Michigan Trees (rev.)

Barnes and Wagner (2004)

University of Michigan Press

Pp. 373-393

[Michigan forest assembly after glaciation;
Presettlement Michigan forests;
Michigan forest communities today]

Forest Communities

A *community* is the collection or assemblage of organisms within a particular area at a given time. If only plants are considered, it is a plant community; if all organisms are considered, it is a biotic community or biome. A forest community is one dominated by trees. They are also associated with shrubs, vines, and herbs and a vast array of other organisms, from ferns, deer, and earthworms to fungi and bacteria. These organisms taken together make up the biotic component of a forest ecosystem. Because of their size, shade-casting crowns, extensive root systems (which extract large

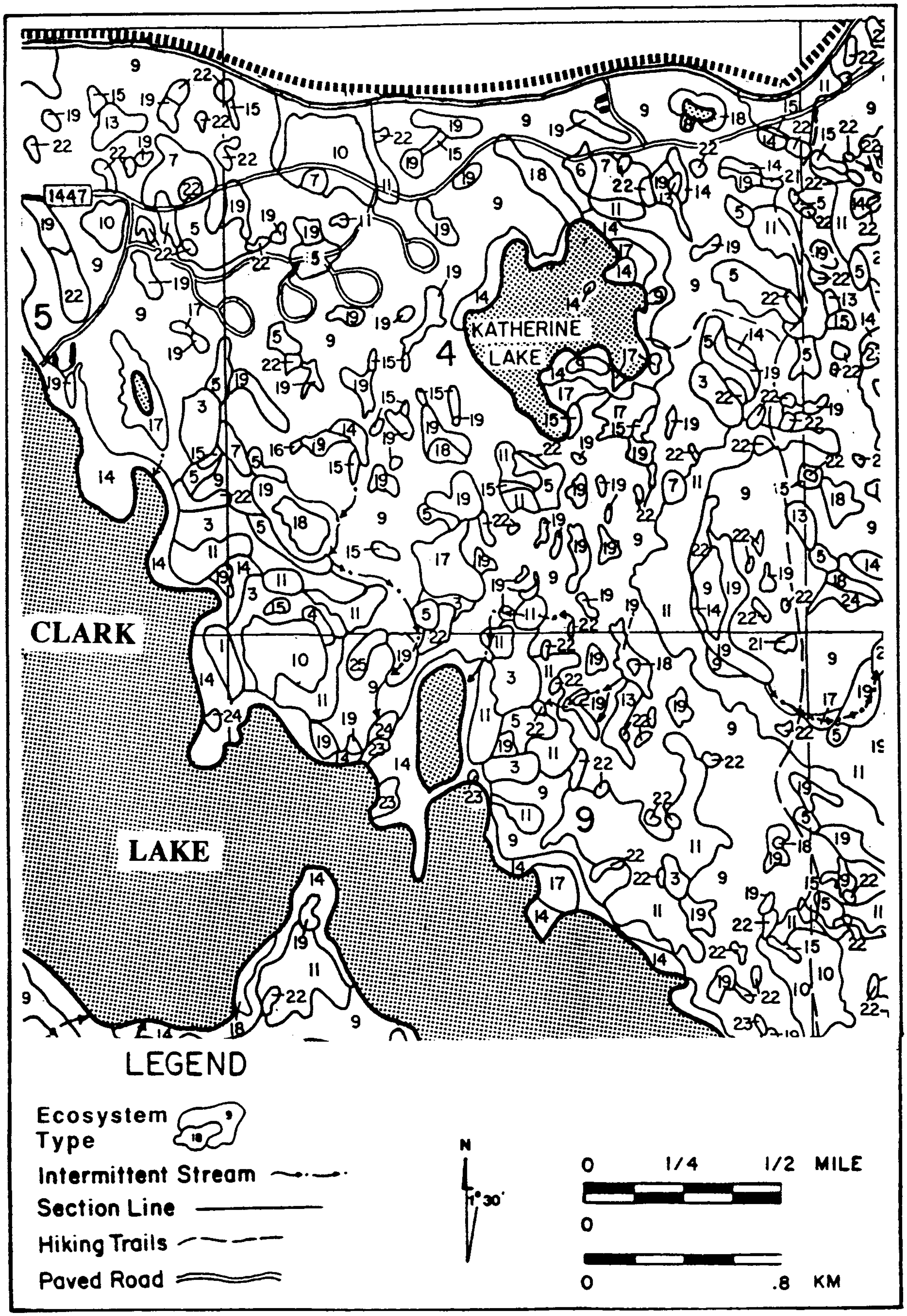


Figure 28. Map illustrating the patterns of landscape ecosystems that occur at a fine scale on the Earth's surface. The map shows the ecosystem types of old growth forest that surround part of Clark Lake in the north-central part of the Sylvania Wilderness Area, Ottawa National Forest, Upper Michigan. Area shown mapped: 13.9 km² (5.4 mi²), 1,390 ha (3,435 acres). Landscape ecosystem types range in size from <0.25 to 80 ha. (After Barnes et al. 1998. *Forest Ecology* © 1998, John Wiley & Sons, Inc. This material is used by

quantities of soil water and nutrients), and their visual appearance and aesthetic qualities, they are often of primary importance and focus. Therefore, tree names are used as a shorthand way of characterizing a forest community—termed a *forest type* (e.g., Oak-Hickory or Spruce-Fir). Such forest types are described later in this section. Keep in mind, however, that a forest is an ecological system—not just trees. It is alive with many interacting parts of air, landform, soil, water, and an enormous array of above- and below-ground plants and animals.

The nature of a given forest community is determined by the interaction of several kinds of factors: first, the physical site (or habitat) conditions available for plant establishment, growth, and reproduction; second, disturbance regimes of fire, wind and ice storms, flooding, herbivory by deer, and insect and disease attack; third, the plants and animals available to occupy a particular area at a given time; and, fourth, changes in the site conditions made by the forest biota themselves, including humans.

Over time, measured in tens and hundreds of years, the physical site conditions (climate, soil, and drainage) of ecosystems change, and forest communities change in response—forming different species combinations. From early times onward, people have observed that forest types succeeded one another (Spurr 1952). This ecosystem change, as seen best in changes in species composition of trees and associated vegetation over time, is termed *succession*. It is defined as what happens with space fixed and time changing, and it can only have meaning in the context of a particular geographic framework—a site-specific forest ecosystem in its regional context. As a part of ecosystem change, forest succession progresses in nearly infinite ways and is driven by many different site and biotic factors along with simultaneously occurring processes. Succession that follows a disturbance to an existing forest, disrupting ecosystem processes and destroying existing biota, is termed *secondary succession*. When ecosystem change occurs on previously unvegetated terrain (e.g., water, rock, or sand dune) and proceeds in the absence of a catastrophic disturbance, it is termed *primary succession*.

An excellent example of successional pathways on Lake Michigan sand dunes is illustrated in Figure 29. Note the different and complex pathways that may occur, depending on the initial substrates, from wet depressions to dry sandy crests. Once the late-successional community is formed, disturbances by wind, fire, or insects and disease would initiate secondary successional pathways for each of the ecosystem substrates.

