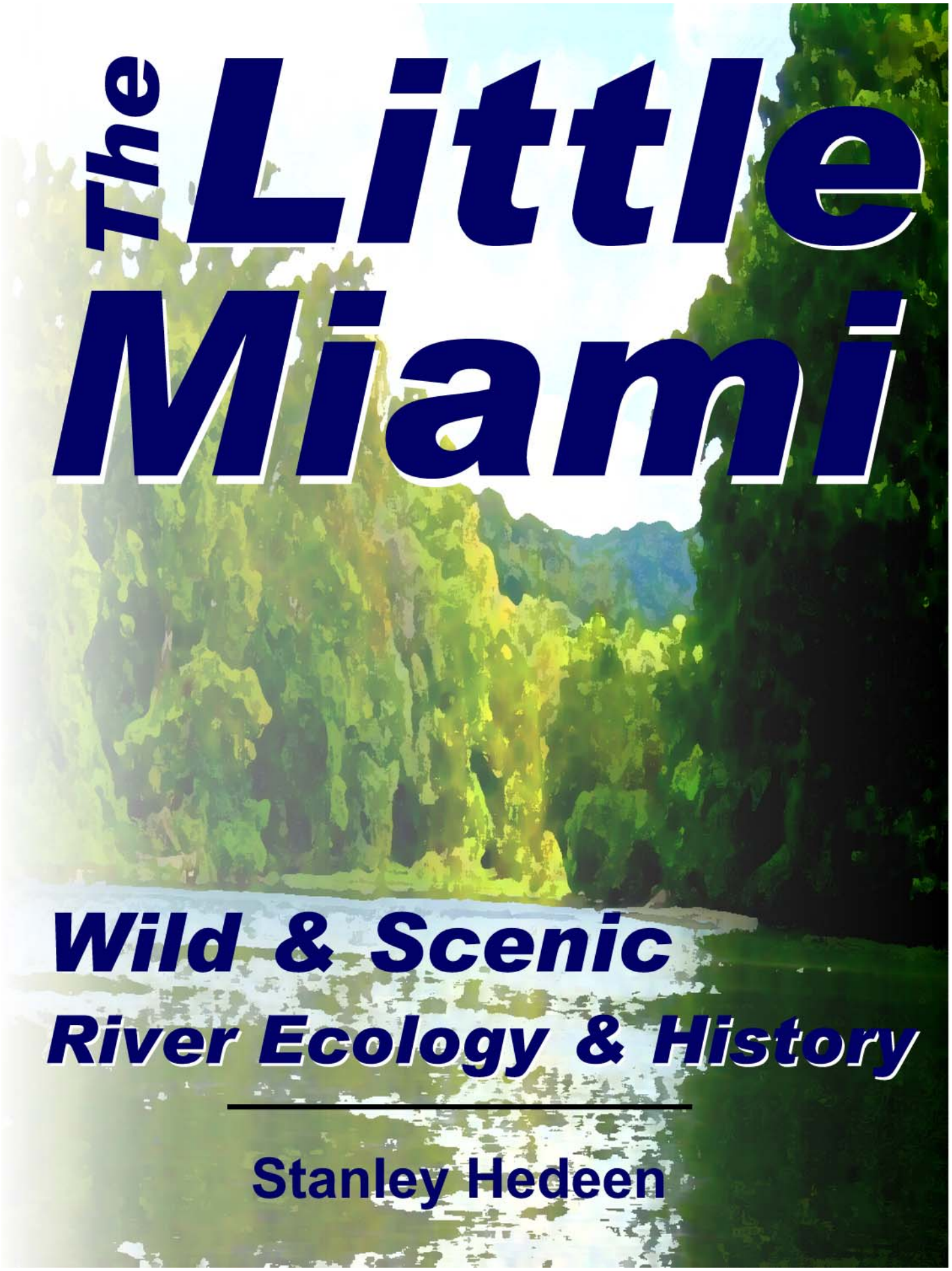

The Little Miami

Wild & Scenic
River Ecology & History

Stanley Hedeen

LITTLE MIAMI RIVER ECOLOGY AND HISTORY

CONTENTS

INTRODUCTION

> But here the valley loveliest
> Of all within the blooming West,
> In morning light before me lies,
> A second earthly Paradise;
> And here Ohio's fairest stream,
> Miami glides,—my chosen theme.
>
> —W. H. Venable, 1872, from "June on the Miami"

The Little Miami River flows almost 107 miles from its headwaters in the Dayton-Springfield region to its mouth on the Ohio River at Cincinnati (Figure 1, below). The Little Miami is unique in being the nation's only designated scenic river that traverses two metropolitan areas, putting it within a one-hour drive of three million people. Over a half-million visits are made to the river each year to boat, wade, swim, fish, hunt, bird watch, horse ride, ski, bicycle, roller blade, jog, or hike along the waterway. Little Miami State Park, containing most of the length of the recreational Little Miami Scenic Trail, parallels the river for fifty miles.

The channel of the river contains nearly ninety continuous miles that are identified as Exceptional Warmwater Habitat, the longest stream segment in Ohio to carry this special distinction. An unusually high diversity of organisms comprises the biotic community of the Little Miami River System. Since 1990, eleven state endangered species, eight state threatened species, and thirteen species of concern have been recorded from the main stem and its tributaries (Table 1, below). State endangered species are those faced with extinction in Ohio, threatened species are those at risk of becoming endangered in the foreseeable future, and species of concern are animals that will become threatened if their statewide populations continue to decline.

In recognition of the Little Miami's outstanding natural features and historic importance, the stream was chosen in 1969 as Ohio's first designated State Wild and Scenic River. The Little Miami gained wider recognition in 1973 when it was named as a stream in the National Wild and Scenic River System. The federal act governing the system declares it to be "the policy of the United States that certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations." Only one quarter of one percent of the rivers in the United States have been recognized as national wild and scenic watercourses. The Little Miami's unique location in a highly populated region makes it an exceptional river among the nation's 165 designated waterways.

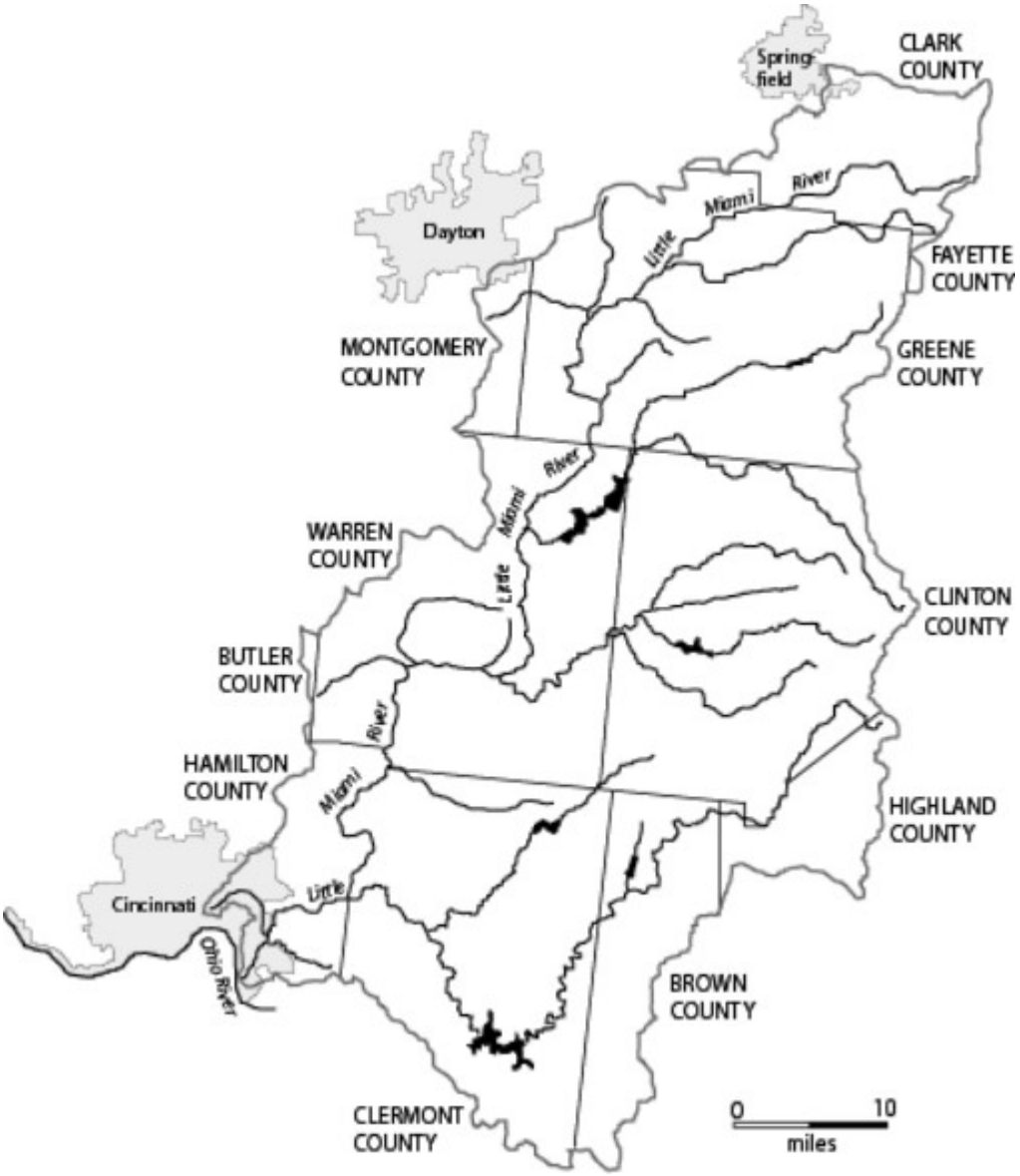

Figure 1. Little Miami River watershed.

Table 1. Ohio “species at risk” residing in and along the Little Miami River System.

Status	Vertebrates	Invertebrates
Endangered	Blue sucker	Clubshell mussel (also federally endangered)
	Mountain madtom	Elephant-ear mussel
	Northern madtom	Little spectaclecase mussel
		Mucket mussel
		Rayed bean mussel
		Snuffbox mussel
		Wartyback mussel
		Washboard mussel
Threatened	American eel	Black sandshell mussel
	Bigeye shiner	Cobblestone tiger beetle
	Spotted turtle	Fawnsfoot mussel
	Tonguetied minnow	Threehorn wartyback mussel
Special Concern	Blanchard's cricket frog	Creek heelsplitter mussel
	Least darter	Deertoe mussel
	Prothonotary warbler	Elktoe mussel
	Queen snake	Flat floater mussel
	River redhorse	Kidneyshell mussel
		Round pigtoe mussel
		Salamander mussel
		Wavy-rayed lampmussel

The following text is a guide to the ecological and historical features of the Little Miami. The physical setting of the river is introduced in Chapter One and the peopling of the Little Miami watershed is covered in Chapters Two and Three. Chapter Four reviews the watermills that once operated on the river and its tributaries, and Chapter Five recounts the help and hindrance of the watercourse to the transportation of humans and goods. Chapter Six examines the stream’s organisms ranging in size from microbes to beavers, while Chapter Seven describes how water pollution is threatening the riverine community and presents methods to control the contamination. Finally, the Appendix lists organizations that the reader may join to assist in the preservation and protection of the Little Miami.

1. WATER, STONE, AND ICE

From shimmering Miami seen
Through openings in the leafy green,
Perpetual babblings hither come,
Scarce audible, elusive tones
Of water plashing evermore
Upon the slanting sandy shore,
Or purling over pebble stones.

—W. H. Venable, 1872, from "June on the Miami"

The water issuing from the mouth of the Little Miami drains from the river's 1,757-square-mile watershed (Figure 2, below). The initial source of the water is atmospheric moisture that falls to the ground, averaging about forty inches annually. Some of the precipitation evaporates from the surface, some runs into the watershed's streams, and some infiltrates the ground. A portion of the water entering the ground is taken up by rooted plants and used in photosynthesis or transpired into the air. Subsurface water may also leave the ground via a spring or seep.

Springs and Seeps

Many of the springs in the watershed are of historic importance. For example, at Newtown in the lower Little Miami Valley, a legendary spring flows at an impressive rate of 600-650 gallons per minute. The springwater was used by the village's founding families in the late 1700s and by a brewery in the 1800s. The spring has supplied ponds of a fish hatchery since 1915.

In the upper portion of the Little Miami watershed, the communities of Spring Valley and Yellow Springs owe their names to springs whose waters were bottled for sale in the nineteenth century. Minerals precipitating from the Yellow Spring have formed an impressive travertine mound 75 feet in height and 500 feet in basal diameter. The 68- to 80-gallon-per-minute flow of the spring was once detained in a large pool on the top of the mound, allowing visitors to bathe in the "healing" water. Yellow Springs Creek carries the springwater through a beautiful, mile-long ravine to the Little Miami River. The spring and creek are located in Glen Helen, a nature preserve open to the public.

At Indian Mound Reserve, a Greene County Park along U.S. Route 42 one mile west of Cedarville, Massie Creek runs through a rock-walled gorge as the stream flows toward the Little Miami. The Big Spring emerging from the north cliff face of the gorge was walled-in during the nineteenth century to create a pool of water. The impounded springwater was carried by a 200-foot-long pipe under Massie Creek to a cattle trough on the south side of the waterway. Springwater was provided to streamside livestock because Massie Creek was contaminated by effluent from a Cedarville paper factory.

Figure 2. Localities referenced in Chapter 1.

The now-vanished Tawawa Springs were located along the south slope of the Massie Creek Valley, three miles downstream from Big Spring. Tawawa Springs consisted of five springs used for bathing by Shawnee Indians in the eighteenth century. The Shawnee called the largest spring "The Bath of Gold" because its water ran down gold-colored rocks. The Indians called another spring "Tears of Silver," reportedly because of its proximity to a Shawnee silver mine. The mine has never been located and probably did not exist, since veins of silver ore do not occur in the bedrock of the Little Miami watershed.

Tawawa Springs was renamed Xenia Springs in 1851 when the site became a health resort with cottages, hotel, pool, fountain, and decorative water wheel. Five years later, the

Cincinnati Conference of the Methodist Episcopal Church purchased Xenia Springs Resort and established Wilberforce University on the property. The springs ceased flowing when their groundwater supply was intercepted by wells, a fate suffered by many springs and seeps in the Little Miami watershed. The campus of Central State University, a public institution carved out of Wilberforce University in 1947, presently borders the former site of Tawawa Springs.

The watershed's greatest density of springs and seeps is located along the Little Miami's Beaver Creek tributary. Numerous groundwater discharges produce wetlands that total over a hundred acres in size. The wetlands include sedge fens and cattail marshes. There are also swamp forests that stand in water throughout the year and wet woods with only occasional puddles. Some seasonally wet habitats are covered with grasses and are known as wet meadows or wet prairies. Agricultural drainage disturbed most of the wetlands in the Beaver Creek Valley, but several are now restored and open to the public. Just east of Beaver Valley Road, for example, there are Philips Park and Beaver Creek Wetland Nature Preserve on Dayton Xenia Road, Siebenthaler Fen on Fairgrounds Road, and Beaver Creek Wetlands Wildlife Area and Fairborn Marsh on New Germany Trebein Road.

Stream Flows and Floods

Groundwater emerging from a spring or seep joins with storm runoff to form a stream. Water in a stream moves downslope at a variety of speeds. The current slows when the streamwater flows into a deep, wide area known as a pool, and quickens when the water enters a riffle or a run. A riffle is a shallow area in which rocks break the water surface, while a run is a chute of fast water where rocks do not reach the surface.

There are thousands of streams in the Little Miami watershed, most of them too small to have been named. Together, the watercourses form the Little Miami River System, a stream network containing approximately 1,200 permanent stream miles and some larger amount of intermittent stream miles. The water in the system is released through the Little Miami's mouth at an average flow of 574,500 gallons per minute. Discharges are smaller during dry periods and may be over fifty times greater during flood events.

Floods result when large amounts of precipitation fall in short periods of time. Because storms occur often in the watershed, a swollen Little Miami is usually afforded little news coverage. Canoe liveries on the river regularly turn away people who have not read or heard that the waterway is in flood. Particularly large inundations, however, are announced in the news when they cause significant property destruction.

The public was notified by the press in 1850 when Caesar Creek floodwaters swept away the Waynesville & Wilmington Turnpike's covered bridge over the stream. An 1881 flood became newsworthy when it destroyed a wagon bridge over the Little Miami at Fort Ancient. Twenty-eight people died on May 12, 1886, when a flash flood on Shawnee Creek in Xenia washed away homes, businesses, railroad bridges, and up to five miles of track. Curiosity seekers from throughout southwestern Ohio filled Xenia's hotels and boarding

houses to capacity in the days following the disaster. Extra police were hired, but thieves still managed to steal items from flood-damaged buildings.

An enormous flood occurred on the Little Miami in 1913. On March 25, following five days of rain, the stream rose into the lower portions of many riverside communities. In Loveland, residents fled to the upper stories and roofs of their houses to await rescue. No lives were lost in the village, but homes were destroyed and downtown businesses were badly damaged. A train crossing the Loveland railroad bridge over the Little Miami was derailed by debris flowing across the tracks, forcing the passengers to climb onto the roof of the coaches to sit out the duration of the flood. Several loaded coal cars were backed onto the bridge to stabilize the span that was being pummeled by floating buildings, trees, and other objects. The railroad bridge withstood the flood, but the adjacent Loveland Avenue wagon bridge was swept away.

Downstream in Milford, it was the town's wagon bridge that survived the flood while the Cincinnati & Columbus Traction Company trestle was washed downstream. The twenty-mile-per-hour current also carried away several Milford homes and businesses. A commercial building at 5 Water Street was secured by a large rope tied around the structure and a nearby sycamore tree. Most Water Street properties, including St. Andrew Church, suffered damage from the swirling floodwaters. No human fatalities occurred, but caged chickens lost their lives.

Finally, the 1913 Flood destroyed a celebrated suspension bridge located near the present Beechmont Avenue crossing at Cincinnati. The 353-foot-long span had withstood many Little Miami floods since its completion in 1876, but it was unable to survive the 1913 maelstrom. A man's life was spared when his horse refused to pull his buggy across the rushing river that had risen to immediately below the floor of the bridge—the span collapsed just as the driver turned his rig back toward home. The 1913 Flood showed that the Little Miami is capable of inundating its floodplain to a depth of several feet.

Bedrock of the Region

While the floodplain lands of the Little Miami and its tributaries may be underwater for a few days following a large storm, the entire surface of the watershed was submerged for virtually the whole period between 550 and 400 million years ago. Southwestern Ohio was at the bottom of a sea for most of that time and became covered by ocean floor sediments. The deposited materials eventually turned into the shale, limestone, and dolomite layers that now form the bedrock strata of the watershed. Fossils of corals, clams, and other marine animals may be seen in the sedimentary layers exposed on the sides of stream channels cut into the bedrock. Fossils eroded out of their stone matrix are found in the rock debris on the bottoms of the waterways.

Clifton Gorge is the best site along the Little Miami to view layers of bedrock (Figure 3, below). From the Clifton Gorge State Nature Preserve parking lot on Ohio Route 43 just west of Clifton, follow the signs to the J. L. Rich (North Gorge) Trail. The trail begins with a staircase descent along a cliff face of Cedarville dolomite (dolomite is a magnesium-rich

limestone). The path then parallels the Little Miami as the river continues its drop into the gorge. The Springfield and Euphemia dolomites soon come into view along cliff face. The two-mile-long riverside trail descends through additional bedrock layers as it makes its way to the John Bryan State Park Lower Picnic Area, which is located on top of a large terrace of Brassfield limestone.

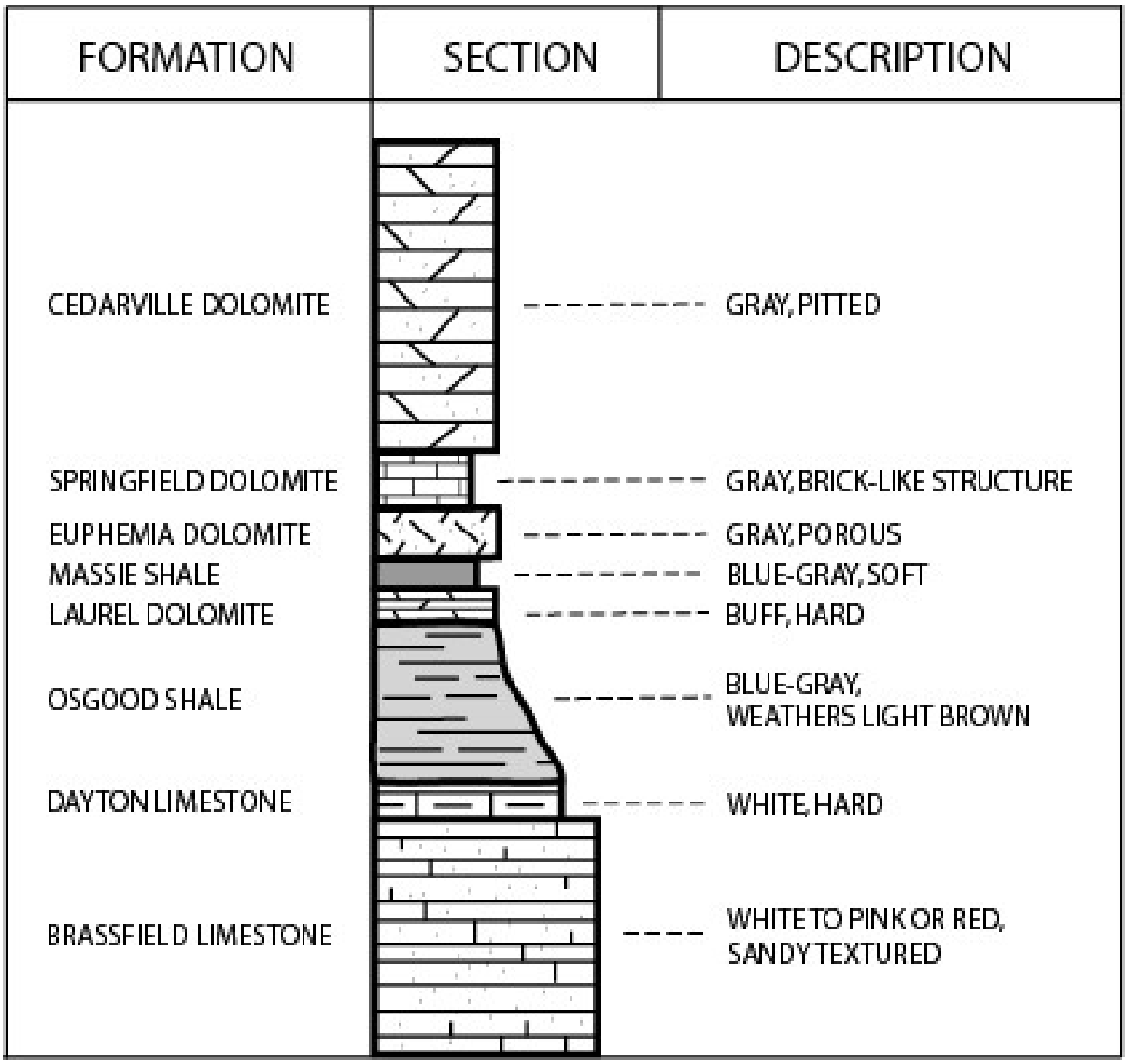

Figure 3. Profile of lower Clifton Gorge. (Adapted from Ohio Academy of Science, Section of Geology. 1960. *Guide to the Thirty-fifth Annual Field Conference*)

Dayton limestone, one of the bedrock layers exposed in Clifton Gorge, was the representative building stone that Ohio contributed to the construction of the Washington

Monument in 1850. The limestone block was polished and placed at the seventh landing of the stairwell inside the obelisk. The quarry from which the limestone block was cut is now filled with water and serves as a pond on the McDonald Farm. A historical marker identifies the quarry site along Stone Road one mile east of U.S. Route 68 south of Xenia. Dayton limestone, Euphemia dolomite, and Springfield dolomite were commonly used for building stones in the Dayton vicinity during the 1800s. Building stones in the Cincinnati region were quarried from the deeper bedrock layers that are exposed in the lower Little Miami Valley.

Continental Glaciers

Besides seawater, ice has also totally covered the Little Miami region during intervals of the prehistoric period. The most recent ice sheet to envelop the entire watershed was the Illinoian glacier of a quarter million years ago. Like all North American continental glaciers, the Illinoian glacier formed during a time of global cooling. An enormous amount of snow built up in northern Canada as more snow fell in winter than melted in summer. The accumulating weight compressed the snow into glacial ice, which then slowly spread out at the margin of the ice sheet. The Illinoian glacier extended as far south as Kentucky before global temperatures warmed and the ice sheet melted back.

