ISSUES IN WATER RESOURCE AND OUTDOOR RECREATION ECONOMICS

Proceedings of two Regional Workshops

sponsored by the Southern Natural Resource Economics Committee (SRIEG 10)
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December 1991
Issues in Water Resource and Outdoor Recreation Economics

Proceedings of two Regional Workshops

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Sponsored by

Southern Natural Resource Economics Committee
Southern Rural Development Center
Farm Foundation

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December 1991
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FOREWARD

In 1990, the Southern Natural Resource Economics Committee held two workshops on current resource and environmental issues. The first workshop, held in Orlando, Florida, in May, 1990, focused on water resource issues. The second workshop, held in Knoxville, Tennessee, in November, 1990, focused on outdoor recreation management issues. This publication is a compilation of papers presented at these two workshops.

The first paper, by Peter Caulkins, discusses environmental research priorities for agriculture. Caulkins points out the need for research which addresses growing concerns related to the impact of agriculture on water resources. Comments on environmental research priorities for agriculture are then offered by Angelos Pagoulatos in the second paper. In the third paper, an overview of USDA water quality data collection efforts is provided by Robbin Shoemaker.

Turning to outdoor recreation issues in the fourth paper, Jane Luzar and James Hotvedt discuss the economic valuation of deer hunting in Louisiana. Linda Langner then discusses the role of private land in providing outdoor recreational opportunities to the public. In the sixth paper, Ken Cordell and John Bergstrom present the results of a study which examined projected future scarcities of various forms of outdoor recreation. The final paper, by Robert Marker, George Humphrey, and Robert Farrell, addresses the application and usefulness of economics research to natural resource planners and decision-makers.
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Environmental Research Priorities for Agriculture

The purpose of this paper is to highlight the environmental research priorities for agricultural activities and policies. This paper begins with a description of the scope of the environmental problems associated with agricultural activities and is followed by discussion of the potential research priorities that these problems have generated.

Scope of Problems

The environmental consequences of agricultural activity include adverse impacts on surface and ground water quality, air quality, wetlands, and human health due to worker exposure and food residues.

With the extensive regulation of point source discharges over the past two decades and the 95% reduction in pollutant loadings that has resulted, agriculture is now responsible for the large majority of the remaining surface water quality problems. At this time, non-point sources (NPS's) account for 76% of the remaining loadings to the Nation’s lakes, 65% of the loadings to the Nation’s rivers and streams, and 45% of the loadings to the Nation’s estuaries (EPA, 1986, Clean Water Act Section 305 (b) State Reports). Agricultural activities account for 50%-70% of these NPS loadings. In lakes, where designated uses are impaired, nutrients account for 49%, sediment 25% and pesticides 5% of the impaired lake acreage. In rivers and streams, sediment accounts for 42% of the impaired river miles while pesticides account for 10% (Section 319 State Reports, 1988). The off-farm damages associated with these loadings has been estimated at $3.2-$13.0 billion annually (Clark, 1985). These damages include instream biological, recreational use, water storage use, and
navigational impacts as well as offstream flood, water conveyance, and water treatment
effects.

Agricultural activity appears to be a pervasive source of ground water contamination
which may have adverse health impacts on the 90% of the rural population that relies solely
on ground water for their drinking water supplies. Preliminary results from EPA’s National
Survey of Pesticides in Drinking Water Wells (October 1990) indicate that 5% of the
Nation’s drinking water wells are contaminated with nitrates at concentrations that exceed
the drinking water Maximum Contaminant Level (MCL) standard of 10 parts per million.
Monsanto’s recent national study detected nitrates in over 50% of the wells sampled and
found concentrations in exceedance of the 10 parts per million standard in 4% of the wells.
The State of Iowa’s recent well survey (April 1990) found 19% of their state wells
contaminated with nitrates in exceedance of the MCL. Two time series studies in Maryland
and Iowa show nitrate concentrations increasing dramatically over time. Nitrate
concentrations in Iowa’s study wells have increased from 12-14 ppm in the 1950s to over 40
indicated 7% of the wells exceeded 10 ppm. By 1983, 15% of the wells exceeded 10 ppm.
Nitrate contamination is the most pervasive ground water contamination problem associated
with agriculture, and it appears to be getting worse. While no pesticide appears with the
same frequency as nitrates do, monitoring data indicate the presence of 74 pesticides in the
ground water of 38 states (EPA, 1988).

Agriculture has been the dominant factor in Wetlands loss. Agricultural activity was
responsible for 87% of the conversions of wetlands from 1955 to 1975 (Conservation
Foundation, 1988). Furthermore, these drained wetlands have been frequently used to produce agricultural commodities that are in excess supply. The Nation continues to lose wetlands at the rate of approximately 300,000 to 450,000 acres per year. However, agriculture’s current role is less certain.

Finally, EPA’s Unfinished Business Report has estimated that as many as 6,000 additional cancer cases per year may result from pesticide residues of 200 potential carcinogens in or on food. Agricultural pesticide-related risks via worker exposure and food residues were ranked in the highest impact category for cancer and non-cancer risks that remain currently unaddressed (EPA Unfinished Business Report, 1987).

**Structural Nature of Agricultural Pollution**

The essential character of non-point source pollution in general, and agricultural pollution in particular, is the ubiquitous nature of its sources. Agricultural pollution stems from literally millions of day-to-day activities and management decisions taken by farmers as they interact with highly site-specific natural events (e.g.: rain, temperature, etc.) and endowments (e.g.: soil type, field slope, etc.) to produce food and fiber. Individually these activities often do not cause discernible environmental harm, but the aggregation of hundreds or thousands of activities over many weeks, months, or years results in significant adverse environmental impacts. Because water pollution is a transitive problem that does not respect property lines, the water pollution problems that result tend to manifest themselves not at their source, but downstream and off the farm.

These characteristics give rise to serious structural impediments to remediation. For example, the fact that two million farmers work over 400 million acres of land makes a
command-and-control approach virtually impossible on account of size and numbers alone. The fact that significant environmental impacts result usually not from individual activities but from the aggregation of thousands of decisions, and that pollutant transport occurs in a non-point fashion, makes an end-of-the-pipe approach equally untenable. Clearly, the most rational and most cost-effective approach is pollution prevention or source reduction. Pollution prevention represents the foundation of EPA’s long-term strategy for agriculture.

Environmental Research Priorities

Since pollution prevention represents the cornerstone of EPA’s strategy for agriculture, it follows that our highest research priorities focus on those alternative agricultural practices that can realize input reductions and curtail off-farm impacts most efficiently. Prominent in both the House and Senate mark-up versions of the research title for the 1990 Farm Bill is increased funding for Low Input Sustainable Agriculture (LISA) research. Both mark-ups authorize $40 million per year in LISA research and the Senate mark-up also authorizes $10 million to train extension agents in LISA techniques. The research objectives include not only the development of less chemically-intensive agricultural practices, but also investigation of what reductions in inputs would result, what reductions in potential off-site loadings would result, impacts on crop yields, and on net farm profitability. Research would result, impacts on crop yields, and on net farm profitability. Research should also identify each alternative practice’s applicability by soil type, climate, rainfall, etc. as well as existing barriers to the practice’s adoption. For the purpose of this paper, LISA is intended to include crop rotational practices, IPM, soil and tissue testing, nutrient management, improved pesticide application techniques, and tillage practices.
Another closely related area for research involves a section in the conservation title mark-up that refers to a pilot Integrated Crop Management (ICM) program. The emphasis here is on a comprehensive, integrated system of BMPs as opposed to individual practices developed in isolation. Field research (Nomini Watershed Demonstration Project, VA) and modelling results (AGNPS) indicate that single-objective, single-BMP approaches can result not in the reduction of environmental risk, but in its shifting from one to another medium. No-till and low-till on highly erodible land as required under conservation compliance, can be effective in reducing sediment and attached particle run-off into surface water, but also can result in increased loadings to ground water. The situation can be further aggravated by the increased herbicide applications associated with no-till. What is preferable would be an integrated farm management system of BMPs, including tillage practices, nutrient management and IPM, that would result in a net reduction in environmental risks. What combination of BMPs constitute the optimal system for reducing environmental risk? How cost-effective are they? How does a farmer's net income under this integrated management system compare with that under conventional practices?

Associated with the development of LISA technologies and ICM systems is the issue of what policies are necessary and sufficient to ensure their adoption by farmers. In the current Farm Bill debate, a substantial amount of attention has been placed on the issue of base flexibility since analysis has shown that current policies provide strong economic incentives for chemical-intensive monoculture and act as an impediment to the adoption of crop rotations. The Administration's recommendations included a proposal for 100% base
flexibility. How much base flexibility is necessary? Is base flexibility, alone, sufficient to ensure adoption? If not, what additional policies should be considered?

Given the predominance of nitrate contamination of ground water, research into soil and tissue testing, especially in humid areas, in conjunction with the determination and calibration of models for the appropriate profit-maximizing, as opposed to yield-maximizing, application rate is a high priority. Soil testing, appropriate application rates, and the timing and placement of applications have led to dramatic reductions in fertilizer use in Iowa (40%-60% reduction in Butler County demonstration), Pennsylvania (> 50% reduction statewide since 1985 and Arizona (20%-30% reduction), all without any discernible loss in yield. What potential for reduction exists in other regions, for vegetables and other crops? What contribution do agricultural drainage wells and sinkholes make to the ground water contamination relative to normal cropping practices? What are the economic damages associated with adverse health impacts of a nitrogen contaminated water supply on livestock?

The combination of livestock manure to the nutrient water quality problem is most likely the least well understood, in particular at the national level. Clean Water Act Section 319 State Reports indicate that 20%-40% of the river segments reported to be significantly adversely impacted by agricultural activity are associated with livestock, yet the Farm Bill focuses primarily on crops. What is the appropriate level of resources to address manure management issues, livestock destruction of riparian habitat, and grazing on public lands?

Wetlands may be the thorniest issue confronting farmers and environmentalists. The Swampbuster subtitle of the 1985 Food Security Act is one of the most contested issues on
Capitol Hill. Mitigation and graduated penalties are both currently being discussed as possible amendments. In the new Farm Bill, eligibility for the Conservation Reserve Program (CRP) will likely be expanded to include wetlands restoration criteria. What kinds of wetlands can be most successfully restored? What are the best available techniques for wetland restoration and what do they cost? Which wetland functions can be restored, and how permanent are the restorations? How long does restoration take for different kinds of wetlands? If a farmer is going to drain a wetland, and the completed restoration of a wetland of comparable value will take years with only partial functional values being restored, what kind of compensation is warranted? What factors should determine the compensation ratios? How can the President's No-Net-Loss of Wetlands policy be realized for agriculture?

Finally, while significant strides have been made by the EPA and USDA towards better integration of agricultural and environmental policies, there still remain very significant cultural differences between the Agency and the Department. EPA is essentially a regulatory agency while USDA has focused on providing technical and financial assistance to farmers. Each has its own vision of what the appropriate policy should be. What is the appropriate role of Federal/State/Local government agencies, and what is the optimal mix of carrots and sticks in achieving the environmental goals for agriculture?
References


ENVIRONMENTAL RESEARCH PRIORITIES FOR AGRICULTURE - A DISCUSSION

Angelos Pagoulatos
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Environmental Research Priorities
for Agriculture - A Discussion

The Caulkins article delineates several research priorities to help develop environmental policy in the areas of nitrates and pesticides as they affect water quality. In particular, he points out the deficiencies in our knowledge necessary to regulate wetlands and the effect of livestock manure to the nutrient water quality problem.

While significant strides have been made by EPA and USDA towards better integration of agricultural and environmental policies, there is still confusion on the optimal mix of carrots and sticks and the appropriate role of Federal, State and local government agencies in achieving the environmental goals of agriculture. EPA is essentially a regulatory agency while USDA has focused on providing technical and financial assistance to farmers as Caulkins points out.

Agricultural policy, through its impact on farmer's production decisions (land, water and agricultural chemical use) has a direct impact on the environment. Existing agricultural and environmental policies can have either positive or negative effects on non-point source pollution. In order to infer an aggregate effect from combination of different policy instruments requires data that do not currently exist. In this section, attention will focus on the use of agricultural policy instruments, to investigate pollution, if used appropriately.

Major current policies are structured so as to allow control over decision on both the intensive and extensive margins, simultaneously. Just and Antle presented an example of an agricultural policy comparing a target price, a diversion requirement, a government payment per acre of diversion and a program yield. They worked with a desegregated
conceptual model where farms are differentiated only by environmental characteristics and does not consider the dynamic issues relating to farmer investment behavior. Nonetheless, the analysis points to the kind of data needed to make valid inferences. In particular, they conclude, that statistically reliable field-specific parameters (such as the correlation between production decisions and environmental attributes of land) are needed to assess the aggregate relationships between agricultural and environmental policy, and the environment.

Their analysis shows that the extensive margin (i.e., the choice of diverted and producing acreage) can be controlled through the target price, the diversion requirement and the diversion payment. The intensive margin can be controlled within certain bounds by the choice of support price and program yield. To illustrate, we know that if the support price is at or below the market price and the program yield is not below the yield that occurs with a market price under noncompliance, then a more intensive use is not induced (Just and Antle).

Controlling chemical use in agricultural production provides an excellent example of the limitations in the coordination of agricultural and environmental policy. Set-aside requirements compiled with higher effective prices for agricultural output could lead to more intensive input use on the land remaining in production. Greater chemical use, as a substitute for land, may lead to greater environmental land food safety concerns. Hrubovcak, Leblanc and Miranowski, studied the difficulties in setting an appropriate tax on chemicals because of increases in productivity over time combined with shifts in foreign demand and changes in price supports which altogether provide uncertainty with respect to future economic conditions.
Direct control of agricultural chemicals and development of BMP's, would reduce uncertainty of farmer response, but implementing and enforcing such controls implies high transition costs and introduces a host of new problems. For example, inadequate knowledge regarding production structure may lead to assumed elasticities of substitution between inputs that overstate or understate the output and price effects of direct controls, even though the environmental inputs may be more certain.

Johnson, Wolcott and Aradhyula recently studied the impacts of changes in selected agricultural policy instruments on the environment. Their results indicate that the effects of changes in target prices and set aside acres for corn was small on soybean output. Increased target prices for corn furthermore appeared to exert a negative effect on aggregate fertilizer use but a positive effect on the aggregate input demand for labor. Target prices and set-aside requirements, had positive effects on own-output supply. The input price changes reflecting taxes were included to suggest possible environment tradeoffs. This study dealt with an aggregate input demand specification, which applies for 1986, and predictably yields a small magnitude for the elasticities obtained. Thus a 1 percent increase in set-aside requirements for corn increased aggregate fertilizer use by 0.04 percent which also points to the fact that even crop-specific program instruments have sector-wide influences output and input use.

The task is to provide through research the necessary information so that agricultural policy can be designed in a way that it minimizes its adverse effect on the environment. At the same time it would also be of interest to see how environmental policy can achieve its goals within a multi-objective framework consistent with the goals of agriculture.
References


USDA WATER QUALITY DATA COLLECTION EFFORT

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This paper was prepared with help from Robert Kellogg and Merritt Padgitt.
USDA Water Quality Data Collection Effort

Congress has mandated two environmentally related efforts to be undertaken by the USDA in cooperation with other Federal agencies. The two efforts are the Water Quality Initiative and Food Safety Initiative. The data collection efforts discussed here deal primarily with the Water Quality effort. The stated goal of the data collection effort is: to develop, analyze and disseminate timely, statistically reliable and detailed data on farm use of pesticides, fertilizers, and related inputs.

The survey effort has two basic objectives. The first is to characterize current chemical use in agriculture to serve as a benchmark for evaluating future changes. This has been the focus of initial efforts by the Economic Research Service (ERS) and the National Agricultural Statistical Service (NASS). The second objective is to examine in detail the linkages between agricultural production and potential water quality effects. This objective is being met through cooperation with efforts by the US Geological Society (USGS). Two pilot survey efforts -- the cotton water quality study and the Delmarva area study -- are being implemented to meet this objective. Plans are to expand the area studies effort in 1991 and 1992 sufficiently to be able to make a national assessment of the scope and nature of the agriculture/water quality problem, and to evaluate the effectiveness of potential solutions.

