact in the foreseeable future. In the more urban southern area of New Hampshire will likely experience more consolidation and more mills exiting out of the market.

Model results predict the general trends of eastern white pine stumpage price change, inventory, stocking and harvest level changes over 50 years (Appendix D average case figures).With the predicted general increasing trend of stumpage price, the decreasing trend of the forest inventory and harvest levels, it is likely that fewer sawmills would remain in operation and sawmills tends to cooperate with one another to coexist. Demand for timber is derived from demand for timber products, and is a function of price of final products and production cost. By cooperation, production costs could go down and increase the sawmill log supply to balance the market equilibrium. Cooperation of sawmills in neighboring regions can support community resilience and industry stability. Sawmill industry will be possibly more regional and international to some extent, ignoring the county, state and border boundaries as a result of combinations of cooperation such as shared ownership, supply agreements and long-term joint ventures. There are also further policy implications in market power and competition, mill numbers and mill size influence. Government taxation and subsidy policies could help forestall the negative impacts on the sawmill industry under strong economic pressure, such as using subsidies for forest management practices and using tax to reduce mill competition in spatial monopsony if any as result of high production mills.

The model results of the condition of the inventory and the harvest level at the end of the projection period predict spatial difference and the vulnerability of the industry and forest land. The base case with average initial mill consumption suggests acceptable inventory conditions at the end of the analysis period. It is not surprising how vast the stumpage price can rise in 50 years. By examining the historical pattern of stumpage price change in Chase and Howard (1990), Dennis et al. (2000) and Wagner and Sendak (2005), our predicted annual rate of stumpage price change falls within the historical performance bounds. For example, from Wood Supply Model Results Table D-90 in Appendix D, for the base case with average initial mill consumption, the initial condition stumpage price is \$797.5/MCF and the price 50 years from now is projected as \$2731.41/MCF. This represents about a $(2731.41/797.5)^{1/50}$ -1= 2.5% annual increase in stumpage price which falls in the range of stumpage changes over the last 50 years. The projected increases in stumpage prices and harvests (except for the best case scenario) indicate the adverse economic pressures and the need to better forest management planning and policies to recover from negative economic and ecological impacts on the sawmill industry.

The paper forecasts that potential shifts in major species composition may occur with the decline of eastern white pine inventory. Low-value species such as hemlock and red maple may replace pine. Improvement in the utilization of harvested trees at the harvest site and in the manufacturing process could reduce the drain on the forest resource and moderate projected decline in inventory and stocking to a balanced growth/harvest ratio. Results also indicate landscape level concerns especially of how land use change affects the sustainable level of eastern white pine inventory through pessimistic, optimistic and base case views. The increasing trend of conversion of forest lands to built uses is harmful for the sustainable development of white pine regeneration and growth.

Future research could address wood supply model expansion to more than one species and a more specific evaluation of the economic forces that shape demand for various kinds of forest products. Future research could also work on getting more precise data in land use change and a more complete database on forest acreage available for timber utilization to model the effect of wood supply more fully and interpret its influence on different distribution in different market conditions. Policies to decrease the forest land use conversion, to create a more favorable business environment for the sawmill industry, and ecological improvements in the balance of species growth, regeneration and utilization could be considered. Strategies involving more private landowner and public assistance and improved-yield silvicultural practices could help maintain the long-term forest health in terms of sustaining the forest resource base which the sawmill industry is embedded.

CONCLUDING REMARKS

This research examined in depth the sawmill industry of New Hampshire and Vermont, and its resource bases with a special focus on the supply of eastern white pine in New Hampshire. Launched with mail surveys in 2004, we profiled the sawmill industry of New Hampshire and Vermont in terms of production, consumption, labor characteristics and regulating economic and policy issues. Based on the findings and data from survey results, we developed a first approximation of a transparent Excel-sheet based wood supply model for eastern white pine in New Hampshire. The model simulated inventory, harvest and stumpage prices for a fifty-year projection period. We modeled inventory dynamics as functions of biology, economics and land use change. The analysis addressed future sufficiency of log supply at both state and county level, accounting for the geographical distribution of sawmills and the spatial nature of inventory and wood flows. By varying parameters and sensitivity tests to base, pessimistic and optimistic cases for sustainability, the model examined nine cases of sustainable relationship between mill consumption and the forest inventory under exogenous market demand growth. This can help decision-makers develop plans based on the future availability of New Hampshire timber and track forest health in terms of inventory and stocking dynamics, and major shifts in forest composition associated with changes in harvest levels and stumpage prices under market forces and land use change.

This survey of New Hampshire and Vermont sawmills profiles the industry in terms of capital investment trends, market conditions of log supply and final products, domestic and international competition, work force characteristics and business environment. We surveyed sawmill operators' perceptions regarding social and economic issues and their concerns about log availability, log procurement sources and cost of logs. Mill operators answered questions about their connections to communities and their willingness to participate in forest products certification programs.

Return statistic analysis indicates that New Hampshire mills are nearly small and medium sized. Mill employees are mostly local and similarly, the log sources for these mills are also mostly local. New Hampshire mills make extensive use of eastern white pine. The products are mostly used locally. Many mill operators claimed involvement with the local community. Majority of the mills do not consider certification of sources, but medium mills used many more certified logs than the small mills. Very few mills track the chain of custody of the log sources. No modernization has been conducted or planned, due to lack of investment. Both small and medium mills agree that Canadian sawmills have an advantage due to lower production costs, lower stumpage prices, and lower wood transportation costs. The mills perceived that Canadian mills threatened the success of their mills. The medium mills were more emphatic that the stumpage price advantage for the Canadians was a factor in their success, and that the transportation costs were also a significant factor.

Compared with the profile of New Hampshire sawmill industry, Vermont's mills were also mostly small and medium, with predominantly local employees using mostly logs from within 50 miles. The medium mills also used logs from further away than small mills. Vermont's sawmills and their forest bases are currently operating at a self-sufficient level of log supply in that they have healthy inventory and good growth/drain ratio. Most logs used by Vermont mills were from private forests in Vermont. This was more the case for small mills than for medium mills. Medium mills were much more reliant on logs from elsewhere in the United States than small mills. The products of Vermont's mills are used worldwide, but mostly locally in Vermont and New England.

Relative to New Hampshire mills, Vermont's mills use less softwood and more hardwood. Most mill operators claimed involvement in the local community, but did not feel involved with Canadian communities despite the common border. The industry has not been overly modernized, with about half mills reporting recent investment. Most mills do not consider certification of log sources and very few track the chain of custody of the log sources. Both small and medium mills agreed that the Canadian mills were a threat to their mill success. The mill size does not affect its owner's agreement with the statement that Canadian sawmills are at an advantage due to lower production costs, lower stumpage price and lower wood transportation costs. Most of the sawmill owners viewed the advantage of the lower stumpage price as insignificant while they viewed the advantage of lower production costs and lower wood transportation costs as significant. The smaller nature of the mill industry in this state leads itself to a community-based analysis of sustainability and economic factors, and allows a more complete analysis of the industry's sustainability, as compared with more international markets. The study can help reinforce the role of the bioregional forest-based economy by defining the relationship between forests, bioregional communities and forest industries.

After profiling the state's sawmill industry, this research modeled eastern white pine dynamics and projected timber supply over 50 years. It addresses the biological factors shaping the forest as well as the economic factors. It provides an integrated analysis of demand, supply, inventory, and stumpage prices all as one package, with model formulas built into a transparent spread-sheet based timber supply model to test nine scenarios and corresponding sensitivity to parameter changes. The model analysis features nine base, pessimistic and optimistic scenarios with base, low-end and high-end initial mill consumptions at both the aggregate state level and the specific county level. It provides impact assessments of future land use change and other market dynamics on future wood supply for the sawmill industry. Model results suggest that the most sustainable case scenario will be the optimistic case with low-end initial mill consumption data and least sustainable scenario will be the pessimistic case with high-end initial mill consumption. In the most sustainable case, sawlog stumpage prices decline while inventory and stocking levels increase two times faster than harvest levels. In 50 years, the growth is predicted to be in balance with harvest. In contrast, the least sustainable case results reflect adverse economic and ecological impacts on the sawmill industry and future possibility of an unsustainable forest resource base.

Except for the base case and the optimistic case with low-end initial mill consumption, model results forecast general trends of increasing stumpage prices and the decreasing inventory, stocking and harvest levels over a 50-year period for eastern white pine in New Hampshire. Policies to absorb the adverse impacts for sustaining a long-term healthy forest industry and its forest resource base are needed. Future works on the species expansion of the model and the integration of a more detailed evaluation at the landscape level of New Hampshire's vanishing forest are suggested. Sawmill industry will be possibly more regional and international to some extent, ignoring the county, state and border boundaries as a result of combinations of cooperation. Policies to sustain the forest industry to its forest resource base should then be balanced against the change of land use with regard to spatial and temporal dimensions of mill log demand. From "co-evolutionist" perspective of sustainability, the wood supply study suggests conserving a minimal stock of New Hampshire's critical natural capital --- eastern white pine is possible, in terms of sustaining the relationship between the regional mill consumption and the state's inventory level over a projection period of 50 years.

LIST OF REFERENCES

Abdelmalki L and Mundler P, 1997. Les industrialisations des Tiers Mondes (Third Worlds' Industrializations). Humanisme et entreprise (Humanism and Enterprise) ISSN 0018-7372. No224. pp. 1-16

Abt, Robert .C.; Cubbage, F.W. and Pacheco, G. 2000. Southern forest resource assessment using the subregional timber supply (SRTS) model. Forest Products Journal. 50(4): 25–33.

Abt, Robert C., January 1986. A "top-down" approach to modeling state forest growth, removals and inventory. Forest Products Journal. Vol 39, No.1.pp. 71-76

Adams, D.; Alig, R.; Anderson, J., et al. 1992. Future prospects for western Washington's timber supply. Institute of Forest Resources Contribution 74. Seattle, WA: University of Washington, College of Forest Resources. 201 p.

Adams, D.M.; Haynes, R.W. 1980. The softwood timber assessment market model: structure, projections, and policy simulations. Forest Science. Monograph No. 22. 62p.

Adams, D.; Haynes, R. 1996. The 1993 timber assessment market model: structure, projections, and policy simulations. Gen. Tech. Rep. PNW–GTR–368. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 58p.

Alan Agresti and Barbara Finlay, 1997. Statistical Methods for the Social Sciences. 3rd Edition. Upper Sadler River, NJ: Prentice Hall

Bailes, J.C. and Nielsen, J.F., 1997.Capital budgeting practices of the forest products industry - 1997. Oregon State University, College of Business and College of Forestry. Studies in Management and Accounting for the Forest Products Industry, Monograph no. 45.16 pp.

Barbier E. and Markandya A., 1990. The Conditions for Achieving Environmentally Sustainable Development. European Economic Review, No.34.pp.659-669.

Baumol, W. J. and Oates, W. E., 1988. The Theory of Environmental Policy. Cambridge University Press, Cambridge, UK, 2nd edition.

Beckerman W., 1972. (Reprinted as Beckerman, WB (1995)) Economic Development and the Environment: A False Dilemma. International Conciliation, No 586, .pp. 57-71, January,1972.

Bentley, J.T.; Horst, R.L., Jr. 1997. Forestry sector benefits of alternative ozone scenarios. Prepared for U.S. EPA under EPA contract 68-D3-0030. Princeton, NJ: Mathtech, Inc. 14 p.

Bentley, J.T.; Horst, R.L., Jr. 1998. Commercial forestry benefits of alternative emission controls for the NOX SIP call. Prepared for U.S. EPA under EPA contract 68-D98-113. Princeton, NJ: Mathtech, Inc. 13 p.

Bromley D.W., 1985, "Recursos y desarollo económico: un enfoque institucionalista" (Resource Economics Development: an institutional approach) Agricultura y Sociedad, n°35,April-June1985,.pp.49-75.

Chanel O., Gérard-Varet L.A. and Ginsburgh V., 1996 Journal of Cultural Economics: The relevance of hedonic price indices. Springer Netherlands, ISSN 0885-2545. Volume 20, Number 1, .pp. 1-24.

Chase, W.E. and T.E. Howard. 1995. Maine stumpage price characteristics and trends. Forest Products Journal. 45(1):31-36.

Constanza R., 1991. Assuring sustainability of ecological economic systems. Ecological Economics: The Science and Management of Sustainability. Columbia University Press, New York, .pp. 330-354.

Costanza R., Daly H.E., 1991. Natural Capital and Sustainable Development Conservation Biology, Vol. 6, No. 1 (Mar., 1992), pp. 37-46

Cummings, Meghan E. 2003.Approaches to Sustainability in Forested Regions: Measures of Forest Sector Dependence and Exploration of the Maine Sawmill Industry in the Northern Forest Bioregion. M.S. Thesis. University of New Hampshire.180 pages.

Dillman, D.A. 1978. Mail and telephone surveys: the total design method. New York, NY: John Wiley and Sons.

Dixit, A. P., P. Hammond, and M. Hoel, On Hartwick's rule for regular maximin paths of capital accumulation and resource depletion, Re¨. Econom. Studies 47, 551]556 1980.

Deal, R.L. and White, S.M.2005.Understanding key issues of sustainable wood production in the Pacific Northwest. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. General Technical Report, PNW-GTR-626. 67 p.
Internet Link: http://www.fs.fed.us/pnw/pubs/pnw_gtr626.pdf

Davis, L., N. Johnson, T. Howard, and P. Bettinger. 2001. Forest Management: To Sustain Ecological, Economic, and Social Values. 4th ed. McGraw-Hill. 815 pages.

Dennis, D.F., Sendak, P.E., and McEvoy, T.J. 2000. Analysis of timber prices in New England.In: Seventh Symposium on Systems Analysis in Forest Resources, Traverse City, MI, May 28-31, 1997. U.S. Forest Service, North Central Res. Sta. General Technical Report NC-205. p.450-452.

Dirr, Michael. 2006. Manual of Woody Landscape Plants. http://www.arborday.org/Trees/TreeGuide/growth.cfm and http://en.wikipedia.org/wiki

Faucheux S. and Noel J.M., 1995. Economics of the environment and natural resources. Armand Colin, Paris.

Gadzik, C.J.; Blanck, J.H. and Caldwell, L.E. 1998. Timber supply outlook for Maine: 1995—2045. Augusta, ME: Department of Conservation, Maine Forest Service. 39 p. http://www.state.me.us/doc/mfs/pubs.htm

Gale, Richard P and Cordray, Sheila M.1994. Making sense of sustainability: nine answers to "what should be sustained." Rural Sociology, 59(2) P.331-332.

Hamilton, Lawrence C., 1990. Modern data analysis: a first course in Applied Statistics. Brooks/Cole Publishing Company, Pacific Grove, California.

Hansen, M.H.; Frieswyk, T.; Glover, J.F.and Kelly, J.F. 1992. The eastwide forest inventory data base: users manual. Gen. Tech. Rep. NC-151. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 48 p.31

Hartwick J.M., 1977. Intergenerational Equity and the Investing of Rents from Exhaustible Resources American Economic Review, Vol. 67, No. 5 (Dec., 1977), .pp. 972-974

Harris, S., Germain, R.H., and, Zhang, L., 2003. Assessing wood procurement management systems in the forest products industry. Forest Products Journal 53(2):17-26.

Hartwick J. M., Forestry economics, deforestation, and national accounting, in ''Toward Improved Accounting for the Environment'' E. Lutz, Ed., The World Bank, Washington, DC 1993.

Haugen, D.E. and, Weatherspoon, A., 2003. 1998 Michigan timber industry: an assessment of timber output and use, St. Paul, MN: USDA Forest Service, North Central Research. Resource Bulletin NC-212. 83 p.

Haynes, R., Adams, D. and Alig, R. 2002. The 2000 RPA timber assessment: an analysis of the timber situation in the United States, 1952 to 2050. Portland, OR: U.S. Department Of Agriculture, Forest Service, Pacific Northwest Research Station.

Haynes, R.W.; Adams, D.M. and Mills, J.R. 1995. The 1993 RPA timber assessment update. Gen. Tech. Rep. RM-GTR-259. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 66 p.

Heal, Geoffrey, 2000, Nature and the Marketplace, Capturing the value of ecosystem services. Island Press.

Hidenfelter, Mindy. H. 2000. White Pine Log Exports from Northern New England to Québec. M.S. Thesis. University of New Hampshire. 64 pages.

Hill, A., 2000. The Alaska wood products industry 1998 sawmill survey. U.S. Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-500. p.203-224.

Holling C.S., 1973. Resilience and stability of ecological systems. Annual Review of Ecological Systems. 4: 1-24

Kapp V.K.W., 1950. The Social Costs of Private Enterprise 1950 edition. Paris, Flamarion. 1971 Edition. New York, Schocken Books.

Klaassen A. J., Opschoor, J. B., 1991. Economics of sustainability or the sustainability of economics: Different paradigms.Elsevier, Ecological Economics Vol 4. (1991) Issue 2 (Nov),.pp.93-115.

Luppold, William G. and Paul E. Sendak. 2004. Analysis of the Interaction between Timber Markets and the Forest Resources of Maine. USDA Forest Service, Northeastern Research Station, 241 Mercer Springs Road, Princeton, WV 24740, Northeast Research Station, 271 Mast Road, Durham, NH 03824 the Society of American Foresters.

Luppold, William G., Paul M. Smith, and Sudipta Dasmohapatra.2003. Regional Differences in the Timber Resources and the Sawmill Industry in Pennsylvania Proceedings of the 2003 SOFEW Annual Meeting pgs. 279-285

Mangun, J.C. and, Phelps, J.E., 2000. Profiling existing markets: the Illinois secondary solid wood products industry. Forest Products Journal 50(5):55-60.

Marshall A., 1890. Principles of Economics. London: Macmillan, 1° ed, 1890

Meadows D.L., Barrens W., Meadows D.H. and Nail R.F., 1977. Growth dynamics in an infinite world. Fayard, Paris.

Mills, J.R. 1990. Developing ATLAS growth parameters from forest inventory plots. In: Proceedings, state of the art methodology of forest inventory symposium. Gen. Tech. Rep. PNW-GTR-263. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 112–118.

Mills, J.R., and Kincaid, J.C. 1992. The Aggregate Timberland Assessment System - ATLAS: A comprehensive timber projection model. USDA Forest Service. Gen.Tech. Report.PNW-GTR-263.169p.

Mills, J.and Zhou, X. 2003. Projecting national forest inventories for the 2000 RPA timber assessment. Gen. Tech. Rep. PNW-GTR-568. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 58 p.

Mill J.S., 1871. Principles of Political Economy, with some of the their Applications to Social Philosophy, 2 volumes, London, Parker, 1848 revised, 1849, 1852, 1857, 1862, 1865, 1871

Mill J.S., 1871. Utilitariamism London, Parker, Son, & Bourn, 1863, revised 1864, 1867, 1871.

Minnesota Department of Natural Resources, 2003. 2003 Minnesota decorative spruce top production and market survey. Division of Forestry. 12 p. St. Paul, MN: Minnesota Department of Natural Resources

Naredo J.M., 1996. La economia en evolución. Historia y perspectivas de las categorias básicas del pensamiento económico. (The economy in evolution. History and perspectives of basic categories in economic thinking) Madrid: Siglo XXI, 2° Ed. actualizada.1996.

Norgaard R.B., 1988. Sustainable development: A co-evolutionary view. Futures, No.20 (6), .pp.606-620.

New Hampshire Department of Revenue and Administration, www.nh.gov/revenue/property-tax/timber/stumpval.htm

New Hampshire's vanishing forests: Conversion, fragmentation, and parcelization of forests in the Granite State Report of the New Hampshire Forest Land Base Study. April, 2001. Society for the Protection of New Hampshire Forests.

New Hampshire's 2004 Primary Wood Processor Report, 2004. http://www.dred.state.nh.us/divisions/forestandlands/reference/documents/Sawmill-04final.pdf

New Hampshire Timberland Owners webpage: www.nhtoa.org

North East State Foresters Association (NEFA) March 2001 Report: The Economic Importance of New Hampshire's Forests.

Opschoor J.B., Van der Straaten J, 1993. Sustainable Development: An Institutional Approach, Elsevier, Ecological Economics, Vol. 7, June 1993, pp. 203-222.

Passet R., 1979. L'économique et le vivant (Economics and the living being) Payot 1979, 287pp.,2°ed.Economica,1996.

Pearce D. W. and Atkinson G. D., 1993. Capital theory and the measurement of sustainable development: An indicator of 'weak' sustainability, Ecolog. Econom. No 8, .pp.103-108 1993.

Pearce D.W. and Turner R.K., 1990. Economics of Natural Resources and the Environment, Harveser Wheatsheaf, Hemel Hempstead, Herts.

Pearce D. W. and Turner R.K., 1990. Economics of Natural Resources and the Environment. Baltimore: John Hopkins University Press.

Perrings, C., 1995. "Ecological Resilience in the Sustainability of Economic Development", Applied Economics, Book 48, No 42, .pp. 678-700.

Perrings,C.H, 1995.Ecological Resilience in the Sustainability of Economic Development, Applied Economics, Book 48, 2: .pp. 121-142. http://www.public.asu.edu/~cperring/

Philip A. Bryce, Dec.2004. Department of Resources and Economic Development Division of Forests and Lands.

Robert C. Abt., January 1986. A "top-down" approach to modeling state forest growth, removals and inventory. Forest Products Journal. Vol 39, No.1.pp. 71-76

Sendak, Paul E., Robert C. Abt and Robert J. Turner. 2003. Timber Supply Projections for Northern New England and New York: Integrating a Market Perspective, USDA Forest Service, Northeastern Research Station, NJAF 20(4) Northern Journal of Applied Forestry 20(4):175-185.

Shook, S.R. and, Eastin, I.L., 2001. A characterization of the U.S. residential deck material market. Forest Products Journal 51(4):28-36.

Smith, P.M., Dasmohapatra, S., and, Luppold, W.G. 2004. A Profile of Pennsylvania's hardwood sawmill industry. Forest Products Journal 54(5):43-49.

Society for the Protection of New Hampshire Forests. 2005. New Hampshire's Changing Landscape. Concord, NH. 13p.

Solow, R.M.,1974. Intergenerational Equity and Exhaustible Resources. Review of Economic Studies, Vol. 41, Symposium on the Economics of Exhaustible Resources, .pp.29-45.

Stoffaës C. (CEPII), 1993. L'Économie Face à l'Écologie (Economics as it relates to Ecology).Rapports officiels, Présidence de Commissions,Commissariat Général du Plan Ed. La Découverte.
Straussfogel, Debra., Theodore Howard, Sylvain Masse, and Difei Zhang.2003. Trans-border interactions in the sawmill industry of Chaudière-Appalaches, Québec: a survey analysis. Forestry Chronicle. 79(5): 936-947.

Teeter, L. and, Zhou, X. A multinomial logit approach to estimating regional inventories by product class in: Abt, K.L. and Abt, R.C., eds. SOFEW '98: Proc. 1998 Southern Forest Economics Workshop, Williamsburg, VA, Mar. 25-27, 1998. U.S. Forest Service, Southern Research Station; North Carolina State University. Department of Forestry. P.238-242.1999

Tietenberg, Thomas H. 2001. Environmental Economics and Policy. 3rd Edition. Addison Wesley Longman, Inc.

Thorne, Sarah and Dan Sundquist. April, 2001. New Hampshire's Vanishing Forests: Conversion, Fragmentation and Parcelization of Forests in the Granite State. Report of the New Hampshire Forest Land Base Study. Society for the Protection of New Hampshire Forests. Concord, New Hampshire.

Turner R.J. and Caldwell, L.E. March 22, 2001. A Forest Resource Model of the States of New York, Vermont, New Hampshire and Maine. Produced for: The North East State Foresters Association Funded through a grant from the USDA Forest Service.

Tromborg, E., Buongiorno, J. and Solberg, B.2000. The global timber market: implications of changes in economic growth, timber supply, and technological trends. Forest Policy and Economics. 1(1): 53–69. United Nations Food and Agricultural Organization. 2000a. Direction of trade, 1997.

The Irland Group RR#2. September 6, 1999.Wood flows in New York, Vermont, New Hampshire and Maine with recommended monitoring system, 1997. Box 9200 Winthrop, Maine 04364

University of New Hampshire Cooperative Extension, Forest Products Market Report, 1998–1999.

University of New Hampshire Cooperative Extension, New Hampshire Directory of Sawmills and Lumber Wholesalers.
http://extension.unh.edu/forestry/sawmill/sawmill_dir_print.cfm

USDA Forest Service, Forest Inventory and Analysis webpage, http://fia.fa.fed.us

Vincent J.R., Panayotou T., and Hartwick J.M., 1997. Resource Depletion and Sustainability in Small Open Economics. Journal of Environmental Economics and Management, Harvard Institute for International Development, Cambridge, Massachusetts; and Queen's University, Kingston, Ontario, Canada. Article No. EE970992, .pp.274-286.

Vloskey, R.P., Chance, N.P., and Doucet, J., 1997. The Louisiana secondary solid wood products industry. Forest Products Journal 47(7/8):29-34.

Wagner, J.E. and Sendak, P.E. 2005. The annual increase of northeastern regional timber stumpage prices: 1961-2002. Forest Products Journal 55(2):36-45.

White, E.M. and Carver, A.D. 2004. Modeling timber mill procurement influence effects on interstate sawlog exportation. Forest Policy and Economics 6(6):529-537.

Wilson, B., Stennes, B., Wang, S., and, Wilson, L. 2001. Secondary manufacturing in British Columbia: structure, significance and trends. Forestry Chronicle 77(2):301-308.

2001 Wood Flows in New York, Vermont, New Hampshire, & Maine--- A report from NEFA, the four state foresters cooperating with the USDA Forest Service. 2001. www.nefainfo.org.

Zar, J.H.1999. Biostatistical Analysis. 4th edition. Upper Sadler River, NJ: Prentice Hall

APPENDICES

APPENDIX A: NEW HAMPSHIRE SAWMILL SURVEY RETURN STATISTICS

Table A-39 NH mill characteristics

Year established

Year established	Average	Latest	Oldest	Response Number	Response Rate
Small Size	1948	1996	1800	28	80.00%
Medium Size	1966	1994	1935	10	90.91%
All	1953	1996	1800	38	82.61%

Business organization

How Is Your Business Organized	Proprietor-ship	Closely Held Corp	Partner – ship	Publicly traded corp.	Other	Response Number	Response Rate
Small Size	10	19	3	0	1	33	94.29%
Medium Size	3	3	3	1	0	10	90.91%
All	13	22	6	1	1	43	93.48%

Is mill a family business

Family business	Yes	No	Response Number	Response Rate
Small Size	32	3	35	100.00%
Medium Size	6	4	10	90.91%
All	38	7	45	97.83%

Parent company ownership

Parent Company	US	Canada	Other	Response Number	Response Rate
Small Size	22	0	0	22	62.86%
Medium Size	6	1	0	7	63.64%
All	28	1	0	29	63.04%

Table A-40: NH mill operations

Type of mill						
Type of Mill	Softwood Dimension	White pine lumber	Hardwood lumber	Other	Response Number	Response Rate
Small Size	14	13	15	10	35	100.00%
Medium Size	3	3	1	2	10	90.91%
All	17	16	16	12	45	97.83%

Approximate total production			
Approximate Total Production (MMBF)	Average	Response Number	Response Rate
Small Size	2	35	100.00%
Medium Size	14	11	100.00%
All	5	46	100.00%

Table A-41: NH mill work force

How many people work in mill							
Number of Employees	1 to 5	6 to 25	26 to 50	51 to 75	more than 75	Response Number	Response Rate
Small Size	19	11	3	0	0	33	94.29%
Medium Size	0	5	6	0	0	11	100.00%
All	19	16	9	0	0	44	95.65%

Average age							
Average Age of Employees	less than 20	21 to 30	31 to 40	41 to 50	more than 50	Response Number	Response Rate
Small Size	0	3	9	11	9	32	91.43%
Medium Size	0	3	6	2	0	11	100.00%
All	0	6	15	13	9	43	93.48%

Table A-41 continued

Average length of employment

Percent of Employees by Length of Employment	less than 1 year	1 to 5 years	6 to 10 years	11 to 20 years	more than 20 years	Response Number	Response Rate
Small Size	4.90	17.97	33.55	23.34	18.66	29	82.86%
Medium Size	9.09	25.18	47.55	8.73	6.27	11	100.00%
All	6.05	19.95	37.40	19.33	14.88	40	86.96%

Average distance

Percent of Employees by Distance to Mill	less than 10 miles	10 to 19 miles	20 to 29 miles	30 to 39 miles	40 to 49 miles	over 50 miles	Response Number	Response Rate
Small Size	67.25	23.00	7.59	5.78	1.11	0.19	28	80.00%
Medium Size	41.36	30.91	20.82	1.82	2.82	1.36	11	100.00%
All	59.95	25.29	11.42	4.63	1.56	0.51	39	84.78%

Prior experience

New Hires With Prior Lumber Mill Experience	None	1 to 25%	26 to 50%	51 to 75%	76 to 100%	Response Number	Response Rate
Small Size	11	6	4	3	3	27	77.14%
Medium Size	0	7	4	0	0	11	100.00%
All	11	13	8	3	3	38	82.61%

Type of training

Type of Training Provided	On the job	Structured training within company	External	No training provided	Response Number	Response Rate
Small Size	29	7	3	3	29	82.86%
Medium Size	7	5	4	0	10	90.91%
All	37	12	7	3	39	84.78%

Table A-41 continued

Number of shifts

Number of Shifts	1	2	3	Response Number	Response Rate
Small Size	29	0	0	29	82.86%
Medium Size	11	0	0	11	100.00%
All	40	0	0	40	86.96%

Factors important to mill success

	Labor issues	Capital costs and Availability	Delivered log costs	End-product markets	Response Number	Response Rate
Small Size	2.61	3.23	2.10	2.03	31	88.57%
Medium Size	3.00	2.82	1.46	2.46	11	100.00%
All	2.71	3.12	1.93	2.14	42	91.30%

Labor factors

	Direct labor costs	Indirect labor costs	Availability of skilled labor	Turnover of workforce	Response Number	Response Rate
Small Size	2.03	1.79	2.93	3.59	29	82.86%
Medium Size	2.28	1.46	2.46	3.46	11	100.00%
All	2.10	1.70	2.80	3.55	40	86.96%

Table A-42: NH mill capital investment

Conducted

Recent Capital Investment	Yes	No	Response Number	Response Rate
Small Size	10	22	32	91.43%
Medium Size	8	3	11	100.00%
All	18	25	43	93.48%

Modernization planned

Modernization Project Planned in Near Future	Yes	No	Response Number	Response Rate
Small Size	8	22	30	85.71%
Medium Size	4	7	11	100.00%
All	12	29	41	89.13%

Why was no project planned?

