5-1973

A Comparison of Consumer's Surplus and Monopoly Revenue Estimates of Recreational Value for Two Utah Waterfowl Marshes

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REPORT TO
THE OFFICE OF WATER RESOURCES RESEARCH
U.S. DEPARTMENT OF THE INTERIOR
THROUGH THE
UTAH CENTER FOR WATER RESOURCES RESEARCH

A COMPARISON OF CONSUMER'S SURPLUS AND MONOPOLY REVENUE ESTIMATES OF RECREATIONAL VALUE FOR TWO UTAH WATERFOWL MARSHES

By C. HOLDEN BRINK

The work reported by this project completion report was supported in part with funds provided by the U.S. Department of the Interior, Office of Water Resources Research under P.L. 88-379, Project No. B-015-UTAH
Agreement No. 14-01-0001-1562

UTAH STATE UNIVERSITY
Logan, Utah
June 29, 1973

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by

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A dissertation submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Wildlife Science

Approved:

UTAH STATE UNIVERSITY
Logan, Utah

1973

ACKNOWLEDGMENTS

This study was financed by the Office of Water Resources Research (U. S. Department of the Interior) through the Utah Center for Water Resources Research at Utah State University. I wish to thank the following people for their help during the course of the study and in the preparation of the manuscript:

(1) Dr. Jessop B. Low, Leader, Utah Cooperative Wildlife Research Unit, for his advice, patience, and fellowship throughout the duration of the project.

(2) Dr. Ross S. Whaley, Associate Dean, College of Forestry and Natural Resources, Colorado State University, and Dr. E. Boyd Wennergren, Professor of Agricultural Economics, for numerous helpful discussions on the problems of evaluating outdoor recreation.

(3) Dr. William F. Sigler, Professor and Head, Department of Wildlife Science, Dr. David F. Balph, Associate Professor of Wildlife Science, and Dr. Howard B. Peterson, Professor and Head, Department of Agricultural and Irrigation Engineering, for critically reading the manuscript.

(4) Dr. Thomas H. Ripley, Director of the Tennessee Valley Authority's Division of Forestry, Fisheries, and Wildlife Development, for extended cooperation without which this work might not have been completed.

(5) William Hallenger for his help with the data collection and data processing.

(6) Fern Highbaugh for typing the final manuscript.

(7) My wife, Launna, for her love and encouragement and for typing most of the drafts.

(8) My father, Charles M. Brink, who will, I am sure, recover from the fact that this work was accomplished at the abysmal rate of about one page every 18 days.

C. Holden Brink

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ABSTRACT

A Comparison of Consumer's Surplus and Monopoly
Revenue Estimates of Recreational Value
for Two Utah Waterfowl Marshes

by

C. Holden Brink, Doctor of Philosophy
Utah State University, 1973

Major Professor: Jessop B. Low
Department: Wildlife Science

Demand curves were estimated for waterfowl hunting and nonconsumptive recreational use from use rate and variable expenditure data collected at the Bear River Migratory Bird Refuge and the Farmington Bay Waterfowl Management Area during fiscal 1969. Consumer's surplus and monopoly revenue estimates were then derived from the demand functions. Adjusted estimates of consumer's surplus for waterfowl hunting amounted to $7,260 per year at Bear River and $11,400 per year at Farmington Bay. For nonconsumptive recreation annual consumer's surplus was estimated to be $18,700 at Bear River and $3,760 at Farmington Bay. Monopoly revenue estimates were between one-half and one-fourth the corresponding consumer's surplus estimates.

The capitalized value (at 8 percent interest) of predicted annual consumer's surplus for all recreation was $865,800 for Bear River and $299,000 for Farmington Bay. Capitalization of the corresponding monopoly revenue estimates gave $276,900 for Bear River and $92,100 for

Farmington Bay. At 3 percent interest, the capitalized consumer's surplus values increase to $4,242,000 for Bear River and $1,184,000 for Farmington Bay, while those for monopoly revenue increase to $1,330,000 for Bear River and $350,000 for Farmington Bay.

The author believes that consumer's surplus estimates are more valuable than monopoly revenue estimates for comparison with other values included in the benefit/cost analysis of water development projects because the needed values include more than a non-discriminating monopolist can extract.

It will never be possible to make additive estimates of all of the relevant values of natural areas used for outdoor recreation. Allocation decisions must draw on several disciplines in addition to economics to determine where the balance will swing for the greatest net benefit to society. Nevertheless, the author believes that exceptions exist where the native flora and fauna can be managed to attract visitors such than an area can remain in natural production in perpetuity and be competitive with potentially conflicting interests in terms of measurable economic values.

It is believed that future research should concentrate on high-value sites and be directed toward sensitivity analysis, the simultaneous evaluation of alternative uses, the influence of the travel-time variable, marginal resource values, and off-site benefits.

(153 pages)

INTRODUCTION

The rapid increase in the demand for water oriented outdoor recreation resources during the last two decades has focused much interest on the problem of evaluating the recreational benefits of wildlife habitats. Conflicting land uses require decisions based upon the comparative value of each use to society. It is generally agreed that an economic model cannot consider all of the societal costs and benefits[1] associated with a recreational experience. Nevertheless, techniques developed in the last 15 years make it possible, if not always practical, to make reasonable value estimates for most forms of outdoor recreation suitable for inclusion in benefit/cost analyses (Clawson, 1959; Pearse and Bowden, 1969).

This does not mean that economic models have the potential to relieve administrators of the burden of deciding between alternative uses for natural areas. It merely means that the economic aspects of the problem can be clarified, thus allowing the decision-maker to focus his attention on the unmodeled aspects--ecological impacts, political realities, and cultural, spiritual and other considerations.

Purpose and Scope

The objectives of this project were: (1) to apply two techniques of recreation evaluation to a type of recreation area (namely waterfowl

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[1]See the Total Values section for a discussion of different kinds of values.

marshes) that have not yet been so evaluated and determine which technique is more appropriate, and (2) to develop a technique whereby the recreational values estimated can be related to the volume and timing of water received by the marshes.

A unique difficulty in evaluating waterfowl marshes is the fact that the benefits produced are often widely dispersed in time and space. On-site benefits may be insignificant compared to benefits produced elsewhere along the migratory route of birds raised and/or temporarily maintained at the marsh in question.

The original scope of this project included an attempt to develop methods suitable for evaluating off-site benefits generated by waterfowl refuges. However, an array of practical and theoretical problems soon made it evident that the task was more than could be accomplished in one study. Therefore, in this study attention was focused on the on-site benefits. The problems associated with evaluating off-site benefits and suggestions for future research are treated in the DISCUSSION section.

Methods of Evaluating Outdoor Recreation Benefits

The difficulties and misconceptions associated with evaluating outdoor recreation benefits[2] coupled with population pressures and technological demands on our resources have resulted in the development of some unorthodox methods of evaluation. Many of these methods produce values that are unrelated to the recreationists' willingness to pay and,

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[2]This has been discussed by several authors including Wennergren (1964) and Clawson (1959).

thus, are usually considered unsuited for comparison with other values in benefit/cost analyses (Water Resources Council, 1964).

Among these unorthodox methods is the gross national product method which assumes that recreation contributes as much as actual working time does toward production equating the value of a recreation-day to the gross national product per day per capita (Lerner, 1962). The market value of fish method implies that the value of a fishing trip is the market value of the fish caught (Clawson and Knetsch, 1966). The cost method, as utilized by the U. S. Park Service during the early- and mid-1950's, assumes that the value of recreation is equal to twice the cost of producing it (Lerner, 1962).

Current attempts at recreation evaluation recognize both primary and secondary benefits. Primary benefits accrue to the recreationists themselves. Secondary benefits accrue to the nation as a whole (Outdoor Recreation Resources Review Commission, 1962) or to the local region affected economically by the site in question (Pearse and Laub, 1969) and include increases in employment and income attributable to recreational developments. "Summing both kinds of benefits--primary and secondary--and deducting costs, one obtains net benefits from recreation." (Outdoor Recreation Resources Review Commission, 1962, p. 62)

This study is concerned with the estimation of primary benefits. Two methods were emphasized: the consumer's surplus method and the monopoly revenue method. Other methods include: the gross expenditure method, the price at alternative facilities method, and the willingness to pay method.

The most frequently quoted definition of consumer's surplus is given by Marshall.

> We have already seen that the price which a person pays for a thing can never exceed, and seldom comes up to that which he would be willing to pay rather than go without it: so that the satisfaction which he gets from its purchase generally exceeds that which he gives up in paying away its price; and he thus derives from the purchase a surplus of satisfaction. The excess of the price which he would be willing to pay rather than go without the thing, over that which he actually does pay, is the economic measure of this surplus satisfaction. It may be called consumer's surplus. (Marshall, 1920, p. 124)

There are several possible ways of estimating consumer's surplus. The simplest conceptually, but probably the most difficult empirically, would be to interview the users of a public outdoor recreation facility and ascertain the maximum daily fee that each would be willing to pay. Individual responses could be plotted in order of decreasing willingness to pay to form a histogram as illustrated in Figure 1. The right-hand extremities of the horizontal portions of the histogram determine the estimated demand curve for the site. This demand function estimates the number of recreationists (Q_o) who would use the site at any selected fee (P_o). The area under the histogram, which is a close but conservative estimate of the area under the demand curve, equals total consumer's surplus or simply the sum of the individual amounts the recreationists are willing to pay.

It can be argued strongly that this area under the demand curve is a measure of recreation benefits appropriate for inclusion in benefit/cost analyses. However, some authorities argue that what is needed for comparative evaluations is a market price surrogate. (See Comparison of the Two Valuation Models, page 48.) The monopoly revenue method

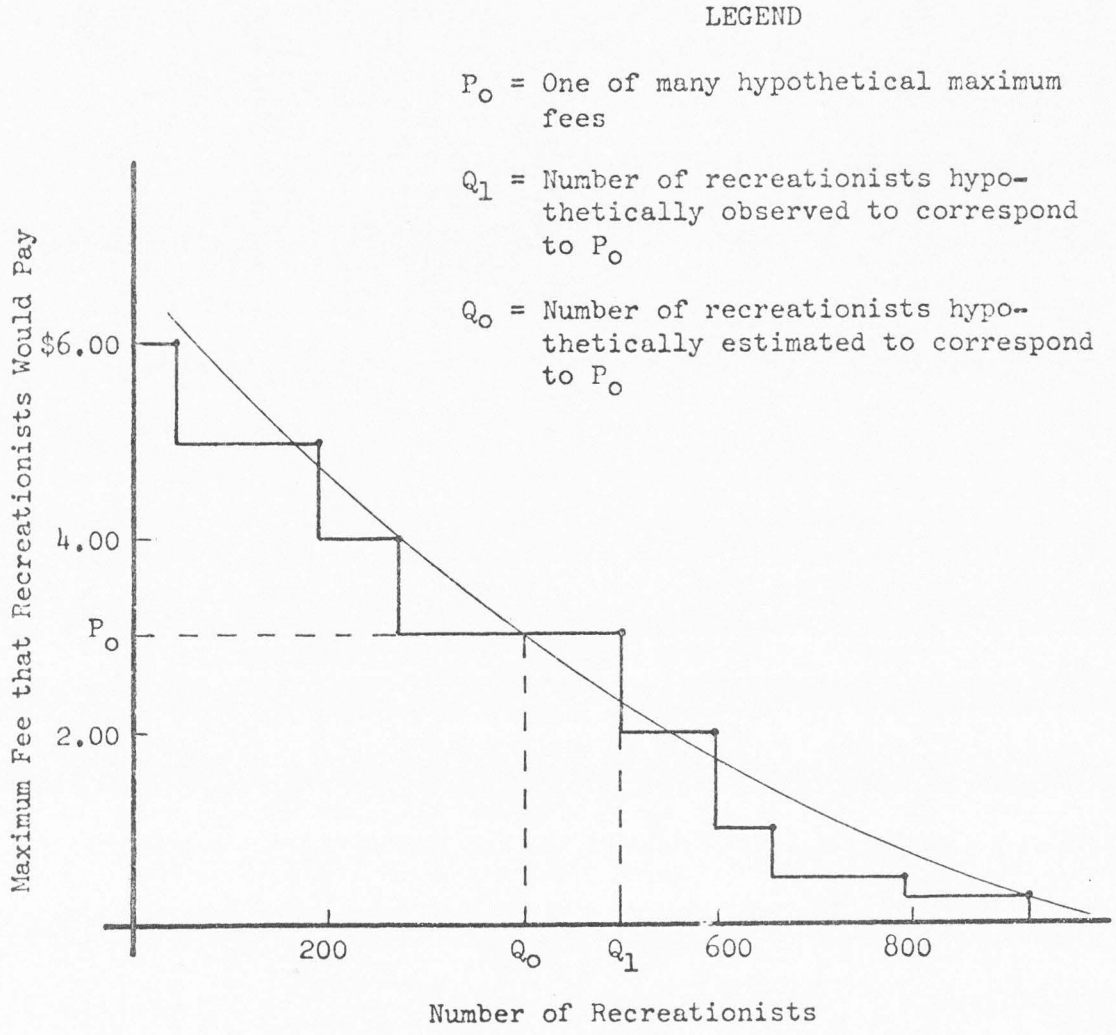

Figure 1. Hypothetical histogram illustrating the principle of consumer's surplus.

provides this market price surrogate by estimating the revenue that could be realized by a monopolist that charged a single revenue maximizing fee.

In our example we can find the revenue maximizing fee by multiplying each of the hypothetical fees ($1.00, $2.00, etc.) by the corresponding observed use rates. The fee that gives the largest product (total revenue) is the revenue maximizing fee. It can be seen from Figure 1 that 500 (Q_1) recreationists are willing to pay a fee of $3.00 ($P_o$) or more. Thus, by charging an entrance fee of $3.00, a monopolist can, given the assumptions of this technique, realize $1,500. This is more than can be realized by any other whole-dollar fee. According to the proponents of this method, $1,500, when properly discounted, is a suitable market value surrogate for the site, appropriate for inclusion in benefit/cost analyses.

The gross expenditure method merely sums the recreationists' travel, equipment, and on-site costs. It is popular with many state and federal conservation agencies because it yields high values that its proponents claim indicate the value participants place on their sport or activity (Davis, 1967; U. S. Department of the Interior, 1956). It is also frequently claimed that these expenditures are comparable to expenditures for the products of major economic sectors--agriculture, mining, retail trade (University of Utah, 1957; Wallace, 1956). The main difficulty with this method stems from the fact that in making an expenditure the recreationist has expressed his evaluation of the item (equipment, lodging, etc.) but not necessarily his evaluation of the

recreational opportunity which he probably could enjoy with a lesser expenditure.

The price at alternative facilities method assumes that the value of a recreation day at a public facility is equal to the entrance fees at comparable private facilities. The U. S. Park Service used this method from 1957 to 1964 with an established value of $1.60 that could be adjusted upward or downward to allow for special site conditions (Outdoor Recreation Resources Review Commission, 1962). This value was then multiplied by the estimated use to obtain an annual value for the site.

A slight variation of the price at alternative facilities method is outlined in Supplement No. 1 to Senate Document 97 (Water Resources Council, 1964). This method, currently used by many government agencies, attempts to estimate the willingness of recreationists to pay for various types of recreation opportunities. Generalized, group-type recreation activities such as swimming and camping that require the development of special facilities are given a value range of $0.50 to $1.50 per person per day. Specialized, individual-type activities (wilderness hiking, big game hunting, etc.) that require a greater investment in personal equipment are given a value range of $2.00 to $6.00 per person per day. Criteria to be used in judging what unit values are appropriate for specific situations are outlined. As with the previous method, once a value is decided upon, it is multiplied by the estimated use (at no fee) to give the annual value.

Both the price at alternative facilities and willingness to pay methods have serious weaknesses. Location and quality differences

between public and private areas make it doubtful that their fees are comparable (Beardsley, 1968). More serious, however, is the fact that these methods assume ". . . constantly increasing benefits with increasing use, making investment in recreation facilities a direct function of quantity of expected use with quality differences between sites and use-rates ignored." (Beardsley, 1968, p. 7). Basic to the problem is the fact that if the selected values were charged, actual use would be less than that estimated at the no-fee level. The definition of the values obtained by these methods, therefore, is vague. They are neither good market surrogates nor estimates of consumer's surplus. Most authorities currently favor variations of the consumer's surplus or monopoly revenue methods used in this study.

STUDY AREAS

The Bear River Migratory Bird Refuge and the Farmington Bay Waterfowl Management Area are two of several important waterfowl marshes along the eastern shore of the Great Salt Lake (Figure 2). They were selected as the sites for our estimates of recreational benefits primarily because of their relatively high public use and because most of this use is funneled through one or two principal access points. Another consideration was the potential for demand curve comparisons based on the location of the two areas. The State-owned Farmington Bay site is immediately adjacent to the populated Wasatch Front and is within 20 miles of downtown Salt Lake City. The Federally-owned Bear River Refuge is located in sparsely populated Box Elder County 15 miles west of Brigham City. Also, the fact that the Bear River Refuge requires most visitors to register and has maintained extensive resource and resource use data for more than 30 years was important in its selection.

For detailed descriptions of these areas see: Chura (1962), Goddard (1962), Joyner (1969), and Kotter (1970). Maps and briefer descriptions are available in Nelson (1966).

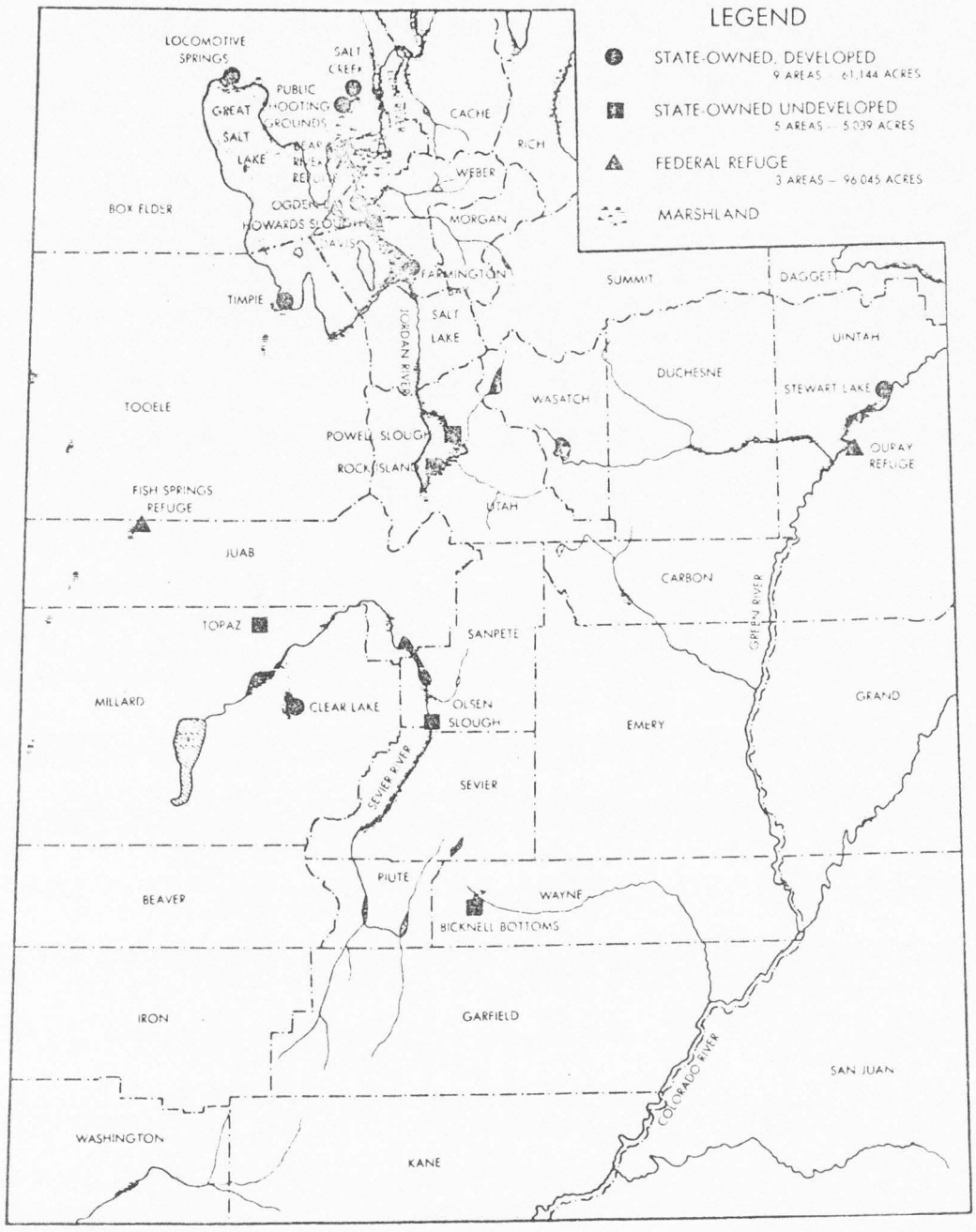

Figure 2. Location of developed and undeveloped State Waterfowl Management Areas, Federal Refuges, and other marshland in Utah. Courtesy Utah State Division of Wildlife Resources. See Nelson (1966, p. 15).

METHODS

Data Collection

The questionnaire and interview schedules discussed below were designed to be as brief as possible and still provide the detailed information desired. Members of Utah State University's Sociology Department and other experts were consulted about the format of the questions and many of their suggestions are incorporated. Responsibility for any deficiencies in the final instruments, of course, remains with the writer.

Personal interviews

Visitors to the Bear River Migratory Bird Refuge and the Farmington Bay Waterfowl Management Area were interviewed on sample days during the year June 15, 1968-June 14, 1969. Normally, all visitors on a given sample day were interviewed. When visitors left before they could be interviewed, the number leaving was noted and used in the calculation of expansion factors.

Although the interview schedule for summer and spring (Appendix A) differed in format from that used during the waterfowl hunt, the objective was the same: to obtain use and variable expenditure data suitable for demand curve estimation. One individual from each car of visitors was asked how many came with him, why they came, what percentage of their travel was specifically for the purpose of coming to the refuge, whether they stopped for a restaurant meal, whether they stayed in a

motel, and what his costs were for various equipment and materials used at the site.

