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MINNESOTA DEPARTMENT OF NATURAL RESOURCES

DIVISION OF ECOLOGICAL SERVICES

**Aeration Permit Program Annual Report
2005-2006**

STAFF REPORT 41

2007

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2005-2006**

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 2005-06 permit year (1 October 2005 – 30 September 2006). 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 2006; Danks 2005; Danks 1999; Danks 1998; Danks 1996; Danks 1995; Danks 1994; Danks 1992; Danks, 1992; Enger-Danks 1992).

AERATION EQUIPMENT

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

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

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

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

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

PROGRAM ADMINISTRATION

The Division of Ecological Services (MDNR) 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 Enforcement Supervisor 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 Services 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, 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 series of mild winters, an average of five lakes statewide are opened to "liberalized fishing" each year. Last winter (2005-06), two lakes were opened to "liberalized fishing" (Figure 1).

A total of 290 aeration permits were issued during the 2005-06 season. This includes 284 renewals (98% of the permits issued) and six (6) new permits. One permittee from the previous season (2004-05) did not reapply for an aeration permit in 2005-06.

The overall trend has been a steady increase in the number of permits issued in the last twenty-five years, with a slight increase in permit numbers occurring last year (Figure 2). The same trend is true for the regions as well (Figure 3).

The 290 permits issued in 2005-06 authorized aeration in 284 lakes, of which 179 permits were issued for public waters with access for winterkill prevention (see MN Rules 1988, part 6116.0010, subpart 6 for definition of public access), for a total of 147,867 acres (Table 1; Figure 4). All acreages listed are from "An inventory of Minnesota Lakes" MN DNR Bulletin 25 (Div. of Waters 1968). Pump and baffle systems were operated in 33 of these lakes, Aire O₂ units were operated in 57 lakes, mechanical surface agitators operated in 10 lakes, and diffuser systems operated in 65 lakes. Bait

dealers and commercial hatchery operations were permitted to operate in 35 public water bodies totaling 1,773 acres. One hundred twelve (112) 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 2005-06.

There have been seven fatalities at aeration system sites, the last occurring in 1999. No deaths resulted from accidents at aeration system sites in 2005-06.

REGIONAL AERATION SUMMARY

REGION I (Bemidji)

There were 62 aeration permits issued in Region 1 during the 2005-06 season, 21.4% of the total number of permits issued. Of the 62 permits issued, 59 (95%) were renewals and three were new permits.

The 62 permits issued in Region I authorized aeration in 68 public waters, or 23.7% of the total public waters aerated statewide. Private hatchery operators accounted for 47% of the aeration permitted water bodies in Region I. Private hatchery operators received six permits for 32 (1,599 acres) public waters (11.2% of the statewide total lakes permitted or 0.01% of the total acres permitted) (Figure 5). Appendix 1 lists water bodies under aeration permit issued to private hatchery operators. Private organizations and municipalities were issued 16 aeration permits to prevent winterkill in 16 lakes (9,858 acres) with public access. Thirty aeration permits were issued to private individuals on eight lakes (24,343 acres) to prevent shoreline property damage due to ice expansion. Three permits were issued to the State covering 5,631 acres. Five other aeration permits were issued to private groups to prevent winterkill in five public waters (356 acres) without public access. No 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 increased from zero permits in 2001 to ten in 2002 to seven in 2005. Most of these permits were absorbed from old Region III. There were no new permits requested.

Of these seven permits, which represent 2.4% of the total number of permits issued, three were operated on lakes with access, one was operated on a lake without access, and two were operated to protect marinas. No aerated lakes reported winterkill according to questionnaire results. For more information, see Table 5.

REGION III (St. Paul)

There were 118 aeration permits issued for 115 lakes/ponds (36,107 acres) in Region III last season (40.2% of the total number of permits issued), 116 renewals (99%), and two new permits. Pine Tree and Moore lakes have two permits each.

Region III, the Metropolitan area, is the most densely populated region of the state. Lakes and ponds receive nutrient run-off from a variety of sources. As a result, many lakes are hypereutrophic. Aeration has been employed to serve a variety of purposes in Region III. Sixty-seven permits were issued to municipalities for operation of aeration systems in 66 lakes (22,687 acres) with public access. Three permits (597 acres) were issued to municipalities for lakes without public access. Seventeen permits (4,731 acres) were issued to clubs for lakes with public access, and seven permits (449 acres) were issued to clubs operating aeration systems in lakes without public access. Eighteen permits for 17 lakes (6,560 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. Three lakes experienced winterkill in Region III according to questionnaire results. For a more detailed breakdown of permit issuance in Region III, see Table 6.

REGION IV (New Ulm)

Region IV has 35% of the permits issued statewide. Last season, 103 permits (66,876 acres) were issued in Region IV; 101 were renewals (99%). Two new permits were issued. The 103 aeration permits issued in Region IV authorized the aeration of 98 public waters. Lakes are less common in this area of the state and many are small and shallow. Soils are fertile and agriculture is extensive. Erosion deposits large amounts of soil, fertilizer and agricultural chemicals into lakes, accelerating eutrophication and creating high oxygen demand. These conditions are typical of Midwestern lakes (Schneberger, 1970). Many anglers reside in this area of the state and winterkill lakes are an important fisheries resource. Eighty-nine permits were issued to private organizations and municipalities to prevent winterkill of fish in 88 lakes (51,936 acres) with public access. Two permits were issued to prevent winterkill in two protected water without public access. Five permits were issued to municipalities and clubs to improve water quality.

According to the questionnaires returned, two aerated lakes experienced some degree of 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 273 of 290 permittees, a 94% 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. Ninety-eight (98) respondents indicated their aeration system was not operated last winter.

The average cost for insurance (n=55) was \$488.25. This figure includes all permittees operating an aeration system in lakes with or without public access. The range in insurance premiums for the 2005-06 season was \$5.00-\$1,647.00. Two respondents 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 50 of those indicated that waterfowl overwintered on the lake. Of these, seven respondents are located in Region I, 26 in Region III, and 17 in Region IV. An estimated 5,500 waterfowl used the open water areas provided by aeration systems (range 2-600). Most of the birds were mallards and Canada geese.

Of the 175 permittees that responded and operated their systems last winter, 163 (93%) indicated they were satisfied with system performance. Sixty-three percent (63%) of permittees operating Clean-Flo systems indicated they were satisfied with their systems' performance. Forty-two percent (42%) of the permittees operating pump and baffle systems were satisfied, 51% of mechanical surface agitators, 73% of Helixor diffusers and 47% of the Aire O₂ systems were satisfied with their systems. Complaints ranged from mechanical failures to undersized and ineffective equipment. Six respondents indicated safety problems with their aeration systems.

Some aerated lakes experienced partial winterkill last season. Five of the 175 respondents that operated their aeration systems last winter reported some evidence of winterkill at ice out. Of these, two were diffuser systems, one was a Clean-Flo system, one was a pump and baffle, and one was an Aire O₂.

Some respondents indicated there were mechanical difficulties with the equipment or that they were dissatisfied with the location of the system. Some systems may have been ineffective if started too late in the season and there may be differences in reporting among the different permittees.

Based on the responses to the questionnaire as summarized in Table 8, Aire-O₂ systems were on average the least expensive to operate per acre, whereas the Clean-Flo systems were the most expensive. Helixors were least expensive to operate based on the horsepower of the system and the length of time they were operated. Helixor systems were used in larger lakes (average area = 668.7), whereas, Clean-Flo systems were used in smaller lakes (average 134.6 acres).

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Table 1. Aerated Acres 2005-06.

ACRES	REGION 1	REGION 2	REGION 3	REGION 4	OVERALL
Lakes with public access	36,752	859	34,416	65,621	137,648
Lakes without public access	5,682	260	1,691	2,586	10,218
TOTAL	42,434	1,119	36,107	68,207	147,867

Table 2. 2005-06 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	18	12	4	2	0	32	6	8	30	8	8	62 (21%)
II	2	2	0	0	0	0	0	0	0	5	5	7 (2.4%)
III	65	12	51	1	1	1	1	2	2	48	50	118 (40.3%)
IV	89	44	49	0	1	0	0	0	0	6	9	103 (35%)
Totals	174	69	104	3	2	33	7	10	32	67	72	290

		Lakes	Acres	Permits
Protected waters with access for winterkill prevention	=	174	74,800	179
Protected waters under permit to Bait Dealers	=	33	1,676	7
Shoreline Protection	=	10	28,786	32
Other**	=	67	42,605	72
		284	147,867	290

Total number of permits for protected waters with access for winterkill prevention = 177

Total number of permits for protected waters without access for winterkill prevention = 17

290 total permits, new permits = 6

04-05 permits not reissued = 1

Other includes – Protected waters with no public access.
Protected waters with public access for wintering waterfowl, and water quality.
Summer only systems.

