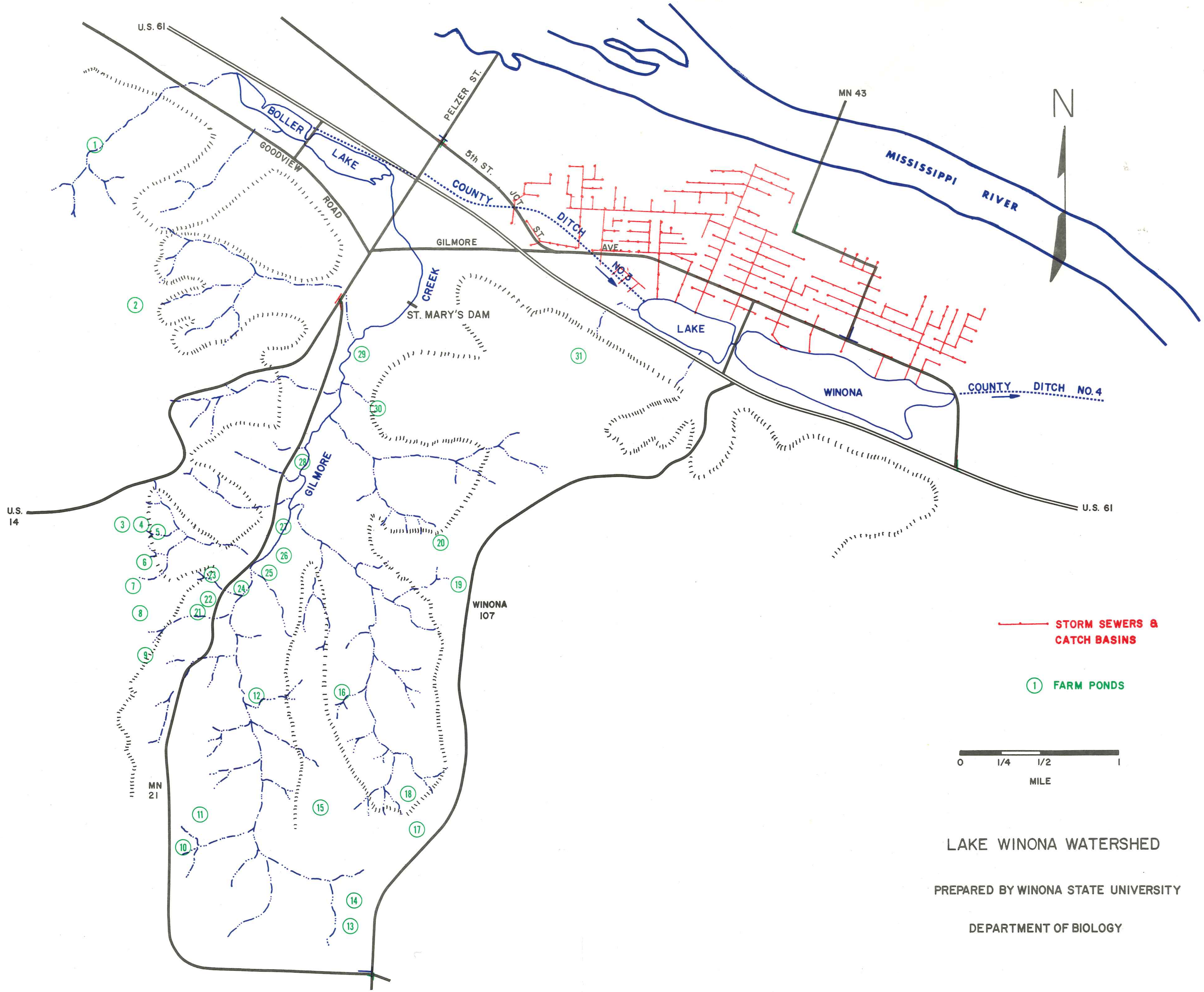
4. A PROBLEM OF OVERABUNDANCE

Lake Winona is extremely fertile because it is rich in nitrogen, phosphorus and potassium - the same nutrient elements which are necessary for the growth of grasses, vegetables, trees and all other plants. In general, a lake is as fertile as the land which surrounds it. The farm land and residential lawns surrounding Lake Winona are heavily fertilized, and the lake serves as a trap for most of the nutrient load which inevitably washes into it. Over 1,600 acres of Winona and Goodview drain into the lake via 26 miles of storm sewers (Fig. 4-1). These sewers bring runoff which is charged with fertilizers, leaves, seeds from trees, grass clippings, silt, detergents, animal feces, debris, road salt and pollutants washed from the atmosphere by rain. Additional quantities of leaves, seeds, soil and nutrients wash into the lake via the ditch which runs through Woodlawn Cemetery. The ditch has been used for years as a self-cleaning facility for disposal of cemetery wastes. Additional fertilizers enter the lake by seepage through the water table. There are no sanitary sewers entering the lake.

