Original: Fish Division
cc: Education-Game
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DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
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Report No. 1321

EXPERIMENT WITH THE USE OF OXYGEN IN TRANSPORTING TROUT

by

Leonard N. Allison

Abstract

The recirculation system has been employed successfully for many years by the Michigan Conservation Department for transporting various species of fish. In this system, a pump powered by a gasoline engine draws water from the bottom of the tanks and sprays it on the surface. However, since it is occasionally necessary to transport fish across the Straits of Mackinac by car ferry where all gasoline engines must be turned off during the hour-long trip, another method of oxygenating the water was sought. After consideration of several methods, commercial oxygen was chosen as the one most adaptable to our needs. It could also be carried on regular trips by the planting units for use in emergencies. Furthermore, the use of oxygen as an aid in transporting fish is common practice in several states at the present time and is therefore a proven method.

Several tests were made in which the fish were carried first with the recirculation system, changed to oxygen for one hour and back to recirculation again to simulate the trip across the Straits of Mackinac.

Tests were also made using several sizes of three species of trout. The use of oxygen was successful and no untoward effects were noted among trout so carried.

Oxygen liberators made of rubber tubing perforated with many small holes proved to be unreliable and further tests are planned using liberators of different types.

The following recommendations are based on the tests which were conducted in the tanks (53.5 inches long, 19.5 inches wide, filled with water to a depth of fifteen inches) on a standard planting unit, with water previously recirculated for twenty minutes (to raise oxygen content to at least 8 ppm.), and with a temperature range of 45° F. to 55° F.

Species	Size	Pounds per tank	Liters of Oxygen per minute
Lake trout	Fingerling (1.5 inches to 4 inches)	40	0.5 for 20 minutes, change to 0.25
Brook trout	Fingerling (1.0 inches to 1.5 inches)	60	0.5 for 20 minutes, change to 0.15
Brook trout	Sub-legal and legal (5 inches to 10 inches)	100	2.0 for 15 minutes, change to 1.0

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Introduction

The recirculation system has been employed successfully for many years by the Michigan Conservation Department for transporting various species of fish. In this system, a pump powered by a gasoline engine draws water from the bottom of the tanks and sprays it on the surface. However, since it is occasionally necessary to transport fish across the Straits of Mackinac by car ferry where all gasoline engines must be turned off during the hour-long trip, another method of oxygenating the water was sought. After consideration of several methods, commercial oxygen was chosen as the one most adaptable to our needs. It could also be carried on regular trips by the planting units for use in emergencies. Furthermore, the use of oxygen as an aid in transporting fish is common practice in several states at the present time and is therefore a proven method.

The experiments reported here were designed to determine whether trout could be changed from one system to another while in transit without detrimental effects to the fish, and to determine the amount

of oxygen required to maintain a safe level during transit across the Straits of Mackinac.

The work of Mr. David C. Haskell of the New York Conservation Department (An Investigation of the Use of Oxygen in Transporting Trout.- Trans. Amer. Fisheries Society, Vol. 70 (1940), pp. 149 to 160) was used as a basis for these tests. The Harrietta station was used for the tests because planting units from this station were scheduled to transfer lake trout from the Federal hatchery at Charlevoix across the Straits on July 16, 1951, and personnel involved could be indoctrinated to the use of oxygen at the same time the tests were being made.

Materials

Two tanks of a standard four-tank planting unit were used in the preliminary tests at Harrietta. Road tests were made using all four tanks. Oxygen was derived from a commercial cylinder with a capacity of 122 cubic feet which was installed on the truck. Oxygen was piped through copper tubing to the space between the four tanks and thence by rubber windshield-wiper tubing through holes above water level in the sides of each tank to liberators on the bottom of the tanks. The liberators used were originated by Mr. Charles Affolter, Rome State Fish Hatchery, Rome, New York, and are described in the Progressive Fish Culturist, Vol. 11, No. 1, p. 24. These liberators are used exclusively by the New York Conservation Department. Mr. David Haskell, Superintendent of the State Fish Hatchery, Rome, New York, sent two of these liberators for the tests. When we were unable to obtain proper materials with which to duplicate them in time for the Straits transfer, he supplied at a moderate cost additional liberators to outfit two planting units necessary for the transfer.

Mr. Haskell's report described oxygen used in cubic feet per hour but we were unable to locate a flow meter that indicated cubic feet. We obtained instead, a flow meter such as is used in hospitals which indicated flow in liters per minute (Flow meter Model No. 212, National Cylinder Gas Company, Medical Gas Division, Chicago).

Method

Mr. Haskell's report suggested one cubic foot per hour for brown trout five and one-half inches long so we elected this quantity as a safe initial flow. In converting from cubic feet per hour to liters per minute, we used 0.5 liters per minute as approximately one cubic foot per hour (one cubic foot per hour equals 28.327 liters per hour or 0.472 liters per minute). Since the scale on the flow meter did not read below one liter per minute, it was necessary to use at least two tanks, each receiving 0.5 liters per minute for the tests. Readings below one liter per minute were estimated.

