

THE HISTORY OF HUMAN DISTURBANCE IN FOREST ECOSYSTEMS OF SOUTHERN INDIANA

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Abstract.—The forests of southern Indiana have been shaped and defined by anthropogenic disturbance. Native Americans influenced composition and structure through land clearing and burning, but the scale and rate of human disturbance intensified with European settlement. Sustained settlement led to the loss of forest land to agriculture and livestock grazing. Forests were also harvested to meet the needs of a growing population. The unglaciated hills of south-central Indiana proved unsuitable for agriculture, and during the Great Depression degraded lands were abandoned and ultimately incorporated into state and national forests. Today, forest cover has returned to these lands, but vegetation communities still bear the mark of centuries of human disturbance.

INTRODUCTION

The wide expanse of hardwood forest in southern Indiana is perhaps the region's most defining feature. When considered in the context of the agricultural land to the north, the landscape of southern Indiana is more akin to the forests of the Appalachian foothills than to the greater Midwest. Although many factors have led to this contemporary dominance of forest, geologic history played a predominant role. The southernmost extent of the Illinoian glaciation reached into the northernmost portion of the region ca. 130,000 years BP and covered three of the nine present-day Hardwood Ecosystem Experiment (HEE) study units (Fig. 1). However, the maximum southern extent of the most recent glaciation, the Wisconsin of ca. 21,000 years BP, is 10 km (6.2 miles) northeast of the study area and did not cover any of the treatment units (Fig. 1).

This lack of recent glaciation resulted in a landscape consisting of steep hills and valleys with bedrock-

derived soils. As discussed below, the rugged topography of this region ultimately led to the abandonment of agriculture and subsequent succession to the forests we see today. In addition, the varied topography of the region has fostered a range of microsite conditions and influenced the frequency and intensity of disturbances, such as fire. The interplay of these factors has contributed to the mosaic of vegetation observed across the contemporary landscape.

According to Homoya et al. (1985), the HEE study sites are all within the Brown County Section (BCS) of the Highland Rim Natural Region of Indiana. This section is characterized by deeply dissected uplands with bedrock composed of early-mid Mississippian siltstone, shale, and sandstone. Small high-gradient intermittent streams are common and drain into larger medium- to low-gradient streams. The process of erosion has produced a local topography that is generally steep, but without bluffs (Logan et al. 1922). All of the HEE study sites are underlain by soils of the Wellston-Berks-Gilpin soil complex (Natural Resources Conservation Service 2011). Wellston and Gilpin soils are classified as fine-silty, mixed, active, mesic Ultic Hapludalfs (Wellston) or Typic Hapludults

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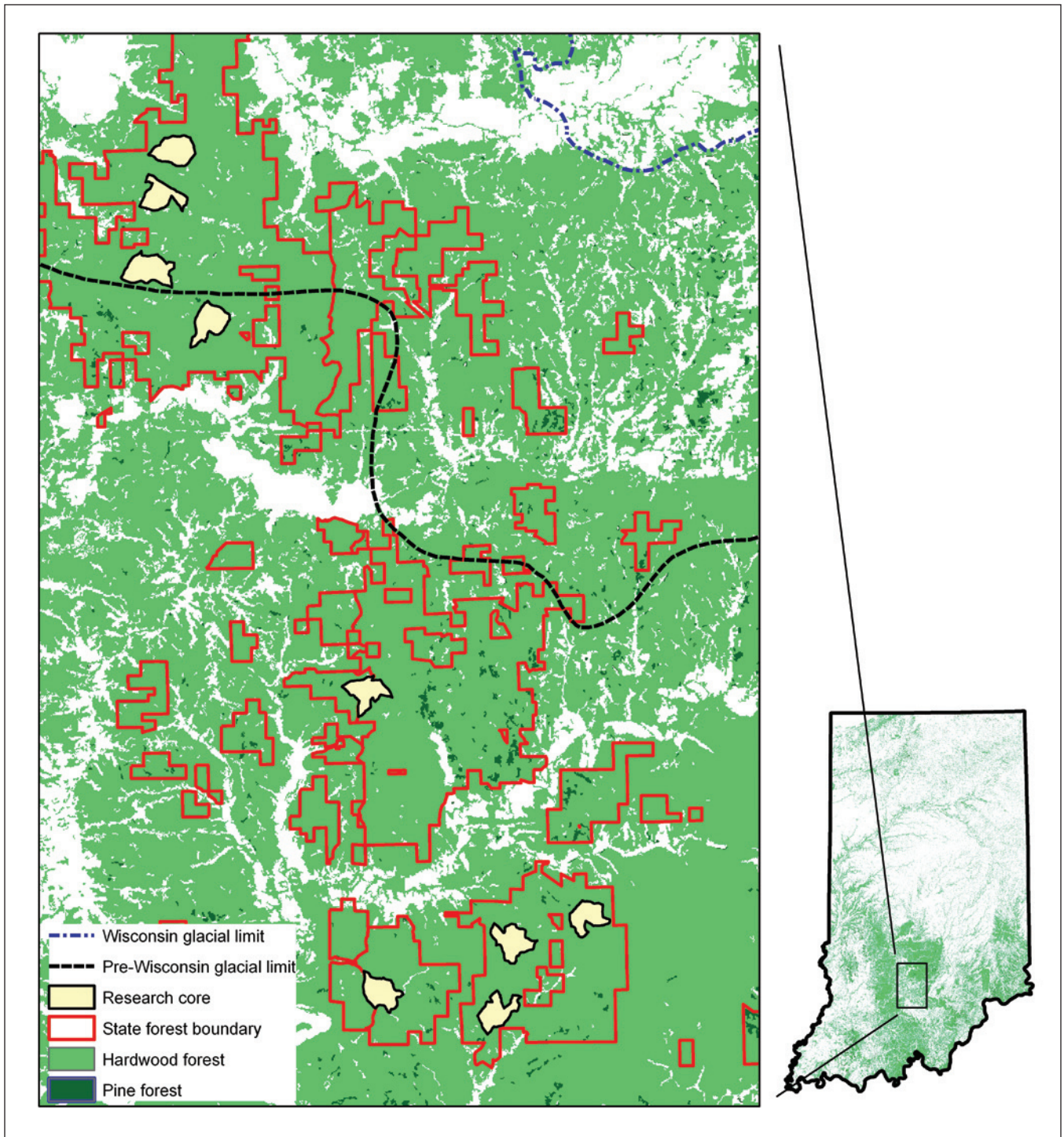


