

Socioeconomic Value of the Trout Fishery in Lake Taneycomo, Missouri¹

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Abstract

Lake Taneycomo, a 700-hectare hydroelectric impoundment in southwestern Missouri, supports an excellent put-grow-and-take fishery for rainbow trout *Salmo gairdneri*. When the fishery became threatened by releases of deoxygenated water from an upstream reservoir, it became important to determine its value. We used three methods for estimating the value of the fishery: replacement cost of fish; travel cost; and income multiplier. Information for the latter two methods was based on 500 angler interviews. Replacement cost of the rainbow trout would be \$0.5 million. The travel-cost method provided an estimate of \$2.9 million for the value of the fishery to anglers (consumers' surplus). The income-multiplier method provided an estimate of \$9.9 million for the net economic benefit to the local economy, or about 7% of all economic activity in the area. The benefit: cost ratio of the rainbow trout stocking program at Lake Taneycomo was 22:1 for the local economy.

Our objective in this paper is to determine the socioeconomic value of the Lake Taneycomo fishery for rainbow trout *Salmo gairdneri*. The discharge of oxygen-deficient water from upstream Table Rock Lake each fall has affected fishing since the fishery was established in the late 1950s. During the 1970s, this annual low-oxygen problem became acute and threatened the trout fishery. The problem is critical because the fishery is an important component of a tourist-based economy. Due to the environmental threat, essential information was needed about angler opinions and the importance of the trout fishery to the economy.

A great deal of controversy is present in the literature on acceptable methods for estimating the value of fisheries. Crutchfield (1962) contended that the value of a commercial fishery equals the market value of the fish. This approach is straightforward because aesthetics are not involved. Valuation of recreational fisheries, however, presents a formidable challenge, because values other than harvest are involved. A few of the methods used to value recreational fisheries include unit day value, gross expenditures, replacement cost, income multiplier, property values, willingness to pay, and travel cost. We chose the replacement-cost method to determine the value of the rainbow trout, the travel-cost method to determine the

value of the fishery to anglers, and the income-multiplier method to determine the value of the fishery to the local economy.

Study Area

Lake Taneycomo, a hydroelectric reservoir, was created in 1913 by the impoundment of the White River in Taney County, Missouri. The lake is 32 km long, with a surface area of 700 hectares. The maximum depth is 12 m in the lower end of the lake. The upper 10 km are shallow, with depths directly related to water releases from Table Rock Lake.

Table Rock Dam was built in 1958 just upstream from Lake Taneycomo. The continuous hypolimnial discharge from Table Rock Lake allowed for the establishment of a coldwater fishery in Lake Taneycomo. A complete description of the change from a warmwater to a coldwater fishery is given by Fry and Hanson (1968).

Stocked rainbow trout thrive in Lake Taneycomo, and many grow to a large size. This put-grow-and-take fishery has become extremely popular, providing 329,000 days of fishing annually. Stocked rainbow trout currently account for 90% of the catch in Lake Taneycomo.²

Taney County and Silver Dollar City (a theme park in adjacent Stone County) were chosen as the geographic area under the direct economic influence of the Lake Taneycomo trout fishery.

¹ This research was conducted by the Missouri Department of Conservation, with 100% funding provided by the United States Army Corps of Engineers—Little Rock District.

² About 44% of the rainbow trout were provided by the United States Fish and Wildlife Service between 1958 and 1979.

