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MEASURING THE VALUE OF GOODS AND SERVICES TRADED IN MARKETS

If goods or services are traded in the market, there are well established and accepted empirical techniques for measuring welfare changes. For measuring producer surplus, it is not necessary to estimate the supply curve. For measuring consumer surplus, it is essential to estimate the demand curves. These conventional techniques of measuring changes in value serve as a springboard for understanding non-market techniques of economic valuation.

To estimate use values, economists employ market resource valuation methodologies. For those resources for which markets exist, economists typically rely on directly observable behavior in the form of market transactions to reveal preferences or the value that individuals place on goods and services and their willingness to pay to avoid loss of such goods and services. The standard method for measuring the use value of resources traded in the marketplace is the estimation of producer and consumer surplus using market price and quantity data.

MEASURING PRODUCER SURPLUS WITHOUT ESTIMATING SUPPLY

Sometimes the measurement of changes in producer surplus does not require complicated econometric modeling to estimate the supply curve (see Chapter 2, Concepts in Environmental Valuation). Careful measurement of all the opportunity costs of production in alternative situations can be used to estimate the change in producer surplus. Consider the hypothetical case in which habitat degradation results in a reduction of striped bass available to the commercial fishery in Chesapeake Bay, a reduction in catch from 8,000 to 5,000 pounds a day. The ex-vessel price, below, refers to the price paid directly to the harvesters for whole fish.

Prior to the reduction in stock size the state of the fishery was estimated as follows:

Catch rate per day (pounds) = 8,000
Ex-vessel price = $0.70/pound
Variable costs per pound = $0.40
Total days fished in season = 16
Total revenue = 16 x 8,000 x 0.70 = $89,600
Total variable cost[5] = 16 x $0.40 x 8,000 = $51,200

Producer surplus = Total revenue minus total variable cost
= $89,600 – $51,200 = $38,400

To simplify the analysis, we assume that the harvesters will not change their fishing behavior, at least in the short run, due to the

[5] Variable costs or costs which vary with output. Fixed costs are not included because, by definition, they do not change in the two scenarios. Thus, even if we bothered measuring them, they would be netted out when comparing the two scenarios.

decrease in stock size. However, reduced stock size can affect harvesters by lowering their catch rate and increasing their variable costs of production. After the reduction in stock size, the state of the fishery is:

Catch rate per day = 5,000
Ex-vessel price = $0.70 (note: for simplicity we assume no price change)
Variable costs per pound = $0.50 (uses more fuel searching for fish)
Total days fished in season = 16
Total revenue = 16 x 5,000 x $0.70 = $56,000
Total variable cost = 16 x $0.50 x 5000 = $40,000

Producer surplus = $56,000 – $40,000 = $16,000

The estimated change in producer surplus is $38,400 – $16,000 = $22,400

Advantages of This Technique. We have a number that can be compared against the producer surplus created by the activity that resulted in the habitat degradation. For the average fisher, the degradation of striped bass habitat has created a welfare loss of $22,400 per year. If there are 100 fishers, the estimated welfare loss would be $2,240,000. In practice the calculation would be more complicated. What will be the predicted response of harvesters due to the reduction in stock size? Will some harvesters drop out of fishing or go after a different species? If so, what is their producer surplus in these alternative activities?

Disadvantage of This Technique. Such an analysis may be problematic because of difficulties in accurately predicting the changes in cost and earnings due to environmental change and in fisher behavior. Also, the prices and cost of inputs and outputs (true opportunity costs) may diverge from accounting costs. This is particularly a problem with fisheries because of the common property nature of the resource. The intricacies of that problem are beyond our study of environmental valuation.