Gilmore Creek is probably the purest source of water that enters the lake, and the creek supports an excellent, naturally reproducing brown trout fishery all the way from its source to its termination at Boller Lake. At the present time there are about 30 farm ponds within the Gilmore Creek watershed (Fig. 4-1). They help minimize pollution of the creek's waters by intercepting silt during heavy rains. As residential construction in Gilmore Valley increases, however, water quality in Gilmore Creek may be lowered. Flow from Gilmore Creek is intermittent because it usually seeps into the bed of County Ditch No. 3 after leaving Boller Lake.

Because Lake Winona is so rich in fertilizers, it can be correctly termed a eutrophic (enriched) lake. In past years, like other eutrophic lakes, it often became "peasoup" green with algae in the summer (Fig. 4-2). The large algae populations in the lake provided food for dense populations of microscopic invertebrate animals which in turn served as food for unusually large populations of fish. At the time that the rehabilitation program was initiated in 1973, Lake Winona contained over 730 pounds of fish per acre. By comparison, the crystal clear, relatively infertile waters of a Canadian trout lake would probably contain as little as 40 pounds of fish per acre.

Eutrophic lakes, such as Lake Winona, typically stratify (become layered) during the summer (Fig. 4-3). As the lake warms, the warm water floats on top of the colder, denser water beneath. During late summer the warm water layer, which is fairly uniform in temperature, is usually about 12 feet deep. If not artificially destratified by aeration, Lake Winona is two lakes during the summer-one warm (the epilimnion), the other cold (the hypolimnion). A third layer (the thermocline) lies between the epilimnion and the hypolimnion and is a zone of rapid temperature change. The uniformly cold hypolimnion is thus completely isolated from the epilimnion and from the atmosphere. Consequently, it receives no oxygen from the atmosphere by wave action; and it usually receives no oxygen via photosynthesis because little sunlight penetrates the algae-rich water above. The hypolimnion tends to be devoid of oxygen in late summer because its abundant organic load, living and dead, consumes so much oxygen.



LAKE WINONA WATERSHED

PREPARED BY WINONA STATE UNIVERSITY

DEPARTMENT OF BIOLOGY

Fig. 4-2 The growth of blue-green algae and rooted aquatic plants is stimulated by fertilizer elements.

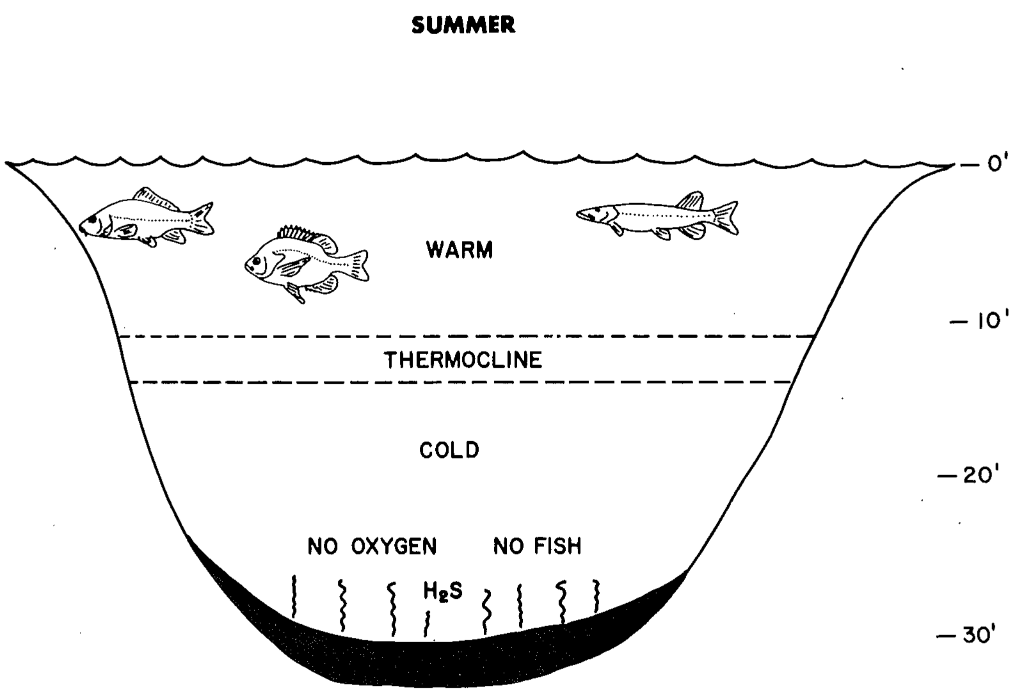


Fig. 4-3 If not artificially aerated, Lake Winona thermally stratifies during the summer. This is a natural process and it occurs in most lakes.

