

*Overwintering Results of Eight Aerated Lakes
in the Northwest Boreal Region*

1996-1997

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ABSTRACT

Lake aeration is a fishery enhancement technique that is used to maintain dissolved oxygen levels in eutrophic lakes prone to winterkill. Eight stocked lakes that are susceptible to winterkill were aerated in the 1996-1997 (October - April) in the Northwest Boreal Region. These lakes were Cecil Thompson Park Pond, Moonshine Lake, Cummings Lake, Sulphur Lake, Spring Lake, East Dollar Lake, Figure Eight Lake, and Zama Pond. The lakes ranged in size from 2.0-53.0 ha and in depth from 3.0-22.0 m. The objective of this project is to sustain dissolved oxygen levels in these lakes at or above 3.0 mg/l. Maintaining the oxygen at this level or higher ensures the survival of trout throughout the winter (Fast 1994). Presently, the Northwest Boreal region is using a point release system of aeration, with mechanical surface aerators being tested on five of the above lakes in the 1996-1997 aeration season. The lakes that were used for conducting the tests were Cecil Thompson Park Pond, Cummings Lake, Moonshine Lake, Sulphur Lake and East Dollar Lake. Theron Miller, a PhD. student at the University of Alberta, is comparing the point release system that the Natural Resources Service now uses to the mechanical surface aerator. Some of the parameters measured were costs (initial, repair and maintenance) and how efficiently these two systems aerate (size of motor to lake and resulting oxygen levels). This is the third and final year in which comparison experiments will be conducted. Details and results from these studies will be in Miller's final report. The 1996-1997 aeration program results were successful with all eight lakes overwintering.

Previous over wintering results and aeration technique comparisons to the 1996-1997 aeration year can be found in Overwintering Results of Nine Aerated Lakes in the Northwest Boreal Region 1995-1996 annual report by David Jackson, June 1997, Natural Resources Service, Northwest Boreal Region.

1.0 INTRODUCTION

Eight stocked lakes that are susceptible to winterkill were aerated during 1996-1997 (October - April) in the Northwest Boreal Region. These lakes were Cecil Thompson Park Pond, Moonshine Lake, Cummings Lake, Sulphur Lake, Spring Lake, East Dollar Lake, Figure Eight Lake and Zama Pond (Figure 1). The lakes aerated ranged in size from 2.0-53.0 ha in size and 3.0-22.0 m in depth. Several lake aeration techniques have been used in the Northwest Boreal Region. Natural Resources Service is presently using a point release aeration system. NRS (Natural Resources Service) in conjunction with the University of Alberta are currently testing mechanical surface aerators. The mechanical surface aerators were tested on five lakes in 1996-1997. They were Cecil Thompson Park Pond, Cummings Lake, Moonshine Lake, Sulphur Lake and East Dollar Lake. There were two changes for the 1996-1997 aeration season. 1) Poirier's Pond has been removed from the aeration program due to the closing of the site to the public by the operators of the facility and 2) Sulphur Lake has a new diesel motor operating 4, new 1 hp mechanical surface aerators. Details of the above techniques are in the Methods section. Oxygen concentrations, ice depth and snow depth were recorded on a bi-weekly basis. Lake aeration is started prior to freeze up to induce oxygenation throughout the whole lake. The 1996-1997 aeration report details each lakes morphometry, aeration techniques, results and recommendations.

Previous over wintering results and aeration technique comparisons to the 1996-1997 aeration year can be found in Overwintering Results of Nine Aerated Lakes in the Northwest Boreal Region 1995-1996 annual report by David Jackson, June 1997, Natural Resources Service, Northwest Boreal Region.

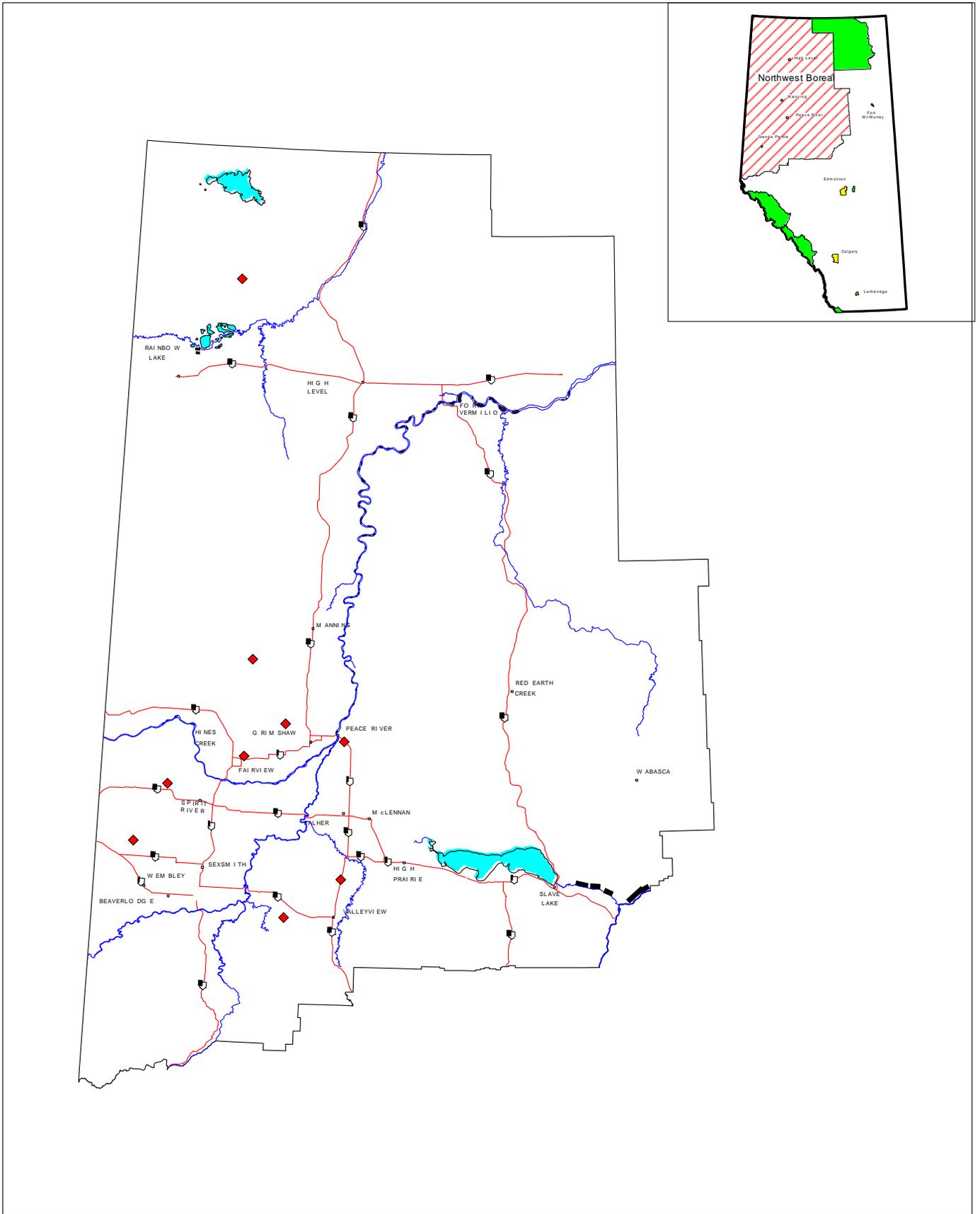


Figure 1. Location of aerated lakes in the Northwest Boreal Region

2.0 STUDY AREA

Table 1.

The study areas are the lakes summarized in the following table.

LAKE	LOCATION	SIZE	DEPTH		FISH STOCKED	YEARS AERATED
			(max)	(avg)		
C. Thompson Pond	SW 23-83-21-W5	.81ha	4.0m		RNTR	3 years
Moonshine Lake	SW 32-79-08-W6	30.8ha	3.9m	1.6 m	RNTR	9 years
Cummings Lake	SE 10-82-03-W6	26.9ha	3.3m	2.0 m	RNTR/BKTR	11 years
Sulphur Lake	NW 07-89-02-W6	53.4ha	7.6m	3.3 m	RNTR/BKTR	8 years
Spring Lake	SE 23-75-11-W6	32.1ha	22.0m	8.6 m	RNTR/BKTR	19 years
East Dollar Lake	NW 08-73-21-W5	5.6ha	8.0m	4.0 m	RNTR/BNTR	12 years
Figure Eight Lake	NE 20-84-25-W5	38.6ha	6.0m	3.0 m	RNTR	11 years
Zama Pond	SE 13-117-05-W6	0.5ha	9.2m		RNTR	13 years

NOTE: Years aerated column does not indicate successful overwintering or winterkills, only the number of years aerated.

