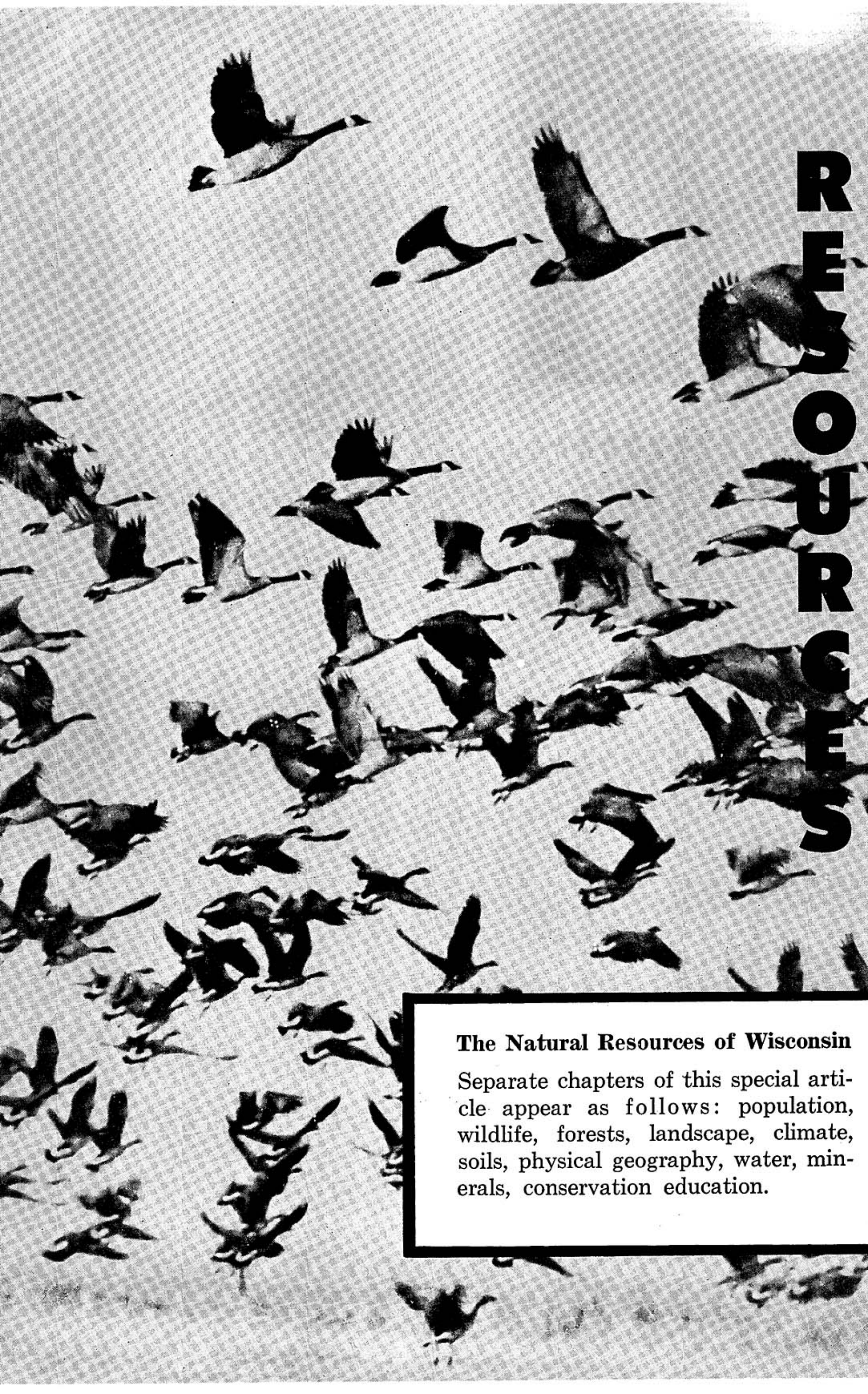


RESOURCES

The Natural Resources of Wisconsin

Separate chapters of this special article appear as follows: population, wildlife, forests, landscape, climate, soils, physical geography, water, minerals, conservation education.

THE POPULATION RESOURCE OF WISCONSIN

M. G. Toepel and *H. R. Theobald*

Legislative Reference Bureau

There are many different objectives in studying the population of a state. Here we are concerned with the people of Wisconsin as the state's most important resource. What is the number of available workers? What are the skills of this population, their productive capacities, their mobility or stability, their wage expectations?

The first white man set foot on Wisconsin soil in 1634, but by 1840 the territory's white population still numbered only about 31,000. Ten years later it had increased tenfold, doubling again by 1860 and once more by 1880. Since then the rate has been less spectacular. For the 1950 to 1960 decade it was 15.1 per cent.

A phenomenal, unexpected and persistent annual rise in the birth rate occurred following World War II, and it was not until 1961 and 1962 that the birth rate dropped.

While immigration was long the basic reason for population increases, Wisconsin's population increase since 1950 was due primarily to the increase of births over deaths. For the decade 1950-1960 there were 565,543 births in Wisconsin, yet a comparison of the census counts on April 1, 1950 and 1960 shows a population increase of only 517,910. The difference is due to migration. During the decade 47,633 more people left the state than came into it. Wisconsin had a net migration loss although it showed an over-all population gain.

In 1960 the people of Wisconsin numbered 3,952,485 or thereabouts. Considering the number of people employed in collecting the data and the fluidity of the population, perfection in enumeration can only be approximated. These people represented 2.2 per cent of the total population of the United States.

Not since the 10-year period ending in 1900 has Wisconsin's rate of population increase equalled that of the whole nation, although Wisconsin came close to the national average during the 1910's and again during the 1950's. Lagging in population increases behind other portions of the nation, Wisconsin's population has become an increasingly smaller part of the total U.S. population. Wisconsin started this century as the 13th most populous state in the Union, containing 2.7 per cent of the U.S. population; in 1960 the percentage had dropped to 2.2 and the rank to 15th.

It is hazardous to forecast what Wisconsin's population will be in the years 2000 or even in 1980. If Wisconsin had kept pace with the rest of the nation since 1900, when its share of the U.S. population was 2.7226 per cent, Wisconsin's 1960 population would have been 4,858,867 instead of the 3,952,485 actually counted. A variety of assumptions have led the forecasters to predict Wisconsin's population to be between 4,785,000 and 5,377,000 in 1980 and between 5,700,000

Table 1: U.S. AND WISCONSIN POPULATIONS BY 10-YEAR INTERVALS

Census Year	United States		Wisconsin			
	Population	% Gain	Population	% Gain	% of U.S.	Rank
1840	17,069,453	32.7	30,945	n.a.	0.2	n.a.
1850	23,191,876	35.9	305,391	886.9	1.3	24th
1860	31,443,321	35.6	775,881	154.1	2.5	15th
1870	38,558,371	22.6	1,054,670	35.9	2.7	15th
1880	50,189,209	30.2	1,315,497	24.7	2.6	16th
1890	62,979,766	25.5	1,693,330	28.7	2.7	14th
1900	76,212,168	21.0	2,069,042	22.2	2.7	13th
1910	92,228,496	21.0	2,333,860	12.8	2.5	13th
1920	106,021,537	15.0	2,632,067	12.8	2.5	13th
1930	123,202,624	16.2	2,939,006	11.7	2.4	13th
1940	132,164,569	7.3	3,137,587	6.8	2.4	13th
1950	151,325,798	14.5	3,434,575	9.5	2.3	14th
1960	179,323,175	18.5	3,951,777*	15.1	2.2	15th

* Because of a discrepancy in the census count for Sauk County and the City of Baraboo, there are 3 different "totals" for the 1960 population of Wisconsin:

3,951,777 in the *Number of Inhabitants* report;
3,952,765 in the *General Characteristics* report; and
3,952,485 in the *General Social and Economic Characteristics* report.

Source: U.S. Census of Population, 1960, Vol. I, pt. A, pp. 1-4, 1-16 to 1-17, 1-18, 1-19 and 1-25.

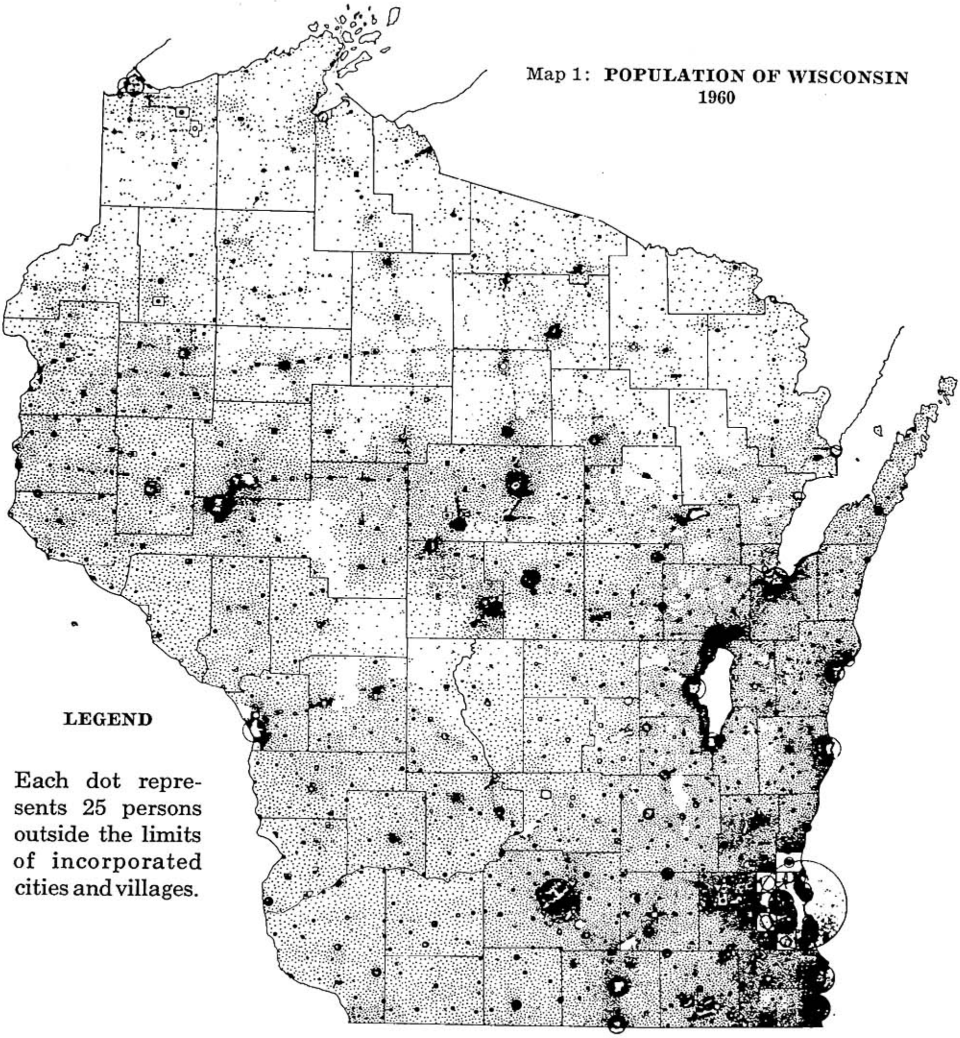
and 7,700,000 in the year 2000. Population projections by the Wisconsin Department of Resource Development, based on employment trends, estimate the 1980 population at 5,068,000 and the population in the year 2000 at 6,401,000.

National Origins of Wisconsin Population

The "Native" Population: Indians

Frequently it is said that there are so few Indians today because most of them died as the result of persecution and disease, and much has been written about the cruelty and exploitation which the Indians suffered from the white men. Actually the number of Indians in Wisconsin today is greater than it appears to have been in the early 1800's.

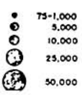
Map 1: **POPULATION OF WISCONSIN**
1960



LEGEND

Each dot represents 25 persons outside the limits of incorporated cities and villages.

Incorporated
Cities and Villages



Area of circles which are used to indicate cities and villages over 1,000 is directly proportional to population.

Distribution of population as indicated by dots was determined by USGS quadrangles and U.S. Census of Population, 1960.

Nobody really knows how many Indians there were in Wisconsin when it was discovered in 1634 by Jean Nicolet. Because the Indian depended on hunting for his livelihood he was largely nomadic. Even when censuses began they did not count Indians because of the prohibition in the U.S. Constitution against counting "Indians not taxed" in allocating congressional seats. It was not until the 1850's that estimates were even made. At that time the estimates included 7,000 Chippewas, Ottawas and Potawatomies, 2,200 Menominees and 2,708 Winnebagoes located in what was to become Wisconsin and part of Minnesota. The Bureau of Indian Affairs estimated that about 1,370 Oneida, Stockbridge and Munsee Indians had left New York for Wisconsin.

There were 14,297 Indians in Wisconsin on April 1, 1960 according to the U.S. census. This is only about four-tenths of one per cent of the total state population. Most of the Indians live in rural areas; only about 25 per cent were found in urban communities. Between 1920 and 1960 the state's Indian population increased from 9,600 to 14,297.

In 1960 only 3 counties contained more than a thousand Indians. These counties were Milwaukee, Brown and Shawano. There were 48 counties with less than 100 Indians each. Menominee County was created in 1961 from parts of Oconto and Shawano Counties. Its population, largely Menominee Indian, was 2,606.

Actually the Indian represents a relatively minor portion of the nonwhite population of Wisconsin today. While the Indian has about held his own during the past 2 decades, the Negro population has more than doubled each decade.

Table 2: RACIAL COMPOSITION OF WISCONSIN'S POPULATION

Year	White	Total Nonwhite	Negro	Indian	All Other Nonwhite
1890	1,680,828	12,502	2,444	9,930	158
1900	2,057,911	11,131	2,542	8,372	217
1910	2,320,555	13,305	2,900	10,142	263
1920	2,616,938	15,129	5,201	9,611	317
1930	2,916,255	22,751	10,739	11,548	464
1940	3,112,752	24,835	12,158	12,265	412
1950	3,392,690	41,885	28,182	12,196	1,507
1960	3,858,903	92,874	74,546	14,297	4,031

Source: U.S. Census of Population, 1960, PC(1)/51B/Wis, Table 15.

National Origins of Wisconsin's "Immigrant" Population

Contrary to the opinion of some, the white man is not indigenous to Wisconsin. In 1634 Governor Samuel de Champlain of "New France" commissioned a voyageur, Jean Nicolet, to explore the lands west of the Great Lakes. Nicolet visited the area which was to become Green Bay, and the Winnebago and Menominee Indians. He was followed by Radisson, Grosseilliers, Father Allouez, Jolliet and Father Marquette, but by 1800 there were still no more than perhaps 200 white men in what was to be Wisconsin.

In 1840 the first federal census was taken in the Territory of Wisconsin, created in 1836. That census showed a total population in the territory of 30,945, including 30,749 white persons, 185 free colored persons and 11 slaves. Indians were not counted. In another 10 years, in 1850, the population excluding Indians increased to 305,391 and by 1870 Wisconsin had passed the million mark.

The first white inhabitants, who came from France and Canada as fur traders and explorers, fixed the sites of many Wisconsin settlements and gave them the French names still found today. The region was French territory until the close of the French and Indian Wars, and then until after the War of 1812 it was under British domination.

Two great population movements thereafter influenced the future of Wisconsin. Migrating lead miners of Welsh and English ancestry organized the first permanent settlements in southwestern Wisconsin in the 1830's, and dominated the early history of Wisconsin as a territory and state. They had come from Missouri and Illinois, bringing southern social and governmental customs and institutions with them.

As tales of the fertile soil of the new west spread to New England and other eastern states, a rapidly rising influx of Yankee farmers and recently arrived north Europeans began. Immigrants spread the news to their relatives at home who followed them by the thousands. This group of people soon acquired a majority and dominated the cultural development of the state, establishing the New York system of local government, featuring the town with its broad application of democratic principles.

The rapid population increases in Wisconsin from 1840 to 1900 were the obvious result of European immigration which reached its crest between 1880 and 1900, although the immigrants actually represented a greater share of the total population in 1850 than subsequently.

Although the percentage of foreign-born has decreased steadily since 1900, it is still possible to recognize the evidences of European heritage in family names, place names, foods, architecture and customs.

Statistics show clearly that while the absolute number and proportion of the population which is foreign-born has declined rapidly and drastically, the number of persons of foreign-born parentage has held up much more.

Table 3: NATIVE AND FOREIGN-BORN POPULATION OF WISCONSIN

Year	Total Population	U.S. Born	Foreign Born	% Foreign Born
1840	30,945	n.a.	n.a.	n.a.
1850	305,391	194,099	110,477	36.2
1860	775,881	498,954	276,967	35.7
1870	1,054,670	690,171	364,499	34.6
1880	1,315,497	910,072	405,425	30.8
1890	1,693,330	1,167,891	518,989	30.6
1900	2,069,042	1,553,071	515,971	24.9
1910	2,333,860	1,821,291	512,569	22.0
1920	2,632,067	2,171,939	460,128	17.5
1930	2,939,006	2,551,026	387,980	13.2
1940	3,137,587	2,848,813	288,774	9.2
1950	3,343,575	3,216,341	218,234	6.4
1960	3,952,485	3,780,966	171,519	4.3

Source: U.S. Census of Population, 1860 to 1960.

In 1960 only 28 of the 72 counties contained more than 1,000 foreign-born people. While Milwaukee led with an absolute total of 74,184, 3 counties—Douglas, Kenosha and Price—had a higher percentage of foreign-born. By 1960 there were only 171,519 foreign-born people in the state or 4.3 per cent of the total.

At the same time, every county except Florence and Menominee had at least 1,000 people whose parents were foreign born. In Price County over 36 per cent of the people were of foreign-born parentage, and 3 out of every 10 people in Milwaukee County are of foreign-born parentage.

The most numerous foreign-stock population segments in 1960 were German (326,313), Polish (93,633), Norwegian (73,505), Canadian (42,411), British (36,620), Swedish (36,352), Austrian (33,446), Czechoslovakian (33,227) and Italian (31,673). Other sizable segments were of foreign stock from Russia (29,733), Denmark (25,140), Yugoslavia (22,751), Holland (18,955) and Switzerland (17,696). In individual counties in 1960 German was the major foreign-stock nationality in 51 counties, Norwegian in 11, Swedish in 3, Polish in 2 cases and Austrian, Italian and Swiss one each (see Table 4).

Intrastate Variation in Population

Although the data show that Wisconsin's population has increased in every decade since census figures were kept, the population trend has not been uniform throughout the state. Some areas have lived up to the predictions of growth while others have not only failed to boom but have actually declined.

Table 4: MAJOR NATIONALITIES OF WISCONSIN'S FOREIGN STOCK POPULATION, 28 COUNTIES, 1960

County	1960 Population	Foreign Stock Number	Foreign Stock %	Foreign Born Number	Foreign Born %	Major Nationalities 1st	Major Nationalities 2nd	Major Nationalities 3rd
Barron	34,270	8,933	26.1	1,160	3.4	Norway	Germany	Sweden
Brown	125,082	18,308	14.6	1,977	1.6	Germany	Other Europe	Poland
Clark	31,527	8,302	26.3	1,460	4.6	Germany	Poland	Norway
Dane	222,095	39,941	18.0	7,615	3.4	Germany	Norway	United Kingdom
Dodge	63,170	12,397	19.6	1,608	2.5	Germany	Netherlands	Poland
Douglas	45,008	15,542	34.5	3,279	7.3	Sweden	Norway	Finland
Eau Claire	58,300	11,814	20.3	1,225	2.1	Norway	Germany	Canada
Fond du Lac	75,085	13,785	18.4	2,019	2.7	Germany	Netherlands	Canada
Green	25,851	5,864	22.7	1,183	4.6	Switzerland	Germany	Norway
Jefferson	50,094	10,334	20.6	1,427	2.8	Germany	Norway	United Kingdom
Kenosha	100,615	31,290	31.1	8,746	8.7	Germany	Italy	Poland
La Crosse	72,465	12,883	17.8	1,309	1.8	Germany	Norway	Canada
Lincoln	22,338	6,445	28.9	1,146	5.1	Germany	Sweden	Canada
Manitowoc	75,215	11,892	15.8	1,398	1.9	Germany	Czechoslovakia	Poland
Marathon	88,874	19,971	22.5	2,477	2.8	Germany	Poland	Canada
Marinette	34,660	9,640	27.8	1,546	4.5	Germany	Poland	Canada
Milwaukee	1,036,041	303,882	29.3	74,184	7.2	Germany	Poland	Austria
Outagamie	101,794	16,807	16.5	2,516	2.5	Germany	Netherlands	Canada
Ozaukee	38,441	6,406	16.7	1,044	2.7	Germany	Poland	Austria
Price	14,370	5,196	36.2	1,083	7.5	Germany	Sweden	Czechoslovakia
Racine	141,781	39,752	28.0	9,533	6.7	Germany	Denmark	Poland
Rock	113,913	19,854	17.4	3,410	3.0	Germany	Norway	United Kingdom
Sheboygan	86,484	21,877	25.3	4,322	5.0	Germany	U.S.S.R.	Netherlands
Walworth	52,368	11,889	22.7	2,545	4.9	Germany	United Kingdom	Sweden
Washington	46,119	6,537	14.2	1,056	2.3	Germany	Switzerland	Poland
Waukesha	158,249	32,152	20.3	5,461	3.5	Germany	United Kingdom	Poland
Winnebago	107,928	22,259	20.6	3,009	2.8	Germany	Poland	Austria
Wood	59,105	11,096	18.8	1,188	2.0	Germany	Poland	Norway

Source: U.S. Census of Population, 1960, PC(1)/51C/Wis, Table 89.

Only one county, Milwaukee, has a population exceeding a million people. Eight others have populations larger than 100,000, but only one of these, Dane County, comes close to a quarter million. Together the 9 most populous counties contain 2,107,498 people, or 53.3 per cent of Wisconsin's total 1960 population. Only 33 counties in 1960 had populations in excess of 30,000 and 10 had less than 10,000 people. Menominee County, created in 1961, contains but 2,606 people, hardly enough to maintain a county government (see Map 1).

Milwaukee, Pepin and Ozaukee Counties contain virtually the same area, yet the population per square mile is 4,335, 31 and 163 respectively. The vast Marathon County which has more than 6 times as much area as Milwaukee County has only 8 per cent as many people. Milwaukee County is totally devoid of towns because all its territory is in cities and villages, while Menominee and Florence Counties contain only towns.

In some rural towns the population is very sparse—in 1960 there were 17 towns of less than 100 people each—while some of the urbanized towns have assumed the character of cities with populations of more than 4,000 (14 in 1960).

Population Change, 1910 to 1960

In the 50 years preceding the 1960 Census of Population, Wisconsin's population increased 69.4 per cent, from 2,333,860 in 1910 to 3,952,765 in 1960. This increase in population was distributed unevenly among the 71 counties (Menominee County created 1961); 17 counties actually lost population during that period (see Table 5).

Map 2:. **POPULATION CHANGE, 1910 TO 1960**

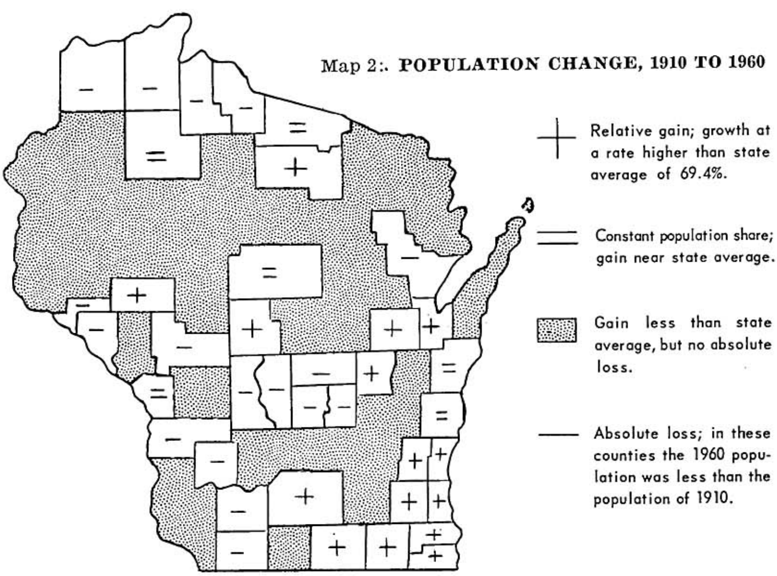


Table 5: NET POPULATION CHANGE OF WISCONSIN 1910 TO 1960, BY COUNTY

		Loss						
County	Population 1910	1910-20	1920-30	1930-40	1940-50	1950-60	Population 1960	Change 1910-60
STATE	2,333,860			none			3,952,765	+69.4
Adams	8,604		x		x	x	7,566	−12.1
Ashland	21,965		x		x	x	17,375	−20.9
Barron	29,114			x		x	34,270	+17.7
Bayfield	15,987		x		x	x	11,910	−25.5
Brown	54,098			none			125,082	+131.2
Buffalo	16,006	x	x		x	x	14,202	−11.3
Burnett	9,026		x		x	x	9,214	+ 2.1
Calumet	16,701		x				22,268	+33.3
Chippewa	32,103			none			45,096	+40.5
Clark	30,074		x	x	x	x	31,527	+ 4.8
Columbia	31,129	x					36,708	+17.9
Crawford	16,288				x	x	16,351	+ .4
Dane	77,435			none			222,095	+186.8
Dodge	47,436			none			63,170	+33.2
Door	18,711		x			x	20,685	+10.5
Douglas	47,422		x		x	x	45,008	− 5.1
Dunn	25,260				x	x	26,156	+ 3.5
Eau Claire	32,721			none			58,300	+78.2
Florence	3,381				x	x	3,437	+ 1.7
Fond du Lac	51,610			none			75,085	+45.5
Forest	6,782				x	x	7,542	+11.2
Grant	39,007		x				44,419	+13.9
Green	21,641	x					25,851	+19.5
Green Lake	15,491	x	x				15,418	− .4
Iowa	22,497	x	x		x		19,631	−12.7
Iron	8,306		x		x	x	7,830	− 5.7
Jackson	17,075		x		x	x	15,151	−11.3
Jefferson	34,306			none			50,094	+46.0
Juneau	19,569	x	x			x	17,490	−10.6
Kenosha	32,929			none			100,615	+205.6
Kewaunee	16,784	x	x				18,282	+ 8.9
La Crosse	43,996			none			72,465	+64.7
Lafayette	20,075	x	x		x		18,142	− 9.6
Langlade	17,062				x	x	19,916	+16.7
Lincoln	19,064		x		x		22,338	+17.2
Manitowoc	44,978			none			75,215	+67.2
Marathon	55,054			none			88,874	+61.4
Marinette	33,812		x		x	x	34,660	+ 2.5
Marquette	10,741	x	x	x	x	x	8,516	−20.7
Menominee became a county April 29, 1961								
Milwaukee	433,187			none			1,036,041	+139.2
Monroe	28,881	x				x	31,241	+ 8.2
Oconto	25,657		x		x	x	25,110	− 2.1
Oneida	11,433			none			22,112	+93.4
Outagamie	49,102			none			101,794	+107.3
Ozaukee	17,123	x					38,441	+124.5
Pepin	7,577	x	x		x	x	7,332	− 3.2
Pierce	22,079	x	x		x		22,503	+ 1.9
Polk	21,367		x	x	x		24,968	+16.9
Portage	30,945				x		36,964	+19.5
Price	13,795		x		x	x	14,370	+ 4.2
Racine	57,424			none			141,781	+146.9
Richland	18,809		x		x	x	17,684	− 6.0
Rock	55,538			none			113,913	+105.1
Rusk	11,160		x		x	x	14,794	+32.6
St. Croix	25,910		x	x			29,164	+12.6
Sauk	32,869	x	x			x	37,167	+13.1
Sawyer	6,227				x	x	9,475	+52.2
Shawano	31,884		x		x	x	34,351	+ 7.7
Sheboygan	54,888			none			86,484	+57.6
Taylor	13,641		x		x	x	17,843	+30.8
Trempealeau	22,928		x		x	x	23,377	+ 2.0
Vernon	28,116		x		x	x	25,663	− 8.7
Vilas	6,019	x				x	9,332	+55.0
Walworth	29,614	x					52,368	+76.8
Washburn	8,196		x		x	x	10,301	+25.7
Washington	23,784			none			46,119	+93.9
Waukesha	37,100			none			158,249	+326.5
Waupaca	32,782		x				35,340	+ 7.8
Waushara	18,886		x	x	x	x	13,497	−28.5
Winnebago	62,116			none			107,928	+73.8
Wood	30,583			none			59,105	+93.3

Source: U.S. Census of Population, 1910 to 1960.

The 17 counties which had a higher population in 1910 than they have in 1960 are, with the exception of Oconto County, all part of 3 small areas: (1) four Lake Superior counties (Ashland, Bayfield, Douglas, Iron), (2) eight of the "sand counties" (Adams, Buffalo, Green Lake, Jackson, Juneau, Marquette, Pepin, Waushara), and (3) four of the southwestern counties (Iowa, Lafayette, Richland, Vernon).

Only 15 counties showed a relative gain (that is, a gain relative to the state's average of 69.4 per cent). These counties are the major industrial counties of Wisconsin (Brown, Dane, Eau Claire, Kenosha, Milwaukee, Outagamie, Racine, Rock, Winnebago Wood) and 4 counties on the industrial periphery (Ozaukee, Walworth, Washington, Waukesha). Oneida County also belongs in this group, due perhaps to the tremendous growth of the vacation industry during the past 50 years.

Another group of 6 counties almost, though not quite, kept pace with the state's rate of population growth. In each of these counties the population increased by at least 50 per cent over the last 50 years. Four industrial counties are in this group (La Crosse, Manitowoc, Marathon, Sheboygan) and 2 counties in Wisconsin's vacationland area (Sawyer, Vilas).

Waushara County had the greatest loss (−28.5 per cent). Marquette County lost population each decade since 1910 (total loss −20.7 per cent). Douglas County was the only industrial county showing an absolute loss (−5.1 per cent).

Waukesha County had the largest percentage gain (326.5 per cent) with three-fifths of its total increase occurring in the last decade. Milwaukee had the largest population increase (602,854); three-eighths of the total state increase 1910 to 1960 (1,618,905) occurred in that county alone.

Migration 1950 to 1960

The Wisconsin State Board of Health keeps detailed statistics for the births and deaths which occur in each county of the state. Using the 1950 Census as a starting point, birth and death figures for each county, and the known population figures of the 1960 Census, the State Board of Health is able to show the net "migration" during the decade for each county (see Table 6).

Sixty-one per cent of the increase in population of Waukesha County is due to migration into the county while in Forest County 30.9 per cent of the decrease is also due to migration out of the county (see Map 3).

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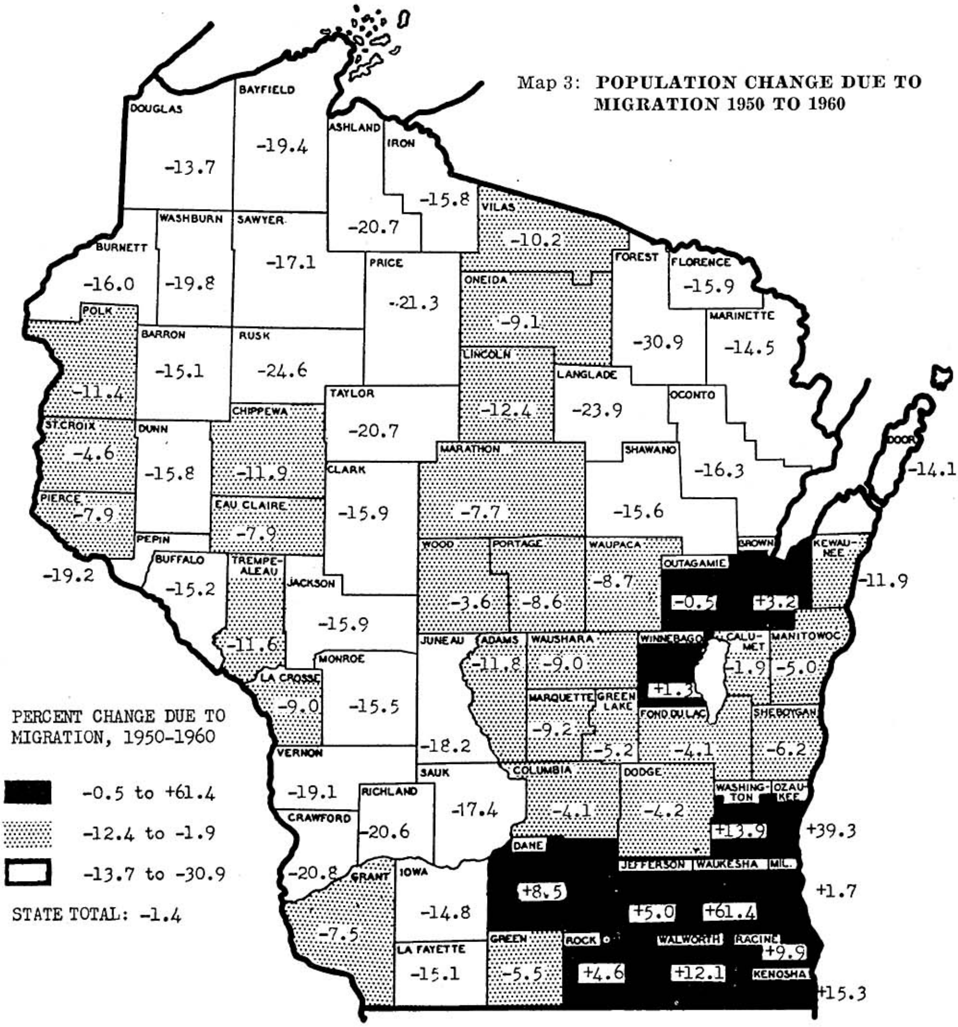
* For the 1960 enumeration of population by county and minor civil divisions, see *1962 Wisconsin Blue Book*, pp. 660-73.

Table 6: FACTORS OF POPULATION CHANGE 1950 TO 1960, BY COUNTY

County	Apr. 1, 1950 Population	Apr. 1, 1960 Population	Population Change Apr. 1, 1950 Apr. 1, 1960	Excess Births Over Deaths Apr. 1, 1950 Apr. 1, 1960	Net Change in Population Attributed to Migration	Net Change Attributed to Migration as Per Cent of 1950 Population
State Total	3,434,575	3,952,485	+517,910	565,543	−47,633	− 1.4
Adams	7,906	7,566	−340	592	−932	−11.8
Ashland	19,461	17,375	−2,086	1,936	−4,022	−20.7
Barron	34,703	34,270	−433	4,790	−5,223	−15.1
Bayfield	13,760	11,910	−1,850	817	−2,667	−19.4
Brown	98,314	125,082	+26,766	23,640	+3,128	+ 3.2
Buffalo	14,719	14,202	−517	1,724	−2,241	−15.2
Burnett	10,836	9,214	−1,022	615	−1,637	−16.0
Calumet	18,840	22,268	+3,428	3,780	−352	− 1.9
Chippewa	42,839	45,096	+2,257	7,003	−4,746	−11.9
Clark	32,459	31,527	−932	4,235	−5,167	−15.9
Columbia	34,023	36,708	+2,685	4,072	−1,387	− 4.1
Crawford	17,652	16,351	−1,301	2,370	−3,671	−20.8
Dane	169,357	222,095	+52,738	38,312	+14,426	+ 8.5
Dodge	57,611	63,170	+5,559	7,961	−2,402	− 4.2
Door	20,870	20,685	−185	2,764	−2,949	−14.1
Douglas	46,715	45,008	−1,707	4,689	−6,396	−13.7
Dunn	27,341	26,156	−1,185	3,136	−4,321	−15.8
Eau Claire	54,187	58,300	+4,113	8,415	−4,302	− 7.9
Florence	3,756	3,437	−319	279	−598	−15.9
Fond du Lac	67,829	75,085	+7,256	10,050	−2,794	− 4.1
Forest	9,437	7,542	−1,895	1,017	−2,912	−30.9
Grant	41,460	44,419	+2,959	6,081	−3,122	− 7.5
Green	24,172	25,851	+1,679	3,014	−1,335	− 5.5
Green Lake	14,749	15,418	+669	1,434	−765	− 5.2
Iowa	19,610	19,631	+21	2,924	−2,903	−14.8
Iron	8,714	7,830	−884	490	−1,374	−15.8
Jackson	16,073	15,151	−922	1,637	−2,559	−15.9
Jefferson	43,069	50,094	+7,025	4,889	+2,136	+ 5.0
Juneau	18,930	17,490	−1,440	2,007	−3,447	−18.2
Kenosha	75,238	100,615	+25,377	13,861	+11,516	+15.3
Kewaunee	17,366	18,282	+916	2,976	−2,060	−11.9
La Crosse	67,587	72,465	+4,878	10,964	−6,086	− 9.0
Lafayette	18,137	18,142	+5	2,742	−2,737	−15.1
Langlade	21,975	19,916	−2,059	3,191	−5,250	−23.9
Lincoln	22,235	22,338	+103	2,866	−2,763	−12.4
Manitowoc	67,159	75,215	+8,056	11,390	−3,334	− 5.0
Marathon	80,337	88,874	+8,537	14,736	−6,199	− 7.7
Marinette	35,748	34,660	−1,088	4,080	−5,168	−14.5
Marquette	8,839	8,516	−323	493	−816	− 9.2
Milwaukee	871,047	1,036,041	+164,994	149,791	+15,203	+ 1.7
Monroe	31,378	31,241	−137	4,718	−4,855	−15.5
Oconto	26,238	25,110	−1,128	3,151	−4,279	−16.3
Oneida	20,648	22,112	+1,464	3,337	−1,873	− 9.1
Outagamie	81,722	101,794	+20,072	20,454	−382	− 0.5
Ozaukee	23,361	38,441	+15,080	5,905	+9,175	+39.3
Pepin	7,462	7,332	−130	1,302	−1,432	−19.2
Pierce	21,448	22,503	+1,055	2,758	−1,703	− 7.9
Polk	24,944	24,968	+24	2,877	−2,853	−11.4
Portage	34,858	36,964	+2,106	5,089	−2,983	− 8.6
Price	16,344	14,370	−1,974	1,501	−3,475	−21.3
Racine	109,585	141,781	+32,196	21,367	+10,829	+ 9.9
Richland	19,245	17,684	−1,561	2,412	−3,973	−20.6
Rock	92,778	113,913	+21,135	16,860	+4,275	+ 4.6
Rusk	16,790	14,794	−1,996	2,129	−4,125	−24.6
St. Croix	25,905	29,164	+3,259	4,439	−1,180	− 4.6
Sauk	38,120	36,887	−1,233	5,383	−6,616	−17.4
Sawyer	10,323	9,475	−848	915	−1,763	−17.1
Shawano	35,249	34,351	−898	4,592	−5,490	−15.6
Sheboygan	80,631	86,484	+5,853	10,892	−5,039	− 6.2
Taylor	18,456	17,843	−613	3,207	−3,820	−20.7
Trempealeau	23,730	23,377	−353	2,402	−2,755	−11.6
Vernon	27,906	25,663	−2,243	3,097	−5,340	−19.1
Vilas	9,363	9,332	−31	925	−956	−10.2
Walworth	41,584	52,368	+10,784	5,757	+5,027	+12.1
Washburn	11,665	10,301	−1,364	944	−2,308	−19.8
Washington	33,902	46,119	+12,217	7,497	+4,720	+13.9
Waukesha	85,901	158,249	+72,348	19,644	+52,704	+61.4
Waupaca	35,056	35,340	+284	3,341	−3,057	− 8.7
Waushara	13,920	13,497	−423	825	−1,248	− 9.0
Winnebago	91,103	107,928	+16,825	15,637	+1,188	+ 1.3
Wood	50,500	59,105	+8,605	10,423	−1,818	− 3.6

Source: State Board of Health, Bureau of Vital Statistics, March 1963.

Map 3: **POPULATION CHANGE DUE TO MIGRATION 1950 TO 1960**

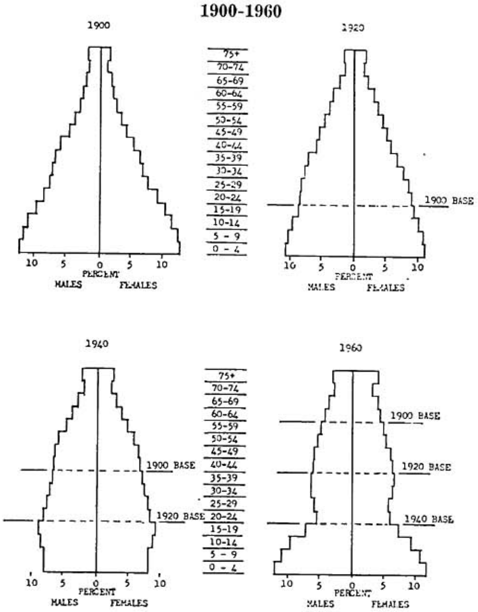


Characteristics of Wisconsin's Population

The Age of Wisconsin's Population

One of the more important factors in the economic implications of population is the age distribution. The larger the proportion of population in the nonproductive age groups, generally considered below 18 and above 65, the heavier the burden on the productive group. This phenomenon has characterized the last decade, and has had important repercussions on the burden on the productive group.

WISCONSIN POPULATION PYRAMIDS
1900-1960



In 1950, 9.0 per cent of Wisconsin's population was over 65 years of age and 31.2 per cent was under 18. In 1960, the over 65 group had increased to 10.2 per cent and the under 18 to 36.8 per cent. Thus it is apparent that in the last decade the people over 65 and under 18 increased as a percentage of the population more rapidly than did those between 18 and 65.

The youngest community in Wisconsin in 1960 was the Village of Brown Deer in Milwaukee County in which but 2.9 per cent of its people were over 65. In contrast to that, the Village of West Milwaukee had the oldest population in the state with only 25 per cent of its people under 18.

While the United States as a whole had 55 per cent of its population in the productive age group between 18 and 65, and the state had an average of 53 per cent in this group, in 1960 the Village of Kimberly, for example, had 48.9 per cent under 18 and 4.3 per cent over 65 or only 46.8 per cent in the productive age group. In the same year Dodgeville and Waupaca had 20 per cent over 65 and 32 per cent under 18 or 48 per cent in the productive age group as compared to the state average of 53 per cent.

Obviously factors which tend to bring particular age groups together affect the results. Residential communities with many retired people, college towns, sites of penal institutions, industrial communities—all have their effect on the characteristics of the population. Madison with the university counted 61 per cent between 18 and 65 and Waupun with the prison counted 61.9 per cent in this age group.

In 1960 there were 21 counties* in which at least 89 per cent of the population was under 65 years of age. Not one of these counties lost population in the 1950-60 decade. On the other hand, 19 counties had no more than 87 per cent of the population under 65 and all but one of them lost population in the decade from 1950 to 1960.

Wisconsin as an Urban State

As "America's Dairyland," Wisconsin finds it hard to dispel the myth that there are more cows than people in the state. In 1960,

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* Detailed statistic for 5-year age groups by county were reprinted in the *1962 Wisconsin Blue Book*, pp. 678-81.

there were 3,773,000 milk cows and 3,952,485 people in the state.

During the past decade Wisconsin has paralleled the national trend of rapid urban growth at the expense of the rural areas.