SPRING AND FALL

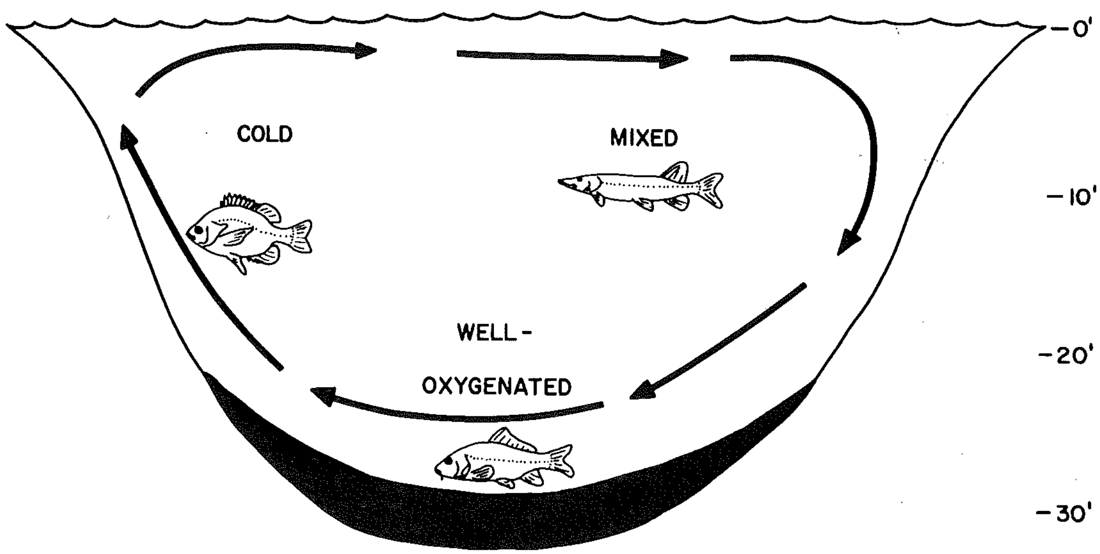


Fig. 4-4 During spring and fall, Lake Winona is not thermally stratified and it is mixed and aerated by the wind.

WINTER

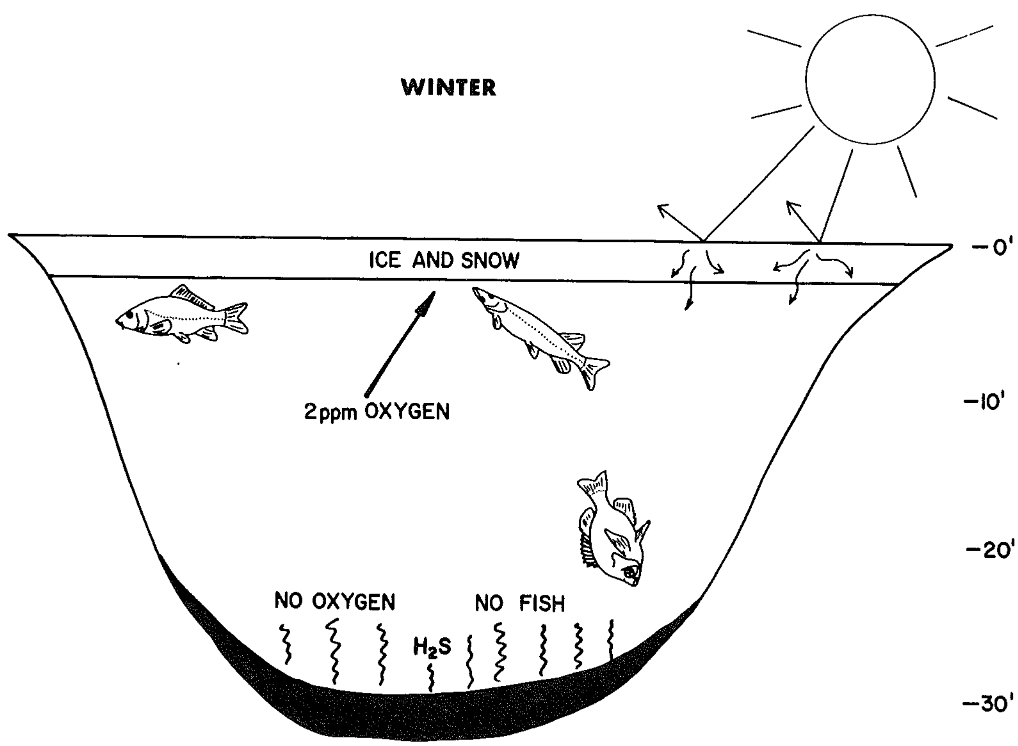


Fig. 4-5 Lake Winona's over-abundance of plants, animals and organic ooze makes it a prime candidate for winter suffocation.

