

# Economic Impacts of Aquatic Vegetation to Angling in Two South Carolina Reservoirs

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## ABSTRACT

Angler creel surveys and economic impact models were used to evaluate potential expansion of aquatic vegetation in Lakes Murray and Moultrie, South Carolina. During this study, average trip expenditures ranged from \$14.60 to \$247.57 depending upon angler category, angling location, and duration of the trip. Boat anglers remaining overnight had the highest trip expenditures. Anglers were asked their angling efforts at current level of aquatic plant coverage, at an intermediate level of coverage, and at former peak levels of coverage. Current coverage at Lake Moultrie is 20 ha and peak levels were 9,090 ha; current coverage at Lake Murray is 790 ha and peak levels were 1,336 ha. Based upon their experiences with aquatic vegetation, all categories of anglers preferred increased aquatic vegetation. Increasing plant coverage from current levels would increase angling effort by 11% to 14% and increase economic activity in selected economic sectors, such as lodging, by 18% to 63%. Expenditure data and economic impact models are an improved way, compared to summarized trip expenditures, to measure economic contributions of angling. Other groups such as pleasure boaters, water skiers, hunters, and homeowners along the lakes should be studied using similar methods. Taken together, such studies incorporate public preferences, perceptions, as well as economic benefits in the local economy and provide justification for aquatic plant management.

*Key words:* economic value, aquatic plant management, angling, recreation.

## INTRODUCTION

The economic impact of aquatic plant coverage is of interest to those participating in recreational activities (Bergstrom et al. 1993, Henderson 1996, McGinnis and Bell 2000) since changing levels of plant coverage can have both positive and negative effects. When aquatic plant densities result in fouled boat propellers, tangled water skis, closed swimming beaches, and degraded water quality, then the public's recreation use is adversely affected. However, anglers generally prefer aquatic vegetation, especially submersed aquatic vegetation. While the role of aquatic vegetation in largemouth bass (*Micropterus salmoides* Lacepede) production is conflicting (Maceina and

Reeves 1996, Hoyer and Canfield 1996), approximately 20% coverage of aquatic vegetation is generally deemed optimal for largemouth bass (Durocher et al. 1984).

Managing for an optimum level of aquatic plant coverage in reservoirs is difficult. User groups have differing coverage and control preferences. These preferences cause different recreation and spending behaviors resulting in disparate economic impacts that should be considered in aquatic plant management. To that end, we report on perceptions and economic impacts by anglers at Lake Moultrie and Lake Murray where aquatic plants are managed after previously high levels of infestation.

## METHODS

Historically, Lake Moultrie, a shallow 27,500 ha coastal plain system, has supported a variety of aquatic plant species (Figure 1). These plants have affected power generation, water supplies, and recreation (de Kozlowski 1994). During the 1980's, hydrilla (*Hydrilla verticillata* (L.f.) Royle) became established and spread throughout the reservoir system (Morrow et al. 1997). Triploid grass carp (*Ctenopharyngodon idella* Valenciennes) were initially stocked in 1989 in Lake Marion, which is connected by a diversion canal to Lake Moultrie, and stockings continued in both reservoirs through 1996 (Morrow et al. 1997, Kirk et al. 2000). Hydrilla coverage peaked in 1994 at 9,090 ha (S. J. de Kozlowski, pers. comm.)

