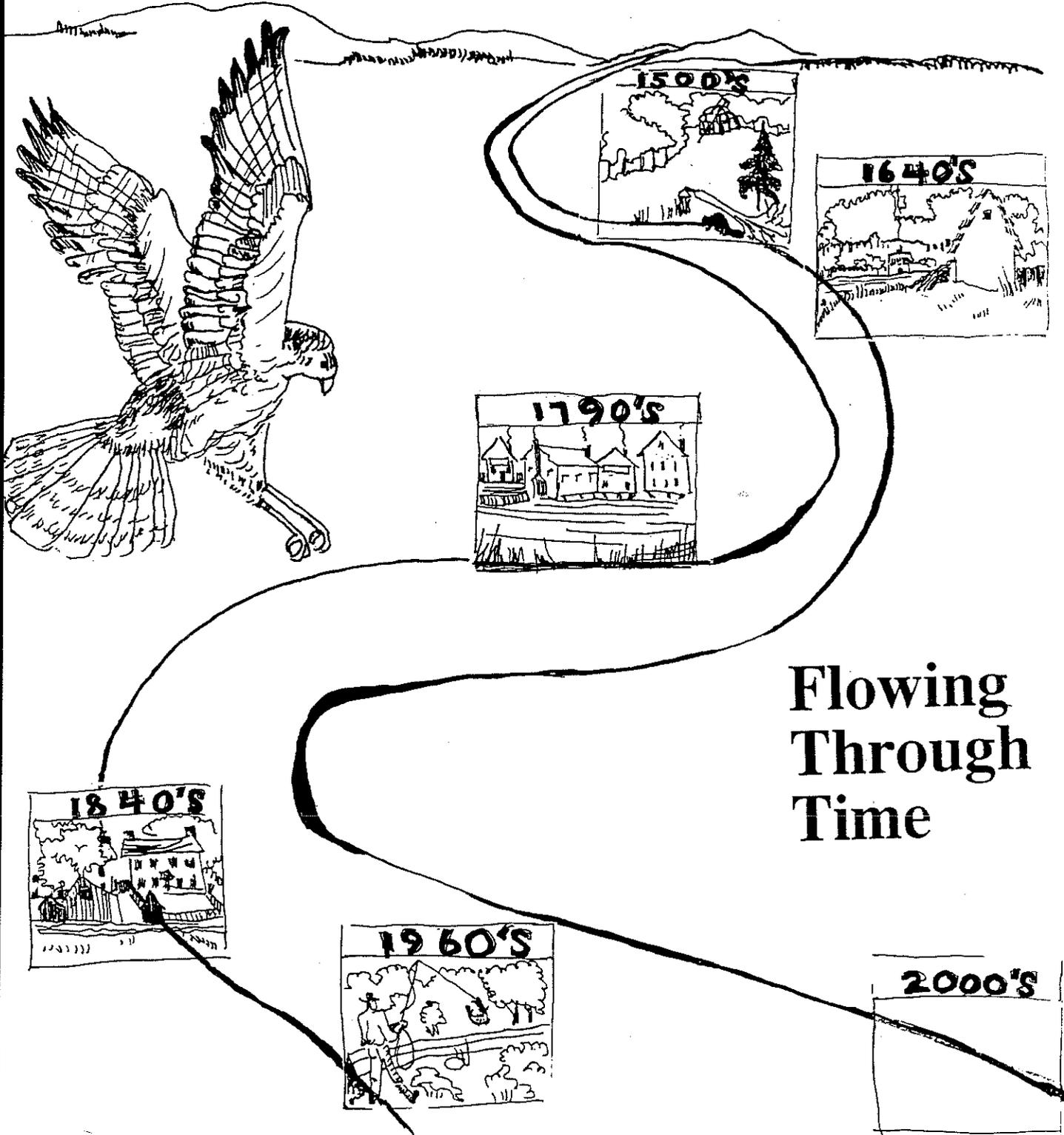


Concord's Mill Brook



Flowing
Through
Time

A History and Ecology Field Guide for Concord Center

A GUIDE TO THE LOWER MILL BROOK
PREPARED FOR THE MILL BROOK TASK FORCE AND THE
TOWN OF CONCORD NATURAL RESOURCES COMMISSION

Concord's Mill Brook: Flowing Through Time

by

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Natural Resources Commission
Town of Concord, Massachusetts

1997

Second Edition, 1999

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CHARGE: To restore and protect Concord's Mill Brook and its watershed by developing, championing, and participating in the implementation of a masterplan. The goal is an ecologically sound and scenic stream with clean water and a protected watershed which will provide for passive recreation and will be aesthetically appealing. The restored and protected Mill Brook will symbolize Concord's rich historical, cultural, and environmental legacies and the community's capability for action.

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This brief guide to a brook flowing through the center of our town is an introduction to the larger Mill Brook drainage basin, and indeed, is a step toward synthesizing ecology and history in Concord. Additions and corrections are gracefully welcomed, and may be sent to the Town's Division of Natural Resources.

Richard Forman
Concord, Massachusetts

Addendum for the Second Printing, 1999

In the two years since this booklet appeared several steps have been taken toward restoring the natural quality of the Mill Brook, and making it a resource for public enjoyment.

The Mill Brook Task Force formed in 1995 meets regularly, and has helped the Town of Concord apply for a federal grant under the Clean Water Act of 1987 and administered by the Massachusetts Department of Environmental Protection. In 1999 the Town received a \$57,000 grant and, supplemented by approximately \$33,000 worth of labor and materials by Town employees and volunteers, plans to accomplish the following:

1. Install a high-tech "catch basin" in the downtown area. This underground settling tank should significantly improve the filtering out of pollutants from street runoff in one of the major stormwater drainage lines entering the Mill Brook. The project will be visible near Chamberlain Park and the Milldam (two key locations of the walking tour described on pages 21 to 25).
2. Upgrade the cleaning ability of four additional catch basins in the downtown area. New pollution-absorbing materials are expected to better absorb pollutants in water runoff from streets. A small tag or logo on street drains to identify catch basins is planned, to remind everyone that what goes into the drains goes into the Mill Brook. A clean brook is the goal!
3. Test water quality of the Mill Brook. At six locations, including three along the lower Mill Brook (see pages 16, 22 and 28), the Task Force has taken regular water samples for three years. Signs of water quality are measured such as dissolved oxygen, pH, conductivity, phosphorus and fecal coliforms. Continuing these measurements will permit comparison of water quality before and after catch basin improvements. Also a good test will be the return of trout populations. The State resumed trout stocking in the springs of 1998 and 1999, but as yet no sighting or catch has been reported. Keep a sharp eye out!
4. Involve the schools and the community in enhancing the Mill Brook. Environmental clubs in several Concord schools have adopted parts of the brook for study and projects. Recent improvements to the walking trail in the wooded corridor by Heywood Meadow (see page 27) are visible. Local merchants are being encouraged to dispose of trash so it does not overflow or flow into the Mill Brook. Volunteers have begun June and September cleanups of the brook at several locations. No more plastic peanuts or vinyl bags, together with more volunteer cleanups, will have a visible impact!

This grant is one big step toward "Creating the Future" (see page 30).

Whether you are a visitor or a resident of Concord, the author and the Mill Brook Task Force hope that you enjoy this booklet, and especially the Mill Brook. Please join and support our efforts to restore it!

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Introduction

"...I walk along the Mill Brook below Emerson's, looking into it for some life... Perhaps what most moves us in winter is some reminiscence of far-off summer. How we leap by the side of the open brooks! What beauty in the running brooks! What life! What society! The cold is merely superficial; it is the summer still at the core, far, far within."

Henry David Thoreau, *Journal*, January 12, 1855

Suppose something right next to us, which we had barely noticed, suddenly became more interesting and important than most familiar objects around us. This is such a story. Written for the Concord community, it is both narrative and field guide. A remarkable resource, the Mill Brook, is portrayed by tying ecology and history together. This synthesis also highlights the brook's potential to be a major community asset.

The Mill Brook flows through the heart of Concord. It marks the cultural, residential and business center, alternating trickles and torrents. Arising in Lincoln, Massachusetts, the brook flows for three miles and disappears into the Concord River. About 2100 acres from Crosby's Corner to Meriam's Corner, Town Forest, and Concord Center are drained by the Mill Brook (see map at end). Downtown the stream runs by familiar places, such as Heywood Meadow, the Milldam and Lowell Rd., finally entering the river just above the North Bridge. Yet who has ever seen it?

In places it is an attractive little brook, in other places but a ditch or trough. The lower Mill Brook (downstream of Heywood Meadow) is channeled along the backyards of businesses and homes, and rushes under three local roads. The stream also passes beneath delightful small footbridges and walkways.

Find a comfortable place. Read the first half of the booklet to explore and absorb the essential foundations of Concord's Mill Brook. Major insights emerge. Then take the second half as a guide for an enjoyable and challenging three-quarter-mile walk. Six dynamic sites along the brook are unraveled. When these pages are combined with the intriguing clues around the stream itself, the ecology and history of this remarkable brook come alive.

A major theme emerging in the booklet is that the Mill Brook has been an important changing resource. Over four centuries it has evolved from a natural biological treasure, to a working energy source and village feature, to a central waste-removal system, to a trout-filled stream, and finally to an uncared-for, nearly invisible channel through Concord's Center.

Today the Mill Brook is one of the most degraded streams in Concord. Channelization, wetland drainage, sedimentation, poor water quality, fish scarcity, and inputs from nearby land practices all raise red flags. Yet the stream, with its bordering corridor of vegetation, could be readily transformed from an unnoticed feature to a key town asset for residents, visitors, and businesses to enjoy. People could stroll, absorb nature, and understand Concord's cultural heritage in a natural garden-like corridor. Fish, birds, and other species would greatly benefit from enhanced water and wetland habitat protection. Such rejuvenation could spread to other brooks in Concord and neighboring towns.

The brook and its tributaries carry off water from a three-square-mile drainage basin (for a period an additional square mile, unshaded on map, may have been diverted from the Elm Brook drainage). The fragile Mill Brook is directly impacted by changing land uses over this broad basin area. Today forest, agriculture and housing cover the upstream portions of the basin. Water drained from this "upper" area then flows into the "lower Mill Brook" downstream from Heywood Meadow, which has mainly commercial and residential land uses. This booklet focuses on the lower Mill Brook, and reference to "brook" or "Mill Brook" normally indicates this portion (see map). The brook itself is the star of the show, but the corridor encompassing the brook is the feature story (Fig. 1). Thus the floodplain, wetland, and stream banks, together forming a vegetated stream corridor, are the key supporting cast. Adjacent land that drains to the streambanks also plays a role.

Another theme running through the booklet is the dynamic between brook and people. The location and changes of the brook have affected human activities in countless ways. Human activities, in turn, have strongly determined the appearance and functions of the brook. In addition, people's perception of the brook and its value has also changed markedly over time.

No publication on Concord's Mill Brook exists. Indeed history, even from the keen observations of H. D. Thoreau, seldom records detailed or full descriptions of streams and their surroundings. Therefore the classic historian's or geologist's approach must be used. Clues and scraps of information on this brook are meshed with known patterns and processes from other places and other times to create a fuller picture. An early soldier's recorded observation, a poet's sonnet, and a trout-stocking data sheet form occasional benchmarks. Many gaps are then filled using general information, such as of stream conditions by a cow pasture or outhouse, sedimentation in a shallow pond with bare banks, and woody vegetation along a trout stream. The results are vignettes of the Mill Brook changing over centuries, analagous to a time-lapse action-packed movie.

