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STATE UNIVERSITY
St. Cloud, Minnesota

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MINNESOTA DEPARTMENT OF CONSERVATION
DIVISION OF GAME AND FISH
BUREAU OF FISHERIES

Investigational Report No. 141

A Study of the Suitability of Abandoned Granite Quarries
Near St. Cloud, Minnesota, For Put-and-Take Fishing
Of Brown and Rainbow Trout.

By

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SUMMARY

Abandoned granite quarries near St. Cloud, Minnesota, have long been stocked with trout to supply trout fishing. These quarries usually contain 50 to 75 feet of water and range in size from less than one-fourth to more than two acres.

Investigations made in the summers of 1950 and 1951 showed thermoclines to be located usually at depths of 15 to 30 feet. Temperatures above the thermoclines in August, 1951, ranged from 66° to 70° F. On the basis of the amount of cooler and deeper water with sufficient oxygen for trout the quarries are of two types: (1) those with a shallow layer of cool water (7 to 12 feet thick) that is suited to trout and (2) those with a thicker layer of cool suitable water (18 to 23 feet thick). Water with a dissolved oxygen content of less than 3.0 p.p.m. was considered to be unsuitable for trout.

Past fishing history of these quarries suggested that a good return to the creel has been had from plantings of catchable-sized trout and that fingerling stocking has been of little value. To gather definite information on survival of stocked catchable-sized trout to the creel, Dodd Quarry was poisoned with rotenone in the fall of 1950 and stocked in the spring of 1951 with 337 brown trout weighing 4.5 to the pound. Subsequent check of anglers' catches showed a known return of 45 percent of the stocked fish and a probable total return of 60 percent.

Eight quarries were selected in 1953 to determine their capabilities for supplying put-and-take fishing of brown and rainbow trout. Four each of the two previously described types were used, two of which were planted with brown trout and two with rainbow trout. Stocking was done at the rate of about 75 pounds per acre and a total of 2,411 brown trout weighing 5.4 to the pound and 1,386 rainbow trout weighing 3.0 to the pound were planted in the eight quarries.

All planted trout were marked with a small monel-metal jaw tag^{1/} attached to the opercle. This type of tagging later proved to be not too satisfactory since many trout were taken with torn opercles that had evidently lost their tags.

Despite tag loss, 33 percent of the tagged brown trout were taken by anglers and tags returned and 50 percent of the rainbow trout. No consistent difference of the percentage return of tags was noted from the two types of quarries.

^{1/} No. 4 tag of National Band and Tag Company.

An estimate of fishing pressure on the different quarries was obtained from 33 morning or evening counts of anglers on all the quarries. To obtain an index of the comparative capability of each quarry to supply put-and-take fishing the percentage return of tags for the season was divided by the total number and anglers counted on the quarry during the 33 counts.

By this index no consistent difference was found in the capabilities of the two types of quarries to supply put-and-take fishing. However, its use showed that the quarries were about three times more efficient in supplying put-and-take fishing for rainbow trout than they were for brown trout.

INTRODUCTION

Since 1920 many of the granite quarries near St. Cloud, Minnesota, have been abandoned and allowed to fill with water. Trout planting in the quarries began about 1937 and since that time over 330,000 fingerlings and 60,000 yearling and adult trout have been planted. Old records are incomplete but it appears that of the trout stocked, about 60 percent were catchable trout and 40 percent were yearlings. More than twenty-five quarries have been stocked at various times and some of them have produced good trout fishing.

In recent years, the quarry plantings have been made with surplus fingerling and small yearling trout that remain in the hatcheries at the end of the season. The quality of fishing is reported to have declined.

The Fisheries Research Unit began investigating conditions in the St. Cloud Quarries in 1950 and terminated the work in 1953 with the stocking experiment described in this report.

DESCRIPTION OF THE ST. CLOUD QUARRIES

Most of the abandoned quarries are in T. 124 N., R. 28 W. of Stearns County, just southwest of St. Cloud, Minnesota. Each is a large pit of solid granite ranging from less than one fourth acre to more than two acres in size. As a rule these quarries have no watersheds but appear to fill with ground water at a slow rate. In most, the water level is within a few feet of the level of the surrounding land. Depths of over 100 feet are not uncommon but maximum depths in most are between 50 and 75 feet.

