Annotated Bibliography of the Economic Implications of Managing Nonpoint Forestry Sources of Water Pollutants[1]

by

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INTRODUCTION

Amendments to the Federal Water Pollution Control Act have focused concern on the quality of water flowing from forest lands and the forest management practices which impact water quality. Of special concern has been the need to better understand the economic implications of altering existing forest practices or undertaking new practices so as to achieve desired levels of water quality from forested areas. What are the marginal or added costs that must be borne by public or private landowners if they are required to undertake new or modify existing forest practices? What impact do such costs have on landowner net revenue? And what might be the economically optimum package of forest practices that is consistent with the revenue objectives of the landowner and with publicly imposed water quality standards? Answers to questions of this nature are important to public and private landowners and to public policy makers charged with responsibility for curbing water pollutants originating from forest land-management practices.

This bibliography seeks to identify a sampling of current literature dealing with the economic implications of managing nonpoint forestry sources of water pollutants. Topics included in the bibliography vary widely in scope and subject material. In general, only articles and reports considered unique to the literature of economic analysis of water quality have been included--efforts were made to avoid duplication. The following general subjects were sought out for inclusion:

- production function relationships
    - . impact (physical) of forest practices on production of quality water.
    - . impact (physical) of forest vegetation on production of quality water
- costs and benefits of managing for quality water
    - . objectives of management
    - . costs of achieving added water quality
    - . benefits attributed to additional water quality
    - . sector-wide (regional) impacts of forest practices undertaken to produce quality water
- techniques and conceptual models for evaluating the economics consequences of managing for quality water.

The contents of the bibliography are listed alphabetically by author and are annotated so as to give the reader a greater appreciation of the subject material being addressed.

BIBLIOGRAPHY

Bailey, G. W. and T. E. Waddell. 1978. Best management practices for agriculture and silviculture: an integrated overview. In: Best Management Practices for Agriculture and Silviculture. Proceedings of the 1978 Cornell Agricultural Waste Management Conference. pp. 33-56.

Reasons for nonpoint sources of pollution are examined. Authors conclude that the pollution problem is multi-dimensional involving physical/technical problems and social/economic constraints. A flowchart is provided for the purpose of identifying, selecting, and implementing best management practices. In conclusion, they list policy issues and research needs which summarize major concerns raised by their article.

Cobb, Gary. 1981. Nonpoint pollution control from the standpoint of research. In: Tools and Techniques for the Future. Proceedings of a Technical Symposium. Interstate Commission on the Potomac River Basin, Publication 81-1. pp. 7-10.

An overview of programs supported by the Office of Water Research and Technology in the U. S. Department of Interior is presented. Most of their programs to date have been concerned with agricultural and urban sources of nonpoint pollution.

Dykstra, Dennis P. and Henry A. Froehlich. 1976. Stream protection: what does it cost? Loggers Handbook (Pacific Logging Congress, Portland, Oregon). Volume 36. pp. 25-28.

Report examines how different harvesting treatments affect felling and yarding costs and influence the quantity of logging debris that enters streams. Costs of removing debris from streams are computed. Comparisons are made between various harvesting methods with regard to their impact on debris loading in streams and the cost of removing the debris following harvesting. A short segment on buffer strip survival is provided.

Ellefson, Paul V. 1976. Forest practices and water quality: opportunities for legislative and educational responses. Presented at the American Forestry Association's workshop on forest practices and water quality. Chicago, Illinois. April 13, 1976.

Need for renewed or continuing flows of high quality water from forest lands as mandated by the 1972 Amendments to the Federal Water Pollution Control Act is highlighted. Author suggests that an educational program be the first step toward achieving or maintaining high water quality. If the educational program is unsuccessful, a subsidy program should be the next step, followed, if necessary, by a regulatory program. Finally, research should be conducted to develop a thorough understanding of water pollutants and the practices and programs that can be used to keep such pollutants at acceptable levels.

Corbett, Edward S., James A. Lynch, and William E. Sopper. 1978. Timber harvesting practices and water quality in the eastern United States. Journal of Forestry 76(8):484-488.

Data from forested experimental watersheds in the eastern United States indicates that concentrations of nutrients in streamwater are highest where revegetation of cutover areas is delayed. Also, increased streamwater temperature (in addition to increased light) caused by exposing stream chnnels may alter water quality. Soil erosion losses from harvesting operations can be reduced by following current land-management guidelines. Buffer strips and filter strips will help minimize sedimentation as well as nutrient leaching and stream temperature increases.