These objectives are being pursued through a series of data collection activities, summarized below. Current and planned surveys will provide detailed estimates of on-farm chemical use, cropping practices, and whole-farm economic information. The survey effort involves three components, the cropping practices surveys, the vegetable survey, and the area
studies. These data will be integrated with other agencies' water quality information efforts for evaluation of environmental and agricultural policies.

**Cropping Practices Surveys**

The primary purpose of the cropping practices surveys is to benchmark and monitor the level and composition of chemical use and measure the changes in use over time. This information will be used to characterize fertilizer and pesticide use and to evaluate the economic implications of government policies intended to reduce that chemical use. Personal interviews with farm operators are used to collect this information. Data are for individual fields, not for whole-farm operations.

Annual cropping practice surveys have been conducted historically in the largest producing states for six major field crops -- wheat, corn, soybeans, cotton, rice, and potatoes. State totals of acres treated are available for plant nutrients and selected herbicides according to crop type, as well as general information on the item and method of application, previously grown crops, tillage operations, and seeding. In 1990 production (47 states) and soybean production (29 states). In addition, information on pesticide application rates will be obtained for all six major crops.
Table 1.--Summary of Cropping Practices Survey Contents

Summary of data provided:

* crop acres treated with any fertilizer and pesticide products
* nutrient and pesticide products applied (active ingredient and rate per acre)
* timing of application (before, at, and/or after planting)
* method of application (broadcast, direct spray, irrigation, spot, etc.)
* field operations tillage and planting
* state level reliability (for major producing states, collection of states for others)
* coverage in smaller states, e.g., the New England states, Corn and Soybeans were collapsed into multi-state regions

Table 2.--State and Total Crop Production Coverage, 1990

<table>
<thead>
<tr>
<th>Crop</th>
<th>States</th>
<th>Regions</th>
<th>Percent of National Production</th>
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</thead>
<tbody>
<tr>
<td>Corn</td>
<td>47</td>
<td>30</td>
<td>99</td>
</tr>
<tr>
<td>Soybeans</td>
<td>29</td>
<td>23</td>
<td>99</td>
</tr>
<tr>
<td>Wheat</td>
<td>14</td>
<td>n.a.</td>
<td>66</td>
</tr>
<tr>
<td>Rice</td>
<td>2</td>
<td>n.a.</td>
<td>61</td>
</tr>
<tr>
<td>Cotton</td>
<td>6</td>
<td>n.a.</td>
<td>81</td>
</tr>
<tr>
<td>Potatoes</td>
<td>12</td>
<td>n.a.</td>
<td>80</td>
</tr>
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Cotton Water Quality Pilot Survey

In addition to providing benchmark data on chemical use, the 1989 Cotton Water Quality Pilot Survey also obtained information on soil resources associated with each field. This additional information will allow analyses that relate agricultural behavior to the underlying resource base and prospects for reduction of environmental damages. The survey covered 14 states and was designed to represent almost all U.S. cotton production. The Soil Conservation Service (SCS) provided detailed soil and soil profile characteristics for each sampled field. Farm operators provided information on treated acreage and mean application rates for the three primary fertilizer nutrients and approximately 50 insecticide, fungicide, defoliants and growth regulators. Additionally operators provided the treated acreage for approximately 20 herbicide products, time and method of application, associated pest managements, tillage and erosion control practices, irrigation systems, distance to wells near the field, and characteristics of the operator.

Vegetable Survey

Because vegetable production relies heavily on chemical use—and therefore has the potential to impact water quality—a special vegetable survey is being implemented for the 1990 production year. The survey will collect whole-farm economic information and data on cropping practices in the five major vegetable producing states—Florida, California, Texas, Arizona, and Michigan. These data will allow a better understanding of the input and output substitution possibilities facing the vegetable producers. The information will be used to quantify the extent to which chemicals are used in vegetable production, and to
predict how producers will most likely change their behavior in response to agricultural and environmental policies.

The survey instrument is structured as a two phase process. The first phase is designed as a whole farm survey collecting data on all crops and chemical inputs used on the farm.

Policy decisions regarding implementing water quality provisions necessitate a clear understanding of their effects on farm profitability. Thus, phase two of the survey will involve enumerating a subsample of farmers for whole farm economic data for environmental policy analysis. The data will permit analysis of the economic behavior of farmers (with particular regard to chemical use) recognizing the tradeoffs they face conditioned by their economic, physical, and policy environments.

Area Studies

The primary purpose of area studies is to close the information gap between specific producer activities (cropping choices, chemical use, farming practices) and their associated impact on water quality. Evidence collected by the physical scientists to date indicates that the agriculture/water quality problem is not uniform throughout the country. Moreover, the economic cost for a unit of water quality degradation is not uniform geographically either, varying according to population, recreation activities, and other elements of water quality demand. Consequently, effective and efficient policies to address the problem may be equally diverse.
Table 3: Summary of Data Collected on Vegetable Survey

Data collected in first phase

- acres owned, rented in, rented out, other sources of land, and total acres operated.
- crops planted, acres planted and harvested, yield per acre, and total production.
- pesticide products used on all crops on the farm (including nonvegetable), units of active ingredient, price per unit, and custom application costs.
- pesticide products applied to vegetable crops, when applied, number of acres, rate of application, and how it was applied.
- fertilizer nutrients used on all crops on the farm (including nonvegetable), price per unit, and custom application costs.
- fertilizer nutrients applied to vegetable crops, when applied, number of acres, rate of application, and how it was applied.
- acres irrigated, amount and cost of water purchased, and irrigation technology, tillage practices, e.g., plastic mulch.

Data collected in the second phase

- all commodities produced, quantity and value.
- all inputs used, quantity and value (land, labor, energy, chemicals, equipment, etc.).
- tillage practices.
- irrigation technology and costs.
- commodity program participation.
The intent is to evaluate the impact of policies on both the producer and the environment for specific geographic areas. The areas will be chosen so that they represent a variety of resource characteristics and farming operations, allowing the results to be used to assess the magnitude of the agriculture/water quality problem for the nation as a whole. Detailed economic and chemical use data will be collected for selected geographic areas where information on resource characteristics associated with farming are available from other federal and state agencies (for example, USGS well monitoring). By establishing a close link between the decision framework of the agricultural producer and the resource base (soil type, rainfall, surface and groundwater drainage patterns associated with the land, and so on), policy evaluation can be extended to include constraints imposed on agriculture by the resource base associated with the farmland.

For 1990, two area studies will be conducted, one covering most of the Delmarva peninsula and another in Florida. Data for the Delmarva area study will be obtained by a special NASS survey designed to interface with an ongoing groundwater study by USGS. Specific objectives of the Delmarva area study are:

1. to relate agricultural practice and chemical use to groundwater and surface water flow conditions within areas proximate to USGS well testing sites. USGS will use these data to explain some of the circumstances associated with water contamination form agricultural sources on the peninsula.

2. to understand how agricultural practice, chemical use, and farm-level decisions regarding choice of outputs and inputs relate to the underlying drainage patterns represented by three hydrogeomorphic regions defined by USGS (a
hydrogeomorphic region constitutes a distinctive combination of characteristics that define separable underground drainage patterns. Using these data, ERS will attempt to establish the extent to which farmers' decisions regarding input use and output choices are influenced by the resource base to which the agricultural land is tied.

The Florida area study will be accomplished through a cooperative agreement with researchers at the University of Florida, who have already collected an extensive database on soil and resource characteristics, agricultural production, and farm-level economic activity. The objectives are similar to those for the Delmarva study, but with an emphasis on vegetable production.

**Future Plans**

Plans for 1991 are to expand the number of states included in the cropping practices survey. For one to three crops, which have not yet been specified, the cropping practices survey will be expanded to represent nearly all producing states. (Priority consideration will be given to wheat and rice for 1991). In 1991, the vegetable survey will be replaced with a survey on production of fruits and nuts. Approximately 30 fruit and nut states will be surveyed covering at least 80% of production. The survey will resemble the 1990 survey of vegetables using a similar two-phase interview technique to obtain detailed measurements on agricultural chemical use and on "whole-farm" economic variables. Long-range plans are to conduct annual surveys of this nature, alternating between vegetables in one year and fruit and nut crops the following year. Plans to obtain agricultural chemical use data for other field crops have been discussed, but have not yet been approved. Other field crops
(listed according to acreage ranking) are: alfalfa, sorghum, barley, oats, small grain hay, sunflowers, field and grass seeds, dry beans, peanuts, sugarbeets, sugarcane, tobacco, rye, and flaxseed. To the extent that these crops are covered, the intention is to obtain "whole-farm" economic and chemical use information in a manner similar to that presently planned for the vegetable and fruit surveys. These surveys will be integrated over time with the Farm Costs and Returns Survey to provide a comprehensive and consistent data base for monitoring the aggregate level and composition of chemical use as well as broader research applications.

It is ERS's intention to substantially expand the area studies aspect of the data collection program. ERS would like to fund 8-10 additional area studies in 1991 and/or 1992. Sites will be selected to provide the coverage required to make a national assessment of the extent of agriculture's role in the water quality problem, and to make an informed assessment of the impact environmental policies will have on agriculture and on the environment for the country as a whole. The same kind of data--whole-farm economic and chemical use data--will--be collected at each site to ensure consistency among the studies. Depending on the results obtained in 1991, additional sites may need to be funded in 1992 to provide the necessary diversity to make a national assessment. As in the Delmarva case, sites could be selected to correspond to work already underway or planned by USGS or other federal and state environmental agencies. USGS has selected 20 large areas to begin its survey of water quality for the country. The link with USGS and other environmental agencies is important because a great deal of collateral information on the resource base has--or will be--collected and computerized by these agencies as part of their efforts.
Collaboration with selected professionals at universities and with other U.S. agencies (USGS, NASS, EPA, and SCS) is planned to help ERS in planning the data collection effort and in conducting the analyses.
ECONOMIC VALUATION OF A CONSUMPTIVE RECREATIONAL ACTIVITY USING THE TRAVEL COST METHOD

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ECONOMIC VALUATION OF A CONSUMPTIVE RECREATIONAL ACTIVITY USING THE TRAVEL COST METHOD

Although wildlife-related recreation is increasingly recognized as an important product of forestland, non-market characteristics of this form of consumptive recreation experience can complicate economic valuation. For example, efforts to value consumptive recreation such as hunting on publicly provided forest lands such as those found on the Louisiana Wildlife Management Areas (WMAs) necessitates use of indirect techniques such as the travel cost method, or direct, but more hypothetical techniques such as contingent valuation. The objective of this study was to use the travel cost method to estimate the net economic value of white-tailed deer (Odocoileus virginianus) hunting on a Louisiana Wildlife Management Area. Specific objectives of this study were to develop a visitation function for the consumptive recreational activity of white-tailed deer hunting on the Sherburne WMA and to estimate the net economic benefits of white-tailed deer hunting on the WMA using the travel cost model.

Research Procedures

The 11,780 acre Sherburne Wildlife Management Area and the 15,220 acre Atchafalaya National Wildlife Refuge formed the study area (both referred to as the Sherburne WMA) for this analysis. The national wildlife refuge was included.
in this study because the two areas are adjacent to each other and hunting seasons, rules, and regulations are the same for both.

The names and addresses of essentially all the deer hunters who hunted on the Sherburne WMA during the 1987-88 hunting season were obtained using data from check stations and the special either-sex gun hunt conducted on Thanksgiving weekend, November 27-28, 1987. These procedures yielded names, addresses, and phone numbers for a total of 2,986 hunters who hunted deer on the Sherburne WMA during the 1987-1988 deer hunting season.

A sample of the Sherburne WMA hunter population was surveyed through mail questionnaires designed to obtain various kinds of information about the hunter; the hunter's hunting experiences on the Sherburne WMA; the cost of the hunting experiences on the Sherburne WMA; and the availability of, hunting experiences on, and costs of hunting on substitute hunting areas, both public and private. Questionnaires were mailed to 2,000 hunters with an original goal of obtaining a 25% sample to represent the hunter population. Due to typical Louisiana hunter characteristics, it was assumed that the response rate would be relatively low. Consequently, to achieve the 25% sample, questionnaires were sent to approximately two-thirds of the population.

A stratified random sample of hunters was chosen to ensure that the survey would include hunters from all distance zones around the WMA. Strata were based on the first three zip code digits (e.g., all 708xx zip codes comprised one stratum). Approximately 66% of the hunters in each stratum were randomly
sampled. Dillman's Total Design Method was used to maximize the survey response rate (Dillman 1987).

Travel Cost Survey Results

Of the 2,000 questionnaires distributed, 1,084 were returned. Of those returned, 104 replies were judged to be unacceptable for determining the total number of hunter trips to the Sherburne WMA. The 980 usable responses comprise a total sample of 33% of the relevant population, and reflect a final response rate of 49%, or 9% greater than anticipated.

Of the hunters surveyed, deer hunting was the primary purpose of going to the Sherburne and the trips were generally taken only to the Sherburne WMA. Multidestination and multipurpose visits that were not dependent upon hunting at Sherburne were not included in the sample. The 980 respondents reported that an average of 7.58 hunting trips were taken to the Sherburne WMA during the 1987-88 deer hunting season. These hunters drove an average of 81.41 miles at a cost of $13.09 per trip, or about 16.1 cents per mile. The average total cost per trip was $57.20, including transportation, food, lodging, ammunition, firearm and bow maintenance, and other costs. This amounts to a total of $1,294,728 spent over 22,636 trips to the Sherburne WMA. Other relevant hunter characteristics are summarized in Table 1.

The average age of the hunters was 31.7 years old. The average hunter was a high school graduate and had a total annual household income in the range
of $20-25,000. Approximately 43% of the hunters would have been unable to
deer hunt during the 1987-88 season if public hunting areas such as the Sherburne
WMA had not been available. Slightly over 11% of the hunters were still in
school and approximately 5.5% were unemployed. An additional 3.9% were
retired.

Over all, the hunters rated the quality of the Sherburne WMA for deer
hunting as fair to good (3.6 on a 5 point scale, with 5.0 rated as excellent). The
39.3% of the sampled hunters who had hunted on other WMA's besides the
Sherburne WMA gave them a somewhat lower average rating than they did the
Sherburne-3.3 as opposed to 3.6. The same was true of the 59% of the sampled
hunters who had also hunted on private lands. These hunters assigned average
ratings of 3.6 to Sherburne and 3.4 to private lands. These data suggest that the
overall quality of the Sherburne WMA for deer hunting is rated somewhat better
than that of either other WMA's or private lands by those who hunted on them.

The Travel Cost Method

Employing the travel cost method in this study involved two major steps: 1)
estimating the visitation function, and 2) using the visitation function to construct
a demand curve and Net Willingness To Pay (NWTP) for hunting on the WMA.
The Rocky Mountain Travel Cost Model (RMTCM) (Rosenthal et al. 1986) was
used to estimate the total and per-trip net willingness to pay for deer hunting on
the Sherburne WMA. The visitation function for the Sherburne WMA was
assumed to be of the following general form (Johnson et al. 1981):

\[ V_i = f(D_i, Q_j, S_{ij}, E_i) \]

where

- \( V_i \) = number of visits from origin \( i \) to the WMA,
- \( D_i \) = distance from origin \( i \) to the WMA,
- \( Q_j \) = measure of deer hunting quality on the WMA,
- \( S_{ij} \) = substitute variable representing hunting area \( j \) available to the
  population of origin \( i \) as a hunting substitute for the WMA, and
- \( E_i \) = demographics of origin \( i \).

By arbitrarily incrementing \( D_{ij} \) in the visitation function, a graph can be
plotted which indicates the number of visits that would occur by hunters from
various distances. Once the distance axis is converted to travel cost, the graph
will show travel cost (i.e., price) versus visits (i.e., quantity), representing a
"second stage" demand curve for deer hunting on that WMA. The area under the
curve reflects the NWTP for deer hunting on the WMA.

The Sherburne WMA Visitation Function

The general a-priori visitation model used in the analysis of the
Sherburne WMA was specified as:

\[ VISITS = f(RTDIST, PCAPINC, POP, DEER, TRIP\%, \text{OTHER}) \]

where
VISITS = number of deer hunting trips by a hunter to the Sherburne WMA,

RTDIST = round-trip distance (cost) incurred by the hunter from a particular origin to the Sherburne WMA,

PCAPINC = total household income of the hunter,

POP = population of the hunter's origin,

DEER = number of trips the hunter saw deer on the Sherburne WMA in previous year,

TRIP% = percentage of total number of hunting trips by the hunter that were taken to Louisiana Department of Wildlife and Fisheries WMA's,

OTHER = other cost, demographic, and substitute site variables.

