MINNESOTA DEPARTMENT OF NATURAL RESOURCES

DIVISION OF ECOLOGICAL RESOURCES

Aeration Permit Program Annual Report 2011-2012

2012

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By

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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 2011-12 permit year (1 October 2011– 30 September 2012). 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 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 (2011-12), no lakes were opened to "liberalized fishing".

A total of 311 aeration permits were issued during the 2011-12 season. This includes 290 renewals (95% of the permits issued) and seven (7) 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 twenty-five years, though a slight decrease in permits was seen in 2011 (Figure 1). The same trend is true for the regions as well (Figure 2).

The 311 permits issued in 2011-12 authorized aeration in 283 lakes totaling 132,932 acres, of which 175 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 69,441 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 26 of these lakes, Aire0_2 units were installed in 70

lakes, mechanical surface agitators were installed in 20 lakes, a combination of system types was used in 11 lakes, and diffuser systems operated in 56 lakes. Bait dealers and commercial hatchery operations were permitted to operate in 24 public water bodies totaling 1,372 acres. Seventy-one (71) 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 2011-12.

Winter inspections of aeration systems were conducted by inspectors from the divisions of Enforcement and Fish and Wildlife (Fisheries). A total of 389 inspections were made in 2011-12, a reduction of 57% from the previous year. Of these, Enforcement inspectors conducted 247 inspections and Fisheries inspectors conducted 142. The inspectors found a total of 67 discrepancies (17%) out of the 389 inspections completed, a 4% 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 85 inspections were completed in Region I of which 18 (21%) showed discrepancies. There was one (1) inspection completed in Region II with zero (0%) discrepancies. Inspectors conducted 72 inspections in Region III of which 12% showed discrepancies, and 231 inspections were conducted in Region IV with 17% 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 2011-12.

REGIONAL AERATION SUMMARY

REGION I (Bemidji)

There were 74 aeration permits issued in Region 1 during the 2011-12 season, 24% of the total number of permits issued. Of the 74 permits issued, 72 (97%) were renewals and two were new permits.

The 74 permits issued in Region I authorized aeration in 57 public waters, or 20% of the total public waters aerated statewide. Private hatchery operators accounted for 40% of the aeration permitted water bodies in Region I. Private hatchery operators received five permits for 23 (1,295 acres) public waters (8% of the statewide total lakes permitted or 0.9% 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 16 aeration permits to prevent winterkill in 16 lakes (8,176 acres) with public access. Fifty-one aeration permits were issued to private individuals on 13 lakes (30,598 acres) to prevent shoreline property damage due to ice expansion. Two permits were issued to the State covering 1,245 acres. Five other aeration permits were issued to private groups to prevent winterkill in public waters (339 acres) without public access. One aerated lake 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 changed from zero permits in 2001 to ten in 2002 to seven in 2005. There were eight (8) permits issued for the 2011-12 season.

Of these eight permits, which represent 2.6% of the total number of permits issued, seven 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 128 aeration permits issued for 124 lakes/ponds (24,634 acres) in Region III last season (41% of the total number of permits issued). Five 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-one permits were issued to municipalities for operation of aeration systems in 71 lakes (9,909 acres) with public access. Seven permits (921 acres) were issued to municipalities for lakes without public access. Eighteen permits (5,638 acres) were issued to clubs for lakes with public access, and six permits (404 acres) were issued to clubs operating aeration systems in lakes without public access. Twenty-four permits for 20 lakes (7,575 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 32.5% of the permits issued statewide. Last season, 101 permits (67,179 acres) were issued in Region IV; 99 were renewals (98%). The 101 aeration permits issued in Region IV authorized the aeration of 96 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-one permits were issued to private organizations and municipalities to

prevent winterkill of fish in 87 lakes (50,340 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 Lake has two permits.

According to the questionnaires returned, no 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 223 of 311 permittees, a 72% 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. One hundred thirteen (113) respondents indicated their aeration system was not operated last winter.

The average cost for insurance (n=31) was $542.12. This figure includes all permittees operating an aeration system in lakes with or without public access. The range of insurance premiums for the 2011-12 season was $5.00-$3,000.00. One respondent indicated there was difficulty in acquiring the required insurance.

One hundred ten (110) of the respondents indicated their aeration system was operated last winter and 40 of those indicated that waterfowl over wintered on the lake. Of these, nine respondents are located in Region I, two in Region II, 25 in Region III, and four respondents are in Region IV. An estimated 2,600 waterfowl used the open water areas provided by aeration systems (range 5-325 per aerated lake). Most of the birds were mallards and Canada geese.

Of the 110 permittees that responded and operated their systems last winter, 101 (92 %) indicated they were satisfied with system performance. Of these, 3% were Helixor systems, 12% were Clean-Flo systems, 6% were pump and baffles, 19% were AireO2 and Aeromix systems, 38% were other types of bubbler systems, and 13% were mechanical surface agitators. Complaints ranged from mechanical failures to undersized and ineffective equipment. Nine respondents indicated safety problems with their aeration systems.

Some aerated lakes experienced partial winterkill last season. Two of the 110 respondents that operated their aeration systems last winter reported some evidence of winterkill at ice out. Of these, one was an AireO2, and one was a mechanical surface agitator system.

Based on the responses to the questionnaire as summarized in Table 8, mechanical surface agitator systems were on average the least expensive to operate per acre, with the Aire-0_2 or the Aeromix tornado 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, and had the highest average horsepower per system. Clean Flo systems were used on smaller lakes up to 250 acres in size. 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 1,500 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.

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Table 1. Aerated Acres 2011-12.

ACRES	REGION 1	REGION 2	REGION 3	REGION 4	OVERALL
Lakes with public access	38,640	1,100	22,803	65,174	127,717
Lakes without public access	1,119	260	1,831	2,005	5,215
TOTAL	39,759	1,360	24,634	67,179	132,932

Table 2. 2011-12 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	23	5	13	47	6	7	74 (23.8%)
II	3	2	0	0	1	0	0	1*	2	2	3	8 (2.6%)
III	66	12	52	1	1	1	1	5	6	52	55	128 (41.2%)
IV	87	41	49	0	1	0	0	1	1	8	9	101 (32.5%)
Totals	171	65	105	2	3	24	6	20	56	68	74	311

		Lakes	**Acres**	**Permits**
Protected waters with access for winterkill prevention	=	171	69,441	175
Protected waters under permit to Bait Dealers	=	24	1,372	6
Shoreline Protection*	=	20	36,338	56
Other**	=	68	25,781	74
		283	132,932	311

Total number of permits for protected waters for winterkill prevention	=	196
Total number of permits for protected waters without access for winterkill prevention	=	21
311 total permits, new permits	=	10
Old permits 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, 2011-12.