During its advance, the Illinoian glacier pushed the Ohio River south out of the portion of its ancestral channel that looped from Columbia past Mariemont to Lawrenceburg, Indiana. The Columbia-to-Mariemont portion of the Ohio River's original valley is now traversed by the Little Miami River flowing in the opposite direction. The channel of the Little Miami within the abandoned pathway of the Ohio River is best observed from the overlook in Cincinnati's Ault Park.

Each continental glacier scraped soil and rock fragments from the land across which it advanced. This material, called till, was then carried south by the ice sheet. Illinoian glacial till is found throughout the watershed and includes rocks from Canada as well as from northern and central Ohio. Canadian stones in the till infrequently include tiny amounts of gold, silver, and platinum, as well as various ores of iron, copper, and lead. At some locations in the region, calcium carbonate (lime) in the Illinoian till has cemented smaller stones to one another, creating conglomerate rock. Fox Rock, situated in the Cincinnati Nature Center's Rowe Woods near Perintown, is an excellent example of a conglomerate feature.

Illinoian till in the upper half of the Little Miami watershed is buried beneath till deposited later by the Wisconsinan glacier (a continental glacier is named after the state in which geologists found the first evidence of the ice sheet's past existence). The Wisconsinan glacier pushed into the region about 70,000 years ago and reached its maximum extent approximately 19,500 years ago. Large volumes of meltwater that rushed from the ice sheet cut several narrow valleys into the landscape.

The Little Miami River, a stream that formed following the retreat of the Wisconsinan glacier, flows through many of the Wisconsinan meltwater valleys, e.g. Clifton Gorge downstream of Clifton, the Narrows at Greene County Park District's Narrows Reserve on Indian Ripple Road five miles west of Xenia, Fort Ancient Valley beneath the Interstate-71

Jeremiah Morrow Bridge near Fort Ancient, and Deerfield Gorge under the High Bridge on U.S. Route 22 at Foster. The Little Miami Scenic Trail along the river passes through the lengths of Fort Ancient Valley and Deerfield Gorge. Little Miami tributaries also traverse Wisconsinan meltwater valleys, e.g. Yellow Springs Creek Valley in Glen Helen, Massie Creek Gorge in Indian Mound Reserve below Cedarville, Caesar Creek Gorge in Caesar Creek Gorge State Nature Preserve three miles north of Oregonia, and Halls Creek Valley in Halls Creek Woods State Nature Preserve three miles east of South Lebanon.

Rock sediment carried by the Wisconsinan glacier was washed from the ice by the meltwater torrents. The outwashed materials formed level fills across the bottoms of preexisting stream valleys. Following the retreat of the Wisconsinan ice sheet, the young Little Miami cut its channel through some of the valley fills, leaving terraces of outwash materials along its riverbanks. These terraces have provided town sites for riverside communities such as Terrace Park, while gravel and sand deposits in the terraces have been mined for use in building and road construction. Several of the mining pits have been converted to recreational use, e.g. Lake Isabella downstream from Branch Hill.

The retreat of the Wisconsinan glacier was soon followed by the arrival of the earliest people in the Little Miami region. Accordingly, the next chapter will begin a chronological account of the human presence in the watershed.

2. FIRST ON THE SCENE

The farm boy, as careless he follows the harrow
O'er lowlands which quicken and ripen the maize,
Reads oft in some token of stone,—axe or arrow,
The wars and the loves of unchronicled days.

Then steals on the air with thy murmuring numbers
A moan of lament for a race and its lore,—
A sigh for yon chieftain forgotten, who slumbers
Beneath the lone mound on thy emerald shore.

—W. H. Venable, 1904, from "To the Little Miami River"

Humans have resided along the banks of the Little Miami since the end of the Ice Age. In addition to obtaining food items from the river and its tributaries, people have secured drinking water, pottery clay, freshwater pearls, ice blocks, waterpower, and rocks and stones from the streams. This chapter will chronicle the early record of humans in the watershed and their use of stream resources.

Prehistoric Indians

The first humans to see the Little Miami were the **Paleoindians** who arrived in southwestern Ohio sometime before 10,000 BC. They descended from people who had walked or boated from Eurasia to North America and then had continued moving toward the middle of the continent. Paleoindians hunted animals and gathered plants in the coniferous woodland that enveloped the postglacial Little Miami area—remnants of that boreal forest still grow in the cool shadows of Massie Creek Gorge and Clifton Gorge. The Paleoindian diet likely included waterfowl and other riverine species in addition to woodland animals. Paleoindian weapons fashioned from streambed stones have been found throughout the watershed.

As the local climate warmed between 8000 and 6000 BC, deciduous forest began to displace the coniferous woodland. Deciduous trees were spreading north due to the lengthening growing season that allowed them to make enough food during the summer months to last through winter, when deciduous trees are leafless. The invading deciduous species eventually replaced the boreal conifers because the wide leaves of the deciduous trees were more efficient in capturing sunlight than the needle-shaped leaves of the coniferous species. Along with the change in forest type, the Paleoindian Culture developed into the **Archaic Culture** by 6000 BC.

Figure 4. Localities referenced in Chapter 2.

Like the Paleoindians, the Archaic people continued to live in small bands of hunter-gatherers moving from place to place. Turkey, raccoon, deer, and other deciduous forest animals were eaten, as were seeds, nuts, berries, and roots. Trees were felled with stone axes and dugout canoes were made by employing stone adzes to hollow out tree trunks. Turtles and waterfowl were hunted along streams and fish were caught on hooks made of bone. Freshwater mussels were consumed and their shells were fashioned into ornamental pendants, as were seashells obtained through long distance trade.

From 1500 to 500 BC, the foraging Archaic Culture slowly transformed into the foraging and gardening **Woodland Culture**. During the transition period, the hunter-

gatherers started to cultivate a few native seed plants as well as imported squash and gourds. Pottery appeared during this time, molded from clay collected along the banks of streams. Earthen mounds began to be built to serve as aboveground burial chambers.

The Woodland Culture, which was fully established by 500 BC, encompassed three periods: Early (or Adena), Middle (or Hopewell), and Late (or Newtown). Archaeologists named the Adena Tradition after the Adena Estate, the Ross County home of former Ohio governor Thomas Worthington. A mound excavated on that property in 1901 contained burial goods that have since been used to identify other Adena sites, such as the publicly accessible Orators Mound at Glen Helen in Yellow Springs. This subconical structure, located about a mile from the Little Miami, is approximately 5 feet high and 45 feet in diameter at its base. Projectile points, ornaments, and other burial objects have been recovered from the mound, along with the bones of between four and six Adena people. Orators Mound was given its name when Yellow Springs residents erected a speakers platform on the earthen structure.

Williamson Mound is a second Adena mound in the Little Miami watershed. The conical structure stands on a ridge above Massie Creek in Indian Mound Reserve, a Greene County Park located along U.S. Route 42 one mile west of Cedarville. With a 28-foot height and a 150-foot diameter, Williamson Mound is one of the largest remaining Adena mounds in the nation. Amateur archaeologists removed pottery, projectile points, and stone axes from the structure prior to 1929, the year when David Williamson donated the site to the State of Ohio.

On the basis of their sizes and shapes, three publicly accessible, unexcavated mounds in the southern portion of the watershed may have been constructed by the Adena. The Elk Lick Road Mound, located at the Indian Mound Picnic Area in East Fork State Park near Williamsburg, is about 5 feet high and 50 feet in diameter. The Flagg Spring (Odd Fellows) Cemetery Mound, located in a Newtown cemetery near the Little Miami, stands about 12 feet high and has an elliptical base 90 by 110 feet in diameter. The Norwood Mound overlooks the valley of Duck Creek, a Hamilton County tributary of the Little Miami River. Standing beside Norwood's Water Tower Park, the 13.5-foot-high structure has an elliptical base 100 by 130 feet in diameter.

Adena people lived in small groups moving among seasonally occupied sites, with local groups banding together to erect the large burial mounds. They likely used stone axes and fire to maintain forest clearings in which they cultivated squash and native plants with edible seeds. The Adena also foraged for the wild plant and animal species that had sustained the Archaic people. Adena artisans produced detailed jewelry, smoking pipes, and engraved stone and clay tablets.

The period of the Adena Tradition (500 BC to AD 100) overlapped with that of the Hopewell Tradition (200 BC to AD 500). Among the first objects identified with the Hopewell society were burial goods excavated in 1891-92 from mounds on the Ross County farm of Mordecai Hopewell. The mounds stood within a somewhat rectangular, earthen-walled enclosure of 111 acres. Similar Hopewell-age, geometric earthworks were located in

the Little Miami watershed before plowing and gravel mining destroyed their features. Stubbs Earthworks, for example, was a fused rectangular and semicircular enclosure surrounding over fifty acres adjacent to the Little Miami two miles west of Morrow. The only visible remnant of Stubbs Earthworks is a half-acre mound encircled by a loop drive running from Morrow-Cozaddale Road to the Little Miami High School entrance.

Hopewell hilltop earthworks, called forts, are also represented in the watershed. The well-preserved Fort Ancient is perched on a promontory 275 feet above the Little Miami in Warren County. The fort's 4- to 23-foot-high earth and stone embankment surrounds 125 acres of a plateau on which many mounds were located. The embankment is broken by sixty-seven gateways.

A second Hopewell fort, the Pollock Works, is located on Massie Creek in Indian Mound Reserve, the Greene County Park that also holds the Adena-age Williamson Mound. Pollock Works consists of a 12-acre plateau bordered by steep drop-offs on the north, east, and south. A gentle ascent to the plateau from the west is blocked by a 3- to 10-foot-high, 300-foot-long earth and stone embankment interrupted by three gateways. A second embankment and three small mounds built downslope of the first embankment were destroyed by historical quarrying activity.

Finally, a 0.8-mile embankment extends along the rim of a Little Miami River bluff in Hamilton County. The linear structure, which parallels the south curb of Miami Bluff Drive in Mariemont, is most evident near its western end where it attains a height of about 4 feet. The unexcavated embankment is possibly a Hopewell construction.

The Hopewell earthworks may have served as water reservoirs, territorial markers, defensive bulwarks, or ceremonial places. The structures may have been sites for public meetings, funerals, and/or astronomical rituals. When Hopewell people weren't engaged in events at an earthwork, they lived in small hamlets in the surrounding countryside. The Hopewell continued the tradition of gathering wild plants and hunting animals, including river snails, crayfish, mussels, fish, frogs, turtles, waterfowl, and beavers. Like the Adena, the Hopewell maintained cleared areas for cultivating crops and carved elaborate pipes for smoking leaves, stems, and flowers. They created ornaments from imported metals and seashells, as well as from the shells and pearls of mussels taken from the Little Miami and its larger tributaries.

There are many tentative explanations for the demise of the Hopewell, including epidemic illness, warfare, drought, and the general acceptance of territorial claims that previously may have necessitated the construction of the earthworks that defined the Hopewell society. With the disappearance of the society in about AD 500, the practice of building large earthworks at a regionally central location was abandoned. If a function of the earthworks had been to serve as venues for ceremonies and meetings, then these activities must have moved to local settlements.

The Woodland Culture's Newtown Tradition (AD 500 to AD 1000) first became known from archaeological excavations along the Little Miami near Newtown. The

Newtown people hunted animals, gathered plants, and cultivated crops, including corn (maize) imported from the Southwest. They added the bow and arrow to the traditional arsenal of spear point weaponry. Their burial mounds often consisted of, or were capped with, limestone slabs from streams. Many of the elements of the Newtown society seemed to have been adopted from southern and western Native American groups.

The last prehistoric society in the watershed was the **Fort Ancient Culture** (AD 1000 to AD 1650), named after the Fort Ancient earthworks on the Little Miami. It was initially assumed that these earthworks had been built by the people whose village sites were found in the vicinity of the hilltop enclosure. It is now believed that the Fort was constructed by Hopewell people and that the nearby villages were built many centuries later by the Fort Ancient people.

Most of the diet of the Fort Ancient people consisted of corn, supplemented by squash, beans, and cultivated and wild native plant species. Wild animals supplied meat as well as many useful articles. Bowls and cups were made from turtle shells, and knives and spoons were fabricated from mussel shells. Chisels were fashioned from beaver incisors. Arrow points were produced from antlers, as were harpoons for fishing. Turkey skulls and turtle shells were filled with stream pebbles to produce rattles. Pearls from mussels were drilled and suspended on necklaces and bracelets.

Plants were cultivated with spades carved from elk antlers and rakes formed from deer antlers. Hoes were made by attaching sticks to shells of mussels and to shoulder blades of elk and deer. These farming tools were only useable in loose soil, and so Fort Ancient cropfields, like the gardens of the preceding cultures, were primarily located on the floodplains of the Little Miami and its larger tributaries.

Fort Ancient people constructed burial mounds near their villages until about AD 1300. After mound building was discontinued, all burials were in cemeteries such as the one at the Madisonville Village site located at the west end of Mariemont's Little Miami bluff. A historical plaque marks the site from which archaeologists continue to extract artifacts, including early-seventeenth-century European trade goods.

Madisonville Village and other Fort Ancient settlements were abandoned in about AD 1650, after which the sites and adjoining croplands returned to forest. The demise of the Fort Ancient Culture may have been the result of epidemic diseases inadvertently brought to North America by European colonists. Native Americans lacked immunity to smallpox, scarlet fever, measles, and other deadly illnesses that swept inland from European colonies on the Atlantic and Gulf coasts.

Another hypothesis attributes the Fort Ancient decline to the "Little Ice Age," a period of global cooling that may have negatively impacted the regional corn crop. Evidence of this cold span during the 1600s includes the skeletal remains of fisher and American martin in the refuse pits of late Fort Ancient settlements. Both species today live only in colder parts of the continent.

A third suggestion is that the Fort Ancient people were pushed out of the region by invaders from the Iroquois Confederacy armed with European guns. The Iroquois and their allies may have been drawn to the Little Miami and surrounding watersheds by the region's large beaver populations. Beaver pelts harvested from the area could be exchanged for more guns and other imported goods.

Landlords: Miami, British, and French

Following the disappearance of the Fort Ancient people, the next village in the watershed was probably established by the Miami Indians at the end of the seventeenth century or the beginning of the eighteenth century. The Miami were then moving south from the Great Lakes region into Indiana and western Ohio, perhaps to improve their hunting for pelts and/or to find better growing conditions for their crops. Although it is uncertain when the Miami first settled in the Little Miami Valley, it is known that a Miami village was located in the watershed by 1733. French traders called the settlement *le Baril* (The Barrel) after the shape of the chief who resided there.

A 1749 French military expedition led by Monsieur de Celeron found *le Baril* to consist of seven or eight cabins. The village was a few miles inland from the mouth of *Riviere la Blanche* (Clear River), the French name for the watercourse that British traders called the Little Miami (Figure 5, below). The English title for the river retained a French connection, for "Miami" is believed to be the French rendering of the tribe's name for itself. Other historical sources state that the Indians actually called themselves "Twightwee," their imitation of the call of the sandhill crane. This alternative name of the tribe is kept alive by the Hamilton County community of Twightwee, an unincorporated area located southwest of Loveland on the west bank of the Little Miami.

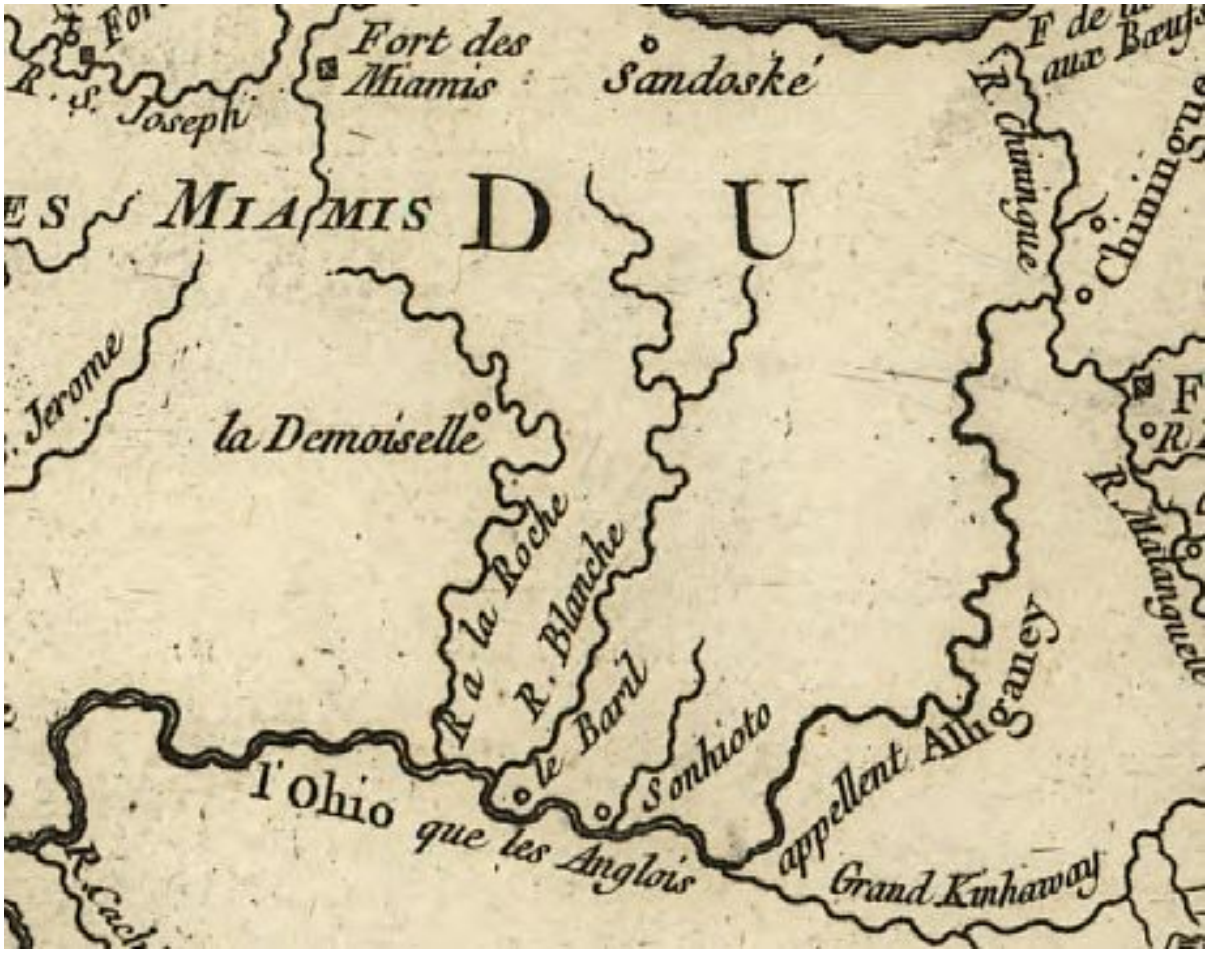

Figure 5. Detail from Jacques Nicolas Bellin's 1755 map *Partie occidentale de la Nouvelle France ou Canada*. The Miami Indian village of Le Baril is located near Riviere la Blanche, the mid-eighteenth-century French name for the Little Miami. (Library of Congress, Geography and Map Division)

The Miami Indian nation was not alone in claiming dominion over the Little Miami region beginning in the seventeenth century. When King James I of England rechartered the Virginia colony in 1609, he extended the north and south boundaries of its frontage on the Atlantic Ocean west across the continent to the Pacific. Based on the charter, the British in Virginia claimed possession of much of North America, including the Ohio Valley. The British claim was dismissed by France, a nation that asserted ownership of the entire Ohio Valley on the basis of LaSalle's seventeenth-century discovery of the Ohio River and some of its tributaries. To reinforce its claim, France sent the above-mentioned Celeron expedition from Montreal to the Ohio Valley.

In 1749, the year that Celeron was in the Ohio Valley, a London merchant and several Virginia speculators established a trading and land development group known as the Ohio Company. The company engaged land surveyor and fur trader Christopher Gist to follow the

trail of Celeron and ascertain if the Indians in Ohio had more allegiance to France or to England. Gist was also instructed to observe "the Ways & Passes thro all the Mountains you cross, & take an exact Account of the Soil, Quality, & Product of the Land, and the Wideness and Deepness of the Rivers."

Gist kept a detailed account of his 1750-51 travels through Ohio. He wrote the following in his journal entry for Sunday, March 3, 1751:

> [I] went to the South Westward down the little Miamee River or Creek, where I had fine traveling thro rich Land and beautiful Meadows, in which I coud sometimes see forty or fifty Buffaloes feeding at once—The little Miamee River or Creek continued to run thro the Middle of a fine Meadow, about a Mile wide very clear like an old Field, and not a Bush on it, I coud see the Buffaloes in it above two Miles off: I traveled this Day about 30 M.

The upper Little Miami Valley through which Gist rode probably had been cleared of trees and repeatedly burned by Indians to provide grassland for the American bison, a valued source of meat. The meadowland also could have been a natural stand of prairie in an otherwise wooded landscape. The trees comprising the upper valley's woodland are noted in Gist's journal entry of Monday, March 4:

> This Day I heard several Guns, but was afraid to examine who fired Them, lest they might be some of the French Indians, so I traveled thro the Woods about 30 M; just at Night I killed a fine barren Cow-Buffaloe and took out her Tongue, and a little of the best of her Meat: The Land still level rich and well timbered with Oak, Walnut, Ash, Locust, and Sugar Trees.

Gist's entry of Tuesday, March 5, records that he had traveled about another thirty miles. Gist rode east out of the Little Miami watershed on either March 5 or March 6, when he "traveled about 30 M, and killed a fat Bear." Gist's reconnaissance determined that most of Ohio's Indian tribes favored the English over the French, probably because British traders were more generous in their bargaining than French traders.

The disagreement between England and France over the ownership of the Ohio Valley was one of the causes of the Seven Years' War, a worldwide conflict that began in 1756 and included battles in Europe, Africa, Asia, and North America. The Royal Governor of Virginia, in order to secure men to fight against France in the American theater of the war, promised land grants in the Ohio Valley to Virginia soldiers, an incentive that Virginia would again offer during the Revolutionary War against Britain. At the end of the Seven Years' War, in 1763, a victorious England took possession of all land east of the Mississippi River, with the exception of New Orleans and a small outlying area.

Shawnee Indians

Around the time of the Seven Years' War, the Miami Indian nation allowed its Shawnee Indian allies to move into the Little Miami Valley. The Shawnee were being pushed

out of Kentucky and eastern Ohio by the encroachment of British colonists from east of the Alleghenies. One Shawnee settlement was established in the vicinity north of the present site of Williamsburg in Clermont County. This Indian village functioned until 1793, when its residents moved north out of the watershed after losing a battle against United States Army troops.

Another Shawnee settlement was established on the Little Miami (the Indian's Che,ke,me,a,mee,sepe) just below the mouth of Massie Creek, at the location of present-day Oldtown. The village was named Chillicothe after the Shawnee clan that founded the settlement. The village was the fifth in what would eventually become a list of seven Shawnee settlements in Ohio with the name Chillicothe, beginning with the first one on the Ohio River at the site of present-day Portsmouth and ending with the last one on the Maumee River near today's Defiance. The locations and founding dates of the Chillicothes reflect the south to north movement of the Shawnee in Ohio. The Chillicothe on the Little Miami is known in historical writings as Old Chillicothe (Figure 6, below), the name it took on in 1781 after the founding of a newer Chillicothe thirty-five miles to the north on the Great Miami.

Figure 6. Detail from John Filson's 1784 *This Map of Kentucke, etc.*, showing the site of Shawnee Indian village Old Chillicothe at the mouth of Massie Creek on the Little Miami. Pecaway Town, a Shawnee village in the Great Miami watershed, is incorrectly included in the Little Miami Valley. (Library of Congress, Geography and Map Division)

Tecumseh, the most famous of the Shawnee chiefs, reportedly was born just outside of Old Chillicothe in 1768. A historical plaque at Old Town Reserve County Park marks the supposed site of the birth. Whether or not Tecumseh was born at the location, he did spend much of his childhood in Old Chillicothe. Blackfish, the war captain of the Chillicothe clan, adopted Tecumseh after the boy's father was killed in a battle against the Virginia militia. Under the guidance of Blackfish, Tecumseh likely joined other boys as they made daily plunges into the winter waters of the Little Miami, following a Shawnee custom for developing endurance, hardiness, and self-control in its young men.

