JOURNAL OF THE

Northeastern
Agricultural
Economics
Council
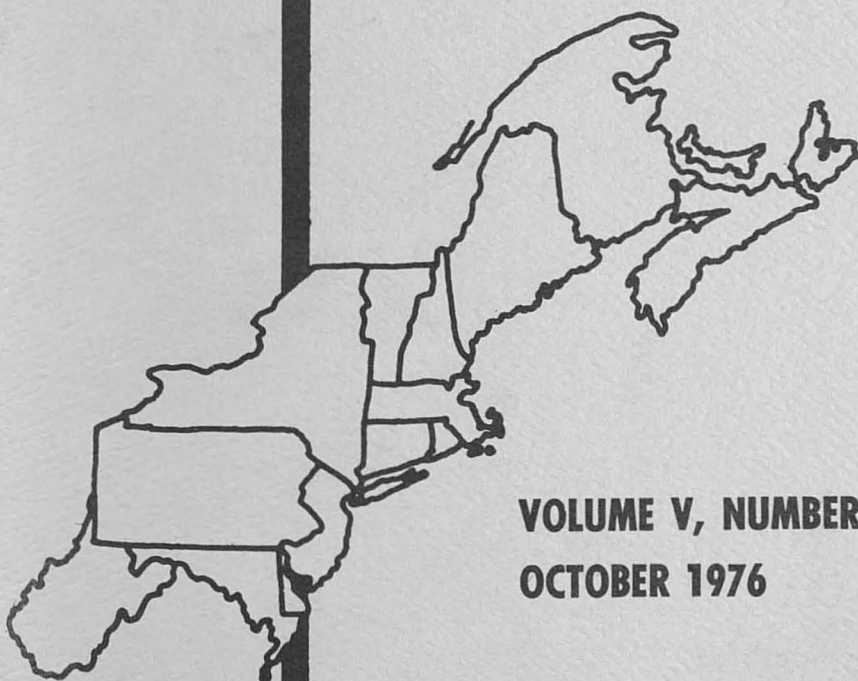
VOLUME V, NUMBER 2

OCTOBER 1976

VALUATION OF A RECREATIONAL ACTIVITY:
CLAMMING IN MASSACHUSETTS†

Richard W. Smith, Jon M. Conrad, and David A. Storey
Graduate Research Assistant, Assistant Professor
and Professor of Resource Economics, respectively
Department of Food and Resource Economics
University of Massachusetts, Amherst

I. Introduction

Economists have long wrestled with the problem of determining the value of nonmarket recreational activities. Knowing the value of a recreational activity could be helpful in at least three respects: (1) if the recreational activity is publicly provided, knowing the value which society places on that nonmarket activity would help in determining the appropriate level of public investment, (2) if a user charge for access to the recreational activity were necessary, a knowledge of the distribution of individual valuations would permit estimates of use (demand under alternative fees) and (3) to the extent that the resources involved in the recreational activity have other uses, knowledge of recreational values would help in determining the appropriate allocation of resources between the recreational activity and the other uses. Often the non-recreational activities already have dollar values established in markets; if the other uses are also nonmarket in nature, imputations of their dollar values would also be necessary.

In the first situation, recreational values might enter into some sort of benefit/cost analysis of public investment in the recreational activity. In the second case, user charges for support of the activity or to discourage congestion would be based on a knowledge of the distribution of user valuation. These two are often reasons for inquiring into the value of a recreational activity. The third reason, determining the appropriate allocation of the resource between recreational and other uses, may for instance be encountered when the activity involves both commercial and recreational harvesting of a common property resource, say a species

of fish or shellfish. Within this situation there may well be reason to implement a system of charges to encourage efficient use of the common property resource, but there is often the additional need to determine the allocation between recreational and commercial users. (In this regard see Crutchfield and Pontecorvo [1969].)

A survey of the literature reveals essentially five methods which have been employed to estimate recreational values: (1) the gross expenditure method, (2) the market value method, (3) the "willingness-to-pay" interview method, (4) the travel cost method and (5) estimation of a vonNeumann-Morganstern utility function for individual recreationists.

The gross expenditure method has as its premise that a minimum estimate of the value of an activity to a recreationist is the amount of money he expends in engaging in that activity (see Crutchfield [1962]). The market value method attempts to identify a comparable recreational activity provided through a private market and relates the value of the public recreational activity to expenditures made on comparable private activities. The willingness-to-pay interview asks the recreationist to state the maximum amount he would be willing to pay to engage in the recreational activity. His response would reveal the amount of consumer's surplus associated with the recreational activity (for which he may or may not have paid a user charge) (See Brown and Hammack [1974]).

