

Economic Research Institute Study Paper

ERI #95-21

**AN AGENDA FOR THE STUDY OF LAND USE, WILDERNESS
DESIGNATION, AND RESOURCE REGULATION IN THE
AMERICAN WEST**

by

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October 1995

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ABSTRACT

Atemporal and intertemporal use of public lands, the determination of optimal levels of wilderness designation and habitat preservation, and the appropriate regulation of natural resources have all been “hot button” issues in the American West for quite some time now. In this paper, I propose and describe a research agenda which promises to yield interesting and useful new policy insights into these fractious resource issues.

JEL Classification: B41, Q20, Q25

Key words: land use, wilderness, regulation, research, agenda

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1. Introduction

The systematic use of natural resources has been a part of life in the American West for well over two hundred years. Grazing, mining, and ranching have all been an important part of the economies of the various states in this area. Not surprisingly, with use has come federal and state involvement; this involvement has primarily been regulatory¹ in nature. While many of the policy issues surrounding natural resource use have not changed much in the last two hundred years (Clawson, 1983, p. 2), the *nature* of the regulatory relationship between the regulating party and the regulated party has changed considerably over time. Increased public expertise of resource management issues, dissatisfaction with governmental resource management policies, and new attitudes toward conservation and exploitation have all combined to dramatically alter the character of this regulatory relationship (Cawley, 1993).

In the American West, the most visible manifestation of this altered relationship has been conflict. There is conflict over federal jurisdiction over and management of public lands (Price, 1982), there is conflict over the extent of wilderness designation and habitat preservation (White, 1994), there is conflict over the desirability of saving endangered species (Mortensen, 1994), and there is conflict over the need for multiple-use management of public forestlands (Blumm, 1994). While this fractious environment has generated considerably more heat than light, the same environment has provided a number of interesting economic research questions.

¹In the rest of this paper, I shall use the terms management and regulation interchangeably.

First, what can economic theory tell us about optimal patterns of land use over time. Specifically, what are the impacts of , potentially, irreversible development on public lands, and how is the pattern of land use altered by the land manager's acquisition of new information about particular aspects of land management?

Second, what is an appropriate mechanism for addressing debates about wilderness designation and habitat preservation? Furthermore, once such a mechanism has been identified, what does this mechanism tell us about equilibrium behavior by the various participants in such debates? Will such participants agree to contractually specifiable levels of wilderness designation/habitat preservation in an inherently noncooperative environment? If such agreements can be designed, what are their properties? On the other hand, if such agreements cannot be designed, what are some of the key stumbling blocks?

Third, given the present level of dissatisfaction with existing federal and state regulatory arrangements, how can one design better natural resource regulatory regimes? For instance, should federal and state regulatory regimes serve parallel or hierarchical regulatory roles? Furthermore, how do asymmetrically held information, bargaining power, and difficulties associated with the monitoring and enforcement of federal and state laws impinge on regulatory activity?

The purpose of this paper is to: (1) discuss these three questions, (2) propose a theoretical research agenda for studying the various issues raised by these questions, and (3) show how specific aspects and objectives of such a research agenda might be accomplished. Wilderness management problems in the Wasatch Mountain range (White, 1994; also see Pope and Jones, 1990), habitat preservation issues in the Virgin River (Gregory and Deacon, 1994), and the

“sagebrush rebellion” (Cawley, 1993) remind us that a thorough understanding of the issues raised by these three questions is vital to the optimal, and presumably less fractious, use and management of natural resources in the American West.

2. Three Resource Issues in the American West

As discussed in the previous section, three principal resource issues in the American West concern: (1) land use over time, in the face of potential irreversibilities and new information acquisition by land managers; (2) mechanisms for appropriately addressing questions of wilderness designation/habitat preservation; and (3) the design of appropriate natural resource management institutions.

New analyses of the first issue are needed to shed light on what Marion Clawson (1983, p. 2) has called the “. . . major policy issues . . .” in federal land management. Specific issues that deserve further research attention include the extent and nature of development on federal lands, the terms on which federal land should be made available to various interested parties, and the implications of alternate intertemporal land use policies.