Figure 1.—Hardwood Ecosystem Experiment research core areas within the forest matrix of south-central Indiana. Southern limits of glaciation events are superimposed on the enlarged portion of the figure.

(Gilpin). Berks soils are classified as loamy-skeletal, mixed, active, mesic Typic Dystrudepts. These silt-loam soils occur on moderate to very steep slopes, are well drained, and are highly prone to erosion.

Uplands in the BCS are dominated by oak-hickory (*Quercus-Carya*) forests with chestnut oak (*Q. prinus*) on the most xeric topographic positions. Mesic slopes and ravines are dominated by red oak (*Q. rubra*), American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), and white ash (*Fraxinus americana*). Common understory species include black huckleberry (*Gaylussacia baccata*), lowbush blueberry (*Vaccinium pallidum*), and greenbrier (*Smilax* spp.) on upper slopes and ridges. Sugar maple frequently dominates the understory of more mesic sites. Herbaceous species richness is generally low on dry ridges where Boott's sedge (*Carex picta*) typically dominates cover and is an indicator species of the landtype. A more diverse array of forest perennials, ferns, and sedges occurs on more mesic sites.

Disturbance is an ecological process in all ecosystems, but it occurs at varying spatial scales and intensities depending upon the inherent characteristics of an ecosystem. In forests, disturbance ranges in intensity, scale, and frequency from gaps formed regularly by the death of single or scattered trees to landscape-scale crown fires that occur at intervals of more than a century. In forests of eastern North America, including those of southern Indiana, humans have been the dominant drivers of disturbance regimes. In this paper, I discuss how the contemporary forest landscape of southern Indiana has been shaped by centuries of human activities.

DISTURBANCE BY NATIVE AMERICANS

Human occupation of Indiana dates to the end of the Wisconsin glaciation approximately 10,000 years BP, although these earliest inhabitants of the state were few in number and lived in a cooler and

changing climate (Jones and Johnson 2008) within a landscape dominated by coniferous forests (Otto 1938). The coniferous forests retreated with the changing postglacial climate, and oak species became dominant approximately 7,000 years BP (Wilkins et al. 1991). More archeological sites exist for this period than for earlier periods because of growth in the human population and increased diversity of activities undertaken to more fully exploit resources that were available within a more varied ecological setting (Jones and Johnson 2008).

Native American populations continued to grow with the development of horticulture of selected plants and the formation of more permanent settlements during the Early Woodland period (ca. 1000-200 B.C.). According to Baltz and Ledford (1991), 118 Native American archaeological sites have been found in the Mogan Ridge Area of Hoosier National Forest. Of these sites, 101 were of prehistoric origin. The link between early and protohistoric (post A.D. 1400) cultures in southern Indiana remains a topic of debate (Jones and Johnson 2008), but some scholars have suggested that the Miami and Shawnee, the dominant tribes prior to European settlement, may be linked to some indigenous late-prehistoric cultures (Sieber and Munson 1994).

