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

**Aeration Permit Program Annual Report
2004-2005**

STAFF REPORT 39

2006

**Aeration Permit Program Annual Report
2004-2005**

by

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2006

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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 which 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 2004-05 permit year (1 October 2004 – 30 September 2005). 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 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 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.

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). On the average, about 125 lakes statewide are opened to "liberalized fishing" each year. Last winter (2004-05), one lake was opened to "liberalized fishing" (Figure 1).

The DNR underwent a reorganization of its regional boundaries in 2002, reducing the number of regions from six to four. The Brainerd region was split between the Bemidji, Grand Rapids and Metro regions, whereas, the Rochester region was combined with New Ulm. Some of the regions were renamed. The Metro region became Region III, also known as the Central Region, and the New Ulm/Rochester offices became the Southern Region or Region IV.

A total of 285 aeration permits were issued during the 2004-05 season. This includes 269 renewals (98% of the permits issued) and sixteen (16) new permits. Five permittees from the previous season (2003-04) did not reapply for aeration permits in 2004-05.

The overall trend has been a steady increase in the number of permits issued in the last twenty-five years, with a decrease in permit numbers occurring last year (Figure 2). The same trend is true for most of the regions as well, except for Region I, which exhibited a reduction in permit numbers relative to permit numbers in 2001. The increase in permit

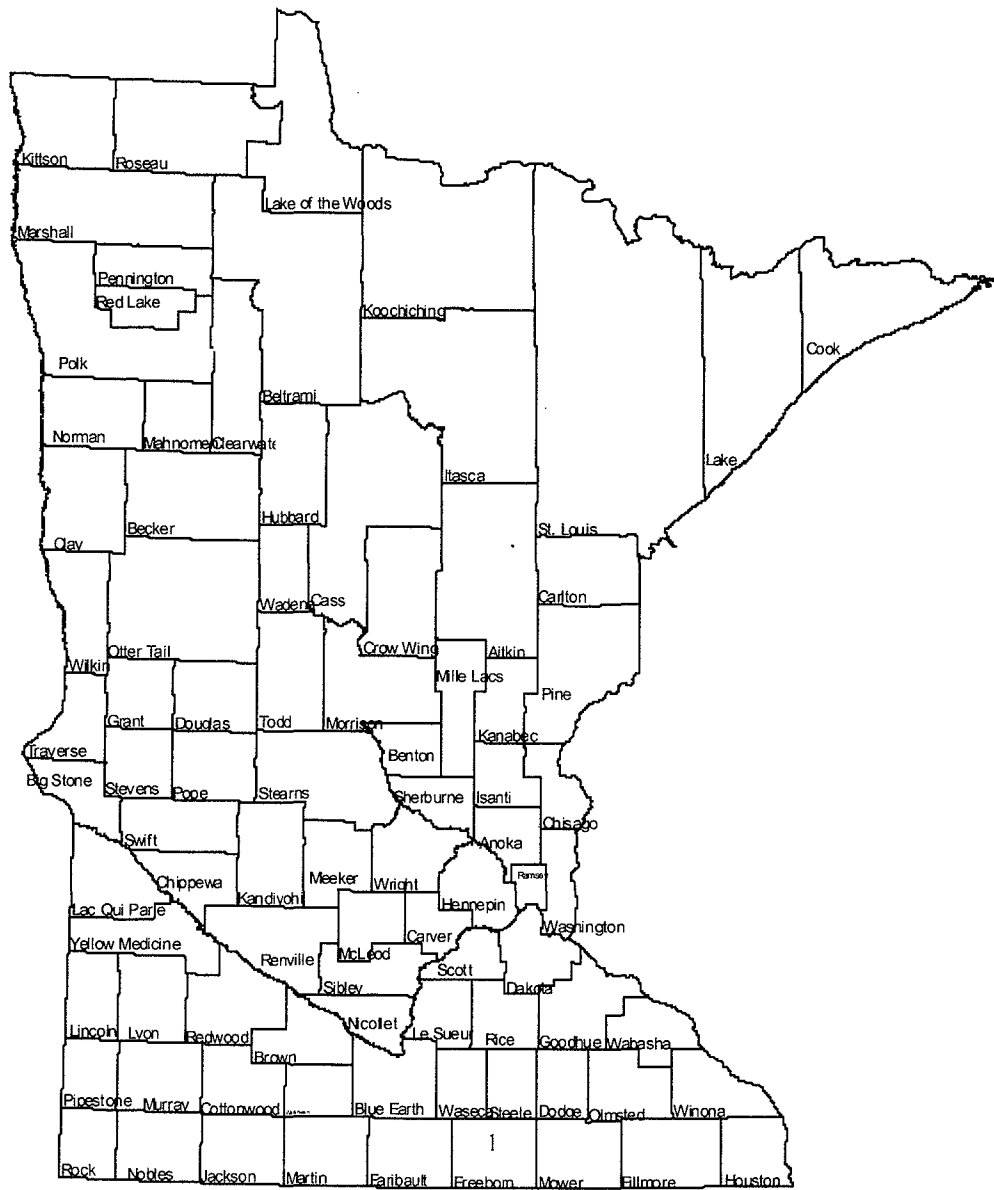


Figure 1. Number of lakes opened to “liberalized” fishing, by county, for the winter of 2004-05.

numbers in Region III since 2001 is due to the inclusion of permits from the old Brainerd region (Figure 3).

The 285 permits issued in 2004-05 authorized aeration in 290 lakes, of which 176 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 145,697 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 36 of these lakes, Aire O₂ units were operated in 30 lakes, mechanical surface agitators operated in 21 lakes, and diffuser systems operated in 64 lakes. Bait dealers and commercial hatchery operations were permitted to operate in 34 public water bodies totaling 1,729 acres. One hundred eleven (111) 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 2004-05.

There have been seven fatalities at aeration system sites, the last occurring in 1999. No deaths resulted from accidents at aeration system sites in 2004-05.

REGIONAL AERATION SUMMARY

REGION I (Bemidji)

There were 60 aeration permits issued in Region 1 during the 2004-05 season, 21% of the total number of permits issued. Of the 60 permits issued, 53 (88%) were renewals and seven were new permits.

The 60 permits issued in Region I authorized aeration in 72 public waters, or 20.7% of the total public waters aerated statewide. Private hatchery operators accounted for 45.8% of the permitted aeration water bodies in Region I. Private hatchery operators received six permits for 33 (1,652 acres) public waters (11.4% 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 12 aeration permits to prevent winterkill in 12 lakes (7,032 acres) with public access. Twenty-six aeration permits were issued to private individuals on ten lakes (30,017 acres) to prevent shoreline property damage due to ice expansion. Five permits were issued to the State covering 9,381 acres. Seven other aeration permits were issued to private groups to prevent winterkill in seven public waters (630 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.

