FISHERIES DIVISION
TECHNICAL REPORT

Number 92-10 August 15, 1992

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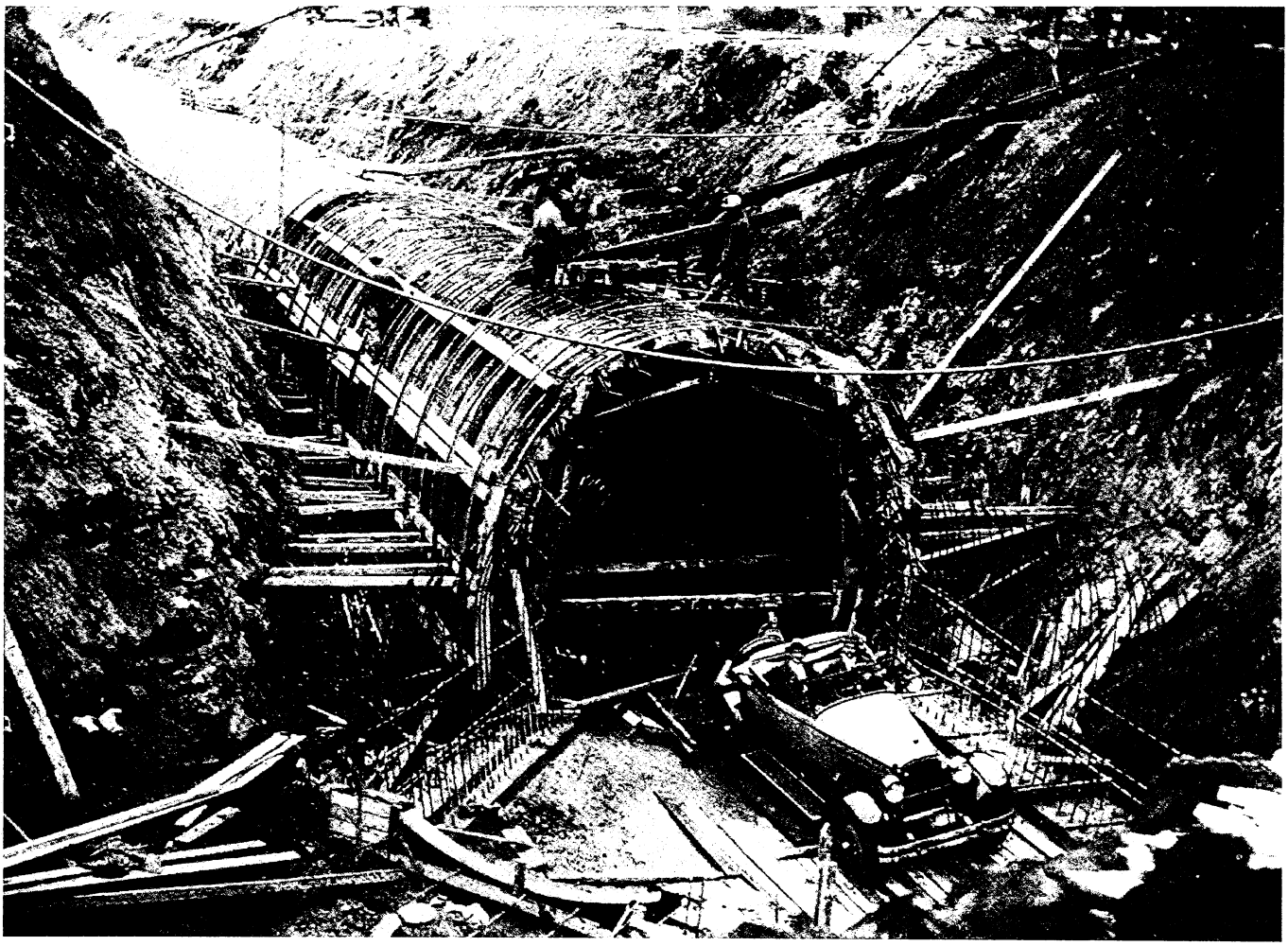

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STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

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Cover photo depicts construction of the Royal Oak Drain, a tributary of the Clinton River, in 1925. Drainage activities throughout much of the watershed have adversely impacted the Clinton River. Car was lowered into the drain for scale.

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Abstract. We encourage the use of a historical perspective when developing watershed management plans. Such a perspective helps managers to define the potential and limits of the river system, to identify changes that have occurred within the watershed over time, and to develop watershed management plans with realistic goals. We reviewed historical records for the Clinton River watershed in southeast Michigan. Based on these records, we described the watershed in its pristine, pre-settlement state. The Clinton River had stable streamflows and clear water as a result of highly permeable soils and abundant wetlands throughout the watershed. Numerous high gradient reaches provided excellent habitat for species such as smallmouth bass, and served as spawning areas for potamodromous stocks of species such as sturgeon and walleye. The watershed was initially impacted in the early 1800s by the construction of mills which impaired or eliminated potamodromous runs. Urban development (paving of land and drainage of wetlands) in the mid 1900s decreased the flow stability of the Clinton River, creating more extreme flood and drought events. Watershed management goals for the Clinton River watershed should focus on preserving and restoring the hydrologic regime through stormwater management that emphasizes infiltration, and preservation and restoration of wetlands. In addition, access to riparian wetlands and rapids should be provided for spawning of potamodromous fishes.

Many midwestern rivers have been dramatically altered since European settlement. Watersheds have been modified by forest clearing, wetland draining, applications of fertilizers and pesticides, and industrial and urban development. River channels have been modified by increased water and sediment inputs, channelization, dam construction, and removal of riparian vegetation. Fish communities have, in turn, changed (Larimore and Smith 1963; Trautman 1981; Karr et al. 1985; Yant and Humphries 1978). Fishes requiring clean, gravelly and rocky bottoms; aquatic vegetation; clear, cool water; and stable flows to complete their life cycles have declined or disappeared. These include many of the larger and more desirable food and sport fishes. Conversely, fishes tolerant of silty bottoms; turbid, warm water; and unstable flows have become more abundant.

Interest in managing midwestern river fisheries has been increasing since the passage of the Federal Clean Water Act in 1972. As point-source pollutants were controlled, water quality has increased to the point where these rivers have become viable recreational resources. Recognizing that most degradation has occurred at the watershed scale, many resource managers have encouraged a compre-

hensive "watershed management planning" approach (Karr et al. 1985 and Pajak 1992, in press). This is a complex process, requiring an understanding of the many physical and biological processes at work, the cooperation of a variety of political entities, and a balancing of resource protection with economic development.

The process of watershed management planning should include the following steps.

(1) Inventory the resource and determine the "health status" of various reaches (river sections).
(2) Set realistic goals for management.
(3) Prescribe actions designed to achieve the goals.
(4) Garner public support for the planned actions.
(5) Implement the actions.
(6) Monitor the effects of these management actions.

Each of these steps (except 5) can be aided by the development of a perspective on the pre-European settlement condition of the river and its watershed. Such a perspective helps: (1) determine the extent of change that has occurred; (2) define the potential and the limits of the system (this gives goals some basis and keeps them realistic); (3) clarify the causal mechanisms of change, thus helping to identify effective management actions; (4) provide a basis for public acceptance and support; and (5) determine critical parameters to monitor for signs of the effectiveness of management actions.

