SURFACE WATER RESOURCES OF CALUMET COUNTY

DEPARTMENT OF NATURAL RESOURCES
MADISON, WISCONSIN
1971

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SURFACE WATER RESOURCES OF CALUMET COUNTY

By

Ronald L. Fassbender

LAKE AND STREAM CLASSIFICATION PROJECT

Drafting by: Al Philpot

Edited by: C. W. Threinen

DEPARTMENT OF NATURAL RESOURCES

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INTRODUCTION

Americans, freed from the every day task of earning a living, are directing more leisure time energy toward our natural resources as a primary source of recreation. In Wisconsin, surface waters--lakes and streams--offer to many the most enjoyment, peace, and solitude attainable. On water man can be angler, boater, hunter, water skier, swimmer, sailor, or passive observer--whatever his liking may be. As people in ever increasing numbers look to water for an ever expanding variety of recreational uses, they find less space available for each activity and each participant. To compound the problem domestic, agricultural, and industrial activities demand more water than ever before.

Various water uses are seldom in harmony. Use conflicts arise and often one interest may control water to the exclusion of others. These problems are complex and call for complex solutions. The water resource planner must consider ecological and aesthetic qualities as well as economic factors when developing use plans. Further, he must seek methods of water apportionment that will maintain harmony and assure equitable use. In 1959, the Wisconsin State Legislature, recognizing these problems and the proposed solutions, directed the Conservation Commission to develop a classification system for lakes according to use. The responsibility was increased to include streams in 1961.

Before a classification system can be devised it is necessary to obtain specific information about each lake and stream in the state. A county waters inventory, such as this one covering Calumet County, is the initial step in providing such information. Each inventory is designed to present the quantity, quality, and character of the water resource with respect to its use for conservation and recreation. Because of time limitations data collection was completed regardless of season and for the most part limited to single visits. Obviously, information such as water analysis, depth, bottom types, transparency, or fishery composition may be inadequate. In spite of shortcomings this inventory presents for the first time a set of vital statistics useful in measuring present condition of the waters and in planning their future management.

* Maps appear at end of report.

Data for this inventory were gathered from many sources, primarily A.S.C.S aerial photos, U.S.G.S. topographic maps, D.N.R. files and surveys, and field inspections. Recreational use of the waters mentioned was of primary concern during data collection. Little consideration was given industrial or agricultural use except where major use conflicts were apparent.

Maps presented with this report should not be considered nor used as a factual and final authority from any legal or regulatory standpoint because of natural or man-made changes which may have occurred.

A BRIEF HISTORY OF CALUMET COUNTY

Long before the advent of "civilization" the region now encompassed by Calumet County was home to wandering bands of Indians. The popularity of this region to these early residents is evidenced by the large numbers of burial mounds, effigy mounds, and food caches found along Lake Winnebago's eastern shoreline. The many marshes along with Lake Winnebago provided all that was necessary for these primitive hunting and gathering people to sustain themselves.

The first Europeans to visit present day Calumet County were probably early French explorers during the mid-1600's. There is little record of their visits and they left no permanent impression on the county other than its name. "Calumet" is a French derivation of an Indian name applied to a small Menominee village and means "Little Reed" or "Pipe of Peace."

"Civilization" first came to Calumet County in 1831 when two fairly well educated Indian tribes, the Stockbridges and the Brothertowns, obtained a large tract of land along Lake Winnebago. Settlement of these lands began two years later in 1833. White settlers, primarily soldiers from Fort Howard in Green Bay, moved to the area as the military road from Green Bay to Prairie du Chien was built. Soon after on December 7, 1836, Calumet County came into legal existence. However, because the white population was small it was attached to Brown County for judicial, tax, and election purposes. Not until March 4, 1840 did Calumet County become completely self governing (Titus, 1930).

Surface Water Resources have played an important role in the early history and development of Calumet County. Lake Winnebago provided easy transportation to and from the markets and trade centers along the Fox River and Green Bay. Brothertown and Chilton are two communities that grew up around water powered gristmills and sawmills.

GENERAL SETTING OF SURFACE WATERS IN CALUMET COUNTY

The various physical and chemical characteristics of any surface water are directly related to the natural history of the surrounding countryside. Man's land use practices superimposed over the natural features of an area are often reflected in the recreational use, both present and potential, of a particular lake or stream. This section discusses the geology, geography, climatology, and demography of Calumet County as they relate to the surface water resources.

Topography

The topography of Calumet County is that of a high undulating plain sloping towards Lake Michigan in the eastern and central portions of the county. A more abrupt incline slopes toward Lake Winnebago along the western edge of the county.

Altitude (feet above mean sea level) varies from the level of Lake Winnebago at 747 feet to over 1,200 feet along the Niagara escarpment (see section on geology) just east of Lake Winnebago in southwestern portion of Calumet County. Relief in the central elevated plain is on the order of 200 feet from valley floor to ridge top (Weidman and Schultz, 1915). Table 1 shows the altitude at various locations throughout the county.

As related to surface waters, topography plays a part in determining general drainage patterns and, to a lesser degree, influences runoff rates.

Drainage

As Figure 1 depicts, Calumet County lies within two of Wisconsin's major drainage basins, the Fox River and Lake Michigan. In Calumet County most of the Fox River watershed drains directly into Lake Winnebago except for the extreme northern edge of the county which drains north-northwest into the Fox River proper. The Lake Michigan watershed drains the eastern two-thirds of Calumet County and is divided into two sub-basins, the Sheboygan River watershed and the Manitowoc River watershed. The Manitowoc River system is by far the largest draining over half of Calumet County. Only the small area encompassing the south-eastern corner of the county is drained by the Sheboygan River system. Drainage in the Lake Michigan watershed is to the east.

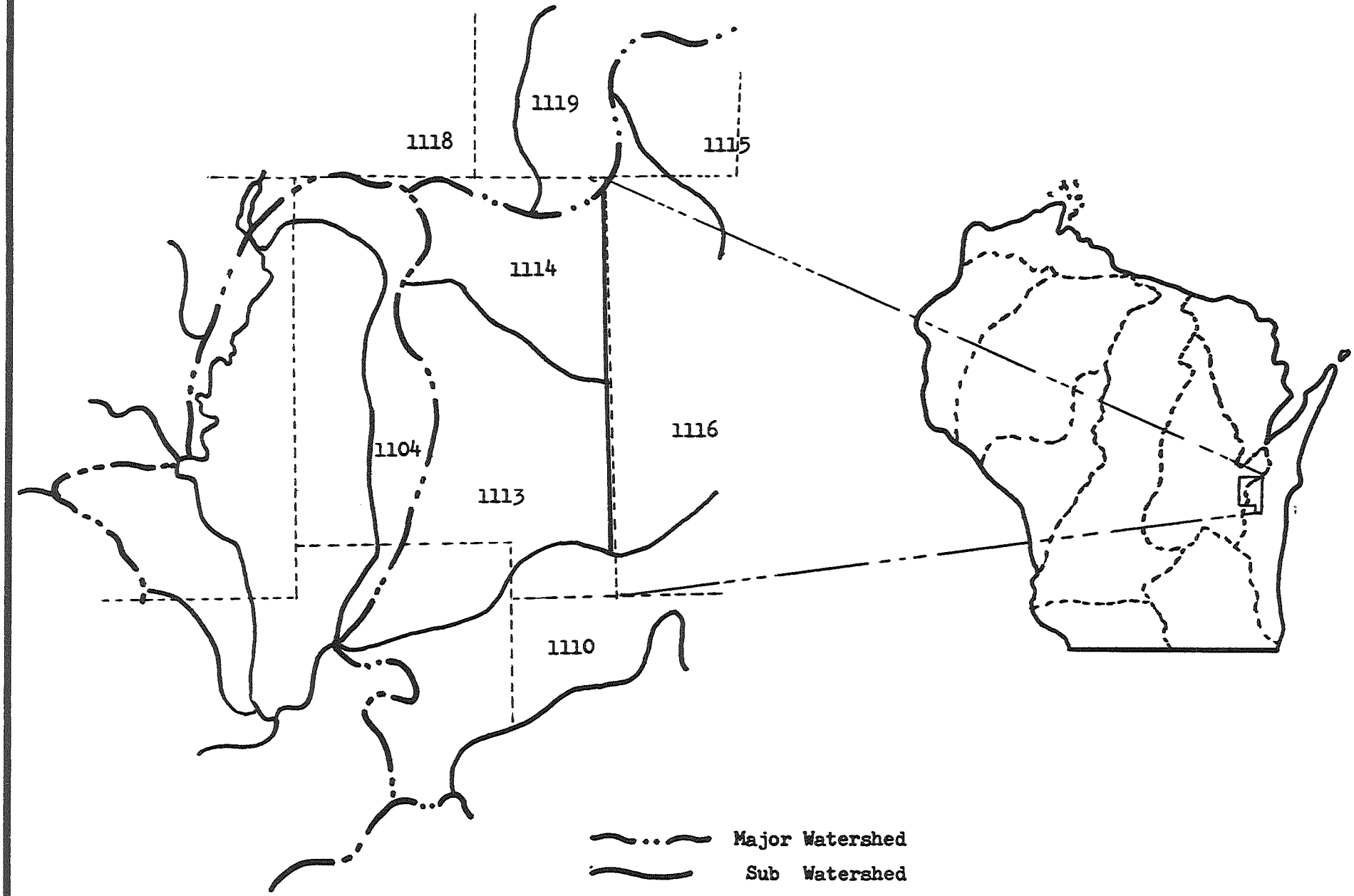

Fig. 1. Location of Calumet County within the state and relative to major watersheds

Table 1. Elevations of Selected Locations in Calumet County

Location	Elevation (Feet)
Brillion	825
Chilton	856
Dundas	819
Forest Junction	833
Hayton	825
High Cliff	794
Hilbert Junction	827
Kiel	918
Lake Park	782
New Holstein	936
Potter	805
Sherwood	834
Winnebago, Lake	747

(Martin, 1965)

Stream gradients vary considerably depending mainly on size of stream and location within the county. The Sheboygan River flowing through a marshy lowland in the southeast has a gradient of less than one foot per mile as does a smaller marsh type stream. Creek 4(7d). Creek 2(11), flowing off the Niagara escarpment into Lake Winnebago has highest gradient at 74.3 feet per mile. Those streams lying within the Fox River watershed have considerably higher gradients than those in the Lake Michigan watershed. A complete list of gradients is presented in Appendix 1b. Figure 2 compares stream gradients of typical Calumet County streams.

Geology

The science of geology is far too complex to give a comprehensive account of the geology of Calumet County in this report. Only the major geologic features will be mentioned and then primarily as they relate to surface water resources.

Niagara dolomite, Maquoketa shale, and Platteville-Galena dolomite are major bedrock materials occurring under surface drift in Calumet County (Figures 3 and 4). These formations dip to the east. The Niagara formation is by far the most prominent feature and covers the eastern two-thirds of Calumet County. The Niagara escarpment, the steep weathered slope of the Niagara formation descends abruptly to Lake Winnebago where at High Cliff it forms a cliff 223 feet high. Further south, near Stockbridge, the top of this escarpment is 313 feet above Lake Winnebago (Martin, 1933). The Maquoketa shale, an impervious layer, forms a narrow belt along the east shore of Lake Winnebago and along the north edge of the county. Platteville-Galena dolomites occupy an area north of Lake Winnebago (Martin, 1932; Weidman and Schultz, 1915; and Bean, 1949). The primary impact of bedrock formations on the county's surface water is the determination of major topographic features and resultant major drainage patterns. For example, the Niagara escarpment is the major topographic feature in the county and is also the major divide between the Fox River drainage basin and the Lake Michigan drainage basin.

Except for the Niagara escarpment the most obvious geological features present are those associated with Cary and Valders substages of the Wisconsin glacier. The Valders substage covered portions of Wisconsin some 11,500 years ago, while the older Cary substage covered much of the state about 16,000 years ago (Finley, 1965; and Thwaites, 1956). That portion of Calumet County immediately north of Lake Winnebago lies within the bed of extinct glacial Lake Oshkosh. This area is relatively flat surface waters. A band of Valders end moraine bisects Calumet County from east to west. Cary ground moraine lies south of the Valders end moraine and Valders ground moraine lies to the north. The Cary ground moraine contains a few perennial streams and a few wetland complexes. Most of Calumet County's surface waters are found in the region covered by Valders ground moraine. Several natural kettle lakes, most major streams, and a few large wetland complexes are present in this region. Figure 5 depicts the glacial geology of Calumet County.

Soils

The location and description of various soil types found in Calumet County are presented in Figure 6. With the exception of isolated pockets of peat, the soils are derived primarily from materials associated with various phases of the Wisconsin glacier (Figures 5 and 6). The peats are formed from decomposed organic materials. For the most part, the county's soils are quite heavy, are fertile, and are well drained making them highly desirable agricultural soils.

These soils generally adversely affect the county's surface water resources. Precipitation does not readily percolate into the heavy soils and more runs off than in lighter soils. As a result there is high runoff during periods of peak rainfall and during periods of peak snow melt and little base flow at other periods from ground water seepage. This condition leads to drastic seasonal fluctuations in stream flow and to a large number of intermittent or seasonal streams. Soil erosion is also accelerated under high flow conditions.

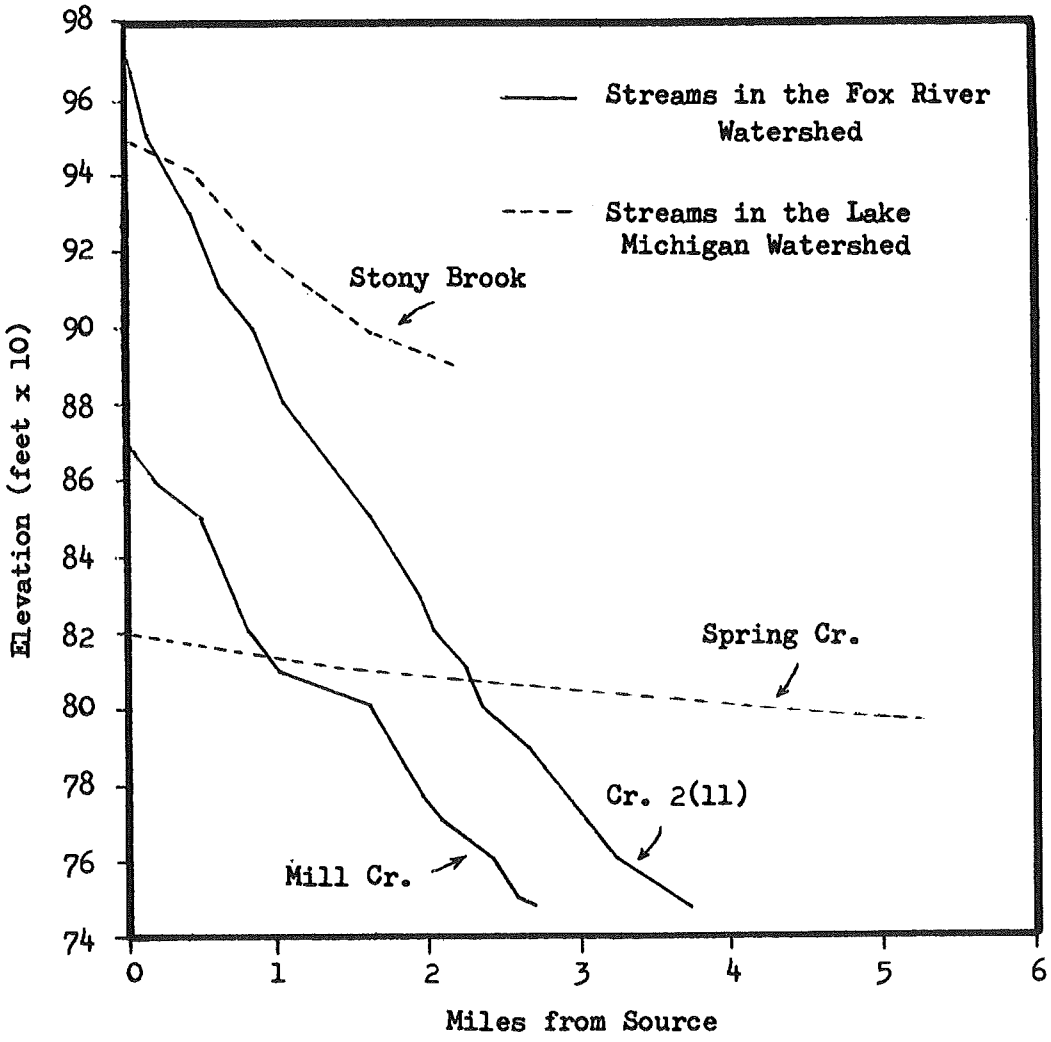

Fig. 2. Profiles of some Calumet County streams

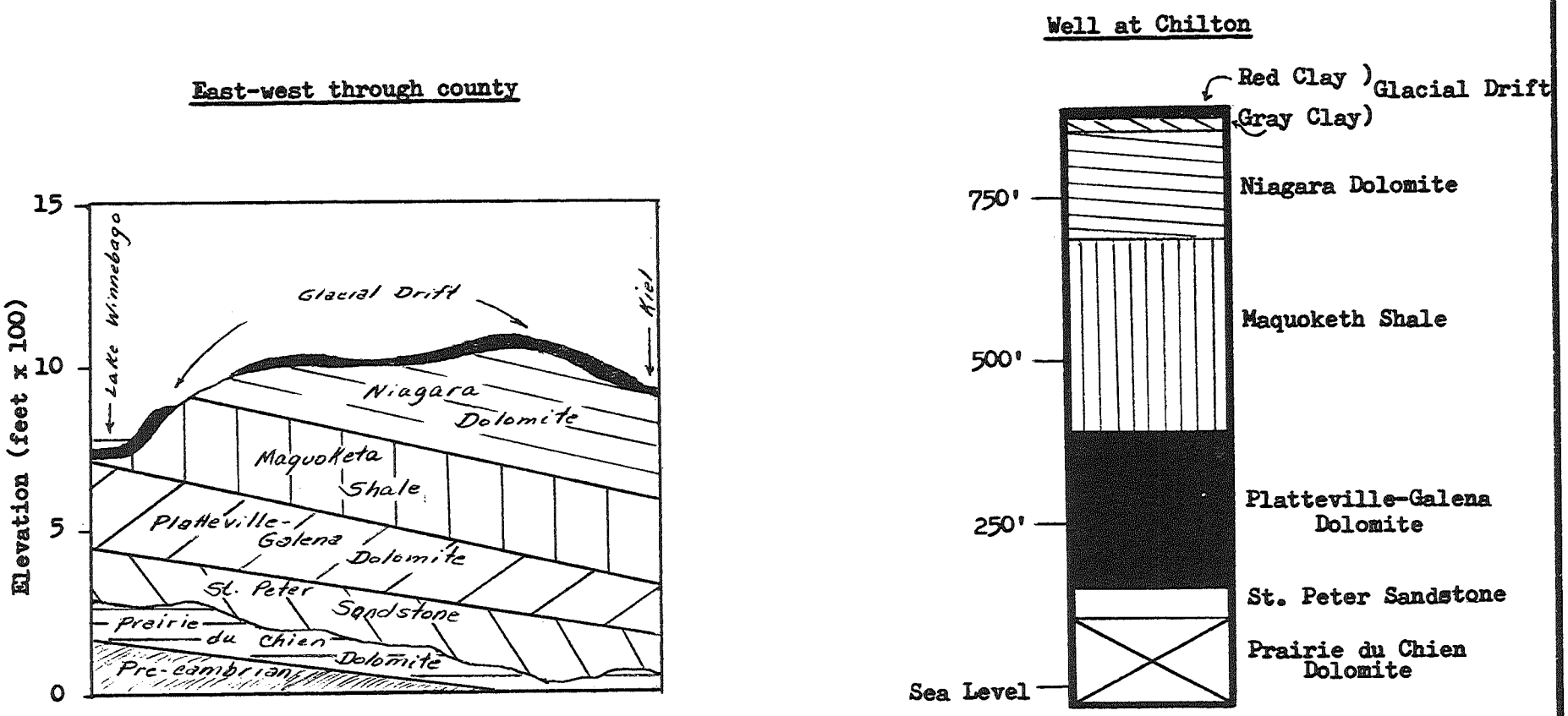

Fig. 3. Geologic sections of Calumet County

(Weidman & Schultz, 1915)

