

The Economics of Natural Environments

Studies in the Valuation of
Commodity and Amenity Resources

JOHN V. KRUTILLA
ANTHONY C. FISHER

A Book from Resources for the Future

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**STUDIES IN THE VALUATION
OF COMMODITY AND AMENITY
RESOURCES**

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THE ECONOMICS OF NATURAL ENVIRONMENTS

RESOURCES FOR THE FUTURE

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PREFACE

This volume represents a synthesis of selected work undertaken in the Natural Environments Program at Resources for the Future. It addresses the valuation, allocation, and management of the resources—commercial and otherwise—of natural environments. In particular it seeks to engage the range of amenity resources that, while long recognized in public policies providing, for example, for National Parks, Wildlife Refuges, and Wilderness Areas, have not been explicitly included in economic analyses. In this respect then, the present work represents a “first generation” effort to incorporate the noncommercial, or amenity, resources of natural environments into the body of economic theory and application. At the same time, the analysis of the more conventional, commercial uses of natural environments has been extended to deal with such important issues as how progress in thermal electric power technology will affect the valuation of a site for hydroelectric power production.

An institutional point worth noting here is that observations and remarks in the text generally apply to the management of public lands in the United States. This is because, as suggested by the empirical cases considered in chapters 5 through 10, most of the remaining natural and scenic areas of any great extent, and related resources, are in fact found on the public lands. It hardly needs to be added that most theorems about resource valuation and allocation are not dependent on the ownership status—public or private—of the resource in question, so that most of our results apply to the socially efficient use of any substantial wilderness area currently in private ownership as well.

As an early effort, this volume doubtless raises more issues than it is capable of resolving satisfactorily. Nevertheless, since the value of the resources it addresses is of considerable magnitude, it is hoped that the effort will stimulate others to a wider and more intensive application of analytical inclinations and talent. With this in mind, both theoretical and practical issues are raised and addressed in this volume. The theoretical apparatus has been presented and advanced as far as our capabilities permitted in the time available. There is, nonetheless, much theoretical work

remaining to be done. We have not on that account, however, avoided confronting urgent practical problems of national significance in the applied portions of the study. As a matter of fact, there is scarcely an applied study in any scientific area to which some theoretical objection cannot be interposed at some level. Specific objections to some of our operational procedures are therefore to be anticipated, but should be regarded more as within the tradition of applied analysis than as an exception to it. Moreover, the approaches adopted in these studies, although within the format laid out in the theoretical sections, and drawing on the theory to organize and interpret the available data to the extent permissible, do represent in most instances the type of analysis that might be expected of conscientious resource managers addressing a real and significant resource allocation issue in a relevant time context.

None of the foregoing is to be interpreted as suggesting that the most sophisticated analytical techniques that may ultimately prove useful in problems of this sort are presented in this volume. The authors are the first to concede that much remains to be done on a much wider scale than permitted within the short period and limited resources available thus far. But while we await the desirable advances in methodology and standardization of practices and conventions in applied analysis, we present this volume as a recommended point of departure for site evaluations when the issue of allocating natural environments among incompatible uses needs to be faced.

One other point, and a very important one, deserves mention here. Doubtless it will occur to some, on the basis of certain themes that run through the book, that we have a point of view. This is quite correct. As was stated earlier, our purpose has been to bring the amenity resources of natural environments into an analytical valuation framework comparable to that for the extractive resources. We have sought to do this by applying tools and concepts of conventional economic theory in somewhat unconventional situations. A relevant special feature of a situation, for example, the irreproducibility of amenity resources, is first introduced and explored in detail. It is then set in an appropriate management decision framework and its implications for efficient use of the environment are derived. The empirical studies are loosely tied to the theory in that the theory indicates what data are relevant and how they are to be processed and interpreted.

Where considerations involving amenity resources are put forward with unusual emphasis, the reason is not that we are advocates for one side or the other in a debate over the use of a particular environment. Rather, we are trying to compensate for a history of analytical neglect. In fact, we could turn the argument around and observe that only by proceeding as we have to build the unconventional special features of natural environ-

ments into our economic models can we as economists hope to contribute to the policy debate.

