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MINNESOTA DEPARTMENT OF NATURAL RESOURCES

DIVISION OF ECOLOGICAL RESOURCES

Aeration Permit Program Annual Report 2006-2007

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Aeration Permit Program Annual Report
2006-2007

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 2006-07 permit year (1 October 2006 – 30 September 2007). 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 2007; Danks 2006; Danks 2005; Danks 1999; Danks 1998; Danks 1996; Danks 1995; Danks 1994; Danks 1992; Danks, 1992; Enger-Danks 1992).

AERATION EQUIPMENT

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

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

2. Air injection systems: Air injection aeration systems function similarly to sub-surface bubblers. However, the pontoon-mounted injection system introduces air just beneath the surface of the lake. Again, the oxygen is provided by removing ice cover and exposing the surface of the lake to the atmosphere and sunlight. Air injection systems are also well suited to lakes, which winterkill frequently, where annual and lengthy operation is likely.

3. Mechanical surface agitators: Mechanical surface agitators are basically submersible or floating pumps which spray water into the air, producing a fountain-like effect. Oxygen is added to the water sprayed into the air, some oxygen is added as the droplets agitate the lake surface, as well as from the open water area created. These systems affect rather small areas and are best suited to small bodies of water.

4. Pump and baffle systems: Pump and baffle aeration systems usually consist of a pontoon-mounted high-volume pump, about 150 feet of hose and a chute or flume. The pump is placed in the lake as far from the chute as possible. Lake water is pumped to the top of the chute where it cascades over a series of baffles, absorbing oxygen before returning to the lake. This type of aeration system does not create, nor does it require, a large open water area to prevent winterkill. Aeration takes place in the chute and the aerated water is returned to the lake.

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

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

PROGRAM ADMINISTRATION

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

REGULATIONS

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

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

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

DISCUSSION

Area fisheries supervisors monitor the dissolved oxygen concentration of lakes in their areas throughout the winter. When winterkill of fish appears to be imminent, a lake may be opened to "liberalized fishing". Under "liberalized fishing" status, regulations regarding limits and methods of capture are relaxed to allow fish that would probably die due to oxygen depletion to be taken by anglers. The number of lakes opened to "liberalized fishing" is a rough indicator of winter severity. During the worst winterkill season of record (1955-56), 308 lakes were opened to "liberalized fishing" (Scidmore 1970). Due to a recent series of mild winters, on average of five lakes statewide are opened to "liberalized fishing" each year. Last winter (2006-07), three lakes were opened to "liberalized fishing" (Figure 1).

A total of 283 aeration permits were issued during the 2006-07 season. This includes 272 renewals (96% of the permits issued) and eleven (11) new permits. Seven permittees from the previous season (2005-06) did not reapply for an aeration permit in 2006-07.

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

The 283 permits issued in 2006-07 authorized aeration in 273 lakes, of which 161 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 125,181 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 26 of these lakes, Aire 0_2 units were operated in 41 lakes, mechanical surface agitators operated in 24 lakes, and diffuser systems operated in 60 lakes. Bait dealers and commercial hatchery operations were permitted to operate in 37 public water bodies totaling 1,934 acres. Seventy-five (75) 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 2006-07.

There have been seven fatalities at aeration system sites, the last occurring in 1999. No deaths resulted from accidents at aeration system sites in 2006-07.

REGIONAL AERATION SUMMARY

REGION I (Bemidji)

There were 69 aeration permits issued in Region 1 during the 2006-07 season, 24% of the total number of permits issued. Of the 69 permits issued, 58 (84%) were renewals and eleven were new permits.

The 69 permits issued in Region I authorized aeration in 78 public waters, or 28.6% of the total public waters aerated statewide. Private hatchery operators accounted for 46% of the aeration permitted water bodies in Region I. Private hatchery operators received eight permits for 37(1,857 acres) public waters (13.2% of the statewide total lakes permitted or 1.5% 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 13 aeration permits to prevent winterkill in 13 lakes (5,011 acres) with public access. Thirty-three aeration permits were issued to private individuals on nine lakes (25,912 acres) to prevent shoreline property damage due to ice expansion. Two permits were issued to the State covering 1,245 acres. Nine other aeration permits were issued to private groups to prevent winterkill in five public waters (683 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. There were nine (9) permits issued in 2006.

Of these nine permits, which represent 3% of the total number of permits issued, five were operated on lakes with access, two were operated on lakes 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 103 aeration permits issued for 100 lakes/ponds (19,092 acres) in Region III last season (36% of the total number of permits issued), 95 renewals (92%), and eight 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. Fifty-eight permits were issued to municipalities for operation of aeration systems in 57 lakes (7,132 acres) with public access. Four permits (597 acres) were issued to municipalities for lakes without public access. Thirteen permits (4,233 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 (6,477 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. Two 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 36% of the permits issued statewide. Last season, 103 permits (68,095 acres) were issued in Region IV; 102 were renewals (99%). One new permit was 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. Ninety permits were issued to private organizations and municipalities to prevent winterkill of fish in 87 lakes (51,234 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. Albert Lea and Hanska lakes have two permits each.

According to the questionnaires returned, no aerated lakes experienced winterkill last season in Region IV. For a detailed breakdown of permit issuance in Region IV including acreages, purpose of operation, permittees (private, clubs, municipalities) and lake location (county), see Table 7.

QUESTIONNAIRE RESULTS

Completed questionnaires were received from 204 of 283 permittees, a 72% return. Operational information is summarized in Table 8, whereas, Appendix 2 lists operational information for individual aerated lakes. Questionnaire information is incomplete and subjective, making it difficult to determine specific system efficiency in preventing winterkill. Eighty-nine (89) respondents indicated their aeration system was not operated last winter.

The average cost for insurance (n=33) was $426.91. This figure includes all permittees operating an aeration system in lakes with or without public access. The range in insurance premiums for the 2006-07 season was $5.00-$2,000.00. No respondents indicated there was difficulty in acquiring the required insurance.

One hundred fifteen (115) of the respondents indicated their aeration system was operated last winter and 31 of those indicated that waterfowl over wintered on the lake. Of these, six respondents are located in Region I, 17 in Region III, and 8 in Region IV. An estimated 2,600 waterfowl used the open water areas provided by aeration systems (range 3-650). Most of the birds were mallards and Canada geese.

Of the 115 permittees that responded and operated their systems last winter, 104 (90.4%) 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. Eleven (11%) of the permittees operating pump and baffle systems were satisfied, 9% of mechanical surface agitators, 12% of Helixor diffusers and 12% of the Aire 0_2 systems were satisfied with their systems. Complaints ranged from mechanical failures to undersized and ineffective equipment. No respondents indicated safety problems with their aeration systems.

Some aerated lakes experienced partial winterkill last season. Three of the 115 respondents that operated their aeration systems last winter reported some evidence of winterkill at ice out. Of these, one was a subsurface bubbler system, one was a Clean-Flo system, and one was a pump and baffle.

Based on the responses to the questionnaire as summarized in Table 8, subsurface aspirating systems, such as the Aire-0_2 and the Aeromix tornado, were on average the least expensive to operate per acre, with Helixor systems a close second. Whereas, pump and baffle systems had the most horsepower per acre but were the most expensive to operate per acre. Helixors were the least expensive to operate based on the horsepower of the system and the length of time they were operated. Helixor and subsurface aspirating systems were on average used on larger sized lakes, up to 2,000 acres. Clean Flo systems were used on smaller lakes up to 250 acres in size.

LITERATURE CITED

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

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

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

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

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

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

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

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

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

Danks, M.A. 1992. Aeration Permit Program Annual Report 1990-91. Minn. Dept. Nat. Res., Div. Fish Wildl., Ecol. Serv. Sec. Staff Report.