The travel cost method estimates the cost incurred by a recreationist based on the distance traveled from residence to recreation site plus any admission fee. Concentric zones are constructed around the recreation site with more distant zones representing higher travel costs and, ceteris paribus, lower participation rates for more distant populations. Assuming residents in all zones have similar preferences for the recreational activity, an increase in the admission price at the recreational site would be tantamount to moving the site further away for all zones, thus lowering the participation rate in each zone.

The utility analysis attempts to determine a utility function for an individual recreationist. The method involves confronting an expected utility maximizing recreationist with two prospects. The first prospect is a gamble between no days at the recreation site in question and one day at an inferior recreational site. Both outcomes are stated as being equally likely. The second prospect is between n_1 days at the site in question and no days at a preferred recreational site. These outcomes are also stated as being equally likely. The interviewer then seeks the value of n_1 (days at the site in question) which leaves the recreationist indifferent between the two prospects. Given the value for n_1, a second game can be constructed where the first prospect now contains the outcomes n_1 days at the site in question and one day at the inferior site, and the second prospect contains the outcomes of n_2 days at the site in question and no days at a preferred site. Outcomes in both prospects are again assumed to be equally likely. The interviewer now attempts to

discover the value of n_2 for which the recreationist is indifferent be-
tween revised prospects one and two. Subsequent games could be con-
structed, and by selecting an arbitrary index for the utility of a day's
recreation at the inferior recreational site, indices could be constructed
for successively longer stays at the site in question. A discussion and
application of this approach may be found in Sinden [1974].

The approach used for evaluating the value of recreational clamming
in Massachusetts is similar to methods within the willingness-to-pay
interview method. Estimates of willingness-to-pay relate to the concept
of compensating surplus from the theory of the consumer. This concept
along with the equivalent surplus will be discussed in the next section of
this paper. The third section presents the results of a survey of recre-
ational clammers in three coastal Massachusetts towns and derives com-
pensated demand curves for the right to clam. An estimate of consumer
surplus is presented along with an estimate for value of the resource in
a recreational use. The final section presents implications and limitations
of the recreational analysis for management of the resource and directions
for future research.

II. The Value of a Recreational Permit

It is assumed that the typical recreationist is a member of the
family "homo economicus" and as such is a utility maximizer. In particular,
it is assumed that he possesses a preference ordering between income (Y)
and the right to engage in some recreational activity (R) and that his
preferences may be represented by a utility function

(1) $U = U(Y,R)$

where R takes on the value one or zero depending on whether the recreationist
has acquired or is without the right to engage in the activity.

In addition we assume that the recreationist is endowed with some
level of income (exogenously determined) and faces a permit price which
requires him to surrender a fraction of that income to acquire the recre-
ation right. Graphically the situation is portrayed in Figure 1.

An individual with initial income Y_o and faced with an extremely
high permit price of P_o would not purchase a permit (R=0). However, at
a lower price $P_1 < P_o$ he would purchase a permit and move from Y_o to point
B where his income has been reduced by AB but he has acquired the full
recreation right (R=1). In such a transaction the individual will have
realized a "surplus," because he would have been willing to surrender up
to AD rather than do without the permit. A permit price of AD would have
left him indifferent between his initial position Y_o and paying AD to
acquire the permit. Hence a surplus of BD is retained by the recreationist,
thus permitting him to attain indifference curve U_1 at point B.