Summer 1968. From June 15 to October 11 (the day before the hunting season) interviews were conducted at the two waterfowl areas. In selecting sample days, it was recognized that use would be highest on weekends and that it would vary throughout the season. Therefore, a stratified random sample in which one weekday and one weekend-day were randomly selected from each of eight two-week periods was decided upon (Appendix B).

1968-69 waterfowl season. Hunters and other visitors to the two areas were interviewed on the basis of a systematic random sample (Appendix B). Arbitrarily included in the sample were the opening weekend (which was handled by mail questionnaire as explained below) and five "special days": Thanksgiving, Christmas, New Year's Day, and the closing weekend.[3] Since hunter registration data at the Bear River Refuge indicated a correlation between the day of the week and use, it was decided to sample the remaining 79 days of the season by selecting at each refuge two sample days for each day of the week. For example, from the 12 Mondays occurring during the season, two (October 28 and December 30) were randomly selected for Farmington Bay and two (December 16 and December 30) were selected for Bear River.

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[3]At Farmington Bay, interviews on these "special days" were conducted by the author. At Bear River, no interviews were conducted on "special days." However, using refuge registration data, the various season totals for the refuge were increased by the ratio: number of hunters during "special days"/number of hunters during the rest of the season.

The mail questionnaire used for the opening weekend served as the interview schedule as explained below. A question on the number of miles traveled by airboat or outboard and the gallons of boat gas used was added to help estimate this variable cost.

Hunter cooperation was generally excellent. Since the questions were simple and required little or no estimating by the respondents, the interviews were easy to administer. On days when the interviews had to be conducted simultaneously at the two areas, personnel at the Bear River Refuge conducted the interviews at that area while the author was at Farmington Bay.

Spring 1969. In January and February following the hunting season, waterfowl populations and visitor use at these two areas are negligible. During the year of this study, the Bear River Refuge was closed to tourists from the end of the hunting season until March 24 because of construction on a bridge near the refuge headquarters. From March 24 through June 14, visitors were interviewed on the basis of a stratified random sample similar to that used the previous summer (Appendix B).

The gate at the Farmington Bay area is kept locked until July 1. However, schools and other groups can arrange for tours with the area manager. Individuals wishing entrance can generally obtain a key at the manager's residence.

Because of the relatively small number and controlled nature of visits at Farmington Bay during this period, the area manager, Mr. Reuben H. Dietz, agreed to conduct the interviews. It was a 100-percent sample.

uestionnaire

Large numbers of hunters turn out for the opening weekend at the ear River Migratory Bird Refuge and the Farmington Bay Waterfowl anagement Area, many more than at any other time during the season. ince many of them would want to leave at about the same time, it was ecided to hand the driver of each car a questionnaire (See Appendix A) nd return envelope rather than try to interview each carload of hunters s we did on sample days during the rest of the season.

The questionnaire was designed to obtain the same information btained in the personal interviews described above and served as the nterview schedule for the interviews conducted during the remainder of he hunting season.

Data Processing

The data from all of the usable questionnaires and interview sched-les were transposed to coding sheets by the author and an assistant, r. William Hallenger. A systematic 10-percent sample of the data was ecoded and compared to the original coding. It is believed that coding rrors are insignificant for all categories of the data, probably mounting to less than 5 percent of the variation.

The data on the coding sheets were punched and verified by ersonnel in the Utah State University Computer Center. Programs were hen written by Computer Center staff to summarize the data in a manner uitable for the analysis presented in the RESULTS section.

Analysis

Demand

Demand functions were estimated following the Hotelling procedure described in Appendix C. The result was four log linear equations (one for hunting and one for other recreation at each of the two areas) of the form

$$\ln Q = a - b \ln P$$

where "Q" is the quantity demanded in trips per thousand population per year and "P" is the proxy market price in dollars per trip.

A trip here equals one visit by one individual for part or all of one 24-hour period. Length of stay bias was not a factor because overnight camping was insignificant at these areas during the period of the study. The number of hunters in our sample from a given county was simply multiplied by the appropriate expansion factor and divided by the county population expressed in thousands.

In the absence of a market price for hunting and other types of outdoor recreation at the two waterfowl areas studied, it was necessary to develop a proxy price. For hunting, this proxy market price consisted of travel costs (gas, oil, and depreciation), restaurant meals, and boat gas and oil.

Travel costs were computed on the basis of $0.08 per mile which is the U. S. Government Equipment Use rental rate for sedans (Beardsley, 1968). Total travel costs of hunters from a given county were divided by the number of trips taken by those hunters to express this portion of the independent variable on a per trip basis.

Hunters reporting that they stopped at a restaurant on the way to the refuge or that they planned to stop at one on the way back home were assumed to have spent $1.00 per person. This avoided complicating the interview by asking for expenditure estimates and is probably as close an estimate of the relevant costs of restaurant meals above normal food costs as could have been obtained by more direct means.

The cost of boat gas and oil was arbitrarily set at $0.33 per gallon (the current cost of regular gas) for outboards and $0.38 per gallon (the current cost of premium gas) for airboats. Total expenses for this item were divided by the number of hunters to give the appropriate cost per trip estimate. For the mail questionnaire used on opening weekend, which did not include a question on the gallons of boat gas used, the average boat gas cost per boat during the rest of the season was applied proportionally to the number of each type of boat reported to have been used on opening weekend.

It is postulated that the above three costs constitute the relevant costs considered by the hunter in deciding to take a given trip. "The rationale for this postulate is the definition of these expenditures as the marginal or variable cost . . ." of hunting (Dyer, 1968, p. 18).

Probably there are additional equipment costs that function as variable costs in the mind of the hunter. The cost of shotgun shells may be one of these and we attempted to incorporate this expense in the model. Hunters were asked to report their expenses for shotgun shells during the seven days previous to their interview. However, it turned out that many hunters bought shells in large quantities making them, in effect, a fixed cost rather than a variable cost. By chance, including

this item in the cost estimates greatly increased the cost per trip for some of the more distant counties.[4] Since these increases had no logical basis in terms of the rationale of the model and since it appeared that shell expense was not functioning consistently as a variable expense, it was decided to assume a fixed shell expense for each hunter at each area equal to the average shell expense for all hunters at that area. The effect was to raise the demand curve by these average amounts ($4.65 for Bear River and $3.93 for Farmington Bay). Since raising the demand curve in this manner does not affect either consumer's surplus or monopoly revenue, this procedure effectively eliminated shell expense from the analysis.

The proxy market price for recreational trips other than hunting consisted of travel costs and restaurant meals only. These were calculated as they were for hunting trips. Again, it is probable that other expenses are relevant to the visitor's decision to recreate. However, no suitable method of measuring these expenses was discovered and it is believed that they are minor compared to travel and meal expenses.

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[4] The problem was caused by a statistical difficulty inherent in this type of demand analysis. The data points upon which the demand curves are based have widely differing confidence intervals caused by large differences in sample size. For example, in the demand curve derived for waterfowl hunting at the Bear River Migratory Bird Refuge, the average variable expense estimate for Utah County was based on data from seven hunters while that for Salt Lake County was based on data from 413 hunters (Table 19). Obviously, an inappropriate component of variable expense, such as shell expense as defined above, will tend to have a relatively large impact on the distant and seldom observed counties and a relatively small impact on those counties for which sample size is sufficient to dampen the impact of individual observations.

Consumer's surplus

Given the demand function, consumer's surplus (See Appendix C) is calculated through integration as follows:

$$C.S. = \sum_i \int_0^{q_i} f(Q)dQ - \int_0^{q_a} f(Q)dQ + p_a q_a - P_i Q_i$$

where "i" is the i th county of origin for the site in question, "p_a" is the highest observed average variable expense, "q_a" is the number of trips per 1000 population observed to be associated with p_a, "P_i" is the average variable expense for trips for the i th county, "Q_i" is trips per 1000 population for the i th county, and "f(Q)" is the demand function rearranged with price as a function of quantity.

This procedure restricts the surplus estimate to the limits of the observed data by eliminating that portion of the area under the demand curve which lies above the highest observed price. Extension of the demand curve beyond the data is at best speculative. As Wennergren explains:

> . . . if the estimate is relatively inelastic with respect to the variable costs ($b > 1.0$), extension of the demand estimate beyond the observed data may not always produce a price intercept estimate. In many cases, functions of this character possess mathematical properties which produce infinitely large surplus estimates; a most unlikely and unrealistic situation.
>
> . . . Furthermore, it is unlikely that the price intercept value is the relevant price limit. By definition, hunters would take no trips at this price. Therefore, the relevant figure reflecting the "highest price an individual is willing to pay" is the highest price at which trips would actually be taken. This would likely be some price less than the price intercept level. The highest observed price may be a realistic estimate of this value, especially in the absence of additional data evidence (Wennergren, 1967, p. 26).

It appears, therefore, that the above procedure is preferable to the straightforward integration done by Dyer (1968), and Beardsley (1968) and others.

Monopoly revenue

As described in Appendix C, demand curves for the on-site experience were derived from the functions utilized in the consumer's surplus evaluation.

The traditional method of locating the revenue maximizing point is to multiply the derived function --- Q = f(P) --- by P (price) to obtain the total revenue function which is then maximized by setting the first derivative equal to zero and solving for P (Yamane, 1962).

To simplify the calculations, it was assumed in this study that the monopolist selected his fees from multiples of $0.25. The revenue maximizing point was located by multiplying each hypothetical fee (P) by the corresponding estimated use level (Q). The revenue maximizing point, of course, was that fee and corresponding use level where this product (total revenue) was the largest.

Marginal values

The production functions for the recreational values estimated in this study include inputs of land quality, management techniques, water supply, and continental waterfowl population. Since the coefficients for these functions are unknown, it is not possible logically to allocate our estimated values among the factors of production.

In order to circumvent the lack of known production functions and attempt to estimate the marginal value of water for waterfowl production,

a water volume index was developed for the Bear River Migratory Bird Refuge. This refuge is divided into five management units that are separated by dikes. Water levels within the units are measured by gauges that measure the elevation to the nearest 0.01 foot. The water volume index for a given year was calculated by adding the last three digits of the lowest gauge reading for each of the five units. If a unit was dry 1 to 7 days, 1.00 was subtracted from its lowest numerical reading; if it was dry 8 to 14 days, 2.00 was subtracted; if it was dry 15 to 21 days, 3.00 was subtracted. If it was dry more than 21 days, a 0.00 reading was recorded.

The water volume index was calculated for each year from 1940 through 1969 and compared with time series data for various recreational use parameters: number of hunters, average kill per hunter, and number of other visitors. Ways of establishing a functional relationship between on-site recreational values and the marginal value of water during periods of scarcity were then explored by inspection of the data.

The basic assumption behind this approach is that user days are a function of bird populations which in turn are a function of the amount of water received by the refuge. However, bird populations were not included in the analysis because of the difficulty of obtaining relevant population estimates. Since water is the resource for which marginal values were desired, the functional relationship of water supply and use was studied directly, ignoring bird populations.

RESULTS

Consumer's Surplus

Preliminary data

Use rate estimates. As expected, those counties closest to a particular refuge showed the highest use rates. Hunters and non-hunting recreationists from Box Elder County were observed to visit the Bear River Migratory Bird Refuge (which is in Box Elder County) at the rate of 31.2 and 138 trips per thousand population per season, respectively (Tables 1 and 3). Corresponding rates at the Farmington Bay Waterfowl Management Area for hunters and non-hunting recreationists from Davis County were 26.8 and 46.4, respectively (Tables 2 and 4). Visitation rates for the more distant counties tapered out to nearly zero. For example, during the year of the study non-hunting visits at Farmington Bay from Cache County amounted to only 0.03 trips per 1,000 population (Table 4).

The details of use estimation are shown in Appendix D.

Variable expenditure estimates. Since most of the variation in total variable expense is due to variation in travel cost, the more distant a county is from the site in question the higher the per trip variable expense (Tables 5-8). For example, at the Bear River Migratory Bird Refuge variable expenses for hunters from Box Elder County averaged $5.94 per trip, while hunters from distant Utah County spent $12.33 per trip (Table 5).

Total variable expense for non-hunting recreational trips (Tables 7 and 8) averaged about $6.00 per trip less than for hunting trips to the

Table 1. Computing hunter use rates at the Bear River Migratory Bird Refuge, 1968-69 waterfowl season

(1) County of hunter origin	(2) Trips per season[a]	(3) County population[b] (thousands)	(4) Trips per thousand population per season[c]
Box Elder	848.58	27.200	31.19
Cache	295.78	43.000	6.88
Davis	175.13	95.000	1.84
Salt Lake	1763.14	462.000	3.84
Tooele	137.84	23.400	5.89
Utah	28.64	127.000	.22
Weber	1177.76	131.000	8.99

[a]From Table 19.

[b]University of Utah. 1969. 1969 statistical abstract of Utah. Bureau of Economic and Business Research, Center for Economic and Community Development. 231 p.

[c]Column (2) divided by column (3).

Table 2. Computing hunter use rates at the Farmington Bay Waterfowl Management Area, 1968-69 waterfowl season

(2) County of hunter origin	(2) Trips per season[a]	(3) County population[b] (thousands)	(4) Trips per thousand population per season[c]
Box Elder	10.30	27.200	.38
Cache	1.08	43.000	.03
Davis	2543.69	95.000	26.78
Salt Lake	7924.07	462.000	17.15
Tooele	90.79	23.400	3.88
Utah	72.19	127.000	.57
Wasatch	40.29	5.700	7.07
Weber	149.82	131.000	1.14

[a] From Table 20.

[b] University of Utah. 1969. 1969 statistical abstract of Utah. Bureau of Economic and Business Research, Center for Economic and Community Development. 231 p.

[c] Column (2) divided by column (3).

Table 3. Computing educational and recreational use rates (except hunting) at the Bear River Migratory Bird Refuge, June 15, 1968, to June 14, 1969

(1) County of visitor origin	(2) Trips per year[a]	(3) County population[b] (thousands)	(4) Trips per thousand population per year[c]
Box Elder	3754.02	27.000	138.0
Cache	1271.20	43.000	29.6
Davis	1708.08	95.000	18.0
Salt Lake	5138.99	462.000	11.1
Tooele	35.67	23.400	1.5
Utah	38.88	127.000	.3
Weber	4757.73	131.000	36.3

[a]From Table 21.

[b]University of Utah. 1969. 1969 statistical abstract of Utah. Bureau of Economic and Business Research, Center for Economic and Community Development. 231 p.

[c]Column (2) divided by column (3).

Table 4. Computing educational and recreational use rates (except hunting) at the Farmington Bay Waterfowl Management Area, June 15, 1968, to June 14, 1969

(1) County of visitor origin	(2) Trips per year[a]	(3) County population[b] (thousands)	(4) Trips per thousand population per year[c]
Cache	1.08	43.000	.03
Davis	4406.21	95.000	46.4
Salt Lake	5820.46	462.000	12.6
Tooele	5.76	23.400	.2
Utah	193.00	127.000	1.5
Weber	352.62	131.000	2.7

[a]From Table 22.

[b]University of Utah. 1969. 1969 statistical abstract of Utah. Bureau of Economic and Business Research, Center for Economic and Community Development. 231 p.

[c]Column (2) divided by column (3).

Table 5. Variable expenses of hunters at Bear River Migratory Bird Refuge, 1968-69 waterfowl season

County of hunter origin	Travel cost per trip[a]	Food, shells, and boat gas expense per trip	Total variable expense per trip
Box Elder	$ .82	$5.12	$5.94
Cache	2.64	5.13	7.77
Davis	3.04	5.44	8.48
Salt Lake	4.46	5.69	10.15
Tooele	4.67	5.29	9.96
Utah	7.11	5.22	12.33
Weber	2.23	5.73	7.96

[a]See page 15 for explanation of expenditure categories.

Table 6. Variable expenses of hunters at the Farmington Bay Waterfowl Management Area, 1968-69 waterfowl season

County of hunter origin	Travel cost per trip[a]	Food, shells, and boat gas expense per trip	Total variable expense per trip
Box Elder	$2.93	$5.93	$8.86
Cache	5.80	3.93	9.73
Davis	.68	4.27	4.95
Salt Lake	1.57	4.34	5.91
Tooele	4.16	3.97	8.13
Utah	3.69	4.43	8.12
Wasatch	4.11	3.93	8.04
Weber	1.54	4.27	5.81

[a]See page 15 for explanation of expenditure categories.

Table 7. Variable expenses of non-hunting recreational and educational users of the Bear River Migratory Bird Refuge, June 15, 1968, to June 14, 1969

County of visitor origin	Travel cost per trip[a]	Meal expense per trip	Total variable expense per trip
Box Elder	$1.00	$ .05	$1.05
Cache	1.76	.29	2.05
Davis	1.87	.20	2.07
Salt Lake	2.37	.33	2.70
Tooele	4.27	.27	4.54
Utah	4.50	1.00	5.50
Weber	1.48	.22	1.70

[a]See page 15 for explanation of expenditure categories.

Table 8. Variable expenses of non-hunting recreational and educational users of the Farmington Bay Waterfowl Management Area, June 15, 1968, to June 14, 1969

County of hunter origin	Travel cost per trip[a]	Meal expense per trip	Total variable expense per trip
Cache	$5.80	$0	$5.80
Davis	.32	.03	.35
Salt Lake	.86	.04	.90
Tooele	1.92	0	1.92
Utah	1.12	0	1.12
Weber	1.25	.19	1.44

[a]See page 15 for explanation of expenditure categories.

two areas (Tables 5 and 6). However, much of this difference may not be real. The estimates of variable expenses for hunting include average shell expense as explained in the METHODS section. If, as the analysis assumes, shell expense is a fixed rather than a variable expense, variable expenses per trip for hunting are only a dollar or two more than those for non-hunting recreation.

Demand. The use rate and average variable expenditure estimates for hunters and non-hunting recreational and educational users of the Bear River Migratory Bird Refuge and the Farmington Bay Waterfowl Management Area were subjected to log linear regression analysis. The following demand functions were generated:

Waterfowl hunting

Bear River Migratory Bird Refuge (d.f. = 5)

(1) $\ln Q = 13.61 - 5.635 \ln P$

$R^2 = .73$, $r = .85$ and is significant at the 98% level

"b" > 0 at 2.5% level

Farmington Bay Waterfowl Management Area (d.f. = 6)

(2) $\ln Q = 14.49 - 7.020 \ln P$

$R^2 = .55$, $r = .74$ and is significant at the 95% level

"b" > 0 at 5% level

Non-hunting recreational and educational use

Bear River Migratory Bird Refuge (d.f. = 5)

(3) $\ln Q = 5.524 - 3.571 \ln P$

$R^2 = .96$, $r = .98$ and is significant at the 99.9% level

"b" > 0 at 5% level

Farmington Bay Waterfowl Management Area (d.f. = 4)

(4) $\ln Q = 1.244 - 2.777 \ln P$

$R^2 = .92$, $r = .96$ and is significant at the 98% level

"b" > 0 at .5% level

When plotted (Figure 3) these functions are relatively flat indicating high average price elasticity.[5] This means that at most points along these functions a change in the price will cause a relatively large change in the quantity demanded. This indicates the presence of close substitutes for the recreational opportunities in question. In Utah, a state with many high quality hunting areas and abundant opportunities for sightseeing and general outdoor recreation, we would expect our analysis to be influenced by such intervening opportunities. We are not, for example, measuring the demand for or value of hunting per se, but rather the demand for or value of hunting at a particular site given the reality of suitable substitute opportunities.

Value estimates

Consumer's surplus generated during the 1968-69 waterfowl season was estimated to be about $4,900 at the Bear River Migratory Bird Refuge and about $6,400 at the Farmington Bay Waterfowl Management Area. Corresponding estimates for non-hunting recreational and educational use during fiscal 1969 amounted to $10,500 at Bear River and $2,600 at Farmington Bay (Figure 4). The details of calculating these estimates are shown in Appendix E.

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[5] Average price elasticity is numerically equal to the "b" coefficient which in these functions ranges from -2.777 to - 7.020.