Succession often occurs when species that are tolerant of understory conditions (e.g., beech and sugar maple) gradually or suddenly, via disturbance, succeed to a position of dominance in the overstory canopy of the forest. Traditionally, we are taught to expect that early-successional or pio-

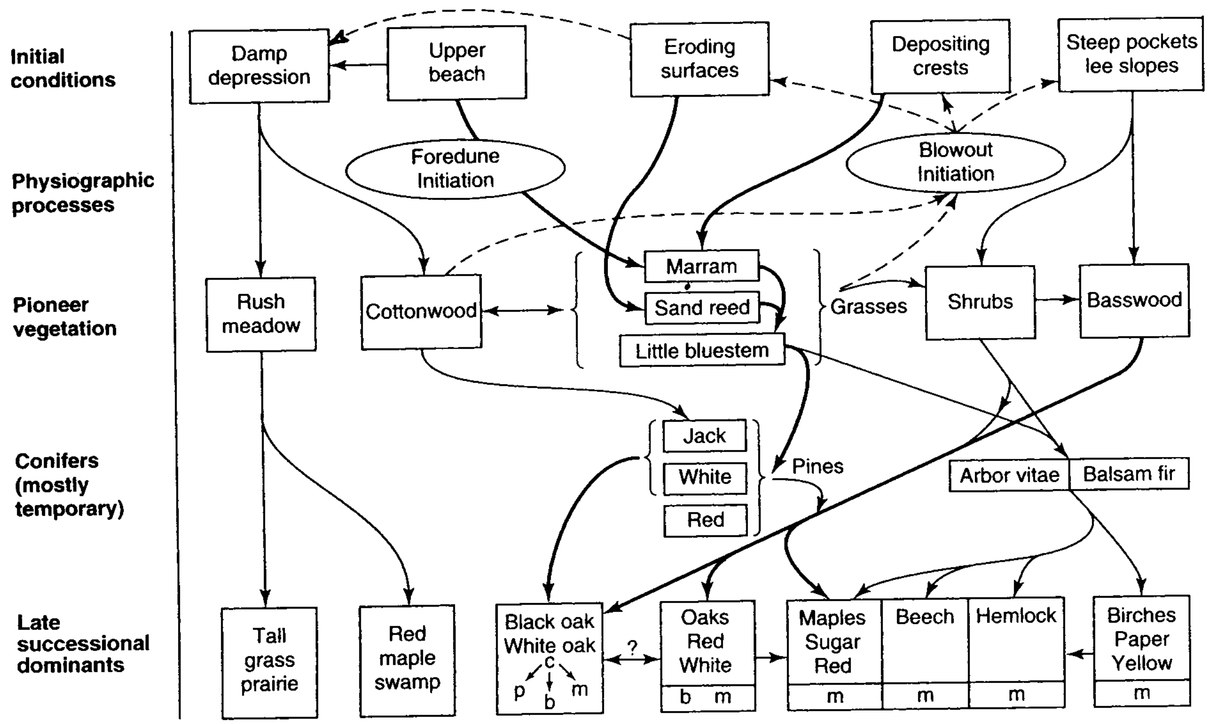


Figure 29. Alternative successional pathways from different initial sites on Michigan sand dunes. Beaches, foredunes, and blowout dunes provide diverse sites, which undergo different successions. The center of the diagram shows an oversimplified outline of "normal" succession, from dune builders to jack or eastern white pine to black oak–white oak, with several ground cover types: chokecherry–poison ivy (*c*), "prairie" (*p*), blueberry-huckleberry (*b*), or mesophytic herbs (*m*), depending on topography, water table, and biotic and fire history. Damp depressions (*left*) and protected lee slopes and pockets (*right*) may lead to richer forests that include basswood, northern red oak, and many mesophytic trees and herbs. (After Olson 1958. Reprinted from *Botanical Gazette,* ©1958 by the University of Chicago. Reprinted by permission of the University of Chicago Press.)

neer species are followed on a given site by midsuccessional species, which in turn may be followed by late-successional species. However, succession is not a tidy process—the trees haven't read the textbooks. Furthermore, there is no endpoint to succession—no climax! Disturbances, small and large, continuously act to interrupt expected trends. Certainly, general succesional trends may be expected, predicted, and observed on markedly contrasting sites, for example, the mesic forest compared to the fire-prone outwash plain or river floodplain. However, only by understanding the natural history of trees, their regeneration ecology, interacting site conditions, and disturbance regimes—all within a regional ecosystem framework—can we make an educated guess as to how forest composition will change for a site-specific ecosystem over time. For a more detailed examination of the history of forest succession, how it works, and examples of this fascinating ecological process, the reader is directed to Barnes et al. 1998 (443–85).

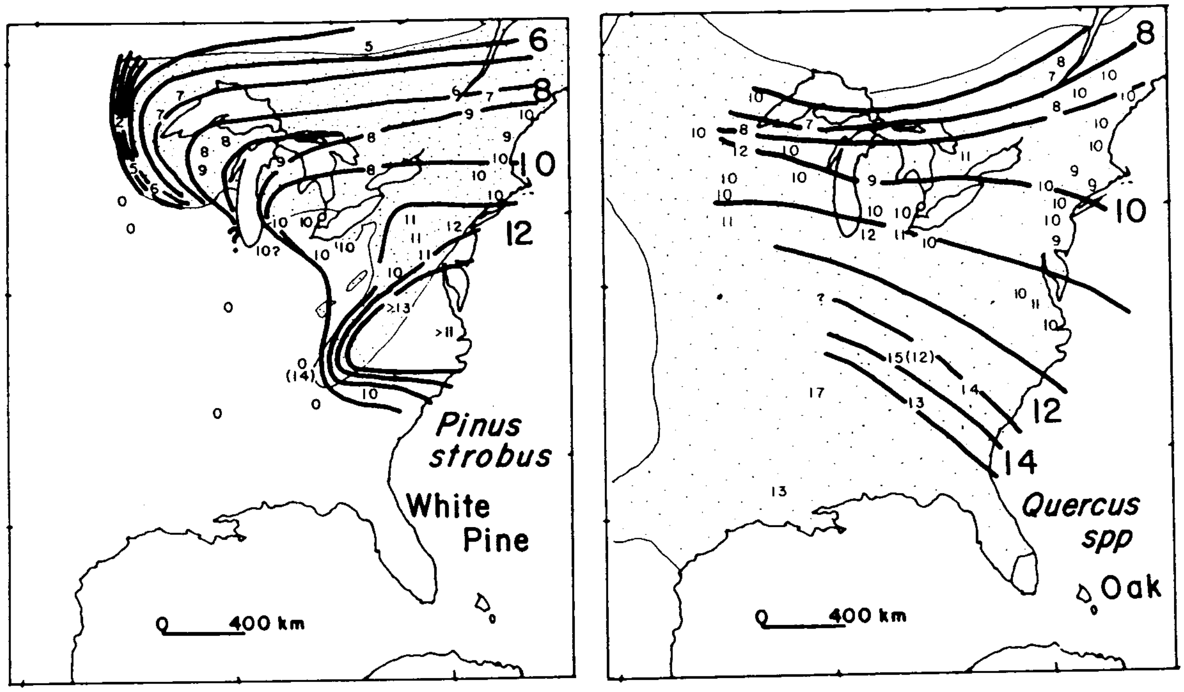
Tree Migrations following the Pleistocene Ice Age

An understanding of Michigan forest communities can be placed in historical perspective by examining post-Pleistocene tree migrations (Davis 1976; Delcourt and Delcourt 1987). This past vegetational history is deciphered primarily by analyzing the pollen buried in successive layers of the sediments taken chiefly from the bottoms of bogs and lakes. Michigan communities are relatively young. Only about 18,000 years ago, ice, up to a few thousands of meters thick, covered the state. Michigan, as part of the western Great Lakes region, is one of the more recently uncovered areas of the world. As glacial ice retreated, tree species migrated into Michigan from the east and south. Boreal forest species, dominated by spruces but also including balsam fir, tamarack, northern white-cedar, and associated hardwoods, reinvaded as the ice retreated approximately 14,000 years before present (B.P.) in southern Michigan and about 9,500 years B.P. in northern Michigan. The spruce-dominated boreal forest reached its maximum abundance about 11,000 to 10,000 years ago and then declined quickly (moving northward) as the climate rapidly became drier and warmer.