Figure 1
Utility Analysis of a Recreational Right:
The Case of Zero Income Elasticity of Demand
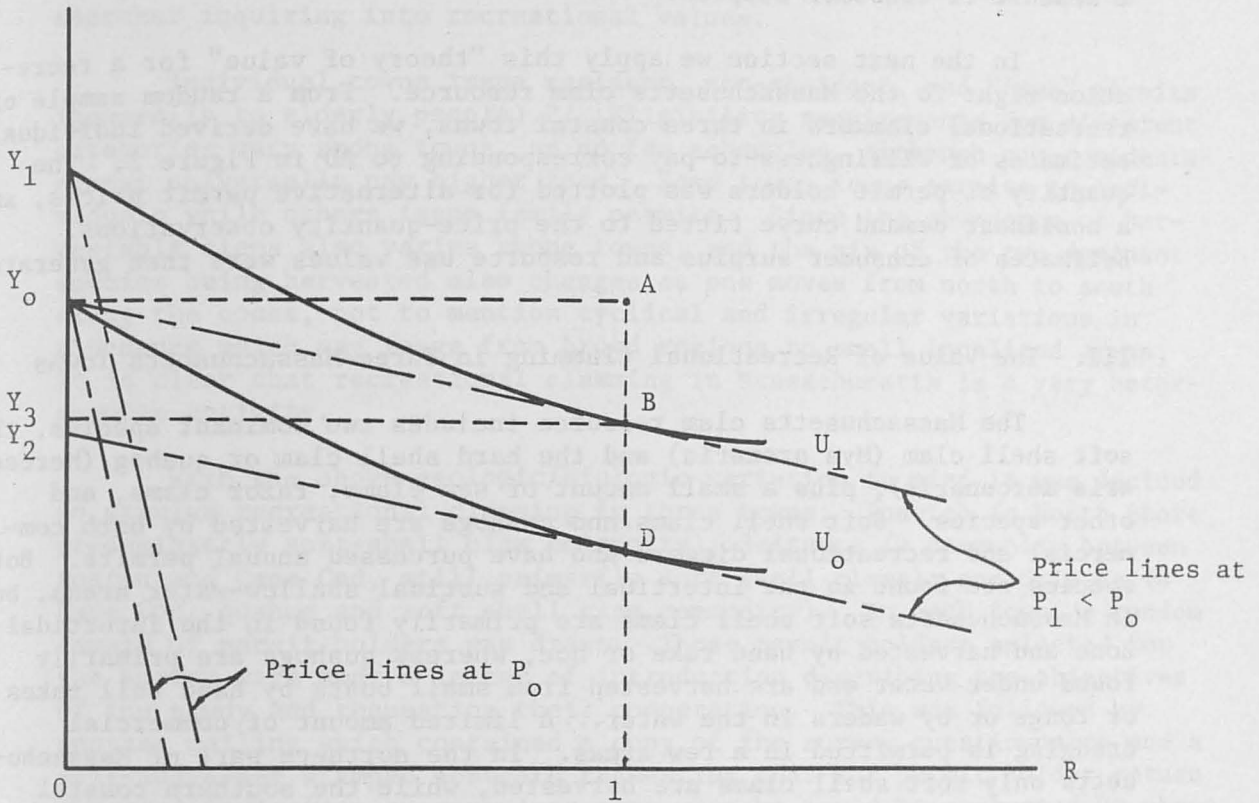
Suppose once at point B we were interested in the amount of income it would take to induce the recreationist to voluntarily surrender the recreation right. Giving up the right would move the individual back to the income axis (where R=0), and thus he would require a payment of at least Y_1Y_3. In Figure 1 the preferences of the individual are such as to exhibit a zero income elasticity for the recreation right. Indifference curves in the preference map are parallel, and the payment Y_1Y_3 can be shown to equal the permit price AB plus the "compensating surplus" BD. In this instance all measures of consumer surplus are equal, and in particular, the "equivalent surplus" Y_1Y_0 equals the compensating surplus BD (see Currie, Murphy, and Schmitz [1971]). It is also the case that the ordinary demand curve coincides with the compensated demand curve, and areas under the ordinary demand curve but above a price line represent consumer surplus (See Patinkin [1963, p. 88]).

This need not always be the case. With a non-zero income elasticity of demand for the recreational right, the compensating and equivalent surplus would differ, and the ordinary demand curve would not coincide with the compensated demand curve. In situations where a commodity (in

our case, a recreational permit) occupies a small fraction of a consumer's budget, it is felt that the assumption of zero income elasticity is plausible, and the area under an ordinary demand curve may be regarded as a measure of consumer surplus.

In the next section we apply this "theory of value" for a recreation right to the Massachusetts clam resource. From a random sample of recreational clammers in three coastal towns, we have derived individual estimates of willingness-to-pay corresponding to AD in Figure 1. The quantity of permit holders was plotted for alternative permit prices, and a nonlinear demand curve fitted to the price-quantity observations. Estimates of consumer surplus and resource use values were then generated.

III. The Value of Recreational Clamming in Three Massachusetts Towns

The Massachusetts clam resource includes two dominant species, the soft shell clam (Mya arenaria) and the hard shell clam or quahog (Mercenaria mercenaria), plus a small amount of sea clams, razor clams, and other species. Soft shell clams and quahogs are harvested by both commercial and recreational diggers who have purchased annual permits. Both species are found in the intertidal and subtidal shallow-water areas, but in Massachusetts soft shell clams are primarily found in the intertidal zone and harvested by hand rake or hoe, whereas quahogs are primarily found under water and are harvested from small boats by hand bull rakes or tongs or by waders in the water. A limited amount of commercial dredging is permitted in a few areas. In the northern part of Massachusetts only soft shell clams are harvested, while the southern coastal areas (Cape Cod, the Islands and the Buzzards Bay area) contain both species, with quahogs generally being more numerous.