County	Permittee C	Permittee M	Permittee S	Total No. of lakes	Total Acres	Average Size (acres)
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	2	1	0	3	1,165	388
Polk	2	0	0	2	376	188
Pope	0	0	1	1	41	41
Stevens	0	0	0	0	0	0
Wadena	1	0	0	1	356	356
Totals	10	4	1	15	6,284	N/A

# lakes with public access aerated to prevent winterkill	=	15 (C = 10; M = 4; S = 1)
Total Acreage	=	6,284
Average lake size (acres)	=	418.9

Permits issued to Municipalities for lakes with access	=	4 (1,767 acres)
Permits issued to Clubs for lakes with access	=	10 (4,476 acres)
Permits issued to the State w/access	=	1 (41 acres)
Permits issued for shoreline protection	=	47 (13 lakes; 29,949 acres)
Permits issued to Bait Dealers, & P. Hatchery operators	=	5 (23 ponds, 1,372 acres)
Permits issued to private individuals to prevent winterkill for lakes without access	=	5 (339 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	=	74 (39,759 acres) in 57 lakes and ponds

Permits issued for shoreline protection:
- Melissa Lake – 1,827 acres – 9 permits
- Lida Lake – 7,277 acres – 13 permits
- Big McDonald – 3,096 acres – 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 permits
- Paul Lake – 334 acres – 1 permit
- Fish Lake – 284 acres – 1 permit
- Big Cormorant Lake – 3,380 acres – 3 permits
- Pelican – 4,314 acres – 11 permits
- Marion Lake – 1,610 acres – 1 permit
- Little McDonald – 1,506 acres – 1 permit
- Bay of Leech Lake –1 permit

*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 2011-12.

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	12	601	50.1
Polk	0	0	0
Pope	2	90	45.0
Stevens	1	78	39.0
Todd	1	69	69.0
Totals	23	1,295	N/A

Averages:

Bait dealers permitted	=	5 (5 permits)
Average number of ponds/permit	=	4.6
Average size of ponds	=	56.3 acres (range 6 to 242 acres)
Average number of acres/permit	=	259

Table 5. Region II lakes with public access aerated to prevent winterkill, 2011-12.

County	Permittee C	Permittee M	Permittee P	Total No. of lakes	Total Acres	Average Size (acres)
Aitkin	0	0	0	0	0	0
Cass	2	0	1	3	373	124.3
Crow Wing	0	0	0	0	0	0
Lake	0	0	0	0	0	0
Totals	2	0	1	3	373	N/A

Lakes with public access aerated to prevent winterkill	=	3
Total Acreage	=	373
Average lake size (acres)	=	124.3

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	=	3 (844 acres)
Permits issued to Clubs for lakes without access	=	1 (260 acres)
Privately operated systems for lakes with access	=	2 (256 acres)
Privately operated systems for lakes without access	=	0 (0 acres)
Permits issued to State with access (marinas)	=	2
Total Permits issued	=	8 (1,360 total acres in 6 lakes/ponds)

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

Table 6. Region III lakes with public access aerated to prevent winterkill, 2011-12.

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
Crow Wing/Morrison	0	0	1	0	1	1,486	1,486
Dakota	0	19	0	0	19	1,074	56.5
Hennepin	1	7	0	1	9	979	108.7
Kanabec	1	0	0	0	1	1,127	1,127
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	0	0	2	692	346
Stearns	0	0	0	0	0	0	0
Washington	0	3	0	0	3	213	71.0
Wright	5	0	0	0	5	1,117	223.4
Totals	12	52	1	1	66	12,444	N/A

Lakes with public access aerated to prevent winterkill = 66
Total Acreage = 12,444
Average lake size (acres) = 188.5

Permits issued to Municipalities for lakes without access = 7 (921 acres)
Permits issued to Municipalities for lakes with access = 71 (9,909 acres)

Permits issued to Clubs for lakes with access = 18 (5,638 acres)
Permits issued to Clubs for lakes without access = 6 (404 acres)

Privately operated systems for lakes with access = 9 (7,146 acres)
(Shoreline protection – 6 permits/5 lakes (5,370))
(2 permits on Lake Alexander)
Privately operated systems for lakes without access = 15 (429 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 = 0 (0 acres)

Total Permits issued = 128 (24,634 total acres in 124 lakes/ponds)

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

Table 7. Region IV lakes with public access aerated to prevent winterkill, 2011-12.

County	Permittee C	M	P	S	Total No. of lakes	Total Acres	Average Size (acres)
Big Stone	0	1	0	0	1	440	440
Blue Earth	5	0	0	0	5	2,834	566.8
Brown	2	1	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	3	0	0	0	3	5,064	1,688
Lyon	0	9	0	0	9	2,518	279.8
Martin	4	3	0	0	7	2,041	291.6
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	1	0	0	0	1	697	697
Steele	0	0	0	0	0	0	0
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	41	49	1	0	87	50,340	N/A

Lakes with public access aerated to prevent winterkill = 87
Total Acreage = 50,340
Average lake size (acres) = 578.6

Permits issued to Municipalities for lakes with access = 52 (26,805 acres)
(2 permits for Albert Lea & Wilson lakes)
Permits issued to Clubs for lakes with access = 41 (24,036 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 = 2 (1,867 acres)

Total Permits Issued = 101 (67,179 acres; 96 lakes)

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

Table 8. Operational Characteristics of Some Aeration Systems, Winter 2011-12.

		Total hp	Lake Area (A)	hp/A	$/A/mo	$/hp/mo	KWH/hp/mo	KWH/hp/A
Helixor	Range	3-15	21-1,844	0.008-0.221	0.04-8.49	$ 4.74-69.50	22.41-782.71	0.03-59.64
	Mean (x)	8.6	468.2	0.09	$ 3.43	$ 39.39	436.97	16.28
	n	5	5	5	4	4	4	4
Clean-Flo	Range	0.5-4.25	13-257	0.008-0.154	$ 0.14-5.12	$ 17.22-132.31	95.61-1,534.15	2.14-483.85
	Mean (x)	1.9	96.9	0.038	$ 2.53	$ 73.98	645.47	84.82
	N	13	12	12	9	10	7	7
Aire-0_2	Range	2.0-6.0	10-720	0.004-0.20	$ 0.20-3.90	$ 32.88-166.67	257.83-1,180.77	1.24-26.71
	Mean (x)	2.7	161.9	0.041	$ 1.87	$ 77.01	642.62	10.61
	N	19	20	20	16	15	12	12
Pump & Baffle	Range	3.0-15	3-83	0.04-1.67	$ 1.17-202.02	$ 32.47-121.21	96.97-434.23	0.33-106.67
	Mean (x)	6.75	41.8	0.45	$ 70.53	$ 69.91	223.18	47.25
	N	6	6	6	3	3	3	3
Mechanical Surface Agitators	Range	0.75-8.5	8-1,255	0.004-0.117	$ 0.12-7.85	$ 21.42-178.10	152.00-1,455.56	1.16-154.12
	Mean (x)	2.9	326.4	0.033	$ 1.85	$ 79.10	677.41	36.97
	n	13	12	10	5	8	7	5