Reason for Not Planning Capital Investment	Recent comple-ted	Expen-sive	Cost	Not necessa-ry	Weak Markets	Gov. Regula-tions	Other	Response Number	Response Rate
Small Size	4	5	4	10	2	5	3	22	62.86%
Medium Size	2	0	0	3	1	0	1	6	54.55%
All	6	5	4	13	3	5	4	26	56.52%

Table A-43: NH mill log supply

How does mill obtain logs?

Percentage of Log Procurement Source by Size Class	Own log buyers	Stumpage purchase	Brokers	Long-term wood supply agreement	Own forest lands	Other	Response Number	Response Rate
Small Size	13.75	18.91	14.94	14.84	12.09	25.47	32	91.43%
Medium Size	63.64	8.82	3.91	8.18	0.91	14.55	11	100.00%
All	26.51	16.33	12.12	13.14	9.23	22.67	43	93.48%

Log sources

Percent from Various Log Sources by Size Class	Private forest within Maine	Public forests	Private forests from NH or VT	Elsewhere in the United States	Canada	Response Number	Response Rate
Small Size	1.17	6.21	83.97	8.66	0.00	29	82.86%
Medium Size	5.00	2.73	89.55	2.55	0.18	11	100.00%
All	2.23	5.25	85.50	6.98	0.05	40	86.96%

Log distance ranges

Percent of Logs from Various Distance Ranges by Size Class	1 to 19 miles from mills	20 to 49 miles from mills	50 to 99 miles from mill	100 to 249 miles from mill	over 250 miles from mill	Response Number	Response Rate
Small Size	51.85	30.56	11.85	1.67	4.07	27	77.14%
Medium Size	20.91	45.00	28.64	4.55	0.91	11	100.00%
All	42.89	34.74	16.71	2.50	3.16	38	82.61%

Table A-44: NH mill markets (primary products)

Where is primary product shipped?

Average Percent Shipped to Each Destination	Within the county	Elsewhere in NH or VT	Elsewhere in New England	To other regions of US	To markets outside the US	Response Number	Response Rate
Small Size	35.81	28.97	15.06	10.97	10.00	31	88.57%
Medium Size	22.00	31.50	25.50	24.50	6.50	10	90.91%
All	32.44	29.59	17.61	14.27	9.15	41	89.13%

Is primary product for wholesale or retail?

Percent Wholesale and Retail	Wholesale	Retail	Response Number	Response Rate
Small Size	47.79	52.21	29	82.86%
Medium Size	83.00	17.00	9	81.82%
All	56.13	43.87	38	82.61%

Table A-45: NH mill markets (value-added products)

Is value-added product manufacturing on-site?

Value- Added Manufacturing On Site	Yes	No	Response Number	Response Rate
Small Size	18	14	32	91.43%
Medium Size	6	5	11	100.00%
All	24	19	43	93.48%

Where is value-added product shipped?

Average Percent Shipped to Each Destination	Within the county	Elsewhere in NH or VT	Elsewhere in New England	To other regions of US	To markets outside the US	Response Number	Response Rate
Small Size	37.63	36.32	20.26	4.21	1.05	19	54.29%
Medium Size	30.83	15.33	45.00	22.50	0.00	6	54.55%
All	36.00	31.28	26.20	8.60	0.80	25	54.35%

Table A-46: NH mill certification

Is log from certified source?

Average Percent from certified log source	Yes	No	Unknown	Response Number	Response Rate
Small Size	16.67	76.74	11.04	24	68.57%
Medium Size	31.11	16.88	54.38	9	81.82%
All	20.61	61.29	21.88	33	71.74%

Does mill track chain of custody?

Does Mill Track Chain of Custody	Yes	No	Response Number	Response Rate
Small Size	1	28	29	82.86%
Medium Size	1	10	11	100.00%
All	2	38	40	86.96%

Considering marketing certified wood?

Is Mill Considering Marketing Certified Wood in The Near Future	Yes	No	Maybe	Response Number	Response Rate
Small Size	0	21	11	32	91.43%
Medium Size	2	8	1	11	100.00%
All	2	29	12	43	93.48%

Not considering marketing certified wood?

Reasons Mills are Not Considering Marketing Certified Wood	Following the chain of custody is too difficult	The market for certified wood is not large enough at this time	The certification process is too difficult	The certification process is too expensive	Other	Response Number	Response Rate
Small Size	5	15	7	12	7	24	68.57%
Medium Size	3	3	3	3	2	8	72.73%
All	8	18	10	15	9	32	69.57%

Table A-47: NH mill community

Importance to local community	1	2	3	4	5	6	Response Number	Response Rate
Small Size	2	8	6	5	4	6	31	88.57%
Medium Size	4	3	2	2	0	0	11	100.00%
All	6	11	8	7	4	6	42	91.30%

Importance to State of New Hampshire	1	2	3	4	5	6	Response Number	Response Rate
Small Size	2	3	9	5	6	6	31	88.57%
Medium Size	3	2	3	3	0	0	11	100.00%
All	5	5	12	8	6	6	42	91.30%

Importance to bordering Canadian community	1	2	3	4	5	6	Response Number	Response Rate
Small Size	0	0	2	0	3	25	30	85.71%
Medium Size	1	2	1	1	3	3	11	100.00%
All	1	2	3	1	6	28	41	89.13%

Involvement in the community

Activities the Mill Has Done Within the Past Years	Money donation	Products donation	Active in non-profit organizations	Open house	Question session	Leadership role	Recreational purposes	other	Response Number	Response Rate
Small Size	20	19	12	6	2	4	3	1	26	74.29%
Medium Size	5	4	5	1	1	4	2	1	10	90.91%
All	25	23	17	7	3	8	5	2	36	78.26%

Table A-48: NH international factors

International factors: order of importance

	International competition for wood	Exchange rate of US and Canadian dollars	The current tariff on Canadian lumber	General trade agreements	Response Number	Response Rate
Small Size	2.44	2.84	2.68	2.68	25	71.43%
Medium Size	1.91	2.55	2.64	2.91	11	100.00%
All	2.28	2.75	2.67	2.75	36	78.26%

International factors: importance of tariff

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	3	2	4	4	6	13	32	91.43%
Medium Size	6	0	1	0	2	2	11	100.00%
All	9	2	5	4	8	15	43	93.48%

International factors: Canadian border mills have advantage because of lower production cost

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	9	10	5	0	2	1	27	77.14%
Medium Size	5	2	4	0	0	0	11	100.00%
All	14	12	9	0	2	1	38	82.61%

International Factors: mills throughout Canada have advantage because of lower production cost

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	8	9	6	0	2	1	26	74.29%
Medium Size	2	4	3	0	0	0	9	81.82%
All	10	13	9	0	2	1	35	76.09%

Table A-48 continued

International factors: Canadian border mills are a threat to US mills

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	0	4	5	4	5	9	27	77.14%
Medium Size	0	0	1	3	2	5	11	100.00%
All	0	4	6	7	7	14	38	82.61%

International factors: mills throughout Canada are a threat to US mills

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	0	2	8	4	3	10	27	77.14%
Medium Size	0	0	1	3	3	3	10	90.91%
All	0	2	9	7	6	13	37	80.43%

International factors: Canadian border mills have advantage because they pay lower stumpage prices

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	3	12	6	2	3	1	27	77.14%
Medium Size	3	1	5	2	0	0	11	100.00%
All	6	13	11	4	3	1	38	82.61%

International factors: mills throughout Canada have advantage because they pay lower stumpage prices

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	5	13	5	2	2	0	27	77.14%
Medium Size	4	3	3	0	0	0	10	90.91%
All	9	16	8	2	2	0	37	80.43%

International factors: Canadian border mills have advantage because they pay lower wood transportation costs

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	3	6	9	5	3	1	27	77.14%
Medium Size	5	1	2	0	2	0	10	90.91%
All	8	7	11	5	5	1	37	80.43%

Table A-48 continued

International factor: mills throughout Canada have advantage because they pay lower wood transportation costs								
	1	2	3	4	5	6	Response Number	Response Rate
Small Size	3	6	8	8	1	1	27	77.14%
Medium Size	3	2	1	2	1	0	9	81.82%
All	6	8	9	10	2	1	36	78.26%

Table A-49: NH mill business environment

Business climate factors						
	State environmental regulations	Taxes	Public acceptance of the industry	Federal environmental regulations	Response Number	Response Rate
Small Size	2.17	2.45	2.90	2.67	29	82.86%
Medium Size	2.73	2.00	2.55	2.64	11	100.00%
All	2.33	2.33	2.80	2.68	40	86.96%
Rank industry assistance factors						
	Financial Assistance	Research and development in production technology	Market development programs	Technical Assistance from state organizations	Response Number	Response Rate
Small Size	2.46	3.00	2.04	2.81	26	74.29%
Medium Size	2.55	2.55	2.27	2.46	11	100.00%
All	2.49	2.87	2.11	2.70	37	80.43%

Table A-49 continued

Rank government entities

	Local government	NH/VT government	US federal government	provincial governments of Quebec and/or New Brunswick	Canadian government	Response Number	Response Rate
Small Size	2.15	2.12	2.54	4.00	4.50	26	74.29%
Medium Size	2.73	1.91	2.00	3.82	4.00	11	100.00%
All	2.32	2.05	2.38	3.95	4.35	37	80.43%

Table A-50 NH response by question

Question	Number Responded	Percent Responded
1). Job Title	45	97.83%
2). Mill location	45	97.83%
3). Other mills in NH?	43	93.48%
4). Year established	38	82.61%
5). Business organization	43	93.48%
6). Family Business?	45	97.83%
7). Parent company ownership	29	63.04%
8a). Types of mill	45	97.83%
8b). Approximate total production	46	100.00%
9a.) How many people work in mill?	44	95.65%
9b). Average Age	43	93.48%
9c). Length Of Employment	40	86.96%
9d). Average Distance	39	84.78%
9e). Prior Experience	38	82.61%
9f). What type of training	39	84.78%
9g). How many shifts?	40	86.96%
9h). How many woman?	37	80.43%
9i). How many women in office?	36	78.26%
9j) How many women in mill?	34	73.91%
10). Factors important to mill success	42	91.30%
11). Labor factors	40	86.96%
12a). Modernization/update	43	93.48%
12b). Modernization planned	41	89.13%
12c). Why no project planned?	28	60.87%
13a). How does mill obtain logs?	43	93.48%
13b). Log Sources	40	86.96%
13c). Log Distance ranges	38	82.61%
14a). Primary Products Produced	43	93.48%
14b). Shipped	41	89.13%
14c). Wholesale/Retail	38	82.61%
14d). Valued-added manufacturing on site?	43	93.48%
14e). Secondary Products produced	25	54.35%
14f). Shipped	25	54.35%
15a). Logs from certified sources?	33	71.74%
15b). Does mill track chain of custody?	40	86.96%
15c). Considering marketing certified wood?	43	93.48%
15d). Why not	32	69.57%
16a). Importance to local community	42	91.30%
16b.) Importance to State of NH	42	91.30%
16c). Importance to border Canadian communities	41	89.13%
17). Involvement in community	36	78.26%
18a). Rank the factors in order of importance	36	78.26%

Table A-50 continued		
18b). Importance of tariff	43	93.48%
18c). Canadian border mills have advantage	38	82.61%
18d). Canadian border mills are not a threat	38	82.61%
18e). Canadian border mills have advantage	38	82.61%
18f). Canadian border mills have advantage	37	80.43%
19a). Rank business climate factors	40	86.96%
19b). Rank industry assistance factors	37	80.43%
20). Rank government entities	37	80.43%
21). Other issues	16	34.78%
22). Desire for results	44	95.65%

NH χ^2 tables – New Hampshire Sawmill Survey

Table A-51: NH χ2 question 16a importance to local community

Observed	1	2	3	4	5	6	Total
Small	2	8	6	5	4	6	31
Medium	4	3	2	2	0	0	11
	6	11	8	7	4	6	42

Observed	1~2	3~4	5~6		
Small	10	11	10	31	74%
Medium	7	4	0	11	26%
	17	15	10	42	

Expected	1~2	3~4	5~6
Small	12.548	11.071	7.381
Medium	4.452	3.929	2.619

	Observed	Expected	(O-E)^2/E
1,1	10	12.548	0.517
1,2	11	11.071	0.000
1,3	10	7.381	0.929
2,1	7	4.452	1.458
2,2	4	3.929	0.001
2,3	0	2.619	2.619
		Chi-Square	5.525
		df	2
		n/(r*c)	7.000

Test result: fail to reject the hypothesis, χ2= 5.525, not significant at the 0.05 confidence level with 2 degrees of freedom

Table A-52: NH $\chi 2$ question 16b importance to the State of New-Hampshire

Observed	1	2	3	4	5	6	Total
Small	2	3	9	5	6	6	31
Medium	3	2	3	3	0	0	11
	5	5	12	8	6	6	42

Observed	1~2	3~4	5~6		
Small	5	14	12	31	74%
Medium	5	6	0	11	26%
	10	20	12	42	

Expected	1~2	3~4	5~6
Small	7.381	14.762	8.857
Medium	2.619	5.238	3.143

	Observed	Expected	(O-E)^2/E
1,1	5	7.381	0.768
1,2	14	14.762	0.039
1,3	12	8.857	1.115
2,1	5	2.619	2.165
2,2	6	5.238	0.111
2,3	0	3.143	3.143
		Chi-Square	7.341
		df	2
		n/(r*c)	7.000

Test result: reject the hypothesis, $\chi 2$= 7.341, significant at the 0.05 confidence level with 2 degrees of freedom

Table A-53: NH $\chi 2$ question 16c importance to the border Canadian communities

Observed	1	2	3	4	5	6	Total
Small	0	0	2	0	3	25	30
Medium	1	2	1	1	3	3	11
	1	2	3	1	6	28	41

Observed	1~2	3~4	5~6		
Small	0	2	28	30	73%
Medium	3	2	6	11	27%
	3	4	34	41	

Expected	1~2	3~4	5~6
Small	2.195	2.927	24.878
Medium	0.805	1.073	9.122

	Observed	Expected	(O-E)^2/E
1,1	0	2.195	2.195
1,2	2	2.927	0.293
1,3	28	24.878	0.392
2,1	3	0.805	5.987
2,2	2	1.073	0.800
2,3	6	9.122	1.068
		Chi-Square	10.736
		df	2
		n/(r*c)	6.833

Test result: reject the hypothesis, $\chi 2$= 10.736, significant at the 0.05 confidence level with 2 degrees of freedom

Table A-54: NH $\chi 2$ question 18b importance of tariff on the Canadian lumber

Observed	1	2	3	4	5	6	Total
Small	3	2	4	4	6	13	32
Medium	6	0	1	0	2	2	11
	9	2	5	4	8	15	43

Observed	1~2	3~4	5~6		
Small	5	8	19	32	74%
Medium	6	1	4	11	26%
	11	9	23	43	

Expected	1~2	3~4	5~6
Small	8.186	6.698	17.116
Medium	2.814	2.302	5.884

	Observed	Expected	(O-E)^2/E
1,1	5	8.186	1.240
1,2	8	6.698	0.253
1,3	19	17.116	0.207
2,1	6	2.814	3.607
2,2	1	2.302	0.737
2,3	4	5.884	0.603
		Chi-Square	6.648
		df	2
		n/(r*c)	7.167

Test result: reject the hypothesis, $\chi 2$= 6.648, significant at the 0.05 confidence level with 2 degrees of freedom

Table A-55: NH $\chi 2$ question 18c1 Canadian border mills have an advantage because they have lower production costs

Observed	1	2	3	4	5	6	Total
Small	9	10	5	0	2	1	27
Medium	5	2	4	0	0	0	11
	14	12	9	0	2	1	38

Observed	1~2	3~4	5~6		
Small	19	5	3	27	71%
Medium	7	4	0	11	29%
	26	9	3	38	

Expected	1~2	3~4	5~6
Small	18.474	6.395	2.132
Medium	7.526	2.605	0.868

	Observed	Expected	(O-E)^2/E
1,1	19	18.474	0.015
1,2	5	6.395	0.304
1,3	3	2.132	0.354
2,1	7	7.526	0.037
2,2	4	2.605	0.747
2,3	0	0.868	0.868
		Chi-Square	2.325
		df	2
		n/(r*c)	6.333

Test result: fail to reject the hypothesis, $\chi 2$= 5.525, not significant at the 0.05 confidence level with 2 degrees of freedom

Table A-56: NH $\chi 2$ question 18c2 mills throughout Canada have an advantage because they have lower production costs

Observed	1	2	3	4	5	6	Total
Small	8	9	6	0	2	1	26
Medium	2	4	3	0	0	0	9
	10	13	9	0	2	1	35

Observed	1~2	3~4	5~6		
Small	17	6	3	26	74%
Medium	6	3	0	9	26%
	23	9	3	35	

Expected	1~2	3~4	5~6
Small	17.086	6.686	2.229
Medium	5.914	2.314	0.771

	Observed	Expected	(O-E)^2/E
1,1	17	17.086	0.000
1,2	6	6.686	0.070
1,3	3	2.229	0.267
2,1	6	5.914	0.001
2,2	3	2.314	0.203
2,3	0	0.771	0.771
		Chi-Square	1.314
		df	2
		n/(r*c)	5.833

Test result: fail to reject the hypothesis, $\chi 2$= 1.314, not significant at the 0.05 confidence level with 2 degrees of freedom

Table A-57: NH $\chi 2$ question 18d1 Canadian border mills do not pose a threat to the success of US mills in the northeast

Observed	1	2	3	4	5	6	Total
Small	0	4	5	4	5	9	27
Medium	0	0	1	3	2	5	11
	0	4	6	7	7	14	38

Observed	1~2	3~4	5~6		
Small	4	9	14	27	71%
Medium	0	4	7	11	29%
	4	13	21	38	

Expected	1~2	3~4	5~6
Small	2.842	9.237	14.921
Medium	1.158	3.763	6.079

	Observed	Expected	(O-E)^2/E
1,1	4	2.842	0.472
1,2	9	9.237	0.006
1,3	14	14.921	0.057
2,1	0	1.158	1.158
2,2	4	3.763	0.015
2,3	7	6.079	0.140
		Chi-Square	1.847
		df	2
		n/(r*c)	6.333

Test result: fail to reject the hypothesis, $\chi 2$= 1.847, not significant at the 0.05 confidence level with 2 degrees of freedom.

Table A-58: NH $\chi 2$ question 18d2 mills throughout Canada do not pose a threat to the success of US mills in the Northeast

Observed	1	2	3	4	5	6	Total
Small	0	2	8	4	3	10	27
Medium	0	0	1	3	3	3	10
	0	2	9	7	6	13	37

Observed	1~2	3~4	5~6		
Small	2	12	13	27	73%
Medium	0	4	6	10	27%
	2	16	19	37	

Expected	1~2	3~4	5~6
Small	1.459	11.676	13.865
Medium	0.541	4.324	5.135

	Observed	Expected	(O-E)^2/E
1,1	2	1.459	0.200
1,2	12	11.676	0.009
1,3	13	13.865	0.054
2,1	0	0.541	0.541
2,2	4	4.324	0.024
2,3	6	5.135	0.146
		Chi-Square	0.974
		df	2
		n/(r*c)	6.167

Test result: fail to reject the hypothesis, $\chi 2$= 0.974, not significant at the 0.05 confidence level with 2 degrees of freedom.

Table A-59: NH $\chi 2$ question 18e1 Canadian border mills are at an advantage because they can buy timber at lower stumpage prices

Observed	1	2	3	4	5	6	Total
Small	3	12	6	2	3	1	27
Medium	3	1	5	2	0	0	11
	6	13	11	4	3	1	38

Observed	1~2	3~4	5~6		
Small	15	8	4	27	71%
Medium	4	7	0	11	29%
	19	15	4	38	

Expected	1~2	3~4	5~6
Small	13.500	10.658	2.842
Medium	5.500	4.342	1.158

	Observed	Expected	(O-E)^2/E
1,1	15	13.500	0.167
1,2	8	10.658	0.663
1,3	4	2.842	0.472
2,1	4	5.500	0.409
2,2	7	4.342	1.627
2,3	0	1.158	1.158
		Chi-Square	4.495
		df	2
		n/(r*c)	6.333

Test result: fail to reject the hypothesis, $\chi 2$= 4.495, not significant at the 0.05 confidence level with 2 degrees of freedom

Table A-60: NH $\chi2$ question 18e2 mills throughout Canada are at an advantage because they can buy timber at lower stumpage prices

Observed	1	2	3	4	5	6	Total
Small	5	13	5	2	2	0	27
Medium	4	3	3	0	0	0	10
	9	16	8	2	2	0	37

Observed	1~2	3~4	5~6		
Small	18	7	2	27	73%
Medium	7	3	0	10	27%
	25	10	2	37	

Expected	1~2	3~4	5~6
Small	18.243	7.297	1.459
Medium	6.757	2.703	0.541

	Observed	Expected	(O-E)^2/E
1,1	18	18.243	0.003
1,2	7	7.297	0.012
1,3	2	1.459	0.200
2,1	7	6.757	0.009
2,2	3	2.703	0.033
2,3	0	0.541	0.541
		Chi-Square	0.798
		df	2
		n/(r*c)	6.167

Test result: fail to reject the hypothesis, $\chi2$= 0.798, not significant at the 0.05 confidence level with 2 degrees of freedom

Table A-61: NH $\chi 2$ question 18f1 Canadian border mills are at an advantage because they pay lower wood transportation cost

Observed	1	2	3	4	5	6	Total
Small	3	6	9	5	3	1	27
Medium	5	1	2	0	2	0	10
	8	7	11	5	5	1	37

Observed	1~2	3~4	5~6		
Small	9	14	4	27	73%
Medium	6	2	2	10	27%
	15	16	6	37	

Expected	1~2	3~4	5~6
Small	10.946	11.676	4.378
Medium	4.054	4.324	1.622

	Observed	Expected	(O-E)^2/E
1,1	9	10.946	0.346
1,2	14	11.676	0.463
1,3	4	4.378	0.033
2,1	6	4.054	0.934
2,2	2	4.324	1.249
2,3	2	1.622	0.088
		Chi-Square	3.113
		df	2
		n/(r*c)	6.167

Test result: fail to reject the hypothesis, $\chi 2$= 3.113, not significant at the 0.05 confidence level with 2 degrees of freedom

Table A-62: NH $\chi 2$ question 18f2 mills throughout Canada are at an advantage because they pay lower wood transportation cost

Observed	1	2	3	4	5	6	Total
Small	3	6	8	8	1	1	27
Medium	3	2	1	2	1	0	9
	6	8	9	10	2	1	36

Observed	1~2	3~4	5~6		
Small	9	16	2	27	75%
Medium	5	3	1	9	25%
	14	19	3	36	

Expected	1~2	3~4	5~6
Small	10.500	14.250	2.250
Medium	3.500	4.750	0.750

	Observed	Expected	(O-E)^2/E
1,1	9	10.500	0.214
1,2	16	14.250	0.215
1,3	2	2.250	0.028
2,1	5	3.500	0.643
2,2	3	4.750	0.645
2,3	1	0.750	0.083
		Chi-Square	1.828
		df	2
		n/(r*c)	6.000

Test result: fail to reject the hypothesis, $\chi 2$= 1.828, not significant at the 0.05 confidence level with 2 degrees of freedom

NH T-test tables – New Hampshire Sawmill Survey

Table A-63: T-test for question 10: factors important to mill success

Importance to mill success A. Labor issues B. Capital costs and availability C. Delivered log cost D. End-product markets				
	A	B	C	D
Mean	2.714286	3.119048	1.928571	2.142857
Standard Deviation	0.99476	1.086556	0.997383	1.138493
Sample Size	42	42	42	42
Degree of Freedom	82			
T Value at 0.05 confidence level with 82 degrees of freedom: 1.98				
Mean Order	C <	D <	A <	B
Two-tailed T-test on C and D				
T Value	-0.91751		Fail to reject H_0: C = D, there C = D	
Two-tailed T-test on D and A				
T Value	-2.44949		Reject H_0: D = A, therefore D < A	
Two-tailed T-test on A and B				
T Value	-1.78065		Fail to reject H_0: A = B, therefore A = B	

(Table A-63) Question 10 asked mills to rank four factors important to mill success from 1 to 4, 1 being the most important and 4 being the least important. The four factors are: A: Labor issue; B: Capital costs and availability; C: Delivered log cost; and D: End-product markets. We calculated the average ranks of these four factors: 2.71 for factor A, 3.11 for B, 1.92 for C and 2.14 for D. So the numerical order of four factors are C < D < A < B. To determine if C is significantly different than D, if D is significantly different than A, or A is significantly different than B, we employed t-test to test the difference of these four means. The test consists of three sub-tests, each of which consists of a pair of hypotheses listed as follows:

Sub test 1:

H_0: C = D

H1: C $\neq$ D

Sub test 2:

H_0: D = A

H1: D $\neq$ A

Sub test 3:

H_0: A = B

H1: A $\neq$ B

We performed a two-tailed t-test analysis on these three pairs of hypotheses. The t-test result on test 1 is 0.91, which is smaller than the tabulated value 1.98 at 0.05 confidence level with 82 degrees of freedom. So we fail to reject H_0, which means C is not significantly different than D. The t-test result of test 2 is 2.449. It is greater than the tabulated value 1.98 at 0.05. So we reject H_0. D is significantly different than A and D is significantly less than A. The result of test 3 (1.78) is also smaller than 1.98. We fail to reject H_0. A is thus not significantly different than B. Thus from t-test results (Table A-63), the statistically significant ranking of importance of these four factors is: (C = D) > (A = B). Delivered log cost (1.92) and end-product markets (2.14) are statistically equally important to mill success while these two factors are statistically shown to be more important than labor issues, capital costs and availability. Though mills gave a higher ordinal ranking for labor issues (2.71) than capital costs and availability (3.11), they are not significantly different in terms of their importance to mill success.

Table A-64: T-test for question 11: labor factors

Labor factor A. Direct labor costs B. Indirect labor costs C. Availability of skilled labor D. Turnover of workforce				
	A	B	C	D
Mean	2.1	1.7	2.8	3.55
Standard Deviation	1.007663	0.882886	0.822753	0.932325
Sample Size	40	40	40	40
Degree of Freedom	78			
T Value at 0.05 confidence level with 78 degrees of freedom: 1.98				
Mean Order	B <	A <	C <	D
Two-tailed T-test on B and A				
T Value	-1.88831		Fail to reject H_0: B = A, there B = A	
Two-tailed T-test on A and C				
T Value	-3.40321		Reject H_0: A = C, therefore A < C	
Two-tailed T-test on C and D				
T Value	-3.81474		Reject H_0: C = D, therefore C < D	

(Table A-64) Question 11 of the survey asked mill owners to rank four labor factors on a scale of 1 to 4, 1 being most important and 4 being least important. These factors are A: Direct labor costs; B: Indirect labor costs; C: Availability of skilled labor; and D: Turnover of workforce. The calculated average ranks of these four factors are: 2.1 for A, 1.7 for B, 2.8 for C and 3.55 for D. So the ordinal ranking of the importance of these four factors is: B >A > C > D. To test if this ranking of importance is statistically true, we constructed pairs of hypotheses as follows:

Sub test 1:

H_0: B = A

H1: B $\neq$ A

Sub test 2:

H_0: A = C

H1: A $\neq$ C

Sub test 3:

H_0: C = D

H1: C $\neq$ D

We performed a two-tailed t-test on these three pairs of hypotheses. The t-test result on test 1 is 1.88, which is smaller than the tabulated value 1.98 at a 0.05 confidence level with 78 degrees of freedom. So we fail to reject H_0, which means B is not significantly different than A. The t-test result of test 2 is 3.4. It is greater than 1.98 so we reject H_0. A is significantly different than C and A is significantly less than C. The result of test 3 (3.81) is greater than 1.98 so we reject H_0. C is significantly different than D and C is significantly less than D. Thus from the t-test results (Table A-64), the statistically significant importance ranking order of these four factors is: (B = A)> C > D. Direct labor costs (2.1) and indirect labor costs (1.7) are not significantly different in terms of their importance to their mill. They are shown by t-test to be equally important to their mill and significantly more important than availability of skilled labor (2.8).Turnover of workforce (3.55) has the least significance level of importance to the mill among all labor factors.