In 1773, Captain Thomas Bullitt and a small group of other Virginia surveyors appeared at Old Chillicothe. Bullitt was the leader of a large survey party sent out by Virginia to inspect its western lands. As the survey team made its way down the Ohio River, Bullitt and a few other men detoured up the Little Miami to find Old Chillicothe and assure

the Shawnee that surveys would only be conducted south of the Ohio. The Indians granted Bullitt the right to work in Kentucky, but also emphasized the right of the Shawnee to continue hunting in their former homeland. Bullitt returned to the Ohio and proceeded downriver with his party to the area of present-day Louisville. Probably the real reason for Bullitt's 120-mile detour to Old Chillicothe was not to gain the blessing of the Shawnee, but was to look over the lands of the Little Miami Valley. Virginia still claimed title to the entire area from the Ohio River north to Canada, based on the King James I grant.

The Revolutionary War started in 1775 as Virginia and England's other twelve American colonies began their attempt to overthrow British rule. In 1777, the beloved Shawnee chief Cornstalk was slain while on a mission of peace to Fort Randolph, an American stockade built on the site of a former British fort in West Virginia. The murder enraged the Shawnee, who then revenged the chief's death by killing and capturing parties of settlers moving into the Indians' Kentucky hunting territory. Among the captives was a black slave named Caesar, a man who the Shawnee adopted and provided with a hunting ground on the stream that became known as Caesar Creek (this being one of many explanations of the stream's name).

A February 1778 Shawnee raid captured Daniel Boone and twenty-seven other men along Kentucky's Licking River, from where the captives were taken northward across the Ohio River and up the Little Miami to Old Chillicothe. Boone was transferred to Detroit in March, but was returned to Old Chillicothe in April and adopted into a Shawnee family. For the next two months, the captive Boone ingratiated himself into the favor of the Shawnee by hunting with them and participating in their shooting matches. When he was taken east from the village to collect salt, he noted that the soil in the Little Miami and Scioto watersheds was even better than the soil in Kentucky. Boone escaped from Old Chillicothe in June, journeyed 160 miles in four days with one meal, and arrived safely home at Boonesborough, Kentucky.

John Bowman, colonel of militia and lieutenant of Kentucky, decided in the summer of 1778 that the Shawnee menace to Kentucky's settlements should be destroyed at its source, Old Chillicothe. He asked Simon Kenton, Alexander Montgomery, and George Clarke to scout out a plan to attack the Shawnee village. The three men crossed the Ohio River in September and stealthily made their way on foot up the Little Miami Valley. As they spied upon Old Chillicothe, they found a pasture containing several horses, many of which had been stolen from Kentucky settlements. Each man mounted a horse and, with other horses in tow, headed down the Little Miami Valley toward home. A turbulent, swollen Ohio River blocked their progress and allowed a pursuing Shawnee party to overtake them. Montgomery was killed and Kenton was captured, but Clarke escaped and reported back to Colonel Bowman with the desired information.

Kenton, a well-known Indian fighter and now a horse thief, was treated harshly by his captors. He was beaten severely, tied to a horse, and taken back to Old Chillicothe. There he was tied to a stake and tormented until midnight by the village's inhabitants. On the following morning, Kenton was forced to run a gauntlet that nearly killed him. He was next taken to a series of other Shawnee settlements and made to run several more gauntlets.

Finally, he was imprisoned by the British (the Shawnee's allies against the Americans) in Detroit, from where he escaped and returned to Kentucky in June 1779.

Colonel Bowman completed his preparations and moved against Old Chillicothe in the summer of 1779. Bowman's army of around 300 men was guided toward the village by Clarke, who had escaped when Kenton was captured the previous year. The force crossed the Ohio at the mouth of the Licking, forded the Little Miami, and marched north to attack Old Chillicothe. Fierce resistance by the village's residents forced the invaders to retreat, but not before the Kentuckians had captured over a hundred horses and looted and burned between thirty and forty dwellings. The horses and stolen goods, including blankets, kettles, and silver ornaments, were auctioned off in Kentucky for a total of 32,000 English pounds.

The angry Shawnee rebuilt Old Chillicothe, effectively closed the Ohio River to American boat traffic, and stepped up their raids across the waterway. They participated in a multitribal assault into Kentucky led by British officer Henry Bird in May 1780, during which over 300 prisoners were taken from two settlements. The Kentuckians retaliated in August by sending an army of 1,000 men north across the Ohio, led by George Rogers Clark and including Boone and Kenton. The blockhouse built for the army's stores on the north bank of the Ohio was the first non-Indian structure on the site of present-day Cincinnati. The expedition marched northeast from the blockhouse, crossed the Little Miami about a mile below the mouth of Caesar Creek, and advanced on Old Chillicothe. The Shawnee survived by evacuating their village before the force arrived, but the Indians' crops were destroyed and their settlement was burned to the ground. After sacking Old Chillicothe, Clark's men continued north into the Mad River Valley and leveled two more Shawnee villages before returning to Kentucky.

Some of Old Chillicothe's residents again rebuilt the village in 1781, while others moved north to establish another Chillicothe, the sixth Shawnee village by that name, at the site of present-day Piqua. Indians from both villages continued to harass, capture, and murder settlers south of the Ohio River. At Blue Licks, in August 1782, the Shawnee joined with several other tribes and a party of British Canadian Rangers to ambush and kill 71 of 182 Kentucky militiamen led by Boone. Clark avenged the deaths by organizing an army of 1,050 men (including Boone and Kenton) and leading the force in November assaults on Old Chillicothe and other Indian settlements in Ohio. Following this third attack on Old Chillicothe in four years, the Shawnee chose to abandon the village. They moved north of the Little Miami watershed into new villages from which they continued to launch raids on non-Indian settlements.

3. PIONEERS IN THE WATERSHED

In one enchanting view are seen
A whitening rye-field's billowy sheen,
A field of faintly yellow wheat,
A belt of purple clover sweet;
While zigzag fences scarce divide
Broad plats of grass from oat-fields wide,
And myriad plumes of waving corn
The river's fertile margin adorn.

—W. H. Venable, 1872, from "June on the Miami"

The Revolutionary War ended when the Americans and British signed the Treaty of Paris in September 1783. The thirteen former colonies that became the American states were given the British land east of the Mississippi River and south of the Great Lakes and St. Lawrence River. With the conclusion of the Revolutionary War, the American Continental Congress needed to sell some of the land in the new nation to pay for materials used in the conflict. Since all of the property was owned by the states, the congress requested that those states with unoccupied western territories turn over ownership of the areas to the federal government.

Virginia Military District

In October 1783, Virginia ceded to the nation the vast territory northwest of the Ohio River, with several stipulations. One of these was that the Northwest Territory eventually had to be divided into new states (later determined to be Ohio, Indiana, Illinois, Michigan, Wisconsin, and the portion of Minnesota east of the Mississippi River.) Another stipulation was that the Virginia Military District, encompassing the area east of the Little Miami River and west of the Scioto River, be reserved to fulfill land grants promised to Virginia soldiers who served in the Continental Army during the Revolutionary War (Figure 8, below). The size of each land grant within the Virginia Military District depended on the rank of the veteran: a Major General was entitled to 15,000 acres, while a private who had been in the entire war was entitled to 200 acres. Any soldier who had served more than six years was awarded with an additional one-sixth for each year served thereafter, e.g. a Captain who served seven years was granted a land warrant of 4,000 acres plus 666⅔ more acres for serving his seventh year.

Figure 7. Localities referenced in Chapter 3.

Figure 8. Detail from Rufus Putnam's 1805 *Map of the State of Ohio*, showing the area between the Little Miami and Scioto Rivers reserved for Virginia veterans of the Revolutionary War. (Library of Congress, Geography and Map Division)

The federal government agreed to Virginia's stipulations when it accepted the state's gift of land in 1784. Colonel Richard Anderson, for whom the Little Miami tributary Anderson Fork is named, was appointed the Principal Surveyor of the Virginia Military District. When a Virginia veteran was given a land warrant, he or his agent went into the district and laid out his claim on the ground. The warrant holder next employed a Deputy Surveyor to survey the tract and deliver the data to the Principal Surveyor's office at the site

of present-day Louisville, Kentucky. A land patent, or deed, was then issued to the warrant owner.

John O'Bannon conducted the first surveys in the Little Miami watershed portion of the Virginia Military District in 1787. In the same year, his name was given to O'Bannon Creek when someone carved the title "O'B. Cr." into a white oak tree at the mouth of the stream. Other Little Miami watershed streams named for surveyors include Massie Creek (after Nathaniel Massie), Todd Fork (after Robert Todd), Lytle Creek (after William Lytle), and Cowan Creek (after John Cowan). The early surveyors were always subject to Shawnee attacks. Massie's survey party, for example, was discovered by Indians in April 1792 and pursued from the headwaters of Stonelick Creek to near the mouth of the Little Miami. On March 22, 1794, the following news note appeared in Cincinnati's first newspaper, *The Centinel of the Northwestern Territory*:

> On Sunday the 17th inst. Mr. Litle [sic] a surveyor accompanied by a small party, running some lines on the east side of the Little Miami, discovered a large encampment of Indians, they had advanced so far as to hear them fire, but fortunately made their escape without being discovered by the enemy.

Lytle was worried about the presence of Indians because they had recently attacked another one of his survey parties, capturing one man, killing a second, and wounding a third before he escaped on his horse.

Land speculators often purchased military land warrants from Virginia veterans who had no interest in moving west. George Washington, for example, bought warrants totaling 3,100 acres, engaged O'Bannon to act as his agent and surveyor, and secured three parcels of land in the Virginia Military District. The two parcels that were in the Little Miami watershed were located adjacent to the river: a 977-acre property that straddled the present Hamilton-Clermont County line directly south of the confluence of East Fork and the Little Miami, and a 1,235-acre property that today includes Scout Camp Friedlander near Miamiville in Clermont County. Washington was personally entitled to a military land warrant of 23,333⅓ acres for his eight years of service as Commander-in-Chief of the Continental Army, but he refused the warrant just as he had refused his pay during the Revolutionary War.

In the 1790s and early 1800s, the portion of the Little Miami watershed in the Virginia Military District (i.e. the area east and south of the Little Miami) was not settled as quickly as the portion of the watershed outside the district (i.e. the area west and north of the river). There were several reasons for the slowness of the population growth in the Virginia Military District. First, many of the Virginia veterans who owned lands did not settle on them because they could not bring their slaves—the Northwest Ordinance of 1787 outlawed slavery north of the Ohio River. Second, the large parcels into which the district had been divided prevented the region's generally poor emigrants from purchasing the big tracts from the Virginia owners. Third, emigrants who were financially able to buy and develop properties often experienced difficulty in finding the owners. Finally, due to the incomplete registration,

incorrectness, and overlapping of many of the district surveys, property deeds were often insecure or in litigation.

A total of 76,735 acres of the Virginia Military District remained unclaimed in 1871. The United States Congress deeded the acreage to the State of Ohio, which in turn granted it to the Ohio Agricultural and Mechanical College, later the Ohio State University, for the school's support. The university subsequently sold the lands to gain money for its endowment. Today, the part of the Little Miami watershed that was included in the Virginia Military District is broken into tens of thousands of private properties, each one contributing some quantity and quality of water to the Little Miami. The same situation exists in the portion of the Little Miami watershed located west and north of the river, land that Virginia ceded to the federal government in 1783 without any restriction on its use.

Land between the Miamis

Benjamin Stites was a Pennsylvania trader who, in 1786, was selling flour, whiskey, and other goods at Washington, Kentucky. One night, a band of Shawnee stole horses and articles from settlers living in the vicinity of the town. A group of volunteers, including Stites, set off after the thieves in the morning. The posse crossed the Ohio River from a point opposite the mouth of the Little Miami and tracked the Indians up the Little Miami Valley. The pursuers eventually abandoned their chase in the region of Old Chillicothe (present-day Oldtown), rode west to the Great Miami, and found their way south to Kentucky.

Stites, determined to relocate to the fertile land he had just ridden through, immediately left for the East to find someone who could make the region between the two Miamis available to settlers. He soon met John Cleves Symmes, a New Jersey congressman who was willing to purchase territory between the Miamis from the federal government, divide it into affordable parcels, and sell the land parcels to settlers such as Stites. In 1787, Symmes contracted with the United States Treasury Board to buy one million acres of the region.

The envisioned boundaries of the Symmes Purchase were the Little Miami on the east, the Ohio on the south, the Great Miami on the west, and a northern boundary line drawn east from the Great Miami to the Little Miami so as to encompass a million acres (Figure 9, below). Due to several difficulties, including insufficient funding, the completed Symmes Purchase in 1794 contained only 311,682 acres. The northern boundary line for the completed purchase was located about a mile north of the site of present-day downtown Lebanon. The federal government subsequently had the territory north of the boundary line surveyed and sold to settlers and land companies. In summary, the portion of the Little Miami watershed west and north of the Little Miami was either part of the Symmes Purchase or, north of Lebanon, part of the U.S. Surveyor General's Between the Miamis Survey.

Figure 9. Detail from a pen-and-ink annotated copy of Thomas Hutchins's 1778 *Map of the Western Parts of Virginia, Pennsylvania, Maryland and North Carolina*. John Cleves Symmes contracted with the federal government in 1787 to purchase land between the Great Miami and Little Miami Rivers. (Library of Congress, Geography and Map Division)

Columbia

Symmes wrote a promotional narrative for his 1787 pamphlet announcing the availability of lands for settlement in the Symmes Purchase. In the piece, he stated:

> that from . . . the unanimous report of all those who have travelled over the tract in almost every direction it is supposed to be equal to any part of the federal territory in point quality of soil and excellence of climate, it lying in latitude of about thirty eight degrees North, where the winters are moderate and no extreme heats in summer. Its situation is such as to command the navigation of several fine rivers as may be seen by the maps of that country, boats are frequently passing by this land as they ply up and down the Ohio. There are no mountains in the tract and excepting a few hills the country is generally level and free from stone on the surface of the earth but there are plenty of stone quaries [sic] for building. It is said to be well watered with springs and

> rivulets and several fine mill streams falling from the dividing ridge into the two Miamis which lie about thirty miles apart, and are both supposed to be navigable higher up the country than the Northern extent of this purchase.

A sentence near the end of the narrative acknowledged the presence of Shawnee, but readers were also told that the United States Secretary of War was disposed to garrison troops in the Symmes Purchase to facilitate its settlement and "in some measure render safety to the first adventurers."

In order to raise funds for his purchase, Symmes began to sell land even before he made his initial payment to the United States Treasury. Not surprisingly, Symmes's first buyer was Stites, who had initiated the idea of settling the region between the Miami Rivers. In 1787, Stites bought 20,000 acres situated along the west bank of the Little Miami from its mouth to some distance upstream, including the site of present-day Lunken Airport. Stites spent the next year gathering together a party of Easterners to occupy the land.

In 1788, Stites and his group of settlers descended the Ohio River to Limestone (now Maysville), Kentucky, where they cut and hauled to a boat many pieces of oak timber that would be used to build a fort at their destination. Two of the wood-gatherers, including Stites's young nephew, were killed during an Indian attack. The settlers also heard from some Kentucky hunters that 500 Indians were camped at the mouth of the Little Miami and would slaughter Stites's group when it landed there.

On November 18, 1788, Stites's twenty-seven-member landing party saw no Indians when it disembarked on the Ohio River's north bank, three-quarters of a mile below the mouth of the Little Miami. The group gave the landing site the name of Columbia and immediately began building Fort Miami, a four-sided structure comprised of long buildings connected together with a blockhouse at each corner. Upon the completion of the fort in December, the settlers celebrated by firing off their guns. Some hunters across the Ohio River heard the shooting, concluded the settlement was being raided by Indians, and rushed upriver to Washington, Kentucky, to sound the alarm. Within two days, a party including Simon Kenton and over fifty other Kentuckians unexpectedly appeared at Columbia to assist in its defense against a nonexistent attack.

Although the Indian raid on Columbia proved imaginary, its residents were nonetheless gladdened by the arrival of a company of U.S. troops in mid December. The soldiers quickly constructed a military blockhouse, but they built it so near to the Ohio that a late December flood drove them out of the structure. The upset commander moved his troops five miles downriver to the future site of downtown Cincinnati, where he had a new fortification erected on a terrace above the Ohio's floodwaters. The structure became a prison for captive Indians when the much larger Fort Washington was built on the same terrace a few months later.

The first Indians to visit Columbia were thirty men, women, and children who were living in a winter hunting camp on the Little Miami near the future site of Newtown. They and the settlers traded goods and enjoyed friendly relations until the spring of 1789 when the Indians disbanded their winter camp, stole the few horses that the settlers owned, and

returned to their village north of the Little Miami watershed. More horses would be taken over the next several years, during which Indians would also kill several settlers who were farming, hunting, or traveling in the area of Columbia. The constant threat posed by hostile Indians caused a large number of soldiers to be garrisoned at the young settlement.

Emigrants continued to arrive at Columbia during 1789, swelling its population to about 200 and necessitating the construction of cabins outside of the fort. Farm fields were established by clearing away bottomland trees along the west side of the Little Miami about a mile from the settlement. The settlers called the cropland "Turkey Bottom" on the basis of the large number of turkeys living there. The turkeys were hunted for meat, as were waterfowl, grouse, deer, bear, and other wild game. A fish dam was constructed in the Little Miami, directing fish to a central opening leading into a trap. Additional protein in the settlers' diet came from the meat of domestic animals, the eggs of chickens, and the milk of cows.

Corn was the principal plant eaten at Columbia, where it was laboriously ground in hand mills. Milling improved for a period in 1790 when the first watermill on the Little Miami operated near Turkey Bottom. Ezra Ferris, one of Columbia's early settlers, later described the short-lived mill:

> A Mr. Coleman, who was an extraordinary genius for a man of his information, undertook, and actually built, a mill in a flat-bottom boat capable of grinding their corn. This boat was placed below a fish dam made by the citizens across the Little Miami about a half a mile above its mouth, and fastened to the shore by a rope, so that when they wanted it to grind it was shoved out so that the water pitching over the fish pit in the dam would fall on the water-wheel and start the mill to grinding, and when they wanted it to stop they drew it to shore where the water was turned away from the wheel. This mill worked well for a time, but unfortunately in the fall of the year, and when most wanted, a flood in the Miami swept it out into the Ohio River and they saw it no more, and the citizens had again to turn to their hand mills.

The year 1790 also marked the founding of Columbia Baptist Church, the first organized religious body in the settlement. The congregation erected a church building in 1792 and began to bury its deceased members in the graveyard at the church. The burial ground today still contains the marked graves of Stites and other church members, the first non-Indian farmers in the Little Miami watershed. The cemetery, now in a park that includes a pioneer-era garden, is located on Wilmer Avenue (formerly Turkey Bottom Road) near Airport Road, across the street from Lunken Airport.

Columbia was well described in *Kate Clarendon*, an 1848 work of fiction about the settlement's pioneer residents. The popular novel, authored by Emerson Bennett, reached its tenth edition by 1854. The book included romantic descriptions of the Little Miami, the wooded floodplain at the river's mouth, and the dramatic Clifton Gorge near the river's headwaters. Columbia, the primary setting for the book, ceased to exist as a separate village in 1873 when it was annexed by Cincinnati.

Settling the Little Miami Valley

Many settlers arriving at Columbia in 1789 soon moved on to establish multifamily settlements on lands bought from Symmes. These early settlements were called "stations" in reference to the army regulars often stationed at them. A station usually consisted of one or more blockhouses around which cabins were erected, all of which was enclosed by a stockade of heavy log pickets.

The first stations in the Little Miami Valley were established in either 1789 or 1790 in the present-day community of Terrace Park, about twelve miles above the mouth of the river. Covalt Station was built near the current site of St. Thomas Episcopal Church at the north end of Miami Avenue, as stated on a historical plaque in front of the church. Round Bottom Station was constructed three-quarter miles distant near the south end of Miami Avenue. A small gristmill erected on Red Bird Creek ground corn raised in the area. Indians killed at least ten men in the vicinity of the settlements, including the millwright and the founders of each of the stations. Fear brought about by the deaths and a temporary removal of the stations' soldiers caused residents to abandon the settlements and move to Garrard's Station for the winter of 1791-92.

In 1790, John Garrard (or Garard) illegally built a station and cleared a crop field on Virginia Military District land that had been deeded to John Steele. Garrard's Station, located on a terrace along the east side of the Little Miami about two miles above its mouth, was reached from Columbia via nearby Flinn's Ford, named for Columbia militia captain James Flinn. There is no record of soldiers being housed at Garrard's Station, perhaps because the government chose to disregard the illegal settlement, or perhaps because the station received its protection from troops garrisoned at nearby Columbia. A historical plaque near the end of Elstun Road marks the site of the station, the first settlement in the Virginia Military District.

On the Little Miami just upstream from where Garrard erected his station, Jacob Wickerham (or Wickersham) built a gristmill near the mouth of Clough Creek in 1790. The mill's wheel was turned by water flowing through a run along the east bank of the Little Miami. Wickerham increased the amount of water in the natural millrace by constructing a milldam of rock and brush across the width of the stream. Wickerham's operation was the prototype for the many riverbank mills that settlers would later erect along the length of the Little Miami. Wickerham also built a station in the vicinity of the mill, but its exact site is unknown.

During 1790, Indians continued to kill southern Ohio and northern Kentucky settlers whose activities took them away from the protection of a fort or station. In an effort to stop the Indian attacks, United States President George Washington ordered General Josiah Harmar to lead a military expedition to destroy Shawnee and Miami villages in Ohio and Indiana. On September 30, 1790, Harmar set out from Cincinnati's Fort Washington with a force of 1,450 men. The army followed the same line of march up the Little Miami Valley that George Rogers Clark had used in the previous decade, crossing the Little Miami about a mile below the mouth of Caesar Creek. After reaching the site of Old Chillicothe, Harmar's troops again crossed the river and continued northward to a disastrous defeat. Harmar

returned to Fort Washington on November 30 after losing almost 200 men, while the Indians sustained fewer than a dozen deaths.

The failure of Harmar's campaign emboldened the Indians to increase their attacks on pioneer settlements. Indians stole many horses at the beginning of 1791, including two taken from inside Columbia's Fort Miami. Thousands of troops sent north from Fort Washington to burn Indian crops and villages had little effect except to provoke the Indians to more killing and robbery. Columbia resident Ezra Ferris later recalled that in 1791 "there was more bloodshed and slaughter" than in any other of the settlement's first years.

During the winter of 1791-92, a few Columbia families built a settlement at the north end of Turkey Bottom in order to be closer to their farm fields. By shortening the travel distance to their crops, the settlers reduced their vulnerability to Indian ambushes. The small settlement included a blockhouse to provide the families with a place for retreat and defense in the case of an Indian raid. The lack of security away from the settlement was made evident when a party of Indians captured a girl within a quarter mile of her cabin. The girl's older, faster brother escaped the warrior who pursued him.

In 1792, other families left Columbia to establish their own settlements in the Little Miami Valley. Aaron Mercer led twelve men in building a station in the Virginia Military District on land purchased from Nathaniel Massie. Mercer's Station was located about six miles from the mouth of the Little Miami, near the present center of Newtown. The settlement that grew up around the station became known as Mercersburgh, a title that was changed in the early nineteenth century when emigrants from Newtown, Virginia, chose to re-name the village after their former home. A historical plaque in front of the fish hatchery on Church Street indicates the site of the Mercer's Station.

John Beasley of Columbia erected a station in future Plainville, about eight miles from the mouth of the Little Miami, in 1792. Beasley's Station was built along the north side of the river near the present intersection of Walton Creek Road and Wooster Pike. Beasley had bought the property from Symmes because its position adjacent to a large riffle in the Little Miami allowed the construction of a mill. Although wounded during an Indian attack on the station early in 1793, later in the same year Beasley constructed a gristmill on the riverbank and a milldam across the width of the river. The miller next improved his property by adding a sawmill and a large orchard of apple and peach trees.

Some settlers followed Garrard's example and built structures on lands they did not own. An example of a squatter settlement was Nelson's Station, constructed in 1792 by Samuel Nelson, his brother, and his brother-in-law. The site of the illegal station was near today's Madison Road between Stewart and Ebersole Avenues in Cincinnati, about two miles from the Little Miami and eight miles from the river's mouth. When Indians stole a horse from near Nelson's Station, a pursuing posse killed one of the thieves on the hill east of the station. This 1794 event gave birth to the name of Indian Hill, the designation for the extensive upland that overlooks twelve miles of the lower Little Miami.