An individual observation based visitation and travel cost model was developed. In a zonal travel cost model, per-capita visits from each origin is regressed on the independent explanatory variables, while in the individual travel cost model, the number of times each individual visits a site is regressed on the individual explanatory variables. Brown et al. (1983) argue that the appropriate dependent variable in individual observation based models is "individual observed visits per-capita" specified, in terms of our study, as (Rosenthal et al. 1986)

$$v_{pcap_{ir}} = t_{ir}(R_{ij}/P_j)S$$

where

$v_{pcap_{ir}}$ = individual observed hunting trips per-capita for the rth sampled hunter from the ith origin

$t_{ir}$ = number of hunting trips to the study site made by the rth hunter from the ith origin
\[ R_i = \text{number of hunters sampled from the } i\text{th origin} \]
\[ P_i = \text{population of the } i\text{th origin} \]
\[ S = \text{expansion factor to correct for the sampling rate, i.e., } 1/(\text{proportion of visitors sampled}) \]

When using the Rocky Mountain Travel Cost Model (RMTCM) to run the Brown et al. model, the population associated with a particular value of \( vpcap_r \) is \((P_i/R_i)\) (Rosenthal et al. 1986).

Based on sample survey responses, multiple-destination and multiple-purpose trips were not identified as a problem in this study as the Sherburne WMA appears to attract hunters from the local area (within 100 miles, one way). In addition, those who camp on the WMA camp in conjunction with a hunting trip, which is the primary purpose of the trip. In this analysis, round-trip cost (RTDIST) incurred by a hunter included only transportation costs and was defined as

\[ \text{RTDIST} = \frac{(\text{dist}_r)(\text{oc})}{p_r} \]

where
\[ \text{dist}_r = \text{round-trip distance from the origin of hunter } r \text{ to the Sherburne WMA}, \]
\[ \text{oc} = \text{variable vehicle operating cost, in dollars per mile (ranging from $.15 to $.21)} , \]
\[ p_r = \text{average number of hunters who rode in hunter } r\text{'s vehicle to the WMA}. \]

RTDIST reflects the average out-of-pocket costs incurred by a hunter when driving a vehicle to the Sherburne WMA. The average variable cost of operating
a vehicle in 1984 was assumed to be $.135 per mile (U.S. Department of Transportation 1984). No special entrance or hunting fees were required for hunting on the Sherburne WMA.

The issue of how and when to account for the time cost of a trip (the opportunity cost of travel time) is currently not reconciled in the professional literature (Cesario and Knetsch 1970, Cesario 1976, Wilman 1980, McConnell and Strand 1981, Johnson 1983, McConnell and Strand 1983, Ward 1983, Smith et al. 1983). Time spent traveling can represent an additional cost to a traveler if it represents an opportunity cost of labor. Alternatively, time spent traveling can be incorporated into the recreationist's utility function as an intricate component of the recreation experience, and thus be accounted for as a benefit rather than a cost. Smith and Kaoru (1987) note that this experience will be specific to each individual in the case where travel is considered as a part of the recreation experience.

Hunters traveling to Sherburne most frequently hunted on weekends or holidays, reducing the necessity of specifying an explicit labor-leisure trade-off by the hunter. In the absence of definitive professional guidelines and an obvious labor-leisure trade-off, travel time to the Sherburne WMA was assumed to be incorporated into the recreational experiences of the deer hunters and thus was not accounted as an additional travel cost.

Since an individual observation travel cost model was developed, per-capita income was total household income as reported by the survey respondent.
was used as a measure of the quality of the Sherburne WMA for deer hunting and would be considered as an attractant to the WMA. The more deer that an individual hunter saw on the site in a previous year, the greater the likelihood that he would again visit the site in the next year.

The variable TRIP% indirectly recognizes the influence of other hunting opportunities on the Sherburne WMA hunters. It was also used as a measure of land availability for hunting to the Sherburne WMA hunter. The ratio ranges from 0 (but not including 0) to 1 where a value of 1 indicates that the hunter hunted only on publicly available sites and a value approaching 0 indicates that the hunter primarily hunted on private land. Generally, a hunter would be expected to make fewer visits to the Sherburne or other WMA's as the availability of other, private hunting opportunities increases.

The variable OTHER was actually a series of variables representing a variety of additional cost, demographic, and substitute site considerations. By individual hunter, these additional variables included the total number of deer hunting trips taken to all sites during the hunting season, an index of land availability for hunting on other sites, the total per-trip cost of hunting on the Sherburne WMA, hunting fees spent to hunt on private land, an employment indicator variable, an education indicator variable, an income indicator variable, round-trip miles to substitute WMA's, round-trip miles to private substitute sites, an either-sex indicator variable, and a ratio of the number of trips that the hunter
saw deer on private land to the round-trip distance to the private hunting site used.

The number of alternative hunting sites offering similar hunting opportunities (substitutes) that are available to a hunter could influence the number of trips that he or she makes to the Sherburne WMA. Rosenthal et al. (1986) distinguish between perfect and imperfect substitute sites. For an alternative site to be considered as a perfect substitute, its quality must equal or exceed the study site in all respects. Further, it must have sufficient excess capacity that the increased use caused by switching from the Sherburne WMA will not deteriorate its quality enough to violate the first condition. Alternative sites not meeting these two conditions would be imperfect substitutes.

Neither other WMA’s nor private sites would generally be considered as perfect substitutes for the Sherburne WMA. The hunters generally rated the Sherburne WMA higher than alternative sites in terms of the overall quality for deer hunting. Further, it is highly likely that if hunters switched from the Sherburne to other WMA’s, congestion would result on those other WMA’s, particularly on the Thistlethwaite WMA, the closest WMA to the Sherburne.

Burt and Brewer (1971), Cicchetti et al. (1975), and Knetsch et al. (1976) recommended various ways of incorporating the influence of substitutes on per-capita visits to a recreation site. These included using the distance from each hunter origin to substitute sites as an independent variable or constructing indexes
that reflect the degree of substitution available to a recreationist. As indicated
above, a number of these recommendations were tested in the visitation function.

Several basic functional forms have been used in previous non-market
valuation studies, including linear, semi-log (dependent), semi-log (independent),
and log-log models. Past experience with the travel cost model indicates that
either the semi-log (dependent) or log-log functional forms are the best suited in
most cases (Rosenthal et al. 1986). Linear, semi-log (dependent), and log-log
models were tested in this study for appropriate functional form. Strong (1983)
found that untransformed per-capita trips can be heteroskedastic, but that a
logarithmic transformation of the variable could alleviate this statistical problem.
However, the semi-log (dependent) functional form is asymptotic to the price axis.
Since there is no finite price that predicts zero visitation from an origin to the
study site in question, the area under the demand curve for the site is infinite.
Consequently, to develop the second stage demand curve and calculate consumer
surplus employing the RMTCM model, an upper bound on round-trip
transportation cost has to be determined. Demand is assumed to fall to zero
when the model predicts less than one trip will go from an origin to the site
(Rosenthal et al. 1986).

The log-log functional form is doubly asymptotic as the function does not
intersect either the price axis or the per-capita trips axis. As with the semi-log
functional form, the demand curve is cut off at the point RMTCM predicts one
trip will go from the origin to the study site. The final visitation function chosen to represent the number of visits of hunters to the Sherburne WMA is given by:

\[
\ln(\text{VPCAP}) = b_0 + b_1 \ln(\text{RTDIST}) + b_2 \ln(\text{POP}) + b_3 \ln(\text{DEER}) \\
+ b_4 \ln(\text{TRIP\%}) + b_5 \text{ES} + b_6 \text{ED}
\]

ES is a binary variable indicating whether the hunter hunted on the Sherburne WMA only during the special either-sex hunt on Thanksgiving weekend. ED is a binary education indicator variable for hunters who did not or have not graduated from high school.

Descriptive statistics and parameter estimates are presented in Table 2. Econometric problems associated with multicollinearity, opposite signs, low levels of significance, and a limit on the number of explanatory variables that could be used in the RMTCM model limited the number of variables associated with the final model.

The model is highly significant with an \( R^2 \) of 0.92 and an F-value of 1359 and all estimated variables are significant at the 2% significance level. All signs met a priori expectations. The signs of DIST and POP are negative, indicating that the per capita visitation rate decreases with increases in distance from the WMA and with increases in population of the hunter's origin. The signs of DEER and TRIP\% are both positive, indicating that the visitation rate increases the greater the number of trips that deer are seen and the greater the proportion
of total deer hunting trips that are taken to Louisiana WMA's. The signs of the indicator variables ES and ED are negative. These imply that, given all else equal, the visitation rate of those who hunted on the Sherburne WMA only during the either-sex hunt and of those who have not finished high school was lower than that of the other hunters.

The predictive power of the model was tested by comparing the total number of trips reported against the total number estimated using the function in conjunction with the RMTCM model. Based on six assumptions discussed below, an average of 19,995 hunting trips were estimated from the model; the number reported from the sample respondents in the survey was 22,636. Thus, the equation underestimated the observed number of trips by 11.8%, a difference in the range considered acceptable for benefit estimation (Loomis et al. 1985, Sorg and Nelson 1986).

Benefit Estimates

The visitation function and various assumed per-mile transportation costs and demand cut-off points were used to derive total consumer surplus (total net willingness to pay) and average consumer surplus per trip (Table 3). Demand cut-off points were specified because substitute prices were not included in the model and because visits would never drop to zero since the log of per-capita visits was used. The assumed demand cut-off point is important since it influences the consumer surplus calculated. Estimated consumer surplus drops as the cut-off
distance is decreased since part of the area under the demand curve is being truncated.

Two alternative approaches were employed to set demand (distance) cut-offs. The first approach accepted the highest observed travel by a hunter as an upper limit on how far all hunters would be willing to travel to hunt on the Sherburne WMA, a procedure that has been used by Wennergren (1967), Smith and Kopp (1980), and Sorg and Nelson (1986). A demand cut-off of 480 miles was assumed under this approach. Under the second approach, the cut-off distance was set at two standard deviations from the mean distance traveled, resulting in a demand cut-off of 198 miles. At this distance, 42 hunters (5.9% of the sample) drove further.

Three costs per mile were used in converting round-trip mileage to transportation costs—$.15, $.18, and $.21. The lowest is higher than the $.135 per mile estimated by the U.S. Department of Transportation (1984), but lower than the $.165 per mile cost reported by the hunters responding to the survey. The third rate, $.21 per mile, is the reimbursement rate that the state of Louisiana currently pays for the public use of a private vehicle.

Using these numbers, total consumer surplus ranges from $392,297 to $1,336,040 and the consumer surplus per trip ranges from $19.69 to $66.92 (Table 3). These figures reflect the value of the Sherburne WMA for deer hunting over and above the costs actually paid by hunters to hunt at the WMA. It is apparent
that these values are quite sensitive to changes in the assumed operating costs and cut-off points.

In comparison, Donnelly and Nelson (1986) reported a per trip consumer surplus of $43.74, assuming operating costs of $.135 per mile traveled. Using the $.185 per mile operating costs actually reported by the Idaho deer hunters in their study, Donnelly and Nelson found that the per trip consumer surplus increased to $50.23. Using the same operating cost of $.135 per mile, Sorg and Nelson (1986) estimated the consumer surplus per elk hunting trip in Idaho to be $63.17.

The variation in these reported results taken together with the ranges in consumer surplus generated in this study through changes in operating costs and specification of cut-off points reinforces the caveat that no single estimate accurately reflects the net economic value of deer hunting at the Sherburne WMA. The correct interpretation and use of these results requires specification of the transportation costs and demand cut-off assumptions. Ranges in this case are more appropriate than point estimates.

Summary and Conclusions

Louisiana, like many states in the South, has a long history of providing open-access recreation sites for consumptive recreation activities through development of wildlife management areas such as the Sherburne WMA. The significance of publicly provided recreation sites such as Sherburne is highlighted by the fact that over 43% of the hunters interviewed for this study indicated that in the absence of a public site such as the Sherburne WMA they would be unable
to hunt. Although explanations underlying this relatively high percentage may include a number of social and economic factors, it does underscore the important role of the WMA system in Louisiana for providing deer hunting recreational experience to the citizens of the state.

Availability of public recreation areas such as the Sherburne WMA will probably increase in significance in the future if the regional trend of privatizing previously open access land through the practice of leasing land for recreation such as hunting continues in Louisiana. As the market for access rights to recreation forestland formalizes in Louisiana, both corporate and non-corporate private forest landowners will have the option of leasing access rights to their land for diverse income or management purposes. Willingness to pay for the right to hunt on private lands will have implications for recreationists’ willingness to pay for the use of public lands.

Economic valuation information on consumptive recreation provided through use of the travel cost method gives state level decision makers previously unavailable dollar figures to use in their evaluation of the Louisiana Wildlife Management Areas. This economic input can be especially useful in subsequent analyses of decisions requiring capital outlays including land acquisition, scheduling of managed activities, or facility enhancement.
References


Table 1. Profile of deer hunters who hunted on the Sherburne Wildlife Management Area and Atchafalaya Wildlife Refuge in the 1987-88 deer hunting season.

<table>
<thead>
<tr>
<th></th>
<th>Sample Mean</th>
<th>Population Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trips per hunter</td>
<td>7.58</td>
<td>22,636</td>
</tr>
<tr>
<td>Round-trip vehicle miles traveled</td>
<td>81.41</td>
<td>774,732</td>
</tr>
<tr>
<td>Number of hunters per vehicle</td>
<td>2.38</td>
<td>---</td>
</tr>
<tr>
<td>Number of trips that hunter drove own vehicle</td>
<td>6.68</td>
<td>19,956</td>
</tr>
<tr>
<td>Number of trips that hunter saw deer</td>
<td>3.67</td>
<td>10,964</td>
</tr>
<tr>
<td>Number of trips that hunter killed a deer</td>
<td>.39</td>
<td>1,173</td>
</tr>
<tr>
<td>Trips that hunter stayed over night</td>
<td>1.76</td>
<td>5,256</td>
</tr>
<tr>
<td>Total cost per trip</td>
<td>57.20</td>
<td>1,294,728</td>
</tr>
<tr>
<td>Transportation cost per trip</td>
<td>13.09</td>
<td>296,289</td>
</tr>
<tr>
<td>Food purchases per trip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grocery store</td>
<td>14.51</td>
<td>328,428</td>
</tr>
<tr>
<td>Restaurant</td>
<td>2.70</td>
<td>61,050</td>
</tr>
<tr>
<td>Lodging costs per trip</td>
<td>6.98</td>
<td>158,039</td>
</tr>
<tr>
<td>City size of hunter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-10,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of hunter</td>
<td>31.70</td>
<td></td>
</tr>
<tr>
<td>Highest level of education</td>
<td>Completed high school</td>
<td></td>
</tr>
<tr>
<td>Total household income</td>
<td>20-25,000</td>
<td></td>
</tr>
</tbody>
</table>

Sample mean is based on sample of 713 hunters (23.9% population sample).