Oxygen is important not only to sustain fish and other animal life, but equally important, oxygen is needed to aid in the rapid decomposition of dead plants and animals which continually settle to the depths of the lake. Due to the cold and lack of oxygen in the hypolimnion, the decomposition process is a slow one, and organic material accumulates at a faster rate than it decomposes. This build-up, in a eutrophic lake, forms the organic ooze found at the lake's bottom. Presently, this organic ooze is several feet deep over much of the lake bottom, with the deep hole at the foot of Hamilton Street recording a depth of over 7 feet of ooze. In the absence of oxygen, organic matter decomposes very slowly, producing methane and hydrogen sulfide gases which frequently bubble to the surface. Hydrogen sulfide causes the rotten egg smell which is often associated with stagnant, foul water.

In the spring and fall, the depths of a eutrophic lake "take a breath" when the lake becomes uniform in temperature from top to bottom and the wind is able to mix the lake thoroughly (Fig. 4-4). During these times of ventilation, the musty smells of anaerobic decomposition can be noticed downwind from a highly eutrophic lake. This was very evident downwind from Lake Winona prior to reclamation.

The most critical time for any highly eutrophic lake is during the winter because the lake is then in danger of having all of its fish smother because of a lack of oxygen (Fig. 4-5). If ice formation is followed by heavy snowfalls, the weight of the snow depresses the ice on the lake and water rises through the cracks in the ice to make a slush layer between the snow and the ice. When this slush layer freezes, it forms translucent ice which transmits little light. To complicate matters, the sun rides low on the horizon during short winter days and its rays tend to glance off the lake's snow-covered surface. Hence, little sunlight penetrates through the snow and ice into the lake. Little oxygen is produced by photosynthesis and the lake "holds its breath" for the remainder of the winter.

Prior to 1965, Lake Winona supported a fair gamefish population. During the severe winter of 1964-65, however, most fish died because of a lack of oxygen. City crews picked up about 225,000 pounds of rotting fish along the shoreline. Buffalofish and carp gained entrance to the lake from the river, and spawned successfully in the spring of 1965. Having no natural enemies to control their numbers, the buffalo did especially well. They literally "took over" the lake. By the end of the summer of 1965, the buffalo weighed about one-half pound and they teemed in schools of thousands along the shore and over the water surface (Fig. 4-6). Their schooling movements were especially apparent in late summer when the depths of the lake became deficient in oxygen and the fish were forced to live near the surface.

During the summer of 1965, young fish of several other species entered the lake from the river by making their way through the outlet dam at Mankato Avenue. In addition, walleyes, northern pike, and bullheads were stocked into the lake by the Minnesota Department of Natural Resources at the request of the city. Another partial winter kill took place during the winter of 1968-79. Again, city crews hauled away about 225,000 pounds of dead fish. Because the kill

Fig. 4-6 Prior to reclamation, Lake Winona was dominated by buffalofish.