3.0 METHODS

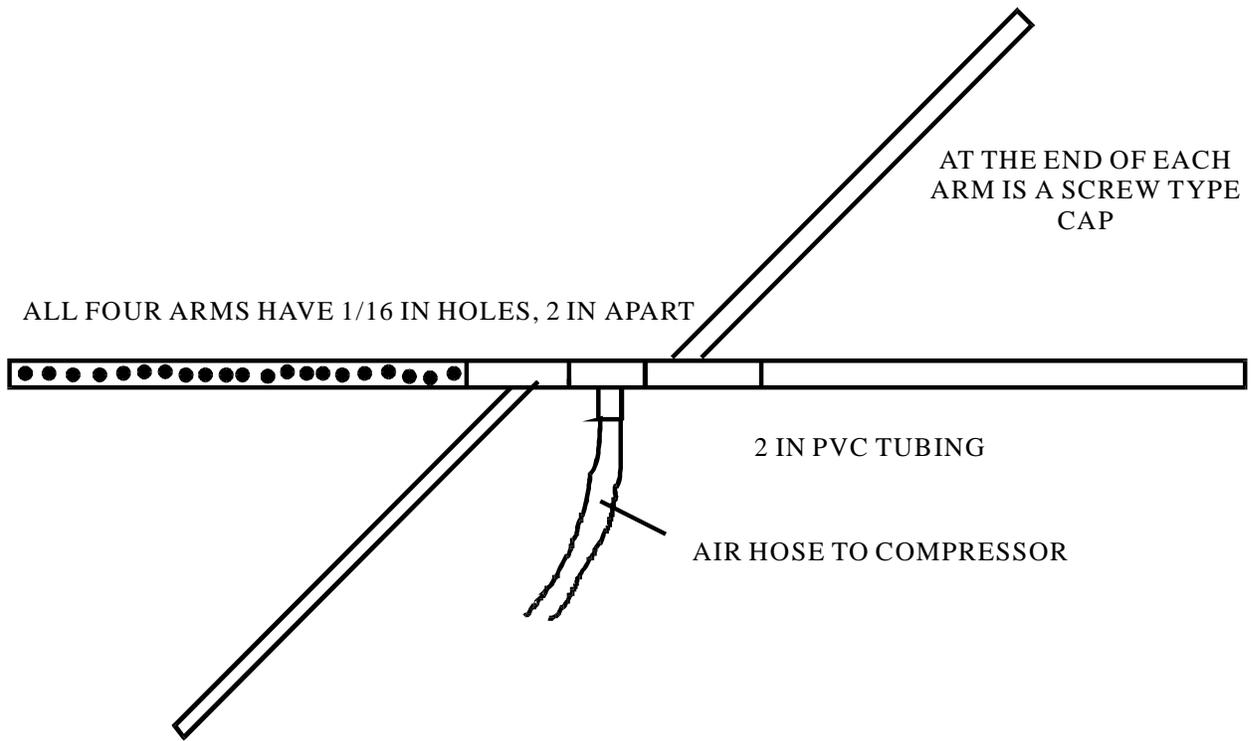
3.1 POINT RELEASE SYSTEM SET UP AND OPERATION

A point release diffuser consists of 3.8 - 5.1 cm PVC tubing glued together in an "X" shape. The diffuser has four, 1.2m arms with 6.35-mm holes, drilled at 25.4-mm intervals (Figure 2). The air is forced through a length of hose, 3.8 cm in diameter, lying along the bottom of the lake. The hose is weighted down with bricks and rebar secured to the hose by quick ties. A Sutorbilt blower or GAST compressor unit, installed in a shed along the shore, forces air into the hose and out through the point release diffuser. A brick is attached to the bottom of the diffuser to prevent it from floating to the surface when in operation. A buoy with a flag attached to the point release keeps it level as well as indicating the location of the aeration system. Each flag/buoy indicates one point release. The numbers of point release systems vary from lake to lake (Table 2).

3.2 MECHANICAL SURFACE AERATOR SETUP AND OPERATION

The aerator fits into the middle of a square float. The float is anchored at the four corners with small diameter nylon rope and a brick attached at the end of each rope. This keeps the aerator in position and from spinning around. The waterproof cord/cable sits on the bottom of the lake and runs out along the bottom of the lake and up to the float. The cord is secured to the float and attaches to the aerator. The motor is submerged and the prop is approximately 7.6-10.1 cm underneath the surface of the water. When operating, the prop throws water up against an inverted bell causing the water to spray up and out in a circular fountain back into the lake. The contact between the water and the inverted bell, breaks up the water into small droplets and falls back into the lake. See Figure 3 for a diagram of a mechanical surface aerator. Maintenance is minimal on these aerators. They are installed and turned on at the beginning of the aeration season (late October) and left running until shutdown (middle of April). The numbers and sizes of mechanical surface aerators vary from lake to lake (Table 2).

TOP VIEW



POINT RELEASE DIFFUSER

ALL JOINTS GLUED (PVC CEMENT)

FIGURE 2. DIAGRAM OF A POINT RELEASE DIFFUSION SYSTEM

Table 2.

Aeration types in each of the eight lakes, with lake locations, oxygen sampling sites and duration of aeration also shown. Details on each lake follow the table.

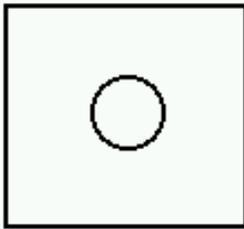
LAKE	AERATION	LOCATION SAMPLING		AERATION
	TYPE	UTM	SITES	DURATION
C. Thompson Pond	(1) 1/6 hp surface aerator	486673 m E 6228449 m N	3	October 8, 96 to April 15,97
Moonshine Lake	(1) 2hp surface aerator	360757 m E 6195124 m N	3	October 9,96 to April 16, 97
Cummings Lake	(1) 2hp surface aerator	415065 m E 6216386 m N	4	November 19, 96 to April 16, 97
Sulphur Lake	New Kubota diesel with 4, 1 hp aerators	419315 m E 6285934 m N	4	October 28, 96 to April 14, 97
Spring Lake	(1) P.R.	337215 m E 6153788 m N	1	October 4, 96 to October 15, 96
East Dollar Lake	(1) P.R.+(1) M.S.A 1hp	486941 m E 6129757 m N	1	November 29, 96 to March 17,97
Figure Eight Lake	(4) P.R.	444308 m E 6240113 m N	5	October 28, 96 to April 14, 97
Zama Pond	(1) O.E.H.	403785 m E 6558188 m N	1	UNKNOWN