The wilderness designation and habitat preservation issues have typically been viewed in black and white terms in the past. On the one hand, there are those who have “. . . used wilderness as the unifying theme for a new conservation agenda . . .” (Cawley, 1993, p. 43), whereas on the other hand, there are those who have viewed wilderness as an “. . . all-purpose tool for stopping economic activity” (Tucker, 1982, p. 131). As a result, a considerable amount of research is needed to study wilderness designation/habitat preservation issues comprehensively. Of particular relevance are game and bargaining theoretic approaches to

wilderness issues. A key goal of this research should be to characterize and study the properties of equilibrium strategies pursued by the various relevant players.

The third main issue that I wish to focus on concerns the design of optimal resource management institutions. In the west, the “. . . relationship . . . between the federal, state, and local governments in the management of [natural resources] . . .” (Clawson, 1983, p. 3), has been a matter of continuing interest. As such, research in this area is needed to facilitate better understanding of the complexities of decision making between the various governmental entities, particularly the efficacy of parallel versus hierarchical organizational structures.²

The methods and techniques of game and stochastic control theory can be used to formally model and thereby rigorously study the three questions discussed above. The application of such methods and techniques to study these questions is still in its infancy. As such, research which uses these methods will attain at least two objectives and thereby contribute substantially to the natural resource economics literature. First, the results of this research can be used to better understand the complex and fractious use and management issues relating to public lands, wilderness designation/habitat preservation, and alternate regulatory regimes. Clearly, such comprehension is the basis for providing constructive policy guidance about how we might go about remedying and improving current resource use and management practices in the American West.

Second, the general methods and the research results can be used to better understand natural resource use and management issues in developing countries. Because sustainable

²This parallel versus hierarchical distinction is useful not only from the perspective of regulatory agencies, but from the point of view of interest groups as well. Hierarchical governing structures have been used by western stock growers to promote their interests. See Cawley (1993, p. 22) for more details.

development policies are so much a function of sustainable natural resource use policies,³ it is important to apply and when necessary modify insights gleaned from a systematic study of resource use and management issues in the United States. The successful pursuit of this research agenda will enable us to apply insights to similar use and management issues in different developing nations.

Clearly, these objectives are central to the optimal use and management of natural resources in the American West. Given the increased national concern about sustainable use of the West's natural resources and the legislative battles over the appropriate use of such resources, it is now more important than ever before to understand and manage the west's natural resources effectively. Such action will ensure that an important part of the regional economy continues to remain healthy in the near and distant future.

3. Previous Research and This Agenda

3a. Use of Public Lands

In the American West, the central question in the management of public lands concerns the appropriate use of such land at a point in time and particularly over time. Although the question of whether a particular type of land use is appropriate or not is, to some extent, in the eyes of the beholder. At a very basic level, this notion of appropriateness can be thought of as one involving development or preservation of land (Cawley, 1993, p. 13). Previous research has focussed on this kind of develop/preserve question in a very simple framework. Arrow and Fisher (1974), and Henry (1974) have shown us that when land development is both indivisible

³For more on this, see Batabyal (1995a), Lele (1991), and Pezzey (1989).

and irreversible, a land manager who ignores the possibility of obtaining new information about the consequences of such development will invariably underestimate the benefits of preservation and, hence, skew the binary choice development decision in favor of development.

This simple and powerful result has been shown to hold in its most general form in a two-period setting. However, this result typically does not hold in more general settings. As a result, a number of interesting research questions arise which have not been adequately dealt with in the literature. First, how should land be used when the development decision is not all or nothing, but in fact, divisible? Work by Epstein (1980) and Hanemann (1989) suggests that this bias toward development will arise in very limited circumstances. However, further research is needed to characterize the set of circumstances in which a development, or for that matter a preservation, bias will arise. Second, what is an appropriate management objective when the manager's time horizon involves many periods, and is possibly infinite? Third, in a stochastic setting with many time periods, the appropriate development question is "When do I develop?" and not "Should I develop today or tomorrow?" Answers to this "When do I develop?" question await further research. Fourth, as Anas (1988) has noted, very few researchers have studied efficient long-run land use when there are multiple recreational uses, multiple consumer groups, and the underlying economy is a multiregional one.