Table 7: URBAN AND RURAL POPULATION INCREASE SINCE 1950

	U.S.	Wisconsin
TOTAL, Population, 1960	179,323,175	3,952,485
Increase since 1950	27,997,377	517,910
Increase in %	18.5%	15.1%
Urban Population, 1960	125,268,750	2,522,887
Increase since 1950	29.3%	26.9%
Per cent of total population	69.9%	63.8%
Rural Population, 1960	54,054,425	1,429,598
Decrease since 1950	−0.8%	−1.2%
Per cent of total population	30.1%	36.2%

Source: U.S. Census of Population, 1960, Vol. I, pt. A, pp. 1-4 and 51-9.

As was true of the entire country, the population of the state tended to congregate in greater numbers in the cities as time went on. In 1850, only 9.4 per cent of the people lived in communities over 2,500. In 1960, 62.1 per cent lived in urban places.

Sometime between 1920 and 1930 the balance in favor of rural living was broken and a larger percentage of the people was found in urban communities.

There are those who believe that a city is not really a city unless it has at least 50,000 people. If that yardstick is used (see Table 8), then the 1960 population of Wisconsin divides rather neatly into 3 almost equal thirds of city people (1,213,041 or 30.7 per cent), rural people (1,429,598 or 36.2 per cent), and small town people (1,310,126 or 33.1 per cent).

RELATION OF RURAL TO URBAN POPULATION

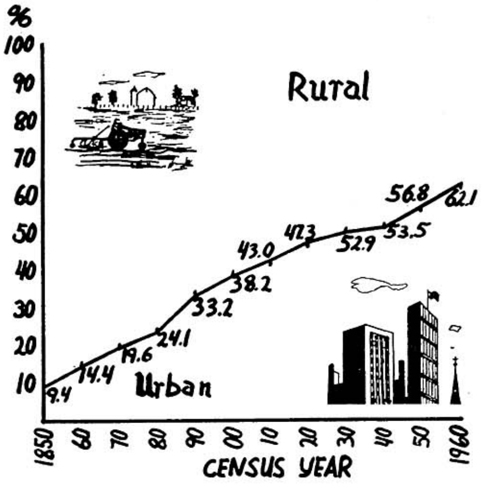
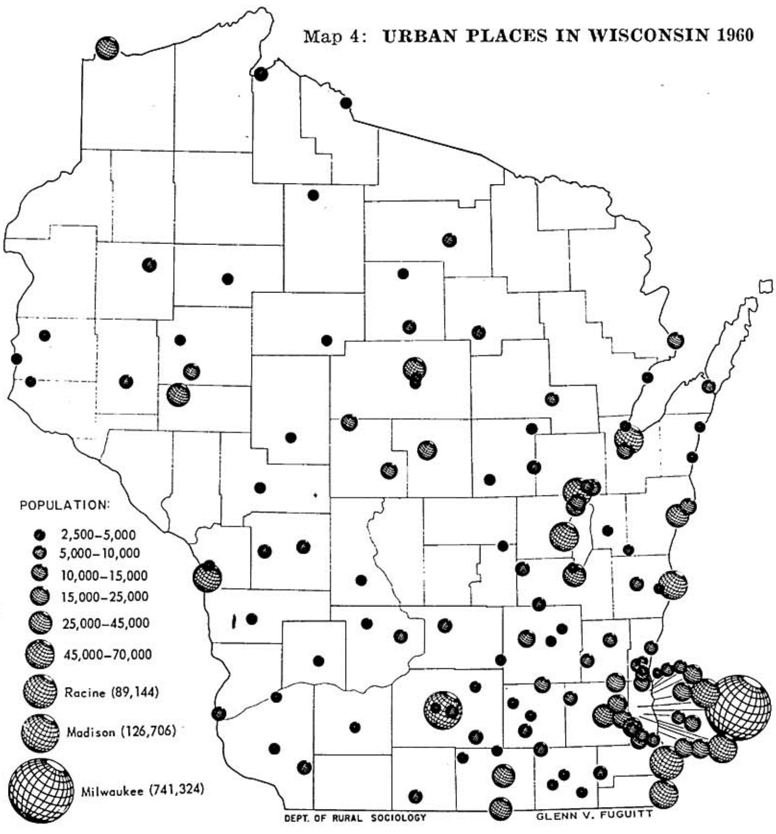


Table 8: RESIDENCE BY SIZE OF PLACE

Metropolitan		Small Town		Rural	
Over 100,000	868,030	25 to 50,000	453,344	1 to 2,500	198,787
50 to 100,000	345,011	10 to 25,000	350,019	1,000 or less	146,005
		5 to 10,000	259,321	other rural	1,084,806
		2½ to 5,000	186,138		
		2,500 or less	10,410		
		other urban	50,894		
TOTAL	1,213,041		1,310,126		1,429,598
%	30.7%		33.1%		36.2%

Source: U.S. Census of Population, 1960, Vol. I, pt. A, pp. 51-9 and 51-19.

Map 4: **URBAN PLACES IN WISCONSIN 1960**



It should be pointed out that there are 2 major ways by which urban areas develop. The first is by increasing the population within the confines of the same area either by migration or more births than deaths. The second way is by annexing territory. The core city frequently does not increase in population, but the outlying areas do.* This point is illustrated by the City of Milwaukee in which that portion of the city which was part of the city in 1950 lost population in 1960, but by annexation the City of Milwaukee grew from 637,392 to 741,324. It is the satellite areas or suburbs which have gained the population as witnessed by the high rises in population of the areas surrounding Milwaukee. Only recently a movement back to the core cities has been noted in a few places.

Wisconsin contains 5 areas known as standard metropolitan statistical areas which contain a city of at least 50,000 people and surrounding urbanized areas. These are Kenosha, Racine and Milwaukee in the southeast, Madison in the south central and Green Bay in the northeast.

Educational Attainment of the People

In 1950 the median school year completed by the people of Wisconsin 14 years of age and older was 9.5. In 1960 it was 10.6.

Virtually every child goes to school in this state during a certain period of his life. The percentage of children of various age groups attending school is as follows:

5 years old 52.0%	12 years old 98.4%
6 years old 88.4	13 years old 97.7
7 years old 98.2	14 years old 96.8
8 years old 98.5	15 years old 96.0
9 years old 98.4	16 years old 91.8
10 years old 98.9	17 years old 84.6
11 years old 98.6	18 years old 60.0

Of the 1,782,822 people between 5 and 34 years of age in the state in 1960, 734,383 attended public schools and 264,789 attended private schools.

Of the 2,175,370 persons in Wisconsin 25 years of age or over in 1960, 1,788,494 had completed the 8th grade, and of them 903,637 had completed high school, and of those 145,043 had completed 4 years of college.

The Wisconsin Labor Force

What Is It?

The Bureau of the Census determined that in 1960 there were 1,527,722 people in the Wisconsin civilian labor force out of 2,743,629 people 14 years of age or over in the state. The components of this estimate were as follows:

* For the 1960 population of Wisconsin urban places, within the area encompassed by each at the time of the 1950 Census of Population, see the *1962 Wisconsin Blue Book*, p. 686.

Table 9: WISCONSIN LABOR FORCE

TOTAL population 14 years of age or over	2,743,629
Total labor force	1,532,961
Labor force in armed services	5,239
Total civilian labor force	1,527,722
Employed	1,468,631
Unemployed	59,091
Total not in labor force	1,210,668
Inmates of institutions	42,232
Enrolled in school	217,223
65 years of age or over	296,159
Others under 65 not in labor force	655,054

Source: U.S. Census of Population, 1960, PC(1)/51C/Wis, Table 52.

The People's Income

Of the 2,743,629 people 14 years of age or over in 1960, 749,431 had no income whatsoever, and 1,994,198 did have income. The distribution of those with incomes in 1959 was as follows:

Table 10: 1959 INCOME OF PERSONS 14 YEARS OF AGE AND OVER

Income bracket	Number	Per Cent
Under $1,000	512,661	25.7%
$1,000 to $1,999	276,811	13.9
$2,000 to $2,999	223,896	11.2
$3,000 to $3,999	210,025	10.5
$4,000 to $4,999	213,375	10.7
$5,000 to $5,999	202,209	10.1
$6,000 to $6,999	136,578	6.8
$7,000 to $9,999	146,436	7.3
$10,000 and over	72,207	3.6
Total with income	1,994,198	
Total w/o income	749,431	
TOTAL 14 years and over	2,743,629	

Source: U.S. Census of Population, 1960, PC(1)/51C/Wis, Table 67.

Weeks Worked in 1959

Of the 2,743,629 persons over 14 years of age in 1959, 1,013,598 did not work at all that year. Of the 1,730,031 who did work in 1959, over a million worked at least 50 weeks.

Table 11: WEEKS WORKED IN 1959

	State	Urban	Rural Nonfarm	Rural Farm
TOTAL 14 and over	2,743,629	1,775,700	596,180	371,749
Worked in 1959	1,730,031	1,135,615	351,733	242,683
50 to 52 weeks	1,037,332	672,179	191,258	173,895
48 to 49 weeks	89,264	53,076	18,660	7,528
40 to 47 weeks	133,784	94,729	28,233	10,822
27 to 39 weeks	141,430	92,476	34,824	14,130
14 to 26 weeks	140,315	93,295	32,724	14,296
13 or less	187,906	119,860	46,034	22,012
Did not work in 1959	1,013,598	640,085	244,447	129,066

Source: U.S. Census of Population, 1960, PC(1)/51C/Wis, Table 55.

Labor Disputes in Wisconsin

In 1959 there were 61 strikes in Wisconsin involving 20,900 workers who were idle 699,000 man days. The trend in labor disputes during the past 20 years is as follows:

Table 12: LABOR DISPUTES IN WISCONSIN

Year	No. of Strikes	Workers Involved	Man-days Lost
1939	55	39,426	366,136
1944	88	36,167	143,743
1949	67	19,900	413,000
1954	59	16,600	641,000
1959	61	20,900	699,000

Source: Employment Relations Board, 22nd Annual Report, p. 48.

Fringe Benefits

Wisconsin was the first state in the Union to establish a system of workmen's compensation. Today a great number of such cases are handled with a minimum of delay. More than 20,000 cases of injury are handled yearly without long drawn out legal litigation.

Wisconsin was the first state to establish a system of unemployment compensation. The first check was paid in 1936. Today payments are made for a maximum of 26 weeks. Under this program more than a million payments, totaling over 40 million dollars, were made in 1962.

Major Categories of Employment

What do the people of Wisconsin do for a living? Of the 1,011,324 males and 457,307 females employed in 1960, the major classifications of employment were as follows:

Table 13: OCCUPATIONS OF THE WISCONSIN POPULATION

Occupational Group	Per cent of Males	Per cent of Females
Professions	8.8%	12.6%
Farmers	10.2	1.4
Managers, officials, proprietors	9.1	3.0
Clerical workers	5.8	28.4
Sales workers	6.2	8.7
Craftsmen	19.3	1.3
Operatives	23.0	14.7
Household and service	5.0	21.3
Farm labor	3.5	3.7
Other laborers	5.7	.6
Unknown	3.5	4.3

Source: U.S. Census of Population, 1960, PC(1)/51C/Wis, Table 57.

Wisconsin and U.S. Compared

How does Wisconsin's human resource compare with other states or with that of the rest of the Nation? In the past decade, Wisconsin's population increased by 15.1 per cent, that of the United States increased by 18.5 per cent. Thus, Wisconsin's rate of increase was seemingly somewhat less than the national average. At the same time, however, we have seen (in Table 6) that during the same period Wisconsin lost 47,633 people who moved out of the state; had all of them remained in Wisconsin our population increase during the 1950's would have been 16.5 per cent.

Wisconsin's population is significantly less apt to move around than the national average: Nationally, only 49.9 per cent of the people lived in 1960 in the same house in which they had lived in 1950; in Wisconsin, the figure was 55.4 per cent.

Wisconsin people believe in education. At all age levels up to 22 years of age, the percentage of Wisconsin residents in school is higher than the national average: 73.3 per cent of the 5 and 6-year-olds were enrolled in school in Wisconsin in 1960, compared to 63.8 nationally; 98.4 per cent of the 7 to 13-year-olds (compared to 97.5); 96.6 per cent of the 14 and 15-year-olds (compared to 94.1); 88.3 per cent of the 16 and 17-year-olds (compared to 80.9 per cent); 45.3 per cent of the 18 and 19-year-olds (compared to 42.1 per cent); and

21.9 per cent of Wisconsin's 20 and 21-year-olds compared to a national average of 21.1 per cent were enrolled. On the other hand, for age-groups over 21 years of age school enrollment in Wisconsin in 1960 was lower than the national average. In Wisconsin, 9.9 per cent of the 22 to 24-year-olds were enrolled in school in 1960; nationally the percentage was 10.2. Similarly, for the 25 to 34 age-group, the Wisconsin figure was 3.5 per cent compared to a national enrollment of 4.6 per cent.

Wisconsin has slightly less people who have a college education than the national average (6.7 per cent compared to 7.7 per cent). At the same time, the number of people who have completed 8 years of elementary school in Wisconsin is 40 per cent higher than the national average (24.9 per cent compared to 17.5 per cent), and the number of high school graduates is also higher than the national average (26.2 per cent compared to 24.6 per cent).

For some reason, the share of Wisconsin's population who are veterans is slightly less than the national average: 36.7 per cent of Wisconsin's 1960 male population over 14 years of age were veterans while the national figure was 38.8 per cent.

Wisconsin's people work. In 1960, 78.4 per cent of our state's men were considered part of the labor force and only 3.8 per cent were unemployed. For the Nation as a whole, only 77.4 per cent of the men were part of the labor force, and 5.0 per cent were unemployed. For Wisconsin's women, the percentage considered part of the labor force was just slightly less than the national average: 34.1 per cent compared to 34.5 per cent. But, again, unemployment was less than the national average: 4.0 per cent compared to 5.4 per cent. There is also a significant difference in the percentage of working mothers (with children less than 6 years old) in Wisconsin and in the United States generally—it seems that Wisconsin mothers, when they can, stay home to raise their children (19.3 per cent Wisconsin compared to 21.1 per cent U.S. were part of the labor force), while women without children go to work (38.5 per cent Wisconsin; 38.3 per cent U.S.).

Wisconsin workers are steady workers. In 1959, 37.8 per cent of them worked more than 50 weeks. Nationally, only 34.8 per cent of the population over 14 years of age worked more than 50 weeks.

Wisconsin farmers are independent, yet have strong family ties. In 1960, 73.0 per cent of the men (63.4 per cent U.S.) were self-employed and 8.5 per cent (U.S. 4.1 per cent) were "unpaid family workers." For Wisconsin's farm women, the family ties are even more striking: 62.1 per cent were "unpaid family workers" (31.3 per cent U.S.). 27.2 per cent of Wisconsin's women were self-employed, compared to a U.S. average of 29.7 per cent.

Wisconsin's nonagricultural workers, on the other hand, typically work as employes: 79.1 per cent of Wisconsin's men (77.0 per cent U.S.) and 79.6 per cent of Wisconsin's women (78.5 per cent U.S.) were "private wage and salary workers"; only 11.4 per cent of the men (11.1 per cent U.S.) and 4.0 per cent of the women (4.6 per cent U.S.) were self-employed.

According to their fields of employment, Wisconsin's people outnumber the national average in such occupations as agriculture (Wis. 11.1 per cent; U.S. 6.1 per cent), crafts, and skilled trades, while they number less than the national average for the professions, managerial positions, or clerical and sales workers. According to industries, the percentage of people employed in agriculture as well as in manufacturing is much higher in Wisconsin than nationwide: Agriculture Wisconsin 11.5 per cent, U.S. 6.7 per cent; manufacturing of durable goods Wisconsin 20.7 per cent, U.S. 15.2 per cent; manufacturing of nondurable goods Wisconsin 12.2 per cent, U.S. 11.9 per cent.

Our Most Valuable Resource

In general, when people talk about "natural resources," they think of wildlife and forests, soils and minerals, water, climate, and similar items. All of them are important, but they derive their importance only in relation to their usefulness to man. For man, and for the community of man, man itself is the most important resource. And, in order to keep man's community a going concern, the resource "man" must grow, usually in numbers but also—and more important—in education, skills, capacities and accomplishments.

THE WILDLIFE RESOURCE OF WISCONSIN

Ruth L. Hine

Research and Planning Division, Conservation Department

The wildlife resource is a part of the total natural community of Wisconsin, of which man is only one of the parts. Wildlife, which includes all animals from bears to beetles, has its own "rules" to live by—rules which determine where it lives and how it survives. Knowledge of these principles must underlie any management measures designed to maintain this resource.

Wildlife depends upon the soil and water and plants which compose the landscape. The *number* of wild animals to be found on a parcel of land depends largely upon the amount, availability and quality of cover and food. The *kind* of wild animals that are present depends mainly on the relationship of this food and cover to their preferences and needs.

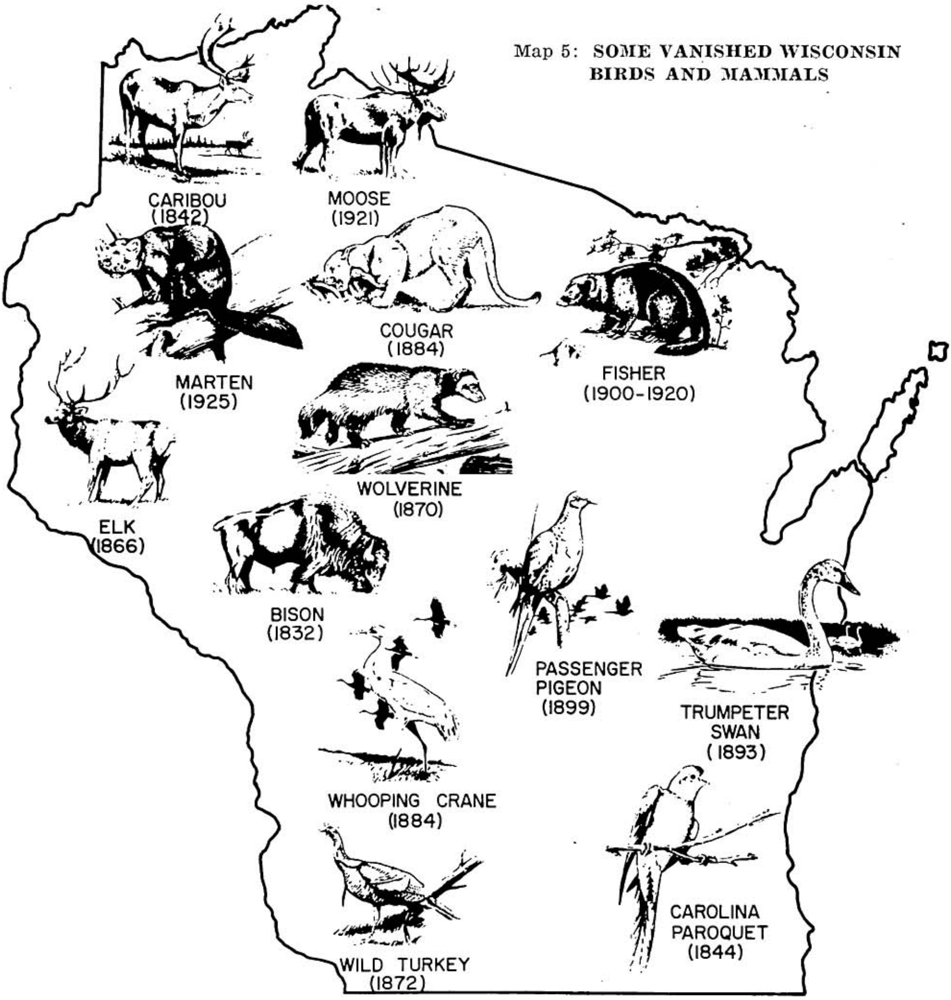
The actions of man on the land, as well as his actions directly on wild animals, become one of the most important considerations in wildlife conservation.

Wildlife History

Wildlife has always been abundant in Wisconsin—it was 100 years ago, it is still today. But there have been changes. When the white man came into our state with the trap and rifle, the ax, plow and cow, he changed the landscape, and knowingly or unknowingly, he changed the wildlife community.

Some wildlife animals took a loss. The buffalo and passenger pigeon which must live as wandering hordes or not at all, were incompatible with settlement and disappeared altogether. The marten, fisher and wolverine yielded to the fur trapper and the changes in forest cover. The wild turkey and paroquet could not retreat—climate cut them off to the north, lack of timber to the west. Some species, like the sharptail and ruffed grouse lost out in the south because of overgrazing by cattle and clean farming, but are still found elsewhere in the state. Waterfowl have been much reduced but could have remained abundant except for overshooting, especially in the early days, and excessive marsh drainage. Hawks and owls and fish-eating birds are still being persecuted in some areas because they eat some game and poultry.

Although some animals became extinct and some retreated, others increased in number. Prairie chickens, quail and cottontails, for example, thrived in the newly created farm land in the southern part of the state which became rich in food, but now all have decreased with intensive cultivation. Prairie chickens have shrunk into a last foothold in the artificial "prairie" of the central Wisconsin marsh country. Deer and beaver were temporarily reduced by overharvesting and were forced out of the south by cultivation. Later they thrived with protection in the northern forests which had been opened up by logging.



Map 5: **SOME VANISHED WISCONSIN BIRDS AND MAMMALS**

Man has introduced many animals into the Wisconsin scene and some have come in of their own accord, such as the coyote and spotted skunk. Some of these have been exotics—"foreigners" brought into the state as substitutes for native species. Others have been native animals reintroduced into Wisconsin. Repeated stocking attempts have been made with most of these animals. Occasionally the spark kindled and the species was successful in gaining a toe-hold; more often the species was not able to adapt to Wisconsin conditions and died out.

These changes in the wildlife community which have taken place have left Wisconsin with about the same number of total species but less big game animals and more kinds of fish and smaller birds. The numbers of some deep forest species have decreased, but many forest edge and farm game animals have increased, favored by the "opening up" of the country by settlement. The future of wildlife animals, however, depends now on the integration of their management with land-use practices.

As far as is known, there are no records of any well-known fish becoming extinct. However, some fish such as brook trout have lost their native home in entire regions of the state because of siltation, pollution and loss of water quality due to changes in cover and land use. Fish are more adaptable to unfavorable conditions than are game birds and mammals. Since there is much scattered habitat in the waters of this state which is not apt to be uniformly destroyed, it is less likely that many fish species will disappear completely.

There are several species, some residents, some visitors, which are losing out in our state because their habitat is being destroyed or their small numbers are being reduced by man or other predators or other factors. Of particular interest are: timber wolf, Canada lynx, white-fronted goose, spruce grouse, prairie chicken, sharp-tailed grouse, duck hawk, whooping crane, long-billed curlew, Hudsonian curlew, and lake trout.

Man and the Land

There are many things that man does to make a living which are unfavorable to wildlife populations. Often they are done too intensively, carelessly, mistakenly or even unnecessarily. For example, streambanks, unprotected and trampled by cattle, quickly gully and erode turning a clear stream into a muddy flow; cows grazing on a hillside thin out the grass allowing the soil to wash down into the fields below; complete removal of brushy cover along roadsides wipes out valuable habitat for upland game, songbirds and pollinating insects and takes away some of the charm of a "country road"; cows grazing in a woodland eliminate wildlife food and cover and cause the eventual death of the woodland; drainage eliminates the marsh homes of waterfowl and muskrats and the sedge and grass cover around marsh edges used for nesting by pheasants; wastes dumped into water areas quickly snuff out the lives of fish and the small water animals.

To combat some of these changes brought about by man's activities, special land-use programs are often needed or many wildlife resources would be lost. There are many ways too in which man's use of land and water resources can be modified to increase wildlife by maintaining a natural "balance" of basic requirements or by restoring missing parts of an animal's habitat. Fish and game are products, not "by-products", of our lands and waters. Therefore specific practices must usually be incorporated into land-and-water-use programs to develop and maintain favorable living conditions, the key to the existence of wildlife resources. Such practices can be designed so that they do not "detract" from agricultural or forestry objectives, but rather contribute to the whole picture of good land use. Examples of practices and conditions which can frequently spell the difference between the abundance or scarcity of wildlife are: strip cropping, sod waterways, field hedges and borders, windbreaks, gully and odd-area plantings, woodlot fencing, woodland borders, selective cutting and hillside plantings.

In the future, water resources will be in demand for many uses. Aquatic wildlife such as fish, waterfowl and furbearing mammals should always have proper consideration along with other uses of water in the public interest. Water uses often make radical changes in the quantity or quality of water or its depth or speed of movement and these changes can greatly affect the wildlife depending on the water.

A change in water level to increase the water available for hydro-electric power production would probably change the food plants and fish life of the water area. Likewise bass or trout living in the fast "whitewater" of a stream would probably be lost if a dam turned their home into a flowage. Generally wildlife responds best to water levels which are more or less constant and which can be controlled. Reservoirs subject to great fluctuations of water levels could possibly be improved for wildlife with study and careful planning for multiple water use, especially for some fishery production.

The Conservation Department, along with other agencies, is working toward the preservation of marshes and other small wetland areas needed for waterfowl nesting, feeding and resting. Similar co-operation is aimed at the improvement of streams through the stabilization of banks and installation of various devices to create deep holes and fast water as well as the removal of all the fish in a lake and replacement with more desirable kinds.

The maintenance of nonpolluted waters is essential in adequate quantities for preservation of wildlife populations and their potential recreational opportunities on public waters.

To provide special places for public recreation, areas are bought or leased by the state—chosen for particular scenic, fish, forest or wildlife values: 41 state parks and forests, over 250 hunting and fishing grounds, over 100 game refuges and wildlife sanctuaries, scientific areas and special management areas for various wildlife species.

Wisconsin has an abundance of lakes and streams, but private property development surrounding many restrict their use. In key areas, the Conservation Department is working with town and county governments to provide for public access. Also more attention is being paid to the maintenance of rights-of-way in order to insure traffic safety, protect against erosion of the soil, beautify the landscape, and provide valuable wildlife cover.

Public Responsibilities

Who is in charge of managing wildlife resources and how much are they responsible for? The answer lies in teamwork between the professional conservationist and each and every citizen or groups of citizens.

The professional conservationist—whether he is a soils technician, wildlife researcher, fish manager, forester or law enforcement officer—is charged primarily with the management that is constantly required to keep our natural resources in the best condition. Nature needs an assist from man in this day and age when we are changing the landscape so drastically (by, for example, fires, erosion and pollution, as well as from such man-made changes as suburban development and highway construction).

Conservation technicians have made great strides in managing individual resources (such as wildlife or forests) on public lands, and in advising private landowners in how best to care for their own lands. The greatest breakthrough in recent years, however, has been the

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Work projects such as building a fish shelter or improving a stream can provide many hours of fun and recreation as well as a real contribution to the conservation effort.

increased co-operation between different federal, state and local government agencies. By pooling knowledge and ideas, these agencies are tackling many controversial problems and coming up with plans for the *multiple use of lands* by very different, and sometimes conflicting, interests. For example, several agencies representing fish and game, agriculture, highways and soil and water interests have worked closely together on watershed problems, weed control and brush management along highways, and the use of pesticides and their relation to wildlife.

However, the "professionals" can do only a limited amount of resource management, for it is a big and expensive job. Thé rest is up to each citizen. Conservation is everybody's business. Those who are concerned with outdoor recreation, fishermen, hunters, bird-lovers, insect-collectors, hikers, picnickers, photographers, even the businessman and housewife all play their part directly or indirectly in the conservation effort. This is why conservation becomes a way of life. It is not something we can put on and take off on week ends or use only during our 2-week vacation each year.

There are 3 main things that the average citizen can do: Develop an awareness and understanding of the outdoors and of the problems which concern our natural resources; support the programs of conservation agencies and good conservation legislation; and participate in the conservation effort either through moral support, money or active work on a community project or in a conservation club.

Above all, an essential ingredient of the conservation effort is what the late Aldo Leopold called an "ecological conscience." We must extend our social conscience from people to the land. "The practice of conservation," Leopold says, "must spring from a conviction of what is ethically and esthetically right, as well as what is economically expedient. A thing is right only when it tends to preserve the integrity, stability, and beauty of the community, and the community includes the soil, waters, fauna, and flora, as well as people . . . The direction is clear, and the first step is to throw your weight around on matters of right and wrong in land use. Cease being intimidated by the argument that a right action is impossible because it does not yield maximum profits, or that a wrong action is to be condoned because it pays. That philosophy is dead in human relations, and its funeral in land relations is overdue."

This is the challenge for the lay worker and the professional conservationist. Everyone must learn to know what is right for the land—and do it, through individual efforts plus support of those promoting a good sound conservation program.

Animal and Plant Communities

The large number of animals that live in Wisconsin are not scattered "helter-skelter" about the landscape. Rather, various animals live together in communities, and the members of a particular community are dependent upon each other. Presented here are some of the relations of wildlife to their surroundings and to each other—how an animal "behaves", how it reacts to changes in its environment, and how it responds to management governed by these relationships.

The Numbers of Animals

The numbers, or densities, of animals vary from place to place. It is amazing how many animals can be found in a limited area, say an acre of land or water, or a square mile of countryside. And when these figures are expanded to an area the size of the state, the total number of animals is almost unbelievable. Of course we are not usually able to count the number of animals over the entire state, but we often count the numbers in sample areas, and this gives us an idea of how many there really are.

In general the smaller the animals, the more there are in a given area. For example, on an acre of land (about the size of a football field), there may be over a million land invertebrates, around 50 field mice, and 2 or 3 cottontail rabbits.

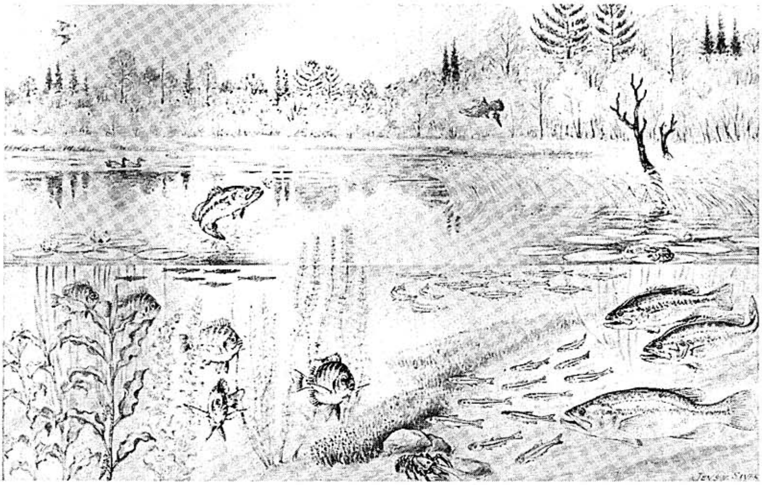
Community Living

In any piece of country, a woodland, prairie or a lake for example, there may be different combinations of mammals, birds, fish, reptiles, amphibians and many of the lower animals. But in each area there is a great deal of order, and directly or indirectly all the animals and plants depend upon each other for their existence.

These groupings of plants and animals in different areas are called communities—just as groups of people live together in small-town or city communities, depending on each other. The study of natural communities is known as the science of *ecology*.

The basis for some of the most important relationships in any natural community is food. Animals can be classified according to the types of diet they have. Some are mostly plant-eaters (for example, deer, field mice, ruffed grouse) and some are mostly flesh-eaters (for example, foxes, skunks, hawks and northern pike). All the animals in a community are in one way or another related to each other through their food. Each kind of animal feeds on some other living organism, plant or animal. And in turn, each kind of animal is fed on by some other animal.

Animals and the food they eat can be arranged in a diagram which the ecologist calls a "food chain". For example, a red fox feeds upon a cottontail rabbit which in turn feeds upon a shrub. Or a horned owl may feed upon a quail (or a rabbit) which feeds upon a grasshopper which in turn feeds on grass. Food chains can also be constructed for communities in lakes or streams. The important starting points are aquatic plants—the tiny, one-celled plants called algae which are commonly called "pond scum", and water weeds which sometimes form large beds in lakes. These are eaten by small plant-eating invertebrates that live in the water. These invertebrates are eaten by minnows and other small fish which, in turn, are eaten by the large



Just as humans form communities and "live together" and depend on each other for food, protection, services, and recreation, so certain groups of plants and animals live together for essentially the same reasons.

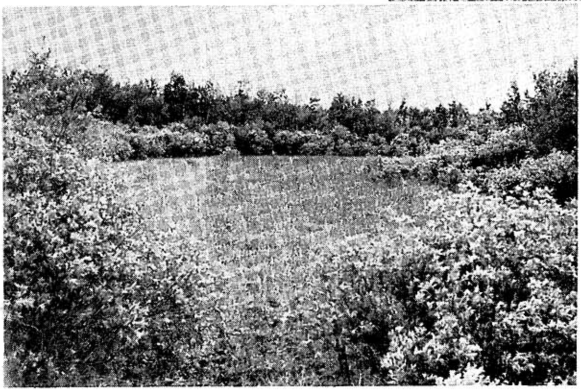
predatory fish. The guiding principle of food chains is that the meat-eating animals are dependent upon the plant-eating animals which in turn eat plants for their food and energy.

If all the plants in an area were placed in a large box and all plant-eating animals in the same area placed in another box on top of it, and a third box on top of this contained all the meat-eating animals of the area, we would have a sort of pyramid, for each box would be successively smaller. Among ecologists this way of diagramming the picture of a community is known as a "pyramid of energy." Since each layer of animals feeds on the layer below it in the pyramid, this must mean that there is always enough plant life to feed the plant-eating animals, and always enough plant-eating animals to feed the meat-eating animals.

This arrangement does not ordinarily get too upset in nature because of a system of checks and balances. The plant-eating animals do not usually exceed the plants, or the meat-eating animals exceed the plant-eaters, at least for very long, because they are checked either by the animals higher in the pyramid that eat them or by disease, starvation and competition among themselves for food and living space or both.

Deer in northern Wisconsin are a good example of this. Wolves used to help keep the numbers of deer in check. As deer increased after logging and as the wolves were killed off, the deer in many areas actually became "top heavy" and ate up the plants which were available to them for food. This is why, in hard winters, there is starvation of deer.

An open pothole left undisturbed . . .



. . . over a number of years, will become a shrubby marsh.

The Changing Community

An open grassy field may become a forest. A lake may become a marsh, then a grassy field and eventually a forest. This will take place naturally, without any help from man. This series of changes, or steps that a plant community goes through over a period of years, is called plant succession. Since changes in animal life are largely influenced by changes in plant life, the animal community also undergoes succession.

Succession is going on continuously, and starting with fresh bare soil in southern Wisconsin, these are the stages of plant growth which would occur over many years: Fast growing weeds such as ragweed and smartweed; grasses; shrubs; oak trees.

In most of Wisconsin the grasses and perennial plants which take over from the weeds are replaced by a variety of shrubs and these in turn by young trees and then a mature forest. Forests are the climax or final stage of vegetation growth in most of Wisconsin—oak and hickory woods in southern Wisconsin, and a mixture of maple, yellow birch, and hemlock in the north.

A body of water also undergoes succession and a pothole or lake will gradually fill in with plants until it becomes a marsh and eventually a woodland.

Any sort of disturbance will set back the natural succession. Continued disturbance may keep an area at one stage (e.g. repeated fire will keep a field in grass instead of allowing the shrubs to take over). Without disturbance an area will gradually go through the stages leading to the climax vegetation.

Since most animals have very specific food and cover requirements, they become adjusted to a fixed pattern of life in a restricted and well-defined type of vegetation. Each kind of animal has slightly different needs and most kinds cannot thrive in other vegetative types. Therefore plant succession on a given area can affect the animal life on that area. If an area has been disturbed and the succession set back to the earliest stages, the only animals that can live there are those adjusted to that particular plant community. As the succession advances into later stages, most of the early stage forms can no longer survive and they give way to animals better adjusted to life in the new stage.

A prime example of animal succession involves 4 northern Wisconsin game birds. The prairie chicken is a bird of wide open grass-covered country. The sharp-tailed grouse likes a mixture of open land, brush and young forest growth. The ruffed grouse or partridge likes mostly wooded country but preferably young woods with some brushy undergrowth. The spruce grouse is a bird of mature (climax) forest.

Animal Production

Nature has provided every animal with a terrific capacity for producing more of its own kind. If there were no influences preventing this increase, animals would soon fill the earth to overflowing. The reason this does not happen is that there are "limiting factors" which hold down an unlimited increase in numbers and keep a population within reasonable bounds. Weather, disease and parasites, predation, accidents, availability of suitable places to live and breed, and availability of food are examples of some limiting factors.

Therefore the life of every animal boils down to a struggle between their breeding rate and the limiting factors of the environment. If we want to increase some desirable fish or game animal we must study the environment and find out what aspects of it are limiting and see if one or more limiting factors can be eased so that there can be a higher production of the animals desired. Or if the problem is one of too many, as in the case of an insect pest, we must learn what must be added to the environment so that the limiting factors may operate more efficiently in reducing the numbers of the pest.

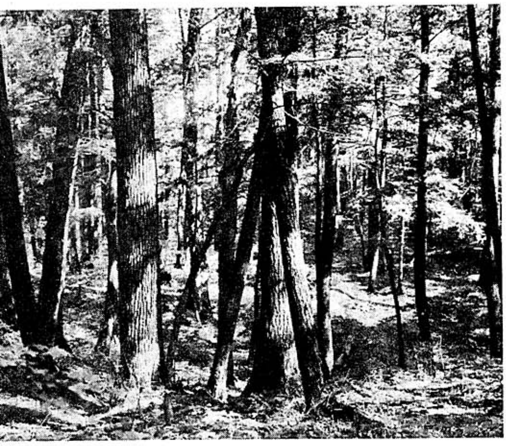
Some common habitat types for Wisconsin wildlife

Wetland areas are essential for waterfowl, furbearers and other aquatic animals.

Farm game thrive where there is good food with nesting and roosting cover nearby.

Brushy roadside cover provides excellent hide-outs and travel lanes for game and songbirds.

A deep forest of virgin timber, with its sparse "floor covering" of herbs and shrubs, attracts relatively few animals . . .



. . . while younger, more open woods with plenty of food producing plants harbor a wide variety of wildlife.

Animal Habitat

Habitat is that part of a landscape in which an animal lives. It provides the necessary food and water, shelter from the elements and enemies, and places to loaf and breed that the animal requires to meet its living needs and reproduce its own kind. Without suitable habitat the animal cannot survive and disappears.

The better the quality of the habitat, the more animals it can carry. When there are no animals of some type in a given area, something is lacking causing the habitat to be unsuitable.

Wildlife Portraits

The animal world is made up of an almost unbelievable variety of kinds, sizes and shapes of creatures. They live in the air, on land, in woods, prairie, forests, in the soil and in water. Streams and lakes are full of animal life of many kinds besides fish.

In Wisconsin animals range in size from those so tiny they can only be seen with the microscope to a black bear which may tip the scales at 600 pounds. The largest and most complicated animals, and the ones most familiar to us, are the *vertebrates,* the ones that have a skeleton with a backbone. These include mammals, birds, reptiles, amphibians and fish. But outnumbering the vertebrates are a vast group known as the *invertebrates,* or animals without backbones. Some of these are the sponges, snails and clams, worms, crayfish and insects, and microscopic single-celled forms.

Mammals

Since the coming of white man, with his curiosity about the animals and plants around him, 78 species of mammals have been recorded within the boundaries of Wisconsin. But his coming spelled doom for 8 mammal species, for habitat destruction and overhunting has extirpated the elk, moose, woodland caribou, bison, wolverine, marten, fisher and cougar. The magnificent timber wolf and the Canada lynx are close to extinction within the state.

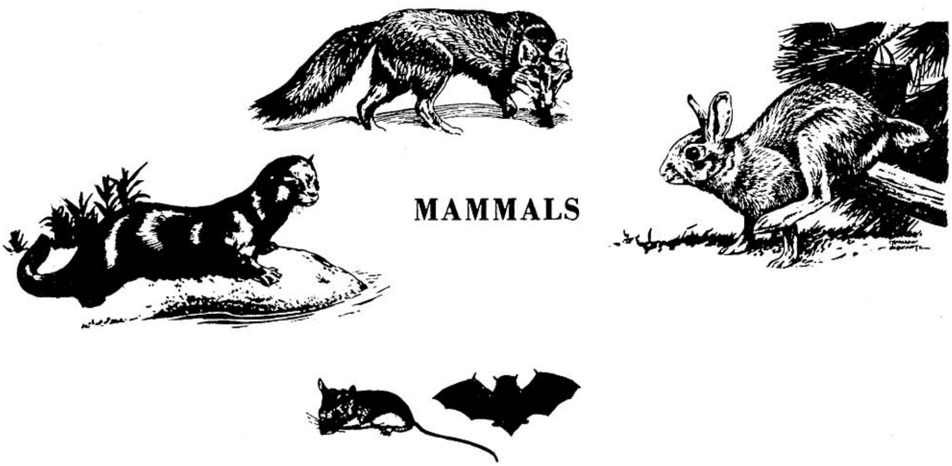
Mammals are those animals that are covered by hair and that suckle their young, giving them nourishment with milk from the mother's body. These are the creatures that many people call "animals" in contrast to birds, reptiles, etc. Actually, every living organism that is not a plant is an animal, hence animals are divided into many classes of which mammals are only one class.

The vast majority of kinds of mammals still found in Wisconsin are present in good numbers. But unlike the birds, mammals are much more difficult to observe in the wild state, since they are very secretive and most of them prefer to be about in the twilight hours or after dark.

Mammals are important to many of us. The game species furnish sport and meat to the hunter, furbearers provide sport and remuneration to the trapper, nongame species supply food for many more valuable animals and most all mammals give many pleasant "observation hours" to nature enthusiasts. Some mammals, especially the smaller rodents, cause millions of dollars worth of damage yearly, while others such as bats, shrews and moles are very beneficial, since they feed primarily upon insects.

Game mammals. Game mammals are those mammals that are hunted usually for their flesh rather than their pelts and include relatively few but very important, species from the small squirrel to the large white-tailed deer and the giant black bear. All of the game mammals are resident the year round in Wisconsin, and are hunted during open seasons in the fall of the year.

Game mammals in Wisconsin: White-tailed deer, black bear, cottontail, jackrabbit, snowshoe hare, gray and fox squirrel.



MAMMALS

Furbearers. The furbearing mammals, especially the beaver, were the great attractions to the very first explorers and trappers that entered Wisconsin. This early fur trade opened up the frontier much faster than it would have been opened by any other endeavor. In pioneer times, trappers took thousands of furs annually in Wisconsin and currently the modern trappers are doing the same thing. Muskrats and mink bring hundreds of thousands of dollars to the trappers in Wisconsin each year and the beaver still plays an important role, bringing in well over $100,000.

Trapping is as much a sport to many as is hunting, and is a part of the American tradition. It is also a necessary tool of good wildlife management, for it helps hold down populations that would otherwise increase to the point of self-extermination by starvation and disease. This would be a great waste and would be much more cruel to many more individual animals than trapping is.

Two furbearers once native to Wisconsin and then extirpated have been reintroduced into the state: The marten, introduced on Stockton

Island in 1953 and the fisher, introduced into the Nicolet National Forest in 1956. At least the fisher seems to be holding its own and time will tell whether or not this animal will again be a permanent part of our fauna.

Furbearers in Wisconsin: Muskrat, beaver, raccoon, red fox, gray fox, timber wolf, coyote, bobcat, Canada lynx, skunk, badger, weasel, mink, otter, opossum.

