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Economic analysis in support of broad scale land management strategies

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Abstract

The US has a century of experience with the development of forest policies that have benefited from or been influenced by economic research activities in the forest sector. At the same time, increasing rigor in policy debates stimulated economics research. During the past four decades economic research has evolved to include increased understanding of consumer demands, producer behavior, landowner behavior and timber resource conditions. Bio-economic models have evolved that combine economic and resource models; these have been used in the US to provide the basis for forecasting future resource and market trends and to shape public perceptions. Economics research has also contributed frameworks for policy analysis using approaches like scenario planning to help decision-makers gauge uncertainty.

Keywords: Forest policy history; Forest sector modeling; Policy analysis; Supply; Demand

1. Introduction

For the past century, US forest policies have been influenced by information about economic efficiency and equity developed through explicit research of both applied and theoretical topics. The impact of this information on land management strategies and forest policies has been evocative.

Outside observers perceive that economics research has helped the US develop a forest policy that seeks to sustain both commodity production and habitat conservation. The actual policy discussion, however, was a series of overlapping debates that lasted 30 years leading to a number of decisions about public land management and influencing decisions of private timberland owners. The result has been a defacto strategic policy of managing large parts of the timberland base either in some type of reserve status or in a custodial fashion while managing a smaller proportion of the remaining exploitable forests more intensively.

This article uses meta analysis to examine how economic research has informed the development of this defacto forest policy. Now with the seeming renaissance of comparative policy analysis (see Deleon and Resnick-Terry, 1998), the lessons from the US in developing forest policies can be instructive. The key is a framework that combines science and policy and uses an integrative assessment modeling as a basis for policy analysis.

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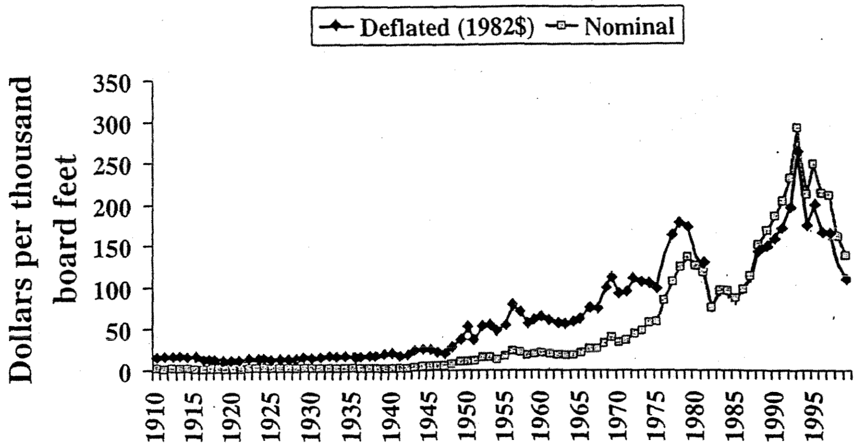

Fig. 1. Stumpage prices for the Pacific Northwest.

The article will proceed in several steps. First, the US forest context is briefly summarized. Second, the evolution of social and economics information that played key roles in the eventual policy debates is summarized. Third, lessons learned that might be useful in guiding work elsewhere are summarized.

1.1. The US context

The US forest situation provides a rich setting for forest policies. Powell et al. (1993) and Smith et al. (2001) provide a detailed description of the US timber resource. Briefly, the US forestland base is 737 million acres that includes 489 million acres of timberland defined by productivity and availability for harvest. US forestland per capita is roughly a third higher than the world average. The US accounts for 7.4% of world resources but 27% of industrial wood consumption and production. It is a net importer of forest products and its largest trading partner is Canada.

Other context setting aspects include land tenure, the policy setting process and the marketing and pricing systems. The majority (73%) of timberlands are privately owned: 70.4 million acres by forest industries and 287.6 million acres by a variety of owners including farmers and others who do not operate wood using plants. Publicly owned timberland accounts for the reminder with the federal government being the largest public owner. Federal lands comprise approximately 20% of all US timberland and 34% of all forestland. The federal government plays a dual role. First, it regulates markets and environmental conditions and, second, it is a major land manager. These dual roles have led to a range of US forest policies that address issues such as terms of trade, performance and quality standards, safety regulations, pollution abatement, as well as policies for the management of federal lands.