Many of the most dramatic changes to midwestern river environments occurred during early settlement of the region by Europeans, when the land was first cleared and drained, and the first dams were built (Larimore and Smith 1963; Trautman 1957). These changes occurred quickly and were frequently not documented. But a thorough review of historical records can trace some of these changes.

First, a historical review can provide background information describing the physical characteristics of the river system in its pristine state (Larimore and Smith 1963; Clark and Allison 1966; Trautman 1957). Descriptions of channel morphometry and morphology, flow magnitude and stability, water clarity, bottom substrates, and location of riffles and rapids can often be found. Second, sometimes records provide descriptions of the original flora and fauna, including comments on watershed, riparian and aquatic vegetation, fish spawning areas such as marshes or rapids, and the presence of fish, mammal, and bird species.

Third, a review can identify specific changes that have occurred in the watershed or the river and document effects on the biota. For example, Trautman (1957) found that construction of dams on Ohio streams in the early 1800s prevented the upstream migration of certain fishes to specific spawning areas like marshes and rapids. Shortly after the dams were built there was a dramatic decline in the abundance of desirable fishes, including muskellunge *Esox masquinongy*, northern pike *E. lucius*, lake sturgeon *Acipenser fulvescens*, walleye *Stizostedion vitreum*, smallmouth bass *Micropterus dolomieu*, and suckers (Trautman and Gartman 1974). Trautman (1957) also described the disappearance of Ohio's "once universally abundant" large springs and perennially wet marshes as a result of land drainage for agriculture. This caused the elimination and decline of fishes dependent on constant, cool summer flows. Excessive siltation is common in agricultural streams and has been correlated with declines in fishes dependent on either clean gravels for spawning or clear water (Trautman 1957; Yant and Humphries 1978; Karr et al. 1985). Clark and Allison (1966) passed along an older citizen's account of the habitat that is now beneath one of the reservoirs within the Maumee River system. It had a boulder-cobble substrate (a source of large foundation stones for local buildings), a narrow channel with alternating deep pools and riffles, and abundant aquatic and riparian vegetation. Smallmouth bass and rock bass *Ambloplites rupestris* were abundant, and muskellunge were also present. Such high-gradient reaches provide optimal summer habitat for many valuable river-resident fishes (including smallmouth bass, rock bass, muskellunge, walleye, and trout) and as spawning habitat for many potamodromous fishes (including lake

sturgeon, muskellunge, walleye, whitefishes, and trout). (Potamodromous fishes migrate between lake and stream habitats.) High-gradient reaches are rare in the flat midwestern United States, and many have been lost beneath reservoirs.

Our objective in writing this paper was to provide a historical perspective of the Clinton River in southeastern Michigan. We chose the Clinton because it represents a system that was settled early and has undergone extensive watershed and channel modifications. In this paper, we describe the presettlement condition of the river, its watershed and biota, and discuss some of the early changes to the system. We hope this effort will stimulate more exhaustive work on the Clinton River and serve as a model for future historical work on other Michigan rivers.

Sources of Historical Information

We drew historical information from a variety of sources, including: writings of early explorers, missionaries, soldiers, surveyors, and settlers; local historical publications; early news journals; archeological studies of fish bones found in Native American middens (trash heaps); and interviews with "old timers".

A variety of sources may be tapped into for future studies. Old mill records and commercial fishery records may provide insight regarding stream characteristics and fish populations. Current maps of topographic features and soil types provide evidence of past features such as high-gradient riffles and rapids, and vegetation types (Albert et al. 1986). Information on land use changes can be deduced from records of drainage, crop and livestock production, and from census records (Wiley et al. 1987). Changes in river flow patterns, siltation, and temperature can be inferred from land use changes (Larimore and Smith 1963; Trautman 1957; Wiley et al. 1987).

Physical Description of the River and Watershed

The following general description of the current physical characteristics of the Clinton River watershed was obtained from Strayer (1980) and Farrand and Bell (1984). The Clinton River drains an area of 763 square miles in the southeastern Michigan, just north of Detroit. Its mean annual flow (measured at Mt. Clemens) is 547 cfs (Blumer et al. 1991). From its headwaters in Independence Township, Oakland County down to Pontiac, the upper mainstem is a small stream (<33 feet wide) flowing through a number of lakes and marshes across a flat outwash and glacial till plain. The sand and gravel soils in this area are well drained. Flowing from Pontiac to Rochester, the middle mainstem has a relatively high gradient (14 feet/mile) and gravelly substrate. It runs through an area of moderately to well drained loamy and clayey soils. In Rochester, the Clinton River receives two major tributaries, Paint Creek and Stony Creek. Both creeks have fairly high gradient (10-21 feet/mile) and flow across areas of medium textured till and glacial outwash sand and gravel. Approximately 8 miles below Rochester, the lower mainstem flows across a level plain composed of former beach and near offshore littoral deposits (clay, silt and sand) of the glacial Great Lakes. Along its route is receives waters from the Red Run and a large tributary stream, the North Branch of the Clinton River. These streams, for the most part, drain former glacial lakebed and beach areas and are characterized as being dominated by runoff and quite turbid.

Early Descriptions of the River and Watershed

In 1835, Ludwik Weslowski, a Polish surveyor and draftsman, "... scrutinized all of the Huron [presently Clinton] river and saw the river's numerous branches. Along the river route he saw the majestic oaks, maples, black walnuts, and whitewood [tulip trees], mentally evaluating such timbers for

construction of the [Clinton-Kalamazoo] canal" (Milostan 1976).

Oakland Township, much of which is drained by Paint Creek, was characterized as being timber covered, mostly by oaks, and having "perfect" drainage with several swiftly flowing streams and little marsh surface (Anonymous 1877). The Detroit Journal and Michigan Advertiser (Anonymous 1831a) mentions that in the forests of Oakland County "... the usual variety of timber found in all parts of the [Lower] peninsula may be obtained, as pine, whitewood, oak, ash, sugar maple, hickory, black walnut, chestnut, butternut...". In 1834, Second Lieutenant A. M. Lea of the United States Topographical Bureau described the country bordering the Clinton River between Rochester and its mouth as "generally dry, level and admirably adapted to agricultural purposes; its products are wheat, flour, Indian corn, oats, pork, beef, potash, and especially lumber, having some of the finest forests of oak and walnut perhaps in the [Michigan] territory" (Lea 1834).

Quite a different report (Anonymous 1877) was made for Royal Oak Township, which drains into the Clinton via the Red Run. The surface of the landscape was described as being "uniformly level", which concurs with the surface geology of the area. The soil is "below average of that of Oakland County in natural fertility and adaptation to the requirements of agriculture...originally this was heavily timbered country. When the government surveyors first penetrated the wilderness which embraced all this region, their judgment of it was very far from being a favorable one, and they did not hesitate to announce their opinion, based upon what they had seen here, and in the still more forbidding country which lay farther east and south, that the lands were irreclaimable, and must remain forever unfit for culture or white occupation, and that their obvious destiny must be to remain in the possession of wild beasts and aborigines." Shortly after receiving the surveyor's report, Lewis Cass led a party along the same route, passing through about 8 miles of forested wetland before reaching more well-drained lands.