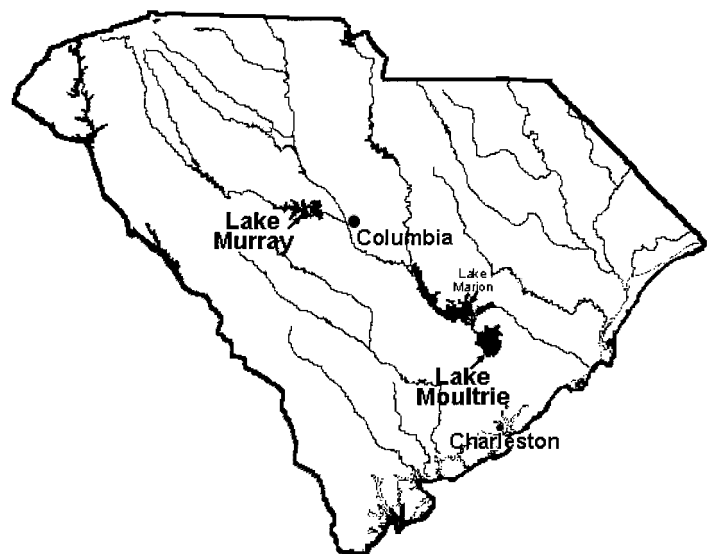


Figure 1. Lakes Murray and Moultrie, South Carolina.

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and triploid grass carp eliminated (<20 surface ha) submersed aquatic vegetation by 1997 (Kirk et al. 2000).

Lake Murray is a 20,000-ha piedmont reservoir near Columbia, South Carolina (Figure 1). Hydrilla, the only abundant non-native species, peaked during 1996 (approximately 1,336 ha, S. J. de Kozlowski, pers. comm.) and was treated with herbicides and winter drawdowns. Since 1999, hydrilla coverage has been increasing; aquatic plant control is maintained near developed shorelines, recreation use islands, access points, and utility withdrawals. During the study period (July 2000 to June 2001), aquatic vegetation covered about 5% (about 790 ha) of the lake (South Carolina Department of Natural Resources 2001). Also, since the high levels of hydrilla in 1996, residential development around Lake Murray has intensified, increasing aquatic plant visibility to the public.

Economic impacts were evaluated with roving angler creel surveys (Malvestuto et al. 1978) and economic impact models that estimate economic effects on the regional economy. The angler creel surveys were conducted for at least 1 year and modified to include trip expenditures, effects of aquatic plants on angling, preferences for plant levels or plant control, and changes in recreation under different levels of aquatic plant coverage. The number of trip expenditure categories differed between Lake Moultrie and Lake Murray because more types of trip costs were captured by the Lake Moultrie survey. Durable goods information, such as the cost of a boat, was not collected in either survey.

To determine how aquatic vegetation affected angling, the creel respondents were asked how their fishing behavior would change in response to changes in aquatic plants. All anglers were asked about their current number of annual fishing trips. This established a baseline or current level of angling use. Those anglers that had fished during years of high aquatic plant coverage were then queried on their recreational use under higher plant conditions and their perceptions of aquatic plants. Anglers were asked whether their number of trips would remain the same, increase, or decrease if aquatic plant levels increased. The interviewees were asked to estimate their number of fishing trips under two different plant conditions—return to former high levels of plants (“Full Plants”) and half the level of the highest plant conditions (“Half Plants”). Those responses from anglers with experience during high levels of plants were expanded to the entire creel sample.

The Lake Moultrie data set allowed comparison between bank and boat anglers, and between inshore, open water, and canal anglers. The perceptions of the effects of aquatic plants on fishing success is important in responding to anglers’ needs. Since hydrilla has been almost eliminated at Lake Moultrie, the question used was “How has the removal of aquatic weeds affected your fishing?” Respondents’ evaluations were “Hurt,” “Help,” “No Effect,” or “No Opinion.” At Lake Murray, the question was “How do aquatic plants affect your fishing success?” The Lake Murray responses were “Helps,” “Hurts,” “Both Helps and Hurts,” “No Effect,” and “Don’t Know/No Opinion.”

Economic impacts are based on the expenditures of different angler groups, such as overnight boat anglers or day user bank anglers, and the linking of those group expenditures to changes in regional demand for goods and services. The im-

pacts of recreation expenditures on economies around Corps of Engineers reservoirs have been documented since the early 1990s when procedures for predicting the economic effects of recreation expenditures, such as gas, bait, equipment, food, and lodging, on local economies were developed (Propst et al. 1992, 1998; Jackson et al. 1996; Chang 2000).