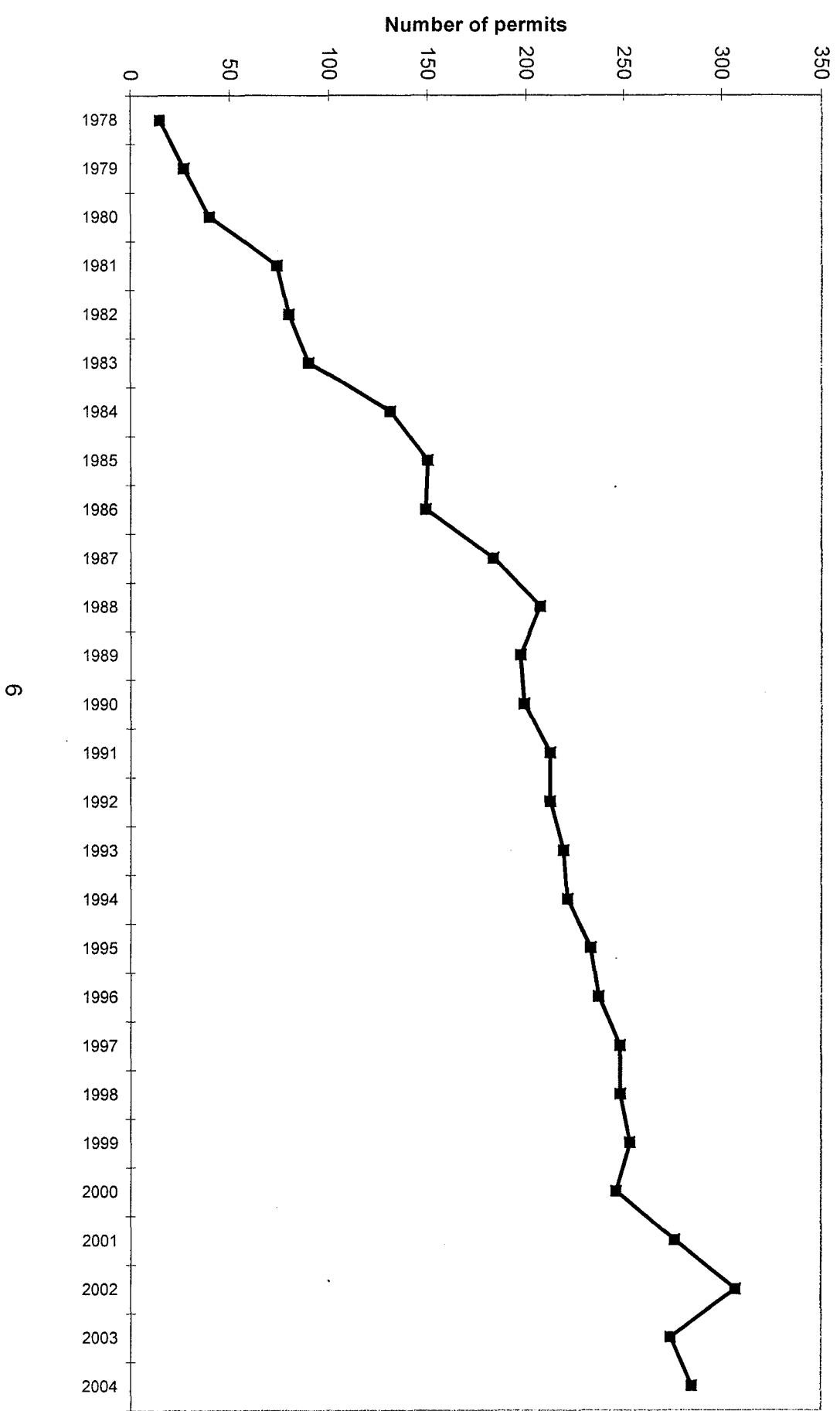
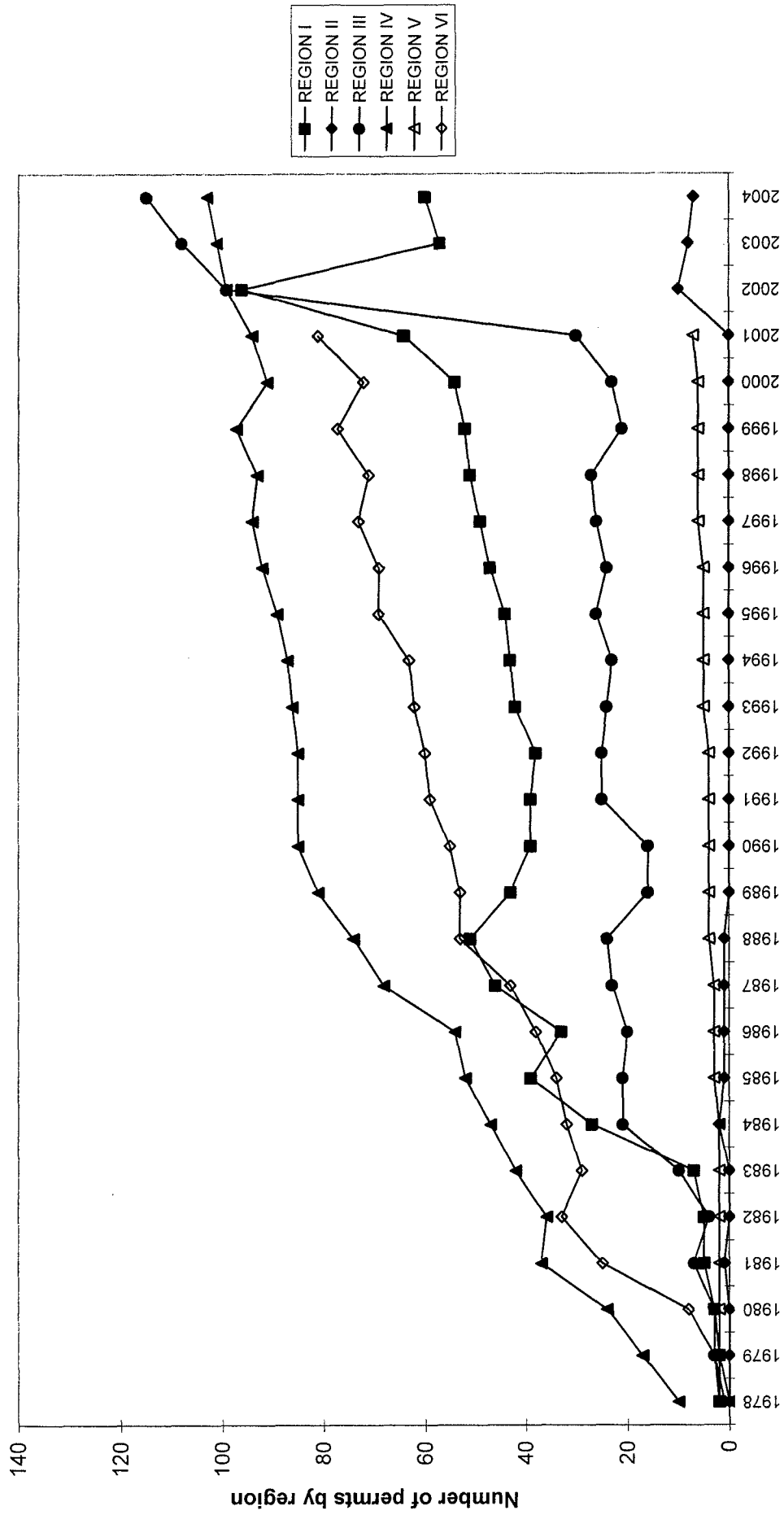


Figure 2. Trends in lake aeration permits issued 1978-2004

Figure 3. Aeration permits issued by DNR region, 1978-2004



*DNR underwent reorganization of regions from six to four.

Table 1. Aerated Acres 2004-05.