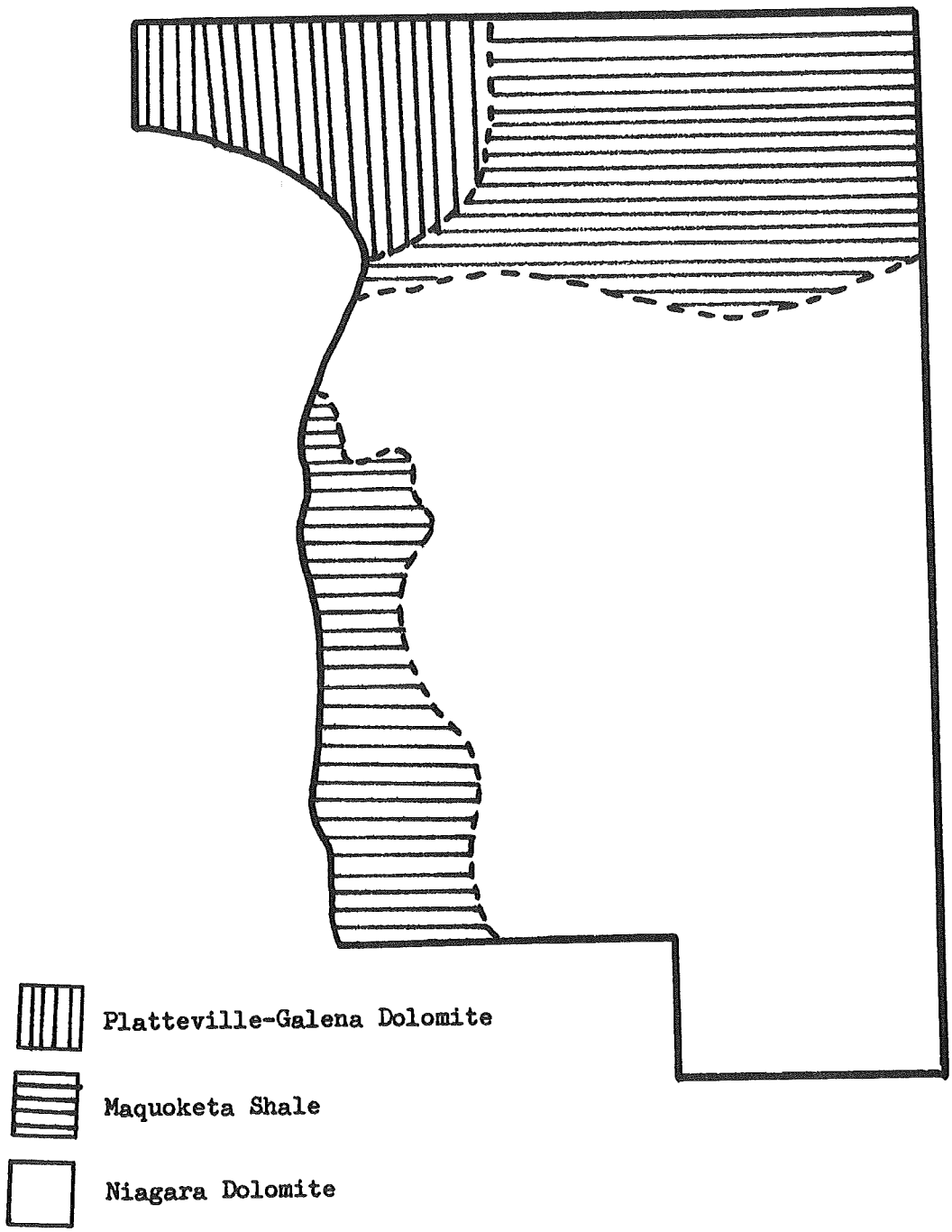

Fig. 4. Bedrock geology of Calumet County

(Bean, 1949)

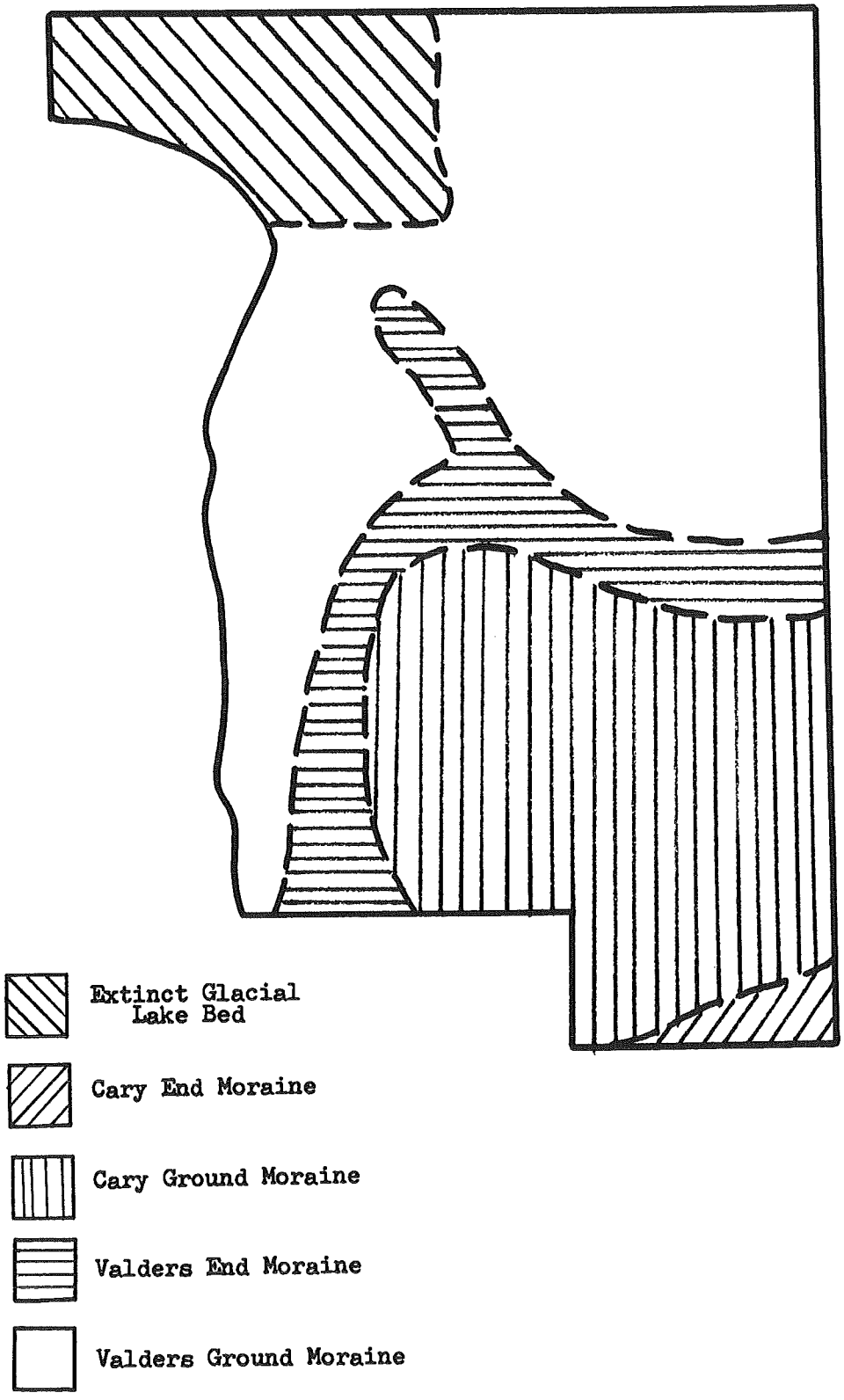

Fig. 5. Glacial geology of Calumet County (Thwaites, 1956)

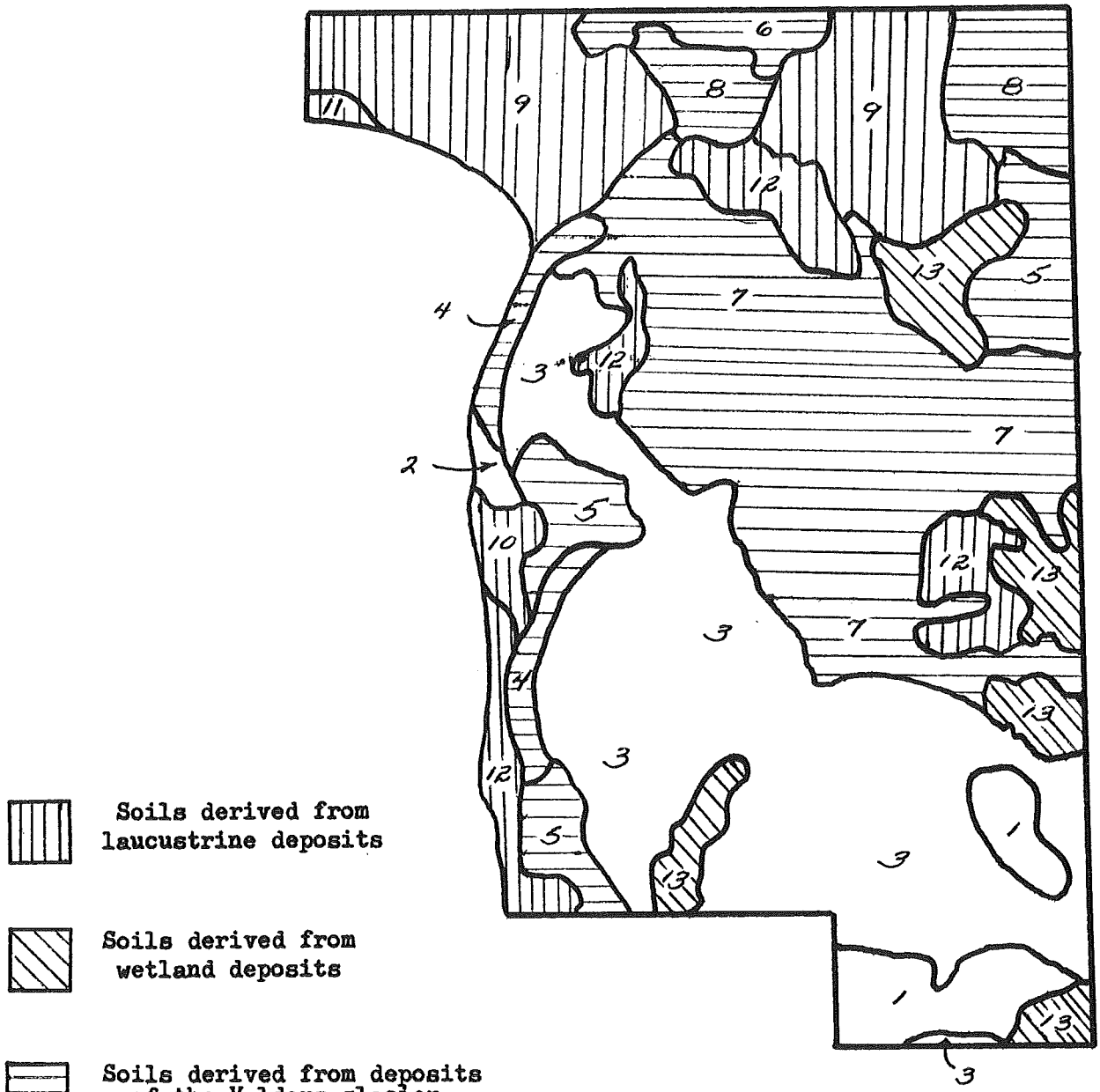

Fig. 6. Soils of Calumet County

(Hanson & Hole, 1967)

Key to the Soils of Calumet County

1. Loess over dolomitic and sandy loams and glacial tills (Hochheim, Theresa, and Brookston silt loam).

2. Loess over dolomitic sand and gravel outwash (Fox, Casco, and St. Charles silt loam).

3. Similar to #1 (Theresa, Hochheim, and Nenno silt loam).

4. Calcareous reddish-brown glacial drift over limestone bedrock (Kolberg, Summerville, and Kewaunee silt loams).

5. Reddish-brown calcareous clay loam and clay glacial till (Kewaunee, Hortonville, Manawa, and Poygan silt loam).

6. Reddish-brown calcareous clay and silty clay glacial till (Kewaunee, Manawa, and Poygan silty clay loam).

7. Similar to #6 (Kewaunee, Manawa, and Poygan silt loam and loam).

8. Reddish-brown calcareous loam and clay glacial till (Kewaunee, Manawa, Poygan, and Hortonville loams, and Tustin loamy sand).

9. Reddish-brown calcareous clay glacial till and lacustine sediments (Ontonagon, Hibbing, and Rudyard silty clay loam).

10. Similar to No. 9 (Oshkosh, Manawa, and Poygan silty clay loam, Tustin sandy loam).

11. Neutral sandy glacial drift and lacustrine deposits (Granby, Shawano, and Emmet sand and sandy loam, shallow peat soils).

12. Calcareous clayey lacustrine sediments (Mittau, Poygan, Poy Sippi, and Borth loams and silty clay loam).

13. Wetland vegetation over loamey and clayey calcareous drift (Pella, Poygan, and Brookston silt loam and silty clay loam).

Minerals found in lakes and streams are often by-products of the soils found within the drainage basin. Surface waters located in regions of high soil fertility will have high water fertility ratings as is the case in Calumet County. Minerals, such as calcium and magnesium, are common in the county's heavy soils and as such, are found in above average concentrations in the surface waters. Because of run off and permeability characteristics associated with the heavy soils nutrients (manure and fertilizer) readily find their way into the surface waters and in some instances lead to excess rates of eutrophication.

Ground Water

The ground water resources of Calumet County play an important role in the maintenance of surface water resources. Natural lakes and many wetlands are exposures of the ground water level or water table and as such, long term fluctuations in ground water levels will be accompanied by corresponding fluctuations in lake and wetland water levels. Base flows of perennial streams flowing into Lake Winnebago are maintained by springs that appear along the interface between the porous Niagara dolomite and the impervious Maquoketa shale. A similar condition, with springs appearing from the Niagara limestone, is found along the North Branch Manitowoc River and its tributaries. In these areas springs would be more common and streams would have stronger base flows if the land surface was not covered with a relatively impervious layer of clayey drift. Ground water seepage is either directly or indirectly (marsh drainage) responsible for maintaining base flows of streams located where springs are not common.

Climate

There is one cooperative weather reporting station in Calumet County located near Chilton in the center of the county. Climatological data from this station and from stations in nearby counties provide a representative cross section general climatic condition prevalent throughout the county. Table 2 is a compilation of climatic data from the area.

The climate of Calumet County is typically continental having four well defined seasons. Winters are cold and snowy while summers are warm and humid. A succession of high and low pressure centers move over the county from west to east and lead to drastic changes in weather every few days, especially during spring and winter months. July, with an average temperature of 70.5° F., is the warmest month while January, with an average temperature of 18.1° F., is the coldest. Ice freeze shallow lakes normally freeze over by late November and break up late March. The growing season averages about 138 days and runs from mid-May to early October. Prevailing winds are southerly in summer and westerly in winter. April and November are the most windy months and August is the least. During April and November when wind is maximum lakes can be expected to experience greatest turnover and mixing. Strong thermoclines are established during the hot, calm month of August.

Average annual precipitation (including water content of snow) approximates 29 inches. Average annual snowfall is about 44 inches. About 55 percent of the normal yearly precipitation falls during the five month period from May through September with June and July being the wettest months. Figure 7 correlates average monthly temperature as recorded at Chilton. The full impact of precipitation on Calumet County's surface waters is discussed in the next section.

Table 2. Climatological Data for Stations In and Near Calumet County

	Precipitation (inches)			Temperature (°F)		Growing	Average date of killing frost	
Station	Mean Rain	Days with Rain	Mean Snow	Mean Monthly	Extremes	Season (Days)	First	Last
Appleton	28.5	65	43.4	45.6	-30 to 107	164	Oct. 14	May 3
Chilton	29.2	64	43.8	45.8	-33 to 100	138	Oct. 2	May 17
Fond du Lac	29.0	65	40.5	46.9	-41 to 110	151	Oct. 9	May 11
Oshkosh	27.9	64	43.8	46.0	-32 to 107	148	Oct. 4	May 11
Plymouth	28.3	61	46.6	45.8	-27 to 107	155	Oct. 11	May 9

(Wis. Climatological Data, 1961)

Runoff and Flow Characteristics

The principle source of water in Calumet County is precipitation. Precipitation is absorbed by soil to be used by plants or evaporated into the air (evapotranspiration), infiltrates the soil to recharge ground water supplies (storage), and runs off directly into the surface waters. In Calumet County annual precipitation amounts to about 29 inches. Of this amount 20 to 22 inches is lost through evapotranspiration and none is lost to storage (net change in storage is zero), leaving seven to nine inches to run off into lakes and streams. These figures (7 to 9 inches) include excess ground water that forms springs and seeps (Olcott, 1968).