It is not difficult to see that these kinds of issues are of great relevance to the American West. Further, these are all questions that have received scant attention in the literature, in part because of the difficulties of incorporating dynamics and uncertainty in the same modeling framework. As such, a satisfactory resolution of these questions is a key component of my suggested research agenda.

3b. Wilderness Designation and Habitat Preservation

Although wilderness designation and habitat preservation have been “hot button” issues for quite some time now,⁴ formal analyses of the strategic interaction between the various players in a noncooperative setting have been few and far between. While there has been progress in the design of wilderness education programs (Thorn, Blahna, and Johnston, 1994), and in understanding the role of capacity constraints in the management of public parks (Harrington, 1988), our knowledge of the strategic aspects of wilderness designation and habitat preservation remains sparse. More specifically, despite the obvious relevance of game theory to the underlying issues, there have been virtually no game theoretic studies of mechanisms within which the question of wilderness designation/habitat preservation may be studied. As a result, we know very little about: (1) the design of agreements/contracts between the various “warring” parties, (2) equilibrium behavior by the different parties in alternate game mechanisms, and (3) optimal levels of wilderness designation in inherently noncooperative environments.

Given this situation, it is easy to see that in order to understand these and other contractual issues as they impinge on wilderness designation and habitat preservation, it is necessary to construct and analyze appropriate game theoretic models. Johnson and Watts (1989, p. 95) have correctly noted that “. . . contractual stipulations are important to understanding behavior.” Indeed, a central premise of this agenda is that in addition to understanding behavior, studies of contractual relations can be an effective basis for concrete and useful policy guidelines.

⁴For more on this, see Callicott (1994).

3c. Design of Regulatory Institutions

Widespread dissatisfaction with current federal and state regimes for natural resource management⁵ has led to questions about the design of alternate and, presumably, more efficient resource regulatory institutions. There are two key issues here. The first concerns problems such as interjurisdictional conflict arising from the fact that there often are multiple regulators operating at different levels. The second concerns the fact that, in addition to the usual agency problems, regulatory interactions in the American West are typically characterized by the regulated parties possessing some degree of bargaining power.

Neither of these two issues have received much research attention in the context of natural resources. Consider the issue of multiple regulation first. Here, van Egteren (1992) has made a promising beginning. In a multiple principal model, he has shown that certain regulatory decisions can have perverse effects on the behavior of the regulated parties. Further, the small literature on common agency—see Baron (1985), Bernheim and Whinston (1986), and Gal-Or (1989)—has shown us that multiple regulation can significantly affect the kinds of regulatory institutions that may be designed. However, more research is needed to fully understand: (1) methods for resolving interjurisdictional conflict, (2) the effects of alternate regulatory requirements on the behavior of the regulated parties, and (3) the impact of one party bargaining power on the design of desirable regulatory institutions.

I now discuss research methods and procedures which provide a framework within which the above described questions and issues can be analyzed.

⁵See Cawley (1993), Clawson (1983), and Culhane (1981) for more details.

4. Proposed Research Methods and Procedures

The theory of games and the theory of stochastic control, as presented in Fudenberg and Tirole (1991) and in Dixit and Pindyck (1993), respectively, have both advanced to a point where it is now possible to comprehensively model, analyze, and understand the issues that I have discussed in section 3. Optimal land-use questions can usefully be analyzed as questions in the theory of stochastic control; issues pertaining to wilderness designation/habitat preservation and the design of alternate resource regulatory institutions are better modeled and understood as problems in the theory of games.

