

Contribution of Hatchery-Reared Muskellunge to the South Dakota Economy in 2025

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Abstract

Muskellunge (*Esox masquinongy*) are a large native North American freshwater fish popular with recreational anglers. In the USA state of South Dakota, because natural reproduction does not occur, muskellunge fisheries are maintained entirely by hatchery production. This study estimated the total economic contribution of muskellunge rearing and stocking to the South Dakota economy in 2025 by aggregating the direct, indirect, and induced effects from both hatchery operational expenditures and recreational angler spending by the estimated 1,300 South Dakota anglers that target muskellunge. The total contribution of muskellunge angler to the South Dakota economy was estimated to be \$6,214,055 (95% CI = \$2,562,290 to \$9,865,819). Based on \$10,000 in 2025 hatchery rearing expenditures to produce juvenile muskellunge for stocking into public fish waters, every \$1 spent on muskellunge rearing contributed \$621 to the South Dakota economy (95% CI = \$256 to \$987). Because the muskellunge caught in 2025 originated from earlier stockings, the \$621 contribution per hatchery dollar spent is best understood as the gross economic-contribution-to-current-expenditure ratio. These results indicate that the relatively small number of muskellunge anglers and the relatively small amount of hatchery resources dedicated to muskellunge rearing have a relatively large impact on the economy of South Dakota.

Keywords

Fish Hatchery, Muskellunge, Economic Contribution, Recreational Angling

1. Introduction

Muskellunge (*Esox masquinongy*) are a large freshwater fish endemic to north-eastern North America (Schlafke et al., 2024). They are challenging to catch, which along with their size, make them a popular sport fish for a specific segment of

recreational anglers (Midwood et al., 2015). They have been widely introduced beyond their native range, including in the USA state of South Dakota (Long, 2025; Murphy, 2009). Natural recruitment of muskellunge is limited, necessitating hatchery production and restocking to maintain many muskellunge fisheries (Cooke et al., 2015; Crane et al., 2015; Diana et al., 2017; Dombeck et al., 1984; Eslinger et al., 2010; Wingate & Younk, 2007; Long, 2025). Hatchery production was required to establish muskellunge fisheries in South Dakota and is essential to sustain muskellunge recreational fisheries in the state (Long, 2025).

Relative to other sport fish produced in fish hatcheries, muskellunge can be more costly per fish to produce, but the recreational value and economic contribution are believed to justify the cost of production (Simonson, 2012). Only two studies have been conducted evaluating the economics of muskellunge fisheries. In the USA state of New York in 1981, Menz (1981) estimated that the state's 15,000 muskellunge anglers had an economic contribution of \$1,400,000 (\$7,795,200 in 2026 dollars adjusted for inflation). No analysis was conducted to separate naturally-maintained and hatchery-maintained fisheries. An analysis of muskellunge angler spending in Minnesota was conducted using a self-report diary system to track spending per fishing day from 1986 to 1989 (Younk & Cook, 1992). This study produced an inflation-adjusted, average-weighted-by-response-count, estimated economic contribution of \$129 per muskellunge angler day.

No studies have determined the economic contribution of muskellunge angling directly attributable to stocking activities. In addition, little is known about the economic contribution of muskellunge angling and hatchery production in South Dakota. This economic information is needed to guide muskellunge management by fisheries managers and direct the allocation of hatchery resources by administrators and policymakers. Thus, the objective of this study was to estimate the total economic contribution of muskellunge rearing and stocking to the South Dakota economy.

2. Methods

The economic contribution of muskellunge rearing and stocking in South Dakota was found by aggregating the direct, indirect, and induced effects of both hatchery operational expenditures and recreational angler spending attributable to the muskellunge produced and stocked by state fish hatcheries owned and operated by the South Dakota Department of Game, Fish and Parks. This state government department is responsible for fisheries management of the public fishing waters in South Dakota. Two South Dakota state hatcheries, Cleghorn Springs in Rapid City, South Dakota and Blue Dog in Waubay, South Dakota, were involved in muskellunge production in 2025.