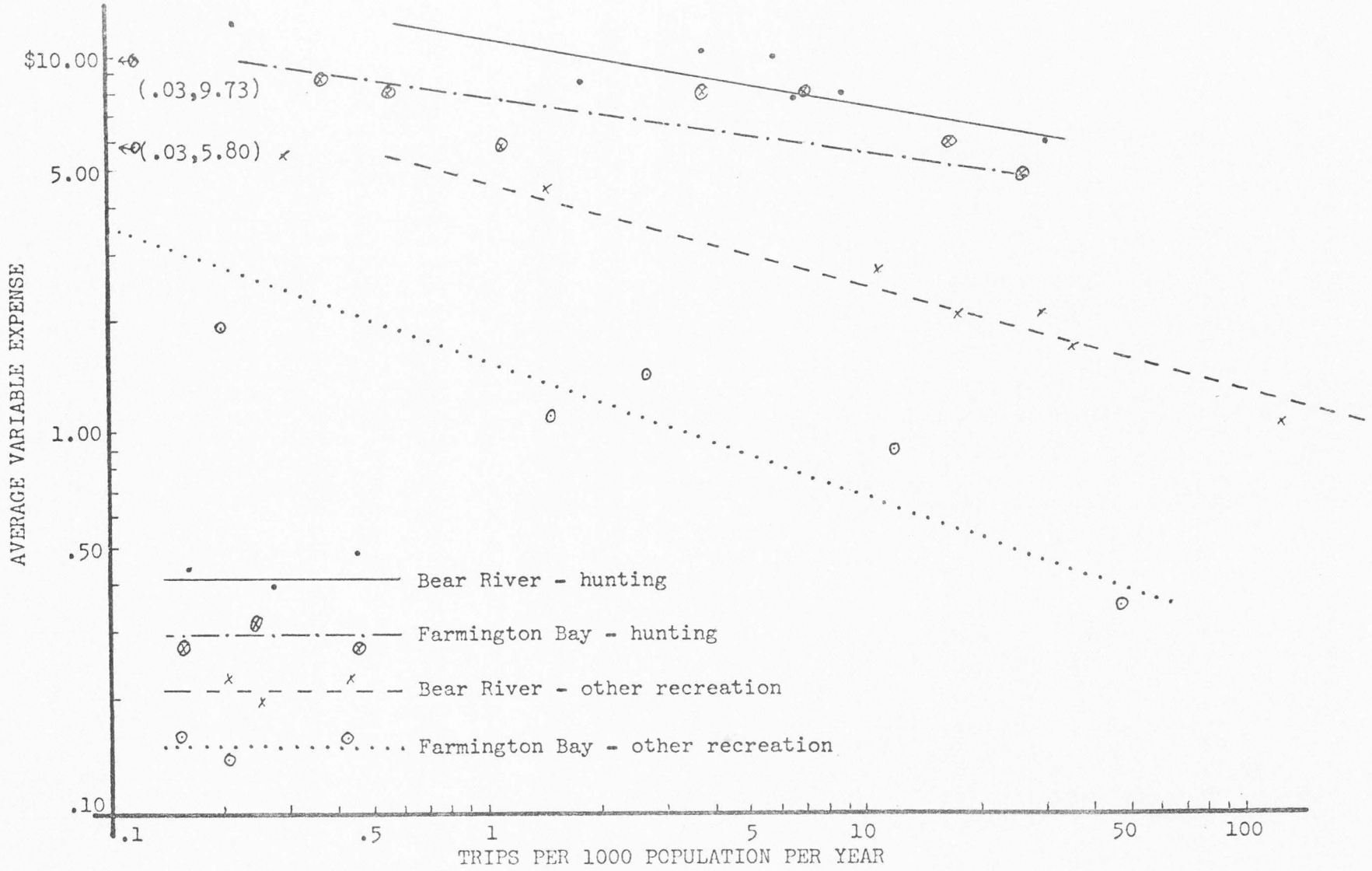

Figure 3. Demand curves for recreational use at two Utah waterfowl refuges. (Data for fiscal 1969)

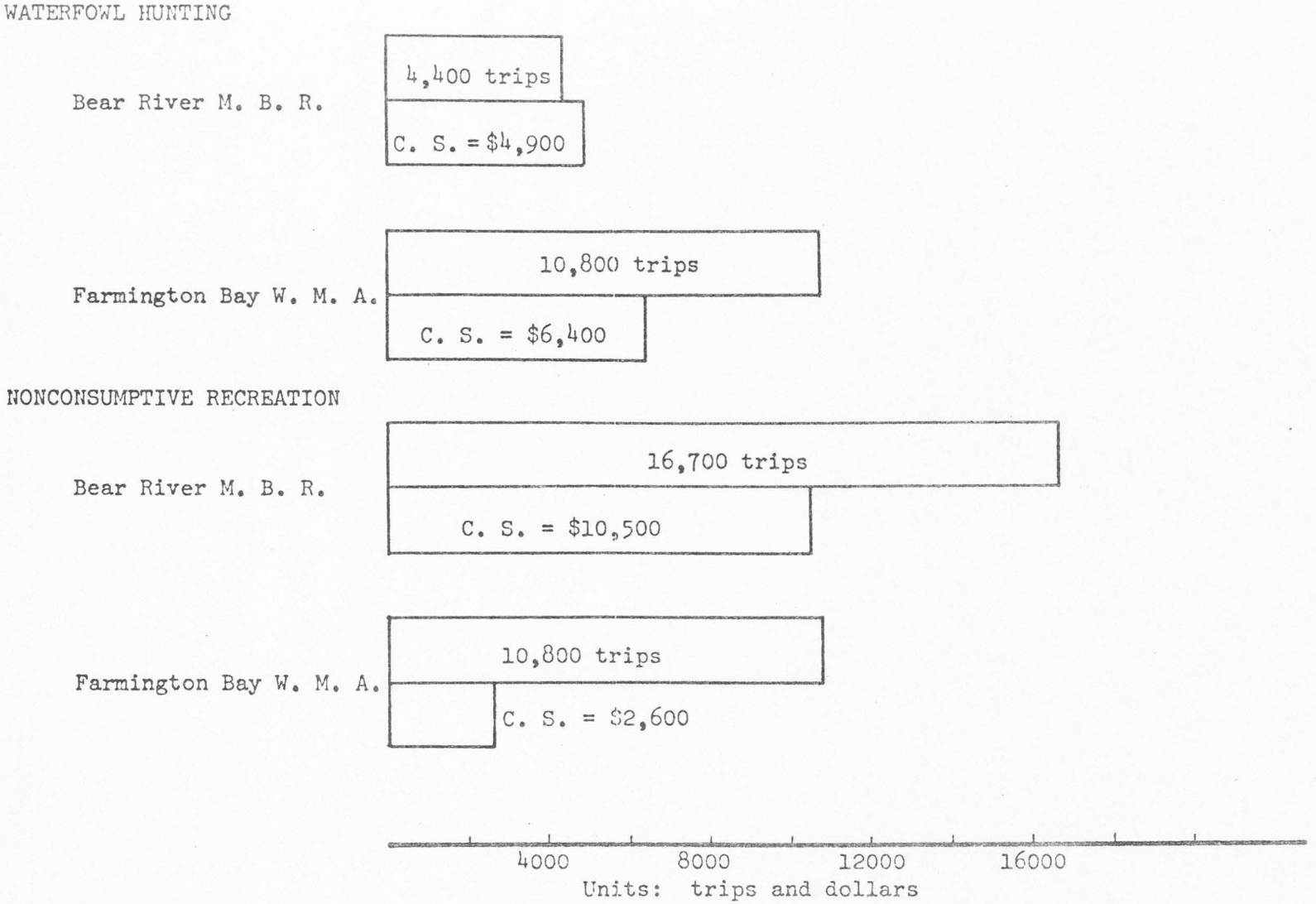

Figure 4. Comparison of consumer's surplus and total trip estimates for hunting and nonconsumptive recreation at the Bear River Migratory Bird Refuge and the Farmington Bay Waterfowl Management Area during fiscal 1969.

Although, as mentioned above, these estimates are somewhat lower than anticipated, their relative magnitudes are explainable in terms of the total use estimates for the respective areas. It was estimated that 1,400 hunting trips were made to Bear River while 10,800 were made to Farmington Bay. Non-hunting recreational and educational trips numbered 16,700 at Bear River and 10,800 at Farmington Bay. In general, the higher the total use the higher the total consumer's surplus. However, Figure 4 clearly shows that the amount of consumer's surplus generated per trip is consistently higher at Bear River than it is at Farmington Bay. The reason for this difference is apparently tied to the uniqueness of the recreational experience available at Bear River. Effective price elasticity[6] is less at Bear River than at Farmington Bay indicating the relative unavailability of substitutes for the recreational experiences offered at Bear River. In other words, those people who visit Bear River, whether for hunting or the other types of recreation, value their experience (in addition to their costs) somewhat higher than do visitors to Farmington Bay. The apparent reason for this is that in general if a visitor were prevented from coming to Farmington Bay he would be able to find a suitable substitute area for the experience he anticipated more easily than would a visitor to Bear River.

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[6] From equations 3 and 4 (pages 30 and 31) it can be seen that the average price elasticity of non-hunting recreational and educational use is greater at Bear River than at Farmington Bay. However, effective price elasticity is greater at Farmington Bay since a relatively high percentage of the observed use (Davis and Salt Lake Counties in Table 22) is concentrated in the lower, more elastic portions of the demand curve (Figure 3).

The behavior of consumer's surplus per trip is discussed in more detail in the DISCUSSION section.

Monopoly Revenue

Preliminary data

From each of the four demand functions utilized in the consumer's surplus evaluations (above), a demand curve for the on-site experience was derived (Figure 5). This was done by calculating the number of recreationists that, according to the assumptions of the model, would be willing to pay a series of hypothetical entrance fees. For example, the demand function for hunting at the Bear River Migratory Bird Refuge (equation 1, page 30) predicts that with no entrance fee 968 hunters from Box Elder County would be attracted to the refuge (Table 9). If a fee of $0.25 were imposed, 201 or 21 percent of these hunters would decide to either hunt elsewhere or not hunt at all. As the entrance is raised, the number of hunters that would still want to hunt at Bear River would progressively decline until with an entrance fee of $10.00, only four hunters from Box Elder County would still be interested (Table 9).

Value estimates

At each hypothetical entrance fee, the estimated amount of revenue that a monopolist could realize is, of course, the entrance fee times the predicted use rate at that fee. Thus, at the Bear River Migratory Bird Refuge monopoly revenue for hunting at the $10.00 fee level amounts to $10.00 times the sum of the hunters that would pay the fee, or $4300 (43 hunters times $10.00, Table 9).

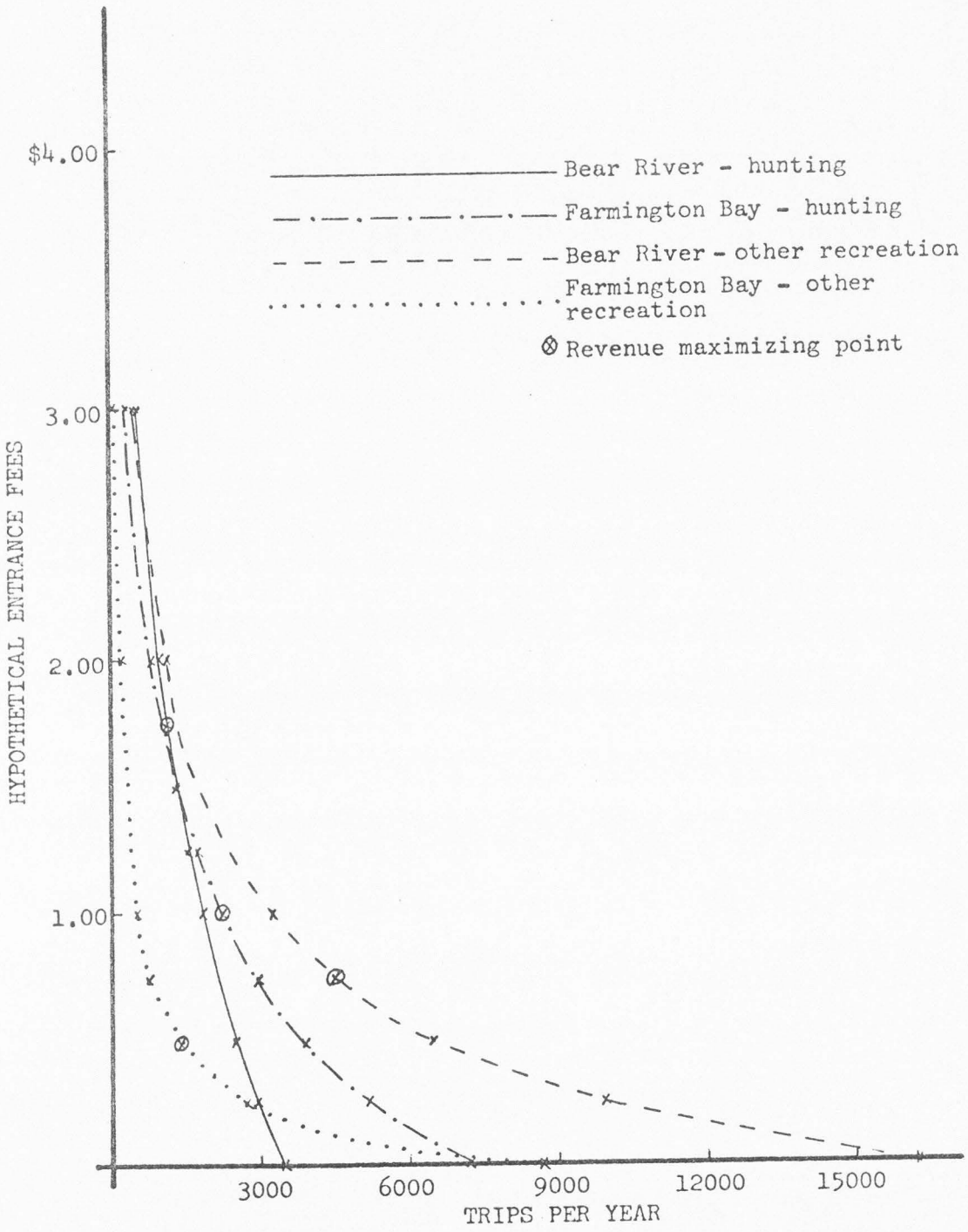

Figure 5. Derived demand curves (monopolist model) for recreational use at two Utah waterfowl refuges.

Table 9. Hunter use (trip) estimates for the Bear River Migratory Bird Refuge at various hypothetical entrance fee levels, 1968-69 waterfowl season

County of hunter origin	Hypothetical entrance fees per trip[a]									
	No fee	$0.25	$0.75	$1.00	$1.25	$1.50	$1.75	$2.00	$3.00	$10.00
Box Elder	968	767	495	403	330	272	226	188	97	4
Cache	337	282	200	170	145	124	107	92	53	3
Davis	454	386	282	242	209	182	158	138	83	6
Salt Lake	799	698	536	471	417	369	328	291	185	17
Tooele	45	39	30	26	23	21	18	16	10	1
Utah	74	66	53	47	43	39	35	32	22	3
Weber	895	752	538	460	394	338	292	253	148	9
Totals	3572	2990	2134	1819	1561	1345	1164	1010	598	43

[a]A trip is a visit to the refuge by any one hunter for any part or all of a given day.

However, it can be seen from Table 10 that a monopolist at the Bear River Refuge would gross more revenue if he would charge less than $10.00. In fact, as the fee is lowered by $0.25 intervals, total revenue increases steadily until it reaches a maximum of $2,037 at a hypothetical entrance fee of $1.75. Further reduction of the fee would attract additional hunters, but not enough to offset the reduced fee. At a fee of $0.25, total revenue would amount to only $748 (Table 10).

Thus, the (maximum) monopoly revenue for waterfowl hunting at the Bear River Migratory Bird Refuge is $2,037 per year. Monopoly revenue at Bear River for educational and recreational use (except hunting) is estimated to be $3,366 (Table 12). Corresponding monopoly revenue estimates for hunting and non-hunting educational and recreational use at the Farmington Bay Waterfowl Management Area amount to $2,273 and $690, respectively (Tables 11 and 13).

Marginal Values for Water

A water volume index was calculated for the Bear River Migratory Bird Refuge for the years 1940-1969 by the technique explained in the METHODS section. The index varied from a low of 8.52 in 1961, when three of the refuge's five units dried up, to 23.64 in 1950 (Table 14).

This water volume index is of interest, of course, as a possible link between our value estimates for recreational opportunities and the marginal value of water at the refuge.

Functions derived in this study have established that the values measured in this study are a function of use. The water volume index is determined primarily by the amount and timing of water received by the

Table 10. Monopoly revenue estimates for hunting at the Bear River Migratory Bird Refuge, 1968-69 waterfowl season

(1) Hypothetical entrance fee	(2) Number of hunters[a]	(3) Total revenue[b]
None	3,571	None
$ 0.25	2,990	$ 748
0.50	2,508	1,254
0.75	2,134	1,601
1.00	1,819	1,819
1.25	1,561	1,951
1.50	1,345	2,018
1.75[c]	1,164	2,037
2.00	1,010	2,020
2.25	882	1,985
3.00	598	1,794
10.00	43	430

[a] From Table 9.

[b] Column (1) times column (2).

[c] Revenue maximizing fee.

Table 11. Monopoly revenue estimates for hunting at the Farmington Bay Waterfowl Management Area, 1968-69 waterfowl season

(1) Hypothetical entrance fee	(2) Number of hunters[a]	(3) Total revenue[b]
None	7,219	None
$ 0.25	5,302	$1,326
0.50	3,955	1,978
0.75	2,979	2,234
1.00[c]	2,273	2,273
1.25	1,753	2,191
2.00	849	1,698
3.00	360	1,080
10.00	6	60

[a]Obtained from calculations similar to those detailed in Table 9.

[b]Column (1) times column (2).

[c]Revenue maximizing fee.

Table 12. Monopoly revenue estimates for educational and recreational use (except hunting) at the Bear River Migratory Bird Refuge, June 15, 1968, to June 14, 1969

(1) Hypothetical entrance fee	(2) Number of hunters[a]	(3) Total revenue[b]
None	16,713	None
$ 0.25	9,949	$2,487
0.50	6,485	3,243
0.75[c]	4,488	3,366
1.00	3,245	3,245
2.00	1,160	2,320
3.00	532	1,596
10.00	26	260

[a] Obtained from calculations similar to those detailed in Table 9.

[b] Column (1) times column (2).

[c] Revenue maximizing fee.

Table 13. Monopoly revenue estimates for educational and recreational use (except hunting) at the Farmington Bay Waterfowl Management Area, June 15, 1968, to June 14, 1969

(1) Hypothetical entrance fee	(2) Number of hunters[a]	(3) Total revenue[b]
None	8,729	None
$ 0.25	2,760	$690
0.50[c]	1,382	691
0.75	784	588
1.00	509	509
2.00	239	478
3.00	65	195
10.00	4	40

[a]Obtained from calculations similar to those detailed in Table 9.

[b]Column (1) times column (2).

[c]Revenue maximizing fee.

Table 14. Time series data for water volume index, hunter and other visitor use, and other related variables obtained from records maintained at the Bear River Migratory Bird Refuge, 1940-1969

Year	Water volume index	Number of hunters	Number of visitors (excl. fishermen)	Number of units that dried up	Average kill per hunter	Maximum[a] legal daily bag limit of ducks and dark geese	Season length days	Population of Utah
1940	10.72	4,685	7,177	2	3.38	13	60	552,000
1941	22.97	6,573	7,527	0	3.57	13	60	551,000
1942	19.49	4,509	3,151	0	3.70	12	70	575,000
1943	21.87	3,646	1,871	0	4.61	12	70	631,000
1944	9.51	3,902	1,834	3	4.37	17	80	605,000
1945	18.95	4,562	3,465	0	3.86	12	80	591,000
1946	17.52	4,565	5,776	2	2.26	9	45	638,000
1947	23.49	3,155	5,319	0	2.66	6	35	636,000
1948	23.59	4,682	10,337	0	2.29	7	40	653,000
1949	22.73	5,775	12,292	0	1.76	7	50	671,000
1950	23.64	6,605	13,428	0	2.46	8	44	696,000
1951	23.22	5,674	15,799	0	2.84	8	60	706,000
1952	23.35	4,765	12,847	0	2.73	10	70	724,000
1953	22.59	6,417	14,511	0	2.04	14	75	739,000
1954	19.83	5,748	12,780	0	2.06	12	80	750,000

Table 14 (continued)

Year	Water volume index	Number of hunters	Number of visitors (excl. fishermen)	Number of units that dried up	Average kill per hunter	Maximum[a] legal daily bag limit of ducks and dark geese	Season length days	Population of Utah
1955	22.26	3,868	10,875	0	2.44	11	80	783,000
1956	19.00	3,636	11,216	1	2.63	11	80	809,000
1957	21.66	4,866	12,016	0	3.40	9	95	826,000
1958	19.02	5,268	14,093	1	3.14	10	95	845,000
1959	19.88	3,666	13,416	0	2.55	6	94	870,000
1960	11.22	3,405	12,830	1	2.28	6	90	900,000
1961	8.52	2,459	14,373	3	1.76	6	75	936,000
1962	19.65	3,700	13,773	0	2.23	7	75	958,000
1963	17.68	4,102	15,122	1	2.54	7	90	973,000
1964	20.00	4,020	11,500	0	1.73	7	90	984,000
1965	22.85	4,326	14,750	0	3.03	7	90	998,000
1966	10.90	4,550	17,940	3	1.63	7	90	1,021,000
1967	23.18	5,121	15,237	0	2.73	7	90	1,036,000
1968	21.24	4,232	18,979	0	1.67	7	85	1,052,000
1969	21.46	4,038	15,893	0	1.58	7	85	1,071,000

[a]From Nelson (1966, p. 30,32).

refuge. If it could be established that use is a function of the water volume index, simple algebraic substitution would express value as a function of the amount and timing of water received by the refuge. That is:

$$\text{If Value} = f(\text{Use})$$

$$\text{and Use} = f(\text{Water})$$

$$\text{then Value} = f(\text{Water})$$

With these functions established, it should be possible in any given situation of water scarcity to predict the marginal value of water received by the refuge.

Unfortunately, marginal values of water were not successfully predicted in this study. The primary difficulty was the choice of water volume index. The index developed monitors water conditions on the refuge itself. Despite the importance of water to the existence of marshland ecosystems, there is a paradox between water conditions and the values that have been measured in this study. We would expect that values would be relatively high in years when water conditions are relatively good. However, the data in Table 14 indicate that this if frequently not the case. In 1943 the water volume index was 21.87. That year 3,646 hunters and 1,871 other visitors came to the refuge. The next year the index dropped drastically to 9.51 and three of the five units dried up. Despite this, the number of hunters <u>increased</u> to 3,902 and the number of other visitors remained about the same (1,834). This is the most drastic example in Table 14, but there were many other years when the relationship was similarly inversed.

It appears that in order to be useful, a water volume index for the Bear River Refuge needs to compare water volumes at the refuge with conditions elsewhere in northern Utah generally. In poor water years, the water available to the refuge is regulated to maintain satisfactory levels in Units 1 and 2 at the expense of the other three units. With many areas throughout the state dried up or reduced, waterfowl concentrations tend to be relatively high in Units 1 and 2 where conditions are relatively good. Since the refuge regulations are set up so that most of the hunting and almost all of the other visitor use takes place on these two units, it is not surprising that refuge use frequently increases during poor water years. Thus, it appears that a more useful water volume index would incorporate the ratio: water volumes received by Units 1 and 2/water conditions in northern Utah generally.