I now provide brief illustrative examples of the kinds of models that can be used to understand the three main issues—land use, wilderness designation, and resource regulation—that are the subject of this paper.

4a. Land-Use Modeling Issues

Consider an aspect of the optimal land-use question. As discussed in section 3, resource economists have, for the most part, analyzed the develop/preserve question in the context of a two-period model.⁶ In this kind of a setting, the appropriate development question is “Do I develop land today or tomorrow?” However, this framework is not very useful for analyzing general land-use questions because any sensible analysis of such questions requires the incorporation of many more than just two time periods. Indeed, in such an intertemporal setting,

⁶See Arrow and Fisher (1974), Henry (1974), Fisher and Hanemann (1987), and Hanemann (1989).

the relevant development question is “When do I develop land?” This kind of question can be meaningfully posed and analyzed as an optimal stopping time problem.⁷

For instance, suppose that a land manager receives information about the consequences of developing land in accordance with a Poisson process $\{I(t):t \geq 0\}$, with a continuous, nonincreasing intensity function $\gamma(t)$. Information is acquired independently, and this information has a cumulative distribution function $F(\bullet)$ with finite mean. By allowing the information acquisition process to follow a nonhomogeneous Poisson process, I am leaving open the possibility that it is more likely that information will be received at certain times than at others. Further, I assume that any information that is not used immediately in deciding whether or not to develop land can be stored and used subsequently.

Upon acquiring information, the land manager decides whether to develop his land or to preserve it and wait for additional information. Let $f(\bullet)$ be the continuous and strictly monotone function which maps information about development to revenue from development. That is, if $i(t)$ is the information acquired by time t , then $f\{i(t)\}$ denotes the revenue from developing, given that a decision to develop land has been made. Should the developer choose not to develop his parcel of land, he incurs benefits and costs. The benefits are the obvious Arrow-Fisher-Henry type benefits; the land manager preserves the flexibility to acquire new information in the future. The costs arise from the fact that the manager has to pay to obtain information; further, he loses revenue from development. This provides the essentials of a model—more specifically, a two-action Markov decision model—within which the “When do I develop land” question can be answered. The model is completely determined once a suitable stopping (developing) rule has

⁷See Ross (1983) or Dixit and Pindyck (1993) for more on stopping time problems.

been specified. One such stopping (developing) rule is the infinitesimal look ahead stopping rule (ILASR).⁸ The ILASR can be thought of as a policy which stops a stochastic—“revenue from development”—process precisely in those states for which developing land immediately yields a higher payoff than waiting an additional amount of time. For my purpose, the ILASR provides the land manager with a rule by which to determine when land should be developed or preserved. As such, this and other kinds of stopping rules can provide a basis for this aspect of optimal land use policy in the American West.

4b. Wilderness Designation Modeling Issues

Next, consider the wilderness designation/habitat preservation issue. Four aspects of the problem are important. First, the relevant players in this “game” have mutually opposed interests and hence there is conflict. Second, the players typically will act strategically. Third, on the part of all the players involved, there is uncertainty not only about the intentions of the other players but also about the effects of a particular policy⁹ on the area that is proposed to be designated as wilderness. Fourth, the interaction between the players is not one shot but ongoing. These four aspects tell us that wilderness designation/habitat preservation issues can usefully be modeled as dynamic games of incomplete information,¹⁰ or as principal/agent games¹¹ with a single principal (the regulator) and at least two agents representing, for instance, environmental interests and development interests, respectively. Furthermore, as research, in other areas of economics, by

⁸For more on the ILASR and other stopping rules, see Ross (1970).

⁹Batabyal and Yoo (1994) call this type of uncertainty “policy uncertainty.”

¹⁰See Fudenberg and Tirole (1991) or Gibbons (1992) for more details.

¹¹See Fudenberg and Tirole (1991) for more details.

Myers and Majluf (1984), Barro (1986), and Dybvig and Zender (1991) has shown us, signaling games can be a particularly appropriate vehicle for studying wilderness designation/habitat preservation issues.