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

Table 3. Region I lakes with public access aerated to prevent winterkill, 2005-06.

County	Permittee			Total No. of lakes	Total Acres	Average Size (acres)
	C	M	S			
Becker	3	0	0	3	2,621	873.7
Clay	1	1	0	2	139	69.5
Clearwater	0	1	0	1	1,465	1,465
Douglas	0	0	0	0	0	0
Marshall	0	1	0	1	42	42
Otter Tail	2	1	0	3	1,165	388.3
Polk	3	0	0	3	1,821	607
Pope	1	0	2	3	1,761	587
Stevens	1	0	0	1	488	488
Wadena	1	0	0	1	356	356
Totals	12	4	2	18	9,858	N/A

# lakes with public access aerated to prevent winterkill	=	18 (C = 12; M = 4; S = 2)
Total Acreage	=	9,858
Average lake size (acres)	=	547.7
Permits issued to Municipalities for lakes with access	=	4 (1,767 acres)
Permits issued to Clubs for lakes with access	=	12 (6,846 acres)
Permits issued to the State w/access	=	2 (1,245 acres)
Permits issued for shoreline protection	=	30 (8 lakes; 24,343 acres)
Melissa Lake – 1,827 acres – 7 permits		Fish Lake – 284 acres – 1 permit
Lida Lake – 7,277 acres – 6 permits		Big Cormorant Lake – 3,380 acres – 3 permits
Lizzie Lake – 4,145 acres – 2 permits		Pelican – 4,314 acres – 9 permits
Little McDonald Lake – 1,506 acres – 1 permit		Marion – 1,610 acres – 1 permit
Permits issued to Bait Dealers, & P. Hatchery operators	=	6 (32 ponds; 1,599 acres)
Permits issued to private individuals to prevent winterkill for lakes without access	=	5 (356 acres)
Permits issued to the State without access	=	1 (4,386 acres)
Permits issued to private individuals to improve water quality for lakes with access	=	2 (1,892 acres)
Total Permits issued	=	62 (42,434 acres) in 66 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 2005-06.

County	Total No. of Ponds	Total Acres	Average Size Pond (Acres) Per County
Becker	1	242	242.0
Clay	1	36	36.0
Douglas	3	47	15.6
Grant	4	230	57.5
Otter Tail	16	740	46.3
Polk	4	145	36.2
Pope	2	90	45.0
Todd	1	69	69.0
Totals	32	1,599	N/A

Averages:

Bait dealers permitted	=	6 (6 permits)
Average number of ponds/permit	=	5.3
Average size of ponds	=	49.9 acres (range 6 to 242 acres)
Average number of acres/permit	=	266.5

Table 5. Region II lakes with public access aerated to prevent winterkill, 2005-06.

County	Permittee			Total No. of lakes	Total Acres	Average Size (acres)
	C	M	P			
Aitkin	0	0	0	0	0	0
Cass	2	0	0	2	330	165
Crow Wing	0	0	0	0	0	0
Lake	0	0	0	0	0	0
Totals	2	0	0	2	330	N/A

Lakes with public access aerated to prevent winterkill = 2
 Total Acreage = 330
 Average lake size (acres) = 165.0

Permits issued to Municipalities for lakes without access = 0

Permits issued to Municipalities for lakes with access = 0

Permits issued to Clubs for lakes with access = 2 (330 acres)

Permits issued to Clubs for lakes without access = 1 (260 acres)

Privately operated systems for lakes with access = 1 (213 acres)

Privately operated systems for lakes without access = 0

Permits issued to State with access = 3 (316 acres)

(2 – protect dock stations)

(1 – induce winterkill)

Total Permits issued = 7 (1,119 total acres in 6 lakes/ponds)

C = Club; M = Municipality; P = Privately Operated

Table 6. Region III lakes with public access aerated to prevent winterkill, 2005-06.

County	Permittee				Total No. of lakes	Total Acres	Average Size (acres)
	C	M	P	S			
Anoka	0	9	0	0	9	3,192	354.7
Carver	0	2	0	0	2	323	161.5
Dakota	0	16	0	0	16	1,056	66.0
Hennepin	1	8	0	1	10	990	99.0
Kanabec	1	0	0	0	1	1,127	1,127.0
Pine	0	0	1	0	1	50	50.0
Ramsey	0	7	0	0	7	806	115.1
Scott	4	4	0	0	8	1,512	189.0
Sherburne	1	1	0	0	2	692	346.0
Stearns	0	1	0	0	1	222	222.0
Washington	0	3	0	0	3	213	71.0
Wright	5	0	0	0	5	1,117	223.4
Totals	12	51	1	1	65	11,300	N/A

Lakes with public access aerated to prevent winterkill	=	65
Total Acreage	=	11,300
Average lake size (acres)	=	173.85
Permits issued to Municipalities for lakes without access	=	3 (597 acres)
Permits issued to Municipalities for lakes with access (2 permits in Moore Lake)	=	67 (22,687 acres)
Permits issued to Clubs for lakes with access	=	17 (4,731 acres)
Permits issued to Clubs for lakes without access	=	7 (449 acres)
Privately operated systems for lakes with access (Shoreline protection – 2 permits/2 lakes (4,443)	=	5 (6,050 acres)
Privately operated systems for lakes without access (2 permits in Pine Tree Lake)	=	13 (510 acres)
Private Hatchery Operator permits for lakes with access	=	1 (77 acres)
Permits issued to State with access	=	2 (838 acres)
Permits issued to State without access	=	3 (168 acres)
Total Permits issued	=	118 (36,107 total acres in 115 lakes/ponds)

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

Table 7. Region IV lakes with public access aerated to prevent winterkill 2005-06.

County	Permittee				Total No. of lakes	Total Acres	Average Size (acres)
	C	M	P	S			
Big Stone	2	1	0	0	3	2,561	853.6
Blue Earth	4	0	0	0	4	2,714	678.5
Brown	2	2	0	0	3	2,459	819.7
Cottonwood	6	0	0	0	5	1,716	343.2
Faribault	1	0	0	0	1	268	268.0
Freeborn	0	4	0	0	3	3,230	1,076.6
Jackson	6	0	0	0	6	2,948	491.3
Kandiyohi	0	9	0	0	9	7,627	847.4
LeSueur	4	0	0	0	4	1,768	442.0
Lincoln	4	0	0	0	4	4,693	1,173.3
Lyon	0	9	0	0	9	2,518	279.8
Martin	2	3	0	0	5	717	143.4
McLeod	2	1	0	0	3	1,505	501.6
Meeker	1	0	1	0	2	774	387.0
Murray	1	10	0	0	10	6,450	645.0
Nobles	1	5	0	0	6	3,903	650.5
Pipestone	0	1	0	0	1	80	80.0
Rice	2	0	0	0	2	1,233	616.5
Sibley	1	0	0	0	1	697	697.0
Steele	0	1	0	0	1	11	11.0
Waseca	1	1	0	0	2	2,581	1,290.5
Watonwan	3	0	0	0	3	819	273.0
Yellow Medicine	0	2	0	0	2	664	332.0
Totals	43	49	1	0	89	51,936	N/A

Lakes with public access aerated to prevent winterkill	=	89
Total Acreage	=	51,936
Average lake size (acres)	=	583.5
Permits issued to Municipalities for lakes with access	=	52 (28,050 acres) (2 permits for Albert Lea & Wilson lakes)
Permits issued to Clubs for lakes with access	=	45 (24,257 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	=	1 (220 acres)
Privately Owned Systems without public access	=	0 (0 acres)
Permits issued to State for lakes with public access	=	1 (13,094 acres)
Permits issued to Municipalities for lakes without access	=	1 (8 acres)
Permits issued to State for lakes without public access	=	1 (1,127 acres)
Total Permits Issued	=	103 (66,876 acres; 98 lakes)

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

Table 8. Operational Characteristics of Some Aeration Systems, Winter 2005-06.