Davey, William B. 1977. United States Forest Service erosion control guidelines. In: Conservation Districts and 208 Water Quality Management. EPA/National Association of Conservation Districts. pp. 285-291.

Guide provides information regarding the control of the following silvicultural nonpoint sources of water pollution: 1) access systems, 2) harvesting, 3) crop regeneration and intermediate practices and activities. The author arrives at these broad conclusions: 1) pollution emmanating from access systems may be greatly reduced by careful location, design, construction, and maintenance of the roads; 2) pollution caused by harvesting operations can be reduced by minimizing soil disturbance and compaction; and 3) pollution caused by regeneration and intermediate activities can be minimized by application of proper techniques under favorable conditions by well trained and supervised personnel.

Environmental Protection Agency. 1980. An approach to water resources evaluation of nonpoint silvicultural sources (a procedural handbook). EPA-600/8-80-012. Environmental Research Laboratory, Athens, GA.

Handbook provides a method of analysis that can be used to describe and evaluate changes to the water resource resulting from nonpoint silvicultural activities. It covers only the pollutant generation and transport processes and does not consider the economic, social, and political aspects of pollution control. This handbook contains numerous flowcharts, tables, and figures.

Environmental Protection Agency. 1977. Silvicultural activities and nonpoint pollution abatement: a cost effectiveness analysis procedure. EPA-600/8-77-018. USDA Forest Service, Office of Research and Development, U.S. Environmental Protection Agency. National Technical Information Service, Springfield, Virginia.

Report focuses on erosion that contributes to nonpoint water pollution occurring in forested environments as a result of silvicultural activities. Specifically the document discusses three topics: 1) silvicultural activities that are currently being applied throughout the United States, with indications of how these practices might affect the rate of erosion; 2) a method for determining the cost-effectiveness of erosion control practices; and 3) examples applying the described method for economic analysis using information provided in 1). The information and outlined method are intended for forest managers and water quality planners to enhance analysis and improve decisions concerning the reduction of nonpoint pollution problems.

Environmental Protection Agency. 1976. Loading functions for assessment of water pollution from nonpoint sources. EPA-600/2-76-151. Office of Air, Land and Water Use, Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 20460.

Handbook has two basic functions. First, it presents loading functions together with the methodologies for their use and assessments of their adequacy. Second, it presents some of the needed data, provides references to other sources of data, and suggests approaches for generation of data when available data are inadequate. The program which generated this handbook made extensive use of the Universal Soil Loss Equation in formulating loading functions for sediment, nitrogen, phosphorus, organic matter, and pesticides. Procedures for estimating background pollution are presented.

Environmental Protection Agency. 1973. Processes, procedures and methods to control pollution resulting from silvicultural activities. EPA-430/9-73-010. EPA, Washington, D.C.

Report presents a brief documentation of silvicultural practices. Of primary concern were those aspects of silvicultural activities which relate to nonpoint source pollution control methods. The study objective was to analyze existing and near-future pollution control methods in terms of technical and economic practicability and usefulness.

Environmental Protection Agency. 1976. Nonpoint-source pollution in surface waters: associated problems and investigative techniques. EPA-680/4-75-004. National Environmental Research Center, Office of Research and Development. EPA, Las Vegas, Nevada.

Brief overview of sources of nonpoint pollution including silviculture is provided. Types of pollution are discussed and methods and models for quantifying the levels of these pollutants are described. Techniques for monitoring nonpoint-source pollutants including manual field sample collection, automated samples, automatic contact sensers, and remote sensing devices are reviewed.

Everett, H. W., II and W. L. Miller. 1975. Sectoral and regional economic impact of controlling nonpoint pollution in forested areas. Water Resources Research Center. Purdue University, West Lafayette, Indiana. Technical Report No. 53.

Study assesses the consequences of alternative methods of managing forest land for the production of timber. Objectives are: 1) to determine the impacts of alternative forest management practices, harvest methods, rates of harvest and rates of discount upon economic output and soil losses generated from forested lands in Lincoln Hills, Indiana; 2) to illustrate the relationship between economic output and soil losses due to the application of alternative forest management practices, harvesting methods, and rates of harvest utilized in the development of this resource; 3) to determine the regional impact of the development of its forest resources. The researchers employ two models in their analysis; a linear program for determining the effects on the "firm" and a general equilibrium model for determining the regional effects.

Gardner, R. B. 1971. Forest road standards as related to economics and the environment. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah. Research Note INT-145.

Economic considerations of building a forest road are weighed against environmental concerns. The author advocates building longer-lived (50-100 years), lower-standard, single-laned forest roads as they will have low impact on the total environment. He concludes that analyses to determine forest road standards cannot end when the direct cost to the user has been determined, as has been the case in the past; this too often results in many indirect costs to environmental quality. The report contains no quantified water pollution data.