Despite the fact that wilderness designation/habitat preservation issues are a fertile area for the application of game theoretic methods of analysis, the application of these techniques to wilderness issues is virtually nonexistent. As such, there remains considerable scope for useful policy oriented research in this area.

To see how a wilderness issue might be modeled as a signaling game, consider the following, somewhat stylized, two-period interaction between an appointed regulatory authority (RA) with jurisdiction over publicly owned land and a western development agency (DA). Let the RA's one period payoff be $U^R(w, w^e, c)$, where $U^R(\bullet)$ is the RA's utility function, w is the actual percentage of land that is designated wilderness, w^e is the percentage of land that is expected, by the development agency, to be designated wilderness, and c is the RA's type. I assume that the RA can be one of two types, i.e., he can be strongly prodevelopment (a weak environmentalist), or he can be weakly prodevelopment (a strong environmentalist). Thus, $c=S$ (strongly prodevelopment), or $c=W$ (weakly prodevelopment). Further, c is private information possessed by the RA. The DA's payoff is $U^D(w, w^e)$, where $U^D(\bullet)$ is the DA's utility function. With no discounting, the total payoffs to the RA and the DA are simply the sum of the first and second period payoffs.

The timing of this two-period game of incomplete information is as follows. First, nature draws the RA's type. Let $Pr\{c=W\}=p$. Second, the DA forms its expectation of first-period percentage wilderness designation, i.e., w_1^e . Third, the RA observes w_1^e and then he chooses w_1 .

Fourth, the DA observes w_1 , but not c , and then it forms its expectation of second-period wilderness designation, i.e., w_2^e . Fifth, the RA observes w_2^e and then he chooses w_2 . This is a simple game framework within which important questions like the optimal tradeoff between wilderness designation and development, the nature of dynamically consistent wilderness policy, and equilibrium behavior by the relevant players can be studied.

4c. Institutional Design Modeling Issues

Finally, consider the question of designing alternate natural resource regulatory institutions. The impetus for this question comes from, *inter alia*, the comments of authors such as Dudley (1990), Lipske (1990), and Probst and Crow (1991). These and other authors have all questioned current natural resource management methods and have asked how alternate and better management regimes might be constructed. As discussed earlier, some of the key issues concerning resource management involves appropriately modeling and understanding: (1) interjurisdictional conflict between multiple regulators operating at different levels, and (2) the role played by the bargaining power possessed by those whose behavior is sought to be regulated. More specifically, issues of interest in the study of optimal hierarchical regulation with multiple regulators include: (1) a study of the properties of parallel versus hierarchical regulatory regimes, (2) a study of the properties of hierarchical regulatory regimes, and (3) an analysis of the effects of multiple regulators and multiple agents. To answer these and related questions, we may draw on the literature on common agency (Baron, 1985; Bernheim and Whinston, 1986; Gal-Or, 1989), and the literature on the economics of hierarchies (Tirole, 1986; Demski and Sappington, 1987; Kofman and Lawarree, 1993, Batabyal, 1995b).

Consider the question of optimal hierarchical regulation with multiple regulators and multiple agents. This question can be analyzed by synthesizing and extending the work of Baron (1985), and Batabyal (1995b). Baron (1985) has studied cooperative and noncooperative regulation of a single agent (firm) possessing private information, by two principals (regulators), i.e., a Public Utility Commission responsible for setting prices and an Environmental Protection Agency responsible for controlling pollution. Baron has analyzed the equilibria of games in which the regulators behave in Cournot and in Stackelberg fashion. Interestingly, he shows that while one regulator prefers cooperative regulation, the other regulator does not necessarily prefer cooperative regulation. Batabyal (1995b) has analyzed the impact of correlated private information in a three-tiered hierarchical model with a single principal, two intermediaries, and two agents. In this model, the two intermediaries and the two agents possess private information. Batabyal (1995b) shows that when this private information is perfectly correlated, in terms of the mechanism that can be implemented, the principal loses nothing from his inability to monitor the actions of the agents or the intermediaries.