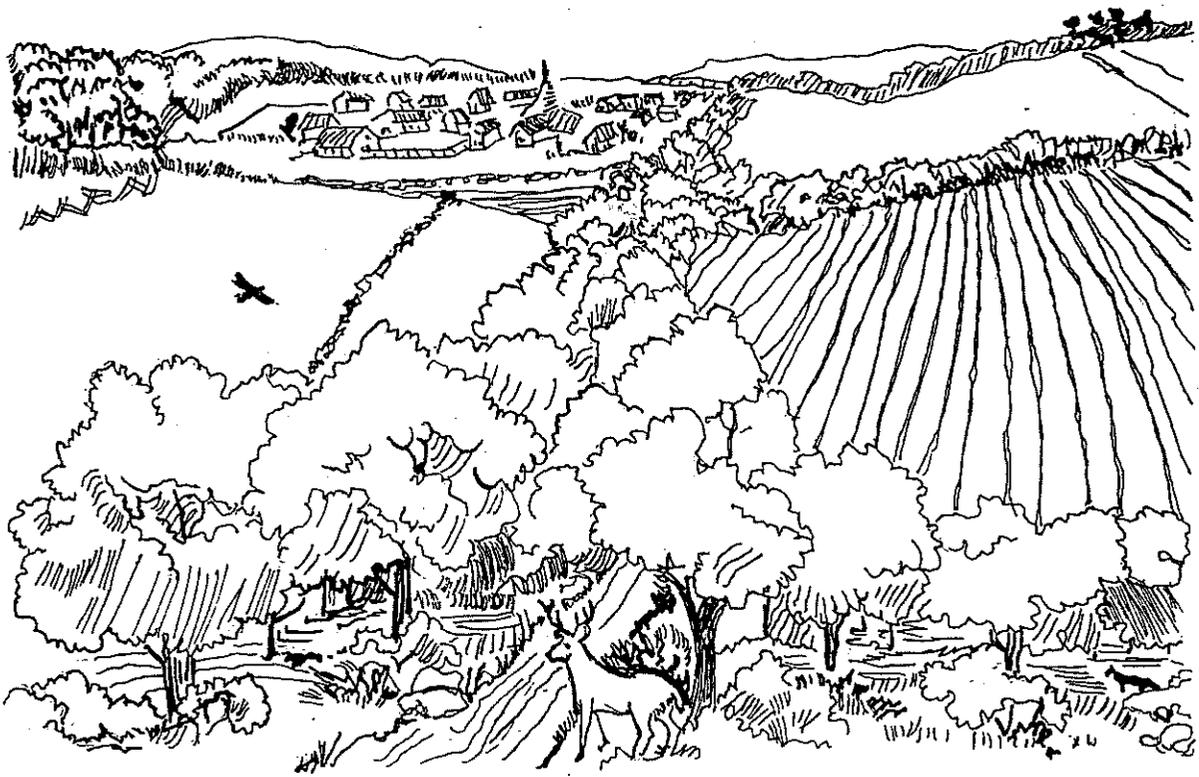


Fig. 1

The Mill Brook scene begins with the key natural processes, both slow and rapid. Then diverse human activities that interact with the brook are portrayed over Concord's centuries. These descriptions of Mill Brook's ecology and history are the foundations for a walk along the brook. Here powerful changes over centuries are portrayed at locations from Mill Brook Way (southeast of Lowell Rd. lumberyard opposite Keyes Rd.) to Heywood Meadow (Heywood St.). Finally, a cornucopia of ideas to create a brighter future for Concord's Mill Brook is spread out for the reader's consideration.

Natural Processes and the Brook

*"I like the maples on my side,
Dead leaves, the darting trout;
Laconic rocks (they sometime put me out)
And moon or stars that ramble with my tide;
The polished air, I think I could abide."*

William Ellery Channing (1817-1901), *The Mill Brook*¹⁷

A brook epitomizes change. Indeed it can be a metaphor for the stream of human history, or for our own lives. The brook rushes, and at different times or in different places at the same time, it drifts imperceptibly by. It's both huge and tiny. Straight, and winding. On this side, and then the other side of a floodplain. Full, and then nearly devoid of fish. Shallow, and deep. Rocky, and smooth. Swift, and slow. Shaded, and sunny. Warm, and cold. Quiet, and roaring. Clear, black, and green. And everything in between.

The brook is linked to the land. To springs and seepages. To wetlands. To stormwater pipes. To other brooks. And to rivers and the sea.

Nature's processes operate at different speeds or time scales, nested within one another like Russian dolls. The largest wooden doll represents a glacially slow time scale, and the tiniest doll inside represents the rapid 24-hr daily cycle. Six time frames are particularly important for the Mill Brook, and are introduced sequentially from slow to fast.

In the first time frame, giant sheets of ice came and melted away at least four times, as global temperatures dropped and rose several degrees. These continental glaciers, perhaps a mile thick over future Concord, smoothed out the rocky ridges. Melting ice laid a blanket of intermixed clay, silt, sand and boulders over the land.^{11,4,25} Glacial meltwater sorted fine from coarse particles, and deposited them in a patchwork manner. Advancing ice wiped out animals and plants, or made them disperse southward. Some species adapted and some new species evolved in the changing settings. After the ice melted new combinations of fauna and flora recolonized the land of future Concord.¹⁴

As the last ice sheet melted about 12,500 years ago, a deep lake formed where Concord Center would later appear (Table 1).^{25,22} For example, see Fig. 2 (left side), a northward view with a mastodon on the high school ridge. The lake then drained to the east, leaving an ancestral Concord River that flowed eastward across the Mill Brook basin (Fig. 2, center) (P.J. Barosh, pers. comm.). Later when the ice front stood far to the north, perhaps 12,000 years ago, the Concord River shifted to its present position and cut downward. The drainage in the Mill Brook basin then reversed its flow to join the new river to the west (Fig. 2, right side). Thus the Mill Brook was born. Today's land upstream of the milldam is sediment from a former glacial lake, whereas downstream much of the sediment was deposited during flooding of the Mill Brook and Concord River. Nevertheless, sandy materials, which are porous to water and pollutant movement, predominantly underlie and surround the entire lower Mill Brook.^{44,11}

Over the past twelve thousand years, the climate has gradually warmed to become hot, then hot and dry, and, for the last few thousand, generally cool and moist. The initial tundra plants were rapidly replaced by spruce forest, which later contained jack and white pines.^{14,5} Oaks and pitch pine from the warmer and drier South soon replaced the evergreens of cooler climates, and various hardwoods and hemlock grew in moist sites. In recent millennia moist sites supported conifers with some hardwoods. Hillsides had oaks and chestnuts, and dry sites grew smaller oaks and pitch pines.

At the outset, mastodons and many other large mammals foraged in the cold near the glacial lake (Fig. 2). With the appearance of the mixed deciduous-coniferous forest, bears, moose, wolves, deer, fox, otter, muskrat and beavers drank from the brook.²⁴ Doubtless, mountain lions, passenger pigeons, turkeys and numerous other animals familiar today enjoyed the stream corridor. Migratory fish such as alewives, shad, and possibly salmon moved from ocean to river and brook,^{30,23} and provided concentrated food for predators.

Major hurricanes (perhaps averaging once a century) have periodically topped or flattened the majority of trees over thousands of acres.¹⁶ The changes were long-lived, as different tree species tended to dominate the succeeding forest. Major species changes also resulted from "100-year" droughts with large fires. Great floods similarly changed the species composition, and even restructured the floodplain. Indeed, both powerful and puny floods were natural and normal events for the brook. Just as the Concord River moved back and forth in its wide floodplain over time, the lower Mill Brook also migrated across its smaller floodplain. These

centuries-long changes commonly caused certain animal and plant species to disappear in particular wetlands or woods. Many of the species returned, but others didn't, and new species colonized along the brook.

At the time scale of a decade or so, some of these local species disappearances and colonizations occurred in wet years and some in dry years. Yet more striking were increases and declines in the number of individuals of a species. Mosquitoes and jewelweed led a boom-or-bust existence at the Mill Brook, but the ever-present turtles and ferns also varied in numbers. The brook slowly shifted laterally across its floodplain, and the streambank was typically altered during the usual annual flood. Scouring of the stream channel by winter ice varied widely. These natural processes rearranged the logs, branches, and rocks of the brook over a decade. Consequently streambank erosion, and the number and distribution of pools for fish, varied from year to year. An increase in dead trees and branches near the stream was often followed a few years later by a pulse of fallen logs, deep pools, and fish.

Beaver dams, ponds, and tree felling along the brook also appeared and disappeared over years. Local wolves relished their beaver meals. So beaver ponds turned into mudflats, and then meadows and swamps. But beavers kept returning, and the stream corridor remained in a state of flux.

From month to month over the year, average precipitation was reasonably constant. Nevertheless, high summer temperature caused plants to pump out vast quantities of water through evaporation. This usually resulted in low streamflow and relatively warm water with little oxygen. In winter, low temperature meant that snow melted slowly until spring, when floods typically occurred and ice scouring was common.

