

**MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ECOLOGICAL RESOURCES**

**Aeration Permit Program Annual Report
2009-2010**

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**Aeration Permit Program Annual Report
2009-2010**

By

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Table of Contents

	Page
Introduction	1
Aeration Equipment	1
Program Administration.....	2
Regulations	3
Discussion	3
Regional Aeration Summary	4
Questionnaire Results	6
Literature Cited	8
Tables	
Table 1. Aerated Acres 2009-10	10
Table 2. 2009-10 Aerated Lakes/Permits	11
Table 3. Region I lakes with public access aerated to prevent winterkill, 2009-10.....	12
Table 4. Summary by county of protected waters in Region I, under aeration permit issued to private hatchery operators in 2009-10	13
Table 5. Region II lakes with public access aerated to prevent winterkill, 2009-10	14
Table 6. Region III lakes with public access aerated to prevent winterkill, 2009-10.....	15
Table 7. Region IV lakes with public access aerated to prevent winterkill, 2009-10	16
Table 8. Operational Characteristics of Some Aeration Systems, Winter 2009-10.....	17

Table of Contents (Continued)

	Page
Figures	
Figure 1. Number of lakes opened to “liberalized” fishing, by county, for the winter of 2009-10.....	18
Figure 2. Trends in lake aeration permits issued 1978-2009	19
Figure 3. Aeration permits issued by DNR region, 1978-2009	20
Figure 4. Number of lakes with public access, by county, issued aeration permits in 2009-10.....	21
Figure 5. Distribution by County of ponds aerated under permits issued to Private hatchery operators in 2009-10.....	22
Appendices	
Appendix 1.....	24
Appendix 2	25

INTRODUCTION

Minnesota has many lakes with a history of winterkill due to oxygen depletion. However, more significant than the number of lakes that winterkill is their location. The majority of Minnesota's winterkill lakes are in the southern half of the state, an area with the "fewest number of fishing lakes and the majority of the population" (Scidmore 1970). Aeration systems have been used in Minnesota to prevent winterkill for many years. More recently, the uses for aeration have expanded to include shoreline property protection, providing open water for captive waterfowl and water quality improvement.

The Department of Natural Resources has regulated the use of aeration in public waters since 1974 due to the potential for user conflicts and the open water hazard created by winter operation of aeration systems. The two major objectives of the aeration permit program are:

1. To ensure the safe winter operation of aeration systems; and
2. To ensure the appropriate use of aeration technology.

This report summarizes work done under the Aeration Permit Program of the Minnesota Department of Natural Resources during the 2009-10 permit year (1 October 2009– 30 September 2010). Work was partially funded under Federal Aid Project FW-9-T.

For a more detailed explanation of winterkill and the history of aeration in Minnesota, see Enger (1988). Pederson (1982) provides a comprehensive review of the program through 1978-81. Annual staff reports detailing the aeration program are also available (Danks 2010; Danks 2010; Danks 2009; Danks 2007; Danks 2006; Danks 2005; Danks 1999; Danks 1998; Danks 1996; Danks 1995; Danks 1994; Danks 1992; Danks, 1992; Enger-Danks 1992).

AERATION EQUIPMENT

Aeration equipment, originally designed for wastewater treatment facilities, has proven to be an effective method of winterkill prevention. The four methods of aeration described below are commonly used in Minnesota:

1. Sub-surface bubblers: Sub-surface bubblers consist of a diffuser(s), weighted air lines and a compressor or high volume, low pressure blower. The diffuser is placed on the lake bottom, near the deepest part of the lake. Air is pumped from the shore-housed compressor or blower through air lines to the diffuser. The diffuser breaks the air stream into small bubbles that rise, lifting warm bottom water to the surface. This warmer water melts the ice cover, exposing a portion of the lake surface to the atmosphere. Oxygen is added to the lake from wind and wave action and photosynthesis. The most efficient and effective method of operation is to group the diffusers so that one open water area is created during normal winter weather (MN Rules Chapter 6116.0020, subp. 3). Sub-surface bubbler systems are best suited to lakes that winterkill frequently. To sustain a gamefish population in these lakes, the aeration system will probably require annual operation for extended periods.

2. Air injection systems: Air injection aeration systems function similarly to sub-surface bubblers. However, the pontoon-mounted injection system introduces air just beneath the surface of the lake. Again, the oxygen is provided by removing ice cover and exposing the surface of the lake to the atmosphere and sunlight. Air injection systems are also well suited to lakes, which winterkill frequently, where annual and lengthy operation is likely.
3. Mechanical surface agitators: Mechanical surface agitators are basically submersible or floating pumps which spray water into the air, producing a fountain-like effect. Oxygen is added to the water sprayed into the air, some oxygen is added as the droplets agitate the lake surface, as well as from the open water area created. These systems affect rather small areas and are best suited to small bodies of water.
4. Pump and baffle systems: Pump and baffle aeration systems usually consist of a pontoon-mounted high-volume pump, about 150 feet of hose and a chute or flume. The pump is placed in the lake as far from the chute as possible. Lake water is pumped to the top of the chute where it cascades over a series of baffles, absorbing oxygen before returning to the lake. This type of aeration system does not create, nor does it require, a large open water area to prevent winterkill. Aeration takes place in the chute and the aerated water is returned to the lake.

Pump and baffle systems are more energy intensive to operate than air pumping systems, but they do not have to be started as early in the winter. Pump and baffle systems are generally best suited to lakes which winterkill infrequently.

All of these systems function by creating a refuge area with adequate dissolved oxygen where fish can survive until ice out in the spring. They do not, nor are they intended to, aerate the entire lake basin.

PROGRAM ADMINISTRATION

The Division of Ecological Resources (MNDNR) has primary responsibility for administration of the Aeration Permit Program. This program allows individuals, organizations and units of government to operate aeration systems on public waters for winterkill prevention, water quality improvement, shoreline property protection and wintering captive waterfowl. An aquatic biologist in St. Paul reviews permit applications, prepares permits for signature and serves as liaison between groups and individuals involved in lake aeration and the department. Regional and area fisheries personnel are often the initial contacts for people interested in lake aeration. Applicants send completed applications to the Regional Fisheries Manager for initial review, the Regional Wildlife Manager, and the Regional Trails and Waterways Manager also review aeration permit applications. Upon completion of regional review, the application is sent to St. Paul with recommendation for issuance or denial. After final review by central office staff, the application is reviewed by the Director of the Division of Ecological Resources and either approved or denied.

REGULATIONS

Aeration system operation in public waters is regulated by Minnesota Statutes Section 103G.611 and Minnesota Rules 1988 parts 6116.0010 to 6116.0070. The statute describes permittee responsibility to post warning signs at access points to the lake, post signs around areas of open water and thin ice, and publish notice of the commencement of operation. The rule describes when permits are required, application procedures, and criteria for permit issuance, permit conditions and other related items.

The aeration rule, which went into effect November 30, 1988, replaced Commissioners' Orders 2194 and 2258. An operational order outlining departmental procedures to ensure rule requirements are met was developed and became effective August 1989 (MN Rules 6116). The Statute, 103G.611 was revised in 2003 to include an annual permit fee for winter time aeration. The Statute was again revised in 2006 to clarify operation of a system on protected waters without public access.

Aeration systems are inspected for compliance with safety regulations by area fisheries personnel and conservation officers. This involves the inspection of all aeration systems, including those operated by private hatchery operators.

DISCUSSION

Area fisheries supervisors monitor the dissolved oxygen concentration of lakes in their areas throughout the winter. When winterkill of fish appears to be imminent, a lake may be opened to "liberalized fishing". Under "liberalized fishing" status, regulations regarding limits and methods of capture are relaxed to allow fish that would probably die due to oxygen depletion to be taken by anglers. The number of lakes opened to "liberalized fishing" is a rough indicator of winter severity. During the worst winterkill season of record (1955-56), 308 lakes were opened to "liberalized fishing" (Scidmore 1970). Due to a recent series of mild winters, on average of five lakes statewide are opened to "liberalized fishing" each year. Last winter (2009-10), nineteen lakes were opened to "liberalized fishing", of which one was permitted for aeration (Figure 1).

A total of 299 aeration permits were issued during the 2009-10 season. This includes 282 renewals (94% of the permits issued) and nine (9) new permits. Eight permits were renewed after having lapsed and nine permittees from the previous season (2008-09) did not reapply for an aeration permit in 2009-10.

The overall trend has been a steady increase in the number of permits issued in the last twenty-five years (Figure 2). The same trend is true for the regions as well, except for region II, which experienced a decrease in permits issued (Figure 3). Region III experienced a 7% increase in permits issued.

The 299 permits issued in 2009-10 authorized aeration in 283 lakes, of which 179 permits were issued for public waters with access for winterkill prevention (see MN Rules 1988, part 6116.0010, subpart 6 for definition of public access), for a total of 73,349 acres (Table 1; Figure 4). All acreages listed are from "An inventory of

Minnesota Lakes” MN DNR Bulletin 25 (Div. of Waters 1968). Pump and baffle systems were operated in 25 of these lakes, Aire O₂ units were operated in 59 lakes, mechanical surface agitators operated in 19 lakes, a combination of system types was used in 10 lakes, and diffuser systems operated in 57 lakes. Bait dealers and commercial hatchery operations were permitted to operate in 31 public water bodies totaling 1,722 acres. Eighty-two (82) other public waters were aerated for other purposes including: shoreline protection; providing open water for captive waterfowl; and preventing winterkill and improving water quality combined. Table 2 provides a detailed analysis of permit issuance for 2009-10.

