Reproduction of Planted Lake Trout in Lake Michigan

Wilbert C. Wagner

Fisheries Research Report No. 1885
October 6, 1980

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
FISHERIES DIVISION

Fisheries Research Report No. 1885

October 6, 1980

REPRODUCTION OF PLANTED LAKE TROUT IN LAKE MICHIGAN[1]

By Wilbert C. Wagner

Abstract

Although lake trout planted in Lake Michigan survive well and many spawn, there has been little evidence of successful reproduction except for the capture of a few sac fry in a power plant intake. To determine if other reproduction occurred, I examined eight natural reefs and three artificial structures in northeastern Lake Michigan in 1973-1979. I used pumps, a beam trawl, and emergent fry traps to sample for eggs and/or fry. A few viable eggs were found on three of the natural reefs and many were collected from the artificial structures. Fry were not found on the natural reefs and one artificial structure; they were rare on one artificial structure and very abundant on another. The fry collected were 24-36 mm (TL) long.

---

[1] Contribution from Dingell-Johnson Projects F-31-R and F-35-R, Michigan.

Introduction

Lake trout (Salvelinus namaycush) in Lake Michigan became essentially extinct in the early 1950's (Eschmeyer 1957). Efforts to reestablish the species have been extensive. Since 1965, 1-3 million yearling lake trout have been stocked annually. Survival to maturity has been excellent (Rybicki and Keller 1978), but reproduction has been scant. The only evidence of reproduction was the capture of a few sac fry in the intake of the Traverse City Municipal Power Plant in 1977 (Madsen 1977). In my study, I examined natural and artificial reefs in northeastern Lake Michigan to determine if reproduction occurred elsewhere and if fry survived past the sac fry stage.

Study areas

I examined three natural reefs near Charlevoix, five in Grand Traverse Bay and three artificial rock-rubble structures near Traverse City (Figure 1) in 1973-1979. All areas sampled were near shore and within 9 km of a stocking site (Table 1). Spawning lake trout of hatchery origin were abundant at all areas (Peck 1979; Ralph Hay, personal communication; my unpublished data). The substrate at natural reefs was generally cobble and boulders ranging in size from 0.05 to 1 m. Some sand was present at Charlevoix and Bowers harbors. The substrate was observed by scuba divers at Bellow Island, New Mission Point, and Bowers Harbor. At other natural reefs, I determined that the substrate

was rocky by observations from the surface in shallow water, by the action of a towing cable, and by the absence of silt, sand, and gravel in samples that were pumped up.

At Elmwood Marina, the breakwall core is 1- to 2-m boulders. The boulders are covered with crushed rock (5-30 cm) near the marina entrance (at Station 6 in Figure 2) and elsewhere by rounded rock (7-30 cm). Some sand, silt, and algae covered the substrate especially on the inner protected side of the breakwall but the rock near the marina mouth was swept clean by currents. The 230-m long breakwall extends 5 to 8 m from the waters edge into water 4 to 7 m deep. Beyond this the substrate is sand.

The crib at the end of the cooling water intake pipe for the Traverse City Municipal Power Plant is 450 m offshore in water 9 m deep. The 2-m high log crib has outer walls 4.9 m square and inner walls 2.7 m square. The 1.1-m space between the walls is filled with rounded rock 5 to 15 cm in diameter. When the crib was built, over 30 years ago, some rock spilled over the sides and covered the sand substrate to a distance of 2 m from the crib.

The 125-m long breakwall at Clinch Yacht Harbor is made of rounded and broken rock 5 cm to 1 m in diameter, but most are larger than 25 cm. The breakwall extends out 3 to 10 m into water 3 to 4 m deep. The substrate beyond this is sand.

Methods

In the fall, after lake trout had spawned, egg pumps were used to sample for eggs. On natural reefs, an air lift pump was used in 1973 and an 8-cm centrifugal pump thereafter. On the artificial reefs, divers probed the interstices with the intake of a 4-cm centrifugal pump. In the spring, eggs and fry were sampled with the pumps. Emergent fry traps and a beam trawl also were used to sample fry. These collecting gear and methods used were described in detail by Stauffer (1980).

Sampling on natural reefs was done at various depths and on representative portions of each reef where it was believed that lake trout had spawned.

