MINNESOTA DEPARTMENT OF NATURAL RESOURCES

DIVISION OF ECOLOGICAL RESOURCES

Aeration Permit Program Annual Report 2012-2013

2013

Aeration Permit Program Annual Report
2012-2013

By

Marilyn Danks
Aquatic Biologist

Minnesota Department of Natural Resources

Division of Ecological and Water Resources

2013

Table of Contents

Table of Contents (Continued)

Page

Figures

Appendices

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 2012-13 permit year (1 October 2012– 30 September 2013). 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, 2012, Danks 2011B; Danks 2011A; 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 game fish 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 and Water 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 Parks and Trails 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 and Water 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 (2012-13), no lakes were opened to "liberalized fishing".

A total of 320 aeration permits were issued during the 2012-13 season. This includes 290 renewals (91% of the permits issued) and seventeen (17) new permits. Eight permits were renewed after having lapsed.

The overall trend has been a steady increase in the number of permits issued in the last thirty years (Figure 1). The same trend is true for the regions as well (Figure 2).

The 320 permits issued in 2012-13 authorized aeration in 294 lakes totaling 122,921 acres, of which 184 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 72,916 acres (Table 1; Figure 3). All acreages listed are from "An inventory of Minnesota Lakes" MN DNR Bulletin 25 (Div. of Waters 1968). Pump and baffle systems were installed in 25 of these lakes, Aire0_2 units were installed in 73 lakes, mechanical surface agitators were installed in 21 lakes, a combination of system types was used in 9 lakes, and diffuser systems operated in 52 lakes. Bait dealers and commercial hatchery operations were permitted to operate in 26 public water bodies

totaling 1,391 acres. Sixty-four (64) 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 2012-13.

Winter inspections of aeration systems were conducted by inspectors from the divisions of Enforcement and Fish and Wildlife (Fisheries). A total of 880 inspections were made in 2012-13, an increase more than double from the previous year. Of these, Enforcement inspectors conducted 365 inspections and Fisheries inspectors conducted 515. The inspectors found a total of 67 discrepancies (8%) out of the 880 inspections completed, a 9% 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 178 inspections were completed in Region I of which 13 (7%) showed discrepancies. There were three (3) inspections completed in Region II with zero (0%) discrepancies. Inspectors conducted 155 inspections in Region III of which 6% showed discrepancies, and 544 inspections were conducted in Region IV with 8% 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 2012-13.

REGIONAL AERATION SUMMARY

REGION I (Bemidji)

There were 62 aeration permits issued in Region 1 during the 2012-13 season, 19% of the total number of permits issued. Of the 62 permits issued, 53 (85%) were renewals, four were renewed after having lapsed, and five were new permits.

The 62 permits issued in Region I authorized aeration in 54 public waters, or 18% of the total public waters aerated statewide. Private hatchery operators accounted for 46% of the aeration permitted water bodies in Region I. Private hatchery operators received five permits for 25 (1,314 acres) public waters (8.5% of the statewide total lakes permitted or 1% of the total acres permitted) (Figure 4). Appendix 1 lists water bodies under aeration permit issued to private hatchery operators. Private organizations and municipalities were issued 12 aeration permits to prevent winterkill in 12 lakes (8,682 acres) with public access. Forty aeration permits were issued to private individuals on 13 lakes (28,889 acres) to prevent shoreline property damage due to ice expansion. One permit was issued to the State covering 41 acres. Four other aeration permits were issued to private groups to prevent winterkill in public waters (382 acres) without public access. Three aerated lakes were 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 changed from zero permits in 2001 to ten in 2002 to seven in 2005. There were ten (10) permits issued for the 2012-13 season, of which nine were renewals and one was a new permit.

Of these ten permits, which represent 3% of the total number of permits issued statewide, nine were issued for lakes with access and one was issued for 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 137 aeration permits issued for 129 lakes/ponds (23,177 acres) in Region III last season (43% of the total number of permits issued). Nine were new permits. Pine Tree and Alexander lakes have two permits respectively.

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-seven permits were issued to municipalities for operation of aeration systems in 71 lakes (10,289 acres) with public access. Seven permits (921 acres) were issued to municipalities for lakes without public access. Sixteen permits (4,221 acres) were issued to clubs for lakes with public access, and seven permits (644 acres) were issued to clubs operating aeration systems in lakes without public access. Thirty-seven permits (6,898 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. One lake 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 34.7% of the permits issued statewide. Last season, 111 permits (58,956 acres) were issued in Region IV; 106 were renewals (95%). The 111 aeration permits issued in Region IV authorized the aeration of 102 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-six permits were issued to private organizations and municipalities to

prevent winterkill of fish in 91 lakes (52,934 acres) with public access. Two permits were issued to prevent winterkill in two protected waters without public access. Three permits were issued to municipalities and private individuals to improve water quality. Albert Lea Lake has two permits.

According to the questionnaires returned, three 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 226 of 320 permittees, a 71% 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. Fifty-one (51) respondents indicated their aeration system was not operated last winter.

The average cost for insurance (n=45) was $387.90. This figure includes all permittees operating an aeration system in lakes with or without public access. The range of insurance premiums for the 2012-13 season was $5.00-$1,027.00. One respondent indicated there was difficulty in acquiring the required insurance.

One hundred seventy-five (175) of the respondents indicated their aeration system was operated last winter and 62 of those indicated that waterfowl over wintered on the lake. Of these, nine respondents are located in Region I, one in Region II, 41 in Region III, and 11 respondents are in Region IV. An estimated 6,099 waterfowl used the open water areas provided by aeration systems (range 4-1,000 per aerated lake). Most of the birds were mallards and Canada geese.

Of the 175 permittees that responded and operated their systems last winter, 165 (94 %) indicated they were satisfied with system performance. Of these, 15% were Helixor systems, 7% were Clean-Flo systems, 8% were pump and baffles, 25% were AireO2 and Aeromix systems, 24% were other types of bubbler systems, and 15% were mechanical surface agitators. Complaints ranged from mechanical failures to undersized and ineffective equipment. Two respondents indicated safety problems with their aeration systems.

Some aerated lakes experienced partial winterkill last season. Seven of the 175 respondents that operated their aeration systems last winter reported some evidence of winterkill at ice out. Of these, one was an AireO2, two were Helixors and two were pump and baffle systems.

Based on the responses to the questionnaire as summarized in Table 8, AireO2 systems were on average the least expensive to operate per acre, with the Helixor and the mechanical surface agitator a close second and third. 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, and had the highest average horsepower per system. Clean Flo systems were used on smaller lakes up to 800 acres in size and had the smallest average horsepower per system. Mechanical surface aerators, on average, were the smallest systems based on total average horsepower, but were used on larger area lakes. Air injector systems and mechanical surface agitators were used on lakes up to 1,600 acres in size. To maximize efficiency and reduce operating costs, it is important to size the aerator to the size of the lake and the intended purpose.

LITERATURE CITED

Danks, M.A. 2012. Aeration Permit Program Annual Report, 2011-12. Minn. Dept. Nat. Res., Div. Ecol. & Water Res. Staff Report.

Danks, M.A. 2011B. Aeration Permit Program Annual Report, 2010-11. Minn. Dept. Nat. Res., Div. Ecol. & Water Res. Staff Report.

Danks, M.A. 2011A. Aeration Permit Program Annual Report, 2009-10. Minn. Dept. Nat. Res., Div. Ecol. & Water Res. Staff Report.

Danks, M.A. 2010. Aeration Permit Program Annual Report, 2008-09. Minn. Dept. Nat. Res., Div. Ecol. Res. Staff Report.

Danks, M.A. 2010. Aeration Permit Program Annual Report, 2007-08. Minn. Dept. Nat. Res., Div. Ecol. Res. Staff Report.

Danks, M.A. 2009. Aeration Permit Program Annual Report, 2006-07. Minn. Dept. Nat. Res., Div. Ecol. Res. Staff Report.

Danks, M.A. 2007. Aeration Permit Program Annual Report, 2005-06. Minn. Dept. Nat. Res., Div. Ecol. Serv. Staff Report.

Danks, M.A. 2006. Aeration Permit Program Annual Report, 2004-05. Minn. Dept. Nat. Res., Div. Ecol. Serv. Staff Report.

