

## AN ABSTRACT OF THE THESIS OF

Brian E. Garber-Yonts for the degree of Doctor of Philosophy in Forest Resources presented on July 14, 2000. Title: A Choice Experiment Analysis of Public Preferences for Conservation of Biological Diversity in the Oregon Coast Range

Abstract approved: \_\_\_\_\_  
Rebecca L. Johnson

Ecosystem management has become an increasingly mainstream paradigm for natural resource management. Nowhere is this more evident than on the public and private forestland of the Pacific Northwest. While ecosystem management has become a widely accepted principle of resource management, substantial questions remain about its implementation. A case in point is the conservation of biological diversity: within both the scientific literature and the policy debate, it is unclear what are the best methods for its conservation. In addition, the public goods nature of biological diversity limits the ability of managers and policy makers to use economic information to prioritize biodiversity policy goals in making resource management decisions.

This study uses a choice experiment (CE) framework to produce utility theoretic estimates of the welfare effects of changes in the level of biodiversity protection under different conservation programs. The sample frame for the study spans Oregon households, with three regional strata (Eastern, Willamette Valley, and Coastal), allowing measurement of regional preference heterogeneity. We present biodiversity policy as an amalgam of four different conservation programs: aquatic habitat conservation, forest rotation management, endangered species protection, and large-scale conservation reserves. The study results indicate substantial support for conservation programs. While WTP is positive for initial increases above baseline levels of protection, results indicate that WTP for large increases fall to zero or become negative, requiring monetary compensation for fur-

ther increases. substantial increases over the current baseline would generate increased consumer surplus, though overallocation of land resources to biodiversity is perceived on average as a welfare loss. The survey instrument included a dichotomous choice contingent valuation WTP elicitation for the purpose of methodological comparison to the CE approach. Results tentatively support the conclusion that the CE approach produces more conservative (lower) estimates of consumer surplus. The study also indicated a strong bias toward the management status quo, though the basis for this preference, and its importance in the context of policy analysis, remains an important subject for further research.

@ Copyright by Brian Garber-Yonts

July 14, 2000

ALL RIGHTS RESERVED

**A Choice Experiment Analysis of Public Preferences for Conservation of  
Biological Diversity in the Oregon Coast Range**

by

**Brian Garber-Yonts**

**A THESIS**

**Submitted to**

**Oregon State University**

**in partial fulfillment of  
the requirements for the  
degree of**

**Doctor of Philosophy**

**Completed July 14, 2000  
Commencement June, 2001**

Doctor of Philosophy thesis of Brian Garber-Yonts presented on July 14, 2000.

APPROVED:

---

Major Professor, representing Forest Resources

---

Chair of Department of Forest Resources

---

Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

---

Brian Garber-Yonts, Author

## Acknowledgments

I am deeply in the debt of many individuals who have contributed to this research and to a great host of people without whom its completion would have been quite hopelessly doomed. To name them all would require an additional volume of similar heft, and regrettably I must limit my specific thanks to:

Dr. Rebecca Johnson, whose guidance, support; motivational influence and collaboration on this work has been instrumental and greatly appreciated; Dr. Joe Kerkvliet, whose many hours of consultation on valuation technique and statistical analysis is outweighed in my appreciation only by the interest and enthusiasm he displayed for the efforts represented herein, and for his exemplary professional and scholarly model, both of which provided utterly necessary inspiration; Drs. Norm Johnson, Walt Ream and Bruce Rettig for their scholarship and perseverance; Drs. Tom Spies and John Loomis, both of whom contributed greatly to getting this work started and provided numerous technical reviews of the survey instrument and ongoing interest and support for extension of the research; Dr. George Stankey who provided financial support and consultation at a critical juncture of the research; Dr. Steve Swallow who provided a particularly detailed and insightful review of the survey instrument developed for this research; Drs. Steve Polasky and the late Ludwig Eisgruber who have provided models of scholarship to which I will ever aspire; the Graduate Students of the Departments of Agricultural and Resource Economics and Forest Resources, most especially Roger Martini whose friendship and cooperative toil on the Separating Hyperbangel Theorem made graduate study an order of magnitude more interesting; with special emphasis to my brother Joseph and to Len and Sylvia Garber for long and unwavering support and encouragement for this work and a number of other endeavors; most especially to Maya Nicole and Gillian Joseph for their wisdom, insight and perspective and for the joy that they continuously provide, and most especially of all to my dear Suz, for her patience and perseverance throughout, and her love and support ongoing.

## Table of Contents

1. Introduction .....	1
1.1 Background .....	1
1.2 Research Purpose and Objectives .....	6
1.3 Organization of the Thesis .....	7
2. Theoretical Background and Literature Review .....	9
2.1 Ecosystem Management and an Operational Definition of Biodiversity ..	9
2.2 Methods for Amenity Resource Valuation .....	15
2.2.1 Elements of Total Economic Value .....	15
2.2.2 Utility Theoretic Foundation of Welfare Estimation .....	18
2.2.3 Valuation Techniques .....	20
3. Theory .....	42
3.1 Random Utility Models .....	42
3.2 A Note On Measures of Central Tendency .....	47
4. Survey Development and Design .....	50
4.1 Definition of measurement objectives and techniques .....	50
4.1.1 Focus Groups and Preliminary Survey .....	51
4.1.2 Mail pretest .....	52
4.1.3 Instrument Design .....	54
4.2 Experimental design .....	58
4.3 Sample and survey administration .....	63
5. Analysis and Results .....	66
5.1 Attitudes .....	66
5.2 Preference Modelling .....	74

## Table of Contents (continued)

5.2.1 Choice Experiment Analysis .....	74
5.2.2 Dichotomous Choice/Contingent Valuation .....	109
6. Discussion .....	123
6.1 Methodological Implications of Study Results .....	123
6.1.1 Status Quo Effect: Interpretations .....	123
6.1.2 Interpreting the magnitude of welfare estimates .....	129
6.1.3 Comparison of CEA and DC/CVM Results .....	132
6.2 Implications of Study Results for Landscape Planning and Policy Analysis .....	137
6.2.1 Attitudes and Preferences .....	137
6.2.2 Benefit Aggregation .....	140
6.2.3 Use of Model Results in CLAMS .....	144
6.2.4 Caveat on strict interpretation of welfare measures in BCA .....	145
7. Conclusions and Future Research .....	148
Bibliography .....	155
Appendices .....	184
Appendix A: Survey Mailings .....	184
Appendix B: Experimental Design .....	204



## List of Figures

<u>Figure</u>	<u>Page</u>
2-1. Elements of Total Economic Value.....	16
4-1. Sample Strata.....	53
4-1. Survey response rates over time.....	64
5-1. Attitudes toward landowner compensation and wild salmon.....	68
5-2. Attitudes toward conservation program importance.....	70
5-3. Rating alternative forest age class distributions.....	72
5-4. Conservation program ranking.....	72
5-5. Rating of conservation and other social program.....	73
5-6. Choice structure.....	83
5-7. Compensated Demand Functions for Salmon and Endangered Species Habitat Programs, by Region.....	100
5-8. Compensated Demand Functions for Old Growth Forest and Biodiversity Reserve Programs, by Region.....	101
5-9. Weighted Average TWTP/TWTA for Changes in Conservation Programs - No Status Quo Effect.....	106
5-10. Weighted Average TWTP/TWTA for Changes in Conservation Programs - Status Quo Effect Included.....	107
5-11. Empirical WTP Distributions.....	118
6-1. Aggregated Total Willingness to Pay Functions.....	141
6-2. CLAMS conceptual model.....	144

## List of Appendix Figures

<u>Figure</u>	<u>Page</u>
A-1. First mailing - cover letter . . . . .	184
A-2. First mailing - survey booklet . . . . .	185
A-3. Second mailing - reminder postcard . . . . .	200
A-4. Third mailing - cover letter . . . . .	201
A-5. Fourth mailing - final reminder postcard . . . . .	203

## List of Tables

<u>Table</u>	<u>Page</u>
4-1. Focus groups .....	52
4-2. Design levels for biodiversity attributes .....	61
5-1. Respondent familiarity and attitudes regarding biodiversity conservation and salmon restoration .....	67
5-2. Description of Model Terms .....	77
5-3. Results of MNL Analysis of Choice Experiment Data .....	79
5-4. Likelihood ratio test results for anchoring effect .....	88
5-5. Likelihood ratio test results for order effect .....	89
5-6. Magnitude of order effects .....	89
5-7. Likelihood ratio test results for nonresponse bias .....	91
5-8. Value of model nonresponse terms .....	92
5-9. Population and survey sample mean values for selected demographics .....	94
5-10. Confidence intervals, mean and adjusted values for WTP .....	98
constants and slope coefficients .....	
5-11. Item Response Rates by Survey Treatment .....	110
5-12. Dichotomous Choice Contingent Valuation Model Results .....	112
5-13. WTP/WTA Estimates from Bivariate Logit Model (\$/year) .....	114
5-14. Results of nonparametric and semiparametric analysis of DC/CVM data .....	121

### List of Tables (continued)

6-1.	Comparison of Choice Experiment and DC/CVM Results . . . . .	136
6-2.	Preference ordering of conservation programs by mean MWTP and mean attitudinal ranking . . . . .	138
6-3.	Household and Aggregate TWTP for Maximum Estimated Value Conservation Scenario. . . . .	143

# A Choice Experiment Analysis of Public Preferences for Conservation of Biological Diversity in the Oregon Coast Range

## Chapter 1: Introduction

### 1.1 Background

Recognizing the value of noncommercial uses of environmental resources in addition to more traditional uses, natural resource management in the Northwest has undergone a paradigmatic shift toward ecosystem management over the last decade. This is evidenced by the President's Northwest Forest Plan and Governor Kitzhaber's Oregon Plan for Salmon and Watersheds, and more generally by the current sustainability emphasis in federal lands policy and a greater recognition of ecosystem service values of private land. A principal objective of these initiatives is the conservation of biological diversity on the landscape. Biodiversity as a scientific construct is complex, encompassing the genetic and functional diversity within and amongst species and communities, and the physical and biotic complexes that comprise ecosystems. As a management objective, this complexity is compounded by the inescapable necessity of setting priorities. While the conservation of biological diversity has emerged as a policy and management objective in part because of pressure from the public as well as the scientific community, the complexity of this endeavor requires the continuing engagement of all constituents in identifying options and setting priorities. An understanding of public preferences plays a crucial role in this process. This thesis documents one attempt to measure public preferences for biodiversity using an economic framework.

The discipline of economics highlights the role of markets and prices in the identification of priorities. Price signals act as powerful and precise indicators of consumer preferences, and both private firms and public entities use these signals to identify demand for goods and services. Firms use prices to identify profit maximizing allocations

of productive assets and, in the context of benefit cost analysis (BCA), public agencies use the same information to identify management alternatives that maximize public welfare. This broader mandate of public agencies, however, requires a broader conception of benefits and costs than that considered by private firms. Agencies are charged with the provision of goods and services that by their nature are not provided by private firms or traded in markets, services which include regulation and monitoring of the activities of firms and individuals to protect assets held in the public trust. The increasing role of BCA in public resource management and regulatory policy has motivated the development of valuation techniques to measure the preferences of beneficiaries of nonmarket goods and services in terms commensurate with those expressed in prices of private goods.

Measurement of the total economic value (TEV) of environmental assets has been the focal point of the development of nonmarket valuation techniques. The TEV concept represents a taxonomy of the values provided by environmental assets. These values include consumptive and nonconsumptive direct use benefits such as commodity extraction and recreation, indirect use benefits provided by ecosystem services, such as watershed protection and waste assimilation, and passive use benefits. The latter identify values that individuals hold for the preservation of environmental assets, either for the satisfaction gained from simple existence or from a sense of responsibility for maintaining natural heritage as a bequest to future generations. What is fundamental in this classification is the recognition that the value of natural assets is not fully captured by direct uses that give rise to marketed goods and services measured by their attendant prices.

Passive use values (PUV's) present a particularly difficult valuation problem in that they typically do not engender any behavioral response independent of research attempts to measure them. To address this, economic researchers have adapted and refined an array of survey and interview techniques for eliciting these values from individuals. Known broadly *stated preference* (SP) techniques, these variously attempt to create a

hypothetical market for public goods and elicit their value from respondents, either through direct statements of willingness to pay (WTP) or willingness to accept compensation (WTA), or by inference from stated choices in hypothetical decision scenarios. In the traditional reliance on real and observable transactions, markets and price responses, known collectively as *revealed preference* (RP) techniques, economists apply a fundamentally behaviorist approach to understanding human behavior individually and in aggregate. Consequently, the development and application of SP techniques has met with much criticism from both economists and many outside the discipline, providing the context for what is perhaps the most vigorous methodological debate in economics (Portney 1994; Kopp and Pease 1997; Diamond and Hausman 1993).

The application of nonmarket valuation arises in both the policy analysis context, as a component of BCA, as well as in a legal context in assessment of natural resource damage awards in court proceedings. Assessment of PUV's arose in the BCA context initially in federal agency rulemaking subsequent to President Reagan's 1981 Executive Order 12291<sup>1</sup>, which directed agencies to conduct BCA as part of a regulatory impact analysis of all significant regulatory initiatives. Two federal laws, the 1980 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the 1990 Oil Pollution Prevention Act, directed agencies (specifically the Interior Department and the National Oceanic and Atmospheric Administration, respectively) to assess compensable damages to injured parties resulting from the release of hazardous substances and, specifically in the case of the latter, oil spills. It was in this context that two important milestones in the development of passive use value measurement and stated preference methods occurred: (1) the federal court's rejection of Interior's proposed rules on grounds that failure to measure and compensate lost passive use values violated congressional intent in the passage of CERCLA (*Ohio v. Dept. of Interior*, 1989), and (2) the

---

1. Superseded in 1994 by President Clinton's Executive Order # 12866 (The White House 1994), which extends the role of BCA in regulatory review and explicitly recognizes passive use values. Also see (OMB 1996), the report of the advisory panel convened by OMB to establish "best practices" for economic review pursuant to EO # 12866.

publication of a comprehensive review of the state of the art in nonmarket valuation and recommended standards and procedures by a high-level panel convened by NOAA and chaired by Nobel Laureates Kenneth Arrow and Robert Solow (Arrow, Solow et al. 1993). These events<sup>1</sup>, along with publication of an important volume on nonmarket valuation techniques by Mitchell and Carson (1989), precipitated a massive growth in the empirical application and methodological investigation and critique on non-market valuation, most particularly the contingent valuation method (CVM).

The CVM has been applied extensively to estimation of passive use values for elements of biodiversity. The context of most of these studies has been the potential loss of individual threatened species, though some studies have looked at habitats more broadly and collections of threatened species populations within a given geographic area<sup>2</sup>. In these applications it must be at least plausible that the effects of resource management can be isolated to one or a few changes in the complex amalgam comprising the biological diversity of a given landscape, or perhaps that all relevant elements of biodiversity are affected uniformly. In most cases, however, both the policy context and the ecological conditions are more complex. Thus, the piecemeal analysis of social and ecological changes associated with resource management of any significant geographic or temporal scale will fail to address important dimensions of multiple, often competing objectives and unavoidability of trade-offs. A more effective tool for examining preferences for biodiversity conservation alternatives, therefore, must permit the consideration of multiple elements or attributes simultaneously.

The conjoint analysis technique, which has been employed extensively in the marketing and transportation fields (Louviere 1988) for well over a decade, offers the advan-

---

1. See Kopp and Pease (1997) for an insightful review of the details of these events and other proceedings in the definition of the role of SP techniques and passive use values in agency and judicial decision making.

2. See Jakobsson and Dragun (1996, Ch. 5) for a review.



tage of permitting valuation of multiple attributes. Conjoint survey instruments are designed to identify distinct attributes of a composite good. Using experimental designs to compose sets of alternative specifications of the composite (analogous to experimental treatments in multiple factor dose-response studies), this method elicits respondent preferences between two or more alternative composites, framed as consumer goods or policy scenarios. As in CVM, conjoint methods vary in the format of the elicitation. The choice experiment variant of conjoint analysis is very similar to the referendum format in dichotomous choice CVM (DC/CVM). In DC/CVM, the respondent is presented with a hypothetical good or policy scenario which includes a specified cost to the respondent, who is asked to "vote" by either accepting or rejecting the good and the associated cost. Thus in the DC/CVM, two alternatives are offered - the specified alternative or status quo. In the choice experiment analysis (CEA) approach, which encompasses the DC/CVM, two *or more* alternatives are offered, one of which may or may not be the status quo. In addition to permitting multiattribute preference elicitation, the greater flexibility and richer scenario descriptions permitted in CEA allow the investigator to address some methodological concerns raised by the CV method.

The recognition that the value of natural environments is complex and multidimensional is reflected in criticisms of the CVM focussing on its unidimensional expression of value for noncommodity elements of natural resource values. Biological diversity is a strong case in point. While most previous attempts to measure biodiversity values have focused on single species or occasionally groups of species and associated habitat, the multiattribute nature of the management problem requires a multiattribute measure of preferences. The recent introduction of conjoint methods to the nonmarket valuation literature addresses an important shortcoming in more familiar techniques. The research undertaken for this thesis exploits this recent development in attempting to measure public preferences for biodiversity conservation efforts.

## 1.2 Research Purpose and Objectives

The research described in this thesis was conducted as part of a broader study of land use change in the Oregon Coast Range Physiographic Province. The Coastal Landscape Analysis and Modelling Study (CLAMS, 1999) is a multi-year, interdisciplinary study to model the social, economic, and ecological effects of alternative forest management and land use policy scenarios involving the full array of ownership classes on the landscape. Using advanced applications of geographic information systems (GIS,) remote sensing, spatial modeling of landowner behavior, vegetation dynamics, and species-habitat relationships, as well as regional economic impacts, the CLAMS project attempts to provide tools for policy analysis and primary research in landscape management and ecological change. The study documented herein is motivated primarily as an ancillary model to the larger CLAMS study, to provide measures of economic value for potential biodiversity outcomes of alternative policy simulations in terms commensurate with values of recreational, commodity and other economic outputs of the Coast Range landscape.

In the investigation of preferences of Oregon residents for the conservation of biological diversity in the Oregon Coast Range, this study addresses three research objectives:

1. Estimate demand curves which measure consumer willingness to pay for marginal changes in distinct attributes of biological conservation in the Coast Range.
2. Identify and test for regional preference heterogeneity in biodiversity preferences. Regions of concern are communities within the Oregon Coast Range, the Willamette Valley and the western slope of the Oregon Cascades, and Eastern Oregon.
3. Evaluate characteristics of choice experiment analysis relative to those of the contingent valuation method for estimating preferences for biodiversity conservation. Specific criteria include relative sensitivity of each method to biases arising from scope and endowment effects.

In the course of this research, four attributes of biodiversity conservation were identified as important and distinct elements in an overall conservation strategy for the

Oregon Coast Range. These are: the amount and distribution of forest in different age classes, including newly established stands as well as old growth forests; the protection of coastal salmon populations and aquatic and riparian habitat; protection of threatened and endangered species habitat on federal as well state and privately owned land; and the designation and reservation of large land areas principally for the purpose of biodiversity protection and ecological function. While these four elements are indicative of the complexity of biological conservation and forest landscape management, they clearly do not encompass the full range of relevant characteristics that individuals may value. Nonetheless, the relative value of these elements, compared amongst these four, as well as relative to other public and private goods, is important information for management of public and private resources in the Oregon Coast Range.

### 1.3 Organization of the Thesis

Chapter 2 of the thesis provides a review of two bodies of literature relevant to this research. The scientific and institutional background of biological conservation is briefly covered to set the context of the valuation exercise upon which the research is focused. The total economic value typology (TEV) and fundamental elements of applied welfare economics as applied to nonmarket valuation are reviewed. A brief survey of nonmarket valuation techniques is followed by a more detailed review of the evolution and current state of the contingent valuation method. Given the astonishing volume of CVM research, this thesis can only offer a shallow review, though the intention is to provide sufficient background for a comparative analysis of CVM with the more recently introduced choice experiment framework. After reviewing the key arguments regarding the validity and reliability of CVM, the structure of the CEA approach and its potential advantages in light of these arguments is presented. This is followed by a review of the small body of published CEA studies applied to estimation of passive use values. Chapter 3 presents the derivation of the statistical models used to interpret the discrete choice data produced by dichotomous choice CVM and CEA survey instruments. Chapter 4

presents the details of the survey design process and the implementation and administration of the survey. This includes a discussion of experimental design principles for conjoint analysis studies as well as the sampling design of the study. Chapter 6 presents the data analysis and results of the study. This includes cross tabulations of survey responses to a set of attitudinal questions by regional strata, as well as econometric estimation of consumer surplus and compensated demand curves for the biodiversity measures discussed in the survey. The analysis of the CEA and DC/CVM data are presented separately and compared in the last section of the survey. Discussion of the results in Chapter 7 provides some interpretive insights gained in the analytical exercise and suggestions regarding the use of the results of the study in the context of the CLAMS model as well as more generally in planning for biological conservation. A review of key results and conclusion is presented in Chapter 8, along with suggestions for future research. Samples of all materials sent to respondents and the experimental design of the study are provided in the appendices.

## Chapter 2: Theoretical Background and Literature Review

### 2.1 Ecosystem Management and an Operational Definition of Biodiversity

Along with “sustainability,” the term “biological diversity,” or “biodiversity,” has become part of the popular vernacular. Perhaps as a consequence of the popularity of the term, nearly every publication addressing the topic offers a definition, with varying degrees of novelty<sup>1</sup>. The key elements of the concept have been broadly defined as: the variety and variability among living organisms and the ecological complexes in which they occur. Diversity so defined functions at three levels: genetic, species and ecosystem diversity (OTA 1987). An alternative typology provides a bit more definition: (a) genetic diversity; (b) within-ecosystem species diversity (so-called alpha species diversity); (c) among-ecosystem species diversity (beta species diversity); (d) within-ecosystem structural diversity; (e) among-ecosystem structural diversity; and (f) temporal diversity (Kimmins 1992), cited in Duinker 1993). While both definitions provide some intuition of the complexity inherent in the meaning of the term, they mainly suggest how difficult it is to provide a fully operational definition of biodiversity. Going beyond simple definition, (Noss 1990) extends and operationalizes the above conceptualization to identify a hierarchical typology of biodiversity indicators. This typology integrates Franklin’s three primary attributes of biodiversity - composition, structure and function (Franklin 1988) with four spatial scales to create a matrix of indicators that are suggested as practical measurement variables for biodiversity monitoring at appropriate scales. Franklin’s three attributes of ecosystems, which are described as constituting the biodiversity of a system, are the following:

---

1. Baydack, Campa et al. (1999, Ch. 1) identify 19 different definitions, illustrating that the useful definition of the term depends on the context in which it is used.

1. Composition: identity and variety of elements in a collection, e.g., species lists and measures of species diversity, and genetic diversity (represents the focus of most biodiversity monitoring and evaluation work to date)
2. Structure: physical organization and pattern of system from habitat complexity (on community scale) to patches and other elements at landscape scale
3. Function: ecological and evolutionary processes

Noss combines the above with four spatial/biological levels of biodiversity to define the following nested hierarchy of indicators:

1. Regional-Landscape
  - Composition: identity, distribution, richness and proportion of patch and landscape types
  - Structure: heterogeneity, connectivity, patchiness, and pattern of habitat layer distribution
  - Function: disturbance processes, nutrient cycling and energy flow rates, geomorphic and hydrological processes, human land use trends
2. Community-Ecosystem
  - Composition: identity, relative abundance, frequency, richness, and diversity of species and guilds; numbers and proportions of endemic, exotic, threatened and endangered (T&E) species
  - Structure: abundance and distribution of physical features and structural elements, slope, aspect, vegetation biomass, canopy characteristics
  - Function: productivity, colonization and local extinction rates, predation rates, disturbance and nutrient cycling rates, rate and intensity of human intrusion
3. Population-Species:
  - Composition: absolute or relative abundance, frequency or cover value, 5 key categories of species/populations to monitor - ecological indicator, keystone, umbrella, flagship, and vulnerable species
  - Structure: dispersion and range, population structure, Despite liabilities, indicator species. approach is important
  - Function: demographic processes, metapopulation dynamics, population genetics
4. Genetic
  - Composition: allelic diversity, presence of rare alleles and dominant recessives
  - Structure: census and effective population size, chromosomal/phenotypic polymorphism

- Function: inbreeding depression, outbreeding rate, genetic drift

While recognizing the need for indicators, Noss criticizes the common use of individual species as the sole indicators of ecosystem health and diversity in a given system. The above broadens the use of indicators to provide valid and reliable measures of diversity. To illustrate the use of such a schema, Noss proposes a ten step process to assess the status and trends in biological diversity in the PNW:

1. Define "what and why:" policy determination of what aspects of biodiversity to promote and monitor
2. Gather and integrate existing data
3. Establish "baseline" conditions; should include data on stressors
4. Identify hotspots and ecosystems at risk
5. Formulate specific questions to address with monitoring
6. Select indicators -structural, functional and compositional elements at appropriate levels
7. Establish controls and treatments
8. Design and implement sampling scheme
9. Validate relationships between indicators and sub-endpoints
10. Analyze trends and recommend management options

Number 1 is described as the necessary first step in which primary and secondary goals are identified, which is a matter of policy rather than science. In the context of the Oregon Coast Range (OCR), (Noss 1993) identifies four fundamental objectives for biological conservation:

1. Represent all native ecosystem types and seral stages in a system of reserved areas
2. Maintain viable populations of all native species in natural patterns of abundance
3. Maintain ecological and evolutionary processes, including disturbance regimes, hydrological processes, nutrient cycles, biotic interactions, and genetic differentiation of populations
4. Manage with responsiveness to short- and long-term environmental change

Objectives 1 through 3 also outline approaches to conservation that, while complementary, are often portrayed in the literature as substitutes, particularly in an institutional sense. The question has been framed thus:

“What are the best strategies? Are approaches based on protecting individual species the most effective tools, both from a pragmatic and from a scientific point of view? Or would approaches that focus on habitat or ecosystem function represent a more scientifically defensible, and more politically practical, alternative?” (Levin 1993, pp. 201)

Franklin (1993) has argued that an ecosystem approach is necessitated by the sheer number of species to manage for at the landscape scale, particularly when invertebrates are considered. Attempting to manage on a species-by-species basis, he argues, faces serious limitations of time, financial resources, societal patience, and scientific knowledge. To achieve broad biological conservation goals which encompass ecosystem function and species other than vertebrates and vascular plants, landscape and regional perspectives are required. In addition to the siting of reserves, it is essential to alter the conditions on land used for commodity production to both buffer effects of extractive uses on reserve function as well as to improve the dispersal of populations through improved connectivity, apart from specific dispersal corridors. While recognizing the value of a species approach to motivating public opinion, it is argued that it cannot ultimately be successful if the objective is to preserve biodiversity more broadly defined.

In an associated article, Orians (1993) points out that the difficulty in defining an institutional response to ecosystem conservation is the difficulty in defining a taxonomy of ecosystems. Noting that the endangered species act (ESA) has been widely criticized for, amongst other things (Rohlf 1991), an “emergency room” approach that is triggered only when a species population is very small and recovery efforts are expensive if not futile, it is suggested that an ecosystem approach would compliment the ESA. The author argues that the chief failure of the ESA is attributable to the single species focus. Orians also argues that the ESA has failed in part due to inadequacy of funding and intransigence on the part of agencies in discretionary listing decisions, recovery plan development and implementation. He seems to argue, nonetheless, that an “Endangered Ecosystems Act” would complement the ESA and address its many shortcomings. The



author's points regarding the biological shortcomings of the ESA and the need for an ecological classification system may be cogent, but they seem to disregard the importance of institutional reasons for failure of the species approach.

In another companion article, Wilcove (1993) provides a counterpoint in the species/ecosystem debate by arguing from a pragmatic perspective that existing federal legislation provides many of the needed levers to protect vertebrate species on large parts of the landscape. With limited augmentation of existing institutions, and careful use of the umbrella function of vertebrates in protecting other elements of biodiversity, conservation objectives could be advanced considerably. Key institutional advances would: (1) strengthen the ESA and extend the National Forest Management Act (NFMA) species protection mandates to other agencies; (2) extend the classification of research natural areas (RNA's) and areas of critical environmental concern (ACEC's) to classify and protect multiple examples of natural communities on all federal land units; and (3) implement the Wild and Scenic Rivers Act and Clean Water Act mandates to protect the integrity of freshwater ecosystems. This latter point is taken up by Naiman, Decamps et al. (1993), who argue that aquatic habitats and riparian corridors represent concentrations of species and ecological diversity due to the sharp environmental gradients and dynamic disturbance regimes which they contain. Due to the strong influence of activities throughout the watershed on conditions in the riparian corridor, landscape scale management is necessary to maintain the diversity and function of freshwater and riparian systems.

The above is a brief review of some of the literature relevant to operationalizing biological conservation and ecosystem management on a landscape scale. Though the literature is vast, the above identifies four key approaches to conservation<sup>1</sup>:

---

1. Also see (Hauffer 1999) for a recent review of the literature on strategies and approaches to biodiversity conservation; the author develops a list rather similar to that provided above.

1. Species-based ("fine filter") approaches: focus on protection of umbrella and keystone species as indicators of general ecosystem health and biological diversity
2. Reserve based approaches: focus on siting networked reserves within which ecological processes, including natural disturbance regimes, are allowed to function largely free from constraints inherent in commercially managed areas
3. Freshwater and riparian zone protection: focus on protection of corridors, both to provide connectivity to facilitate species dispersion over the landscape, and to protect diversity "hotspots" given characteristics of riparian zones as steep environmental gradients and loci of disturbance processes
4. Integrated management of unreserved land ("coarse filter"): focuses on integrating diversity objectives into management of developed and semi-developed land to increase resident diversity and improve connectivity function of managed portions of landscapes

Each of the above is discussed in the literature largely in terms of their scientific attributes. Each of these techniques, however, also defines the core element of an institutional response to conservation and each is represented by management initiatives that are currently being implemented within the OCR by various agencies and jurisdictions. Both the federal and state endangered species processes have been invoked and federal recovery plans for listed species have been adopted, as well as numerous Habitat Conservation Plans (Service 1982; Service 1983; Service 1986; Service 1991; Service 1992; Service 1997). The reserve based approach is represented by the network of designated Wilderness Areas, areas of critical environmental concern (ACEC's), research natural areas (RNA's), and late successional reserves (LSR's) designated under the Northwest Forest Plan (USDA Forest Service 1994). Other elements of the NWFP are comprised of riparian zone management and integrated management of unreserved land. The Oregon State Plan for Salmon and Watersheds (OWPSW) (Oregon Coastal Salmon Restoration Initiative 1997) is also focussed on aquatic and riparian habitat in the OCR. The OSPSW was arguably initiated as an alternative to endangered species listing of coastal coho salmon and constituted a species based approach focussed on salmon and associated habitat. Finally, the structure-based management approach being implemented by the State of Oregon on its holdings in the northern OCR (Oregon. Dept. of Forestry 1998) is focussed in part on maintaining representation of a diversity of forest

age classes and structures, including late seral conditions, on land actively managed for timber production.

The process of defining a landscape scale strategy for conserving biodiversity thus defined is clearly extraordinarily complex and demanding in terms of required time, expertise, and public expenditure. While different approaches are advocated by the authors cited above, all advocate an integrated approach that employs a variety of methods, and all advocate clear definition of goals and objectives. It seems essential, then, that Noss's first step - setting priorities and identifying objectives - incorporate the interests of stakeholders if the outcome of planning efforts are to be useful in terms of managing resources in the public interest.<sup>1</sup> In discussing what are identified as ten key "themes" of ecosystem management, Grumbine (1997) concludes by emphasizing the need for scientists and resource managers to step away from purely technical considerations and confront the nature and variety of human values that principally drive management decisions. The research documented in this thesis is intended to provide one measure of (public) stakeholder preferences to assist policy makers in setting objectives for management in the OCR.

## **2.2 Methods for Amenity Resource Valuation**

### **2.2.1 Elements of Total Economic Value**

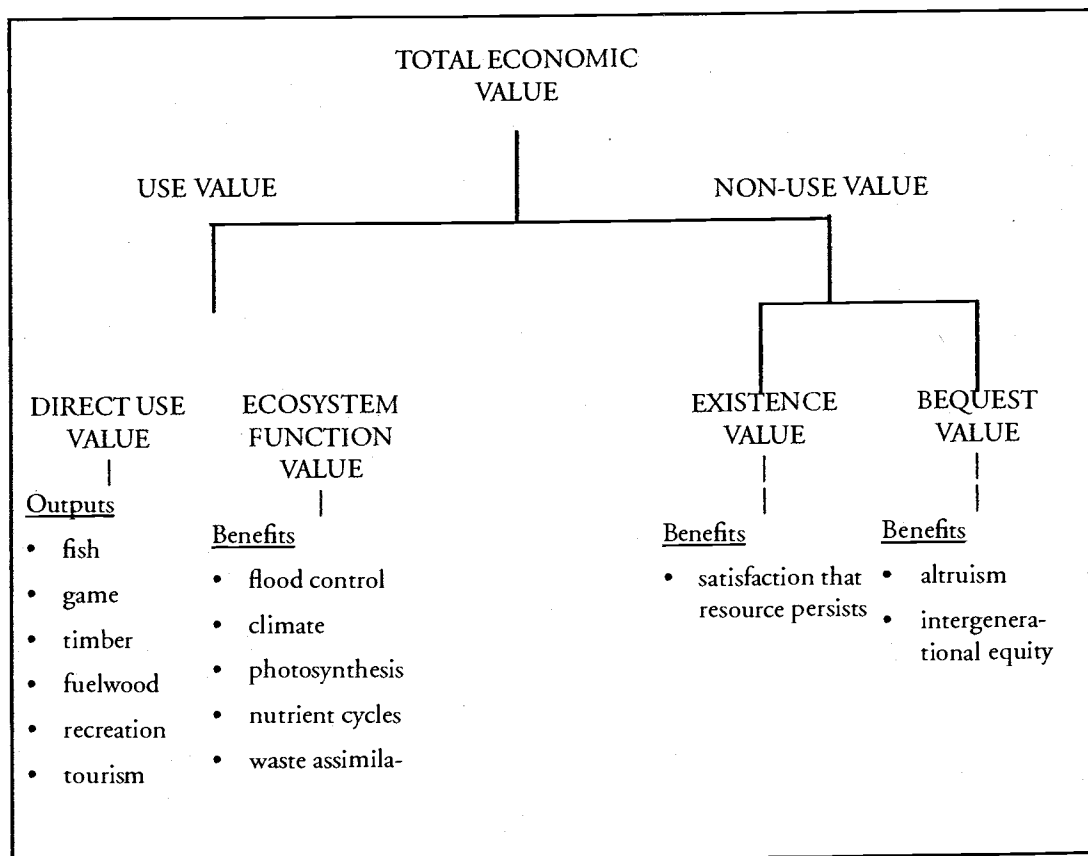
There is an extensive literature on the values that people, individually and collectively receive from natural resources, ecosystems and their constituent elements. Typologies of these values are manifold (Krutilla 1967; Edwards and Abivardi 1998; Pearce,

---

1. Though the point is overlooked by Noss, there is likely to be some endogeneity between step 1 and the successive steps in the process, particularly with Steps 4, 5, and 6, and most especially, with Step 3. As discussed in Chapter 7, public preferences tend to anchor on the status quo.

Moran et al. 1994; Jakobsson and Dragun 1996; Brown 1990; Freeman 1993, Ch. 5, amongst many others), but the central theme is typically that benefits can be classed as either direct- or indirect-use. benefits, or non-use benefits.<sup>1</sup> Direct use benefits are those

Figure 2-1. Elements of Total Economic Value



Adapted from Pearce, Moran et al. (1994, p. 20),

derived from the active use of the resource, either through extraction and consumption, such as timber harvest or mining, or nonconsumptive use such as recreational activities

1. (Turner 1999) provides a detailed discussion for the motivation for existence values, as well as a broader classification of ecosystem values than those cited above.

or genetic prospecting Indirect benefits are those which contribute to the production of goods and services which provide direct uses. Many ecosystem services, such as carbon cycling and waste assimilation fall into this class. Option value is the value of maintaining capacity and access to the flow of goods and services for future direct or indirect use, though no such use may be occurring in the present period. Thus, option value is in essence a risk premium when there is uncertainty about future demand or supply of a good.<sup>1</sup>

Non-use benefits are those benefits which do not arise from any physical contact with a good or with other goods derived or produced therefrom. The insight that economic value could be attributed to the essentially psychological benefits in this class of goods was crystallized by Krutilla (1967). Three sources of non-use value were identified in his seminal article: existence, bequest, and scientific. Existence value is the value that individuals derive from simply knowing that some desirable state, e.g. the existence of a species or grove of ancient trees, is maintained, without any anticipation of actually visiting or using them in the future. Bequest value is the altruistic value of maintaining the resource for the benefit of future generations. Charitable giving to organizations like the World Wildlife Fund or Nature Conservancy is often cited as evidence of the validity of the existence value construct. A third element of non-use values discussed by Brown (1990) in the context of biodiversity is the scientific value of public knowledge that may derive from study of a species or ecosystem function in the future, which the author distinguishes from the option value of potential future use noted above. Freeman (1993) further distinguishes between pure existence value and non-use value. Given tolerance thresholds for renewable resources that are subject to irreversible loss, such as species extinction, pure existence value is the value for maintaining the resource just above the threshold. Non-use value is that which is derived from levels of the resource above this

---

1. The concept of option value and the related but distinct quasi-option value, are enmeshed in the literature on the economics of uncertainty, Useful discussions in the context of biodiversity valuation can be found in Johansson (1993, Ch 8-9.), Freeman (1993, Ch. 8), and Walsh and McKean (1999).

threshold. Thus, given this distinction, non-use value is lost due to degradation of a resource, whereas pure existence value is lost only when existence of a species or other valued resource is eliminated. Though Freeman is concerned mainly with the additivity of the various elements of TEV in the consumers utility function, the distinction relates also to the existence of substitutes for an exhaustible good in the utility function. In the case of a species, for example, individual representatives of the species are essentially fungible at levels above viability thresholds<sup>1</sup>, though consumers may regard the last remnant of a species as having only imperfect substitutes.

### 2.2.2 Utility Theoretic Foundation of Welfare Estimation

The estimation of non-use values typically has the intent of identifying the welfare impacts of changes in the level of environmental services. The fundamental construct of welfare theory is the consumers' utility function and the optimization problem:<sup>2</sup>

$$\max U(G, Q) \text{ s.t. } m \geq PG \quad (2-1)$$

where  $U$  is the consumer's utility expressed as a function of  $G=(g_1, \dots, g_N)$ , a vector of market goods, and  $Q=(q_1, \dots, q_M)$ , a vector of environmental goods and service flows.  $P$  is a vector of market prices and  $m$  is the consumers income. For simplicity it is assumed that all elements of  $Q$  are unpriced. The solution to this problem is the consumers indirect utility function (where conditional demand functions for the goods are implicit):

$$V = V(P, Q, m) \quad (2-2)$$

Inverting Equation 2-2 for  $m$  yields the consumers' expenditure function, which is the dual of the maximization problem in Equation 2-1:

1. Though, perhaps many of the fans of Keiko the killer whale and Tsing Tsing and Ling Ling the giant pandas would balk at characterization of these icons as fungible.

2. See Johansson (1993) and Freeman (1993, Ch3) for more complete exposition.

$$\bar{V}^{-1}(P, Q, m) = E(P, Q, U) = \min PG \text{ s.t. } U(G, Q) \geq \bar{U} \quad (2-3)$$

Thus, the expenditure function minimizes cost subject to a utility constraint. By replacing  $U$  in the expression for  $E$  with the indirect utility function, we can express utility entirely in observable terms in what is known as the indirect money metric of utility:

$$m^0 = E(P, Q^0, V(P, Q^0, m^0)) = E(Q^0, V(Q^0, m^0))$$

where, for simplicity  $P$  is suppressed on the assumption of constant prices.

Given a change in the level of environmental services, holding prices and income constant, the change in utility (welfare) for a given individual can be described as

$$\Delta V = V(P, Q^1, m) - V(P, Q^0, m) \quad (2-4)$$

Given that utility is unobservable, measurement of the welfare impact of the change in environmental service from  $Q_0$  to  $Q_1$ , requires money measures of utility change for empirical analysis. The most common measures are the Hicksian utility measures of compensating and equivalent surplus (Hicks 1943). Compensating surplus is defined such that:

$$V(P, Q^1, m - CS) = V(P, Q^0, m) \quad (2-5)$$

$$CS = |m^0 - E(Q^1, U^0)| \quad (2-6)$$

where  $CS$  is the adjustment to income required to maintain constant utility as  $Q$  changes from  $Q_0$  to  $Q_1$ .  $CS$  assumes that the initial state,  $Q_0$ , is the reference point. Thus, if the change from  $Q_0$  to  $Q_1$  is an improvement,  $CS$  is the maximum willingness to pay (WTP) for the change, and if the change is a deterioration in environmental services, then  $CS$  is the minimum willingness to accept compensation (WTA) for the change. Equivalent surplus is defined such that:

$$V(P, Q^0, m + ES) = V(P, Q^1, m). \quad (2-7)$$

$$ES = |m^1 - E(Q^0, U^1)| \quad (2-8)$$

In contrast to CS, ES assumes that the subsequent state,  $Q_1$ , is the point of reference. Thus, if the change from  $Q_0$  to  $Q_1$  is a decrement in environmental services,  $ES$  is the maximum willingness to pay to avoid the loss. In the event of an environmental improvement,  $ES$  is the minimum WTA to forego the improvement and maintain level  $Q_0$ . Thus, CS measures the income change (positive or negative) associated with maintaining the initial utility level given the subsequent (post-policy change) level of environmental services; ES measures the income change (+/-) that maintains the subsequent level of utility given the initial level of environmental services. Choice of an appropriate measure depends on the reference level inherent in the policy question at hand and hinges largely on the presumed allocation of property rights. This can often be a matter of considerable controversy as private property rights and environmental resources in the public trust can often be in conflict (Bromley 1995) and the choice of appropriate measure can have significant implications for the magnitude of the measured welfare change (Hanemann 1989). This issue is taken up further below.

### 2.2.3 Valuation Techniques

Non-use benefits of species and ecosystems, as well as some indirect and non-consumptive use benefits such as some types of recreation are pure public goods manifesting both nonrivalry in consumption and nonexcludability properties.<sup>1</sup> As a result of these properties, markets for these goods do not develop and there is, therefore, no basis on which market prices can be observed as indicators of marginal social values. Lacking mar-

---

1. Nonrivalry denotes the property that the amount of a good consumed by one individual does not appreciably effect the amount that is available to others. Nonexcludability refers to the practical impossibility of rationing a good by denying access to it.



kets, public goods are externalities which must be provided through extramarket mechanisms, typically by government or other collective choice institutions (Ostrom 1990). To the extent that either markets or benefit cost analyses influence management decisions, failure to consider the value of public goods in this calculus will underallocate resources to the maintenance and provision of public goods. This has long been recognized in the economics discipline (Ciriacy-Wantrup 1947)(Krutilla 1967), and development and refinement of techniques for estimating the values of public goods has been a defining stream of research in resource economics. Methods for estimating values for non-marketed goods have been broadly classed as revealed preference approaches (RP), which use observable market transactions and other behavior to make inferences about the value of associated non-market amenities, and stated preference (SP) methods which utilize a variety of survey based methods to elicit statements of individuals' value for a nonmarket good. Mitchell and Carson (1989, pp 74-87) further stratify non-market techniques along two dimensions: whether the observation is based on actual behavior (as in RP) or responses to a hypothetical market specified in a survey context (SP), and whether the technique measures value directly or indirectly through inference.

Observed/Indirect methods include *hedonic price* (HPM) and *travel cost* methods (TCM). The HPM utilizes the prices of private goods in determining the values of some public goods. Price of a private good is specified as a function of attributes of the good (one or more of which are unpriced amenities), and implicit prices for attributes are inferred. Thus, in the market for real estate, attributes of property include public good elements such as air quality, proximity to open space, and other amenity values. By comparing sales prices of homes which are differentiated by different levels of a given amenity, its value can be inferred. The chief limitation of this method that it only applies to certain public goods for which there are associated private goods to use as indirect surrogates of value. Operationally, the large number of attributes that determine value of complex goods like homes, and the difficulty of gathering sufficient sales data to effectively control for variation in all of the relevant attributes make it difficult in practice to

identify the value of the public good attribute of interest. Further, buyers must have perfect information on the level of the amenity good associated with the surrogate good, and must not have subjective (unobservable) expectations regarding the level. Finally, Freeman (1993, Ch 11) reviews further results on the identification problem associated with the endogeneity of the indirect price and quantity chosen of the public good attribute.

The travel cost method, initially implemented by Clawson (1959) uses the differentials in access and travel costs that individual users of an amenity resource pay in order to construct a demand function for the resource. TCM is used primarily for estimating site-specific recreation benefits. In the simplest "zonal model" form of TCM, distance zones from a site are defined, number of visits from each zone to the site for a given time period are counted, and per capita visits are then estimated as a function of travel distance and other control variables. To express the value of the site in monetary terms, it is then necessary to impute a cost to travel time and distance. While the cost of distance is typically measured simply as the cost of whatever mode of travel is employed, the opportunity cost of travel time is more difficult to gauge. Rules of thumb have been applied to associate opportunity costs of travel time as some fraction of the wage rate, but these are largely arbitrary. Mitchell and Carson (1989) cite a number of studies that have found that, at least in scenic areas, the opportunity cost of travel is negative, i.e. travel itself generates positive utility. Multi-site models have been developed that incorporate the effect of substitute sites, though the large number of substitutes in many cases can make estimation difficult. See Freeman (1993) for a review. To address some the limitations of TCM, Brown and Mendelsohn (1984) introduced the hedonic travel cost method, which integrates the TCM and HPM. Not surprisingly, however, use of the method is hampered by the compounding of liabilities associated with TCM and HPM, particularly data intensiveness and the identification problem on HPM noted above. Fundamentally, the chief limitation of all Observed/Indirect, and RP methods generally, is the very limited range of values that can be estimated, namely direct use benefits asso-

ciated with recreation, and to some extent ecosystem service benefits. Estimation of broader classes of non-market goods requires more flexible methods.

Mitchell and Carson (1989) discuss a variety of hypothetical approaches to valuation. The principal advantage of these methods is in the flexibility to estimate values for virtually any class of goods, and they are the only methods capable of estimating non-use benefits.<sup>1</sup> As with the revealed preference methods discussed above, the authors partition hypothetical methods into direct and indirect methods. The authors describe a number of direct methods, though only the contingent valuation method is commonly employed in natural resource valuation applications. Indirect hypothetical methods discussed include contingent ranking, allocation games, priority evaluation techniques, and conjoint analysis. Though not included explicitly in this listing, choice experiments are another indirect hypothetical method closely related to contingent ranking. All hypothetical methods attempt to simulate a decision-making scenario to elicit the behavioral intentions of respondents. As such, these methods uniformly depend on the consistency of responses in real and hypothetical scenarios, the lack of any strategic responses, and the ability of the process to collect data without inducing distortions.