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

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

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

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

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

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

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

Table 1. Aerated Acres 2006-07.

ACRES	REGION 1	REGION 2	REGION 3	REGION 4	OVERALL
Lakes with public access	34,060	1,100	17,525	64,919	117,604
Lakes without public access	2,540	330	1,567	3,140	7,577
TOTAL	36,600	1,430	19,092	68,059	125,181

Table 2. 2006-07 Aerated Lakes/Permits.

Region	Lakes w/access	Winterkill Permits C	M	S	P	Bait Dealers Ponds	Permits	Shoreline Lakes	Permit	Other Lakes	Permit	Total Permits
I	15	10	3	2	0	36	8	7	34	10	11	68 (24%)
II	3	2	0	0	1	0	0	0	2	4	4	9 (3.2%)
III	56	8	46	1	2	1	1	2	2	41	43	103 (36.4%)
IV	87	42	49	0	1	0	0	0	0	11	11	103 (36.4%)
Totals	161	62	98	3	4	37	9	9	38	66	69	283

		Lakes	**Acres**	**Permits**
Protected waters with access for winterkill prevention	=	161	67,899	167
Protected waters under permit to Bait Dealers	=	37	1,934	9
Shoreline Protection	=	9	30,355	38
Other**	=	66	24,993	69
		273	125,181	283

Total number of permits for protected waters with access for winterkill prevention	=	167
Total number of permits for protected waters without access for winterkill prevention	=	22
283 total permits, new permits	=	11
05-06 permits not reissued	=	7

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

* = Marinas along Lake Superior

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

Table 3. Region I lakes with public access aerated to prevent winterkill, 2006-07.

County	Permittee C	Permittee M	Permittee S	Total No. of lakes	Total Acres	Average Size (acres)
Becker	3	0	0	3	1,247	415.7
Clay	1	1	0	2	139	69.5
Clearwater	0	0	0	0	0	0
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	2	0	0	2	1,574	787
Pope	0	0	2	2	1,245	622.5
Stevens	1	0	0	1	488	488
Wadena	1	0	0	1	356	356
Totals	10	3	2	15	6,256	N/A

# lakes with public access aerated to prevent winterkill	=	15 (C = 10; M = 3; S = 2)
Total Acreage	=	6,256
Average lake size (acres)	=	417
Permits issued to Municipalities for lakes with access	=	3 (302 acres)
Permits issued to Clubs for lakes with access	=	10 (4,709 acres)
Permits issued to the State w/access	=	2 (1,245 acres)
Permits issued for shoreline protection	=	33 (9 lakes; 25,912 acres)
Melissa Lake – 1,827 acres – 6 permits		Fish Lake – 284 acres – 1 permit
Lida Lake – 7,277 acres – 8 permits		Big Cormorant Lake – 3,380 acres – 4 permits
Big McDonald – 3,096 acres – 1 permit		
Larson Lake – 83 acres – 1 permit		Pelican – 4,314 acres – 9 permits
Lizzie Lake – 4,145 acres – 2 permits		
Little McDonald Lake – 1,506 acres – 1 permit		
Permits issued to Bait Dealers, & P. Hatchery operators	=	8 (36 ponds, 1,857 acres)
Permits issued to private individuals to prevent winterkill for lakes without access	=	9 (683 acres)
Permits issued to the State without access	=	2 (1,245 acres)
Permits issued to private individuals to improve water quality for lakes with access	=	2 (1,892 acres)
Total Permits issued	=	68 (36,600 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 2006-07.

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	17	760	44.7
Polk	6	305	50.8
Pope	2	90	45.0
Stevens	1	78	39.0
Todd	1	69	69.0
Totals	37	1,857	N/A

Averages:

Bait dealers permitted	=	8 (8 permits)
Average number of ponds/permit	=	4.6
Average size of ponds	=	49.0 acres (range 6 to 242 acres)
Average number of acres/permit	=	232.13

Table 5. Region II lakes with public access aerated to prevent winterkill, 2006-07.

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

Lakes with public access aerated to prevent winterkill	=	3
Total Acreage	=	373
Average lake size (acres)	=	124.3
Permits issued to Municipalities for lakes without access	=	0
Permits issued to Municipalities for lakes with access	=	0
Permits issued to Clubs for lakes with access	=	2 (330 acres)
Permits issued to Clubs for lakes without access	=	1 (260 acres)
Privately operated systems for lakes with access	=	3 (770 acres)
Privately operated systems for lakes without access	=	1 (70 acres)
Permits issued to State with access (2 – protect dock stations)	=	2 (316 acres)
Total Permits issued	=	9 (1,430 total acres in 8 lakes/ponds)

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

Table 6. Region III lakes with public access aerated to prevent winterkill, 2006-07.

County	Permittee C	M	P	S	Total No. of lakes	Total Acres	Average Size (acres)
Anoka	0	9	0	0	9	3,082	342.4
Carver	0	2	0	0	2	323	161.5
Crow Wing/Morrison	0	0	1	0	1	1,486	1,486
Dakota	0	15	0	0	15	549	36.6
Hennepin	1	4	0	1	6	670	111.7
Kanabec	0	0	0	0	0	0	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	0	1	0	0	1	466	466
Stearns	0	1	0	0	1	222	222.0
Washington	0	3	0	0	3	213	71.0
Wright	3	0	0	0	3	657	219
Totals	8	46	1	1	57	10,036	N/A

Lakes with public access aerated to prevent winterkill	=	57
Total Acreage	=	10,036
Average lake size (acres)	=	176.1
Permits issued to Municipalities for lakes without access	=	4 (597 acres)
Permits issued to Municipalities for lakes with access (2 permits in Moore Lake)	=	58 (7,132 acres)
Permits issued to Clubs for lakes with access	=	13 (4,233 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 (427 acres)
Private Hatchery Operator permits for lakes with access	=	1 (77 acres)
Permits issued to State with access	=	1 (110 acres)
Permits issued to State without access	=	1 (17 acres)
Total Permits issued	=	103 (19,092 total acres in 100 lakes/ponds)

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

Table 7. Region IV lakes with public access aerated to prevent winterkill 2006-07.

County	Permittee C	M	P	S	Total No. of lakes	Total Acres	Average Size (acres)
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	3	0	0	2	576	288.0
Jackson	6	0	0	0	6	2,948	491.3
Kandiyohi	0	10	0	0	9	10,143	1127.0
LeSueur	4	0	0	0	4	1,768	442.0
Lincoln	3	0	0	0	3	4,138	1,379.3
Lyon	0	9	0	0	9	2,518	279.8
Martin	3	3	0	0	7	1,884	269.1
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	2	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	41	49	1	0	87	51,234	N/A

Lakes with public access aerated to prevent winterkill	=	87
Total Acreage	=	51,234
Average lake size (acres)	=	588.9
Permits issued to Municipalities for lakes with access	=	52 (27,912 acres) (2 permits for Albert Lea & Wilson lakes)
Permits issued to Clubs for lakes with access	=	43 (23,693 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	=	1 (18 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	=	2 (2,994acres)
Total Permits Issued	=	103 (68,059 acres; 98 lakes)

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

Table 8. Operational Characteristics of Some Aeration Systems, Winter 2006-07.