The second contextual aspect is the rich tradition of science based policy development using information derived from both empirical and fundamental research. For the past century, this work has been conducted both in university and agency institutions and has been facilitated by collaborative arrangements between the land management agencies and university partners. During this same period, there has been an evolving array of institutional arrangements and stakeholder groups reflecting the growing public interest in environmental issues.

The third contextual aspect is the presence of functional markets for forest products. Fig. 1 illustrates the functioning of markets for stumpage (a factor of production) in the Pacific Northwest. The rise and fall of prices over time reveals the existence of dynamic markets. For example, Fig. 1 shows how forces such as the elimination of

World War II price controls and rapid economic adjustments resulted in an upward shift in stumpage prices.

2. Analysis of overlapping policy developments

The evolving links between economics research and policy development can be portrayed in five parts. The first part deals with helping understand the need for policies for forest management. The second part focuses on understanding market forces. The third part deals with understanding market performance. The fourth part deals with economic models that were used in the 1990s to understand the impacts of policies. The fifth part considers how economic models are being used in discussions about the progress towards sustainable forest management.

2.1. Understanding the need for policies for forest management

Early economics research focused on understanding the incentives for public and private timberland owners to practice forest management. In the 1920s, there were intense discussions about the need for policies for regulation of private timberlands. Opponents often cited the positive returns for forest management as an incentive for landowners to practice forestry. During the 1930s, concerns that over harvesting on western public timberlands would reduce stumpage prices and incentives for private forest management led to the Sustained Yield Forest Management Act, 1944. In the 1970s and 1980s, concerns that private landowners were not reforesting after harvesting led to several incentive programs and favorable tax treatment. While not a part of any formal policy debate, economic and financial research stressed the payoffs of both improved utilization of all material on harvested sites as well as increased economies of scale and integration in the design and operation of mill facilities.

Proponents of forest management also advocated the role of forestry in promoting economic development by supporting community stability through sustained yield even-flow timber policies. In the early 1960s, the Federal emphasis on rural development stimulated both interest in forest based economic development and emerging concerns about the effectiveness of forestry as a tool for regional economic development (see Kromm, 1972). Economists continued to speculate about the link between sustained yield of timber and community stability contributing to an intense political debate that did not subside until the 1990s when proponents were unable to change the debate about the relatively modest costs associated with habitat protection for the Northern spotted owl (*Strix occidentalis caurina*).

2.2. Understanding market forces

The theoretical and methodological roots of modern broad scale forest policy analysis owe much to developments in the economics and agricultural sectors. In the economics sector, Samuelson (1952) conceptualized the equilibrium conditions in spatially distinct markets leading to efforts to use programmatic approaches to solve for the prices, quantities and trade flows that maximizes the sum of consumer and producer surplus. In the agricultural sector, the development of macro-econometric models in the late 1960s and their use in policy simulation experiments (see, for example, Naylor, 1972 who described the form of the policy simulation approach still used today) served as examples for forestry research. McKillop (1967) is often credited with the first comprehensive econometric analysis of forest product demand using a theoretically complete specification.

Policy relevant forest economics research expanded rapidly in the 1970s, enabled by access to modern computers, more rigorous empirical training of researchers and the evolution of improved time series data for a number of key variables. Policy analysis that in the past had been based on hypothetical relations was now based on empirically developed frameworks that proved to be robust in an array of applications.

One outcome of this expanded research capacity was the development of models that represented the complete forest sector.[1] The development of a

[1] See Haynes, 1993 for, a synthesis of the development and uses of forest sector analysis.

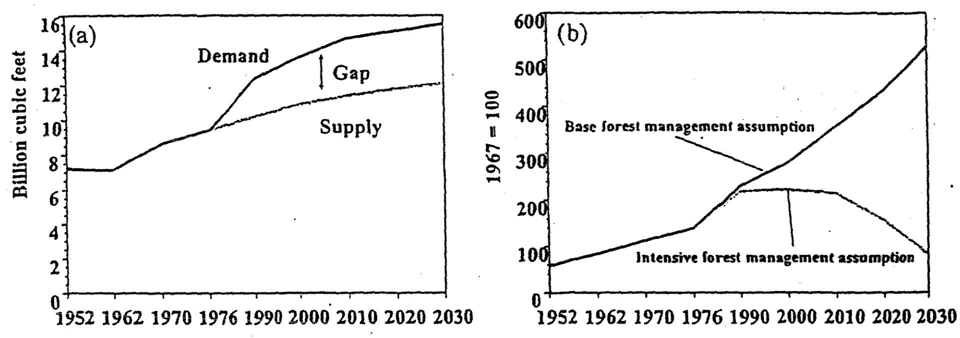

Fig. 2. (a) Determining policy needs based on quantity differences. (b) Determining policy needs based on prices.