Direct effects are the initial rounds of spending that contribute to the economy. Indirect and induced effects, known together as the multiplier effect, occur as direct spending travels through the South Dakota economy. Indirect effects are the multiplicative impacts of subsequent rounds of purchases made by linked indus-

tries within the supply chain (Windfeld & Lhermie, 2022). Induced effects are the multiplicative impacts of household spending generated by the salaries supported within those related industries (Malik & Palmeiri, 2008). To calculate the total economic contribution, direct operational and recreational expenditures attributable to muskellunge rearing and stocking were estimated. To account for the indirect and induced outputs, these values were multiplied by industry-specific and state-specific regional economic multipliers from the U.S. Bureau of Economic Analysis's Regional Input-Output Modeling System II (RIMS-II).

2.1. Direct Effects of Operational Expenditures

Operational expenditures were expenses incurred by state fish hatcheries during the rearing of muskellunge for stocking into public fishing waters. Based on actual expenditures and estimates by hatchery management, approximately \$10,000 was spent in labor, feed, utilities, overhead, and infrastructure depreciation at Cleg-horn Springs State Fish Hatchery and Blue Dog State Fish Hatchery rearing muskellunge in 2025. All of these expenses were in-state and included as direct economic contributions.

2.2. Direct Effects of Recreational Expenditures

Only anglers specifically targeting muskellunge were included in this analysis; anglers targeting multiple species where muskellunge catch was incidental or accidental were excluded. The number of anglers specifically targeting muskellunge during their fishing activities was sourced from the 2021 South Dakota Angler Survey (Wolter, 2022). Of the 1899 anglers responding to the survey, nine anglers specifically identified as targeting muskellunge, resulting in a 0.474% targeting rate. Residency of these nine anglers was not noted in the report. Because of the low response count, statistical inference was used to better estimate the true targeting rate. Standard confidence interval calculations require at least 10 occurrences of interest. Because there were only nine muskellunge anglers identified in the 2021 survey, an Agresti-Coull adjustment was applied using the following two formulas (Agresti & Coull, 1998):

Agresti-Coull Adjustment Formula

$$\tilde{p} = \frac{x + 2}{n + 4}$$

Modified Wald Confidence Interval Formula

$$CI = \tilde{p} \pm \left[1.96 \sqrt{\frac{\tilde{p}(1 - \tilde{p})}{n + 4}} \right]$$

Where x is the unadjusted number of muskellunge targeting responses (9), n is the unadjusted total of survey responses (1899), $\tilde{p}$ is the adjusted muskellunge targeting rate, and CI is the 95% confidence interval (i.e., the range of possible muskellunge targeting rates within which the true targeting rate which can be stated with 95% confidence).

After this adjustment, the muskellunge targeting rate in South Dakota was estimated to be 0.578% (95% CI = 0.237-to-0.919%). To determine the direct spending of South Dakota anglers fishing for muskellunge, the targeting rate was multiplied by total angler spending in South Dakota. In 2022, statewide angler spending totaled \$530,743,523 (Southwick Associates, 2022). This value was adjusted to 2025 dollars using a CPI (Consumer Price Index) inflation multiple of 1.162 (Bureau of Labor Statistics, 2026), yielding an inflation-adjusted statewide angler spending value of \$616,887,814. To determine the portion of the spending attributable to muskellunge angling, \$616,887,814 was multiplied by the muskellunge targeting rate, producing an estimated direct effect from muskellunge anglers of \$ 3,565,826 (95% CI = \$1,464,695-to-\$5,666,956). Because muskellunge do not naturally reproduce in South Dakota and all muskellunge fisheries are entirely dependent on hatchery production and stocking, this value is fully attributable to hatchery activity.

2.3. Indirect and Induced Effects

Indirect and induced effects were calculated from direct spending for both recreational and operational sources using state-level multipliers. For recreational spending, an angling activity multiplier of 0.738 was used, representing both the indirect and induced effects (Bushnell & Barnes, 2026a). After applying this multiplier to the range of direct recreational expenditures, resulted in an indirect and induced effect of \$2,631,579 (95% CI = \$1,080,945-to-\$4,182,213; Table 1).

Table 1. Economic contribution by expenditure category for the hatchery production of muskellunge in South Dakota and the associated recreational fishery.

	Operational	Recreational	Recreational 95% CI
Direct Effect	\$10,000	\$3,565,826	\$1,464,695 - 5,666,956
Multiplier	0.665	0.738	0.738
Indirect & Induced Effect	\$6,650	\$2,631,579	\$1,080,945 - 4,182,213
Total Effect	\$16,650	\$6,197,405	\$2,545,640 - 9,849,169

For operational expenditures, a multiplier of 0.665 was used (Bushnell & Barnes, 2026a), also representing both the indirect and induced effects. Applying this multiplier to direct operational expenditures, produced an indirect and induced effect of \$6650.