Danks, M.A. 2005. Aeration Permit Program Annual Report, 2003-04. Minn. Dept. Nat. Res., Div. Fish Wild., Ecol. Serv. Sec. Staff Report.

Danks, M.A. 1999. Aeration Permit Program Annual Report 1997-98. Minn. Dept. Nat. Res., Div. Fish Wildl., Ecol. Serv. Sec. Staff Report.

Danks, M.A. 1998. Aeration Permit Program Annual Report 1996-97. Minn. Dept. Nat. Res., Div. Fish Wildl., Ecol. Serv. Sec. Staff Report.

Danks, M.A. 1996. Aeration Permit Program Annual Report 1995-96. Minn. Dept. Nat. Res., Div. Fish Wildl., Ecol. Serv. Sec. Staff Report.

Danks, M.A. 1995. Aeration Permit Program Annual Report 1994-95. Minn. Dept. Nat. Res., Div. Fish Wildl., Ecol. Serv. Sec. Staff Report.

Danks, M.A. 1994. Aeration Permit Program Annual Report 1993-94. Minn. Dept. Nat. Res., Div. Fish Wildl., Ecol. Serv. Sec. Staff Report.

Danks, M.A. 1994. Aeration Permit Program Annual Report 1992-93. Minn. Dept. Nat. Res., Div. Fish Wildl., Ecol. Serv. Sec. Staff Report.

Danks, M.A. 1992. Aeration Permit Program Annual Report 1991-92. Minn. Dept. Nat. Res., Div. Fish Wildl., Ecol. Serv. Sec. Staff Report.

Danks, M.A. 1992. Aeration Permit Program Annual Report 1990-1991. Minn. Dept. Nat. Res., Div. Fish Wildl., Ecol. Serv. Sec. Staff Report.

LITERATURE CITED (Continued)

Division of Waters, Soils and Minerals. 1968. An Inventory of Minnesota Lakes. Minnesota Conservation Department, Bulletin No. 25.

Enger, S.M. 1988. Aeration Permit Program Annual Report 1987-88. Minn. Dept. Nat. Res., Div. Fish Wildl., Ecol. Serv. Sec. Staff Report 1.

Enger, S.M. and M.A. Danks, 1992. Aeration Permit Program Annual Report 1989-1990. Minn. Dept. Nat. Res., Div. Fish. Wildl., Ecol. Serv. Sec. Staff Report.

Pederson, D.W. 1982. Aeration and mixing systems in Minnesota lakes. Minn. Dept. Nat. Res., Div. Fish Wildl., Spec. Pub. No.133.

Schneberger, E., ed. 1970. A symposium on the management of Midwestern winterkill lakes. Special Publication, North Central Division, American Fisheries Society.

Scidmore, W.J. 1970. Using winterkill to advantage. Pages 47-51 in: E. Schneberger, ed. A symposium on the management of Midwestern winterkill lakes. Am. Fish. Soc. Spec. Publ., North Central Div.

Table 1. Aerated Acres 2012-13.

ACRES	REGION 1	REGION 2	REGION 3	REGION 4	OVERALL
Lakes with public access	36,235	3,112	20,949	55,824	116,120
Lakes without public access	1,181	260	2,228	3,132	6,801
TOTAL	37,416	3,372	23,177	58,956	122,921

Table 2. 2012-13 Aerated Lakes/Permits.

Region	Lakes w/access	Winterkill Permits C	M	S	P	Bait Dealers Ponds	Permits	Shoreline Lakes	Permit	Other Lakes	Permit	Total Permits
I	12	8	3	1	0	25	5	13	40	4	5	62 (19%)
II	4	3	0	0	1	0	0	2*	3	2	3	10 (3%)
III	71	11	57	1	2	1	1	4	8	54	57	137 (43%)
IV	97	45	51	0	1	0	0	1	1	4	13	111 (35%)
Totals	184	67	111	2	4	26	6	20	52	64	78	320

		Lakes	**Acres**	**Permits**
Protected waters with access for winterkill prevention	=	184	72,916	184
Protected waters under permit to Bait Dealers	=	26	1,391	6
Shoreline Protection*	=	20	35,864	52
Other**	=	64	12,750	78
		294	122,921	320
Total number of permits for protected waters for winterkill prevention	=	206		
Total number of permits for protected waters without access for winterkill prevention	=	22		
320 total permits, new permits	=	17		
Old permits reissued	=	8		

**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, 2012-13.

County	Permittee C	M	S	Total No. of lakes	Total Acres	Average Size (acres)
Becker	1	0	0	1	1,453	1,453
Clay	0	0	0	0	0	0
Clearwater	0	1	0	1	1,465	1465
Douglas	0	0	0	0	0	0
Marshall	0	1	0	1	42	42
Otter Tail	2	1	0	3	1,165	388
Polk	3	0	0	3	1,821	607
Pope	0	0	1	1	41	41
Stevens	1	0	0	1	488	488
Wadena	1	0	0	1	356	356
Totals	8	3	1	12	6,831	N/A

lakes with public access aerated to prevent winterkill = 12 (C = 8; M = 3; S = 1)
Total Acreage = 6,831
Average lake size (acres) = 569.3

Permits issued to Municipalities for lakes with access = 3 (1,756 acres)
Permits issued to Clubs for lakes with access = 8 (5,034 acres)
Permits issued to the State w/access = 1 (41 acres)
Permits issued for shoreline protection = 40 (13 lakes; 28,889 acres)

- Melissa Lake – 1,827 acres – 8 permits
- Lida Lake – 7,277 acres – 7 permits
- Little Pine – 2,036 – 1 permit
- Eunice Lake – 370 acres – 1 permit
- Lizzie Lake – 4,145 acres – 2 permits
- Island Lake – 1,209 acres – 1 permit
- West McDonald – 597 acres – 1 permit
- Paul Lake – 334 acres – 1 permit
- Fish Lake – 284 acres – 1 permit
- Big Cormorant Lake – 3,380 acres – 2 permits
- Pelican – 4,314 acres – 12 permits
- Marion Lake – 1,610 acres – 2 permits
- Little McDonald – 1,506 acres – 1 permit

Permits issued to Bait Dealers, & P. Hatchery operators = 5 (25 ponds, 1,314 acres)
Permits issued to private individuals to prevent winterkill for lakes without access = 4 (382 acres)
Permits issued to the State without access = 0 (0 acres)
Permits issued to private individuals to improve water quality for lakes with access = 1 (1,892 acres)
Total Permits issued = 62 (37,416 acres) in 54 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 2012-13.

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	13		620		47.7	
Polk	0		0		0	
Pope	2		90		45.0	
Stevens	2		78		39.0	
Todd	1		69		69.0	
Totals	25		1,314		N/A	

Averages:

Bait dealers permitted	=	5 (5 permits)
Average number of ponds/permit	=	5
Average size of ponds	=	52.6 acres (range 6 to 242 acres)
Average number of acres/permit	=	263

Table 5. Region II lakes with public access aerated to prevent winterkill, 2012-13.

County	Permittee			Total No. of lakes	Total Acres	Average Size (acres)
	C	M	P			
Aitkin	0	0	0	0	0	0
Cass	3	0	1	4	1,093	273.3
Crow Wing	0	0	0	0	0	0
Lake	0	0	0	0	0	0
Totals	3	0	1	4	1,09	N/A

Lakes with public access aerated to prevent winterkill = 4
Total Acreage = 1,093
Average lake size (acres) = 273.3

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 = 4 (1,564 acres)
Permits issued to Clubs for lakes without access = 1 (260 acres)
Privately operated systems for lakes with access = 3 (1,548 acres)
Privately operated systems for lakes without access = 0 (0 acres)
Permits issued to State with access (marinas) = 2
Total Permits issued = 10 (3,372 total acres in 8 lakes/ponds)

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

Table 6. Region III lakes with public access aerated to prevent winterkill, 2012-13.