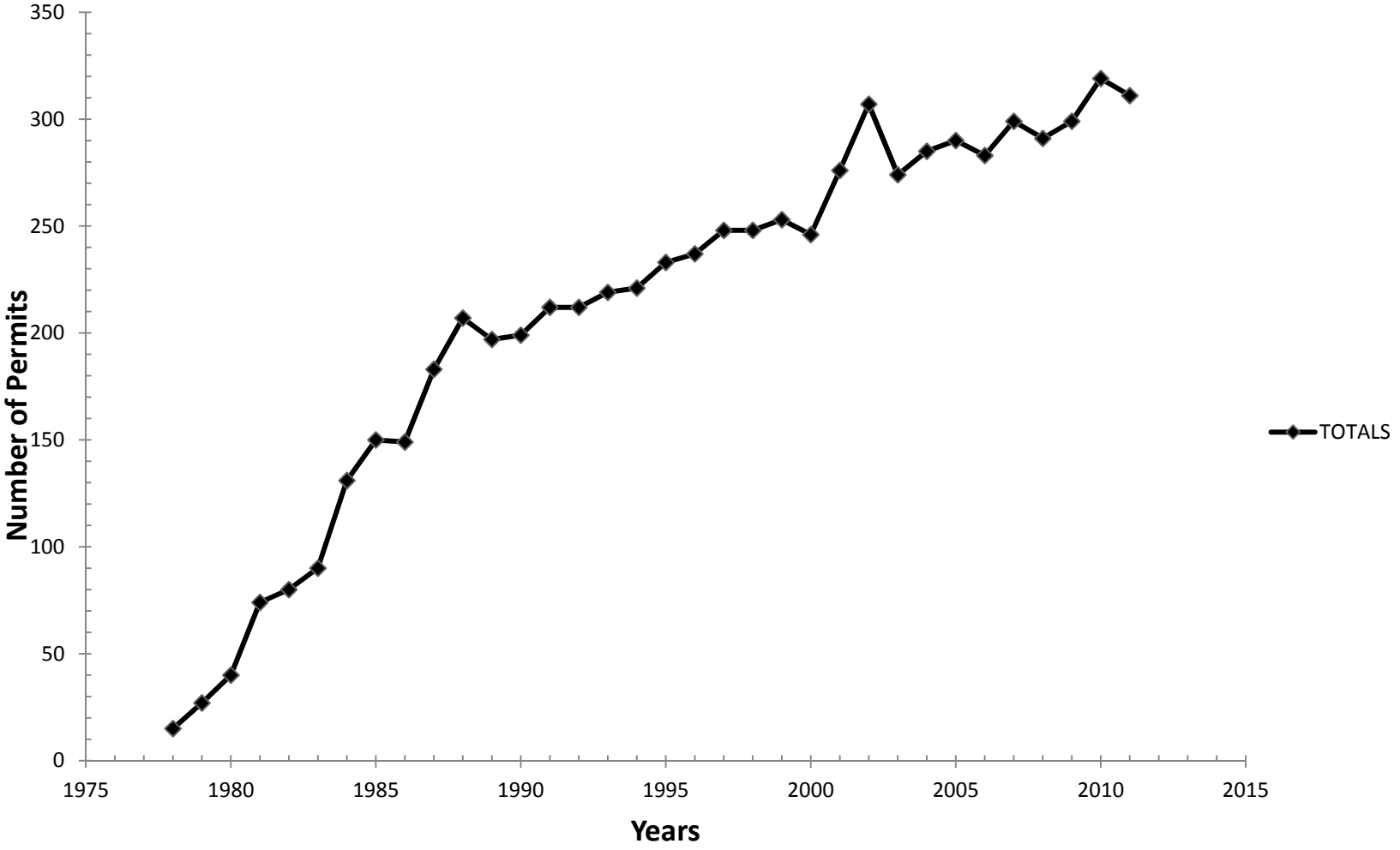

Figure 1. Trends in lake aeration permits issued 1978-2011.