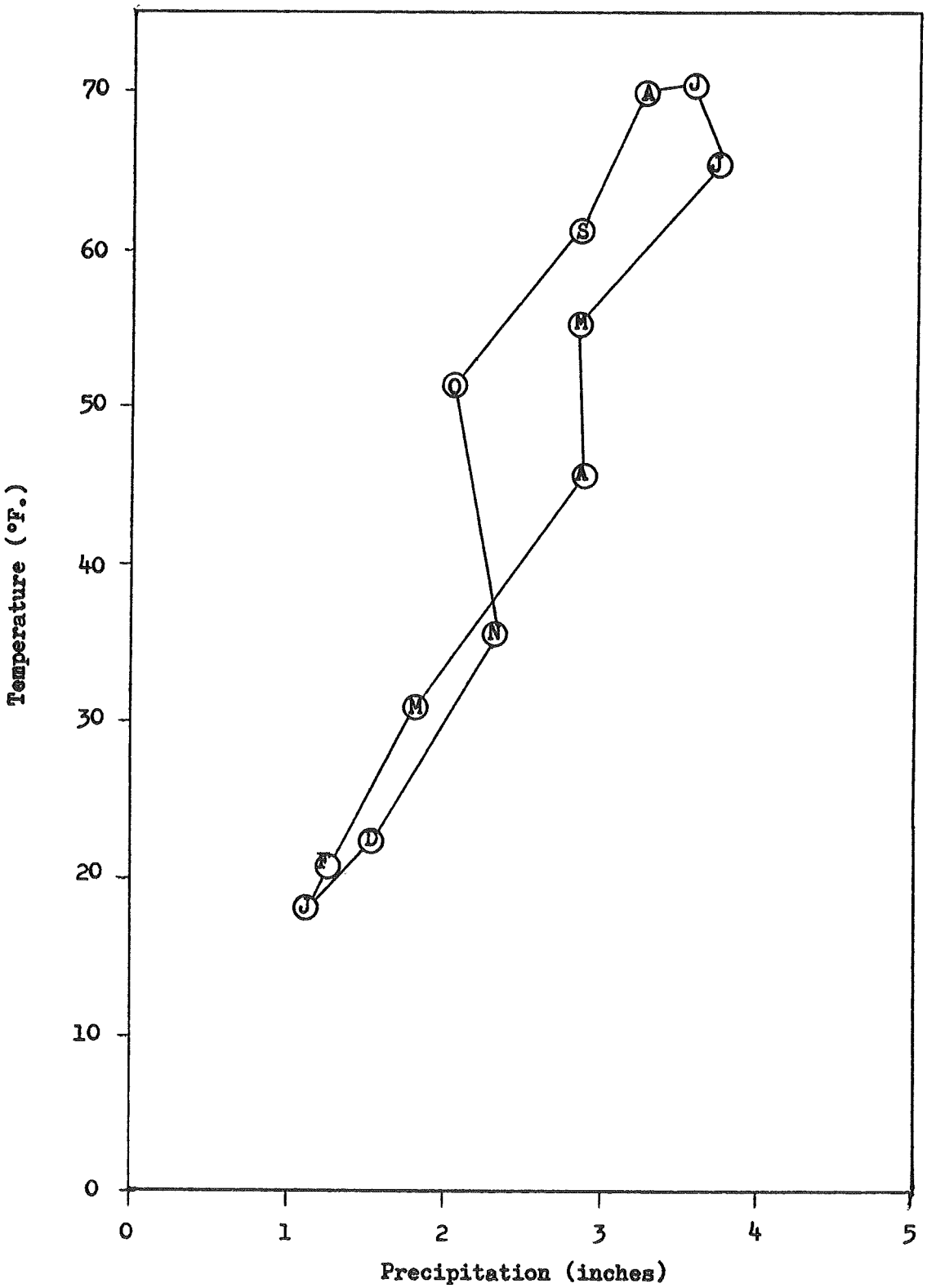

Fig. 7. Climograph of mean monthly data recorded at Chilton.

(Wis. Climatological Data 1961)

Seasonal fluctuations in runoff (both ground water and surface) and subsequent stream flows are affected by topography soil conditions, temperature, vegetative cover, antecedent moisture and amount of precipitation. Greatest stream flows can be expected in March and April when winter snows are melting, rainfall is relatively large, and soils are still frozen minimizing percolation into ground water supplies. Minimal flows can be expected in August when evapotranspiration is high and precipitation is moderate. Minimal flows can also be expected in January when ground water levels are low and runoff is zero because of freezing conditions. Representative low flows of most county streams can be found in Appendix 1a.

Lake levels are more stable than stream flows and are more directly correlated with ground water levels than with seasonal runoff rates. Drastic fluctuations in lake levels are more pronounced on a long term basis (several years) than on a short term basis (seasonal).

Population and Area

Calumet County, with an area of 315 square miles, contains 0.6 percent of Wisconsin's total land area. The county ranks 68th in size among the 72 Wisconsin counties.

In 1970, 27,604 persons resided in Calumet County representing approximately 0.6 percent of Wisconsin's population. Calumet ranks 36th in population among the counties. Projections indicate that by 1990 Calumet County will support a population of nearly 35,000 people, an increase of about 60 percent over 1960 levels. (Fuch's and Marshall, 1968). This projected rate of increase is only slightly below that of the entire state and reflects a fairly stable population. Greatest gains in population are in the 15 to 64 age group (Fuchs, et. al., 1966). People are moving into Calumet County from the larger industrial cities located in adjoining counties primarily to have the freedom rural living provides yet still be close to large employment centers. Population data are presented in Table 3.

Eight incorporated cities and villages are present in this county. Of these, four are large enough to be classed as urban areas (over 2,500 or more population). Just over 51 percent of the county residents live in these municipalities. From 1960 to 1970 the urban population grew 43.2 percent (Table 4).

Land Use

When civilized man (in this case Indians from the east) first settled in Calumet County, they found vast hardwood forest consisting primarily of maple, basswood, and elm. Intermingled with this general cover type were smaller stands of lowland hardwoods (willow, ash, soft maple) and oak Savanna among others (Figure 8). Through industrious use of axe, plow, and fire this pristine landscape was soon converted into one of the most intensely developed agricultural areas in the state--often in complete disregard for the environment. Today approximately 93.5 percent (188,408 acres) of the total land area is devoted to agricultural related uses (USDA, 1966). Dairy farming is the mainstay of the present agricultural economy. Table 5 provides a breakdown of 1964 agricultural land uses. The continual state of influx of overall land use limits a complete compilation of such data under one heading.

In addition to agricultural land, Calumet County contains about 24,000 acres of commercial forest land, about 12 percent of the total land area (WCD, 1958). The remainder consists of wetlands; rights-of-way; industrial, residential, and recreational lands, and water areas (Figure 9).

Table 3. Population of Calumet County and Wisconsin

	Area (Square Miles)	Population 1950	1960	1970	Population per square mile 1970
Calumet County	315	18,840	22,268	27,604	87.6
Wisconsin	52,044	3,434,575	3,952,771	4,417,933	84.9

Table 4. Population of Incorporated Cities and Villages in Calumet County

Incorporated Place	Population 1960	1970	Percent Change 1960 to 1970
Calumet County	22,268	27,604	+ 24.0
Appleton	1,653	3,401	+105.7
Brillion	1,733	2,588	+ 45.1
Chilton*	2,578	3,030	+ 17.5
Hilbert	736	896	+ 21.7
Kiel	271	298	+ 10.0
New Holstein	2,401	3,012	+ 25.4
Sherwood	---	350	----
Stockbridge	476	532	+ 22.3
Total:	9,848	14,107	+ 43.2

*County Seat

Table 5. Agricultural Land Use Acreages in Calumet County

Land Use	Acres (Approx.)
Total Farmland	188,408
Cropland	147,867
Harvested	125,631
Pastured	16,987
Not harvested or pastured	5,249
Vegetables harvested	5,782
Woodland	18,909
Pastured	7,904
Not pastured	11,005
Other Pasture	7,132
Irrigated land in farms	10
Irrigated cropland harvested	10
Farm ponds, pits, reservoirs, earthen tanks (number--area)	80-49

(U.S. Census of Agriculture, 1966)

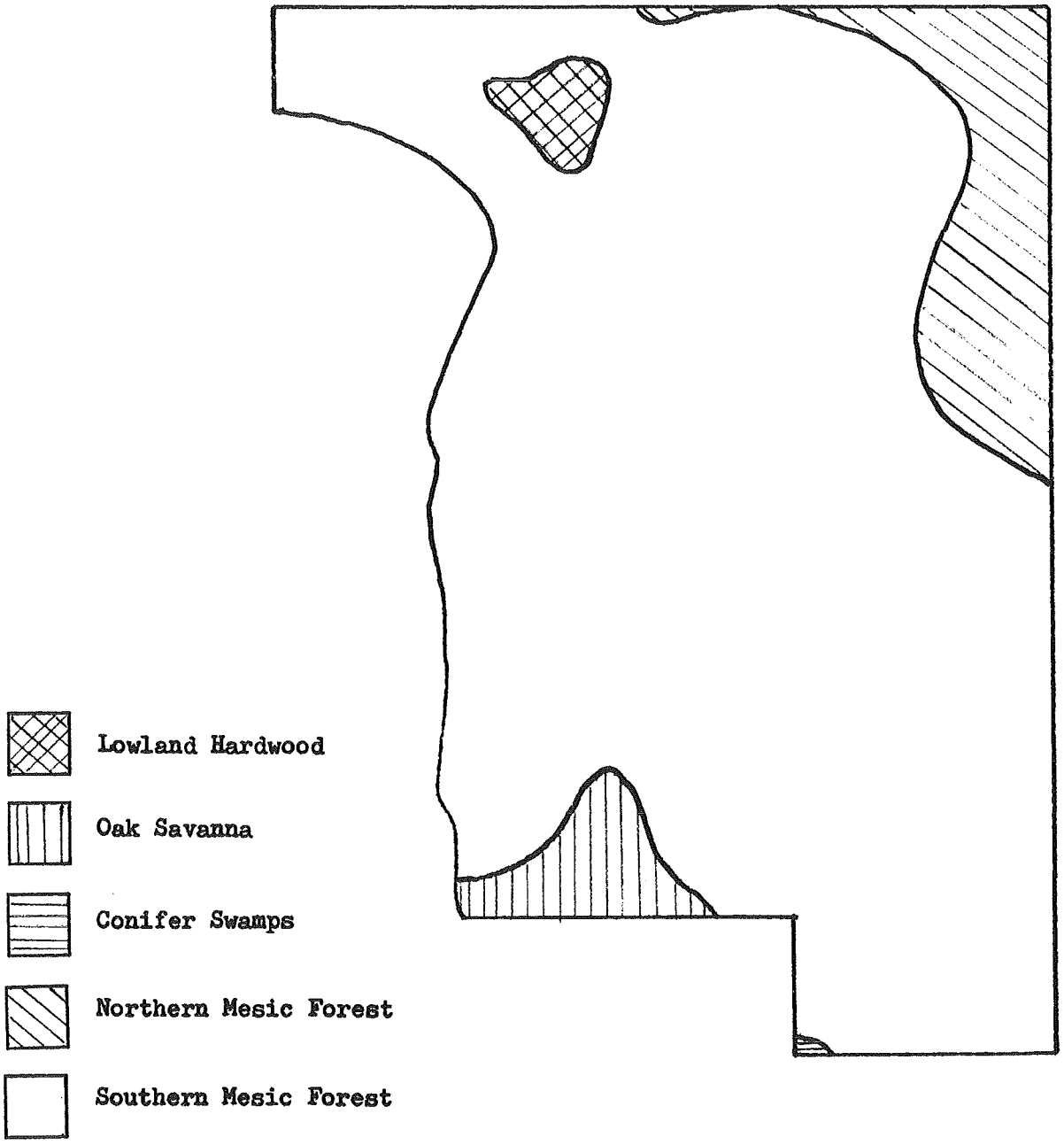

Fig. 8. The early vegetation of Calumet County

(Hanson, 1965)

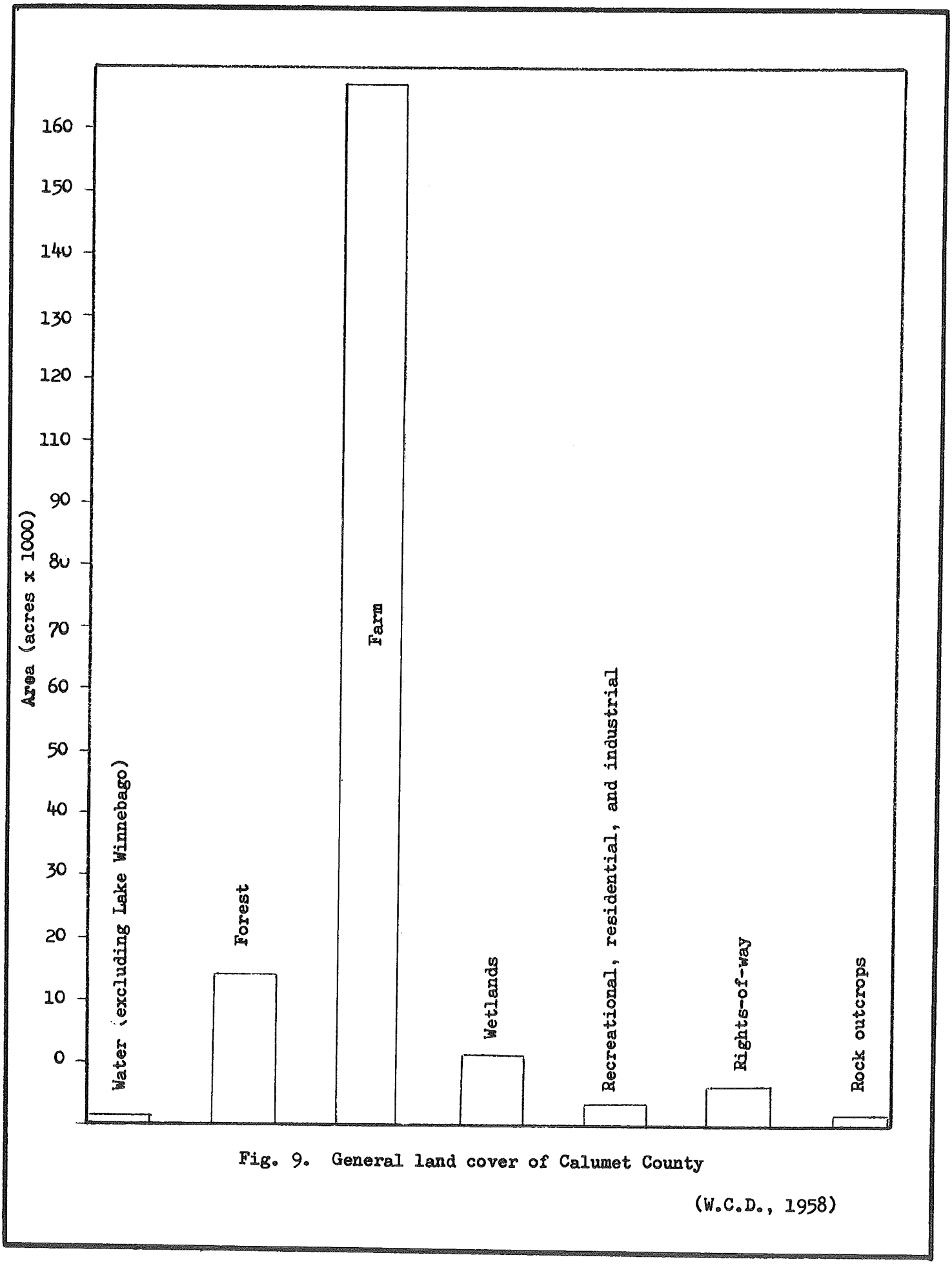

Fig. 9. General land cover of Calumet County

(W.C.D., 1958)

ALPHABETICAL LISTING AND DESCRIPTION OF LAKES AND STREAMS

Data presented in this and most following sections are based primarily on information collected during the past year. Some factors; such as number of cottages, types of commercial facilities, or degree of public access; change with time and may differ from present conditions. Some discrepancies may be noted. For the purpose of this inventory all lakes and streams have been discussed in a brief narrative paragraph.

Each lake is described by location (township, range, section, forty), area, maximum depth, and water clarity (secchi disk). Significant fish species present are listed as are problems associated with the recreational use of the lake. Wildlife values, littoral bottom materials (to a depth of five feet), water source, water quality, and other pertinent data are also presented. This degree of public access, if any, is indicated and depicted on access and public land maps. Additional data can be found in Appendix 1a. Hydrographic maps of several lakes appear in Figure 10. Private fish hatcheries and ponds less than 0.5 acre in size are not included.

Each stream is described by the location of its mouth (or where it leaves the county) area and length within the county, and gradient. The major fishery is listed along with degree of public access, bottom types, streambank vegetation, and water quality. Other conditions which may affect the recreational value of the stream are also shown. Additional physical and chemical data are presented in Appendix 1b. For this report streams are described as all named water courses (both perennial and intermittent) and all unnamed perennial water courses greater than 1.0 mile in length.

Named Lakes

Becker Lake T-19-N, R-20-E, Sec. 12 (4), Area = 31.2 acres, Maximum Depth = 51 feet, Secchi Disk = 1.5 feet

Becker Lake is a hard water seepage basin landlocked except for an intermittent outlet to nearby Grass Lake and an intermittent inlet from Long Lake in Manitowoc County. The lake contains turbid water throughout most of the open water season. Sand, gravel, silt, and detritus are primary littoral bottom materials. Bluegill, black crappie, black bullhead, perch, and carp are the most common fish species found while other species present include northern pike, largemouth bass, brown bullhead, pumpkinseed, and white or common sucker. Northern pike and largemouth bass can and do enter Becker from Long Lake during high water. The lake suffers from an occasional partial winterkill affecting primarily the game fish species. Becker Lake had been scheduled for chemical fish removal in an attempt to rejuvinate the marginal fishery but because of local opposition the project was never completed. Poor agricultural practices in the adjacent watershed have contributed to an increase in the rate of eutrophication of this basin as is reflected in the intense algae blooms often present. Most of the immediate shoreline is either pastured or cultivated. Over pasturing has caused extensive shoreline erosion along the south and east shore. Wildlife use is limited to a few puddle ducks during spring and fall migrations. Hunting is permitted. Public access is available from a county-owned launching ramp. Limited parking is available. Other developments include two cottages.

Boot Lake T-19-N, R-20-E, Sec. 1 (4), Area = 9.7 acres, Maximum Depth = 15 feet, Secchi Disk = 1.0 feet

Boot Lake is a landlocked seepage basin containing turbid hard water. During high water periods Boot Lake is connected to Long Lake in Manitowoc County. Nutrient-rich runoff water from a predominately agricultural watershed is largely responsible for heavy algae blooms commonly seen on this lake. At present most of the shoreline is either pastured or under cultivation. In 1965, Boot Lake was treated with a piscicide to eliminate the undesirable fish population then present. Subsequently the lake was restocked with northern pike, largemouth bass, bluegill, and brook trout. Brook trout are probably no longer present while perch and black bullhead have been reintroduced into the system since eradication. This lake is subject to frequent winterkill. Low numbers of migrant diving and puddle ducks are present during spring and fall. Silt is the major littoral bottom material. Developments consist of two homes and a public boat launching facility with limited parking.