Most of the tests were timed to run for one hour, since that was the interval needed while crossing the Straits. With the exception of two instances (No. 6 and No. 8), water was recirculated for about twenty minutes before introducing the fish to bring the oxygen content up to at least eight parts per million because the well water used to fill the tanks contained only three parts per million of oxygen.

Oxygen determinations were made of the water in the tanks every fifteen minutes during most of the tests and every ten minutes during others. The Winkler method of oxygen determination was used.

A series of eight experiments were conducted in the tank truck at Harrietta involving heavy (60 pounds per tank) and light (40 pounds

per tank) loads of lake trout fingerlings (3 inches to 5 inches long), small lake trout fingerlings (1.5 inches long), small brook trout fingerlings (1 inch to 1.5 inches long) loaded sixty pounds per tank, legal brook trout (5 inches to 10 inches long) ninety-five and one hundred pounds per tank. To simulate transfer operations across the Straits, a road test (No. 3) was made in which lake trout fingerlings loaded sixty pounds per tank were carried a distance of twenty-five miles from Harrietta under recirculation, changed to oxygen for one hour while the unit was parked at the side of the road, and changed to recirculation for two hours returning to Harrietta.

Observations

The experiments indicated that there was some variation in oxygen requirements for normal loads of trout depending upon the size and species of the fish. Fingerling lake trout averaging 1.5 inches long and loaded sixteen thousand per tank required 0.5 liters per minute for fifteen minutes and 0.25 liters per minute for the ensuing forty-five minutes in a test made while crossing the Straits. This schedule of oxygen flow raised the oxygen content of one tank from 8.1 ppm. to 10.0 ppm. and another tank from 8.1 ppm. to 14.0 ppm. in fifteen minutes and maintained the levels for the next forty-five minutes between 10.0 and 10.1 ppm. in one case and 14.0 and 14.3 ppm. in the other case. Difference in the oxygen content of the two tanks was due to variations in the rate of escape of oxygen from the two rubber liberators. Another test (No. 5) indicated that brook trout fingerlings of the same size would require only 0.15 liters of oxygen after the first twenty minutes of 0.5 liters. Legal rainbow trout (No. 9)

(5 inches to 10 inches in length) and legal brook trout (No. 7) (5 inches to 10 inches in length) loaded one hundred pounds per tank (11.11 pounds per cubic foot) required two liters of oxygen per minute for ten minutes and one liter of oxygen per minute for the remainder of the ninety-minute test to maintain the dissolved oxygen at a constant level.

The oxygen content of the water was not permitted to exceed 14.4 ppm. at any time as a precaution against any possible untoward effects upon the fish. Haskel reported a concentration of oxygen of 27.7 ppm. with no damage to brown trout. Neither during the tests nor afterward was any mortality or unnatural behavior noted among the fish that could be attributed to the tests.

Recommendations

On the basis of the present tests, the following recommendations are made for trout to be held for one hour in one tank 53.5 inches long, 19.5 inches wide and a water depth of fifteen, previously recirculated for twenty minutes (to raise oxygen content to at least 8 ppm.), and a temperature range of 45° to 55° F.:

Species	Size	Pounds per tank	Liters of Oxygen per minute
Lake trout	Fingerling (1.5 inches to 4 inches)	40	0.5 for 20 minutes, change to 0.25
Brook trout	Fingerling (1.0 inches to 1.5 inches)	60	0.5 for 20 minutes, change to 0.15
Brook trout	Sub-legal and legal (5 inches to 10 inches)	100	2.0 for 15 minutes, change to 1.0

Discussion

The experiments demonstrated that it is possible to change from the recirculation system, to oxygen and back to recirculation with no damage to the fish and with little effort on the part of the transport crew. However, some difficulty was encountered due to unpredictable behavior of the rubber liberators. Mr. Bill Waters of the Harrietta hatchery assisted with all experiments and drove one of the units involved in the transfer of fingerling lake trout across the Straits from the Charlevoix Federal hatchery. He reported that the rubber liberators had proved to be unreliable in that some of the holes sometimes stuck shut and could not be opened by stretching the tubes. The next time the tubes were used, the ones that had been plugged before functioned perfectly while some holes stuck shut in liberators that had operated satisfactorily during previous runs. Since there was one liberator in each of the four tanks on a unit and the oxygen supply for all four passed through one flow meter, the meter would not indicate that a liberator was plugged because oxygen would be diverted through the other three liberators. It was necessary, then, to closely observe the fish in each tank and if they became distressed from lack of oxygen, manual aeration of the water was undertaken.

Due to the fact that we did not understand too well the operation of the rubber liberators, further tests are planned using copper or brass tubing perforated with a jeweler's drill, as is currently used by the Minnesota Conservation Department, and with aloxite carborundum stones as used by the Wisconsin Conservation Department.

INSTITUTE FOR FISHERIES RESEARCH

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