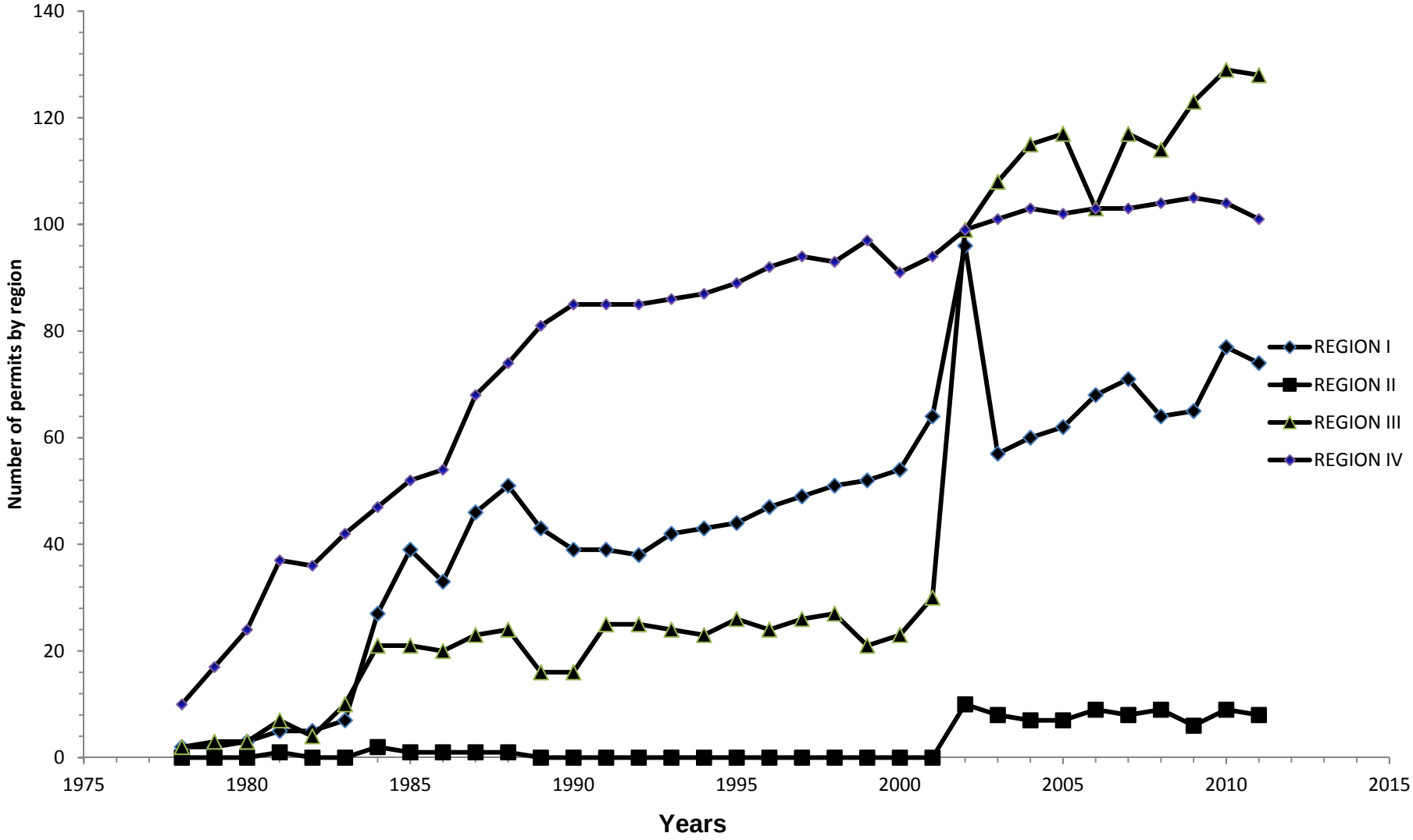

Figure 2. Aeration permits issued by DNR region, 1978-2011.

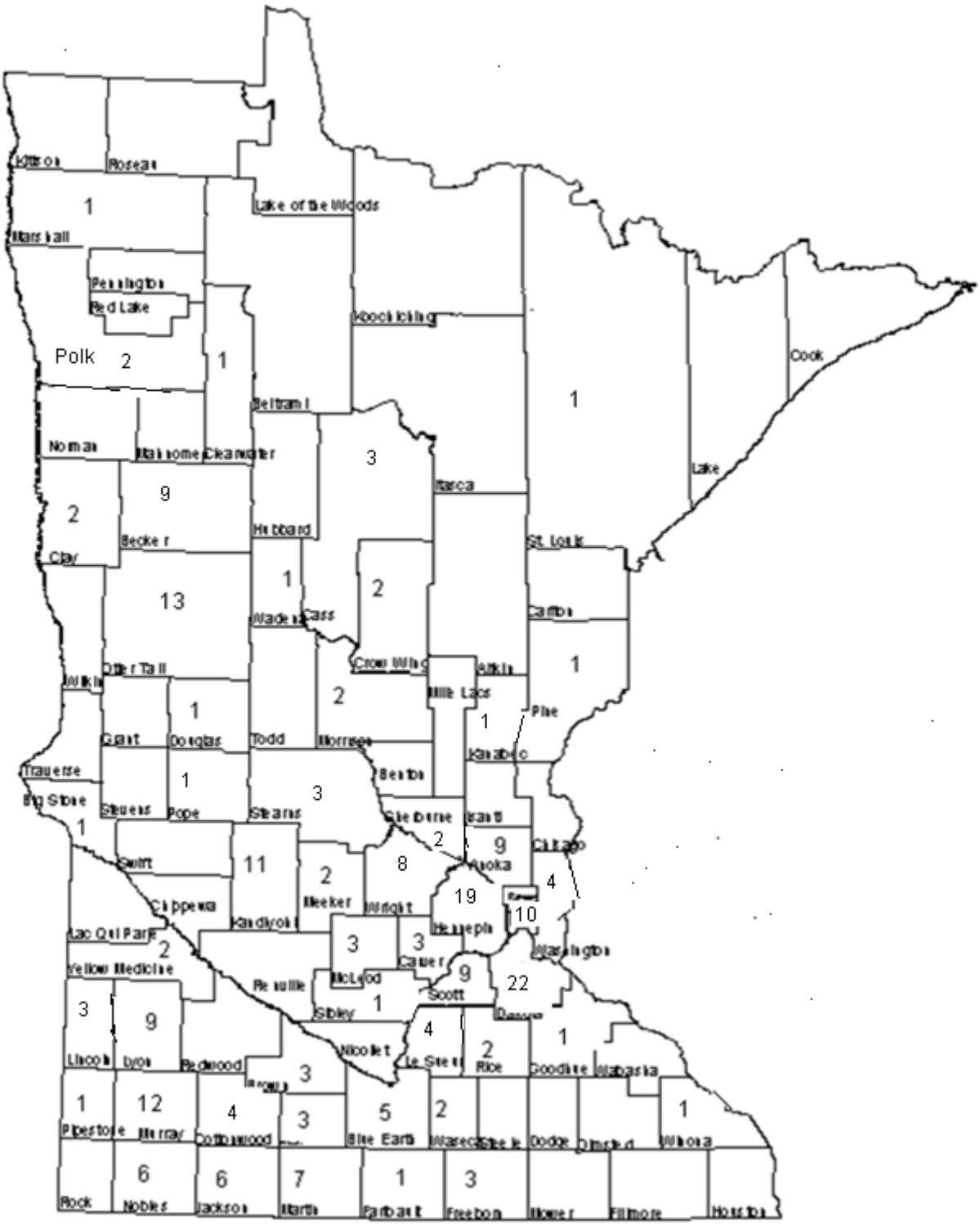

Figure 3. Number of lakes with public access, by county, issued aeration permits in 2011-12.