Economic impact models for Lake Moultrie and Lake Murray, South Carolina, were developed by the Engineer Research and Development Center using the Impact Analysis for Planning (ImPlan™) software (Minnesota ImPlan Group 1999). ImPlan™ is an input-output economic model that uses raw materials, labor, and other inputs to evaluate outputs of commodities, goods, and services. Input-output models track the dollars spent on recreation through expenditures within the regional economy. A region was defined as 48.4 km (30 miles) around the reservoir, or roughly one county’s distance. Besides the direct purchase of goods and services, purchases of the raw material, labor, and other requirements are accounted for in the local economic sectors. These expenditures are then used to estimate total sales of goods and services, income, and jobs. Changes in the number of recreation trips, due to different plant conditions, result in changes in expenditures and thus changes in economic impacts.

## RESULTS

Table 1 shows trips under current conditions (2000 to 2001), and trips for “Half Plants” and “Full Plants.” Increased plant coverage would cause anglers to make more trips. For Lake Moultrie, estimated trips increase by 14% when plants increase to half their highest level, and projected effort remains essentially unchanged at the “Full Plants” level. During the creel survey year, there were an estimated 96,000 trips to Lake Murray (Table 1). If plants increase to the half historic level, use would be 100,000 visits. At the historic high plant level, 106,000 trips would be realized, an 11% increase.

Lake Moultrie is a shallow, round-shaped impoundment connected to Lake Marion by a canal (Figure 1). This configuration results in three angling segments— inshore, open water, and canal anglers. Perceptions of the effects of plant removal were significantly different ( $\alpha < 0.05$ ) between the three groups, with 76% of inshore anglers believing plant removal “hurt” fishing compared to 64% of open water anglers and 59% of canal anglers (Figure 2).

At Lake Murray, the question was “How do aquatic plants affect your fishing success?” Of the anglers, 62% responded

TABLE 1. SUMMARY OF ANGLING TRIPS FOR CURRENT AND INCREASED LEVELS OF AQUATIC VEGETATION IN LAKES MOULTRIE AND MURRAY, SOUTH CAROLINA.

Length of stay	Current <sup>1</sup>	Half plant level <sup>2</sup>	Full plant level <sup>3</sup>
Lake Moultrie			
Day use	31,640	35,516	35,513
Overnight	2,984	3,962	3,915
Lake Murray			
Day use	93,381	95,975	101,940
Overnight	2,927	4,282	4,717

<sup>1</sup>Reported number of trips for 2000 to 2001.

<sup>2</sup>Trips at half the former peak of aquatic plant coverage.

<sup>3</sup>Trips at the former peak of aquatic plant coverage.

that plants help, and 2% responded “both helps and hurts.” Responses in Figure 3 are shown by type of plant encountered; emergent, submersed, or both, as reported by respondents. The proportion of “Hurts” responses equals the proportion that said “No Effect.”

The Lake Moultrie survey allowed comparison of perceptions of boat and bank anglers (Figure 4). Of bank anglers, 21% believed plant removal helped fishing success as compared to only 15% of boat anglers. A somewhat higher percentage of boat anglers believed plant removal hurt fishing (73% boat, 63% bank). Based on these results, there is not a significant difference between bank and boat anglers.

At Lake Murray, average trip expenditures for day users were \$14.60 and for overnight anglers \$61.08. At Lake Moultrie, the day users averaged \$41.94 and overnight trips \$247.57. In all cases, boaters spent more than non-boaters and anglers from outside the economic impact region spent more than residents within 48.4 km of the lakes. The higher average expenditures at Lake Moultrie are attributed to more extensive expenditure data and differences in recreation patterns, including: 1) average overnight trips to Lake Moultrie were 4 nights versus 2 nights at Lake Murray and 2) expenditures related to fishing guide services for Lake Moultrie’s prominent striped bass and catfish fisheries.