At Elmwood Marina, in November-December 1977 and April 1978, divers sampled with the 4-cm pump in areas which they judged to be the most suitable substrate. Suitable substrate was assumed to be rock and rubble with deep interstices and free of sand, silt, and algae. Pumping in November 1977 was done in the area between stations 7 and 8 (Figure 2). In December 1977 and April 1978, half of the pumping was done in the same area and half near Station 6. In April-June 1978, eight fry traps were fished on what the divers judged to be the best substrate along the outside of the east breakwall. Traps were 3 to 36 m from the end of the breakwall in water 2 to 6 m deep. In July 1978, five traps were fished on each side of the marina mouth (near stations 5 and 6) in water 2 to 6 m deep. In November 1978, 17 collecting stations were

established at intervals of 30 m along the inside and outside of both breakwalls. Subsequently at each station in November 1978 and May 1979, divers pumped for about 5 minutes in an area 1-2 m wide that extended from the submerged base of the breakwall to where it emerged from the water. During May-July 1979, one to four emergent fry traps were fished at each station.

At the power plant crib, 4-cm pump samples were taken from small areas on the top and base of the crib in November and December 1977, and in April and November 1978. Three emergent fry traps were fished on the top and three on the base of the crib during April-June 1978.

At Clinch Yacht Harbor, five stations at 30-m intervals along the breakwall were sampled in November 1978 and May 1979. At each station, divers sampled with the 4-cm pump for about 5 minutes in an area 1-2 m wide that extended from the submerged base of the breakwall to where it emerged from the water. A fry trap was fished at each station during May-July 1979.

Results

A few live eggs were collected from three of the five natural reefs that were sampled in November (Table 2). Ten percent of these eggs had reached the eyed stage. However, extensive sampling with the 8-cm pump, the beam trawl, and emergent fry traps in the following spring failed to produce any fry (Table 2). No fry were collected from the three reefs that were sampled only in the spring.

At Elmwood Marina, scuba divers with the 4-cm pump, collected many live eggs in November and December 1977, but did not find eggs or fry in April 1978 (Table 2). However, fry traps caught substantial numbers of fry (24-36 mm, TL) in May and June from the same areas that had been sampled with the pump. One sac fry was caught during 19 April-18 May, 79 swim-up fry were caught during 19 May-8 June, 78 during 9-28 June, and none during 6-26 July.

In November 1978, live eggs were collected at 12 of the 17 stations at Elmwood Marina (Table 3). Stations 2, 3, 5, and 6, which were located outside the marina, produced 86% of the live eggs collected. Most stations without eggs were in protected areas where silt deposits covered the substrate. Extensive pumping in May 1979 at all stations produced only five live eggs which suggested that over-winter survival was very low. However, large numbers of fry (24-31 mm, TL) were caught in the fry traps in May-July 1979 (Table 3). Fry were caught in all but four of the 32 traps; the majority were caught during 24 May-19 June at a rate of 0.53 fry per trap per day.

At the power plant crib, eggs were very abundant in November and December 1977 (Table 2). Pumping in April 1978 showed that many eggs and fry had survived. No fry were found in the fry traps. However, the number of ninespine sticklebacks (Pungitius pungitius) in the six traps on 18 May, 8 June, and 28 June were 7, 232, and 499, respectively. If lake trout fry entered the traps they may have been eaten. Pumping at the crib in November 1978 again showed that large numbers of eggs were deposited. I did not assess survival of these eggs to the fry stage.

At Clinch Yacht Harbor, a few eggs were collected in November 1978, but no eggs or fry were collected in the spring of 1979 by pumping or fry traps (Table 2). The breakwall is exposed to northerly winds and divers reported extreme turbulence even with moderately rough seas.

Discussion

I could not determine why successful reproduction occurred only at Elmwood Marina. However, the cause of failure at other areas probably was not inadequate numbers of spawners, contaminants, or predators (in most cases). Abundance of hatchery spawners was equal to or greater than in self-sustaining populations of wild fish (Peck 1979; Ralph Hay, personal communication). DDT and PCB's did not have an effect on early survival of lake trout in Lake Michigan (Stauffer 1979). Further, there is no reason to believe that the level of contaminants at Elmwood Marina was lower than in areas where reproduction did not occur. Fish predation on eggs and fry is not severe (Stauffer and Wagner 1979). However, the abundant ninespine sticklebacks at the power plant crib may have caused extensive mortality, because Scott and Crossman (1973) report that sticklebacks eat small fish fry. The differences in survival between Elmwood Marina and the other areas likely was caused by subtle differences in substrate or other conditions that I was unable to detect.