Another difficulty that may limit the usefulness of even an appropriately derived water volume index is the fact that there are many other variables that influence visitor use. With the exception of minor annual fluctuations, the number of hunters at Bear River has remained amazingly constant since 1940 (Table 14). During this period the number of Federal migratory waterfowl stamps sold in Utah has doubled from 16,886 in 1940 to 33,928 in 1969 (Martin, 1972). Although duck stamp sale increases are less consistent than population increases, apparently because of hunter sensitivity to annual hunting conditions and the price of the stamp, in the long run the proportion of waterfowl hunters in the population has remained about constant. Why, then, has the number of hunters at Bear River not increased?

Probably two related factors are involved. Much of the population growth in Utah has taken place along the Wasatch Front. Thus, much of the increase in duck stamp sales comes from hunters from urban areas along the Front. These hunters apparently are attracted to nearby areas such as Ogden Bay and Utah Lake rather than to the more distant Bear River Refuge. Also, because of Bear River's remoteness and the fact that hunters have to walk further there than at other areas, Bear River appears to attract and maintain a core of dedicated hunters but remains relatively unattractive to those who lack a local knowledge of the area. Goddard (1962) found that 69 percent of the hunters at Bear River had hunted there before, and only 34 percent had hunted elsewhere during the season.

Despite the difficulty of relating our value measures to marginal volumes of water, it is recommended that future research be directed toward that end. Non-marginal values such as we have derived are useful when comparing alternative uses of the sites. They are of little help, however, if a decision maker needs to know the value during a dry year of an additional 10,000 acre feet that is also being fought for by irrigation interests upstream.

DISCUSSION

Comparison of the Two Valuation Models

Monopoly revenue estimates are generally less than half the corresponding consumer's surplus estimates for the same activity (Figure 4 and Tables 10-13). The reason for this can be seen by examining Figure 11. The demand curve in Figure 11 shows the number of trips that visitors to the site would take if their costs of use were increased by the entrance fees indicated on the Y axis. The area under the curve is consumer's surplus[7] or the total willingness of the observed (no-fee) user group to pay above their normal costs of use. A monopolist will try to capture as much of this consumer's surplus as he can. However, the rules of geometry dictate that a non-discriminating monopolist will not be able to capture more than half the surplus, assuming that the demand function is either linear or convex to the origin (Lerner, 1962).

Arguments from the literature

Despite this large difference in the magnitude of corresponding consumer's surplus and monopoly revenue estimates, there is no agreement among outdoor recreation economists as to which is more appropriate as a measure of value. Clawson (1959), Crutchfield (1962), Brown et al. (1964), and Beardsley (1968) seem to favor non-discriminating monopoly revenue while Hotelling (1949), Lerner (1962), Knetsch (1963), Dyer

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[7]Consumer's surplus calculated in this manner is technically equivalent to what was estimated in this study from the demand curve for the experience as a whole (Jamsen and Ellefson, 1971).

(1968), Grubb and Goodwin (1968), and Kalter (1971) argue that consumer's surplus, or discriminating monopoly revenue, is more appropriate.

The main argument in favor of monopoly revenue is that it is more like a market value than is consumer's surplus. Brown et al. (1964) say that its main advantage is that it imputes a value to the fishery resource comparable to what its value would be to a profit-maximizing owner. Beardsley elaborates further:

> In current political and administrative practice, the relative values of the various commodities and services which enter into decisions are market prices. These prices are a direct indication of aggregate marginal willingness to pay on the part of the consumer. They do not include the amounts of consumer's surplus obtained through purchase of the commodity or service (Beardsley, 1968, p. 62).

He goes on to say that until competing land uses are evaluated by consumer's surplus methods, monopoly revenue estimates will remain more appropriate for allocation decisions.

Interestingly, most of the arguments in favor of consumer's surplus emphasize that such estimates are analogous and probably comparable to many of the values included in current benefit/cost analyses of Federal water control projects.

> Calculations of other benefits from multi-purpose water development projects, such as flood control, water quality, and water supply, also incorporate features of consumer surplus. The benefits for each single-purpose project are usually considered either equal to the value of the most likely or least costly single alternative when alternative projects could be undertaken, as in municipal water supply, or are based on the potential economic losses to the economy without the project, as in flood control benefits. Neither of these methods of benefits estimation uses the concepts of willingness to pay as would a market price. In practically all cases, the benefits for single-purpose projects are of such nature that consumers either have little choice of whether or not to engage in projects, as in water supply, or must bear high

> risk, as in flood hazard. The benefits, therefore, are more nearly indicative of the total value of projects to water-oriented recreation consumers as stated here than if the benefits estimates were based entirely on total revenue to be derived from the sale of water or the "book value" of flood damaged property (Grubb and Goodwin, 1968, p. 18).

Knetsch points out the usefulness of the consumer's surplus concept in public decision making:

> For most purposes involving allocation and planning decisions the interest centers on the worth of the recreational use of the resources to society. . . . The value of benefit, in an economic sense, which is derived from a given use of resources is simply the value it has for the consumer and is measured by his willingness to pay for it (Knetsch, 1963, p. 392).

Also, since consumer's surplus includes all of the area under the demand curve for the on-site experience, it avoids "problems connected with the derivation of a monopoly price under conditions when demand is inelastic or of constant elasticity over a broad price range." (Kalter, 1971, p. 81)

Conclusion

Brown et al. (1964) indicate that the identification of a proper value measure is highly dependent upon the decision-making situation for which it is to be used. In this study it was desired to estimate values that would be comparable with other values used in benefit/cost analyses of water development projects such as the proposed Honeyville Reservoir on the Bear River. It was also desired to have estimates that reflected the amount of societal welfare attributable to the recreational opportunities studied (See page 74).

Given these objectives, consumer's surplus estimates are more useful than monopoly revenue estimates. Not only are consumer's surplus

estimates a better measure of societal welfare, they are generally more comparable to other values estimated for water development projects than are monopoly revenue estimates. For example, irrigation benefits are computed on the basis of the increase in the value of agricultural production that can be attributed to the increased water supply. Thus, benefits from irrigation

> . . . exceed what a monopolist could extract as revenue. In order to extract the full increase in return to land and water as revenue, it would be necessary for a monopolist not only to discriminate between crops and land classes, but also between different landowners. The hypothetical monopolist in the Monopoly Revenue Method, however, is assumed to charge all the recreationists the same price, regardless of distance zone (Lerner, 1962, p. 68).

On the other hand, if one's purpose were to compare the value of fishing recreation with the value of an offshore oil facility, non-discriminating monopoly revenue values would probably be the most useful, depending upon the actual market situation facing the oil company. Such a scheme would compare the hypothetical market value of the fishery with the actual single-price-times-quantity value of the various oil products produced by the facility.

Bias

Sources

The above estimates of consumer's surplus and monopoly revenue are subject to several sources of bias. These biases are caused by conservative use estimates, missing data, and the tendency of travel time and intervening opportunities to push demand curves to the left.

Reduced universe. All observed visitors to the two areas were from counties in the northwestern corner of the state. Thus, the values

generated below refer only to this portion of the state. To the degree that these areas are visited by non-residents and people living in Utah counties south of the Tooele-Juab County line and east of the Wasatch-Duchesne County line, the estimates are conservative. Figure 2 shows county and state boundaries.

Missing data. The four demand curve estimates (Figure 3) are based only on data observed for six to eight of the eleven counties in the northwestern corner of the state. For example, no resident of Summit County was observed to visit either site; therefore, Summit County was excluded from the sample even though it is closer to the site than some of the counties from which visitors were observed. Average variable expense could have been estimated for these zero-use counties and included in the demand estimate. Their inclusion would pull the demand curve to the left, reducing the value estimates.

Unsampled use. The use estimates for hunting are low because only those hunters who entered by the main gates of the two areas were included in the samples. Car counts made at the various entrances on our sample days indicate that our hunter-use estimates at Bear River and Farmington Bay should be increased by 13.4 percent and 42.4 percent, respectively.

With minor exceptions, non-hunting visitors used the main gates and, thus, were included in the samples.

A small but unknown number of hunters and other recreationists escaped being interviewed because they arrived and/or left extremely early or late on sample days. Occasionally individuals or

groups were not interviewed because of the confusion that was created when larger numbers of people arrived or left at the same time.

During the 3,282 interviews that were made as part of this study, only one invididual had to be excluded from the sample because of non-cooperation.

Incidental visits. Non-hunters that indicated that more than half their travel from their home to the refuge was for some purpose other than visiting the refuge were excluded from the sample. Thus, tourists and others who happened to visit the Bear River Migratory Bird Refuge while passing through Bringham City were excluded. If these "incidental visits" were added to our original use estimates for the two areas (Tables 21 and 22), it would increase the estimates by 27 percent and 6 percent, respectively.

Because of the difficulties of interviewing hunters that are tired and anxious to get home, the information necessary for supplemental visit determination was not collected for the waterfowl hunt. It was assumed that all travel from the hunters' counties of origin to the areas was for the purpose of hunting at those areas. This assumption gives an upward bias to our estimates and it may be substantial. The degree to which hunters at these areas hunt at other sites on the same day is not known. Since hunters at Bear River and Farmington Bay hunt an average of five hours and four hours, respectively, many of them have time to visit other areas on the same day.

Out-of-state visits. Non-resident hunters were either assigned the county of origin of their hunting companions or the county in which they spent the previous night. Few, if any, hunters from out-of-state came

specifically to hunt these areas. Mostly they hunted there incidentally to hunting at private clubs. It is unknown if including them in our sample as we have caused an under or over estimation of consumer's surplus. If it is true that consumer's surplus per trip increases with an increase in the distance between the site and the visitors' home (See page 82.), it is probable that our procedure tends to produce conservative estimates.

About 190 non-hunting visitors from out-of-state, mostly ardent wildlife photographers and birdwatchers, travel an average of 530 miles (round-trip) specifically to visit the Bear River Migratory Bird Refuge. Obviously, our measurements of value do not include the net benefits enjoyed by these distant visitors. The Farmington Bay Waterfowl Management Area apparently does not attract non-hunting visitors from out-of-state.

Time bias. Probably the largest source of downward bias in our estimates is time bias. Most authors have recognized this problem (Clawson, 1959; Brown, 1964; Kalter, 1971). It stems from the fact that most recreationists have a limited amount of time they can give to their chosen activities. In many cases the decision as to whether or not a trip to a distant site will be taken probably depends more upon the amount of travel time involved than upon the monetary cost. Thus, in Figure 3, as observed costs increase, the corresponding observed use rates are less than what would be observed if monetary costs were the only relevant costs involved.

Several authors have developed models that attempt to account for the time-travel distance variable complex. Beardsley (1968) was

apparently the most successful. From a three variable (use rate, cost, travel time) demand function he was able to predict "use rates of visitors at O_i if their costs were increased to those of visitors at O_{i-1}, while holding travel time constant at that presently observed for O_i" (Beardsley, 1968, p. 52). This technique increased his uncorrected Clawson (Clawson, 1959) monopoly revenue estimate by 70 percent.

On the other hand, Cesario and Knetsch (1970, p. 702) found it "virtually impossible statistically to separate the effect(s) of . . ." travel costs and time. They resorted to an extention of Smith and Kavanagh's (1969) model which placed an actual monetary value on time and added it to the cost of travel. However, instead of heroically assuming, as did Smith and Kavanagh, that money can be substituted for time in a linear fashion, they formulated a trade-off function to produce a new variable which combined elements of time and cost. While the trade-off function reduces the number of assumptions required by the model, there "is no guarantee, without some empirical verification, that the slope indicated by this particular formulation of the trade-off between time and money is correct" (Cesario and Knetsch, 1970, p. 704).

Adjustments

In order to illustrate the importance of these biases, rough estimates were made of their magnitude. Adjusted consumer's surplus and monopoly revenue estimates were then computed. These adjusted estimates (Tables 15 and 16) range from 46 to 82 percent greater than the original estimates. For example, these adjustments increase the consumer's surplus estimate for hunting at the Bear River Migratory Bird Refuge from $4,910 to $7,260 or 48 percent (Table 15).

Table 15. Adjustments for bias in consumer's surplus estimates for hunting and other recreation at the Bear River Migratory Bird Refuge and the Farmington Bay Waterfowl Management Area, fiscal 1969

	Original estimate	Adjustments				Adjusted estimate
		Unsampled use	Incidental visits	Out-of-state visits	Time bias	
Bear River M.B.R.						
Hunting	$ 4,910	+$ 640 (13%)	-$ 250 (-5%)	--	+$1,960 (40%)	$ 7,260
Other recreation	10,500	--	+ 2,800 (27%)	+$1,200 (11%)	+ 4,200 (40%)	18,700
Farmington Bay W.M.A.						
Hunting	6,400	+ 2,700 (42%)	- 300 (-5%)	--	+ 2,600 (40%)	11,400
Other recreation	2,580	--	+ 150 (6%)	--	+ 1,030 (40%)	3,760

Table 16. Adjustments for bias in monopoly revenue estimates for hunting and other recreation at the Bear River Migratory Bird Refuge and the Farmington Bay Waterfowl Management Area, fiscal 1969

	Original estimate	Adjustments				Adjusted estimate
		Unsampled use	Incidental visits	Out-of-state visits	Time bias	
Bear River M.B.R.						
Hunting	$2,040	+$270 (13%)	-$100 (-5%)	--	+$ 820 (40%)	$3,030
Other recreation	3,370	--	+ 910 (27%)	+$130 (4%)	+ 1,350 (40%)	5,760
Farmington Bay W.M.A.						
Hunting	2,270	+ 950 (42%)	- 110 (-5%)	--	+ 910 (40%)	4,020
Other recreation	691	--	+ 41 (6%)	--	+ 276 (40%)	1,010

Reduced universe. The small amount of consumer's surplus enjoyed by visitors from distant counties that were included in the samples (i.e., Tooele County in Table 25) indicates that the bias introduced because of this shortcoming of the models is insignificant. No adjustment was made for reduced universe bias.

Missing data. The zero use rates observed for certain relatively nearby counties are almost certainly a function of the interview sample sizes and the populations of these counties and not a function of some unique characteristic of their outdoor recreation consumers. For example, for waterfowl hunters at the Bear River Migratory Bird Refuge the observed use rate from Utah County was .22 trips per 1,000 population per season (Table 1). Wasatch County is about the same distance from Bear River as is Utah County; therefore, one would expect average variable expenses for hunters from the two counties to be about the same. With similar expenses, their use rates are probably about the same. If these assumptions are true, hunters from Wasatch County made only one trip to Bear River during the entire season.[8] Thus, it is to be expected that an approximately 10 percent sample such as was used in this study would have only a 10 percent chance of observing any use from Wasatch County.

Although excluding those relatively nearby counties for which zero use rates were observed technically gives a positive bias to the value estimates, it is believed that the resulting value estimates are closer

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[8] 5,700 (population of Wasatch County) x .22/1000 (use rate for Utah County) = 1.25 (estimated number of hunters from Wasatch County).

6 percent, respectively, to account for incidental visits. The assumptions were the same as for unsampled use. However, here it is probable that the adjustment for consumer's surplus is conservative, since these individuals were from distant origins where consumer's surplus per trip is relatively high.

The upward bias from counting incidental hunter trips as regular trips was not measured. It is the belief of the writer that this would not cause an overestimation of more than 5 percent. To account for this bias, 5 percent was subtracted from the original value estimates for hunting at the two areas.

Out-of-state visits. No adjustment was believed necessary for trips by out-of-state hunters at either of the two areas studied nor for trips by non-hunting recreationists at the Farmington Bay Waterfowl Management Area. However, out-of-state visits for non-hunting recreation at the Bear River Migratory Bird Refuge amounted to about 1.1 percent of the visits that were included in the model. Many of these visitors were interviewed and it was found that their visits were usually highly purposeful--planned in advance, and generally involving the purchase of considerable equipment (usually photographic). For these reasons plus indications that consumer's surplus per trip tends to increase with distance, it was judged that these visitors received in the order to 10 times the consumer's surplus received by the average visitor. Thus, consumer's surplus for non-hunting recreation at Bear River was adjusted up 11 percent for out-of-state visits.

It is believed that under a monopoly revenue situation, these visitors from out-of-state would pay whatever fee was charged. Since

the estimated nonconsumptive use level for Bear River at the revenue maximizing fee is approximately one-fourth that observed for the no fee level (Table 12), these out-of-state visitors would increase the monopoly revenue about 4 percent (about four times the percentage they constitute of observed use). Thus, the monopoly revenue estimate for non-hunting recreation at Bear River was adjusted up 4 percent for out-of-state visits.

Time bias. Although it is certain that time bias is an important source of downward bias in our estimates, we have no empirical basis for estimating it. The author has arbitrarily selected 40 percent as the magnitude of the adjustment to be made for this bias. In light of Beardsley's (1968) findings, this may be conservative. It is felt that with this adjustment the estimate is more accurate than it is without it.

Time bias pushes both the original (consumer's surplus) and derived (monopoly revenue) demand curves to the left. For the purpose of this analysis, it is assumed that a given amount of bias will reduce the monopoly revenue and consumer's surplus estimates by the same ratio. Thus, all our value estimates were reduced 40 percent for time bias.

Predicted Future Values and Capitalized Values

The consumer's surplus enjoyed by non-hunting recreationists at the Bear River Migratory Bird Refuge during fiscal 1969 was estimated (after adjustments for bias) to be $18,700 (Table 15). Capitalization of this annual value at an interest rate of 3 percent gives a present value of

$123,000. However, such capitalization requires the assumption of a constant annual value, an assumption that may be false.

The future magnitudes of the annual values estimated in this study depend upon two things: (1) changes in the consumer's surplus enjoyed by individual visitors and (2) changes in the annual visitation rate. Both of these changes can be produced by changes in the variable expense per visit, the quality of the experience, consumer tastes and preferences, the availability of substitutes, and the travel time involved. If, for example, the quality of the experience is improved, the demand curve for the on-site experience may move to the right pivoting, in effect, on its intersection with the x-axis. Such a change in slope would indicate that although those who participate enjoy increased consumer's surpluses, no new participants have been attracted to the activity. A more likely result of a quality increase, however, would be both a slope and x-axis intercept change; i.e., an increase in the number of visits and the net benefit per visit.

The prediction of future visitation rates at recreational facilities has been the subject of considerable research (Dyer and Whaley, 1968; Kalter, 1971). Variables known to be important use rate determinants include: human population levels, site quality indexes, intervening opportunities, travel and other variable costs per visit, travel time, capital investment required, and various socio-economic characteristics of the user populations such as age, income, and education. The usual approach has been to regress observed use rates from various user origins or zones with cross-sectional data on several of the above demand determinants. For example, Dyer and Whaley (1968, p. 11-12)

developed the following pooled prediction equation for fishing on two small trout streams in Utah:

$$Y_{ij} = -32,716 - 0.045X_1 + 1.633X_2 + 0.903X_3 \quad (R^2 = .74)$$

Where:

Y_{ij} = use of stream j per thousand population of origin i.

X_1 = round-trip distance in miles between county i and stream j.

X_2 = percent of population in county i which is 65 years or older in age.

X_3 = percent of families in county i with annual incomes in the $4,000 to $6,000 range.

However, once the relationship is established, "predictions of future participation necessitate assumptions regarding changes in the causal factors" (Dyer and Whaley, 1968, p. 4). Predicting the future magnitude of the independent variables may not be easy and certainly will introduce error. More important, perhaps, is the likelihood that during the time period of an expected benefit stream (i.e., 50 years) the originally estimated relationship will change.

Another serious problem involves the identification of supply and demand. The demand data utilized in these models is obtained by estimating visitor use at the sites in question. The problem is that use is often determined as much by supply as it is by demand.

> If, for example, one were to predict the (future) demand for a new swimming facility on the basis of extrapolating past participation rates for a region which presently has no swimming facilities, he would grossly underestimate the desire for this group to swim. Conversely, predictions based on participation rates for groups of individuals with abundant swimming facilities would indicate that,

> because of the inclination of this group to swim, new investments for swimming facilities should be directed toward the latter groups, not the former. This would lead to an obvious error in determining investment priorities based on past participation rates (Dyer and Whaley, 1968, p. 5).

Clearly, this problem is most serious near urban centers where outdoor recreation facilities are often used at or beyond capacity. In this study, the identification problem is more serious for Farmington Bay, which is located less than 20 miles from Salt Lake City, than it is for the more remote Bear River Refuge. Except for the opening weekend, however, both of these areas are currently operating considerably below capacity.

No formal attempt was made to predict the future magnitude of the annual values estimated in this study. However, the probable changes in the relevant variables and their impact on the benefit streams will be discussed below. Capitalized values will then be estimated. All of the factors discussed are assumed to have a proportional impact on both the consumer's surplus and monopoly revenue estimates.

Waterfowl hunting

Changes in the consumer's surplus enjoyed by individual visitors. It is probable that the amount of consumer's surplus generated by individual hunting trips at the Bear River Migratory Bird Refuge and the Farmington Bay Waterfowl Management Area will remain roughly constant. The quality of the experience will decline slightly because of decreases in the continental waterfowl populations and perhaps some increase in the number of hunters. It is expected that the anti-hunting influences will reduce the value of a hunting trip to some individual hunters by eroding their confidence in the social acceptability of their sport.

But this (as well as any quality decline) will be compensated for by the gradual removal of available substitutes.

Changes in the annual visitation rate. As previously discussed, the number of hunters at the Bear River Migratory Bird Refuge has remained amazingly constant. In 1940, 4,685 hunting trips were recorded at the refuge headquarters. In 1971, with no quota system in force, the number was 3,923, more than 750 less. During the 31-year interval, the high was 6,605 in 1950 and the low was 2,459 in 1961 (Table 14). Records for the Farmington Bay Waterfowl Management Area are less complete but also indicate a relatively stable number of hunters despite a steadily increasing urban population. The main reason why the number of hunters has not increased at Bear River probably has been the general decline in the continental waterfowl population. This, of course, is reflected in the average daily bag which has about halved since 1940 while the human population was doubling (Table 14). Increases in the cost of duck stamps and hunting licenses reduced the number of hunters in some years (Martin, 1972), but generally these cost increases were negated by increases in real income and leisure time. The efforts of anti-hunting elements within the population may have reduced the number of hunters some, but this is a relatively recent phenomenon associated with the ecology movement and in Utah, where hunting is a deeply ingrained part of the culture, its impact will be slow and probably minor.