County	Permittee C	M	P	S	Total No. of lakes	Total Acres	Average Size (acres)
Anoka	0	8	0	0	8	3,082	385.3
Carver	0	3	0	0	3	333	111
Chisago	0	1	0	0	1	35	35
Crow Wing/Morrison	0	0	1	0	1	1,486	1,486
Dakota	0	21	0	0	21	1,279	60.9
Hennepin	1	7	0	1	9	979	108.7
Kanabec	0	1	0	0	1	63	63
Pine	0	0	0	0	0	0	0
Ramsey	0	6	0	0	6	796	132.7
Scott	4	5	0	0	9	1,545	171.7
Sherburne	1	1	1	0	3	841	280.3
Stearns	0	0	0	0	0	0	0
Washington	0	4	0	0	4	282	70.5
Wright	5	0	0	0	5	1,117	223.4
Totals	11	57	2	1	71	11,838	N/A

Lakes with public access aerated to prevent winterkill	=	71
Total Acreage	=	11,838
Average lake size (acres)	=	166.7
Permits issued to Municipalities for lakes without access	=	7 (921 acres)
Permits issued to Municipalities for lakes with access	=	77 (10,289 acres)
Permits issued to Clubs for lakes with access	=	16 (4,221 acres)
Permits issued to Clubs for lakes without access	=	7 (644 acres)
Privately operated systems for lakes with access	=	12 (6,329 acres)
(Shoreline protection – 6 permits/5 lakes (5,370)) (2 permits on Lake Alexander) Privately operated systems for lakes without access	=	15 (569 acres)
(2 permits in Pine Tree Lake) 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	=	137 (23,177 total acres in 129lakes/ponds)

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

Table 7. Region IV lakes with public access aerated to prevent winterkill, 2012-13.

	Permittee				Total No. of		Average Size
County	C	M	P	S	lakes	Total Acres	(acres)
Big Stone	2	1	0	0	3	2,561	853.7
Blue Earth	5	0	0	0	5	2,834	566.8
Brown	2	2	0	0	3	2,459	819.7
Cottonwood	5	0	0	0	4	788	197
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	3	0	0	0	3	1,178	392.7
Lincoln	5	0	0	0	5	6,327	1,265.4
Lyon	0	9	0	0	9	2,518	279.8
Martin	5	3	0	0	8	2,157	269.6
McLeod	2	1	0	0	3	1,505	501.7
Meeker	1	0	1	0	2	774	387.0
Murray	1	12	0	0	12	6,689	557.4
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
Waseca	1	1	0	0	2	2,581	1,290.5
Watonwan	3	0	0	0	3	819	273
Yellow Medicine	0	2	0	0	2	664	332.0
Totals	45	51	1	0	92	53,154	N/A

Lakes with public access aerated to prevent winterkill	=	92
Total Acreage	=	53,154
Average lake size (acres)	=	577.8
Permits issued to Municipalities for lakes with access	=	54 (26,816 acres) (2 permits for Albert Lea & Wilson lakes)
Permits issued to Clubs for lakes with access	=	46 (27,080 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	=	4 (1,928 acres)
Privately Owned Systems without public access	=	1 (18 acres)
Permits issued to State for lakes with public access	=	1 (0 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	=	111 (58,956 acres; 102 lakes)
C=Club; M=Municipality; P=Privately Operated, S=State		

Table 8. Operational Characteristics of Some Aeration Systems, Winter 2012-13.

		Total hp	Lake Area (A)	hp/A	$/A/mo	$/hp/mo	KWH/hp/mo	KWH/hp/A
Helixor	Range	2-30	21-2,011	0.006-0.143	0.13-7.21	$ 21.05-96.76	31.34-1208.71	0.05-104.9
	Mean (x)	12.6	672.9	0.04	$ 1.54	$ 40.90	343.97	6.86
	n	25	23	23	18	18	14	14
Clean-Flo	Range	0.5-3.67	22-818	0.008-0.077	$ 0.15-35.26	$ 18.60-664.93	390.03-1,629.43	9.59-84.87
	Mean (x)	2.1	191.8	0.029	$ 7.41	$ 146.55	412.78	14.04
	N	12	11	11	8	8	5	5
Aire-0_2	Range	0.1-12.0	7-1,634	0.003-0.29	$ 0.09-2.73	$ 19.04-115.38	142.2-994.75	0.36-541.54
	Mean (x)	3.2	259.5	0.056	$ 0.75	$ 42.43	290.94	58.33
	N	41	40	40	31	31	27	27
Pump & Baffle	Range	3.0-20	3-488	0.02-1.67	$ 0.43-120.80	$ 9.26-118.59	56.0-939.01	0.65-93.9
	Mean (x)	8.8	121.2	0.33	$ 18.68	$ 54.01	252.86	17.75
	N	14	14	14	9	9	9	9
Mechanical Surface Agitators	Range	0.25-8.5	17-3,380	0.0001-0.117	$ 0.15-7.10	$ 48.27-161.00	362.44-1,363.87	0.60-248.71
	Mean (x)	2.3	628.1	0.021	$ 1.67	$ 88.69	672.33	31.82
	n	24	17	17	13	13	11	11

Figure 1. Trends in lake aeration permits issued 1978-2012.

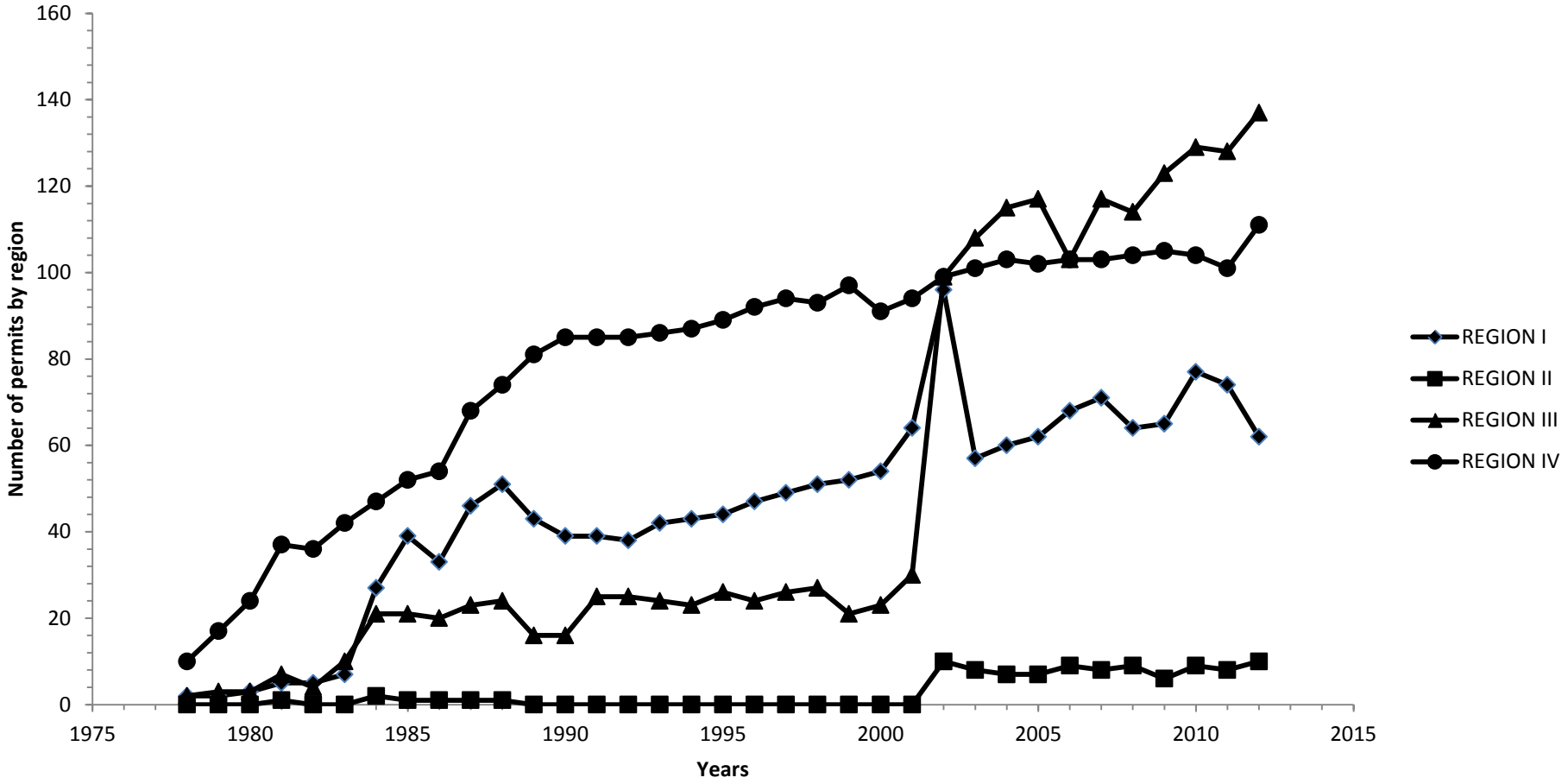

Figure 2. Aeration permits issued by DNR region, 1978-2012.