Nongame mammals. The nongame mammals are generally the smaller species that are not sought for their sporting qualities, meat or pelts. Many of them such as the insect-eating bats and the shrews are very beneficial while others such as many species of mice are decidedly destructive to farm crops and properties.

Some are quite interesting in their habits and very pretty in appearance. The world of nature would be much less interesting if it were not for these little creatures!

Many millions of these small mammals are eaten by other more important animals in Wisconsin each year and indeed form the basic food for many of the larger species. Since many larger animals are typical predators, they would prey much more on our important game species if it were not for the abundance of these smaller mammals. They absorb the "shock" of the predators and are therefore called "buffer" species.

Typical groups of nongame mammals in Wisconsin: Porcupines, bats, chipmunks, ground squirrels, flying squirrels, red squirrels, moles and shrews, voles and mice, pocket gophers.

(The common house mouse and the Norway rat are not native mammals, but are introduced or exotic species.)

Birds

Birds are valued as creatures of beauty and many have pretty songs which in spring hearten many a winter-weary person.

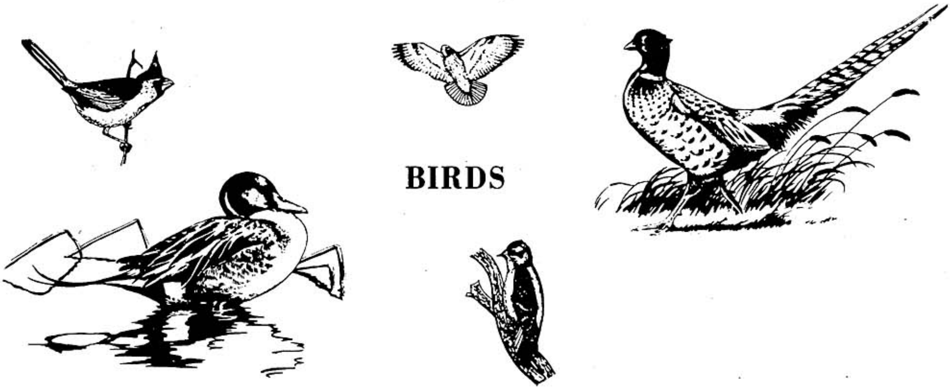
Some 336 species of birds can be found in Wisconsin. Most of them are quite common, a smaller number are rare and yet a smaller number are only occasional visitors.

Birds are wonderfully adapted for flight, with hollow bones and feathers. They are very active and have high blood temperatures. This naturally requires much food daily and there are many birds that will eat almost their body weight in food each day. Some individuals may eat up to 3,000 small insects a day!

Each species of bird, like every other animal or plant, has a certain habitat preference, some tolerating wide variations in habitat and others being unable to tolerate even rather small changes.

Upland game birds. There are 8 kinds of upland game birds in Wisconsin which live in the state the year around: Ruffed grouse, bobwhite quail, sharp-tailed grouse, ring-necked pheasant and Hungarian partridge are hunted; prairie chickens, spruce grouse and wild turkey are now protected. Willow ptarmigan was once recorded for the state.

Upland game birds, along with migratory game birds, bring sport to many hunters and when properly prepared are delicious eating. Since most birds have a very high natural mortality and live only a relatively short time, it is good management to harvest them, for hunting gives one much-needed exercise, mental release from tensions and some good eating.



BIRDS

Waterfowl. Waterfowl migrate varying distances—many breed in Canada, travel through the United States, and winter in the Gulf states, Mexico and points south. Migratory game birds thus become an international problem and hunting regulations must be agreed upon by all countries concerned.

Much effort has been expended in reclaiming nesting grounds in Canada and intensive studies are being undertaken in the Canadian breeding areas to determine just exactly what each duck species needs as far as good quality habitat is concerned.

An effort is being made in Wisconsin to preserve the remaining wetlands and everyone should give this program full support. Artificial flowages have been created on many areas to help migrating and nesting waterfowl. The thousands of beaver ponds that exist in Wisconsin produce many ducks and give feeding and resting areas to many thousands of them during spring and fall migrations.

There are 42 kinds of waterfowl and 6 kinds of shore birds that are hunted in Wisconsin.

Marsh and shore birds. This general group is composed of birds found near water, commonly on shore lines or in the marsh vegetation not far from water. They are well adapted to their particular environments; some wading birds have exceptionally long legs for stalking in deeper water, while other wading birds have relatively short legs for running in the shallows. Many have very long bills for probing into the wet earth for food.

Some typical groups in Wisconsin include: Herons, sandpipers, gulls and terns.

Miscellaneous water birds. A few typically water-loving birds are found in Wisconsin that are migratory but not game birds. They are given protection from hunting since they are not overly abundant but afford much "seeing" pleasure, and most are not good eating. These include: Loons and grebes, cormorants and swans.

Songbirds. This is a very large group of birds which are usually quite colorful (with many absolutely beautiful!) and generally possessing characteristic songs. As contrasted with other general groups of birds, they are usually smaller and are the typical birds of the fields and forests.

Common groups in Wisconsin include: Doves, whippoorwills, kingfishers, woodpeckers, hummingbirds, swallows, wrens, thrushes, warblers, meadowlarks, sparrows.

Birds of prey. These are among our most beneficial birds since their food consists mainly of small mammals, especially rodents. They are powerful for their size and have sharp talons and a strong curved beak designed primarily for tearing flesh. If an occasional hawk or owl becomes a nuisance to farmers by developing a liking for chickens, it should be destroyed. However, wholesale destruction of hawks and owls would be very foolish since in general they do much more good than harm.

Common groups in Wisconsin: Hawks, eagles, owls.

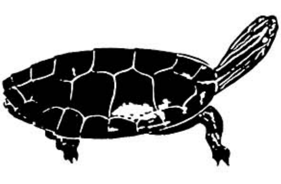
Reptiles and Amphibians

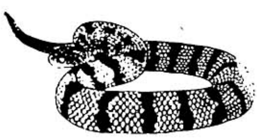
Reptiles. Snakes, lizards and turtles are the representatives of this class of animals in Wisconsin. Generally most species of snakes and lizards prefer land, while most species of turtles prefer water.

Reptiles are important animals, some beneficial, some harmful, especially the poisonous snakes.

A fact of great importance is that we have only 2 species of poisonous snakes in Wisconsin, both rattlesnakes. They occur primarily in southwestern Wisconsin. All of the rest of our snakes are **NOT** poisonous.

There are 40 species and subspecies of reptiles in the state: 23 snakes, 4 lizards and 13 turtles.





REPTILES

AMPHIBIANS

Amphibians. Frogs, toads and salamanders, the common representatives of this class in Wisconsin, have smooth, glistening, moist skins, and bulging eyes. All require habitat types that are wet, such as marshes, swamps, moist woodlands, streams, ponds and potholes.

Most amphibians breed in the water, lay their eggs and spend a larval or tadpole period in the water, then transform into an adult. As adults they live on moist land, returning to water only to breed, escape enemies or keep themselves wet. They are important animals since most feed principally on insects and other invertebrates, and practically every kind of amphibian is eagerly sought by other animals for food.

We have 8 kinds of salamanders, one toad and 11 kinds of frogs, for a total of 20 different kinds of amphibians in Wisconsin. No amphibians have poisonous bites, and *the toad does not cause the handler to grow warts.*

Fish

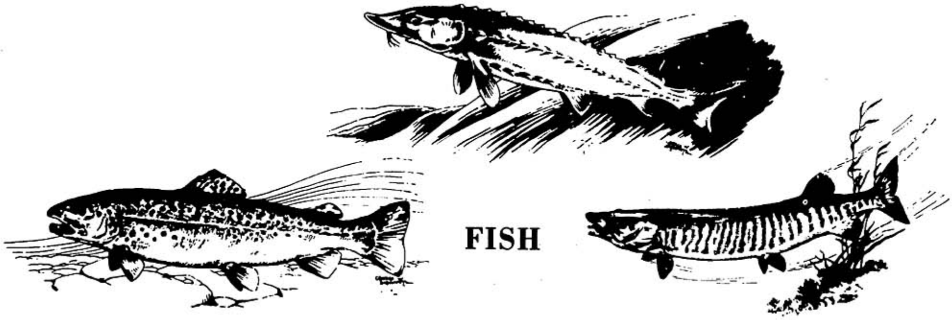
Wisconsin is richly blessed with water—and therefore has many kinds of fish—about 174 different species recorded in the state. The fish populations of lakes and streams form an important source of food. However, the ever-increasing value of recreational fishing has surpassed the food value of most of our fishery resources.

Fish can be grouped in the following categories: Sport or game fish, minnows, rough fish, and commercial fish. The sport fish are species regularly caught by hook and line which have premium recreational values. Some sport fish may also be commercial fish, the perch, catfish, and lake trout falling in this category on the bigger waters. The term "minnows" usually refers to small species which are used mainly for bait. Technically, however, "minnow" is the term applied to a family of fish which lack teeth in their jaws. The carp is a minnow.

"Commercial" fish are species which are abundant, and best caught with nets or other commercial gear. Catfish, carp, cisco, lake chubs, whitefish, smelt, perch, suckers, freshwater drum are all commercial species.

"Rough fish" are species generally regarded as undesirable or detrimental, and their release alive is prohibited by law. Many species legally termed rough fish are commercial species, the carp and drum especially. Predator species of rough fish such as dogfish and garfish are not now regarded as being so detrimental as they were once thought to be.

Typical sport or game fish in Wisconsin include: Muskellunge and northern pike, walleye and sauger, largemouth and smallmouth bass, brook, rainbow and brown trout, panfish, yellow perch, bluegill, lake sturgeon, catfish, bullheads, lake trout.



Other Wisconsin Animals

Besides the hundreds of kinds of vertebrate animals, Wisconsin has many thousands of species or kinds of invertebrate animals—those animals that do not have a backbone.

Invertebrates can be found on every square foot of land and in every cubic foot of water and the number of individuals in the state is beyond comprehension. Since we are "overrun" with such armies of invertebrates of diverse forms and habits, it is very easy to see that they must play a tremendously important role in any biological or ecological community. Invertebrates are particularly significant to man and his interests because they form the basic food for other predaceous species and, therefore, keep these predators from killing larger numbers of animals of importance to man.

Important groups of invertebrates in Wisconsin include: Spiders, insects, crayfish, clams and snails, earthworms and leeches, roundworms and flatworms, fresh-water sponges and one-celled animals.

Research and Management

Conservation means *intelligent use* of our natural resources, not merely preservation or locking them up to "protect" them, or stockpiling so that maybe there will be more some day. In fact, attempts to stockpile most species leads to habitat destruction and waste.

The wildlife conservation effort consists of a charting of the course by research and planning (with constant evaluation to make sure we're on the right course) and the directing and activating of field operations by management and administration, and education.

Management involves the caring for wildlife resources to keep



Other Wisconsin Animals


them healthy and productive at the highest possible level, against high odds—land-use changes and human population pressures. To do this, 5 major management efforts are needed: Inventory, maintenance and security, improvement, restoration and the promotion of proper utilization of the resources.

Much of the "how, when, where and why" of managing wildlife comes from research. By constantly observing, testing, and experimenting, research develops new management measures, and investigates and evaluates practices currently in use. This often involves "deep digging" into habits and characteristics and needs of plants and animals.

Management has the great responsibility of making it possible for research to obtain the necessary knowledge and then putting this into effective programs. This effort requires the experience and ability to receive and transmit research findings into production.

Inventory

A "check list" of our resources is vital to both management and research efforts. Managers need to keep tabs on the ups and downs of fish and game populations each year to watch out for their welfare, and to set proper hunting and fishing seasons. Research also works out and refines methods for making surveys which may involve a simple process of listening, or the construction and use of a complicated electrical gadget.

Population inventories, which are taken every year, consist of 3 steps: Censusing populations to obtain a record of the stock on hand (determine how many animals are present either by actual count or by obtaining a sample of the population); determining production (estimates of how many new animals are being added to the existing population); and finding out how many animals are being lost through harvest and other causes.

Since changes in land-use practices and in natural plant growth affect the use of habitat by fish and game, especially in intensively farmed or forested areas, there must also be constant inventory of food and cover conditions.

Security and Maintenance

Continual inventories not only give estimates of numbers and trends which show population levels from season to season and from year to year, but also point up conditions which may threaten these fish and game populations—for example, overpopulation, competition, disease, and damaging land-use practices. These factors can set back production or harm the welfare of fish and wildlife and thereby reduce the number of animals available for public use.

Research investigates such outside influences and works out ways to secure and maintain good populations of fish and wildlife. This does not mean putting on a padlock, but merely safeguarding these resources against loss, overuse, or abuse.

Some of these factors such as disease may work directly on the animal itself. Others may cause a decrease in total numbers through a depressing effect on breeding. Poor deer range, for example, may in certain areas result in lowered fawn production. Still others may act in a very roundabout way. Nevertheless, the job is to find those influences or factors which can be *controlled* or *managed.* Some of course, such as weather, cannot be controlled directly, but others such as overpopulation can be taken care of through proper harvest; or through prevention of damaging land-use practices, by some modification to adapt the practice where possible to the needs of fish or game.

Improvement

The improvement of conditions for better production and growth of a good crop is another goal of the resource manager.

A knowledge of age ratios or of disease prevention will not produce one more pheasant or rabbit or deer or walleye unless there is a place for them to live—to feed, hide, rest, sleep, play and breed. Wildlife is a product of the lands and waters—dependent upon them for food and cover.

Habitat improvement consists of bettering the habitat to sustain or increase fish and game populations. This sometimes involves providing missing elements of habitat or the removal of undesirable elements. Above all it requires a co-ordination of specific management practices with the general patterns of land use.

To accomplish effective habitat management, resource managers must know what the needs of fish and wildlife are in relation to what kind of habitat is preferred and what is happening to it—as a result of both natural and man-made changes. They must also know what can be done, and must finally evaluate conditions following habitat improvement—is the population better off "after" than "before"?

Restoration

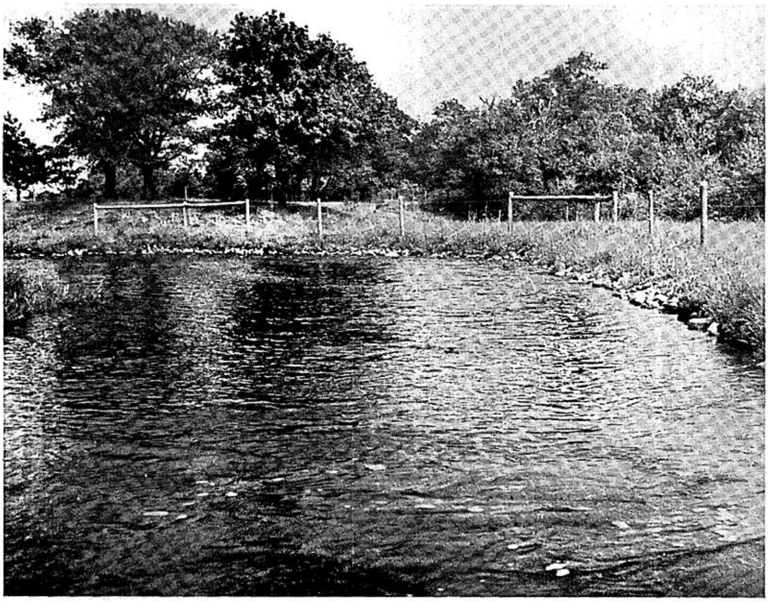
Although most of our fish and game resources are produced in the wild, these natural populations are often supplemented with artificially propagated stock. This is done to increase existing populations of certain species of fish or game to give some immediate (but short-lived) benefits to sportsmen, or to restore some species which were once native in Wisconsin.

In many research studies, fish and game animals are caught, weighed, measured, examined for parasites, marked, and released. This provides valuable information on their condition, movement, and habitat preference.

One phase of the restoration effort is to raise healthy and vigorous stock to release. Another is determining whether stocking fish and game animals is doing enough good to be worth the money. Regardless of how high the returns on stocked animals are, researchers have found that the wild-reared pheasant and trout still produce the bulk of the harvest each year. Good pheasant hunting or trout fishing comes from thriving wild populations in good habitat. This can be padded a bit with a large stocking operation, but if the native birds or fish aren't there to start with, we can never afford to raise enough in pens or raceways to make good sport. Under no circumstances can stocking be a substitute for long-term habitat development and management.

Utilization

The Conservation Department's goal is to provide a continuing supply of wildlife and the means for best using this resource by many varied interests. There are first of all the recreational users: The hiker, camper, birdwatcher, hunter, fisherman—an increasing mass of



This stream, after habitat improvement, has protected streambanks, faster flowing water, deeper holes — and many more trout!

people seeking all kinds of outdoor enjoyment. There are also commercial users: The private landowner or industry desiring wood products, the licensed game and fish farm or shooting preserve, and the commercial fisherman.

The department helps to promote maximum use by the greatest number of people—watching out at the same time for the welfare of both the resource and the user. In addition to encouraging good land and water use throughout the state in co-operation with other agencies, the Conservation Department provides many special places for public recreation, including state parks and forests and public hunting and fishing grounds, and areas which will provide access to public lands and waters. Under certain conditions managed hunting (limiting the number of hunters) insures a suitable harvest where otherwise there would be closed seasons or overshooting, and shooting preserves, licensed game, fur and fish farms offer special opportunities for the development and use of private lands.

So far as the use of the fish and game crop by sportsmen is concerned, the question from management is how to make the most satisfactory and equitable harvest. In all cases, we are concerned with regulations which will assure a sustained yield and the best recreational opportunities. For example, the removal of restrictions on panfishing means more fish in the creel, with no harm to the fish population, while careful regulation of the harvest of sturgeon is necessary to protect these huge fish from overfishing.

THE FOREST RESOURCE OF WISCONSIN

Louis A. Haertle

Forest Management Division, Conservation Department

The Past. Wisconsin forests originally covered 30 million acres of the approximately 35 million total land area of the state, and were estimated to scale more than 200 billion board feet. Natural prairies or grassland occurred in the southern part of the state, and there were several extensive areas of sedge marsh, mostly in central Wisconsin.

Much of this valuable resource has been wasted. To the land-clearing pioneer farmers, trees were an obstacle in the planting of crops. Having once cleared most of his land for farming, he continued to use the remaining trees for firewood and for other purposes without ever a thought of replanting what he had cut. Then, after the Civil War, came the era of the lumber barons, transforming much of the northern part of the state into a cut-over wasteland. Like the farmers before them, the lumber interests of the 1890's never made any effort to replenish what then appeared an inexhaustible resource.

The Present. Today, our attitude toward forests has changed. We are conscious of their value. We protect against forest fires. The Forest Crop Law, in operation since 1927, has created a tax climate favorable to sustained yield management by private and public owners of forest land. There has been extensive reforestation of what was once cut-over land or submarginal farmland. The frontier of agricultural settlement has ceased to advance and forestry has become an accepted form of land use, which has been reinforced by rural zoning ordinances (of the forestry-recreation type) in northern and central counties. The establishment of effective control of forest fires and an equitable system of forest taxation have removed the 2 traditional obstacles to private forestry. The original forest of pine is gone except for a few outdoor museum pieces; but several large tracts of northern hardwoods have been perpetuated by selective cutting. There is less uneconomical grazing of farm woodlands, which was the most harmful practice in these stands.

In cubic foot volume, the stage has been reached where the annual cut is now below annual increment and even below the allowable cut. This is true for the hardwoods and saw timbers. For the softwoods, though annual growth and cut are nearly in balance, the actual cut exceeds the allowable cut. This latter fact explains why forest planting is almost 100 per cent conifers.

The Future. Thus, the hope for a more adequate growing stock of conifers lies in the plantations. It is safe to assume that these plantations will receive better management than was accorded the natural stands. It is the nature of man to give better care to his own plantings than to the free gift of nature. The record of early financial returns from periodic thinnings at Star Lake demonstrates the greater income which can be gained from good practices as opposed to premature clear cutting, and should serve as an incentive to better management of the increasing acreage of young plantations.

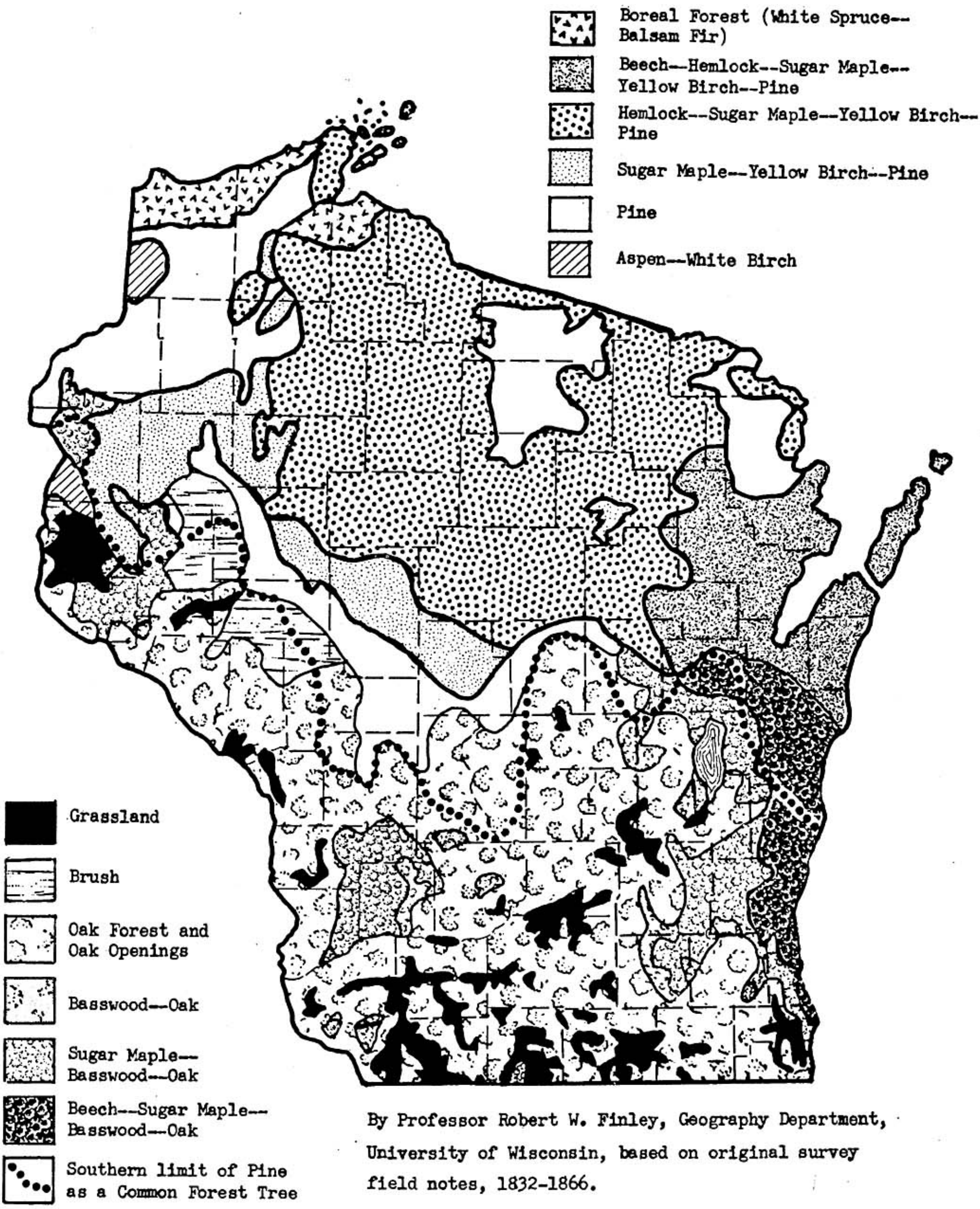
Soil, climate, and markets are favorable to the growing of forest products in Wisconsin, and the acreage of forest land is still enormous, though far from full productivity. It is too late to speak of conserving our forests; rather it is a case of building up the forest growing stock in both volume and quality, with the goal of a high and sustained annual yield. The public benefits which managed forests contribute as extra dividends, regardless of whether they are in public or private ownership, are of great value. They include water conservation and stabilization of stream flow through increased ground water storage, prevention of soil erosion, a more attractive area for recreation, better habitat for forest game species, clear running streams for trout. Foresters have cited these values in advocating better forestry as the concept of multiple use. But foresters know that they, like the farmer, will be judged by the harvest. The forests must produce a full crop of timber to provide jobs in the woods and mills, to sustain and enrich the economy of Wisconsin.

Forest Exploitation

The forests of Wisconsin must be credited with a major contribution to the development of the state. While traffic in furs opened the first trade routes, it brought only small and scattered settlements. Later the pioneer farmers, though they found trees an obstacle in clearing land, nevertheless drew on the forests for the timber to build their homes, barns and first crude implements. They never felt the lack of fuel which confronted the settlers on the prairies. From the beginning, the forests provided some cash income. In the lake shore counties, choice logs, cut in land clearing, were burned and the ashes leached for potash, which could be sold. Fuel wood found a limited market in the newly developing cities and brought some cash income, even though the price represented only the labor of cutting and hauling. Wood was used to fire the kilns for burning lime or bricks.

Plank Roads. During the era of wheat production in Wisconsin, plank roads of 3-inch oak planks were built westward from the lower Lake Michigan ports so that the wheat could be hauled to the grain elevators and loaded on ships. State Highway 23 still largely follows the location of the plank road between Sheboygan and Fond du Lac, with the old Wade House at Greenbush as a survivor of the inns which provided food and shelter for the stage coach traveler. For several decades, shipyards on the lower lake ports turned Wisconsin timber into sturdy schooner-rigged ships, which sailed the Great Lakes carrying freight and passengers, including many of our first settlers who came via the Great Lakes. With the coming of the first railroads, there was ample timber for ties, for bridges, and for fuel, since the first locomotives were wood-burners. Meanwhile the oak-clad hills along the Mississippi were supplying the fuel wood for the river steamboats.

Map 5: **ORIGINAL VEGETATION COVER**



By Professor Robert W. Finley, Geography Department, University of Wisconsin, based on original survey field notes, 1832-1866.

Sawmills. The first sawmill in Wisconsin is said to have been built on the Fox River at De Pere in 1809; the British did not yield this territory until after the War of 1812. A sawmill on the Wisconsin River was built above Portage in 1831-1832. Another sawmill was built in Sheboygan in 1835. By 1860, there were 40 sawmills in Sheboygan, Manitowoc and Kewaunee Counties, most of the lumber going by boat to the fast growing cities of Milwaukee and Chicago. The assault on the northern forests of white pine began after the Civil War. Sawmills were built farther up on the Wisconsin River and the lumber piled into "cribs," strings of which constituted "brails" and these in turn combined to make rafts. These had to be broken up and the brails run through the rapids at certain points, notably the Little Bull at Mosinee and at the Dells. Thereafter the rafts had no obstructions, except sandbars, all the way to St. Louis. The wealth of pine floated down the Wisconsin, the Black, the Chippewa and the St. Croix into the Mississippi, provided the settlers on the treeless western prairies with an abundance of cheap, but excellent, building material.

Log jams sometimes filled a river for miles. Breaking a log jam such as this was tricky business.

In the heyday of old-time logging, really big loads were hauled by teams of horses over carefully laid out roads.

Meanwhile logs were coming down the Menominee, the Peshtigo and the Oconto to provide raw material for the mills shipping lumber to the ports on the Great Lakes. The choice pine of the Wolf and the Embarrass made Oshkosh the "Sawdust City," where one plant turned out 15,000 doors a day. Sheboygan for over a half-century was noted for the manufacture of chairs. By 1870, Wisconsin sawmills were producing more than a billion board feet of lumber annually, but that was not fast enough. Steam replaced waterpower, bigger and faster mills with band saws were built, "shotgun feed" drove the carriage, and the first steam mechanism for turning logs was installed in a mill at Marinette. Transport by logging railroads superseded the sleigh haul and the river drive. By 1899, Wisconsin was sawing 3-1/3 billion board feet annually and leading the world in lumber production.

The Cutover. The wealth of timber attracted railroads seeking the tonnage of freight which the sawmills were producing. The forests built the cities and the transportation system of northern Wisconsin. The so-called inexhaustible forests, which assertedly were sufficient to supply the world for a hundred years almost disappeared in half that time. In 1898, Roth (Bulletin No. 1, *Wisconsin Geological and Natural History Survey,* 1898) in reporting on the northern forest, stated:

> *"The pine has disappeared from most of the mixed forests and the greater portion of pineries proper has been cut. There is to-day hardly a township in this large*

> *area where no logging has been done. In addition to this, the fires, following all logging operations or starting on new clearings of the settler, have done much to change these woods. Nearly half of this territory has been burned over at least once: about 3 million acres are without any forest cover whatever, and several million acres more are but partly covered by the dead and dying remnants of the former forest."*

Yet he found more than 17 billion board feet of pine, 11 billion of hemlock and 16 billion of hardwoods still remaining. There were also 1,200,000 cords of spruce and 800,000 cords of balsam pulpwood.

The trend in production of lumber by Wisconsin sawmills is a good index of the depletion of our virgin forest.

Production. Lumber production in Wisconsin climbed swiftly following the Civil War and reached a peak about 1899. As the old-growth timber was cut over a rapid decline followed, with the lowest point reached in 1932. In the last decade lumber production has been around 350,000,000 board feet annually.

The production by species groups shows varying trends. Softwood production, once the backbone of the lumbering industry, has declined from about 209 million board feet in 1936 to 78 million board feet in 1956. A slight increase in the sawing of hardwoods helped sustain the total lumber production. Even though hardwoods have partly replaced softwoods in lumber output, the 2 are not interchangeable in use. The decline in softwood lumber output has resulted in increased imports of softwood lumber from southern and western states.

The Present Resource

The decline of the annual lumber cut does not mean that the forests as a resource are virtually gone. The scene has changed. The major shift in timber cut has been from sawlogs to pulpwood. Lumber and veneer industries, although still large, consume less Wisconsin wood than do pulp mills. Wisconsin timber markets are strong and demand more timber than is harvested in the state. Much of the wood used by Wisconsin forest industries is imported from other states and Canada. The last mile of logging railroad has been pulled up and trucks have replaced the logging locomotive, which set so many forest fires. The last real logging camp, the temporary home of the wandering lumberjack, is gone and woods workers now drive automobiles to their jobs and return home at night. The epic days have passed, but the change is for the better.

An inventory of forest acreage and timber volumes by species and size classes, as of June 1958, was published in 1961 by the Lake States Forest Experiment Station. It showed that Wisconsin, even though a great industrial and agricultural state, is still 45 per cent forested.

Wisconsin's land area totals about 35 million acres. Of every 100 acres, 44 are commercial forest land capable of producing crops of industrial wood. In addition to 15.4 million acres of commercial forest, there are about 200,000 acres (one per cent) of noncommercial forest. This land, either in parks, reserves, or inherently unproductive, adds substantially to the wildlife and recreational resources of the state. The term "north woods" aptly describes the distribution of much of the forests—61 per cent of the forest land is in the northern portion of the state where most of the timber is now harvested. Nevertheless, over 6 million acres of commercial forest area are distributed throughout the central and southern parts of the state.

Commercial Forestry

In 1956, the area of land classed as commercial forest was about 15.4 million acres. This was nearly 9 per cent less than it had been in 1936 when the area was 16.9 million acres. Acreages of sawtimber, seedling and sapling stands, and nonstocked areas were lower in 1956 than they had been 20 years earlier; poletimber area, on the other hand, increased by over 2 million acres.

The decrease in forest area was caused by a gradual conversion to other uses over the 20-year period. For example, several hundred thousand acres of "stump pasture," formerly considered woodland, were classed as pasture in 1956. In southern Wisconsin alone, more than 700,000 acres of formerly commercial forest are now nonforest. In the southern counties a large share of the pastured woodland has gradually been converted to a more or less open condition, and many of the remaining trees are highly defective.

On the other hand, industrial users of the forestry resource are becoming conservation conscious. Over one million acres, privately owned by industry in Wisconsin, have been dedicated and are being maintained for permanent tree growth under standards approved by the Wisconsin Conservation Department. Industries owning these properties have made substantial investments in reforestation, and fire detection and suppression equipment which supplements state equipment for emergency purposes. Most of our industrial forests serve as fine examples of intensive forestry. They are some of the best managed forests in the state today.

Volume of Sawtimber. During the 20 years between 1936 and 1956, sawtimber volume in Wisconsin increased by over one billion board feet. Pine, aspen, oak, basswood, and elm now are in greater supply than in 1936, but hemlock, sugar maple, yellow birch, and cedar have decreased. Sawtimber volumes have expanded enough in southern Wisconsin to more than cancel the reduction in northern Wisconsin. However, the over-all sawtimber situation presents no substantial improvement over 1936, since timber in southern Wisconsin is found in smaller blocks, has more defects, is of less-preferred species, and is farther from well developed sawlog industries.

The potential sawtimber supply shows more promise. Between 1936 and 1956 poletimber acreage nearly doubled. As these stands mature they should add considerable volume to the sawtimber stockpile.

Hardwood. Hardwood trees make up 76 per cent of the total sawtimber volume. Red oak, the leading species, comprises 17 per cent of all the sawtimber. Other species with over one billion board feet of sawtimber are sugar maple, elm, white pine, hemlock, and white oak. Oak sawtimber volume is increasing faster than that of any other species. Softwoods and northern hardwoods are the major sawtimber species in northern Wisconsin; in southern Wisconsin the oaks are the leading sawtimber species.

In 1936, about 79 per cent of the sawtimber volume was made up of trees 14 inches in diameter and larger; in 1956, only 68 per cent was in these larger trees. Since tree size and sawlog quality are closely related, the downward trend in sawtimber tree size has caused a decline in quality. Small logs yield a lower percentage of clear lumber than do large logs.

Not only are the sawtimber trees smaller, but there is less sawtimber volume in some of the preferred species. For example, since 1936 the volume of sugar maple sawtimber has dropped 26 per cent and yellow birch 52 per cent. The trend is unfavorable even though the decline has been more than offset by increases in other species, primarily the oaks and aspen. Continued heavy cutting of good-quality sawtimber trees, woodland grazing, and poor logging practices have combined to diminish sawtimber quality. Only 5 per cent of the white oak sawtimber volume is in Grade 1 logs. Sugar maple still has 22 per cent of its diminished volume in Grade 1 logs; few species fare better.

Most of the sawtimber trees contain one or more low-quality logs suitable for poor lumber or tie cuts. Poor trees tend to remain in the stand because their wood is seldom worth the cost of cutting and processing.

Pulpwood. In the 20 years between 1936 and 1956 the combined volume of the principal pulpwood species—jack pine, spruce, balsam fir, hemlock, and aspen—increased from 22.9 million cords to 29.8 million cords. The softwoods actually declined in volume from 14.3 million cords to 9.2 million cords, but aspen more than made up the difference, increasing from 8.6 million cords to 20.6 million cords in the same period.

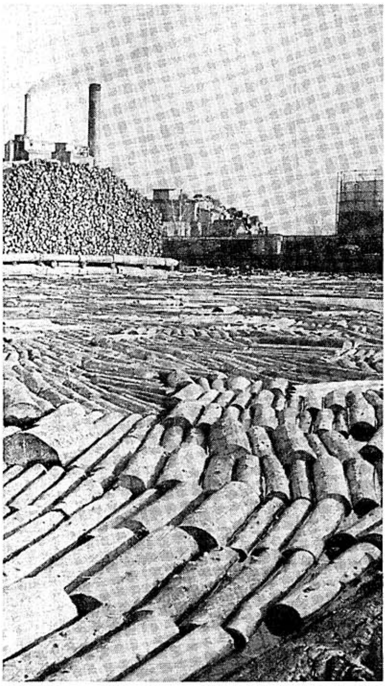
Timber volume in the major pulpwood species is largely concentrated in northern Wisconsin. The northeastern and northwestern districts have about equal volumes of pulpwood; combined, they account for over four-fifths of the state total.

Annual Growth and Drain of the Forestry Resource

Wisconsin's forests are growing rapidly. Net annual growth for 1956-1966 is estimated at 3.7 million cords, a daily increase averaging 10,300 cords. The net annual growth equals 3.8 per cent of total 1956 volume. Sawtimber is growing faster than all growing stock. In 1956 sawtimber growth totaled 778 million board feet, 4.8 per cent of sawtimber volume. Total increment before deducting annual mortality was 5.9 million cords annually.

Although total growth seems favorable, the annual net growth averages only about one-fourth cord per acre of commercial forest land and 100 board feet per acre for sawtimber trees in sawtimber stands. When these averages are compared to growth on well-managed stands growing more than one cord or 200 board feet per acre yearly, it becomes clear that timber growth several times the current growth is possible.

The upward growth trend is due in part to improved timber stocking. Net annual growth in 1956 was 16 per cent higher than in 1936. For sawtimber, the improvement was even more—sawtimber growth increased 59 per cent during the 20-year period. Softwood sawtimber growth has climbed by 12 per cent since 1936; it has increased in every species but hemlock and red pine. The largest increase has occurred in jack pine and balsam fir, although very little of these species are utilized for saw logs.



Wood for the paper industry. Wisconsin imports much of what the industrty uses but is working hard to become self-sufficient.

Among the hardwoods, only yellow birch had lower sawtimber growth in 1956 than in 1936. Total hardwood sawtimber growth climbed nearly 72 per cent, with the greatest increases in aspen, basswood, red maple, and paper birch. Aspen sawtimber growth increased nearly fivefold since 1936; basswood sawtimber growth jumped by 2½ times.

The 16 per cent increase in annual growth of growing stock was largely accounted for by jack pine, spruce, balsam fir, basswood, elm, and red maple. Yellow birch and hemlock had lower growing stock growth in 1956 than in 1936.

Net annual growth rate for the softwoods averaged 3.5 per cent of growing stock volumes and 3.8 per cent of sawtimber volumes. For hardwoods the growth rate was 3.9 per cent for growing stock and 5.1 per cent for sawtimber.

Over-all, the total cut is slightly below the allowable cut (the silviculturally desirable cut that can be made while maintaining a steady flow of wood products and improving the balance of tree sizes). In the principal softwood species, however, the actual cut exceeds the allowable cut in every district except southwestern Wisconsin. Overcutting of pulpwood is especially prevalent in central Wisconsin. The cut there not only is greater than allowable cut, but also exceeds the net growth for several key species.

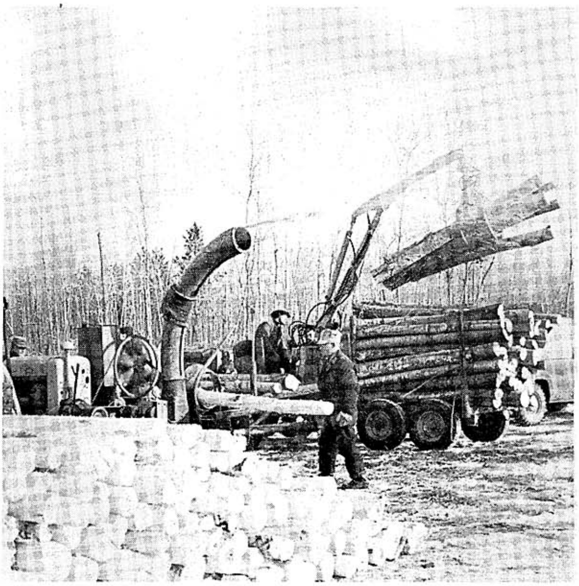
About 2.3 million cords of timber were cut from growing stock in 1956, including about 404 million board feet of sawtimber. Another 1.3 million cords were harvested from cull trees, dead timber, trees smaller than merchantable size, hardwood limbs, and from noncommercial forest sources such as shade and fencerow trees. Nearly all of the saw logs, veneer logs, pulpwood, piling, and poles came from growing-stock timber, while most of the nongrowing-stock material went into fuelwood and fence posts.

Public Promotion of Forestry

In an enterprise so vital to the state, it is natural that state government has contributed to the physical and economic advancement of forestry. The 2 traditional obstacles to forestry by private enterprise, fire and taxes, had to be overcome. The wave of tax delinquency, which became formidable in 1927 and threatened to submerge the "cutover" counties, called for legislation enabling other agencies to participate in the task, for the state could not purchase and manage all of this land. Though large areas were restocked by nature, often to inferior species, extensive denuded areas were in need of reforestation. The need for better inventories of forest growth and for research became increasingly evident. The valuable, though scattered, stands of farm woodlands could not be ignored. Sound legislation and stability of appropriations were basic to a constructive program.

Great advances have been made in the restoration of the forest resource through improved management and this has been facilitated by consolidations of forest land ownerships into large holdings by the counties, the state, the federal government, and forest-based industries also.

Forest Protection. The greatest enemy of the forests was fire, though early in the beginning people were concerned with the loss of life and building improvements, and did not worry much about the young forest growth. Not until 1927, when the Conservation Commission was authorized to establish forest protection districts with responsibility for fire control, was real progress possible, though protection of the state forest lands in Vilas and portions of adjoining counties had been effective since 1911. In 1962 there were 12 forest protection districts covering over 17,800,000 acres in northern, northwestern and central Wisconsin. In addition, co-operative districts have been established in the southern part of the state, giving statewide forest fire protection. The physical equipment of look-out towers, telephone lines, ranger stations, and the headquarters and shops at Tomahawk are adequate. So are mechanical equipment, including trucks, trailers, tractors, plows and pumpers, though periodic replacements must be made. Most important of all is a well-trained and competent force of rangers. Minimum time in reaching a fire with adequate equipment remains a major requirement. With the passing of large, unbroken areas of logging slash, the severity of fires has declined, but there are still too many forest fires. The effectiveness of fire control measures now in force is shown by the fact that less than 10 per cent of all the forest fires of the past 20 years burned more than 10 acres.



Some pulpwood bolts are now peeled right in the forest before being transported to the mill.

More recently outbreaks of destructive forest insects, especially in plantations, have caused more damage than fires in some seasons. The first forest entomologist was employed by the Conservation Department in 1952. As of 1962 there were 6, and more will be needed. The forest pest control act of 1955 placed this activity in the Conservation Department. Supplies of insecticides and mixers are held at several stations, and contracts for spraying insecticides from the air can be let without delay.

Tree diseases can also cause losses. Tree diseases are more susceptible to control where the disease is spread by an alternate host, as in the case of the white pine blister rust, or where an insect is the carrier of the disease. Centers of oak wilt can be isolated.

Forest Taxation. The "uniform rule of taxation" provision of the Wisconsin Constitution, which made it necessary to tax forest lands on the same basis as other lands, prevented a taxation policy favorable to the management of forest lands on a sustained yield basis until 1927. The timber on the land, as well as the land, was taxed annually, even though there was no income from it. A policy of "cut and get out" of forest land ownership was inevitable. Clear cutting followed by tax delinquency became usual. As these lands became increasingly tax delinquent, the situation of the "cutover" counties became desperate.

A constitutional amendment, ratified in 1924, made it possible to adopt a tax policy favorable to sustained yield management. The 1927 Legislature enacted the Forest Crop Law (Chapter 77, Statutes), by which the *land* is taxed annually at 10 cents per acre, but the *timber* on the land, which is the income, is taxed only once; when it is cut and the income is realized.

With the new tax system, private forestry was greatly encouraged. There are now (1963) over 400,000 acres of private land entered under the Forest Crop Law.

The owner of a tract of land containing less than 40 acres originally could not place his land under the forest crop law and was denied the advantage of a lower tax on his woodland. To fill this gap in land and timber taxation for the owners of small tracts, the 1953 Legislature enacted the Woodland Tax Law, which applies mostly to agricultural areas. It provides that the owner of any tract of land of less than 40 acres, that is suitable for the growing of trees, may apply for entry. The landowner is also given technical advice and assistance by the Conservation Department foresters to make his woodland more productive.