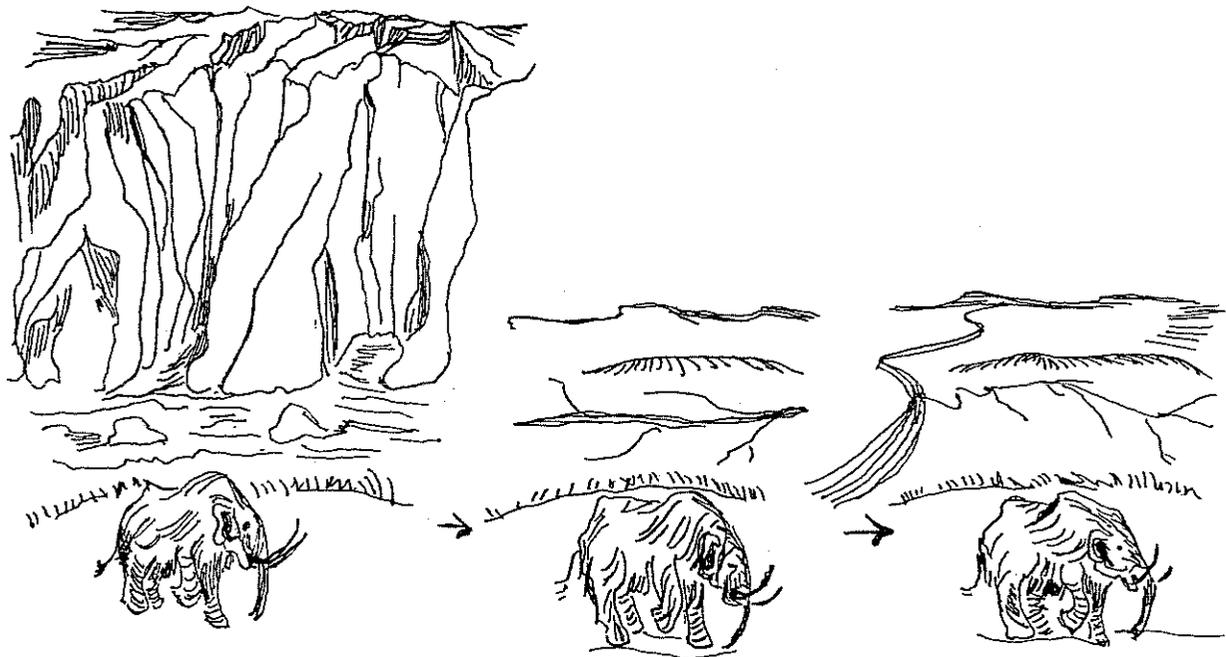


FIG. 2

Table 1. Key events in lower Mill Brook history

- Ca. 12,500 years ago** - Glacier melts from most of Mill Brook basin and forms lake over Concord Center area.^{4,25}
- Ca. 12,300 yr** - Lake drains away and ancestral Concord River forms, flowing eastward across Mill Brook basin.^{25,34}
- Ca. 12,000 yr** - Concord River shifts to present course, and drainage reverses to form the Mill Brook.³⁴
- Ca. 8000 to 1000 yr** - People of Middle Archaic to Middle Woodland time hunt and fish along Mill Brook, & establish two major upstream base camps at different times.^{6,34,14,15}
- Ca. 1000 to 400 yr** - Late Woodland People ("Farmers") hunt, fish, and grow crops in the Old Manse/North Bridge area.^{6,34,14,15}
- 1635** - English settlers establish village along lower Mill Brook.
- 1636** - Dam, pond, and mill are established at the Milldam.²⁴
- 1655** - Second Division of Concord land converts surrounding common land to large landholding farms.^{30,13}
- 1673** - Meetinghouse is built next to pond; rebuilt in 1712.³⁰
- By 1739** - Diversion of water between Elm Brook and Mill Brook.^{39,34,30}
- 1742** - Road is constructed across milldam.³⁰
- 1775** - British soldiers arrive and Revolution begins.
- 1792** - Hunt's Bridge over Concord River is built, so local Calf Pasture road becomes route to Groton and New Hampshire.^{14,30}
- 1790's** - Water and flood levels of Concord River and lower Mill Brook rise due to dam at Billerica and other changes.^{18,22,28}
- 1828** - Pond drained, mill closed, and mill dam buildings removed.
- 1830's** - Road is widened, and industry and commerce rapidly develop along lower Main St. and Walden St.^{19,20}
- Mid 19th C.** - Forest cover reaches its minimum of ca 10% of Concord.³²
- Mid 19th C.** - Heyday of R. W. Emerson, L. M. Alcott, N. Hawthorne, H. D. Thoreau, et al.
- By 1862** - Stormwater drainage system of sluices in Concord Center, and some concrete culverts by 1880.³
- 1871-72** - Middlesex Central Railroad from Boston & Bedford puts tracks & station on brook.
- 1874** - First water system brings water from Sandy Pond in Lincoln; additions in 1883.^{26,12}
- Early 1880's** - Roads in town center are covered by crushed stone.³
- By 1887** - Footbridge over brook by First Parish church & town armory on Walden St.^{47,20}
- 1891** - Tuttle's livery constructed by brook.²⁶
- 1899** - First sewer system for Concord Center.¹²
- 1912-13** - First Concord gas station and garage, built next to brook.²⁶
- 1922** - Walden Pond land is protected in Walden Woods.
- 1925** - Horse sheds by First Parish church are removed.
- 1928** - Town passes first zoning bylaw.¹²
- 1935** - Route 2 is constructed, separating highest headwaters from rest of drainage basin.¹²
- 1947** - First long-range plan for Concord.²
- 1959** - Concord Land Conservation Trust, Minuteman National Historic Park, and floodplain conservancy district are established.¹²
- 1964-90** - State stocks trout in brook.⁴²
- 1971-74** - Chamberlin Park is established and wooden footbridge built.
- 1975** - Mill Brook Way is established on old railroad bed.
- 1979** - Major expansion of shopping center by brook and Lowell Rd.

In spite of the relatively low rate of flow, the Mill Brook was always a natural eroding stream, ever so slowly cutting deeper into the land. Thus more silt and sand was annually washed out of the brook to the river, than entered the brook from the surrounding drainage basin. However, in local places such as above Heywood St. and below Mill Brook Way, the brook may have meandered, with sedimentation exceeding erosion.

In the annual cycle, foliage, flowers, and fruits appeared and disappeared like seasonal clockwork. Streamside foliage cast shade that kept the stream water cool, favoring the brilliantly colored, native brook trout. Shrubs and other native vegetation provided important cover for many nesting birds and foraging animals. Insects appeared and disappeared in prodigious numbers. Deer moved to and from evergreen winter "deer yards", such as Concord's hemlock stands.^{11,28} Bears hibernated in local hollow trees and logs. Shad, alewives, and probably salmon migrated between salt water and Concord's rivers. Multitudes of flashy birds from the brook's drainage basin migrated latitudinally, some hundreds of miles and some thousands of miles. Animal behaviors, including reproduction, nesting and raising young, occurred at regular times each year.

Finally, species were well adapted to the daily cycles of light-dark, warm-cool and dry-moist. Shallow sluggish summer pools in the brook were enriched by oxygen bubbles from photosynthesizing algae. Cold-blooded snakes and frogs moved between morning sun and afternoon shade. Mink and white-tailed deer foraged at dawn and dusk. Herons and hawks were active around the brook all day long. Bats, flying squirrels, great-horned owls, raccoons, caterpillars, and many other animals slept during the day, but were lively at night in the stream corridor.

In short, the Mill Brook, its fauna and flora, and its critical vegetation corridor were constantly and dramatically changing. The picture varied at different hours of the day, seasons of the year, over years, over centuries, over millennia, and over hundreds of millennia. Robert Burns said it all: "*Change, Nature's mighty law.*"

Human Activities and the Brook

Ever since Native People fished and had small agricultural fields here, humans have intensely altered the Mill Brook. Conversely, the brook has impacted Concordians and their activities in countless ways. Indeed, over time the combination of natural fluctuations and human impacts have crystallized in the heart of Concord. These combined forces kept the brook on center stage, as the 1901 *Town Report* so pithily states:³

"The Mill Brook caused the usual amount of trouble."

Concord was founded in 1635 with a six-mile-square land grant.^{13,30} The Mill Brook flowed through its geographical center, where the meetinghouse and English settlement were to be located. A network of regional Native American trails intersected here. Warmth on an east-west slope would be useful for homes, gardens and orchards. Nearby were a friendly native community, planting fields on good soil, and three rivers. River meadows could provide hay for sustaining livestock through the winter.¹⁴ Several Concord streams were suitable for powering a mill to grind grain. Yet the Mill Brook became the site of Concord's earliest mill, and supported the first cottage industries of the village that was to grow rapidly into a bustling town center.



FIG. 3

Eight categories of human activity over time will now be presented in the following order: (1) hunting and fishing; (2) woods and wood products; (3) cultivation, livestock and pastures; (4) transportation; (5) residential, industrial and commercial activity; (6) services and tourism; (7) planning and nature protection; and (8) public perception or consciousness.

1. Hunting and Fishing. Paleo-Indians and Early Archaic People (ca. 12,000 to 8000 years ago) hunted in Concord but left no detected evidence in the Mill Brook corridor.^{5,34,14,15} People of Middle and Late Archaic time hunted here ca. 8000 to 3000 years ago, and had short-term hunting or fishing camps near the mouth of the Mill Brook and the Milldam, as well as upstream in eastern Concord (Table 1).³⁴ A longer-term base camp, possibly for residence, was located near Heywood Meadow in Late Archaic time.

Native People of Late Woodland time (ca. 1000 to 400 years ago) migrated throughout the area, and had seasonal hunting, fishing and farming camps near the mouth of Mill Brook, and along the three rivers.^{6,14,34} Regional population estimates for 1600^{8,31} suggest that Concord's present 25 square miles may have had an average population between 50 and 200. In the 1670's, long after English settlement, Concord's native population was about fifty.²⁴ Archaeological evidence¹⁵ is consistent with such a number for many preceding centuries (S. Blancke, pers. comm.). Perhaps the persecution, displacement, and disease epidemics which ravaged native populations of the region in the early and mid 17th C. were less severe in the

local community of Musketaquid. In 1637 "planting-grounds" were noted by the English,²⁴ suggesting that some Native People may have been growing enough food to lead a somewhat settled life here for several years at a time (S. Blancke, pers. comm.). Such sedentary periods do not obscure the primary widespread pattern of groups migrating in tune with their environment. Thus the number of Native People at a place usually fluctuated over the seasons and over the years.

The native population hunted with bows and arrows, and carefully built weirs²⁴ perhaps of brush and rocks to trap fish. They made dug-out canoes, and gathered freshwater clams in the river and possibly the brook. Moose, deer, turkey, raccoon, and perhaps bear, mink and wolf were hunted for the many necessities of life. Canopy forest fires were probably rare in this year-round moist cool climate where few lightning-caused fires occur. Also the area was covered with swamps, ponds, brooks and rivers.^{14,31} Nevertheless, at times local spots near seasonal camps must have appeared open, due to firewood collecting, tree girdling, escaped fires, or controlled burns for hunting, planting or harvesting resources.

An early 17th C. fur trade was important along the rivers.^{24,31} However, English settlers of 1635 established a year-round village, where species harvested locally had little chance to rebound. Fish populations requiring cool clear water dropped sharply. The building of a milldam where Main St. is located blocked all or most fish movement, such as of shad and alewives. However, the long, narrow mill pond created by the dam provided a new habitat for some warm-water fish. Wolves were last seen in the 18th C.,²⁸ and beaver, turkey, wapiti (elk), mountain lion, deer, moose and other species doubtless became locally extinct in Concord progressively through the 17th and 18th centuries.³¹

With development of an agricultural landscape (Fig. 3), the Mill Brook was heavily polluted for two and a half centuries with farm sediment, livestock manure, human wastes, and wastes of local industries. The brook was channelized and the protective vegetated corridor largely disappeared. Thus hunting and fishing decreased.

In the 20th C., with no milldam or pond present, and with some forest regrowth and nature protection, water quality improved somewhat. Long-scarce species including mink, muskrat, deer and turkeys returned, though little hunting and trapping returned to the Mill Brook area. Native brook trout were apparently absent in 1860, but had returned by 1925.^{7,28} (Mar. 1860) They were then stocked by the state from 1964 to 1990,⁴² when Mill Brook was a put-and-take trout stream with fishermen.

2. Woods and Wood Products. Just before English settlement the Concord area was nearly all forest. Scattered small openings included ponds, rivers, marshes, planting fields of Native People, and perhaps a recent hurricane blowdown or escaped crown fire. The settlers began a continual two-century process of forest removal in town largely for agricultural development.^{32,14} Sawmills used brook power in the upper Mill Brook; indeed the main headwater stream was called Saw Mill Brook. Oaks and chestnuts provided heavy timber frames for the town's early buildings, cedars provided shingles, white pines provided floorboards, and other species were harvested for various industries. Constant firewood cutting, especially in the many small private woodlots of the Mill Brook basin, warmed the woodcutters, and then kept non-stop fires going in the large fireplaces of homes along the Mill Brook.

By the mid 19th C. barely 10% of Concord was wooded.^{32,14} Wood for fuel and industry was scarce. Only small scattered woodlots remained, except for Walden Woods and one or two other areas. This habitat fragmentation meant that much had disappeared. Gone were the

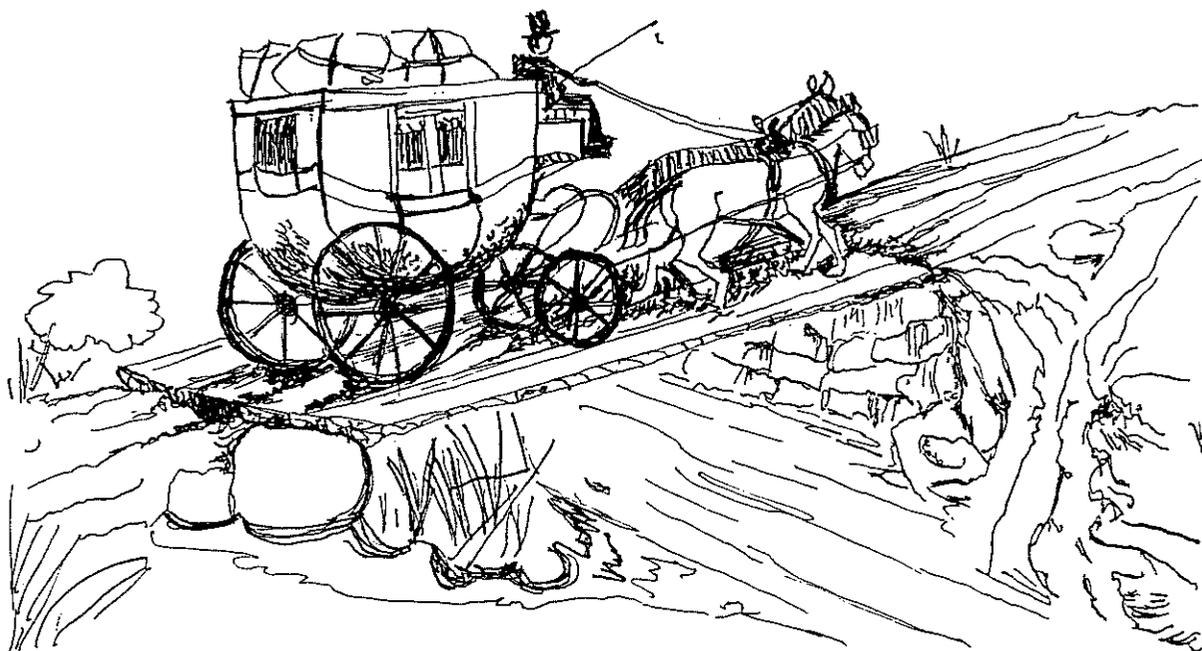


FIG. 4.