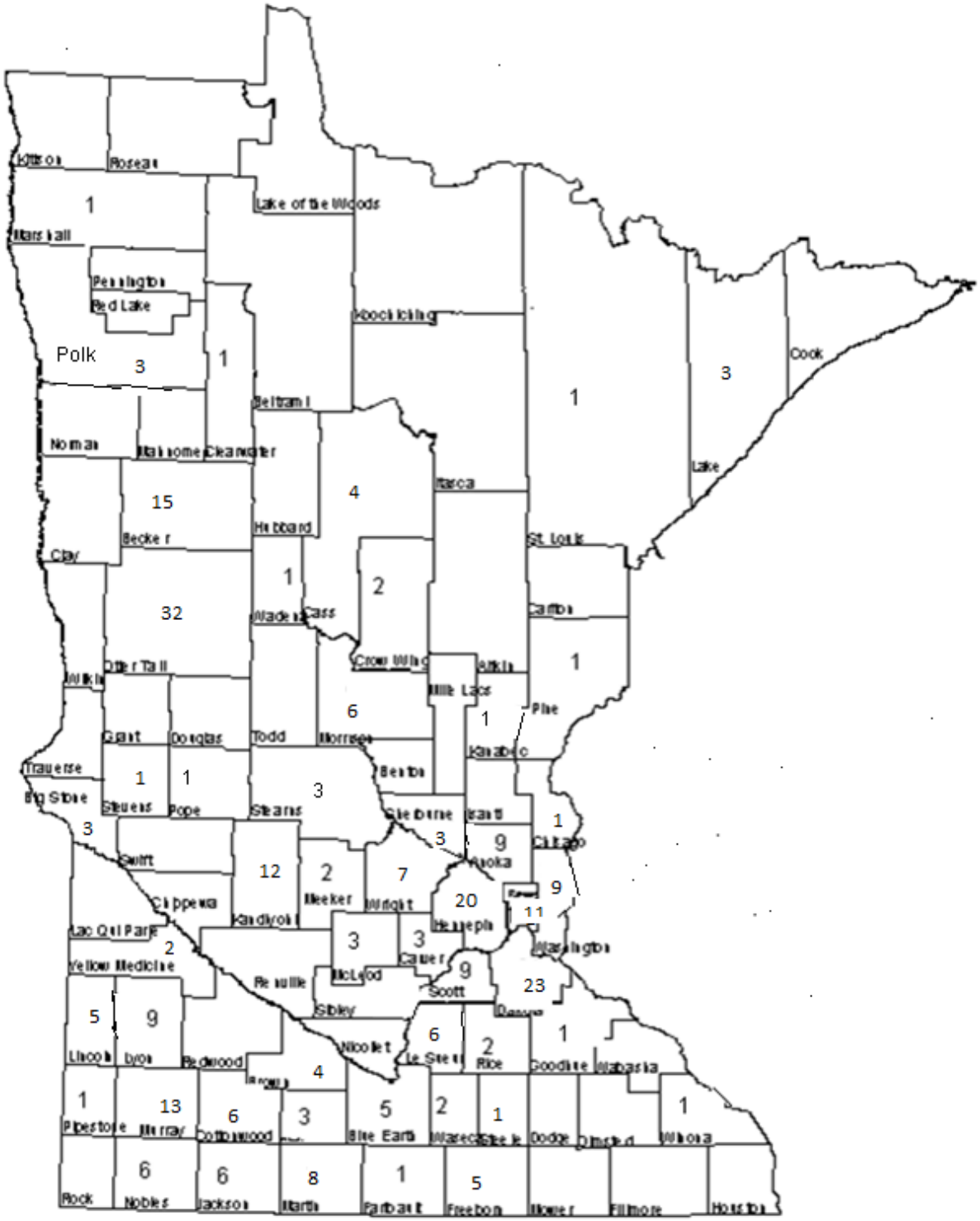

Figure 3. Number of lakes with public access, by county, issued aeration permits in 2012-13.

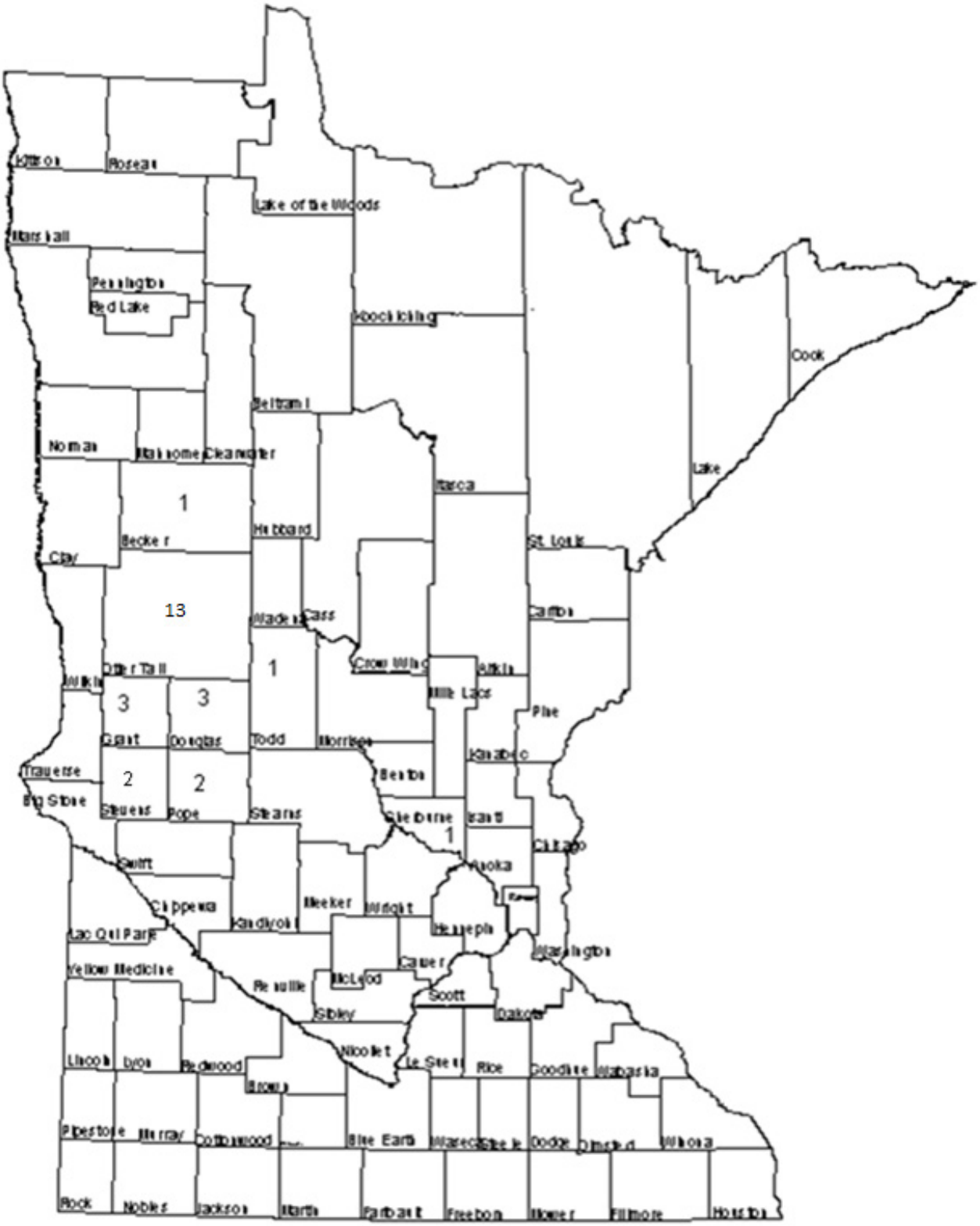

Figure 4. Distribution by County of ponds aerated under permits issued to private hatchery operators in 2012-13.

APPENDICES

Appendix 1. Private hatchery operators and protected waters under permit for 2012-13.