forest sector model for the US was supported by the US Forest Service, who needed a comprehensive planning framework to meet the requirements of the Resources Planning Act (RPA).[2] This forest sector model (the timber assessment market model (TAMM) (Adams and Haynes, 1980; Haynes and Adams, 1985; Adams and Haynes, 1996) provided, an integrated structure for considering the behavior of regional prices, consumption and production in both stumpage and product markets. TAMM has been used for the past two decades to provide forecasts of market activity and to explore the need for, and the consequences of, various policy actions. It can be called a bio-economic model because it combines both economic and resource models.

The application of forest sector models changed forest policy development from describing policy needs in terms of quantity shortfalls (that were not observable with real world data) to trying to identify policy needs in terms of price impacts. This shift in the US occurred in the mid-1970s during a period of rapid changes in commodity prices (see Fig. 1) and concerns about the effectiveness of various policies to alter price trajectories. Prior to the 1970s, there had been relative stability in prices for protracted periods of time (for example, 1910–1945 and 1953–1968) leading to less emphasis on prices as a policy variable. This price based approach appealed to policy makers interested in price changes and estimates of consumer or producer impacts. This latter issue led to research estimating various welfare measures for addressing economic equity questions of who gains and who loses.

The power of looking at prices as a policy variable can be illustrated in Fig. 2 using data from a US Forest Service Assessment (USDA Forest Service, 1982). Fig. 2a illustrates the results of a gap analysis for projected supply–demand balances for US softwoods. Fig. 2b illustrates a stumpage price projection for softwoods in the Southern region of the US associated with balancing supply and demand in the stumpage market. To a policy maker, the inference in Fig. 2a is that projected demands will exceed available supplies and that policy actions will be needed to reduce the gap. For example, the policy discussion could be framed around reducing some shortfall of, say, 2.7 billion cubic feet in the year 2000. Fig. 2b illustrates the case where stumpage prices are used as the policy variable of interest. For example, if we assume continuation of recent timberland management practices, stumpage prices are expected to increase (net of inflation) at 2.1% per year between 1990 and 2030. The policy issue is framed around the societal acceptance of that rate of price increase. If, for example, it is not acceptable, we

[2] The Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA, 1974), as amended by the National Forest Management Act of 1976 (NFMA, 1976), directs the Secretary of Agriculture to prepare a Renewable Resource Assessment. The purpose of this Assessment is to analyze the timber resource situation in order to provide indications of the future cost and availability of timber products to meet the Nation's demands. The analysis also identifies developing resource situations that may be judged desirable to change, and it identifies developing opportunities that may stimulate both private and public investments.

could institute programs to increase softwood tree planting and conversion of low value hardwood stands on privately owned timberlands that would stabilize stumpage prices in the near decades and as the planted stands mature, eventually lower stumpage prices (see Fig. 2b).

The use of empirical policy tools also increased the ability to differentiate the regional and national market impacts of changes in the supply from one ownership in one region. The first practical application of this was an analysis of the potential responses of softwood markets to the Monongahela decision (see Adams et al., 1976) which had the potential to stop timber harvesting on all national forests and would especially impact western producers. In this analysis, lumber and stumpage prices would rise, increasing harvests from private timberlands and lumber imports from Canada. Stumpage prices would increase the most on the West Coast accentuating the concentration of lumber and plywood production in the South.

These latter results demonstrated the broad market impacts of what had been characterized as relatively local or regional policy issues. Similar results (see Haynes and Adams, 1979) about the impacts of expanded wilderness withdrawals demonstrated that changes in the availability of public timber in the West did not lead to drastic changes in timber prices. Rather increased production from private lands mostly in the South and increased lumber imports from Canada greatly reduced the potential price impacts associated with policy changes. These results infuriated proponents of maintaining or expanding Forest Service harvest flows but they were quickly adopted in ensuing policy discussions. The results were reaffirmed in the early 1990s following reductions in federal harvests in the West for habitat conservation.