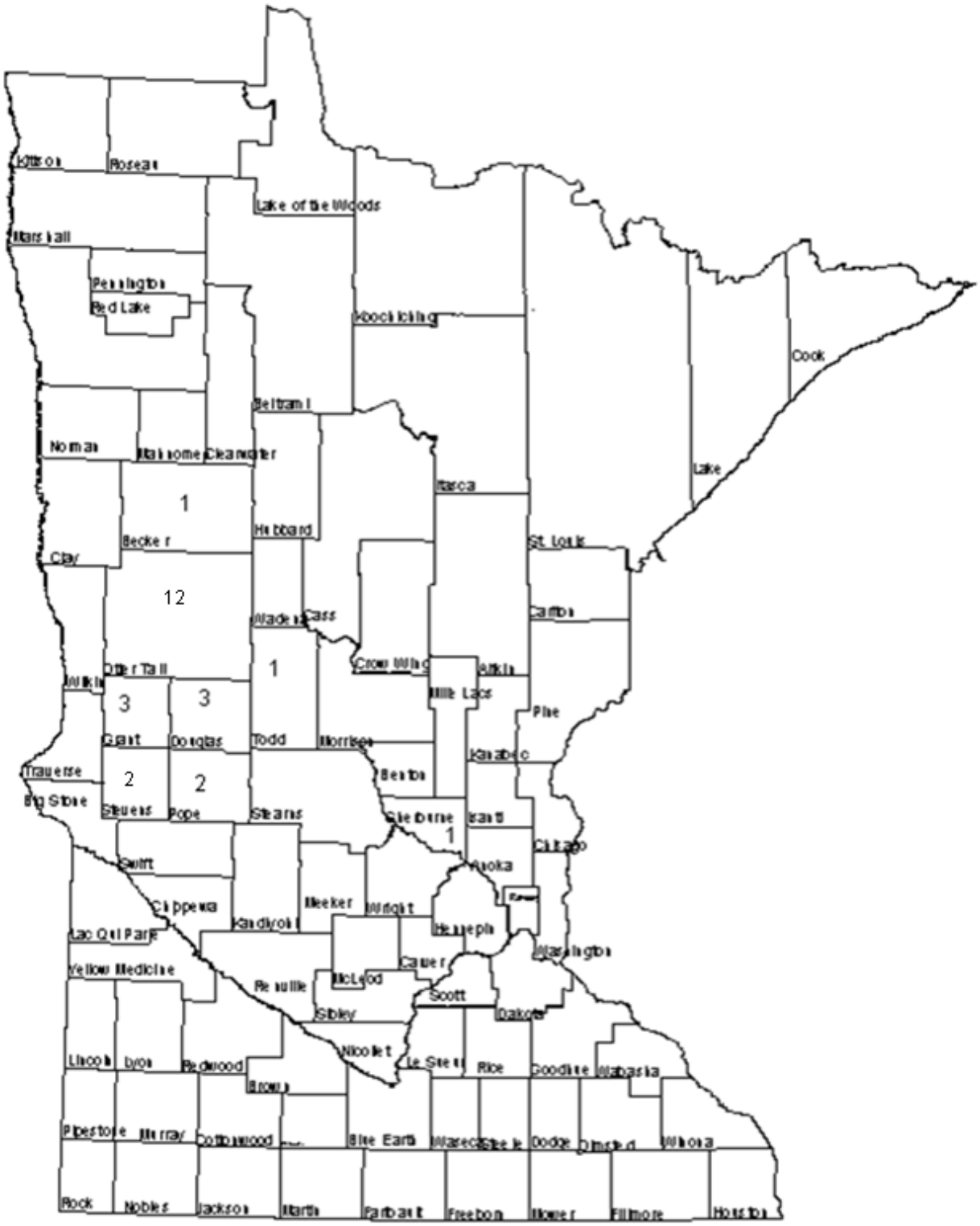

Figure 4. Distribution by County of ponds aerated under permits issued to private hatchery operators in 2011-12.

APPENDICES

Appendix 1. Private hatchery operators and protected waters under permit for 2011-12.

Permit #	Last Name	County	D.O.W.	Acres
Region 1				
F1121032	P. Koep	Douglas	21-74	17
			21-116	24
		Otter Tail	56-136	34
			56-155	21
			56-720	30
			--	15
F1121038	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
F1121092	Joe Koep	Otter Tail	56-149	180
F1121103	Goeden	Becker	3-269	242
		Grant	26-114	93
F1121199	Tanner	Stevens	75-25	28
			75-26	50
Region 3				
F1123100	McDonald	Sherburne	71-129	77

Appendix 2. Questionnaire results of aeration systems operating in winter in lakes with or without public access, 2011-2012.