Winter inspections of aeration systems were conducted by inspectors from the divisions of Enforcement and Fish and Wildlife (Fisheries). A total of 835 inspections were made in 2009-10. Of these, Enforcement inspectors conducted 259 inspections and Fisheries inspectors conducted 575. The inspectors found a total of 81 discrepancies (10%) out of the 835 inspections completed, a 7% decrease from the previous year. Discrepancies included fallen or missing thin ice or warning signs, signs too far apart, open water extending beyond the thin ice signs, or malfunctioning aeration equipment. A total of 193 inspections were completed in Region I of which 33 (17%) showed discrepancies. There were fourteen (14) inspections completed in Region II with no discrepancies. Inspectors conducted 125 inspections in Region III of which 17% showed discrepancies, and 499 inspections were conducted in Region IV with 5% discrepancies.

There have been seven fatalities at aeration system sites, the last occurring in 1999. No deaths resulted from accidents at aeration system sites in 2009-10.

REGIONAL AERATION SUMMARY

REGION I (Bemidji)

There were 65 aeration permits issued in Region 1 during the 2009-10 season, 22% of the total number of permits issued. Of the 65 permits issued, 64 (98%) were renewals and one was a new permit.

The 65 permits issued in Region I authorized aeration in 63 public waters, or 22.3% of the total public waters aerated statewide. Private hatchery operators accounted for 48% of the aeration permitted water bodies in Region I. Private hatchery operators received seven permits for 30 (1,645 acres) public waters (10.6% of the statewide total lakes permitted or 1.2% of the total acres permitted) (Figure 5). Appendix 1 lists water bodies under aeration permit issued to private hatchery operators. Private organizations and municipalities were issued 14 aeration permits to prevent winterkill in 14 lakes (7,272 acres) with public access. Thirty-six aeration permits were issued to private individuals on ten lakes (27,512 acres) to prevent shoreline property damage due to ice expansion. One permit was issued to the State covering 1,204 acres. Six other aeration permits were issued to private groups to prevent winterkill in public waters (613 acres) without public access. Two aerated lakes was reported to have experienced winterkill according to questionnaire results. For more details, including

acreage of water under aeration permit, permittee, and purpose of operation see Tables 3 and 4.

REGION II (Grand Rapids)

Lakes in Region II are generally deeper and less fertile than in other areas of the state and very few winterkill. The abundance of lakes in this region, which do not winterkill greatly outnumber those lakes that do.

The reorganization of the regions from six to four in 2002 lead to a redistribution of aeration permits between the regions. Region II increased from zero permits in 2001 to ten in 2002 to seven in 2005. There were six (6) permits issued, of which one permit was new for the 2009-10 season.

Of these six permits, which represent 2% of the total number of permits issued, five were operated on lakes with access and one was operated on a lake without access. No aerated lakes reported winterkill according to questionnaire results. For more information, see Table 5.

REGION III (St. Paul)

There were 123 aeration permits issued for 118 lakes/ponds (23,290 acres) in Region III last season (41% of the total number of permits issued), 117 renewals (95%), and six new permits. Pine Tree, Alexander and Mitchell lakes have two permits each.

Region III, the Metropolitan area, is the most densely populated region of the state. Lakes and ponds receive nutrient run-off from a variety of sources. As a result, many lakes are hypereutrophic. Aeration has been employed to serve a variety of purposes in Region III. Seventy-three permits were issued to municipalities for operation of aeration systems in 73 lakes (9,735 acres) with public access. Five permits (605 acres) were issued to municipalities for lakes without public access. Sixteen permits (5,922 acres) were issued to clubs for lakes with public access, and eight permits (445 acres) were issued to clubs operating aeration systems in lakes without public access. Eighteen permits for 16 lakes (6,379 acres) were issued to private individuals. The Minnesota Zoological Garden received one permit to operate three aeration systems (17 acres) for waterfowl and water quality. One permit was issued to Fort Snelling State Park for prevention of winterkill in Snelling Lake. One permit was issued to a private hatchery operator to aerate one (77 acres) public water. Four lakes experienced winterkill in Region III according to questionnaire results. For a more detailed breakdown of permit issuance in Region III, see Table 6.

REGION IV (New Ulm)

Region IV has 35% of the permits issued statewide. Last season, 105 permits (68,941 acres) were issued in Region IV; 104 were renewals (99%). One new permit was issued. The 105 aeration permits issued in Region IV authorized the aeration of 98 public waters. Lakes are less common in this area of the state and many are small and shallow. Soils are fertile and agriculture is extensive. Erosion deposits large amounts of soil, fertilizer and agricultural chemicals into lakes, accelerating eutrophication and

creating high oxygen demand. These conditions are typical of Midwestern lakes (Schneberger, 1970). Many anglers reside in this area of the state and winterkill lakes are an important fisheries resource. Ninety-four permits were issued to private organizations and municipalities to prevent winterkill of fish in 88 lakes (51,423 acres) with public access. Two permits were issued to prevent winterkill in two protected waters without public access. Four permits were issued to municipalities and clubs to improve water quality. Albert Lea and Hanska lakes have two permits each.

According to the questionnaires returned, ten aerated lakes experienced winterkill last season in Region IV. For a detailed breakdown of permit issuance in Region IV including acreages, purpose of operation, permittees (private, clubs, municipalities) and lake location (county), see Table 7.

QUESTIONNAIRE RESULTS

Completed questionnaires were received from 189 of 299 permittees, a 63% return. Operational information is summarized in Table 8, whereas, Appendix 2 lists operational information for individual aerated lakes. Questionnaire information is incomplete and subjective, making it difficult to determine specific system efficiency in preventing winterkill. Thirty-two (32) respondents indicated their aeration system was not operated last winter.

The average cost for insurance (n=51) was \$489.00. This figure includes all permittees operating an aeration system in lakes with or without public access. The range of insurance premiums for the 2009-10 season was \$5.00-\$1,263.00. No respondents indicated there was difficulty in acquiring the required insurance.

One hundred fifty-seven (157) of the respondents indicated their aeration system was operated last winter and 38 of those indicated that waterfowl overwintered on the lake. Of these, eight respondents are located in Region I, 23 in Region III, and seven in Region IV. An estimated 2,400 waterfowl used the open water areas provided by aeration systems (range 2-400). Most of the birds were mallards and Canada geese.

Of the 157 permittees that responded and operated their systems last winter, 143 (91%) indicated they were satisfied with system performance. Of these, 17% were Helixor systems, 8% were Clean-Flo systems, 10% were pump and baffles, 19% were AireO2 and Aeromix systems, 27% were other types of bubbler systems, and 10% were mechanical surface agitators. Complaints ranged from mechanical failures to undersized and ineffective equipment. Three respondents indicated safety problems with their aeration systems.

Some aerated lakes experienced partial winterkill last season. Sixteen of the 157 respondents that operated their aeration systems last winter reported some evidence of winterkill at ice out. Of these, two were Helixor systems, four were Clean-Flo systems, three were other bubbler systems, two were AireO2's, two were pump and baffles, and two were surface agitator systems.

Based on the responses to the questionnaire as summarized in Table 8, some systems, such as the Aire-0₂ and the Aeromix tornado, were on average the least expensive to operate per acre, with the Helixor system a close second. Whereas, pump and baffle systems were the most expensive to operate per acre and had the most horsepower per acre. Helixors were the least expensive to operate based on the horsepower of the system and the length of time they were operated. Helixor systems were on average used on larger sized lakes, up to 2,000 acres. Clean Flo systems were used on smaller lakes up to 250 acres in size. Air injector systems and mechanical surface agitators were used on lakes up to 1,500 acres in size.

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Table 1. Aerated Acres 2009-10.

ACRES	REGION 1	REGION 2	REGION 3	REGION 4	OVERALL
Lakes with public access	37,880	1,086	21,767	65,809	126,542
Lakes without public access	2,258	260	1,523	3,132	7,173
TOTAL	40,138	1,346	23,290	68,941	133,715

Table 2. 2009-10 Aerated Lakes/Permits.

Region	Lakes w/access	Winterkill Permits				Bait Dealers		Shoreline		Other		Total Permits
		C	M	S	P	Ponds	Permits	Lakes	Permit	Lakes	Permit	
I	15	10	4	1	0	30	7	10	36	7	7	65 (22%)
II	3	2	0	0	1	0	0	0*	0	2	3	6 (2%)
III	67	12	53	1	1	1	1	2	3	42	52	123 (41%)
IV	88	44	49	0	1	0	0	1	1	8	10	105 (35%)
Totals	173	68	106	2	3	31	8	13	40	59	72	299

		Lakes	Acres	Permits
Protected waters with access for winterkill prevention	=	173	73,349	179
Protected waters under permit to Bait Dealers	=	31	1,722	8
Shoreline Protection	=	13	32,974	40
Other**	=	66	25,670	72
		<u>283</u>	<u>133,715</u>	<u>299</u>

Total number of permits for protected waters with access for winterkill prevention = 179

Total number of permits for protected waters without access for winterkill prevention = 18

299 total permits, new permits = 17

08-09 permits not reissued = 9

Other includes – Protected waters with no public access.
Protected waters with public access for water quality improvement.
Summer only systems.

* = Marinas along Lake Superior

C = Clubs; M = Municipalities; S = State; P = Privately Operated

Table 3. Region I lakes with public access aerated to prevent winterkill, 2009-10.