Gillick, Thomas and Billy Dean Scott. 1975. Buffer strips and the protection of fishery resources: an economic analysis. State of Washington Department of Natural Resources. DNR Report No. 32.

Report provides insight into methods of determining optimal width of buffer strips. The method used employs decision theory, which is based on probability estimates incorporated into an economic model. The analysis uses the net economic value approach to evaluate timber and fishery resources. Subjective probabilities of fish losses are used to develop a relationship between different buffer widths. A sensitivity analysis of differential probabilities and prices is made also. This analysis supports, economically, the position that buffers do not have to be extensive to protect fishery resources.

Grefath, Bruce C. 1974. Federal Water Pollution Control Act and forestry. Journal of Forestry Vol. 72, pp. 757-759.

The goals and definitions of the Federal Water Pollution Control Act are reviewed by the author. Specifically discussed are: 1) the role of the federal government in administering the act; 2) the states' obligations; and 3) the obligations of local governing bodies. Author concludes that the FWPCA will have an impact on forestry and that foresters have a responsibility to initiate momentum for the development and implementation of state water pollution control programs.

Gregersen, Hans M. and K. Brooks. 1978. Economic analysis of watershed projects: special problems and examples. FAO Forestry Paper 17, Suppl. 2. Economic analysis of forestry projects: readings. Rome, 1980. pp. 133-174.

Paper presents an overview of some special problems associated with economic analysis of watershed projects. Several examples and case studies are provided to give insight into these problems. Several aspects receive special attention: 1) consideration of alternative means for achieving project goals, 2) determination of project scope and context, 3) identification of costs for watershed projects, 4) identification of benefits, 5) treatment of benefits and costs in multiple purpose projects, and 6) presentation of cost and benefit information in an appropriate form. A summary of some of the relevant literature is also presented.

Hartung, Robert E. and James M. Kress. 1977. Woodlands of the northeast-erosion and sediment control guidelines. USDA Soil Conservation Service and Forest Service, Broomall, Pennsylvania.

Handbook is designed to guide practitioners in the planning and application of soil erosion and sediment control measures to forest lands in the northeastern United States. The handbook contains both current information on the subject and information about practices that have existed for many years. In general, the guidelines are designed to minimize soil erosion from forest lands during and after harvesting practices.

Hickman, Clifford A. and Ben D. Jackson. 1979. Economic impacts of controlling soil loss from silvicultural activities in east Texas. Forest Service, Vol. 25 (4):627-640.

A linear programming model was used to study some of the economic consequences of imposing controls to limit soil loss from silvicultural activities in a northeast Texas county. Specifically, four control alternatives were evaluated in terms of their impacts on aggregate net income to forest landowners and aggregate timber output. These alternatives were an aggregate soil loss limit, a per unit area soil loss limit, a tax on excess soil loss and a subsidy for reduced soil loss. It was found that each of these controls necessitated substantial reductions in landowner income and timber output to achieve only modest reductions in soil loss. The significance of these results is discussed as is the potential usefulness of the linear programming model as a basis for decisionmaking about the rationality of silvicultural nonpoint source controls.

Kemper, Robert E. 1974. Costs of Environmental Constraints on Timber Harvesting and Regeneration Programs. MS Thesis. Utah State Univ.

Study objective was to develop and empirically test a method for estimating the costs of environmental and aesthetic constraints associated with timber harvesting and regeneration programs. Constraints used in the study were: 1) smaller cut areas; 2) more clean-up of slash and debris; 3) prompt regeneration; 4) increased supervision; and 5) fewer and better roads. "Environmental cost" was arrived at by first calculating the cost of the "standard" timber harvesting and regeneration program and then subtracting this value from the cost of the specified "most aesthetic" program. Significant cost increases occurred in the regions studied between mid-1960's and 1975 due to new environmental and aesthetic constraints.

Kemper, Robert E. and Lawrence S. Davis. 1976. Costs of environmental constraints on timber harvesting and regeneration. Journal of Forestry, Vol. 74(11):754-761.

Responding to public concern, the Forest Service has adopted timber harvesting and regeneration practices that enhance environmental and aesthetic values. A method for measuring the cost of these practices has been developed and empirically quantified for two western national forests. Between Earth Day (1969) and 1973, these practices increased costs by 14 and 26 percent on the two forests.

Kerns, Waldon R. 1981. Nonpoint pollution: future economic and financial issues. In: Tools and Techniques for the Future. Interstate Commission on the Potomac River Basin, Publication 81-1. pp. 267-273.

