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Forest Economics and Policy Decisions in the PNW: Retrospective and Outlook

BY DARIUS M. ADAMS

As I have always reminded students in my forest economics classes, economics isn't about "money." Economic analysis as it's applied in forestry focuses on how people and institutions make decisions in environments where resources are scarce and trade-offs among resource values must be made.

Sometimes policy decisions relate largely to marketable goods and services, such as public or private forest owners considering the extent and timing of selling logs into regional markets. In these instances economists might employ well-tested tools such as supply and demand analysis to evaluate alternatives. In other cases, trade-offs can involve marketable goods on one hand against other services and outcomes that do not have markets or readily available prices. The policy debate over reducing federal timber harvest to enhance the likelihood of spotted owl survival in the early 1990s provides a notable example. In such cases economists must often devise novel means to model and quantify value trade-offs. The primary aim in analysis of all these questions, however, is to provide information to decision makers to facilitate their decision process. Economic analyses attempt to characterize gains and losses, benefits and costs, and who wins and who loses from a policy decision using measures consonant with the decision maker's values.

PHOTO COURTESY OF LONE ROCK TIMBER

Applications of economic analysis in forestry aim to help managers make better land stewardship decisions for their specific ownership objects.

The past few decades have seen a steady growth in application of economic analysis to forest policy problems and a significant increase in the scope and complexity of the methods used. Evaluations that were once only discussed in theoretical terms or conducted in highly simplified and aggregated form are now readily accessible to a broad range of owners and frequently applied. Two major types of forest policy problems, timber management decisions and policies that involve multiple and conflicting resource uses, provide useful examples of these changes.

Examples of trends in economic analysis

When I started my first job as an economist in the late 1960s, evenaged stand-level decisions on rotation age and other silvicultural practices were commonly made by extrapolation from responses measured in fixed silvicultural experiments. Stocking and marking guides for selection harvesting systems east of the Cascades were derived in a similar fashion, though from a much smaller set of experiments. These field studies were commonly established by public agencies and universities assuming management objectives that may or may not have coin-

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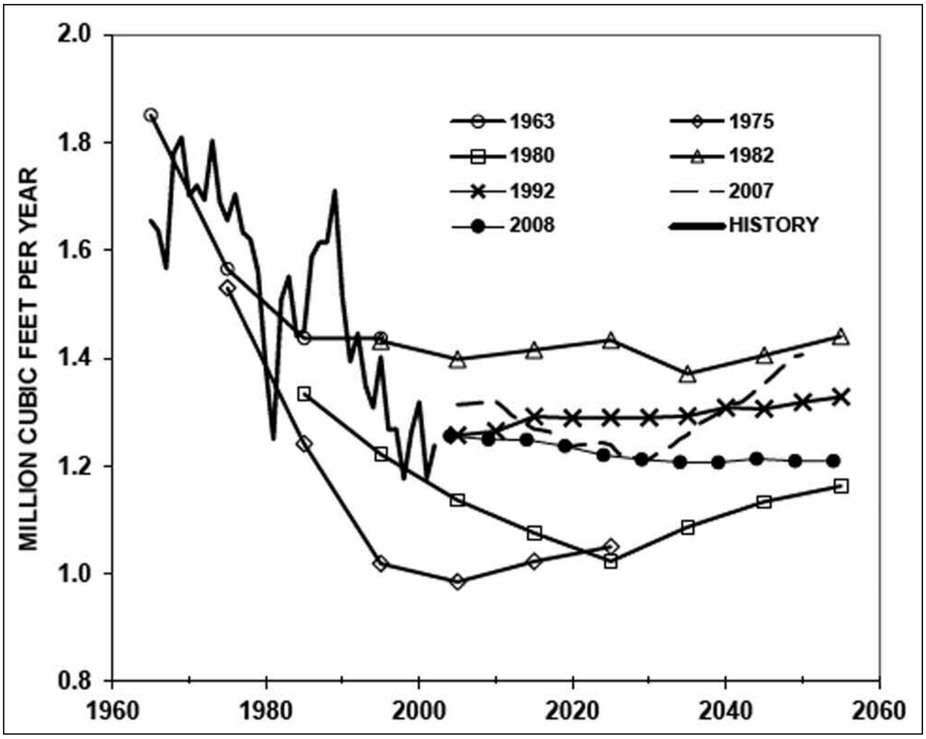
cided with those of any user.