		Total hp	Lake Area (A)	hp/A	$/A/mo	$/hp/mo	KWH/hp/mo	KWH/hp/A
Helixor	Range	3-30	21-1,844	0.008-0.221	$ 0.19 – 4.56	$ 7.55-97.88	54.52-780.12	0.027-92.08
	Mean (x)	13.13	641.0	0.059	$ 1.21	$ 30. 71	343.41	10.31
	n	16	15	15	13	14	13	12
Clean-Flo	Range	0.5-6.8	13-257	0.003-0.400	$ 0. 37-20.33	$ 19.68-1148.47	130.34-1,774.17	3. 96-104. 73
	Mean (x)	2.49	81.8	0.073	$ 4.94	$ 176.83	734.86	31.30
	n	18	18	18	10	10	6	6
Aire-0_2	Range	1.0-12.0	37-1,043	0.004-0.050	$ 0.24-4.25	$ 20.85-157.10	161.79-1,770.00	0. 79-11.96
	Mean (x)	4.71	320.2	0.039	$ 1.19	$ 62.30	605.38	4.21
	n	14	14	14	10	10	8	8
Pump & Baffle	Range	3.0-15.0	3-500	0.020-1.67	$ 0. 89-19.34	$ 3.33-102.95	30.00-776.49	4.54-58.62
	Mean (x)	6.8	93.5	0.29	$ 7.74	$ 49.79	461.70	27.70
	n	13	13	13	12	12	7	7

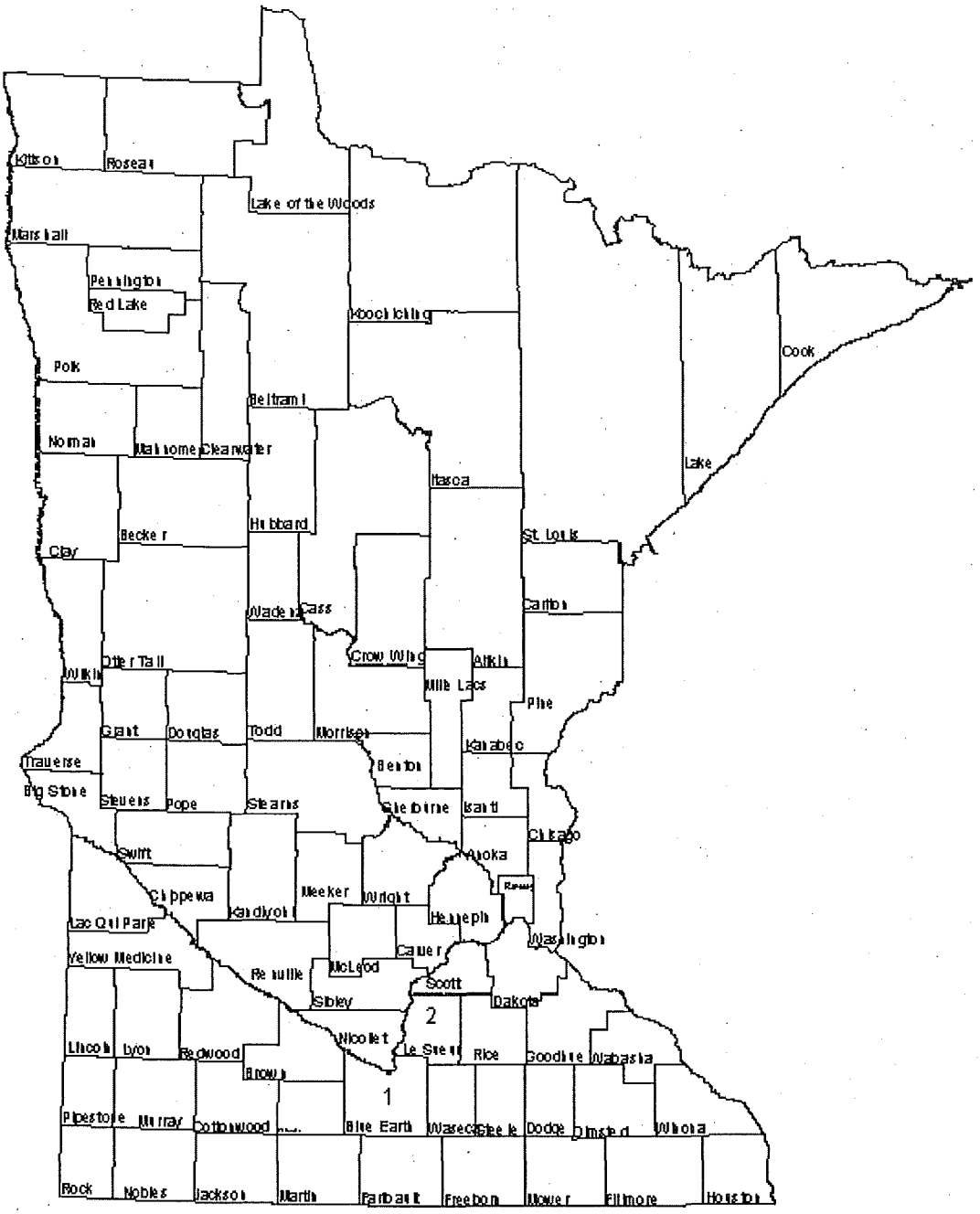

Figure 1. Number of lakes opened to “liberalized” fishing, by county, for the winter of 2006-07.

Figure 2. Trends in lake aeration permits issued 1978-2006

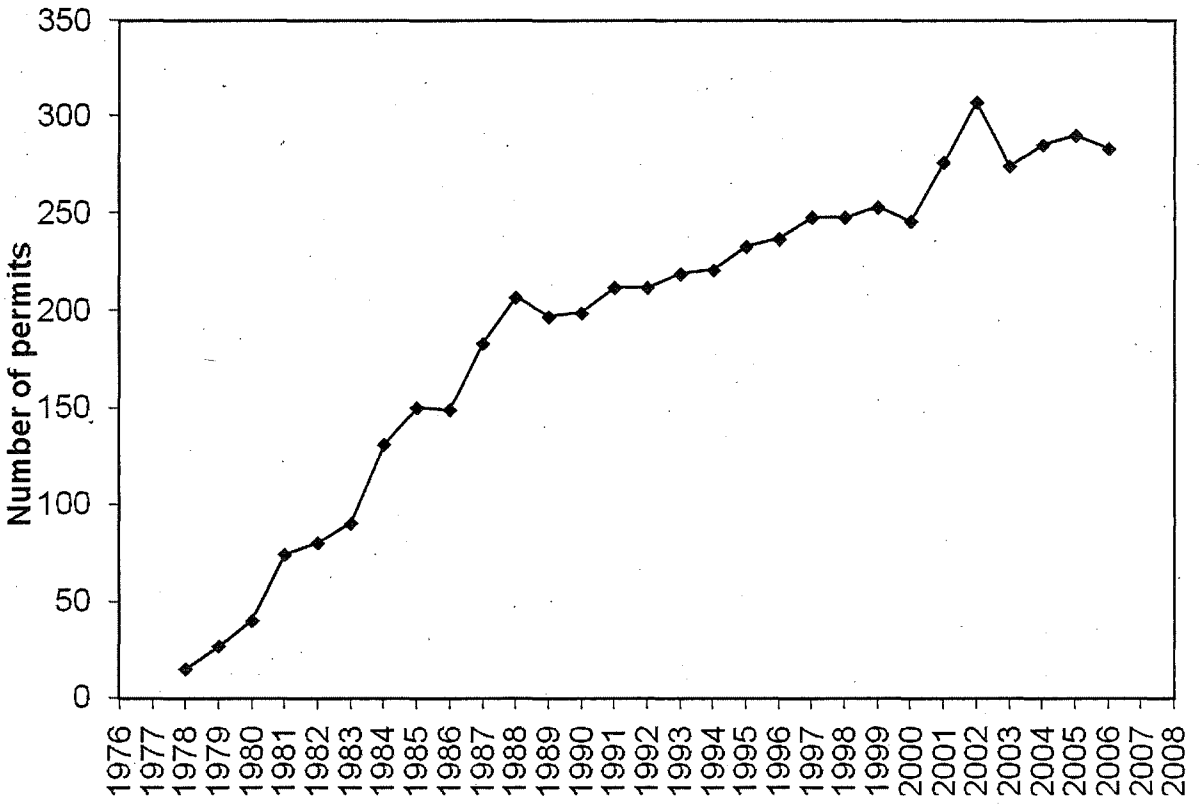

Figure 2. Trends in lake aeration permits issued 1978-2006.

