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A REPORT

TO THE

WATER RESOURCES COMMITTEE



OF THE

WISCONSIN LEGISLATIVE COUNCIL

ON

THE WOLF RIVER BASIN

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A REPORT
to the
WATER RESOURCES COMMITTEE
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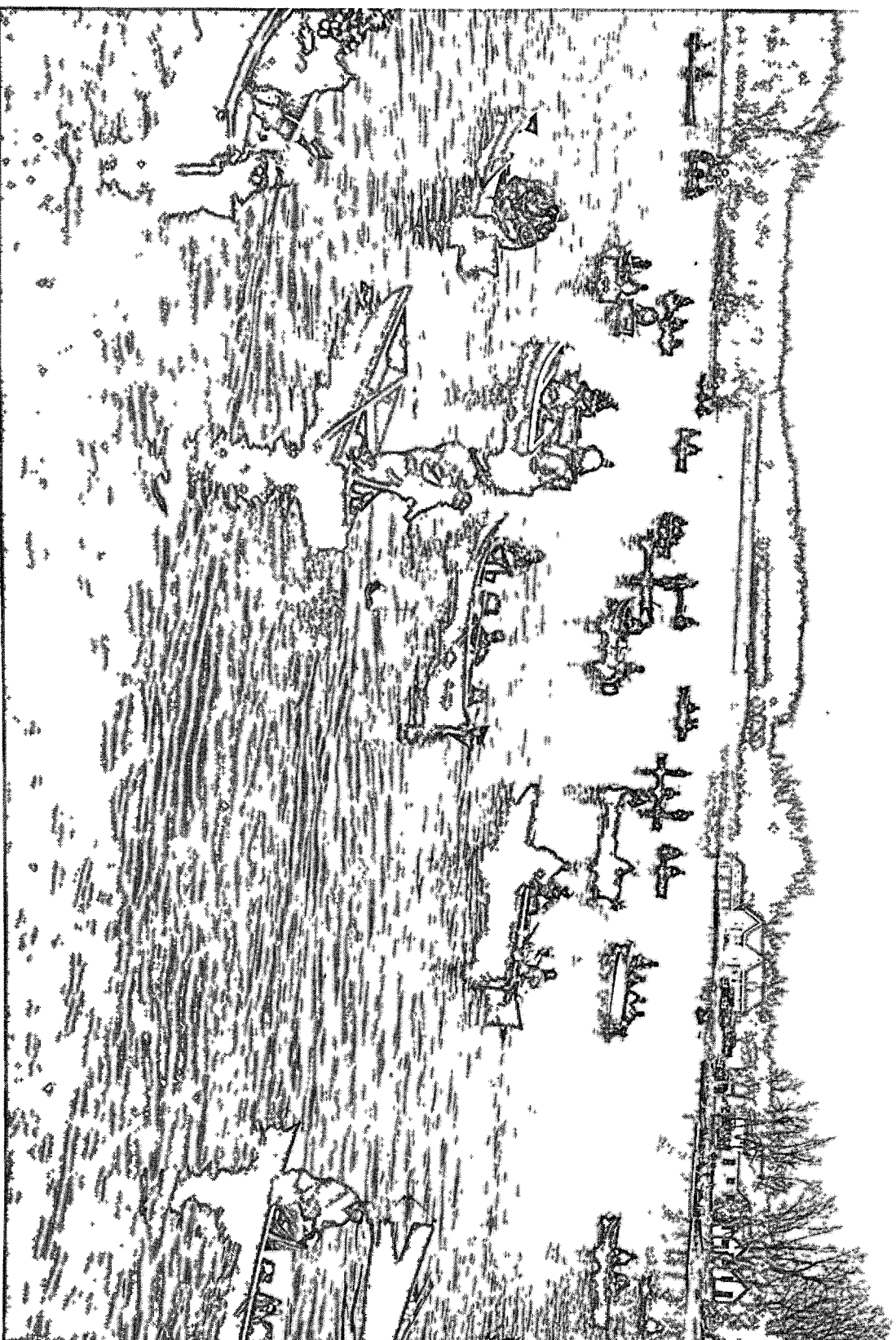
(Prepared by Ann C. Williams and others under the supervision of
Professor J. H. Beuscher, University of Wisconsin Law School)

Legislative Council
Room 202 South

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State Capitol
Madison, Wis.

May 10, 1960



Fishing for walleyes - Wolf River
near Shiocton
April 1958

May 10, 1950

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PREFACE

The 1959 Wisconsin legislature directed the legislative council, through its water resources committee, to study the water problems of the Wolf River Basin (Jt. Res. No. 51, S. and 94, S.). A great deal of information on the Wolf River watershed is available even without further field studies. This report summarizes much of that information for the committee.

A comprehensive river basin study cuts across many of the principal fields of learning, including among others, economics, law, political science, engineering and geology. The cooperation of the university of Wisconsin therefore was enlisted in this study. The Wolf River Basin was made the subject of study in a seminar on river basin planning in which students in law, engineering, economics and planning participated. Each student studied and reported on a particular phase of the Wolf River Basin. Some of the information summarized in the present report was obtained as a result of this seminar. Other important sources of information were a 1938 report by the state planning board on the Fox-Wolf River Basin and a 1960 report by the state conservation department on recreational values of the Wolf River Basin, reproduced as Appendix B of the present report. Population and economic data were obtained from the census and other sources.

The present report was written largely by Ann C. Williams under the supervision of Professor J. H. Beuscher of the University of Wisconsin Law School. Professor Beuscher, along with Professors Arno Lenz, Fred A. Clarenbach and Lionel Thatcher, directed the seminar on the Wolf River Basin.

The present report describes (1) the physical setting of the Wolf River Basin, (2) the population characteristics of the basin, (3) the economic setting of the basin, (4) the various agencies of government involved, (5) the present land and water uses in the basin and related problems, and (6) past proposals for solution of various problems of the basin. It is hoped that the report will be of material assistance to the committee in making recommendations for the future.

MAY 10, 1960

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SYNOPSIS

I. The Physical Setting

The Wolf River Basin, in northeast Wisconsin, drains about 3,750 square miles of forests, farms, swamp land, and lakes. The northern part of the basin is mostly rugged, steeply sloping land, and the southern part is relatively flat and therefore more subject to flooding. This difference in topography explains why the Wolf in its northern reaches is a fast-moving white-water river and in its southern parts is sluggish, sprawling, and marshy.

II. The Demographic and Economic Setting

The basin has a sparse population compared with the population of the whole state. About half of the people are farmers, or about 50,000 out of a total population of about 100,000. In March of 1959, 6,133 people were employed in the eight cities of the basin in industries subject to unemployment compensation.

The equalized full value of taxable property in the basin is about \$356,000,000, or a little more than half of the value of property in Oshkosh, Appleton, Neenah, and Menasha in the neighboring Lower Fox River Basin. Bank resources are also relatively low. Retail sales in the four largest cities of the basin total about \$45,000,000 a year.

III. The Governmental Setting

The key governmental agencies and their principal roles are as follows:

A. Federal Agencies

1. The Corps of Engineers operates Menasha Dam, which controls lake levels in the Winnebago Pool (i.e., Lakes Winnebago, Butte des Morts, Winneconne, Poygan, Partridge, Cincoe, and Partridge Crop and connecting streams). The Corps also dredges a 47-mile-long, 4-foot-deep channel for navigation from the mouth of the Wolf to New London.

2. The Coast Guard claims jurisdiction to enforce Great Lakes Pilot and Navigation Rules on the lakes of the Winnebago Pool and on the Wolf as far north as New London.

3. The United States Department of Agriculture carries out the Soil Bank program and gives technical assistance in soil conservation programs.

4. The United States Fish and Wildlife Service advises state and local groups about measures to encourage fish and wildlife and to maintain fair distribution among the states.

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5. The Federal Power Commission can give or withhold consent to applicants for permits to develop hydro-electric power.

B. State Agencies

1. The Public Service Commission administers the dam, lake level, and stream irrigation permit systems.

2. The Conservation Commission represents the interests of conservation in Public Service Commission hearings and carries out various programs, among them, the protection of fish and wildlife, the purchase of wetlands, the purchase and lease of public hunting lands, and the enforcement of hunting and fishing laws.

3. The Board of Health is responsible for maintaining pure water supplies, for administering the high capacity well law, and, with the State Committee on Water Pollution, for protecting streams and lakes from pollution.

4. The Department of Resource Development is responsible for preparing long-range plans for the wise use of Wisconsin's natural and industrial resources.

C. Local Agencies

1. Soil Conservation Districts cooperate with the State Soil Conservation Committee in carrying out soil conservation measures.

2. Ten counties, ninety-one unincorporated civil towns, twenty-nine villages, and eight cities are the local units of government.

3. There is no governmental unit of a regional character to view the problems of the region and to plan and develop solutions. The powers for land use planning and zoning are distributed among the many local units in the basin.

IV. Some Present Land and Water Uses and Problems

About 66% of the land is in farms. Dairy products, potatoes, corn, oats, and garden vegetables are the main crops. Some farm land, mostly in Langlade and Waupaca counties is irrigated from streams, wells, and pits. The chief irrigated crops are potatoes and garden vegetables. About 57,189 acres are in the Soil Bank; 12,404 of them are in flood plain towns.

Hydro-electric power is produced in small quantity in the basin. It

amounts to about one tenth of the hydro-electric power in the Wolf-Fox Basin and one one-hundredth of all Wisconsin hydro-electric power.

Parts of the basin are popular recreational areas, particularly the area from New London south, the forests, and the Menominee Indian Reservation. The American Automobile Associations lists only seven motels and one resort. No one has ever studied the quantity or quality of recreational accommodations in the basin. Recreational boating rather than commercial boating is important, as is fishing for sturgeon, pike, white bass, pan fish, and trout. Family camping and hunting for wildfowl are also popular recreational activities.

The forests of the basin provide resources for recreation and also for industry. Logging in the nineteenth century stripped large parts of the basin, but second-growth timber has replaced much of the virgin forest. The Menominee Indian Reservation has a 174,000-acre stand of sustained-yield forest used for logging and recreation. About 23,830 acres of Nicolet National Forest, a popular camping region, are in the basin. Langlade county owns 46,000 acres of forest land, part of which is in the basin. In the northern part of the basin, 80,000 acres of industrial forests provide timber for lumber, paper, and other wood products.

Some of these uses of land and water are competitive, and together with floods they present important problems. Flooding is a problem principally in the southern part of the basin, where the land is flat and people have built on the flood plain. Most of the land flooded is either unused or is farm land. The only city with a flood problem is New London. The Corps in 1949 estimated an average annual damage of \$3,000 to New London and about \$78,000 to agricultural lands and crops.

No watershed districts have been set up under Public Law 566, but prospects exist for such activity.

V. Proposals for the Wolf, 1922-1960

Many groups have studied the Wolf, but all have done so in patchwork fashion. The most comprehensive report has been that of the Corps of Engineers in 1949. The Corps, reporting primarily on hydro-electric power and flood control, stated that further development of hydro-electric power in the basin would be uneconomic and that the most sensible proposed systems of dams would be of very little help in lessening major floods. For example, the disastrous 1922 flood could have been lessened by only about six inches with the help of these dams. Until now, no study of the basin has been made in the perspective of the basin's total resources and economic and social needs. The Conservation Department's 1960 study of the basin indicates the benefits of a basin-wide approach to planning for recreational development. A 1960 university joint seminar was particularly helpful in its analysis of flood control, hydro-electric development, and irrigation in the basin.

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VI. Possible Kinds of Regional Organization for the Wolf Basin

A Regional Planning Commission under Wis. Stat. 1959, §66.945, is a possible form of regional organization. The Governor would create it on petition from one or more local governmental units. It would have advisory planning and promotional powers only. It could charge back the costs of its activities to local units but not to exceed .003 per cent of the equalized value of land and buildings for property tax purposes.

Ohio and Minnesota have established locally controlled organizations for comprehensive control and development of water resources. Problems in these states are different from those in the Wolf Basin, but the experience of these states can serve as guides (and perhaps in some ways as warnings) for a basin-wide approach to Wisconsin's water problems.

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WOLF RIVER BASIN STUDY (1960)

I. THE PHYSICAL SETTING

The Wolf River Basin can be studied as a unit, but such a study has limitations: the basin and other areas are interdependent in several important ways. One of these areas is the Lower Fox River. The amount of water flowing down the Wolf into the Fox affects the amount of water available for industrial, municipal, and other uses in the Winnebago Pool and in the Lower Fox. The dam at Menasha controls the level of water in Lake Winnebago and therefore has some control of levels upstream into the Wolf. A second area is the Wisconsin River Basin. The canal at Portage joining the Wisconsin and the Upper Fox is a potentially important link between the Fox-Wolf Basin and the Wisconsin River Basin. Therefore, even though this report focuses principally on the Wolf Basin, as such, references must be made to the Fox-Wolf Basin and to the Wisconsin-Fox-Wolf complex.

A. Location

Pine Lake, about 25 miles south of the Michigan line in west-central Forest County, gives rise to the Wolf River. This river flows 223 miles to the south, through Langlade County, the Menominee Indian Reservation, Shawano and Outagamie Counties, New London, and Waupaca and Winnebago Counties. It joins the Fox River ten miles upstream from and west of Lake Winnebago, near Oshkosh. The Fox then flows to Green Bay, and the Fox-Wolf thus connects with the Great Lakes-St. Lawrence Seaway System. (See Map 1, Wolf River Drainage Basin, p. 3.)

The main tributaries of the Wolf flow into it from the northwest. They are the West Branch, the Red, Embarrass, Little Wolf, and Waupaca Rivers. The Shioc, a rather small tributary, enters from the northeast. The Embarrass is particularly important, for it joins the Wolf at New London and helps create rather large floods in and near that city. (See Table 1, Tributaries of the Wolf River, p. 2.)

The Wolf and its tributaries drain 3,750 square miles covering part or all of 10 counties--the six noted above and Oneida, Marathon, Portage, and Waushara. This is more than half the drainage area of the Fox-Wolf system, which is 6,520 square miles. Together the Fox and Wolf drain more than half as much area as does the Wisconsin River, which drains 11,715 square miles. The second largest basin in Wisconsin is the Chippewa-Flambeau, draining 9,519 square miles. The Rock and Pocatonia drain 5,569 square miles and the St. Croix drains 4,206 square miles. The Black, draining 2,439 square miles, is the only major Wisconsin River draining less land than does the Wolf. (See Appendix A, Drainage Area, Fox-Wolf River System).

B. Geology and Topography

The northern part of the Wolf travels through rugged country. Ancient Precambrian bedrock juts out through a relatively thin layer of glacial drift and

May 10, 1956

Table 1

TRIBUTARIES OF THE WOLF RIVER

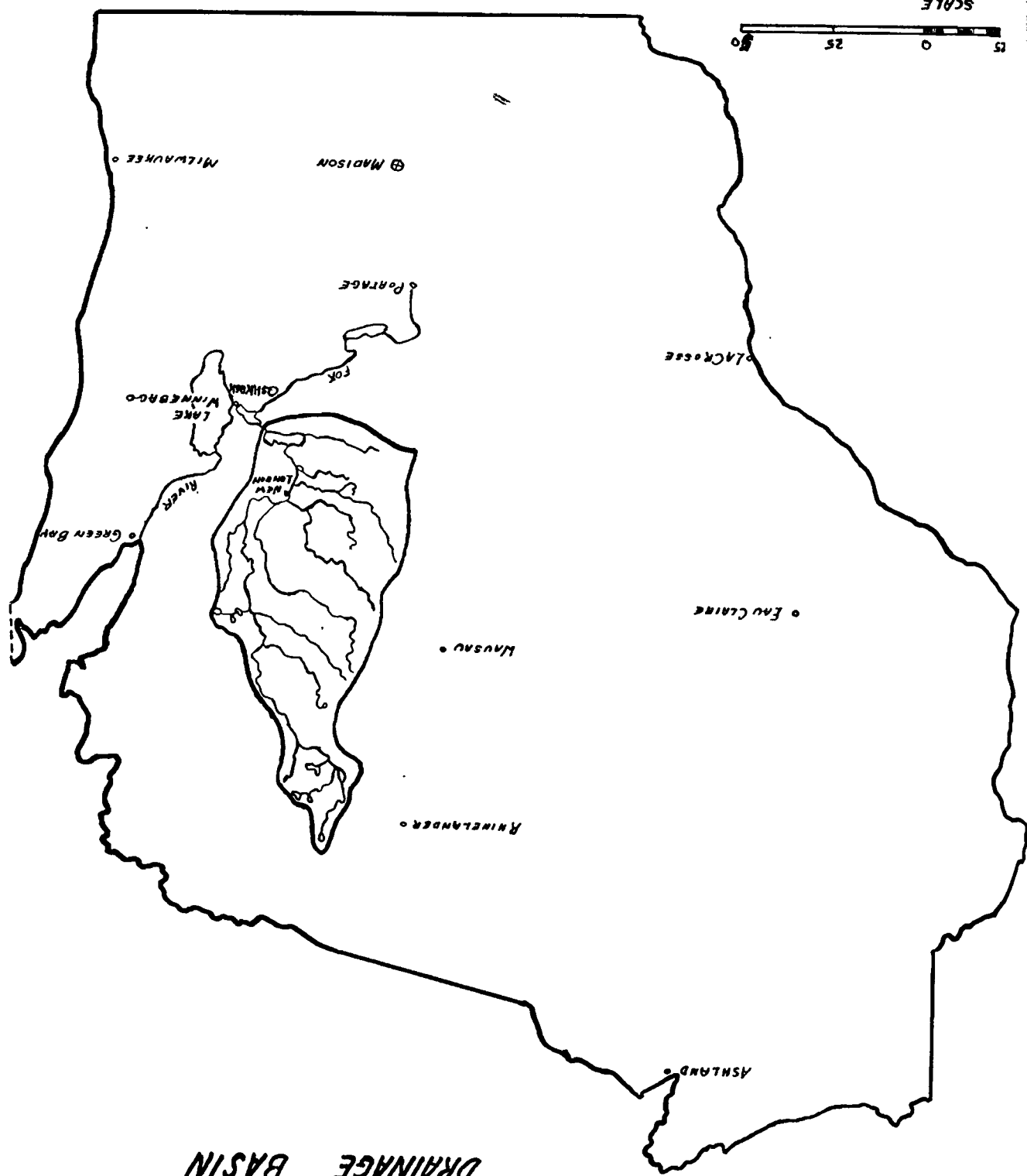
Name	Place of Entry		Drainage Area - sq. mi.	
	Side	Miles above Lake Winnebago (1)	Tributary	Wolf River Including Tributary
Evergreen Creek	West	152.6	100	632
West Branch of Wolf River	West	139.5	160	812
Red River	West	128.8	200	1050
Shioc River	East	81.3	200	1450
Embarass River	West	56.5	660	2240
Little Wolf River	West	50.1	510	2770
Waupaca River	West	37.7	330	3140
Little River	West	34.0	80	3240
Rat River	East	25.7	90	3350
Pine River	West (2)	(2)	110	3500
Willow Creek	West (2)	(2)	160	3670

(1) Mouth of Wolf River is 10 miles upstream from Lake Winnebago.

(2) Enters west end of Lake Poygan about 24.7 miles upstream from Lake Winnebago.

WOLF RIVER DRAINAGE BASIN

Map 1



MAY 10, 1950

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m from Lake

3670

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creates rapids, waterfalls, gorges, unusual rock formations, and other natural beauty spots attractive to visitors. The river in most of its northern reaches flows within high banks. Heavy rain and the spring thaw do not generally bring about a spillover there. The generally steep slope of the land allows the Wolf to rush along rapidly for 109 miles to Shawano Dam, falling 775 feet. The only sizeable stretch of slow water is in Langlade County where the river falls only about 10 feet in about 20 miles. Much of the scenic area is in the Menominee Indian Reservation.

In the lower part of the river a great change in the lay of the land creates a great change in the nature of the Wolf. Sandstone covers the Pre-Cambrian rock, and glacial drift covers the sandstone. Plains replace gorges and lakes replace waterfalls. The high banks recede gradually from about the Shawano-Outagamie County line to the nearly flat land of the New London and Winnebago Pool areas. The Winnebago Pool includes 263.3 square miles of water in lakes Winnebago, Butte des Morts, Winneconne, Poygan, Partridge, Cincoe, and Partridge Crop. Three of these lakes (Winnebago, Poygan and Butte des Morts) are included among the 20 largest lakes in Wisconsin. The Wolf, flowing through low-lying marshlands and some of the lakes of the Pool, falls only about 56 feet from Shawano Dam to the river's mouth at Lake Butte des Morts, a distance of 114 miles. The water rushing along the upper 109 miles slows down and spreads over the river bottoms, which become great reservoirs. Periodically floods interfere with use of land along this lower end of the Wolf. (See Appendix A, Profile of the Wolf River and Appendix J, Topography of the Wolf River.)

The waters themselves are in a comparatively late stage in their life span. In geologic terms, lakes have a rather short life. Wisconsin's many bogs are remnants of lakes that were once like those in the Wolf Basin. Young lakes are relatively algae-free, but eroded land and organic debris enrich the water and encourage massive development of algae. Fertilizers and drainage of land nearby hasten the old age of a lake. The process is not necessarily inevitable: a bog lake can be limed to make it suitable for rainbow trout. In general, man knows too little and acts too little to restore lakes to a much more pleasant condition.

C. Soils and Rainfall

The kind of soil along the various parts of the river and particularly the amount and distribution of rainfall throughout the year (here "rainfall" signifies all kinds of precipitation) are important to understand why the Wolf is a problem.

The soil in the northern part of the basin is predominantly silt loam with subsoils of gravel and loam. It is rocky land, most of which is more suited to its covering of second growth timber than to cultivation. In the central section, below Shawano, silt loams and sandy loams are a little better suited to agriculture. Marshy peat soils in the lowlands and red clay predominate in the southernmost part.