It is hoped that the volume will prove useful to resource managers and related administrative personnel in the field. Indeed, it is intended to be of utility to decision makers since several of the empirical studies have been prepared specifically in response to requests from public officials for assistance in presenting analyses of relative benefits of alternative uses of natural environments. At the same time it is hoped that the format, the level of both theoretical and empirical inquiry, and the relevance of the issues addressed will commend themselves to economists interested in problems of natural and environmental resource use, benefit-cost analysis, and price and welfare theory generally, and to graduate students and upper division undergraduates in these areas. We want to emphasize the accessibility of virtually all of the material presented here to students, including undergraduates. In a few places material is indented to indicate that the discussion becomes more technical. This material may be quickly skimmed, or even skipped without interrupting the flow of the discussion.

John Krutilla is responsible for the outline and general content of the volume, and is primarily responsible for chapters 1, 2, 5, 6, 7, 10, and 11. Anthony Fisher is primarily responsible for chapters 3, 4, 8, and 9. Finally, each has reviewed and participated in the revision of the parts of the manuscript for which the other has been primarily responsible.

Resources for the Future
January 1975

J. V. K.
A. C. F.

PREFACE TO THE SECOND EDITION

The objectives that motivated the first edition of this volume were first of all to show how economic analysis can be used to address certain vital issues in an area that had been notably neglected by economics; and second, in doing so, to introduce relevant economic information into the debate over how the issues should be resolved. The effort, we believe, has been largely successful. Although all of the issues that were addressed in the first edition have by now been resolved, the tack taken in some cases was sufficiently novel and approach to the problems sufficiently distinctive to continue to serve students in natural resources and environmental economics courses. With a new printing required to keep the volume in print, we felt certain things should be done to bring the volume up to date. Hence, this revised edition.

One matter deals with the theoretical developments that have occurred over the many years since the Arrow-Fisher paper on environmental preservation, uncertainty, and irreversibility—on which chapter 4 of the first edition was partially based—was originally published. Thus, section 3 of chapter 4 has been completely reworked to include these developments.

Another area demanding attention, as suggested by calls from teaching faculty, was: “So what happened next?—The students want to know.” This is understandable, given the celebrated set of cases we worked with. It, therefore, seemed a good idea to summarize briefly the outcomes. This we have done in an afterword.

Another reason for providing such a summary is to underscore the fact that a set of studies which meets the standards for use in academic curricula, ought not to be dismissed out of hand as “ivory tower” by program officers who have lost the inclination to read. We are convinced that high quality analysis can also affect the outcome of policy debate. Indeed, it is the only kind that should.

April 1985

J.V.K.
A.C.F.

ACKNOWLEDGMENTS

The research reported in this volume has been undertaken over several years by members of the Natural Environments Program staff of Resources for the Future. We should first of all like to acknowledge with appreciation the general contribution of our former colleagues, Charles J. Cicchetti and V. Kerry Smith, which goes quite beyond the reference in the text to specific debts of gratitude associated with the writing of this volume. Charles Cicchetti also reviewed chapter 10, which is based on his *Alaskan Oil: Alternative Routes and Markets*. Similarly, chapter 9 has been reviewed by Judd Hammack, co-author with Gardner Brown of the study, *Waterfowl and Wetlands: Toward Bioeconomic Analysis*, on which it is based.

A first draft of the manuscript was reviewed by our program colleagues Talbot Page and Kerry Smith, and by Mancur Olson, Anthony Scott, and Vernon Smith. We are most grateful for their perceptive comments and constructive suggestions on both matters of substance and style. We are also grateful to Henry Jarrett and Irving Fox for their valuable comments on a later version of the study. A debt of gratitude is also due Adrian Gilbert and John Butt of the U.S. Forest Service for careful review and detailed comments, particularly regarding chapter 8, which deals with the Mineral King Valley project.