Responsibility for the regulation of coastal shellfisheries in Massachusetts resides primarily in the individual coastal towns. The State establishes a few regulations, primarily those concerned with protection of public health (closure of polluted areas and regulation of harvesting and depuration of clams taken from moderately polluted areas), commercial licensing requirements, and minimum permissible harvest sizes. However, for the most part the regulation of open (pollution-free) flats is left to the town. Thus, the town has the discretionary power to establish a system of permits, adopt permit (user) fees, establish permissible times, place and methods of harvesting, and determine how much of the local revenues should be committed to enforcement and investment in the resource.

There are 87 coastal communities in Massachusetts. About 50 communities have active shellfisheries. The others are inactive either because of a lack of naturally productive areas or because their productive areas cannot be harvested due to municipal and industrial pollution. However, the local responsibility for resource regulation does result in a highly decentralized and complex system of management. We are not in

a position to make a normative assessment of the institutional system
at this time. This is currently the subject of a companion study on
shellfish institutions.1/ The decentralized nature of the resource
management scheme does, however, present unique difficulties to a re-
searcher inquiring into recreational values.

Individual towns issue resident, non-resident, and "free" permits
(generally to elderly people).2/ Eligibility requirements for different
categories vary among towns, as do fee schedules, although non-residents
almost universally pay higher fees. Some towns issue permits to indi-
viduals while others issue family permits. Since the abundance of har-
vestable clams also varies among towns, and the mix of the two dominant
species being harvested also changes as one moves from north to south
along the coast, not to mention cyclical and irregular variations in
abundance which may range from broad regions to small localized areas,
it is clear that recreational clamming in Massachusetts is a very heter-
ogenous activity.

With the above geologic/biologic variation in mind it was decided
to examine recreational clamming in three towns: Ipswich (a North Shore
predominantly soft-shell clam community); Scituate (a community between
Boston and Cape Cod, still primarily soft shell clams); and Orleans (a
Cape Cod, quahog and soft shell clam community). In each town, a random
sample of permit holders was drawn. Those permit holders selected for
the survey were sent a letter of introduction describing the objectives
of the study and requesting their cooperation. This was followed by
another mailing which contained a copy of the survey questionnaire and a
self-addressed stamped postcard requesting that the permit holder return
the card indicating a convenient time when he could be contacted by phone.
When the postcard was returned, an interviewer would call at the indicated
time and conduct the interview by phone. This survey method proved rela-
tively effective with an average completion rate of 72% for the three
random samples.

The survey included 21 questions inquiring into the frequency with
which the permit was exercised, percentage effort expended on certain
species, number of quarts harvested, number of people usually on the
outing, other recreational activities engaged in while clamming, (such
as swimming, picnicking, fishing, boating, etc.), perception of the town's
enforcement and biological management, as well as other socio-economic
variables.

1/The institutional analysis is being undertaken by Mr. Benjamin Muse
and is also being supported by the University of Massachusetts Experi-
ment Station.

2/The State requires that towns issue permits to non-residents as well
as residents.

The question relating to willingness-to-pay was prefaced by the following assumptions concerning the quality and conditions of clamming next year.3/

(a) The availability of the various species of clams would be the same as this year.

(b) The clamming season would not be shortened by closures due to "Red Tide."4/

(c) Not purchasing a permit means you would be unable to clam in this or any other town for the duration of the year.

With the above assumptions or ground rules in mind the permit holder was asked the following question:

Suppose you have not purchased next year's permit. What is the highest fee that you would be willing to pay to purchase next year's permit?

Given the individual's response, the compensating surplus could be estimated by subtracting permit price from the stated willingness-to-pay.

At this point several comments might be made as to the shortcomings and bias inherent in this sort of question. We will defer a discussion of these difficulties until Section Four and proceed under the hypothesis that an individual's response to such a question provides a reasonable estimate of true willingness-to-pay.

Within each town the sample was then stratified into resident and nonresident permit holders. Starting at a prohibitively high fee, the permit price was incrementally lowered and at each increment the number of permit holders with a stated willingness-to-pay which equaled or exceeded the permit price was determined. This resulted in a series of "price-quantity" observations indicating the number of surveyed clammers who would demand a permit at various prices.