#### 2.2.3.1 The Contingent Valuation Method

The contingent valuation method was originally proposed by Ciriacy-Wantrup (1947) and implemented by Davis (1963). The method underwent a period of heightened scrutiny due to a series of events spanning from 1989, with the publication of Mitchell and Carson's book (1989), which provided a reference manual for CVM and precipitated a small explosion in the number of CVM studies performed, to the publi-

---

1. However, (Larson 1993) argues this is only in the (implausible) case of pure existence values which don't enter the budget constraint and are weakly separable from demand for other goods. If these assumptions are relaxed, the author argues, indications of existence values can be identified in normal consumer spending decisions.

cation of the NOAA Blue Ribbon Panel Report on CVM (Arrow, Solow et al. 1993).<sup>1</sup> The NOAA Panel's report identified a set of baseline standards for the practice of CVM which included five "burden of proof" criteria which, if failed, would render the results unreliable in the Panel's judgement. These include:

- High instrument or item nonresponse
- Insensitivity to scope of environmental change
- Lack of understanding of choice task
- Lack of belief in full restoration scenario
- Yes/no votes not supported in follow up questions by reference to cost/benefit of program

General guidelines also included the following:

- Probability sampling
- Personal interview survey
- Detailed reporting
- Careful instrument pretesting
- Conservative design
- Willingness to pay/referendum elicitation format
- Accurate description of policy/program
- Pretesting of photographs
- Reminder of substitutes
- No-answer option
- Open ended follow to referendum question to identify invalid responses

The conclusion of the panel was that, conditional on high standards for survey design and administration, the CVM is capable of producing valid estimates of WTP for existence values as well as direct use values. Many of the Panel's guidelines apply to survey research in general and are required to maximize the reliability and validity of ana-

---

1. (Portney 1994) provides a synopsis of the events leading up to the formation of the Panel and its conclusions regarding the use of CVM in damage assessment and BCA.

lytical results in any survey context. Key elements that apply to elicitation of non-market values are the WTP/referendum format and the inclusion of reminders to prompt consideration of budget constraints and substitutes for the goods under consideration.<sup>1</sup> Subsequent to the Panel's prescriptions, debate over the validity of the method has continued unabated. Jakobsson and Dragun (1996, Ch. 6) provide a review of the recent literature on methodological concerns in CVM. "Embedding" remains a prominent concern, though the authors find that the term is used in the literature to describe a number of different effects. Hanemann (1994) and Carson, Flores et al. (1993) are credited with identifying three main themes in the literature on embedding effects: scope, sequencing and subadditivity effects. The scope effect describes the failure of respondents to distinguish differences in the amount or scale of environmental change. The sequencing effect describes the tendency of respondents to indicate different WTP values depending on whether a hypothetical good is offered at the beginning of a list of possible goods than if it appears at the end of the list. The subadditivity effect is in evidence when non-use values elicited separately for different goods sum to a larger amount than if values are elicited jointly. Both the sequencing and subadditivity effects are argued to be consistent with utility theory and represent substitutions and diminishing marginal utility (Hanemann 1994). Since these effects arise in the valuation of any sequence of goods, regardless of method, they are endemic to the analysis of the welfare effects of a continuum of public goods.

Diamond and Hausman (1994) cite four studies which find respondents' answers to WTP elicitation are insensitive to scope, including Kahneman and Knetsch (1992), which originally identified the embedding effect in the CV literature. However, Carson and Mitchell (1995) and Hanemann (1994) identify numerous severe flaws in all of these studies, which fail to meet many of the NOAA Panel's guidelines intended to maintain validity of results. Subsequent to the Kahneman and Knetsch (1992) study and

---

1. A number of the Panel's guidelines not listed above specifically addressed issues pertaining to assessment of damages in a litigation context.

it's echoing in Diamond and Hausman (1994), CV researchers have responded strongly with a series of studies which demonstrate a pervasive sensitivity to scope. Carson (1997) demonstrates that, in three of the four papers cited in Diamond and Hausman (1994), sensitivity to scope is indicated using more appropriate statistical tests. He also identifies a large number of studies (contrary to the claim of Diamond and Hausman) in the CV literature that perform split sample tests of scope and find that nearly all reject scope insensitivity with high p-values. Other meta-analyses with similar implications include Hanemann (1995), Walsh, Johnson et al. (1992), and Smith and Osborne (1996). Noting a claim by Desvousges, Johnson et al. (1993) that non-use values are particularly insensitive to scope, Carson finds that 19 out of 31 studies he reviewed included substantial non-use components, all of which were sensitive to scope. Several other papers are cited which demonstrate that survey respondents are sensitive to other subtle specifications in the value elicitation context. A notable example is a study valuing water level changes at Mono Lake (Jones and Stokes Associates 1993) which found that over three level increases, respondents expressed increasing WTP over the first two levels, but a decline in preference for the third and highest level to very near the baseline water level. The third level was described as having ambiguous effects on species overall and loss of some visual features of the lake. Thus, rather than having a simple "more is better" response, the survey found that preferences were sensitive to specifics of the scenario.

In addition to the embedding issue, Jakobsson and Dragan (1996) review several additional sources of bias inherent in hypothetical methods. Two key issues are whether or not respondents know and can express their willingness to pay for the specified change, and whether or not they express their WTP truthfully. The latter gives rise to the question of strategic bias. Strategic bias arises if there is an incentive to misrepresent preferences. In the context of public goods, this is typically manifested as an opportunity to free ride. The empirical evidence cited suggests that, particularly where the referendum format is employed with a tax based payment vehicle, there is little indication that strategic bias is common in CVM studies. Despite the common conclusion that the ref-

erendum format is incentive compatible, i.e. no respondent has an incentive to misrepresent her preferences, Sugden (1999) argues that, to the extent that respondents understand the nature of the hypothetical referendum, the survey offers a costless way to make a point. Ultimately, however, the author observes that strategic incentives are weak and that any divergence between stated and actual WTP is more likely to be attributable to difficulty respondents have defining preferences for public goods.

The issue of hypothetical bias is somewhat more problematic in that it is generally only possible to test in situations where actual payments can be collected. Bishop, Champ et al. (1997) refer to this as the criterion validity of CVM studies. Several studies have appeared in the recent literature that tend to support the criterion validity of CVM, particularly in the context of use-values of public goods. A particularly notable study by Carson and et al. (1996) identifies 83 studies that contained both stated preference and revealed preference estimates of WTP for a given environmental change, which yielded 616 possible comparisons of SP and RP WTP. Overall, this study found that CVM studies produced lower estimates of WTP than comparable SP estimates, though the ratio was very close to one, indicating a high degree of convergent validity<sup>1</sup>. Studies which have tested for hypothetical bias in statements of preferences for non-use values, however, are largely inconclusive.

Although the criticisms of Diamond and Hausman (1994), Kahneman and Knetsch (1992), and others in the same vein appear to have been largely refuted by the large preponderance of empirical evidence, the issues they raise regarding the nature of preferences for public goods and non-use values particularly, bears further consideration. Sugden (1999) discusses the theory of public goods and a number of theoretical attempts to explain voluntary contributions in terms of rational self interest. The phenomenon of free ridership and the result of the Prisoner's dilemma game are well known examples

---

1. Convergent validity is defined as the tendency of two measurement instruments to produce similar empirical measurements of the object of study.

from economic theory that suggest that socially suboptimal outcomes will be jointly achieved by individually utility maximizing individuals. Attempts to explain voluntary contributions to public goods use the device of including a private good benefit to voluntary contributions. Thus, contributions to public goods have instrumental, non-rival value to the contributor insofar as the contribution increases the provision of the public good. In the case of large social goods funded by many contributors, the instrumental value is proportional to the increase associated with the individual and is therefore very small. It is hypothesized, therefore, that voluntary contributions must have some private value, which Sugden terms *expressive value*, which enhances the individual's self-image. This is the motivation for the "warm glow" effect, which Kahneman and Knetsch (1992) suggest as motivating existence values with the implication that responses to elicitation of the value of non-use goods reveal more about expressive value than they do about instrumental value. While the case is somewhat different in referendum voting than in voluntary contributions, Sugden cites theorists who argue that the act of voting itself cannot be explained in terms of instrumental value, at least not where electorates are large and costs of voting are nonnegligible. Given this, Sugden infers that decisions expressed on the ballot are not motivated wholly by instrumental values, and turns to the notion of *fairness* as contributing an essential motive in voting behavior. As evidence for this, the author cites a common result in CVM studies using a willingness to accept compensation (WTA) format to elicit the amount of private benefit an individual requires to accept a decrease in provision of a public good. The high rate of protest responses commonly observed in these studies suggest that respondents reject this conception of property rights that allows exchange of public benefits for private benefits. Sugden argues that such protest responses reveal respondents' sense of fairness rather than their preferences in an instrumental sense. While Sugden admits that the expressive/instrumental dichotomy is imprecise and that purchases of some private goods may be motivated as much by expressive value as by instrumental value, his argument is the logical extension of reasoning put forth by the strongest critics of the use of hypothetical techniques to measure existence values. It is worth pointing out, that the implication of the above is that



because preferences for public goods cannot be purely instrumental and preferences for existence values are insensitive to scale, therefore expressive values must be insensitive to scale. Apart from the large body of empirical results that refute the second proposition above, the argument appears to be a false syllogism. Even accepting the notion of expressive value as describing preferences for existence values, it is an empirical question whether these preferences are sensitive to scale.

### 2.2.3.2 Choice Experiment Analysis

The choice experiment analytical technique is one variant of the conjoint analysis approach to preference elicitation.<sup>1</sup> Conjoint techniques in general use multiattribute specification of a good coupled with experimental designs to vary the attributes and create different "treatments" or alternative specifications of the good. By observing individuals' preferences over alternative treatments, it is possible to estimate "part-worth utilities" to the individual attributes. The conjoint technique was developed in the marketing research literature and was originally conceived as a tool for pretesting the market performance of alternative product designs.<sup>2</sup> Other variants of conjoint analysis have appeared in the economics literature, including contingent ranking, contingent ratings and paired comparisons (Mackenzie 1993), though the choice experiment method has emerged as the most common.<sup>3</sup> In terms of Mitchell and Carson's typology of non-market valuation techniques, the choice experiment analysis (CEA) approach is most

---

1. See Louviere (1988) for an extended treatment of the theory of complex decision making that underlies conjoint approaches, as well as the experimental design and analysis of multiattribute decision models.

2. Louviere cites Green and Wind (1973) and Green (1971 #365) as the earliest references to conjoint analysis.

3. The focus herein in the comparison of the choice experiment method to dichotomous choice CVM. See Mackenzie (1993) and Adamowicz, Boxall et al. (1999) for a review of alternative conjoint methods in economics.

consistent with the indirect hypothetical methods, though it employs the referendum framework and random utility model (RUM) specification of dichotomous choice CVM (Hanemann, 1984) with the multiattribute specification employed in the hedonic travel cost framework (Bockstael, McConnell et al. 1991).

In the CEA method, respondents are presented with panels of choices (choice sets) with two or more alternatives each, where each alternative is a bundle of attributes which are specified at different levels in each alternative. The inclusion of a price or cost attribute permits estimating the effect of cost on the respondents' choice. For example, a recreationist may choose from a number of different sites in her choice set, each of which exhibits variation in an array of attributes such as scenic quality, congestion, travel distance, and access fee (where the latter two are price components). The recreationist chooses the site to visit on any given trip depending on the balance of preferences for different attributes and the degree to which they are represented at a given site. In a survey context, the researcher identifies the essential attributes and levels of the environmental good in question and designs the choice question to reveal the structure of the respondents preferences<sup>1</sup>.

Using a RUM framework<sup>2</sup> to estimate the effect of the attribute levels on the probability of choosing or rejecting a given alternative, it is possible to estimate Hicksian measures of surplus associated with changes in individual attributes (Ben-Akiva and Lerman 1985; Hanemann 1984). Because multiple levels of each attribute can be included in the choice set, the CS/ES values can be estimated for a continuum of changes in the attribute, thus estimating a "valuation function" and by differentiation, compen-

---

1. Hanley, Wright et al. (1998) cites the "characteristics theory of value" (Lancaster 1966) as providing a theoretical foundation for the attribute-specific depiction of utility.

2. The random utility model is rigorously defined in Chapter 3. In short, the RUM assumes that an individual's utility, though known to the individual with certainty" is only measurable by an observer, up to a known (estimable) distribution. Thus, the individual's utility function can be specified as the sum of fixed and random components.

sated demand functions.<sup>1</sup> Methodological advantages of CEA relative to CVM are discussed further below, but two principal advantages are readily apparent: given the complexity of natural resource decisions, the CEA method can provide important information on preferences over a number of decision attributes or variables as well as over continuous variation in each of the attributes. Thus, the greater flexibility afforded by this technique potentially renders it a much more powerful tool for policy analysis applications of non-market valuation.

Adamowicz, Boxall et al. (1999) review the components of a CEA study:

1. Identification of relevant attributes
2. Selection of measurement unit for each attribute
3. Specification of the number and magnitude of the attribute levels
4. Experimental design
5. Model estimation
6. Use of parameters to simulate choice.

Steps 1-3 closely parallel the initial phase of design for a CVM study, where the focus is on developing a concise and sufficiently complete representation of the valuation scenario which will provide the survey respondent with an appropriate information set on which to base statements of preference. This phase uses information from secondary sources and experts in fields relevant to the decision scenario, focus groups and personal interviews, and pretesting to refine the informational content of the survey instrument. Step 4 is much more complex in CEA in that the experimental design is critical to producing a data set that will yield estimable parameters for the attributes in an econometric model of preferences. In dichotomous choice CVM, the only appreciable experimental design issue is the specification of the bid vector, i.e. the set of bid levels to include in alternative specifications of the referendum.<sup>2</sup> Carson, Louviere et al. (1994) illustrate the

---

1. Formal derivation of these measures is presented in Chapter 3.

2. Noting that in most CVM studies experimental design is approached in an ad hoc fashion, Kristrom (1997) reviews several recent papers on optimal design theory as applied to CVM.

issue of experimental design by considering the problem of a choice experiment with four three-level attributes, generating  $3^4$  potential alternatives. Assuming choice sets comprised of three alternatives each results in 85,320 possible triples. If the design is specified to contain 54 choice sets, the problem then becomes selecting which of  $85,320!/54!(85,320-54)!$  designs to employ, which is a very large number. More complete discussion of statistical issues and techniques of experimental design are provided below in Chapter 4. Louviere (1988) provides a comprehensive discussion of the fundamentals of experimental design in CEA. Kuhfeld, Tobias et al. (1994) provide a more recent review and discuss alternative design selection criteria. Given the importance of experimental design in the CEA, a common refrain in many publications is the need for extending statistical insights into the properties of alternative design criteria.

Steps 5-7 are again similar to the CVM process, although the specification of multiple alternatives and choices renders these tasks more complex in a CEA study. In particular, the instrument design phase involves decisions about the number of attributes to include in each alternative, the number of levels for each attribute to include in the experimental design, and the number of alternatives to include in each choice scenario.<sup>1</sup> Determination of these limits is principally determined by the analyst's judgement regarding the cognitive capacity of respondents and the complexity and familiarity of the choice context. Carson, Louviere et al. (1994) suggest that the average CEA survey employs seven attributes, four choice sets and four alternatives per set, though they note that there is a great deal of variability and this average does not constitute a best practice. Swait and Adamowicz (1996) investigate the effect of respondents' learning and fatigue over successive choice sets and find that both effect the variance of responses for the choice task at either end of the choice section of a survey. Thus, warm up questions which allow the respondent to become familiar with the choice task and to refine their internal preference map are recommended. Carson, Louviere et al. (1994) claim to have

---

1. A DC/CVM can be viewed as a choice experiment with two alternatives and one choice set.

successfully administered surveys with up to 32 choice tasks, though this requires scaling down the number of alternatives and attribute levels accordingly. Adamowicz, Boxall et al. (1999) cite evidence that suggests that respondents can endure large numbers of choice sets but sets with more than 6 alternatives tend to exceed cognitive limits. Additional bounds to be considered are the plausibility of attribute levels and combinations thereof: alternative specifications which are perceived by the respondent as implausible are unlikely to be treated seriously by respondents and may degrade the quality of the data on successive choice tasks. It is also important to avoid presenting choice tasks where a preferred alternative is obvious in that it dominates other alternatives, i.e. one alternative has greater benefits and lower cost. These observations reveal nothing about the marginal effect of attribute level on the choice probabilities.

An additional design consideration is the inclusion of a constant status quo alternative which appears in all choice sets. The liability of including a status quo alternative is that respondents may use it as a means of limiting cognitive effort. Boxall, Adamowicz et al. (1996) and Mazzotta et al. (2000) specify a status quo alternative and represent it with an alternative-specific constant (ASC) in the econometric model. Both studies find that the ASC is significant, suggesting that, *ceteris paribus*, respondents have some preference for or against the status quo that is not attributable to the values of the respective attributes<sup>1</sup>. Though this result has not been highlighted in the literature, it does have implications for isolating the component of preferences which is insensitive to scope *vis-a-vis* the embedding effect discussed above. That is, since CEA is structured to identify the effect of variation in attribute levels on the choice probabilities, it automatically measures sensitivity to scope. However, as the dichotomy between instrumental and expres-

---

1. Adamowicz, Boxall et al. (1999) and Hanley, Wright et al. (1998) speculate that CEA avoids the "yea saying" bias exhibited in DC/CVM (Brown and et al. 1996) because it avoids the stark 'all or nothing' contrast inherent in the latter. Since the choices presented are between alternative specifications of environmental improvements, there is no unambiguous "pro-environment" alternative and responses are therefore more likely to express preferences rather than environmental attitudes. However, as these studies indicate, neither yea- or nay-saying are eliminated in the CEA approach, but the structure of the method permits isolating these effects.

sive values discussed above illustrates, there may be some component of preferences which is insensitive to scale. The capacity to distinguish this component from preferences that are scale sensitive offers the ability to defuse the debate over the embedding effect that has characterized the CV literature. Apart from these advantages and liabilities, in the referendum context, the status quo alternative represents a "no" vote and therefore must be included to realistically represent an actual voting scenario.

### 2.2.3.3 Advantages of CEA Relative to DC/CVM

Several advantages of CEA have already been noted:

- A common utility theoretic foundation with DC/CVM and hedonic travel cost models;
- The ability to estimate compensated demand functions (i.e. marginal values) for discretely or continuously variable attributes of a good, and therefore the capacity to evaluate more complex decision scenarios. Natural resource decisions typically concern changes in attributes of natural environments rather than wholesale gains or losses in environmental resources;
- Tests for scope are built into the structure of the method as well as the ability to test for a component of preferences that is insensitive to scope (i.e. yea- and nay-saying effects);
- An experimental design phase that permits structuring choices to identify attribute effects.

There is also a considerable advantage in avoiding the juxtaposition inherent in CVM of the trade-off between a public (environmental) good and money. As Kahn (1995) has pointed out, many respondents perceive this trade-off as one between money and an ethical principle. Spash and Hanley (1997) and Stevens, More et al. (1991) find that stark trade-offs between money and biodiversity prompt reactions based on ethical considerations rather than preferences in the neo-classical sense, and find that these expressions can be interpreted as lexicographic preferences<sup>1</sup>. As Kahn (1995) points out, the CEA skirts this problem by presenting alternative states of the world which are char-

acterized by an array of attributes which include cost, rather than the stark contrast of DC/CV. By portraying the decision scenario as more complex than a simple ethics/money trade-off, respondents may engage in the more complex task of considering their preferences. An associated advantage is the ability of the method to measure compensating amounts of attributes for changes in a given attribute. This is particularly advantageous in the damage assessment context, where it has been suggested that compensating goods, e.g. restoration and mitigation at the damaged site in addition to environmental improvements at other sites, rather than monetary compensation is a potential means for defusing the controversy over disbursement of damage compensation (Mazzotta, Opaluch et al. 1994).

An additional advantage is the greater data gathering efficiency of CEA. While most CVM studies collect a single data point, the CEA produces as many data points from a given respondent as alternatives included in the survey instrument. Though this is less of a methodological advantage than the others noted above, considerable cost savings can result, permitting improved quality in other elements of the survey process.

#### 2.2.3.4 Empirical Applications of CEA in Environmental Valuation

Compared to the number of published studies using CVM, there is a small handful of CEA and other conjoint-based studies in the published environmental economics literature. Recent papers include Layton, Brown et al. (1999), Roe, Boyle et al. (1996), Opaluch and et al. (1993) and Mackenzie (1993) which employed a conjoint rating elic-

---

1. Lexicographic preferences over a pair of goods implies that the goods are perfect compliments, and thus that efficient consumption occurs in fixed proportions. When a WTA elicitation reveals a refusal to accept money compensation for decreases in an environmental amenity, lexicographic preferences imply that income and the amenity are perfect compliments and therefore any change in their relative proportions decreases total utility resulting in a refusal to accept the compensation offer.

itation techniques, and Champ and Loomis (1998), Loomis and et al. (1998), and Peterson and Brown (1998) which employed paired comparison techniques.

Adamowicz, Louviere et al. (1994) employed a CEA to evaluate preferences for alternative flow regimes on two rivers in Alberta in recreationists' site selection decisions. Choice sets were constructed which included ten site attributes: travel distance (used as proxy for cost), water quality, fish size and catch rate and others, as well as attributes specific to either standing or running water. Other design elements included 16 choice sets per survey and a constant "other" alternative which allowed the respondent to abstain from the hypothetical market. A key element in this study is the inclusion of a revealed preference (travel cost) model and a model which pools revealed and stated preference data for site demand. All estimated parameters in the CEA study were significant, though not in the revealed preference model, and it was found that CEA data could be pooled with RP data control problems with collinearity in attributes in the latter. While the CEA produced welfare estimates 2-5 times greater than the RP model, the pooled model estimates were very close to those from the RP.

Boxall, Adamowicz et al. (1996) report the use of a CEA to measure recreation values for moose hunting sites in Alberta. Six attributes of the design included distance travelled, moose population size, grade of roaded access to and within the site, congestion, and timber harvest operations at the site. Three alternatives were specified per choice set, one of which was a constant status quo alternative. With the exception of road quality and timber harvest, all attributes were significant and of the expected sign. A DC/CVM elicitation was included in the instrument design to measure WTP (in terms of increased travel) for increases in moose populations. The DC/CVM produced WTP estimates 20 times higher than the CEA. Possible explanations for the disparity are respondents' failure to understand the choice task, yea-saying in the DC/CV, and respondents' failure to consider substitute sites when replying to the DC/CVM query. The authors provide some statistical evidence that the latter is the chief cause.



Xu (1997) performed a CEA to estimate values for ecosystem management in western Washington State amongst timber-rural, other-rural and urban households. Attributes of ecosystem management were identified as: aesthetics, biodiversity, rural unemployment, dominant management strategy, and cost to households. Aesthetics were characterized visually with photographs and charts as forest age class distributions. Biodiversity is described in terms of a biodiversity restoration index (a weighted version of the Shannon Index) with a baseline level of 50 and a historical-norm value of 100. Management strategies (three alternative strategies - preservation, commercial, and multiple-use) are described in terms of principle focus and pros and cons, thus nesting additional attributes which are not individually valued. Cost is specified as increases in wood products costs with a payment vehicle of increased product costs and sales taxes. The study included a DC/CVM question regarding WTP for increases in the biodiversity index, and results were compared to the CEA to test for an "omitting information" effect, i.e. the effect of omitting the information on trade-offs and substitutes that is built into the CEA elicitation. Other statistical tests included an independence of irrelevant alternatives (IIA) test and a test for anchoring using split sample bid vectors, both of which present favorable results. The author follows the utility-balance approach to experimental design advocated by Huber and Zwerina (1996). This approach uses prior information on attribute utilities (gained from a pretest of the survey instrument) to compose sets of experimental contrasts (choice sets) that are very close in utility. In theory, this permits more statistically efficient estimation of preferences, though Xu recognizes that significant cost is incurred in terms of unrealistic alternatives which he speculates may have impeded carefully considered responses. It may also assume a greater precision in preferences over passive use goods than is realistic. Survey results indicate a maximal total willingness to pay (TWTP) of nearly \$1300/year for increases in mature and overmature forest to 60% of the forest age class distribution amongst urban households and \$400 and \$700 annually for timber-rural and other-rural households, respectively. Values for biodiversity increases range up to \$680/year and \$400/year amongst urbanites and other-rural communities for a BRI level of 75. Timber-rural residents

expressed an intermediate value of \$580/year, which is maximized at a slightly lower BRI level than that preferred by the other regions.

In the first published application of CEA to measurement of non-use values, Adamowicz, Boxall et al. (1998) study public preferences for old growth forest preservation and protection of threatened caribou populations in Alberta<sup>1</sup>. The survey instrument incorporates both CEA and DC/CVM WTP elicitation or comparison purposes. The survey design specified three alternatives in each choice set, one of which was the status quo, and eight choice sets in each instrument. Five attributes describe each alternative (with four levels for each attribute): (1) wildlife populations (caribou and moose), (2) wilderness area, (3) recreation restrictions, (4) forest industry employment, and (5) tax increases. Attribute levels also spanned the status quo, thus allowing estimation of both WTP for increases and WTA for decreases in the attributes. Random digit dialing was used to identify 900 individuals who agreed to receive the survey, which was then mailed and self-administered.

Data analysis included models estimated on both the CEA and CVM datasets as well as a pooled dataset. In the pooled and CEA data, a status quo alternative specific constant (ASC) is estimated, and both linear and quadratic functional forms are estimated for all three data sets. The authors discuss the inclusion of demographic covariates in the model, but note that only environmental group membership and income were significant (with the latter only in the quadratic specification) and do not present this with the model results, leaving demographic effects for further investigation. With the exception of employment, all attribute parameters are significant and of the expected sign. In the CEA, the quadratic model outperforms the linear specification, while the opposite result was found for the CVM models. The status quo ASC was negative and significant, indicating a disutility for varying from the status quo condition. When allowing for hetero-

---

1. Though not yet published in a peer-reviewed journal, (Xu 1997) appears to be a concurrent application of CEA to passive-use values.

geneous error variance between the data sets, the CEA and CVM were not significantly different in the bid parameter. Comparisons over other attributes are made on the basis of welfare estimates. Given the linear specification, the CEA produced more conservative WTP estimates for the caribou program. In the quadratic specification, the opposite was true, although inclusion of the status quo ASC lowered the CEA estimate to below that of the CVM. Marked nonlinearity in WTP for caribou population improvements observed in the quadratic model is attributed to characterization of an intermediate population level as a minimum viable population (MVP). Thus individuals expressed high marginal values up to the MVP, and low marginal values thereafter. The authors interpret the status quo term as indication of an endowment effect, and conclude that the welfare estimates based on the quadratic model which incorporate the status quo effect are likely the most accurate measures. Using effects codes for above and below baseline levels of the caribou, wilderness and cost attributes, the authors identify further evidence of endowment effects analogous to a WTA/WTP disparity. Negative marginal utilities for decreases in the wilderness and caribou attributes are found to be much larger in magnitude than the marginal utility of increases above baseline. This suggests that there should be a kink in the compensated demand curves at the baseline level, though the authors fail to discuss the implications of this disparity for welfare estimation.

Hanley et al. (1998) employed a CEA study to estimate willingness to pay for designation and implementation of Environmentally Sensitive Areas (ESAs), a program used in Scotland to improve biodiversity conservation in agricultural areas. Five attributes of ESA designation were identified: woods, heather moors, wet grasslands, dry stone walls, and protection of archeological features, in addition to a cost attribute. The design included eight choice pairs per respondent and the response format offered either of the choice pair (choice A/choice B) neither (i.e. status quo), or "don't know". The instrument used visual characterizations to describe changes in attributes as part of the survey design, though depicted changes were qualitative rather than quantitative. Attribute levels under with/without ESA scenarios were predicted using ecological models. All

attributes were statistically significant with parameters of the expected signs in the choice models. Linear and quadratic forms were estimated (only a quadratic term for tax was included) with the latter exhibiting superior fit, and ASC's were estimated but not found to be significant. Parallel surveys were conducted using both dichotomous choice and open-ended CVM elicitation formats and results of the DC/CVM and CEA were not found to be significantly different, though both produced higher estimates than the open-ended CV. The authors conclude with a discussion of the use of CEA attribute values in benefit transfer analyses, suggesting that, insofar as the value of environmental changes can be decomposed, the flexibility of CEA measures render benefits transfer much more viable.

Finally, Mazzotta et al. (2000) presents a CEA study of public values for protection of the Peconic Bay Estuary on eastern Long Island. Attributes of the bay environment included in the study were acres of: farmland, undeveloped land, wetlands, safe shellfishing areas, and eelgrass communities. The latter was included as a proxy for fish and shellfish populations because of the close association of the two and given the recognition of unpredictability in the fish populations. The survey was administered using convenience intercept sampling at high visitation locations around the bay. The instrument was designed with five choice sets, each of which features a status quo scenario and two conservation alternatives, where the status quo was a 20-year projection under the current management regime. The design specifies three levels for each of the attributes - the projected baseline level and two increases relative to the baseline projection. Three alternative modeling techniques are used to analyze the data, a standard conditional logit with and without ASC's for each of the non-baseline alternatives, and a nested logit model which specifies the status quo as one branch and the two other alternatives within a separate branch. All attribute coefficients in all three model specifications are significant with expected signs. Both the nested and conditional model with ASC's indicate a *ceteris paribus* inclination to choose a non-baseline alternative, which the authors interpret as a yea-saying bias reflecting respondents' symbolic value for environmental protection.

Welfare estimates from the two models are not significantly different, though attribute values are 1/2 to 2/3 the magnitude of those estimated based on the conditional logit that fails to control for yea-saying. It is interesting to note that the authors regard it a matter of course that the yea-saying effect should be controlled for and excluded from the welfare calculation. This effect is essentially the same as that observed by Adamowicz, Boxall et al. (1998), though in this instance it has a positive value versus a negative value which the earlier paper interprets as a status quo bias or endowment effect. Adamowicz et al. apparently interpret the value as a legitimate expression of preferences in that they judge welfare estimates with a deduction for status quo effect to be the most accurate of the alternative specifications. While it remains ambiguous which perspective is correct (i.e. inclusion or exclusion of the SQ value), it should be pointed out that the interpretation of a yea-saying bias in Mazzotta et al. appears to be erroneous. Because the specification of the status quo in their design was a 20-year projection of current trends, whereas the levels under the conservation scenarios would maintain conditions closer to the present day baseline relative to the 20-year projection, the observed status quo effect appears to be the same as that observed by Adamowicz et al. and interpreted as an endowment effect.

Again, the above is only a brief review of a vast literature on nonmarket valuation techniques and applications. Though the published literature on CEA is currently very limited, the apparent advantages offered by the method in terms of flexibility, potential for benefits transfer, and measurement of multiattribute preferences presage a growth in this literature similar to that observed in the CVM over the last decade. As public and private land managers increasingly confront the complexities and implications of ecosystem management, multiattribute methods such as CEA are likely to become increasingly necessary. The research documented in this thesis identifies some important advantages of CEA as well as significant areas for future development.

## Chapter 3: Theory

### 3.1 Random Utility Models

Statistically, both the DC/CVM and choice experiment models in this survey are of the class of multinomial choice models used to analyze the discrete response data produced by the survey instrument. The principal alternative method of WTP elicitation is using open ended questions to which the respondent provides a direct statement of the amount they would pay to gain an economic benefit, or alternatively, accept in compensation to forego. Although this elicitation method is much simpler to analyze from a statistical perspective, it has been shown to be problematic in eliciting accurate responses (Arrow, et al. 1992). The advantages of closed-ended, discrete response elicitation questions with respect to realism and incentive compatibility are purchased at the cost of greater statistical complexity. Both the DC/CVM and the choice experiment methods rely on the random utility model (RUM) framework to provide a utility theoretic interpretation of the discrete responses observed from the respondents.

Given a set of alternatives  $A_n$ , presented to an individual  $n$ , the probability that any one alternative  $i$  is chosen is given by:

$$P(i|A_n) = Pr(U_{in} \geq U_{jn}, \forall j \in A_n) \quad (3-1)$$

where  $U_{in}$  is the utility that individual  $n$  achieves by choosing alternative  $i$ . The principal insight of random utility theory (Ben-Akiva and Lerman 1985; Hanemann 1984 from which the following derivations are adapted) is that utility, which is not directly observable, can be partitioned into a deterministic component and a random component. The accompanying assumption is that the individual knows their utility function with certainty, but due to unmeasured attributes of the good being valued, variations in tastes, and other measurement errors, from the perspective of the investigator, utility is stochastic:

$$U_{in} = V_{in} + \varepsilon_{in} \quad (3-2)$$

where  $V_{in}$  is the mean and  $\varepsilon_{in}$  the random disturbance of the stochastic random utility function. The specification of  $V_{in}$  includes a vector of attributes of alternative  $i$ ,  $X_{in}$ , which includes a price or bid variable, and a vector of characteristics of the respondent,  $R_n$ , including income. Thus:

$$U_{in} = \beta' f(X_{in}, R_n) + \varepsilon_{in} \quad (3-3)$$

where the deterministic component is here specified as linear in parameters, though the function  $f(\cdot)$  can be nonlinear. While it is possible to specify a non-linear in parameters statistical model, this becomes much more complicated to estimate and interpret. With the indirect utility specified as above, the individual seeks to maximize utility such that

$$\begin{aligned} P_n(i|A_n) &= P(\beta' f(X_{in}, R_n) + \varepsilon_{in} > \beta' f(X_{jn}, R_n) + \varepsilon_{jn}) \\ &= P(\beta' f(X_{in}, R_n) - \beta' f(X_{jn}, R_n) \geq (\varepsilon_{jn} - \varepsilon_{in})); i, j \in A_n, i \neq j \end{aligned} \quad (3-4)$$

Notice that, unless  $R_n$  enters the function  $f(\cdot)$  nonadditively, it appears identically on both sides of the inequality and cancels out of the equation. Thus,  $R_n$  must enter nonadditively if the effects of respondent characteristics on choice are to be measured. If  $\varepsilon_{in}$  and  $\varepsilon_{jn}$  are assumed to be extreme value independently and identically distributed (IID) with scale parameter  $\mu$ , then  $\varepsilon^* = \varepsilon_{jn} - \varepsilon_{in}$  is logistically distributed (Ben-Akiva and Lerman 1985, pp. 104-106). This distributional assumption approximates the normal and is used for mathematical convenience as  $P_n(i|A_n)$  is an indefinite integral if the normal distribution is used. This distributional assumption leads to the multinomial logit (MNL) model for the choice probabilities (McFadden 1974; Ben-Akiva and Lerman 1985):

$$P_n(i|A_n) = \frac{e^{\mu V_{in}}}{\sum_{j \in A_n} e^{\mu V_{jn}}} = \frac{e^{\mu \beta' f(X_{in}, R_n)}}{\sum_{j \in A_n} e^{\mu \beta' f(X_{jn}, R_n)}} \quad (3-5)$$

Since  $\mu$  appears as a multiplicative constant on every parameter of the model, it is not identifiable. A common assumption employed by users of MNL models is that the scale parameter,  $\mu$ , is equal to one, which connotes homoscedastic disturbances. While this assumption is sufficiently innocuous for a given set of observations, it can confound the comparison of parameters estimated on different sets of observations if the data give rise to different scale parameters such that  $\mu_M/\mu_N \neq 1$  where M and N denote datasets 1,...,m and 1,...,n,  $M \neq N$ . Empirical observations in similar studies have found that this ratio was not significantly different than one (Xu 1997; Adamowicz, Boxall et al. 1998), and we adhere to this assumption in this study.

The log likelihood function for the MNL model above is

$$\ln L = \sum_n \sum_{i \in A_n} s_{in} P(i|A_n) = \sum_n \sum_{i \in A_n} s_{in} \left( \beta' f(X_{in}, R_n) - \ln \sum_{j \in A_n} \beta' f(X_{jn}, R_n) \right) \quad (3-6)$$

where  $s_{in}=1$  if alternative  $i$  is chosen by individual  $n$ , else  $s_{in}=0$ . The necessary first order conditions to maximize the likelihood function are obtained by setting the first derivative of Equation 3-6 with respect to the parameter vector equal to zero:

$$\frac{\partial}{\partial \beta} \ln L = \sum_n \sum_{i \in A_n} s_{in} \left( f(X_{in}, R_n) + \frac{\sum_{j \in A_n} e^{\mu \beta' f(X_{jn}, R_n)} f(X_{in}, R_n)}{\sum_{j \in A_n} e^{\mu \beta' f(X_{jn}, R_n)}} \right) = 0 \quad (3-7)$$

or in more compact form

$$\frac{\partial}{\partial \beta} \ln L = \sum_{n=1}^N \sum_{i \in A_n} (s_{in} - P_n(i)) f(X_{ink}, R_n) = 0, k = 1, \dots, K \quad (3-8)$$



McFadden(1974) demonstrates that, under relatively weak conditions,  $\ln L$  in Equation 3-6 is globally concave so that a solution to Equation 3-7, if it exists, is unique. Thus the ML estimator of  $\beta$  is consistent, asymptotically normal, and asymptotically efficient. Also note that the binary logit used in the DC/CVM component of the analysis is a special case of the multinomial logit, where there are two elements in the set  $A_n$  and Equation 3-5 collapses to

$$P_n(i) = \frac{e^{\mu\beta'f(X_{in}, R_n)}}{e^{\mu\beta'f(X_{in}, R_n)} + e^{\mu\beta'f(X_{jn}, R_n)}} = \frac{1}{1 + e^{(-\mu)\beta'(f(X_{in}, R_n) - f(X_{jn}, R_n))}} \quad (3-9)$$

with log likelihood function:

$$\ln L = \sum_{n=1}^N \left\{ s_{in} \ln \left( \frac{e^{\mu\beta'f(X_{in}, R_n)}}{e^{\mu\beta'f(X_{in}, R_n)} + e^{\mu\beta'f(X_{jn}, R_n)}} \right) + s_{jn} \ln \left( \frac{e^{\mu\beta'f(X_{jn}, R_n)}}{e^{\mu\beta'f(X_{in}, R_n)} + e^{\mu\beta'f(X_{jn}, R_n)}} \right) \right\} \quad (3-10)$$

and first order conditions

$$\frac{\partial}{\partial \beta_k} \ln L = \sum_{n=1}^N [s_{in} - P_n(i)] f(X_{nk}, R_n) \quad (3-11)$$

WTP/WTA estimation: Estimation of Hicksian welfare effects from the MNL choice probabilities follows the method outlined by Hanemann (1984) and Hanemann and Kanninen (1999). Given a quantity change in the level of a public good from  $X^0$  to  $X^1$ , the compensating surplus which exactly offsets the utility gain of the change is the level of  $C$  which solves the equality:

$$v(p, X^1, y - C, R, \varepsilon) = v(p, X^0, y, R, \varepsilon) \quad (3-12)$$

where  $v$  is indirect utility,  $p$  is the vector of market prices (hereafter assumed constant and left implicit for simplicity), a  $X$  is vector of attributes other than the bid level  $C$ ,  $y$  is income,  $R$  is a vector of sociodemographic characteristics, and  $\varepsilon$  is a random error term. The objective is to solve for the expected value of  $C = C(p, X^0, X^1, y, R, \varepsilon)$ , which is the maximum WTP for the change from  $X^0$  to  $X^1$ . Assuming the additive separability of the cost attribute of the good in the individual's indirect utility function, we can express the deterministic part of utility as

$$v_{in} = \beta' f(X_{in}, R_n) + \alpha C_{in}$$

where  $C$  is the specified bid level for alternative  $i$ , and  $\alpha$  is associated parameter. The following measures TWTP/TWTA for a change in the attributes of a good from state  $i$  to state  $j$  aggregated over all observations (adapted from Hanemann (1984), see also Adamowicz, Fletcher et al. (1994) and Xu (1997)):

$$\begin{aligned} TWTP|TWTA = CS &= -\frac{1}{\alpha} \left\{ \ln \sum_{i \in A} e^{v_{in}} - \ln \sum_{j \in A} e^{v_{jn}} \right\} \\ &= -\frac{1}{\alpha} \left\{ \ln \sum_{i \in A} e^{\beta' f(X_{in}, R_n) + \alpha C_{in}} \right\} - \left\{ \ln \sum_{i \in A} e^{\beta' f(X_{jn}, R_n) + \alpha C_{jn}} \right\} \end{aligned} \quad (3-13)$$

If the mean value of TWTP/TWTA for the change in all attributes from state  $i$  to state  $j$  is of interest, Equation 3-13 simplifies to

$$TWTP|TWTA = CS = -\frac{1}{\alpha} (\alpha(C_i - C_j) + \beta'(f(X_p, \bar{R}) - f(X_j, \bar{R}))) \quad (3-14)$$

where  $f(X, R)$  is evaluated at the sample mean value of  $R$ , recalling that  $R$  drops out of the equation if it enters  $f(\cdot)$  additively. The TWTP/TWTA for the “part-worth” of the change of an individual attribute  $k$  from state  $i$  to state  $j$ , holding other attributes constant, further simplifies to

$$TWTP|TWTA_k = CS_k = -\frac{\beta_n}{\alpha}(f(X_{ik}, \bar{R}) - f(X_{jk}, \bar{R})) \quad (3-15)$$

Finally, the Hicksian compensated demand curve, depicting marginal WTP/WTA for attribute  $k$  at level  $i$ , is given as:

$$MWTP|MWTA_k = \frac{\partial}{\partial X} CS = -\frac{\beta}{\alpha} f'(X_{ik}, \bar{R}) \quad (3-16)$$

(Hanemann 1991; Beenstock, Goldin et al. 1998; Li, Lofgren et al. 1996)

### 3.2 A Note On Measures of Central Tendency

Hanemann and Kanninen (1999, pp18-19.) make an important distinction between the conventional regression techniques used in analysis of open ended WTP data and the limited dependent variable models used in conjunction with discrete choice elicitation methods. With the former, the investigator obtains an estimate of the mean WTP conditional on the regressors. The latter estimates the entire conditional cumulative distribution function (cdf) of the dependent variable. The preferred measure of central tendency by which to summarize the estimated cdf is therefore at the discretion of the investigator, and its selection can significantly alter the results of the analysis. This is distinct from the selection of central tendency in the sample, i.e. whether to evaluate WTP at the sample mean, median or other quantile values of the covariates.

Given a linear specification of the regression model  $f(\cdot)$ , the mean and median of the logistic distribution coincide, though this is not the case with other, e.g. log-linear, functional forms. Generally, therefore, it is important to note that the mean is more highly sensitive to the tails of the distribution. Thus, for example, in instances where the tails are not well defined given a high proportion of yes responses to the highest bid level specified in the survey design, the investigator must be cautious about using the mean WTP to summarize the distribution.

It is customary to use the sample mean to represent aggregate welfare effects for the purpose of benefit cost analysis. The economic foundation of the BCA decision rule is the Kaldor-Hicks potential compensation criteria, which compares the aggregate gain to aggregate losses over the entire population (Johansson 1993, pp. 117-120). Kaldor-Hicks is in fact a social decision rule that states that, if a given policy initiative results in sufficient aggregate net benefits that gainers could compensate losers and still achieve a net gain, i.e. if the policy creates a *potential* Pareto improvement, then the policy is considered to improve social welfare. Hanemann (1989) restates a point that has been made repeatedly: as a social decision rule, the Kaldor-Hicks criteria is inadequate as on ethical grounds<sup>1</sup>, and suggests that a more acceptable decision rule in many contexts is a majority voting rule, which is equivalent to the sample median WTP. That is, the sample median is equivalent to the level of policy cost at which 50% of the population would vote yes. The essential point is that, by choosing a measure of central tendency by which to summarize the analytical results, the investigator makes a decision that may strongly influence the conclusions of the study, and which has important ethical dimensions *vis a vis* the operative social decision rule. While the objective of a given nonmarket valuation study may be to obtain welfare estimates strictly for the purpose of BCA, consider-

---

1. Amongst other objections, the K-H criteria is criticized on the grounds that it would approve a resource reallocation that benefits wealthy individuals at the expense of the poor, so long as the beneficiaries' gain outweighs the total losses of those who bear the costs.

ation of the appropriateness of BCA in a specific context is not beyond the domain of economic analysis and should not be ignored in any complete study.

## Chapter 4: Survey Development and Design

### 4.1 Definition of measurement objectives and techniques

Development of the valuation survey began in March, 1998. The initial planning consisted of several meetings with collaborators in the Coastal Landscape Analysis and Modeling Study (CLAMS) to determine the informational needs of the larger modeling project. These meetings identified an extensive list of biodiversity indicators which would be produced by the CLAMS models and for which economic values were desired. This initial list was determined to be far too extensive to incorporate into a standard valuation exercise. Through consultation with CLAMS scientists and review of the conservation biology and forest management literature, it was determined that most biodiversity indicators of interest in CLAMS could be nested within five themes: game management, aquatic habitat and anadromous fish, threatened and endangered species, forest structural and age-class diversity, and biological reserve networks. Each of these themes represents both a key element in the biodiversity literature as well as distinct programs of management institutions operating on the Coast Range landscape (see Section 2.1 for further detail).

Amongst the range of valuation techniques available, the choice experiment method was identified as offering the greatest potential to address the range of valuation issues identified for analysis, specifically the need for continuous value estimates (i.e. demand functions) rather than point measures, the multiattribute nature of the valuation problem, and the largely passive-use nature of biodiversity benefits. It was also determined that a mail survey would be necessary given the need to present a relatively large information set to survey respondents. Despite liabilities of mail surveys associated with non-response problems (Arrow, Solow et al. 1993), the need for visual aids rendered telephone surveys infeasible and time and budget limitations precluded a personal inter-

view approach with sufficient sample sizes. The survey was carefully designed, tested and administered to minimize problems of nonresponse.

#### 4.1.1 Focus Groups and Preliminary Survey

During July and August of 1998, a series of six focus groups were conducted, two in each of the three principal geographic regions of the state<sup>1</sup>. The initial round of three focus groups were principally ethnographic investigations to determine the level of familiarity of the lay public with environmental issues, and the appropriate vernacular for conveying forest management concepts in a survey instrument (Carson, Louviere et al. 1994). Questions addressing participants' use of Coast Range resources and relative importance of attributes were posed to prompt discussion. In importance ratings, all five of the elements discussed above were rated as moderately to very important. In ranking the elements, game species were universally identified as least important, although responses varied between the remaining four attributes. The game species attribute was subsequently dropped from the survey design. Responses to written material indicated a need for more simplified terminology.

Prior to the second round of focus groups, additional consultations with CLAMS investigators were conducted to identify hypothetical scenario descriptions and a simplified information set to present to focus group participants. Portions of a preliminary survey instrument were developed describing the management situation, factors influencing elements of biodiversity, and alternative metrics for describing change in each of the attributes. Due to inability to predict changes in salmon population levels, a determination was made to express changes affecting coastal salmon populations in terms of quantity of habitat protected. Subsequent focus groups were used to pretest a number of

---

1. Redmond and Klamath Falls (Eastern Oregon); -Portland (Willamette Valley), and Coos Bay and Newport (Coast Range).

Table 4-1. Focus groups

Focus group location	Date	Number of participants
Redmond	7/13/98	11
Newport	7/15/98	9
Portland	7/22/98	12
Portland	8/12/98	7
Klamath Falls	8/19/98	6
Coos Bay	8/20/98	3

potential survey questions and formats. Acceptability of policy scenarios, specifically payment vehicle, was addressed and it was found that, though generally unpopular, respondents felt that income taxes were the most appropriate funding source for biodiversity protection. It was thus concluded that this payment vehicle would not generate an excessive level of protest response. Graphic elements were pre-tested including pie charts, icons and photographs used to illustrate changes in attribute levels, and found to be perceived as neutral.