It is concluded that the factors that have maintained a relatively constant number of hunters at these areas (bag limit and kill declines, population increases, income and leisure time increases, and the anti-

hunting movement) will continue to be operative and that the number of hunters will remain constant for the foreseeable future.

Computation of capitalized values. Here and in the following section on Non-Hunting Educational and Recreational Use discount rates (3 percent and 8 percent) have been arbitrarily selected. Obviously, the choice of social discount rate greatly affects the magnitude of the capitalized values. The Water Resources Council (1971a, p. 12) recommends that the discount rate "reflect the relative values placed by society on benefits and costs toward the multi-objectives occurring in the future as compared with benefits and costs occurring in the present." The going rate for Federal water and related land projects has been about 3 percent. However, indications are that when Congress acts on this matter, the rate will be set considerably closer to 8 percent than to 3 percent. This will lower the capitalized values. But since most of the costs of large development projects are in the present with the benefits strung out in the future, the higher discount rate means that it will be much more difficult to justify development projects. This will tend to protect environmental values not included in the benefits cost equations and, indeed, this is what Congress has in mind as it considers this discount rate increase.

Since in this case the annual benefit is expected to remain relatively constant, the computation of the capitalized values merely involves dividing the annual values by the interest rates.

At 3 percent interest, the capitalized value of the adjusted annual consumer's surplus estimate for waterfowl hunting at the Farmington Bay Waterfowl Management Area is $380,000; the corresponding estimate for

the Bear River Migratory Bird Refuge amounts to $242,000 (Figures 6 and 7). Capitalized adjusted monopoly revenue estimates for the two areas are $134,000 and $100,000, respectively. When the discount rate is increased to 8 percent, the capitalized values are decreased proportionally (62.5 percent). For example, at 8 percent the capitalized consumer's surplus estimate for hunting at Farmington Bay drops from $380,000 to $143,000 (Figure 7).

Non-hunting educational and recreational use

Changes in the consumer's surplus enjoyed by individual visitors. It is believed that the consumer's surplus of individual visits will increase at the rate of 4 percent per year for 20 years. This estimate is based upon a belief in the profound significance of the current environmental movement. Public education is nurturing and will continue to nurture a stronger and stronger preference for nonconsumptive uses of wildlife. A peak level of awareness will probably not be reached for more than two decades.

In some respects, increased use of these facilities will reduce the quality of the experience. However, this will be largely offset by improvements in on-site facilities. The Bear River Migratory Bird Refuge is in the process of developing extensive interpretive facilities for visitors. In the opinion of the author, interpretive facilities will be developed at the Farmington Bay Waterfowl Management Area as soon as the State legislature appropriates sufficient general funds for use by the Division of Wildlife Resources.

Changes in the annual visitation rate. It is anticipated that nonconsumptive recreational use at the two sites in question will increase

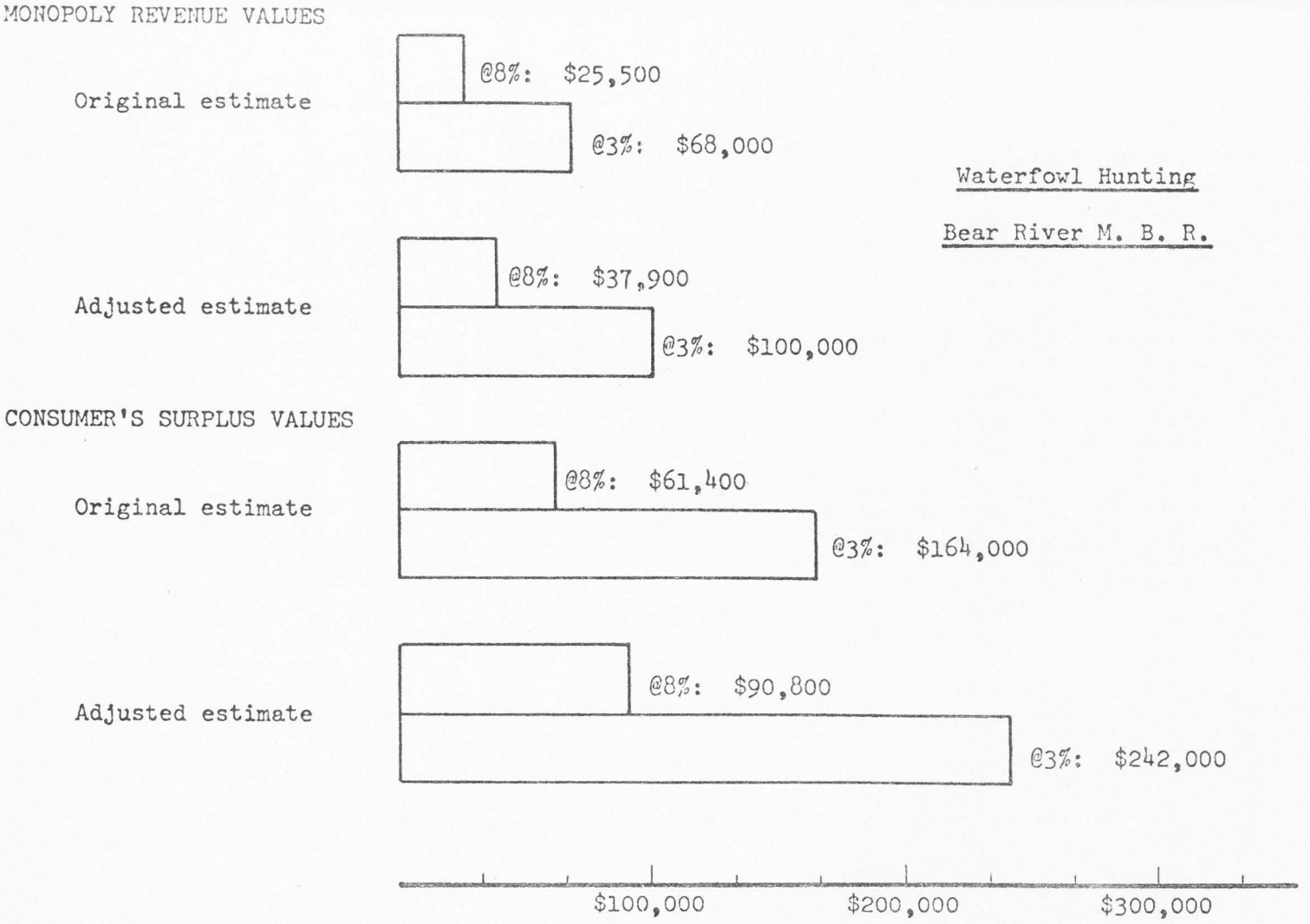

Figure 6. Relation between capitalized consumer's surplus and monopoly revenue values for waterfowl hunting at the Bear River Migratory Bird Refuge based on data collected in fiscal 1969.

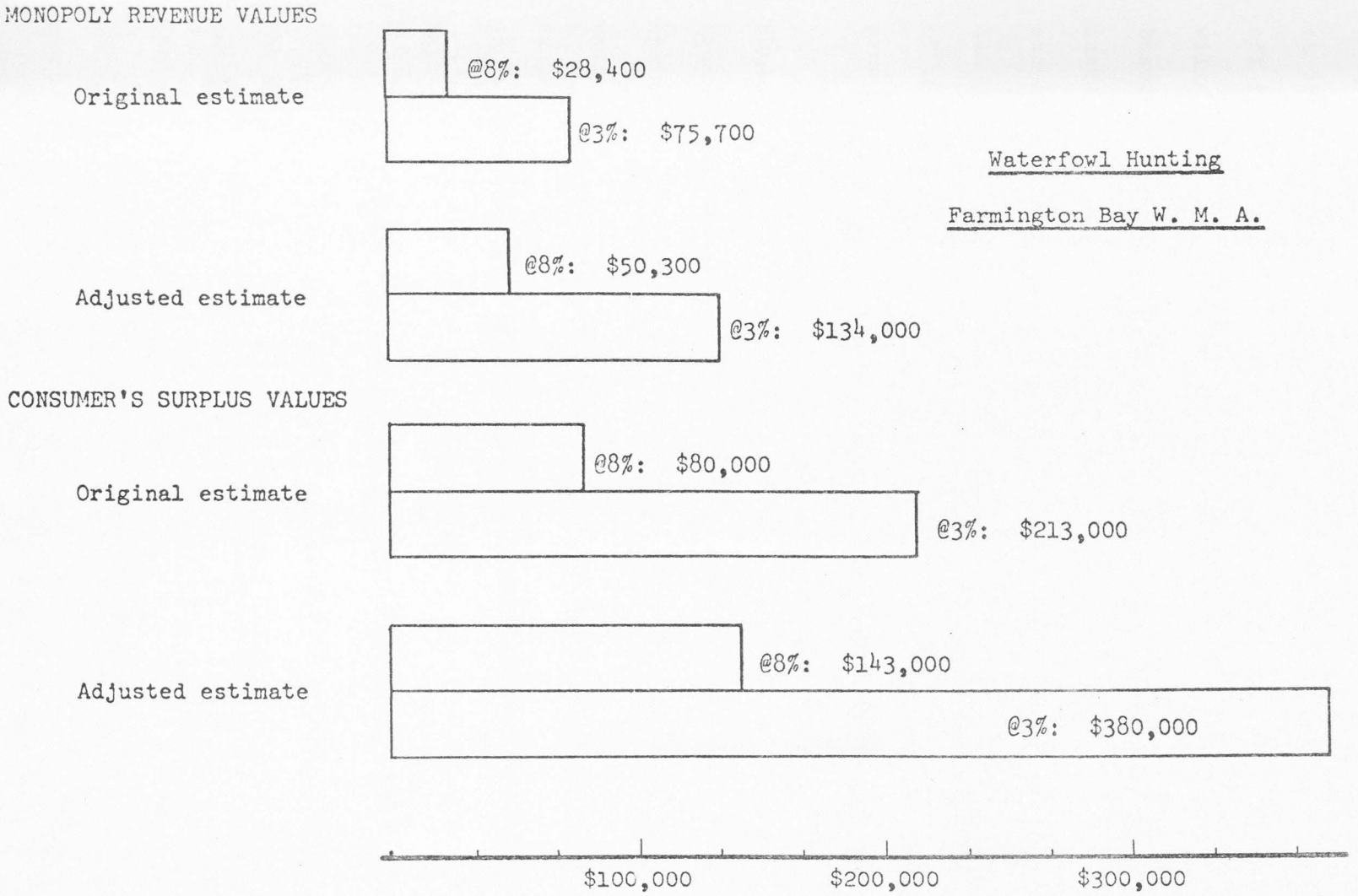

Figure 7. Relation between capitalized consumer's surplus and monopoly revenue values for waterfowl hunting at the Farmington Bay Waterfowl Management Area based on data collected in fiscal 1969.

at the constant rate of 5 percent per year for 20 years and then level off for 4 years down to a constant rate of increase of 1 percent which will continue through the fiftieth year and then drop to zero. This is based primarily on two reasonable assumptions: (1) that the state will install interpretative facilities at Farmington Bay in the near future and (2) that public interest in wildlife will increase faster than the human population for at least two decades. Eventually a capacity level of concern will be reached and interest in this type of activity will grow only in proportion to population growth.

Of course, most if not all of the demand determinants discussed above will play a role in determining future visitation rates at these areas. Entrance fees and crowding will reduce visits. Increased income and education and reduced travel time will increase visits. Other environmental education opportunities that probably will be developed at other sites may siphon off visitors from these sites. However, population increases and an increasing environmental awareness are expected to dominate and produce the use increases indicated.

Computation of capitalized values. To account for anticipated changes in the use rate and the consumer's surplus of individual visits, the annual value in each case was increased by 9 percent per year for 20 years. This rate of increase was decreased 2 percent per year for 4 years giving a rate of increase of 1 percent for the twenty-fourth year. This rate of increase (1 percent) was maintained through the fiftieth year, after which it was assumed that the annual value remained constant.

These income streams were capitalized by a computer program which adjusted the annual values according to the predicted increases, discounted them individually, and then summed them through successive iterations until the discounted value of the last year was less than $1.00.

The highest current adjusted annual value was $18,700 of consumer's surplus at the Bear River Migratory Bird Refuge (Table 15). At the 3 percent discount rate the program required 586 iterations and gave a capitalized value of $4,000,000. At 8 percent only 173 iterations were required and the value dropped to $775,000 (Figure 8). Corresponding consumer's surplus estimates for the Farmington Bay Waterfowl Management Area amounted to $804,000 and $156,000, respectively (Figure 9).

Capitalized monopoly revenue estimates are only about one-third the magnitude of the estimates for consumer's surplus (Tables 8 and 9). For example, while capitalized consumer's surplus at Bear River amounts to $4,000,000, the corresponding monopoly revenue estimate is only $1,230,000. This difference, of course, is due to and proportional to the difference between the adjusted estimates of current annual value ($18,700 and $5,760, Tables 15 and 16).

Combined recreational use

The capitalized values of the adjusted estimates of consumer's surplus for hunting and non-hunting educational and recreational use can be summed as follows:

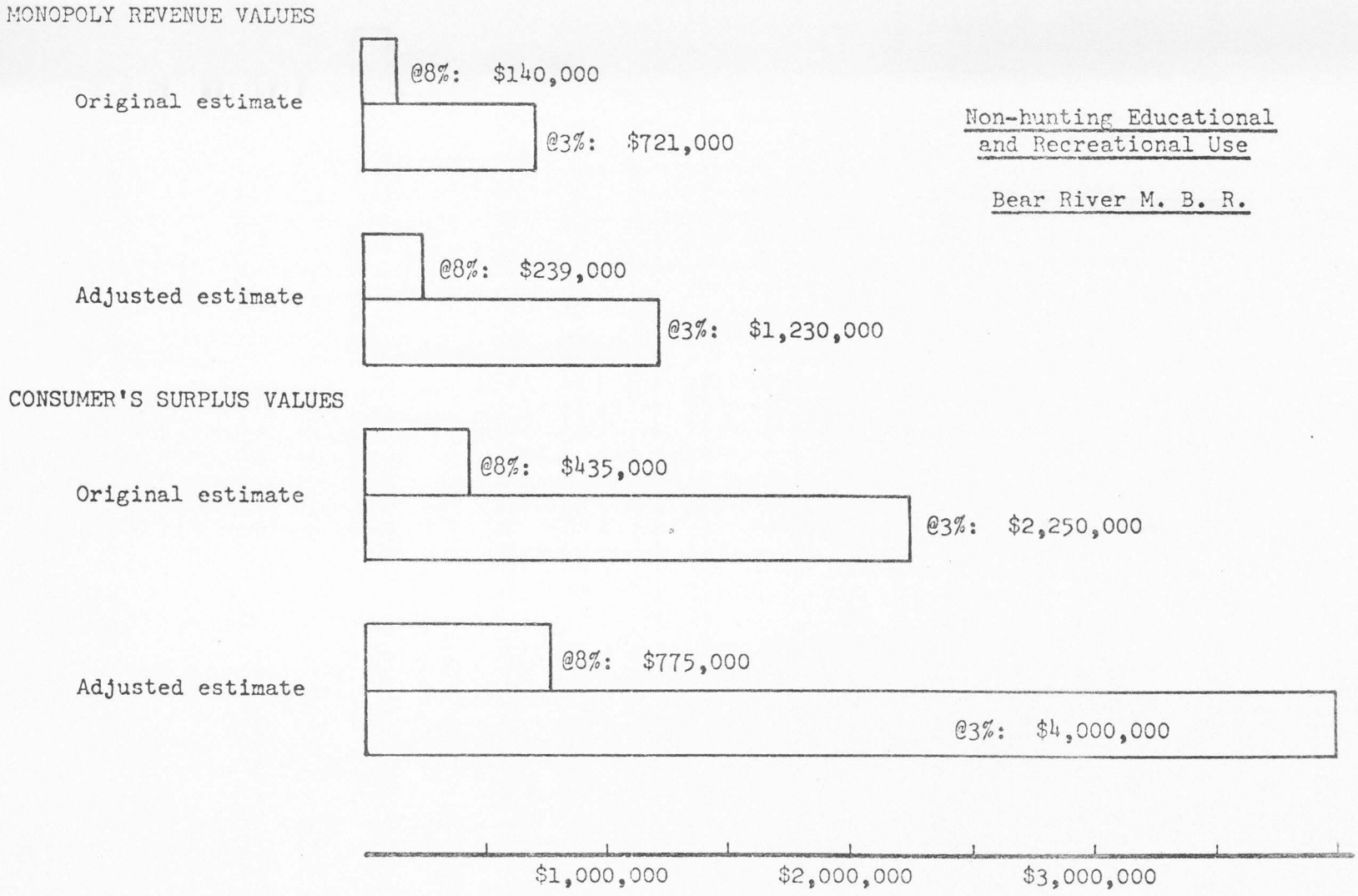

Figure 8. Relation between capitalized consumer's surplus and monopoly revenue values for non-hunting educational and recreational use at the Bear River Migratory Bird Refuge based on data collected in fiscal 1969. Note that the scale here is one-tenth that of Figures 6 and 7.

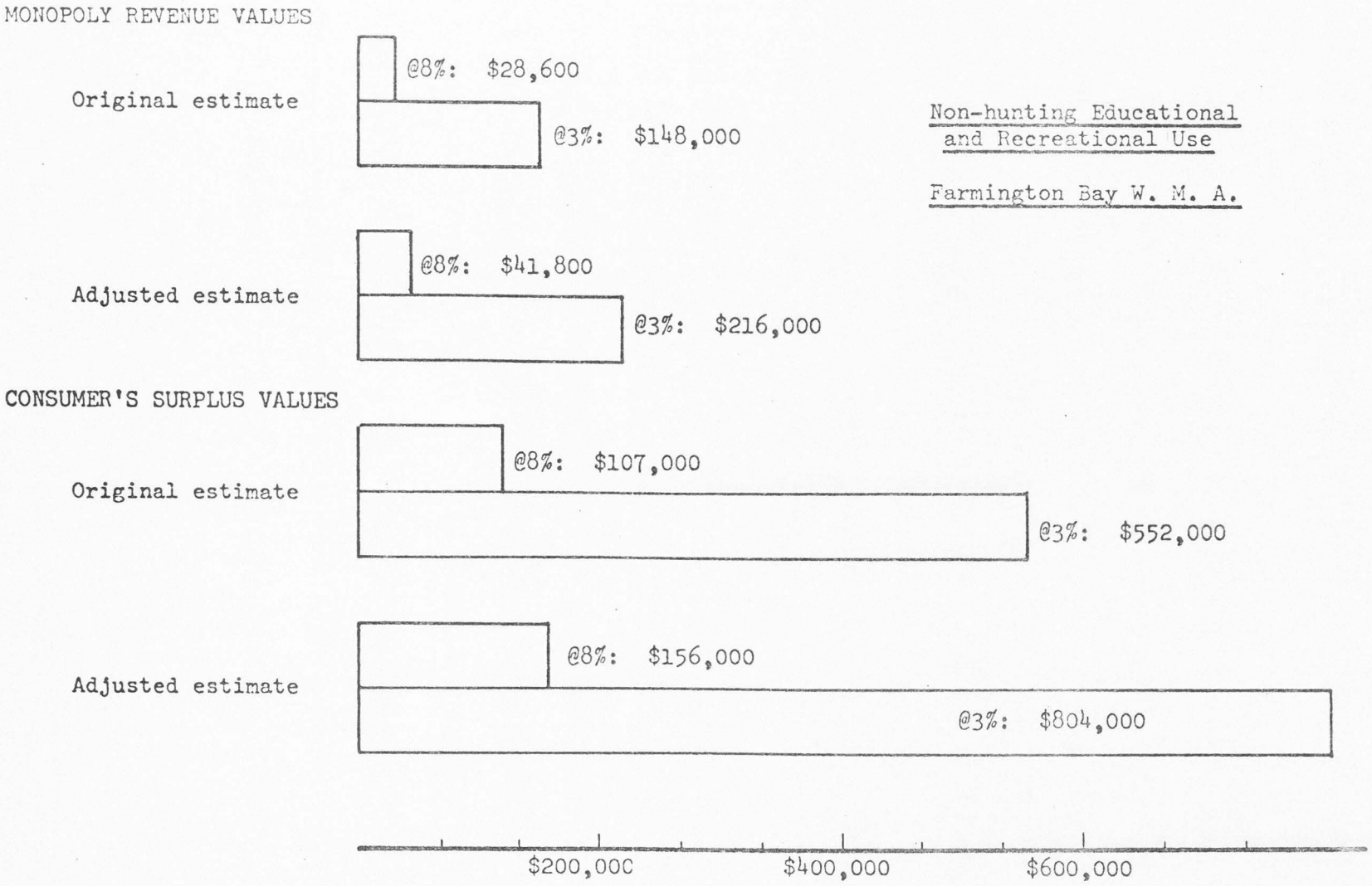

Figure 9. Relation between capitalized consumer's surplus and monopoly revenue values for non-hunting educational and recreational use at the Farmington Bay Waterfowl Management Area based on data collected in fiscal 1969. Note that the scale here is five times that of Figure 8 and one-half that of Figures 6 and 7.

Bear River Migratory Bird Refuge

At 8 percent, total recreational value equals...

$90,800 + $775,000 = $865,800

At 3 percent, $242,000 + $4,000,000 = $4,242,000

Farmington Bay Waterfowl Management Area

At 8 percent, total recreational value equals...

$143,000 + $156,000 = $299,000

At 3 percent, $380,000 + $804,000 = $1,184,000

Corresponding totals for the adjusted monopoly revenue estimates are as follows:

Bear River Migratory Bird Refuge

At 8 percent, total recreational value equals...

$37,900 + $239,000 = $276,900

At 3 percent, $100,000 + $1,230,000 = $1,330,000

Farmington Bay Waterfowl Management Area

At 8 percent, total recreational value equals...

$50,300 + $41,800 = $92,100

At 3 percent, $134,000 + $216,000 = $350,000

It should be noted that these values are quite specifically defined and represent only a small percentage of the total value of the two areas (See Total Values, below).