Permit #	Last Name	County	D.O.W.	Acres
Region 1				
F1231032	P. Koep	Douglas	21-74	17
			21-116	24
		Otter Tail	56-85	19
			56-136	34
			56-155	21
			56-720	30
			--	15
F1231038	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
			56-858	43
			56-1182	12
		Pope	61-63	28
			61-22	62
		Todd	77-52	69
F1231092	Joe Koep	Otter Tail	56-149	180
F1231103	Goeden	Becker	3-269	242
		Grant	26-114	93
F1231199	Tanner	Stevens	75-25	28
			75-26	50
Region 3				
F1233100	McDonald	Sherburne	71-129	77

Appendix 2. Questionnaire results of aeration systems operating in winter in lakes with or without public access, 2012-2013.

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)
Polcon Helixors								
Artichoke (6-2)	Big Stone	2,011	Save A Lake Aeration	2-15 HP motor/blowers 12 diffusers	45,598	5,302.72	3.6	N
Clear (8-11)	Brown	325	New Ulm Area Sport fisherman	1-10 HP motor/blower 7 diffusers	did not return questionnaire			
Hanska (8-26)	Brown	1,844	Brown Co. Park Dept.	1-15 HP blower 6 diffusers	34,398	2,705.99	2.8	N
Hanska (8-26)	Brown	1,844	Lake Hanska Area Association	1-15 HP Helixor	26,944	2,713.30	2.8	N
Sleepy Eye (8-45)	Brown	290	City of Sleepy Eye	2-5 HP motor/blowers 4 diffusers	-	313.92	0.8	N
Bingham (17-7)	Cottonwood	274	Cottonwood County Game & Fish League	1-5 HP blower 4 diffusers	did not return questionnaire			
Cottonwood (17-22)	Cottonwood	146	Cottonwood County Game & Fish League	1-5 HP motor/blower 3 diffusers	did not return questionnaire			
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	did not return questionnaire			
Morin (24-43)	Freeborn	21	City of Alden	1-3 HP blower 1 diffuser	6,609	469.19	3.1	N
Round (27-71)	Hennepin	34	City of Eden Prairie	1-7.5 HP blower 1 diffuser	did not return questionnaire			
Loon	Jackson	738	Jackson County	2-7.5 HP motor/blowers	-	-	1.5	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)
(32-20)			Conservation League	9 diffusers				
Polcon Helixors (Con't.)								
Pearl (32-33)	Jackson	117	Jackson County Conservation League	1-7.5 HP blower 3 diffusers	-	-	1.1	N
Round (32-69)	Jackson	947	Round Lake Sportsmen's Club	2-7.5 HP motor/blowers 9 diffusers	did not return questionnaire			
East Solomon (34-246)	Kandiyohi	733	Kandiyohi County	1-10 HP motor 6 diffusers	-	1,322.00	2.9	N
Foot (34-181)	Kandiyohi	576	Willmar Parks Department	1-25 HP motor/blower 6 diffusers	37,664	3,766.64	2.6	Y
Long (34-192)	Kandiyohi	1,715	Kandiyohi County	2-10 HP motors 12 diffusers	-	151.00	3.0	N
Mud (Monongalia) M Fk Crow R. (34-158)	Kandiyohi	2,516	Kandiyohi County	1-15 HP motor 6 diffusers	-	1,012.00	3.0	Y
Ringo (34-172)	Kandiyohi	774	Kandiyohi County	1-10 HP motor 9 diffusers	-	1,210.00	-	N
Swenson (34-321)	Kandiyohi	123	Kandiyohi County	1-7.5 HP motor 5 diffusers	-	792.00	3.0	N
Wakanda (34-169)	Kandiyohi	1,792	Kandiyohi County	2-15 HP blowers 12 diffusers	2,821	-	3.0	N
Willmar (34-180)	Kandiyohi	761	Willmar Public Works	1-15 HP blower 6 diffusers	25,985	2,662.72	3.3	N
Clear	LeSueur	282	Lexington Sportsmen's	1-7.5 HP motor	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)
(40-79)			Club	3 diffusers				
Polcon Helixors (Con't.)								
Gorman (40-32)	LeSueur	590	LeCenter Sportsman's Club	1-7.5 HP compressor 3 diffusers	13,894	783.35	2.9	N
Greenleaf (40-20)	LeSueur	306	Montgomery Sportsmen's Club	1-5 HP compressors 3 diffusers	6,958	669.11	1.8	N
Cottonwood (42-14)	Lyon	383	Lyon County	1-15 HP compressor 6 diffusers		did not return questionnaire		
George (46-24)	Martin	82	City of Fairmont	1-5 HP blower 2 diffusers	5,315	540.83	2.2	N
Sisseton (46-25)	Martin	139	City of Fairmont	1-15 HP blower 2 diffusers	7,896	1,110.72	2.2	N
Swan (43-41)	McLeod	482	Silver Lake Sportsmen's Club	1-7 HP blower 3 diffusers	-	1,200.00	2.6	N
Bloody (51-40)	Murray	248	Murray County	1-7.5 HP blower 2 diffusers	25,383	2,031.95	2.8	N
First Fulda (South) (51-21)	Murray	122	Murray County	2-7.5 HP motor/blowers 4 diffusers	10,203	1,333.28	3.0	N
Sarah (51-83)	Murray	1,176	Murray County	1-7.5 HP motor/blower 4 diffusers	2,570	473.61	3.0	N
Indian (53-7)	Nobles	204	Round Lake Sportsmen's Club	1-10 HP blower 4 diffusers		did not return questionnaire		
Okabena	Nobles	785	City of Worthington	2-7.5 HP blowers	26,665	2,547.33	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)
(53-28)				9 diffusers				
Polcon Helixors (Con't.)								
Cedar (70-91)	Scott	749	New Prague Sportsmen's Club	1-20 HP pump 12 Helixor diffusers		did not return questionnaire		
Clean-Flo Systems								
Shack Eddy (2-109)	Anoka	22	Armstrong Kennels	2-0.5 HP blower 2 diffuser	-	300.00	5.0	N
Crystal (7-98)	Blue Earth	396	Crystal and Look Lake Rec., Inc.	2-0.75 HP compressors 4 diffusers	-	-	3.0	N
Ida (7-90)	Blue Earth	120	Lura Lake Aeration Corp.	1-5 HP compressor 8 diffusers		did not return questionnaire		
Loon (7-96)	Blue Earth	818	Crystal and Loon Lake Rec., Inc.	4-0.75 HP compressors 8 diffusers	-	-	3.0	N
Lura (7-79)	Blue Earth	1,263	Lura Lake Aeration Corp.	1-5 HP & 1-4 HP compressor, 12 diffusers		did not return questionnaire		
Rice Marsh (10-01)	Carver	130	Riley Purgatory Bluff Creek Watershed District	1-2 HP and 1-1.5 HP 7 diffusers	6,689	859.16	4.9	N
Alimagnet (19-21)	Dakota	113	City of Apple Valley	1-2 HP compressor 6 diffusers	6,322	596.15	2.4	N
Arrowhead (27-45)	Hennepin	23	City of Edina	1-1.5 HP compressor 3 diffusers		did not return questionnaire		
Indianhead (27-44)	Hennepin	13	City of Edina	4-0.5 HP compressors 4 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)
Gleason (27-95)	Hennepin	167	Gleason Lake Improvement Assn	4-0.5 HP compressors 16 diffusers	did not return questionnaire			