Several reports mention the "openings", probably marshes (Mitchell 1992), along the river and throughout the watershed. A description of the upper mainstem in Pontiac Township in 1877 states that "there is a considerable amount of low bottom or meadow land along this stream, particularly between the built up portions of the city, and the lakes to the southwest, and also above and below the village of Auburn [the middle mainstem]" (Anonymous 1877). The abundance of meadows, likely marshes, is mentioned by the Detroit Journal and Michigan Advertiser (Anonymous 1831a) which states that "The county is about equally divided between timbered land and openings...In the vicinity of most of the lakes are extensive meadows, yielding from one and one half to three tons of wild hay per acre, which is of a very good quality, and on which cattle will do well. The wild meadows are not confined to the vicinity of the lakes, many very extensive ones being found on the shores of almost all of the large streams. For pasturage, perhaps no county in the [Michigan] territory excels that to be obtained two thirds of the year on all the openings."

Much of the mainstem of the Clinton River supported macrophyte growth. In Pontiac Township, "...during the warm months its channel is more or less filled and obstructed by water-plants and grasses" (Anonymous 1877). Samuel M. Leggett, one of Oakland County's old settlers, describes the Clinton and Huron rivers saying that "these rivers are in the summer dotted with the water-lily, as they flow on through the 'openings', and on their banks are huge old oaks under which, in the days that are gone, stood many a wigwam" (Seely 1912).

Second Lieutenant A. M. Lea (1834) gives a fairly detailed description of the lower mainstem: "...From Rochester to Mt. Clemens, 6 miles above the mouth, the river gradually widens, deepens, and grows less rapid, though in this distance there is fall enough to afford water power for several mills. The least depth, in a medium stage of the water is about 2 feet, so that it may be navigated at all times by boats of light draught. From Mt. Clemens to the mouth the

width is uniformly about 300 feet, and the current is barely perceptible. The channel gradually deepens, with a few slight exceptions, till within about a mile of the mouth it maintains a depth of 20 feet, thence it gradually grows more shallow, till it affords a depth of only 4 feet on the bar at the junction of the river with Lake St. Clair...There are three points in the river below Mt. Clemens, having a low water depth of only 5 feet, said to be formed by sunken logs, which would be easy to remove."

Descriptions of the seasonal flow characteristics for two stretches of the Clinton River mainstem were found in the literature. In July 1782, David Zeisberger, describes the area from the mouth of the river to near present day Moravian Drive on the west side of Mount Clemens: "Monday 21... Thus far we have found no place satisfactory to us, for all the land we have seen is too low, swampy, and exposed to overflow, though we landed several times and examined several places... We examined the 22d, further up the creek, and found on the south side of the river a fine place to lay out a town..." (Magee 1980). The area described lies along the mainstem below mouth of the North Branch, which drains a large area of lake plains having fine soils with low infiltration. As a result, the receiving waters of the mainstem would be subject to flooding during the spring and other periods of high precipitation. Lowlands adjacent to the lower mainstem would also have been inundated at these times. The upper mainstem, in Pontiac Township, however appeared to have been quite different: "...during the cooler months in the spring and autumn it is a remarkably clear and swift-flowing stream... Being the outlet of the group of lakes in the center of the county, its waters are not subject to floods, the large area of the water surface covered by lakes acting as an equalizing reservoir, and hence its flow is remarkably uniform at all seasons" (Anonymous 1877). The highly permeable soils of the upper mainstem's basin reduced the contribution of surface runoff to the stream's flow, while the lakes and marshes along is course slowed or stopped the stream's current allowing suspended particles to settle out of the water column. The soils and wetlands also allowed for more groundwater recharge, resulting in greater streamflows during periods of drought.

Nearly all literature we found commented on the swiftness of the river's current and its potential for, or use by, mills. The following statements from Anonymous (1877) clearly attest to the swiftness of the Clinton, which falls 200 feet over 79 miles between its headwaters in Independence Township and its mouth in Lake St. Clair. Regarding the upper mainstem in Pontiac Township, "For a stream of its size it affords a remarkable amount of water power, there being no less than six dams within the limits of the township, including five in the City of Pontiac". Regarding the upper mainstem in Avon Township, "...no less than six dams across it in the township". Regarding Stony Creek in Avon Township, "...very rapid and constant, and several dams breast its waters within the distance of a mile and a half". Regarding Paint Creek in Oakland Township, "...its course is marked by numerous little falls and a rapid descent, producing excellent water power". Statements from other sources are similar. "The waters of all the streams and lakes are very pure and brisk, well stored with fish. The outlets and inlets to the lakes are generally large and rapid... Mill privileges are almost innumerable, and owing to the course of the streams every part of the country can be accommodated whenever the settlements shall warrant the erection of machinery." (Anonymous 1831a). "...The River Clinton which passes through the townships of Pontiac and Oakland is perhaps one of the best streams for mills in the territory. There are now seven sawmills, three gristmills, a woolen factory, and two carding machines on this stream." (Anonymous 1831b). Hagman (1970) states, "wherever water flowed swiftly, pioneers dammed it and erected mills", and by 1840 there were nearly 40 mills in Oakland County. Figure 1 shows the location of many mill sites within the watershed. Figure 2 shows the function of several of the old mills in the Rochester area. Figure 3 provides some detail of millrace construction and size.

Human Development and Resulting Changes to the River

The first residents of the watershed apparently came from "a race, long since extinct, who were undoubtedly connected with the early civilization of Europe" (Seely 1912). Primitive tillage and industry occurred along the banks of the Clinton River south of the City of Rochester. Evidence of this consists of old tools and well defined rows of hills for hoed crops (corn and vegetables) which at the time of their discovery supported the largest oaks and other trees in the forest.

European Settlement 1782-1850

Unless otherwise indicated, all of the following information regarding the settlement and development of the Clinton River watershed was obtained from Willis (1987).

In the late 18th century, the first settlers arrived in Macomb County. The Moravian missionaries fled their Ohio settlement in 1782, during the Revolutionary War, because they were accused of being spies. Through negotiations with the British at Fort Detroit and the Chippewa Indians, they were allowed to settle on a high bluff overlooking the Clinton River near what is now Moravian Drive, just west of Mt. Clemens. The settlement consisted of 30 log houses and a Moravian temple. The Indians resented sharing their hunting grounds with the Moravians, and in 1786, pressured them into leaving.

In 1798, a military surveying party which was laying out a military road between Detroit and Port Huron, stopped for a short while at the old settlement. One of the members of the party, Christian Clemens, was impressed by the "rapidly flowing river alive with freshwater fish." Three years later, he purchased 500 acres, including the Moravian settlement, and called his new settlement "High Banks". After the War of 1812, "High Banks", which now contained almost 30 permanent homes, was platted and later became Mt. Clemens.