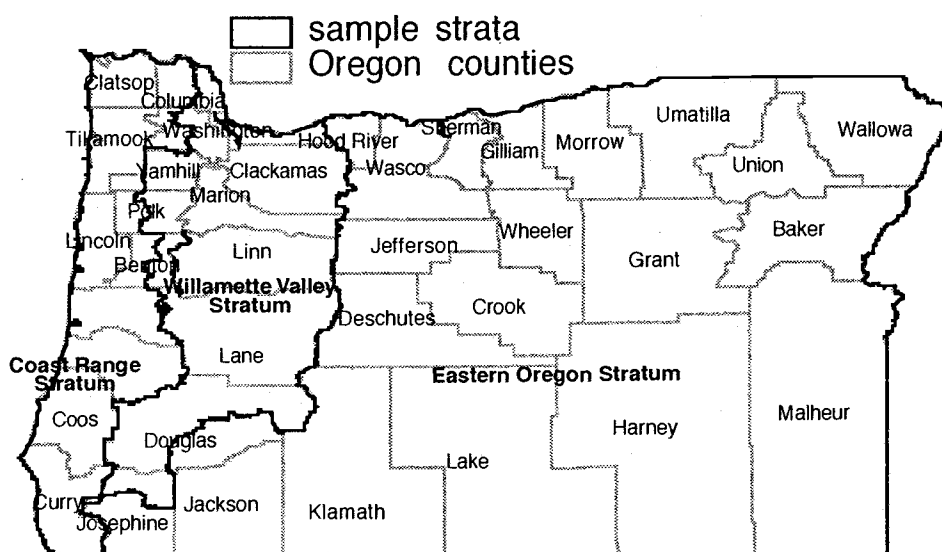
#### 4.1.2 Mail pretest

A pretest survey was sent out on November 10, 1998. A random stratified sample of Oregon households was generated by a professional sampling firm, with 40 households each in the Coast Range, the Willamette and Umpqua Valleys, and Central and Eastern Oregon regions. Strata were identified on the basis of postal zip code boundaries to conform as closely as possible to the Coast Range physiographic provincial boundary and the Eastern Oregon congressional district (Figure 4-1). The survey was administered according to a modification of Dillman's Total Design Method (Dillman 1978), with a cover letter describing the survey and its purpose, a \$1 bill and a postage paid return envelope. A reminder postcard was sent one week later, followed by a second copy of the survey instrument after an additional week, accompanied by a cover letter reiterating the



importance of representing the respondents' views. A final reminder postcard was sent December 3. Forty-two respondents returned partially or fully completed questionnaires and 20 surveys were returned as undeliverable. Phone calls to nonrespondents indicated that the relatively low effective response rate of 42% was due primarily to the holiday

Figure 4-1. Sample Strata



season, and did not represent a systematic effect due to particular disinterest or views on biodiversity amongst the nonrespondent group. The cover letter for the pretest mailing noted that it was a preliminary version and requested comments from respondents on the content and design of the survey instrument, and several respondents provided extensive comments. Of particular concern was the high rate of item nonresponse in the choice experiment section, given that a majority of respondents completed only the first of three elicitation questions.

As a result of information gained from the pretest, significant revisions were made to simplify the design of the survey. Examples of changes include simplification of the

forest age class description from four to three classes, reconfiguration of the choice experiment section to improve clarity of alternative descriptions and decrease item nonresponse, and a change in the endangered species attribute from probability of species extinction to percent of endangered species habitat under protection, the same metric used to express changes in salmon protection.

A subsequent draft of the survey was reviewed by a public school science instructor, who suggested several changes to address the questionnaire at a 7th-grade reading level. Additional reviews by valuation practitioners Drs. Stephen Swallow, Rebecca Johnson and John Loomis suggested numerous changes in phrasing, layout and experimental design. After incorporation of these changes, a draft questionnaire was tested in 10 personal interviews using a verbal protocol analysis (Schkade and Payne 1994). Interview participants included a shop owner, a blacksmith, a retired farmer, and a waiter, and spanned a broad array of income and education levels. Results were quite satisfactory, with respondents able to independently understand the informational content and the choice tasks. Respondents typically completed the survey in approximately 25 minutes, although many suggested that they would go slower if they had received the survey at home and were not in an interview setting. After minor corrections, the final draft of the survey was mailed using the same protocol as for the pre-test survey, with a stratified sample of 1000 households in each of the three regional strata. Details of the survey administration are provided below. A copy of the final draft of the survey instrument and accompanying cover letter and reminder postcards are included in Appendix A.

#### 4.1.3 Instrument Design

The survey instrument is composed of four sections. An introduction and informational section review the background and purpose for the survey, introduce the concept of biodiversity and ask the respondents to identify personally important benefits of Oregon forests. Five pages of the survey booklet are devoted to describing the four

attributes of biodiversity protection, identifying causal factors for decline, and current state, federal, and private actions to improve their status. Each of the attributes is described in terms of a programmatic mechanism for protecting one of the elements of biodiversity and the baseline level of implementation is specified. Thus, for example, salmon protection is described as the extension of the current level of habitat protection on federal land encompassing 15% of Coast Range streams (see Appendix A for conservation program descriptions). Color graphics are used extensively throughout to maintain respondents' interest. Graphic icons are presented for each of the conservation programs which visually depict quantitative changes in the program by incorporating either a pie chart or histogram with a representative image of the program. These are designed to be used in the choice questions to present variation of the attribute levels in visual as well as textual terms.

The information section is followed by a summary in which the four biodiversity programs are contrasted, and the choice situation is motivated. Creation of a biodiversity trust fund is identified as a mechanism to pay for improvements in biodiversity protection, to be paid for through income taxes paid by the general public as well as fees paid by industrial and recreational forest users. Questions that ask the respondents to rate and then rank the four programs are posed, followed by a question that asks the respondents to compare the biodiversity programs' importance to other social programs requiring public funding, e.g. education, crime prevention, rural development, et cetera. A DC/CVM question asking the respondent's willingness to pay is presented for one of the conservation programs (where the design specifies one program in each of our versions of the survey instrument) preceded by a brief paragraph exhorting the respondent to consider trade-offs to biodiversity in the Coast Range and constraints on household spending.

A brief passage precedes the CEA section which provides instructions, specifically emphasizing the importance of answering all of the choice questions. The choices are

described as hypothetical ballots in a state referendum and the income tax payment vehicle is reiterated. Each of four choice scenarios asks the respondents to express their first choice of three alternatives: a status quo alternative and two alternatives which include variations in the levels of the four conservation attributes and a bid level described as an annual cost to the household. The choice questions include a follow-up asking the respondent to briefly describe the reason for their selection. The CEA section is followed by a set of demographic questions and an open page for comments.

Principles of conservative design: As noted above, the design of the survey offered the opportunity to incorporate both choice experiment and dichotomous choice contingent valuation elicitation questions. In addition to empirical objectives of identifying welfare measures and relative preferences for changes in biodiversity conservation, methodological development is achieved by comparative analysis of alternative measurement techniques.

Following the NOAA Panel's recommendation, the design of the survey instrument incorporated a number of measures to control instrument effects and other biases, tending to produce conservative welfare estimates. The selection of the CEA framework was motivated in part by the suggestion of the NOAA Panel and several other authors that the CEA will tend to produce more conservative estimates of WTP. By portraying natural resource decision making in light of complex trade-offs, the existence of substitutes is emphasized in the framework of the elicitation question (although in most applications the range of substitutes portrayed is narrowly restricted to attributes of the good, rather than alternative goods). To the extent that respondents are inclined to respond positively to referendum questions due to a yea-saying or symbolic bias, the multiple alternatives in the CEA render the "symbolically superior" alternative ambiguous. Since the status quo alternative is described in terms of the baseline level of the attributes, each of which is a positive value, it is less starkly contrasted to the other alternatives and the

relative "symbolic value" of the latter is diminished. Thus, arguably, the choice experiment is less prone to yea-saying. Additional conservative design elements include:

- Use of willingness to pay welfare measure rather than willingness to accept<sup>1</sup>, which is frequently demonstrated in the literature as generating much higher welfare estimates than WTP (Knetsch 1990; Hanemann 1989)
- The elicitation of household WTP rather than individual WTP, the latter of which has been demonstrated by Quiggin (1998) to be subject to double counting due to within-household altruism;
- Questions prior to the WTP elicitations that prompt the respondent to rank and rate the biodiversity attributes. To remind respondents of budget constraints and other substitute public goods, a question is included that asks respondents to rate the importance of a number of public goods programs, including the biodiversity measures in the survey as well as public education, crime reduction, health care and others. These exercises prepare the respondents for the prioritizing exercise encountered in the choice experiment section of the instrument. Carson, Louviere et al. (1994) speculate that warm-up exercises such as these reduce the error variance of the WTP estimates as respondents refine their preference mapping. Loomis, Gonzalez-Caban et al. (1994) also finds that reminders of substitutes and budget constraints tend to decrease estimated WTP by controlling hypothetical bias.
- The potential for interviewer bias inherent in telephone and in-person interview surveys is eliminated by use of a self-administered survey instrument delivered by mail. The mail format presents some liabilities in terms of high nonresponse rates. This is outweighed, however, by the ability to gather large amounts of data affordably with a well-designed and thoroughly pretested instrument.
- Tests of the effect of the order of presentation of the attributes in the information section and the DCCV and CEA elicitations on choice probabilities are included to identify anchoring biases.

As a final note, it is widely recognized in the valuation literature that the validity and reliability of hypothetical values are in opposite proportion to the familiarity of the respondent with the subject of valuation. Ajzen, Brown et al. (1996) provides evidence

---

1. The CEA elicitations in the survey instrument are always expressed as WTP, i.e. bid amounts are all positive. However, other attributes include levels that are below baseline. It is possible, therefore, to identify how much less the average individual is WTP for an alternative which is characterized by a decrease from the baseline level for a given attribute, relative to a alternative with no decreases and which is otherwise identical. In effect, this measures WTA for decreases below baseline without directly asking the individual to accept money compensation for a decrease in biodiversity protection.

that unfamiliarity increases variance of estimates and, if the survey instrument invokes an altruistic response, WTP is biased upward. The survey instrument designed for this research attempts to present a balanced view of resource management of the relative trade-offs required in identifying a conservation strategy for the Coast Range. The long history of resource use and controversy in Oregon and the prominence of the public debate and media coverage concerning natural resource use and policy has resulted in a population that has an uncommonly high degree of familiarity with these issues. Thus, it is likely that respondents do not regard the choice scenarios presented as purely hypothetical, as there have been comparable precedents on recent state ballots and in policy and management decisions at all levels of jurisdiction.

## 4.2 Experimental design

A key element of choice experiment analysis and conjoint methods generally is experimental design. Conjoint methods are essentially experiments in which the investigator measures the effect of experimental factors on choice probabilities. Thus, the specification of choice scenarios is analogous to experimental contrasts of alternative treatments represented by composite goods. Composites are distinguished by differences in attribute (factor) levels. The interface of the conjoint analysis literature with the experimental design literature is much greater than that of CVM. In the latter, the bid vector is typically the only attribute which is subject to variation, and the relative simplicity of the design issue in CVM studies has been typically treated in an ad hoc fashion (Kristrom 1997). As noted in Section 2.2.3.2, the potential number of contrasts in an experiment as large as the one executed in this research is huge. The problem of selecting which contrasts to specify in the design is critical to minimizing the variance of parameter estimates in the choice modelling.

Central design questions in a CEA are the number of attributes to identify, the number of alternatives to present in each choice set (i.e. contrast), and the number of

choice sets to present to a given respondent. These effectively define the parameters of the experimental design and are determined largely on the basis of the investigator's judgement with respect to respondent's cognitive limits and the complexity of the decision scenario. Carson, Louviere et al. (1994) suggest "average" designs feature seven attributes, four alternatives per choice set and four choice sets per survey instrument, though they note that there is considerable variation in the published literature<sup>1</sup>. As described above, the design used in this research included four attributes to describe biodiversity conservation. With the addition of the bid attribute, there are five factors specified in each choice alternative. Given the complexity of the subject and the length of the questionnaire booklet, it was determined that four choice sets would be included in each questionnaire. Each choice set is composed of three alternatives - one constant status quo alternative which does not vary between choice sets, and two alternatives which vary in attribute levels. In the survey instrument, alternatives are labelled Alternative A, Alternative B and Alternative C: No Change. Carson et al. note the advantages and liabilities of specifying a status quo alternative. Advantages are the added realism that the SQ alternative adds given that in most purchase or referendum decisions the no-purchase or no vote are available choices, as well as defining a baseline for comparison of relative values. In a nonmarket valuation context, the status quo alternative is particularly useful for identifying an element of choice probability that is insensitive to changes in the attribute levels. The principle liability is the potential that respondents will choose the SQ simply to avoid the cognitively demanding task of weighing alternatives. Inclusion of the SQ alternative requires a somewhat more complex choice probability model, though its effect can be captured quite simply using an alternative specific constant (ASC) in the utility model.

---

1. Many of the studies reviewed were marketing analyses for consumer goods with which respondents are likely to be much more familiar than is the case with public goods and passive-use amenity resources. The number of alternatives and choice questions that are feasible is generally in opposite proportion to the unfamiliarity and complexity of the goods being valued.

The reviewed literature suggests that quadratic effects of all attributes are potentially significant. Thus, a minimum of three levels for each attribute are required to permit estimation of linear and quadratic effects. Statistical efficiency of the design is enhanced by specification of the minimum number of levels necessary to estimate all terms of interest. For a linear model, for example, an optimal design will feature two levels of each factor, set at the upper and lower extreme of the relevant range. Statistical efficiency notwithstanding, valuation practitioners strongly recommend use of 5-9 levels for the cost attribute, to permit identification of nonlinear effects of cost on choice and to minimize the chance of poorly defined tails in the choice distribution (Swallow, personal communication; Loomis, personal communication). Boman, Bostedt et al. (1999) also point out that maximizing the number of points of the bid vector is the most important design criteria for nonparametric methods, since the proportion of yes responses at each bid level is the sole basis for estimation of the WTP distribution. Thus, eight levels of the bid factor are specified in the design for the CEA and DC/CVM portions of the survey instrument. The range of bid levels was adapted from those used in the study by Xu (1997) and adjusted based on the results of the survey instrument pretest. Design levels are listed in Table 4-2 along with the description of the conservation programs from which alternatives were composed. In order to permit estimation of willingness to accept (WTA) for decreases below the baseline level of the respective conservation programs, below baseline levels are specified in the design. For the forest age program this is represented by an elimination of the estimated 5% of old growth remaining in the OCR as well as a decrease in the amount of forest in the <50 year age class, supplanted by an increase in the middle age class. Above baseline levels were selected based on the range of management proposals appearing in a survey of both the published and gray literature. The upper levels are intended to represent "extremes" and the lower levels represent more broadly acceptable alternatives as indicated in responses to the preset survey. Baseline levels for salmon and endangered species habitat are the percent of land in the OCR federally owned. Biodiversity reserves comprising the baseline level of 10% of the OCR are the contiguous areas of land under federal ownership that are designated in protected



status (i.e. areas of critical environmental concern, wilderness areas, research natural areas, and Late Successional Reserves, identified using digital maps of ownership and management status in the CLAMS database. The baseline age class distribution is taken from Wimberly, Spies et al. (2000). Two bid vectors are defined based on results from the pretest that indicated the Willamette Valley stratum expressed a schematically higher WTP than the Coast Range or Eastern Oregon strata. Thus, the bid vector for the WV stratum is shifted up from the values for the other strata as indicated in Table 4-2.

Table 4-2. Design levels for biodiversity attributes

attribute description	below baseline level	baseline level	above baseline levels
Salmon habitat-% of coastal streams managed at highest level of protection for coastal salmon	5%	15%	40%, 90%
Endangered species:% of Coast Range land covered by recovery plans for endangered species	5%	15%	25%, 75%
Forest age class:% of Coast Range Forests in <50 year, 50-150 year and >150 year age classes	55%/45%/0%	70%/25%/5%	33%/34%/33%, 25%/25%/50%
Biodiversity reserve:% of Coast Range land placed in network of large scale reserves set aside for biodiversity and natural processes and functions	5%	10%	20%, 40%
Annual cost in increased income taxes		0	CR, EO:10, 22, 45, 86, 145, 236, 365, 648; WV: 22, 45, 86, 145, 236, 365, 648, 1272

Design of Choice Sets: Each survey questionnaire includes four choice sets, each composed of two variable alternatives plus the constant status quo alternative. A balanced incomplete block (BIB)<sup>1</sup> design was used to select the set of alternatives (termed *runs* in the design literature) from the universe of possible factor-level combinations and

arrange them into blocks of four choice sets of two runs each. To each pair of runs was added the constant status quo alternative to compose the choice sets. A design of 64 runs was specified to permit estimation of all linear and quadratic effects of the five attributes. The SAS OPTEX procedure was used to generate efficient designs according to the D-efficiency criteria<sup>1</sup> (Kuhfeld, Tobias et al. 1994) using the technique outlined in Kuhfeld (1996). The OPTEX procedure iteratively selected sets of 64 runs from a candidate set of 640 runs representing a full factorial design. By iteratively selecting design sets and testing their efficiency, the OPTEX procedure identified sets of 64 runs blocked into 16 blocks of four pairs each, that achieved the same level of D-efficiency as the full factorial design<sup>2</sup>. In a second phase, the procedure selects balanced designs from the most efficient designs identified in the first phase. Ten maximally efficient, balanced designs were generated using this process and then manually inspected to identify dominating and dominated alternatives in each choice pair. The least dominated design included four out of 64 pairs which included a dominating alternative. In each of these, the bid levels were swapped to eliminate the dominance. The resulting design was tested again using the OPTEX procedure (Kuhfeld 1996, p. 69) and found to exhibit no loss in efficiency. The final choice set design is listed in Appendix B.

---

1. The BIB design is balanced in that each level within each attribute appears in the design set an equal number of times, resulting in minimal design pairs in which a given attribute has the same level in both alternatives. Incomplete block refers to the blocking of the design set into subsets such that each respondent responds to only eight choice sets, in four pairs. In an unblocked design, respondents would be exposed to all 64 alternatives in the design simultaneously. Thus in the incomplete block design employed in this study, respondents are exposed to triplets of alternatives - two design alternatives and the constant SQA - rather than the entire design set simultaneously. Individual respondents receive different blocks of choice sets, and therefore do not receive the full set of blocks which comprise the complete design. See (Kuhfeld 1996) for further detail.

1. D-efficiency is quantified as the determinant of the information matrix  $[XX]$  of the design. See Carson (1994) and Kuhfeld, Tobias et al. (1994) for further discussion of this and alternative efficiency criteria.

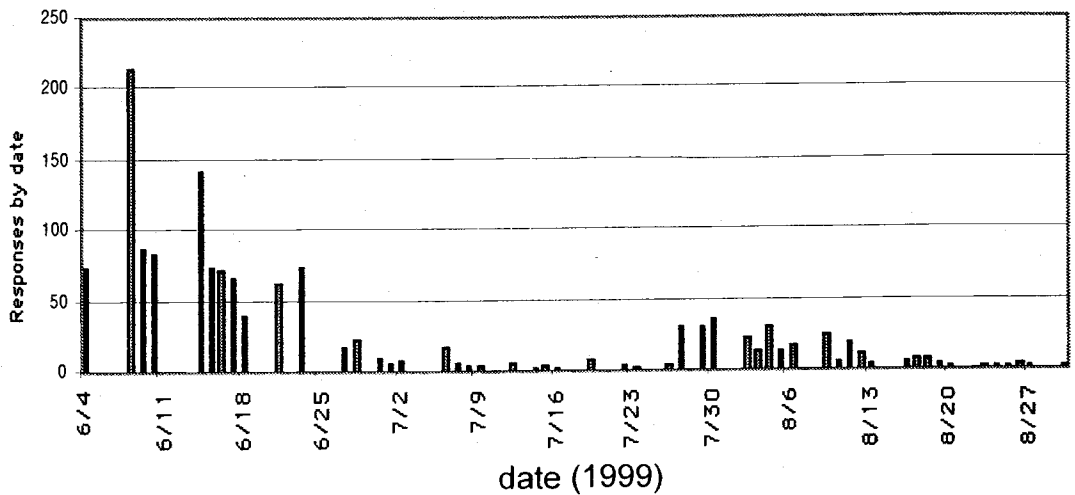
2. D-efficiency levels of 33.56% were achieved by both the 640 run full factorial and balanced incomplete blocks designs of 64 runs. As D-efficiency is a relative measure of design efficiency, the design employed in the study achieved 100% efficiency relative to the full factorial design.

### 4.3 Sample and survey administration

The sample for the final survey was selected at random from the population of Oregon households by Affordable Samples, Inc., drawing from a database compiled from a variety of sources and updated monthly using postal service and telephone company change of address records. A sample of 3000 households was drawn, stratified by region with 1000 records in the CR, WV and EO strata, respectively. The survey was administered using the same process as that for the pretest survey. A copy of the survey booklet with an accompanying cover letter, business reply envelope and an attached \$1 bill was mailed on June 2nd, 1999. A reminder postcard was sent one week later on June 8th. Difficulties in reproduction of the survey booklet delayed the third mailing until July 16th. This mailing contained a second copy of the survey booklet (which matched the version of the booklet sent to each respondent in the first mailing), a cover letter and a business reply envelope. A second reminder postcard was sent one week later on June 23. The pattern of survey returns is plotted in Figure 4-1, which indicates that 79% of the responses were received prior to the mailing of the second survey copy.

Of the original 3000 surveys mailed, 460 (15.3%) were returned as undeliverable by the postal service. Of the deliverable surveys, 1372 were returned either fully or partially completed representing an effective response rate of 54%. Of these, 1090 surveys produced usable results, with 20% of those returning the surveys failing to complete the valuation questions or providing unusable responses.

Figure 4-1. Survey response rates over time.



Many of the design and administration principles that have been developed over the last decade for CVM studies are directly applicable to CEA studies. However, this newer technique introduces several new elements to survey development and design for which there is little published research on which to draw. Definition of attributes in the multi-attribute framework is likely to remain something of an art. This component of CEA research must balance informational needs of managers and policy makers (and possibly other technical analysts in the case of integrated policy analyses), which may be quite narrowly defined, with the interests and cognitive limits of the lay public. The number and complexity of choice tasks presented to respondents is also determined largely on the basis of the investigators' judgement, though some empirical work has recently been undertaken to attempt to define some of these limits. Similarly, criteria for selection of experimental designs that will minimize the variance of parameter estimates and permit estimation of sufficiently flexible econometric models is an additional area ripe for research. If the vigor of research in CEA applications in nonmarket valuation resembles that seen in CVM research, many of these issues are likely to be addressed with consid-

erable insight in the short term, though new controversies are likely to erupt just as rapidly.

## Chapter 5: Analysis and Results

The focus of this research is the estimation of simulated prices for biodiversity conservation. Analysis of willingness to pay data collected in this survey is presented in this chapter. In addition to the elicitation questions, the survey design included questions to investigate respondents' attitudes regarding each of the four conservation programs, general attitudes regarding alternative uses for Oregon's coastal forests, and rating and ranking questions of the four programs relative to public programs which are alternative targets for public expenditures. These latter questions were intended to set both the DC/CVM and CE elicitation questions in the context of public referenda and to remind the respondent of constraints on personal and public budgets and the existence of substitutes for the goods being valued (Loomis, 1994; Arrow, Solow et al. 1993). The following section presents the analysis of data collected with these questions. This is followed with the results of the WTP modeling analysis and a comparison of the CEA and DC/CVM results.

### 5.1 Attitudes

Table 5-1 presents cross tabulations of response data for four questions regarding respondents' familiarity with and attitude toward biodiversity conservation and salmon restoration. The uniformly high proportion of respondents stating that they have read or heard the term "biodiversity" and are aware of the decline in salmon populations reflects the generally high rate of literacy on environmental issues of the Oregon public (OFRI 1999). While the data do not reveal the degree of familiarity or the level of understanding of conservation issues, it is likely that most survey respondents will have some prior information about the policy context of the survey instrument. With the exception

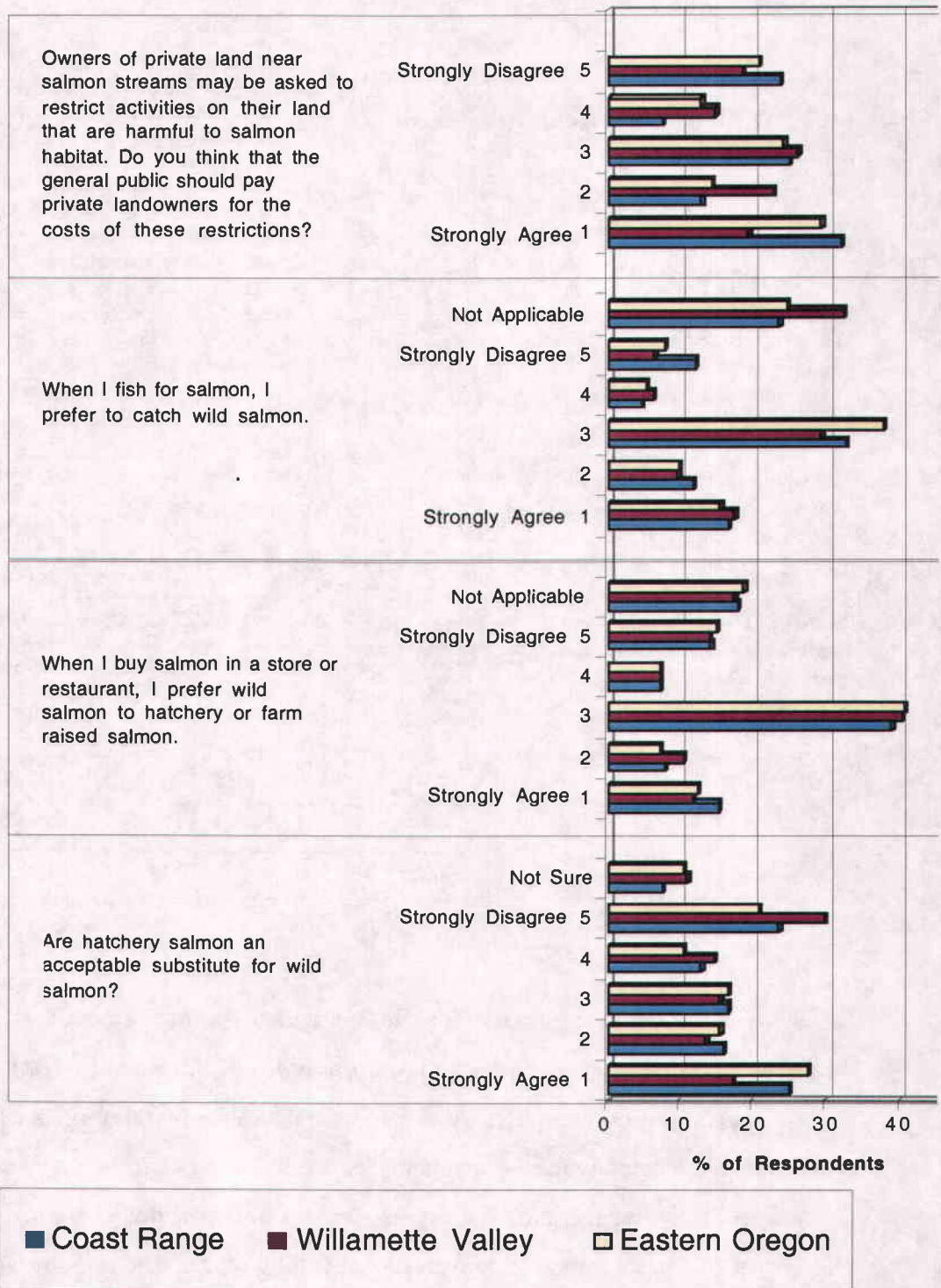
of a slightly lower level of familiarity of Eastern Oregon (EO) residents with the Governor's salmon restoration initiative and importance rating of Coast Range biodiversity loss, there is little difference in the regional strata.

**Table 5-1. Respondent familiarity and attitudes regarding biodiversity conservation and salmon restoration**

Survey question	Response	Coast Range	Willamette Valley	Eastern Oregon
Have you read or heard of the term "biodiversity" before?	no	20%	18%	20%
	yes	71%	76%	72%
	not sure	8%	6%	8%
Do you think that loss of biodiversity is an important issue in the Oregon Coast Range?	no	14%	1%	11%
	yes	66%	71%	62%
	not sure	20%	20%	27%
Have you read or heard about the decline of Oregon's native salmon populations?	no	1%	2%	3%
	yes	98%	98%	96%
	not sure	1%	0%	1%
Have you heard or read about the Governor's salmon restoration plan?	no	21%	21%	26%
	yes	67%	66%	59%
	not sure	12%	13%	15%

Figure 5-1 presents responses to questions intended to probe respondents' attitudes toward wild versus hatchery salmon, and compensation of landowners for restrictions on land use for conservation purposes. With respect to use values for salmon, specifically for sport fishing and culinary uses, respondents tended not to have strong preferences with the neutral response generating the highest proportions. It should be noted that the phrasing of the question regarding recreational fishing renders the response somewhat

Figure 5-1. Attitudes toward landowner compensation and wild salmon





ambiguous in that the respondent may have interpreted "strongly disagree" as either no preference or a preference for catching hatchery fish. The only marked difference between the regions on either of these questions is the lower rate of recreational fishing in the Willamette Valley (WV), as exhibited by a somewhat higher rate of N/A responses. Views on substitutability of hatchery versus wild salmon were much more polarized, both within and across regions. Eastern Oregon and Willamette Valley residents differed most strongly – 44% of Willamette Valley residents regarded hatchery fish as poor substitutes compared to 30% who held the opposite view. By almost exactly opposite proportions, Eastern Oregonians regarded hatchery fish as an adequate substitute. Amongst Coast Range (CR) residents, similarly strong views were expressed, though they were more equally divided. Regarding the compensation of riparian landowners, residents in all three regions tended to favor compensation, though WV residents tended to be somewhat more ambivalent: EO and CR residents responded with both strong agreement or strong disagreement at higher rates than WV residents.

Figures 5-2 and 5-3 present cross tabulations of respondents' importance ratings of the four conservation programs identified in the survey. There is a notable difference between WV residents rating of endangered species protection and biodiversity reserves (Figure 5-2): WV residents regarded endangered species protection as highly important and reserves as unimportant, whereas both CR and EO residents tended to take the opposite view. For both of these programs, however, the largest proportion expressed a neutral view. In contrast, a much larger proportion of respondents across all regions of the state expressed a high importance rating for salmon habitat protection<sup>1</sup>. The most striking result of the forest age class question (Figure 5-3) is the large proportion of respondents across all strata that prefer an even distribution (33%/34%/33%). Whether

---

1. The 1998 Oregon Population Survey [Vaidya, 1999 #131] found that 14% of the state's residents felt that salmon protection was unimportant. A population weighted average of the stratified importance ratings in the lower panel of Figure 5-2 indicates that 14.6% of survey respondents felt salmon habitat protection is unimportant.

this indicates a strong evaluation of the merits of this choice or a heuristic response is uncertain. Also of interest is the relatively higher approval amongst CR residents for the status quo alternative. CR residents also had approximately equal proportion (9%) preferring the maximal old growth alternative as preferred the alternative with zero old growth.

Figure 5-2. Attitudes toward conservation program importance

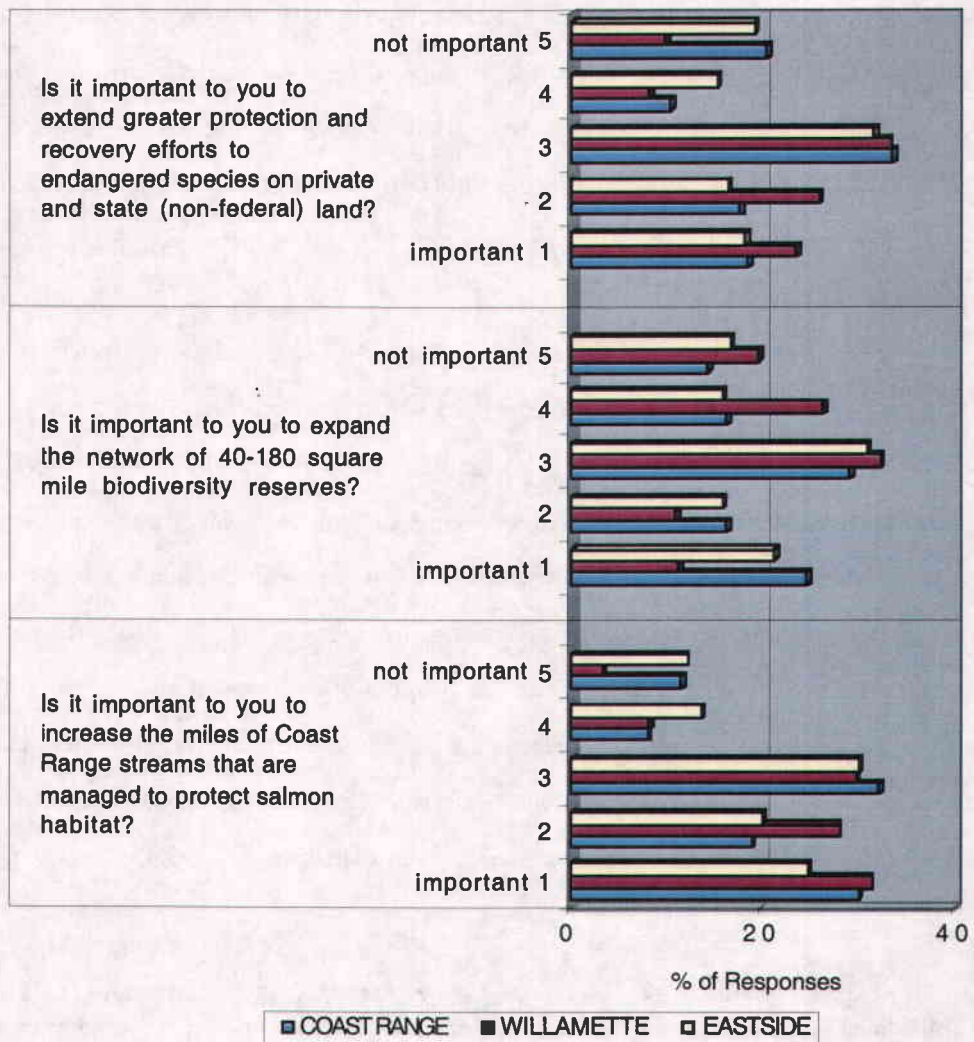


Figure 5-4 depicts the relative ranking of the four programs by region. Across all three regions, increasing forest age and salmon habitat protection were ranked as most important, and endangered species recovery was identified as least important. Biodiversity reserves were regarded as intermediate in importance. Overall, there was strong agreement amongst the three regions in the ranking scores, with salmon habitat protection having a slightly higher mean ranking by CR residents than by the other two strata.

To set the policy context for respondents and reinforce the existence of budget constraints and substitutes at both the household and social level, respondents were asked to rate the importance of several other government and social services as well as the four conservation programs. The results of these ratings are presented in Figure 5-5. The most marked result is that CR and EO residents regarded conservation programs as less important than any other social program; whereas WV residents rated two of the conservation programs as more important than social programs other than crime reduction and education. Generally the results are consistent with the results of the conservation program rankings in Figure 5-4, though there is some reversal regarding the relative importance of salmon conservation and forest age, though probably not at a significant level. On the whole, the comparison of the results in Figures 5-4 and 5-5 is evidence of stable preferences.

Figure 5-3. Rating alternative forest age class distributions

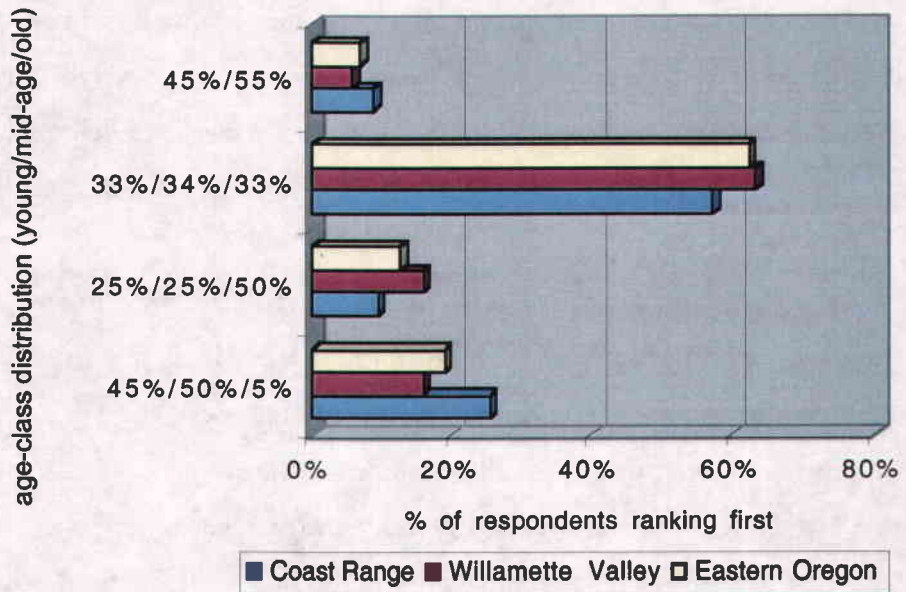


Figure 5-4. Conservation program ranking

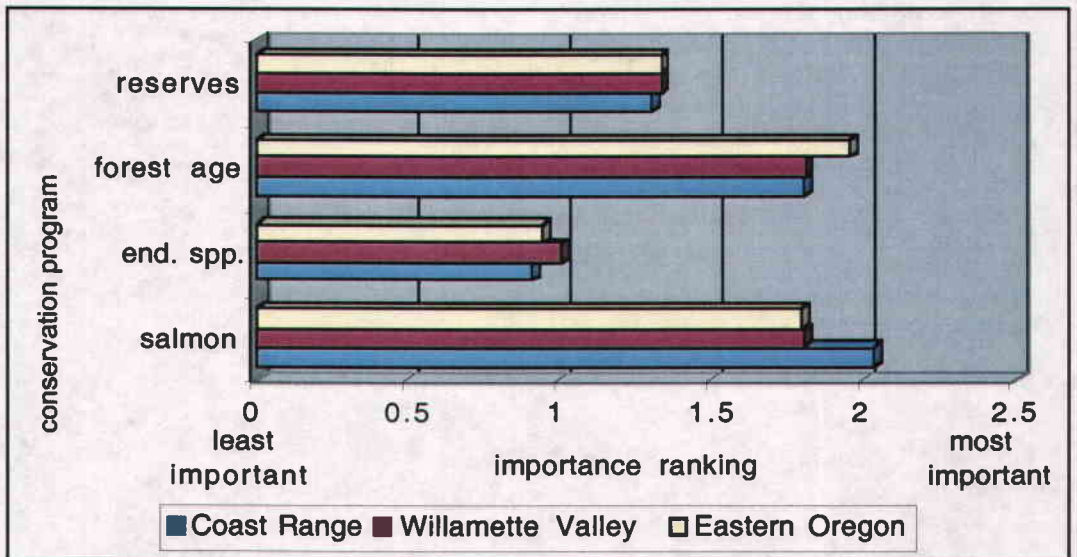
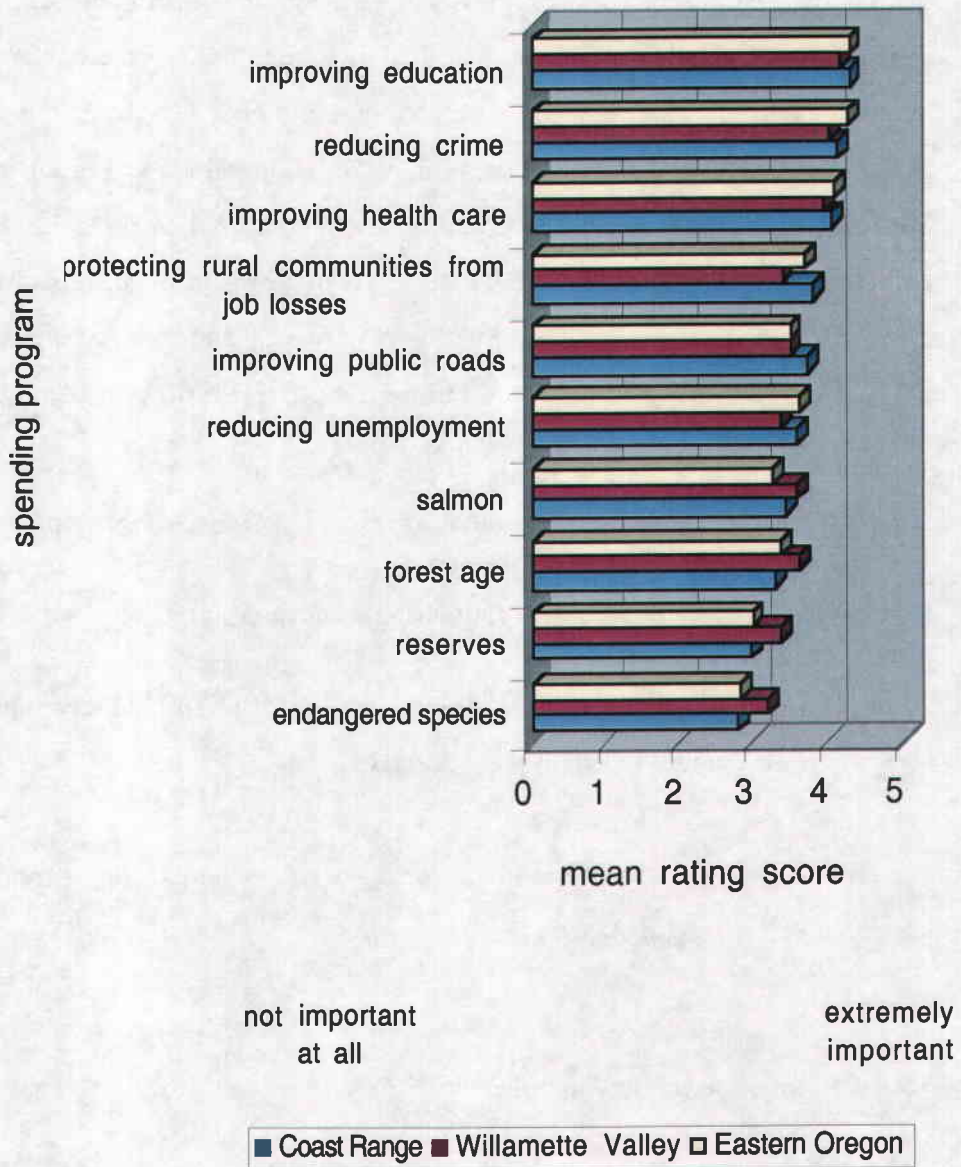


Figure 5-5. Rating of conservation and other social program



## 5.2 Preference Modelling

As discussed in Section 4.1.3, the design of the survey instrument included two separate groups of WTP elicitations: a standard dichotomous choice contingent valuation question eliciting willingness to pay for an increase in one of the four conservation programs from the level identified as the status quo, followed by a set of four choice experiment questions which were structured to simultaneously elicit preferences for all four programs. The DC/CVM and CEA analyses are discussed in the next two sections, and comparison of the two will be presented later in this chapter. For responses to both the DC/CVM and CEA questions, observations were censored from the data set under the following conditions:

- observations of yes responses to bid levels exceeding 5% of the respondent's reported income
- respondent indicated a failure to understand the question

A total of 20 yes responses and 54 no responses out of 1327 observations were censored from the data set based on these criteria.

This chapter presents the results of these models. Comparison of model results is presented in Section 6.1.3.

### 5.2.1 Choice Experiment Analysis

Multinomial Logit (MNL) was used to analyze data collected in the CEA section of the survey instrument, using the PHREQ procedure in SAS (Kuhfeld 1996). Numerous alternative model specifications were tested and included terms for the attributes in the choice experiment, alternative specific constants (ASC's) and demographic terms. The

final model specification which appeared to achieve the best fit to the data included both linear and quadratic terms for the attributes, as well as a subset of the demographic terms for which data were collected, and an ASC term for the status quo alternative<sup>1</sup>:

$$P_k(i|A) = \frac{e^{\beta'X_{ki} + \alpha C_{ki} + \tau Q_{ki} + \gamma' R_i Z_{ki}}}{\sum_{j \in A} e^{\beta'X_{kj} + \alpha C_{kj} + \tau Q_{kj} + \gamma' R_k Z_{kj}}} \quad (5-1)$$

where  $P_k(i|A)$  is the probability that respondent  $k$  chooses alternative  $i$  from elements  $j$  of choice set  $A$ ;  $X_{ki}$  is the vector of linear and quadratic terms for the four conservation program attributes and  $\beta_{ki}$  is the vector of associated regression coefficients;  $C_{ki}$  is the bid level and  $\alpha$  is the bid coefficient;  $Q_{ki}$  is a binary term with value set to zero for the status quo alternative and set to unity for the other two alternatives in the choice set, and  $\tau$  is the associated coefficient<sup>2</sup>; and  $R_k$  is a vector of demographic terms describing the respondent and  $Z_{ki}$  is the linear component of the vector  $X_{ki}$  such that  $R_k Z_{ki}$  is a vector of interactions between the demographic terms and the program attributes, and  $\gamma$  is the associated vector of coefficients on these terms.

Because of the linear-in-parameters structure of the MNL model, demographic and other terms which do not vary across alternatives within a choice set for a given respondent simply cancel out of the equation, which can be seen by inspection of Equation 5-1. It is necessary, therefore, to enter these terms in such a way that they do not cancel or to stratify the data by demographic group and estimate separate models. The method

1. A specification with logarithmic transformations of the four attribute level variables replacing the linear and quadratic terms was tested. Results indicated that the logarithmic model exhibited highly significant parameter estimates on the attribute levels for the Coast Range strata, but performed very poorly for the other two strata. This may indicate that different functional forms may be appropriate for the different strata, but this was not tested in the analysis.

2. As a point of clarification, it is noted that this is a somewhat unusual way to treat the coding of dummy variables. Though it would be more standard to code the status quo term equal to unity when the condition is true, i.e. the alternative in question is the status quo, the convention used herein is consistent with the published literature that focuses on the status quo issue.

used in this analysis was to interact demographic variables with the attribute terms in order to measure the effect of respondents' characteristics on choice. This offers the advantage of providing estimates of the relative preferences amongst different demographic groups for the individual attributes without unnecessarily complicating the statistical analysis with numerous pairwise t-tests or sacrificing degrees of freedom.

Table 5-2 describes the variables entered into the model and Table 5-3 presents the results of the analysis stratified by region, for both a quadratic and linear utility model specification. Additional demographic interaction terms were considered in the analysis but were found to be insignificant and were dropped from the final model. These included income and regional length of residence. It should also be noted that the variables F and F2 describe the proportion of old growth forest in the coast range forest age class distribution. However, the alternative depictions included pie charts for the distribution which also identified the proportion of young and mid-age forest. Due to insufficient degrees of freedom in the experimental design, it was not possible to estimate more than ten parameters for attribute effects. The specification of a simple index function which would capture the effect of all three age classes was explored, however, none could be devised that would have a unique value for each of the four age class distributions offered in the choice sets without excessively abstracting from the information presented in the survey instrument. Though it would have been desirable to capture the effect of all three age classes, only the linear and quadratic effect of old growth are included in the final model. Further discussion of alternative model specifications with respect to forest age class as well as the other conservation programs is included in Section 6.1.2.