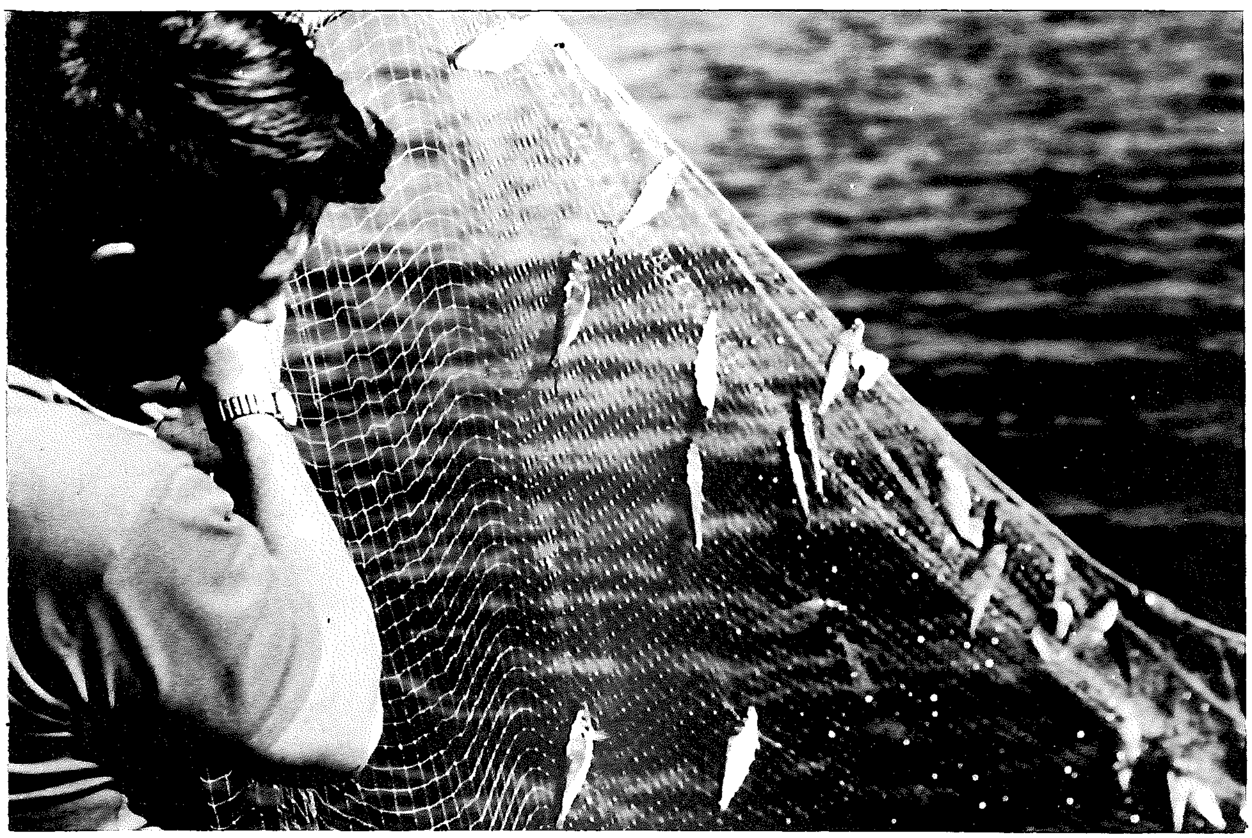


Fig. 4-7 Prior to reclamation, most fish species were over-abundant and stunted due to competition for food and space.

mainly killed game fish, it worked to the advantage of the rough fish. Between the years of 1965 and 1973, buffalo remained the dominant species, although all other species present in the lake managed to live a marginal existence. Thus, in 1973 the lake contained an extremely large, complex population of fish which, being too numerous, were severely stunted (Fig. 4-7, 4-8, 4-9).

The buffalo, which were 7 years old in 1973, averaged only two-thirds of a pound, but still dominated the lake by their sheer abundance. They competed with the game fish for food and space, and they kept the lake muddy. By feeding heavily upon the large zooplankters which eat algae, they allowed the algae to become a nuisance. The lake also contained stunted populations of crappies, black bullheads, sheepshead, carp, gizzard shad, sunfish and perch. A few walleyes (up to 7 pounds) and northern pike (up to 15 pounds) also lived in the lake. They had attained their large sizes because of abundant food and for the same reason were seldom caught.

As early as July, 1968, Lake Winona had been under surveillance by biology classes and student researchers at Winona State University. A number of chemical and physical analyses were made and the lake was occasionally test-netted. Lake sediments were sampled by dredging to determine the types and quantities of aquatic life residing there; weed beds were mapped and plankton was sampled. Unfortunately, however, early sampling was not intensive, nor was it done systematically because of limited amounts of equipment, supplies and labor. For complete data on various analyses, the reader is referred to the Appendix of this volume.

Early testing was done to gather baseline data and to reaffirm assumptions concerning the lake's problems. The long-range problem was obviously that of excess eutrophication. The lake was being supplied with too many nutrients. To solve this problem, however, appeared impossible because the nutrients were supplied by almost every home owner living in the watershed. With every rain or spring thaw, additional nutrients poured into the lake. It was obvious that most nutrients entered the lake via storm sewers, but stopping this nutrient flow would have entailed the construction of extremely expensive interceptor lines to divert storm sewer water away from the lake and into the river.

The most obvious symptoms of the lake's "terminal illness" were winter kills and the resultant domination of the lake by buffalo, carp and bullheads. The lake became so cloudy from mud stirred up by the rough fish that aquatic plants could not grow in the lake. The weed beds of previous years vanished, and the turbidity also decreased the transparency of the water for swimmers. Due to a lack of oxygen at the lake's bottom, the rapidly accumulating layer of organic ooze was incapable of supporting populations of aquatic insects. Therefore, most of the bottom was rendered unproductive, and the malnourished fish which teemed above the bottom received little benefit from it. It was obvious in 1973 that winter kills would increase in frequency and severity if nothing was done.

Fig. 4-8 Typical stunted fish caught by young fishermen at the Steamboat Days kid's fishing contest. July 1973.