Examination of the resulting scatter diagram indicated that a

---

3/Assumptions (a)-(c) were made so as to give respondents a specific set of expectations about the quality of next year's clamming. No attempt was made to account for possible time or risk discounting on the part of the respondent.

4/"Red Tide" is a microscopic algal bloom which occurs episodically and renders bi-valve mollusks unfit for human consumption. Ingestion of a mollusk contaminated by Red Tide could lead to paralysis or death.

non-linear demand function of the form

(2) $q = \alpha e^{-\beta}$ $\alpha, \beta > 0$

seemed to conform to the data where q is the number of permits demanded
at price p. Such a functional form has the additional advantage of
being linear in natural base logs and is easily integrated for consumer
surplus calculations. A graph of the function is shown in Figure 2.

Two log linear regressions were run for Ipswich and Scituate,
and three for Orleans, separating resident, nonresident and free permits.
The results of these regressions are given in Table I.

The first column of Table I indicates the town and residence
classification. The second and third columns give estimates of the para-
meters α and β with t-statistics given below the estimates. The fourth

Figure 2
A Graph of the Function
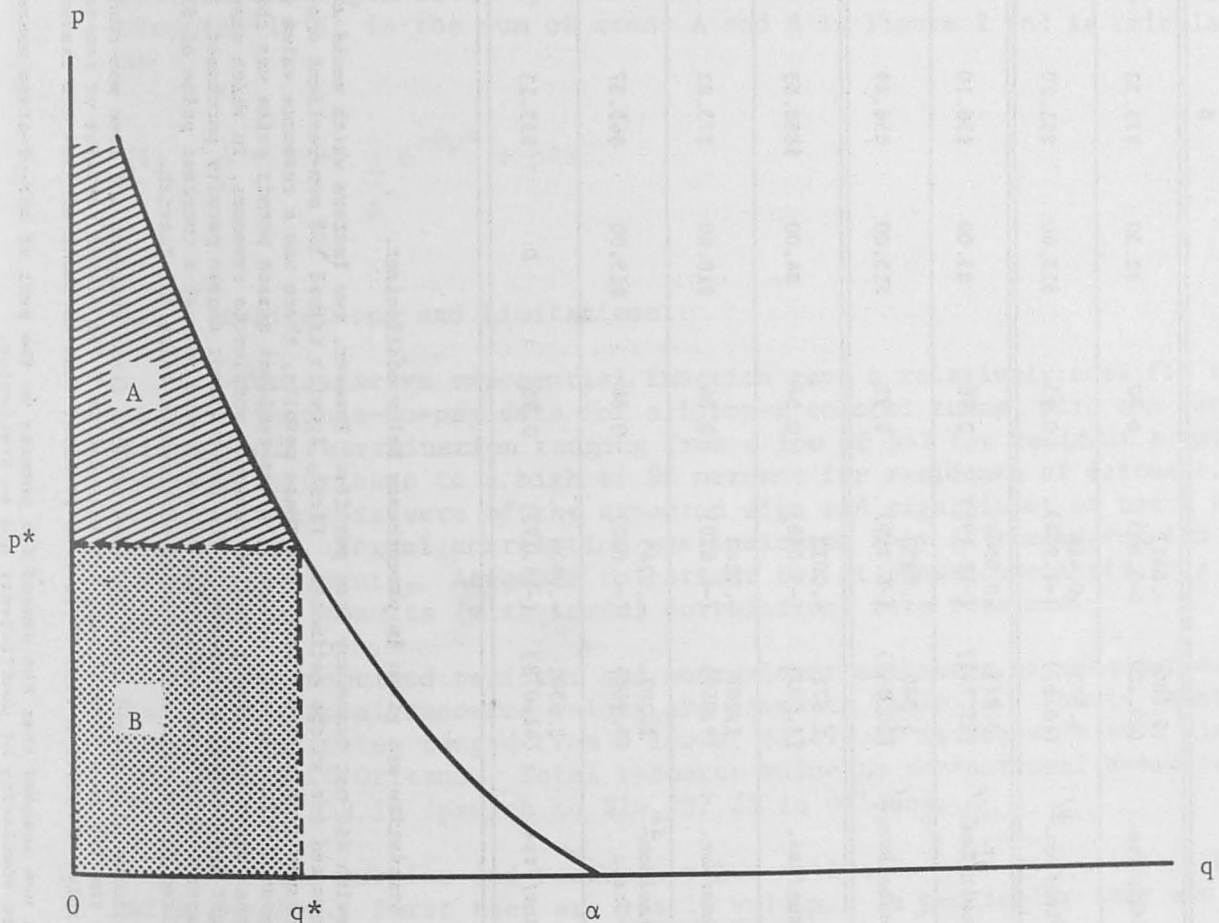
$$q = \alpha e^{-\beta p} \qquad \alpha, \beta > 0$$