APPENDIX B: VERMONT SAWMILL SURVEY STATISTICS

Table B-65: VT mill characteristics

Year established

Year established	Average	Latest	Oldest	Response Number	Response Rate
Small Size	1968	2000	1800	36	92.31%
Medium Size	1964	1987	1929	8	80.00%
All	1967	2000	1800	44	89.80%

Business organization

How Is Your Business Organized	Proprietorship	Closely-Held Corporation	Partnership	Publicly-traded corporation	Other	Response Number	Response Rate
Small Size	17	10	5	1	5	38	97.44%
Medium Size	3	3	0	1	2	9	90.00%
All	20	13	5	2	7	47	95.92%

Is mill a family business

Family business	Yes	No	Response Number	Response Rate
Small Size	26	12	38	97.44%
Medium Size	5	4	9	90.00%
All	31	16	47	95.92%

Parent company ownership

Parent Company	US	Canada	Other	Response Number	Response Rate
Small Size	20	2	3	25	64.10%
Medium Size	5	0	0	5	50.00%
All	25	2	3	30	61.22%

Table B-66: VT mill operations

Type of mill						
Type of Mill	Softwood Dimension	White pine lumber	Hardwood lumber	Other	Response Number	Response Rate
Small Size	14	13	15	10	38	97.44%
Medium Size	3	3	1	2	7	70.00%
All	17	16	16	12	45	91.84%

Approximate total production			
Approximate Total Production (MMBF)	Average	Response Number	Response Rate
Small Size	1.11	39	100.00%
Medium Size	16.60	10	100.00%
All	4.27	49	100.00%

Table B-67: VT mill work force

How many people work in mill							
Number of Employees	1 to 5	6 to 25	26 to 50	51 to 75	more than 75	Response Number	Response Rate
Small Size	25	13	0	0	0	38	97.44%
Medium Size	2	2	1	1	1	7	70.00%
All	27	15	1	1	1	45	91.84%

Average age							
Average Age of Employees	less than 20	21 to 30	31 to 40	41 to 50	more than 50	Response Number	Response Rate
Small Size	0	5	15	12	6	38	97.44%
Medium Size	0	0	4	1	2	7	70.00%
All	0	5	19	13	8	45	91.84%

Table B-67 continued

Average length of employment

Percent of Employees by Length of Employment	less than 1 year	1 to 5 years	6 to 10 years	11 to 20 years	more than 20 years	Response Number	Response Rate
Small Size	10.96	28.64	13.64	26.39	15.96	28	71.79%
Medium Size	5.60	15.60	17.60	19.00	34.20	5	50.00%
All	10.15	26.67	14.24	25.27	18.18	33	67.35%

Average distance

Percent of Employees by Distance to Mill	less than 10 miles	10 to 19 miles	20 to 29 miles	30 to 39 miles	40 to 49 miles	over 50 miles	Response Number	Response Rate
Small Size	70.92	20.69	5.69	0.00	0.38	0.00	26	66.67%
Medium Size	60.60	26.60	14.00	0.00	0.00	0.00	5	50.00%
All	69.26	21.65	7.03	0.00	0.31	0.00	31	63.27%

Prior experience

New Hires With Prior Lumber Mill Experience	None	1 to 25%	26 to 50%	51 to 75%	76 to 100%	Response Number	Response Rate
Small Size	13	13	3	2	0	31	79.49%
Medium Size	2	1	3	1	0	7	70.00%
All	15	14	6	3	0	38	77.55%

Type of training

Type of Training Provided	On the job	Structured training within company	External	No training provided	Response Number	Response Rate
Small Size	30	7	3	3	33	84.62%
Medium Size	7	5	4	0	7	70.00%
All	37	12	7	3	40	81.63%

Table B-67 continued

Number of shifts

Number of Shifts	1	2	3	Response Number	Response Rate
Small Size	34	0	0	34	87.18%
Medium Size	6	0	1	7	70.00%
All	40	0	1	41	83.67%

Factors important to mill success

	Labor issues	Capital costs and Availability	Delivered log costs	End-product markets	Response Number	Response Rate
Small Size	2.58	2.97	2.18	2.30	33	84.62%
Medium Size	2.57	3.43	2.29	1.71	7	70.00%
All	2.58	3.05	2.20	2.20	40	81.63%

Labor Factors

	Direct labor costs	Indirect labor costs	Availability of skilled labor	Turnover of workforce	Response Number	Response Rate
Small Size	2.37	1.37	2.70	3.63	27	69.23%
Medium Size	2.29	1.43	2.71	3.57	7	70.00%
All	2.35	1.38	2.71	3.62	34	69.39%

Table B-68: VT mill capital investment

Conducted

Recent Capital Investment	Yes	No	Response Number	Response Rate
Small Size	16	19	35	89.74%
Medium Size	6	1	7	70.00%
All	22	20	42	85.71%

Table B-68 continued								
Modernization planned								
Modernization Project Planned in Near Future	Yes			No			Response Number	Response Rate
Small Size	10			25			35	89.74%
Medium Size	3			4			7	70.00%
All	13			29			42	85.71%
Why was no project planned?								
Reason for Not Planning Capital Investment	Recently completed	expensive	cost	Not necessary	Weak markets	Government regulations	others	Response Number	Response Rate
Small Size	4	5	4	10	2	5	3	21	53.85%
Medium Size	2	0	0	3	1	0	1	5	50.00%
All	6	5	4	13	3	5	4	26	53.06%

Table B-69: VT mill log supply

How does mill obtain logs?								
Percentage of Log Procurement Source by Size Class	Own log buyers	Stumpage purchase	Brokers	Long-term wood supply agreement	Own forest lands	Other	Response Number	Response Rate
Small Size	37.42	14.70	2.58	11.06	19.55	13.03	33	84.62%
Medium Size	53.33	4.11	0.56	0.00	36.78	6.67	9	90.00%
All	40.83	12.43	2.14	8.69	23.24	11.67	42	85.71%

Table B-69 continued							
Log sources							
Percent from Various Log Sources by Size Class	Private forest within Maine	Public forests	Private forests from NH or VT	Elsewhere in the United States	Canada	Response Number	Response Rate
Small Size	0.00	9.53	88.43	2.03	0.00	32	82.05%
Medium Size	1.43	3.00	79.86	18.43	0.14	7	70.00%
All	0.26	8.36	86.89	4.97	0.03	39	79.59%
Log distance ranges							
Percent of Logs from Various Distance Ranges by Size Class	1 to 19 miles from mills	20 to 49 miles from mills	50 to 99 miles from mill	100 to 249 miles from mill	over 250 miles from mill	Response Number	Response Rate
Small Size	47.03	40.16	8.28	2.03	0.31	32	82.05%
Medium Size	57.63	19.13	10.63	4.25	0.63	8	80.00%
All	49.15	35.95	8.75	2.48	0.38	40	81.63%

Table B-70: VT mill markets (primary products)

Where is primary product shipped?							
Average Percent Shipped to Each Destination	Within the county	Elsewhere in NH or VT	Elsewhere in New England	To other regions of US	To markets outside the US	Response Number	Response Rate
Small Size	41.06	30.00	12.03	6.06	10.76	33	84.62%
Medium Size	44.11	9.22	8.44	36.44	1.89	9	90.00%
All	41.71	25.65	11.26	12.57	8.86	42	85.71%

Table B-70 continued				
Is primary product for wholesale or retail?				
Percent Wholesale and Retail	Wholesale	Retail	Response Number	Response Rate
Small Size	60.81	39.19	36	92.31%
Medium Size	55.44	44.56	9	90.00%
All	59.73	40.27	45	91.84%

Table B-71: VT mill markets (value-added products)

Is value-added product manufacturing on-site?				
Value- Added Manufacturing On Site	Yes	No	Response Number	Response Rate
Small Size	13	23	36	92.31%
Medium Size	4	4	8	80.00%
All	17	27	44	89.80%

Where is value-added product shipped?							
Average Percent Shipped to Each Destination	Within the county	Elsewhere in NH or VT	Elsewhere in New England	To other regions of US	To markets outside the US	Response Number	Response Rate
Small Size	47.53	22.89	10.11	13.16	1.58	19	48.72%
Medium Size	25.00	0.00	0.00	69.75	5.00	4	40.00%
All	43.61	18.91	8.35	23.00	2.17	23	46.94%

Table B-72: VT mill certification

Is log from certified source?

Average Percent from certified log source	Yes	No	Unknown	Response Number	Response Rate
Small Size	4.47	66.58	28.95	19	48.72%
Medium Size	40.63	56.88	2.50	8	80.00%
All	15.19	63.70	21.11	27	55.10%

Does mill track the chain of custody?

Does Mill Track Chain of Custody	Yes	No	Response Number	Response Rate
Small Size	2	33	35	89.74%
Medium Size	1	5	6	60.00%
All	3	38	41	83.67%

Considering marketing certified wood?

Is Mill Considering Marketing Certified Wood in The Near Future	Yes	No	Maybe	Response Number	Response Rate
Small Size	4	24	8	36	92.31%
Medium Size	1	3	2	6	60.00%
All	5	27	10	42	85.71%

Table B-72 continued

Not considering marketing certified wood?							
Reasons Mills are Not Considering Marketing Certified Wood	Following the chain of custody is too difficult	The market for certified wood is not large enough at this time	The certification process is too difficult	The certification process is too expensive	Other	Response Number	Response Rate
Small Size	5	15	7	12	7	25	64.10%
Medium Size	3	3	3	3	2	4	40.00%
All	8	18	10	15	9	29	59.18%

Table B-73: VT mill community

Importance to local community								
	1	2	3	4	5	6	Response Number	Response Rate
Small Size	2	8	9	11	2	6	38	97.44%
Medium Size	3	1	1	2	1	0	8	80.00%
All	5	9	10	13	3	6	46	93.88%
Importance to State of New Hampshire								
	1	2	3	4	5	6	Response Number	Response Rate
Small Size	0	2	9	8	8	11	38	97.44%
Medium Size	0	2	2	0	3	1	8	80.00%
All	0	4	11	8	11	12	46	93.88%
Importance to bordering canadian community								
	1	2	3	4	5	6	Response Number	Response Rate
Small Size	0	0	2	4	6	25	37	94.87%
Medium Size	0	0	0	1	0	7	8	80.00%
All	0	0	2	5	6	32	45	91.84%

Table B-73 continued										
Involvement in community										
Activities the Mill Has Done Within the Past Years	Monetary charitable donations	Product charitable donation	Activity in local or state non-profit	Open house	Question and answer	Encourage employees' leadership	Recreational purposes	Other	Response Number	Response Rate
Small Size	20	19	12	6	2	4	3	1	31	79.49%
Medium Size	5	4	5	1	1	4	2	1	7	70.00%
All	25	23	17	7	3	8	5	2	38	77.55%

Table B-74: VT international factors

International factors: order of importance						
	International competition for wood	Exchange rate of US and Canadian dollars	The current tariff on Canadian lumber	General trade agreements	Response Number	Response Rate
Small Size	1.47	2.47	2.84	3.05	19	48.72%
Medium Size	1.33	2.50	3.17	3.00	6	60.00%
All	1.44	2.48	2.92	3.04	25	51.02%

International factors: importance of tariff								
	1	2	3	4	5	6	Response Number	Response Rate
Small Size	6	0	2	1	4	22	35	89.74%
Medium Size	0	2	1	2	1	1	7	70.00%
All	6	2	3	3	5	23	42	85.71%

Table B-74 continued

International factors: canadian border mills have advantage because of lower production cost

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	14	14	1	1	0	1	31	79.49%
Medium Size	4	0	2	0	0	0	6	60.00%
All	18	14	3	1	0	1	37	75.51%

International factors: mills throughout Canada have advantage because of lower production cost

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	10	10	4	1	0	1	26	66.67%
Medium Size	3	0	3	1	0	0	7	70.00%
All	13	10	7	2	0	1	33	67.35%

International factors: canadian border mills are a threat to US mills

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	1	3	3	5	9	11	32	82.05%
Medium Size	0	0	0	0	1	5	6	60.00%
All	1	3	3	5	10	16	38	77.55%

International factors: mills throughout Canada are a threat to US mills

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	1	2	2	7	8	8	28	71.79%
Medium Size	0	0	0	2	2	3	7	70.00%
All	1	2	2	9	10	11	35	71.43%

International factors: canadian border mills have advantage because they pay lower stumpage prices

	1	2	3	4	5	6	Response Number	Response Rate
Small Size	8	6	5	6	4	1	30	76.92%
Medium Size	3	0	0	2	0	1	6	60.00%
All	11	6	5	8	4	2	36	73.47%

Table B-74 continued								
International factors: mills throughout Canada have advantage because they pay lower stumpage prices								
	1	2	3	4	5	6	Response Number	Response Rate
Small Size	8	6	6	4	3	1	28	71.79%
Medium Size	4	1	0	1	0	1	7	70.00%
All	12	7	6	5	3	2	35	71.43%
International factors: canadian border mills have advantage because they pay lower wood transportation costs								
	1	2	3	4	5	6	Response Number	Response Rate
Small Size	2	7	10	5	5	1	30	76.92%
Medium Size	3	0	1	1	1	0	6	60.00%
All	5	7	11	6	6	1	36	73.47%
International factor: mills throughout Canada have advantage because they pay lower wood transportation costs								
	1	2	3	4	5	6	Response Number	Response Rate
Small Size	2	6	8	6	4	2	28	71.79%
Medium Size	1	1	1	1	1	0	5	50.00%
All	3	7	9	7	5	2	33	67.35%

Table B-75: VT mill business environment

Business climate factors						
	State environmental regulations	Taxes	Public acceptance of the industry	Federal environmental regulations	Response Number	Response Rate
Small Size	1.74	2.29	3.23	2.68	31	79.49%
Medium Size	1.57	2.86	3.14	2.43	7	70.00%
All	1.71	2.40	3.21	2.63	38	77.55%

Table B-75 continued

Rank industry assistance factors

	Financial Assistance	Research and development in production technology	Market development programs	Technical Assistance from state organizations	Response Number	Response Rate
Small Size	2.56	2.72	2.12	2.84	25	64.10%
Medium Size	3.50	2.00	2.17	2.33	6	60.00%
All	2.74	2.58	2.13	2.74	31	63.27%

Rank government entities

	Local government	NH/VT government	US federal government	provincial governments of Québec and/or New Brunswick	Canadian government	Response Number	Response Rate
Small Size	1.96	1.70	2.56	3.96	4.63	27	69.23%
Medium Size	3.40	1.40	2.00	4.00	4.20	5	50.00%
All	2.19	1.66	2.47	3.97	4.56	32	65.31%

VT χ^2 Tables – Vermont Sawmill Survey Chi-square Analysis

Table B-76: VT $\chi2$ question 16a importance to local community

Observed	1	2	3	4	5	6	Total
Small	2	8	9	11	2	6	38
Medium	3	1	1	2	1	0	8
	5	9	10	13	3	6	46

Observed	1~2	3~4	5~6		
Small	10	20	8	38	83%
Medium	4	3	1	8	17%
	14	23	9	46	

Expected	1~2	3~4	5~6
Small	11.565	19.000	7.435
Medium	2.435	4.000	1.565

	Observed	Expected	(O-E)^2/E
1,1	10	11.565	0.212
1,2	20	19.000	0.053
1,3	8	7.435	0.043
2,1	4	2.435	1.006
2,2	3	4.000	0.250
2,3	1	1.565	0.204
		Chi-Square	1.768
		Df	2
		n/(r*c)	7.667

Test result: reject the hypothesis, $\chi2$= 1.768, not significant at the 0.05 confidence level with 2 degrees of freedom

Table B-77: VT $\chi 2$ question 16b importance to the State of Vermont

Observed	1	2	3	4	5	6	Total
Small	0	2	9	8	8	11	38
Medium	0	2	2	0	3	1	8
	0	4	11	8	11	12	46

Observed	1~2	3~4	5~6		
Small	2	17	19	38	83%
Medium	2	2	4	8	17%
	4	19	23	46	

Expected	1~2	3~4	5~6
Small	3.304	15.696	19.000
Medium	0.696	3.304	4.000

	Observed	Expected	(O-E)^2/E
1,1	2	3.304	0.515
1,2	17	15.696	0.108
1,3	19	19.000	0.000
2,1	2	0.696	2.446
2,2	2	3.304	0.515
2,3	4	4.000	0.000
		Chi-Square	3.584
		Df	2
		n/(r*c)	7.667

Test result: reject the hypothesis, $\chi 2$= 3.584, not significant at the 0.05 confidence level with 2 degrees of freedom

Table B-78: VT $\chi 2$ question 16c importance to the border Canadian communities

Observed	1	2	3	4	5	6	Total
Small	0	0	2	4	6	25	37
Medium	0	0	0	1	0	7	8
	0	0	2	5	6	32	45

Observed	1~2	3~4	5~6		
Small	0	6	31	37	82%
Medium	0	1	7	8	18%
	0	7	38	45	

Expected	1~2	3~4	5~6
Small	0.000	5.756	31.244
Medium	0.000	1.244	6.756

	Observed	Expected	(O-E)^2/E
1,1	0	0.000	0.000
1,2	6	5.756	0.010
1,3	31	31.244	0.002
2,1	0	0.000	0.000
2,2	1	1.244	0.048
2,3	7	6.756	0.009
		Chi-Square	0.069
		Df	2
		n/(r*c)	7.500

Test result: reject the hypothesis, $\chi 2$= 0.069, not significant at the 0.05 confidence level with 2 degrees of freedom

Table B-79: VT $\chi 2$ question 18b importance of tariff on Canadian lumber

Observed	1	2	3	4	5	6	Total
Small	6	0	2	1	4	22	35
Medium	0	2	1	2	1	1	7
	6	2	3	3	5	23	42

Observed	1~2	3~4	5~6		
Small	6	3	26	35	83%
Medium	2	3	2	7	17%
	8	6	28	42	

Expected	1~2	3~4	5~6
Small	6.667	5.000	23.333
Medium	1.333	1.000	4.667

	Observed	Expected	(O-E)^2/E
1,1	6	6.667	0.067
1,2	3	5.000	0.800
1,3	26	23.333	0.305
2,1	2	1.333	0.333
2,2	3	1.000	4.000
2,3	2	4.667	1.524
		Chi-Square	7.029
		Df	2
		n/(r*c)	7.000

Test result: reject the hypothesis, $\chi 2$= 7.029, significant at the 0.05 confidence level with 2 degrees of freedom

Table B-80: VT $\chi 2$ question 18c1 Canadian border mills have an advantage because they have lower production costs

Observed	1	2	3	4	5	6	Total
Small	14	14	1	1	0	1	31
Medium	4	0	2	0	0	0	6
	18	14	3	1	0	1	37

Observed	1~2	3~4	5~6		
Small	28	2	1	31	84%
Medium	4	2	0	6	16%
	32	4	1	37	

Expected	1~2	3~4	5~6
Small	26.811	3.351	0.838
Medium	5.189	0.649	0.162

	Observed	Expected	(O-E)^2/E
1,1	28	26.811	0.053
1,2	2	3.351	0.545
1,3	1	0.838	0.031
2,1	4	5.189	0.273
2,2	2	0.649	2.815
2,3	0	0.162	0.162
		Chi-Square	3.879
		Df	2
		n/(r*c)	6.167

Test result: reject the hypothesis, $\chi 2$= 3.879, not significant at the 0.05 confidence level with 2 degrees of freedom

Table B-81: VT $\chi 2$ question 18c2 mills throughout Canada have an advantage because they have lower production costs

Observed	1	2	3	4	5	6	Total
Small	10	10	4	1	0	1	26
Medium	3	0	3	1	0	0	7
	13	10	7	2	0	1	33

Observed	1~2	3~4	5~6		
Small	20	5	1	26	79%
Medium	3	4	0	7	21%
	23	9	1	33	

Expected	1~2	3~4	5~6
Small	18.121	7.091	0.788
Medium	4.879	1.909	0.212

	Observed	Expected	(O-E)^2/E
1,1	20	18.121	0.195
1,2	5	7.091	0.617
1,3	1	0.788	0.057
2,1	3	4.879	0.724
2,2	4	1.909	2.290
2,3	0	0.212	0.212
		Chi-Square	4.094
		Df	2
		n/(r*c)	5.500

Test result: reject the hypothesis, $\chi 2$= 4.094, not significant at the 0.05 confidence level with 2 degrees of freedom

Table B-82: VT $\chi 2$ question 18d1 Canadian border mills do not pose a threat to the success of US mills in the Northeast

Observed	1	2	3	4	5	6	Total
Small	1	3	3	5	9	11	32
Medium	0	0	0	0	1	5	6
	1	3	3	5	10	16	38

Observed	1~2	3~4	5~6		
Small	4	8	20	32	84%
Medium	0	0	6	6	16%
	4	8	26	38	

Expected	1~2	3~4	5~6
Small	3.368	6.737	21.895
Medium	0.632	1.263	4.105

	Observed	Expected	(O-E)^2/E
1,1	4	3.368	0.118
1,2	8	6.737	0.237
1,3	20	21.895	0.164
2,1	0	0.632	0.632
2,2	0	1.263	1.263
2,3	6	4.105	0.874
		Chi-Square	3.288
		Df	2
		n/(r*c)	6.333

Test result: reject the hypothesis, $\chi 2$= 3.288, not significant at the 0.05 confidence level with 2 degrees of freedom

Table B-83: VT $\chi 2$ question 18d2 mills throughout Canada do not pose a threat to the success of US mills in the northeast

Observed	1	2	3	4	5	6	Total
Small	1	2	2	7	8	8	28
Medium	0	0	0	2	2	3	7
	1	2	2	9	10	11	35

Observed	1~2	3~4	5~6		
Small	3	9	16	28	80%
Medium	0	2	5	7	20%
	3	11	21	35	

Expected	1~2	3~4	5~6
Small	2.400	8.800	16.800
Medium	0.600	2.200	4.200

	Observed	Expected	(O-E)^2/E
1,1	3	2.400	0.150
1,2	9	8.800	0.005
1,3	16	16.800	0.038
2,1	0	0.600	0.600
2,2	2	2.200	0.018
2,3	5	4.200	0.152
		Chi-Square	0.963
		Df	2
		n/(r*c)	5.833

Test result: reject the hypothesis, $\chi 2= 0.963$, not significant at the 0.05 confidence level with 2 degrees of freedom

Table B-84: VT $\chi2$ question 18e1 Canadian border mills are at an advantage because they can buy timber at lower stumpage prices

Observed	1	2	3	4	5	6	Total
Small	8	6	5	6	4	1	30
Medium	3	0	0	2	0	1	6
	11	6	5	8	4	2	36

Observed	1~2	3~4	5~6		
Small	14	11	5	30	83%
Medium	3	2	1	6	17%
	17	13	6	36	

Expected	1~2	3~4	5~6
Small	14.167	10.833	5.000
Medium	2.833	2.167	1.000

	Observed	Expected	(O-E)^2/E
1,1	14	14.167	0.002
1,2	11	10.833	0.003
1,3	5	5.000	0.000
2,1	3	2.833	0.010
2,2	2	2.167	0.013
2,3	1	1.000	0.000
		Chi-Square	0.027
		Df	2
		n/(r*c)	6.000

Test result: reject the hypothesis, $\chi2$= 0.027, not significant at the 0.05 confidence level with 2 degrees of freedom

Table B-85: VT $\chi2$ question 18e2 mills throughout Canada are at an advantage because they can buy timber at lower stumpage prices

Observed	1	2	3	4	5	6	Total
Small	8	6	6	4	3	1	28
Medium	4	1	0	1	0	1	7
	12	7	6	5	3	2	35

Observed	1~2	3~4	5~6		
Small	14	10	4	28	80%
Medium	5	1	1	7	20%
	19	11	5	35	

Expected	1~2	3~4	5~6
Small	15.2	8.8	4
Medium	3.8	2.2	1

	Observed	Expected	(O-E)^2/E
1,1	14	15.200	0.095
1,2	10	8.800	0.164
1,3	4	4.000	0.000
2,1	5	3.800	0.379
2,2	1	2.200	0.655
2,3	1	1.000	0.000
		Chi-Square	1.292
		Df	2
		n/(r*c)	5.833

Test result: reject the hypothesis, $\chi2$=1.292, not significant at the 0.05 confidence level with 2 degrees of freedom

Table B-86: VT $\chi 2$ question 18f1 Canadian border mills are at an advantage because they pay lower wood transportation cost

Observed	1	2	3	4	5	6	Total
Small	2	7	10	5	5	1	30
Medium	3	0	1	1	1	0	6
	5	7	11	6	6	1	36

Observed	1~2	3~4	5~6		
Small	9	15	6	30	83%
Medium	3	2	1	6	17%
	12	17	7	36	

Expected	1~2	3~4	5~6
Small	10.000	14.167	5.833
Medium	2.000	2.833	1.167

	Observed	Expected	(O-E)^2/E
1,1	9	10.000	0.100
1,2	15	14.167	0.049
1,3	6	5.833	0.005
2,1	3	2.000	0.500
2,2	2	2.833	0.245
2,3	1	1.167	0.024
		Chi-Square	0.923
		Df	2
		n/(r*c)	6.000

Test result: reject the hypothesis, $\chi 2$= 0.923, not significant at the 0.05 confidence level with 2 degrees of freedom

Table B-87: VT $\chi 2$ question 18f2 mills throughout Canada are at an advantage because they pay lower wood transportation cost

Observed	1	2	3	4	5	6	Total
Small	2	6	8	6	4	2	28
Medium	1	1	1	1	1	0	5
	3	7	9	7	5	2	33

Observed	1~2	3~4	5~6		
Small	8	14	6	28	85%
Medium	2	2	1	5	15%
	10	16	7	33	

Expected	1~2	3~4	5~6
Small	8.485	13.576	5.939
Medium	1.515	2.424	1.061

	Observed	Expected	(O-E)^2/E
1,1	8	8.485	0.028
1,2	14	13.576	0.013
1,3	6	5.939	0.001
2,1	2	1.515	0.155
2,2	2	2.424	0.074
2,3	1	1.061	0.003
		Chi-Square	0.274
		Df	2
		n/(r*c)	5.500

Test result: reject the hypothesis, $\chi 2$= 0.274, not significant at the 0.05 confidence level with 2 degrees of freedom

Vermont T-test tables – Vermont Sawmill Survey

Table B-88: T-test for question 10: factors important to mill success

Importance to mill success
A. Labor issues
B. Capital costs and availability
C. Delivered log cost
D. End-product markets

	A	B	C	D
Mean	2.575	3.05	2.2	2.2
Standard Deviation	1.106797	0.904405	1.136797	1.202561
Sample Size	40	40	40	40
Degree of Freedom	78			

T Value at the 0.05 confidence level with 78 degrees of freedom:1.98
Mean Order: C =D <A <B

Two-tailed T-test on C and D		
T Value	0	Fail to reject H_0: C = D, therefore C = D
Two-tailed T-test on D and A		
T Value	-1.48698	Fail to reject H_0: D = A, therefore D = A
Two-tailed T-test on A and B		
T Value	-2.15372	Reject H_0: A = B, therefore A < B

(Table B-88) In the Vermont Survey, Question 10 asked respondents to rank labor factors from 1 to 4 in their order of importance to their mill; with 1 being the most important factor and 4 being the least important. The four factors are: A: Labor issue; B: Capital costs and availability; C: Cost of Delivered log; and D: End-product markets. We calculated the average ranks of these four factors for all responding mills. The results are: 2.58 for factor A, 3.05 for B, 2.2 for C and 2.2 for D. So, the ordinal ranking of importance for these four factors are (C = D) > A > B. To determine if the value of C (2.2) is significantly different than D (2.2), if the value of D is significantly less than A, and if the value of A is significantly less than B, we employed t-test to test the difference of these four means. The test consists of three sub-tests, each of which consists of a pair of hypotheses listed as follows:

Sub test 1:

H_0: C = D

H1: C $\neq$ D

Sub test 2:

H_0: D = A

H1: D $\neq$ A

Sub test 3:

H_0: A = B

H1: A $\neq$ B

We performed a two-tailed t-test on these three pairs of hypotheses. The t-test result on test 1 is 0, smaller than the tabulated value (1.98) at the 0.05 confidence level with 78 degrees of freedom. So we fail to reject H_0, which means C is not significantly different than D. The t-test result of test 2 is 1.49, smaller than 1.98, so we fail to reject H_0. D is not significantly different than A. The t-test result of test 3 (2.15) is bigger than 1.98, so we reject H_0. The value of A is significantly different than B and is significantly smaller than B. Thus, observed from the t-test results (Table B-88), the importance ranking of these four factors is: C = D = A > B. Different than the ordinal ranking of the average rank values, the t-test results suggest that the importance of the end–product markets (2.2) and delivered log costs (2.2) to Vermont sawmills are not significantly different than the importance of labor issues (2.58) even though their numerical average rank values are different. It also suggests that capital costs and availability (3.05) are significantly less important than all other three factors to mill success.

Table B-89: T-test for question 11: labor factors

Labor factor A. Direct labor costs B. Indirect labor costs C. Availability of skilled labor D. Turnover of workforce				
	A	B	C	D
Mean	2.352941	1.382353	2.705882	3.617647
Standard Deviation	0.8836	0.779071	0.905519	0.652023
Sample Size	34	34	34	34
Degree of Freedom	66			
T Value at the 0.05 confidence level with 66 degrees of freedom:1.98				
Mean Order	B <	A <	C <	D
Two-tailed T-test on B and A				
T Value	-4.80426		Reject H_0: B = A, therefore B < A	
Two-tailed T-test on A and C				
T Value	-1.62662		Fail to reject H_0: A = C, therefore A = C	
Two-tailed T-test on C and D				
T Value	-4.76453		Reject H_0: C = D, therefore C < D	

(Table B-89) In the Vermont Survey, Question 11 asked respondents to rank labor factors from 1 to 4 in their order of importance to their mill, with 1 being most important and 4 being least important. The four labor factors are: A: Direct labor costs; B: Indirect labor costs; C: Availability of skilled labor; and D: Turnover of workforce. The average ranks of these four factors are 2.35 for A, 1.38 for B, 2.71 for C and 3.62 for D. So the numerical order of these four factors is: B < A < C < D. To determine that these four factors are significantly different, we constructed four pairs of hypotheses as follows:

Sub test 1:

H_0: B = A

H1: B $\neq$ A

Sub test 2:

H_0: A = C

H1: A $\neq$ C

Sub test 3:

H_0: C = D

H1: C $\neq$ D

We performed a two-tailed t-test on these three pairs of hypotheses. The t-test result on test 1 is 4.8, which is greater than the tabulated value (1.98) at the 0.05 confidence level with 66 degrees of freedom. So we reject H_0, which means B is significantly different than A, and the value of B is significantly smaller than A. The t-test result of test 2 is 1.63, smaller than 1.98, so we fail to reject H_0. A is not significantly different than C. The result of test 3 (4.76) is greater than 1.98 so we reject H_0. C is significantly different than D, and the value of C is significantly smaller than D. Thus, the t-test results (Table B-89) suggest the importance ranking order of these four factors is: B > (A = C) >D. The importance of direct labor costs (2.35) to Vermont mills is not significantly different than the importance of availability of skilled labor (2.71) though the numerical average rank values of the two factors are different. Turnover of workforce is significantly less important than all other three labor factors while indirect labor cost is statistically proved to be the most important labor factor to Vermont mills.

APPENDIX C: A SURVEY OF NEW HAMPSHIRE AND VERMONT SAWMILLS

(9-page booklet)

A Survey Of New Hampshire and Vermont Sawmills

Dear Sawmill Operator,

We are conducting a study of the sawmill industry in New Hampshire and Vermont, focusing on economic and social factors affecting mill operations, as well as the connections between the mills and the communities in which they are located. The results of the study will be useful to both people in the industry and policy makers by providing a profile of our sawmill industry as well as identifying current concerns and issues affecting the industry. Individuals in both New Hampshire and Vermont government agencies and the industry have expressed interest in the information being sought through this study. Additionally, as part of a larger regional project, this study will contribute to the understanding of forest product industry issues in Northern New England and Southern Quebec, Canada.

Information for this study is being collected through a survey of New Hampshire and Vermont sawmill operators. We welcome your input into the study and invite you to complete the survey and return it in the enclosed postage-paid envelope. The survey takes about 20 minutes to complete, and we ask that you answer each question. All responses are strictly confidential. The number assigned to your survey is used only for mailing purposes. Your name or the name of your company will not be associated with the survey you complete. Your participation in the survey is voluntary, and you may refuse to answer any question(s).

We welcome any additional comments you may have, so please feel free to use the space provided at the end of the survey. If you would like to receive a summary of the results of the study, please indicate so in question 22.

We are happy to answer any questions relating to the study. Please contact Difei Zhang at dzhang@cisunix.unh.edu. If you have any questions about your rights as a research subject, you may contact Julie Simpson in the UNH Office of Sponsored Research at (603) 862-2003 to discuss them.

Thank you very much for your participation. Your responses are most appreciated.

Sincerely,

Difei Zhang
Graduate Research Assistant
University of New Hampshire
Department of Natural Resources

Theodore E. Howard
Professor of Forest Economics
University of New Hampshire
Department of Natural Resources

1. What is your job title? ____________________

2. Where is your mill located?
Town ____________________ County ____________________

3. Does your company operate other sawmills in New Hampshire or Vermont? Yes ☐ No ☐
If your company does operate other sawmills in New Hampshire or Vermont, please respond to the following questions as they relate to the mill location identified in question 2. Please do not include information about other mill locations in your responses.

4. In what year was your mill established? ____________________

5. How is your business organized?

☐ Proprietorship ☐ Closely-held corporation

☐ Partnership ☐ Publicly-traded corporation ☐ Other ____________

6. Is your mill a family business? Yes ☐ No☐

7. Is the parent company of your mill:

☐ US owned ☐Canadian owned ☐Other Nationality____________________ (specify)

8. **Operations**

a. What type of mill is your facility?