ACRES	REGION 1	REGION 2	REGION 3	REGION 4	OVERALL
Lakes with public access	44,328	859	21,091	70,145	136,423
Lakes without public access	6,056	260	1,703	1,255	9,274
TOTAL	50,384	1,119	22,794	71,400	145,697

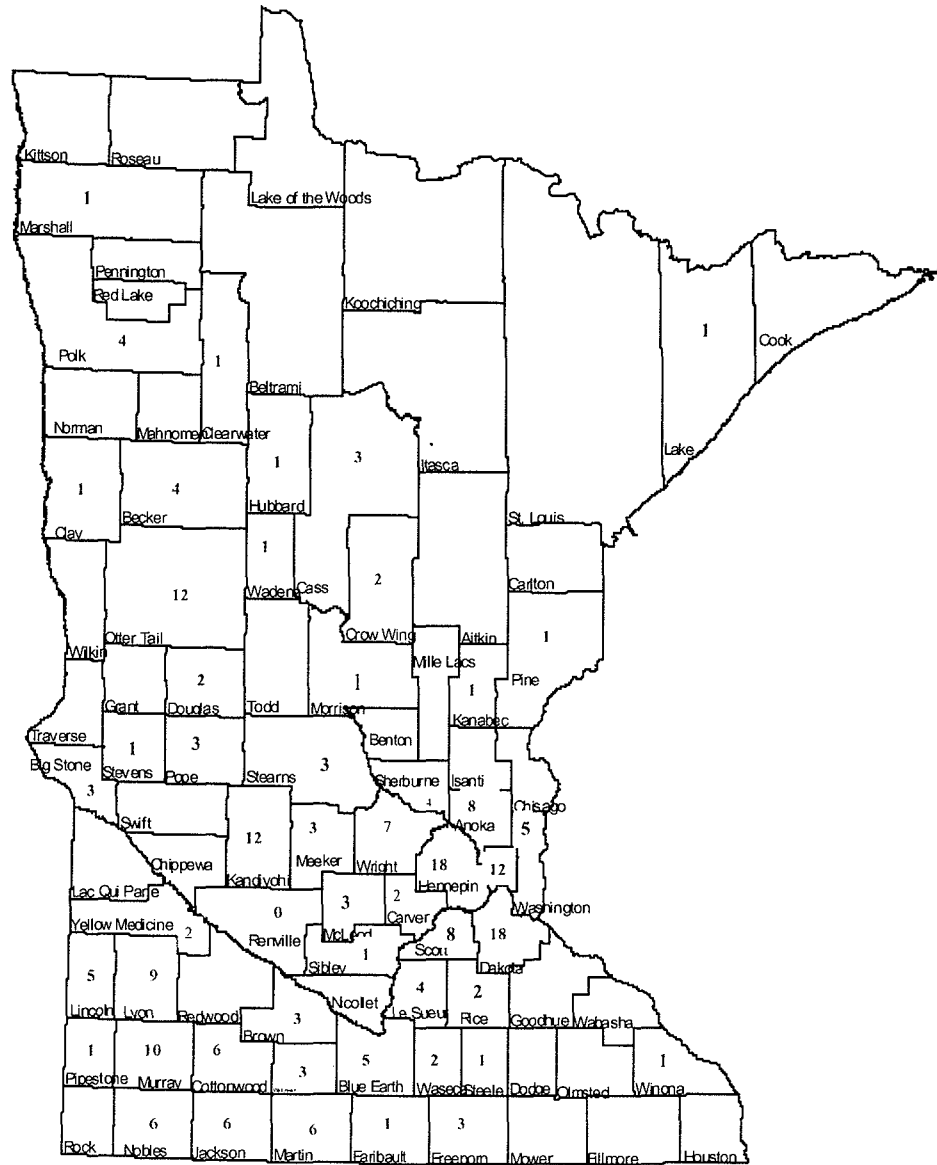


Figure 4. Number of lakes with public access, by county, issued aeration permits in 2004-2005.

Table 2. 2004-05 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	8	4	2	1	33	6	8	26	16	13	60 (21%)
II	2	2	0	0	0	0	0	1	2	3	3	7 (2.5%)
III	66	12	51	1	2	1	1	1	2	45	46	115 (40.4%)
IV	93	42	50	0	1	0	0	0	0	6	10	103 (36.1%)
Totals	176	64	105	3	4	34	7	10	30	70	72	285

		Lakes	Acres	Permits
Protected waters with access for winterkill prevention	=	176	77,588	176
Protected waters under permit to Bait Dealers	=	34	1,652	7
Shoreline Protection	=	10	33,850	30
Other**	=	70	32,607	72
		<u>290</u>	<u>145,697</u>	<u>285</u>

Total number of permits for protected waters with access for winterkill prevention = 176

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

285 total permits, new permits = 16

03-04 permits not reissued = 5

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

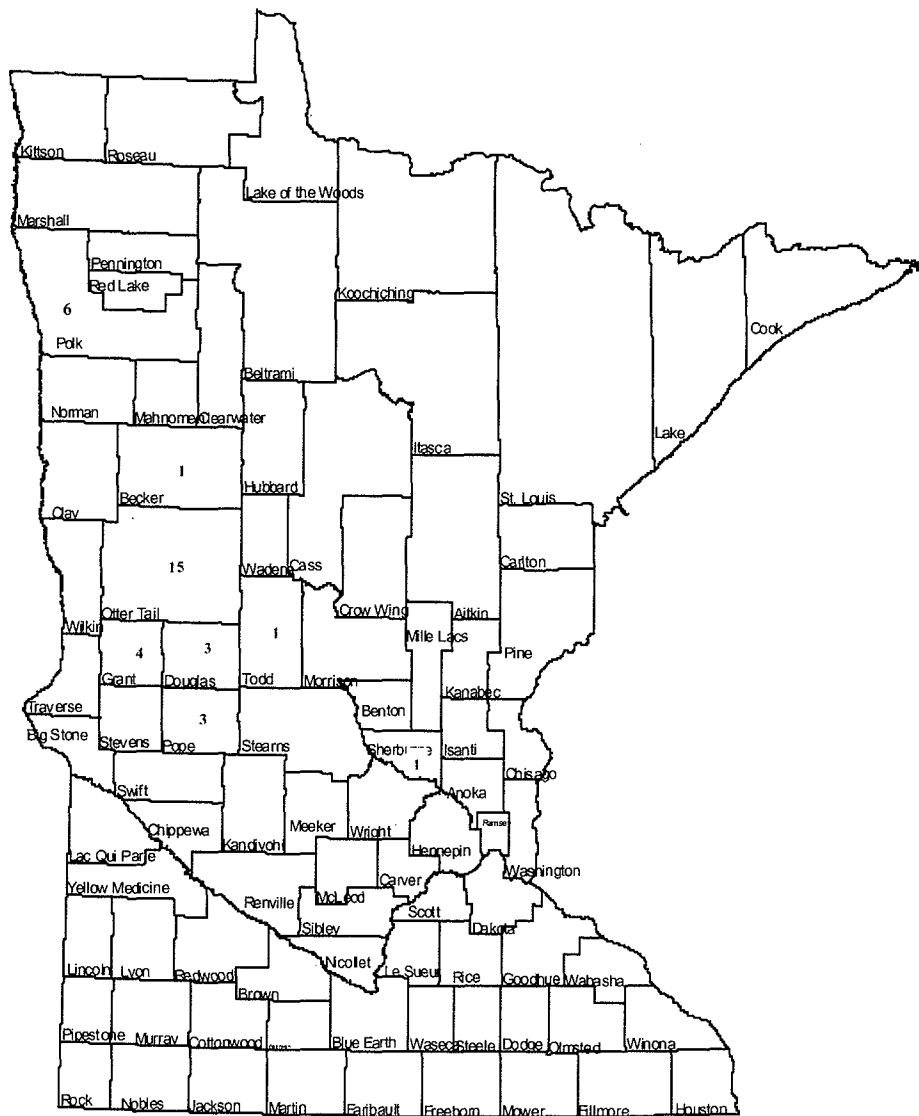


Figure 5. Distribution by County of ponds aerated under permits issued to private hatchery operators in 2004-05

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 2004. Most of these permits were absorbed from old Region III. One permittee did not renew their permit. There were no new permits requested.