County	Permittee			Total No. of lakes	Total Acres	Average Size (acres)
	C	M	S			
Becker	4	0	0	4	2,700	675
Clay	1	1	0	2	139	69.5
Clearwater	0	1	0	1	1,465	1465
Douglas	0	0	0	0	0	0
Marshall	0	1	0	1	42	42
Otter Tail	1	1	0	2	749	374.5
Polk	3	0	0	3	1,821	607
Pope	0	0	1	1	1,204	1,204
Stevens	0	0	0	0	0	0
Wadena	1	0	0	1	356	356
Totals	10	4	1	15	8,476	N/A

# lakes with public access aerated to prevent winterkill	=	15 (C = 10; M = 4; S = 1)
Total Acreage	=	8,476
Average lake size (acres)	=	565.1
Permits issued to Municipalities for lakes with access	=	4 (1,767 acres)
Permits issued to Clubs for lakes with access	=	10 (5,505 acres)
Permits issued to the State w/access	=	1 (1,204 acres)
Permits issued for shoreline protection	=	36 (10 lakes; 27,512 acres)
Melissa Lake – 1,827 acres – 8 permits		Fish Lake – 284 acres – 1 permit
Lida Lake – 7,277 acres – 7 permits		Big Cormorant Lake – 3,380 acres – 5 permits
Big McDonald – 3,096 acres – 2 permit		Pelican – 4,314 acres – 7 permits
Eunice Lake – 370 acres – 1 permit		Marion Lake – 1,610 acres – 1 permit
Lizzie Lake – 4,145 acres – 2 permits		
Island Lake – 1,209 acres – 1 permit		
Permits issued to Bait Dealers, & P. Hatchery operators	=	7 (30 ponds, 1,645 acres)
Permits issued to private individuals to prevent winterkill for lakes without access	=	6 (613 acres)
Permits issued to the State without access	=	0 (0 acres)
Permits issued to private individuals to improve water quality for lakes with access	=	2 (1,892 acres)
Total Permits issued	=	65 (40,138 acres) in 62 lakes and ponds

*C = Club; M = Municipality; S = State

Table 4. Summary by county of protected waters in Region I, under aeration permit issued to private hatchery operators in 2009-10.

County	Total No. of Ponds	Total Acres	Average Size Pond (Acres) Per County
Becker	1	242	242.0
Douglas	3	47	15.6
Grant	3	168	56.0
Otter Tail	11	588	53.5
Polk	7	296	42.3
Pope	3	157	52.3
Stevens	1	78	39.0
Todd	1	69	69.0
Totals	30	1,645	N/A

Averages:

Bait dealers permitted	=	7 (7 permits)
Average number of ponds/permit	=	4.3
Average size of ponds	=	54.8 acres (range 6 to 242 acres)
Average number of acres/permit	=	235

Table 5. Region II lakes with public access aerated to prevent winterkill, 2009-109.

County	Permittee			Total No. of lakes	Total Acres	Average Size (acres)
	C	M	P			
Aitkin	0	0	0	0	0	0
Cass	2	0	1	3	873	291
Crow Wing	0	0	0	0	0	0
Lake	0	0	0	0	0	0
Totals	2	0	1	3	873	N/A

Lakes with public access aerated to prevent winterkill	=	3
Total Acreage	=	873
Average lake size (acres)	=	291
Permits issued to Municipalities for lakes without access	=	0
Permits issued to Municipalities for lakes with access	=	0
Permits issued to Clubs for lakes with access	=	2 (830 acres)
Permits issued to Clubs for lakes without access	=	1 (260 acres)
Privately operated systems for lakes with access (2 permits for Nisswa Lake)	=	3 (256 acres)
Privately operated systems for lakes without access	=	0 (0 acres)
Permits issued to State with access	=	0
Total Permits issued	=	6 (1,346 total acres in 5 lakes/ponds)

C = Club; M = Municipality; P = Privately Operated, S = State

Table 6. Region III lakes with public access aerated to prevent winterkill, 2009-10.

County	Permittee				Total No. of lakes	Total Acres	Average Size (acres)
	C	M	P	S			
Anoka	0	8	0	0	8	3,082	385.3
Carver	0	3	0	0	3	333	111
Crow Wing/Morrison	0	0	1	0	1	1,486	1,486
Dakota	0	20	0	0	20	1,125	56.3
Hennepin	1	5	0	1	7	829	118.4
Kanabec	1	0	0	0	1	1,127	1,127
Pine	0	0	0	0	0	0	0
Ramsey	0	7	0	0	7	806	115.1
Scott	4	5	0	0	9	1,158	171.7
Sherburne	1	1	0	0	2	692	346
Stearns	0	1	0	0	1	222	222.0
Washington	0	3	0	0	3	213	71.0
Wright	5	0	0	0	5	1,117	223.4
Totals	12	53	1	1	67	12,577	N/A

Lakes with public access aerated to prevent winterkill	=	67
Total Acreage	=	12,577
Average lake size (acres)	=	187.7
Permits issued to Municipalities for lakes without access	=	5 (605 acres)
Permits issued to Municipalities for lakes with access	=	73 (9,735 acres)
Permits issued to Clubs for lakes with access	=	16 (5,922 acres)
Permits issued to Clubs for lakes without access	=	85 (445 acres)
Privately operated systems for lakes with access (Shoreline protection – 3 permits/2 lakes (4,443)) (2 permits on Lake Alexander)	=	7 (6,000 acres)
Privately operated systems for lakes without access (2 permits in Pine Tree Lake)	=	11 (379 acres)
Private Hatchery Operator permits for lakes with access	=	1 (77 acres)
Permits issued to State with access	=	1 (110 acres)
Permits issued to State without access	=	1 (17 acres)
Total Permits issued	=	123 (23,290 total acres in 118 lakes/ponds)

C = Club; M = Municipality; P = Privately Operated, S = State

Table 7. Region IV lakes with public access aerated to prevent winterkill, 2009-10.

County	Permittee				Total No. of lakes	Total Acres	Average Size (acres)
	C	M	P	S			
Big Stone	0	1	0	0	1	440	440
Blue Earth	5	0	0	0	5	2,834	566.8
Brown	2	2	0	0	3	2,459	819.7
Cottonwood	6	0	0	0	5	1,716	343.2
Faribault	1	0	0	0	1	268	268.0
Freeborn	0	4	0	0	3	3,230	1,076.7
Jackson	6	0	0	0	6	2,948	491.3
Kandiyohi	0	9	0	0	8	7,627	953.4
Le Sueur	4	0	0	0	4	1,768	442.0
Lincoln	5	0	0	0	5	6,327	1,265.4
Lyon	0	9	0	0	9	2,518	279.8
Martin	4	3	0	0	7	1,884	269.1
McLeod	1	1	0	0	2	889	444.5
Meeker	1	0	1	0	2	774	387.0
Murray	1	10	0	0	10	6,450	645.0
Nobles	1	5	0	0	6	3,903	650.5
Pipestone	0	1	0	0	1	80	80.0
Rice	2	0	0	0	2	1,233	616.5
Sibley	0	0	0	0	0	0	0
Steele	0	1	0	0	1	11	11.0
Waseca	2	1	0	0	2	2,581	1,290.5
Watsonwan	3	0	0	0	3	819	273
Yellow Medicine	0	2	0	0	2	664	332.0
Totals	44	49	1	0	88	51,423	N/A

Lakes with public access aerated to prevent winterkill	=	88
Total Acreage	=	51,423
Average lake size (acres)	=	584.4
Permits issued to Municipalities for lakes with access	=	49 (27,700 acres) (2 permits for Albert Lea & Wilson lakes)
Permits issued to Clubs for lakes with access	=	44 (23,503 acres) (2 permits for Double & Hanska lakes)
Permits issued to Clubs for lakes without access	=	2 (120 acres)
Private Hatchery Operator	=	0
Privately Owned Systems with public access	=	2 (1,239 acres)
Privately Owned Systems without public access	=	1 (18 acres)
Permits issued to State for lakes with public access	=	1 (13,094 acres)
Permits issued to Municipalities for lakes without access	=	0 (0 acres)
Permits issued to State for lakes without public access	=	3 (2,994 acres)
Total Permits Issued	=	105 (68,941 acres; 98 lakes)

C=Club; M=Municipality; P=Privately Operated, S=State

Table 8. Operational Characteristics of Some Aeration Systems, Winter 2009-10.

		Total hp	Lake Area (A)	hp/A	\$/A/mo	\$/hp/mo	KWH/hp/mo	KWH/hp/A
Helixor	Range	3-25	21-1,844	0.007-0.14	\$ 0.40 – 7.91	\$ 5.82-425.07	173.8-891.14	0.48-117.3
	Mean (x)	11.5	562.2	0.04	\$ 1.95	\$ 57.87	408.44	10.4
	n	24	24	24	22	22	17	17
Clean-Flo	Range	1.0-9.0	13-1,263	0.007-0.182	\$ 0.02-9.62	\$ 0.42-188.06	103.1-1,031.2	11.2-54.5
	Mean (x)	3.4	174.3	0.054	\$ 3.34	\$ 77.09	658.8	20.6
	N	15	15	15	9	9	5	5
Aire-0₂	Range	1.0-9.0	3-2,462	0.001-0.67	\$ 0.15-4.31	\$ 11.11-160.71	222.4-1,607.1	0.2-33.5
	Mean (x)	3.6	369.0	0.051	\$ 1.28	\$ 75.33	665.2	8.0
	N	28	28	28	20	20	14	14
Pump & Baffle	Range	3.0-20.0	3-500	0.020-1.67	\$ 0.75-166.67	\$ 12.26-149.48	80.0-710.0	2.1-106.7
	Mean (x)	9.9	108.6	0.25	\$ 19.99	\$ 53.62	343.9	26.0
	N	14	14	14	12	12	9	9
Mechanical Surface Agitators	Range	1-19	17-2,875	0.003-0.125	\$ 0.10-5.05	\$ 10.28-122.55	717.50-1,251.86	6.44-118.18
	Mean (x)	3.5	523.2	0.029	\$ 0.97	\$ 58.06	969.66	48.41
	n	12	13	12	7	6	3	3

