

## The Natural Regions of Indiana

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### Introduction

Schemes recognizing regions of natural features have a long history in Indiana. The surveyors and workers for the General Land Office (29) were possibly the first to describe and map the major natural community types, such as prairie and forest, found in presettlement Indiana. Starting in the early 1800s geologists were mapping and describing geologic features, with occasional references to vegetation, while naturalists were cataloging the flora and fauna. One of the first regionalizations of Indiana biota was by W.S. Blatchley, who in 1909 defined three life zones of the state using insect distribution as the criterion (11). Thirteen years later, the classic work on the physiographic regions of Indiana was published by C.A. Malott (45). Since then, a number of works have been published depicting regionalizations of various natural features, including maps on the Forestal Areas of Indiana (20) and Floral Areas of Indiana (21) by Deam, vegetation maps by Gordon (31), Potzger et al. (64), and Lindsey et al. (41), and maps of faunal areas by Barnes (9) and Chandler (16). The Natural Divisions of Indiana map by Lindsey et al. (43) was the first in Indiana to delineate natural landscape units based on a combination of natural features (with an emphasis on presettlement vegetation). Illinois (72) and Missouri (75) are two nearby states that have used this concept to develop natural region classifications. The present work is also a development of this concept.

A natural region is a major, generalized unit of the landscape where a distinctive assemblage of natural features is present. It is part of a classification system that integrates several natural features, including climate, soils, glacial history, topography, exposed bedrock, presettlement vegetation, species composition, physiography, and flora and fauna distribution to identify a natural region. A section is a subunit of a natural region where sufficient differences are evident such that recognition is warranted. The text and map presented here describe and illustrate the twelve natural regions and twenty-five sections determined by the authors.

In a practical sense, knowledge of the features of a natural region should help one visualize the landscape and permit expectations about what can and cannot be found in a region. For example, only in the Knobstone Escarpment Section of the Highland Rim Natural Region can one expect to see a natural community with chestnut oak and Virginia pine growing on a steep hillside composed of Mississippian shale and siltstone. Conversely, one would not expect to see a calcareous fen natural community in the section.

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The enclosed map, Plate I, which accompanies this manuscript was made possible with the assistance of Henry Gray, John Hollingsworth and William Moran. The original map by J.E. Switzer, upon which the map is based, was printed previously in the following publications:

Kingsbury, R.C. 1970. An Atlas of Indiana. Dept. of Geography, Indiana Univ., Bloomington, IN. 94 p.  
Switzer, J.E. 1937. The Geography of Indiana. Ginn and Co., Boston. 52 p.

### Methods

No single criterion was used in determining natural regions although some single feature may have been emphasized for mapping purposes. For instance, the boundaries of some natural regions may have been determined by the extent of the major natural community present, e.g., Grand Prairie Natural Region, or by the area of a dominant topographic feature, e.g., Shawnee Hills Natural Region. Although a single feature is used to delimit some boundaries, it is the combination of natural features that distinguish a natural region.

Species composition was an important criterion, especially when considering the occurrence of rare and/or disjunct species, or species at the periphery of their range. These species reveal much about the landscape, not only about the area where they occur, but also about the area where they do not. For example, swamp chestnut oak (*Quercus michauxii*), a southern species on the periphery of its range in the Bluegrass Natural Region, does not occur in the adjacent Central Till Plain Natural Region. Some significant difference in soil, glacial history, or other natural feature between the two natural regions is implied by the absence of this species in the Central Till Plain. Therefore, the distribution of this species was one criterion used to support separation of the Bluegrass Natural Region from the Central Till Plain Natural Region.

A natural community is a group of organisms that are interrelated with each other and their environment (80). They are identified by such natural features as soil moisture and reaction, substrate, species composition, vegetation structure and topographic position. An excellent discussion of natural communities and their classification can be found in White and Madany (80). Although the present work is not intended to be a treatise on natural communities, those occurring most frequently in each natural region are discussed as are those restricted to or best developed in a region. Most of the communities found in Indiana are discussed somewhere in the text, although not in every region where they occur. For example, the fen natural community type occurs throughout northern Indiana, but is described in some detail only in the Northwestern Morainal region. Since fens are rather uniform compositionally, it would be redundant to describe them in every natural region where they occur. If a natural community type is significantly different from one region to another, a description of the community is given in the discussion of each region.

In describing features of a natural region, certain terms are used that need clarification. *Characteristic* refers to an association of one or more natural features with another. It may refer to a species commonly associated with a community (but not necessarily restricted to it), or to a species that occurs uncommonly in a community type, especially if it is restricted to it. For example, both the cliff clubmoss (*Lycopodium porophyllum*) and Bradley's spleenwort (*Asplenium bradleyi*) are indigenous species of sandstone cliff natural communities in the Shawnee Hills. The former is regularly seen, but the latter has been found only once. Both characterize the community. Since it is usually difficult to identify a natural community by a single species, an assemblage of species is listed to distinguish one community from the next.

The state is roughly divided into quadrants with northern and southern divisions separated by U.S. Highway 40 east of Indianapolis and U.S. Highway 36 west of Indianapolis, and eastern and western divisions separated by U.S. Highway 31 north of Indianapolis and State Route 135 south of Indianapolis. Species that are geographically restricted are those found in only one section or region of a particular quadrant, yet also occurring in at least one other quadrant of the state. For example, the blunt-lobed grape fern (*Botrychium oneidense*) is a geographically restricted species of the Muscatatuck Flats and Canyons Section, for it occurs in no other section of the southeast quadrant. The species occurs elsewhere in the state, however, namely the northeast

and northwest quadrants. *State restricted* species are indigenous to only one section or region in the entire state, e.g. French's shooting star (*Dodecatheon frenchii*) is a state restricted species known in Indiana only from the Crawford Upland Section of the Shawnee Hills Natural Region. These distinctions are intended only to illustrate disjunct or restricted occurrences of organisms and to help distinguish further one natural unit from the next.

Except in a few instances, it is not stated whether natural communities listed for a region are extant. The reader can assume that communities listed have current examples, albeit in many cases small and/or highly degraded ones.

Because of their strong community association and relative lack of mobility, reptiles and amphibians are some of the best community indicators of the fauna and are used for that purpose here when appropriate. Most birds and mammals are normally highly mobile and ubiquitous, and thus are used less frequently here as indicators, although some good community indicators are known. All organisms (plant and animal) listed in the text reflect documented occurrences of native populations but may or may not be extant.

In the assignment of names for regions and sections, the traditional name identifying a particular region was used when appropriate, e.g. Scottsburg Lowland physiographic region became the Scottsburg Lowland Section of the Bluegrass Natural Region. In some cases, a traditional name was altered to emphasize major characteristic natural features, e.g. Mitchell Plain physiographic region became Mitchell Karst Plain Section of the Highland Rim Natural Region. Names of topographic features were incorporated into most names to help distinguish the area, e.g. Central *Till Plain* Natural Region. Where possible, names were given to maintain continuity with similar classifications in surrounding states, e.g. the Grand Prairie Natural Region adjoins the Grand Prairie Natural Division in Illinois.

Boundary lines on the map (Plate 1 in envelope in back cover) do not necessarily indicate an abrupt change in all natural features, i.e. all the distinctive features listed for a region do not terminate at the line indicated, to be replaced by an entirely new set of features. As there is a continuum from one natural community to the next, so it is with natural regions.

A variety of sources was consulted for information detailing natural features of the state. Physiographic works by Fenneman (25), Malott (45), Schneider (71), and Quarterman and Powell (65) proved most useful. County soil surveys and the Map of the Soil Associations of Indiana (44) were consulted for soils information. Regional geologic maps published by the Indiana Geological Survey were invaluable for illustrating bedrock and unconsolidated deposits. Wayne (77), and Wayne and Zumberge (78) were major sources of information on glacial geology. Information on the flora, including nomenclature, came from Deam (21) and the Indiana Natural Heritage Program (36). The latter, along with Lindsey et al. (43), were good references for vegetation information on specific sites, and survey notes of the General Land Office provided pre-settlement information (29). Separate works on the state's fish, birds, mammals, and herpetofauna by Gerking (30), Mumford and Keller (52), Mumford and Whitaker (53), and Minton (50), respectively, proved invaluable. Several additional papers consulted are cited in the text.

### Description of Natural Regions

#### Region One—Lake Michigan Natural Region

This natural region is an entirely aquatic one that includes Indiana's portion of a tremendous body of water, Lake Michigan. Formed from meltwater of the Wisconsinan ice sheet, this large lake is so different from the rest of Indiana's natural features

that it deserves recognition as a separate natural region. It harbors (or formerly harbored) a number of fish species found nowhere else in the state, including lake whitefish (*Coregonus clupeaformis*), brook trout (*Salvelinus fontinalis*), lake trout (*Salvelinus namaycush*), longnose sucker (*Catostomus catostomus*), slimy sculpin (*Cottus cognatus*), fourhorn sculpin (*Myoxocephalus quadricornis*), and ninespine stickleback (*Pungitius pungitius*). Unfortunately, many of these fishes have been replaced largely by exotics either by accidental or by intentional introduction.