Total Values

The values measured in this study are quite specific and quite small compared to the total spectrum of values generated by waterfowl marshes. The purpose of this section is to describe the major benefits

and costs generated by the Bear River Migratory Bird Refuge. These benefits and costs can be outlined as follows:

BENEFITS

- Net value (consumer's surplus) to recreationists
- Social externalities
- Secondary economic benefits
  - Visitor expenditures
  - Management, maintenance, capital and research expenses
- Research
- Option demand
- Enjoyment of photographs, paintings, and stuffed mounts from the area
- Reduced waterfowl depredations
- Reduced bird hazards to aircraft
- Reduced trespassing
- Reduced competition at other recreation sites
- Ecological benefits
  - Species protection
  - Scientific
  - Human health

COSTS

- Opportunity costs
- Depreciation
- Management, maintenance, and research
- Mosquito production

Benefits

The following paragraphs discuss the various categories in the outline. Note that of the eleven major benefits listed, only one--net value to recreationists--was estimated in this study. Gross expenditures and monopoly revenue do not appear on the list because they are not direct measures of societal welfare.

Social externalities are based on the widely accepted belief that users of recreational facilities are somehow made more productive and better citizens than they would be without a given recreational opportunity. However, it ". . . is difficult to substantiate claims that the rest of society benefits from those who participate in outdoor recreation, and these claims are probably overemphasized" (Pearse and Bowden, 1969, p. 290).

Secondary economic benefits are discussed in the INTRODUCTION. These can be important locally and include increases to personal income due to visitor expenditures and management, maintenance, capital, and research expenses associated with the operation of the refuge.

During the year of this study about $84,800 were spent on research carried out at the Bear River Refuge. Most of this was applied research and is considered important to society for three reasons: (1) the possible application of its findings to present and future resource management, (2) the possibility of an unexpected breakthrough or discovery of significance to society, and (3) the training of students in research theory and technique. A dollar evaluation of such benefits would, obviously, be extremely difficult and was not attempted.

Whatever their magnitude, however, the benefits to society from research conducted at Bear River are at best only partially attributable to that refuge. If the refuge were lost, much of the research that now takes place on it would probably be displaced to some other saline marsh in Utah. Probably the loss of Bear River would spur additional research on the depleted available habitat. This would increase both primary and secondary benefits from research and lead to the conclusion that research benefits due to the existence of the Bear River Refuge are small. However, in the writer's opinion, totally satisfactory substitutes for this fine area could not be found. Because of the quality of the present habitat, the value of the research presently being conducted is greater than the research that would be stimulated by the loss of the area. Thus, the area should be credited with a positive net benefit from research.

Option demand may be one of the more important benefits of an area such as the Bear River Refuge. Pearse and Bowden describe it well:

> . . . there may be non-participants who value recreational resources, either because they appreciate the option of being able to take advantage of them in the future . . . or simply because they believe that the availability of such resources benefits society. . . . These values are exceedingly difficult to quantify. They are probably insignificant in most cases but become important when the resources under consideration are unique, or where decisions affecting them are irreversible. (Pearse and Bowden, 1969, p. 290)

The enjoyment of photographs, paintings, and stuffed mounts from Bear River may in some cases be partially attributable to the area. In most cases, however, the item probably could have been created or obtained elsewhere; in which case only a small increment of the value generated would be attributable to the area.

Discussions with state and Federal authorities revealed that the existence and location of the Bear River Refuge probably has only a minor impact on waterfowl depredations, bird hazards to aircraft, and trespassing. Waterfowl depredations are not a serious problem in Utah and are not influenced much by the refuge, which is located in ancestral waterfowl breeding and migratory resting grounds. Although the refuge enhances the area, it has not markedly modified waterfowl movements and distribution. If there is any impact, it is probably beneficial and results from attracting waterfowl from intensively farmed areas to the refuge near which there is little farming.

After talking with military, commercial, and private air traffic authorities in the state, it is the author's opinion that the location of the Bear River Refuge in relation to airports has no effect upon the danger of bird strikes. It is away from the normal line of flight of airplanes approaching and taking off from presently existing airports. Probably the refuge attracts more waterfowl to the Wasatch Front area than would otherwise be there. However, it is likely that the refuge attracts birds away from the immediate vicinity of the airports. This may be particularly important in the case of the Salt Lake International Airport which is bordered on the west by several private duck clubs.

If the refuge were eliminated, there would be an increase in trespassing by waterfowl hunters. However, the increase would be small because most of the displaced hunters would probably shift to other public areas where there is sufficient room to handle them, except perhaps on opening weekend.

The Bear River Refuge undoubtedly produces some small benefit by reducing competition at other recreation sites (golf courses, bowling alleys, etc., as well as other marshes). There may be some negative values here, too. The greater demand for these and other sports that would be possible without competition from waterfowl marshes might lead to investment in better facilities and significant primary and secondary benefits.

Ecological benefits are probably the most significant benefits produced by the refuge. They can be broken down into three interrelated categories: species protection, scientific benefits, and human health benefits.

For various reasons society places an increasingly large value on the protection of individual species, particularly the larger and more spectacular species. To the degree that the Bear River Refuge helps sustain the bald eagle, for example, it produces a value that society recognizes and appreciates.

Scientific benefits are subtle, but very important. They stem from the importance of having natural ecosystems available for study and comparison with disturbed areas. By learning how undisturbed ecosystems function, the effects and remedies of man-made pollution and other disturbances be determined. The Bear River Refuge, of course, is not totally undisturbed. The water it receives is contaminated with human and agricultural wastes and management is aimed at slowing succession from marshland to upland. Nevertheless, the area is sufficiently undisturbed to be of great value as an outdoor laboratory where ecological relationships can be discovered and tested.

Human health benefits stem from the fact that most of the wonders of science and medicine are derived from the natural world. It cannot be predicted when, through accident or design, some discovery of great import will come from the study of protected ecosystems. Another human health benefit is related to the importance of maintaining variety of experience and choice in the human environment. Different individuals have different needs. To the degree that the Bear River Refuge provides experiences and satisfies needs that could not otherwise be met, it is of value to society.

Costs

For a complete discussion, of course, it is necessary to consider what it costs society to keep the Bear River Migratory Bird Refuge. The biggest cost is probably the opportunity cost--the net benefits (all of them) that would be produced by the area in its next best alternative use. Opportunity cost was not estimated in this study, but it would be an interesting topic for future research.

Depreciation of capital equipment (dikes, buildings, etc.) plus the cost of management, maintenance, and research must be included in any assessment of net benefits. As noted above, however, much of the research would probably go on without the refuge; in fact, if the refuge were lost, research efforts might be increased. Thus, it is possible that research expense is a negative cost (actually a benefit) caused by the existence of the refuge.

Mosquitoes and other insects produced at the refuge could be considered a cost. Generally, however, this is not too much of a problem because of the refuge's relatively constant water levels and

steep-banked ditches. The duck clubs produce many more mosquitoes than the refuge. The remoteness of the refuge also helps. The Box Elder County Mosquito Abatement District spends an average of about $1,500 per year to control mosquitoes produced at Bear River. Since most alternative uses of the area (cattle ranching, farming, no management, etc.) would probably produce as many or more mosquitoes, the actual mosquito "cost" of the area is nil and may be negative.

Net value

Although the above does not consider all of the benefits and costs associated with the Bear River Migratory Bird Refuge, probably it does consider the major ones. It would be nice to be able to add these benefits and costs and come up with a net value for the area. However, this would be possible only if all of the categories were evaluated by comparable methods.

The most fruitful approach would be to consider each category from a societal welfare point of view and try to come up with a value comparable to consumer's surplus. However, for some of the categories, such as research or ecological benefits, where the timing and magnitude of the benefits are unpredictable, it is unlikely that useful values could be estimated. Thus, the best approach would seem to be to evaluate those categories for which justifiable values can be estimated and to quantitatively describe the remaining categories using a "system of accounts" as recommended by the Water Resources Council (1971b).

In the opinion of the author, it is clear that the benefits produced by the Bear River Migratory Bird Refuge greatly exceed all of the associated costs. With a detailed display of the various accounts

involved, it is likely that most people would come to the same conclusion. However, as is the case with all such decisions, one's final conclusion cannot be determined by simple arithmetic. Estimates for some of the categories will not be additive. In such cases the final decision must draw on several disciplines (sociology, psychology, ecology) in addition to economics to determine where the balance will swing for the greatest net benefit to society.

Consumer's Surplus Per Trip

One of the advantages of the consumer's surplus model is that unlike the gross expenditure method it ". . . suggests that (recreationists) capture surplus in greater amounts from sites closer to their points of origin" (Wennergren, 1965, p. 8). In Figure 10 it is clear that an individual at origin 1 enjoys more surplus ($1DP_1$) than does an individual at the more distant (and therefore more expensive) origin 2 where the surplus equals $2DP_2$.

Early in the data analysis stage of this study, however, it was noted that consumer's surplus per trip was lowest for the county (zone) in which the refuge occurred and highest for the more distant counties (Table 17). Examination of Dyer's (1968) data for trout fishing and Beardsley's (1968) data for general recreation showed similar trends (Table 18).

The basic explanation for this apparent paradox is that recreationists living near a site take relatively many trips and, thus, are more frequently out on the more elastic portion of the average individual demand curve where marginal cost approaches marginal utility

Table 17. Consumer's surplus per trip by distance zones for hunters and other recreationists at the Bear River Migratory Bird Refuge and the Farmington Bay Waterfowl Management Area during fiscal 1969. Corresponding costs (variable expenses) per trip are shown in parentheses.

Distance zone[a]	Waterfowl hunters				Other recreationists			
	Bear River MBR		Farmington Bay WMA		Bear River MBR		Farmington Bay WMA	
	C. S./trip		C. S./trip		C. S./trip		C. S./trip	
1	$1.24	($5.94)	$ .81	($4.95)	$ .40	($1.05)	$ .20	($ .35)
2	1.49	(7.96)	.93	(5.91)	.63	(1.70)	.49	(.90)
3	1.48	(7.77)	.92	(5.81)	.74	(2.05)	.76	(1.44)
4	1.77	(8.48)	.92	(8.04)	.75	(2.07)	.95	(1.92)
5	1.31	(10.15)	.66	(8.86)	.92	(2.70)	.60	(1.12)
6	0 (2.66)[b]	(12.33)	.93	(8.12)	.99	(4.54)	0 (2.33)[b]	(5.80)
7	1.35	(9.96)	.92	(8.13)	0 (1.84)[b]	(5.50)		
8			0 (1.48)[b]	(9.73)				

[a]The distance zones are the counties of origin ranked in order of increasing distance from the site in question.

[b]Consumer's surplus per trip for origin with highest costs assuming the demand curve continues to the verticle axis.

Table 18. Consumer's surplus per trip by distance zones for several types of recreationists. Corresponding costs (variable expenses) per trip are shown in parentheses. The data are adapted from the studies indicated.

Distance zone[a]	Deer hunters[b] C. S./trip		Boaters[c] C. S./trip		Trout fishermen[d] C. S./trip		General recreationists[e] C. S./trip	
1	$5.10	($14.70)	$ 9.50	($ 4.96)	$1.48	($1.80)	$ .50	($ 4.13)
2	3.30	(9.05)	11.43	(5.99)	1.98	(2.28)	.50	(4.14)
3	6.75	(24.40)	18.91	(9.89)	2.42	(2.91)	.52	(4.37)
4	6.75	(25.60)	17.09	(8.99)	3.82	(4.60)	.68	(5.58)
5	6.44	(28.10)	31.50	(16.50)	0	(5.30)	.74	(6.15)
6	6.36	(29.25)	40.74	(21.29)	4.59	(5.53)	.85	(7.09)
7	5.81	(31.10)	38.76	(19.98)	0	(6.09)	.88	(7.37)
8	6.35	(29.55)	74.77	(40.25)	5.29	(6.39)	1.29	(10.83)
9	0	(40.55)	59.31	(31.02)	6.45	(7.81)		
10	6.18	(30.25)	37.46	(19.81)				
11	5.29	(32.70)	59.69	(30.60)				
12	5.38	(32.58)	71.40	(35.94)				
13	5.11	(33.40)	90.86	(44.66)				
14	1.15	(39.35)	43.14	(22.73)				

[a]Except for the boating study, the distance zones are cities or counties of origin ranked in order of increasing distance from the site in question.

[b]Wennergren (1967, p. 30)

[c]Wennergren (1965, p. 13)

[d]Dyer (1968, p. 35)

[e]Beardsley (1968, p. 46)

gradually over a wide span of use rates. Although consumer's surplus per trip is low for these individuals, they take relatively many trips and, therefore, enjoy more total consumer's surplus than do more distant visitors. That their consumer's surplus is low is logical both because they have visited the site many times thus reducing its novelty for them and because they are generally more familiar with the vicinity of the site than are more distant visitors.

As described on page 54, it has generally been assumed that increased travel time pushes the demand curve to the left reducing both total and net utility. The data in Tables 17 and 18 indicate that this may not be the case. It appears that the uniqueness and excitement (utility) of traveling from a distant place outweigh the disutilities involved and result in higher net utility than would be experienced from a less distant origin.

Wennergren's data for boating and deer hunting (Table 18) show a different pattern, but do not refute the hypothesis that consumer's surplus per trip is a function of travel distance. Instead of consistently increasing with the distance of the origin from the site, consumer's surplus per trip was lowest for origins near the site, increased to a peak for intermediate origins and then decreased for the more distant origins.

Thus, it appears that while utility initially increases with travel distance, a point (distance) is eventually reached where the trip is so long that the uniqueness of the area visited no longer outweighs the travel duress involved in getting there. The fact that only Wennergren's data demonstrated this inflection point is explained by the fact that

the other studies included relatively short observed travel distances (generally less than 250 miles round trip). The distance at which the net utility from travel became negative was never reached. Also, the distance at which this occurs undoubtedly varies with the sites and activities involved. In the case of boating, we would expect the disutility of hauling a boat for a long distance to show up rather quickly. Wennergren's data indicate that this occurs at a distance of about 240 miles (Wennergren, 1965, p. 13).

It is concluded that the behavior of consumer's surplus per trip should be studied further, particularly its relationship to travel time and the conservative bias produced by travel time.

Off-site Benefits

This section consists of a brief analysis of the problem of off-site benefits and some suggested directions for future research.

Waterfowl marshes produce waterfowl which in many cases are enjoyed by hunters, students, scientists, birdwatchers and others who may be located hundreds of miles from the originating marsh. Breeding, resting, and staging areas are needed by all waterfowl, but seldom does one marsh alone fulfill more than one of these needs for a given bird. Thus, there is an interdependence between wetlands with respect to the values generated by waterfowl.

If drought curtails duck production on the Canadian prairie, fall and winter populations at the Bear River Migratory Bird Refuge will be low, regardless of the quality of the habitat. If the Bear River Refuge were drained, the effect would be more than the loss of so many acres of

habitat valuable for hunting, scientific research, and public education and inspiration. Some, but certainly not all, of the thousands of waterfowl that nest there would successfully relocate in other areas without forcing resident nesters into marginal habitat. Migrants that normally rest and stage at Bear River would find other areas. However, the resulting increased population densities at the other areas, while responsible for higher short-run values at those areas, would lead to greater vulnerability to hunting and disease. Food could become a critical factor. As other habitat is eliminated, these effects would be compounded and the waterfowl population would soon, if not immediately, decline proportionally with the loss of habitat. If wetlands (breeding grounds, wintering areas, and migration stop-over points) were systematically eliminated, it seems probable that some of the less adaptable species would be exterminated long before all of their habitat was gone. As habitat gets scarcer, a given marsh, instead of being just another marsh, may well be <u>essential</u> for the survival of one or more species.

Thus, it is clear that the existence of the Bear River Migratory Bird Refuge affects some of the values generated at the Farmington Bay Waterfowl Management Area and vice versa. The problem, however, is sorting out these values. We estimated that hunters at Bear River currently enjoy a consumer's surplus of $7,490 (Table 15). How much of this value is attributable to northern production areas where most of the birds hunted at Bear River are raised? How much is attributable to areas that provided food and rest to these birds and their parents during migration? How much is attributable to wintering areas without which the birds could not survive? Conversely, how much does waterfowl

production and habitat use by migrants at Bear River contribute to values generated at other sites?

There appear to be two possible approaches to the estimation of off-site benefits. One approach would be to measure on-site benefits at all areas where the benefits under consideration are known to occur. In effect, this allows the problem of off-site benefits to be ignored since, if the task were actually undertaken, the sum of the on-site benefits at all sites would include all off-site benefits.

Although such a system might produce an estimate of the recreational value of the total waterfowl resource for waterfowl hunting, it would not accurately indicate the relative importance of the different areas that produced this value. In fact, important production areas, such as those in Alaska where little or no hunting occurs would be credited with little or no value.

A less simplistic but more realistic approach would be to (1) determine through banding or other techniques the breeding and wintering grounds and migratory stopover points of the birds visiting the site in question, (2) estimate the marginal value of waterfowl at off-site locations with regression equations that link recreational value with waterfowl numbers, and (3) multiply the appropriate marginal values by the number of waterfowl going from the site in question to each off-site location. These values plus the values generated at the site itself (on-site values) would then have to be distributed among the habitats utilized by the birds. Probably the most logical scheme would be based on the number of bird-days of use. That is, if in a given year a duck spends .08 years at Bear River, then 8 percent of the value

produced by that duck in that year should be attributed to Bear River. The remaining 92 percent of the value produced must be distributed among the other areas that supported the creature, regardless of where that value was generated.

Note that the above scheme does not attach any special significance to the breeding grounds. Since water conditions in the breeding grounds greatly influence reproductive success and, thus, population levels, it might seem logical to attribute most of the value generated by a bird to its breeding grounds. However, ducks like all other animals must survive every day of their lives, not just their birthday! With migration stopovers or wintering grounds eliminated, waterfowl would be just as extinct as they would be without breeding grounds. Thus, the most logical measure of the recreational value of a given waterfowl marsh is the number of waterfowl days supported by that marsh times a factor that incorporates the sum of the marginal benefits generated by those birds.

It is recommended that future studies address themselves specifically to the problem of off-site benefits. Empirical problems will be very great. However, the ability to estimate economic values for remote areas that currently produce no on-site human benefits may enable the justification of protective measures that will bring ecological benefits which far outweigh the difficulties and expenses of the necessary research.

What the Derived Values Mean to the Wildlife Manager and Layman

The wildlife manager and layman should be warned against even the hope that values such as those derived in this study will provide the means whereby all the values they see in natural areas can be quantified and thereby protected from industrial and other aspects of economic expansion.

As pointed out in the section on Total Values, the values measured in this study represent only a small percentage of the total value generated by the Bear River Migratory Bird Refuge and the Farmington Bay Waterfowl Management Area. Unfortunately, some authors give the impression that total values can be estimated:

> Estimates of the direct value gained by participating recreationists, and of the indirect gains (and losses) that accrue to others as a result of recreationists' spending, yield estimates of the total value of specific recreational facilities (italics added) (Pearse and Bowden, 1969, p. 289).

However, Whaley gives the proper perspective:

> This concept of a single inherent value for each commodity is false, since every good and service has several values. Each has a value in exchange, that being the number of goods that can be obtained by means of giving up or exchanging one unit of the commodity in question. Each good or service also has a unique value for each individual consumer. This is the amount that the individual's psychic welfare is improved through owning or consuming the particular commodity. A good has a third value that equates with its cost of production.
>
> The fallacy is therefore obvious in an assumption that a particular resource has only one unique value and that the researcher has but to gaze into a crystal ball to find this heretofore hidden number. Rather, determining a value for a particular type of recreation . . . is a problem solved by arriving at an index number (expressed in dollars) that approximates one of the above measures of value (Whaley, 1970, p. 562).

Whaley (1970) further explains that the usefulness of such an index depends upon its accuracy and its comparability with the other measures of value used in the allocation model.

If one accepts the fact that the techniques of outdoor recreation economics are relevant (or applicable) to only a small part of the total spectrum of values produced by natural areas and the fact that any value derived for that small part is merely a value rather than the value, then it is logical for him to raise the question as to whether or not such values can provide administrators with a basis for decisions (Weeden, 1969).

It appears that in limited situations estimates of recreational benefits can be helpful; but for basic decisions on the long-term use of resources they are of little or no value. For example, if the basic decision to eliminate either the Bear River Migratory Bird Refuge or the Farmington Bay Waterfowl Management Area had already been made (perhaps because of insufficient water to support both areas) and it were known that the two areas were equally valuable ecologically, estimates of recreational values together with other economic values would be helpful in deciding which area to sacrifice. However, the previous and more basic decision to sacrifice one of the areas in favor of competing water uses would not be made easier by the type of value estimates we are discussing here. This is because recreational values loom so very small and are technically not comparable to the non-measurable values that would have to be considered.

Perhaps Robert B. Weeden says it best:

> . . . measuring wildlife or other renewable resource values in monetary terms is just one of the games we play so that our favorite resource can compete successfully for budget and space. . . .
>
> . . . Preserving nature does not have to be justified on economic grounds. The only excuse for not preserving nature is when real shortages of material resources threaten our survival at some reasonable level of comfort beyond bare existence. . . . It seems to me that the two main challenges to economists today are to examine the myth of perpetual growth in production and consumption, and to begin examining the utility of goods and services to society so that distinctions can be made between the frivolous and the essential.
>
> In summary, there are facets of resource management activity in which knowledge of dollar values is useful. These usually are when a middle-level planner is trying to decide how to allocate land and other resources under his jurisdiction among competing users. When it comes to basic questions about how people will benefit or lose under alternate management programs, or about what people want, economic estimates based on market or simulated market transactions are of scarcely any value at all. (Weeden, 1969, p. 295-296)

The above notwithstanding, it is imperative that efforts to measure the economic value of recreational opportunities be continued. The difficulties of assessing and balancing environmental factors will necessitate that many basic resource-use decisions will continue to be made on the basis of economic criteria. Interest in natural areas in general and wildlife in particular is high, and areas do exist where the native flora and fauna can be managed to attract visitors (hunters, photographers, etc.) such that the area can remain in natural production in perpetuity and produce measurable economic values that will compare favorably with those of potential conflicting interests. In other words, the public is beginning to place sufficient value on natural areas that many can be justified <u>economically</u> without considering the environmental impact of alternative uses.