☐ Softwood Dimension ☐White Pine Lumber ☐Hardwood Lumber ☐Other____________ (specify)

b. What is the approximate annual total production at your mill in millions of board feet (MMBF)?________

9. **Work Force**

a. How many people work at your mill?

☐ 1-5 ☐ 6-25 ☐ 26-50 ☐ 51-75 ☐ more than 75

b. What is their average age?

☐ less than 20 ☐ 21-30 ☐ 31-40 ☐41-50 ☐ more than 50

c. How long have your employees worked at the mill? (Please estimate the percent for each time span category that applies).

☐ less than 1 year ____% ☐ 1-5 years ____% ☐ 6-10 years ____%

☐ 11-20 years ____% ☐ more than 20 years ____%

d. What is the average distance from the mill that most employees live? (Please check all that apply and give approximate percentages)

☐ Less than 10 miles ______% ☐ 10-19 miles ______%

☐ 20-29 Miles ______% ☐ 30-39 Miles ______%

☐ 40-49 Miles ______% ☐ Over 50 Miles ______%

e. Approximately what percent of new employees have prior lumber mill experience?

☐ None ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-100%

f. What type of training programs do you offer? (Please check all that apply)

☐ On-the-job

☐ Structured training within company (e.g. OSHA, safety training, job-specific training)

☐ External (e.g. NELMA grading school, college level courses)

☐ No training provided

g. How many shifts do you run? ☐ 1 ☐ 2 ☐ 3

h. How many employees are women? ____

i. How many women work in the office? ____ j. How many women work in the mill? ____

10. Please rank the following factors from 1-4 in order of their importance to your mill with 1 being most important and 4 being least important. Please use each number only once.

______ Labor issues (costs and availability)
______ Capital costs and availability
______ Delivered log costs
______ End-product markets

11. Please rank the following labor factors from 1-4 in order of their importance to your mill with 1 being most important and 4 being least important. Please use each number only once.

______ Direct labor costs
______ Indirect labor costs (insurance, workers' comp., etc.)
______ Availability of skilled labor
______ Turnover of workforce

12. **Capital investment**

a. Has there been a major modernization/upgrade project (ex. kiln, sorter, de-barker, etc.) undertaken at your mill within the past 5 years?

No ☐ Yes ☐ Date of most recent project________ Type of project ____________________

b. Is there a modernization/upgrade project planned at your mill for the near future (within the next 3 years)? No ☐ Yes ☐ Type of project planned________________________

c. If no projects are planned within the next 3 years, what are the reasons? (check all that apply)

_______ Project was just recently completed
_______ Such a project is too expensive
_______ Cost of borrowing money is too expensive
_______ No modernization is necessary (mill is operating efficiently)
_______ Weak markets for products
_______ Government regulation makes project too difficult
_______ Other ________________________ (Specify)

13. **Log Supply**

a. How does your mill obtain logs? (Please give approximate percentage for all that apply)

Own log buyers	______%	Long-term wood supply agreements	______%
Stumpage purchase	______%	Own forest lands	______%
Brokers	______%	Other ________________	______%

b. What log sources do you use? (Please give approximate percentages)

Private forests within Maine	______%
Public forests	______%
Private forests from N.H. or VT	______%
Elsewhere in the United States	______%
Canada	______%

c. Please give approximate percentages of logs sawn in your mill that come from the following distance ranges:

1-19 Miles from mill	______%
20-49 Miles from mill	______%
50-99 Miles from mill	______%
100-249 Miles from mill	______%
Over 250 Miles from mill	______%

14. **Markets - Primary Products**

a. What primary products does your mill produce and sell? (Please check all that apply)

☐ Bark	☐ Pallet stock	☐ Studs/dimension
☐ Beams and timbers	☐ Pulp chips	☐ Veneer
☐ Firewood	☐ Saw dust	☐ Other________
☐ Green lumber	☐ Shavings	
☐ Kiln-dried lumber	☐ Shingles	

b. Where do you ship your primary products? (Please give approximate percentages for all that apply)

Within the county	_____%
Elsewhere in New Hampshire or Vermont	_____%
Elsewhere in New England	_____%
To other regions of US	_____%
To markets outside of the US	_____%

c. Please indicate the approximate percentage of your mill's sales that are:
Wholesale _______% Retail______%

Markets - Value-added Products

d. Does your mill do any value-added manufacturing on site? Yes ☐ No ☐

e. If your mill produces any value-added products on site, please check all that apply

- ☐ Boat lumber
- ☐ Cedar decking and/or siding
- ☐ Clapboards
- ☐ Fencing
- ☐ Craft and hobby items
- ☐ Dowels
- ☐ Furniture
- ☐ Furniture squares
- ☐ Furniture stock
- ☐ Landscaping ties and timbers
- ☐ Laths
- ☐ Log home stock
- ☐ Novelty turnings
- ☐ Pallets
- ☐ Tongue depressors/ popsicle sticks/ toothpicks
- ☐ Turnings
- ☐ Doors and windows
- ☐ Flooring
- ☐ Other __________

f. Where do you ship your value-added products? (Please give approximate percentages for all that apply)

Within the county	_____%
Elsewhere in New Hampshire or Vermont	_____%
Elsewhere in New England	_____%
To other regions of US	_____%
To markets outside of the US	_____%

15. **Certification**

a. Do any of your logs come from sources that are currently third-party certified (Forest Stewardship Council, Sustainable Forestry Initiative) as sustainable?
Yes _____% No _____% Unknown______%

b. Does your mill track the chain of custody of certified wood? Yes ☐ No ☐

c. If your mill does not currently market certified wood, is your operation considering doing so in the near future? Yes ☐ No ☐ Maybe ☐

d. If you answered no to question c above, please indicate why (check all that apply):

☐ Following the chain of custody is too difficult

☐ The market for certified wood is not large enough at this time

☐ The certification process is too difficult

☐ The certification process is too expensive

☐ Other ____
Specify

16. **Community**

How important do you think your mill is to the social and economic well-being of each of the following? (Please make one choice for each)

a. Your community

Extremely 1	2	3	4	5	Not at all 6
☐	☐	☐	☐	☐	☐

b. The State of New Hampshire or Vermont

Extremely 1	2	3	4	5	Not at all 6
☐	☐	☐	☐	☐	☐

c. Canadian communities adjacent to the border

Extremely 1	2	3	4	5	Not at all 6
☐	☐	☐	☐	☐	☐

17. Please check all of the following that your mill has done within the past year

☐ Made monetary donation to local non-profit organization or community group

☐ Made a donation of products to a local non-profit organization or community group (e.g. lumber for affordable housing)

☐ Been active in a local or state non-profit organization

☐ Held an open house for community to tour mill

☐ Held a question and answer session about the mill in the community

☐ Encouraged employees to take leadership roles within the community (e.g. join a school board, etc.)

☐ Invited community members on to company lands for recreational purposes

☐ Other________________________

18. **International Factors**

a. Please rank the following factors from 1 to 4 in order of importance to your mill with 1 as most important and 4 as least important. Please use each number only once.

_______ International competition for wood
_______ Exchange rate of US and Canadian dollars
_______ The current tariff on Canadian lumber
_______ General trade agreements (NAFTA, GATT/WTO)

b. In spring 2002, US government officials imposed tariffs and duties averaging 29% on some Canadian lumber that is shipped into the US.

How important is maintenance of the current tariff on Canadian lumber to the success of your mill?

Extremely important					Not important
1	2	3	4	5	6
☐	☐	☐	☐	☐	☐

The following table contains statements regarding the Canadian lumber industry. Please indicate your level of agreement with each statement in regards to both Canadian mills on the New England border and mills throughout all of Canada. For each statement, please check whether you: Strongly agree, Agree, Somewhat agree, Somewhat disagree, Disagree, Strongly disagree.

c. Canadian sawmills have an advantage because they have lower production costs.	**Border Mills**					
	Strongly Agree ☐1	Agree ☐2	Somewhat Agree ☐3	Somewhat Disagree ☐4	Disagree ☐5	Strongly Disagree ☐6
	Mills throughout Canada					
	Strongly Agree ☐1	Agree ☐2	Somewhat Agree ☐3	Somewhat Disagree ☐4	Disagree ☐5	Strongly Disagree ☐6
d. Canadian mills do not pose a threat to the success of US mills in the northeast.	**Border Mills**					
	Strongly Agree ☐1	Agree ☐2	Somewhat Agree ☐3	Somewhat Disagree ☐4	Disagree ☐5	Strongly Disagree ☐6
	Mills throughout Canada					
	Strongly Agree ☐1	Agree ☐2	Somewhat Agree ☐3	Somewhat Disagree ☐4	Disagree ☐5	Strongly Disagree ☐6
e. Canadian mills are at an advantage because they can buy timber at lower stumpage prices	**Border Mills**					
	Strongly Agree ☐1	Agree ☐2	Somewhat Agree ☐3	Somewhat Disagree ☐4	Disagree ☐5	Strongly Disagree ☐6
	Mills throughout Canada					
	Strongly Agree ☐1	Agree ☐2	Somewhat Agree ☐3	Somewhat Disagree ☐4	Disagree ☐5	Strongly Disagree ☐6
f. Canadian mills are at an advantage because they pay lower wood transportation costs.	**Border Mills**					
	Strongly Agree ☐1	Agree ☐2	Somewhat Agree ☐3	Somewhat Disagree ☐4	Disagree ☐5	Strongly Disagree ☐6
	Mills throughout Canada					
	Strongly Agree ☐1	Agree ☐2	Somewhat Agree ☐3	Somewhat Disagree ☐4	Disagree ☐5	Strongly Disagree ☐6

19. **Business Environment**

a. Please rank the following business climate factors from 1 to 4 in order of their importance to the success of your mill with 1 being most important and 4 being least important. Please use each number only once.

_______ State environmental regulations
_______ Taxes
_______ Public acceptance of the industry
_______ Federal environmental regulations

b. Please rank the following industry assistance factors from 1 to 4 in order of their importance to the success of your mill with 1 being most important and 4 being least important. Please use each number only once.

_______ Financial Assistance
_______ Research and development in production technology
_______ Market development programs
_______ Technical assistance from state organizations (State forestry agencies, Cooperative Extension, etc.)

20. Please rank the following government entities from 1 to 5 in order of their importance to your mill, with 1 as most important and 5 as least important. Please use each number only once.

______ The local government
______ The New Hampshire / Vermont state government
______ The US federal government
______ The provincial governments of Quebec and/or New Brunswick
______ The Canadian government

21. Are there any other issues of concern to your mill you would like us to know about?

22. Would you like to receive the results of this study? Yes☐ No☐

Thank you very much for your time!

APPENDIX D: WOOD SUPPLY STUDY

Part I: Results From Average, Best and Worst Case Scenarios

Wood supply model results:

Table D-90: [average case scenario] base-case wood supply model summary results with average initial mill consumption

Wood supply model summary results
Average Initial Mill Consumption
Base case
Unit: MCF
White Pine Inventory

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	98595	84923	72413	61078	50916	41904	34004	27167	21330	16422
Carroll	142917	139305	135009	130044	124436	118218	111434	104138	96395	88281
Cheshire	167752	169279	170053	170012	169094	167241	164402	160531	155595	149569
Coos	39679	30915	23692	17835	13166	9513	6713	4612	3075	1981
Grafton	147042	144798	141741	137863	133170	127678	121416	114429	106774	98529
Hillsborough	276617	280993	284450	286884	288189	288255	286970	284227	279916	273936
Merrimack	272232	260883	248356	234757	220210	204853	188841	172346	155555	138665
Rockingham	160335	149398	138362	127308	116315	105463	94829	84488	74513	64973
Strafford	86860	82869	78542	73920	69043	63958	58716	53371	47982	42608
Sullivan	83467	82865	81707	79977	77668	74781	71328	67335	62841	57898
Total Inventory	**1475496**	**1426228**	**1374325**	**1319678**	**1262210**	**1201864**	**1138652**	**1072644**	**1003976**	**932863**
Annual Change %		**-0.0068**	**-0.00739**	**-0.0081**	**-0.00887**	**-0.0098**	**-0.01075**	**-0.01187**	**-0.01314**	**-0.0146**

Total White Pine Harvest – All Products

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	21326	19104	16956	14904	12965	11153	9477	7946	6564	5333
Carroll	19918	20191	20369	20446	20416	20273	20010	19625	19112	18470
Cheshire	18981	19920	20830	21701	22524	23285	23968	24561	25046	25406
Coos	12660	10258	8183	6419	4945	3735	2759	1990	1396	949
Grafton	21558	22078	22496	22802	22985	23033	22936	22685	22271	21685

Table D-90 continued

Hillsborough	24336	25710	27092	28473	29849	31205	32531	33813	35035	36180
Merrimack	43082	42937	42549	41911	41027	39891	38507	36881	35022	32943
Rockingham	22695	21993	21202	20329	19383	18369	17295	16171	15005	13806
Strafford	13570	13464	13283	13028	12698	12295	11819	11275	10664	9993
Sullivan	14108	14566	14951	15250	15455	15553	15534	15390	15111	14691
Total Harvest (all)	**212234**	**210220**	**207911**	**205264**	**202248**	**198791**	**194839**	**190337**	**185227**	**179455**

Total White Pine Sawlog Harvest **75.00% (utilization)**

(Sawlog)	**Period 1**	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
County										
Belknap	15995	14328	12717	11178	9724	8365	7108	5959	4923	3999
Carroll	14938	15143	15277	15334	15312	15205	15008	14719	14334	13852
Cheshire	14236	14940	15622	16276	16893	17463	17976	18421	18785	19054
Coos	9495	7693	6137	4814	3709	2801	2070	1492	1047	712
Grafton	16168	16558	16872	17101	17239	17275	17202	17014	16703	16264
Hillsborough	18252	19283	20319	21355	22387	23404	24398	25360	26277	27135
Merrimack	32312	32203	31911	31434	30770	29918	28880	27661	26267	24707
Rockingham	17021	16495	15901	15247	14537	13777	12972	12128	11254	10355
Strafford	10177	10098	9963	9771	9524	9221	8865	8456	7998	7495
Sullivan	10581	10925	11213	11438	11591	11665	11651	11542	11333	11018
Total Harvest (Sawlog)	**159176**	**157665**	**155933**	**153948**	**151686**	**149093**	**146129**	**142753**	**138921**	**134591**

White Pine Sawlog Price ($/MCF)

	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
Price	$797.5	$898.11	$1014.21	$1149.16	$1307.64	$1495.13	$1719.15	$1989.88	$2321	$2731.41

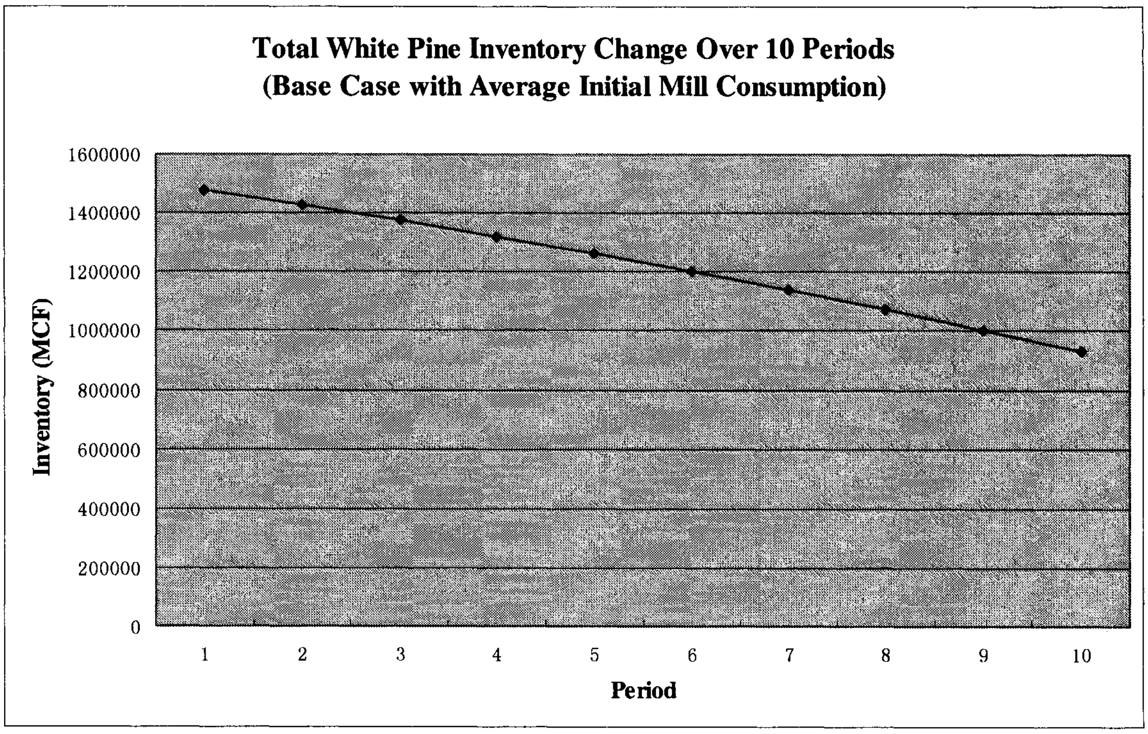


Figure D-4: Total white pine inventory change over 10 periods (base-case with average initial mill consumption)

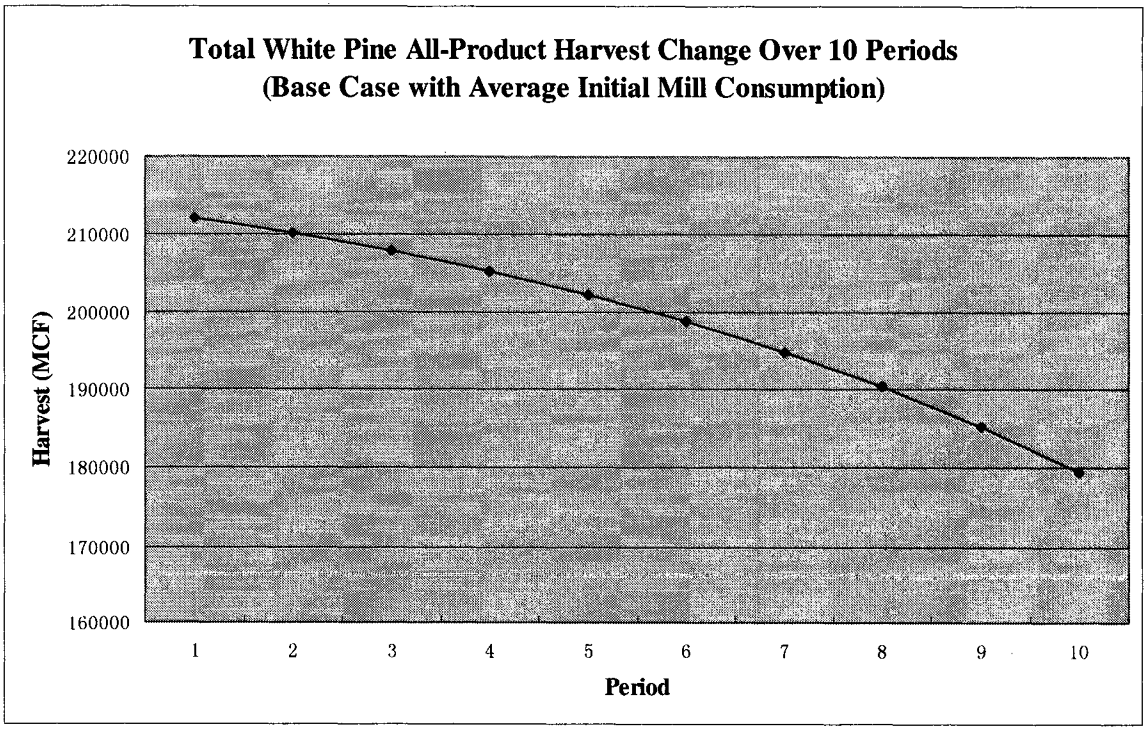


Figure D-5: Total white pine all-product harvest change over 10 Periods (base-case with average initial mill consumption)

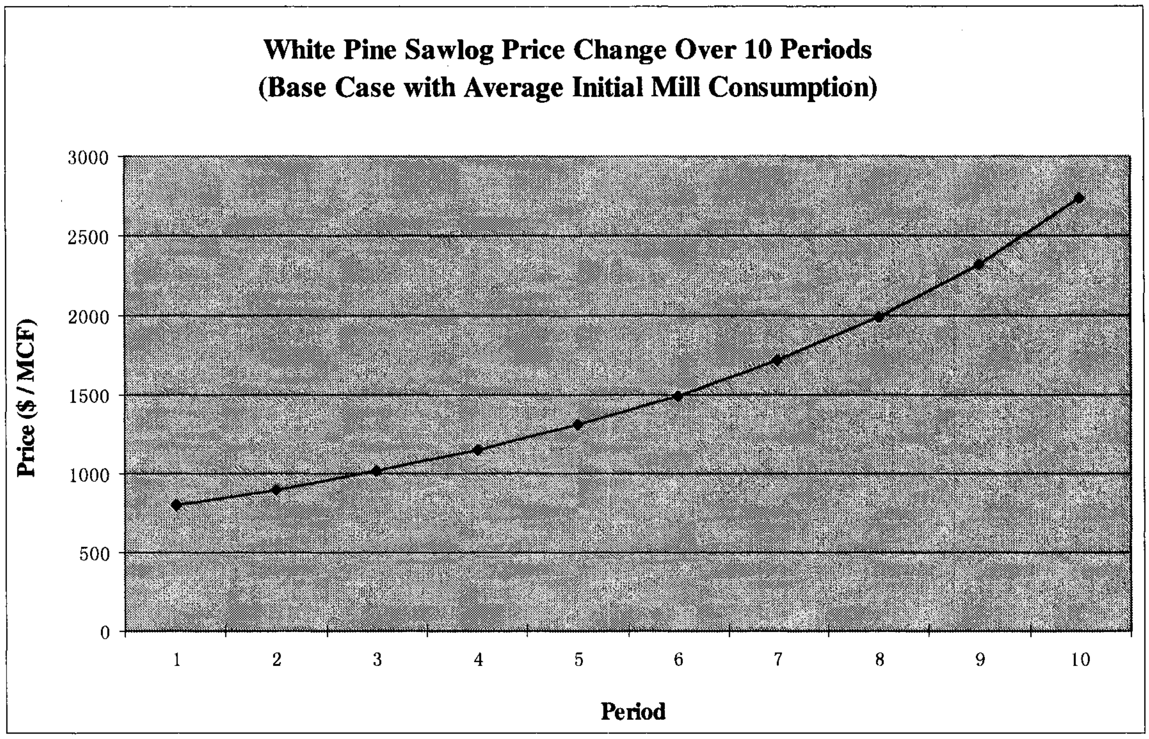


Figure D-6: White pine sawlog harvest change over 10 periods (base case with average initial mill consumption)

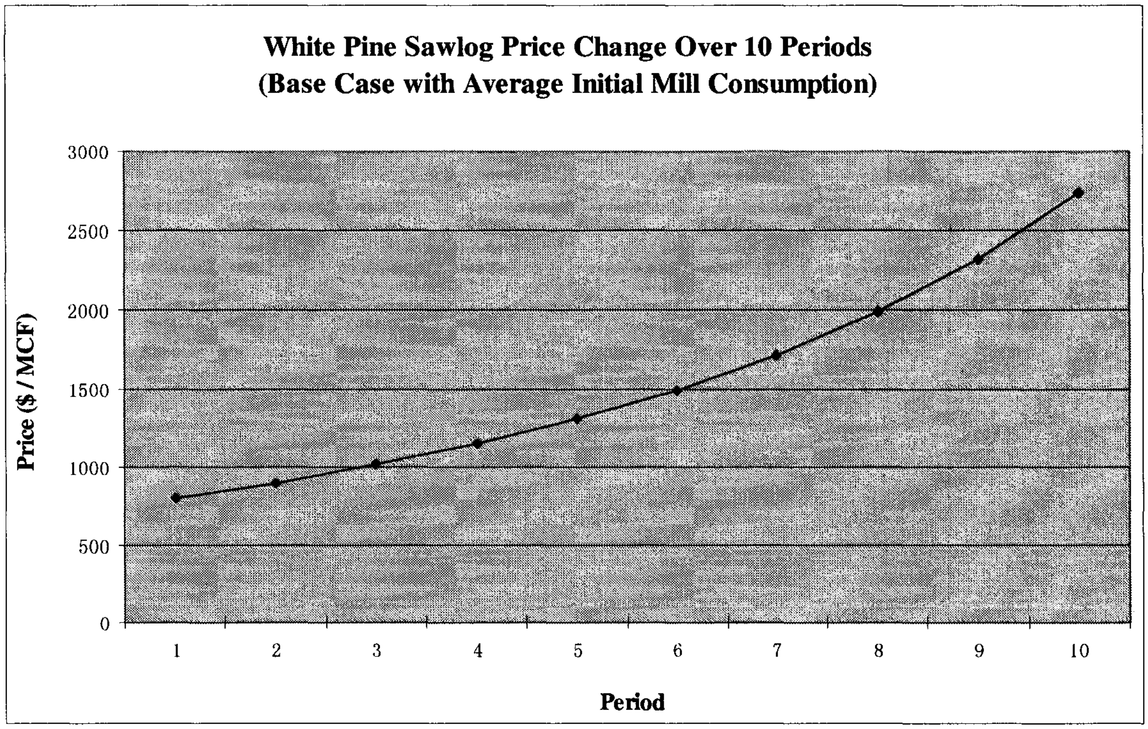


Figure D-7: White pine sawlog price change over 10 periods (base-case with average initial mill consumption)

Table D-91: [worst scenario] pessimistic case wood supply model summary results with high-end initial mill consumption

Wood supply summary results
High End Initial Mill Consumption
Pessimistic Case
Unit: MCF

White Pine Inventory

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	98595	80338	62234	46784	33943	23595	16050	11034	7662	5371
Carroll	142917	133841	121628	108482	94649	80425	67313	56491	47535	40102
Cheshire	167752	163726	156088	146623	135357	122381	109298	97739	87516	78461
Coos	39679	28087	18255	11309	6618	3614	1919	1052	593	343
Grafton	147042	138091	125464	111666	97001	81835	67901	56517	47186	39515
Hillsborough	276617	272895	264523	253575	239930	223505	206275	190499	176047	162799
Merrimack	272232	247624	217247	186397	155781	126145	100362	80191	64341	51832
Rockingham	160335	141815	121463	102009	83714	66820	52524	41452	32840	26115
Strafford	86860	78844	69103	59271	49561	40193	32044	25652	20617	16634
Sullivan	83467	79218	72513	64892	56542	47709	39524	32858	27409	22941
Total Inventory	**1475496**	**1364479**	**1228518**	**1091008**	**953098**	**816223**	**693208**	**593483**	**511745**	**444113**
Annual Change %		**-0.01552**	**-0.02077**	**-0.02346**	**-0.02667**	**-0.03053**	**-0.03214**	**-0.03059**	**-0.0292**	**-0.02795**

Total White Pine Harvest - All Products

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	24602	23274	19456	15851	12533	9063	6049	4082	2784	1917
Carroll	23447	25671	25377	24741	23742	21200	17591	14637	12212	10217
Cheshire	22158	25336	26337	27113	27607	26312	23372	20788	18514	16511
Coos	15032	12267	8529	5671	3578	2008	1033	550	301	170
Grafton	26556	29161	28820	28036	26779	23733	19514	16097	13321	11058
Hillsborough	27678	32006	33856	35605	37203	36587	33640	30950	28494	26251
Merrimack	52497	55745	53106	49711	45595	38706	30452	24065	19100	15224
Rockingham	27084	27926	25941	23744	21365	17865	13878	10826	8479	6667

Table D-91 continued

Strafford	16234	17200	16369	15317	14057	11952	9424	7462	5933	4736
Sullivan	16565	18393	18321	17925	17177	15225	12498	10296	8513	7063
Total Harvest (All Products)	**251852**	**266979**	**256111**	**243715**	**229636**	**202651**	**167451**	**139753**	**117652**	**99813**

Total White Pine Sawlog Harvest 75.00% (utilization)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	18451	17455	14592	11888	9400	6798	4537	3062	2088	1438
Carroll	17585	19254	19033	18556	17806	15900	13193	10978	9159	7663
Cheshire	16619	19002	19753	20335	20705	19734	17529	15591	13886	12383
Coos	11274	9200	6397	4253	2684	1506	775	412	226	127
Grafton	19917	21871	21615	21027	20084	17800	14635	12073	9991	8294
Hillsborough	20758	24005	25392	26704	27903	27440	25230	23212	21370	19688
Merrimack	39372	41809	39829	37283	34197	29029	22839	18049	14325	11418
Rockingham	20313	20945	19456	17808	16024	13399	10409	8119	6359	5000
Strafford	12175	12900	12277	11488	10543	8964	7068	5596	4450	3552
Sullivan	12424	13795	13741	13444	12882	11419	9373	7722	6385	5297
Total Harvest (Sawlog)	**188889**	**200234**	**192083**	**182786**	**172227**	**151988**	**125589**	**104815**	**88239**	**74860**

White Pine Sawlog Price ($/MCF)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
Price	$797.5	$1213.5	$1533.44	$1967.67	$2573.40	$3446.02	$4753.62	$6810.12	$10248.2	$16478

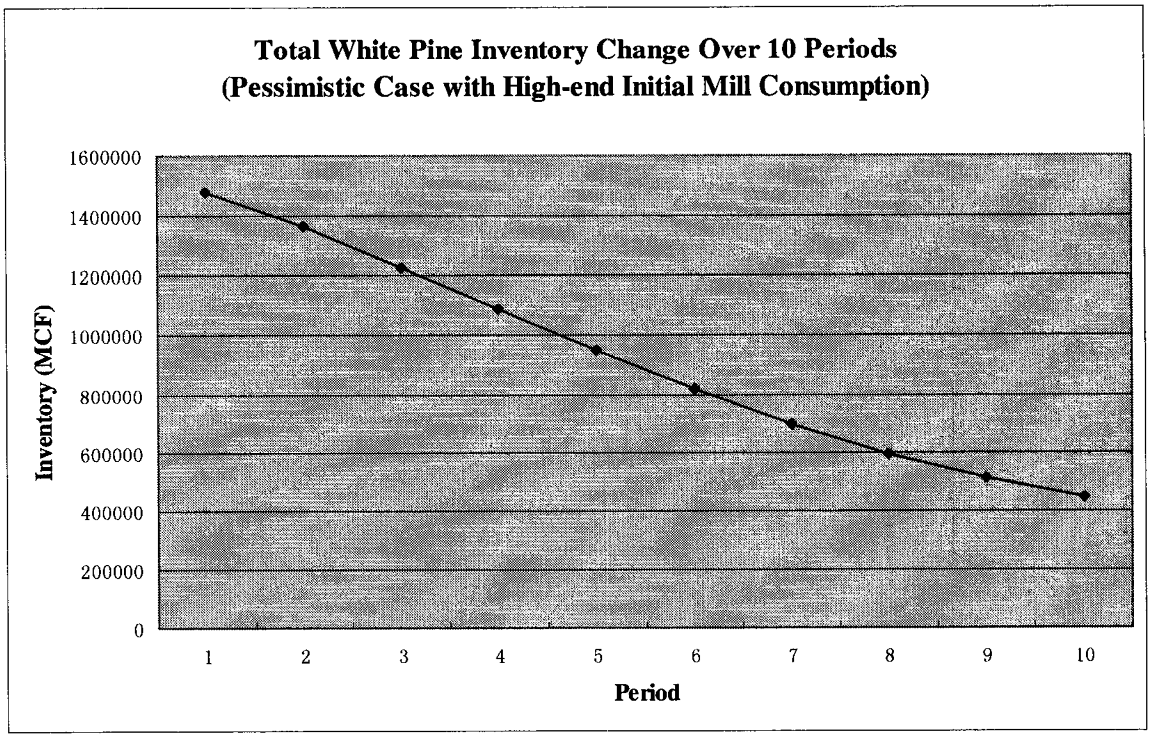


Figure D-8: Total white pine inventory change over 10 periods (pessimistic case with high-end initial mill consumption)