#### Region Two—Northwestern Morainal Natural Region

The glaciated area formed in part by the latest advances of the Lake Michigan Lobe of the Wisconsinan ice sheet identifies this natural region. It is divided into three sections: the Valparaiso Moraine Section, the Chicago Lake Plain Section, and the Lake Michigan Border Section.

A tremendous diversity of natural communities is present for such a small region, and floristically, no other natural region can compare in species diversity, at least on an acre for acre basis. This is due in part to the merging of several major vegetation types, these being the eastern deciduous forest, the tall grass prairie, and the northern forest and wetlands. In addition, an interesting assemblage of Atlantic Coastal Plain species, along with Lake Michigan shoreline endemics contribute to the diversity.

The region is heavily populated and industrialized, but because much of it is poor agricultural land, and thus was never cultivated, high quality natural areas can be found interspersed among factories, homes, landfills, and city streets. The region and its sections correlate with Illinois natural regions of similar names. Physiographic regions identified by Malott (45) include the Valparaiso Moraine Section and the Calumet Lacustrine Section of the Northern Moraine and Lake Region. Ecological studies of the region include Cowles (18), Olson (54), Rohr and Potzger (69), Bacone and Campbell (5), and Wilhelm (81).

#### Section 2A—Valparaiso Moraine Section

This section is identified by the presence of the Valparaiso Moraine, a moraine characterized by a mostly knob-and-kettle topography in the east that grades into a gently rolling till plain in the west. The soils generally are well drained, mostly calcareous silty clay loams of the Markham, Elliott, Morley, Blount, and Pewamo series. The eastern portion formerly was predominantly forested, while much of the western area was prairie. Other natural community types include fen, bog, lake, marsh, savanna, seep spring, and swamp.

The forest community on mesic sites is of special interest, for it marks the western limit of the beech-maple community in the lower Lake Michigan region. Oak-hickory forest characterize drier sites, and include white oak (*Quercus alba*), red oak (*Q. rubra*), black oak (*Q. velutina*), shagbark hickory (*Carya ovata*), pignut hickory (*C. glabra*), and black cherry (*Prunus serotina*). Bur oak (*Quercus macrocarpa*) and black oak savannas occurred formerly but now are gone completely. The areas of prairie also are gone, except for a few small remnants in pioneer cemeteries and railroad rights-of-way. Species composition of these prairies is similar to those of the Grand Prairie Region. One notable exception is the former presence of Mead's milkweed (*Asclepius meadii*), as extirpated, state restricted species of this section.

Excellent examples of the fen natural community type occur on the moraine. These normally unforested areas of mineral-rich seepage through muck commonly have a high diversity of species that include Kalm's lobelia (*Lobelia kalmii*), shrubby cinquefoil (*Potentilla fruticosa*), Indian plantain (*Cacalia tuberosa*), tofieldia (*Tofieldia glutinosa*), small white ladyslipper (*Cypripedium candidum*), parnassia (*Parnassia glauca*), prairie dock (*Silphium terebinthinaceum*), fringed gentian (*Gentiana crinita*), marsh

muhly (*Muhlenbergia racemosa*), and several *Carex* species, notably *Carex leptalea* and *C. sterilis*. Bog communities are similar in composition to those of the Northern Lakes Natural Region. Deep River is characteristic of streams of this section.

#### Section 2B—Chicago Lake Plain Section

This section is identified by the ridge-and-swale and lacustrine plain topography that occurs between the Valparaiso Moraine and the Border Section along Lake Michigan. It is located on the former site of Lake Chicago, and the ridge-and-swale topography is a remnant of water-level fluctuations of that glacial lake. Almost all of the natural communities are on sand substrates. Most of the sand is acid in reaction. Characteristic soil associations include the Whitaker-Milford-Del Rey and Oakville Maumee-Brems. Muck soils are scattered throughout.

Major natural communities of this section include marsh, lake, sand savanna, sand prairie, and swamp, along with minor areas of various forest types. The sand savana is primarily comprised of two types: the black oak (*Quercus velutina*) and the black oak-pine (*Pinus strobus*, *P. Banksiana*) savanna. Almost pure stands of black oak characterize the savannas throughout most of this section, whereas the black oak-pine savannas are associated with the dune complex in the north part of the section. Typical species of the savannas include little bluestem (*Andropogon scoparius*), Junegrass (*Koeleria cristata*), goat's-rue (*Tephrosia virginiana*), lupine (*Lupinus perennis*), and sedges (*Carex muhlenbergii* and *C. pensylvanica*). Sand prairie intergrades with the savanna. Extensive areas of marsh once occurred throughout the section, especially along the Little and Grand Calumet Rivers.

Many of the same animals found in the Kankakee Sand Section occur here also, apparently owing to the similarities of natural communities. The Chicago garter snake (*Thamnophis sirtalis semifasciata*) may be more common here than elsewhere in the state.

#### Section 2C—Lake Michigan Border Section

The three major natural features distinguishing this section are the beach community, the high dunes (especially the foredune community), and the pannes. All occur in the immediate vicinity and influence of Lake Michigan, and all are representative of natural communities bordering the Lake throughout much of its shoreline. Sand is the major substrate, and the Oakville fine sand is the major soil series of the high dunes. Various mucks occur in the interdunal depressions. Calcareous sand occurs locally in the pannes.

The beach community occupies a narrow strip of sand between the edge of Lake Michigan and the first line of dunes. It is an area of shifting sands where characteristic pioneer species include sea rocket (*Cakile edentula* var. *lacustris*), beachgrass (*Ammophila breviligulata*), bug-seed (*Corispermum hyssopifolium*), spurge (*Euphorbia polygonifolia*), and silverweed (*Potentilla anserina*). The beach community grades into the foredune of the high dunes complex. The foredune, like the beach, is on the windward side of the high dunes, but it is somewhat more stable than the beach because of the presence of stabilizing plants, e.g. little bluestem (*Andropogon scoparius*), longleaf reedgrass (*Calamovilfa longifolia*), red-osier dogwood (*Cornus stolonifera*), beach pea (*Lathyrus japonicus*), aromatic sumac (*Rhus aromatica*), Pitcher's thistle (*Circium pitcheri*), bearberry (*Arctostaphylos uva-ursi*), prostrate juniper (*Juniperus communis*), jack pine (*Pinus banksiana*), and gland leaf willow (*Salix syrticola*).

Forests of the lee side high dunes are characterized by a mixture of mesophytic forest and savanna. White pine (*Pinus strobus*), red oak (*Quercus rubra*), white oak (*Q. alba*), black oak (*Q. velutina*), basswood (*Tilia americana*), red maple (*Acer rubrum*), white ash (*Fraxinus americana*), dogwoods (*Cornus florida* and *C. rugosa*), witchhazel (*Hamamelis virginiana*), and wafer ash (*Ptelea trifoliata*) are characteristic species of

this area. The savanna component is similar to that of the Chicago Lake Plain Section, except that conifers are more important.

Pannes are interdunal depressions composed of wet, calcareous sand typically on the lee side of the first or second line of dunes from the lakeshore. They are characterized by an unique floristic composition suggestive of a fen. Typical panne species include Kalm's lobelia (*Lobelia kalmii*), fringed gentian (*Gentiana crinita*), bladderwort (*Utricularia cornuta*), white upland aster (*Aster ptarmicoides*), rose gentian (*Sabatia angularis*), loesel twayblade (*Liparis loeselii*), rush (*Juncus balticus*), cladium (*Cladium mariscoides*), and sedges (*Carex aurea*, *Rhynchospora capillacea*, and *Scleria verticillata*).

State restricted species from this section include beach grass, sea rocket, Pitcher's thistle, gland leaf willow, white upland aster, spurge, russet buffaloberry (*Shepherdia canadensis*), fringed polygala (*Polygala paucifolia*), Hooker's orchid (*Platanthera hookeri*), and sedge (*Carex richardsonii*). The piping plover (*Charadrius melanotos*) was known in Indiana only from this section but is now extirpated.

#### Region Three—Grand Prairie Natural Region

This region is identified by the predominance of the tall grass prairie community type. The name "Grand Prairie" is applied in reference to the large expanse of prairie that occurred here and over much of northern Illinois. This area in Indiana is the major eastern lobe of the Prairie Peninsula as illustrated by Transeau (76). The region occupies a glaciated plain where a variety of unconsolidated deposits of Wisconsinan age are present, including dune sand, lacustrine sediments, outwash plain sediments (mostly sand and gravel), and till (end and ground moraines). The southern and eastern borders of the region are defined by the Wabash River Valley and the Maxinkuckee Moraine, and the Valparaiso Moraine marks the northern boundary.

This region is identified not only by what is present, but by what is not. Many species characteristic of the eastern deciduous forest are noticeably absent here. Beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*), the major components of the beech-maple forest, are exceptionally rare species in this region. On a percentage basis, this region is the most altered of all natural regions in the state. Only remnants of the Grand Prairie are known to exist. Three sections are recognized: the Grand Prairie Section, the Kankakee Sand Section, and the Kankakee Marsh Section. They occupy parts of the Tipton Till Plain physiographic region and the Northern Moraine and Lake physiographic region of Malott (45). Ecological studies in this region include Finley and Potzger (26), Welch (79), Meyer (48), and Betz (10).