The opening of the Erie Canal in 1825 provided an easy route for many settlers from New York to reach southeast Michigan. By the mid-1830s Shelby and Washington townships and the Village of Romeo had been incorporated. "Pioneers settling in Warren Township and the Village traveled around a vast cranberry swamp, using the Clinton River and Red Run to reach tillable land. As the swamp was drained more settlers arrived and by 1850, 750 people lived in Warren."

The first white settlers came to Oakland County in 1817. James Graham and his family traveled westward from Mt. Clemens, "skirting the swampland", and squatted on land at the juncture of Paint and Stony creeks in what is now Rochester. "The Graham's found a land of virgin oaks, pine, elm, maple, and beech with three fast streams to provide power for a mill." Within 10 years several mills had been built near this site. The area grew rapidly and by 1836, every piece of land in Avon Township had been sold. At about the same time a group of men from Detroit formed the Pontiac Company, purchasing 1,440 acres at the junction of the Clinton River and the Saginaw Trail, and established Pontiac as the county seat. Several mills were also built there. Settlers continued to push north and west along the shores of the Clinton River, reaching Clarkston by 1830.

The Clinton-Kalamazoo Canal

With Michigan's admission into statehood in 1837, the new state legislature recognized a need to improve internal transportation. The Clinton-Kalamazoo Canal was selected as the state's first public works project. It was to provide a waterway, across 216 miles of dry land, between Lake St. Clair and Lake Michigan (Figure 4). From the eastern port, Mt. Clemens, farm products produced in the Clinton River watershed would be loaded on ships sailing the Great Lakes. From Pontiac westward, the canal would carry new settlers and supplies to the interior of the state and eventually connect with the "thriving" Lake Michigan port of Singapore (which is now a ghost town).

Singapore was to ship passengers and freight to Chicago. Only 12 miles of the canal (between Mt. Clemens and Rochester) were completed over a period of 4 years before the state treasury went into bankruptcy. Construction of the canal stopped, and the coming of railroads ended any future support for the canal.

Industrial and Residential Development 1851-present

Growth, spurred by an expanding system of plank (later gravel) roads and railroads, continued at a moderate pace during the next 100 years. Mills constructed earlier in the 1800s continued to provide an important source of power for industry in the late 1800s. Many mills were modified to produce products such as wool, paper, and agricultural implements. Mt. Clemens developed a prosperous "mineral bath" industry. Abundant hardwood forests and water resources drew wagon and cart makers to Pontiac. In the decade following the purchase of many car manufacturing companies by the General Motors Corporation during 1909 and 1910, the population of Pontiac increased from 14,532 to 34,173.

A human population explosion occurred in the watershed after World War II ended. Between 1950 and 1970, Macomb County's population increased from 185,000 to 625,000. Oakland County experienced even greater population growth. During the 1950s nearly 300,000 people entered the county, and another 511,870 arrived during the following 20 years. By 1980, its population exceeded 1 million.

Summary

A fairly clear picture of the Clinton River watershed emerges from these historical accounts. Nearly the entire watershed was covered with hardwood forests, which shaded much of the waters. The upper mainstem and Paint and Stony Creeks drained regions of coarse soils with high infiltration, so their flows were stable, containing a substantial proportion of groundwater. The contribution of surface runoff increased and flows became more unstable on the lower mainstem, which drained an area of glacial, lake-bed soils having low infiltration.

Many marshes were found in the watershed of the upper mainstem, and large tracts of forested and scrub-shrub wetlands probably occurred in the downstream areas of the watershed. The waters were clear in areas upstream of the Oakland-Macomb county line. Downstream waters, draining soils of low permeability, were probably more subject to turbidity at high streamflows.

Judging from the number of mills, high gradient stretches of stream were numerous, particularly along Paint and Stony creeks and the upper and middle mainstem of the Clinton. Areas with relatively high stream gradient historically supported mills (Figure 5). This is further substantiated by gradient measurements made from U. S. Geological Survey topographic maps. The streambed of these reaches was probably dominated by gravel, cobble, boulder, and organic debris; low gradient reaches would have contained a higher proportion of finer substrates.

The upper and middle mainstem, being warmed by lakes and cooled by groundwater, contained a coolwater fish fauna which required clear waters and coarse substrates. This includes fishes such as smallmouth bass and other centrarchids, darters *Etheostoma spp.*, suckers and minnows. The fish fauna of Paint and Stony creeks consisted of fishes such as sculpins *Cottus spp.*, dace, and chubs which require similar habitat conditions but colder water. By the 1880s, these creeks supported brook trout (*Salvelinus fontinalis*) populations, which originated from hatchery plants (Westerman 1974).

The lower mainstem (especially below Utica), the North Branch, and Red Run provided different conditions for fish. With their flows being dominated by runoff, these streams were warmer, had lower flow in the summer, and were more prone to flooding than other reaches. Fine substrates (silt and sand) were more common due to the extremely low gradient of these streams, and riparian wetlands were also abundant. These

reaches supported pikes, smallmouth bass, largemouth bass *Micropterus salmoides*, other sunfishes, suckers and minnows.

Judging from the relatively slow growth within the watershed during the years prior to World War II, the watershed probably remained in a fairly natural state, with a few exceptions. Land drainage for agriculture, which began as early as the 1840s, probably increased the flow "flashiness" and sediment load of the several downstream reaches (Red Run, the North Branch and the lower mainstem).

In sections of streams below towns and industries, pollution problems existed. By the mid 1800s Pontiac was already experiencing these problems, as the following quote shows. "In the spring (the Clinton's) floods [apparently the result of upstream mill operations] menaced a good part of the community and often did heavy damage... Discharges from the growing number of outhouses, and the practice of dumping dead animals, including horses, into the water, also made the river troublesome." Such occurrences were probably localized, and the overall degradation of the Clinton river system was most likely minor.

Rapid industrial and residential growth during the post-World War II decades had a major impact on the watershed. Development (paving) of headwater areas decreased soil permeability, causing increased flooding of areas downstream (Leopold 1968). Flooding became such a problem in Mt. Clemens that a 4 km spillway (the "Cut Off Canal") was constructed between the city and Lake St. Clair in order to carry away the floodwaters. In 1964, Pontiac solved its flooding problems by enclosing the Clinton in concrete culverts and burying it beneath the city. Such problems were quite a change for a reach of stream whose flow was once described as "remarkably uniform at all seasons." The Clinton River Remedial Action Plan (Anonymous 1988) lists the following additional problems for the "area of concern" (the mainstem below the mouth of the Red Run): contaminated sediments (heavy metals, PCB's, oil, and grease); degraded biota; low dissolved oxygen; sedimentation; and excessive nutrients, pesticides, and fecal coliform.