The raising of livestock was a key to the settlers' success. Cattle were first pastured on common land, and for generations were fed hay from the prized riverside hay meadows. Pigs, cattle, sheep, and horses probably cleaned out the understory of the Mill Brook forest. They trampled the stream banks and stream bottom, quickly transforming the cool clear brook to a soggy channel polluted with muddy sediment and manure (Fig. 3). Livestock were "everywhere" for two and a half centuries, so viable trout streams in Concord disappeared. In the mid 19th C. the bulk of the town was pastureland and hayfield. Farmland then decreased for a century and a half. Today some horse farms and one dairy herd remain.

4. Transportation. Native people traveled the rivers by canoe, and paddled part way up the Mill Brook especially in spring flood periods. Early trappers collecting beaver and other skins also moved easily along rivers.²⁴ A system of native walking trails was well used.²⁴ Indeed the Mill Brook area may have been a trail intersection connecting the eastward Cambridge trail with others to the north, south, and west.

Settlers then converted the Cambridge route into the Bay Road for horses and wagons. By 1655 fords across the brook at Heywood St. and Hawthorne Lane (see map) helped connect the village to Watertown, Sudbury, Nine Acre Corner, and Lancaster.¹⁴ Gradually, as roads proliferated and wagon and carriage traffic increased, the early fords were replaced by wooden bridges (Fig. 4), which often washed away and required replacement. A bridge was constructed on Heywood St., and much later (1742) a road was built across the milldam.³⁰ Sometimes stone slab bridges were erected, and later cut-stone arched bridges, which were then often upgraded to concrete. On Hawthorne Lane some of the large stone slabs over the Mill Brook are still visible. Twentieth century automobiles led to paved roads, gas stations and garages. Oil, gasoline and roadsalt then entered the brook.

The Fitchburg Railroad from Boston was built in 1844, and trains chugged and hissed across the upper edge of the Mill Brook drainage basin.^{13,26} Later the Middlesex Central Railroad from Boston and Bedford crossed the Mill Brook in 1871-72, with its terminus next to the brook by Lowell Rd.²⁶ In 1879 this rail line was extended across Lowell Rd., the Sudbury River, and the Assabet River to the Reformatory (state prison) station. Trains brought markets closer for agricultural products, industry and commerce. Fires in Walden Woods, commuters, and tourists also increased. For a brief period streetcars from Bedford rattled across the brook on Main St. on their way west. Today trains regularly run to Boston on the old Fitchburg line, and a local road network covers much of the town, with vehicles often clogging primary roads.

5. Residential, industrial and commercial activity. Compared with the small mobile native community of Musketaquid at Nashawtuc Hill, the fixed English-type village created by settlers along Revolutionary Ridge and the Mill Brook was a sight. Houses spread up Monument St. to the Liberty St. area, down Lexington Rd. to Meriam's Corner, and south along Main St.^{13,27,29,1} After 1655, farms spread across town and mills became active in West Concord and on Spencer Brook. Farms and residences typically dumped solid waste in wetlands or along brooks, including the Mill Brook. After the Civil War many farms, including some along the upper Mill Brook, were subdivided for residential development.

Hubbard St. was an early residential real estate development with carriage houses laid out in 1872. This drained directly to the Mill Brook.^{26,13} Until the end of the 19th C. virtually all homes had outhouses or cesspools, and human wastes readily washed or percolated into the brook. In 1899 inside water closets were finally hooked up to a town sewer. Residential developments in the area continued to be built through the 20th C., and today cover a significant portion of the drainage basin.¹² Fertilizers and pesticides used on yards and gardens still wash into the brook. Impervious driveways, sidewalks, parking lots, and local roads accelerate overland water flow to the stream.

The street drainage system of pipes also carries and empties stormwater into the Mill Brook at spots, such as just below Main St. Salt, sand, oil and trash pour into the brook with the runoff water. Road sand used to facilitate winter travel, like the sands of the Mill Brook valley, is readily washed downstream by the flowing brook, especially where channelized. However, accumulations occur in slowly moving water, such as during dry periods in summer or where a blockage of streamflow is present. Accumulated sediments tend to be scoured out by high velocity flows in stream channels and in floods.

Soon after settlement small manufacturing shops began to develop around the meetinghouse or church green on Lexington Rd.^{13,26,27} Manufacturing mills thrived in the western part of town, whereas the small industrial operations in Concord Center were heavy users and polluters of the Mill Brook.^{20,19}

Removal of the historic milldam in 1828 eliminated the pond and some offensive odors associated with it. The change sparked a major commercial renaissance on Lower Main St. and Walden St., when most of today's buildings there were built (see Table 1).^{13,26} Concord Center was a bustling regional center through the mid 19th C., with inns and taverns, stores, boarding houses, and local manufacturing, all concentrated near the Mill Brook. This poor brook was the drainage channel for carrying off human and industrial wastes from all village activities. Debris in the stream has been a recurring problem, and in 1895 the town "*warned people by posting notices forbidding the throwing of anything into the brook.*"³ Today the vibrant commercial activity around the brook focuses on tourists, local residents, and office activities. Yet the value of the brook to Concord's business center remains largely unrecognized.

6. Services and tourism. Mud permeated everything (Fig. 4), like an eternal part of life. Each spring for three centuries town meetings faced the challenges of repairing roads and bridges, cleaning ditches or brooks, and, before 1828, maintaining the milldam and flushing the mill pond.³ On the heavily used common the county court house was a center of activity until the 1860's. A public bathhouse, granite jail, and a large hotel on Monument Square all stood with their backs to the brook, which carried away many of their wastes. Horse sheds and livery stables remained near the brook, including the large church operation and, later, Tuttle's Livery. Mud, manure, and much more funneled into the brook. In 1874 a water system began piping water to the town center from Sandy Pond in Lincoln, just beyond the Mill Brook headwaters.

Then near the turn of the 20th C. three major rapid-fire events produced a cleaner brook. First a sewer system was built in 1899, extending from Independence Rd. along the Mill Brook to a pumping station on today's Keyes Rd. Second, automobile usage produced less horse manure. And third, road paving reduced mud. Offsetting these improvements, however, today stormwater, road salt, sand, oil, heavy metals, and trash enter the stream from bridges, and especially from a three-mile-long stormwater-drainage system (Fig. 5). In some parking lots snowplows push piles of snow laden with sand and salt onto the floodplain next to the streambank, or even directly into the brook.



FIG. 5

A major celebration in 1825, on the 50th anniversary of the Concord Fight, helped catalyze a tourism industry that remains economically and culturally vibrant today. With erection of the Battle Monument for the 1836 town bicentennial, monuments began marking historic sites.¹⁵ Concord increasingly attracted visitors as historical interest in Revolutionary and literary sites grew through the end of the 19th C. Crowds also flocked to Concord for an amusement park at the west end of Walden Pond and for county agricultural shows. In the 20th C. a national park, national wildlife refuge, and state reservation were protected. The numbers of tourists continue to grow, today exceeding a million per year. Many of Concord's tourist sites are near the lower Mill Brook. Several require short walks, so many visitors tend to be walkers who also shop, eat and often sleep nearby. Although the Mill Brook and its corridor of vegetation are frequently crossed, visitors rarely notice them.

7. Planning and nature protection. The initial colonial settlement at Concord was a highly planned imitation of English-village structure, with a meetinghouse, burial ground, animal pound (enclosure for corralling loose animals), mill, and training field at the core of a tightly clustered residential settlement.¹³ Many homes were aligned along the main route on narrow houselots extending from the brook, pond or road up over Revolutionary Ridge to common land beyond. Common land included river meadows for hay, upland for grazing and cultivation, and forest for fuel, building materials and hunting. Over the next three centuries the town meeting system ensured that some localized planning preceded each new road, bridge, railroad, and, eventually, housing development.

But town-wide planning began in earnest in the 20th C.¹² From 1928 on Concord was a leader in passing a zoning bylaw, guiding town growth and development, and establishing a Department of Natural Resources. Comprehensive planning efforts were completed in six different years from 1947 to 1995.^{2,12,15} A primary recommendation of the town's major pioneering 1947 plan read:²

"The Mill Brook is an unobtrusive but nonetheless attractive natural feature that should be given increased prominence by the construction of a path paralleling its course...preferably bordering both sides of the brook and forming a more or less continuous park ribbon approximately 1 mile long extending from Lowell Road to the Mill Dam and thence westward...to the Hapgood Wright Forest..."

In 1959 the Concord Land Conservation Trust and the Minuteman National Historic Park were established.¹² Floodplains, groundwater, and wetlands received some protection using "overlay" districts established from 1959 to 1976, plus a later state wetlands protection act. After centuries of draining swamps and marshes, some valuable remaining wetlands along the Mill Brook were saved from the potential threat posed by large deep drainage pipes³⁸ under roads and paths in Concord Center. And large tracts of land were protected across the town, including Great Meadows National Wildlife Refuge, Walden Pond Reservation, a portion of Estabrook Woods, land trust tracts, Concord Conservation Land, and private lands with conservation restrictions. Most of these actions strongly affected the Mill Brook drainage basin.

Today about 40% of Concord is developed and about 30% protected as open space, while 30% is subject to future development.¹² But some roads and spreading development cut the wildlife, walking, and water-protection corridors, leaving natural areas fragmented and isolated. The lowest portion of the Mill Brook is connected to the floodplain forest of the Concord River. Above Heywood St. a partial stream corridor (Fig. 1) is connected to the upper Mill Brook tributary system via "Clintonia Swamp", just south of the nearby bridge on

Cambridge Turnpike. Despite planning and land-use protection efforts, the water conditions and biological quality of the lower Mill Brook corridor remain poor. In effect, the brook mirrors conditions on its streambanks, in its neighborhoods, and across its drainage basin.

8. Public perception. Some impacts of the brook and people may not be visible, yet are still quite real in the minds of individuals or the community. Native People presumably knew the brook as a convenient source of fish and game. To the early English settlers the brook was the requisite energy source, and the pond was a dependable water source for industrial processes and fire fighting. Mud in the fords and along the stream was part of normal life.