Public Forests and Rural Zoning for Forestry and Recreation

County Forests. Larger than the sum of state and national forests in Wisconsin, county forests were built up without an appropriation to buy land. Under Wisconsin tax procedure, the levies of all taxing units other than counties must first be paid in full and the county must absorb the shortage in uncollected taxes; reimbursing itself if possible, through sale of delinquent tax certificates. When the tax certificates on tax delinquent forest lands could not be sold, the counties took the lands on tax deeds. In 1929, the counties were thus enabled to establish county forests and permitted to enter the lands so acquired under the forest crop law without paying the 10 cents per acre required of other owners. A contribution of 10 cents per acre for development of county forests paid out of the forestry appropriation to the Conservation Department was provided in 1931 and the severance tax was increased; it is now 50 per cent. County forests increased rapidly; the largest gain came in 1933, with 419,622 acres. As of January 1963, 27 counties owned over 2,200,000 acres.

Zoning. As extensive areas were dedicated to forestry and it became clear that the advance of the agricultural frontier had been checked, numerous cases of isolated settlers with excessive per family costs for roads and schools were noted, and the need for preventing additional cases arose. An exceptionally aggravating case in 1932 led Oneida County to request the Dean of the College of Agriculture and the Director of the Conservation Department for assistance in enacting a zoning ordinance. Representatives of these agencies, with the guidance of the office of the Attorney General, worked on the project. On May 16, 1933, the Oneida County board adopted the first rural zoning ordinance in the nation, establishing districts in which land

Big white pine in Menominee County. Under sustained yield management for many years, the volume of merchantable timber has increased steadily.

use was restricted to forestry and recreation and closed to agricultural development and legal settlement. The movement spread rapidly until 26 northern and central counties had closed more than 5,000,000 acres to agricultural development. Subsequent buying out of non-conforming users living on these lands has greatly reduced forest fire hazard.

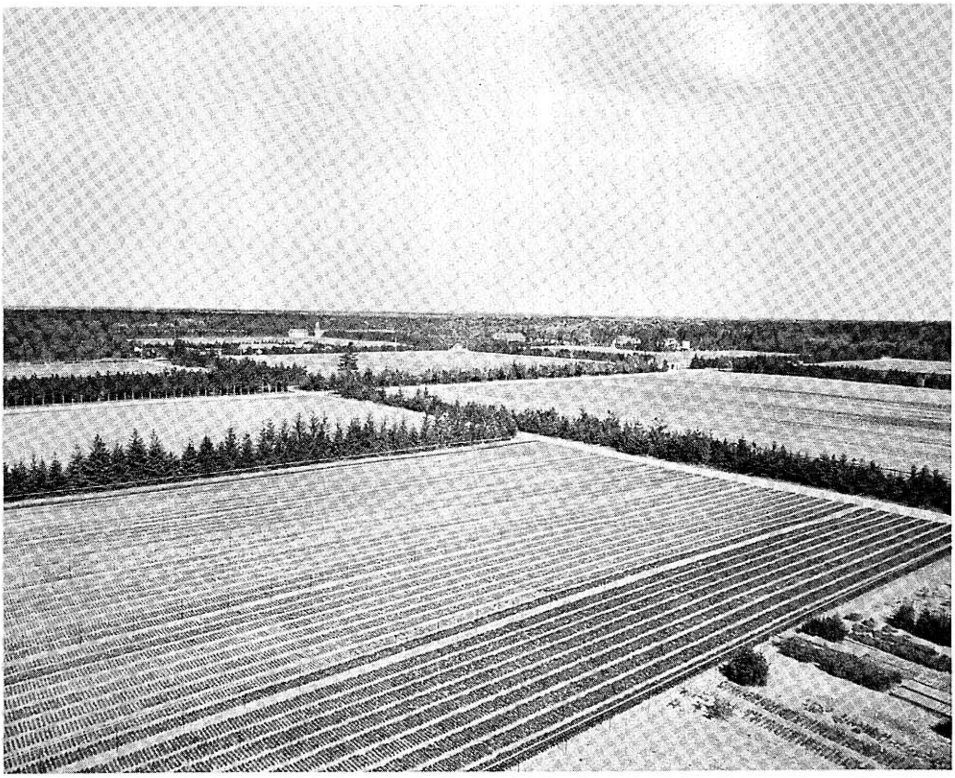
National Forests. Authority for the federal government to establish national forests in Wisconsin was granted by the Legislature in 1925. There are 2 national forests (Chequamegon and Nicolet) with a federal ownership of over 1,460,000 acres. During the years of the Civilian Conservation Corps (CCC) and the Works Progress Administration (WPA), much work was done to develop the national forests, and most of the denuded areas were reforested.

State Forests and Nurseries. In selecting the area at the headwaters of the Wisconsin and Chippewa Rivers for acquisition in 1905, State Forester E. M. Griffith gave consideration to the value of forests for stabilization of stream flow and public recreation. Similarly, he secured a grant of 4,320 acres from Frederick Weyerhaeuser in 1907, which formed the nucleus of the Brule River Forest. The principle was followed in acquiring the Flambeau River State Forest, while the origin of the Kettle Moraine Forest may trace back to the efforts for a forest at the headwaters of the Milwaukee River, which caused periodic flood damage. The value of the Kettle Moraine for conservation and recreation was set out in the State Planning Board's Bulletin No. 3, *A Conservation and Recreation Plan for Southeastern Wisconsin,* issued in 1936. Provision for the purchase of land was made by the Legislature of 1937. As of December 1962, the state forests totaled 374,601 acres.

Income from timber sales on state forests, of which one-fourth is distributed to the counties, totaled $133,313 in the fiscal year 1961-62. Most of this income is derived from natural growth, but the older plantations are beginning to yield some products from thinnings. As an example of the returns from intensive forestry, the one-acre demonstration thinning plot in the red pine plantation at Star Lake has already given 21.9 cords of pulpwood in 3 thinnings, leaving a residual stand of 35.6 cords. In terms of sawtimber, this stand carries 9,700 board feet per acre and has recently been growing at the rate of 1,000 board feet per year.

Four principal nurseries are now operated by the state. Current annual shipments exceed 30 million trees, of which about 60 per cent are sold for planting on privately owned lands.

Recreation and Wildlife. It has long been recognized that the forests of the state produce many benefits other than sawlogs and wood fiber. An increasing population and increasing leisure time for recreational pursuits are working new demands on forest management. It is apparent that the wildlife resources of the state, their production and utilization, are intimately tied in with techniques of



Part of the Griffith State Nursery at Wisconsin Rapids. State owned, it is one of 4 which each year together produce more than 30 million new trees for planting.

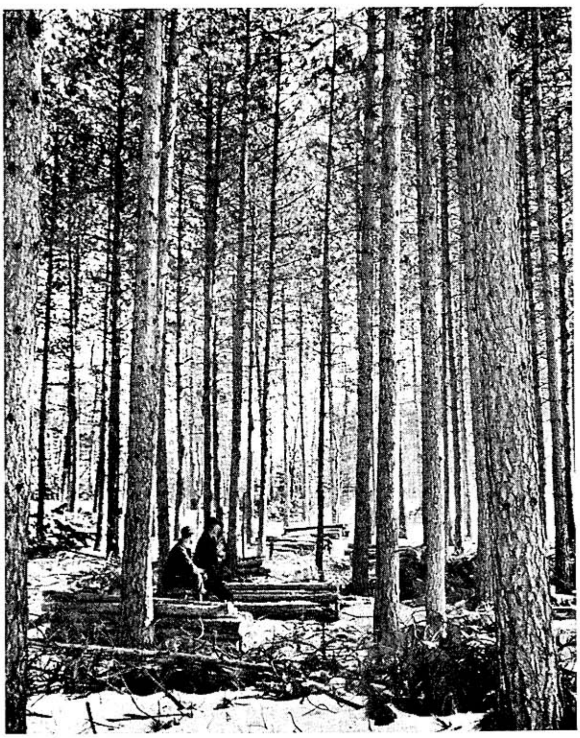
timber management. It is also apparent that their over-all importance is steadily increasing, and that management for timber production and management for wildlife are completely compatible. For these reasons, practically all public forest lands in the state are now managed for the production of both timber products and wildlife, along with maximum utilization of other recreational and scenic opportunities. Private landowners of all classes are also exhibiting an awareness of these values, and forest management practices on private lands are beginning to reflect this trend.

Small Woodlands. The least productive forest conditions and the most difficult problems of marketing are found on the holdings of farmers and "small private" owners (those with less than 5,000 acres of forest land each), many of whom hold their lands primarily for purposes other than timber growing. In the aggregate, farm and small private ownerships include 60 per cent of Wisconsin's commercial forests, and for many years they have supplied a large proportion of the raw material used by forest industries. Since these ownerships total more than 9 million acres, they are a key factor if wood supplies are to be increased.

In Wisconsin, small private and farm owners number over 143,000 persons, each small private owner having an average of 120 acres of woodland and each farmer an average of 45 acres.

Wisconsin assists the small owner in meeting technical problems of forest management by making available the services of 65 farm foresters. Furthermore, the Agricultural Conservation Program offers incentives to the small owner to improve his woodland or plant trees on his unneeded cropland. Yet the small owners, as a group, are not practicing forestry. Grazing and indiscriminate logging are common and, as a result, income from rundown woodlots is small and infrequent. In many cases, the owner sees little incentive to spend time and money in an effort to raise woodlot productivity. Nevertheless, future timber supplies for Wisconsin's timber industries rest largely

Tree growing and proper management can provide a financially profitable periodic crop.



upon the actions these owners take in regard to improving their timber stands.

Forestry Research

Since its establishment, the Lake States Forest Experiment Station has received the co-operation of the Wisconsin Conservation Department on studies in silviculture and forest management. In the early 1940's, the need for research in fields basic to forestry became pressing. Instead of setting up a research section, it was held that more effective work could be done with available funds by supporting research at the University of Wisconsin's Agricultural Experiment Station, where laboratory and library facilities were available and where excellent work in these fields was under way. Funds were first contributed for work in forest pathology in 1941, forest soils in 1942, forest entomology in 1946 and in forest genetics in 1948, and have been continued in increasing amounts annually since. Notable results have justified this program, and research will make further contributions to forestry in Wisconsin.

Trees for Tomorrow. Supported by member paper mills and power companies, Trees for Tommorrow, Inc., of Merrill, Wisconsin, was organized to help build a sound forestry economy in northern Wisconsin. They publish a monthly newsletter, "Tree Tips," available to schools on request, and conduct a conservation education camp at Eagle River in co-operation with the U.S. Forest Service and the Wisconsin Conservation Department. The Wisconsin state colleges and other conservation groups use the camp facilities for conservation workshops.

Trees for Tomorrow also provides forest management services to landowners in northern Wisconsin. The objective of these services is to help develop the full potential of the woodlands. In keeping with the philosophy of self-help, a small fee is charged to place a value on the time spent and technical skill required to improve the forests.

THE LANDSCAPE RESOURCES OF WISCONSIN

Philip H. Lewis, Jr.

Department of Resource Development

The landscape resources of Wisconsin can be divided into those physical resources possessing intrinsic values and those possessing extrinsic values: *intrinsic* values being those found in the natural landscape and the *extrinsic* values those that have been created by man-made changes, adaptations, and additions to the natural landscape resource.

When working, living, and playing, people value in the landscape what they can *see, feel,* and *reflect* upon as well as what they can *do* in natural and man-modified landscapes. One set of values (largely natural) recreates the mind, another supported by well designed facilities recreates or serves the body.

The modern-day "rush" to ensure food, shelter, transportation, and play for as many people as possible, has over-emphasized providing extrinsic values only (and often badly designed ones) at the expense of intrinsic values. Both the intrinsic and well designed extrinsic resources are important to the full enjoyment of the Wisconsin landscape.

The great task is one of achieving "balanced development" between these intrinsic and extrinsic values. For instance we know that in our recreation landscapes, where picnic tables are plentiful, where trails and barbecue ovens are abundant, that these facilities would provide considerably less enjoyment without grassy banks, steep bluffs, sandy spits, overhanging trees, and shielding from traffic and other types of civilization's encroachments.

The task in the urban, metropolitan townscape is one of re-introducing at great cost the intrinsic values that once existed. The task in the rural regional landscape is one of identifying, preserving, and protecting the most outstanding intrinsic values, and seeing that introduced man-made values are developed in harmony with these resources. Both of these tasks depend upon a *greater awareness* of the landscape resources by *everyone.*

Under the Wisconsin Outdoor Recreation Act (penny-a-pack cigarette tax), an opportunity has been provided to observe and record the many values in the Wisconsin landscape that make it an outstanding recreation state. In the first year of this planning program the following intrinsic and extrinsic values have been identified (see Table 14), are being observed, and plotted on county and state-wide mapping.

Once these intrinsic and extrinsic values have been identified, "professional" judgment can render a quality interpretation of the individual resource, excellent, good, substandard, etc.

The soil scientist can identify the many soils that will provide good crops as well as those that can be expected to withstand heavy recreational traffic. The wildlife expert can identify quality wetlands for wildlife habitat. The architectural historian can identify man-made structures with historical quality. The forester can identify

(text continues on p. 135)

The rocks that form this canyon at the Wisconsin Dells are an intrinsic resource of the natural landscape. Their natural beauty, however, would remain unknown to the tourist were it not for the fenced boardwalk—an extrinsic, man-made resource—to make the canyon safely accessible and yet in such a manner—that the intrinsic resource is protected aginst over use.

Table 14: LANDSCAPE RESOURCES FOR RECREATION

Water Resources

Natural (Intrinsic) Resources

1. Waterfalls
2. Rapids, Whitewater
3. Bathing Beaches
4. Agate Beaches
5. Natural Springs, Artesian Flows
6. Canoe Routes
7. Wild Rice Areas
8. Exceptional Islands
9. Fish Habitat
10. Chasms
11. Trout
12. Muskellunge
13. Walleye
14. Bass
15. Northern Pike
16. Sturgeon
17. Catfish
18. Panfish

Man-Made (Extrinsic) Resources

19. Swimming Facilities
20. Boating Facilities, Ramps
21. Fuel, Repair and Supplies
22. Marines
23. Boating Areas
24. Outfitting Posts
25. Harbors of Refuge
26. Campsites
27. Canals
28. Dams, Fishways, Drainage Ways
29. Locks
30. Lighthouses
31. Fish Hatcheries
32. Mill Ponds
33. Reservoirs
34. Shelters for Ice Skating Areas

Wetland Resources

35. Exceptional Wetlands
36. Wildlife Observation
37. Wildlife Hunting
38. Observation Platforms
39. Wetland Projects, Levees, Ditching and Dyking
40. Wildlife Preserves
41. Hunting Preserves

Topographic Resources

Unique Geological Formations

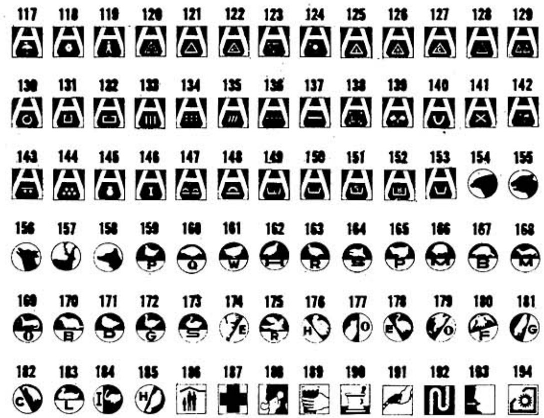
42. Caves
43. Balanced Rocks
44. Castle Rocks
45. Exceptional Glacial Remains
46. Natural Bridges
47. Stones and Fossil Collection Areas
48. Mineral Ore Outcroppings
49. Outstanding Soil Conservation Projects— also farm conservation
50. Ski Lifts
51. Ski Rope Tows
52. Ski Slope Structures
53. Snow Play Areas, Sledding, etc.
54. Ski Trails
55. Ski-(Cross Country)
56. Riding
57. Hiking
58. Nature Trails
59. Trail Shelters
60. Picnic Areas
61. Golf Courses
62. Youth Camps
63. Nature Camps
64. Day Camps

Vegetation Resources

65. Virgin Stands (Timber)
66. Rare Remnants
67. Outstanding Reforestation Projects
68. Wildflowers
69. Prairies
70. Specimens (Trees, etc.)
71. Unusual Crops
72. Orchards
73. Fire Towers
74. Fire Trails and Breaks
75. State Forests (Existing Potential)
76. County Forests (Existing Potential)
77. County Parks (Existing Potential)
78. State Parks (Existing Potential)
79. State Recreation Areas (Existing Potential)

(table continues on p. 134)

RESOURCE SYMBOLS



These are the uniform resource symbols which will be used by the Department of Resource Development in maps showing the recreational resource values of various parts of our state.

The meaning of each symbol is shown in Table 14.

Table 14: LANDSCAPE RESOURCES FOR RECREATION, con'td.

Man-Made Resources

Historical and Cultural Resources

80. Blacksmith Shops
81. Bridges (Covered, etc.)
82. Trading Posts
83. Old Mills
84. Taverns, Saloons
85. Old Mines
86. Opera Houses
87. Historical Homes
88. Old Forts
89. Barracks
90. Lumber Camps
91. Battlefields
92. Historical Markers
93. Museums
94. Restaurants (Unusual-Native Dishes)
95. Native Handicrafts (Draftmen's Shop)
96. Local Festivals, Celebrations
97. Outstanding Farmers Markets
98. Modern Mines
99. Power Plants
100. Modern Mills
101. Interesting Industries Open for Visits
102. Commercial Fishing
103. Berry Picking
104. Ghost Towns
105. Rifle Shooting Ranges
106. Archery Ranges
107. Sugar Bush
108. Songbirds
109. Aesthetic Areas
110. Art Museums
111. Outstanding Buildings
112. Theaters
113. Existing Public Lands
114. Existing Private Lands
115. Proposed Public Lands
116. Proposed Private Lands

Archeological Resources

117. Effigy Mound
118. Sugar Bush
119. Petroglyph
120. Quartzite
121. Pipestone
122. Steatite
123. Quarry Flint
124. Copper
125. Lead
126. Quartz
127. Chorite
128. Campsite
129. Village Site
130. Circular Enclosure
131. Square Enclosure
132. Rectangular Enclosure
133. Wild Rice
134. Cornfield
135. Garden Bed
136. Trail
137. Ford
138. Fort
139. Battlefield
140. Cache Pits
141. Workshop
142. Historic Village Sites
143. Provision Cache
144. Shell Heap
145. Ceramic Artifacts
146. Conical Mound
147. Mound Group
148. Mound—Round—Oval
149. Historic Cemetery
150. Prehistoric Cemetery
151. Stone Grave
152. Burial Ground
153. Grave

Wildlife

Big Game

154. Bear
155. Bobcat
156. Wolf
157. Deer
158. Red and Grey Fox

Small Game

159. Pheasant
160. Quail
161. Woodcock
162. Hungarian Partridge
163. Ruffed Grouse
164. Sharp-tailed Grouse
165. Prairie Chicken
166. Muskrat
167. Beaver
168. Mink
169. Otter
170. Badger

Water Fowl

171. Ducks
172. Geese
173. Swans

Birds

174. Eagles
175. Red-tailed Hawks
176. Herons
177. Great Horned Owls
178. Egrets
179. Ospreys
180. Falcons
181. Goshawks
182. Cranes
183. Loons
184. Ibis
185. Hawks

Tourist Service Facilities

186. Accommodations
187. Hospital
188. Telephone
189. Water
190. Pharmacies
191. Gas Stations
192. Toilet Facilities
193. Restaurant
194. Washer-Dryer

quality patterns of timber, the anthropologist quality patterns of prehistoric culture. The botanist and ecologist can identify unique ecological communities with values for present and future generations, and the landscape architect can identify landscape patterns with unique perceptual qualities ... and so on until we have exhausted the number of professions studying the physical qualities of the landscape.

To each of these many experienced professionals, there are compelling reasons to preserve the values known to them for the present and future beauty and utility of the Wisconsin landowners.

The years of research within each profession to develop a better understanding and use of their particular resource should not go unheeded. An effort to understand each other's responsibilities should

Map 7: EVIRONMENTAL CORRIDORS

be encouraged in our age of narrowing specialities. It has been the past and present taxpayers' willingness to provide the classrooms, the research laboratories and the extensional activities, that has provided us with the opportunity to evaluate quality within these many classified resources.

Further opportunities have now been made in Wisconsin to pool this vast accumulation of resource information. The Outdoor Recreation Act has as a primary goal more than merely rediscovering the many landscape resources in terms of parks, play, recreation and fun; but also an inventory being conducted by the Recreation Division of the state's Department of Resource Development, is concerned with identifying, preserving and developing wisely state-wide and county-wide landscape patterns that provide a source of strength, spiritual health and wisdom for the individual.

You will find environmental corridors *along ridges and shorelines . . .*

. . . you will also find them along rivers, flood plains and wetlands.

The state and county values, being inventoried (with the assistance of our state agencies, universities, and local clubs and organizations), are far more than a combination vacation land-and-supply room; they are the resources that offer exceptional patterns containing a heritage of experiences and inner development beyond price.

At the end of the first year of perceptual inventory, it is apparent that the extensive landscape resources of water, wetlands, and significant topography created by wind, water, and glacial action through the ages have etched predominantly linear patterns on the face of the Wisconsin landscape. The flat rolling farm lands and extensive forest patterns between these corridors have their share of beauty, but it is the bluffs, ridges, roaring and quiet waters, mellow wetlands and sandy soils combining in elongated patterns that tie the landscape together in regional and state-wide corridors of outstanding landscape quality.

In the first phase of our program we have chosen to call these patterns "environmental corridors." By mapping these corridor values *we hope to make the people of Wisconsin aware of the following points*:

1. Resource values in vast quantities still remain in the Wisconsin landscape with a *linear distribution.*

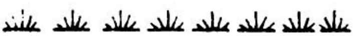
2. Within these linear environmental corridors lie 4 major surfaces:

   a. *Water*

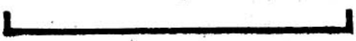
   All navigable water in Wisconsin belongs to the public. Kept clean, water offers vast acreages of resource quality and open space within the corridor pattern.

   b. *Wetlands*

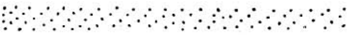
   Wetlands serving as headwater marshes, wildlife habitat and sources of natural springs should, when possible, be protected as a valuable surface within the corridor pattern.

   c. *Flood Plains*

   The flood plains of Wisconsin offer exceptional recreational opportunities as well as natural channels for surface water drainage. Subject to flooding these "surface" patterns offer little opportunity for safe man-made development and should be protected from such encroachments.

   d. *Sandy Soils*

   Sandy soils are often found adjacent to water "surface" and offer outstanding areas for swimming if protected from cabin and urban related development.

3. "Surfaces" of water, wetlands, flood plains, and sandy soils are in most cases enclosed by varying degrees of slope.

   Slope

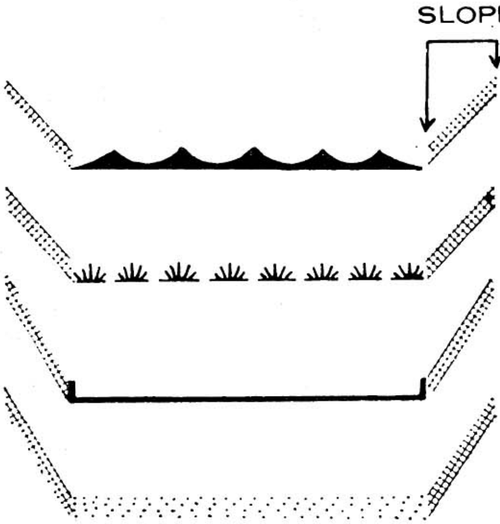
   Most "surfaces" are bracketed by slope and since slope is subject to various degrees of erosion it should be protected and stabilized to prevent silting and pollution of the "surface" resources below.

4. "Rims" of slope offer the very best opportunity to observe and contemplate the "surface" resources.

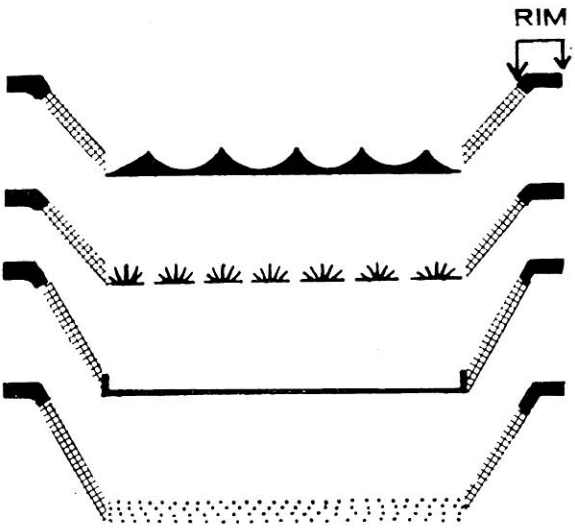
   Rims

   To assure as many Wisconsin citizens an opportunity to traverse the Wisconsin rims along bridal, hiking, bicycle trails or parkways, certain controls over rim development should be considered.

Slope



Rims



5. "Surfaces", "slopes" and "rims" of Wisconsin combine to form our environmental corridors.
   Additional Resource Values
   State-wide field checks in Wisconsin and Illinois also indicate that these additional values lie for the most part within these corridor patterns.

6. Adjacent lands paralleling the environmental corridor can be termed corridor fringe areas.

   Corridor Fringe Area

   By protecting the corridors and encouraging *new patterns* of development within the fringe areas, the tax base of the counties could be increased and assured over a longer period of time. It is the corridor quality that attracts development in the first place. Loss to single rows of cabins and other unplanned physical development offers an alternative of quality obliteration or extensive and expensive rehabilitation by future generations.

7. An alternative to quality obliteration and expensive rehabilitation is protection of corridor qualities through better design guidelines, use of present and possible forms of legislation, and volunteered participation by individuals and organizations in corridor protection programs.

   a. *Better Guidelines*

   The Division of Design and Recreation in the Department of Resource Development is concentrating on various design standards that could be utilized in corridor fringe areas.

   b. *Legislation*

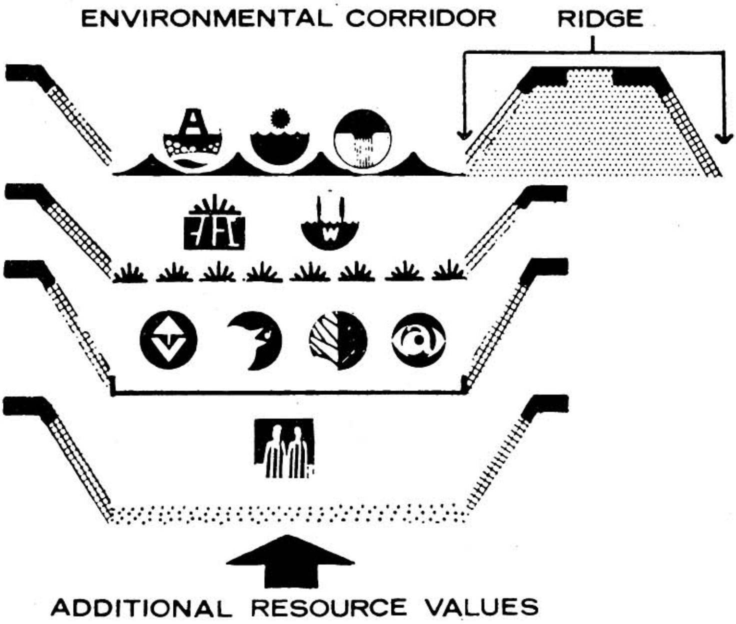
   The second phase of the state planning program in the Department of Resource Development is an implementation phase in which existing and potential forms of needed legislation can be evaluated.

   c. *Volunteered Participation*

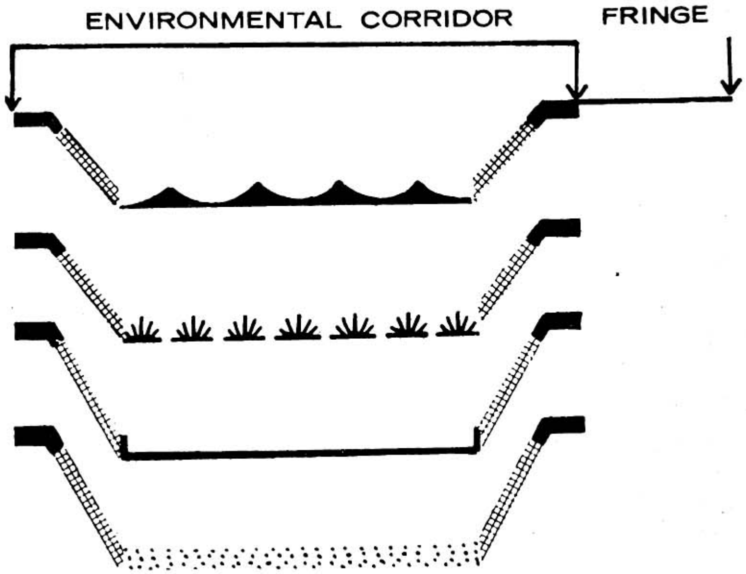
   More than 100 clubs, agencies and organizations now contribute to conserving, protecting and developing wisely our various landscape resource values. By demonstrating that the values held by all lie within a common corridor pattern we hope that an integrated effort by all can be encouraged.

8. Developed wisely by all levels of government, the farmer and the urbanite, these corridors can serve as a county and state-wide landscape foil to an ever advancing urban landscape of brick, steel, glass and asphalt, mellowing the conformity and

Environmental Corridor—Additional Resource Values

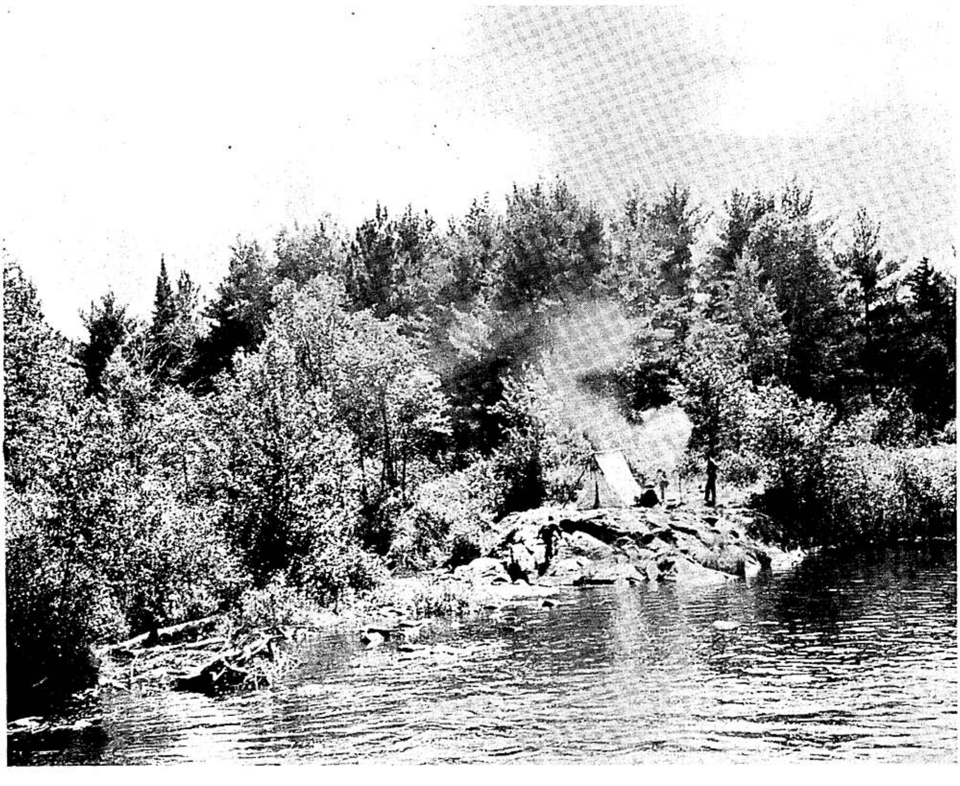


Environmental Corridor—Corridor Fringe Area



boredom that need not become synonymous with the Wisconsin landscape resource. Enjoyment of our natural and cultural heritage means something to the present generation, through whetted perception, careful planning and sound environmental design our heritage and its extensive corridor variety can continue to be enjoyed by future generations.

Be it a river for fishing, or a forest for hunting, or simply a sunny spot for camping—there are untold recreational resources in Wisconsin's out-of-doors.



THE CLIMATE OF WISCONSIN

Marvin W. Burley

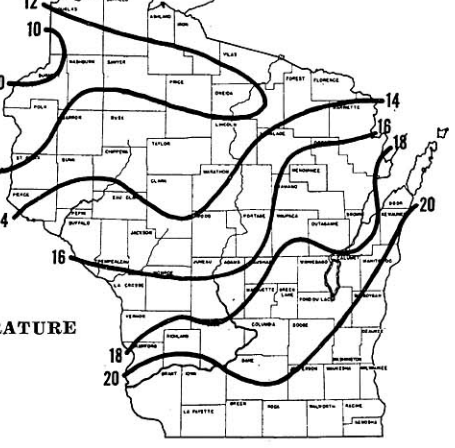
Wisconsin State Climatologist, U.S. Weather Bureau

Wisconsin climate is classified as continental and characterized by marked weather changes common to the latitude and interiors of large land masses. The state is under the influence of pressure centers that move eastward along the northern border and northeastward from the southwestern part of the country. A variety of weather can be expected year round with changes occurring every few days from late fall through early spring.

Summer and Winter

Possible sunshine has averaged between 50 per cent to 60 per cent for the year. Throughout the year, possible sunshine has averaged 40 per cent to 50 per cent in January; 50 per cent to 60 per cent in February through April, and in October; 60 per cent or greater in May through September; and nearly 40 per cent in November and December. Percentages in the extreme northern counties and in a narrow band along Lake Michigan have averaged closer to the lower figure.

Winters are relatively cloudy, cold, and snowy, beginning in November and lasting through March, although November and March are transitional in nature. Most of the rivers and lakes in the north are frozen from late November until early April. Heavy winter fogs occasionally form over the southern half of the state when warm



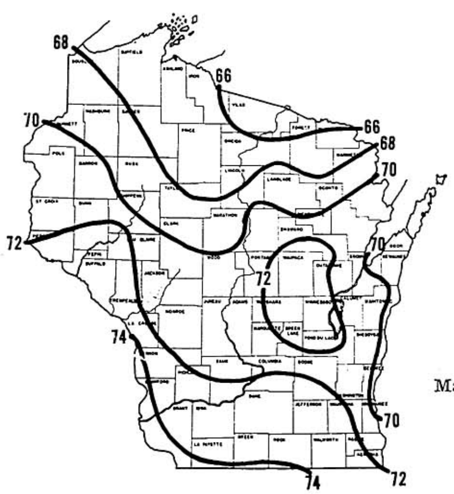
Map 8: **MEAN TEMPERATURE (°F.) January**

moist air from the Gulf of Mexico is cooled by contact with the cold ground surface, especially when the ground is covered with snow.

Summers are warm with a tendency for cool nights. Markedly cool periods may be experienced any month during summer. A period of Indian Summer usually follows late September rains. Spring and fall are sometimes short and mixtures of both winter and summer. Lake Superior and Lake Michigan modify adjacent areas by cooling summer temperatures and warming winter temperatures. The lake effect is most pronounced up to 15 to 20 miles from the shore line. Day length in the extreme south varies from 15 hours 20 minutes in June to 9 hours 7 minutes in December and in the extreme north from 15 hours 50 minutes in June to 8 hours 37 minutes in December.

Temperatures. Extremes vary considerably throughout the seasons as well as from year to year. Average annual temperatures are 42° in the north and 48° in the south. January is the coldest month with averages of 12° in the north and 22° in the south. The coldest recorded temperature is −54°, occurring at Danbury in Burnett County, January 1922. The average number of days in a winter with 0° or lower ranges from less than 15 in the extreme southeast and a narrow band along Lake Michigan to more than 40 in the northwest and extreme north.

Extreme cold is common with more than half of the winters having −40° or lower somewhere in the state and nearly every winter having −30° or lower. July is the warmest month with temperature averages of 68° in the north and 74° in the south. The hottest temperature on record is 114°, occurring at Wisconsin Dells, July 1936. The average

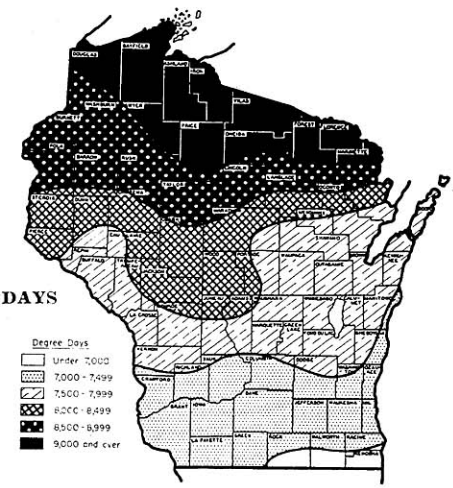


Map 9: **MEAN TEMPERATURE (°F.) July**

number of days in a summer with 90° or more ranges from 20 in the south to 5 in the north with a narrow band along Lake Michigan averaging about 10 days. There have been few summers during which the temperature did not reach 100° or higher in some locality, usually in the southwestern half of the state.

Heating Degree Days

"Heating degree days" are a way of estimating what your heating requirements will be to get you through the winter in any particular location. The estimate is based on the concept that when daily outside mean temperatures average below 65° F., the amount of fuel consumed to maintain an inside temperature of 70° varies approximately with the number of degrees the daily mean is below 65°. Generally, home or office heating is not considered necessary when outside mean temperatures are 65° or more. The difference between 65° and the day's mean temperature is called the number of "degree days" for that day; if the daily mean was warmer than 65° then that is counted as zero degree days.



Map 10: **HEATING DEGREE DAYS**

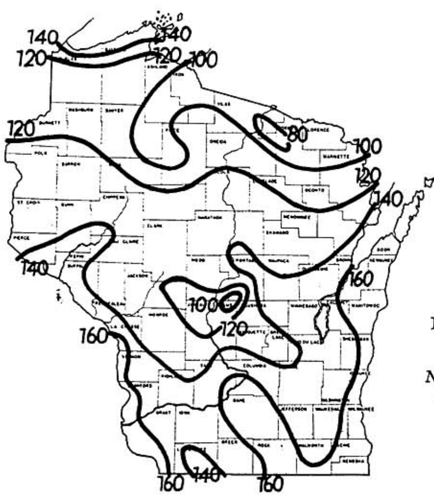
Average annual heating degree days to base of 65° F.

In Wisconsin, the number of degree days in a heating season average from a low of less than 7,000 for Kenosha County and the southern halves of Walworth and Rock Counties, to over 9,000 degree days for the counties along the Michigan boundary and Lake Superior.

Growing Season

The average number of days between dates of the last 32° freeze in the spring and the first in the fall is less than 100 in the extreme north central part of the state, less than 120 in the central marshlands, and greater than 160 along Lake Michigan, the south central counties, and the Mississippi River Valley south of La Crosse.

July, normally the warmest month, has had 32° or lower reported nearly half the years at some place in the state. The shorter growing season in the central portion is attributed to a number of factors, among them an inward cold air drainage and the low heat capacities of peat and sandy soils. The average date of the last 32° freeze in the spring ranges from early May in southern counties and along Lake Michigan to early June in northern counties. The average first 32° freeze in the fall occurs in early September in the north and central marshlands to mid-October along Lake Michigan.



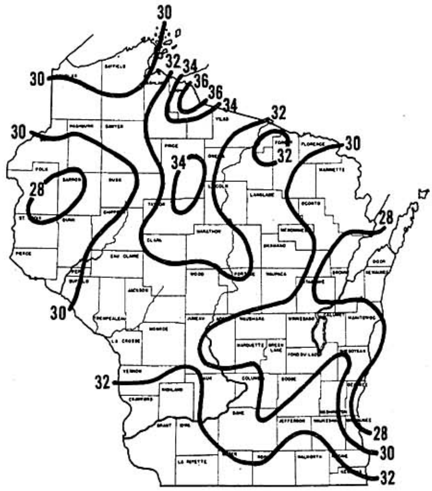
Map 11: **AVERAGE LENGTH OF GROWING SEASON**

Number of days between average dates of last 32° freeze in spring and first 32° freeze in fall.

Rain and Snow

Precipitation is normally adequate for the vegetation and economy of the state. Droughts do occasionally occur but are seldom widespread. Annual precipitation averages between 30 and 32 inches with the exception of the northwest, northeast, and east central sections where it has been between 28 and 30 inches. From one-half to two-thirds of the annual precipitation falls from May through September.

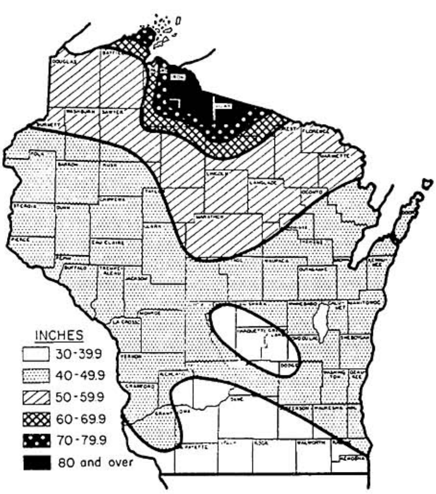
The wettest part of the year is June while the last part of December is the driest. The frequency of dry spells increases decidedly over the state late in August. Several dry weeks usually follow the late September rains. Most of the significant amounts of rain during July and August fall from thunderstorms that tend to be erratic and poorly distributed. The frequency of very light amounts of precipitation is greater in winter than in summer. Greatest precipitation intensities occur in June with a slight decrease in the probability of intensity in July.



Map 12: **MEAN ANNUAL PRECIPITATION**

Numbers stand for inches of precipitation.

Average winter snowfall ranges from 30 inches in extreme southern portion of the state to 100 inches or more along the steep northwest slope of the Gogebic Range. The differences in the state's seasonal snowfall is due in large part to the latitudinal temperature decrease northward, prevailing winds. topographic variations, proximity of large lakes, and winter storm tracks. Snowfall is highly variable; seasonal totals have ranged from a third or less of normal to more than twice normal. The mean dates of the first snowfall of consequence (an inch or more) varies from early November in northern counties to early December in southern counties. Snow cover during a winter can be expected about 90 per cent of the time in the north and about 65 per



Map 13: **AVERAGE SEASONAL SNOWFALL**

1930 to 1959

cent of the time in the south. In southern portions thaws usually melt the snow several times during a winter, but another snowfall often precedes the next cold wave. The probability of snow on the ground increases rapidly until the third week in December, after which time it gains only gradually until the middle of February, when it decreases rapidly.

Storms

The number of days in a year with thunderstorms averages about 40 in southern and west central counties and 30 in northern counties. Hail has fallen on an average of 2 days a year with individual years varying from none to 6 days or more. Occasionally these storms have been violent with heavy rain, hail, and damaging wind. The most destructive thunderstorms are more common in the southwest and west than elsewhere. Tornado occurrences have averaged 4 per year. Better observations and public awareness have increased in recent years, resulting in more tornadoes being reported. The state's tornado frequency is highest in June and July, followed in order by April, May, and September.