Horse stealing was responsible for a large skirmish that occurred in 1792. A Shawnee party captured 56 animals from Kentucky settlements, crossed the Ohio River, and camped on East Fork above present-day Williamsburg. A group of twenty-four Kentuckians led by Simon Kenton tracked the Shawnee to the campsite and staged a night ambush, shooting at least two of the Indians. The Shawnee, who were led by Tecumseh, fought back and killed one of the Kentuckians, causing Kenton to order a retreat during which another one of his men was slain. Tecumseh, in the following years, led the Shawnee into many battles against settlers, frontier militia, and the U.S. Army.

The year 1793 included several more instances of horse stealing. In Columbia, for example, Indians boldly took two horses from a stable in the heart of the settlement that had grown to 1,100 residents. A group of men pursued the thieves up the Little Miami Valley to near the site of Old Chillicothe, where the chase was abandoned. A second posse had more success a few weeks later when it caught up with an Indian party that had taken a pair of horses from another Columbia stable. Although the Indians escaped, the posse retrieved the stolen animals and claimed an eighty-dollar reward.

The frequency of Indian robberies and raids discouraged settlers from leaving the protection of Columbia and its nearby stations. No new communities were established in the watershed during either 1793 or 1794. The year 1795, in contrast, saw the founding of numerous settlements in the Little Miami Valley, the result of the U.S. Army's defeat of the Shawnee and allied tribes in the previous year at Fallen Timbers, Ohio. General Anthony Wayne, commander of the victorious troops, forced the chiefs of the losing Indian nations to sign the 1795 Treaty of Greenville. The Indians ceded most of present-day Ohio and southern Indiana to the United States, and relinquished their claim to any land south of the Ohio River. A few Indians led by Tecumseh continued to resist until the War of 1812, but their insurgency took place well to the north of the Little Miami Valley.

Settlements established in 1795 included the first ones to be located in the area of the Little Miami watershed outside of today's Hamilton County. Thomas Paxton, a participant in the Battle of Fallen Timbers, founded a settlement just west of Ward's Corner Road about a half mile south of the present boundary of Loveland in Clermont County. William Beedle, who discovered his site of settlement while working as a surveyor, erected a station in today's Warren County five miles southwest of Lebanon, just north of the County Road 13 bridge over Station Creek. Also in present-day Warren County, William Mounts established a settlement along the south side of the Little Miami just west of Stubbs Mill Road, two and a half miles west of the mouth of Todd Fork at present-day Morrow. The residential structures at Mounts's Station were strategically built in a circle around a large spring.

With the lessening of the Indian threat, pioneers began to purchase land and erect separate residences some miles distant from existing stations or settlements. One of these cabins, the 1796 Miller-Leuser Log House located at 6550 Clough Pike in Hamilton County, is still standing and may be visited at its original location along Clough Creek. The earliest settlers in today's Greene County constructed isolated houses south of present-day Bellbrook in 1796, near Old Chillicothe in 1797, by Massie Creek in 1798, and along Caesar Creek in 1799. Morgan Van Meter became the earliest resident of today's Clinton County when he

built a cabin in 1799 near the head of East Fork. The 1799 Galloway Log House, erected in the present-day Greene County community of Goes, has been relocated and opened to visitors at 74 West Church Street in Xenia. Other early buildings from throughout the Little Miami watershed are reconstructed in the Caesar Creek State Park Pioneer Village located near Harveysburg.

As had occurred in the lower Little Miami Valley, the first areas cleared for agriculture in the upper valley were lowlands along streams. The rich soil and flatness of the bottomlands were attractive features for farmers. Once lowland forests had been converted into farm fields, settlers felled upland timber to establish croplands on the plateaus between the tributaries of the Little Miami. Cattle, sheep and swine were raised in the slope forests between the uplands and lowlands. The hogs fed by constantly overturning the woodland soil, thereby exposing tree roots and eventually destroying hillside timber.

Even forests on slopes too steep for livestock did not escape destruction. Trees were cut down for firewood, fencing material, and construction lumber. Oak timber was felled in order to meet the leather tanners' demand for tanbark. The pioneers' destruction of the watershed's forest cover initiated the erosion of soil into the Little Miami, thereby reducing the clarity of the stream once known as *Riviere la Blanche*, the "Clear River."

4. HARNESSING WATERPOWER

> The crimson flags of sunset fly
> Defeated down the western sky,
> And up the concave orient height
> Advance the conquering hosts of night.
> The ambient air is cool and still;
> Hushed is the rumble of the mill;
> The mill-dam scarcely heard before,
> Sends up a low and muffled roar.
>
> —W. H. Venable, 1872, from "June on the Miami"

Francis Baily, an Englishman who visited settlers in the Little Miami Valley in 1797, included an astute observation in his journal: "If any one . . . would wish to fix his residence amongst the first inhabitants, he ought to choose out a spot where he can fix a mill, as this is a thing indispensable in a young country; he ought to build both a grist-mill and a saw-mill as soon as he has built himself a house." The meal made by a gristmill and the lumber produced by a sawmill could either be used by the pioneer or exchanged for other commodities as needed.

The value of mills was made apparent by the large number that settlers constructed on the Little Miami and its tributaries. As related in the last chapter, four watermills were built in the lower valley prior to 1795. Several more mills were erected during the following years as the wave of settlement swept through the Little Miami Valley. Philip Gatch, an early resident of present-day Milford, wrote of mills in 1802 in an unpunctuated letter to an out-of-state friend:

> The L Miami is a Beautiful stream it [i]s clear summer and winter Flush and swift and the best stream for Mills I ever saw not excepting Brandywine there is about near a Dowzen Mills on this stream and is sufficient for mills in a straight direction about sixty miles up it I have been up it about 40 miles and there is a Mill still higher up it there are also many other good streams for mills in this Countrey that I have seen Cezar Creek, and Todds Forks, and Andersone Fork, these are good for Mills

Gatch could have lengthened his list of streams with available mill sites by adding East Fork, Stonelick Creek, O'Bannon Creek, Turtle Creek, Little East Fork, Lytle Creek, Cowan Creek, Glady Run, Massie Creek, Little Beaver Creek, and Beaver Creek. It was on the latter stream in 1798 that Owen Davis erected Alpha Mill, the appropriately titled first mill in the upper Little Miami Valley. Settlers from as far as thirty miles away made their way through the woods on horseback and foot to have their grain ground at Alpha Mill. Davis obliged those who traveled long distances by often operating the mill at night and on Sundays. Neighbors who observed the Sabbath objected to the Sunday operations and initially threatened Davis with prosecution. The issue was dropped when Davis announced that any

attempt to enforce a Sunday shutdown would result in the loss of his neighbors' milling privileges.

Figure 10. Localities referenced in Chapter 4.

The community that developed near Alpha Mill took on the name of Alpha and, in the 1800s, grew to include sawmills, a flourmill, a woolen mill, and an oil mill. The latter operation pressed linseed oil from flax seeds and molded the crushed seeds into high protein cakes for livestock. The woolen mill at Alpha was located on Bullskin Run, a tributary of Little Beaver Creek, reflecting the fact that only a small source of water was required to run such a mill.

Mills on the Little Miami

Owen Davis, the proprietor of Alpha Mill on Beaver Creek, also erected watermills on the Little Miami at present-day Clifton. In 1802, Davis and his son-in-law built a sawmill in the upper Clifton Gorge to produce lumber for further construction. They built a gristmill by 1803, along with a trading post, a distillery, a tavern, and several cabins. The settlement, known as Davis Mills, was later renamed Clifton (short for "Cliff Town") and its gristmill was rebuilt after being damaged by fire in the 1840s. Clifton Mill, as it became known, again burned and was again rebuilt in 1869. The mill continued to operate in the twentieth century, with its water-powered turbine running the milling machinery as well as producing electricity during the period 1908-37 for the Clifton-Cedarville-Yellow Springs area. Now open to visitors and education groups, the mill is the only one still operating in the Little Miami watershed.

Other mills were erected downstream of Clifton in Clifton Gorge during the 1800s, including a woolen mill and a paper mill. The oft-flooded enterprises eventually closed when they couldn't withstand the competition brought on by steam and electric mills. One structure, Grinnell Mill, survives at the lower end of the gorge at 3536 Bryan Park Road. The 1821 building rests on a limestone block foundation laid in 1812—the original mill burned down. The gristmill's waterwheel was damaged by the 1913 Flood and was replaced by a water turbine. The mill ceased operation in 1937 due to illness in the Grinnell family and a decline in business. Greene County's Miami Township now owns Grinnell Mill, which is open to the public.

The Little Miami, with an average gradient of six and one-half feet per mile, proved to be an excellent stream on which to erect watermills. Dozens of milling businesses were established along the waterway between Clifton Gorge and the Ohio River. All were abandoned in the nineteenth and twentieth centuries as water-powered mills became unprofitable to maintain and operate. A representative sampling of the vanished Little Miami mills follows.

At Beaver Station, nine miles downstream from Grinnell Mill, Adam Emory built a gristmill on the Little Miami in about 1812. The operation passed through several owners before Frederick Christian Trebein acquired it in the 1870s. The community around the mill subsequently became referred to as Trebein, the name it retains even though Mr. Trebein sold the mill to the Colonial Company during the late nineteenth century.

During the early nineteenth century, at a site eight miles downriver from Beaver Station (now Trebein), a man named Staley established a milling business next to the main road from Bellbrook to Xenia. The mill complex, which contained both a gristmill and a sawmill, became known as Eureka Mills after it was rebuilt in 1839. Beginning in October 1850, the fourteen-year-old William Dean Howells spent a year at the site as his father unsuccessfully attempted to transform the operation into a paper mill. Howells, who grew up to become "the dean of American letters," wrote of his life at Eureka Mills in the autobiographical books *My*

Year in a Log Cabin (1891) and *Years of My Youth* (1916). In the latter work, Howells described the biologic richness of the Little Miami in 1851:

> We believed that there were snapping-turtles and water-snakes in our swimming holes, though we never saw any. There were fish in the river, chiefly suckers and catfish in the spring, when the water was high and turbid, and in summer the bream that we call sunfish in the West, and there was a superstition, never verified by us, of bass. We did not care much for fishing, though of course that had its turn in the pleasures of our rolling year. There were crawfish, both hard shell and soft, to be had at small risk, and mussels in plenty. Their shells furnished us the material for many rings zealously begun and never finished; we did not see why they did not produce pearls; but perhaps they were all eaten up, before the pearl-disease could attack them, by the muskrats, before whose holes their shells were heaped.

Howells drew on the experiences of his year at Eureka Mills to produce the novels *New Leaf Mills* (1913) and *The Leatherwood God* (1917). Literary critic William Baker wrote that the Little Miami served as Howells's Walden Pond, allowing "his discovery of the real world, of the world of nature, and of himself." As for Eureka Mills, it was rebuilt for a second time in the 1870s before following other Little Miami mills into decay.

Waynesville, located twelve miles downstream of the Eureka Mills site, was laid out in 1796 by English emigrant Samuel Heighway. The village was named in honor of Anthony Wayne, the leader of the1794 victory over the Indians at Fallen Timbers. Although fourteen families resided in Waynesville by 1797, it was 1803 before Heighway erected a gristmill. The structure was built on a nearby Little Miami tributary, a stream that became known as Newman's Run after Jonathan Newman bought the mill in about 1805. Newman added a sawmill and a carding mill, but these burned down and were not rebuilt. Newman's gristmill was abandoned after other Waynesville residents erected mills on the Little Miami that proved to be more efficient operations. All of the Waynesville's Little Miami mills have disappeared, but the milldam and millrace that supplied them remain.

In 1802 or 1803, Nebo Gaunt constructed a gristmill at the site of present-day Oregonia, six miles below Waynesville. Other millers later added a carding mill, a sawmill, and a flourmill. Gaunt's original structure burned down on Christmas Day in 1852 due to the careless use of holiday firecrackers.

Two miles downstream from Oregonia, Richard Mather arranged in 1807 to have a milldam constructed by George Zentmire and a mill erected by Lewis Rees. Although the Mathers Mill is long gone, it continues to be the name of the community that grew up around the enterprise. In like manner, the vanished Stubbs Mill remains as the name of the road that crosses the Little Miami nine miles below Mathers Mill. Situated on the river's north bank two miles east of South Lebanon, Zimri Stubbs's mill was built by Jabish Phillips in about 1802.

At today's Foster, eight miles below Stubbs Mill, Brazilla Clark built a mill in 1806 that operated until it burned in 1844—fire was a constant enemy in the dust-filled operations.

A mile downriver, Jeremiah Morrow erected a grist- and sawmill in 1812 as he completed his fifth term as Ohio's sole Representative in the United States Congress. Morrow, while owning the mill, served as a United States Senator from Ohio (1813-19), as Ohio Governor (1822-26), and, again, as a Representative in the United States Congress (1841-43). When Morrow was elected governor, a delegation of citizens set off from Lebanon to ceremoniously bring him the good news. They found Morrow behind his mill, in the waters of the Little Miami, engaged in dislodging a piece of timber from the mill's watergate. The dripping-wet governor-elect was informed of his victory upon his return to shore. Morrow wasn't afforded the celebratory announcement that the delegation had been planned for the occasion, since the designated orator couldn't bring himself to make an eloquent speech "to a man who looked so much like a drowned rat."

At the site of present-day Loveland, three miles downstream from Morrow's Mill, area residents held a "bee" at which they helped Peter Sears build a dam for his mill in about 1820. The dam was improved over the years, so that by 1874 the 400-foot-long structure created a six-foot fall of water for the Loveland mill. Seven miles downriver, in about 1810, the family of Enoch Buckingham (or Bochenheim) erected a gristmill at the site of present-day Miamiville. The four-foot drop created by the 600-foot-long Buckingham milldam also powered the family's sawmill on the opposite riverbank.

Two miles downstream, at the southern end of today's Camp Dennison, Christian Waldschmidt (or Waldsmith) raised a sawmill, a gristmill, and a fulling mill, beginning in 1797. The structures were built on a millrace cut into the floor of Big Bottom, the local name for a wide section of the lower Little Miami River Valley. In 1804, Waldschmidt built and moved his large family into a nearby Pennsylvania-Dutch style stone house. The well-preserved Camp Dennison home, one of the oldest buildings in the Little Miami watershed, is located on Ohio Route 126 and is open for public visits.

The industrious Waldschmidt erected the first paper mill in the Little Miami Valley, and in the Northwest Territory, in 1810. The enterprise shipped its products to markets in the South as well as to stores and printers in Cincinnati. Papers produced by the mill bore the watermarks "W & CO" and "MIAMI." Upon Waldschmidt's death in 1814, his son-in-law, Mathias Kugler, assumed management of the mills. The route running west from Big Bottom through Indian Hill is still named Kugler Mill Road, although most of the mills burned down in 1828 and the paper mill closed in about 1850.

At today's Milford, two miles below Big Bottom, John Hageman built a milldam, millrace, and gristmill in 1803. Water in the race also powered an oil mill, a carding mill, and a sawmill during the first half of the nineteenth century. The gristmill was improved by subsequent owners, among them Mathias Kugler and his son, John. The mill burned down in a spectacular, three-day fire in 1920.

In 1800, Nathaniel Armstrong began to clear a mill site about five miles below today's Milford. Helped by his six sons, Armstrong was constructing a pole, plank, and stone milldam in the Little Miami when a flood swept everything away except for the dam's heavy rocks. This taught the Armstrongs, in the words of son Leonard, "that stone would sink,

while lumber would swim." The family rebuilt the dam with rocks and opened a sawmill along the north bank of the river. The business did well until a flooding Little Miami sent the mill floating down the stream, reportedly "sawing as it went." A replacement sawmill was erected and a gristmill was added, after which four of the Armstrong brothers established their own mills downstream.

William and John Armstrong bought out Beasley's 1793 mill in today's Plainville. They rebuilt the structure and called it the Lower Mill since it sat a half-mile downstream from their father's business, thereafter named the Upper Mill. Leonard and Thomas Armstrong bought Bass Island and, in 1809, erected the Middle Mill, located along the stretch of river between the other two Armstrong enterprises. The Middle Mill offered carding and fulling as well as grinding and sawing. Wool brought to the mill was carded, then taken home and spun into yarn or thread, then woven into cloth, and finally brought back to the mill for fulling (thickening and shortening). The addition of new machinery in about 1830 allowed the Middle Mill to become a woolen mill that took wool through all of the above steps without leaving the property.

Five miles downstream of the Middle Mill and three miles upstream of the Little Miami's mouth, Wickerham's 1790 mill operated into the early nineteenth century as the most southern mill on the river. After passing through a series of owners, the mill was purchased in 1822 by Philip Turpin and replaced by an up-to-date flourmill built nearby. Turpin obtained a license to ferry customers by boat from the west side of the Little Miami to his mill on the east bank.

Mills on the Tributaries

The approximately fifty mills on the Little Miami were exceeded in number by the approximately 300 mills situated along the river's tributaries, examples of which included the abovementioned Covalt's Mill on Red Bird Creek, Newman's Mill on Newman's Run, and Alpha Mill on Beaver Creek. The bigger tributary systems of the Little Miami watershed each powered several milling operations. For example, East Fork and its feeder streams supported over twice as many watermills as did the Little Miami's main stem.

The first mill on East Fork was established at Williamsburg in 1798. The settlement's owners engaged Kentucky millwright Peter Wilson to superintend the construction of the dual gristmill and sawmill. After completing his work at Williamsburg, Wilson built about fifty more mills in Ohio, often for land developers who had mills constructed in order to attract settlers. Developers also attracted land buyers by discounting the cost of real estate to the first settlers who agreed to erect mills. Robert Eachus, for example, was enticed to build a gristmill on Todd Fork in 1805 in exchange for a reduced price of seventy-five cents per acre for land he bought nearby.

The importance of a mill to a pioneer community was made evident by the coercion practiced by Ebenezer Davis, owner of a gristmill on East Fork near St. Martins. Uncle 'Nezar was an eccentric character who often changed his religious beliefs. When the other members of his church would disagree with his latest points of doctrine, Davis would

announce that he would never "grind another grist for a Baptist." Davis thus successfully used the mill to enforce his self-appointed role as the congregation's theologian.

Another mill on East Fork became notorious for its millrace rather than for its miller. In about 1836, at a horseshoe bend below Williamsburg, property-owner Thomas Shields planned to construct a millrace across the rocky peninsula of land defined by the river bend. The race was to be about one-fifth-mile long, while the stretch of East Fork between the upper and lower ends of the race would be approximately two miles in length. The twenty-five-foot cascade of water that would issue from the lower end of the race would power a mill built at that location. Shields did not go forward with his novel plan, likely due to the prohibitive cost of trenching the millrace through the high limestone ridge that caps the peninsula.

However, in about 1840, Elijah and James Dennis purchased the millsite and erected the mill envisioned by Shields. Instead of establishing the millrace by cutting a trench through the ridge, the Dennis brothers tunneled through the divide. They excavated the tunnel between two limestone layers located four feet apart, with the limestone forming the roof and floor without any other support. The millrace not only supplied water for Tunnel Mill but also provided children with a short route to Williamsburg during the periods when East Fork's water level was low and the tunnel was dry. Tunnel Mill was dismantled in the early twentieth century, but its site on the East Fork may be viewed across from the Tunnel Mill Boat Ramp in East Fork State Park.

A watermill operated only when there was an adequate supply of water. During an interval of low stream levels, a miller would either have to shut down his business or switch to an alternate source of power. Luckily for early settlers in the Little Miami Valley, streams supplied ample amounts of water through much of the year. The Little Miami watershed was covered by a dense growth of timber that reduced the evaporation of rainfall and snowmelt from the earth's surface. Fallen leaves, downed trees, and rotting logs prevented the rapid drainage of the water from the forest floor. Runoff from rain and snow events reached waterways slowly and evenly, producing steady flows through stream channels during all but the driest months.

Stonelick Creek, an East Fork tributary, had the most consistent flow of any tributary in the Little Miami watershed during the early nineteenth century. The creek had its source in an extensive swamp forest located in the vicinity of Blanchester. The steady, natural drainage of the flat swampland supplied all of the water that mills needed during at least nine months of the year. Stonelick Creek powered more mills per mile than did any other waterway in the Little Miami region.

One miller, Samuel Hill, built a mill turned by Stonelick Creek and an adjacent one turned by oxen during periods when the stream could not supply enough power to the watermill. There were many such animal-mills scattered through the Little Miami watershed in the early nineteenth century, most of them turned by horses. Sometimes a single mill was constructed with the capacity to convert from waterpower to animal power when conditions

dictated. By the mid nineteenth century, steam power had mostly replaced animal power in the establishments that provided milling during dry periods.

Demise of the Watermills

Watermills disappeared from the streams by the late 1800s due to a severe reduction in the availability of water. An entry in the 1882 *History of Clinton County* provides a typical account of the fate of the watermills:

> In or about the year 1823, Judge Sewell erected a grist-mill and saw-mill on the Little East Fork, about two miles above Clarksville, where David Pond now lives. The improvement was one of great utility to the neighborhood. The stream which was depended on to furnish the power was small, but at that time, when the head-waters in the vicinity of Morrisville were in a forest and the flow of water was obstructed by logs and brush, when the meanderings of the main stream were such that it almost cut off sections of its own course in places, it furnished power nearly all the year; but after the streams were cleaned out, and the land ditched, and the main channel straightened, the water passed off so rapidly that in the dry season it would not run the mill. Steam mills in time came into use, and water-mills on the small streams went out of use. The Sewell mills shared the common fate—decay seized upon the buildings, a freshet swept away the dam, the wash from the hillsides filled the race, and now there is scarcely a mark to show where these once flourishing mills stood.

The story of the disappearance of stream flow is repeated in all of the nineteenth-century histories of the counties in the watershed. For example, the 1880 *History of Clermont County* reports: "as the country was cleared up the water-power became so small that the mills could not be operated except after a rainy spell. This class of mills was then appropriately named thundergust mills." The thundergust mills were subsequently abandoned as farmers transferred their business to milling establishments that were not based on unpredictable waterpower.

During the early twentieth century, almost all of the work still performed by surviving Little Miami Valley watermills was moved to steam and electric mills. On Little Beaver Creek, for example, a recently closed watermill was bought in 1921, relocated at some distance from the stream, and fitted with metal burrs powered by electricity. The more usual fate of abandoned watermills was destruction by rot, fire, or high water. Sediment filled unused millraces and floods destroyed untended milldams. Surprisingly, the highest milldam ever erected in the watershed is still largely intact in Massie Creek Gorge downstream of Cedarville. This stone dam of a vanished mill remains wedged between the cliffs at Indian Mound Reserve, creating a nearly forty-foot drop of water known as Cedar Cliff Falls. The beautiful falls serves a memorial of the decades when watermills were essential to the economy of the Little Miami Valley.

5. MOVING THROUGH THE VALLEY

Pursuing crooked country roads,
Strong wagons bear their bulky loads;
Along the valley's gradual bend
The railway's level bars extend,
And trains impetuous thunder by
And hoarsely shriek their warning cry,
Or, freight-retarded, moving slow,
Clank harshly as they rumbling go.

—W. H. Venable, 1872, from "June on the Miami"

The Little Miami greatly influenced the development of the region's transportation options. Locations of fords determined the routes of roads in the watershed. Varying depths along the length of the waterway restricted the sizes of boats carrying goods to market. The river's valley provided a corridor for the first railroad in southwestern Ohio. The wide floodplain at the river's mouth became the site for a commercial airfield in Cincinnati—Lunken Airport today serves mostly private planes while a recreation trail around its perimeter carries leg-powered travelers.

Fords, Ferries, and Bridges

The most utilized ford across the Little Miami in the nineteenth century was the riffle in front of Hageman's Mill. The settlement overlooking the riffle became known as Milford, the shortened form of "Mill Ford." Hundreds of other fords were also used by travelers in the watershed, resulting in wet feet for those who didn't cross the streams on a horse or in a wagon. One Greene County settler, Rev. Robert Armstrong, kept his shoes dry on the way to church by fording the Little Miami on stilts, although he sometimes would get a dunking.

Fording a flooding stream was an especially dangerous activity. Frederick Bonner of Greene County recalled a serious incident in Hamilton County that occurred during his family's crossing of the Little Miami in 1803. The Bonner family was part of a group of settlers from Virginia that forded the river in a covered wagon caravan:

> The water was high, and running swiftly. Our four-horse wagon crossed without accident; but when the wagon containing the wife of a Mr. Day proceeded as far as the middle, or swiftest part of the stream, one of the horses fell, and could not rise. Mr. Day, in attempting to assist, was washed off down stream with the horses. Father went in to his assistance, and the water tripped him up, and he also went struggling down the river, to the alarm of all. Fortunately, he got out on the same side from which he entered, while Day was still struggling in the river near his horses. Finally, they succeeded in fastening a chain to the end of the tongue, and hitching our horses to it, we

drew it out. All this time Day's wife and child were in the wagon, in imminent danger of being capsized into the river, and washed away.