Emerson, Alcott, Hawthorne and, at times, Thoreau all lived next to Mill Brook. They used it, drew inspiration from it, and wrote about it, though not often. Channing wrote a whole poem, *The Mill Brook*.¹⁷ Ephraim Bull, the grape breeder, and the School of Philosophy also looked down on the ditched brook and meadow upstream of Heywood St. Bronson Alcott planted willows and built a bathing place by the Mill Brook for his daughters.²⁰ Henry Thoreau surveyed several properties along the brook and thoroughly explored the area. Ralph Waldo Emerson bought his house between Cambridge Turnpike and the brook in 1835, which started this remarkable concentration of literary luminaries. Shortly after his beloved son Waldo died Emerson writes:

*"From the roadside to the brook
Wherein he loved to look.
Step the meek fowls where erst they ranged;
The wintry garden lies unchanged,
The brook into the stream runs on;
But the deep-eyed boy is gone."*

Ralph Waldo Emerson, *Threnody*, 1847

Perceptions doubtless appeared, disappeared, and reappeared over Concord's centuries. At times the brook or pond was an aesthetic resource. At others, a source of mosquitoes and smells. A source of ice. An ice skating site. A local water source for livestock. An inspiration for poetry. An obstacle during flood periods. A channel behind the outhouses. A disposal system for commercial and small-industry wastes. A favorite fishing place and source of excitement for youngsters. Yet sometimes the brook was unseen or ignored.

Over time people have commonly perceived brooks and associated wetlands as places to drain, remove, straighten, and reduce the variability or unpredictability of nature; in effect, to control. Overall, perceptions of the Mill Brook have probably evolved from a biological treasure chest, to a working energy source, to a necessary waste-disposal system, and to an invisible stormwater-drainage channel. But perceptions can change quickly. An attractive brook at the heart of Concord could reappear.

In summary, over centuries the brook has been repeatedly transformed, chameleon-like. Natural processes have played a role, but human activities have had an overwhelming impact on the lower section in the heart of town. People have altered the brook, its vegetated stream corridor, and its drainage basin. Concurrently the brook's location and dynamics have altered and determined human activities. The varied forms of the stream over time have created equally contrasting human perceptions of the brook. The fundamental ever-present natural processes, including their unpredictability, provided the major pervasive repairs and restorations. Thus, despite a sometimes appreciated and sometimes battered history, the Mill Brook today can be rapidly transformed once more into a community asset for the enjoyment of all, and for enhancement of our environment.

Six Locations Transformed Over Time

Now take this booklet with you for a walk. The preceding natural processes and human history of the lower Mill Brook are essential foundations. Building from them, the following pages are a field guide to unravel and explore six fascinating sites along the brook. At each site today's vegetation, wildlife, and stream characteristics are introduced. Brief descriptions then permit the observer to visualize the spot at five time periods: (a) **Pre-Concord** (especially just before 1635); (b) **Settlement phase** (1635-1655); (c) **Forest-to-farmland era** (1655-1828); (d) **Literary and railroad era** (1828-1915); and (e) **Automobile and nature-protection era** (1915-1997). Questions are occasionally included to encourage keener observation and greater understanding.

The walk begins at Mill Brook Way (southeast of Lowell Rd. lumberyard opposite Keyes Rd.) and proceeds upstream nearly three-quarters of a mile to Heywood St. (see map at end). Downstream from the first location, the mouth of the Mill Brook is hidden in a floodplain swamp. There, just upriver of the Old Manse and across from French's Rock near the Minuteman Statue, the brook joins the Concord River. This swamp is flooded and ice-scoured every year. The patchy vegetation ranges from dense thickets of exotic honeysuckle and buckthorn to stands of native ash and silver maple.^{49,35} Oft-flooded cellar holes here along Lowell Rd. symbolize the problems of housing development before floodplain wetlands received protection.

1. MILL BROOK WAY (Southeast of Lowell Rd. lumberyard opposite Keyes Rd.)

[Note: *Concord's flora and fauna have always included poison ivy, ticks, and thorns in woods and overgrown grassy areas. Thus a path and closely mowed area are normally maintained here.*]

The Mill Brook Way is a pleasant woodland path beginning on Lowell Rd. opposite Keyes Rd., passing eastward through a savanna-like grassy woods, and continuing on to Monument St. (see map at end). The design and construction of the path was generously funded by the Garden Club of Concord. The grassy woods contain many ashes and boxelders. Buried evidence remains of an old dump by the brook. A former railroad station or depot was located at the high point in the trail, just west of the Mill Brook.

Looking upstream toward an attractive cattail marsh is an adjacent residential area. Could fertilizers, pesticides, and yard waste reach the floodplain wetland or brook? From the marsh, the brook is channelized into a narrow stream corridor dominated by littleleaf linden (a non-native or exotic species), silver maple, willow, and shrubs, which provide summer shade. What other interesting species are visible?

Water enters the brook from a 600 ft. street drainage system along Lang St. The stream is then funneled into a 170 ft. long stone culvert under the lumberyard, where it races along a hard bottom with a rather steep drop. The culvert is very small and can hold less than half of the estimated water flow for a 25-year flood.³⁸ For readers interested in water quality, April 18, 1996 measurements are available: pH 6.6; water temperature 6.3°C; dissolved oxygen 8.5 mg/l; and conductivity 291 microS/cm.⁵¹ These scarce water-quality data permit no real conclusion, but do remind us that the brook holds secrets to be discovered.

Walk around the bend in the path beyond the lumberyard. Downstream is a grass-covered marsh bordered by a swamp of red maple and ash. Water enters the marsh in channelized form

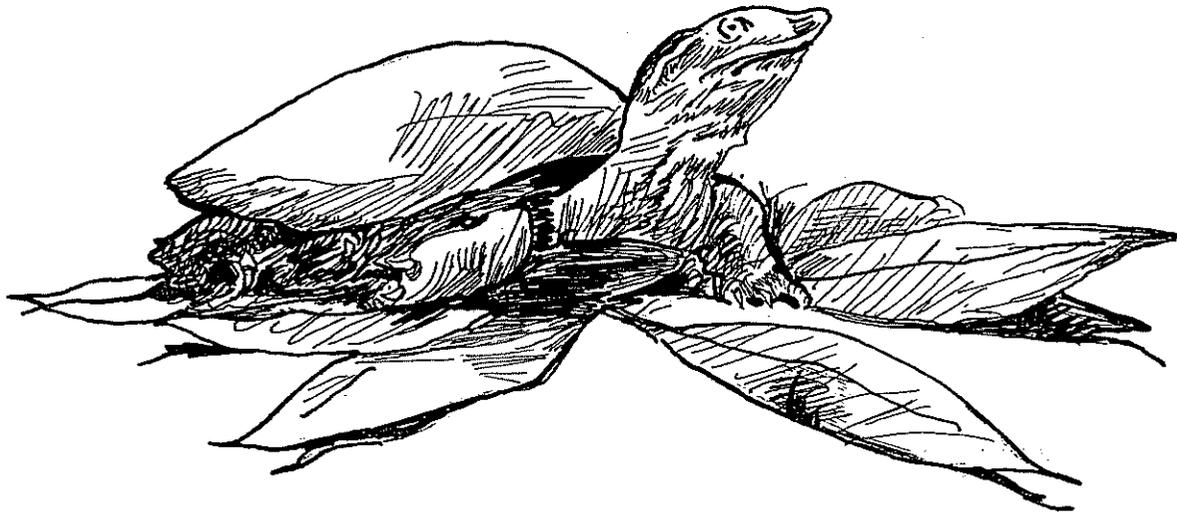


Fig. 6

from the long culvert, but begins its natural meanders near the end of the marsh. There the brook disappears into a floodplain swamp of ash (see leaf in Fig. 6) and silver maple before reaching the Concord River.

Birds recently reported at Mill Brook Way include wood thrush and red-eyed vireo.³⁵ Other species include the stinkpot (a turtle) (Fig. 6),⁵⁰ green frog, bull frog, and crayfish.³⁷ Fish are somewhat diverse, including the American eel, bluegill sunfish, pumpkinseed sunfish, redbin pickerel, chain pickerel, largemouth bass, yellow bullhead, yellow perch, white sucker, and common shiner (see Fig. 11).^{50,37}

Continue along the path for a few yards. Several black walnut trees form the forest edge on one side, while oaks are visible on the other side. Do you see any poison ivy to be avoided in the area? If not, find the railway ties under the oaks. How many parallel tracks could there have been here? Guess the age of the double-trunked black oak and the two scarlet oaks in the track area. Other clues to the past are visible near the Mill Brook Way path.

Pre-Concord (pre-1635). Before English settlement the Mill Brook meandered here through a swamp on the Concord River floodplain, and emptied into the river a quarter mile downstream (Fig. 2). Relative to today, the river was lower and the land all forested. Thus for example, perhaps only the 50-year river flood reached the Mill Brook Way path level. The channel of the brook had a smooth bottom, but plenty of logs and branches were present. Nearby land above the river floodplain provides considerable archaeological evidence of native seasonal camps (see Table 1).^{6,34,14} Native People intensively hunted, fished and used this area, especially in spring. A small Algonquian community, Musketaquid, located just upriver existed when English settlers arrived. Migratory fish such as alewives and shad were often common, in addition to local brook trout. Natives regularly removed beaver from the Mill Brook, and early European trappers may have taken some too. Water in the brook was clean, cool, and relatively evenly flowing through the year, thus providing fine habitat for fish and other wildlife species.

Settlement phase (1635-1655). After settlement beaver were quickly eliminated from the brook. The arrival of livestock, associated with Concord's Calf Pasture to the southwest and the houses along today's Monument St.,^{1,30} signaled major changes for the brook. The animals browsed away the understory and trampled the stream banks (Fig. 3), making conditions less suitable for natural fish populations.

"Returning, I notice a large pool of water in A. Heywood's cow-yard a thick greenish-yellow scum mantling it, an exceedingly rich and remarkable color, as if it were covered with a coating of sulphur. This sort of scum seems to be peculiar to cow-yards..."

Henry David Thoreau, *Journal*, July 1860²⁷

Forest-to-farmland era (1655-1828). Note the open scattered trees by Lowell Rd., currently managed to be reminiscent of widespread wood-pastures or hay meadows of the time. Forest cover was removed for pastures leaving warm and muddy water in summer. Pollutants from the village center upstream were somewhat cleansed by filtering through wetlands.

In the 1790's a controversial dam across the Concord River was constructed 10 miles downriver at Billerica.^{18,22,28} This, together with widespread forest removal and alterations far up the Sudbury River, raised the river level a small amount in Concord. But that had a large horizontal effect on how far wet soils and floods extended over the floodplain. Riverside hayfields were radically changed, and probably various structures were significantly affected. Instead of, for example, 50-year river floods reaching Mill Brook Way, perhaps floods reached here on the average every 10 years. Today, almost every spring one can paddle up the Mill Brook channel to the culvert outlet, and visit the nearby shopping center.

Literary and railroad era (1828-1915). Livestock in pastures, as well as the adjacent transportation route along today's Lowell Rd., must have impacted the brook. In 1871-72 the Middlesex Central Railroad from Boston and Bedford reached Concord. Locomotives crossed the Mill Brook to end at Lowell Rd.²⁶ An area equal to a large soccer field of original wetland was filled in for the terminus, where a depot, engine house, car shed, coal shed, milk house, turntable, and four parallel tracks were eventually built. The brook was channelized under these railroad structures. In 1879 the railroad extended westward across Lowell Rd., the Sudbury River, and the Assabet River to the Reformatory (state prison) Station. Eventually the railroad was acquired by the Boston & Maine and closed by ca. 1920. The filled-in area around the depot then became a local business.

Automobile and nature-protection era (1915-1997). Houses continued to be built nearby along Lang and Bow Streets. Motorized vehicle traffic and resulting noise along Lowell Rd. continued to increase. However, wetland protection of the downstream marsh and swamp was accomplished by the National Park and the Town of Concord. What kind of designs, plans or changes would produce an enhanced future for the Mill Brook corridor in the area of Mill Brook Way?