O.E.H - Open Ended Hose

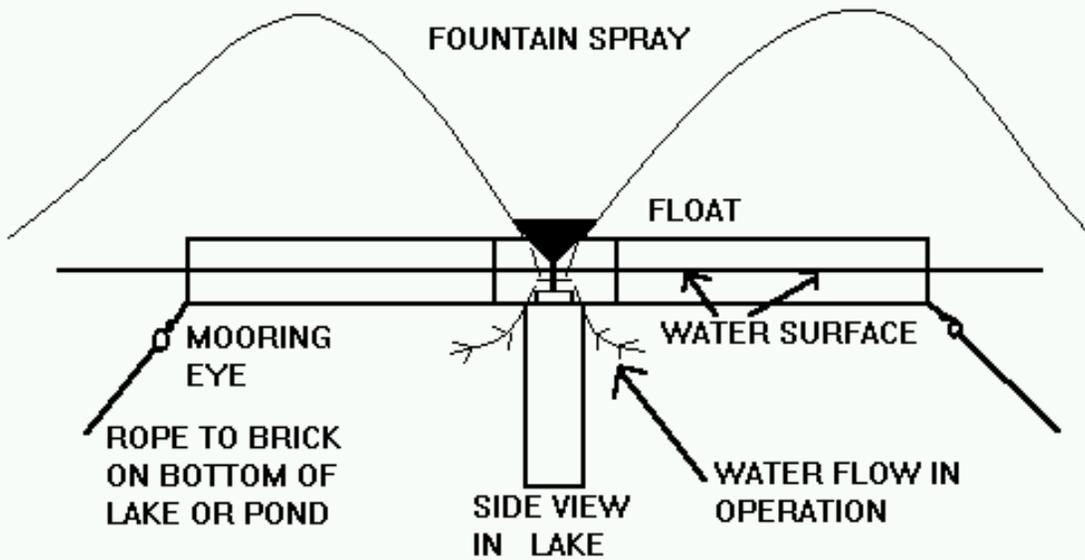
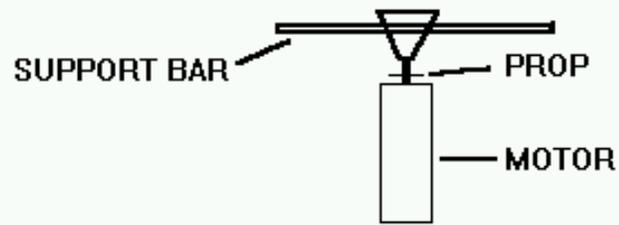
M.S.A - Mechanical Surface Aerator

P.R. -Point Release

TOP VIEW
FLOAT



MECHANICAL SURFACE AERATOR



3.3 OXYGEN SAMPLING METHODS

In the 1996-1997 aeration sampling season, Theron Miller (University of Alberta) and David Jackson (Natural Resources Service) sampled oxygen levels at the same time and same location. The NRS staff used an Oxyguard Handy Mark 2 digital meter. It has a liquid crystal display, a 10m waterproof cord and probe. The meter/probe displays percent of saturation, mg/l and temperature. The probe is lowered to the appropriate depth where mg/l and temperature readings are measured, while the probe is moved up and down in the water column. The percent of saturation is used to calibrate the meter before field use. Occasional maintenance of the Oxyguard unit is required. This involves replacing the electrolyte and membrane, then re-calibrating the unit.

Theron Miller used the modified Winkler method of dissolved oxygen sampling (Carpenter, J.H. 1965).

Oxygen sampling is completed twice monthly. At that time, the aeration units are checked for operation and maintenance is completed, if necessary. The number of sampling locations varies from lake to lake as do the sampling depths. Dissolved oxygen levels and sampling depths were averaged to get one point each month for the graphs.

The Winkler method is a well recognised method for sampling dissolved oxygen and was used exclusively after December 1996 for the duration of the 1996-1997 aeration season.

3.4 CECIL THOMPSON PARK POND **(JUNCTION POND)**

The pond was aerated with one mechanical surface aerator. The unit was an Otterbine 1/6 h.p. aerator with 230v/single phase power. Also included with the aerator were 30.48 m of 14/4 interconnecting cable and an "energy saver" capacitor control box. The mechanical surface aerator was positioned in 4.0 m of water approximately 9-12 m from the east shore (Figure 4).

3.5 MOONSHINE LAKE

Moonshine Lake was aerated two mechanical surface aerators. The two surface aerator units were: (1) a 2-hp air-o-lator model # SCCF 622 aerator, 230v single phase power, c/w 152.44 m of 10/4 interconnecting cable and matching deluxe control box; (2) a 1-hp air-o-lator model # SCCF C612 aerator, 230v single phase power, c/w 182.93 m of 12/4 interconnecting cable and an "energy saver" capacitor control box. The depth of the two point releases is 1.75 m (Figure 5). This aeration system is run by one 5.0 h.p. GAST Rotary Vane compressor with a capacity of 47 cfm at 15 psi.

Cecil Thompson Park Pond

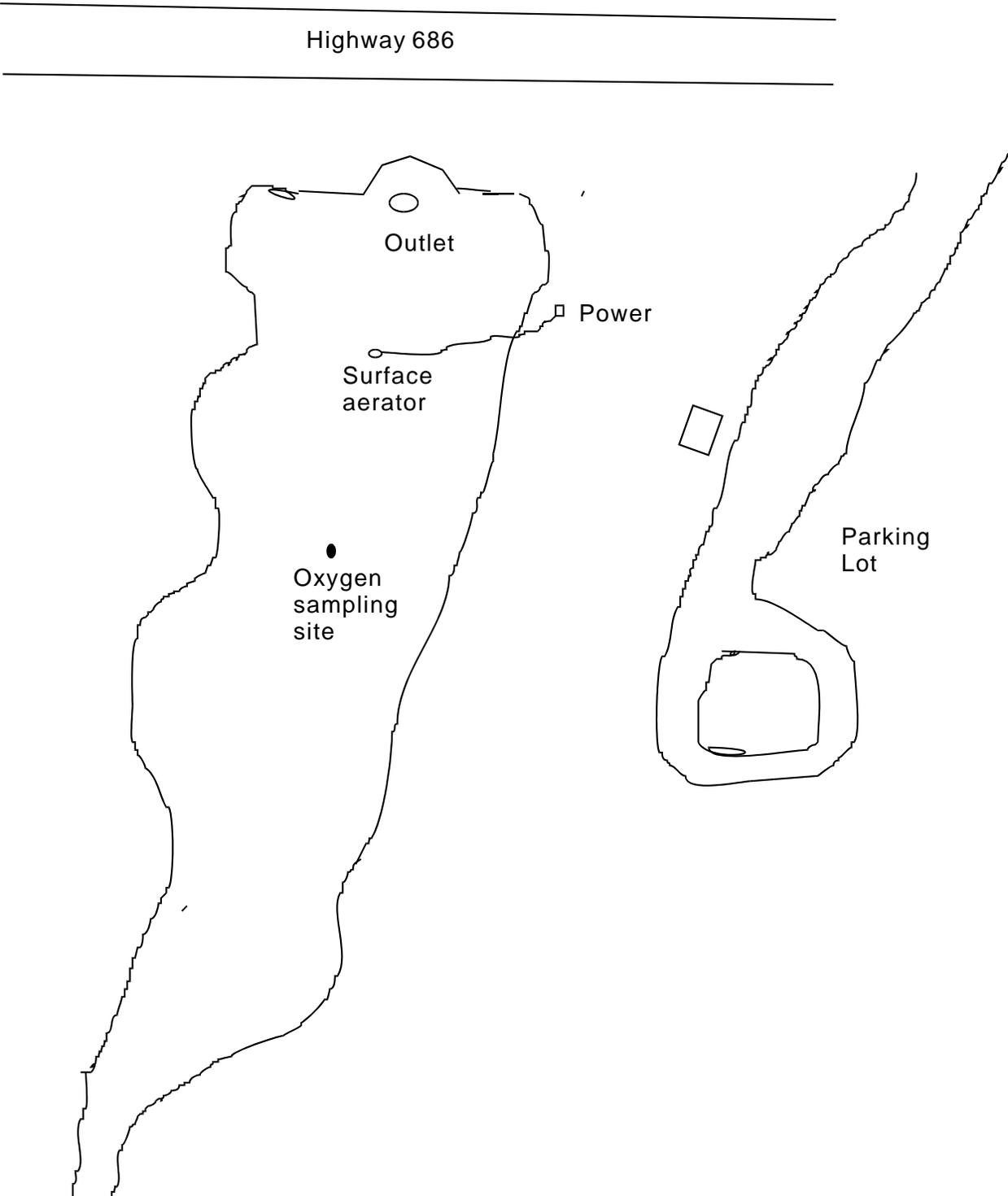


Figure 4. Cecil Thompson Park Pond.