Brillion Quarry T-20-N, R-20-E, Sec. 24 (11), Area = 3.2 acres, Maximum Depth = 10 feet, Secchi Disk = 2.5 feet

Brillion Quarry is a flooded, abandoned limestone quarry located in the City of Brillion. It is a seepage basin containing clear, hard water. Limestone bedrock is the primary littoral bottom material. This water is managed primarily for bass and panfish with northern pike, perch, largemouth bass, bluegill, black crappie, pumpkinseed, black bullhead, carp, and bowfin comprising the fishery. The panfish are slow-growing or "stunted". Wildlife make little use of this excavation. Hunting is not allowed because of the quarry's proximity to Brillion. A natural water level fluctuation of one to five feet is a serious use problem. In the past the City of Brillion attempted to acquire the quarry and develop it into a public recreation area. They were not successful and the quarry is still privately owned. There is no public access. Primary use at present is as a children's fishing pond. It is also used as a managed swimming area by the City of Brillion. Developments consist of a redimix concrete plant and a dump.

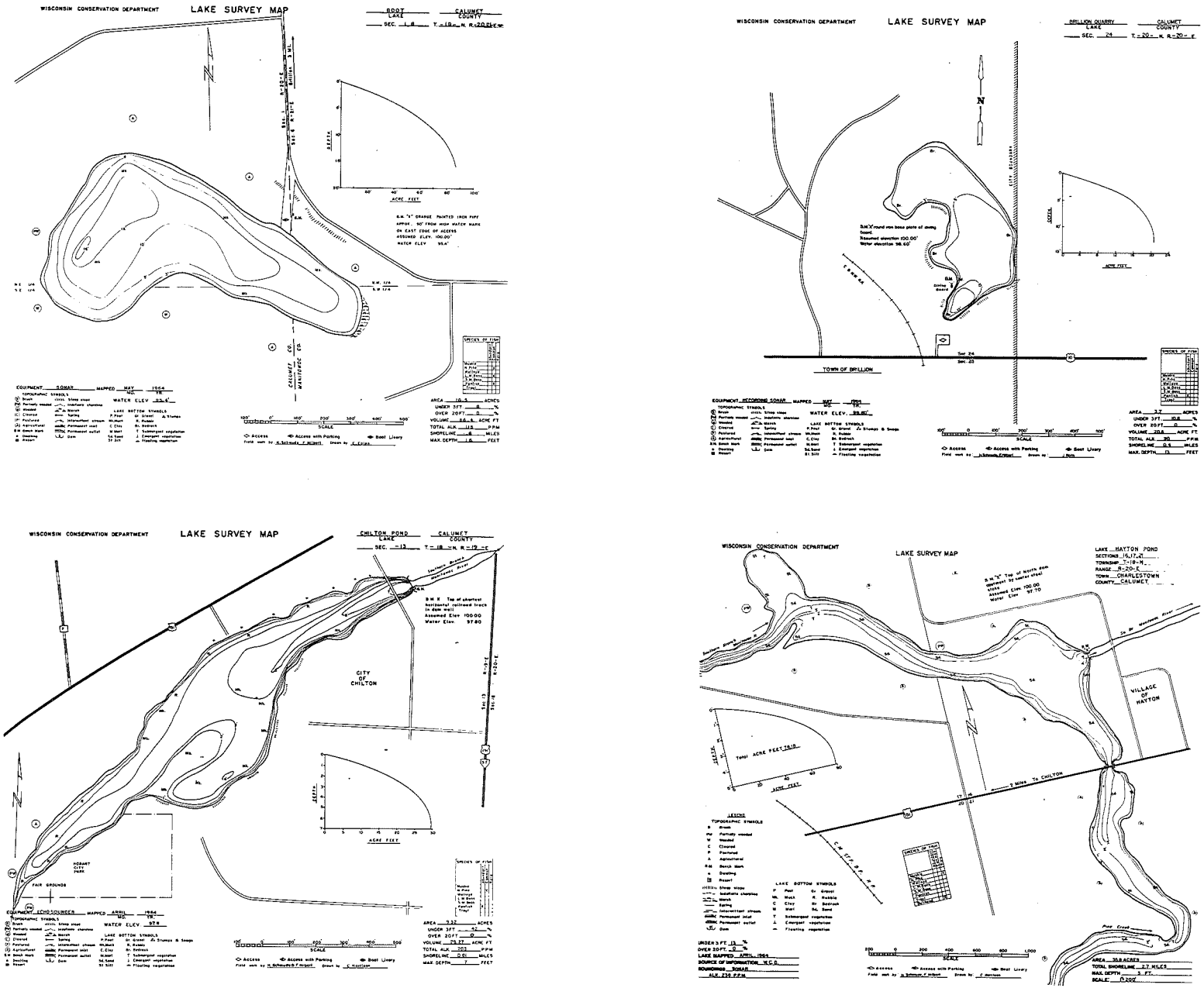

Fig. 10. Hydrographic maps of some Calumet County lakes

Chilton Millpond T-18-N, R-19-E, Sec. 13 (13), Area = 8.9 acres, Maximum Depth = 6 feet, Secchi Disk = 1.0 foot

Chilton Millpond is a shallow, hard water impoundment situated on the South Branch of the Manitowoc River. The water is generally turbid and silt is the predominant littoral bottom material. Water levels are maintained by a seven foot dam owned by the City of Chilton. Carp are the dominant fish species present. Northern pike, rock bass, pumpkinseed, channel catfish, and black bullhead, constitute the game fishery. Rough fish present, other than carp, are white sucker and redhorse. Chilton Millpond suffers from a wide variety of use problems including an occasional partial winterkill, dense growths of rooted aquatic plants, heavy algae blooms, carp, pollution in the form of silt, and fluctuating water levels. In spite of all of these problems the pond does provide some fair northern pike fishing the spring of the year. Wildlife use is limited to visits by an occasional migrant duck. Hunting is not allowed within the city limits. Developments consist of 22 dwellings and 5 commercial buildings. Hobart Park, a Chilton city park, provides walk-in access. Navigable water access via the inlet and outlet is also available.

Grass Lake T-19-N, R-20-E, Sec. 1 (6)

This is a marshy basin and is included in this report only because it is named. It contains no fishery and has little recreational use except waterfowl hunting. There is no public access.

Hayton Pond T-18-N, R-20-E, Sec. 16 (11), Area = 26.6 acres, Maximum Depth = 6 feet, Secchi Disk = 1.5 feet

Hayton Pond is an impoundment of the South Branch Manitowoc River containing turbid hard water. Water levels are maintained by a 6-foot head spillway type dam. The only access available is navigable water access via the inlet and outlet and walk-in access from U. S. Highway 151. The fishery consists of northern pike, bluegill, pumpkinseed, channel catfish, black bullhead, carp, white or common sucker, and redhorse. Carp are by far the most dominant species. Use problems include heavy algae blooms, carp, fluctuating water levels, and pollution in the form of silt and effluent from the Chilton Sewage Plant. The pond supports a significant muskrat population and a few migrant puddle ducks. Hunting is allowed. Developments consist of seven dwellings and a bar. It is surrounded by privately owned land and the dam is privately owned.

Round Lake T-19-N, R-20-E, Sec. 1 (2), Area = 10.0 acres, Maximum Depth = 55 feet, Secchi Disk = 7 feet

Round Lake is a landlocked seepage basin containing medium brown hard water. At 55 feet it is the deepest lake in Calumet County. Silt and muck are the predominant littoral bottom material present along with a lesser amount of sand. In 1959 the lake was treated with chemicals to eradicate the very marginal warm water fishery then present. After this highly successful project the lake was restocked with bluegills, largemouth bass, and rainbow trout. Today the lake supports an excellent bass--bluegill--trout fishery. A thermo-chemical profile of Round Lake is shown in Figure 11. In addition to being excellent fishing waters, Round Lake supports a wide variety of wildlife species. Hooded merganser, blue-winged teal, mallard, and ringneck duck are but a few waterfowl species observed. Sora rails, other shorebirds, and muskrats are also present. Round Lake suffers from very rare partial winterkills (bluegills most affected) and receives pollution in the form of barnyard drainage. At times algae blooms are present. Most of the shoreline is either pastured or under cultivation. Developments consist of one farm and a town road around the north end of the lake. This road provides public access. Two boat launching areas and limited parking areas are available. Round Lake is the most valuable water from a recreational and ecological viewpoint in Calumet County and as such should be subjected to every effort to protect and enhance its natural attributes.

Schildhauer Pond T-17-N, R-20-E, Sec. 11 (16), Area = 2.2 acres, Maximum Depth = 5 feet, Secchi Disk = 5.0 feet

Schildhauer Pond is the only natural spring pond present in Calumet County. It contains clear to turbid hard water and has an outlet to Pine Creek but no inlet. Water levels are partially controlled by a four-foot head dam. Much of the pond has been dredged. Sandy loam is the major bottom material. Watercress is a common aquatic plant. Hardwoods and lowland brush are common shoreline vegetation types. This pond is managed for trout with rainbows being common. Dense growths of rooted aquatic plants limit recreational use. A few migrant ducks use the pond as a rest area. Developments consist of one cottage and a private campground (not open to the public). There is no public access.

Lake Winnebago, Area = 137,708 acres, Maximum Depth = 21 feet

Lake Winnebago is the most important surface water resource in Calumet County. Some 23.2 miles of Lake Winnebago shoreline are located in Calumet County.

Because of its size and general character, Lake Winnebago provides a wide range of boating opportunities. Several very good public access sites are present in Calumet County as enumerated in Table 6. Boating intensity is high during seasonal peak use periods (weekends and holidays).

The water in Lake Winnebago is fertile and very productive and as such the lake supports a very diverse fishery. Walleye, perch, sauger, white bass, and northern pike provide excellent fishing in most years. Ice fishing for walleye and sauger is quite popular during the winter months as is the annual lake sturgeon spearing season. A complete listing of Lake Winnebago fishes can be found in Priegel, 1967.

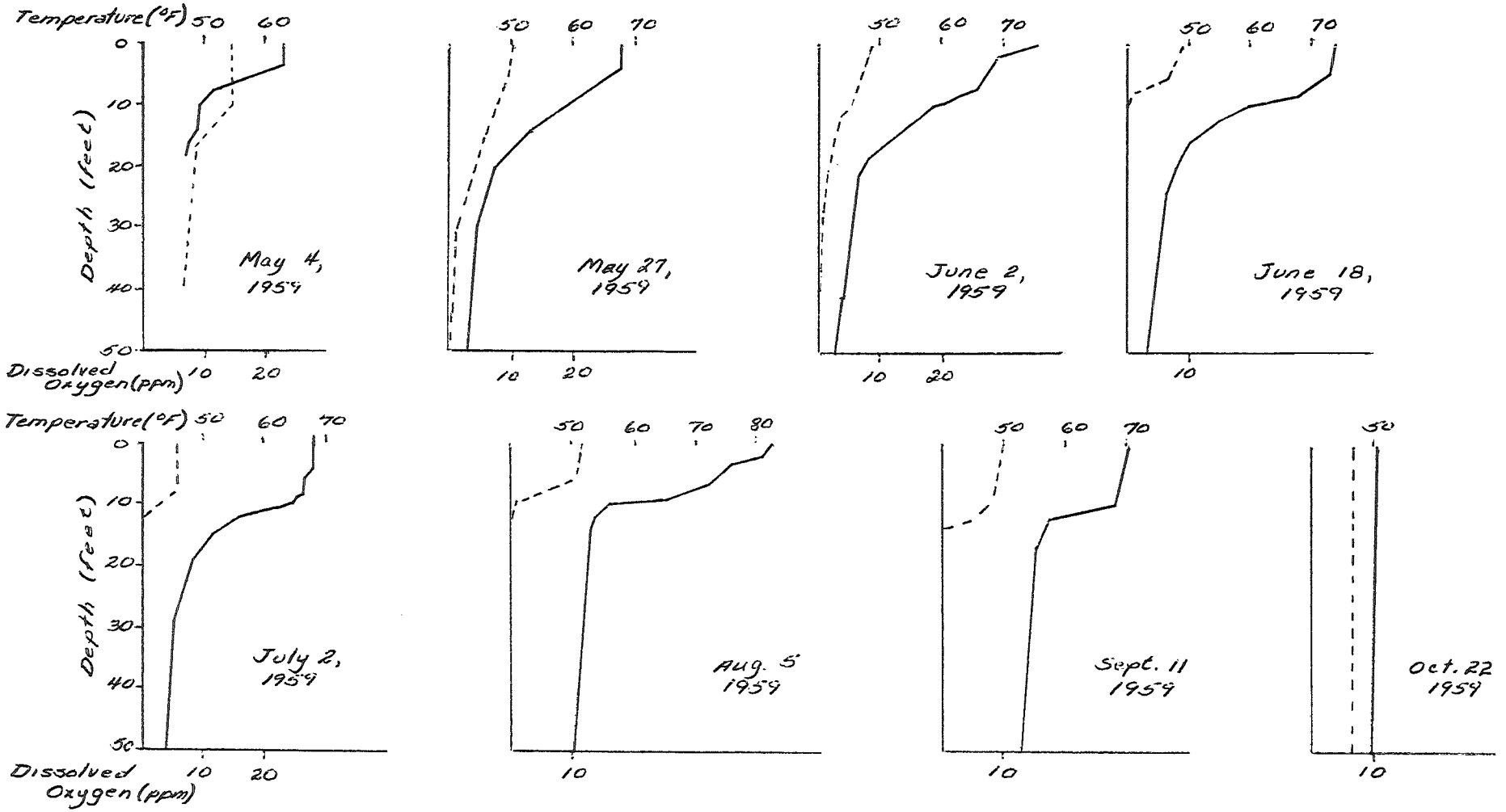

Fig. 11. Thermo-chemical profiles of Round Lake

(Data collected by P. T. Schultz)

Table 6. Public Access Sites Along Lake Winnebago

Number	Name	Parking[1]	Type of Ramp	Winter Drive-On	Bank Fishing	Toilets	Camping
1	Fire Lane No. 8	Limited	Gravel	X	-	-	-
2	No Name	Limited	Concrete	X	-	-	-
3	High Cliff State Park	Adequate	Concrete Plank	-	X	X	X
4	No Name	Limited	NO FACILITIES				
5	Stockbridge Harbor	Limited	Concrete	X	X	-	-
6	No Name	Limited	NO FACILITIES				
7	Twilight Beach Road	None	None	X	-	-	-
8	Quinney Road	Limited	Concrete	X	-	-	-
9	Lakeland Drive	Limited	Gravel	X	-	-	-
10	Driftwood Beach	Limited	Gravel	X	-	-	-
11	Gladwater Beach	None	Gravel	X	-	-	-
12	Calumet County Park*	Adequate	Concrete	X	X	X	X
13	Brothertown Harbor*	Limited	Concrete	X	X	-	-

[1] None - no parking
Limited - parking for less than 10 units
Adequate - parking for more than 10 units

* Fee charged for launching boats

Hunting opportunities along Lake Winnebago's Calumet County shoreline is limited mainly to waterfowl shooting. Concentrations of 50,000 to 100,000 waterfowl, mostly divers such as canvasback and bluegill, gather on Lake Winnebago each fall. Because the shoreline is quite steep in most places it does not lend itself to shore type shooting. A recent rule change allowing open water shooting has greatly increased waterfowl hunting opportunities on Lake Winnebago.

Most of the Calumet County shoreline of Lake Winnebago is quite steep primarily because it is formed by the west facing slope of the Niagara Cuesta (see section on geology). For this reason no significant wetlands have formed along this shoreline.

This discussion has been very brief touching only upon the most important aspects of Lake Winnebago as concerning Calumet County. A more detailed discussion of Lake Winnebago can be found in the Winnebago County Surface Water Resources Report.

Unnamed Lakes

Lake 18 (2) T-20-N, R-18-E, Sec. 18 (2), Area = 2.7 acres, Maximum Depth = 9 feet, Secchi Disk = 1.5 feet

This small pond is an excavated sand pit that has become flooded with hard, turbid water. Sand is the major littoral bottom material. The pond is landlocked and depends on seepage as a main water supply. Black bullheads are the only fish present. This excavation suffers from both summerkill and winterkill. Excessive algae blooms are also a use problem. The pond provides little benefit to game. Swimming is the primary recreational use presently offered by this water. Development consists of one home. There is no public access and the adjacent land is posted against trespass.

Lake 36 (2c) T-20-N, R-18-E, Sec. 36 (2c), Area = 1.3 acres, Maximum Depth = 8 feet, Secchi Disk = 1.5 feet

This is a turbid, hard water impoundment located on an intermittent tributary of Lake Winnebago. Water levels are maintained primarily by pumping. Clay is the major bottom material. Bank vegetation consists mainly of grasses. Panfish are the major fish species present. Winterkill, carp, and severe water level fluctuations are use problems. Game values are very limited. At one time this pond was a private fish hatchery licensed to raise trout. All of the pond presently lies within the boundaries of High Cliff State Park. There are no developments. Unimproved public access is available across state lands.

Lake 36 (2d) T-20-N, R-18-E, Sec. 36 (2d), Area = 3.4 acres, Maximum Depth = 9 feet, Secchi Disk = 1.5 feet

This is a turbid hard water excavation having a navigable inlet from Lake 36 (2c). It has a small intermittent outlet to Lake Winnebago. Panfish are the only species known to be present. Winterkill and natural water level fluctuations are major use problems. Game values are limited. Clay is the predominant bottom material. Bank vegetation consists of grasses and upland hardwoods. Like Lake 36 (2c) this pond was once used as a trout rearing area in spite of very poor water quality. Unimproved access is available across state lands. The entire pond is located in High Cliff State Park.

Named Streams

Black Creek T-20-N, R-20-E, Sec. 26

Black Creek is an intermittent named stream that seasonally flows into Brillion Marsh. It offers little or no fishery potential and limited potential for other forms of aquatic recreation.

Hayton Creek T-18-N, R-20-E, Sec. 24 (16), Area = 3.9 acres, Length = 2.2 miles, Gradient = 4.5 feet per mile

Hayton Creek is a clear, hard water stream tributary to the Manitowoc River. Throughout most of its course it drains the large wooded Hayton Swamp. Silt and detritus are predominant bottom materials. Bank vegetation consists of wooded swamp, shrub meadow, and open meadow. The fishery consists of forage species only. Wood ducks, snipe, and woodcock are major game species present. Access is provided by one town road crossing.

Johnson Creek T-18-N, R-18-E, Sec. 23 (10)

Johnson Creek is a small intermittent tributary to Lake Winnebago. It was dry during 1970. This stream offers very limited recreational potential.

Kankapot Creek T-20-N, R-19-E, Sec. 5 (6), Area = 3.0 acres, Length = 2.4 miles, Gradient = 15.8 feet per mile

Kankapot Creek is a turbid, hard water stream that flows north out of the county to join the Fox River. Shoreline vegetation consists primarily of firm pasture and upland hardwoods. Hardpan is the major bottom material present. Both fish and game values are quite limited. The fishery is limited to a few forage species. Access is available from three town roads, one county highway, and one federal highway. Since the adjoining watershed is largely agricultural this stream offers little recreational potential.