Table 1.--Location and characteristics of areas where lake trout egg and fry survival were assessed, northeastern Lake Michigan, 1973-1979.

Location	Substrate[a]	Depth (m) of sample	Distance (km) to nearest stocking site	Abundance[b] of spawners
North Point	G,C,B	2-18	2	21[c]
Charlevoix Harbor	S,G,C	2-8	0	20[d]
Fishermans Island	RR,B[e]	2-16	9	117
Bellow Island	C,B[e]	2-18	9	103
New Mission Point	C,B[e]	2-15	7	126
Suttons Point	RR[e]	2-12	4	138
Bowers Harbor	S,P,C,B[e]	1-18	1	46
Marion Island	C,B[e]	1-17	4	86
Elmwood Marina	C,B,S	0-7	1	
Power Plant Crib	C	8-9	2	
Clinch Yacht Harbor	C,B	0-4	2	

[a] RR = rock-rubble of unknown size, otherwise substrate classified by size according to Wentworth in Welch (1948) as follows:
B (boulder) = > 256 mm
C (cobble) = 64-256 mm
P (pebble) = 4-64 mm
G (granule) = 2-4 mm
S (sand) = 0.06-2 mm

[b] Number of mature lake trout caught overnight per 305 m of 11.4-cm mesh gill net except at North Point and Charlevoix Harbor (Peck 1979).

[c] Number of mature lake trout caught in 1 hour in 30 m of 6.4-cm mesh net, 30 October 1975.

[d] Number of mature lake trout caught in 0.5 hour in 30 m of 6.4-cm mesh net, 4 November 1975.

[e] Peck (1979).

Table 2.--Collection data and catch of lake trout eggs and fry in northeastern Lake Michigan.

Location and gear	Date	Sampling effort[a]	Lake trout catch[b] Eggs	Fry
North Point				
Pump (A.L.)[c]	20 Nov 1973	15	9 (44)	
Pump (8 cm)	30 Apr 1974	930	0	0
Pump (8 cm)	5-22 Nov 1974	1,774	10 (60)	
Pump (8 cm)	1-21 May 1975	613	0	0
Pump (8 cm)	19 Nov 1975	185	23 (78)	
Pump (8 cm)	28 Apr-6 May 1976	752	0	0
Trawl	27-28 May 1976	4,310		0
Charlevoix Harbor				
Pump (A.L.)	14-20 Nov 1973	24	1 (0)	
Pump (8 cm)	17 Apr 1974	2,452	0	0
Pump (8 cm)	6-20 Nov 1974	1,635	1 (0)	
Fishermans Island				
Pump (8 cm)	7 May 1974	490	0	0
Pump (8 cm)	6 Nov 1974	736	0	
Pump (8 cm)	15 May 1975	296	0	0
Pump (8 cm)	13 May 1976	138	0	0
Trawl	2 June 1976	5,351		0
Bellow Island				
Pump (8 cm)	27 Apr 1977	292	0	0
Trawl	18 May-15 June 1977	14,230		0
Fry trap	11 May-15 June 1977	140		0
New Mission Point				
Pump (8 cm)	9 Nov 1976	49	18 (94)	
Pump (8 cm)	27 Apr 1977	276	0	0
Trawl	12 May-15 June 1977	16,798		0
Fry trap	11 May-15 June 1977	175		0
Suttons Point				
Trawl	26 May-9 June 1977	8,490		0

(continued, next page)