Of these seven permits, 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 115 aeration permits issued for 113 lakes/ponds (22,794 acres) in Region III last season (40.3% of the total number of permits issued), 108 renewals (100%), and seven 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 pollution 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-four permits were issued to municipalities for operation of aeration systems in 63 lakes (8,362 acres) with public access. Four permits (603 acres) were issued to municipalities for lakes without public access. Sixteen permits (4,610 acres) were issued to clubs for lakes with public access and six permits (438 acres) were issued to clubs operating aeration systems in lakes without public access. Seventeen permits for 17 lakes (7,546 acres) were issued to private individuals. The Minnesota Zoological Garden received two permits to operate four aeration systems (23 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 36.1% of the permits issued statewide. Last season, 103 permits (72,731 acres) were issued in Region IV; 98 were renewals (97%). Three permits were not renewed from the previous year, whereas, five new permits were issued. The 103 aeration permits issued in Region IV authorized the aeration of 99 public waters. Lakes

Table 3. Region I lakes with public access aerated to prevent winterkill, 2004-05.

County	Permittee			Total No. of lakes	Total Acres	Average Size (acres)
	C	M	S			
Becker	1	0	0	1	1,453	1,453
Clay	0	1	0	1	11	11
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	0	0	0	0	0	0
Totals	8	4	2	14	8,206	N/A

Lakes with public access aerated to prevent winterkill	=	14 (C = 8; M = 4; S = 2)
Total Acreage	=	8,206
Average lake size (acres)	=	586.1
Permits issued to Municipalities for lakes with access	=	5 (3,199 acres)
Permits issued to Clubs for lakes with access	=	8 (5,194 acres)
Permits issued to the State w/access	=	3 (4,977 acres)
Permits issued for shoreline protection	=	26 (10 lakes; 30,017 acres)
Melissa Lake – 1,827 acres – 5 permits		Fish Lake – 284 acres – 1 permit
Lida Lake – 7,277 acres – 4 permits		Big Cormorant Lake – 3,380 acres – 3 permits
Lizzie Lake – 4,145 acres – 3 permits		Pelican – 4,314 acres – 5 permits
Little McDonald Lake – 1,506 acres – 2 permits		Marion – 1,610 acres – 1 permit
Rush – 5,340 acres – 1 permit		Paul – 334 acres – 1 permit
Permits issued to Bait Dealers, & P. Hatchery operators	=	6 (33 ponds; 1,652 acres)
Permits issued to private individuals to prevent winterkill for lakes without access	=	7 (630 acres)
Permits issued to the State without access	=	2 (4,404 acres)
Permits issued to private individuals to improve water quality for lakes with access	=	2 (1,892 acres)
Permits issued to private individuals for pond without Access	=	1 (29 acres)
Total Permits issued	=	60 (51,994 acres) in 72 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 2004-05.

County	Total No. of Ponds	Total Acres	Average Size Pond (Acres) Per County
Becker	1	242	242.0
Douglas	3	47	15.6
Grant	4	230	57.5
Otter Tail	15	666	44.4
Polk	6	242	40.3
Pope	3	157	52.3
Todd	1	69	69.0
Totals	33	1,652	N/A

Averages:

Bait dealers permitted	=	6 (6 permits)
Average number of ponds/permit	=	5.5
Average size of ponds	=	50.1 acres (range 6 to 242 acres)
Average number of acres/permit	=	275.3

Table 5. Region II lakes with public access aerated to prevent winterkill, 2004-05.

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
 (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, 2004-05.

County	Permittee				Total No. of lakes	Total Acres	Average Size (acres)
	C	M	P	S			
Anoka	0	8	0	0	8	3,155	394.4
Carver	0	2	0	0	2	323	161.5
Dakota	0	16	0	0	16	992	62.0
Hennepin	1	9	0	1	11	1,007	91.5
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	11,216	N/A

Lakes with public access aerated to prevent winterkill	=	65
Total Acreage	=	11,216
Average lake size (acres)	=	172.5
Permits issued to Municipalities for lakes without access	=	4 (603 acres)
Permits issued to Municipalities for lakes with access	=	64 (8,362 acres)
Permits issued to Clubs for lakes with access	=	16 (4,610 acres)
Permits issued to Clubs for lakes without access	=	6 (438 acres)
Privately operated systems for lakes with access	=	5 (7,050 acres)
Privately operated systems for lakes without access	=	12 (496 acres)
Private Hatchery Operator permits for lakes with access	=	1 (77 acres)
Permits issued to State with access (2 permits in Moore Lake) (2 permits in Pine Tree Lake)	=	4 (1,069 acres)
Permits issued to State without access	=	3 (89 acres)
Total Permits issued	=	115 (22,794 total acres in 113 lakes/ponds)

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

are less common in this area of the state and most 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 permits were issued to 87 lakes (56,460 acres) with public access to prevent winterkill of fish by private organizations and municipalities. 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, three 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.

Table 7. Region IV lakes with public access aerated to prevent winterkill 2004-05.

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	5	0	0	0	5	2,834	566.8
Brown	2	2	0	0	3	2,459	819.7
Cottonwood	2	0	0	0	2	420	210.0
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	10	0	0	10	10,143	1,014.3
LeSueur	3	0	0	0	3	1,178	392.7
Lincoln	5	0	0	0	5	6,327	1265.4
Lyon	0	9	0	0	9	2,518	279.8
Martin	3	3	0	0	6	1,768	294.6
McLeod	2	1	0	0	3	1,505	501.6
Meeker	2	0	1	0	3	1,863	621.0
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
Renville	0	0	0	0	0	0	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	42	50	1	0	90	56,460	N/A

Lakes with public access aerated to prevent winterkill	=	90
Total Acreage	=	56,460
Average lake size (acres)	=	627.3
Permits issued to Municipalities for lakes with access	=	53 (30,566 acres) (2 permits for Albert Lea Lake)
Permits issued to Clubs for lakes with access	=	43 (26,265 acres) (2 permits for Double, Hanska & Wilson 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 (8.0 acres)
Permits issued to State for lakes without public access	=	2 (2,458 acres)
Total Permits Issued 04-05	=	103 (72,731 acres; 99 lakes)

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

QUESTIONNAIRE RESULTS

Completed questionnaires were received from 245 of 285 permittees, a 86% 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. Submerged diffuser type systems were more popular than pump and baffle systems. Surface air injection systems ranked third in popularity. Eighty-six (86) respondents indicated their aeration system was not operated last winter. The average cost for insurance (n=56) was \$438.00. This figure includes all permittees operating an aeration system in lakes with or without public access. The range in insurance premiums for the 2004-05 season was \$25.00-\$1,200.00. Two respondents indicated there was difficulty in acquiring the required insurance.