Killsnake River T-18-N, R-20-E, Sec. 12 (3), Area = 14.0 acres, Length = 14.0 miles, Gradient = 7.1 feet per mile

The Killsnake is a clear, hard water stream located in east-central Calumet County. About one-fourth of the stream flows through a large marsh-swamp complex before entering the Manitowoc River. Game species such as pheasant, duck, rail, rabbit, and a few aquatic furbearers are present in this area. The upper three-fourths of the stream flows through an intensely developed agricultural area. Game values are quite limited in this region.

The fishery consists of northern pike, black bullhead, carp, and white sucker. Carp are a problem on this stream. Fish cover is provided primarily by dense aquatic vegetation. Silt is the predominant bottom material. About three-fourths mile of stream is located in a state-owned public hunting ground. Additional access is available from ten town roads, two county roads and one state highway.

Manitowoc River (N. Br.) T-19-N, R-20-E, Sec. 36, Area = 190 acres, Length = 9.5 miles, Gradient = 2.1 feet per mile

The North Branch Manitowoc River is a turbid, hard water stream that drains most of northeastern Calumet County. It is a very sluggish stream subject to annual partial winterkills. Muck and silt are most common bottom materials. Northern pike, perch, bullhead, carp, suckers, and redhorse are predominant fish species present. Carp are abundant making them a major problem species. Various wetland complexes located along the upper portion of this stream are quite attractive to game animals. Ducks, pheasant, deer, and small game mammals are common in these areas. A state-owned waterfowl flowage is presently being developed on this river. About one and one-half miles of stream are located in state-owned public hunting grounds. Additional access is available from two town roads and one state highway. If properly developed this stream could offer some excellent hunting and nature study areas.

Manitowoc River (S. Br.) T-18-N, R-20-E, Sec. 12 (1), Area = 56.7 acres, Length = 19.7 miles, Gradient = 5.1 feet per mile

The South Branch Manitowoc River is the longest stream in Calumet County. It contains clear, hard water and drains about one-half of the county. Two impoundments, Hayton Pond and Chilton Millpond are located on this stream. Most of the watershed is intensively farmed. Silt and sand are major bottom materials with lesser amounts of rubble, gravel, boulder, and detritus present. Streambank vegetation consists of marsh, shrub meadow, meadow pasture, swamp hardwood, and upland hardwood. Common fish species include northern pike, pumpkinseed, bullhead, sucker, and redhorse. Other species present are perch, rock bass, green sunfish, and channel catfish. Carp are abundant. Fishing for northern pike is fair during the spring on portions of this stream. Waterfowl make moderate use of the river and adjacent wetlands during spring and fall migrations. Wood ducks nest along portions of the river. About one-half mile of stream is located in a state-owned public hunting ground. Seven town roads, one county highway, and one state-federal highway provide additional access.

Mill Creek T-19-N, R-18-E, Sec. 34 (15), Area = 3.6 acres, Length = 2.6 miles, Gradient = 47.3 feet per mile

Access to Mill Creek is provided by two town roads, one county road, and one state highway. The mouth of this stream has been developed into a harbor of refuge and public boat landing providing access to Lake Winnebago. Mill Creek contains clear, hard water. Major bottom materials are sand, gravel, rubble, and silt. Forage minnows are the only species known to inhabit Mill Creek. Because the stream is small and located in a heavily developed agricultural watershed it does not support a significant wildlife population. Recreational potential is limited.

Mud Creek T-18-N, R-18-E, Sec. 3 (16)

Mud Creek is an intermittent tributary to Lake Winnebago. During 1970 this stream was dry.

Pine Creek T-18-N, R-20-E, Sec. 16 (11), Area = 8.0 acres, Length = 7.1 miles, Gradient = 8.5 feet per mile

Pine Creek is a clear, hard water stream entering the South Branch Manitowoc River at Hayton Pond. Most of the watershed through which Pine Creek flows is intensely developed for agriculture. Industrial pollution from the Tecumseh Corporation enters this stream through Creek 2-15, a tributary. Silt is the major bottom material with lesser amounts of rubble and boulder present. Streambank vegetation consists of open meadow, cultivated crops, meadow pasture, and shrub meadow. The lower reaches of Pine Creek contain northern pike, black bullhead, carp, and white sucker. Carp are present in sufficient numbers to constitute a problem. Forage minnows are the only fish common to the upper reaches of the stream. Wildlife values are quite limited. Six town roads, two county roads, and one federal highway provide access.

Roberts Creek T-18-N, R-18-E, Sec. 11 (7), Area = 0.6 acre, Length = 1.2 miles, Gradient = 44.2 feet per mile

Roberts Creek is a very small, clear hard water stream running off the Niagara Escarpment into Lake Winnebago. It contains only forage minnows and supports no significant wildlife population. Cattle overgrazing the streambanks have destroyed any fish and wildlife habitat this creek may have once provided. Silt is the major bottom material. Meadow pasture and hardwood uplands form the streambanks. One town road provides limited access.

Sheboygan River T-17-N, R-20-E, Sec. 36, Area = 8.8 acres, Length = 1.4 miles, Gradient = <1 foot per mile

The Sheboygan River in Calumet County is actually the upper portion of Kiel Pond in Manitowoc County. Carp are present in sufficient numbers to cause a problem. Northern pike, perch, pumpkinseed, and black bullheads are common. Species present in lesser numbers include walleye, largemouth bass, black crappie, rock bass, green sunfish, channel catfish, and white sucker. Because of its close proximity to Sheboygan Marsh fairly large numbers of waterfowl use the river during spring and fall migrations. Seasonally, this stream offers good northern pike fishing and duck hunting. In Calumet County the entire river flows through state-owned public hunting ground consisting of marsh and swamp lands. Silt and muck are predominant bottom materials.

Spring Creek T-19-N, R-20-E, Sec. 4 (7a), Area = 1.9 acres, Length = 5.2 miles, Gradient = 3.8 feet per mile

Spring Creek is a clear, very hard water stream flowing through most of Brillion Marsh. In some areas marsh vegetation becomes so dense that the stream itself is completely obliterated. Muck is the major bottom material. The fishery consists of forage species only. Marsh land adjacent to the stream provides excellent breeding habitat for a wide variety of aquatic wildlife including ducks, rail, heron, muskrat, and mink. Many ducks visit the area during spring and fall migrations. About two miles of stream flows through state-owned public hunting grounds. Two town roads, one state highway, one federal highway, and one county highway provide additional access. Spring Creek receives pollution in the form of effluent from the Brillion Sewage Treatment Plant.

Stony Brook T-18-N, R-19-E, Sec. 27 (4), Area = 0.6 acre, Length = 2.5 miles, Gradient = 24.0 feet per mile

Stony Brook is a clear hard water tributary to the South Branch Manitowoc River. Muck is the major bottom material. Shoreline vegetation consists of upland hardwood, cultivated crops, and pasture. Intensive agricultural practices adjacent to the streams and within the watershed has greatly reduced any recreational potential Stony Brook may have once offered. The fishery consists of forage minnows only. Many very large individual northern creek chubs are present. Game values are quite limited. Access is provided by three town roads and one federal highway.

Unnamed Streams

Creek 2 (11) T-17-N, R-18-E, Sec. 2 (11), Area = 1.1 acres, Length = 3.0 miles, Gradient = 74.3 feet per mile

This is a very small, clear hard water stream flowing from the Niagara Escarpment into Lake Winnebago. Bottom materials consist of clay and hardpan. Streambank vegetation consists of shrub meadow, fallow pasture, and cultivated crops. Forage minnows are the only fish species present. Game values are quite limited. The mouth of this stream has been developed into a harbor and public access to Lake Winnebago. Three town roads and one federal highway provide additional access.

Creek 2 (15) T-17-N, R-20-E, Sec. 2 (15), Area = 0.6 acre, Length = 1.2 miles, Gradient = 33.3 feet per mile

This hard water tributary to Pine Creek serves as a drain for effluent from the Tecumseh Corporation plant in New Holstein. Flows are maintained by the discharge of effluent from this manufacturing plant. Water color varies with the type of material being discharged. No fish or other aquatic animals were noted during the survey. Rubble, gravel, boulder, and silt are predominant bottom materials. Access is available from two town roads.

Creek 4 (7d) T-19-N, R-20-E, Sec. 4 (7d), Area = 5.6 acres, Length = 1.5 miles, Gradient = <1.0 foot per mile

Creek 4 (7d) is a clear hard water stream lying entirely within Brillion Marsh. It provides excellent wildlife habitat but has a limited fishery consisting of forage minnows. Wood ducks, mallards, and blue-winged teal nest along this stream. Deer and aquatic furbearers are common as are migrating waterfowl during spring and fall months. Bank vegetation consists entirely of marsh plants. Silt is the predominant bottom material. About one-half mile of stream lies within a state-owned public hunting ground. There is no other public access.

Creek 21 (1) T-20-N, R-18-E, Sec. 21 (1), Area = 2.4 acres, Length = 1.4 miles, Gradient = 30.1 feet per mile

A tributary to Lake Winnebago, this stream contains turbid, hard water having an exceptionally high specific conductance. The watershed is largely agricultural but contains several suburban developments and a golf course. Boulder, silt, detritus, muck and golf balls are primary bottom materials. Fish species present include only forage minnows. Game values are quite limited. Access is provided by one federal-state highway.

SUMMARY AND EVALUATION OF DATA

The previous section of this report dealt primarily with each lake and stream on an individual basis. In this section data collected from each lake and stream during this and previous surveys and extracted from previous reports have been summarized and presented to provide an overall view of the county's surface water resources. Significant problems that may affect the quality or in some instances the quantity of the resource are discussed. Also discussed are the present and future potentials afforded to the various recreational uses of the resource.

Water Quantity

Calumet County contains 10 lakes and 15 streams having a total surface area of 399 acres. Lakes encompass only 99.2 acres of water while streams account for the remaining 299.8 acres. Excluded from these acreage figures are the acreages of the Calumet County portion of Lake Winnebago, dry named lakes, dry named streams, and all dry or intermittent unnamed lakes and streams.

Those waters treated as lakes have been categorized according to origin and include spring ponds, kettle lakes, impoundments, and excavations (Table 7). Spring ponds and kettle lakes are natural water basins while impoundments and excavations are man-made basins.

At 31.2 acres Becker Lake is the county's largest accounting for 31.5 percent of the total lake area. Only three lakes are ten acres in size or larger and contain a total of 67.8 acres. They account for 68.3 percent of the total lake area. The seven lakes under ten acres contain 31.4 surface acres of water.

Table 7. Origin of Calumet County lakes

Category	Number	% Total Number	Area (Acres)	% Total Area (Lakes)	% Total Area (All Waters)
Kettle Lakes	3	30	50.9	51.3	12.8
Spring Ponds	1	10	2.2	2.2	0.6
Impoundments	3	30	36.8	37.1	9.2
Excavation	3	30	9.3	9.4	2.3
Total	10	100	99.2	100.0	24.0

Round Lake with a depth of 55 feet is the county's deepest. Becker Lake is 51 feet deep. The remaining lakes are 15 feet deep or less.

Calumet County's 15 streams have a total length of nearly 75 miles with an average length of 5.0 miles. The S. Br. Manitowoc River, the county's longest stream, is 19.7 miles long. The N. Br. Manitowoc River contains 190 acres making it the county's largest stream. Over 50 percent of the streams are less than ten feet wide. These small streams account for only 9.8 percent (29.4 acres) of the total stream area but 49.1 percent (36.8 miles) of the total length. Table 8 provides a summary of size categories of Calumet County streams.

Water Quality and Pollution

During field surveys water samples were collected from each lake and stream and analyzed for pH, total alkalinity, and specific conductance (see Appendix 1a and 1b).

The pH (a measurement of hydrogen ion concentration) values recorded for Calumet County range from 6.8 to 9.0. All lakes and most streams are alkaline with pH values greater than 7.0. The mean pH is 8.1.

Total alkalinity; an expression of available carbonates, bicarbonates, and hydroxides recorded as milligrams per liter of water; is a measurement of water fertility. All waters in Calumet County are very hard with total alkalinity ranging from 129 mg/l to 386 mg/l. These waters are very fertile.

Table 8. Size classes of Calumet County streams by width*

Average Width (feet)	Number	% Total Number	Area (Acres)	% Total Area	Total Length of Shore (miles)	% Total Length	Public Frontage (miles)	% Total
<5.0	5	33-1/3	4.8	1.6	13.1	17.5	1.6	25.4
5.0-- 9.9	3	20	24.6	8.2	23.7	31.6	0.9	14.3
10.0--19.9	3	20	9.3	3.1	6.0	8.0	---	---
20.0--40.0	2	13-1/3	62.3	20.8	21.2	28.3	1.4	22.2
>40.0	2	13-1/3	198.8	66.3	10.9	14.6	2.4	38.1
Totals	15	100	299.8	100.0	74.9	100.0	6.3	100.0

*Does not include dry or intermittent streams

Specific conductance reflects the amount of total dissolved electrolytes present in the water and is expressed as μmhos/cm @ 77° F. When excessive amounts of strong electrolytes such as dissolved acids, alkalies, or salts enter water they may be detrimental to aquatic organisms. In Calumet County specific conductance ranged from 267 μmhos/cm to over 2,000 μmhos/cm. Several lakes and most streams had excessive specific conductance readings. These waters were generally small and suffering from extremely low water levels. The excessive electrolyte levels are probably due to excessive rates of evaporation rather than any artificially induced electrolyte pollution. When more water is evaporated than is replaced, electrolytes become more concentrated and will be reflected in higher specific conductance readings.

No detailed analysis of water samples are available from Calumet County lakes. Nitrogen and phosphate levels can be expected to be sufficiently high to produce moderate to dense growths of aquatic vegetation. Ions indicative of pollution (sodium, potassium, sulphate, and chlorides) probably occur in above normal concentration in most waters, especially those receiving large volumes of runoff from agricultural lands.

Among the factors that contribute to the decline of water quality, pollution is probably the most readily apparent. From 1963 through 1969 the DNR identified 23 potential municipal and industrial pollution souces in Calumet County. Of these, 12 were discharging inadequately treated wastes into the county's surface waters, primarily the Manitowoc River system. The 1963 - 1969 surveys led to the issuance of orders requiring polluters to install more effective waste treatment devices. Additional surveys are being conducted at the present time to determine compliance with orders and to determine if any new pollution sources are present.

In a highly agriculturalized county such as Calumet, cities and industries are not the only sources of pollution. Agricultural by-products such as manure, excess fertilizer, pesticides, herbicides, and silt enter surface waters and underground water supplies through runoff and seepage. Siltation, along with man induced enrichment, have caused considerable downgrading of the quality of Calumet County's surface waters. Nearly all lakes and streams suffer from some degree of siltation, caused almost entirely by poor agricultural practices. Enrichment, caused largely by nutrient rich agricultural runoff, has been responsible for excessive plant production prevalent in most streams and lakes. Plant decay has been responsible for several summerkills and numerous winterkills on both lakes and streams. At least one lake, Chilton Millpond, has been treated with chemicals ($Na_2As_2O_3$) for the control of rooted aquatic plants. Records from 1950 through 1966 indicate that this lake was treated in 1957, 1958, 1959, 1963, 1964, 1965, and 1966. During these years 6,165 gallons of $Na_2As_2O_3$ were applied to Chilton Millpond, apparently with little or no positive impact. Monies spent on aquatic nuisance control could have been better invested by treating the cause of this problem rather than the end result.

Other factors that contribute to declines in water quality include marsh drainage and dredging, spread of carp, and poor farming practices. Marshes act as stabilizing forces in the environment that act to filter polluting agents from the water and to stabilize stream flows and lake levels. When marshes are drained these valuable benefits are lost. Carp destroy aquatic vegetation and contribute to water turbidity that can lead to the upsetting of the delicate ecological balance found in all lakes and streams. Poor farming practices are very prevalent in Calumet County. Lake and stream bank pasturing and cultivation are but two examples. Poor farming methods lead to advanced erosion and subsequent siltation of surface waters. They also contribute directly to excess water fertility by allowing nutrient rich runoff easy access to surface waters.

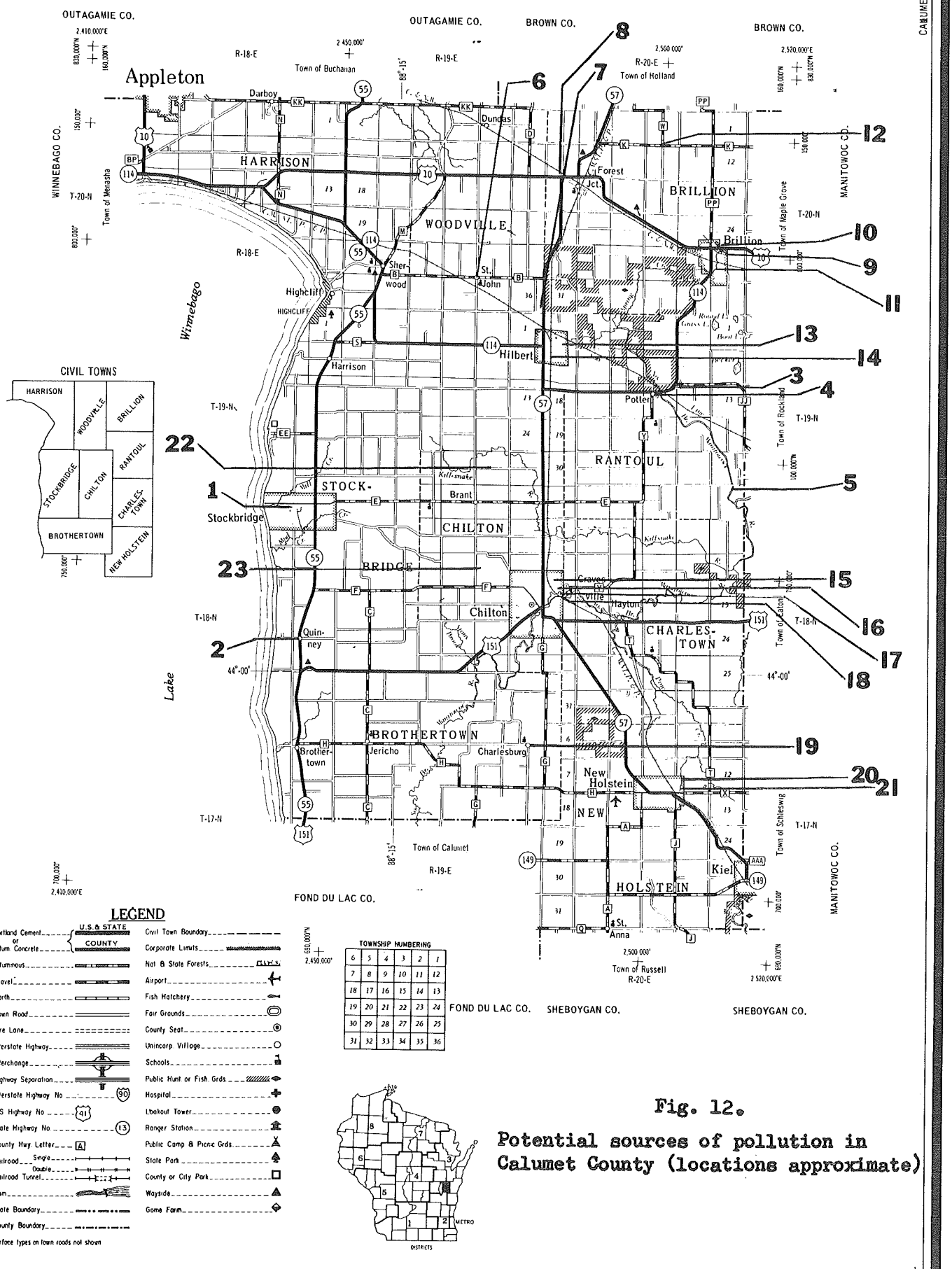

Fig. 12.