Average yearly rainfall for the Wolf Basin is about 30 inches. This figure is typical of rainfall in Wisconsin as a whole. From 1930 to 1959 the maximum

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annual precipitation was about 43 inches and the minimum about 23 inches. Approximately 60% of the rain comes from April to September, June having the highest average. Uneven distribution during the spring and summer can produce floods. In April of 1922, 3.36 inches fell on frozen ground and created the worst storm on record for the basin. In the summer, heavier rains, such as the 6.35 inches that fell in June of 1905, create less run-off. For example, run-off from the April, 1922, storm was 2.13 inches, but from the heavier summer rain in June, 1905, the run-off was only 1 inch and thus the flood situation was much less severe. The total average annual run-off is about 1/3 of the rainfall. Two thirds of the rainfall is absorbed by the soil, transpired, or evaporated. Much of the water absorbed by the soil finds its way to the water table.

The character of the soil determines in large part the ability of the soil to absorb and retain water. Sand absorbs much, clay less, and rocky ground still less. Humus and vegetable matter increase the power to absorb. Frozen soil of course sheds water. In general, then, in the highlands the rocky soil sheds water and in the lowlands the soil, when not frozen, can retain or absorb a great deal.

D. Ground Water

In the northern half of the river basin, the underlying bedrock of the Pre-Cambrian age contains little or no water. Such ground water as exists in this area is found in glacial outwash and sand and gravel deposits above this bedrock. An intensive ground water survey in 1948 in northwestern Langlade County estimated an annual recharge for a 90-square-mile area of 30,000 acre-feet a year. Pumpage in this area was 1,100 acre-feet. Of this pumpage, 69% was for a municipal supply, 26% for rural supply, and 5% for irrigation. Known depths to water ranged from 25 to 117 feet. The quantity of ground water in particular areas of the northern half of the basin varies according to the thickness of the water-holding material above bedrock.

In the southern part of the basin, water is available either from glacial deposit or from underlying Cambrian or St. Peter sandstone.

Throughout the basin the water in the glacial drift flows southward and responds to changes in rainfall much more than does water in the sandstone in the southern part of the basin. Water in the sandstone generally flows under artesian pressure conditions.

In general, ground water in the glacial drift supplies the Wolf and its tributaries, and accordingly long-term deficiencies in rainfall will not only affect the ground water supply but also the flow of the Wolf and its tributaries. Over the basin as a whole there seems to be little danger that present and immediately prospective uses of ground water, including irrigation, will seriously endanger ground water supply. However, local overpumpage, particularly from relatively thin glacial deposits, may cause local "cones of depression" in the aquifer so as, at least temporarily, to deprive the shallower wells located within the local zone of water.



Smokey Falls
Menominee Indian Reservation
 May 8, 1956

May 10, 1956

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II. THE DEMOGRAPHIC AND ECONOMIC SETTING

A. Population Data

The 1950 U. S. Census, a 1954 Wisconsin State Crop Reporting Service survey, and preliminary U. S. Census figures for all counties and for some cities are the chief sources for the following data. Detailed and exact information on the 1960 population will not be available until the fall of 1960.

Compared with the rest of Wisconsin, the basin has been relatively sparsely populated. In 1950, the basin held 3.2% of Wisconsin's population in an area about 6.7% the size of the state. It is predominately a rural area: in its 91 towns, there are only 8 small cities and 29 villages.

The cities, villages and unincorporated civil towns, the areas of which are at least 50% within the basin, are listed in Table 2, p. 8. In 1950, the population of this basin area was 110,096.

From 1950 to 1960, the ten basin counties increased in population from 424,305 to about 463,430, or about 9%. In 1950, the basin itself held 1/4 the population of the ten basin counties.

However, it is clear that this ratio is no longer accurate. The population of the three counties in the heart of the basin has decreased: Langlade by 10.1%, Shawano by 3.1% and Waupaca by .2%. The seven basin cities for which preliminary 1960 census figures are available (excluding Weyauwega) have increased a little more than 1%. Cities outside the basin but within the basin counties--Neenah, Menasha, Appleton and Oshkosh--have increased 26.1%. It appears that, within the ten basin counties, fewer people live in the basin itself and more live in the urban areas outside the basin than in 1950. It is therefore most likely that the population of the basin has decreased since 1950. This trend is in keeping with the statewide and nationwide decrease of population in rural areas.

B. Occupational Data

Of the total basin population, 50,165 or 49.8% were engaged in farming in 1950. Estimates indicate a decrease in the farm population since then. However, in spite of a decrease in farm population, there seems to be a surplus farm population in the ten basin counties (an area greater than just the drainage area). Youngsters coming of age to farm are numerically more than replacing their elders, and many must leave to seek employment elsewhere. For example, in Outagamie county 164 farm boys will come of age to farm during the 1950-60 decade for every 100 men who leave farming, according to estimates made in 1957 by the department of rural sociology of the University of Wisconsin. The average farm population replacement ratio for the state as a whole is 127 to 100. (See Chart 1, Wisconsin Farm Population Replacement Ratio, 1950-1960, p. 11).

Chart 2, p. 13 shows the percent of total farm operators working off the farm 100 days or more in 1954 in the state. In the ten counties of the basin about 24.3% of the farm operators worked off the farm 100 days or more in 1954. This compares with 22.4% for the state as a whole and with 22.4% for the 17 Wolf-Fox counties. The fact that so many work off the farm is perhaps a reflection of the

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Table 2

TOWNS, VILLAGES, AND CITIES WITHIN THE WOLF RIVER BASIN
(Includes only those whose area is 50% or more within the basin)

<u>County</u>	<u>Towns</u>		<u>Villages</u>	<u>Cities</u>
Forest	Crandon Hiles	Lincoln Nashville	-	Crandon
Langlade	Ainsworth Evergreen Langlade Norwood	Polar Price Rolling Wolf River	White Lake	-
Marathon	Elderon Franzen Norrie		Elderon Hatley	-
Oneida	Schoepke		-	-
Outagamie	Black Creek Bovina Center Cicero Dale Deer Creek	Ellington Greenville Hortonia Liberty Maine Maple Creek	Bear Creek Black Creek Hortonville Shiocton	New London
Portage	Alban Amherst Belmont Lanark New Hope		Amherst Amherst Junction Nelsonville	-
Shawano	Almon Aniwa Bartelme Belle Plaine Birnamwood Fairbanks Germania Grant Hartland Herman Hutchins Lessor	Menominee Indian Res. Morris Navarino Pella Red Springs Richmond Seneca Washington Waukechon Wescott Wittenberg	Aniwa Birnamwood Bonduel Bowler Cecil Eland Gresham Mattoon Tigerton Wittenberg	Shawano

(Table 2 continued)

R BASIN (basin)	County	Towns		Villages	Cities
<u>Cities</u> Crandon - - New London - ction Shawano	Waupaca	Bear Creek	Lind	Big Falls	Clintonville
		Caledonia	Little Wolf	Embarrass	Marion
		Dayton	Matteson	Fremont	New London
		Dupont	Mukwa	Iola	Waupaca
		Farmington	Rayalton	Manawa	Weyauwega
		Fremont	St. Lawrence	Ogdensburg	
		Harrison	Scandinavia	Scandinavia	
		Helvetia	Union		
		Iola	Waupaca		
		Larrabee	Weyauwega		
		Lebanon	Wyoming		
	Waushara	Bloomfield		Wild Rose	Wautoma
		Leon			
		Mount Morris			
		Poysippi			
		Rose			
		Saxeville			
		Springwater			
		Wautoma			
	Winnebago	Clayton		Winneconne	
		Poygan			
		Winchester			
		Winneconne			
		Wolf River			

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nation-wide surplus of farm products and of farm population. The farm operator replacement ratios of Chart 2 do not take into consideration this nation-wide surplus of farm operators, so the effect of the surplus of young people is really greater than the chart indicates.

We were able to find March, 1959, figures for the number of people working in firms large enough to be subject to unemployment compensation. (These figures with possible slight exception do not include workers in establishments with fewer than four employees.) The total number working in subject firms in and near the eight cities of the basin was about 6,133 or about 5.6% of the total 1950 population. Only 402 were working in service industries. (See Table 3, p. 15.)

C. Other Economic Data (See Table 4, p. 16.)

The full value of assessed property in the Wolf Basin compares rather poorly with the value of property of cities along the Fox River. For example, the 1957-8 full value of all assessed property in the basin was only 59% of the combined full value of only Appleton, Neenah, Menasha, and Oshkosh. The increase of value of all assessed property in the basin from 1947 to 1957-8 was 54.8% and of the Fox cities 117%. Much of the increase is, of course, simply an inflationary increase and not a real one. The full value of all assessed property in all of the Wolf Basin cities increased by 91.4%, but that of the four Fox Basin cities increased by 117%. Within the basin itself, farming areas increased in value by 35.7% and villages by 79%.

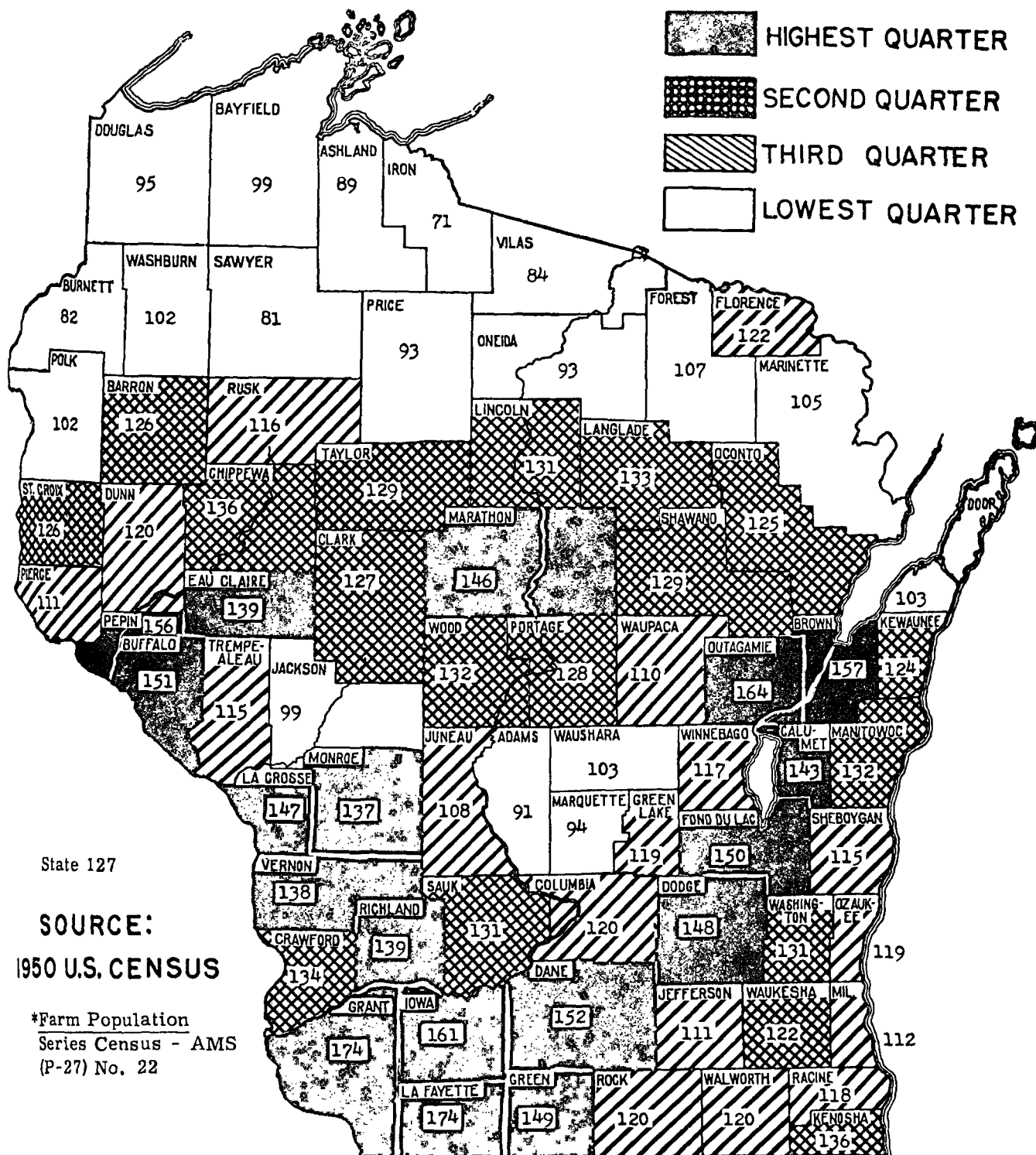
Bank resources are another measure of the economy of the basin. The total footings (i. e., assets and liabilities) of all National and commercial State banks in the Wolf Basin are \$86,515,469, or about 1.8% of the total footing of all Wisconsin banks, and 42% of the total footings of the Fox Basin cities of Appleton, Neenah, Menasha, and Oshkosh.

Several informed people have suggested that potential development of the basin not for agriculture, but for vacationers, may represent the most fruitful way of increasing the area's economic base. It was noted above that in 1959 relatively few people in the basin were engaged in service industries, and present investment for recreational facilities seems slight. The American Automobile Association's Great Lakes Tour Book lists only eight approved motels or hotels in the basin and these have a total of only 92 units and rooms. Harold C. Jordahl's 1960 report for the Conservation department, "Recreational Values of the Wolf River Basin, Wisconsin", Appendix B of this report, gives several pages of important information on recreational facilities. (See pp. 16-21 of Appendix B.)



CHART I

Wisconsin Farm Population
Replacement Ratio - 1950-60*



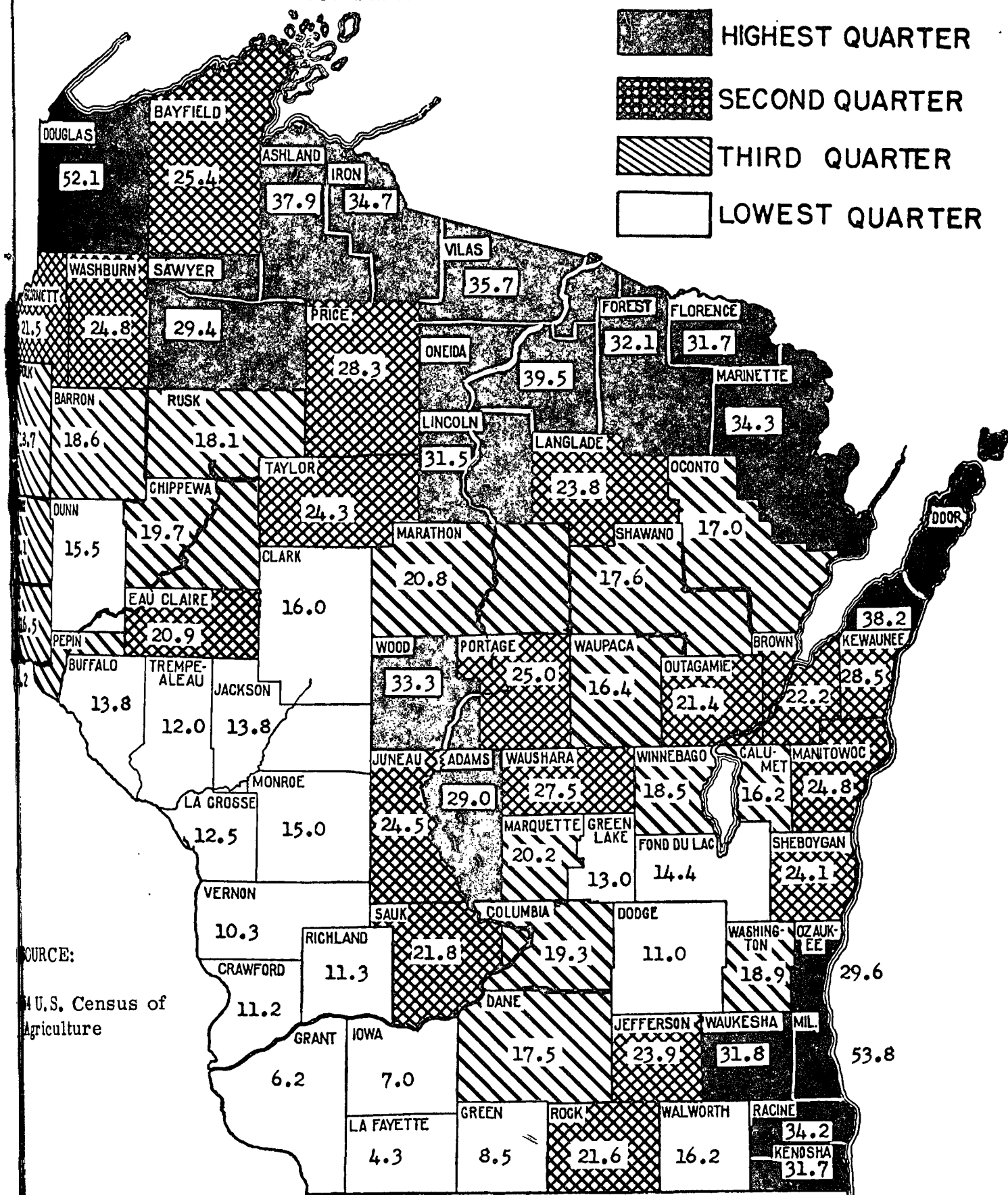
State 127

SOURCE:
1950 U.S. CENSUS

*Farm Population
Series Census - AMS
(P-27) No. 22

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Percent of Total Farm Operators Working Off the Farm
100 Days or More
Wisconsin 1954

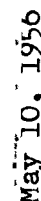


SOURCE:
U.S. Census of
Agriculture

As with 1950 the cut-over counties plus those counties in the Milwaukee-Racine-Kenosha area and the central sand plains have the greatest proportion ~~of operators working off the farm~~ 100 days or more.

May 10, 1956

Percent of Total Farm Operators Working Off the Farm
100 Days or More
Wisconsin 1954

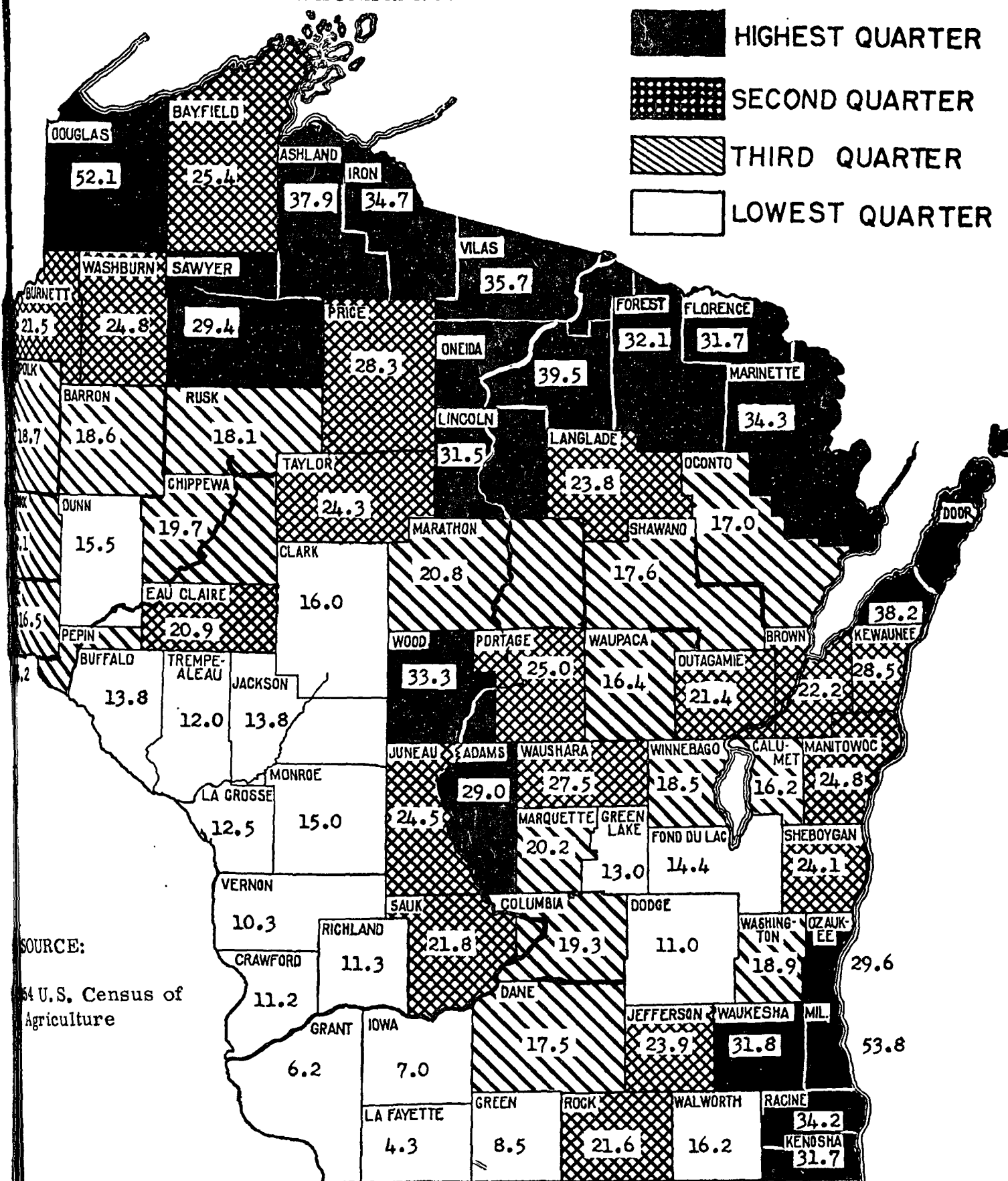


54 U.S. Census of
Agriculture

As with 1950 the cut-over counties plus those counties in the Milwaukee-Racine-Kenosha area and the central sand plains have the greatest proportion of farm operators working off the farm 100 days or more.