Population total is the total for all 2,986 hunters.
Table 2. Descriptive statistics and parameter estimates of the Sherburne WMA deer hunter visitation model.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimate</th>
<th>t</th>
<th>Prob &gt; t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.79322</td>
<td>5.00</td>
<td>0.0000</td>
</tr>
<tr>
<td>Ln(DIST)</td>
<td>-0.15522</td>
<td>6.10</td>
<td>0.0000</td>
</tr>
<tr>
<td>Ln(POP)</td>
<td>-0.98016</td>
<td>74.32</td>
<td>0.0000</td>
</tr>
<tr>
<td>LN(DEER)</td>
<td>0.70548</td>
<td>28.76</td>
<td>0.0000</td>
</tr>
<tr>
<td>LN(TRIP%)</td>
<td>0.21624</td>
<td>7.99</td>
<td>0.0000</td>
</tr>
<tr>
<td>ES</td>
<td>-0.40316</td>
<td>8.73</td>
<td>0.0000</td>
</tr>
<tr>
<td>ED</td>
<td>-0.12202</td>
<td>2.39</td>
<td>0.0171</td>
</tr>
</tbody>
</table>

R² = .92
F = 1359
N = 713
Table 3. Total consumer surplus and consumer surplus per trip under various transportation cost and demand cut-off scenarios.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Transportation Cost ($/mile)</th>
<th>Demand Cut-off (miles)</th>
<th>Total Consumer Surplus ($)</th>
<th>Average Consumer Surplus ($/trip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.21</td>
<td>198</td>
<td>549,977</td>
<td>27.61</td>
</tr>
<tr>
<td>2</td>
<td>.21</td>
<td>480</td>
<td>1,336,040</td>
<td>66.92</td>
</tr>
<tr>
<td>3</td>
<td>.18</td>
<td>198</td>
<td>471,371</td>
<td>23.63</td>
</tr>
<tr>
<td>4</td>
<td>.18</td>
<td>480</td>
<td>1,138,673</td>
<td>56.94</td>
</tr>
<tr>
<td>5</td>
<td>.15</td>
<td>198</td>
<td>392,297</td>
<td>19.69</td>
</tr>
<tr>
<td>6</td>
<td>.15</td>
<td>480</td>
<td>952,563</td>
<td>47.69</td>
</tr>
</tbody>
</table>

1 Each scenario is a combination of assumed cost/mile and demand cut-off values.
THE ROLE OF PRIVATE LAND IN OUTDOOR RECREATION

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THE ROLE OF PRIVATE LAND IN OUTDOOR RECREATION

Introduction

Outdoor recreation requires different natural environments that can be provided on public and private land ownerships. Although recreation is generally associated with public lands, the private lands in the United States cover a larger land area and have the potential to provide recreation opportunities where public lands are not available.

The existing land base for outdoor recreation and expected future trends in the land base are discussed in the first section. Trends affecting recreation demand and projections of future demand are discussed in the second section, focusing on the trends most likely to affect demand for private lands. The information in these two sections is based on Cordell, et al. (1990) unless otherwise referenced. The potential of private lands to provide recreation opportunities is assessed, followed by a review of estimates of private land that are currently accessible for recreation and a discussion of the factors that influence landowners’ access decisions. The information in these sections are based on Wright et al. (1989) unless otherwise referenced.

Outdoor Recreation Land Base

The coterminous United States has an extensive land base for outdoor recreation (Table 1). The public lands cover 417 million acres in the
coterminous United States, while the private lands cover approximately 1.3 billion acres.

Public Land Base

Almost 90 percent of the public lands are in federal ownership (Table 1). Federal lands are located primarily in the western United States and are not well-distributed relative to the nation's population. For example, only 8 percent of the United States population lives in the Rocky Mountain region, but 64 percent of the federal lands are located there. State and local lands are distributed more evenly both geographically and relative to population distribution, but are not as extensive as the federal lands. The disparity between the location of recreational lands and the population distribution creates potential barriers to recreation opportunities.

Private Land Base

Private lands cover about 1.3 billion acres in the coterminous United States. Although not all of these lands may be suitable for recreation, many of the private tracts in agricultural or forest land have potential for providing recreational opportunities. The majority of these lands are located in the eastern United States. Because of the scarcity of public lands in the east, private lands are viewed as having a potentially important role for meeting future recreation demand in this region.
Trends in the Recreation Land Base

No significant expansion is expected for federal or state recreation areas. Land acquisition and recreation development are not generally high priorities in times of tight budgets. Local governments have been increasing investments in recreation areas and facilities. These efforts are primarily focused on facilities and tend to provide for high-density, intensive recreation activities, such as jogging trails, playgrounds, and sports fields. Private investments in recreation are also occurring in the developed recreation site arena. The private land base is expected to remain relatively stable. However, subdivisions of private tracts and conversions of natural environments to more intensive uses are expected to decrease the actual acres suitable for recreation purposes.

Expected Outlook for Recreation Demand

Recreation demand is influenced by many variables. These variables can affect the choice of recreation activities, the degree of participation, and the choice of recreation location. The variables most likely to affect the need for recreation on private land are discussed first. Second, the future outlook for recreation demand is discussed. The combination of projected demand for recreation activities and the projected supply of recreation opportunities have several implications for private lands.

Trends Affecting Recreation Demand

Recreation demand trends are affected by various socioeconomic and demographic trends in the nation that in turn influence the potential role of
private lands for recreation. Demographic trends affect recreation demand in sometimes conflicting ways. The most straightforward effect is from population increases. Any additions to the population increase the number of potential recreationists, and therefore increase overall demand.

Other demographic effects are more complex. The distribution of the population affects where people want to recreate, and often affects the types of preferred recreation activities. The United States population has been shifting to the south and west, a shift that is expected to continue in the future. Recreation opportunities are more plentiful in the west, which eases the demands on eastern lands as populations in the northeast decline. The population is also becoming more concentrated along the coastlines. In 1984, 40 percent of the population lived within 50 miles of an ocean. By 2000 the percent is expected to reach 80 percent. This distribution implies increasing recreation demand for lands in close proximity to coastal areas. In the eastern United States that implies pressure on private lands.

Recreation demand is also affected by leisure time. As the American population ages (by 2000 over half the population will be over 40), the proportion of the population in retirement will continue to increase. Retirees have the most available leisure time for recreation. On the other hand, leisure time has apparently been decreasing for the working-age population. The increase in dual-income and single-parent households has resulted in less leisure time. The effect
on recreation has been an increased demand for recreation opportunities close to home. The two to three week family vacation has been replaced by more frequent, shorter recreation trips that are within a few hour driving radius of home. The implication is that recreation opportunities need to be available in close proximity to populated areas, i.e. within close driving distance.

**Trends in Recreation Demand**

Outdoor recreation covers a broad spectrum of activities. Information from surveys and other sources generally agree that the future holds a continued growth in recreation demand. Projections of recreation demand estimate the amount of recreation Americans would prefer if resource availability remains similar and real costs remain constant (based on 1987). Projected increases in demand (measured in recreation trips) by recreation activity range from 20 percent to over 200 percent between 1987 and 2040. Table 2 lists selected recreation activities and their projected demand growth by 2040. The most rapid growth rates are expected for physically demanding activities such as downhill skiing and backpacking. The less physically demanding activities, such as walking for pleasure, have low projected growth rates. However, the number of participants is so high for these activities that they will still account for a large proportion of total demand in the future.
Availability of Recreation Opportunities

Satisfying the projected demand for recreation will depend on an adequate supply of recreation lands, facilities, and access to opportunities. Developed site uses (e.g. camping, golf, tennis) are provided primarily by local governments and the private sector. Demand is growing rapidly for developed site use. However, local and private investments are expected to be adequate to meet future demand. Private lands are not likely to play an important role for these activities.

Aside from developed use, three categories of recreation environments can be considered. First is wilderness and remote backcountry areas which are found over 3 miles from roads. These types of environments are provided primarily on federal lands. Private lands are not usually remote enough to fall into this category. The federal land base is sufficient to meet the demand, although the location of the federal lands may prevent some recreationists from participating in activities that require remote lands.

The second type of environment is extensive undeveloped areas, which are located between 0.5 and 3 miles from a road. As in wilderness uses, the federal land area is large enough to meet the projected demand, but the location of the lands may be a barrier to participation.

The third type of environment is partially developed, roaded lands which are within 0.5 miles of a road. The largest share of federal lands fall into this category, but again are primarily located in the west. The majority of dispersed recreation use occurs in this recreation environment. Most private lands fall into
this category as well. In fact, the private land base has an extensive system of roads and trails that could provide access to recreation opportunities for the public. These lands are better placed relative to population centers in the eastern United States than most public lands.

Assessing Private Lands for Recreation Potential

The potential for private lands to provide outdoor recreation opportunities depends on several factors: physical suitability, adjacent land uses, proximity to recreationists, and the landowner’s objectives. These factors determine the actual supply of private lands for recreation.

There are little data on the availability of private land for recreation. The only national source of data is the National Private Land Ownership Study (NPLOS). NPLOS was first conducted in 1976, with a second survey conducted in 1986 to develop trend estimates. It was designed to survey nonindustrial, private rural landowners. A representative sample of private tracts was selected from county master tax rolls. Counties with high population densities (200 or more people per square mile) or a high concentration of government-owned land (50 percent or more) were eliminated from consideration.

The physical characteristics required for outdoor recreation can vary widely by activity. For example, a fairly small area is sufficient for picnicking, while a fairly extensive area is necessary for backpacking. Tract size is an important determinant of suitability. Adjacent land uses may be equally important. Land
type, whether forest or agricultural, also affects the type of recreation opportunities available. For example, agricultural lands often provide hunting opportunities, while forests are likely to be a preferred environment for hiking.

The average tract size in the NPLOS survey was 183 acres. Regionally, the largest average tracts were in the Pacific Coast and Rocky Mountain regions (310 and 304 acres respectively). The averages for the South and North regions were 163 and 132 acres respectively. No information was provided on adjacent land uses.

Most nonindustrial tracts are fairly small in size. Of the total acres surveyed, 81 percent were in tracts of less than 100 acres, 16 percent were in tracts between 100 and 449 acres, less than 3 percent were from 500 to 2,499 acres, and 1 percent were over 2,500 acres. Tract size can be increased by cooperative efforts between adjoining landowners if adjoining land uses are compatible.

Recreation Activities Suitable for Private Land

Respondents to the NPLOS were asked to rate the suitability of their land for different recreation activities, regardless of whether they allowed access for those activities (Table 4). Hunting was selected as the activity most conducive to private lands. Water-related activities were generally rated as unsuitable, at least partially because of the scarcity of water resources reported by the landowners (only 30 percent reported owning surface water). The ranking of activities by
suitability did not vary greatly by region. The Rocky Mountain and Great Plains Region had less suitable tracts in all activity groups.

These results imply that private lands have a high potential for numerous recreation activities. Whether the landowners will allow access to these opportunities is a separate decision, and one that is difficult to analyze.

**Preferred Recreation Activities on Private Land**

The previous section dealt with the recreation activities that would be suitable on private tracts. The owners surveyed were also queried on what activities they would allow on their property, regardless of whether any use was actually occurring. Landowners were only allowed to respond for those activities they had indicated were suitable for their land. The responses are presented in Table 5. Hunting was the most allowed activity. The other most allowed activities (photography, bird watching, nature study, hiking, picnicking) are nonconsumptive in nature. Although consumptive, fishing is generally not considered to pose any danger to participants or others. Activities that were allowed by less than half the landowners tended to be activities that disturb the landscape (ORV use, camping), or activities that are considered risky and are more likely to create liability problems (horseback riding, swimming).

The NPLOS results can be compared to the results of a Wisconsin survey of nonindustrial private forest landowners. The surveyed owners were asked about the type of activities they would be most willing to allow (without being
constrained by suitability). The results were similar to NPLOS except for hunting, which was considered less acceptable in the Wisconsin survey. Generally, owners were more permissive towards nonconsumptive activities (80 percent indicated they would allow activities such as wildlife photography and hiking). Sixty percent favored access for consumptive activities such as hunting and berry picking; while 50 percent would allow activities that were perceived as disturbing the landscape or tranquility of the area (e.g. camping and snowmobiling)(Ruff and Isaac, 1987).

Trends in Recreational Access to Private Lands

A comparison between the 1976 and 1986 results of NPLOS indicate that recreational access to private lands by the general public has decreased over that period. In 1976 29 percent of private lands were open to public recreation use, in 1986 the percent had decreased to 23 percent. This finding at the national level is supported by state-level studies. For instance, a New York study compared the proportion of frontage road posted and the total acres of private land posted for the 10-year period between 1963 and 1973. The proportion of frontage road posted increased from 16 to 29 percent, and the number of acres posted increased from 25 to 42 percent. The proportional increase in posting was greater near metropolitan areas (Brown and Thompson, 1976).
Access Policies on Private Land

Landowners have a variety of recreational access choices between no access and complete public access. The access trends reported from the NPLOS results were for public access only. However, significant amounts of recreation appear to take place on private land, although no quantitative estimates are available for the number of recreationists involved, or the number of days or trips being consumed.

A landowner’s decision on the degree of recreational access involves a variety of factors. Wright and Fesenmaier (1988) and Wright, et al. (1988) developed a model of private land access that includes three groups of factors. The first group is personal attributes, including the socioeconomic characteristics of the owner, ownership objectives, whether the owner resides on the property, and attitudes towards recreation. The second group is user behavior, such as litter, property damage, and misuse of firearms. The final category is resource attributes, which includes the physical characteristic of the land and its ability to support various activities.

These three groups of factors will interact to determine a landowner’s access policy. The access choices can be placed in five categories:

1) prohibitive: no recreation use allowed.
2) exclusive: recreational use by the landowner only.
3) restrictive use: recreational use by family, friends, and business associates.
4) fee access: recreational use on a paid basis.

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5) open use: recreational use by the general public, with or without permission.

The results of the NPLOS survey indicate that the largest proportion of private acres fell into the restrictive category (Table 6). This category had the largest number of acres in every region except the Pacific Coast. Nationally, over one-half billion acres were in this category. Only 5 percent of the total acres were closed to all access, and even fewer acres were available on a fee access basis.

Two state studies can be compared to the NPLOS results. In the Wisconsin study of nonindustrial private forest landowners, about half the lands were open to the general public, while 10 to 15 percent were totally closed (Ruff and Isaac, 1987). The proportions at the two extremes are higher than for the NPLOS results. A 1982 Texas study (Wright, et al., 1988) looked at how hunters got access to land for hunting. Even in a state where leasing land is common, 33 percent of the hunters reported using land owned by friends or relatives, while 39 percent purchased leases directly.

Little work has been done to correlate landowner characteristics and choice of access policy. The results of the East Texas study on hunting offer some insights (Wright and Fesenmaier, 1988). Prohibitive landowners were likely to have higher levels of education and be female (females being generally more opposed to hunting). This group also reported significantly less wildlife available, indicating the land was not physically suitable. Exclusive and restrictive owners placed the highest values on outdoor recreation, and restrictive owners reported
the most wildlife present. The access decision was most heavily influenced by past experiences with hunters, liability beliefs, opposition to hunting, and lack of economic opportunities.

**Fee Access Recreation**

Charging fees for access to private land is a topic of intense debate. The focus is usually on hunting, since most fee activity is for hunting. A variety of perceptions exist about fee hunting. On the negative side is the contention that fee hunting excludes some segments of the population and is therefore elitist, and has decreased total hunting opportunities. On the positive side is the contention that it provides incentives to landowners to manage their wildlife resources, and actually increases opportunities because of the incentive for economic return.

Aside from the myths and perceptions, the fact is that fee access is the exception to the rule, even for hunting. According to NPLOS, only 6 percent of all rural, private nonindustrial acres were leased for recreation. The largest proportion of leasing occurred in the south (9 percent of acres leased in NPLOS) and Texas. In the Wisconsin study only 3 percent of nonindustrial private forest landowners reported leasing land for hunting; regionally, 6 percent of landowners leased in the southeast, where population is denser and public lands are more scarce, while only 1 percent of the landowners leased in the northwest, where population is scarce and public lands are abundant (Ruff and Isaac, 1987).
State wildlife agencies were surveyed on their perceptions of the effect of lease hunting on hunting opportunities (Wiggers and Rootes, 1987). Only 15 states considered leasing of major importance in the state; 23 noted it had little effect on hunting opportunities; 12 believed it increased opportunities while 4 believed it decreased opportunities. The effects on game abundance were either considered to be nonexistent or positive.

Conclusions

The private land base has the potential to provide many recreation opportunities to the public. In the eastern United States they could provide a valuable supplement to the scarce public lands. Private lands close to metropolitan areas tend to be more strategically located than public lands. Yet the apparent trend is for landowners to be closing more land from public access, particularly lands close to urban areas.

The private lands are suitable for a number of recreation activities, including many that are likely to experience significant growth in demand. Realization of those opportunities on private lands will depend primarily on landowner attitudes. A majority of private lands are already providing recreation for some people, generally family and friends of landowners. Access for the general public will be more problematic.