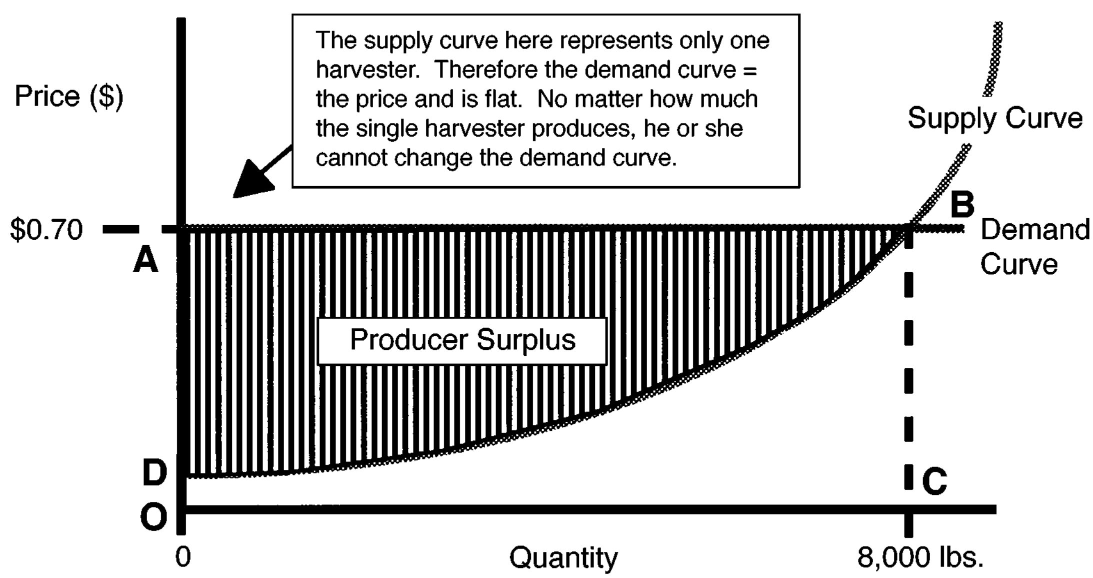
Data Needs. The data required for such an analysis include detailed costs and earnings for a representative fisher. Such information could be obtained from an industry survey.

MEASURING PRODUCER SURPLUS BY ESTIMATING SUPPLY

Econometric (statistics of economics), techniques can be used to estimate the industry supply curve — these techniques are an alternative to the previous methods for directly calculating changes in producer surplus. The method is directly linked to the previous approach for measuring producer surplus because the industry supply curve is another way of representing the variable costs of production that that method employs. The area under the industry supply curve (to any given quantity) is equal to the industry's total variable cost to produce that quantity.

From Figure 4.1 we can geometrically determine the producer suprlus: draw a rectangle connecting the price of striped bass (Y-axis) and the quantity caught (X-axis) through its point on the supply curve (OABC). The area of this rectangle is simply price times quantity or total revenue, the same as in the previous example. If we subtract from this rectangular area, the area under the supply curve (area of ODBC, equal to total industry variable costs when producing

Figure 4.1. Chesapeake Bay Striped Bass: Measuring Producer Surplus



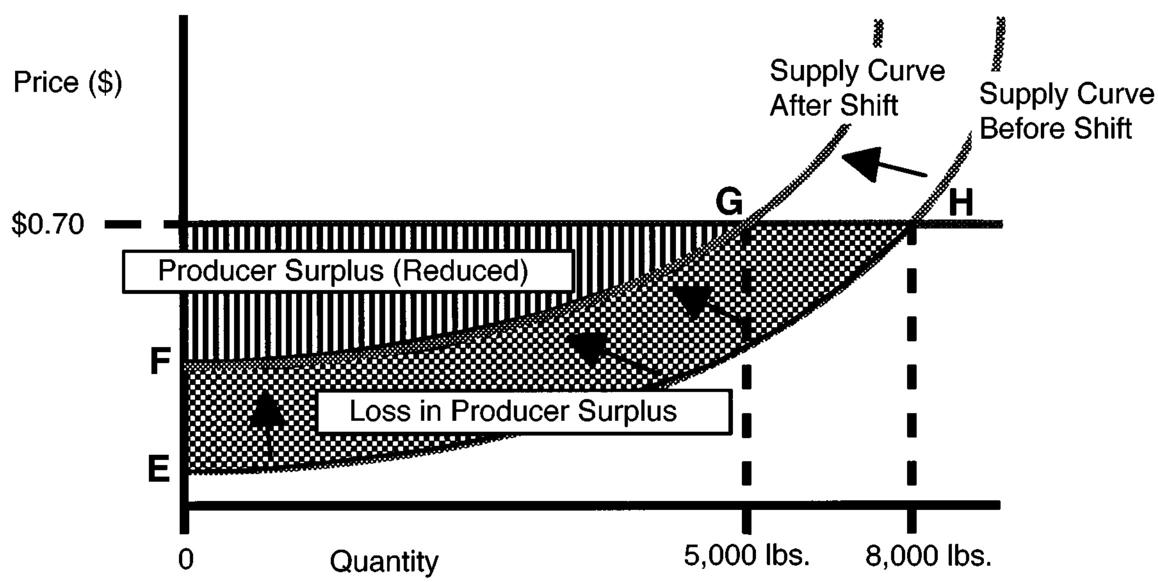
that quantity), the remaining area (ABD) is equal to the producer surplus from the previous method.