Changes in Aquatic Biota

Fish

The letters of Father Pierre Dejean (1825-26) mention that in the Clinton River, one fishes for "sturgeon, trout, carp [likely suckers], pike—this last fish is dull and tasteless" (Dejean 1986). The mention of trout may refer any of a variety of species including lake trout (*Salvelinus namaycush*), which occasionally stray into the lower river (Smith et al. 1981), largemouth bass ("trout" in the southern United States), or walleye, which Pennsylvania anglers refer to as "Susquehanna salmon" (R. Clark, MDNR, Ann Arbor, personal communication). Life-long Oakland County resident, Ray Russel said that his grandfather told him of spearing sturgeon in the Clinton below the village of Rochester in the 1880s. Most mentions of fish in the historical literature were of a general nature such as, "[the streams are] well stored with fish" (Anonymous 1831a) or we "caught a mess of fish" (Zeisberger 1885). Appendix A lists fish species found in the Clinton River system between 1900-50 (University of Michigan Museum of Zoology records), and those found during a recent, comprehensive survey done by Smith et al. (1981).

Little information on the early fish fauna of the Clinton was found in the archaeological literature. Wayne State University archaeology professor Dr. Arnold Pilling stated that historical records on Clinton River fishes are "unbelievably absent... probably due early habitat damage" i.e. development within the watershed. He also mentions that there are few archaeological dig records because the sandy soils of the area do not preserve bones well.

Fitting (1965) found bones from at least 21 walleye and 1 freshwater drum *Aplodinotus grunniens* at a dig site located along the Clinton River, approximately 1.75 mi east of Mt. Clemens. The site was used between 1000-1200 A.D. and again around 1400 A.D.

At this time, Native Americans may not have had technology (trap or gill nets, hooks and lines) for fishing in waters that were more than a few feet deep. The size and uniformity in size of the walleye (9 fish 14.7-16.2 in, 9 fish 16.2-18.3 in, and 3 fish >18.3 in) led Fitting to conclude that these fish were collected during the spring spawning migration from Lake St. Clair.

The University of Michigan Museum of Zoology has no record of walleye in the watershed between 1900 and 1950. Perhaps the construction of mills and dams in the 1880s prevented the passage of spawning walleyes to the extent that a potamodromous Clinton River stock was eliminated. Currently, walleye do inhabit the river, and their presence is likely the result of recent walleye stockings (the North Branch was stocked annually from 1975-81) and improved water quality conditions in the last several years. Given that walleye formerly resided in the Clinton river system, restoration of a self-sustaining walleye population in the Clinton appears to be a reasonable goal for fisheries managers.

Urban and industrial development within the watershed during the past century has altered the fish community. For example, a recent survey of the lower mainstem by Smith et al. (1981) failed to collect 3 fish species (central mudminnow *Umbra limi*, grass pickerel *Esox americanus*, and brook stickleback *Culea inconstans*) which require slow, weedy areas for spawning. University of Michigan Museum of Zoology records show these species being present in this area prior to 1950. Their disappearance may reflect the loss of this habitat. In their study of the Huron River in southeast Michigan, Yant and Humphries (1978) found that fish species requiring clean gravel substrates or rooted aquatic vegetation at some time in their life histories had declined in abundance, apparently due to the loss of some of these habitats.

Mussels

Strayer (1980) did an intensive survey of mussels in the Clinton River system. He found that the Clinton contained the second highest number of species in the Great Lakes drainage. Seven of these species are listed as rare, threatened, or endangered in Michigan. He reported that four species (*Cyclonaias tuberculata, Obovaria subrotunda, Ligumia recta*, and *Ligumia nasuta*) are now apparently extinct from the Clinton system. These four species resided in the lower mainstem prior to 1935 according to University of Michigan Museum of Zoology records. Unfortunately, little is known about the life history of mussels at the species level (R. Hoeh, University of Michigan, personal communication). Further research into their life histories may provide a better picture of the habitat conditions in this stretch prior to man's settlement.

Urban pollution apparently has a negative impact on mussel populations. Strayer (1980) found that all stream reaches in the Clinton system subjected to urban pollution lost their mussel faunas, whereas those free of urban pollution (though they may have been disturbed in other ways) still contained dense and diverse beds of mussels. Many sites which he sampled in 1977-78 still had their original faunas. These areas included most of the North Branch, Stony Creek, and the upper mainstem drainages. Habitat information from these areas can probably be used to visualize what some of the more degraded stream reaches should look like.

Application to Watershed Management Plans

We developed several possible goals for a watershed management plan. First, the upper mainstem and Stony and Paint creeks have fairly permeable soils and abundant groundwater which produce stable streamflows and cool, stable water temperatures. Wetland draining, paving of land, and lake-level control structures, particularly in the upper mainstem, have caused increased flooding and fluctuating water temperatures.

Goal #1. Prevent further destabilization of flows and increase flow stability by protecting existing groundwater recharge areas, and by encouraging stormwater management through development of retention that emphasizes infiltration (Bobrin 1992). Manage flows at lake control structures to simulate natural conditions.

Second, the middle mainstem and Paint and Stony creeks feature numerous high gradient areas. In addition to their aesthetic appeal and recreational value, these reaches are quite valuable from a fisheries perspective. They provide high quality summer habitat for desirable fishes and would serve as excellent spawning areas for potamodromous fishes.

Goal #2. Identify, protect, and consider restoration of high gradient reaches, especially those which are most accessible to potamodromous stocks.

Third, the lower mainstem and its tributaries, the North Branch and Red Run, had naturally unstable flows, low summer flows, and received little groundwater because they drained areas of impermeable soils. Some of the greatest values of these reaches were the swamps and marshes for spawning and water filtration. Urban and agricultural development have eliminated most of these wetlands.

Goal #3. Restore or create riparian wetlands in areas where possible.

Goal #4. Address erosion of sediment into streams through non-point source pollution management, best management practices (Bobrin 1992), riparian buffer strips, and so on.

Potamodromous migrations of fish into Great Lakes streams were spectacular, with large runs of sturgeon, lake trout, suckers, pike, muskellunge, and walleye. Many of these and others have been recorded from other streams in the Clinton River area (Trautman and Gartman 1974, Clark and Allison 1966). Schnicke (MDNR, Crystal Falls, personal communication) reports that runs of additional species, including smallmouth bass, yellow perch *Perca flavescens*, white bass *Morone chrysops*, lake whitefish *Coregonus clupeaformis*, lake herring *C. artedi*, and round whitefish *Prosopium cylindraceum*, currently occur in the Menominee River. The Menominee River was less impacted by human development than the Clinton. Many of these species were originally present in the Clinton River, so it seems possible that they could have used the Clinton for migrations also, at least to a greater extent than at present.

Goal #5. Develop productive potamodromous runs of desired fish species by removing barriers to migration restoring spawning areas.