The available information on landowner choice in access decision clearly shows that economic incentives is only one factor for consideration. Recreationist
behavior, concerns about liability, and owner objectives are equally important as potential barriers to recreational access. Any policies aimed at increasing public access to private lands will have to address all these factors.
Table 1. Public land and water areas available for outdoor recreation by ownership and region in the coterminous United States, 1987 (million acres).

<table>
<thead>
<tr>
<th>Level of Government</th>
<th>North</th>
<th>South</th>
<th>Rocky Mountain</th>
<th>Pacific Coast</th>
<th>Total U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>13.0</td>
<td>17.4</td>
<td>258.7</td>
<td>79.9</td>
<td>369.0</td>
</tr>
<tr>
<td>State</td>
<td>22.9</td>
<td>6.6</td>
<td>7.8</td>
<td>8.6</td>
<td>45.9</td>
</tr>
<tr>
<td>Local</td>
<td>1.0</td>
<td>0.5</td>
<td>0.3</td>
<td>0.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Total</td>
<td>36.0</td>
<td>24.8</td>
<td>266.8</td>
<td>88.9</td>
<td>417.1</td>
</tr>
<tr>
<td>Percent of public acres</td>
<td>9.0</td>
<td>6.0</td>
<td>64.0</td>
<td>21.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Percent of population</td>
<td>47.0</td>
<td>31.0</td>
<td>8.0</td>
<td>14.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Cordell, et al., 1990.
Table 2. Recreational trips and projected recreational trips for selected recreation activities to 2040 (million trips).

<table>
<thead>
<tr>
<th>Activity</th>
<th>Recreational Trips in 1987</th>
<th>Projected Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>Backpacking</td>
<td>26.0</td>
<td>34.8</td>
</tr>
<tr>
<td>Bicycle Riding</td>
<td>114.6</td>
<td>143.2</td>
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<tr>
<td>Canoeing/Kayaking</td>
<td>39.8</td>
<td>45.0</td>
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<tr>
<td>Cross-country Skiing</td>
<td>9.7</td>
<td>14.3</td>
</tr>
<tr>
<td>Day Hiking</td>
<td>91.2</td>
<td>119.5</td>
</tr>
<tr>
<td>Horseback Riding</td>
<td>63.2</td>
<td>77.7</td>
</tr>
<tr>
<td>Nature Study</td>
<td>70.8</td>
<td>74.3</td>
</tr>
<tr>
<td>Walking for Pleasure</td>
<td>266.5</td>
<td>309.1</td>
</tr>
<tr>
<td>Wildlife Observation and Photography</td>
<td>69.5</td>
<td>80.6</td>
</tr>
</tbody>
</table>

Source: Cordell, et al., 1990.
Table 3. Suitability of private land resources for selected recreational activities (percent respondents indicating property suitable for activity).

<table>
<thead>
<tr>
<th>Recreational Activity</th>
<th>North</th>
<th>South</th>
<th>Rocky Mt./Grt. Plains</th>
<th>Pacific Coast</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunting</td>
<td>90</td>
<td>88</td>
<td>80</td>
<td>87</td>
<td>88</td>
</tr>
<tr>
<td>ORV Driving</td>
<td>84</td>
<td>77</td>
<td>69</td>
<td>76</td>
<td>79</td>
</tr>
<tr>
<td>Shooting</td>
<td>79</td>
<td>79</td>
<td>66</td>
<td>76</td>
<td>77</td>
</tr>
<tr>
<td>Photography</td>
<td>80</td>
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<td>68</td>
<td>76</td>
<td>77</td>
</tr>
<tr>
<td>Nature Study</td>
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<td>74</td>
<td>68</td>
<td>74</td>
<td>75</td>
</tr>
<tr>
<td>Hiking</td>
<td>77</td>
<td>72</td>
<td>60</td>
<td>71</td>
<td>73</td>
</tr>
<tr>
<td>Birdwatching</td>
<td>75</td>
<td>73</td>
<td>59</td>
<td>73</td>
<td>72</td>
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<tr>
<td>Picnicking</td>
<td>73</td>
<td>75</td>
<td>62</td>
<td>70</td>
<td>72</td>
</tr>
<tr>
<td>Horseback Riding</td>
<td>72</td>
<td>72</td>
<td>66</td>
<td>75</td>
<td>71</td>
</tr>
<tr>
<td>Camping</td>
<td>65</td>
<td>70</td>
<td>51</td>
<td>61</td>
<td>64</td>
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<tr>
<td>Fishing</td>
<td>45</td>
<td>56</td>
<td>32</td>
<td>42</td>
<td>47</td>
</tr>
<tr>
<td>Swimming</td>
<td>37</td>
<td>47</td>
<td>29</td>
<td>35</td>
<td>39</td>
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<tr>
<td>Canoeing</td>
<td>32</td>
<td>38</td>
<td>22</td>
<td>29</td>
<td>32</td>
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<tr>
<td>Boating</td>
<td>30</td>
<td>36</td>
<td>20</td>
<td>25</td>
<td>30</td>
</tr>
</tbody>
</table>

Source: Wright et al., 1989
Table 4. Landowners’ receptivity to selected recreation activities (percent of respondents with suitable acres that would allow access).

<table>
<thead>
<tr>
<th>Recreational Activity</th>
<th>North</th>
<th>South</th>
<th>Rocky Mt./Grt. Plains</th>
<th>Pacific Coast</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunting</td>
<td>72</td>
<td>64</td>
<td>64</td>
<td>60</td>
<td>67</td>
</tr>
<tr>
<td>Photography</td>
<td>69</td>
<td>57</td>
<td>63</td>
<td>66</td>
<td>64</td>
</tr>
<tr>
<td>Birdwatching</td>
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<td>53</td>
<td>63</td>
<td>60</td>
<td>61</td>
</tr>
<tr>
<td>Nature Study</td>
<td>65</td>
<td>52</td>
<td>60</td>
<td>62</td>
<td>60</td>
</tr>
<tr>
<td>Hiking</td>
<td>64</td>
<td>51</td>
<td>60</td>
<td>55</td>
<td>59</td>
</tr>
<tr>
<td>Picnicking</td>
<td>54</td>
<td>48</td>
<td>52</td>
<td>53</td>
<td>51</td>
</tr>
<tr>
<td>Fishing</td>
<td>50</td>
<td>53</td>
<td>42</td>
<td>47</td>
<td>51</td>
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<tr>
<td>Horseback Riding</td>
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<td>63</td>
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<td>50</td>
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<td>Shooting</td>
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<td>31</td>
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<td>Camping</td>
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<td>Swimming</td>
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<tr>
<td>ORV Driving</td>
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<td>14</td>
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</tr>
<tr>
<td>Canoeing</td>
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<td>19</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>Boating</td>
<td>16</td>
<td>12</td>
<td>7</td>
<td>15</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 5. Estimated total nonindustrial private acres available for recreation by access policy (thousand acres).

<table>
<thead>
<tr>
<th>Recreational Activity</th>
<th>North</th>
<th>South</th>
<th>Rocky Mt./Grt. Plains</th>
<th>Pacific Coast</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prohibitive</td>
<td>11,857</td>
<td>27,377</td>
<td>13,361</td>
<td>10,557</td>
<td>63,152</td>
</tr>
<tr>
<td>Exclusive</td>
<td>84,614</td>
<td>123,789</td>
<td>54,241</td>
<td>32,365</td>
<td>295,009</td>
</tr>
<tr>
<td>Restrictive</td>
<td>156,310</td>
<td>188,041</td>
<td>206,731</td>
<td>17,891</td>
<td>568,973</td>
</tr>
<tr>
<td>Fee Access</td>
<td>5,923</td>
<td>34,719</td>
<td>3,194</td>
<td>9,500</td>
<td>53,336</td>
</tr>
<tr>
<td>Open</td>
<td>66,663</td>
<td>53,658</td>
<td>97,799</td>
<td>11,544</td>
<td>229,664</td>
</tr>
<tr>
<td>Total</td>
<td>325,367</td>
<td>427,584</td>
<td>375,326</td>
<td>81,857</td>
<td>1,210,134</td>
</tr>
</tbody>
</table>

Literature Cited


PROJECTIONS OF OUTDOOR RECREATION
SCARCITIES FOR THE 1990 RPA
ASSESSMENT

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USDA Forest Service
Southeastern Forest Experiment Station

and

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The University of Georgia
PROJECTIONS OF OUTDOOR RECREATION SCARCITIES FOR THE 1990 RPA ASSESSMENT

Introduction

One of the more formidable challenges to have faced resource managers and researchers is that of identifying a process for expressing the value and scarcity of recreational opportunities dependent upon resources. The core of this challenge is to produce estimates that are comparable to and as credible as commonly used measures of commodity values. One of the principal commodity uses of forest lands is for timber production, for which there exists a well-established market with observable values (prices). Developing a method and data that would produce a measure and analysis of scarcity comparable to that used to evaluate timber production was a major objective of the 1989 Assessment of Outdoor Recreation and Wilderness. This Assessment was completed under the mandate of the Renewable Resources Planning Act, RPA (USDA Forest Service 1990).

The purpose of this paper is to summarize projections of outdoor recreation scarcities developed for the 1989 RPA Assessment. In the next section, the conceptual background for projecting outdoor recreation scarcities is briefly discussed. Next, scarcity projections for thirty-six recreational activities are presented. The implications of these projections are then discussed, and conclusions are presented.
Conceptual Background

Measures of value and scarcity are frequently used in planning and formulating policy where the desired end result is improvement of national welfare. The most commonly used welfare objective is maximization of net economic development (NED). This is accomplished by making choices where the social benefits outweigh social costs. Commonly this involves choosing resource development and management options which offer positive benefit-to-cost returns for each successive dollar invested. Optimum contribution to NED is achieved by pushing development and management investments to the point at which the return (marginal benefit, MB) is just equal to the last dollar invested (marginal cost, MC).

The above is the most basic of economic tenets. In outdoor recreation, it usually seems that the optimum level of investment where MB = MC is not achieved. Across time or space, wherever MBs are not equal to MCs, investing more to produce more of a good, service, or opportunity, up to the point where MB = MC, will eliminate disequilibrium and the shortage.

Following this line of reasoning for application to outdoor recreation, scarcity and less-than maximum net social benefits exist whenever consumers are willing to pay more for the last unit produced than it cost to produce that last unit. In figure 1, for illustration, a quantity q1 of recreational opportunity is produced at a price (cost) of p2. Producing q1 results in a scarcity (shortage) of opportunities, q1-q2. Consumers are willing to pay p1 when no more is available than q1 and the resulting disequilibrium price, p1, is higher than the equilibrium price, p3, indicating that some
net social benefits, area abc, have not been realized. This is because \( q_t \) rather than the optimum quantity of opportunity, \( q_o \), has been produced.

This inextricable relationship between price and scarcity is the basis for Harrington's recent monograph on measuring relative scarcity of outdoor recreation (1987). Price changes provide a meaningful index for tracking trends of relative scarcity. Over time, outdoor recreation price rises indicate growing scarcity and may point to a need, or opportunity, for changing investments and management emphasis. This is precisely the context of the economic analysis which has been applied to the national timber demand and supply in recent years. This timber analysis is described in the most recent Renewable Resources Planning Act (RPA) Assessment of Timber (USDA Forest Service 1990).

The research problem in developing the RPA Assessment of Outdoor Recreation was to provide a comparable analysis to that done for timber (a marketed commodity) for which market prices typically are readily observable. Needed was a suitable theoretical basis for defining a market setting that was holistic enough to enable description and modeling of equilibrium and disequilibrium price-quantity relationships. Without being able to observe and simulate market shifts and equilibria, true measures of relative scarcity were not possible. The RPA Recreation Assessment question being asked was, "Is there likely to be a difference (gap or shortage) between the number of outdoor recreational trips the American public would prefer in the future if their trip costs were to remain constant and ample
opportunities were to be made available and the number of trips they would consume if the public and private sectors continue to provide outdoor recreational opportunities as they have in recent past years?"

The above question appears to be straight forward, but existing econometric approaches seemingly have not been sufficient (Hof and Kaiser 1983). Typically, sufficient national-level data are not available to answer such questions, and economic analysis techniques for outdoor recreation have mostly focused on site-level valuation and rarely on supply (Daniels and Cordell 1989).

In evaluating alternative approaches to address the above RPA question, several needs were considered. First, a national assessment is necessarily aggregate in nature and an approach which focused mostly on aggregate data seemed appropriate. Second, measurement of scarcity in the RPA context must involve consideration of all forest and range ownerships, not just those managed by the Forest Service, or any other single agency. Third, the adopted approach had to express scarcity either in terms of price or quantity differentials. In addition to the above three criteria, the selected approach needed to have a solid theoretical footing, be feasible to operationalize, and provide a general equilibrium solution. A summary of the approach is provided below. A more detailed description of the approach is provided in Cordell and Bergstrom (1991).

**The Household Market Approach**

Many outdoor recreational opportunities are public goods, or at least quasi-public goods. They possess characteristics such that once they are produced, at least some of their benefits become available to "everyone", whether or not everyone has
formally gained rights to access (Buchanan 1968). Some outdoor recreation opportunities are publicly provided, even though they may be quasi-private goods. Whether public goods or private goods publicly provided, a competitive private market resulting in cleanly observable market clearing prices and all of the attendant nice measurement properties, are mostly absent. An indirect extramarket approach must be used if the earlier described problem of measuring scarcity is to be addressed. Household production theory is a conceptualization meeting this need (Bockstael and McConnel 1981). For the RPA Assessment, household production theory was applied within the context of the travel cost method (Ward and Loomis, 1986).

The zonal travel cost (ZTCM) was selected as the method for estimating the needed household market parameters. ZTCM has several advantages for the problem at hand. These advantages include: (1) ZTCM accounts for both changes in the probability and frequency of participation, (2) estimation can proceed using more simple OLS estimation procedures, and (3) ZTCM estimates broad, price-quantity relationship between communities and recreational sites, consistent with the intent of RPA. A regional ZTCM model was used since the modeling objective was to describe recreational trip behavior from a zone (community) to all sites available to the community population. The basic zone was defined as a county, considered to be a homogenous community. This specification enabled modeling trips taken by such communities to all sites visited by community population.
An important premise of household production theory is that an "output" of a
recreational experience is not solely determined by site operators, guides or other
providers who, for example, provide the ski lodge or the hiking trail. Recreational
experiences also involve the participants themselves as they invest their time, money,
equipment, skills, and enthusiasm in creating a satisfying trip. Thus recreationists are
both the ones who demand recreational opportunities, and as well the one who
supply them using available sites, facilities, and services as inputs.

Supply

In its fullest sense, recreation supply is a two-step process. In the first step,
public and private providers develop and manage land and water resources to make
different kinds of opportunities available. At this step, the resources made available
represent merely opportunities. It is here that the more commonly used site demand
and supply analysis apply. But in the household production model there is a second
step which combines the environments and opportunities resulting from management
with their knowledge, skills, equipment and technology to create (produce)
recreational experiences or trips. New technology and equipment, such as mountain
bikes, contribute toward a greater variety of recreation by creating new opportunities.
In the household production context, then, supply of recreation is a two-step process.
The second step involves households making decisions about how many trips to
produce given their knowledge, skills, and equipment and the number, quality, and
distribution of sites and facilities provided by public and private sector providers at various distances from their residence community.

The cost of producing trips includes out-of-pocket travel expenses and the cost of time. Other costs, such as for services, equipment, or training, may also be included on a prorated basis, but these usually are considered to be fixed costs which do not (should not) enter into marginal production decisions. Generally, as distance increases, so do travel and time costs. Recreationists as producers, if willing to increase their distance of travel for recreational trips, find more opportunities open to them resulting in the upward sloping household supply curve in Figure 1. Household supply is described by the following function:

(1)  \[ S_{ki} = h(P_{ki}, N_{ki}, H_i) \]

where,

- \( S_{ki} \) = annual number of trips for activity \( k \) produced by households in community \( i \),
- \( P_{ki} \) = cost or price of producing recreational trips for activity \( k \) facing households in community \( i \),
- \( N_{ki} \) = activity \( k \) opportunities available to community \( i \),
- \( H_i \) = vector of community \( i \) household characteristics.