		Total hp	Lake Area (A)	hp/A	\$/A/mo	\$/hp/mo	KWH/hp/mo	KWH/hp/A
Helixor	Range	3-30	21-2,462	0.006-0.143	\$ 0.13 – 8.26	\$ 9.46-57.84	95.65-770.37	0.11-136.44
	Mean (x)	13.25	668.7	0.040	\$ 1.44	\$ 30.17	415.99	10.71
	n	30	28	28	19	19	18	18
Clean-Flo	Range	0.5-9.0	10-1,263	0.007-0.400	\$ 0.41-102.13	\$ 36.48-178.57	246.45-1,325.49	13.41-97.83
	Mean (x)	2.78	134.6	0.069	\$ 15.21	\$ 91.14	671.61	35.62
	n	21	20	20	9	9	5	5
Aire-0₂	Range	1.0-9.0	37-1,043	0.004-0.049	\$ 0.16-5.68	\$ 13.89-163.34	75.0-1,702.36	0.29-19.24
	Mean (x)	3.94	279.2	0.021	\$ 0.98	\$ 45.22	449.37	4.76
	n	29	29	29	12	12	11	12
Pump & Baffle	Range	3.0-30.0	3-1,445	0.020-1.667	\$ 0.25-52.78	\$ 11.88-94.87	14.30-1,090.21	0.16-113.33
	Mean (x)	11.42	255.4	0.237	9.98	39.40	424.9	35.09
	n	13	12	12	10	10	8	8

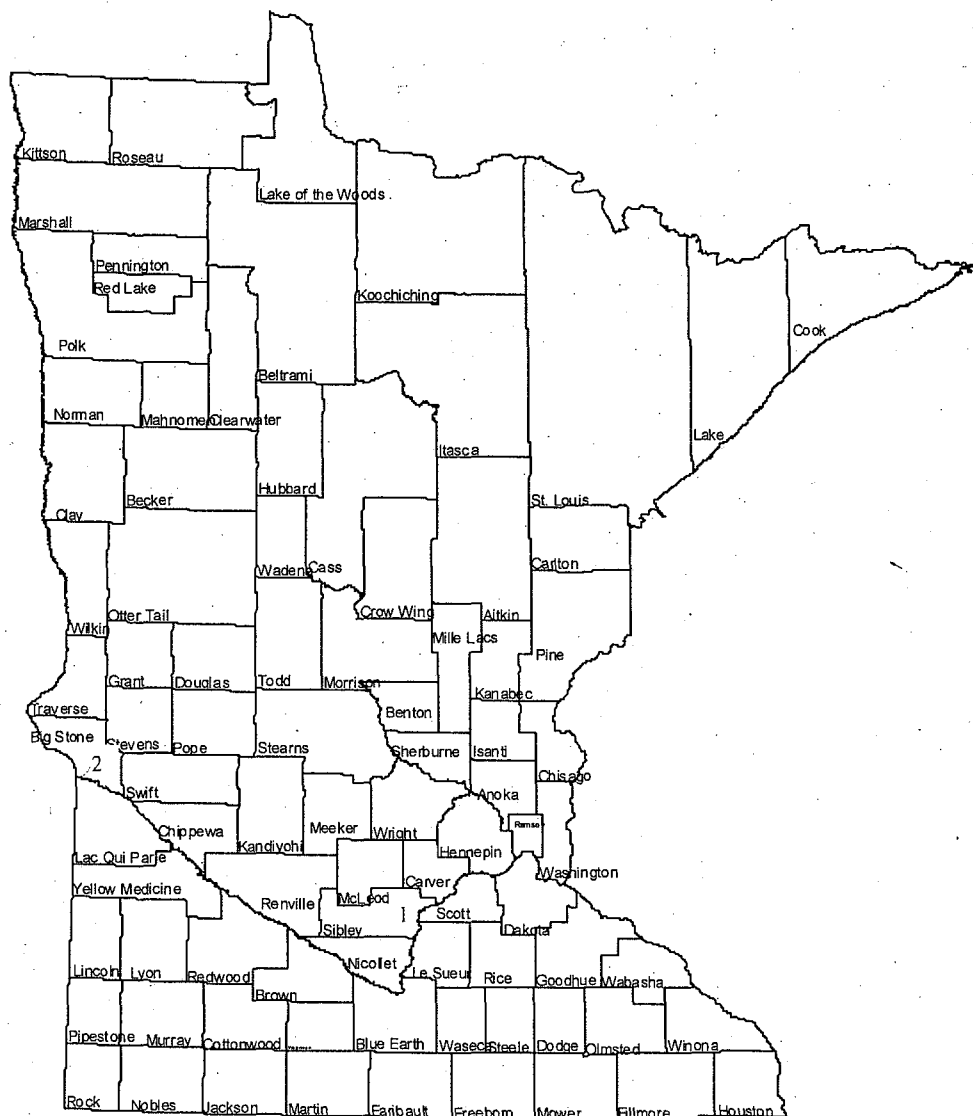


Figure 1. Number of lakes opened to "liberalized" fishing, by county, for the winter of 2005-06.

Figure 2. Trends in lake aeration permits issued 1978-2005

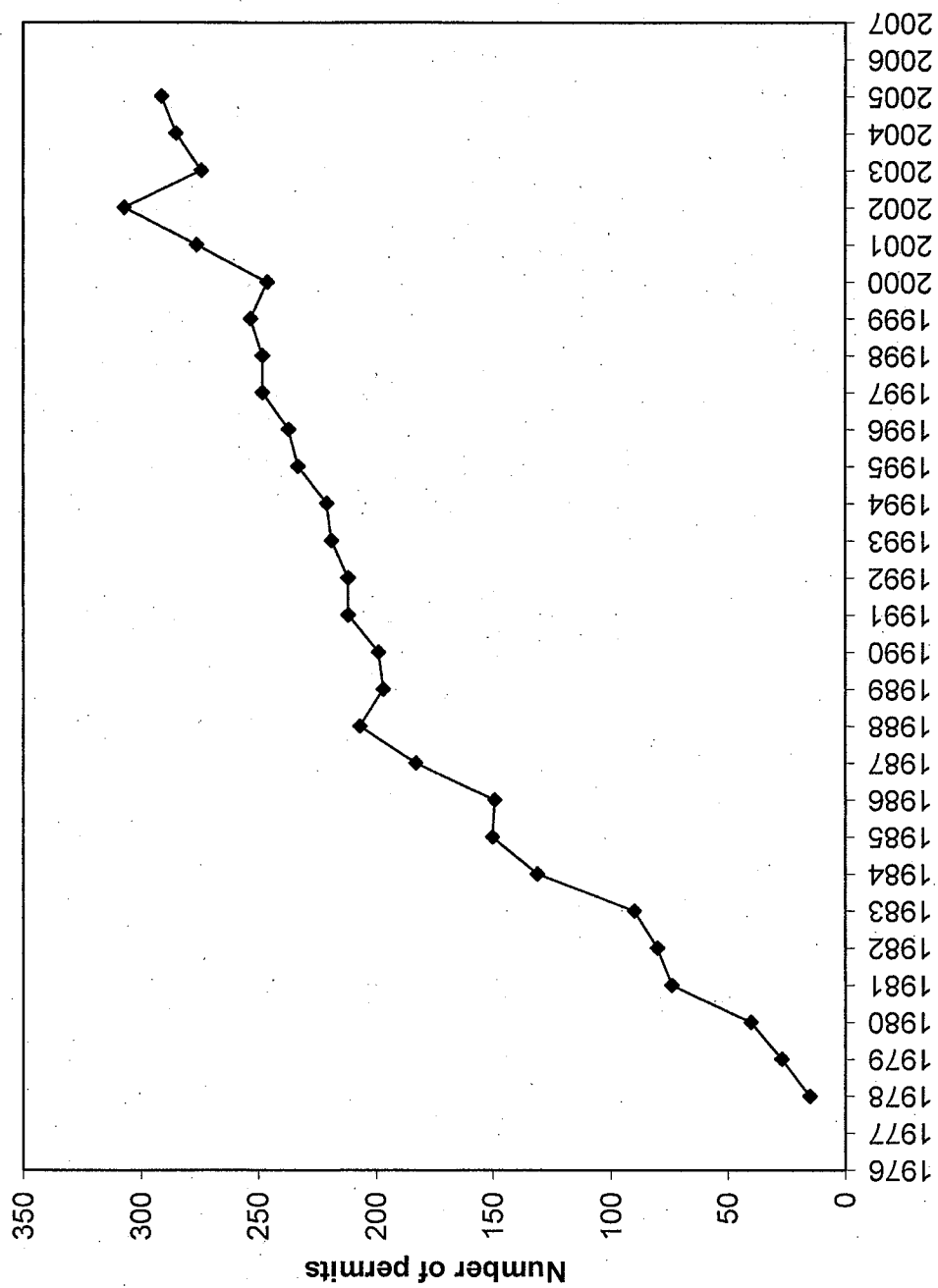


Figure 2. Trends in lake aeration permits issued 1978-2005.