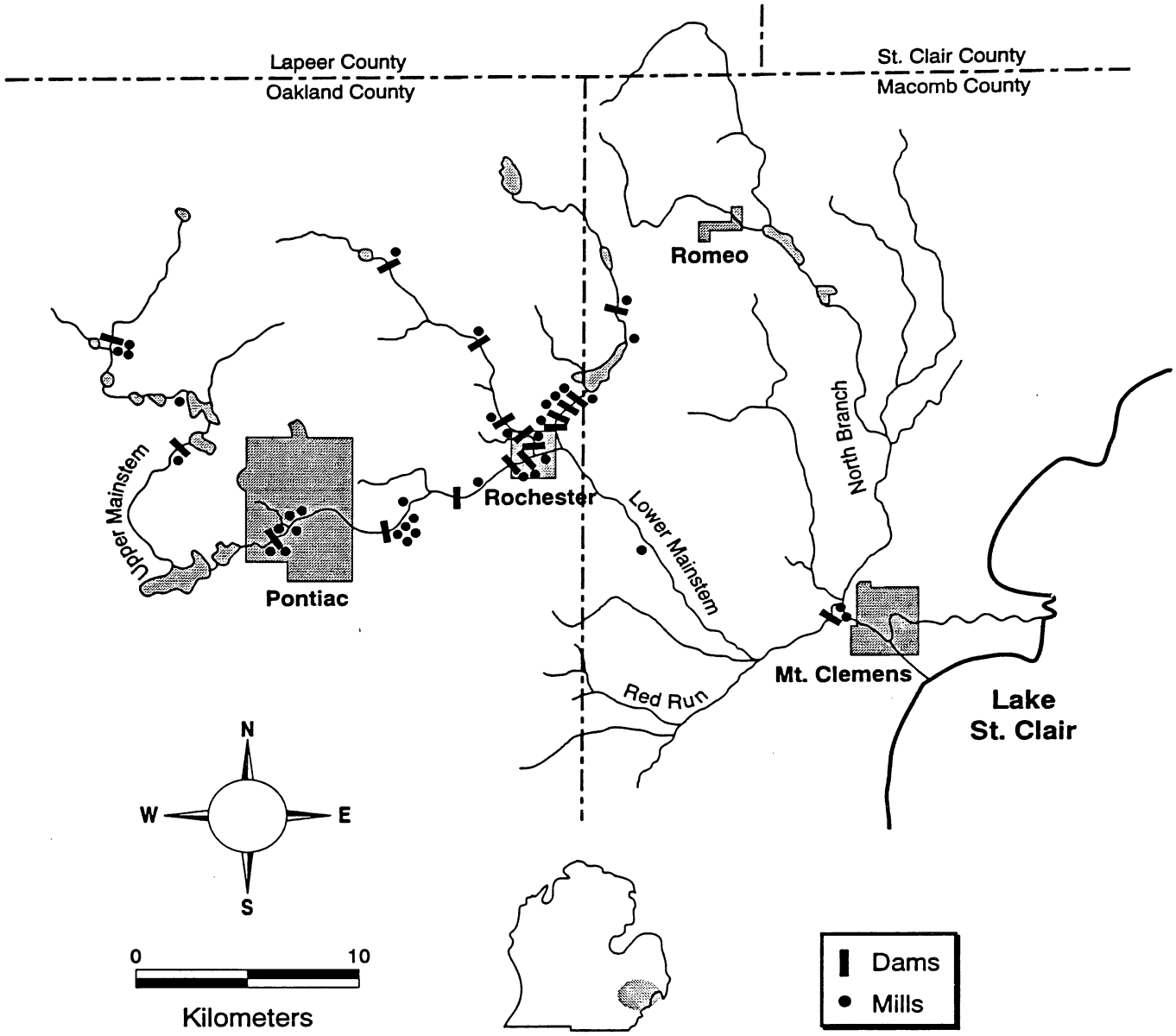


Figure 1.—Map of the Clinton River system in southeast Michigan showing the locations of some former dams and mills.

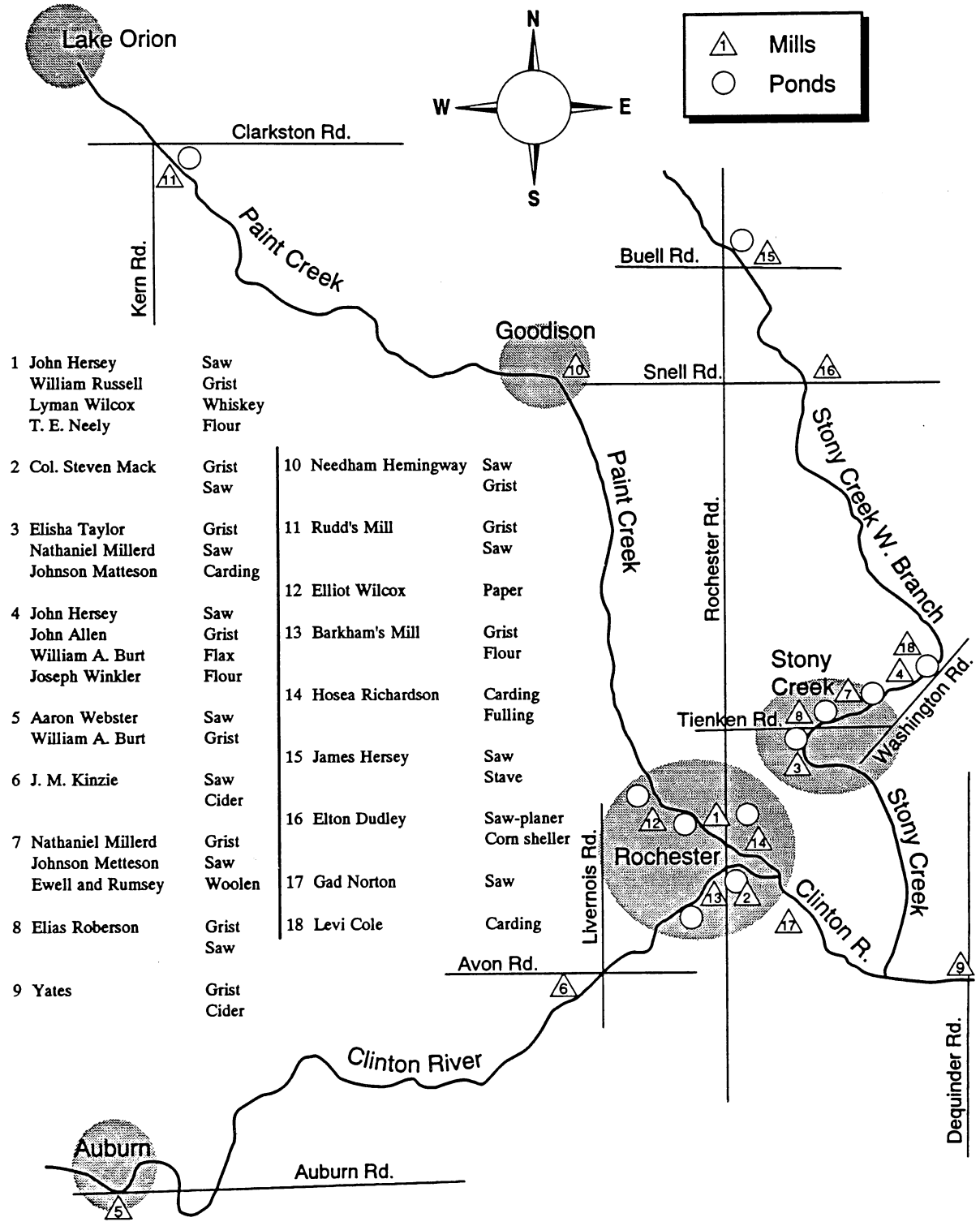
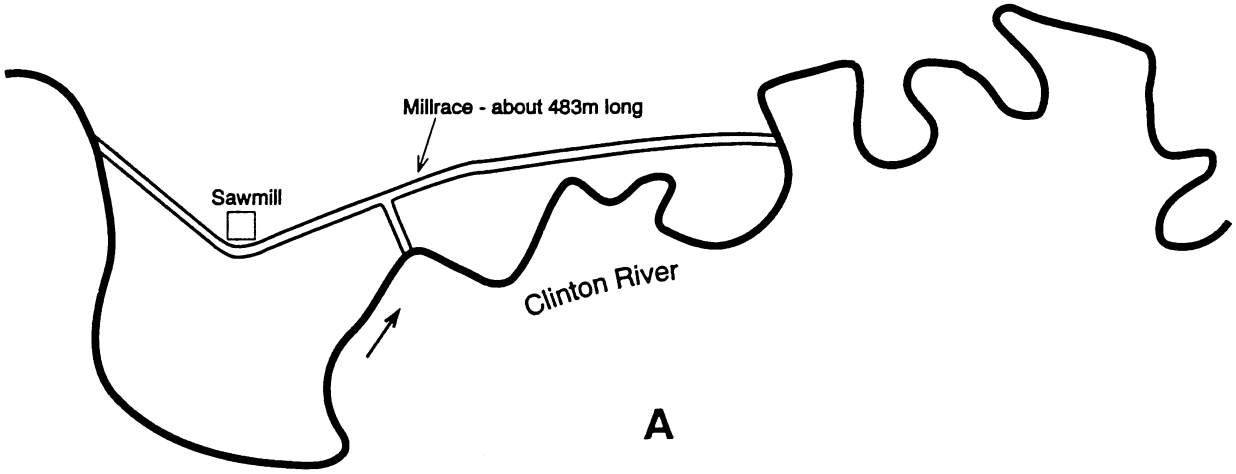