Potential sources of pollution in Calumet County (locations approximate)

Key to pollution sources of Calumet County

Source	Map Number	Type of waste	Treatment	Adequacy	Reason for Inadequacy	Surface Waters Affected
Village of Stockbridge	1	Municipal Sewage	Activated Sludge	Adequate	---	Lake Winnebago
Pauly Cheese Company	2	Dairy Waste	Spray Irrigation	Inadequate	Too small irrigation area untreated waste reaches lake	Lake Winnebago
Potter Cheese Factory	3	Dairy Waste	Holding Pond	Inadequate	Pond too small, overflow into marsh and river	N.Br. Manitowoc River
Potter Sanitary District	4	Municipal Sewage	Activated Sludge	Adequate	---	N.Br. Manitowoc River
Riverview Cheese Factory	5	Dairy Waste	Septic tank-tile	Adequate	---	N.Br. Manitowoc River
Theil's Milk Products	6	Dairy Wash Water	Ridge & furrow	Adequate	---	None
White Clover Dairy	7	Dairy Waste	Holding tank	Adequate	---	None
School Grove Cheese Company	8	Dairy Waste	Septic tank	Adequate	---	None
Brillion Iron Works	9	Cooling Water	None	Adequate	---	Spring Creek
Larsen Company	10	Canning Waste	Holding pond	Inadequate	Pond too small	Spring Creek
City of Brillion	11	Municipal Sewage	Activated Sludge	Inadequate	No disinfection, excess clear water, poor BOD removal	Spring Creek
Brillion Center Cheese Factory	12	Dairy Waste	None	Adequate	---	None
Village of Hilbert	13	Municipal Sewage	Activated Sludge	Inadequate	Poor BOD removal, excess clear water, small sludge beds	N.Br. Manitowoc River
Cold Spring Cheese Company	14	Dairy Waste	Holding tank	Inadequate	Direct discharge to stream	N.Br. Manitowoc River
Aluminum Specialty Company	15	Cooling water, rinse water	Direct Discharge	Inadequate	Detergent discharge	S.Br. Manitowoc River
Chilton Canning Company	16	Canning waste	Spray irrigation	Adequate	---	S.Br. Manitowoc River
Carnation Company	17	Dairy waste	Trickling Filter	Inadequate	Inconsistent operation No disinfection	S.Br. Manitowoc River
City of Chilton	18	Municipal Waste	Diffused operation trickling filter	Inadequate	Overloaded freezes in winter	S.Br. Manitowoc River
Charlesburg Cheese Factory	19	Dairy waste	Seepage lagoon	Adequate	---	None
Village of New Holstein	20	Municipal Waste	Secondary	Inadequate	Excess clear water No disinfection	Pine Creek
Tecumseh Corp.	21	Industrial Waste	None	Inadequate	Oil directly discharged to stream	Pine Creek
Killsnake Valley Cheese Co.	22	Dairy Waste	Septic Tank	Inadequate	Untreated waste reaches river	Killsnake River
Hillside Cheese Factory	23	Dairy Waste	Septic Tank	Adequate	---	None

(From various DNR Water Pollution Surveys)

With the exception of Lake Winnebago, overall quality of Calumet County's surface water resources is very poor. Quite obviously the value and importance of this resource has never been completely realized or understood by the citizenry. Only recently has the county established a floodplain and shoreline zoning ordinance in an effort to protect water quality.

Wetlands

No complete inventory and classification of wetlands has been completed for Calumet County. A map compiled from U.S.G.S. topographic maps showing location and extent of wetlands is shown in Figure 13.

Calumet County contains approximately 11,000 acres of wetlands, of which, about three-quarters are wooded. All large tracts of wetlands are located in the eastern half of the county, primarily along the Sheboygan River, N. Br. Manitowoc River, and Killsnake River. No wetlands are located along the Lake Winnebago shoreline.

Portions of larger marshes have been drained while many smaller marshes and swamps have been filled. Most wetland destruction has been done for agriculture. Marsh soils are often fertile (for a year or two at least) thus by draining larger marsh areas made them available as "productive" farm land. Those who drained these areas soon found out that many of these "reclaimed" wetlands had shortcomings and were soon abandoned as barren wastelands incapable of even supporting meager crops of hay.

In spite of what many believe, wetlands are important segments of the total environment by providing food, cover, and nesting areas for waterfowl, shore birds, and some upland game species; habitat for aquatic furbearers; and spawning areas for fish. In addition, wetlands reduce runoff and soil erosion, control floods, and improve water quality.

In an effort to save some of the remaining Calumet County wetlands,the Department of Natural Resources has established a large wetlands acquisition program. Over 1,750 acres of prime wetland are presently under public ownership. Additional areas are leased or rented on a year-to-year basis.

Fish and Fishing

Major fish species found in Calumet County's various surface waters are shown on the coded resource map, Figure 14. Individual species found in each lake and stream can be found in the narratives.

All ten of Calumet County's lakes support some type of fishery. Six of the lakes are subject to winterkill of some magnitude. Northern pike are found in five lakes and largemouth bass in four. No lakes contain walleye. The most common panfish species are bullhead (three species) and pumpkinseed. Trout are found in two lakes and possibly three. Carp, a major problem species, are present in four lakes. Figure 15 shows the frequency of occurrence of the common fish species found in both lakes and streams.

All streams contain strictly a warm water fishery as shown in Figure 14. There are no trout streams in Calumet County. Ten of the fifteen streams contain only forage minnows. No streams are classified as smallmouth bass waters. Fairly common warm water game fish found in streams include northern pike, perch, and bullhead. No streams contain what could be considered a good sport fishery. Carp are found in all streams containing a fishery other than forage minnows.

The overall decline in fish habitat is by far the most severe problem encountered in the management of Calumet County waters. Among other factors erosion, siltation, excess fertility, and high turbidity have combined to make many waters uninhabitable for finer game fish such as smallmouth bass, walleye and other sight-feeders. Stream erosion has destroyed much spawning habitat. Cover, other than aquatic vegetation, is very scarce on most streams and in many lakes.

The presence of carp and other undesirable fish species is a second major fish management problem. Carp and other undesirables such as stunted or slow-growing panfish disrupt the environment by destroying habitat and competing for food and cover of more valuable game fish species.

In recent years various chemicals known as piscicides have been used to eliminate undesirable fish populations. In Calumet County, Round and Boot Lakes have been treated with these chemicals, both successfully. Both lakes were subsequently restocked with desirable fish species. However, frequent winterkills on Boot Lake have negated the beneficial effects of the treatment project.

A third problem is winterkill. Six lakes and two streams suffer from some type of winterkill ranging from annual complete to occasional partial. Round Lake has an occasional winterkill of such minor proportions that it is not a problem. Conceivably a few winterkill lakes could be dredged and/or supplied with oxygenating devices to prevent winterkill if the need for additional fishing waters becomes great enough.

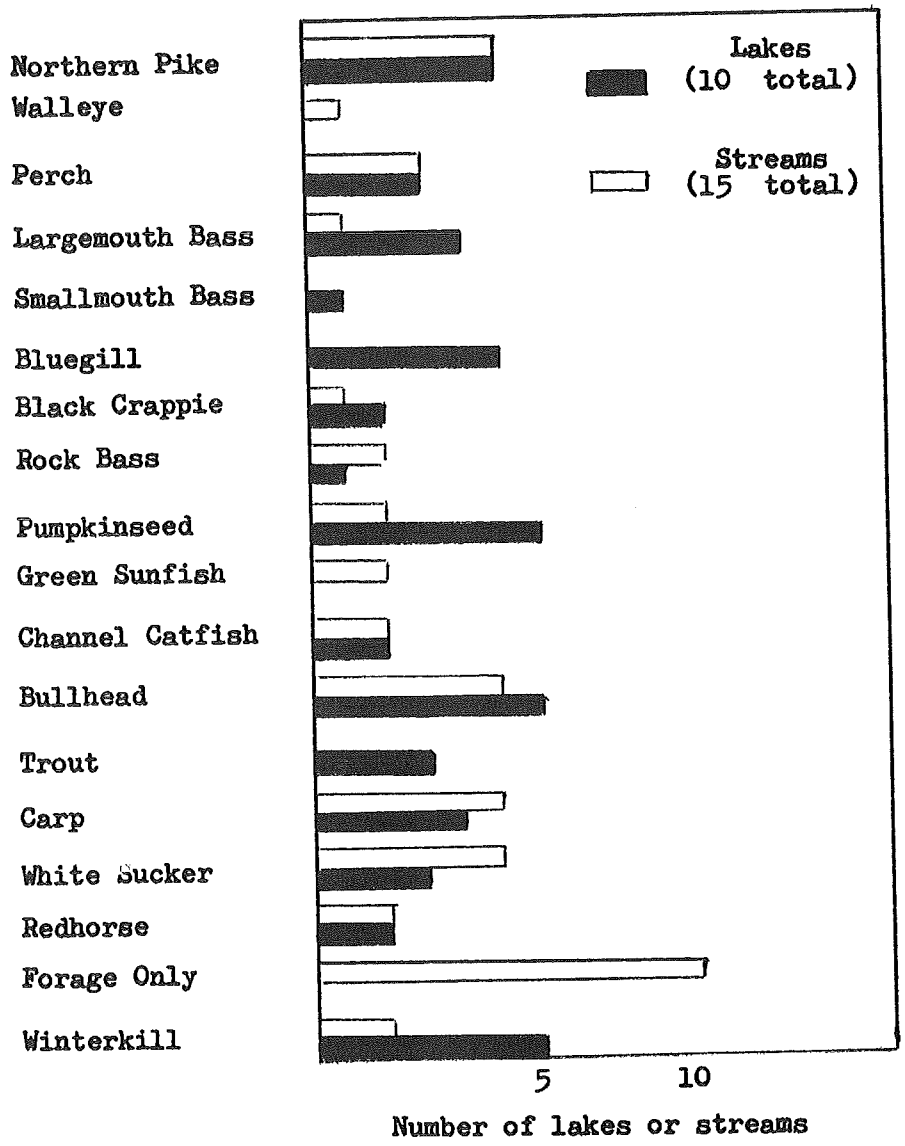

Fig. 15. Fish species found in Calumet County waters

Records of fishing license sales from 1965 through 1969 are presented in Figure 16. Sales of resident fishing licenses within the county vary somewhat from year-to-year. Usually, however, between 4,700 and 5,800 resident licenses, including sportsman's licenses are issued. Licenses issued within the county to nonresidents of Wisconsin are low, from 150 to 250 annually indicating a general disinterest in fishing county lakes and streams.

Most actual fishing pressure within the county is centered around Lake Winnebago rather than around the "inland" lakes and streams. Overcrowding is seldom a problem simply because few bother to fish in county waters except Lake Winnebago. Another exception would be Round Lake which receives heavy pressure during the early portion of the general trout season. Even to maintain the generally low level of fishing pressure--experienced on most county waters--may require expensive maintenance stocking of fish and habitat improvement work, if the overall decline in quality of the water resources continues.

Access and Public Lands

During field inspections all lakes and streams were categorized by degree of public access as shown on Figure 17. Of the ten lakes inspected, three were found to have no means of public access. Access to one lake is provided by unimproved public lands. Improved boat launching facilities are primary means of access on three lakes (two with parking, one without parking). Walk-in access through developed public parks is available on three lakes. Lake Winnebago is well supplied with various types of access. Those lakes with no means of public access are quite small and offer limited recreational opportunities. At present and expected future use levels access to lakes is adequate.

Primary access to most streams is provided by highway and bridges. Walk-in access to six streams is available through state-owned public hunting grounds. As in the case with lakes, stream access is generally considered adequate.

Public lands (state, county, and location) located in Calumet County are shown in Figure 17 and summarized in Table 9. All state and county lands listed are managed as recreational lands. Township and city lands are often used as dumps or building sites. Public lands located within corporate boundaries are not shown primarily because they do not affect the use of surface water resources. One park in Chilton does provide walk-in access to Chilton Millpond, however. Public lands provide about 1.1 miles of public frontage on lakes and about 6.3 miles on streams.

While access to lakes and streams is adequate, available public lands for other recreational uses such as hunting, snowmobiling, bicycling, and hiking are in short supply. Additional lands for these uses may be necessary in future years.

Boating

Recent information on boat registrations in Calumet County is presented in Table 10. Of the 1,385 boats only 67 or 4.8 percent are fleet boats available for rent to the public. The remainder (1,318) are private boats most of which are used on Lake Winnebago. All but 44 boats are powered by outboard motors.

During the summer of 1964 aerial boat counts were made to determine boating use levels on several lakes. Three lakes checked on each of two separate occasions indicated only three boats in actual operation, all fishing. At present, boat use levels on Calumet County lakes is not excessive. Because the lakes are very small (less than 50 acres) overcrowding could easily become a problem should use levels increase.

Farm Ponds and Private Fish Hatcheries

Eighty farm ponds containing 49 acres of water are located in Calumet County (1964 census of agriculture). Most are used for irrigation or stock watering with a few used for hunting or fishing. Because of their small size (generally less than one acre) farm ponds should be designed and used primarily for this one basic purpose, namely stock watering. A carefully planned and developed farm pond can be a valuable asset, especially in Calumet County where natural surface waters are scarce. The recent interest shown in farm ponds by private landowners is due largely to the fact that many ponds can be constructed with financial assistance from various agencies of the United States Department of Agriculture. These agencies also provide technical aid to those wishing to manage their ponds.

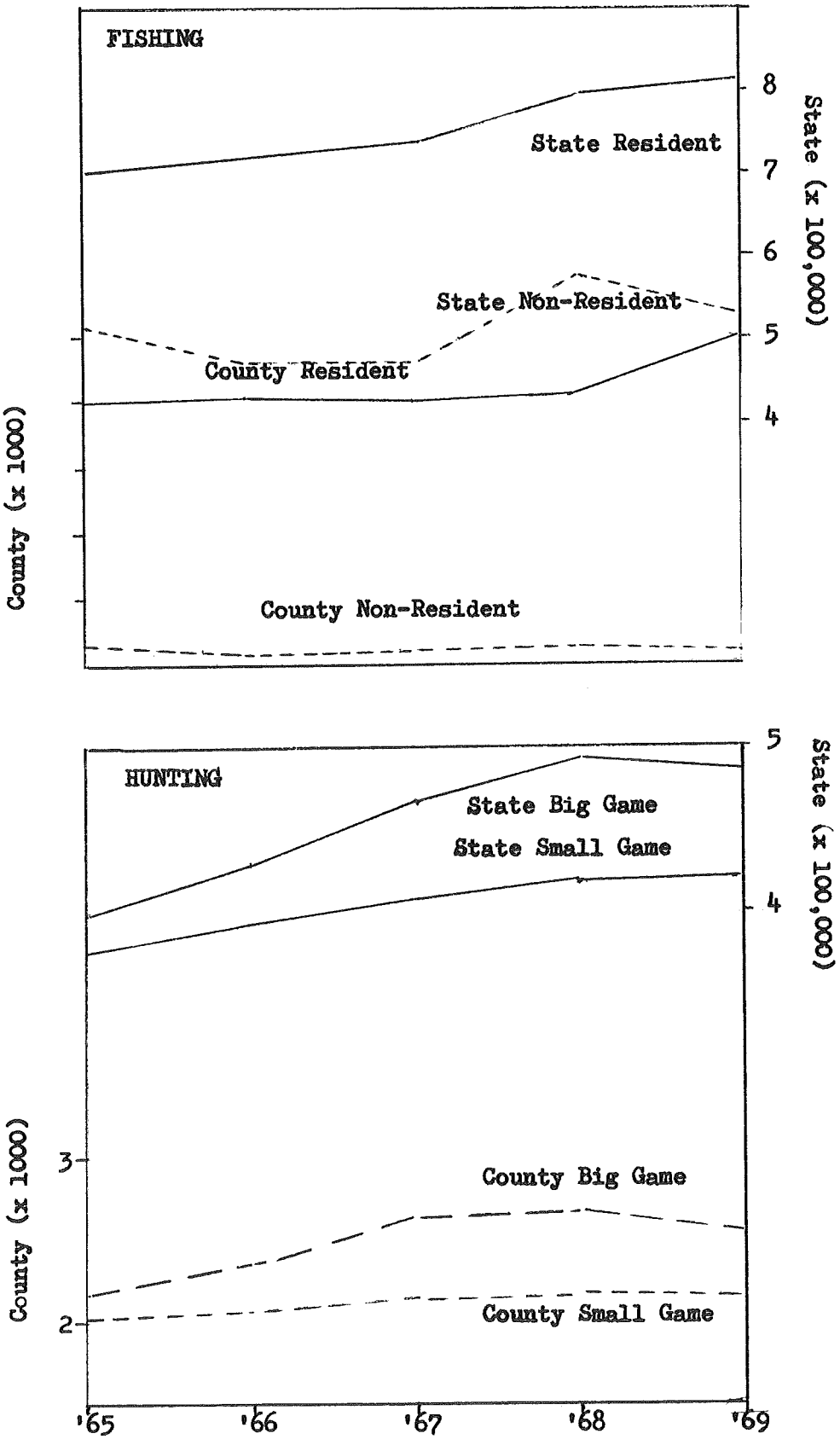

Fig. 16. Hunting and fishing licenses issued in Calumet County

Table 9. Public Lands in Calumet County

State Lands	
High Cliff State Park	899
Brillion Public Hunting Grounds	2,319
Kiel Marsh Public Hunting Grounds	280
Killsnake River Public Hunting Grounds	552
Total:	4,050
County Lands*	
Calumet County Park	181
Misc. County Lands	20
Total:	201
Local Lands*	
Township Lands	25
City or Village Lands	57
Total:	82
Grand Total (all public lands)	4,333

*Does not include land within corporate boundaries

Table 10. Summary of boat registration data as of December 31, 1969

	Outboard Motor	Sail	Inboard Motor	Total	Percent of State Total
Calumet County					
Originals	1,275	18	25	1,318	0.6
Fleet	66	0	1	67	0.2
Total:	1,341	18	26	1,385	0.5
Percent of State Total:	0.6	0.4	0.5	0.5	---
State of Wisconsin					
Originals	206,578	4,480.0	5,195.0	216,253	86.4
Fleet	33,811	466	162	34,439	13.6
Total:	240,389	4,946	5,357	250,692	----

Recent figures from DNR files indicate that 19 private fish hatcheries are licensed in Calumet County and contain 31 ponds encompassing approximately 19.3 acres. All are licensed as noncommercial hatcheries meaning fish cannot be sold from them. Location of private fish hatcheries is shown on the fishery resource map, Figure 14. Licensing of private fish hatcheries is closely regulated by Wisconsin Statutes and DNR Directives. Navigable streams, lakes, ponds, and springs cannot be licensed if such licensing will be detrimental to public interests and rights. No area larger than 160 contiguous acres can be included on one license.