Chart 2

Percent of Total Farm Operators Working Off the Farm
100 Days or More
Wisconsin 1954



SOURCE:

1954 U.S. Census of
Agriculture

As with 1950 the cut-over counties plus those counties in the Milwaukee-Racine-Kenosha area and the central sand plains have the greatest proportion of farm operators working off the farm 100 days or more.

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Table 4

ECONOMIC DATA ON THE WOLF RIVER BASIN

I. Total land area in Wisconsin	c. 56,000 sq. miles		
II. Total land area in the Wolf River basin	3,750 sq. miles		
3,566 of the 3,750 square miles cited by the Corps of Engineers are located in the towns listed in Appendix A. The 184 square miles not included are located in towns whose area is less than 50% within the basin.			
III. Land in agricultural use in the Wolf River basin			
Square miles	2,438		
Acres	1,560,320		
% of Total land	about 66%		
Number of farms, 1954	10,458		
Average size of farms, 1954, acres	149		
IV. Full value of all assessed property			
	1949	1957-8	% Increase
Wolf River basin:			
Towns	\$146,422,935	\$198,678,665	35.7%
Villages	23,024,815	41,355,675	79.0%
Cities	60,389,400	115,636,245	91.4%
Total	\$229,837,150	\$355,660,585	54.8%
Fox Basin Cities:	\$275,837,070	\$600,174,800	117.0%
(Appleton, Neenah, Menasha, Oshkosh)			
V. Retail sales in the four largest cities of the Wolf River basin in 1958			
Shawano		\$14,226,000	
Clintonville		11,517,000	
Waupaca		9,433,000	
New London		8,609,000	
Total		\$43,785,000	
VI. Bank resources: total footings (assets and liabilities), 1959			
	Wolf River basin	Fox River basin cities	Wisconsin
Villages	\$27,015,702	(Appleton, Neenah, Menasha	
Cities	59,499,767	Oshkosh)	
Total	\$86,515,469	\$205,732,137	\$4,835,049,110

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III. THE GOVERNMENTAL SETTING

The planning and carrying out of action programs for the development of the Wolf River Basin have been and will largely continue to be the responsibility of public bodies. Therefore it helps to survey quickly the governmental agencies and units which have authority for planning or action in the basin, emphasizing the salient aspects of this authority.

A. Federal Agencies

1. General Powers

The powers of the federal government to develop water and other resources are limited to those expressly granted by the Constitution and those which can reasonably be implied from these express powers. Among the powers expressly granted are powers to (1) regulate commerce among the states, (2) provide for the common defense, (3) make war, (4) make treaties, (5) control compacts between states, (6) manage federal property, and (7) provide for the general welfare. The most important of these for our purposes is the power to regulate commerce among the several states. Commerce includes transportation, and navigation comes within this meaning. Power over navigation requires control over navigable water.

2. The U. S. Army, Corps of Engineers

This power to regulate interstate commerce is the constitutional basis for the activities of the Corps of Engineers on the Wolf. Technically the Corps "exercises jurisdiction" from the mouth of the Wolf to the highway bridge at Leeman, a distance of 86.2 miles. Actually the head of navigation is at New London, some 39 miles south of Leeman. Congress in 1896 instructed the Corps to dredge, snag and otherwise improve a channel 4-feet deep and 100 feet wide from the mouth of the Wolf to New London. The corps also has vital control power over the Winnebago Pool by regulating its level through operation of the Menasha Dam. In addition the Corps, in response to Congressional directives, has several times studied and reported on the Wolf, once on the Wolf alone and twice on the Fox-Wolf. Undoubtedly the Corps, if properly authorized by Congress, could make a new and comprehensive study of the basin. (See 16 U.S.C. §§701.1, 701a; 541 and 542 for statutory powers of the Corps generally. See Appendix C, for 1958 report by the Corps.)

3. U. S. Coast Guard

The Coast Guard enforces the Great Lakes Rules of the Road on the Wolf as far north as New London and maintains two lights and various navigational aids on this segment of the river. (See 33 U.S.C. §§241-245 and C. G. 172, "Rules of the Road, Great Lakes" (May 1, 1959). It does not undertake to enforce state or local boating rules. (See Appendix D, for 1959 Coast Guard projects in the Winnebago Pool and Wolf River.) The problem of possible conflict and confusion in federal and state-local boating rules on water such as the Wolf was recognized by the Congress in the Federal Boating Act of 1958 (46 U.S.C. §527f). This act encourages cooperative enforcement exemplified by action taken by the 1959 legislature (ch. 505, Laws of 1959) to provide a state-administered boat numbering system complying with federal requirements. Having set up such a system, Wisconsin may enforce state

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000 sq. miles

750 sq. miles

%

2,438

1,560,320

about 66%

10,458

149

% Increase

35.7%

79.0%

91.4%

54.8%

117.0%

1 1958

Wisconsin

\$4,835,049,110

boating regulations on the Wolf and comparable navigable waters of the United States. (See 46 U. S. C. §527h.)

4. U. S. Fish and Wildlife Service of the Department of Interior

This agency is authorized to and does cooperate with the state conservation department in fish restoration and management and other conservation projects and with the Corps in connection with river basin studies and multi-purpose river projects. It has been relatively inactive in the Wolf Basin because of the absence of a specific program for which its cooperation by way of study and recommendation has been requested. It has direct interest in migratory bird conservation and hence in the annual kill of migratory waterfowl and other migratory birds in the Wolf Basin, as in other areas of the state. (See 16 U. S. C. §§661-669i for the general powers of this agency.)

5. Federal Power Commission

If dams or reservoirs are to be built on the Wolf or its tributaries, the Federal Power Commission might come into the picture. It is given the power to license construction of dams or reservoirs on any streams over which Congress has jurisdiction under the commerce clause. Congress has frequently and expressly declared particular rivers or portions of them non-navigable in order to free them for exclusive control by the states. This could conceivably happen for part or all of the Wolf. But until it happens, an applicant for a permit to build a dam anywhere in the Wolf Basin would probably give serious consideration to the question of whether or not to apply to the Federal Power Commission as well as to our state Public Service Commission. This would be true even if the dam was to be located in the white water section of the Wolf or one of its tributaries. Some years ago, for example, the state P. S. C. argued unsuccessfully to a U. S. Court of Appeals that the F. P. C. had no jurisdiction over a proposed dam at Snap Tail Rapids on the Chippewa because these rocky rapids were not navigable. The court said they were navigable enough to give the F. P. C. jurisdiction. Wisconsin v. Federal Power Commission, 214 F. (2d) 334 (CCA 7th, 1954). On the other hand, there is no requirement that P. S. C. advise F. P. C. of an application, so it is possible that a dam might be built with state permission only. If this did happen and if the dam was a relatively small one, the F. P. C. would probably as a matter of administrative discretion take no action. (See 16 U. S. C. §797 for the general powers of the F. P. C.)

6. U. S. Soil Conservation Service and U. S. Forestry Service of the Department of Agriculture

The Soil Conservation Service of the U. S. Department of Agriculture cooperates with local soil conservation districts in the basin by giving technical assistance in planning and carrying out individual farm plans for soil and water conservation. (See 16 U. S. C. §§590a - 590h.) Table 5, p. 20, summarizes these activities for those counties, a part or all of which is in the basin. To fill the gap between these individual farm measures and major dams constructed by the Corps, Congress in 1954 (and by amendments in 1956) enacted so-called Public Law 566 providing for financial and technical assistance (through S. C. S.) to state and local agencies in the construction of small multi-purpose projects for flood control, conservation and utilization and disposal of water for watersheds

up to 250,000 acres. The federal government assumes up to \$250,000 of the cost, but matching local contributions, the size of which depends on the purposes of the project, are required. Dams may be constructed that will impound up to 25,000 acre-feet of water, including up to 500 acre-feet of flood water detentions. (See 16 U.S.C. §§1001-1008.) In some states, two or more individual Public Law 566 projects have been coordinated and planned together so that the total watershed areas affected exceed the 250,000 acre minimum. Typically these projects are in headwater areas. None has yet been established in the Wolf Basin. To have measurable effect in leveling out the flow of the Wolf, many thousands of acres would have to be brought into carefully planned and executed projects. It is well to recall that we are concerned here with a drainage area of almost 2-1/2 million acres, --3,750 square miles.

The Forestry Service of the U. S. Department of Agriculture operates the Nicolet National Forest, two small portions of which (totaling about ~~1,100~~ 23,830 acres) are in the basin. However, the camping facilities and scenic attractions of the forest as a whole are so close to the basin that they should be thought of when considering the basin's potential.

B. State Agencies

1. General Focus

Thirteen state agencies play some role in the implementation of state water policies in Wisconsin:

- (a) Public Service Commission
- (b) Conservation Commission
- (c) Board of Health
- (d) Department of Resource Development
- (e) Committee on Water Pollution
- (f) Natural Resources Committee of State Agencies
- (g) State Soil Conservation Committee
- (h) State Geologist
- (i) Water Regulatory Board
- (j) Great Lakes Compact Commission
- (k) Portage Levee Commission
- (l) Agricultural Extension Service
- (m) Laboratory of Hygiene

We consider in detail only the first seven named, although the others listed are of great importance. For example, certainly the records of work of the State geologist and the educational work of the agricultural extension service through its county agricultural agents could become outstandingly important to the future development of the Wolf Basin. Or again, the planning and construction of state trunk highways by the highway commission may be of major importance in terms of scenic drives, access to recreational areas, wayside parks, drainage, and dual purpose highway fill and water impoundment structures.

Table 5

SOIL CONSERVATION SERVICE REPORT FOR THE
10 COUNTIES OF THE WOLF RIVER BASIN

1. Summary of Soil Conservation Plans

<u>County Soil Conservation District</u>	<u>District Cooperators</u>	<u>Basic Plans</u>	<u>Woodland Protected</u>
Forest	26	7	--
Langlade	348	187	5,416 acres
Marathon	1,499	788	6,057 acres
Oneida	12	4	--
Outagamie	509	256	1,923 acres
Portage	384	190	1,882 acres
Shawano	391	140	6,649 acres
Waupaca	751	507	7,169 acres
Waushara	342	224	2,557 acres
Winnebago	334	157	340 acres

2. Summary of Acres of Applied Practices, Lineal Feet of Terraces,
Square Feet of Waterways and Number of Structures

<u>County</u>	<u>No. of Farms</u>	<u>Acres of Applied Practices</u>	<u>Lineal feet of Terraces & Diversions</u>	<u>Square feet of Waterways</u>	<u>Number of Structures</u>
Forest	86	1,371	None	None	None
Winnebago	129	1,316	6,421	1,503,000	1
Waushara	367	5,587	7,622	390,000	1
Waupaca	567	13,528	25,878	663,000	2
Shawano	594	10,611	8,350	225,000	1
Marathon	1,329	29,562	141,575	487,000	17
Portage	537	9,757	None	53,000	None
Outagamie	174	2,461	19,395	462,000	4
Oneida	50	744	None	2,000	None
Langlade	275	4,057	3,400	142,000	None
Totals	4,108	78,995	244,641	3,957,000	26

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2. Public Service Commission

The state Public Service Commission is our chief water regulatory agency. Its permission is required for (1) constructing dams on navigable streams, (2) withdrawing water from streams or lakes for supplemental irrigation, (3) establishing lake or stream levels, and (4) other important actions affecting navigable lakes and streams. (See Wis. Stats. 1959 §§30.18, 31.02 and 31.04.) Presumably its power to establish lake levels does not apply to the lakes of the Winnebago Pool because of the longstanding assumption of this authority by the Corps as described above. Probably under Wisconsin Supreme Court decisions, the consent of the Public Service Commission or comparable state agency would be required before major water development actions could be taken by a basin-wide water conservancy district, assuming one were established for the Wolf. (See Muench v. Public Service Commission, 261, Wis. 492, 53 NW (2d) 514 (1952).)

3. Conservation Commission

The State Conservation Commission and its department have the responsibility to provide "an adequate and favorable system for the protection, development and use of the forests, fish and game, lakes, streams, plant life, flowers and other outdoor resources in the State of Wisconsin." In carrying out this broad responsibility, the department (1) administers the fish and game laws, (2) establishes forest, water and wet land policies, (3) protects the forests from fire, (4) promotes and aids watershed management programs, (5) represents the outdoor recreationist's point of view in proceedings for irrigation or dam permits, (6) aids in the enforcement of water pollution orders and irrigation permits, and (7) surveys and acquires lands for public access to navigable streams and lakes. Exercise of the latter power to survey for and provide public access to Wolf Basin waters might well be used in connection with an overall basin development program. With respect to irrigation permits, the irrigator must get the written consent of the Conservation Commission before a permit to take water from a trout stream can be issued. Annually the Commission reviews all of the irrigation permits with the Public Service Commission. Obviously this agency is of major importance in a river basin development program. (See generally Wis. Stats. 1959, ch. 23 and §30.18.)

4. Board of Health

The State Board of Health has primary responsibility for the purity of the public water supply. It also sets specifications for drilling and constructing wells and administers the so-called high capacity well law. Under this law, an irrigator, municipality, industry or other person must obtain a Board of Health permit before drilling a well with a capacity of more than 100,000 gallons a day. It can deny the permit only if the proposed well "will adversely affect or reduce the availability of water to any public utility in furnishing water to or for the public." (See Wis. Stats. 1959, §144.03 (6) to (8).) It also has important responsibilities to inspect restaurants, hotels, motels, boys' and girls' camps and other recreational establishments. It cooperates intimately with the State Committee on Water Pollution in carrying out the state's program for pollution control. (Wis. Stats. 1959, chs. 143 and 144).

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5. Department of Resource Development

This new department created by the 1959 legislature has broad powers to promote development and maximum wise use of natural and human resources. It is authorized to prepare coordinated plans for resource development within watersheds, and river valleys. It is directed to cooperate with federal, state, regional and local, public and private agencies in the making of plans for control, use, conservation, allocation and use of the water supply and the development of new water resources. It also has important responsibility for the promotion of industrial and recreational development. When fully staffed, it could play a major role in the planning and development of the Wolf River Basin. (See Wis. Stats. 1959 §§109.01 - 109.09.)

6. Committee on Water Pollution

This inter-agency committee, on the basis of basin-wide surveys of industrial, municipal, and household pollution of surface waters, issues pollution prevention orders directing polluters to take specified steps to reduce and eliminate the dumping of waste and other polluting materials into surface waters. Such a basin-wide study of the Wolf Basin was completed in 1949. Orders were issued, many of which now have been complied with. The orders have been particularly successful in inducing the construction of municipal sewage disposal plants in the basin area. Further work by the committee is vital to the elimination of pollution in the basin. (See Wis Stats. 1959 §§144.51 - 144.57.)

7. Natural Resources Committee of State Agencies

This interdepartmental committee was set up by the legislature in 1951 to coordinate the activities of several state agencies concerning natural resources. The committee has no staff as such and no budget. It meets four times a year and is divided into subcommittees, one of which is concerned with water. Its general recommendations with respect to water have been largely restricted to four unsuccessful attempts to get the legislature to amend the high capacity well law so as to make it apply to bulldozed irrigation pits and permit the board to deny a permit where the proposed new high capacity well would seriously and adversely affect neighboring private wells, not just municipal supply wells. It is now an advisory arm of the new Department of Resource Development. It could be an important help in coordinating the efforts of the State agencies in a development program for the Wolf River Basin. (See Wis. Stats. 1959 § 23.26.)

8. State Soil Conservation Committee

This committee is primarily a service agency charged with the duties of encouraging the creation of soil conservation districts, assisting soil conservation districts in carrying out soil conservation programs, and approving and supervising Public Law 566 on small watershed programs. It is closely tied to the Agricultural Extension Service and has intimate working relations with the Conservation Commission. It could play a major role in promoting and assisting in the establishment of coordinated small watershed programs throughout the Wolf Basin. (See Wis. Stats. 1959 § 92.04.) Individual farm soil conservation measures

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being sponsored by the soil conservation districts in basin counties under the state committee's guidance are listed in Table 5, p. 20.

C. Local Governmental Units

1. General Focus

This is not the place to review the many powers of local units which could be brought to bear upon problems of planning and development in the Wolf Basin. For example, local powers over roads, streets and bridges are obviously important in this regard but are so well understood as not to require special attention. Instead, we have emphasized less well-known but important powers of local units.

2. The Ten Counties and Their Soil Conservation Districts

Parts or all of Forest, Oneida, Langlade, Marathon, Portage, Outagamie, Winnebago, Waushara, Shawano, and Waupaca Counties are in the Wolf Basin. The ten counties could join in petitioning the Governor to create a Regional Planning Commission under §66.945, Wis. Stats. 1959. Such an agency would have only powers to advise in planning. To be effective, its recommendations would need to be implemented by the counties and other local units. For example, if a basin-wide zoning program were recommended, the counties would have to enact the ordinances, and even then to be effective in any town, the town board must also approve the ordinance. (See Wis. Stats., 1959 §59.97.) Perhaps federal matching planning funds would be available to such an agency.

Counties, under §66.30 of the statutes, can contract to do jointly whatever they could do separately. This offers some prospect for use in fostering a basin-wide program.

Even though town approval is required for zoning, counties can, without consent of towns, establish set-backs along county highways. (See Wis. Stats. 1959 §80.64.)

Counties operating marine developments could be of help in setting up boating regulations for adjacent waters. This authority now exists under the recently enacted boating code, Wis. Stats. 1959 §30.77 (3).

In addition under Wis. Stats. §236.46 each of these basin counties can set up a planning agency and adopt a county-wide regional plan which presumably could be meshed with a basin-wide plan. If it sets up a planning agency, the county, under Wis. Stats. §236.10, can exercise important control over land use patterns being laid down by subdividers, including those dividing water front lands.

In Wisconsin, soil conservation districts are county-wide in their jurisdiction and the agricultural committee of the county board is ex officio the board of supervisors of the district. This close tie between the district and the county board means that active support of both must be obtained for any small watershed program that may be undertaken. (See Wis. Stats. 1959 ch. 92.)

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3. The Ninety-one Towns

There are 91 civil towns, all or more than half of which are located within the Wolf Basin. Cooperation of these towns must be sought if a basin-wide development program is to succeed. But, in general, this cooperation will be reflected through town representatives on county boards.

Towns have authority to approve planning and subdividing but, in general, they must get county board approval before they can zone. (See Wis. Stats. 1959 §§60.183, 236.10 and 60.74) They may, under Wis. Stats. 1959 § 60.29 (41) and (43), act jointly with other local units for regional planning and cooperate with the county in rural planning. Under Wis. Stats. 1959 §§ 60.18 (21) and (22), towns through the annual town meeting may vote to raise money to assist in creating and developing watershed protection areas and to assist in the development of a soil conservation district.

4. The Twenty-nine Villages and Eight Cities

These incorporated units of government have zoning powers for their areas under Wis. Stats. 1959 § 62.23 (7). They also have authority under appropriate circumstances to adopt boating regulations. (Wis. Stats. 1959 § 30.77.) Their planning powers can be used for areas outside the municipality which in the opinion of the plan commission, bear a relation to the development of the municipality. (See Wis. Stats. 1959 § 62.23 (2).) The powers of cities and villages of the Wolf Basin to approve subdividing extend 1-1/2 miles beyond the municipal limits as do also their official mapping powers. (See Wis. Stats. 1959 §§236.02 (2) and 62.23 (6).) Under section 66.30 they have broad powers to enter into cooperative contracts with other units of local government.

5. Flood Control Boards, Drainage and Other Special Purpose Districts

Chapter 87 of the Wisconsin Statutes authorizes the creation, with the approval of the Public Service Commission, of local Flood Control Boards. No such board has ever been created even though this legislation has been on the books since 1931. The probable reasons lie in the quite involved procedures and in the fact that the only mechanism provided for the financing of flood control works is the assessment of benefits to benefited lands.

Drainage Districts as such may no longer legally be created in Wisconsin but it is possible to bring into existence so-called "farm drainages" under chapter 88 of the statutes. This is a mechanism for group drainage of land under a county-wide board subject to approval of all major decisions by the county court.

Likelihood of group activity under the Flood Control Board Act or under the Farm Drainage Act in the Wolf Basin is not great. There is no legislative authority for the creation in Wisconsin of multiple-purpose watershed conservancy districts like the famous Muskingum District in Ohio or like some of the Watershed Districts which have recently been set up in our neighboring state of Minnesota. See Appendix E for a summary of the Ohio and Minnesota multiple-purpose districts.

