

WATER USE FOR AQUACULTURE IN MINNESOTA, 1984

By Lee C. Trotta

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 88-4159

Prepared in cooperation with the
MINNESOTA DEPARTMENT OF NATURAL RESOURCES

St. Paul, Minnesota

1988



DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
Water Resources Division
702 Post Office Building
St. Paul, Minnesota 55101

Copies of this report can be
purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center, Building 41
Box 25425
Denver, Colorado, 80225

CONTENTS

	Page
Abstract.....	1
Introduction.....	1
Measurement approaches.....	3
Area of water used.....	3
Volume of water used.....	3
Trends.....	4
Significance.....	5
Conclusion.....	5
References.....	6

ILLUSTRATIONS

Figure 1.--Aquaculture in Minnesota, 1984.....	2
------------------------------------------------	---

CONVERSION FACTORS

Readers who prefer to use metric (International System) units rather than inch-pound units can make conversions using the following factors:

<u>Multiply Inch-Pound Unit</u>	<u>By</u>	<u>To obtain Metric Unit</u>
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (m)	1.609	kilometer (km)
square mile (mi ²)	2.590	square kilometer (km ²)
foot per mile (m/km)	0.1894	meter per kilometer (ft/mi)
foot squared per day (ft ² /d)	0.09294	meter squared per day (m ² /d)
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second (m ³ /s)
acre	0.4047	square hectometer (hm ²)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm ³ /yr)
acre-foot per year (acre-ft/yr)	0.001233	cubic hectometer per year (hm ³ /yr)
acre-foot per square mile (acre-ft/mi ²)	0.000476	cubic hectometer per square kilometer (hm ³ /km ²)

WATER USE FOR AQUACULTURE IN MINNESOTA, 1984

By Lee C. Trotta

ABSTRACT

Aquaculture supports a large sportfishing industry in Minnesota. Licensed fish farms that hatch and (or) harvest minnows or gamefish are located throughout the State. The volume of water used in these operations can be expressed as the minimum capacity per pound of fish, total water consumed, total water dedicated to the farming operation, or total water withdrawn.

In expressing water dedicated to the farming operation, the total surface area of water bodies dedicated to aquaculture in Minnesota in 1984 was about 141,500 acres, based on interpretation of data reported in license applications. Water withdrawals to fish holding tanks amounted to 0.73 million gallons per day in 1984.

Water-use calculations address the possibility of errors in reporting. About 15 percent of the licensees use municipally supplied water for their holding tanks. One thermoelectric powerplant recently began reusing the heated water from its cooling towers to raise catfish.

Little change in the number of licensees since 1980 indicates that aquaculture is a viable segment of the Minnesota economy. Trout farming has grown from 10 farms in 1978, to 23 in 1984; most use dug ponds sustained by ground-water inflow. Withdrawals for aquaculture are nonconsumptive and are small compared to other water-use categories in Minnesota.

INTRODUCTION

This report provides estimates of water use for aquaculture in Minnesota. Aquaculture is use of water to raise and harvest fish, underwater vegetation, or other water organisms for consumption or sale. It supports the sportfishing industry, which brings \$500 million in revenue to Minnesota annually by supplying bait for fishermen and game fish for stocking streams and lakes. Aquaculture also supplies fee-fishing ponds and several restaurants and meat markets in the State.

All licensed fish farms that hatched or harvested minnows or game fish in 1984 are shown on the aquaculture map in figure 1. The map shows that these operations are found across the entire State, with the exception of several counties in the southeast and along the western border where lakes are scarce. Each symbol represents the approximate location of the streams, canals, ponds, or lakes used by a licensed fish farmer. Nonharvesting minnow retailers are not included.