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	did not return questionnaire			
Clear (8-11)	Brown	325	New Ulm Area Sport fisherman	1-10 HP motor/blower 7 diffusers	1,782	191.00	0.8	N
Hanska (8-26)	Brown	1,844	Brown Co. Park Dept.	1-15 HP blower 6 diffusers	773	163.69	2.3	N
Hanska (8-26)	Brown	1,844	Lake Hanska Area Association	1-15 HP Helixor	did not operate			
Sleepy Eye (8-45)	Brown	290	City of Sleepy Eye	2-5 HP motor/blowers 4 diffusers	did not operate			
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	3,757	285.38	1.6	N
Round (27-71)	Hennepin	34	City of Eden Prairie	1-7.5 HP blower 1 diffuser	-	-	1.0	N
Loon (32-20)	Jackson	738	Jackson County Conservation League	2-7.5 HP motor/blowers 9 diffusers	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)
Polcon Helixors (Con't.)								
Pearl (32-33)	Jackson	117	Jackson County Conservation League	1-7.5 HP blower 3 diffusers	4,320	417.00	0.8	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	did not operate			
Foot (34-181)	Kandiyohi	576	Willmar Parks Department	1-25 HP motor/blower 6 diffusers	did not operate			
Long (34-192)	Kandiyohi	1,715	Kandiyohi County	2-10 HP motors 12 diffusers	did not operate			
Mud (Monongalia) M Fk Crow R. (34-158)	Kandiyohi	2,516	Kandiyohi County	1-15 HP motor 6 diffusers	did not operate			
Ringo (34-172)	Kandiyohi	774	Kandiyohi County	1-10 HP motor 9 diffusers	did not operate			
Swenson (34-321)	Kandiyohi	123	Kandiyohi County	1-7.5 HP motor 5 diffusers	did not operate			
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	did not operate			
Clear (40-79)	LeSueur	282	Lexington Sportsmen's Club	1-7.5 HP motor 3 diffusers	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)
Polcon Helixors (Con't.)								
Gorman (40-32)	LeSueur	590	LeCenter Sportsman's Club	1-7.5 HP compressor 3 diffusers	did not return questionnaire			
Greenleaf (40-20)	LeSueur	306	Montgomery Sportsmen's Club	1-5 HP compressors 3 diffusers	did not operate			
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	did not operate			
Sisseton (46-25)	Martin	139	City of Fairmont	1-15 HP blower 2 diffusers	did not operate			
Swan (43-41)	McLeod	482	Silver Lake Sportsmen's Club	1-7 HP blower 3 diffusers	did not operate			
Bloody (51-40)	Murray	248	Murray County	1-7.5 HP blower 2 diffusers	did not operate			
First Fulda (South) (51-21)	Murray	122	Murray County	2-7.5 HP motor/blowers 4 diffusers	did not operate			
Sarah (51-83)	Murray	1,176	Murray County	1-7.5 HP motor/blower 4 diffusers	did not operate			
Indian (53-7)	Nobles	204	Round Lake Sportsmen's Club	1-10 HP blower 4 diffusers	did not return questionnaire			
Okabena (53-28)	Nobles	785	City of Worthington	2-7.5 HP blowers 9 diffusers	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)
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	1-0.5 HP blower 1 diffuser	-	-	4.0	N
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	did not operate			
Loon (7-96)	Blue Earth	818	Crystal and Loon Lake Rec., Inc.	4-0.75 HP compressors 8 diffusers	did not operate			
Lura (7-79)	Blue Earth	1,263	Lura Lake Aeration Corp.	1-5 HP & 1-4 HP compressor, 12 diffusers	did not operate			
Rice Marsh (10-01)	Carver	130	Riley Purgatory Bluff Creek Watershed District	1-2 HP and 1-1.5 HP 7 diffusers	11,299	1,852.28	4.0	N
Alimagnet (19-21)	Dakota	113	City of Apple Valley	1-2 HP compressor 6 diffusers	3,206	316.42	1.4	N
Arrowhead (27-45)	Hennepin	23	City of Edina	1-1.5 HP compressor 3 diffusers	1,804	261.29	4.1	N
Indianhead (27-44)	Hennepin	13	City of Edina	4-0.5 HP compressors 4 diffusers	12,580	174.75	4.1	N
Gleason (27-95)	Hennepin	167	Gleason Lake Improvement Assn	4-0.5 HP compressors 16 diffusers	-	-	0.4	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)
Clean-Flo Systems (Con't.)								
Hadley (27-109)	Hennepin	39	Hadley Lake Improvement Assn	6-0.5 HP compressors 7 diffusers	-	-	3.6	N
Sweeny-Twin (27-35)	Hennepin	96	Sweeny Lake Assn	2-0.75 HP compressors 2 vent diffusers	5,361	1,586.00	4.0	N
Unnamed (Upper) (34-28)	Kandiyohi	22	City of Atwater	2-2 HP compressors 4 diffusers		did not operate		
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	-	35.00	0.3	N
Unnamed (40-58)	LeSueur	18		1-0.75 compressor 2 diffusers	-	150.00	3.6	Y
Unnamed (58-141)	Pine	23		1-0.75 compressor 2 diffusers	-	-	2.1	N
Birch (62-24)	Ramsey	127	Birch Lake Improvement Assn	1-1 HP compressor 3 diffusers	-	100.00	4.4	N
Willow (62-40)	Ramsey	75	Natural Preserve Foundation	3-0.5 compressors 6 diffuers		did not operate		
Cody (66-61)	Rice	257	Wheatland Twin Lakes Sportsmen's Club	4-0.5 and 2-0.75 HP Compressors, 12 diffusers	2,983	400.92	2.6	N
Krenz (Sunset) (70-09)	Scott	15		1-HP 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)
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	-	438.00	2.6	N
Loon (81-15)	Waseca	119	City of Waseca	1-5 HP compressor 9 diffusers	did not operate			
Pine Tree (82-122)	Washington	174		1-0.5 HP compressor 2 diffusers	588	105.92	4.1	N
Pine Tree (82-122)	Washington	174			-	120.00	3.8	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	did not operate			
Mills (7-97)	Blue Earth	237	Crystal and Loon Lake Restoration	2-0.75 HP compressors 4 diffusers	did not operate			
Oak (10-93)	Carver	185		4-1 HP compressors 8 diffusers	-	-	3.9	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 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 operate		
Rice (22-7)	Faribault	268	Faribault County	2-0.75 compressors 9 diffusers		did not return questionnaire		
Albert Lea (24-14)	Freeborn	2,654	Faribault County	1 HP compressors Diffuser tubing		did not operate		
Pottery Pond (25-38	Goodhue	8	City of Red Wing	1-0.75 HP Vane compressor, 2 diffusers	1,611	80.00	2.0	N
Marion (43-84)	McLeod	616	Brownton Rod and Gun Club	1-5 HP blower 3 mat diffusers		did not operate		
Perch (56-95)	Otter Tail	57		1-0.75 HP compressor 1 diffuser		did not return questionnaire		
Unnamed (56-549)	Otter Tail	17		1-0.25 HP motor and diffuser hose		did not return questionnaire		
Cable (60-293)	Polk	129	Cable Lake Association	3-0.25 HP pump	2,196	208.62	2.0	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)
Other Bubblers (Con't.)								
Gilfillan (62-27)	Ramsey	86	Lake Gilfillan Assn.	1-1 HP bubbler	did not return questionnaire			
Pleasant (62-46)	Ramsey	585	St. Paul Regional Water Utility	2-30 HP compressors 2 diffusers	did not operate			
Ann (71-69)	Sherburne	226	Ann Lake Improvement Club, Inc.	1-.5 HP compressor 2 copper diffusers	did not operate			
Kohlmeier (74-19)	Steele	11	City of Owatonna	2-0.75 HP compressors 3 diffusers	-	-	2.3	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	-	600.00	4.0	N