Table 5-2. Description of Model Terms

Variable	Description <sup>a</sup>
C	Bid level: two bid sets were specified in the design, [0*, 22, 48, 86, 145, 236, 325, 648, 1272] for the Willamette Valley, and [0*, 10, 22, 48, 86, 145, 236, 325, 648] for the Coast and E. Oregon regions
S	% of coastal salmon habitat protected at highest protection standard: [5, 15*, 40, 90]
S2	squared value of S to capture quadratic effect of salmon program
E	% of endangered species habitat in the Coast Range in which species are protected at highest protection standard: [5, 15*, 25, 75]
E2	squared value of E to capture quadratic effect of endangered species program
F	% of forest age class distribution > 150 years [0, 5*, 33, 50]
F2	squared value of F to capture quadratic effect of forest age program
B	% of Coast Range land designated as Biodiversity Reserves [5, 10*, 20, 40]
B2	squared value of B to capture quadratic effect of reserve program
STATUSQ	dummy variable for status quo alternative
SXOCCN, EXOCCN, FXOCCN, BXOCCN	dummy variable indicating forest products occupation <sup>b</sup> multiplied by S, E, F, and B
SXGRN, EXGRN, FXGRN, BXGRN	dummy variable indicating environmental group membership multiplied by S, E, F, and B
EXLOR, FXLOR, BXLOR,	quantitative variable indicating length of residence in Oregon multiplied by E, F, and B (the interaction with S could not be estimated due to collinearity in the model)
SXPOL, EXPOL, FXPOL, BXPOL	interaction Likert scale rating for political alignment multiplied by S, E, F, and B; 1=liberal...5=conservative; response values 1-2 recoded to -1, and 4-5 recoded to 1.
SXED, EXED, FXED, BXED	quantitative variable for years of education multiplied by S, E, F, and B
SXAGE, EXAGE, FXAGE, BXAGE	quantitative variable for age of respondent multiplied by S, E, F, and B

a. Attribute levels identified as status quo are denoted by \*.

b. Responses were coded as forest products employees if the indicated occupation fell into SIC codes 081, 083, 085, 241, 242, 243, 261, 262, 263 (Budget 1987)

Results in Table 5-3 generally have expected signs and high degrees of significance. For all three strata, the null hypothesis  $H_0: \beta = 0$  for all  $\beta$  is rejected with  $p=0.0001$ , and the Pseudo- $R^2$  statistics are quite high<sup>1</sup>. Most of the conservation program attributes are significant in the quadratic model, with the exception of the linear effects of salmon and old growth forest amongst Coast Range residents, and the linear effect of reserves across all three regions. All quadratic-term effects were significant at the 95% level and 10 out of 12 are significant at the 99% level. The linear and quadratic effects of attribute levels were retained in the model if either were significant at 95%. The demographic covariates were grouped as sets of interaction terms as indicated in Table 5-2. Statistical significance of these terms was determined by testing the null hypothesis that all four (three, in the case of length of residence) coefficients were equal to zero on the basis of the likelihood ratio test and retained in the model if found jointly significant at  $p \leq 0.05$ . The effects of demographic interaction terms for income and regional (i.e. CR, WV, EO) length of residence were found to be insignificant (though length of residence in Oregon was significant) and were dropped from the final model. The effect of the bid amount is highly significant and negative, as expected. The status quo effect is also negative and significant, indicating a significant tendency amongst respondents to refuse any of the actions offered as alternatives for increasing or decreasing biodiversity conservation, regardless of the degree of increase or decrease. The interpretation of this effect raises important methodological questions and is discussed further below. With the exception of the effect of salmon amongst CR residents, all of the linear effects are positive with negative quadratic effects, indicating respondents regard the four conservation programs as positive economic goods which generate declining marginal utility. As the level of the program activity increases, however, the negative quadratic effect in some

---

1. Pseudo- $R^2$  is used as a somewhat analogous measure of model fit to the  $R^2$  (coefficient of determination) measure used in linear regression models (Greene 1993), though it does not measure the proportion of variation in the dependent variable explained by the regressors as the  $R^2$  does. The Pseudo- $R^2$  values reported in the studies reviewed in Section 2.2.3 ranged from 0.04 to 0.354, and 8 of the 12 models reported had values of 0.17 or less. Noting, as Hanemann and Kanninen (1999) point out, that there is no standard threshold that indicates a satisfactory model fit, the values derived from the estimation performed in this analysis are relatively high.

Table 5-3. Results of MNL Analysis of Choice Experiment Data

Parameter	Term	Estimated Coefficients <sup>a</sup>					
		Coast Range		Willamette Valley		E. Oregon	
		Quadratic model	Linear model	Quadratic model	Linear model	Quadratic model	Linear model
$\alpha$	C	-0.003214**	-0.003153**	-0.002153**	-0.002134**	-0.004297**	-0.004304**
$\beta_{S1}$	S	-0.006982	-0.031761**	0.016116	-0.00144	0.034209**	0.012636
$\beta_{S2}$	S2	-0.000278**		-0.000193**		-0.000226**	
$\beta_{E1}$	E	0.037968**	0.015436	0.058958**	0.00567	0.044707**	0.008389
$\beta_{E2}$	E2	-0.000251*		-0.000638**		-0.000415**	
$\beta_{F1}$	F	0.026838	-0.030927*	0.06135**	0.015521	0.037894*	-0.004812
$\beta_{F2}$	F2	-0.001198**		-0.000904**		-0.000837**	
$\beta_{B1}$	B	0.026756	-0.003711	0.034725	-0.008161	0.019884	-0.027302
$\beta_{B2}$	B2	-0.000692*		-0.000871*		-0.001054**	
$\tau_Q$	STATUSQ	-0.776431**	-0.903957**	-0.30116*	-0.472129**	-0.745023**	-0.884193**
$\gamma_{SxO}$	SXOCCN	0.003812	0.003359	-0.002281	-0.002331	-0.00102	-0.000214
$\gamma_{ExO}$	EXOCCN	-0.016453**	-0.015814**	-0.00103	-0.002117	-0.00747	-0.007584
$\gamma_{FxO}$	FXOCCN	-0.012441*	-0.012001*	-0.014782	-0.013177	-0.007399	-0.007305
$\gamma_{BxO}$	BXOCCN	0.006422	0.005192	-0.0078	-0.005321	-0.01366	-0.013445
$\gamma_{SxG}$	SXGRN	0.002325	0.003424	0.005406	0.005106	0.003889	0.003797
$\gamma_{ExG}$	EXGRN	-0.003116	-0.003734	0.004046	0.002927	0.010723	0.010086
$\gamma_{FxG}$	FXGRN	0.005829	0.005019	-0.004745	-0.002803	0.007948	0.007762
$\gamma_{BxG}$	BXGRN	0.003473	0.003393	0.016448	0.015586	0.023427*	0.020778*
$\gamma_{ExL}$	EXLOR	-0.00014*	-0.000125*	0.000105	0.000090	0.00001560	0.00000881
$\gamma_{FxL}$	FXLOR	-0.00026*	-0.00024*	-0.000144	-0.000127	-0.000342**	-0.000327**
$\gamma_{BxL}$	BXLOR	0.00009194	0.00004092	-0.000129	-0.000109	0.00000899	0.00001336
$\gamma_{SxP}$	SXPOL	-0.000651	-0.000752	-0.001983	-0.00189	-0.003053	-0.0028
$\gamma_{ExP}$	XPOL	-0.004939*	-0.004811*	-0.001225	-0.00141	0.000361	-0.000183
$\gamma_{FxP}$	FXPOL	-0.00691**	-0.006467**	-0.008663**	-0.007916**	-0.005904*	-0.004807
$\gamma_{BxP}$	BXPOL	-0.010671*	-0.009914*	-0.007922	-0.008209	-0.00997*	-0.009161*
$\gamma_{SxE}$	SXED	0.002344**	0.002233**	0.000436	0.000378	0.000272	0.000207
$\gamma_{ExE}$	EXED	-0.000122	-0.000166	0.000165	0.000135	-0.00057	-0.000503

Table 5-3. (Continued) Results of MNL Analysis of Choice Experiment Data

Parameter	Term	Estimated Coefficients <sup>a</sup>					
		Coast Range		Willamette Valley		E. Oregon	
		Quadratic model	Linear model	Quadratic model	Linear model	Quadratic model	Linear model
$\gamma_{FxE}$	FXED	0.003414**	0.003323**	0.001612*	0.001602*	0.002236**	0.002319**
$\gamma_{BxE}$	BXED	0.000425	0.00055	-0.000254	0.00001392	0.001371	0.001294
$\gamma_{SxA}$	SXAGE	0.000185*	0.000155	-0.0000323	-0.00004068	-0.000199*	-0.000195*
$\gamma_{ExA}$	EXAGE	-0.000147	-0.000125	-0.0000950	-0.000103	0.0000059	0.00001743
$\gamma_{FxA}$	FXAGE	0.0000255	0.0000390	-0.000356*	-0.000324*	-0.0000168	-0.0000184
$\gamma_{BxA}$	BXAGE	-0.0000915	-0.000104	0.000258	0.000237	0.000131	0.000133
	Obs	3987	3987	3303	3303	3756	3756
	Log L	-1239.4455	-1280.308	-1010.687	-1081.056	-1041.901	-1176.76
	$\chi^2$	771.013**	689.288**	417.179**	351.146**	429.456**	650.19**
	Adj. R <sup>2</sup>	0.24862672	0.2222490	0.18624905	0.1528479	0.18559813	0.2274487

a. \* significant at  $\geq 95\%$  level; \*\* significant at  $\geq 99\%$  level

cases causes marginal benefit to become negative, potentially overwhelming the linear effect and causing total utility from the increase to be negative. This effect is illustrated by the estimated willingness to pay functions in the next section.

Across the three sample strata, forest products occupation, political alignment, length of Oregon residency and age all had predominantly negative effects, though individual terms were significant in only a few cases. Coast range residents exhibited a negative interaction effect between both forest products occupation and length of residency and the endangered species and forest age programs. Politically conservative CR residents exhibited a negative preference for both old growth protection and biodiversity reserves. Amongst WV respondents the only significant negative demographic effects - age and political alignment, occur with respect to the forest age program. EO residents

exhibited a less consistent pattern of preferences, with significant negative interactions between old growth and length of residency, biodiversity reserves and political alignment, and salmon habitat and respondents' age. The lack of significance for forest products occupation may have been due to the low proportion of respondents in all three strata who reported being employed in this sector, particularly in the WV and EO samples. Forest products occupation, length of residency, and political alignment were consistently and negatively associated with preferences for biodiversity conservation across all programs and regions, though not uniformly significant. The lack of significance of linear effects of both salmon and old growth forest conservation programs in determining CR residents' choices in the quadratic model is interesting and contrary to expectation. The large and positive, and significant values of the  $S \times AGE$  and  $S \times ED$  terms, however, exert a strongly offsetting effect to the negative value of the  $S$  term.

In contrast, age and education had a significant positive effect on preference for salmon habitat amongst CR respondents, as well as a positive association between education and preference for old growth protection. Interactions between the salmon habitat attribute and environmental group membership, and forest age and education, identified positive and significant preferences amongst WV residents. Endangered species protection/environmental group membership, and old growth/education interactions acted positively in EO residents' preferences. Overall, education and environmental group membership were largely associated with positive preferences, and the insignificance of the latter is probably due to the low rate of membership reported in all three regions. Age had a less consistent effect on preferences across regions and programs, perhaps indicating a more complex relationship between age and preference for biodiversity conservation.

### 5.2.1.1 Model Selection

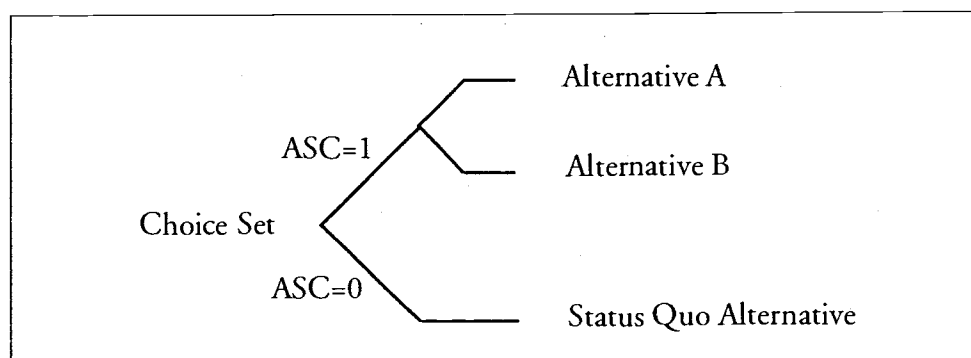
#### Status-quo term

Carson, Louviere et al. (1994) point out that inclusion of a status quo alternative (SQA) is desirable in that it increases the realism of the choice scenario. In both public referenda and most consumer choice situations, the no-change alternative is present. In a consumer context, it also avoids eliciting preferences of individuals who are not actually in the market for the goods being studied. However, as the authors point out, the SQA also has the liability of offering an "easy out" for the respondent, impeding accurate measurement of preferences. This is particularly problematic where evaluation of choice scenarios is cognitively demanding. Results of the analysis reported herein strongly indicate that respondents are inclined to choose the SQA. There are several possible explanations for this, with implications for comparison of DC/CVM and choice experiment results, and for interpretation of passive-use valuation studies in general. These broader considerations will be taken up in Section 6.1.1. It should be pointed out, however, that inclusion of the status quo effect in the calculation of welfare estimates may bias these estimates downward to the extent that individuals choose the status quo alternative to avoid the more cognitively demanding task of weighing the merits of the other two alternatives.

Carson, Louviere et al. (1994) also note that inclusion of a status quo alternative has implications particular to the MNL framework. Citing Olsen and Swait (1993), the authors observe that decision processes are quite different when a no-action alternative is present. The assumption of independence of irrelevant alternatives implicit in the MNL framework does not likely hold in the presence of a no-action alternative and is directly analogous to the red bus/blue bus<sup>1</sup> problem common to MNL (Ben-Akiva and Lerman 1985; Hanemann and Kanninen 1999). The authors suggest using a nesting structure or other modeling technique to control for dependence amongst alternatives.

Inclusion of the status quo parameter is analogous to imposing a nested structure, where the no-change alternative is one branch and the other two alternatives (Alternatives A & B) are the other branch (Figure 5-6) (Train 1986, pp. 69). Since the status quo dummy is set equal to one for the Alternative A/Alternative B branch of the nesting structure, the reference level of the parameter becomes the inclusive value of the SQA. As in a nested model, inclusion of ASC's permits the probability ratios to change between nests, though IIA is not maintained within a nest. Thus, nested models or ASC's are only a partial solution for the IIA problem generally, but in the current problem, with only two alternatives in the largest nest, IIA is maintained both within and across nests.

Figure 5-6. Choice structure



1. The red bus/blue bus problem is commonly used to illustrate the IIA property of MNL: if an individual has a choice of using a private car or a red bus to commute and chooses each with a probability of  $1/2$ , such that the ratio of probabilities between the two mode choices is  $1/2$  to  $1/2 = 1$ , the IIA property requires that the ratio of choice probabilities is unchanged by the addition of an additional alternative. Thus, if a blue bus becomes available as a third commute alternative, IIA requires that the ratio of choice probabilities between the red bus and the private car must remain equal to one, i.e.  $1/3$  to  $1/3$ . Since there is most likely little difference between the two buses in terms of choice probability, a more likely scenario is that the original probability of choosing the bus versus car would remain  $1/2$  and  $1/2$ , respectively, and the choice probability of each color bus would be split evenly, such that the choice probabilities would become  $1/2$  car to  $1/4$  red bus to  $1/4$  blue bus. This, however would violate the IIA assumption by changing the ratio of choice probabilities of the original two choices. from  $1/2$  to  $1/2 = 1$  to  $1/2$  to  $1/4 = 2$ . It may well be that the choice between conservation alternatives A and B is the survey instrument relative to the status quo is similar in nature to the choice between a red bus or a blue bus relative to the private auto in this example.

### Quadratic terms

Specification of quadratic terms in the model seems to capture an essential feature of preferences for the biodiversity programs. Without these terms, it would be impossible to estimate the slope of the compensated demand functions and, by implication, the x-intercepts that identify levels in the programs associated with zero marginal utility (see Figures 5-7 and 5-8 below). The quadratic shape of the TWTP function is to some degree an artifact of the functional form of the specified model, which is very limited in its flexibility. This gives rise to a non-standard result from the perspective of neoclassical consumer theory, which holds that marginal utility values are non-negative and TWP is nondecreasing (i.e. demand is nonsatiated) (Varian 1984, pp. 39). Apart from limitations in model flexibility, two observations may explain this result. Nonsatiation is predicated on the assumption of free disposal.<sup>1</sup> The standard assumption of free disposal in consumer theory doesn't necessarily apply in the case of public goods: a correlate of the nonexcludability characteristic of public goods is that in many cases they are non-refuseable (Hanemann 1994), thus violating the assumption of free disposal. Beyond some satisfactory level, then, it is plausible that increasing levels of the conservation programs are associated directly with disutility. Alternatively, and probably more likely, respondents infer increasing opportunity costs as resources are increasingly allocated to conservation programs: allocation of land in the Coast Range to one particular conservation purpose necessarily requires that other activities be reduced. Although the instrument instructs respondents that the cost of the alternatives includes compensation of affected land owners, respondents may anticipate additional externalities of over-allocation of land to conservation purposes, giving rise to threshold levels where compensated demand curves cross the x-axis. Both of these effects are at play to some degree in any decision regarding public goods provision, and welfare effects such as those described in this study (with total utility not monotonically increasing), are likely characteristically

---

1. In consumer theory, free disposal is defined as the ability to dispose of any quantity of a good at zero cost.



sensitive to threshold effects<sup>1</sup> (the term 'threshold' is used here to refer to the level of the conservation programs where demand falls to zero and beyond which WTP is negative). This having been said, it is possible that a less restrictive specification than the quadratic model used here would generate qualitatively different results. As noted in the discussion of the research below, introducing greater flexibility is a primary objective for further research<sup>2</sup>. In future applications of CEA, it seems critical that experimental designs have sufficient resolution to permit flexible model specifications and identification of thresholds with adequate precision, including quadratic and, possibly, cubic terms as well as ASC's.

### Demographic terms

In the brief CEA literature in resource economics, there are few instances of inclusion of respondent specific effects in the model analysis (Boxall, Adamowicz et al. 1996). An alternative approach, used by Xu (1997), is stratification of the data and estimation of separate models for different demographic groups. As noted above, the approach used here has the advantage of simplifying the analysis and preserving degrees of freedom. An alternative specification was tested which interacted the demographic variables with ASC's for each alternative instead of with the linear terms for the respective conservation

---

1. This is an untested hypothesis. It has been uncommon in the nonmarket valuation literature to estimate demand functions for environmental amenities, and thus the issue of thresholds does not seem to have appeared widely in the literature. Further investigation with the use of CEA and similar techniques may shed more light on this question.

2. Options to explore for increasing the flexibility of the model are inclusion of a cubic term for some or all of the conservation programs, use of the Box-Cox specification (Hanemann 1999), or a semiparametric specification such as that suggested by Creel and Loomis (1997). The use of functional forms has not, as of this writing, been addressed in the published literature on CEA in nonmarket valuation.

programs. While this method also avoided cancellation of the demographic terms from the probability response equation (Equation 5-1), it was not found to significantly improve model fit. While this approach would be preferred if there is a desire to isolate the demographic effect from the scale of the conservation program, the demographic/program interactions seemed to provide useful insight to this analysis.

#### 5.2.1.2 Validity and Reliability

Considerable effort was invested to ensure the validity and reliability of the survey, from the instrument and experimental design, to survey administration and data analysis. These procedures were discussed in previous chapters. This section focuses on a variety of statistical tests and comparisons to identify any potential biases in the results presented herein.

#### Anchoring Bias and Order Effect

Insofar as possible, it is important in valuation survey design to capture cognitive effects of the survey instrument itself on the respondent's replies, and to attempt to identify and correct any biases that may result (Arrow, Solow et al. 1993; Hanemann and Kanninen 1999; Carson, Louviere et al. 1994)<sup>1</sup>. The design of the survey instrument included a contingent valuation elicitation prior to the choice experiment section of the survey. There is, therefore, the potential that the size of the DC/CVM bid level provides an implied value cue to the respondent. This effect, widely recognized in the CVM literature, is termed the *anchoring effect* and is driven by a cognitive bias originally

---

1. The broader classes of bias effects important in survey research and revealed preference valuation techniques in particular are reviewed in Section 2.2.2 and Section 2.2.3. The literature on survey bias is extensive and the distinction between different bias effects can be subtle (Mitchell and Carson 1989, pp. 235-260; McLeod 1994, Ch. 2). This exposition does not attempt to provide a detailed catalog of bias effects but identifies prominent effects.

identified by Tversky (1974; see also Giraud 1999). Other elements in the instrument design, such as the conservation program specified in the CVM scenario or order of presentation of the conservation programs, may provide additional value cues. If the bias is shown to be present, this is indication that individuals do not consult a stable preference ordering to identify preferred alternatives, but rather use information presented in the survey instrument to spontaneously construct a preference ordering (Payne, Bettman et al. 1992; Schkade and Payne 1994). As Hanemann (1994) has argued, the theory of constructed preferences is not inconsistent with neoclassical utility theory, so long as constructed preferences are stable. If individuals adjust their WTP responses in the choice questions depending on the relative size of the CVM bid, this bias effect would suggest that respondent's preferences are in fact unstable and would call into question the validity of the WTP estimates as approximating a global preference ordering.

There are three tests for anchoring bias and survey context effects effect built into the structure of the survey instrument. One is the specification of the bid amount in the DC/CVM section of the instrument prior to the choice experiment section. If the specification of the CVM bid amount induces an anchoring effect, then WTP estimated in the choice experiment model will be positively correlated with the CVM bid level. This is tested by including interaction terms for each program with the CVM bid level. With the null hypothesis  $H_0: \beta_{Bx}CVBID = \beta_{Ex}CVBID = \beta_{Fx}CVBID = \beta_{Sx}CVBID = 0$  (df=4), the likelihood ratio test (LRT) results are displayed in Table 5-4. For all three regional strata, the null hypothesis is not rejected at the 95% level.

The second test is the effect of the program specified in the DC/CVM scenario. The hypothesized effect is that respondents will be prompted to react more strongly to the program specified in the CVM scenario than the other programs in responses to the CE questions. To measure this effect, four dummy variables are created in the data vector, one for each program, and coded = 1 where the corresponding program appears in the CVM scenario. The linear term for level of each program in the CE model is interacted

with the respective program dummy to create four interaction terms:  $BxCVProgB$ ,  $ExCVProgE$ ,  $FxCVProgF$ , and  $SxCVProgS$ .<sup>1</sup> The null hypothesis for this test is  $H_0: \beta_{BxCVProgB} = \beta_{ExCVProgE} = \beta_{FxCVProgF} = \beta_{SxCVProgS} = 0$ . The LRT results are also depicted in Table 5-4. The results of both tests do not reject the null hypotheses. Thus, there is no statistical evidence of anchoring on either the bid level or the program specified in the DC/CVM scenario.

Table 5-4. Likelihood ratio test results for anchoring effect

Region	LRT Critical Value ( $p=.95$ , $df=4$ )	2*LogLikelihood Restricted Model	Test: CVM Bid Level		Test: CVM Program	
			2*LL-Unrestricted	Test Statistic	2*LL-Unrestricted	Test Statistic
Coast Range	9.49	2252.308	2248.877	6.999	2245.309	3.431
Willamette	9.49	2013.942	2007.85	7.882	2006.06	6.092
E. Oregon	9.49	2124.881	2119.962	7.458	2117.423	4.919

The third test for context effect designed into the instrument uses alteration of the order of presentation of the programs in both the information section of the survey and in the choice sets. The hypothesis implicit in the order effect is that respondents take the sequence of presentation of informational elements in the survey as somehow implying the relative importance of the conservation programs. Two sequences are specified<sup>2</sup>, and a 0/1 dummy variable is created in the data vector to represent the sequence presented to a given respondent. Interaction terms are coded and entered in the regression model

1. For example,  $CVProgB = 1$  where the biodiversity reserve program is specified in the DC/CVM scenario, and  $= 0$  otherwise. The parameter on the interaction term  $BxCVProgB$  therefore measures the effect that the CVM scenario alters the respondents' valuation of the respective programs.

2. Sequence 1: Salmon, Forest Age, Biodiversity Reserves, Endangered Species; Sequence 2: Salmon, Endangered Species, Forest Age, Biodiversity Reserves. Note that salmon always appeared first due to formatting restriction in the survey instrument.

in the manner discussed above. Results of the likelihood ratio test for the order terms as a group are presented in Table 5-5. The null hypothesis is that  $\beta_{B \times ORDER} = \beta_{E \times ORDER} = \beta_{F \times ORDER} = \beta_{S \times ORDER} = 0$ , and is rejected for the Coast Range strata at the  $p=0.95$  level. The values of the order effect parameters are presented in Table 5-6. Only the old

Table 5-5. Likelihood ratio test results for order effect

Region	Critical Value ( $p=0.95$ ), $df=4$	2LogL-Restrict	2LL-Unrestricted	Test stat ( $df=4$ )
Coast Range	9.49	2252.308	2257.294	9.986
Willamette Valley	9.49	2013.942	2015.191	1.249
E. Oregon	9.49	2124.881	2125.753	0.872

growth forest program interaction term is individually significant. This result is surprising, given that respondents are thought to be particularly prone to context effects when preferences are not well-defined (Mitchell and Carson 1989, pp. 240). Since preferences regarding old growth forests amongst Coast Range residents are likely to be rather well-defined relative to other preferences measured in the survey, this effect is unexplained. Since there is no utility theoretic interpretation of the order effects detected, they are not included in the estimation of welfare effects described below. The reader is cautioned, however, that these results may suffer from a small but unexplained context bias.

Table 5-6. Magnitude of order effects

Program/Order Interaction	Coast Range	Willamette Valley	E. Oregon
SXORD	0.002028	-0.000998	0.000534
EXORD	-0.004114	-0.00077	0.001348

Table 5-6. Magnitude of order effects

Program/Order Interaction	Coast Range	Willamette Valley	E. Oregon
F3XORD	0.009961*	0.002226	-0.002034
BXORD	0.001228	-0.006952	0.003859

### Nonresponse Bias

A fundamental element of validity for any survey instrument is the issue of self-selection, or non-response bias. There is always a potential that the individuals opting to complete and return the survey hold systematically different views than the sample as a whole and the larger population. Since, by definition, the researcher has no data collected from non-respondents, detection of nonresponse bias can be difficult.<sup>1</sup> Since the survey administration process employed in this research involves a series of reminders following the initial mailing, one test for nonresponse bias can be achieved by comparing the responses of individuals who responded shortly after receiving the first mailing to those who responded only after being repeatedly contacted. The implicit behavioral assumption is that individuals with more strongly formed preferences will respond promptly, whereas those who respond only after repeated reminders have less defined preferences for biodiversity conservation. If the central tendency of the later group is distinct from that of the earlier group, this is evidence that nonresponse bias is present.

---

1. In a study which employed extensive follow ups with sample nonrespondents, Mattson and Li (1994) found that there were no significant differences in attitudes regarding recreational access to Swedish forests between respondents and nonrespondents to an initial mail survey. Bostedt and Boman (1996) also found that attitudes regarding environmental values did not differ significantly between respondents to a mail survey and nonrespondents contacted through follow up telephone interviews, concluding that non-response was due to general rather than survey specific factors.

As indicated in Figure 4-2 on page 64, surveys were collected over the period spanning from June 4 to August 30, 1999. Prior to the third mailing on July 16, which consisted of a replacement copy of the survey pamphlet, 79% of all responses had been received. A test for differences in preferences between the early and late groups of responders is therefore employed to detect nonresponse bias. To implement the test, a dummy variable for date of response is created in the data vector and coded= 1 if the response was received after July 16, and 0 otherwise. As for the tests described above, interaction terms were entered for each of the four programs, resulting in four model terms: BxDATE, ExDATE, SxDATE, and FxDATE. The significance of these interaction terms was tested for the group using the LRT. Results of the test of  $H_0: \beta_{BxDATE} = \beta_{ExDATE} = \beta_{SxDATE} = \beta_{FxDATE} = 0$  are given in Table 5-7. As the test statistic for E. Oregon indicates, there is a significant difference in response probabilities between the early and late groups.

Table 5-7. Likelihood ratio test results for nonresponse bias

Region	Critical Value ( $p=0.95$ ), $df=4$	2LogL-Restrict	2LL-Unrestricted	Test stat (df=4)
Coast Range	9.49	2426.885	2433.168	6.283
Willamette Valley	9.49	2122.574	2123.743	1.169
E. Oregon	9.49	2198.206	2209.871	11.665*

The values of the response date /program interaction terms for E. Oregon are given in Table 5-8. The value of the terms indicate that respondents in the late group, who are likely to be more representative of nonrespondents than the early group, have higher response probabilities for higher levels of the conservation programs than the early group. Thus, the E. Oregon WTP estimates represented in Table 5-3 are biased downwards and constitute conservative estimates. Adjustment for this and other bias effects is suggested below.

As noted on page 69 n. 1, the 1998 Oregon Population Survey (Vaidya, 1999) found that 14% of the Oregon public rated salmon protection unimportant, compared to a weighted average of 15% of respondents to the attitudinal question regarding salmon habitat in the biodiversity survey. This lends further evidence that survey respondents' attitudes are generally representative of the Oregon population.

Table 5-8. Value of model nonresponse terms

Nonresponse term	Parameter value	p-value
SXDATE	0.002191	0.5204
EXDATE	0.010207	0.0228
F3XDATE	0.003318	0.5403
BXDATE	0.004706	0.582

### Representativeness

A validity concern closely associated with nonresponse is sample bias. Sample bias occurs when the selected sample is not drawn at random from the population. The sample of household from each of the regional strata used in this analysis was purchased from a professional sampling agency and was drawn from a variety of sources, including phone company records, postal service change of address records, and others. Though the multiplicity of sources is intended to avoid any systematic bias built into a given source, it is nonetheless practically impossible to generate a perfectly random sample of households. Coupled with the issue of sample source is the nondeliverable rate of the sampled addresses (15% of the original sample) and any systematic differences between the respondents and the general population. The test for nonresponse bias above controlled for differences in significant demographic covariates between the early and late group. This does not, however, account for demographic differences between respon-



dents and the population. To identify any demographic differences between the respondent group and the population at large, the sample mean values of the demographic parameters for each of the three regions are compared in Table 5-9 with statistics from other sources which are less prone to nonresponse, e.g. US Census data. As indicated, the sample means for age and length of residence are much higher than for the population of each region, (-40% and -80% higher, respectively). This is common amongst surveys, and is particularly common with mail surveys, which are much more likely to be completed by older recipients (John Loomis, personal communication). Education rates are slightly higher amongst the survey sample in all three strata, with about 1 additional year of education amongst survey respondents. The rate of environmental group membership is overrepresented in the CR and WV samples (156% and 24% higher, respectively), and the EO strata reporting a 12% lower rate of membership than in the population. Similarly, rates of forest products employment are 188%, 64% and 54% higher amongst the CR, WV, and EO samples than in the respective regional populations. With political alignment coded on a -1 to 1 scale (liberal to conservative), the population is considerably more liberal than the samples in each region.<sup>1</sup>

Given the significant discrepancies in the population and sample demographic characteristics, adjusted welfare estimates can be calculated by weighting the calculations by the estimated population means rather than the sample means for the significant demographic covariates. This adjustment is depicted along with the unadjusted WTP estimates described below.

---

1. No direct measure of the liberal/conservative distribution of Oregon residents was available. As a proxy, voter registration in the Democratic and Republican political parties is used. With Democrats coded -1 and Republicans coded 1, the proportion of registered voters in each party was multiplied by these codes and the mean value of the two weighted proportions was taken as an index of mean political alignment. This assumes both that proportions of voters registering in the two largest political parties is representative of the political alignment of the Oregon population generally, and that political moderates (i.e. those indicating "neutral" on the liberal-conservative Likert scale) are divided evenly amongst the two parties). While this approach nests two untested assumptions, it nonetheless provides the best available estimate of political alignment by which to adjust the sample mean value.

Table 5-9. Population and survey sample mean values for selected demographics

	Coast Range		Willamette Valley		E. Oregon	
	population	sample	population	sample	population	sample
Length of Residence <sup>a</sup>	20.0355	38.1890	19.4480	35.2108	19.8179	33.9482
Education <sup>b</sup>	13.1709	13.8850	13.9073	14.7528	13.1068	14.3254
Environmental Group Membership <sup>c</sup>	0.0400	0.1024	0.1065	0.1325	0.1115	0.0986
Political Alignment <sup>d</sup>	-0.0687	0.1457	-0.0474	0.0476	0.0427	0.0822
Age <sup>e</sup>	40.6737	56.0299	35.7637	51.1735	37.6606	54.8546
Forest Products Employment <sup>f</sup>	5.9727%	17.23%	3.5077%	0.0578%	7.7834%	12%

a. (Oregon Progress Board 1998, Table All-R1)

b. (Oregon Progress Board 1998, Table All-EL1)

c. (OFRI 1999)

d. (State of Oregon, Secretary of State Office 1998)

e. (USACE 1999)

f. cit

### 5.2.1.3 WTP Estimation

Estimation of willingness to pay for increases in the level of protection of biodiversity for each of the four conservation programs is presented below. The calculation of WTP is based on the utility-difference approach derived by Hanemann (Hanemann 1984; see also Hanemann 1991; Beenstock, Goldin et al. 1998; Li, Lofgren et al. 1996) and detailed in Equations 3-12 through 3-16 above, where compensating surplus for a change in the quality or quantity of attributes of a good is represented as:

$$TWTP/TWTA_n = CS_n = -\frac{\beta_n}{\alpha} [f(X_{jn}) - f(X_{in})] \quad (5-2)$$

and marginal WTP, which defines the compensated Hicksian demand curve, is derived as

$$MWTP/MWTA_n = \frac{\partial}{\partial X_{jn}} CS_n \quad (5-3)$$

The computations of WTP for the four conservation programs using the estimated MNL parameters in Table 5-3 are the following:

$$TWTP(X_k) = -\frac{1}{\alpha} \left[ \tau_Q + \left( \beta_{X_k} + \sum_l \gamma_{kl} R_l \right) (X_{kj} - X_{ki}) + \beta_{X_k^2} (X_{kj}^2 - X_{ki}^2) \right] \quad (5-4)$$

$$MWTP(X_k) = -\frac{1}{\alpha} \beta_{X_k} + \sum_l (\gamma_{kl} R_l) + 2\beta_{X_k^2} X_k \quad (5-5)$$

where  $X$  denotes the four conservation programs  $k=1...4$ ;  
 $R$  denotes the demographic covariates  $l=1...7$ .  
 and parameters are as described in Table 5-2

The measures above represent both the mean and median of the individual respondents' logistic WTP/WTA distribution, which coincide given the linear specification of the regression function, which is additive in the attributes and covariates, and linear in the cost (bid) level (Hanemann 1989). Noting the caveats raised in Section 3.2, the mean is used as the measure of central tendency in computing the aggregate WTP measures for the regional strata presented in the figures below<sup>1</sup>. Inspection of Equation 5-5

indicates that there is a constant component,  $\frac{-(\beta_{X_k} + \sum_l \gamma_{kl} R_l)}{\alpha}$ , and a component that

1. As noted in Section 3.2, there are two separate distributional issues pertaining to welfare estimation in discrete choice, random utility modeling: the distribution of individual WTP, which we have assumed to be logistic, and the distribution of aggregate WTP, for which no particular distributional assumption is made. For the former, the summary measure produced (mean, median, etc.) depends on the manipulation of model parameters represented by Equations 5-4 and 5-5. For the latter, the summary expression of individual WTP must be evaluated for some representative member of the sample, typically represented by either the sample mean or median values of demographic covariates. In the figures presented below, the mean used to summarize both the individual and aggregate WTP distributions.

varies with  $X$ ,  $-\frac{\beta_{X^2}X}{\alpha}$ , representing the intercept and slope of the compensated demand curve, respectively. Integration of the area under the demand curves gives the TWP/TWTA functions, which are shifted by the value of the status quo constant.<sup>1</sup> The mean value of the intercept and slope for the four compensated demand curves and the status quo constant are presented by region in Table 5-10 with 95% confidence intervals for the mean values of these terms.<sup>2</sup> Finally, the table presents the adjusted intercept, slope and SQ constants for the four compensated demand curves, evaluated at the regional population means of the demographic covariates given in Table 5-9.

Coast Range residents exhibit the largest status quo preference and Willamette Valley the smallest, and all three regions exhibit negative status quo effects. This is an intuitive result: Coast Range residents are likely to be subject to the greatest constraints on land use under any conservation initiative. Insofar as the status quo effect measures a generic aversion to change of any kind (Samuelson and Zeckhauser 1988), clearly the region that is most directly affected by this change will express the strongest aversion. However, because E. Oregon residents express a status quo preference intermediate to the other strata, physical proximity to the changes in land use implied by the conservation scenarios is unlikely to be the only explanation for the magnitude of status quo effects. While extended discussion of the status quo issue is reserved for the next chapter, it is noted that the sample includes individuals whose choice of the status quo was explained in the follow up question as a protest of government policy, taxation, interference in private property rights, or other form of protest. The higher degree of political conservatism in the EO strata relative to WV respondents may therefore explain the rel-

---

1. Further discussion of the interpretation of the status quo effect is presented in Section 6.1.1.

ative magnitude of the EO status quo effect. While it is customary in CVM research to censor protest responses, they were retained in this study for two reasons: the recognition that policy vehicles are relevant to preferences for public goods, and the ability to isolate the protest effect from the marginal values for increases in the conservation programs by inclusion of the status quo term in the model.

The width of the confidence intervals provides a measure of the variability in MWTP within a given region, where wide intervals tend to suggest a high degree of polarization on a given issue. The forest program exhibits the narrowest intervals, relative to the size of the estimated slope and intercept terms, indicating that there is a relatively high degree of agreement amongst residents within each of the three regions. The widest intervals are associated with the biodiversity reserve program, indicating a relative lack of consensus regarding the WTP for this program. The adjustments for sample representativeness are nearly uniformly increases, with WTP terms being lower for the reserve program in WV and EO strata, and all other adjustments resulting in higher WTP. This

---

2. CIs are computed using the Krinsky-Robb method with 5000 random draws with replacement (Krinsky and Robb 1986; Park, Loomis et al. 1991). While reporting of confidence intervals for point measures of WTP is becoming increasingly common in the CVM literature, an added dimension of complexity arises in calculation of CIs for WTP *functions* in CEA applications. In the Krinsky-Robb method for calculating CIs, a simulated WTP distribution is constructed by taking multiple random draws from the distribution of the parameter vector using information contained in the parameter vector and variance covariance matrix from the ML estimation. Ordering the replicated WTP values permits construction of a confidence interval around the mean of the simulated distribution. In the case of WTP functions the ordering depends on the value of  $X$  (i.e. the level of the environmental amenity) at which the WTP function is evaluated. Thus some arbitrary level of  $X$  at which to evaluate the CI must be selected. The CIs depicted above are selected from an ordering of the intercept terms alone, which amounts to evaluating the CI at  $X=0$ . An additional complication arises from the calculation of CIs for the distinct attributes from choice observations of composite goods. Distributions for the compensated demand functions can be simulated separately and corresponding CIs constructed for point measures of WTP for the respective attributes. Alternatively, a TWTP distribution can be simulated for some particular composite (i.e. the summed value of MWTP for the  $k$  attributes, each evaluated at a particular level), and corresponding CIs for TWTP constructed. The former method, which is used to estimate the CIs depicted above, represents the full variability in the marginal WTP functions, but overstates the variability in TWTP. That is, there is more variability indicated by separate orderings of the demand curve intercept values for the four programs than in a joint ordering of the sum of these four values.

Table 5-10. Confidence intervals, mean and adjusted values for WTP constants and slope coefficients

	Coast Range				Willamette Valley				E. Oregon			
	Lower Bound	Mean	Upper Bound	Adjusted	Lower Bound	Mean	Upper Bound	Adjusted	Lower Bound	Mean	Upper Bound	Adjusted
Status Quo Constant	-330.55	-241.55	-174.13	-241.55	-234.9	-139.88	-49.39	-139.88	-233.70	-173.37	-121.64	-173.37
Salmon Program												
Intercept	6.35	11.68	17.81	10.18	1.99	9.66	17.15	9.84	2.47	6.35	10.19	7.17
Slope	-0.089	-0.173	-0.092	-0.173	-0.089	-0.179	-0.090	-0.179	-0.050	-0.105	-0.051	-0.105
Endangered Species Program												
Intercept	0.81	5.15	13.44	7.74	16.67	27.97	35.65	27.87	3.85	8.88	14.06	9.10
Slope	-0.022	-0.156	-0.088	-0.156	-0.243	-0.592	-0.360	-0.592	-0.075	-0.193	-0.138	-0.193
Forest Age Program												
Intercept	18.39	20.92	30.85	22.50	22.67	28.02	38.61	31.85	11.748	12.80	19.74	13.68
Slope	-0.355	-0.745	-0.450	-0.745	-0.375	-0.840	-0.522	-0.840	-0.194	-0.390	-0.231	-0.390
Biodiversity Reserve Program												
Intercept	-1.674	9.702	20.095	10.05	-13.19	17.45	51.57	17.0576	1.87	11.15	20.71	10.72
Slope	-0.257	-0.430	-0.276	-0.430	-0.257	-0.809	-0.275	-0.809	-0.156	-0.491	-0.393	-0.491

indicates that the unadjusted results are relatively conservative and also suggests that any nonresponse bias is unlikely to be due to higher environmental values in the respondent group than in the population. The difference between mean and population adjusted values is generally quite small, with the largest adjustment being a 33% increase in CR residents WTP for endangered species protection.<sup>1</sup> All other adjustments are less than 15%. This indicates that the estimated values are relatively robust to the degree of representativeness of the respondent group.

Figures 5-7 and 5-8 depict the compensated demand curves constructed from the adjusted figures in Table 5-10. Note that each figure includes a vertical line identifying the status quo level for each program and the above and below baseline levels specified in the experimental design. The survey design included a below-baseline level for each of the programs in addition to two above baseline levels, with the intention of measuring WTA for decreases below baseline as well as WTP for increases. Also note that the estimated demand curves for all four programs in all three regional strata cross the x-axis, indicating threshold levels for each of the attributes below which program increases generate negative utility. Taking the current baseline as defining the current specification of property rights and the reference level of utility, changes in the amount of provision that generate negative utility would require compensation to, rather than payment from, the individual to maintain the initial level of utility (WTA), and the theoretically correct measure of welfare is therefore equivalent surplus (ES), where  $ES = -CS$  (Hanemann and Kanninen 1999). Since the compensated demand functions in Figures 5-7 and 5-8 depict marginal changes in CS, integration of the area bounded by the demand curves and the x-axis from level  $i$  to level  $j$  provides a measure of CS for the quantity level change from  $i$  to  $j$  (where the status quo effect is an integration constant). Thus, for quantity changes to the left of the baseline level in Figures 5-7 and 5-8,  $WTA = EV = -CS$  is the negative of the value shown on the figure. As discussed above in Section 5.2.1.1, the esti-

---

1. Note that demographic parameters only enter the intercept term, and the status quo and slope terms are not affected by adjustment.

Figure 5-7. Compensated Demand Functions for Salmon and Endangered Species Habitat Programs, by Region

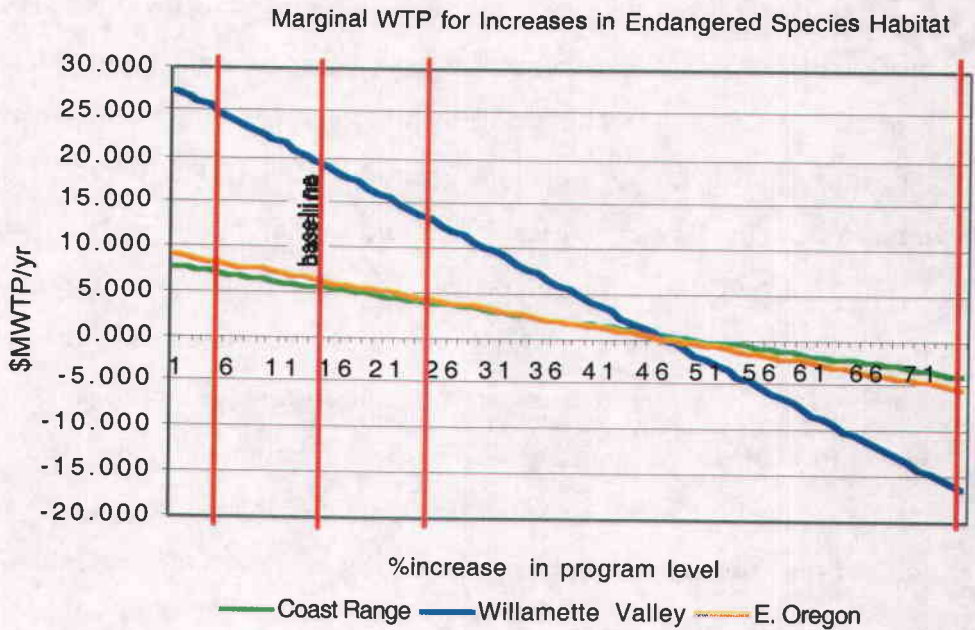
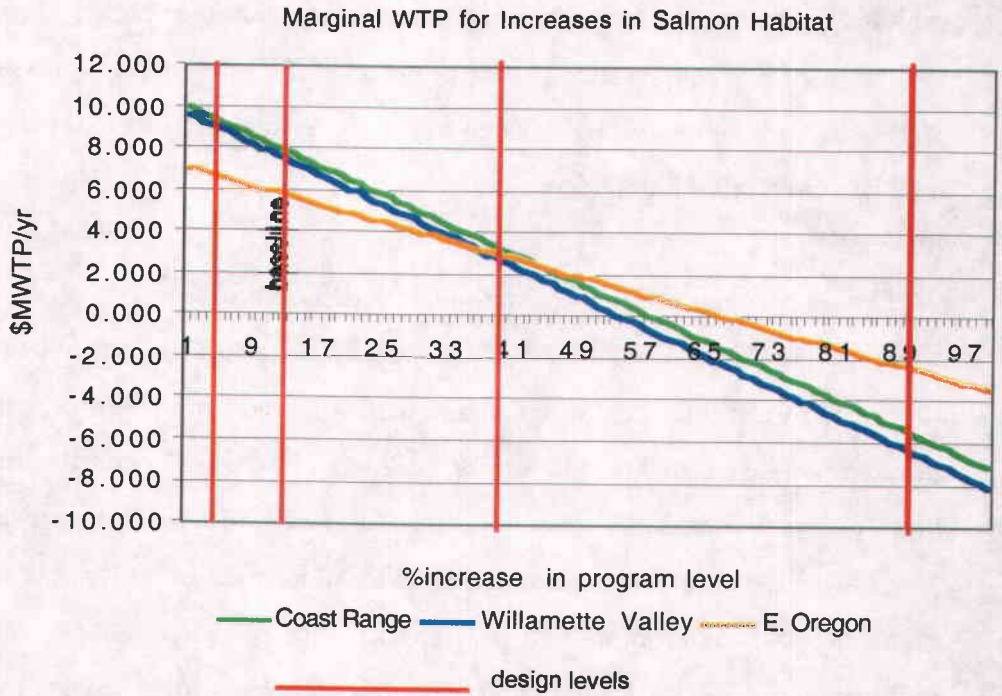
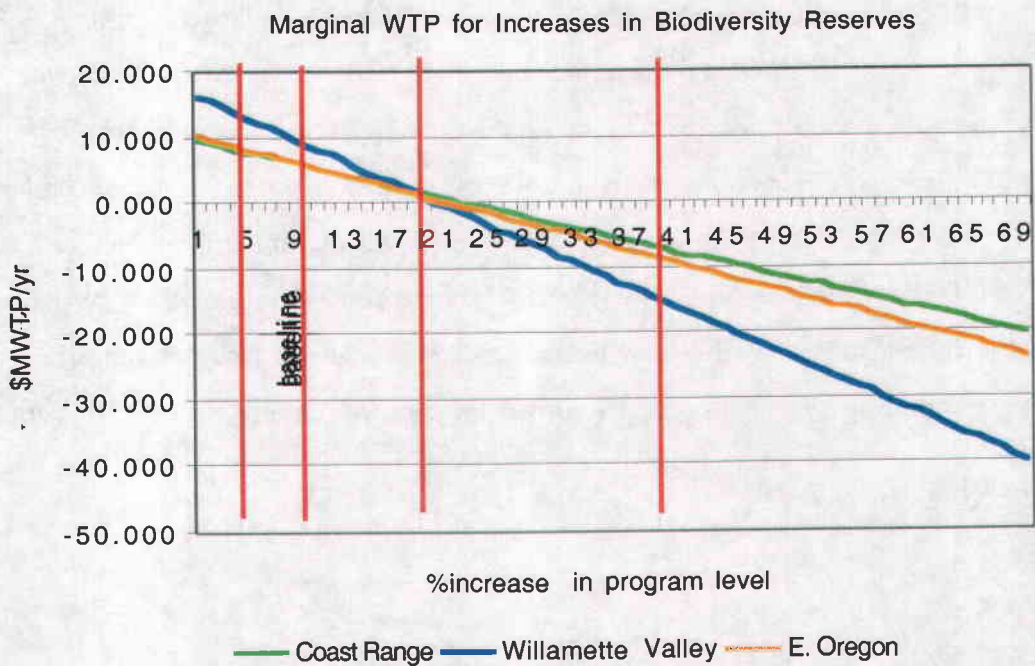
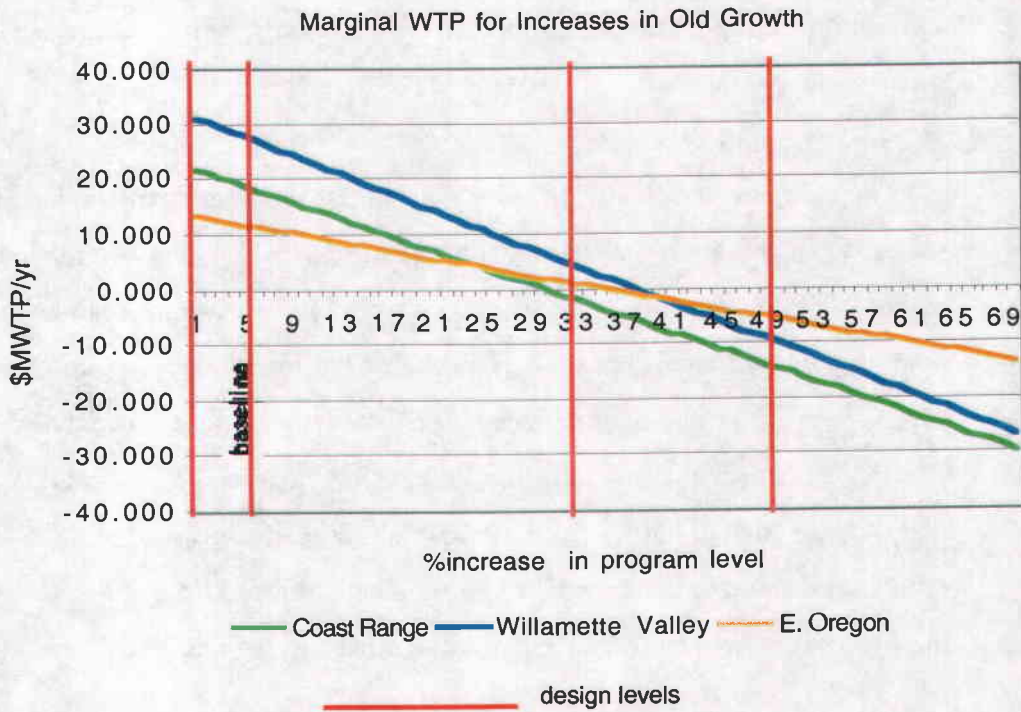




Figure 5-8. Compensated Demand Functions for Old Growth Forest and Biodiversity Reserve Programs, by Region



mated marginal and total welfare functions depicted in Figures 5-7 and 5-8 display some anomalous properties in the context of standard neoclassical conventions. Unlike the figures below, well-behaved demand curves tend to be non-negative at positive values on the  $x$ -axis, and CS/ES functions are correspondingly non-decreasing in  $x$ . As noted above, in the current context it is not surprising that the estimated curves violate these conventions.