MOONSHINE LAKE

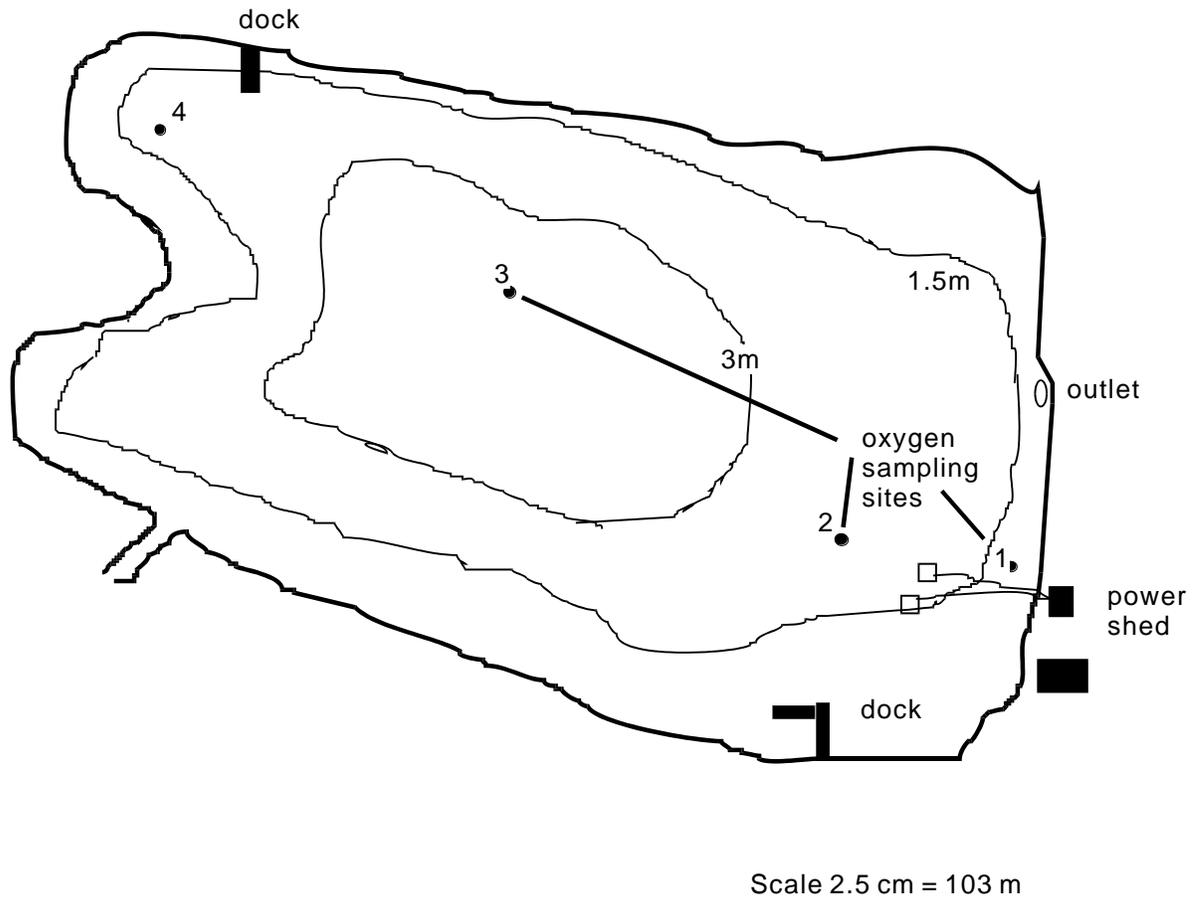


Figure 5. Moonshine Lake contour map with aeration and oxygen sampling sites, 1996-1997.

3.6 CUMMINGS LAKE

Lake aeration performed this year involved the use of one surface mechanical aerator. The 2 h.p. air-o-lator model # SCCF 622 aerator, 230v single phase power, c/w 153.44 m of 10/4 interconnecting cable and matching deluxe control box . Cummings Lake had two point release systems as "backups". They were the main aeration systems for the lake before the mechanical surface aerators were used. Each set (2) of the point release diffusers was run by a 5 h.p. GAST Rotary Vane #5565-p104 compressor, capacity 47cfm at 15 psi. One compressor has 121.95 m of weighed down hose (bricks/rebar) and the other compressor has 137.19 m of weighted down hose attached. At the end of each length of hose is a "T" splitter from where two, 15.24 m lengths of 19.05 mm hose run out. At the end of each hose was a point release diffuser. The point release diffusers were set in approximately 3 m of water, while the msa (mechanical surface aerator) was in 2-3 m (Figure 6).

3.7 SULPHUR LAKE

The aeration system was changed this year to a new Kubota 1402-D diesel motor. This operated 4, new 1hp mechanical surface aerators. Each unit consists of a 1-hp motor, 230v, w/600ft of 12/4 SOW cable, a float, and weed guard. This was the first year at this lake with the new surface aerators. The four aerators were set up in a square shape. Fuel is needed to run the diesel motor and is delivered to the 1892.5-L (500-gal) tank in the aeration shed every four to five weeks.

CUMMINGS LAKE

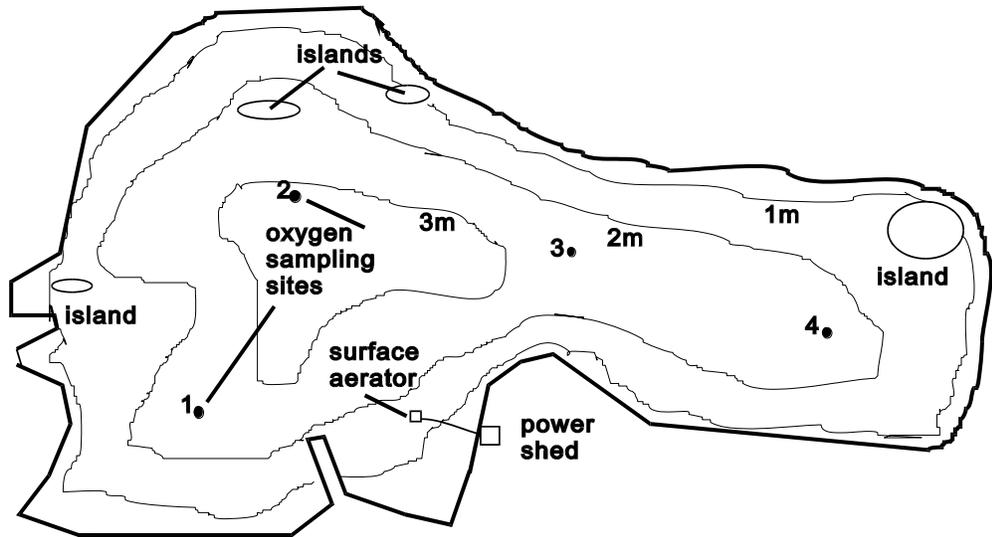


Figure 6. Cummings Lake contour map with aeration and oxygen sampling sites, 1996-1997.

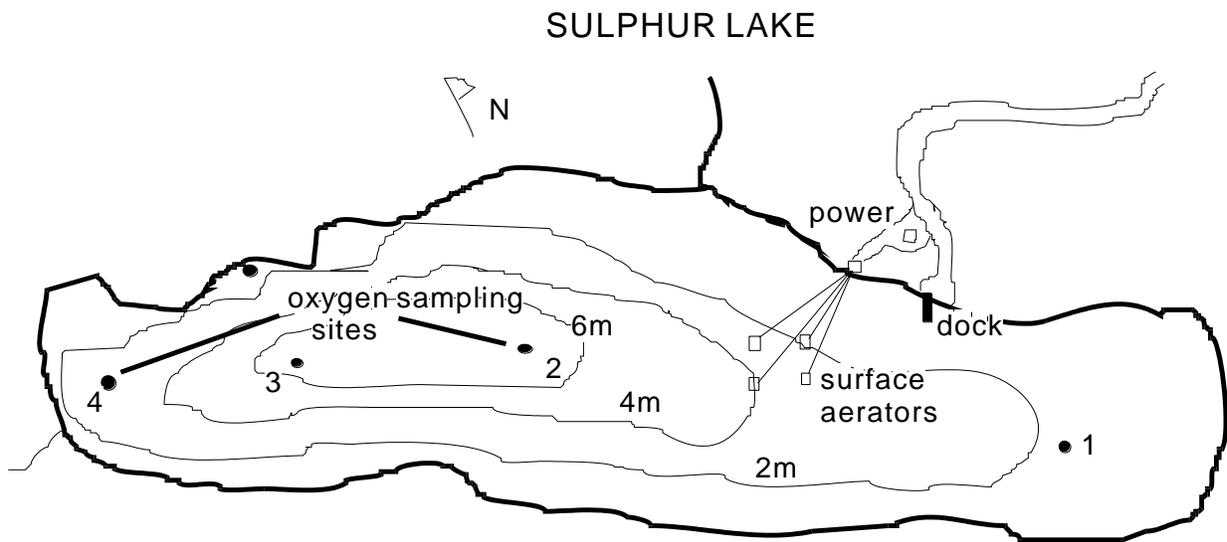


Figure 7. Sulphur Lake contour map with aeration and oxygen sampling sites, 1996-1997.