Although earlier estimates of pre-Columbian Native American populations suggest that North America was largely unpopulated, more recent estimates of Native American populations suggest that North America was more populated than previously thought (DeVivo 1991). Twentieth-century estimates of the pre-Columbian population of North America ranged from 1.1 to 18 million (Denevan 1992, Thornton 2000). Population estimates for the land area that became the United States range from 720,000 to 7 million (Thornton 2000). Pre-Columbian population estimates are lacking at finer scales for most geographic areas, but archeological records do suggest that large river systems in southwestern Indiana contained well-developed population centers.

Native cultures of the Mississippian period (A.D. 1000-1650), evident in the archeological record of Angel Mounds State Historic Site and other sites in southwestern Indiana, practiced intensive agriculture and occupied well-populated cities, villages, and hamlets (Jones and Johnson 2008). The Angel Mounds site is estimated to have had a population between 1,000 and 3,000 at its peak and was linked through trade to other large population centers throughout the Midwest, including Cahokia in Illinois. However, Angel Mounds and other Mississippian sites were abandoned prior to European contact (Cobb and Butler 2002). Archeological evidence has not shown a link between the mound builders and tribes such as the Miami and Shawnee that occupied southern Indiana at the time of European contact (Jones and Johnson 2008, Sieber and Munson 1994). These later cultures were more mobile and did not occupy large permanent population centers, but they likely affected local resources through collection of fuelwood and nuts.

Beyond population density, whether Native Americans influenced their environment has been a subject of study and debate (Denevan 1992, Pyne 1982). Much like modern-day humans, pre-Columbian Native Americans used the tools at hand to create conditions that better addressed their sustenance needs. Burning and tree deadening (girdling by damaging the cambium) were used to clear land for agricultural use (Kellar 1966, Parker 1989). The impact of this disturbance was probably quite limited at any single point in time, but over the centuries the character of natural communities was most likely changed as areas were cleared, cultivated, and abandoned (Parker 1997, Parker and Ruffner 2004). The continuous shifts in land cultivation combined with the use of fire to clear new lands probably created a mosaic of various stand ages and forest types across the landscape (Buckner 1989, Guyette and Cutter 1991, Ruffner and Abrams 2002).

Burning also was used to drive or create conditions that attracted large animals such as bison (*Bison bison*)

and white-tailed deer (*Odocoileus virginianus*) (Billard 1979). It is highly likely that these fires burned much larger areas than were intended, especially during drier years (Denevan 1992, DeVivo 1991, Parker 1997). According to survey records from the Government Land Office, presettlement forests (ca. 1820) of unglaciated southern Indiana were dominated by oak and hickory species (Lindsey et al. 1965, Potzger et al. 1956), which likely reflects these early land-use practices. The current overstory dominance of seral oak and hickory species in many old-growth remnants throughout the Central Hardwood Region is also probably the result of pre-settlement land use (Parker 1997).

Fire history records from southern Indiana are limited. In a barren-dry forest complex on the Hoosier National Forest, Guyette et al. (2003) observed regular burning prior to 1674, followed by a 128-year fire-free interval that persisted until 1801. The authors suggested that this interval may have resulted from the retreat of Native Americans from the Ohio Valley into Arkansas and Missouri ahead of Iroquois invaders. Fire frequency increased again after 1801 and frequent burning continued until 1849, likely due to eastern tribes migrating westward ahead of European expansion.

As the European population increased in the eastern United States, the need for new lands for settlement also increased (Sieber and Munson 1994). By 1790 there were already 70,000 European settlers in Kentucky, and many were eager to move into the lands of Indiana, Illinois, and Ohio. As settlers moved into lands formerly held by Native Americans, confrontation was inevitable. The years between 1790 and 1795 and from 1808 to 1814 were marked with numerous scattered fights between European settlers and Native Americans. Between 1790 and 1800, when the Indiana Territory was created, Native Americans controlled two-thirds of Indiana (Cockrum 1907). However, Native American dominance was greatly weakened when the Prophet and his Shawnee

followers were defeated at the Battle of Tippecanoe in 1811 (Indiana State Teachers Association 1914). With the ever-increasing number of settlers, defeat appeared inevitable, and most tribes surrendered their land through various treaties and were forced to move farther west.