The compensated demand curves indicate distinctly different preferences for the respective conservation programs across regions. Generally, the WV residents indicate higher WTP for increases at most quantity levels of the programs than do either of the other regions and consistently display less elastic demand. An exception is the salmon habitat program, where coastal residents' demand is everywhere above the other regions. With a steeper demand function, but a lower threshold level, WV residents' WTP is only slightly below that of CR residents over the full range of increase in protection level. EO residents exhibit a flatter demand for salmon habitat protection, with a lower intercept but higher threshold level than either of the other two regions.

The regional disparity in MWTP for increasing endangered species protection is striking. All three regions indicate positive WTP for increasing protection of critical endangered species habitat up to approximately 50% of the total. However, WV residents have much lower demand elasticity overall, corresponding to much higher WTP/WTA for changes from the baseline level. Given the similarity of WV residents' WTP for increases in salmon habitat with that of the other two regions, the much higher WTP for endangered species may indicate that WV residents regarded the latter program as capturing the benefits of the narrower focus on salmon. In addition, the salmon habitat

program was described in the information section as being associated with the Governor's salmon recovery plan, whereas the endangered species program was described in the context of the federal ESA. Thus, the disparity in demand for endangered species protection may indicate a higher degree of acceptability of federal intervention amongst WV residents.

The relative preferences of WV and EO residents for increasing the proportion of coastal forests in the >150 year age class are qualitatively similar to the endangered species program, with both exhibiting positive WTP for increases up to approximately 38% as consistent with attitudinal findings in Figure 5-3, and the WV demand function being everywhere above that of the other strata. All three regions expressed higher marginal WTP for the old growth program than for any of the other programs, with the CR demand curve having an intercept twice that of any other program. This is offset by a relatively low threshold value, however, indicating a relatively strong disutility for increases above the 33% level. It should be noted that the scenario described in the survey instrument was framed in terms of age class distribution, rather than strictly old growth forest, which is used as a proxy for the full age class distribution in the utility modelling due to constraints in the experimental design. Given that the threshold levels indicated by the respondents are clustered around the 33% old growth level that was described as part of an even age class distribution (i.e. 33% young forest, 34% mid-age, and 33% old growth), this may indicate a preference for a maximally diverse age class distribution. It is also quite plausible, however, that the amenity benefits (e.g. recreational and aesthetic benefits) of the forest age-class program apart from biodiversity conservation were most likely perceived by respondents as being much greater than the other programs, in which case it is not surprising that WTP is highest for this program.

The demand functions of CR and EO residents for biodiversity reserves are nearly identical, with positive WTP up to a level of approximately twice that of the baseline and very small marginal values (below \$5/year for increases above baseline). With approximately the same threshold level, the WV region has mean WTP about twice that of the other regions. At the baseline level, both WV and EO residents' marginal values are virtually the same as for endangered species protection. The biodiversity reserve program elicited the lowest values of all the conservation programs presented in the survey. With respect to the threshold levels, this is indication of a solid understanding of the relative merits of the programs, in that the other programs would have a lower impact on the total amount of land designated, i.e. the other programs focus on increasing coverage of certain classes of land - riparian zones and critical habitat for example - whereas the reserves program would increase the percent of the total land in the Coast Range in reserve status. It is not surprising, then, that respondents would view large allocations to reserves as having greater implicit opportunity costs beyond those captured by the bid price.

As a general observation, EO residents indicate a WTP of approximately \$6 for small increases above baseline levels for all but the old growth program, for which they indicated a higher WTP of ~\$11 for marginal increases just above the baseline level. However, the elasticity of demand varies significantly over the different programs, perhaps indicating different levels of tolerance for high levels of resource allocation to the different programs. Again, as expected, WV residents have expressed nearly uniformly higher WTP/WTA for conservation. Despite some significant disparities in the quantitative levels of WTP, it is notable that no gross qualitative differences are indicated: all regions exhibit significant WTP for the conservation programs and threshold levels tend to be similar between regions, but distinct between programs.

Figures 5-9 and 5-10 depict TWTP/TWTA (i.e. compensating surplus/equivalent surplus) for changes above and below the baseline level for each of the four programs<sup>1</sup>. For simplicity of exposition, the weighted average TWTP/TWTA (adjusted for population representativeness) for each of the four programs, averaged over the three regions, are presented<sup>2</sup>. TWTP functions are depicted without the status quo effect in Figure 5-9, and with the SQE in Figure 5-10. Given the much larger population of the Willamette Valley, the weighted average TWTP is largely reflective of higher marginal WTP values of the WV region. However, given the qualitative similarity of the compensated demand functions between regions, the weighted average does not mask any fundamental differences in preferences.

As noted above, TWTP/TWTA curves in each graph represent the area under the compensated demand curves with and without the negative value of the status quo effect (SQE). For the CR, WV and EO regions, the value of the status quo effects are -\$242, -\$140, and -\$173 respectively. The without-SQE curves cross the x-axis at the baseline level, whereas each of the with-SQE curves drawn in Figure 5-10 are shifted downward by the full value of the SQE.<sup>3</sup> As discussed in the next chapter, the SQE represents a dispreference for changing the status quo in the context of changes in all four of the conservation programs in the survey. It is not possible to identify interactions between the SQE and the individual programs in the statistical model<sup>4</sup>. Thus, relative allocation of the SQE to individual programs is ambiguous, and the curves drawn in Figure 5-10 where the full value of the SQE applies to each program, represent the polar extreme to

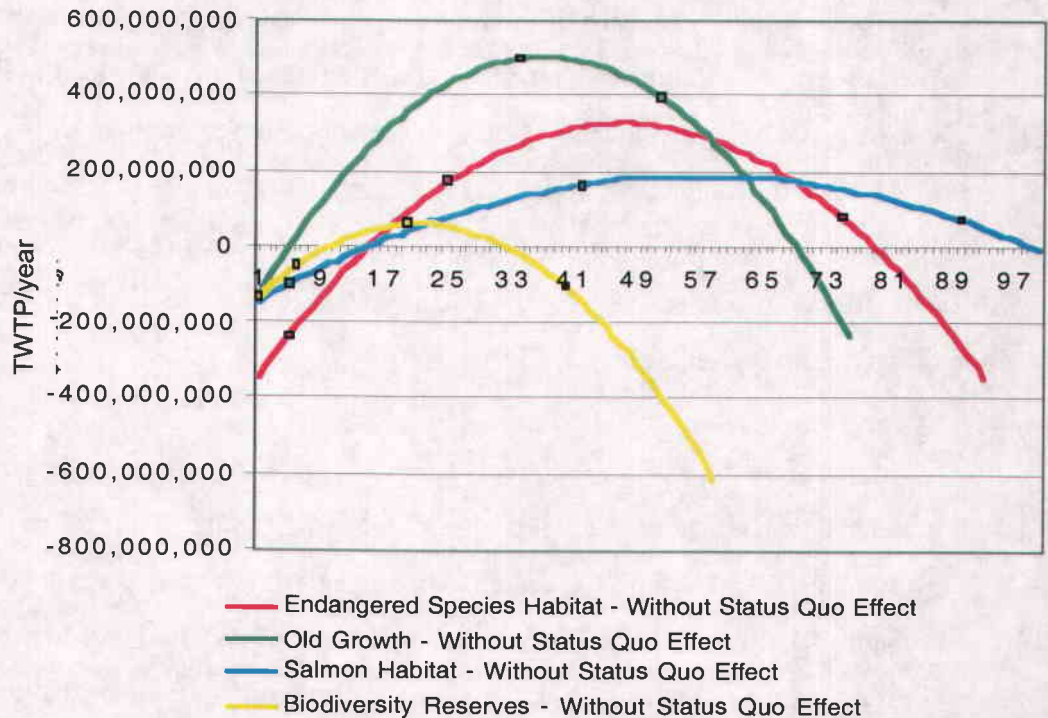
---

1. Again, below baseline levels are associated with total willingness to accept compensation (TWTA) for the reduction, compared total willingness to pay (TWTP) for increases above baseline.

2. 1998 population levels in the three regions CR, WV and EO are 78353, 996010, and 269750, respectively (USACE, 1999).

3. Note that the value of both sets of functions is zero at the baseline level, meaning that the with-SQE curves have a discontinuity at the baseline level, though they are otherwise continuous. This discontinuity is not visible in the graphs because it appears only at the baseline level of the respective programs, and thus represents a single point of discontinuity in an otherwise continuous function.

Figure 5-9. Weighted Average TWTP/TWTA for Changes in Conservation Programs - No Status Quo Effect<sup>a</sup>

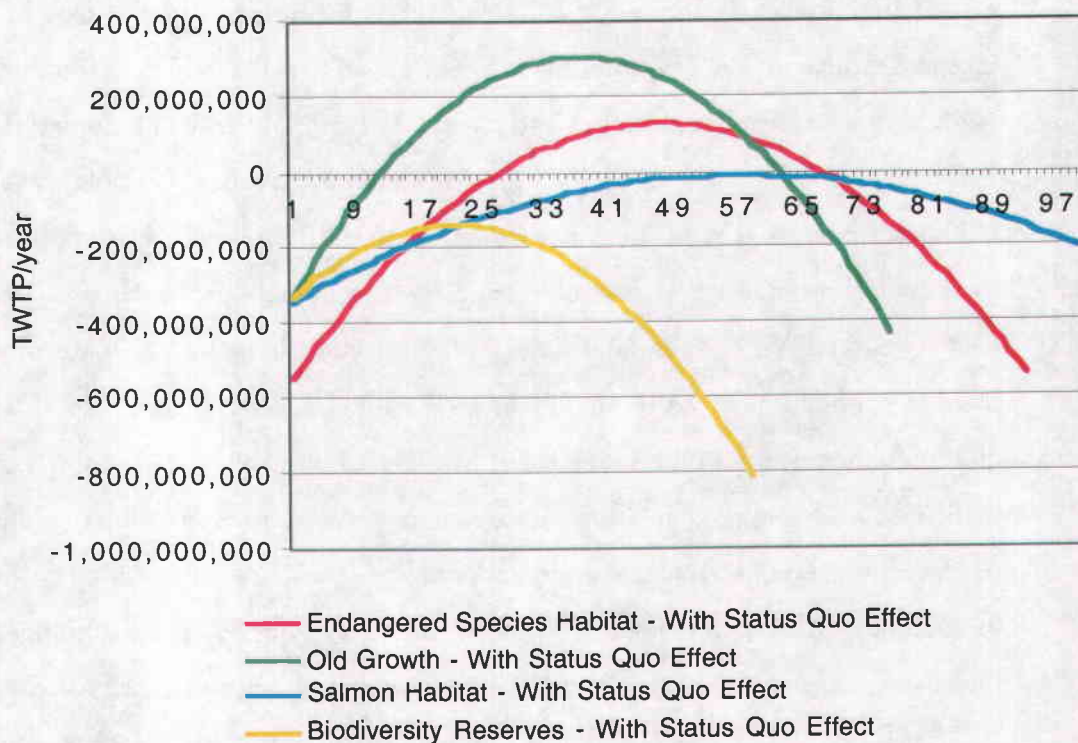


a. Markers on the curves denote above- and below-baseline design points. The status quo level is the x-intercept in the without-status quo figure.

those in Figure 5-9 where the SQE does not apply to any of the four programs. Note that allocation of the full value of the SQE to two or more programs separately overcounts the SQE, and therefore each of the curves in Figure 5-10 should be interpreted as the TWTP/TWTA for the respective program, holding the other three programs constant at the baseline level. Joint changes in two or more programs would require using

4. Because baseline levels of the programs appeared only in the baseline alternative of each choice set, and not in either of the other two alternatives, there were no scenarios in the design that features changes from baseline levels for some programs and not for others. Including baseline levels for some attributes in non-status quo alternatives would permit identification of attribute-specific status quo effects. While this would decrease the statistical efficiency of the design, in future applications this should be considered.

Figure 5-10. Weighted Average TWTP/TWTA for Changes in Conservation Programs  
- Status Quo Effect Included



the without-SQE values depicted in Figure 5-9, and adjustment in the total value of the joint change to account for the SQE. An alternative would be to apply some allocation rule to divide the SQ constant across the four programs. Lacking any particular basis for such an allocation rule, the curves are presented with and without the SQE. Again, discussion of these implications are addressed in the next chapter. As a last point of clarification, note that the TWTP/TWTA curves are truncated below the 100% attribute level to avoid extrapolating far beyond the limits of the design. Maximum levels specified in the experimental design are 90% for salmon habitat, 75% for endangered species habitat, 50% for older forests and 40% for biodiversity reserves. Owing to the quadratic

shape of the TWTP curves, extrapolations far beyond the design points result in highly negative WTP values that are not reliable. The curves are truncated 10 percentage units above the maximum design level for each of the programs.

As indicated in Figure 5-9, exclusive of the status quo effect, all programs exhibit positive estimated TWTP values for increases above baseline, which becomes negative with large increases above baseline. Estimated TWTP for old growth forest has the highest maximum value, peaking at \$384 per year for an increase to 37% of forests in the > 150 year age class. TWTP for the historical level of 50% of old growth falls from the peak WTP, to \$322 per year per household and becomes negative at levels above 70%. Estimated TWTP for endangered species protection peaks at \$250/year at 47% of habitat covered, falling to zero WTP at 79% habitat coverage. Maximum TWTP for salmon habitat protection is estimated at \$144/year/household at 57% habitat coverage and remains above zero up to nearly full coverage of all salmon habitat in the Coast Range. Biodiversity reserves are associated with the lowest TWTP, peaking at \$46/year/household at 22%, approximately twice the baseline level of 10% of Coast Range land in large-scale protected reserve status. All four programs are associated with negative TWTP for decreases below baseline, i.e. respondents indicate that compensation would be demanded for decreases in current levels of biodiversity protection. The shapes of the estimated curves suggest that endangered species habitat protection is associated with a higher aversion to decreases, with twice the level of compensation demanded relative to the other three programs. With the SQE included, only the old growth forest and endangered species programs exhibit positive surplus values. Maximum TWTP for these programs are \$231/year at 37% old growth forest and \$97/year to increase endangered species habitat protection to 47% of the Coast Range landscape. While both the salmon habitat and biodiversity reserve programs are associated with positive marginal WTP up to 56% and 21% of the Coast Range landscape, respectively, the TWTP does not outweigh the full value of the status quo effect for either of these programs. As this simply



represents a uniform upward shift in the curves by a constant of \$153, the qualitative change in the results is trivial in a sense, but it again highlights the importance of the status quo effect in the interpretation of the analytical results.

### 5.2.2 Dichotomous Choice/Contingent Valuation

The experimental design of the DC/CVM is derived as a subset of the CEA design with three experimental factors. The conservation programs are merged into a single experimental factor with four levels represented by the four conservation programs. A policy change factor is specified with two levels of increase above the baseline for each of the conservation programs (levels specified were the two above-baseline levels specified in the CEA design), and the eight-level cost factor. This comprised a 4x2x8 full factorial design. Each respondent received one treatment which elicited WTP for a specified increase in one of the four programs. The response rates by treatment, pooled over the bid level factor, are listed in Table 5-11 for the three regions. An informal inspection of the response rates does not indicate any clear pattern of invalid or "don't know" (DK) responses by treatment. Two modelling techniques were employed in the analysis of the DC/CVM data produced in the survey: a standard binomial logit model and a nonparametric method based on the empirical distribution of positive response rates plotted against bid level. In both models, the DK responses were censored from the data set.<sup>1</sup> The latter method was employed in the attempt to address the small sample properties of the data and to further investigate the decision process employed by respondents.

---

1. In addition, an ordered logit model was estimated, treating the DK responses as intermediate between 'yes' and 'no' responses (Wang 1997; Cameron, Poe et al. 1999; Svento 1999). While the results were interesting with regard to incorporation of preference uncertainty, the results of the ordered model did not differ significantly in the WTP calculations and are not reported here.

Though the pooled data set contained a total of 765 valid observations with yes or no responses (with 244 DK responses and 225 otherwise invalid responses), estimation of both the effect of regional preference differences for different conservation programs and the sensitivity of responses to scope, through either stratified models or covariates in a pooled model, drew on very small subsamples (Table 5-11).

Table 5-11. Item Response Rates by Survey Treatment

Region	Program	Increase level	Observations	Valid	% Valid	DK	%DK	Used Obs	
Coast Range	reserves	20%	51	38	75%	10	26%	28	
		40%	63	53	84%	9	17%	44	
	old growth	33%	58	46	79%	8	17%	38	
		50%	52	43	83%	12	28%	31	
	salmon	40%	62	49	79%	6	12%	43	
		90%	56	44	79%	10	23%	34	
	end. Species	20%	68	49	72%	13	27%	36	
		40%	48	39	81%	9	23%	30	
	Willamette Valley	reserves	20%	47	38	81%	14	37%	24
			40%	57	48	84%	15	31%	33
old growth		33%	41	35	85%	5	14%	30	
		50%	47	42	89%	14	33%	28	
salmon		40%	37	29	78%	8	28%	21	
		90%	47	38	81%	9	24%	29	
end. Species		20%	36	31	86%	3	10%	28	
		40%	53	40	75%	14	35%	26	
E. Oregon		reserves	20%	51	42	82%	9	21%	33
			40%	56	43	77%	10	23%	33
	old growth	33%	48	39	81%	11	28%	28	
		50%	49	44	90%	10	23%	34	
	salmon	40%	62	59	95%	14	24%	45	
		90%	53	45	85%	10	22%	35	
	end. Species	20%	46	37	80%	8	22%	29	
		40%	46	38	83%	13	34%	25	
	Total			1234	1009	81%	244	24%	765

### 5.2.2.1 Model Specification and Selection

The general form of the logit model employed in the analysis of the data catalogued in Table 5-11 is defined as:

$$\text{logit}(P_i) = \ln \frac{P_i}{1 - P_i} = c + \alpha \text{BID}_i + \beta' X_i + \gamma' R_i \quad (5-6)$$

where  $i$  denotes the individual respondent,  $P$  is the probability of a 'yes' response;  $c$  is a model intercept term;  $\text{BID}$  is the bid level and  $\alpha$  is the associated parameter;  $X$  is a vector of variables associated with the conservation programs with coefficient vector  $\beta$  and  $R$  is a vector of demographic variables with coefficients  $\gamma$ .

The logit model results are presented in Table 5-12. Data were pooled across program and regional strata in order to preserve degrees of freedom given the small sample properties noted above, and the effect of program and region was represented by intercept terms. As in the CEA, the percentage of old growth forest in the age class distribution is used in the model as proxy for the full distribution described in the scenario. Several alternative model specifications were tested, with the inclusion of additional demographic variables for income, age, and length of residence in region (CR, WV, or EO). These additional terms were not found statistically significant and were dropped from the final model. Several linear models with interaction terms between the program intercepts, the strata intercepts, and the demographic variables were tested and not found significantly different at  $p=0.90$  from the final model using the likelihood ratio test. Thus, the data do not provide any evidence that the program constants differ by region or that the effect of respondent characteristics interact differently with the respective program attributes across the regional strata, or that stratified models would be justified. A loglinear specification of the utility model was estimated as well, with the natural log of the bid replacing the linear effect of the bid in the original linear specification, but did not perform as well as the linear model. The restriction of nonnegative WTP imposed by the loglinear model is also inconsistent with the structure of preferences indicated by the CEA models.

Table 5-12. Dichotomous Choice Contingent Valuation Model Results

Parameter	Model term	Variable Description	Parameter values <sup>a</sup>
C	INTERCPT	Model intercept	0.1291
$\beta_B$	B	0/1 dummy set to 1 if biodiversity reserve program specified in CVM question	-0.7034**
$\beta_E$	E	0/1 dummy set to 1 if endangered species program specified in CVM question	-0.7318**
$\beta_S$	S	0/1 dummy set to 1 if salmon habitat program specified in CVM question	-0.7549**
	F	0/1 dummy set to 1 if forest age program specified in CVM question; used as reference level for the program dummies - no parameter estimated	
$\beta_L$	LEVEL	0/1 dummy set to 1 for higher level increase	-0.0582
$\alpha$	CVBID	quantitative variable for bid level	-0.00228**
$\gamma_{s1}$	STRATA1	0/1 dummy set to 1 if resident of Coast Range	-0.7196**
	STRATA2	0/1 dummy set to 1 if resident of Willamette Valley; used as reference level for the region dummies - no parameter estimated	
$\gamma_{s3}$	STRATA3	0/1 dummy set to 1 if resident of Eastern Oregon	-0.7449**
$\tau_{LOR}$	RESLOR	quantitative variable for length of residence in Oregon	-0.021**
$\tau_{FP}$	FPCODE	0/1 dummy for employment in forest products industry	-1.1358**
$\tau_{ENV}$	ENVIRO	0/1 for membership in environmental organization	1.2365**
$\tau_{POL}$	POLAFF	1-5 Likert scale rating for political orientation, 1=liberal, 5=conservative	-0.4588**
$\tau_{ED}$	EDUC	quantitative variable for years of education	0.1038**
Obs			879
Log Likelihood			-438.9405
$\chi^2$			218.523
Adj. Pseudo R <sup>2</sup>			0.210253702
Correct Predictions			77.80%

a. \* denotes parameters significance at the 95% level and \*\* denotes the 99% significance level.

Generally, the linear model fits the data quite well, with a pseudo-R<sup>2</sup> value comparable to the CEA models. Nearly all parameters are significant at the p=0.05 level. The important exception is the term for level of program increase, suggesting that respon-

dents may be unresponsive to the degree of quantitative change of the program<sup>1</sup>. The negative sign on the level term indicates that the higher level of conservation program implementation elicits lower TWTP values, consistent with the results of the CEA models<sup>2</sup>. The negative sign on the three program dummies indicate that respondents are less likely to select the 'yes' response for these programs relative to the forest program. As expected, the parameter on the bid level is negative and significant. The negative value of the strata1 and strata3 terms indicate that respondents in the Willamette Valley are more likely to give a positive response than the other two regions. Both environmental group membership and education contribute positively to likelihood of choosing the yes response, while length of residence, political conservatism and an occupation in the forest products sector all contribute negatively.

Calculation of willingness to pay for increases in the conservation programs is done in the following manner:

For the linear model specification, WTP/WTA is:

$$WTP|WTA_{i,j} = CS|ES = -\frac{1}{\alpha} \left[ C + \beta_i + \gamma_j + \sum_k \tau_k R_k \right] \quad (5-7)$$

where  $i = 1 \dots 3$  denotes conservation program, (old growth program = reference level);

$j = 1 \dots 3$  denotes region, (STRATA2 = reference level)

$k = 1 \dots 5$  denotes demographic covariates

(Hanemann 1984; Hanemann 1989).

---

1. While this insensitivity to the scope of the program change provides some evidence of the embedding effect for which the CVM is frequently criticized, the results of the choice experiment analysis provide an alternative interpretation. Given that the TWTP curves estimated in the CEA exhibit regions of falling TWTP above the threshold levels, individuals may be indifferent to high and low levels of increase, though they may exhibit increasing TWTP up to the threshold. Since the levels specified in the DC/CVM design span the threshold values, it is conceivable that the insensitivity to scope measured in the DC/CVM analysis is due to the underlying bell shape of the TWTP function. The two level design of the CVM experiment is thus inadequate to identify this quadratic effect, which is strongly indicated in the CEA.

2. Inspection of Figure 5-9 reveals that a line intersecting the two above-baseline design points for each of the four programs would be negatively sloped.

Table 5-13 presents average WTP values for each of the three strata, based on the respective sample means and medians. Given the characteristic sensitivity of the mean measure of central tendency to the tails of a distribution, comparison of mean and median estimates gives an indication of how well-defined the tails of the estimated distribution are. WTP is not significantly different between the upper and lower level of the programs specified, given the insignificance of the level term, so a single point measure is identified in the table, derived from the model estimated without the level term. In addition, a population mean adjusted value is identified, consistent with the adjustment applied to the CEA results for the difference between sample and population mean values of significant demographic covariates. Finally, an adjusted TWTP value for each of the programs, by weighted average over regional strata, is identified.

Table 5-13. WTP/WTA Estimates from Bivariate Logit Model (\$/year)

	Reserve Program		Endangered Species Program		Forest Age Program		Salmon Habitat Program	
	median	mean	median	mean	median	mean	median	mean
<b>Coast Range</b>								
1a. Linear model - No Level	-279	-258	-302	-281	-4	17	-284	-263
Adjusted for population means		-228		-241		80		-251
<b>Willamette Valley</b>								
2a. Linear model - No Level	121	133	98	110	396	408	117	129
Adjusted for population means		146		134		454		124
<b>E. Oregon</b>								
3a. Linear model - No Level	-214	-202	-237	-225	61	73	-218	-206
Adjusted for population means		-211		-223		97		-233
<b>Weighted average of adjusted means</b>		51		38		359		28

The results of the model indicate that CR respondents would require substantial compensation (ES) to offset the utility loss associated with increases in any of the conservation programs except for the forest age program. The biodiversity reserve, endangered species and salmon habitat programs are all characterized by negative WTP estimates of nearly equal magnitude. The median values are all more strongly negative, though the sample means and median values are close in magnitude, indicating a well-defined upper tail. The adjustment for population demographic values shifts the estimates in the positive direction, increasing mean WTP for expansion of old growth forest to \$80/year, though WTP for other programs remains strongly negative.

Sample mean results for the WV stratum indicate again that increasing forest age is the most strongly preferred conservation program, with an estimated sample mean WTP of \$408/year, increasing to \$458/year with adjustment. The other programs are all associated with positive WTP, estimated at \$110/year for the endangered species program and approximately \$130/year for both the reserve and salmon habitat programs. Median values are very similar to the means, again suggesting well-defined tails and adjustment for population demographics increases the estimates by proportions ranging from 4% to 20%.

Results for the EO strata indicate a pattern similar to the CR stratum. Estimated values are negative for increases in the biodiversity reserve, endangered species and salmon habitat programs, somewhat less in magnitude than revealed by CR respondents, and all within a -\$200 to -\$225/year range. Adjustments for population representation only slightly exceed this range. Positive WTP for increased forest age is somewhat higher than the CR estimate, though the disparity is decreased after adjustment. General observations of the above results suggest substantial heterogeneity in welfare effects between the WV and the CR and EO regional strata. However, while WTP estimates differed substantially, the preference rankings were very consistent, indicating a strong preference for increased forest age class diversity and old growth forests, and similar values for the

other programs. This conclusion is supported by hypothesis tests indicating statistical insignificance of region/program interaction terms in the regression model. While the results of the choice experiment suggest an explanation for the negative WTP values if one assumes that the status quo effect indicated therein is also expressed (though not identified statistically) in the DC/CVM results, concerns about the influence of functional form and specification bias in both the CEA and DC/CVM analysis suggest further investigation. Lacking an *a priori* basis for selecting an alternative functional form, the nonparametric methods discussed below offer some possibility of revealing WTP while avoiding some of the potential for specification bias inherent in the parametric approach.

#### 5.2.2.2 Non-parametric Analysis of DC/CVM Data

The contingent valuation literature has recently seen the development of a number of nonparametric and semiparametric techniques for analyzing dichotomous choice data (Kristrom 1990; Duffield and Patterson 1991; Creel and Loomis 1997; Haab 1997; Boman, Bostedt et al. 1999). The principle advantage of these techniques is the independence from non-theoretical distributional assumptions. While the techniques are mathematically rather simple, the utility theoretic foundation is well established and is consistent with the RUM framework. As in the RUM approach of specifying the probability of an individual respondent accepting a contingent offer at bid level  $A_i$  as  $P_i = H(A_i) = 1 - G_{cv}(A_i)$  where  $G_{cv}(\cdot)$  is a parametric specification of the TWTP (CS) distribution, the alternative method specifies  $H(A)$  nonparametrically using the proportion of yes responses as a function of the bid level (Hanemann and Kanninen 1999). Thus, the specification is based entirely on the empirical observations without relying on distributional assumptions. The only restriction is that  $H(A)$  must be monotonically nonincreasing, which is the discrete equivalent of the restriction that  $\frac{\partial H}{\partial A} \leq 0$  as specified in the random utility formulation.

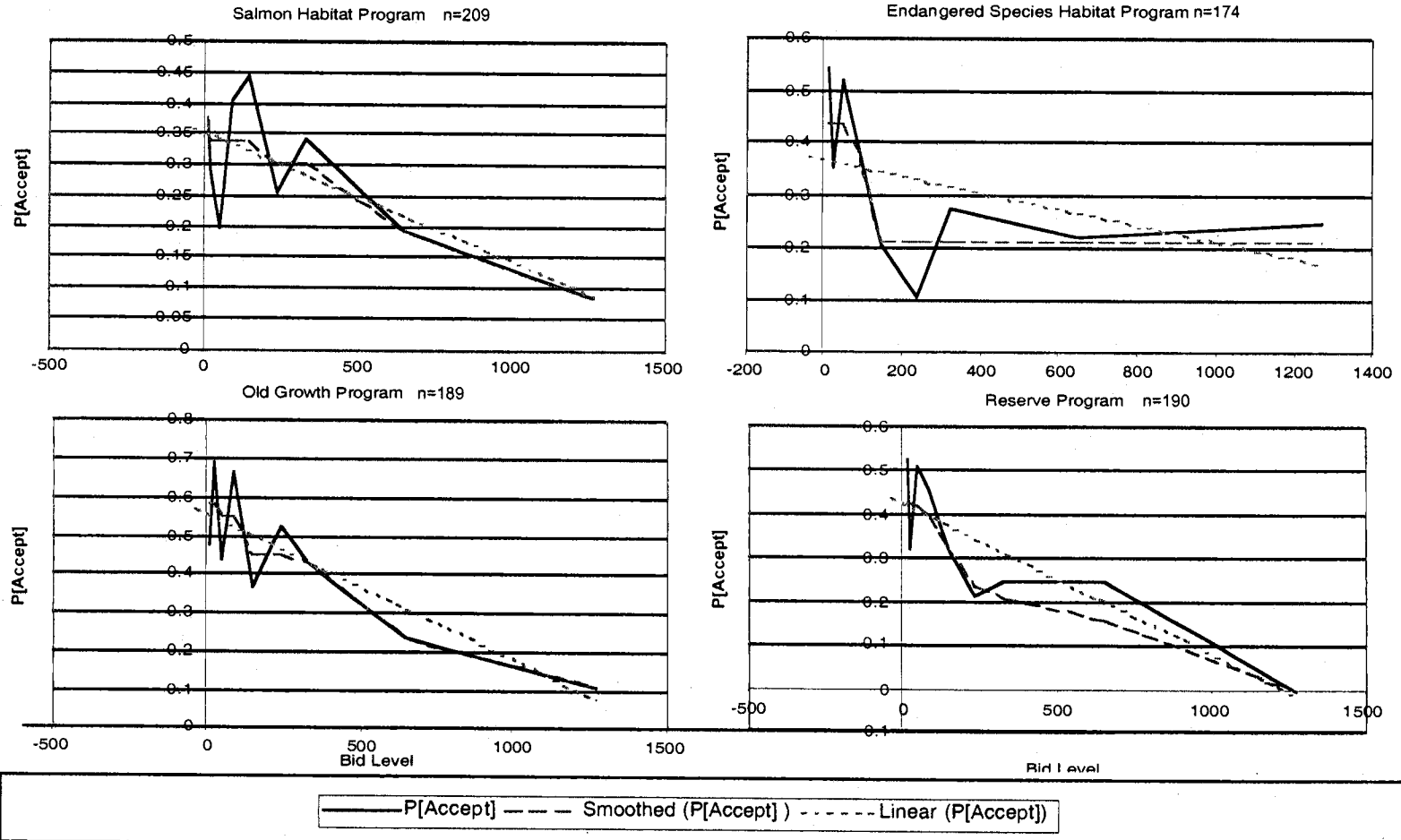


The sample proportions of  $P[\text{accept}(A_i)] = \pi_i$  are plotted in Figure 5-11 for each of the four programs, based on the sample pooled across strata. As is quite clear from the plots, the  $\pi_i$  functions violate the monotonicity restriction, which is a common result, particularly for small samples. Kristrom (1990) introduced an algorithm originally proposed by Ayer, Brunk et al. (1955) into the CVM literature which converts a nonmonotonic function into a monotonic one. The algorithm, known as the pooled-adjacent-violators rule (PAVA), specifies the replacement of  $\pi_i$  and  $\pi_{i+1}$ , where  $\pi_i < \pi_{i+1}$  with the mean of the two values such that

$$\hat{\pi}_i = \hat{\pi}_{i+1} = \frac{(k_i + k_{i+1})}{(n_i + n_{i+1})} \quad (5-8)$$

Equation 5-8 is solved iteratively until the sequence  $\pi_1 \dots \pi_m$  is smoothed into a non-increasing monotonic function. The resulting functions calculated for the survey data are labelled Smoothed( $P[\text{Accept}]$ ) in the figures. In addition, a linear regression line estimating  $\pi = \alpha + \beta A$  is also fitted for the purpose of comparison. Recalling that the median of the WTP distribution is the value of  $C$  that solves  $1 - G(C) = 0.5$ , the figures suggest the basis of the negative welfare estimates produced in the logit models - in all but the forest program, the linear estimated function takes the value  $p = 0.5$  in the negative quadrant. Similarly, without restricting WTP to be non-negative, the mean is calculated as the area below the curve to the right of the vertical axis, less the area above the curve in the negative quadrant, and clearly negative mean values would be estimated based on the linear estimates depicted below. On casual inspection it appears that, with the exception of the salmon habitat program, both the empirical and smoothed functions appear to have an approximate logistic shape, though they do not appear to be strictly positive and may pass into the negative quadrant in the lower (leftmost) tail of the distribution.

Figure 5-11. Empirical WTP Distributions



Boman, Bostedt et al. (1999) identify three welfare estimation techniques based on the smoothed empirical distribution which have been used in the literature which represent, respectively, an empirical maximum likelihood estimator of WTP ( $\mu_{ML}$ ), and estimated upper and lower WTP bounds ( $\mu_U, \mu_L$ ):

$$\mu_{ML} = \sum_{i=1}^{k-1} \frac{1}{2} (|A_{i+1}| - |A_i|) (\hat{\pi}_i + \hat{\pi}_{i+1}) \quad (5-9)$$

$$\mu_U = \sum_{i=1}^{k-1} (|A_{i+1}| - |A_i|) \hat{\pi}_i \quad (5-10)$$

$$\mu_L = \sum_{i=1}^{k-1} (|A_{i+1}| - |A_i|) \hat{\pi}_{i+1} \quad (5-11)$$

Since  $\pi_i$  is decreasing in  $i$ ,  $\mu_L$  produces a lower estimate than  $\mu_U$ . An intermediate value is produced by  $\mu_{ML}$ , which sums the area under the linear interpolation of points  $\pi_1 \dots \pi_{k-1}$ . Though terminology varies somewhat,  $\mu_L$  is commonly cited as the Kaplan-Meier-Turnbull estimator and  $\mu_{ML}$  is cited as the Spearman-Kärber estimator of mean WTP. Notice that both of these estimators truncate the tails of the WTP distribution at  $A_1$  and  $A_k$ . Results of these two estimators for the pooled data for each of the four conservation programs are presented in Table 5-14. A disadvantage of the empirical distribution generally is the difficulty in either incorporating covariates or extrapolating beyond the endpoints. A variety of semiparametric techniques have been suggested which break  $H(A)$  into components with known and unknown distributions (Horowitz 1994; Hanemann and Kanninen 1999). A simple semiparametric alternative is proposed in this analysis and implemented in an attempt to identify differences in the WTP between the regional strata. This combines a parametric specification of strata-specific intercepts (analogous to the strata specific constants in the logistic regression model described above) with the nonparametric specification of choice probability as a function of the bid level.

For each conservation program, separate linear OLS models were estimated for the function  $\pi = \alpha + \beta A$  on each sample strata. The three resulting intercept terms from these regressions for each of the conservation programs are used to adjust the Turnbull and Spearman-Kärber estimates from the pooled data set in the following manner:<sup>1</sup>

$$\mu_{sML} = \sum_{i=1}^{k-1} \frac{1}{2} (|A_{i+1}| - |A_i|) (\hat{\pi}_i + \hat{\pi}_{i+1} - 2(\alpha_s - \pi_1)) \quad (5-12)$$

$$\mu_{sL} = \sum_{i=1}^{k-1} (|A_{i+1}| - |A_i|) (\hat{\pi}_{i+1} - (\alpha_s - \pi_1)) \quad (5-13)$$

While the Turnbull estimator is regarded as a lower-bound estimator of WTP (Boman, Bostedt et al. 1999), this specification maintains the restriction that  $P(A_0)=1$ , i.e. that WTP is nonnegative. Haab (1997) maintain that this assumption is appropriate in the context of most public goods, since an unwanted public good can simply be ignored, and attribute the frequent occurrence of negative welfare estimates in CVM analyses as artifacts of statistical fit and functional form. Thus, the authors argue, it is theoretically justified in most cases to impose the restriction of nonnegative WTP. As noted above, however, there are reasons to remain more agnostic regarding nonnegativity of preferences in the current context, and the interpretation of the Turnbull estimates depicted below as lower bounds only holds insofar as this assumption is maintained. Further consideration of this assumption in light of the CEA results will be taken up in the next section.

---

1. This method is employed in an exploratory manner to investigate the structure of preferences expressed in the data, and the influence of regional preference differences. While this appears to be a simple and intuitive means of incorporating the effect of one covariate into the nonparametric method, and is consistent with the general approach of semiparametric methods discussed by Hanemann and Kaninen (1999), it is not formally supported. Thus, use of the stratified results in Table 5-14 for any purposes other than qualitative comparison is strongly cautioned against.

Table 5-14. Results of nonparametric and semiparametric analysis of DC/CVM data

	Reserve Program	Endangered Species Habitat Program	Old Growth Program	Salmon Habitat Program
<b>Pooled</b>				
WTP <sub>LB</sub>	213	375	273	294
WTP <sub>ML</sub>	147	307	222	293
<b>Coast Range</b>				
WTP <sub>LB</sub>	218	177	131	138
WTP <sub>ML</sub>	152	120	88	132
<b>Willamette Valley</b>				
WTP <sub>LB</sub>	252	578	415	436
WTP <sub>ML</sub>	186	503	361	429
<b>E. Oregon</b>				
WTP <sub>LB</sub>	180	494	322	179
WTP <sub>ML</sub>	125	419	268	173

The results of the nonparametric analysis suggest distinctly different preference rankings of the four programs than those drawn from the logit analysis. Unlike the logit analysis, preference rankings are not found to be consistent across regions. Most notably, for CR respondents, the biodiversity reserve and endangered species programs are ranked first and second, respectively, and WTP is substantially higher than the old growth or salmon habitat programs. This result is contrary to findings of the CEA as well as to the attitudinal statements depicted in Figures 5-2 and 5-3. If one regards the CEA results as more robust, this suggests that truncation of the negative portion of the WTP distribution significantly distorts the estimation of preferences for Coast Range residents, both in terms of magnitude of welfare estimates and the relative preference orderings. Results for WV and EO respondents are generally more consistent qualitatively with the choice experiment results, with both ranking endangered species protection first and biodiversity reserves last.

While the visualization of the empirical WTP functions is useful for developing insight on the nature of the negative WTP estimates resulting from the logit analysis, it is unclear whether WTP estimates based on this analysis are more accurate than those from the logit results. While the latter are certainly more conservative with respect to the status quo, they may overstate the magnitude of negative WTP to some degree. Inspection of Figure 5-11 suggests that the left tail of the empirical distributions for the endangered species, forest age and reserve programs are likely to be quite small. That is, it appears that the empirical distributions conform roughly to a logistic shape, though it is likely that they intercept the vertical axis. An informal visual extrapolation of the smoothed empirical curves into the negative quadrant suggests that the tail might be small relative to the negative tail indicated by the linear regression line. While this observation is purely speculative, it does suggest that the linear specification in the logit analysis may overstate the size of the left (negative) tail, leading to larger negative WTP estimates and smaller positive estimates.

## Chapter 6: Discussion

The objectives of this study encompass both empirical and methodological issues in the investigation of public preferences for passive use resources in the context of landscape-level planning and resource management. With competing, and to some extent, mutually exclusive demands for resource use and allocation in the Oregon Coast Range, there is a clear need to investigate the preferences Oregonians hold regarding priorities for conservation, as well as commercial use, of resources. This research attempts to empirically map the structure of Oregonians preferences for four distinct approaches to conserving biological diversity currently in effect on this landscape. The demands of this empirical objective suggested the need for a multiattribute approach to non-market valuation, which offers the opportunity to investigate the properties and effectiveness of a variant of the conjoint approach to preference analysis (Carson, Louviere et al. 1994; Louviere 1988). With a common utility theoretic and statistical foundation, both the choice experiment variant of conjoint analysis and the dichotomous choice CVM approach produce comparable welfare analyses. A further objective of this study is to investigate the advantages of CE relative to the more commonly used CVM. This discussion interprets the results of the analysis in light of these objectives.

### 6.1 Methodological Implications of Study Results

#### 6.1.1 Status Quo Effect: Interpretations

A central issue in the interpretation and application of the study results involves understanding the nature of the status quo effect identified in the CEA model. As indicated in Figures 5-7 and 5-8, the inclusion of the SQE influences estimation of total WTP by shifting the respective curves downward by a large lump sum. The puzzling implication is that any change in the current state of forest management and biodiversity

conservation induces a discontinuous drop in the welfare of Oregonians due to the loss of the status quo itself, though this loss is offset to some degree by further incremental increases in conservation measures which are regarded as beneficial, ultimately producing positive welfare effects. This interpretation of the statistical result probably reflects respondents' preferences to some degree, but likely also reflects survey instrument and cognitive effects as well. Thus, what exactly the SQE measures and whether it is included in calculating the welfare effect of changes in Coast Range conservation policy bear further consideration.

A review of the literature reveals a number of papers which indicate that a status quo preference arises, at least in part, from a pervasive cognitive bias. Kahneman and Tversky (1984) termed this *loss aversion* and it is widely known in the valuation literature as the *endowment effect*. This effect is apparently inherent in choice behavior (Kahneman, Knetsch et al. 1991; Samuelson and Zeckhauser 1988) and in essence causes individuals to overweight losses relative to gains in decision making. Even in the case of apparent gains, the uncertainty associated with change can be perceived as a loss. Interestingly, this cognitive effect is also cited as a causal factor in the disparity between WTA and WTP welfare measures for equivalent goods (Brown and Gregory 1999). Several recent or pending publications identify the status quo effect in the context of non-market valuation survey research. Beenstock, Goldin et al. (1998) and Hartman, Doane et al. (1991) both identified a status quo effect in simulated markets for improved reliability in electrical service. This effect was expressed as *negative* value estimates for small *improvements* in electrical service, i.e. respondents required compensation for improvements in reliability resulting in reduction in power outages of four hours annually. As service improvements increased, the investigators found that increasing utility eventually outweighs the status quo effect, resulting in positive net WTP for greater levels of improvement. Both authors interpret this effect as a nuisance parameter inconsistent with rationality, though both are ambiguous about how to treat its effect on WTP estimates. The broader implication is that *any* disturbance of the status quo in itself is perceived as



a "bad" because it increases uncertainty, though with sufficient gains from the change, the negative effect of uncertainty is outweighed by positive benefits. The perceived certainty of the status quo can thus be seen as an endowment in itself.

Adamowicz, Boxall et al. (1998) employed a choice experiment in a valuation context quite similar to the one reported herein, with the inclusion of a status quo alternative in the experimental design and an alternative specific constant in their econometric model to capture the *ceteris paribus* inclination of respondents to choose the status quo alternative. As in this analysis, the authors identify a negative status quo effect, indicating a disutility for taking any action to increase attribute levels, though parameters on the environmental attributes themselves were positive and resulted in positive WTP estimates. While recognizing that the SQE is consistent with an endowment effect where respondents perceive change in itself as a loss, the authors speculate that it could also indicate doubts on the part of respondents that programs would be implemented effectively. It could also be the default choice of respondents who were uncertain about preferences between the other two alternatives. Carson, Louviere et al. (1994) note that the principle liability of specifying a status quo alternative is that it provides an "easy out" for the respondent when the choice task is complex, but that it is necessary to provide a reference level for welfare calculations. The authors find that a quadratic model with a status quo ASC provides the best statistical fit, and interpret WTP adjusted downward by the amount of the SQE to be the most accurate estimate of TWTP.

Mazzotta et al. (2000), using similar experimental and statistical methods in a study of amenity values of the Peconic Bay estuary, identified a *negative* value for maintaining the status quo, i.e. there was a *ceteris paribus* preference for taking some conservation action to alter the status quo. The author attributes this "yea-saying bias" to the value of conservation that is symbolic and not sensitive to the level of conservation program attributes. If this interpretation is correct, this would appear to be the embedding effect that Kahneman and Knetsch (1992) attribute to "the purchase of moral satisfaction" and

is one of the chief points of criticism of passive-use value estimation and stated preference methods in general (Diamond and Hausman 1994). In contrast to Adamowicz, et al., however, the baseline scenario in Mazzotta et al. was described in terms of expected conditions 20 years hence under current trends. This was contrasted with alternative scenarios that mitigated the current trends and maintained environmental conditions closer to those of the present day status quo. Thus, rather than being a symbolic preference for environmental protection, the effect measured in their research is entirely consistent with the status quo preference revealed in both Adamowicz and this thesis, which the former interpret as an endowment effect. In calculating aggregate WTP estimates, Mazzotta et al. used only the part-worth values of the attributes of the conservation programs and did not include the status quo value attributed to symbolic bias, thus reducing the magnitude of the WTP estimates<sup>1</sup>.