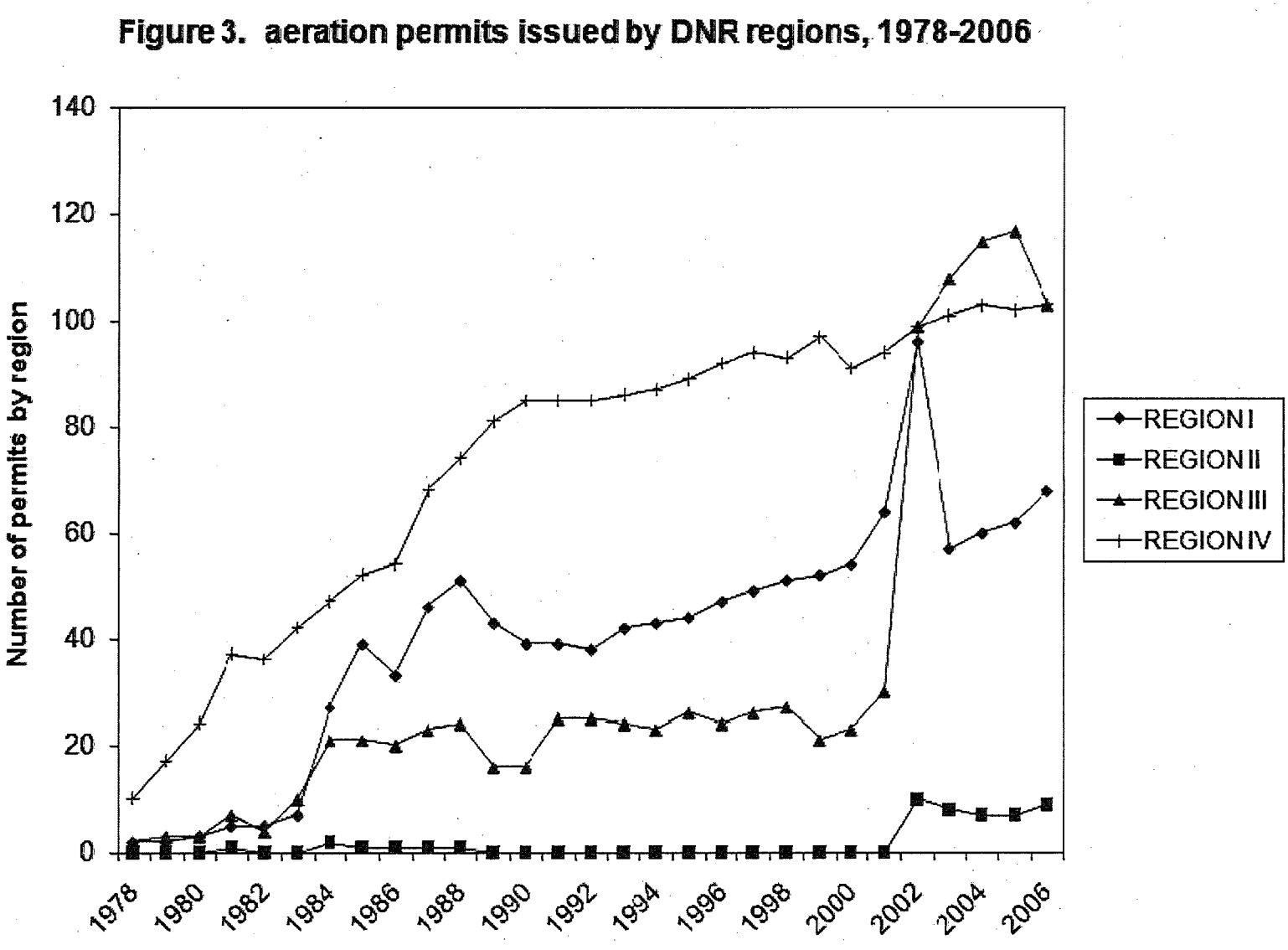

Figure 3. Aeration permits issued by DNR region, 1978-2006.

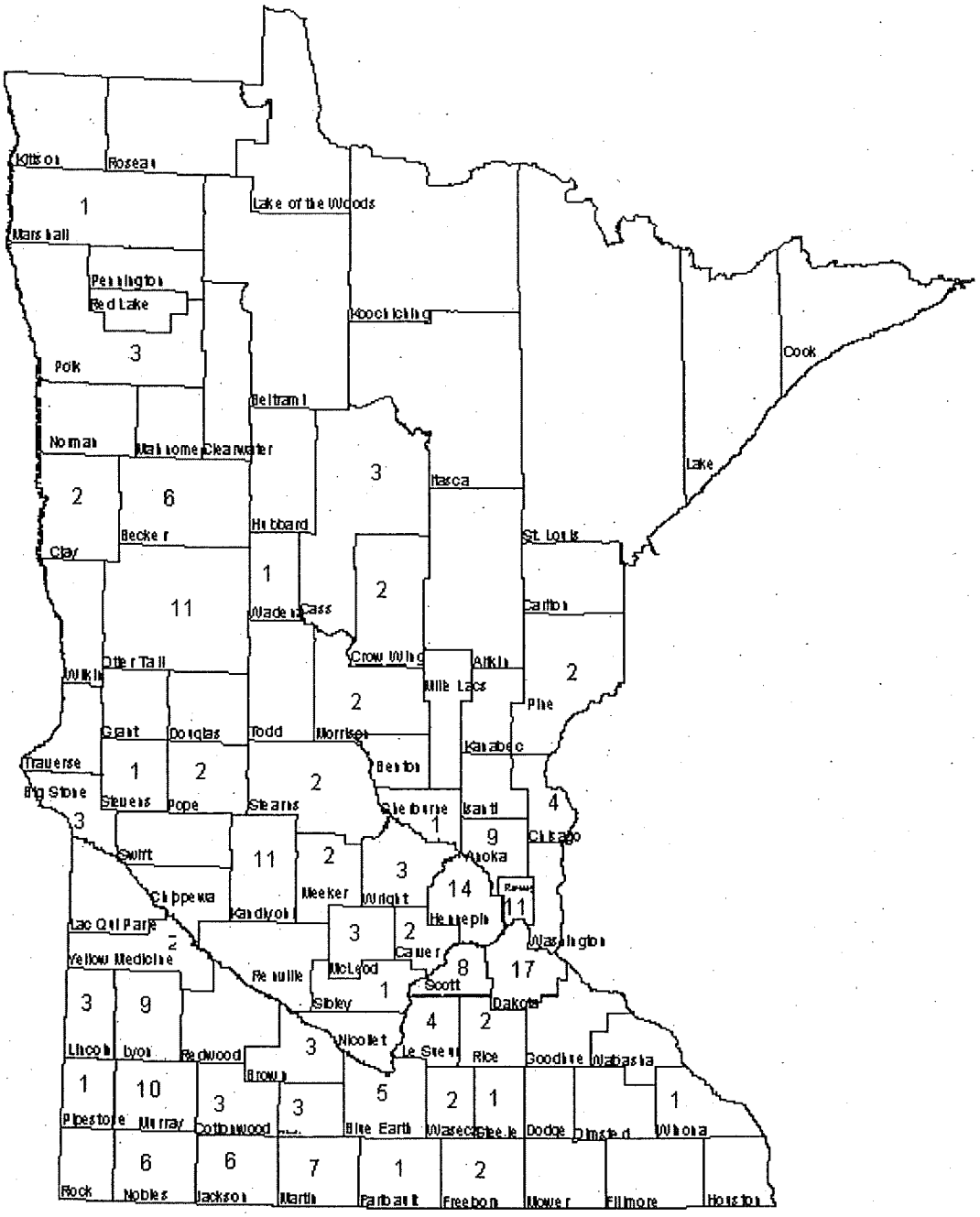

Figure 4. Number of lakes with public access, by county, issued aeration permits in 2006-2007.