#### Section 3A—Grand Prairie Section

This section is distinguished by the predominance of loamy soil as opposed to the sandy and highly organic soils of the other sections of Region Three. The swell and swale topography in the northern part of the section is best characterized by the silty clay loam soils of the Brookston-Odell-Corwin Association. Some areas of muck, particularly Carlisle muck, are present. The better drained soils in the south of the section are characterized by Parr silt loam and the Elston-Shipshe-Warsaw Association of well drained neutral to acid loam. Outwash and lacustrine deposits are characterized by the Rensselaer-Darroch-Whitaker Association. This area was the epitome of the vast tall grass prairie of presettlement times. A great variety of prairie natural community types must have existed, but little is known about the species composition except what can be determined from small remnants in railroad rights-of-way and abandoned pioneer cemeteries. Characteristic species of prairies on well drained sites include little bluestem (*Andropogon scoparius*), big bluestem (*A. gerardii*), Indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), side-oats grama (*Bouteloua*

*curtipendula*), compass plant (*Silphium laciniatum*), prairie dock (*Silphium terebinthinaceum*), blazing star (*Liatris pycnostachya*), hairy sunflower (*Helianthus mollis*), feverfew (*Parthenium integrifolium*), pale purple coneflower (*Echinacea pallida*), yellow coneflower (*Ratibida pinnata*), leadplant (*Amorpha canescens*), rattlesnake master (*Eryngium yuccifolium*), prairie clovers (*Petalostemum candidum* and *P. purpureum*), prairie goldenrod (*Solidago rigida*), and prairie violet (*Viola pedatifida*). The wet prairies are characterized by cordgrass (*Spartina pectinata*), big bluestem, Culver's-physic (*Veronicastrum virginicum*), water parsnip (*Sium suave*), golden alexander (*Zizia aurea*), cowbane (*Oxypolis rigidior*), *Carex* spp., and bluejoint grass (*Calamagrostis canadensis*). Other community types present include savanna, marsh, pond, bog (rare), and forest, the latter mostly along stream courses and in oak groves. Animals characteristic of this section include fox snake (*Elaphe vulpina*), prairie king snake (*Lampropeltis calligaster*), smooth green snake (*Ophiodrys vernalis*), plains garter snake (*Thamnophis radix*), Franklin's ground squirrel (*Spermophilus franklinii*), western meadowlark (*Sturnella neglecta*), upland sandpiper (*Bartramia longicauda*), and the extirpated prairie chicken (*Tympanuchus cupido*). Typical streams of this section are low-gradient and silty, e.g. Sugar Creek (Benton County) and Iroquois River.

### Section 3B—Kankakee Sand Section

This area is characterized by the presence of predominantly prairie and savanna natural community types associated with sandy soils. It consists mostly of dune sand and outwash plain sediments. The dune areas are typically the Plainfield-Maumee-Oshtemo Association of acidic to neutral sand and sandy loams. The outwash plains consist of poorly drained sandy loams of the Maumee-Gilford-Sebewa Association and well drained sandy loams of the Tracy-Door-Lydic Association. The sand prairie and savanna communities are similar in species composition to the prairie of the Grand Prairie Section except that, in addition, a number of sand-dwelling species are present. These include porcupine grass (*Stipa spartea*), dropseed (*Sporobolus clandestinus*), longleaf reedgrass (*Calamovilfa longifolia*), Junegrass (*Koeleria cristata*), prairie talinum (*Talinum rugospermum*), puccoon (*Lithospermum croceum*), primrose violet (*Viola primulifolia*), sedges (*Carex gravida* and *C. cumulata*), and dwarf-dandelion (*Krigia virginica*). Savannas dominated by black oak (*Quercus velutina*) and prairie species occur on the dunal areas. Typical associates of the savannas include sand prairie species along with goat's-rue (*Tephrosia virginiana*), bracken fern (*Pteridium aquilinum*), lupine (*Lupinus perennis*), sedge (*Carex pensylvanica*), bird's-foot violet (*Viola pedata*), black huckleberry (*Gaylussacia baccata*), dryland blueberry (*Vaccinium vacillans*), and lowbush blueberry (*V. angustifolium*). Swales between the dunes might have any of several possible natural community types, including wet prairie, marsh, swamp, wet sand flat, and wet muck flat. A remarkable assemblage of plants with coastal plain affinities is known from the wet sand/muck flat community, including bladderwort (*Utricularia radicans*), panic grass (*Panicum verrucosum*), nutrush (*Scleria reticularis*), beak rush (*Psilocarya scirpoidea*), sedge (*Fimbristylis caroliniana*), yellow-eyed grass (*Xyris caroliniana*), bugleweed (*Lycopus amplexens*), and flax (*Linum intercursum*). Forest natural communities occur primarily in the eastern part of the section, where white oak (*Quercus alba*) and black oak (*Q. velutina*) are dominants. Pin oak flatwoods characterize some of the swales in dunal areas. Fauna of the Grand Prairie Section are found in this section also, along with species that thrive in sandy habitat, e.g. ornate box turtle (*Terrapene ornata*), bull snake (*Pituophis melanoleucus*), glass lizard (*Ophisaurus attenuatus*), plains pocket gopher (*Geomys bursarius*), and lark sparrow (*Chondestes grammacus*). A geographically restricted population of eastern mud turtles (*Kinosternon subrubrum*) occurs here. State restricted species of the section include bladder-

wort (*Utricularia radiata*), flax (*Linum intercursum*), St. John's-wort (*Hypericum adpressum*), and sedge (*Carex cumulata*). Stream communities have all been altered greatly by channelization.

### Section 3C—Kankakee Marsh Section

This section is identified by the predominance of marsh, lake, and wet prairie communities that existed along the Kankakee River in presettlement times. The marsh was several miles wide on both sides of the river for almost its entire run in Indiana. Extensive ditching beginning in the late 1800s has all but eliminated the natural wetlands. The section is part of a large Wisconsinan glacial outwash plain, with a substrate of acidic silt and sand. Characteristic soil series include Suman, Gilford, Maumee, and Bourbon. Good examples of prairie and marsh are absent from the area today. Remnants indicate that the wetlands were characterized by spatterdock (*Nuphar advena*), watershield (*Brasenia schreberi*), swamp loosestrife (*Decodon verticillatus*), bluejoint grass (*Calamagrostis canadensis*), reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites communis*), giant bur-reed (*Sparganium eurycarpum*), knotweeds (*Polygonum* spp.), Spanish needles (*Bidens* spp.), arrowheads (*Sagittaria* spp.), and sedges (*Scirpus* spp. and *Carex* spp.). A narrow border of forest along the river contains characteristic floodplain species, e.g. silver maple (*Acer saccharinum*), red maple (*A. rubrum*), black willow (*Salix nigra*), green ash (*Fraxinus pennsylvanica*), cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), river birch (*Betula nigra*), and indigo bush (*Amorpha fruticosa*), the last geographically restricted here. Two plants occurring as remarkable disjuncts include American snowbell (*Styrax americana*) and climbing hempweed (*Mikania scandens*). The northern weed shiner (*Notropis texanus*) is state restricted here. The area was formerly a significant breeding habitat for waterfowl.

### Region Four—Northern Lakes Natural Region

This natural region is identified by the presence of numerous fresh water lakes of glacial origin. Approximate borders of the area are the southern edge of the Packerton Moraine, the eastern edge of the Mississinewa and Salamonie Moraines north of the Eel River, and the western edge of the Maxinkuckee Moraine.

This area was invaded from the northwest by the Lake Michigan Lobe of the late Wisconsinan ice sheet, from the northeast by the Saginaw Lobe, and from the east by the Erie Lobe. Consequently, the area is covered now with a thick and complex deposit of glacial material which, in places, is over 450 feet thick. Glacial topography also is complex and is characterized by knobs, kettles, kames, valley trains, and outwash plains. The diversity of soils include: loamy soils in the morainal areas and till plains, typically the Miami-Crosier-Brookston-Riddles Association; neutral, clayey soils in morainal areas of the southeastern portion of the section, typically the Morley-Blount-Pewamo Association; and sandy loam soils on the outwash deposits, typically by the Oshtemo-Fox Association and the Plainfield-Maumee-Oshtemo Association. Muck soils, which are important components of wetland natural communities, include Houghton, Edwards and Adrian series.

Natural community types are numerous, including bog, fen, marsh, prairie, sedge meadow, swamp, seep spring, lake, and various deciduous forest types. Oak and hickory species, especially red oak (*Quercus rubra*), white oak (*Q. alba*), black oak (*Q. velutina*), shagbark hickory (*Carya ovata*), and pignut hickory (*C. glabra*) dominate the dry and dry-mesic upland forests which once covered approximately one half of the region. Mesic sites characteristically have beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), black maple (*A. nigrum*), and tulip tree (*Liriodendron tulipifera*) as dominants. Floodplain forests typically include sycamore (*Platanus occidentalis*), American elm (*Ulmus americana*), red elm (*U. rubra*), green ash (*Fraxinus pennsylvanica*), silver maple (*Acer*

*saccharinum*), red maple (*A. rubrum*), cottonwood (*Populus deltoides*), hackberry (*Celtis occidentalis*), and honey locust (*Gleditsia triacanthos*).