Mud (Battle Creek) (82-91)	Washington	103	City of Woodbury	2-1 HP compressors 6 diffusers	-	300.00	2.1	N
Unnamed Pond (82-257)	Washington	7		0.25 HP blower 2 diffusers	did not operate			
Pump and Baffle								
Centerville (2-6)	Anoka	464	Anoka County Parks and Recreation Dept.	1-20 HP pump and baffle	did not return questionnair			
Crooked (2-84)	Anoka	130	City of Coon Rapids	1-10 HP pump and baffle	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)
Pump and Baffle (Con't.)								
Golden (2-45)	Anoka	50	City of Circle Pines	1-7.5 HP permanent pump and baffle	13,027	1,681.41	4.0	N
Martin (2-34)	Anoka	218	Anoka County Parks and Recreation	1-10 HP pump and baffle	did not return questionnaire			
Susan (10-13)	Carver	93	City of Chanhassen	1-7.5 HP pump and baffle	did not operate			
Marion (19-26)	Dakota	489	City of Lakeville	1-20 HP pump and baffle	did not operate			
Roger's (19-80)	Dakota	116	City of Mendota Heights	1-10 HP pump and baffle	did not operate			
Penn (27-4)	Hennepin	47	City of Bloomington	15 HP pump and baffle	did not operate			
Red Rock (27-76)	Hennepin	83	City of Eden Prairie	1-7.5 HP pump and baffle	did not operate			
Wirth (7-37)	Hennepin	37	Mpls. Park and Recr. Board	1-5.0 HP pump and baffle	did not operate			
Wolfe (27-664)	Hennepin	3	City of St. Louis Park	Built in waterfall – 5 HP	1,600	2,000.00	3.3	N
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	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)
Pump and Baffle (Con't.)								
Adley (56-31)	Otter Tail	249	Parker's Prairie Sportsmen's Club	1-15 HP pump and baffle		did not operate		
Fish (56-66)	Otter Tail	500	Parker's Prairie Sportsmen's Club	1-10 HP pump and baffle		did not operate		
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		did not operate		
Island (62-75)	Ramsey	63	Ramsey County Public Works Dept.	1-20 HP pump and baffle		did not operate		
Loeb (62-231)	Ramsey	10	City of St. Paul	1-5 HP pump and baffle	-	-	2.5	N
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	-	-	1.7	N
Silver (62-83)	Ramsey	67	City of Columbia Heights	1-10 HP pump and baffle		did not operate		
Cleary (70-22)	Scott	137	Three Rivers Park District	1-7.5 HP pump and baffle		did not operate		
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 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)
Pump and Baffle (Con't.)								
Goose (82-59)	Washington	83	Town of New Scandia	1-3 HP pump and baffle	83	19.48	0.2	N
Shields (82-162)	Washington	27	City of Forest Lake	CORE pump and baffle 3 HP		did not operate		
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		did not return questionnaire		
Ham (2-53)	Anoka	193	City of Ham Lake	3-2 HP Aeromix tornadoes		did not return questionnaire		
Peltier (2-4)	Anoka	483	Anoka Co. Parks	2-2 HP Aeromix		did not return questionnaire		
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		did not operate		
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 operate		
George (11-101)	Cass	720	Lake George Association	1-Aire 02	3,138	402.00	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)
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
Loon (11-226)	Cass	220	Loon Lake Property Owners	2-2 HP Aeromix tornadoes		did not return questionnaire		
Platte (18-88)	Crow Wing	1,486	Platte Lake Association	1-2 HP Aeromix tornadoes		did not operate		
Bald (19-61)	Dakota	10	City of Eagan	1-2 HP Neptune air injector		did not return questionnaire		
Birch Pond (19-202)	Dakota	3	School of Environmental Studies	Neptune air injection system		did not operate		
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	2,945	353.08	1.5	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 operate		
Hay (19-62)	Dakota	20	City of Eagan	1-2 HP air pump		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)
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
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	-	-	1.9	N
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	-	-	2.4	N
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	-	-	1.9	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	did not return questionnaire			
Albert Lea (24-14)	Freeborn	2,654	Shellrock River Watershed District	2-7.5 HP Aeromix systems	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)
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
Frontenac Pond (25-3)	Goodhue	34	Frontenac Sportsman's Club	1-2 HP Aire-02	1,816	146.75	1.4	N
Bass (27-98)	Hennepin	175	Bass Lake Improvement Assn	2-2 HP Aire-02	1,487	165.64	0.5	N
Crystal (27-34)	Hennepin	74	City of Robbinsdale	2-2 HP Aire-02	6,461	778.68	2.7	N
Hyland (27-48)	Hennepin	87	Three Rivers Park District	2-2 HP Aeromix Tornado	4,510	405.90	2.1	Y
Mitchell (27-70)	Hennepin	116	City of Eden Prairie	2-2 HP Aire 0-2's	did not operate			
Rebecca (27-192)	Hennepin	290	Three Rivers Park District	3-2 HP Aire-02 aerators	did not operate			
Petite (29-147)	Hubbard	58	Wonewok Conference Center	1-2 HP air injection system	-	-	4.0	N
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	did not operate			
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 operate			
Stay (41-34)	Lincoln	220	Arco Sportsmen's Club	2-2 HP Aqua 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)
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
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	2-2 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	-	600.00	1.8	N
Buffalo (46-146)	Martin	116	Mt. Lake-Odin-Ornsby Sportsmen's Club	1-3 HP Aire-02	did not operate			
Clear (46-96)	Martin	273	Clear Lake Preservation Assn.	1-2 HP Aire-02	769	110.00	0.5	N
Fish (46-145)	Martin	156	Watonwan Game and Fish	1-2 HP Aire-02	did not operate			
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	4,111	524.68	2.0	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)
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
Corabelle (51-54)	Murray	99	Murray County	1-2 HP Aire-02	1,547	197.26	3.0	N
Kinbrae (53-16)	Nobles	87	Nobles County Park	2-1 HP Aeromix tornado		did not operate		
Tamarac (59-931)	Otter Tail	416	Tamarac Lake Association	2-2 HP aspirating aerators		did not operate		
Split Rock (59-1)	Pipestone	80	Split Rock Creek State Park	2-2 HP Aeromix tornadoes	-	-	2.0	N
Johanna (61-6)	Pope	1,204	DNR Fisheries	2-5 HP Aire-02's		did not return questionnaire		
Signalness (61-149)	Pope	41	Glacial Lakes State Park	1-2 HP Aire-02		did not operate		
Unnamed (61-71)	Pope	21		1-2 HP Aeromix tornadoes		did not return questionnaire		
Otter (2-3)	Ramsey/ Anoka	173	Ramsey County Public Works	2-2 HP Aeromix tornadoes	1,678	187.00	0.6	N
Circle (66-27)	Rice	976	Tri-Lakes Sportsmen's Club	3-2 HP Aeromix tornadoes		did not operate		
O'Dowd (70-95)	Scott	256	O'Dowd Lakes Chain Assn	3-2 HP Aire-02		did not operate		