3.8 SPRING LAKE

Natural Resources Service personnel and Weyerhaeuser Canada personnel install the aeration unit every fall. This is done in the first week of October. An Ingersoll-Rand portable diesel compressor, model P-185-W-W is set up on the east shore. This unit has a capacity of 185 cfm at 100 psi. From the compressor 182.93 m of 19.05 mm feeder hose is ran out into the lake to a depth of 15-18 m (Figure 8). Attached to this hose is an "X" shaped point release made of 2.54 cm metal piping. It has 91.44 cm arms with 1/16 in holes at 5.1 cm intervals . The system is run for approximately 10 days to destratify the lake and induce oxygenation prior to freeze up.

3.9 EAST DOLLAR LAKE

East Dollar Lake was aerated a 1-hp surface aerator in 1996-1997 and was used as part of T. Millers aeration experiments (T.G. Miller and W.C.Mackay, Sept 1996 draft). The NRS aeration system in East Dollar lake is operated by one 5 hp GAST Rotary Vane #5565-P104 compressor with a capacity of 47 cfm at 15 psi. Attached to the compressor was 60.97 m of 5.1 cm feeder rubber hose with an "X" shaped point release diffuser at the end. The aeration system in the lake is at a depth of 6.0-m (Figure 9). This setup is now the backup system and was used for a multi depth fine bubble experiment as part of Miller's thesis.

SPRING LAKE

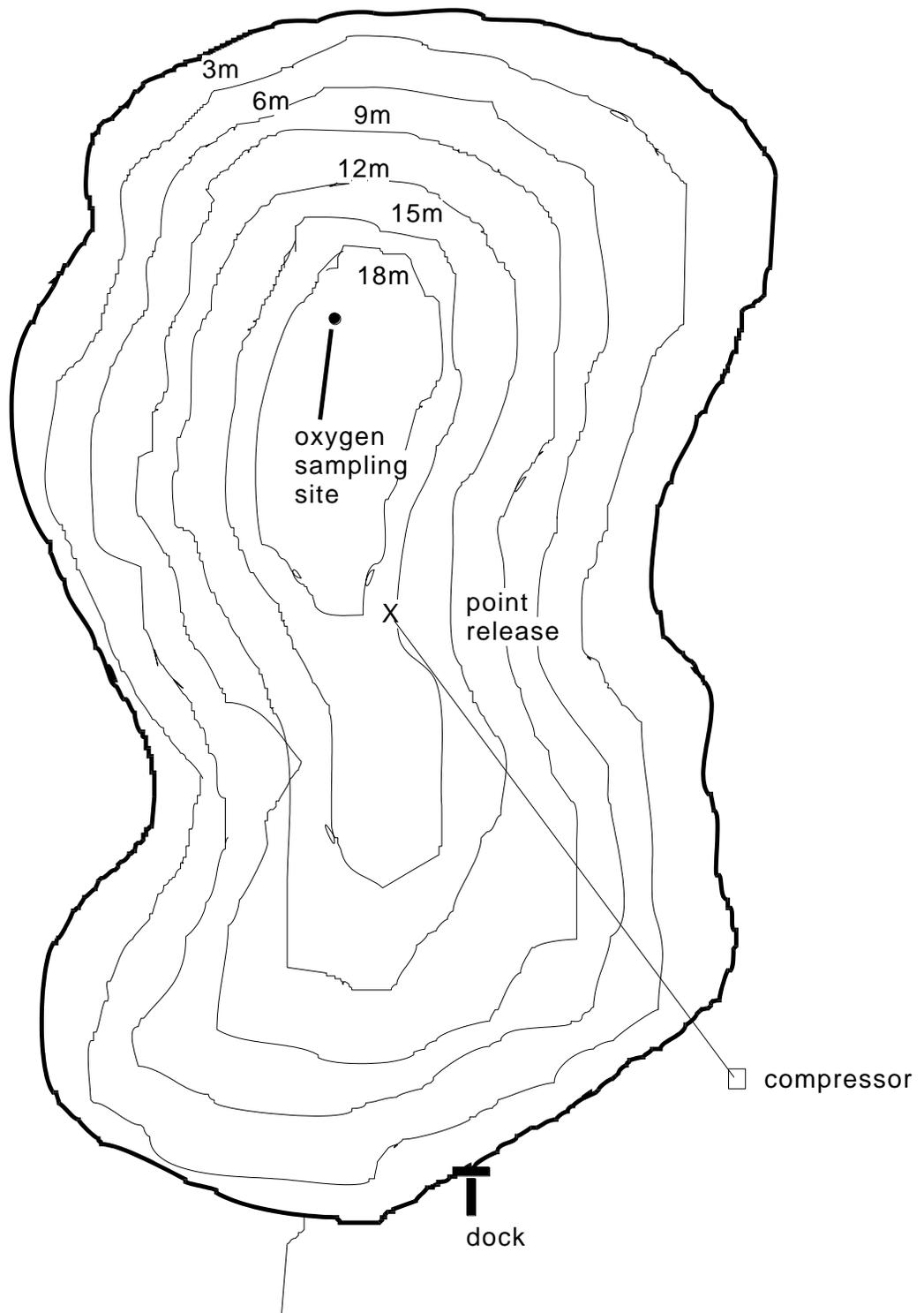


Figure 8. Spring Lake contour map with aeration and oxygen sampling sites, 1996-1997.

EAST DOLLAR LAKE

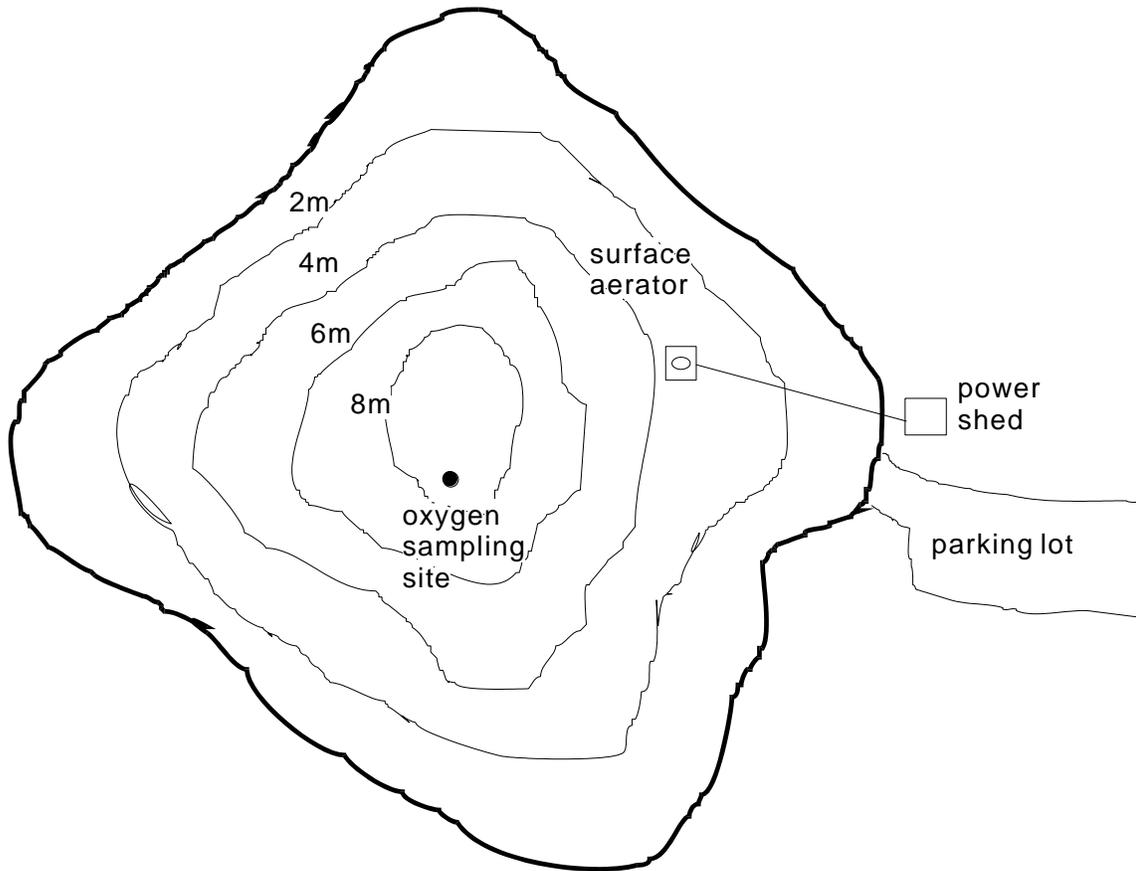


Figure 9. East Dollar Lake contour map with aeration and oxygen sampling sites, 1996-1997.