EUROPEAN SETTLEMENT TO PRESENT

During the first two decades of the 1800s the population of Indiana grew rapidly, and statehood was granted in 1816 (Sieber and Munson 1994). The early settlers of south-central Indiana were mostly from Kentucky, North Carolina, Virginia, and Tennessee. Ethnically, the majority of these settlers were of English and Scots-Irish descent. The large influx of Scots-Irish settlers into the region made south-central Indiana culturally unique in comparison to the rest of the state. The ethnic heritage of the region's early settlers more closely linked them culturally to the early settlers of the southern Appalachians and the Missouri and Arkansas Ozarks (Rafferty 1980). According to Pyne (1982) the Scots-Irish of the settlement era had a cultural predisposition towards the broadcast burning of woodlands. This burning was conducted to reduce insect pests, improve hunting, and encourage the regeneration of hardwood species. In many areas, such as southwestern Missouri, this cultural burning continues today.

Early European settlers adopted the clear-and-abandon agriculture methods of Native Americans (Parker 1997). Most of these early farms operated at the sustenance level and were fairly ephemeral in nature (Otto 1983). Forests were most desired for farmland, since wetlands were difficult to drain and prairie was not considered good for farming (Urban 2005). Livestock (mostly hogs) were allowed to forage in the forest, thereby adding to disturbance through their feeding and trampling. Bradbury (1817) described land clearing by early settlers: "They have two modes of clearing land; one by cutting the trees around,

so as to kill them, and afterwards clearing away the underwood, the quantity of which is very small: this mode is called girdling and is only resorted to by those, to use their own phrase are weak handed. The other mode is by cutting down the trees, dragging them into heaps and burning them."

Much of the land cleared by these early settlers was allowed to return to forest after it was abandoned as westward expansion continued. During the later stages of settlement, continued land clearing for farming and timber served to further reduce Indiana's once extensive forests to smaller, isolated, and heavily disturbed woodlands (Parker 1997). By the mid-1800s, large amounts of forest had been cleared, creating a highly fragmented landscape.

During this period of intensive settlement, numerous animal species of ecological importance became extinct or were extirpated from Indiana and the larger Midwest region. The last record of the passenger pigeon (*Ectopistes migratorius*) in Indiana was in 1893 (Lindsey 1977). Among large ungulates, bison and elk (*Cervus elaphus*) were extirpated from Indiana in the early 1800s (1808 and 1830, respectively) (Whitaker 2010). Though highly abundant on the contemporary landscape, white-tailed deer were extirpated in the 1880s and reintroduced in the 1930s and 1940s (Whitaker 2010). Although the effects of ungulates on vegetation have been widely studied, the historic ecological role of the passenger pigeon is poorly understood. Schorger (1955) estimated the total population of this species at 3 to 5 billion. Interestingly, Neumann (1985) suggested that prior to European contact, the passenger pigeon population in North America was much smaller due to competition with Native Americans for tree nuts. European settlement disrupted this competition and allowed pigeon populations to greatly expand.

As would be expected for such an abundant species, natural history accounts of the passenger pigeon abound from throughout its former range, including

southern Indiana. For example, after the population had been drastically reduced, the Indiana Gazetteer in 1849 described a place called Pigeon Roost in Scott County, IN, as “formerly so much resorted to by Pigeons, that for miles nearly all the small branches of a thick forest were broken off by their alighting in such numbers on them, and the ground was covered with ordure several inches in depth for years afterwards” (as cited by Wright 1911). Obviously, the roosting and feeding activities of this species had a profound effect on the structure and composition of forests.

The pattern of over-harvest and land abuse through excessive grazing, high-grading, and poor farming methods continued into the 20th century (Parker 1997). Continued agriculture in the region’s hilly terrain resulted in massive erosion (Fig. 2); sheet erosion was estimated at 99 percent in parts of Crawford County and 92 percent in parts of Brown County (U.S. Geologic Survey data as cited in Sieber and Munson 1994). The farms on these steep hillsides were often referred to as “10-year land,” which meant that they could be tilled for 10 years before enough soil eroded away to make further tillage unprofitable (Visser 1937). Woodlands that were not cleared for



Figure 2.—Eroded farmland in Brown County, IN, October 1935. Much of this highly degraded land was purchased from willing sellers and incorporated into state and federal forests. (Photo credit: U.S. Department of Agriculture, Farm Security Administration)

agriculture were still heavily cut to provide wood resources. However, the stands that regrew on these disturbed sites form most of the contemporary forest in the region.