The availability of opportunities for activity \( k \) are fixed in the short run (for our analysis, assumed to be 12 months to match the time frame for reported recreational
In the long run, opportunities are determined by public policy and private investments. An increase of opportunities, \( N_{ki} \), caused by adding, for example, public sites at various distances from the communities will shift the supply curve to the right, indicating that more trips can now be produced at each production cost level.

**Demand**

Demand in the household market context is of the classical specification. At successively higher (lower) prices, fewer (more) trips are consumed. The level of trips demanded at any one price is determined by income, strength of preferences, and available substitutes which may compete for households' recreational uses of their time and money. Across households at community or national levels, equilibrium is attained where marginal costs of supplying trips equals willingness to pay to consume trips. Important determinants of the cost of supplying trips are the access cost, quantity, and location of input sites, facilities and services.

Community-level recreation demand for trips taken away from home, that is, outside the yard or neighborhood, is determined by several community characteristics, and by the availability of recreational opportunities and substitutes. The general ZTCM specification of household demand was:

\[
\text{(2) } D_{ki} = f \left( P_{ki}, S_{ki}, G_i, Z_{ki}, H_{ki} \right)
\]

where,

\[
D_{ki} = \text{annual number of trips away from home for activity } k \text{ demanded by people in community } i,
\]
\[ P_{ki} = \text{cost of traveling to sites used by county i residents for activity k}, \]
\[ S_{ki} = \text{suitability of sites used by county i for activity k}, \]
\[ G_i = \text{substitute recreational opportunities for activity k available to county i}, \]
\[ Z_i = \text{county i population 12 years old and older}, \]
\[ H_i = \text{vector of county i community-level household characteristics}. \]

A community-level demand function for activity k is illustrated in Figure 1. The demand curve shows decreasing numbers of trips, q, taken as trip costs, p, increase, holding recreational suitability, substitutes, population, and household characteristics constant. Trip costs for this analysis include only relevant direct travel expenses and the opportunity cost of time.

**Consumption**

Projections of future outdoor recreation consumption were based on estimated consumption functions. Consumption of outdoor recreation is determined by both demand and supply factors. Equilibrium consumption is determined by the intersection of the demand function (Equation 2) and the supply function (Equation 1). This intersection is illustrated by point C in Figure 1. Equilibrium consumption can be estimated by the reduced form of Equations 1 and 2, or

\[ (3) \quad C_{ki} = \left( N_{ki}, S_{ki}, G_i, Z_i, H_i \right). \]

The RPA Assessment question posed earlier in this paper was: "Is there likely to be a difference (shortage) between the number of outdoor recreational trips the
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\[ C_{ki} = (N_{ki}S_{ki}G_{i}Z_{i}H_{i}). \]

The RPA Assessment question posed earlier in this paper was: "Is there likely to be a difference (shortage) between the number of outdoor recreational trips the
American public would prefer in the future if their trip costs were to remain constant and ample (non-constraining) opportunities were to be made available, compared to the number of trips they would consume if the public and private sectors continued to change outdoor recreational opportunities in the future as they have in recent past years?"

These two different, but possible, futures are referred to here as "preferred demand" and "expected consumption" of recreational trip opportunities. These futures can be compared as "unconstrained", demand-driven consumption and as supply-constrained consumption. The difference between these projected futures indicates possible degrees of future scarcity. Where preferred household demand is greater than expected household consumption of recreational trips, the costs of taking recreational trips can be expected to rise, reflecting heightened opportunity scarcity. If more recreational opportunity were to be made available in future years, such price (cost) rises could be avoided (it should be noted that other future scenarios could be contemplated and compared using the above demand/supply model).

Preferred Demand. Preferred demand is defined simply as the number of outdoor recreational trips Americans would take if there were no shortages of opportunities and the future cost of a recreational trip remained as it is today. Thus preferred demand is the number of trips Americans would prefer to take in the future given no change in the cost of trips. Preferred demand is illustrated in Figure 2. Suppose in base year 1987, the demand curve for activity k is given by $D^1$ in
Figure 2 and the supply curve for activity k is given by \( S^1 \). Hence equilibrium consumption of activity k consumption in 1987 would be equal to \( Q^1 \) trips. The 1987 cost per trip would be equal to \( p^1 \).

Next, suppose that by the year 2000, demand for activity k is expected to increase from \( D^1 \) to \( D^2 \). Given this new demand curve (which may result, for example, from an increase in population or income), Americans would prefer to take \( Q^3 \) trips at the current cost per trip of \( p^1 \). Hence, preferred demand for activity k trips in the year 2000 would be equal to \( Q^3 \).

**Expected Consumption.** Because total recreational trips are limited by available recreational facilities or resources, people may not be able to take all of the trips they would prefer to take. For the RPA Assessment, the expected consumption (or "supply") of recreational opportunities was defined as the number of trips Americans would take if recent past trends in making recreational facilities and resources available continued into the future. Put another way, it was assumed that there would be no significant changes in either private operations or public policies (i.e., a massive federal land acquisition program) that would dramatically alter the annual rate of change in the availability of outdoor recreational facilities and resources to American households.

Expected consumption is also illustrated in Figure 2. Again assume that the 1987 base year trip consumption and cost per trip are equal to \( Q^1 \) and \( P^1 \), respectively. Also, assume again that demand for activity k will increase from \( D^1 \) to \( D^2 \) by the year
2000. Given continuation of recent past trends in the availability of resources and facilities to support activity k, assume that the supply curve for activity k will shift from $S^1$ to $S^2$ by the year 2000. Thus, given $D^2$ and $S^2$, Americans would be expected to take $Q^2$ trips at a cost of $P^2$ per trip. The expected consumption of trip opportunities in the year 2000 would therefore be equal to $Q^2$.

Outdoor Recreation Scarcity Analysis

The future demand and supply of commercial forest products, such as timber, is often compared using a demand/supply gap analysis. A future gap or shortage of a product is defined as the amount by which future demand exceeds future supply. For the RPA Assessment, an outdoor recreation gap was defined as the amount by which preferred demand exceeds expected consumption (or "supply") in the future. This gap represents scarcity.

An outdoor recreation gap is illustrated in Figure 2. As discussed previously, if the demand and supply curves for activity k in the year 2000 are $D^2$ and $S^2$, respectively, at the 1987 trip cost of $P^1$ preferred demand would be equal to $Q^3$ and expected consumption will be equal to $Q^2$. Thus, in the year 2000 there will be a gap or shortage associated with activity k trips equal to $Q^3 - Q^2$.

The gap or shortage of $Q^3 - Q^2$ for activity k is also indicated by an increase in the price or cost per trip from $p^1$ to $p^2$. An increase in the price or cost of a trip indicates that demand is increasing faster than supply and outdoor recreational opportunities are becoming more scarce. For example, a gap for an activity may
mean that people have to travel greater distances in order to find available recreational opportunities. Conversely, a decrease in the price or cost per trip indicates that recreational opportunities are becoming less scarce (e.g., supply is increasing faster than demand, or demand is decreasing).

Estimation Methodology

Using the above ZTCM specification, estimates of the household market parameters needed for estimating future scarcities of outdoor recreational opportunities, in a general market equilibrium context, were developed in 4 steps. The first step was to estimate the demand function for 31 recreational activities (Equation 2). The second step was to estimate the consumption function (Equation 3) derived as a reduced form of equations (1) and (2). The third step was to project future levels of trip demand and consumption under alternative recreational opportunity scenarios. The fourth step was to compare future consumption trends under alternative opportunity level scenarios and to determine whether trip cost changes would result, indicating potential future increasing scarcity.

Demand Functions

Individual activity k demand functions corresponding to equation (2) were estimated from cross-sectional data. The United States was divided into 241 multicounty subregions and a representative county was selected for each region. Total annual trips, \( D_{kp} \), were estimated for each representative county based upon a 12-month profile of recreational trips reported by respondents to the Public Area
Recreation visitor Study (PARVS) (Cordell et al. 1986). This profile reports the number of trips a respondent took over a 12-month period for activity k to all sites. Because it is a function of trips per capita, the specification of total trips as the dependent variable in equation (2) implicitly accounts for both the probability and frequency of participation (Walsh 1986, Ward and Loomis 1986). Thus, the data truncation problem, often encountered in applications of the individual travel cost method, where nonparticipants are excluded from the analysis, was avoided (Ward and Loomis 1986). After estimating total annual activity k trips taken from a representative county, the proportion of these trips taken to each site actually used by people in the representative county for activity k were estimated. This allocation of trips was based upon probability weights calculated from the PARVS national data set.

Activity k trips from representative counties, as expected, varied across subregions because of differences in the costs of producing trips, substitute opportunities, site suitabilities, population sizes, and demographic and socioeconomic characteristics. The relationships between these variables and activity k trips were estimated by the general equation:

\[
(4) \quad \text{TRIPS}_{kij} = B_0 - B_1 \text{PRICE}_{kij} + B_2 \text{INCOME} + B_3 \text{PCT18T32} + B_4 \text{POP} - B_5 \text{PCTFARM} - B_6 \text{SUBEROS}_{ki} + B_7 \text{SUIT}_{kj}
\]

where,
LTRIPS_{kij} = \text{natural log of annual activity k trips from representative county i to site j},

PRICE_{kij} = \text{cost of activity k trips from representative county i to site j},

INCOME = \text{percent of representative county population with annual income of at least $30,000},

PCT18T32 = \text{percent of representative county population aged 18 to 32 years},

POP = \text{total population of representative county (12 years old or older)},

PCTFARM = \text{percent of representative county population living on farms},

SUBEROS_{ki} = \text{a general index of substitute effective recreational opportunities available to representative county i which compete with activity k for recreation consumers' time and money (Cordell and English 1990)},

SUIT_{kj} = \text{suitability of site j for activity k}.

In order to calculate the price variable in equation (3), PRICE_{kij} travel distance in miles from representative county i to site j were estimated by calculating the straight-line distance from the county centroid to the site and applying a measured circuitry factor. These circuity factors were estimated for each region of the country as the ratio of reported travel miles to straight-line distance. Travel distance was
then converted to travel costs using typical out-of-pocket travel expenditures as reported by the Department of Transportation, and the opportunity cost of travel time valued at one-half the estimated wage rate for a representative county as recommended by Rosenthal et al. (1986).

The substitute variable in equation (3) was derived from an extensive recreational facility and resource data base maintained by the Outdoor Recreation and Wilderness Group in Athens, Georgia. This data base shows the effective supply of recreational opportunities approximately as defined by Clawson (1984). Effective opportunity indices are calculated by weighting per capita recreational facilities and resources by a distance decay function. This distance decay function accounts for the effect of location on per capita recreational opportunities. The substitute variable, SUBEROS, requires massive amounts of data and mainframe operations, but it more comprehensively reflects opportunities for recreation which compete with activity k for the time and money of households.

The suitability variable in equation (3), SUIT, represents the suitability of a site j for activity k. SUIT is a rating based on responses to a nationwide survey of recreation site managers who were asked to rank the suitability of their sites for a number of outdoor recreational activities. Socioeconomic variables in equation (3), including INCOME, PCT18T32, POP, and PCTFARM, were obtained from U.S. Bureau of the Census data.
The semi-log functional form of equation (3), recommended by previous studies, resulted in the best fit of the data. This functional form is theoretically consistent with recreation demand behavior and reduces problems with heteroskedasticity (Rosenthal et al. 1986; Ward and Loomis 1986; Ziemer et al. 1980). Equation (3) was estimated using ordinary least squares for 39 recreational activities (Table 1).

After estimating equation (3), an aggregate demand function was derived for each activity. These demand functions were derived by substituting mean values for all independent variables, except for cost, into an empirically estimated equation (4) for 39 activities and solving for a composite constant term. This reduced equation was then multiplied by the average number of sites used for activity k by a community i. The result was a set of 39 aggregate demand curves for the k activities across the representative communities (Table 2).

Estimation of the functions depicted by equation (2) assumes that our cross-sectional modeling approach correctly identifies the intended demand functions. Identification of the demand functions requires an assumption about the supply function within the community-level household market for recreational trips. In order to identify the aggregate demand curve, it was necessary to assume that local site capacity does not truncate the aggregate supply curve, as would be the case if a community were actually an island and recreationists could not travel beyond its shores to find alternative recreation opportunities. Rather it is assumed that recreationists are free to move into other regions (destinations) until an equilibrium
point is reached where the marginal benefits and costs of the last trip produced and the last trip consumed are equal (point c in Figure 1). Variations of availability of recreational sites and facilities across the regions lead to shifts of the supply function as the analysis moves from region to region. Changes in consumption caused by region-to-region shifts of the supply function identify the aggregate community level demand function for trips. More detail on the demand function estimation process is provided by Bergstrom and Cordell (1991).

Consumption Functions

Estimation of consumption futures assumes that community-level household markets for trips are observed as equilibrium solutions between demand and supply functions. Household market equilibrium consumption is explained generally by equation (4), specified for estimation purposes as:

\[ LTERPS_{kij} = B_0 + B_1 INCOME + B_2 PCT18T32 + B_3 POP + B_4 PCTFARM - B_5 SUBEROS_{ki} + B_6 \text{FACILITY}_{ki} \times \text{SUIT}_{ki} \]  

where,

\text{FACILITY}_{ki} = \text{quantity of recreational facilities, space, or other resources available for activity k within a 120-mile radius of central county i,}
and all other variables are as defined for equation (4). Equation (5) is the empirical specification of the reduced form of the household recreational demand and supply models (Equation 3).

In equation (5), the variable FACILITY\textsubscript{ki} was obtained from another extensive nationwide recreational resource and facility data set maintained by the Outdoor Recreation and Wilderness Assessment Group, U.S. Forest Service, Athens, Georgia. This data set contained measures of the quantity of various recreational facilities and resources found within all counties across the United States as of base year 1987. Quantities of facilities and resources which support each specific activity modelled were available within this data set. For each central county, the quantity of activity specific facilities and resources within a 120-mile radius of the centroid of the representative county was calculated. These facilities and resources were weighted by the average suitability of known sites used by people in this representative county i for activity k. Equation (4) was estimated by ordinary least squares for 39 recreational activities. In some equations it was necessary to delete the PCTFARM variable because of collinearity problems.

Summary statistics describing the mathematically estimated models for the 39 activities are provided in Table 1. In general, the models were highly significant, theoretically consistent, and demonstrated the hypothesized sensitivity to regional variations in direct and substitute opportunities, FACILITY * SUIT and SUBEROS, respectively. These estimated models provided a set of general equilibrium specifications for evaluating national-level household demand and supply of outdoor
recreation. The base year from which future change conditions were evaluated was 1987.

Results

Expected Consumption of Recreational Trips

Often, people cannot take all of the trips they would prefer. This is because the type and number of recreational trips which can be taken are limited by available recreational facilities or resources. In Table 3, the expected consumption "or supply" of recreational trips was reported. These projections assumed continuation into the future of recent past trends in change of the availability of recreational facilities and resources. Put another way, this assumes that there would be no significant future change either in the private market for outdoor recreation or in public policies (i.e., a massive federal land acquisition program) that would dramatically alter the availability of outdoor recreational facilities and resources to American households.

Continuing recent trends in the availability of different land, water, and snow and ice facilities and resources were presented in Chapter 3 of the 1989 RPA Assessment (USDA 1990). These trends, as applied to land resources, showed both gains and losses, largely reflecting the building of roads and site development which typically follow improved access. Thus, categories of resources which are developed have increased while unroaded areas and sparsely developed roaded areas all show declines.

For water resources, the most remote and wild lakes and streams, as well as intensively developed water sites, both showed increases of access, facilities and resources. Lakes and streams near roads showed a decline, reflecting both
development and loss of access because of the closure of private lands. For snow and ice, only intensively developed winter sports sites showed increases in available facilities and resources. Remote, roadless areas and areas somewhat near roads in regions with good snowfall showed decreases.

Households will use the facilities and resources available in the future to produce recreational trips. If changes in the amount and access to facilities and resources follow recent past trends, they may produce a somewhat more limited number of trips than they might prefer. Rates are highly variable among activities. Expected consumption of trips have increased at relatively high rates for some of the more physically active, but simple recreational activities, including, biking, day hiking, walking, running and jogging. Among the more passive recreational activities, some also show a relatively high projected increase in expected consumption of trips including developed camping, sightseeing, visiting museums, and visiting historic and prehistoric site. Expected trip consumption will also increase at relatively high rates for some of the more risky and adventurous some activities, including rafting and downhill skiing.