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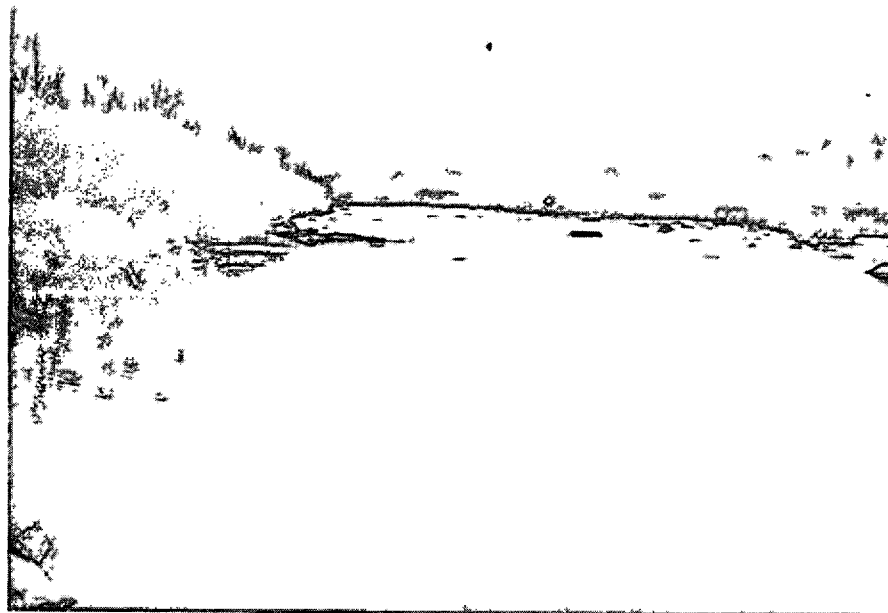
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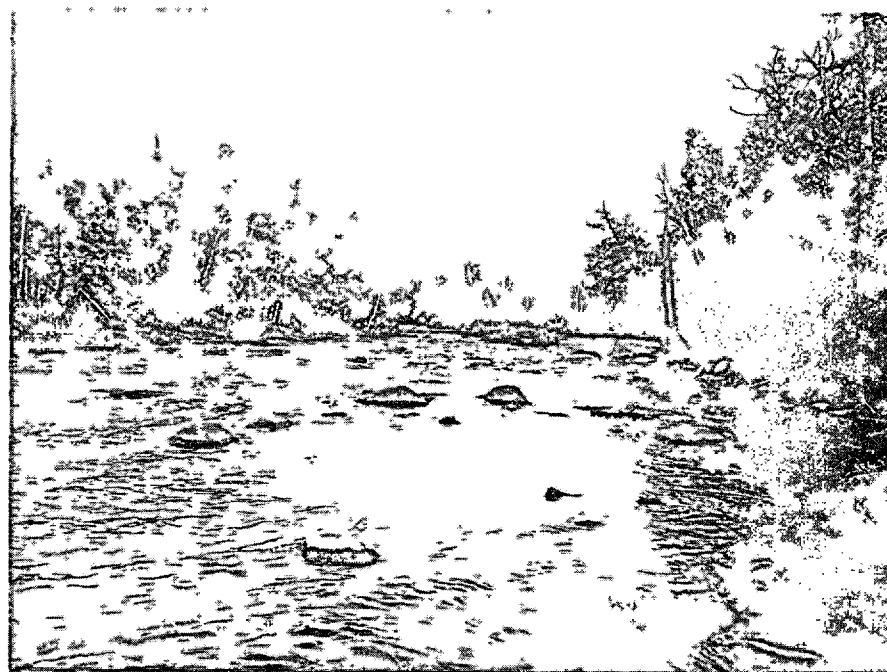
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Site of Proposed Dam on Wolf River at County Trunk "A" in Langlade County. Upper photograph shows the area which would be flooded while lower photograph shows the area immediately below the dam site.



May 10, 1956

IV. SOME PRESENT LAND AND WATER USES AND PROBLEMS

A. General Uses and Problems

The Wolf is Wisconsin's least harnessed major river. What should be its future? Should it be left in its relatively natural state? Should it be harnessed for hydro-electric power? Should flood control dams and reservoirs be established? Should water be impounded to stabilize summer flow? How much of its water should be taken for agricultural irrigation? How much for industrial use?

To find answers to these questions it is well to look first to present land and water uses and problems of the basin as a whole.

B. Present Hydro-electric Power

There are 29 dams in the Wolf River Basin, four on the Wolf itself, (Post Lake, Keshena Falls, Upper Shawano, and Shawano); the remainder are on its tributaries. The total water wheel capacity of all these dams is small, only 6,720 horsepower, and their total generating capacity is a meager 4,164 kilowatts. Their total water wheel capacity is only about 1/10 that of plants in the joint Fox-Wolf basin and only about 1/100 that of all hydro-electric plants in Wisconsin. (See Tables 6 and 7, pp. 26 and 27.) Most of the plants supply power to private industry, primarily to utility companies and paper mills. Some are small grist and saw mills. The Public Service Commission does not yet know the number of plants in the basin that have gone out of operation, but the presumption is that some have. Only 3 out of 4 dams on the Wolf have power plants: Keshena Falls, Upper Shawano and Shawano. They have a total installed capacity of 1,950 horsepower and 1,515 kilowatts. The major dams are on the tributaries: Gresham on the Red, Hayman Falls on the Embarrass, Big Falls on the Little Wolf, and Manawa and Weyauwega on the Waupaca. They have a total installed capacity of 2,459 horsepower and 1,735 kilowatts.

Obviously to pass judgment on proposals for additional hydro-electric development on the Wolf, one should know of other present sources of electric power in the basin and within the economic radius. We attempt no such listing here but note the recent substantial expansion of steam generation by the Wisconsin Public Service Company, principal supplier of electricity in north-eastern Wisconsin.

C. Present Flood Problems and Control Measures

1. Average Annual Damage

The average annual damages by flooding in the Wolf River Basin, according to the 1949 Corps of Engineers' report, was then about \$81,000, exclusive of damage to fish and wildlife. Of this amount, the Corps estimated about \$78,000 to be damage to agricultural lands and crops because of overflow of bottom lands, and \$3,000 to be damage to the city of New London. Estimates for damage to crops are difficult to establish and may well be higher or lower than actual damage. (See Table 8, pp. 28 and 29.) Interruption of business accounts for about half of the damages in urban areas. There is very little danger to human life: few people live in the lowlands, the current is usually sluggish, and no epidemics have resulted.

MAY 10, 1950

Table 6

EXISTING HYDRO POWER IN THE WOLF RIVER BASIN AS COMPARED
TO THE STATE AS A WHOLE

Stream	No. of Plants	Total Head in feet	Installed Generating Capacity K. W.	Water Wheel Horse Power Installed
The Wolf, Main Stream	3	40	1,590	2,053
The Wolf, tributaries				
The Pine	5	58	100	435
The Waupaca	5	68	710	1,450
The Little Wolf	3	49	584	830
The Embarass	5	94	548	1,031
Other Minor tributaries	6	106	533	723
Total, Wolf System	27	415	4,585	6,522
Total, Fox-Wolf System	58	807	24,070	63,387
The Wisconsin River System	62	1,071	147,749	236,000
The Chippewa River System	30	809	159,552	223,090
The St. Croix River System	29	827	33,183	53,834
The Black River System	9	270	5,734	10,663
The Rock River System	28	273	3,392	6,887
The Mississippi minor streams	14	172	535	1,297
The Illinois Fox	2	16		98
The Fox-Wolf System	58	807	24,070	63,387
The Lake Superior drainage	9	269	5,091	8,479
The Lake Michigan drainage	46	1,032	79,794	133,272
Grand Total	287	5,846	459,092	737,007
(All Wisconsin Installations)				

Data from Natural Resources of Wisconsin, The Natural Resources Committee of
State Agencies, December 1956.

Since this time, the Waupaca River has lost one plant, and other tributaries of the
Wolf have gained three. Changes in other basins have probably taken place, but
these 1956 figures are still helpful for making general comparisons.

Dam No.
P. S. C. No.

1	58.10	Neo
2	58.6	Kes
3	58.23	Upp
4	34.9	Phl
5	58.3	Gre
6	58.14	Sha
7	58.18	Till
8	58.21	Wit
9	58.1	Car
10	58.22	Hay
11	58.12	Pel
12	68.6	Ma
13	68.1	Big
14	68.4	Ma
15	68.3	Iola
16	68.9	Oge
17	68.14	Lig
18	68.15	Wal
19	68.17	Fis
20	68.13	Fel
21	68.19	We
22	69.10	Cla
23	69.9	Wil
24	69.3	Idl
25	69.7	Sax
26	69.5	Pir
27	69.6	Pot
28	69.4	Mo
29	69.1	Au

*OWNERSHIP:

- (1) U. S. Gover
- (2) Wis. Power
- (3) Shawano Pap
- (4) Wis. Public

Data obtained from
the No. units, w

Table 7

EXISTING DAMS IN THE WOLF RIVER BASIN

S COMPARED

g
K. W. Water Wheel
Horse Power
Installed

P. S. C. No.

Name of Dam

Owner*

Head

Drainage area

No. units

Q H/8.8

THP 50% time

Installed

Gen. KW Capacity

Installed

Water Wheel HP

2,053

435

1,450

830

1,031

723

6,522

63,387

236,000

223,090

53,834

10,663

6,887

1,297

98

63,387

8,479

133,272

737,007

Committee of

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OWNERSHIP:

U. S. Government-Indian Agency

Wis. Power & Light Co.

Shawano Paper Mills

Wis. Public Service Corp.

(5) Wis. -Michigan Power Co.

(6) City of Waupaca

(7) Village of Gresham

(8) Private

obtained from list prepared by Wis. Public Service Comm. Jan. 1, 1960, except for
No. units, which was obtained from House Document No. 276, 72nd Congress, 1st Session

May 10, 1956

4,164 6,720

Table 8

AVERAGE ANNUAL FLOOD DAMAGES TO AGRICULTURAL PROPERTY IN WOLF-FOX BASIN

Item of Damage	Upper Fox River	Wolf River	Lake Winnebago	
			Below upper limit of regulation	Above upper limit of regulation
Marsh land suitable for cutting hay that is not accessible in average year due to floods or high water - Acres	17,000	25,000	600	
Value of lost production, estimating one ton of marsh hay per acre and value at \$6.00 per ton (1)	\$102,000	\$150,000	\$3,600	
Less value of labor not expended for harvesting hay, at \$4.00 per acre	<u>68,000</u>	<u>100,000</u>	<u>2,400</u>	
Net Loss due to loss of hay harvest	\$34,000	\$50,000	\$1,200	
Marginal land suitable for cultivated crops not accessible in average year due to flood or high water - Acres	1,500	4,000	100	225
Value of lost production, assuming equal acreages of corn, oats and tame hay, at \$22.00 (2)	\$33,000	\$88,000	\$2,200	\$4,950
Less value of labor, seed and fertilizer not expended for production and harvesting crop, at \$19.00 per acre (3)	<u>28,500</u>	<u>76,000</u>	<u>1,900</u>	<u>1,800 (6)</u>
Net Loss due to loss of crops other than marsh hay	\$4,500	\$12,000	\$300	\$3,150
Garden land not accessible in average year due to floods or high water - Acres	- -	400	- -	- -
Value of lost garden production at \$140 per acre (4)		\$56,000	- -	
Less value of labor, seed, and fertilizer not expended in production and harvesting of crop at \$100 per acre		<u>40,000</u>	- -	
Net loss due to loss of garden crops		\$16,000		
Total Net Loss in Area	<u>\$38,500</u>	<u>\$72,000</u>	<u>\$1,500 (5)</u>	<u>\$3,150</u>

28

(Table 8 continued)

- (1) Based on approximate average yield of wild hay in Wis. 1933-44 at 70 percent of 1944 average price received by farmers for loose prairie hay.
- (2) Based on 75 percent of average 1933-44 yield of corn, oats and tame hay in Wisconsin and 1944 average price received by farmers which is approximately the price now prevailing assuming equal acreages of the three crops. Usually it is not feasible to reduce loss by planting a later crop, as season is too far advanced before land dries to workable condition.
- (3) Based on average cost of production in 1942 in Wisconsin and other States in same production group, less land rent and 25 percent of cost of fertilizer and miscellaneous costs, plus 33 percent of cost of preparation, planting, cultivating, and harvesting to allow for approximately 50 percent wage increase.
- (4) Based on 1944 average production and price received by farmers for 9 common Wisconsin garden crops. (cabbage, beets, sweet corn, onions, green peas, green lima beans, snap beans, tomatoes, potatoes).
- (5) Loss on lands below upper limit of regulation to which United States has acquired perpetual rights by payment of flowage damages. Not to be included in justification of additional work.
- (6) At \$8.00 per acre covering cost of cultivating and harvesting only, as loss normally occurs after crop has been planted.

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(Table 8 continued)

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- (6) At \$8.00 per acre covering cost of cultivating and harvesting only, as loss normally occurs after crop has been planted.

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Most of the Wolf Basin's flooding is between the Winnebago Pool and Leeman. (The previous discussion of topography explains the reason for this concentration.) About 39,000 acres next to the river between Leeman and New London are subject to frequent overflow. Most of this is low, marshy river bottom not used for agricultural purposes. About half of the flooding is in Outagamie County. Below New London, about 35,000 rural acres are subject to frequent flooding. This land is primarily marshland.

The only major urban area flooded by the Wolf is New London, part of which was built on the river bottom and is flooded by both the Wolf and its tributary the Embarrass. The Lower Fox, into which the Wolf flows, floods other urban areas, but the Corps of Engineers uses the Winnebago Pool as a great series of storage reservoirs to lessen such floods. Early each spring, the Corps manipulates the Menasha Dam to lower the level of Lake Winnebago by 18 or 24 inches. If its estimate of probable spring flood waters proves to have been too high, low water may result. If its estimate is too low, flooding at Oshkosh and Fond du Lac may result because of the high lake level.

2. Unusual Damages

In 1922, a spectacular flood covering about 73,000 acres caused damages of about \$52,000 in New London. In the fifty-three years after 1896, four lesser floods in New London caused about \$10,000 damage each. During about two of five summers, a crop-damaging flood occurs along the Wolf and its tributaries. In Outagamie County, which gets the brunt of the floods, 25% of such crop-damaging flooding covers cultivated land and 75% covers marsh and pasture.

3. Tables of Flow

Table 9, p. 31, gives figures for average, high, and low flows at six gauging stations in the basin. Appendix F gives hydrographs of floods to be expected every 10, 25 and 40 years, and Appendix G, stages of the Pool.

4. Flood Control Measures

None of the existing 29 dams in the basin is a flood control structure as such, and the total effect of these dams on floods is negligible. As noted above, the Menasha Dam is a key dam for the joint Fox-Wolf Basin. This dam has three primary functions: (1) to maintain the level of the Winnebago Pool, (2) to help prevent floods on the Lower Fox, and (3) to stabilize the flow of the Lower Fox for navigation, power and industry. The Corps of Engineers has operated the Menasha Dam since the beginning of its construction in 1850. The lower level of the Pool during periods of navigation is fixed at 746.7 feet above sea level. As already stated, the Corps lowers the level 18 or 24 inches in anticipation of a large spring flow from melting snow and ice. In 1886 the War Department set an upper limit of 21-1/4 inches above the crest of Menasha Dam, a limit which is still in effect. This level was the average of annual high water stages of the lake for 1859-1886 (excluding the unusual high in 1881 and low in 1860). The United States paid \$592,375.09 for flowage damages, including future damages, resulting from the new water level.

Table 9

STREAM GAUGING STATIONS ON WOLF RIVER SYSTEM

Station	Year estab- lished	Location		Drainage Area (sq. mi.)		Extreme Records							
						High water			Low water			Average Discharge cfs Yrs.	
		River	Miles above mouth	Above station	Above mouth river	Date	Gauge (ft.)	Daily disch. (c.f.s.)	Date	Gauge (ft.)	Daily disch. (c.f.s.)		
4 mi. north of Keshena (about West branch of Wolf river)	1928	Wolf	129	633	3750	4/8/29	6.10	2580	2/20/36	--	199	584	17
Keshena & Keshena Falls	1907	Wolf	124.7	840	3750	4/10/22	7.30	4390	12/22/32	4.67	91 ^a	798	35
	1928	Wolf	126.2	812									
New London	1888 ^b	Wolf	46.4	2240	3750	4/13/22	11.4	15500	9/6/33	-0.4	261	1842	32
Embarrass (4 mi. above village)	1919	Embar- rass	39.3	395	650	4/10/22	c. 11	6280	8/3, 6, 7/31	2.32	23	305	26
Royalton	1914	Little Wolf	4	485	505	3/30/43	c. 7-8	6950	2/10/34	--	57	439	31
Waupaca (4 mi. below city)	1917	Waup.	10	305	335	3/17/19	5.6	2600	1/22, 28/26	--	35	253	29

-- Indicates information not available.

a. Result of low temperature.

b. Exact date unknown; records available since 1 March 1896.

c. Maximum stage reported was 11.6 feet on 16 April 1888. Discharge not known but flood volume was less than that of 1922.

When water reaches the limit at the dam, some land near the Winnebago Pool is flooded. At the time of the 1949 report by the Corps of Engineers, most of that land was uncultivated marsh and pasture.

Occasionally water rises above the 21-1/4 inch limit and floods agricultural lands and summer homes along Lake Winnebago causing sewers in parts of Fond du Lac and Oshkosh to back up. This is understandable when one realizes that flood waters may be entering Lake Winnebago at a rate of 40,000 c.f.s., whereas the maximum safe discharge rate at Menasha Dam is 15,000 c.f.s., faster flow. The Wolf typically provides more than 60% of the high water entering Lake Winnebago.

The Corps of Engineers is often blamed for high water conditions in the Winnebago Pool and in turn for floods on the lower Wolf, which some people assume are caused by water backing up from the Pool. The Corps contends that much of the land along the lower Wolf would be flooded regardless of the level of Lake Winnebago since the nearly flat slopes of the rivers' natural cross section are "entirely inadequate to pass the large volume of flood waters without expansion into the adjacent lowlands." (House Document 276, 72nd Congress, 1932, p. 26.) The Corps claims that the Menasha Dam at no time backs up flood waters farther than Fremont. Above Fremont the entire depth of the flood waters is due, says the Corps, to the volume of water, the condition of the natural channel, and the nearly flat slope of the river. Flooding of the lakes below Fremont begins almost as soon as Lake Winnebago rises one-half foot above the crest of Menasha Dam and becomes extensive at the stage of 1.25 feet above the crest.

5. Bridges

Some bridges in the past have helped to increase the danger of flooding by constricting the flow of various streams in the Wolf Basin. According to the District Engineer of the Corps of Engineers, in a report submitted in compliance with the Flood Control Act of June 22, 1936, three bridges on the Wolf and five on the Embarrass in New London were then constricting flow enough to cause one to two feet of flood backwater in that city. It should be noted that the system of nine flood control reservoirs proposed at various times in the past would reduce the stage of a major flood by only about six inches, whereas the local bridges were said to have backed up two to four times that many inches. Appendix H, from Highway Commission records, lists the locations, number, and dimensions of existing bridges on the Wolf, the Little Wolf, and the Embarrass. A few bridges located on city or village streets not on the state or county trunk system may not be included in this list. Information about them may be secured through local municipalities.

6. Navigation

By about 1918 logs were no longer floated down the Wolf to mills on Lake Winnebago and on the Lower Fox. In the era thus ended, millions of logs had been brought each year to the mills on the Wolf and the Fox. Agricultural crops and small amounts of freight are no longer shipped on the Wolf, nor is there any passenger-boat traffic. The scheduled excursions between Oshkosh and Justin on Lake Poygan, or Lake Winneconne, Fremont, or New London are only memories.

To replace commercial navigation, pleasure boating has come by hundreds of motor boats, canoes, and other pleasure craft. Here on the Wolf is a dramatic illustration of a shift that has occurred on many public waters away from commercial navigation to recreational boating. This boating has implications for the economy of the lower Wolf and of the basin, implications at least as great as those of former commercial uses, including logging. The need to maintain a reliable 4-foot navigable channel from the mouth of the Wolf to the head of navigation at New London is as great as ever.

In 1896 Congress decided to maintain a 4-foot-deep, 100-foot-wide navigable channel from the mouth of the Wolf 47 miles north to New London. In that year it amended earlier legislation under which the Corps had been attempting, at considerable expense, to maintain a navigable channel on the Upper Fox as far south as Portage. The 1896 amendment directed the Corps to dredge, snag and otherwise improve the Wolf to New London. Initial work was done between 1911 and 1921 at a cost of only \$15,400, of which \$10,500 was for the improvement of the channel and the rest for maintenance. About 3/4 of the money spent for improvement was spent on mile 23 above Fremont. The natural depth of the river below New London exceeds 4 feet, except for Boom Cut at the head of Lake Poygan. In 1932 the Corps estimated that an annual expenditure of \$500 for dredging would be required if full depth was to be maintained at all times in Boom Cut.

Based on the latest available soundings taken in the mid-30's the natural depth of the river at times of standard low water is also 4 feet or more for 10 miles above Fremont, but in the next 14 miles a number of large shoals and bars lower the controlling depth at standard low water to only about 2.5 feet. There are no funds presently available to complete the dredging of this channel. From information available to the District Engineer of the Corps at Chicago, the following amounts have been spent for dredging and snagging on the Wolf river:

Year	Amount	Work
1897 to 1921	\$10,500	Improvement Dredging
1921	4,900	Dredging
1922	3,030	Dredging & Snagging
1926	175	Snagging
1934	1,845	Dredging & Snagging
1936	9,555	Dredging & Snagging
1937	3,575	Dredging & Snagging
1938	14,115	Dredging & Snagging
1942	12,220	Dredging & Snagging
1950	12,500	Dredging & Snagging
1956	10,000	Snagging
1957	12,670	Dredging & Snagging
1959	19,300	Dredging & Snagging
Total	\$114,385	

As will be seen in the next section of this report, the Corps in 1949 reported that a system of nine dams and reservoirs as proposed at various times on the Wolf above New London would produce relatively minor benefits to navigation below New London. In view of the increasing use of this 47 miles, one of the key problems of the Wolf is to maintain adequate depth in this channel for motor boats of moderate size.

This 47-mile channel is treated as a tributary of the Great Lakes and the Great Lakes Pilot Rules apply to it. The U. S. Coast Guard claims jurisdiction for the enforcement of these rules in this section of the river and also maintains at least two lights and various channel buoys and markers. So far there seems to have been no conflict between the Coast Guard, charged with enforcing federal rules of navigation, and agencies attempting to enforce state or local boating rules. Typically present in summer in this stretch of the river are many small anchored boats occupied by fishermen. Power boats often disturb these fishermen. Here, as wherever fishermen and motor boat operators use the same waters, is a source of increasing conflict between competing public users.

7. Recreation

Mr. Harold C. Jordahl's report for the State Conservation Department "Recreational Values of the Wolf River Basin, Wisconsin," (Appendix B of this report) contains much valuable detail. Pages 2-4 give information of fishery resources, pages 5-9 on game resources, and pages 16-21 on other recreational aspects such as camping and skiing.