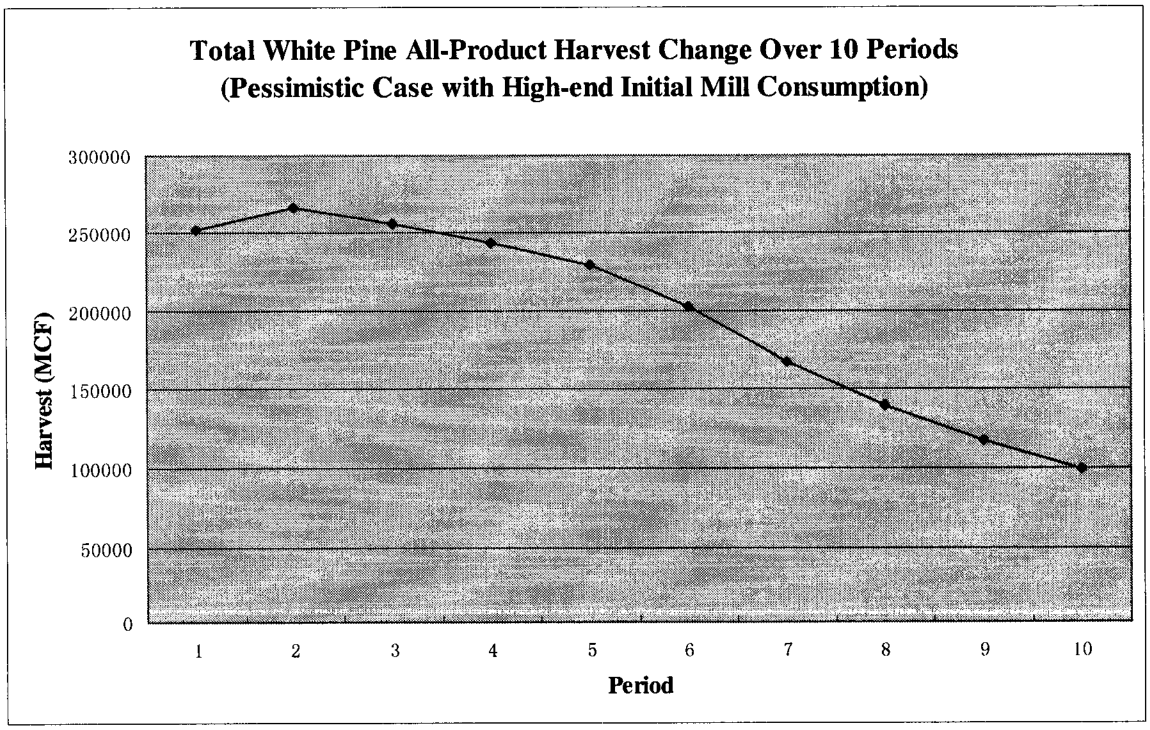


Figure D-9: Total white pine all-product harvest change over 10 periods (pessimistic case with high-end initial mill consumption)

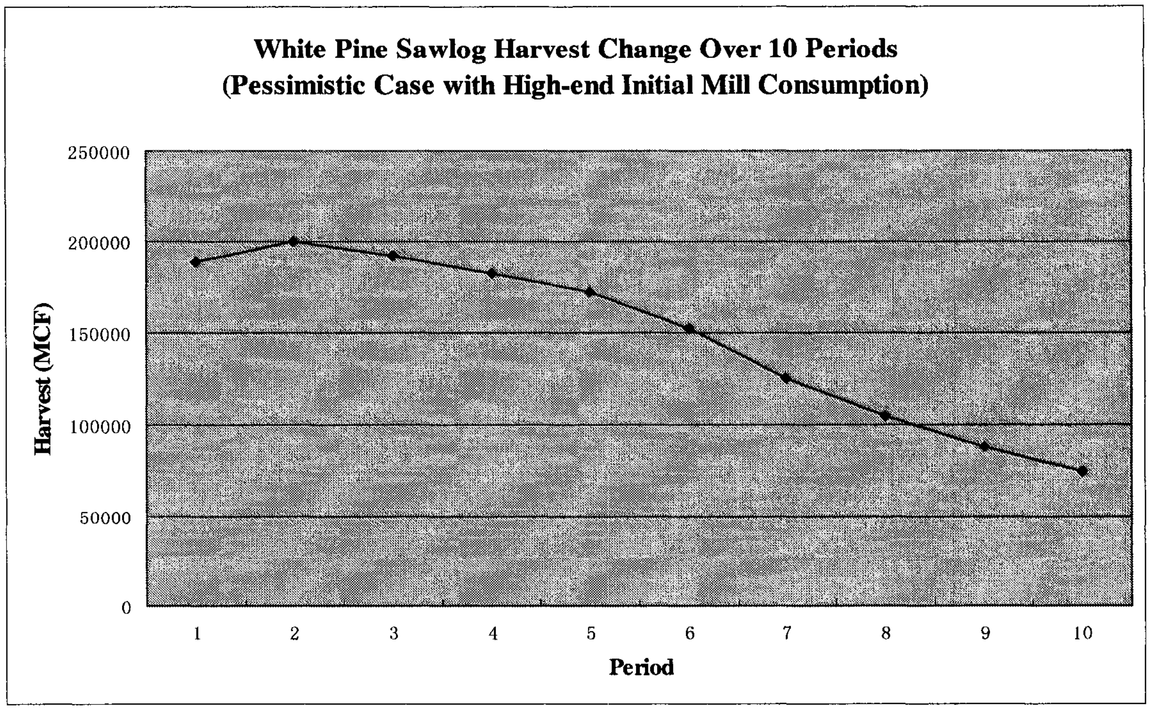


Figure D-10: White pine sawlog harvest change over 10 periods (pessimistic case with high-end initial mill consumption)

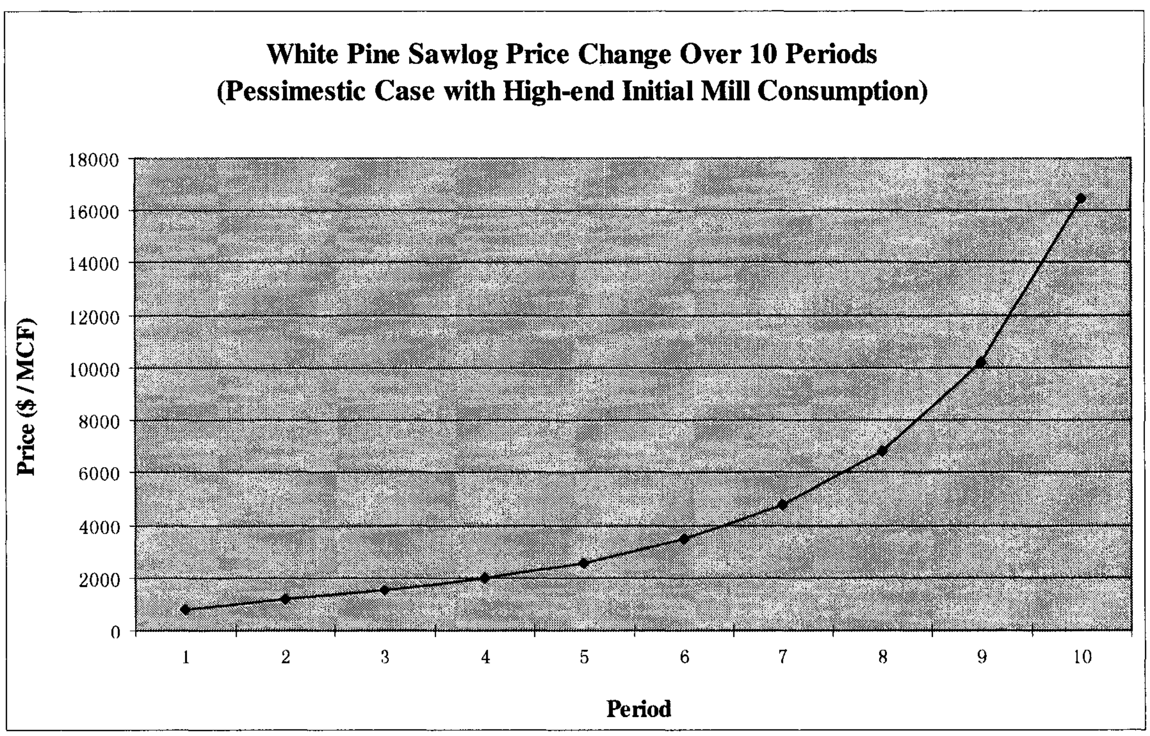


Figure D-11: White pine sawlog price change over 10 periods (pessimistic case with high-end initial mill consumption)

Table D-92: [best scenario] optimistic case wood supply model summary results with low-end initial mill consumption

Wood supply summary results
Low End Initial Mill Consumption
Optimistic Case
Unit: MCF
White Pine Inventory

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	98595	89521	82244	75448	69090	63159	57643	52524	47787	43415
Carroll	142917	144789	147745	150721	153691	156661	159636	162623	165629	168661
Cheshire	167752	174854	183329	192196	201445	211102	221191	231738	242774	254332
Coos	39679	33746	29187	25165	21620	18508	15789	13422	11371	9601
Grafton	147042	151784	157785	163997	170398	177003	183825	190877	198177	205742
Hillsborough	276617	289150	303684	318924	334870	351564	369051	387379	406601	426773
Merrimack	272232	274183	278302	282392	286400	290338	294218	298049	301848	305627
Rockingham	160335	157023	154894	152724	150490	148203	145873	143511	141127	138731
Strafford	86860	86908	87644	88355	89023	89653	90248	90812	91350	91867
Sullivan	83467	86524	90477	94595	98865	103299	107906	112700	117695	122905
Total Inventory	**1475496**	**1488483**	**1515292**	**1544519**	**1575891**	**1609491**	**1645380**	**1683636**	**1724359**	**1767654**
Annual Change %		**0.001754**	**0.003576**	**0.003828**	**0.00403**	**0.004228**	**0.00442**	**0.004608**	**0.004791**	**0.004972**

Total White Pine Harvest – All Products

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	18051	15428	14285	13228	12221	11268	10367	9519	8724	7981
Carroll	16388	15544	15901	16288	16667	17041	17410	17773	18130	18485
Cheshire	15804	15400	16166	16994	17849	18736	19655	20607	21592	22616
Coos	10287	8262	7224	6307	5484	4750	4099	3524	3018	2575
Grafton	16560	15988	16647	17357	18081	18821	19579	20353	21145	21958
Hillsborough	20995	20514	21569	22711	23895	25126	26405	27732	29112	30547
Merrimack	33668	31755	32323	32941	33534	34109	34664	35198	35714	36216

Table D-92 continued										
Rockingham	18307	16813	16656	16518	16361	16189	16004	15805	15595	15376
Strafford	10906	10222	10341	10474	10596	10711	10816	10913	11002	11085
Sullivan	11651	11294	11826	12399	12988	13596	14221	14865	15530	16217
Total Harvest (All)	**172616**	**161223**	**162937**	**165218**	**167677**	**170347**	**173221**	**176290**	**179562**	**183056**
Total White Pine Sawlog Harvest		75.00%	(utilization)							
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
County										
Belknap	13538	11571	10714	9921	9166	8451	7775	7139	6543	5985
Carroll	12291	11658	11926	12216	12500	12781	13057	13330	13598	13864
Cheshire	11853	11550	12124	12745	13387	14052	14741	15455	16194	16962
Coos	7715	6197	5418	4730	4113	3563	3074	2643	2263	1931
Grafton	12420	11991	12485	13018	13561	14116	14684	15265	15859	16469
Hillsborough	15746	15386	16177	17033	17921	18844	19804	20799	21834	22910
Merrimack	25251	23816	24242	24706	25151	25581	25998	26399	26786	27162
Rockingham	13730	12610	12492	12388	12271	12142	12003	11854	11696	11532
Strafford	8180	7667	7756	7856	7947	8033	8112	8185	8252	8314
Sullivan	8738	8471	8869	9300	9741	10197	10666	11149	11647	12163
Total Harvest (Sawlog)	**129462**	**120917**	**122203**	**123913**	**125758**	**127760**	**129915**	**132218**	**134672**	**137292**
White Pine Sawlog Price ($/MCF)										
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
Price	$797.5	$631.68	$639.72	$651.45	$661.91	$371.47	$680	$687.35	$693.58	$698.88

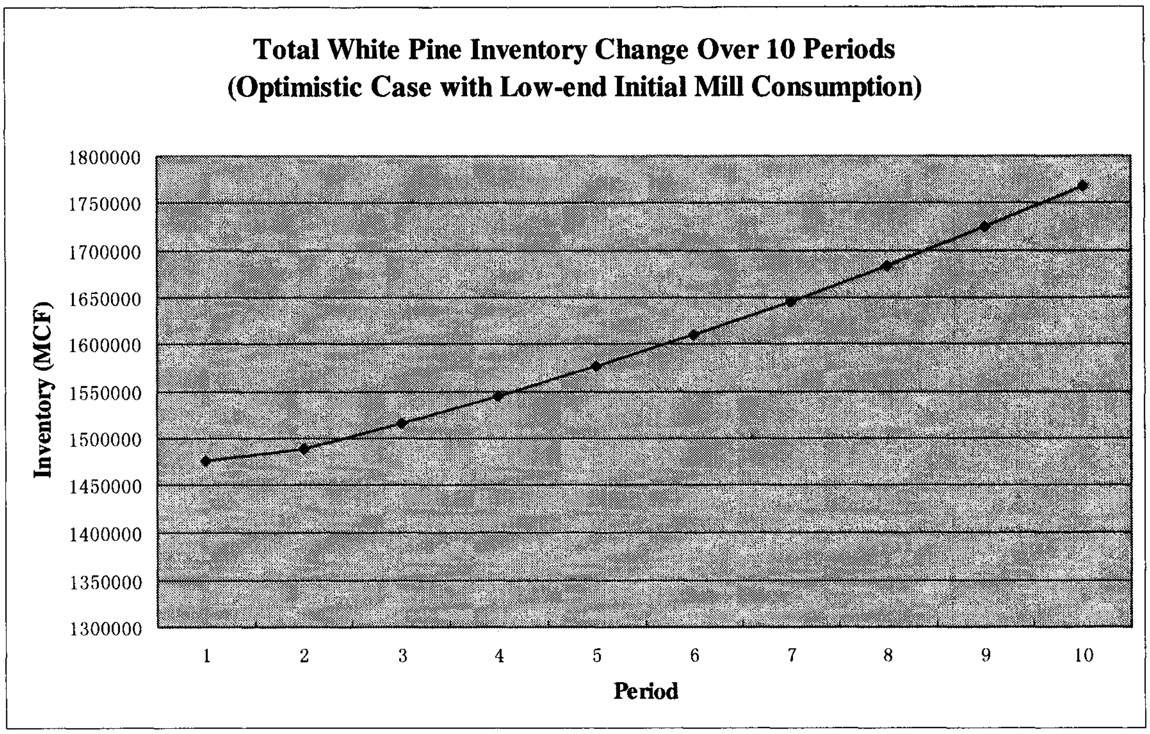


Figure D-12: Total white pine inventory change over 10 periods (optimistic case with low-end initial mill consumption)

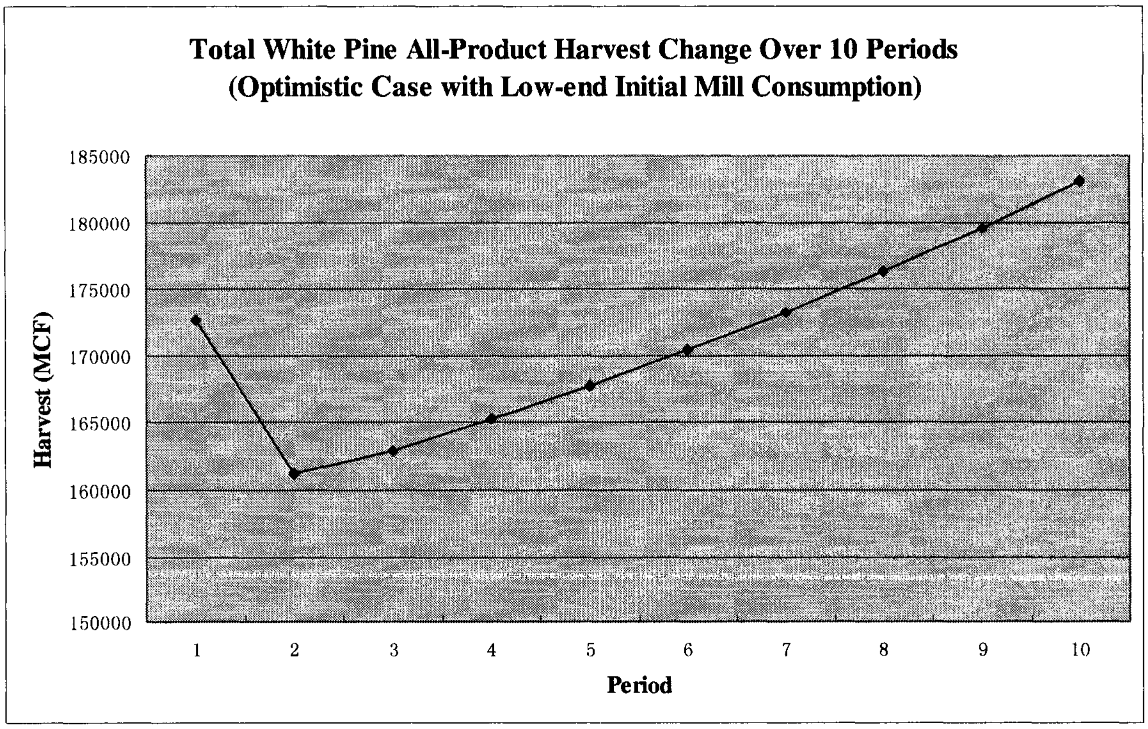


Figure D-13: Total white pine all-product harvest change over 10 periods (optimistic case with low-end initial mill consumption)

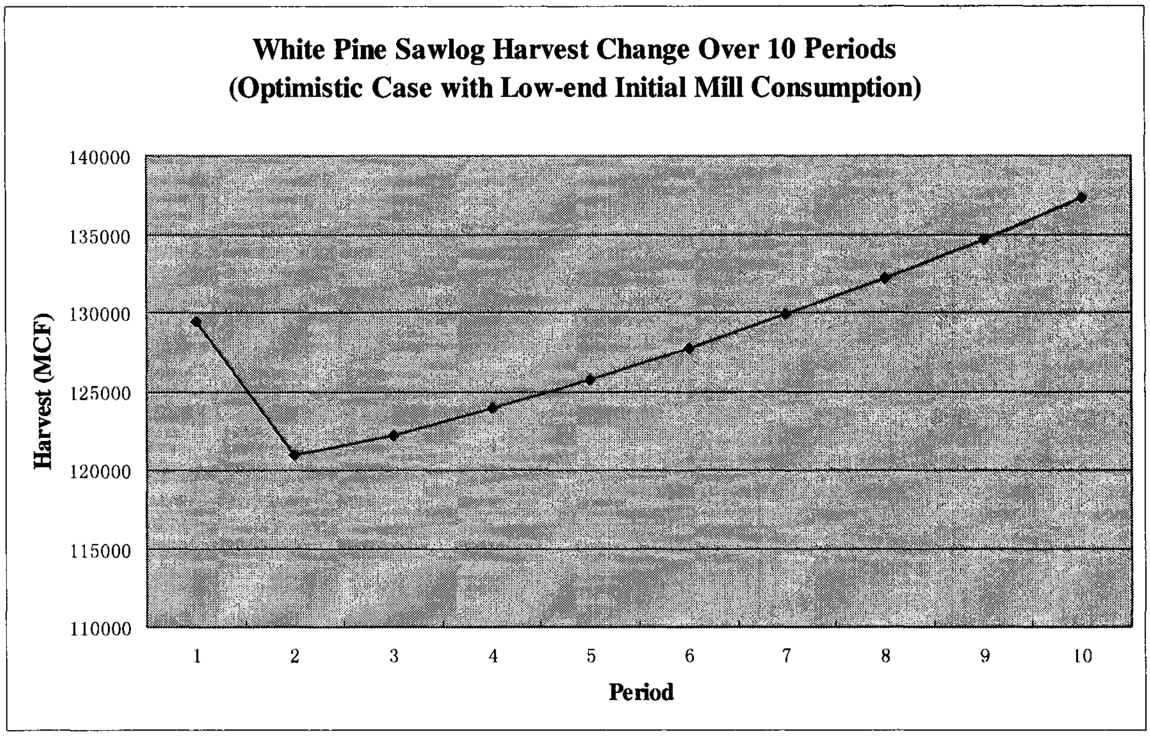


Figure D-14: White pine sawlog harvest change over 10 periods (optimistic case with low-end initial mill consumption)

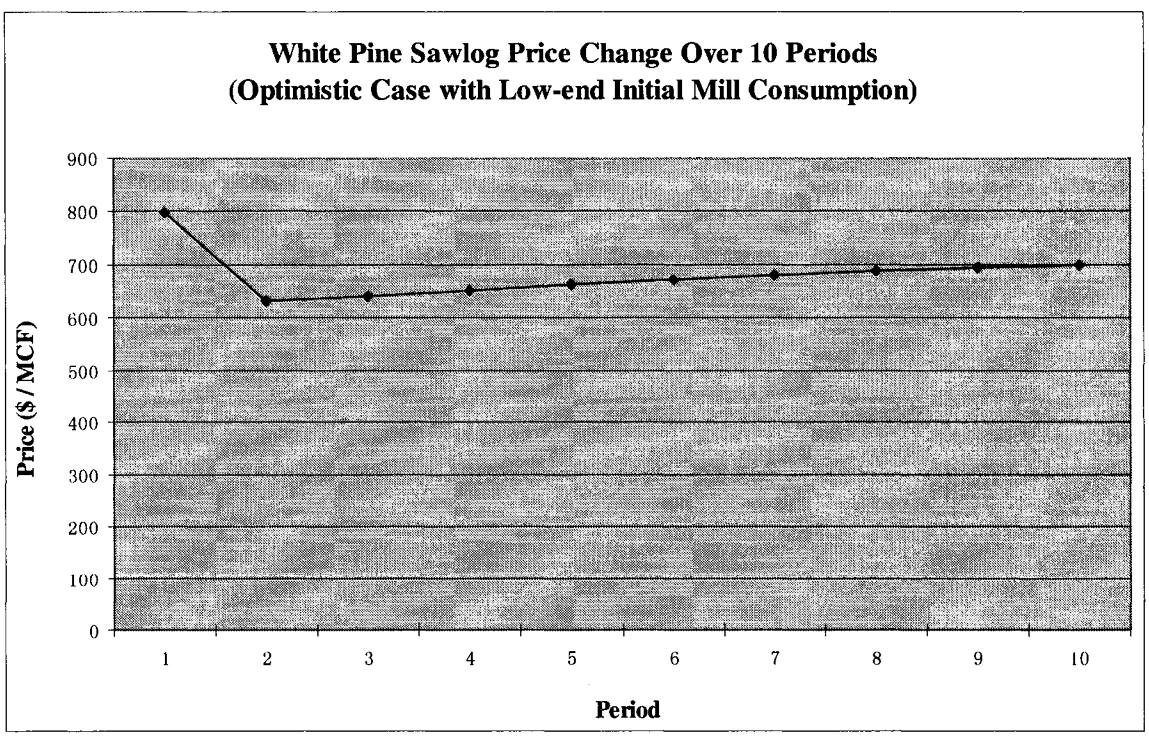


Figure D-15: White pine sawlog price change over 10 periods (optimistic case with low-end initial mill consumption).

Part II: Results From the Remaining Six Case Scenarios

Table D-93: Pessimistic case wood supply model summary results with average initial mill consumption

Wood supply summary results
Average Initial Mill Consumption
Pessimistic Case
Unit: MCF
White Pine Inventory

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	98595	83613	68257	54656	42820	32717	24280	17746	13062	9678
Carroll	142917	137370	129094	119855	109761	98948	87585	76697	67274	59103
Cheshire	167752	166903	163116	157869	151112	142827	133029	122806	113455	104896
Coos	39679	30460	22013	15457	10504	6876	4309	2648	1657	1055
Grafton	147042	143089	136001	127629	118059	107415	95871	84601	74776	66198
Hillsborough	276617	276236	272064	265938	257736	247352	234707	221169	208501	196641
Merrimack	272232	257038	236477	214573	191672	168167	144496	122667	104383	89031
Rockingham	160335	146203	130196	114510	99308	84748	70982	58823	48868	40696
Strafford	86860	81508	74544	67250	59738	52132	44566	37648	31880	27061
Sullivan	83467	81675	77783	72997	67375	61008	54029	47226	41363	36301
Total Inventory	**1475496**	**1404097**	**1309545**	**1210733**	**1108083**	**1002190**	**893853**	**792032**	**705220**	**630660**
Annual Change %		**-0.00987**	**-0.01385**	**-0.01557**	**-0.01756**	**-0.01989**	**-0.02262**	**-0.0239**	**-0.02295**	**-0.0221**

Total White Pine Harvest – All Products

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	21326	20738	17993	15353	12858	10543	8096	5827	4224	3084
Carroll	19918	22090	22220	22147	21850	21313	19695	17136	14935	13038
Cheshire	18981	21828	22879	23820	24619	25237	24601	22625	20823	19180

Table D-93 continued										
Coos	12660	11088	8465	6292	4539	3164	2034	1220	746	464
Grafton	21558	24220	24655	24852	24779	24405	22749	19954	17531	15428
Hillsborough	24336	28095	29688	31234	32704	34067	33864	31823	29917	28137
Merrimack	43082	46894	46130	44883	43140	40898	36632	30851	26046	22042
Rockingham	22695	23816	22640	21319	19864	18292	15950	13097	10782	8899
Strafford	13570	14675	14346	13874	13258	12498	11134	9329	7836	6598
Sullivan	14108	15943	16263	16393	16307	15981	14775	12831	11166	9737
Total Harvest (All)	**212234**	**229387**	**225279**	**220168**	**213919**	**206397**	**189531**	**164692**	**144005**	**126606**
Total White Pine Sawlog Harvest		**75.00%**	(utilization)							
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
County										
Belknap	15995	15553	13495	11515	9644	7907	6072	4370	3168	2313
Carroll	14938	16567	16665	16610	16388	15985	14771	12852	11201	9779
Cheshire	14236	16371	17159	17865	18464	18928	18451	16969	15617	14385
Coos	9495	8316	6349	4719	3404	2373	1526	915	560	348
Grafton	16168	18165	18491	18639	18584	18304	17062	14965	13148	11571
Hillsborough	18252	21071	22266	23425	24528	25550	25398	23867	22437	21102
Merrimack	32312	35170	34597	33662	32355	30674	27474	23138	19534	16532
Rockingham	17021	17862	16980	15989	14898	13719	11963	9823	8086	6674
Strafford	10177	11006	10760	10406	9943	9373	8351	6997	5877	4948
Sullivan	10581	11957	12197	12295	12231	11986	11082	9623	8374	7303
Total Harvest (Sawlog)	**159176**	**172040**	**168959**	**165126**	**160439**	**154798**	**142149**	**123519**	**108004**	**94954**
White Pine Sawlog Price ($/MCF)										
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
Price	$797.5	$1168.24	$1408.69	$1714.54	$2110.21	$2632.24	$3336.89	$4314.1	$5713.2	$7795.3

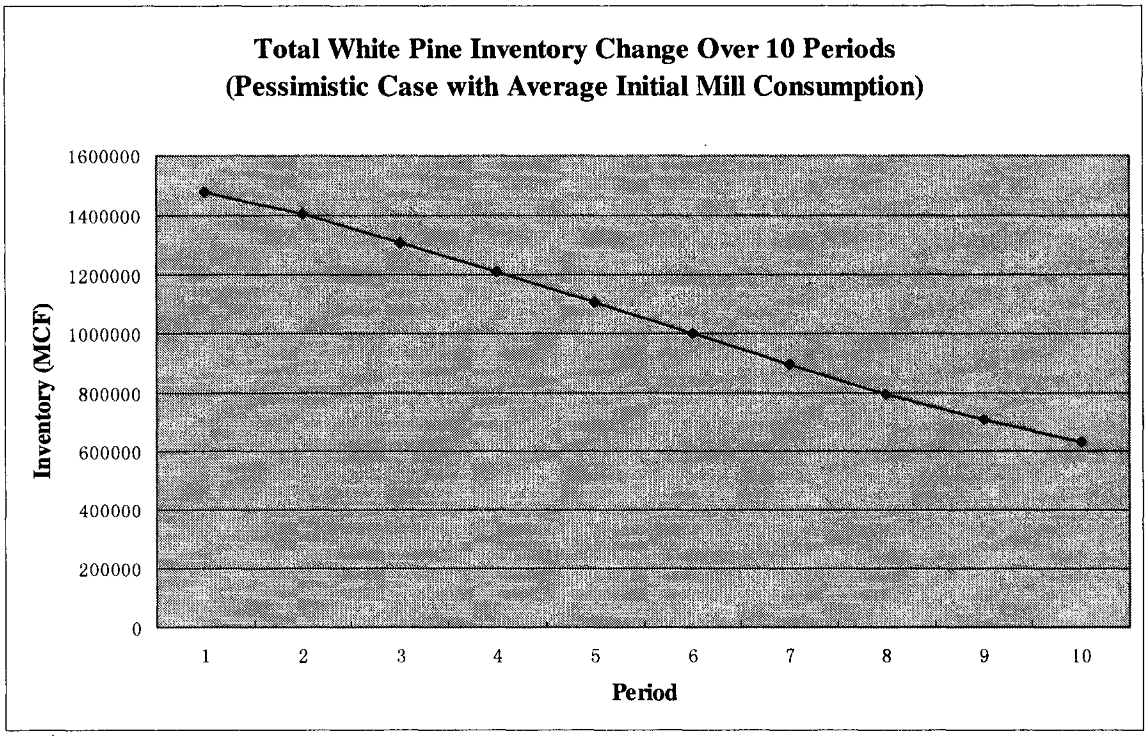


Figure D-16: Total white pine inventory change over 10 periods (pessimistic case with average initial mill consumption)