The sides are for the most part vertical walls of granite and littoral areas are limited to a few rock ledges. Coontail (Ceratophyllum demersum) grows on many of these ledges and mosses and algae cover the vertical sides beneath the water. Snails and caddis fly nymphs are numerous.

The bottom of the quarries is covered with a very fine black flocculant material that probably is decomposed plankton. There was no oxygen at the bottom of any of the quarries that were tested and the odor of hydrogen sulfide gas was strong in bottom samples and in water samples taken within a few feet of the bottom. Large red bloodworms (Chironomus spp.) were the only animals noted in bottom collections.

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A water sample collected from the surface of the Black Diamond Quarry on May 25, 1950, had a total alkalinity of 122 p.p.m. and a fairly low nitrogen content (0.34 p.p.m.).

So far as is known all of the quarries stratify thermally during the summer months. Thermocline limits in late August, 1951, were between 15 and 30 feet in most of the twenty quarries that were checked. Only three of these quarries had sufficient oxygen below the thermocline to support trout. At that time temperatures above the thermocline (epilimnion) were between 66 and 70 degrees F. and no doubt raise above that during extended periods of hot weather. Table 1 is a summary of physical and chemical data collected on twenty quarries on August 20-23, 1951.

EXPERIMENTAL STOCKING OF DODD QUARRIES, 1951

On September 21, 1950, the Dodd Quarry in Sherburne County was treated with emulsified rotenone. Thirteen rainbow trout, weighing about a third of a pound each were collected along with over 5,000 small green sunfish, four large suckers, and 186 tadpole matdoms. A total of 213 pounds of fish were removed from this quarry which has an area of about one acre.

On June 13, 1951, the Dodd Quarry was restocked with 337 brown trout weighing 75 pounds or 0.22 pounds each. Six men from St. Cloud who fished the quarry regularly caught 151 of these trout and either observed or heard of another 51 being taken during the first summer. Some of these fish had grown to better than half a pound when they were caught and it is probable more pounds of trout were removed than were stocked.

EXPERIMENTAL STOCKING OF EIGHT QUARRIES, 1953

Eight quarries were stocked with large trout in the spring of 1953. The purpose of the experimental stocking was to determine:

1. Whether or not the difference in thermocline depth and dissolved oxygen content observed during late summer of 1953 would have any bearing on the return of stocked trout.
2. What species of trout would produce the best returns to the angler.

Four of the quarries were selected that had, at the time of the 1951 investigation, from 7 to 12 feet of water between the top of the thermocline and the lower level of 3 p.p.m. oxygen content. During extended periods of hot weather trout would, theoretically, be restricted to this layer. Two of these quarries were planted with brown trout and two with rainbow trout.

Four other quarries were selected that had, at the time of the 1951 investigation, from 18 to 23 feet of this theoretically "suitable" trout water. Two of these quarries were also planted with brown trout and two with rainbow trout.

Accurate acreages of the quarries are not known but as near as could be estimated trout were planted on a 75 pound-per-acre basis in all quarries. Twenty-four hundred and eleven brown trout weighing 443 pounds and 1,386 rainbow trout weighing 462 pounds were planted on May 5 and May 6, 1953, a few days after the opening of the trout season. Table 2 shows the fish stocked in these eight quarries.

All of the brown trout and 602 (43.5 percent) of the rainbow trout were tagged with small monel-metal jaw tags attached to the opercles a few days before planting.

Tag Recovery

The St. Cloud Community Wildlife Club in co-operation with local merchants sponsored a contest offering prizes for tags to encourage anglers to return tags from captured trout. Signs were erected at all quarries advertising the contest and requesting anglers to turn their tags in to one of three sporting goods stores in St. Cloud. The planting and the contest was given considerable publicity in the St. Cloud newspaper. It is felt that because of the excellent co-operation of these groups, a high percentage of the tags taken were returned.