Fishing, as well as the boating mentioned above, is a popular pastime in the Wolf Basin: trout fishing in the northern stretches of white water, and sturgeon, white bass, walleye, and pan fishing to the south and in the Winnebago Pool. Campgrounds and summer cottages ring some of the lakes and border some streams. A number of summer resorts exist, but the American Automobile Association lists but one, with only eight units, in its Great Lakes Tour Book. Many hundreds of people annually visit the basin because of scenic attractions, particularly those in the Menominee Indian Reservation. Abundant wildlife provides much hunting, particularly of waterfowl and deer.

Mr. Jordahl points out that there are no state parks in the basin and that the only non-urban parks or public recreation areas in the whole of this 3,750 square-mile basin are the following:

Upper Basin

Two recreation areas in the Nicolet National Forest about ^{23,830}~~4,100~~ acres of which lies within the basin. (20 more adjacent areas are in this forest but not in the basin.)

Two Langlade County Parks

Lower Basin

Six county parks totaling 118 acres:

Shawano County

Shawano County Park - 36 acres; located on Shawano Lake; swimming beach, bathhouse, boathouse, dock and pier, picnicking, camping, group camping, fishing, playground, toilets.

Wilson Lake - 9 acres; located on Wilson Lake; swimming.

Portage County

Collins Park - 23 acres; located on Collins Lake; swimming beach, bathhouse, fishing, boat rental, picnic area, playground equipment.

Elderon Park - 12 acres; located on Lily Lake; picnic area, camping, playground equipment.

Waupaca County

Gills Landing - 11 acres; located on the Wolf River; provides public access, two boat landings, docks, toilets.

Keller Park - 37 acres; located on Little Lake; swimming beach, fishing, picnic area, playground.

8. Forests

Of tremendous value to the recreational potential of the Wolf Basin is the superb 174,000 acre sustained-yield forest of the Menominee Reservation. Here is perhaps the best example in the northern lake states of how forest of quality looked in this part of the country before the white man came.

All the other forests of the basin are second growth: the trees have grown again to hide the ugly scars of clean-cutting and of the devastating fires that followed the butchery of our forests. Most of this second-growth land is privately owned. There is no state forest and only small parts (about 23,830 acres) of the Nicolet National Forest lap over into the basin area. The only county forest lands are the 46,000 acres owned by Langlade. In many places the second growth is of substantial size and the northern reaches of the basin have many large and relatively remote forests. About 80,000 acres of this is in industrial forests.

9. Soil Conservation

Soil erosion on the Wolf itself is relatively slight. Spring floods sometimes break up or move floating bogs from one place to another, but agricultural land is not affected in this way. Potential regulation by reservoirs would probably not appreciably affect such action, according to the Corps of Engineers, although it might increase erosion by increasing the speed of run-off in some areas. See "State Soil Conservation Committee", at page 22, and Table 5, p. 20 for a further consideration of soil conservation.

10. Agriculture

a. Land. About 66% of the land in the Wolf River Basin, or 1,560,320 acres, is used for agricultural purposes. The central part of the basin contains much of this acreage. Rocky timber land in the north and marshland to the south are less suitable for agriculture. See Appendix I. for information about agricultural land of the basin which currently is in the Soil Bank.

b. People. About 50,000 people or about half of the people of the basin were engaged in farming in 1950. Apparently the farming population has decreased during the past ten years, and it also appears that farms are getting larger. (See "Occupational Data," at page 7 of this report, for a fuller consideration of the farming population of the basin.)

c. Crops. The main crops are dairy products, potatoes, corn, oats and garden vegetables. Langlade County, about half of which is in the basin, derives about half of its farm income from dairying and one-fourth from potatoes. The Antigo Flats, in Langlade County but outside the basin, is a particularly productive potato area. Langlade produced one-fourth of the state crop of potatoes in 1959 from 11,700 acres. In 1959 about 400 Mexicans and southern Negroes were hired in Langlade, but harvesting machinery is replacing manual labor.

Other agricultural products in the basin are wood products, livestock, poultry, eggs, alfalfa, hay, furs, and maple syrup. The Menominee Indian Reservation produces high-quality timber for various wood products. Muskrat farms in the marshy areas of the basin produce valuable furs. Maple syrup is produced in Langlade County and presumably elsewhere in the basin.

11. Irrigation.

The variety of soils in the basin, their varying ability to absorb and retain water, and the variation in rainfall present conflicts between agricultural uses of water for irrigation and other uses, particularly recreational ones. It should be remembered that irrigation is not a completely consumptive use of water: much of the water used for irrigation returns to ground water. For example, only about 40% of 10 inches of irrigation is actually used by plants in evapotranspiration.

a. Irrigation from Streams (See Table 10, pp. 38-9.). Because land in Langlade and Waupaca Counties is generally not prime agricultural land and because rainfall is often uneven on soils that dry out quickly, some farmers in these two counties have turned to supplemental irrigation. In Langlade the irrigated crop is potatoes; in Waupaca potatoes are the main crop but the longer, warmer growing season there permits some diversification to truck crops and hay. Most of the irrigable soil in Langlade County is now being irrigated. All 37 of the holders of permits for stream irrigation in the basin are in these two counties. They are authorized to withdraw a total maximum of 57 cubic feet per second. This is 23% of the record low flow of the river, but pumping is not continuous, the irrigators are spread over a large area, and they draw water mostly from tributaries, which may possibly be recharged from ground supplies before entering the Wolf.

Irrigation in the Wolf Basin involves the interests of recreation. Some plans for irrigation could result in serious damage to fish and other aquatic life. Irrigation also involves the interests of industry, particularly of mills below the point from which the water is taken. The demands upon water for irrigation and power are not completely compatible: irrigation uses up some water that hydro-plants might want to feed through their turbines.

Sometimes, and in some places, however, the quantity of water available and the quantity of water to be taken for irrigation causes more imaginary than real damage. Nine objectors, mostly representing sportsmen's groups, appeared at a hearing against one application for withdrawal of water from the Wolf, even though the applicant proposed to withdraw a maximum of only two cubic feet per second from a point where the low flow was 200 cubic feet per second.

b. Irrigation From Wells. One of the chief difficulties with stream irrigation is that water for crops is often needed most when streams are lowest. One possible help would be more irrigation from wells and less from streams. Such in fact seems to be the present tendency. Conflicts over the use of water and the comparative high costs of stream irrigation also tend to encourage irrigation from wells instead of from streams. Potato production in Portage and Waushara counties is rapidly expanding, and, since the sandy soil there dries out rapidly, irrigation is essential about every five days during the critical growing season. This irrigation is primarily from wells, not from streams. Langlade and Waupaca have large numbers of well irrigators and stream irrigators, too. Figures for the number of permits granted to well irrigators in the basin were not available for this report, but by counties the numbers for January, 1960, are:

Central counties in the basin (Some of these permits may be for wells outside the basin.)		Fringe counties (Many of these permits are probably for wells outside the basin.)	
Langlade	30	Oneida	2
Waupaca	19	Forest	0
Shawano	0	Marathon	10
Outagamie	0	Portage	86
Winnebago	0	Waushara	60

Irrigation from wells involves serious problems, too, however. Ground water supply is inadequate in some areas, and in some, underlying soil structure, particularly the presence of quicksand and glacial boulders, seriously interferes with drilling. One farmer in Langlade County was successful in establishing only two wells in seven attempts. When water becomes low in a functioning well, farmers need water from streams, but streams can quite likely be low at such times. The problem of securing water in sandy areas where irrigation is necessary for efficient agricultural use, and not merely helpful, is therefore a serious one involving many interests.

c. Irrigators and the Law. Stream irrigators and well irrigators both are required to have permits but under quite different laws from different state agencies.

Stream irrigators apply to the Public Service Commission, which holds formal hearings after appropriate notice. From 1950 to 1959 the Commission evolved a permit system that paid great attention to public rights in streams and lakes and also gave consideration to interests of private coriparians who might be substantially affected. Consent of riparians who would not be substantially affected was not required. In late 1959 the state Supreme Court held that such consent of lower riparians was required before a permit for non-surplus water could be issued.

V. PROPOSALS FOR THE WOLF, 1922-1960

For several decades people in Wisconsin have been interested in problems of further developing the Wolf and its tributaries. We outline here first some proposals that have not been intensively studied and then turn to those which have been.

A. Proposals Not Commented on in Detail

Proposals which have not been studied in detail by any group are listed below and are not commented on in detail in this report. These are proposals to:

1. Push for intensive small watershed programs in the upper reaches of the tributaries. In each of the counties in the basin a soil conservation district is in existence to carry out small watershed programs under Public Law 566, should any be proposed--something which has not yet happened. If proposals are forthcoming in the future it would be well to mesh them into a coordinated basin-wide development program.
2. Be more active about dredging and maintaining a 4-foot channel from New London south. As was indicated in the previous section under the heading "Navigation," the natural low-water level in the 14-mile section of the channel immediately south of New London is on the average considerably below 4 feet. The Corps reports that it has no money with which to carry on future dredging operations. This proposal contemplates a request to Congress that funds be made available to dredge in this and other sections of the channel.
3. Restore the level of White Lake. White Lake covers about 1,100 acres and its level rises and falls with that of the ground water table. Because of deficiencies of rainfall over a period of years, the level by the summer of 1959 had declined about 2 feet. Since last fall heavy replenishment of the ground supply has brought the lake back to an acceptable level, but undoubtedly low levels will recur from time to time in the future after extended periods of deficient rainfall. The proposal is to build a dam across the South Branch of the Wolf and to bring water in from the west through a ditch about a mile long. Estimates of the cost of the project vary greatly. The local association believes it can be done for about \$27,500; the Conservation Department estimates a cost of at least \$100,000.
4. Raise the level of upstream lakes not in the Winnebago Pool and use them as storage reservoirs to help even out the flow of the Wolf. It is doubtful that these lakes would provide sufficient storage to affect noticeably the flow of the river. The mid-summer draw-down of these lakes to increase the river flow would probably bring protests from persons who own summer cottage properties on them. No estimate of the cost or of the engineering feasibility of such a project has been made.
5. Establish lateral reservoirs in the lower basin to store flood waters

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feasibility of this suggestion has not been investigated. Topographical conditions
may not permit reservoirs of adequate depth and size and there are important
implications for fish and wildlife that need full and careful study, for example
the growth of rough fish in such shallow reservoirs and the maintenance of
sufficient current in the reservoirs to permit pike spawn to hatch.

6. Engage in a comprehensive overall basin-wide study with a view to-
ward evolving affirmative proposals for the improvement of the basin as opposed
to studying and evaluating single proposals. This proposal has substantial value,
but will involve basin-wide, local organization and leadership and substantial
financing. The Corps has repeatedly, in its reports, pointed to local unwillingness
to help finance development.

B. Proposals Considered in Detail

Proposals for the development along the Wolf and its tributaries that have
been intensively studied relate mostly to hydro-electric power, flood control and
stabilization of the flow of the river. They have been of the following six types,
which will be commented on in relation to the findings of the various agencies and
individuals who have investigated the proposals:

1. Develop dams for hydro-electric power;
2. Build dams and other impoundment structures for flood control pur-
poses, and take certain other steps for flood control purposes;
3. Build dams for water storage purposes to stabilize the flow of the river,
the depth of the navigable channel below New London, the level of the Winnebago
Pool and the release of water into the Lower Fox;
4. Build multiple purpose dams for two or more of the above purposes;
5. Use water for supplemental agricultural irrigation (considered in
"Some Present Land and Water Uses and Problems," at page 25 of this report);
6. Leave the river system alone and protect it as a wildlife and fishing
resource and for other recreational purposes.

More specifically, the above six proposals considered in past surveys
involve nine possible sites for hydro-electric power dams--five in the Menom-
inee Indian Reservation, three at and above Lily, and one at Leeman. They
also involve proposed flood control dams at the same sites and more recent
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but as pointed out later this is thought by the Corps not to be a serious problem on the Wolf and its tributaries.)

C. Specific Surveys and Interests

There have been a number of studies of most of these proposals, some involving both the Fox and the Wolf. Among formal surveys are those of the Corps of Engineers in 1922, 1926, 1932, 1939, and 1949, the United States Department of Agriculture in 1926 and 1929, the Wisconsin State Planning Board in 1938, private firms and public utilities, the Conservation Commission in 1960 (attached as Appendix B to this report), and those of graduate students in a 1960 University of Wisconsin interdepartmental seminar in River Basin Planning. It should be noted that most of these conclusions have been based on reviews of a specific project or projects. To date there has been little or no attempt to study the basin as a whole with a view toward affirmatively proposing programs of action for the overall development of the basin. It is the difference between reviewing relatively isolated suggestions and making coordinated proposals founded upon a comprehensive study of the land and water uses and economic and social problems of the basin.

1. Corps of Engineers, 1922, 1926 and 1932

In 1922 the Corps recommended: (a) abandoning the improvement of the Wolf River above Fremont, (b) lowering the Winnebago Pool to two feet below the crest of Menasha Dam and deepening all channels if power interests furnished a bond as a guarantee to lease at a specified annual rental the power resulting from the improvement, and (c) cooperation of the United States in plans for reclamation of land along the Wolf by making necessary changes in Government dams on the Lower Fox. Congress took no action on these proposals. In 1926, the Corps reported unfavorably on a proposal for controlling floods by means of a cut-off canal at Shiocton from the Wolf near Leeman's Bridge into Duck Creek Valley. It reported favorably on conducting a survey on the Wolf above New London provided that local interests contributed \$33,000 of the estimated \$50,000 cost. Congress took no action on this recommendation. In 1932, the Corps reported unfavorably on additional improvement on the Wolf for navigation, flood control, water power, and irrigation. In 1939, a preliminary examination was unfavorable to a survey for improvement of the Wolf for flood control because the potential reservoir capacity would not be effective for controlling floods.

The Corps carried out a further preliminary examination of the Fox and its tributaries in 1949. This report is considered at length below.

2. Department of Agriculture

U. S. Department of Agriculture reports of 1926 and 1929 stated that the costs of various flood control measures along the Wolf would be greater than the probable benefits. The Associate Drainage Engineer, in a 1926 report on "The Possibility of Diminishing Floods in the Wolf River Valley, Wisconsin," considered plans for diverting flood waters but found costs and legal complications

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Wisconsin State Planning Board

The Wisconsin State Planning Board report of 1938, "The Fox River Valley," Bulletin No. 5, was prepared at the request of city officials from the cities of Fond du Lac, Oshkosh, Menasha, Appleton, and New London, who represented the Fox River Improvement and Conservation Committee, a group interested in regulating stream flow to minimize flood damage. The Planning Board's findings were not encouraging about methods of control except for changes in New London. Specifically, its findings were:

- a. The cost of diversion of water from the Wolf above New London would exceed benefits.
- b. Any reservoirs built on the Wolf at North Lily and Leeman, the two most practicable sites, would not help diminish floods in New London very much.
- c. More rapid sluicing at the Menasha Dam would cut down on the amount of water accumulated in the Winnebago Pool, but consequent readjustments would involve perhaps prohibitive costs.
- d. Raising levees around New London's low area, or raising the grades of streets and buildings, or abandoning or removing to higher ground certain streets and buildings, would have to be brought about to protect New London. (Levees are still being proposed in 1960).
- e. Storage reservoirs at North Lily and Leeman could increase flow in dry periods, although initial costs would be about \$1,000,000 in 1938 money.

In a second report in 1938, "The Proposed Wisconsin-Fox Rivers Development Plan," Bulletin No. 6, the Wisconsin State Planning Board considered the control of floods on the Wisconsin, the development of power on the Wisconsin and the Fox, the expansion of employment and industry, and the improvement of sanitation, navigation, and recreation. It proposed construction of a reservoir of very great capacity on the Little Eau Pleine River, construction of three new hydro-electric power plants on the Wisconsin below the reservoir, and provision for diversion of some stored water to the Fox River by way of the canal at Portage. Expected benefits were:

- a. Flood control on the Wisconsin River.

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- a. Flood control on the Wisconsin River.

- b. Increased hydro-electric power.
- c. Facilitation of treatment of sewage effluent in cities on the Wisconsin below the proposed reservoir and on the Fox, and disposal of industrial wastes, because of increased flow during the season of normal low flow.
- d. Improvement of navigation and recreation because of increased low flow.
- e. Expansion of employment during construction of the project and expansion of employment and industry as a result of its completion.

The Board claimed ample evidence to justify every conclusion and strongly urged such use of surplus water on the Wisconsin which was at that time going to waste. The reservoir and canal have not been constructed.

4. Private and Local Groups

The engineers' reports for private firms and municipalities include quite a number of investigations carried out from 1913 to 1944. Most of them concluded that construction for power and flood control at specific sites would not be economically justified.

The Wolf River Improvement Company, representing power companies operating on the lower Fox River, was authorized by a State Act of July 21, 1913, "to construct, acquire, maintain, and operate a system of water reservoirs on the Wolf River and its tributaries north of township 32 (Lower Post Lake) . . . for the purpose of producing a uniform flow of water in the Wolf and Lower Fox Rivers, and thereby improving navigation and other uses of said streams and diminishing the injury to property, both public and private." Plans were made for a large reservoir in the vicinity of Lower Post Lake, but the project was later abandoned because the engineers' report showed that costs would be great in comparison with benefits.

In 1926-28 a public utility company made a detailed investigation of the Menominee Indian Reservation with the idea of constructing five hydro-electric plants on the Wolf. None of the dams has been built. Scenic areas would have been endangered and the economic benefits of such reservoirs were doubtful.

In 1936 the Wolf River Hydro-Electric Company, a group organized to own and lease lands for dams and reservoirs and to go into the power business, prepared a report on flooding on the Wolf for a 1936 Corps of Engineers' public hearing in connection with the preliminary examination of the Fox River and its tributaries for flood control required by the Flood Control Act of June, 1926. The report specially emphasized the area near Lily, also known as Strauss Rapids, Squaw Creek, and Olk site, as a location for a reservoir. The Corps report was unfavorable. A rehearing in 1938 resulted in the report

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that the limited potential reservoir capacity in the Wolf River Basin would not be effective for controlling floods and that construction of reservoirs for water power could not be economically justified.

In 1937 and 1938 the Fox River Water Power Users Association, a private group, commissioned a report on the Lily site to determine the size and capacity of the reservoir, the stream flow, storage effects, advantages to be expected, and to provide a basis for further study. A complex problem of costs and jurisdiction arose. In 1939 the Wisconsin legislature authorized the Wolf River Reservoir Company (formerly the Wolf River Hydro-Electric Company) to build the Lily dam and assess tolls from the users of the water power (Chapter 441, Laws of 1939). Much of the land for the site was owned by an officer of the Wolf River Reservoir Company and was being offered at what the Fox River Water Power Users Association considered an excessive price. The water power users, who would be the ones to pay the tolls, appeared against the Reservoir Company's plans at a Public Service Commission hearing. The P. S. C. did not approve the plans and the specifications of the Wolf River Reservoir Company, stating that the plans were not sufficiently detailed.

In 1937, the Fox and Wolf River Control Association presented a brief at a public hearing conducted by the District Engineer of the Corps of Engineers in Oshkosh. The aims of the Association, according to their brief as summarized by the Corps, were to improve sanitation, prevent floods, reduce soil erosion and restore the water table, provide a more uniform river water supply, improve navigation, and improve recreational facilities on the Fox and Wolf River System.

The Corps reported that the president of the Association believed that a "complete field survey of the upper Wolf River and its tributaries would disclose reservoir sites whose costs would be justified by all of the resulting benefits." However, the Corps further reported that "No local cooperation was offered for or on behalf of the water power, industrial, agricultural, or municipal interests informally represented by the Association which requested the multiple purpose improvement of the river."* A definite plan for improvement and a finding of its economic justification would have been necessary for a detailed discussion of the kind of local cooperation required for participation in a federal program under the provisions of the 1936 and 1944 Flood Control Act. (See Corps report, pp. 36-7, for a detailed listing of local responsibilities according to these Acts.) At this hearing, the secretary of the Wisconsin State Planning Board suggested that the United States outline such a plan for complete development of the Wolf and Fox River Basin. It will be noted that the Planning Board itself had prepared a plan for the Wisconsin-Fox-Wolf complex in 1938 and that the plan had not been put into effect.

* Corps of Engineers, U. S. Army, "Preliminary Examination Report on Fox River and its Tributaries, Wisconsin, for Flood Control and Other Purposes," Milwaukee, 1949, p. 56.

5. Corps of Engineers, 1949

The Oshkosh hearing of 1947 was part of the preliminary investigation of the Fox and its tributaries undertaken by the Corps of Engineers and authorized by the Federal Flood Control Act of 1946.

Part of the work of the Corps was an evaluation of the proposals of the Fox and Wolf River Control Association, whose representatives appeared at the hearing with a request for investigation of multiple use projects. The District Engineer concluded that "benefits to be derived from the most favorable comprehensive project for flood control and improved water usage probably would justify such improvements" and that such a survey of economic benefits should be made (p. iv). Congress has not provided money for such a survey, nor has one been commissioned locally. It must be remembered that the Corps' report and its conclusions dealt with both the Wolf and the Fox. The Corps' conclusion concerning power, flood control, and regulation of flow on the Wolf alone are given below.

The Corps found in connection with water power and flood control that all practicable reservoirs would hold only a minor fraction of floods such as that of 1922 and that consequently such reservoirs would primarily benefit water power. They found in detail that:

- a. Five sites in the Menominee Indian Reservation were not suitable for flood control because of excessive cost. However, the Indians were interested in developing a power site in the Menominee Reservation if one could be found that would not flood too much land or timber or cover scenic attractions.
- b. Three sites at and above Lily had a total capacity of about 120,000 acre-feet and would be adequate for maximum practicable power benefits and would provide all practicable storage capacity for flow of the river system down through the Reservation. (A permit for construction of a dam above Lily for recreational purposes has just been granted to Langlade County.)
- c. South of the Reservation, the Leeman site, with a capacity of about 70,000 acre-feet, would provide all further practicable storage and power on the main river to a point about 10 miles south of Leeman (i. e., with the power and storage of three existing dams at and above Shawano).
- d. Sites farther down the main stream were not suitable.
- e. Additional sites for storage reservoirs on tributaries did not seem likely to be of much practical benefit.
- f. Capacity for storage of 725,000 acre-feet would be necessary

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for practical control of floods like that of 1922. Only about 200,000 acre-feet could be stored in the above sites. Such storage would probably have lowered the 1922 flood by only six inches. Therefore, such reservoirs would be primarily for the benefit of water power, not for control of major floods.