Different tree species migrated at different rates, and some still may be advancing westward. The pines came rapidly from the east, first jack and red pines, followed about 1,000 years later by eastern white pine (Fig. 30*A*). Pines already present 11,000 years ago, dominated central and northern Michigan 10,000 to 9,000 years ago, when oaks and associated dry-mesic and dry-site hardwoods rapidly invaded southern Michigan from the south (Fig. 30*B*). Warming and drying continued, and with it came a shift to the dry-mesic oak forest, which advanced northward to replace pines in the central and northern parts of the Lower Peninsula. This dominance by the dry oak forest probably reached its peak about 7,000 years ago when the prairie and oak savanna reached its maximum eastward extent in the Midwest.

By 7,000 years ago, the climatic influence of the continental ice sheet had declined markedly, and the vegetational changes from 7,000 to 2,000 B.P. were much smaller than before. As the climate slowly became moister and cooler, the prairie and oak savanna retreated to the west. Mesophytic species such as yellow birch, maples, beech, and hemlock, which had initially migrated into Michigan from the south and east 8,000 years ago, increased markedly in abundance from 7,000 to 2,000 B.P. with the cooler and moister climatic trend. Some of these species have moved much less toward the west than others; for example, beech has reached only as far as Marquette County in the Upper Peninsula.

From 500 B.P. to the present, and especially during the twentieth century, humans have had a profound, often catastrophic, impact on the land-



A B

Figure 30. Migration routes in late glacial and early Holocene times, 14,000 to 6,000 years ago. *A*, eastern white pine; *B*, oak species. Small numbers on the maps indicate the time of arrival at individual sites. Contours show the leading edge of population advance at 1,000-year intervals. Shaded areas (with dots) are the presettlement ranges for the genus or species. (After Davis 1983. Reprinted by permission of Margaret B. Davis and the Missouri Botanical Gardens.)

scape, due primarily to agriculture, land drainage, logging, dam building, urbanization and suburbanization, fire prevention and suppression, failure to control deer herds, and road building. In these ways, forest ecosystems are fragmented, fires are easily stopped, regeneration of forest species is prevented, and wildlife corridors are eliminated.

Although the spruce-fir forest, the pines, and the dry oak-hickory forests were apparently in past times much more widespread in the Lower Peninsula than they are today, they still remain in local ecosystems that are suited to their particular requirements. Relict pockets of black spruce, tamarack, and other boreal plants remain in cold, wet bogs and swamps in southern Michigan. Oaks keep their foothold in the north on warm, dry, south-facing slopes, rocky sites, and near lakes—microsites where the climate is milder than elsewhere. However, due to the exclusion of wildfire, they are systematically being replaced by more mesophytic species, especially red and sugar maples and beech. The postglacial history is thus a complex sequence of events, with species migrating from different directions, at different times and different rates, and forming communities—sometimes quite similar to those of today and sometimes markedly different.

Michigan Forest circa 1800

What were the native forests like prior to widespread European settlement in the 1800s? To answer this question, we are fortunate to have a detailed map of our native Michigan forests circa 1800 (Comer and Albert 1998). The map, developed using an ecosystem approach, shows the occurrence of 26 different forest or vegetative types (e.g., emergent marsh and inland wet prairie). They are described in the context of the regional landscapes of Michigan in an accompanying publication (Comer et al. 1995).

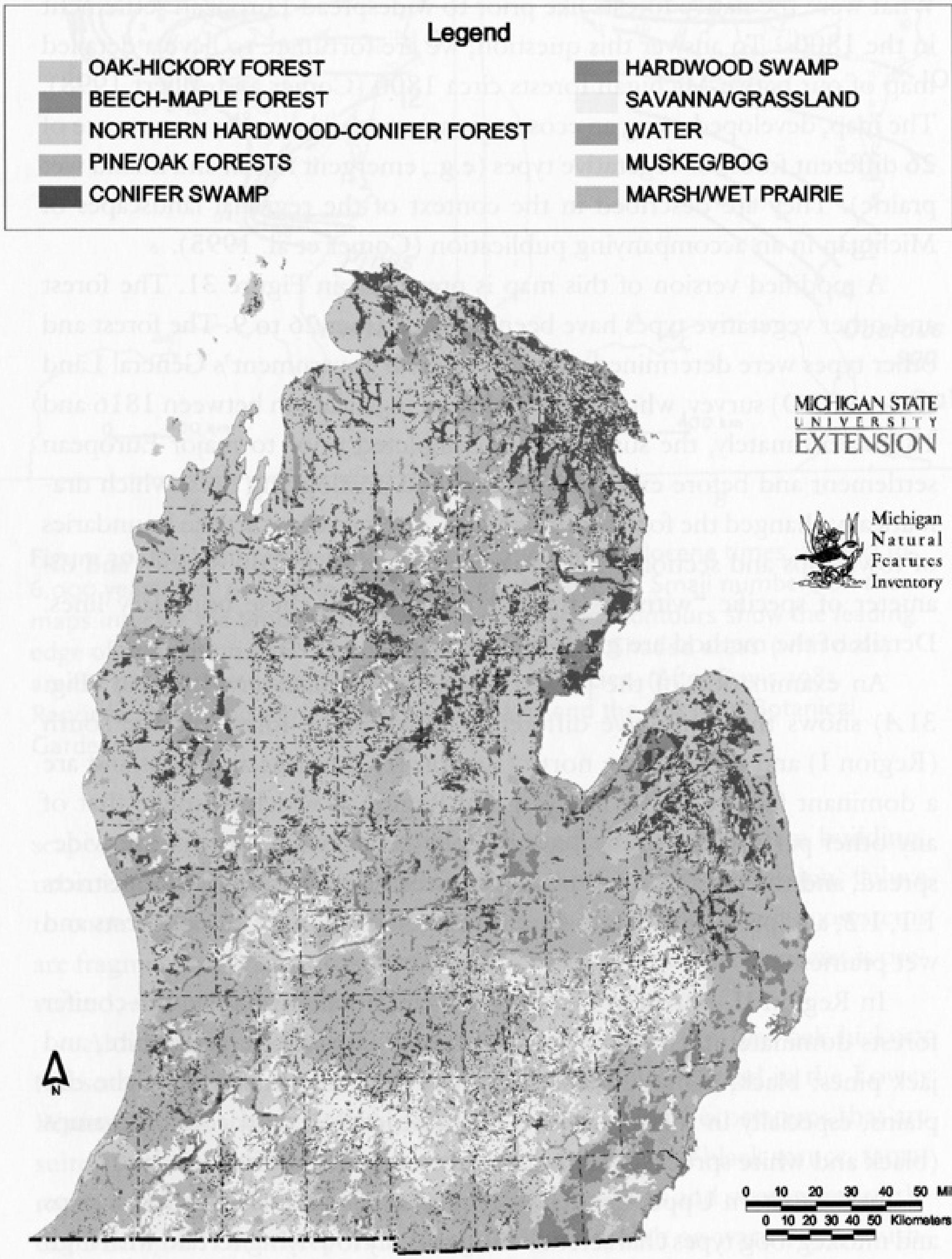
A modified version of this map is presented in Figure 31. The forest and other vegetative types have been reduced from 26 to 9. The forest and other types were determined using the federal government's General Land Office (GLO) survey, which was conducted in Michigan between 1816 and 1856. Fortunately, the surveys were completed prior to major European settlement and before extensive logging and postlogging fires, which dramatically changed the forests of Michigan. The surveyors set the boundaries of townships and sections. They marked and recorded the species and diameter of specific "witness" trees at points along these boundary lines. Details of the method are given by Comer et al. (1995).