Swamp communities commonly border lake and bog sites where red maple, silver maple, green ash, American elm, black ash (*Fraxinus nigra*), and locally, yellow birch (*Betula lutea*), are typical associates. Swamps dominated by black ash typically are associated with seep springs.

Bogs are more numerous here than in any other natural region. These communities commonly consist of a floating mat of *Sphagnum* moss occupying a glacial depression. Distinctive bog plants include leatherleaf (*Chamaedaphne calyculata*), cranberry (*Vaccinium macrocarpon*), bog rosemary (*Andromeda glaucophylla*), pitcher plant (*Sarracenia purpurea*), sundews (*Drosera rotundifolia* and *D. intermedia*), mountain holly (*Nemopanthus mucronata*), tamarack (*Larix laricina*), Virginia chain fern (*Woodwardia virginica*), grass-pink orchid (*Calopogon pulchellus*), rose pogonia orchid (*Pogonia ophioglossoides*), sedges (*Carex oligosperma* and *Rhynchospora alba*), poison sumac (*Rhus vernix*), and *Sphagnum* spp.

Areas of marsh commonly are associated with the lake community. Typical marsh species include swamp loosestrife (*Decodon verticillatus*), cattails (*Typha angustifolia* and *T. latifolia*), bulrush (*Scirpus validus*), marsh fern (*Thelypteris palustris*), marsh cinquefoil (*Potentilla palustris*), and sedges, notably *Carex stricta* and *C. lasiocarpa*. In deeper water bordering the marsh, the lake community begins, where such distinctive species as spatterdock (*Nuphar advena*), watershield (*Brasenia schreberi*), fragrant water-lily (*Nymphaea tuberosa*), pickerelweed (*Pontederia cordata*), hornwort (*Ceratophyllum demersum*), wild celery (*Vallisneria americana*), pondweeds (*Potamogeton* spp.), Virginia arrow-arum (*Peltandra virginica*), and sedge (*Scirpis subterminalis*) occur.

Wet sand flats and muck flats border some of the lakes and shallow basins. In some places an unique flora of Atlantic Coastal Plain disjuncts is associated with these communities, including sedges such as *Psilocarya scirpoides*, *Fuirena pumila*, *Rhynchospora macrostachya*, and *Eleocharis olivacea*.

State restricted plants of this region include ginger-leaved pyrola (*Pyrola asarifolia*), needle-and-thread grass (*Stipa comata*), knotted spikerush (*Eleocharis equisetoides*), autumn willow (*Salix serissima*), and Deam's rockcress (*Arabis missouriensis* var. *deamii*). Distinctive fauna of the region include spotted turtle (*Clemmys guttata*), massasauga rattlesnake (*Sistrurus catenatus*), Blanding's turtle (*Emydoidea blandingii*), star-nosed mole (*Condylura cristata*), cisco (*Coregonus artedii*), marsh wren (*Cistothorus palustris*), swamp sparrow (*Melospiza georgiana*) and sandhill crane (*Grus canadensis*).

Typical streams are clear, medium to low-gradient, and have sandy gravel beds. Good examples are Pigeon River, Elkhart River, upper Tippecanoe River and Fawn River. Exemplary lakes include Olin Lake, Crooked Lake, Marsh Lake and Lake Manitou. Ecological studies of the region include Scott (73), Potzger and Friesner (62), Mills (49), Everman and Clark (24) and Aldrich (2).

#### Region Five—Central Till Plain Natural Region

This, the largest natural region in Indiana, is a formerly forested plain of Wisconsinan till in the central area of the state. Aside from the Entrenched Valley Section, it is topographically homogeneous, although several glacial features, especially moraines, are common. The region is a major divide between the communities with strong northern affinities and those with strong southern affinities, and the Entrenched Valley Section is a concentrated melting pot of species with northern, southern, eastern, and western affinities.

The three sections of the region are: the Entrenched Valley Section, characterized by moderately thick loess over Wisconsinan till; the Tipton Till Plain Section,

characterized by loamy Wisconsinan till; and the Bluffton Till Plain Section, characterized by clayey Wisconsinan till. Besides the predominant forest community types, areas of prairie, marsh, fen, seep spring, bog, swamp, and lake are known.

This region occupies most of Malott's (45) Tipton Till Plain physiographic region and portions of the Northern Moraine and Lake physiographic region. Ecological studies of the region include Cain (13), Friesner and Potzger (28), Potzger (59), Ebinger and Bacone (23), Petty and Harwood (55), Hollet and Jackson (33), and Post et al. (57).

#### Section 5A—Entrenched Valley Section

This section is quite unlike the other sections of the region. It is identified by the deeply entrenched valleys along major drainages, particularly the Wabash, Sugar, and Big Pine riverine systems. Bedrock is exposed in many places, and massive cliffs are common. Pennsylvanian, Mississippian, Devonian, and Silurian sandstone, siltstone, shale, and limestone are the predominant rock types. A variety of soils is present, including poorly drained to well drained silt loams that are acid to neutral in reaction and commonly covered with a moderately thick layer of loess. Representative soil series include Fincastle, Russell, Miami, and Brookston. Upland forests, bottomland forests, and flatwoods are the major natural community types present.

Except in the specialized cliff and ravine communities, the forest associations are essentially the same as those of the Tipton Till Plain Section. Other natural community types present in the section include prairie, gravel-hill prairie, fen, marsh, savanna, cliff, seep spring, and pond. The circumneutral seep spring is well represented and possibly is more common here than elsewhere in the state. This relatively open community typically is situated on the lower slopes of hills, particularly those bordering larger drainages, such as the Wabash River. Water oozes through a muck soil in a diffuse manner, creating an environment where such plants as skunk cabbage (*Symplocarpus foetidus*), marsh marigold (*Caltha palustris*), Pennsylvania saxifrage (*Saxifraga pensylvanica*), swamp woodbetony (*Pedicularis lanceolata*), jewelweed (*Impatiens biflora*), queen-of-the-prairie (*Filipendula rubra*), nannyberry (*Viburnum lentago*), black ash (*Fraxinus nigra*), sedges (*Carex bromoides*, *C. trichocarpa*, and *C. sterilis*), white turtlehead (*Chelone glabra*), roughleaf goldenrod (*Solidago patula*), and purple-stem aster (*Aster puniceus*) are characteristic.

The cliff and ravine communities provide an environment for an interesting assemblage of species, many of which occur as disjuncts that have northern affinities. Two of these, white pine (*Pinus strobus*) and hemlock (*Tsuga canadensis*), give a boreal appearance to the landscape. Other northern disjuncts include Canada yew (*Taxus canadensis*), Canada blueberry (*Vaccinium canadense*), shinleaf (*Pyrola elliptica*), wild sarsaparilla (*Aralia nudicaulis*), northern enchanter's nightshade (*Ciraea alpina*), roundleaf dogwood (*Cornus rugosa*), false melic grass (*Schizachne purpurascens*), and two-leaf Solomon's seal (*Maianthemum canadense*). Gravel hill prairies are state restricted here. Along with typical prairie species, they also have geographical and state restricted species, including many that have southern and western affinities. These include plains muhly (*Muhlenbergia cuspidata*), western wallflower (*Erysimum arkansana*), narrowleaf houstonia (*Houstonia nigricans*), gromwell (*Lithospermum incisum*), androsace (*Androsace occidentalis*), and post oak (*Quercus stellata*). This section marks the northern limit of several herpetofaunal species, including the cave salamander (*Eurycea lucifuga*), zigzag salamander (*Plethodon dorsalis*), long-tailed salamander (*Eurycea longicauda*), earth snake (*Carpophis amoenus*), and copperhead (*Agkistrodon contortrix*). State restricted species of this section include pitcher sandwort (*Arenaria patula*), forked aster (*Aster furcatus*), Forbe's saxifrage (*Saxifraga forbesii*), Canada yew, plains muhly, and Canada blueberry. Streams of this section are typically medium-gradient, relatively clear, and rocky, e.g. Sugar Creek, Big Walnut Creek, and Raccoon Creek.

### Section 5B—Tipton Till Plain Section

This section is a mostly undissected plain formerly covered by an extensive beech-maple-oak forest. The soils are predominantly neutral silt and silty clay loams of the Crosby-Brookston Association. The northern flatwoods community associated with these poorly drained soils was ubiquitous but now is confined to scattered woodlots. Species common within the community include red maple (*Acer rubrum*), pin oak (*Quercus palustris*), bur oak (*Q. macrocarpa*), swamp white oak (*Q. bicolor*), Shumard's oak (*Q. shumardii*), American elm (*Ulmus americana*), and green ash (*Fraxinus pennsylvanica*). In slightly better drained sites beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), black maple (*Acer nigrum*), white oak (*Quercus alba*), red oak (*Q. rubra*), shagbark hickory (*Carya ovata*), tulip poplar (*Liriodendron tulipifera*), red elm (*Ulmus rubra*), basswood (*Tilia americana*), and white ash (*Fraxinus americana*) are characteristic. Other community types of this section include bog, prairie, marsh, seep spring, and pond. A few fens are known, including the well studied Cabin Creek Bog (28). They are similar in composition to fens elsewhere in the state. Because of the section's location and the scarcity of specialized natural communities, there are no restricted species.