One hundred fifty-nine (159) of the respondents indicated their aeration system was operated last winter and 42 of those indicated that waterfowl overwintered on the lake. Of these, seven respondents are located in Region 1, one in Region II, 21 in Region III, and 13 in Region IV. An estimated 5,300 waterfowl used the open water areas provided by aeration systems (range 2-600). Most of the birds were mallards and Canada geese.

Of the 159 permittees that responded and operated their systems last winter, 153 (96%) indicated they were satisfied with system performance. Ninety-six percent of permittees operating Clean-Flo systems indicated they were satisfied with their systems' performance. One hundred percent of the permittees operating pump and baffle systems were satisfied, 96% of mechanical surface agitators, 94% of Helixor diffusers and 100% of Aire O₂ systems were satisfied. Complaints ranged from mechanical failures to undersized and ineffective equipment. One respondent indicated safety problems with their aeration system.

Some aerated lakes experienced partial winterkill last season. Nine of the 159 respondents that operated their aeration systems last winter reported some evidence of winterkill at ice out. Of these, three were diffuser systems, three were Clean-Flo systems and three were mechanical surface agitators.

One respondent indicated there was 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 seen in Table 8, on average Aire-0₂ systems seemed to be the least expensive to operate per acre, whereas the pump and baffle systems were the most expensive. If the average cost of operation is based on the horsepower of the systems and the consumption of electrical power in kilowatts per hour, then the Clean-Flo and Aire-0₂ systems were more expensive to operate, and the least expensive were the Helixor systems. On average, Helixor systems were used in

larger lakes (average area = 728.1 acres), whereas, Clean-Flo systems were used in smaller lakes (average 114.5 acres). The reason for this is based on the size of horsepower used. Clean-Flo systems are routinely built with smaller horsepower and therefore, affect a smaller area.

Table 8. Operational Characteristics of Some Aeration Systems, Winter 2004-05.

		Total hp	Lake Area (A)	hp/A	\$/A/mo	\$/hp/mo	KWH/hp/mo	KWH/hp/A
Helixor	Range	3-25	21-3,596	0.006-0.220	\$ 0.11 – 5.73	\$ 7.18-60.61	68.15-638.46	0.10-118.57
	Mean (x)	12.24	593.0	0.051	\$ 1.38	\$ 27.25	384.94	12.55
	n	32	31	31	14	14	12	12
Clean-Flo	Range	0.5-6.0	10-818	0.004-0.400	\$ 0.33-7.87	\$ 12.15-131.32	64.55-1,774.62	1.83-90.58
	Mean (x)	2.42	111.9	0.072	\$ 2.97	\$ 59.03	509.91	27.04
	n	22	21	21	9	10	5	5
Aire-0₂	Range	2.0-12.0	41-1,634	0.005-0.153	\$ 0.21-1.83	\$ 14.87-168.66	20.83-1,906.94	0.20-6.54
	Mean (x)	4.64	332.4	0.026	\$ 0.76	\$ 59.31	627.88	3.07
	n	22	22	22	6	6	7	7
Pump & Baffle	Range	3.0-60.0	3-1,445	0.018-1.667	\$ 0.20-11.87	\$ 3.00-87.50	30.00-728.36	1.31-58.27
	Mean (x)	14.09	292.4	0.158	4.86	49.05	374.56	38.56
	n	29	29	29	7	7	4	4

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APPENDICES

Appendix 1. Private hatchery operators and protected waters under the permits 2004-05.

Permit #	Last Name	County	D.O.W.	Acres
Region 1				
F0451032	P. Koep	Douglas	21-74	17
			21-116	24
		Grant	26-141	62
			56-268	19
		Otter Tail	56-720	30
			56-136	34
			56-85	19
			56-258	21
			56-883	21
			56-155	21
	Pope	61-212	67	
F0451038	Jeff Koep	Douglas	Gravel Pit	6
			Grant	26-8
		Otter Tail	26-33	44
			56-1183	10
			56-23	87
			56-25	73
			56-29	53
			56-49	43
			56-858	43
		Pope	56-1182	12
		Pope	61-63	28
			61-22	62
		Todd	77-52	69
F0451042	Wertish	Polk	60-392	10
			60-157	41
			60-172	48
			60-141	46
F0451061	Spartz	Polk	60-53	30
			60-288	67
F0451092	Joe Koep	Otter Tail	56-149	180
F0451103	Goeden	Becker	3-269	242
		Grant	26-114	93

Appendix 1. (Continued)

Permit #	Last Name	County	D.O.W.	Acres
Region 3				
F0453100	McDonald	Sherburne	71-129	77

Appendix 2. Questionnaire results of aeration systems operated to prevent winterkill in lakes with or without public access, 2004-05.