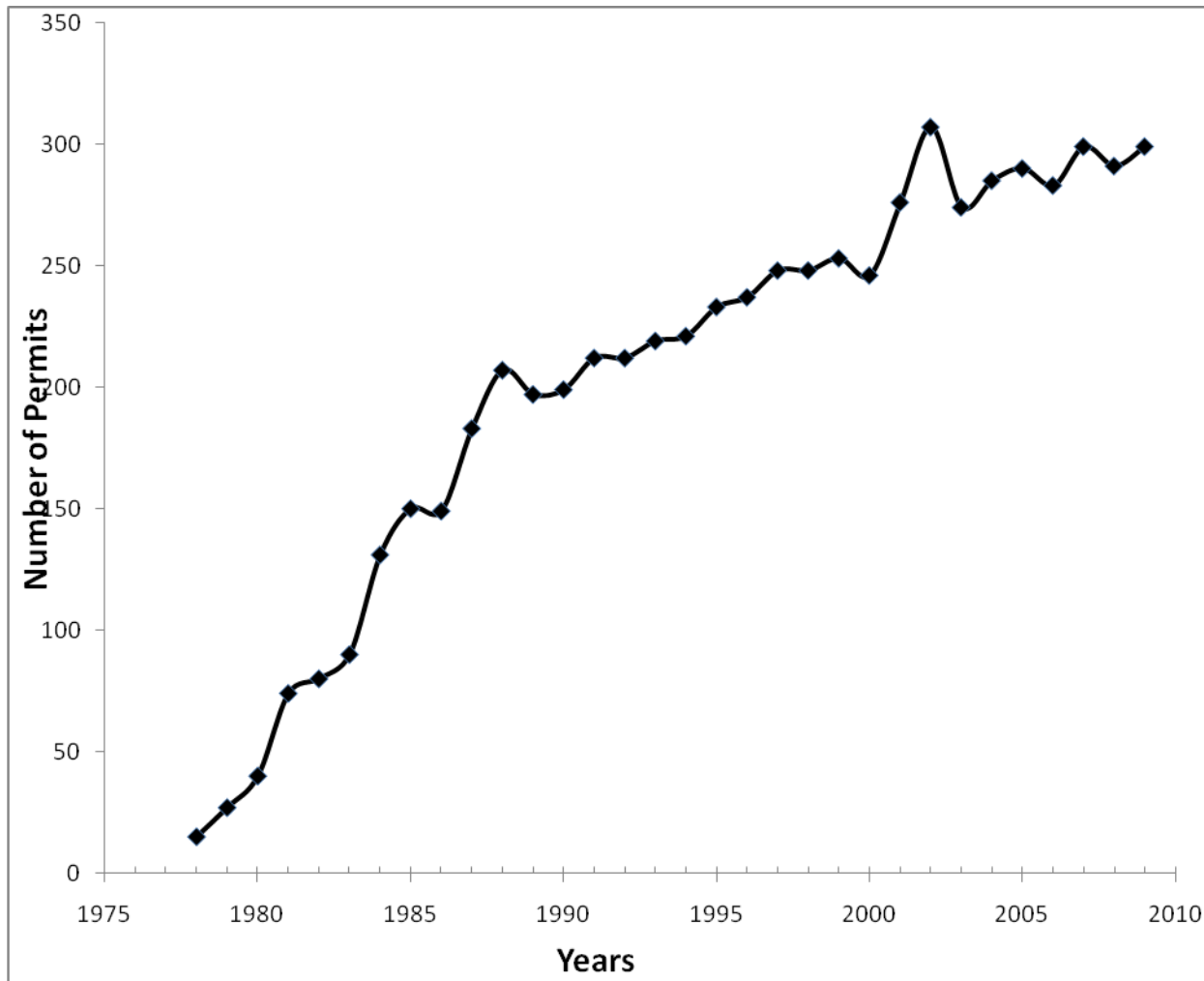


Figure 2. Trends in lake aeration permits issued 1978-2009.

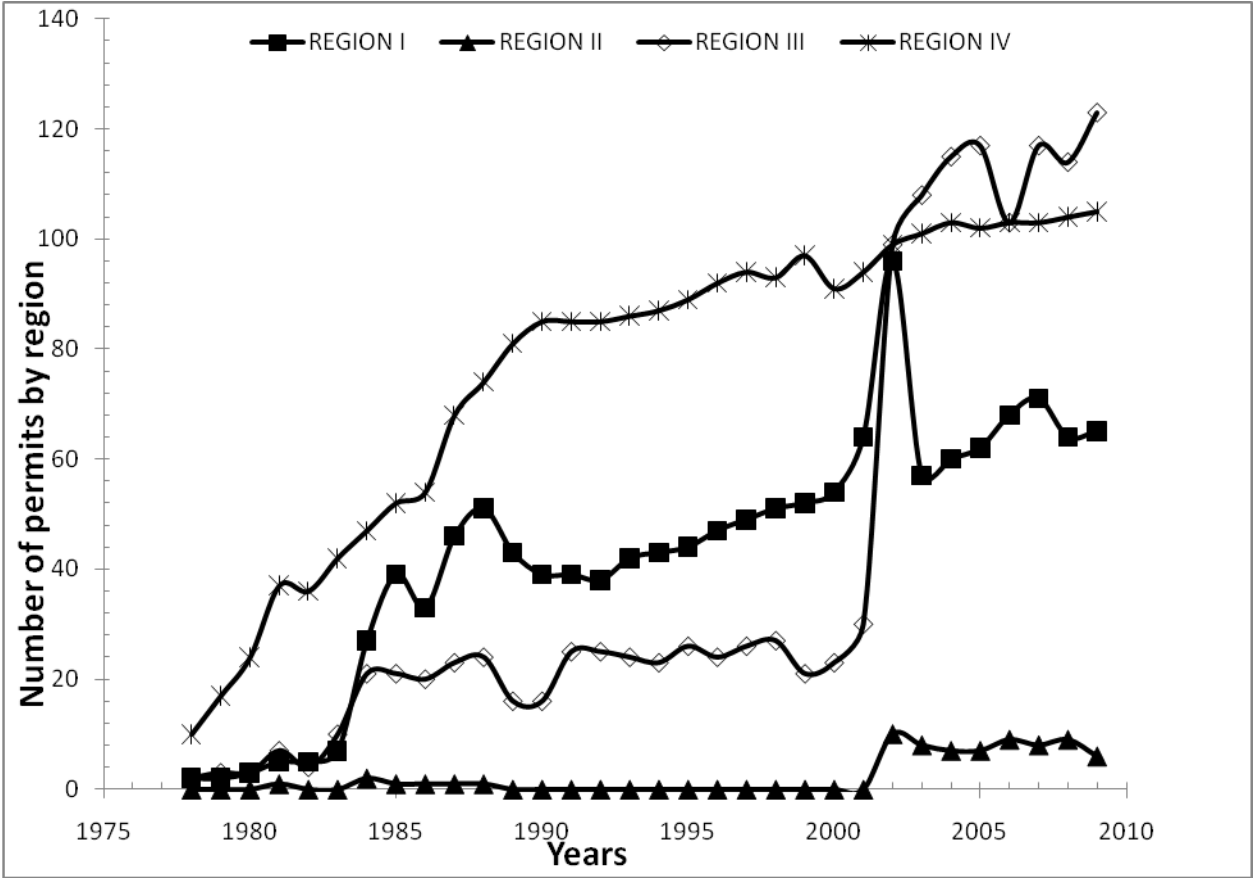


Figure 3. Aeration permits issued by DNR region, 1978-2009

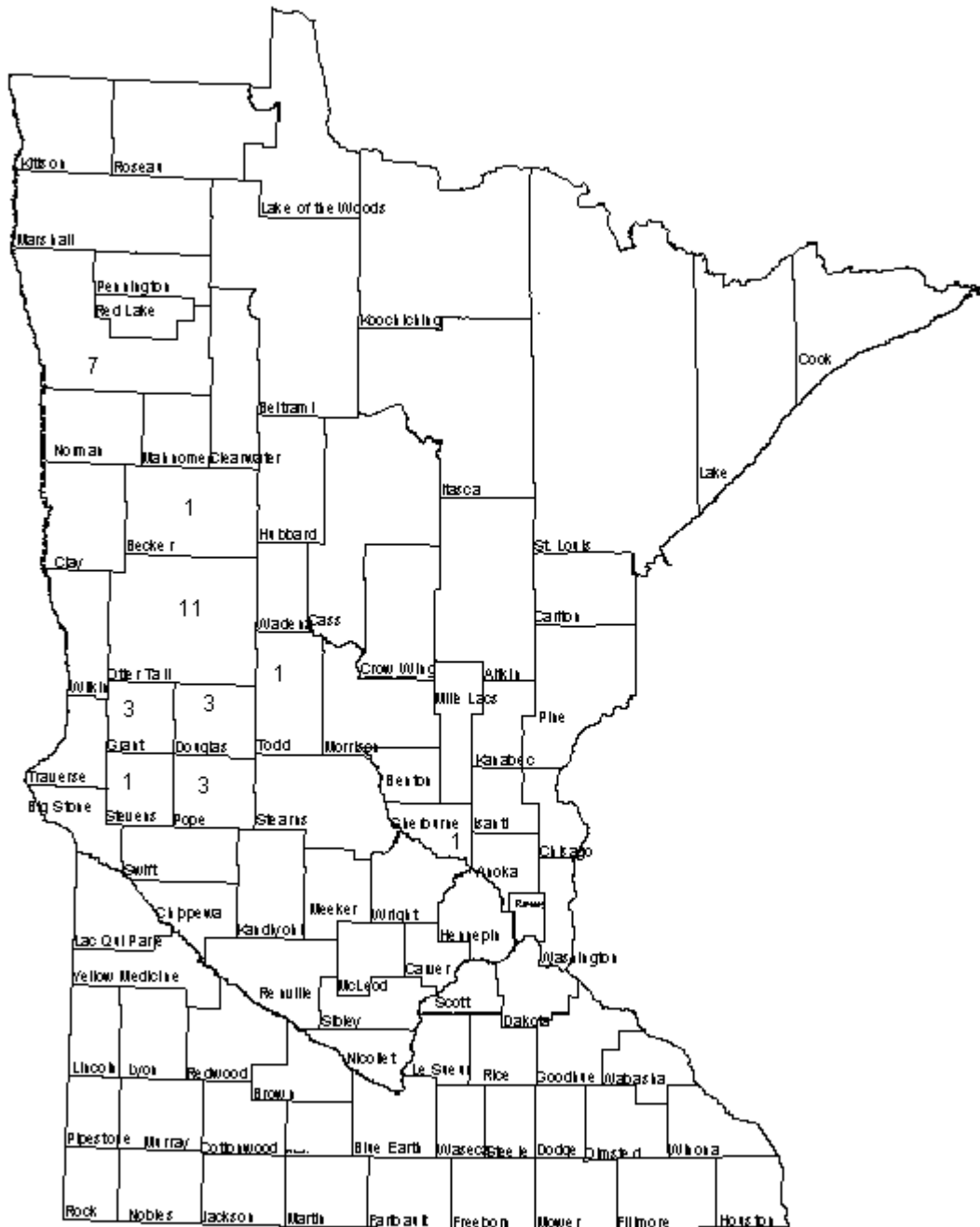


Figure 5. Distribution by County of ponds aerated under permits issued to private hatchery operators in 2009-10.