### Section 5C—Bluffton Till Plain Section

This section is characterized by the predominance of clay-rich soils on a relatively level till plain. This area, along with the Black Swamp, Northern Lakes and Northwestern Morainal Natural Regions, was one of the last areas of Indiana to be occupied by glacial ice, in this case, by the Ontario-Erie Lobe of the Wisconsinan ice sheet. A distinct series of moraines is evident in this section, and the Union City Moraine marks its southern border. As a consequence of the widespread presence of clayey till, much of the area is poorly drained. The acid to neutral silty clay loams of the Blount-Pewano-Morley Association characterize the region. Most of the natural communities are forested, along with minor areas of bog, prairie, fen, marsh and lake communities. Composition of forest species is similar to the Tipton Till Plain Section, although swamp cottonwood (*Populus heterophylla*) which formerly occurred regularly in swamps here, was and is rare on the Tipton Till Plain. A greater number of northern wetland species occur in this section than in the others of the region, e.g. cottongrass (*Eriophorum gracile*), northern St. John's-wort (*Hypericum boreale*), pitcher plant (*Sarracenia purpurea*), and sedges (*Carex alopecoidea*, *C. larinina*, and *C. limosa*). Interestingly, two southern swamp species are known here as geographic restrictions, namely, swamp St. John's-wort (*Triadenum tubulosum*) and log sedge (*Carex decomposita*).

### Region Six—Black Swamp Natural Region

This region is the western lobe of a large lacustrine plain occupying the area once covered by the ancient Lake Maumee. Lake Maumee, a predecessor to modern Lake Erie, was created when the meltwater of the Ontario-Erie Lobe of the Wisconsinan ice sheet was dammed by the Fort Wayne Moraine (45). The Lake, long since abandoned, is now an almost featureless, naturally poorly drained plain. Soils are typically deep, acidic to neutral clay and silt loams of the Hoytville-Nappanee Association. This area is the same as Malott's (45) Maumee Lacustrine Section of the Northern Moraine and Lake Region.

Named the Black Swamp by early settlers, the predominant natural community in the region consisted of swamp forest dominated by American elm (*Ulmus americana*), black ash (*Fraxinus nigra*), and maples (*Acer rubrum* and *A. saccharinum*). This and other natural community types are virtually non-existent in this region of Indiana today, for extensive drainage has permitted an almost complete conversion of the landscape to agricultural uses. Other species known from the swamp forest and environs

included bur oak (*Quercus macrocarpa*), swamp white oak (*Q. bicolor*), white ash (*Fraxinus americana*), shellbark hickory (*Carya laciniosa*), pawpaw (*Asimina triloba*), and spicebush (*Lindera benzoin*). No flora and fauna are known to be restricted to the region. Typical streams are low-gradient, silty and shallowly entrenched, e.g. Maumee River.

#### Region Seven—Southwestern Lowlands Natural Region

This region, which is characterized by low relief and extensive aggraded valleys, includes the area bounded in Indiana by the Shawnee Hills Natural Region to the east, the Wisconsinan glacial border to the north, the Southern Bottomlands Natural Region (along the Ohio River) to the south, and the Wabash River (north of Vincennes) to the west. Similar terrain occurs across the Wabash and Ohio Rivers in Illinois and Kentucky. Much of the region is nearly level, undissected, and poorly drained, although in several areas the topography is hilly and well drained. This region, except for the southern portion, was glaciated by the Illinoian ice sheet. The region is divided into three sections: the Plainville Sand Section, the Glaciated Section, and the Driftless Section. The extant natural communities are mostly forest types, although barrens were formerly dominant in the Plainville Sand Section, and large areas of prairie occurred in the Glaciated Section. All of this region occurs in the Wabash Lowland physiographic region of Malott (45).

Ecological studies in the region include Lawlis (39), Lindsey (40), Ridgway (68), McCoy (46), Schneck (70), Homoya (34), Aldrich and Homoya (4), and Green (32).

#### Section 7A—Plainville Sand Section

The Plainville Sand Section is a small but unique area of eolian sand dunes east of the Wabash River and the White River. The sandy, acid soils are mostly in the Princeton, Bloomfield, and Ayrshire series. The barrens natural community type, now virtually gone from the landscape, was predominant on the ridges and well drained sites, and swamp, marsh, and wet prairie occupied the swales (29). The barrens vegetation consisted mostly of prairie species, along with a collection of sand dwelling species of western and southern affinities, including beard grass (*Gymnopogon ambiguus*), Carolina anemone (*Anemone caroliniana*), tube penstemon (*Penstemon tubaeformis*), clustered poppy-mallow (*Callirhoe triangulata*), hairy golden-aster (*Chrysopsis villosa*), narrowleaf dayflower (*Commelina angustifolia*), black hickory (*Carya texana*), sand hickory (*C. pallida*), androsace (*Androsace occidentalis*), rose gentian (*Sabatia campanulata*), sedge (*Carex gravida*), and fleabane (*Erigeron pusillus*). In a few degraded remnants, one can still observe barrens vegetation, including little bluestem (*Andropogon scoparius*), big bluestem (*A. gerardii*), Indian grass (*Sorghastrum nutans*), side-oats grama (*Bouteloua curtipendula*), New Jersey tea (*Ceanothus americanus*), and blackjack oak (*Quercus marilandica*). These areas also were inhabited by a prairie fauna. Species geographically restricted here include bull snake (*Pituophis melanoleucus*), ornate box turtle (*Terrapene ornata*), and six-lined racerunner (*Cnemidophorus sexlineatus*). The biota of this section are similar to those of the Kankakee Sand Section of the Grand Prairie Natural Region.

#### Section 7B—Glaciated Section

This section coincides with the Illinoian till plain of southwestern Indiana. The soils are predominantly acid to neutral silt loams with a thick layer of loess, typically the Iva, Cincinnati, Avon, Vigo, and Alford series. Natural communities are mostly forest types, but several types of former prairie are known. The flatwoods community type is common, but it is of different composition than the flatwoods in the Driftless

Section, i.e. several species of southern affinity are uncommon or absent. Common flatwoods species include shagbark hickory (*Carya ovata*), shellbark hickory (*C. laciniosa*), pin oak (*Quercus palustris*), shingle oak (*Q. imbricaria*), hackberry (*Celtis occidentalis*), green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), and silver maple (*A. saccharinum*). Black ash (*Fraxinus nigra*) swamps are near their southern limit here. This section appears to have had the largest amount of prairie south of the Wisconsinan glacial border in Indiana. Little is known about the composition of the prairie, but it probably was very similar to the prairies of the Grand Prairie Region. Additional community types include swamp, marsh, pond, and low-gradient stream. Typical examples of the latter are Eel River and Busseron Creek. The prairie kingsnake (*Lampropeltis calligaster*) and the crawfish frog (*Rana areolata*) are characteristic species of this region. Smallmouth bass (*Micropterus dolomieu*) and northern rock bass (*Ambloplites rupestris*), common game fishes, are uncommon or absent in this section and in the natural region.

#### Section 7C—Driftless Section

This section is south of the Illinoian glacial border, and is therefore placed in the Interior Low Plateaus Physiographic Province. It is characterized by a topography of low hills and broad valleys, in an area that has the longest growing season and highest average summer temperature in the state. Most of the natural communities are upland forest types, occupying well drained slopes underlain by soils of the Zanesville, Wellston, and Tilsit series, which were formed in loess and weathered bedrock. Southern flatwoods occupy the lacustrine plains and river terraces, which are characterized by the McGary, Weinbach, Elkinsville, and Ginat series. Soils are predominantly acid in reaction. Characteristic species of the flatwoods include cherry bark oak (*Quercus falcata* var. *pagodaefolia*), sweetgum (*Liquidambar styraciflua*), shellbark hickory (*Carya laciniosa*), pin oak (*Quercus palustris*), swamp white oak (*Q. bicolor*), Shumard's oak (*Q. shumardii*), green ash (*Fraxinus pennsylvanica*), black gum (*Nyssa sylvatica*), and locally, post oak (*Quercus stellata*). State restricted species of the flatwoods are Indian pink (*Spigelia marilandica*), black quillwort (*Isoetes melanopoda*), and lesquerella (*Lesquerella globosa*). The barrens associated with the post oak flatwoods do not have a typical prairie flora as do most other barrens communities. Instead, these xeric, ephemerally wet sites characteristically are dominated by lichens, mosses, poverty grass (*Danthonia spicata*), three-awn grass (*Aristida ramosissima*), spike-rush (*Eleocharis verrucosa*), and rushfoil (*Crotonopsis elliptica*), the latter state restricted here. The upland sites of this section are relatively dry oak-hickory dominated natural communities. The occurrence and abundance of southern red oak (*Quercus falcata*), post oak (*Q. stellata*), blackjack oak (*Q. marilandica*), and locally, chestnut oak (*Q. prinus*) help distinguish the upland forests of this section from those of the Glaciated Section. At least one acid seep spring community is known from this section. Other natural community types include marsh, swamp, sandstone cliff, and low to medium-gradient stream.