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
East Toqua (6-138)	Big Stone	440	City of Graceville	1 diffuser 1-10 HP motor/blower				did not operate
Clear (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	2,760.0	737.15	2.7	N
Hanska (8-26)	Brown	1,844	Hanska Area Association	1-15 HP Helixor	19,810.0	1,289.96	2.5	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	0	0	1.4	N
Cottonwood (17-22)	Cottonwood	146	Cottonwood County Game & Fish League	1-5 HP motor/blower 3 diffusers	0	0	1.7	N
Rebecca (19-3)	Dakota	35	City of Hastings	1-5 HP blower 2 diffusers	2,136.0	143.63	2.9	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	7,470.0	468.88	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)
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	2,800.0	400.00	1.1	N
Pearl (32-33)	Jackson	117	Jackson County Conservation League	1-7.5 HP blower 3 diffusers	5,200.0	500.00	1.1	N
Round (32-69)	Jackson	947	Round Lake Sportsmen's Club	2-7.5 HP motor/blowers 9 diffusers	0	183.07	1.7	N
East Solomon (34-246)	Kandiyohi	733	Kandiyohi County	1-10 HP motor 6 diffusers	10,754.0	744.44	2.6	N
Foot (34-181)	Kandiyohi	576	Willmar Parks Department	1-25 HP motor/blower 6 diffusers	34,717.0	2,279.40	2.8	N
Long (34-192)	Kandiyohi	1,715	Kandiyohi County	2-10 HP motors 12 diffusers			did not return questionnaire	
Mud (Monongalia) M Fk Crow R. (34-158)	Kandiyohi	2,516	Kandiyohi County	1-15 HP motor 6 diffusers			did not return questionnaire	
Ringo (34-172)	Kandiyohi	774	Kandiyohi County	1-10 HP motor 9 diffusers			did not return questionnaire	
Swenson (34-321)	Kandiyohi	123	Kandiyohi County	1-7.5 HP motor 5 diffusers			did not return questionnaire	
Wagonga (34-169)	Kandiyohi	1,792	Kandiyohi County	2-15 HP blowers 12 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)
Polcon Helixors (Con't.)								
Willmar (34-180)	Kandiyohi	761	Kandiyohi County	1-15 HP blower 6 diffusers	22,414.0	1,568.35	2.9	N
Clear (40-79)	LeSueur	282	Lexington Sportsmen's Club	1-7.5 HP motor 3 diffusers				did not return questionnaire
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				did not return questionnaire
East Twin (42-70)	Lyon	280	Lyon County	1-7 HP blower 2 diffusers				did not return questionnaire
West Twin (42-74)	Lyon	237	Lyon County	1-7.0 HP motor/blower 2 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	1-7HP blower 3 diffusers				did not return questionnaire
Bloody (51-40)	Murray	248	Murray County	1-7.5 HP blower 2 diffusers	0	0	1.7	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>Polcon Helixors (Con't.)</u>								
First Fulda (South) (51-21)	Murray	122	Murray County	2-7.5 HP motor/blowers 4 diffusers	0	0	1.7	N
Sarah (51-83)	Murray	1,176	Murray County	1-7.5 HP motor/blower 4 diffusers	0	0	2.2	N
East Graham (53-20)	Nobles	523	Nobles County Parks Department	1-10 HP blower 4 diffusers	0	0	3.0	N
Indian ((53-7)	Nobles	204	Nobles County	1-10 HP blower 4 diffusers	0	218.78	1.9	N
Okabena (53-28)	Nobles	785	City of Worthington	2-7.5 HP blowers 9 diffusers	16,905.0	1,123.00	1.9	N
West Graham (53-21)	Nobles	526	Nobles County Parks Department	2-7.5 HP blowers 6 diffusers	0	0	3.0	N
Becker (73-156)	Stearns	222	Sauk River Watershed District	1-15 HP blower 9 diffusers			did not operate	
Elysian (81-95)	Waseca	2,462	Smith's Mill-Janesville Sportsmen's Club	3-7.5 HP blowers 15 diffusers			did not operate	
Winona (85-11)	Winona	318	City of Winona	3-7.5 HP compressors 6 diffusers			did not return questionnaire	
Wood (87-30)	Yellow Medicine	484	Yellow Medicine County	1-15 HP compressor 6 diffusers	0	0	0.9	N
<u>Clean-Flo Systems</u>								
Shack Eddy (2-109)	Anoka	22	Armstrong Kennels	1-0.5 HP blower 1 diffuser	0	180.00	6.0	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)
Clean-Flo Systems (Con't.)								
Crystal (7-98)	Blue Earth	396	Crystal and Loon Lake Rec., Inc.	2-5 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.	4-0.5 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 return questionnaire	
Alimagnet (19-21)	Dakota	113	City of Apple Valley	1-2 HP compressor 6 diffusers	1,400.0	407.44	1.7	N
Arrowhead (27-45)	Hennepin	23	City of Edina	1-1.5 HP compressor 3 diffusers	0	0	4.0	N
Crystal (27-34)	Hennepin	74	City of Robbinsdale	8-0.5 HP compressors 16 diffusers	0	0	4.0	N
Indianhead (27-44)	Hennepin	13	City of Edina	4-0.5 HP compressors 4 diffusers	0	0	4.0	N
Gleason (27-95)	Hennepin	167	Gleason Lake Improvement Assn	12-0.5 HP compressors 24 diffusers	0	0	2.9	N
Hadley (27-109)	Hennepin	39	Hadley Lake Improvement Assn	6-0.5 HP compressors 7 diffusers	-	884.21	4.0	N
Irene (27-189)	Hennepin	29		2-0.5 HP compressors 4 diffusers	-	800.00	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)
Clean-Flo Systems (Con't.)								
Sweeney-Twin (27-35)	Hennepin	96	Sweeney Lake Assn	4-0.5 HP to 5-0.75 HP compressors, 18 diffusers	50,000.0	3,700.00	4.9	N
Unnamed (Upper) (34-28)	Kandiyohi	22	City of Atwater	2-2 HP compressors 4 diffusers	1,345.0	205.24	2.9	Y
Unnamed (Tadd) (34-376)	Kandiyohi	10	City of Atwater	2-2 HP compressors 4 diffusers	852.0	160.32	3.3	Y
Mabel (40-11)	LeSueur	103	Lucky 13 Sportsmen's Club	2-0.5 compressors 4 diffusers	0	120.00	2.1	N
Unnamed (40-58)	LeSueur	18		1-0.75 compressor 2 diffusers	0	120.00	4.0	N
Unnamed (58-141)	Pine	23		1-0.75 compressor 2 diffusers	0	0	0.7	Y
Birch (62-24)	Ramsey	127	Birch Lake Improvement Assn	1-1 HP compressor 3 diffusers	0	166.67	4.0	N
Willow (62-40)	Ramsey	75	Natural Preserve Foundation	3-0.5 compressors 6 diffusers	-	-	4.1	N
Cody (66-61)	Rice	257	Wheatland Twin Lakes Sportsmen's Club	4-0.5 and 2-0.75 HP compressors, 12 diffusers	7902.0	799.66	3.4	N
Unnamed (Fawn) (71-110)	Sherburne	33	Carefree Country Club	2-0.5 HP compressors 4 diffusers	0	0	3.4	N
Loon (81-15)	Waseca	119	City of Waseca	1-5 HP compressor 9 diffusers	1,090.0	106.71	1.2	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Clean-Flo Systems (Con't.)</u>								
Benz (82-120)	Washington	36	Benz Lake Homeowners Association	3-0.75 HP, 1-0.33 HP 8 diffusers	0	0	3.2	N
Pinetree (82-122)	Washington	174		1-0.5 HP compressor 2 diffusers	0	0	3.0	N
Sunset (82-153)	Washington	125	Sunset Lake Homeowners Association	2-0.5 HP compressor 4 diffusers	0	0	2.7	N
Unnamed (82-330)	Washington	9		1-0.5 HP compressors 2 diffusers	1,000.0	120.00	4.0	N
<u>Other Bubblers</u>								
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 compressors 4 diffusers	-	80.00	3.5	N
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		3-1 HP compressors 6 diffusers	0	0	1.5	N
Eagle (11-342)	Cass	110	Eagle Lake Association	1-0.5 HP pump 2 diffusers	0	172.00	2.1	N
Meadow (11-419)	Cass	43	Wilderness Park Assoc.	1 HP compressor 2 diffusers		did not operate		
Blue Eagle (14-93)	Clay	11	City of Barnesville	2-1/2 HP pumps 4 diffusers	-	-	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)
Other Bubblers (Con't.)								
Lake Fifteen (14-30)	Clay	128	Cormorant Lake Sportsmen's Club	2-1 HP motor 4 ceramic diffusers				did not return questionnaire
Pine (15-149)	Clearwater	1,465	Red Lake Watershed District	Bubbler				did not return questionnaire
Rice (22-7)	Faribault	268	Wells Rifle & Pistol Club	2-0.75 compressors 9 diffusers				did not return questionnaire
Albert Lea (24-14)	Freeborn	2,654	Freeborn County	2-HP compressors diffuser tubing				did not return questionnaire
Scotch (40-109)	LeSueur	590	German-Jefferson Sportsmen's Club	2-0.75 compressors 9 diffusers				did not return questionnaire
Marion (43-84)	McLeod	616	Brownston Rod and Gun Club	1-5 HP blower 3 mat diffusers	10,358.0	916.44	2.3	N
Shamineau (49-127)	Morrison	1,453		Regiair Vane blower 1.5 HP	-	350.00	4.0	N
Wilson (South) (51-81)	Murray	164	Murray County	1-0.75 HP Ice Eater	-	-	2.3	N
Ocheda (53-24)	Nobles	1,778	Nobles County	1-0.5 HP portable blower	0	0	3.0	Y
Pete (56-294)	Otter Tail	34		1-0.75 HP compressor	0	0	6.0	N
Cable (60-293)	Polk	129	Cable Lake Association	3-0.25 HP pump	2,376.0	128.70	2.2	N
Pleasant (62-46)	Ramsey	585	City of St. Paul Water Utility	2-30 HP compressors				did not return questionnaire