An examination of the presettlement map of Lower Michigan (Fig. 31*A*) shows the distinctive difference between the forests of the south (Region I) and those of the north (Region II). Savanna and grassland are a dominant feature of the landscape of Region I, which is unlike that of any other part of Michigan. Beech-maple (sugar maple) forests are widespread, and the old Lake Erie plain of southeastern Michigan (Subdistricts 1.1, 1.2, and parts of 5.2) is distinctive for its hardwood swamp forests and wet prairies.

In Region II, northern Lower Michigan, northern hardwood–conifer forests dominate much of the landscape; pine-oak forests (red, white, and jack pines; black, white, and northern pin oak) forests dominate the dry plains, especially in the high plains (Subdistrict 8.2); and conifer swamps (black and white spruces, northern white-cedar) are abundant.

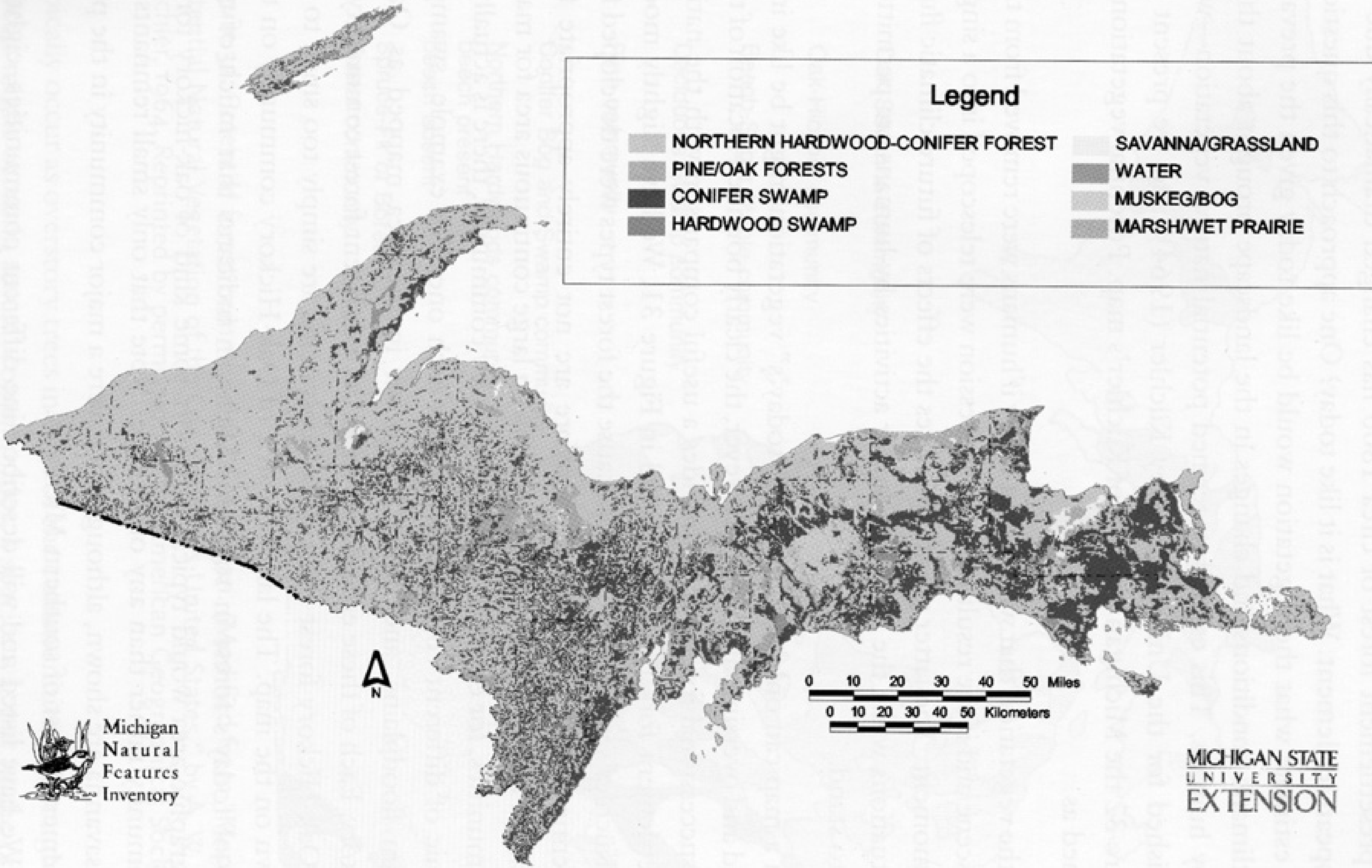
In the eastern Upper Peninsula, Region III (Fig. 31*B*), conifer swamps and muskeg-bog types characterize the generally low-lying terrain with high water tables. Distinctive pine forests border Lake Superior. In the western Upper Peninsula, Region IV (Fig. 31*B*), a fine-grained mosaic of northern hardwood–conifer forest and conifer swamp forest essentially blanket this region of crystalline bedrock. Several large fire-prone plains with pine forest are also noticeable.

Overall, this magnificent baseline, developed with keen regional and local ecological understanding by the compilers, provides the basis for scien-



A

Figure 31. Map of presettlement vegetation circa 1800. *A*, Lower Michigan; *B*, Upper Michigan. (After Comer et al. 1998.)


Legend
NORTHERN HARDWOOD-CONIFER FOREST
PINE/OAK FORESTS
CONIFER SWAMP
HARDWOOD SWAMP
SAVANNA/GRASSLAND
WATER
MUSKEG/BOG
MARSH/WET PRAIRIE
0 10 20 30 40 50 Miles
0 10 20 30 40 50 Kilometers
N
Michigan Natural Features Inventory
MICHIGAN STATE UNIVERSITY EXTENSION

B

tific studies in tracking future forest and land use trends and in managing Michigan's landscape ecosystems.

Michigan Forests Today

The presettlement forest of circa 1800 has changed dramatically due to European settlement. What is it like today? One approach to this question is to estimate what the vegetation would be like today given the prevailing climatic conditions and changes in the landscape brought about thus far by humans. This estimate—termed potential natural vegetation—was published for the United States by Küchler (1964), and we present in Figure 32 the Michigan portion of Küchler's map. Potential vegetation is defined as

> the vegetation that would exist today if humans were removed from the scene and if the resulting plant succession were telescoped into a single moment. The latter point eliminates the effects of future climatic fluctuations while the effects of earlier activities by humans are permitted to stand.