Table 2.--continued

Location and gear	Date	Sampling effort[a]	Lake trout catch[b] Eggs	Fry
Bowers Harbor				
Pump (8 cm)	10 Nov 1976	118	5 (80)	
Pump (8 cm)	21-26 Apr 1977	330	1 (0)	0
Trawl	11 May-14 June 1977	14,812		0
Fry trap	12 May-14 June 1977	148		0
Marion Island				
Pump (8 cm)	26 Apr 1977	151	0	0
Trawl	24 May-14 June 1977	11,500		0
Fry trap	12 May-14 June 1977	129		0
Elmwood Marina				
Pump (4 cm)	8 Nov 1977	20	76 (93)	
Pump (4 cm)	6 Dec 1977	16	264 (48)	
Pump (4 cm)	19 Apr 1978	10	0	0
Fry trap	19 Apr-26 July 1978	760		158
Pump (4 cm)	28 Nov 1978	85	600 (74)	
Pump (4 cm)	1 May 1979	82	9 (56)	0
Fry trap	2 May-2 July 1979	1,952		572
Power Plant Crib				
Pump (4 cm)	8 Nov 1977	17	527 (91)	
Pump (4 cm)	6 Dec 1977	12	589 (31)	
Pump (4 cm)	19 Apr 1978	10	150 (41)	15
Fry trap	19 Apr-28 June 1978	420		0
Pump (4 cm)	28 Nov 1978	10	852 (91)	
Clinch Yacht Harbor				
Pump (4 cm)	28 Nov 1978	23	9 (33)	
Pump (4 cm)	1 May 1979	25	0	0
Fry trap	2 May-2 July 1979	305		0

[a] Pump (A.L. and 8 cm) and trawl = m^2, 4-cm pump = minutes, fry trap = trap days.

[b] Percentage of live eggs in parentheses, all fry were alive when caught.

[c] Airlift.

Table 3.--Number of eggs collected with a 4-cm pump and number of fry caught in fry traps, Elmwood Marina, 1978-1979.

Station	Number of eggs [a] pumped		Number of traps	Fry trapped 1979		
	28 Nov 1978	1 May 1979		2 May-23 May	24 May-19 June	20 June 2 July
1	17 (70)	0	2	0	11	0
2	146 (87)	1 (100)	4	1	58	8
3	88 (73)	0	2	1	62	17
4	14 (57)	2 (0)	3	0	44	3
5	128 (77)	3 (100)	4	0	48	2
6	123 (76)	1 (0)	4	3	136	57
7	12 (17)	0	2	1	27	6
8	10 (50)	0	2	1	25	1
9	0	1 (0)	2	0	3	0
10	9 (67)	0	1	0	0	0
11	26 (85)	0	1	0	1	0
12	7 (43)	0	0			
13	0	0	1	0	0	0
14	6 (0)	1 (100)	1	0	2	0
15	11 (45)	0	1	0	38	15
16	0	0	1	0	0	0
17	3 (0)	0	1	0	0	1
Total	600 (74)	9 (56)	32	7	455	110

[a] Percentage alive in parentheses.