2.4. Total Economic Contribution

The total economic contribution was calculated by aggregating the multiplied effects of both operational and recreational expenditures attributable to muskellunge rearing and stocking. The total economic contribution was divided by 2025 hatchery expenditures attributable to muskellunge rearing to determine the economic contribution per budgetary dollar spent on muskellunge hatchery rearing.

3. Results

The total economic contribution of muskellunge rearing and stocking to the South Dakota economy in 2025 was estimated to be \$6,214,055 (95% CI = \$2,562,290-to-\$9,865,819; **Table 2**). The economic contribution per budgetary dollar spent was estimated to be \$621 (95% CI = \$256-to-\$987).

Table 2. Aggregate effect for the hatchery production of muskellunge in South Dakota and the associated recreational fishery, with the economic contribution per hatchery budgetary dollar spent.

	Contribution	95% CI
Recreational	\$6,197,405	\$2,545,640 - 9,849,169
Operational	\$16,650	\$16,650
Total	\$6,214,055	\$2,562,290 - 9,865,819
Per Dollar Spent	\$621	\$256-987

4. Discussion

The results of this analysis demonstrate a disproportionately high and positive contribution of recreational muskellunge angling to the South Dakota economy relative to the minor costs of hatchery production. The over six-million-dollar economic contribution of muskellunge fishing to the South Dakota economy in 2025 is not surprising. People who fish for muskellunge, though small in number, are highly dedicated, specialized anglers who typically have the financial resources required to purchase the equipment needed for muskellunge fishing and undertake the travel to musky fisheries (Cook & Solomon, 1987; Hitzhusen et al., 1997). The \$621 of economic contribution per hatchery dollar spent clearly illustrates the relatively large expenditures by the small number of muskellunge anglers as well as the relatively small expenditures from hatchery rearing.

Because the muskellunge caught in 2025 originated from earlier stockings, the \$621 contribution per hatchery dollar spent is best understood as the gross economic-contribution-to-current-expenditure ratio. Economic and biological data are not available from these earlier stockings to be able to describe the exact costs for those fish that survived and recruited into the fishery. While this current study is a snapshot in time, it attempts to show how much the hatchery muskellunge program costs in a specific year in relation to angler expenditures in the same year. Describing hatchery costs over a longer time frame going back to when the fish caught in 2025 were likely stocked, including biological data on how many of the fish stocked actually recruited into the fishery, and then compiling angler expenditure data for the entire time period is well beyond the scope of this study.

Because this is the first study to document the economic contribution of muskellunge fishing in South Dakota, no historical comparisons can be made. However, comparisons can be made to other recently published economic studies on recreational fishing and hatchery production in South Dakota. Specifically, a 2026 analysis of McNenny State Fish Hatchery using similar methods found a hatchery-

specific figure of \$133 in economic contribution per budgetary dollar spent on the rearing of trout and salmon in 2025 (Bushnell & Barnes, 2026b). A 2020 analysis of Cleghorn Springs State Fish Hatchery found a higher figure of \$172 in economic contribution per budgetary dollar spent, again focusing on trout and salmon angling and production (Martling et al., 2020). While higher than that reported for trout and salmon, the economic contribution of muskellunge for hatchery dollar spent is lower than that reported for walleye (*Sander vitreus*) fishing in South Dakota. A 2026 study using near-identical methods to this investigation calculated that the walleye rearing in South Dakota contributed an estimated \$1,066 per hatchery budgetary dollar spent (Bushnell & Barnes, 2026a).

In comparison to trout fishing, hatchery production of muskellunge appears to have a higher economic contribution per dollar spent, but because of the much larger number of trout and salmon stocked, it has a much lower total economic contribution. For example, the total economic contribution of muskellunge fishing in South Dakota calculated in this study was \$6,214,055. This is dwarfed by the total economic contribution of trout and salmon fishing, which is estimated to be approximately \$210,000,000 (Bushnell & Barnes, 2026b; Martling et al., 2020). The total economic contribution of trout and salmon fishing is further dwarfed by that of walleye fishing in South Dakota, which is estimated to be \$714,694,161 (Bushnell & Barnes, 2026a).