Economic impacts are reported in Table 2 as output of goods and services, income, and jobs. Lake Moultrie apparently benefited less from full plant coverage in terms of economic impacts than Lake Murray. However, income impacts improved in both regions with higher levels of aquatic vegetation. Using the linkages of the input-output model to trace expenditures, the specific economic sectors most affected by increased recreation spending are presented in Table 3. Sectors with greatest increases are hotels and lodging, transportation, food processing, and construction sectors. These sectors showed increases ranging from 18% to 63%; however, some sectors had very little or no increase.

## DISCUSSION

The aquatic plant conditions at the two reservoirs differ: at Lake Moultrie, hydrilla has been eliminated; at Lake Murray, hydrilla is on the rise. Anglers at both lakes perceive aquatic

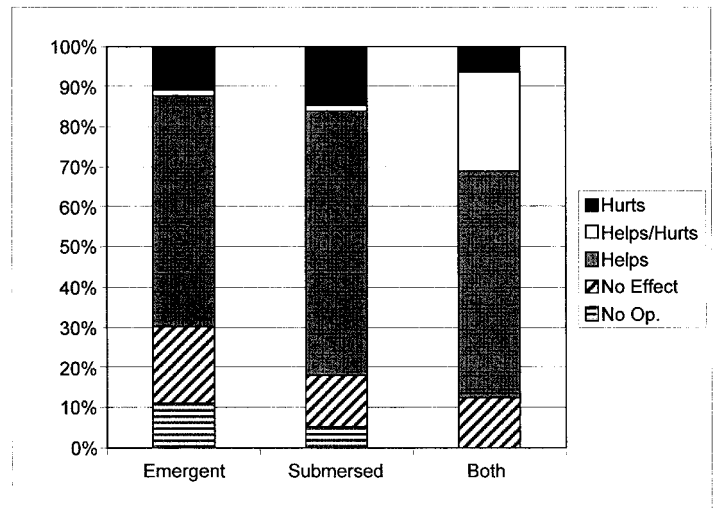


Figure 3. Response of anglers at Lake Murray, South Carolina to the question “How do aquatic plants affect your fishing success?” by categories of emergent and submersed aquatic vegetation.

plants to be beneficial and the economic impacts of angling will increase, in varying degrees, with increased plant coverage. The projected increases in economic impacts for selected sectors of the local economy were impressive and benefits ranged from 18% to 63% (Table 3). Plant abundance that produces highest level of economic impact is different for the two lakes. Fishing trips at Lake Moultrie increase to the “Half Plants” level and then there is essentially no increase in fishing activity above that level (Table 1). At Lake Murray, fishing activity would increase as the level of plants increased (Table 1).

Creel surveys proved to be an efficient way to obtain the expenditure, perception, and change in behavior information. The “face-to-face” interviews were effective in obtaining expenditure and perception information that could be used to evaluate economic impacts and aquatic plant management plans. This information was useful in developing economic models that better measure the economic impact value of angling on the communities surrounding the reservoirs. Such an approach, in our opinion, is an improvement on summarized

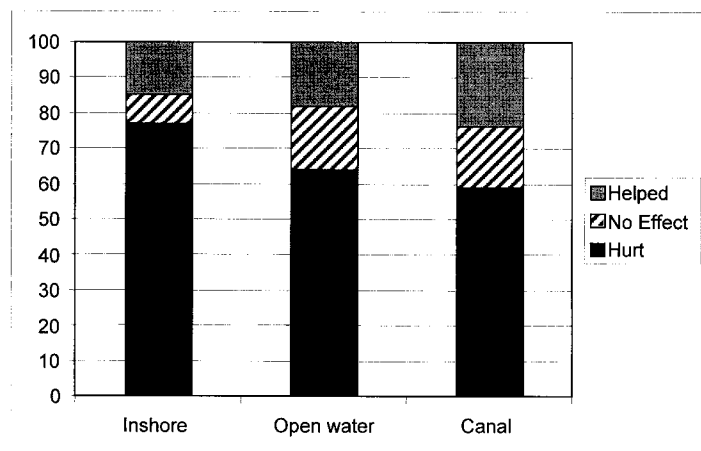


Figure 2. Response of differing categories of anglers at Lake Moultrie, South Carolina to the question “How has removal of weeds affected your fishing?”