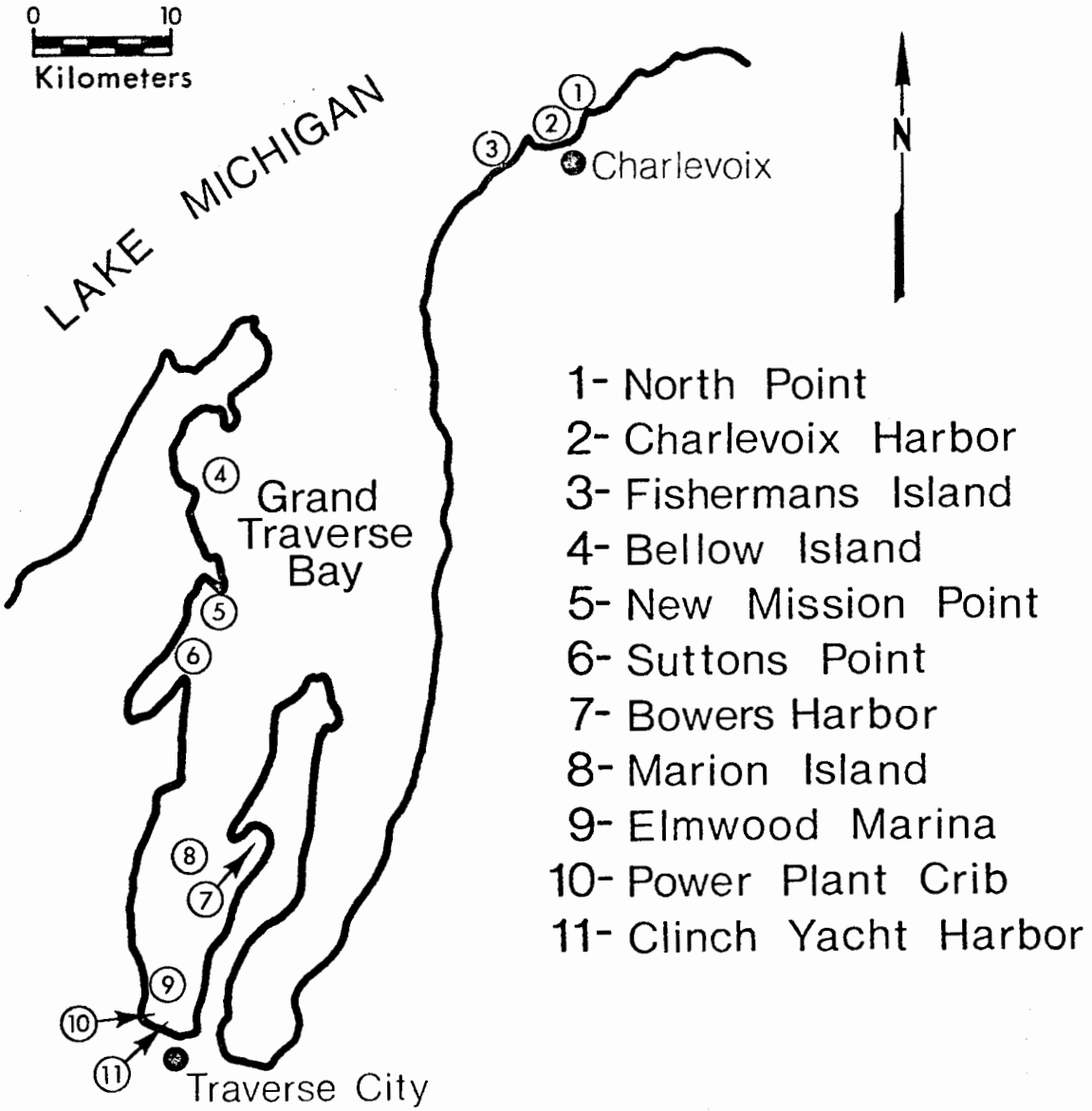

Figure 1.--Areas where lake trout egg and fry survival was assessed, northeastern Lake Michigan, 1973-1979.