At the forest level, scheduling harvests was commonly limited to estimates of aggregate volumes by period without identifying specific stands or areas and often with highly simplified assumptions about desired future forest structure such as the classic "full regulation." In many cases these approaches were dictated as much by insufficiently detailed inventory data as by lack of analytic methods. And at the regional level, projections of potential future timber supplies were based on crude projections of future yields, simple and highly aggregated inventory, and harvest decision models based largely on assumptions (or artificial targets such as "even-flow") rather than analysis of actual historical decision behavior.

In current practice, silvicultural decisions can be tailored to individual inventory units (stands, etc.) using methods that optimize thinnings and other treatments for the owner's objectives and values. Forest-level scheduling and management decisions can be based on detailed temporal and spatial models that may also be integrated with physical features to allow optimization of infrastructural and logistical decisions as well. Stand actions are often derived from forest harvest schedules to ensure consistency with overarching enterprise goals.

In today's approaches, long-term forest structures are shaped by intertemporal optimization of owner objectives and need not be imposed to facilitate the scheduling method (such as requiring some form of regulation). Even selection harvesting systems can be modeled and optimized in detail, yielding marking guides tailored to an owner's actual stands. And at the regional level, it is now possible to model resource actions at the inventory plot level, track harvest shipments from plots to mills over the transport grid, and estimate potential product output from log harvest by mill. Current capabilities even allow simulation of the development of new products to assess their feasibility and impact on the forest resource and existing industries.



SOURCE: UPDATED FROM ADAMS, D. M. AND G. S. LATTA. 2007. TIMBER TRENDS ON PRIVATE LANDS IN WESTERN OREGON AND WASHINGTON: A NEW LOOK. WESTERN JOURNAL OF APPLIED FORESTRY 22(1):8-14.

Examples of projections of regional private timber harvest in western Oregon and Washington from seven past studies by date of publication with actual historical cut, 1965-2016.

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Next Issue: Editor's Choice

Policy decisions involving multi-resource trade-offs (e.g., timber, wildlife, types of recreation, visual amenities, water quality, or housing and infrastructural developments) have occasioned major controversies in the Pacific Northwest. Decision analysis is highly complex because of modeling and measurement problems across the various resources and conflicting views about the relative importance of resource values.

Examples include design of wildlife reserve or refuge areas involving limitations on timber harvest and infrastructure, wildlife corridors to allow habitat connectivity with associated exclusion of development or other land use changes, and allocation of reserved lands to alternative types of recreation activities (e.g., motorized or non-motorized). Past analyses have often taken the form of scenario comparisons in which a limited number of decision options are evaluated across a range of resource value measures. Expert panels have frequently been used to identify alternatives and also to select the "best" option based on personal knowledge of physical trade-offs and subjective weightings of conflicting use values.

In recent years economists and decision analysts have developed methods to aid in the identification of alternatives in these cases. New approaches allow the structuring of alternatives such that land allocations yield the highest output of one set of competing values for a given (restricted) set of competing outputs. These are termed "efficient" alternatives. Selecting among them still requires some subjective weighting of alternative values. But decision makers know that each option yields the greatest output of any specific resource value given the restricted output levels of the others. Indeed, this knowledge alone is often sufficient to identify use allocations that allow expansion in a subset of values with no reduction in others simply by eliminating inefficient management actions.