Clean-Flo Systems (Con't.)								
Hadley (27-109)	Hennepin	39	Hadley Lake Improvement Assn	6-0.5 HP compressors 7 diffusers	-	1,313.00	1.1	N
Sweeny-Twin (27-35)	Hennepin	96	Sweeny Lake Assn	2-0.75 HP compressors 2 vent diffusers	29,900	3,898.00	5.0	N
Unnamed (Upper) (34-28)	Kandiyohi	22	City of Atwater	2-2 HP compressors 4 diffusers	did not require questionnaire			
Unnamed (Tadd) (34-376)	Kandiyohi	10	City of Atwater	2-2 HP compressors 4 diffusers	did not return questionnaire			
Mabel (40-11)	LeSueur	103	Lucky 13 Sportsmen's Club	2-0.5 compressors 4 diffusers	did not return questionnaire			
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	-	-	3.2	N
Birch (62-24)	Ramsey	127	Birch Lake Improvement Assn	1-1 HP compressor 3 diffusers	did not return questionnaire			
Cody (66-61)	Rice	257	Wheatland Twin Lakes Sportsmen's Club	4-0.5 and 2-0.75 HP Compressors, 12 diffusers	8,626	1,052.89	3.6	N
Krenz	Scott	15		1-HP compressor	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)
(Sunset) (70-09)				2 diffusers				
Clean-Flo Systems (Con't.)								
Unnamed (Fawn) (71-110)	Sherburne	33	Carefree Country Club	2-0.5 HP – 4 diffusers 1-0.75 HP – 2 diffusers	1,000	1,280.00	1.1	N
Loon (81-15)	Waseca	119	City of Waseca	1-5 HP compressor 9 diffusers	did not return questionnaire			
Pine Tree (82-122)	Washington	174		1-0.5 HP compressor 2 diffusers	588	120.00	4.7	N
Pine Tree (82-122)	Washington	174		1-0.5 HP compressor 2 diffusers	-	120.00	4.3	N
Other Bubblers								
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			
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	-	100.00	5.5	N
Mills	Blue Earth	237	Crystal and Loon Lake	2-0.75 HP compressors	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)
(7-97)			Restoration	4 diffusers				
Oak (10-93)	Carver	185		4-1 HP compressors 8 diffusers	-	-	3.6	N
Other Bubblers (Con't.)								
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	did not return questionnaire			
Blue Eagle (14-93)	Clay	11	City of Barnesville	2-1/2 HP pumps 4 diffusers	did not return questionnaire			
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			
Isabella (19-04)	Dakota	105	City of Hastings	Kasco Aire4, 2-0.25 HP compressors, 4 diffusers				
Rice (22-7)	Faribault	268	Faribault County	2-0.75 compressors 9 diffusers	-	-	2.7	N
Albert Lea (24-14)	Freeborn	2,654	Faribault County	1 HP compressors Diffuser tubing	did not return questionnaire			
Pottery Pond (25-38	Goodhue	8	City of Red Wing	1-0.75 HP Vane compressor, 2 diffusers	784	30.00	3.9	N
Marion	McLeod	616	Brownton Rod and Gun	1-5 HP blower	14,105	1,800.00	3.5	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)
(43-84)			Club	3 mat diffusers				
Perch (56-95)	Otter Tail	57		1-0.75 HP compressor 1 diffuser	-	260.00	4.5	N
Unnamed (56-549)	Otter Tail	17		1-0.25 HP motor and diffuser hose		did not return questionnaire		
Other Bubblers (Con't.)								
Cable (60-293)	Polk	129	Cable Lake Association	3-0.25 HP pump	3,852	400.61	3.5	Y
Gilfillan (62-27)	Ramsey	86	Lake Gilfillan Assn.	1-1 HP bubbler	-	550.00	3.9	N
Ann (71-69)	Sherburne	226	Ann Lake Improvement Club, Inc.	1-.5 HP compressor 2 copper diffusers		did not return questionnaire		
Kohlmeier (74-19)	Steele	11	City of Owatonna	2-0.75 HP compressors 3 diffusers	-	-	3.5	N
Jacobs (77-37)	Todd	28		1-0.75 HP compressor 1 diffuser		did not return questionnaire		
Unnamed (77-230)	Todd	15		2-0.75 HP compressor 2 diffusers		did not return questionnaire		
Stocking (80-37)	Wadena	356	Stocking Lake Boosters, Inc.	2 Gast compressors 5 diffusers	-	300.00	5.0	N
Mud (Battle Creek) (82-91)	Washington	103	City of Woodbury	2-1 HP compressors 6 diffusers	-	510.48	3.2	N
Unnamed Pond (82-257)	Washington	7		0.25 HP blower 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)
Foster (86-01)	Wright	124	Foster Lake Association	1-0.5 HP Kasco Comp. 3 diffusers	-	-	4.9	Y
Pump and Baffle								
Centerville (2-6)	Anoka	464	Anoka County Parks and Recreation Dept.	1-20 HP pump and baffle	did not return questionnair			
Pump and Baffle (Con't.)								
Crooked (2-84)	Anoka	130	City of Coon Rapids	1-10 HP pump and baffle	-	-	1.2	N
Golden (2-45)	Anoka	50	City of Circle Pines	1-7.5 HP permanent pump and baffle	did not return questionnaire			
Martin (2-34)	Anoka	218	Anoka County Parks and Recreation	1-10 HP pump and baffle	-	-	1.0	N
Susan (10-13)	Carver	93	City of Chanhassen	1-7.5 HP pump and baffle	did not return questionnaire			
Marion (19-26)	Dakota	489	City of Lakeville	1-20 HP pump and baffle	did not return questionnaire			
Roger's (19-80)	Dakota	116	City of Mendota Heights	1-10 HP pump and baffle	did not return questionnaire			
Penn (27-4)	Hennepin	47	City of Bloomington	15 HP 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	-	-	4.4	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)
Wolfe (27-664)	Hennepin	3	City of St. Louis Park	Built in waterfall – 5 HP	1,400	1,800.00	5.0	N
Wolf (29-81)	Hubbard	274		1-5.0 HP pump and baffle	-	-	2.9	Y
Pump and Baffle (Con't.)								
Unnamed (Florian Res.) (45-119)	Marshall	42	Marshall County Park Board	1-9 HP pump and baffle	did not return questionnaire			
Wilson (51-81)	Murray	164	Murray County	1-10 HP pump and baffle	1,646	268.59	2.9	N
Adley (56-31)	Otter Tail	249	Parker's Prairie Sportsmen's Club	1-15 HP pump and baffle	did not return questionnaire			
Fish (56-66)	Otter Tail	500	Parker's Prairie Sportsmen's Club	1-10 HP pump and baffle	did not return questionnaire			
Maple (60-305)	Polk	1,445	Maple Lake Improvement District	3-5 HP pump and baffle	did not return questionnaire			