As far as this institutional design question is concerned, research that will combine the types of models discussed in the previous paragraph and extend them to allow for the possibility of one party bargaining power is very much in need. This kind of research will enable us to acquire new insights into, *inter alia*, (1) the state/federal regulatory interface and its effects on resource use and management in the American west, (2) the extent to which state and federal cooperation on regulatory matters is feasible and desirable, and (3) the ways in which regulators might best deal with constituent groups—such as developers and the livestock industry—with bargaining power over the outcome of regulation.

5. Conclusion

Given the fractious nature of public policy debates about land use, wilderness designation, and current resource regulatory regimes, there is great need for rigorous research on these questions. I believe that the research agenda described in this paper will enable us to obtain a deep and thorough understanding of the many and varied intricacies of natural resource use in the American West. Further, because a key aim of this paper is to delineate a *policy* oriented research agenda, I expect that the conduct of this kind of research will generate significant and implementable policy guidelines. Finally, as indicated in section 2, extension of previous research,¹² and the suitable application and adaptation of the results of this research agenda will enable us to better understand the pressing natural resource use and management problems in the different developing countries of the world.

¹²See Batabyal (1995c).

References

- Anas, A. (1988) "Optimal Preservation and Pricing of Natural Public Lands in General Equilibrium." *Journal of Environmental Economics and Management* 15:158-72.
- Arrow, K.J., and Fisher, A.C. (1974) "Environmental Preservation, Uncertainty, and Irreversibility." *Quarterly Journal of Economics* 88:312-9.
- Baron, D. (1985) "Noncooperative Regulation of a Nonlocalized Externality." *Rand Journal of Economics* 16:553-68.
- Barro, R. (1986) "Reputation in a Model of Monetary Policy with Incomplete Information." *Journal of Monetary Economics* 17:3-20.
- Batabyal, A.A. (1995a) "Development, Trade, and the Environment: Which Way Now?" *Ecological Economics* 13:83-8.
- Batabyal, A.A. (1995b) "On the Irrelevance of Collusion in Perfectly Correlated Environments." Mimeo. Utah State University.
- Batabyal, A.A. (1995c) "Environmental Policy in Developing Countries: A Dynamic Analysis." Mimeo. Utah State University.
- Batabyal, A.A., and Yoo, S.J. (1994) "Renewal Theory and Natural Resource Regulatory Policy under Uncertainty." *Economics Letters* 46:237-41.
- Bernheim, D.B., and Whinston, M. (1986) "Common Agency." *Econometrica* 54:923-42.
- Blumm, M.C. (1994) "Public Choice Theory and the Public Lands: Why 'Multiple Use' Failed." *Harvard Environmental Law Review* 18:405-32.
- Callicott, J.B. (1994) "The Wilderness Idea: A Critique and an Alternative." *Inner Voice* 6(3):12-3.
- Cawley, R.M. (1993) *Federal Land, Western Anger: The Sagebrush Rebellion and Environmental Politics*. Lawrence, KS: University of Kansas Press.
- Clawson, M. (1983) *The Federal Lands Revisited*. Baltimore, MD: Johns Hopkins University.
- Culhane, P.J. (1981) *Public Lands Politics: Interest Group Influence on the Forest Service and the Bureau of Land Management*. Baltimore, MD: Johns Hopkins University Press.