Figure 3. aeration permits issued by DNR regions, 1978-2005

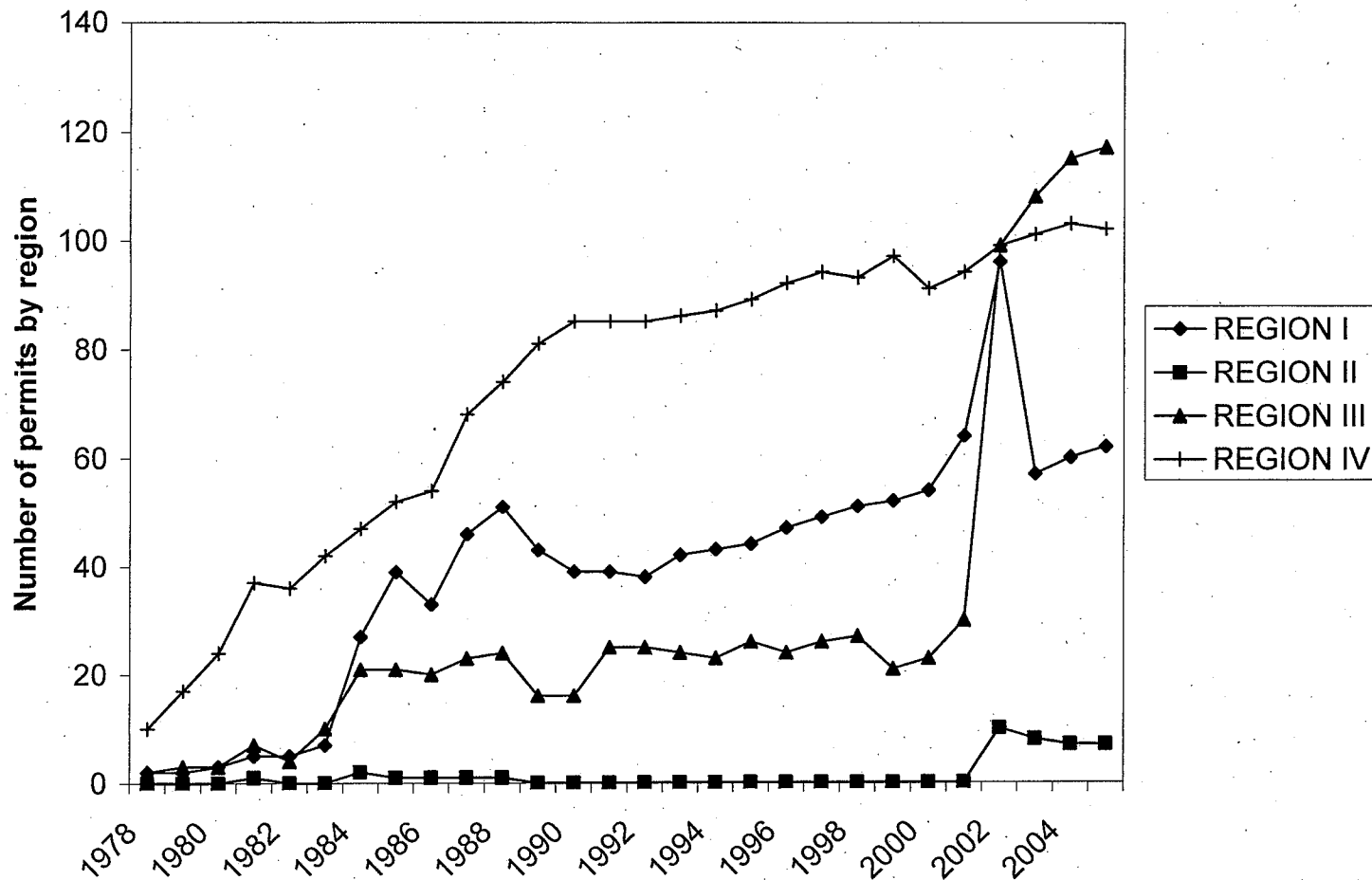


Figure 3. Aeration permits issued by DNR region, 1978-2005.

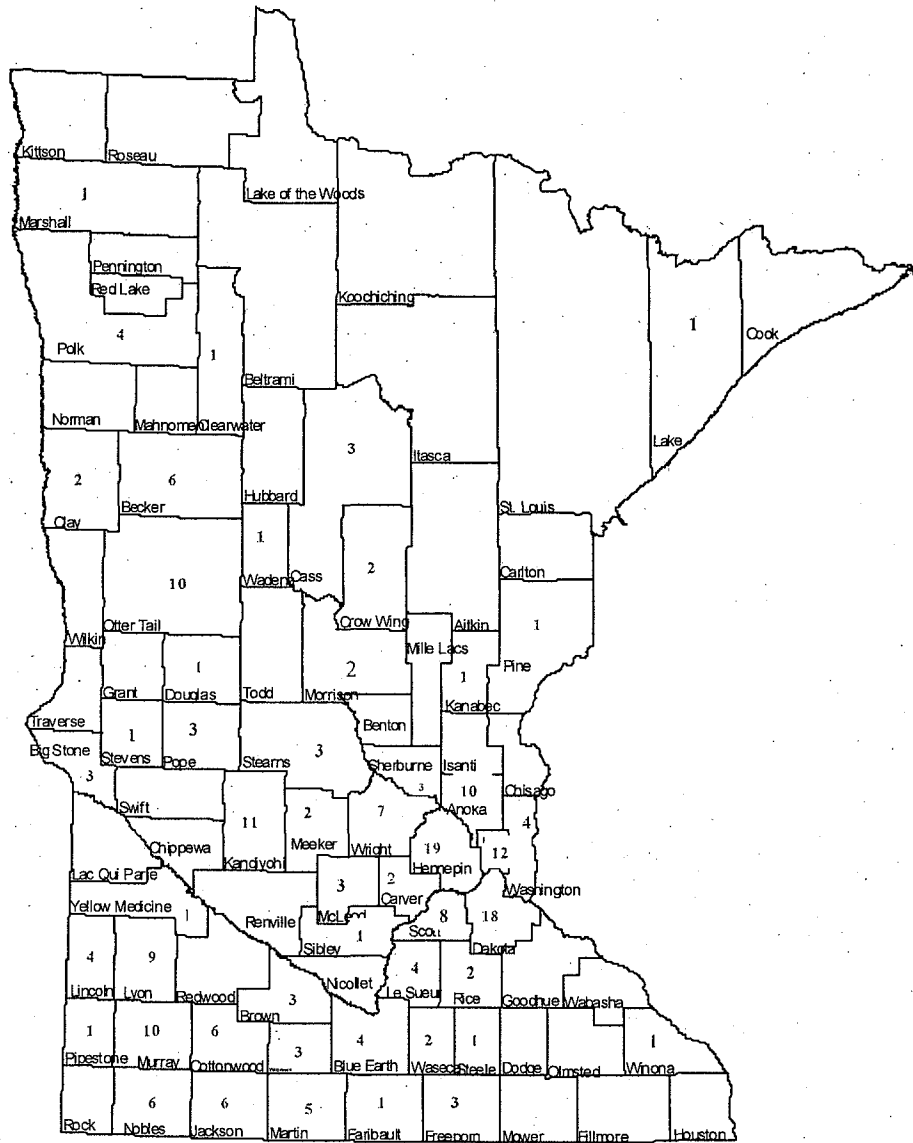


Figure 4. Number of lakes with public access, by county, issued aeration permits in 2005-2006.