The amount of market based supply response in these policy debates stimulated interest in understanding the nature of market incentives for private landowners to increase forest stewardship. A survey in the late 1970s had identified a number of treatment opportunities on private timberlands that in spite of forecasts of rising prices were not implemented. This led to a policy discussion about the need for planting incentives. The results of economic models showed that incentives that increased the extent of plantations in the near term would lead to increased inventories in two decades, reducing stumpage prices in the South, and elsewhere reducing financial returns of practices already implemented and lowering incentives for further stewardship. This dynamic link between actions now and impacts in the future was also an issue in the estimation of the economic effects associated with growth slowdowns expected to result from increased forest declines caused by acid rain or other air pollutants (Haynes and Kaiser, 1990). These results were contrary to biases of proponents for action since they showed that reductions in growth did not have economic impacts until growth in inventory levels slowed along with harvests several decades later.

2.3. *Broadening the understanding of market performance*

By the early 1980s, empirical economics research helped producers and landowners gauge the impact of the reductions in demands for forest products associated with the 1982–1984 recession. The accompanying collapse of forest product prices (Fig. 1) raised the need to discern real and nominal price trends. Within several years most US forest policy discussions shifted to differences in real price trends abstracting away from the influence of inflationary spirals. Also, the welfare impacts of broad scale forest policies had been examined. In general, this led to an understanding that most policies impacting the supply side had relatively modest consumer impacts but larger producer and stumpage owner impacts.

The growing importance of globalization increased the interest in understanding the economic basis for trade. In the US, the log export debates starting in the late 1960s and concerns about lumber imports from Canada had increased the interest in the economic basis for trade as well as how political action could intervene in bilateral trade issues. In concert with northern European countries, a world trade model at the International Institute for Applied Systems Analysis (IIASA) was developed for forest products based on the spatial equilibrium approach used in the US to forecast changes in world trade patterns of forest

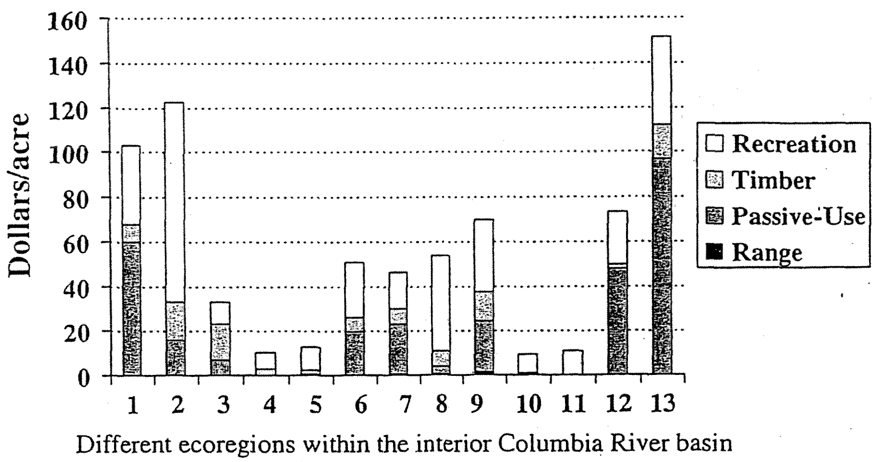

Fig. 3. Current market basket value per acre of Forest Service and Bureau of Land Management lands, 1994.

products (Kallio et al., 1987 for details). More recently, this long-standing interest in relying on economics to help inform trade policy has been focused more broadly on trade and environment questions (Brooks et al., 2001).

2.4. Measuring impacts

In the early 1990s, economic models were used to deal with the twin issues of the market impacts of reductions of federal timber flows and job impacts associated with those reductions. For the first issue, reductions in federal timber harvests (mostly for habitat conservation) were found to have little impact on consumers but relatively large impacts on producers who were caught between rising stumpage prices and a general inability to pass cost increases along to consumers. Timber owners generally enjoyed higher stumpage prices. For the second issue, job impact estimates were based on production levels that tended to fall slower than harvest levels.

The economic analyses used in the spotted owl controversy[3] were, in hindsight, relatively accurate and played a key role in the eventual policy decision. At the time, the results were extraordinarily controversial because they suggested that large-scale reductions in public harvest could be accommodated with few national impacts other than relatively severe local impacts on the forest products industry. The forest products industry and community groups argued that job losses in the forest industries would be detrimental to the survival of communities throughout the West. By the mid-1990s this controversary was often characterized as jobs vs. the environment. This characterization was in spite of two decades of economics research suggesting opportunities for mutual gains among forested goods and services and, at best, only weak links between timber harvest and community well-being.