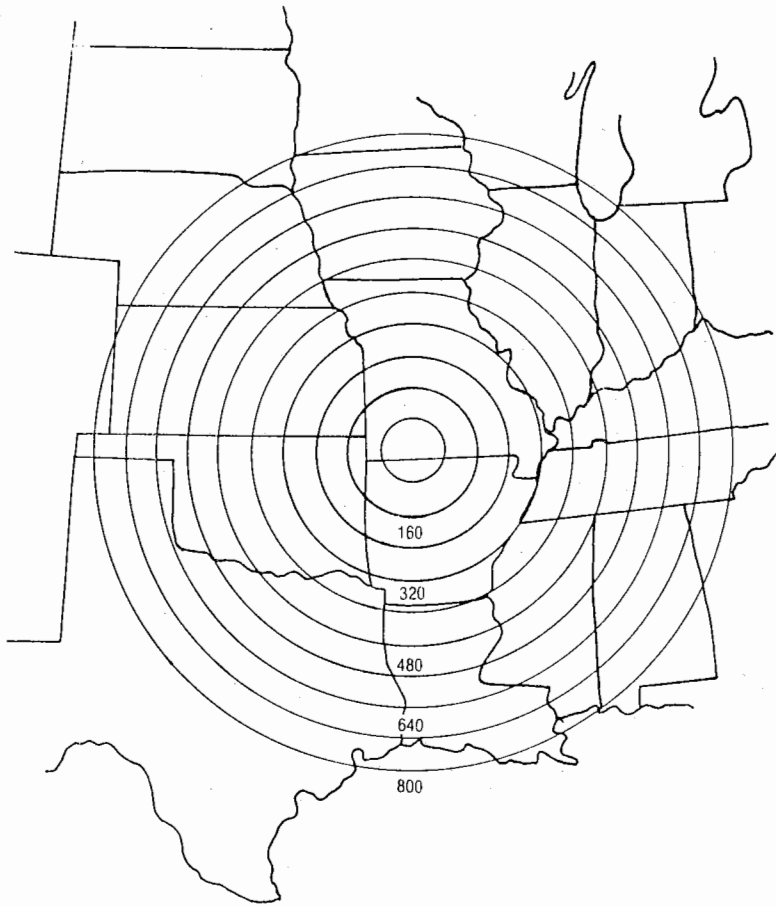


FIGURE 1.—Distance rings (km) from Lake Taneycomo, Missouri, used in our analysis of consumers' surplus as a method of determining the value of the fishery to anglers.

mination $R^2 = 0.88$), developed for the Lake Taneycomo fishery, is described by the equation:

$$\log V_i = 9.522 - 1.889 \log_e(C_i + \gamma_i T_i);$$

- V_i = visits per 1,000 population from within ring i ;
- C_i = round-trip travel cost from ring i to Lake Taneycomo;
- γ_i = a fraction of the mean wage rate of people within ring i ;
- T_i = round-trip travel time in hours from ring i to Lake Taneycomo.

Expression of V_i on a per-capita basis allows differences in population between rings to be considered. Population estimates were based on 1970 census figures. Travel costs were estimated from the mean round-trip distance traveled from each ring to Lake Taneycomo divided by

the average number of people per vehicle and multiplied by the cost per kilometer traveled (source of figures: United States Department of Transportation 1980). We assumed a linear tradeoff between travel costs and travel time. Time in transit (T_i) was multiplied by 35% of the average wage rate within each ring (γ_i), and then added to travel costs (C_i).

The effects of substitute sites are not included in the model because the Lake Taneycomo fishery is unique. No other tailwater trout fisheries exist in Missouri, Illinois, Iowa, or Kansas (source of 87% of visitation).

A site-demand curve was constructed for Lake Taneycomo by evaluation of potential visitation from each ring, given a hypothetical fee structure (Fig. 2). Travel time from each ring is held constant; only marginal travel costs are assumed to be increased. The area under the curve (\$2.9 million) represents consumers' sur-

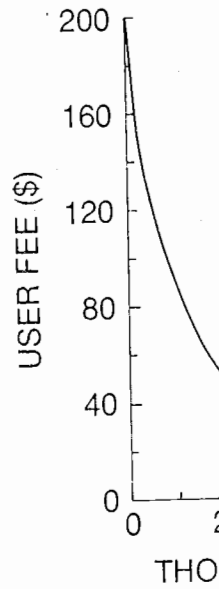


FIGURE 2.—Site-demand curve for Lake Taneycomo. The area under the curve represents the net benefits to anglers (consumer surplus) plus or benefits of their expenses (F