Many individuals have contributed in one way or another to the material presented in the separate chapters. We are indebted to Marion Clawson for a review of chapter 1, and to him and Robert Dorfman for suggestions concerning revision of the content of chapter 2, appearing in *The Governance of Common Property Resources*, edited by Edwin Haefele.

Chapters 3 and 4, as indicated by a number of references, owe much to the work of Kenneth Arrow. Beyond this, the treatment of uncertainty and information is based on collaboration between Arrow and Anthony Fisher. Helpful suggestions by John Brown and Harl Ryder regarding the formulation and solution of the optimal control problem are gratefully acknowledged, as are editorial suggestions by George Borts on an earlier version of some of this material, published in the *American Economic Review*.

The discussion of the intergenerational problem in chapter 4 has been importantly affected by the ongoing work of Talbot Page.

Chapters 5 and 6, the Hells Canyon studies, have benefited from many constructive suggestions by Darwin Nelson, Arnold Quint, and Donald Sander of the Federal Power Commission, and from students and staff of the Natural Resources Institute held at Oregon State University during the summer of 1969. We are also grateful for input to the study by Charles Cicchetti and Clifford Russell, and for comments on drafts of an earlier version by Gardner Brown, Ronald Cummings, Myrick Freeman, and Richard Judy.

Chapter 7 was undertaken in part using information supplied by members of the staff of Region 4 of the U.S. Forest Service. Particular mention needs to be made of the assistance of Fred Wagstaff, regional economist of the U.S. Forest Service, Ogden, in preparing a report with John Krutilla from which this chapter is abstracted. We are also indebted to Don T. Nebeker, study coordinator, White Cloud-Boulder-Pioneer Mountain Area investigations for making numerous arrangements to obtain data and for access to study reports. Acknowledgment of assistance is also due Frank Gunnell, wildlife biologist, U.S. Forest Service; and to William Mellick, Clayton District, and Dan Pence, Clayton District ranger, for much assistance in connection with data and analysis of grazing on the district. To Richard Carter, White Cloud patrolman, we are indebted for testing impressions gained in the field, particularly in connection with estimates of recreational carrying capacity and to Ed Schlatterer, ecologist, U.S. Forest Service, for information regarding ecological carrying capacity in connection with recreational uses. Robert Williams was very helpful, along with Delworth Gardner and Darwin Nielson of Utah State University in assisting with the unit value of grazing permits. To Kenji Shiozawa, staff assistant for landscape architecture and perhaps others in the field of recreation planning at the Ogden office of the Forest Service, we are most grateful for the information on trails, developmental and maintenance costs, and related information on recreational facilities. Acknowledgment is also due Les Pengelly, of the Department of Wildlife Management, School of Forestry, University of Montana, and to Keith Whiting of the American Smelting and Refining Company for information supplied in connection with the study.

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Chapter 8, as noted in the text, draws on a study by Charles Cicchetti, Kerry Smith, and Anthony Fisher. Comments and suggestions by Anthony Scott and Joseph Seneca on a draft of the study are gratefully acknowledged. Generous assistance in obtaining and interpreting the data on the use of California ski sites, and much information about Mineral King, has been provided by Craig Stanley, and through Stanley, by the U.S. Forest Service, in particular Pete Wyckoff. Programming assistance has been provided by Joseph Tu.

Chapters 9 and 10, as noted above, represent our condensed versions of work done by others (Charles Cicchetti, Gardner Brown, and Judd Hammack) in the Natural Environments Program at RFF, and graciously made available to us for inclusion here.

In revising and editing this volume, it has been our good fortune to work with Ruth Haas of the RFF editorial staff. Although her contributions are too many and varied to list here, much of the credit for the readability of the final product is due to her.

The list of those to whom acknowledgment is due grows long, but it cannot be terminated without reflecting our appreciation for the even-tempered toleration, patience, and perseverance of Rita Gromacki in typing and retyping the manuscript.

Needless to say, while assistance has been rendered by many individuals and organizations, the responsibility for the material included, analysis, and conclusions remain solely with the authors.

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December 1974

John V. Krutilla
Anthony C. Fisher

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