Town/Permit	$\hat{\alpha}$ [a]	$\hat{\beta}$ [a]	R^2	p^*	$\frac{\hat{\alpha}}{\hat{\beta}} e^{-\hat{\beta}p^*}$	n	N	$\frac{\hat{\alpha}}{\hat{\beta}} e^{-\hat{\beta}p^*} \cdot \frac{N}{n}$	$\frac{\hat{\alpha}}{\hat{\beta}} e^{-\hat{\beta}p^*} \cdot \frac{N}{n} + p^*N$
Ipswich/Res.	3.486 (12.10)	-.0417 (-5.635)	0.82	$2.50	$75.32	50	725	$1,092.19	$2,904.68
Ipswich/Non. [b]	3.955 (16.57)	-0.411 (-7.904)	0.93	$15.00	$51.20	38	349	$470.28	$5,705.28
Scituate/Res. [c]	3.925 (25.742)	-0.0844 (-12.195)	0.96	$3.00	$36.10	51	977	$691.64	$3,622.64
Scituate/Non. [c]	3.386 (20.889)	-.0353 (-8.219)	0.92	$15.00	$56.49	31	340	$619.61	$5,719.61
Orleans/Res.	2.972 (8.501)	-.0033 (-3.088)	0.54	$4.00	$888.65	61	639	$9,308.93	$11,864.93
Orleans/Non.	2.287 (9.969)	-.0243 (-4.620)	0.84	$10.00	$73.82	13	106	$601.88	$1,661.88
Orleans/Non. [d] Non State	2.287 (9.969)	-.0243 (-4.620)	0.84	$15.00	$65.37	13	45	$226.28	$901.28
Orleans/Free	2.6501 (41.078)	-.0800 (-14.193)	0.96	0	$33.13	19	206	$359.16	$359.16

[a] t- Statistics are given in parentheses below coefficient.

[b] Ipswich did not issue any free permits. However, two factors which would affect consumer surplus and resource value were not accounted for in the estimates. First, Ipswich issued 158 non-resident one-day permits at a price of $3. Even if there was no consumer surplus associated with these permits, there was a resource value of $474 which was not included in the non-resident resource value figure. Second, the non-resident season permit price was changed from $15 to $25 on July 1, 1975. This price change might have simply shifted consumer surplus to revenues, in which case it would not have changed resource value; or it might have caused a decrease in the non-resident season permits purchased, in which case it would have decreased non-resident resource value compared to what it would have been at a constant price of $15. In net, these two complications probably resulted in a slight underestimate of resource value for Ipswich.

[c] Scituate also issued about 100 free permits (some resident and some non-resident). None of these were included in the sample, so the 100 free permits were not included in N for either resident or non-resident. If, as seems likely, there was any consumer surplus associated with these free permits, then consumer surplus and resource value were underestimated for Scituate.

[d] It was assumed that the demand for permits on the part of out-of-state nonresidents was the same as state-nonresidents, thus the similarity of coefficients and t- Statistics.

column is the coefficient of determination. The fifth column is the permit price (resident or nonresident) prevailing in each of the three towns.

The sixth column contains an estimate of consumer surplus; that being the area under the demand curve but above the permit price. Consumer surplus appears as area A in Figure 2 and was estimated as

$$(3) \quad A = \int_{p^*}^{\infty} \hat{\alpha} e^{-\hat{\beta}p} \, dp = -\frac{\hat{\alpha}}{\hat{\beta}} e^{-\hat{\beta}p} \Big|_{p^*}^{\infty} = \frac{\hat{\alpha}}{\hat{\beta}} e^{-\hat{\beta}p^*}$$

The seventh column (n) is sample size, while the eighth column (N) gives the total number of resident or nonresident permit holders in 1975. The consumer surplus estimated in column six represents the surplus accruing to those individuals within our sample of size n. To estimate the aggregate surplus accruing to all such permit holders in 1975, the value obtained in column six was multiplied by $\underline{N}$ and recorded in column nine.