Figure 11. Localities referenced in Chapter 5.

After 1804, travelers in Hamilton County had the option of using a ferry instead of a ford to cross the Little Miami. One ferry was located near Flinn's Ford at Columbia while a second boat operated at Plainville. Upstream in Warren County, a ferry was used during periods when the ford at Waynesville became impassable due to high water. Construction began around 1812 on a bridge that would replace the Waynesville ford and ferry. A flood swept the structure away before it was finished, and so it wasn't until 1817 that a bridge was completed at the location. The wooden span lasted only about ten years since it was not weather-boarded. Subsequent bridges built at the site had longer lives due to improved construction techniques and materials.

Other early bridges over the Little Miami were built near the mouth of Todd Fork in 1815 and at Milford in 1818. The Milford span was a toll bridge, charging different fares for pedestrians, horse riders, wagon passengers, cattle, and hogs. A local tale relates that a flock of turkeys, being driven on foot to market, was denied use of the bridge because the species didn't appear on the toll board. The Milford bridge, like most of the longer spans built in the watershed during the nineteenth century, was a covered bridge. The bridge's roof protected its wooden beams and floorboards against the weather, shielded wagon cargo during sudden downpours, afforded young lovers a semi-dark location for kissing, and provided rafters in which children could practice acrobatics.

Metal spans replaced the watershed's covered bridges as they rotted apart, washed away, burned up, or blew down. A covered bridge at Trebein, for example, was wrecked by a strong gust or a small tornado. A Civil War veteran, who had driven his wagon onto the bridge as the storm approached, was blown into the Little Miami. He was lucky to survive the wind, the water, and the kicks from the horse entangled with him in the river.

In the twentieth century, destruction caused by errant automobile and truck drivers added to the demise of the region's remaining covered bridges. Almost all of the hundreds of the covered bridge sites in the watershed are now the locations of modern spans or are bridgeless due to the rerouting of access roads. Only eleven original covered bridges survive (Table 2, below), eight of which remain at their nineteenth-century sites.

Table 2. Surviving covered bridges of the Little Miami watershed.

Name of Bridge	Built	Length	Location and Notes
Ballard Road	1883	80 feet	North Branch of Caesar Creek northwest of Jamestown, Greene Co.; closed to traffic, but visitors may drive across; only covered bridge in Ohio painted green
Cemetery Road	1886	60 feet	Yellow Springs Creek in Glen Helen Preserve, Yellow Springs, Greene Co.; closed to traffic; center section of a 130-foot-long bridge that crossed Anderson Fork northeast of New Burlington before 1975
Charleton Mill Road	1883	128 feet	Massie Creek southwest of Cedarville, Greene Co.; only Greene Co. covered bridge still carrying traffic
Engle Mill Road West	1877?	148 feet	Anderson Fork southeast of Spring Valley, Greene Co.; closed to traffic; moved to site from Spring Valley Rd. in about 1887
Feedwire Road	1870	56 feet	Miami and Erie Canal bed at Carillon Historical Park, 2001 S. Patterson Blvd., Dayton, Montgomery Co.; closed to traffic; crossed Little Sugar Creek northwest of Bellbrook, Greene Co., before 1948
Jasper Road	1869	71 feet	Mudlick Creek near intersection of Oxford Rd. and Astoria Rd., Germantown, Montgomery Co.; private; closed to traffic; crossed Casear Creek southwest of Jamestown, Greene Co., before 1965
Lynchburg	1870	120 feet	East Fork near intersection of High St. and Memory Ln. in Lynchburg, Highland Co.; closed to traffic; bridge partially in Clinton Co.
Martinsville Road	1871	72 feet	Todd Fork northwest of Martinsville, Clinton Co.; heavily reinforced for modern traffic
McCafferty Road	1877	170 feet	East Fork southwest of Vera Cruz, Brown Co.; longest covered bridge remaining in the Little Miami Valley
Stevenson Road	1877	95 feet	Massie Creek northeast of Xenia, Greene Co.; closed to trafffic; location on curve at foot of hill led to vehicle accidents
Stonelick	1878	140 feet	Stonelick Creek at Stonelick-Williams Corner Rd. crossing east of Perintown, Clermont Co.; lights and infrared cameras discourage vandalism

Since the end of the nineteenth century, almost all of the watershed's bridges have been constructed of steel and concrete instead of wood. The largest structure is the Jeremiah Morrow Bridge on Interstate-71 upstream of Fort Ancient. The 2,300-foot span is the longest bridge on an interstate highway in Ohio. It is also the tallest road bridge in the state, with a clearance of 239 feet between the highway and the Little Miami River.

Canoes, Flatboats, and Canal Boats

A canoe is the type of boat usually associated with the Little Miami. The historic Native American cultures used the canoe for transport and also for stalking animal prey. An Indian who was hunting deer, for example, would tie a large bush in the bow of his vessel. Then, at night, he would secure a torch to the front of the boat and paddle off to search for a deer coming to drink at the stream. The strange appearance of fire floating on water would attract the inquisitive animal toward the canoe, allowing an easier shot for the hunter hidden behind the tethered bush.

Canoes appearing on the Little Miami today are typically made of aluminum or fiberglass instead of wood or bark. The majority of the boats are rented from one of the six canoe liveries located along the length of the stream. Some canoes are used for fishing or waterfowl hunting, but most are paddled by people enjoying outings on the scenic river. The large number of canoes floating downstream on summer weekends causes resident great blue herons to temporarily relocate to less-disturbed feeding sites.

During the nineteenth century, the waters of the Little Miami carried flatboats in addition to canoes and ferries. Perhaps the earliest flatboats on the river were those constructed at the Armstrong Middle Mill near Plainville in 1805. The United States Army paid $1,000 for ten vessels that were built to transport soldiers on the Ohio River. The boats were never used, and the government ended up selling them at public auction for twenty-two dollars apiece. The buyers likely were "river traders" who supplied Southern markets with agricultural products rafted down the Ohio and Mississippi Rivers.

Other flatboats were built and launched from sites on the Little Miami located as far north as Warren County. Samuel Perin, a millwright, directed the construction of a particularly large vessel on the riverbank at Milford in 1820. It measured one hundred feet in length and forty feet in width, and had a cabin-like shelter at the center of the deck. Log rollers were used to move the boat into the river, where it was loaded with barrels of salt pork, whiskey, and other locally produced commodities. The crew then waited for high water before casting off and descending to the mouth of the Little Miami. Continuing down the Ohio and Mississippi Rivers, the boat stopped at shoreline communities and plantations to sell portions of its cargo. The vessel and the goods that remained were sold at Natchez, Mississippi, after which the crew returned overland to Milford.

The success of the Milford flatboat venture convinced Perin that flour manufactured in the Little Miami Valley could profitably be exported to the South. In 1823, Perin added a large flourmill to the sawmill and gristmill he already operated on East Fork. He constructed and launched fifty-three flatboats at Perin's Mills, now known as Perintown, between 1823

and 1827. The boats carried barrels of flour down the East Fork, Little Miami, Ohio, and Mississippi Rivers to southern markets, chiefly New Orleans.

The use of flatboats on the Little Miami and East Fork suffered from two major problems. First, after loading the cargo, a crew had to wait days or weeks for a high water event that would allow them to proceed downstream without becoming stuck. Second, the current in the streams did not allow a flatboat to return to its place of origin to be reused. A canal boat, in contrast, could embark, deliver its cargo, and return to its port, assuming the existence of a canalized waterway.

In 1817, the Ohio Legislature granted the Little Miami Canal and Banking Company a charter to construct dams and locks for "ascending and descending boat navigation on the Little Miami River from the Ohio to the town of Waynesville." Most of the boats envisioned for use on the canal would transfer their cargos onto larger vessels at the mouth of the Little Miami. The Legislature authorized the company to raise $300,000 to canalize the Little Miami and construct new mills and factories along the waterway. The company was further authorized to collect tolls of ten cents per ton at each lock.

Work never commenced on the Little Miami Canal, probably because potential investors were not convinced that the project would prove profitable. In the Great Miami watershed, on the other hand, the state-financed Miami Canal was completed between Middletown and Cincinnati in 1827. When the first boats on the Miami Canal arrived at Cincinnati on March 17, 1828, they were greeted by a crowd of thousands and a bust of New York Governor DeWitt Clinton, the father of American canals. The Miami Canal was extended north to Lake Erie at Toledo by 1845 and was re-designated four years later as the Miami and Erie Canal.

The Warren County Canal, which connected to the Miami Canal at Middletown, was completed in about 1840. The waterway followed a preglacial stream channel from Lebanon in the Little Miami watershed to Middletown in the Great Miami watershed (Figure 12, below). Turtle Creek, a Little Miami tributary, supplied water for the eastern segment of the canal while streams in the Great Miami watershed supplied the western segment. Animal-towed canal boats carried goods from the Lebanon area through a series of six locks to the Miami Canal, on which the boats could travel south to Cincinnati.

Figure 12. Detail from G. W. Colton's 1854 *Railroad and Township Map of the State of Ohio*, with banded line showing the Warren County Canal route from Lebanon to the Miami and Erie Canal at Middletown. (Library of Congress, Geography and Map Division)

The badly constructed Warren County Canal was abandoned after about ten years of operation, primarily due to the high cost entailed in dredging silt from the channel. The canal's closure in 1850 was a disappointment to Lebanon area residents, but they still had three other routes by which their commodities could reach Cincinnati. Their products could be transported by wagon (1) all the way to Cincinnati, (2) to the Miami and Erie Canal, or (3) to the recently constructed tracks of the Little Miami Railroad.

Little Miami Railroad Company

In the 1820s, the earliest American railways demonstrated that a train could travel much faster than a canal boat. The higher speed quickly made railroad transportation the first

choice for moving heavy loads to market. Between 1830 and 1836, as the nation's total trackage grew from thirty to 1,273 miles, citizens of the Little Miami Valley decided that a railway would be a valuable addition to the region.

The Ohio Legislature chartered the Little Miami Railroad Company in 1836. The company was granted the right to "construct and maintain a railway . . . commencing at any eligible point in or near the town of Springfield . . . thence by the most practical route through the town of Xenia . . . and down the valley of the Little Miami river and of the Ohio river to the city of Cincinnati." The Legislature authorized the company to raise a capital stock of $750,000 and to establish rates of five cents per ton-mile for freight and three cents a mile for passengers.

The Little Miami Railroad Company spent the following years in obtaining funds for construction and equipment. Stock in the company was sold to towns and counties as well as to individuals. Subscriptions included $200,000 from Cincinnati and $50,000 from Greene County. Mathias Kugler subscribed $10,000 on the condition that the railroad's tracks would run near his mill in Big Bottom. Other mill owners, who knew that a railroad along the Little Miami would increase the profitability of their businesses, also purchased stock in the company.

By December 1841, the railroad's track extended from Fulton, an Ohio River community on the east side of Cincinnati, through Columbia and Plainville to the west end of the covered bridge at Milford. The first train to travel up the Little Miami Valley carried Cincinnati City Council members, citizens, and news reporters. On the day following the December 14 excursion, the *Gazette* described the trip as "joyous in the extreme." The Cincinnati newspaper reported that the fifteen-mile ride to Milford took an hour and a half due to a delay caused by a small landslide, while the return trip to Fulton required just over an hour. The *Gazette* continued:

> We felt strongly, as we whirled along at rapid pace, what a change a few years had caused in this glorious West. There were men with us who could tell the tales of Indian warfare, of the hardships of our pioneer fathers, of the isolated condition of the new settlement, with all its dangers and difficulties and trials, and yet in their day they have lived to see the power of science turning this wilderness into a garden, and bringing distant points together as if they were one neighborhood. All honor to the enterprise and energy of that people who can work such wonderful changes.

The railroad's builders proceeded slowly north of Milford, building a bridge across the Little Miami at Miamiville and continuing along the east bank of the river through Loveland. When construction reached the mouth of Todd Fork in 1844, a village was established at the site and named in honor of Jeremiah Morrow, the former governor who was serving as president of the railroad. Construction continued from Morrow through Fort Ancient and Corwin to the brand new settlement of Spring Valley, from where the track was built north through the Glady Run Valley to Xenia in 1845. Above Xenia, the railway's contractors again bridged the Little Miami, continued the track through Yellow Springs, and reached Springfield in 1846 (Figure 13, below).

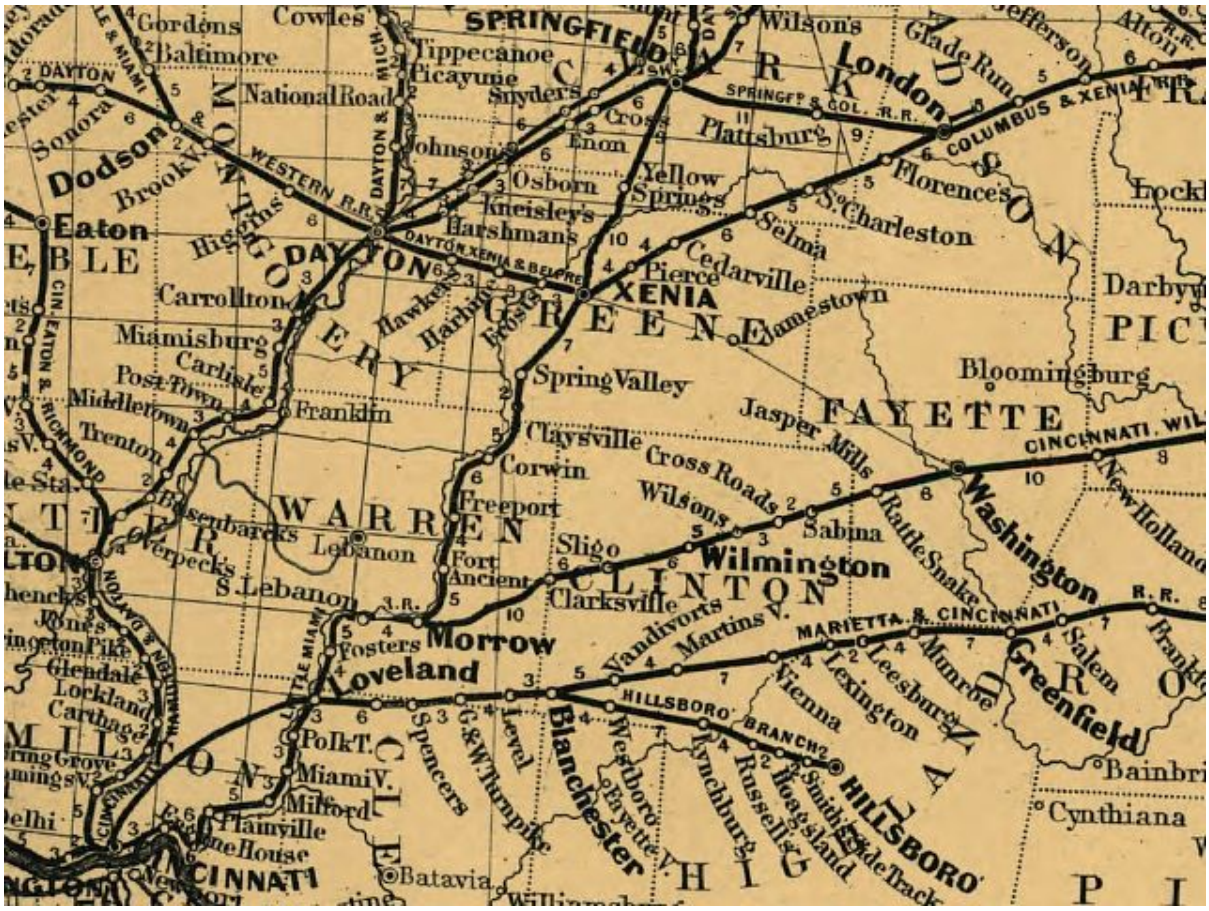

Figure 13. Detail from the G. W. & C. B. Colton & Company's 1867 *Railroad and Express Map of the Middle States*, showing the route of the Little Miami Railroad between Cincinnati and Springfield. (Library of Congress, Geography and Map Division)

In 1849, with the completion of the Mad River & Lake Erie Railroad stretching from Springfield to Sandusky, products loaded on trains in the Little Miami Valley could reach out-of-state destinations via Great Lakes ships sailing from Sandusky as well as via Ohio River boats setting out from Cincinnati. When the Columbus & Xenia Railroad opened in 1850, Little Miami Railroad passengers and freight could transfer at Xenia onto trains that would take them to the state capitol at Columbus. Sadly, two men returning from the 1850 Ohio State Fair died after being struck by the overhead bracing on the Little Miami Railroad Bridge across Caesar Creek. The tragedy could have been averted had the men heeded the conductor's repeated warning to stay off the roof of the passenger car. On a more positive note, the Little Miami Railroad Company's report for the year 1850 announced that a record amount of over $200,000 was collected from 144,490 passengers while about $192,000 was earned for the principal articles of freight—hogs, grains, and flour.

Mad River & Lake Erie and Columbus & Xenia were not the only lines to link to the Little Miami Railroad. The Cincinnati & Hillsboro Railroad connected Loveland to Hillsboro by 1852. Part of the Cincinnati & Hillsboro line was soon incorporated into the Marietta & Cincinnati Railroad route that reached Ohio's eastern border by 1857. The Cincinnati, Wilmington & Zanesville Railroad connected Morrow to Wilmington in 1853 and continued east to Zanesville by 1856. The Dayton, Xenia & Belpre Railroad completed its tracks between Xenia and Dayton by 1854. The amount of passenger and freight traffic on the Little Miami Railroad increased with each new connection to another railroad's route. In 1860, the Little Miami Railroad transported 357,858 passengers, carried 30,532,575 ton-miles of freight, and earned $1,289,844.

While on their rail journey from Illinois to Washington, D.C., President-elect Abraham Lincoln and his family rode a special train from Cincinnati to Xenia on February 13, 1861. The train moved along at thirty miles per hour, stopping at Milford, Miamiville, Loveland, Morrow, and Corwin. At Morrow, the wife of the president of the Little Miami Railroad presented a bouquet of white camellias to Mary Todd Lincoln. An enthusiastic crowd of 5,000 people greeted the Lincolns in Xenia, from where the train continued on to Columbus and points east.

The Little Miami Railroad during the Civil War helped transport Union troops and munitions between camps and toward battlefields. In the spring of 1861, Camp Dennison was established along the railroad line in the Big Bottom area between Milford and Miamiville. The camp's extensive grounds housed up to 15,000 soldiers, and a total of 75,000 men passed through the installation over the course of the war. A Little Miami River ferry consisting of two flatboats running on a cable connected Camp Dennison with Milford, where the troops could purchase articles that were not supplied by the army. The May 10, 1861 *Cleveland Plain Dealer* printed a letter from a soldier explaining how a fellow Clevelander named Clark ended up in the waters of the Little Miami:

> In front of the lines of the seventh and sixth regiments, is a sugar loaf shaped mound, whose summit is about 200 feet above the surrounding level, one side of which slopes down to the waters of the romantic Little Miami. The summit of the mound is level and contains about three acres. Last evening, while Clark was enjoying the fine breeze and beautiful scenery from the top of the mound, his eyes fell upon a good-sized calf grazing not far from him. Slipping up behind his victim, who evidently had no thought of an attack from behind, he suddenly seized his calfship by the tail. The frightened animal bounded down the hill at a rapid speed, with Clark flying after, in full view of the whole regiment. Faster and faster the calf went, until on the very brink of the river, when it made a sudden "right wheel," bringing Clark around with a sudden jerk, whereby his hold was broken, and he went lunging into the river! Clark says he has enough of the calf, if that is the way he brings up his "rear."

On July 13, 1863, despite the proximity of Camp Dennison, a 2,000-man Confederate force being led east by General John Hunt Morgan forded the Little Miami upstream of Miamiville. The rebels erected a barrier across the tracks of the Little Miami Railroad on a

blind curve between Branch Hill and Miamiville. When a train slammed into the obstruction, the locomotive overturned, the fireman was killed, and the engineer was seriously injured. The 150 Union militiamen aboard the train were captured, disarmed, and released to walk south to Camp Dennison. Morgan and some of his soldiers were caught a few days later in southeastern Ohio and taken to the Ohio Penitentiary in Columbus. The general, however, escaped from the jail in November, bought a passenger ticket with money secretly supplied by his sister, and rode a train south over the Little Miami Railroad during his flight to Kentucky.

The Little Miami Railroad was brought into the giant Pennsylvania Railroad network when it was leased to the Pittsburgh, Cincinnati & St. Louis Railroad Company in 1869. Although the Little Miami Railroad had become part of a national system, the line continued to provide transportation for the people and businesses of the Little Miami Valley. Among the largest enterprises served by the railroad were two powder manufacturers situated on the Little Miami River—the Miami Powder Company in Greene County and King's Great Western Powder Company in Warren County.

The Miami Powder Company had its beginnings in 1846 when two Austin brothers and a Mr. Carlton erected water-powered powder mills nearby the Little Miami Railroad's Goes Station (later renamed Goes to stop mail delivery mix-ups with Gore's Station, another Ohio community). Freight trains brought raw materials to the powder company's mills on the Little Miami. The trains also carried away the company's finished products—blasting powder and gunpowder labeled with the name of Austin Brothers. The firm's title was changed to Austin, King & Company when Joseph Warren King bought interest in the enterprise in 1852, and to Miami Powder Company when King acquired the entire concern in 1855. Over the following decades, the power source for the powder mills changed from water to steam to electricity. The company went out of business in 1925 after an explosion leveled most of its buildings and blew out windows for miles around.

King's Great Western Powder Company began in 1878 when Joseph Warren King and his nephew Ahimaaz King bought the property of a gristmill on the Little Miami downstream from the mouth of Muddy Creek. The men sold their shares of the Miami Powder Company and used the money to construct powder mills along the millrace running through their new purchase. The water in the race was used both to power the mills and to fight the fires resulting from accidental explosions. The Little Miami Railroad transported raw materials to the powder company and carried away its output.

Joseph Warren King died in 1885 and his son-in-law Gershom Moore Peters became the company president. Ahimaaz King took on the role of operating manager and was responsible for building the company village Kings Mills on the upland above the mills. The powder firm shortened its name to King Powder Company and adopted new manufacturing processes based on steam and electric power. The company operated until 1958, when the King family closed the firm, sold the machinery, and dismantled the powder buildings.

In 1887, Peters established an adjacent, separate company to pack King gunpowder into shotgun shells. Unfortunately, in 1890, most of the Peters Cartridge Company buildings were

destroyed by explosions brought about by the careless coupling of railroad cars filled with powder. The blasts killed several people and cost the Little Miami Railroad $220,000 when it was required to pay for damages.

The facilities of Peters Cartridge Company were enlarged as they were rebuilt following the 1890 disaster. In 1917, during the First World War, the firm produced up to 1,500,000 military cartridges per day. The Remington Arms Company acquired the cartridge company from the King family in 1934 and continued production at the site until 1944. The cartridge factory was subsequently used for the manufacture of Columbia Long Playing Records until 1948, and in 1950 became a storage area for barrels of aging Seagrams Whiskey. The factory buildings have remained mostly empty since Seagrams left in 1970, and the Eiffel Tower replica at Kings Island has replaced the factory's smokestack as the area's tallest structure.

Bicycles, Roller Blades, and Feet

Due to the closing of Little Miami Valley industries and a decline in rail passengers, trains stopped running on the Little Miami Railroad line in the 1970s. Since the 1980s, municipalities, counties, and the state have converted most of the railroad right-of-way into the Little Miami Scenic Trail. The paved path runs south from Springfield in Clark County toward the mouth of the Little Miami in Hamilton County.

The Little Miami Scenic Trail is met by additional rails-to-trails projects as it passes through Xenia in Greene County. The Creekside Trail runs west from Xenia on the Dayton, Xenia & Belpre Railroad right-of-way completed by 1854. The Ohio-to-Erie Trail runs northeast from Xenia over the Columbus & Xenia Railroad route finished in 1850. The Xenia-Jamestown Connector runs southeast from Xenia along the Dayton & Southeastern Railroad segment constructed between Xenia and Washington Court House in 1882. In Warren County, the Lebanon Countryside Trail leaves the Little Miami Scenic Trail opposite the mouth of Muddy Creek. The first portion of the Lebanon trail crosses the Little Miami on a bridge built by the Middletown & Cincinnati Railroad, a line established in 1892 to connect Middletown to the Little Miami Railroad.