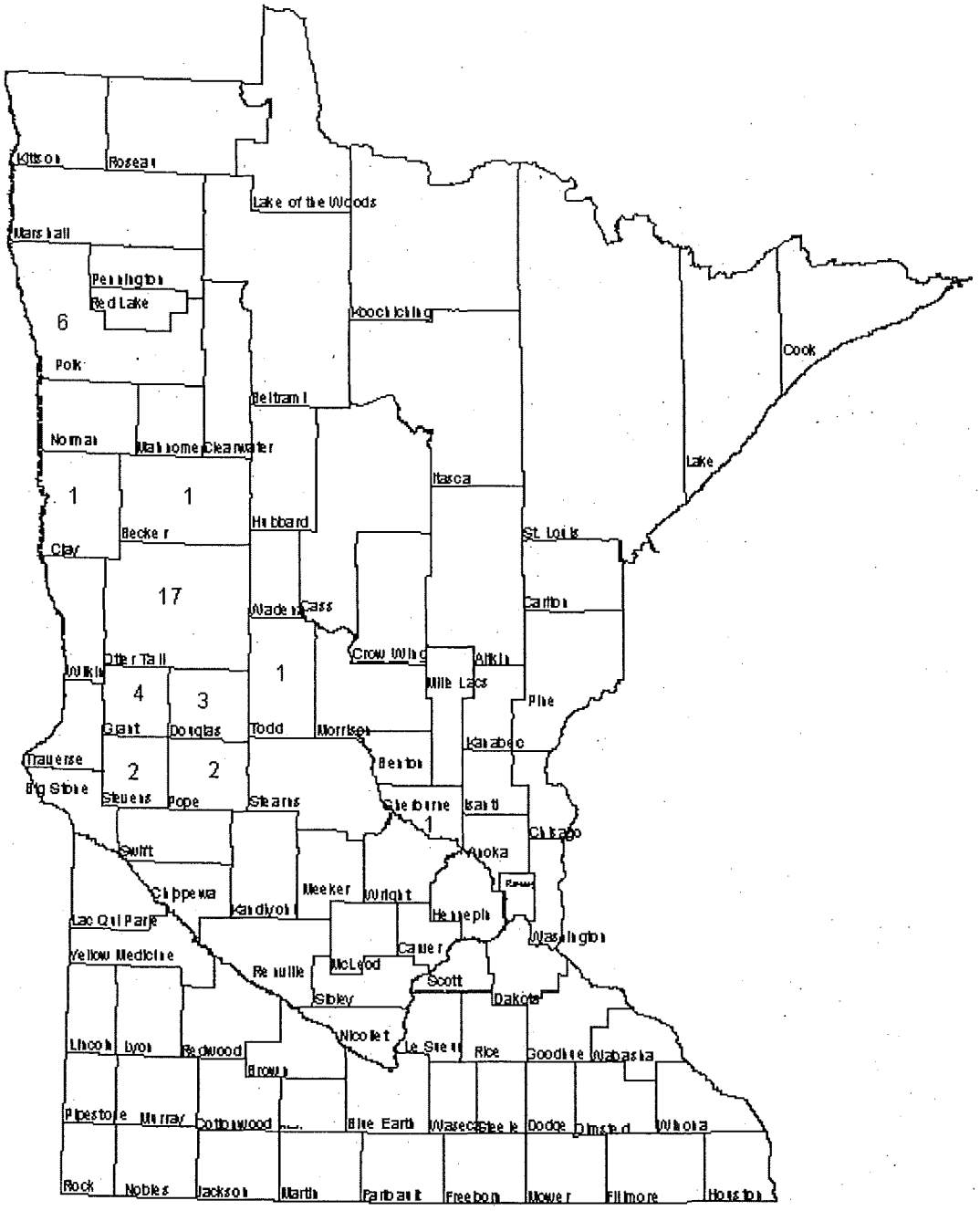

Figure 5. Distribution by County of ponds aerated under permits issued to private hatchery operators in 2006-07.

APPENDICES

Appendix 1. Private hatchery operators and protected waters under the permits 2006-07.

Permit #	Last Name	County	D.O.W.	Acres
Region 1				
F0671032	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
			56-1074	20
F0671038	Jeff Koep	Douglas	Gravel Pit	6
		Grant	26-8	31
			26-33	44
		Otter Tail	56-1183	10
			56-23	87
			56-25	73
			56-29	53
			56-49	43
			56-858	43
			56-1182	12
		Pope	61-63	28
			61-22	62
		Todd	77-52	69
F0671042	Wertish	Polk	60-392	10
			60-157	41
			60-172	48
			60-141	46
F0671061	Spartz	Polk	60-53	30
			60-288	67
F0671092	Joe Koep	Otter Tail	56-149	180
F0671103	Goeden	Becker	3-269	242
		Grant	26-114	93
F0671192	Scholtes	Clay	14-350	36
F0671199	Lint	Stevens	75-25	28
			75-26	50

Appendix 1. Continued

Permit #	Last Name	County	D.O.W.	Acres
Region 3				
F0673100	McDonald	Sherburne	71-129	77

Appendix 2. Questionnaire results of aeration systems operated to prevent winterkill in lakes with or without public access, 2006-07.

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Polcon Helixors								
Artichoke (6-2)	Big Stone	2,011	Save A Lake Aeration	2-15 HP motor/blowers 12 diffusers	did not return questionnaire			
Clear (8-11)	Brown	325	New Ulm Area Sport fisherman	1-10 HP motor/blower 7 diffusers	did not return questionnaire			
Hanska (8-26)	Brown	1,844	Brown Co. Park Dept.	1-15 HP blower 6 diffusers	did not operate			
Hanska (8-26)	Brown	1,844	Lake Hanska Area Association	1-15 HP Helixor	10,030.0	699.24	1.2	N
Sleepy Eye (8-45)	Brown	290	City of Sleepy Eye	2-5 HP motor/blowers 4 diffusers	-	150.00	0.5	N
Bingham (17-7)	Cottonwood	274	Cottonwood County Game & Fish League	1-5 HP blower 4 diffusers	did not return questionnaire			
Cottonwood (17-22)	Cottonwood	146	Cottonwood County Game & Fish League	1-5 HP motor/blower 3 diffusers	did not return questionnaire			
Rebecca (19-3)	Dakota	35	City of Hastings	1-5 HP blower 2 diffusers	1,992.0	83.05	2.2	N
Fountain (24-18)	Freeborn	555	City of Albert Lea	2-7.5 HP blowers 6 diffusers	did not operate			
Morin (24-43)	Freeborn	21	City of Alden	1-3 HP blower 1 diffuser	5,801.0	345.00	3.6	N
Round (27-71)	Hennepin	34	City of Eden Prairie	1-7.5 HP blower 1 diffuser	-	-	1.5	N
Loon (32-20)	Jackson	738	Jackson County Conservation League	2-7.5 HP motor/blowers 9 diffusers	did not operate			