In the context of the research reported herein, there are a number of possible explanations for the status quo effect, and it is likely that multiple factors are in effect. Given the apparent ubiquity of the endowment effect, it is likely to account to some degree for the magnitude of the SQE. However, there are most likely other factors in effect. The choice task with which respondents are confronted is fairly complex, and it is likely that some respondents choose the SQ as a proxy for a "don't know" response.<sup>2</sup> Like the

---

1. It is interesting to note that, while both Mazzotta et al. and Adamowicz et al. reflect careful and insightful analyses, they make what appear to be contradictory assumptions regarding interpretation of the SQE in order to produce conservative estimates of WTP. This may be indicative of a tendency throughout the literature to produce conservative estimates of WTP as recommended by the NOAA Panel (Arrow, Solow et al. 1993). While a conservative bias in WTP estimates may be advisable in a damage assessment context, the aggregate effect of such a bias in policy analysis may ultimately lead to under provision of public good amenities, particularly if cost benefit ratios are heavily weighted in decision criteria (Knetsch 1990).

On a related note, the endowment effect is frequently cited as a reason for using a WTP elicitation when, in many cases, a WTA measure is more consistent with the property rights allocation in a given valuation setting. Given the NOAA Panel's dictum to use conservative estimates, the WTP measure is frequently used when the WTA measure is more appropriate. Although inclusion of the status quo effect in the calculation of welfare estimates may produce more conservative estimates, it would be logically inconsistent to do so when using WTP in place of WTA when the latter is the theoretically appropriate measure as this would, in effect, double count the endowment effect.

endowment effect, this introduces a downward influence on the TWTP estimate if it is included in the calculation, at least relative to what we would expect in the context of well-behaved utility functions. Notwithstanding the reinterpretation of the results in Mazzotta et al. above, to the extent that there is a "warm glow effect" to choosing a non-status quo alternative, it will also be captured in this term, pushing its value upward. Thus, the tendency to choose the status quo (in the face of uncertainty or undefined preferences) and the yea-saying effect influence the value of this parameter in opposite directions. Ideally both factors would be excluded from welfare estimation as they are both response biases which hold no information on preferences, though neither can be identified independent of other factors influencing the status quo term.

It should be noted that the approach to treating "protest no's" in this analysis differs from the more customary approach: 76 respondents indicated that they chose the status quo due to distrust of the government, opposition to property rights interference, opposition to taxes in general, or other forms of protest relating to the policy mechanism or bid vehicle. While it is customary to censor protest responses such as these, they are retained in this data set with the recognition that their effect on estimation of mean WTP estimates will be captured in the SQE. Protest responses are typically censored because they are not interpreted as revealing anything about preference for the good being valued, but rather for the policy mechanism or payment vehicle specified in the survey instrument. In the context of this study, however, the goods being valued are inseparable from policy mechanisms, and therefore "protest" responses do reveal something about preferences. In any case, these responses are particularly relevant to consideration of the choice scenarios as hypothetical public referenda. The SQE is largest in the Coast Range strata, which suggests that it may reflect respondents' reticence to undergo further dislocation due to additional regulatory changes in resource management insti-

---

2. One area for further investigation would be the inclusion of a DK response in addition to the SQ alternative, in order to isolate the effects of uncertainty. While this may help to better isolate the SQE, it carries the liability of further reducing the incentive for respondents to think carefully through the choice task. An alternative may be to include a strength of preference follow up question.

tutions (Keith, Fawson et al. 1996). Though it is not possible to isolate this component of the SQE from the bias effects discussed above, it has the most interesting implications in terms of application of welfare estimates to public decision making. From the perspective of policy makers, should reticence on the part of the public to advocate government action influence welfare estimation? In a sense, the SQE could be viewed as a sunk cost which should not influence decision making, provided some initial public choice decision has been made to take action. That is, once a sunk cost is sunk, it no longer contributes to efficiency analysis. Thus, it must be decided where society is on the decision making continuum - before or after the point where regulation is unavoidable and the cost is sunk. While this could easily become either a semantic or philosophical debate, and neither would be appropriate in the current context, the point is worth further consideration. The question posed, then, is whether it is possible to remain at the status quo point, i.e. can government legally or feasibly refrain from taking further regulatory action in a dynamic environment? If not, then the aversion that the public has to any government action, regardless of the merits of the action itself, should not influence welfare estimation, though it undoubtedly influences decision making more broadly. While the answer is ambiguous and beyond the scope of this research, the significant effect of the SQE on welfare estimation implies that the question is an important one.<sup>1</sup>

Clearly, an advantage of the choice experiment approach is its capacity to more fully model the respondents' choice behavior. It is notable that the status quo effect is implicit in DC/CVM approach, but that it cannot be isolated in the dichotomous choice scenario. Thus, DC/CVM estimates are unavoidably influenced, though there is no way to discern the direction, much less the magnitude, of this distortion<sup>2</sup>. This should provide

---

1. (Diamond 1996) also makes the point that there are difficulties in the BCA context of including preferences over (government) action by the following example: "Assume that people have a utility gained from seeing a development proposal blocked. Then a government with no interest in developing wilderness could raise welfare by proposing such welfare and then not doing it." (Diamond 1996, p. 345). As measured by the SQE, social welfare could be improved by proposing a conservation policy and then not implementing it. While Diamond's point is arguable, it does point out the awkwardness of the status quo effect in the context of orthodox welfare economics.

strong incentive to further develop the choice experiment method and suggests that it is a more powerful tool for measuring public preferences for non-market goods.

### 6.1.2 Interpreting the magnitude of welfare estimates

An examination of the TWTP functions in Chapter 5 reveals that, under the maximum benefits scenario (where TWTP is evaluated at the peak of the respective curves), mean TWTP of Willamette Valley residents for the optimal<sup>1</sup> level of all four programs is in excess of \$800/year. Excluding the status quo value would increase this by an additional \$140/year. With a median household income in the Willamette Valley of less than \$50,000/year, this represents approximately 1.6% of annual income. Estimated TWTP for increased old growth forest alone reaches as high as 380, 0.76% of annual household income. Estimates of maximal joint TWTP for both the Coast Range and E. Oregon strata are both approximately \$275/year. Statistical tests indicate a high degree of validity and reliability, and comparison with the DC/CVM results indicates that the CEA produced relatively conservative estimates of WTP, particularly in the Willamette Valley stratum which predominates in the statewide weighted average. The reader is cautioned that summing across the TWTP estimates for all four programs is problematic in that this could produce TWTP estimates for policy scenarios that are patently infeasible. While a definitive validity test is not available, some insights gained both from the analysis as well as from comparable studies shed some perspective on the empirical results.

---

2. Ready, Whitehead et al. (1995) for example used a polychotomous choice format which allowed respondents to express ambivalence to the yes/no alternatives. Comparison to a parallel DC/CVM elicitation demonstrated that respondents in the DC/CVM format who are ambivalent tend to vote no. WTP estimates were as much as an order of magnitude smaller for the DC/CVM results.

1. Optimal only in the sense of maximal WTP, not maximal net private or social value.

Estimated WTP for biodiversity protection amounting to as much as 0.76% of annual gross income represents a nonnegligible reallocation of household resources. Given the general aversion of Oregonians to income and property tax increases, and numerous competing demands for public funding and private spending, any estimate of this magnitude should be considered carefully. It should also be noted, however, that the values being estimated in this survey are not exclusively existence values, but most likely encompass an array of amenity values. Given that the scenarios specified in the choice experiment described different degrees of reallocation of Coast Range land to alternative uses which benefit biodiversity, respondents may have perceived other amenity benefits to the reallocation apart from the passive-use values associated with increasing species and ecosystem diversity.

In a telephone survey of Oregon residents, the Oregon Forest Resources Institute (OFRI, 1999) found that a majority of Oregonians place the highest value of the state's forest resources on wildlife protection and ecosystem services (principally protection of water resources). While 84% of respondents stated that private property rights and financial returns to forest owners were important, these values were generally attenuated by the public goods values of forests. Forty-eight percent of respondents rated "tax and other [voluntary] incentives" as the best means of promoting environmental protection. Haynes and Horne (1997) estimated that 89% of economic benefits produced on federal land in the Columbia basin in 1995 were environmental amenity values. In a study similar to that reported herein, Xu (1997) estimated an average household annual WTP of \$1417 to increase the forest age class distribution in western Washington from 25% to 45% mature and overmature stages (i.e., greater than 50 years) and extend biodiversity protection to a similar degree.

While these and other studies suggest that WTP for biological conservation is substantial, there are significant concerns about the potential for overestimating mean values. There is some evidence that the estimates suffer to some extent from

misspecification bias, which is problematic in most dichotomous choice valuation studies (Creel and Loomis 1997; Haab 1997). The magnitude of the estimates would likely be reduced with the use of a more flexible functional form, possibly with the inclusion of cubic terms for the program attributes. Unfortunately, any changes in form to improve fit would require additional model terms and the current model specification exhausts the degrees of freedom in the experimental design.

Of particular concern is the inability to model the disparity between WTP for increases in program attributes and WTA for decreases below the baseline. There is ample evidence in the literature that there is a strong discontinuity between WTP and WTA (Knetsch 1990; Hanemann 1991; Beenstock, Goldin et al. 1998). Hanemann argues that this disparity can be explained in utility theoretic terms and arises when there are no close substitutes for the public good in question. Other arguments suggest that the disparity arises from cognitive biases and is inconsistent with utility theory. In either case, empirical results in the literature indicate that there may be a kink in the actual compensated demand curves at the status quo point<sup>1</sup>, with the curve being much steeper for decreases below the baseline. The failure to incorporate this discontinuity, if it indeed exists in the data, would have the effect of biasing above-baseline estimates upward and below-baseline estimates downward. It should be noted that an advantage of the choice experiment approach is that it is possible to specify a design that will estimate both WTP and WTA values by including levels of the attributes below the WTP/WTA reference point, while suppressing the tendency of WTA questions to elicit protest responses. Researchers should be cautious if using a design of this type, however, to have sufficient statistical flexibility to model the discontinuity in the compensated demand curve. The first priority for extending this research is to improve the accuracy of welfare estimates

---

1. A model was tested which included a dummy variable for decreases below baseline for each of the conservation programs. While the parameters on these terms were highly significant and negative, suggesting a discontinuity in demand at the baseline and proportionately higher WTA for decreases, there were insufficient degrees of freedom to estimate more than one of these terms in the model, and none could be estimated simultaneously with the status quo term.

through the use of more flexible functional forms. A promising direction is the potential for bootstrapping the experimental design to simulate responses to additional experimental treatments, thus gaining additional degrees of freedom. It is unclear at this point if this will ultimately be successful, however, and the required statistical research is beyond the scope of this thesis. If successful, however, this could provide a useful tool for controlling the need for large designs and simplifying the complex survey design and administration process attendant with CEA.

### 6.1.3 Comparison of CEA and DC/CVM Results

In addition to the empirical objectives of estimating WTP/WTA for changes in the implementation of biological conservation, a methodological objective of this research is to compare the results of the choice experiment and DC/CVM methods to determine if the CEA produces results that are systematically different. The null hypothesis is that the CEA will produce more conservative (lower) estimates of compensating or equivalent surplus for each program. The reason this might be expected is that the CEA has been suggested as an improved method for passive use valuation in that it avoids the embedding problem associated with contingent valuation. While the method certainly offers advantages in terms of efficiency and flexibility, the accuracy of measurement of true welfare effects of environmental change is the most essential criteria. While DC/CVM is not without critics who dispute the validity of the method and of hypothetical methods generally, comparison of CEA can shed some light on whether some improvement in accuracy is achieved with the alternative method.

Cameron, Poe et al. (1999) argue that the literature on comparative analysis of non-market valuation techniques mistakenly focuses on mean measures of willingness to pay. Of greater importance, the authors argue, is the compatibility of underlying utility functions revealed in alternative applications. Thus, pairwise comparisons of WTP for similar goods estimated in separate studies are not particularly meaningful if the ad-hoc



assumptions regarding the form of the average respondent's utility function (e.g. functional form) are inconsistent. In a case study, the authors employ a set of survey instruments which are carefully designed to permit comparison of seven different preference elicitation techniques, including DC/CVM and CEA, finding very little statistical evidence that there is any distinction between preferences elicited with these two techniques.

While the need for a consistent basis of comparison is well taken, it is ambiguous to what extent this criteria applies to pairwise comparisons of empirical results which do not fully meet the standards of experimental control established by Cameron, Poe et al. (1999). In the context of the thesis research, such experimental controls are not available. The investigative objective is to identify the effect of including multiple attributes in the CEA, which function to some degree as substitutes, compared to the single attribute specification in CVM. It was necessary, therefore, to vary both the elicitation format and the description of the valuation scenario in comparing the CEA to the CVM. While it may be possible to construct a more rigorous experimental design for this comparison, which controls one or the other of these confounding factors, the other study objectives in this research imposed limitations on the experimental design for the comparative analysis. The comparisons which follow, therefore, are not fully generalizable to differences in the CVM and CEA framework.

While Cameron, Poe, et al. (1999) criticize comparisons based on different ad hoc statistical model formulations rather than identical utility specifications, there is some intuitive appeal to pairwise comparisons of results based on models which best fit their respective data sets. In order to address both of these comparative standards, Table 6-1 presents comparisons of the DC/CVM results with results of three different model formulations for the CEA data. The DC/CVM model is that reported previously in Table 5-12, which used a linear specification of the utility function with a number of demographic covariates. Given the key importance of both the quadratic and status quo

terms in the CEA, which are not estimable in the DC/CVM specification, the statistical model which best fits the CEA data is not applicable to the CVM data. For purposes of comparison, then, a pair of linear models with and without the status quo term are estimated using the CEA data.<sup>1</sup> The linear CEA model with no SQ term is equivalent to the model specification in the DC/CV. Also, recall that the scope of increase in the four programs was not found to be significant in the DC/CV. Thus, the estimates in Table 6-1 represent TWTP/TWTA evaluated at the midpoint between the upper and lower attribute levels specified in the CVM design for each of the respective conservation programs: 25%/50% for the endangered species program, 20%/40% for the reserves programs, 33%/50% for the forest age program and 40%/90% for the salmon habitat program. Given the concavity of the TWTP/TWTA curves estimated in the quadratic specification of the CEA model, the means of the estimated WTP values at the above-baseline levels for the respective programs, rather than the midpoints on the estimated curves, represent the valid measures from the quadratic CEA model results to compare.

Comparison of the linear-without-SQ CEA model (i.e. the linear model with no status quo term specified) to the DC/CVM results indicate that the CEA is nearly uniformly more conservative than the CVM, with the CVM estimates being lower in two of the twelve pairwise comparisons, though not to a large degree. The relative rankings resulting from these two models are almost identical, with only small rank reversals (for example, switching between rank 1 and 2, but not 1 and 3) occurring. In the E. Oregon results, there are larger rank reversals, but this is attributable to rather small differences in estimated WTP for three of the programs.

A comparison of the linear-with-SQ CEA model with the CVM is qualitatively similar: in four of the twelve pairwise comparisons, the DC/CVM WTP estimates are lower

---

1. Statistical results of the linear model with SQ term are presented in Table 5-3. The specification of the linear model without the SQ term is identical except for the dropped SQ term. Parameter estimates for the latter model are not presented in the thesis, though it is noted that the parameters will be biased downwards due to misspecification given the high degree of significance of the SQ term.

that those from the CEA, though the difference is relatively modest. In the remaining eight comparisons, the CEA results are substantially more conservative. Preference rankings models are identical within the Coast Range and E. Oregon strata, though a significantly different preference ranking results from the CEA in the Willamette Valley strata. The WTP disparity is smaller than that resulting from the linear-without-SQE model. Given that excluding the SQ term clearly generates a misspecification bias, it appears that controlling this bias increases the convergence of the CEA and CVM results. Results of the quadratic CEA increase in the positive direction for most programs across all three strata relative to the linear specifications. A notable exception is the forest age program, which is ranked first in all strata according to the DC/CVM model, eliciting the only positive WTP values out of the four programs from the CR and EO strata. This program does not stand out as strongly in the quadratic CEA results as in the DC/CVM estimates, and is associated with WTP estimates which are not significantly different from the values estimated for the endangered species and reserve programs in the CR and WV regions. A possible interpretation for this effect is that the forest age program is not characterized as highly by the status quo effect as the other programs. That is, it is not possible to differentiate the SQE between programs in the CEA results since there are no alternatives that hold one program at the status quo level while other vary. In the DC/CV, the SQE is not identifiable, but since the programs appear in separate elicitation questions, it is quite possible that the SQE affects the estimates differentially. Thus, given the much higher WTP estimates for the forest age program produced by the DC/CVM elicitation relative to the other programs, it is plausible that respondents are much less averse to the institutional mechanism of increasing diversity in the forest age distribution than is the case for the other programs.

Stevens, Belkner et al. (2000) reviews the small published literature on comparative analysis of DC/CVM with variants of the conjoint method, including CEA. They conclude that, contrary to the null hypothesis above, conjoint methods tend to produce WTP estimates which are biased upward. In three of the four articles they review, con-

Table 6-1. Comparison of Choice Experiment and DC/CVM Results

Region	WTP Measure	Salmon Habitat Program	Endangered Species Program	Forest Age Program	Biodiversity Reserve Program
<b>Coast Range</b>					
	DC/CVM Linear Model	-258 (2)	-281 (4)	17 (1)	-263 (3)
	CEA-Linear Model, No SQ Term	-205 (1)	-404 (4)	-290 (2)	-368 (3)
	CEA Linear Model with SQ Term	-92 (2)	-378 (4)	-88 (1)	-289 (3)
	CEA-Quadratic Model	-57 (1)	-287 (4)	-272 (3)	-241 (2)
<b>Willamette Valley</b>					
	DC/CVM Linear Model	133 (2)	110 (4)	408 (1)	129 (3)
	CEA-Linear Model, No SQ Term	-195 (2)	-219 (3)	-172 (1)	-264 (4)
	CEA Linear Model with SQ Term	-162 (3)	-45(2)	275(1)	-257 (4)
	CEA-Quadratic Model	-99 (1)	-143 (3)	-140 (2)	-171 (4)
<b>E. Oregon</b>					
	DC/CVM Linear Model	-202 (2)	-225 (4)	73 (1)	-206 (3)
	CEA-Linear Model, No SQ Term	-222 (3)	-142 (2)	-21 (1)	-302 (4)
	CEA Linear Model with SQ Term	-127 (2)	-166 (3)	7 (1)	-202 (4)
	CEA-Quadratic Model	-70 (3)	-20 (1)	-57 (2)	-155 (4)

joint methods produce estimates of WTP that are considerably larger than the standard CVM approach. The exception, cited above, was Boxall, Adamowicz et al. (1996) which used a CEA elicitation format similar to that employed in this study, including the specification of a status quo alternative. The strong evidence of status quo preference in both the CEA and DC/CVM results of this research, as exhibited in the pairwise comparisons depicted above, suggest that careful consideration of the effect of the status quo on responses must be considered in the design of CEA studies and is critical in the comparison of this technique to the CVM.

## 6.2 Implications of Study Results for Landscape Planning and Policy Analysis

There is considerable evidence that protection of biological diversity is of great importance to Oregonians. The results of this study lend further definition to the preferences that Oregonians hold regarding conservation of biodiversity in the Coast Range, specifically the relative priorities of particular elements of biodiversity and institutional approaches to conservation and landscape management. By employing the perspective of welfare economics to identify the structure of public preferences, including preference differences between stakeholder groups and regional communities, this study provides valuable information which should help to inform public policy deliberations over forest management and land use planning.

### 6.2.1 Attitudes and Preferences

At one level, the results of the study provide measures of political support for conservation policy initiatives. The framing of the survey instrument in the context of hypothetical public referenda, while intended to provide a greater degree of realism for respondents, also provides projections of support that the hypothesized scenarios would receive in actual public voting.<sup>1</sup> The attitudinal data collected in the survey provides a gauge of public support. The CEA analysis provides at least an alternate measure, and potentially a much more precise one.<sup>2</sup>

---

1. The predictions of the analysis unadjusted for representativeness of the public at large (see Figure 5-2 on page 70) most likely provide the best predictor of voting results. While voter participation was not indicated as a significant predictor of preferences amongst survey respondents, the degree to which the sample overrepresents political conservatives, elderly and environmental group members most likely correlates strongly with the degree to which it represents active voters.

2. Vatn and Bromley's (1994) caution regarding misplaced precision is, however, well taken.

As noted above, the relative rankings of the programs as indicated by marginal WTP depends on the levels of the programs at which the respective demand functions are evaluated. The ranking question in the survey instrument asked respondents to rank the importance of making increases in each of the four programs, with the most important ranking 1 and the least ranking 4. There was no indication in the question about the scale of increase being referred to. For the purpose of comparison to importance inferred from WTP statements, it seems reasonable to assume respondents attitudes toward increasing the programs referred to the importance of marginal increases above baseline, and therefore the marginal WTP at the baseline levels provides a reasonable basis for comparison. Table 6-2 compares MWTP for each of the four programs with the mean attitudinal ranking and rating values, and the preference orderings indicated by each criteria (though this is a qualitative comparison not intended to provide testable hypotheses). Across all three

Table 6-2. Preference ordering of conservation programs by mean MWTP and mean attitudinal ranking<sup>a</sup>

Program	Baseline level	Coast Range			Willamette Valley			E. Oregon		
		MWTP \$/year	Attitude Rank	Attitude Rating	MWTP \$/year	Attitude Rank	Attitude Rating	MWTP \$/year	Attitude Rank	Attitude Rating
salmon	15%	9 (2)	2.0 (1)	81% (1)	7 (4)	2.2 (1)	88% (1)	5 (4)	2.2 (1)	75% (1)
end. species	15%	3 (4)	3.1 (4)	68% (2)	19 (2)	3.0 (4)	86% (1)	6 (2)	3.1 (4)	65% (3)
old growth	5%	17 (1)	2.2 (1)	69% (2)	24 (1)	2.2 (1)	80% (3)	11 (1)	2.1 (1)	77% (1)
reserves	10%	5 (3)	2.7 (3)	70% (2)	9 (3)	2.7 (3)	55% (4)	6 (2)	2.7 (3)	65% (3)

a. MWTP is evaluated at status quo level for each of the conservation programs. Attitudinal ranking (taken from Figure 5-4 on page 72) is mean attitudinal score in a 1-4 preference ordering, with 1 indicating most important. Attitudinal ratings (taken from and Table 5-2 on page 70 and Table 5-3) are % of respondents rating the program as "somewhat important" to "extremely important."

Figures in parentheses are ordering by WTP and attitudinal criteria, noting that some differences in preference orderings are probably not significant.

strata, the forest age program stands out as a preferred program according to the WTP criteria. This is largely consistent with the attitudinal criteria, though WV residents do exhibit some inconsistency between rating and the other preference measures. Endangered species protection consistently stands out as the least preferred program amongst CR res-

idents, though the rating criteria indicates a much closer ordering than the other criteria. Both the WV and EO strata exhibit less consistency in orderings across the three preference measures, most notably exhibiting an apparent preference reversal regarding salmon habitat protection, with the lowest marginal WTP compared to the highest importance rating and ranking scores. This may indicate that WV and EO respondents regard salmon protection as highly important, but captured by broader conservation measures, although endangered species protection is ranked last in importance. Whether these differences are attributable to greater consideration of trade-offs in the CEA questions or general preference instability in the CR and EO strata is unknown. A further test for preference instability may be possible by testing for preference reversals by individual respondents in the four CEA elicitations in the survey instrument, though this extension is not attempted in the thesis.

As the marginal WTP/WTA curves in Figures 5-7 and 5-8 indicate, attempts to allocate large proportions of the coast range landscape to biological conservation, regardless of cost to the public in the form of taxes, is unlikely to receive political support in public referenda. It is important to note that the estimation of the threshold levels of the conservation programs associated with the transition from positive to negative welfare effects are highly sensitive to the specification of functional form. While further work on functional forms in CEA was discussed above, the salient point in the policy context is that there are most likely threshold levels of resource allocation to biodiversity conservation that would not currently receive the support of the Oregon electorate. Given that the policy scenarios described in the survey instrument specified that a portion of the cost to households would be used to compensate landowners for financial burdens imposed by conservation requirements, it appears that survey respondents inferred additional negative externalities associated with excessive reallocation of Coast Range land to conservation. Since the primary and secondary economic impacts of harvest restrictions subsequent to past ESA listings have extended beyond landowners to other elements of local economies, particularly to forest products employees, it is highly plausible that allocation thresholds

are an important component of preference structures for the types of public goods characterized in this study. In a similar study which included changes in rural forest products employment as an attribute of ecosystem management, Xu (1997, pp 101-102) found that both urban and rural respondents expressed significant WTP to prevent rural employment impacts.<sup>1</sup> This disutility, though not measured directly in this study, most likely accounts to some degree for the estimated negative marginal benefits at high levels of resource allocation to biodiversity programs.

### 6.2.2 Benefit Aggregation

Figure 6-1 displays the aggregated TWTP/TWTA curves for each of the four conservation programs, adjusted for demographic representation (see Section 5.2.1.3), with and without the status quo effect. The reader is reminded of the caveats stated above regarding concerns about overestimation of total and marginal willingness to pay resulting from misspecification bias and is advised to interpret these figures with caution. It should also be stressed that these figures do not represent net social benefit, but rather estimates of the maximum WTP to compensate land owners and management entities for costs of implementing these changes. As this scenario describes substantial changes from the status quo condition, the costs associated with this change are likely to be quite high and it is conceivable that the cost-benefit ratio of such a change would be less than one. Speculating at the magnitude of these costs is, however, beyond the scope of this analysis.

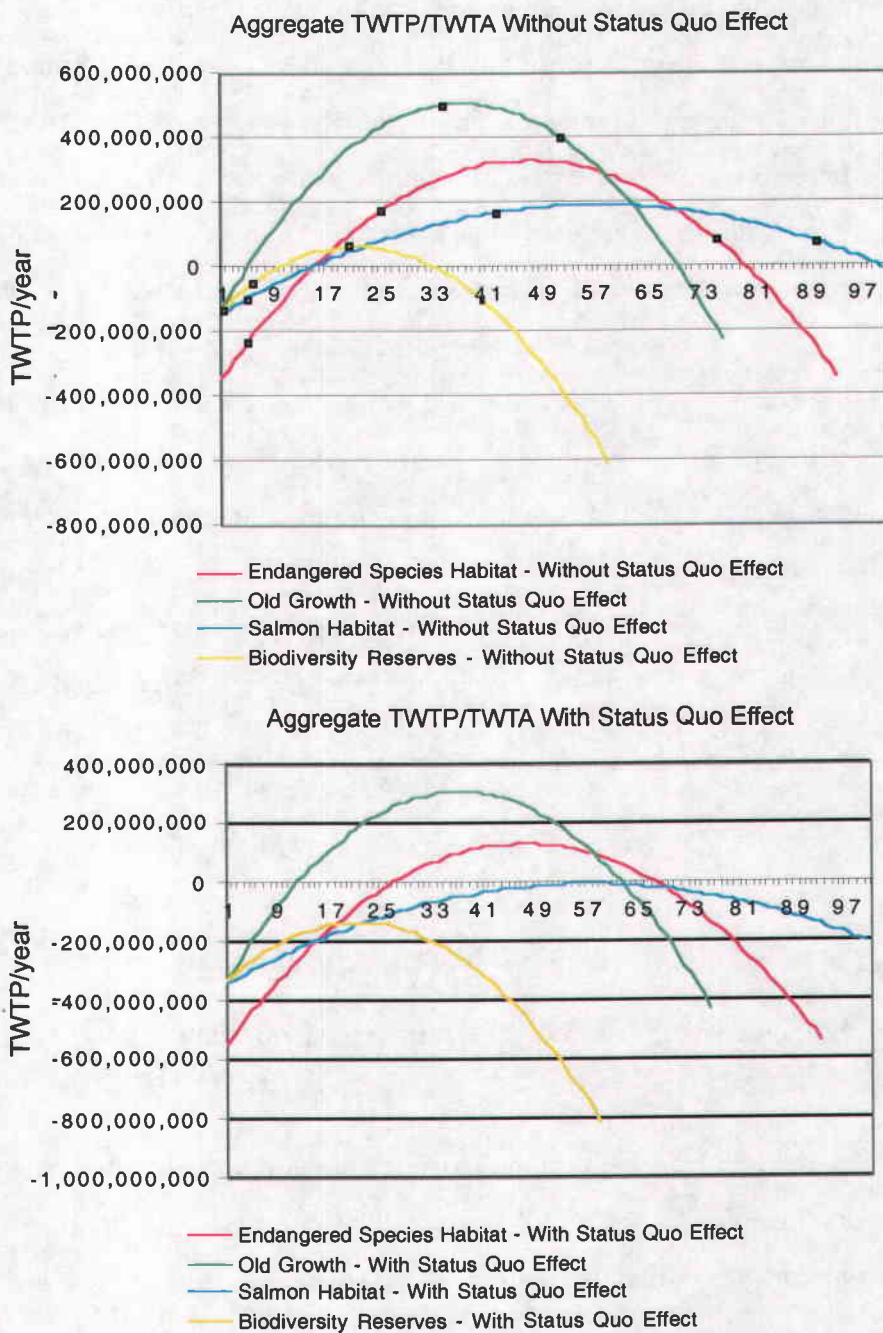
As noted above, the TWTP curves for individual programs which include the negative value of the status quo effect represent conservative estimates of economic value (again, any unmeasured misspecification bias notwithstanding). It is assumed for the sake of discussion that the status quo effect mainly reflects respondents' disutility for

---

1. For many respondents, particularly in the urban strata, this represents existence values for rural jobs and economies.



Figure 6-1. Aggregated Total Willingness to Pay Functions<sup>a</sup>



a. Markers on TWTP curves in upper graph identify the levels specified in the experimental design. Curves are truncated to give better resolution to graphs over the range specified in the design, though truncation is otherwise arbitrary. Points on the curves beyond the upper design point represent extrapolations and should accordingly be interpreted with caution.

government regulatory changes and that this disutility properly belongs in the calculation of welfare effects. It should also be noted that, to avoid double counting, the status quo effect should be deducted only once from the aggregated WTP for any joint change in two or more of the programs. Thus, the lower graph in Figure 6-1 indicates estimated value functions for each of the programs in isolation and any joint conservation initiative would have a greater net value than the summed values indicated by points on these individual curves. Rather, aggregated value should be the sum of the values indicated in the upper graph, less the value of the status quo effect.

As an example, one possible scenario would specify a comprehensive policy which implements each of the four programs at the level that maximizes the aggregate benefit as indicated by the curves in Figure 6-1. The (gross) benefit maximizing levels and associated values are listed in Table 6-3. The joint TWTP for a comprehensive program aggregates the benefits of the respective programs exclusive of the status quo cost, and deducts a single lump sum in the amount of the (negative) status quo effect from the aggregated value<sup>1</sup>:

$$JTWTP_k = \sum_i TWTP_{ik} + Q_k$$

$$JTWTP = \sum_k JTWTP_k = \sum_k \sum_i TWTP_{ik} + Q_k$$

where  $k$  denotes region,  $i$  denotes conservation program, and  $Q_k < 0$  is the status quo constant.

Note that the equity effects of this policy scenario are generally unbiased. That is, given that the joint TWTP of Willamette Valley residents for this alternative is an order of magnitude greater than that of the other two regions, there is the potential that the

---

1. The caution is repeated that summing across conservation attributes to produce a joint TWTP estimate must be done with recognition of the feasibility of the underlying scenario. Indeed, it is entirely possible that the scenario depicted in Figure 6-3 is beyond the bounds of what can be produced on the Coast Range landscape, and is presented for illustrative purposes only.

preferences of WV region would dominate in the context of the Kaldor-Hicks criterion, though the other regions may suffer net losses in utility. Despite a degree of preference heterogeneity between regions indicated in the data, aggregation does not appear to result in identifying an aggregate benefit maximizing alternative that is associated with qualitatively different regional preferences.

This discussion, of course, does not consider the opportunity costs of devoting resources to conservation apart from any negative passive use values, so reference to the scenario depicted in Table 6-3 as benefit-maximizing is only in a limited, partial equilibrium sense.

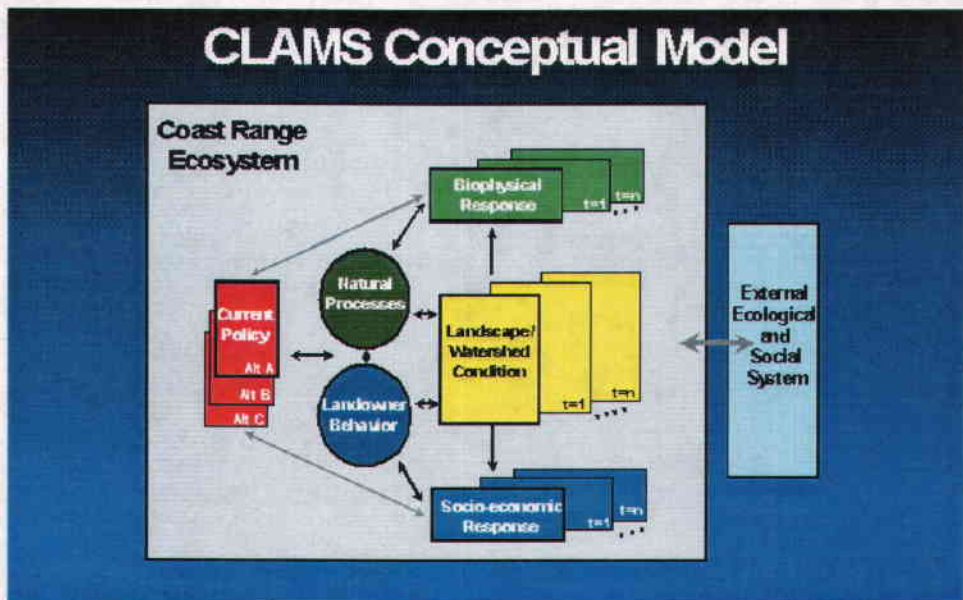
**Table 6-3. Household and Aggregate TWTP for Maximum Estimated Value Conservation Scenario**

	Program Level	Coast Range	Willamette Valley	E. Oregon	State Weighted Average
<b>Household TWTP</b>					
salmon	52	166	142	143	144
endangered species	48	93	304	99	249
old growth	37	219	455	176	384
reserves	21	37	50	34	46
status quo cost		-242	-140	-173	-153
<b>Total Households</b>		78,353	966,010	269,750	1,314,113
<b>Aggregate TWTP</b>					
salmon	52	13,035,185	137,485,973	38,580,265	189,101,423
endangered species	48	7,304,846	293,644,049	26,829,429	327,778,325
old growth	37	17,166,704	439,455,724	47,471,684	504,094,111
reserves	21	2,913,423	48,009,828	9,242,094	60,165,344
status quo cost		-18,926,553	-135,124,743	-46,765,287	-200,816,583

### 6.2.3 Use of Model Results in CLAMS

While the results of this analysis bear relevance to any consideration of changes in biodiversity conservation policy in Oregon, an important motivation in the development of this study was its role as an ancillary model in the context of a larger study, the Coastal Landscape Analysis and Modeling Study, which is at its core a complex, integrated model of landscape change over time in the Oregon Coast Range Physiographic Province. The CLAMS model ultimately is expected to produce projections of an array of resource outputs and conditions of alternative management regimes, which will include multiple elements of biodiversity as well as commodity and recreational resources, land use and availability and ecological services. Thus, this research is, in part, an attempt to partially fill the boxes in the lower right corner of Figure . Other elements of the CLAMS project address the opportunity costs of alternative conservation scenarios.

Figure 6-2. CLAMS conceptual model



As an example, a hypothetical management scenario might include a change in minimum rotation ages on public and private forest land. The CLAMS model simulates landowner responses to policy restrictions as well as other exogenous changes such as market values for stumpage. Amongst other model output, projections of changes in forest age class distribution on the Coast Range landscape over time will be produced, including the change in the old growth component of the age class distribution. Another ancillary model will predict stumpage production under the hypothetical scenario. Using market values for stumpage and applying these to the changes in timber production on the Coast Range, the analyst can directly compare the economic welfare effects of changes in stumpage values to the change in economic welfare reflected in the compensating surplus measures for changes in the proportion of old growth in the Coast Range. Combining these estimates with the welfare effects of any additional changes such as increases in recreational resources, the analyst can calculate the net welfare effect in terms of the benefit-cost results of the policy scenario.

#### **6.2.4 Caveat on strict interpretation of welfare measures in BCA**

The model sketched above would not, of course, provide a decision making "machine", but would provide a powerful information tool to managers and policy makers attempting to cope with the spatial complexity of resource planning. Further social and ecological concerns would have to be addressed in the decision making process, including equity concerns. Additionally, relying solely on estimated demand curves for biodiversity resources to motivate conservation potentiates irreversible losses. The adequacy of benefit-cost analysis as the sole decision rule in the face of irreversibilities has been the subject of much discussion in the economics literature (Castle, Berrens et al. 1994; Berrens and et al. 1998). Notably, Hanemann and other widely published non-market valuation practitioners advise against relying on benefit-cost calculations as the sole decision rule in environmental policy determinations, particularly in the case of irreversibilities (Hanemann 1994; Hanley 1992; Turner 1999; Castle, Berrens et al. 1994;

Stevens, Glass et al. 1991). As a result of these concerns, the safe minimum standard (SMS) has received increasing attention in the environmental economics literature (Swallow 1996; Berrens, 1998; Berrens, 1999; Farmer, 1998). As a decision rule, the SMS places irreversible decisions under a spotlight, invoking a broader decision making process than suggested in the algorithmic approach depicted above. As described by Randall:

The SMS rule places biodiversity beyond the reach of routine trade-offs, where to give up ninety cents worth of biodiversity to gain a dollars worth of ground beef is to make a net gain. It also avoids claiming trump status for biodiversity, permitting some sacrifice of biodiversity in the face of intolerable costs... The idea of intolerable costs invokes an extraordinary decision process that takes biodiversity seriously by trying to distinguish costs that are intolerable from those that are merely substantial. (Randall, 1992)

If, in fact, minimum viability levels for species populations and other ecological thresholds can be identified, they could be incorporated as constraints in an optimization model such as that sketched above. Under the SMS, optimization proceeds normally at above threshold levels, and decisions to relax viability constraints are considered in light of the costs of maintaining the constraint and other concerns. Thus, in the event that SMS constraints imposed on the optimization model are binding, shadow prices could be deduced from the model to identify preservation costs, which would reflect opportunity costs net of nonmarket conservation values.

In summary, as is typically the case in application of new techniques, the research presented in this thesis raises as many questions as it answers. This is not to say that the empirical measures of willingness to pay have not value. On the contrary, it would appear that the measurement of relative preferences amongst the alternative conservation measures analyzed with the CEA method should provide significant guidance to resource managers and policy makers. While there are concerns regarding the absolute accuracy of the simulated prices, there is promise that further refinement can improve

the accuracy of these measures, at least insofar as correction of presumed misspecification problems move estimated surplus measures closer to their "true" value. Perhaps the principal value of this research, however, is the questions raised. These are provocative and should provide important directions for future inquiry and development of the CEA.

## Chapter 7: Conclusions and Future Research

Conservation of biological diversity is a complex undertaking at any scale. At the scale of regions or landscapes, biodiversity conservation represents a massive commitment of public and private resources. The management of forests in the Pacific Northwest and throughout the US has undergone a paradigmatic change since the listing of the northern spotted owl in 1992. While the intervening period has seen heated, even violent controversy, management of public and private forests alike has been fundamentally, perhaps irrevocably, changed. The debate has largely moved beyond whether to conserve biological diversity, to how and to what degree it will be conserved. The application of economic methods for weighing the value of biological conservation has been criticized from all directions, from advocates of preservationism to staunch neoclassical traditionalists in the economics discipline. However, the very complexity of conservation efforts, particularly at regional and landscape scales, generates multiple (innumerable?) alternative strategies for achieving broader conservation objectives. Though technical expertise is crucial in making intelligent decisions about the long term management of living resources, in many cases, managers confront multiple alternatives with little technical criteria for choosing preferred development paths. The input of the public is essential in providing policy makers and resource managers with guidance to make decisions that have important consequences over large temporal and geographic scales.

Estimation of passive use values for biological diversity and other environmental resources and amenities represents the locus of one of the most energetic debates in the economics discipline. The hypothetical nature of passive use valuation methods, and the very nature of passive-use or existence values, places a spotlight on neoclassical consumer theory and its attendant assumptions regarding the formation and stability of consumer preferences. A confounding factor in the debate is the broad variety of biases and measurement effects that are attendant in survey-based, "stated preference" approaches to measuring economic value. Improvements in survey techniques which help to amelio-



rate measurement effects arising from more standard techniques have the potential to provide greater clarity to the debate over the nature of preferences. At the very least, new techniques may offer insights into the choice process which further stimulate the methodological debate.

The objectives of this research are, therefore, twofold. By confronting the inherent complexity of biodiversity conservation planning, at least to a greater degree than has been achieved in previous valuation efforts in the OCR, this study endeavors to produce improved empirical estimates of public preferences regarding the management of biodiversity. Further, the study focuses on regional heterogeneity to disaggregate the preferences of Oregonians into distinct regional preferences. In conjunction with the Coastal Landscape Analysis and Modeling Study, the insights offered by the study results can contribute significantly to envisioning alternative development paths for the OCR and the attendant benefits and opportunity costs of use and preservation. In addition, this research has provided valuable insight into the relative merits of the choice experiment analysis and the more commonly used dichotomous choice contingent valuation method.

The choice experiment analysis technique is used in this research to estimate the preferences of Oregonians for four elements of a composite biodiversity conservation strategy for the OCR. Extension of habitat conservation plans under the Endangered Species Act to a larger portion of the private land in the OCR is one alternative program that brings the protection of T&E species in the OCR to a level closer to that achieved on public land under the Northwest Forest Plan, while still maintaining commercial production, though likely at reduced levels. The restoration of coastal riparian areas and resident anadromous fishes focuses on one very narrow group of species, but would enhance a crucially important landscape feature and habitat element with broad benefits for numerous species and ecosystem functions. Protection of large scale biological reserves is an important feature of current landscape management occupying approxi-

mately 10% of the Coast Range landscape and is an important mechanism for the maintenance of small, nondescript species that would be difficult to maintain in a targeted approach, as well as the persistence of minimally altered ecosystem function and natural disturbance regimes. Finally, altering active forest management to restore greater structural and age class diversity to the forested landscape addresses a move toward the historically dominant vegetative characteristic on the OCR. These four alternative conservation mechanisms represent the principal institutional conservation initiatives operating in the OCR, as well as key themes in the applied conservation literature. These approaches are to a degree complementary, but given the constraints of opportunity costs, decisions regarding how to allocate resources amongst these efforts are unavoidable.

The CEA approach is used in this thesis to measure the relative preferences of residents in Coast Range communities, the Willamette Valley, and Eastern Oregon for these four alternatives at different levels of implementation. The CEA survey instrument reviews the essential background information to set the context for choice statements, and then offers choices between sets of alternative conservation plans that are distinguished by the level of representation of each of the four attributes and the associated (hypothetical) cost to the respondent in increased income taxes. The random utility framework is used to model the exhibited choice behavior to estimate Hicksian compensated demand functions and compensating and equivalent surplus functions for each of the conservation programs.

Econometric analysis of responses to CEA WTP elicitation questions proved to be highly significant with respondents expressing identifiable preferences over the four programs. A key finding was that the individual programs were characterized by downward sloping compensated demand curves which intersected the x-axis and became negative at high levels of resource allocation to any one of the four programs. Programs differed in the threshold levels at which marginal WTP fell to zero: residents of all three regions of

the state expressed marginal WTP  $< 0$  for any increases in endangered species habitat above 48% of Coast Range land, while the threshold level indicated by all three regions for biological reserves was approximately 21% of Coast Range land designated with this status. With respect to increasing forest age diversity, Coast Range residents indicated a threshold somewhat lower than the other two regions at approximately 30% old growth in the age class distribution compared to 39% for the other two regions. Finally, for the salmon habitat program, Eastern Oregon residents indicated a significantly higher threshold at 69% of salmon habitat in protected status compared to the other two regions clustered around 57%. With the exception of the salmon habitat program, Willamette Valley residents expressed higher positive WTP for all levels of the programs. Coast Range residents indicated higher WTP for salmon habitat protection up to approximately 40% coverage of Coast Range streams, where the compensated demand curve is intersected by that of the Eastern Oregon strata.

A finding which has significance for nonmarket valuation generally, and conjoint methods particularly, is the identification of a substantial status quo preference amongst all three regional strata, which is most strongly stated amongst Coast Range residents. That is, holding all other changes constant, respondents indicated a tendency to choose the status quo alternative. This effect is echoed elsewhere in the literature and appears to be motivated at least in part by an endowment effect, though it is likely also a reflection of cognitive and instrument effects. In this context, the endowment effect arises as respondents perceive the possibility of regulatory policy changes in land and resource use which are regarded negatively. Thus, while increases in the conservation programs were regarded with positive MWTP up to the threshold levels noted above, the disutility of varying from the status quo has the effect of shifting TWTP downward for changes in one or more of the conservation programs. The nature of the status quo preference is something of an anomaly in the context of neoclassical economic theory, and it has important implications for modeling consumer preferences using CEA as well as more common valuation techniques.

In comparing the dichotomous choice CVM with the CEA approach, the latter appears to generally produce more conservative estimates of WTP. While this effect is not uniform, it is expressed more strongly when estimation using the CEA and DC/CV data sets employs similar utility specifications (i.e. linear effects only). Quadratic effects in the CEA model improve model fit substantially, and also tend to decrease the divergence of the CEA and DC/CV estimates.

Several caveats should be noted. There is evidence that there may be misspecification bias in the quadratic CEA model due to inability to specify a sufficiently flexible functional form. Insufficient degrees of freedom in the experimental design prohibit estimation of higher order terms or a Box-Cox specification. There is particularly strong evidence that there is a discontinuity in the compensated demand curves at the baseline level such that the curves are much steeper below the baseline level than above it. This also is echoed elsewhere in the literature and suggests even further that misspecification may be a significant problem in the CEA analysis. The high level of significance of the estimated models suggests that the qualitative results derived are most likely accurate, though literal interpretation of marginal WTP values and threshold levels must be treated with caution.

The representation of biodiversity attributes as identified with institutional approaches to conservation carries some liabilities as well. A more standard approach in the valuation literature is to divorce the estimation of value from means of provision, e.g. the institutional context. However, it was felt that this is a rather artificial distinction, in that the institutional framework of conservation planning and management carries important welfare implications in itself, as clearly indicated in this research. This research has attempted to extract from the literature key elements of the biodiversity complex that are distinct in terms of public preferences, represent distinct management objectives, and identify key indicators of the biological integrity of the Coast Range landscape. While focus group research indicated that the portrayal of biodiversity attributes

was meaningful to group participants and survey respondents, it necessarily simplified a complex management issue and may well have missed key issues to which public preferences may be sensitive. On a similar note, the survey instrument relied on a very limited information set upon which respondents were asked to formulate or express preferences. While the evidence is quite strong that respondents were successful in comprehending and executing the decision task with which they were presented, the weight given to the welfare estimates derived in this research must give note to the divergence between the complexity of the decision scenario in reality and the simplified version portrayed in the survey booklet.

Further research: The length of the results and discussion sections of this thesis are less indicative of the depth of the analysis than of the richness of the data set. The choice experiment approach offers a research technique which has very considerable advantages relative to the more standard techniques in use. Though survey design and administration in CEA is an order of magnitude more complex than in the DC/CV, the well developed statistical foundation of DC/CV adapts readily to the CEA. An exception to this, however, is the recent work in nonparametric and semiparametric analyses of DC/CV data. The CEA places proportionately greater demands on the ad hoc assumptions on utility structure that characterize discrete response choice models generally. Extension of empirical techniques have shed considerable light on a number of DC/CV studies to which CEA would potentially be very useful.