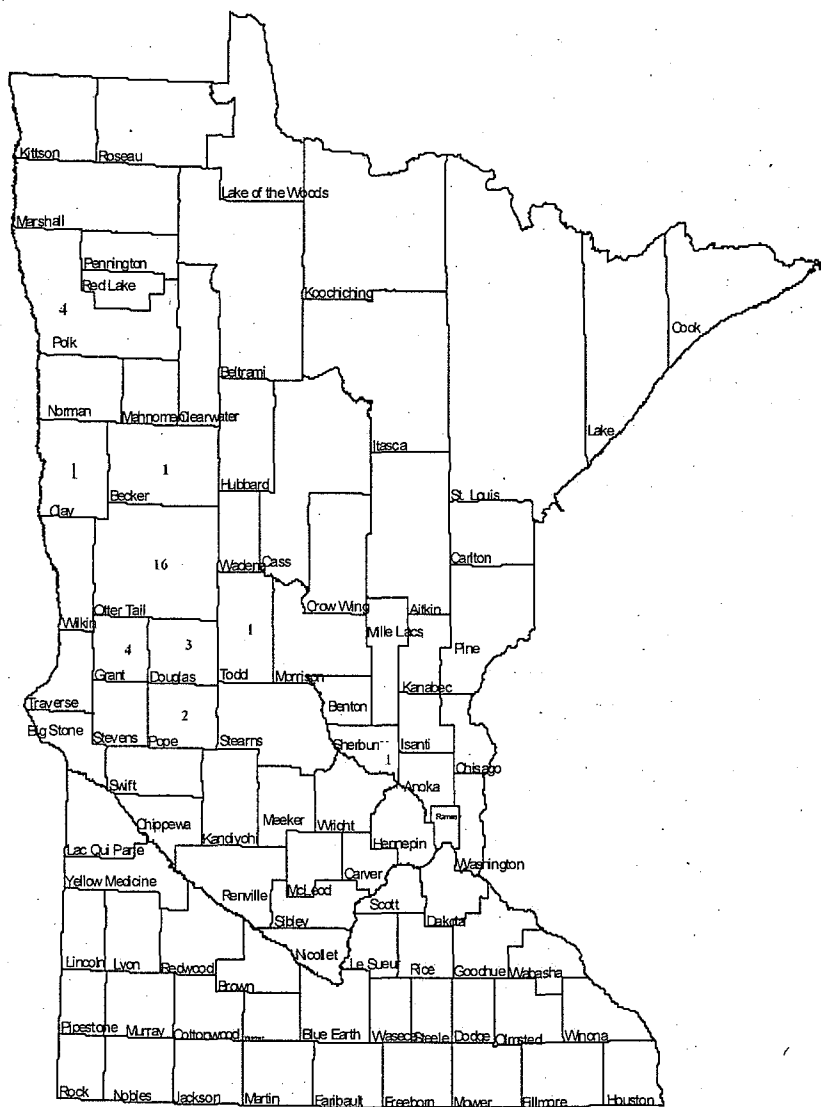


Figure 5. Distribution by County of ponds aerated under permits issued to private hatchery operators in 2005-06.

APPENDICES

Appendix 1. Private hatchery operators and protected waters under the permits 2005-06.

Permit #	Last Name	County	D.O.W.	Acres
Region 1				
F0561032	P. Koep	Douglas	21-74	17
			21-116	24
		Grant	26-141	62
		Otter Tail	56-714	59
			56-720	30
			56-136	34
			56-85	19
			56-258	21
			56-883	21
			56-155	21
			56-234	34
F0561038	Jeff Koep	Douglas	Gravel Pit	6
			26-8	31
		Grant	26-33	44
			56-1183	10
		Otter Tail	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
F0561042	Wertish	Polk	60-392	10
			60-157	41
			60-172	48
			60-141	46
F0561092	Joe Koep	Otter Tail	56-149	180
F0561103	Goeden	Becker	3-269	242
		Grant	26-114	93
F0561192	Scholtes	Clay	14-350	36
Region 3				
F0563100	McDonald	Sherburne	71-129	77

Appendix 2. Questionnaire results of aeration systems operated to prevent winterkill in lakes with or without public access, 2005-06.