Trail hikers, joggers, bicyclists, and rollerbladers today cross more railway bridges over the Little Miami than do railroads. Only three railroad spans are still used by trains: (1) the Indiana & Ohio Railway Bridge at the South Charleston crossing site established in 1878 by the Springfield, Jackson & Pomeroy Railroad, (2) the CSX Bridge at the Loveland crossing site established in 1868 by the Marietta & Cincinnati Railroad, and (3) the Norfolk Southern Bridge at the Mariemont crossing site established in the early 1880s by the Cincinnati & Eastern Railroad.

Humans and their means of transportation are not the only users of bridges across the Little Miami. The spans also provide nesting sites for birds that feed on insects emerging from the stream below. The following chapter will introduce these animals as well as the multitude of other species supported by the river.

6. ORGANISMS OF THE RIVER

Now laughing in ripples and dancing the sedges,
  Now fretting the minnows in eddy and whirl,
Now kissing the pebbles that sprinkle thy edges,
  And laving the pearl and the mother-of-pearl.

—W. H. Venable, 1904, from "To the Little Miami River"

Tributaries of the Little Miami include creeks named Beaver, Turtle, and Duck. These stream dwellers share the riverine resources of the watershed with over a thousand other species. This chapter will introduce the myriad forms of life, starting with the organism that has the greatest influence on the biotic community of the Little Miami River System.

Humans

People, since their appearance in the region at the end of the Ice Age, have always taken animals from the watershed's streams. For example, humans through the centuries have collected large mussels to eat and to examine for the presence of pearls. The usually pink-shaded pearls vary in diameter, with the largest being slightly bigger than the size of a pea. The nineteenth-century Little Miami River Pearl Fisheries, headed by Israel Hopkins Harris of Waynesville, obtained its specimens from both the Little and Great Miami Rivers. Harris sold about 2,000 pearls to Tiffany & Company in 1888, an assemblage that won a gold medal at the 1889 Paris Exposition as the world's finest collection of freshwater pearls.

Mussel gathering is no longer allowed in Ohio streams, but bullfrogs, green frogs, snapping turtles, softshell turtles, waterfowl, and fish are still legally taken for food. The large sport fish populations in the Little Miami led to the recent opening of a fishing store near the riverbank in Milford. Beavers, muskrats, and minks continue to be harvested for their fur. Otter trapping will again be allowed once the Little Miami Valley population returns to a sustainable level.

Humans, like otters, swim in the watershed's streams during the summer and skate over their frozen surfaces during the winter. In the 1800s, prior to the introduction of electric refrigeration, river ice was collected and used for the storage of perishable goods. The Cincinnati Ice Company, for example, had workers cut frozen blocks from the lower Little Miami. Mule teams then hauled the ice blocks to a long shed situated next to the Little Miami Railroad tracks in Plainville, the riverbank community named for its floodplain location. Sawdust from the Armstrong Upper Mill insulated the ice blocks until they were loaded onto freight trains bound for Cincinnati. From eight to ten railroad cars daily carried ice to the city through the summer months. The Plainville ice business ceased operating in the late 1800s after its icehouse was destroyed in a fire ignited by a spark from a passing locomotive.

Figure 14. Localities referenced in Chapter 6.

Ice was also harvested from the Little Miami at Oregonia and placed in two riverside icehouses, each about thirty feet square and twenty feet high. After a house was completely filled with several layers of frozen blocks, the ice was covered with a two- to three-foot-thick insulating blanket of straw. The blocks were separated during the following summer and carried by wagon to customers in Lebanon. The Oregonia ice company disappeared in 1897 after a flooding Little Miami destroyed its icehouses.

Although the river is no longer used as a source of ice, it continues to provide water for local residents. River water infiltrates into the Little Miami River Aquifer System that supplies the wells of many valley communities. Milford, for example, pumps its water from

the sand and gravel layers buried beneath the city's well field. Over eighty percent of Milford's groundwater supply originates from the passage of river water through the Little Miami's bottom sediments. In dry weather periods, more than ninety-five percent of the pumped groundwater is infiltrated river water.

Several communities in the watershed draw their water from surface reservoirs created by the damming of streams. The reservoirs range in size from under an acre to the 2,830 acres covered by Caesar Creek Lake. The depth of the lake reaches 115 feet, making it the deepest impoundment in the state. Water supply reservoirs in the Little Miami Valley also provide swimming, boating, fishing, and waterfowl hunting. Two of the reservoirs, Caesar Creek Lake and William H. Harsha Lake, additionally furnish dilution water for downstream sewage discharges during dry periods and flood reduction for downstream communities during wet periods. The lakes' dams hold back potential floodwaters and then slowly release them after the threat of flooding is past.

Many of the watershed's lakes were built with the primary purpose of providing water-based recreation. Examples are the Ohio State Park reservoirs Cowan Lake and Stonelick Lake, and the private impoundments Lake Lorelei and Lake Shawnee. Small dams have created dozens of fishing lakes and hundreds of farm ponds, ponds being lakes under a couple of acres in size. Brooks and creeks in parks, nature centers, and wildlife refuges have been dammed to provide habitats for lake and pond species. The Spring Valley Wildlife Area contains a good example of a large reservoir created specifically for lake organisms.

A stretch of a stream is drowned behind every dam. The few stream species that survive in dammed water bodies are those that normally dwell in stream pools. Riffle and run species are absent from impoundments because they require the higher levels of oxygen found in the tumbling waters of a stream, as opposed to the lower levels of oxygen present in the slackwaters of a reservoir. Most riffle and run animals also depend on the water current in a stream to bring in food and take away wastes.

Lake and pond species that live only in stilled waters comprise most of the biotic community in an impoundment. Smaller slackwater organisms may arrive at new impoundments as passengers on the feet of waterfowl. Insects also fly in, while slackwater fishes are introduced by people who hope to catch them later. The abundant gizzard shad in many of the watershed's impoundments were probably stocked as prey for transplanted sport fishes, although the shad could also be the descendants of animals that lived in stream pools located above the dam sites.

When a stream is interrupted by a dam, its aquatic community changes downstream as well as upstream of the structure. In East Fork, for example, an increased algal growth is apparent in the three miles of stream located below the Harsha Lake dam. The greater predominance of algae may be due to the reduction in the number of bottom-scouring water flows downstream of the flood control dam. Alternatively, the algal growth may be due to the increased clarity of the stream below the East Fork impoundment in which stream-borne erosion particles settle out of the stilled water.

In addition to flood control dams, earthen levees have been constructed to protect lowlands from flooding. Several levees exist in the watershed, e.g. along East Fork in the vicinity of Fayetteville and surrounding Cincinnati's Lunken Airport in the Little Miami floodplain. Levees keep a flooding stream away from areas into which the waterway had originally overflowed during storm events. However, by reducing the amount of surface over which floodwaters may spread, a levee increases flooding on adjacent, unprotected lands.

Another method to reduce the threat of flooding is to divert a stream into an artificial channel excavated at some distance from the flood-threatened property. A levee is sometimes constructed along the repositioned stream in order to prevent the waterway from returning to its natural course. The stream's original route is typically filled in and converted to the same economic use as the adjacent land. Examples of relocated stream segments in the watershed are a portion of the Little Miami channel next to Lunken Airport and a stretch of Indian Run flowing through Wilmington Air Park.

One final method to reduce flooding is to channelize a waterway. Channelization, or ditching, facilitates land drainage by straightening and smoothening a stream's channel to allow more rapid runoff. The channel also is deepened and widened so that the stream can handle increased volumes of runoff without overbank flooding. Streamside trees are removed, since their lower branches could retard the speed of bank-full flood flows. Tree branches could also catch debris carried downstream by floodwaters, thereby further slowing flood flows. Finally, trees along the banks could be uprooted by a flood current, floated downstream, and hung up on a bridge abutment where they would block stream flow.

Channelization destroys a stream's natural mosaic of riffles, runs, and pools. Water instead flows at a uniform speed and depth down a straightened waterway lined with clay, rocks, concrete, etc. During periods of heavy precipitation, the water velocity in a channelized stream may exceed what many species can tolerate. During low water intervals, the flow in a channel may be only inches deep, too shallow to conceal or support many types of aquatic organisms. The shallowness of a channelized stream and the absence of shade from streambank trees may cause summer water temperatures to reach levels that are lethal to some species. In sum, biologic diversity is lowered in a stream where channelization destroys the natural variety of depth, current, substrate, and light conditions.

Channelized locations in the Little Miami River System include segments of the upper main stem as well as portions of tributaries in agricultural areas. Channelized waterways also exist in flood-threatened residential and commercial zones. One channelized waterway, Duck Creek, is so confined within the Cincinnati urban region that stretches of its side slopes are too steep to be able to hold soil. The creek banks in these areas are instead covered with cement. Cement paving also covers the creek bottom where high velocity channels and passages under bridges must be protected from erosion. Natural stream habitats are totally absent from the paved sections of the creek.

Categories of Stream Life

Most of the stream miles in the Little Miami River System have not been impounded, channelized, or otherwise physically changed by humans. An unmodified waterway continues to support a natural biotic assemblage comprised of algae, bacteria, fungi, invertebrates, and vertebrates. The structure and functioning of an unaltered stream community is most easily understood by apportioning its many species into ecological categories (Figure 15, below).

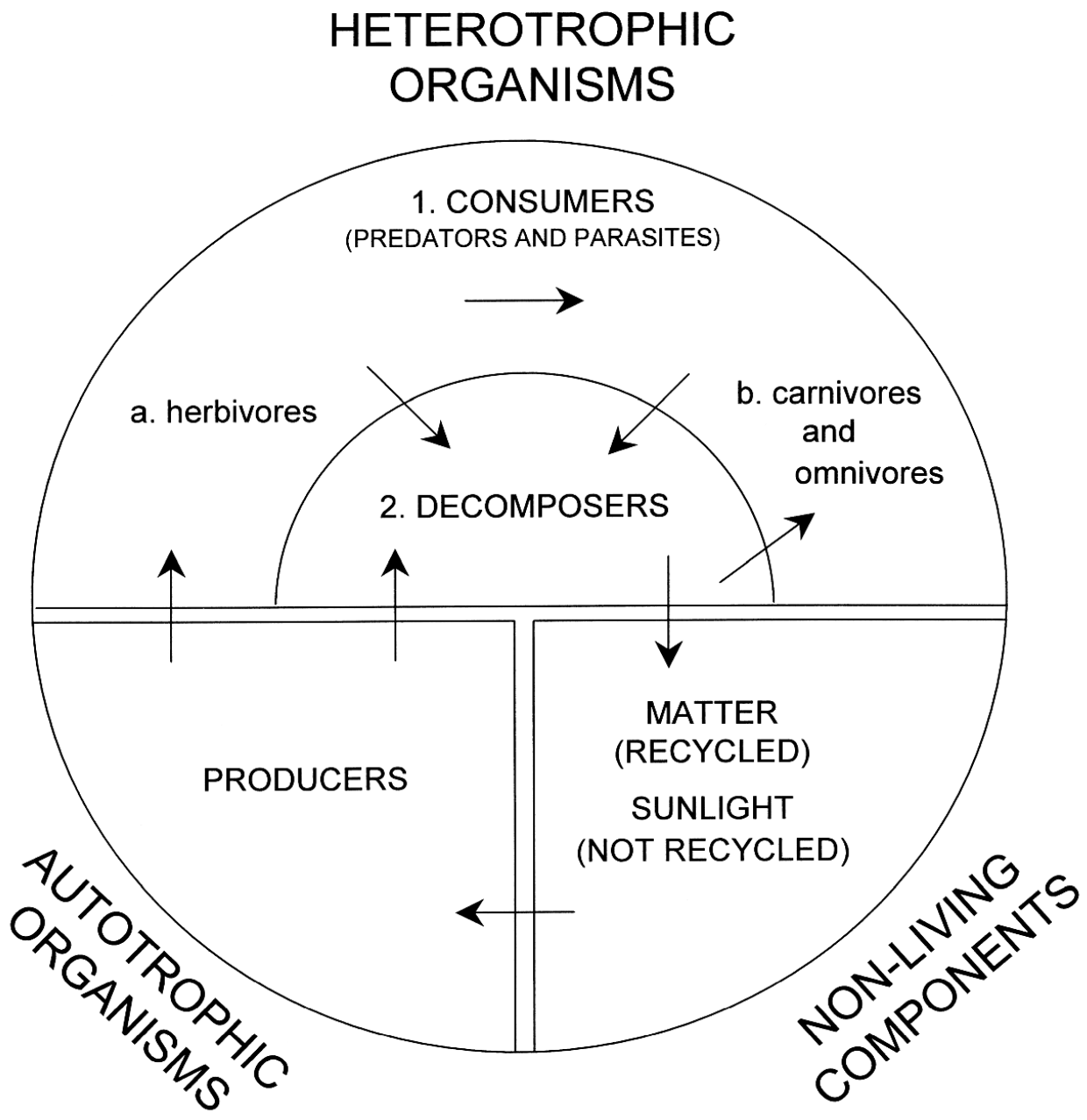

Figure 15. Flow of energy and cycling of matter in a stream community.

Autotrophs ("self-feeders"), also known as producers, are photosynthetic species that produce their own food by drawing energy from sunlight and matter from nutrients dissolved in the stream. In contrast, heterotrophs ("other-feeders") are species that cannot make their own food and so must obtain their energy and matter from other organisms. Heterotrophs that feed on dead things are known as decomposers because they break apart the dead tissues as they devour them. Heterotrophs that consume living or recently living things are called consumers, a category that includes herbivores, carnivores, and omnivores. An herbivore eats producers, a carnivore feeds on consumers and decomposers, and an omnivore functions sometimes as an herbivore and sometimes as a carnivore.

Producers in a stream are primarily single- and multiple-celled algae that live on the sunlit surfaces of bottom materials. One square centimeter of a submerged rock in the Little Miami may be covered by over a million algal cells representing more than a hundred species. The algae are consumed by *grazers*, an invertebrate feeding guild that includes species of snails, insects, and crustaceans (Figure 16, below).

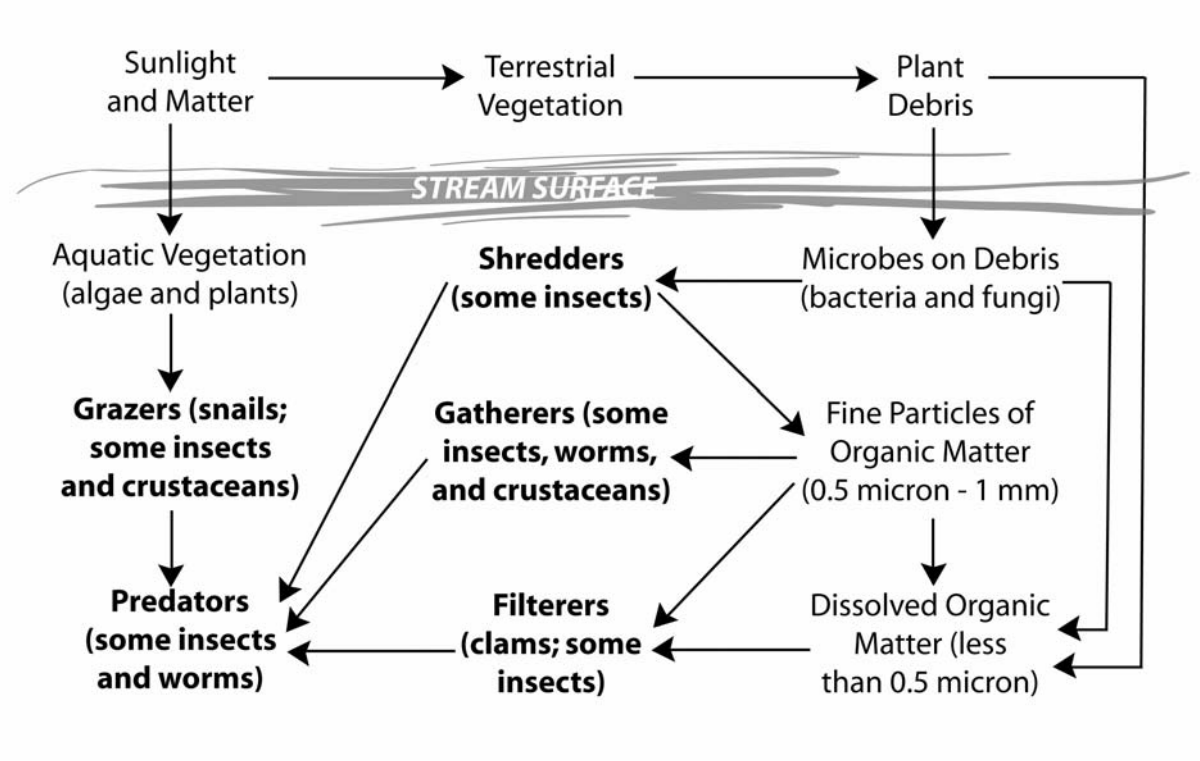

Figure 16. Invertebrate feeding guilds in a stream food web.

For the majority of stream consumers, however, the source of energy and matter is the plant debris carried into the waterway by storm runoff from the surrounding land. The terrestrial plant detritus constitutes almost the entire input of energy and matter to consumers living in deeply shaded streams where there is little sunlight to support algal growth. Plant material entering the water provides food for an insect-dominated feeding guild called the

shredders, who also obtain nutrition by consuming the bacterial and fungal microbes feeding on the plant tissues. Another feeding guild, composed of bivalve mollusks and some insects, is known as the *filterers*. These invertebrates filter the water to obtain the tiny organic particles that result largely from the action of shredders and microbes. The *gatherers*, a feeding guild made up of various species of insects, crustaceans, and worms, collect particles that settle to the stream bottom.

Carnivorous insects, crustaceans, and worms comprise the *predators*, the fifth invertebrate feeding guild in a stream. The predatory animals prey on grazers, shredders, filterers, gatherers, and other predators, as well as on terrestrial invertebrates that fall or wash into the water. A well-known predator in the Little Miami is the hellgrammite, the worm-like aquatic larva of the dobsonfly. The three-inch-long hellgrammite is the best bait when fishing for bass in the river.

As noted above, insects are members of all five invertebrate feeding guilds in a stream. Two types of life cycles are found in aquatic insects. Beetles, true flies, caddisflies, and the dobsonfly have four life stages (egg-larva-pupa-adult), while true bugs, dragonflies, damselflies, stoneflies, and mayflies have three (egg-nymph-adult). Aquatic beetles and true bugs generally stay in the stream for their entire life cycle, but the various types of flies leave the stream as adults, mate, and return to the stream to lay eggs.

Plankton, tiny organisms that swim weakly or float, appear in the larger pools of the Little Miami River System during the low flow period stretching from June through November. Phytoplankton ("plant-plankton") are microscopic algae and that serve as photosynthetic producers. Zooplankton ("animal-plankton") are microscopic and barely-visible invertebrates that consume phytoplankton and, sometimes, other zooplankton. The zooplankton group includes single-celled protozoans, minute crustaceans, and freshwater jellyfish.

Over 1,100 species of algae and invertebrates have been identified in the Little Miami River and its tributaries. At least twenty-three of these species were new to science when they were first collected in the watershed. Algae and small invertebrate species lack specific common names since they are not often seen by casual observers. Larger invertebrate species, on the other hand, typically do have common names. For example, the watershed's fifty native mussel species carry descriptive titles such as creek heelsplitter, elephant-ear, pimpleback, pocketbook, and snuffbox (Table 3, below). The region's two non-native bivalves are the appropriately titled Asian clam, named after the animal's place of origin, and zebra mussel, a European species with a black-and-white striped pattern covering its two shells.

Table 3. Native mussels of the Little Miami River System, with totals of individuals collected at 41 sites in 1990-91 and 2006-07. (Cincinnati Museum Center collection; Hoggarth, 1992; Hoggarth and Goodman, 2007)

Common Name	Scientific Name	1990-91	2006-07
Black sandshell	*Ligumia recta*	0	0
Clubshell	*Pleurobema clava*	1	0
Creek heelsplitter	*Lasmigona compressa*	14	3
Cylindrical papershell	*Anodontoides ferussacianus*	64	2
Deertoe	*Truncilla truncata*	1	72
Elephant-ear	*Elliptio crassidens*	0	0
Elktoe	*Alasmidonta marginata*	24	9
Fanshell*	*Cyprogenia stegaria*	0	0
Fatmucket	*Lampsilis radiata luteola*	870	108
Fawnsfoot	*Truncilla donaciformis*	11	25
Flat floater	*Anodonta suborbiculata*	1	0
Fluted-shell	*Lasmigona costata*	121	43
Fragile papershell	*Leptodea fragilis*	200	72
Giant floater	*Pyganodon grandis*	135	24
Kidneyshell	*Ptychobranchus fasciolaris*	99	17
Lilliput	*Toxolasma parvus*	3	1
Little spectaclecase	*Villosa lienosa*	23	0
Mapleleaf	*Quadrula quadrula*	38	52
Monkeyface*	*Quadrula metanevra*	0	0
Mucket	*Actinonaias ligamentina*	0	1
Paper pondshell	*Utterbackia imbecillis*	25	1
Pimpleback	*Quadrula pustulosa pustulosa*	1	1
Pink heelsplitter	*Potamilus alatus*	83	214
Pink papershell	*Potamilus ohiensis*	5	11
Pistolgrip	*Tritogonia verrucosa*	60	101
Plain pocketbook	*Lampsilis cardium*	308	76
Pocketbook*	*Lampsilis ovata*	0	0
Pondhorn*	*Uniomerus tetralasmus*	0	0
Purple lilliput*	*Toxolasma lividus*	0	0
Purple wartyback	*Cyclonaias tuberculata*	0	0
Rabbitsfoot*	*Quadrula cylindrica cylindrica*	0	0
Rainbow	*Villosa iris iris*	5	0
Rayed bean	*Villosa fabalis*	4	0
Round hickorynut	*Obovaria subrotunda*	0	0
Round pigtoe	*Pleurobema sintoxia*	1	0
Salamander mussel	*Simpsonaias ambigua*	0	0
Scaleshell*	*Leptodea leptodon*	0	0
Sheepnose*	*Plethobasus cyphus*	0	0
Slippershell	*Alasmidonta viridis*	176	20
Snuffbox	*Epioblasma triquetra*	3	0
Spike	*Elliptio dilatata*	330	93

Squawfoot	*Strophitus undulatus undulatus*	86	7
Threehorn wartyback	*Obliquaria reflexa*	0	22
Threeridge	*Amblema plicata*	377	146
Tubercled blossom*	*Epioblasma torulosa*	0	0
Wabash pigtoe	*Fusconaia flava*	294	35
Wartyback	*Quadrula nodulata*	1	2
Washboard	*Megalonaias nervosa*	0	1
Wavy-rayed lampmussel	*Lampsilis fasciola*	13	4
White heelsplitter	*Lasmigona complanata*	70	102

*no records after 1989

Stream Vertebrates

A total of 113 fish species have been found in the streams of the watershed (Table 4, below). As adults, they display a range of sizes, diversity of shapes, and variety of diets. One fish, the least brook lamprey, does not eat after reaching adulthood. This non-parasitic member of the lamprey family lives instead on reserves acquired during its filter-feeding juvenile stage.