The repeated measures dimension of CEA studies, wherein each respondent receives several choice elicitations, is largely and regrettably overlooked in this thesis, but for this comment. The repeated measures aspect offers the capacity to measure the stability of respondents' preferences. Swait and Adamowicz (1996) have identified learning and fatigue effects that develop as a respondent answers successive choice elicitations. Thus, measurement of preferences may be influenced by the cognitive demands of the choice exercise itself. It is also possible to test for preference reversals exhibited by individual

respondents and the use of decision heuristics such as lexicographic preference maps (Mazzotta and Opaluch 1995). While the issue of insensitivity to scope in CVM WTP estimates increasingly appears to be a red herring, the stability of preferences in the face of complex choice tasks over unfamiliar goods is a more cogent issue. CEA provides somewhat greater possibilities for assessing the general stability of preferences than other methods currently available.

This analysis has employed a multinomial logit (MNL) framework to model the choice probabilities. While this model is perhaps the most commonly used in empirical work, it has well known limitations in terms of sensitivity to the independence of irrelevant alternatives property. Improvements over MNL that have appeared relatively recently in the econometric literature include random coefficients models and numerical approximation methods for multinomial probit models (Alberini, Kanninen et al. 1994; Revelt and Train 1998). While the inclusion of alternative specific constants appears to account sufficiently for correlation in choice probabilities between alternatives, models which are less sensitive to this property nonetheless offer clear advantages.

On a final note, the chief limitation encountered in this study is the inability to specify an econometric model which is sufficiently flexible to allow the CEA data to fully express itself. As noted above, a more flexible functional form would be highly desirable, but is constrained by confounding in the experimental design. Additional terms that would ideally be specified in the econometric models would be dummy variables for below baseline attribute levels and potentially attribute specific status quo terms. An interesting potential for extending experimental designs may be bootstrapping to permit estimation of additional model terms. Given the complexity of CEA designs, the ability to extend relatively simple experimental designs to permit model flexibility offers considerable promise.

## Bibliography

Aadland, D. M. and A. J. Caplan (1999). "Household Valuation of Curbside Recycling." Journal of Environmental Planning and Management 42(6): 781-99.

Adamowicz, V. (1995). "Alternative Valuation Techniques: A Comparison and Movement to a Synthesis." Willis, K. G. Corkindale, J. T., eds.. Environmental valuation: New perspectives. Wallingford, Oxon, U.K.: CAB International: 144-59.

Adamowicz, W., P. Boxall, et al. (1999). "Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation." American Journal of Agricultural Economics 80(1): 64-75.

Adamowicz, W. and et al. (1997). "Perceptions versus Objective Measures of Environmental Quality in Combined Revealed and Stated Preference Models of Environmental Valuation." Journal of Environmental Economics and Management 32(1): 65-84.

Adamowicz, W. L. (1988). "Behavioral Implications of Nonmarket Valuation Models." Canadian Journal of Agricultural Economics 36(4): 929-39.

Adamowicz, W. L., V. Bhardwaj, et al. (1993). "Experiments on the Difference between Willingness to Pay and Willingness to Accept." Land Economics 69(4): 416-27.

Adamowicz, W. L., V. Bhardwaj, et al. (1994). "Experiments on the Difference between Willingness to Pay and Willingness to Accept: Reply." Land Economics 70(4): 523-24.

Adamowicz, W. L., J. J. Fletcher, et al. (1994). "Functional Form and the Statistical Properties of Welfare Measures: Reply." American Journal of Agricultural Economics 76(4): 958-59.

Adamowicz, W. L., J. Louviere, et al. (1994). "Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities." Journal of Environmental Economics and Management 26(3): 271-92.

Ajzen, I., T. C. Brown, et al. (1996). "Information Bias in Contingent Valuation: Effects of Personal Relevance, Quality of Information, and Motivational Orientation." Journal of Environmental Economics and Management 30(1): 43-57.

Alberini, A., B. Kanninen, et al. (1997). "Modeling Response Incentive Effects in Dichotomous Choice Contingent Valuation Data." Land Economics 73(3): 309-24.

Alberini, A., B. J. Kanninen, et al. (1994). Random-Effect Models of Willingness to Pay Using Discrete Response CV Survey Data: 27.

Albers, H., A. C. Fisher, et al. (1995). "Valuation and Management of Tropical Forests: Implications of Uncertainty and Irreversibility." University of California, Berkeley Department of Agricultural and Resource Economics and Policy Working Paper 756: 41.

Alverson, W. S., D. Kuhlman, et al. (1994). Wild forests : conservation biology and public policy. Washington, D.C., Island Press.

Ando, A., J. Camm, et al. (1998). "Species Distributions, Land Values, and Efficient Conservation." Science 279(5359): 2126.

Ando, A. W. (1997). Delay on the path to the endangered species act: Do costs and benefits matter. Washing,ton, D.C., Resources for the Future.

Arrow, K., R. Solow, et al. (1993). "'Report of the NOAA Panel on Contingent Valuation." Report to the National Oceanic and Atmospheric Administration, U.S. Department of Commerce." Federal Register 58: 4601-4614.

Arthur, J. L., Mark Hachey, Kevin Sahr, Manuela Huso and A. Ross Keister (1997). "Finding All Optimal Solutions to the Reserve Site Selection Problem: Formulation and Computational Analysis." Environmental and Ecological Statistics 4: 153-65.

Assessment(OTA), O. o. T. (1987). Technologies to maintain biological diversity. Washington, D.C., U.S. Government Printing Office.

Ayer, M., H. D. Brunk, et al. (1955). "An empirical distribution function for sampling with incomplete information." Annals of Mathematical Statistics 26(4): 641-47.

Barbier, E. B., J. C. Burgess, et al. (1991). "The Economics of Tropical Deforestation." Ambio XX(2): 55.



Bateman, I. and K. G. Willis (1999). Valuing environmental preferences : theory and practice of the contingent valuation method in the US, EU, and developing countries. Oxford [England] ; New York, Oxford University Press.

Bateman, I. J., I. H. Langford, et al. (1999). Elicitation effects in contingent valuation. Valuing environmental preferences : theory and practice of the contingent valuation method in the US, EU, and developing countries. I. Bateman and K. G. Willis. Oxford [England] ; New York, Oxford University Press: 511-539.

Baydack, R. K., H. Campa, et al. (1999). Practical approaches to the conservation of biological diversity. Washington, D.C., Island Press.

Beenstock, M., E. Goldin, et al. (1998). "Response Bias in a Conjoint Analysis of Power Outages." Energy Economics 20(2): 135-56.

Ben-Akiva, M. and S. R. Lerman (1985). Discrete choice analysis : theory and application to travel demand. Cambridge, Mass, MIT Press.

Bennett, J., M. Morrison, et al. (1998). "Testing the Validity of Responses to Contingent Valuation; Questioning." Australian Journal of Agricultural and Resource Economics 42(2): 131-48.

Bergstrom, J. C., J. R. Stoll, et al. (1989). "Information Effects in Contingent Markets." American Journal of Agricultural Economics 71(3): 685-91.

Bergstrom, J. C., J. R. Stoll, et al. (1990). "The Impact of Information on Environmental Commodity Valuation Decisions." American Journal of Agricultural Economics 72(3): 614-21.

Berrens, R. P. and et al. (1998). "Exploring Nonmarket Values for the Social Impacts of Environmental Policy Change." Resource and Energy Economics 20(2): 117-37.

Berrens, R. P. and et al. (1998). "Implementing the Safe Minimum Standard Approach: Two Case; Studies from the U.S. Endangered Species Act." Land Economics 74(2): 147-61.

Berrens, R. P., M. McKee, et al. (1999). "Incorporating Distributional Considerations in the Safe Minimum Standard Approach: Endangered Species and Local Impacts." Ecological Economics 30(3): 461-74.

Binger, B. R., R. Copple, et al. (1995). "Contingent Valuation Methodology in the Natural Resource Damage Regulatory Process: Choice Theory and the Embedding Phenomenon." Natural Resources Journal 35(3): 443-59.

Bishop, R., P. A. Champ, et al. (1997). Measuring non-use values: theory and application. Determining the value of non-marketed goods : economic, psychological, and policy relevant aspects of contingent valuation methods. R. J. Kopp, W. W. Pommerehne and N. Schwarz. Boston, Kluwer Academic Publishers: viii, 333.

Blamey, R., M. Common, et al. (1995). "Respondents to contingent valuation surveys: consumers or citizens." Australian Journal of Agricultural Economics 39(3): 263-288.

Blamey, R. K., J. W. Bennett, et al. (2000). "A test of policy labels in environmental choice modelling studies." Ecological Economics 32(2): 269-286.

Bockstael, N., K. E. McConnell, et al. (1991). Methods for Valuing Classes of Benefits: Recreation. Measuring the demand for environmental quality. J. B. Braden and C. D. Kolstad. Amsterdam ; New York, N.Y., U.S.A., North-Holland; Distributors for the U.S. and Canada Elsevier Science Pub. Co.: xii, 370.

Bockstael, N. E. and K. E. McConnell (1993). "Public Goods as Characteristics of Non-market Commodities." Economic Journal 103(420): 1244- 57.

Boman, M., G. Bostedt, et al. (1999). "Obtaining Welfare Bounds in Discrete-Response Valuation Studies: A Non-parametric Approach." Land Economics 75(2): 284-94.

Bostedt, G. and M. Boman (1996). "Nonresponse in Contingent Valuation--Reducing Uncertainty in Value Inference." Environmental and Resource Economics 8(1): 119-24.

Boxall, P. C., W. L. Adamowicz, et al. (1996). "A comparison of stated preference methods for environmental valuation." Ecological economics : the journal of the International Society for Ecological Economics 18(3): 243.

Boyle, K. J. and J. C. Bergstrom (1999). Doubt, doubt and doubters: the genesis of a new research agenda. Valuing environmental preferences : theory and practice of the contingent valuation method in the US, EU, and developing countries. I. Bateman and K. G. Willis. Oxford [England] ; New York, Oxford University Press: 183-206.

Boyle, K. J. and et al. (1996). "Valuing Public Goods: Discrete versus Continuous Contingent-Valuation Responses." Land Economics 72(3): 381-96.

Braden, J. B. and C. D. Kolstad (1991). Measuring the demand for environmental quality. Amsterdam ; New York, N.Y., U.S.A., North-Holland; Distributors for the U.S. and Canada Elsevier Science Pub. Co.

Bromley, D. W. (1995). "Property Rights and Natural Resource Damage Assessments." Ecological Economics 14(2): 129-35.

Brown, G. M., Jr. and R. Mendelsohn (1984). "The Hedonic Travel Cost Method." Review of Economics and Statistics 66(3): 427-33.

Brown, T. C. and et al. (1996). "Which Response Format Reveals the Truth about Donations to a Public Good?" Land Economics 72(2): 152-66.

Brown, T. C. and R. Gregory (1999). "Why the WTA-WTP Disparity Matters." Ecological Economics 28(3): 323-35.

Brown, T. C., G. L. Peterson, et al. (1995). "The Values Jury to Aid Natural Resource Decisions." Land Economics 71(2): 250-60.

Cameron, T. A. (1985). "Consistent Multinomial and Nested Logit Point Estimates: A Practical Note." Oxford Bulletin of Economics and Statistics 47(1): 83-89.

Cameron, T. A. (1988). "A New Paradigm for Valuing Non-market Goods Using Referendum Data: Maximum Likelihood Estimation by Censored Logistic Regression." Journal of Environmental Economics and Management 15(3): 355-79.

Cameron, T. A. (1991). "Cameron's Censored Logistic Regression Model: Reply." Journal of Environmental Economics and Management 20(3): 303-304.

Cameron, T. A. and D. D. Huppert (1989). "OLS versus ML Estimation of Non-market Resource Values with Payment Card Interval Data." Journal of Environmental Economics and Management 17(3): 230-46.

Cameron, T. A. and D. D. Huppert (1991). "Referendum Contingent Valuation Estimates: Sensitivity to the Assignment of Offered Values." Journal of the American Statistical Association 86(416): 910-18.

Cameron, T. A., G. L. Poe, et al. (1999). Alternative nonmarket value-elicitation methods: Are revealed and stated preferences the same?, Working Paper, Department of Economics, University of California, Los Angeles: 32.

Camm, J., S. Polasky, et al. (1996). "A note on optimal algorithms for reserve site selection." Biological Conservation 78: 353-58.

Carson, R., N. E. Flores, et al. (1998). "Sequencing and Valuing Public Goods." Journal of Environmental Economics and Management 36(3): 314-23.

Carson, R. and P. Navarro (1988). "Fundamental Issues in Natural Resource Damage Assessment." Natural Resources Journal 28(4): 815-36.

Carson, R. T. (1991). Constructed Markets. Measuring the demand for environmental quality. J. B. Braden and C. D. Kolstad. Contributions to Economic Analysis, no. 198; Amsterdam; Oxford and Tokyo, North-Holland; distributed in the U.S. and Canada by Elsevier Science New York: 121-62.

Carson, R. T. (1997). Contingent valuation surveys and tests of insensitivity to scope. Determining the value of non-marketed goods : economic, psychological, and policy relevant aspects of contingent valuation methods. R. J. Kopp, W. W. Pommerehne and N. Schwarz. Boston, Kluwer Academic Publishers: viii, 333.

Carson, R. T. (1997). "Contingent Valuation: Theoretical Advances and Empirical Tests; since the NOAA Panel." American Journal of Agricultural Economics 79(5): 1501-07.

Carson, R. T. and et al. (1994). Contingent Valuation and Lost Passive Use: Damages From the Exxon Valdez: 56.

Carson, R. T. and et al. (1996). "Contingent Valuation and Revealed Preference Methodologies: Comparing the Estimates for Quasi-Public Goods." Land Economics 72(1): 80-99.

- Carson, R. T. and et al. (1996). Was the NOAA Panel Correct about Contingent Evaluation?: 28.
- Carson, R. T. and et al. (1997). "Temporal Reliability of Estimates from Contingent Valuation." Land Economics 73(2): 151-63.
- Carson, R. T. and et al. (1998). "Referendum Design and Contingent Valuation: The NOAA Panel's No-Vote Recommendation." Review of Economics and Statistics 80(3): 484-87.
- Carson, R. T., N. E. Flores, et al. (1999). The theory and measurement of passive-use values. Valuing environmental preferences : theory and practice of the contingent valuation method in the US, EU, and developing countries. I. Bateman and K. G. Willis. Oxford [England] ; New York, Oxford University Press: 42-96.
- Carson, R. T., J. Louviere, et al. (1994). "Experimental Analysis of Choice." Marketing Letters 5(4): 351-368.
- Carson, R. T. and R. C. Mitchell (1993). Contingent Valuation and the Legal Arena. Valuing natural assets: The economics of natural resource damage assessment. R. J. Kopp and V. K. Smith. Washington, D.C., Resources for the Future: 231-47.
- Carson, R. T. and R. C. Mitchell (1993). The Issue of Scope in Contingent Valuation Studies: 10.
- Carson, R. T. and R. C. Mitchell (1995). "Sequencing and Nesting in Contingent Valuation Surveys." Journal of Environmental Economics and Management 28(2): 155-73.
- Castle, E. N., R. P. Berrens, et al. (1994). "Natural Resource Damage Assessment: Speculations about a Missing Perspective." Land Economics 70(3): 378-85.
- Castle, E. N., R. P. Berrens, et al. (1996). "The Economics of Sustainability." Natural Resources Journal 36(4): 715-30.
- Champ, P. A. and J. B. Loomis (1998). "WTA Estimates Using the Method of Paired Comparison: Tests of Robustness." Environmental and Resource Economics 12(3): 375-86.

Chen, H. Z. and A. Randall (1997). "Semi-nonparametric Estimation of Binary Response Models with an Application to Natural Resource Valuation." Journal of Econometrics 76(1-2): 323-40.

Ciriacy-Wantrup, S. V. (1947). "Capital returns from soil-conservation practices." Journal of Farm Economics 29: 1188-90.

CLAMS (1999). Coastal Landscape Analysis and Modelling Study Webpage.

Clawson, M. (1959). Methods for measuring the demand for and the value of outdoor recreation. Washington, D.C., Resources for the Future.

Creel, M. and J. Loomis (1997). "Semi-nonparametric Distribution-Free Dichotomous Choice Contingent Valuation." Journal of environmental economics and management 32(3): 341.

Csuti, B., S. Polasky, et al. (1997). "A Comparison of Reserve Selection Algorithms Using Data on Terrestrial Vertebrates in Oregon." Biological Conservation 80: 83-97.

Davis, R. K. (1963). "Recreation planning as an economic problem." Natural Resources Journal 3(2): 239-249.

Desvousges, W. H., F. R. Johnson, et al. (1993). Measuring natural resource damages with contingent valuation: test of validity and reliability. Contingent valuation : a critical assessment. J. A. Hausman. Amsterdam ; New York, North-Holland: xii, 503.

Diamond, P. (1996). "Testing the Internal Consistency of Contingent Valuation Surveys." Journal of Environmental Economics and Management 30(3): 337-47.

Diamond, P. A. and J. A. Hausman (1993). "On Contingent Valuation Measurement of Nonuse Values." Hausman, Jerry A., ed.. Contingent valuation: A critical assessment.. Contributions to Economic Analysis 220: 3-38.

Diamond, P. A. and J. A. Hausman (1994). "Contingent Valuation: Is Some Number Better than No Number?" Journal of Economic Perspectives 8(4): 45-64.

Dillman, D. (1978). Mail and Telephone Surveys, John Wiley and Sons.

Duffield, J. W. and D. A. Patterson (1991). "Inference and Optimal Design for a Welfare Measure in Dichotomous Choice Contingent Valuation." Land Economics 67(2): 225-39.

Duinker, P. N. (1990). "Climate change and forest management, policy and land use." Land use policy 7(2): 124-137.

Duinker, P. N. (1993). Indicators and goals for biodiversity in Canada's model forests. Indicators of Sustainable Development Workshop, Corner Brook, Newfoundland.

Edwards, P. J. and C. Abivardi (1998). "The value of biodiversity: where ecology and economy blend." Biological conservation 83(3): 239.

Ekstrand, E. R. and J. Loomis (1998). "Incorporating Respondent Uncertainty When Estimating Willingness to Pay for Protecting Critical Habitat for Threatened and Endangered Fish." Water Resources Research 34(11): 3149-55.

Farmer, M. C. and A. Randall (1998). "The Rationality of a Safe Minimum Standard." Land Economics 74(3): 287-302.

Flores, N. E. and R. T. Carson (1997). "The Relationship between the Income Elasticities of Demand and Willingness to Pay." Journal of Environmental Economics and Management 33(3): 287-95.

Franklin, J. F. (1988). Structural and functional diversity oin temperate forests. Bziodiversity. E. O. Wilson. Washington, D.C., National Academy Press: 166-175.

Franklin, J. F. (1993). "Preserving biodiversity: species, ecosystems, or landscapes?" Ecological applications : a publication of the Ecological Society of America 3(2): 202-205.

Freeman, A. M. (1993). The measurement of environmental and resource values : theory and methods. Washington, D.C., Resources for the Future.

Giraud, K. L., J. B. Loomis, et al. (1999). "Two Valuation Questions in One Survey: Is It a Recipe for Sequencing and Instrument Context Effects?" Applied Economics 31(8): 957-64.

- Gowdy, J. M. (1997). "The Value of Biodiversity: Markets, Society, and Ecosystems." Land Economics 73(1): 25-41.
- Green, D. P., D. Kahneman, et al. (1994). "How the Scope and Method of Public Funding Affect Willingness to Pay for Public Goods." Public opinion quarterly 58(1): 49-67.
- Green, P. E. and V. R. Rao (1971). "Conjoint measurement for quantifying judgemental data." Journal of Marketing Research 8: 355-363.
- Green, P. E. and Y. Wind (1973). Multiattribute decisions in marketing: a measurement approach. Hinsdale, IL, Dryden Press.
- Greene, W. H. (1993). Econometric analysis. New York, London ; Collier Macmillan.
- Gregory, R. (1986). "Interpreting Measures of Economic Loss: Evidence from Contingent Valuation and Experimental Studies." Journal of Environmental Economics and Management 13(4): 325-37.
- Gregory, R. and et al. (1995). "How Precise Are Monetary Representations of Environmental Improvements?" Land Economics 71(4): 462-73.
- Gregory, R. and et al. (1997). "Decision-Pathway Surveys: A Tool for Resource Managers." Land Economics 73(2): 240-54.
- Gregory, R., S. Lichtenstein, et al. (1993). "Valuing Environmental Resources: A Constructive Approach." Journal of Risk and Uncertainty 7(2): 177-97.
- Gregory, R. and D. MacGregor (1990). Valuing Changes in Environmental Assets. Economic valuation of natural resources: Issues, theory, and applications. R. L. Johnson and G. V. Johnson. Social Behavior and Natural Resources Series; Boulder and Oxford, Westview Press: 67-77.
- Gregory, R., D. MacGregor, et al. (1992). "Assessing the Quality of Expressed Preference Measures of Value." Journal of Economic Behavior and Organization 17(2): 277-92.
- Gregory, R. and T. McDaniels (1987). "Valuing Environmental Losses: What Promise Does the Right Measure Hold?" Policy Sciences 20(1): 11-26.



Gregory, R. and P. Slovic (1997). "A Constructive Approach to Environmental Valuation." Ecological Economics 21(3): 175-81.

Grumbine, R. E. (1997). "Reflections on "What is Ecosystem Management?"." Conservation biology : the journal of the Society for Conservation Biology 11(1): 41.

Haab, T. C. (1997). "Referendum models and negative willingness to pay: alternative solutions." JEEM 32: 251-270.

Hanemann, W. M. (1984). Applied welfare analysis with qualitative response models. Berkeley, University of California.

Hanemann, W. M. (1984). "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses." American Journal of Agricultural Economics 66(August): 332-341.

Hanemann, W. M. (1987). "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses: Reply." American Journal of Agricultural Economics 69(1): 185-86.

Hanemann, W. M. (1989). "Welfare Evaluations in Contingent Valuation Experiments with Discrete Response Data: Reply." American Journal of Agricultural Economics 71(4): 1057-61.

Hanemann, W. M. (1991). "Willingness to Pay and Willingness to Accept: How Much Can They Differ?" American Economic Review 81(3): 635-47.

Hanemann, W. M. (1994). "Valuing the Environment through Contingent Valuation." Journal of Economic Perspectives 8(4): 19-43.

Hanemann, W. M. (1995). "Contingent Valuation and Economics." Willis, K. G. Cor-kindale, J. T., eds.. Environmental valuation: New perspectives. Wallingford, Oxon, U.K.: CAB International: 79-117.

Hanemann, W. M. (1996). "Theory versus Data in the Contingent Valuation Debate." Bjornstad, David J. Kahn, James R., eds.. The contingent valuation of environmental resources: Methodological issues and research needs. New Horizons in Environmental Economics series. Cheltenham, U.K.: Elgar: 38-60.

Hanemann, W. M. (1996). "Welfare Analysis With Discrete Choice Models." University of California, Berkeley, Department of Agricultural and Resource Economics 792: 47.

Hanemann, W. M. (1999). Neo-classical economic theory and contingent valuation. Valuing environmental preferences : theory and practice of the contingent valuation method in the US, EU, and developing countries. I. Bateman and K. G. Willis. Oxford [England] ; New York, Oxford University Press: 42-96.

Hanemann, W. M. and B. Kanninen (1999). The Statistical Analysis of Discrete-Response CV Data. Valuing Environmental Preferences. I. J. Bateman and K. G. Willis. Oxford, Oxford University Press: 128.

Hanemann, W. M. and A. G. Keeler (1996). "Economic Analysis in Policy Evaluation, Damage Assessment and Compensation; A Comparison of Approaches." University of California, Berkeley Department of Agricultural and Resource Economics and Policy Working Paper 766: 17.

Hanemann, W. M., B. Kristrom, et al. (1996). "Nonmarket Valuation Under Preference Uncertainty: Econometric Models and Estimation." University of California, Berkeley, Department of Agricultural and Resource Economics 794: 7.

Hanemann, W. M., B. Kristrom, et al. (1996). Nonmarket Valuation Under Preference Uncertainty: Econometric; Models and Estimation: 7.

Hanley, N. (1992). "Are There Environmental Limits to Cost Benefit Analysis?" Environmental and Resource Economics 2(1): 33-59.

Hanley, N. and et al. (1998). "Contingent Valuation versus Choice Experiments: Estimating the Benefits of Environmentally Sensitive Areas in Scotland." Journal of Agricultural Economics 49(1): 1-15.

Hanley, N. and R. Ruffell (1992). The Valuation of Forest Characteristics: 45.

Hanley, N., C. Spash, et al. (1995). "Problems in Valuing the Benefits of Biodiversity Protection." Environmental and Resource Economics 5(3): 249-72.

- Hanley, N., R. E. Wright, et al. (1998). "Using Choice Experiments to Value the Environment: Design Issues, Current Experience and Future Prospects." Environmental and Resource Economics 11(3-4): 413-28.
- Hartman, R. S., M. J. Doane, et al. (1990). "Status Quo Bias in the Measurement of Value of Service." Resources and Energy 12(2): 197-214.
- Hartman, R. S., M. J. Doane, et al. (1991). "Consumer Rationality and the Status Quo." Quarterly Journal of Economics 106(1): 141-62.
- Haufler, J. B. (1999). Strategies for conserving terrestrial biological diversity. Practical approaches to the conservation of biological diversity. R. K. Baydack, H. Campa and J. B. Haufler. Washington, D.C., Island Press: xiv, 313.
- Hausman, J. A. (1993). Contingent valuation : a critical assessment. Amsterdam ; New York, North-Holland.
- Haynes, R. W. and A. L. Home (1997). "Chapter 6: Economic Assessment of the Basin". An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins. T. M. Quigley and S. J. Arbelbide. Portland, OR, US Department of Agriculture, Forest Service, Pacific Northwest Research Station. IV.
- Hicks, J. R. (1943). "The four measures of consumer surplus." Review of Economics Studies 8: 108-116.
- Hoehn, J. P. and A. Randall (1987). "A Satisfactory Benefit Cost Indicator from Contingent Valuation." Journal of Environmental Economics and Management 14(3): 226-47.
- Hoehn, J. P. and A. Randall (1989). "Too Many Proposals Pass the Benefit Cost Test." American Economic Review 79(3): 544-51.
- Hoehn, J. P. and A. Randall (1991). "Too Many Proposals Pass the Benefit-Cost Test: Reply." American Economic Review 81(5): 1450-52.
- Horowitz, J. L. (1994). "Advances in random utility models: Report of the workshop on advances in random utility models- Duke Invitational Symposium on Choice Modeling Behavior." Marketing Letters 5(4): 311-322.

Huber, J. and K. Zwerina (1996). "The Importance of Utility Balance in Efficient Choice Designs." IMR, Journal of marketing research 33(3): 307.

Institute, O. F. R. (1999). Oregonians discuss forest values, management goals, and related issues: A public opinion research project. Portland, Oregon: 19.

Irwin, L. L. and T. B. Wigley (1993). "Toward an experimental basis for protecting forest wildlife." Ecological applications : a publication of the Ecological Society of America 3(2): 213-217.

Jakobsson, K. M. and A. K. Dragun (1996). Contingent valuation and endangered species : methodological issues and applications. Cheltenham, UK ; Brookfield, Vt., US, E. Elgar.

Johansson, P.-O. (1987). The economic theory and measurement of environmental benefits. Cambridge [Cambridgeshire] ; New York, Cambridge University Press.

Johansson, P.-O. (1993). Cost-benefit analysis of environmental change. Cambridge ; New York, Cambridge University Press.

Johansson, P.-O., B. Kriström, et al. (1995). Current issues in environmental economics. Manchester ; New York, Manchester University Press ; Distributed exclusively in the USA and Canada by St. Martin's Press.

Johnston, R. J. and S. K. Swallow (1999). "Asymmetries in ordered strength of preference models: implications of focus shift for discrete-choice preference estimation." Land Economics 75(2): 295-310.

Johnston, R. J., S. K. Swallow, et al. (1999). "Estimating Willingness to Pay and Resource Tradeoffs with Different Payment Mechanisms: An Evaluation of a Funding Guarantee for Watershed Management." Journal of Environmental Economics and Management 38(1): 97-120.

Johnston, R. J., T. F. Weaver, et al. (1995). "Contingent valuation focus groups: Insights from ethnographic interview techniques." Agricultural and Resource Economics Review 24(1): 56-69.

Jones and Stokes Associates, I. (1993). Environmental impact report for the review of Mono Basin water rights of the City of Los Angeles., California State Water Resources Control Board.

Kahn, J. R. (1995). "Square Pegs and Round Holes: Can the Economic Paradigm Be Used to Value the Wilderness?" Growth and Change 26(4): 591-610.

Kahneman, D. and J. L. Knetsch (1992). "Valuing Public Goods: The Purchase of Moral Satisfaction." Journal of Environmental Economics and Management 22(1): 57-70.

Kahneman, D., J. L. Knetsch, et al. (1991). "The Endowment Effect, Loss Aversion, and Status Quo Bias: Anomalies." Journal of Economic Perspectives 5(1): 193-206.

Kahneman, D., J. L. Knetsch, et al. (1991). Experimental Tests of the Endowment Effect and the Coase Theorem. Quasi rational economics. New York, Russell Sage Foundation: 167-88.

Kahneman, D., I. Ritov, et al. (1993). "Stated willingness to pay for public goods: A psychological perspective." Psychological Science 4(5): 310-315.

Kahneman, D., P. Slovic, et al. (1982). Judgment under uncertainty : heuristics and biases. Cambridge ; New York, Cambridge University Press.

Kahneman, D. and A. Tversky (1984). "Choices, values and frames." American psychologist 39: 341-350.

Keith, J. E., C. Fawson, et al. (1996). "Preservation or Use: A Contingent Valuation Study of Wilderness Designation in Utah." Ecological Economics 18(3): 207-14.

Kimmins, J. P. H. (1992). Biodiversity: An environmental imperative. Forestry on the Hill. Ottawa, Canada, Canadian Forestry Association: 3-12.

Knetsch, J. L. (1990). "Environmental Policy Implications of Disparities between Willingness to Pay and Compensation Demanded Measures of Values." Journal of Environmental Economics and Management 18(3): 227-37.

Knetsch, J. L. (1992). "Preferences and Nonreversibility of Indifference Curves." Journal of Economic Behavior and Organization 17(1): 131-39.

Knetsch, J. L. (1994). "Environmental Valuation: Some Problems of Wrong Questions and Misleading Answers." Environmental Values 3(4): 351-68.

Knetsch, J. L. (1997). Evaluation and Environmental Policies: Recent Behavioural Findings and Further Implications. Sustainability and global environmental policy: New perspectives. Cheltenham, U.K. and Lyme, N.H., Elgar; distributed by American International Distribution; Corporation ; Williston Vt.: 193-212.

Knowles, D. R. and United States. Dept. of the Interior. (1992). Recovery plan for the northern spotted owl - draft. [Portland, Or.?], U.S. Dept. of the Interior.

Kohn, R. E. (1993). "Measuring the Existence Value of Wildlife: Comment." Land Economics 69(3): 304-08.

Kopp, R. J. and K. A. Pease (1997). Contingent valuation: economics, law, and politics. Determining the value of non-marketed goods : economic, psychological, and policy relevant aspects of contingent valuation methods. R. J. Kopp, W. W. Pommerehne and N. Schwarz. Boston, Kluwer Academic Publishers: viii, 333.

Kopp, R. J., W. W. Pommerehne, et al. (1997). Determining the value of non-marketed goods : economic, psychological, and policy relevant aspects of contingent valuation methods. Boston, Kluwer Academic Publishers.

Krinsky, I. and A. L. Robb (1986). "On Approximating the Statistical Properties of Elasticities." Review of Economics and Statistics 68(4): 715-19.

Krinsky, I. and A. L. Robb (1990). "On Approximating the Statistical Properties of Elasticities: A Correction." Review of Economics and Statistics 72(1): 189-90.

Kristrom, B. (1990). "A Non-parametric Approach to the Estimation of Welfare Measures in Discrete Response Valuation Studies." Land Economics 66(2): 135-39.

Kristrom, B. (1997). Practical problems in contingent valuation. Determining the value of non-marketed goods : economic, psychological, and policy relevant aspects of contingent valuation methods. R. J. Kopp, W. W. Pommerehne and N. Schwarz. Boston, Kluwer Academic Publishers: viii, 333.

Krutilla, J. K. (1967). "Conservation reconsidered." American Economic Review 57(4): 777-786.

Kuhfeld, W. (1996). Multinomial Logit, Discrete Choice Modeling: An Introduction to Designing Choice Experiments, Collecting, Processing and Analyzing Choice Data with the SAS System, SAS Institute, Inc.: 160.

Kuhfeld, W. F., R. D. Tobias, et al. (1994). "Efficient Experimental Design with Marketing Research Applications." JMR, Journal of marketing research XXXI(4): 545.

Lancaster, K. (1966). "A new approach to consumer theory." Journal of Political Economy 74: 132-157.

Lande, R. (1988). "Demographic models of the northern spotted owl." Oecologia 75: 601-607.

Langford, I. H. and I. J. Bateman (1999). Multi-level modeling and contingent valuation. Valuing environmental preferences : theory and practice of the contingent valuation method in the US, EU, and developing countries. I. Bateman and K. G. Willis. Oxford [England] ; New York, Oxford University Press: 442-459.

Larson, D. M. (1993). "On Measuring Existence Value." Land Economics 69(4): 377-88.

Layton, D. F., G. M. Brown, Jr., et al. (1999). Valuing multiple programs to improve fish populations. Seattle, WA, University of Washington, Dept. of Economics: 25.

Lazari, A. G. and D. A. Anderson (1994). "Designs of Discrete Choice Set Experiments for Estimating Both Attribute and Availability Cross Effects." JMR, Journal of marketing research XXXI(3): 375.

Levin, S. A. (1993). "Introduction to Ecological Applications Forum on Preserving Biodiversity." Ecological Applications 3(2): 201.

Li, C.-Z., K.-G. Lofgren, et al. (1996). "Real Versus Hypothetical Willingness to Accept: The Bishop and Heberlein Model Revisited." University of California, Berkeley, Department of Agricultural and Resource Economics 793: 15.

Loomis, J., M. Creel, et al. (1991). "Comparing Benefit Estimates from Travel Cost and Contingent Valuation Using Confidence Intervals for Hicksian Welfare Measures." Applied Economics 23(11): 1725-31.

Loomis, J. and E. Ekstrand (1998). "Alternative Approaches for Incorporating Respondent Uncertainty When Estimating Willingness to Pay: The Case of the Mexican Spotted Owl." Ecological Economics 27(1): 29-41.

Loomis, J. and et al. (1996). "Improving Validity Experiments of Contingent Valuation Methods: Results of Efforts to Reduce the Disparity of Hypothetical and Actual Willingness to Pay." Land Economics 72(4): 450-61.

Loomis, J. and et al. (1997). "Evaluating the Validity of the Dichotomous Choice Question Format in Contingent Valuation." Environmental and Resource Economics 10(2): 109-23.

Loomis, J. and et al. (1998). "Paired Comparison Estimates of Willingness to Accept versus Contingent Valuation Estimates of Willingness to Pay." Journal of Economic Behavior and Organization 35(4): 501-15.

Loomis, J. and et al. (1998). "Paired Comparison Estimates of Willingness to Accept versus; Contingent Valuation Estimates of Willingness to Pay." Journal of Economic Behavior and Organization 35(4): 501-15.

Loomis, J., A. Gonzalez-Caban, et al. (1994). "Do Reminders of Substitutes and Budget Constraints Influence Contingent Valuation Estimates?" Land Economics 70(4): 499-506.

Loomis, J., A. Gonzalez-Caban, et al. (1995). "Do Reminders of Substitutes and Budget Constraints Influence Contingent Valuation Estimates? Reply." Land Economics 71(4): 544-45.

Loomis, J. B. (1997). "Panel Estimators to Combine Revealed and Stated Preference Dichotomous Choice Data." Journal of Agricultural and Resource Economics 22(2): 233-45.

Loomis, J. B. and E. Ekstrand (1997). "Economic Benefits of Critical Habitat for the Mexican Spotted Owl: A Scope Test Using a Multiple-Bounded Contingent Valuation Survey." Journal of Agricultural and Resource Economics 22(2): 356-66.



- Loomis, J. B. and A. Gonzalez-Caban (1996). "The Importance of the Market Area Determination for Estimating Aggregate Benefits of Public Goods: Testing Differences in Resident and Nonresident Willingness to Pay." Agricultural and Resource Economics Review 25(2): 161-70.
- Loomis, J. B. and A. Gonzalez-Caban (1998). "A Willingness-to-Pay Function for Protecting Acres of Spotted Owl Habitat from Fire." Ecological Economics 25(3): 315-22.
- Loomis, J. B. and D. S. White (1996). "Economic Benefits of Rare and Endangered Species: Summary and Meta-analysis." Ecological Economics 18(3): 197- 206.
- Louviere, J. J. (1988). Analyzing decision making : metric conjoint analysis. Newbury Park, Sage Publications.
- Lux, A., D. Au, et al. (1993). 1993 Oregon covered employment and payrolls by industry and county. Salem, Oregon, Employment Department, State of Oregon.: 245.
- Mackenzie, J. (1993). "A Comparison of Contingent Preference Models." American Journal of Agricultural Economics 75(3): 593-603.
- Macmillan, D., N. Hanley, et al. (1996). "A Contingent Valuation Study of Uncertain Environmental Gains." Scottish Journal of Political Economy 43(5): 519-33.
- Mattson, L. and C.-Z. Li (1994). "Sample non-response in a mail contingent valuation survey: an empirical test of the effect of nonresponse bias." Journal of Leisure Research 26(2): 182-188.
- Mazzotta, M. J., J. J. Opaluch, and T.A. Grigalunas (2000). "Identifying symbolic effects from contingent choice surveys: a case study of the Peconic Bay Estuary System." University of Rhode Island, Department of Environmental and Natural Resource Economics Working Paper.
- Mazzotta, M. J. and J. J. Opaluch (1995). "Decision Making When Choices Are Complex: A Test of Heiner's Hypothesis." Land Economics 71(4): 500-515.
- Mazzotta, M. J., J. J. Opaluch, et al. (1994). "Natural Resource Damage Assessment: The Role of Resource Restoration." Natural Resources Journal 34(1): 153-78.

- McConnell, K. E. (1990). "Models for Referendum Data: The Structure of Discrete Choice Models for Contingent Valuation." Journal of Environmental Economics and Management 18(1): 19-34.
- McConnell, K. E. (1995). "Consumer Surplus from Discrete Choice Models." Journal of Environmental Economics and Management 29(3): 263-70.
- McConnell, K. E. (1997). "Does Altruism Undermine Existence Value?" Journal of Environmental Economics and Management 32(1): 22-37.
- McConnell, K. E., J. N. Daberkow, et al. (1983). "Planning Timber Production with Evolving Prices and Costs." Land Economics 59(3): 292-99.
- McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. Frontiers in econometrics. P. Zarembka. New York, Academic Press: 105-142.
- McLeod, D. M. (1994). Valuing nonmarket goods and services : a test for bias in the iterated referendum-contingent valuation format.
- McLeod, D. M. and O. Bergland (1999). "Willingness-to-Pay Estimates Using the Double-Bounded Dichotomous-Choice Contingent Valuation Format: A Test for Validity and Precision in a Bayesian Framework." Land Economics 75(1): 115-25.
- Metrick, A. and M. L. Weitzman (1996). "Patterns of Behavior in Endangered Species Preservation." Land economics 72(1): 1.
- Metrick, A. and M. L. Weitzman (1998). "Endangered Species Act - "Conflicts and Choices in Biodiversity Preservation"." The journal of economic perspectives : a journal of the American Economic Association 12(3): 21.
- Mitchell, R. C. and R. T. Carson (1986). Some Comments on the State of the Arts Assessment of the Contingent Valuation Method Draft Report: Appendix. Valuing environmental goods: An assessment of the contingent valuation method. R. G. Cummings. Totowa, N.J., Littlefield Adams; Rowman and Allanheld: 237-45.
- Mitchell, R. C. and R. T. Carson (1989). Using surveys to value public goods: The contingent valuation method. Washington, D.C., Resources for the Future.

Mitchell, R. C. and R. T. Carson (1995). Current Issues in the Design, Administration, and Analysis of; Contingent Valuation Surveys. Current issues in environmental economics. P.-O. B. K.-G. Johansson. Manchester, Manchester University Press; distributed in the U.S. and Canada by; St.; Martin's Press New York: 10-34.

Montgomery, C. and G. M. Brown, Jr. (1992). "Economics of Species Preservation: The Spotted Owl Case." Contemporary Policy Issues 10(2): 1- 12.

Montgomery, C. A., G. M. Brown, Jr., et al. (1994). "The Marginal Cost of Species Preservation: The Northern Spotted Owl." Journal of Environmental Economics and Management 26(2): 111-28.

Montgomery, C. A. and et al. (1999). "Pricing Biodiversity." Journal of Environmental Economics and Management 38(1): 1-19.

Naiman, R. J., H. Decamps, et al. (1993). "The role of riparian corridors in maintaining regional biodiversity." Ecological applications : a publication of the Ecological Society of America 3(2): 209-212.

Nickerson, C. A. E. (1995). "Does Willingness to Pay Reflect the Purchase of Moral Satisfaction? A Reconsideration of Kahneman and Knetsch." Journal of Environmental Economics and Management 28(1): 126-33.

Noss, R. F. (1990). "Indicators for Monitoring Biodiversity: A Hierarchical Approach." Conservation biology : the journal of the Society for Conservation Biology 4(4): 355.

Noss, R. F. (1993). "A conservation plan for the Oregon Coast Range: Ssome preliminary suggestion." Natural Areas Journal 13(4): 276-290.

Noss, R. F., E. T. L. III, et al. (1995). Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation, National Biological Service: 58.

Oliver, C. D. (1992). "A landscape approach. Achieving and maintaining biodiversity and economic productivity." Journal of Forestry 90(10): 20-25.

OMB. (1987). Standard Industrial Classification Index. Washington, D.C., Office of Management and Budget, Executive Office of the President.

OMB. (1996). *Economic Analysis of Federal Regulations Under Executive Order 12866*. Washington, D.C., Office of Management and Budget, Executive Office of the President.

Opaluch, J. J. and et al. (1993). "Evaluating Impacts from Noxious Facilities: Including Public Preferences in Current Siting Mechanisms." Journal of Environmental Economics and Management 24(1): 41-59.

Oregon Coastal Salmon Restoration Initiative. (1997). The Oregon plan : restoring an Oregon legacy through cooperative efforts. [Salem, Or.], Coastal Salmon Restoration Initiative.

Oregon Progress Board, State of Oregon. (1998). *Oregon Population Survey*, State of Oregon Office of Economic Analysis, Oregon State Library, Oregon Progress Board. 2000.

Oregon Department of Forestry. (1998). Northwest Oregon state forests management plan : draft. Salem, OR, Oregon Department of Forestry.

Orians, G. H. (1990). The Preservation and valuation of biological resources. Seattle, University of Washington Press.

Orians, G. H. (1993). "Endangered at what level?" Ecological applications : a publication of the Ecological Society of America 3(2): 206-208.

Park, T. A., J. B. Loomis, et al. (1991). "Confidence Intervals for Evaluating Benefits Estimates from Dichotomous Choice Contingent Valuation Studies." Land Economics 67(1): 64-73.

Patterson, D. A. and J. W. Duffield (1991). "Comment on Cameron's Censored Logistic Regression Model for Referendum Data." Journal of Environmental Economics and Management 20(3): 275-83.

Payne, J. W., J. R. ettman, et al. (1992). "Behavioral decision theory: A constructive processing perspective." Annual review of psychology 43: 87-131.

Pearce, D. W., D. Moran, et al. (1994). The economic value of biodiversity. London, Earthscan.

- Peterson, G. L. and T. C. Brown (1998). "Economic Valuation by the Method of Paired Comparison, with; Emphasis on Evaluation of the Transitivity Axiom." Land Economics 74(2): 240-61.
- Phillips, W. E., T. J. Haney, et al. (1993). "An Economic Analysis of Wildlife Habitat Preservation in Alberta." Canadian Journal of Agricultural Economics 41(4): 411-18.
- Polasky, S., J. Camm, et al. (2000). "Selecting Biological Reserves Cost-Effectively: An Application to Terrestrial Vertebrate Conservation in Oregon." Land Economics in press.
- Polasky, S., A. Solow, et al. (1993). "Searching for Uncertain Benefits and the Conservation of Biological Diversity." Environmental and Resource Economics 3(2): 171-81.
- Polasky, S. and A. R. Solow (1995). "On the Value of a Collection of Species." Journal of Environmental Economics and Management 29(3): 298-303.
- Pollak, R. A. and T. J. Wales (1991). "The Likelihood Dominance Criterion: A New Approach to Model Selection." Journal of Econometrics 47(2-3): 227-42.
- Portney, P. R. (1994). "The Contingent Valuation Debate: Why Economists Should Care." Journal of Economic Perspectives 8(4): 3-17.
- Quiggin, J. (1998). "Individual and Household Willingness to Pay for Public Goods." American Journal of Agricultural Economics 80(1): 58-63.
- Randall, A. (1982). "Economic Surplus Concepts and Their Use in Benefit Cost Analysis." Review of Marketing and Agricultural Economics 50(2): 135-63.
- Randall, A. (1985). "Benefit Cost Analysis of Environmental Program Alternatives: Economics, Political Philosophy and the Policy Process." Ricerche Economiche 39(4): 483-90.
- Randall, A. (1986). Valuation in a Policy Context. Natural resource economics: Policy problems and contemporary analysis. D. W. Bromley. Recent Economic Thought Series; Dordrecht and Lancaster, Kluwer Nijhoff; distributed in the U.S. and Canada by Kluwer Academic Hingham Mass: 163-99.

- Randall, A. (1988). Property Institutions and Economic Behavior. Institutional economics. W. J. Samuels. Schools of Thought in Economics series, no. 5; Aldershot, U.K., Brookfield, Vt.; Elgar Gower: 338-58.
- Randall, A. (1993). "What Practicing Agricultural Economists Really Need to Know about Methodology." American Journal of Agricultural Economics 75(0): 48-59.
- Randall, A. (1994). "A Difficulty with the Travel Cost Method." Land Economics 70(1): 88-96.
- Randall, A. (1997). "The NOAA Panel Report: A New Beginning or the End of an Era?" American Journal of Agricultural Economics 79(5): 1489-94.
- Randall, A. (1998). "Beyond the Crucial Experiment: Mapping the Performance; Characteristics of Contingent Valuation." Resource and Energy Economics 20(2): 197-206.
- Randall, A. and J. Hoehn (1989). Benefit Estimation for Complex Policies. Valuation methods and policy making in environmental economics: Selected and integrated papers from the Congress "Environmental Policy in a Market Economy," Wageningen, The Netherlands, 8-11 September 1987. H. Folmer and E. van Ierland. Studies in Environmental Science, no. 36; Amsterdam; Oxford; New York and Tokyo, Elsevier Science: 219-29.
- Randall, A. and J. P. Hoehn (1996). "Embedding in Market Demand Systems." Journal of Environmental Economics and Management 30(3): 369-80.
- Randall, A., J. P. Hoehn, et al. (1983). "Contingent Valuation Surveys for Evaluating Environmental Assets." Natural Resources Journal 23(3): 635-48.
- Randall, A. and J. R. Stoll (1980). "Consumer's Surplus in Commodity Space." American Economic Review 70(3): 449-55.
- Ready, R. C., J. C. Whitehead, et al. (1995). "Contingent Valuation When Respondents Are Ambivalent." Journal of Environmental Economics and Management 29(2): 181-96.
- Riddel, M. and J. Loomis (1998). "Joint Estimation of Multiple CVM Scenarios under a Double Bounded Questioning Format." Environmental and Resource Economics 12(1): 77-98.

Roe, B., K. J. Boyle, et al. (1996). "Using Conjoint Analysis to Derive Estimates of Compensating Variation." Journal of Environmental Economics and Management 31(2): 145-59.

Samuelson, W. and R. Zeckhauser (1988). "Status Quo Bias in Decision Making." Journal of Risk and Uncertainty 1(1): 7-59.

Schkade, D. A. and J. W. Payne (1993). Where Do the Numbers Come from? How People Respond to Contingent Valuation Questions. Contingent valuation: A critical assessment. J. A. Hausman. Contributions to Economic Analysis, vol. 220.; Amsterdam; London and Tokyo, North-Holland; distributed in the U.S. and Canada by Elsevier Science New York: 271-93.