2. LOWELL ROAD CROSSING AT MILLBROOK TARRY (Small bridge)

Upstream of Lowell Rd. a channelized Mill Brook reveals a stony sandy bottom essentially without pools. This channel extends to the rock bottom under the bridge, where waterflow further accelerates. The aggressive exotic (non-native) species, Japanese knotweed, dominates both upstream banks. Water, salt, sand, oil and trash from the shopping-area parking lot readily enter the brook. Another exotic, littleleaf linden, and several other tree species grow near the road.

Look at the stream banks, stream bottom, and stream water. Is there good continuous shade? Leaf and branch litter covering the soil? Signs of erosion? Debris from the street? Shrub cover? Rooted aquatic plants? Logs, branches, and rocks forming pools in the stream? A stream bottom smoothed by sedimentation, or heterogeneous with many microhabitats? Fish visible? How huge? Trash? Water color? Turbidity (suspended particles obscuring light and visibility)? Any evidence of pollution by septic output, nitrogen, phosphorus, organics, chlorine, fertilizer, herbicide, pesticide, phosphorus-containing detergent, or other toxics? Stream banks, stream bottom, and stream water are good indicators of the state of the Mill Brook, and of what's needed for improvement.

A cattail marsh (Fig. 7) downstream of Lowell Rd. contains jewelweed and red maple seedlings, and has been recently invaded by the exotic plant, purple loosestrife.³⁵ The brook shows a slight meander, but is channelized downstream of the bridge and again on the far side of the marsh. Traffic noise doubtless impacts the marsh fauna. The relatively high elevation and small size of the culvert at Mill Brook Way probably maintain the wetland as a valuable wide marsh habitat and flood-control sponge, instead of being but a narrow swamp.

Wildlife recently reported include red-eyed vireo, common yellowthroat, cowbird and kingfisher.³⁵ In spring and summer red-winged blackbirds are a joy to hear and watch (Fig. 7). Redfin pickerel and American eel are the only fish recently reported here.⁴⁵ Do you hear or see any interesting animals?

Water quality measurements are reported for February 9 to April 6, 1995 here: pH 6.5; dissolved oxygen 7.0 mg/l; DO saturation 49%; total fecal coliforms 80 per 100 ml; nitrate 2.8 mg/l; phosphate 0.54 mg/l; conductivity 430 micromho/cm; total dissolved solids 258 mg/l;



Fig. 7

alkalinity 20 mg/l as calcium carbonate; total hardness 43 mg/l as calcium carbonate.⁴⁶ An overall Water Quality Index of 61 indicates a "medium" range for this Mill Brook water, though some attributes of quality are good and some very poor.

An 800 ft. stormwater drainage system for Lowell Rd. enters the brook at the bridge. For each human-made object you see in the brook or marsh, how far did it travel? The Mill Brook headwaters near Sandy Pond are 3.0 miles upstream, Meriam's Corner 2.0 mi, Town Forest 1.5 mi., Heywood Meadow 0.6 mi., Main St. 0.2 mi., and the Concord River 0.4 mi. downstream.

Pre-Concord (pre-1635). Before the town was founded the brook here was probably cool and clean in a curvy channel through a swamp. The stream bottom was mainly smooth sand-and-silt sediments. Fish from the river were common. Ample archaeological artifacts found nearby on the eastern side indicate active use of the area by Native People (see Table 1).^{6,34,14} Perhaps river floods reached here about every 50 years.

Settlement phase (1635-1655). Most homes east of the brook were connected by the North Rd., near today's Monument St., which crossed the Concord River. A road also began along the present Lowell Rd., with a ford across the Mill Brook here. This connected the village center with the protected grazing land (Calf Pasture) by the intersection of the three rivers. Presumably the brook and its floodplain were heavily used by livestock.

Forest-to-farmland era (1655-1828). Trees here were largely removed for pastures or hay meadows, and probably the brook was channelized for better drainage (Fig. 3). That left a muddy summer-warm stream running in a marshy strip through the flat area. Livestock trampled and fertilized the brook, and pollution from upstream village activities near the mill pond was evident. The ford was probably replaced by a wooden bridge (Fig. 4), and eventually by a stone bridge. Channelization of the brook both above and below the bridge helped prevent wash-out of the road. Hunt's Bridge (the red bridge) over the Concord River was built by the Calf Pasture, so today's Lowell Rd. became a major route connecting Concord with Groton, Chelmsford, Billerica, Acton, Carlisle, and New Hampshire. The 1790's dam in Billerica and other changes raised the Concord River level, and river floods might have reached the culvert outlet here on about 10-year intervals.

Literary and railroad era (1828-1915). Carriages, wagons, and horses streamed northward to the Hildreth's Corner village (Lowell and Barrett's Mill Roads),^{13,26} and on to Groton and New Hampshire. Mud, dust, and countless other materials poured into the Mill Brook (Fig. 4). A railroad and station were constructed across the brook 600 feet downstream in the early 1870's. A few years later houses on Bow St. popped up along the north side of the marsh. Pollution poured down the brook from the town center, and fish remained scarce.

Every early farmhouse, village and town had at least one solid-waste dump. Often located by a streambank or wetland, chemicals leached and debris entered directly into the aquatic system. By 1895 a town dump was located here, presumably on the upstream side of the road, much to the complaint of nearby residents.³ On the other hand, Concord's 1899 sewer system made the streamwater significantly cleaner. A 1904 photograph by H. W. Gleason shows young willows lining both sides of the upstream channel.

Automobile and nature-protection era (1915-1997). Motorized vehicles and traffic noise increased. Oil, lead and salt from the road washed into the brook and marsh. The adjacent Block House, believed to be one of Concord's oldest houses, was moved here in 1928-29. The major expansion of the shopping center, Millbrook Tarry, at an existing sharp turn in the brook occurred in 1979. How could the Mill Brook corridor around Lowell Rd. be improved for the future?



FIG. 8

3. CHAMBERLIN PARK (Footbridge between Keyes Rd. parking lot and Lowell Rd.)

A wooden footbridge and boardwalk connect a delightful Chamberlin Park to the large town parking lot by Keyes Rd. across the brook (see map). This charming walkway ties Concord Center together with a scenic walk for residents and visitors (Fig. 8).

The Mill Brook's stream bottom here shimmers with eel-grass, water starwort, and common floating pondweed. On the park side of the brook the wettest marshy area is covered with narrow-leaved cattails, ferns, American water-plantain, bitter nightshade, and purple loosestrife. Where the soil is inundated for fewer months, shrubs and trees form a tiny swamp. Just beyond, where floods rarely reach, is a tiny stand of planted evergreens. Reminiscent of northern forests, this contains the non-native Norway spruce, white pine, eastern hemlock, white birch, and mountain laurel. Can you find cones chewed by squirrels after seeds? Remains of an old apple orchard grace the drier slope of the park, offering a glimpse into New England's long history.

Wildlife recently reported include swamp sparrow, song sparrow, towhee, catbird, kingbird, great-crested flycatcher, yellow warbler, and red-eyed vireo.³⁵ Green frog, bull frog, and crayfish were observed here. Fish include banded sunfish, brown bullhead, largemouth bass, redbin pickerel, American eel, and white sucker.³⁷ Bevies of damselflies and dragonflies relish the smaller insects along lush banks during summer hours.

Stand on the footbridge and look upstream. The vegetated corridor containing the channelized brook is but a narrow line of white willows, alders, and other plants. This line of greenery is squeezed between impervious asphalt covering the floodplain on both sides of the brook (Fig. 5). A drain in the west-side parking lot indicates where a 6700 ft. pipe system with

fifteen catch basins (underground concrete boxes to catch sediments) enters the brook. This system drains stormwater from Main St., Sudbury Rd., Academy La., Middle St., and Belknap St. Why are there so few large trees on the west bank? The answer links the parking lot to the brook in winter.

The ranges for water quality measurements reported on four 1996 dates, April 18, May 16, June 13 and July 18, are as follows: pH 6.7 in April to 7.0 in May; dissolved oxygen 6.1 mg/l in June to 8.6 in May; conductivity 290 microS/cm in April to 440 in June; fecal coliforms 33 per 100 ml in July to 710 in May; phosphorus 0.1 mg/l in May to 1.13 in July; and turbidity 12 FTU in June to 15 in July.⁴⁵ These are but tiny clues to the brook's water quality, as well as its deeper mysteries.

Looking downstream from the bridge, a rare swamp wetland along the lower Mill Brook is visible. The current enters the swamp carrying sediments, including winter road sand that poured into the brook upstream. Except during scouring floods these sediments may accumulate in the swamp, which tends to disperse the flowing water into small channels over the wetland. This swamp is highly diverse structurally, and includes red maple, American elm, several shrub species, ferns in abundance, and open marshy spots. Muskrat is reported here.³⁶ Scattered dead trees and branches, common where water levels vary over time, may be visible (Fig. 8). These remind us of an earlier era when periodic beaver activity produced dead trees supporting herons, owls, woodpeckers, wood ducks, and flying squirrels. A small tributary joins the swamp from a town maintenance area on Keyes Rd. At the lower end of the swamp the channelized brook has rapidly flowing water carrying sediment away. Here floodplain vegetation has been replaced by mowed grass and an impervious parking lot right to the streambank.

Pre-Concord (pre-1635). Before Concord the forested brook here was somewhat straighter than downstream, as the ridge to the northeast is closer. Logs and pools were evident, but also some areas of smooth bottom sediment. Native People hunted and fished in the stream corridor.

Settlement phase (1635-1655). Here the brook was just west of the intensively used Concord training field or common. Water came charging down in a straight channel from an upstream mill and pond. This created a relatively homogeneous stony sandy bottom with little habitat diversity for fish, aquatic insects, and other species.

Forest-to-farmland era (1655-1828). The channelized stony brook had swift water much of the time. But metamorphosis was the stream's watchword. Periodically water and sediment were flushed from the pond upstream.²⁰ The brook then became a raging muddy torrent of scouring floodwater. In contrast, at low-rainfall times, as in late summer, the upstream dam trapped scarce water. This left little or no water movement in the stagnant brook here. Alternatively, running the mill with shallow pond water may have maintained a flow of warm water in the brook. Wastes from a rich assortment of upstream sources---pond, mill, outhouses, domestic animals, artisan shops, and tanyards---probably maintained a well-polluted brook.²⁰ But its flavorful consistency fluctuated radically. Few fish ventured here. No fishing.

Literary and railroad era (1828-1915). Although the pond and mill were eliminated in 1828, pollution of diverse types continued to run down this straight channel. Wastes entered the brook from horses at stables and sheds, as well as roads. From the remaining manufacturing shops. From the privies of an 18-cell granite jail. And from the large Middlesex Hotel on the square.^{20,30,26,27} The brook continued as an essential waste-disposal system for the town. Fish remained scarce.

Automobile and nature-protection era (1915-1997). Thanks to the generosity of the Chamberlin family, Chamberlin Park was established with an endowment as town conservation land in 1971. The attractive footbridge and walkway that bring pleasure to so many residents and employees were completed three years later. Other nearby changes during this era include construction of Keyes Rd., and impervious blacktop paving of the two large upstream parking lots on the floodplain. Today snowplows sometimes pile snow, salt and sand directly on the streambanks, or even into the brook itself. What could be done in this area for the future of the Mill Brook corridor?

4. THE MILLDAM (The first block of Main St.)

From the town flagpole in Monument Square walk down past milldam signs on both sides of Main Street (see map). You are standing on the widened dam for the town's original mill pond and mill. Where was the pond? Most of the buildings here were built shortly after the mill pond was drained in 1828 (see Table 1).^{26,20} Today the Mill Brook races through a culvert under the buildings and street. Can you determine where the brook crosses the street? Where are the stormwater drains? A 1700 ft. pipe system brings water from Lexington Rd. and Main St. to enter the stream there. From near 37 Main St. look northward across at the site of



the original town mill, which was replaced by an 1828-29 brick building (#42/44) with three chimneys. The brook is under your feet, and passes along the eastern edge of the old mill-building site.