Expected consumption of trips should increase at moderate rates for picnicking, horseback riding, stream and lake swimming, canoeing and kayaking and cross country skiing. Expected consumption of trips for specialized land-based activities, including primitive camping, nature study, wildlife observation, and off-road driving, will increase at relatively low rates. General activities which show a relatively low increase of expected consumption include many of the motorized activities such as boating and pleasure driving.
Preferred Demand for Recreational Opportunities

Preferred demand is defined simply as the number of outdoor recreational trips Americans would take if there were no shortages of opportunities and the future cost of trips remained at the levels they were in 1987. In 1987 Americans took a total of 2.7 billion recreational trips away from home, mostly to rural forest, range, and water areas. For America's growing number of older citizens and those baby boomers who now have families, simple recreational activities like picnicking, pleasure driving, sightseeing, and day hikes will continue to be popular in the future, even though rates of increase should be modest. Preferred demand for these types of activities, which are easily accessible, inexpensive, and easy to organize, will increase steadily. Somewhat in contradiction to these trends toward passive and easily accessed recreation is the rise in preference for more expensive, time consuming, and adventuresome recreational activities. These include rafting, canoeing, kayaking, downhill skiing, cross-country skiing, and backpacking. Preferred demand for some of these activities will increase considerably. This predicted trend may fall off as baby boomers age, but may rise again toward the end of the 50-year time frame considered here as boomers' children begin to pursue the recreation interests they learned from their parents.

Continued interest in health and physical fitness may contribute to increased preferred demand for exercise-oriented activities which are broadly available and easily engaged in close to home. Preferred demand projections for these activities, including bicycling, swimming, walking, and running and jogging, show a steady increase into the future. Slight increases in preferred demand will occur for typical
land- and water-based outdoor recreational activities, including primitive camping, off-road driving, nature study, collecting forest products, wildlife observation, motor boating, and water skiing.

Estimates of Future Scarcities

Estimates of possible long-run future scarcities of various kinds of outdoor recreational trip opportunities were estimated using the household market consumption models. These estimated futures were computed by summing the product of the models' partial regression coefficients and forecasts of future values for each of the respective variables in the models for each decade through 2040. Future values of the independent variables in the models were derived mostly from USDA Forest Service basic assumptions, most of which were provided by Wharton Econometrics (USDA Forest Service 1989). The resulting projected recreation futures provided consumption trend lines as shown in Figure 3 for 5 selected activities. These trend lines represent simultaneous shifts of both household demand and supply as the independent variables in Equation (5) change in future years. Consumption levels depicted by these trend lines represent household market equilibria at every point along them for the corresponding demand/supply conditions. The principal relationship of interest is that between consumption and amount of recreational opportunity. The trend lines shown in figure 3 represent the most likely future to occur if there were to be no future departure from recent past trends in rate or direction of change in quantity and availability of recreation sites, facilities,
and services. Thus, the trend lines in figure 3 illustrate changes in expected consumption or "supply" defined previously.

Projections of possible future scarcities are summarized in Table 3. Shown are preferred demand (at constant trip costs and unconstrained growth of recreational facilities and resources) and expected consumption assuming continuation of recent past trends in the supply of recreational facilities and resources (with costs permitted to increase or decrease, reflecting increasing or decreasing scarcity, respectively. These measure are shown as an index, where the 1987 base levels of trips equals 100 and the projected future levels of consumption under the two different scenarios represent the percentage of this 1987 base level. Also shown is the percentage difference between preferred demand and expected consumption. In this table, the larger the difference between the preferred and expected indices, the greater is the predicted increase in future scarcity of recreational trip opportunities.

With increasing scarcity, there is an increase of costs to the recreation-seeking public. Figure 4 shows projected cost indices for camping, wildlife observation, and cold-water fishing under the assumption that percent past growth trends of recreational facilities and resources would continue into the future. The 1987 estimated trip costs are indexed at 100, thus the future trip costs represent percentages of these 1987 trip cost levels.

Household market trip costs are estimated by substituting future expected consumption of trips into the appropriate future aggregate demand function and solving for costs. The appropriate future aggregate demand function is determined by shifting out the 1987 aggregate demand functions.
The example cost indices in Figure 4 summarize the relationship between outdoor recreation supply and demand over time. An increase in household market costs (for example, wildlife observation) indicates that demand is growing faster than supply and that trip opportunities are becoming more scarce. Constant household market costs would indicate that demand and supply are changing at about the same rate. A decrease in household market costs (for camping) indicates that supply is increasing faster than demand.

Implications of Scarcity Projections for Activities

The numbers in Table 3 suggest that there may be shortages of many recreational activities in the future. The implication of a shortage is that past trends extended into the future will not provide growth of recreational facilities and resources at rates sufficient for Americans to take as many recreational trips as they desire at the current (1987) level of trip costs.

No shortages are predicted for some land-based activities including developed camping, picnicking, family gatherings, walking, and attending special events. A "no shortage" situation is also predicted for several water-based activities including stream/lake/ocean swimming, motorized boating, water skiing, and rafting. One snow and ice-based activity, downhill skiing, is predicted to have a no shortage situation. Near zero shortages are predicted for several land-based activities including bicycling, running and jogging, and visiting museums. Also, near zero shortages are predicted for two water-based activities, canoeing/kayaking and pool swimming.
For other land-based activities, relatively small to moderate shortages between preferred demand and expected consumption are projected. These activities include cutting firewood, collecting berries, and off-road driving. A relatively small to moderate shortage is predicted for one water-based activity, rowing/sailing. For a number of land-based activities, relatively large shortages are predicted between preferred demand and expected consumption. Included among these activities are primitive camping, backpacking, day hiking, horseback riding, wildlife observation, nature study, photography, pleasure driving, sightseeing, and visiting historic and prehistoric sites. A relatively large shortage will also occur for cross country skiing.

Implications of Scarcity Projections for Environments

Another way to examine recreation futures is to compare demand for and supply of trips by the type of recreational setting or environment within which activities occur. If recent past trends of availability of space, access, and facilities (public and private) were to continue into the future, the outcome would be a mixture of gains and losses among remote to developed environments. One such outcome would be losses of remote, unroaded, and roaded forest, farm, and range areas available for recreation, while developed recreational opportunities would continue to increase. The most serious scarcity is the expected shortfall in opportunities for warm-season trips using land-based roaded and partially developed environments. These environments provide access for activities such as hiking, nature study, horseback riding, and sightseeing. These are also the environments where hunting and most other general forms of land-based dispersed recreation occur. In particular, private forest and range lands near populated areas, as well as "close-in" public lands,
represent both a reason for possible future shortages, and an opportunity to better meet projected demand growth. Providing access to roaded areas with adequate future opportunities for wildlife observation, day hiking, photography, pleasure driving, sightseeing, and similar activities would address about 75 percent of the predicted national shortages of supply for outdoor recreation.

The availability of developed recreation sites responds more readily to market signals than other types of land-based opportunities. Thus long-run, planned increases involving the public sector may be unnecessary. The market will likely attract sufficient investments to increase the number of developed sites.

While demand for water and snow and ice recreation typically have grown at faster rates than land-based recreation, the magnitude of the projected shortages for land-based recreation in terms of trip opportunities tends to be overshadowing. And even though the shortage for developed land recreation is small relative to that for dispersed land recreation, the projected shortage of developed land recreational trip opportunities still is approximately four times that projected for water and snow and ice opportunities combined.

If recent past trends in availability of facilities and resources continue, there should be relatively little shortage of water recreation opportunities. Shortages should primarily affect opportunities for nonmotorized lake and river activities and for pool swimming. Increases in water quality and improved access in recent years have had dramatic effects. Shortages of snow and ice-based recreation opportunities will likely limit dispersed activities, such as cross-country skiing.
One major implication of these findings seems to be that prompt attention is needed to develop research and incentives regarding public access to private lands. Continuation of closure and leasing trends could have significant future consequences. The effects of these trends are certainly being felt now. Another implication is that access and information about available public land near urban centers is needed. The most visible need seemingly is not for development of public lands only, but for access and trails on both public and private lands.

Policy Implications of Predicted Future Scarcities

What are the policy implications if recent past trends of resource and facility availability continue into future years? One such implication is the implied commitment to continue current policies and levels of public spending for outdoor recreation. Without a conscious change of budgeting that is sufficient to significantly alter future availabilities of resources and facilities, the scarcities or shortages of future opportunities may, for some activities, be quite large. For others, it is more likely to be negligible to modest. Whatever the impact, substantial public sector spending will seem to be necessary, even if recent resource availability trends were to be continued.

Deviating from past trends would involve substantial changes of public budgets and of private investments. With deviation from past public sector trends, it is highly likely that some undesirable consequences for the recreation seeking public will occur and benefits may be foregone. Even a small change to address projected scarcities may mean many millions of additional dollars. For example, a decision to maintain
all existing facilities and resources at their current quantity and quality would result in a major shift away from some of the decreases in facilities and resources experienced since 1970; this policy would require hundreds of millions of new dollars at the federal level alone. If projections for natural-resource-based outdoor recreation are indicative of the future, public and private lands must be managed more intensively for dispersed recreation. Opportunities for primitive camping, backpacking, hiking, horseback riding, nature study, and wildlife observation are all projected to become more scarce, particularly in the East. Making opportunities better known to the public, improving roads and trails, increasing interpretive and education programs, improving safety, and protecting natural, historical, and prehistoric sites will all be needed. These management emphases will require identification of heretofore unused sites and areas, and perhaps purchase of additional sites and areas, if demand grows as projected. Partnerships with other public and private entities will likely be essential.

Research Implications

This national study was undertaken to answer a rather well defined policy question. As a result, policy and management implications flowed rather easily. But important research implications also became clear.

First, unlike most studies involving economic valuation, data were not a major limitation. The Public Area Recreation Visitors Study and the National Outdoor Recreation Supply Information System are powerful and directly appropriate data sets. This offered a rare opportunity to attempt estimation of a general equilibrium system in a relatively simple and straightforward manner. The complex econometric
methods typically employed in valuation studies to overcome data problems, were not needed in this study.

For future such efforts, the question becomes one of which strategy is most cost effective. Smaller amounts of primary data and resort to use of secondary data cuts the cost of doing research. On the other hand, larger investment in better data up front cuts the costs and effort needed to econometrically analyze and model from the data. The models estimated for this study were derived from powerful data sets which provided many avenues for exploration and iteration.

Second, even with strong data, some measures which are believed to be important were not available. In particular, better measures of site quality would appear to offer opportunity for improvement of the estimated model parameters. Such site quality measures should better reflect the public's definition of quality. Our measure of suitability measures little more than the term implies. But as a rough measure of quality, it was an important and stable variable. In addition, better measures are needed of the quantity of recreational facilities and resources which are relevant and necessary for each kind of recreational activity.

Third, the household production concept has been shown here to be an extremely appropriate aggregate modeling basis, one which offers estimates of equilibrium demand and supply conditions. Predicting demand and supply futures in equilibrium provides policy and land management staff with information more appropriate to setting policy directions than do partial or disequilibrium results.


Figure 1.--Disequilibrium in a recreation market
Figure 2.--Shift in preferred demand and expected supply and the scarcity measure
Figure 3.—Projected future consumption of outdoor recreation (if recent trends) in growth of available sites, facilities, and service continue
Figure 4.--Future scarcities of recreational trip opportunities for 3 example activities indexed as a percentage of 1987 trip costs.
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Table 1--Estimated Community Consumption Functions for Recreational Activities--continued

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**WATER**

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Table 1—Estimated Community Consumption Functions for Recreational Activities--continued

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<td>.187*</td>
<td>-2.48**</td>
<td>.0000014*</td>
<td>.0025*</td>
<td>-</td>
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<td>(.124)</td>
<td>(5.66 E-07)</td>
<td>(.001)</td>
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<td>(.00007)</td>
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*Significant at 0.01 level; **Significant at 0.05 level; ***Significant at 0.10 level; * For these activities, age variable was MEDAGE = medium age of central county population.
<table>
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<tr>
<th>Activity</th>
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<tr>
<td>Cross-country skiing</td>
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<td>Downhill skiing</td>
<td>11.2286</td>
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*All models significant at $p < 0.01$. 

115
Table 3—Projected gap between maximum preferred demand and expected consumption of outdoor recreational trips away from home, measured as percentage difference by decade to 2040

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<thead>
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<tr>
<td>Wildlife Observation and Photography</td>
<td>69.5</td>
<td>116/107/9</td>
<td>131/113/18</td>
<td>146/120/26</td>
<td>162/120/26</td>
<td>174/130/44</td>
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<tr>
<td>Camping in Primitive Campgrounds</td>
<td>38.1</td>
<td>114/108/6</td>
<td>127/115/8</td>
<td>140/122/18</td>
<td>154/130/24</td>
<td>164/134/30</td>
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<tr>
<td>Backpacking</td>
<td>26.0</td>
<td>134/124/10</td>
<td>164/144/20</td>
<td>196/165/31</td>
<td>230/185/45</td>
<td>255/198/57</td>
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<td>Nature Study</td>
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<td>105/99/6</td>
<td>113/101/12</td>
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<td>131/107/24</td>
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<td>Horseback Riding</td>
<td>63.2</td>
<td>125/114/9</td>
<td>141/125/10</td>
<td>160/135/25</td>
<td>177/144/33</td>
<td>190/149/41</td>
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<tr>
<td>Day Hiking</td>
<td>91.2</td>
<td>131/123/8</td>
<td>161/144/17</td>
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<td>244/198/46</td>
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<td>Photography</td>
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<td>123/115/8</td>
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<tr>
<td>Visiting Prehistoric Sites</td>
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<td>133/127/6</td>
<td>160/148/12</td>
<td>192/173/19</td>
<td>233/203/30</td>
<td>276/236/42</td>
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<td>Collecting Berries, Seashells, Mushrooms, etc.</td>
<td>19.0</td>
<td>113/110/3</td>
<td>126/120/6</td>
<td>143/132/11</td>
<td>166/149/17</td>
<td>192/169/23</td>
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<td>Collecting Firewood</td>
<td>30.3</td>
<td>112/109/3</td>
<td>124/118/6</td>
<td>138/130/8</td>
<td>157/144/13</td>
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<td>Walking for Pleasure</td>
<td>266.5</td>
<td>116/116/0</td>
<td>131/132/0</td>
<td>146/148/0</td>
<td>164/168/0</td>
<td>177/183/0</td>
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<tr>
<td>Running/ Jogging</td>
<td>83.7</td>
<td>133/131/2</td>
<td>163/160/3</td>
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<td>262/260/2</td>
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<td>Bicycle Riding</td>
<td>114.6</td>
<td>125/124/1</td>
<td>148/146/2</td>
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<td>202/197/5</td>
<td>222/218/4</td>
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<tr>
<td>Driving off road</td>
<td>80.2</td>
<td>105/104/1</td>
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<td>Driving for Pleasure</td>
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<td>115/110/5</td>
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<td>Sightseeing</td>
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<td>117/120/0</td>
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<td>136/145/0</td>
<td>144/156/0</td>
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<td>Camping in Developed Campgrounds</td>
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<td>155/158/0</td>
<td>173/178/0</td>
<td>186/195/0</td>
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<td>124/140/0</td>
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<td>Rafting/Tubing</td>
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<td>258/317/0</td>
<td>333/359/0</td>
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</table>

1 D is the maximum preferred demand; S is the expected consumption, and G is the percentage difference (gap) between D and S. D, S, and G are all expressed as percentages of the 1987 base number of trips. In the projection base year of 1987, demand is assumed to equal supply with zero gap, that is, demand and supply are in equilibrium.
APPLICATIONS OF ECONOMICS RESEARCH IN THE
DECISION-MAKING PROCESS

by

ROBERT A. MARKER, GEORGE M. HUMPHREY, and ROBERT G. FARRELL
Tennessee Valley Authority, Natural Resources Building, Norris, TN 37828-2009.
APPLICATIONS OF ECONOMICS RESEARCH IN THE
DECISION-MAKING PROCESS

Background

The Tennessee Valley Authority (TVA) is an independent federal agency created in 1933 by the United States Congress. It was given considerable flexibility to undertake a broad range of projects oriented toward natural resource conservation and improvement of the social and economic conditions within the Tennessee River watershed area (a region covering some 41,000 square miles, including parts of seven southeastern states). TVA's primary mission, however, was to harness the Tennessee River and its tributaries, to provide for flood control, improve navigation, and generate hydroelectric power. To meet these three objectives, TVA has developed a series of 28 multipurpose dams on the Tennessee River and its tributaries. Most of these projects were completed during the 1930s, 1940s, and 1950s.