APPENDICES

Appendix 1. Private hatchery operators and protected waters under permit for 2009-10.

Permit #	Last Name	County	D.O.W.	Acres
Region 1				
F0901032	P. Koep	Douglas	21-74	17
			21-116	24
		Otter Tail	56-136	34
			56-85	19
			56-234	34
		Pope	61-212	67
F0901038	Jeff Koep	Douglas	Gravel Pit	6
		Grant	26-8	31
			26-33	44
		Otter Tail	56-1183	10
			56-23	87
			56-25	73
			56-29	53
			56-49	43
		Pope	56-858	43
			56-1182	12
			61-63	28
		Todd	61-22	62
			77-52	69
F0901042	Wertish	Polk	60-392	10
			60-157	41
			60-172	48
			60-141	46
F0901061	Spartz	Polk	60-242	37
			60-288	67
			60-310	47
F0901092	Joe Koep	Otter Tail	56-149	180
F0901103	Goeden	Becker	3-269	242
		Grant	26-114	93
F0901199	Lint	Stevens	75-25	28
			75-26	50
Region 3				
F0903100	McDonald	Sherburne	71-129	77

Appendix 2. Questionnaire results of aeration systems operated to prevent winterkill in lakes with or without public access, 2009-2010.

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Polcon Helixors</u>								
Artichoke (6-2)	Big Stone	2,011	Save A Lake Aeration	2-15 HP motor/blowers 12 diffusers				did not return questionnaire
Clear (8-11)	Brown	325	New Ulm Area Sport fisherman	1-10 HP motor/blower 7 diffusers	6,216	648.10	2.7	Y
Hanska (8-26)	Brown	1,844	Brown Co. Park Dept.	1-15 HP blower 6 diffusers				did not return questionnaire
Hanska (8-26)	Brown	1,844	Lake Hanska Area Association	1-15 HP Helixor	21,620	1,788.97	2.4	N
Sleepy Eye (8-45)	Brown	290	City of Sleepy Eye	2-5 HP motor/blowers 4 diffusers	5,188	528.60	1.8	N
Bingham (17-7)	Cottonwood	274	Cottonwood County Game & Fish League	1-5 HP blower 4 diffusers				did not operate
Cottonwood (17-22)	Cottonwood	146	Cottonwood County Game & Fish League	1-5 HP motor/blower 3 diffusers	-	-	2.5	N
Rebecca (19-3)	Dakota	35	City of Hastings	1-5 HP blower 2 diffusers				did not return questionnaire
Fountain (24-18)	Freeborn	555	City of Albert Lea	2-7.5 HP blowers 6 diffusers	-	1,358.00	2.4	N
Morin (24-43)	Freeborn	21	City of Alden	1-3 HP blower 1 diffuser	7,388	547.89	3.3	N
Round (27-71)	Hennepin	34	City of Eden Prairie	1-7.5 HP blower 1 diffuser				did not return questionnaire
Loon (32-20)	Jackson	738	Jackson County Conservation League	2-7.5 HP motor/blowers 9 diffusers	19,040	1,464.00	2.8	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Polcon Helixors (Con't.)</u>								
Pearl (32-33)	Jackson	117	Jackson County Conservation League	1-7.5 HP blower 3 diffusers	11,450	904.00	2.8	N
Round (32-69)	Jackson	947	Round Lake Sportsmen's Club	2-7.5 HP motor/blowers 9 diffusers	13,450	1,053.39	2.9	N
East Solomon (34-246)	Kandiyohi	733	Kandiyohi County	1-10 HP motor 6 diffusers	-	1,234.00	2.2	N
Foot (34-181)	Kandiyohi	576	Willmar Parks Department	1-25 HP motor/blower 6 diffusers	24,002	2,099.62	2.1	N
Long (34-192)	Kandiyohi	1,715	Kandiyohi County	2-10 HP motors 12 diffusers	-	2,854.00	2.2	N
Mud (Monongalia) M Fk Crow R. (34-158)	Kandiyohi	2,516	Kandiyohi County	1-15 HP motor 6 diffusers	-	1,090.00	2.2	N
Ringo (34-172)	Kandiyohi	774	Kandiyohi County	1-10 HP motor 9 diffusers	-	1,160.00	2.2	N
Swenson (34-321)	Kandiyohi	123	Kandiyohi County	1-7.5 HP motor 5 diffusers	-	758.00	2.2	N
Wakanda (34-169)	Kandiyohi	1,792	Kandiyohi County	2-15 HP blowers 12 diffusers		did not operate		
Willmar (34-180)	Kandiyohi	761	Willmar Public Works	1-15 HP blower 6 diffusers	15,071	13,389.84	2.1	N
Clear (40-79)	LeSueur	282	Lexington Sportsmen's Club	1-7.5 HP motor 3 diffusers		did not return questionnaire		

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Polcon Helixors (Con't.)</u>								
Gorman (40-32)	LeSueur	590	Izaak Walton League	1-7.5 HP compressor 3 diffusers	13,684	658.71	2.2	N
Greenleaf (40-20)	LeSueur	306	Montgomery Sportsmen's Club	1-5 HP compressors 3 diffusers		did not return questionnaire		
Cottonwood (42-14)	Lyon	383	Lyon County	3-0.5 HP Ice Eaters		did not return questionnaire		
George (46-24)	Martin	82	City of Fairmont	1-5 HP blower 2 diffusers	3,459	534.16	2.4	N
Sisseton (46-25)	Martin	139	City of Fairmont	1-15 HP blower 2 diffusers	12,218	840.00	2.4	N
Swan (43-41)	McLeod	482	Silver Lake Sportsmen's Club	1-7 HP blower 3 diffusers	-	-	1.9	N
Bloody (51-40)	Murray	248	Murray County	1-7.5 HP blower 2 diffusers	18,180	1,460.17	2.6	Y
First Fulda (South) (51-21)	Murray	122	Murray County	2-7.5 HP motor/blowers 4 diffusers	7,560	726.28	2.9	N
Sarah (51-83)	Murray	1,176	Murray County	1-7.5 HP motor/blower 4 diffusers	4,510	462.90	2.9	N
Indian (53-7)	Nobles	204	Round Lake Sportsmen's Club	1-10 HP blower 4 diffusers	8,827	871.31	2.9	N
Okabena (53-28)	Nobles	785	City of Worthington	2-7.5 HP blowers 9 diffusers	20,477	1,847.59	2.3	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Polcon Helixors (Con't.)</u>								
Cedar (70-91)	Scott	749	New Prague Sportsmen's Club	1-20 HP pump 12 Helixor diffusers			did not return questionnaire	
Becker (73-156)	Stearns	222	Sauk River Watershed District	1-15 HP blower 9 diffusers			did not return questionnaire	
Elysian (81-95)	Waseca	2,462	Smith's Mill-Janesville Sportsmen's Club	3-7.5 HP blowers 15 diffusers			did not operate	
Winona (85-11)	Winona	318	City of Winona	3-7.5 HP compressors 6 diffusers			did not return questionnaire	
Wood (87-30)	Yellow Medicine	484	Yellow Medicine County	1-15 HP compressor 6 diffusers			did not return questionnaire	
<u>Clean-Flo Systems</u>								
Shack Eddy (2-109)	Anoka	22	Armstrong Kennels	1-0.5 HP blower 1 diffuser	-	-	2.4	Y
Crystal (7-98)	Blue Earth	396	Crystal and Look Lake Rec., Inc.	2-0.75 HP compressors 4 diffusers			did not return questionnaire	
Ida (7-90)	Blue Earth	120	Lura Lake Aeration Corp.	1-5 HP compressor 8 diffusers	-	-	2.7	Y
Loon (7-96)	Blue Earth	818	Crystal and Loon Lake Rec., Inc.	4-0.75 HP compressors 8 diffusers			did not return questionnaire	
Lura (7-79)	Blue Earth	1,263	Lura Lake Aeration Corp.	1-5 HP & 1-4 HP Clean Flo, 12 diffusers	-	-	2.6	N
Alimagnet (19-21)	Dakota	113	City of Apple Valley	1-2 HP compressor 6 diffusers	2,800	677.00	1.8	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
Clean-Flo Systems (Con't.)								
Arrowhead (27-45)	Hennepin	23	City of Edina	1-1.5 HP compressor 6 diffusers	-	-	3.0	N
Crystal (27-34)	Hennepin	74	City of Robbinsdale	8-0.5 HP compressors 16 diffusers	did not return questionnaire			
Indianhead (27-44)	Hennepin	13	City of Edina	4-0.5 HP compressors 4 diffusers	-	-	3.0	N
Gleason (27-95)	Hennepin	167	Gleason Lake Improvement Assn	4-0.5 HP compressors 16 diffusers	-	-	2.1	N
Hadley (27-109)	Hennepin	39	Hadley Lake Improvement Assn	6-0.5 HP compressors 7 diffusers	-	1,500.00	4.0	N
Sweeny-Twin (27-35)	Hennepin	96	Sweeny Lake Assn	2-0.75 HP compressors 2 vent diffusers	36,600	4,028.00	6.0	N
Unnamed (Upper) (34-28)	Kandiyohi	22	City of Atwater	2-2 HP compressors 4 diffusers	1,155	323.76	2.8	N
Unnamed (Tadd) (34-376)	Kandiyohi	10	City of Atwater	2-2 HP compressors 4 diffusers	did not operate			
Mabel (40-11)	LeSueur	103	Lucky 13 Sportsmen's Club	2-0.5 compressors 4 diffusers	-	195.00	2.6	N
Unnamed (40-58)	LeSueur	18		1-0.75 compressor 2 diffusers	did not return questionnaire			
Unnamed (58-141)	Pine	23		1-0.75 compressor 2 diffusers	did not return questionnaire			