Prevailing winds are westerly from mid-fall through late spring, averaging between 10 and 13 miles per hour. The remainder of the year has southerly winds that average between 8 and 11 miles per hour. March and November, the transitional months, are the windiest while July and August are least windy. Highest wind speeds usually blow from the west.

THE SOILS OF WISCONSIN

Professors Marvin T. Beatty, Ingvald O. Hembre, Francis D. Hole, Leonard R. Massie, and Arthur E. Peterson

Department of Soils, University of Wisconsin*

Because of the importance of agriculture, dairying, and forestry to the economy of our state, soils are one of Wisconsin's most valuable natural resources. The soils in southern, eastern and western Wisconsin have responded very favorably to the careful husbandry practiced by most dairy farmers. They have helped to make Wisconsin America's Dairyland, because feed and forage for dairy cows could be produced on them with less expense than in some other regions of the United States. The value of other soils in the state for forestry, wildlife production, water management and outdoor recreation is only now beginning to be recognized.

Map 14 shows the 8 major soil regions of Wisconsin and Table 15 summarizes the principle land uses and land-use problems in each soil region. The factors responsible for soil formation and the important characteristics of major groups of soils—called soil associations—are described briefly for each of the 8 regions.

Wisconsin Soil and Water Conservation Needs

The *Soil and Water Conservation Needs Inventory for Wisconsin* was developed as a part of the *National Inventory of Soil and Water Conservation Needs* established by the Secretary of Agriculture.

The inventory was made under the supervision of a state conservation needs committee. It was developed on a county basis in co-operation with the local soil and water conservation district supervisors and their co-operating agencies. The Soil Conservation Service was designated by the Department of Agriculture to provide leadership in making the inventory.

The inventory is expected to provide an appropriate standard for each county's soil and water conservation activities. It is proposed as a guide for recommendations on future agricultural conservation programs and other programs involving the use of land. For information contact the local County Extension Office.

Tables 16 and 17 provide estimates of expected land use in Wisconsin by 1975 and the shifts which will take place.

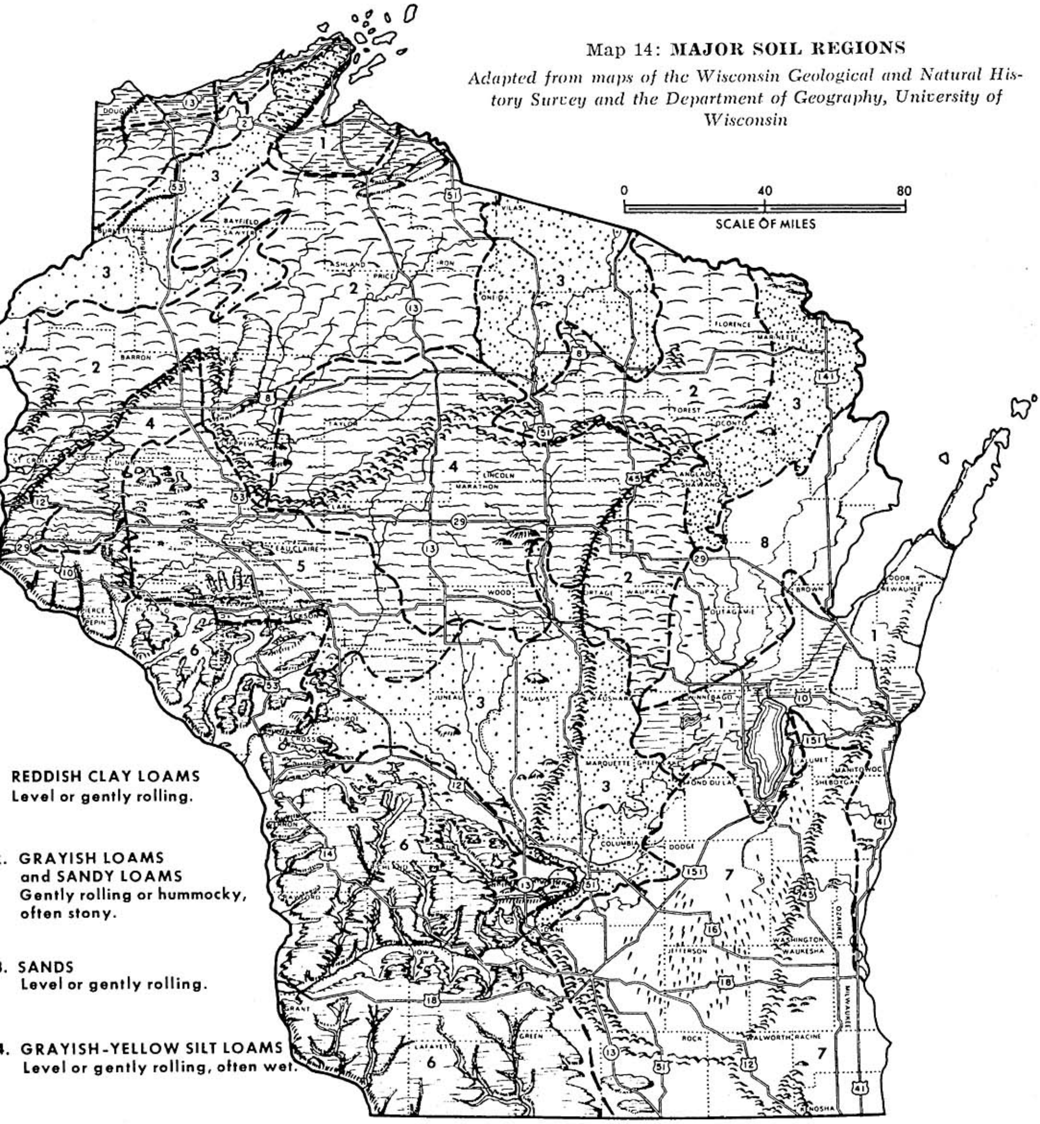
* Professors Beatty and Hole are also affiliated with the Wisconsin Geological and Natural History Survey, and Hembre with the State Soil and Water Conservation Committee.

Table 15: USES AND PROBLEMS OF MAJOR SOIL REGIONS

Major Soil Region	Principal Land Uses	Important Soil Management Problems
Region 1 Reddish Clay Loams. Level or gently rolling.	1. Dairy farming. 2. Fruit growing (Door Peninsula). 3. Canning crop production. 4. Small woodlots (in north-eastern Wis.) 5. Forestry (Lake Superior area). 6. Urban centers.	1. Clay soils are hard to till. 2. Soils erode readily on small knolls and steep slopes. 3. Wet soils usually need drainage. 4. Some northern soils need lots of lime for best growth of alfalfa. 5. Some soils require considerable fertilization with phosphate. 6. Clay soils cause some problems in urban areas.
Region 2 Grayish Loams and Sandy Loams Gently rolling or hummocky, often stony.	1. Forestry. 2. Limited dairy farming. 3. Recreation. 4. Intensive cash cropping to potatoes in local areas.	1. Irregular slopes, stones, low fertility, acidity and the short growing season all limit soil use for agriculture. 2. Wet soils are often difficult to drain and drainage is often economically unfeasible. 3. Subsoil pans limit plant growth. Pans cannot be broken economically. 4. Acidity and low soil fertility severely limit alfalfa production.
Region 3 Sands. Level or gently rolling.	1. Forestry. 2. Recreation. 3. Irrigated cash crops. 4. Dairy farming. 5. Cranberry production.	1. Soils are droughty. 2. Fertilizers must be used for agricultural crops and applications must be properly timed to minimize leaching. 3. Most peat is very acid and infertile. 4. Wind erosion occurs when land is bare. 5. Crops under irrigation require very careful soil management. 6. Drainage of sandy soils is difficult, since tile cannot be used.
Region 4 Grayish-Yellow Silt Loams. Level or gently rolling often wet.	1. Dairy farming. 2. Foresty (many farm woodlots).	1. Soils require improved surface drainage, liming and heavy potash fertilization if alfalfa is to be grown successfully. 2. Sloping soils need to have erosion control measures applied. 3. Stony soils are extensive.
Region 5 Sandy Loams. Gently rolling, hilly or steep.	1. Dairy farming. 2. Forestry. 3. Recreation. 4. Strawberry production.	1. Water and wind erosion need to be controlled more adequately. 2. Irregular slopes limit the use of contour strip cropping. 3. Many wet soils cannot be drained economically. 4. Most soils need heavier fertilization, especially with potassium.
Region 6 Grayish-Brown Unglaciated Silt Loams. Hilly or steep.	1. General livestock farming. 2. Forestry (many farm woodlots). 3. Recreation (along Mississippi River Valley).	1. Water erosion must be controlled more adequately. 2. Grazing of farm woodlots is undesirable and should be discontinued. 3. Potash fertilization is inadequate on many soils. 4. Many soils in valleys are flooded each year.
Region 7 Grayish-Brown Glaciated Silt Loams.	1. General livestock farming. 2. Forestry (mostly farm woodlots). 3. Canning and vegetable crop production. 4. Urban centers. 5. Recreation.	1. Soil erosion is not fully controlled. 2. Grazing of farm woodlots is undesirable and should be discontinued. 3. Some soils need more lime, others need more fertilizers, especially potash. Some need both. 4. Urban sprawl is wasting some good agricultural land.
Region 8 Pink Loams.	1. Dairy farming. 2. Forestry (many farm woodlots). 3. Recreation.	1. The sandy soils are somewhat droughty. 2. Many of the wet soils need drainage if they are to be used successfully for agriculture. 3. Wind and water erosion are not fully controlled. 4. Many soils need heavier fertilization with phosphate and potash. Some soils need lime.

Map 14: **MAJOR SOIL REGIONS**

Adapted from maps of the Wisconsin Geological and Natural History Survey and the Department of Geography, University of Wisconsin



REDDISH CLAY LOAMS
Level or gently rolling.

GRAYISH LOAMS and SANDY LOAMS
Gently rolling or hummocky, often stony.

SANDS
Level or gently rolling.

GRAYISH-YELLOW SILT LOAMS
Level or gently rolling, often wet.

5. SANDY LOAMS
Gently rolling, hilly or steep.

6. GRAYISH-BROWN UNGLACIATED SILT LOAMS
Hilly or steep.

7. GRAYISH-BROWN GLACIATED SILT LOAMS
Nearly level or rolling.

8. PINK LOAMS
Nearly level or rolling.

Table 16: LAND USE OF INVENTORIED ACREAGE IN 1958, AND EXPECTED USE IN 1975

Land Group	1958 Acreage	1975 Acreage
1. Cropland	12,470,822	12,016,147
2. Pasture and Range	3,211,607	2,791,968
3. Forest and Woodland	13,917,421	13,944,629
4. Other Land	2,011,083	2,014,387
Net change in land use		843,802
TOTAL	31,610,933	31,610,933

Table 17: ESTIMATED LAND USE CONVERSIONS, WISCONSIN, 1958 TO 1975

Item	Cropland (in acres)	Pasture (in acres)	Forest and Woodland (in acres)	Other Land (in acres)	Total (in acres)
1958 inventory acreage	12,470,900	3,211,600	13,917,400	2,011,100	31,611,000
1958 inventory acreage* expected to be used in 1975 as:					
Cropland	11,335,600	426,300	204,300	50,000	12,016,200
Pasture	233,300	2,342,100	201,200	15,400	2,792,000
Woodland	364,900	272,200	13,174,300	133,200	13,944,600
Other	122,500	90,900	93,300	1,707,700	2,014,400
Out of inventory acreage	414,600	80,100	244,300	104,800	843,800

* As an example, the 12,470,900 acres of cropland included in the "1958 inventory acreage" are expected to be found in the following uses in 1975: 11,335,600 acres are expected to remain in cropland; 233,300 acres in pasture; 364,900 acres in woodland; and 122,500 acres diverted to other uses.

Source: Information taken from County Soil and Water Conservation Needs Inventory Reports.

Region 1. Reddish Clay Loams

Shaded areas indicate the approximate location of reddish clay loams.

Soil Forming Factors

Soil Parent Material. Most of the soils in Region 1 have formed from fine textured glacial deposits. These deposits are reddish-brown and are high in calcium and magnesium carbonates (lime). They were deposited by Valders glacial advance about 11,000 years ago. Sand ranging from a few inches to several feet in thickness, and patches of wind-laid silt, overlie the glacial deposits in local areas.

Topography. Most of this region has low relief. Steep slopes are largely confined to the Niagara escarpment and to the edge of the lowland bordering Lake Superior. Because of this low relief, and the low permeability of some of the fine textured parent materials, wet soils are extensive. They are most common in broad depressions, small potholes and on gentle slopes. Often they are intricately intermingled with soils which are well drained.

Native Vegetation. The natural vegetation in the Fox River Valley and near Lake Michigan consisted of mixed hardwoods (mostly maple and basswood) with some hemlock, white pine and other conifers. Near Lake Winnebago some small prairies occurred. Near Lake Superior spruce, fir and hemlock formed the predominant vegetation.

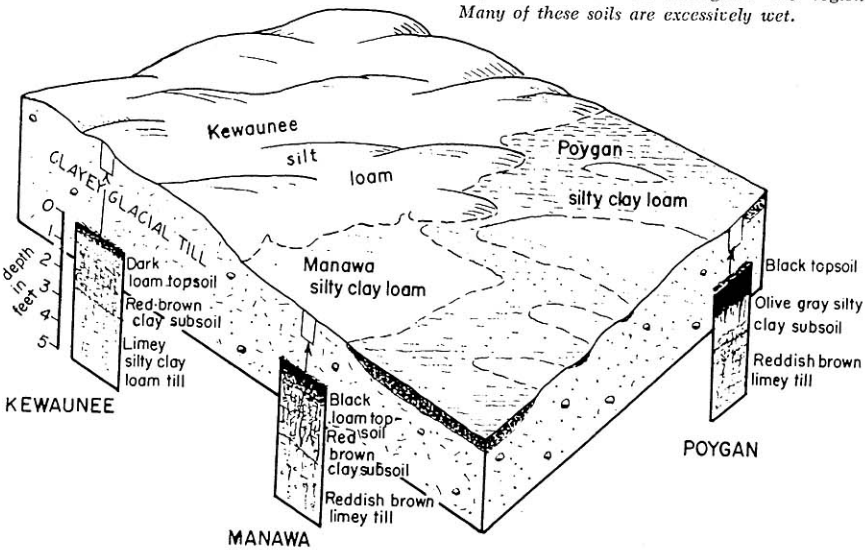
Climate. Soils are most strongly leached throughout the part of the region adjacent to Lakes Superior and Michigan where the climate is coolest. Some of the action of climate may have been indirect, since hemlocks and other coniferous trees formed a greater proportion of the vegetation near the lakes where summer temperatures are coolest. Hemlocks and other conifers are apparently more conducive to the development of leached soils with a distinctive light gray layer in the subsoil than are maple and basswood trees.

Major Soil Associations

Unique combinations of the soil forming factors including climate, parent materials, native plants and animals, topography and time have

Region 1

Diagramatic soil profiles and landscape of the Kewaunee, Manawa, Poygan soil association. Reddish clayey soils underlain by limey glacial deposits are common throughout the region. Many of these soils are excessively wet.



given rise to unique groups of soils called soil associations. The most extensive in this region is the Kewaunee, Manawa, Poygan association which occurs throughout that portion of the region which adjoins Lake Michigan. The names Kewaunee, Manawa and Poygan refer to soil series. Soil series are carefully defined units which form the lowest level of the classification scheme for soils. Soil series are named after towns, villages, cities, rivers, lakes or counties near where they were first studied and defined.

The *Kewaunee* series has the best surface and internal drainage of the 3 soils in the association. Kewaunee soils usually occur on convex slopes and are often eroded. There may be considerable variation in texture of the surface soil, but the subsoil is almost always a reddish-brown clay. At depths of 16 to 24 inches this grades into calcareous glacial till which has been only slightly affected by soil forming processes.

Manawa soils are somewhat wet. They usually occur in small drainage-ways and along the edges of large depressions. The surface soil is thicker and darker colored than that of the Kewaunee and the subsoil is less reddish and may be mottled or variegated in color.

Poygan soils are very poorly drained. They have a thick black clay surface, a gray calcareous clay subsoil and are underlain by reddish calcareous clay. They usually occur in depressional areas where surface water accumulates and ground water is high.

A large number of other soil series occur less extensively in the northeastern part of the region. Shallow soils over limestone are very extensive on the Door Peninsula.

The most extensive soil association in the northern part of the region is made up largely of the Ontonagon, Pickford and Bergland series. These soils, like the Kewaunee, Manawa and Poygan, vary principally in surface and internal drainage. This variation in drainage has strongly influenced humus accumulation in the surface soil. Ontonagon soils, which have the best drainage, contain very little humus after being cleared. The gray, acid surface soil is underlain by a reddish clay subsoil. Pickford soils are somewhat poorly drained, and often contain considerable humus in the surface soil. Bergland soils are very wet, and are high in humus in the surface layer. All 3 of these soils are high in clay and are underlain by calcareous clayey glacial deposits. Much of this area has very gentle slopes and many fields contain numerous small depressions. In these cases bodies of Ontonagon, Pickford and Bergland soils are intricately intermingled.

Sandy soils occur where a thin covering of sand overlies fine textured glacial deposits. Where the sand covering over the clay is thin, many of the soils are wet.

Region 2.
Grayish Loams and Sandy Loams

Shaded areas indicate the approximate location of grayish loams and sandy loams.

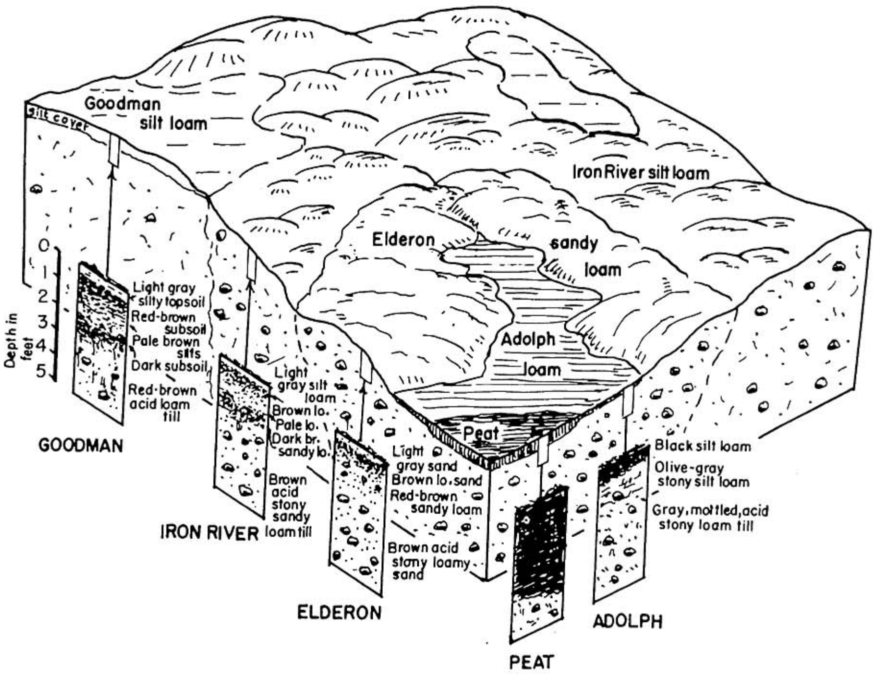
Soil Forming Factors

Soil Parent Materials. Soil parent materials in Region 2 are mostly glacial deposits, which were derived mostly from local bedrock formations. Dark colored stones derived from these bedrocks are common in and on the soils. In much of the area the glacial deposits have been covered by one-half to 2 feet of wind blown silt, or loess. Many of the depressions in the area which were formerly occupied by lakes have been filled by partially decomposed plant remains which form the parent materials for organic soils.

Topography. Most of this area has rolling topography with low to moderate relief. The most prominent exceptions are the hills of the

Region 2

Diagramatic soil profiles and landscape of the Goodman, Iron River, Elderon, Adolph, peat soil association. Most of the soils in this region are acid, stony, shallow, and medium textured.



Gogebic iron range and the Blue Hills in western Rusk and eastern Barron Counties where slopes are steep and there is considerable relief.

Vegetation and Climate. Soils in this region have developed under a cover of conifer-hardwood vegetation in a relatively cool moist climate. This combination of factors has contributed to the accumulation of a thin layer of raw and partly decomposed organic matter on the surfaces of the soils. This organic layer promotes rapid leaching of iron and several other elements by water.

Soil Associations

The most extensive group of soils in this region is the Iron River, Goodman, Elderon, Adolph peat soil association. Iron River soils occur on nearly level to steep slopes in the uplands. They are well drained and acid throughout. The surface soil is light gray, platy, and ranges in texture from sandy loam to silt loam. Immediately below this is a loam or sandy loam layer which has been colored reddish-brown by deposits of iron oxides and organic matter. Below this reddish-brown layer is grayish compact zone, called a fragipan which ranges from

3 to about 15 inches in thickness. Stones are common in and on Iron River soils. Goodman soils are very similar to Iron River, but are silty rather than loamy to a depth of 3 feet or more. Elderon soils are very shallow and very stony. They normally occur on steep ridges of glacial till.

Adolph soils and peat occupy many of the wet depressions in this region. Where the depression contains peat, Adolph soils frequently occupy the periphery. Adolph soils have a black medium textured surface layer 8 to 12 inches thick. Below this the soil is light gray, is loamy or silty for a foot or more and gradually grades into reddish glacial till. The peat soils of this region are nearly all acid. Most of them have formed from the remains of sedges, reeds and trees. Some have a thin layer of moss on the surface.

In the western part of this region the Milaca, Cloquet, peat soil association is widespread where slopes are irregular, short, and steep. *Milaca* soils are very similar to the Iron River soils described previously, but have developed in a more coherent sandy loam material. *Cloquet* soils differ from Milaca chiefly in being more sandy throughout. Peat occurs in the many small depressions.

Region 3. Sands

Shaded areas indicate the approximate location of sandy soil areas.

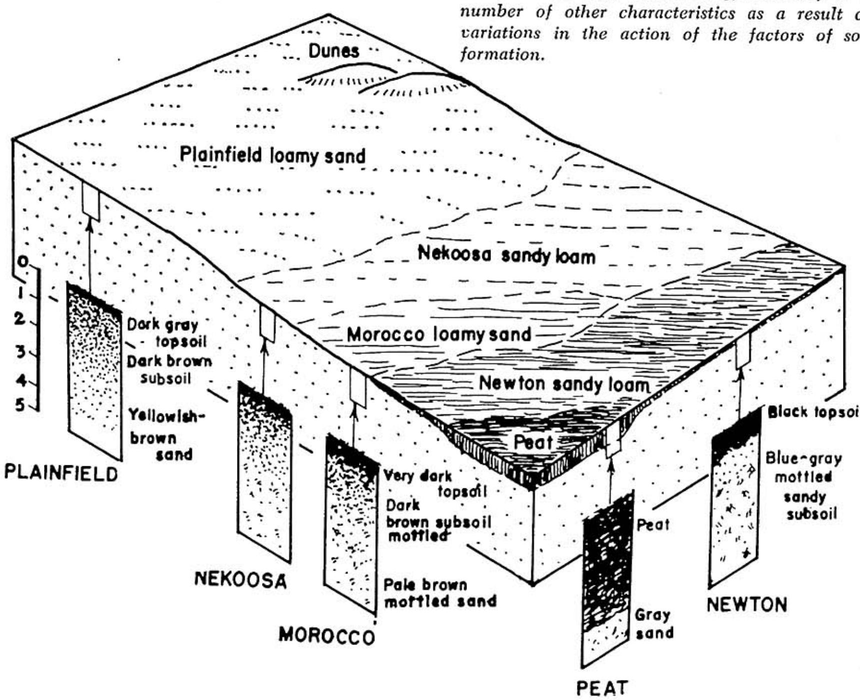
Soil Forming Factors

Soil Parent Materials. Sandy parent materials have had by far the greatest influence on the properties of these soils. These sandy materials were originally derived from the Cambrian and Lake Superior sandstone formations. In parts of Region 3 the sandy parent materials were deposited by glacial ice, while in other parts they were deposited by water. The surfaces of many of these sandy soils have probably been extensively reworked by wind.

Native Vegetation and Topography. Prior to the coming of white settlers most of these sandy soils supported a vegetative cover of jack pines or a combination of scattered pines, scrub oak and grasses called a savanna. Considerable leaching of soluble compounds has occurred, because water moves downward through these soils very readily. This region as a whole has low relief, but short steep slopes occur locally.

Region 3

Diagramatic soil profiles and landscape of the Plainfield, Nekoosa, Morocco, Newton, peat soil association. Most of the soils in this region are sandy. They vary considerably, however, in a number of other characteristics as a result of variations in the action of the factors of soil formation.



Major Soil Associations

In the extensive south central part of this region there are 2 dominant groups of soils. Plainfield, Nekoosa, Newton and peat soils occur in areas where sandy sediments were deposited primarily by water. In areas where soil materials were deposited primarily by ice the Lapeer, Wyocena and Oshtemo soils are most extensive.

Plainfield, Nekoosa and *Newton* soils are sandy throughout. In the Plainfield, the sand which makes up the top 6 to 12 inches of the soil has been darkened by organic matter, and the sand in the next 12 to 20 inches has been reddened by iron oxide. Nekoosa and Newton soils are similar to Plainfield in being extremely sandy, but differ by having subsoils which are periodically saturated by high ground water. Shallow peat, which often occurs in association with the Newton, has resulted from a more extreme high water table condition. The largest area of Nekoosa, Newton and peat soils is in northern Juneau, northern Adams, southern Wood and eastern Jackson Counties.

Lapeer, Wyocena and *Oshtemo* soils all have more silt and clay in the subsoil than Plainfield soils. In the case of the Lapeer, the surface soil is also less sandy. These 3 soils generally occur on nearly level to rolling slopes. In many places these soils have been eroded by wind and water.

In the northern parts of this region *Vilas, Omega, Pence* and peat soils are most common. Vilas and Omega soils are extremely sandy. They each have very thin dark-colored surface layers and sand subsoils which are reddish-brown. In addition, the Vilas soils have a thin layer of light grayish sand between the dark-colored surface and the reddish subsoil. Pence soils are less sandy than either the Omega or the Vilas, especially in the subsoil. Many of the depressions in this part of the region contain acid peat formed from partially decomposed remains of reeds, sedges and trees.

Region 4. Grayish-Yellow Silt Loams

Shaded areas indicate the approximate location of grayish-yellow silt loams.

Soil Forming Factors

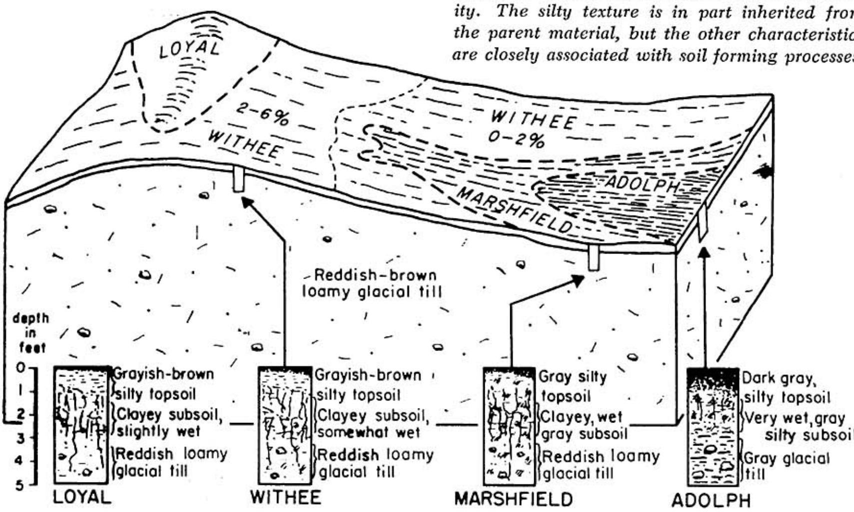
Soil Parent Materials. All of Region 4 has been glaciated during the Pleistocene, and glacial deposits are important soil parent materials. The glacial drift was largely derived from the local metamorphic rocks of the northern Wisconsin highlands. In the vicinity of Wausau the glacial till is locally thin or absent and the soils have formed in part from underlying granitic and metamorphic rocks. In most of the region the glacial drift has been covered by one to 3 feet of silty wind-deposited material called loess.

Topography. Large parts of this region have typical glacial topography with low relief and long gentle slopes. The prominent terminal moraine which bisects Taylor County is an exception. Here slopes are short, irregular and usually steep. Steep slopes are also common around Rib Mountain and along the escarpment in western Dunn County.

Native Vegetation and Climate. Before the white settlers arrived nearly all of this region was forested with typical northern hardwoods and conifers. This forest cover and the relatively cool moist climate promoted the formation of a thin mat of raw and partially decomposed organic matter on the soil surface and accentuated leaching of the soils.

Region 4

Diagramatic soil profiles and landscape of the Loyal, Withee, Marshfield, Adolph soil association. The dominant characteristics of soils in this region are silty texture, wetness and strong acidity. The silty texture is in part inherited from the parent material, but the other characteristics are closely associated with soil forming processes.



Major Soil Associations

One of the principal groups of soils in this region is the Withee, Marshfield, Adolph association which occupies most of the landscape in northern Wood, western Marathon, Clark, southern Lincoln and southeastern Taylor Counties.

Withee silt loam is the most extensive soil. It occurs on the crests and side slopes of most of the upland ridges. Withee soils have a grayish silt loam surface layer which is often platy. The strongly acid loamy subsoil is mostly grayish in color, but contains numerous reddish and yellowish spots called mottles. This color pattern is a result of periodic saturation of the subsoil by water. The lower subsoil has developed in dense reddish-brown loam glacial till. Water moves downward through this soil extremely slowly.

The *Marshfield* and *Adolph* soils differ from the Withee chiefly by being wet more of the time. Because of this greater wetness they tend to have grayer subsoils. Adolph soils are extremely wet and have large amounts of organic matter in the upper foot. Marshfield and Adolph soils occur mainly in areas where extra water accumulates from nearby areas of higher ground. Unless artifically drained, Marshfield and Adolph soils are saturated with water for long periods of time each year.

In the portions of this region located in Price, Rusk, Barron, St. Croix and northwestern Taylor Counties the loess deposit was usually thicker and most of the soils are silty to a depth of 2 to 4 feet.

The principal soils of this area are the *Otterholt, Spencer, Almena* and *Auburndale* silt loams. In their most important characteristics the Almena and Auburndale soils are very similar to the Withee and Marshfield soils, respectively. The Spencer and Otterholt soils have better subsoil drainage than the Almena and Auburndale soils. Their subsoils, therefore, exhibit less of the variegated grayish and reddish patterns which are characteristic of most poorly drained soils.

In central Marathon County a group of soils which have developed in part from weathered bedrock are common. These soils usually have one to 3 feet of silty or loamy material over the weathered bedrock. Slopes in this area are long and often quite steep. Most of the soils are well drained.

Region 5. Sandy Loams

Shaded area indicates the approximate location of sandy loam soils.

Soil Forming Factors

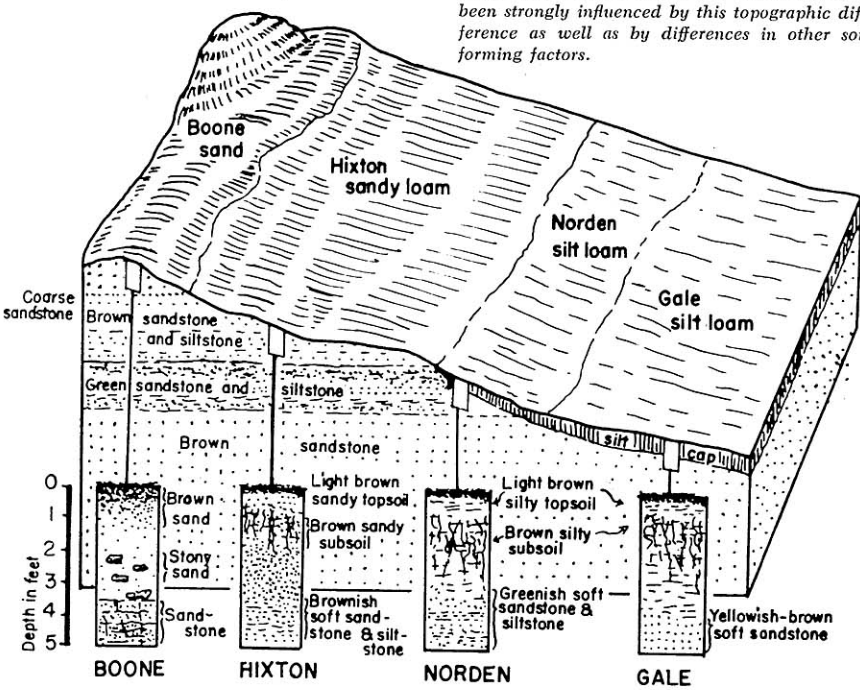
Soil Parent Materials. Most of the parent materials for soils in Region 5 are Cambrian sandstones or sands derived from weathered sandstones. Some sandy glacial deposits occur in the northwestern part of the region. In a few places wind-blown silt has been deposited over the sandy materials, and medium textured soils have been formed.

Topography. The topography of the region varies considerably. In most parts of northeastern Jackson, southwestern Clark and western Wood Counties geologic erosion has reduced the landscape to a nearly level plain. Isolated high erosion remnants locally called "mounds" occur throughout the plain. Further west the landscape has more relief. The sandstone has been partially dissected by geologic erosion, and slopes are irregular and range from nearly level to steep.

Native Vegetation. Before this region was cleared it contained a variety of native plant associations. Some of the more exposed and droughty sites were occupied by scrub oak. Other sandy soils supported jack pine, Norway pine and white pine. In the eastern part of the region where many wet soils occur, hardwoods were interspersed among the conifers. On some of the less sandy soils in the west side of the region an oak-hickory plant association was dominant.

Region 5

Diagramatic soil profiles and landscape of the Boone, Hixton, Norden, Gale soil association. This region of sandy soils is hilly and steep in the western portion and nearly level in much of the eastern portion. The soils of this region have been strongly influenced by this topographic difference as well as by differences in other soil forming factors.



Major Soil Associations

The Kert, Vesper, Veedum, Humbird soil association is very extensive, in the eastern part of this region where the sandstone often contains shale strata. The shale layers together with the flat slopes, have caused many of the soils to be wet.

Kert soils have formed mainly from silts and shaley materials and are usually medium textured. They usually occur on nearly flat slopes and are somewhat poorly drained. In undrained depressions and flats of the area the poorly drained *Vesper* soils and the very poorly drained *Veedum* soils occur. They both have surface soils which are high in humus, and wet gray subsoils underlain by shaley sandstone. In areas where the sandstone is less shaley and where the silt covering is missing the moderately sandy *Humbird* soils occur. Water drains through these sandy Humbird soils readily.

In the hilly and steep portions of this region the Boone, Hixton, Norden soil association is dominant. They have all formed primarily from sandstone. *Boone* soils are very sandy and usually shallow. They have a thin surface which has been enriched by humus. Below this is a layer of reddish-brown loose sand. This loose sand may grade into sandstone at depths of one to 4 or 5 feet. Boone soils are infertile, very droughty and are easily eroded.

Hixton soils are less sandy and usually deeper than Boone soils. *Norden* soils have formed where the sandstone contained a greenish mineral called glauconite. This mineral is associated with shaley layers in the sandstone. Norden soils may be medium textured or moderately sandy. Norden and Hixton soils occur on a wide variety of slopes. Many of them have been severely eroded.

In the northern part of this region some thin glacial deposits occur. Some soils of this area have formed from both loamy glacial till and weathered sand from sandstone.

Sandy soils formed from water-deposited sandy materials are extensive along the Red Cedar, Chippewa and Black Rivers and their major tributaries. In some areas the soils are almost entirely sand, while in others the sand has been mixed with silt and clay to form sandy loams and loams. Slopes are mostly nearly level or gently undulating.

Region 6.

Grayish-Brown Unglaciated Silt Loams

Shaded area indicates the approximate location of grayish-brown unglaciated silt loams.

Soil Forming Factors

Soil Parent Materials. The soils of Region 6 are distinctive because of properties which reflect the native vegetation, the materials from which the soils have formed and the wide range of slopes occurring in the region.

Topography. The wide range of slopes is the result of a great deal of local relief. Often the bottoms of valleys are 500 to 600 feet lower than the tops of nearby ridges. The bold topography of this region exists today because glacial ice had little effect throughout this part of the state.

Native Vegetation. The principal kinds of vegetation which have influenced soil formation are prairie, oak-hickory forestry and oak savannas.

Soil Parent Materials. Soils in this region have been derived largely from 4 kinds of material: (1) clay residue weathered from limestone, (2) weathered sandstone, (3) wind-laid silt called loess and (4) stream-laid sand and gravel. The first 3 of these materials are extensive throughout the region, whereas, stream-laid sands and gravels occur only locally along the valleys of large streams much as the Mississippi, Wisconsin and Chippewa Rivers and their major tributaries.

Sandstone and limestone are the predominant bedrocks throughout this region and, were it not for the wind-laid silt which was deposited during glacial times, soils would have been derived primarily from clay and sand. The wind-laid silt was blown out of valleys of the major rivers and covered the uplands and valley slopes to depths ranging from one to several feet.

Major Soil Associations

The Dubuque, Fayette, rough broken land association occurs widely throughout the region wherever limestone forms the bedrock and the native vegetation was deciduous hardwoods. On the top and side

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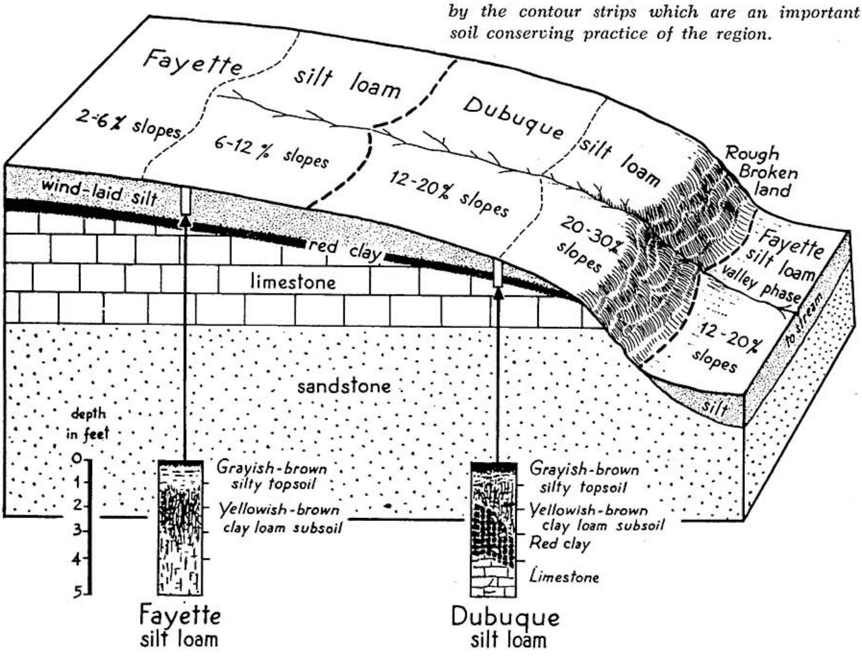
Region 6

Diagramatic soil profiles and landscape of the Fayette, Dubuque soil association. This region of the state has a distinctive and beautiful landscape pattern. The pattern has been enhanced by the contour strips which are an important soil conserving practice of the region.



slopes or flanks of upland ridges *Dubuque* and *Fayette* silt loams are extensive. The weathered loess is shallow in Dubuque soils, ranging from one to 3 feet in thickness. Clay weathered from limestone and the partly weathered limestone itself occur below the weathered loess. Fayette silt loam has formed over clay and limestone where loess was greater than 3½ or 4 feet thick, usually near the tops of ridges.

A steep escarpment of very stony land generally occurs below the edges of these rounded ridges and separates the ridge tops from the valleys. These escarpments may be only a hundred feet or so in width or they may be several hundred feet wide in areas of steep relief.

Soils in the Dodgeville, Sogn, Tama soil association are dark-colored in the upper one to one and one-half feet. They occur whereever prairie vegetation was dominant. *Tama* and *Dodgeville* soils occur on broad tops of limestone ridges where the loess covering is from one to 5 feet or more in thickness. On steep slopes where the loess covering becomes almost nonexistent, very shallow *Sogn* soils are common. Dodgeville, Tama and Sogn soils tend to occupy the broader ridges and less sloping portions of the landscape than do the lighter-colored Dubuque and Fayette soils described previously. Many are south of the Wisconsin River along the Military Ridge and its various associated ridges.

The Gale, Norden, Fayette, valley phase soil association occurs where sandstone is the dominant bedrock, as in parts of Jackson, Trempealeau, Buffalo and La Crosse Counties. The sandstone in this area has weathered to form narrow, irregular ridges. Slopes on these ridges are often irregular and hummocky due to difference in the hardness of the sandstone which influenced the rate at which it weathered. Soils in this region have formed from a combination of the loess, mentioned previously, and sandy material weathered from the sandstone. Where there is a covering of silty material derived from loess 2 feet or more in thickness Gale and Norden soils are common. The *Gale* soils are underlain at depths of 2 to 3 feet by weathered sandstone which is reddish or buff in color. The *Norden* soils are very similar, but the lower subsoil has formed from a greenish shaley sandstone which continues the mineral glauconite. Near the lower slopes of the valleys where the silt covering is quite thick *Fayette* valley phase soils occur.

Soils along many of the major streams have nearly level slopes. Some of these soils are formed from loess and are silty to a depth of 3 or 4 feet. In other cases the soils are sandy, having formed almost entirely from water-laid sands and gravels. Wet silty soils which are subject to frequent overflow are common along the bottoms of many of the narrow steep-sided valleys. In many valleys dark-colored Prairie soils have been covered by lighter colored sediments since the clearing of the country by the white settlers.

Region 7. Grayish-Brown Glaciated Silt Loams

Shaded area indicates the approximate location of grayish-brown glaciated silt loams.

Soil Forming Factors

Soil Parent Materials. Nearly all of the soils in Region 7 have been formed, at least in part, from glacial materials. In the western part of the region these glacial deposits have been covered by one to 4 feet of wind-blown silt or loess. In the eastern part the loess is thin or absent.

Glacial deposits vary considerably within this region. Along Lake Michigan the glacial till is calcareous and high in clay. Extensive sand and gravel deposits left by glacial melt waters occur in and adjacent to the Kettle Moraine. West of this moraine the glacial till is mostly a calcareous loam, although some rather sandy till occurs along the extreme western edge of the region in Columbia, Dane and Rock Counties.

Topography. Most of this area has low relief and slopes are dominantly from near level to rolling. The stream drainage system is poorly developed and undrained depressions are common. Much of the Kettle Moraine and the western edge of this region in Dane and Rock Counties have considerably more relief and a more mature drainage system than the rest of the region.