Table 4. Fishes recorded in the Little Miami River System. (Harrington, 1999)

Common Name	**Scientific Name**	**pre-1955**	**1955-89**	**post-1989**
LAMPREYS	**PETROMYZONTIDAE**			
Least brook lamprey	*Lampetra aepyptera*	x		
PADDLEFISHES	**POLYODONTIDAE**			
Paddlefish	*Polyodon spathula*	x		
GARS	**LEPISOSTEIDAE**			
Longnose gar	*Lepisosteus osseus*	x	x	x
MOONEYES	**HIODONTIDAE**			
Goldeye	*Hiodon alosoides*		x	
Mooneye	*Hiodon tergisus*		x	x
HERRINGS AND SHADS	**CLUPEIDAE**			
Skipjack herring	*Alosa chrysochloris*		x	x
Gizzard shad	*Dorosoma cepedianum*		x	x
TROUTS AND SALMONS	**SALMONIDAE**			
Rainbow trout	*Oncorhychus mykiss*		x	
MUDMINNOWS	**UMBRIDAE**			
Central mudminnow	*Umbra limi*	x	x	x
PIKES	**ESOCIDAE**			
Grass pickerel	*Esox americanus vermiculatus*	x	x	x
Northern pike	*Esox lucius*		x	

Muskellunge	*Esox masquinongy*	x	x	
SUCKERS	**CATOSTOMIDAE**			
River carpsucker	*Carpiodes carpio*	x	x	x
Quillback carpsucker	*Carpiodes cyprinus*	x	x	x
Highfin carpsucker	*Carpiodes velifer*	x	x	x
White sucker	*Catostomus commersoni*	x	x	x
Blue sucker	*Cycleptus elongatus*			x
Creek chubsucker	*Erimyzon oblongus*	x	x	x
Northern hog sucker	*Hypentelium nigricans*	x	x	x
Smallmouth buffalo	*Ictiobus bubalus*	x	x	x
Bigmouth buffalo	*Ictiobus cyprinellus*		x	x
Black buffalo	*Ictiobus niger*		x	x
Spotted sucker	*Minytrema melanops*	x	x	x
Silver redhorse	*Moxostoma anisurum*	x	x	x
River redhorse	*Moxostoma carinatum*	x	x	x
Black redhorse	*Moxostoma duquesnei*	x	x	x
Golden redhorse	*Moxostoma erythrurum*	x	x	x
Shorthead redhorse	*Moxostoma macrolepidotum*	x	x	x
MINNOWS AND CARPS	**CYPRINIDAE**			
Central stoneroller	*Campostoma anomalum*	x	x	x
Goldfish	*Carassius auratus*		x	x
Redside dace	*Clinostomus elongatus*	x		
Spotfin shiner	*Cyprinella spiloptera*	x	x	x
Steelcolor shiner	*Cyprinella whipplei*	x	x	x
Common carp	*Cyprinus carpio*	x	x	x
Streamline chub	*Erimystax dissimilis*	x		
Gravel chub	*Erimystax x-punctata*	x	x	x
Tonguetied minnow	*Exoglossum laurae*	x	x	x
Mississippi silvery minnow	*Hybognathus nuchalis*	x		
Striped shiner	*Luxilus chrysocephalus*	x	x	x
Rosefin shiner	*Lythrurus ardens*	x	x	x
Redfin shiner	*Lythrurus umbratilis*			x
Silver chub	*Macrhybopsis storeriana*	x	x	x
Hornyhead chub	*Nocomis biguttatus*		x	
River chub	*Nocomis micropogon*	x	x	x
Golden shiner	*Notemigonus crysoleucas*	x	x	x
Bigeye chub	*Notropis amblops*	x	x	
Emerald shiner	*Notropis atherinoides*	x	x	x
River shiner	*Notropis blennius*	x	x	x
Bigeye shiner	*Notropis boops*		x	x
Silverjaw minnow	*Notropis buccatus*	x	x	x
Ghost shiner	*Notropis buchanani*	x	x	x
Blacknose shiner	*Notropis heterolepis*	x		
Silver shiner	*Notropis photogenis*	x	x	x
Rosyface shiner	*Notropis rubellus*	x	x	x
Sand shiner	*Notropis stamineus*	x	x	x
Mimic shiner	*Notropis volucellus*	x	x	x
Channel shiner	*Notropis wickliffi*	x		

Suckermouth minnow	*Phenocobius mirabilis*	x	x	x
Southern redbelly dace	*Phoxinus erythrogaster*	x	x	x
Bluntnose minnow	*Pimephales notatus*	x	x	x
Fathead minnow	*Pimephales promelas*	x	x	x
Bullhead minnow	*Pimephales vigilax*	x	x	x
Blacknose dace	*Rhinichthys atratulus*	x	x	x
Creek chub	*Semotilus atromaculatus*	x	x	x
CATFISHES	**ICTALURIDAE**			
Black bullhead	*Ameiurus melas*	x	x	x
Yellow bullhead	*Ameiurus natalis*	x	x	x
Brown bullhead	*Ameiurus nebulosus*	x	x	x
Channel catfish	*Ictalurus puctatus*	x	x	x
Mountain madtom	*Noturus eleutherus*	x	x	x
Stonecat madtom	*Noturus flavus*	x	x	x
Tadpole madtom	*Noturus gyrinus*			x
Brindled madtom	*Noturus miurus*	x		x
Northern madtom	*Noturus stigmosus*	x	x	x
Flathead catfish	*Pylodictis olivaris*	x	x	x
FRESHWATER EELS	**ANGUILLIDAE**			
American eel	*Anguilla rostrata*		x	x
KILLIFISHES	**CYPRINODONTIDAE**			
Eastern banded killifish	*Fundulus diaphanus*		x	
Blackstripe topminnow	*Fundulus notatus*	x	x	x
HAKES AND BURBOT	**LOTIDAE**			
Burbot	*Lota lota*		x	
TROUTPERCHES	**PERCOPSIDAE**			
Troutperch	*Percopsis omiscomaycus*	x	x	x
SILVERSIDES	**ATHERINIDAE**			
Brook silverside	*Labidesthes sicculus*	x	x	x
TEMPERATE BASSES	**PERCICHTHYIDAE**			
White bass	*Morone chrysops*		x	x
Striped bass	*Morone saxatalis*			x
BASSES AND SUNFISHES	**CENTRARCHIDAE**			
Rock bass	*Ambloplites rupestris*	x	x	x
Green sunfish	*Lepomis cyanellus*	x	x	x
Pumpkinseed	*Lepomis gibbosus*	x	x	x
Warmouth	*Lepomis gulosus*	x	x	x
Orangespotted sunfish	*Lepomis humilis*	x	x	x
Bluegill	*Lepomis macrochirus*	x	x	x
Longear sunfish	*Lepomis megalotis*	x	x	x
Redear sunfish	*Lepomis microlophus*			x
Smallmouth bass	*Micropterus dolomieu*	x	x	x
Spotted bass	*Micropterus punctulatus*	x	x	x
Largemouth bass	*Micropterus salmoides*	x	x	x
White crappie	*Pomoxis annularis*	x	x	x
Black crappie	*Poxomis nigromaculatus*	x	x	x
DARTERS	**PERCIDAE**			
Eastern sand darter	*Ammocrypta pellucida*	x		

Greenside darter	*Etheostoma blennioides*	x	x	x
Rainbow darter	*Etheostoma caeruleum*	x	x	x
Fantail darter	*Etheostoma flabellare*	x	x	x
Least darter	*Etheostoma microperca*		x	x
Johnny darter	*Etheostoma nigrum*	x	x	x
Orangethroat darter	*Etheostoma spectabile*	x	x	x
Variegate darter	*Etheostoma variatum*	x	x	x
Banded darter	*Etheostoma zonale*	x	x	x
Logperch	*Percina caprodes*	x	x	x
Channel darter	*Percina copelandi*	x		
Blackside darter	*Percina maculata*	x	x	x
Slenderhead darter	*Percina phoxocephala*	x	x	x
Sauger	*Stizostedion canadense*		x	x
Walleye	*Stizostedion vitreum*		x	x
DRUMS	**SCIAENIDAE**			
Freshwater drum	*Aplodinotus grunniens*	x	x	x
SCULPINS	**COTTIDAE**			
Mottled sculpin	*Cottus bairdi*	x	x	x
STICKLEBACKS	**GASTEROSTEIDAE**			
Brook stickleback	*Culaea inconstans*	x	x	x

Bottom-dwelling invertebrates comprise the diet of about 35% of the fish species, including sculpin, madtoms, many true minnows, and most of the sucker and darter families. Aquatic invertebrates in the water column and terrestrial invertebrates fallen to the water surface are taken by 10% of the species, among them the topminnow, killifish, silverside, mooneye, goldeye, and some true minnows. Invertebrates from all levels of a stream are eaten by another 10% of the fishes, including trout, mudminnow, a number of true minnows, and many of the sunfishes. A fourth group of carnivores, constituting approximately 20% of the fish fauna, feed on fish and, infrequently, other aquatic vertebrates. Among the fish-eaters are crappies, basses, gar, herring, eel, burbot, pickerel, pike, muskellunge, green sunfish, warmouth, sauger, walleye, drum, and flathead catfish.

Aquatic algae and terrestrial plant debris are consumed by the 5% of the fish species that are herbivores, including stoneroller, fathead minnow, silvery minnow, redbelly dace, and carpsuckers. Omnivores that eat a wide range of algae, plant debris, invertebrates, and fishes constitute 10% of the fish species, among them the creek chub, carp, goldfish, bluntnose minnow, stickleback, channel catfish, and bullheads. Other omnivores, comprising 5% of the fish fauna, strain phytoplankton and zooplankton from the water. Examples of plankton-eaters are bigmouth buffalo, shad, chubsucker, golden shiner, and paddlefish, a species that grows to six feet in length and over a hundred pounds in weight. Finally, 5% of the fishes in the Little Miami River System have uncertain or unknown diets.

The shallow, shaded headwaters of a stream support few fishes, typically darters and other small invertebrate-eaters, because there are few habitats and food items available for fish. Habitat diversity increases downstream as riffles become interspersed with deeper run

and pool habitats, enabling more types of fish to inhabit the waterway. Invertebrate-eaters share the lower stretches of larger streams with plankton-eaters, fish-eaters, herbivores, and general omnivores.

Fish in the Little Miami River System are caught and consumed not only by other fish, but also by amphibians, reptiles, birds, and mammals. One fish-eating amphibian is the mudpuppy, a foot-long salamander that lives submerged beneath rocks and sunken logs. The brown, mottled animal forages on the stream bottom, eating invertebrates as well as fish. The water snake, large turtles, and big fishes prey on the mudpuppy. Human anglers also contribute to the mortality of the salamander when they accidentally catch mudpuppies and discard the slimy-skinned animals on land or return them injured to the water.

Unlike the mudpuppy that is a permanent aquatic resident, the dusky, long-tailed, spring, streamside, and two-lined salamanders spend only their larval stage underwater. The larvae reside in the fishless headwaters of the watershed's creeks where they eat invertebrates and younger salamander larvae. The larval salamanders are eaten by the water snake, crayfish, and larger salamander larvae. Following metamorphosis, the adult salamanders live on land in the vicinity of the creeks and return to the waterways to breed.

Stream amphibians include frogs as well as salamanders. The six-inch-long bullfrog (named for its deep voice) takes invertebrates, fish, small frogs, juvenile snakes, and newly hatched turtles from the shallows of slow streams. The four-inch green frog, three-inch northern leopard frog (with rounded "leopard spots"), three-inch pickerel frog (with squared spots), and one-inch Blanchard's cricket frog (with an insect-like call) sit along stream margins where they feed on insects. The frogs at a stream are usually immigrants that metamorphosed in nearby ponds, since frogs rarely deposit their eggs in moving water. Frogs are eaten by a great number of animals, including fish, larger frogs, snakes, turtles, herons, hawks, owls, otter, mink, muskrat, and human.

Two semi-aquatic snakes reside along streams in the watershed. The queen snake is a slender, one- to two-foot-long serpent with a brown back bordered along each side by a yellow stripe. The queen snake has a restricted diet, feeding almost exclusively on recently molted, soft-shelled crayfish. The northern water snake is a stout, two- to three-foot-long serpent covered by dark brown blotches on a paler brown background. The species is often mistaken for the cottonmouth or water moccasin, a venomous snake whose range does not reach as far north as the Little Miami watershed. The northern water snake is primarily a fish-eater that also takes crayfish, worms, salamanders, frogs, and young turtles. Depending on their age, queen and water snakes are preyed upon by fish, frogs, turtles, herons, birds of prey, otter, and mink. A good place to observe snakes is along the lowermost Little Miami tributary, Lick Run, in Cincinnati Parks' California Woods Nature Preserve.

Turtles occupy the pools of larger waterways where they feed on fallen terrestrial plant material, carrion, and any animals they can catch—invertebrates, fish, amphibians, snakes, and waterfowl. Juvenile turtles are eaten by predatory fish, frogs, turtles, and the water snake. Herons, otter, mink, and muskrat take small- and medium-sized turtles, while people capture large snapping and softshell turtles to make into stews and soups. Listed from biggest to

smallest, the turtles in the Little Miami River System are: (1) snapping turtle, with a large head and long tail, (2) eastern spiny softshell turtle, with spines or bumps on a leathery carapace, (3) midland smooth softshell turtle, with a smooth, leathery carapace, (4) common map turtle, with a map-like pattern formed by yellow lines on its carapace, (5) red-eared slider, with a bright red bar behind each eye, (6) midland painted turtle, with a striking red and black pattern along the margin of its carapace, and (7) spotted turtle, with yellow polka dots on its carapace. Adult carapace lengths range from twelve inches in the snapping turtle to three inches in the spotted turtle.

The Audubon Society has recognized the Little Miami River as an Important Bird Area due to the variety and number of birds that occur along the stream. Many types of waterfowl swim on the river and its larger tributaries, especially in colder months when northern breeding species overwinter in southwestern Ohio or pass through during migration. Among the waterfowl, mergansers and grebes are carnivores that prey mostly on fish, while most duck species are omnivores that consume invertebrates along with plant matter. Herbivorous waterfowl include geese and a few ducks, e.g. the Canada goose, mallard, and wood duck that nest in the watershed. Waterfowl are eaten by the snapping turtle, birds of prey, mink, and human.

Non-waterfowl bird species that feed along watershed streams are all carnivores. Shorebirds, waterthrushes, and the prothonotary warbler capture aquatic invertebrates, and the bridge-nesting swallows and Eastern phoebe catch insects emerging from the water. The belted kingfisher makes aerial dives for fish, but also takes crayfish from shallows when turbidity in the water makes fish difficult to locate. Herons spear fish and any other streamside animals they can swallow. Fish are also taken by the osprey and bald eagle, while other birds of prey have unspecialized diets that include frogs, snakes, birds, and mammals.

The human is but one of the mammal species that procure food from the Little Miami River System. The northern river otter is an excellent swimmer that feeds primarily on fish and crayfish in the water flowing past its streambank den. A second carnivore, the American mink, usually lives in a ground burrow near a stream where it preys on fish, crayfish, mussels, amphibians, turtles, muskrat, and young beaver. The mink also hunts on land for turtle eggs, birds, and mammals. Otters and minks have no aquatic enemies, but predatory terrestrial mammals and birds of prey capture and eat them. Fur trappers legally take minks and illegally take otters in the watershed.

The muskrat consumes living mussels as well as fish, frogs, and aquatic carrion. Animals, however, constitute only a small part of the muskrat's omnivorous diet—most of its food is herbaceous plant material taken from the shoreline. Uneaten plant parts are cached in the muskrat's streambank burrow. Muskrats living in impounded streams construct water-encircled, mud-and-vegetation lodges instead of underground bank dens. The muskrat is taken by the snapping turtle, birds of prey, otter, mink, and fur trapper.

The beaver, like the muskrat, is a semiaquatic rodent that resides either in a streambank burrow or in a lodge built in an impoundment. The beaver typically creates its own impoundment by building and maintaining a stick-and-mud dam across a stream. The

herbivorous animal primarily eats the bark and cambium layers of trees growing along the banks of a watercourse. Otters and minks eat young beavers, while humans trap beavers for their skins and to stop property damage caused by the animals' tree harvesting and dam building activities.

Riparian Forest Organisms

Riparian (streamside) woodland is an integral part of a stream ecosystem. The riparian forest is the breeding habitat for the wood duck, prothonotary warbler, and other wildlife taking food from the stream. Riparian trees are essential resources for beavers, and the leaves and woody debris that drop into the stream become food items for aquatic microbes and animals. Riparian forest invertebrates that fall into the watercourse likewise provide nutrition for stream species.

Leafy shade cast by the deciduous trees in a riparian woodland bring about cooler water temperatures in the summer. During winter months, the leafless trees allow sunlight to slightly warm the stream. Leaf litter on the floor of the woodland acts to filter erosion sediments from storm runoff flowing to the waterway. Tree root systems hold the banks while allowing undercutting by the stream, thus providing cover among the submerged roots for many aquatic animals. Trees falling into the watercourse cause the formation of aquatic habitats with varying water velocities and depths, thereby permitting many different species to co-exist in the stream. In sum, the plants and animals in a riparian forest greatly influence the organisms in the adjacent stream.

7. SPECIES CHANGES AND POLLUTION

Glide, whispering now under sycamore shadow,
Now singing by hamlet and cottage and mill,
Now shimmering onward through flowery meadow,
Now glassing the image of foresty hill.

—W. H. Venable, 1904, from "To the Little Miami River"

The trees in a riparian forest are species that can withstand frequent flooding, saturated soil, and reduced soil aeration. Riparian woodlands in the Little Miami watershed are composed of such flood-tolerant species as cottonwood, silver maple, black willow, box elder, green ash, and Ohio buckeye—the state tree. The largest riparian tree species is the sycamore, often called the buttonwood due to the resemblance of its fruits to big buttons. Another characteristic of the sycamore is the development of a large trunk cavities in older trees.

The now-extinct Carolina parakeet roosted and nested in sycamore cavities and ate sycamore fruits. The twelve-inch-long bird also ate fruits and seeds of other plants, but clearly preferred sycamore buttons. The prevalence of sycamores along the Little Miami was probably responsible for the large number of parakeets seen at the mouth of the river in 1810. The observer was Alexander Wilson, the father of American ornithology, who was boating down the Ohio River on his way to New Orleans. According to Wilson, the "gay and glossy" parakeet had "a very beautiful and splendid appearance."

Farmers, on the other hand, knew the parakeet as "the winged rat" that supplemented its diet of native foods with grains from cropfields and fruits from orchards. Farmers throughout the parakeet's range in eastern United States shot the despised bird, an activity made easier by the parakeet's trait of returning to fallen members of its flock. Other human actions also contributed to the steep decline in the number of parakeets during the nineteenth century. Hunters killed the birds for food, for sport, or for feathers—the parakeet's plumage decorated the hats of many fashionable women. The brightly colored species was also captured alive and sold in markets as a cage bird. Finally, honeybees imported from Europe usurped the tree cavities in which the parakeet roosted and nested.

The parakeet disappeared from the Little Miami watershed in about 1840, and the last free-flying parakeet was taken in Florida in 1913. The final surviving parakeet, a male named Incas, passed away at the Cincinnati Zoo on February 21, 1918. The extinction of the Carolina parakeet meant that the riparian species would nevermore grace the shores of the Little Miami. On the other hand, the river's sycamores now hosted a new species, the European honeybee.

Figure 17. Localities referenced in Chapter 7.

The human-assisted addition of a non-native species such as the honeybee has occurred many times along the Little Miami and its tributaries. For example, the osage orange or hedge-apple is an introduced tree that often grows in the watershed's riparian forests. Farmers imported the osage orange to Ohio from the southern United States during the early nineteenth century. They planted hedges of young osage orange trees in places where they otherwise would have to construct and maintain wooden fences. The dense growth and two-inch thorns of the trees served to contain livestock in pastures and exclude free-ranging animals from croplands. Once the osage orange became established on Ohio farms, its spreading seeds allowed the species to become a naturalized tree in a variety of habitats,

including the state's riparian woodlands. Meanwhile, farmers stopped planting the tree on their properties following the mid-nineteenth-century invention of barbed wire.

Arrivals and Departures of Stream Species

The non-native turtle known as the red-eared slider is one of a number of vertebrate species brought into the Little Miami watershed during the twentieth century. Thousands of recently hatched sliders were sold in local stores as "baby turtles" beginning in the 1950s. Releases of pet sliders by children and parents allowed the south-central United States species to join the native turtle fauna. The goldfish and eastern banded killifish, two non-native fishes kept in home aquaria, were also released by people into the waters of the Little Miami basin. Six other non-native fishes—rainbow trout, northern pike, common carp, white bass, striped bass, and redear sunfish—were introduced by federal, state, and private agencies attempting to improve fishing in the watershed.

While new animals appeared in the river, other species vanished. Nine native fishes have not been seen in the Little Miami River System since the mid twentieth century. Two of the animals, the paddlefish and the channel shiner, are difficult-to-catch Ohio River species that probably continue to swim unnoticed into the Little Miami near its mouth. The other fishes that have not been recorded since the 1950s are the least brook lamprey, redside dace, blacknose shiner, eastern sand darter, channel darter, streamline chub, and Mississippi silvery minnow (the chub and minnow were last collected in the watershed during the nineteenth century). These seven missing species disappeared from the Little Miami basin due to the siltation of their environment.

In the eighteenth century, according to surveyors' and pioneers' journals, the Little Miami and its tributaries ran clear, even during floods. The watershed then was heavily forested, with prairie patches and Indian clearings likely comprising less than one percent of the land. Tree litter covering the ground and extensive tree root systems kept the soil in place and out of streams.

The watershed's soil became exposed as farmers stripped away the original forest cover. Plowing of the land stirred the soil up into greater contact with the eroding agents of rainfall and snowmelt. Runoff carried loose soil particles into waterways inhabited by the above-mentioned seven fishes, eventually causing them to disappear because the erosion silt (1) covered bottom habitats in which the fish resided, (2) smothered algae and invertebrates used for food, (3) caused asphyxiation by clogging gills, (4) obscured mating activities that relied on sight, and (5) suffocated eggs deposited in spawning areas. The Ohio Environmental Protection Agency reports that siltation continues to adversely impact the remaining fishes and other organisms in the Little Miami River System. Farming remains the major source of silt, but construction activities also contribute erosion sediment to the waterways.

Mirroring the loss in the variety of native fishes, the diversity of native mussels has also declined. Biologic surveys since 1990 have not recorded nine of the fifty species of native mussels previously reported from the Little Miami River System. In addition, biologist

Michael Hoggarth found that between 1990-91 and 2006-07 there occurred a drop in the total number of individual native mussels, an increase in Asian clam populations, and the arrival of zebra mussels (Table 5, below).

Table 5. Bivalve mollusks collected from four streams.
(Hoggarth and Goodman, 2007)

Stream	**1990-1991**	**2006-2007**
Little Miami River (26 sites)		
Native mussels	853	774
Asian clam	70	6632
Zebra mussel	0	0
East Fork (10 sites)		
Native mussels	1681	472
Asian clam	222	995
Zebra mussel	0	0
Todd Fork (3 sites)		
Native mussels	182	1
Asian clam	0	0
Zebra mussel	0	0
Caesar Creek (2 sites)		
Native mussels	731	18
Asian clam	129	1520
Zebra mussel	0	880

The Asian clam, whose native range is Southeast Asia, was somehow brought to the west coast of the United States during the early twentieth century. The Asian clam appeared in the Midwest via unknown pathways in the late 1950s, spreading up the Ohio River and into tributaries such as the Little Miami. A second non-native mollusk, the zebra mussel, was accidentally introduced into the Great Lakes in the 1980s, apparently having been a stowaway in the ballast of freighters sailing from freshwater ports within the mussel's range in Europe. The zebra mussel reached the mouth of the Little Miami in the early 1990s by hitchhiking on barges traveling from Chicago via the Illinois, Mississippi, and Ohio Rivers.

Competition introduced by the Asian clam and zebra mussel could be causing the decline of native mussels in the Little Miami basin. Alternatively, the native mussels may be declining due to water pollution, thereby opening up space to be colonized by the more pollution-tolerant invaders. Water pollution is definitely the responsible agent at stream

locations where native mussels are vanishing and the Asian clam and zebra mussel are absent.

The Ohio Environmental Protection Agency monitors stream health by sampling fish and macroinvertebrates (invertebrates visible to the naked eye) at over one hundred sites in the Little Miami River System. The agency's data shows that while exceptional and good fish and macroinvertebrate communities are found at most sampling locations, fair and poor assemblages do occur at some sites. The reduced fauna at a particular location is sometimes due to the aquatic habitat being modified by channelization or streambank modification. More often, a degraded stream community is the result of water pollution caused by eroded soil (siltation), chemicals, livestock manure, or human waste.

Chemicals in Runoff

Chemical pollutants in urban runoff degrade streams in the Dayton, Xenia, Wilmington, and Cincinnati regions. For example, the poor health of the biologic community in Little Beaver Creek is due to high concentrations of cadmium, copper, mercury, organochlorine pesticides, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons in the stream's bottom sediments. The creek's aquatic animals sicken and die when they acquire these chemicals through absorption or through ingestion of food items. The source of the toxic substances in Little Beaver Creek is stormwater runoff from metropolitan Dayton neighborhoods and industrial areas.