3.10 FIGURE EIGHT LAKE

The aeration system is housed in a shed located on the south side of the lake. There are two systems in the shed. System #1 is a 4.9 hp GAST compressor model #5565-P102 with a 5.0 hp, 230v/1/60 direct drive electric motor. It has a capacity of 63 cfm at 10 psi. System #2 is a 7.6 hp Sutorbilt blower unit with a 7.5 hp Baldor Electric motor. It has capacity of 89 cfm at 12 psi. Attached to each system is 182.93 m of weighted down hose (bricks/rebar) out to a "T" splitter where two lengths of 15.24 m , 19.05 mm hose are adjoined. At the end of these hoses are the point release diffusers. There are four point release systems in Figure Eight Lake (Figure 10). Maintenance of the aeration units is done the same day as the oxygen sampling. The GAST unit requires only a felt filter to be replaced while the Sutorbilt unit needs an oil change, greasing and drive belt check.

3.11 ZAMA POND

Zama Pond is aerated by a 1/3 hp GAST compressor. Attached to the compressor is a hose , which runs into the pond. There are no attachments (ie. point release pod) on the deep water end of the hose; it is an open ended hose. Oxygen sampling is done once a year in late March by fisheries technician, Don Schroeder .

FIGURE EIGHT LAKE

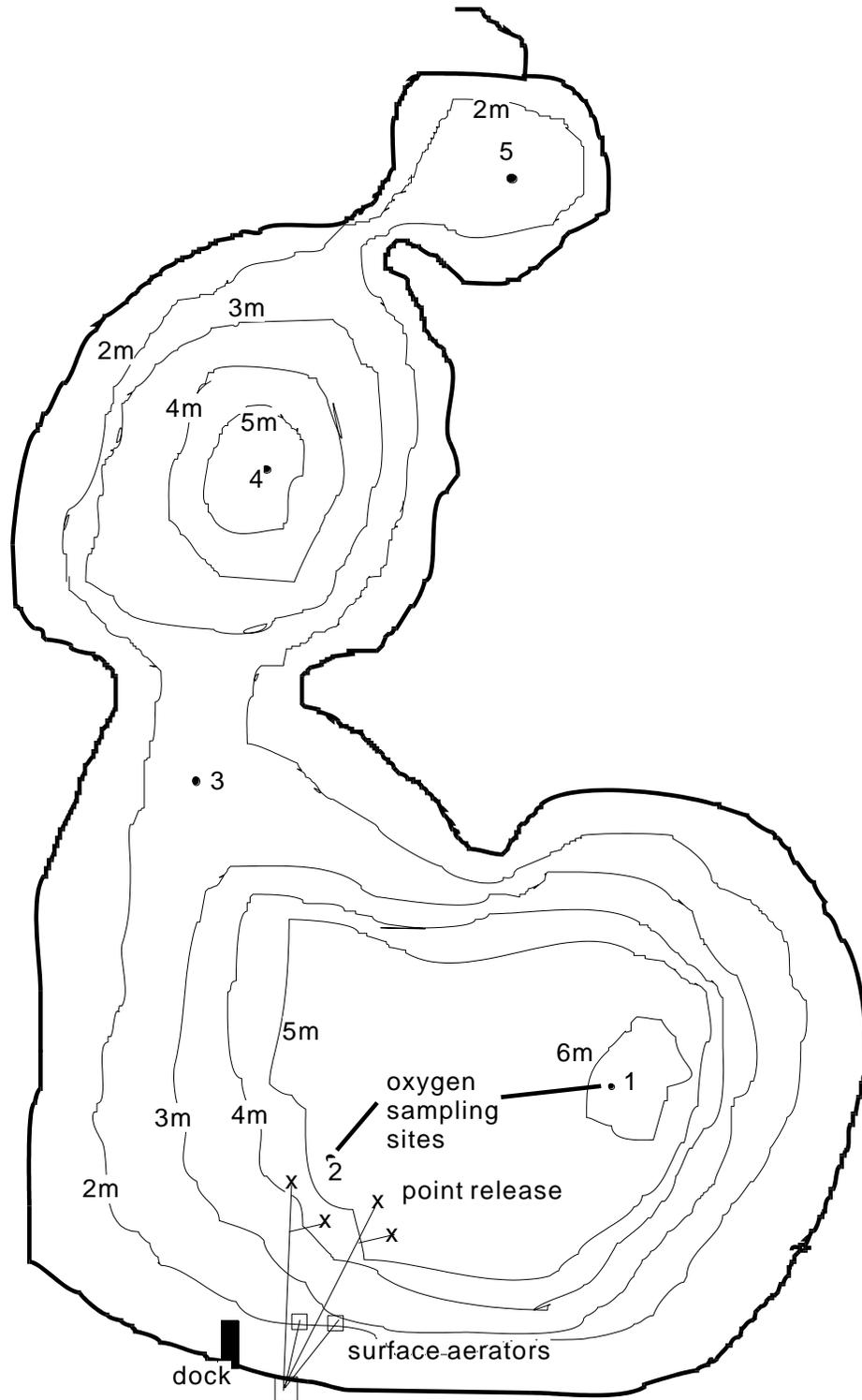


Figure 10. Figure Eight Lake contour map with aeration and oxygen sampling sites, 1996-1997.

4.0 RESULTS

4.1 CECIL THOMPSON PARK POND

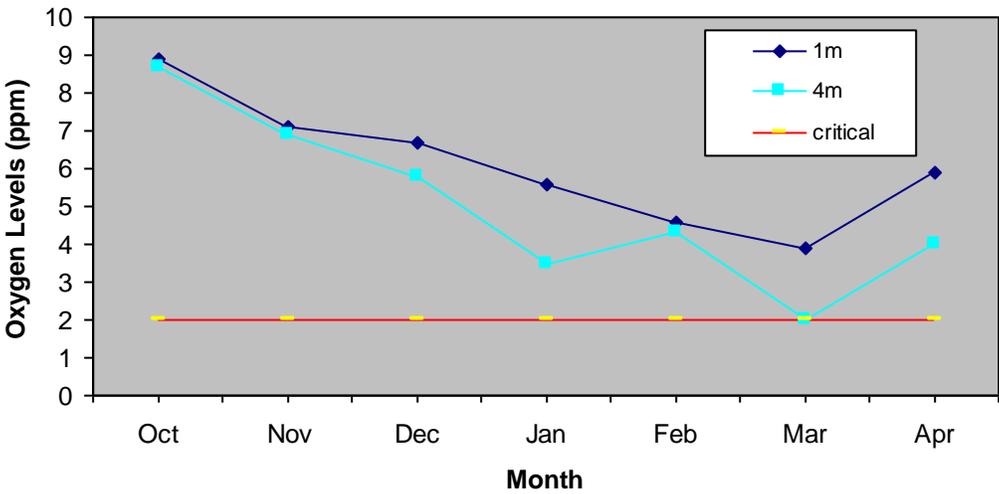
(JUNCTION POND)

The mechanical surface aerator operated from October 8, 1996-February 4, 1997 and from March 10, 1997-April 15, 1997. Repairs to the unit were needed in February and the aerator was vandalized in April. Dissolved oxygen levels ranged from 8.9–3.8 mg/l at 1m and 8.7-2.0 mg/l at 4 m (Figure 11). This was the third year of aeration and the third year in a row of successfully providing adequate oxygen concentrations to overwinter trout.