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Polcon Helixors (Con't.)								
Pearl (32-33)	Jackson	117	Jackson County Conservation League	1-7.5 HP blower 3 diffusers	7,680.0	524.00	1.6	N
Round (32-69)	Jackson	947	Round Lake Sportsmen's Club	2-7.5 HP motor/blowers 9 diffusers	did not return questionnaire			
East Solomon (34-246)	Kandiyohi	733	Kandiyohi County	1-10 HP motor 6 diffusers	4,065.0	378.67	2.2	N
Foot (34-181)	Kandiyohi	576	Willmar Parks Department	1-25 HP motor/blower 6 diffusers	15,822.0	1,130.74	2.2	N
Long (34-192)	Kandiyohi	1,715	Kandiyohi County	2-10 HP motors 12 diffusers	942.0	195.77	0.1	N
Mud (Monongalia) M Fk Crow R. (34-158)	Kandiyohi	2,516	Kandiyohi County	1-15 HP motor 6 diffusers	5,315.0	514.21	1.7	N
Ringo (34-172)	Kandiyohi	774	Kandiyohi County	1-10 HP motor 9 diffusers	4,982.0	446.59	3.1	N
Swenson (34-321)	Kandiyohi	123	Kandiyohi County	1-7.5 HP motor 5 diffusers	2,471.0	281.57	3.5	N
Wakanda (34-169)	Kandiyohi	1,792	Kandiyohi County	2-15 HP blowers 12 diffusers	1,472.0	260.35	0.9	N
Willmar (34-180)	Kandiyohi	761	Willmar Public Works	1-15 HP blower 6 diffusers	25,744.0	1,786.42	2.2	N
Clear (40-79)	LeSueur	282	Lexington Sportsmen's Club	1-7.5 HP motor 3 diffusers	did not return questionnaire			

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Polcon Helixors (Con't.)								
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 return questionnaire		
Sisseton (46-25)	Martin	139	City of Fairmont	1-15 HP blower 2 diffusers		did not return questionnaire		
Swan (43-41)	McLeod	482	Silver Lake Sportsmen's Club	1-7HP blower 3 diffusers	-	-	1.7	N
Bloody (51-40)	Murray	248	Murray County	1-7.5 HP blower 2 diffusers		did not operate		
First Fulda (South) (51-21)	Murray	122	Murray County	2-7.5 HP motor/blowers 4 diffusers		did not operate		
Sarah (51-83)	Murray	1,176	Murray County	1-7.5 HP motor/blower 4 diffusers		did not operate		

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.)								
East Graham (53-20)	Nobles	523	Nobles County Parks Department	1-10 HP blower 4 diffusers		did not operate		
Indian (53-7)	Nobles	204	Round Lake Sportsmen's Club	1-10 HP blower 4 diffusers		did not return questionnaire		
Okabena (53-28)	Nobles	785	City of Worthington	2-7.5 HP blowers 9 diffusers		did not operate		
Cedar (70-91)	Scott	749	New Prague Sportsmen's Club	1-20 HP pump 12 Helixor diffusers		did not return questionnaire		
Becker (73-156)	Stearns	222	Sauk River Watershed District	1-15 HP blower 9 diffusers		did not 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	83,046.0	6,102.49	4.0	N
Wood (87-30)	Yellow Medicine	484	Yellow Medicine County	1-15 HP compressor 6 diffusers		did not operate		
Clean-Flo Systems								
Shack Eddy (2-109)	Anoka	22	Armstrong Kennels	1-0.5 HP blower 1 diffuser	1,152.0	150.00	1.9	N
Crystal (7-98)	Blue Earth	396	Crystal and Loon Lake Rec., Inc.	2-0.75 HP compressors 4 diffusers		did not return questionnaire		
Ida (7-90)	Blue Earth	120	Lura Lake Aeration Corp.	1-5 HP compressor 8 diffusers		did not return questionnaire		

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Clean-Flo Systems (Con't.)								
Loon (7-96)	Blue Earth	818	Crystal and Loon Lake Rec., Inc.	4-0.75 HP compressors 8 diffusers	did not return questionnaire			
Lura (7-79)	Blue Earth	1,263	Lura Lake Aeration Corp.	1-5 HP & 1-4 HP Clean Flo, 12 diffusers	did not return questionnaire			
Alimagnet (19-21)	Dakota	113	City of Apple Valley	1-2 HP compressor 6 diffusers	2,129.0	1,378.16	0.6	N
Arrowhead (27-45)	Hennepin	23	City of Edina	1-1.5 HP compressor 3 diffusers	-	-	4.5	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	-	-	4.6	N
Gleason (27-95)	Hennepin	167	Gleason Lake Improvement Assn	4-0.5 HP compressors 16 diffusers	-	-	3.0	N
Hadley (27-109)	Hennepin	39	Hadley Lake Improvement Assn	6-0.5 HP compressors 7 diffusers	did not return questionnaire			
Irene (27-189)	Hennepin	29		2-0.5 HP compressors 4 diffusers	-	-	4.0	N
Sweeney-Twin (27-35)	Hennepin	96	Sweeney Lake Assn	3-0.5 HP to 7-0.75 HP compressors, 18 diffusers	-	-	4.2	N
Unnamed (Upper) (34-28)	Kandiyohi	22	City of Atwater	2-2 HP compressors 4 diffusers	1,957.0	655.43	2.9	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)
Clean-Flo Systems (Con't.)								
Unnamed (Tadd) (34-376)	Kandiyohi	10	City of Atwater	2-2 HP compressors 4 diffusers	1,512.0	227.84	2.9	N
Mabel (40-11)	LeSueur	103	Lucky 13 Sportsmen's Club	2-0.5 compressors 4 diffusers	did not operate			
Unnamed (40-58)	LeSueur	18		1-0.75 compressor 2 diffusers	-	125.00	4.0	N
Unnamed (58-141)	Pine	23		1-0.75 compressor 2 diffusers	did not return questionnaire			
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	-	-	3.2	N
Cody (66-61)	Rice	257	Wheatland Twin Lakes Sportsmen's Club	4-0.5 and 2-0.75 HP compressors, 12 diffusers	3,559.0	380.43	2.1	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	-	-	2.8	N
Loon (81-15)	Waseca	119	City of Waseca	1-5 HP compressor 9 diffusers	5,752.0	539.25	1.8	N
Benz (82-120)	Washington	36	Benz Lake Homeowners Association	3-0.75 HP, 1-0.33 HP 8 diffusers	-	575.00	4.0	Y

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Clean-Flo Systems (Con't.)								
Pine tree (82-122)	Washington	174		1-0.5 HP compressor 2 diffusers	-	280.00	4.1	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
Other Bubblers								
Bijou (3-638)	Becker	229	Cormorant Lake Sportsmen's Club	4-Wifle Webber diffusers 2-pumps	did not return questionnaire			
Ellison (3-484)	Becker	79	Cormorant Lake Sportsmen's Club	1-1.0 HP pump 2 diffusers	did not return questionnaire			
Little Cormorant (3-506)	Becker	939	Cormorant Lake Sportsmen's Club	3-1 Hp pumps 6 ceramic brick diffusers	did not return questionnaire			
Ewert's (4-205)	Beltrami	34		2-2 HP compressors 4 diffusers	-	50.00	2.5	N
Mills (7-97)	Blue Earth	237	Crystal and Loon Lake Recreation	2-0.75 HP compressors 4 diffusers	did not return questionnaire			
Oak (10-93)	Carver	185		4-1 HP compressors 8 diffusers	-	-	3.5	N
Eagle (11-342)	Cass	110	Eagle Lake Association	1-0.5 HP pump 2 diffusers	0	200.00	2.5	N
Meadow (11-419)	Cass	43	Wilderness Park Assn.	1-1.0 HP pump 2 diffusers	-	-	2.2	Y