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Polcon Helixors</u>								
Artichoke (6-2)	Big Stone	2,011	Save A Lake Aeration	2-15 HP motor/blowers 12 diffusers		did not return questionnaire		
					2,200.00	275.00	2.3	Y
East Toqua (6-138)	Big Stone	440	City of Graceville	1 diffuser 1-10 HP motor/blower				
Cl��ar (8-11)	Brown	325	New Ulm Area Sportfisherman	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	3,160.0	316.00	1.3	N
Hanska (8-26)	Brown	1,844	Lake Hanska Area Association	1-15 HP Helixor	1,840.0	186.05	1.8	N
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	-	-	2.8	N
Cottonwood (17-22)	Cottonwood	146	Cottonwood County Game & Fish League	1-5 HP motor/blower 3 diffusers	-	-	2.9	N
Rebecca (19-3)	Dakota	35	City of Hastings	1-5 HP blower 2 diffusers	2,233.0	147.02	3.1	N
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	8,596.0	642.00	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)
Polcon Helixors (Con't.)								
Round (27-71)	Hennepin	34	City of Eden Prairie	1-7.5 HP blower 1 diffuser		did not operate		
Loon (32-20)	Jackson	738	Jackson County Conservation League	2-7.5 HP motor/blowers 9 diffusers	8,300.0	575.00	2.2	N
Pearl (32-33)	Jackson	117	Jackson County Conservation League	1-7.5 HP blower 3 diffusers	10,400.0	700.00	1.8	N
Round (32-69)	Jackson	947	Round Lake Sportsmen's Club	2-7.5 HP motor/blowers 9 diffusers	1,780.0	124.41	0.8	N
East Solomon (34-246)	Kandiyohi	733	Kandiyohi County	1-10 HP motor 6 diffusers	18,334.0	1,188.53	2.7	N
Foot (34-181)	Kandiyohi	576	Willmar Parks Department	1-25 HP motor/blower 6 diffusers	31,561.0	2,188.88	2.5	N
Long (34-192)	Kandiyohi	1,715	Kandiyohi County	2-10 HP motors 12 diffusers	28,532.0	1,821.39	2.5	N
Mud (Monongalia) M Fk Crow R. (34-158)	Kandiyohi	2,516	Kandiyohi County	1-15 HP motor 6 diffusers	13,451.0	844.52	2.8	N
Ringo (34-172)	Kandiyohi	774	Kandiyohi County	1-10 HP motor 9 diffusers	11,457.0	798.31	2.2	N
Swenson (34-321)	Kandiyohi	123	Kandiyohi County	1-7.5 HP motor 5 diffusers	10,257.0	714.70	2.8	N
Wagonga (34-169)	Kandiyohi	1,792	Kandiyohi County	2-15 HP blowers 12 diffusers	38,300	2,409.71	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)
Polcon Helixors (Con't.)								
Willmar (34-180)	Kandiyohi	761	Willmar Public Works	1-15 HP blower 6 diffusers	18,977.0	1,353.39	2.5	N
Clear (40-79)	LeSueur	282	Lexington Sportsmen's Club	1-7.5 HP motor 3 diffusers		did not operate		
Gorman (40-32)	LeSueur	590	Izaak Walton League	1-7.5 HP compressor 3 diffusers		did not operate		
Greenleaf (40-20)	LeSueur	306	Montgomery Sportsmen's Club	1-5 HP compressor 3 diffusers		did not operate		
Cottonwood (42-14)	Lyon	383	Lyon County	1-15 HP motor 6 diffusers	-	500.00	1.2	N
East Twin (42-70)	Lyon	280	Lyon County	1-7 HP blower 2 diffusers		did not operate		
West Twin (42-74)	Lyon	237	Lyon County	1-7.0 HP motor/blower 2 diffusers		did not operate		
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	1-7HP blower 3 diffusers	-	-	2.3	N
Bloody (51-40)	Murray	248	Murray County	1-7.5 HP blower 2 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.)								
First Fulda (South) (51-21)	Murray	122	Murray County	2-7.5 HP motor/blowers 4 diffusers	-	-	1.7	N
Sarah (51-83)	Murray	1,176	Murray County	1-7.5 HP motor/blower 4 diffusers	-	-	1.3	N
East Graham (53-20)	Nobles	523	Nobles County Parks Department	1-10 HP blower 4 diffusers	-	-	0.5	N
Indian (53-7)	Nobles	204	Round Lake Sportsmen's Club	1-10 HP blower 4 diffusers	1,710.0	139.07	0.6	N
Okabena (53-28)	Nobles	785	City of Worthington	2-7.5 HP blowers 9 diffusers	16,468.0	1,160.79	2.3	N
West Graham (53-21)	Nobles	526	Nobles County Parks Department	2-7.5 HP blowers 6 diffusers	-	-	2.5	N
Cedar (70-91)	Scott	749	New Prague Sportsmen's Club	1-20 HP pump 12 Helixor diffusers	did not return questionnaire			
Becker (73-156)	Stearns	222	Sauk River Watershed District	1-15 HP blower 9 diffusers	16,571.00	1,800.36	2.3	N
Elysian (81-95)	Waseca	2,462	Smith's Mill-Janesville Sportsmen's Club	3-7.5 HP blowers 15 diffusers	-	50.00	-	N
Winona (85-11)	Winona	318	City of Winona	3-7.5 HP compressors 6 diffusers	54,891.0	3,419.21	4.0	N
Wood (87-30)	Yellow Medicine	484	Yellow Medicine County	1-15 HP compressor 6 diffusers	-	-	2.3	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Clean-Flo Systems</u>								
Shack Eddy (2-109)	Anoka	22	Armstrong Kennels	1-0.5 HP blower 1 diffuser			did not operate	
Crystal (7-98)	Blue Earth	396	Crystal and Loon Lake Rec., Inc.	2-0.75 HP compressors 4 diffusers			did not operate	
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			did not operate	
Lura (7-79)	Blue Earth	1,263	Lura Lake Aeration Corp.	1-5 HP & 1-4 HP Clean Flo, 12 diffusers			did not operate	
Alimagnet (19-21)	Dakota	113	City of Apple Valley	1-2 HP compressor 6 diffusers	-	250.00	0.7	N
Arrowhead (27-45)	Hennepin	23	City of Edina	1-1.5 HP compressor 3 diffusers	-	-	3.0	N
Crystal (27-34)	Hennepin	74	City of Robbinsdale	8-0.5 HP compressors 16 diffusers	-	-	4.0	N
Indianhead (27-44)	Hennepin	13	City of Edina	4-0.5 HP compressors 4 diffusers	-	-	3.0	N
Gleason (27-95)	Hennepin	167	Gleason Lake Improvement Assn	4-0.5 HP compressors 16 diffusers	-	-	3.2	N
Hadley (27-109)	Hennepin	39	Hadley Lake Improvement Assn	6-0.5 HP compressors 7 diffusers	-	1,800.00	3.5	N
Irene (27-189)	Hennepin	29		2-0.5 HP compressors 4 diffusers	9,480.00	900.00	-	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.)								
Sweeney-Twin (27-35)	Hennepin	96	Sweeney Lake Assn	3-0.5 HP to 7-0.75 HP compressors, 18 diffusers	-	1,466.70	4.0	N
Unnamed (Upper) (34-28)	Kandiyohi	22	City of Atwater	2-2 HP compressors 4 diffusers	3,056.0	594.81	3.1	N
Unnamed (Tadd) (34-376)	Kandiyohi	10	City of Atwater	2-2 HP compressors 4 diffusers	3,913.0	452.30	3.1	N
Mabel (40-11)	LeSueur	103	Lucky 13 Sportsmen's Club	2-0.5 compressors 4 diffusers	-	190.00	2.1	N
Unnamed (40-58)	LeSueur	18		1-0.75 compressor 2 diffusers,	-	200.00	4.0	N
Unnamed (58-141)	Pine	23		1-0.75 compressor 2 diffusers	-	-	2.8	N
Birch (62-24)	Ramsey	127	Birch Lake Improvement Assn	1-1 HP compressor 3 diffusers	did not return questionnaire			
Willow (62-40)	Ramsey	75	Natural Preserve Foundation	3-0.5 compressors 6 diffusers	-	-	3.3	Y
Cody (66-61)	Rice	257	Wheatland Twin Lakes Sportsmen's Club	4-0.5 and 2-0.75 HP compressors, 12 diffusers	12,062.0	1,102.00	2.6	N
Kronz (Sunset) (70-09)	Scott	15		1-HP compressor 2 diffusers	-	-	2.5	N
Unnamed (Fawn) (71-110)	Sherburne	33	Carefree Country Club	2-0.5 HP – 4 diffusers 1-0.75 HP – 2 diffusers	-	-	2.1	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Clean-Flo Systems (Con't.)</u>								
Loon (81-15)	Waseca	119	City of Waseca	1-5 HP compressor 9 diffusers	10,212.0	909.08	2.6	N
Benz (82-120)	Washington	36	Benz Lake Homeowners Association	3-0.75 HP, 1-0.33 HP 8 diffusers	-	-	3.9	N
Pinetree (82-122)	Washington	174		1-0.5 HP compressor 2 diffusers	4,110.0	300.00	4.0	N
Sunset (82-153)	Washington	124	Sunset Lake Homeowners Association	2-0.5 HP compressor 4 diffusers		did not operate		
Unnamed (82-330)	Washington	9		1-0.5 HP compressors 2 diffusers	1,300.0	100.0	4.0	N
<u>Other Bubblers</u>								
Bijou (3-638)	Becker	229	Cormorant Lake Sportsmen's Club	4-Wifle Webber diffusers 2-pumps		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 return questionnaire		
Mills (7-97)	Blue Earth	237	Crystal and Loon Lake Recreation	2-0.75 HP compressors 4 diffusers		did not operate		
Oak (10-93)	Carver	185		4-1 HP compressors 8 diffusers	-	-	3.4	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)
Other Bubblers (Con't.)								
Eagle (11-342)	Cass	110	Eagle Lake Association	1-0.5 HP pump 2 diffusers	0	149.60	2.1	N
Blue Eagle (14-93)	Clay	11	City of Barnesville	2-1/2 HP pumps 4 diffusers	-	-	3.0	N
Lake Fifteen (14-30)	Clay	128	Cormorant Lake Sportsmen's Club	2-1 HP motor 4 ceramic diffusers		did not return questionnaire		
Pine (15-149)	Clearwater	1,465	Red Lake Watershed District	Bubbler		did not return questionnaire		
Main (19-203)	Dakota	6	MN Zoological Gardens	0.75 HP compressor 16 diffusers		did not return questionnaire		
Rice (22-7)	Faribault	268	Wells Rifle & Pistol Club	2-0.75 compressors 9 diffusers	-	-	2.5	N
Albert Lea (24-14)	Freeborn	2,654	Freeborn County	2-1 HP compressors diffuser tubing		did not operate		
Scotch (40-109)	LeSueur	590	German-Jefferson Sportsmen's Club	2-0.75 compressors 9 diffusers	1,635.0	141.00	2.7	N
Marion (43-84)	McLeod	616	Brownton Rod and Gun Club	1-5 HP blower 3 mat diffusers	10,367.0	933.22	1.9	N
Shamineau (49-127)	Morrison	1,453		Regiair Vane blower 1.5 HP		did not return questionnaire		
Ocheda (53-24)	Nobles	1,778	Nobles County	1-0.5 HP portable blower	-	-	2.5	Y
Pete (56-294)	Otter Tail	34		1-0.75 HP compressor		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)
Other Bubblers (Con't.)								
Lena (58-18)	Pine	50	Lake Lena Acres Assn	2-0.25 HP bubbler	-	-	1.7	N
Cable (60-293)	Polk	129	Cable Lake Association	3-0.25 HP pump	2,988.0	179.28	2.7	N
Pleasant (62-46)	Ramsey	585	City of St. Paul Water Utility	2-30 HP compressors 2 diffusers	did not return questionnaire			
Ann (71-69)	Sherburne	226	Ann Lake Improvement Club, Inc.	1-.5 HP compressor 2 copper diffusers	did not operate			
Kohlmeier (74-19)	Steele	11	City of Owatonna	2-0.75 HP compressors 3 diffusers	-	-	3.0	N
Stocking (80-37)	Wadena	356	Stocking Lake Boosters, Inc.	2 Gast compressors 5 diffusers	-	250.00	4.8	N
Mud (Battle Creek) (82-91)	Washington	103	City of Woodbury	2-1 HP compressors 6 diffusers	2,157.0	225.43	1.9	N
Unnamed Pond (82-257)	Washington	7		0.50 HP blower 2 diffusers	-	-	4.5	N
Pump and Baffle								
Centerville (2-6)	Anoka	464	Anoka County Parks and Recreation Dept.	1-20 HP pump and baffle	did not operate			
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)
<u>Pump and Baffle (Con't.)</u>								
Golden (2-45)	Anoka	50	City of Circle Pines	1-7.5 HP permanent pump and baffle	18,591.3	1,644.61	4.0	N
Martin (2-34)	Anoka	218	Anoka County Parks and Recreation	1-10 HP pump and baffle		did not operate		
Moore, West (2-75)	Anoka	110	City of Fridley	1-10 HP pump and baffle	-	-	4.6	N
Peltier (2-4)	Anoka	483	Anoka County Parks and Recreation	1-20 HP pump and baffle		did not operate		
Wolf (3-101)	Becker	1,453	Wolf Lake Sportsmen's Club	2-10 HP pump and baffle		did not return questionnaire		
Susan (10-13)	Carver	93	City of Chanhassen	1-7.5 HP pump and baffle		did not operate		
Platte (18-88)	Crow Wing	1,486	Platte Lake Association	1-7.5 HP pump and baffle		did not operate		
Marion (19-26)	Dakota	489	City of Lakeville	1 pump and baffle 20 HP homemade		did not operate		
Roger's (19-80)	Dakota	116	City of Mendota Heights	1-10 HP pump and baffle	13,888.0	1,040.00	2.4	N
Hyland (27-48)	Hennepin	87	Three Rivers Park District	Permanently install. 7.5 HP pumps		did not return questionnaire		
Mitchell (27-70)	Hennepin	116	City of Eden Prairie	1-7.5 HP Crisafulli pump and baffle		did not return questionnaire		