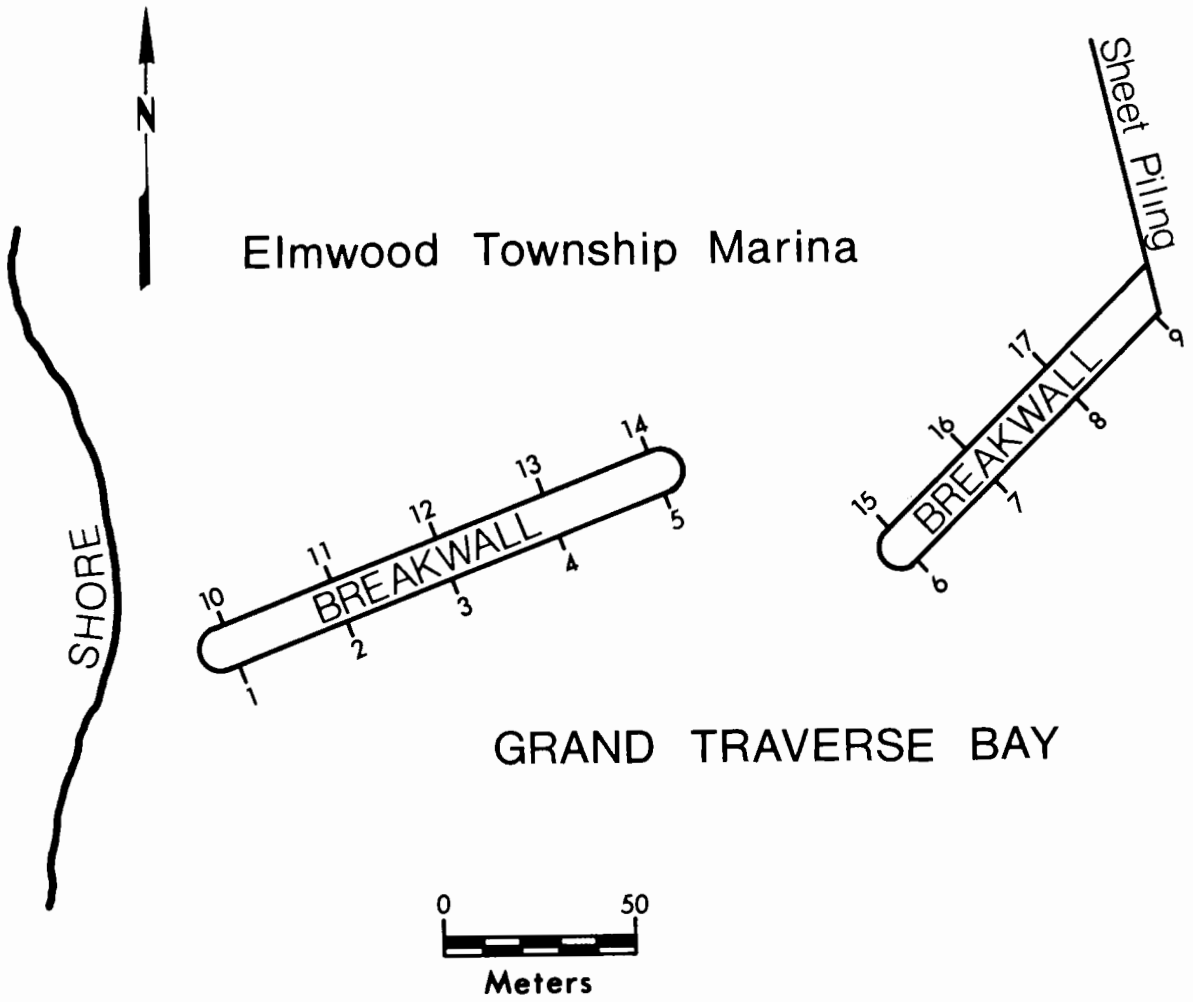

Figure 2.--Sampling stations (numbers 1-17) at Elmwood Marina, November 1978 and May-July 1979.

Acknowledgments

Many of the field data were collected by James W. Peck and Paul R. Hannuksela. Alan D. Sutton drafted the figures. The manuscript was reviewed by Thomas M. Stauffer, James W. Peck, and William C. Latta.

Literature cited

Eschmeyer, Paul H. 1957. The near extinction of lake trout in Lake Michigan. Transactions of the American Fisheries Society 85:102-119.

Madsen, Charleen S. 1977. Traverse City 316(b) demonstration. Final report of WAPORA Inc. to Traverse City Municipal Power Plant, Traverse City, Michigan (unpublished).

Peck, James W. 1979. Utilization of traditional spawning reefs by hatchery lake trout in the upper Great Lakes. Michigan Department of Natural Resources, Fisheries Research Report 1871, 33 pp.

Rybicki, Ronald W., and Myrl Keller. 1978. The lake trout resource in Michigan waters of Lake Michigan, 1970-1976. Michigan Department of Natural Resources, Fisheries Research Report 1863, 71 pp.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184, 966 pp.

Stauffer, Thomas M. 1979. Effects of DDT and PCB's on survival of lake trout eggs and fry in a hatchery and in Lake Michigan, 1973-1976. Transactions of the American Fisheries Society 108:178-186.

Stauffer, Thomas M. 1980. Collecting gear for lake trout eggs and fry. Michigan Department of Natural Resources, Fisheries Research Report 1884, 23 pp.

Stauffer, Thomas M., and Wilbert C. Wagner. 1979. Fish predation on lake trout eggs and fry in the Great Lakes, 1973-1978. Michigan Department of Natural Resources, Fisheries Research Report 1864, 13 pp.

Welch, Paul S. 1948. Limnological methods. McGraw-Hill, New York, New York, 381 pp.

Report approved by W. C. Latta

Typed by M. S. McClure