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Other Bubblers (Con't.)								
Blue Eagle (14-93)	Clay	11	City of Barnesville	2-1/2 HP pumps 4 diffusers	did not return questionnaire			
Lake Fifteen (14-30)	Clay	128	Cormorant Lake Sportsmen's Club	2-1 HP motor 4 ceramic diffusers	did not return questionnaire			
Pine (15-149)	Clearwater	1,465	Red Lake Watershed District	Bubbler	did not return questionnaire			
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	did not operate			
Albert Lea (24-14)	Freeborn	2,654	Freeborn County	2-1 HP compressors diffuser tubing	did not operate			
Pottery Pond (25-38)	Goodhue	8	City of Red Wing	1-0.75 HP Vane compressor 2 diffusers	-	-	2.6	N
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	Brownton Rod and Gun Club	1-5 HP blower 3 mat diffusers	6,620.0	583.94	1.7	N
Alexander	Morrison	2,990		1-3 HP Vein pump 500 pt diffuser hose	-	500.00	3.5	N
Shamineau (49-127)	Morrison	1,453		Regiair Vane blower 1.5 HP	-	-	3.5	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Other Bubblers (Con't.)								
Perch (56-95)	Otter Tail	57		1-0.75 HP compressor	did not return questionnaire			
Pete (56-294)	Otter Tail	34		1-0.75 HP compressor	did not operate			
Unnamed (56-549)	Otter Tail	17		1-0.25 HP motor and diffuser hose	-	-	4.0	N
Lena (58-18)	Pine	50	Lake Lena Acres Assn	2-0.25 HP bubbler	did not return questionnaire			
Cable (60-293)	Polk	129	Cable Lake Association	3-0.25 HP pump	2,376.0	142.56	2.2	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	did not operate			
Stocking (80-37)	Wadena	356	Stocking Lake Boosters, Inc.	2 Gast compressors 5 diffusers	-	250.00	4.3	N
Mud (Battle Creek) (82-91)	Washington	103	City of Woodbury	2-1 HP compressors 6 diffusers	did not return questionnaire			
Unnamed Pond (82-257)	Washington	7		0.25 HP blower 2 diffusers	-	-	4.6	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)
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 return questionnaire		
Golden (2-45)	Anoka	50	City of Circle Pines	1-7.5 HP permanent pump and baffle	16,419.0	1,529.67	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		
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 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		

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Pump and Baffle (Con't.)								
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 operate			
Penn (27-4)	Hennepin	47	City of Bloomington	15 HP pump and baffle	17,471.0	1,332.88	1.5	N
Powderhorn (27-14)	Hennepin	11	Mpls. Park & Recr. Board	Pump and baffle 4HP	-	935.90	4.4	N
Red Rock (27-76)	Hennepin	83	City of Eden Prairie	1-7.5 HP pump and baffle	did not return operate			
Wirth (7-37)	Hennepin	37	Mpls. Park & Recr. Board	1-5.0 HP pump and baffle	-	569.89	4.1	N
Wolfe (27-664)	Hennepin	3	City of St. Louis Park	Built in waterfall– 5 HP	600.0	66.67	4	N
Wolf (29-81)	Hubbard	274		1-5 HP pump and baffle	-	700.00	2.0	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	22,160.0	2,017.00	4.6	N
Jennie (47-15)	Meeker	1,089	Lake Jennie Improvement Corp.	1 pump and baffle system 2,000 gpm 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)
Pump and Baffle (Con't.)								
Wilson (51-81)	Murray	164	Murray County	1-10 HP pump and baffle		did not operate		
Adley (56-31)	Otter Tail	249	Parker's Prairie Sportsmen's Club	1-15 HP pump and baffle		did not operate		
Fish (56-66)	Otter Tail	500	Parkers Prairie Sportsmen's Club	10-HP pump and baffle	-	400.00	0.9	N
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		did not return questionnaire		
Pelican (61-111)	Pope	516	Pelican Lake Association, Inc.	1-20 HP pump and baffle		did not return questionnaire		
Beaver (62-16)	Ramsey	65	Ramsey County Public Works Dept.	1-7.5 HP pump and baffle	6,171.0	600.00	1.4	N
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	-	-	0.5	N
Owasso (62-56)	Ramsey	360	Ramsey County Public Works Dept.	1-20 HP pump and baffle		did not operate		
Silver (East) (62-1)	Ramsey	68	Ramsey County Public Works Dept.	1-15 HP pump and baffle		did not operate		
Silver (62-83)	Ramsey	67	City of Columbia Heights	1-10 HP pump and baffle	3,042.0	296.00	0.8	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Pump and Baffle (Con'.t)								
Cleary (70-22)	Scott	137	Three Rivers Park District	1-7.5 HP pump and baffle	did not return questionnaire			
McMahon (Carls) (70-50)	Scott	136	New Market Sportsmen's Club	1-10 HP pump and baffle	did not operate			
Hattie (75-200)	Stevens	488	Save A Lake Aeration, Inc.	1-10 HP pump and baffle	did not return questionnaire			
Goose (82-59)	Washington	83	Town of New Scandia	1-3 HP pump and baffle	2,362.0	268.95	2.1	N
Shields (82-162)	Washington	27	City of Forest Lake	CORE pump and baffle 3 HP	-	247.09	0.8	Y
Subsurface Aspirating Systems (Aire-0_2, Aeromix Tornado)								
Cedar (1-165)	Aitkin	260	Cedar Lake Assn	3-2 HP Aeromix tornado	11,000.0	1,143.00	3.3	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			
Spring (2-71)	Anoka	37	City of Spring Lake Park	1-2 HP Aeromix	-	-	2.0	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	2,379.0	235.15	1.3	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)
Subsurface Aspirating Systems (Con't.)								
Loon (11-226)	Cass	220	Loon Lake Property Owners	2-2 HP Aeromix tornadoes		did not operate		
Platte (18-88)	Crow Wing	1,486	Platte Lake Association	1-2 HP Aeromix tornado		did not operate		
Birch Pond (19-202)	Dakota	3	School of Environmental Studies	Neptune air injection system		did not operate		
Blackhawk (19-59)	Dakota	39	City of Eagan	1-2 HP air injection system		did not return questionnaire		
Burr Oaks (19-259)	Dakota	19	City of Eagan	1-2 HP pump		did not return questionnaire		
Farquar (19-23)	Dakota	74	City of Apple Valley	1-2 HP air injection system	1,770.0	157.10	0.5	N
Fish (19-57)	Dakota	28	City of Eagan	1-2 HP air injection system		did not return questionnaire		
Gun Club (19-245)	Dakota	8	City of Inver Grove Heights	1-2 HP Aeromix tornado		did not 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		

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Subsurface Aspirating Systems (Con't.)								
Pickerel (19-79)	Dakota	51	City of St. Paul	1-2 HP Neptune pump		did not operate		
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		
Bass (27-98)	Hennepin	175	Bass Lake Improvement Assn	2-2 HP Aire-02	4,219.0	692.97	1.9	N
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		did not operate		

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Subsurface Aspirating Systems (Con't.)								
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		
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 return questionnaire		
Shaokotan (41-89)	Lincoln	1,043	Shaokotan Sportsmen's Club	2-2 HP Power House Aerators	-	750.00	3.0	N
Stay (41-34)	Lincoln	220	Arco Sportsmen's Club	2-2 HP Aqua tornadoes		did not return questionnaire		
Clear (42-55)	Lyon	68	Lyon County	1-2 HP Aire-02		did not return questionnaire		
East Goose (42-93)	Lyon	151	Lyon County	2-2 hp Aire-02		did not return questionnaire		
Lady Slipper (42-20)	Lyon	262	Lyon County	2-2 HP Aeromix tornadoes		did not return questionnaire		
Rock (42-52)	Lyon	422	Lyon County	2-2 HP Aire-02		did not return questionnaire		
School Grove (42-2)	Lyon	333	Lyon County	2-3 HP Aire-02		did not return questionnaire		
Yankton (42-27)	Lyon	382	Lyon County	3-3 HP Aire-02		did not return questionnaire		