The Fox and Wolf River Control Association was also interested in the use of reservoirs to even out the flow of water during the year. The Corps reported that reservoirs could provide incidental benefits, such as some control of summer floods, but its findings were not at all specific. At present, the Wolf River Improvement Association is interested in regulating the flow for recreational boating purposes.

The Corps also reported on various proposals to reduce flood damage at New London. They found that about equal costs and benefits would result from the creation of a by-pass for the Embarrass around New London. The Embarrass is responsible for much of New London's flood damage, and if some of its water could be diverted around New London to join the Wolf two miles downstream, the peak flood level in the city could be reduced by about two feet near the northerly city limits. Low levees around the city would still be needed. The Wolf usually reaches a peak flood stage after the Embarrass does, and could usually take some water from it without endangering land to the south.

The Corps found, too, that costs of reducing floods on crop lands on the Wolf would probably exceed the value of the land. About 11,700 acres of good farm land in two possible levee districts on the lower part of the Embarrass and on the Shioc River could probably be economically protected from floods. A combination of the cut-off of the Embarrass around New London, levees to confine the flow, and pumping facilities could probably protect an additional 1,000 acres economically. (See Section 7 below)

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The Conservation Commission report of 1960 by Harold C. Jordahl, entitled "Recreational Values of the Wolf River Basin, Wisconsin", attached as Appendix B, considers fishery and wildlife resources, existing water management, effects of flowages and dams on fish and game, and park needs, boating, canoeing, skiing, camping and motoring. Appendix 1 of that report gives a summary of action taken during the past thirty years by the Commission and Department regarding protection of recreational values.

The discussion of effects of proposed dams and flood control is particularly interesting. The four major proposed dams outside the Reservation would evidently bring disaster to fish and wildlife. The Commission states that a dam at Lily "would destroy the downstream trout fishing of the Wolf as well as portions of the Lily River." A dam at Leeman would eliminate or adversely affect sturgeon in the Winnebago Pool. Summer drawdowns could strand broods of ducks nesting along the edge of the water. A dam at Upper Post Lake would destroy small-mouth bass fishing and one at Lower Post Lake, would cause game losses and "would jeopardize the trout habitat of the entire Wolf River as well as portions

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As previously noted, the Public Service Commission has recently granted Langlade County permission to construct a dam between Lily and Lower Post Lake. The Conservation Commission is, however, seeking a court review of this action. The commission claims that the reservoir would, by warming the water, destroy about 35 miles of Wisconsin's finest trout water below the dam on the Wolf and possibly on other streams. Langlade County wants to back up water for about 9 miles to the outlet of Post Lake to develop shore properties and increase recreational use for fishing, hunting and boating. Congressman Reuss recently requested the Secretary of the Interior to investigate possible harmful effects in the Menominee Indian Reservation.

7. University of Wisconsin Seminar in River Basin Planning

Members of a 1960 interdepartmental seminar on River Basin Planning at the University of Wisconsin in Madison prepared a number of reports on problems of the Wolf River. These reports were studies of present conditions and current proposals for flood control, power and irrigation, considered principally from the points of view of engineering, economics and law. The following is a summary of findings on flood control and power by members of the seminar. See "Some Present Land and Water Uses and Problems", at page 25 of this report for a consideration of irrigation, and "The Governmental Setting" at page 17 of this report for legal aspects.

a. Rural Area Protection with Levees and Pumping. Robert Kohnke, a graduate engineer, reported that a proposal for reclamation of wet lands along the Wolf by means of levees and pumping would have serious unwanted consequences:

Such a plan would probably increase the stages and damages somewhat upstream from where the levees would start at Portage and New London. Also, the marshlands in their present condition act as a vast storage basin and retard the movement of floodwaters on these streams. The construction of levees would probably increase the flood discharges into the Winnebago Pool, due to the loss of the flood storage area in the marshlands along the rivers. This would require increased outflow from the Winnebago Pool into the Lower Fox River in order to prevent excessive stages in the Winnebago Pool. In 1922 the Corps of Engineers estimated that enlarging the spillways along the Lower Fox River to handle the increased flows would cost about \$250,000. It is possible that, at present prices, the cost of such changes would be a million dollars or more.

This plan to protect the wetlands would convert vast marshland areas, which are now producing wildlife of various sorts, to agricultural lands. No doubt this would have an effect on the wildlife population of the area. Possibly the net returns from such a project would exceed the costs but the cost of development and operation of the lands involved would be much greater than the cost of comparable lands in that vicinity.*

*Robert Kohnke, "Engineering Aspects of Flood Control in the Wolf-Fox River Basin", Unpublished Univ. of Wisconsin seminar report (June, 1960), pp. 8-9.

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The Corps of Engineers, in its 1949 report, stated that only a small area of land in the basin, 11,700 acres of rich land on the Lower Embarrass and on the Shioc near Shiocton, could probably be economically protected by levees and pumping.

b. Embarrass River Diversion at New London. Mr. R. M. Dave, a graduate engineer, brought up to date analysis of the proposal for constructing a by-pass for the Embarrass River around New London to help prevent floods. Mr. Dave calculated the benefits over a 40-year period to be far less than the costs. The total cost of the construction, including the cost of necessary levees, movement of earth, purchase of land, construction of a bridge, engineering, overhead, and 10% for contingencies would be about \$690,607. Mr. Dave listed probable benefits of this project as:

1. Improvement of drainage of land along the Embarrass.
2. Reduction of flow on the Wolf at New London by 3,500 c. f. s.
3. Reduction of water level on the Embarrass by as much as 2.0 feet and on the Wolf at New London by as much as 0.6 feet.

c. Levee Protection for New London. Mr. Kohnke reported on the long-standing proposal to protect New London from floods by constructing low levees. His conclusion was that a properly planned and constructed levee system "would give good, positive protection against all except very extreme floods" at probably the lowest cost of all plans for flood control at New London. His conclusion agrees with that of the Wisconsin State Planning Board in 1938.

Mr. Dave's report presented figures on some costs and benefits of this project. He calculated costs, excluding the unknown cost of twelve blocks of river-front property, to be \$58,987; and benefits over a forty-year period, excluding enhancement of property values and other intangible benefits to be \$144,200. If the cost of purchasing river-front property is not prohibitive, it appears that benefits would justify costs of constructing a levee system for control of floods at New London.*

Mr. Kohnke stated that if this levee plan and the plan for a by-pass of the Embarrass around New London were combined, New London could fill in and use the part of the channel of the Embarrass that meanders through the city and thereby increase property values.

d. Multiple-purpose Projects Involving Storage of Upstream Water. Mr. Kohnke provided information concerning the repeated hope that storing the run-off from spring floods and releasing it when the flow is low would work to the advantage of people in the Wolf Basin. Some people have expected

*R. M. Dave, "Economic Aspects of Flood Damage Prevention for Wolf River Basin," Unpublished University of Wisconsin Seminar report, June, 1960.

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benefits for flood control, navigation, power, and other purposes if a system of storage reservoirs were constructed.

Proposed dams at Lily and Leeman would be much more effective in controlling small summer floods that damage agricultural and other land than in controlling large spring floods, Mr. Kohnke said. These proposed dams would reduce the flood stage of a flow like that of 1922 by less than a foot at New London.

The Lily dam could hold enough spring flow to release 580 c.f.s. for 120 days during the summer when flow is normally low. The dam at Leeman could provide 290 c.f.s. for 120 days. This increased flow would make little difference in the navigability of the Wolf during the summer.

Mr. Kohnke said that there are no other practical sites for storage reservoirs on the main stream of the Wolf.

He stated that it did not seem that the proposal for a five or six mile dam across the Embarrass and the Wolf above New London would be practical for flood control. Two proposed dams above New London, one on the Wolf and one on the Embarrass, would permanently flood areas that the proposed Lily and Leeman dams would be supposed to protect. They would also flood the village of Shiocton if their reservoirs were more than a few feet deep.

He stated that benefits from reservoirs on the Wolf therefore would probably not equal costs. Mr. Dave figured benefits of all four reservoirs to be about one-fourth their cost.

e. Diversion Plans for the Winnebago Pool and the Shioct River.

Occasionally high water in the Winnebago Pool causes damages. Three proposals for alleviating the problem have been made. For a consideration of the reasons for such high water conditions, see pages 30 and 31.

One proposal, the Manitowoc Diversion Plan, would require the diversion of water from Lake Winnebago (747 feet above mean sea level) to the east over or through the Niagara Escarpment (834 feet above mean sea level) to the Manitowoc River. Eight miles to the east of the lowest convenient part of the escarpment, the elevation is still 58 feet higher than Lake Winnebago. Therefore excavating costs would be exceedingly high. Mr. Dave claims that costs and legal problems would not justify the project. He also says that such a diversion would not lower the stage at New London appreciably and the Lower Fox could handle any normal flood without damage if there were a more rapid draw-down through the Menasha Dam.

A second proposal, the Shiocton Cut-off, calls for the diversion of water from the Wolf near Leeman eastward to Green Bay. Mr. Kohnke says that such a project would still not prevent floods in New London about every other year, although it would reduce stages somewhat. The cost of excavating about 23,000,000 cubic yards would be about \$57,500,000, according to Mr. Dave. Other costs would bring the total to about \$71,000,000. The project therefore does not seem economically justifiable.

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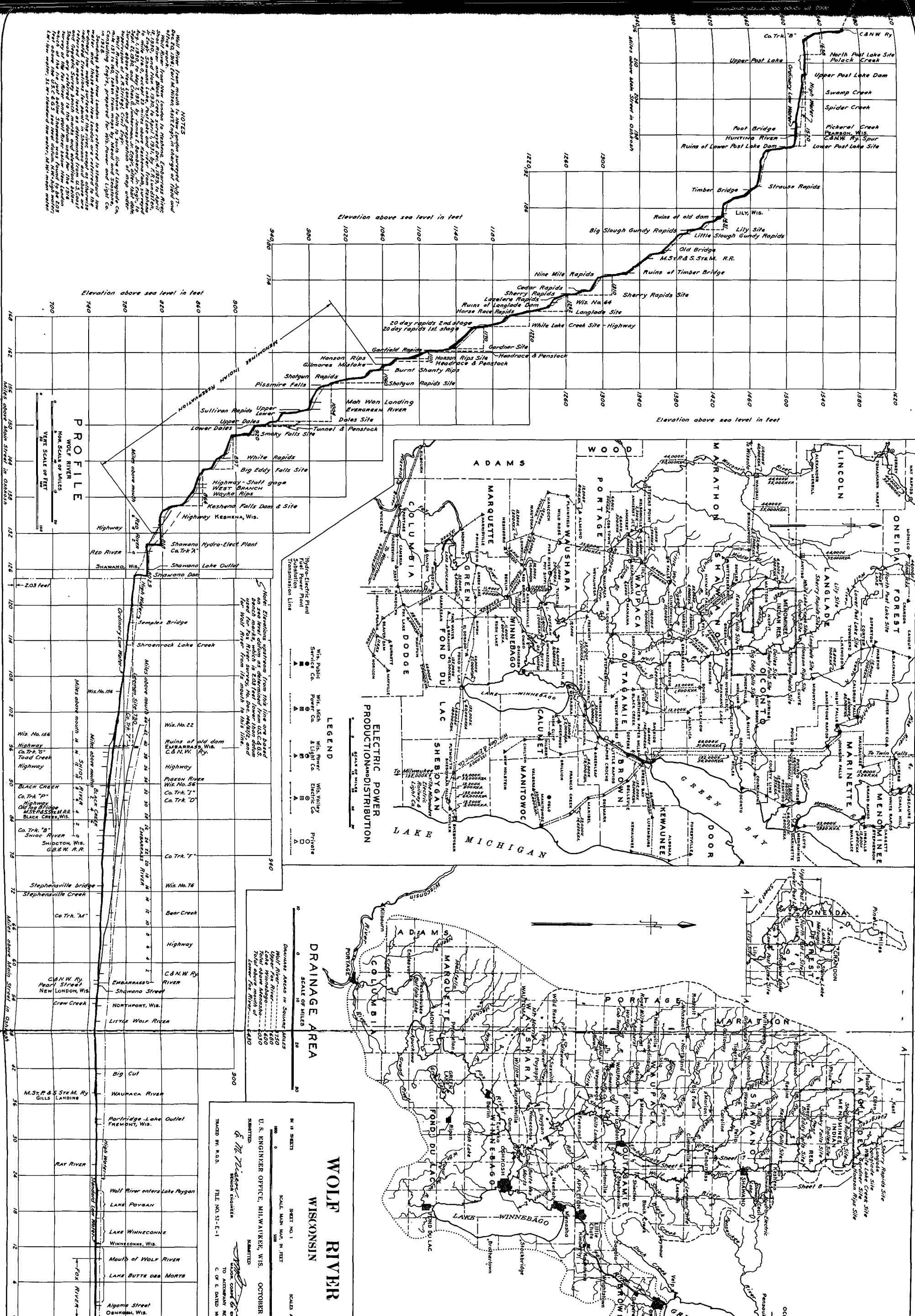
A third proposal is for more rapid draw-down through the Winnebago Pool to the Lower Fox River. Such a plan, according to Mr. Kohnke, would be much less costly in preventing flood damages in the Winnebago Pool than would the two plans considered above, but would have the same disadvantage as those plans. They would all waste water that is now stored for later release for hydro-electric power and navigation. The chief problem in analyzing costs and benefits of preventing flood damages in the Pool is that no study of such damages has been made. Mr. Kohnke's guess is that the third plan would be most economical, but even it would cost about \$1,000,000.

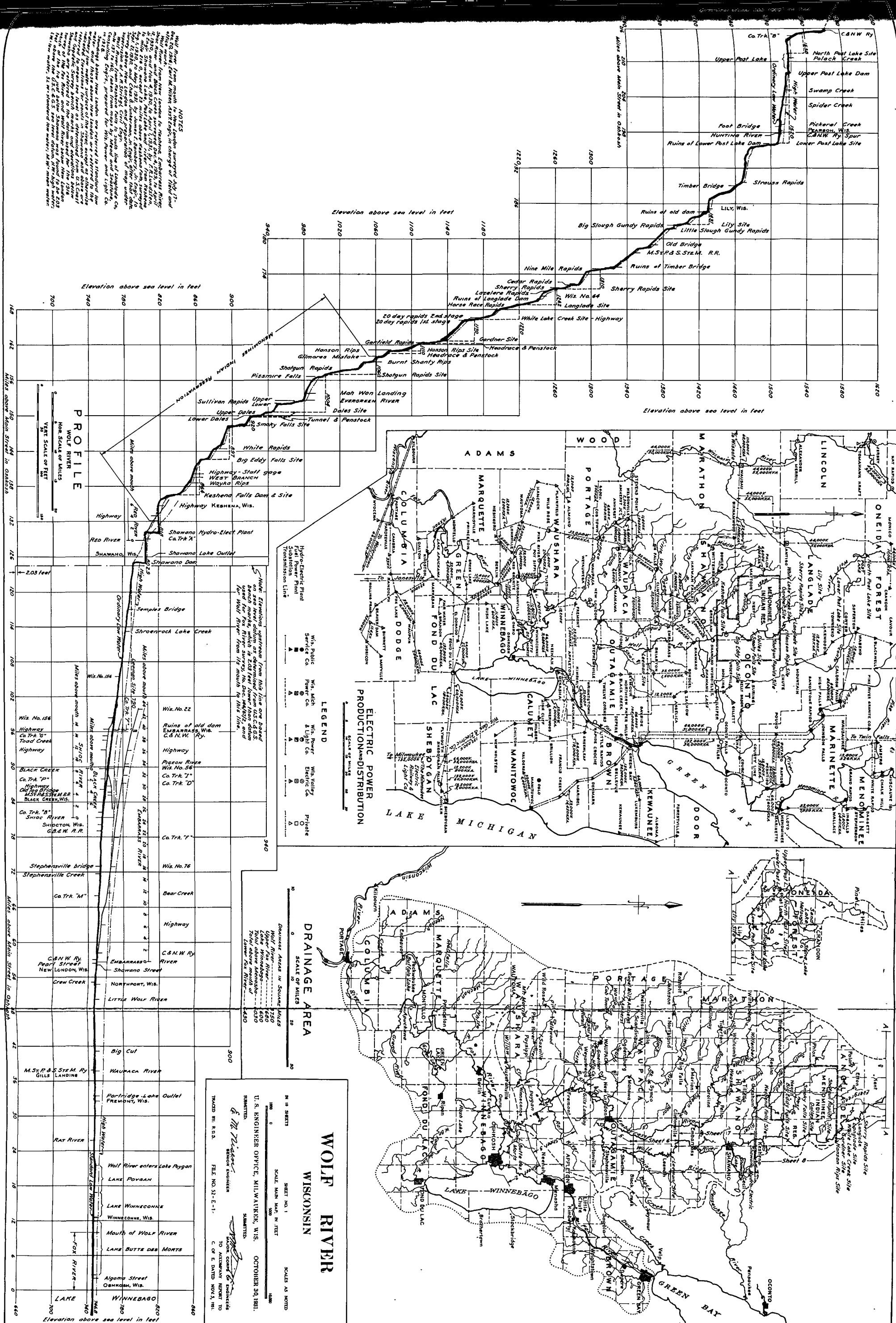
f. Hydro-electric Power. C. K. Sarkar, a graduate civil engineer, analyzed two proposed hydro-electric projects and found that neither was economically justifiable. He concluded that other less desirable sites would also be uneconomical. One site is at the Dalles of the Wolf, where an existing plant has an installed water wheel capacity of 7,000 horsepower. The other is Keshena Falls, where an existing plant has an installed water wheel capacity of 4,500 horsepower. Stream flow could at times produce more power if bigger wheels were installed. Keshena Dam, on the Wolf, has water wheels for 340 kilowatts, and if larger wheels were installed, 660 kilowatts could probably be produced 50% of the time and 428 kilowatts 90% of the time. However, Mr. Sarkar says that construction costs far outweigh potential benefits. It would perhaps be less expensive to build and operate steam power plants.

The graduate students' conclusions concerning development of hydro-electric power agreed with those of engineers commissioned by local firms to investigate sites for power plants.

May 10, 1970







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A PRELIMINARY REPORT *

by

Harold C. Jordahl
Wisconsin Conservation Department

May, 1960

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Fishery resources are analyzed first, followed by a discussion on wildlife values. Subsequent sections discuss Conservation Department projects, and private investment in fish and game. Existing water management devices and effects of flowages and dams on fish and game are presented next. Non-urban park needs, boating, canoeing, skiing, camping, and motor- ing complete the report. Two appendices are attached. The first summarizes Wisconsin Conservation Commission and department action regarding conservation values in the basin. The second lists miles of trout stream for each county.

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FISHERY RESOURCES

Trout

Of the 8,930 miles of trout water in Wisconsin, 1,105 miles or 12 per cent are located in the Wolf River Basin. These waters support populations of brook, brown and rainbow trout. All of the streams and headwaters on the western side of the basin are trout water and consist of some of Wisconsin's most famous fishing streams. Thousands of anglers from population centers in the Fox River Valley each year fish for trout in the Wolf River Basin.

The Wolf River offers "big stream" fishing in a setting of rushing water, forested hills and wilderness. Because of intense sportsmen interest, a portion of the Wolf River in Langlade County has been set aside for fly fishing only; worms, spinning rods and casting rods are prohibited.

Fishery biologists indicate that one of the major problems of maintaining the trout fishery in the Wolf River is that of high water temperatures caused by heavy silting, beaver dams and destruction of the watershed cover. Beaver control operations, and improvement of more than 168 springs, seeps, and cold water streams by the Conservation Department have been conducted to maintain low-water temperatures. Efforts have also been made to interest landowners in tree and shrub planting, streambank fencing and other conservation practices designed to protect the trout resource.

Stocking has been another approach to maintaining the trout fishery. For example, from 1950 through 1956, 145,220 brook, brown and rainbow trout were stocked in the Wolf River from the start of the trout water at Hunting Creek to the Menominee Indian Reservation. Each year trout are released in the Wolf River and in the tributaries.

Warm Water Fishery

Some comment on the "Winnebago Pool," Lakes Poygan, Winneconne, Butte des Morts, and Winnebago, is included in the discussion on warm water fishes because the Wolf River Basin provides the bulk of the water supply for these lakes and the fisheries are closely inter-related.

The warm water fishery then includes the "Winnebago Pool," the Wolf River to the dam at Shawano, the warm headwaters above Pearson, and the warm water stretches of the tributaries. Generally, these waters contain large and smallmouth bass, walleyes, muskellunge, and panfish. Some of the tributaries, the Waupaca, Little Wolf, and Embarrass, for example, are outstanding smallmouth bass streams. There are intensive resort developments on the major lakes and fishing for warm water species is heavy during the summer. During winter months ice fishing for pike and panfish is common on the Winnebago Pool, in the lakes of the basin and on the backwater sloughs such as Cynco, Partridge and Partridge Crop Lakes.

Walleye Pike

Walleye populations in the Winnebago Pool are the earliest migrants moving up the Wolf River at the time the ice is going out. This early movement puts them near their spawning grounds as water temperatures reach a favorable level. Despite great distances and strong water currents, walleyes from Lakes Winnebago and Poygan travel as far as 80 miles to spawning ground marshes over which water is moving. The upper limit of this migration is believed to be five miles above Shiocton. Although male walleyes frequent the quiet water areas, spawning activity has never been observed in this type of habitat. Ten to twenty days after spawning, the fry move with the current out of the marshes into the main river.