Drivers of past change

The dramatic changes illustrated in the timber management and multi-

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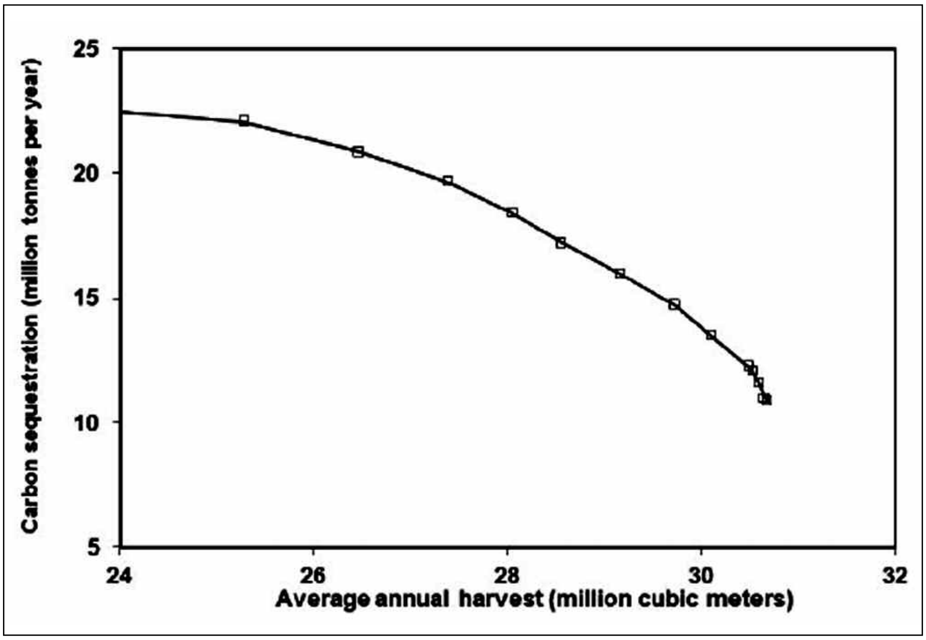
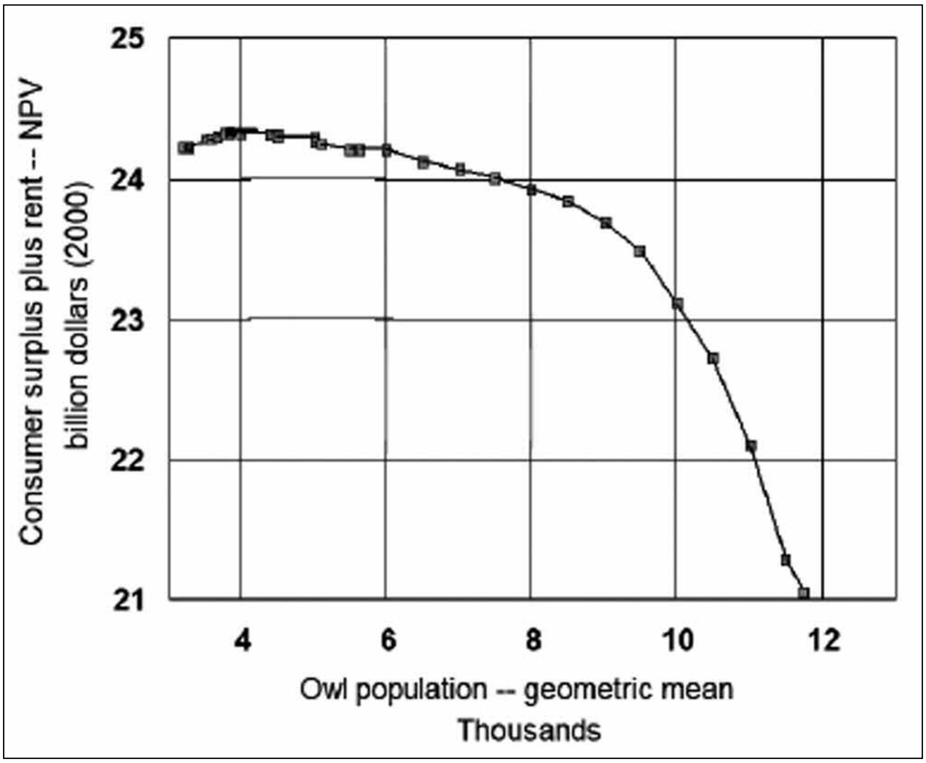


SOURCE: ADAPTED FROM IM E, DM ADAMS, GS LATTA. 2010. THE IMPACTS OF CHANGES IN FEDERAL TIMBER HARVEST ON FOREST CARBON SEQUESTRATION IN WESTERN OREGON. CANADIAN JOURNAL OF FOREST RESEARCH 40: 1710-1723.

This graph depicts estimated recent average timber harvest and forest carbon sequestration on all lands in western Oregon (single point) and the simulated trade-off curve between timber harvest and carbon sequestration IF harvest on federal lands was expanded to Northwest Forest Plan volumes. The curve is obtained by optimally constraining private harvest in the region at various levels.