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Pump and Baffle (Con't.)</u>								
Penn (27-4)	Hennepin	47	City of Bloomington	15 HP pump and baffle	27,867.0	1,955.74	2.8	N
Powderhorn (27-14)	Hennepin	11	Mpls. Park & Recr. Board	Pump and baffle 4HP		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 & Recr. Board	1-5.0 HP pump and baffle		did not return questionnaire		
Wolfe (27-664)	Hennepin	3	City of St. Louis Park	Built in waterfall— 5 HP	566.7	63.30	4	N
Wolf (29-81)	Hubbard	274		1-5 HP pump and baffle	-	600.00	2.6	N
Knife (33-28)	Kanabec	1,127	Knife Lake Improvement District	1-10 HP pump and baffle 1-20 HP pump and baffle		did not operate		
Unnamed (Florian Res.) (45-119)	Marshall	42	Marshall County Park Board	1-9 HP pump and baffle		did not return questionnaire		
Jennie (47-15)	Meeker	1,089	Lake Jennie Improvement Corp.	1 pump and baffle system 2,000 gpm pump		did not operate		
Adley (56-31)	Otter Tail	249	Parker's Prairie Sportsmen's Club	1-15 HP pump and baffle	-	1,400.00	2.7	N
Fish (56-66)	Otter Tail	500	Parkers Prairie Sportsmen's Club	10-HP pump and baffle	-	950.00	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)
<u>Pump and Baffle (Con't.)</u>								
Badger (60-214)	Polk	247	Erskine Lions Club	CORE Project pump and baffle			did not operate	
Maple (60-305)	Polk	1,445	Maple Lake Improvement District	3-5 HP pump and baffle	6,792.0	427.56	1.2	N
Pelican (61-111)	Pope	516	Pelican Lake Association, Inc.	1-20 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	-	-	3.4	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	4,030.0	290.00	1.2	N
Silver (62-83)	Ramsey	67	City of Columbia Heights	1-10 HP pump and baffle	286.0	740.00	2.0	Y
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 operate.	

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Pump and Baffle (Con't.)</u>								
Hattie (75-200)	Stevens	488	Save A Lake Aeration, Inc.	1-10 HP pump and baffle				did not return questionnaire
Goose (82-59)	Washington	83	Town of New Scandia	1-3 HP pump and baffle	2,275.0	294.36	2.4	N
Shields (82-162)	Washington	27	City of Forest Lake	CORE pump and baffle 3 HP	5,233.0	455.40	1.6	N
<u>Aire-02</u>								
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 tornadoes				did not operate
Ham (2-53)	Anoka	193	Anoka County Parks	3-2 HP Aeromix tornadoes				did not operate
Spring (2-71)	Anoka	37	City of Spring Lake Park	1-2 HP Aeromix	-	-	1.9	N
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	35,409.0	3,397.49	2.6	N
Loon (11-226)	Cass	220	Loon Lake Property Owners	2-2 HP Aeromix tornadoes	6,205.0	572.00	2.5	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)
<u>Aire-02 (Con't.)</u>								
Blackhawk (19-59)	Dakota	39	City of Eagan	1-2 HP air injection system				did not return questionnaire
Burr Oak (19-259)	Dakota	19	City of Eagan	1-2 HP pump				did not return questionnaire
Farquar (19-23)	Dakota	74	City of Apple Valley	1-2 HP air injection system				did not operate
Fish (19-57)	Dakota	28	City of Eagan	1-2 HP air injection system				did not return questionnaire
Gun Club (19-245)	Dakota	8	City of Inver Grove Heights	1-2 HP Aeromix tornado				did not return questionnaire
Hay (19-62)	Dakota	20	City of Eagan	1-2 HP air pump				did not return questionnaire
Heine (19-153)	Dakota	7	City of Eagan	1-2 HP pump				did not return questionnaire
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
Pickrel (19-79)	Dakota	51	City of St. Paul	1-2 HP Neptune pump	-	-	-	Y
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

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)
Air-02 (Con't.)								
Thompson (19-48)	Dakota	10	Dakota County Parks	1-2 HP Neptune pump	-	50.00	0.7	N
Unnamed (Schwartz) (19-63)	Dakota	13	City of Eagan	1-2 HP air injection pump	did not return questionnaire			
Aldrich (21-222)	Douglas	173		2-2 HP Aeromix tornadoes	-	1,340.00	4.3	N
Albert Lea (24-14)	Freeborn	2,654	Shellrock River Watershed District	2-Aeromix systems	did not operate			
Pottery Pond (25-38)	Goodhue	8	City of Red Wing	Kasco aeration 1-0.75 HP	300.0	216.00	1.0	N
Bass (27-98)	Hennepin	175	Bass Lake Improvement Assn	2-2 HP Aire-02	did not operate			
Rebecca (27-192)	Hennepin	290	Three Rivers Park District	3-2 HP Aire-02 aerators	did not return questionnaire			
Rice (27-116)	Hennepin	306	Rice Lake Area Association	1-2 HP Aire-02	did not 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 operate			
Elizabeth (34-22)	Kandiyohi	1,153	Kandiyohi County	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)
Aire-02 (Con't.)								
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				did not operate
Shaokotan (41-89)	Lincoln	1,043	Shaokotan Sportsmen's Club	2-2 HP Power House Aerators	1,200.0	650.00	4.0	N
Stay (41-34)	Lincoln	220	Arco Sportsmen's Club	2-2 HP Aeromix tornadoes				did not return questionnaire
Clear (42-55)	Lyon	68	Lyon County	1-2 HP Aire-02	2,390.0	367.00	-	N
East Goose (42-93)	Lyon	151	Lyon County	2-2 hp Aire-02	760.0	251.00	2.0	N
Lady Slipper (42-20)	Lyon	262	Lyon County	2-2 HP Aeromix tornadoes				did not operate
Rock (42-52)	Lyon	422	Lyon County	2-2 HP Aire-02	1,813.0	326.00	-	N
School Grove (42-2)	Lyon	333	Lyon County	2-3 HP Aire-02				did not operate
Yankton (42-27)	Lyon	382	Lyon County	3-3 HP Aire-02	2,500.0	250.00	2.0	N
Big Twin (46-133)	Martin	457	Trimont Area Conservation Club	2-1 HP Aire-02				did not return questionnaire
Buffalo (46-146)	Martin	116	Mt. Lake-Odin-Ormsby Sportsmen's Club	1-3 HP Aire-02				did not return questionnaire