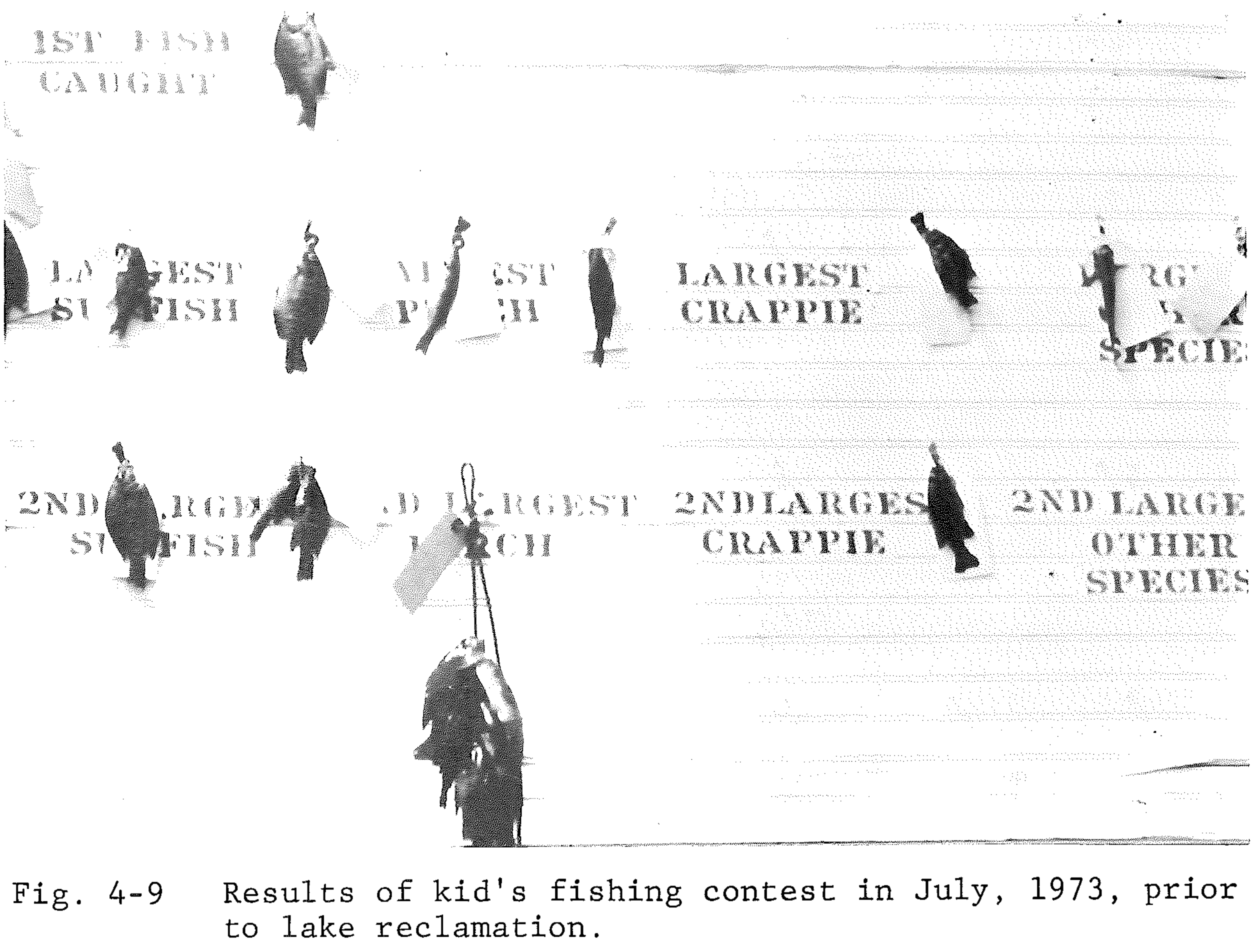


Fig. 4-9 Results of kid's fishing contest in July, 1973, prior to lake reclamation.

A review of base-line data collected by Winona State University biology students ultimately led the City, University and concerned townspeople to jointly search for a way to reclaim the lake as a sport fishery. In January, 1972, personnel of the U.S. Department of Interior Fish Control Laboratory at LaCrosse, Wisconsin informally reviewed the situation and outlined options for reclamation of the lake. Concurrently, and for several years previous, informal discussions concerning rehabilitation possibilities had been held with members of the Minnesota Department of Natural Resources, the Wisconsin Department of Natural Resources and with fisheries scientists from other areas of the U.S. and Canada. By fall, 1972, as a result of media coverage of the lake's problem, the community began to become interested enough in the situation to voice a call to action. Most important, the Minnesota DNR offered its support. Without its permission, counsel, encouragement and assistance the project would have been impossible.

FARM PONDS OF LAKE WINONA WATERSHED

Farm ponds are listed numerically as they appear on accompanying map. Dimensions of ponds are based upon the water content of the ponds on October 19, 1972 and not upon the potential capacity of the ponds. The fall of 1972 was unusually wet.

1. 150 feet in diameter; 3 feet deep. Pond dries up in summer, freezes out in winter. The owner said he tried to stock it with bullheads but failed, no fish in pond. Edward Bronk (454-3823).

2. 50 feet in diameter; 5 feet deep. Pond freezes to bottom in winter; actually consists of two ponds - a large and a small one, no fish. Edward Curtis (454-1241).