Behind the buildings the stream banks, stream bottom, and stream water are visible. Upstream, the brook is channeled between stone walls, and is rather deep due to a small barrier just before water runs under the buildings and street. The culvert under Main St. is very small, and can hold less than half of the estimated water flow for a 25-year flood.³⁸ Downspouts that carry stormwater from roofs toward the brook may be visible.

Downstream, the brook rushes along the foundation of the mill site building. Then a large pipe is visible that pours stormwater, sediments, and many substances directly into the brook. These come from a 3100 ft. street drainage system of pipes with twelve catch basins, which drains Bedford St., Bedford Court, and Davis Court.

Pre-Concord (pre-1635). Upstream the forested brook splashed along parallel to Revolutionary Ridge. Beaver liked this location and often maintained dam, pond, dead wood, mudflat, meadow, and stream habitats in flux (Fig. 9). Downstream the land was flatter, and the stream turned northward and became more winding (Fig. 2). Native People had a short-term hunting or fishing camp here,³⁴ and particularly used the brook corridor in spring. They probably built a number of fish weirs, perhaps composed of brush and rocks, which were carefully laid to funnel fish into a spot for ready harvest. The milldam and certain spots on the Concord River convenient to the Musketaquid people at Nashawtuc Hill are likely locations for a fish weir recorded in 1637 by English settlers.^{29,6,34,24}

Settlement phase (1635-1655). The first meetinghouse and burial ground were on the ridge to the northeast. Below them was the military training ground or common, which contained an animal pound to hold stray animals.^{13,26,27} A mill was constructed on the brook ca. 1636 to grind grain. To get more energy from a higher drop in water, a dam was built (along today's Main St. from near Walden St. to ca. 15 Main St.). The pond was attractive, with some shore vegetation remaining and fair water quality. The Mill Brook had changed, now flowing from its brawling headwaters in southeastern Concord to a placid pond and mill.

*"Rocked in a cradle of sanded stone
Our waters wavered ages alone,
Then glittered at the spring
On whose banks the feather-ferns cling;
Down jagged ravines
We fled tortured,
And our wild eddies nurtured
Their black hemlock screens;
And o'er the soft meadows we rippled along,
And soothed their lone hours with a pensive song,
Now at this mill we're plagued to stop
To let the miller grind the crop."*

William Ellery Channing (1817-1901), *The Mill Brook*¹⁷

Forest-to-farmland era (1655-1828). The first burials in the South Burying Ground, visible to the west of the mill site, were made toward the end of the 17th C. A road was built across the dam in 1742, and the milldam area gradually became a beehive of entrepreneurs and shops of local industry.^{30,20} In the early 19th C. on the southern upstream side, a printing shop, cabinetmakers, a laundry, and hatshop doubtless poured inks, chemicals, soaps, and dyes into the pond. On Walden St. a tanyard, where cowhides were treated with tannin from bark and

dried, added to the pollution.²⁰ Prior to 1828 buildings overhung the pond on pilings. Cannonballs found in the pond here may have been thrown in by British soldiers on April 19, 1775.²⁴ On the north side, a blacksmith shop stood west of the mill. East of the grist mill was another tanyard. This smelly operation brought pond water under the road in its own aqueduct, which changed to a ditch carrying waste water down to the brook. The dam was regularly opened to flush out sediment accumulations and polluted water.^{20,21}

Literary and railroad era (1828-1915). By the early 19th C. pollution and stagnant water in the mill pond had become both a public nuisance and a health hazard. With mills on other Concord brooks and with active transportation, the mill pond was obsolete. The dam and pond were removed in 1828, the road widened, and major development on lower Main St. and Walden St. ensued. The building set back from the road on the southeast side (9-11 Independence Court) was built ca. 1850 as the town's first true firehouse. Some Mill Brook water ran under it in a ditch.²⁶

"The waste water brook [or ditch] ran across and under the street....entered the Hotel lot [and passed the stable]... When the jail was built the water....continued in a northwesterly course under the jail and discharged into the Mill Brook lower down."

C. H. Walcott, *Notes on Land, Roads, Concord, Mass and Vicinity* (ca. 1890), for January 1, 1841

Main St. here was covered by crushed stone in the early 1880's to reduce the interminable mud. A sewer system in Concord didn't begin until 1899, so human wastes from the concentration of everyone's outhouses and cesspools still entered the Mill Brook. A large jail (see plaque near the common) and hotel were major contributors. Wastes from the town's local manufacturing and commercial activities were often flushed out by the brook to the Concord River. An electric trolley line briefly ran down Main St. connecting Bedford to West Concord and beyond.²⁶

Automobile and nature-protection era (1915-1997). Horses, wagons and carriages (Fig. 4) were gradually replaced by automobiles. The street and shops evolved in tandem. Finally, the milldam area is the core of Concord. Here history and nature coalesce. Would a footbridge above or below the buildings help highlight our cultural heritage for residents, for visitors, and for the business community? Indeed, what changes in this area would best enhance the Mill Brook corridor?

5. TUTTLE'S LIVERY (Behind 35-45 Walden St.)

A narrow line of greenery over the water trough here (see map) helps evoke the image of a stream rather than a pipe. Boxelder, American elm, maples, white ash, bittersweet, and planted arbor vitae are a mixture of native and exotic species. What proportion of the brook would be shaded from summer sun here? Sunlight heats water depriving it of oxygen necessary for cool water fish such as trout.

Look at the stream banks, stream bottom, and stream water. The interesting walls are of different age and origin. Channelization accelerates water downstream and divorces the brook from its floodplain processes. Moreover, the diversity of aquatic habitats, from swift splashing currents to calm silted pools, is decimated when the natural alteration of pools and riffles in a stream is missing (Fig. 10). Instead the relatively even stony bottom with sparse rooted plants is characteristic of high velocity flows that scour out leaves, silt and most sand. Normally logs,



FIG. 10

large branches, and pools are scarce here. Are any (big) fish visible? White suckers are the only fish recently reported here.⁴⁵ Each April the big suckers have a "run" from the river to the brook's upstream pools.

Where do the oil, sand and salt from the parking lot go? The visible stormwater drain is connected to a 3000 ft. pipe system with catch basins draining Hubbard and Stow streets. Stand by the drain. Where does the piped water enter the brook? Where does plowed snow go? How many trash disposal containers are visible? Cost-effective and careful trash removal is important both for local businesses and the community.

Pre-Concord (pre-1635). Before settlement the forested brook here was relatively straight between Revolutionary Ridge (Fig. 2) to the northeast and high ground by today's Walden St. to the southwest. Logs, pools, and fish were normally abundant. Native People hunted and fished here.

Settlement phase (1635-1655). The mill dam was built downstream of the site by today's row of brick buildings. It created a mill pond extending upstream past this spot to today's Heywood St. Standing by the brook behind Tuttle's Livery, could the pond surface here have been over your head? The width of the pond varied, but probably extended nearly from Walden St. across to the site of the present First Parish church on Lexington Rd. The pond was shaped like an eel, five times longer than broad.

Forest-to-farmland era (1655-1828). The pond at this spot was very muddy with warm-water fish, such as sunfish and bullheads. Sediments and pollutants from upstream farming covered the bottom. During summer, mosquitoes and smells from the pond were the talk of the town. For a while a slaughterhouse on Walden St. added to the effect. The meetinghouse (forerunner of the present church) was first built by the pond in 1673, and rebuilt in 1712. Small manufacturing shops, homes and tenements were located on its green by the road, and, eventually, horse sheds were added back by the pond.^{20,27} The pond shore was bare of protective woody vegetation at least in its northern portion.¹⁰

Literary and railroad era (1828-1915). In 1828 the pond was drained, and the Mill Brook reappeared as a ditch in the new central mudflat. Buildings began to fill the spaces along Walden St., including businesses at #7-11, 17-23, Tuttle's Livery Stable at 35-45, and the town armory at 51. Today all have rear areas along the brook.^{26,14} Horses were fed, cared for, and rented out at the livery. Mud, horse manure, urine, and much else from the livery, as well as from horse sheds of the church, were funneled into the downstream brook (Fig. 4). The present church building was built after a fire in 1901.^{26,14} At this time a narrow lane stretched from Walden St. to Lexington Rd. along the southeast sides of the armory and church. Today an attractive footbridge crosses the Mill Brook there.

Automobile and nature-protection era (1915-1997). Concord Center's first gas station and garage (#29-33 Walden St.) was built with a diagonal front in 1912-13. This doubtless added new pollutants, oil and gasoline, to the brook in significant quantity. Today upstream homes and businesses with yards and gardens may use pesticides, fertilizers and other chemicals which percolate or wash into the brook. What designs, plans and changes here would most improve the Mill Brook corridor for Concord's future?

6. HEYWOOD MEADOW (At Heywood St.)

The Heywood St. area (see map) is shaded by pin oaks, sweet gums, sugar maples, and other trees, and the remnant of an apple orchard adorns part of the meadow. Such orchards were once common along the warm slope above, and provided Concord's favorite drink, fermented cider. The predominant trees near the Mill Brook include red maple, pin oak, American elm, apple and black cherry, while shrubs include glossy buckthorn, arrowwood, silky dogwood, alder and multiflora rose.^{33,35} The small upstream marsh includes cattail, golden ragwort, forget-me-not, arrowhead, purple loosestrife, Joe-Pye-weed, and fern species.

Upstream is a partially wooded stream corridor (Fig. 1), which provides some shade and a route for wildlife movement from the southeast into, and potentially through, Concord Center. Mammals recently reported include beaver and muskrat, which can use the brook to traverse Concord Center. Birds include black duck, catbird, kingbird, great-crested flycatcher, flicker, yellowthroat, veery and phoebe.^{35,40} Bull frog and crayfish are also reported here.³⁷

From 1946 to 1990 over 10,000 trout, overwhelmingly brook trout (Fig. 11), were stocked by the state in the vicinity of Heywood Meadow. What excitement, stories and dreams there were for the children and adults of Concord! Nature was absorbed around every Mill Brook tributary. Alas, sampling of the brook for fish in 1954, 1979, 1994 and 1996 indicates a steep decline in both number of species and individuals.^{43,34,37} Also the largest fish was 3.5 lb in 1954, 0.7 lb in 1979, none in 1994, and a 19-inch brown bullhead in 1996. The original 1954 sample had redbfin pickerel, pumpkinseed, bluegill, eastern banded sunfish, johnny darter, brown bullhead, American eel, white sucker, brown trout, and brook trout (the 1979 sample also had yellow perch and largemouth bass). This is a relatively diverse fish fauna.⁴³ In contrast, the 1994 and 1996 samples only recorded redbfin pickerel, brown bullhead, American eel, and banded sunfish.^{45,37}

Water rushes under the Heywood St. bridge over a rock bottom. The relatively high elevation and small size of the culvert here help to maintain the large upstream marsh and its wetland habitat (Fig. 7). During floods the culvert also creates an upstream impoundment over hundreds of acres, which helps protect the Concord Center area from serious flooding. The brook remains channelized upstream to the firehouse, and downstream through the center of town.

Find the stormwater drain by the bridge (Fig. 5). This is where drainage water enters the brook from a 1700 ft. pipe system with three catch basins. Stormwater runoff, including road salt, sand, oil, and truck spills, is collected from portions of Lexington Rd., Walden St., and Everett St. Water quality measurements are reported for April 18, 1996: pH 6.7; water temperature 5.9°C; dissolved oxygen 7.3 mg/l; and conductivity 282 microS/cm.⁵¹ These provide scraps of insight only for experts. Therefore the state of the brook must be interpreted from the stream banks, stream bottom, and stream water.