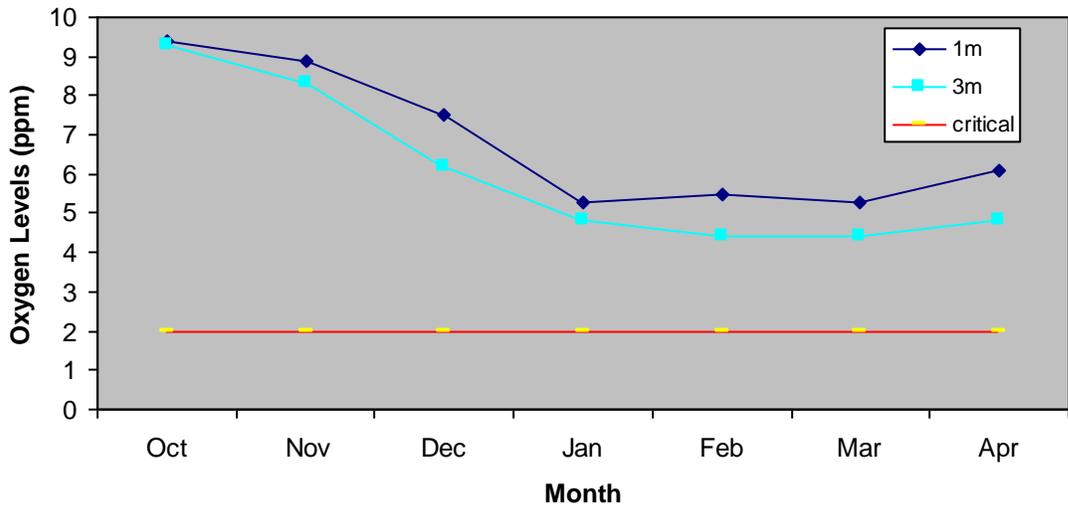
4.2 MOONSHINE LAKE

Aeration was conducted from October 9, 1996 to April 16, 1997. A second aerator was operated from February 5-8 as part of Miller's experiments. The dissolved oxygen levels ranged from 9.4 – 5.3 mg/l at 1m and 9.3 – 4.4 mg/l at the bottom sampling depth of 3 m throughout the winter (Figure 12). The 1996-1997 season is the ninth year of aeration and the third with the mechanical surface aerators. The lake overwintered successfully.

Cecil Thompson Park Pond 1996-1997



Moonshine Lake 1996-1997



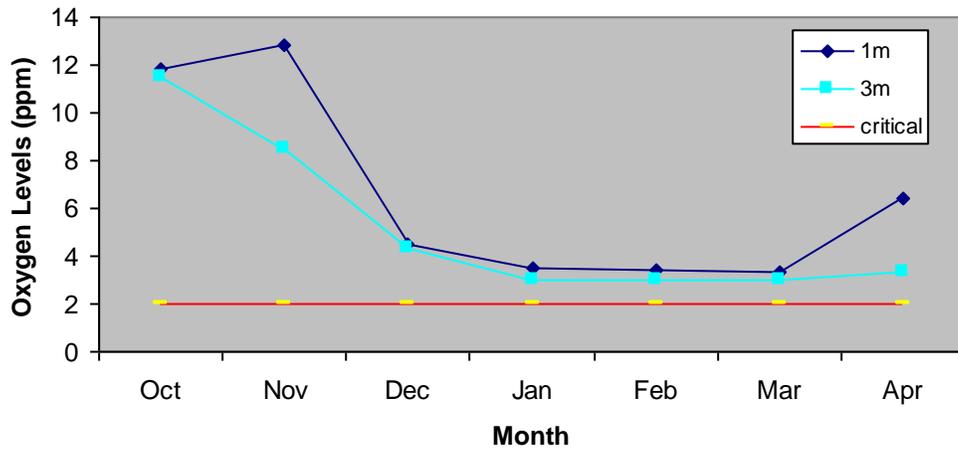
4.3 CUMMINGS LAKE

The 2-hp mechanical surface aerator operated from November 19, 1996 to April 16, 1997. The 2-hp unit was replaced on January 29, 1997. Oxygen levels ranged from 12.8–3.3 mg/l at 1 m and 11.5-3.0 mg/l at 3 m (Figure 13) bottom sampling depth This year was the second year with the mechanical surface aerator the tenth year of aeration. The lake overwintered successfully.

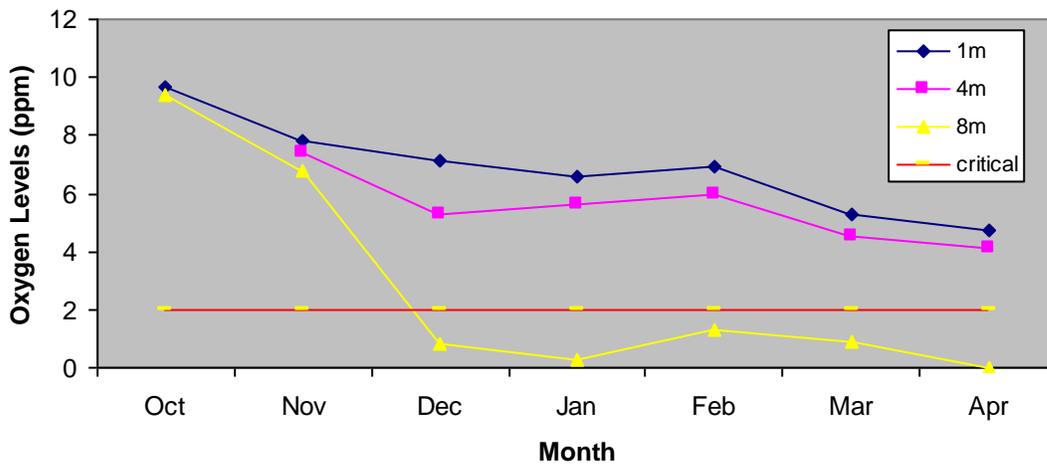
4.4 SULPHUR LAKE

The new Kubota diesel motor operated from October 28, 1996 to April 14, 1997 except for shutdown for maintenance requirements (oil changes, greasing, and belt inspections) performed by NRS staff. Problems with the support bars in February had only one aerator operating from February 18-March 4 when the three repairs units were reinstalled. Oxygen levels ranged from 9.7-4.7 mg/l at 1 m, 7.4-4.1 mg/l at 4 m and 9.4-0.0 mg/l at 7 m bottom sampling depth as shown in Figure 14. This was the first year with the new surface aerators. The lake overwintered.