3. 160 feet long; 45 feet wide; 6 feet deep (an elliptical shape). There was no evidence of fish; however, a few minnows were stocked into lake two years ago. Farmer's wife hasn't seen any fish this summer. Vincent Ashelin (452-9578).

4. A triangular shaped pond with 180 ft. base and 60 feet height; 5 feet deep. The pond is 1000 feet below another pond on the hillside, and is a catch basin for its overflow. No fish. Not a farm pond.

5a. Elliptical pond. 30 feet long; 8 feet wide; 2 feet deep. It freezes out in winter, dries up in summer; no fish. Not a farm pond.

5b. Elliptical pond, 40 feet long, 24 feet wide; 3 feet deep. It freezes out in winter, dries up in summer; no fish. Not a farm pond.

6. Triangular shaped pond with 60 feet base, 30 feet height, 3 feet deep. It freezes out in winter and dries up in midsummer; no fish. Not a farm pond.

7. Pond was dried up so it had no surface dimensions. It contains water only in spring; therefore no fish. Sylvester Erpelding (454-2631).

8. Pond was dried up so it had no surface dimensions. It contains water only in spring; therefore no fish. Sylvester Erpelding (454-2631).

9. Triangular shaped pond 120 feet base, 100 feet sides, depth 6 feet. It is the diking off of a valley; no fish seen. Don't known if it freezes out. Harold Bergler (454-1307).

10. Triangular shaped, 225 feet base, 123 feet sides. It contained no overflow pipe. No fish seen, but it never dries up or freezes out. It contains sparse amounts of aquatic vegetation. Albert Gernes (454-1484).

11. Triangular shaped pond, 180 feet base, 123 feet sides. It supposedly contains no fish but it is quite deep and turbid. It also never freezes out or dries up. Donald Rakstad (454-1481).

12. Rectangular pond, 195 feet long, 120 feet wide. It has fish in it, is surrounded by vegetation, has no overflow and is probably spring fed. It looks quite shallow. Albert Doerr (454-2628).

13. Rectangular pond, 20 feet wide, 30 feet long, freezes out in winter; it is only 2 feet deep. Arthur Redig (454-2627).

14. Small circular pond, 20 feet diameter, 3 feet deep. No fish. May have mudpuppies, saw something swimming in it. Arthur Redig (454-2627).

15. Rectangular pond, 250 feet long, 225 feet wide, a large part is 8 feet deep. No fish seen but could exist, farmer doesn't think so. Hoover (452-9643).

16. Rectangular shaped pond, 150 feet by 90 feet, 5 feet deep. Dike is running along the longest side. Dry wash was 1 foot above water level. Fish have been introduced occasionally. Owner doubts that any are still alive. Ralph Pickard (454-1291).

17. Triangular shaped pond, 100 feet base, 60 feet sides. No fish. It freezes the bottom in winter. 5 feet deep. Louis Thill (454-1361).

18. Circular pond, 30 feet diameter, no fish. Freezes out in winter. 5 feet deep. Roger Ehlers (452-7709).

19. Circular pond, 30 feet diameter, 5 feet deep. Supposedly, there are no fish according to owner. Erwin Michael (454-1314).

20. No pond was found, and people in area knew of no pond. A dump was located where pond was mapped. Erwin Michael (454-1314).

21. Rectangular pond, 55 feet long, 25 feet wide, 1½ feet deep. It is a dry wash diked over. It dries out in summer and is gone by winter. No fish. Nicholas Erpelding (452-9645).

22. Rectangular pond, 30 feet long, 20 feet wide. No fish. It dries up in summer. One foot deep. Nicholas Erpelding (452-9645).

23a. Rectangular pond, 25 feet long, 10 feet wide. No fish. It dries up during. One half foot deep. Nicholas Erpelding (452-9645).

23b. Circular pond, 30 feet diameter, 1 foot deep. No fish. It dries up in summer. Nicholas Erpelding (452-9645).

24 & 25. Both are represented by 4 marshy areas, 6 inches deep. 50-40 feet in length, 10-20 feet wide. Very near creek, the ponds are oxbows of the creek. Could contain fish; none seen. Albert Doerr (454-2628).

26. This pond is owned by Cy A. Hedlund (454-1283). The pond is two years old and it presently contains no fish. Mr. Hedlund plans to stock the pond with channel catfish in early summer 1973. If it proves necessary, he will permit the seining of the pond to allow it to be treated - providing the seined-out fish are restocked into the pond. The spring-fed pond has no connection with the creek. The drop from the outlet pipe to the creek is about four feet.

27. This pond is also owned by Cy Hedlund. The pond is 2 years old. The pond is spring fed and there is about a 4 foot drop from the outlet pipe to the level of the creek. It is extremely unlikely that fish could enter the pond from the creek. The pond presently contains about 30 rainbow trout which average about 3 lbs. in weight. Mr. Hedlund is sure that there are no bullheads or carp in the pond. He fed the trout bait minnows at one time and a few of them may still be in the pond. He is very reluctant to allow the seining of this pond.