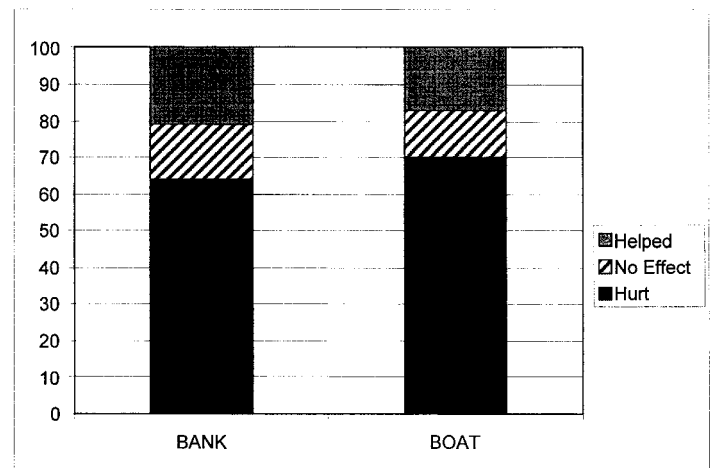


Figure 4. Response of boat and bank anglers at Lake Moultrie, South Carolina to the question “How has the removal of weeds affected fishing?”

TABLE 2. SUMMARY OF ECONOMIC IMPACTS OF ANGLING FOR CURRENT AND INCREASED LEVELS OF AQUATIC VEGETATION IN LAKES MOULTRIE AND MURRAY, SOUTH CAROLINA.

Economic Parameter	Current <sup>1</sup>	Half plant level <sup>2</sup>	Full plant level <sup>3</sup>
Lake Moultrie			
Output	\$2,617,262	\$3,122,868	\$3,126,766
Income	\$1,222,841	\$1,336,386	\$1,338,637
Jobs	52	62	62
Lake Murray			
Output	\$981,335	\$1,082,740	\$1,302,977
Income	\$393,716	\$433,058	\$515,768
Jobs	19	21	25

<sup>1</sup>Current plant conditions.  
<sup>2</sup>Half the former peak plant conditions.  
<sup>3</sup>Former peak plant conditions.

trip expenditures that have been used in the past to measure economic benefit. However, evaluation of economic impacts could be improved by incorporating expenditures associated with durable goods. Additionally, collecting point of purchase (at home, in transit, at the lake) information would allow allocation of economic impacts to all areas, not just the lake region, that experience economic impacts due to angling. This type of information is more reliably collected from mail back surveys, completed at home, rather than in an intercept survey.

Angler values and perceptions should be viewed as one part of the aquatic plant management puzzle. Other lake user groups such as water skiers, pleasure boaters, or swimmers, may have differing perceptions on an optimal level of aquatic plants. These other users would likely have different responses to increases in aquatic plants, and different expenditure categories and economic impacts. The economic impacts and perceptions of these other groups, in addition to lake residential homeowners, need to be identified and quantified. A method similar to the one employed in this study is suggested involving statistically designed surveys, well-designed and tested questions, and expansion of the expenditure information. Economic information and perceptions derived from multiple reservoir user groups can then be combined to better measure the economic and recreational benefits of aquatic plant management strategies.

TABLE 3. HIGHEST INCREASES IN ECONOMIC SECTORS UNDER "FULL PLANT COVERAGE" LEVELS OF AQUATIC VEGETATION AT LAKES MOULTRIE AND MURRAY, SOUTH CAROLINA.

Economic Sector	Output	Jobs
Lake Moultrie		
Hotels and Lodging	+24%	+25%
Eating and Drinking	+22%	+23%
Food Processing	+22%	
Construction		+21%
Lake Murray		
Hotels and Lodging	+63%	+50%
Transportation	+36%	+33%
Eating and Drinking	+18%	+18%

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