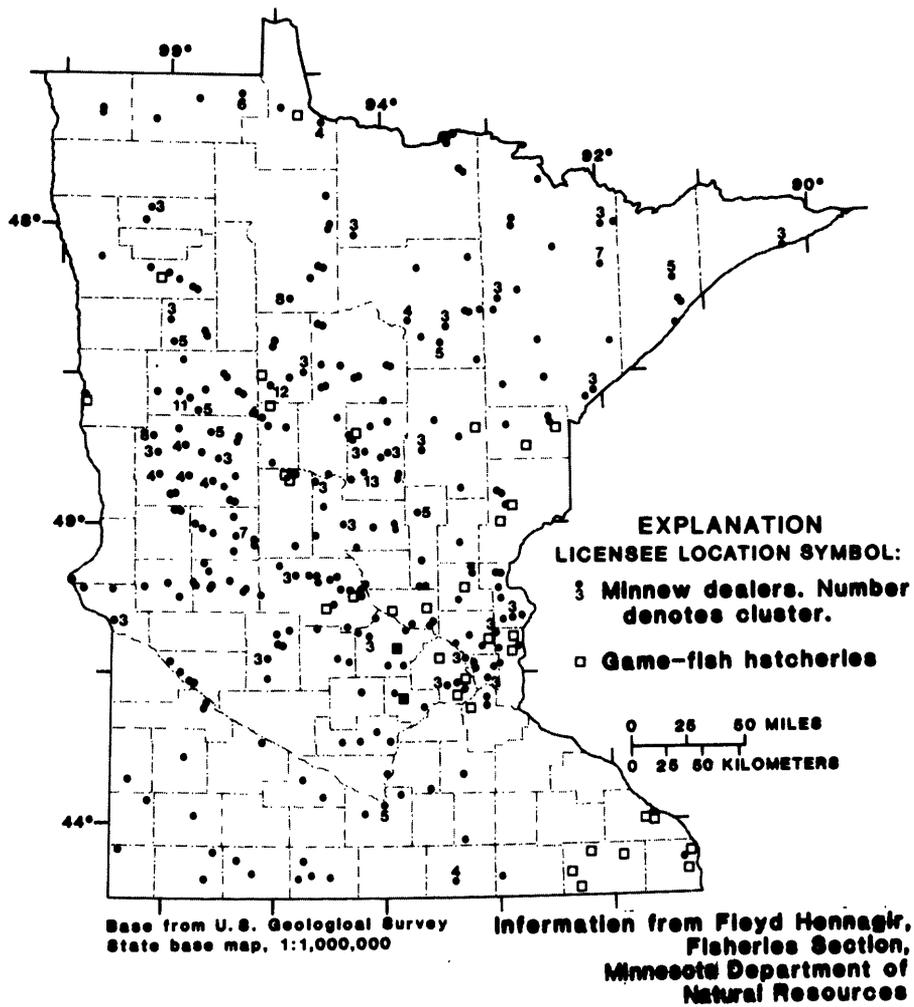


Figure 1.--Aquaculture in Minnesota, 1984.

MEASUREMENT APPROACHES

Water used by fish farms is seldom accounted for in the literature. The term "use" is difficult to apply to aquaculture because the ponds act only as a vehicle for raising the fish, and the water still is available for other purposes. Most minnow ponds are natural in origin. Water is used in the traditional sense only when holding tanks are filled or when sucker or gamefish hatcheries transfer water from ponds, lakes, or wells. Even this "use" of water is nonconsumptive.

How much water is used in these operations? The amount depends on how it is measured. One could (1) measure the pounds of fish harvested and compute the minimum water capacity needed to raise the fish; that is, 2,500 gallons for 100 pounds of fish, with filtration (Limburg, 1980); (2) measure the quantity of water actually consumed (which is insignificant); (3) measure the area of water set aside for or dedicated to the raising of aquacultural products, adjusted for the intensity of use; or (4) measure the quantity of water transferred or withdrawn. In Minnesota, data are available for applying methods (3) and (4).

AREA OF WATER USED

The area of water set aside for or dedicated to the raising of fish is reported annually to the Minnesota Department of Natural Resources (MDNR). Applications for license renewal of gamefish and sucker-minnow hatcheries in Minnesota require the reporting of the area of water used for fish farming. The MDNR Fisheries Section has compiled data from these applications needed to calculate a State total. Minnow dealers report only acres used for suckers. Acreages for other species are not reported, because some minnows are harvested from public waters. Assuming that all minnow dealers operate at an economically-efficient size, the average number of acres reported by 312 sucker-egg hatcheries was assumed to apply to the other licensed minnow dealers. The total area dedicated to aquaculture in Minnesota in 1984, therefore, is estimated to be 141,500 acres.

This area is only 4 percent of the acreage covered by lakes that are 10 acres or larger in size in Minnesota, but this area represents billions of gallons of water.

VOLUME OF WATER USED

The amount of water transferred or withdrawn is not included on license renewal reports. Only a rough estimate can be made on the basis of survey methods, which generalize highly individual systems of fishing management. A 1978 survey of the Minnesota live-bait industry by the MDNR Fisheries Section provides some needed statistics (Peterson and Hennagir, 1980). About 94 percent of interviewed dealers reported that bait fish commonly are held for sale in concrete or steel tanks. Water needs to be transferred from some source

to these tanks. Water sources for holding facilities included wells (75 percent), city supply (15 percent), springs (7 percent), and ponds or lakes (2 percent). In 1984, there were 447 minnow dealers in Minnesota (96 of which operated private hatcheries), based on a compilation by the MDNR Fisheries Section. A 1986 telephone survey of 3 percent of the State's minnow dealers revealed that the average bait-fish holding-tank operation is drained either continuously or periodically at an annual rate of 250 gal/d (gallons of water per day) for nonhatchery operations and 10,000 gal/d for hatchery operations. Combining the above statistics, an estimated 0.6 Mgal/d (million gallons per day) of ground water and 0.03 Mgal/d of surface water was pumped (or withdrawn) for bait-fish-holding tanks during 1984.