Tag Loss

Unfortunately the opercles of the trout were soft and many tags were torn off during the season. Many anglers reported catching as many trout with tags torn off as with tags intact. An accurate estimate of the loss of tags is impossible but from all reports it appears that almost half of the tags were lost before the end of the summer.

Return of Stocked Trout

By the end of the trout season, 635 tags were turned in from the quarries where brown trout had been planted and 303 from quarries where rainbow trout had been planted. This represents a 33.4 percent return of stocked brown trout and a 50.3 percent return of stocked rainbow trout. Since tag losses probably approached fifty percent, the actual return to the angler of stocked brown trout probably approached 60 percent and that of stocked rainbow trout may have approached 90 percent.

Relative Angling Pressure

Any comparison of the tag returns from individual quarries must take into account the differences in angling pressure on the individual quarries. Between May 9 and the end of the trout season, 33 counts of anglers fishing on the quarries were made. These counts were made by Mr. D. Y. Carpenter, a graduate student at the St. Cloud Teachers College, either in the morning before 8 A. M. or in the evening between 6 P. M. and sunset. Much of the angling fell within these periods. Counts were spaced evenly throughout the summer and each time all quarries were counted within a period of two hours. The heaviest fishing pressure was observed to be prior to the opening of the general fishing season on May 15. These counts, representing comparative fish pressures on the individual quarries, are shown in Table 3.

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A relative index of the capability of each quarry to supply put-and-take fishing was obtained by dividing the percentage return of the tags by the total number of anglers counted on that quarry during the fishing season.^{1/} Table 3 shows the percentage return of tagged trout, the counts of fishermen on each quarry or relative angling pressure, and this "index of put-and-take fishing capability".

There was no consistent difference either in the percentage of tag returns or the "index of put-and-take fishing capability" in the two types of quarries with thick and thin layers of "suitable" trout water. Hole 13 Quarry, that had only 11 feet of "suitable" trout water in 1951, and Trabetusky Quarry that had 23 feet, both produced exceptionally good trout fishing for the few anglers who fished there. The Dodd Quarry with only three feet of "suitable" water, the Transformer Quarry with 20 feet, the Algren No. 5 Quarry with ten feet, and the Melrose Deep Quarry with 20 feet, all produced fishing of about equal quality. The poorest angling was from the Melrose Red Quarry that had only five feet of "suitable" trout water, but the second poorest fishing occurred in the Theilman Quarry that had fifteen feet of "suitable" water. This suggests that, while trout may be limited to the water below the top of the thermocline and above the lower limits of about three parts per million oxygen content during extended periods of hot weather, they are also able to use the entire epilimnion during most of the summer. Thermocline depths and oxygen concentrations within the range found in the quarries may have a definite bearing on the survival of trout from one year to the next but they do not seem to have any effect on angling quality during the first season.

There was a consistent difference in both the percentage of tag returns and the "index of put-and-take capability" for brown and rainbow trout. All of the quarries stocked with rainbow trout showed a higher percentage of tags returned than did any of the quarries stocked with brown trout. The average "index of put-and-take capability" for rainbow trout was 2.24 compared with 0.83 for brown trout.

^{1/} Such a calculation assumes: (1) that the tag loss and mortality of trout was proportionate in all the quarries and (2) that the total angler counts are proportionate to the total fishing pressure. Thus, by such a calculation a return of 50 percent of the fish from a quarry with a total angler count of 100 would give an index figure of 50/100 or 0.5. If the return were 50 percent and the number of anglers was 25 the factor would be 50/25 or 2.0 showing that the latter quarry allowed better fishing because fewer anglers caught the proportion of the stocked fish. The index figures are comparative only and shows the combined effect of conditions in the quarries and the inherent values of the two species of trout for supplying put-and-take fishing.

DISCUSSION

The purpose of this study was to determine what sort of quarry and what species of trout would give the best return to the angler. Only large trout were used because past evidence indicates that fingerling trout or even small yearlings do not produce much fishing. There are a good many quarries that have had considerable numbers of small trout in them for years. These fish do not grow well and they are too small to attract the angler.

There is evidence that trout do not reproduce in the quarries. Stocking there, should be on a put-and-take basis with the angler being encouraged to take as many as possible the first summer. This seems assured if large fish are planted.