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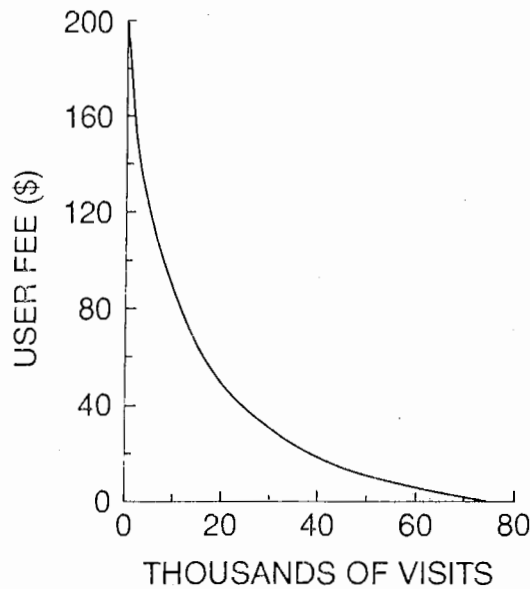


FIGURE 2.—Site-demand curve for trout fishing at Lake Taneycomo. The area under the curve represents benefits to anglers (consumers' surplus). Predicted use at a zero fee is 74,000 trips.

plus or benefits derived by anglers in excess of their expenses (Fig. 2).

Income-Multiplier Method

The income-multiplier method has been recommended to estimate the value of recreational fisheries to regional development. The result of this technique is an estimate of net benefits to the region, in this instance Taney County, Missouri. Net benefits include total direct and indirect (multiplier) income derived from anglers minus the costs of importing goods. On a regional basis, this approach takes into account that some money will be exported to purchase goods and pay taxes, while what remains will continue to circulate (Ives and Youmans 1978).

Income multipliers measure the circulation of expenditures through the individual components of the economy in a specific geographic region. Multipliers reflect general relationships. Labor-intensive industries, such as amusement and recreation, have high multiplier values. Much of the revenue from these industries is converted to employee wages—money that remains, in part, in the local economy to be spent again. Industries that market products, such as grocery stores, have low multiplier values. Much of their revenue pays the cost of imported goods, and is lost to the local economy.

TABLE 1.—Average daily expenditures (\$) per person, annual gross expenditures (\$1,000s), and annual adjusted expenditures (\$1,000s) by Lake Taneycomo anglers.

Category	Daily	Gross	Adjusted ^a
Lodging	3.78	1,244	1,727
Food stores	1.59	523	727
Restaurants	1.98	651	905
Fishing	1.40	461	640
General merchandise	0.74	243	338
Automotive services	0.79	260	361
Amusement and recreation	0.89	293	407
Total	11.17	3,675	5,105

^a We adjusted gross angler expenditures upward to take into account expenditures by Lake Taneycomo anglers and their groups for the 225,000 days they were in the area but did not fish. A portion (57%) of the days not spent fishing at Lake Taneycomo was added to the number of days fished (329,000). This addition (128,000 days) is justified because 57% of the groups traveled to or moved to the area primarily to fish at Lake Taneycomo. Therefore, 457,000 days spent in the area are attributable to the fishery. The adjusted expenditures are calculated by multiplying 457,000 days by the average daily expenditures.

Gross expenditures are needed as an input for the income-multiplier method. Our estimate of daily angler expenditures is \$11.17 ± \$0.84 (α = 0.05) per person for fishing at Lake Taneycomo (Table 1). This figure is comparable to values reported in the literature (Table 2). Expenditures by Lake Taneycomo anglers do not include fishing-license fees or marginal travel costs. Only expenditures made in the study area are included in this analysis. We estimated gross expenditures by Lake Taneycomo anglers to be \$3.7 million from 1 June 1979 to 31 May 1980 (Table 1). This estimate was made by multiplying the average daily expenditure per person (\$11.17) by the estimated 329,000 days fished.

The value of \$3.7 million only represents expenditures by the anglers themselves. Martin et al. (1974) considered it essential to include the expenditures of all members of a family or group. Whether they fish or not, these other people were considered equal participants in the trip. Brown (1976) determined expenditures attributed to the Salmon River salmonid fishery by asking anglers their primary reasons for being in the area. Therefore, we adjusted gross angler expenditures upward based on: (1) the percentage of anglers whose main reason for moving to or traveling to the area was trout fishing (57%); and (2) the average number of people accompanying each angler to the area.

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TABLE 2.—Daily angler expenditures for recreational fishing throughout the United States.