Cummings Lake 1996-1997



Sulphur Lake 1996-1997



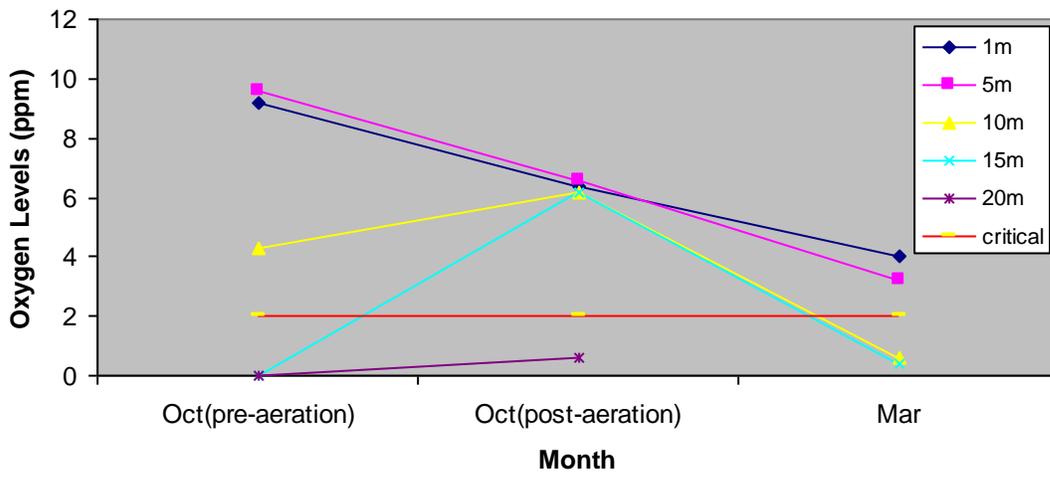
4.5 SPRING LAKE

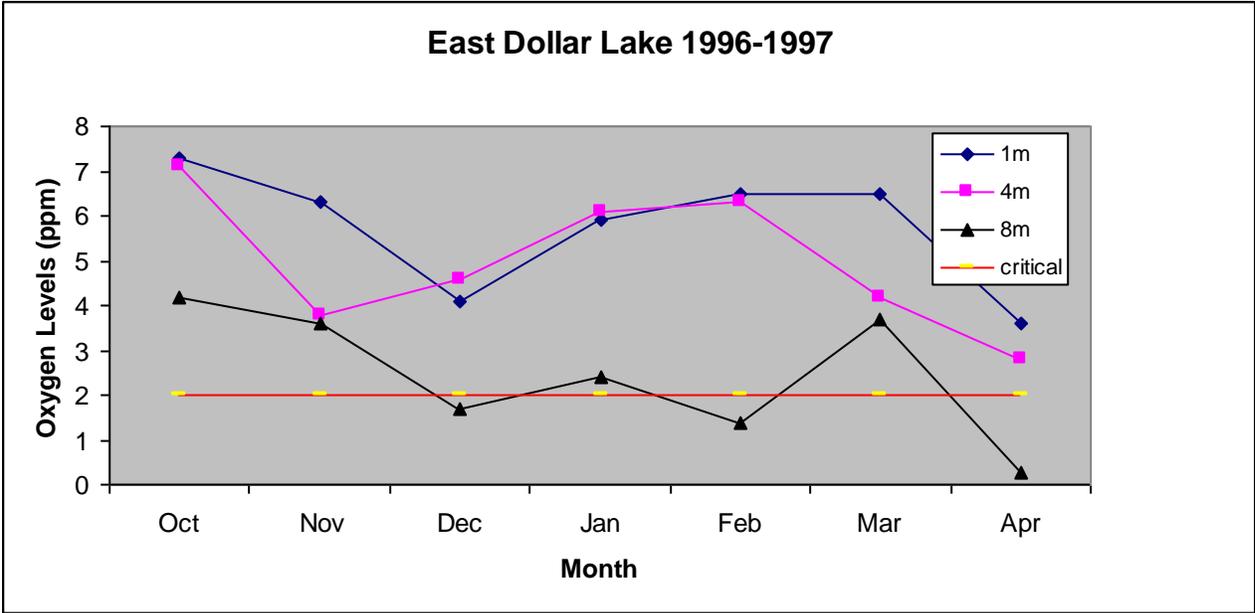
The Spring Lake aeration system is operated for approximately 10 days every year. In 1996-1997 the aeration system ran from October 4, 1996 to October 15, 1996. Oxygen levels throughout the winter ranged from 9.2-4.0 mg/l at 1 m and 6.2 – 0.6 mg/l at 10 m in March (Figure 15). The lake overwintered successfully for the 19th year consecutively while aerating.

4.6 EAST DOLLAR LAKE

The aeration system operated from November 29, 1996 to March 17, 1997. Experiments were conducted with a multi level fine bubble diffuser from February 21-March 17, 1997. Oxygen levels ranged from 7.3-3.6 mg/l at 1 m, 7.1-2.8 mg/l at 4 m and 7.1-0.0 mg/l at 7 m bottom sampling depth throughout the winter (Figure 16). This was the 12th year of aeration and has never winter killed while being aerated. Even with the changes in the aeration systems, the oxygen levels remained above the critical level of 3.0 mg/l, successfully overwintering the lake.

Spring Lake 1996-1997





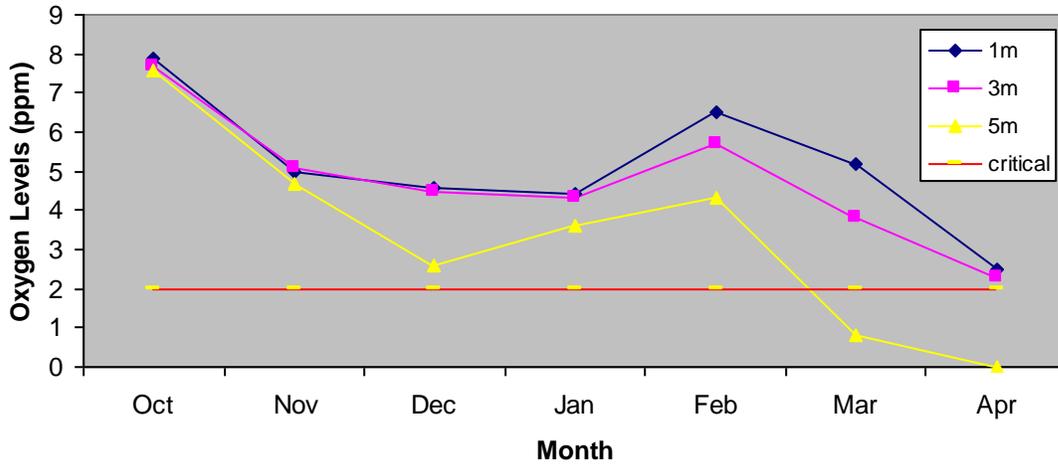
4.7 FIGURE EIGHT LAKE

Aeration began on October 28, 1996 and was completed on April 14, 1997. In December 96, a 1-hp and a ½-hp mechanical surface aerators were installed in Figure Eight Lake to help increase the oxygen levels as the oxygen concentrations were dropping. Both systems ran until February when the point release was shut off to see what effect that would have on the oxygen levels. March 12, 1997 the 1-hp quit working, while the ½ -hp unit continued to operated until April 14, 1997. The oxygen levels ranged from 7.9-2.5 mg/l at 1 m, 7.7-2.3 mg/l at 3 m and 7.6-0.0 mg/l at 5 m bottom sampling depth (Figure 17).

4.8 ZAMA POND

Zama Pond is a dugout measuring 76.21m X 36.58 m. Approximately 0.5 ha in size, with a maximum depth is 9.15 m. The pond was built in 1984 to provide more angling opportunity in the area. Don Schroeder does oxygen sampling once a year, usually February/March. Oxygen recorded this year was 9.0 mg/l at 1 m, indicating there was sufficient oxygen to over winter trout.

Figure Eight Lake 1996-1997



5.0 SUMMARY

The 1996-1997 aeration program successfully overwintered all eight lakes. The lakes that were used for the mechanical surface aerator experiments were Cecil Thompson Park Pond, Cummings Lake, Moonshine Lake, Sulphur Lake and East Dollar Lake. Figure Eight Lake had a 1 hp and ½ hp units installed in December 1996 to assist the point release system with aeration as oxygen levels were dropping rapidly. Results from the mechanical surface aerators this year were excellent. 1996-1997 is the third and final year of experimenting with the mechanical surface aerators on eutrophic lakes in the NWBR.

The 1997-1998 aeration season should provide even better results in oxygen levels as the Theron Miller's experiments will be completed and the aeration systems will be started before freeze up and run constantly for the entire aeration season.

Previous over wintering results and aeration technique comparisons to the 1996-1997 aeration year can be found in Overwintering Results of Nine Aerated Lakes in the Northwest Boreal Region 1995-1996 annual report by David Jackson, June 1997, Natural Resources Service, Northwest Boreal Region.

6.0 RECOMMENDATIONS

1. Change over all aeration systems that operated from Oct-Apr, from the point release to the mechanical surface aerators. These units provide oxygen to the lakes better than anything else Natural Resources Service has tried previously. The ease of installation, removal, and virtually no maintenance are other factors in the changing of aeration systems.
2. Oxygen sampling can be reduced to a monthly schedule.
3. Removal of point release units (pods, hose, compressors) from all lakes.

7.0 LITERATURE CITED

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