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Clean-Flo Systems (Con't.)</u>								
Birch (62-24)	Ramsey	127	Birch Lake Improvement Assn	1-1 HP compressor 3 diffusers				did not return questionnaire
Willow (62-40)	Ramsey	75	Natural Preserve Foundation	3-0.5 compressors 6 diffusers	-	-	2.8	N
Cody (66-61)	Rice	257	Wheatland Twin Lakes Sportsmen's Club	4-0.5 and 2-0.75 HP Compressors, 12 diffusers	11,549	1,310.42	2.8	Y
Krenz (Sunset) (70-09)	Scott	15		1-HP compressor 2 diffusers				did not return questionnaire
Unnamed (Fawn) (71-110)	Sherburne	33	Carefree Country Club	2-0.5 HP – 4 diffusers 1-0.75 HP – 2 diffusers				did not operate
Loon (81-15)	Waseca	119	City of Waseca	1-5 HP compressor 9 diffusers	6,893	689.30	2.7	Y
Benz (82-120)	Washington	36	Benz Lake Homeowners Association	3-0.75 HP, 1-0.33 HP 8 diffusers				did not operate
Pine Tree (82-122)	Washington	174		1-0.5 HP compressor 2 diffusers	-	100.00	4.0	N
Sunset (82-153)	Washington	124	Sunset Lake Homeowners Association	2-0.5 HP compressors 4 diffusers				did not return questionnaire
<u>Other Bubblers</u>								
Bijou (3-638)	Becker	229	Cormorant Lake Sportsmen's Club	4-Wifle Webber diffusers 2-pumps				did not return questionnaire
Ellison (3-484)	Becker	79	Cormorant Lake Sportsmen's Club	1-1.0 HP pump 2 diffusers				did not return questionnaire

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
Other Bubblers (Con't.)								
Little Cormorant (3-506)	Becker	939	Cormorant Lake Sportsmen's Club	3-1 HP pumps 6 ceramic brick diffusers				did not return questionnaire
Ewert's (4-205)	Beltrami	34		2-2 HP compressors 4 diffusers	-	-	4.0	N
Mills (7-97)	Blue Earth	237	Crystal and Loon Lake Restoration	2-0.75 HP compressors 4 diffusers				did not operate
Courthouse (10-05)	Carver	10	Carver County	1-1.5 HP compressor 1 diffuser				did not operate
Oak (10-93)	Carver	185		4-1 HP compressors 8 diffusers	-	-	3.8	N
Eagle (11-342)	Cass	110	Eagle Lake Association	1-0.5 HP pump 2 diffusers				did not return questionnaire
Meadow (11-419)	Cass	43	Wilderness Park Assn.	1-1.0 HP pump 2 diffusers	-	-	2.6	N
Blue Eagle (14-93)	Clay	11	City of Barnesville	2-1/2 HP pumps 4 diffusers	-	-	4.0	N
Lake Fifteen (14-30)	Clay	128	Cormorant Lake Sportsmen's Club	2-1 HP motor 4 ceramic diffusers				did not return questionnaire
Pine (15-149)	Clearwater	1,465	Red Lake Watershed District	Bubbler				did not return questionnaire
Rice (22-7)	Faribault	268	Wells Rifle & Pistol Club	2-0.75 compressors 9 diffusers				did not return questionnaire

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
Other Bubblers (Con't.)								
Albert Lea (24-14)	Freeborn	2,654	Wells Rifle & Pistol Club	2-0.75 compressors 9 diffusers	2,200	400.00	2.8	N
Pottery Pond (25-38)	Goodhue	8	City of Red Wing	1-0.75 HP Vane compressor 2 diffusers	567	86.52	2.8	N
Marion (43-84)	McLeod	616	Brownton Rod and Gun Club	1-5 HP blower 3 mat diffusers	10,646	1,197.97	2.6	N
Alexander	Morrison	2,990		1-3 HP Vein pump 500 pt diffuser hose	-	600.00	3.3	N
Shamineau (49-127)	Morrison	1,453		Regiair Vane blower 1.5 HP	-	567.55	3.5	N
Perch (56-95)	Otter Tail	57		1-0.75 HP compressor				did not return questionnaire
Unnamed (56-549)	Otter Tail	17		1-0.25 HP motor and diffuser hose				did not return questionnaire
Lena (56-18)	Pine	50	Lake Lena Acres Assn	2-0.25 HP bubbler				did not return questionnaire
Cable (60-293)	Polk	129	Cable Lake Association	3-0.25 HP pump	2,304	163.58	2.1	N
Pleasant (62-46)	Ramsey	585	City of St. Paul Water Utility	2-30 HP compressors 2 diffusers				did not return questionnaire
Ann (71-69)	Sherburne	226	Ann Lake Improvement Club, Inc.	1-.5 HP compressor 2 copper diffusers	-	120.00	1.5	N
Kohlmeier (74-19)	Steele	11	City of Owatonna	2-0.75 HP compressors 3 diffusers	-	-	4.2	Y

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Other Bubblers (Con't.)</u>								
Stocking (80-37)	Wadena	356	Stocking Lake Boosters, Inc.	2 Gast compressors 5 diffusers	-	500.00	4.0	N
Mud (Battle Creek) (82-91)	Washington	103	City of Woodbury	2-1 HP compressors 6 diffusers	3,852	415.00	2.3	Y
Unnamed Pond (82-257)	Washington	7		0.25 HP blower 2 diffusers	-	-	4.7	N
<u>Pump and Baffle</u>								
Centerville (2-6)	Anoka	464	Anoka County Parks and Recreation Dept.	1-20 HP pump and baffle				did not return questionnaire
Crooked (2-84)	Anoka	130	City of Coon Rapids	1-10 HP pump and baffle				did not operate
Golden (2-45)	Anoka	50	City of Circle Pines	1-7.5 HP permanent pump and baffle	16,932	2,022.34	6.0	N
Martin (2-34)	Anoka	218	Anoka County Parks and Recreation	1-10 HP pump and baffle				did not return questionnaire
Peltier (2-4)	Anoka	483	Anoka County Parks and Recreation	1-20 HP pump and baffle				did not return questionnaire
Wolf (3-101)	Becker	1,453	Wolf Lake Sportsmen's Club	2-10 HP pump and baffle				did not return questionnaire
Susan (10-13)	Carver	93	City of Chanhassen	1-7.5 HP pump and baffle	-	-	1.4	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Pump and Baffle (Con't.)</u>								
Marion (19-26)	Dakota	489	City of Lakeville	1 pump and baffle		did not operate		
Roger's (19-80)	Dakota	116	City of Mendota Heights	1-10 HP pump and baffle	-	1,500.00	-	N
Hyland (27-48)	Hennepin	87	Three Rivers Park District	Permanently install. 7.5 HP pumps		did not return questionnaire		
Mitchell (27-70)	Hennepin	116	City of Eden Prairie	1-7.5 HP Crisafulli pump and baffle		did not return questionnaire		
Penn (27-4)	Hennepin	47	City of Bloomington	15 HP pump and baffle	6,763	792.07	2.7	Y
Powderhorn (27-14)	Hennepin	11	Mpls. Park and Recr. Board	Pump and baffle		did not return questionnaire		
Red Rock (27-76)	Hennepin	83	City of Eden Prairie	1-7.5 HP pump and baffle		did not return questionnaire		
Wirth (7-37)	Hennepin	37	Mpls. Park and Recr. Board	1-5.0 HP pump and baffle		did not return questionnaire		
Wolfe (27-664)	Hennepin	3	City of St. Louis Park	Built in waterfall – 5 HP	1,600	2,000.00	4.0	N
Wolf (29-81)	Hubbard	274		1-5 HP pump and baffle		did not return questionnaire		
Unnamed (Florian Res.) (45-119)	Marshall	42	Marshall County Park Board	1-9 HP pump and baffle	-	-	2.2	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Pump and Baffle (Con't.)</u>								
Jennie (47-15)	Meeker	1,089	Lake Jennie Improvement Corp.	1 pump and baffle system 2,000 gpm pump				did not return questionnaire
Wilson (51-81)	Murray	164	Murray County	1-10 HP pump and baffle	3,380	330.89	2.7	N
Adley (56-31)	Otter Tail	249	Parker's Prairie Sportsmen's Club	1-15 HP pump and baffle	-	400.00	0.7	N
Fish (56-66)	Otter Tail	500	Parker's Prairie Sportsmen's Club	1-10 HP pump and baffle	-	800.00	1.8	N
Maple (60-305)	Polk	1,445	Maple Lake Improvement District	3-5 HP pump and baffle				did not operate
Beaver (62-16)	Ramsey	65	Ramsey County Public Works Dept.	1-7.5 HP pump and baffle	12,496	1,200.00	2.2	N
Island (62-75)	Ramsey	63	Ramsey County Public Works Dept.	1-20 HP pump and baffle	22,005	2,117.00	2.0	Y
Loeb (62-231)	Ramsey	10	City of St. Paul	1-5 HP pump and baffle				did not return questionnaire
Owasso (62-56)	Ramsey	360	Ramsey County Public Works Dept.	1-20 HP pump and baffle				did not operate
Silver (East) (62-1)	Ramsey	68	Ramsey County Public Works Dept.	1-15 HP pump and baffle	11,930	1,150.00	2.4	N
Silver (62-83)	Ramsey	67	City of Columbia Heights	1-10 HP pump and baffle	6,978	717.24	1.8	N
Cleary (70-22)	Scott	137	Three Rivers Park District	1-7.5 HP pump and baffle				did not return questionnaire