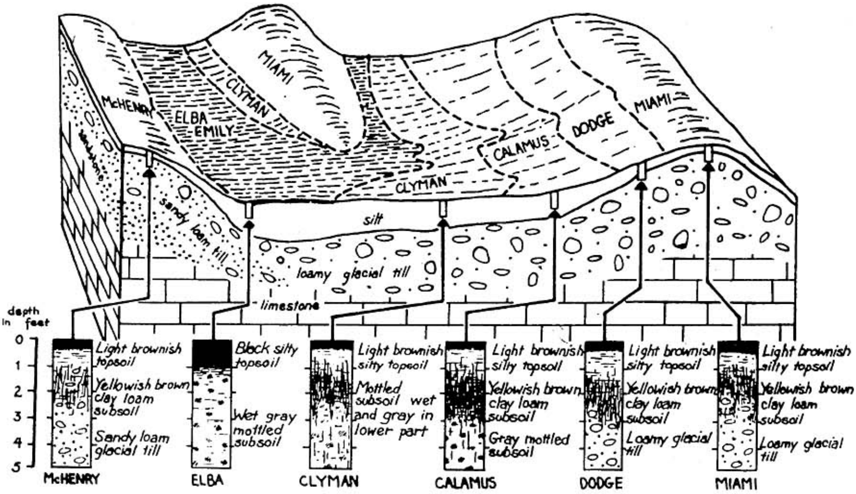
Native Vegetation. Oak-hickory forests and oak openings or savannas were the dominant vegetative cover in this region. Tracts of prairie vegetation were also extensive. These vegetative differences have had considerable influence on the soils.

Major Soil Associations

One of the most extensive soil associations in this region includes a group of soils most of which have formed from loess and loamy glacial till under a cover of forest vegetation. On drumlins and other upland ridges the principal members of the association are *Dodge, Miami* and *McHenry* silt loams. Most of these 3 well drained soils

Region 7

Diagramatic soil profiles and landscape of the McHenry, Miami, Dodge, Calamus, Clyman, Elba soil association. This region contains a variety of soils, most of which are well suited to crop production. Nearly all of these soils have silt loam surface layers which are underlain by finer textured subsoils.



have surface soils of silt loam texture. Their subsoils differ somewhat in thickness and color, but all contain more clay than the surface soils or the underlying glacial till. Free lime may be encountered at depths of 2 to 4 feet.

On gentle slopes, usually near the edges of lowlands, the somewhat poorly drained *Clyman* silt loam occurs. It differs from the Dodge, Miami and McHenry soils principally by being silty to a greater depth, wetter, and by having a more grayish subsoil and a slightly thicker darker surface.

Most of the depressions in this region contain poorly drained soils. *Elba* silty clay loam is the most extensive of these. Unlike the other soils of this association it has formed under a cover of swamp grasses. It has a black surface which is often a foot or more thick. Below this is a thick bluish-gray subsoil which contains yellowish and reddish spots in the lower portion.

In Milwaukee, Racine, Kenosha and eastern Waukesha Counties the Morley, Elliott, Blount, Ashkum soil association occupies most of the landscape. These soils are all high in clay, especially in the subsoils; as is the underlying glacial till. They all have restricted subsoil drainage. *Morley* silt loam usually occurs on the most sloping portions of this area and is moderately well drained. *Blount* and *Elliott* silt loams are common on many of the nearly level slopes. Both of these soils are somewhat poorly drained and have noticeable variegated color patterns of reddish and yellowish spots in their subsoils. The surface soils differ greatly in color. In the Elliott the surface is nearly black for about a foot; whereas, the Blount has a lighter colored surface. This color difference results from a difference in native vegetation. Blount soil developed under forests; Elliott under prairies.

Prairie vegetation has also influenced the development of a distinct association of soils in the loam till region described previously. Here the Waupun, Parr, Bristol and Elba soils are common. The *Waupun* and *Parr* soils are very similar to the Dodge, McHenry and Miami soils described previously, but have noticeably thicker, darker surface layers and less clay in their subsoils. *Bristol* silt loam is very similar to Clyman silt loam, but has a thicker and darker surface. Elba silty clay loam occurs in depressions in association with these prairie soils as it does with the Dodge, Miami, McHenry and Clyman.

Soils underlaid by sand and gravel are extensive in and adjacent to the Kettle Moraine. The principal soils are the Casco, Rodman, Fox, Warsaw and Wea. *Rodman* gravelly sandy loam is a very shallow soil which consists almost entirely of gravel and sand. It occurs on steep convex slopes, often in close association with *Casco* soils which consist of one to one and one-half feet of loamy material over sand and gravel. *Fox, Warsaw* and *Wea* soils are medium textured and considerably deeper. Fox soils developed under forests have a lighter colored surface than do Wea and Warsaw soils which formed under prairies.

Region 8. Pink Loams

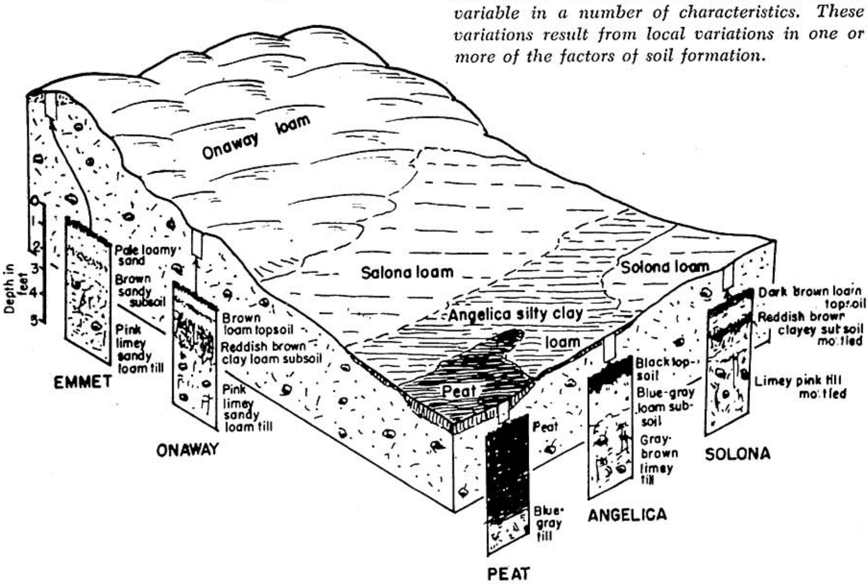
Shaded area indicates the approximate location of pink loams.

Soil Forming Factors

Soil Parent Materials. Region 8 had been glaciated during the Pleistocene; most recently by the Valders ice advance which occurred about 11,000 years ago. Most of the soil parent materials are, therefore, of glacial origin. The glacial ice deposits (tills) have been influenced by the limestone and sandstone bedrock formations which occur in the region. Medium textured calcareous glacial tills have

Region 8

Diagramatic soil profiles and landscape of the Onaway, Emmett, Solona, Angelica, peat soil association. The soils of this region are widely variable in a number of characteristics. These variations result from local variations in one or more of the factors of soil formation.



been formed from limestones, while sandy tills were formed from sandstones. Many soil parent materials in this region have been deposited by streams or in lakes.

Climate and Native Vegetation. This region has a subhumid climate with summer temperatures which are cooler than those further south and west in the state. Climate has influenced the native vegetation and the soil. Native vegetation was a maple-pine association which included numerous other species such as basswood, hemlock and yellow birch. The climatic-vegetative combination has resulted in the development of a thin mat of raw and decomposing organic matter on the ground surface. Some of the decomposition products of this organic layer have promoted considerable leaching of iron and related elements in the soils.

Topography. Most of this region has low relief and gentle slopes. Surface drainage by streams is often poorly developed and wet mineral and organic soils are very extensive.

Major Soil Associations

The most extensive soil association in this region includes Onaway, Emmett, Solona, Angelica and peat soils. This association is common in the gently rolling uplands and intervening very poorly drained depressions.

Onaway soils are well drained and are usually medium textured. The surface layer which contains considerable organic matter and is dark in color, is usually one to 3 inches thick in unplowed soils. Below this the soil is light grayish in color for several inches and then becomes distinctly reddish-brown. Most of this soil has formed in glacial till which contains numerous stones and gravels. Free lime occurs at depths of 2 to 3 feet. *Emmett* soils are similar to Onaway but are somewhat more sandy.

Solona soils occur on gentle slopes in areas where high ground water saturates the subsoil periodically. The subsoil layers in Solona soils show the effect of this periodic saturation. They are grayer than subsoils of Onaway soils and usually have reddish and yellowish spots (mottles).

Angelica soils are very wet. They have a 6 to 12-inch thick black surface layer which contains a great deal of organic matter. This layer grades into a distinctly gray subsoil which is saturated with water most of the time unless artificially drained. Angelica soils may be sandy or of medium texture. Peat often occurs in undrained depressions in close association with Angelica soils. This peat has formed from the partly decomposed remains of reeds, sedges and trees. It is usually brownish in color and slightly acid to slightly alkaline in reaction.

This region contains many soils which have formed from sediments deposited by water. These soils range in texture from fine sand to clay. Textured variations often occur in a layered or stratified pattern within a given soil. Many of these soils are wet and must be drained artificially before they can be used for agriculture. A belt of such wet sandy soils occurs along the north shore of Green Bay.

THE PHYSICAL GEOGRAPHY OF WISCONSIN

Professor Robert F. Black
Department of Geology, University of Wisconsin

On the basis of the kinds of rocks and the topography they produce, Wisconsin may be divided into 2 general geomorphic regions—northern and southern. The Northern Highland region is part of the Laurentian Upland or pre-Cambrian shield. This is the southernmost extension of a vast area of northern and eastern Canada. In it a complex of igneous and metamorphic rocks is more than 600 million years old and represents the roots of ancient mountains. Among the rocks represented are various kinds of granite, granitic gneiss, rhyolite, basalt, and metasediments. The southern region is part of the Central Plains Region which extends southward along the Mississippi River drainage. It contains flat-lying sedimentary sandstones, shales, and dolomites lithified from sediments laid down in ancient oceans 300 to 600 million years ago. Those rocks constitute the Paleozoic section of Wisconsin.

Topography

The topography of the shield area or "Northern Highland" is characterized by irregularities and low to moderate relief averaging perhaps 200 feet. The general elevation is 1,400 to 1,650 feet. Familiar high points are Rib Mountain at Wausau and Sugarbush Hill near

Map 15: **GEOMORPHIC REGIONS OF WISCONSIN**

Laona, each about 1,940 feet above sea level. In 1962, the United States Geological Survey established that Tim's Hill with the Ogema fire tower on top and nearby Pearson Hill are 1,952.9 and 1,951.1 feet respectively, the 2 highest known elevations in the state.* The topography of the southern region is perhaps more uniform locally than the northern, but it varies markedly within the region. Because of that variation, it is convenient to subdivide it further (see Map 15) into: 1. Southwestern Upland, 2. Central Plain, and 3. Eastern Ridges and Lowlands. In the deeply dissected Southwestern Upland the general elevation is 1,000 to 1,250 feet above sea level. The highest points reach 1,450 feet and the lowest valleys, tributary to the Mississippi River, are cut below 700 feet. Relief commonly approaches 500 feet along the steep-sided valleys. Rocky bluffs, castellated spurs, and rock monuments provide some of the most striking scenery in the state. In the Central Plain, as the name implies, flat surfaces or gently rolling surfaces are characteristic. Relief is low except for occasional pinnacles and hills of sandstone here and there like a child's blocks on the bedroom floor. Elevations between 750 and 850 feet are widespread. The Eastern Ridges lack the distinction of being very high although the Lowlands along Lake Michigan at 580 feet above sea level are the lowest attained within the state. Relief on the order of 100 to 250 feet takes in the bulk of this subdivision.

Within the 2 major geomorphic regions of the state many other smaller units than those named will come to the mind of the knowledgeable traveler—the Lake Superior Lowland, the Fox River-Green Bay Lowland, the Rock River Lowland, the Baraboo Range, etc., each a descriptive geographic locality. In the major division and the named subdivisions the boundaries are determined actually by a complex of bedrock type, of topography, of soils, of vegetation, of climate, and of land use. Such a complex is not easily defined or applied. Individual boundaries may be moved somewhat according to the weight given any one factor. Obviously bedrock and topography are here weighed most heavily.

Drainage

Although many geographic units named above apply to drainage basins, the major river systems of the state cross the geomorphic subdivisions. Topography controls the slope down which water can flow. That topography is related ultimately to the bedrock and effects of constructional and destructional processes working on it through geologic time. A complex interrelationship exists. The more resistant rocks of the Northern Highland stand higher generally than the overlapping Paleozoic rocks to the south.

The Northern Highland area culminating in Vilas County is the source for streams which flow radially outward—north to Lake Superior; east and southeast through the Menominee and Wolf Rivers

* For table of *High Points in Wisconsin* see the *GEOGRAPHY* section of the statistical part of this *Blue Book*.

Devil's Chimney, a rock monument of sandstone, 2 miles southeast of Mt. Vernon, Dane county.

to Lake Michigan and ultimately to the Atlantic Ocean; west, southwest, and south to the St. Croix, Chippewa, Black, and Wisconsin Rivers to the Mississippi River and ultimately to the Gulf of Mexico.

The peculiarity of the drainage basins played an important role in the historical development of Wisconsin. Especially this is true for the Lake Michigan, Green Bay, Fox River and lower Wisconsin River waterway with its original short portage and later canal at Portage, or the Lake Superior-Mississippi River route via the Brule and St. Croix Rivers.

Minerals

The bedrock significantly determines the mineral resources of the state. Beside the direct role of yielding exploitable minerals to supply us with iron, lead, and zinc; of dimensional stone for buildings, tombstones, and the like; or of crushed rock for highway construction and agricultural lime; the bedrock has yielded a variety of rock to the great glaciers that many times entered the state. Sand and gravel from the drift is still our number one mineral commodity in terms of actual dollar value.

Glacial Drift

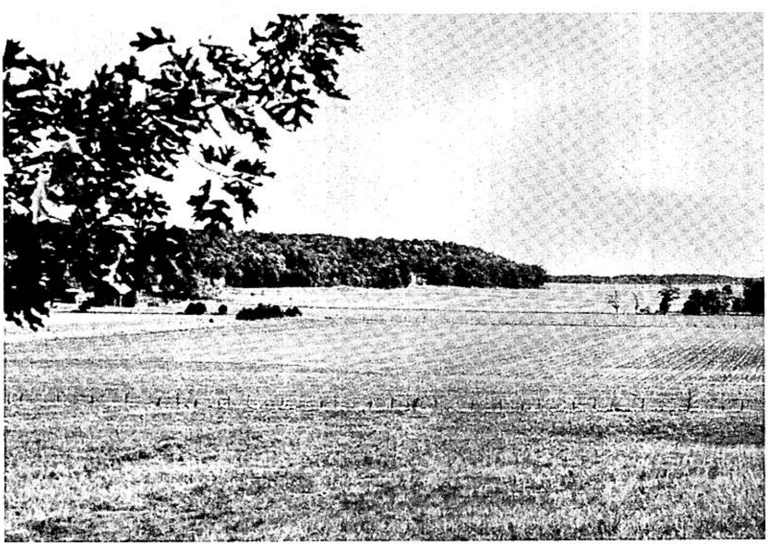
The advances and stagnation of ice in Wisconsin have left behind over three-fourths of the state a generally thick blanket of glacial drift.* This drift contains a variety of rocks of different degrees of weathering. In places farming is well-nigh impossible. Elsewhere glaciers left many feet of rich soil parent materials. Moreover, melt waters from the stagnating ice created mud flats and bars in the major rivers from which wind picked up silt-sized particles. That

* See Map 16 on page 177.

. . . in some places glacial deposits make farming well-nigh impossible, while elsewhere the glaciers left many feet of rich soil . . .

Upper: granitic erratics in glacial drift near *Wis. 29*, 6 miles east of Wittenberg in Shawano County.

Lower: glacial end moraine forming sky line and outwash plain in foreground near *U.S. 51*, 11 miles south of Stevens Point in Portage County.



dust was deposited in an important blanket of "loess" in the southwestern upland especially where little drift may be found. This provides a good soil on relatively sterile bedrock surfaces. Our soils then throughout the state owe much of their fertility and variability directly or indirectly to the mixing and transportation of vast quantities of debris by glaciers. In many rural homes and smaller communities, too, the glacial drift provides a cheaper source of drinking water, and commonly of better quality, than that from bedrock. The distribution of bog or forest, of pine or maple, of beaver or oppossum, of quail or cottontail, of trout or walleye, among many others, is determined by several factors chief of which is glaciation. It commonly determines topography, soils, and drainage (including ground water and surface runoff) which in turn control the kinds of plants and animals that can use the land. Finally, glacial erosion and deposition and geomorphic processes accompanying and following glaciation produced all natural lakes and the scenery in many parks.

Because of the importance of glaciation in the resources of Wisconsin—mineral, water, and recreation—it is interesting as well as economically sound practice to develop our concept of the chronology of the Great Ice Age more fully. Various arguments are now being presented as a result of new data and reinterpretation of established facts. More than three-quarters of a century ago, Professor T. C. Chamberlin, ex-president of the University of Wisconsin, summarized our knowledge of the Pleistocene of Wisconsin with maps and lengthy reports describing "older" and "younger" drifts—or a major twofold

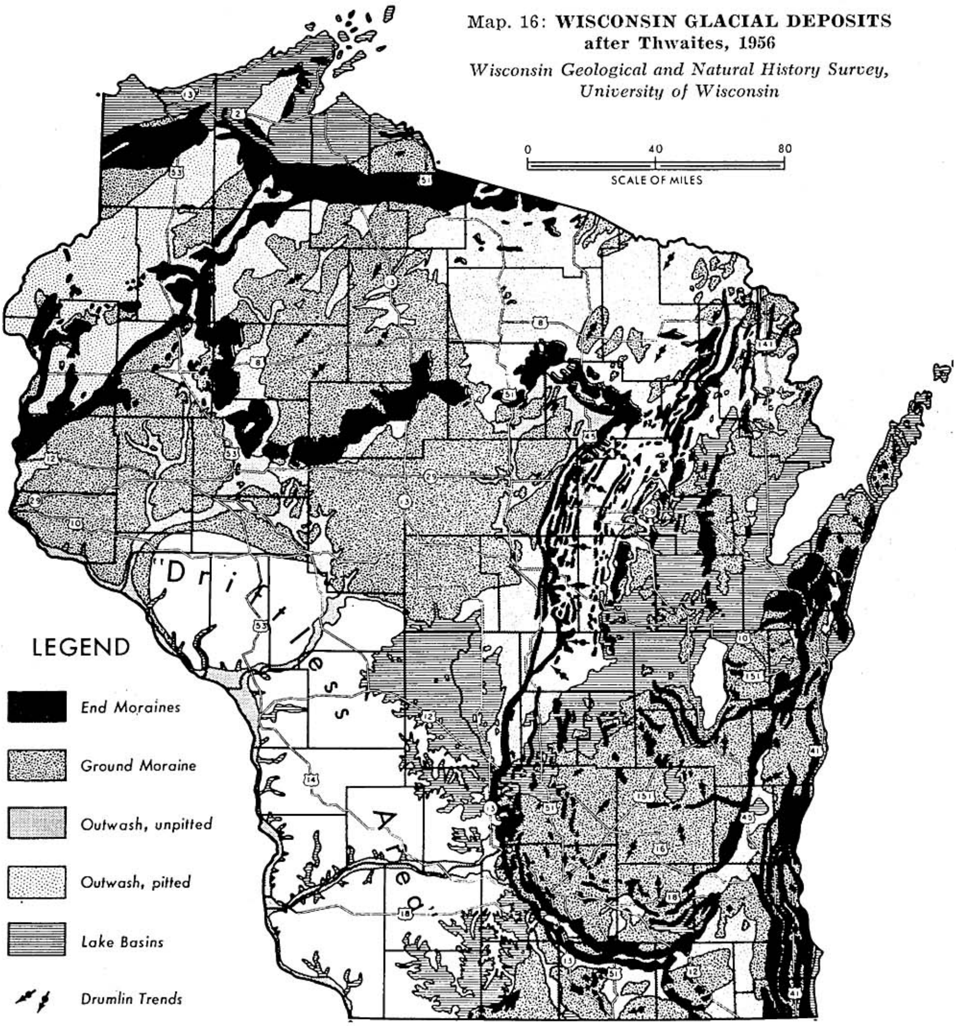
The spectacular Brownstone Falls on a tributary to the Bad River in Copper Falls State Park, Ashland County, are an example of the scenery produced by "glacial erosion and deposition and geomorphic processes . . ."

subdivision of the Pleistocene. Subsequently, other workers in the upper Mississippi Valley established the generally accepted fourfold classification named after the respective states in which such deposits were considered to be well represented. These are from oldest to youngest, Nebraskan, Kansan, Illinoian, and Wisconsin. All told they may encompass most or all the last million years of geologic time. Within each major division many regional ice advances and retreats were mapped in various places in the upper Mississippi Valley by the 1920's.

A major "Driftless Area" in southwest Wisconsin and adjoining states was recognized as early as 1823 and later described in great detail by Chamberlin and others. Most descriptions of the natural history of the state make much of the distinction between the Southwestern Upland, which includes but does not coincide precisely with the Driftless Area, and other parts of the state.

We now recognize that the last or "Wisconsin Stage" of glaciation began perhaps 50,000 to 70,000 years ago. The bulk of the older drift in Wisconsin, which was correlated erroneously with the Nebraskan, Kansan, and Illinoian Stages, is only about 30,000 years old. The younger drift is mostly only 10,000 to 15,000 years old. Nowhere at the surface or at depth in the state have glacial deposits been found which truly can be said to be older than 30,000 years. Such deposits are recognized in Illinois and adjoining states. However, our older drift contains material believed to be reworked from older glaciations. Possible exceptions are the very local gravels traditionally assigned to the Windrow formation. Unfortunately, we can say little about the bulk of events of the Pleistocene as they affected our state except by extrapolation from the adjoining states. Based on evidence of erratics, rock structure, age of loess, reconstruction of logical glacier flow patterns and thicknesses of ice, etc., the writer believes that all or most of the Driftless Area was glaciated. Ice that left the "older" drift about 30,000 years ago went well into what we call the Driftless Area, but clean, slow-moving ice did little work and left little obvious evidence of its former presence. Ice during at least 3 younger glaciations left drift in conspicuous patterns but definitely did not enter the Driftless Area. Hence, the distinction between younger thick drift and older thin drift or bedrock with only scattered erratics is very striking.

The climate between the time of the older and younger drifts was colder and drier than now. Ground was perennially frozen, and wind action was strong. Forests could not grow in the state. Unfortunately the absence of wood has prevented the precise dating of many events that took place during that interval of time. We know that rapid and striking climatic changes were the rule from about 30,000 years ago to perhaps 10,000 years ago, but many details remain shrouded in mystery. Proof is present that man was in the state during an interval of deglaciation about 11,000 to 12,500 years ago, yet still later another



Map. 16: **WISCONSIN GLACIAL DEPOSITS after Thwaites, 1956**
Wisconsin Geological and Natural History Survey, University of Wisconsin

ice tongue advanced down the Lake Michigan Valley to the vicinity of Milwaukee.

Many years of study yet remain, before the chronology of the Pleistocene will be told in full. Wisconsin's part in that chronology will be only in the deciphering of the very latest events—the last half of the Wisconsin Stage. Yet the events of the last 30,000 years are perhaps of more direct importance to the natural resources of this state than all the billions of geologic time which prepared the way.

THE WATER RESOURCES OF WISCONSIN

C. L. R. Holt, Jr., and *Ken. B. Young*, U.S. Department of the Interior

William H. Cartwright, Public Service Commission

Wisconsin's water resources are among the state's most valuable natural assets. While its surface waters have been recognized and utilized throughout the state for many years, particularly for hydroelectric power, recreation and wildlife, its ground waters have received but scant attention. As the state's population grows and economy expands, the ground water resources will be drawn on more heavily. Because surface and ground waters are interrelated, the heavier use of both will generate more acute problems of supply, distribution, quality, and pollution. There is a pressing need for a better knowledge of the water resources of the state and an understanding of the operation of the hydrologic systems in which water occurs. This requires a background of facts about the occurrence and distribution of water; the discharge, recharge and movement of ground water; the flow of rivers and streams; the interrelations of surface and ground waters; and the quality of the water.

Wisconsin's large water reserve is readily available in most parts of the state for municipal, industrial, rural, and recreational uses. Natural underground reservoirs of fresh water absorb an average of 16 billion gallons a day of water. An average of 24 billion gallons a day of water run off in the state's rivers and streams. It is estimated that in 1960 about 4.1 billion gallons of water a day were withdrawn from surface and ground water sources in Wisconsin for various uses. Estimates for the nation as a whole indicate that water demand will more than double by 1980.

Use of Water

The use of water in Wisconsin may be separated into 3 categories—municipal, industrial, and rural. It should be recognized that there is considerable overlapping between the 3. Municipal use includes much water pumped for industries which are wholly or partially dependent upon public supplies. Also included in all these categories is water for air conditioning, a use that is increasing in Wisconsin each year.

Municipal Use

In 1959, ground water was the source of water for about 1,390,000 people living in 446 Wisconsin communities having public supplies. Madison, the largest city using ground water for public supply, used about 18 mgd (million gallons per day). Total municipal pumpage from ground-water sources was estimated to average about 160 mgd.

The remaining urban population, about 1,250,000 in 36 communities, was supplied with surface water, about 210 mgd, principally from Lakes Michigan and Superior.

Industrial Use

Self-supplied industrial use of water is estimated to have been about 3,600 mgd in 1959. This includes about 2,900 mgd of surface water for cooling in power production. The rest is for other industrial uses, of which 230 mgd was ground water and 470 mgd was surface water.

Rural Use

In 1960, about 1,430,000 people in Wisconsin lived in rural homes or in small villages not having public water supplies. It is estimated that the per capita use in homes with running water was 50 gpd (gallons per day) and the per capita use in homes without running water was 10 gpd. About 70 mgd of water constituted the rural domestic use, principally from ground water sources.

The amount of ground or surface water used for stock watering cannot be accurately calculated. It is estimated, however, that about 75 mgd was used for this purpose.

The supplemental irrigation of farm crops has been increasing for the past 5 years, particularly by ground water. Most irrigation in the state is applied by sprinkling, largely owing to the sandy nature of the soil in the irrigation areas. The largest single use is for irrigation of potatoes, but many truck crops are also irrigated. It is estimated that about 13,000 acre-feet of ground water and 4,000 acre-feet of surface water were used for irrigation in 1959.

Water Occurrence and Movement

Hydrologic Cycle and System

All water comes to us in the form of precipitation, either as rain or as snow. Some of this water immediately runs off in rivers and streams to the ocean. Some of it soaks into the ground to replenish ground water supplies and to form the base flow of many streams. A larger amount is evaporated from water surfaces and transpired by plants back into the air. From here the water comes to us again in the form of precipitation. This continuous circulation of water is known as the hydrologic cycle.

Once it reaches the earth, water continues to move in a hydrologic system. Part of this system is on the land surface and we recognize it as the streams and rivers in which the water moves. Another part not so easily visualized is underground where the water moves through the small openings and cracks in soil and rock formations.

Evapotranspiration

Although Wisconsin receives a lot of water in the form of precipitation, only about one-third of that amount is available for use by its people. This is because much water is lost through plants, which is known as transpiration, and from water surfaces and moist soil, known as evaporation. The combination of these 2 losses is known as evapotranspiration and averages more than 20 inches annually in Wisconsin.

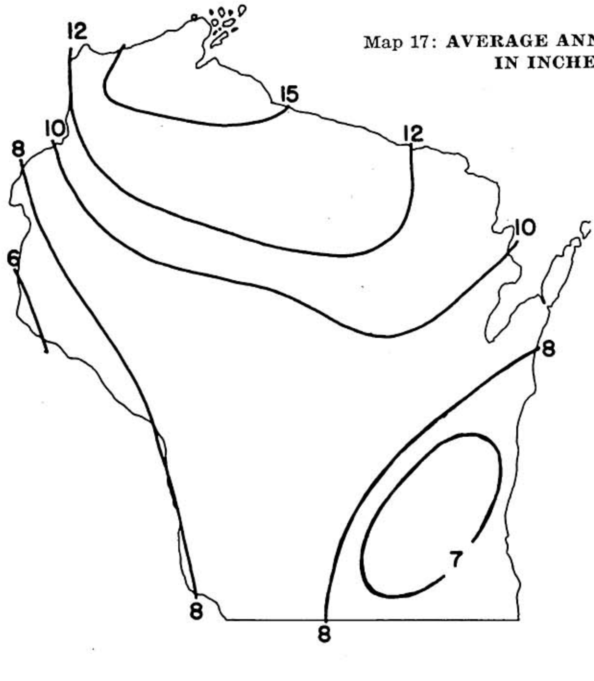
Surface Water

Water in lakes, ponds, rivers, and streams and flowing over the surface of the ground is called surface water. Wisconsin has a plentiful supply of such water although it varies considerably from place to place and from year to year.

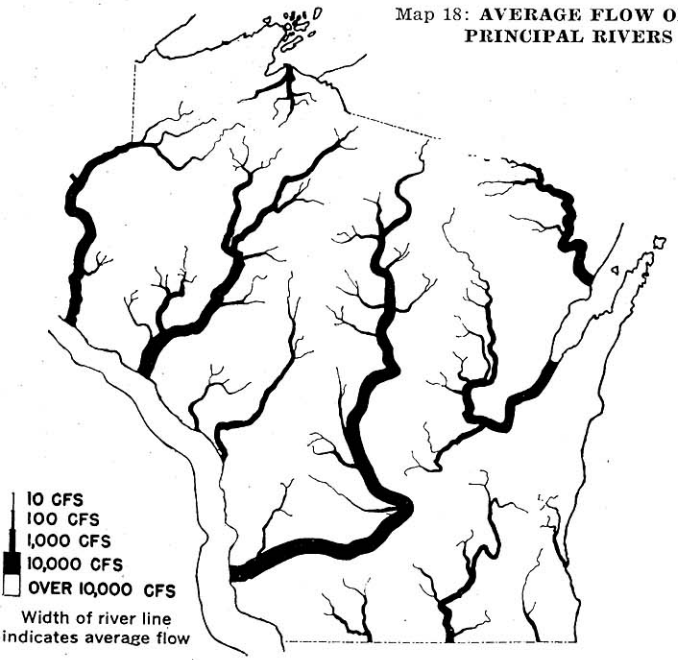
Runoff

Runoff is that part of the precipitation that finally appears in surface streams. Compared to the annual average of 28 to 32 inches of precipitation that falls on Wisconsin, the average annual runoff in rivers and streams ranges from 6 to 20 inches, generally increasing from south to north. There are, of course, wide deviations from these averages, and during some of the drier years of record, runoff has totaled less than 2 inches for some smaller drainage basins in central and southern Wisconsin.

State's River Basins. Wisconsin lies in 2 major drainage systems. About 30 per cent of the state, 17,500 square miles, drains to the St. Lawrence River through Lake Superior and Lake Michigan. The



Map 17: **AVERAGE ANNUAL RUNOFF IN INCHES**



Map 18: **AVERAGE FLOW OF THE PRINCIPAL RIVERS**

remaining 70 per cent of the area, about 38,600 square miles, drains to the Mississippi River. The interior of the state is drained by 7 principal river systems which, with their approximate drainage areas, are: Wisconsin (11,715 square miles), Chippewa-Flambeau (9,519 square miles), St. Croix (4,206 square miles), Black (2,493 square miles, Rock, including the Pecatonica River, (5,569 square miles), Fox-Wolf (6,520 square miles), and Illinois-Fox (900 square miles).

Variations in Flow. For making comparisons and noting trends, it is customary to use figures of average annual runoff. However, it is very seldom that we experience average conditions. To begin with, precipitation which produces the flow in rivers and streams varies widely from day to day, month to month, and year to year. For any one river, runoff fluctuates from periods of peak discharges during floods caused by excessive precipitation, to periods of extreme low flows during droughts when there is a lack of rainfall. Runoff from snow melt contributes substantially to the peak discharges of many rivers in Wisconsin. High flows may occur at most any time from March to September, but almost 30 per cent of the peak flows during the year occur during March as a direct result of snow melt and occasionally accompanying rains. The next highest month in the number of peaks is April with 25 per cent, while June has the third highest number, or 15 per cent of the peaks.

During periods of limited precipitation, runoff reaches the low end of the scale, with many small streams drying up completely during long periods of no rainfall. Runoff during these periods is water draining from ground-water reservoirs into streams.

Runoff not only varies for any one stream, it also varies from stream to stream. Because of differences in topography, vegetation, geology, land use, etc., no 2 streams have exactly the same runoff characteristics. For example, in hilly, dense-soil areas, water falling on the land will run off rapidly, producing high rates of flow, and little water will soak into the ground to appear later as the base flow of streams. In flat sandy areas, on the other hand, much of the water falling on the land soaks into the ground, thus avoiding extreme high flows, and storing the water underground to enter the streams slowly.

Lakes

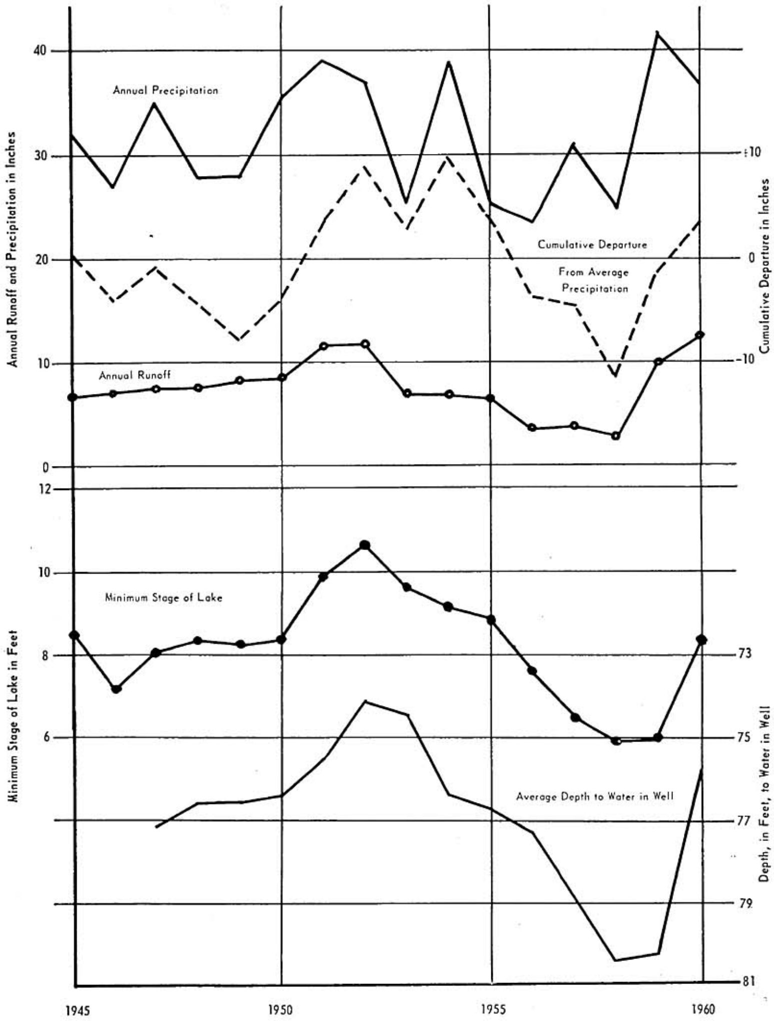
Wisconsin has more than 8,800 ponds and lakes ranging in size from a few acres to large Lake Winnebago with about 137,000 acres. Many of these are land-locked with no surface outlet. Most lakes are directly related to ground water in that they are the visible part of the ground-water table in low-lying areas. The water level of lakes to a large degree reflects the long-term precipitation pattern, usually with more lag than does stream flow. This is because much of the water that gets into many ponds and lakes comes from movement underground, a slow process. The existence of lakes in a river basin provides natural storage for water, and thereby tends to reduce the magnitude of floods that occur on such a river compared to one with no lakes. The relation between precipitation, stream runoff, lake level, and ground-water level in an area of southeastern Wisconsin is striking. The measurements, made between 1945 and 1960, were based on the annual precipitation (and its cumulative departure from the average) in the Janesville, Fort Atkinson, Lake Geneva area. Runoff is shown for the Turtle Creek Basin; the minimum lake stage is that of North Lake near Holden; and the "depth to water" measurement is based on observation well Ww 9 in Walworth County.

Wisconsin is bordered by 2 of the Great Lakes, Superior on the north and Michigan on the east. The waters in these 2 lakes constitute a virtually inexhaustible supply for the communities on their shores, and for communities inland as far as it is practicable to bring Great Lakes water. The inland natural lakes are located in the once glaciated portion of the state (about 75 per cent of Wisconsin's total area). Most of them are in the headwaters of the St. Croix, Chippewa-Flambeau, Wisconsin, and Wolf Rivers. There are also lakes in southeastern Wisconsin in the Fox-Wolf, Illinois-Fox, and Rock River basins.

Quality of Surface Waters

There is a natural range of dissolved and suspended material in water which results largely from the manner and time it takes precipitation to reach the streams. During rainy periods, or when water from melted snow reaches the stream quickly over the surface of the ground, the quantity of dissolved salts in the water is usually relatively small. At the same time, the quantity of suspended material is relatively large. During dry periods when a large proportion of the water travels through the ground to reach the stream, the concentration of

INTERDEPENDENCE OF PRECIPITATION, SURFACE AND GROUND WATER, 1945 TO 1960



dissolved salts is ordinarily much higher and the suspended material much lower. The range in concentration in dissolved solids for any stream or underground waters is dependent on the solubility of the soil and rocks through or over which the water passes and the length of time the water is in contact with the rocks.

In general, water in the state's rivers from the Wisconsin River basin west and north is relatively soft (low in dissolved solids). Rivers east and south of the Wisconsin River basin have a somewhat higher concentration of dissolved solids and their waters are moderately hard. Suspended material, or sediment, is more prevalent in the smaller tributary streams to the Mississippi River from the junction of the St. Croix River south and in rivers in southwestern Wisconsin. Heaviest concentrations of sediment are found in streams in the southwest corner of the state, particularly the Grant, Platte, and Galena Rivers.

Ground Water

Wisconsin's ground-water resources are more or less taken for granted. Yet as the state's population grows and economy expands, these resources will be drawn on heavily and problems of supply, distribution, quality, and pollution will become more acute. There is a pressing need for a better knowledge of the ground-water resources of the state and an understanding of the operation of hydrologic systems. This requires a background of facts about the occurrence and distribution of ground water; its recharge, discharge, and movement; its relation to surface water; and its quantity and quality.

Wisconsin's large underground water reserve is readily available in most of the state for municipal, industrial, rural, and recreational uses. The natural reservoirs of fresh water annually absorb about 16 billion gallons a day of water. It is estimated that in 1961 about 600 million gallons a day were used in Wisconsin and that the use of ground water will have doubled by 1980.

In order that water may soak into the ground, the soil must be able to absorb the water and transmit it to the underlying rocks. The underlying rocks must in turn be permeable if they are to transmit water to points of discharge. A rock unit that will transmit water to wells or springs is called an aquifer, a term which means "water bearer." Permeability may be defined as the ease with which water moves through a material, and depends upon the amount, size, and interconnection of pore space. Few rocks of the earth's crust, when taken in aggregate, are entirely impermeable. The crystalline rocks, such as granites and quartzites, have little pore space and are relatively impermeable except where they are fractured or weathered. Fine-grained rocks, such as shales, may be very porous and contain a great amount of water, but are relatively impermeable owing to the very small size of the pore spaces. Limestones and dolomites (limestones rich in magnesium) usually have little primary permeability, but often have high secondary permeability owing to fractures and bedding planes along which water can move and which are sometimes enlarged by solution to open channels. In limestones and dolomites the permeability then depends to a large degree upon the interconnection of the fractures. The most uniformly permeable materials are gravels, sands, and sandstones. The permeability in such materials will depend upon the uniformity of grain size, the shape of the grains, and the amount of cementation.

Water Table and Artesian Conditions

The upper surface of the zone of saturation is known as the water table. The water table is usually a subdued replica of the surface topography; the water is highest under the hills and lowest in the valleys. The depth to the water table is, however, greatest beneath the hills. Water moves in the direction of slope of the water table; in most areas, the movement is toward the streams.

When an aquifer is confined beneath a relatively impermeable bed, and water rises above the top of the aquifer in a well, the water is said to be under artesian conditions and the aquifer is called an artesian aquifer. The height to which the water will rise in a well penetrating an artesian aquifer may be, but is not necessarily, sufficient to cause the well to flow at the land surface. The imaginary surface that coincides with the height to which water in wells tapping artesian aquifers will rise is known as the piezometric surface. The piezometric surface, like the water table, slopes in the direction of ground-water movement through the aquifer.

Ground-Water Movement

Ground water moves in the direction of slope of the water table or piezometric surface from areas where the ground-water reservoir is being replenished to points where ground water is being discharged, such as streams, springs, drainage ditches, and well fields. The rate of movement is proportional to the slope, or gradient, of the water table or piezometric surface and to the permeability of the aquifer materials. For instance, much more water will move through the sandy glacial-outwash deposits of the central Wisconsin sand plain province than through the less permeable glacial drift of northern Wisconsin where the water table in both areas slopes at a gradient of 10 feet per mile.

Ground water behaves similar to water in the pipes of your house. Under pressure, it can move from a low to a high point. For example in eastern Wisconsin, if the water table in the Niagara Dolomite lies below the piezometric surface of the underlying sandstone aquifer, water will move upward across the confining bed from the artesian aquifer to the water table aquifer. Conversely, if the piezometric surface lies below the water table, water will move downward from the water table aquifer to the artesian aquifer.

Water-Level Fluctuations

The water table does not remain stationary, but fluctuates in response to changes in storage within the ground-water reservoir. When more water is being recharged than discharged, the water levels rise, and conversely when more water is being discharged than recharged, they fall. In Wisconsin, water levels in shallow wells usually rise in the spring and decline through most of the rest of the year. Water levels also show long-term fluctuations in response to cyclic changes in the annual amount of precipitation. The water levels in artesian wells located near the recharge or discharge area also fluctuate in response to changes in storage. Such fluctuations are usually damped out, however, when wells are located far from the recharge or discharge areas. Water levels in artesian aquifers also fluctuate in response to changes in barometric pressure, earthquakes, tides, and other phenomena. Such fluctuations do not represent changes in ground-water storage, however.

Although water levels fluctuate seasonally and cyclically, they remain fairly constant over long periods. However, when water is artificially removed by wells or drains, water levels decline until enough additional recharge is induced to the reservoir and enough of the natural discharge is intercepted to replace the water being withdrawn. If water is withdrawn so rapidly that it cannot be replaced by increased recharge or decreased discharge, water levels will continue to decline until the aquifer is depleted.

Recharge

Recharge to the ground-water reservoir is the replacement of water that has been discharged or removed. Recharge occurs when rainfall and snow melt percolate to the water table, and when water moves from streams, ponds, or lakes into the ground to become ground water. In Wisconsin, most of the ground-water recharge occurs during the spring, from melting snow and rainfall when evaporation and transpiration are low. In areas of marshland and in areas near streams and lakes, the ground-water reservoir cannot accept all the water available for recharge. In these areas additional recharge is induced when water is withdrawn by wells or drainage ditches.

Artesian aquifers are recharged both from precipitation in areas where the aquifer crops out on the surface and by movement of water to the artesian aquifer from overlying or underlying aquifers. Although this movement of water represents recharge to the artesian aquifer, it does not represent recharge to the ground-water reservoir as a whole, because recharge to one aquifer is balanced by discharge from another.