There was also an evolution in how policy impacts were measured. The original definition of forest dependency in the late 1970s was in terms of jobs, which led to employment being used as a proxy for economic well-being. Controversy often surrounds the choice of direct and/or indirect job measures and by the early 1990s job estimates were based on only direct jobs (see FEMAT, 1993). Later policy impacts were being measured using broader notions of economic well-being of associated communities (McCool et al., 1997). Job estimates still play a role as a policy variable but its power to persuade has diminished.

There was also a resurgence of interest in the broader value of the collection of various goods

[3] See, for example the testimony describing the economic impacts of an injunction on selling federal timber in the Pacific Northwest (Seattle Audubon Society and others v. John L. Evans, Washington Contract Loggers Association, and others).

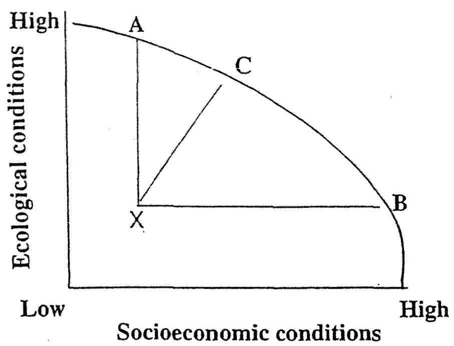

Fig. 4. Hypothetical joint production function between ecological and socioeconomic conditions showing opportunities for compatible changes of both.

and services derived from forest management. For example, Fig. 3 illustrates the value of different collections produced in different sub ecoregions. It shows the variation in the mix of goods and services depending on levels of use and the different resource endowments. Its estimation is based on the development of values and output measures for each of the goods and services.

Another implication from Fig. 3 is that forest managers are considering the opportunity to manage for mutual gains in an array of goods and services. This shift in focus from tradeoffs to seeking mutual gain (or greater balance) is still evolving but basic economic concepts lie at its inception. Fig. 4 suggests that compatibility exists between changes in environmental and socioeconomic changes, at least across a range of options. That is, opportunities exist for either mutual gains or increase in one dimension while the other dimension remains stable. Haynes and Quigley (2001) have found that for broad scale management alternatives there are extensive opportunities for complementary changes.

2.5. Emerging views on forest sustainability

Strategic discussions of broad scale forest policies are being increasingly set in the context of whether we can sustain[4] both increasing consumption of forest products and forest resource conditions. At the same time, there is interest in using existing data to understand relative changes in environmental and economic conditions.

Selected national data (converted to indices to make them comparable) grouped by criterion are shown in Table 1. These indicators are direct and indirect or proxy measures and show that there has been a general decline in many indicators charac-

[4] The US adopted the Montreal Process to facilitate a discussion of indicators for sustainable forest management (for a list see http://www.fs.fed.us/land/sustain_dev/sd/welcome.htm).

Table 1
Indices of changes for selected indicators for the US

	Criterion 1			Criterion 2			Criterion 6
	Extent of softwood area Percent of total	Extent of older stands 1976=100	Fragmentation 1952=100	Area of timberland 1952=100	Total growing stock inventory 1952=100	Ratio of growth to harvest Percent	Total harvest 1952=100
1952	70		100	100	100	128	100
1962	68		89	99	108	161	95
1970	66		97	97	114	164	111
1976	64	100	96	95	119	171	118
1986	59	76	124	96	124	125	162
1991	57	74	124	99	128	121	164
2000	58	67	110	99	136	144	151
2010	58	66	108	98	153	140	167
2020	60	65	107	97	166	130	181
2030	61	65	106	97	177	123	193
2040	62	65	105	96	186	117	202
2050	62	65	105	96	193	110	212

terizing conservation of biological diversity (criterion 1) and maintenance of productive capacity (criterion 2) but that this decline has slowed in the 1990s and is expected to stabilize in the future. At the same time, timber harvest (one indicator of socioeconomic benefits (criterion 6)) has shown increases suggesting that while in the period 1950–1980s there were tradeoffs between ecological conditions and economic growth, changes in public attitudes, improving forest management and increased productivity of forestlands resulted in greater balance by the 1990s. The various indicators also suggest that we are seeing an aging of the forests as production shifts to fewer planted acres. Overall timber types remain relatively stable after some initial declines in the 1950s and 1960s. The results also show that while fragmentation has emerged as a critical natural resource issue, it is expected to decline as an issue to the extent that it is driven by the amount of area harvested. Finally, these results have positive implications for the contribution of US forests to global carbon cycles (criterion 5). In general, US forest management has resulted in increasing total levels of carbon storage given that inventory levels are expected to increase by 42% over the next 50 years.