Many landowners in the region during the 1920s and 1930s were forced to abandon their holdings due to the poor condition of the land or their inability to pay back taxes (Sieber and Munson 1994). The severe degradation of land combined with the Great Depression plunged the region into a dire economic condition. These desperate conditions led to the depopulation of many areas, as reflected in population trends observed for Brown County. In 1900, the county had a population of 9,727, but by 1930 the population had declined to 5,168, a 47-percent decrease (Forstall 1995). The population of Brown County did not recover to its 1900 level until the 1970s. Following the abandonment of these lands, disturbance frequency and severity decreased due to fire suppression, reduced grazing, reduced farming on marginal lands, and the creation of public lands.

Reforestation has reduced the degree of fragmentation in large parts of the Central Hardwood Region. The incorporation of abandoned marginal farmland into the public domain has served to reduce fragmentation in areas such as southern Indiana, where large areas that were formerly dominated by hillside farms were incorporated into Hoosier National Forest and Indiana state forests during the early 1900s (Carman, this publication). Many landowners were quite willing to divest themselves of their eroded and depleted lands. Sieber and Munson (1994) reported that by August of 1935 the U.S. Forest Service received 2,000 offers to sell more than 80,940 ha (200,000 acres) of land. Throughout the Midwest during the 1930s, workers from the Civilian Conservation Corps and Works Progress Administration replanted large tracts of the most severely eroded ridgetops and stream bottoms with pine species, including white pine (*Pinus strobus*), red pine (*Pinus resinosa*), and shortleaf pine (*Pinus echinata*) (Otis et al. 1986, Sieber and Munson 1994) (Fig. 3).



Figure 3.—Works Progress Administration (WPA) crew planting 1-0 shortleaf pine on the Hoosier National Forest in 1940. Workers from both the WPA and the Civilian Conservation Corps planted pine on abandoned agricultural land throughout southern Indiana. Many of these plantations remain on state and federal land throughout the region. (Photo credit: U.S. Department of Agriculture, Forest Service)

The recovery of lands incorporated into public ownership has been dramatic. An examination of historic land use in the Charles C. Deam Wilderness of the Hoosier National Forest, an area located less than 10 km (6.2 miles) from the southernmost HEE site, found that, in 1939, 33 percent of the wilderness comprised abandoned agricultural land or old fields, 26 percent was open-canopy forest (indicating livestock grazing), and only 41 percent was closed-canopy forest (Jenkins and Parker 2000a). Although ridgetops and stream bottoms composed most of the agricultural land, nearly 20 percent of the slopes were also cleared. By 1990, 86 percent of the wilderness was covered by closed-canopy forest and the overall landscape was much less fragmented, as shown by a greater than 50-percent decrease in total edge.

Closed-canopy forest has returned to the landscape of southern Indiana, but vegetation communities in forests that have regrown on abandoned agricultural land differ from mature secondary forests. Jenkins and Parker (2000b) identified distinct differences in the herbaceous-layer composition of forests located on abandoned agricultural lands resulting from a loss of forest perennials and an influx of exotic and non-forest species. According to Jenkins and Parker (2001),

overstory composition on abandoned agricultural land also differed from that of mature secondary forests due to heavy domination by tulip poplar (*Liriodendron tulipifera*). Due to the post-disturbance dominance by tulip poplar, however, overstory composition of abandoned agricultural land was very similar to that of clearcuts and group selection openings created in mature secondary forests.

The reduced frequency and intensity of fire and other disturbance in unmanaged forests since the mid-20th century have allowed succession of formerly oak-dominated forests to eventual domination by shade-tolerant species (Abrams 1992, Lorimer 1984, Ruffner and Groninger 2006). In southern Indiana, sugar maple typically dominates the understories of oak-dominated forests and likely will dominate future canopies in the continued absence of disturbance (Jenkins and Parker 1998). Single-tree selection harvest has been shown to accelerate succession toward dominance by sugar maple and other shade-tolerant species when overstory oak trees are removed (Abrams and Scott 1989, Jenkins and Parker 1998, Ozier et al. 2006). Understanding how the long-term loss of oak species will affect forest structure, processes, and trophic interactions is an important objective of the HEE.

The rugged land of southern Indiana that was incorporated into public ownership is typical of public forest land throughout the Midwest. Flatter, more fertile areas, such as north-central Indiana, that were forested in presettlement times have remained in agriculture. Thus, much of the present-day forest land in the Central Hardwood Region is found in areas with steeper topography, such as south-central Indiana, that were greatly disturbed by poor land-use practices. Consequently, the woodlands of today are probably not reflective of the wide expanses of forests that once covered the region. Instead, the forests of today, according to Parker and Merriitt (1995), “represent the culled over remains of once magnificent forests and will continue to bear the scars of mismanagement well into the future.”

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