$\qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad n$

The final column contains what can be regarded as an estimate of recreational resource value. This is simply aggregate consumer surplus plus revenues generated by the sale of resident or nonresident permits. Graphically it is the sum of areas A and B in Figure 2 and is calculated as

$$(4) \quad A + B = \frac{\hat{\alpha}}{\hat{\beta}} e^{-\hat{\beta}p^*} + p^*N$$

IV. Implications and Limitations

The negative exponential function gave a relatively good fit to the willingness-to-pay data for all three coastal towns, with the coefficient of determination ranging from a low of 54% for resident permit holders in Orleans to a high of 96 percent for residents of Scituate. All coefficients were of the expected sign and significant at the 1 per cent level. Serial correlation was indicated only in the regression for Orleans residents. Attempts to correct for it proved unsatisfactory and the initial results (with serial correlation) were retained.

The combined resident and nonresident estimates of consumer surplus and recreational resource values are given in Table II. Yearly consumer surplus estimates ranged from a low of $1,478.07 in Scituate to a high of $10,496.25 in Orleans. Total resource value to recreational users ranged from $8,607.39 in Ipswich to $14,787.25 in Orleans.

These surplus and resource value estimates need to be interpreted with caution. First they are yearly values. In particular they are values

Table II
Combined (Resident and Nonresident) Surplus and Resource Values

Town	Combined Consumer Surplus	Combined Resource Value
Ipswich	1,599.89	8,607.39
Scituate	1,478.07	10,034.07
Orleans	10,496.25	14,787.25

based on the resource as it existed in the 1975 season. Time series data
on catch per permit for the three towns was not obtainable. One would
expect, however, that catch/permit or some measure of success (such as
catch per trip) would influence the individual's willingness-to-pay for
next season's permit. In particular if 1975 was a poor year in terms of
catch per unit effort this might depress willingness-to-pay for next
year's permit. The limited data we do have indicates that 1975 showed a
slight improvement in catch/permit over 1974, but we have no extensive
history to determine if these two years were poor, average or good.

A second factor which has undoubtedly influenced willingness-to-
pay has been the reoccurrence of the "Red Tide" which has resulted in the
closure of parts of the Massachusetts shellfishery each year starting in
1972. As noted earlier, the "Red Tide" produces a highly toxic substance
which is concentrated within shellfish and can cause sickness or death.
Its recent occurrence in coastal Massachusetts would tend to have a nega-
tive effect on recreational values for two reasons. First, it creates a
fear that clams taken before or after a "Red Tide" closure might still be
toxic. Second, even if one has confidence in public health officials,
ability to safely open and close flats, the occurrence of "Red Tide" re-
sults in lost clam harvests and hence a diminishment in the value of a
permit. Of course, if "Red Tide" is to be a persistent phenomenon then it
will consistently affect values.

Finally a third factor tending to bias downward the estimates of
consumer surplus and hence resource value is the nature of the willingness-
to-pay question itself. This sort of question has been criticized for its
economic naivete. It presumes that the individual will truthfully reveal
his maximum willingness-to-pay, when in fact "homo economicus" would
probably understate his true willingness-to-pay in order to retain some
surplus for fear that he might be taken at his word.

Thus there is considerable suspicion that these values may be an
underestimate of the true surplus and resource values. Even so, it is
still possible to make some assessment of these values with respect to re-
source investment and distribution of the resource between recreational

and commercial users.

In 1974 the Towns of Ipswich, Scituate, and Orleans spent $30,000, $5,600 and $20,000 respectively on shellfish programs (resource improvement, enforcement of regulations, etc.).5/ In the Towns of Ipswich and Orleans, these expenditures support both recreational and commercial activity, and it is difficult to separate those departmental activities and expenditures which are exclusively directed at just the recreational resource. In Scituate, there is no commercial activity, while in Ipswich and Orleans it has been estimated that 18-19 percent of the total shellfish harvest was attributable to recreational clammers (For Ipswich, the basis is a report by the Division of Marine Fisheries, Department of Natural Resources, 1968, p. 53, while for Orleans the basis is conversation with the town Shellfish Biologist). If in fact 18 percent of the town's shellfish budget was devoted to support of recreational activities, this would imply recreational resource expenditures of $5,400 for Ipswich and $3,600 for Orleans. Assuming the $5,600 expenditure in Scituate to be devoted entirely to support of recreational clamming, we would conclude that resource values are 1.6 to four times the current recreational related town expenditure in the three communities.

In comparison to commercial values, one finds the Towns of Ipswich and Orleans supporting commercial activities yielding approximately $514,800 and $273,000 to commercial diggers respectively.6/ This far exceeds our estimates of recreational value but what is probably the appropriate measure for comparison would be the value of a bushel of clams taken recreationally versus the value of a bushel of clams harvested commercially. Average 1975 commercial prices in Massachusetts were $15.73 per bushel for hard clams and $17.16 per bushel for soft clams (U.S. Department of Commerce, 1976, p. 6).