#### Region Eight—Southern Bottomlands Natural Region

This natural region includes the alluvial bottomlands along the rivers and larger streams in southwestern Indiana. It is distinguished from other bottomland regions in the state by the presence of several species with affinities to the lower Mississippi Valley and Gulf Coastal Plain. The Illinoian glacial border (see enclosed map) bisects the region, thus placing the northern portion in the Central Lowlands Physiographic Province and the southern portion in the Interior Low Plateaus Physiographic Province. The glacial border has had little effect on the bottomland biotic communities; therefore, the region is presented as one natural unit.

The soils are mostly neutral to acid silt loams, and include series such as Nolin, Newark, Huntington, Linside, Stendal, and Bonnie. Much of the area is subject to frequent flooding (or did flood prior to the construction of control structures).

The natural communities of the region include bottomland forest, swamp, pond, slough, and formerly marsh and prairie. The bottomland forest, the major community of this region, is characterized by pecan (*Carya illinoensis*), sugarberry (*Celtis laevigata*), swamp chestnut oak (*Quercus michauxii*), pin oak (*Q. palustris*), swamp white oak (*Q. bicolor*), red maple (*Acer rubrum*), silver maple (*Acer saccharinum*), honey locust (*Gleditsia triacanthos*), catalpa (*Catalpa speciosa*), shellbark hickory (*Carya laciniosa*), sycamore (*Platanus occidentalis*), and green ash (*Fraxinus pennsylvanica*). The strongest southern influence is reflected in the swamps and sloughs, where bald cypress (*Taxodium distichum*), swamp cottonwood (*Populus heterophylla*), water locust (*Gleditsia aquatica*), pumpkin ash (*Fraxinus tomentosa*), and overcup oak (*Quercus lyrata*) occur.

Other distinctive southern species (many of which are restricted to this region) include American featherfoil (*Hottonia inflata*), bloodleaf (*Iresine rhizomatosa*), acanthus (*Dicliptera brachiata*), climbing dogbane (*Trachelospermum difforme*), milkweed (*Asclepias perennis*), catbird grape (*Vitis palmata*), woolly pipe-vine (*Aristolochia tomentosa*), sedge (*Carex socialis*), swamp privet (*Forestiera acuminata*), American snowbell (*Styrax americana*), climbing hempweed (*Mikania scandens*), spiderlily (*Hymenocallis occidentalis*), mistletoe (*Phoradendron flavescens*), and giant cane (*Arundinaria gigantea*).

Distinctive southern animals include cottonmouth (*Agkistrodon piscivorus*), hieroglyphic turtle (*Pseudemys concinna hieroglyphica* × *floridana hoyi*), diamondbacked watersnake (*Nerodia rhombifera*), eastern mud turtle (*Kinosternon subrubrum*), northern copperbelly (*Nerodia erythrogaster*), swamp rabbit (*Sylvilagus aquaticus*), mosquitofish (*Gambusia affinis*), harlequin darter (*Etheostoma histrio*—only one occurrence in Indiana), and yellow-crowned night heron (*Nyctanassa violacea*).

The Patoka River is exemplary of a silt-bottomed, low-gradient stream characteristic of this region. Other typical aquatic features include large bottomland ponds, especially along the Wabash River, e.g. Foote Pond, Half Moon Pond, and Wabash Pond. The Wabash, Ohio, and White Rivers themselves are considered a separate natural region.

Ecological studies in this region include: Cain (15), DenUyl (22), Lindsey (40), Schneck (70), and Ridgway (68).

#### Region Nine—Shawnee Hills Natural Region

"Shawnee Hills" is a name given by Flint (27) to a physiographic region of the Interior Low Plateaus in southwestern Indiana, southern Illinois, and western Kentucky. Only the contiguous belt of rugged hills on the outer (southern and eastern) periphery of the physiographic region denotes the Shawnee Hills Natural Region as identified here. The region is divided into the Crawford Upland Section and the Escarpment Section. Pennsylvanian and Mississippian bedrock, mostly sandstone, crops out in many places to form distinctive cliffs and rockhouses. Except for small areas of till in the northern portion, the region is driftless.

This region appears to represent general presettlement conditions better than any other terrestrial region in the state. It is a rugged and generally sparsely populated area. The majority of natural communities are upland forest types, although a few sandstone and limestone glades, gravel washes, and barrens are known.

Ecological studies in this region include Potzger et al. (63), Petty and Lindsey (56), Abrell and Jackson (1), Bacon et al. (6), and Badger and Jackson (8).

### Section 9A—Crawford Upland Section

The most distinctive features of this section are the rugged hills with sandstone cliffs and rockhouses. Mississippian sandstone composes most of the cliffs in the eastern portion of the section, as well as lower elevation outcrops to the west, whereas Pennsylvanian sandstone (especially the Mansfield Formation) dominates the western portion and higher hills. The well drained acid silt loams of the Wellston-Zanesville-Berks Association are characteristic. The forest vegetation consists of an oak-hickory assortment of the upper slopes, while the coves have a mesic component. Characteristic upper slope species include black oak (*Quercus velutina*), white oak (*Q. alba*), chestnut oak (*Q. prinus*), scarlet oak (*Q. coccinea*), post oak (*Q. stellata*), pignut hickory (*Carya glabra*), small-fruited hickory (*C. ovalis*), shagbark hickory (*C. ovata*), and rarely, sourwood (*Oxydendrum arboreum*). The cove forests, especially those associated with rockhouses, most resemble the mixed mesophytic forest communities of the Mixed Mesophytic Region of the Cumberland Plateau as defined by Braun (12). Characteristic species include beech (*Fagus grandifolia*), tulip tree (*Liriodendron tulipifera*), red oak (*Quercus rubra*), sugar maple (*Acer saccharum*), black walnut (*Juglans nigra*), white ash (*Fraxinus americana*), and locally, yellow buckeye (*Aesculus octandra*), white basswood (*Tilia heterophylla*), umbrella magnolia (*Magnolia tripetala*), hemlock (*Tsuga canadensis*), and yellow birch (*Betula lutea*). The sandstone cliff and rockhouse communities provide an environment for several species with Appalachian affinities, e.g. mountain laurel (*Kalmia latifolia*), mountain spleenwort (*Asplenium montanum*), sourwood, and umbrella magnolia. Distinctive species of the rockhouses include filmy fern (*Trichomanes boschianum*), alumroot (*Heuchera parviflora*), Bradley's spleenwort (*Asplenium bradleyi*), French's shooting star (*Dodecatheon frenchii*), and the Appalachian gametophyte (*Vittaria* sp.). A few examples of the acid seep spring community, a type extremely rare in Indiana, occur in this section. The characteristic flora of these bog-like environments includes cinnamon fern (*Osmunda cinnamomea*), royal fern (*O. regalis*), sedges (*Carex bromoides*, *C. lurida*), small clubspur orchid (*Platanthera clavellata*), black chokeberry (*Aronia melanocarpa*), winterberry (*Ilex verticillata*), tearthumb (*Polygonum arifolium*), jewelweed (*Impatiens biflora*), crested wood fern (*Dryopteris cristata*), and *Sphagnum* spp. The barrens community is (and probably was) a minor component of this section. Only a few high quality remnants remain. Floristically, they are similar to the glades and barrens of the Highland Rim Natural Region, although missing many of the distinctive glade species. Sandstone glades are almost non-existent in Indiana, but at least two small ones are known from this section. Characteristic species of sandstone glades include little bluestem (*Andropogon scoparius*), slender knotweed (*Polygonum tenui*), poverty grass (*Danthonia spicata*), farkleberry (*Vaccinium arboreum*), goat's rue (*Tephrosia virginiana*), pineweed (*Hypericum gentianoides*), pinweed (*Lechea tenuifolia*), and panic grass (*Panicum depauperatum*). Most of Indiana's timber rattlesnake (*Crotalus horridus*) collections have come from this region and the Brown County Hills Section of the Highland Rim Natural Region (51). Two interesting mammals characteristic of this section are the smoky shrew (*Sorex fumeus*) and the pygmy shrew (*Sorex hoyi*), which are restricted in Indiana to this region and the Highland Rim (19).

### Section 9B—Escarpmment Section

This section includes the rugged hills situated along the eastern border of the region. It is a blend of the Crawford Upland Section and the Mitchell Karst Plain Section of the Highland Rim. Sandstone and sandstone derived soils (Wellston-Zanesville) cap most of the hills, and the lower elevations present limestone and limestone-derived soils (Crider, Hagerstown, Bedford, and Corydon). Sandstone cliffs and rockhouses

are virtually unknown, but, limestone crops out to form large cliffs, especially along the Ohio River, and smaller stream courses. Karst features are not uncommon, especially in the lower and middle elevations. The natural communities consist of various upland forest types, especially dry-mesic and mesic. The species composition is similar to that of the Crawford Upland Section, except that certain species, e.g. post oak (*Quercus stellata*) and black oak (*Q. velutina*) commonly replace chestnut oak (*Q. prinus*) in the dry sites, and some of the mesic cove species, especially those with Appalachian affinities, are absent. Limestone glades and barrens occur in this section, but are not nearly as common as in the Highland Rim region. Limestone cliff communities occur mostly at the southern end of the section. Here, rare calciphiles such as alumroot (*Heuchera villosa*), wall-rue spleenwort (*Asplenium ruta-muraria*), cleft phlox (*Phlox bifida* var. *stellaria*), wild liveforever (*Sedum telephiooides*), and black-seeded sedge (*Carex eburnea*) occur. Eastern woodrats (*Neotoma floridana*) inhabit the crevices of cliffs along the Ohio River, which is also a favorite roosting and nesting site for black vultures (*Coragyps atratus*). Cave communities are common in this section, where some of the largest caves in Indiana occur. They support an unique fauna, including a troglobitic crayfish (*Orconectes inermis*) and the northern cavefish (*Amblyopsis spelaea*). Some caves support large populations of hibernating bats, especially the endangered Indiana bat (*Myotis sodalis*). Limestone gravel wash communities are well represented here, and are similar to the same community type in the Highland Rim and Bluegrass Natural Regions. The wild blue indigo (*Baptisia australis*) is apparently confined in Indiana to this community type in this section. The typical aquatic features include normally clear, medium and high-gradient streams, springs, and sinkhole ponds. The lower Blue River is an exceptionally fine example of a larger stream in this section.