Economic issues of our water quality programs are presented by the author. Questions raised included: 1) should water quality goals vary with locality? 2) who will benefit and who will pay for improved water quality? 3) should water pollution control be based on incentives and individual voluntary initiative, or by the more traditional regulatory approach? 4) how much pollution control is enough in light of economic constraints? 5) where should government direct its influence?

Kimmins, J. P. 1976. How to provide for environmental protection -- by regulation or by use of the price system? In: Timber Policy Issues in British Columbia. University of British Columbia Press. Vancouver, British Columbia. pp. 109-123.

Author compares government regulation with the price system as methods for achieving "environmental protection." Guidelines and standards are recommended over the use of a simple regulation system or a price system in protecting the environment.

Klock, Glen O. 1976. Estimating two indirect logging costs caused by accelerated erosion. USDA Forest Service. General Technical Report PNW-44.

Effects of eroded soil material in a stream system can be measured in terms of loss of site productivity, sedimentation, water quality, fisheries habitat loss, and increased need for erosion seeding and control. By developing unit cost figures for these effects, it may be possible to show that soil loss by erosion can be a long-term, indirect cost. The author discusses total indirect costs--a combination of onsite and downstream damages--and concludes that if the erosion costs can be determined they should be added to the direct operational costs when systems of log removal for a particular forest site are evaluated. When these indirect costs are added in the total cost of using "advanced" logging methods may be less than that of traditional systems.

Larson, F. R., P. F. Ffolliett, W. O. Rasmussen, and D. R. Carder. 1978. Estimating impacts of silvicultural management practices on forest ecosystems. Rocky Mountain Forest and Range Experiment Station and School of Renewable Resources, University of Arizona.

Authors describe a family of computer simulation models called ECOSIM. The component of interest with regard to water quality is the WATER module. The WATER module is comprised of generalized components to predict stream flow yield, suspended sediment load, and chemical quality of stream flow. The program outputs estimates of stream sedimentation resulting from alternative silvicultural management practices.

McClimans, Richard J., George F. Taylor, Andrew Huggins, and Ann Bowen. 1978. Annotated Bibliography of Forest Practices in Relation to Water Quality. State University of New York, College of Environmental Science and Forestry, Syracuse, New York 13210. Applied Forestry Research Institute.

Bibliography is topically organized as follows: 1) Forest Hydrology Soils and Water Quality; 2) Forest activities and their impacts on Water Quality; 3) Forest Management and Economics; and 4) Legislative and Social considerations.

McGreer, Dale Jay. 1974. Stream Protection and Three Timber Falling Techniques: a Comparison of Costs and Benefits. M.S. Thesis. Oregon State University, Corvallis, Oregon.

Study objective was to quantify the amounts of logging residues that are added to mountain stream channels as a result of three different timber falling-logging procedures, and to evaluate these procedures with respect to both ecological and economic considerations. Economic considerations included stream debris removal, timber volume left unharvested in buffer strips, timber falling labor and equipment, and timber breakage. Streamside environmental impact was evaluated in terms of the quantity of logging debris entering stream channels during falling and yarding and remaining in the stream channels after logging was completed.

O'Hayre, Arthur Paul. 1976. A Hydronomic Analysis of Resource Management Alternatives: A Case Study of Itasca County. Ph.D. Thesis. University of Minnesota. St. Paul, Minnesota.

Thesis presents a methodology based on input-output analysis capable of predicting the regional economic and water quality effects of resource management alternatives. Environmental models were developed to simulate regional lake and river water quality for given levels of sector outputs and residuals discharged. Data requirements for these models are extensive.

Pennock, C. M. 1977. Virginia's water quality control program for loggers. Southern Journal of Applied Forestry, 1977. 1(4):2-3.

Reports on a series of meetings held throughout Virginia for the purpose of informing loggers about the Federal Water Pollution Control Act and the probable impact on the logging industry. Meetings emphasized the need for voluntary compliance with good management practices to avoid regulatory programs. Since the meetings, field inspections have documented increased voluntary forest road stabilization.

Miller, W. and D. Byers. 1972. Economic efficiency vs. environmental quality in small watershed development. American Water Resource Association, National Symposium on Watersheds in Transition, CSU Proc. pp. 63-67.

A modified linear programming model was developed for this study in order to weigh the many variables associated with watershed planning and to permit comparison of economic efficiency and environmental quality. The key elements of the model included an objective function for net national benefits subject to constraints for environmental quality. The report is divided into four major sections: 1) description of the case study watershed, 2) discussion of the multiple objective watershed planning model, 3) analysis of the relationship between the nongame bird environmental component and economic efficiency, and 4) examination of the policy implications of the study.