Little is known regarding the contributions of the lower lakes to the spawning walleye; therefore, it must be presumed at this time that the lake fishing for walleyes is dependent on the Wolf River spawning migration.

Major angling intensity extends from April 5 to May 1. During this period thousands of people are fishing in the lower basin. A sustained fishery is generally provided by male fish which gradually move downstream. Females move downstream very quickly after they have spawned and provide a fishery of short duration.

White Bass

At the time the last male walleyes are completing their downstream movement, the first white bass begin their upstream spawning trek which continues through May. White bass do not travel as far upstream as the walleyes. They spawn on the river bars and shoreline shelves and do not leave the river bed. Only when there is sustained high water will white bass move beyond New London and then only in scattered numbers. The normal peak of spawning usually falls between May 10 and May 20.

White bass are a major fishery on the Wolf River and are heavily fished by thousands of people each year. Although they are not considered comparable to the walleye as food, white bass are a scrappy sport fish, easy to catch and they migrate during favorable angling weather.

Lake Sturgeon

Intermingled with the walleye and white bass migration is the movement of lake sturgeon up the Wolf River. This primitive, slow-growing fish uses the entire 125 miles of the river from Lake Poygan to the Shawano dam. The area below this dam in fact is a major spawning grounds. The sturgeon migration is substantial and attractive to sightseers. Although legal fishing at this time of the year is not permitted, they do occasionally bite or become snagged by walleye fishermen and provide great excitement and thrills. Sturgeon move upstream from April 10 to May 15 and they spawn in boulder-strewn sites along the river's edge.

Sturgeon in the Wolf River Basin constitute one of the largest remaining populations in North America. Fish biologists theorize that this magnificent

population is due to the 125 miles of unobstructed large river spawning grounds. In contrast, sturgeon which were once common in the Great Lakes are now at the point of extinction. The absence of large free-flowing rivers without barriers may account for this decline. All of the major rivers flowing into the Great Lakes have dams close to their outlets. Even though sturgeon have been protected from over-exploitation, they have never maintained reproduction or recovered in the Great Lakes. Also, the fact that sturgeon fry use the river and nearby waters for their home for a longer period than either the walleye or white bass may account in part for good populations in the Winnebago Pool.

Although sturgeon are known to spawn in Lake Winnebago on limited occasions, it is believed that such spawning is generally unsuccessful. On the one occasion when eggs were found in Lake Winnebago, they were covered with filamentous algae and did not hatch.

A carefully regulated season is held each year for the spearing of sturgeon through the ice on the waters of the Winnebago Pool. One of the heaviest catches was made in 1955 when 2,600 sturgeon weighing 85,000 pounds were harvested. It is not uncommon during a normal season to have several thousand sturgeon spearing shacks on Lake Winnebago.

Catfish, Black Bass and Panfish

Catfishing during the summer months follows the spring fishing season. Each year more interest is shown in rod and reel angling, bank pole activity and set lining for catfish which are highly prized as excellent fighters and delicious eating, especially when smoked.

Channel cat and, to a lesser extent, flathead catfish, contribute to this harvest. Relatively little is known regarding the spawning movements of these species. Migrations during May and June contribute to the angling success which tends to substantiate the theory that a reasonable percentage of the Winnebago Pool catfish leave the lower lakes to spawn in the Wolf River.

Black bass fishing on the river and tributary waters during summer periods is highly prized by local residents. Panfishing for crappies, bullheads, perch, etc., in the quiet water areas, sloughs, lakes, and river cutoffs provides many hours of recreation throughout the summer. These waters are directly associated with and dependent upon the fish population and water level of the Wolf River.

Other Migrant Species

The Wolf River accommodates large numbers of other spawning fishes generally known as "rough fish." Dominated principally by carp and suckers, these species provide a limited fishery by means of hook and line or spearing. Local residents fish for these species principally to obtain food for pickling or smoking.

GAME RESOURCES

Ducks, Coot and Geese

The Wolf River Basin provides diversity for a variety of duck species. In the upper headwater regions and along the forested flood plain, black ducks and woodducks are common nesters. On the open marshes, mallards and blue-winged teal are the common nesting species. Excellent diver duck hunting is available on some of the headwater lakes. The waters of the Winnebago Pool provide canvasback hunting which is not equaled anywhere in Wisconsin, and with the possible exception of the mouth of the Detroit River in Michigan, is tops in the Midwest.

On Pine, Little Rice, Metonga, Pickeral, Rolling Stone, Shawano, White, Partridge, Partridge Crop and Cynco Lakes, spring and fall migration of waterfowl is common. Excellent puddle duck hunting is available on Partridge and Partridge Crop Lakes each fall. Refuge areas on White Lake and Partridge Crop Lake have been very effective in holding waterfowl for sustained fall hunting. Waupaca County lakes are important to diver ducks and coots during migrations probably because they are located in close proximity to the Winnebago Pool. Shawano Lake in some years receives heavy fall use by diver ducks.

Waterfowl hunting in the basin ranges from moderate to high. Opportunities for free-lance hunting on the better marshes in the southern part of the area are limited due to private control, leasing and heavy posting.

In the Post Lake region, there is some excellent hunting during certain years as a result of wild rice production on the following waters; Bishop Lake, Rice Lake, junction of Mud Creek and Wolf River, junction of Swamp Creek and Wolf River, Wolf River west of Lake Lucille, rice beds of the Hunting River, Maniwagon Lake. These wild rice areas are responsible for the largest concentration of puddle ducks in northeastern Wisconsin.

It is not possible to estimate the harvest of ducks in the basin. However, data available for the counties in the basin (Forest, Langlade, Shawano, Portage, Waupaca, Outagamie, Waushara, Oneida, Marathon; unless specified, all other harvest estimates which follow are for these counties) indicate that 112,237 (20 per cent of the state harvest) ducks were shot in 1958. In these counties 46,280 coot were taken in 1958 (30 per cent of the state harvest).

The Wolf River Valley is one of the principal fall migration routes of Canada geese. While few geese are harvested along the river, migration surveys have definitely established it as a major route to Horicon Marsh and points south.

Woodcock and Snipe

Woodcock will be found during the spring and fall migration wherever wet brush and timber lands are located in the Wolf River Basin. They are common nesters wherever the right association of wooded wetlands and open uplands exist. Although this game bird is not heavily hunted, sportsmen that pursue

the woodcock are enthusiastic about its sporting qualities. In 1958, 5,364 woodcock were harvested in the aforementioned counties (20 per cent of the state harvest).

Snipe, in contrast to woodcock, occupy the open marsh lands of the basin and may be readily observed both spring and fall on the open mud flats and wet sedge-grass marshes. Snipe are common nesters in the basin. Although snipe are only lightly hunted, they do provide top-notch sport.

Pheasants

From the Menominee Indian Reservation south, the basin may be classed as poor to fair pheasant range. In the Lake Poygan area the pheasant habitat is excellent. In the counties in the basin, it is estimated that the kill in 1958 was 48,736 (10 per cent of the state harvest). Marshes along the Wolf River, especially in the lower basin when located near good food supplies, provide pheasants with cover necessary for surviving the rigorous winters. These marshes are in fact the single most important habitat type for pheasants in this region of Wisconsin.

In 1959, there were 19 sportsmen's clubs in the basin counties participating in the department's day-old pheasant chick program. These clubs raised and released in and adjacent to the basin 24,500 pheasants (approximately 50 per cent cocks and 50 per cent hens). Under good release conditions, it is possible to take about one-half of the cocks which are released and in the poor counties in the upper portion of the basin these releases may account for better than half of the total pheasant kill. These clubs are listed below.

Sportsmen's Clubs That Stock Pheasants in the Wolf River Basin

<u>Club</u>	<u>Location</u>	<u>No. Stocked</u>
<u>Shawano County</u>		
Bonduel Conservation Club	Bonduel	500
Caroline Fish and Game Club	Tigerton	700
Gresham Sportsmen's Club	Gresham	600
Red River Sportsmen's Club	Shawano	1,050
Shawano County Conservation Club	Wittenberg	10,000
Wolf River Game Club	Navarino	700
		<u>15,500</u>
<u>Outagamie County</u>		
Bear Creek Fish and Game Club	Bear Creek	350
Nichols Game Club	Nichols	400
Osborn Conservation Club	Seymour	350
		<u>1,100</u>
<u>Portage County</u>		
Tomorrow River Valley Conservation Club	Amherst	1,400

Waupaca County

Manawa Fish and Game Club	Manawa	350
Chain O'Lakes Conservation Club	King	350
New London Fish and Game Club	New London	1,400
Embarrass River Conservation Club	Clintonville	350
Hobart's Sportsmen's Club	Weyauwega	700
Marion Conservation Club	Marion	2,100
Iola Conservation Club	Iola	500
Weyauwega Conservation League	Weyauwega	700
		<u>6,450</u>

GRAND TOTAL. 24,500

Ruffed Grouse

The forested northern portion of the basin is major ruffed grouse range. This bird is also found in the larger woodlots and along the timbered bottomlands of the lower basin. This sporty, elusive, erratic flyer is one of Wisconsin's most popular game birds and provides countless hours of recreation to sportsmen each fall. The 1958 estimated kill was 92,205 (21 per cent of state harvest).

Sharp-tailed Grouse and Prairie Chicken

Scattered populations of sharp-tailed grouse are found in the open type brushlands of the northern portion of the basin. The estimated kill in 1958 was 792 (13 per cent of state harvest) in Forest, Langlade, Oneida and Marathon Counties. Although there may be remnant populations of prairie chicken in the basin, we have no current knowledge on this species in this region.

Spruce Grouse

In the dense conifer swamps of the upper basin, the rare spruce grouse is occasionally observed. This bird, although once common in the state, is now practically extinct. There is no open season on this bird.

Hungarian Partridge

Although the Wolf River Basin lies to the west of the major Hungarian partridge range in Wisconsin, in the intensively farmed regions of Shawano, Waupaca, Outagamie, Winnebago, and Waushara Counties populations are present. The estimated kill in 1958 was 4,721 birds (13 per cent of state harvest).

Quail

In general, the Wolf River Basin is too far north for quail. In the farming regions of Portage, Waupaca and Waushara Counties, however, the department estimated that sportsmen harvested 2,636 quail in 1958 (6 per cent of state harvest).

Cottontail Rabbit and Snowshoe Hare

The hare is common in the forested portion of the basin north of the Menominee Indian Reservation. This animal is not heavily hunted. In contrast, the cottontail rabbit is one of the major small game species in the farm regions of the basin and is actively hunted each year. During the 1958-59 season, the estimated kill of hare and rabbits was 124,753 (12 per cent of state harvest).

Squirrels

Both gray and fox squirrels are common and are pursued by large numbers of hunters each year. During the 1958-59 season, the estimated harvest of squirrels was 193,171 (14 per cent of state harvest).

Muskrats, Beaver, Otter, Mink

Wherever there is water and marshland in the Wolf River Basin the above furbearers may be found. The estimated harvests and value of these species are as follows:

Species	Year	Number Harvested	Value	Total Value	Per Cent of State Harvest
Beaver	1959	1,038	\$10	\$ 10,380	9
Otter	1959	214	\$22	4,608	16
Muskrat	1958	64,865	65¢	42,162	12
Mink	1958	4,925	\$10	49,250	14

TOTAL.....\$106,400

In 1949, a year of good fur prices, the U. S. Fish and Wildlife Service in a report to the Corps of Engineers on the Wolf River Basin, estimated the fur value in the basin at \$1,400,000.00 (includes the lakes in the Winnebago Pool except Lake Winnebago).

Bear

Bear are common in the upper portion of the basin and it is expected that this fine big game animal will assume more importance to hunters in the future. The estimated kill in Forest, Langlade, Shawano, Oneida and Marathon Counties in 1959 was 72 bear (12 per cent of state harvest).

Deer

One of the most important wildlife resources in the basin is the white-tailed deer. In 1959, an estimated 6,477 deer were killed in the basin which represents 6.2 per cent of the total state harvest. A harvest of this magnitude obviously provides many hours of recreation to Wisconsin hunters.

There are an estimated 54 square miles of major deer wintering areas in the basin (excludes the Menominee Indian Reservation) which serve deer herds in an area of more than 1,000 square miles.

In 1959, the estimated average hunting pressure in counties in the upper basin was as follows:

County	Average Pressure/Sq. Mile Full Season
Forest	7.7
Langlade	5.7
Marathon	5.5
Oconto	7.3
Oneida	6.4
Shawano	6.4

The average kill per square mile in the various management units in the upper basin in 1959 varied from one-half deer per square mile to a high of 5.4 per square mile.

Other Species

Skunk, weasel, opossum, jackrabbits, woodchuck, bobcat, coyote, gray and red fox, raccoon, and badger are all inhabitants of the Wolf River Basin and with the exception of badger and woodchuck each year provide sport to a limited number of hunters.

WISCONSIN CONSERVATION DEPARTMENT PROJECTS

For more than 20 years the department has operated a public hunting and fishing grounds lease and land purchase program. For over a decade the department has been engaged in a stream improvement program. Projects located in the basin of the Wolf River are discussed below.

Acquisition Projects

Deer Creek, Outagamie County - 1,010 acres purchased at a cost of \$5,021.75. Approximately 250 acres remain to be purchased in this project which adjoins the Wolf River. Primary species are rabbits, deer and ruffed grouse.

Demlow Lake, Langlade County - 59 acres purchased at a cost of \$3,600.00. Primary species is trout. This is a small spring pond which is a feeder to the Red River.

Emmons Creek, Portage, Waupaca Counties - 39 acres purchased at a cost of \$1,125.00. Remaining to be purchased are 2,110 acres. This project is on a tributary to the Waupaca River and is excellent trout water.

Little Rice, Forest County - 1,565 acres owned at a cost of \$4,309.00; 1,280 acres leased. The Wolf River at the outlet of Little Rice Lake was dammed in 1936 by W.P.A. and the Town of Crandon. The dam cost \$50,235.00 and flooded approximately 1,800 acres for waterfowl and furbearers. Game biologists question whether wildlife values were improved by the dam. The water is acid and the flowage frequently has winterkills of fish.

Maine, Outagamie County - 720 acres at a cost of \$1,440.00. Primary species are pheasants, rabbits, ruffed grouse, and deer.

Trout Creek, Waupaca County - A new project on a tributary to the South Branch of the Little Wolf River. Proposed for purchase are 1,552 acres primarily for trout. Twenty acres are currently under lease.

Navarino, Shawano County - 4,224 acres owned at a cost of \$22,391.00. Remaining to be purchased are 5,112 acres. This project on the Shiocton River is one of the major game projects in the basin. Long-range plans call for an extension of this project to the east shore of the Wolf River to include an additional 4,000 acres of big hardwood bottomland of great wildlife value. The Navarino area is currently important to pheasants, ruffed grouse, deer, squirrels, rabbits, woodcock, and river bottom furbearers.

Outagamie, Outagamie County - 411 acres purchased at a cost of \$4,000.00. Current studies indicate this project should be enlarged approximately 200 acres. Eventual plans call for shallow flowages for aquatic game. The project which fronts on the Wolf River is now important for ducks, rabbits, pheasants, ruffed grouse, and deer.

Radley Creek, Portage, Waupaca Counties - A tributary of the Waupaca River where the department owns 11 acres at a cost of \$500.00. Remaining to be purchased are 2,768 acres. Four acres are currently under lease. Primary species is trout.

Tomorrow River, Portage County - A tributary to the Waupaca River where the department has acquired 183 acres at a cost of \$12,775.00. Remaining to be purchased are 2,426 acres. Fourteen acres are under lease. Primary species is trout.

Waupaca River, Waupaca County - Proposed for purchase are 120 acres along this stream for public access. Primary species are smallmouth bass and warm water fish.

Woods Flowage, Langlade County - 82 acres purchased at a cost of \$2,575.00. This is a spring pond area important to trout. Adjacent to this project is the 160-acre Hogelee Springs which are proposed for purchase. Both are tributaries to the West Branch of the Wolf River.

Leased Areas

Dent Creek, Shawano County - 45 acres. A cooperative stream improvement project for trout sponsored by the department and the Morris Fish and Game Club on a feeder stream to the Middle Branch of the Embarrass River.

North Branch Embarrass River, Shawano County - 40 acres. A cooperative stream improvement project for trout jointly sponsored by the department and the Bowler Fish and Game Club.

Evergreen River, Langlade County - 5 acres. A cooperative stream improvement project for trout jointly sponsored by the department and the White Lake High School. The department eventually plans to buy 1,293 acres in this area.

Lambert Springs, Langlade County - 4 acres. A cooperative stream improvement project for trout jointly sponsored by the department and the Whitetail Sportsmen's Club. These springs are feeders to the East Branch of the Lily River.

Sportsmen's Lake, Shawano County - 55 acres. A cooperative stream improvement project for trout jointly sponsored by the department and Birnamwood Sportsmen's Club on spring ponds and outlet stream to the North Branch Embarrass River.

Spranger Creek, Marathon County - 20 acres. A cooperative stream improvement project for trout jointly sponsored by the department and the Elderon Sportsmen's Club on spring ponds and feeder stream to the South Branch Embarrass River.

Peterson-Sannes, Waupaca County - 74 acres. A state stream improvement project for trout on a tributary to the Waupaca River.

Marion, Waupaca County - 2,538 acres. A wetland with primary species being ruffed grouse, rabbits, pheasants and squirrels.

Clintonville, Waupaca County - 1,467 acres. A wetland with primary species being ruffed grouse, pheasants, rabbits and waterfowl.

Mukwa, Waupaca County - 1,555 acres. A marsh with primary species being pheasants, ruffed grouse, rabbits, waterfowl and woodcock.

Bay Boom, Winnebago County - 2,286 acres. A marsh with primary species being pheasants, waterfowl and squirrels.

Deltox, Winnebago County - 854 acres. A marsh with primary species being pheasants and rabbits.

Game managers estimate that each year more than 4,000 hunters use the Deltox, Bay Boom, Mukwa, Clintonville, Marion, Maine, Mack and Outagamie Wildlife Areas.

Development and management work on leased areas consists of such activities as posting, patrol, fish and game stocking, access road construction, controlled burning, parking lot construction, tree and shrub planting, stream-bank fencing, soil conservation measures, food-patch planting, bank stabilization, winter feeding and in-stream improvement practices.

EXISTING AND PROPOSED DAMS AND WATER DIVERSION
IN THE WOLF RIVER BASIN
AND EFFECTS ON FISH AND GAME

Existing Permit Dams

Some 21 dams capable of developing usable power (30 h.p. or more) exist in the basin. In general they are relatively low-head structures averaging about 12 feet and ranging from 9 to 34 feet. One 30-foot-deep pool has been created (Big Falls in Little Wolf). In general the high-head structures employ a tube-penstock system with relatively shallow ponds. A number of the older low-head structures are no longer owned or operated by public utilities and are returning to their original grist mill status. Some of these structures are likely to be abandoned in the not too distant future. Several still exist because they create ponds adjacent to smaller towns and serve as swimming pools or scenic adjuncts to local parks. Those still operating as power sources fluctuate downstream water levels extensively in a run-on-demand and shutdown-for-refill system. One study found five drops and five raises of 1.5 feet in three hours' time in the stream level below the project. Pond levels had similar fluctuations but of lesser magnitude. In general, when structures exist on trout water, the pond head marks the lower level of trout habitat. There are exceptions to this where abundant spring flow downstream rehabilitates some streams.

The proposal which was made to abandon the Lower Shawano Dam which controls levels on Shawano Lake would have resulted in a large loss of fish and game habitat in the lake. Construction of a structure in the Shawano Lake outlet would have resulted if the mainstream dam had been abandoned.

Proposed Dams - Flood Control

The U.S. Corps of Engineers considered nine storage reservoir sites on the Wolf River. Operation of these structures purely for flood control would lower flood stage by less than one foot at New London and throughout the Winnebago Pool. Of the nine, five in the scenic trout water of the Menominee Indian Reservation were not too desirable as reservoir sites.

The four remaining sites are:

(1) Leeman Site - 70,000 acre feet of storage. It would obstruct the spawning run of sturgeon and might adversely influence walleye and/or northern pike spawning sites. It is thought that the sturgeon in the Winnebago Pool would be eliminated or adversely affected by the structure (see section on warm water fishery). If the device were operated purely for flood control, even with a minimum "conservation pool," little or no compensatory fish values would develop. The structure would not materially increase duck production over that presently in the river and sloughs. A late storage season could result in conditions which would encourage duck nesting along the pond edge. Later drawdowns, however, would strand broods and result in losses. Furbearers would not be likely to benefit from this structure.

(2) Upper Post Lake Site. This site is a scenic, wadeable, and fast-water portion of the Wolf. Smallmouth bass fishing would be destroyed and replaced by a mediocre panfish and northern pike fishery.

(3) Lower Post Lake Site. (Presently before the Public Service Commission for permit to Langlade County.) A dam at this site would jeopardize the trout habitat of the entire Wolf River as well as portions of the Hunting River trout fishery. Game losses would also occur.

(4) Lily Dam Site. This dam would destroy the downstream trout fishing of the Wolf as well as portions of the Lily River. Deer yards would also be damaged as a result of flooding.

Water Diversion

Thirty-seven irrigators are authorized to divert up to 57 cubic feet per second in the Wolf basin. U.S. Geological Survey records show low flow at New London of 150 c/s. Adding a low flow or record for the Waupaca, Little Wolf and Royalton Rivers, we find 57 of 245 c/s or 23 per cent of the water could be diverted.

A series of dams on outlets of lakes maintain levels or prevent outlet throat erosion. Seven such units exist. In addition, two low-head structures maintain wildlife pools.