Pre-Concord (pre-1635). Before Concord a clear curving brook here drained three square miles of forest land, and on its northeast side flowed along the base of the ridge (Figs. 2 & 9). Just upstream the area was probably heterogeneous, with patches fluctuating over time from swamp to beaver pond, marsh, mudflat and meadow. Fish, including migrating alewives from the sea (Fig. 11), were often abundant in pools formed by fallen trees and shaded by continuous cover. Late Archaic People more than 3000 years ago migrated through the area mainly in spring and autumn (Table 1). They had a base camp upstream of Heywood Meadow for hunting or fishing,^{6,34} and some years would have resided there for months at a time.

Settlement phase (1635-1655). This was Luke Potter's lot, one of the original long, narrow parallel lots extending from the brook northward up over the ridge to common grazing land beyond.^{29,27,1} A road and ford across the brook at this point connected the northern and southern parts of town. From the ford down to the milldam stretched the town's mill pond. A muddy Bay Road at the base of the ridge connected Concord with Cambridge, Boston, and indirectly, England. Some forest cover was removed for pastures. Work began on straightening the brook and draining adjacent wetlands to form ditches in which livestock sloshed around (Fig. 3).^{41,7,9} The brook was straightened both upstream and downstream of today's bridge.

Forest-to-farmland era (1655-1828). Upstream trees were progressively axed for fuel and pastureland, such as the Town Meadow on Mill Brook south of Meriam's Corner, and also for hayfields and cultivation. Peak flows of water in spring and after heavy rains increased, and hence large floods came more often. Sediment washed into the muddy brook, and then was largely scoured out in floods. Logs, pools and fish decreased. Most nearby houses of the era persisted to the present, including the stylish 1719 saltbox at 105 Lexington Rd. and the 1788 house, tavern and store at 92 Walden St.²⁷

Literary and railroad era (1828-1915). Despite a few structures that were built and removed, the meadow basically remained a meadow, orchard, or garden. A vegetable cellar was dug into the bank of the brook even in the 20th C. The upstream drainage basin was mostly deforested, and the muddy brook flowing through farmland alternated between a fickle trickle and a massive flood.^{32,7,21} On Walden St. 19th C. houses were added between older homes.²⁶

Automobile and nature-protection era (1915-1997). A house just downstream of the bridge was built with some water flowing under the structure, through which muskrats could swim.²⁷ On the southwest side of the brook a commercial brick building was erected. On the northern side the historic meadow continued to be threatened by development. A gun house, town information booth, and garage were added, and Middlesex County attempted to build a courthouse. But citizens rallied in the 1970's, 80's and 90's to protect most of the meadow for its historic and aesthetic values. Within the Mill Brook drainage basin, lands for national park, state, town, and private conservation were protected.¹² Meanwhile residential streets and houses proliferated.

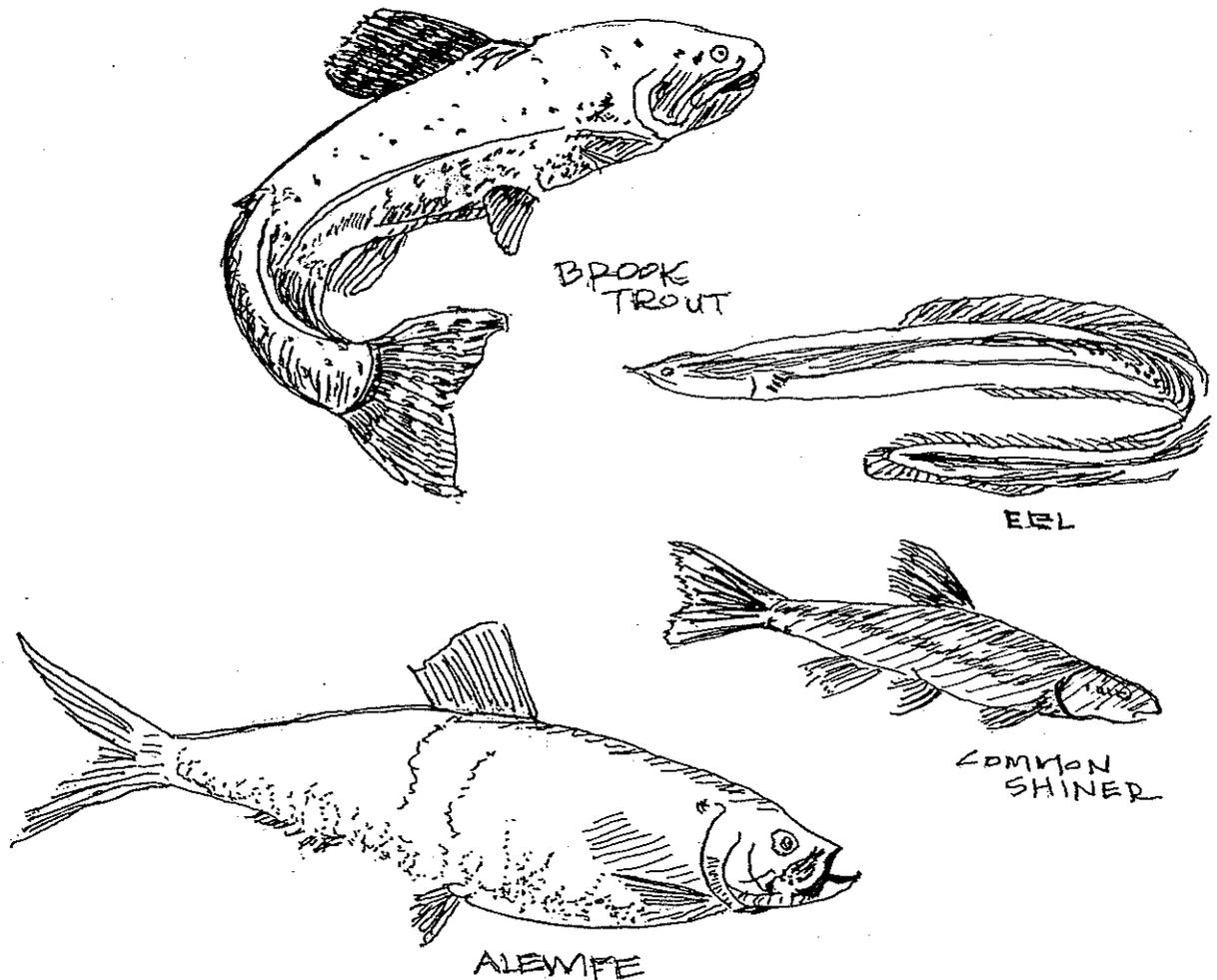


FIG. 11

The land across the drainage basin changed from mostly agriculture to a mixture of forest, marsh, residential land, and farmland.³² This meant that the brook improved noticeably in water quality, and that peak floods ameliorated. The large wetland sponge upstream of Heywood St. reaches its peak floodwater level long after the lower Mill Brook floodwater has drained away over hard surfaces and in pipes. In 1987 the Mill Brook was dredged and cleared of brush and fallen trees from Heywood St. to Cambridge Turnpike, and along tributaries to Revolutionary Ridge and the High School.⁴⁴ What steps could Concordians take in the Heywood Meadow area to improve the Mill Brook corridor for the future?

In conclusion, the six locations visited along the lower Mill Brook in Concord Center provide a closeup view of a dynamic brook. They integrate its ecology and history. To get a fuller picture, however, it is important to "put on a wide-angle lens" and explore the drainage basin of the brook and beyond. Highly informative and enjoyable loop walks beckon. For example, take the **North Bridge loop**, proceeding from Mill Brook Way to Monument St., North Bridge, Liberty St., and back on Lowell Rd. (see map). Walk the **Hawthorne Lane loop**, going from Heywood Meadow to Lexington Rd., Cambridge Turnpike, Hawthorne La., and back on Lexington Rd. And explore the **Town Forest loop**, leading from Heywood Meadow to Walden St., Town Forest, and back on Walden St. (seasonal paths may be open). At every step across this dynamic area you can see something linked to the Mill Brook.

Creating the Future

The Mill Brook has been transformed several times during four centuries, and could be again. Many possible targets, possible solutions to present problems, and possible resulting benefits exist, as illustrated below. Your thoughts are invited. All promising ideas warrant consideration by the diverse readership of this booklet. Indeed, some ideas here are compatible and some incompatible with each other. Nevertheless, solutions offer roles to numerous individuals, organizations, and agencies in Concord, in effect, a "barnraising", a "brookraising" or a "brookshed" for the entire community. The benefits are for all of us, including the children and grandchildren of Concord.

1. Possible Targets

- A naturally functioning brook
- A brook with "swimmable and fishable" water quality
- A native trout stream
- Return of migratory fish runs from the sea, such as of alewives, shad and salmon, to our rivers and brooks
- An area for natural biodiversity, insect gardens, plantings of unusual native plants, or managed wildlife
- A vegetated stream corridor with intimate walkways and footbridges
- An open channel with streamside boardwalks and trail network
- Mini-parks at selected locations
- A hidden pipe

2. Approaches and Solutions

- Establish a continuous stream corridor of trees and shrubs to enhance wildlife movement, bird nesting, and shade for cool water in summer
- Create a wider strip of floodplain vegetation, and encourage the straightened channels to become more curvy
- Reduce the use and runoff of winter road salt and sand near the brook
- Use porous pavement and porous base material for driveways, sidewalks, and parking lots in the drainage basin, so soil can absorb and clean stormwater and reduce flood levels
- Disperse stormwater from buildings into the soil rather than funneling it into the brook
- Modify the street drainage system, and install and maintain filters, to better protect the brook from stormwater, soil sediments, oil, heavy metals and trash
- Use more soil conservation measures for agricultural and nursery activities in the drainage basin
- Increase the number of dead trees, branches and logs in the stream corridor to revitalize populations of numerous birds, mammals, and other species that use dead wood
- Promote designs, practices and education that increase compatibility between current Concordians and returning native species, such as beaver, coyote, fisher, moose & turkey
- Extend sewer lines to remove seepage of nitrogen, phosphorus, and organics
- Reduce the sources of nearby trash, and introduce more efficient trash storage and removal systems for businesses in the area
- Reduce the usage of fertilizers, herbicides, insecticides, and other chemicals around homes, yards, gardens and nurseries
- Introduce logs, large branches and large boulders in selected locations to create pools and oxygenating riffles for fish, and to help scour out sediments from smooth stream bottoms
- Return to stocking of brook trout or other native fish
- Improve river water quality and address problems of dams that inhibit fish movement

Protect wetlands more rigorously and restore damaged wetlands
Continue to acquire and protect agricultural and other open space lands in the drainage basin

3. Resulting Benefits

Walkways and footbridges that attract residents to stroll, meet, and take a deeper sustained interest in their community
Promote a greater educational interest in Concord's natural history and cultural history for residents and students
Provide a pleasant central area for visitors who like to walk, and link historic sites with walking rather than driving routes
Increase downtown customers and business opportunities
Increase fish populations, fishing opportunities for families, and fishermen in the drainage basin
Improve the brook's water quality
Decrease flood frequency and flood heights
Restore the richness and connectivity for birds, plants, aquatic species, and other wildlife

References and Reports

Literature, rather than new research, forms the foundation of this booklet. Especially useful are Shattuck (1835), Jarvis (1993), *Annual Reports of the Town Offices of Concord* (various dates), *Memoirs of Members of the Social Circle* (various dates), and the 1994 five-volume *Concord Survey of Historical and Architectural Resources*^{26,27}, plus three 1995 references derived from it: *Narrative Histories of Concord and West Concord*¹³; *Historic Resources Masterplan of Concord, Massachusetts*¹⁵; *Highlights of Concord's Historic Resources*.¹⁴

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