Wildlife and Hunting

Nearly all lakes, streams, and wetlands in Calumet County contribute directly to the welfare of some type of wildlife. Waterfowl are one of the most important wildlife species using the county's surface waters. Significant numbers of ducks, both divers and dabblers, were observed on and near county waters during the spring of 1970. Large tracts of public lands are used almost exclusively for duck hunting during the fall. Local hunting pressure is moderate to heavy on most lakes and many streams. Nesting puddle ducks (mallard, blue-winged teal, and wood ducks) are fairly common.

Muskrats are the most common aquatic furbearers followed in abundance by mink. Beaver and otter are very rare if not absent from Calumet County. Deer are scarce with less than 200 commonly killed during the annual deer gun season. Rabbits, squirrels, pheasant, and Hungarian partridge are major upland game species present.

Hunting may well be the most popular recreational endeavor carried out in Calumet County. County hunting license sale trends (both big game and small game) parallel statewide trends showing moderate increases in the past several years (Figure 16). Most hunting opportunities are provided by private farm lands and over 3,000 acres of public land. Posting of private lands against trespass limits hunting opportunities in some portions of the county.

Decreasing wildlife habitat (both in quantity and quality) and an increasing number of hunters are major wildlife management problems encountered in Calumet County. Agricultural practices such as intensive cultivation, early spring hay mowing, stream bank pasturing, road side brush cutting, and wetland drainage are responsible for most habitat destruction. Through sound educational programs and economic assistance programs (ACP for example) some of these problems may be overcome. Quality hunting is achieved only when hunting pressure can be kept at most desirable levels which varies with type of hunting and species sought.

Shorelands

Calumet County lakes provide only about seven miles of water frontage (excluding Lake Winnebago) while streams provide some 150 miles of water frontage of which less than half is located on the larger rivers. A complete listing of shoreline lengths can be found in Appendix 1a and 1b.

The degree of shoreline developments depends on many factors. The most important of which include shoreline development factor (S.D.F.), depth of water, and nature of shoreline. In Calumet County shoreline development is very light. On only one lake (Chilton Millpond) located in the City of Chilton do the number of homes or cottages exceed ten: Hayton Pond with only seven dwellings is next most intensively developed. The remainder have two dwellings or less. Most streams have little or no development other than a few scattered farm houses. The reasons for the general lack of shoreline developments include the relative poor quality and small size of the lakes, poor lake shores and stream banks (highly eroded or marshy in most cases), and the availability of good lake frontage on Lake Winnebago.

In an attempt to prevent future haphazard development of shore lands, Calumet County has passed a shore land and floodplain zoning ordinance. Whatever protection to the aquatic environment that this ordinance may provide depends largely on the degree to which it is enforced.

Other Uses and Problems

Aesthetics, the attraction of the eye and ear to the ever changing panorama of nature, is limited in Calumet County. Most natural features aesthetically pleasing to the amateur naturalist such as water, hills, trees, and rocks, have long since been altered by the intensive agricultural practices carried on in the county. The Niagara escarpment along Lake Winnebago, an isolated valley, or a few marshes are about all that is left of "natural" Calumet County.

While Cohee (1969) estimates that over 50 percent of those using surface water resources engage in some type of beach activity, there are only two developed public beaches present in Calumet County, both located along Lake Winnebago. Only one (Brillion Quarry) of the "inland" lakes and streams has a public beach. Part of the demand for swimming facilities is taken up by municipal pools. The primary reason for the absence of developed beaches is the lack of adequate sites. Desirable characteristics for a beach or swimming facility include clear unpolluted water, firm sand or gravel bottoms, and a lack of heavy algae blooms and dense weed growths. No lakes and streams in Calumet County offer these characteristics.

Calumet County contains seven developed campgrounds of which two are public (DNR, 1969). High Cliff State Park and Calumet County Park, located on the Niagara escarpment overlooking Lake Winnebago, offer camping for some 115 units. Five private campgrounds open to the public on a fee basis provide camping for an additional 70 plus units. One campground is located on Becker Lake with the remainder on Lake Winnebago. As the need increases as expected, expansion of existing campgrounds and development of new ones may be necessary.

Flooding is not a serious problem in Calumet County. Excessive runoff during spring snow melt and during heavy rainfall occasionally cause streams to overflow. Damage is usually limited to a flooded field or basement and an occasional road washout. A PL-566 small watershed flood protection project is being considered for the Brillion area. Opposition to this project is being advanced by those who feel that any benefits that may be realized will in no measure compensate for the environmental destruction that will be caused through marsh drainage and stream channelization.

OVERVIEW

With the exception of Lake Winnebago, the surface water resources of Calumet County offer limited recreational potential as they presently exist. After a hundred years of exploitation little remains that most persons would find appealing. Water quality is poor, the fishery is minimal, and most shorelands have been altered. As such, county residents must search elsewhere to satisfy their recreational needs. Physical circumstances have contributed to the relatively poor status of county waters viewed.

The future of Calumet County's surface water resource is very bleak viewed in the light of present conditions. Many people in the county who are vitally concerned about the environment direct much of their attention to Lake Winnebago ignoring the problems facing many of the smaller lakes and streams. Perhaps there is hope, though. When man fully realizes that what he does today will be the legacy left to his children and grandchildren then he may begin to save and improve what remains.

Some positive factors are emerging. Farmers are awakening to and participating in various federal programs designed to revitalize and protect the land and water resources. Many more should participate before real, lasting benefits will be realized.

Calumet County has enacted a shoreland and floodplain zoning ordinance designed to prevent further destruction of the aquatic environment. Because it is new the impact of this regulation on the environment has not yet been evaluated. Like most laws, however, this ordinance is only as good as its enforcement.

Planning is the real key to the future of Calumet County's surface water resources. Formulating a wise but flexible plan and then following through with it will assure orderly development thereby giving the environment a chance in tomorrow's world.

ACKNOWLEDGEMENT

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Appendix 1a. Physical and chemical characteristics of Calumet County lakes

Lakes	Location T-N	R-E	Sec.	Area Acres	Length Miles	Width Miles	Max. Depth Feet	Est. Mean Depth Feet	% >20' Deep	%<3' Deep	Public Front Miles	Shoreline Length Miles	Shoreline Devel. Factor S.D.F.
Becker Lake	19	20	12 (4)	31.2	0.39	0.19	51	15	30	11	0.05	0.98	1.25
Boot Lake	19	20	1 (4)	9.7	0.23	0.13	15	6	0	10	0.01	0.62	1.42
Brillion Quarry	20	20	24 (11)	3.2	0.12	0.07	10	5	0	25	0.00	0.45	1.79
Chilton Millpond	18	19	13 (3)	8.9	0.35	0.09	6	3	0	60	0.06	0.81	1.94
Grass Lake	19	20	1 (6)	See narrative - dry on date of survey									
Hayton Pond	18	20	16 (11)	26.6	0.85	0.11	6	2	0	70	0.01	2.05	2.84
Round Lake	19	20	1 (2)	10.0	0.22	0.11	55	30	65	1	0.20	0.55	1.24
Schildhaver Pond	17	20	11 (16)	2.2	0.13	0.05	5	3	0	50	0.00	0.33	1.59
Lake Winnebago				See Winnebago County Surface Water Resources Report									
Lake 18 (2)	20	18	18 (2)	2.7	0.11	0.07	9	5	0	10	0.00	0.35	1.52
Lake 36 (2c)	20	18	36 (2c)	1.3	0.10	0.05	8	5	0	10	0.25	0.25	1.56
Lake 36 (2d)	20	18	36 (2d)	3.4	0.16	0.06	9	5	0	10	0.18	0.48	1.86

Lakes	Lake Type	pH	Total Alkalinity mg/l $CaCO_3$	Specific Conductance µmhos/cm @ 77° F.	Color	Sechhi Disk (Feet)	Sampling Date	Water Source	Watershed Sq. Miles	Direct Drainage Sq. Miles
Becker Lake	Natural	8.0	129	350	Turbid	1.5	Aug. 31, 1970	Seepage	14.50	13.30
Boot Lake	Natural	9.0	130	267	Turbid	0.8	Aug. 28, 1970	Seepage	0.24	0.18
Brillion Quarry	Excavation	8.4	135	426	Clear	2.5	Aug. 31, 1970	Seepage	0.04	0.04
Chilton Millpond	Impoundment	8.6	239	529	Turbid	1.0	Aug. 28, 1970	Drainage	67.00	32.10
Grass Lake			See narrative - dry on date of survey							
Hayton Pond	Impoundment	8.4	386	1584	Turbid	1.5	Aug. 28, 1970	Drainage	104.00	73.80
Round Lake	Natural	8.4	180	435	Med. Brn.	7.0	Aug. 28, 1970	Seepage	0.70	0.18
Schildhaver Pond	Natural	8.3	238	757	Turbid	5.0	Aug. 26, 1970	Springs	0.23	0.23
Lake Winnebago			See Winnebago County Surface Water Resources Report							
Lake 18 (2)	Excavation	8.4	164	604	Turbid	1.5	Aug. 25, 1970	Seepage	0.50	0.50
Lake 36 (2c)	Impoundment	8.8	174	430	Turbid	1.5	Aug. 25, 1970	Drainage	1.05	1.05
Lake 36 (2d)	Excavation	8.8	176	513	Turbid	1.5	Aug. 25, 1970	Drainage	1.07	1.07

Appendix 1b. Physical and chemical characteristics of Calumet County streams

Streams	Location			Area	Length	Width	Flow	Public Front.	Drainage
	T-N	R-E	Sec.	Acres	Miles	Feet	C.F.S.	Miles of Stream	System
Black Creek	20	20	26	See	Narrative	Dry on date of survey			Spring Cr.
Hayton Creek	18	20	24 (16)	3.9	2.2	15.0	No flow	None	Manitowoc Rv
Johnson Creek	18	18	23 (10)	See	Narrative	Dry on date of survey			L.Winnebago
Kankapot Creek	20	19	5 (6)	3.0	2.4	10.0	No flow	None	Fox Rv.
Killsnake River	18	20	12 (3)	14.0	14.0	8.0	----	0.8	Manitowoc Rv
Manitowoc River (N. Br.)	19	20	36	190.0	9.5	160.0	----	1.0	L. Michigan
Manitowoc River (S. Br.)	18	20	12 (11)	56.7	19.7	23.0	6.8	1.1	L. Michigan
Mill Creek	19	18	34 (15)	2.6	2.6	8.0	1.7	0.1	L. Winnebago
Mud Creek	18	18	3 (16)	See	Narrative	Dry on date of survey			L. Winnebago
Pine Creek	18	20	16 (11)	8.0	7.1	9.0	1.1	None	Manitowoc Rv
Roberts Creek	18	18	11 (7)	0.6	1.2	4.0	0.2	None	L. Winnebago
Sheboygan River	17	20	36	8.8	1.4	50.0	----	1.4	L. Michigan
Spring Creek	19	20	4 (7a)	1.9	5.2	3.0	No flow	1.5	Manitowoc Rv
Stony Brook	18	19	27 (4)	0.6	2.5	2.0	0.5	None	Manitowoc Rv
Cr. 2 (11)	17	18	2 (11)	1.1	3.0	3.0	0.4	0.1	L. Winnebago
Cr. 2 (15)	17	20	2 (15)	0.6	1.2	4.0	1.8	None	Pine Cr.
Cr. 4 (7d)	19	20	4 (7d)	5.6	1.5	30.0	No flow	0.3	Manitowoc Rv
Cr. 21 (1)	20	18	21 (1)	2.4	1.4	15.0	No flow	None	L. Winnebago

Streams	pH	Total Alkalinity mg/l $CaCO_3$	Specific Conductance µmhos/cm @ 77° F	Color	Sampling Date	Gradient Feet/mile	Watershed Sq. Miles	Direct Drain. Sq. Miles
Black Creek		See Narrative	Dry on date of survey					
Hayton Creek	7.0	177	645	Clear	Sep. 4, 1970	4.5	11.80	6.39
Johnson Creek		See Narrative	Dry on date of survey					
Kankapot Creek	8.3	324	837	Turbid	Aug. 31, 1970	15.8	41.10	41.10
Killsnake River	7.5	227	775	Clear	Sep. 2, 1970	7.1	43.20	43.20
Manitowoc River (N.Br.)	9.0	292	1050	Turbid	Sep. 8, 1970	2.1	46.90	27.85
Manitowoc River (S.Br.)	7.8	305	1400	Clear	Sep. 4, 1970	5.1	194.46	35.48
Mill Creek	7.7	298	776	Clear	Sep. 4, 1970	47.3	4.00	4.00
Mud Creek		See Narrative	Dry on date of survey					
Pine Creek	7.6	310	1240	Clear	Sep. 2, 1970	8.5	31.60	23.48
Roberts Creek	7.9	318	770	Turbid	Sep. 2, 1970	44.2	1.02	1.02
Sheboygan River	8.4	185	470	Turbid	Sep. 4, 1970	<1.0	-	-
Spring Creek	6.8	333	1900	Clear	Sep. 11, 1970	3.8	13.30	11.84
Stony Brook	7.6	285	745	Clear	Sep. 1, 1970	24.0	11.20	11.20
Cr. 2 (11)	7.8	297	770	Turbid	Sep. 1, 1970	74.3	5.40	5.40
Cr. 2 (15)	7.3	369	1144	Turbid	Sep. 1, 1970	33.3	5.22	5.22
Cr. 4 (7d)	7.0	270	775	Clear	Sep. 11, 1970	<1.0	5.75	5.75
Cr. 21(1)	8.5	250	>2000	Turbid	Aug. 31, 1970	30.1	2.25	2.25

Appendix 1c. Physical and chemical characteristics of Calumet lakes and streams--Summary

Parameter	Lakes*	Streams*	Total*
Number	10	15	25
Area			
Total:	99.2	299.8	399.0
Average:	9.9	20.0	---
Maximum Depth (Lakes)			
Average (Feet)	17.4	---	---
Length (Streams)			
Total (miles)	---	74.9	---
Average (miles)	---	5.0	---
Shoreline Length (Lakes)			
Total (miles)	6.87	---	---
Average (miles)	0.69	---	---
Public Frontage			
Total (miles)	1.06	6.30	7.36
pH			
Average	8.5	7.7	8.1
Total Alkalinity (mg/l			
Average	195	283	248
Specific Conductance (μmhos/cm @ 770)			
Average	590	1020	848

*Does not include Lake Winnebago or dry lakes and streams

Appendix 2. Definitions

aesthetics - Scenic qualities of water and related resources.

alkalinity - A measure of carbonates, bicarbonates, and hydroxides present in water, expressed as milligrams per liter of calcium carbonate. Alkalinity was determined with the acid-base indicator methyl purple and is assumed to represent total alkalinity.

aquatic vegetation - Plants that grow in or very near water. For this report aquatic vegetation was categorized as follows:

a. Submergent - plants commonly found growing beneath the surface (pondweeds, coontail, algae, etc.).

b. Floating - plants, at least portions of which float on the water's surface (lily, water shield, duckweed).

c. Emergent - rooted vegetation commonly found in shallow water or along lake margins. Much of the plant stands out of the water.

aquifer - Any geological formation capable of bearing or storing ground water.

artesian well - Wells in which the water encountered is under sufficient hydraulic pressure to force it to the surface.

coldwater fishery - A fish population composed of species generally requiring water temperatures of 75° F. or less to survive for more than a few days (trout--cisco).

crystalline rock - Igneous rocks of precambrian age composed of granular interlocking minerals such as feldspar, orthoclass, and mica.

dolomite - A sedimentary rock containing a large amount of $CaMg(CO_3)_2$.

ecosystem - The entire realm of both living and nonliving materials within a given area.

environment - All external influences and conditions affecting the life and development of an organism.

escarpment - A steep hill or slope, often the weathered edge of a rock formation.

eutrophication - The enrichment or natural aging of lakes. Man through pollution has greatly increased the rate of eutrophication on many waters.

fertility classification - As follows:

Total Alkalinity	Classification	Productivity	Waters Are:
0 - 14	very soft	low	infertile
15 - 49	soft	low-medium	infertile
50 - 99	medium hard	medium high	fairly fertile
100 -199	hard	high	moderately fertile
Over -200	very hard	high	very fertile

forest land - commercial - forest land capable of producing standard size pulpwood within 100 years.

forest land - noncommerical - forest land not capable of producing standard size pulpwood within 100 years.

glacial features:

ground moraine - Extended sheets of glacial till deposited in the path of former glaciers. These fairly level areas are composed of sand, gravel, clay, and boulders and often contain shallow marshy lakes.

kettle - A depression formed by melting of a block of stagnant ice buried by glacial drift. Many are filled with water to form lakes.

outwash plain - Gently sloping fans of various sediments deposited by water flowing from a stationary glacial ice sheet.

recessional moraine - A deposit similar to a terminal moraine only deposited during a temporary halt of a retreating glacier.

terminal moraine - A ridge of glacial till marking the furthest advance of particular glacier or lobe of a glacier.

lake types:

drainage - Having both an inlet and outlet and deriving most of its volume from inflowing surface waters.

drained - Having an outlet but no appreciable inlet.

seepage - Having no inlets or outlets. Water levels are maintained by nearby ground water supplies.

spring pond - Having either marginal or internal springs which corm the bulk of the water supply. Often no inlets are present but outlets are always present.

littoral bottom materials - Bottom sediments lying in water less than five feet deep and are classfied as follows:

sand - Particles 0.0625 mm to 1.9 in diameter.

gravel - A mixture of round coarse material of various sizes, mostly larger than sand, ranging in size from 2.0 mm to 3.0 inches.

rubble - Broken rocks 3.0 inches to 10.0 inches in diameter.

boulders - Rocks over 10.0 inches in diameter.

bedrock - Solid rock shelf.

clay - A dense gummy material consisting of very fine particles less than 0.0039 mm in diameter.

hardpan - Compressed clay.

detritus - Decaying organic matter.

silt - Fine soil particles 0.0039 mm to 0.0624 mm in diameter

marl - Very fine calcareous deposits, usually whitish in color.

limnology - The study of freshwater lakes and streams.

piscicides - Chemicals formulated for the specific purpose of killing fish (rotenone and antimycin are examples).

shale - A sedimentary rock formed of layers of compressed, hardened clay.

shoreline development figure (S.D.F.) - A method of expressing degree of shoreline irregularity. It is the ratio of the length of the shoreline of a lake to the circumference of a circle of the same area. An S.D.F. of 1.00 indicates a circle. Greater values reflect shoreline irregularities.

specific conductance - A measure of water's ability to conduct an electrical current. It indicates relative amounts of dissolved electrolytes present in water and is expressed in micomhos per centimeter at 25° C.

thermocline - The layer of water in which the drop in temperature equals or exceeds 1 degree centigrade for each meter of depth.

vernal pond - A small pond that contains water only during certain seasons of the year.

warm water fishery - A fish population composed of species able to tolerate extended periods when water temperatures exceed 75° F.

water table - The upper surface of the saturation zone of a ground water supply.

wetland - Any area where the ground is too wet to raise an agricultural crop without major drainage. Wetlands are classified as follows:

deep marsh - Water from six inches to three feet deep during growing seasons. Cattails, reeds, bulrushes, spike rushes, and pond weeds are common.