The results of trial stocking in 1953 suggest that most of the quarries are suitable for stocking of large trout.

The most positive fact brought out was that stocked rainbow trout produced better angling than did brown trout. The fact that the rainbow trout were somewhat larger when planted may have had some influence, but experience in other trout waters have shown rainbows are often more easily taken than brown trout and also survive well in warmer waters.

TABLE 1

Chemical and Physical Data On St. Cloud Quarries - 1951

Quarry Name	Quarry Number	Date Surveyed	Temperature Epilimnion ^{2/} Degrees F.	Limits Of Thermocline Feet	Lower Limits 3.0 p.p.m. Oxygen-feet	Lower Limit Of Any Oxygen-feet	Maximum Depth Feet
Melrose	1	August 23	67	23-40	33	--	68
Graham	2	August 23	68	17-33	27	37	50
Graham	3	August 23	68	17-27	28	42	70
Robinson Hill	4	August 22	70	13-23	17	22	30
Algren	5	August 20	69	17-27	27	37	50
Melrose Red (#1)	6	August 21	66	17-27	22	40	65
Melrose Deep (#2)	7	August 21	66	17-43	37	70	100
Oberg (#4)	8	August 21	67	12-18	26	40	60
Thielman (#7)	9	August 21	68	12-23	27	36	65
Trabetusky (#8)	10	August 23	68	17-27	40	65	98
Cemetery	11	August 20	69	17-37	38	--	40
Holes	12	August 22	74	12-23	14	22	30
Holes	13	August 22	70	12-33	23	31	55
Benzy } #5 15 & 18	14	August 22	68	17-36	34	52	55
Benzy }	15	August 22	66	17-27	42	57	60
Transformer	16	August 21	63	22-29	42	50	55
Young	17	August 20	66	13-27	27	50	55
Algren	18	August 20...	69	17-33	47	60	100
Black Diamond	19	August 20	68	17-23	24	32	45
Dodd	20	August 23	68	20-40	23	30	40

1/ Quarries are numbered for identification because of duplication of names.
 2/ Epilimnion - warm-water layer above the thermocline.

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TABLE 2

Stocking Of Eight St. Cloud Quarries In 1953

Quarry Name	Quarry Number	Area-Acres	Brown Trout		Rainbow Trout	
			Number	Pounds	Number	Pounds
Group 1 - "Suitable" trout water 7 to 12 feet thick.						
Melrose Red	6	+ 2.5	974	179	--	--
Dodd	20	+ 1.2	479	88	--	--
Algren	5	+ 2.0	--	--	486	162
Holles	13	+ 1.0	--	--	225	75
Group 2 - "Suitable" trout water 18-23 feet thick.						
Thielman	9	+ 1.2	479	88	--	--
Transformer	16	+ 1.2	479	88	--	--
Melrose Deep	7	+ 2.0	--	--	450	150
Trabctusky	10	+ 1.0	--	--	225	75
Totals			2,411	443	1,386	462

TABLE 3

Percentage Return Of Tanned Fish Against Counts And T...

TABLE 3

Percentage Return Of Tagged Fish, Angler Counts And Indices Of Capabilities Of The Quarries To Supply Put-And-Take Fishing.

Quarry Name	Quarry Number	Species Of Trout	Percent Tag Return	Total Anglers Counted On 33 Counts.	Index Of Quarry Capability For	
					Brown Trout	Rainbow Trout
Group 1 - "Suitable" trout water 7-12 feet thick.						
Melrose Red	6	Brown	24.1	103	0.24	1.25
Dodd	20	Brown	29.8	25	1.19	3.18
Algren	5	Rainbow	57.4	46		
Holes	13	Rainbow	38.2	12		
Group 2 - "Suitable" trout water 18-23 feet thick.						
Thielman	9	Brown	31.3	42	0.75	1.25
Transformer	16	Brown	23.8	21	1.13	5.08
Melrose Deep	7	Rainbow	57.4	46		
Trabetusky	10	Rainbow	66.0	13		
Totals				308		
Means			41.0		0.83	2.69