Such a map can only present what "today's" vegetation might be like in a broad and oversimplified way. However, the clearly bounded location of the late-successional forest types provides a useful comparison with the native presettlement forest types displayed in Figure 31. We have slightly modified Küchler's map of Michigan because the forest types were developed for the entire United States and therefore are not entirely appropriate for Michigan itself. Although the map shows a large continuous area for many communities, for example, the Oak-Hickory community, there is actually a mosaic of different communities within each one. For example, swamps, stream floodplains, and moist flats occur in the area mapped as Oak-Hickory. Each of these ecosystems supports a different forest community—not Oak-Hickory forest—but these ecosystems are simply too small to be shown on the map. The large expanse of Oak-Hickory community on the map of today's forest in southern Michigan indicates that much of this geographic area would typically support some kind of oak-hickory forest community rather than any other type. Note that only small remnants of oak savanna are shown, although they were a major community in the presettlement forest of southern Michigan.

We have listed and will describe nine different communities, eight of which are shown on Küchler's map. In addition, we have presented a list of early-successional or pioneer species that may be found at an early stage on lands occupied by one or more of these communities. Following the description of all communities, we list in Table 4 the tree species that would

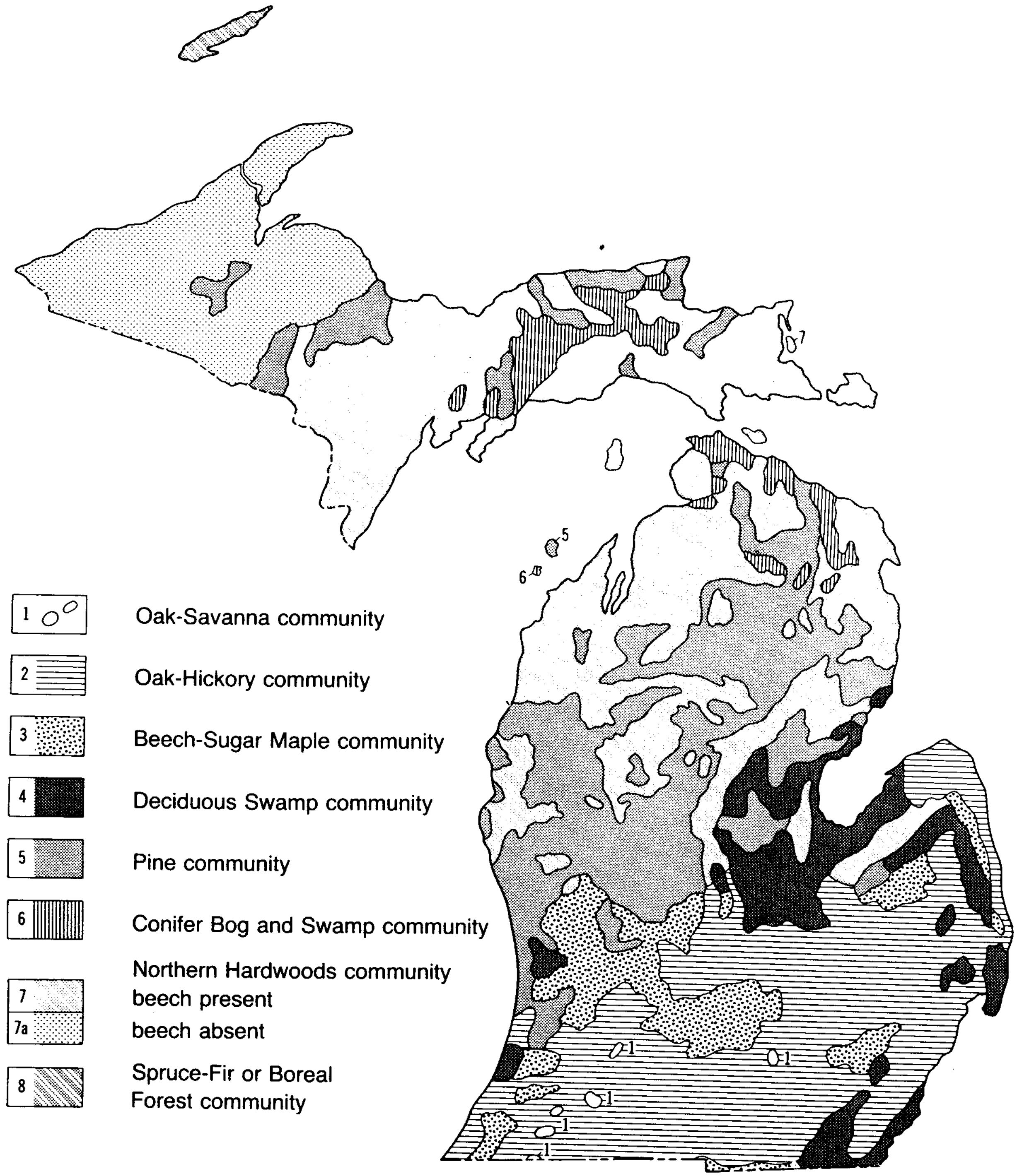


Figure 32. Potential forest communities of Michigan. (Modified from "Map of Potential Natural Vegetation of the Conterminous United States," by A. W. Küchler, 1964. Reprinted by permission of the American Geographical Society.)

typically occur as overstory trees in each of the communities. Although one species might occur in several communities, a species was put in the one or two communities in which it would be most characteristic.

1. Oak-Savanna Community. In southern Michigan, many small pockets of Oak-Savanna mark the interface between prairie and forest (Fig. 32). The habitat is characterized by hot, dry summers, conducive to frequent fires that favor grasses over trees. These areas are often wet in the spring, so plants persisting there are adapted to seasonally wet conditions—wet in spring and dry in summer. Oaks, such as bur and northern pin, are dominant trees. Since European settlement, oak-savanna communities (oak openings) have sometimes persisted as a result of fire along railroad lines. Today fires are virtually absent, and oaks encroach on the prairie patches. Therefore, ecosystem restoration efforts are under way to eliminate the woody vegetation and restore native prairies to their former diversity and beauty.

2. *Oak-Hickory Community.* Occurring only in southern Lower Michigan (Region I, Fig. 27*A*), the habitat is characterized by a relatively warm climate, long growing season, relatively high nutrient availability, and dry to dry-mesic, well drained soil conditions. Drought, causing trees to become stressed by lack of soil water, is a major factor influencing the composition of oak and hickory species. Black and northern pin oak are favored on the driest sites together with pignut hickory. The hot and dry conditions led to periodic fires in presettlement time, which together with drought stress favored oaks and hickories over mesophytic species. Oaks and hickories are particularly well adapted to fire for two main reasons. First, although their seedling and sapling stems may be injured and sometimes killed by fire, they sprout vigorously from the root collar (the juncture of stem and root). These new trees rapidly overtop competing vegetation while drawing water and nutrients from deep root systems. In contrast, young plants of mesophytic species (maples, beech, white ash, basswood) are easily killed (thin bark, shallow roots) or, if roots survive, they are less able to resprout or maintain themselves in the face of vigorous oak-hickory competitors. Second, oaks and hickories soon develop bark thick enough to survive the light or moderate surface fires of these forests, whereas the thin-barked competitors are killed. However, fire exclusion in these forests over the last 50 years or more has allowed the mesic species to successfully invade and dominate the understories and subdominant overstories of many oak-hickory forests. Given this trend, the present generation of old oaks may well be the last for all but the driest sites in many parts of southern Michigan. Therefore, restoration of natural processes such as fire in such forest ecosystems is receiving increasing attention.