Optimum operation of TVA's multipurpose reservoirs for flood control, navigation, and power generation requires seasonal fluctuation of reservoir water levels. Beginning in December, the multipurpose reservoirs are at low levels to provide storage space for the major rain storms that can be expected. As rainfall occurs during the winter, the reservoirs are allowed to rise gradually until April. Thereafter, they are allowed to rise more rapidly. Starting in late spring and early summer, the water is drawn out gradually to supplement the natural flow of the river for navigation, power production, and water supply. Drawdown becomes more rapid during the drier fall months. This lowers the reservoirs to be ready for the next flood season's rains. By late December, the reservoirs are at their lowest levels once more, completing the annual cycle.
The extent of total annual reservoir fluctuation varies from project to project. Because of the need to maintain adequate year-round water depths for commercial navigation on the Tennessee River, mainstream reservoirs undergo relatively modest annual fluctuations ranging from 2 to 7 feet. However, on tributary projects, the annual cycle typically calls for substantial fluctuation, and the difference between normal "full" pool elevations achieved in the spring and the normal "minimum" winter pool elevations can exceed 100 feet. The annual flood control cycle complements the need to use TVA's hydro generation units to meet peak power demands. During the hot summer months when demand for electricity is high, hydro power is generated as water is released from the reservoirs as part of the annual flood control cycle.

Over the years since the majority of TVA's reservoirs were constructed, recreation benefits associated with TVA reservoirs have become increasingly important to the public. It is generally acknowledged that operation of the reservoir system for optimum flood control and power generation results in some negative impacts on recreation development and use. Specifically, the annual cycle of reservoir-water level fluctuations increases the costs associated with water-based recreation facility development and operation, creates negative aesthetic impacts, and makes recreation access to reservoir waters and shorelines more difficult.

Some general qualitative assessments on the effects that drawdowns had on two tributary reservoirs were undertaken by TVA's recreation planning staff in the early 1970s. These assessments indicate that deep seasonal draws have negative impacts on recreation development and use. Shortly after, the completion of these studies, a review of all existing normal minimum winter pool levels established for tributary lakes was completed by TVA's water control planning staff. This study concluded that normal winter pool levels established for tributary lakes was completed by TVA's water control planning staff. This study
concluded that normal winter pools on most tributary lakes could be raised without any adverse impact on TVA's flood control, navigation, and power generation priorities, and lake operations were thereafter modified to achieve higher winter pool levels.

More recently, efforts have been initiated to review reservoir operation policies to determine if benefits are being optimized. In 1985, a task force with representatives from a wide variety of TVA programs was assembled to examine specific reservoirs to determine if alternative water management policies would result in an overall enhancement of the benefits derived from these projects. In 1987, a more comprehensive assessment of TVA's reservoir system was undertaken. The purpose of this assessment was to provide recommended policy guidelines for future operation of the river system to ensure that TVA continues to be responsive to the changing needs and values of the region. This study, known as the TVA Reservoir System Operation and Planning Review, is nearing completion.

Another emerging issue related to the operation of TVA's reservoirs is the spread of exotic aquatic plants. The problem is primarily confined to mainstream reservoirs where shallow waters and stable lake levels combine to provide for plant growth. The increasing incidence of these plants in several of TVA's mainstream reservoirs has caused considerable public controversy. TVA, in cooperation with the U.S. Army Corps of Engineers (USACE), has undertaken a five-year project that includes an attempt to evaluate the impacts which these plants have on recreation.

In the process of evaluating project and program changes, it is inevitable that someone will ask "What is the benefit of making this change? Will we be better off after making it?" These types of questions usually occur simultaneously with a tight deadline and make it necessary to go through the unit-day-value process or rely on relevant studies to determine recreation benefits. It has become apparent that most reservoir operation changes currently being considered would benefit recreation and that the focus will now be
to evaluate these changes. Many of the operational changes suggested severely stretch the
unit-day-value "professional guess" factor or the "relevant" study approach.

Pool-Level Valuations

In many cases, changing existing water management policies to benefit recreation, for
example, will likely increase costs to other TVA programs. For this reason, we believe it
is important to conduct quantitative assessments that measure costs and benefits associated
with any change in TVA's reservoir management policy. The following subject description
and study summary serve to illustrate this process.

It is assumed that the value of a recreation trip and the number of annual recreation
trips will increase if reservoir levels are changed to favor recreation; however, no current
relevant studies could be found to confirm these assumptions. Recently, TVA and North
Carolina contracted with the U.S. Department of Agriculture Forest Service (Forest Service)
and the University of Georgia to answer these questions. A summary of this study
(Bergstrom, et al., 1990) follows.

During the spring and summer of 1988 and 1989, trained enumerators conducted
interviews at public and private campgrounds, private marinas, and public day-use areas, and
boat ramps on Chatuge, Hiwassee, Fontana and Santeetlah Reservoirs. From these
interviews, home addresses were obtained for two follow-up mail questionnaires. One
questionnaire dealt with economic expenditures and the other dealt with the net economic
value of the four reservoirs under current management and the three management
alternatives. About 1,760 people were interview onsite and about 630 people responded to
the mailed questionnaires.

The economic expenditure was estimated using an I/O model, IMPLAN, developed
by the Forest Service (Palmer and Siverts 1985). The information fed into IMPLAN was
gathered from the mailback questionnaire and was of two types. The first was trip-related expenditures for specific items within the general categories of food, lodging, transportation, and activities. The survey also requested information on annual spending on durable recreation equipment, such as recreational vehicles, boats, motorcycles, guns, and skis. Respondents were asked what recreational equipment was taken on the trip and used at the site of the interview.

The net economic value was measured using the contingent value method (CVM). The CVM questionnaire is designed so that three reservoir management alternatives are described using color paintings of the reservoirs at three levels that differ from normal operational levels. Respondents are asked to suppose that everyone 12 years old or older is required to purchase an annual recreation pass for that reservoir. They were then asked to bid for the current management system and the three alternative management systems using the dichotomous choice or referendum method.

The three management alternatives were to keep reservoirs "near full" for one, two, and three months longer, respectively, during the prime recreation season. Using estimated visitation data, expert panels determined if the relative ranking seemed accurate and ranked them according to their own estimate of current visitation. The expert panels were also requested to estimate the percent of change in visitation for each of the three management alternatives. These estimates were used as the upper bound of the recreation use changes. The lower bound of the recreation use changes was based on questionnaire responses about how many additional visits people would make to the reservoir if it were managed differently. The information presented in the following tables is the mean of the upper and lower bounds.

The analysis indicates, as one might suspect, that people place a greater value on higher reservoir levels at certain times of the year and that they value reservoirs differently.
Table 1. Mean net economic value per visitor by reservoir and alternative

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Current Management</th>
<th>Management Alternative 1</th>
<th>Management Alternative 2</th>
<th>Management Alternative 3</th>
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<tbody>
<tr>
<td>Chatuge</td>
<td>$48.99</td>
<td>$58.65</td>
<td>$73.10</td>
<td>$84.13</td>
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<td>Fontana</td>
<td>44.56</td>
<td>53.73</td>
<td>67.25</td>
<td>77.68</td>
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<td>Hiwassee</td>
<td>35.26</td>
<td>42.63</td>
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<td>62.83</td>
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<td>Santeetlah</td>
<td>30.54</td>
<td>37.14</td>
<td>47.12</td>
<td>55.11</td>
</tr>
</tbody>
</table>

In addition to the net economic benefit, the economic impact of nonresidents was estimated for different regions of North Carolina. As might be expected, individuals spend significant amounts of money per trip, and the further away from the site, the more they spend as table 2 shows.

Table 2. Direct spending by nonresidents, mean per person per day.

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>6-County Impact Region</th>
<th>20-County Impact Region</th>
<th>State Impact Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chatuge</td>
<td>$40.24</td>
<td>$54.73</td>
<td>$51.92</td>
</tr>
<tr>
<td>Fontana</td>
<td>67.15</td>
<td>63.82</td>
<td>113.09</td>
</tr>
<tr>
<td>Hiwassee</td>
<td>33.72</td>
<td>38.65</td>
<td>42.79</td>
</tr>
<tr>
<td>Santeetlah</td>
<td>70.63</td>
<td>72.61</td>
<td>88.27</td>
</tr>
</tbody>
</table>

From the analyses conducted by the expert panels, visitation is expected to increase by 30, 60, and 99 percent, respectively, as lake levels are held nearly full one, two or three months longer. As can be seen from table 3, there are substantial net recreation benefits and regional economic impacts to be gained by enhancing reservoir levels.

Table 3. Net economic value and impact of three management changes.

<table>
<thead>
<tr>
<th>Category</th>
<th>Alternative 1 Add. Value</th>
<th>Alternative 2 Add. Value</th>
<th>Alternative 3 Add. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Value</td>
<td>$3,700,000</td>
<td>$7,600,000</td>
<td>$13,600,000</td>
</tr>
<tr>
<td>Gross Output</td>
<td>$29,400,000</td>
<td>$58,200,000</td>
<td>$97,600,000</td>
</tr>
</tbody>
</table>
Valuation of Aquatic Plant Control

Our most recent initiated project involving the application of economics research to natural resources management is the joint TVA/USACE project for aquatic plant management on Guntersville Reservoir. The overall purpose of this joint project is to develop a program for managing aquatic plants so that the multipurpose uses of the reservoir will continue to be realized.

Guntersville Reservoir is a 67,900-acre impoundment of the Tennessee River in northeastern Alabama and southeastern Tennessee. It was constructed for the primary purposes of navigation, flood control, and hydroelectric generation. Other beneficial uses include recreation; water quality; and habitat for fish, waterfowl and wildlife. It is the second largest TVA reservoir and receives over 7.5 million visits annually. There is also extensive facility development with over 30 boat access areas; 2 state parks; 12 local parks; 33 commercial and private marinas, boat docks, group camps, campgrounds, and resorts; and many shoreline residences.

The most severe aquatic plant problems in the TVA system have occurred on Guntersville. In 1988, aquatic plants colonized a historic high of 20,242 acres or 29 percent of the reservoir (TVA 1990). Only about 10 percent of this vegetation consists of native plants. The most troublesome aquatic plants are the exotic species Eurasian water milfoil, hydrilla, and spinyleaf naiad. These exotics comprise approximately 90 percent of the total aquatic plant acreage in TVA reservoirs (Burns et al. 1990). Aquatic plants can also be beneficial in the reservoir ecosystem, most notably by providing cover and nursery area for fish and food and resting areas for waterfowl. Obviously, however, excessive amounts of vegetation can conflict with reservoir uses. Plants can restrict access to docks and launching areas; interfere with swimming, fishing, water skiing, and boating; foul shorelines with
unsightly plant debris; increase mosquito populations; degrade water quality; and clog water intakes.

Recreation/Economic Assessment

Although most people agree excessive levels of aquatic plants can severely impact recreational activity, there have been few studies concerning this or the effects of plant control. Milon et al. (1986), in an economic analysis of fishing on two Florida lakes, addressed sport anglers’ preferences for aquatic plant conditions, the economic benefits of aquatic plant control, and the economic impact of recreational fishing. The total economic benefits of a plant control program designed to prevent severe infestations of hyacinth and hydrilla at the two lakes were estimated at $386,000 in 1985 dollars.

One area of research within the Guntersville project will be to study the effect of aquatic plant occurrence and control on overall reservoir recreation use and to assess the benefits and conflicts associated with aquatic plants. A basic objective from the perspective of TVA’s Aquatic Plant Management Program is to obtain a measure of the economic value of aquatic plant control. This economic value would be represented primarily by the willingness to pay by users perceiving a gain in recreation suitability. Survey instruments are being prepared to determine how recreation use is effected by aquatic plant coverage and distribution; describe user preferences and perceptions toward aquatic plants and control methods; estimate local economic effects associated with user spending; and estimate the direct economic value of recreational use associated with current conditions and alternative reservoir conditions that reflect varying levels of plant control.

This research project is complex because of the nature of the impacts of aquatic plants on reservoir use. A key concern in agency decision making is to identify perceptions of and conflicts among the different user groups, such as water-skiers, fishermen, and waterfowl.
hunters. Although excessive plant coverage can cause conflict with boaters, swimmers, water-skiers, and lakefront residents, many fishermen believe the aquatic vegetation on Guntersville is the key factor to the excellent bass fishing that presently exists. However, Milon et al. (1986) found that a large majority of anglers agreed plant control is a necessary part of fisheries management and that most prefer fishing on lakes with low levels of hyacinth and hydrilla. Guntersville has attained national acclaim for largemouth bass fishing and has been the site of numerous major tournaments. Also, the benefits provided to waterfowl habitat help make it one of the top waterfowl hunting areas in the Tennessee Valley. Aquatic plant conditions present different impacts depending on the users’ primary activity, perceptions of aquatic plants, and expectations of the recreation experience.

The study will employ surveys of lake users and residents in combination with metering, observational procedures, and aerial reconnaissance to determine use patterns, levels, and characteristics. The contingent valuation method will be used to estimate the direct economic value of recreational use under present conditions and the change in use and value for alternative conditions of plant coverage and distribution. Some of the alternatives that are envisioned for depiction in the CVM survey include scenarios of lake conditions with no exotic aquatic plant species; 10 percent coverage (7,000 acres) of the reservoir which represents the five-year average of vegetation coverage from 1975-1980; and 29 percent coverage, which is the 1988 historic high level of vegetation.

Changes in the amount, type, and distribution of reservoir use that would result from the execution of aquatic plant control alternatives are of key interest. The key comparison of management alternatives will likely revolve around the effects associated with present conditions in comparison with 10 percent vegetation coverage and 29 percent coverage. It is not the goal of TVA’s Aquatic Plant Management Program to eliminate all aquatic vegetation. Actually, only about 10 percent of the existing aquatic vegetation is presently
treated with herbicides. These areas include high-priority areas such as public access sites, resorts, marinas, group camps, parks, and shoreline residential areas (Burns et al. 1990). The target goal of the Guntersville Aquatic Plant Management Project is to reach an area equivalent to about 7,000 acres of vegetation. However, it is evident that the distribution of vegetation may be a more critical factor to interference of reservoir use than the amount of vegetation cover. The objective is to manage aquatic vegetation to maintain a balance between vegetated and open water areas.

Ultimately, it is hoped that the economic analysis will help identify trade-offs and the alternative distribution combination of vegetation that provides the highest aggregate value. It is difficult to find the optimum alternative that is acceptable to each user group, technologically feasible to manage or maintain, and ecologically and biologically sound. The integration of information about user perceptions and economic valuation with other factors that influence aquatic plant management can help provide a credible basis for decision making. The focus will continue to be on maintaining a balance between desirable and undesirable effects of aquatic vegetation and the beneficial uses of the reservoir that are influenced by it. The strategy of aquatic plant management is to enhance recreational opportunities by controlling plant growth where open water is most beneficial and allowing vegetation where it is most beneficial.

The Guntersville project will provide useful guidance for both the management of the reservoir and the future direction of TVA’s Aquatic Plant Management Program. As a national demonstration, the project will produce knowledge that can be applied to the management of other reservoirs throughout the country where exotic aquatic plants occur.
In summary, the projects and research objectives that are discussed illustrate the need for valuation of natural resources and recreational use to establish resource management priorities. Information on users' willingness to pay for recreation and users' preferences for recreation activities and different resource conditions is valuable in the process of evaluating the trade-offs of management alternatives. A better understanding of the aspects of recreation benefits and the relationship of agency policy and decision making to local economic impacts can help allow operation of TVA's reservoir system to achieve a more optimal balance of project purposes and beneficial uses. More specifically, these projects revealed a general lack of information concerning the net economic value for nonconsumptive water-oriented recreation. This gap in the recreation literature must be filed if the various water-recreation user groups are to be adequately represented.
References