Beaver (62-16)	Ramsey	65	Ramsey County Public Works Dept.	1-7.5 HP pump and baffle	11,931	1,313.38	2.5	N
Island (62-75)	Ramsey	63	Ramsey County Public Works Dept.	1-20 HP pump and baffle	10,489	1,154.64	0.9	N
Loeb (62-231)	Ramsey	10	City of St. Paul	1-5 HP pump and baffle	-	-	3.7	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)
Owasso (62-56)	Ramsey	360	Ramsey County Public Works Dept.	1-20 HP pump and baffle	did not return questionnaire			
Silver (East) (62-1)	Ramsey	68	Ramsey County Public Works Dept.	1-20 HP pump and baffle	11,934	1,313.71	3.1	N
Silver (62-83)	Ramsey	67	City of Columbia Heights	1-10 HP pump and baffle	5,504	642.08	1.2	N
Pump and Baffle (Con't.)								
Cleary (70-22)	Scott	137	Three Rivers Park District	1-7.5 HP pump and baffle	did not return questionnaire			
McMahon (Carls) (70-50)	Scott	136	New Market Sportsmen's Club	1-10 HP pump and baffle	did not return questionnaire			
Hattie (75-200)	Stevens	488	Save A Lake Aeration, Inc.	1-10 HP pump and baffle	3,155	400.32	1.9	Y
Goose (82-59)	Washington	83	Town of New Scandia	1-3 HP pump and baffle	2,441	303.44	1.8	N
Shields (82-162)	Washington	27	City of Forest Lake	CORE pump and baffle 3 HP	7,606	960.58	2.7	N
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado)								
Cedar (1-165)	Aitkin	260	Cedar Lake Assn	3-2 HP Aeromix tornado	did not return questionnaire			
Coon (2-42)	Anoka	1,507	Anoka County Parks	3-2 HP Aeromix tornado	-	-	1.0	N
Ham	Anoka	193	City of Ham Lake	3-2 HP Aeromix tornadoes	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)
(2-53)								
Peltier (2-4)	Anoka	483	Anoka Co. Parks	2-2 HP Aeromix	-	-	0.9	N
Spring (2-71)	Anoka	37	City of Spring Lake Park	1-2 HP Aeromix	did not return questionnaire			
East Toqua (6-138)	Big Stone	440	City of Graceville	2-2.5 HP Aeromix	7,941	1,118.00	3.4	N
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
Long Tom (6-29)	Big Stone	110	Save A Lake Aeration	2-2 HP Aqua tornadoes	3,979	300.54	1.0	Y
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	3,197	490.00	1.1	N
Loon (11-226)	Cass	220	Loon Lake Property Owners	2-2 HP Aeromix tornadoes	7,669	931.00	2.8	N
Moody (13-23)	Chisago	35	Comfort L, Forest L. W.D.	2-2 HP Aire-02	did not return questionnaire			
Platte (18-88)	Crow Wing	1,486	Platte Lake Association	1-2 HP Aeromix tornadoes	did not return questionnaire			
Bald (19-61)	Dakota	10	City of Eagan	1-2 HP Neptune air injector	4,699	568.00	2.9	N
Birch Pond (19-202)	Dakota	3	School of Environmental Studies	Neptune air injection system	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)
Blackhawk (19-59)	Dakota	39	City of Eagan	1-2 HP air injection system	4,435	536.00	2.8	N
Burr Oaks (19-259)	Dakota	19	City of Eagan	1-2 HP pump	4,752	575.00	3.0	N
Cliff (19-68)	Dakota	16	City of Eagan	1-2 HP air injection system	4,541	549.00	2.8	N
Farquar (19-23)	Dakota	74	City of Apple Valley	1-2 HP air injection system	4,446	565.01	2.4	N
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
Fish (19-57)	Dakota	28	City of Eagan	1-2 HP air injection system	3,432	415.00	2.1	N
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	4,699	568.00	2.9	N
Heine (19-153)	Dakota	7	City of Eagan	1-2 HP pump	739	89.00	0.4	N
Holland (19-65)	Dakota	33	Dakota Co. Parks	1-2 HP Aire 02		did not return questionnaire		
LeMay (19-55)	Dakota	44	City of Eagan	1-2 HP air injection system	3,484	421.00	2.2	N
Manor (19-64)	Dakota	14	City of Eagan	1-2 HP air injection system	3,538	428.00	2.2	N
McDonough (19-76)	Dakota	19	Dakota County Parks	1-2 HP Aire 02	-	-	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)
Pickerel (19-79)	Dakota	51	City of St. Paul	1-2 HP Neptune air injector	-	-	3.2	N
East Thomas (19-161)	Dakota	39	City of Eagan	1-0.1 HP solar powered pump	2,112	255.00	1.3	N
Thomas (19-67)	Dakota	56	City of Eagan	1-2 HP air injection pump	5,438	658.00	3.4	N
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
Thompson (19-48)	Dakota	10	Dakota County Parks	1-2 HP Neptune pump	did not return questionnaire			
Unnamed (Schwartz) (19-63)	Dakota	13	City of Eagan	1-2 HP air injection pump	4,435	536.00	2.8	N
Aldrich (21-222)	Douglas	173		2-2 HP Aeromix tornadoes	did not return questionnaire			
Albert Lea (24-14)	Freeborn	2,654	Shellrock River Watershed District	2-7.5 HP Aeromix systems	-	-	2.9	N
Frontenac Pond (25-3)	Goodhue	34	Frontenac Sportsman's Club	1-2 HP Aire-02	1,842	158.00	1.7	N
Bass (27-98)	Hennepin	175	Bass Lake Improvement Assn	2-2 HP Aire-02	8,105	971.20	2.7	N
Crystal (27-34)	Hennepin	74	City of Robbinsdale	2-2 HP Aire-02	10,333	1,275.88	3.8	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)
Hyland (27-48)	Hennepin	87	Three Rivers Park District	2-2 HP Aeromix Tornado	did not return questionnaire			
Mitchell (27-70)	Hennepin	116	City of Eden Prairie	2-2 HP Aire 0-2's	did not return questionnaire			
Rebecca (27-192)	Hennepin	290	Three Rivers Park District	3-2 HP Aire-02 aerators	did not return questionnaire			
Petite (29-147)	Hubbard	58	Wonewok Conference Center	1-2 HP air injection system	-	-	-	-
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
Mora (33-34)	Kanabec	63	City of Mora	1-2 HP Aqua tornado	did not return questionnaire			
Elizabeth (34-22)	Kandiyohi	1,153	Kandiyohi County	2-2 HP Aeromix systems	-	-	2.5	N
Dead Coon (41-21)	Lincoln	555	Tyler Rod & Gun Club	2-2 HP Aire-02	did not return questionnaire			
Hendricks (41-110)	Lincoln	1,634	Lake Hendricks Improvement Assn	4-2 HP Aire-02 aerators	4,778	639.90	4.2	N
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			