3. Evaluation of the role of research in shaping these processes

Economics research, both formal and informal, has been shaped by both broad policy questions and practical land management questions. Much of the context has been shaped by the strong emphasis on scientific management including social and economic aspects. Additional context is provided by the manifestation of social values as laws and regulations. In addition, perceptive individuals have influenced research agendas based on their observations of events and connections among events.

We have also benefited from a robust link between economics research and policy development. In this context, research has evolved to fill three roles: (1) specific information needs of managers and policy makers; (2) the development of systematic approaches to complex problems and (3) the provision of more rigorous understanding of processes where management often relied on intuitive approaches.

There has also been an evolution in the use of models in strategic planning by both government and non-government organizations. This is particularly evident in the use of simulation techniques to analyze alternative futures and management strategies to improve the perceptions held by land managers and the public. This approach, called scenario planning (Wack, 1985), has been a part of the RPA efforts since 1983 (USDA Forest Service, 1982; Haynes, 1990; Haynes et al., 1995). These applications take a classical sensitivity analysis approach where a limited number of key exogenous and endogenous elements were varied and key projection results were examined for differences. These differences allow the identification of emerging problems and provide a way to measure the effectiveness of possible solutions to various problems.

We have also treated policy analysis as a deliberate line of scientific inquiry. Such research is distinguished by its focus on contemporary questions, its inclusion of variables that reflect how policies are implemented and its ability to develop relevant measures of policy outcomes. Until the 1980s, this approach included individuals working in policy development who were familiar with research findings and who often acted as information entrepreneurs facilitating both research and policy development. In the last decade, the evolving notions of civic (see Lee, 1993) science have often placed researchers in this role.

Taking deliberate approaches to policy development has shaped the perceptions of land managers and policy makers eventually leading to better decisions. This approach has not resulted in less acrimonious debate or less controversy but these debates have been better informed. There are also instances where the policy analysis itself led to more intense controversy by exposing the importance of underlying processes that were themselves controversial.

4. Informing the policy processes

The US experience illustrates the evolution of interests in the role of science in developing land management and forest policies. This evolution mirrors, the general interest about the role of science in contemporary society (Lee, 1993) as well as an interest in developing science based approaches to ecosystem management (Sexton et al., 1999). In addition, the controversy stirred by the book, *the Skeptical Environmentalist* (Lomborg, 2001) suggests discord within the science community about the policy inferences suggested by many environmental trends. However, advancements from management and policy sciences are helping us understand that policy analysis is primarily concerned with changing the beliefs of policy makers about the consequences of alternative policies (Thorngat, 2001).

The increasing prevalence of broad scale questions is changing the nature of both science and the science/policy interface. Lee (1993) calls this civic science since it has to recognize a partnership between the science of broader landscapes or ecosystems and the political tasks of governing. In the recent large-scale ecoregion assessments, the socioeconomic sciences have readily contributed to an improved understanding of the context leading to the policy issues, the values of various stakeholders, the need to develop measures of the outcomes, and some notion of who gains and who loses in the decision process.

The experience in the US also is instructive in the use of integrative assessment modeling as a basis for policy analysis. Elsewhere, this is a topic of discussion (Tol and Vellinga, 1998 for a discussion of status in Europe) where the emphasis is on describing structure and greater standardization of methods. In the US, discussions of integrated assessments are often in the context of generalized approaches to planning (see Weiner and Vining, 1992) or in the use of risk assessments (US EPA, 1992). In the forest sector, we have a 50-year history of using formal assessments to describe the need and/or effectiveness of policy actions (Haynes, 1993 for a history of US assessment efforts).

Given how the evaluation of forest policy discussions have frequently involved economic questions, economic researchers have, in general, been effective at informing policy debates. This effectiveness has been enhanced by the tendency of economists to embrace rigorous approaches to policy analysis. This experience is similar to Kline's (2001) discussion of the growing recognition of the power of economic methods in understanding of environmental policy.