Year	Location	State	Type of fishing	Daily expenditures (\$)	Source
1966	Dale Hollow Tailwater	Tennessee	Trout	7.50	Little (1967)
1970	Statewide	Arizona	Trout	4.97	Gum et al. (1973)
1970	Statewide	Vermont	Streams	8.94	Gilbert and Khayami (1973)
1973	Possum Kingdom Tailwater	Texas	Trout	7.02	Forshage (1976)
1973-1975	Apalachia Tailwater	Tennessee	Trout	8.23	Myhr (1977)
1975	Nationwide	United States	Salmonid	12.45	USFWS (1977)
1975	Salmon River	New York	Salmon	19.61	Brown (1976)
1978-1979	Lake Taneycomo	Missouri	Trout	11.17	Present study

The annual adjusted expenditures attributed to the Lake Taneycomo fishery were estimated to be \$5.1 million (Table 1).

Some trends were apparent when the expenditure data for nonresident anglers were separated by season (Table 3). Daily lodging expenditures were highest in the winter (\$7.45 per person) and lowest in the summer (\$2.66 per person). Nearly everyone stayed in motels or resorts in the winter, whereas in the summer many anglers camped. Expenditure patterns for food were similar to those for lodging—more money was spent in restaurants in winter and less was spent on food in the summer. Apparently, in summer, more anglers brought food from home and prepared their own meals. Average daily fishing expenditures were highest in the winter (\$3.21 per person) because few nonfishermen accompanied winter anglers. Average daily expenditures for amusement and recreation and general merchandise declined markedly in the winter. Not surprisingly, win-

ter anglers and their groups mentioned no other activities in which they participated.

Brown (1976) used an overall multiplier of 1.2 for a locally popular New York salmonid fishery. Gilbert and Khayami (1973) used a multiplier of 2.5 for tourism when evaluating the impact of nonresident sportsmen in Vermont. Rohdy and Lovegrove (1970) derived an overall multiplier of 1.99 for hunter and fishermen expenditures in Grand County, Colorado.

Income multipliers are available for southwestern Missouri (Jerry West, Department of Agricultural Economics, University of Missouri-Columbia, personal communication). These multipliers were applied to Lake Taneycomo anglers' annual gross expenditures for lodging, food stores, restaurants, fishing, general merchandise, automotive services, and amusement and recreation. The estimated value of the Lake Taneycomo fishery to Taney County is \$9.9 million (Table 4).

TABLE 3.—Seasonal variation in the average daily expenditures (\$) per person for Lake Taneycomo anglers.

Category	Season				
	Summer (N = 166)	Fall (N = 112)	Winter (N = 58)	Spring (N = 109)	Year (N = 445)
Lodging	2.66	5.50	7.45	4.61	3.78
Food stores	1.37	2.17	1.14	1.78	1.59
Restaurants	1.47	2.30	4.60	3.21	1.98
Fishing	0.99	1.56	3.21	2.71	1.40
General merchandise	0.54	1.19	0.11	1.26	0.74
Automotive services	0.58	0.92	1.46	1.57	0.79
Amusement and recreation	0.83	0.93	0.00	1.62	0.89
Total	8.44	14.57	17.97	16.76	11.17

TABLE 4.—Annual adjusted Lake Taneycomo angler expenditures, and total contributions of the area economy.

Category
Lodging
Food stores
Restaurants
General merchandise ^a
Automotive services
Amusement and recreation
Total

^a Fishing expenditures included in general merchandise category.

Importance of Trout

The Lake Taneycomo fishery is regionally important because of the recreation it provides and the economic benefits it provides. The Taney County economy of fishing provided 5% of all reservoir recreation. Recreation comprises less than 1% of all reservoir recreation in Missouri.

Retail trade and services are the County economy. Lodging and their groups contribute 10% to the County economy. Lodging and their groups contribute 10% to the County economy. Lodging and their groups contribute 10% to the County economy. Lodging and their groups contribute 10% to the County economy.

The income multiplier is 1.2.

TABLE 5.—Total estimated adjusted expenditure.

Category
Lodging
Food stores
Restaurants
General merchandise ^b
Automotive services
Amusement and recreation
Total

^a Estimated by multiplier in sales taxes collected.
^b Fishing expenditures included.
^c Estimated; Silver Lake.