- Demski, J.S., and Sappington, D. (1987) "Hierarchical Regulatory Control." *Rand Journal of Economics* 18:369-83.
- Dixit, A.K., and Pindyck, R.S. (1993) *Investment Under Uncertainty*. Princeton, NJ: Princeton University Press.
- Dudley, R.L. (1990) "A Framework for Natural Resource Management." *Natural Resources Journal* 30:107-22.
- Dybvig, P., and Zender, J. (1991) "Capital Structure and Dividend Irrelevance with Asymmetric Information" *Review of Financial Studies* 4:201-19.
- Epstein, L.G. (1980) "Decision Making and the Temporal Resolution of Uncertainty." *International Economic Review* 21:269-83.
- Fisher, A.C., and Hanemann, W.M. (1987) "Quasi-Option Value: Some Misconceptions Dispelled." *Journal of Environmental Economics and Management* 14:183-90.
- Fudenberg, D., and Tirole, J. (1991) *Game Theory*. Cambridge, MA: MIT Press.
- Gal-Or, E. (1989) "A Common Agency with Incomplete Information." Mimeo. University of Pittsburgh, Pittsburgh, PA.
- Gibbons, R. (1992) *A Primer in Game Theory*. Hertsfordshire, England: Harvester-Wheatsheaf.
- Gregory, S.C., and Deacon, J.E. (1994) "Human Induced Changes to Native Fishes in the Virgin River Drainage." Paper presented at the AWRA Symposium on the *Effects of Human-Induced Changes on Hydrological Systems*. Jackson Hole, WY, June 26-29.
- Hanemann, W.M. (1989) "Information and the Concept of Option Value." *Journal of Environmental Economics and Management* 16:23-37.
- Harrington, W. (1988) "Efficient vs Open-Access Use of Public Facilities in the Long Run." *Journal of Environmental Economics and Management* 15:462-9.
- Henry, C. (1974) "Option Values in the Economics of Irreplaceable Assets." *Review of Economic Studies* 41:89-104.
- Johnson, R.N., and Watts, M.J. (1989) "Contractual Stipulations, Resource Use, and Interest Groups: Implications from Federal Grazing Contracts." *Journal of Environmental Economics and Management* 16:87-96.

- Kofman, F., and Lawarree, J. (1993) "Collusion in Hierarchical Agency." *Econometrica* 61:629-56.
- Lele, S. (1991) "Sustainable Development: A Critical Review." *World Development* 19:607-21.
- Lipske, M. (1990) "Who Runs America's Forests?" *National Wildlife* 28(6):24-8.
- Mortensen, J. (1994) "The Upstream Battle in the Protection of Utah's Instream Flows." *Journal of Energy, Natural Resources, and Environmental Law* 14:113-38.
- Myers, S., and Majluf, N. (1984) "Corporate Financing and Investment Decisions When Firms Have Information that Investors do not Have." *Journal of Financial Economics* 13:187-221.
- Pezzey, J. (1989) "Economic Analysis of Sustainable Growth and Sustainable Development." *Environment Department Working Paper No. 15*. Washington, DC: World Bank.
- Pope, C.A., and Jones, J.W. (1990) "Value of Wilderness Designation in Utah." *Journal of Environmental Management* 30:157-74.
- Price, K.A. (ed.). (1982) *Regional Conflict and National Policy*. Washington, DC: Resources for the Future.
- Probst, J.R., and Crow, T.R. (1991) "Integrating Biological Diversity and Resource Management." *Journal of Forestry* 89:12-7.
- Ross, S.M. (1970) *Applied Probability Models with Optimization Applications*. San Francisco, CA: Holden-Day.
- Ross, S.M. (1983) *Introduction to Stochastic Dynamic Programming*. New York, NY: Academic Press.
- Thorn, T.F., Blahna, D.J., and Johnston, B. (1994) "A Process for Developing Wilderness User Education Plans." *Journal of Environmental Education* 25:37-43.
- Tirole, J. (1986) "Hierarchies and Bureaucracies: On the Role of Collusion in Organizations." *Journal of Law, Economics, and Organization* 2:181-214.
- Tucker, W. (1982) *Progress and Privilege: America in the Age of Environmentalism*. Garden City, NY: Anchor Press/Doubleday.

van Egteren, H. (1992) "State Versus Federal Environmental Regulation in a Non-Cooperative Monopoly Screening Model." *Journal of Environmental Economics and Management* 23:161-78.

White, J. (1994) "Wilderness Management on the Midland-Urban Front." *Inner Voice* 6(3):6-7.