RECOMMENDATIONS

1. Sensitivity analyses on existing data. Accurate economic data are expensive and time consuming to obtain. Sensitivity analysis reveals the impact of changes in the estimates of selected variables on the estimates produced by the model. Its judicious use will reveal where the time and money available for data collection can best be spent. It is also an excellent way for students to develop insight into the workings of economic models. Using the data of this study, it is recommended that the sensitivity of the following variables and assumptions be studied: travel cost per car-mile, meal cost, boat gas and oil expense, visitation rate, and demand curve cutoff.

2. Travel time as a use determinant. Future studies should be aimed at determining the influence of the travel time variable on demand functions and the related behavior of consumer's surplus per trip.

3. Simultaneous evaluation of alternative uses. Rather than comparing areas (Bear River and Farmington Bay), methods of evaluation (consumer's surplus and monopoly revenue), and types of recreation (hunting and other recreational and educational activities) as was done in this study, future studies should simultaneously derive values for alternative uses of a given marsh.

4. Marginal resource values. It is recommended that future studies attempt to evaluate the marginal value of water received by the Bear River Migratory Bird Refuge using a water condition index that compares water conditions at the refuge with water conditions elsewhere in northern Utah.

5. Off-site benefits. Off-site benefits should be studied by methods that combine information on the wintering grounds and migratory stopover points of the birds visiting the site in question with estimates of the marginal value of waterfowl.

6. Emphasis on high-value sites. Attempts at site evaluation should concentrate on those natural areas where it appears that the measurable economic values will be sufficient, from both national and local points-of-view, to compete successfully with potentially conflicting interests.

SUMMARY

1. During the 1968-69 waterfowl season, hunters at the Bear River Migratory Bird Refuge and the Farmington Bay Waterfowl Management Area were interviewed on sample days to obtain use rate and variable expenditure data suitable for demand curve estimation.

2. Similar use rate and variable expenditure data were collected from non-hunting visitors to the two areas during the year beginning June 15, 1968.

3. Using the demand curves mentioned in 1 (above), the following estimates of consumer's surplus were made:

Bear River: hunting - $4,910; other recreation - $10,500

Farmington Bay: hunting - $6,400; other recreation - $2,580

4. When adjustments for various sources of bias were made, the above estimates were increased, respectively, to the following amounts: $7,260, $18,700, $11,400, and $3,760.

5. Taking into account probable changes in these adjusted estimates of annual consumer's surplus and assuming an interest rate of 8 percent, capitalized values (representing the present worth of the anticipated stream of annual benefits) were calculated to be as follows:

Bear River: hunting - $90,800; other recreation - $775,000

total - $865,800

Farmington Bay: hunting - $143,000; other recreation -

$156,000; total - $299,000

Reducing the interest rate to 3 percent increases the values for hunting by 167 percent (to $242,000 for Bear River and $380,000 for Farmington

Bay) and those for other recreation by 416 percent (to $4,000,000 for Bear River and $804,000 for Farmington Bay). Thus, at 3 percent, total capitalized consumer's surplus estimates for all benefits measured become $4,242,000 for Bear River and $1,184,000 for Farmington Bay.

6. From functions derived from the above-mentioned demand curves, the following estimates of monopoly revenue were made:

Bear River: hunting - $2,040; other recreation - $3,370

Farmington Bay: hunting - $2,270; other recreation - $691

7. When adjustments for various sources of bias were made, the monopoly revenue estimates were increased, respectively, to the following amounts: $3,010, $5,760, $4,020, and $1,010.

8. Taking into account probable changes in these adjusted estimates of annual monopoly revenue and assuming an interest rate of 8 percent, capitalized values were calculated to be as follows:

Bear River: hunting - $37,900; other recreation - $239,000
total - $276,900

Farmington Bay: hunting - $50,300; other recreation - $41,800
total - $92,100

Reducing the interest rate to 3 percent increases the monopoly revenue values for hunting by 167 percent (to $100,000 for Bear River and $134,000 for Farmington Bay) and those for other recreation by 416 percent (to $1,230,000 for Bear River and $216,000 for Farmington Bay). Thus, at 3 percent, total capitalized monopoly revenue estimates for all benefits measured become $1,330,000 for Bear River and $350,000 for Farmington Bay.

9. Efforts to estimate the marginal value of water received by the Bear River Migratory Bird Refuge were unsuccessful. Time series data revealed that the values estimated in this study were inversely related to water conditions at the refuge. Future attempts to estimate marginal water values should use a water condition index that compares water conditions at the refuge with water conditions in northern Utah generally.

10. It is recommended that off-site benefits be studied by methods that combine information on the wintering grounds and migratory stopover points of the birds visiting the site in question with estimates of the marginal value of waterfowl.

11. Economists do not agree as to which is the more appropriate measure of recreation benefits--consumer's surplus or monopoly revenue. The author believes that consumer's surplus estimates are more valuable than monopoly revenue estimates for comparison with other values included in the benefit/cost analysis of water development projects because the needed values include more than a non-discriminating monopolist can extract. A proper choice of value is highly dependent upon the decision-making situation in which the value is to be used.

12. The values estimated in this study constitute only a small percentage of the total value to society of the sites in question. In considering the benefits and costs of such areas, it will never be possible to make additive estimates of all of the relevant values. Allocation decisions must draw on several disciplines (sociology, psychology, ecology) in addition to economics to determine where the balance will swing for the greatest net benefit to society.

13. Although recreational values such as those estimated in this study usually are very small compared to associated non-measurable values, exceptions exist where the native flora and fauna can be managed to attract visitors such that the area can remain in natural production in perpetuity and be competitive with potentially conflicting interests in terms of measurable economic values.

14. It is believed that future research should concentrate on high-value sites and be directed toward sensitivity analysis, the simultaneous evaluation of alternative uses, the influence of the travel-time variable, marginal resource values, and off-site benefits.

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Appendix A

Questionnaire and Interview Schedules

INTERVIEW FORM *** Non-consumptive Refuge Use
Summer 1968 and Spring 1969

Refuge: Bear River, Farmington Bay

Date:

Interviewer:

1. Number in party: _____

2. Means of transportation: car, box, other (specify) _____

3. City of origin: _____

4. Purpose of trip: sightseeing, birdwatching, educational excursion
photography, other (specify) _____

5. Was all travel from origin to refuge primarily for the purpose of visiting the refuge? yes no

6. If no, what percent of the travel can be allocated to the refuge?
____%

7. Expenses incurred in order to visit the refuge:

   a. Restaurant meals $ _____ per person

   b. Lodging $ _____ per person

   c. Entrance fee $ _____ per person

   d. Other (specify)
   _____ $ _____ per person

8. Cost of equipment purchased during the last 12 months and percent allocatable to the refuge:

   a. Binoculars $ _____, ____%

   b. Spotting scope $ _____, ____%

   c. Fishing gear $ _____, ____%

   d. Photographic equipment $ _____, ____%

   e. Other (specify)
   _____ $ _____, ____%

9. Specifically, what is of interest to you at the refuge? ducks, geese, swans, shorebirds, other birds, carp, muskrats, insects, plant succession, other (specify) _____

(Note: As actually used, this entire questionnaire was printed on one side of regular-sized paper.)

Mail Questionnaire
Opening Weekend, 1968-69 Waterfowl Hunt

W A T E R F O W L R E S E A R C H

Waterfowl research is an important part of the maintenance and development of duck hunting opportunities. The information asked for below will be part of a study coordinated by the Utah Cooperative Wildlife Research Unit at Utah State University. Your help is needed. All we ask is that the driver of this car or truck answer the questions below and return this sheet in the postage-paid envelope provided.

Sincerely,

Jess Low, Unit Leader
Holden Brink, Graduate Student

PLEASE CHECK THE APPROPRIATE BOXES AND FILL IN YOUR ANSWERS IN THE SPACES PROVIDED.

1) How many people including yourself came to the refuge in this vehicle today? _____ people.

2) Of the people that came in your vehicle, how many including yourself hunted? _____ hunted. _____ did not hunt.

3) Why did those who did not hunt come to the refuge? _____

_____

4) Where did you drive from today in order to get to the refuge?

_____ (city), _____ (county)

5) Did you stop at a restaurant for something to eat
on the way to the refuge? /7/ Yes /7/ No
on the way back home? /7/ Yes /7/ No

6) In order to hunt at this refuge did you have to stay overnight at a motel? /7/ Yes /7/ No

7) How many hours did you hunt today? _____ hours.

8) ---Optional--- How many ducks, geese and swans did you and your passengers kill today? _____ ducks, _____ geese, _____ swans.

9) Did you or any of your passengers use an airboat today? /7/ Yes /7/ No

10) Did you or any of your passengers use an outboard motorboat today?
/7 Yes /7 No

11) Within the last week (7 days), how much have you and your passengers spent for shotgun shells or shotgun reloading supplies?
$_____ within the last week (7 days).

Thank you for helping.

(Note: As actually used, this entire questionnaire was printed on one side of regular-sized paper.)

Appendix B

Sampling Schedules

Sampling Schedule for Interviews at the Bear River Migratory Bird Refuge
-- Summer 1968 --

June	(15)	Sat.	August	1			16	
	16			Fri. (2)			17	
	17			3			18	
	18			4			19	
	19			5			20	
	20			6			Sat. (21)	
	21			7			22	
1*	22		4*	8		7*	23	
	23			9			24	
	24			10			25	
	25			Sun. (11)			26	
	26			12			Fri. (27)	
	Thurs. (27)			13			28	
	28			14			29	
	29			15			30	
	30			16		October	1	
July	1			17			2	
	2			18			Thurs. (3)	
	3			19			4	
	4			20			5	
	5			21			6	
	Sat. (6)			22			7	
	7		5*	23		8*	8	
2*	8			24			9	
	9			Sun. (25)			10	
	10			Mon. (26)			11	
	11			27				
	12			28				
	13			29				
	14			30				
	Mon. (15)			31				
	16		September	1				
	17			2				
	18			3				
	19			4				
	20			5				
	Sun. (21)			6				
	22			Sat. (7)				
3*	23		6*	8				
	24			Mon. (9)				
	25			10				
	26			11				
	27			12				
	28			13				
	Mon. (29)			14				
	30			15				
	31							

( ) Sample days

* Stratum number. Each month was divided into two strata of 15 or 16 days each.

APPENDIXES

Sampling Schedule for Interviews at the Farmington Bay Waterfowl Management Area, Summer 1968

June	15	August	1		Mon. (16)
	16		2		17
	17		Sat. (3)		18
	18		4		19
	19		5		20
	20		6		21
	Fri. (21)		Wed. (7)		22
1*	Sat. (22)	4*	8	7*	23
	23		9		24
	24		10		25
	25		11		26
	26		12		27
	27		13		28
	28		14		Sun. (29)
	29		15		30
	30		16	October	1
July	1		17		2
	2		18		3
	3		19		4
	4		20		Sat. (5)
	5		Wed. (21)		6
	6		22		7
	7	5*	23	8*	8
2*	8		Sat. (24)		9
	9		25		10
	10		26		11
	11		27		
	Fri. (12)		28		
	13		29		
	Sun. (14)		30		
	15		31		
	16	September	(1) Sun.		
	Wed. (17)		2		
	18		3		
	19		4		
	20		5		
	21		Fri. (6)		
	22		7		
3*	23	6*	8		
	24		9		
	25		10		
	26		11		
	27		12		
	Sun. (28)		13		
	29		14		
	30		15		
	31				

( ) Sample days

* Stratum number. Each month was divided into two strata of 15 or 16 days each.

Sampling Schedule for Interviews at the Bear River Migratory Bird Refuge
-- 1968-69 Waterfowl Hunting Season --

October	12*		24
	13*		25
	14		26
	15		27
	16		28*
	17		Fri. (29)
	18		30
	19	December	1
	20		2
	21		Tues. (3)
	22		4
	23		5
	Thurs. (24)		6
	25		Sat. (7)
	Sat. (26)		8
	27		9
	28		10
	29		11
	Wed. (30)		12
	31		13
November	1		14
	2		15
	Sun. (3)		Mon. (16)
	4		17
	5		Wed. (18)
	6		Thurs. (19)
	7		20
	Fri. (8)		21
	9		22
	10		23
	11		24
	12		25*
	13		26
	14		27
	15		28
	16		29
	Sun. (17)		Mon. (30)
	18		Tues. (31)
	19	January	1*
	20		2
	21		3
	22		4*
	23		5*

( ) Sample days
* Special days (arbitrarily included in sample)

Sampling Schedule for Interviews at the Farmington Bay Waterfowl Management Area, 1968-69 Waterfowl Hunting Season

October	12*
	13*
	14
	15
	16
	Thurs. (17)
	18
	19
	20
	21
	22
	23
	24
	25
	26
	Sun. (27)
	Mon. (28)
	29
	30
	31
November	1
	2
	3
	4
	5
	Wed. (6)
	7
	8
	9
	10
	11
	12
	13
	14
	Fri. (15)
	16
	17
	18
	19
	20
	21
	22
	Sat. (23)
	24
	25
	26
	27
	28*
	29
	30
December	Sun. (1)
	2
	3
	4
	5
	6
	7
	8
	9
	10
	11
	12
	Fri. (13)
	14
	15
	16
	Tues. (17)
	Wed. (18)
	Thurs. (19)
	20
	21
	22
	23
	24
	25*
	26
	27
	Sat. (28)
	29
	Mon. (30)
	Tues. (31)
January	1*
	2
	3
	4*
	5*

( ) Sample days
* Special days (arbitrarily included in sample)

Sampling Schedule for Interviews at the Bear River Migratory Bird Refuge
-- Spring 1969 --

March	24			8	
	25			9	
Wed.	(26)			10	
	27			11	
	28			12	
	29			13	
1*	30		4*	14	
	31			15	
April	1			16	
	2			17	
	3		Sun.	(18)	
	4			19	
Sat.	(5)**			20	
	6		Wed.	(21)	
	7			22	
	8			23	
	9			24	
	10			25	
	11			26	
	12			27	
	13			28	
2*	14		5*	29	
Tues.	(15)			30	
	16			31	
	17		June	(1)	Sun.
	18			2	
Sat.	(19)			3	
	20			4	
	21		Thurs.	(5)	
	22			6	
	23			7	
	24			8	
Fri.	(25)			9	
	26			10	
	27		Wed.	(11)	
	28			12	
3*	29		6*	13	
	30		Sat.	(14)	
May	1				
	2				
	3				
Sun.	(4)				
	5				
	6				
	7				

( ) Sample days

* Stratum number. Each month was divided into two strata of 15 or 16 days each.

** Because of administrative difficulties, interviews were actually conducted on Saturday, April 12, instead of April 5.

Appendix C

Economic Models Used in This Study

Economic Models Used in This Study

The two economic models utilized in this study (consumer's surplus and monopoly revenue) are described in the literature (Beardsley, 1968; Wennergren, 1967; Dyer, 1968). The purpose of this Appendix is to briefly outline the underlying theory and assumptions of the models and to illustrate in more detail than is practical in the METHODS section how they can be applied to an evaluation problem.

Consumer's surplus

Hotelling is credited with the first suggestion to utilize consumer's surplus in recreation evaluation:

> Let concentric zones be defined around each park so that the cost of travel to the park from all points in one of these zones is approximately constant. The persons entering the park in a year, or a suitably chosen sample of them, are to be listed according to the zone from which they come. The fact that they come means that the service of the park is at least worth the cost, and this cost can probably be estimated with fair accuracy. If we assume that the benefits are the same no matter what the distance, we have, for those living near the park, a consumer's surplus consisting of the differences in transportation costs. The comparison of the cost of coming from a zone with the number of people who do come from it, together with a count of the population of the zone, enables us to plot one point for each zone on a demand curve for the service of the park. By a judicious process of fitting it should be possible to get a good enough approximation to this demand curve to provide, through integration, a measure of the consumer's surplus resulting from the availability of the park. It is this consumer's surplus (calculated by the above process with deduction for the cost of operating the park) which measures the benefits to the public in the particular year. This, of course, might be capitalized to give a capital value for the park. . . . (Hotelling, 1949, n. p.)

Instead of the concentric ring origins suggested by Hotelling, county origins were used in this study to take advantage of available demographic information. For each of seven or eight counties of origin,

use rates and travel and on-site costs were determined and plotted to form a demand curve as schematically represented in Figure 10.

This methodology requires several assumptions: (1) the populations are homogeneous among origins with respect to income and tastes and preferences; (2) the marginal utility of money remains constant; (3) additional units of the commodity encounter diminishing marginal utility at some point, not only for an individual, but also within the population. (That is, not only will individuals tend to receive less utility from each additional visit, but also we can expect that persons from a given origin can be ranked according to decreasing utility from one visit. This extension of the assumption is necessary because many visitors to recreation areas come only once a year.); (4) given his income and other resources, the visitor attempts to maximize his total utility; (5) the visitor has perfect knowledge regarding the costs of each visit and the utility to be derived therefrom; (6) units of cost and utility are such that net utility can be determined; and (7) the utility obtained from a visit is the reason for making that visit. (See Wennergren, 1964, p. 305.)

The accuracy of a consumer's surplus estimate depends largely, of course, on the reality of these assumptions. In the opinion of the writer, assumptions 3, 6, and 7 are axiomatic. Conversely, it is self-evident that the other four assumptions are not 100 percent valid. Take assumption 5, for example. Hunters do not know exactly how much they will enjoy a given hunt. If their boat tips over or if they are injured on a day the birds aren't flying, a trip may produce negative utility in addition to the incurred costs. However, most hunters are sufficiently

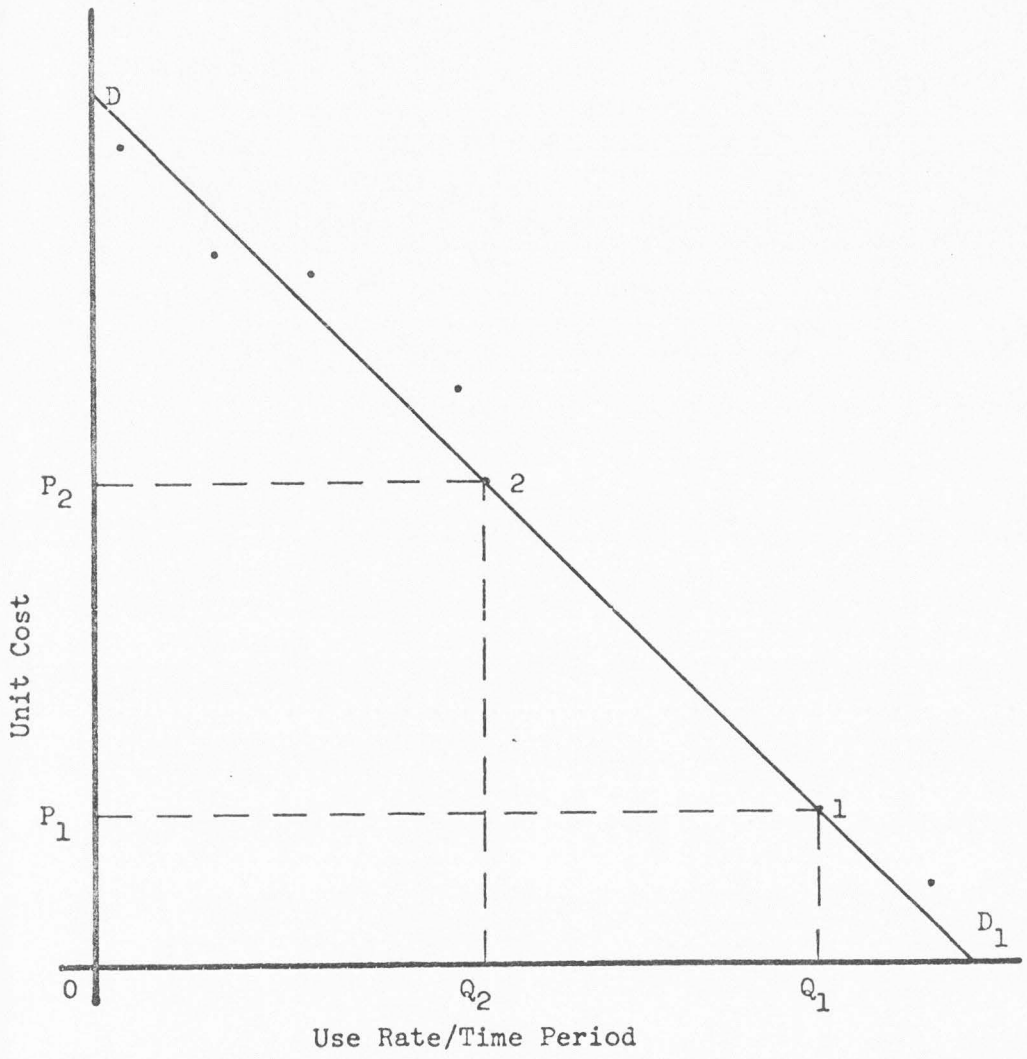

Figure 10. Hypothetical demand curve illustrating the principle of consumer's surplus.

aware of the costs and returns of a given hunt to make a rational allocation decision regarding it. It is believed that all these assumptions approximate reality sufficiently closely so as to not destroy the validity of the model.

The rational for consumer's surplus evaluation can be further explained by reference to Figure 10.[9] The inhabitants of county 1 are observed to visit the site at a rate of Q_1 visits per year per 1,000 population and to pay in the form of travel and on-site costs and average price of P_1. For their purchase of all visits previous to the Q_1th visit, for example the Q_2th, they also incur an average cost of P_1, but would have willingly paid as much as P_2 (as do visitors from origin 2) which represents the ranked gross utility of the Q_2th unit purchased. The excess utility (consumer's surplus) received by the individual purchasing the Q_2th visit is:

$$OP_2 - OP_1 = P_1P_2$$

As additional ranked purchases are made, Q_2 approaches Q_1, and the surplus utility diminishes (P_2 approaches P_1) until at the margin (the Q_1th visit) the surplus utility is zero.