#### Region Ten—Highland Rim Natural Region

This natural region occupies in part the Highland Rim physiographic region of the Interior Low Plateaus that occurs in a discontinuous belt from northern Alabama through Tennessee, Kentucky, and into Indiana (65). The underlying strata are predominantly of Mississippian age, although some Pennsylvanian aged strata crop out in places. The region is unglaciated, except for relatively unmodified glaciated areas at the northern and eastern boundary. A distinctive feature of this region is the large expanse of karst topography, although several other major topographic features are known including cliffs and rugged hills. Much of the area was forested in presettlement times, but large areas of barrens occurred along with smaller areas of glade (limestone and siltstone) and gravel wash communities.

This natural region is divided into three sections: the Mitchell Karst Plain Section, the Brown County Hills Section and the Knobstone Escarpment Section. They essentially occupy three of Malott's (45) physiographic regions: the Mitchell Plain, the Norman Upland, and the Scottsburg Lowland.

Ecological studies in this region include Cain (14), Lindsey and Schmelz (42), Potzger (58), McQueeney (47), Keith (38), Bacone et al. (7), Aldrich et al. (3), and Homoya and Hedge (35).

#### Section 10A—Mitchell Karst Plain Section

The major feature of this section is the karst (sinkhole) plain. Several natural community types are associated with this plain, including cave, sinkhole pond and swamp, flatwoods, barrens, limestone glade and several upland forest types. The plain is relatively level, although in some areas, especially near the section's periphery, limestone cliffs and rugged hills are present. Caves are common. The soils are generally well drained silty loams derived from loess and weathered limestone. Acid cherty Bax-

ter silt loam is present mostly in the south (correlating somewhat with the barrens community type), as is the neutral to basic Corydon stony silt loam (correlating with the limestone glade and cliff community type). Crider silt loam is a major soil throughout most of the region. Possibly the largest area of barrens in Indiana was located in this section. Species commonly found in remnants of this prairie-like community include Indian grass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), rattlesnake master (*Eryngium yuccifolium*), prairie dock (*Silphium terebinthinaceum*), hairy sunflower (*Helianthus mollis*), prairie willow (*Salix humilis*), clasping milkweed (*Asclepias amplexicaulis*) and *Carex meadii*. Most of Indiana's limestone glades occur in this region, particularly in Harrison and Washington Counties. This bedrock community, like the barrens, has a prairie flora with additional distinctive glade species including downy milk pea (*Galactia volubilis* var. *mississippiensis*), angle-pod (*Gonolobus obliquus*), axe-shaped St. John's-wort (*Hypericum dolabriiforme*), adder's tongue fern (*Ophioglossum engelmannii*), crested coral root orchid (*Hexalectris spicata*), and heartleaf alexander (*Zizia aptera*). Gravel wash communities composed of limestone and chert gravel border most streams. Characteristic species include big bluestem, Indian grass, Carolina willow (*Salix caroliniana*), water willow (*Justicia americana*), ninebark (*Physocarpus opulifolius*), pale dogwood (*Cornus obliqua*), and bulrush (*Scirpus americanus*). Karst wetland communities are the major aquatic features of the section. Southern swamp species are known from some of the sinkhole swamps, including beakrush (*Rhynchospora corniculata*), log sedge (*Carex decomposita*), giant sedge (*C. gigantea*), Virginia willow (*Itea virginicia*), and small buttercup (*Ranunculus pusillus*), and netted chain fern (*Woodwardia areolata*). Usual dominants of these swamps are swamp cottonwood (*Populus heterophylla*), pin oak (*Quercus palustris*), swamp white oak (*Q. bicolor*), red maple (*Acer rubrum*), and sweet gum (*Liquidambar styraciflua*). Sinkhole pond communities normally have open water and marshy borders with cattails (*Typha latifolia*), bulrush (*Scirpus validus*), bur-reed (*Sparganium androcladum*), spatterdock (*Nuphar advena*), buttonbush (*Cephaelanthus occidentalis*), swamp loosestrife (*Decodon verticillatus*), bladderwort (*Utricularia gibba*) and *Carex comosa*. Several forest communities are present in the section, but the western mesophytic forest type predominates (41), in which white oak (*Quercus alba*), sugar maple (*Acer saccharum*), shagbark hickory (*Carya ovata*), pignut hickory (*C. glabra*), and white ash (*Fraxinus americana*) are typical. Near the glade communities, some xeric forest occurs in which post oak (*Quercus stellata*), chinquapin oak (*Q. muhlenbergii*) and blue ash (*Fraxinus quadrangulata*) are characteristic. Chestnut oak (*Quercus prinus*), a very common component of the Brown County Hills Section and the Knobstone Escarpment Section, is uncommon in this section. State restricted species include quillwort (*Isoetes engelmannii*), netted chain fern, monkshood (*Aconitum uncinatum*), manna-grass (*Glyceria acutiflora*), blackstem spleenwort (*Asplenium resiliens*), glade violet (*Viola egglestonii*), and southern cavefish (*Typhlichthys subterraneus*). In karst areas, surface streams are few. Typical examples include medium and high-gradient streams with rocky bottoms, e.g. Indian Creek, Clear Creek, Buck Creek, and upper stretches of the Blue River.

#### Section 10B—Brown County Hills Section

This section is characterized by deeply dissected uplands underlain by siltstone, shale, and sandstone. The soils are well drained acid silt loams with minor amounts of loess, specifically the Berks-Gilpin-Weikert Association. Bedrock is near the surface, but rarely crops out. The natural communities are rather uniform in composition, with uplands dominated by oak-hickory, especially chestnut oak (*Quercus prinus*), and ravines with mesic species, e.g. beech (*Fagus grandifolia*), red oak (*Q. rubra*),

sugar maple (*Acer saccharum*), and white ash (*Fraxinus americana*). Typically, upper slopes have an almost pure stand of chestnut oak, a thick growth of greenbriar (*Smilax* spp.), low growing shrubs (*Gaultheria procumbens* and *Vaccinium vacillans*), and a carpet of sedges, notably *Carex picta*. The latter is essentially restricted in Indiana to this section, and yet is ubiquitous here. Yellowwood (*Cladrastis kentukea*) is known in Indiana only from a small area of this section. The green adder's mouth orchid (*Malaxis unifolia*), trailing arbutus (*Epigaea repens*), and large whorled pogonia orchid (*Isotria verticillata*) are geographically restricted here except for single collections of the latter two in the Knobstone Escarpment Section. One occurrence of an acid seep spring community is known (58). Small, high-gradient ephemeral streams are common. Most larger streams are predominantly medium to low-gradient streams, e.g. Guthrie Creek, and all forks of Salt Creek.

#### Section 10C—Knobstone Escarpment Section

This section is similar to the Brown County Hills Section in terms of substrate and topography, but is distinguished by floristic, faunistic, and compositional differences of the forest communities. The major compositional difference is the presence of Virginia pine (*Pinus virginiana*) in the upland forest communities. The pine is commonly a co-dominant with chestnut oak (*Quercus prinus*) on many of the ridge crests and south-facing slopes. American chestnut (*Castanea dentata*) was a dominant historically, given the frequency that it was mentioned in the survey records of the General Land Office and its continued presence today as stump sprouts. Its place has been taken by chestnut oak. *Carex picta*, a species common in the Brown County Hills Section, is rare here. Rock outcrops are few and are restricted to ridge tops. Glades with a shaly substrate (fragments of siltstone, shale, and sandstone) are present but rare and normally occur on south-facing slopes. They are typically rather sterile environments primarily because of the unstable substrate and harsh climatic conditions. Typical associates include scattered clumps of little bluestem (*Andropogon scoparius*), goat's rue (*Tephrosia virginiana*), bird-foot violet (*Viola pedata*), and St. Andrew's cross (*Ascyrum hypericoides*). Xeric forests of blackjack oak (*Quercus marilandica*), chestnut oak, and scarlet oak (*Q. coccinea*) commonly border these glades. Species restricted in Indiana to this section include stout goldenrod (*Solidago squarrosa*), rattlesnake-weed (*Hieracium venosum*), bluegrass (*Poa cuspidata*), Virginia pine, red salamander (*Pseudotriton ruber*), scarlet snake (*Cemophora coccinea*), and crowned snake (*Tantilla coronata*). Small, and ephemeral high-gradient streams are the major aquatic features of this section. Typical larger streams include Muddy Fork of Silver Creek, Buffalo Creek, Twin Creek and Rush Creek.