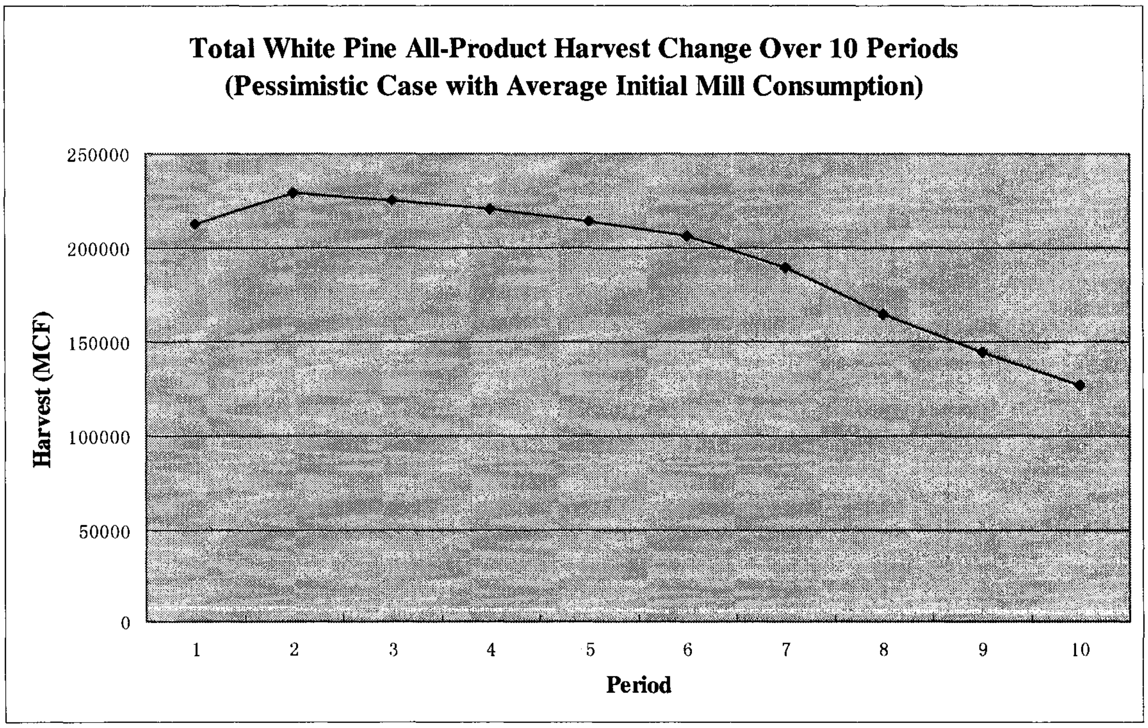


Figure D-17: Total white pine all-product harvest change over 10 periods (pessimistic case with average initial mill consumption)

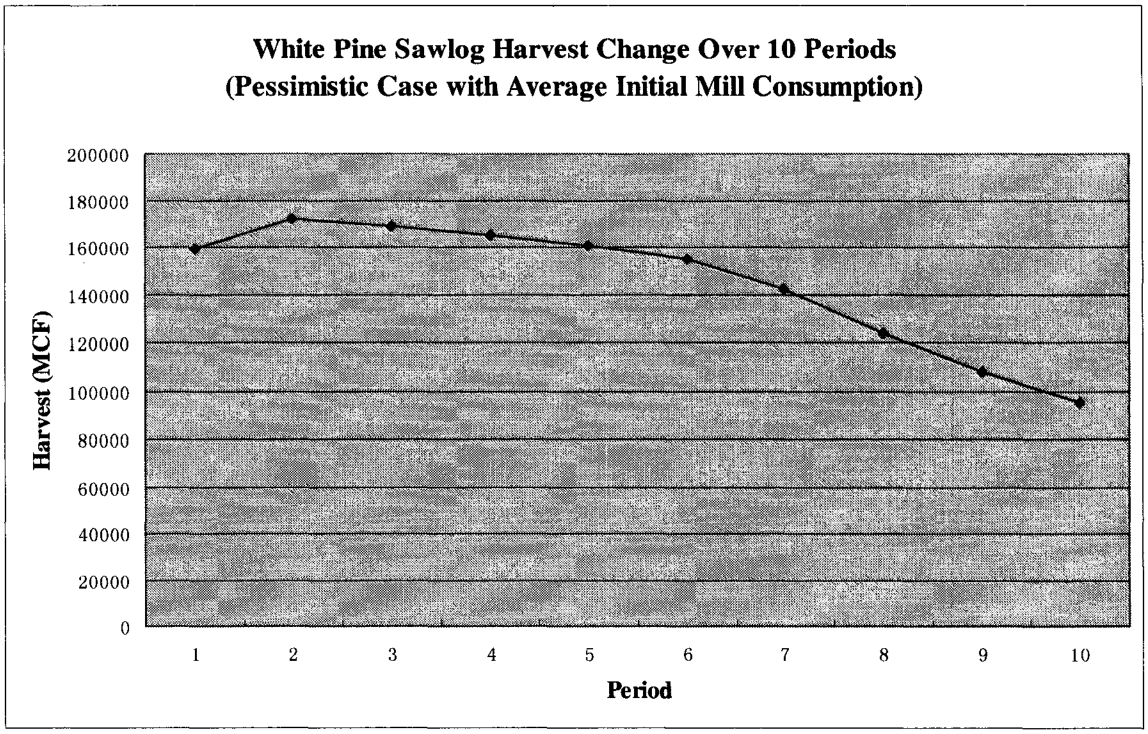


Figure D-18: White pine sawlog harvest change over 10 periods (pessimistic case with average initial mill consumption)

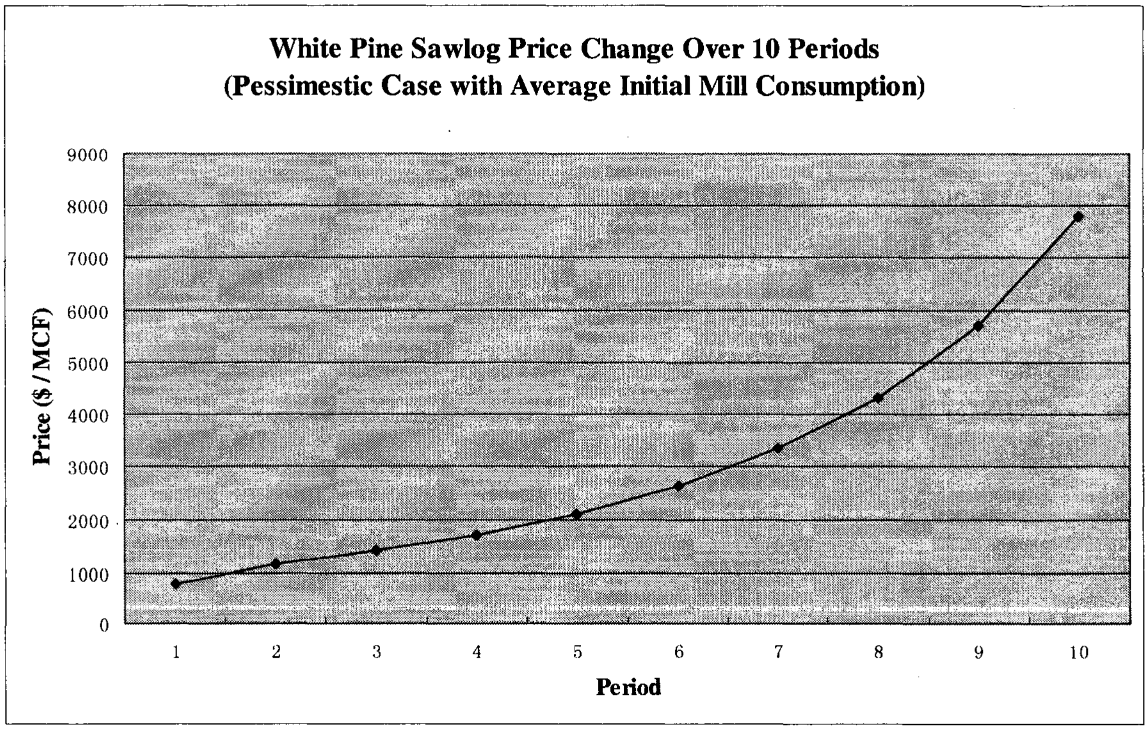


Figure D-19: White pine sawlog price change over 10 periods (pessimistic case with average initial mill consumption)

Table D-94: Optimistic case wood supply model summary results with average initial mill consumption

Wood supply summary results
Average Initial Mill Consumption
Optimistic Case
Unit: MCF
White Pine Inventory

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	98595	86246	76355	67258	58936	51366	44519	38361	32856	27963
Carroll	142917	141259	140697	139846	138708	137283	135577	133594	131338	128816
Cheshire	167752	171677	176787	181784	186649	191359	195893	200227	204337	208197
Coos	39679	31374	25247	20112	15852	12355	9515	7236	5430	4016
Grafton	147042	146786	147717	148344	148658	148650	148318	147655	146657	145321
Hillsborough	276617	285809	296733	307740	318807	329905	341009	352086	363103	374020
Merrimack	272232	264769	259768	254220	248157	241605	234600	227177	219372	211221
Rockingham	160335	152634	146446	140162	133813	127424	121024	114637	108288	102000
Strafford	86860	84244	82414	80420	78276	75989	73573	71039	68401	65670
Sullivan	83467	84067	85461	86678	87707	88537	89158	89562	89740	89682
Total Inventory	**1475496**	**1448865**	**1437626**	**1426565**	**1415563**	**1404474**	**1393185**	**1381575**	**1369520**	**1356905**
Annual Change %		**-0.00364**	**-0.00156**	**-0.00154**	**-0.00155**	**-0.00157**	**-0.00161**	**-0.00167**	**-0.00175**	**-0.00185**

Total White Pine Harvest - All Products

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	21326	17744	16050	14445	12937	11524	10211	8998	7885	6868
Carroll	19918	18611	18828	19006	19148	19247	19306	19325	19303	19240
Cheshire	18981	18331	19142	19956	20776	21595	22414	23230	24041	24846
Coos	12660	9569	7905	6467	5237	4195	3323	2600	2009	1532
Grafton	21558	20334	20774	21177	21544	21868	22150	22389	22582	22728
Hillsborough	24336	23718	24960	26234	27544	28884	30256	31660	33094	34557

Table D-94 continued										
Merrimack	43082	39643	39536	39326	39021	38617	38118	37529	36853	36093
Rockingham	22695	20463	19979	19457	18903	18318	17705	17070	16416	15745
Strafford	13570	12454	12386	12286	12158	11999	11811	11597	11357	11092
Sullivan	14108	13420	13843	14245	14626	14980	15307	15605	15871	16103
Total Harvest (All)	**212234**	**194287**	**193404**	**192600**	**191893**	**191227**	**190602**	**190003**	**189412**	**188804**
Total White Pine Sawlog Harvest	75.00%	(utilization)								
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
County										
Belknap	15995	13308	12038	10834	9702	8643	7658	6749	5913	5151
Carroll	14938	13958	14121	14255	14361	14435	14480	14494	14477	14430
Cheshire	14236	13749	14357	14967	15582	16196	16810	17422	18031	18634
Coos	9495	7177	5929	4850	3928	3146	2492	1950	1507	1149
Grafton	16168	15251	15581	15883	16158	16401	16613	16792	16937	17046
Hillsborough	18252	17789	18720	19676	20658	21663	22692	23745	24820	25918
Merrimack	32312	29732	29652	29494	29266	28962	28588	28147	27640	27070
Rockingham	17021	15347	14984	14593	14177	13738	13279	12802	12312	11809
Strafford	10177	9340	9289	9215	9118	8999	8858	8698	8518	8319
Sullivan	10581	10065	10382	10684	10969	11235	11480	11704	11904	12078
Total Harvest (Sawlog)	**159176**	**145715**	**145053**	**144450**	**143919**	**143420**	**142951**	**142503**	**142059**	**141603**
White Pine Sawlog Price ($/MCF)										
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
Price	$797.5	$651.1	$687.93	$726.26	$766.66	$808.85	$853.22	$900.1	$949.76	$1002.48

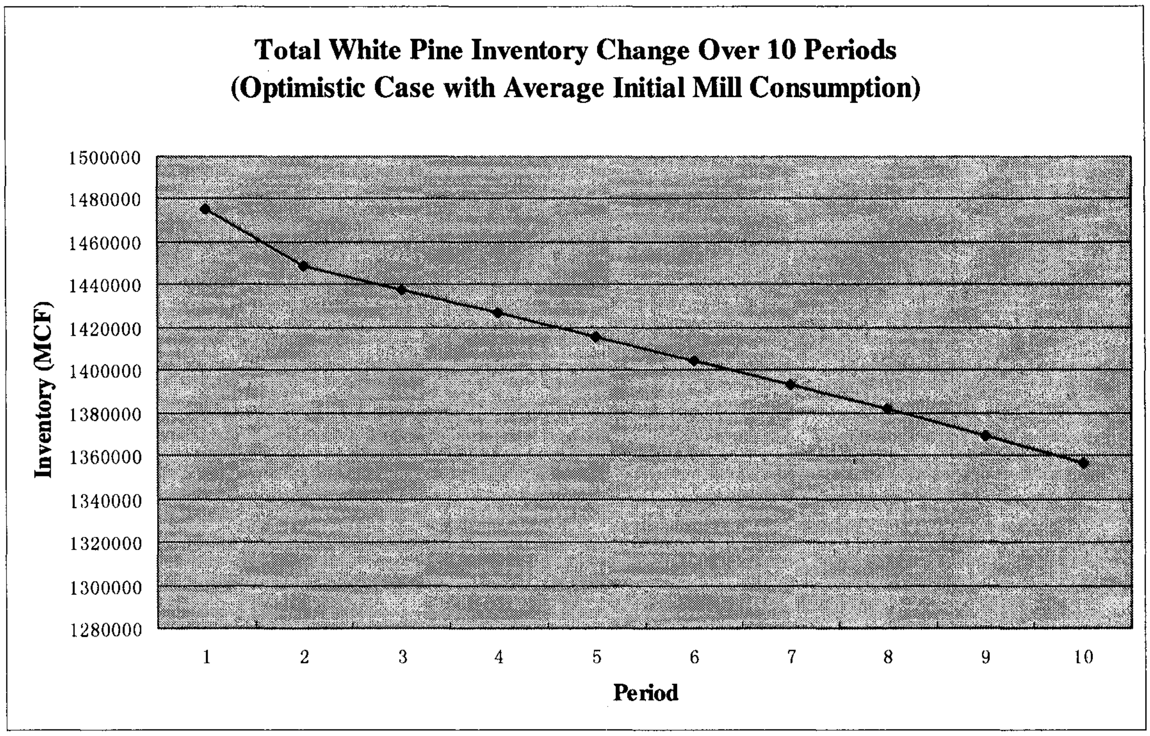


Figure D-20: Total white pine inventory change over 10 periods (optimistic case with average initial mill consumption)

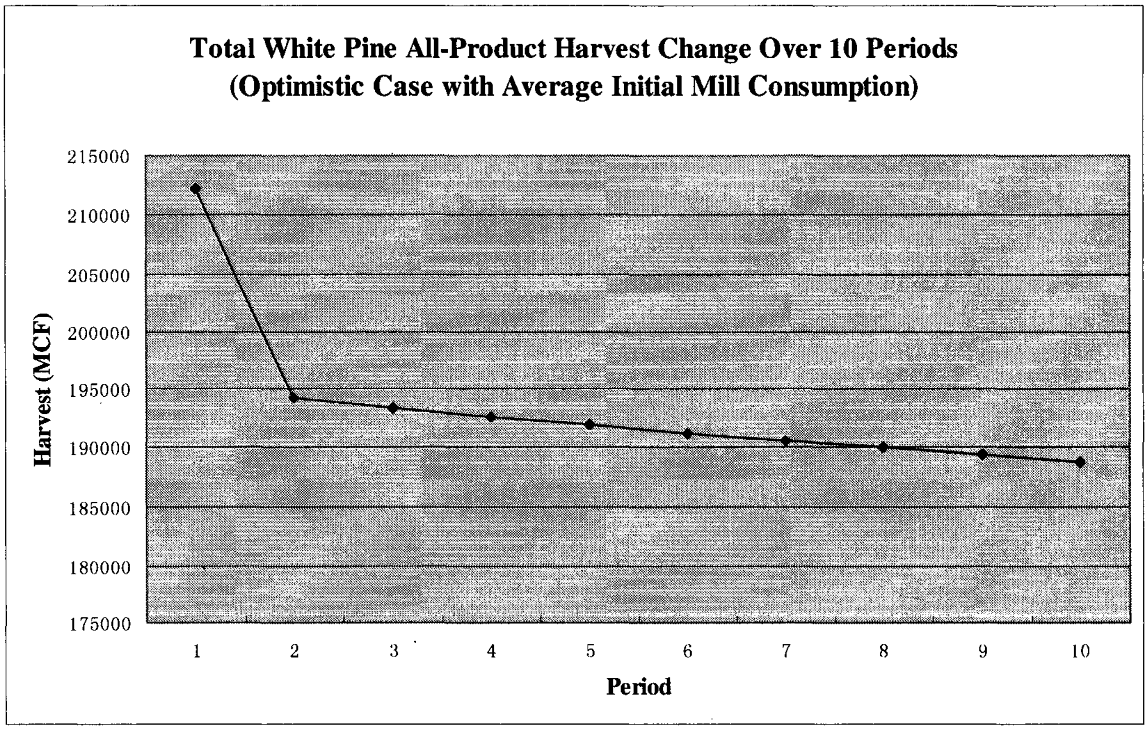


Figure D-21: Total white pine all-product harvest change over 10 periods (optimistic case with average initial mill consumption)

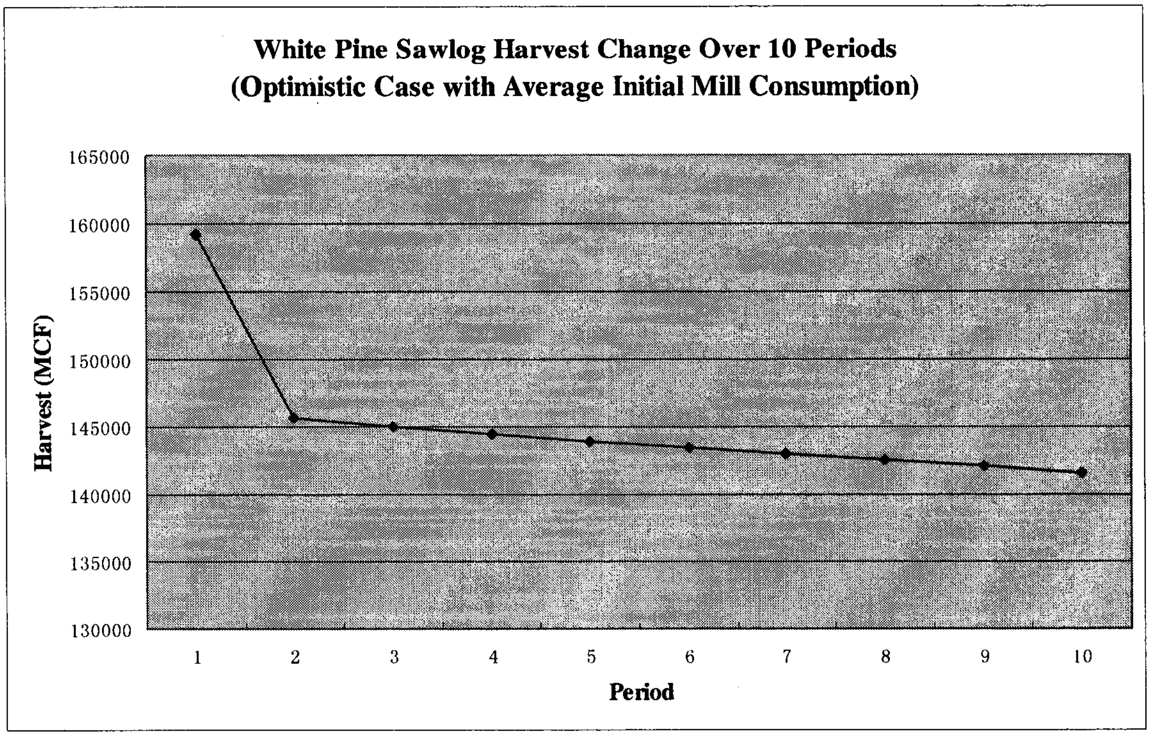


Figure D-22: White pine sawlog harvest change over 10 periods (optimistic case with average initial mill consumption)

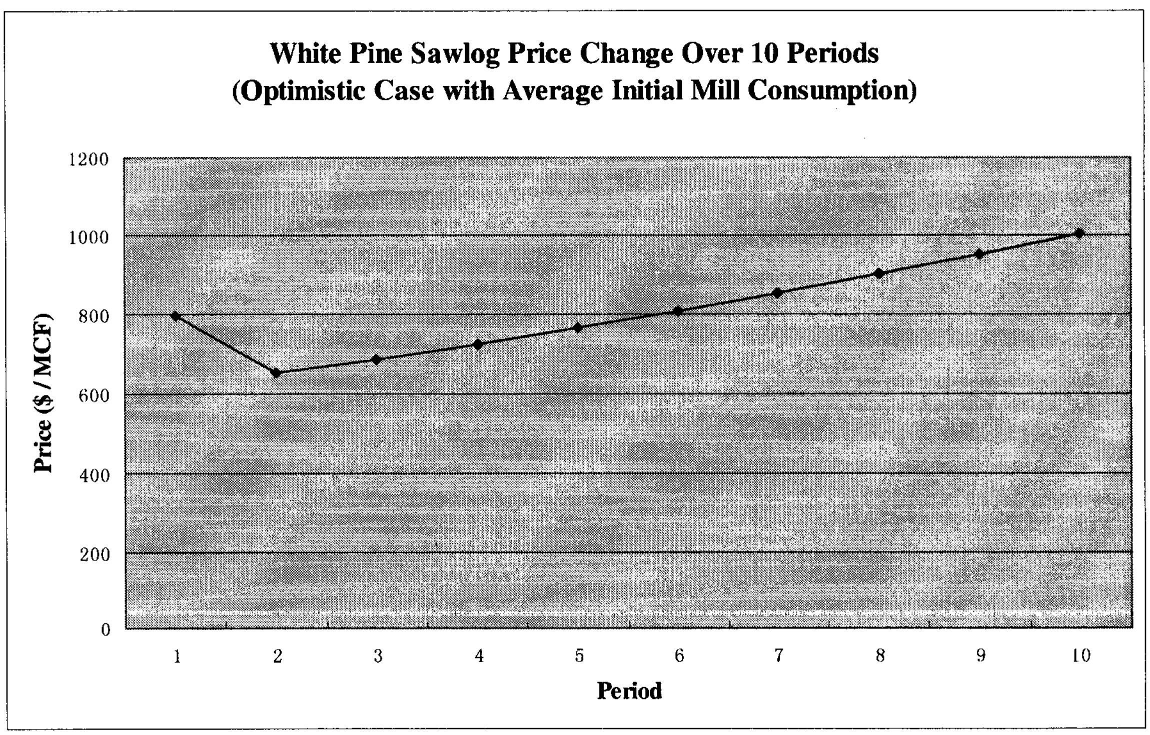


Figure D-23: White pine sawlog price change over 10 periods (optimistic case with average initial mill consumption)

Table D-95: Base-case wood supply model summary results with high-end initial mill consumption

Wood supply summary results										
High End Initial Mill Consumption										
Base Case										
Unit: MCF										
White Pine Inventory										
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
County										
Belknap	98595	81648	66530	53245	41761	32010	23897	17298	12071	8347
Carroll	142917	135776	127807	119086	109707	99782	89444	78844	68152	58623
Cheshire	167752	166102	163300	159291	154031	147492	139671	130589	120299	110413
Coos	39679	28542	19955	13512	8821	5520	3287	1844	962	492
Grafton	147042	139800	131573	122447	112536	101977	90933	79594	68170	58070
Hillsborough	276617	277652	277213	275161	271358	265670	257973	248154	236120	224064
Merrimack	272232	251468	229709	207255	184433	161586	139073	117261	96513	78959
Rockingham	160335	145010	129847	114993	100593	86783	73695	61450	50158	40724
Strafford	86860	80205	73262	66123	58888	51658	44544	37652	31094	25528
Sullivan	83467	80408	76612	72110	66955	61220	55004	48427	41634	35583
Total Inventory	**1475496**	**1386610**	**1295808**	**1203224**	**1109083**	**1013700**	**917521**	**821113**	**725174**	**640804**
Annual Change %		**-0.01235**	**-0.01345**	**-0.01472**	**-0.01616**	**-0.01782**	**-0.01974**	**-0.02196**	**-0.02454**	**-0.02443**
Total White Pine Harvest – All Products										
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
County										
Belknap	24602	21457	18450	15618	12993	10599	8454	6569	4662	3224
Carroll	23447	23461	23304	22966	22442	21723	20805	19688	17305	14887
Cheshire	22158	23107	23972	24733	25368	25852	26157	26254	24593	22575
Coos	15032	11388	8402	6017	4167	2775	1766	1063	564	289
Grafton	26556	26591	26409	25995	25342	24439	23284	21879	19054	16234
Hillsborough	27678	29259	30827	32364	33855	35274	36597	37792	36565	34703

Table D-95 continued										
Merrimack	52497	51072	49230	46981	44346	41348	38024	34417	28804	23569
Rockingham	27084	25798	24377	22834	21187	19452	17650	15799	13113	10648
Strafford	16234	15787	15217	14527	13723	12811	11803	10710	8994	7385
Sullivan	16565	16807	16898	16823	16569	16123	15477	14628	12788	10931
Total Harvest (All)	**251852**	**244726**	**237086**	**228859**	**219992**	**210396**	**200017**	**188799**	**166443**	**144445**
Total White Pine Sawlog Harvest		**75.00%**	(utilization)							
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
County										
Belknap	18451	16092	13837	11713	9745	7949	6341	4927	3496	2418
Carroll	17585	17595	17478	17225	16832	16292	15604	14766	12979	11166
Cheshire	16619	17330	17979	18550	19026	19389	19618	19690	18445	16931
Coos	11274	8541	6302	4513	3125	2081	1324	797	423	216
Grafton	19917	19943	19807	19496	19006	18329	17463	16409	14291	12175
Hillsborough	20758	21944	23120	24273	25391	26455	27448	28344	27424	26027
Merrimack	39372	38304	36923	35236	33259	31011	28518	25812	21603	17676
Rockingham	20313	19348	18282	17125	15890	14589	13237	11849	9835	7986
Strafford	12175	11840	11413	10895	10292	9608	8852	8033	6745	5539
Sullivan	12424	12605	12674	12617	12427	12092	11608	10971	9591	8198
Total Harvest (Sawlog)	**188889**	**183545**	**177814**	**171644**	**164994**	**157797**	**150012**	**141599**	**124832**	**108334**
White Pine Sawlog Price ($/MCF)										
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
Price	$797.5	$933.11	$1098.26	$1301.77	$1556.34	$1879.44	$2297.08	$2847.9	$2995.87	$2997.15

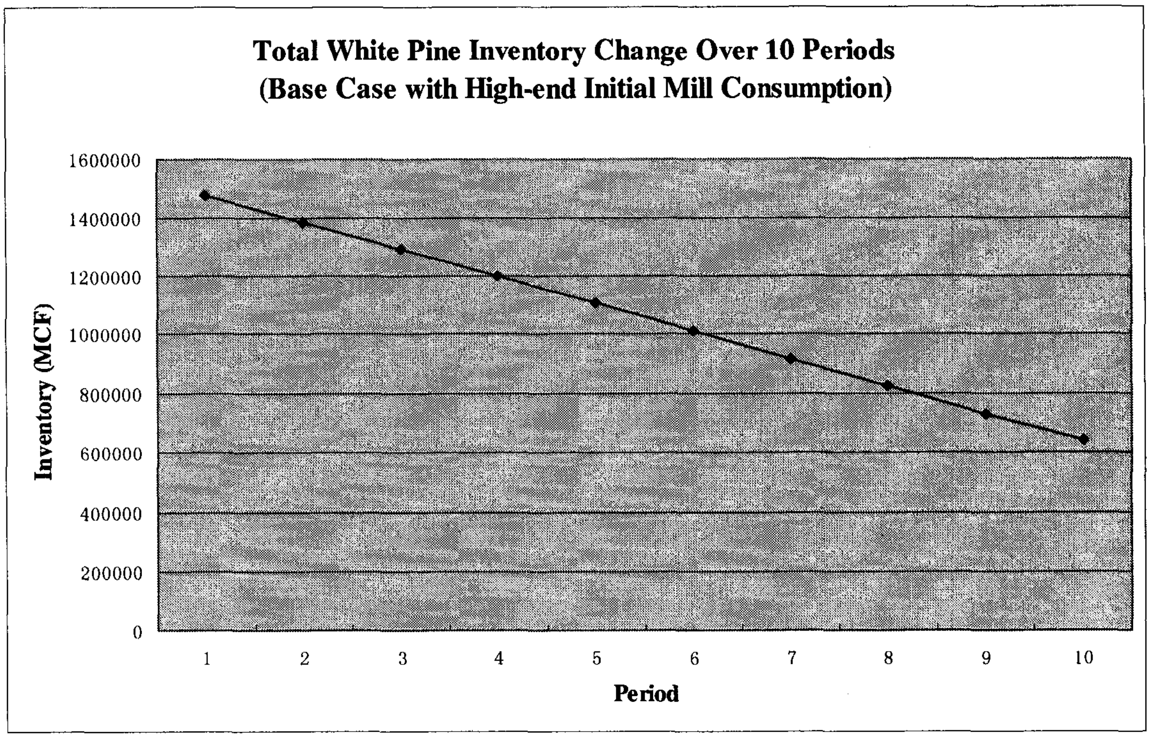


Figure D-24: Total white pine inventory change over 10 periods (base-case with high-end initial mill consumption)