Discharge

Water is discharged naturally from the ground-water reservoir to streams, springs, and other surface-water bodies. Ground water is also discharged to the atmosphere by evaporation and by plant transpiration in areas where the water table lies within a few feet of the surface. Ground water is artificially discharged by pumping from wells and mines, development of springs, and the drainage of marshland.

Quality

The geologic structure of Wisconsin generally is such that through proper development of wells, water can be obtained that is free from bacteriological contamination. Only in the few limited areas where a very thin glacial drift covers crystalline rock does the development of safe water supplies pose a problem. In areas where shallow limestone aquifers may be subject to contamination, safe supplies can be obtained by utilizing deeper strata.

The mineral content of ground waters varies materially and in general is related to the geologic structure. The softest water is in the north-central part of the state, while the hardest water area is in the eastern section of the state. Highly mineralized waters (saline waters) are found along the eastern and northern boundaries of the state and also at a few other isolated locations. In the areas where highly mineralized water is found, it is usually possible to develop suitable water supplies from other formations.

The iron content of water from wells drilled for domestic purposes ranges from zero to about 30 ppm (parts per million). Most of the high-iron content waters are derived from the sandstones or from the glacial drift. In the sandstone formations, the iron content generally increases with depth. In the glacial drift, the iron content is generally high in areas of poor drainage such as swamps and marshes. Through site and aquifer selections, based on existing data or test-well observations, it is usually feasible to develop supplies having an iron content of less than 0.3 ppm. Where this is not possible, the water can be treated.

Except for a narrow belt extending from Green Bay to the Illinois State line, ground waters have a low fluoride content. The maximum content of 2.8 ppm was found in a Green Bay city well. About 1.5 ppm of fluorides in water is considered desirable for dental caries control. Only 13 of the public-utility ground-water supplies show a natural fluoride content of 1.0 ppm or more.

Ground-Water Provinces

The map entitled "Ground-Water Provinces in Wisconsin" shows the principal aquifers in the state. The "Geologic Map of Wisconsin" shows the rock units (formations) which would be exposed if the surficial material were removed. The tabulation "Geologic Section for Wisconsin" lists the geologic formations and their general characteristics.

Map 19:
GROUND-WATER PROVINCES OF WISCONSIN

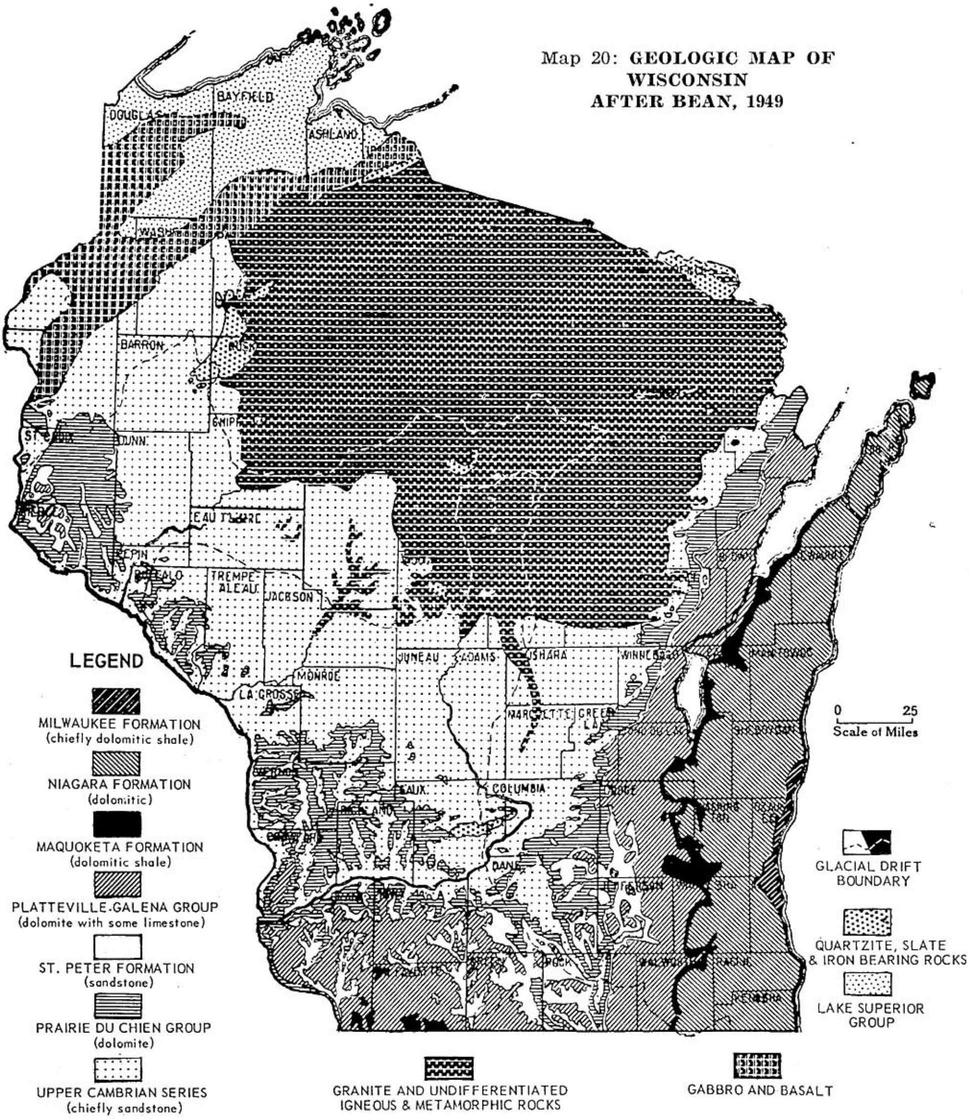
Drift Province

In a large part of northern Wisconsin, plentiful supplies of ground water are obtained from sands and gravels in the unconsolidated surficial deposits of glacial origin or from valley alluvium. In areas where such deposits are scarce or lacking, little or no water can be obtained. The bedrock is composed of crystalline rocks of Pre-Cambrian age which contain very limited amounts of water in fractures near the surface. The extreme northwestern part of the state is underlain by sandstones of Pre-Cambrian age which contain rather highly mineralized water.

The communities of Marshfield, Neilsville, Abbotsford, and Junction City are in an area in the southern part of the province where water shortage is an important problem. Ground-water supplies are not extensive because crystalline rocks are at or near the surface and covered with a thin layer of clay till. Plentiful supplies of ground water may be obtained in gravel-filled preglacial valleys. Test drilling and geophysical surveys are used to locate the gravels in buried valleys.

Sand Plain Province

The sand plain province is located in the central part of the state and includes glacial outwash and lake deposits, alluvium, and weathered sandstones. Large-capacity wells have been obtained in extensive deposits of unconsolidated sand and gravel. The unconsoli-



Map 20: **GEOLOGIC MAP OF WISCONSIN AFTER BEAN, 1949**

dated sands are underlain by sandstones of Cambrian age. The sandstones are less permeable and, therefore, of secondary importance as an aquifer.

Recharge to the sand plain is by direct precipitation. Induced recharge from the Plover River occurs near Stevens Point and Whiting and from the Wisconsin River near Wisconsin Rapids and Biron. Discharge is to streams, by evaporation, transpiration, movement into the sandstones, and by wells, pits, and drainage ditches.

The use of ground water for supplemental irrigation and industry has increased rapidly in the last few years. Flat land, proper soil, and adequate water at reasonable cost have been important factors in the expansion of irrigation.

Because ground water and surface water are intimately related, the effect of pumping of ground water may reduce the flow of a stream, or diversions from a stream may affect the storage of ground water. An investigation was started in 1959 on the Little Plover River area to gather facts and knowledge on the complex relationships of geology and ground and surface water and to determine types of data needed for analysis of water-management and conservation problems.

Drift-Paleozoic Province

Overlying the Pre-Cambrian rocks in eastern, southern, southeastern, and western Wisconsin are rocks of Paleozoic age which in turn are covered by glacial deposits of Pleistocene age. Locally any one of the formations, except the Maquoketa shale, may be considered an aquifer. Generally speaking, however, certain formations may be grouped and considered as a single aquifer. Thus, the sandstone aquifer is composed primarily of sandstones of Cambrian and Ordovician age but includes dolomite and limestone of Ordovician age.

The sandstone aquifer underlies the entire Drift-Paleozoic province. It includes the Mount Simon, Eau Claire, Galesville, and Franconia sandstones and the Trempealeau formation of Cambrian age, all of which are composed mostly of sandstone with some interbedded shale and dolomite. Each of the formations contributes some water to wells, but the Mount Simon and Galesville sandstones are believed to be the most productive. The Prairie du Chien dolomite, the Platteville limestone, and the Galena dolomite, all of Ordovician age, are important where they are exposed or are overlain only by glacial drift, but are believed to contribute little water where they are deeply buried, particularly where the Maquoketa shale overlies the Galena dolomite. The St. Peter sandstone, also of Ordovician age, contributes some water depending primarily upon its thickness.

Recharge to the sandstone aquifer is through the glacial drift (deposits) in the area west of the west edge of the Maquoketa shale. Water from precipitation must percolate through the drift and through the limestones and dolomites, where present, in order to reach the sandstones.

Table 18: GEOLOGIC SECTION FOR WISCONSIN

System	Group or Formation	Thickness (feet)	Character	Water-Bearing Characteristics	Province: Drift	Sand Plain	Drift-Paleozoic	Paleozoic
Quaternary	Recent alluvium	0-100	Sand, gravel, peat, muck, marl	Small to large yields from sand and gravel	X	X	X	X
	Pleistocene deposits	0-500	Boulder clay, silt, sand, gravel		X	X	X	X
Mississippian		55	Black carbonaceous shale	Not water yielding			X	
Devonian	Milwaukee Formation	110	Shale, dolomite, limestone	Yields small amounts of water			X	
	Thiensville Formation	50					X	
Silurian	Waubakee Dolomite	300-825	White to gray dolomite Crevices and solution channels abundant	Yields small to moderate amounts of water			X	
	Niagara Dolomite						X	
Ordovician	Maquoketa Shale	50-540	Dolomitic shale	Usually not an aquifer Yields small amounts locally			X	X
	Galena Dolomite Decorah Shale Platteville Limestone	200-350	Dolomite and limestone Some shale	Yields small supplies, principally in areas where not overlain by shale			X	X
	St. Peter Sandstone	0-330	Sandstone, fine- to medium-grained, dolomitic in places	Yields small to moderate amounts of water			X	X
	Prairie du Chien Group	0-200	Dolomite; sandy in some zones	Yields small to moderate amounts of water			X	X
Cambrian	Trempealeau Formation Franconia Sandstone Galesville Sandstone Eau Claire Sandstone Mount Simon Sandstone	0-1000+	Fine- to coarse-grained sandstone, dolomitic, some shale and dolomite beds	Yields small to large amounts of water depending upon permeability and thickness		X	X	X
Pre-Cambrian			Sandstone, quartzite, slate, granite, and other crystalline rocks	Water in sandstone is highly mineralized; other rock types yield small amounts of water where creviced or weathered	X	X	X	X

Discharge from the sandstone aquifer is both natural and artificial. The principal natural discharge is to rivers and their tributaries. In eastern Wisconsin, some discharge occurs by movement of the water upward through the Maquoketa shale, Niagara dolomite, and mantle deposits into Lake Michigan.

The sandstone aquifer is the most heavily pumped aquifer in the state, largely because it occurs in nearly one-half of the state, and because of the concentration of population and industry in the eastern part. It provides the public supply for many of the cities in the province.

In the eastern part of the state, the Niagara dolomite of Silurian age is an important aquifer that supplies moderate to large amounts of water. In parts of Ozaukee, Sheboygan, Manitowoc, Calumet, Kewaunee, and Door Counties, the Niagara is the only source of ground water because the water from the sandstone aquifer is saline.

Recharge to the Niagara aquifer is from direct precipitation on areas of outcrop and from water which percolates through the overlying glacial deposits.

Discharge from the Niagara aquifer is principally to streams and to Lake Michigan, but artificial discharge through wells is also important. Discharge, like recharge, is usually quite localized so that the water generally travels less than 5 miles in the Niagara aquifer.

In many places the Niagara dolomite is overlain by sand and gravel deposits of Pleistocene and recent age. Such deposits are often hydraulically part of the Niagara aquifer but may be small local aquifers in their own right.

The heavy concentration and rapid increase of population and industry in Milwaukee County and in the eastern half of Waukesha County has placed a large demand upon the water resources. Although Lake Michigan is the principal source of water in terms of total pumpage, ground water was pumped in 1961 at an estimated rate of 40 mgd, of which about 20 mgd was pumped from the sandstone aquifer and about 20 mgd from the Niagara dolomite.

In the Milwaukee-Waukesha area, static water levels in wells in the sandstone aquifer have declined about 400 feet since 1875. Although water levels of wells in the Niagara dolomite have declined by as much as 100 feet, the decline is generally local.

Although ground water of good chemical quality may be found in all parts of the province, saline water has been found to occur at depth in several places. The saline water is not currently contaminating municipal and industrial supply wells, but it is a potential source of contamination. Heavy pumping from the aquifer may cause movement of saline water toward the area of pumping and result in contamination of water supplies.

In the Green Bay area, water levels in wells tapping the sandstone aquifer persistently declined to August 1957 as a result of concentrated and gradually increasing withdrawals. In August 1957, the City of Green Bay went to Lake Michigan for its water supply and ceased pumping its wells. The cessation of pumping resulted in a decrease in ground-water withdrawals in the area and a rise in water levels of as much as 300 feet by September 1960.

Paleozoic Province

Overlying the Pre-Cambrian rocks in western and southwestern Wisconsin are sandstones, shales, limestones, and dolomites of Cambrian and Ordovician age. The entire sequence of formations may act as a single aquifer or, where there are less permeable zones separating parts of the sequence, as several aquifers. This area is known as the "Driftless Area" because of the lack or scarcity of glacial deposits. The mantle material overlying the bedrock is generally thin and, therefore, is not important as a source of water.

Recharge to the aquifers is by precipitation and from overlying aquifers. Discharge is ultimately to streams, but many of the aquifers discharge into the underlying aquifers. Because of the nearly horizontal stratification of the formations and the steep-sided valleys, the aquifers are subject to discharge by natural drainage and evaporation where they are exposed on the hillsides.

Within the province sufficient water for small wells usually can be obtained from either the sandstones or the limestones, provided the well extends below the water table during the dry season. Large-capacity wells usually must be drilled into the sandstones of Cambrian age.

Valley Alluvium

The Wisconsin, Mississippi, Chippewa, Rock, and several other river valleys contain as much as 200 feet of sand and gravel and are locally very productive aquifers. The river valleys were eroded before and during glacial times and subsequently filled with sand and gravel and smaller amounts of silt and clay. The valleys are in the Paleozoic and the Drift-Paleozoic provinces and are underlain by sandstones, except the upper Wisconsin and Chippewa River valleys that are underlain by crystalline rocks.

Precipitation directly recharges the alluvium and indirect recharge occurs in most of the valleys by water under artesian pressure leaking upward from underlying sandstones. Discharge is primarily to surface streams.

Water Problems

In most parts of Wisconsin, good water is plentiful, cheap, and taken for granted. In the few areas, however, where water is poor in quality, polluted, or scarce, the problems of maintaining an adequate water supply are of vital concern to everyone.

The depletion of the water supply of the state is not a problem as both surface water and ground water are renewable resources. In order to utilize the storage capabilities of a surface reservoir, it is necessary to draw down the water stage in the reservoir. The same procedure applies for ground water, as it is necessary to draw down a ground-water reservoir if it is to be used for storage of infiltration. Nearly all reservoirs in the state are completely renewable as their water is replenished in the wet seasons.

The wise use and management of the state's water supply will depend to an important degree upon accurate knowledge of the availability of its water resources. New practices and techniques will need to be developed which will permit the ever-increasing need for pure water to be filled from the available resources.

The growing demand for good water, the many uses of water, and the variability of its occurrence all lead to problems in its development and management, and in the maintenance of suitable quality standards. Increasing population and the rapidly rising interest in water-based recreation point inevitably to the importance of maintaining quality standards appropriate for the present and expected uses of water in particular areas. Forethought and planning in these matters can help to avoid serious problems in the future. The more important current and prospective water problems in Wisconsin may be conveniently placed in 6 general categories.

Water of Unsatisfactory Natural Quality

In some areas of the state, the natural chemical quality of water is objectional or unsuitable for many uses because of excessive amounts of iron, manganese, chloride, sulfate, and other chemical impurities. Fortunately, alternate sources of satisfactory water are often available in areas having problems of water quality. Unsatisfactory water can generally be treated to produce water of acceptable quality.

Distribution

Water is not uniformly distributed throughout the state. Many areas have abundant reserves of both surface and ground water while some areas have large reserves of ground or surface water and a few areas have small reserves of water.

A few of the approaches to this problem are to manage watersheds for sustained increased water yield, to develop more efficiently the ground-water reservoirs, to transfer water between and within areas, and to develop methods of water use to insure maximum productivity.

Variability of Supply

The supply of water not only varies from place to place in the state, but also varies with time. During drought periods, annual average stream flow may be as little as 50 per cent of the long-term average, while during wet periods, annual average stream flow may be as much as 150 per cent of the long-term average. The storage of ground water also varies somewhat with time.

Man's demands for water are also variable and are likely to be greatest when recharge to ground water and stream flow are the least.

The chief means of providing water during drought periods is by storage in dams and surface reservoirs. Induced recharge to ground-water reservoirs should be considered, especially in areas where surface storage is not practicable.

Floods

A river in flood stage inundates low sections of river valleys, damages homes, stores, industries, farm crops, highways and bridges, and carries away valuable soil. Floods become a problem and are destructive mainly because people choose to settle on flood plains. Wisconsin has its share of localized floods, but it has fortunately been relatively free of the widespread catastrophic floods which hit other sections of the country. Nevertheless, a local flood is a serious occurrence to those who experience loss of property, soil, or lives.

A direct approach to the majority of flood problems is flood-plain zoning. This means identifying those lands which are subject to being inundated during floods and limiting the use of that land to activities which floods would not harm.

A better definition of flood-frequency relationships for small drainage areas will aid in improving the design of highway drainage structures and reduce damage to bridges and highways.

Conflict of Interest

Although there is an abundant supply of water in the state, various interests such as private, recreation, industry, municipal, irrigation, and conservation may have differing ideas on the best use of available water supplies. Examples of conflicts of interest are (1) downstream users of water being concerned about amounts of water used and polluted upstream, (2) fishermen being concerned about the effects of water withdrawal on lake levels and stream flows, (3) swamps being drained by farmers and land developers in some areas and being protected in other areas for the preservation of wildlife.

Pollution

The disposal of domestic and industrial wastes into the ground and into streams has created locally complex problems of pollution of the water resources. Although the treatment of sewage and waste waters is steadily improving, the problem of pollution is expected to continue because greater volumes of liquid waste are constantly being produced. Streams are often utilized for direct discharge of treated and partially treated domestic and industrial wastes. Wastes from cesspools or septic-tank systems are the principal source of pollution of ground water.

The disposal of refuse on the surface is another possible source of pollution to ground water. Both biological and chemical contaminants may be leached from refuse by the movement of water through the refuse. Sand and gravel deposits act as a natural filter bed and restrict the movement of bacterial contaminants into the ground-water reservoir. Chemical contaminants, because they are usually in solution, are not removed by the natural filter and may contaminate ground water.

Water is said to be polluted if it contains man-made substances in concentrations that are objectionable for intended uses. Water that has been polluted may have displeasing tastes, odors, and colors; detergents or natural organic constituents may create foam; or the water may contain nitrates, bacteria, and viruses that may be detrimental to health. A colorless water may be polluted. It is especially important to safeguard the quality of a ground-water supply from pollutants because once an aquifer is polluted, it may take months or years for the pollutant to be flushed out.

Pollutants generally decrease in concentration with time, with chemical or physical sorption, and with dilution through dispersion. Some pollutants may become harmless and undetectable near the points of release and others may travel for great distances.

Although a heavily pumped well located near a river may induce movement of polluted river water toward the well, the sand and gravel in the aquifer acts as a filtration system that generally removes bacterial pollutants.

Water Resources Investigations

Various state and federal agencies are active in obtaining information about the water resources of Wisconsin. The work that is the foundation for much of the planning of water use and development is the program conducted by the U.S. Geological Survey in co-operation with such state agencies as the Wisconsin Geological and Natural History Survey, the Public Service Commission, the Highway Commission, the Committee on Water Pollution, the Board of Health, and the Conservation Department; and with other federal agencies as the Corps of Engineers, Soil Conservation Service, and the Fish and Wildlife Service. From this program comes valuable information on the occurrence, quantity, and quality of water in rivers and streams and in underground reservoirs.

The collection of stream flow data has been in progress since 1913, first in a co-operative program between the U.S. Geological Survey and the Wisconsin Railroad Commission and later with that agency's successor, the Public Service Commission. Much has been learned about the runoff characteristics of the larger and principal rivers.

For years all ground-water investigations were conducted by the Wisconsin Geological Survey (WGS), but in 1945 the Legislature authorized the state university to enter into a co-operative agreement with the Ground Water Branch of the U.S. Geological Survey (USGS) to undertake studies of the ground water in the state. The WGS and the USGS work in very close co-operation in order that the work of one may supplement that of the other without conflict or duplication. Both agencies also work closely with the State Board of Health which has the responsibility of insuring that wells are properly constructed and maintained to guard against pollution, and of controlling installation of wells of high capacity.

Through the study program, information is being obtained on (1) the rock formations underlying the surface that serve as the container of ground water, (2) on the fluctuations of ground-water levels throughout the state, and (3) on the occurrence and availability of ground water in specific areas.

Ground-water investigations fall into 2 broad categories: those undertaken on a state-wide basis for the collection of basic data, and detailed investigations of areas where supply problems may exist. The type of work undertaken by the 2 surveys may be roughly divided as follows:

1. Well logging and subsurface geology. A knowledge of the formations underlying the surface is the keystone of all ground-water studies. In order to provide this, samples of rock from wells, taken at 5-foot intervals, are forwarded to the WGS by well drillers. They are carefully examined, bottled and filed, and a log drawn up in order to provide a permanent record. Over 150,000 samples have thus been examined.

2. Measurement of ground-water levels. There are 202 observation wells maintained throughout the state, of which 25 are equipped with continuous recording devices, and the remaining wells are read, at regular intervals, by means of a tape. Supervision of this work is by the USGS.

3. Detailed area investigations. Areas to be investigated are determined by a university committee headed by the State Geologist, and the investigations are made by geologists and engineers of the USGS. These investigations are quantitative in nature and require highly trained and specialized personnel. They enable a true inventory to be made of the water resources of the area in question. This not only permits the current problems to be analyzed but, by projecting the effects of ground-water withdrawal into the future, allows future problems to be anticipated. The results of these investigations are published by the USGS and WGS.

4. Public Service. The data gathered over the years by the WGS, and more recently by the USGS, are of inestimable value in providing information to municipalities, industries, well drillers, and consultant engineers on water-supply problems. It is not the policy of either

survey to usurp the functions of professional groups engaged in the development and maintenance of water supplies, but rather to provide them with the available information to aid them in their work.

In addition to co-operative investigations of the U.S. Geological Survey, some state agencies are collecting information on the state's water resources. The Committee on Water Pollution obtains water quality data at many points on Wisconsin rivers for determining pollution control measures. The Conservation Department, as part of its lake classification work, is inventorying rivers and streams in each county.

THE MINERAL RESOURCES OF WISCONSIN

George F. Hanson
State Geologist

The most important minerals produced in Wisconsin are nonmetallic, such as sand, gravel and stone. The only metallic ores which are mined in the state are iron in the north, and zinc and lead in the southwest.

Production statistics included in this report are taken from compilations made by the U.S. Bureau of Mines in co-operation with the Wisconsin Geological Survey. As many operators of small sand and gravel pits or limestone quarries do not always report their production, the figures represent only minimum values and tonnages.

As mineral deposits are nonreplaceable assets it is self-evident that the future supply rests upon 3 fundamentals.

1. *Conservation.* Wise use of the minerals that we have, in order that the maximum present and future benefits may be assured for society.
2. *Geological studies.* The most easily found mineral deposits have already been developed; hence finding new deposits calls for geologic studies utilizing the most up-to-date methods.
3. *Technologic research.* New uses must be sought for minerals that are abundant, and substitutes developed for those that are scarce or lacking. Research in mineral processing must be diligently pursued.

Table 19: MINERAL PRODUCTION IN WISCONSIN
(Millions of Dollars)

Year	*Sand & Gravel*	*Stone*	*Zinc & Lead*	*Misc.*	*TOTAL*
1925	2.7	4.2	3.4	9.0	19.3
1935	2.0	3.1	1.1	5.5	11.7
1945	4.1	8.6	3.9	5.7	22.3
1955	18.7	16.2	5.2	19.7	59.8
1956	19.1	20.4	7.2	19.2	65.9
1957	18.7	22.5	5.5	21.9	68.6
1958	25.8	23.3	2.7	19.5	71.3
1959	27.5	23.8	2.9	17.8	72.0
1960	25.6	22.3	5.1	24.1	77.1
1961	28.5	19.7	3.3	22.0	73.5
1962	24.4	19.7	3.3	20.8	68.2

Source: U.S. Department of the Interior, Bureau of Mines, *The Mineral Industry of Wisconsin,* annual summaries.

Metallic Minerals

Iron "Ranges" and Districts

Gogebic Range. The Gogebic Range is a narrow band of iron-bearing rocks of Pre-Cambrian age which is some 80 miles long but locally not much more than half a mile wide. It extends in a southwesterly direction from Lake Gogebic in Michigan to Lake Namekagon in Wisconsin, and, although 53 miles of its total length lie in this state, the greater production has come from the east end in Michigan. Mining on the range has been continuous since 1884 and some 300,000,000 tons of ore have been shipped. At the time of writing there is one active mine in Wisconsin, the Cary Mine.

The Cary Mine is located at Hurley in Iron County. It is an underground mine which was opened in 1886 and, except for 1932, shipments have been continuous and amount to a total of 17 million tons. The production capacity of the mine is about 500,000 tons of ore per year and it has been worked to a depth of over 3,350 feet. The ore is hard, blue-red, non-Bessemer grade hematite.

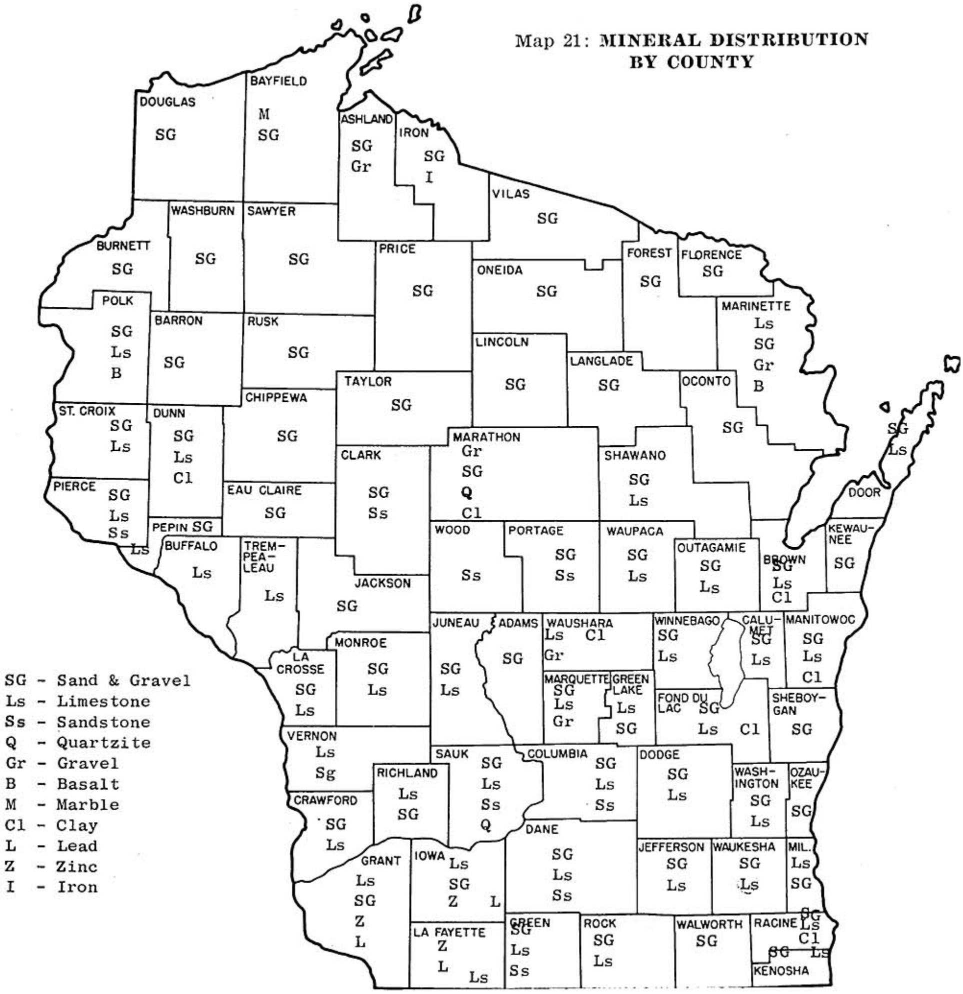
The Montreal Mine, which closed in 1962, was located just west of the Cary Mine. It was opened in 1886 and shipped every year except 1921. It was the largest producing mine on the range and was one of the deepest iron mines in the world, with workings extending over 4,000 feet below the surface. The mine had a production capacity of 1,000,000 tons of ore per year and produced 44.7 million tons between 1886 and 1962.

Menominee Range. The greater part of the Menominee Range lies in Michigan, but the iron-bearing formation extends into Florence County, Wisconsin. The range has been active since 1887 and has produced about 275 million tons of ore of which about only 7 million tons came from Wisconsin.

The Wisconsin mines are located in a small area near the unincorporated village of Florence. The last major shipment was made in 1931 and during 1953-55 a few thousand tons of ore were produced by open-pit mining.

Baraboo Range. This range is located approximately in the center of the Baraboo Hills in Sauk County. It has never been a large producer. The Cahoon Mine, which opened in 1919 and closed in 1925, produced 327,683 tons; the Illinois Mine, which operated from 1904 to 1916, produced 315,350 tons. The complex geology of the district has made it extremely difficult to estimate the extent of the iron-bearing formation. Mining is hampered by an overabundance of ground water.

Mayville District. Mining here has been restricted to the vicinity of Neda in Dodge County. It was first begun in 1849 when the Iron Ridge Mine was opened to supply ore to local charcoal furnaces. The mine was closed in 1892 but reopened 4 years later and continued in operation until 1914, when it was closed down after having produced



Map 21: MINERAL DISTRIBUTION BY COUNTY

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about 436,000 tons of ore. The Mayville Mine was opened in 1892 but abandoned in 1928 after producing 2,144,000 tons.

Unlike all others in the state, the ore in this district occurs in flat-lying beds of Ordovician age. The extent of the iron formation is large and hence the calculated reserves are many million tons. The ores are very high in sulfur and phosphorous and low in iron. Consequently they have no present use except in limited quantities as a coloring pigment; also, as the beds are often extremely thin, they cannot be mined economically.

Black River Falls District. This district is located in Jackson County and centers around a large butte known locally as Iron Mound. Production of ore has been reported as early as 1857 but has met with no success due to the low grade. However, it has been calculated that some 300,000 tons of concentrates could be produced annually from this district over a period of about 40 years, with the aid of beneficiation.

Other Deposits. Small pockets of iron ore formed in ancient bogs, or from the alteration of sulfide minerals, are fairly widespread but of no economic value. One such deposit was mined at Ironton, Sauk County, and smelted locally. The mine was opened in 1850 and operated for about 25 years.

The Future of Iron Mining in Wisconsin

High-grade Ores. The outlook for the continued production of "high-grade" ore from the Gogebic Range is very poor. High-mining costs, competition from higher grade imported ores and from ore concentrates (taconite) are among the factors which render production of ore from the deep underground mines no longer economical. In spite of the fact that substantial ore reserves still exist, the abandonment of the only remaining deep mine seems imminent.

Low-grade Ores. The relationship of high-grade ore bodies to the iron-bearing formation that contains them is like plums in a pudding. The iron formation is extensive but the ore-bodies are few. All the iron formation, however, contains substantial quantities of iron which may be released from the enclosing rock matrix by fine-grinding, and then concentrated into a very high-grade product. The ability to produce iron concentrates economically from low-grade ores depends primarily upon the texture of the ore, whether the minerals are coarse-grained or very fine-grained, and the mineralogy, whether the iron minerals are magnetic or nonmagnetic. The "taconite" ores of Minnesota are magnetic iron oxides whereas the "jasper" ores of Michigan are nonmagnetic. Magnetic ores are usually most desirable due to the relative ease with which the iron may be separated from the rock. Low grade deposits of magnetic ore in Wisconsin that may prove of economic value are located in the following areas:

1. Western half of the Gogebic Range.
2. Township of Agenda and vicinity, near the Town of Butternut in southern Ashland County.
3. Pine Lake, south of Hurley, Iron County.
4. Black River Falls district, Jackson County.

Although iron concentrates may ultimately be produced from other areas, such as the eastern end of the Gogebic Range or the Florence district, the areas listed above appear the most favorable.

Zinc and Lead Mining

Production of zinc and lead is confined to Grant, Iowa and Lafayette Counties in southwestern Wisconsin. The area of mineralization extends into Iowa and Illinois, where some ore is produced.

Lead was mined by the Indians before the advent of the white man, and it was the lure of this metal, rather than the agricultural resources, that attracted the first settlers to this part of the state. The first permit to dig lead was given to Julien Dubuque in 1788; however, he confined his activities principally to Iowa, and it was not until 1822 that Colonel Johnson began mining in Wisconsin a few miles north of Galena, Illinois.

The number of mines which have produced lead and zinc is not known. Some are mere holes in the ground. Over 300 zinc mines in the state have been large enough to deserve names, and the number of lead mines is even greater.

Zinc was first marketed in 1860. To date the Upper Mississippi Valley district (Wisconsin, Illinois and Iowa) has produced some 858,500 tons of lead and 1,482,400 tons of zinc.

The Future of Lead and Zinc Mining in Wisconsin. No mining industry is more at the mercy of fluctuating prices than that of lead and zinc, and the question of how to insure a healthy mining industry has been the subject of much debate, but no satisfactory solution has been found. Many smaller mines open or shut down as the price of ore dictates. The erratic production is reflected in the table below:

Table 20:
MINE PRODUCTION OF LEAD AND ZINC IN WISCONSIN
(In terms of recoverable metal)

	Lead		*Zinc*		
Year	*Short tons*	*$ Value*	*Short tons*	*$ Value*	*TOTAL $ Value*
1952	2,000	644,000	20,588	6,835,216	7,479,216
1953	2,094	548,628	16,830	3,870,900	4,419,528
1954	1,261	345,514	15,534	3,355,344	3,700,858
1955	2,065	615,370	18,465	4,542,390	5,157,760
1956	2,582	811,000	23,890	6,546,000	7,357,000
1957	1,900	543,000	21,575	5,006,000	5,549,000
1958	800	187,200	12,140	2,476,560	2,663,760
1959	745	171,350	11,635	2,676,050	2,847,400
1960	1,165	272,610	18,410	4,749,780	5,022,390
1961	680	140,080	13,865	3,188,950	3,329,030
1962	1,394	256,496	13,292	3,057,160	3,313,656

Source: U.S. Department of the Interior, Bureau of Mines, *The Mineral Industry of Wisconsin in 1962.*

Detailed geological studies in the district, undertaken co-operatively by the state and federal geological surveys, have added much to the knowledge of the district, and adequate ore bodies exist to suport future mining.

Molybdenite

Molybdenite is the ore of the metal molybdenum used in the manufacture of special steels. Occurrences are known in Marinette County but in insufficient quantities to be mined.

Nonmetallic Minerals

Sand and Gravel

Unconsolidated deposits of sand and gravel are widely distributed throughout the state. The most important were formed as a direct result of the last glacial period and are generally found within the boundaries of glaciation, although some river gravels may occur along stream valleys in the Driftless Area in the southwestern quarter of the state.

When the glaciers advanced over the state, they first deposited a heterogeneous mixture of rock fragments, boulders, sand and clay which is known as "till." However, as they began to melt, the melt-water washed the till and separated the various components according to their size. The fine clay was deposited in lakes or carried to rivers and washed away, but the coarser sand and gravel could not be transported as far and was deposited in front of the retreating ice margin in broad flats known as "outwash plains." Such outwash deposits now constitute the most important source of sand and gravel used in construction.

Molding sand is sand which is mixed with certain binders to make the forms used in foundries for metal castings. Some glacial sands still retain enough clay binder to be suitable for this purpose and are called natural molding sands. However, most of the molding sand now used is not from glacial deposits but from rather loosely consolidated sandstones which are crushed and mixed with the necessary binders, at the foundry. This results in a more uniform product than is found naturally. Sandstone for this purpose is quarried near Portage in Columbia County, at Browntown in Green County, at Klevenville in Dane County, and from the sandstone strata underlying the bluffs of the Mississippi in the vicinity of Maiden Rock in Pierce County.

Wisconsin has long been noted for its policy of using local materials for highway construction. This enables the state to make good use of local deposits and reduces the cost of construction and maintenance. For many years the Highway Commission has financed the geologic investigation of such deposits and much information on their location and nature has been obtained.

In 1960 Wisconsin, which ranked thirty-third in national mineral production, was the seventh largest producer of sand and gravel.

Table 21: SAND AND GRAVEL PRODUCTION IN WISCONSIN

(Thousand short tons and thousand dollars)

	1961		1962	
Class of operation and use	Quantity	Value	Quantity	Value
Commercial operations:				
Sand: (1)				
Molding	106	$ 266	560	$ 1,544
Building	3,378	2,852	3,022	2,418
Paving	2,814	2,054	1,888	1,525
Railroad ballast	102	81	(2)	(2)
Fill	874	451	985	564
Undistributed(3)	282	303	203	550
TOTAL	7,556	6,007	6,662(4)	6,600(4)
Gravel:				
Building	3,570	3,184	3,124	2,636
Paving	9,401	6,836	11,482	7,936
Railroad ballast	415	291	303	151
Fill	608	346	691	332
Other	946	801	214	178
TOTAL	14,940	11,458	15,814	11,233
TOTAL SAND AND GRAVEL	22,496	17,465	22,476	17,833
Government-and-contractor operations:				
Sand:				
Paving	5,401	2,762	2,685	1,414
Fill	481	184	421	147
Undistributed(5)	34	18	76	33
TOTAL	5,916	2,964	3,182	1,594
Gravel:				
Building	.....	.....	400	211
Paving	11,311	7,913	7,211	4,608
Fill	249	111	379	162
Other	6	4	.....	.....
TOTAL	11,566	8,028	7,991(4)	4,981
TOTAL SAND AND GRAVEL	17,482	10,992	11,173	6,575
All operations:				
Sand	13,472	8,971	9,844	8,194
Gravel	26,506	19,486	23,805	16,214
GRAND TOTAL	39,978	28,457	33,649	24,408

(1) Includes friable sandstone.

(2) Included with "Undistributed" to avoid disclosing individual company confidential data.

(3) Includes sand for other uses, engine, blast, filter, oil (hydrafrac), and other industrial sands (1961-62), glass and foundry sand (1962).

(4) Data do not add to totals shown because of rounding.

(5) Includes sand for other uses (1961-62), building sand (1962).

Source: U.S. Department of the Interior, Bureau of Mines, *The Mineral Industry of Wisconsin in 1962.*

The Future of Sand and Gravel Mining in Wisconsin. The reserves of sand and gravel are very large; however, individual deposits are often small and rapidly depleted. Continuous exploration is therefore necessary to locate adequate deposits close to the project in hand. In some areas of heavy demand it is becoming necessary to move further afield. Crushed limestone will provide an acceptable substitute for gravel in many places where gravel is in short supply.

Limestone

The rocks which are commonly called "limestones" in Wisconsin are actually dolomites. The difference between the 2 is not very precise, however. Limestone is composed essentially of calcium carbonate while dolomite also contains the carbonate of magnesium. It is this magnesium content that causes Wisconsin limestones to be unsatisfactory for the manufacture of Portland cement.

There are 3 separate dolomite rock units which outcrop in the state; they are the Lower Magnesian or Prairie du Chien, the Platteville-Galena, and the Niagara. The Lower Magnesian is used for building stone and agricultural lime, but it is of particular importance as a source of crushed rock aggregate for concrete construction in the Driftless Area, where sand and gravel for construction is lacking. The Platteville-Galena group, which is the host rock for the lead-zinc deposits, is used primarily for agricultural lime. It has been used for building purposes but disintegrates rapidly when in contact with water. The Niagara dolomite is a good all-purpose stone; it is used for agricultural lime, crushed rock, aggregate, building stone, refractory, iron ore flux and a variety of other uses. The well-known Lannon stone, which is used extensively for building, is quarried from this formation near Lannon in Waukesha County. Stone of similar quality may be obtained from this formation at numerous locations throughout the eastern part of the state.

The Future of Limestone Mining in Wisconsin. The reserves of limestone are so large as to be virtually unlimited. In most cases the successful operation of a limestone quarry is the result of factors other than the availability of the stone, such as strategic location of the quarry with regard to transportation and market, availability of labor, and demand for the product.

Granite

Granite, unlike limestone, which is often soft rock of many purposes, is an extremely hard rock of very limited uses. The resources of the state are immense and include stone of a wide variety of textures and colors, indeed it has been written that:

> "For monumental purposes the granites of Wisconsin have been selected by competent judges in preference to granites from any other part of the United States, and, in one conspicuous instance, in preference to granites of three competing con-

Table 22: LIMESTONE PRODUCTION IN WISCONSIN(1)

Use	1961 Quantity	1961 Value (thousands)	1962 Quantity	1962 Value (thousands)
Dimension:				
Rough construction thousand short tons.......	12	$ 95	12	$ 95
Rubble ....do..........	23	91	15	86
Rough architectural thousand cubic feet........	5	9	7	13
Dressed (cut and sawed) thousand cubic feet........	479	1,167	475	1,151
Flagging ....do..........	108	102	52	51
Subtotal .....approximate thousand short tons(2).....	83	1,464	70	1,396
Crushed and broken:				
Riprap.thousand short tons..	143	118	60	75
Concrete aggregate and roadstone ....do..........	9,895	9,960	10,173	10,212
Agriculture ....do..........	1,322	1,837	1,365	1,792
Lime ....do..........	84	93	87	78
Other(3) ....do..........	135	190	63	87
Subtotal ....do..........	11,579	12,198	11,749(4)	12,244
TOTAL ....do..........	11,662	13,662	11,818(4)	13,641(4)

(1) Includes both commercial and Government-and-contractor production.

(2) Average weight of 160 pounds per cubic foot used to convert cubic feet to short tons.

(3) Includes limestone for paper mills (1961), flux, asphalt, fertilizer, filter beds, and other uses.

(4) Data do not add to totals shown because of rounding.

Source: U.S. Department of the Interior, Bureau of Mines, *The Mineral Industry of Wisconsin in 1962.*

tinents. In point of color, durability and finish, they have no superior." *Wisconsin Geol. Survey,* Bulletin 6, 1898.

Dimension stone for building or monumental purposes is, or has been produced from numerous areas. The total production of granite for stone in 1960 was valued at over $1,500,000.