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Pump and Baffle (Con't.)</u>								
McMahon (Carls) (70-50)	Scott	136	New Market Sportsmen's Club	1-10 HP pump and baffle			did not operate	
Hattie (75-200)	Stevens	488	Save A Lake Aeration, Inc.	1-10 HP pump and baffle			did not return questionnaire	
Goose (82-59)	Washington	83	Town of New Scandia	1-3 HP pump and baffle	2,468	281.09	2.1	N
Shields (82-162)	Washington	27	City of Forest Lake	CORE pump and baffle 3 HP	-	627.80	1.4	N
<u>Subsurface Aspirating Systems (Aire-02, Aeromix Tornado)</u>								
Cedar (1-165)	Aitkin	260	Cedar Lake Assn	3-2 HP Aeromix tornado	8,205	1,042.00	3.0	N
Coon (2-42)	Anoka	1,507	Anoka County Parks	3-2 HP Aeromix tornado			did not return questionnaire	
Ham (2-53)	Anoka	193	Anoka County Parks	3-2 HP Aeromix tornadoes	-	-	0.9	N
Spring (2-71)	Anoka	37	City of Spring Lake Park	1-2 HP Aeromix			did not return questionnaire	
Long Tom (6-29)	Big Stone	110	Save A Lake Aeration	2-2 HP Aqua tornadoes			did not return questionnaire	
Eagle (10-121)	Carver	230	Carver County Public Works Dept.	4-2 HP Aire-02 aerators			did not return questionnaire	
George (11-101)	Cass	720	Lake George Association	1-Aire 02			did not operate	

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Subsurface Aspirating Systems (Aire-02 Aeromix Tornado (Con't.))</u>								
Loon (11-226)	Cass	220	Loon Lake Property Owners	2-2 HP Aeromix tornadoes	5,026	740.00	1.9	N
Platte (18-88)	Crow Wing	1,486	Platte Lake Association	1-2 HP Aeromix tornadoes	480	160.00	0.7	N
Birch Pond (19-202)	Dakota	3	School of Environmental Studies	Neptune air injection system	-	-	1.8	N
Blackhawk (19-59)	Dakota	39	City of Eagan	1-2 HP air injection system				did not return questionnaire
Burr Oaks (19-259)	Dakota	19	City of Eagan	1-2 HP pump				did not return questionnaire
Cliff (19-68)	Dakota	16	City of Eagan	1-2 HP air injection system				did not return questionnaire
Farquar (19-23)	Dakota	74	City of Apple Valley	1-2 HP air injection system	4,950	534.15	2.3	N
Fish (19-57)	Dakota	28	City of Eagan	1-2 HP air injection system				did not return questionnaire
Gun Club (19-245)	Dakota	8	City of Inver Grove Heights	1-2 HP Aeromix tornado				did not return questionnaire
Hay (19-62)	Dakota	20	City of Eagan	1-2 HP air pump				did not return questionnaire
Heine (19-153)	Dakota	7	City of Eagan	1-2 HP pump				did not return questionnaire
Holland (19-65)	Dakota	33	Dakota Co. Parks	1-2 HP Aire 02				did not operate

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Subsurface Aspirating Systems (Aire-02 Aeromix Tonadao (Con't.))</u>								
LeMay (19-55)	Dakota	44	City of Eagan	1-2 HP air injection system				did not return questionnaire
Manor (19-64)	Dakota	14	City of Eagan	1-2 HP air injection system				did not return questionnaire
Pickerel (19-79)	Dakota	51	City of St. Paul	1-2 HP Neptune pump				did not return questionnaire
East Thomas (19-161)	Dakota	39	City of Eagan	1-0.1 HP solar powered pump				did not return questionnaire
Thomas (19-67)	Dakota	56	City of Eagan	1-2 HP air injection pump				did not return questionnaire
Thompson (19-48)	Dakota	10	Dakota County Parks	1-2 HP Neptune pump	-	-	1.5	N
Unnamed (Schwartz) (19-63)	Dakota	13	City of Eagan	1-2 HP air injection pump				did not return questionnaire
Aldrich (21-222)	Douglas	173		2-2 HP Aeromix tornadoes	-	1,200.00	4.3	Y
Albert Lea (24-14)	Freeborn	2,654	Shellrock River Watershed District	2-7.5 HP Aeromix systems				did not operate
Bass (27-98)	Hennepin	175	Bass Lake Improvement Assn	2-2 HP Aire-02	6,063	652.29	2.1	N
Crystal (27-34)	Hennepin	74	City of Robbinsdale	2-2 HP Aire-02	4,985	574.41	1.8	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Subsurface Aspirating Systems (Aire-02 Aeromix Tonadao (Con't.))</u>								
Rebecca (27-192)	Hennepin	290	Three Rivers Park District	3-2 HP Aire-02 aerators			did not return questionnaire	
Rice (27-116)	Hennepin	306	Rice lake Area Association	1-2 HP Aire-02			did not return questionnaire	
Petite (29-147)	Hubbard	58	Wonewok Conference Center	1-2 HP air injection system			did not return questionnaire	
Crow River (34-158)	Kandiyohi	2,516	City of New London	2-2 HP Aeromix systems			did not return questionnaire	
Elizabeth (34-22)	Kandiyohi	1,153	Kandiyohi County	2-2 HP Aeromix systems	-	214.09	0.8	N
Dead Coon (41-21)	Lincoln	555	Tyler Rod & Gun Club	2-2 HP Aire-02			did not operate	
Hendricks (41-110)	Lincoln	1,634	Lake Hendricks Improvement Assn	4-2 HP Aire-02 aerators			did not return questionnaire	
Stay (41-34)	Lincoln	220	Arco Sportsmen's Club	2-2 HP Aqua tornadoes			did not return questionnaire	
Clear (42-55)	Lyon	68	Lyon County	1-2 HP Aire-02			did not return questionnaire	
East Goose (42-93)	Lyon	151	Lyon County	2-2 HP Aire-02			did not return questionnaire	
Lady Slipper (42-20)	Lyon	262	Lyon County	2-2 HP Aeromix tornadoes			did not return questionnaire	
Rock (42-52)	Lyon	422	Lyon County	2-3 HP Aire-02			did not return questionnaire	

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)</u>								
School Grove (42-2)	Lyon	333	Lyon County	2-3 HP Aire-02				did not return questionnaire
Yankton (42-27)	Lyon	382	Lyon County	3-3 HP Aire-02				did not return questionnaire
Big Twin (46-133)	Martin	457	Trimont Area Conservation Club	2-1 HP Aire-02	-	600.00	2.0	N
Buffalo (46-146)	Martin	116	Mt. Lake-Odin-Ornsby Sportsmen's Club	1-3 HP Aire-02	-	180.00	2.3	N
Fish (46-145)	Martin	156	Watowan Game and Fish	1-2 HP Aire-02				did not return questionnaire
Winsted (43-12)	McLeod	407	City of Winsted	6-2 HP Aire-02				did not return questionnaire
Star (47-129)	Meeker	554	Star Lake Association	3-2 HP Aire-02	4,003	512.81	3.0	N
Corabelle (51-54)	Murray	99	Murray County	1-2 HP Aire-02	-	-	2.9	N
Kinbrae (53-16)	Nobles	87	Nobles County Park	1-1 HP Aeromix tornado	-	-	2.0	N
Tamarac (59-931)	Otter Tail	416	Tamarac Lake Association	2-2 HP aspirating aerators	5,158	600.96	2.1	N
Split Rock (59-1)	Pipestone	80	Split Rock Creek State Park	2-2 HP Aeromix tornadoes	-	-	2.8	N
Johanna (61-6)	Pope	1,204	DNR Fisheries	2-5 HP Aire-02's				did not operate

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)</u>								
Signalness (61-149)	Pope	41	Glacial Lakes State Park	1-2 HP Aire-02				did not return questionnaire
Unnamed (61-71)	Pope	21		1-2 HP Aeromix tornadoes				did not return questionnaire
Otter (2-3)	Ramsey/ Anoka	173	Ramsey County Public Works	3-2 HP Aeromix tornadoes	8,036	773.00	3.0	N
Circle (66-27)	Rice	976	Tri-Lakes Sportsmen's Club	3-2 HP Aeromix tornadoes	8,871	1,142.00	2.5	N
O'Dowd (70-95)	Scott	256	O'Dowd Lakes Chain Assn	3-2 HP Aire-02	5,000	580.00	2.1	N
Thole (70-120)	Scott	131	O'Dowd Lakes Chain Assn	1-2 HP Aire-02	2,840	300.00	2.1	N
McColl (70-17)	Scott	20	City of Savage	2-2 HP Aeromix tornadoes				did not return questionnaire
Murphy (70-10)	Scott	70	Hennepin Parks	2-2 HP Aeromix tornadoes				did not return questionnaire
Birch (71-57)	Sherburne	149	Birch Lake Association	1-2 HP Aire-02				did not return questionnaire
Fremont (71-16)	Sherburne	466	City of Zimmerman	2-2 HP Aire-02's				did not operate
Silver (72-13)	Sibley	697	Silver Lake Conservation Club	3-2 HP Aire-02				did not return questionnaire
Black Oak (73-241)	Stearns	121	Green Grove Sportsmen's Club	1-2 HP Aire-02				did not return questionnaire