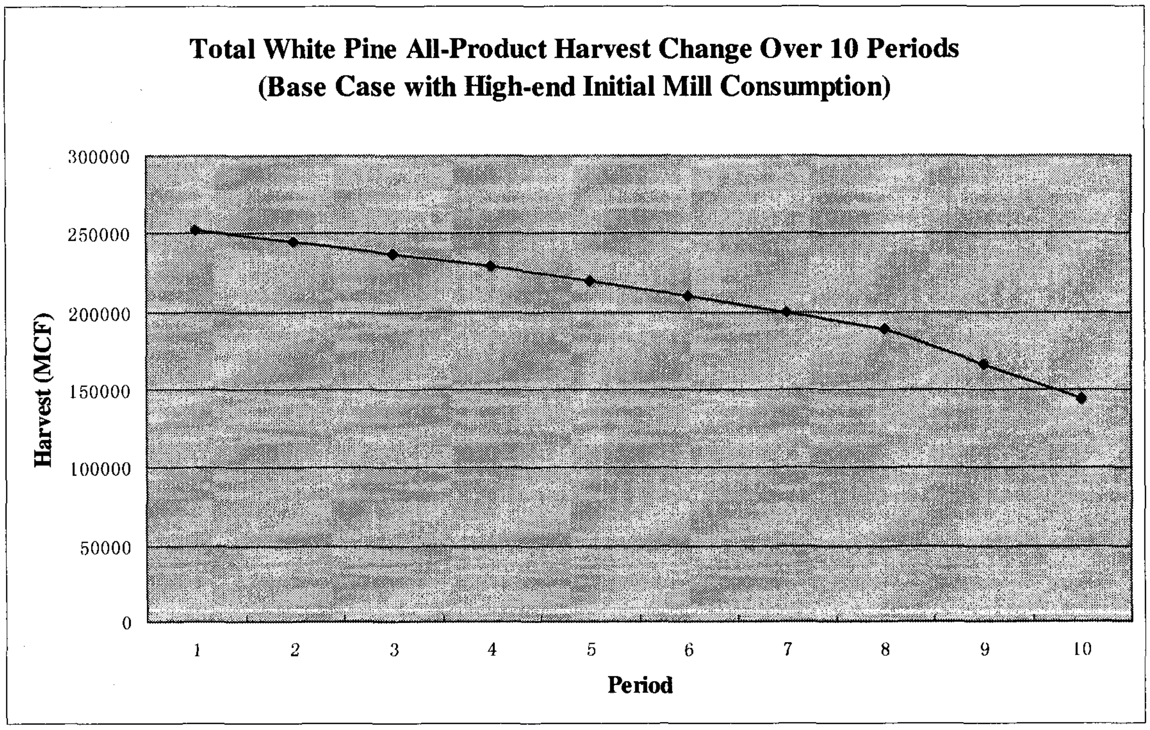


Figure D-25: Total white pine all-product harvest change over 10 periods (base-case with high-end initial mill consumption)

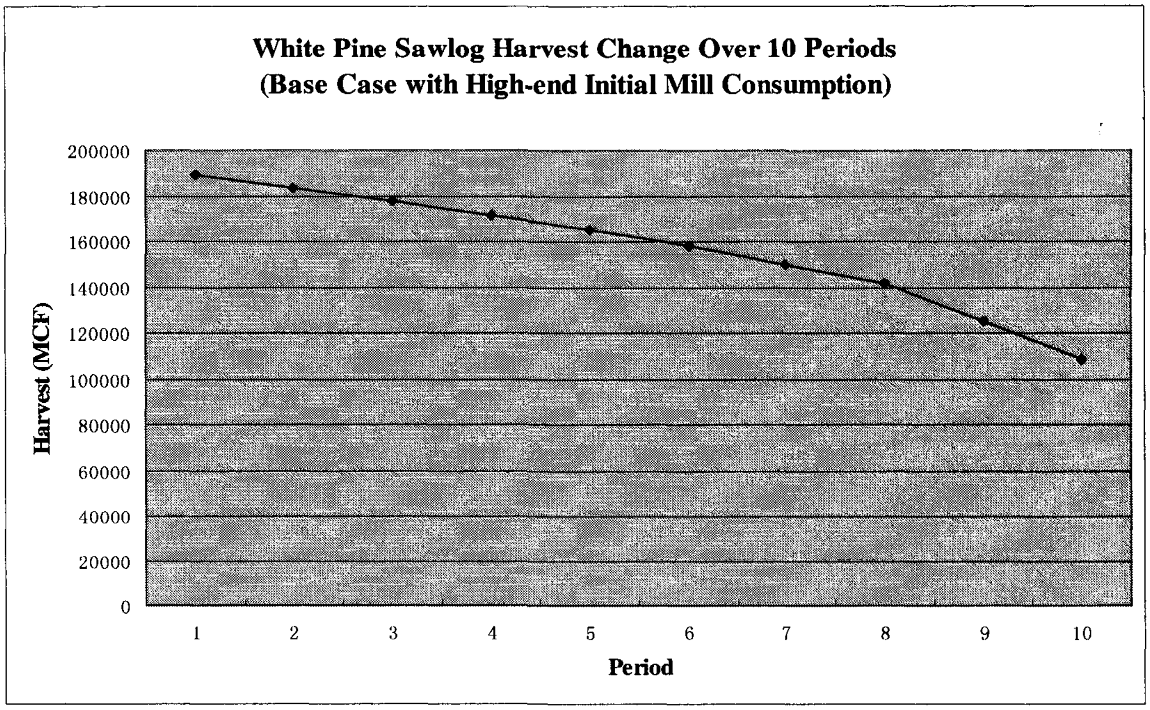


Figure D-26: White pine sawlog harvest change over 10 periods (base-case with high-end initial mill consumption)

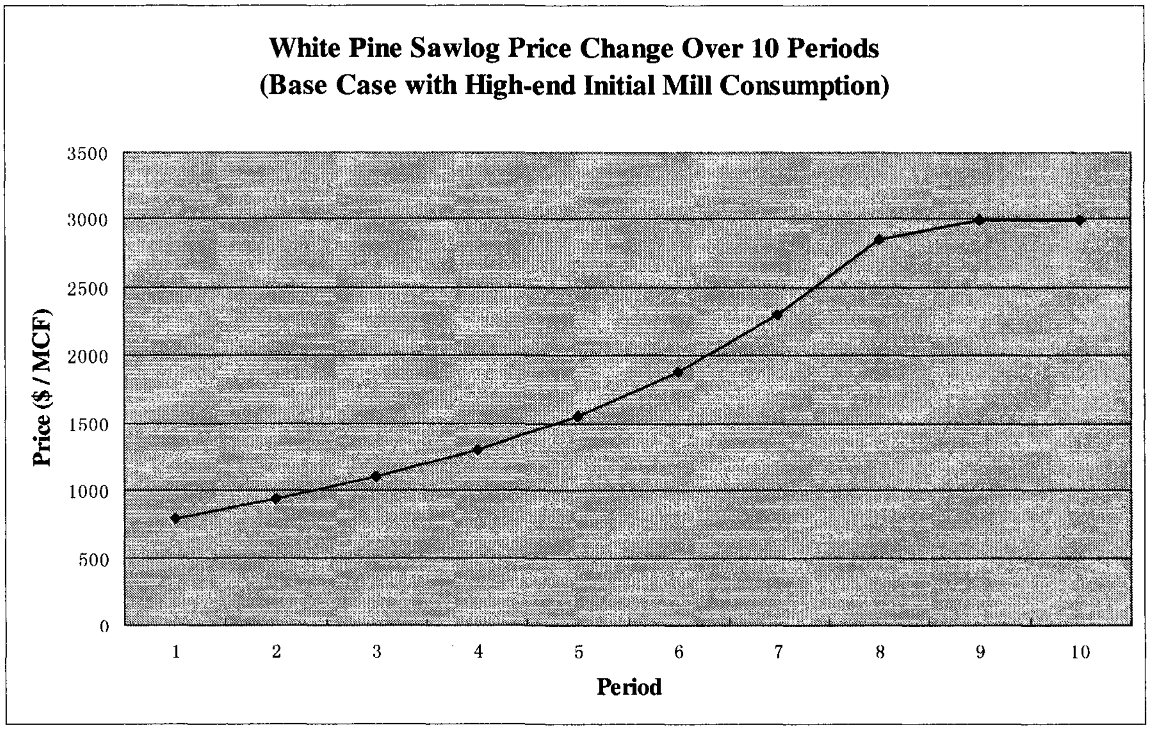


Figure D-27: White pine sawlog price change over 10 periods (base-case with high-end initial mill consumption)

Table D-96: Optimistic case wood supply model summary results with high-end initial mill consumption

Wood supply summary results
High End Initial Mill Consumption
Optimistic Case
Unit: MCF
White Pine Inventory

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	98595	82970	70579	59453	49558	40843	33249	26706	21137	16458
Carroll	142917	137730	133705	129217	124289	118948	113226	107160	100790	94161
Cheshire	167752	168500	170254	171475	172125	172161	171545	170240	168211	165426
Coos	39679	29001	21523	15644	11113	7695	5178	3373	2118	1273
Grafton	147042	141788	137826	133317	128287	122764	116785	110394	103638	96571
Hillsborough	276617	282468	289738	296508	302700	308228	313006	316939	319927	321865
Merrimack	272232	255354	241581	227255	212496	197421	182158	166835	151580	136521
Rockingham	160335	148246	138098	127977	117948	108069	98399	88993	79902	71173
Strafford	86860	81580	77259	72766	68137	63408	58616	53801	49002	44256
Sullivan	83467	81610	80504	79002	77104	74813	72139	69095	65700	61980
Total Inventory	**1475496**	**1409247**	**1361067**	**1312614**	**1263756**	**1214350**	**1164302**	**1113536**	**1062003**	**1009684**
Annual Change %		**-0.00915**	**-0.00693**	**-0.00722**	**-0.00756**	**-0.00794**	**-0.00838**	**-0.00888**	**-0.00943**	**-0.01005**

Total White Pine Harvest - All Products

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	24602	19946	17553	15309	13227	11313	9571	8001	6603	5372
Carroll	23447	21623	21572	21438	21222	20920	20533	20062	19507	18869
Cheshire	22158	21254	22026	22764	23467	24124	24728	25274	25754	26157
Coos	15032	10660	8240	6247	4637	3361	2373	1626	1077	685
Grafton	26556	24503	24476	24345	24109	23764	23310	22749	22081	21306
Hillsborough	27678	26967	28349	29747	31161	32582	34006	35428	36840	38234
Merrimack	52497	47184	45935	44493	42878	41093	39157	37084	34892	32598
Rockingham	27084	24012	23036	21998	20910	19777	18609	17414	16201	14978

Table D-96 continued										
Strafford	16234	14609	14236	13805	13322	12787	12207	11584	10925	10234
Sullivan	16565	15488	15688	15819	15878	15858	15757	15571	15298	14935
Total Harvest (All Products)	**251852**	**226245**	**221111**	**215966**	**210810**	**205579**	**200250**	**194793**	**189178**	**183368**
Total White Pine Sawlog Harvest		75.00%	(utilization)							
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
County										
Belknap	18451	14959	13164	11482	9920	8485	7178	6001	4953	4029
Carroll	17585	16217	16179	16078	15916	15690	15400	15046	14630	14152
Cheshire	16619	15940	16519	17073	17600	18093	18546	18956	19315	19617
Coos	11274	7995	6180	4685	3478	2521	1780	1220	808	514
Grafton	19917	18377	18357	18258	18081	17823	17483	17062	16561	15980
Hillsborough	20758	20225	21262	22311	23371	24437	25505	26571	27630	28676
Merrimack	39372	35388	34451	33370	32158	30820	29367	27813	26169	24448
Rockingham	20313	18009	17277	16498	15682	14833	13956	13060	12151	11233
Strafford	12175	10956	10677	10354	9991	9590	9155	8688	8194	7675
Sullivan	12424	11616	11766	11864	11908	11893	11817	11678	11473	11201
Total Harvest (Sawlog)	**188889**	**169683**	**165833**	**161974**	**158107**	**154184**	**150187**	**146095**	**141883**	**137526**
White Pine Sawlog Price ($/MCF)										
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
Price	$797.5	$676.94	$742.34	$815.2	$897.08	$989.3	$1094	$1213.77	$1351.9	$1512.3

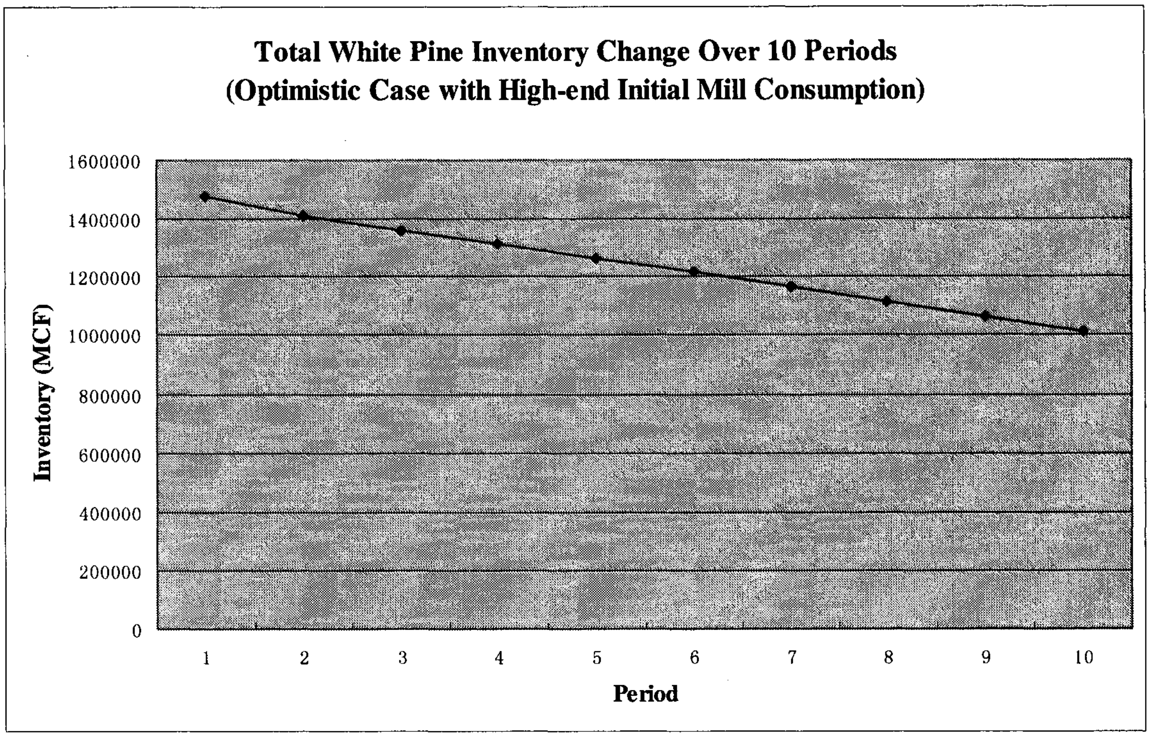


Figure D-28: Total white pine inventory change over 10 periods (optimistic case with high-end initial mill consumption)

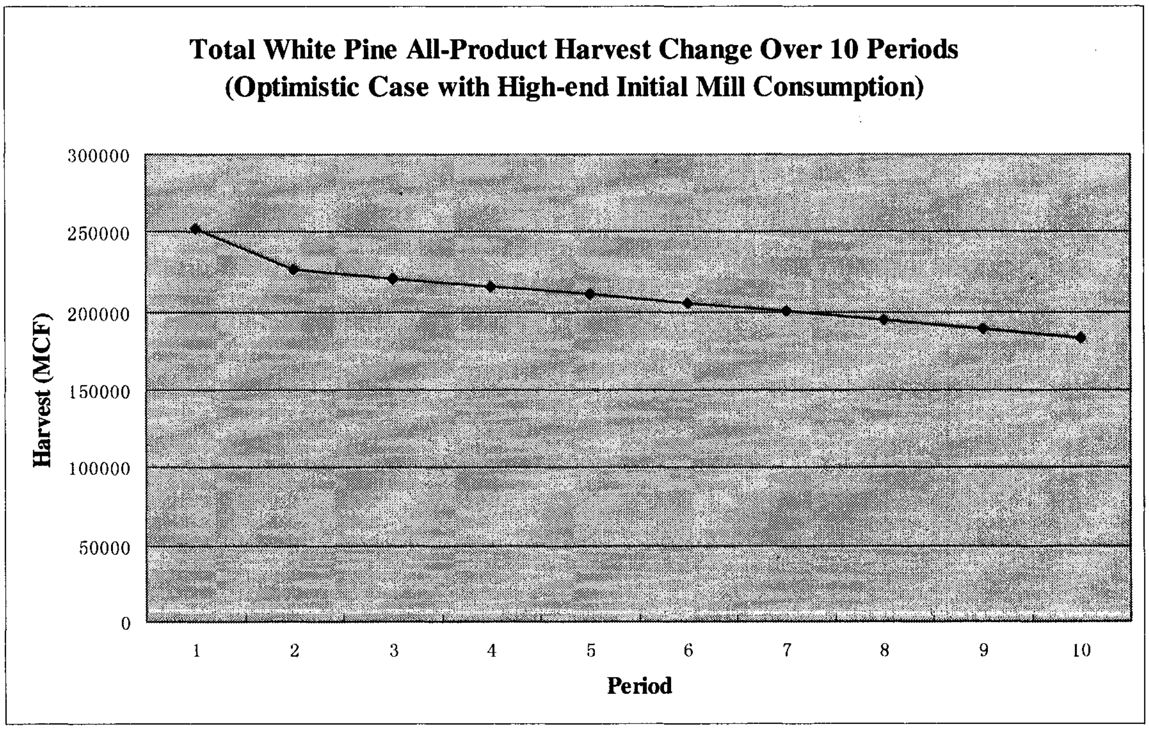


Figure D-29: Total white pine all-product harvest change over 10 periods (optimistic case with high-end initial mill consumption)

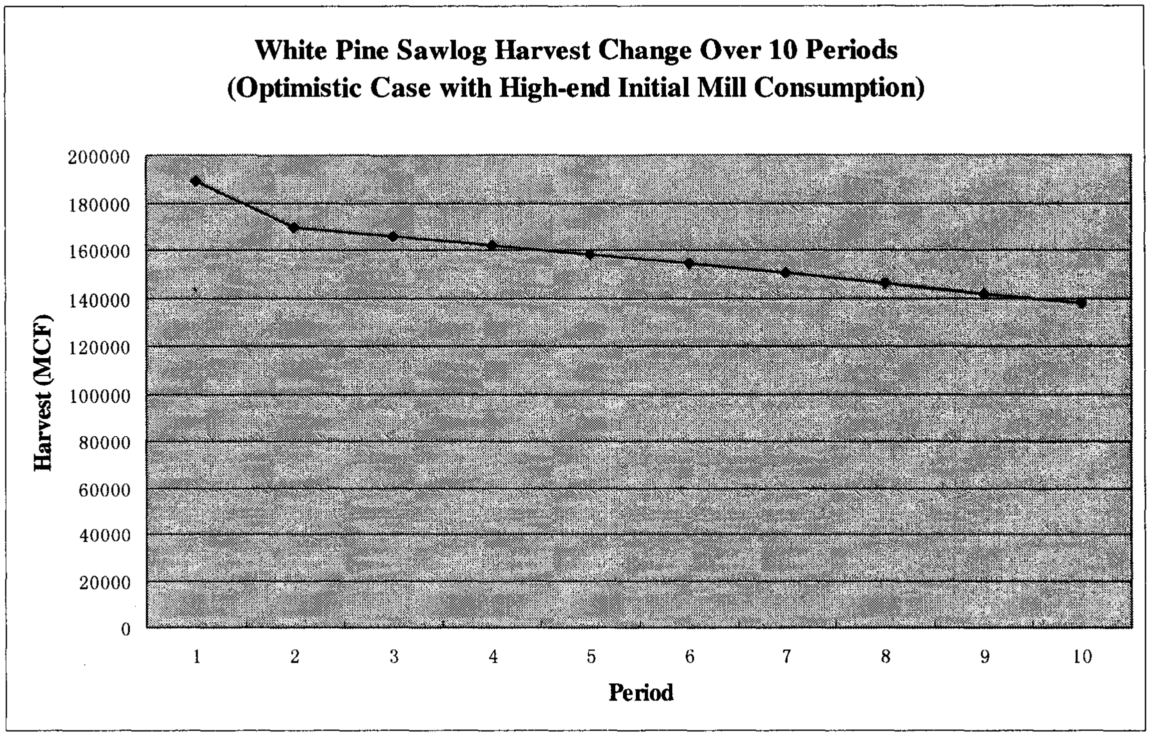


Figure D-30: White pine sawlog harvest change over 10 periods (optimistic case with high-end initial mill consumption)

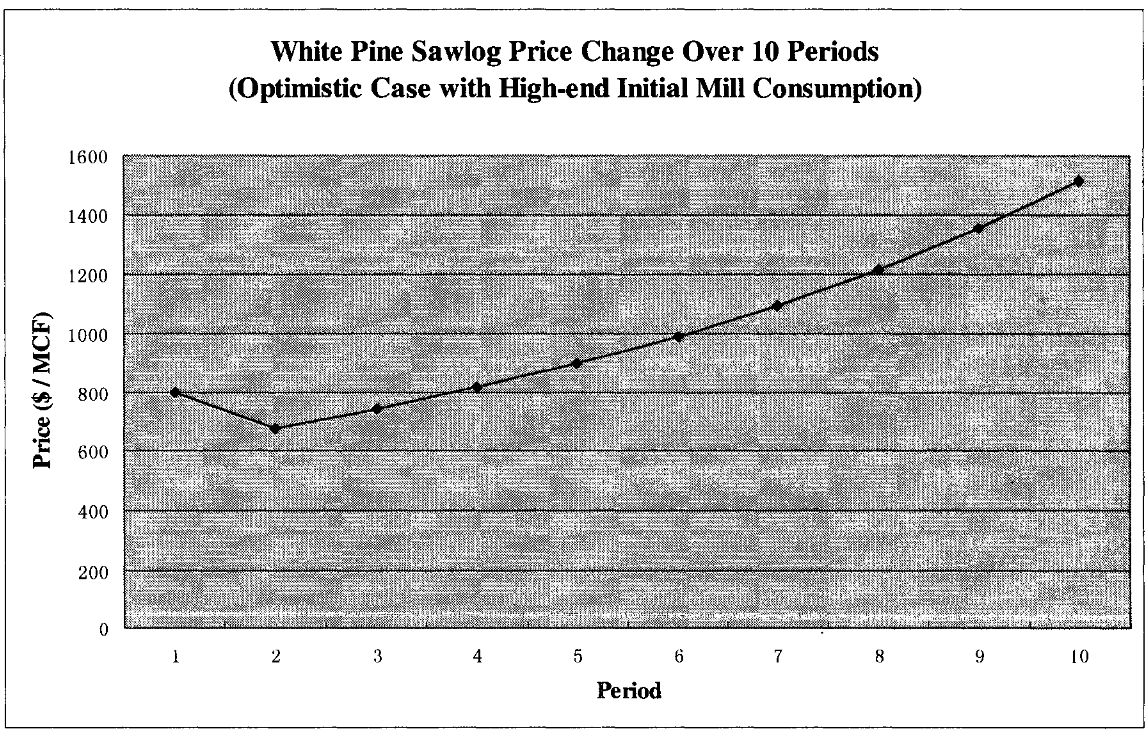


Figure D-31: White pine sawlog price change over 10 periods (optimistic case with high-end initial mill consumption)

Table D-97: Base-case wood supply model summary results with low-end initial mill consumption

Wood supply summary results
Low End Initial Mill Consumption
Base case
Unit: MCF
White Pine Inventory

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	98595	88198	78455	69380	60980	53253	46190	39778	33995	28817
Carroll	142917	142835	142303	141310	139846	137902	135476	132566	129175	125309
Cheshire	167752	172456	176845	180873	184489	187642	190279	192346	193787	194546
Coos	39679	33288	27689	22828	18645	15080	12071	9556	7476	5776
Grafton	147042	149796	152140	154033	155438	156316	156631	156350	155439	153870
Hillsborough	276617	284335	291675	298576	304971	310790	315960	320403	324039	326783
Merrimack	272232	270297	267458	263710	259050	253486	247031	239705	231536	222560
Rockingham	160335	153787	147024	140082	132995	125799	118530	111222	103910	96629
Strafford	86860	85532	83929	82057	79923	77535	74904	72044	68970	65698
Sullivan	83467	85322	86891	88144	89053	89587	89722	89432	88697	87499
Total Inventory	**1475496**	**1465846**	**1454408**	**1440994**	**1425390**	**1407391**	**1386795**	**1363400**	**1337024**	**1307488**
Annual Change %		**-0.00131**	**-0.00157**	**-0.00185**	**-0.00218**	**-0.00254**	**-0.00294**	**-0.0034**	**-0.0039**	**-0.00446**

Total White Pine Harvest - All Products

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	18051	16591	15166	13787	12461	11197	9998	8871	7817	6839
Carroll	16388	16829	17229	17588	17900	18161	18368	18517	18605	18627
Cheshire	15804	16693	17591	18495	19400	20302	21195	22073	22930	23759
Coos	10287	8867	7579	6423	5395	4490	3700	3017	2434	1941
Grafton	16560	17334	18091	18829	19540	20217	20856	21448	21987	22464
Hillsborough	20995	22174	23374	24597	25837	27090	28354	29622	30891	32152
Merrimack	33668	34347	34925	35399	35760	36003	36122	36110	35965	35681

Table D-97 continued										
Rockingham	18307	18042	17724	17360	16950	16496	16001	15469	14902	14302
Strafford	10906	11034	11127	11183	11201	11180	11120	11019	10877	10693
Sullivan	11651	12237	12806	13355	13875	14362	14808	15206	15551	15833
Total Harvest (All)	**172616**	**174147**	**175612**	**177016**	**178320**	**179497**	**180521**	**181351**	**181958**	**182293**
Total White Pine Sawlog Harvest		75.00%	(utilization)							
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
County										
Belknap	13538	12443	11374	10340	9346	8397	7499	6653	5863	5129
Carroll	12291	12622	12922	13191	13425	13620	13776	13887	13953	13970
Cheshire	11853	12520	13193	13871	14550	15226	15896	16555	17198	17820
Coos	7715	6650	5684	4817	4046	3367	2775	2263	1826	1456
Grafton	12420	13000	13568	14121	14655	15163	15642	16086	16490	16848
Hillsborough	15746	16630	17531	18448	19378	20318	21265	22216	23168	24114
Merrimack	25251	25760	26193	26549	26820	27002	27091	27083	26974	26761
Rockingham	13730	13531	13293	13020	12712	12372	12001	11601	11176	10727
Strafford	8180	8276	8345	8387	8401	8385	8340	8264	8158	8020
Sullivan	8738	9178	9605	10016	10406	10771	11106	11405	11663	11875
Total Harvest (Sawlog)	**129462**	**130610**	**131709**	**132762**	**133740**	**134623**	**135391**	**136014**	**136469**	**136720**
White Pine Sawlog Price ($/MCF)										
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
Price	$797.5	$865.76	$940.26	$1022.29	$1112.77	$1213.03	$1324.82	$1449.98	$1591.1	$1751.02

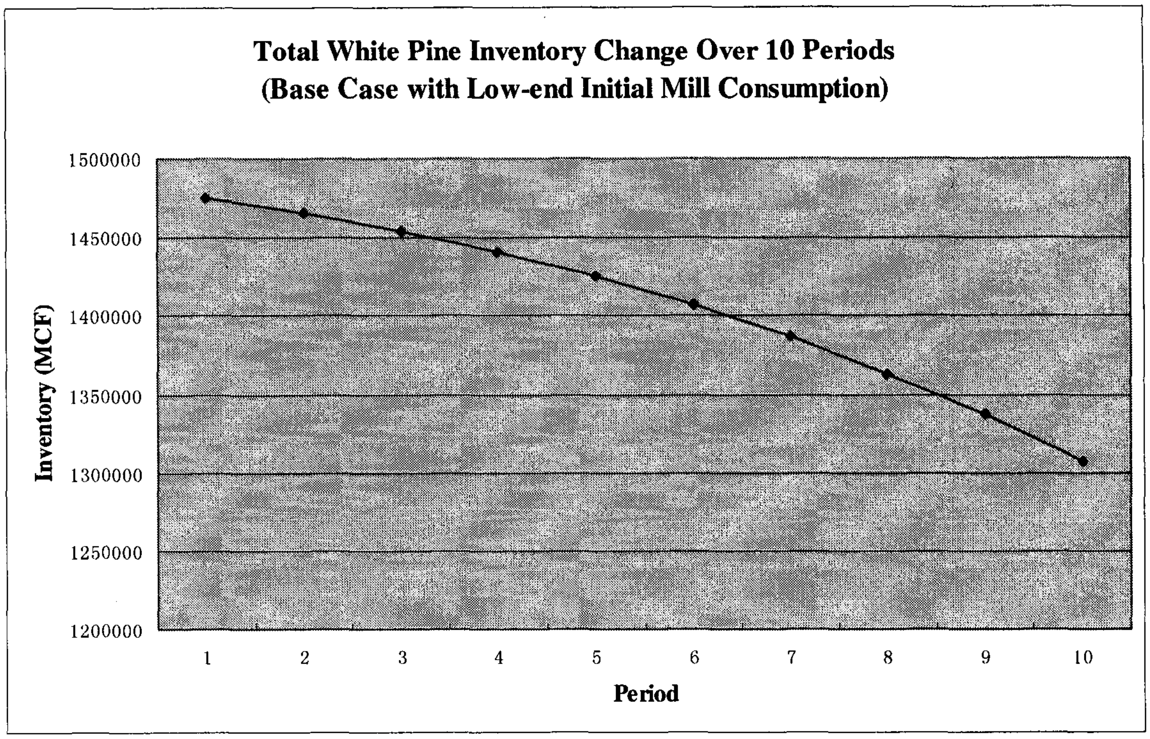


Figure D-32: Total white pine inventory change over 10 periods (base-case with low-end initial mill consumption)