Thole (70-120)	Scott	131	O'Dowd Lakes Chain Assn	1-2 HP Aire-02		did not operate		
McColl (70-17)	Scott	20	City of Savage	2-2 HP Aeromix tornadoes		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)
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
Murphy (70-10)	Scott	70	Three Rivers Park District	2-2 HP Aeromix tornadoes		did not operate		
Birch (71-57)	Sherburne	149	Birch Lake Association	1-2 HP Aire-02		did not operate		
Fremont (71-16)	Sherburne	466	City of Zimmerman	2-2 HP Aire-02's		did not operate		
Masford (71-126)	Sherburne	90		1-2 HP Aeromix	2,440	301.00	2.0	N
Silver (72-13)	Sibley	697	Silver Lake Conservation Club	3-2 HP Aire-02		did not operate		
Black Oak (73-241)	Stearns	121	Green Grove Sportsmen's Club	1-2 HP Aire-02	3,070	275.00	1.3	N
Elysian (81-95)	Waseca	2,462	So. Lakes Chain Dark House Angles Association	2 sets of 3-3 HP Aire-02's		did not operate		
Unnamed (Cloverdale) (82-9)	Washington	39	Cloverdale Farm Homeowner's Assn	1-2 HP Aeromix systems	-	250.00	2.1	N
McDonald (82-10)	Washington	3.7	Cloverdale Farm Homeowner's Assn	1-2 HP Aeromix tornado	-	330.00	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 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)
Subsurface Aspirating Systems (Aire-02, Aeromix Tornado) (Con't.)								
St. James (83-43)	Watonwan	252	Watonwan Game and Fish Club	2-2 HP Aire-02		did not operate		
Crawford (86-46)	Wright	117	Crawford Lake Improvement Assn	2-2 HP Aire-02		did not operate		
Dean (86-41)	Wright	204	Dean Lake Assn	2-2 HP Aire-02		did not operate		
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		did not operate		
Somers (86-230)	Wright	156	Assn of Mink & Somers Lakes	1-2 HP Aire-02		did not operate		
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		did not operate		
Sprayers								
Crystal (70-61)	Scott	33	City of Prior Lake	1-3 HP Otterbine	90	40.81	1.9	N
Lakefront Park Pond (70-169)	Scott	13	City of Prior Lake	1-3 HP Otterbine	2,732	330.87	1.9	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)
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		did not operate		
Carlson (19-66)	Dakota	14	City of Eagan	1-3 HP lift station Air injection pump		did not return questionnaire		
Powerhorn (27-14)	Hennepin	11	Mpls Park and Rec. Board	Pump and baffle, 4 HP motor w/5 lines	-	-	3.7	N
Snelling (27-1)	Hennepin	110	Fort Snelling State Park	2-5 HP sump pumps		did not return questionnaire		
Clear (32-22)	Jackson	415	Jackson County Conservation League	2-5 HP motor/blowers, 6 Helixor diffusers, 3-3 HP Ice Eaters		did not operate		
Independence (32-17)	Jackson	97	Jackson County Conservation League	1-5 HP Helixor 3-3 HP Ice Eater		did not operate		
Little Spirit (32-24)	Jackson	634	Jackson County Conservation League	2-7.5 HP motors 6 diffusers; 3-3 HP Ice Eaters		did not operate		
Scotch (40-109)	LeSueur	590	German-Jefferson Sportsmen's Club	2-0.75 compressors, 1-10 HP Helixor, 9 diffusers		did not operate		
Cedar (46-121)	Martin	710	Trimont Area Conservation Club	1-2 HP Aire-02, 1-0.75 HP Ice Eater	-	800.00	1.8	N
Thompson (47-159)	Meeker	220	Meeker County Parks	1-20 HP pump and baffle 2-2 HP 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)
Mixed Systems (Con't.)								
Shetek (51-63)	Murary	3,596	Murray County	3-7.5 HP motor/blowers 12 diffusers, 2 Ice Eaters	3,331	373.37	2.9	N
Bennett (62-48)	Ramsey	41	Roseville Parks and Recr.	3-0.5 HP blower and 6 diffusers, baffle system	13,617	1,127.67	4.5	N
Hypolimnetic Aerators								
Moore (East) (2-75)	Anoka	110	City of Fridley	1-7.5 HP Palatek Compressor	-	-	4.0	N
Lucy (10-70)	Carver	137	CH2M Hill	2-IPS, 3 Gast compressors each	7,029	835.51	2.4	N
Como (62-55)	Ramsey	69	Ramsey County Public Works Dept.	1-10 HP Hypo system	12,876	1,281.00	2.4	N
Vadnais (62-38)	Ramsey	477	City of St. Paul Water Utility	2-30.0 HP Atlas Copco	-	-	4.0	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			
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	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 (Mechanical Surface Agitators, homemade, etc.) (Con't.)								
Bean (17-54)	Cottonwood	141	Red Rock Sportsmen's Club	2-1 HP Ice Eaters		did not operate		
Double (17-56)	Cottonwood	227	Red Rock Sportsmen's Club	2-1 HP Ice Eaters		did not operate		
South Double (17-56)	Cottonwood	227	Red Rock Sportsmen's Club	2-1 HP Ice Eaters		did not operate		
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	-	-	3.4	Y
Thomas (27-501W)	Hennepin	8		1-0.75 Kasco propeller	-	-	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	-	-	4.0	N
Silver (40-48)	LeSueur	17	N. Elysian Silver Lakers Sportsmen's Club	1-0.75 HP motored propeller	1,965	240.43	1.8	Y
Benton (41-43)	Lincoln	2,875	Lake Benton Sportsmen's Club	5-0.25 HP Ice Eaters		did not operate		
Shaokotan (41-89)	Lincoln	1,043	Shaokotan Sportsmen's Club	4-0.75 HP Ice Eaters		did not operate		
East Twin (42-70)	Lyon	280	Lyon County	3-0.5 HP Ice Eaters		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 (Mechanical Surface Agitators, homemade, etc.) (Con't.)								
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			
Current (51-82)	Murray	394	Murray County	3-0.75 HP Ice Eaters	1,026	144.60	3.0	N
Fox (51-43)	Murray	174	Murray County	2-0.75 HP Ice Eaters	3,147	214.08	2.6	N
Lime (51-24)	Murray	316	Murray County	2-0.75 HP Ice Eaters	did not operate			
Louisa (51-6)	Murray	211	Murray County	2-0.75 HP Ice Eaters	2,644	306.41	3.0	N
Second Fulda (51-20)	Murray	65	Murray County	2-0.75 HP Ice Eaters	did not operate			
Wilson (South) (51-81)	Murray	164	Murray County	1-0.75 HP Ice Eater	did not operate			
East Graham (53-20)	Nobles	523	Nobles County Parks Department	3-0.75 HP Powerhouse	did not operate			
West Graham (53-21)	Nobles	526	Nobles County Parks Department	3-0.75 HP Powerhouse	did not operate			
Ocheda (53-24)	Nobles	1,778	Nobles County Parks Department	2-0.75 HP portable Powerhouse motors	did not operate			

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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 (Mechanical Surface Agitators, homemade, etc.) (Con't.)								
Badger (60-214)	Polk	247	City of Erskine	2-0.75 HP Kasco agitators	3,394	274.74	3.4	Y
Community Center Pond (62-63)	Ramsey	32	City of Shoreview	1-0.75 HP Kasco agitators 1-2 HP, 1-1 HP	-	-	4.0	N
Legends (70-287)	Scott	29	Legends Club	1-HP Aqua control surface pump	-	-	4.4	N
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	did not operate			
White Bear Lake (82-167)	Washington	1,255	City of White Bear Lake	6-0.75 HP Kasco marine de-icers	-	-	0.3	N
Winona (85-11)	Winona	318	City of Winona	3-3 HP Neptune aspirating units with propellers	-	-	5.4	N