Figure 2.—Functions of eighteen early mills in the Rochester area, with names of owners and locations. The map is not to scale. Courtesy of Merritt Romine, Rochester Historian.



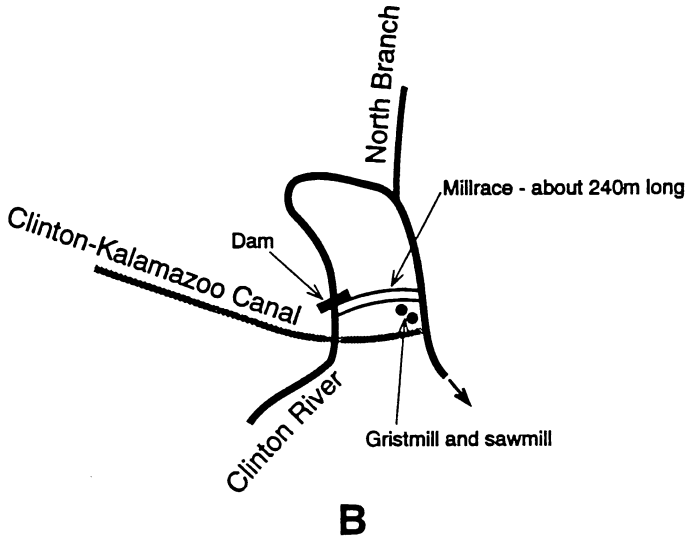


Figure 3.—Detail of two millraces along the Clinton River. (A) The Sheldon's sawmill in Section 14 along the river (probably T2N R12E Sec. 14, Macomb County). (B) Mills near the junction of the Clinton River and the North Branch. Courtesy of Michigan History Division Archives.

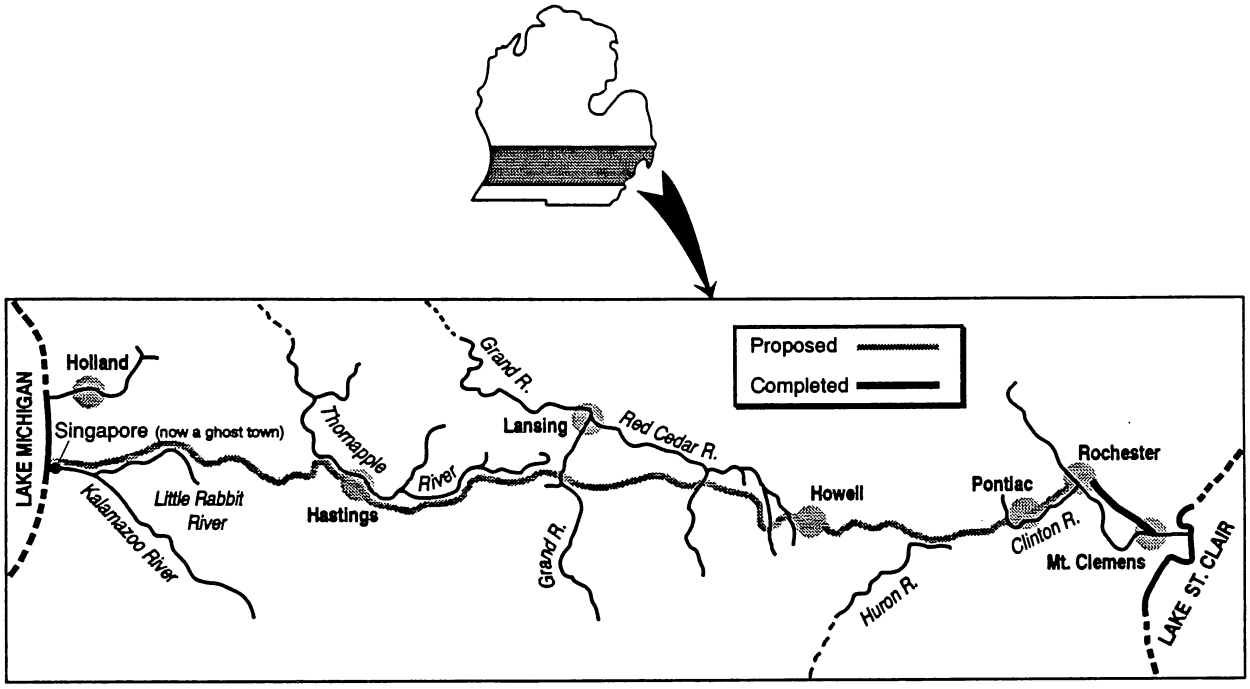


Figure 4.—Proposed route of the Clinton-Kalamazoo Canal.