SOURCE: ADAPTED FROM NALLE, DJ, CA MONTGOMERY, JL ARTHUR, NH SCHUMAKER, AND S POLASKY. 2004. MODELING JOINT PRODUCTION OF WILDLIFE AND TIMBER IN FORESTS. JOURNAL OF ENVIRONMENTAL ECONOMICS AND MANAGEMENT 48(3): 997-1017.

Simulated trade-off between great horned owl population and present value of net future timber harvests on all lands in west-central Oregon Cascades using a 150-year look-ahead period. Trade-offs obtained by optimally constraining timber harvest from all owners at various levels.

resource trade-off examples described above were driven by four major trends. Most important has been the improvement in resource inventory data on all ownerships, particularly use of remeasured plot systems, more plots to reduce sampling error, and more detailed stem and stand measurements. Better inventories allow use of more sophisticated tree growth models calibrated to the owner's specific stands and more detailed estimates of tree and stand qualities for both timber and non-timber values. More plot measurements and the advent of GIS technologies also facilitated the addition of spatial detail to inventories and explicit recognition of location-dependent processes (such as transportation) in economic studies.

Economic analysis of forest policy decisions is wholly dependent on knowledge of the response of natural systems to management actions. Thus improvements in tree growth and other biophysical models have allowed expansion in the scope and detail of economic studies. For example, movement from earlier age and site-dependent yield tables to individual tree models with explicit inter-tree competition provided a basis for more useful analysis of intermediate stand treatments such as thinning. With more detailed stand and vegetation data supplemented by spatial characteristics, it has also been possible to replace crude habitat suitability indexes with species occurrence, and even species population models in estimating wildlife impacts.

More inventory data, inclusion of the spatial dimension, and better biophysical models have allowed analysts to approach more realistic (i.e., detailed) decision problems with much larger computational burdens. Steady improvements in computer capacity and speed have made simulation or solution of these problems feasible. Analytical software—such as harvest scheduling programs, linear programming and other optimization codes, and generic system simulation programs—with large solution capacities is now widely available in commercial form. For example, closed form optimization problems entailing millions of activities and hundreds of thousands of constraints are readily accommodated with many commercial programs and can be run on a laptop PC.

Economic theory and modeling have also evolved to permit more flexible approaches to depict the behavior of economic agents in markets and resource use decisions. For example, early studies of markets or timber supply commonly represented private owners' harvest decisions by means of simple fixed rules (e.g., harvest some fraction of trees over a certain age or diameter) or using crude and largely ad hoc price-sensitive supply equations (e.g., cut is a function solely of price and inventory). With expanded theory, better inventory, and more market data it is now possible to statistically estimate behaviorally consistent private timber harvest relations. And where this is not feasible, private utility maximizing behavior can be simulated from basic components of prices, costs, discount rate, and growth characteristics of the inventory. In effect we can mimic the harvesting decisions that would result if private owners behaved exactly as our theories suggest, including the recognition of side constraints (such as amenity or other non-monetary values derived from older stands).

Outlook and challenges

Looking to the future, I believe that technical inventory advances (such as LIDAR measurements within stands, improved GIS software, and more extensive and detailed use of satellite imagery to extrapolate fixed inventory measurements) will continue to allow improvements in economic analysis. Studies will have still greater detail and produce results more apt to decision makers' specific circumstances. Computer capabilities and access (such as cloud computing) will improve apace to accommodate the increased computational burden.

The stage is also set, I think, to see some early applications of machine learning to forestry decision problems, fueled by the growing number and detail of stand and forest databases. Some examples might include: use of classification algorithms developed from existing databases to "grade" logs by tree in stands surveyed with emerging LIDAR methods; fire suppression decision support based on weather, fuels, topographic, and spatial fire details; and improved biophysical models of wildlife species occurrence and populations based on vegetation, disturbance history, and climate outlook.

My comments to this point were intended to paint a broad picture of trends in methods of economic analysis available to aid forest policy decisions. There are, of course, wide differences in the extent to which these methods and improvements have actually been employed by various forest owners.

Generally, larger private ownerships have been aggressive and early adopters while smaller private owners have been much more variable in access and use. Applications in public ownerships have varied markedly over time, ostensibly as their specific mixes of values and objectives have changed. In all cases, however, both knowledge of available decision aids and the extent of foresters' basic skills in forest policy analysis represent key barriers to access. ◆

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