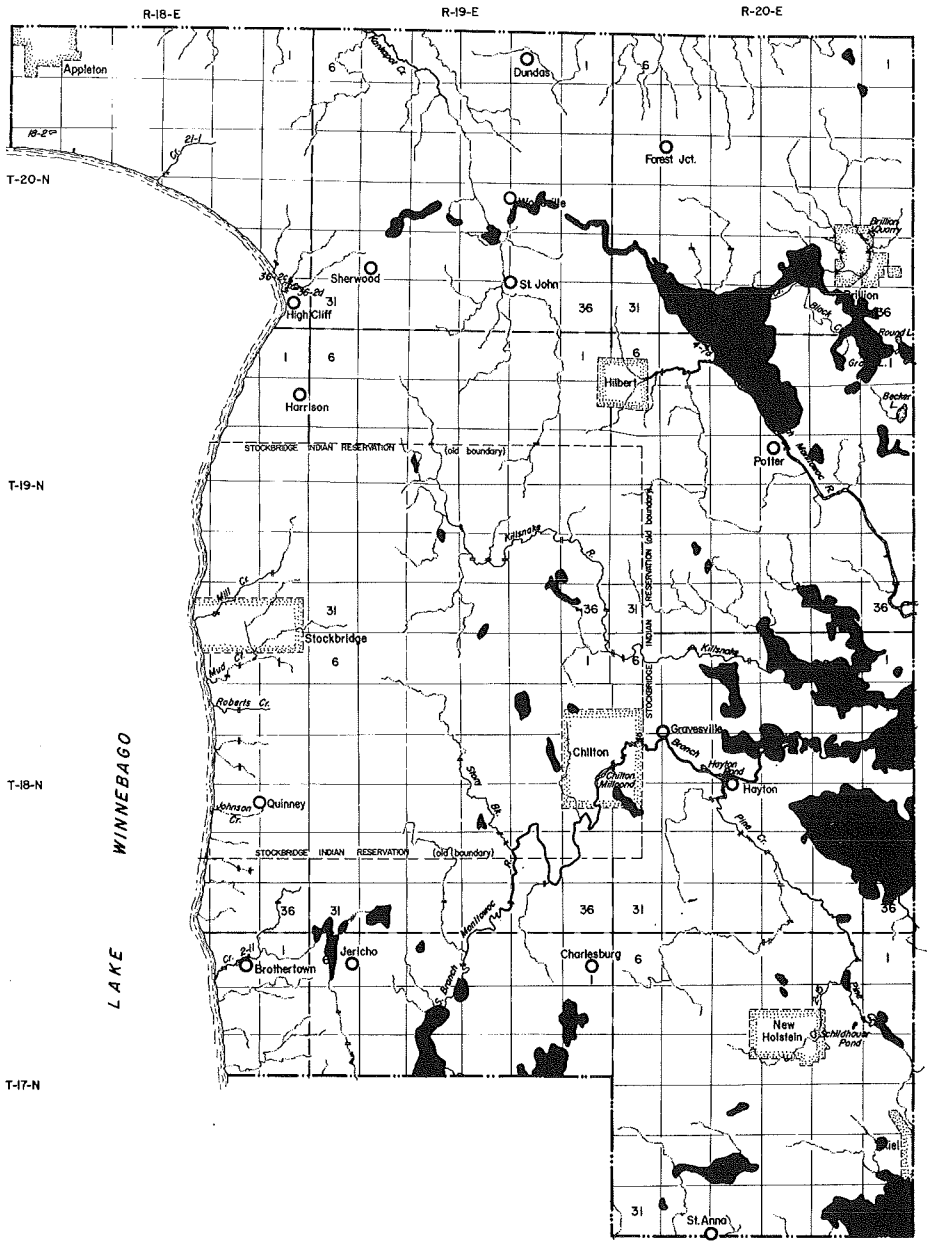
shallow marsh - Water present during part of the growing season. Cattails, river rush, spike rush, and bulrush are typical vegetative types.

fresh meadow - Soggy ground, often seasonally flooded. Vegetation of smartweed, grass, sedge, bur reed.

shrub swamp - Water logged soil with occasional standing water. Tamarack, black spruce, black ash, and elm are common trees.

wilderness lake - A lake located over 200 feet from any building, road, commercial facility, etc. The shoreline is not developed.

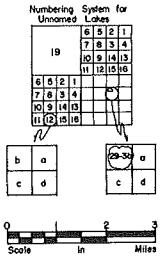
winterkill - Death of fishes resulting from inadequate dissolved oxygen levels under ice.



LAKES AND STREAMS OF CALUMET COUNTY

Prepared by:
Wisconsin Dept. of Natural Resources
Lake Classification
Biologist: Ronald L. Fassbender
Draftsman: R.F. Scheele, A.H. Philpot
Date: February, 1971

Numbering System for Unnamed Lakes



Stream Width
- Intermittent
- < 10'
- Bridge
- 10'–20'
- Dam
- 20'–40'
- >40'

- County line
- Township lines
- Corporate limits
- Unincorporated town

Scale 0 1 2 3 Miles

Data
- Population - 27,604 (1970)
- Area - 315 square miles
- Water Area - 399 acres (excluding Lake Winnebago)
- Miles of Stream - 74.9
- Area of Streams - 299.8 acres
- Number of Lakes - 10 (excluding Lake Winnebago)
- Area of Lakes - 99.2 acres (excluding Lake Winnebago)

FIGURE 13. WETLANDS

Generalized wetlands

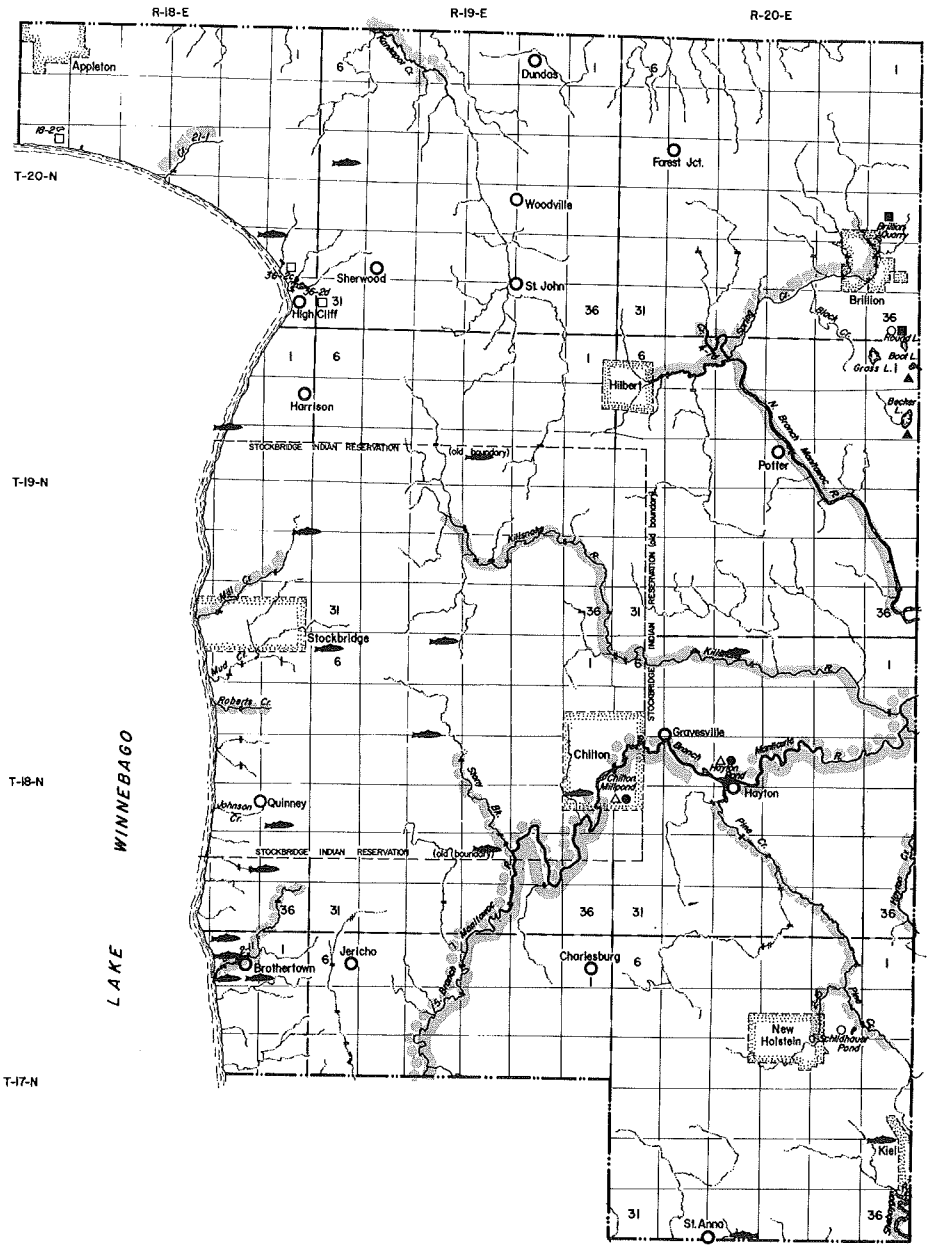


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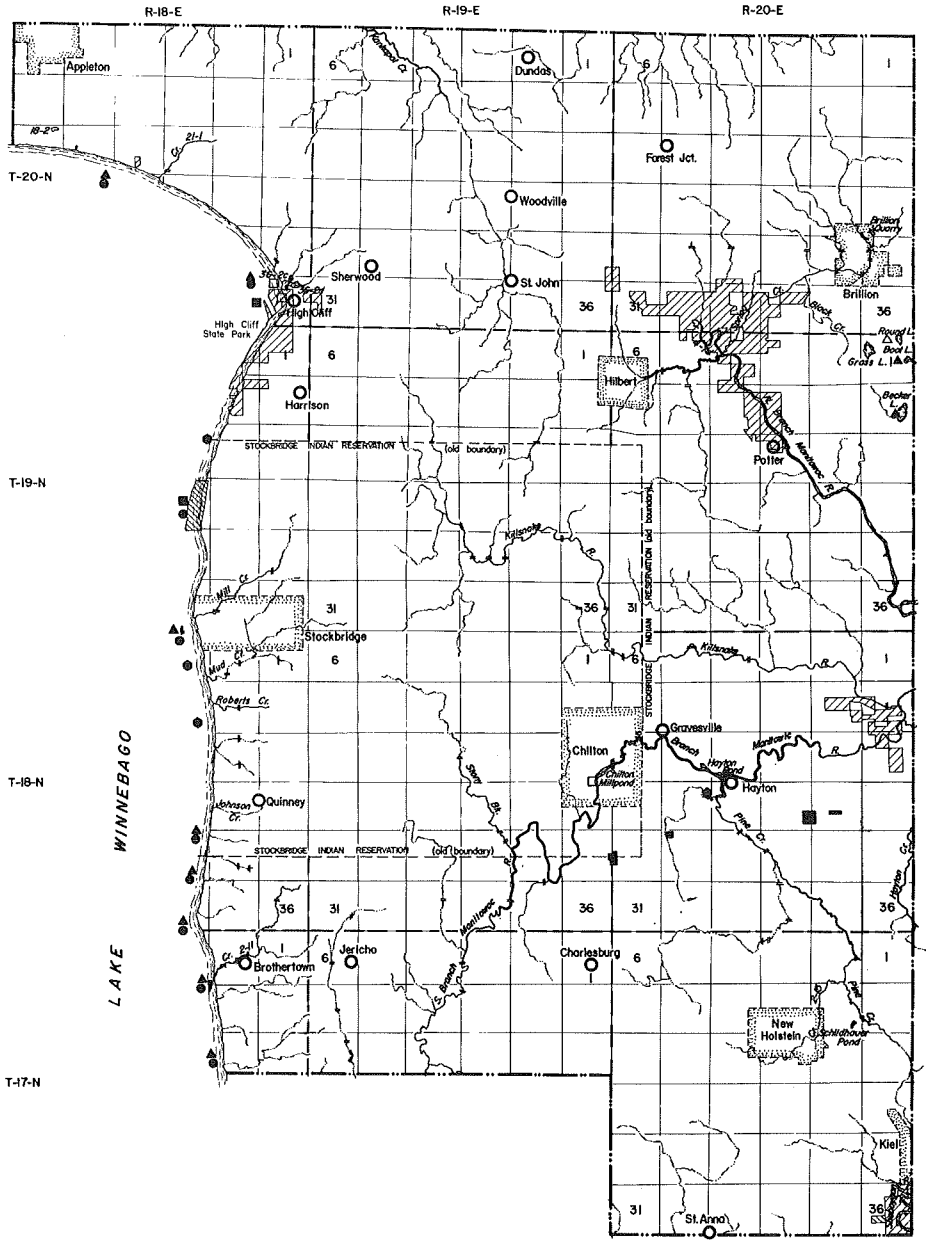
FIGURE 14. FISHERY

Basic Fisheries

Lake	Stream	
		Forage
□		Panfish
■		Bass, panfish
△		Northern pike, panfish
▲		Bass, northern pike, panfish
		Bass, northern pike, walleye, panfish
○		Trout
●		Channel catfish
		Private fish hatchery



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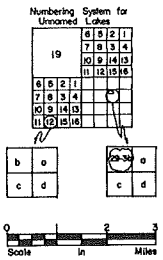

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FIGURE 17. PUBLIC LANDS and ACCESS

Public Lands
- State
- County
- Township or City

Access
- Boat launching - parking
- Boat launching - no parking
- Multiple use - launching
- Multiple use - walk-in
- Unimproved or difficult
- Winter drive-on (Lake Winnebago)

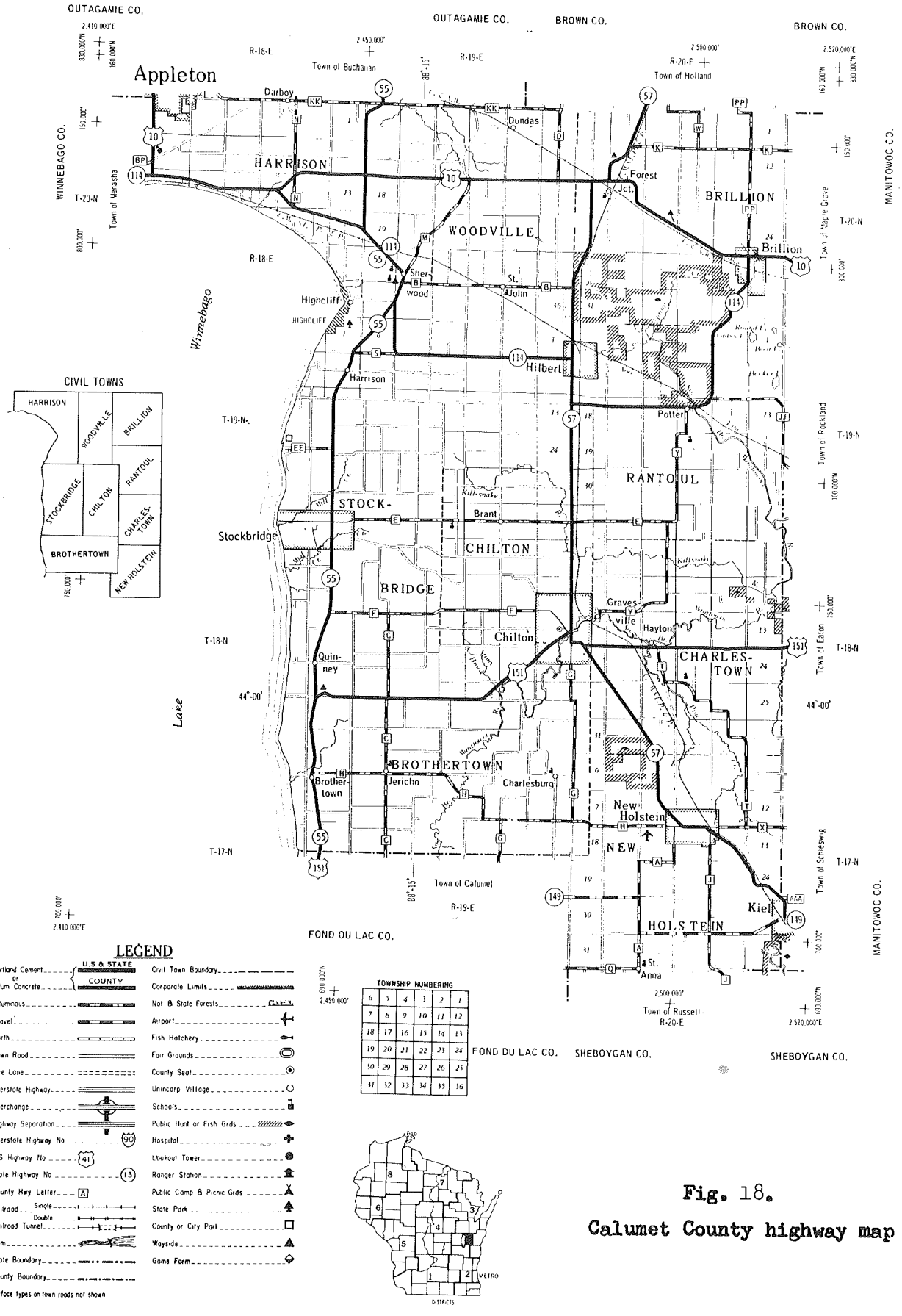

Fig. 18.

Calumet County highway map