Many game-fish operations also withdraw water for holding tanks prior to sale. The trout is the predominant game fish raised. These cold-water species commonly are raised more intensively (more management to increase production) than are other game-fish species by use of dug rather than natural ponds. This is possible because the dug ponds generally are supplied with ground water from springs or wells that ranges in temperature from about 40 to 52 °F (Trippler, 1982), which is in the temperature range required for trout. Probably 90 percent of the State's trout production came from two large operations in 1984. These two operations were surveyed for this report to determine water withdrawals. As a result, an estimated 0.08 Mgal/d of ground water was pumped for Minnesota game-fish-holding tanks in 1984.

Combining results for bait and game fish, water withdrawals for aquaculture in Minnesota amounted to about 0.7 Mgal/d of ground water and 0.03 Mgal/d of surface water in 1984. This total does not include aquacultural water use for leeches, salamanders, crayfish, frogs, or commercial and private aquariums, which do not require a license and involve only minor water use. Water was not used for cultivation of seaweed or rice (as opposed to harvesting of wild varieties) during 1984.

TRENDS

Trends in licensing, production, pond availability and nature indicate that, so far, aquaculture lacks growth stability as a segment of the Minnesota economy. The total amount of water used for aquaculture probably has remained about constant over the last several years, because the number of licensees hasn't changed substantially since 1980. Droughts and winter freezes in 1981 and 1982 resulted in fish kills and loss of production, according to the MDNR Fisheries Section files.

Such weather calamities, coupled with the lack of resource and medium control during crucial management stages, make aquaculture less manageable than agriculture. There is no technique available to manipulate natural fry-feeding habits, which may include cannibalism. The minnow dealer also is steadily losing ponds to other private and public interests, such as fishing clubs and wildlife refuges. The U.S. Department of Commerce (Bureau of Census, 1984, p.374) reports growth in the number of trout operations in Minnesota from 10 farms in 1978 to 12 farms in 1982; MDNR's compilation lists 23 active trout farms in 1984. However, part of this growth can be attributed to current licensees who simply add trout raising to their operation.

The previous water-use totals were categorized according to national standards, so as to incorporate aquaculture into the State's total water-use picture. For this reason, situations such as reuse of water for a second purpose and the potential for double counting of use were noted. About 15 percent of licensees surveyed in 1978 used municipally supplied water, which presents the possibility of a single use of water being counted in two categories (once in the public supply and once in either the aquaculture or livestock-use category). In an example of actual water reuse, Elizabeth Moosbrugger (1985, oral commun.) of Minnesota Power (Duluth) reports "on June 4, 1985, Minnesota Power began reusing the heated water from its cooling towers at the Cohasset thermoelectric plant to raise catfish for a DNR stocking experiment."

SIGNIFICANCE

The withdrawal of water for aquaculture in Minnesota has been compared to the withdrawal of water for other purposes as listed in the MWUDS (Minnesota Water-Use Data System) data base constructed by the U.S. Geological Survey and by the Minnesota Department of Natural Resources. These computerized data and reports prepared from the data are used by State and local agencies for water management. The 1984 estimate of total aquaculture water withdrawal (0.73 Mgal/d) is less than any of the 10 categories of water use currently compiled. For example, about 60 Mgal/d of ground water was withdrawn for livestock in 1980 and consumed, whereas the water used for aquaculture was not consumed. Because the use of water for aquaculture is considered to be nonconsumptive, it currently (1988) is not included in MWUDS processing efforts.

CONCLUSION

In 1984, about 141,500 acres of water area were dedicated to aquaculture and water withdrawals were about 0.73 million gallons per day. Though economically important, aquaculture operations withdraw little water compared to other types of water use in Minnesota.

REFERENCES

- Bureau of Census, 1984, 1982 census of agriculture-Minnesota State and county data: U.S. Department of Commerce, v. 1, part 23, 414 p.
- Limburg, P. R., 1980, Farming the water: Beaufort Books, Inc., New York, Toronto, 223 p.
- Peterson, D. L., and Hennagir, F. A., 1980, Minnesota livebait industry assessment study: Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, Investigational Report No. 367, 75 p.
- Trippler, Dale, 1982, Ground water quality monitoring program--a compilation of analytical data for 1981: Minnesota Pollution Control Agency, St. Paul, v. 4, 237 p.