The following granite mining areas are among Wisconsin's most important:

1. *Montello area,* Marquette County. This granite is fine-grained and red to grayish red. Stone from these quarries furnished the sarcophagi of General U. S. Grant and Mrs. Grant in their famous tomb in New York City.
2. *Berlin area,* Green Lake County. The stone produced here is technically a rhyolite but is commonly referred to as granite. It is very dense, extremely durable and almost black.
3. *Waushara area,* Waushara County. This granite is quarried some 10 miles north of Berlin and is very similar to that of Montello but a little lighter in color.
4. *Waupaca area,* Waupaca County. A very coarse grained stone is produced here which varies in color from pink to red.
5. *Utley area,* Green Lake County. Rhyolite, which is very similar to that of Berlin, is quarried in this area.
6. *Granite City area,* Green Lake County. The granite is reddish, or gray with a red tinge.
7. *Granite Heights area,* Marathon County. This area lies about 10 miles north of Wausau and is the most active granite mining area in the state at the present time. A wide variety of colors is produced varying from gray to the striking "Ruby Red."
8. *Amberg area,* Marinette County. This is the second most active area at the present time and is noted for the wide variety of colors and textures of the granite. Some of the finest grained stone as well as some of the coarsest is found here and the colors range from red through pink to gray. An exceptionally coarse gray granite is quarried at Athelstane.

Crushed or weathered granite is also produced for surfacing highways. Formerly some of the tailings from the dimension stone quarries were crushed but they were too hard for profitable operation. However, in certain locations there is granite that has disintegrated by weathering to such an extent that it can be mined with a power shovel. This is used as a gravel-type surfacing material on local roads, especially in Wood County.

The Future of Granite Mining in Wisconsin. The use of granite as a construction stone has been steadily decreasing as cheaper construction materials have been adopted. It will always be in demand as a monumental stone as long as the finest possible product is desired. Skilled craftsmen are necessary to produce dimension stone and therefore the availability and cost of such skilled labor is extremely important.

All first class granites are about equally durable and sales depend greatly upon cultivating the taste of the public for a particular variety; hence advertising and salesmanship are more important here than in many other mineral industries. The granites of Wisconsin are second to none in quality and reserves are great; expansion of the industry is limited only by the demand and production costs.

Sandstone, Silica Sand and Quartzite

Sandstone is a term which denotes a sedimentary rock composed of sand-sized mineral grains. When such a rock is so thoroughly cemented or fused that it breaks across the original grains, it is termed a quartzite. Quartz (silica) is the predominant constituent of such rocks but many impurities are usually present. However, when the silica content is so high that the rock may be used for chemical or refractory purposes, it is called silica sand or refractory quartzite.

The uses of sandstone and quartzite depend either upon the physical or chemical characteristics. Sandstone with suitable color, texture and degree of cementation may be used as a building stone. At one time the red Lake Superior sandstone of Douglas, Bayfield and Ashland Counties was in large demand for this purpose but production now is negligible. In 1952 dimension sandstone was produced from Clark, Portage and Wood Counties.

Quartzite may be used for refractory purposes if its silica content is very high, but is also commonly used in grinding mills due to its great toughness. Its resistance to erosion usually causes it to remain conspicuous in the landscape in the form of hills such as Rib Mountain, McCaslin Mountain, Thunder Mountain, Mosinee Hill and the Baraboo Range. In 1960 quartzite was quarried from the Baraboo area for railroad ballast, refractories and grinding pebbles. Quartzite from Rib Mountain in Marathon County was used for abrasives.

Sandstone which may be readily crushed finds a market as molding sand, filter sand and a variety of other purposes. Production statistics of such sandstone are included in those given for sand and gravel.

Silica sand is the most valuable of the sandstone commodities. A high-grade silica sand deposit will warrant a considerable investment in machinery to wash, crush, grind and grade the raw material so that the finished product will conform to narrow specifications of both size and chemical purity. The variety of purposes for which silica sand products are used is very great.

Outlook for the Future. There are large reserves of sandstone, silica sand and quartzite in the state. These are high-bulk, low-cost commodities in which transportation costs are a major factor. New deposits may be opened up as the demand grows or as older deposits nearer the centers of use become depleted.

Clay and Shale

Clay and shale are used for the manufacture of tile and brick and also as an ingredient in cement. Deposits are widely distributed and their development depends largely upon the availability of transportation, local demand and cheap power for firing. The decline in the use of brick as a building material dealt the industry a blow from which it has not recovered.

In 1960 clay production was listed from Brown, Dunn, Fond du Lac, Marthon, Manitowoc, Racine and Waupaca Counties and was valued at $156,000

Outlook for the Future. Certain clays and shales possess the quality of bloating, when fired under certain conditions, and form a material suitable for making lightweight concrete. Recent tests on Wisconsin samples indicate that a shale formation that occurs in the eastern part of the state will make a suitable raw material but no immediate production is contemplated.

Cement

The value for cement production is included in the mineral production statistics but, with the exception of a little clay, the raw materials are imported.

The limestone in Wisconsin is generally too high in magnesium to be used in the manufacture of cement, but recent tests on some of the formations in the southwest part of the state indicate that they may be suitable.

Roofing Granules

Rather large quantities of crushed stone are used for the production of roofing granules. Rock used for this purpose must be chemically inert, must crush without crumbling and must possess a surface to which paint will stick. Rhyolite is quarried for this purpose near Wausau, Marathon County, and greenstone (meta-basalt) east of Pembine in Marinette County.

Marble

Marble is quarried near Grandview, Bayfield County, and is crushed for use in terrazzo tiling.

Miscellaneous Minerals

There is a wide variety of minerals in the state that may, at some date, have some economic value but have not been developed due to inadequate known reserves or poor quality. Among them are:

Asbestos. Known to occur in Marinette County but quantity is inadequate to develop.

Beryl. Occurs near Tigerton in Shawano County but present reserves do not warrant mining.

Copper. Large copper deposits may exist in northwestern Wisconsin as the same formation is present there that is host to the Michigan copper deposits. The rocks, however, are obscured by a thick blanket of glacial deposits which renders prospecting extremely difficult.

Marl. Marl is a form of lime which is deposited in lakes. It is used locally for agricultural lime but is generally more expensive to process, and is less satisfactory, than ground dolomite or limestone.

Peat. There are extensive areas of peat in the state but no use is made of it other than in very minor quantities as a soil conditioner.

Diamonds. Diamonds have been found in glacial deposits in Waukesha, Pierce, Dane and Racine Counties. About 20 were found between 1875 and 1885. Their source is not known and, in spite of rather intense prospecting, none have been found since.

Kyanite. Kyanite is a silicate of aluminum used for special refractory porcelains as that of spark plugs. Deposits are found near Powell in Iron County but the use of this mineral has now been largely displaced by synthetic products.

Feldspar and Nepheline. Feldspar and nepheline are alkali silicates of aluminum used in making glass and ceramics. Deposits are known near Wausau in Marathon County, but the quality at the known locations is poor.

Radioactive Minerals. The scattered occurrence of radioactive minerals is quite common especially in areas of granite. Thorium occurrences near Wausau have been investigated frequently but adequate reserves are lacking.

Talc. Talc deposits occur, and were mined in 1929 and 1930, near Milladore in Wood County. The quality was too poor for economic competition.

Zircon. Zircon is a silicate of aluminum and is used for refractories at very high temperatures. There is evidence that sizeable deposits may exist near Wausau. Only minor deposits have as yet been located.

CONSERVATION EDUCATION IN WISCONSIN

Professor Ingvald O. Hembre

Secretary, Education Subcommittee

Natural Resources Committee of State Agencies

Conservation Education and Wisconsin Schools

It took Wisconsin and her sister states a long time to arouse from a deep sleep of indifference and learn that there is a need for good sound conservation practices.

Immediately following the awakening, laws were enacted for the protection of some of our resources, assuming that regulation through law and enforcement would achieve the desired ends. We now realize that conservation is not the affair of any one group, nor exclusively the function of local, state, or federal government. It is the concern and business of every citizen. Laws alone will neither make wise users for the present, nor thoughtful forward-looking planners for the future.

Conservation education is a major responsibility of the schools. To achieve success in conservation education, a well-considered program of continuous experiences must be planned from kindergarten through high school.

The effectiveness of the teacher in conservation education is in direct proportion to his native ability, education, interest, and attitudes in this field. The program, therefore, must include a rich practical preservice teacher education and a sound helpful inservice program built upon the college foundation previously laid.

Administrators and teachers will look with favor upon the extension and enrichment of the school offerings in this field. Much interesting and attractive visual-auditory material is at hand for use, and the area is replete with challenging problems and interest developing situations concerning an ever-changing land. Furthermore, science has opened the way to unlimited improvement, and many illustrations such as tree plantings, farm woodlots, soil erosion control projects, improved fish and wildlife habitats and recreational and scenic centers may be found in each county for observation and other instructional use. A reasonable understanding of the purposes, principles and practices involved in each should be imparted. With such understanding, and a will to achieve improvement and progress, each pupil will be well able to take his position in our work-a-day world and help to make wise use and efficient management of natural resources a rich reality serving the interests of man rather than a vision of hope awaiting fulfillment.

Legislation Concerned with Conservation Education

Wisconsin is a recognized leader in the teaching of conservation in her schools and much of this credit must be given to early legislation. From meager beginnings in 1935, legislation for conservation education, and conservation curriculum offerings, have steadily improved. Along with fundamental courses has come further legislation covering teacher training, license certificates, text materials, and providing funds. The creation of school conservation camps and the expansion of the school forest idea have been instrumental in promoting the basic program; the most recent legislation pertaining to conservation is that of *Youth Conservation Camps.*

Listed below are the sections of the *Wisconsin Statutes* directly applicable to conservation education:

40.46 (1) (8) Curriculum

37.29 Teacher Training

40.43 Teachers' certificates and licenses

39.02 (23) Text material

40.67 (1) (d) (2) (a) (g) (4) State aid district

40.98 (1) (2) (3) (4) (5) School conservation camps

28.20 Community forests

28.21 Management

46.70 Youth camps

The Progress of Conservation Education in Wisconsin Schools

The early recognition of the importance of natural resources to the continuing well being of the people and the economy of the state is revealed in the educational leadership of such pioneers as Charles Van Hise who was President of the University of Wisconsin from 1902 to 1918; W. A. Henry, the first Dean of the College of Agriculture; Aldo Leopold, an internationally recognized naturalist, and others.

This leadership saw clearly that the demands upon the state's natural resources would soon outstrip nature's efforts to replenish the supply, unless man became a better steward. Thus the teaching of conservation education and the wise use of natural resources became recognized as a public school responsibility. Such recognition led to the enactment of the law which is still a part of the *School Code, Section* 40.46 (1), making "conservation of natural resources" one of the fundamental courses of our school curriculum.

Wisconsin pioneered the use of the school forest in its teaching program; there are now over 250 registered school forests. When soil conservation districts were established beginning in 1937, they were greatly assisted by the special skills of the county superintendents of schools, who in each county became members of the governing body of that county's soil conservation district. Conservation education programs were vigorously advanced through these county soil and water conservation districts and Wisconsin took a position of leadership in this field.

Research Studies Reveal Progress

Research studies on the status of conservation education were made in co-operation with the University of Wisconsin in 1950 and in 1956. Both studies followed the same pattern to make an evaluation of progress possible. They applied to conservation teachings in the high schools of the state by taking a 20 per cent random sample in 4 different categories. Eight Wisconsin counties were selected in which to make the study.*

Both studies reveal that much excellent conservation education work is being taught in both the elementary and secondary grades. Ninety-one per cent of the elementary schools reported a use of the out-of-doors in their conservation teaching in the 1956 study—an increase of 16 per cent over the 1950 study. The 1950 study revealed that 24.6 per cent of the elementary teachers had received conservation education preparation for their teaching; 81.2 per cent reported training in the 1956 study. In the secondary schools 43 per cent of the teachers reported preparation in conservation education in the 1950 study, and the 1956 report indicated that all schools had at least one teacher trained in this field. Both studies agree that there is less emphasis on conservation education in the secondary school grades than in the elementary grades. The elementary classes use the out-of-doors more extensively in their conservation education classes.

There are several strong indications of a healthy growth in conservation education in Wisconsin. In November of 1961, the faculty of the University of Wisconsin (Madison and Milwaukee) approved *Document 1515* prepared by a faculty committee entitled *The University of Wisconsin's Obligation for Conservation Education.*

This document states:

"The overall instructional responsibility of the University of Wisconsin in the field of conservation education is thus considered to be:

"1. To include in the programs of liberal education open to all students a sound introduction to the philosophy and knowledge of conservation.

"2. To prepare teachers, particularly those in the elementary grades and in such subject fields as social studies and science, to teach conservation in elementary and secondary schools.

"3. To prepare specialists in aspects of natural resource development and management who will be qualified for leadership positions in these fields.

"4. To provide a program of conservation education to youths and adults through the various extension services of the University."

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* Copies of both studies are available in the University of Wisconsin Library, through the Department of Agricultural Education, College of Agriculture.

In March of 1962, conservation education and administrative representatives of the 10 state colleges of the state held a conference considering ways and means to strengthen conservation education offerings at the several state colleges in the state.

A one-week conservation education seminar with special credit sponsored jointly by the State Association of School Administrators, the Department of Public Instruction, was held at *Trees for Tomorrow* in August 1962 and repeated in August 1963. The cosponsorship of this seminar by the administrators association is an unquestionable indication that the schools through their school administrators are increasing their interest and participation in conservation education.

Services of Agencies and Institutions in Conservation Education

Wisconsin Department of Public Instruction

Instruction in the conservation of natural resources occupies a significant place in the services and supervisory activities of the Department of Public Instruction. The department has a working membership in a number of organizations and agencies concerned with conservation. It has the primary responsibility for the curriculum planning associated with conservation education.

One member of the Department of Public Instruction staff has been assigned a leadership function in conservation education. A considerable amount of his time is devoted to assisting with the promotion of special conservation education projects. Beyond this, all other members of the general supervisory staff of the department consider conservation education supervision an important part of their specialized duties.

One committee of strategic importance in guiding the Wisconsin conservation education program is the state-wide Conservation Education Curriculum Committee. This committee has made numerous contributions to the improvement of instruction during the past 15-20 years with the most recent being a revised *Guide to Conservation and Resource-Use Education in Wisconsin Schools.*

The state supervisors of school libraries are constantly on the alert for enrichment materials in the field of conservation and these are listed in the school library catalog.

Teacher Education Centers

Teachers now have improved opportunity in Wisconsin, in the initial undergraduate program or later, to supplement their training in the areas of conservation and resource education, and to gain credit for advanced work. Most institutions within the state are offering some credit-courses in the conservation fields. A move is on foot to take another look at the present program in order to strengthen the core and corollary conservation education courses. Both the University of Wisconsin and the state colleges have made studies of this area and are adjusting their curricula in light of their findings.

Public interest in conservation education is increasing in Wisconsin. Many new state-wide organizations have been formed in its support, and older organizations have joined to give the movement greater strength. The Legislature has assisted with some nationally recognized legislation. By the public, by the concerned state agencies, and through the common publicity media schools are urged to give greater recognition to conservation subjects. The Legislature has actually spelled this out by enacting special directives into law.

There is a new trend in outdoor education: Institutions of higher education are acquiring blocks of land, and set this land aside as natural laboratories for outdoor study and to initiate and strengthen summer field work programs. College libraries select more books dealing with natural resources. Visual and audio departments have grown and their inventories are better able to support conservation teaching.

The colleges of Wisconsin are making similar progress in providing community services. Colleges are assisting the state in conducting exhaustive resource inventories. Likewise, staff members versed in conservation fields are contributing their share to adult education.

State Vocational Board, Rural Division

Conservation of natural resources is an integral part of the classroom, and individual on-the-farm instruction being carried on by vocational agriculture departments in the high schools and vocational schools of Wisconsin. These departments offer 4-year courses which incorporate a conservation emphasis at every grade level. They also offer young farmer and adult farmer classes beyond high school.

Conservation in vocational agriculture is not handled as an isolated emphasis, but is taught as part of such units as "How Plants Grow," "Land Classification According to Its Best Use," "Soil Management," "Water Control," "Crop Production," "How Wildlife Concerns the Farmer," "Farm Credit and Financing," and "Farm Management." Many instructors in agriculture serve also as managers of their schools' forests. The school forests provide a practical medium where conservation practices can be applied, for observation and participation by elementary and secondary school students who may not otherwise have direct farm contacts.

Effective use of soil, water, plants, forests and wildlife resources is the goal of a good farmer. Vocational agriculture strives constantly to develop constructive attitudes and appreciations on the part of students toward the resources with which they work. This is done through an emphasis on those agricultural practices which make successful farmers and at the same time conserve natural resources.

Agricultural instructors have a continual opportunity to acquire new appreciations and techniques in conservation through such activities as:

1. Workshops in farm forestry at the *Trees for Tomorrow Camp* at Eagle River.
2. Workshops on land classification, land judging and soil conservation held on a district basis.
3. The development of various teaching aids such as charts, slides, slide films, a crop history record book and teaching outlines on soil conservation.

Wisconsin Conservation Department

The Wisconsin Conservation Department, through various department programs and in co-operation with other agencies supports the promotion and teaching of good conservation practices. Some of the department's activities include:

1. *Conservation Education Center, Poynette.* The center at the State Game Farm offers a complete conservation education program on a tour basis to schools, teachers, scouts, and other organized groups. A visit offers experiences in the areas of soil, water, forestry and wildlife conservation. These experiences are presented through demonstration areas, model examples and displays, including birds, animals, fish and reptiles of Wisconsin. Also included is a demonstration of forest management exercises, value of shelter belt, a nature trail and other activities pertinent to this field.

2. *Summer High School Conservation Program.* At the present time, the Conservation Department is assisting 7 school systems in a 4-week summer conservation program. Trained technicians, conservation materials, project guidance and equipment are furnished by the department in a work-learn conservation program involving high school boys.

3. *Conservation Education Materials.* Materials include about 35 publications, covering resource management in fish, game, forestry and recreation uses. Some 700 copies of conservation films are available to 12,000 current users per year.

Conservation education exhibits are also made available at the WEA Convention at Milwaukee and at other educational meetings in the state.

4. *Conservation Education Consultant Service.* Service is available to schools, in order to promote conservation education. Regular workshops involving school forests, school camping, outdoor education and curriculum materials are scheduled from time to time. Field visits by school groups are popular and occur at state parks, fish hatcheries, the State Game Farm, state forests, state nurseries and other specialized management units.

The Conservation Department co-operates in the development of school forests, although the actual census and registration rests with the College of Agriculture. The management and use of school forests, as they affect resource-use, is the legal responsibility of the department.

The development of nature trails and use of the outdoors have increased in Wisconsin through this service. It is co-operation with Wisconsin schools, made possible under existing laws, that permits Wisconsin to continue towards its goals in conservation education.

State Soil and Water Conservation Committee

The State Soil and Water Conservation Committee consists of a representative of the Wisconsin Extension Service, the Wisconsin Experimental Station, the Wisconsin Conservation Department, and several farmers appointed by the Governor of the state.

The committee's staff includes conservation education specialists and a watershed engineer assigned to the task of assisting local soil and water conservation districts in developing and carrying out their district programs of work. These district programs give high priority to conservation education programs within the schools, and with adult and junior groups in the county.

Each of the counties in the state is organized as a soil and water conservation district. Each district receives technical assistance from the Federal Soil Conservation Service. The County Extension Service provides the educational leadership for the district.

The over-all major objective of these districts is to get soil and water conservation plans established on all the land in the state. The public schools and all conservation agencies are utilized very effectively in the educational programs of the district to establish a favorable public opinion and landowner and operator interest in applying soil and water conservation practices to the land.

The State Soil and Water Conservation Committee also has supervisory responsibility over federal Public Law 566, establishing programs for watershed protection and flood prevention. In 1961 the Wisconsin Legislature enacted Chapter 427 which, among other conservation programs, provides funds for the development of multiple purpose structures in the P.L. 566 watersheds. Two such lakes have begun lakes for fish, wildlife and recreation in certain feasible flood control this development in 1963.

Soil and water conservation districts were created under Section 92.05 of the *Wisconsin Statutes* for the purpose of effectuating the legislative policy announced in Section 92.02.

> 92.02 **Declaration of policy.** *"It is declared to be the policy of the legislature to provide for the conservation of the soil and soil resources of this state, and for the control and prevention of soil erosion, and for the prevention of floodwater and sediment damages, and for furthering agricultural phases of the conservation, development, utilization and control of water, and thereby to preserve natural resources, control floods, prevent impairment of dams and reservoirs, assist in maintaining the navigability of rivers and harbors, preserve wildlife, protect the tax base, protect public lands, and protect and promote the health, safety and general welfare of the people of this state."*

Each county is engaged in a program of carrying out this policy. Through this program of assistance to farmers, landowners are meeting the problems of soil and water conservation, watershed protection, flood prevention, farm forestry, wildlife and recreation development, including education, technical assistance, cost sharing, credit and research.

Wisconsin Extension Service, College of Agriculture

The Wisconsin Extension Service is recognized as the educational arm of the United States Department of Agriculture in the state, and as the extension arm of the College of Agriculture and School of Home Economics of the University of Wisconsin.

The Wisconsin Extension Service of the College of Agriculture and School of Home Economics, University of Wisconsin, and the USDA will assist the districts in planning and carrying out their programs of work whenever called upon to do so.

The district extension leaders provide the liaison with the county extension staff, the Wisconsin Extension Service administrative staff at the university, and the extension specialists located in each of the departments of the College of Agriculture and School of Home Economics.

The resources of the Wisconsin Extension Service and the university are available to the local county through its county extension office.

U.S. Soil Conservation Service

The U.S. Soil Conservation Service provides technical assistance to 72 county soil and water conservation districts in Wisconsin. Conservation education is one of the important district program objectives. All people need to recognize their dependence upon soil and water and their stake in its wise use and conservation.

1. *Soil Conservation Service* technicians located in 72 field offices assist landowners and operators plan and apply conservation work on their lands based upon soils and other technical land use information.
2. Service personnel co-operate in planning and participate in county, school and youth group conservation programs, teacher or leader training workshops, field trips or tours, conservation camps, and special conservation events.
3. The *Soil Conservation Service* furnishes some soil and water conservation publications, subject matter outlines, bulletins, and visual aids in conservation education.

State-wide Conservation Education Curriculum Committee

From the beginning of the Wisconsin Cooperative Educational Planning Program in 1944 there has been a state-wide Conservation Education Committee. This committee has included members from the State Department of Public Instruction, the elementary and secondary schools, the colleges and the state university, the State Conservation Department, the United States Forest Service and other local, state and national conservation agencies working in Wisconsin.

The objectives of this committee are to devise and recommend sound educational procedures and to develop and distribute useful educational materials for the purpose of improving education in resource-use and management. The state-wide Conservation Education Committee is responsible to the State Superintendent of Public Instruction and through it he carries out part of his statutory responsibility in conservation education.

This committee in 1957 published a *Guide to Conservation Education Bibliography in Wisconsin Schools.* Recently, the committee revised the bulletin "Guide to Conservation Education in Wisconsin Schools" and republished it under the new title *Guide to Conservation and Resource-Use Education in Wisconsin Schools.*

Trees for Tomorrow

The *Trees for Tomorrow* camp at Eagle River in Vilas County, sponsored by *Trees for Tomorrow, Inc.,* has become a conservation education center serving all of Wisconsin.

The program is directed by a council consisting of representatives of the Department of Public Instruction, University of Wisconsin, the state colleges, Conservation Department, Wisconsin Valley Improvement Corp., State Board of Vocational Education, State Soil and Water Conservation Committee, U.S. Forest Service, and school administrators and teachers. The staff for conducting the workshops at *Trees for Tomorrow* is recruited from these groups.

Since 1947, 13,071 Wisconsin high school boys and girls from 302 schools have taken part in *Trees for Tomorrow* 3-day workshops. Each workshop has 25 hours of instruction time. Approximately three-fourths of all the high school pupils come on scholarships furnished by individuals, organizations and industry, and the schools themselves.

A 6-week summer school session is held at the camp sponsored by the 10 state colleges. Teacher scholarships are provided annually by the Wisconsin Federation of Women Clubs, Guido Rahr Foundation, Garden Clubs of Wisconsin, First National Bank of Eagle River, and Dane County Conservation Committee.

Seniors from 18 of the 22 county colleges attend 3-day workshops at *Trees for Tomorrow.* Twenty-five other adult and junior groups with a wide range of civic and professional interest attended 3-day workshops at the camp in 1962.

A summer school session group of teachers leaving on a conservation tour from Trees for Tomorrow *camp at Eagle River in Vilas county.*

In this natural setting, technicians take time to explain their daily work of resources management to the groups on field tours. Through conservation exercises, the visiting groups participate in this management, and see the interdependence of the renewable natural resources of soil, water, forests and wildlife.

School of the Air-Radio-TV

Since 1933 the Wisconsin School of the Air has sponsored broadcasts designed to promote an understanding of conservation and a love of nature, and to awaken in each listener a sense of personal responsibility for the wise use of natural resources.

A special radio program of 31 broadcasts presenting "The Wonderful World of Nature" has been broadcast over the state radio network into the classrooms of the state; 2,100 classrooms with approximately 48,000 students have used this service. A similar program has been televised over the university's Madison channel.

The programs have been an effective stimulus for "conservation corner" and school museum projects. With the advent of television, additional staff and increased budgets in agencies supporting the conservation education program have enhanced this opportunity for learning.

Conservation Education in School Forests

The idea of the school forest was first suggested by Dean H. L. Russell, Wisconsin College of Agriculture, who, while traveling with Frank Tate, Minister of Education, Province of Victoria, was told that school forests were meeting with considerable success in Australia. He brought the idea back to Wisconsin and the first school forest was dedicated at Laona, Forest County, in 1927.

Wisconsin now has more than 250 school forests which are owned by elementary schools, high schools, and county and state colleges. A recent study revealed that school forests are used increasingly as outdoor laboratories for classes in biology, nature study, social problems, mathematics, forest management. They are used also for recreation and school outings. To enhance this latter purpose, a comprehensive handbook available for school use has been prepared jointly by the University of Wisconsin and the State Conservation Department.

The University Arboretum and Upham Woods

The University Arboretum comprises about 1,500 acres, on the south shore of Lake Wingra near the City of Madison, as a sanctuary for native Wisconsin plants and animals. Soil and moisture conditions in the area vary sufficiently to allow the establishment of practically all plants native to Wisconsin. The arboretum's small size precludes establishment of many of the larger native animals. However, there is a very large representation of the smaller native Wisconsin animals.

Upham Woods near the City of Wisconsin Dells, comprising some 500 acres of land on Blackhawk Island in the Wisconsin River and on the surrounding fringe of land, is dedicated to the preservation of the flora and fauna native to that area. Cabins, an assembly hall, kitchen and dining room have been erected on the property to provide living accommodations for study groups.

The University Arboretum serves, primarily, university level students and teacher groups in the study of the conservation of natural resources. Upham Woods provides group camping facilities and is used extensively by school and other groups studying resource use and conservation education. Both provide excellent outdoor laboratory facilities for conservation education and are widely used.

Miscellaneous Conservation Education Programs

Conservation Education Institute Effort. Emphasis on conservation education in Wisconsin has received encouragement through the attention given the topic in many school inservice education programs.

The focus varies from the place of conservation and resource-use education in the kindergarten to grade 12 curriculum to its relation to physical and social science learnings. Present attempts are to determine the attitudes of the students toward conservation; further attempts to evaluate the product will involve measuring the students' mastery of a set of predetermined concepts.

The *United States Forest Service,* with a regional office in Milwaukee and area offices in the Nicolet and Chequamegon National Forests, offers assistance in the promotion of conservation education in the forestry field. Specialized facilities under the auspices of this agency, as the Forest Products Laboratory and the Genetics Center at Rhinelander, provide excellent opportunities for conservation education field trips. Educational materials and films are available on request from the main office in Milwaukee.

School Camping and Conservation. From a very small start in the early 1950's, school camping and outdoor education has gained added importance in Wisconsin. Some 40 school systems, involving several thousand children, participate in a 3-day or week-long camping experience. This is in support of the regular school offerings and provides the necessary enthusiasm for a sound conservation program.

The *National Audubon Society's* camp at Sarona, Wisconsin, offers a series of summer workshops to acquaint teachers with the outdoor aspects of conservation. Special studies in nature, geology, ornithology and botany are offered.

Everyone has a Stake in Conservation

Civic, welfare, religious, patriotic and other public and private groups, agencies and individuals are contributing greatly to the development of conservation education in its manifold interests, aspects and possibilities. Scholarships, equipment, instructional materials and awards help to assist in the development of a fine, rich and effective program of conservation education. This program will serve Wisconsin's present people and generations which are yet to come.

The Education Subcommittee of the Natural Resources Committee of State Agencies

The Natural Resources Committee of State Agencies was established by the 1951 Wisconsin Legislature. The legal duties and responsibilities of this committee can be found under Section 23.26 of the *Wisconsin Statutes.* In brief, the committee was charged with co-ordinating, and strengthening wherever possible, the programs of the several state agencies related to the natural resources of the state.

The Education Subcommittee is a working group of the natural resources committee charged with co-ordinating and strengthening the conservation education program of the state. The membership of this subcommittee consists of representatives designated by the several educational organizations interested in resource use and conservation education. The subcommittee meets regularly and reports to the parent organization.

Activities of the subcommittee include:

1. Conferences on "More Effective Teacher Preparation for Conservation Education." Two have been held, one in 1952, the other in 1954. The 1952 conference sponsored an *Inventory of Conservation Offerings in Wisconsin Teacher Education Centers.* The 1954 conference devoted much of its activities to perfecting *A Self-Evaluation Instrument for Use in Conservation Teacher Preparation Institutions.* The self-evaluation instrument approved by the 1954 conference was duplicated and made available to all Wisconsin teacher preparation institutions by the education subcommittee.
2. In 1957 the subcommittee sponsored pilot schools to which assistance was given by the committee membership and co-operating agencies in developing conservation education programs from grade 1 through 12.
3. In 1959 the subcommittee was divided into 2 groups to give special attention to the encouragement of education programs in (1) adult organizations, and (2) the formal school education programs.

In 1962 the committee developed a *conservation attitudes inventory* which is being used to evaluate pupils' attitudes toward conservation of our natural resources.

The Future of Conservation Education

A vital interest in a strong program of conservation education and resource use is evident in Wisconsin. Increasing numbers of conservation education teachers are adequately prepared for this responsibility. Schools use the out-of-doors more extensively as laboratories for conservation education. The personnel of conservation agencies is being used more effectively in the planning and execution of the enriched courses of study. School administrators show increased interest and participation in strengthening the conservation education programs in the elementary and secondary grades.

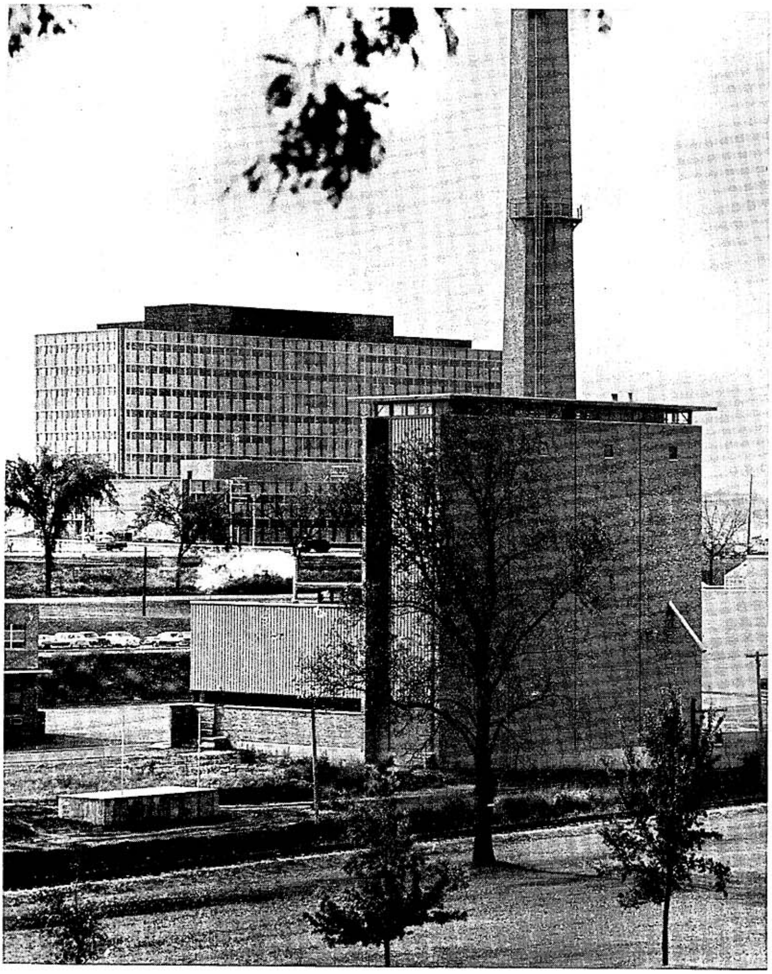
The universities and the state, county and private colleges are expanding and enriching their offerings for the more adequate preparation of teachers and other leaders in the field of conservation and use of our natural resources. This strengthening of Wisconsin's conservation education program is further evidenced by the participation of people from many walks of life in conservation interest centered groups.

The Wisconsin Council of Conservation Education was organized in the fall of 1961. A Wisconsin Council for Resource Development and Conservation was championed by Governor Nelson in the fall of 1962. These 2 new organizations, supplementing active organizations of the Conservation Education Association of America, the Soil Conservation Society of America, the Izaak Walton League, and the Audubon Society which has a national training center located at Sarona, Wisconsin, indicate a growing interest and concern for the wise use of Wisconsin's natural resources.

The success of conservation resource-use education in the Wisconsin schools looks to a good future, depending principally on the leadership of dedicated local conservation teachers, supported by a favorable school administration and local community providing natural resource areas and conservation agencies ready to help when called upon to assist.

This local interest in conservation education is supported by the State Superintendent of Schools. Angus Rothwell, demonstrated his vital interest in this field when he served as superintendent of one of the leading schools and communities in conservation education in Manitowoc, Wisconsin. State Superintendent of Schools Angus Rothwell has this to say about the school's responsibility in conservation education and resource use:

> *"A free and democratic people expects the educator to inform the future citizens of the nation of how they may use the natural resources so as to maintain and improve the standard of living for themselves and their children. This is a trust which our schools must accept and effectively discharge."*



This is the new Hill Farms State Office Building complex on Madison's west side. The buildings in the foreground (on University Avenue) house the heating plant, the State Crime Laboratory, the dairy and food laboratory of the State Department of Agriculture, and the sign shop of the State Highway Commission. The 2-story building in the background contains the offices of the Departments of Agriculture, Civil Defense, Conservation, Nurses, and the Employment Relations Board. The high-rise office building behind it (it fronts on Sheboygan Avenue) is the new home of the Departments of Banking, Insurance, Motor Vehicles, the Industrial Commission, and the Public Service Commission.

SPECIAL ARTICLES IN PREVIOUS BLUE BOOKS 1935-1962

A listing of those printed in the 1919-1933 Blue Books will be found in the 1954 Blue Book, pages 177-182.

Agriculture

Alice in Dairyland and Her Associates — An Example of State Promotional Activity, by Willard T. Reese, 1956 Blue Book, pp. 101-104.

A Century of Agriculture in Wisconsin, by Walter H. Ebling, 1940 Blue Book, pp. 185-196.

Consumer Co-operation in Wisconsin, by Harold M. Groves, 1937 Blue Book, pp. 209-228.

An Example of Technical Assistance — The Animal Disease Diagnostic Laboratory, by E. P. Pope, 1956 Blue Book, pp. 105-106.

The Future of Agriculture in Wisconsin, by Chris L. Christensen, 1937 Blue Book, pp. 155-168.

Protecting the Consumer through Inspection to Assure Conformity to Standards, by Dwight D. Forsyth, W. B. Griem and Claire Jackson, 1956 Blue Book, pp. 95-100.

Research and Technical Assistance to the Farmer — The Development of Grasslands, by Richard Powers, 1956 Blue Book, pp. 90-94.

The Situation in Agriculture, by Walter H. Ebling, 1935 Blue Book, pp. 45-57.

Soil Erosion Control in Wisconsin, by Noble Clark, 1940 Blue Book, pp. 143-154.

The State's Activity in Assuring That Dairy Farmers Are Paid for Their Milk, by Richard Powers, 1956 Blue Book, pp. 83-89.

Wisconsin's Agriculture, 1958 Blue Book, pp. 103-113.

Aviation

Wisconsin's Future in Aviation, by Ralph M. Immell, 1940 Blue Book, pp. 177-184.

Business (See Industry and Business)

Citizenship

Citizenship Training in Wisconsin, by Richard C. Wilson, 1942 Blue Book, pp. 169-175.

Commerce (See Industry and Business)

Conservation

Forestry in Wisconsin, by F. G. Wilson, 1942 Blue Book, pp. 177-185.

Elections

The Election Processes in Wisconsin, 1958 Blue Book, pp. 177-184.

Sovereignty and Democracy in Wisconsin Elections, by George Brown, 1935 Blue Book, pp. 71-93.

Geography

The Use of Wisconsin Land, by John S. Bordner, 1935 Blue Book, pp. 59-70.

Wisconsin's Land, 1958 Blue Book, pp. 89-95.

Government (See also Municipalities)

The Community of Governments in Wisconsin, by M. G. Toepel, 1952 Blue Book, pp. 75-172.

The State Government of Wisconsin, 1958 Blue Book, pp. 139-147.

Your State — Wisconsin, 1942 Blue Book pp. 219-231.

Wisconsin, the State, by M. G. Toepel, 1952 Blue Book, pp. 77-119.

The Wisconsin State Building Program, by Wisconsin Legislative Reference Library, 1952 Blue Book, pp. 173-184.

Handicapped, Vocational Rehabilitation

Opening Employment Opportunities to the Handicapped, by C. L. Greiber, 1956 Blue Book, pp. 124-128.

Highways

Traffic Safety in Wisconsin, by R. C. Salisbury, 1942 Blue Book, pp. 159-168.

The State as a Buyer — Building a Highway, by William F. Steuber, 1956 Blue Book, pp. 146-154.

History

Anniversaries, Wisconsin, by Joseph Schafer, 1935 Blue Book, pp. 3-28.

Capitols, The Four Wisconsin, 1948 Blue Book, pp. 127-139.

Centennial Observances, 1937 Blue Book, p. 193.

Centennial, Wisconsin Celebrates Its, by Merle C. Palmer, 1950 Blue Book, pp. 123-175.

Centennial, Wisconsin Plans Its, by Merle C. Palmer, 1948 Blue Book, pp. 77-83.

Centennial Year, Official Opening of Wisconsin's, by Merle C. Palmer, 1948 Blue Book, pp. 85-128.

Defense Program, Wisconsin in the, by R. S. Kingsley, 1942 Blue Book, pp. 151-158.

Famous People, Wisconsin's, 1958 Blue Book, pp. 193-202.

Governors, Wisconsin's Former, 1848-1959, 1960 Blue Book, pp. 67-206.

History, Some Land Marks in Wisconsin, 1958 Blue Book, pp. 213-222.

Northwest, The Old, by Joseph Schafer, 1937 Blue Book, pp. 185-192.

Thirtieth Star, Wisconsin, by Edgar G. Doudna, 1948 Blue Book, pp. 141-200.

U.S.S. Wisconsin, Well Done, by E. N. Doan, 1946 Blue Book, pp. 185-192.

War, Wisconsin Government Enrolls for, by Edward N. Hein, 1944 Blue Book, pp. 75-113.

Industry and Business

Authorizing and Regulating a State Bank, by William E. Nuesse, 1956 Blue Book, pp. 178-182.

Approving the Plans and Construction of Certain Buildings, by Roger Ostrem, 1956 Blue Book, pp. 174-177.

An Engineering Service Function — The Electrical Standards and Instrumentation Laboratories, by Robert J. Parent, 1956 Blue Book, pp. 214-217.

Licensing by the State, by M. G. Toepel, 1956 Blue Book, pp. 155-162.

An Overview of the Relationship of Wisconsin State Government to Business, by Warren J. Samuels, 1956 Blue Book, pp. 71-82.

Protecting the Public and Producer Interests in Public Utilities, by H. J. O'Leary, 1956 Blue Book, pp. 204-208.

Regulating the Transportation of Passengers within Urban Communities, by A. W. Larson, 1956 Blue Book, pp. 201-203.

Restraints on the Sale of Securities, by Edward J. Samp, 1956 Blue Book, pp. 141-145.

Safeguarding Our Food Supply, by Jerry Dunn, 1956 Blue Book, pp. 163-167.

Securing Permission to Operate a "For Hire" Truck, by Eugene Henkel, 1956 Blue Book, pp. 194-200.

State Regulation of Advertising, by Kathleen Kepner, 1956 Blue Book, pp. 183-193.

The University Promotes Community Employment Development, by Kenneth E. Rindt, 1956 Blue Book, pp. 168-173.

Wisconsin's Commerce, 1958 Blue Book, pp. 129-138.

Wisconsin's Industry, 1958 Blue Book, pp. 115-127.

Labor

State Services in Bringing the Job and the Worker Together, by A. L. Beier, 1956 Blue Book, pp. 129-135.

The State and Labor Relations, by Arvid Anderson, 1956 Blue Book, pp. 136-140.

Legislature

Members of Wisconsin Legislatures: For 1848 to 1915, inclusive, 1915 Blue Book, pp. 253-315 and pp. 488-539; for 1917 to 1927, inclusive, 1927 Blue Book, pp. 643-652; for 1927 to 1935, inclusive, 1935 Blue Book, pp. 261-266; for 1937 to 1943, inclusive, 1944 Blue Book, pp. 186-190; for 1945 to 1957, inclusive, 1958 Blue Book, pp. 315-322.

Statute Lawmaking in Wisconsin, by Edwin E. Witte, 1937 Blue Book, pp. 129-154.

Libraries

State Aid to Libraries, by C. B. Lester, 1940 Blue Book, pp. 155-160.

Municipalities

City and Village Government in Wisconsin, by F. N. MacMillin, 1952 Blue Book, pp. 136-146.

The Cities of Wisconsin, 1958 Blue Book, pp. 149-163.

Special Districts in Wisconsin, by M. G. Toepel, 1952 Blue Book, pp. 163-172.

Town Government in Wisconsin, by George S. Wehrwein, 1935 Blue Book, pp. 95-107.

Village Government in Wisconsin, by George S. Wehrwein, 1940 Blue Book, pp. 161-170.

Wisconsin County Government, by M. G. Toepel, 1952 Blue Book, pp. 120-135.

The Wisconsin Town and Its Government, by M. G. Toepel, 1952 Blue Book, pp. 147-162.

Pensions (See Public Welfare)

Population

Some Trends Revealed by the 1940 Census, by Edwin E. Witte, 1942 Blue Book, pp. 129-150.

Wisconsin's People, 1958 Blue Book, pp. 79-88.

Public Welfare

The Care of the Unfortunates in Wisconsin, 1958 Blue Book, pp. 185-192.

Development of the Wisconsin Pension Program, by George Keith, 1940 Blue Book, pp. 129-141.

Radio

W.H.A. Wisconsin Radio Pioneer, by Harold B. McCarty, 1937 Blue Book, pp. 195-207.

Recreation

Recreation Facilities in Wisconsin, 1958 Blue Book, pp. 203-212.

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