The same exercise can be done to describe the situation after the decrease in the size of Chesapeake Bay striped bass populations. The reduction in stock size causes a shift left in the industry supply curve because supply is dependent on the size of the stock. The difference between the areas of the producer surplus triangles with and without the environmental impact is the change in producer surplus (Figure 4.2) or welfare loss (area EFGH).

Disadvantage of This Technique. The major problems associated with this technique include the need to account for all the factors that affect the supply curve over time (e.g., technical change in fishing and regulations) to isolate the effect of the environmental welfare loss.

Data Needs. The data required for this analysis include time series data on input and output prices, landings, and stock abundance.

Figure 4.2. Chesapeake Bay Striped Bass: Measuring Change in Producer Surplus



EMPIRICAL TECHNIQUES FOR MEASURING CONSUMER SURPLUS

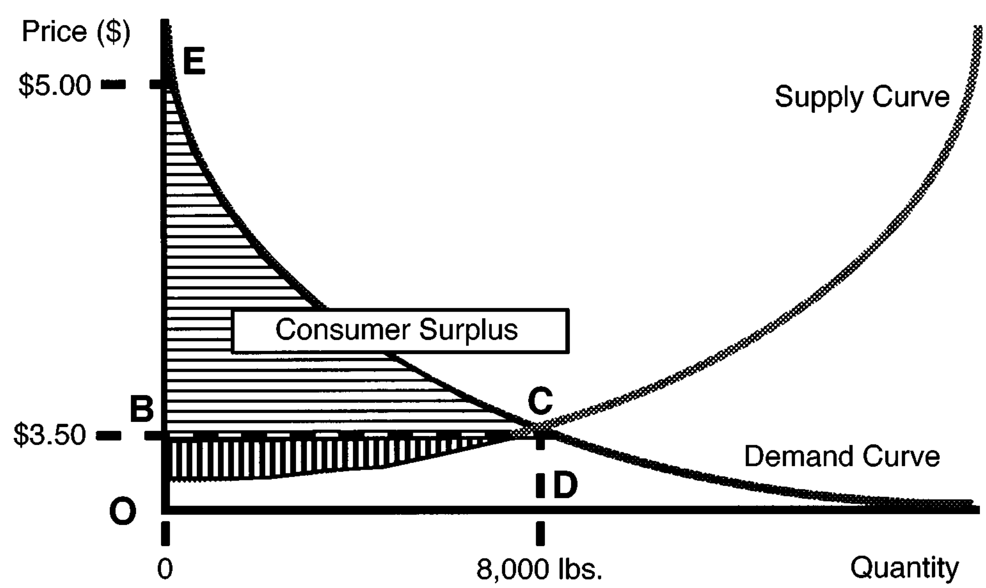
As in the case of producer surplus, econometrics can also be used to estimate consumer demand and thus changes in consumer surplus. The area under the demand curve is equal to the consumer's total willingness-to-pay. Suppose that initially fish consumers must pay $3.50 per pound at the retail fish market. At that price 8,000 pounds of fish are purchased. A simple calculation tells us:

consumer expenditures = $3.50 x 8,000 = $28,000

From Figure 4.3 we can draw a rectangle (area OBCD) connecting the price of striped bass (Y-axis) and the quantity demanded (X-axis) through its point on the demand curve. The area of this rectangle is simply price times quantity or total expenditure, the same as calculated above.