28. No pond found, but a cement dike was found that partially blocked a drywash running into the creek. No chance that fish could exist there.

29 & 30. Represents two diked off dry washes that were just catch basins for run off. Could not hold fish. Owned by Saint Mary's College.

31. The pond represents a diked dry wash. 150 feet long, 20 feet wide, 1-2 feet deep, no fish. It is a dike to break the flow of water from washing area of houses below.

STORM SEWERS ENTERING COUNTY DITCH
NUMBER 3 AND LAKE WINONA

County Ditch 3 Sewer Outlets	Location	Description
A	Runs along Kerry Drive and empties into Ditch 3 just south of Pelzer-Highway 61 intersection.	A cement culvert from a pipe below the waterline of Co. Ditch No. 3.
B	Runs along Pelzer Street from Fourth Street and empties into Ditch 3 northeast of the Pelzer Street-Highway 61 intersection.	A cement culvert from a pipe below waterline of the Ditch.
C	Runs down from Druey Court, Housing Project and empties south of Druey Street.	An open pipe sticking out above the waterline of Ditch.
D	Runs northerly down Hiawatha and Sunset Boulevard under Highway 61 and empties into Ditch 3 directly across Highway 61 from Hiawatha Boulevard.	An open pipe above waterline of Ditch.
E	Enters Ditch 3 just above the junction of Kraemer Drive and Service Drive along the highway.	Enters below waterline.
F_1	Runs down Emherst Street to Ditch 3 from north direction.	Empties into Ditch 3 from an open pipe sticking out above waterline.
F_2	Runs along Service Drive and enters Ditch 3 below junction of Kraemer Drive and the Service Drive.	Cement culvert at the water-level of the Ditch.
G	Runs down Elm Street to Ditch 3 from north direction.	Empties into Ditch 3 from open pipe sticking out above the waterline.
H	Runs north one block from King Street into Ditch 3 across from Oak Street.	Empties into Ditch 3 below waterline of the creek.
I	Runs down Oak Street from north to Ditch 3.	Empties from an open pipe above waterline.
J	Runs along Wayne Street north to Ditch 3.	Below the waterline.
K	Runs down along Fifth Street and along Junction Street entering Ditch 3 just above where it goes beneath Junction Street.	Below the waterline, cement culvert.
L	Runs down east side of Junction and enters below where Ditch 3 goes below Junction Street.	Below the waterline, cement culvert.
M	Runs from the southwest corner of St. Anne's Hospice to Ditch 3.	Enters Ditch 3 from a cement culvert above the waterline of the Ditch.
N_1	Runs along Gilmore easterly to enter Ditch 3 just before it goes beneath Gilmore Avenue.	Enters Ditch 3 from a cement culvert below waterline.
N_2	Runs down Hilbert Street, enters just above where Ditch 3 goes beneath Gilmore Avenue.	Enters Ditch 3 from a cement culvert below waterline of Ditch.
O	Runs south along Vila Street and enters Ditch 3 above where it goes below the east entrance to Miracle Mall.	Enters Ditch 3 from a cement culvert above the waterline of the Ditch.
P, Q & R	Drainage pipes for the Winona Senior High School field west of the school.	Irrigation pipes stick out above the waterline of Ditch.

Lake Winona Sewer Outlets	Location	Description
I	Runs south along Wilsie Street to east side of Winona Senior High School and enters on north shore.	Enters through cement culvert below waterline of lake.
II	Runs down Sioux Street from Sarnia Street to lake.	Empties through open pipe below waterline of lake.
III	Runs along Olmstead Street down to lake.	Runs the full length of Olmstead Street, empties into both lake and river. The sewer enters from an open pipe below the waterline.
IV a & b	They run down Grand and Wilson Streets, one block from Lake Street to lake.	Open pipe above waterline.
V	Runs down Harriet Street from Wabasha Street to lake.	Enters lake from open pipe below the waterline of lake.
VI	Runs down Johnson Street and east along Lake Park Drive, enters lake directly south of Center Street.	Below waterline.
VII	Runs down Lafayette Street east of bandshell and enters lake south of block between Lafayette and Walnut Streets.	Below waterline.
VIII a & b	Two sewer systems running along Franklin Street to lake.	Enters the lake from a cement culvert above waterline of lake.
IX	Runs along Sarnia Street from Liberty to Laird Street and south to lake.	Enters below the level of the waterline of the lake but it is silted in with sand so that there is no standing water between it and the lake.
X	Runs down Hamilton Street to lake.	Enters from a cement culvert below the waterline.
XI	Runs along Belleview Street, down Carimona Street to lake.	Enters above the waterline of the lake.
XII	Runs from Sarnia Street to lake south of block between St. Charles Street and High Forest Street.	Enters the lake just inches above the waterline.