3. *Beech–Sugar Maple Community.* Occurring mainly in the southern half of the Lower Michigan (Region I, Fig. 27*A*), the habitat is characterized by a relatively warm climate, long growing season, relatively high nutrient

availability and mesic soil-water conditions (i.e., soils adequately supplied with moisture throughout the growing season), and moderately well drained soils. This community is similar in many respects to the Hemlock-Northern hardwoods community of northern Michigan (Regions II, III, IV; Fig. 27), but hemlock and eastern white pine are absent, and it includes several species (walnuts, bitternut hickory, and tuliptree, among others) that are not hardy in northern Michigan. This community was once widely distributed on the moist, fertile, morainal soils of southern Michigan (Fig. 31*A*) and in Indiana and Ohio in presettlement time, but it was replaced with agriculture and now is reverting to housing developments. Today very few of these once magnificent ecosystems dominated by beech and sugar maple still remain in southern Michigan.

4. Deciduous Swamp Community. Occurring mainly in southern Michigan (Region I, Fig. 27*A*), the habitat is wet and cool. Water tables are high, they fluctuate only slightly, and water and nutrients are available to tree roots throughout the year—although oxygen, required for root respiration, is lacking. Soil drainage is poor to very poor. Although large areas of this community are shown in the central and southern parts of the state (Fig. 32), deciduous swamps also occur in the north, and these two types are described separately.

Swamps in the southern and central parts of Lower Michigan (primarily in Region I, Fig. 27*A*) shown in Figure 32 occupy the major postglacial lake basins adjacent to Lakes Erie and Huron. These habitats are typically flat, low-lying, lake plain with clayey soil, high water tables, and abundant nutrients. These habitats are found primarily in Subdistricts 1.2 and 5.1, District 6 of Region I (Fig. 27*A*), and to a lesser extent Subdistrict 7.1 in Region II. In addition, a slightly different swamp community is found in the small depressions (kettles) that are located in ice-contact landforms (e.g., Subdistrict 1.4) within the area mapped as Oak-Hickory forest. They are too small to be mapped in Figure 32, but tiny areas may be seen on the presettlement vegetation map (Fig. 31*A*). Besides being wet, poorly drained, lacking in oxygen, and nutrient rich, these kettle swamps are characterized by finely decomposed organic soil (muck). Also, they are cold and prone to freezing because of cold air drainage from surrounding higher terrain. Two species of the northern swamps, yellow birch and black ash, are dominant here, together with American elm, red and silver maples, and lesser amounts of other species, including swamp white oak, blue-beech, and pin oak. Tamarack was once a major dominant, but it is decreasing today. Due to the death of American elm in these ecosystems, water tables have risen and considerable mortality of other species has occurred.

Not shown on the map of today's vegetation (Fig. 32) are small areas in northern Lower Michigan (Region II) and in Upper Michigan (Regions III and IV) that have a similar composition to that of the southern deciduous swamps. However, they differ from the foregoing in their simpler composition; they lack blue-beech, pin oak, swamp white oak, and other trees and shrubs. However, black ash and yellow birch are common, and species absent in the south, balsam poplar and speckled alder, are present. A common conifer associate is northern white-cedar. These ecosystems are colder than the surrounding terrain, have high water tables during the year, and are acid to circumneutral in soil reaction.

5. Pine Community. Occupying large areas in central Lower Michigan (Regions I and II, Fig. 27*A*) and small areas in Regions III and IV (Fig. 27*B*) of Upper Michigan, the habitat is characterized by sandy (sometimes rocky), droughty, well to excessively drained, acid, nutrient-poor soils. Wildfire was frequent in presettlement time but is greatly diminished today. Jack pine is most frequent on the extremely dry and nutrient-poor sites, whereas red pine and white pine dominated, together with oaks, on the dry-mesic sites. Eastern white pine also competes with hardwoods on more mesic and nutrient-rich sites adjacent to the sandy and fire-prone pine lands. Today aspens, oaks, and other hardwoods such as red maple, in addition to jack pine, dominate on the pine lands. This change in composition is due to logging and postlogging fires. An immense logging industry prevailed in the era 1850–1900 during which waves of cutting removed the large and medium-sized pines (primarily eastern white pine) and hemlock. The small coniferous trees were not cut, and they and their progeny would have maintained coniferous forest on the cut-over lands. However, widespread fires in the logging slash (highly flammable treetops and branches) inevitably followed logging and killed most of these small trees. The hardwoods that were present in pine forests sprouted after fire, and the light-seeded, wind-dispersed bigtooth and trembling aspens, white birch, and to a lesser extent red maple colonized great portions of the former white pine–red pine–hemlock and oak-pine forests. Today the aspens are declining, and white pine, together with the opportunistic red maple, is reclaiming the historic Michigan pine and oak-pine forests.

6. Conifer Bog and Swamp Community. Occurring in the northern tip of Lower Michigan (Region II, District 12, Fig. 27*A*) and in the eastern Upper Peninsula (Region III, Fig. 27*B*), the habitat is characterized by flat, low-lying, poorly drained terrain of former glacial lake basins. The consistently high water table and low oxygen availability favor certain conifers and bog shrubs. In addition, there are hundreds or thousands of small pockets of this community scattered throughout the state that are too small to appear on the map. Many of these form part of the classic bog: a small lake surrounded by an open, marshlike, floating mat, a shrubby area, and then the acidic, conifer-dominated swamp forest. Often ridges supporting eastern white pine and mesic hardwoods are interspersed throughout the bog-muskeg habitat, especially in the eastern Upper Peninsula. Where limestone influence is strong, northern white-cedar is abundant, particularly when aerated water seeps continuously through the soil. Where water movement is severely restricted, as in stagnant swamps, black spruce, tamarack, and bog shrubs predominate. As aeration and nutrients increase, northern white-cedar, speckled alder, and other hardwoods such as red maple, yellow birch, and black ash increase in abundance. Thus, the conifer bog and swamp community may grade into a northern deciduous-conifer swamp community and the circumneutral northern deciduous swamp.

7. Hemlock–Northern Hardwoods Community. This is a widespread community in the northern United States (Braun 1950). It occurs from Minnesota to Maine and south to North Carolina and Tennessee in the southern Appalachian Mountains. In Michigan, we divide this community into two parts, the major part, which contains beech (7, Fig. 32), and the part in the western Upper Peninsula where beech is absent (7a, Fig. 32). The habitat of both parts is characterized by cool, mesic, nutrient-rich or nutrient-poor conditions and mainly acid, mineral soils. It is essentially a northern, less diverse version of the Beech–Sugar Maple community, with conifers of hemlock and white pine added. Because of the moist conditions, fire is not frequent. Its rarity enables the fire-susceptible hardwoods to reproduce and control the habitat for long periods. However, fire is frequent enough to maintain hemlock and eastern white pine as scattered but important components. In addition, stands of white and red pine are interspersed on the drier and rockier sites (often on south and west aspects). Large amounts of this community are seen on the presettlement map (Fig. 31) and the map of today's vegetation. This broad area, mapped as Hemlock–Northern Hardwoods in Figure 32, is actually a mosaic of communities—conifer swamp, pine forest, stream floodplain forest, and deciduous swamp—that are individually too small to show on the map. However, this mosaic of communities is evident on the presettlement map (Fig. 31).

8. Spruce-Fir or Boreal Forest Community. Mapped as occurring only on Isle Royale, this community is scattered throughout Upper Michigan but is widespread in Canada and Alaska. The north shore of Lake Superior is a good example. The habitat is characterized by cold, wet conditions with low oxygen and shallow, poorly drained, rocky, acid, infertile soils; fire is a very important site factor. It is similar in many respects to a climatically severe conifer swamp community.