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Subsurface Aspirating Systems (Con't.)								
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	1,180.0	100.00	0.9	N
Cedar (46-121)	Martin	710	Trimont Area Conservation Club	1-2 HP Aire-02	did not return questionnaire			
Fish (46-145)	Martin	156	Watonwan Game and Fish	1-2 HP Aire-02	did not operate			
Winsted (43-12)	McLeod	407	City of Winsted	6-2 HP Aire-02	-	-	3.0	N
Star (47-129)	Meeker	554	Star Lake Association	3-2 HP Aire-02	-	204.0	1.2	N
Corabelle (51-54)	Murray	99	Murray County	1-2 HP Aire-02	-	-	3.0	N
Kinbrae (53-16)	Nobles	87	Nobles County Park	1-1 HP Aeromix tornado	-	-	0.5	N
Tamarac (59-931)	Otter Tail	416	Tamarac Lake Association	2-2 HP aspirating aerators	did not operate			
Split Rock (59-1)	Pipestone	80	Split Rock Creek State Park	2-2 HP Aeromix tornadoes	did not operate			
Johanna (61-6)	Pope	1,204	DNR Fisheries	2-5 HP Aire-02's	did not operate			
Signalness (61-149)	Pope	41	Glacial Lakes State Park	1-2 HP Aire-02	did not operate			

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Subsurface Aspirating Systems (Con't.)								
Unnamed (21-71)	Pope	21		1-2 HP Tornado		did not operate		
Otter (2-3)	Ramsey/Anoka	173	Ramsey County Public Works	3-2 HP Aeromix tornadoes	1,359.0	200.00	1.4	N
Circle (66-27)	Rice	976	Tri-Lakes Sportsmen's Club	3-2 HP Aeromix tornadoes	4,637.0	658.00	0.9	N
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		
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		did not return questionnaire		
Silver (72-13)	Sibley	697	Silver Lake Conservation Club	3-2 HP Aire-02		did not operate		
Black Oak (73-241)	Stearns	121	Green Grove Sportsmen's Club	1-2 HP Aire-02		did not return questionnaire		
Elysian (81-95)	Waseca	2,462	So. Lakes Chain Dark House Anglers Association	3-3 HP Aire-02's		did not return questionnaire		

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Subsurface Aspirating Systems (Con't.)								
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			
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	1,877.0	141.78	1.7	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			
Little Waverly (86-106)	Wright	336	Little Waverly Lake Association	1-2 HP Propeller aspirator	did not operate			
Mink (86-229)	Wright	304	Assn of Mink & Somers Lakes	1-2 HP Aire-02	did not 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			

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)
Sprayers								
Lakefront Park Pond (70-169)	Scott	13	City of Prior Lake	3 HP Otterbine	-	200.00	3.5	N
Dullinger (73-103)	Stearns	21		1-1 HP Kallep floating aerator	did not return questionnaire			
Mixed Systems								
East Toqua (6-138)	Big Stone	440	City of Graceville	1-10 HP Helixor 2-2.5 HP Tornadoes	did not operate			
Mountain (17-3)	Cottonwood	241	Mountain Lakes Area Sportsmen's Club	5-0.5 HP compressors 2-2 HP Aeromix Tornadoes	did not operate			
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	-	388.0	1.1	N
Clear (32-22)	Jackson	415	Jackson County Conservation League	2-5 HP motor/blowers 6 diffusers, 3-3 HP Ice Eaters	-	-	-	N
Independence (32-17)	Jackson	97	Jackson County Conservation League	1-5 HP Helixor 3-3 HP Ice Eater	4,980.0	303.78	3.4	N
Little Spirit (32-24)	Jackson	634	Little Spirit Lake Conservation Club	2-7.5 HP motors 6 diffusers; 3-3 HP Ice Eaters	4,640.0	283.04	3.4	N
Thompson (47-159)	Meeker	220	Meeker County Parks	1-20 HP pump and baffle 2-2 HP Tornadoes	7,582.0	405.85	3.1	N

Appendix 2. (Con't.)

Lake (DOW #)	County	Lake Area (A)	Permittee	System description (No. of units, rating)	Electrical Consumption (KWH)	Electrical costs ($)	Number Months operated	Winterkill (Y or N)
Mixed Systems (Con't.)								
Shetek (51-63)	Murray	3,596	Murray County	3-7.5 HP motor/blowers 12 diffusers, 2 Ice Eaters		did not operate		
Bennett (62-48)	Ramsey	41	Roseville Parks and Recr.	3-0.5 HP blower and 6 diffusers, baffle system	9,537.5	629.1	-	N
Scotch (40-109)	LeSueur	590	German and Jefferson Sportsmen's Club	1-10 HP Helixor 2-0.75 HP blower and 9 diffusers	9,105.0	972.07	2.6	N
Hypolimnetic Aerators								
Moore (East) (2-75)	Anoka	110	City of Fridley	1-7.5 HP Palatek compressor		did not return questionnaire		
Como (62-55)	Ramsey	69	Ramsey County Public Works Dept.	1-7.5 HP Hypo system	12,998.0	1,190.48	2.3	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 operate		
Augusta (86-284)	Wright	186	Clearwater River Watershed District	1-20 HP Atlas Copco		did not operate		
Louisa (86-282)	Wright	183	Clearwater River Watershed District	1-10 HP Atlas Copco		did not operate		
Other (Mechanical Surface Agitators, homemade, etc.)								
Leech (11-203)	Cass		Coborn's Leech Lake Cruises	2-3/4 HP Kasco de-icers		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 (Con't.)								
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		did not operate		
South Double (17-56)	Cottonwood	227	Red Rock Sportsmen's Club	1-5 HP Ice Eater		did not operate		
Talcott (17-60)	Cottonwood	928	Red Rock Sportsmen's Club	1-5 HP Ice Eater		did not operate		
Nisswa (18-399)	Crow Wing	213		1-3/4 HP Ice Eater	-	-	3.1	N
Silver (40-48)	LeSueur	17	N. Elysian Silver Lakers Sportsmen's Club	1-0.75 HP motored propeller	1,977.0	160.00	2.6	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 return questionnaire		
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		did not operate		
Louisa (51-6)	Murray	211	Murray County	1-0.75 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 (Con't.)								
Wilson (51-81)	Murray	164	Murray County	1-0.75 HP Ice Eater		did not operate		
Wilson (South) (51-81)	Murray	164	Murray County	1-0.75 HP Ice Eater		did not operate		
West Graham (53-21)	Nobles	526	Nobles County Parks Department	2-7.5 HP blowers 6 diffusers	-	-	2.5	N
Ocheda (53-24)	Nobles	1,778	Nobles County	2-0.75 HP portable powerhouse motors		did not operate		
Community Center Pond (62-63)	Ramsey	2	City of Shoreview	3-1 HP Kasco agitators		did not operate		
Legends (70-287)	Scott	29	Legends Club	1-HP Aqua control surface pump	-	-	5.0	N
Masford (71-126)	Sherburne	90	DNR Fisheries	2-1 HP mechanical surface agitators		did not operate		
Fedji (83-21)	Watonwan	179	Madelia Sportsmen's Club	3-1 HP Powerhouse systems		did not return questionnaire		