Streams draining agricultural portions of the Little Miami watershed also contain a variety of deadly chemicals, i.e. herbicides, insecticides, and fungicides. In East Fork, for example, forty-two pesticide compounds have been detected. Atrazine is the most common pesticide in the stream as well as in most watercourses of the Little Miami River System. Atrazine eliminates broadleaved weeds in cropfields, but when carried into waterways by stormwater runoff, the herbicide may severely impact biological communities. Atrazine kills some species of aquatic algae and is absorbed into others that are consumed by stream invertebrates. Crayfish in the Little Miami are accumulating atrazine through the food chain and are passing the herbicide on to vertebrate predators that are susceptible to atrazine poisoning. Several nations have banned the use of atrazine on croplands, but it continues to be a commonly applied herbicide on farms in the United States.

When chemically polluted stormwater flows off a confined area, a catch basin and treatment system can be built to prevent the contaminated runoff from reaching a waterway. Such a solution was implemented at Wilmington Air Park to intercept propylene glycol, an airplane deicer that was causing invertebrate and fish deaths in Lytle Creek. Structural projects, however, are unaffordable when dealing with polluted runoff from large metropolitan areas and agricultural tracts. Instead, extensive grassed or wooded strips should be established along ditches and streams to filter and adsorb the chemical pollutants.

While some chemicals destroy life, others are the building blocks for living things. Chemicals essential for photosynthetic organisms include carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, and others. Of the chemical elements in the Little Miami

River System, phosphorus is the one present in the least favorable amount for algal growth. In other words, the quantity of algae in a stream is limited by the amount of phosphorus in the water.

Algal growth increases when various human activities add more phosphorus to the stream. The resulting greater biomass of algae is usually capable of meeting its oxygen needs during daylight hours. However, when photosynthetic oxygen production ceases at sunset, the unnaturally abundant algae consume most of the dissolved oxygen in the surrounding water. This depletion of oxygen in the stream creates lethal nighttime conditions for many invertebrate and fish species.

Excess quantities of phosphorus are introduced throughout the Little Miami River System. One source is eroded soil entering a waterway from farms and construction sites. Soil contains phosphorus, and agricultural soil holds elevated amounts of the element due to the application of fertilizer. As long as large amounts of eroded soil run into watershed streams, aquatic animal populations will suffer from nighttime deoxygenation as well as from siltation.

Agricultural erosion needs to be addressed through the adoption of soil conservation practices such as no-till farming, contour strip cropping, and riparian woodland restoration. In no-till farming, crop residue is left on the cropland to reduce the erosive power of raindrops. Contour strip cropping involves plowing rows parallel to a stream corridor rather then perpendicular to it. All denuded riparian zones in rural and urban areas should be replanted so that they may again intercept land runoff and hold soil particles out of adjacent watercourses. Finally, at building and road construction sites, either plastic barriers or straw bales need to be put in place to block the movement of erosion silt into streams.

Livestock Manure and Human Sewage

Phosphorus is present in animal and human wastes as well as soil. Drainage from livestock facilities and effluents containing human wastes are the sources for most of the phosphorus in watershed streams during dry periods. As discussed above, elevated phosphorus levels create excessive algal growths that lead to nocturnal oxygen depletion in waterways. Stream oxygen levels may also be depressed during daylight hours if elevated amounts of manure and human wastes reach a watercourse and feed large populations of bacteria and fungi. The overabundant microbes will use up the waterway's dissolved oxygen and cause suffocation of the stream's aquatic animals.

To stop animal manure from entering a stream, grazing livestock should be fenced out of the waterway and a vegetated riparian buffer should be established to capture runoff from the pasture. Fecal waste that is generated in a feedlot should be fully contained until it can be composted or applied properly to croplands. Many procedures need to be implemented to keep human fecal material out of streams, as is outlined below.

Body wastes from people were once deposited in pits dug into the ground. When the pits became filled, new ones were excavated. Outhouses were erected over the waste pits in

order to provide comfort, privacy, and protection from the weather. Today, most outhouses are historic structures, having been replaced by indoor bathrooms with flush toilets.

Since the adoption of indoor plumbing, rural homeowners have installed underground septic vaults to receive toilet effluent and other wastewaters draining from the bathroom, kitchen, and laundry. Older septic vaults drain their contents into a leach field, while newer ones may discharge to a subsurface sand filter or an aerobic digester. Tens of thousands of individual septic systems exist in the Little Miami watershed, many of them producing inadequately treated sewage that is carried downhill to a stream. Sewage in a waterway not only causes oxygen depletion, but also exposes stream-using humans to pathogenic microbes present in feces of infected people. Disease-causing microbes may also be transmitted to humans by insects and dogs that come in contact with sewage-contaminated stream water.

Septic systems in the watershed are failing due to poor maintenance, faulty construction, incorrect installation for the soil type, or inadequate capacity. A large number of the systems were designed for houses that employed a cistern for their water source. The majority of these homes have since been connected to public water supplies, but their septic systems have not been upgraded to deal with the increased use of water associated with "unlimited" public supplies. Undersized and poorly functioning septic systems should be replaced or repaired, and homeowners should be educated on the proper operation and maintenance of the systems. Where feasible, individual septic systems should be eliminated through the extension of municipal sewers.

Municipal sewer systems appeared when the evolution of sewage treatment took a different path in urban areas. In the nineteenth century, backyard outhouses were as universal in cities as they were in rural areas. However, with the adoption of the indoor toilet, city-dwellers could no longer use their house lots for on-site sewage disposal. An urban backyard was too small to serve as a wastewater drainage field, and so toilet effluent was instead directed into the storm sewer pipe that ran beneath the street in front of the house.

Cities had originally installed their storm sewers to reduce urban flooding by having the pipes carry rain and snowmelt directly to local waterways. However, with the introduction of toilet wastes into the storm sewers, the stormwater conduits turned into "combined sewers" carrying a combination of storm and sanitary sewage. Urban tributaries of the Little Miami River soon became contaminated by inflowing human feces and urine, as well as by kitchen and laundry wastes that came to be included in sanitary (actually *unsanitary*) sewage. Public concern about the unhealthiness and smell of wastewater-polluted urban streams led to the routing of combined sewer systems to newly constructed wastewater treatment plants during the first half of the twentieth century.

A wastewater treatment plant removes polluting materials from sewage prior to its release into a watercourse. However, during stormy periods, many of the contaminants do not reach the wastewater treatment facility when much of the stormwater-swollen combined sewage overflows the sewer pipes and drains into streams. Combined sewer overflows have grown in number and size as (1) the volume of urban storm sewage has increased due to the conversion of vegetated areas into impervious parking lots and building sites, and (2) the

volume of urban sanitary sewage has increased due to population growth and higher per capita water usage. Presently, over 1.5 billion gallons of combined sewage enters the Little Miami during a year with average precipitation.

To eliminate municipal sewage contamination in the Little Miami and the nation's other river systems, the United States Environmental Protection Agency is now requiring sewer districts to stop untreated combined sewage from entering urban waterways. One solution is to construct a small sewage-cleansing unit at each combined sewer overflow point, a unit that operates only during overflows. Another option is to enlarge the capacity of the combined sewer system so that it can carry all of its contents to the treatment plant, even during a large storm. A third option is to build storage facilities to accept stormwater-swollen combined sewage that would otherwise overflow. The stored sewage is slowly returned to the sewer and carried to the treatment plant after the storm ends.

A final method to eliminate the combined sewer overflow problem is to construct a separate "sanitary sewer" system throughout the sewage collection area. All sanitary sewage is then directed through the sanitary sewer pipes to the treatment facility. Without the influx of stormwater that causes overflows, sewage in a sanitary sewer system always reaches the treatment plant. Following the installation of a sanitary sewer system, the combined sewer pipes can return to serving solely as stormwater conduits leading to streams.

Sewer service areas in the Little Miami watershed have been built with separate sanitary and storm sewers ever since problems with combined sewers became evident in the early twentieth century. Unfortunately, some sanitary sewer pipes are beginning to deteriorate with age, allowing the infiltration of stormwater that overfills the sanitary sewers and causes them to overflow their polluted contents into watercourses. Stormwater also enters sanitary sewers when builders unlawfully tap into sanitary sewer pipes in order to direct water away from basement foundations. To eliminate sanitary sewer overflows, sewer districts must replace deteriorated sewer pipes and enforce the disconnection of illegal tap-ins.

Sewage-caused stream deoxygenation will be reduced by stopping overflows of untreated sewage, but it will be eliminated only after all of the watershed's wastewater treatment plants cease discharging inadequately treated effluent. One of the plants, the Wilmington treatment facility, is widely known for its record of polluting Lytle Creek. The treatment plant's notoriety is due to the selection of Lytle Creek in 1949 as the site for a federal government study on the environmental effects of sewage. Several oft-cited publications resulted from the research project conducted by the Environmental Health Center of the United States Public Health Service.

Lytle Creek is an eleven-mile-long stream that empties into Todd Fork. At the time of the federal study, effluent from the Wilmington wastewater treatment plant entered Lytle Creek at a point 7.3 miles above the stream's mouth. The sewage effluent comprised most of the volume of the creek during dry periods. In summer and fall months, stream flows averaged about one-tenth cubic foot per second above the treatment plant outfall and one cubic foot per second below it. As in all waterways, the algae in Lytle Creek produced

oxygen through photosynthesis only during daylight hours, thereby causing a wide day-night difference in stream oxygen levels at locations both above and below the outfall (Figure 18, below).

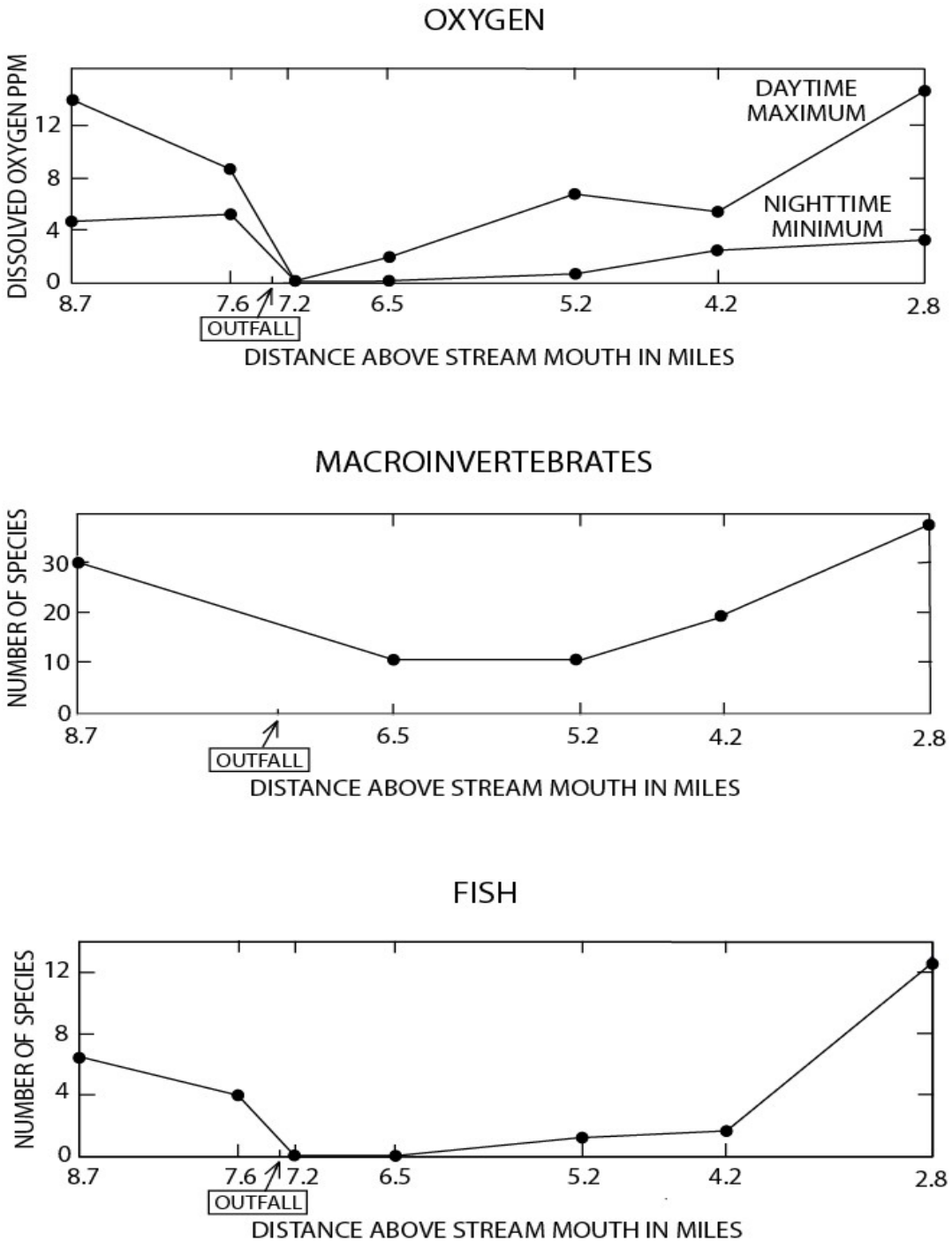

Figure 18. Impact of partially treated Wilmington sewage plant effluent on Lytle Creek. *Top:* Range of dissolved oxygen levels, August 22-23, 1951. *Middle:* Total macroinvertebrate species taken during six collections, April-August, 1951. *Bottom:* Mean number of fish species taken per collection; 20 collections from May 1950 to July 1952. (Gaufin and Tarzwell, 1952; Katz and Gaufin, 1953)

The Wilmington treatment plant used a precipitation process that removed only about half of the sewage solids prior to releasing the wastewater into the creek. By the time the partially treated sewage was discharged from the plant, bacterial and fungal decomposition was well advanced and there was no dissolved oxygen in the effluent. Therefore, during dry months, no oxygen was present in the creek immediately below the discharge point of the plant. The creek's oxygen level remained depressed for over four miles downstream of the outfall.

Lytle Creek's macroinvertebrate community exhibited a loss of species in the section of the stream below the outfall. The only species that survived in the poorly-oxygenated water were those with special adaptations, e.g. an elevated hemoglobin level in the blood, the ability to obtain dissolved oxygen through skin as well as gill surfaces, and structures for drawing oxygen from the air above the stream surface. The fish community was also impacted by the deoxygenation of the creek. Fish were absent from the first mile of Lytle Creek below the Wilmington plant outfall, and in the next two miles there existed only species that can tolerate oxygen-poor environments, e.g. creek chub, fathead minnow, and green sunfish.

The degradation of Lytle Creek was well documented by federal scientists who studied the watercourse in the mid twentieth century. Concurrent state investigations of other stream communities in the Little Miami basin revealed that they were also impaired by outflows from wastewater treatment plants. The Wilmington facility has been upgraded several times over the last half century, and its outflow now has less impact on the macroinvertebrates and fishes of Lytle Creek. Improvements at the other treatment plants in the Little Miami watershed have also reduced the environmental damage associated with the discharge of sewage effluent. However, phosphorus in the treatment plant outfalls continues to create algal blooms that can lead to the nighttime suffocation of many stream animals. The average concentration of phosphorus in the Little Miami is significantly higher than the maximum recommended by the federal government, and yet more sewage treatment plants are planned for the future in order to service the increasing human population in the watershed.

In 2000, the Ohio Environmental Protection Agency announced that the anticipated increase of phosphorus-laden sewage effluent in the Little Miami would cause a worsening of the stream's health. The conservation organization American Rivers substantiated the state's assessment and, in 2005, added the Little Miami to its roster of the nation's most endangered rivers. In announcing the listing of the stream, the president of American Rivers explained, "We haven't put the Little Miami River on our list to tell the public how polluted the Little Miami River is today. We have put the river on our list to warn how polluted it may become tomorrow."

At present, most of the summer and early autumn flow in the lower Little Miami consists of phosphorus-laden sewage treatment plant effluent that causes a reduction in the river's biotic community. To help restore the natural diversity of species in the river, more phosphorus must be removed at the treatment plants. Sewer taxes will have to increase to fund expensive phosphorus-reduction processes, but such is the cost of stewardship for those of us who reside in the watershed of a beautiful National Scenic River.

APPENDIX: LITTLE MIAMI RIVER CONSERVATION GROUPS

In addition to federal, state, and local government offices, the following organizations are working to preserve the natural qualities of the Little Miami.

Audubon Ohio, through education and advocacy, promotes the conservation of natural environments and the protection of birds and other wildlife in the state. The organization has identified the Little Miami River corridor as an Important Bird Area that merits protection for its vital bird habitats. The corridor serves as a breeding, migration, wintering, or year-around location for several species on the Audubon Society WatchList, the roster of the nation's most imperiled birds.

Beaver Creek Wetlands Association forms alliances with government agencies and conservation groups to protect the Beaver Creek wetland ecosystem in the Little Miami watershed. The Association has facilitated the protection of over 1,700 acres along Beaver Creek and Little Beaver Creek. An almost continuous corridor for wildlife now stretches for over twelve miles, and the Association continues its work to make the final connections in the corridor.

The Association develops education materials and participates in regional expositions, fairs, and festivals. Wetland access is improved through the construction of trails and boardwalks, allowing schools to reach areas for study and research. Disturbed wetlands are restored through removal of drainage tiles and planting of wetland vegetation.

Cincinnati Chapter of the Izaak Walton League of America is a regional chapter of an organization dedicated to protecting outdoor recreation resources. The Chapter's lodge and campground are located on the east bank of the Little Miami between Loveland and Branch Hill. Among its many conservation activities in the Little Miami Valley, the organization is best known for its sponsorship of river cleanups.

The Chapter, in conjunction with river canoe liveries, organizes the summertime Little Miami Scenic River Challenge, one of the oldest waterway cleanups in the nation. Every year since the early 1980s, participants have collected litter from over eighty miles of riverbank. The Chapter also loans its own canoes and trailers to organized groups that conduct Little Miami cleanups at other times of the year.

Cincinnati Nature Center presents educational programs and preserves streams and land at two locations, Rowe Woods and Long Branch Farm. Rowe Woods protects the Avey's Run basin in the East Fork Valley. The 1,025-acre site contains old-growth forest, young woodlands, meadows, waterfalls, ponds, a lake, and a large glacial conglomerate feature known as Fox Rock. Long Branch Farm is a 582-acre property containing agricultural and natural communities along O'Bannon Creek.

Clinton StreamKeepers has a mission to preserve, protect, and improve water quality in the many Little Miami tributaries originating in Clinton County. The group monitors water quality in the streams and sponsors streamwalks. It also promotes riparian buffer zoning and

scrutinizes highway plans, sewage treatment plant projects, gravel quarry activities, and concentrated animal feeding operations.

East Fork Watershed Collaborative brings together individuals and organizations to protect and enhance the biological, chemical, and physical integrity of East Fork and its tributaries. The Collaborative prepares and periodically reassesses management plans for the five sub-regions comprising the East Fork region of the Little Miami watershed. The plans include goals and strategies for wastewater management, stormwater management, and ecological land use.

In the area of education, the Collaborative hosts workshops for home sewage treatment plant owners and pursues partial funding for failed systems. Workshops concerning stream management are offered for landowners, developers, engineers, environmental consultants, planners, and zoning officials. An annual East Fork River Sweep attracts volunteers to collect litter from the waterway and its shorelines.

Friends of the Little Miami State Park, Inc. acts as a link between the park management and the surrounding communities. The group believes that the restoration and preservation of the park depends on an engaged and informed citizen presence. Friends of the Little Miami State Park assists with the planning, maintenance, improvement, safety, parking, park access, and promotion of the park.

Glen Helen Association supports the programs of the Glen Helen Ecology Institute. Glen Helen is a 1,000-acre nature preserve located in Yellow Springs. The preserve protects the community's namesake spring, a waterfall, a relocated covered bridge, a mill building, prehistoric Indian earthworks, the lower portion of Yellow Springs Creek, and a stretch of the Little Miami River shoreline below John Bryan State Park.

Greenacres Water Quality Project LLC improves and protects the lower Little Miami and its tributaries through education and involvement of the public. The Project sponsors a school-based, stream quality monitoring program and conducts teacher training sessions on water issues. It also organizes community streamwalks, waterway cleanups, and homeowner workshops on planting rain gardens to capture stormwater runoff.

The Project's Saturday Stream Snapshot Citizen Volunteer Water Monitoring Program collects water quality data from throughout the lower Little Miami watershed. The information is made available online for use in stream protection and planning activities. Identified water quality problems are reported immediately to proper government agencies.

Little Miami Incorporated is the foremost organization working for the protection of the river and its valley corridor. Founded in 1967, the group played the leadership role in having the stream designated as a State and National Scenic River and in the establishing the Little Miami Scenic Trail. The executive director and staff continue to work closely with local, state, and federal government agencies that have management responsibilities for the river and its floodplain. The group's major goals are to protect water quality and to restore and conserve riparian woodland.

Little Miami Incorporated sponsors ecological investigations of the river community, operates the educational Little Miami Scenic River & Trail Center in Loveland, and manages

more than fifty nature preserves and reforestation projects. Largely due to the group's negotiation of land gifts, conservation easements, and property purchases, most of the river's riparian woodland is permanently preserved. Much of the remaining riverbank forest is semi-protected through river buffer zoning ordinances that Little Miami Incorporated proposed for local political jurisdictions.

Little Miami River Partnership is an umbrella organization of citizens, businesses, communities, government agencies, and conservation groups dedicated to improving the Little Miami and its tributaries. The Partnership provides planning, facilitation, and networking services for projects that restore and protect the water quality in the watershed. Using scientific data gathered from many sources, the organization prepares and updates action plans to solve environmental problems in three sub-watersheds: Upper Little Miami/Caesar Creek, Todd Fork, and Lower Little Miami.

The Partnership organizes educational events such as the Annual Water Quality Symposium, the Annual Little Miami River Water Festival at Caesar Creek State Park, and various trainings. Winning submissions to the Little Miami River Watershed Photo Contest are shown in Cincinnati, Dayton, and Springfield galleries.

Little Miami Scenic River Advisory Council advises the Ohio Department of Natural Resources Division of Natural Areas and Preserves on issues concerning the preservation of the river. The goal of the Council is to protect the waterway from uses and activities that would destroy its natural attributes. The ten-member Council is comprised of local government officials, representatives of conservation groups, and private citizens. The Southwest Ohio Scenic Rivers Coordinator provides a link between the Council and the state office in Columbus.

Lytle Creek League of Conservators works for clean water, public access, and scenic river designation for Todd Fork and its major tributaries, including Lytle Creek. The organization promotes the establishment of a bike path or nature trail in a linear riparian park to be sited along Lytle Creek and Todd Fork.

Miami Group of the Sierra Club defends the Little Miami and other regional ecosystems on behalf of the national body, the nation's oldest and largest environmental organization. The mission of the Sierra Club is to protect the natural world through responsible use, education, and advocacy. The Miami Group holds outings along the Little Miami, informs the public about the uniqueness of the metropolitan river, and defends the stream against threats to its quality.

Among its accomplishments, the Miami Group brought legal action that accelerated the elimination of sewer overflows into the Little Miami and its tributaries. For the past thirty-five years, the Miami Group has successfully opposed the construction of a new highway through the Little Miami Valley that would connect Cincinnati to Clermont County. The proposed road would bridge the Little Miami and closely parallel the channel, bringing noise, litter, air contaminants, and water pollutants to the State and National Scenic River. The Miami Group advocates the establishment of mass transportation in the corridor through the use of existing railroad lines.

Rivers Unlimited is a statewide association whose mission is to preserve and restore Ohio rivers. The group assisted in having the lower Little Miami included in the National Wild and Scenic River System and has continued to promote the river. In addition to cosponsoring canoe floats and races on the Little Miami, Rivers Unlimited leads workshops on stream resource economics that show that the benefits of a scenic river exceed the costs of its protection and maintenance.

Rivers Unlimited also contributes to the defense of the Little Miami against visual, road, and water pollution. The group employs aerial photography to identify sources of water contamination in the watershed. Photos are forwarded to governmental enforcement agencies when questionable or illegal activities are discovered.

The Nature Conservancy in Ohio identifies and protects high-quality natural areas in the state. The Conservancy has assisted in the acquisition of several streamside properties in the Little Miami Valley, including Clifton Gorge, Glen Helen, Beaver Creek Wetlands, Red Bird Hollow, and Kroger Hills. Red Bird Hollow is a forested ravine bisected by Red Bird Creek, a Little Miami tributary that flows from Indian Hill through Terrace Park to its mouth in Milford. The entrance to a 1.5-mile-long trail in Red Bird Hollow is from a parking area at the base of the Given Road ascent up Indian Hill.

Downstream from the mouth of Red Bird Creek, Kroger Hills is an area of upland forest, meadow, and riparian woodland along the Little Miami. The preserve lies immediately west of Terrace Park and is accessible from the Little Miami Scenic Trail. The Hamilton County Park District leases the property from the State of Ohio and manages the site.

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