Estimates of recreational value could be calculated by dividing total resource value by the number of bushels taken. Unfortunately, good estimates of total recreational harvest are difficult to obtain. For Scituate the 1975 estimate of recreational harvest was 450 bushels.7/ Given our resource value estimate of $10,034.07 this would yield a per bushel value recreationally of $22.30. However, in Ipswich and Orleans

---

5/These figures come from the 1974 Town Reports and include salaries for full and/or part-time staff within the shellfish departments.

6/This assumes a price of $17.16 per bushel for the soft clam harvest in Ipswich. In Orleans the estimated total commercial harvest of 17,000 bushels was assumed to be 2/3 hard clams (valued at $15.73 per bushel) and 1/3 soft clams (valued at $17.16 per bushel).

7/The estimate of 450 bushels as the recreational harvest was obtained in a personal conversation with the shellfish warden for the Town of Scituate.

1975 estimates of recreational harvest were 5,000 bushels and 2,875 bushels respectively.8/ This implies per bushel recreational values of $1.72 and $5.14 respectively. Thus, the Scituate per bushel estimate exceeds the per bushel commercial estimate, while the Ipswich and Orleans estimates are considerably less. Given these contradictory estimates it is difficult to make an assessment of the appropriate distribution of the resource between commercial and recreational users without additional research.9/

In summary it appears that yearly town recreational values exceed yearly town recreational expenditures. No clear statement can be made about the per bushel value of clams taken recreationally versus per bushel commercial value. Additional research would be necessary to make some statement about the appropriate allocation of the resource between recreational and commercial users. There is a strong suspicion on the part of the authors that the estimates of resource value may underestimate the true recreational value. It might also be noted that willingness-to-pay (hence value) is a lagged function of resource investment programs (such as transplanting, predation control, etc.). Thus, investments made today, to the extent that they result in higher catch per unit effort in the future, would undoubtedly increase willingness-to-pay and resource value.

The estimates of resource values themselves might not be the most significant result of this study. What is important is the fact that methods of valuing nonmarket activities can play a role in investment and allocation decisions for coastal zone resources at the local level as well as at higher levels of government. In Massachusetts, there is an intense demand for access to coastal zone resources which are largely managed by the local communities. Consequently, there is a need for further application and refinement of evaluative techniques that are useful in decision making at the local level as well as providing a basis for the developing state level effort (under the Coastal Zone Management Act) to review and judge the effectiveness of local decisions.

8/The estimate of 5,000 bushels for Ipswich was based on 18 percent of a total 1975 harvest of 28,000 bushels. The estimate of 2,875 bushels for Orleans came from a personal conversation with the town's Shellfish Biologist.

9/It should also be noted that no estimate is made of the consumer surplus of those individuals who consume commercially harvested clams.

References

1. Brown, G. M. and J. Hammock, 1974, <u>Waterfowl and Wetlands: Toward Bioeconomic Analysis</u>, Baltimore: The Johns Hopkins University Press, for Resources for the Future, Inc.

2. Crutchfield, J. A., 1962, "Valuation of Fishery Resources," <u>Land Economics</u> 38 (May):145-54.

3. Crutchfield, J. A. and G. Pontecorvo, 1969, <u>The Pacific Salmon Fisheries: A Study of Irrational Conservation</u>, Baltimore: The Johns Hopkins University Press.

4. Currie, J. A., J. A. Murphy, and A. Schmitz, 1971, "The Concept of Economic Surplus and Its Use in Economic Analysis," <u>The Economic Journal</u> 81 (Dec.):741-99.

5. Jerome, W. C., Jr., A. P. Chesmore and C. O. Anderson, Jr., 1968, <u>A Study of the Marine Resources of the Parker River-Plum Island Sound Estuary</u>, Mono., Ser. No. 2, Massachusetts Division of Marine Fisheries.

6. Patinkin, D., 1963, "Demand Curves and Consumer's Surplus" in <u>Measurement in Economics: Studies in Mathematical Economics and Econometrics in Memory of Yehuda Grunfeld</u>, Palo Alto: Stanford University Press.

7. Sinden, J. A., 1974, "A Utility Approach to the Valuation of Recreational and Aesthetic Experiences," <u>American Journal of Agricultural Economics</u> 56 (Feb.):61-72.

8. U. S. Department of Commerce, National Marine Fisheries Service, 1976, <u>Massachusetts Landings, December 1975</u>, Washington, D.C., Current Fisheries Statistics No. 6948.