9. River Floodplain and Bottomland Hardwood Communities. Not shown on the map is a group of very important ecosystems that occur along rivers and streams throughout the state. They are remarkably diverse in tree and vegetative composition. The habitat is characterized by periodic flooding during the growing season, nutrient-rich alluvial soils, low oxygen availability (required for root respiration), and low fire incidence. In addition, siltation, the accumulation of silt particles around the bases of the trees, further reduces the oxygen supply. The local climate is warmer and more humid in the summer and cooler in the spring than that of surrounding upland terrain. Unlike the deciduous swamp, more marked changes in water level occurred nearly every year due to flooding in presettlement time. Today dams and channel control have eliminated or reduced this natural ecosystem process. The river floodplain is characterized by a distinctive pattern of landforms and ecosystems from river to upland terrace that have different flooding frequencies and water table levels. Figure 33 illustrates this diversity for a stretch of the Manistee River in northwestern Lower Michigan (Region II, District 9; Baker and Barnes 1998). At the river's edge, a natural *levee* is formed and behind it a wet *first bottom* and even more poorly drained *backswamp*. The *second bottom* has a similar pattern of wet and even wetter ecosystems. Each of these local ecosystems supports a different kind of forest community depending on the duration of flooding and associated siltation, soil drainage, and oxygen availability. Silver maple, red ash, and American elm are species that tolerate and thrive in the first bottoms, where lack of oxygen brought about by flooding during the growing season was or is a major site factor. Because they are adapted to low oxygen availability, these three floodplain species were widely planted street trees throughout eastern North America. Except where the elm has been killed by the Dutch elm disease and the ash by the emerald ash borer, they survive and even thrive where concrete and asphalt pavement and soil compaction severely limit oxygen availability to fine roots.

The species composition differs in the southern and northern parts of the state. Also, these two areas differ markedly in tree species diversity. In the list (in Table 4), species characteristic of Region I versus those in northern Regions II, III, and IV are identified with an *S* or an *N*. In the southern third of the state, the bottomland forest is extremely rich in tree and

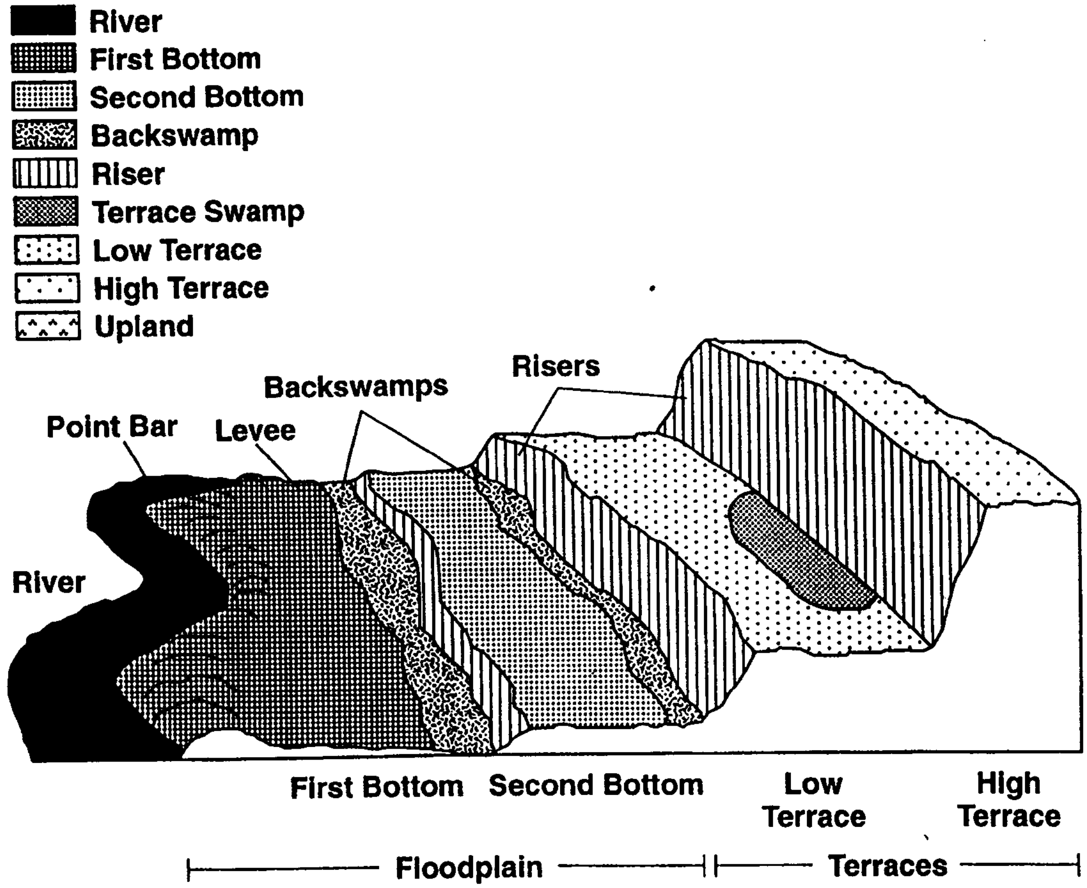


Figure 33. Diagram of idealized river valley landforms, Manistee River, Manistee National Forest, northwestern Lower Michigan. The floodplain has a distinctive pattern of landforms and ecosystems created by fluvial processes and corresponding tree and other plant distributions. (After Baker and Barnes 1998. Reprinted with permission of National Research Council Canada.)

woody plant species. Some species with a predominantly southern geographic distribution in the United States occur in southern Michigan but primarily in river floodplains. These trees include honeylocust, Kentucky coffeetree, northern hackberry, Ohio buckeye, redbud, red mulberry, and shingle oak. One of the most distinctive communities in southern Michigan is found on the clayey and seasonally wet lake plain of Belle Isle, located in the Detroit River, Wayne Co. Forests there include a unique community of the rare species shumard oak, pumpkin ash, and shellbark hickory, together with silver maple, red ash, pin and swamp white oaks, and hawthorns.

These and the other "southern" species thrive primarily in the river bottomlands because of the hotter and more humid summer environment compared to that of the surrounding terrain and especially because the colder spring conditions act to retard the leafing out of trees, enabling them to avoid late spring frosts. The slow warming of the river water and cold air drainage into the river basin combine to bring about the colder spring condition of the floodplain compared to that of the adjacent upland, which heats up rapidly. Similar site conditions prevail in northern Lower Michigan and the Upper Peninsula, but the overall climate is markedly colder and the communities conspicuously lack the diversity of tree species found in the southern floodplains.

Pioneer Species

An assorted group of early-successional, short-lived, pioneer species rarely become the dominant overstory species of the late-successional communities just described. However, many, such as the aspens, may occur in early stages in most of the above communities, and all occur in the beginning of at least one. Such species are not indicated on the maps of either the presettlement or today's forest, but we have listed them at the end of Table 4. Pioneer species colonize disturbed habitats rapidly; seeds of many of these species are disseminated widely every year by wind, water, mammals, and birds. Seeds of some species, cherries in particular, may lie dormant in the forest floor for several years and are stimulated to germinate following a disturbance. In addition, many deciduous, broadleaf species sprout from roots or at the base of the stem (root collar) and thereby quickly revegetate and dominate a burned or cut-over area. Pioneer species usually require full sunlight and an open, competition-free site for establishment and vigorous growth. These short-lived species are rapidly or gradually replaced in the absence of fire or windstorm with longer-lived shade- and understory-tolerant species. The pioneers are usually the initiators of our forest communities, together with herbs and shrubs, and they have extremely important functions in forest ecosystems. They protect the habitat from erosion and excessive drying; absorb mineral nutrients that might be removed by water percolating through the soil; provide food, shelter, and hiding places for wildlife; and provide favorable conditions for herbs, shrubs, and the next generation of trees.