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Other Bubblers (Con't.)</u>								
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	0	0	2.1	N
Stocking (80-37)	Wadena	356	Stocking Lake Boosters, Inc.	2 Gast compressors 5 diffusers			did not return questionnaire	
Mud (Battle Creek) (82-91)	Washington	103	City of Woodbury	2-1 HP compressors 6 diffusers			did not return questionnaire	
Pine Tree (82-122)	Washington	174		0.50 HP blower	1,000.0	120.00	4.0	N
<u>Pump and Baffle</u>								
Centerville (2-6)	Anoka	464	Anoka County Parks and Recreation Dept.	1-20 HP pump and baffle			did not operate	
Crooked (2-84)	Anoka	130	City of Coon Rapids	1-10 HP pump and baffle			did not operate	
Golden (2-45)	Anoka	50	City of Circle Pines	1-7.5 HP permanent pump and baffle	21,851.0	1,909.70	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			did not return questionnaire	
Peltier (2-4)	Anoka	483	Anoka County Parks and Recreation	1-20 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>								
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 return a questionnaire
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				did not return questionnaire
Hyland (27-48)	Hennepin	87	Hennepin Regional Parks District	Permanently install. 7.5 HP pumps				did not operate
Mitchell (27-70)	Hennepin	116	City of Eden Prairie	1-7.5 HP Crisafulli pump and baffle				did not operate
Penn (27-4)	Hennepin	47	City of Bloomington	15 HP pump and baffle	38,543.0	2,064.21	3.7	N
Powderhorn (27-14)	Hennepin	11	Mpls. Park & Recr. Board	Pump and baffle 4HP	0	880.00	3.5	N
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 & Recr. Board	1-5.0 HP pump and baffle	0	458.00	1.8	N
Wolfe (27-664)	Hennepin	3	City of St. Louis Park	Built in waterfowl – 5 HP	600.00	60.00	4	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Pump and Baffle (Con't.)</u>								
Wolf (29-81)	Hubbard	274		1-5 HP pump and baffle	-	700.00	1.6	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	City of Parkers Prairie	1-15 HP pump and baffle	0	1,500.00	1.4	N
Fish (56-66)	Otter Tail	500	Parkers Prairie Sportsmen's Club	10-HP pump and baffle	0	1,200.00	1.6	N
Badger (60-214)	Polk	247	Erskine Lions Club	CORE Project pump and baffle		did not return questionnaire		
Maple (60-305)	Polk	1,445	Maple Lake Improvement District	3-5 HP pump and baffle		did not operate		
Pelican (61-111)	Pope	516	Lake Pelican Sportsmen's Club	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		

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>								
Loeb (62-231)	Ramsey	10	City of St. Paul	1-5 HP pump and baffle	0	0	3.4	N
Owasso (62-56)	Ramsey	360	Ramsey County	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		did not operate		
Silver (62-83)	Ramsey	67	City of Columbia Heights	1-10 HP pump and baffle		did not operate		
Cleary (70-22)	Scott	137	Hennepin Regional 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 return questionnaire		
Goose (82-59)	Washington	83	Town of New Scandia	1-3 HP pump and baffle	347.0	40.06	2.4	N
Shields (82-162)	Washington	27	City of Forest Lake	CORE pump and baffle 3 HP		did not operate		
<u>Aire-02</u>								
Eagle (10-121)	Carver	230	Carver County Public Works Dept.	4-2 HP Aire-02 aerators	3,318.0	333.00	2.8	N
Bass (27-98)	Hennepin	175	Bass Lake Improvement Assn	2-2 HP Aire-02	4,919.0	401.97	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)
<u>Aire-02 (Con't.)</u>								
Rebecca (27-192)	Hennepin	290		3-2 HP Aire-02 aerators			did not operate	
Rice (27-116)	Hennepin	306	Rice Lake Area Association	1-2 HP Aire-02	4,000.0	325.00	2.1	N
Dead Coon (41-21)	Lincoln	555	Tyler Rod & Gun Club	2-2 HP Aire-02			did not operate	
Hendricks (41-110)	Lincoln	1,634	Lake Hendricks Improvement Assn	4-2 HP Aire-02 aerators			did not operate	
Shaokatan (41-89)	Lincoln	1,043	Shaokatan Sportsmen's Club	2-2 HP Power House Aerators			did not return questionnaire	
Clear (42-55)	Lyon	68	Lyon County	1-2 HP Aire-02			did not operate	
East Goose (42-93)	Lyon	151	Lyon County	2-2 hp Aire-02			did not operate	
Rock (42-52)	Lyon	422	Lyon County	2-2 HP Aire-02			did not operate	
School Grove (42-2)	Lyon	333	Lyon County	2-3 HP Aire-02			did not return questionnaire	
Yankton (42-27)	Lyon	382	Lyon County	3-3 HP Aire-02			did not return questionnaire	
Big Twin (46-133)	Martin	457	Trimont Area Conservation Club	2-1 HP Aire-02			did not return questionnaire	
Cedar (46-121)	Martin	710	Trimont Area Conservation Club	1-2 HP Aire-02			did not return questionnaire	