Thus, for each 1,000 inhabitants of origin 1, total consumer's surplus equals the area under the demand curve and above the price line or P_1D1. Mathematically, total consumer's surplus for origin 1 equals

---

[9]Note that this paragraph and the next follow closely the discussion of Beardsley (1968, p. 21-23), except that he focuses on an individual visitor while here the focus is on the population of a particular origin.

the integral of the demand function from D to P_1 times the population of origin 1 in thousands.

Monopoly revenue

The monopoly revenue method has been applied by Clawson (1959), Brown (1964), Beardsley (1968), and others. It is based upon the same demand curve as the consumer's surplus method (Figure 10).

Clawson (1959) calls the curve in Figure 10 the demand curve for the experience as a whole. It represents the number of travel experiences (trips) recreationists will "buy" at various costs. Anticipation, preparation, travel, on-site experiences, and memories are all part of the "trip" and are weighed against anticipated costs.

A demand curve for the on-site experience can be derived from one for the experience as a whole. This is accomplished by calculating the expected visitation rate for each of several hypothetical entrance fees. For example, in Figure 10, if visitors from origin 1 were charged a fee equal to P_1P_2, they would purchase Q_2 units as do visitors from origin 2.

> Similarly, the reaction of visitors at all (origins) to the fee increase may be determined. Total number of use-units sold at this entrance fee is plotted as one point. . . . In like manner, additional fee increases are postulated, and the results plotted." (Beardsley, 1968, p. 24)

Figure 11 shows a hypothetical derived demand curve for the on-site experience. At any point along this curve total revenue equals price times quantity. The revenue maximizing point can be determined mathematically by maximizing the total revenue function (see METHODS). Maximum gross revenue is the highest gross return a non-discriminating

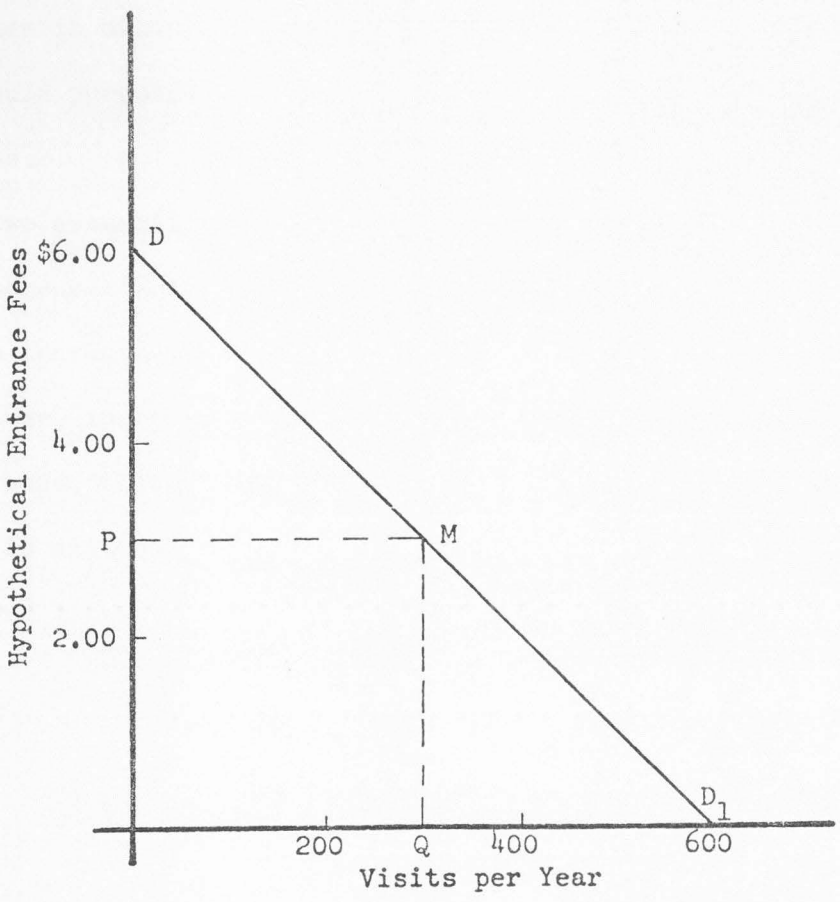

Figure 11. Hypothetical derived demand curve for the on-site experience.

monopolist could realize if the recreational opportunity in question were actually placed on the market.

In addition to the assumptions required by the consumer's surplus method, the monopoly revenue technique requires that: (1) visitors to the site would react to a fee increase in the same way they would react to an increase in other costs of use; and (2) users from different locations would purchase the same amount of recreation, if their costs were the same.

These two assumptions are more difficult to accept than those listed for consumer's surplus. Visitors probably react more to an entrance fee increase than they would to an increase in normal transfer costs. However, in cases where there will be no attempt to capture monopoly revenue, this assumption is not critical. Assumption 2, on the other hand, is critical. It is discussed at length in the section on Bias.

Appendix D

Tables Showing the Details of Use Estimation

Table 19. Estimating hunter use at the Bear River Migratory Bird Refuge, 1968-69 waterfowl season

County of hunter origin	Number of hunter groups contacted	Hunters per group	Number of trips on days sampled[a]	Trips per season[b]
Box Elder				
Opening weekend	19	2.47	47	125.17
Remainder of season	48	2.52	121	717.59
Subtotal[c]	67			848.58
Cache				
Opening weekend	7	2.71	19	50.60
Remainder of season	19	2.16	41	243.15
Subtotal[c]	26			295.78
Davis				
Opening weekend	9	2.56	23	61.25
Remainder of season	8	2.38	19	112.68
Subtotal[c]	17			175.13
Salt Lake				
Opening weekend	81	2.59	210	559.25
Remainder of season	84	2.42	203	1203.89
Subtotal[c]	165			1763.14
Tooele				
Opening weekend	5	3.60	18	47.94
Remainder of season	5	3.00	15	88.96
Subtotal[c]	10			137.84
Utah				
Opening weekend	2	2.00	4	10.65
Remainder of season	2	1.50	3	17.79
Subtotal[c]	4			28.64
Weber				
Opening weekend	46	2.67	123	327.56
Remainder of season	60	2.37	142	842.13
Subtotal[c]	106			1177.76
Total	395			4426.87

[a] A trip is a visit to the refuge by any one hunter for any part or all of any given day. Except on the opening weekend, essentially all hunters visiting the refuge on a given sample day were interviewed.

Table 19. Continued

[b]Expension factors for the opening weekend and the remainder of the season are 2.6631 and 5.9305, respectively.

[c]The sum of the trips taken on the opening weekend and the remainder of the season has been increased by a ratio of .0069 to allow for certain days which were excluded from the sample. See page 12.

Table 20. Estimating hunter use at the Farmington Bay Waterfowl Management Area, 1968-69 waterfowl season

County of hunter origin	Number of hunter groups contacted	Hunters per group	Number of trips on days sampled[a]	Trips per season[b]
Box Elder				
Opening weekend	1	3.00	3	10.30
Special days[c]	0	0	0	0
Remainder of season	0	0	0	0
Subtotal	1			10.30
Cache				
Opening weekend	0	0	0	0
Special days[c]	1	1.00	1	1.08
Remainder of season	0	0	0	0
Subtotal	1			1.08
Davis				
Opening weekend	78	2.23	174	597.64
Special days[c]	57	1.88	107	115.77
Remainder of season	188	1.69	318	1,830.28
Subtotal	323			2,543.69
Salt Lake				
Opening weekend	335	2.36	791	2,716.85
Special days[c]	163	1.98	323	349.49
Remainder of season	487	1.73	844	4,857.73
Subtotal	985			7,924.07
Tooele				
Opening weekend	3	2.67	8	27.48
Special days[c]	0	0	0	0
Remainder of season	6	1.83	11	63.31
Subtotal	9			90.79
Utah				
Opening weekend	5	2.80	14	48.09
Special days[c]	1	1.00	1	1.08
Remainder of season	2	2.00	4	23.02
Subtotal	8			72.19

Table 20. Continued

County of hunter origin	Number of hunter groups contacted	Hunters per group	Number of trips on days sampled[a]	Trips per season[b]
Wasatch				
Opening weekend	0	0	0	0
Special days[c]	0	0	0	0
Remainder of season	3	2.33	7	40.29
Subtotal	3			40.29
Weber				
Opening weekend	8	2.38	19	65.26
Special days[c]	4	2.25	9	9.74
Remainder of season	7	1.86	13	74.82
Subtotal	19			149.82
Total	1349			10,832.23

[a]A trip is a visit to the hunting area by any one hunter for any part or all of any given day. Except on the opening weekend, essentially all hunters visiting the refuge on a given sample day were interviewed.

[b]Expansion factors for the opening weekend, special days, and the remainder of the season are 3.4347, 1.082, and 5.7556, respectively.

[c]See page 12.

Table 21. Estimating educational and recreational use (except hunting) at the Bear River Migratory Bird Refuge, June 15, 1968, to June 14, 1969

County of visitor origin	Number of visitor groups contacted	Visitors per group (excluding buses)	Number of trips on days sampled[a]	Trips per season[b]
Box Elder				
Summer (6/15-10/11)				
Weekdays	28	3.64	102	1,084.26
Weekends	48	4.17	200	1,069.20
Hunting season (10/12-1/5)				
Opening weekend	7	1.86[c]	13	34.82[d]
Remainder of season	37	2.89[c]	107	638.89[d]
Spring (3/24-6/14)[e]				
Weekdays	7	2.57	18	180.00
Weekends	46	2.07	95	746.85
Subtotal	173			3,754.02
Cache				
Summer				
Weekdays	6 (incl. 1 bus)	3.60	56	595.28
Weekends	18	3.94	71	345.06
Hunting season				
Opening weekend	5	3.20[c]	16	42.85[d]
Remainder of season	4	1.25[c]	5	28.85[d]
Spring				
Weekdays	1	6.00	6	60.00
Weekends	15	3.74	52	199.16
Subtotal	49			1,271.20

Table 21. Continued

County of visitor origin	Number of visitor groups contacted	Visitors per group (excluding buses)	Number of trips on days sampled[a]	Trips per season[b]
Davis				
Summer				
Weekdays	20	3.05	61	648.43
Weekends	28	4.00	112	544.32
Hunting season				
Opening weekend	2	4.00[c]	8	21.43[d]
Remainder of season	8	4.50[c]	36	214.95[d]
Spring				
Weekdays	2	1.50	3	30.00
Weekends	13	5.00	65	248.95
Subtotal	73			1,708.08
Salt Lake				
Summer				
Weekdays	24 (incl. 2 buses)	2.04	49	520.87
Weekends	46	4.00	184	894.24
Hunting season				
Opening weekend	17	1.53[c]	26	69.74[d]
Remainder of season	16	2.38[c]	38	225.34[d]
Spring				
Weekdays	34 (incl. 2 buses)	3.16	205	2,050.00
Weekends	91	3.96	360	1,378.80
Subtotal	228			5,138.99

Table 21. Continued

County of visitor origin	Number of visitor groups contacted	Visitors per group (excluding buses)	Number of trips on days sampled[a]	Trips per season[b]
Tooele				
Summer				
Weekdays	0	0	0	0
Weekends	1	2.00	2	9.72
Hunting season				
Opening weekend	2	1.50[c]	3	8.04[d]
Remainder of season	2	1.50[c]	3	17.91[d]
Spring				
Weekdays	0	0	0	0
Weekends	0	0	0	0
Subtotal	5			35.67
Utah				
Summer				
Weekdays	0	0	0	0
Weekends	2	4.00	8	38.88
Hunting season				
Opening weekend	0	0	0	0
Remainder of season	0	0	0	0
Spring				
Weekdays	0	0	0	0
Weekends	0	0	0	0
Subtotal	2			38.88

Table 21. Continued

County of visitor origin	Number of visitor groups contacted	Visitors per group (excluding buses)	Number of trips on days sampled[a]	Trips per season[b]
Weber				
Summer				
Weekdays	18	4.72	85	903.55
Weekends	64	3.94	252	1,224.72
Hunting season				
Opening weekend	10	2.30[c]	23	61.60
Remainder of season	26	2.88[c]	75	447.82
Spring				
Weekdays	13 (incl. 3 buses)	3.20	140	1,400.00
Weekends	44	4.27	188	720.04
Subtotal	175			4,757.73
Total	705			16,704.57

[a]A trip is a visit to the refuge by any one visitor for any part or all of any given day. Except on the opening weekend, essentially all hunters visiting the refuge on a given sample day were interviewed.

[b]Expansion factors were as follows: summer weekdays, 10.63; summer weekends, 4.86; opening weekend of hunting season, 2.66; remainder of season, 5.93; spring weekdays, 10.00; spring weekends, 3.83.

[c]Excluding hunters

[d]Increased as explained in footnote c of Table 19.

[e]The refuge was closed until March 24.

Table 22. Estimating educational and recreational use (except hunting) at the Farmington Bay Waterfowl Management Area, June 15, 1968, to June 14, 1969

County of visitor origin	Number of visitor groups contacted	Visitors per group (excluding buses)	Number of trips on days sampled[a]	Trips per season[b]
Cache				
Summer (6/15-10/11)				
Weekdays	0	0	0	0
Weekends	0	0	0	0
Hunting season (10/12-1/5)				
Opening weekend	0	0	0	0
Special days[c]	1	1.00[d]	1	1.08
Remainder of season	0	0	0	0
Spring (3/19-6/14)[e]				
Weekdays and weekends	0	0	0	0
Subtotal	1			1.08
Davis				
Summer				
Weekdays	23	3.26	75	910.50
Weekends	104	3.05	317	1,372.61
Hunting season				
Opening weekend	32	2.06[d]	66	226.38
Special days	26	2.23[d]	58	62.64
Remainder of season	113	2.28[d]	258	1,486.08
Spring				
Weekdays and weekends	15 (incl. 6 buses)	7.33	348	348.00
Subtotal	313			4,406.21

Table 22. Continued

County of visitor origin	Number of visitor groups contacted	Visitors per group (excluding buses)	Number of trips on days sampled[a]	Trips per season[b]
Salt Lake				
Summer				
Weekdays	12 (incl. 1 bus)	2.91	50	607.00
Weekends	98	3.11	305	1,320.65
Hunting season				
Opening weekend	132	1.69[d]	223	764.89
Special days	26	2.27[d]	59	63.72
Remainder of season	161	1.68[d]	270	1,555.20
Spring				
Weekdays and weekends	67 (incl. 25 buses)	4.55	1509	1,509.00
Subtotal	496			5,820.46
Tooele				
Summer				
Weekdays	0	0	0	0
Weekends	0	0	0	0
Hunting season				
Opening weekend	0	0	0	0
Special days	0	0	0	0
Regular days	1	1.00[d]	1	5.76
Spring				
Weekdays and weekends	0	0	0	0
Subtotal	1			5.76

Table 22. Continued

County of visitor origin	Number of visitor groups contacted	Visitors per group (excluding buses)	Number of trips on days sampled[a]	Trips per season[b]
Utah				
Summer				
Weekdays	0	0	0	0
Weekends	0	0	0	0
Hunting season				
Opening weekend	0	0	0	0
Special days	0	0	0	0
Remainder of season	0	0	0	0
Spring				
Weekdays and weekends	4 (incl. 4 buses)	--	193	193.00
Subtotal	4			193.00
Weber				
Summer				
Weekdays	4	5.25	21	254.94
Weekends	4	2.00	8	34.64
Hunting season				
Opening weekend	3	1.33[d]	4	13.72
Special days	2	1.50[d]	3	3.24
Remainder of season	5	1.60[d]	8	46.08
Spring				
Weekdays and weekends	0	0	0	0
Subtotal	18			352.62
Total	833			10,779.13

Table 22. Continued

[a]A trip is a visit to the area by any one visitor for any part or all of any given day. Except on the opening weekend, essentially all hunters visiting the refuge on a given sample day were interviewed.

[b]Expansion factors were as follows: summer weekdays, 12.14; summer weekends, 4.33; opening weekend of hunting season, 3.43; special days, 1.08; remainder of season, 5.76; spring weekdays and weekends, 1.00.

[c]See page 12.

[d]Excluding hunters.

[e]Visitor use was nil from end of hunting season to March 19.

Appendix E

Tables Showing the Details of the Consumer's Surplus Calculations

Table 23. Estimating the consumer's surplus of waterfowl hunters at the Bear River Migratory Bird Refuge, 1968-69 season

(1) County of hunter origin	(2) Trips per 1000 population[a]	(3) Variable expense per trip[b]	(4) Total benefit per 1000 population[c]	(5) Total cost per 1000 population[d]	(6) Consumer's surplus per 1000 population[e]	(7) County population[f]	(8) Total consumer's surplus[g]
Box Elder	35.57	$ 5.94	$255.31	$211.29	$44.02	27,200	$1,197.34
Cache	7.83	7.77	72.42	60.84	11.58	43,000	497.94
Weber	6.83	7.96	64.56	54.37	10.19	131,000	1,334.89
Davis	4.78	8.48	48.51	40.53	8.16	95,000	775.20
Tooele	1.93	9.96	21.83	19.22	2.61	23,400	61.07
Salt Lake	1.73	10.15	19.82	17.56	2.26	462,000	1,044.12
Utah	.58	12.33	7.15	7.15	0	127,000	0
Total							$4,910.56

[a] From regression curve (Figure 3).

[b] Observed (See Table 5).

[c] Total benefits = $\int_0^{q_i} f(Q)\,dQ - \int_0^{.58} f(Q)\,dQ + (.58 \times 12.33)$.

[d] Column (3) times column (2).

[e] Column (4) minus column (5).

[f] From Table 1.

[g] Column (6) times column (7) in thousands.

Table 24. Estimating the consumer's surplus of waterfowl hunters at the Farmington Bay Waterfowl Management Area, 1968-69 season

(1) County of hunter origin	(2) Trips per 1000 population[a]	(3) Variable expense per trip[b]	(4) Total benefit per 1000 population[c]	(5) Total cost per 1000 population[d]	(6) Consumer's surplus per 1000 population[e]	(7) County population[f]	(8) Total consumer's surplus[g]
Davis	26.12	$4.95	$150.41	$129.29	$21.12	95,000	$2,006.40
Weber	8.48	5.81	57.11	49.27	7.84	131,000	1,027.04
Salt Lake	7.53	5.91	51.52	44.50	7.02	462,000	3,243.24
Wasatch	.87	8.04	7.79	6.99	.80	5,700	4.56
Utah	.809	8.12	7.32	6.57	.75	127,000	95.25
Tooele	.802	8.13	7.26	6.52	.74	23,400	17.32
Box Elder	.44	8.86	4.19	3.90	.29	27,200	7.89
Cache	.23	9.73	2.24	2.24	0	43,000	0
Total							$6,401.70

[a] From regression curve (Figure 3).

[b] Observed (See Table 6).

[c] Total benefits = $\int_0^{qi} f(Q)\,dQ - \int_0^{.23} f(Q)\,dQ + (.23 \times 9.73)$.

[d] Column (3) times column (2).

[e] Column (4) minus column (5).

[f] From Table 2.

[g] Column (6) times column (7) in thousands.

Table 25. Estimating the consumer's surplus of educational and recreational users (except hunters) at the Bear River Migratory Bird Refuge, June 15, 1968, to June 14, 1969

(1) County of hunter origin	(2) Trips per 1000 population[a]	(3) Variable expense per trip[b]	(4) Total benefit per 1000 population[c]	(5) Total cost per 1000 population[d]	(6) Consumer's surplus per 1000 population[e]	(7) County population[f]	(8) Total consumer's surplus[g]
Box Elder	210.6	$1.05	$306.15	$221.13	$85.02	27,200	$ 2,312.54
Weber	37.7	1.70	87.97	64.09	23.88	131,000	3,128.28
Cache	19.3	2.05	53.92	39.57	14.35	43,000	617.05
Davis	18.7	2.07	52.69	38.71	13.98	95,000	1,328.10
Salt Lake	7.2	2.70	26.06	19.44	6.62	462,000	3,058.44
Tooele	1.1	4.54	6.08	4.99	1.09	23,400	25.51
Utah	.57	5.50	3.14	3.14	0	127,000	0
Total							$10,469.92

[a] From regression curve (Figure 3).

[b] Observed (See Table 7).

[c] $$\text{Total benefits} = \int_0^{q_i} f(Q)\,dQ - \int_0^{.57} f(Q)\,dQ + (.57 \times 5.50).$$

[d] Column (3) times column (2).

[e] Column (4) minus column (5).

[f] From Table 3.

[g] Column (6) times column (7) in thousands.

Table 26. Estimating the consumer's surplus of educational and recreational users (except hunters) at the Farmington Bay Waterfowl Management Area, June 15, 1968, to June 14, 1969

(1) County of hunter origin	(2) Trips per 1000 population[a]	(3) Variable expense per trip[b]	(4) Total benefit per 1000 population[c]	(5) Total cost per 1000 population[d]	(6) Consumer's surplus per 1000 population[e]	(7) County population[f]	(8) Total consumer's surplus
Davis	64.00	$ .35	$34.95	$22.40	$12.55	95,000	$1,192.25
Salt Lake	4.65	.90	6.47	4.19	2.28	462,000	1,053.63
Utah	2.53	1.12	4.36	2.83	1.53	127,000	194.31
Weber	1.26	1.44	2.77	1.81	.96	131,000	125.76
Tooele	.57	1.92	1.63	1.09	.54	23,400	12.64
Cache	.03	5.80	.17	.17	0	43,000	0
Total							$2,578.59

[a] From regression curve (Figure 3).

[b] Observed (See Table 8).

[c] Total benefits = $\int_0^{q_i} f(Q)\,dQ - \int_0^{.03} f(Q)\,dQ + (.03 \times 5.80)$.

[d] Column (3) times column (2).

[e] Column (4) minus column (5).

[f] From Table 4.

[g] Column (6) times column (7) in thousands.

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