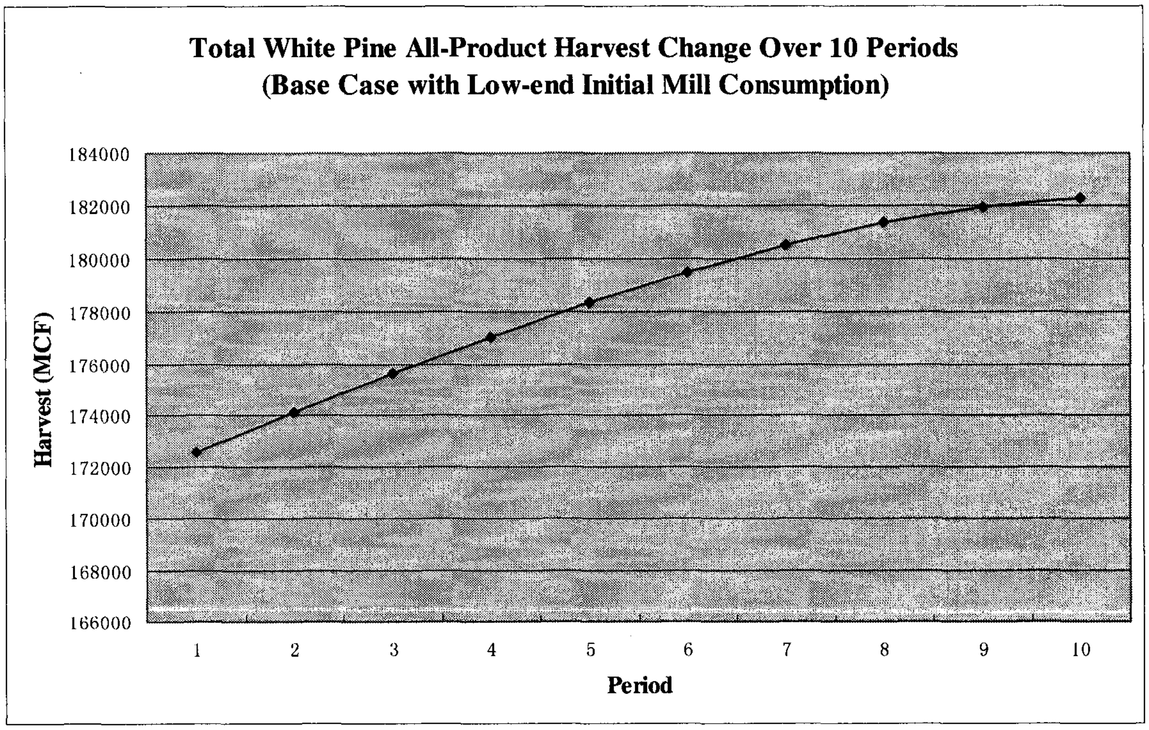


Figure D-33: Total white pine all-product harvest change over 10 periods (base-case with low-end initial mill consumption)

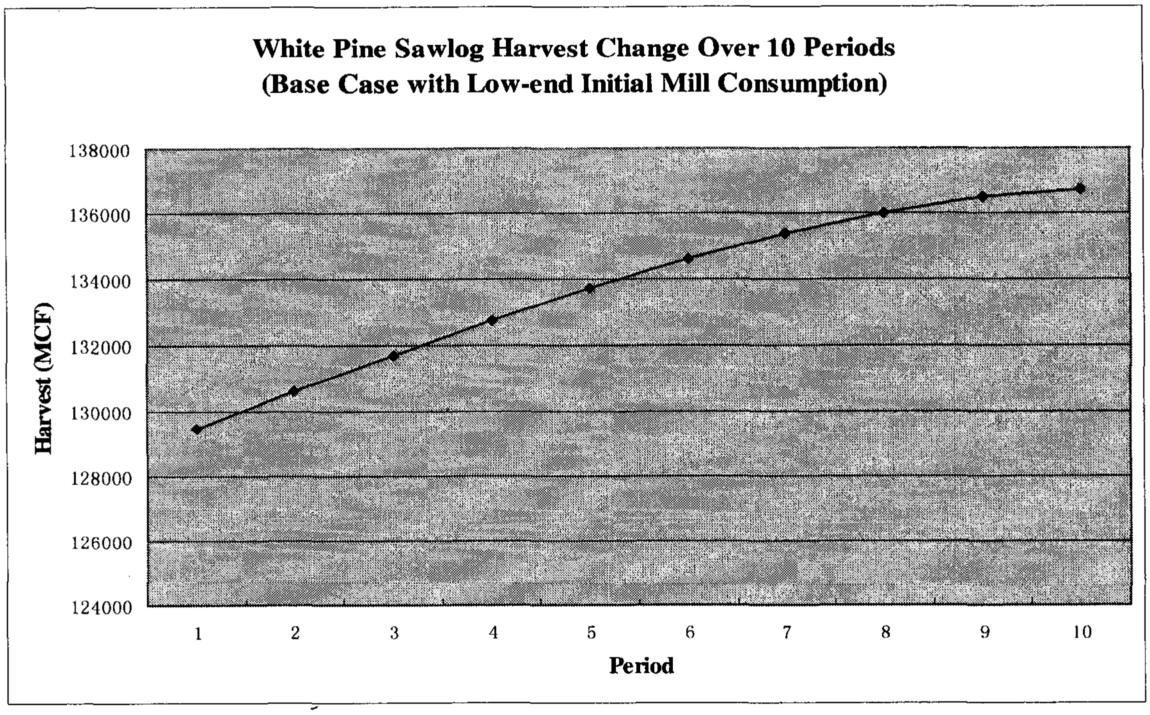


Figure D-34: White pine sawlog harvest change over 10 periods (base case with low-end initial mill consumption)

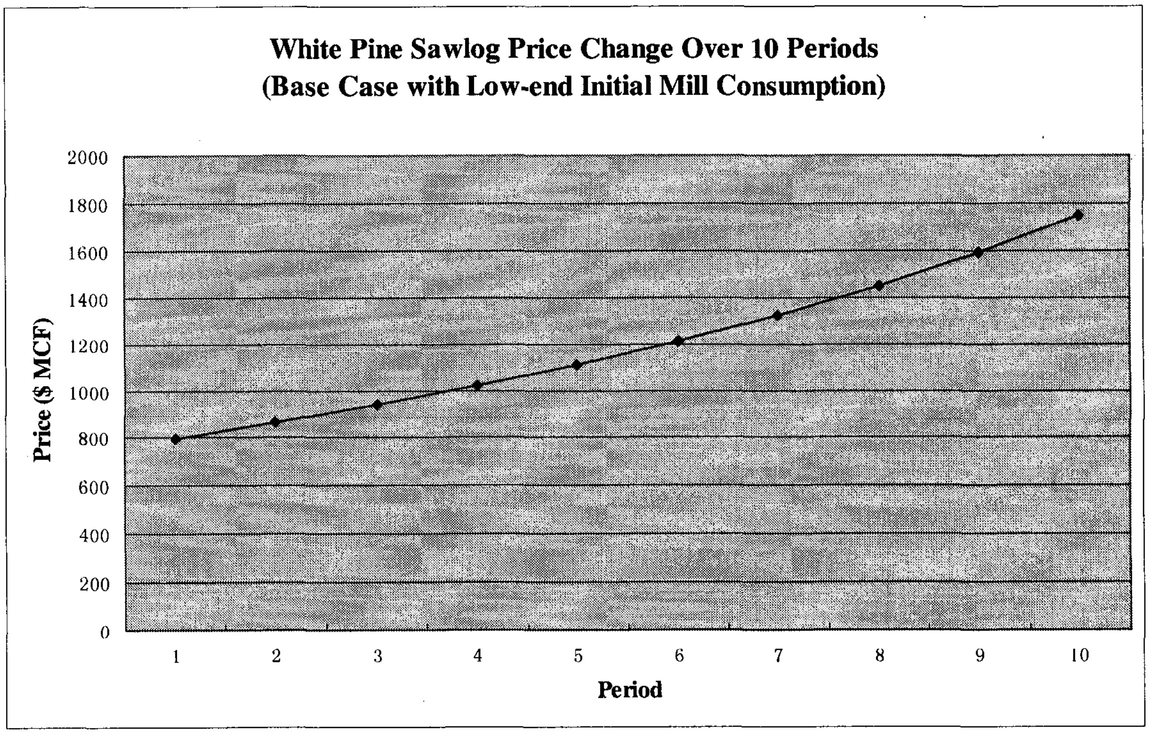


Figure D-35: White pine sawlog price change over 10 periods (base-case with low-end initial mill consumption)

Table D-98: Pessimistic case wood supply model summary results with low-end initial mill consumption

Wood supply summary results
Low End Initial Mill Consumption
Pessimistic Case
Unit: MCF
White Pine Inventory

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	98595	86889	74456	63063	52738	43492	35316	28185	22058	17282
Carroll	142917	140900	136658	131573	125663	118960	111514	103391	94677	86611
Cheshire	167752	170081	170181	169257	167229	164028	159593	153881	146867	140014
Coos	39679	32833	26065	20358	15620	11754	8656	6222	4353	3060
Grafton	147042	148087	146794	144465	141054	136530	130880	124114	116269	108790
Hillsborough	276617	279578	279581	278229	275415	271037	265001	257223	247632	238170
Merrimack	272232	266453	256214	244423	231161	216541	200708	183841	166151	150023
Rockingham	160335	150592	139090	127532	116005	104597	93397	82494	71974	62763
Strafford	86860	84172	80102	75619	70761	65577	60122	54463	48671	43459
Sullivan	83467	84132	83149	81445	78998	75800	71865	67224	61936	56991
Total Inventory	**1475496**	**1443715**	**1392289**	**1335964**	**1274643**	**1208315**	**1137052**	**1061039**	**980586**	**907162**
Annual Change %		**-0.0043**	**-0.00723**	**-0.00823**	**-0.00935**	**-0.0106**	**-0.0121**	**-0.01374**	**-0.01565**	**-0.01545**

Total White Pine Harvest - All Products

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10
County										
Belknap	18051	18025	16185	14383	12640	10975	9404	7940	6196	4796
Carroll	16388	18410	18827	19141	19339	19409	19336	19111	17586	16019
Cheshire	15804	18284	19319	20323	21277	22164	22962	23648	22727	21618
Coos	10287	9614	7967	6503	5221	4117	3184	2409	1671	1154
Grafton	16560	19024	19904	20708	21413	21997	22436	22706	21399	19959
Hillsborough	20995	24209	25565	26910	28230	29509	30728	31868	30907	29673
Merrimack	33668	37536	38038	38302	38301	38016	37429	36524	33149	29783

Table D-98 continued										
Rockingham	18307	19545	18987	18339	17604	16786	15892	14927	13055	11308
Strafford	10906	12032	12061	12012	11879	11658	11347	10945	9817	8717
Sullivan	11651	13397	13973	14465	14854	15120	15244	15208	14084	12908
Total Harvest (All)	**172616**	**190076**	**190826**	**191085**	**190757**	**189751**	**187962**	**185284**	**170592**	**155936**
Total White Pine Sawlog Harvest		75.00%	(utilization)							
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
County										
Belknap	13538	13519	12138	10787	9480	8231	7053	5955	4647	3597
Carroll	12291	13808	14120	14356	14504	14556	14502	14333	13190	12014
Cheshire	11853	13713	14489	15242	15958	16623	17222	17736	17046	16214
Coos	7715	7211	5975	4877	3915	3088	2388	1807	1253	866
Grafton	12420	14268	14928	15531	16060	16498	16827	17029	16049	14969
Hillsborough	15746	18157	19173	20182	21172	22132	23046	23901	23180	22255
Merrimack	25251	28152	28529	28726	28726	28512	28072	27393	24862	22338
Rockingham	13730	14659	14240	13754	13203	12590	11919	11195	9791	8481
Strafford	8180	9024	9046	9009	8909	8743	8510	8208	7363	6538
Sullivan	8738	10047	10480	10849	11140	11340	11433	11406	10563	9681
Total Harvest (Sawlog)	**129462**	**142557**	**143119**	**143313**	**143068**	**142313**	**140971**	**138963**	**127944**	**116952**
White Pine Sawlog Price ($/MCF)										
	Period 1	**Period 2**	**Period 3**	**Period 4**	**Period 5**	**Period 6**	**Period 7**	**Period 8**	**Period 9**	**Period 10**
Price	$797.5	$1126.58	$1300.16	$1508.05	$1789.32	$2066.42	$2446.43	$2923.43	$2995.8	$2996.98

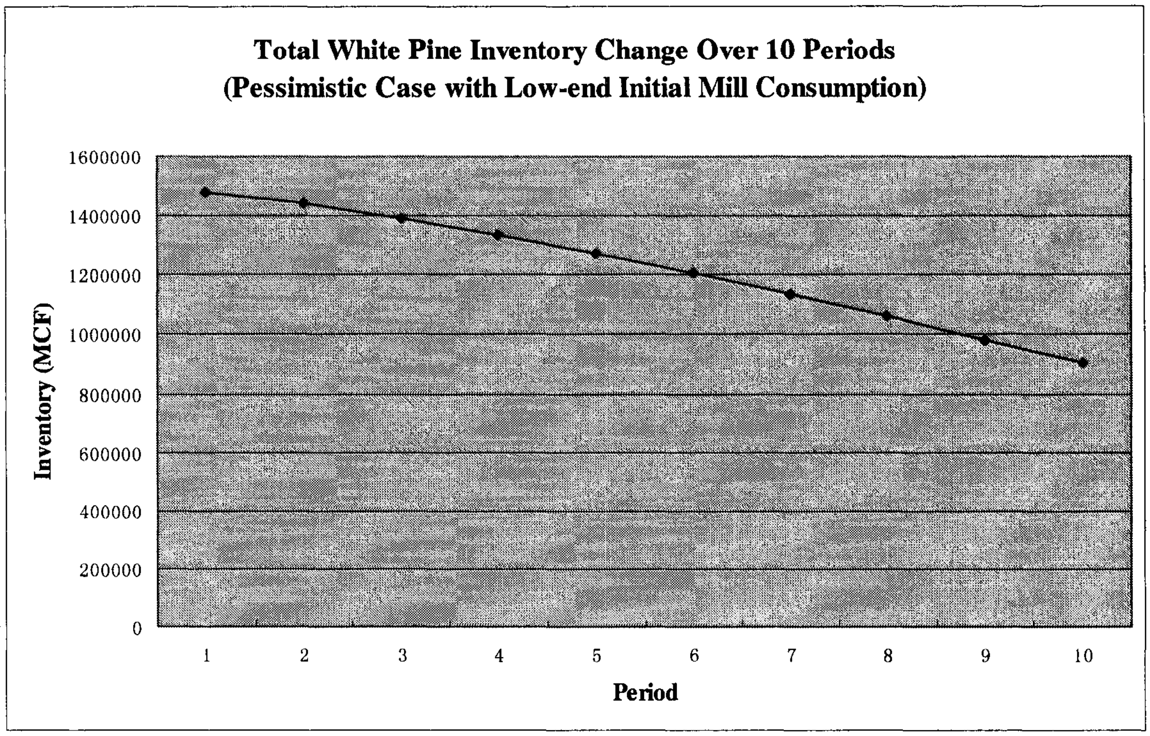


Figure D-36: Total white pine harvest change over 10 periods (pessimistic case with low-end initial mill consumption)

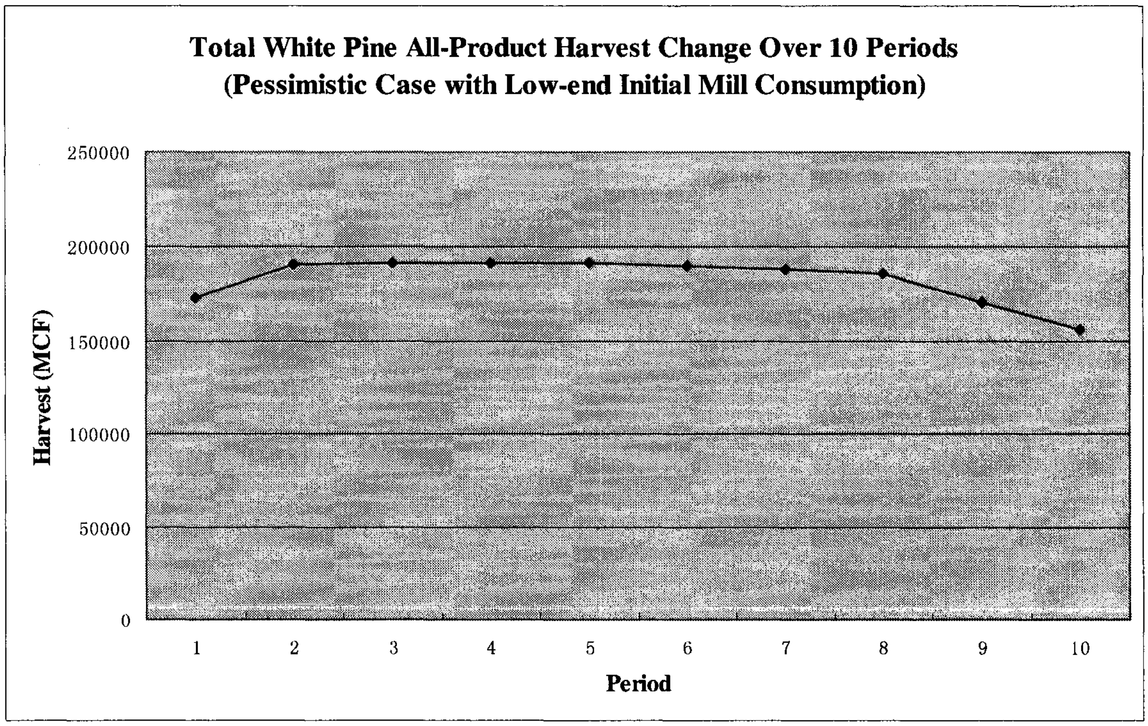


Figure D-37: Total white pine all-product harvest change over 10 periods (pessimistic case with low-end initial mill consumption)

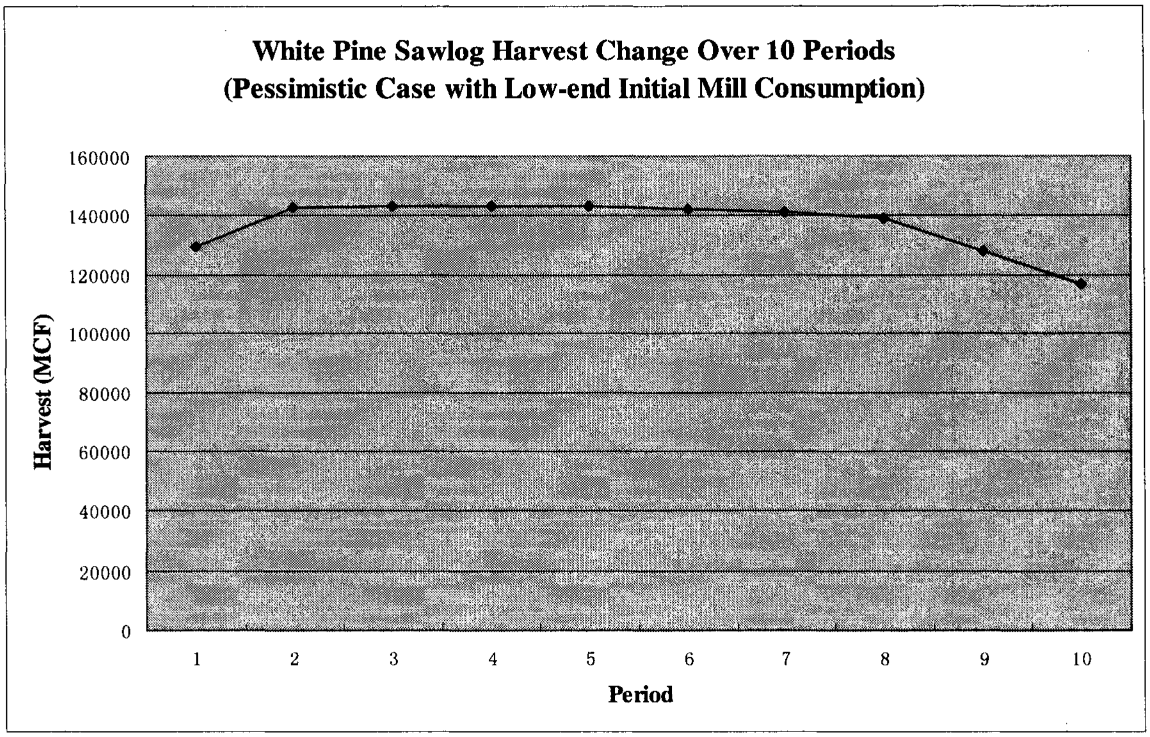


Figure D-38: White pine sawlog harvest change over 10 periods (pessimistic case with low-end initial mill consumption)

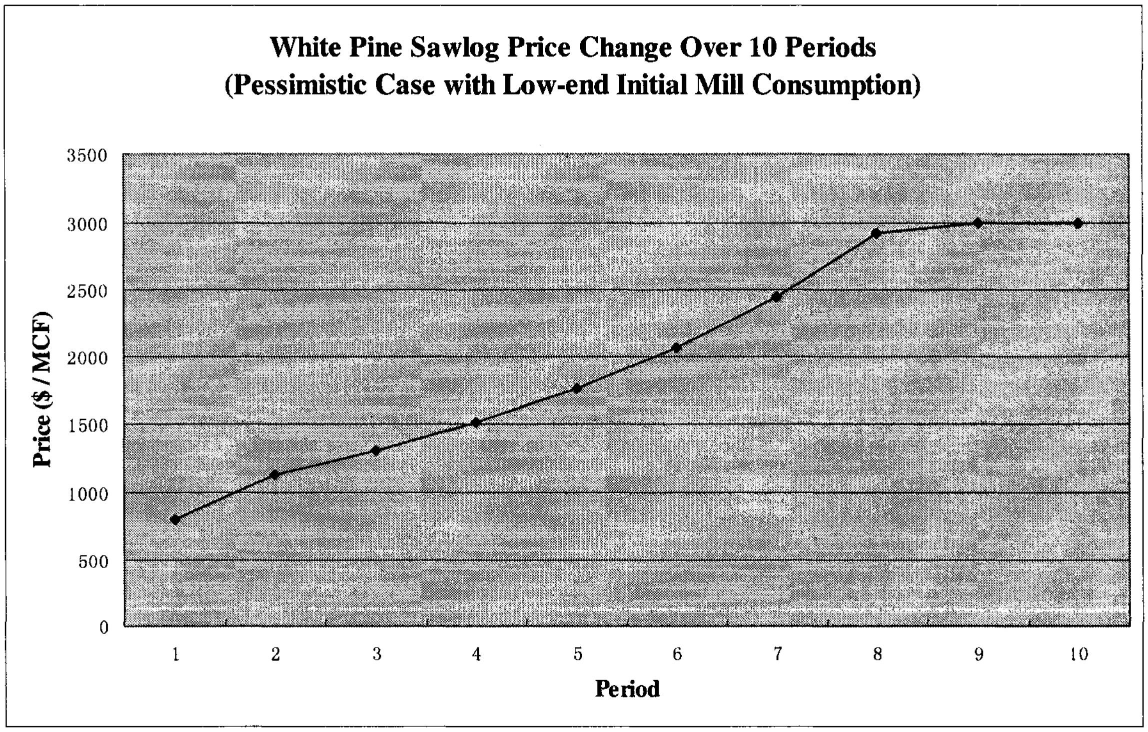


Figure D-39: White pine sawlog price change over 10 periods (pessimistic case with low-end initial mill consumption)

Table D-99: New-Hampshire ten county's wood supply (total wood demand (in MMBF) from ten counties in New-Hampshire)

County supply	High End	Low End	Average
Belknap			
Outside Demand from Belknap	18.934	13.529	16.232
Adjacent NH counties	16.104	11.449	13.777
Carroll	1.883	1.179	1.531
Grafton	3.028	2.167	2.597
Merrimack	6.079	4.461	5.270
Strafford	4.000	3.000	3.500
Rockingham	1.114	0.643	0.879
Adjacent ME counties	2.250	1.500	1.875
York	2.25	1.500	1.875
Own Demand	1.363	1.363	1.363
Quebec Demand	0.580	0.580	0.580
Total Demand	20.296	14.892	17.594
Carroll			
Outside Demand from Carroll	18.444	12.995	15.720
Adjacent NH counties	9.578	6.254	7.916
Belknap	0.300	0.300	0.300
Grafton	3.028	2.167	2.597
Strafford	4.000	3.000	3.500
Coos	2.250	0.788	1.519
Adjacent ME counties	7.250	5.125	6.188
Oxford	5.00	3.625	4.313
York	2.25	1.500	1.875
Own Demand	0.900	0.525	0.713
Quebec Demand	1.616	1.616	1.616
Total Demand	19.344	13.520	16.432
Cheshire			
Outside Demand from Cheshire	13.964	11.163	12.563
Adjacent NH counties	8.535	6.025	7.280
Sullivan	2.413	1.543	1.978
Hillsborough	0.043	0.021	0.032
Merrimack	6.079	4.461	5.270
Adjacent VT counties	1.033	0.742	0.888
Windsor	0.85	0.618	0.734
Windham	0.18	0.124	0.154
Adjacent MA counties	3.115	3.115	3.115
Worcester	1.525	1.525	1.525
Middlesex	0.000	0.000	0.000
Franklin	1.590	1.590	1.590
Own Demand	4.317	1.875	3.096
Quebec Demand	1.281	1.281	1.281
Total Demand	18.280	13.038	15.659
Coos			
Outside Demand from Coos	10.902	7.836	9.369
Adjacent NH counties	4.661	3.171	3.916

Table D-99 continued			
Carroll	1.883	1.179	1.531
Grafton	2.778	1.992	2.385
Adjacent VT counties	0.600	0.400	0.500
Essex	0.60	0.400	0.500
Adjacent ME counties	5.000	3.625	4.313
Oxford	5.00	3.625	4.313
Own Demand	1.500	0.650	1.075
Quebec Demand	0.641	0.641	0.641
Total Demand	12.402	8.486	10.444
Grafton			
Outside Demand from Grafton	19.909	12.799	16.354
Adjacent NH counties	13.238	7.585	10.411
Carroll	1.883	0.300	1.092
Belknap	0.300	0.300	0.300
Merrimack	6.079	4.461	5.270
Sullivan	2.226	1.437	1.831
Coos	2.750	1.088	1.919
Adjacent VT counties	5.186	3.730	4.458
Essex	0.60	0.400	0.500
Caledonia	1.46	0.844	1.152
Orange	2.28	1.868	2.073
Windsor	0.85	0.618	0.734
Own Demand	2.000	0.863	1.431
Quebec Demand	1.484	1.484	1.484
Total Demand	21.909	13.662	17.785
Hillsborough			
Outside Demand from Hillsborough	17.134	13.671	15.403
Adjacent NH counties	10.899	7.436	9.167
Cheshire	1.948	1.172	1.560
Merrimack	6.079	4.461	5.270
Rockingham	0.614	0.343	0.479
Sullivan	2.258	1.460	1.859
Adjacent MA counties	1.765	1.765	1.765
Essex	0.240	0.240	0.240
Middlesex	0.000	0.000	0.000
Worcester	1.525	1.525	1.525
Own Demand	5.700	3.650	4.675
Quebec Demand	4.470	4.470	4.470
Total Demand	22.834	17.321	20.078
Merrimack			
Outside Demand from Merrimack	11.860	8.451	10.155
Adjacent NH counties	11.717	8.308	10.013
Grafton	3.028	2.167	2.597
Belknap	0.613	0.613	0.613
Rockingham	1.114	0.643	0.879

Table D-99 continued			
Sullivan	2.288	1.468	1.878
Strafford	4.000	3.000	3.500
Hillsborough	0.043	0.021	0.032
Cheshire	0.631	0.397	0.514
Own Demand	31.450	19.325	25.388
Quebec Demand	0.143	0.143	0.143
Total Demand	43.310	27.776	35.543
Rockingham			
Outside Demand from Rockingham	15.544	12.205	13.874
Adjacent NH counties	10.484	7.895	9.189
Belknap	0.563	0.563	0.563
Strafford	3.800	2.850	3.325
Merrimack	6.079	4.461	5.270
Hillsborough	0.043	0.021	0.032
Adjacent ME counties	2.250	1.500	1.875
York	2.25	1.500	1.875
Adjacent MA counties	0.240	0.240	0.240
Middlesex	0.000	0.000	0.000
Essex	0.240	0.240	0.240
Own Demand	6.800	2.898	4.849
Quebec Demand	2.570	2.570	2.570
Total Demand	22.344	15.103	18.724
Strafford			
Outside Demand from Strafford	12.193	8.448	10.320
Adjacent NH counties	9.939	6.944	8.441
Carroll	1.883	1.179	1.531
Belknap	0.563	0.563	0.563
Merrimack	6.079	4.461	5.270
Rockingham	1.414	0.741	1.078
Adjacent ME counties	2.250	1.500	1.875
York	2.25	1.500	1.875
Own Demand	1.200	0.550	0.875
Quebec Demand	0.004	0.004	0.004
Total Demand	13.393	8.998	11.195
Sullivan			
Outside Demand from Sullivan	11.949	8.998	10.474
Adjacent NH counties	9.530	6.871	8.201
Cheshire	0.631	0.397	0.514
Grafton	2.778	1.992	2.385
Merrimack	6.079	4.461	5.270
Hillsborough	0.043	0.021	0.032
Adjacent VT counties	1.033	0.742	0.888
Windsor	0.85	0.618	0.734
Windham	0.18	0.124	0.154
Own Demand	1.718	0.614	1.166

Table D-99 continued			
Quebec Demand	1.385	1.385	1.385
Total Demand	13.666	9.612	11.639
NH Total Demand	207.778	142.408	175.093

APPENDIX E: IRB APPROVAL LETTER

UNIVERSITY OF NEW HAMPSHIRE

Office of Sponsored Research
Service Building
51 College Road
Durham, New Hampshire 03824-3585
(603) 862-3564 FAX

LAST NAME	*Howard*	**FIRST NAME**	*Theodore*
DEPT	*Department of Natural Resources - James Hall*	**APP'L DATE**	*5/9/2003*
OFF-CAMPUS ADDRESS (if applicable)		**IRB #**	*2951*
		REVIEW LEVEL	*EXE*
		DATE OF NOTICE	*5/12/2003*
PROJECT TITLE	*New Hampshire and Vermont Sawmill Survey*		

The Institutional Review Board (IRB) for the Protection of Human Subjects in Research has reviewed and approved the protocol for your study as Exempt as described in Federal Regulations 45 CFR 46, Subsection 101 (b), category 2.

Approval is granted to conduct your study as described in your protocol. **Prior to implementing any changes in your protocol, you must submit them to the IRB for review and gain written, unconditional approval. If you experience any unusual or unanticipated results with regard to the participation of human subjects, report such events to this office within one working day of occurrence.** Upon completion of your study, please complete the enclosed pink Exempt Study Final Report form and return it to this office along with a report of your findings.

The protection of human subjects in your study is an ongoing process for which you hold primary responsibility. In receiving IRB approval for your protocol, you agree to conduct the study in accordance with the ethical principles and guidelines for the protection of human subjects in research, as described in the following three reports: Belmont Report; Title 45, Code of Federal Regulations, Part 46; and UNH's Federalwide Assurance of Protection of Human Subjects. The full text of these documents is available on the Office of Sponsored Research (OSR) website at http://www.unh.edu/osr/compliance/Regulatory_Compliance.html and by request from OSR.

If you have questions or concerns about your study or this approval, please feel free to contact me at 862-2003. Please refer to the IRB # above in all correspondence related to this study. The IRB wishes you success with your research.

For the IRB,

Julie F. Simpson
Regulatory Compliance Manager

cc: File
Difei Zhang