TABLE 4. List of Tree Species of the Forest Communities of Michigan (including small tree species that may occur as shrubs)

1. Oak-Savanna Community

Bur oak, *Quercus macrocarpa*
White oak, *Quercus alba*
Black oak, *Quercus velutina*
Northern pin oak, *Quercus ellipsoidalis*
Scarlet oak, *Quercus coccinea*

2. Oak-Hickory Community

White oak, *Querqus alba*
Black oak, *Quercus velutina*
Northern red oak, *Quercus rubra*
Pignut hickory, *Carya glabra*
Shagbark hickory, *Carya ovata*
American chestnut, *Castanea dentata*
Black cherry, *Prunus serotina*
Hop-hornbeam, *Ostrya virginiana*
Flowering dogwood, *Cornus florida*
White ash, *Fraxinus americana*
Black walnut, *Juglans nigra*
Witch-hazel, *Hamamelis virginiana*
Downy serviceberry, *Amelanchier arborea*
Eastern redcedar, *Juniperus virginiana*
Dwarf chinkapin oak, *Quercus prinoides*
Chinkapin oak, *Quercus muehlenbergii*
Dwarf hackberry, *Celtis tenuifolia*

3. Beech–Sugar Maple Community

Beech, *Fagus grandifolia*
Sugar maple, *Acer saccharum*
Black maple, *Acer nigrum*
Basswood, *Tilia americana*
Northern red oak, *Quercus rubra*
White ash, *Fraxinus americana*
Bitternut hickory, *Carya cordiformis*
Tuliptree, *Liriodendron tulipifera*
Shagbark hickory, *Carya ovata*
Blackgum, *Nyssa sylvatica*
Hop-hornbeam, *Ostrya virginiana*
Black cherry, *Prunus serotina*
Slippery elm, *Ulmus rubra*
Rock elm, *Ulmus thomasii*
Alternate-leaf dogwood, *Cornus alternifolia*
Blue ash, *Fraxinus quadrangulata*
Downy serviceberry, *Amelanchier arborea*

4. Deciduous Swamp Community

Black ash, *Fraxinus nigra*
Red maple, *Acer rubrum*
Yellow birch, *Betula alleghaniensis*
American elm, *Ulmus americana*
Silver maple, *Acer saccharinum*
Swamp white oak, *Quercus bicolor*
Pin oak, *Quercus palustris*
Blackgum, *Nyssa sylvatica*
Shumard oak, *Quercus shumardii*
Pumpkin ash, *Fraxinus profunda*
Swamp cottonwood, *Populus heterophylla*
Blue-beech, *Carpinus caroliniana*
Alternate-leaf dogwood, *Cornus alternifolia*
Nannyberry, *Viburnum lentago*

5. Pine Community

Eastern white pine, *Pinus strobus*
Red pine, *Pinus resinosa*
Jack pine, *Pinus banksiana*
White oak, *Quercus alba*
Black oak, *Quercus velutina*
Northern pin oak, *Quercus ellipsoidalis*

(continued)

Note: See Figure 32, map of the forest communities, (p. 383), modified from Küchler 1964. Plants are ranked more or less in order of their abundance in the community.

5. Pine Community (*continued*)

Black cherry, *Prunus serotina*

Pin cherry, *Prunus pensylvanica*

6. Conifer Bog and Swamp Community

Black spruce, *Picea mariana*

Tamarack, *Larix laricina*

White spruce, *Picea glauca*

Balsam fir, *Abies balsamea*

Northern white-cedar, *Thuja occidentalis*

American mountain-ash, *Sorbus americana*

7. Northern Hardwoods or Hemlock–Northern Hardwoods Community

Sugar maple, *Acer saccharum*

Beech, *Fagus americana*

Yellow birch, *Betula alleghaniensis*

Basswood, *Tilia americana*

Red maple, *Acer rubrum*

Striped maple, *Acer pensylvanicum*

Eastern hemlock, *Tsuga canadensis*

Eastern white pine, *Pinus strobus*

Hop-hornbeam, *Ostrya virginiana*

Black cherry, *Prunus serotina*

Balsam fir, *Abies balsamea*

8. Spruce-Fir or Boreal Forest Community

White spruce, *Picea glauca*

Black spruce, *Picea mariana*

Balsam fir, *Abies balsamea*

Tamarack, *Larix laricina*

Speckled alder, *Alnus rugosa*

Trembling aspen, *Populus tremuloides*

Balsam poplar, *Populus balsamifera*

White birch, *Betula papyrifera*

American mountain-ash, *Sorbus americana*

9. River Floodplain and Bottomland Hardwood Communities, Streamside

Speckled alder, *Alnus rugosa* (N)

Black willow, *Salix nigra* (S)

Eastern cottonwood, *Populus deltoides* (S)

Silver maple, *Acer saccharinum*

Red ash, *Fraxinus pennsylvanica*

American elm, *Ulmus americana*

Slippery elm, *Ulmus rubra*

Black maple, *Acer nigrum* (S)

Bur oak, *Quercus macrocarpa* (S)

Black walnut, *Juglans nigra* (S)

Shagbark hickory, *Carya ovata* (S)

Boxelder, *Acer negundo* (S, rarely N)

Sycamore, *Platanus occidentalis* (S)

Redbud, *Cercis canadensis* (S)

Pawpaw, *Asimina triloba* (S)

Butternut, *Juglans cinerea* (S, rarely N)

Mountain maple, *Acer spicatum* (N)

Rock elm, *Ulmus thomasii*

Red mulberry, *Morus rubra* (S)

Northern hackberry, *Celtis occidentalis* (S)

Chinkapin oak, *Quercus muehlenbergii* (S)

Honeylocust, *Gleditsia triacanthos* (S)

Kentucky coffeetree, *Gymnocladus dioicus* (S)

Shellbark hickory, *Carya laciniosa* (S)

Shingle oak, *Quercus imbricaria* (S)

Ohio buckeye, *Aesculus glabra* (S)

Dotted haw, *Crataegus punctata* (S)

Blue ash, *Fraxinus quadrangulata* (S)

Peachleaf willow, *Salix amygdaloides* (S)

Balsam poplar, *Populus balsamifera* (N)

TABLE 4—*Continued*

Pioneer or Early-Successional Species (not shown on map)

White birch, *Betula papyrifera*	Black cherry, *Prunus serotina*
Jack pine, *Pinus banksiana*	Choke cherry, *Prunus virginiana*
Trembling aspen, *Populus tremuloides*	Hawthorns, *Crataegus spp.*
Bigtooth aspen, *Populus grandidentata*	Eastern redcedar, *Juniperus virginiana*
Eastern cottonwood, *Populus deltoides*	Peachleaf willow, *Salix amygdaloides*
Black willow, *Salix nigra*	Wild crab apple, *Malus coronaria*
Sassafras, *Sassafras albidum*	Canada plum, *Prunus nigra*
Pin cherry, *Prunus pensylvanica*	