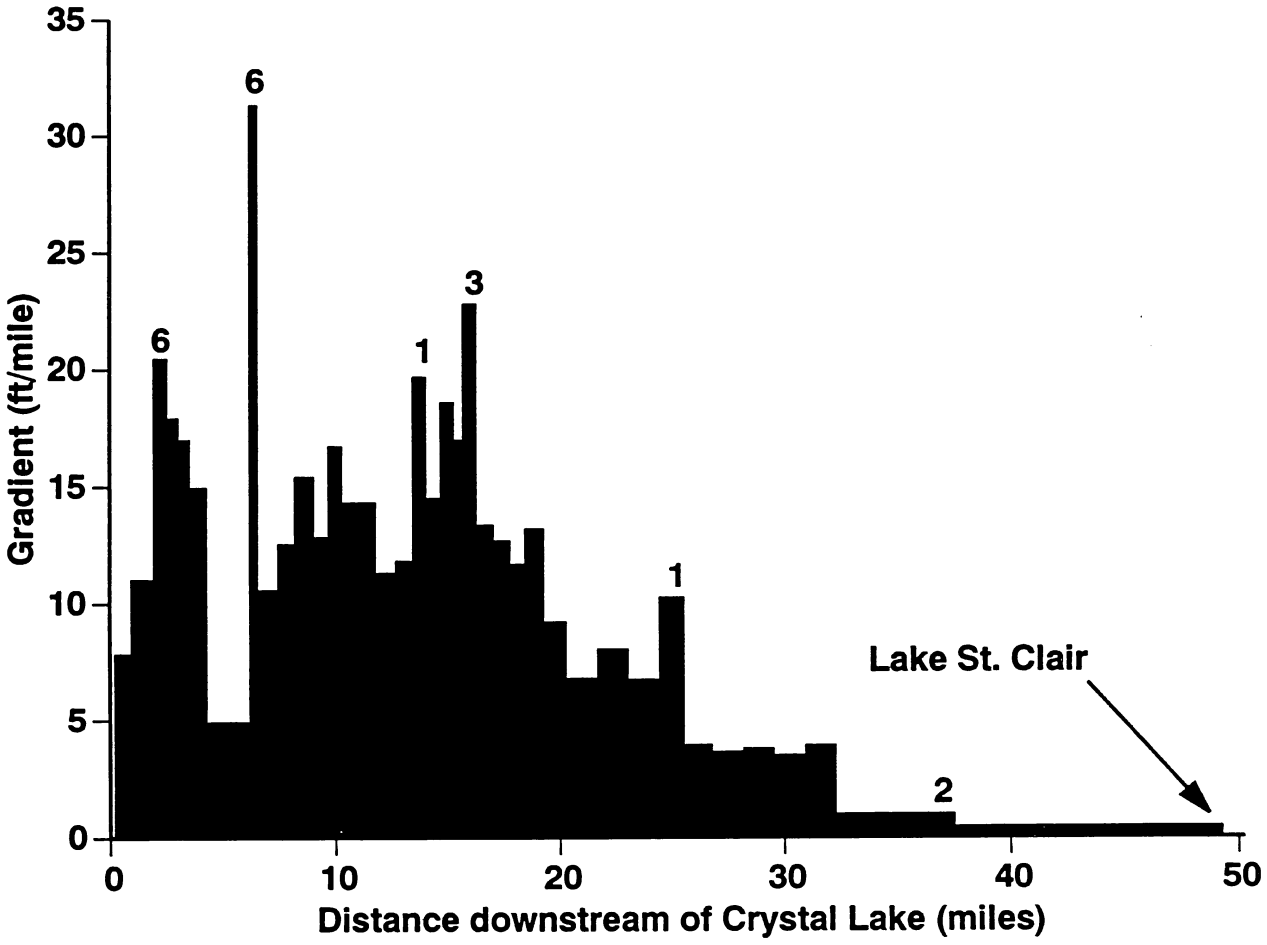


Figure 5.—Gradient of the Clinton River from Crystal Lake (in Pontiac) to Lake St. Clair. Bars represent gradient at 0.25-mile intervals along the river. Numbers above the bars indicate the number of mills located within the stream reach.

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Appendix A.—Species found in the Clinton River watershed between 1900-1950 (The University of Michigan Museum of Zoology records) and in 1981 (Smith et al).

Species	Common name	1900-50	1981
Ichthyomyzon fossor	northern brook lamprey	x	
Ichthyomyzon unicuspis	silver lamprey	x	
Petromyzon marinus	sea lamprey	x	
Lepisosteus osseus	longnose gar		x
Amia calva	bowfin	x	
Oncorhynchus mykiss	rainbow trout	x	
Salmo trutta	brown trout	x	x
Salvelinus fontinalis	brook trout	x	
Catostomus commersonni	white sucker	x	x
Hypentelium nigricans	northern hogsucker	x	x
Minytrema melanops	spotted sucker	x	
Moxostoma anisurum	silver redhorse	x	x
Moxostoma duquesnii	black redhorse	x	x
Erimyzon sucetta	lake chubsucker		x
Campostoma anomalum	common stoneroller	x	x
Carassius auaratus	goldfish	x	x
Chrosomus eos	northern redbelly dace	x	x
Rhinichthys atratulus	blacknose dace	x	x
Cyprinus carpio	carp	x	x
Pimephales notatus	bluntnose minnow	x	x
Pimephales promelas	fathead minnow	x	x
Nocomis biguttatus	hornyhead chub	x	x
Nocomis micropogon	river chub	x	x
Semotilus atrocmaculatus	creek chub		x
Notemigonus crysoleucas	golden shiner	x	x
Notropis atherinoides	emerald shiner	x	
Notropis chrysocephalus	striped shiner	x	x
Notropis cornutus	common shiner	x	x
Notropis stramineus	sand shiner	x	x
Notropis heterodon	blackchin shiner	x	x
Notropis heterolepis	blacknose shiner	x	x
Notropis hudsonius	spottail shiner	x	x
Notropis rubellus	rosyface shiner	x	x
Notropis spilopterus	spotfin shiner	x	x
Notropis umbratilis	redfin shiner	x	x
Notropis volucellus	mimic shiner	x	x
Ictalurus melas	black bullhead	x	x
Ictalurus natalis	yellow bullhead	x	x
Ictalurus nebulosus	brown bullhead	x	x
Ictalurus punctatus	channel catfish	x	
Noturus flavus	stonecat	x	x
Esox lucius	northern pike	x	x
Esox masquinongy	muskellunge	x	

Appendix A.—Continued:

Species	Common name	1900-50	1981
Esox americanus	grass pickerel	x	x
Umbra limi	central mudminnow	x	x
Fundulus diaphanus	banded killifish	x	x
Fundulus notatus	blackstripe topminnow		x
Roccus chrysops	white bass	x	
Etheostoma nigrum	johnny darter	x	x
Etheostoma flabellare	fantail darter		x
Etheostoma blennoides	northern greenside darter	x	x
Etheostoma exile	Iowa darter		x
Etheostoma caeruleum	rainbow darter	x	x
Percina caprodes	logperch	x	x
Perca flavescens	yellow perch	x	x
Stizostedion vitreum	walleye		x
Ambloplites rupestris	rock bass	x	x
Micropeterus salmoides	largemouth bass	x	x
Micropterus dolomieux	smallmouth bass	x	x
Lepomis cyanellus	green sunfish	x	x
Lepomis gibbosus	pumpkinseed	x	x
Lepomis macrochirus	bluegill	x	x
Lepomis megalotis	longear sunfish	x	x
Pomoxis nigromaculatus	black crappie	x	x
Cottus bairdi	mottled sculpin	x	x
Labidesthes sicculus	brook silverside		x
Culaea inconstans	brook stickleback	x	x