Some consumers may be willing to pay more than $3.50 per pound for their fish, but everyone pays the same price in the store. The area under the demand curve captures the information about the total amount consumers would be willing to pay for the various quantities offered. By subtracting what they actually pay, we obtain an es-

Figure 4.3. Chesapeake Bay Striped Bass: Measuring Consumer Surplus



timate of their net welfare from the consumption of striped bass. In our example, the total area under the demand curve (area OECD) out to 8,000 pounds is the consumer total willingness-to-pay ($34,000). Subtracting what the consumers must pay ($28,000) from their total willingness-to-pay, the consumer surplus is equal to $6,000 ($34,000 – $28,000) — this is the area BEC.

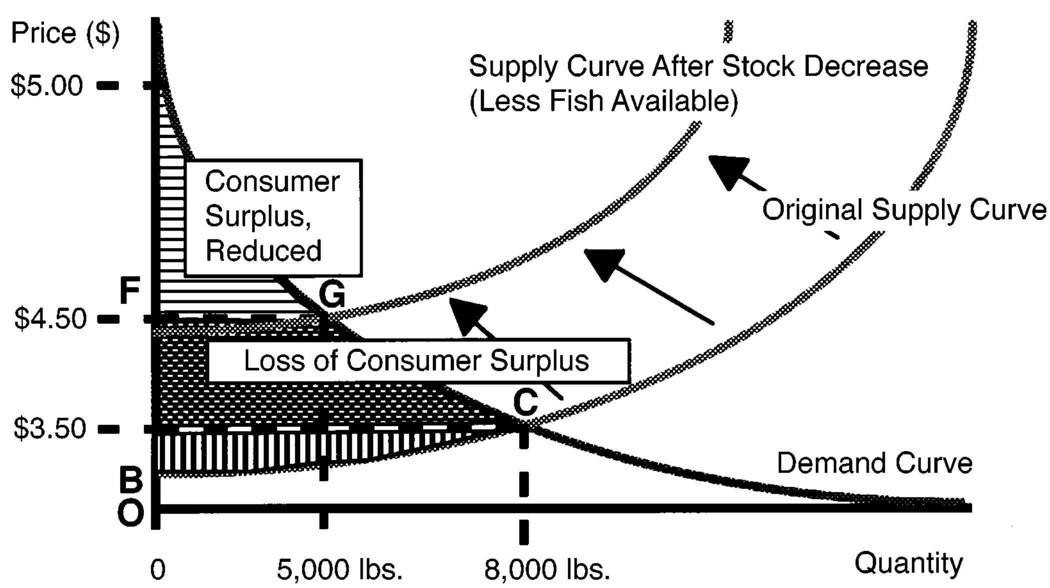
This same exercise can be done to describe the situation after the decrease in the size of Chesapeake Bay striped bass populations. As outlined previously, the reduction in stock size will cause a shift left in the industry supply curve, causing the price of striped bass to rise (Figure 4.4). The difference between the areas of the consumer surplus triangles with and without the environmental impact is the change in consumer surplus (area BFGC).

Suppose now that with the decrease in stock size and subsequent reduction (8,000 to 5,000 pounds) of striped bass being harvested consumers see an increase in the retail price from $3.50 to $4.50 per pound. A simple accounting shows:

consumer expenditures = $4.50 x 5,000 = $22,500

In this new situation, the total area under the demand curve out to 5,000 pounds is the consumer total willingness to pay ($23,750). Subtracting what the consumer must pay ($22,500) from their total

Figure 4.4. Chesapeake Bay Striped Bass: Measuring Consumer Surplus



willingness to pay, the new consumer surplus is equal to $1,250. The estimated change in consumer surplus is then:

$6,000 – $1,250 = $4,750

or a loss of $4,750 to society.

Disadvantage of This Technique. The major difficulty with this approach is that effects from changes in supply must be separated from the effects on demand; and shifts in demand, if any, must be accounted for over time.

Data Needs. The data required for this analysis are time series information on market price for the product and quantity consumed, along with measures of other factors that affect demand.

SUMMARY

For environmental goods or services traded in markets, standard economic techniques of measuring supply and demand and determining changes in producer and consumer surplus can be applied using market price and quantity data. There is no difference in the techniques suggested here and measuring the economic value of any non-environmental good or service. In the next chapter, we demonstrate techniques economists have developed to deal with the situation when goods and services and other benefits do not result from market transactions.