Miller, W. L. and H. W. Everett. 1975. The economic impact of controlling nonpoint pollution in hardwood forestland. American Journal of Agricultural Economics. Vol. 57(4):576-583.

Authors examine the economic impact of alternative methods of sediment control. Research objective was to determine economic impact of altering forest management practices, harvesting methods, and rates of harvest to reduce the sediment loss from forest land. Two models were used to form an economic analysis. One model was used to analyze the direct change in income to forest land owners and the other was used to analyze regional income change. Regional income change was determined to be 23 times greater than the direct income change to forest land owners.

Schick, Bruce A. 1977. Forest practice regulations: weighing their potential economic effects. (Unpublished).

Author discusses potential benefits and costs of various forest practice regulations. Forest practices examined include: 1) minimum tree diameter limits; 2) road construction and forest clean-up activities; and 3) a requirement for management, harvest and regeneration plans. Although benefits and costs are not quantified a framework of reference for defining apparent benefits and costs of suggested forest practice regulations is provided.

Soil Conservation Service. 1964. Economics Guide for Watershed Protection and Flood Prevention. U.S.D.A. S.C.S. Washington, D.C. March 1964.

Purpose of text is to provide guidance in the use of economic evaluation procedures on watershed projects. Evaluation methods, procedures, and examples are outlined along with basic economic principles and concepts. These evaluation techniques can be made to fit the widely varying physical and economic characteristics encountered in the field.

Sonzogni, William C., Timothy J. Monteith, Thomas M. Heidtke, and Rose Ann C. Sullivan. 1980. WATERSHED: a management technique for choosing among point and nonpoint control strategies. In: Seminar on Water Quality Management Trade-offs--Point Source vs. Diffuse Source Pollution. EPA No. 905/9-80-009. 1980. pp. 87-124.

A modeling technique, WATERSHED, was designed to assist water quality managers and planners in formulating cost-effective pollution control strategies for alternative point and nonpoint source control within a drainage area. With WATERSHED the user can estimate loadings from each major pollutant source and examine load reductions and costs associated with control options. Point and nonpoint source control strategies can then be ranked on the basis of cost per unit reduction in pollutant loading to the receiving waters.

Unger, Samuel G., Jarvin M. Emerson, and David L. Jordening. 1973. State-of-Art Review: Water Pollution Control Benefits and Costs. EPA-600/5-73-008a.

Survey reviews methods for analyzing economic effects of pollution control. Some of the subjects covered include: 1) benefit cost framework, 2) pollution control costs, 3) benefit measurement, 4) benefit cost aggregation framework, and 5) general equilibrium models. A number of summary observations regarding the current state-of-art are presented and a final section outlines research needs.

Waelti, John J. 1975. Some economic considerations in water quality management. Water Resources Research Center, University of Minnesota, Unpublished.

Author describes two costs of water pollution: 1) abatement costs and 2) costs due to pollution damage, and explores the economic reasons for water pollution. The optimum level for water pollution is cited as being the point at which the marginal benefit of the last unit of waste treatment equals the marginal cost of treating that unit. The author describes how the burden of pollution control costs will be distributed depending on whether a regulatory or subsidization approach is taken by government.

Weible, Ralph E. 1978. The economics of managing nonpoint forestry sources of water pollutants. Plan B Masters Thesis, University of Minnesota, St. Paul, MN.

Author: 1) reviews the 1972 Amendments to the Federal Water Pollution Control Act; 2) describes how forest practices affect water quality; 3) reviews the literature of the day; 4) describes an economic method for determining the best management practices for controlling sedimentation; and 5) examines in detail the costs to a small southeast Minnesota timber operator of implementing forest practices (buffer strips, seeding, skid trail layout) to diminish the amount of sedimentation due to logging. Benefits derived from implementing the forest practices are not quantified.

Winger, Harold S. 1978. No problems: no BMPs needed. Forest Farmer. Vol. 38(1):11,16.

Author describes in brief Section 208 of the Federal Water Pollution Control Act (PL 92-500). Section 208 enjoins each state to assess current water quality problems arising from silvicultural activities. If there are problems, the state is to enact either voluntary or regulatory Best Management Practices (BMPs). If no water quality problems exist, there would be no need for BMPs. The author outlines the status of 208 Silvicultural Plans by state for the southern states. He concludes by suggesting that the timber industry control its fate by maintaining high water quality thus negating the need for the implementation of BMPs.