TABLE 4.—Annual adjusted expenditures (\$1,000s) by Lake Taneycomo anglers, total economic activity multipliers, and total contribution (\$1,000s) to various components of the area economy.

Source	Category	Annual adjusted expenditures	Multiplier	Total contribution
Little (1967)				
Gum et al. (1973)	Lodging	1,727	2.03	3,506
Gilbert and Khayami (1973)	Food stores	727	1.93	1,403
	Restaurants	905	1.71	1,548
Forshage (1976)	General merchandise ^a	978	1.93	1,888
	Automotive services	361	1.97	711
Myhr (1977)	Amusement and recreation	407	2.15	875
	Total	5,105		9,931

^a Fishing expenditures are included in the general merchandise category.

Importance of the Lake Taneycomo Trout Fishery

The Lake Taneycomo rainbow trout fishery is regionally important because of the recreation it provides and the dollars it generates for the Taney County economy. The 329,000 days of fishing provided by the lake represent about 5% of all reservoir fishing although the lake comprises less than 1% of the available area of reservoirs in Missouri.

Retail trade and services dominate the Taney County economy. Lake Taneycomo anglers and their groups contribute about 5% of the revenues in retail trade and services, in terms of gross expenditures (Table 5). Based on the income-multiplier method, anglers generate about 7% of all economic activity in the area. Anglers are particularly important to the lodging, general-merchandise, and food-service sectors of the area economy.

The income-multiplier method gives the most

reliable estimate of net economic benefits to the area. This is the figure required to calculate potential regional benefits as a result of water-quality improvement. The replacement cost of fish does not take into account the recreational value of the fishing experience, or the fact that sometimes large fish cannot be replaced at any cost. Estimated gross expenditures are required for calculations in the income-multiplier method, but other than that they are only useful to establish trends or look at particular sectors of the area economy. They underestimate the true value of a fishery because they do not take into account any benefits perceived by an angler in excess of expenses (Binkley and Hanemann 1976). Gross expenditures also include items such as food that would be consumed whether or not the trip were made (Langford and Cocheba 1978). Consumers' surplus represents the value of the fishing to the anglers, but does not include benefits to the area.

A benefit:cost ratio for the fishery can also be calculated if the income-multiplier or travel-cost methods are used to determine benefits to the area and anglers, respectively, and dollars expended to stock rainbow trout are used as the cost. About 1,115,000 15- to 25-cm rainbow trout were stocked during the 1979-1980 study year at a cost of \$0.40 per fish, for a total cost of \$446,000. The benefit:cost ratio based on the income-multiplier technique is 22:1; based on consumers' surplus it is 7:1.

The United States Army Corps of Engineers is responsible for all phases of operation of Table Rock Dam. Releases of deoxygenated water from the hypolimnion of Table Rock Lake might seriously affect the Lake Taneycomo trout fishery. Knowledge of the value of the Lake Ta-

TABLE 5.—Total estimated sales and receipts (\$1,000s) for Taney County and Silver Dollar City in 1979-1980, annual adjusted expenditures (\$1,000s) by anglers, and percentage contribution to the Taney County economy by anglers.

Category	Estimated sales and receipts 1979-1980 ^a	Annual adjusted expenditures	Contribution by anglers (%)
Lodging	14,108	1,727	12
Food stores	21,073	727	3
Restaurants	10,531	905	9
General merchandise ^b	9,201	978	11
Automotive services	9,877	361	4
Amusement and recreation ^c	28,900	407	1
Total	93,690	5,105	5

^a Estimated by multiplying 1972 sales and receipts (United States Bureau of the Census 1978a) by the percentage increase in sales taxes collected in Taney County between 1972 and 1979.

^b Fishing expenditures are included in the general merchandise category.

^c Estimated; Silver Dollar City does not report gross revenues.

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neycomo fishery is critical to decision-making by the Corps in the future. An analysis of the direct and indirect benefits that can be attributed to the Lake Taneycomo fishery allows comparison with other fisheries or other uses of the resource. These data also serve as baseline information for future studies in the area. The travel-cost and income-multiplier methods can be used by administrators to project economic effects of a change in a fishery, and to evaluate programs and management strategies.

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