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)</u>								
Elysian (81-95)	Waseca	2,462	So. Lakes Chain Dark House Angles Association	3-3 HP Aire-02's	-	300.00	3.0	Y
Unnamed (Cloverdale) (82-9)	Washington	39	Cloverdale Farms	2-1 HP Aeromix systems	-	225.00	-	N
McDonald (82-10)	Washington			1-1 HP Aeromix tornado	-	300.00	2.7	N
Sand (82-67)	Washington	46	Sand Lake Lakeshore Association	1-2 HP Aeromix tornado		did not operate		
Kansas (83-36)	Watonwan	388	Watonwan Game and Fish Club	3-2 HP Aire-02		did not return questionnaire		
St. James (83-43)	Watonwan	252	Watonwan Game and Fish Club	2-2 HP Aire-02		did not return questionnaire		
Crawford (86-46)	Wright	117	Crawford Lake Improvement Assn	2-2 HP Aire-02	3,335	270.00	2.1	N
Dean (86-41)	Wright	204	Dean Lake Club Assn	2-2 HP Aire-02	1,434	166.31	1.0	N
Little Waverly (86-106)	Wright	336	Little Waverly Lake Association	1-2 HP Propeller aspirator		did not operate		
Mink (86-229)	Wright	304	Assn of Mink & Somers Lakes	1-2 HP Aire-02	2,250	225.00	0.7	N
Somers (86-230)	Wright	156	Assn of Mink & Somers Lakes	1-2 HP Aire-02	2,150	210.00	1.0	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)</u>								
Tyson (87-19)	Yellow Medicine	180	Yellow Medicine County	2-2 HP Aire-02		did not operate		
Wood (87-30)	Yellow Medicine	484	Yellow Medicine County	2-2 HP Aire-02	-	-	2.8	N
<u>Sprayers</u>								
Crystal (70-61)	Scott	33	City of Prior Lake	3 HP Otterbine	-	615.88	3.1	N
Lakefront Park Pond (70-169)	Scott	13	City of Prior Lake	3 HP Otterbine		did not operate		
Dullinger (73-103)	Stearns	21		1-1 HP Kallep floating aerator		did not return questionnaire		
<u>Mixed Systems</u>								
East Toqua (6-138)	Big Stone	440	City of Graceville	1-10 HP Helixor 2-2.5 HP Tornadoes	1,260	335.00	2.4	N
Mountain (17-3)	Cottonwood	241	Mountain Lake Area Sportsmen's Club	5-0.5 HP compressors 4-2 HP Aeromix Tornadoes	13,300	752.38	2.6	N
Carlson (19-66)	Dakota	14	City of Eagan	1-3 HP lift station Air injection pump		did not return questionnaire		
Snelling (27-1)	Hennepin	110	Fort Snelling State Park	2-5 HP sump pumps	8,293	908.00	2.1	N
Clear (32-22)	Jackson	415	Jackson County Conservation League	2-5 HP motor/blowers, 6 diffusers, 3-3 HP Ice Eaters	11,190	859.00	3.1	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Mixed Systems (Con't.)</u>								
Independence (32-17)	Jackson	97	Jackson County Conservation League	1-5 HP Helixor 3-3 HP Ice Eater	6,470	500.00	3.1	N
Little Spirit (32-24)	Jackson	634	Little Spirit Lake Conservation Club	2-7.5 HP motors 6 diffusers; 3-3 HP Ice Eaters	5,340	421.00	3.1	N
Scotch (40-109)	LeSueur	590	German-Jefferson Sportsmen's Club	2-0.75 compressors, 1-10 HP Helixor, 9 diffusers	-	780.00	2.7	N
Cedar (46-121)	Martin	710	Trimont Area Conservation Club	1-2 HP Aire-02, 1-0.75 HP Ice Eater	-	780.00	2.2	N
Thompson (47-159)	Meeker	220	Meeker County Parks	1-20 HP pump and baffle 2-2 HP Tornados		did not operate		
Shetek (51-63)	Murray	3,596	Murray County	3-7.5 HP motor/blowers 12 diffusers, 2 Ice Eaters	18,180	1,460.17	2.6	Y
Bennett (62-48)	Ramsey	41	Roseville Parks and Recr.	3-0.5 HP blower and 6 diffusers, baffle system		did not return questionnaire		
<u>Hypolimnetic Aerators</u>								
Moore (East) (2-75)	Anoka	110	City of Fridley	1-7.5 HP Palatek Compressor	-	4,862.52	4.0	N
Como (62-55)	Ramsey	69	Ramsey County Public Works Dept.	1-7.5 HP Hypo system	19,594	1,885.00	3.4	N
Vadnais (62-38)	Ramsey	477	City of St. Paul Water Utility	2-30.0 HP Atlas Copco		did not return questionnaire		
Marie (Maria) (73-14)	Stearns	145	Clearwater River Watershed District	1-20 HP Atlas Copco		did not return questionnaire		

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Hypolimnetic Aerators (Con't.)</u>								
Augusta (86-284)	Wright	186	Clearwater River Watershed District	1-20 HP Atlas Copco			did not return questionnaire	
Louisa (86-282)	Wright	183	Clearwater River Watershed District	1-10 HP Atlas Copco			did not return questionnaire	
<u>Other (Mechanical Surface Agitators, homemade, etc.)</u>								
Wolf (3-101)	Becker	1,453	Wolf Lake Sportsmen's Club	3-1 HP Ice Eaters			did not return questionnaire	
Bean (17-54)	Cottonwood	141	Red Rock Sportsmen's Club	2-5 HP Ice Eaters			did not return questionnaire	
Double (17-56)	Cottonwood	227	Red Rock Sportsmen's Club	2-5 HP Ice Eaters			did not return questionnaire	
South Double (17-56)	Cottonwood	227	Red Rock Sportsmen's Club	2-5 HP Ice Eaters			did not return questionnaire	
Talcott (17-60)	Cottonwood	928	Red Rock Sportsmen's Club	1-5 HP Ice Eater			did not return questionnaire	
Nisswa (18-399)	Crow Wing	213		25-3/4 HP Ice Eaters	-	-	3.0	N
Knife (33-28)	Kanabec	1,127	Knife Lake Improvement District	4-2 HP floating aspirators			did not operate	
Nest (34-154)	Kandiyohi	1,019	North Shore Estates	Morgan Winds Windmill			did not return questionnaire	
Silver (40-48)	LeSueur	17	N. Elysian Silver Lakers Sportsmen's Club	1-0.75 HP motored propeller	2,009	240.20	2.8	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
Other (Con't.)								
Benton (41-43)	Lincoln	2,875	Lake Benton Sportsmen's Club	5-0.25 HP Ice Eaters	19,937	976.00	2.8	N
Shaokotan (41-89)	Lincoln	1,043	Shaokotan Sportsmen's Club	4-0.75 HP Ice Eaters		did not return questionnaire		
East Twin (42-70)	Lyon	280	Lyon County	3-0.5 HP Ice Eaters		did not return questionnaire		
West Twin (42-74)	Lyon	237	Lyon County	2-0.5 HP Ice Eaters		did not return questionnaire		
Budd (46-30)	Martin	224	City of Fairmont	Water plant pumps		did not operate		
Buffalo (51-18)	Murray	124	Murray County	2-0.75 HP Ice Eaters		did not operate		
Currant (51-82)	Murray	394	Murray County	3-0.75 HP Ice Eaters	5,074	476.75	2.7	Y
Lime (51-24)	Murray	316	Murray County	2-0.75 HP Ice Eaters	-	101.49	2.6	Y
Louisa (51-6)	Murray	211	Murray County	2-0.75 HP Ice Eaters	-	53.44	2.6	N
Mitchell (27-07)	Hennepin	116	Riley Purgatory Bluff Creek Watershed District	2-Solarbee Units		did not return questionnaire		
Wilson (51-81)	Murray	164	Murray County	1-0.75 HP Ice Eater		did not return questionnaire		
Wilson (South) (51-81)	Murray	164	Murray County	1-0.75 HP Ice Eater	3,380	330.89	2.7	N

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Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
Other (Con't.)								
East Graham (53-20)	Nobles	523	Nobles County Parks Department	3-0.75 HP Powerhouse	-	-	1.9	N
West Graham (53-21)	Nobles	526	Nobles County Parks Department	3-0.75 HP Powerhouse	-	-	1.9	N
Ocheda (53-24)	Nobles	1,778	Nobles County	2-0.75 HP portable powerhouse motors		did not operate		
Badger (60-214)	Polk	247	City of Erskine	2-0.75 HP Kasco agitators	-	127.30	2.9	N
Community Center Pond (62-63)	Ramsey	2	City of Shoreview	3-1 HP Kasco agitators	-	-	4.0	N
Legends (70-287)	Scott	29	Legends Club	1-HP Aqua control surface pump	-	-	1.4	N
Fedji (83-21)	Watsonwan	179	Madelia Sportsmen's Club	3-1 HP Powerhouse Systems		did not operate		
White Bear Lake (82-167)	Washington	1,255	City of White Bear Lake	6-0.75 HP Kasco marine de-icers	-	-	-	N