#### Region Eleven—Bluegrass Natural Region

This natural region is identified and named not for a predominance of bluegrass (*Poa* spp.), but for similarities of the physiography and natural communities to the Bluegrass region of Kentucky. Traditionally, this portion of Indiana has not been considered a part of the Interior Low Plateaus Bluegrass Region as outlined by Fenneman (25). However, several geologists have pointed out similarities in the Kentucky Bluegrass Region and the Indiana area, including Malott (45) and Ray (66), the latter placing them together in the Bluegrass part of the Interior Low Plateaus. Major portions of three of Malott's (45) physiographic regions are included in the Bluegrass Natural Region: the Dearborn Upland, the Muscatatuck Regional Slope, and the Scottsburg Lowland. The three sections of this natural region, the Switzerland Hills Section, the Muscatatuck Flats and Canyons Section, and the Scottsburg Lowland Section, approximate the area of these physiographic units.

Although the entire natural region has been covered by one or more of the pre-Wisconsin ice sheets, today much of it is mantled by only a relatively thin veneer of till. The northern boundary of the region approximates the southern terminus of Wisconsinan glaciation. This boundary marks the northern limit in this region for several southern plant species, as well as many herpetofaunal species (74).

Most of the natural region was originally forested, although a few glade, cliff, and barrens remnants are known, as well as non-forested aquatic communities. Ecological studies in the region include those of McCoy (46), Chapman (17), Potzger and Chandler (60, 61), Reidhead (67), and Jackson and Allen (37).

#### Section 11A—Scottsburg Lowland Section

The main features of this section are the wide alluvial and lacustrine plains that border the major streams, particularly the Muscatatuck River, the East Fork of White River, Silver Creek, and their tributaries. Major soils are acid to neutral silt loams, particularly of the Stendal, Atkins, Haymond, and Wilbur series. A sizable area of eolian sand occurs just east of the East Fork of the White River, but no unique communities or species are known to have been associated with it. Bedrock rarely crops out, the major exception being the Falls of the Ohio near Clarksville. Predominant natural communities are floodplain forest and swamp, although areas of upland forest are included that grade into the Muscatatuck Flats and Canyons Section. The swamp community is characterized by the occurrence of swamp cottonwood (*Populus heterophylla*), red maple (*Acer rubrum*), pin oak (*Quercus palustris*), river birch (*Betula nigra*), green ash (*Fraxinus pennsylvanica*), stiff dogwood (*Cornus foemina*), and button-bush (*Cephalanthus occidentalis*). The slightly better drained floodplain forest adds sweetgum (*Liquidambar styraciflua*), swamp chestnut oak (*Quercus michauxii*), swamp white oak (*Q. bicolor*), American elm (*Ulmus americana*), black gum (*Nyssa sylvatica*), beech (*Fagus grandifolia*), shellbark hickory (*Carya laciniosa*), and rarely, pecan (*Carya illinoensis*). Characteristic herbs include *Carex muskingumensis*, *C. louisianica*, Virginia day flower (*Commelina virginica*), lizard's tail (*Saururus cernuus*), and woodreed (*Cinna arundinacea*). The very rare southern pale green orchid (*Platanthera flava* var. *flava*) is geographically restricted here, as are the northern copperbelly (*Nerodia erythrogaster neglecta*), and the eastern ribbon snake (*Thamnophis sauritus sauritus*). The northern studfish (*Fundulus catenatus*) is known in Indiana only from streams in the far northern portion of this section. State restricted plants include the extinct stipuled scurf-pea (*Psoralea stipulata*), and the extirpated Short's goldenrod (*Solidago shortii*). Wetland features in this section include swamps, acid seep springs, low-gradient, silty-bottomed streams and rivers and ponds. Were it not for the location of this section, it conceivably could fit into the Southern Bottomlands Natural Region.

#### Section 11B—Muscatatuck Flats and Canyons Section

This section consists primarily of a broad, relatively flat west sloping plain with steep walled canyons entrenched by major streams. The plain is characterized best by the presence of poorly drained, acidic Cobbsfork and Avonburg silt loam soils and the occurrence of a southern flatwoods natural community type. These flatwoods typically have beech (*Fagus grandifolia*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), pin oak (*Quercus palustris*), swamp chestnut oak (*Q. michauxii*), and tulip tree (*Liriodendron tulipifera*). A few species are restricted geographically here, including fox grape (*Vitis labrusca*), blunt-lobed grape fern (*Botrychium oneidense*), swamp dewberry (*Rubus hispida*), dwarf ginseng (*Panax trifolium*) and false lily-of-the-valley (*Maianthemum canadense*). In canyons, cliffs and slopes of Silurian and Devonian limestone provide an environment quite unlike the flats. These sites are com-

paratively rich floristically, and have a predominantly mixed mesophytic forest composition. Canada violet (*Viola canadensis*), longspur violet (*V. rostrata*), and crinkleroot (*Dentaria diphylla*) are more common here than elsewhere in southern Indiana. American pennywort (*Hydrocotyle americana*), wideleaf ladies' tresses (*Spiranthes lucida*), and *Carex pedunculata* are restricted geographically here. Sullivantia (*Sullivantia sullivantii*) and golden St. John's-wort (*Hypericum frondosum*) are known in Indiana only from canyons in this section. The dusky salamander (*Desmognathus fuscus*) is a distinctive species of this section and the Bluegrass Natural Region. Non-forested community types include small areas of limestone gravel wash and limestone glade, the latter harboring the only Indiana occurrence of Michaux leavenworthia (*Leavenworthia uniflora*). Minor areas of karst topography occur along valley borders. The major aquatic features include medium-gradient streams with beds of pavement-like limestone, such as Graham Creek, Big Creek, and the upper stretches of the Vernon Fork of the Muscatatuck River.

#### Section 11C—Switzerland Hills Section

This section is characterized by deeply dissected uplands composed of calcareous shale and limestone of Ordovician age. Bedrock is near the surface, but cliffs are rare. The area was glaciated, yet unconsolidated deposits are thin or absent. The Eden, Switzerland, and Pate neutral silty clay loams are the dominant soils series. Most of the natural communities are forested, although a few barrens remnants are known. A mixed mesophytic forest type is well represented, especially in the ravines. These forests should not be confused with the mixed mesophytic forests of the Cumberland Mountains as described by Braun (12), for there is little similarity in terms of floral composition, bedrock, soils, etc. Characteristic tree species include beech (*Fagus grandifolia*), white ash (*Fraxinus americana*), sugar maple (*Acer saccharum*), white oak (*Quercus alba*), chinquapin oak (*Q. muehlenbergii*), red oak (*Q. rubra*), shagbark hickory (*Carya ovata*), blue ash (*Fraxinus quadrangulata*), tulip tree (*Liriodendron tulipifera*), Ohio buckeye (*Aesculus glabra*), and black walnut (*Juglans nigra*), with occasional occurrences of yellow buckeye (*Aesculus octandra*), and white basswood (*Tilia heterophylla*). Historical evidence indicates that this area, especially along the Ohio River, possibly may be the only location where black locust (*Robinia pseudoacacia*) is native in the state (20, 29). Although no indigenous plant species is unique to this section, two species are more common here than elsewhere in the state, namely a fox-glove (*Penstemon canescens*), and Kentucky viburnum (*Viburnum molle*). The ravine salamander (*Plethodon richmondi*) is essentially restricted in Indiana to this section. Rocky, gravel-bottomed, medium-gradient streams such as Laughery Creek and Whitewater River, typify the major aquatic features of the region.

#### Region Twelve—Big Rivers Natural Region

This aquatic natural region includes those rivers (or portions of rivers) where the average flow is 7000 cubic feet per second or greater. This includes all of the Ohio River bordering Indiana, the White River up to the confluence of its two forks, and the Wabash River from its mouth to near Attica in Fountain County. These rivers provide an environment for several species not found in smaller riverine systems, e.g. the lake sturgeon (*Acipenser fulvescens*), shovelnose sturgeon (*Scaphirhynchus platorynchus*), alligator gar (*Lepisosteus spatula*), shortnose gar (*Lepisosteus platostomus*), ship-jack herring (*Alosa chrysocloris*), smallmouth buffalofish (*Ictiobus bubalus*), goldeye (*Hiodon alosoides*), mooneye (*Hiodon tergisus*), and the blue sucker (*Cyclopterus elongatus*).

Mussel species distinctive of the Big Rivers Region include the fat pocketbook pearly mussel (*Potamilus capax*), white cat's paw pearly mussel (*Epioblasma sulcata*

(*delicata*), tubercled-blossom pearly mussel (*E. torulosa torulosa*), pink mucket pearly mussel (*Lampsilis orbicularis*), and Sampson's pearly mussel (*Epioblasma sampsoni*—extinct). The alligator snapping turtle (*Macroclemys temminckii*), and the hellbender (*Cryptobranchus alleganiensis*) are characteristic species of this region, but currently are very rare if not absent. At least one vascular plant is state restricted to this region, that being riverweed (*Podostemum ceratophyllum*).

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