Fishways and Dams

Fishways and fish ladders used for salmon in the western United States are not known to be effective for warm water species in Wisconsin. Walleyes and lake sturgeon are not considered swift water species that readily ascend low-head dams or stream rapids. While it is true that 8- to 12-inch falls can be ascended by walleyes, and that lake sturgeon use fast water in which to spawn, concentrations of both species are found below dams which are readily ascended by such species as suckers, redhorse, and carp. Wisconsin experience has demonstrated that "rough fish" are usually benefited by fishways and not game fish.

Fishery experts indicate that shallow water impoundments on our major rivers create ideal habitat for carp which prosper and dominate other more desirable species. Flowages frequently create either a superabundance of weeds or exposed mud flats. Oxygen depletion on flowages is common. Silt basins frequently result. On the basis of our current knowledge of the Wolf River, it does not appear that dams would aid the fishery. When selective carp poisoning chemical is available and when engineers have perfected "fool-proof" fishways which will serve game species, dams on the Wolf River may be viewed in a different light by the fish biologist, except in areas of the stream supporting trout where dams would eliminate these species due to increased water temperatures.

Dams and Wildlife

Between Keshena and Lower Post Lake, the steep gradient of the Wolf River precludes expansive marsh type flooding and development which is essential for good game areas. Flowing would in many instances damage important

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Dams and Wildlife

Between Keshena and Lower Post Lake, the steep gradient of the Wolf River precludes expansive marsh type flooding and development which is essential for good game areas. Flowing would in many instances damage important

deer wintering areas and destroy important bottomland game range (deer, ruffed grouse, wood and black duck, woodcock, hare, squirrels, and furbearers). Moreover, important wild rice stands could easily be damaged.

On the lower Wolf, large-scale flowages would probably not have a high proportion of emergent type marsh vegetation but would consist of open water which would be of value primarily to diving ducks which with the large acreage of diving duck habitat in the Winnebago Pool (156,800 acres) is not needed in this part of Wisconsin. Likewise, fluctuations of water levels in flooded areas would be inevitable and would have a damaging effect on the habitat and on resident game. Private fur farm areas would be seriously damaged by large impoundments in the lower floodplain. Also, valuable pheasant wintering and nesting habitat would be destroyed.

RECREATIONAL ASPECTS

Non-urban Parks

Upper Wolf

There are no state parks in the upper Wolf River area. Four sites within the drainage area and one just across the divide in the Oconto River watershed have been investigated as possible state park areas. All five areas are located in the Menominee Indian Reservation and the possibility of acquisition by the state for park purposes is unknown at this time. In view of the forthcoming termination of federal trusteeship over the Menominee Tribe, no predictions can be made. It should be pointed out that the Indian Reservation, per se, has a tremendous recreational potential which should be the subject of special study and analysis.

Two recreation areas operated by the U.S. Forest Service are located in the upper Wolf River watershed. In addition there are nearly 20 U.S. Forest Service recreation areas immediately adjacent to the drainage area in the Nicolet National Forest.

There are two county parks in the upper Wolf River watershed which are maintained by Langlade County. The department has no data on available facilities.

Wausau, with a population of 30,414 in 1950, is the nearest city of any importance to the upper Wolf River watershed. It is 56 miles from the Village of Lily, the approximate center of the drainage area. There are no other large population centers and relatively few small towns in the drainage or adjacent area.

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Lake Poygan to Shawano, signs preventing trespass are common. The problem of access, of course, is so great in a basin of this size that it can only be served by all units of government and all types of civic groups working together. No one group or unit of government alone is big enough to meet the problem.

SUMMARY

The Wolf River and tributaries contain one of the most important trout fisheries in Wisconsin. Twelve per cent of all trout water in Wisconsin is located in the basin. Maintenance of low water temperatures constitutes one of the major problems in conserving the trout resource.

The warm waters of the basin support bass, walleye and northern pike, muskellunge, panfish, sturgeon, catfish, white bass, and "rough fish." Walleye pike, white bass, and sturgeon migrate in large numbers up the lower Wolf to spawn and provide tremendous fishing opportunities. The lower Wolf in fact constitutes the major spawning grounds for walleye and sturgeon in the Winnebago Pool. The magnificent sturgeon population in these waters is probably due to 125 miles of unobstructed river spawning grounds.

The low-land floodplains of the Wolf River Basin contain wildlife habitat of top-notch value to furbearers; beaver, otter, muskrats, mink. Moreover, this vegetative type is valuable for ruffed grouse, deer, bear, pheasants, snipe, woodcock, waterfowl, spruce grouse, rabbits, and squirrels. On the uplands many of these species and in addition quail, sharp-tailed grouse, and Hungarian partridge are found. Sportsmen's clubs in 1959 raised and released 24,500 pheasants in the basin. Almost 600,000 pieces of game were harvested in the basin in 1958. On the basis of four hours of hunting for each animal shot, there were 2,400,000 hours of recreation provided by the game resource. Fur harvests likewise are important and during the 1958-59 season 71,042 fur animals were trapped which had a raw fur value of \$106,400. There are an estimated 54 square miles of deer yards along the bottomlands of the basin, excluding the Menominee Indian Reservation, which influence deer populations in an area of more than 1,000 square miles.

The Wisconsin Conservation Department has an active program of, lease, acquisition and development of public hunting and fishing grounds in the basin. To date, the department has invested \$57,736.00 for 8,304 acres on 12 project areas. Approximately 20,000 acres remain to be purchased. In addition, there are 10,241 acres under lease to the department. These projects are located in

May 10, 1956

The stretch of river from lower Post Lake to Shawano is one of the most scenic, exciting, rugged and dangerous canoe water trails in Wisconsin. This stretch is not recommended for inexperienced canoeists nor to those who are not willing to include tough portages in their travel. The best time of year to make this trip is during spring and fall high water periods.

In the headwaters region and the lower Wolf, including Partridge Crop and Partridge Lakes, the canoeist will find excellent jump shooting for waterfowl. An occasional goose will also be taken. Fishing, of course, is excellent all the way from Pine Lake to Poygan.

Boating and canoeing is also popular on all the headwater lakes and the Waupaca Chain of Lakes. A popular trip may be had from the Chain of Lakes via the Crystal River, the Waupaca River and down the Wolf. Practically all of the other rivers in the Wolf River system receive some boating and canoeing use especially during high water periods.

Skiing

The development of ski hills represents an untapped potential especially in the upper Wolf River Basin along the glacial moraines. At the present time there is one ski hill on State Highway 52 east of Antigo near the Village of Lily. This hill receives relatively heavy use by local residents.

Auto Traveling

The entire basin represents a great auto travel area. Generally, the towns and counties have not capitalized on this type of recreational pursuit. Careful zoning, for example, which would prevent the erection of obtrusive signs, auto junk yards, and the shack type development along many portions of the lower Wolf, would make traveling throughout much of the basin more pleasant.

One of the best car trips in the region would be from the Village of Shiocton north along the Wolf River to Shawano, through the magnificent timber stands of the Menominee Indian Reservation and on up into the rugged wilderness areas of the upper basin. Convenient pullouts, relocation of the road to capitalize on outstanding scenic views -- glimpses of the Wolf River, for example -- would all stimulate auto travel.

Camping

The number of organized camps in the basin is not known. However, the basin does offer many excellent opportunities for camping along the lakes and the numerous streams.

Individual camping in the state forests and county parks is high. Numerous additional facilities are needed to meet the increasing demand for this type of recreation.

Access to the Wolf River and tributary streams and lakes for camping, boating, fishing, hunting, could be vastly improved. There are, for example, many miles of the Wolf River which can only be reached by the canoeist. From

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the floodplains and lowlands and along the Wolf River and tributaries. Emphasis has been placed on the conservation of fish and game resources indigenous to wildland types.

Private investment in wildlife resources includes three shooting preserves of 2,422 acres, two game farms of 340 acres, and five deer farms of 804 acres. The floodplain of the lower basin has the greatest concentration of fur farms in Wisconsin; 59 operators have under fur farm license 9,677 acres from which the fur harvest in 1953 was valued at \$7,520.00. Lease of hunting rights on these natural floodplains likewise provides additional income and recreational opportunity.

The department has memoranda of understanding for fish and game management on 65,000 acres of public forest land in the basin and in addition provides technical service to industrial forest land corporations.

There are 21 dams presently in the basin. Generally, these dams mark the lower limits of trout water. Several of the pools provide recreational opportunity for local communities. Nine dams on the Wolf River which have been proposed for flood control would lower flood stage by less than one foot at New London.

Within the basin there are 37 irrigators that have permits authorizing maximum withdrawals of 23 per cent of the low flow of the Wolf River.

Generally, dams on the lower Wolf River would seriously damage fishery resources in the basin and the Winnebago Pool. Sturgeon and walleye pike would be seriously affected. In the upper basin and on the tributaries, dams would warm water and seriously affect trout resources. Likewise, important deer yards, wild rice beds, and bottomland game range would be seriously damaged by dams in the upper region, while large-scale flowages in the lower basin would destroy fur farms, pheasant habitat, bottomland game range and encourage carp, concomitant carp damage, and would only be of prime value to diver ducks for which there already is ample habitat in the Winnebago Pool.

Non-urban parks include two county parks in the upper basin, 20 recreational areas on U.S. Forest Service land adjacent the basin, and six county parks in the lower basin.

In the northern region, large blocks of managed public forest land provide opportunities for new recreational development when needed. Also, the Menominee Indian Reservation offers a unique situation for providing recreational pursuits of high quality.

The greatest need for new recreational opportunities exists in the lower basin which is close to numerous population centers. In this area, however, high costs of land and development will make acquisition difficult. Attention in this region should be given to incorporating state fish and game lands into a broad recreational program. Formation of regional plan commissions would be most helpful in meeting present and future recreational needs.

Boating and canoeing are popular sports in the entire basin. The upper Wolf provides a canoe trip of rugged character and top-notch quality.

Skiing and auto traveling presently represent an untapped potential for development. Coordinated local and regional planning and zoning will facilitate these types of recreational pursuits. Camping, likewise, is high wherever facilities exist. Problem of access to the natural resources of the basin will have to be overcome by coordinated local and governmental action to permit maximum recreational use.

May 10, 1956

Excerpt from the
1958 ANNUAL REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY
on
CIVIL WORKS ACTIVITIES
(Vol. 2, pp. 1192-1197)

FOX RIVER, WIS.

Location. This river rises in Columbia County, Wis., and flows in a northerly direction into Green Bay. Its length is about 176 miles. The Wolf River, physically the main river but by designation a tributary of the Fox River, rises in the central part of Forest County, Wis., and flows in a southerly direction about 220 miles into the Fox River 10 miles above Oshkosh. (See U. S. Lake Survey Chart No. 726 for Lake Winnebago and lower Fox River.)

Previous projects. As provided by special act of July 7, 1870, and River and Harbor Act of June 10, 1872, the original project was modified by the River and Harbor Act of March 3, 1873.

The improvement of the Wisconsin River was abandoned in 1887 (Annual Report for 1887, p. 2096). For further details see page 1940 of Annual Report for 1915 and page 1434 of Annual Report for 1938.

Existing project. This provides for deepening and widening the channel of Fox River from De Pere, 7 miles above the mouth to Portage, Wis., a total length of 156 miles, the depth between De Pere and Montello, 125 miles, to be 6 feet, with 9.6 feet in rock cut below De Pere lock and 7 feet in other rock cuts on the lower river below Menasha lock; and from Montello to Portage, 31 miles, the depth to be 4 feet; the width of channel from Lake Winnebago to Montello to be 100 feet, with necessary widening at bends, for the construction and reconstruction of 27 locks and 16 dams; for a concrete retaining wall at Kaukauna; for construction and maintenance of harbors having depths of 6 feet on Lake Winnebago; for widening Neenah Channel to 100 feet, with a 6-foot depth for a length of about 1 mile; and for dredging, snagging, and otherwise improving Wolf River from its mouth to New London, a distance of 47 miles, the depth to be 4 feet. All depths are referred to standard low water.

Ordinary and extreme fluctuations of water level above and below mean stages on various parts of the improvement, due to floods and other causes, are about as follows:

Place	Ordinary fluctuations		Extreme fluctuations	
	Above mean stage (ft.)	Below mean stage (ft.)	Above mean stage (ft.)	Below mean stage (ft.)
Lower Fox River at De Pere Dam	1.0	1.4	2.5	4.0
Lake Winnebago	1.2	1.3	2.2	3.7
Upper Fox River at Berlin Dam	2.7	1.4	5.7	2.0
Wolf River at New London	5.0	2.6	8.8	3.0

May 10, 1956

The cost of the completed portion of the project is \$358,300 for the upper river and \$513,400 for the lower river, a total of \$817,700 exclusive of previous projects. The River and Harbor Act, March 3, 1925, portion of the project is considered to be inactive and is excluded from the foregoing cost estimate. The cost of this portion was last revised in 1954 and was estimated to be \$2,886,000. The average annual maintenance cost during the past 5 years was \$246,400.

Recommended modifications of project. Legislation authorizing the abandonment of that part of the improvement of Wolf River above Fremont and the upper Fox River from the mouth of the Wolf to the Wisconsin River has been recommended in House Document 146, 67th Congress, 2d session.

Local cooperation. None required.

Terminal facilities. The wharf and landing facilities are, in general, adequate for the accommodation of existing commerce.

The existing project was authorized by the following:

ACTS	WORK AUTHORIZED	DOCUMENTS
Aug. 5, 1886 ¹	Improvement of Fox River	Annual Report, 1855, pp. 2041-2045 (plan of a board approved Dec. 10, 1884, as modified by Corps of Engineers, May 1, 1886).
Sept. 19, 1890	Dredging Fond du Lac Harbor on Lake Winnebago	H. Ex. Doc. 24, 51st Cong., 1st sess., Annual Report, 1890, p. 2390.
June 3, 1896	Improvement of Wolf River	No prior survey or estimate.
Do	Improvement of Stockbridge of Calumet and Miller Bay, and of Brothertown Harbors, on Lake Winnebago	Do.
June 13, 1902		
Mar. 2, 1907		
Mar. 3, 1925 ²	Increased depth in rock cuts on lower river, widening Neenah Channel, and for a concrete retaining wall at Kaukauna.	H. Doc. 294, 68th Cong., 1st sess.
June 26, 1934 ³	Operation and care of locks and dams provided for with funds from War Department appropriations for rivers and harbors.	

¹ \$2,600,000 inactive.

² \$286,000 inactive.

³ Permanent Appropriations Repeal Act.

The latest published maps are contained in H. Doc. 146, 67th Cong. 2d sess., and in H. Doc. 294, 68th Cong., 1st sess.

Operations and results during fiscal year. Conditions surveys, discharge observations and inspections and reports were conducted by hired labor at a cost of \$9,628. The locks and dams were operated as required and the necessary repairs made to the structures at a cost of \$237,398. The total maintenance costs were \$247,026.

Condition at end of fiscal year. The existing project is about 44 percent complete (upper river, 25 percent; lower, 83 percent). Twenty-two original locks and nine original dams have been rebuilt; five additional locks and dams have been built by the United States. (See existing project for year of completion of each.) The structures and the dredging in pools have increased the original depths generally about 2 feet. The controlling depths at standard low water at the close of the fiscal year were as follows:

Fox River:	Feet
De Pere to mouth of Wolf River	6.0
Thence to Eureka lock	4.0
Wolf River:	
Mouth to 1 mile below Partridge Crop Lake	4.0
Thence to New London	4.0
Harbors on Lake Winnebago	1.0 - 3.0

The practicable drafts of vessel are about one-half foot less than the controlling depths which prevail throughout the year except when the rivers are frozen, usually from December 1 to April 1. As commerce no longer existed on the upper Fox River from the Wolf River to the Wisconsin River, Federal expenditures for continuing the operation of the nine locks on this portion of the project were no longer justified. Accordingly the operation of these structures was discontinued in July 1951. The work remaining to be done to complete the project consists of dredging in the upper Fox River and the upper portion of the Wolf River, and rock removal and deepening Neenah Channel on lower Fox River, which are no longer considered necessary. Except for Menasha lock, which should be rebuilt, the existing locks and dams are in generally fair to good condition. The costs under the existing project were \$871,724 for new work and \$6,995,312 for operation and maintenance, a total of \$7,867,036. In addition, the sum of \$3,795,496 (including \$89,309 under previous projects) was expended between July 5, 1884 and June 30, 1935, on the operating and care of the works of improvement under the provision of the permanent indefinite appropriation for such purposes.

May 10, 1956

map no. 1



WISCONSIN

IN 10 SHEETS SHEET NO. 2 SCALES AS NOTED

U. S. ENGINEER OFFICE, MILWAUKEE, WIS. OCTOBER 30, 1931

SUBMITTED: SUBMITTED:

Wm. H. Miller

MAJOR, CORPS OF ENGINEERS

FILE NO. 43-E-1
C. OF E. DATED MAY 4 1951
TO ACCOMPANY REPORT TO

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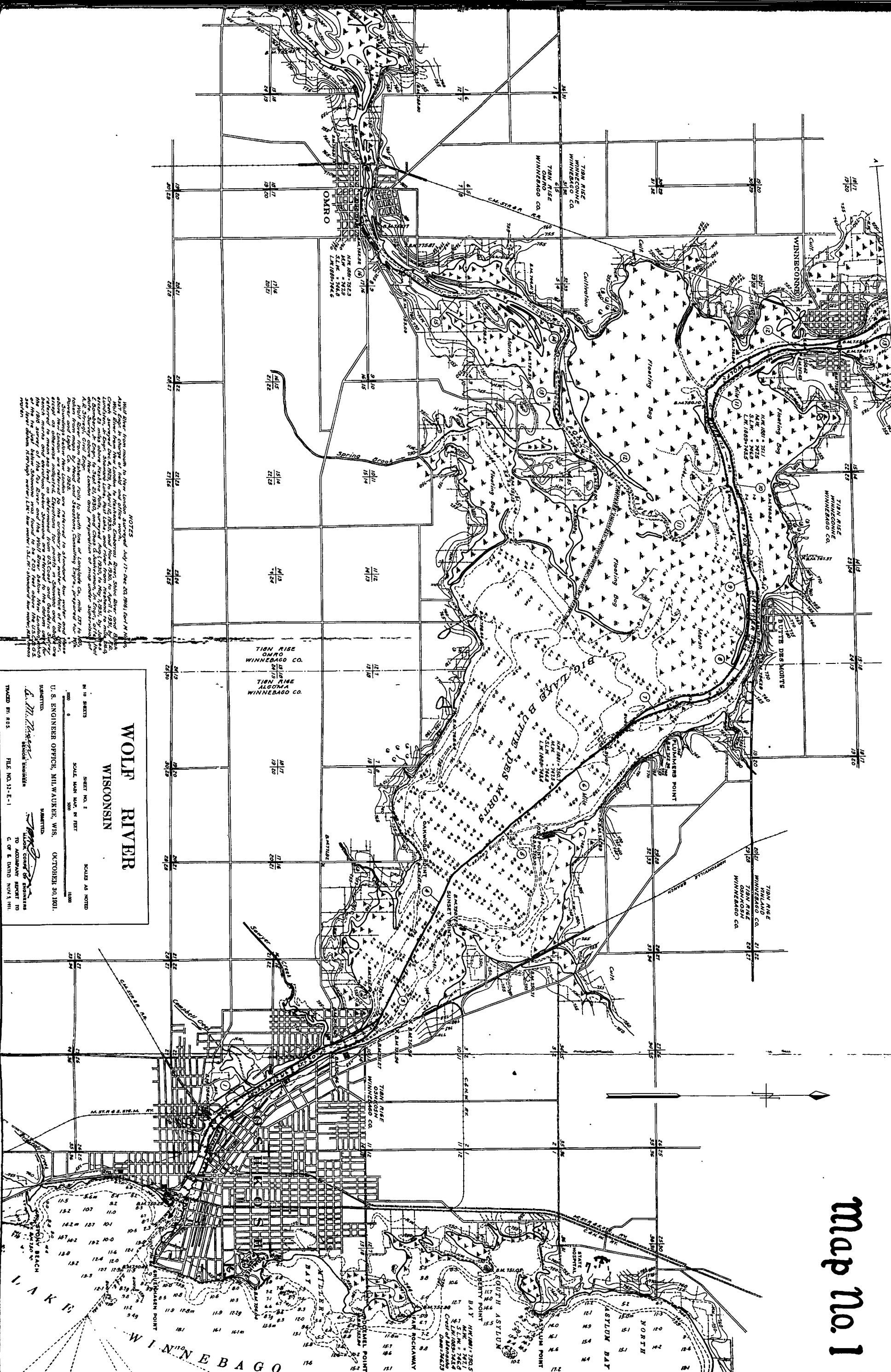
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Table 1. Demographic characteristics of study population

Cont'd. on map No. 2

map no.1



WOLF RIVER

WISCONSIN

IN 10 SHEETS SHEET NO. 2 SCALES AS NOTED

SCALE, MAIN MAP, IN FEET

U. S. ENGINEER OFFICE, MILWAUKEE, WIS. OCTOBER 30, 1931

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MAJOR, CORPS OF ENGINEERS

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map no. 1



Wolf River from mouth to New London surveyed July 17-Dec. 29, 1916; Earl N. Mearns, Asst. Eng'r in charge of field and office work.

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IN 10 SHEETS
SHEET NO. 1
SCALE, MAIN PLAN, IN FEET
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U. S. ENGINEER OFFICE, MILWAUKEE, WIS. OCTOBER 30, 1901

DESIGNED BY
E. M. Weaver
SENIOR ENGINEER

CHECKED BY
W. J. [Signature]
SENIOR ENGINEER

MAILED 870, R.O.S. FILE NO. 12-E-1

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C. OF E. LAYED NOV. 11, 1901

ALTON, CHRG. OF ENGINEERS

FILE NO. 32-E-
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