5. Lessons learned

The US has a long history of economics research in support of public policies for forest conservation as well as for production. This research has helped shape the perceptions of decision and policy makers as well as the interested lay public. Its legacy can be summarized in three components. The first deals with a number of lessons about how economic process functions. The second deals with the treatment of risk and uncertainty. The third deals with the importance of effective advocacy.

5.1. Economic lessons

There are seven lessons about economic processes that can be generalized from the US experience and that have relevance elsewhere.

1. Land tenure matters. Private timberland owners do respond (based on their objectives) both in terms of harvest and land management intensity to changes in prices and land values.
2. Increased environmental regulations often increase timber costs shifting production to cheaper producers both in that region/county and elsewhere.
3. In the US, economic adjustment costs for habitat conservation have been both modest and localized.
4. The public perceives a broader array of goods and services from the forest than do the land managers. Land managers often see production driven by timber values leading to shorter rotations, more softwood plantations and little incentive for management in places with limited potential for utilization.
5. There is an increased expectation for public goods especially from public timberlands. There is a general understanding of the effectiveness of incentives (such as Environmental Service Payments) to induce production of public goods on private forests but only a slight understanding

of the issues of continuity given the propensity for changes in land use.

6. While market mechanisms are reasonably well understood, there is less understanding of the relative power of other various institutional arrangements.
7. Models have been helpful in synthesizing information for policy development, but they share all of the limitations of those who build them.

5.2. *Treatment of risk and uncertainty*

Economic research; as one component of the management sciences, has influenced the contemporary thinking about the need and way to consider the relative risks associated with various policies. Most proposals for the use of environmental risk assessments as a part of policy development are set within a decision-making framework. In such an approach information is needed about relative risks, risk attitudes of decision-makers and costs and benefits.

The use of scenario planning approaches have facilitated strategic planning by providing policy makers with information necessary for decision making without knowledge about their welfare preferences or particular targets. These approaches also shifted the focus from predicting the future to looking at a set of plausible futures, each dependent on the assumptions that underlie that future. By doing so, the technique focuses on what might happen or go wrong and how to deal with it.

5.3. *Importance of effective advocacy*

The last and perhaps most important lesson is the absolute importance of effective advocacy of how science and particularly economic science can lead to better (in terms of impacts) and more enduring decisions or policies. To think that good science by itself will lead to better policies is naïve. Successful application of science to policy depends on those engaged in civic science or those policy information entrepreneurs who advocate for the use of selected science to specific policy questions.

6. Recommendations

The increasing complexity of the forest policy debates in the US greatly facilitated the evolution of economic research used in policy analysis. The key recommendation suggested by the US experience is the need for deliberate approaches to policy science. Without it economics research is no more powerful than other disciplines. With deliberate approaches to policy analysis, economic research can provide powerful tools and information that can help shape enduring policies that are both efficient and equitable.

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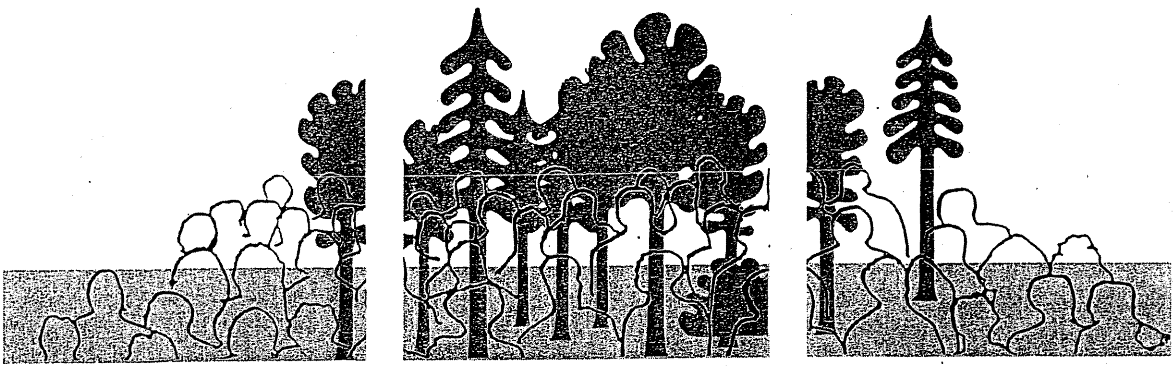

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