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)
Lady Slipper (42-20)	Lyon	262	Lyon County	2-2 HP Aeromix tornadoes	did not return questionnaire			
Rock (42-52)	Lyon	422	Lyon County	2-2 HP Aire-02	did not return questionnaire			
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	did not return questionnaire			
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
Buffalo (46-146)	Martin	116	Mt. Lake-Odin-Ornsby Sportsmen's Club	1-3 HP Aire-02	did not return questionnaire			
Clear (46-96)	Martin	273	Clear Lake Preservation Assn.	1-2 HP Aire-02	did not return questionnaire			
Fish (46-145)	Martin	156	Watonwan Game and Fish	1-2 HP Aire-02	did not return questionnaire			
Winsted (43-12)	McLeod	407	City of Winsted	2-15 HP Aire-02	did not return questionnaire			
Star (47-129)	Meeker	554	Star Lake Association	3-2 HP Aire-02	10,263	1,278.04	3.5	N
Corabelle (51-54)	Murray	99	Murray County	1-2 HP Aire-02	1,581	212.00	3.1	N
Kinbrae (53-16)	Nobles	87	Nobles County Park	2-1 HP Aeromix tornado	-	-	3.0	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)
Tamarac (59-931)	Otter Tail	416	Tamarac Lake Association	2-2 HP aspirating aerators	did not return questionnaire			
Split Rock (59-1)	Pipestone	80	Split Rock Creek State Park	2-2 HP Aeromix tornadoes	did not return questionnaire			
Signalness (61-149)	Pope	41	Glacial Lakes State Park	1-2 HP Aire-02	-	-	5.6	N
Otter (2-3)	Ramsey/ Anoka	173	Ramsey County Public Works	2-2 HP Aeromix tornadoes	7,519	827.70	3.4	N
Circle (66-27)	Rice	976	Tri-Lakes Sportsmen's Club	3-2 HP Aeromix tornadoes	-	1,800.00	2.6	N
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
O'Dowd (70-95)	Scott	256	O'Dowd Lakes Chain Assn	3-2 HP Aire-02	did not return questionnaire			
Thole (70-120)	Scott	131	O'Dowd Lakes Chain Assn	1-2 HP Aire-02	did not return questionnaire			
McColl (70-17)	Scott	20	City of Savage	1-2 HP Aeromix tornadoes	did not return questionnaire			
Murphy (70-10)	Scott	70	Three Rivers Park District	2-2 HP Aeromix tornadoes	did not return questionnaire			
Birch (71-57)	Sherburne	149	Birch Lake Association	1-2 HP Aire-02	6,890	866.50	3.0	N
Fremont (71-16)	Sherburne	466	City of Zimmerman	2-2 HP Aire-02's	did not return questionnaire			
Masford	Sherburne	90		1-2 HP Aeromix	-	-	4.2	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)
(71-126)								
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			
Elysian (81-95)	Waseca	2,462	So. Lakes Chain Dark House Angles Association	2 sets of 3-3 HP Aire-02's	did not return questionnaire			
Unnamed (Cloverdale) (82-9)	Washington	39	Cloverdale Farm Homeowner's Assn	1-2 HP Aeromix systems	-	360.00	3.4	N
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
Colby (82-94)	Washington	69	City of Woodbury	1-2 HP Aire-02	-	85.00	1.0	N
McDonald (82-10)	Washington	3.7	Cloverdale Farm Homeowner's Assn	1-2 HP Aeromix tornado	-	360.00	3.5	N
Sand (82-67)	Washington	46	Sand Lake Lakeshore Association	1-2 HP Aeromix tornado	-	-	1.9	N
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	4,431	628.42	3.0	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)
Dean (86-41)	Wright	204	Dean Lake Assn	2-2 HP Aire-02	did not return questionnaire			
Little Waverly (86-106)	Wright	336	Little Waverly Lake Association	1-2 HP Propeller aspirator	6,192	768.81	2.1	N
Mink (86-229)	Wright	304	Assn of Mink & Somers Lakes	1-2 HP Aire-02	did not return questionnaire			
Somers (86-230)	Wright	156	Assn of Mink & Somers Lakes	1-2 HP Aire-02	did not return questionnaire			
Tyson (87-19)	Yellow Medicine	180	Yellow Medicine County	2-2 HP Aire-02	-	-	2.0	N
Wood (87-30)	Yellow Medicine	484	Yellow Medicine County	2-2 HP Aire-02	-	-	-	N
Sprayers								
Crystal (70-61)	Scott	33	City of Prior Lake	1-3 HP Otterbine	6,384	785.32	2.6	N
Lakefront Park Pond (70-169)	Scott	13	City of Prior Lake	1-3 HP Otterbine	did not return questionnaire			
Mixed Systems								
Mountain (17-3)	Cottonwood	241	City of Mountain Lake	5-0.5 HP compressors 4-2 HP Aeromix Tornadoes, 1-5 HP Helixor	11,630	752.25	2.3	N
Carlson (19-66)	Dakota	14	City of Eagan	1-3 HP lift station Air injection pump	2,587	313.00	1.6	N
Powerhorn	Hennepin	11	Mpls Park and Rec. Board	Pump and baffle, 4 HP	-	-	3.8	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)
(27-14)				compressor w/5 lines				
Snelling (27-1)	Hennepin	110	Fort Snelling State Park	2-5 HP sump pumps	7,220	810.41	1.7	N
Clear (32-22)	Jackson	415	Jackson County Conservation League	2-5 HP motor/blowers, 6 Helixor diffusers, 3-3 HP Ice Eaters	did not return questionnaire			
Independence (32-17)	Jackson	97	Jackson County Conservation League	1-5 HP Helixor, 3 diffusers 3-3 HP Ice Eater	did not return questionnaire			
Little Spirit (32-24)	Jackson	634	Jackson County Conservation League	2-7.5 HP Helixors 6 diffusers; 3-3 HP Ice Eaters	did not return questionnaire			
Scotch (40-109)	LeSueur	590	German-Jefferson Sportsmen's Club	2-0.75 compressors, 1-10 HP Helixor, 9 diffusers	-	1,025.00	1.9	N
Mixed Systems (Con't.)								
Cedar (46-121)	Martin	710	Trimont Area Conservation Club	1-2 HP Aire-02, 1-0.75 HP Ice Eater	did not return questionnaire			
Thompson (47-159)	Meeker	220	Meeker County Parks	1-20 HP pump and baffle 2-2 HP Tornadoes	did not return questionnaire			
Shetek (51-63)	Murary	3,596	Murray County	3-7.5 HP motor/blowers 12 diffusers, 2 Ice Eaters	2,880	343.84	2.8	N
Bennett (62-48)	Ramsey	41	Roseville Parks and Recr.	3-0.5 HP blower and 6 diffusers, baffle system	did not return questionnaire			
Hypolimnetic Aerators								
Moore (East) (2-75)	Anoka	110	City of Fridley	1-7.5 HP Palatek Compressor	-	-	5.0	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)
Lucy (10-70)	Carver	137	CH2M Hill	2-IPS, 3 Gast compressors each	10,194	1,283.92	5.1	N
Como (62-55)	Ramsey	69	Ramsey County Public Works Dept.	1-10 HP Hypo system	23,290	2,563.79	4.4	N
Pleasant (62-46)	Ramsey	585	City of St. Paul Water Utility	Mobley Hypo System				
Vadnais (62-38)	Ramsey	477	City of St. Paul Water Utility	2-30.0 HP Atlas Copco	-	-	5.0	N
Marie (Maria) (73-14)	Stearns	145	Clearwater River Watershed District	1-20 HP Atlas Copco	did not return questionnaire			
Augusta (86-284)	Wright	186	Clearwater River Watershed District	1-20 HP Atlas Copco	did not return questionnaire			
Hypolimnetic Aerators (Con't.)								
Louisa (86-282)	Wright	183	Clearwater River Watershed District	1-10 HP Atlas Copco	did not return questionnaire			
Other (Mechanical Surface Agitators, homemade, etc.)								
Wolf (3-101)	Becker	1,453	Wolf Lake Sportsmen's Club	3-1 HP Ice Eaters	7,200	792.00	4.6	N
Bean (17-54)	Cottonwood	141	Red Rock Sportsmen's Club	2-1 HP Ice Eaters	3,320	460.00	3.0	N
Double (17-56)	Cottonwood	227	Red Rock Sportsmen's Club	2-1 HP Ice Eaters	3,387	420.00	3.0	N
South Double	Cottonwood	227	Red Rock Sportsmen's	2-1 HP Ice Eaters	3,387	420.00	3.0	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)
(17-56)			Club					
Nisswa (18-399)	Crow Wing	213		25-3/4 HP Ice Eaters	did not return questionnaire			
Albert Lea (24-14)	Freeborn		MNDOT	Windmill driven impeller	-	-	5.3	N
Thomas (27-501W)	Hennepin	8		1-0.75 Kasco propeller	did not return questionnaire			
Knife (33-28)	Kanabec	1,127	Knife Lake Improvement District	4-2 HP floating aspirators	did not return questionnaire			
Nest (34-154)	Kandiyohi	1,019	North Shore Estates	Morgan Winds Windmill	-	-	5.0	N
Silver (40-48)	LeSueur	17	N. Elysian Silver Lakers Sportsmen's Club	1-0.75 HP motored propeller	3,171	374.32	3.1	Y
Other (Mechanical Surface Agitators, homemade, etc.) (Con't.)								
Benton (41-43)	Lincoln	2,875	Lake Benton Sportsmen's Club	5-0.75 HP Ice Eaters	6,478	798.00	1.9	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 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)
Buffalo (51-18)	Murray	124	Murray County	2-0.75 HP Ice Eaters	3,166	371.73	3.0	N
Current (51-82)	Murray	394	Murray County	3-0.75 HP Ice Eaters	4,683	523.56	2.9	N
Fox (51-43)	Murray	174	Murray County	2-0.75 HP Ice Eaters	3,669	255.91	3.0	N
Lime (51-24)	Murray	316	Murray County	2-0.75 HP Ice Eaters	2,424	334.59	3.0	N
Louisa (51-6)	Murray	211	Murray County	2-0.75 HP Ice Eaters	1,631	217.21	3.0	N
Second Fulda (51-20)	Murray	65	Murray County	2-0.75 HP Ice Eaters	3,815	267.93	3.0	N
Wilson (South) (51-81)	Murray	164	Murray County	1-0.75 HP Ice Eater	1,646	268.59	2.9	N
Other (Mechanical Surface Agitators, homemade, etc.) (Con't.)								
East Graham (53-20)	Nobles	523	Nobles County Parks Department	3-0.75 HP Powerhouse	-	-	-	N
West Graham (53-21)	Nobles	526	Nobles County Parks Department	3-0.75 HP Powerhouse	-	-	-	N
Ocheda (53-24)	Nobles	1,778	Nobles County Parks Department	2-0.75 HP portable Powerhouse motors	did not return questionnaire			
Badger (60-214)	Polk	247	City of Erskine	2-0.75 HP Kasco agitators	did not return questionnaire			
Community	Ramsey	32	City of Shoreview	1-0.75 HP Kasco agitators	-	-	5.0	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)
Center Pond (62-63)				1-2 HP, 1-1 HP				
Legends (70-287)	Scott	29	Legends Club	1-HP Aqua control surface pump	did not return questionnaire			
Colby (69-249)	St. Louis	514	Minnesota Power	2-1 HP Powerhouse	did not return questionnaire			
Fedji (83-21)	Watonwan	179	Madelia Sportsmen's Club	3-0.75 HP Powerhouse Systems	-	577.00	2.1	N
White Bear Lake (82-167)	Washington	1,255	City of White Bear Lake	6-0.75 HP Kasco marine de-icers	did not return questionnaire			
Winona (85-11)	Winona	318	City of Winona	3-3 HP Neptune aspirating units with propellers	did not return questionnaire			