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
Aire-02 (Con't.)								
Cedar (46-121)	Martin	710	Trimont Area Conservation Club	1-2 HP Aire-02		did not return questionnaire		
Fish (46-145)	Martin	156	Watowwan Game and Fish	1-2 HP Aire-02	1,800.0	136.00	1.9	N
Winsted (43-12)	McLeod	407	City of Winsted	6-2 HP Aire-02		did not operate		
Star (47-129)	Meeker	554	Star Lake Association	3-2 HP Aire-02	-	-	1.2	N
Corabelle (51-54)	Murray	99	Murray County	1-2 HP Aire-02		did not operate		
Kinbrae (53-16)	Nobles	87	Nobles County Park	1-1 HP Aeromix tornado	-	-	2.5	N
Tamarac (59-931)	Otter Tail	416	Tamarac Lake Association	2-2 HP aspirating aerators	7,850.0	714.81	3.0	N
Split Rock (59-1)	Pipestone	80	Split Rock Creek State Park	2-2 HP Aeromix tornadoes		did not operate		
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		
Otter (2-3)	Ramsey/Anoka	173	Ramsey County Public Works	3-2 HP Aeromix tornadoes	3,227.0	250.00	2.2	N
Circle (66-27)	Rice	976	Tri-Lakes Sportsmen's Club	3-2 HP Aeromix tornadoes	10,000.0	1,000.00	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)
Aire-02 (Con't.)								
O'Dowd (70-95)	Scott	256	O'Dowd Lakes Chain Assn	3-2 HP Aire-02	4,200.0	300.00	2.6	N
Thole (70-120)	Scott	131	O'Dowd Lakes Chain Association	1-2 HP Aire-02	3,090.0	285.00	2.6	N
McColl (70-17)	Scott	20	City of Savage	2-2 HP Aeromix tornadoes		did not operate		
Murphy (70-10)	Scott	70	Hennepin Parks	2-2 HP Aeromix tornadoes		did not return questionnaire		
Birch (71-57)	Sherburne	149	Birch Lake Association	1-2 HP Aire-02		did not return questionnaire		
Fremont (71-16)	Sherburne	466	City of Zimmerman	2-2 HP Aire-02's	3,298.0	311.70	2.1	N
Silver (72-13)	Sibley	697	Silver Lake Conservation Club	3-2 HP Aire-02	6,895.0	367.61	2.0	N
Black Oak (73-241)	Stearns	121	Green Grove Sportsmen's Club	1-2 HP Aire-02	-	180.00	1.4	N
Unnamed (Cloverdale) (82-9)	Washington	39	Cloverdale Farms	2-1 HP Aeromix systems		did not return questionnaire		
McDonald (82-10)	Washington	37		1-1 HP Aeromix tornado		did not return questionnaire		
Sand (82-67)	Washington	46	Sand Lake Lakeshore Association	1-2 HP Aeromix tornado		did not operate		

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Aire-02 (Con't.)</u>								
Kansas (83-36)	Watonwan	388	Watonwan Game and Fish Club	3-2 HP Aire-02		did not operate		
St. James (83-43)	Watonwan	252	Watonwan Game and Fish Club	2-2 HP Aire-02	2,490.0	209.91	2.8	N
Fedji (83-21)	Watonwan	179	Madelia Sportsmen's Club	3-1 HP Powerhouse systems	-	360.00	2.5	N
Crawford (86-46)	Wright	117	Crawford Lake Improvement Assn	2-2 HP Aire-02	3,890.0	315.09	2.4	N
Dean (86-41)	Wright	204	Dean Lake Club 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		did not return questionnaire		
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		
<u>Sprayers</u>								
Lakefront Park Pond (70-169)	Scott	13	City of Prior Lake	3 HP Otterbine	-	333.33	4.0	N
Dullinger (73-103)	Stearns	21		1-1 HP Kallep floating aerator	-	-	2.5	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)
Mixed Systems								
Mountain (17-3)	Cottonwood	241	Mountain Lakes Area Sportsmen's Club	5-0.5 HP compressors 2-2 HP Aeromix Tornadoes	-	-	3.0	N
Carlson (19-66)	Dakota	14	City of Eagan	1-3 HP lift station Air injection pump	did not return questionnaire			
Snelling (27-1)	Hennepin	110	Fort Snelling State Park	2-5 HP sump pumps	-	-	1.3	N
Clear (32-22)	Jackson	415	Jackson County Conservation League	2-5 HP motor/blowers 6 diffusers, 3-3 HP Ice Eaters	4,790.0	341.00	0.8	N
Independence (32-17)	Jackson	97	Jackson County Conservation League	1-5 HP Helixor 3-3 HP Ice Eater	5,570.0	470.0	1.4	N
Little Spirit (32-24)	Jackson	634	Little Spirit Lake Conservation Club	2-7.5 HP motors 6 diffusers; 3-3 HP Ice Eaters	8,780.0	881.00	1.3	N
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)	Murray	3,596	Murray County	3-7.5 HP motor/blowers 12 diffusers, 2 Ice Eaters	-	-	1.6	N
Perch (56-95)	Otter Tail	57		1-0.75 HP, 1 diffuser 1 pusher	did not return questionnaire			
Bennett (62-48)	Ramsey	41	Roseville Parks and Recr.	3-0.5 HP blower and 6 diffusers, baffle system	9,639.0	3,951.00	4.0	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Hypolimnetic Aerators</u>								
Moore (East) (2-75)	Anoka	110	City of Fridley	1-7.5 HP Palatek compressor	-	-	-	N
Como (62-55)	Ramsey	69	Ramsey County Public Works Dept.	1-7.5 HP Hypo system	16,451.0	1,226.00	2.8	N
Vadnais (62-38)	Ramsey	477	City of St. Paul Water Utility	2-30.0 HP Atlas Copco	did not return questionnaire			
Marie (Maria) (73-14)	Stearns	145	Clearwater River Watershed District	1-15 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			
<u>Other (Mechanical Surface Agitators, homemade, etc.)</u>								
Leech (11-203)	Cass		Coborn's Leech Lake Cruises	2-3/4 HP Kasco de-icers	did not return questionnaire			
Bean (17-54)	Cottonwood	141	Red Rock Sportsmen's Club	1-5 HP Ice Eater	did not operate			
Double (17-56)	Cottonwood	227	Red Rock Sportsmen's Club	1-5 HP Ice Eater	-	-	2.0	N
South Double (17-56)	Cottonwood	227	Red Rock Sportsmen's Club	1-5 HP Ice Eater	-	-	2.0	N
Talcott (17-60)	Cottonwood	928	Red Rock Sportsmen's Club	1-5 HP Ice Eater	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)
Other (Mechanical Surface Agitators, homemade, etc.) (Con't.)								
Nisswa (18-399)	Crow Wing	213		1-3/4 HP Ice Eater	-	-	3.6	N
Silver (40-48)	LeSueur	17	N. Elysian Silver Lakers Sportsmen's Club	1-0.75 HP motored propeller	1,991.0	170.00	2.9	N
Benton (41-43)	Lincoln	2,875	Lake Benton Sportsmen's Club	5-2 HP Ice Eaters		did not operate		
Budd (46-30)	Martin	224	City of Fairmont	Water plant pumps		did not operate		
Buffalo (51-18)	Murray	124	Murray County	2-0.75 HP Ice Eaters		did not operate		
Currant (51-82)	Murray	394	Murray County	3-0.75 HP Ice Eaters		did not operate		
Lime (51-24)	Murray	316	Murray County	3-0.75 HP Ice Eaters	-	-	1.9	N
Louisa (51-6)	Murray	211	Murray County	1-0.75 HP Ice Eater		did not operate		
Wilson (51-81)	Murray	164	Murray County	1-0.75 HP Ice Eater	-	-	2.1	N
Wilson (South) (51-81)	Murray	164	Murray County	1-0.75 HP Ice Eater	-	-	2.1	N
Community Center Pond (62-63)	Ramsey	2	City of Shoreview	3-1 HP Kasco agitators		did not operate		

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Other (Mechanical Surface Agitators, homemade, etc.) (Con't.)</u>								
Legends (70-287)	Scott	29	Legends Club	1-HP Aqua control surface pump	-	-	4.0	N
Masford (71-126)	Sherburne	90	DNR Fisheries	2-1 HP mechanical surface agitators	did not return questionnaire			