Schkade, D. A. and J. W. Payne (1994). "How People Respond to Contingent Valuation Questions: A Verbal Protocol Analysis of Willingness to Pay for an Environmental Regulation." Journal of Environmental Economics and Management 26(1): 88-109.

Scott, J. M., F. Davis, et al. (1993). Gap Analysis: A geographic approach to protection of biological diversity, Wildlife Society.

Secretary of State Office, E. D., State of Oregon (1998). Official voter participation by party, November 3, 1998 General Election. 2000.

Shogren, J. F. and et al. (1994). "Resolving Differences in Willingness to Pay and Willingness to Accept." American Economic Review 84(1): 255-70.

Smith, V. K. (1996). "Can Contingent Valuation Distinguish Economic Values for Different Public Goods?" Land Economics 72(2): 139-51.

Smith, V. K. and L. L. Osborne (1996). "Do Contingent Valuation Estimates Pass a "Scope" Test? A Meta-analysis." Journal of Environmental Economics and Management 31(3): 287-301.

Solow, A., S. Polasky, et al. (1993). "On the Measurement of Biological Diversity." Journal of Environmental Economics and Management 24(1): 60-68.

Spash, C. L. and N. Hanley (1997). Preferences, Information and Biodiversity Preservation. The development of ecological economics. R. C. J. C. Costanza. Elgar Reference Collection. International Library of Critical; Writings in; Economics, vol. 75.; Cheltenham

ham, U.K. and Lyme, N.H., Elgar; distributed by American International Distribution; Corporation ; Williston Vt.: 552-69.

Steckel, J. H., W. S. DeSarbo, et al. (1991). "On the creation of acceptable conjoint experimental designs." Decision Science 22: 435-442.

Stevens, T. H., R. Belkner, et al. (2000). "Comparison of contingent valuation and conjoint analysis in ecosystem management." Ecological Economics 32(1): 63-74.

Stevens, T. H., R. Glass, et al. (1991). "Wildlife Recovery: is Benefit--Cost Analysis Appropriate?" Journal of environmental management 33(4): 327-334.

Stevens, T. H., T. A. More, et al. (1991). "Measuring the Existence Value of Wildlife." Land Economics 67(4): 390-400.

Sugden, R. (1999). Public goods and contingent valuation. Valuing environmental preferences: theory and practice of the contingent valuation method in the US, EU, and developing countries. I. Bateman and K. G. Willis. Oxford [England] ; New York, Oxford University Press: 17-41.

Svento, R. (1999). "On the Asymmetry of the Vagueness Band in Willingness to Pay Answers." Environmental and Resource Economics 14(1): 151-63.

Swait, J. and W. Adamowicz (1996). The Effect of Choice Environment and Task Demands on Consumer Behavior: Discriminating Between Contribution and Confusion. Edmonton, Alberta, University of Alberta, Department of Rural Economics: 36.

Swait, J. and J. Louviere (1993). "'The Role of the Scale Parameter in the Estimation and Comparison of Multinomial Logit Models'." JMR, Journal of marketing research XXX(3): 305.

Swallow, S. K. (1996). "Economic Issues in Ecosystem Management: An Introduction and Overview." Agricultural and Resource Economics Review 25(2): 83-100.

Swallow, S. K. and et al. (1994). "Heterogeneous Preferences and Aggregation in Environmental Policy Analysis: A Landfill Siting Case." American Journal of Agricultural Economics 76(3): 431-43.



The White House, O. o. t. P. (1994). Executive Order #12866: Regulatory Planning and Review.

Train, K. (1986). Qualitative Choice Analysis: Theory, Econometrics, and Application to Automobile Demand. Cambridge, Mass, The MIT Press.

Train, K. E. (1995). Simulation Methods for Probit and Related Models Based on; Convenient Error Partitioning: 17.

Train, K. E. (1998). "Recreation Demand Models with Taste Differences over People." Land Economics 74(2): 230-39.

Turner, R. K. (1999). The place of economic values in environmental valuation. Valuing environmental preferences : theory and practice of the contingent valuation method in the US, EU, and developing countries. I. Bateman and K. G. Willis. Oxford [England] ; New York, Oxford University Press: 17-41.

Tversky, A. and D. Kahneman (1974). "Judgement under uncertainty: Heuristics and biases." Science 185: 1124-1131.

Tversky, A., P. Slovic, et al. (1988). "Contingent weighting in judgement and choice." Psychological Review 95(3): 371-384.

USACE. (1999). Estimates of the Population of Counties by Age, Sex, Race and Hispanic Origin: 1990 to 1998. US Army Corps of Engineers, Washington, D.C..

USDA Forest Service, U. B. o. L. M. (1994). Record of Decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl and Standards and Guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. Portland, OR, USDA Forest Service and USDI Bureau of Land Management.

USFWS. (1982). Pacific Coast recovery plan for the American peregrine falcon. Denver, CO, U.S. Fish and Wildlife Service: 87.

USFWS. (1983). Revised Columbian white-tailed deer recovery plan. Denver, CO, U.S. Fish and Wildlife Service: 75.

- USFWS. (1986). Recovery Plan for the Pacific bald eagle. Portland, OR, U.S. Fish and Wildlife Service: 160.
- USFWS. (1991). Aleutian Canada goose recovery plan. Anchorage, AK, U.S. Fish and Wildlife Service: 55.
- USFWS. (1992). Recovery Plan for the Northern Spotted Owl, Final Draft. Portland, OR, U.S. Fish and Wildlife Service.
- USFWS. (1997). Recovery Plan for the Threatened Marbled Murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, Or, U.S. Fish and Wildlife Service.
- Vaidya, K. L. (1999). 1998 OREGON POPULATION SURVEY: SUMMARY OF FINDINGS. Salem, Oregon, Office of Economic Analysis, Department of Administrative Services, State of Oregon: 12.
- Varian, H. R. (1984). Microeconomic analysis. New York, W.W. Norton.
- Vatn, A. and D. W. Bromley (1994). "Choices without Prices without Apologies." Journal of Environmental Economics and Management 26(2): 129-48.
- Walsh, R. G., D. M. Johnson, et al. (1992). "Benefit Transfer of Outdoor Recreation Demand Studies, 1968-1988." Water Resources Research 28(3): 707-13.
- Walsh, R. G. and J. R. McKean (1999). Option and anticipatory values of US wilderness. Valuing environmental preferences : theory and practice of the contingent valuation method in the US, EU, and developing countries. I. Bateman and K. G. Willis. Oxford [England] ; New York, Oxford University Press: xxii, 645.
- Wang, H. (1997). "Treatment of "Don't-Know" Responses in Contingent Valuation Surveys: A Random Valuation Model." Journal of Environmental Economics and Management 32(2): 219-32.
- Weiss, A. A. (1997). "Specification Tests in Ordered Logit and Probit Models." Econometric Reviews 16(4): 361-91.

Wilcove, D. (1993). "Getting ahead of the extinction curve." Ecological applications : a publication of the Ecological Society of America 3(2): 218-220.

Wilson, E. O. and F. M. P. A. Ed.), Eds. (1988). Biodiversity. Washington, D.C., National Acedemy Press.

Wimberly, M. C., T. A. Spies, et al. (2000). "Contributed Papers - Simulating Historical Variability in the Amount of Old Forests in the Oregon Coast Range." Conservation biology : the journal of the Society for Conservation Biology 14(1): 167.

Xu, W. (1997). Experimental Choice Analysis of Non-market Values for Ecosystem Management with Preference Heterogeneity. Forestry. Seattle, WA, University of Washington: 156.

Yankelovich, D. (1991). Coming to public judgment : making democracy work in a complex world. Syracuse, N.Y., Syracuse University Press.

## Appendix A: Survey Mailings

Figure A-1. First mailing - cover letter

June, 1999

Dear Mr. Pruett,

The forests of the Oregon Coast Range are among our state's most valued natural assets. For generations, Oregonians have enjoyed a host of benefits provided by Coast Range forests, including timber and wood products, wildlife, recreation, and scenery. In the last decade, there has been much controversy over how to manage Oregon's forests as competing uses have come into increasing conflict. Better understanding of what Oregonians want from coastal forests is essential for managers to use and conserve these resources responsibly. Currently, forest managers lack information on Oregonians' preferences for the full range of forest benefits, particularly the value of ecological conservation.

Your participation in this project is very important. You are one of a very small number of people receiving the enclosed questionnaire, which asks you to give your opinions on forest management policy. Your name was drawn from a scientific sample of Oregon residents. In order for the study to accurately represent the range of views held by Oregonians on forest and wildlife management, it is important that you complete the enclosed questionnaire. It should only take about 25 minutes to complete.

Any information you provide is strictly confidential and will be used only in combination with information provided by other Oregon households. The identification number on the front page is for mailing purposes only. It will be used to avoid sending you any unnecessary follow-up mailings.

The answers that you provide will be important for forest management in Oregon. The results of the study will be used by federal and state forest management agencies and will be made available to government representatives and any interested citizens.

When you have completed the questionnaire, please place it and any comment pages into the addressed, stamped return envelope and drop it into any mailbox.

The dollar bill in the envelope is a token of our appreciation for your participation in the project. Your answers are much more valuable than this, and we understand you are busy. Please accept our thanks for your time and effort.

Again, your answers and comments are very important to the success and reliability of this study. Questions about this survey can be addressed to Brian Garber-Yonts at (541) 737-5874, or by email at [yonts@cof.orst.edu](mailto:yonts@cof.orst.edu).

Thank you very much for your assistance!

Sincerely,

Professor Rebecca Johnson  
Project Leader

Figure A-2. First mailing - survey booklet

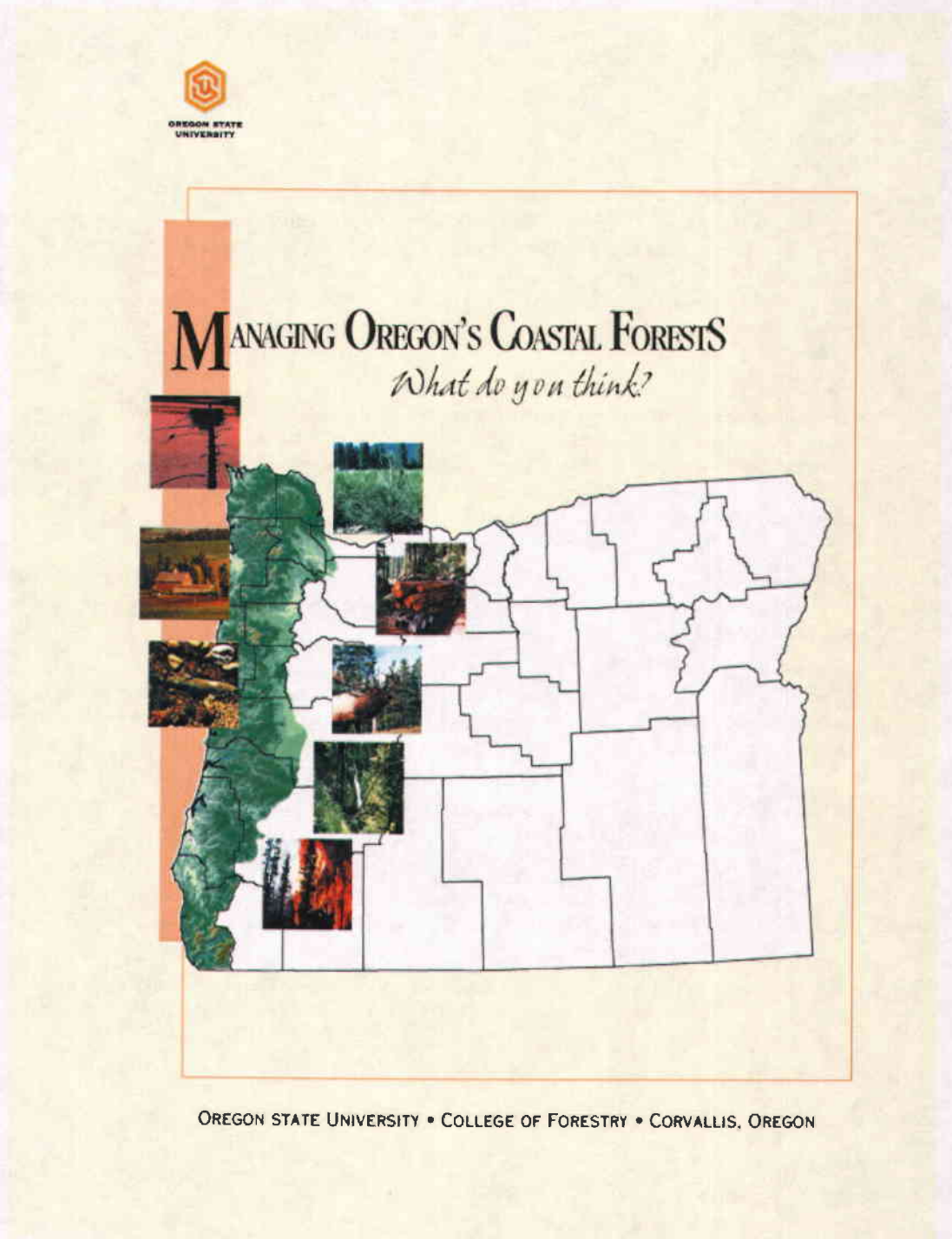


Figure A-2.(Continued) First mailing - survey booklet



The Forests of the Oregon Coast Range are among the most productive in the world. Coastal forests provide lumber and wood products, wildlife, recreation, scenery, and water quality. Forest managers are finding better ways to produce all of these benefits together. Nonetheless, management of coastal forestlands often involves making some tradeoffs between different forest benefits.

Forest managers and policy makers would like to know what you as an Oregonian want from Coast Range forestlands. Please answer all of the questions in this survey. This is your chance to give us your opinion.

Please indicate how important the following Coast Range forest benefits are to you. Circle one numbered response on each line.

	Not Important	2	3	4	5 Extremely Important
Hiking and camping . . . . .	1	2	3	4	5
Wildlife viewing . . . . .	1	2	3	4	5
Paper, lumber, and other wood products . . . . .	1	2	3	4	5
Mushroom, berry, or greenery picking . . . . .	1	2	3	4	5
Pleasure from seeing the forests . . . . .	1	2	3	4	5
Fishing . . . . .	1	2	3	4	5
Off-road motorized recreation . . . . .	1	2	3	4	5
Control of flooding and soil erosion . . . . .	1	2	3	4	5
Firewood . . . . .	1	2	3	4	5
Satisfaction of knowing forests are there now and in the future . . . . .	1	2	3	4	5
Hunting . . . . .	1	2	3	4	5
Mountain biking . . . . .	1	2	3	4	5
Other (please specify below) . . . . .	1	2	3	4	5

Have you ever visited the Oregon Coast Range before? . . . . . (circle one) Yes No  
If yes, about how long has it been since your last visit? \_\_\_\_\_

Figure A-2.(Continued) First mailing - survey booklet

**SECTION I: BIODIVERSITY MANAGEMENT**



*What Is Biodiversity?.....*

Scientists use the term **biodiversity** to describe the variety of life found in places from as small as a mud puddle to as large as the Oregon Coast Range. Biodiversity includes the number and variety of individual species, as well as the variety of habitats and natural communities found over the landscape.

State and federal officials, as well as private landowners, are considering ways to conserve biodiversity in Oregon's Coast Range. This requires making decisions about which species and habitats to give the highest priority and the best ways to conserve them. There are different approaches that can be taken to conserve biodiversity. For example, some approaches may target endangered species at high risk of extinction while others focus on protecting large areas of forest habitat.

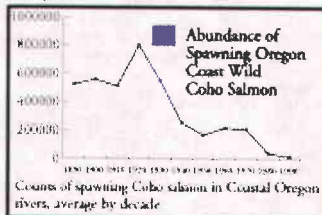
Have you read or heard the term "biodiversity" before? .....	YES	NO	NOT SURE
Have you read or heard about the loss of biodiversity around the world? .....	YES	NO	NOT SURE
Do you think that loss of biodiversity is an important issue in the Oregon Coast Range? .....	YES	NO	NOT SURE

The following pages will describe four different biodiversity conservation programs and ask your opinion about their importance to you.

**PROGRAM I: PROTECTION OF COASTAL SALMON HABITAT**

Scientists warn that most native salmon and steelhead species on the Oregon coast are at levels far below their historical numbers. Three species have been identified as endangered by the federal government.

The populations of some species of salmon are maintained by hatcheries, however, many wild salmon populations native to individual streams in the Coast Range are at very low levels.



Are hatchery salmon an acceptable substitute for wild salmon?					
Definitely Yes	Indifferent		Definitely No		Don't Know
1	2	3	4	5	6

When I buy salmon in a store or restaurant, I prefer wild salmon to hatchery or farm-raised.

Strongly Agree	Indifferent		Strongly Disagree		Not Applicable
1	2	3	4	5	6

When I fish for salmon, I prefer to catch wild salmon.

Strongly Agree	Indifferent		Strongly Disagree		Not Applicable
1	2	3	4	5	6

Figure A-2.(Continued) First mailing - survey booklet

Poor stream habitat, in addition to other factors, is believed to be an important cause of decline in many salmon populations. Road building, farming, logging, urban and residential development and other land uses have all contributed to the problem by

- contaminating streams with fertilizer, soil, and other pollutants
- altering fresh water flow and increasing water temperature
- decreasing streamside vegetation
- reducing other stream habitat elements needed by salmon

Scientists believe protection of wild salmon in each individual Coast Range stream is important to maintaining the long-term health of salmon species. Protection would also improve water quality and stream habitats for other species.

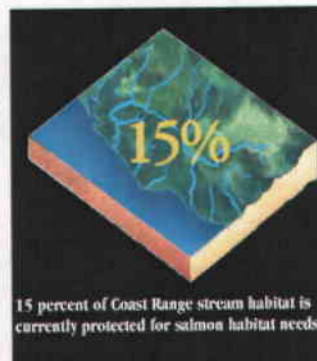


Have you read or heard about the decline of Oregon's native salmon populations? ..... YES NO NOT SURE

Have you read or heard about the Governor's salmon restoration plan? ..... YES NO NOT SURE

Currently, streams on federally owned land are managed to give the highest level of protection for salmon habitat. Many individual land owners are also involved in improving salmon habitat on their own land. Extending salmon habitat protection on other public and private land is the next step in improving the conditions for wild salmon populations on the Oregon Coast.

There are about 14,000 miles of salmon streams in the Coast Range. Currently, about 15% are managed to give salmon the highest level of protection. Increasing the miles of streams with high-quality salmon habitat would require restricting many activities on land near each stream. This could reduce the number of trees available for harvest and limit the building and use of roads near streams. Farming, grazing, logging, and building practices that cause erosion and pollution would all be reduced and the cost of these activities would go up. Habitat restoration such as removal of artificial barriers and erosion control will entail additional costs.



Is it important to you to increase the miles of Coast Range streams that are managed to protect salmon habitat?

Not Important at All		Somewhat Important		Extremely Important
1	2	3	4	5

Owners of private land near salmon streams may be asked to restrict activities on their land that are harmful to salmon habitat. Do you think that the general public should pay private landowners for the costs of these restrictions?

Definitely Yes		Neutral		Definitely No
1	2	3	4	5




Figure A-2.(Continued) First mailing - survey booklet

**PROGRAM II: THREATENED AND ENDANGERED SPECIES PROTECTION**

Endangered species are those plant and animal species which are at very high risk of becoming extinct. The federal government has identified 48 endangered species in the state of Oregon, 12 of which are native to the Oregon Coast Range. Natural factors have played a role in the decline of some species, however loss of habitat to land uses like agriculture, timber harvest and residential and urban development is often the most important cause of decline in coast range species. Other factors are the effects of non-native species imported by humans and direct uses like hunting and fishing.

**THREATENED AND ENDANGERED SPECIES  
NATIVE TO THE OREGON COAST RANGE**

<p><b>Mammals</b></p> <p>a. Columbian white-tailed deer</p>	<p><b>Flowering plants</b></p> <p>f. Western lily g. Nelson's sidalcea</p>	
<p><b>Fish</b></p> <p>b. coho salmon c. coastal cutthroat trout d. winter steelhead trout</p>	<p><b>Birds</b></p> <p>h. marbled murrelet i. bald eagle j. peregrine falcon k. California condor l. Northern spotted owl</p>	
<p><b>Insects</b></p> <p>e. Oregon silverspot butterfly</p>		

In the table above, please circle any of these species that you have heard of.

Which three species do you think should be top priority for conservation efforts? (please write the letter of each species)

1st priority \_\_\_\_\_  
2nd priority \_\_\_\_\_  
3rd priority \_\_\_\_\_

The federal Endangered Species Act requires federal agencies to develop recovery plans with the goal of restoring each endangered species so that they are no longer in danger of dying out. Federal land makes up about 15% of the Coast Range, and species recovery plans give the highest priority to protection of endangered species. Private individuals and state and local governments are also restricted from harming endangered species. Species that require very large areas of habitat or whose populations exist mainly on non-federally owned land receive some protection, but their long-term survival is much less certain. One way to increase the level of protection given to endangered species is to extend recovery plans to some non-federal land in the Coast Range. This would allow habitat protection and active recovery efforts to include up to an additional 85% of the land in the Coast Range.

Species recovery plans are expensive to design and put to work. In addition to the limitations on land uses that harm endangered species, plans require the work of many scientists and other trained individuals. Recovery plans for non-federal land would require the cooperation of private landowners and state and local agencies, and it would limit the use of land for recreational, residential, timber, and farm uses.



15%

Current policy protects endangered species habitat on 15% of the Oregon Coast Range.

Is it important to you to extend greater protection and recovery efforts for endangered species on non-federal land?

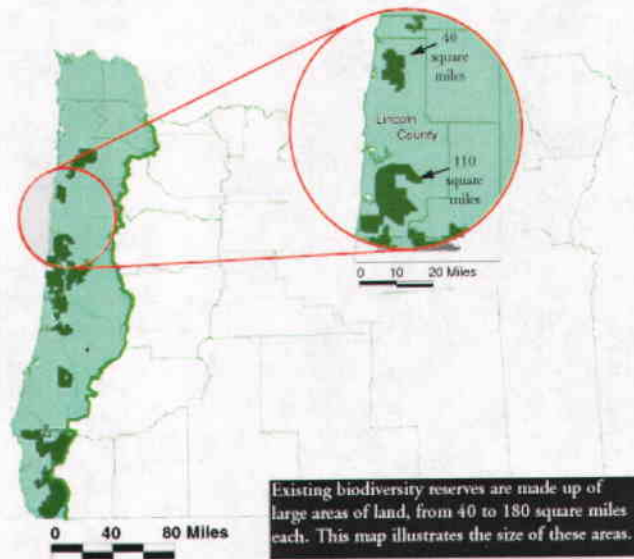
Not Important at All	Somewhat Important	Extremely Important
1	2	3
		4
		5

Figure A-2.(Continued) First mailing - survey booklet

**PROGRAM III: BIODIVERSITY RESERVES**

Protection of Coast Range ecosystems is an important element of biodiversity protection. Ecosystems are made up of the community of species and their complex interactions with each other and the physical environment. There are over 500 species of plants and animals native to the Oregon Coast Range, and a much larger but unknown number of small species such as insects, fungi, lichen, and soil micro-organisms. Ecological processes are important in maintaining this rich diversity of species. Many natural processes, like the cycle of forest fire and natural forest renewal, have been disrupted by human use of the landscape during this century. The long term consequences of this disruption for biodiversity and the health of Coast Range forests are unknown.

Forest managers have set aside some reserved areas that are large enough to maintain complex natural processes. These biodiversity reserves serve as natural laboratories to protect a large variety of species and habitats and limit the unknown effects of human land uses. To be effective, biodiversity reserves must be located on large areas of land, from 40 to 180 square miles in size. The map at right illustrates the location and size of areas currently reserved for biodiversity maintenance.



About 10% of Coast Range forests are now in biodiversity reserves, almost all of which are on land owned by the federal government. Expanding the network of biodiversity reserves would focus on protecting other habitats not presently found on federal land. Practices like logging, road building, grazing and residential development are sharply limited in biodiversity reserves. However, many types of low-impact recreation are permitted. Devoting private land to biodiversity reserves would require the cooperation of landowners and possibly the payment of compensation for lost land value.

Is it important to you to expand the network of 40-180 square mile biodiversity reserves?

Not Important at All		Somewhat Important		Extremely Important
1	2	3	4	5

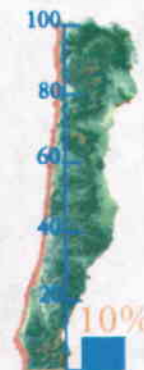


Figure A-2.(Continued) First mailing - survey booklet

**PROGRAM IV: THREATENED AND ENDANGERED SPECIES**

Endangered species are those plant and animal species which are at very high risk of becoming extinct. The federal government has identified 48 endangered species in the state of Oregon, 12 of which are native to the Oregon Coast Range. Natural factors have played a role in the decline of some species, however loss of habitat to land uses like agriculture, timber harvest and residential and urban development is often the most important cause of decline in coast range species. Other factors are the effects of non-native species imported by humans and direct uses like hunting and fishing.

**THREATENED AND ENDANGERED SPECIES  
NATIVE TO THE OREGON COAST RANGE**

<p><b>Mammals</b></p> <p>a. Columbian white-tailed deer</p> <p><b>Fish</b></p> <p>b. coho salmon</p> <p>c. coastal cutthroat trout</p> <p>d. winter steelhead trout</p> <p><b>Insects</b></p> <p>e. Oregon silverspot butterfly</p>	<p><b>Flowering plants</b></p> <p>f. Western lily</p> <p>g. Nelson's sidalcea</p> <p><b>Birds</b></p> <p>h. marbled murrelet</p> <p>i. bald eagle</p> <p>j. peregrine falcon</p> <p>k. California condor</p> <p>l. Northern spotted owl</p>
---	---

In the table above, please circle any of these species that you have heard of.

Which three species do you think should be top priority for conservation efforts?  
(please write the letter of each species)

1st priority \_\_\_\_\_  
2nd priority \_\_\_\_\_  
3rd priority \_\_\_\_\_

The federal Endangered Species Act requires federal agencies to develop recovery plans with the goal of restoring each endangered species so that they are no longer in danger of dying out. Federal land makes up about 15% of the Coast Range, and species recovery plans give the highest priority to protection of endangered species. Private individuals and state and local governments are also restricted from harming endangered species. Species that require very large areas of habitat or whose populations exist mainly on non-federally owned land receive some protection, but their long-term survival is much less certain. One way to increase the level of protection given to endangered species is to extend recovery plans to private and state land. This would protect endangered species habitat on the remaining 85% of land in the Coast Range.



Current policy protects endangered species habitat on 15% of the Oregon Coast Range.

Species recovery plans are expensive to design and put to work. In addition to the limitations on land uses that harm endangered species, plans require the work of many scientists and other trained individuals. Recovery plans for non-federal land would require the cooperation of private landowners and state and local agencies, and it would limit the use of land for recreational, residential, timber, and farm uses.

Is it important to you to extend greater protection and recovery efforts for endangered species on private and state (non-federal) land?

Not important at All	Somewhat Important	Extremely Important
1	2	3
		4
		5

Figure A-2.(Continued) First mailing - survey booklet

## MAKING A BIODIVERSITY PLAN

Each of the four programs on the previous pages is one part of a possible overall conservation strategy. The four programs overlap somewhat, but each has different advantages and no single approach is adequate to protect all of the elements of biodiversity.

Public agencies, working with private landowners, are discussing long range plans for conservation of species and ecosystems in our State. Each of the four programs discussed above could be part of the overall plan, but how to combine them is a difficult question.

Scientists and experts can provide some of the answers, but the most important input comes from you and other Oregonians.

On the next few pages, we ask that you consider the four conservation programs and decide which ones you prefer. All of the programs require public funding and some limitations on other forest uses. One way to pay for these programs would be to establish a biodiversity trust fund that would be paid into by the general public through income taxes. Forest users such as the timber industry and recreationists would also contribute through user fees. This money would only go to pay for protection of species and habitats in the Coast Range through some combination of the four biodiversity programs.

### Four Programs: A quick review

#### Program I: Salmon Streams

This program focuses on protecting and restoring salmon habitat in Coast Range streams. This would improve conditions for endangered salmon, and would focus on bringing all populations of salmon to greater levels of abundance.



#### Program II: Forest Age Management

This program focuses on changing the average age of the working forests of the Oregon Coast Range. This would improve species and habitat diversity on lands managed mainly for timber production.



#### Program III: Biodiversity Reserves

Instead of modifying land uses over the entire Coast Range to protect individual species, this approach reserves large patches of land from most human uses in order to protect whole ecosystems and retain natural processes.



#### Program IV: Endangered Species

This program focuses protection on the most severely threatened species. This approach gives some protection to other species using the same habitat, but generally doesn't become effective until a species is at extreme risk.



Each of the programs above addresses important concerns. In order to proceed with a conservation plan, it is necessary to prioritize. Please rank the following in terms of their importance to you, with the most important ranking 1 and the least important ranking 3: (do not rank any the same)

- \_\_\_\_\_ Increase the number of miles of stream habitat managed at the highest level of protection for coastal salmon.
- \_\_\_\_\_ Increase endangered species recovery on non-federal land
- \_\_\_\_\_ Increase the amount of forest in mid-age and old stages.
- \_\_\_\_\_ Increase the number of Biodiversity Reserves in the Coast Range.

Figure A-2.(Continued) First mailing - survey booklet

Policy makers need to know how you rate biodiversity protection compared to other government programs. How important are the following issues to you?

	Not Important at All	Somewhat Important	Extremely Important		
Improving public roads . . . . .	1	2	3	4	5
Improving education . . . . .	1	2	3	4	5
Improving health care . . . . .	1	2	3	4	5
Reducing unemployment . . . . .	1	2	3	4	5
Reducing crime . . . . .	1	2	3	4	5
Protecting rural communities from job losses . . . . .	1	2	3	4	5
Increase endangered species recovery on non-federal land . . . . .	1	2	3	4	5
Increase the number of miles of stream habitat managed at the highest level of protection for coastal salmon . . . . .	1	2	3	4	5
Increasing the number of Biodiversity Reserves in the Coast Range . . . . .	1	2	3	4	5
Increase the amount of forest in mid-age and old stages . . . . .	1	2	3	4	5

### Your Chance to Vote

One potential action to improve biodiversity protection in Coast Range forest land would be to increase the amount land set aside in biodiversity reserves (Program III). This program would increase the amount of land in reserves from the current 10% to a total of 35% of the Coast Range, an increase of 1.5 million acres. Land uses like logging, road building, farming and residential development are strictly limited in biodiversity reserves, though many recreational activities are permitted. Costs to the public would include management expenditures by government agencies as well as payments to compensate private landowners. Suppose this program were presented to you as a ballot measure in the next state election. Would you vote for this change if it cost your household an additional \$45 per year in increased income taxes? Keep in mind the annual income and expenses of your household when you answer.

- Yes, I would vote for this change.  
 No, I would not vote for this change.  
 Not sure.

Please briefly describe the reason for your response \_\_\_\_\_

\_\_\_\_\_

On the next few pages, we ask that you evaluate and vote on several different potential conservation plans. Suppose that each of the following four pages is a ballot in a state referendum. On each ballot, there are three alternative conservation plans for the Oregon Coast Range. Each alternative is made up by combining and prioritizing the four programs in different ways. The "No-Change" alternative is the same on each page and represents the current management situation and no *additional costs* to Oregon households.

On each page, compare the no change alternative to the other alternatives for changing biodiversity conservation in the Coast Range. Other alternatives would entail management costs which would be paid by households through an increase in Oregon income taxes. We would like to know how you would vote if one of these choices appeared on a state ballot. Even though we are presenting you with four different ballots, please approach them independently, as if it were the only ballot on which you were voting.

These are difficult choices, but your answers are critical for informing policymakers. There are no right answers - we want to know your opinion. Please consider the alternatives offered on each of the next four ballots and make your choices carefully. Again, *please complete all four pages.*

Figure A-2.(Continued) First mailing - survey booklet

Suppose that Oregon voters are presented with *only* the following ballot and that no other conservation plans are being voted on. Compare the three alternatives and consider which one you would vote for.

BALLOT I	No Change	Alternative A	Alternative B
Annual Cost to Your Household			
Salmon Habitat			
Forest Age Management			
Biodiversity Reserves			
Endangered Species Protection			
I prefer ..... (check one)	<input type="checkbox"/> No Change	<input type="checkbox"/> Alternative A	<input type="checkbox"/> Alternative B
Please briefly describe the reason for your selection: _____			

Figure A-2.(Continued) First mailing - survey booklet

Suppose that Oregon voters are presented with *only* the following ballot and that no other conservation plans are being voted on. Compare the three alternatives and consider which one you would vote for.




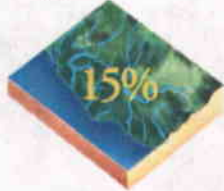











<b>BALLOT II</b>	No Change	Alternative A	Alternative B
Annual Cost to Your Household			
Salmon Habitat			
Forest Age Management			
Biodiversity Reserves			
Endangered Species Protection			
I prefer ..... (check one)	<input type="checkbox"/> No Change	<input type="checkbox"/> Alternative A	<input type="checkbox"/> Alternative B
Please briefly describe the reason for your selection: _____ _____			

Figure A-2.(Continued) First mailing - survey booklet

Suppose that Oregon voters are presented with *only* the following ballot and that no other conservation plans are being voted on. Compare the three alternatives and consider which one you would vote for.

BALLOT III	No Change	Alternative A	Alternative B
Endangered Species Protection	15%	90%	5%
Salmon Habitat	15%	25%	25%
Forest Age Management	25% Mid-age, 70% Young, 5% Older	34% Mid-age, 33% Young, 33% Older	45% Mid-age, 55% Young
Biodiversity Reserves	10%	20%	5%
Annual Cost to Your Household	\$0/year	\$45/year	\$10/year
I prefer ..... (check one)	<input type="checkbox"/> No Change	<input type="checkbox"/> Alternative A	<input type="checkbox"/> Alternative B
Please briefly describe the reason for your selection: _____			



Figure A-2.(Continued) First mailing - survey booklet

Suppose that Oregon voters are presented with *only* the following ballot and that no other conservation plans are being voted on. Compare the three alternatives and consider which one you would vote for.




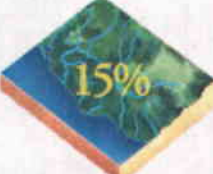











<b>BALLOT IV</b>	No Change	Alternative A	Alternative B
Annual Cost to Your Household			
Salmon Habitat			
Forest Age Management			
Biodiversity Reserves			
Endangered Species Protection			
I prefer .....	<input type="checkbox"/> No Change	<input type="checkbox"/> Alternative A	<input type="checkbox"/> Alternative B
Please briefly describe the reason for your selection: _____			

Figure A-2.(Continued) First mailing - survey booklet

### Section III About YOU:

These last few questions will help us to ensure that we've reached a cross-section of Oregonians with this survey. Your answers are strictly confidential and will only be used in the analysis of this study. Your answers will not be associated with your name or address in any way, and will not be released under any circumstances.

1. Are you           \_\_ male       \_\_ female
2. What is your age? \_\_\_\_\_ years
3. What is your zip code? \_\_\_\_\_
4. How long have you lived in Oregon? \_\_\_\_\_ years
5. How long have you lived in the region of Oregon in which you currently reside? (for example, Coastal Oregon, Willamette Valley, Central Oregon, Eastern Oregon) \_\_\_\_\_ years
6. Are you a member of a conservation or environmental organization? YES NO
7. Are you a member of sporting club? YES NO
8. What is your occupation? \_\_\_\_\_
9. Did you vote in the last national election? YES NO
10. Highest level of formal schooling?
 

1 2 3 4 5 6	7 8 9	10 11 12	13 14 15 16	17 18 19 20 21+
(Elementary)	(Jr. High)	(High School)	(College)	(Graduate or Professional School)
11. How many people live in your household? \_\_\_\_\_ people
12. How many contribute to paying household expenses? \_\_\_\_\_ people
13. Including these people, about how much was your household income from all sources?
 

__ less than \$10,000	__ \$40,000 to \$49,999	__ \$80,000-89,999
__ \$10,000 to \$19,999	__ \$50,000 to 59,999	__ \$90,000-\$99,999
__ \$20,000 to \$29,999	__ \$60,000 to \$69,999	__ \$100,000-\$149,999
__ \$30,000 to \$39,999	__ \$70,000 to \$79,999	__ \$150,000 or more

Figure A-2.(Continued) First mailing - survey booklet

## Comments

We would appreciate any further comments you may wish to provide.

Thank you for your participation in this study. When you have completed the questionnaire, please fold and insert it into the included stamped, addressed return envelope and drop it in any mailbox.

Figure A-2.(Continued) First mailing - survey booklet



OREGON STATE  
UNIVERSITY

**Figure A-3. Second mailing - reminder postcard**

June 8, 1999

Dear «title cover» «name2»,

Last week a questionnaire asking for your views regarding forest and wildlife management in the Oregon Coast Range was mailed to you.

If you have completed the questionnaire already, please accept our sincere thanks. If not, could you please return it today? Because it was sent to a small representative sample it is most important that your views be included in the study if we are to represent the views of Oregonians adequately.

If by some chance you did not receive the questionnaire or have mislaid it, please call Brian Garber-Yonts at (541) 737-5874 or email him at [yonts@cof.orst.edu](mailto:yonts@cof.orst.edu) and we will send you another copy immediately.

Yours sincerely,

Professor Rebecca Johnson

Project Director

### Figure A-4. Third mailing - cover letter

July, 1999

Dear Mr. Pruett,

I am writing to you about our study of public preferences for forest management policy in the Oregon Coast Range. We have not yet received your completed questionnaire.

The large proportion questionnaires that we have received so far are very encouraging. However, whether we will be able to describe accurately how Oregonians feel on these important issues depends upon you and the others who have not yet responded. This is because our experience suggests that those of you who have not yet sent in your questionnaire may hold quite different views on forest management than those who have.

This is the first statewide study of this type that has ever been done. Therefore, the results are of particular importance to officials and representatives in Oregon State government, members of Congress and all interested citizens. The usefulness of our results depends on how accurately we are able to describe what the people of Oregon want. It is for these reasons that I am sending you this letter.

Any adults in your household can complete the survey. In case our other correspondence did not reach you, a replacement questionnaire is enclosed. May I please urge you to complete and return it as soon as possible?

Your contribution to the success of this study will be genuinely appreciated.

Sincerely,

Professor Rebecca Johnson

Project Leader

**Figure A-5. Fourth mailing - final reminder postcard**

July 29, 1999

Dear «title\_cover» «name2»,

I am writing to you again about our study of public preferences for forest management policy. We have not yet received your completed questionnaire. If you have just sent out the questionnaire, please accept our sincere appreciation and ignore the following message.

Your opinion is important to the success of this study. Your name is among a small group which was drawn through a scientific sampling process in which every household in Oregon had an equal chance of being selected. In order for the results of the study to provide accurately represent the views of Oregonians to forest managers and policy makers, it is essential that each person in the sample return their questionnaire. As mentioned in the last letter, any adult in the household can complete the questionnaire.

If you have any questions, please contact Brian Garber-Yonts (541-737-5874, [yonts@cof.orst.edu](mailto:yonts@cof.orst.edu)). Your cooperation is greatly appreciated.

## Appendix B: Experimental Design

**Table B-1. Choice set design**

BLOCK	SET	salmon habitat	endangered species habitat	age class distribution	biodiversity reserves	cost
1	1	90%	25%	40%/45%/15%	20%	\$86
1	1	90%	75%	25%/25%/50%	40%	\$325
1	2	90%	5%	55%/45%	5%	\$45
1	2	5%	25%	55%/45%	40%	\$236
1	3	5%	75%	40%/45%/15%	5%	"\$1,272"
1	3	5%	25%	25%/25%/50%	5%	\$648
1	4	5%	5%	25%/25%/50%	20%	"\$1,272"
1	4	5%	5%	40%/45%/15%	40%	\$22
2	1	90%	75%	25%/25%/50%	20%	\$648
2	1	90%	25%	40%/45%/15%	40%	"\$1,272"
2	2	40%	75%	40%/45%/15%	5%	\$22
2	2	5%	75%	55%/45%	40%	\$45
2	3	5%	25%	40%/45%/15%	20%	\$325
2	3	5%	5%	25%/25%/50%	5%	\$236
2	4	40%	75%	25%/25%/50%	40%	\$145
2	4	40%	5%	55%/45%	20%	\$86
3	1	90%	75%	25%/25%/50%	5%	"\$1,272"
3	1	5%	75%	40%/45%/15%	20%	\$648
3	2	40%	5%	25%/25%/50%	20%	\$325
3	2	5%	5%	40%/45%/15%	40%	\$236
3	3	90%	25%	40%/45%/15%	20%	\$86
3	3	5%	25%	55%/45%	5%	\$22
3	4	90%	75%	55%/45%	40%	\$145
3	4	40%	75%	40%/45%/15%	5%	\$45
4	1	90%	5%	25%/25%/50%	5%	\$22
4	1	5%	75%	40%/45%/15%	40%	\$86
4	2	90%	25%	25%/25%/50%	40%	\$45
4	2	40%	5%	55%/45%	40%	\$22
4	3	5%	25%	55%/45%	5%	\$145



## Appendix B: Experimental Design

**Table B-1.** Choice set design

BLOCK	SET	salmon habitat	endangered species habitat	age class distribution	biodiversity reserves	cost
4	3	40%	75%	25%/25%/50%	20%	\$325
4	4	90%	75%	55%/45%	20%	"\$1,272"
4	4	40%	25%	40%/45%/15%	5%	\$236
5	1	90%	25%	25%/25%/50%	5%	\$86
5	1	40%	25%	25%/25%/50%	20%	\$236
5	2	90%	5%	40%/45%/15%	20%	"\$1,272"
5	2	5%	25%	40%/45%/15%	40%	\$145
5	3	5%	5%	25%/25%/50%	40%	\$325
5	3	40%	5%	55%/45%	5%	\$236
5	4	5%	75%	55%/45%	20%	\$45
5	4	90%	25%	55%/45%	40%	\$648
6	1	5%	25%	25%/25%/50%	40%	\$45
6	1	90%	75%	40%/45%/15%	40%	\$236
6	2	5%	75%	55%/45%	40%	\$325
6	2	90%	25%	55%/45%	5%	\$22
6	3	5%	5%	40%/45%/15%	5%	\$648
6	3	40%	25%	55%/45%	40%	\$86
6	4	90%	5%	25%/25%/50%	40%	\$145
6	4	40%	75%	25%/25%/50%	5%	\$45
7	1	40%	25%	40%/45%/15%	40%	\$145
7	1	40%	5%	40%/45%/15%	20%	\$22
7	2	90%	5%	25%/25%/50%	40%	\$86
7	2	5%	75%	40%/45%/15%	20%	\$236
7	3	90%	5%	40%/45%/15%	5%	\$325
7	3	90%	25%	55%/45%	20%	\$45
7	4	5%	5%	55%/45%	40%	\$648
7	4	40%	75%	55%/45%	40%	"\$1,272"
8	1	40%	5%	25%/25%/50%	5%	\$648
8	1	40%	25%	55%/45%	20%	\$22
8	2	5%	75%	25%/25%/50%	20%	\$86

## Appendix B: Experimental Design

**Table B-1.** Choice set design

BLOCK	SET	salmon habitat	endangered species habitat	age class distribution	biodiversity reserves	cost
8	2	90%	25%	25%/25%/50%	40%	"\$1,272"
8	3	5%	25%	40%/45%/15%	5%	\$45
8	3	90%	75%	55%/45%	5%	\$86
8	4	40%	75%	40%/45%/15%	40%	\$648
8	4	5%	5%	55%/45%	40%	\$145
9	1	90%	25%	25%/25%/50%	5%	\$325
9	1	5%	5%	55%/45%	20%	\$648
9	2	5%	25%	40%/45%/15%	40%	\$22
9	2	40%	5%	40%/45%/15%	5%	\$86
9	3	5%	75%	25%/25%/50%	5%	\$145
9	3	40%	25%	25%/25%/50%	20%	"\$1,272"
9	4	90%	75%	40%/45%/15%	20%	\$325
9	4	40%	5%	25%/25%/50%	40%	\$236
10	1	90%	5%	55%/45%	5%	"\$1,272"
10	1	40%	25%	25%/25%/50%	40%	\$86
10	2	90%	5%	25%/25%/50%	20%	\$648
10	2	90%	25%	55%/45%	20%	\$145
10	3	40%	75%	55%/45%	5%	\$45
10	3	90%	75%	40%/45%/15%	40%	\$325
10	4	5%	75%	25%/25%/50%	20%	\$22
10	4	40%	5%	40%/45%/15%	20%	\$236
11	1	5%	75%	40%/45%/15%	5%	\$325
11	1	40%	5%	25%/25%/50%	5%	"\$1,272"
11	2	40%	25%	40%/45%/15%	20%	\$45
11	2	5%	5%	25%/25%/50%	20%	\$86
11	3	90%	5%	40%/45%/15%	40%	\$648
11	3	40%	25%	25%/25%/50%	40%	\$22
11	4	90%	75%	25%/25%/50%	5%	\$236
11	4	40%	75%	55%/45%	20%	\$145
12	1	90%	75%	40%/45%/15%	5%	\$145

## Appendix B: Experimental Design

**Table B-1.** Choice set design

BLOCK	SET	salmon habitat	endangered species habitat	age class distribution	biodiversity reserves	cost
12	1	40%	25%	55%/45%	5%	\$45
12	2	40%	75%	55%/45%	20%	\$236
12	2	40%	5%	40%/45%/15%	40%	\$325
12	3	90%	5%	55%/45%	40%	\$86
12	3	90%	25%	25%/25%/50%	20%	\$145
12	4	5%	75%	25%/25%/50%	40%	"\$1,272"
12	4	5%	5%	55%/45%	20%	\$22
13	1	40%	75%	25%/25%/50%	5%	\$86
13	1	40%	25%	40%/45%/15%	40%	\$325
13	2	90%	75%	55%/45%	40%	\$22
13	2	5%	25%	25%/25%/50%	20%	\$236
13	3	90%	25%	40%/45%/15%	5%	\$648
13	3	40%	75%	40%/45%/15%	20%	"\$1,272"
13	4	90%	5%	40%/45%/15%	20%	\$145
13	4	40%	5%	55%/45%	5%	\$45
14	1	90%	5%	55%/45%	20%	\$325
14	1	40%	5%	40%/45%/15%	40%	"\$1,272"
14	2	40%	25%	55%/45%	20%	\$648
14	2	90%	25%	40%/45%/15%	5%	\$236
14	3	90%	75%	25%/25%/50%	20%	\$145
14	3	5%	5%	40%/45%/15%	20%	\$22
14	4	5%	75%	55%/45%	5%	\$22
14	4	5%	5%	25%/25%/50%	5%	\$45
15	1	5%	25%	25%/25%/50%	5%	\$22
15	1	90%	25%	55%/45%	40%	\$325
15	2	5%	25%	40%/45%/15%	20%	\$648
15	2	5%	75%	55%/45%	5%	\$236
15	3	90%	5%	40%/45%/15%	5%	\$145
15	3	40%	25%	55%/45%	5%	"\$1,272"
15	4	40%	5%	25%/25%/50%	20%	\$45

## Appendix B: Experimental Design

**Table B-1.** Choice set design

BLOCK	SET	salmon habitat	endangered species habitat	age class distribution	biodiversity reserves	cost
15	4	40%	75%	25%/25%/50%	40%	\$236
16	1	40%	25%	25%/25%/50%	5%	\$145
16	1	90%	5%	55%/45%	20%	\$236
16	2	40%	5%	55%/45%	40%	\$45
16	2	5%	25%	55%/45%	20%	"\$1,272"
16	3	40%	75%	40%/45%/15%	20%	\$86
16	3	5%	75%	25%/25%/50%	40%	\$648
16	4	90%	75%	55%/45%	5%	\$648
16	4	5%	5%	40%/45%/15%	5%	\$86