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs (\$)	Number Months operated	Winterkill (Y or N)
<u>Aire-02 (Con't.)</u>								
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	6-2 HP Aire-02	0	1,000.00	4.0	N
Star (47-129)	Meeker	554	Star Lake Association	3-2 HP Aire-02	6,865.0	607.16	0.6	N
Corabelle (51-54)	Murray	99	Murray County	1-2 HP Aire-02			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	
Cedar (70-91)	Scott	749	New Prague Sportsmen's Club	1-20 HP Aire-02			did not return questionnaire	
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 Association	1-2 HP Aire-02			did not operate	
Birch (71-57)	Sherburne	149	Birch Lake Association	1-2 HP Aire-02			did not return questionnaire	
Fremont (71-16)	Sherburne	466	City of Zimmerman	2-2 HP Aire-02's			did not return questionnaire	
Silver (72-13)	Sibley	697	Silver Lake Conservation Club	3-2 HP Aire-02	7,683.0	381.94	2.6	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>Aire-02 (Con't.)</u>								
Black Oak (73-241)	Stearns	119	Green Grove Sportsmen's Club	1-2 HP Aire-02				did not operate
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	1,999.0	154.53	2.2	N
Crawford (86-46)	Wright	117	Crawford Lake Improvement Assn	2-2 HP Aire-02				did not operate
Dean (86-41)	Wright	204	Dean Lake Club Assn	2-2 HP Aire-02				did not operate
Mink (86-229)	Wright	304	Assn of Mink & Somers Lakes	1-2 HP Aire-02				did not return questionnaire
Somers (86-230)	Wright	156	Assn of Mink & Somers Lakes	1-2 HP Aire-02				did not return questionnaire
Tyson (87-19)	Yellow Medicine	180	Yellow Medicine County	2-2 HP Aire-02				did not operate
<u>Sprayers</u>								
Lakefront Park Pond (70-169)	Scott	13	City of Prior Lake	3 HP Otterbine	0	331.71	4.0	N
Dullinger (73-103)	Stearns	21		1-1 HP Kallep floating aerator	0	0	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)
Mixed Systems								
Mountain (17-3)	Cottonwood	241	Mountain Lakes Area Sportsmen's Club	5-0.5 HP compressors 2-2 HP Aeromix Tornadoes	10,080.0	395.42	1.8	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		did not return questionnaire		
Clear (32-22)	Jackson	415	Jackson County Conservation League	2-5 HP motor/blowers 6 diffusers, 3-3 HP Ice Eaters	7,440.0	453.84	1.7	N
Independence (32-17)	Jackson	97	Jackson County Conservation League	1-5 HP Helixor 3-3 HP Ice Eater	5,770.0	351.97	1.6	N
Little Spirit (32-24)	Jackson	634	Little Spirit Lake Conservation Club	2-7.5 HP motors 6 diffusers; 3-3 HP Ice Eaters	3,630.0	221.43	2.6	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, 1 Ice Eater	0	0	1.7	N
Perch (56-95)	Otter Tail	57		1-0.75 HP, 1 diffuser 1 pusher	2,072.0	760.00	4.6	N
Lena (58-18)	Pine	50	Lake Lena Acres Assn	1-0.25 HP bubbler and windmill		did not return questionnaire		
Bennett (62-48)	Ramsey	41	Roseville Parks and Recr.	3-0.5 HP blower and 6 diffusers, baffle system	8,877.0	436.67	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				dd not return questionnaire
Como (62-55)	Ramsey	69	Ramsey County Public Works Dept.	1-7.5 HP Hypo system	16,832.0	1,182.00	2.9	N
Vadnais (62-38)	Ramsey	477	City of St. Paul Water Utility	2-30.0 HP Atlas Copco				did not return questionnaire
Marie (73-14)	Stearns	145	Clearwater River Watershed District	1-15 HP Atlas Copco				dd not operate
Augusta (86-284)	Wright	186	Clearwater River Watershed District	1-20 HP Atlas Copco				dd not operate
Louisa (86-282)	Wright	183	Clearwater River Watershed District	1-10 HP Atlas Copco				dd not operate
<u>Other (Mechanical Surface Agitators, homemade, etc.)</u>								
Cedar (4-165)	Aitkin	260	Cedar Lake Assn	3-2 HP Aeromix tornado	10,593.0	926.00	3.2	N
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
Long Tom (6-29)	Big Stone	110	Save A Lake Aeration	2-2 HP Aeromix tornadoes				did not return questionnaire
Loon (11-226)	Cass	220	Loon Lake Property Owners	2-2 HP Aeromix tornadoes	5,490.0	495.00	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 (Mechanical Surface Agitators, homemade, etc.) (Con't.)								
Bean (17-54)	Cottonwood	141	Red Rock Sportsmen's Club	1-5 HP Ice Eater				did not return questionnaire
Double (17-56)	Cottonwood	227	Red Rock Sportsmen's Club	1-5 HP Ice Eater				did not return questionnaire
South Double (17-56)	Cottonwood	227	Red Rock Sportsmen's Club	1-5 HP Ice Eater				did not return questionnaire
Talcott (17-60)	Cottonwood	928	Red Rock Sportsmen's Club	1-5 HP Ice Eater				did not return questionnaire
Nisswa (18-399)	Crow Wing	213		1-3/4 HP Ice Eater	0	0	4.0	N
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
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

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.)								
Manor (19-64)	Dakota	14	City of Eagan	1-2 HP air injection system				did not return questionnaire
Pickerel (19-79)	Dakota	51	City of St. Paul	1-2 HP Neptune pump				did not return questionnaire
East Thomas (19-161)	Dakota	39	City of Eagan	1-0.1 HP solar powered pump				did not return questionnaire
Thomas (19-67)	Dakota	56	City of Eagan	1-2 HP air injection pump				did not return questionnaire
Thompson (19-48)	Dakota	10	Dakota County Parks	1-2 HP Neptune pump				did not return questionnaire
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-Aeromix systems				did not operate
Pottery Pond (25-38)	Goodhue	8	City of Red Wing	Kasco aeration 1-0.75 HP	374.0	35.00	0.9	N
Petite (29-147)	Hubbard	58	Wonewok Conference Center	1-2 HP air injection system				did not operate
Crow River (34-158)	Kandiyohi	2,516	City of New London	2-2 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)
Other (Mechanical Surface Agitators, homemade, etc.) (Con't.)								
Elizabeth (34-22)	Kandiyohi	1,153	Kandiyohi County	2-2 HP Aeromix tornadoes				did not return questionnaire
Silver (40-48)	LeSueur	17	N. Elysian Silver Lakers Sportsmen's Club	1-0.75 HP motored propeller	2,042.0	183.00	2.4	N
Benton (41-43)	Lincoln	2,875	Lake Benton Sportsmen's Club	5-2 HP Ice Eaters	6,650.0	543.29	3.0	N
Stay (41-34)	Lincoln	220	Arco Sportsmen's Club	2-2 HP Aeromix tornadoes				did not operate
Lady Slipper (42-20)	Lyon	262	Lyon County	2-2 HP Aeromix tornadoes				did not return questionnaire
Budd (46-30)	Martin	224	City of Fairmont	Water plant pumps				did not operate
Buffalo (51-18)	Murray	124	Murray County	2-0.75 HP Ice Eaters				did not operate
Currant (51-82)	Murray	394	Murray County	3-0.75 HP Ice Eaters	0	0	2.3	N
Lime (51-24)	Murray	316	Murray County	3-0.75 HP Ice Eaters	0	0	2.4	N
Louisa (51-6)	Murray	211	Murray County	1-0.75 HP Ice Eater	0	0	1.4	N
Wilson (51-81)	Murray	164	Murray County	1-0.75 HP Ice Eater	0	0	2.3	N
Kinbrae (53-16)	Nobles	87	Nobles County Park	1-1 HP Aeromix tornado	0	0	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)
Other (Mechanical Surface Agitators, homemade, etc.) (Con't.)								
Tamarac (56-931)	Otter Tail	416	Tamarac Lake Association	2-2 HP aspirating aerators	5,781.0	526.15	2.2	N
Split Rock (59-1)	Pipestone	80	Pipestone County	2-2 HP Aeromix tornadoes	0	0	2.3	N
Otter (2-3)	Ramsey/Anoka	173	Ramsey County Public Works	3-2 HP Aeromix tornadoes	1,606.0	120.00	0.6	Y
Community Center Pond (62-63)	Ramsey	2	City of Shoreview	3-1 HP Kasco agitators	0	0	6.0	N
Circle (66-27)	Rice	976	Tri-Lakes Sportsmen's Club	1-2 HP Aeromix tornado	0	350.00	3.0	N
Legends (70-287)	Scott	29	Legends Club	1-HP Aqua control surface pump	0	0	5.9	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	0	0	1.4	N
Masford (71-126)	Sherburne	90	DNR Fisheries	2-1 HP mechanical surface agitators		did not operate		
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		

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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.)								
Unnamed (Cloverdale) (82-9)	Washington	39	Cloverdale Farms	2-1 HP Aeromix systems				did not return questionnaire
Fedji (83-21)	Watsonwan	179	Madelia Sportsmen's Club	3-1 HP Powerhouse	3,030.0	228.87	2.2	N
Little Waverly (86-106)	Wright	336	Little Waverly Lake Association	1-2 HP Propellor aspirator				did not operate