To the best of our knowledge, no other studies have attempted to estimate the economic contribution of specifically of muskellunge stocking. However, a 1981 analysis estimated the regional economic contribution, not specific to stocking, from the activities of 15,000 muskellunge anglers in the USA state of New York at \$1,400,000 including multiplier effects (Menz, 1981). Adjusted for inflation, \$1,400,000 is approximately \$7,795,200 in 2025 dollars (Bureau of Labor Statistics, 2026), indicating that the economic contribution per muskellunge angler in New York was \$520. There were 224,970 anglers in South Dakota in 2021 (Southwick Associates, 2022). Assuming 0.578% of these angler's specific target muskellunge (Wolter, 2022), then there are an estimated 1,300 muskellunge anglers in South Dakota. Dividing the muskellunge-angling-specific economic contribution of \$6,197,405 by 1,300 gives an estimated contribution per South Dakota muskellunge angler of \$4,767. On a per-angler basis, South Dakota muskellunge anglers contribute approximately nine times more than New York muskellunge anglers to the state-level economy.

Similar comparisons can be drawn from a 1992 Minnesota muskellunge angler self-report diary analysis (Younk & Cook, 1992). Using an inflation-adjusted average weighted by response count to the data from this Minnesota study produces an estimated muskellunge-related direct spending of \$65.55 per fishing day. To account for the indirect and induced effects, this figure was multiplied by the Minnesota-specific RIMS-II multiplier ratio of 1.965 (American Sportfishing Association, 2007), yielding an economic contribution of \$129 per muskellunge angler day. In South Dakota, there were a total of 3,155,550 fishing days taken in 2021 (Southwick Associates, 2022). Applying the muskellunge targeting rate of 0.578% gives an esti-

mated 18,240 muskellunge-specific fishing days in the state. Dividing the economic contribution of \$6,197,405 by the 18,240 fishing days produces an estimated contribution of \$340 per muskellunge fishing day in South Dakota. On a per-fishing-day basis, South Dakota muskellunge anglers contribute approximately 2.64 times more than Minnesota muskellunge anglers to the state-level economy.

Because of the paucity of information on muskellunge angling in South Dakota, this analysis faced several limitations that may have affected the results. The primary limitation was the reliance on a small sample size of nine muskellunge anglers out of 1,899 anglers sampled (Wolter, 2022). While the Agresti-Coull adjustment successfully mitigates much of the statistical uncertainty associated with this small sample size (Agresti & Coull, 1998), the 95% confidence interval was still relatively wide. The range of 0.237% to 0.919% represents a fourfold difference in potential targeting rates between the two extremes. By extrapolating the target range to statewide spending, this wide disparity also applied to the direct muskellunge angling expense figures. Further, this simple extrapolation ignores differences in muskellunge angler spending habits. Muskellunge anglers must have specialized equipment and spend significant amounts of time fishing (Cook & Solomon, 1987; Hitzhusen et al., 1997), implying that they are likely to contribute much more to recreational spending than a typical angler would for a given period spent fishing. Because of this, the center baseline figure for contribution per budgetary dollar may be significantly understated. It is possible that the actual economic contribution may be closer to the higher extreme of the confidence interval (\$750 to \$950 per budgetary dollar spent).

In conclusion, the rearing and stocking of muskellunge in South Dakota public fishing waters generates a highly positive economic contribution, serving as an efficient investment of state hatchery resources. Further, South Dakota muskellunge anglers contribute substantially more to the regional economy on both a per-angler and per-fishing-day basis than in other states. These results should be used by state employees making fisheries management decisions, as well as by hatchery managers and administrators tasked with allocating hatchery resources. Based on the return on hatchery resources in relation to the economic contribution, this study provides considerable justification for investments in hatchery infrastructure benefitting muskellunge production.

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Author Contributions

Conceptualization, M.E.B.; methodology, R.C.B.; validation, R.C.B. and M.E.B.; formal analysis, R.C.B.; investigation, R.C.B.; resources, M.E.B.; data curation, M.E.B.; writing—original draft preparation, R.C.B.; writing—review and editing, M.E.B.; supervision, M.E.B.; project administration, M.E.B. Both authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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